Sustainable Wastewater Management Project

Construction and Operation of Telavi Wastewater Treatment Plant (with a Design Capacity of 14 400 m³/d)

Environmental Impact Assessment Report

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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 Due to outdated and faulty infrastructure, the water resources are irrationally used, and as a result of improper wastewater management and absence of treatment facility, in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 two wastewater treatment plans (WWTPs). Present EIA report is for the construction and operation of Telavi WWTP with the capacity of 14 400 m^3/d.

This subproject will improve wastewater management: Wastewater discharge will be provided in one point of the surface water body (Alazani 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 Framework:

EIA report of Telavi WWTP was prepared out on the basis of the national legislation, as well as the safeguard policies of the WB The Law of Georgia on Environmental Permit is the main piece of the national legislation that framed the EIA process. This law stipulates that "arrangement of a wastewater treatment plant with a capacity of 1000 m^3 and above, and of the main sewer is subject to ecological expertise and the issuance of an environmental permit. According to the WB OP/BP 4.01 Environmental Assessment, the subproject for the construction and operation of Telavi WWTP was classified as the environmental category B and Environmental Impact Assessment procedure should be implemented accordingly.

EIA Objectives:

The objectives of EIA for the construction and operation of Telavi WWTP is: assessment of the scale and extent of negative impacts considering the on-site baseline conditions and the project design; 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)

The current unorganized situation of wastewater management was considered. Due to the discharge of untreated wastewater into Alazani river, the natural environment and the human health is exposed to

serious threat. The implementation of the subproject and normal operation of treatment facility will significantly eliminate the poor sanitary condition and improve qualitative value of some receptors. In the result, living standards of local population will be raised. Therefore, no action alternative was rejected.

Location Alternative 1:
The area of the old existing WWTP in the North of Kondola village of Telavi municipality was the first location considered for the construction of the new plant. It was already used for analogous purposes (old WWTP operated on this area) and construction works will not increase the environmental footprint of the WWTP. Also, the land under the dilapidated former WWTP is in the ownership of UWSC of Georgia (nowadays, equitable servitude is transferred to Municipal Development Fund LEPL) and the project implementation will not require any type of involuntary resettlement.

Location Alternative 2
Agricultural lands in the north-west of Kondola 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.

Technological alternatives
Three main technological alternatives were considered in the process of EIA, mainly: I – arrangement of individual treatment units; II - Biological treatment using the phyto-depuration method, which considers water treatment in the canal and pond systems, and III - Biological treatment in a WWTP using 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. Additional options of the chosen alternative were discussed and on the basis of analysis, the alternative of using anaerobic tanks and trickling filter was adopted.

Subproject Description

The selected location for Telavi WWTP is the area of the old treatment plant situated on the right bank of the Alazani River. The area of the territory is 86 426 m^2 (about 8.64 ha) and it is located 356m a.s.l.

The secondary vegetation cover is presented within the area – it is heavily anthropogenous and altered habitat; Original state of the forest is disrupted; therefore the habitat has no high conservative value.

Implementation of the subproject is divided into two stages: at the first stage, arrangement of infrastructure facilities that will provide wastewater treatment from suspended solids, BOD and COD, in 2030. At the second stage, additional infrastructure facilities will be arranged, as a result, it is expected wastewater treatment 2030-2040. Additional removal of nitrogen and phosphorus will be provided at that point.

At the first stage, the treatment plant will be equipped with following infrastructure: anaerobic tanks, trickling filters, secondary sedimentation tanks, sludge dewatering on sludge drying beds etc. At the second stage, anaerobic tanks will be added and removal of nitrogen and phosphorus will be added.

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, demolition and 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 phas. About 15-20 people will serve the WWTP, who work according to 8 hour work shift.

Baseline Conditions:

From administrative point of view, subproject area belongs to Telavi municipality, Kakheti region, and as to the physical-geographical zone, the area is situated within western part of Alazani or Kakheti plain.

There is humid subtropical climate in the construction area. The area is characterized with cold winter and hot summer. Average annual temperature is 11-12^0 C, number of precipitation is 700-800mm/y.

Alazani Velley is accumulated and it is situated between Gombori range and Iveri Plateau. Its length is about 110km and situates a.s.l 200-470m. Relief of the wastewater treatment construction area is straight; slightly sloping toward the river Alazani. It is situated 350-360m a.s.l.

Quaternary sediments are formed within the selected area that is represented with clays, clayey, pebble soil. Ground seismisity is defined by 9 points. 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 9.5-10.5 m.

One of the main rivers of the east Georgia, Alazani, is the nearest river to the study area and at the same time it is enough wastewater receiver river. The river consists of different type of water (underground, rain and snow waters). Discharge of the underground water is about 40%, rain and snow water – 30-30%. Flooding takes place in the first part of spring and summer and overflow is presumable in autumn. The area is situated 1.0-1,2km from the active river-bed. During the flood risk of inundation is very low.

Secondary landscape under heavy anthropogenic load is developed here. Vegetation cover is rather dense, but cannot be considered as of high conservative value according to specie composition. Following species dominate from trees: Poplar *(poplus hybrida),* Black poplar *(Poplus Negra),* the Common Alder *(Alnus barbata),* white willow *(Salix alba, S. Caprea)* dominate the area. Most part of the territory is presented by low conservation value liana and thorny shrubby plants: goat-leaf honeysuckle (*Lonicera caprifolium*), common ivy (*Hedera helix*), greenbriers (*Smilax excels*), Old man's beard (*Clematis vitalba*), silkvine (*Periploca graeca*). Gleditsia (*Gleditschia triacanthos*) blackthorn (*Prunus spinosa*), blackberry (*Rubus*), Oriental Hornbeam (*Carpinus orientalis*) and Hawthorn (*Crataegus sp*).

Following mammal species are distributed in the adjacent forest zone: wolf (*Canis lupus),* Jackals – *(Canis aureus)*, Pine marten – (*Martes martes)*, least weasel – (*Mustela nivalis)*, fox – *(Vulpes vuples)*, Badger –(*Meles meles).* Directly the project area is very favorable habitat for small animals, such as: European Hedgehog – (*Erinaceus concolor)*, Caucasian mole – (*Talpa caucasica)*, Small Forest Mouse – (*Sylvaemus uralensis),* Common Toad – (*Bufo bufo),* Forest Fog – (*Rana rididunda),* etc. Following bird

species can be observed on the area: Jays – (*Garrulus grandarius),* common blackbird – (*Turdus merula)*, Wood pigeon – (*Columba palumbus)*, great tit – (*Parus major),* Magpie – (*Pica pica*), Rook – (*Corvus frugilegus*), Spades – (*Corvus cornix*), etc.

The riparian line of the river is favorable living environment for Common Otter – *(Lutra lutra)*, which is enlisted in the Red List of Georgia. Otter is especially attracted by fish ponds, located in 1,0-2,0 km to the east of the project area, and which does not get within the impact zone. The project area itself and other project impacted sites (water conveyance pipeline corridor) are not permanent habitat for otter. According to field work results, areas, favorable for bat shelters are not got within the project impact zone.

Protected areas are in significant distance from the allocated area and risks of direct impact on them is at minimum.

There are no historic-architectural monuments on the WWTP area and its surroundings.

EIA Methodology:

The assessment methodology of possible environmental impact of the subproject was developed based on the guidance of the WB and the national regulatory framework.

The values for qualitative indicators of the environment (air, water, soil, etc.) established in regulatory documents of Georgia, EU and the WB Group, 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.

Expected Environmental Impacts and Mitigation Measures:

Emission of harmful substances to ambient air: in the construction phase, that lasts about 12 months, the main source of emission 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.

Modeling, carried out as part of the EIA, showed that in WWTP construction and operation phases, the ambient air pollution won't exceed maximum allowable concentrations established by regulatory document (order #38 dated February 24, 2003 of the Minister of Labor, Health and Social Affairs "On approval of the norms of qualitative state of the environment), within 500 m zone. The distance from the nearest residential house is 3.7 km. So, changing of ambient air quality is not expected on construction and operation phases.

In order to protect ambient air quality, appropriate mitigation measures have been developed for the construction and operation phases. Mitigation measures in construction phase include: proper maintenance of the machinery; regulating speed of the traffic movement; and covering materials from where the dust can be easily spread. Due to the long distance from the human settlement (3.7 km and more), there is no necessity of any special mitigation measures for reducing impact caused by odor nuisance.

Noise propagation: WWTP construction is likely to impact baseline noise. The main receptors of the negative impact connected with the noise will be wild life and workers. Distance from the local's settlement is long (3.7 km and more), accordingly, there are no risks of negative impact caused by noise.

In the operation phase, the main sources of noise propagation are engines and in case of necessity, operation of diesel-generator. In such case main impact receptor is wild life.

With ensuring proper maintenance of machinery, implementation of 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: River Alazani is in 1.0-1.2km distance from the project area, so there are no high risks of water body pollution on construction phase.

During assessment of possible impact in operation phase, it is crucial to consider current negative condition, in particular: Due to the improper management of wastewater in Telavi city and the adjacent settlements, there is significant negative impact on the local surface water, including Alazani River. Untreated wastewater is discharged in several points of the river. Project implementation (in case of normal operation) will positively affect local water quality. It is noteworthy that based on the corresponding calculations within the EIA, the impact scale on Alazani river water quality in normal operation conditions of WWTP has been determined. According to calculations in both phases of the subproject, negative impact on Alazani 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 in operation phase, the monitoring will be set on the efficiency of wastewater plant operation and in case of failure, corresponding corrective measures will be carried out. Systematic control will be established on implementation of requirements considered by Waste Management Plan.

Impact on ground water: Deterioration of ground water 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.

In the operation phase risks of ground water pollution is low and there is no necessity of implementation any mitigation measures.

Impact on soil stability and quality: 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 removed 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.

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.

Visual impacts of landscape alteration: 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, the

distance from the population is quite large (3,7 km and more) and the project area does not get within the vision. Therefore, there will be no negative visual impact on the local population. After the completion of the construction, machinery, material and waste will be removed from the construction site. Reinstatement of the area is envisaged.

Impact on biological environment: The similar WWT plant used to operate on the selected area for years and the vegetation cover is secondary here. About 415 trees and shrubs will be cut during construction. Majority of them will be low value species, such as Gleditsia (*Gleditschia triacanthos*) blackthorn (*Prunus spinosa*), blackberry (*Rubus*), Oriental Hornbeam (*Carpinus orientalis*) and Hawthorn (*Crataegus sp*). It should be noted that Red List species - Common walnut *(Juglans regia)* and Grayish oak (*Quercus pedunculiflora)*, identified during the field works will not get within the project impact zone. As a whole, the project does not consider cutting species of significant value and possible impact on the vegetation cover may be assessed as "moderate". Re-cultivation works considered after completion of the construction will partly mitigate the impact. In the operation phase, direct impact on the vegetation cover is not possible.

Impact on animals is possible as a result of noise, dust and cut of trees. Direct impact is also possible (e.g. damage of nests, accidents, falling in holes etc.). In the result of the construction, which envisages trees and vegetation cleanup, living environment of certain habitats will be restricted, such as: Hedgehog – (*Erinaceus concolor)*, Caucasian mole – (*Talpa caucasica)*, Small Forest Mouse – (*Sylvaemus uralensis),* Common Toad – (*Bufo bufo),* Forest Fog – (*Rana rididunda),* etc. However, it should be noted that animal migration to far distances will not take place. They will be able to find suitable living conditions in the direction of riparian areas of Alazani river, where trees and vegetation cover is dense enough and free from impact of agricultural activities of people. It should be highlighted that due to intensive agricultural activities on adjacent areas, habitats for species distributed in the region and included in the Red List of Georgia, are not got within the project impact area; such species are: wolves – (*Canis lupus),* Common Otter *(lutra lutra),* thus direct impact on them is not anticipated. Construction works will have an impact on following bird species: Jays – (*Garrulus grandarius),* common cuckoo – (*Cuculus canorus)*, common blackbird – (*Turdus merula)*, Wood pigeon – (*Columba palumbus)*, great tit – (*Parus major),* Magpie – (*Pica pica*). According to surveys, Red List bird species (eagle, falcon) have not been identified within the area and direct impact on them is not expected. Taking into consideration aforementioned, construction works will not have an impact on critical habitats and the impact can be assessed as "**moderate**".

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 Alazani river. Following species can get within the impact zone: Alazani Nase – (*Ghondrostoma nasus)*, ray-finned fish – *(Barbus mursa)*, Barbel – (*Barbus capito),* Sevan khramulya – (*Varicorhinus capoeta)*, Barbel – (*Barbus barbus)*, etc. In order to reduce such risks, special attention should be paid to following of WWTP operation technological scheme. Red List specie of Georgia – brook trout *(Salmo fario)* does not inhabit within the potential impact zone and impact on this specie is not anticipated. In normal operation conditions of WWTP the likelihood of impact on fish fauna and in general, on wildlife is insignificant. Positive effects are expected, as discharges of untreated wastewater into the river will be eliminated and living conditions will be improved for certain species.

Due to the significant distance from protected areas, the impact on them is not expected.

In the operation phase, impact on wildlife is expected in case of violation of technological process of WWTP and accidental discharge of untreated wastewater into one point of Alazani river .

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 (3500-4000 m^3) generated in the result of demolishing works and sludge (≈3688 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 Telavi 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 sanitary landfill. In prospect this issue can be reviewed. Sludge disposal conditions (issues of sludge delivery and disposal to Telavi landfill near Gulguli village) is agreed with Solid Waste Management Company of Georgia.

Total storage volume of sludge drying beds is 2903 m^3. According to the project annual production of sludge is 3688 m^3. Accordingly, temporary storage of sludge is possible for maximum 287 days. However, the off-site sludge disposal will be organized on a regular 3 or 4 month basis, such that the disposal trips will be conducted about once per season. It is supposed to use 10 m^3 capacity dump trucks (with canvas top) for sludge transportation, to avoid sludge scattering or dusting risks during transportation process. Sludge must be loaded on trucks using auto-loader. Annual transportation cost for sludge transportation, generated during Telavi WWTP operation will be 37000 GEL (15400 USD). Based on active tipping fees for sludge disposal on landfill, overall cost for disposal of sludge, generated during operation of Telavi WWTP will be 74 000 GEL (30 800 USD). Overall cost for sludge transportation-disposal will be about 111 000 GEL (46 000 USD).

Impact on Social-economic Environment: The project area is within 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.

On construction phase (mostly during preparatory works) traffic movement will be intensified, and this can cause dissatisfaction of local population. 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.

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. Mitigation measures of the operation phase, as defined in the Environmental Management Plan, will be applied by Telavi Regional Service Center. An environmental supervisor will be assigned by central office of the Company.

Stakeholder Engagement and Grievance Mechanism:

Stakeholders engagement will be provided in decision-making process, as well as in WWTP construction and operation phases with consideration of World Bank Policy and national legislation requirements and according to 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, numerous sewer networks collect wastewater and concentrate, 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 subproject of Telavi Wastewater Treatment Plant (with a design capacity of 14400 m^3/day) is envisaged. The implementing agency of the mentioned investment sub-project is Municipal Development Fund of Georgia LEPL.

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 subproject 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.

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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 (except Tbilisi, Georgia, Mtskheta, Georgia, 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 Telavi.
Executive director	Ilia Darchiashvili
The contact person	Ana Rukhadze
The contact number	(99532) 2437001; 2437002; 2437003; 2437004
Fax	(99532) 2437077
E-mail	mdf@mdf.org.ge
The consulting company	Gamma Consulting Ltd
The director 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 subproject 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 1000m^3/ 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 Telavi 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 description of national environmental laws that should be considered during the environmental impact assessment of the project on the construction and operation of Telavi treatment plant:

Law of Georgia on Protection of Environment (adopted in 1996; final version adopted by the parliament - 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 (approved 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.

As it was mentioned in paragraph 1.2., 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 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 Telavi 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 working days after the registration of the application, only in case of positive conclusion.

Law of Georgia on Ecological Expertise (approved 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 Telavi WWTP subproject will be issued on the basis of positive conclusion of ecological expertise. The process is carried out 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 (approved 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 (approved 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. Everyone 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; amended - 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 (approved 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 Telavi 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 Telavi 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 Telavi 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 Telavi 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 Telavi 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. Within EIA process of Telavi WWTP subproject, water sampling from Alazani River, transportation, storage and conservation of water samples will be carried out in accordance with the requirements of the technical regulation.

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 Telavi 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).

Treated wastewater from Telavi WWTP will be discharged in Alazani river, which is trans-boundary river. Therefore, WB operational policy - OP/BP 7.50 Projects on International Waterways - is triggered by the Sustainable Wastewater Management Project. Identified subproject has been examined to see if any measurable qualitative and/or quantitative positive or negative changes may be caused to water flow of the international waterways as a result of their implementation and whether subproject information should be communicated to the riparian countries

WB operational policy OP/BP 4.11 - Physical Cultural Resources - is triggered to ensure that if construction works are to be undertaken in the proximity to cultural and historic heritage sites, they do not affect structural stability of the existing constructions and do not depreciate historical and aesthetic value of 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 Telavi 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 Telavi 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 applied to the given subproject.

The World Bank operational policies also require that all investment designs 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 Gaps between 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 a zero alternative implies refusal to the project implementation, therefore the problem related to wastewater management in Telavi and its surrounding settlements will remain unresolved.

The Government of Georgia, with the assistance of international finance organizations intends to improve the wastewater drainage system and construct the treatment plant in significant towns of the regions. Creating the adequate wastewater treatment and drainage infrastructure will make an important positive effect in terms of further development of the settlements, attracting the investments, increasing the tourism potential and the living standards of the local society. Consequently the implementation of such projects will be a significant contribution for social-economic development of the country.

The construction and operation project of Telavi wastewater treatment plant is the most important component of this program. Currently there is practically no organized management of wastewater generated in Telavi. In some cases, population uses sanitation pits, while more frequently wastewater is discharged into nearby surface water bodies (natural ravines, irrigation canals and Alazani River) without any treatment. These results in 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 activity in terms of environmental protection, can practically fix the existing unsatisfactory situation. In addition, project implementation will contribute to the development of local socio-economic conditions.

All the above mentioned suggests the following: In case of the project failure, neither the normative treatment of the wastewater in the mentioned settlement, nor minimizing the risks of surface water pollution will be possible. Considering the reasonable design decisions and appropriate mitigation measures the construction and operation of the wastewater treatment plant will cause the ecological and economic profit of much more importance than non-realization. Therefore the no action alternative was rejected.

3.2 Alternatives for the Location of the Treatment Plant

Two alternatives can be considered for the location of Telavi wastewater treatment plant, in particular:

- According to the first alternative, treatment plant will be arranged to the north of Kondoli village, on the old treatment plant area, with the following coordinates: X= 548924; Y= 4646548. This nonagricultural land is owned by the state and an old treatment plant has been operating for many years there. At present, infrastructure of the building is completely destroyed and looted. Area experiences high anthropogenic load. The nearest residential house (Kondoli village) is in 3.7 km to the south-west direction;
- According to the second alternative, arrangement of the treatment plant is planned to the north-west of Kondoli village, with following coordinates: X – 546455; Y - 4647051. This area is used for agricultural purposes. There is no infrastructure on this area. The nearest residential house (Kondoli village) is in about 4.4. km to the south-west.

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

During the comparative analysis of alternatives, the first thing to be noted is the existing distances to the major receptor of the impact – local population. At this point, both alternatives are in significant distance from population.

The geological conditions are stable within both alternative areas. Relief is – moderate and providing the large volume of earth works is not necessary during the construction phase. No important difference is noticeable at this point.

The secondary vegetation cover is represented in both alternative areas. Although, in terms of possible impact on the biological environment, the first alternative is preferable since there is more technological load.

The second alternative area is used for agricultural purposes and therefore, there is a relatively high risk of the impact on topsoil quality and stability during the construction works.

In terms of the impact on the social environment, the first alternative is more preferable, as the area is owned by the state, where the similar infrastructure already exists.

Another environmental and social advantage of the first alternative is as follows: As a consequence of the project implementation, in the area of old treatment plant the current infrastructural facilities (reservoirs and etc.) will be deconstructed, the waste will be removed and the area will be fenced. Therefore existing unsatisfactory sanitary-ecological conditions of the area will be improved and the sources of the impacts on the separate receptors (including human health and safety) will be eliminated.

Based on the above mentioned and considering the scales and scope of the adverse impacts on the various receptors, the first alternative is more preferable.

Figure 3.2.1. Situational scheme for the alternative areas considered 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 and technological accessibility. Three basic alternatives for the wastewater treatment might be discussed:

I. Arrangement of the individual treatment system;
II. Biological treatment using the phytodepuration method. Prior to preliminary sedimentation, this method provides water purification in canals and ponds, where water plants are growing;
III. Biological 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 Telavi. 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, III alternative was preferred, which is the collective treatment of wastewater with the biological treatment plant.

The feasibility study was provided for 3 technically feasible alternatives:

- Alternative 1: Primary sedimentation tank + trickling filter;
- Alternative 2: Anaerobic pond + trickling filter;
- Alternative 3: Primary sedimentation tank + activated sludge;

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

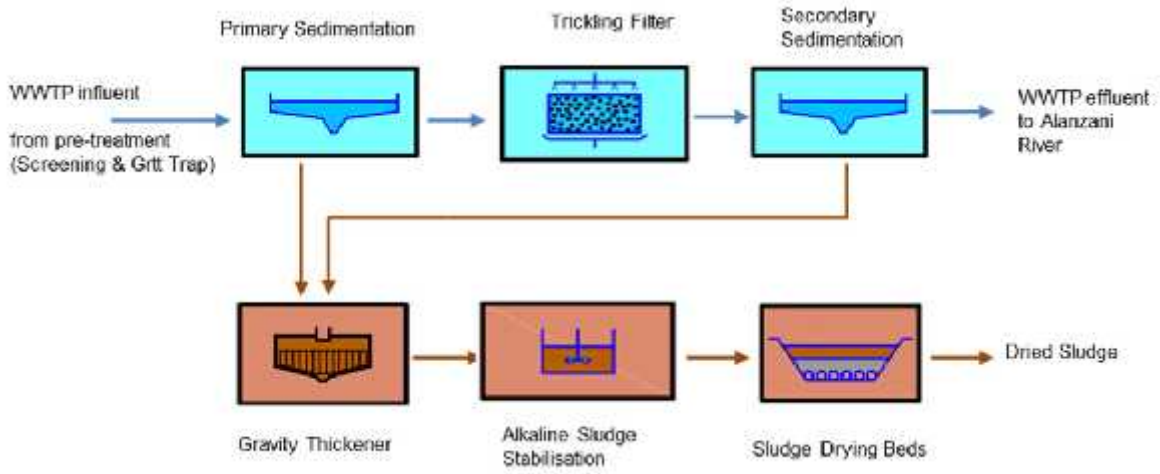
Alternative 1 - Primary settler + trickling filter

	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 of Telavi WWTP 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.

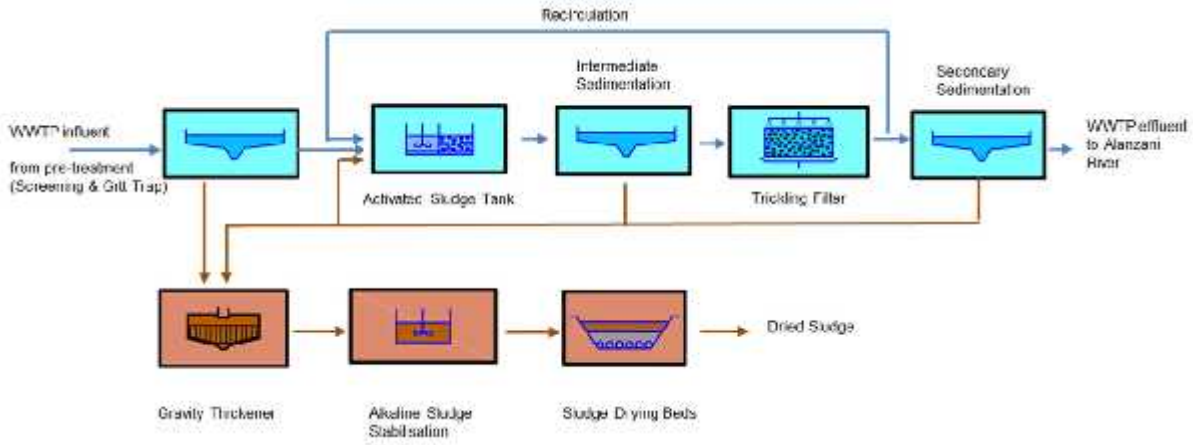
Figure 3.3.1. The Alternative 1 of Telavi WWTP – Phase 1



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 Telavi 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).

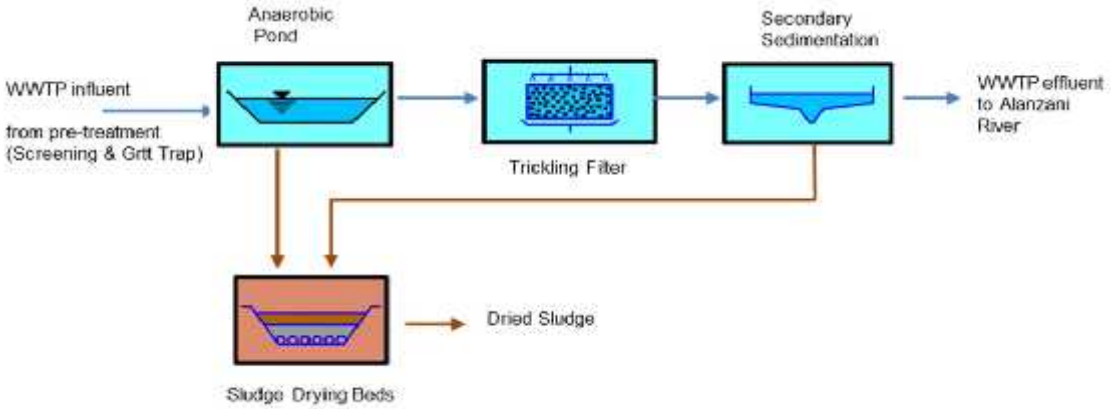
Alternative 2 - Anaerobic pond + trickling filter

	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 of Telavi WWTP 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.

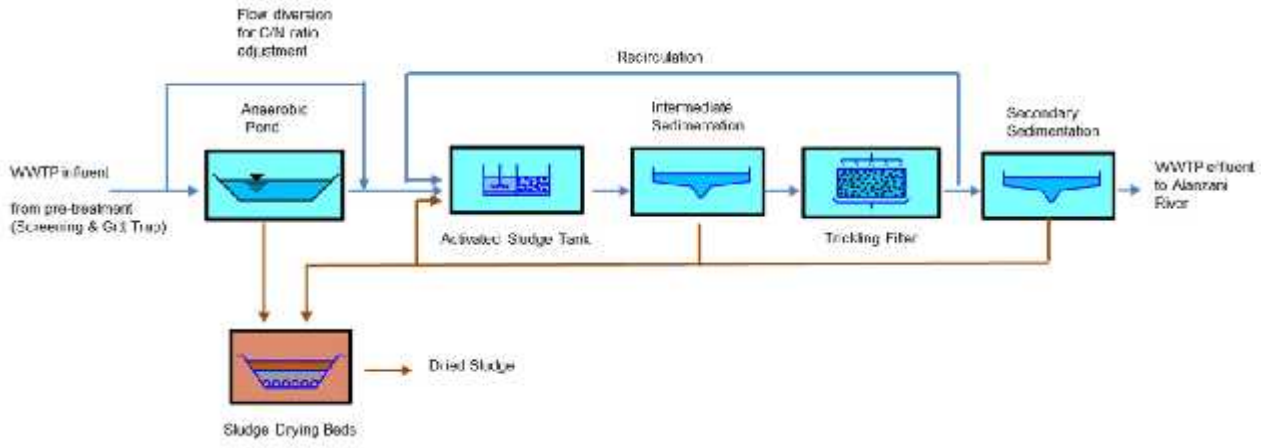
The sludge that will be extracted every day will be fed to the anaerobic ponds, where it will be stabilized by anaerobic digestion. The sludge has to be removed from the anaerobic ponds in long term intervals (approx. every 1-2 years). The sludge withdrawn from the anaerobic ponds can be effectively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

Figure 3.3.3. The Alternative 2 of Telavi WWTP – Phase 1 (2030)



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 (2040)



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.

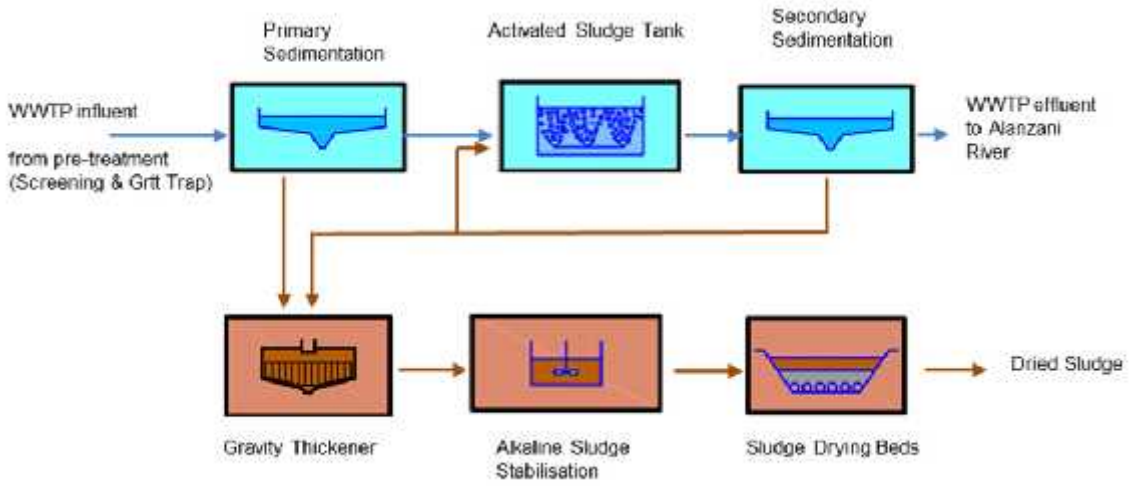
Alternative 3 - Primary settling + activated sludge

	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

Telavi 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.

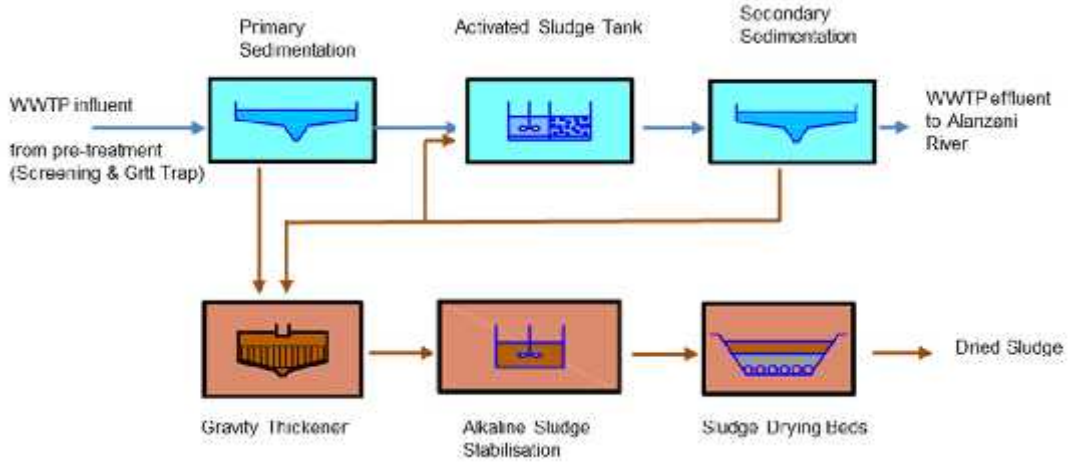
After sludge thickening, the sludge will be stabilized by means of liquid alkaline sludge stabilization (lime addition will lead to a pH increase to 12, suppressing all biological activity in the sludge, killing pathogens and improving the sludge dewatering characteristics). The sludge drying beds dewater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

Figure 3.3.5. The Alternative 3 of Telavi WWTP – Phase 1 (2030)



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 Telavi WWTP – Phase 2 (2040)



Conclusion:

Based on the relevant analysis, 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, which is significant in terms of environmental protection;
- The capital investment and operation related costs are low: It should be considered that the project is not implemented by private investment and its operation costs will be covered from State budget.

4 Description of the Adopted Alternative

4.1 General Overview

Area selected for the construction of WWTP, non-agricultural land (cadastral code: 53.05.33.062) is located to the northeast of Telavi, on the right bank of Alazani River at 356 m a.s.l. The land plot is the property of United Water Supply Company of Georgia. Project area is about 86 426 m^2 (8,6 ha). Geographic coordinates of the center of the project area: X= 548924; Y= 4646548.

The wastewater treatment plant of Telavi Municipality was operating on this area in the past years, which is completely destroyed and reconstruction of the existing buildings and structures for re-use is impossible.

Dense vegetation cover is developed on the project WWTP section and around it. Bordering areas to the forested zone are privately owned agricultural land plots, which are used for viticulture. The above-mentioned plots are intensively used.

Alazani River flows in 1.0-1.2 km distance to the North of the project area. In about 1.0-1.2 km to the east, there are fishponds, owned by Tobi LTD.

The nearest residential house (Kondoli village) is in 3.7 km to the south of the project area; Telavi city air base is in 3,5 km to the west.

Currently, untreated wastewater is discharged into Alazani River since sewerage infrastructure does not operate in Telavi.

Layout scheme of the design structure is given in Figure 4.1.1.

Figure 4.1.1. Layout scheme of the project area

4.2 Brief Description of Telavi WWTP Project

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

- On the first phase, the infrastructure facilities that provide wastewater treatment in the amount expected for 2030, will be arranged (Population Equivalent PE_{60} - 52000). The mechanical cleaning and BOD and COD removal will be achieved. The design daily flow will be 14400 m^3/d, peak flow – 960 m^3/h;
- On the second phase, the infrastructure facilities, that provide wastewater treatment in the amount expected for 2030-2040, will be arranged (Population Equivalent PE_{60} – 91000). It is planned to update the treatment plant for total nitrogen and total phosphorus removal. The design daily flow will be 18760 m^3/d, peak flow – 1407 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	Concentration
Wastewater Quality - Phase 1- Design year 2030	
Biochemical oxygen demand (BOD5 at 20 °C) without nitrification	25 mg/l
Chemical oxygen demand (COD)	125 mg/l
SS	35 mg/l
Phase 2- Design Year 2040	
Total Nitrogen (TN)	15 mg/l
Total Phosphorus (TP)	2 mg/l

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

- Mechanical treatment unit (so-called screening system);
- Grit chamber and distribution chamber;
- Anaerobic tanks;
- Trickling filter and trickling filter pumping station;
- Secondary sedimentation tank;
- Flow meter for treated effluents and junction to the bypass pipe;
- Sludge Drying Beds.

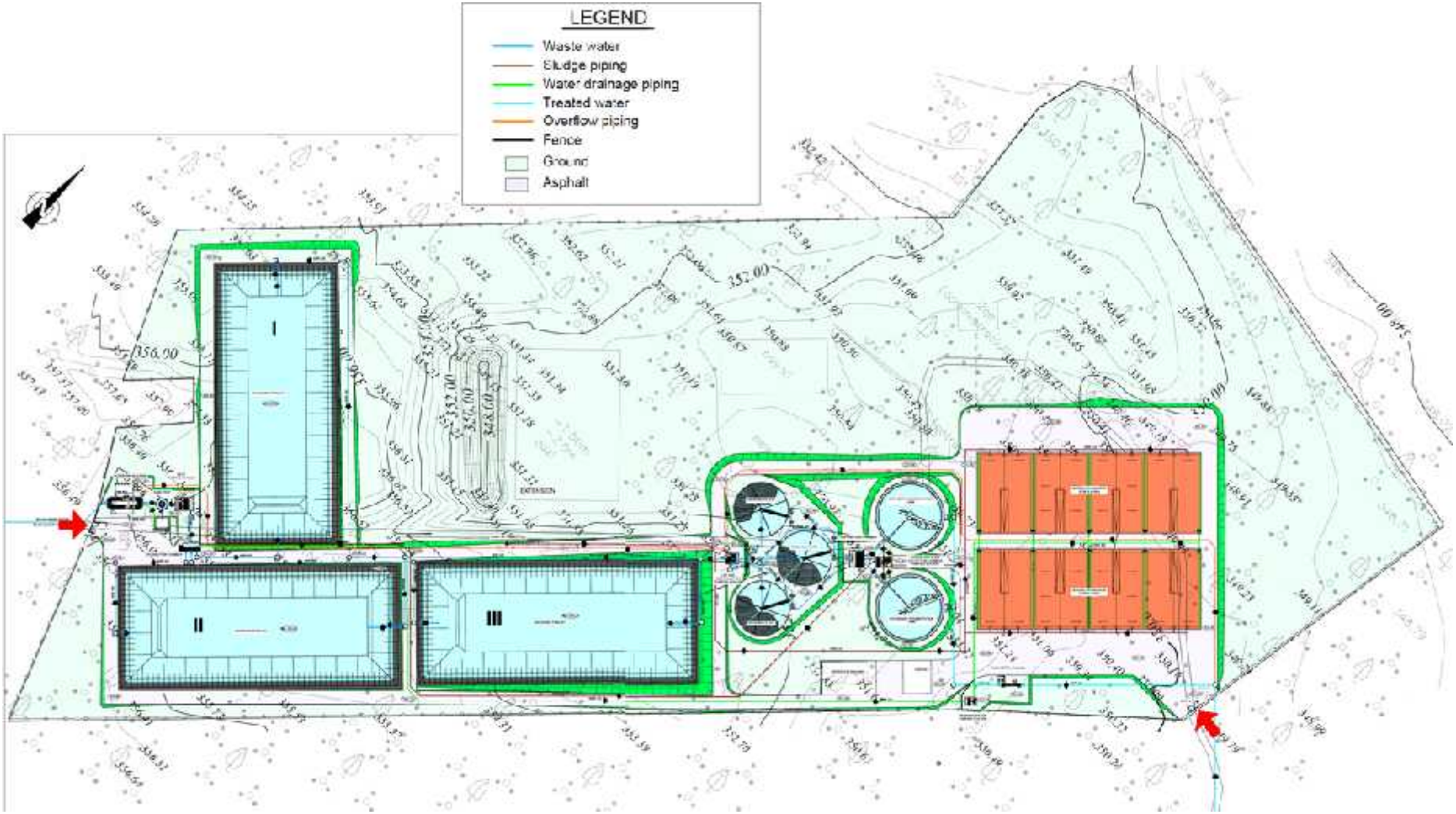
Power supply and technical water supply network; Control Room and Maintenance Station will be arranged as auxiliary facilities.;

Within Phase 2 activated sludge tank, blower station and supplementary clarifier will be arranged for nitrogen removal.

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

Detailed description of Telavi WWTP and figures of infrastructural facilities are given in Annex 1.

Figure 4.2.1 Master plan of Design WWTP ; 1:500



4.3 Brief Description of Wastewater Treatment Process

For Phase 1 the operational scheme of WWTP envisages removal of suspended solids, BOD and COD reduction. Anaerobic tanks, trickling filters, secondary settler and sludge drying d\beds participate in treatment process.
At initial stage wastewater entered the WWTP is undergone the mechanical treatment on fine screens and sand trap. Raw water will pass through 2 automatically tilted fine screens. Screens will be placed in separately. Fine screens are designed so that in case of failure of one of them, full stream can be passed through another screen. On following stages wastewater moves to 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, silted on the bottom of the cesspool, is transferred to the grit disposal site through air pump.
After removal of grit, raw wastewater will move to inlet pumping station. If in rainy period inflow stream exceeds pump capacity, the water will be discharged through the pipeline. After passing through inlet pumping station, the water will be evenly distributed between 3 anaerobic tanks.

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. The anaerobic tank also provides storage of sludge. When the accumulated digested sludge on the bottom of the tank reaches a threshold level, a removal of the settled sludge is required, which typically is only required in a one to two year interval. Arrangement of 3 anaerobic tanks is considered.

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 pieces of material and through perforated floor and then is led on the bottom slope to drainage ring-channel, then goes out to secondary settler. Considering long distance from population (3,7 km and more) it is not required to arrange "Domed" trickling filter for better management of odor nuisance and propagation of flies.

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.

Sludge will be stabilized 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 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

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.

The Telavi WWTP will generate 686 000 kg SS / year of sewage sludge – once the full capacity level of the 2030 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.

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 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; Sludge drying beds contain 8 sections. (each section with following dimensions: 29.5 x 20.5 m). Total storage volume of sludge drying beds is 29.5 x 20.5 x 8 x 0.6 = 2903 m^3. According to the project annual production of sludge is 3688 m^3. Thus the capacity of sludge drying beds will be sufficient for storage of generated sludge for 287 days (periodicity, transportation conditions, etc. of 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 figure s below.

Figure 4.3.1. Wastewater Treatment Technological Scheme - Phase 1.

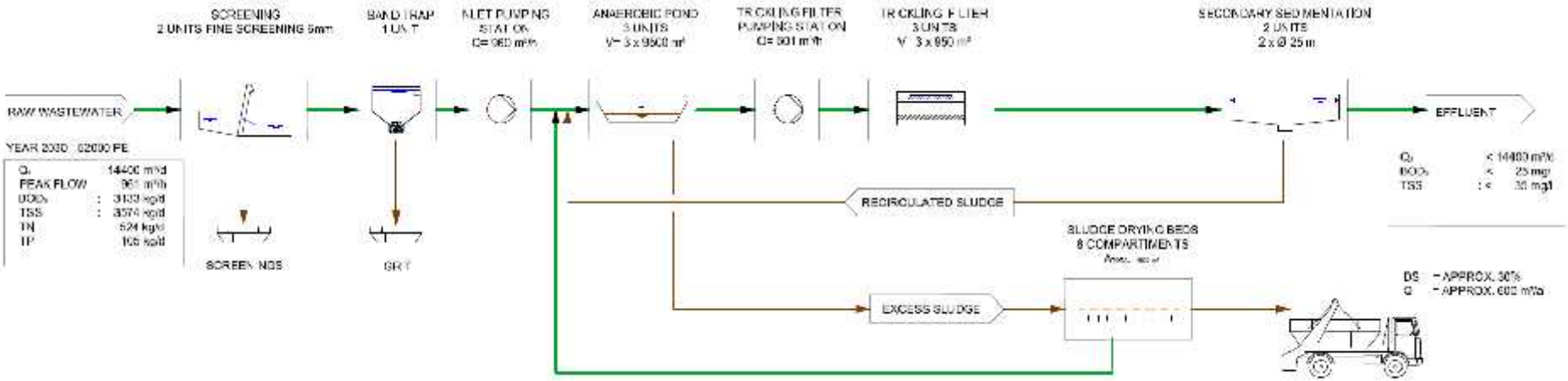
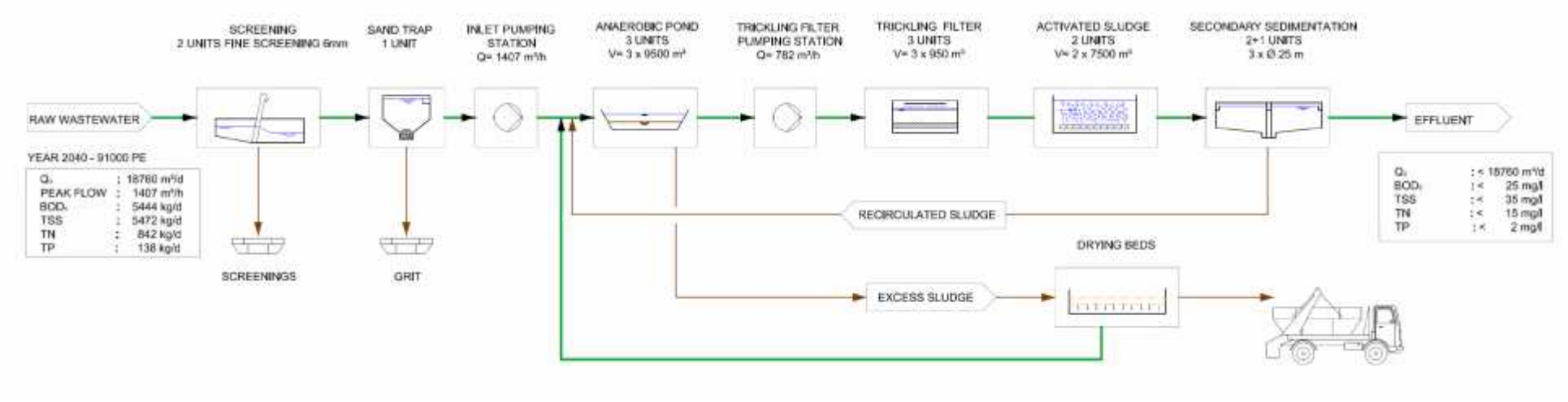


Figure 4.3.2. Wastewater Treatment Technological Scheme - Phase 2.



Supportive Infrastructure

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). 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. 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.

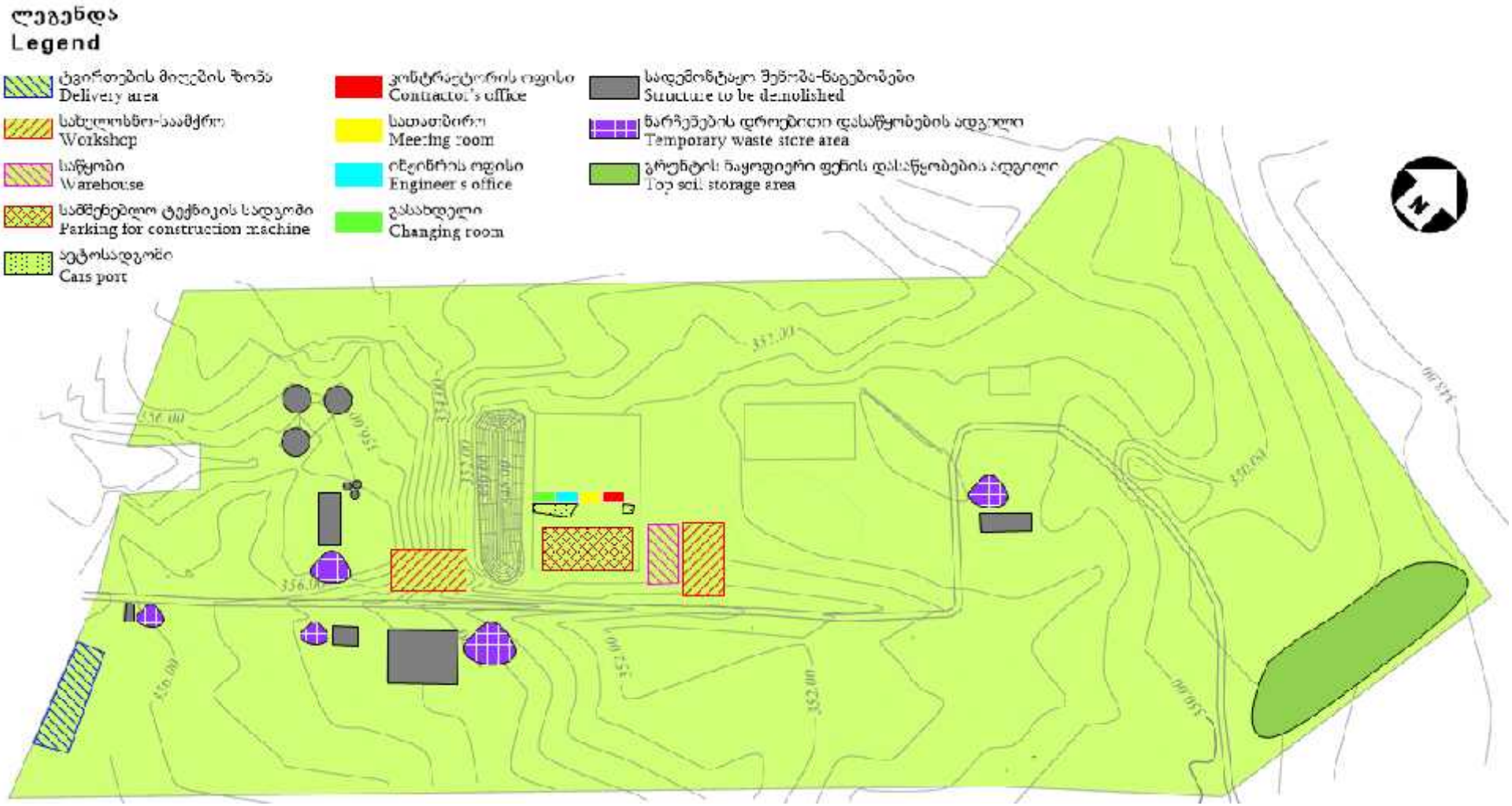
Construction Camp

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 be presented in construction site. 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. Temporary Infrastructure Locations



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 3500-4000 m^3 concrete and 85-90 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. 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 Telavi 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. Secondary bushy plants are widespread there.

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

As mentioned above, remains of old structures are presented within the major part of the territory. Considering the area required for the arrangement of construction infrastructure and the volume of existing structures, topsoil will be removed from about 48530 m^2 area. In consideration of the average topsoil depth (20 cm), approximate volume of removed topsoil will be 9706 m^3. Hydraulic excavator will be used for removing the topsoil. After completion the excavation works the territory should be properly leveled and surface water drainage channel should be provided.

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. Recultivation plan will be submitted to the Ministry of Environment and Natural Resources protection of Georgia after obtainment the construction permit.

Power Supply

Currently, there is no transmission line within the project area. For power supply of the construction site, installation of transformer is planned. WWTP will be connected to power system through 2.4 km long transmission line. Connection will be ensured by the local electricity company. There is a private power transmission line near the WWTP. Approximate consumption of WWTP will be 115 kV.

Water Supply and Wastewater

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

The potable-industrial water will be periodically delivered by tankers. The water storage reservoir will be installed on construction site.

Considering the fact that the arrangement of the concrete plant and crushing and sorting plant is not planned on the site during construction works, the technical water flow will not be high.

The technical water will be needed for fire-fighting purposes. The water necessary for fire-fighting and for the training of the personnel will be consumed from the reservoir.

On the construction phase consumption of potable and industrial water depends on number of laborers and water consumption per person. Approximate design flow of consumed water will be: **1,5 m^3/d and 720 m^3/a.**

In addition, it is possible to arrange showers, two points on the site. The daily water flow for one shower point will be 500 l. Required volume of water will be: **1 m^3/d and 480 m^3/a.**
Total consumption of potable-industrial water will be: **1200 m^3/a.**
For collection of fecal wastewater pressurized cesspool with the capacity of 25-30 m^3 is considered, which will be treated periodically by sanitation machine. Approximate volume of household-fecal water during construction works will be: **1140 m^3/a.**

During the year the cesspool will be discharged thrice a month, depending on the working day number.

Recultivation Works

After finalization of the construction works, recultivation works will be provided according to 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 recultivation project. The recultivation project of WWTP will be developed after revealing the contractor constructor. The project will cover technical and biological recultivation stages.

Working Schedule 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

Environmental and social baseline of Telavi Municipality is described in this paragraph.

From physical and geographical point of view, project area lies within the western part of Kakheti plain included in Iberian region (according to L.I.Maruashvili). Physiographic units of Alazani Valley are: From north and northeast side - Kakhetian Caucasus, from south and southwest side - less steep northern slopes of Gombori.

According to administrative-territorial division, the project area is included within the boundaries of Telavi Municipality, Kakheti region. Telavi municipality is bordered by Akhmeta Municipality from west and north side, by Kvareli Municipality from east side and by Sagarejo Municipality from southwest side.

Results of Audit Conducted within the Project Area

During the environmental audit of Telavi WWTP project area, carried out by Gamma Consulting Ltd, the specialists visited the area selected for the arrangement of WWTP. In addition, water samples have been taken from Alazani river in order to determine background concentration of pollutants in them.

As mentioned above, sewage system of Telavi is actually turned into a ruin and it cannot be recovered according to its initial scheme.

Out of four sewage pipelines only one is operating in Telavi. Also, initial collector is not connected to an old treatment plant and it ends along the main road leading to Telavi Bridge, where untreated wastewater is discharged underground.

Because of improper operation of sewage network, major part of wastewater generated in Telavi is discharged into the main irrigating channel (flowing to east west) through the existing sewage main collectors. Wastewater discharge point into irrigation channel has been revealed during the audit, approximate coordinates of which are: X: 539653; Y: 4642636; (see Picture 1).

Within the corridor of the collector, before crossing Kurdghelauri road, on the left side of the road, coordinates are as follows: X: 539653; Y: 4642636; collector pipe is above the ground and wastewater flows out on the surface (see Picture). Area contaminated by wastewater is a source of odor propagation.

Infrastructure of an old treatment plant was located within the project area. Therefore, amortized buildings and technological structures (sedimentation tank, sludge bed, chlorine contact tank and other) of an old treatment plant are still found there. During the audit, 5 one story buildings and 4 sedimentation tanks have been found there. As mentioned above, existing infrastructure could not be used. Therefore, the part of the existing infrastructure, which is within the new infrastructure location area, will be dismantled prior to the construction works.

Treated wastewater from treatment plant area will be discharged into Alazani River through 1.65 km long pipeline. Secondary bushy types of different plants are quite common within the corridor of discharge pipe. The forest is not dense (0.3-0.4) and it is not a habitat of a high conservation value. Topsoil should be removed within this corridor prior to the construction works (the volume of removable topsoil layer and conditions are described in relevant paragraph).

General views of the project area are given in Figure 5.1.1.

Figure 5.1.1 Views of the project area

Wastewater discharge point into irrigation channel

Wastewater flowing out from damaged pipe

Area for the arrangement of WWTP

Corridor of the collector

5.1 Physical-Geographical Environment

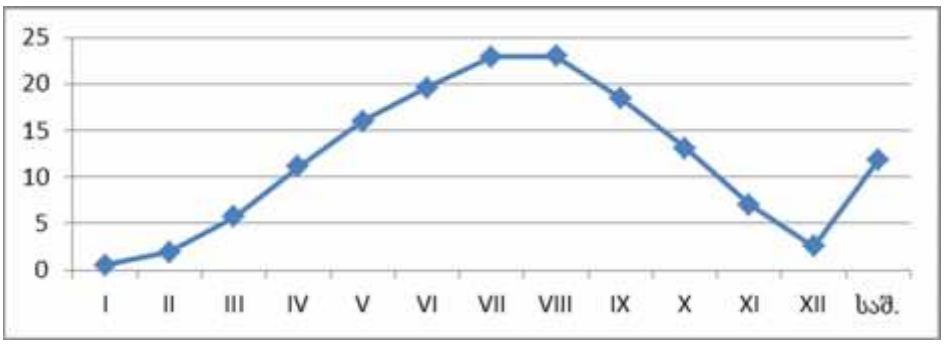
5.1.1 Climate and Meteorological Conditions

Telavi Municipality is within a moderately humid subtropical climate zone. There is a moderately humid climate within Alazani Valley, with moderately cold winters and hot summers. The average annual temperature is 11-12^{0}C, in January – 0,2^{0}C, in July - 22-24^{0}C. The absolute maximum temperature is 39^{0}C, while the absolute minimum -21^{0}C. Precipitation - 700-800 mm per year.

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 Telavi meteorological station (source: Construction Climatology PN 01.05-08).

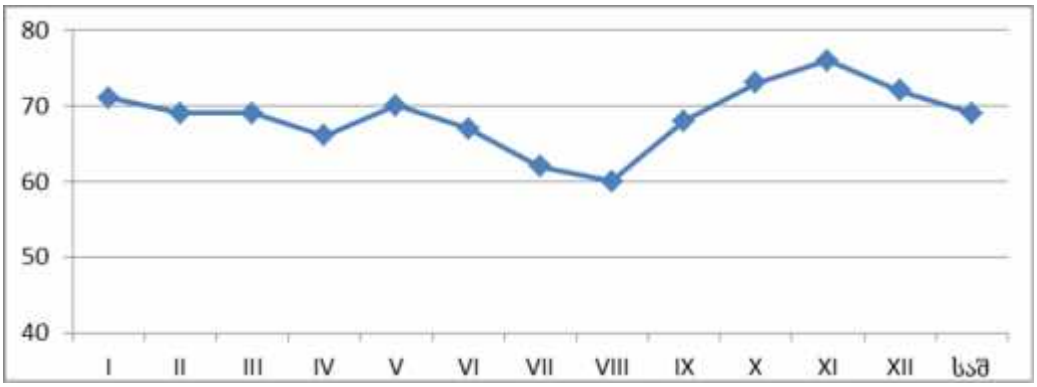
Ambient air temperature

month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	**Average annual**	**Abs. min. annual**	**Abs. max. annual**
^{0}C	0.5	1.9	5.7	11.1	16	19.6	22.9	23	18.5	13.1	7	2.5	11.8	-23	38



Relative humidity - %

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
%	71	69	69	66	70	67	62	60	68	73	76	72	69



Relative humidity - %

Average relative humidity at 13:00		Average daily amplitude of relative humidity	
The coldest month	The hottest month	The coldest month	The hottest month
69	46	14	31

Precipitation, mm

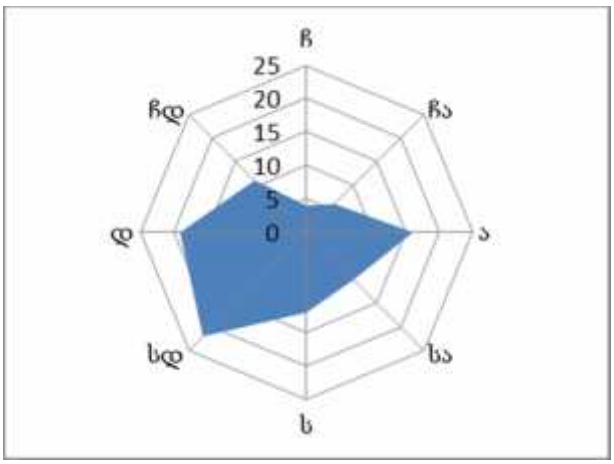
Annual precipitation, mm	Daily maximum of precipitation, mm
794	147

Wind characteristics

Highest wind speed, possible once in 1,5,10,15,20 years. m/s				
1	5	10	15	20
17	21	23	24	25

Average highest and lowest wind speed, m/s	
January	July
3,3/0,7	3,2/1,1

Annual repeatability of wind direction and calm (%)								
North	Northeast	East	Southeast	South	Southwest	West	Northwest	Calm
4	6	16	10	12	22	19	11	23



Source: Construction climatology PN 01.05-08

5.1.2 Geology

Relief

Alazani Valley is an intermountain accumulative plain between Gombori range and Iori slope. It is located at 200–470 m a.s.l. The plain is inclined towards South-East and it is extended as Agrichai plain on the territory of Azerbaijan. The total length of the plain is 200 km. the length of the plain on the territory of Georgia is 110 km. Its greatest width is 28-30 km.

The major characteristic of physiographic unit of Alazani Valley is its relief, which is typical continental geosyncline. Alazani Valley is a flat plain, but in fact it is complicated by fans of left and right tributaries of Alazani River and by formations with little depth and rare erosions.

Telavi is located at 550-800 m a.s.l. relief of the city (mostly its southern part) is inclined and deeply fragmented by V-shaped steep valleys. Absolute elevations of the relief decrease consistently towards the north of the city and are 350-360 m a.s.l. near Alazani riverbed. Sharply expressed negative or positive forms of relief have not been observed along the study corridor.

From Geomorphological point of view, the project area is included in Transcaucasian intermountain zone. Folded complex, Alpine, late orogenic (collisional), the late collisional (Quaternary) slightly folded. It is a geological complex of sedimentary rocks. Geologically it is built up by Alluvial-Proalluvial sediments, rocky and semi-rocky sediments of Cretaceous age.

Geological and Tectonic Conditions

Geologically, Alazani Valley is very peculiar tectonic unit of Georgia. This is a zone of intense immersion - continental geosyncline accumulating sediments. Formation of geosyncline has begun since Pliocene. Evolution of Alazani-Agrichai depression began since Upper Pliocene. Immersion still continues, which is approved by the stratigraphic and geomorphological facts. Caucasus foothill is built up by folded Upper Jurassic and Cretaceous sediments. Gombori range is built up by Mesozoic and Cenozoic suits, which are clearly divided into two different complexes from tectonical and lithological point of view. Older complex combines formations of diverse composition (clays, sandstones, limestones), while younger complex is represented Neogene (Sarmatian-Kimmerian) molasses series. The series is called Alazani Series.

Accumulative plain of Alazani, which is located between already mentioned two geomorphological elements is built up by Quaternary alluvial, proluvial and proalluvial-dealluvial cobbles, sandstone and clay.

Based on stock material and reconnaissance works it can be said that Quaternary sediments (gravel, sandstone) are represented within the study corridor. Areas adjacent to the corridor are extensively used for agricultural purposes and therefore surface layer is represented by quite productive topsoil.

Results of Engineering-Geological Survey Conducted within the WWTP 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 January 14, 2017 and February 16, 2017.

Description of engineering-geological conditions of the study are 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, 3 soil layers and 1 engineering geological element (EGE) have been identified in the geological section, within the surveyed depth (12.0 m):

Layer 1: Topsoil layer penetrated by plant roots; this layer was found in each of the test holes at a depth of 0.5 to 1.6 m below ground surface. The thickness of the layer makes 1.6 m.

Layer 2 (aQIV): Sandy loam of EGE I, fine-grain, of yellowish colour, of tight-plastic consistency. The layer was discoved in each of the test holes within a depth interval of 0.5 -1.6 m and 1.5-2.9 m. The thickness of the layer is changeable, varying within 0.90 and 2.90 m.

According to the laboratory findings, the characteristics of Layer 2 are as follows:

Item No	Physical Properties of Soil			Unit of Measur.	Values Variation Range	Mean (Regulatory) Value
1	Plasticity (Atterberg's limits)		W_L	–	0,25 – 0,28	0,26
			W_P	–	0,19 – 0,22	0,20
			J_p		0,04 – 0,07	0,05
2	Moisture content		W	%	13,5 – 14,9	14,6
3	Density of	soil	ρ	g/cm^3	1,62 – 1,70	1,66
		dry soil	ρ_d		1,41 – 1,49	1,45
		soil particles	ρ_s		2,69	2,69
4	Porosity		n	%	44,6 – 47,0	45,80
5	Voids ratio		e	-	0,805 – 0,904	0,855
6	Coefficient of fluidity		J_l	-	(-1,18) – (-1,88)	-1,53
7	Saturation degree		S_r	-	0,38– 0,50	0,44

Layer 3 (adQIV) - EGE I: cobble-pebblestone with boulder inclusions, stuffed with yellowish-greyish sandy loam. This layer was discoved in each of the boreholes within a depth interval beginning from 1.50-2.90 m through 12.0 m i.e. throughout the surveyed depth. The thickness of the layer would vary between 7.50 and 9.20 m.

From Layer 3, cobble-pebble stone with boulder inclusions, 6 soil samples were taken. Testing of the soil samples was carried at the Geotechnical Laboratory of the Engineering Survey Department of the Akhali Sakkalakmshenproekti Ltd.

The top layer to be seen in the geological section of the surveyed area represents topsoil penetrated by plant roots; the above soil cannot be used as foundation soil; the density of the topsoil layer is ρ=1.2- 1.5 g/cm^3.

Layer 2 foud on the site survey (I), which immediately underlays the topsoil layer , represents yellowish loam thet would prevail through the area and was found in each of the boreholes.

Surveyor found out as a result of its laboratory testing, this layer would exhibit setting/subsidence sings as soon as gets saturated; at that, the layer is of minor thickness. Proceeding from the above, we think that this layer should not be used as foundation soil either. Hence, the above two soil layer should be cut and stored ad an earth fill so that the facilities to be built could be rested upon soil of layer 3 – cobble – pebblestone containing bounder inclusions and stuffed with loamy sand.

The material sampled from the test holes underwent both field (visual) and laboratory examination. Findings of the laboratory examination of the soil samples are given in Annex 8.

According to the findings of the sieve analysis, the soil should be classified as cobble-pebblestone with boulder inclusions and stuffed with sandy loam. The sandy loam serving as a filling agent for the layer, is of solid consistency.

It is recommended to have the design buildings and structures rested upon Layer 3 – cobble-pebblestone with boulder inclusions, stuffed with sandy loam, where the cobble-pebblestones are present as thin, 0.50 to 0.60 m thick inter-beds stuffed with sandy or clayey filling agent. Both of the above interbeds have the same bearing capacity.

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

Following conclusions have been made on the basis of surveys about engineering-geological conditions of the construction site:

1. Reasoning from the findings of the above engineering geological survey and in view of the fact that no perilous geological processes (such as landslides, 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 site, allotted for construction of Telavi WWTP, 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 (simple for development).
3. The construction site is built up of the Miocene-Pliocene continental molassic sediments of the Alazani series. The sediments are overlaid by massive (up to 300 m thick) complex of the Quaternary alluvial-proluvial sedimentary material. Lithologically, the alluvial-proluvial sediments are represented by alternation of boulder-cobble-pebblestone stuffed with sand and sandy loam, The alluvial-proluvial sediments are overlaid by a 0.5 m to 10 m thick layer of loess-like loam and loamy sand. The upper portion of the alluvial-proluvial layer is humusized and converted into topsoil layer sometimes overlaid by filled-up soil, or made ground.
4. Within the site, three layers and one engineering geological element (EGE) have been identified, namely:
    - Layer 1 – topsoil layer penetrated by plant roots. The layer was present in all the test holes up to a depth of 0.5 -1.6 m below ground surface; thickness of the layer makes 1.6 m;
    - Layer 2 (aQIV) – sandy loam of EGE I, fine-grain, yellowish, of tightplastic consistency. It was found in all the test holes and would stretch from a depth of 0.5-1.6 m to a depth of 1.5-2.0 m; thickness of the layer varies between 0.90 and 2.90 m;

- Layer 3 (aQIV) representing cobble-pebblestone of EGE I, with boulder inclusions, of yellowish-grayish colour and stuffed with sandy loam. This layer found in all the test pits (boreholes) drilled within the site, lies beginning from a depth of 1.50-2.90 m through a depth of 12.0 m – up to the very bottom of the boreholes; the surveyed thickness of the layer varies between 7.50 and 9.20 m.

5. Proceeding from the geological structure of the site intended for construction, the designers of the sewage disposal system should be advised to rest foundations of one or two-storey buildings or structures upon Layer 3 - cobble-pebblestone with boulder inclusions and yellowish sandy loam serving as a filling agent; the conditional design resistance of the soil makes R0=6.0kgf/cm^2 as specified for gravel soils stuffed with loam (Refer to Table 1. p. 33 in the Article 2 of Addendum 3 to the Georgian Design Norms PN 02.01-08).
6. For foundation design, the table below gives the design values of the physical and mechanical characteristics of the cobble-pebblestone with boulder inclusions and sandy loam as a filling agent, obtained as a result of the laboratory examination of the material and derived from relevant normative 16 documents and reference bibliographic sources (the "Designer's Computation-Theoretical Reference Book").

Item No	Soil Characteristics		Design Values	
			Layer 2	Layer 3
1	Density	ρ გ/სმ^3	1,66	1,95
2	Specific cohesion	C კგ/სმ^2	10,0	2,0
3	Angle of internal friction	φ°	18	43
4	Conditional design resistance	Ro კგ/სმ^2	2,5	6,0
5	Deformation modulus	E კგ/სმ^2	240	500
6	Poisson's ratio	μ	0,25	0,17
7	Coefficient of friction b/w concrete and soil	*f*	0,50	0,55
8	Coefficient of subgrade reaction	k კგ/სმ^3	4,0	8,0

7. Foundation design to be selected for the sewage disposal plant, as supposed by the requirements specified above, may be either cast-in situ reinforced concrete intermittent footing/pad foundation tied by foundation beams or combined strip-intermittent foundation.
8. It is advisable to install the foundation at a depth of at least 2.50 m below the ground level/grade existing for the time being. To have the foundation depth reduced, the sandy loam (Layer 2) should be strengthened/reinforced through laying cushion of detrital material (crushed stone or pebblestone) to be then rammed adequately and properly. 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 for hydrogeological conditions of the site we should state that during the period of the field survey (January of 2017), no ground water was found within the depth (12 m) surveyed under the Project.

10. The maximum inclination of 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.
11. As per Design Norms "Antiseismic Construction" (PN 01.01-09), the city of Telavi lies within 9-point earthquake prone zone; hence the surveyed area and the construction site located there belong to 9-point earthquake prone zone.
12. As to the seismic characteristics of the material, we should state that according to Table 1 Design Norms PN 01.01-09 "Antiseismic Construction", the soils participating in the geological structure of the site, by their seismic characteristics should be classified as Class II - Class IV ones. The design seismicity of the site shall be considered as 9 points.
13. 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) Sandy loam of tight plastic consistency (Layer 2), No 10v - to Category II; its in-situ bulk weight makes 1700 kg/m^3;
    c) Cobble-pebble stone with boulder inclusions (Layer 3), No 6g – to Category IV; its in-situ bulk weight makes 2000 kg/m^3.
14. Excavation and the substructure construction cycle shall be performed under supervision of the geological engineer.

Hydrogeology

Central part of Georgia is covered by hydrogeological district of Georgian and Azerbaijan belts. The major aquifers are Tertiary rocks, which built up artesian basins of Alazani and Iori.

Among Tertiary sediments highest waters are observed in continental series of Aghchagil Apsheron and in loose formations of Middle Miocene. Aghchagil Apsheron series have been studied in artesian basins of Alazani and Iori. It contains a large amount of calcium bicarbonated fresh water. The second one is common in artesian basin of Kartli and from hydrogeological point of view, it is relatively less studied.

Study area is located near the active riverbed of Alazani, in 1,0-1,2 km distance. It should be also considered that moisture and marsh-loving plants are common within this area.

According to the engineering-geological studies, conducted within the study area, the groundwater level is 9.5-10.5 m.

Seismic Conditions

According to the Annex #1 of the construction norms and rules - "Seismic Resistance Construction" (pn 01.01-09), investigation territory Telavi and its surrounding areas are located in 9 scale (MSK 64) seismic region (see Figure 5.1.2.1.). Dimensionless ratio of seismicity within the settlements of the study area is: Telavi - 0,32 m/s^2, Kurdghelauri village - 0,33 m/s^2; Kondoli village - 0,36 m/s^2 .

Figure 5.1.2.1 Seismic map of Georgia

Risks of Flooding the Territory

JSC Saktskalproekti (Georgian Water Project) carried out calculation of maximum flows of different return periods of Alazani River at the section of the proposed Wastewater Treatment Plant. 49-year observation data of Shakriani hydro-meteorological station were used for the calculation. At the project section, maximum flows were recalculated in accordance with the guidelines of the former Soviet Union (Технические Указания по Расчету Максимального Стока Рек в Условиях Кавказа, Тбилиси 1980. Закавказский Региональный Научно-Исследовательский Институт). Maximum flows of different provisions obtained by the calculation are given in the table 5.1.2.2.

Table 5.1.2.2. Maximum flows of different provision of Alazani River at the project territory of the WWTP

Return period τ, year	100	50	20	10
Max. flow Q , m^3/sec	1430	1200	940	750

100-year return period is considered as the highest level of flooding, its elevation is 344.79 m a.s.l. There is no risk of flooding on the project territory, as the WWTP is located significantly above the elevation of 100-year return period of flooding.

The risk of development of any kind of dangerous natural processes is very low within the study corridor, which is determined by flat relief and sustainable geological structure.

5.1.3 Hydrology

The Alazani River – the second largest river of the east of Georgia, originates from the south slopes of the Caucasus Mountains, in the north of near Mount Borbala (3294 m) 0.6 km, at 3060 m a.s.l. and joins Mingechauri basin at the south end of Outer Kakheti plateau. The length of Alazani River is 351 km, total drop – 3000 m, average slope - 8,55 % basin area – 11 800 km^2.

Different 1803 tributaries join the river, their total length is 6851 km. In Georgia the large tributaries are as follows: Samkuristsqali Riv. (length 18 km). Ilto Riv. (43 km), Khodasheniskhevi Riv. (31 km), Stori Riv (38 km), Turdo Riv. (28 km), Lopota Riv. (33 km), Chelti Riv. (28 km), Kisiskhevi (37 km), Duruji Riv. (26 km), Cheremiskhevi Riv. (35 km), Bursa Riv. (27 km), Papriskhevi Riv. (32 km), Avaniskhevi Riv. (28 km), Kabali Riv (48 km), Chartliskhevi Riv. (39 km), Matsimi Riv (39km) and others.

Catchment basin of the river is asymmetric by the shape. 65,3% of the basin is situated on the left bank of the river. The upper part of the basin, from its head to Akhmeta town, is situated in the high and medium mountainous zone of the Caucasus Mountains. The other part of the basin, approximately 330 km length, from Akhmeta town to its head, is located on the intermountain lowland of Kakheti.

The River Valley is the box shape, its slopes merge to the slopes of the nearby ranges. The River Valley is not shaped distinctly below Akhmeta town. The width, depth and speed of the flow are changed from the head to the confluence. Width of the flow varies from 10-12 m (at Birkiani village) to 60-80 m (below the confluence of Agrichai River), depth – from 1,0-1,5 m to 4,5-5,8 m, speed –from 1,5-2,5 m/sec reduced to 0,8-1,2 m/sec. Bottom of the stream is gravelly at the head, while the bottom is sandy below the Chiauri bridge.

The River is fed by groundwater, rain and snow waters. Its water regime is characterized by the floods caused by the snow melt in spring, by high water caused by summer-autumn rains and by more or less expressed water shallow of winter. The river runoff is 65-72% of the annual runoff (spring - 35-40%, summer - 30-32%) during the flooding period of spring-summer. 20-23% of the annual runoff flows in autumn that is frequently changed in accordance with the river water amount and in some certain years it equals to the summer runoff. Just 8-18% of the runoff is observed in winter period.

The Alazani River is used for irrigation and energy purposes. There are 23 irrigation channels, including 3 of them are main channels and 3 - pumping station, on Alazani River and its tributaries. Others are just local channels. Except the main and local irrigation channels, there are 5 irrigation reservoirs in Alazani River basin, which are not operating currently. Within the last years, Khadori HPP-1 and Khadori HPP-2 were built and commissioned at the head of Alazani River, at the connection point of Samkuristsqali and Tsiplovaniskhevi Rivers; Alazani HPP-1 and Alazani HPP 2 operate on the main channel of the irrigation system of Qvemo (Lower) Alazani River.

Basic hydrological characteristics of Alazani River are given in the table 5.1.3.1. (Source: Ресурсы поверхностных вод СССР, том 9, Закавказье и Дагестан, выпуск 1, Западное Закавказье. Гидрометеоиздат, Ленинград, 1974 г. стр. 578). The nearest hydrological station of the project area of the design WWTP is “Shakriani”.

Table 5.1.3.1. Basic hydrological characteristics of Alazani River

Description		Hydrological Station					
		Birkiani village	Shakriani village	Chiauri village	Zemo Qedi village	Below the joining point of Agrichai river, in 2 km	Confluence
Area of water catchment basin, km²		282	2190	4530	7450	11600	11800
Average elevation the water catchment basin, m		2200	1260	980	900	-	-
Average annual flow, m³/sec	Average multiannual	14,4	45,2	71,4	-	112	-
	75% provision	12,6	37,6	57,6	-	91,9	-
	97% provision	9,96	27,8	40,0	-	65,8	-
Maximum flow, m³/sec	Average multiannual	88,0	319	395	479	397	-
	1% provision	496	1086	1232	1312	1114	1133
	2% provision	418	917	1040	1107	940	956
	5% provision	310	679	770	820	696	708
	10% provision	264	577	654	697	592	602
Minimum average monthly flow	Average multiannual	4,66	16,3	20,9	-	60,0	-
	75% provision	5,50	12,4	12,4	-	50,6	-
	97% provision	2,70	7,80	5, 07	-	37,9	-

m^3/sec.							
Water depth, m		-	0,3-3,0	-	-	-	-
Water speed, m/sec		-	1,5-2,0	-	-	-	-

The project area of the WWTP is located on the right floodplain terrace of Alazani River, in 1,0-1,2 km distance from the active riverbed. The project corridor does not cross the other significant surface water bodies.

According to classification, defined by national legislation, Alazani river belongs to the industrial-household water use category. According to the classification, defined by EU Council Directive 91/271/EEC – on "Urban (Industrial-Fecal) Wastewater Treatment", dated as May 21, 1991, Alazani river affected areas should be considered as riparian waters that are not subject to eutrophication and are not exposed to oxygen deficit, or above-listed processes (eutrophication, oxygen deficit) are not expected due to urban wastewater discharges. Therefore, Alazani river should belong to a less sensitive water object and in case of discharge of urban wastewater, first of all, reduction of BOD (up to 25 mg/l), COD (125 mg/l) and Suspended Solids (35 mg/l) should be considered.

Water Quality of Alazani River

As it was mentioned above, wastewater sewage and treatment system of Telavi and adjacent villages are practically completely out of commission. Wastewaters are discharged in Alazani River without any treatment.

During the ecological audit (February 2015 and March 2017) water samples were taken for the assessment of the water baseline quality from the upper stream of the discharge point of the design WWTP, in two points. Lab surveys were conducted in the accredited laboratory of the scientific-research firm - "Gamma". Results of the analysis are given in the table 5.1.3.2.

Table 5.1.3.2. Lab survey results of Alazani River water quality

№	Defined component	Unit	Received values			MPCs based on ND
			February 2015	March 2017		
			Point 1 X – 548227 Y - 4648530	Point 1 X – 548227 Y - 4648530	Point 2 X – 547399 Y - 4649826	
1.	BOD	mg/l	1,0	1,9	1,3	6,0 mg/0_2dm^3
2.	BOD	mg/l	1,36	<15	<15	30
3.	Common N	mg/l	-	0,7	0,7	12,2[1]
4.	Common P	mg/l	-	<0,1	<0,1	1,2[2]
5.	Suspended particles	mg/l	-	28,0	36,0	-
6.	Turbidity	FTU	2,47	101,00	119,00	-
7.	electric conductance	S(Siemens)/m	0,02366	0,02964	0,02548	-
8.	Hardness	mg–equiv	2,994	2,594	2,891	-
9.	pH	-	8,15	7,95	8,00	6,5-8,5
10.	Ca	mg/l	50,00	42,00	44,0	-
11.	Mg	mg/l	6,00	6,00	8,40	-

[1], [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.

12.	Na	mg/l	6,49	5,50	5,28	-
13.	K	mg/l	0,66	0,61	0,55	-
14.	Cl	mg/l	5,51	9,217	8,508	-
15.	HCO_3	mg/l	170,80	136,640	136,640	-
16.	SO_4	mg/l	6,80	20,40	30,00	500
17.	NO_3	mg/l	2,80	3,10	3,10	45
18.	Mineralization	mg/l	252,06	223,467	236,478	1000
19.	Significance of Mezophilic aerobes and facultative anaerobes for per ml		-	37^0C - 58 22^0C - 130	37^0C - 52 22^0C – 110	- -
20.	Total coliforms in 1000 ml		-	6 500	3200	≤10 000
21.	EE.coli,1000 ml		-	3 000	2500	≤10 000
22.	Faecal streptococci (S.faecalis), for 100 ml		-	100	56	≤100
23.	Pseudomonas aeruginosa, 100 ml		-	10	6	-
24.	Sulfate-reducing Clostridia (Cl.perfringens) in 100 ml		-	24	12	-
25.	Pathogenic microorganisms, including salmonella in 100 ml		-	Not found	Not found	Not permitted

5.1.4 Soils

Alluvial strongly calcareous clay soils are developed on the right plain of Alazani River, while on the right side - meadow-forest Alluvial not calcareous clay soils. The same type is developed in fragments in foothill zone, brown soil developed on conglomerates and sandstones weathering products. Forest brown soils are developed in Kakhetian Caucasus and lower part of Gombori range, under mixed deciduous forest, on clay shales and sandstones weathering crust; above the forest zone, under subalpine herbaceous vegetation - mountain meadow lawn, in some places peat soils and primitive mountain meadow soils.

Land plots adjacent to the study area are agricultural lands and they are actively cultivated. Thickness of the topsoil within the influence zone is 20 cm.

5.2 Description of Biological Environment

5.2.1 Vegetation Cover

General Description of Vegetation Cover in the Region

Natural vegetation within Telavi Municipality area is heavily altered due to agricultural activities. Plains favorable for agricultural lands are cleaned up from forests, which led to a gradual decline in forest cover and sometimes to its disappearance. Major part of the area is covered by vineyards, corn fields and pastures.

Following plants are spread within the forested areas: Georgia Oak *(Quercus iberica),* Caucasian hornbeam (*Carpinus caucasica*), Oriental beech (*Fagus orientalis),* Black alder (*Alnus barbata*), Maple (*Acer* sp.), Oriental hornbeam (*Carpinus orientalis),* black locust (*Robinia fseudoacacia),* Gleditsia (*Gleditschia triacanthos),* wych elm (*Ulmus scabra),* Ash tree (*Fraxinus excelsior),* wild pear (Pyrus caucasica), wild apple (Malus *orientalis*), Common nut (*Corylus avellana),* Plums (*Prunus divaricata*), Pomegranate (*Punica granatum);* Thorny and liana plants spread in forests and remote areas: Medlar (*Mespilus germanica*), Hawthorn (*Crataegus sp.)*, Dog-rose (*Rosa canina),* Peripcola (*Periploca graeca*), Blackberry *(Rubus),* Catbriers (*Smilax excelsa*), Clematis (*Clematis vitalba*), etc.

Grain crops are sown in small quantities within this zone. Priority is given to vines and fruit crops. As for the pastures, they are widespread on the river banks and along the forests.

Results of Botanical Research Conducted Within the Study Area

Botanical survey was conducted both on the territory of the WWTP. Surveys were carried out in February 2015 and in April 2017.

The major part of WWTP area is covered with shrubby and thorny vegetation cover. Gradient of the territory is about 0-5^0. It is strongly anthropogenous and modified habitat. Primary sight of the forest is violated, it is deforested and Oriental Hornbeam, Hawthorn, Gleditsia and other different invasive plants are presented there.

Within the project corridor, deciduous vegetation cover is composed of different species, including: Gleditsia (*Gleditschia triacanthos*), Ash trees (*Fraxinus excelsior*) Elm (*Ulmus foliacea*), Oriental Hornbeam (*Carpinus orientalis*) wild apple (*Malus orientalis*), field maple (*Acer campestre*), Hawthorn (*Crataegus sp*), Cornelian Cherry (*Cornus mas*), cherry plum (*Prunus divaricata*) common hazel (*Corylus avellana*), pomegranate (*Punica granatum*), common medlar (*Mespilus germanica*) and others.

Most part of the territory is presented by canopy of Liana goat-leaf honeysuckle (*Lonicera caprifolium*), common ivy (*Hedera helix*), greenbriers (*Smilax excels*), Old man's beard (*Clematis vitalba*), silkvine (*Periploca graeca*) thorny shrubby plants, their percentage of their abundance is high and equals to 61-70%, due to which free movement is practically impossible on the territory. Following plants are densely presented there: Gleditsia (*Gleditschia triacanthos*) blackthorn (*Prunus spinosa*), blackberry (*Rubus*), Oriental Hornbeam (*Carpinus orientalis*) and Hawthorn (*Crataegus sp*), they form impenetrable massifs on the territory. According to the density, forest massif is medium (0,5-0,6) within the study area, as to the age, they are composed of young groves, which mix as units with middle-age and grown Grayish oak (*Quercus pedunculiflora*), poplar (*Populus hibrida*), white mulberry (*Morus alba*), ash (*Fraxinus*), elm (*Ulmus foliacea*).

According to the project of Telavi WWTP, total area cleared from the vegetation cover is 48 530 m^2. Perimeter of the territory is given on the figure 5.2.1.1.

Abundance-coverage index of trees and shrubs, which shall be removed from the environment, is given in the table 5.2.1.1.

Figure 5.2.1.1. Borders of the territory clearing from the vegetation cover

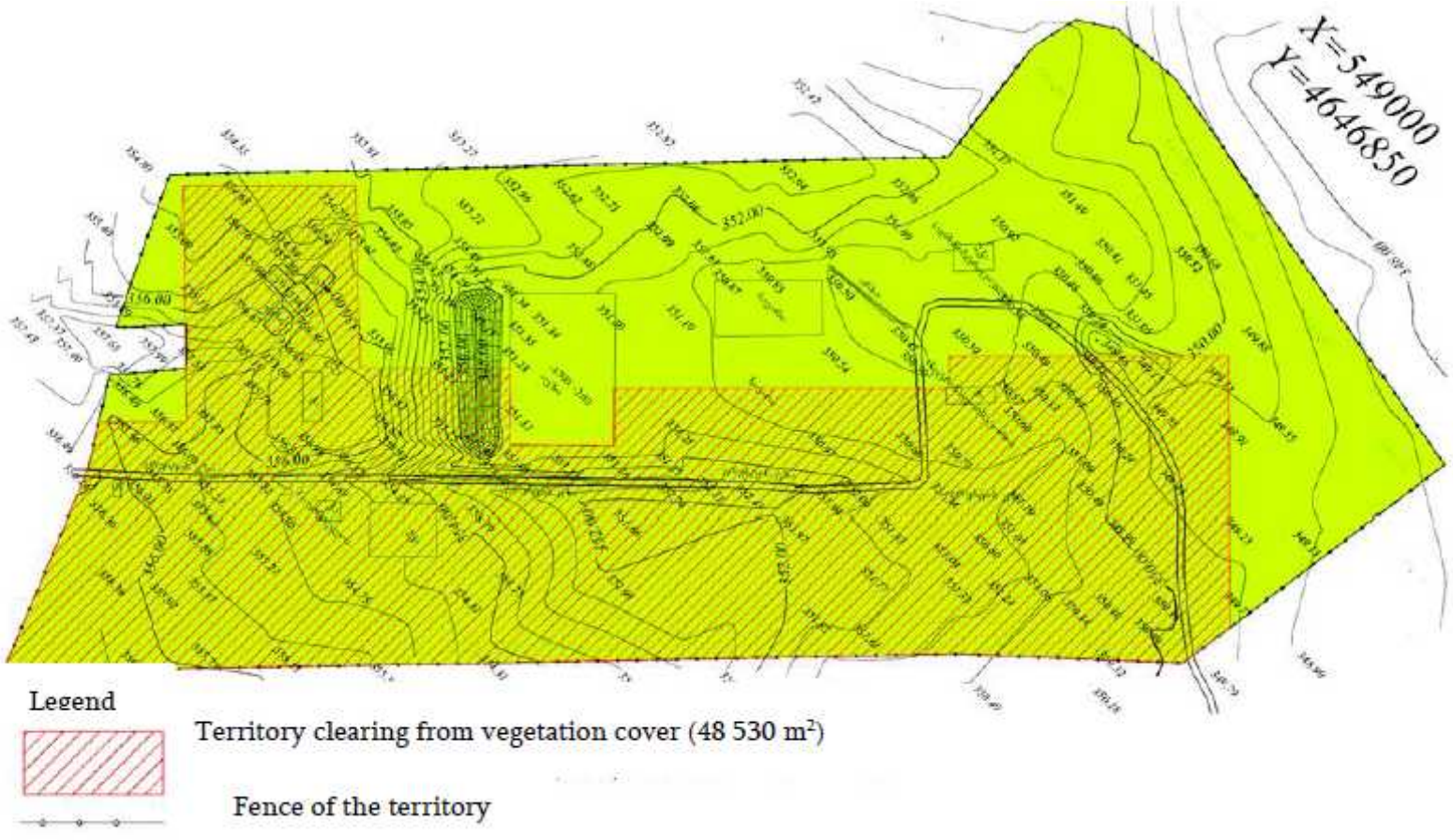


Table 5.2.1.1. Trees and shrubs subject to removal from the environment on the project territory

Trees	**Tree-shrubs**
Coverage of trees (35 %)	**Coverage of tree-shrubs (60 %)**
Gleditsia *(Gleditschia triacanthos*) - **Cop²**	Oriental hornbeam (*Carpinus orientalis)* - **Soc**
Ash *(Fraxinus excelsior)* - **Sp²**	Hawthorn (*Crataegus* sp.) - **Cop²**
Elm *(Ulmus foliacea)* - **Sp³**	Cornelian Cherry (*Cornus mas)* – **Sol**
Grayish oak (*Quercus pedunculiflora)* – **Sol**	Blackthorn (*Prunus spinosa*)- **Cop²**
field maple *(Acer campestre0* – **Sol**	Common hazel (*Corylus avellana*) - **Sp¹**
Wild apple (*Malus orientalis)* -**Sol**	Pomegranet (*Punica granatum*)- **Sol**
White mulberry (*Morus alba*)– **Sol**	Common medlar (*Mespilus germanica)* - **Sol**
Poplar (*Populus hibrida*)- **Sol**	Blackberry (*Rubus)* - **Cop³**
Apple (*Malus domestica*)- **Sol**	Common ivy (*Hedera helix)* - **Sol**
Common walnut *(Juglans regia)* - **Un**	Old man's beard *(Clematis vitalba)* – **Sol**
Cherry plum (*Prunus divaricata)* -**Sol**	Goat-leaf honeysuckle (*Lonicera caprifolium)* - **Sol**
	Silkvine *(Periploca graeca)* - **Un**

Symbols presented in the table indicate abundance-coverage of the species:

Sol (solitarie)-Small amount of species, cover-abundance up to 10%;

Un (unicum) One individ .

Sp^1 (sporsal)- cover-abundance is approximately 10%;

Sp^2 (sporsal) cover-abundance is approximately 20%;

Sp^3 (sporsal) cover-abundance is approximately 30%;

Cop^2-represented by a variety of species, cover-abundance is 50%;

415 tree-plants will be cut during the construction process in the project corridor; according to the age, they are middle age and grown.

Just one species of special status, Common walnut *(Juglans regia)* **(VU)** (young) and 5 species of grown Grayish oak (*Quercus pedunculiflora)* **(VU)** were recorded within the project-construction corridor.

Photos of plants of vegetation distributed within the project-construction corridor are given below.

Grayish oak (*Quercus pedunculiflora) (VU)*

Elm (*Ulmus foliacea)*

Poplar (*Populus hibrida)*

Gleditsia(*Gleditschia triacanthos)*

Blackthorn (*Prunus spinosa)*

Oriental hornbeam (*Carpinus orientalis*)massif

Blackberry (*Rubus)*

goat willow with common hazel (*Corylus avellana*)

Hawthorn (*Crataegus sp)* with Silkvine (*Periploca graeca)*

5.2.2 Fauna

Wildlife of the Region

According to literary sources, following animal species can be found within the municipality area: Chamois, wolves, foxes, jackals, wild boars, rabbits, weasels, voles, the normal mouse, rat, etc. There are a lot of bird species. Following fish species can be found in Rivers: Cyprinid, ray-finned fish, Chub, Barbell, catfish, carp, Barbel, Asp, etc.

Animal Species Common within the Study Area

Inspection of the project area revealed that the forest is extremely anthropogenically impacted. Major part is deforested for the purpose of obtaining wood. However, still it is the favorable shelter for animals. The proximity to the river, flat terrain, understory - Open and dark place at the right is tailored to different species of animals inhabiting there. Most likely, the territory is used as a migration corridor by large mammals, as Alazani River groves and surrounding forest areas are probably the best area for animal migration.

Existence of **mammals** has not been identified during the preliminary study; Neither animal - traces, feces and other signs were found. According to the locals, there are many wolves - *Canis lupus,* Jackals - *Canis aureus*, Pine marten - *Martes martes*, least weasel - *Mustela nivalis*, fox - *Vulpes vuples*, Badger - *Meles meles,* European Hedgehog - *Erinaceus concolor*, Caucasian mole - *Talpa caucasica*, Small Forest Mouse - *Sylvaemus uralensis;* During snowfall local population has observed Roa - *Capreolus capreolus* and Wild boar - *Sus scrofa.* The project area is not attractive for above-mentioned sensitive animal species considering high anthropogenic load and the fact that adjacent arable lands are intensively cultivated and the disturbance factor is high. The area itself is favorable only for small mammals: Hedgehog – (*Erinaceus concolor)*, Caucasian mole – (*Talpa caucasica)*, Small Forest Mouse – (*Sylvaemus uralensis);*

The riparian line of Alazani river and in 1,0-1,2 km to the east of WWTP, near existing fish ponds, there is favorable living environment for Common Otter – *(Lutra lutra)*, which is enlisted in the Red List of Georgia. The project area itself is not favorable habitat for otter, which is proved by analysis of baseline condition, namely: From the one hand the disturbance factor is quite high due to intensive activities on

adjacent agricultural and arable lands, and on the other hand, the water body is in large distance (1.3 km) (as a rule, otter makes its hole near water, and exit from the hole is inside the water).

According to the survey results, areas, favorable for bat shelters are not got within the project impact zone.

Birds: The survey observed distribution of the following bird species in the region: Lesser Spotted Eagle – (*Aguila pomarina),* Peregrine – (*Falco biarmicus* **VU)**, common kestrel – (*Falco tinnunculus),* Kite – (*Milvus migrans),* Forest Owl – (*Strix aluco)*, great spotted woodpecker – (*Dendrocopos major)*, lesser spotted woodpecker – (*Dendrocopos minor),* Jays – (*Garrulus grandarius),* common cuckoo – (*Cuculus canorus)*, common blackbird – (*Turdus merula)*, Wood pigeon – (*Columba palumbus)*, great tit – (*Parus major),* Eurasian wren – (*Troglodytes troglodytes)*, common chaffinch – (*Fringilla coelebs)*, Magpie – (*Pica pica)*, Rook – (*Corvus frugilegus)*, Spades – (*Corvus cornix),* Seagull – (*Larus* sp.), Hoopoe – (*Upupa epops)*, European bee-eater – (*Merops apiaster),* Quail – (*Coturnix coturnix),* etc. During field works within the WWTP project area following small bird species have been identified: Jay, blackbird, bearded tit, magpie; within adjacent agricultural lands - pigeon, orn rook, crow. The habitat for large size predatory birds (especially Red List species) is significantly restricted within the area and they are not inhabited here. WWTP area is not a significant migratory corridor of birds and it is unlikely that such birds can get within the site.

Following should be singled out from **Amphibians** distributed in the region**:** Green Toad –(*Bufo viridis)*, Common Toad – (*Bufo bufo),* Caucasian parsley frog – (*Pelobates caucasicus)*, as well as forest Fog – (*Rana rididunda)*, for which favorable habitat conditions are created within the project area. Due to significant distance from Alazani river and other important water bodies, populations of various amphibians should not be large on the project area. That is why the number of animals preying them is small.

Reptiles inhabiting in the region**:** grass snake – (*Natrix natrix),* water snake – (*Natrix besselata)*, large-headed water snake – (*Natrix megalocephala),* Aesculapian snake – (*Elaphe Longissima),* slow worm – (*Anguis fragilis)*, Greek Tortoises – (*Testudo pontica)*, Caucasian lizard – (*Darevskia caucasica)*, Georgian lizard – (*Darevskia rudis)* is more frequently found, Dagestan lizard –(*Darevskia dagestanica)*, etc. Turtle, lizard, slow-worm can be observed in the region.

Fish. Information on fish species in Alazani River is based on literary data and interviews with local communities and fishermen. Freshwater fishes are widespread within the section of Alazani River where it is bordered to the project area. Alazani River in the upstream is a mountain river, which according to the inclination is an ecosystem zone of trout, where fish populations, characteristic to wide riverbed and slow stream rivers are widespread.

The following fish species have been identified in Alazani River: Alazani Nase – (*Ghondrostoma nasus)*, ray-finned fish – *(Barbus mursa)*, common carp - *(Cyprinus carpio),* Barbel - *(Barbus capito),* Sevan khramulya - *(Varicorhinus capoeta)*, Barbel - *(Barbus barbus)*, Danube bleak - *(Chalcalburnus chalcoides)*, Chub - *(Leuciscus cephalus)*, Bleaks - *(Alburnus filippi)*, Roach - *(Rutilus rutilus),* River Goby - *(Gobius cephalarges),* common carp - *(Cyprinus carpio),* Barbel - *(Barbus capito)*, Catfish - *(Silurus glanis),* Trout (*Salmo fario)*, (lives in upper reaches of the river) etc. Based on literary sources and interviews with local fishers, there are no habitats for river trout within the impact zone (downstream from effluent discharge point).

Invertebrate animals: following groups of invertebrate animals are represented within the study area: Nematodes – (*Nematoda, Oligocheta),* Leeches – (*Hirudinea),* Molluscs – *(Mollusca), Crustacea, Arachnida* and Insects – (*insect).*

5.2.3 Protected Areas

There is no any protected area in the vicinity of the study corridor.

5.3 Description of the Socio-Economic Environment

5.3.1 Population

Based on the data of the National Statistics Office, the approximate population of Telavi Municipality is 38,7 thousands individuals, population density is 36 individuals on km^2 that is significantly less than the average indicator of the country (67individuals/km^2). It should be noted that the demographic situation is extremely troublesome in the recent years in Telavi municipality. This is caused by the low birth rate and migration from the municipality.

Number of population of Kakheti region, including in Telavi Municipality (2009-2016) is presented in the table 5.3.1.1.

Table 5.3.1.1. The number of population in Georgia, in a research region and municipality (thousand persons).

	2009	2010	2011	2012	2013	2014	2015*	2016
Georgia	4,385.4	4,436.4	4,469.2	4,497.6	4,483.8	4,490.5	3,713.7	3,720.4
Kakheti region	401.4	404.5	406.2	407.1	405.1	405.0	318.4	318.4
Telavi Municipality	69.8	70.5	71.0	71.2	70.9	70.9	58.3	38.7

Note: the given data is based on the results of population cencus of November 5, 2014 and the sum of natural increase of the last 2 months of 2014 (natural increase + balance of migration).

Based on the data of the National Statistics Office, according to 2016, 19,6 thousands persons live in Telavi.

Prognostic number of population within the area served by the proposed treatment plant is given in Table 5.3.1.2.

Table 5.3.1.2 Prognostic number of population within the area served by the proposed treatment plant

	Phase 1 – 2030		Phase 2 – 2040	
Town/village	Number of population	Associated with the treatment plant	Number of population	Associated with the treatment plant
Telavi	23,065	Yes	23,461	Yes
Kurdghelauri	5,096	Yes	5,183	Yes
Chinandali	3,843	Yes	3,909	Yes
Vardisubani	3,270	Yes	3,326	Yes
Shalauri	2,902	Yes	2,952	Yes
Kodoli	2,772	Yes	2,820	Yes
Kisiskhevi	2,524	Yes	2,567	Yes
Nasamkhrali	637	Yes	648	Yes
Karajala	9,123	No	9,279	Yes
Rusipiri	3,213	No	3,268	Yes
Ikalto	2,985	No	3,036	Yes
Akura	2,536	No	2,579	Yes
Kvemo Khodasheni	1,829	No	1,860	Yes
Gulgula	1,527	No	1,553	Yes
Busheti	1,419	No	1,443	Yes
Vanta	1,276	No	1,298	Yes

5.3.2 Migration

There is a natural decrease of population in Kakheti, both in cities and villages. Therefore, in- and out-migration of the population is obvious. Based on surveys, carried out in the region and according to the obtained information, there is a whole number of deserted villages in Kakheti.

Feminization of out-migration is observed in Kakheti as well as in whole Georgia, which has a sharp negative impact on the demographic indicator of population.Due to the lack of prospects for finding a job, young people often leave the region. This leads to the ageing of population, especially in villages.

5.3.3 Employment Rate

The table given below shows the level of the economic activity of Kakheti region. The figures are obtained from HIS (Integrated Household Survey).

Table 5.3.3.1. Economic Activity Level in Kakheti Region for 2014-2015 (thousands person and %)

	year	
	2014	**2015**
Total active population (workforce)	196.3	192.0
Employed	186.2	180.7
Hired	45.6	53.2
Self-employed	140.6	127.4
Undefined	0.0	0.1
Unemployed	10.1	11.3
Population out of the workforce	76.4	77.1
Unemployment Rate (%)	5.2	5.9
Activity Rate (%)	72.0	71.4
Employment Rate (%)	68.3	67.1

5.3.4 Economics

Leading field of the region is viticulture; gardening, cereals farming, horticulture, production of oilseeds, meat and dairy are also developed. Significant enterprises are wineries, food and light industry facilities. Highway passes through the territory of the region.

Manufacturing is not well-developed in Telavi. Small processing factories, wineries, small bake houses and others operate on the territory of the municipality. Certain amount of enterprises uses energy-efficient installations.

Road construction companies are actively operating in the construction field. Rural Areas Assistance Program and infrastructural works funded by the Municipal Development Fund significantly supported activation of the construction field. But number of locals employed in the construction works is not considerable and doesn't exceed 5%.

Basic income source of the population is trading, agriculture and service field (population trade with wine, vodka, vegetables and meat).

There are no large industrial facilities in the vicinities of Telavi WWTP. Population is mostly employed in agriculture (viticulture) sector. It should be also noted that there is a fish farm near the project territory.

5.3.5 Agriculture

38% of Georgia's agricultural land is in the Kakheti region, where arable lands and pastures occupy the largest area. Kakheti ranks first in Georgia in this category of lands and is therefore a leading region in the production of cereals and livestock.

Agriculture is one of the leading fields of economy in Telavi municipality. The administrative unit is mostly distinguished by viticulture. According to the local government, land resources of the municipality have not reduced in the last 10 years and they have not been degraded as well. Certain amount of agricultural lands is in the ownership of the population, while the other part is leased.

Vine is the priority in the municipality. As for the other cultivated cultures, decrease of their productivity is observed in the recent years, basic reasons of such processes are ineffective farming, insufficient irrigation and bad weather conditions. In addition, reduction of productivity is also caused by the high costs of equipment and fuel. Due to the lack of agricultural equipment, their failure and absence of funds, considerable part of the arable lands is not cultivated on the territory of Telavi municipality. Approximately 80% of arable lands of the municipality need irrigation, but the lack of irrigation system and their failure hamper the irrigation process. In addition, 5 % of the arable lands are required drainage, but there is no drainage system in the municipality.

One of the main income sources of the population is also animal husbandry. Grazing of the cattle from other municipalities on Telavi pastures is not observed. Cattle breeding, as well as sheep and goats farming is basic fields of animal husbandry.

Agricultural services such as veterinary services and mechanization centers are poorly developed in the municipality. There is the Agricultural Service in Telavi, but the non-governmental sector mainly carries out introduction of new technologies in this field. Both, males and females participate in the management of the agriculture.

As it was mentioned, agriculture is well developed near the project territory. Nearby agricultural lands are intensively cultivated and locals also follow the viticulture. They also have cattle. Fish farm located near the project area, which is in the ownership of Tobi Ltd, is also noteworthy.

5.3.6 Healthcare and Social Welfare

There are 16 medical institutions in Telavi municipality, including hospitals, out-patient clinics and emergency centers. Main data about healthcare in the region is given below, in Table 5.3.6.1.

Table 5.3.6.1. Main Indicators of Healthcare in Kakheti Region

	Year	
	2014	**2015**
Number of physicians of all specialties total, thsd.	1.1	1.2
Number of paramedical personnel total, thsd. *	0.7	0.7
Number of hospitals, unit	16	16
Number of hospital beds, thsd.	0.4	0.5
Number of medical institutions rendering out-patient services to population, unit	251	260
Number of visits in medical institutions rendering out-patient services to population (including prophylactics), thsd.	645.4	531.4

5.3.7 Tourism

Around 30 hotels of different levels (including the expensive hotel Ambassador, Lopota, Dzveli Telavi, Kvarlis Tba), more than 100 small hotels and guest houses, around 70 catering facilities, restaurants, café-bars, etc. (being only 3.4% of similar facilities in Georgia), and 15 travel companies operate in the Kakheti region.

The natural biodiversity of Kakheti provides an opportunity for the development of recreational tourism in Akhmeta, Gurjaani, Telavi, Sagarejo, Signagi and Kvareli municipalities.

There are no significant tourist sites observed near the project WWTP site. The area has the lowest value from touristic point of view.

5.3.8 Waste Management

Waste management is provided by special service (Solid Waste Management Company of Georgia LLC) in the municipality, which serves Telavi city and adjacent villages. There is no sanitary landfill in the municipality. Waste Management Service provides waste disposal on areas near Telavi. Leachate and gases are not controlled on landfill. The information on number and volume of waste, disposed on the landfill by the above-mentioned service is not available to the Working Group.

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. Composting is not introduced in the municipality. According to the Working Group, in recent years the central government has not implemented waste management improvement projects.

5.3.9 Historical Cultural Heritage Monuments

Ikalto Monastery Complex is noteworthy from architectural monuments of Telavi municipality. Old Shuamta Monastery is also noteworthy. The ensemble includes the Basilica of V century, domed and small domed church. In XVI century the old Shuamta Monastery was abandoned. Not far from it a New Shuamta Monastery was built by Tinatin Gurieli, the wife of King Kakheti Levan II.

The ancient (VI-VII centuries) church of Virgin Mary is located in Kisiskhevi village. Mamadaviti Monastery is in Akura village. Historical monuments are also preserved in Ruispiri village. Other monuments are also there: Vanti Palace Complex, Adamant Fortress and others.

There are no historical-cultural monuments in the vicinities of the project territory. Due to the anthropogenic loading of the territory, possibility of chance finding of archeological monuments is quite low.

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 populations, 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 quantitatively. Assessment of the impacted environment has been implemented based on their quality 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.

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 is also given in this annex.

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 2.

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.

Table 6.5.1 Evaluation criteria of the impacts related to the noise

Ranking	Category	Residential zone	Working, industrial or commercial zone
1	Very low	Acoustic background will increase by less than 3 dBA[3], 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 Alazani River Water Quality Impact Assessment Methodology and Criteria on WWTP Operation Phase

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

From WWTP wastewater will be discharged in one point of Alazani 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 Alazani 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.

[3] Such alteration is not felt by the majority of people

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 Groundwater

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 water bodies, which will cause a seasonal drought.	Hazardous substances of I group is observed
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.

[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"

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 Engineering-Geological Survey Methodology and Assessment Criteria

Methods Used during engineering-Geological Survey

Boreholes (11 units) and pits trial pit have been arranged on the project area. The depth of each borehole is 10,0-12,0 m, total depth - 12,0 longitudinal meters. After completion of drilling works, boreholes were filled with drilled material, each with 0,3-0,4 m layer compaction.

In order to study engineering-geological conditions of the construction site and determine foundation conditions of the project structures, “Construction Norms and Rules” - 1.02.07-87 p.p. 3.62; 3,63; 3,64; 3,65; 3,67) were used. Boring was provided with device “УГБ-50 1ВС”, which is installed on vehicle “ГАЗ-66”, state № WUW-379. Mechanical- Core Drilling method was applied, pile diameter– 160 mm, without washing, using dry boring rule, with reduced travel, with continuous extraction of test core..

Engineering-Geological Hazard Assessment Criteria

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 6.12.1.).

Table 6.12.1 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 6.13.1 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 have been defined and possible changes in the quantitative and qualitative characteristics of the environment have been determined.

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.

Considering the distance to the nearest residential house (3.77 km), the main control point is defined to be at 500 meter radius, though emission calculation has been performed for residential zone as well.

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 maximum permissible concentrations of harmful substances established by Georgia's Normative Document.

Major receptors of the impact caused by deterioration of ambient air will be animal species inhabiting near the project area. Mitigation measures will be considered for the construction phase in order to reduce impact on animal species.

Overall, significance of the residual impact during the construction will be "low" or "very low".

Graphic reflection of the scattering of harmful substances is given in the Figures below.

Maximum concentrations of hydrogen sulfide (code 333) on the border of 500 meters zone (control points № 1,2,3,4) and on the border of nearest settlement (point № 5)

Maximum concentrations of Saturated hydrocarbons C_{12}-C_{19} (code 2754) on the border of 500 meters zone (control points № 1,2,3,4) and on the border of nearest settlement

Maximum concentrations of suspended particles (code 2902) on the border of 500 meters zone (control points № 1,2,3,4) and on the border of nearest settlement (point № 5)

Maximum concentrations of total impact group 6039 (code 330+342) on the border of 500 meters zone (control points № 1,2,3,4) and on the border of nearest settlement (point № 5).

Operation Phase

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.

As for the construction phase, the main control point is defined to be at 500 meter radius. Calculations have been performed for the nearest residential houses as well. (Software print-out of the report on harmful substance emission in the ambient air is given in the annex 2.)

Calculation results – or maximum concentrations of pollutants in the control points per MPC shares are given in Table 7.2.1., while the graphic reflection of the scattering of harmful substances is given in the Figures below.

Table 7.2.1 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	0,000079	0,0008
Ammonia	0,00049	0,005
Hydrogen sulphide	0,00098	0,01
Carbon oxide	-	-
Methane	0,00017	0,0018
Methyl mercaptan	0,0001	0,001
Ethyl mercaptan	0,00009	0,00092
Total Impact Group 6003	0,0015	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.

Nitrogen dioxide (code 301), Methyl mercaptan (code 1715), Ethyl mercaptan (code 1728) and Methane (code 410) maximum concentrations on the border of 500 meters zone (control points № 1,2,3,4) and on the border of nearest settlement (point № 5)

The maximum concentrations of Ammonia (code 303) on the border of 500 meters zone (points № 1, 2,3,4) and on the border of the nearest residential zone (points. № 5)

Maximum concentrations of hydrogen sulfide (code 333) on the border of 500 meters zone (control points № 1,2,3,4) and on the border of nearest settlement (point № 5)

Maximum concentrations of total impact of the 6003 group (codes 303 +333) on the border of 500 meters zone (control points № 1,2,3,4) and on the border of nearest settlement (point № 5)

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 pavement or watering is required in order to prevent windblown dust from spreading;
  - To locate generators and other equipment 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;
  - Recurrent monitoring will be set on spread of unpleasant odors. If necessary, appropriate adjustment measures should be implemented.

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,** Taking into account the mitigation measures - **low.**

7.2 Impact of Noise Propagation

Construction Phase

According to the calculation results, noise level will not exceed neither during the day time nor during the night time. In addition, a number of circumstances should be considered that makes it possible to conclude that the construction activities will not cause significant impact even at the border of 500 m radius, 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;
- 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, impact is temporary and after completion of the construction works, the majority of species will be returned to old habitats.

Operation Phase

Obtained results are consistent with the established norms for both, the day and night hours. Therefore, impact caused by noise propagation will not be significant. Though, some mitigation measures are to be implemented during the operation phase.

7.2.1 Mitigation Measures

In order to minimize noise propagation levels on WWTP construction phase, following mitigation measures are carried out:

- 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 site;
- Generators and other noisy equipment should to be allocated away from sensitive receptors (residential houses) (to the south of the construction site, which is relatively far from sensitive receptors);
- 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;
- 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

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	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	They are adjacent to the treatment plant	Long term	Reversible	**Very low**

7.3 Impact on Surface Water

Construction Phase

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

Contamination of Alazani 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.

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 on the site 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 Alazani River Water Quality

During the operation of wastewater treatment plant, purified wastewater is planned to be discharged into one section of Alazani River. Effective system of wastewater treatment is proposed in accordance with the project, which provides regular treatment of wastewaters in case of the proper operation rules. On the first phase of the project (reference year – 2030) removal of suspended particles, BOD and COD is planned from the wastewaters, while on the second phase (reference year – 2040) 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 Alazani 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 Alazani 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 - 36,4 mg/l and total phosphorous - 7,29 mg/l.

According to the relevant calculation, in order to provide proper water quality 200 m below from the discharge section, wastewater with total nitrogen no more than 83,5 mg/l (more by 2,3 than the actual discharge) and total phosphorous no more than 8,0 mg/l can be discharged in Alazani River. For the 2nd and 3rd reference sections, calculated values of maximum permissible discharge are far more than the actual discharge.

It means that hydrological characteristics of Alazani 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 – as it was mentioned above, industrial-fecal wastewaters are discharged in Alazani River without any treatment. After rehabilitation of the drainage system of sewage waters, 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 wastewaters 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 Alazani 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 Alazani River

According to the project, peak flow of wastewaters for 2030 is 0,267 m^3/sec, while for 2040 - 0,391 m^3/sec. In compliance with the information given in the EIA report, paragraph 5.2.2.6., maximum flow of Alazani River for 100 –year return period is 1430 m^3/sec, maximum flow of 10-year period is 750 m^3/sec. Difference between the wastewater flow and natural flow of Alazani River is so considerable that practically, no impact is expected on Alazani River 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 (Alazani River) pollution prevention measures during the construction phase are:

- To ensure proper maintenance of vehicles / equipment;
- Vehicles / equipment 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 on the site 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 will be protected, project of MPD norms will be updated in every 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 of Georgia will be provided with an accurate information about the volume and quality of wastewater;
- Control of the efficiency of wastewater treatment plant operation and in case of possible malfunction implementation of appropriate corrective measures;
- 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 normative documents, following measures will be immediately carried out for improvement 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;
    - Repair-maintenance and calibration works of the treatment plant will be carried out;
- 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
- In case maximum permissible discharge of pollutants are exceeded, appropriate measures will be taken to remedy the situation promptly (appropriate repairs and maintenance works will be implemented). At the same time, 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;

7.3.2 Impact Assessment

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 Alazani 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.	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	Alazani 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 Alazani 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	Alazani 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 equipment 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 / equipment. In case of damage and fuel / oil spillage, 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 on the area and construction sites. Industrial-fecal wastewaters will be collected in cesspools;
- Drainage / water channels should to be arranged throughout the perimeter of potentially polluting sites of wastewater;
- Systematic control will be set on measures considered by the Waste Management Plan;
- 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

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 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 (Alazani River)	Mostly indirect	Medium risk	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 (Alazani 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 Integrity

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 (preparation of the construction site, movement of vehicles, earth works, arrangement of temporary and permanent infrastructure, 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 (on the north periphery) till the completion of construction works. In frames of the project capacity of removable topsoil layer from the project territory, where the infrastructure shall be located, will be approximately 9706 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.

Soil/Ground 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 equipment 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).

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 prevent 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 temporarily 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 stock pails should not exceed 2 meters; the tilt angles of the slopes of stock pails 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 spillage 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 equipment 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

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	Medium risk, taking into account mitigation measures – low risk	Work 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 (in case of siltation with sediment contaminated water – indirect). Negative	Medium risk	Work 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 Alazani River. However, the area of the treatment plant will have a vertical layout, namely, elevations of the area will be raised and the infrastructure of the treatment plant will be arranged above the existing elevation of the land surface. In addition, insulating layer will be used, which means clay roofing system. Appropriate drainage system will be arranged within the project area.

7.7 Landscape and Visual Impact

Construction Phase

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

Residents of the nearest settlement and passengers, moving on the highway should be singled out among sensitive receptors to visual and landscape changes. It should be noted that the project area is 3.7 km away from the nearest settlement (Kondoli village). Based on this, the impact risk on population is almost absent. As for the passengers, it should be noted that the impact is temporary and short-term.

After completion of construction works, vehicles and equipment, 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, passengers 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 color 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

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: – Temporary structures; – Waste disposal; – Works related to construction and transportation.	Animal species inhabiting in the vicinity, population	Direct, Negative	Medium risk	Areas adjacent to construction 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 surveys revealed that the project area is heavily anthropogenous and modified habitat. It is floristically impoverished.

Secondary bushy types of different plants are quite densely distributed on the territory. Various secondary shrubberies can often be met here. Area is mostly covered with lianas and thorny shrubs. According to the conducted surveys about 415 trees will be cut during construction works. One unit of walnut (*Juglans regia) (VU)* and 6 specimens of European oak *(Quercus pedunculiflora*), included in the Red List of Georgia, are observed within the site. However, according to WWTP infrastructure layout, they will not get within the direct impact zone. If on construction phase it will be necessarily required to cut these species, consequent actions should be taken in accordance with requirements of Georgian legislation (see mitigation measures).

In spite of the fact that the project area is under heavy anthropogenic load, density of vegetation cover and proximity to Alazani river creates favorable habitat for mammals, amphibians and reptiles. Vegetation cleanup on the area will limit their living environment at some extent, however, it should be noted that analogous habitats are quite widespread within Alazani river valley. Accordingly, impact on critical habitats will not take place. Reduction of vegetation cover and other factors of disturbance will not result in animal migration to far distances. They will be able to find suitable living conditions in the direction of riparian areas of Alazani river, where trees and vegetation cover is dense enough and free from impact of agricultural activities of people. Despite the fact that the project will not have significant impact on habitat integrity, it is necessary to carry out certain mitigation measures.

After completion of construction works the area will be recultivated and this will significantly reduce the quality of the impact.

Considering the aforementioned impact on vegetation cover and habitat integrity can be assessed as **Medium**. Project related impact can be mitigated by proper organization/management and implementation of corresponding mitigation measures.

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 occur 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. In the north quite dense vegetation cover is developed. Accordingly, habitat fragmentation impact will be minimal.

Potential impact on vegetation cover and habitat integrity during the operation phase can be assessed as very low-quality impact.

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. Detailed compensation measures of the damage will be determined by a stat body that issues permits:
    - 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;
    - The issue of removal of less valuable plants will be agreed with the local government (administration (Gamgeoba) of Telavi municipality). Proper compensation measures will be determined by agreement with the mentioned body. The cut timber will be transferred to the administration of Telavi 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; lianas and shrubs dominate among other vegetation cover, which cannot create critically significant habitat for large mammals. It is noteworthy that adjacent agricultural and arable lands are intensively cultivated, 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 due to construction works is not expected.

During vegetation cleanup habitat for small mammals such as Hedgehog – (*Erinaceus concolor)*, Caucasian mole – (*Talpa caucasica)*, Small Forest Mouse – (*Sylvaemus uralensis).* Construction works

may have direct impact on following bird species: Common blackbird – (*Turdus merula)*, Wood pigeon – (*Columba palumbus)*, great tit – (*Parus major),* common chaffinch (*Fringilla coelebs),* Magpie – (*Pica pica*), Jays – (*Garrulus grandarius).*

During implementation of earth works shelters of small animals (hedgehog, mole, 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 and make them to leave the area. However, it should be noted that they will not migrate to far distances. They will be able to find suitable living conditions in the direction of riparian areas of Alazani river, where trees and vegetation cover is dense enough and free from impact of agricultural activities of people. Bird species inhabiting within the area will be the most sensitive toward the impact.

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

There were no habitats of Red List species of Georgia observed within the project area and accordingly direct impact on them is not expected.

It is noteworthy that construction works will last for 1 year. After completion of works and stopping disturbance sources, many species will return to old habitats.

Based on the above mentioned, impact on the wildlife during the construction phase can be assessed as a medium. In case of implementing mitigation measures and constant monitoring, it will be possible to reduce impact to a “low” or “Medium” significance.

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 Alazani River water, impact on aquatic 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 Alazani river. Following species can get within the impact zone: Alazani Nase – (*Ghondrostoma nasus)*, ray-finned fish – *(Barbus mursa)*, Barbel – (*Barbus capito),* Sevan khramulya – (*Varicorhinus capoeta)*, Barbel – (*Barbus barbus)*, etc. In order to reduce such risks, special attention should be paid to following of WWTP operation

technological scheme. Red List specie of Georgia – brook trout *(Salmo fario)* does not inhabit within the potential impact zone and impact on this specie 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 Alazani 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;
- Usage of direct light will be minimized in order to reduce the spread of light;
- Activities causing too much disturbance of animals should be implemented in a short period of time, not during breeding period if possible;
- Recultivation of the site and other damaged areas 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

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 site – Indirect impact area – areas adjacent to the 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 work 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 Alazani 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 Telavi 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 solid household waste landfill near Gulgula village. An agreement will be signed with Solid Waste Management Company of Georgia on the above-mentioned issue. Waste delivery and disposal to the landfill will be carried out in accordance with technical conditions issued by the above-mentioned company.

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 Telavi 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).

The important fact is that the Georgian legislation does not regulate the sludge usage issue for agricultural purposes. According to European Regulations, 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 (Telavi landfill, in the vicinity of Gulgula village, the approximate distance of transportation is 10 km). Operator Company of the landfill is Solid Waste Management Company of Georgia LLC. Solid Waste Management Company has made a commitment on disposal of sludge on Telavi Landfill.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 Telavi 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. Prior to commissioning of WWTP, issue of dried sludge delivery to Telavi landfill and its disposal conditions must be agreed with Solid Waste Management Company of Georgia.

Considering the capacity of sludge drying beds (2903 m^3) and annual amount of generated sludge (about 3700 m^3), temporary storage of sludge is possible for maximum 287 days. However, the off-site sludge disposal will be organized on a regular 3 or 4 month basis, such that the disposal trips will be conducted about once per season. The sludge will be transported to the offsite disposal site by the transportation means owned or hired by WWTP and its existing personnel.

It is supposed to use 10 m^3 capacity dump trucks (with canvas 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 370 trips (95-125 trips per season). As it was mentioned above, transportation distance is 10 km. Considering the practice introduced in Georgia, the expenses, required for 1 m^3 transportation on 10 km distance is 10 GEL (4,2 USD). This includes all expenses (fuel, vehicle maintenance, driver wage, etc.). Accordingly, annual transportation cost for sludge transportation, generated during Telavi WWTP operation will be: 3700 x 10 = 37000 GEL (15400 USD).

As for 2017, on Gulgula landfill tipping fee for disposal of 1 m^3 solid waste is 20 GEL (8,3 USD). Accordingly, overall annual tariff for disposal of sludge, generated during operation of Telavi WWTP will be about: 3700 x 20 = 74 000 GEL (30 800 USD).

Overall cost for sludge transportation-disposal will be about 111 000 GEL/a (46 000 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 Telavi 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 prevent 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;
- Maximum protection of safety rules during the transportation;
- Transportation should to be limited to a minimum in populated areas;

- Risk assessment should be conducted regularly 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 employed by the construction contractor, which is the positive impact on employment.

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.

As it was already mentioned, 15-20 people will be employed during the operation phase. Despite this is not a significant number, implementation of the project may be considered as a positive impact on municipal development of Telavi and improvement of life quality of population.

Impacts on Transport Infrastructure, limited Traffic

The road, which is connected to Telavi-Shakriani highway 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.

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 Telavi);
- 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.

The use of vehicles during the operational phase will be necessary for repair works. Accordingly, traffic will not be intensified and impacts on traffic are not expected.

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 Telavi 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 Telavi 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 employed during the treatment plant operation, which is a small though positive impact in terms of employment of 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. Even though some projections about expected tariffs can be made, 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

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 Telavi	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	Telavi city	Long-term	-	**Low**
Improvement of local wastewater infrastructure (positive impact)	Local population and tourists	Direct positive	High probability	Telavi 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

Telavi WWTP is projected on the area, where similar plant 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, 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 will be of medium significance. It is noteworthy that after commissioning of WWTP, the existing situation of wastewater management will be significantly improved, which will reduce negative impact on surface water quality.

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, 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 using of modern equipment (arrangement of floating aerator devices on each anaerobic tank). 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 and Financing Source

Telavi WWTP operation will be provided by local (Telavi) service center of "United National Water Supply Company of Georgia" LLC . WWTP operation costs will be covered from the budget of "United National Water Supply Company of Georgia" LLC.

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 Client'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 for construction	Cutting down the vegetation, habitat lose/fragmentation	õ Before starting the works, the personnel will be instructed on issues related to the protection of vegetation cover; 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; õ To prevent vegetation from additional damage construction site borders should be strictly define and control on border adherence should be established; õ Preparation of recultivation and landscaping project and approval by the client/the Ministry of Environment and Natural Resource Protection of Georgia;	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 sealed 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.	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;	Civil contractor	Must be included into the total cost of the project.

			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.		
		Topsoil loss and WWTP site degradation	õ Remove topsoil and separate the subsoil layer from other materials and stockpile on preliminary allocated area: 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, disruption of living areas, habitat fragmantation	õ Construction site borders 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 possible 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 the surfaces of operation roads during intensive movement in 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 infrastructural facilities	WWTP and pumping station site	Noise propagation, dust and combustion product emissions	õ Ensure maintenance of machinery; • To turn off the engines or work at minimum turn, when they are not in use; õ Provide information and explanations for local population;	Civil contractor	Must be included into the total cost of the project.

			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.		
		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 site for temporary storage of hazardous waste, and arrange labeled, sealed containers on construction sites; õ Removal of the hazardous waste from the construction sites for the further management to be done by the contractor having an appropriate permission on these	Civil contractor	Must be included into the total cost of the project.

			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 coniferous plants on the perimeter of treatment plant site	Civil contractor	Must be included into the total cost of the project.
		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; õ Instruct personnel on environmental issues.	UNWSCG	Must be included in WWTP OPEX
		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 dump trucks with canvas top; õ Disposal of dewatered sludge extracted from WWTP on Telavi 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
Labor protection and ensure human safety	WWTP area	Human (working personnel, local residents) health and safety risks	**a.** Train personnel on health and labor protection issues; **b.** Provide staff with personal protective equipment; **c.** Fencing work areas dangerous for health; **d.** Provide medical kits on the plant; **e.** Ensure proper working of machinery; **f.** Control getting and moving of strangers at the workplace without special permit or without special protective equipment; **g.** Keep register for accidents and incidents.	UNWSCG	Must be included in WWTP OPEX

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 – Construction Phase

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 Check dust spreading during intensive work and traffic movement, especially in dry weathers; õ Check technical functionality at the beginning of the working day;	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 Check technical functionality at the beginning of the working day;	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;	õ Visual observation – at the end of the working day;	õ Visual observation - Through MDF technical supervisor.
Temporary storage of removed ground and topsoil	õ Construction area; õ Civil contractor	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; Check documented agreement on temporary disposal of soil.	Shortly after completion of earth works.	Through MDF technical supervisor

	office			
Industrial-fecal wastewater management	õ Construction area; õ Civil contractor office	Visual observation: õ Collection of industrial-fecal wastewater in sealed 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 Check documented agreement on cleaning of vegetation cover;	õ Visual observation – during cleaning process of vegetation cover; õ Check documentation – prior to cleaning works of vegetation cover;	Through MDF technical supervisor

Habitats of animal species	õ Construction area perimeter;	Visual observation: • No habitats of animal species (nests, holes, shelters) are identified.	õ On each section of the project area prior to dismantling works.	Through MDF technical supervisor
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 field lactometer).	Control of technical functionality - periodically; Personnel/population survey - periodically; Instrumental measurement -	By UNWSCG through designated technical supervisor

			periodically, especially in dry and windy weather, as well as in case of grievances.	
Alazani River water quality	õ In 200 m downstream from wastewater discharge point.	õ Laboratory test of Alazani 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 Alazani river	õ Effluent laboratory test:		UNWSCG, with the help of accredited laboratory if necessary
		o PH	daily	
		o Suspended solids;	daily	
		o BOD;	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-drying of excess sludge; õ Places with corresponding areas and solid surface are used for temporary disposal of excess sludge; õ Excess sludge is not kept for a long time; 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	Periodically	By UNWSCG through designated technical

		allocated on the site, which is labeled appropriately; õ Hazardous waste storage areas are protected from outsiders infringement and weather 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;		supervisor
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;	After making decision on termination of WWTP operation .	Local government; Ministry of Environment Protection and Natural Resources of Georgia and other stakeholders.

		õ Management conditions for generated waste; õ Safety issues.		
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 Telavi WWTP local self-government (Administration of Telavi 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 old 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 was published in central (to be filled after publication in the press), as well as in local (to be filled after publication in the press) press, where the time and place of holding public hearing was indicated (to be filled after publication in the press) (the building of Telavi municipality, address: King Erekle II av. №16, Telavi town). The statement containing similar information will be posted in the building of Telavi 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:
  - Telavi Municipality building- address: King Erekle II av. №16, Telavi town;
  - 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 and Natural Resources Protection 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;
- Giorgi Bzhalava Tel: 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. Participation in public hearing is important for the residents of following settlements of Telavi municipality: Telavi city, Kondoli village, Gulgula village, Kisiskhevi village, Shalauri village. 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 (Telavi 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 Telavi Municipality Administration. Announcement will be placed in the building of Telavi 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 Telavi 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 Telavi 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.	Telavi Municiaplity 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 Telavi 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 Telavi 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 4).

The forms will be uploaded on the website of the project: www.mdf.org.ge and will be available at local administrative offices, 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.

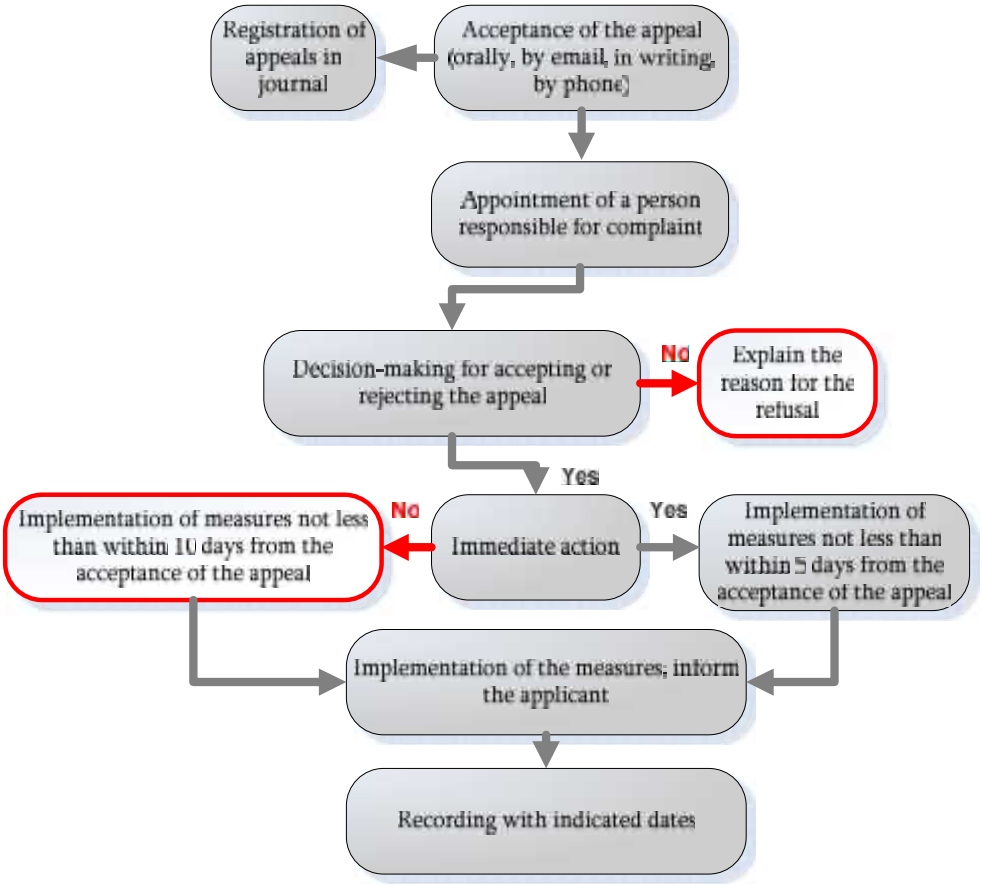
Full documentation of appeals is kept in a folder for 2 years and then it is archived. MDF will monitor the types and level of an appeal. If the appeal cannot be met within the above-mentioned period of time, MDF should inform the applicant about this and the after conducting the investigation, they 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.

Grievance procedure chart is given below in figure 12.1.

Figure 12.1 Grievance procedure



(Applicant will be informed on prolongation of claiming timeframe 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 project proposed effective system of wastewater treatment and in case of its implementation, normalized treatment of sewage wastewater of Telavi town and adjacent villages (Kurdghelauri, Vardisubani, Shalauri, Kondoli, Kisiskhevi, etc., will be provided;
- The project will be implemented in two phases: On phase 1 treatment of wastewater, expected for 2030 is projected, and on phase 2- wastewater, expected for 2040 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 Telavi town (mainly into Alazani 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;
- 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, Alazani 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;
- Local population is in the distance of 3.7 m and more from the project area, thus the negative impact risks on population will be minimized;
- 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 not expected. Therefore, carrying out corresponding mitigation measures is not required;
- 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;
- 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. 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 animal environment will not be high. Even positive influence is expected in this direction;
- 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. Vegetation cover cleaning works will start after agreement with local government. 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;
5. In case of fuel storage reservoir arrangement on the construction 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 site, and in the 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 further 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. Plants will be planted/grown on the perimeter of the site;
10. According to monitoring plan, the laboratory examination of the treated and recipient water will be carried out periodically.

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15 Annexes

15.1 Annex 1. Telavi WWTP Project Description

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

- On the first phase, the infrastructure facilities, that provide wastewater treatment in the amount expected for 2030, will be arranged. The mechanical cleaning and BOD and COD removal will be achieved;
- On the second phase, the infrastructure facilities, that provide wastewater treatment in the amount expected for 2030-2040, will be arranged. It is planned to update the treatment plant for total nitrogen and total phosphorus removal.

Design Loads and Flows

Initial data (project flows and loads of pollutants), to be considered during designing of the phase-1 (2030) and phase-2 (2040) of the project, are given in the table below.

WWTP design flows and loads for both phases

Parameter	Dimensioning Unit	2030 (I Phase)	2040 (II Phase)
Population Equivalent	PE_{60}	52000	91000
Average daily project flow	m^3/d	14400	18760
	m^3/h	600	782
Peak flow	m^3/h	960	1407
	l/s	267	391
Biochemical Oxigen Demand (BOD5) load	Kg/l	3133	5444
	mg/l	217,57	290,19
Suspended Solids	Kg/l	3574	5472
	mg/l	248,19	291,68
Nitrogen Load	Kg/d	524	842
	mg/l	36,39	44,88
Phosphorus Load	Kg.d	105	138
	mg/l	7,29	7,36

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 2030) the WWTP will provide SS (Suspended Solids), BOD and COD removal. In the second Phase (design year 2040), the WWTP will be upgraded to perform nitrogen and phosphorous removal.

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

Design Quality requirements for the treated wastewater

Parameter	Concentration
Wastewater Quality - Phase 1- Design year 2030	
Biochemical oxygen demand (BOD5 at 20 °C) without nitrification	25 mg/l
Chemical oxygen demand (COD)	125 mg/l
SS	35 mg/l
Phase 2- Design Year 2040	
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 Suspended Solids, BOD and COD decrease. The WWTP treatment process composed of anaerobic tanks, biofilters, secondary sedimentation tanks and sludge drying beds is well suited to achieve this treatment goal with low investment costs, low power consumption and low operational complexity.

The process design of Phase 1 is depicted below on the drawing.

The technical scheme for WWTP process for 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 biological process which generally requires higher efforts.

For implementation of nitrogen and phosphorous removal in Phase 2 the approach is proposed, that allows full utilization of all units previously implemented in phase 1 and other treatment stages are added to it. Main changes to be implemented on Phase-2:

- Activated sludge tank will be arranged for Nitrogen removal;
- Air-blowing station will be arranged;
- High concentration of sludge requires arrangement of the additional filter.

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:

- Connection of main pipeline to the WWTP;
- Mechanical treatment unit (so-called screening system)- 2 fine screens (automated);
- Grit chamber and distribution chamber;
- Inlet Station: 6 pumps (4+2 stand-by);
- Flow meter at the entrance;
- Anaerobic tanks – 3 units;

- Trickling filter pumping station – 4 pumps (3+1 stand-by);
- Trickling filter – 3 units;
- Secondary sedimentation tank – 2 units;
- Flow meter for treated effluents and junction to the bypass pipe in order to discharge into Alazani river;
- Operation building;
- Power supply system.

Sludge handling:

- Sludge removal from anaerobic tanks;
- Sludge dewatering on sludge drying beds – 8 units.

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

Wastewater Pre-Treatment (Mechanical Treatment)

For pre-treatment it is planned to arrange fine screens (automatic), sand trap and inlet pumping station. All of them are designed considering design peak flow of Phase-2 of the project.

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

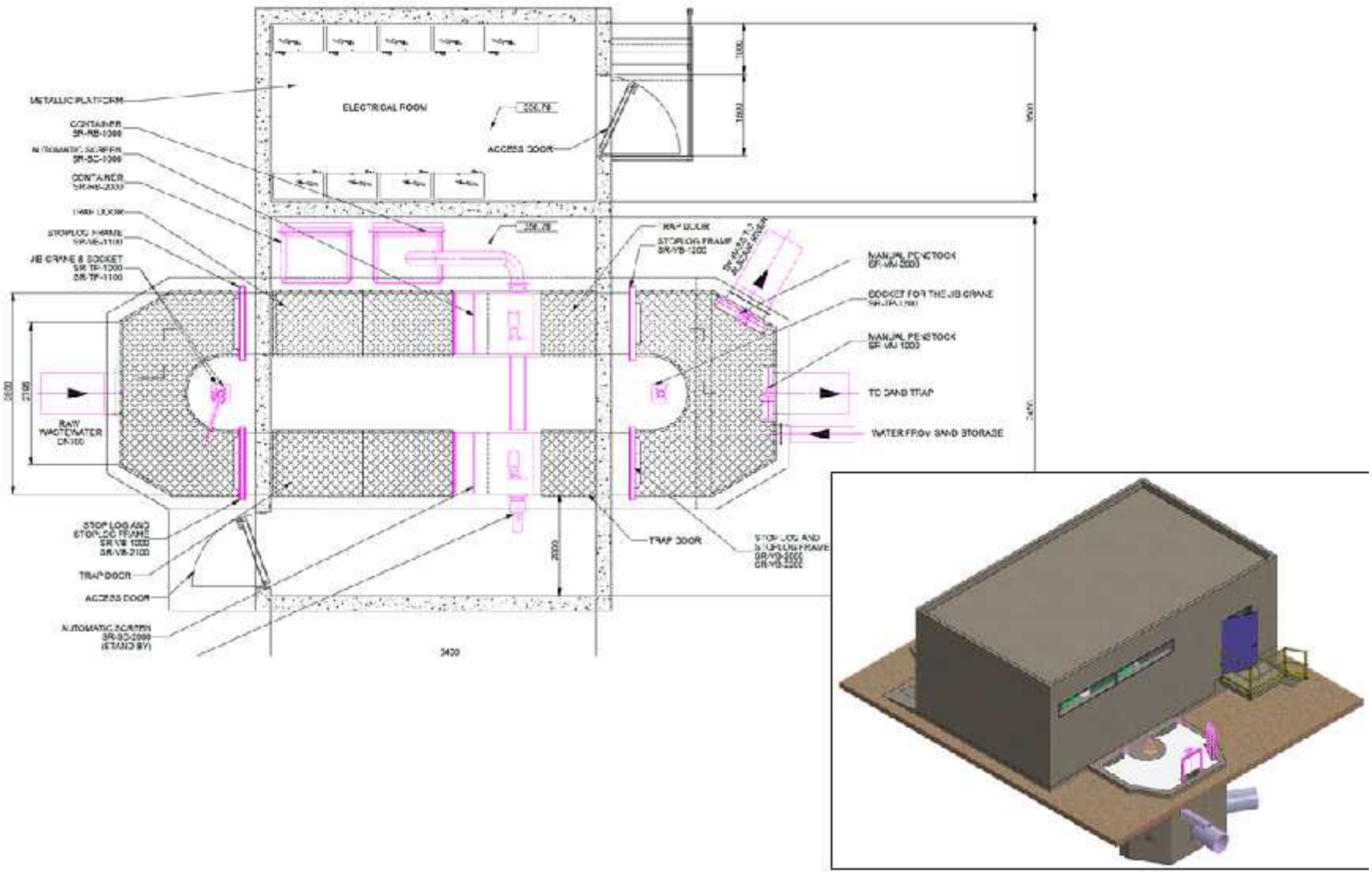
Access accumulation of grit in the water can cause wearing of mechanisms. On following stages of the technological scheme, in order to protect installed machinery, the project considers arrangement of the grit chamber. Wastewater will be discharged into channel through this grit chamber with relatively 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 and 3d image of grit chamber on figure.

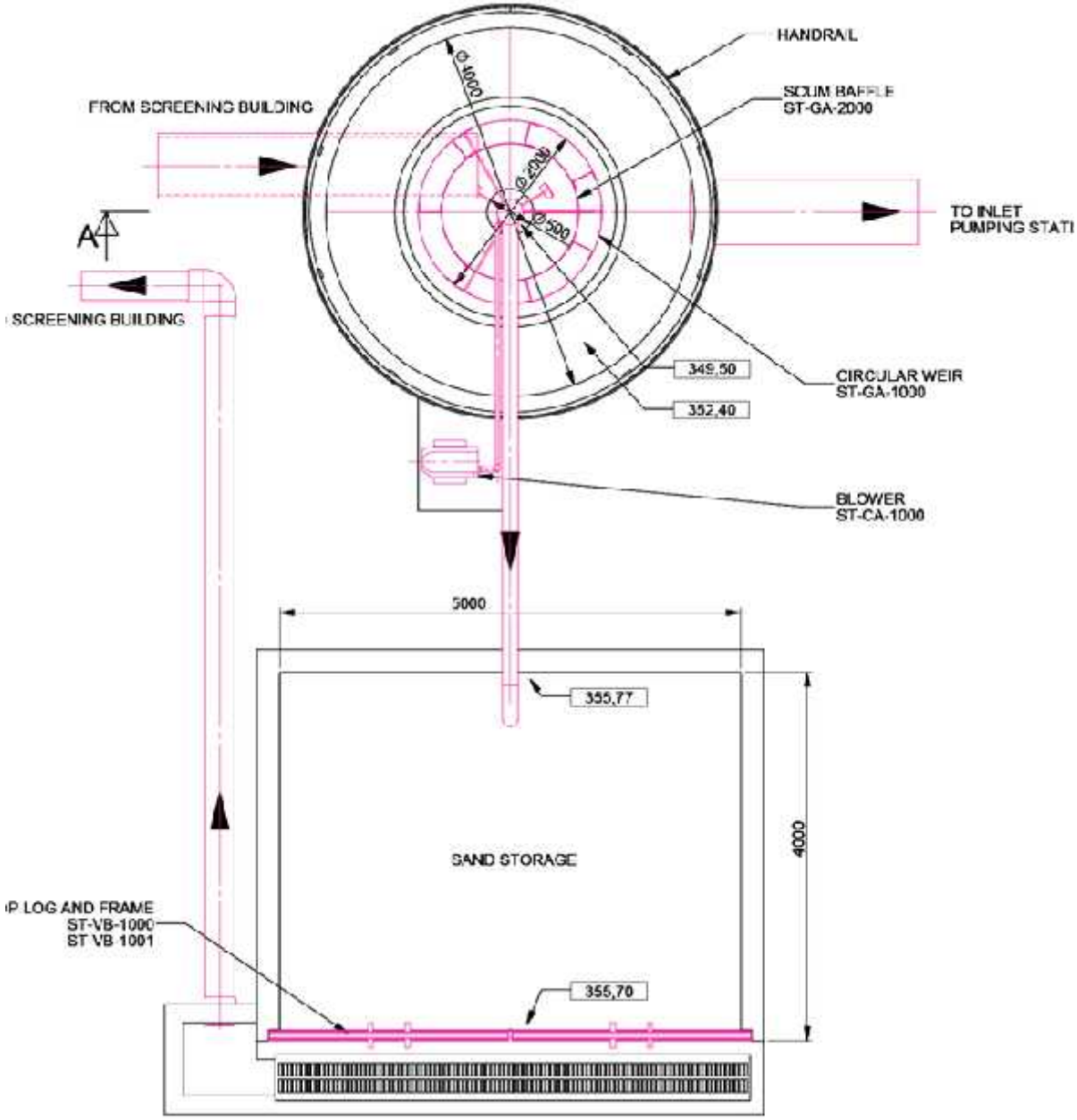
Inlet Pumping Station

After removal of grit, raw wastewater will move to inlet pumping station. It is considered to arrange 4 submerged, centrifugal pumps, calculated for 267 l/s peak flow. In order to avoid frequent switching between pumps, total capacity for two pumps will be 1/3 of maximum flow of 1 phase, and the total capacity of the rest two pumps will be 2/3 of maximum flow of 1 phase. If in rainy period inflow stream exceeds pump capacity, the water will be discharged through the pipeline. Flow meter devicee will be installed on the pipeline. After passing through inlet pumping station, the water will be evenly distributed between 3 anaeorbic tanks. Each compartment will be equipped with manually operated lock shield.

Mechanical Treatment Building Plan (m 1:50) and 3D image



Grit Chamber Plan (m 1:50) and 3D Image



Biological Treatment

Distribution Chamber

After pre-treatment (screening), the water undergoes biological treatment. The distribution chamber is divided into three compartments. Each compartment will be equipped with manual stop logs.

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 anaerobic tank also provides storage of sludge. When the accumulated digested sludge on the bottom of the tank reaches a threshold level, a removal of the settled sludge is required, which typically is only required in a one to two year interval.

Arrangement of 3 anaerobic tanks is considered. Anaerobic tanks can be operated in parallel or in series (only in one direction) .

Proposed anaerobic tanks have the following features:

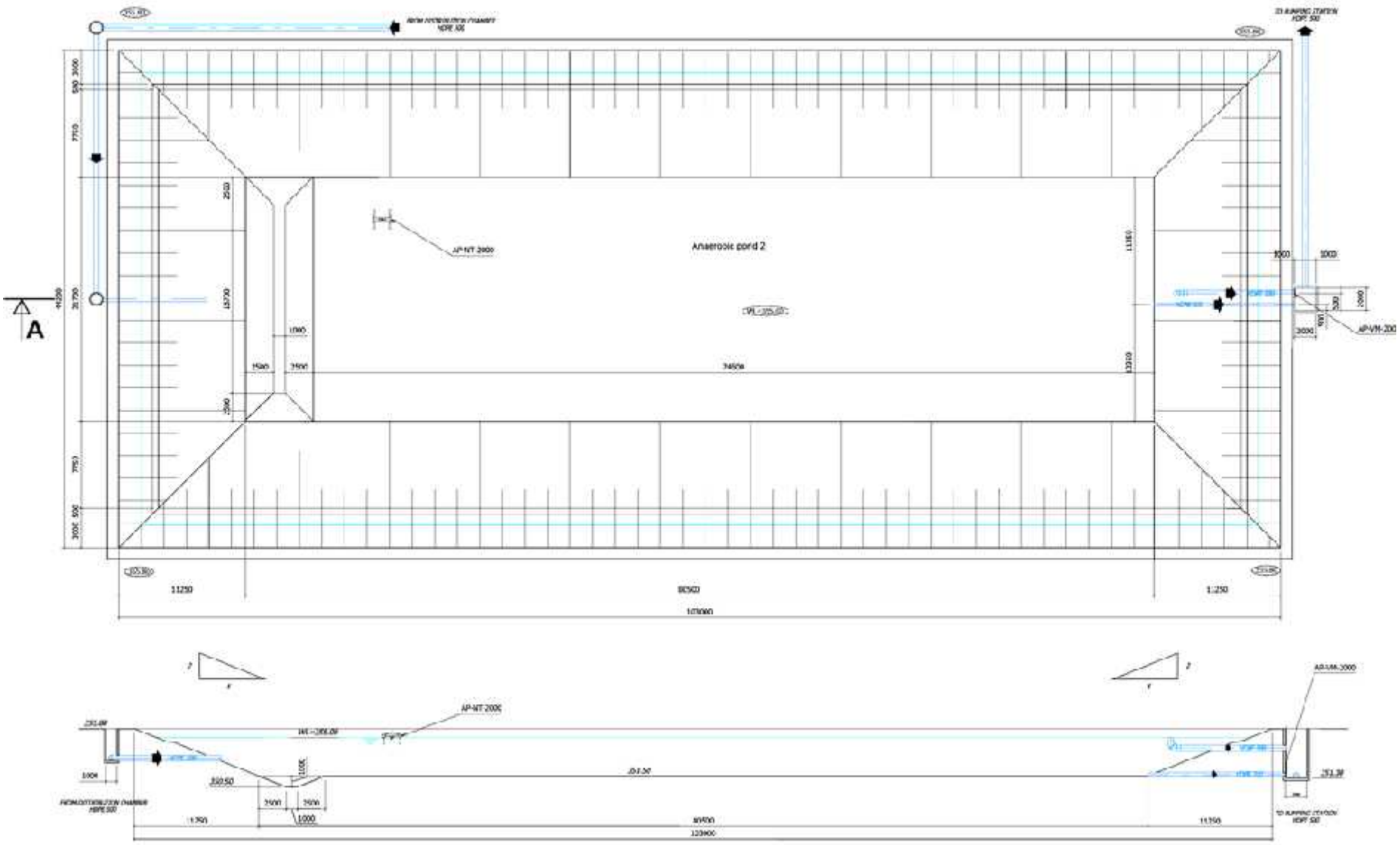
- Tanks are water resistant (covered with concrete or PEHD liner);
- Tanks serve for buffering of the hydraulic peaks for balancing the inflow. As the hydraulic peaks will be broken, the downstream treatment processes are designed for the average daily flow;
- Anaerobic tanks can be operated in parallel or in series;
- Submerged inlet and outlet will be foreseen on the tanks.

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:

- 3 small deep mixer;
- 1 sludge removal device including submerged pump.

Plan and section of anaerobic pond is given in figure.

Plan and section of anaerobic pond (m 1:200)



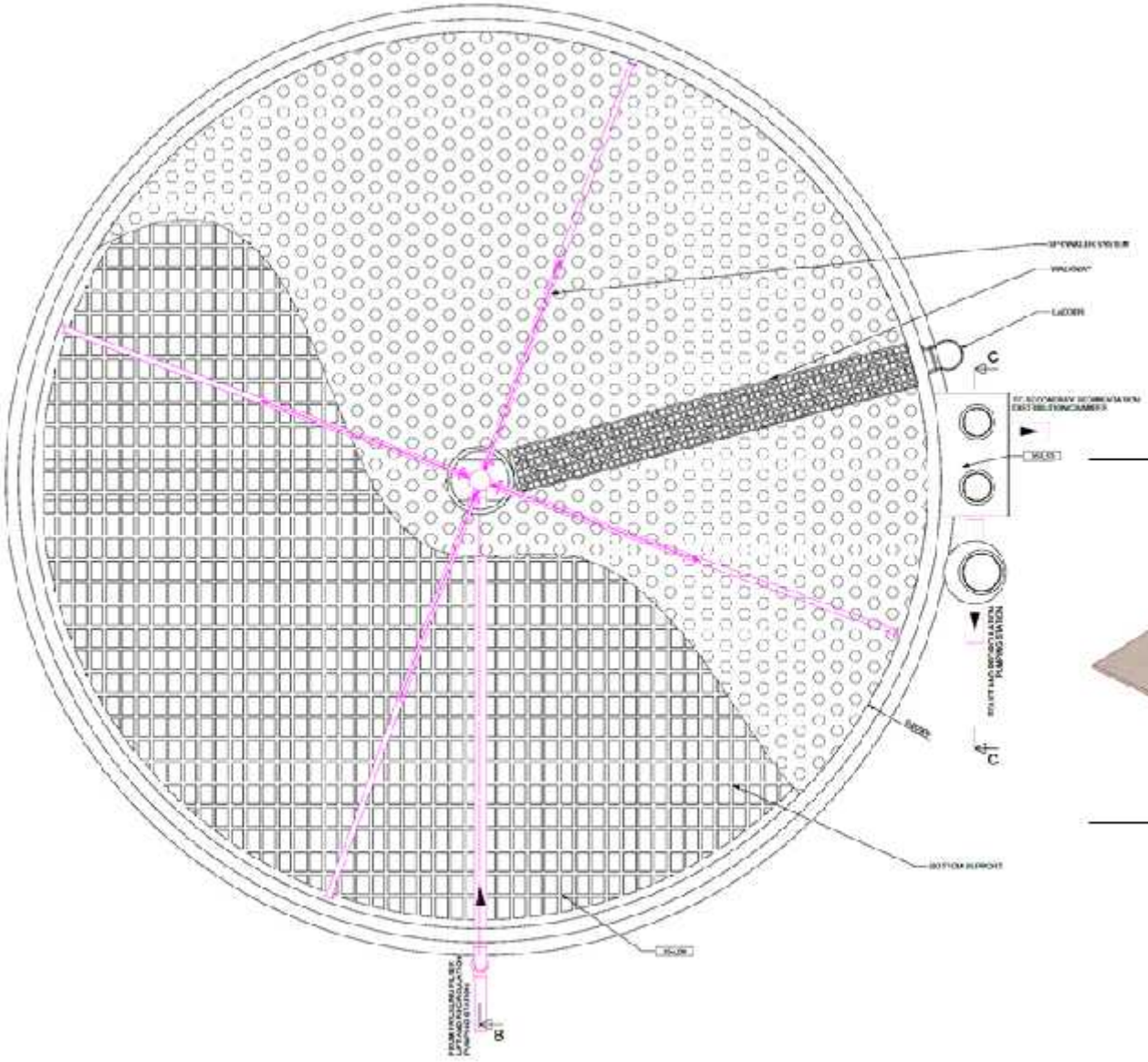
Trickling Filter

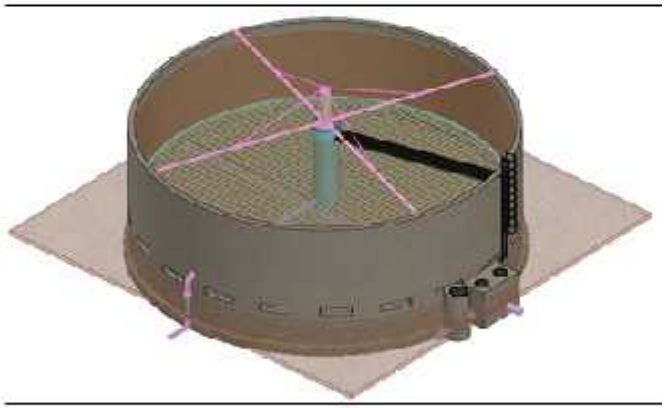
The biological treatment is defined as a low-load trickling filter. The purpose of this treatment is to allow sewage water to be in contact with biological population. Organic matters degradation occurs when biological population is growing.

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.

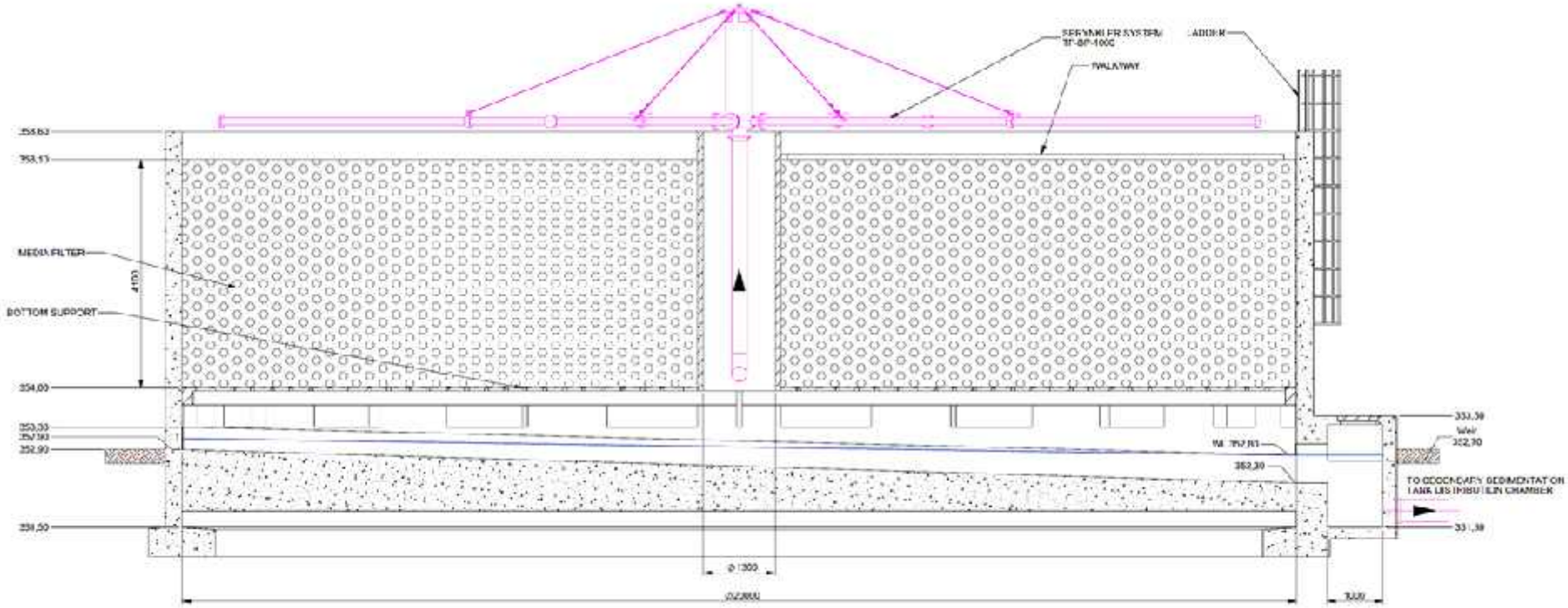
Trickling filter generally operates in aerobic conditions. Raw water goes down through pieces of material and through perforated floor and then is led on the bottom slope to drainage ring-channel, then goes out to secondary settler. To allow recirculation of organic matters and treated water, a valve 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 3 filters (for a total population of 52 000 PE). Total flow of the installation is divided by 3 and by the way 75 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 figures

Trickling Filter Plan (m 1:50) and 3D Image





Trickling Filter Section (m 1:50)



Distribution Chamber to Secondary Settlers

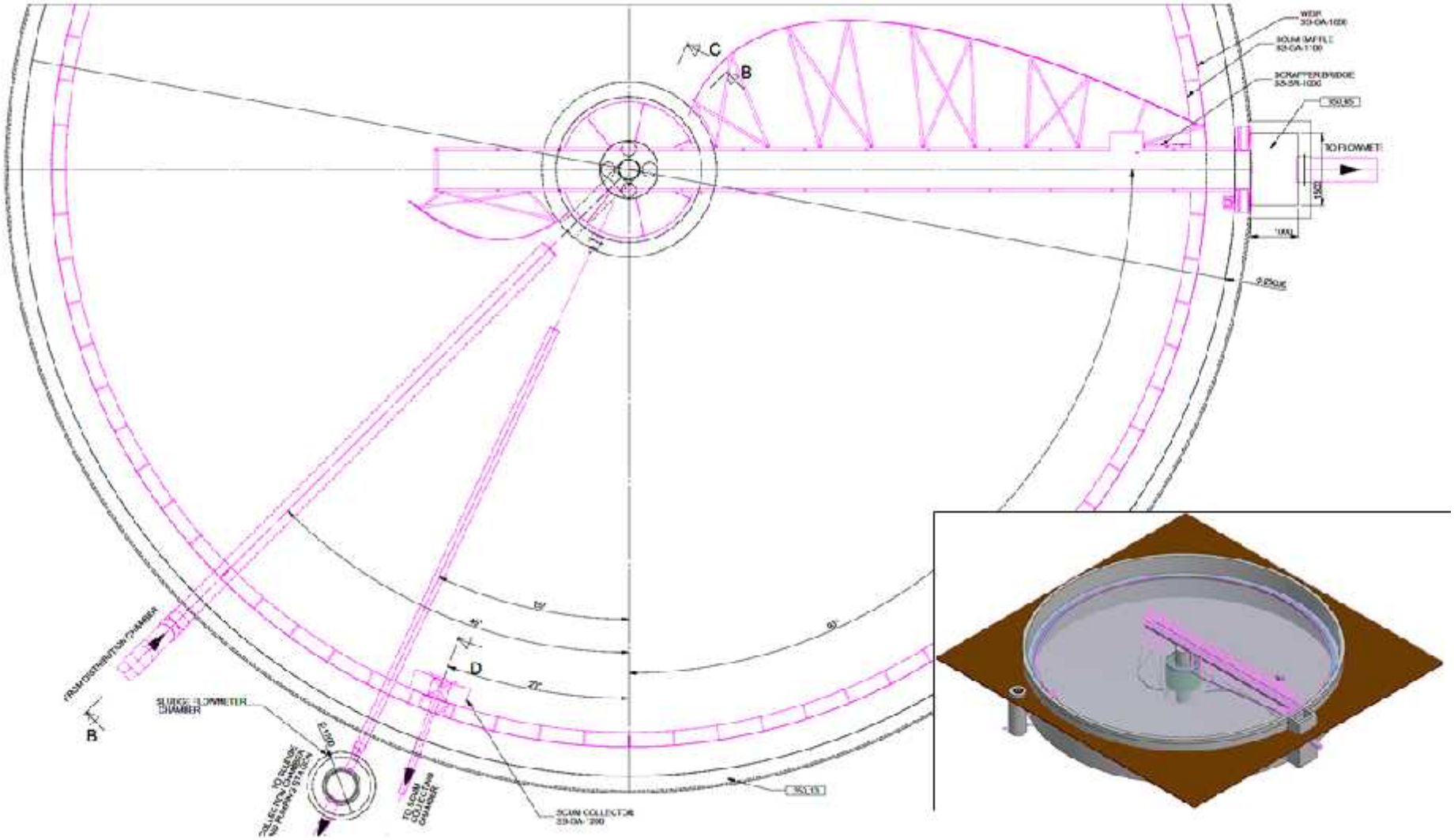
After passing through the trickling filter the water enters the secondary settling step. A distribution chamber will be provided to split the flow into two equal parts. Each treatment line will be equipped with manual stop logs.

Secondary Sedimentation Tanks

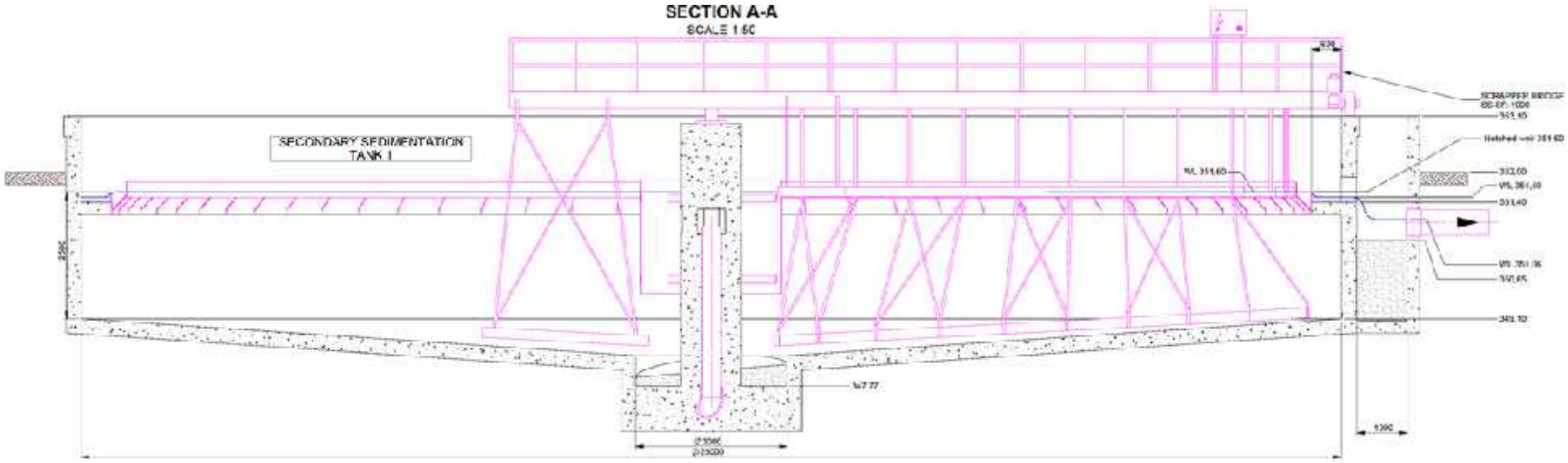
The outflow of the trickling filters contains biofilm fragments that have been sloughed off from the trickling filter media. The secondary sedimentation tank separates the sludge particles from the clear effluent. Flow enters through the central diffuser drum and is forced downward, ensuring a proper 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 figures

Secondary Sedimentation Tank Plan (m 1:50) and 3D Image



Secondary Sedimentation Tank Section (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. This process is repeated until 600mm of sludge is stored on the drying bed; after that dewatered sludge will be removed.

The sludge treatment/drying process data:

Sludge removal

Parameter	Unit	Value
Annual generation of dry solid material from basin system PE.	kg/ (PE60*a)	10
Annual generation of sludge PE from basin system	l/(PE60*a)	200
Consumption coefficient from sludge generation	% of design load	80
Capacity of sludge suction device	m³h	40

Sludge Drying Beds

Parameter	Unit	Value
Dry load	kg/m²*a	100
Specific sludge generation	g/PE 60*d	28
PE ave. load	PE 60	46500
N of sludge beds	unit	8
Toal area of drying beds	m²	4800

Sludge Treatment after Dewatering

Considering the fact that there are not any important industrial enterprises in Telavi, 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 wastes. For this purpose, it is assumed to use Telavi town landfill. 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 (2040)

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:

- 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 (project area is a grove of Alazani River), high-quality water 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

Emissions while Receiving-Storage of Diesel Fuel

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
Code	Title		
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, m³/hr	Tank capacity, m³	Number of tanks	Simultaneousness
	$B_{aut-win}$	$B_{sum-spr}$					
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:

$$M = (C_1 \cdot K^{max}_p \cdot V^{max}_ч) / 3600, \text{ g/s};$$

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 · 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;

Emission During the Welding Works

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 on 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 emissions of pollutants

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
304	Nitrogen 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 K^x_m of the consumption material;		
123	Iron oxide	g/kg	10,69
143	Manganese and its compounds	g/kg	0,92
301	Nitro en 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:

$M = B'' \cdot K^{x}_{m} \cdot (1 - n_o / 100) \cdot \eta \cdot 10^{-6}$, 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.

Emissions 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 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	Soot	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 data of calculations

Name of the road-construction vehicles (RCV)	Idle mode, minute	Number	One vehicle working time							Number of working days
			Per day, hr				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
	Particulate	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:

$G_{301} = (1,976 \cdot 12+1,3 \cdot 1,976 \cdot 13+0,384 \cdot 5) \cdot 1/1800 = 0,0327924$ g/s;

$M_{301} = (1,976 \cdot 1 \cdot 300 \cdot 3,5 \cdot 60+1,3 \cdot 1,976 \cdot 1 \cdot 300 \cdot 3,2 \cdot 60+0,384 \cdot 1 \cdot 300 \cdot 1,3 \cdot 60) \cdot 10^{-6} = 0,281436$ t/a;

$G_{304} = (0,321 \cdot 12+1,3 \cdot 0,321 \cdot 13+0,0624 \cdot 5) \cdot 1/1800 = 0,0053272$ g/s;

$M_{304} = (0,321 \cdot 1 \cdot 300 \cdot 3,5 \cdot 60+1,3 \cdot 0,321 \cdot 1 \cdot 300 \cdot 3,2 \cdot 60+0,0624 \cdot 1 \cdot 300 \cdot 1,3 \cdot 60) \cdot 10^{-6} = 0,04572$ t/a;

$G_{328} = (0,27 \cdot 12+1,3 \cdot 0,27 \cdot 13+0,06 \cdot 5) \cdot 1/1800 = 0,0045017$ g/s;

$M_{328} = (0,27 \cdot 1 \cdot 300 \cdot 3,5 \cdot 60+1,3 \cdot 0,27 \cdot 1 \cdot 300 \cdot 3,2 \cdot 60+0,06 \cdot 1 \cdot 300 \cdot 1,3 \cdot 60) \cdot 10^{-6} = 0,038632$ t/a;

$G_{330} = (0,19 \cdot 12+1,3 \cdot 0,19 \cdot 13+0,097 \cdot 5) \cdot 1/1800 = 0,00332$ g/s;

$M_{330} = (0,19 \cdot 1 \cdot 300 \cdot 3,5 \cdot 60+1,3 \cdot 0,19 \cdot 1 \cdot 300 \cdot 3,2 \cdot 60+0,097 \cdot 1 \cdot 300 \cdot 1,3 \cdot 60) \cdot 10^{-6} = 0,028467$ t/a;

$G_{337} = (1,29 \cdot 12+1,3 \cdot 1,29 \cdot 13+2,4 \cdot 5) \cdot 1/1800 = 0,0273783$ g/s;

$M_{337} = (1,29 \cdot 1 \cdot 300 \cdot 3,5 \cdot 60+1,3 \cdot 1,29 \cdot 1 \cdot 300 \cdot 3,2 \cdot 60+2,4 \cdot 1 \cdot 300 \cdot 1,3 \cdot 60) \cdot 10^{-6} = 0,234025$ t/a;

$G_{2732} = (0,43 \cdot 12+1,3 \cdot 0,43 \cdot 13+0,3 \cdot 5) \cdot 1/1800 = 0,0077372$ 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:

$M = Q_{exc} \times E \times K_{exc} \times K_1 \times K_2 \times N/T_{sb}$, 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 the 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:
$G = (Q_{bull} \times Q_{density} \times V \times K_1 \times K_2 \times N)/(T_{bc} \times K_{ð3})$, 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.

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 mg/m³	
			Maximum single	
1	Iron oxide	123	-	0,04
2	Manganese and its compounds	143	0,01	0,001
3	Nitrogen dioxide	301	0,2	0,04
4	Nitrogen oxide	304	0,4	0,06
5	Soot	328	0,15	0,05
6	Sulfur dioxide	330	0,5	0,05
7	Hydrogen Sulfide	333		
8	Carbon monoxide	337	5,0	3,0
9	Gaseous fluorides	342	0,2	0,03
10	Hardly soluble fluorides	344	0,02	0,005
11	Hydrocarbon oil fraction	2732	1,2	-
12	Saturated hydrocarbons C_{12}-C_{19}	2754		
13	Dust: 70-20% SiO_2	2902	0,5	0,15
14	Dust: <70-20% SiO_2	2908	0,3	0,1

Calculation of Harmful Substances Emitted in Ambient Air on Operation Phase

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 [4,5].

Calculation of maximum emission of the ***i***-type pollutant substances in air 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).

$$M_{iB} = 5{,}47 * 10^{-8} * (1{,}312+U) * F * C_i * K_2 / m^{0.5} * (t_{ж}+273) \text{ g/s}$$

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.

$$M_{is} = 0.001 \cdot Q_j \cdot C_i, \text{ g/sec.}$$

Where,

Q_j - Aeration air flow of purifying water for separate j-type devices (m^3/sec);

The total volume of ***i***-type pollutant substances that are emitted annually from separate devices, are calculated according to the following formula:

$$M_{ic}^{annual} = 0{,}0036 * M * t \text{ , t/a.}$$

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 value of coefficient **K_2** for **F_0/F** is determined according to the following 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 pollutants emission

Name	Molecular mass	Constants for the Antoine Equation		
		A		
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	Active sludge tank (anaerobic tank)	0,0022	0,018	0,0000014	0,0000028	0,068	0,0039	2,04
2	Secondary settler	0,0011	0,01	0,0000011	0,0000027	0,061	0,0035	0,15
3	Primary settler (biological filter)	0,0015	0,012	0,0000018	0,0000035	0,06	0,0036	0,18
4	Sludge bed	0,0010	0,01	0,0000013	0,0000027	0,060	0,0038	0,15

Emission Calculation from Anaerobic Tank

$M_{301} = 5,47 * 10^{-8} * (1,312+3,3) * 1135,5 * 0,0039 * 1 / 46,01^{0,5} * (18+273) = 0.000478$ g/s
$M_{301} = 0.000478$ g/a * 3600s * 24hr * 365day * $10^{-6} =$ 0.015074 t/a

$M_{303} = 5,47 * 10^{-8} * (1,312+3,3) * 11335,5 * 0,018 * 1 / 17,03^{0,5} * (18+273) = 0.00363$ g/s
$M_{303} = 0.00363$ g/a * 3600s * 24 hr * 365 day * $10^{-6} =$ 0,114476 t/a

$M_{333} = 5,47 * 10^{-8} * (1,312+3,3) * 11335,5 * 0,0022 * 1 / 34,08^{0,5} * (18+273) = 0.000314$ g/s
$M_{333} = 0.000314$ g/a * 3600s * 24 hr * 365 day * $10^{-6} =$ 0,009902 t/a

$M_{337} = 5,47 * 10^{-8} * (1,312+3,3) * 11335,5 * 0,068 * 1 / 28,01^{0,5} * (18+273) = 0.010693$ g/s
$M_{337} = 0.010693$ g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0,337214 t/a

$M_{410} = 5,47 * 10^{-8} * (1,312+3,3) * 11335,5 * 2,04 * 1 / 16,03^{0,5} * (18+273) = 0.424087$ g/s
$M_{410} = 0.424087$ g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 13,37401 t/a

$M_{1715} = 5,47 * 10^{-8} * (1,312+3,3) * 11335,5 * 0,0000028 * 1/48,11^{0,5} * (18+273) = 0.0000003359$ g/s
$M_{1715} =$ 0.0000003359 g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0.00001059 t/a

$M_{1728} = 5,47 * 10^{-8} * (1,312+3,3) * 11335,5 * 0,0000014 * 1/62,13^{0,5} * (18+273) = 0.0000001478$ g/s
$M_{1728} =$ 0.0000001478 g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0,00000467 t/a

Emission Calculation from Secondary Settler

$M_{301} = 5,47 * 10^{-8} * (1,312+3,3) * 982,5 * 0,0035 * 1 / 46,01^{0,5} * (18+273) = 0.0000372$ g/s
$M_{301} = 0.0000372$ g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0,0011731 t/a

$M_{303} = 5,47 * 10^{-8} * (1,312+3,3) * 982,5 * 0,01 * 1 / 17,03^{0,5} * (18+273) = 0.0001748$ g/s
$M_{303} = 0.0001748$ g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0.005512 t/a

$M_{333} = 5,47 * 10^{-8} * (1,312+3,3) * 982,5 * 0,0011 * 1 / 34,08^{0,5} * (18+273) = 0.00001359$ g/s
$M_{333} = 0.00001359$ g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0,0004285 t/a

$M_{337} = 5,47 * 10^{-8} * (1,312+3,3) * 982,5 * 0,061 * 1 / 28,01^{0,5} * (18+273) = 0.0008314$ g/s
$M_{337} = 0.0008314$ g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0.026219 t/a

$M_{410} = 5,47 * 10^{-8} * (1,312+3,3) * 982,5 * 0.15 * 1 / 16,03^{0,5} * (18+273) = 0.002702$ g/s
$M_{410} = 0.002702$ g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0.08521 t/a

$M_{1715} = 5,47 * 10^{-8} * (1,312+3,3) * 982,5 * 0,0000027 * 1/48,11^{0,5} * (18+273) = 0.000000028$ g/s
$M_{1715} =$ 0.000000028 g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0,000000883 t/a

$M_{1728} = 5,47 * 10^{-8} * (1,312+3,3) * 982,5 * 0,0000011 * 1/62,13^{0,5} * (18+273) = 0.00000001$ g/s
$M_{1728} =$ 0.00000001 g/a * 3600s * 24hr * 365 day * $10^{-6} =$ 0.000000315 t/a

Emission Calculation from Biological Filter

$M_{301} = 5,47 * 10^{-8} * (1,312+3,3) * 510 * 0,0036 * 1 / 46,01^{0,5} * (18+273) = 0.0000198$ g/s
$M_{301} = 0.0000198$ g/a * 3600s * 24hr * 365day * $10^{-6} =$ 0,0006244 t/a

$M_{303} = 5,47 * 10^{-8} * (1,312+3,3) * 510 * 0,012 * 1 / 17,03^{0,5} * (18+273) = 0.00010889$ g/s

M_{303} = 0.00010889 g/a * 3600s * 24hr * 365day * 10^{-6} = 0.0034339 t/a

M_{333} = 5,47 * 10^{-8} * (1,312+3,3) * 510* 0,0015 * 1 / 34,08 ^{0,5} * (18 +273) = 0.00000962 g/s
M_{333} = 0.00000962 g/a * 3600s * 24hr * 365day * 10^{-6} = 0.00030337 t/a

M_{337} = 5,47 * 10^{-8} * (1,312+3,3) * 510 * 0,06 * 1 / 28,01 ^{0,5} * (18 +273) = 0.0004244 g/s
M_{337} = 0.0004244 g/a * 3600s * 24hr * 365day * 10^{-6} = 0.0133838 t/a

M_{410} = 5,47 * 10^{-8} * (1,312+3,3) * 510 * 0.18 * 1 / 16,03 ^{0,5} * (18 +273) = 0.00168355 g/s
M_{410} = 0.00168355 g/a * 3600s * 24hr * 365day * 10^{-6} = 0.0530924 t/a

M_{1715} = 5,47 * 10^{-8} * (1,312+3,3) * 510 * 0,0000035 * 1/48,11^{0,5} *(18 +273) = 0.0000000188 g/s
M_{1715} = 0.0000000188 g/a * 3600s * 24hr * 365day * 10^{-6} = 0,0000005928 t/a

M_{1728} = 5,47 *10^{-8} *(1,312+3,3)* 510 * 0,0000018 * 1/62,13^{0,5} * (18 +273) = 0.00000000855 g/s
M_{1728} = 0.00000000855 g/a * 3600s* 24hr * 365day * 10^{-6} = 0,000000269 t/a

Emission Calculation from Sludge Bed

M_{301} = 5,47 * 10^{-8} * (1,312+3,3) * 4800 * 0,0038 * 1 / 46,01 ^{0,5} * (18 +273) = 0.000197 g/s
M_{301} = 0.000197 g/a * 3600s * 24hr * 365day * 10^{-6} = 0,006212 t/a

M_{303} = 5,47 * 10^{-8} * (1,312+3,3) * 4800* 0,01 * 1 / 17,03 ^{0,5} * (18 +273) = 0.000854 g/s
M_{303} = 0.000854 g/a * 3600s * 24hr * 365day * 10^{-6} = 0.026931 t/a

M_{333} = 5,47 * 10^{-8} * (1,312+3,3) * 4800 * 0,0010 * 1 / 34,08 ^{0,5} * (18 +273) = 0.0000603 g/s
M_{333} = 0.0000603 g/a * 3600s * 24hr * 365day * 10^{-6} = 0,001901 t/a

M_{337} = 5,47 * 10^{-8} * (1,312+3,3) * 4800 * 0,060* 1 / 28,01 ^{0,5} * (18 +273) = 0.0039995 g/s
M_{337} = 0.0039995 g/a * 3600s * 24hr * 365day * 10^{-6} = 0.126128 t/a

M_{410} = 5,47 * 10^{-8} * (1,312+3,3) * 4800 * 0,15 * 1 / 16,03 ^{0,5} * (18 +273) = 0.013204 g/s
M_{410} = 0.013204 g/a * 3600s * 24hr * 365day * 10^{-6} = 0.416401 t/a

M_{1715} = 5,47 * 10^{-8} * (1,312+3,3) * 4800 * 0,0000027 * 1/48,11^{0,5} *(18 +273) = 0.000000137 g/s
M_{1715} = 0.000000137 g/a * 3600s * 24hr * 365day * 10^{-6} = 0,00000432 t/a

M_{1728} = 5,47 * 10^{-8} *(1,312+3,3)* 4800 * 0,0000013 * 1/62,13^{0,5} * (18 +273) = 0.0000000581 g/s
M_{1728} = 0.0000000581 g/a * 3600s * 24hr * 365day * 10^{-6} = 0,00000183 t/a

Total Emission of Pollutants

Name	Max. Single emission, g/sec	Total emission, t/a
Nitrogen dioxide	0,000732	0,0230835
Ammonia	0,004768	0,150353
Hydrogen sulphide	0,00039751	0,01253487
Carbon oxide	0,015948	0,502945
Methane	0,441677	13,92871
Methyl mercaptan	0,0000005197	0,0000163858
Ethyl mercaptan	0,00000022445	0,000007084

Parameters of Atmospheric Emissions

Characterization of sources of emissions 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	e-1	Unorganized	1	2	Active sludge tank (anaerobic tank) 4684 m²	7	24	8760	Nitrogen dioxide	301	0,015074
									Ammonia	303	0,114476
									Hydrogen sulphide	333	0,009902
									Carbon oxide	337	0,337214
									Methane	410	13,37401
									Methyl mercaptan	1715	0,00001059
									Ethyl mercaptan	1728	0,00000467
				3	Secondary Settler 706.5 m²	7	24	8760	Nitrogen dioxide	301	0,0011731
									Ammonia	303	0,005512
									Hydrogen sulphide	333	0,0004285
									Carbon oxide	337	0,026219
									Methane	410	0,08521
									Methyl mercaptan	1715	0,000000883
									Ethyl mercaptan	1728	0,000000315
				4	Primary Settler (biological filter) 113,5 m²	7	24	8760	Nitrogen dioxide	301	0,0006244
									Ammonia	303	0,0034339
									Hydrogen sulphide	333	0,00030337
									Carbon oxide	337	0,0133838
									Methane	410	0,0530924
									Methyl mercaptan	1715	0,0000005928
									Ethyl mercaptan	1728	0,000000269
Aerobic wastewater treatment system	e-1	Unorganized	1	5	Sludge Bed 2755 m²	7	24	8760	Nitrogen dioxide	301	0,006212
									Ammonia	303	0,026931
									Hydrogen sulphide	333	0,001901
									Carbon oxide	337	0,126128
									Methane	410	0,416401
									Methyl mercaptan	1715	0,00000432
									Ethyl mercaptan	1728	0,00000183

Description of sources of emissions 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, m^3/sec	Temperature, t^0C		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
ჭ-1	2	-	-	-	18	301	0,000732	0,0230835	-	-	-131,0	-169,0	116,0	160,0
						303	0,004768	0,150353						
						333	0,00039751	0,01253487						
						337	0,015948	0,502945						
						410	0,441677	13,92871						
						1715	0,0000005197	0,0000163858						
						1728	0,00000022445	0,000007084						

Description of air filter and dust collector

Harmful substance			Air filter and dust collector		Concentration of harmful substances, g/m^3		Quality of purification of air filter and dust collector, %	
# of source of generation of harmful substances	# of source of emission of harmful substances	Code	Name	Number, unit	Prior to the treatment	After the treatment	Design	Actual
1	2	3	4	5	6	7	8	9

Air filter and dust collector are not considered in technological cycle

Atmospheric emissions, their treatment 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)X 100
Code	Name		Emitted without treatment		Passed the treatment facility	Total	Utilized Total		
			Total	From organized emission sources					
1	2	3	4	5	6	7	8	9	10
301	Nitrogen dioxide	0,0230835	0,0230835	-	-	-	-	0,0230835	0,00
303	Ammonia	0,150353	0,150353	-	-	-	-	0,150353	0,00
333	Hydrogen sulphide	0,01253487	0,01253487	-	-	-	-	0,01253487	0,00
337	Carbon oxide	0,502945	0,502945	-	-	-	-	0,502945	0,00
410	Methane	13,92871	13,92871	-	-	-	-	13,92871	0,00
1715	Methyl mercaptan	0,0000163858	0,0000163858	-	-	-	-	0,0000163858	0,00
1728	Ethyl mercaptan	0,000007084	0,000007084	-	-	-	-	0,000007084	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.

According to the methodology, ambient air quality is assessed according to the number of population

Reference background values of pollutants according to number of population

population, (1,000 people)	Background value of pollutants, mg/m³			
	NO_2	SO_2	CO	Dust
250-125	0,03	0,05	1,5	0,2
125-50	0,015	0,05	0,8	0,15
50-10	0,008	0,02	0,4	0,1
<10	0	0	0	0

Number of population of Telavi Municipality is 70,900 people. Background values of pollutants are obtained from the following Table.

As the distance between the project area and the nearest settlement is 3,77 km (point № 5), modeling the air quality [3] performed with regard to the control points (point № 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	68,00	686,00	2	On the border of 500 meters zone	To the North
2	665,00	115,00	2	On the border of 500 meters zone	To the East
3	-17,00	-709,00	2	On the border of 500 meters zone	To the South
4	-674,00	-100,00	2	On the border of 500 meters zone	To the West
5	-524,00	-3861,00	2	Control point on the border of the populated area	Nearest settlement

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].

Printout Version of Emission Calculation into Ambient Air – Operation Phase

УПРЗА ЭКОЛОГ, версия 3.1

Serial number 01-01-2568, Scientific-Research Firm «Gamma»

Enterprise number 484: Telavi WWTP
Telavi

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	28,8° C
Average temperature of the coldest month	-2,7° C
Coefficient depending on the temperature of the atmosphere stratification, A	200
Maximum wind speed for the area (repeatability of exceeding is 5%)	5,3 m/sE

Enterprise structure (sites, workshop)

Number	Name of the site (workshop)

Emission Sources Parameters

Recording:
"%" - Background has been excluded 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	cord. X1 axis (m)	Coordi. Y1 axis (m)	Coordi. X2 axis (m)	Coordi.Y2 axis (m)	Width of the source (m)
+	0	0	1	Surface of WWTP	1	3	2,0	0,00	0	0,00000	0	1,0	-131,0	-169,0	116,0	160,0	120,00

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)	0,0008000	0,0000000	1		0,143	11,4	0,5		0,143	11,4	0,5
0303	Ammonia	0,0050000	0,0000000	1		0,893	11,4	0,5		0,893	11,4	0,5
0333	Sulfide	0,0004000	0,0000000	1		1,786	11,4	0,5		1,786	11,4	0,5
0410	Carbon monoxide	0,4420000	0,0000000	1		0,316	11,4	0,5		0,316	11,4	0,5
1715	Methane	0,0000005	0,0000000	1		0,186	11,4	0,5		0,186	11,4	0,5
1728	Methyl mercaptan	0,0000002	0,0000000	1		0,164	11,4	0,5		0,164	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	+	0,0008000	1	0,1429	11,40	0,5000	0,1429	11,40	0,5000
Total:					**0,0008000**		**0,1429**			**0,1429**		

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	+	0,0050000	1	0,8929	11,40	0,5000	0,8929	11,40	0,5000
Total:					**0,0050000**		**0,8929**			**0,8929**		

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	+	0,0004000	1	1,7858	11,40	0,5000	1,7858	11,40	0,5000
Total:					**0,0004000**		**1,7858**			**1,7858**		

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	+	0,4420000	1	0,3157	11,40	0,5000	0,3157	11,40	0,5000
Total:					**0,4420000**		**0,3157**			**0,3157**		

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	+	0,0000005	1	0,1857	11,40	0,5000	0,1857	11,40	0,5000
Total:					**0,0000005**		**0,1857**			**0,1857**		

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	+	0,0000002	1	0,1643	11,40	0,5000	0,1643	11,40	0,5000
Total:					**0,0000002**		**0,1643**			**0,1643**		

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	0,0050000	1	0,8929	11,40	0,5000	0,8929	11,40	0,5000
0	0	1	3	+	0333	0,0004000	1	1,7858	11,40	0,5000	1,7858	11,40	0,5000
Total:						**0,0054000**		**2,6787**			**2,6787**		

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
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 meteo parameters
Automatic selection

Wind speed selection is conducted automatically

Wind direction

Start of the sector	End of the sector	Wind selection bid
0	360	1

Design area

Calculated Area

№	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	Given	-1200	0	1200	0	2000	100	100	2	

Reference points

№	Coordinates of points (m)		Height (m)	Type of point	Note
	X	Y			
1	68,00	686,00	2	At border of 500 m zone	To the North
2	665,00	115,00	2	At border of 500 m zone	To the East
3	-17,00	-709,00	2	At border of 500 m zone	To the South
4	-674,00	-100,00	2	At border of 500 m zone	To the West
5	-524,00	-3861,00	2	At border of the settlement	Nearest settlement to the West

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)									
1	68	686	2	8,0e-4	185	0,67	0,000	0,000	3
4	-674	-100	2	7,8e-4	84	0,67	0,000	0,000	3
2	665	115	2	7,8e-4	262	0,67	0,000	0,000	3
3	-17	-709	2	7,7e-4	359	0,67	0,000	0,000	3
5	-524	-3861	2	7,9e-5	8	5,30	0,000	0,000	4

Substance: 0303 Ammonia

1	68	686	2	5,0e-3	185	0,67	0,000	0,000	3
4	-674	-100	2	4,9e-3	84	0,67	0,000	0,000	3
2	665	115	2	4,9e-3	262	0,67	0,000	0,000	3
3	-17	-709	2	4,8e-3	359	0,67	0,000	0,000	3
5	-524	-3861	2	4,9e-4	8	5,30	0,000	0,000	4

Substance: 0333 Hydrogen Sulfide

1	68	686	2	1,0e-2	185	0,67	0,000	0,000	3
4	-674	-100	2	9,8e-3	84	0,67	0,000	0,000	3
2	665	115	2	9,7e-3	262	0,67	0,000	0,000	3
3	-17	-709	2	9,7e-3	359	0,67	0,000	0,000	3
5	-524	-3861	2	9,8e-4	8	5,30	0,000	0,000	4

Substance: 0410 Methane

1	68	686	2	1,8e-3	185	0,67	0,000	0,000	3
4	-674	-100	2	1,7e-3	84	0,67	0,000	0,000	3
2	665	115	2	1,7e-3	262	0,67	0,000	0,000	3
3	-17	-709	2	1,7e-3	359	0,67	0,000	0,000	3
5	-524	-3861	2	1,7e-4	8	5,30	0,000	0,000	4

Substance: 1715 Methyl mercaptan

1	68	686	2	1,0e-3	185	0,67	0,000	0,000	3
4	-674	-100	2	1,0e-3	84	0,67	0,000	0,000	3
2	665	115	2	1,0e-3	262	0,67	0,000	0,000	3
3	-17	-709	2	1,0e-3	359	0,67	0,000	0,000	3
5	-524	-3861	2	1,0e-4	8	5,30	0,000	0,000	4

Substance: 1728 Ethyl mercaptan

1	68	686	2	9,2e-4	185	0,67	0,000	0,000	3
4	-674	-100	2	9,0e-4	84	0,67	0,000	0,000	3
2	665	115	2	9,0e-4	262	0,67	0,000	0,000	3
3	-17	-709	2	8,9e-4	359	0,67	0,000	0,000	3
5	-524	-3861	2	9,0e-5	8	5,30	0,000	0,000	4

Substance: 6003 Total impact group (2) 303 333

1	68	686	2	0,01	185	0,67	0,000	0,000	3
4	-674	-100	2	0,01	84	0,67	0,000	0,000	3
2	665	115	2	0,01	262	0,67	0,000	0,000	3
3	-17	-709	2	0,01	359	0,67	0,000	0,000	3
5	-524	-3861	2	1,5e-3	8	5,30	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, 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 (4 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.

It should be noted that the nearest settlement (Kondoli village) is 3.7 km away from the project area. Considering a big distance, calculation of noise levels on the borders of settlements is not required. However, noise levels on the borders of 500 m zone have been conducted in order to determine impact on wildlife and peasants working in agricultural lands to the South of the treatment plant (the nearest distance is 550 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:

During construction phase:

$$10\lg\sum_{i=1}^{n}10^{0,1Lpi} = 10\lg\ (10^{0,1x90}+ 10^{0,1x85}+ 10^{0,1x92})= 94,6 \text{ dBA}$$

During operation phase:

$$10\lg\sum_{i=1}^{n}10^{0,1Lpi} = 10\lg\ (10^{0,1x90}+ 10^{0,1x90}+10^{0,1x90}+10^{0,1x90}+10^{0,1x85})=96,3 \text{ dBA}.$$

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 72 dBA.

By putting the data in the first formula, we will obtain noise level from reference point, the nearest receptor:

Construction phase:

$$L=L_p-15\lg r+10\lg\Phi-\frac{ar}{1000}-10\lg\Omega, = 94,6 - 15*\lg500+10*\lg2-10.5*500/1000-10x\lg2\ \pi=43,9 \text{ dBA}.$$

Operation phase:

$$L=L_p-15\lg r+10\lg\Phi-\frac{ar}{1000}-10\lg\Omega, = 72 - 15*\lg500+10*\lg2-10.5*500/1000-10x\lg2\ \pi=21,2 \text{ dBA}.$$

15.4 Annex 4. Water Quality Impact Assessment after Mixing Effluents with Alazani River

Wastewater from WWTP is considered to be discharged into Alazani River. 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:

$$C_{\text{წ.ღ.ჩ.}} = p\left(\frac{a \cdot Q}{q} + 1\right) + C_{\text{ვ}} \qquad (1)$$

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. According to the table, given in par. 5.1.3 of EIA report, at Shakriani village (near the project section) the minimum flow of Alazani River with 97% provision is **7,8 m³/s;**

q – is maximum wastewater flow m³/s. According to the table, given in par.4.2. of EIA report, peak wastewater flow for 2013 is **960 m³/h (0,267 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 **32 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 Alazani 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 **1,4 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):

$$C_{\text{ზ.ღ.ჩ.}} = \frac{aQ}{q}(C_{\text{ზ.ღ.ჯ.}} - C_{\text{ფ.}}) + C_{\text{ზ.ღ.ჯ.}} \qquad (3)$$

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 the table, given in par. 5.1.3. of EIA report, average background concentration of pollutant at the design section is determined as :

- COD - **10,5 mg/l;**
- Total Nitrogen - **0,7 mg/l;**
- Total Phosphorus - **0,1 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:

$$:= e^{-\sim\sqrt[3]{L}} \quad (5)$$

L – is the distance between wastewater discharge point and the design section in river stream direction, in meters. 3 design sections are selected:

- **Design section №1** – In **200 m** from wastewater discharge point;
- **Design section №2** – Headworks of Alazani irrigation system, which is in ≈**7700 m** from wastewater discharge point**;**
- **Design section №3 –** Headworks of potable water of Gurjaani, which is located in ≈**25 000 m** wastewater discharge point**.**

α- coefficient, considering hydraulic factors of mixing and is determined by the following formula:

$$\alpha = \ell \cdot i \sqrt[3]{\frac{E}{q}} \quad (6)$$

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, the estimated value is **1,0.**

i – River curvature factor, equals to:

$$\mathbf{i} = \frac{L_{\text{backgr}}}{L_{\text{alignment}}} \quad (7)$$

L_{backgr}- is the distance between wastewater discharge point and the design section in river stream direction, in meters. It equals to **200 m, 7700 m and 25000 m.**

$L_{alignment}$ – The shortest distance between these points (according to the alignment) and it is:

- **Design section №1** - **200 m;**
- **Design section №2** - **5700 m;**
- **Design section №3 – 20000.**

Accordingly, **i** equals to:

- **Design section №1** – $\frac{200}{200}=1$
- **Design section №2** – $\frac{7700}{5700}=1.35$
- **Design section №3 –** $\frac{25000}{20000}=1.25$

E – is the factor of turbulent diffusion, which equals to:

$$\mathbf{E} = \frac{V_{ave} * H_{ave}}{200} \quad (8)$$

V_{ave}, H_{ave} – is the average speed and depth at the design section. According to the par. 5.1.3. of EIA report, average water layer depth at the design section is **1,65 m**, and average speed - **1,75 m³/s.**

Accordingly:

$$E = \frac{1.65 \times 1.75}{200} = 0{,}01444$$

Taking into consideration the aforementioned, according to the formula 6:

For design section №1

$$\sim = 1 \times 1 \sqrt[3]{\frac{0{,}01444}{0.267}} = 0.38$$

For design section №2

$$\sim = 1 \times 1.35 \sqrt[3]{\frac{0{,}01444}{0.267}} = 0.51$$

For design section №3

$$\sim = 1 \times 1.25 \sqrt[3]{\frac{0{,}01444}{0.267}} = 0.47$$

and according to the formula 5:

For design section №1

$$\beta = 0.10944469$$

For design section №2

$$\beta = 0.00004143$$

For design section №3

$$\beta = 0.00000099$$

By inserting the data into Rodzileri formula, we will get:

For design section №1

$$a = \frac{1 - 0.10944469}{1 + \frac{7.8}{0.267} 0.10944469} = 0.212$$

For design section №2

$$a = \frac{1 - 0.00004143}{1 + \frac{7.8}{0.267} 0.00004143} = 0.999$$

For design section №3

$$a = \frac{1 - 0.00000099}{1 + \frac{7.8}{0.267} 0.00000099} = 0.99997$$

Maximum permissible concentrations of pollutants (C_{MPC}) have been determined by using formulae (1), (2) and (3) for all three design sections. 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 Alazani River

Pollutants	Maximum Permissible Concentrations (MPC) of pollutants in the wastewater (mg/l)			Efficiency of treatment plant, mg/l	
	Design section №1 (200 m below from the discharge point)	Design section №2 (headwork section of the irrigation system)	Design section №2 (section of the headwork of Gurjaani potable water)	Phase 1- project year 2030	Phase 2- project year 2040
Suspended Solids	37,4	54,7	54,7	35,0	35,0
BOD	35,5	140,4	140,5	25,0	25,0
COD	150,9	600,0	600,4	125,0	125,0
Total Nitrogen	83,5	312,4	348,6	36,4	15,0
Total Phosphorus	8,0	33,3	33,4	7,3	2,0

15.5 Waste Management Plan for Plant Construction and Operation Phases

Introduction

The present paragraph describes waste management plan for waste, generated during Telavi 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 amount more than 120 kg[6], 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 generation of significant amount of non-hazardous and inert wastes, as well as hazardous waste is expected, the waste management plan is developed for waste, generated during Telavi WWTP construction and operation process, which includes:

- Waste management goals and objectives;
- Hierarchy and principles of waste management;
- Information on waste generation;
- 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 waste;
- Requirements for the safe handling of waste;
- Waste control methods.

Developer of the Telavi WWTP project is Municipal Development Fund of Georgia LEPL. WWTP will be operated by UNWSC. The information on mentioned organizations is given in Table 15.2.1.1.

	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 Telavi Wastewater Treatment Plant	Operation of Telavi WWTP
Chairman	Director – Gagi Buadze	To be clarified before commissioning
Contact person	Ana Rukhadze	To be clarified before commissioning

[6] Decree №446. Of GoG, dated as September 16, 2016, Tbilisi, on approval of regulation rules for some obligations, determined by Waste management Code. The amendment is made – Before January 1, 2020, any natural or legal person is free from obligation to develop Waste Management Plan of the company, if he/she carries out any activity, listed in the economic activities defined by the National Classification of Georgia approved by the Decree No.10 of the National Statistics Office of Georgia, dated as July 28, 2016 or other activity, and generates 120 kg or less hazardous waste per year.

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	

Aims and Objectives of Waste Management Plan

The present waste management plan sets the rules for collection, transportation, disposal, deactivation and utilization of waste, generated during Telavi 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;
- Use methods of neutralization, recycling or utilization, safe for environment and 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 in normal 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 waste 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“	100-200 kg/a	20-50 kg/a	20-50 kg/a	D 10	Will be transferred to the organization, appropriately licensed on hazardous waste management (JSC Sarini, Nasadgomari LTD, Sanitari LTD- will be specified during preparation of Waste Management Detailed Plan)	Y12
08 03 17*	Waste printing toner containing hazardous substances (Laser printers)	Solid	Yes	H 5 – „Harmful“	10-20 kg/a	20-50 kg/a	20-50 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	20-50 kg/a	20-50 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	-	50-100 kg	20-50 kg/a	20-50 kg/a	D1/R4	Will be disposed on the Telavi household waste landfill 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“	20-50 kg	10-20 kg	10-20 kg	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“	20-50 kg	10-20 kg	10-20 kg	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"	20-50 kg	10-20 kg	10-20 kg	R9	Will be transferred to the organization, appropriately licensed on hazardous waste management	Y8
15 01 01	Paper and cardboard packaging	Solid	No	-	500-1000 kg/a	50-100 kg/a	50-100 kg/a	D1	Will be disposed on Telavi household waste landfill	-
15 01 02	Plastic packaging (polyethylene wastes, packaging sealing material, tubes, etc.)	Solid	No	-	1000-2000 kg/a	100-200 kg/a	100-200 kg/a	D1	Will be disposed on Telavi household waste landfill	-
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"	200-500 kg/a	100-200 kg/a	100-200 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	-	2000-3000 kg/a	500-1000 kg/a	500-1000 kg/a	D1/ R1, R3, R4	Will be transferred to a sub-contractor having tire utilization infrastructure	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	-	80-100 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	200-300 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	-	3500-4000 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 Telavi 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 of Telavi town.	-
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 of Telavi 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 Telavi 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 Telavi 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	-	-	3688 m^3/a	3688 m^3/a	D1	Will be disposed on Telavi 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	-	50 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 Telavi landfill.	Y 46
20 03 04	Septic tank sludge	Fluid	No	-	≈1140 m^3/a	-	-	D 4	By means of dump trucks with canvas top of UWSC of Georgia LLC it will be removed and discharged in the nearest sewerage system based on agreement, signed between constructor contractor and UWSC of Georgia LLC.	-

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.
- While selecting the contractor for hazardous waste removal, the preference will be given to the organization, which operate in recovery of certain types of waste.

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 removed from the site and under agreement with local government will be used for vertical planning of corresponding areas;
- **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;[7];
- 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:

[7]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".

- Pavement of the site will be solid;
- 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 [8] 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

Code of hazardous wastes _____		**Name of hazardous wastes** _____	
Hazardous properties	Classification system	H codes	Hazard defining characteristics
	Main:		
	Additional:		
Process/activity that generate hazardous wastes			

[8] Decree №143 of the Government of Georgia on "Waste Transportation Rule", dated as March 29, 2016

Physical properties	Solid Liquid Sludge Gas	□ □ □ □	Note
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** _____

Hermetically sealed dump trucks with canvas 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 (Telavi 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 Telavi landfill (located on the area adjacent to Gulguli village). 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[9], 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[10]:

a) Preparation and updating of the Waste Management Plan of the company;
b) Organizing implementation of the Waste Management Plan;

[9] Waste Management Code, Article 15
[10] Waste Management Code, Article15, paragraph 2.

c) Responsible for implementation of internal control on performance of waste management requirements considered by the legislation of Georgia

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 techno genic 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 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 site, 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 Alazani River will occur, which will be especially significant during touristic season.

Main mitigation measure for such emergency is prevention of accidents and in case it still occurs, operative termination of problem. Use of pumping stations' reservoir capacities for delaying sewage water, 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 works 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 incline 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 operation roads;
- 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. Alazani.	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 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 Alazani River. 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, 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:

- 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.

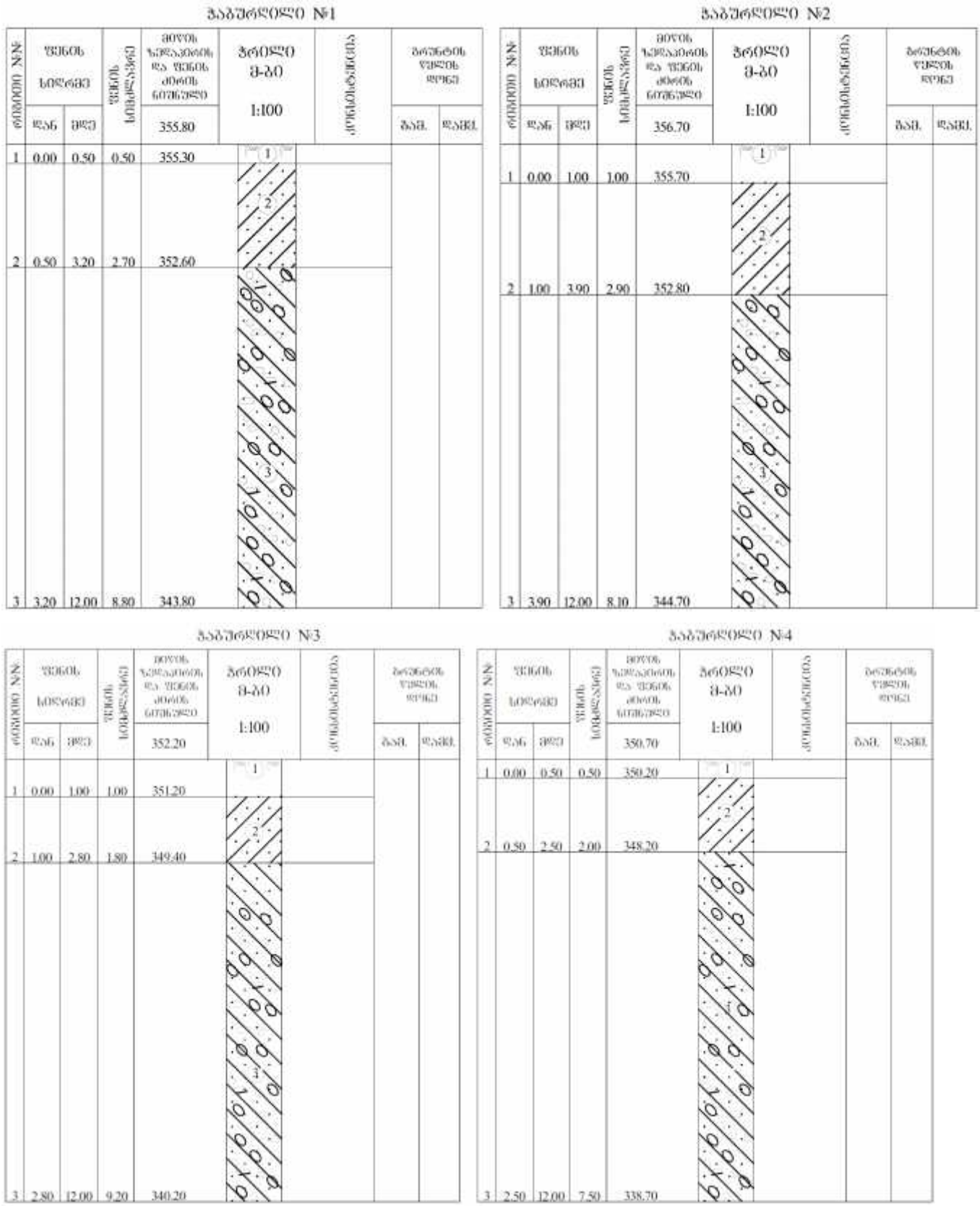
Anonymity: If you wish you can file a complaint without indicating your name and contact details in the attached form. The complaint will be examined but it will be rather difficult for MDF to investigate the case.

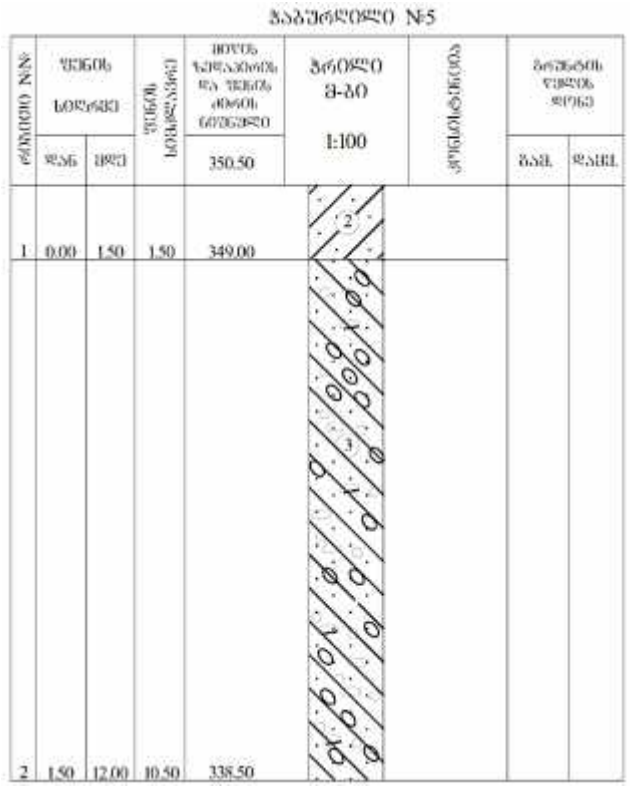
Complaint form for Public grievances

<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

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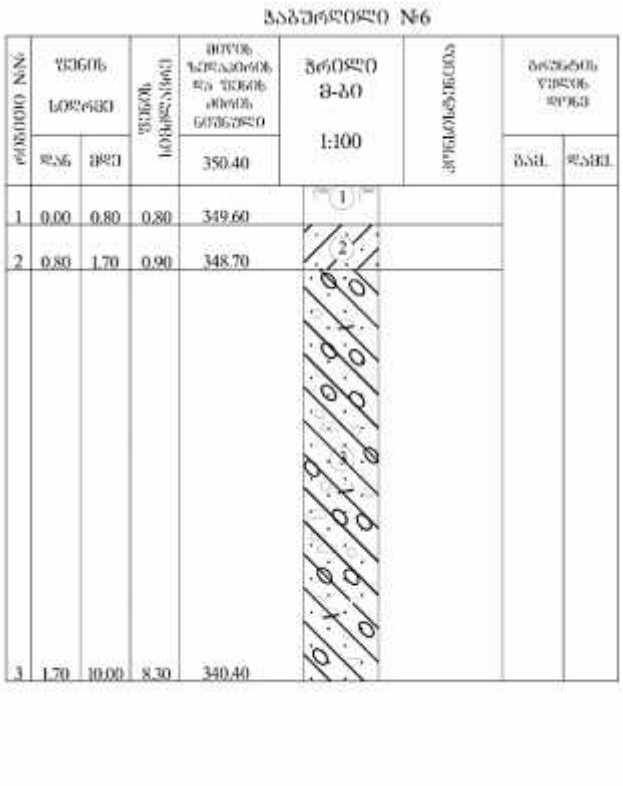
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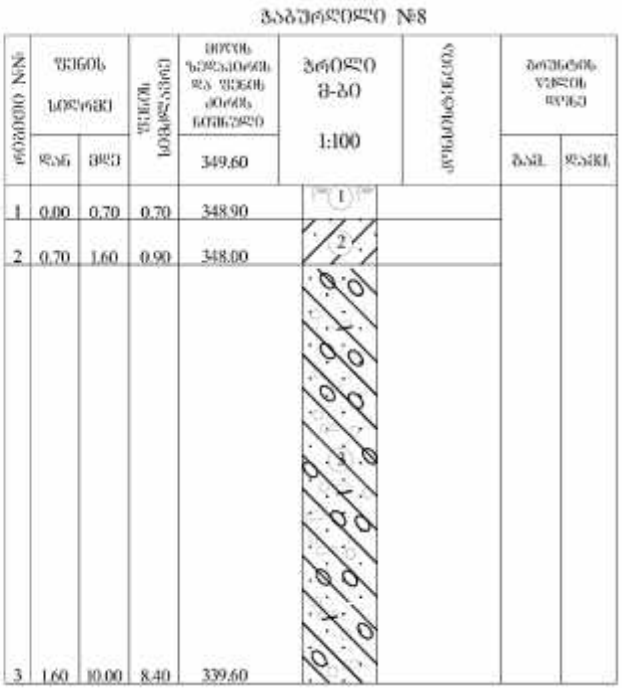
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ჭაბურღილი №9

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				351.40				
1	0.00	1.60	1.60	349.80	2			
3	1.60	10.00	8.40	341.40	3			

ჭაბურღილი №10

ფენების №№	ფენის სიღრმე დან	ფენის სიღრმე მდე	ფენის სიმძლავრე	ჭის ზედაპირის და ფენის ძირის ნიშნული	ჭრილი მ-ბი 1:100	ლითოლოგიური აღწერა	გრუნტის წყლის დონე გამ.	გრუნტის წყლის დონე დამყ.
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ჭაბურღილი №11

ფენების №№	ფენის სიღრმე დან	ფენის სიღრმე მდე	ფენის სიმძლავრე	ჭის ზედაპირის და ფენის ძირის ნიშნული	ჭრილი მ-ბი 1:100	ლითოლოგიური აღწერა	გრუნტის წყლის დონე გამ.	გრუნტის წყლის დონე დამყ.
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შურფი №1

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3	1.50	2.50	1.00	348.50	3			

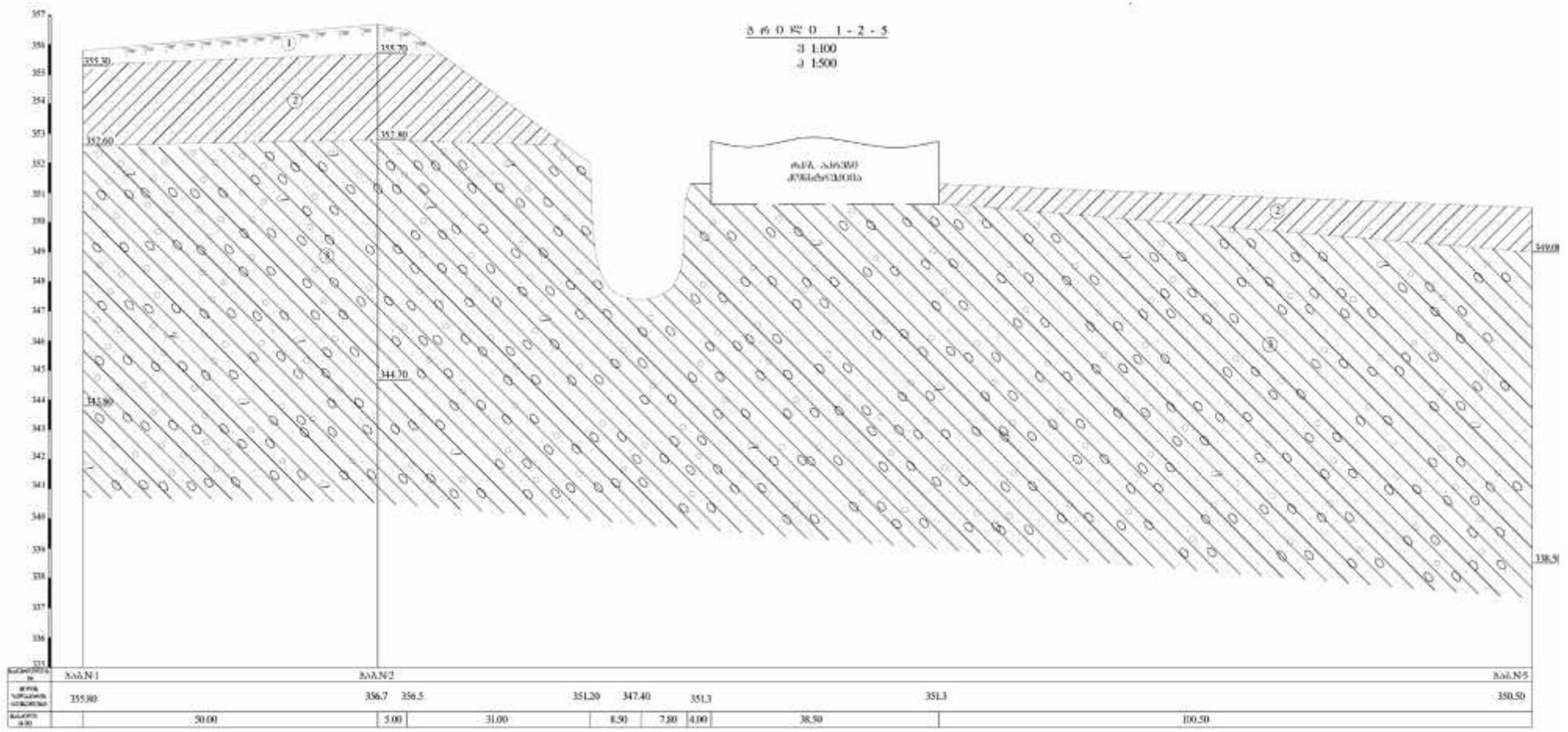
პ ი რ ო ბ ი თ ი   ა ღ ნ ი შ ვ ნ ე ბ ი

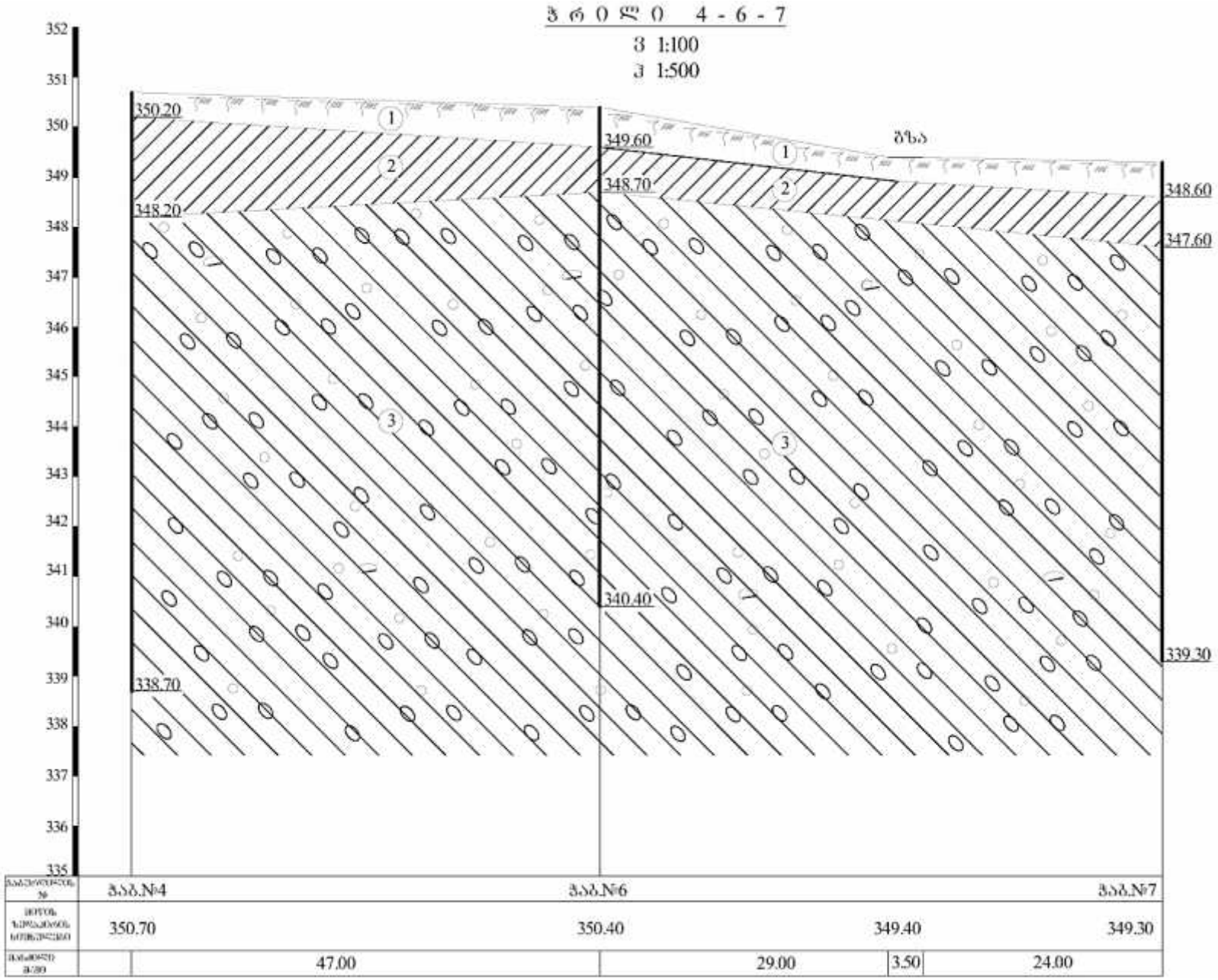
1 — ნიადაგური ფენა ჰუმუსირებული, მცენარეული ფესვებით, მოშავო

2 — ქვიშნარი წვრილმარცვლოვანი, მოყვითალო (ლიოსისებრი თიხნარი)

3 — კაჭარ-კენჭნარი, ლოდების ჩანართებით 10-20%, ხვინჭის და ქვიშნარის შემავსებლით, მოყვითალო-მონაცრისფრო

Engineering-Geological Sections of The Project Area

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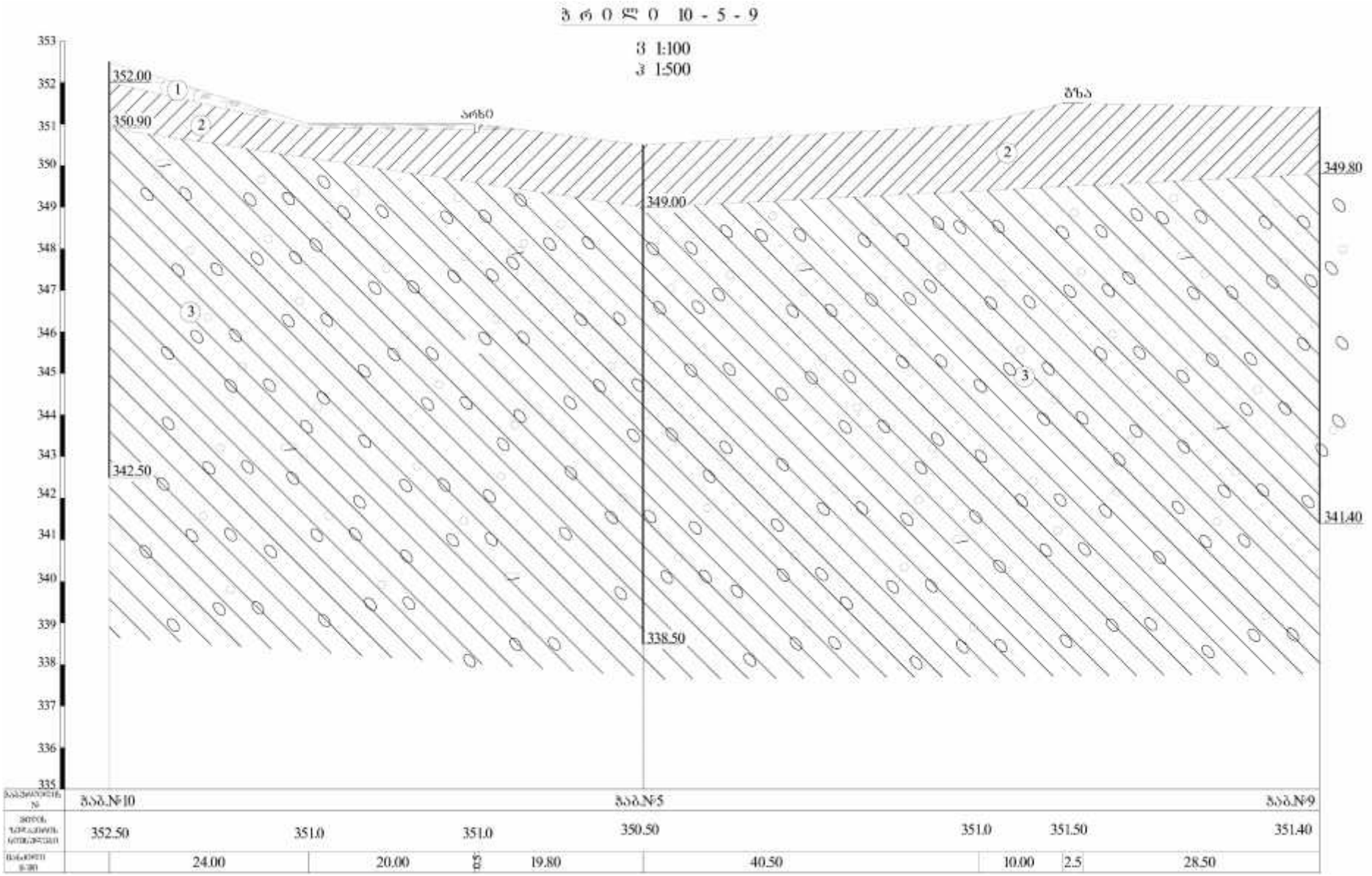
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Laboratory Examination Results of Soils, Presented within the Project Area

შპს „ახალი საქალაქმშენპროექტი" საინჟინრო გეოლოგიური კვლევების განყოფილება

გრუნტების ლაბორატორიული გამოკვლევის შედეგები

ობიექტის დასახელება: ქ. თელავის კანალიზაციის გამწმენდი სისტემა

გეოტექნიკური ლაბორატორია ქ. თბილისი

რიგითი №	გამონამუშ. №	ნიმუშის სიღრმე	ნიმუშის სტრუქტურა	ლაბ. №	პლასტიკურობა: დენადობის ზღვარი	პლასტიკურობა: გორვის ზღვარი	პლასტიკურობა: რიცხვი	ბუნებრივი ტენიანობა	სიმკვრივე: ბუნებრივი	სიმკვრივე: მშრალი გრუნტის	სიმკვრივე: გრუნტის ნაწილაკების	ფორიანობა	ფორიან. კოეფ-ტი: ბუნებრივი	ფორიან. კოეფ-ტი: დენადობის ზღვარზე	კონსისტენციის მაჩვენებელი	ტენიანობის ხარისხი	ჯირჯვებადობა	წინაღობა ძვრაზე: შინაგანი ხახუნის კუთხე	წინაღობა ძვრაზე: შეჭიდულობა	გრანულომეტრ. შემადგენლობა, ფრაქციის ზომა, მმ			დამლაშების ხარისხი	ორგანული ნივთიერებათა შემცველობა	თაბაშირის შემცველობა	კარბონატების შემცველობა	ნაწილობრივ დაშლილობის მაჩვენებელი	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	>10	10-2	<2	D_{sal}	-	$CaSO_4 \cdot 2H_2O$	$CaCO_3$	I_r	
		მ			-	-	-	%	გ/სმ³			%	-	-	-	-	-	გრად.	კპა	%				%	%	%	-	
1	ჭაბ. №1	1.7	თიხ.	88	0.28	0.22	0.06	14.9	1.64	1.43	2.69	46.9	0.885	0.753	-1.18	0.45	-0.07	19	9				არა მლაშ.	2.4	3.3	4.0	0.073	თიხნარი
2		4.0-7.0	ღორღ. სტრ.	89	0.24	0.20	0.04	8.9							-2.78					60.8	9.9	29.3						კენჭნარი, ხრ. შევ. თიხნარით
3	ჭაბ. №3	2.5	თიხ.	90	0.26	0.21	0.05	12.2	1.62	1.44	2.69	46.3	0.863	0.699	-1.76	0.38	-0.09											თიხნარი
4		3.5-7.5	ღორღ. სტრ.	91	0.22	0.20	0.02	6.8							-8.60					70.7	6.6	22.7						კენჭნარი, ხრ. შევ. თიხნარით
5	ჭაბ. №5	3.5	თიხ.	92	0.27	0.22	0.05	14.1	1.70	1.49	2.69	44.6	0.805	0.726	-1.58	0.47	-0.04	19	8				არა მლაშ.	2.1	3.0	3.6	0.070	თიხნარი
6		4.5-8.0	ღორღ. სტრ.	93	0.24	0.22	0.02	10.0							-6.00					52.4	19.7	27.9						კენჭნარი, ხრ. შევ. თიხნარით
7	ჭაბ. №6	1.5	თიხ.	94	0.27	0.20	0.07	16.5	1.66	1.42	2.69	47.0	0.888	0.726	-0.50	0.50	-0.09											თიხნარი
8		2.0-5.5	ღორღ. სტრ.	95	0.25	0.21	0.04	9.1							-2.98					62.3	9.8	27.9	არა მლაშ.	1.5	0.8	2.0	0.043	კენჭნარი, ხრ. შევ. თიხნარით
9	ჭაბ. №9	1.5	თიხ.	96	0.26	0.19	0.07	16.8	1.65	1.41	2.69	47.5	0.904	0.699	-0.31	0.50	-0.11											თიხნარი
10		2.5-7.0	ღორღ. სტრ.	97	0.26	0.21	0.05	9.0							-2.40					60.7	11.2	28.1						კენჭნარი, ხრ. შევ. თიხნარით
11	ჭაბ. №10	2.0	თიხ.	98	0.25	0.21	0.04	13.5	1.68	1.48	2.69	45.0	0.817	0.673	-1.66	0.44	-0.08	17	13				არა მლაშ.	2.5	3.5	4.0	0.075	თიხნარი
12		3.0-6.0	ღორღ. სტრ.	99	0.23	0.20	0.03	8.1							-3.97					65.4	12.6	22.0						კენჭნარი, ხრ. შევ. თიხნარით

შენიშვნა: სვეტში „წინაღობა ძვრაზე" მოცემული მნიშვნელობები მიღებულია ლაბორატორიული ნიმუშების.