Japan International Cooperation Agency (JICA)
Ministry of Environment and Physical Planning (MEPP)

Former Yugoslavia Republic of Macedonia

Data Collection Survey for Ohrid Lake Environmental Improvement

Final Report

October, 2012

NIHON SUIKO SEKKEI Co., Ltd.

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Currency Exchange Rates in this Report are as shown below;
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SURVEY AREA

Macedonia and Neighboring Countries in the Balkan Peninsula

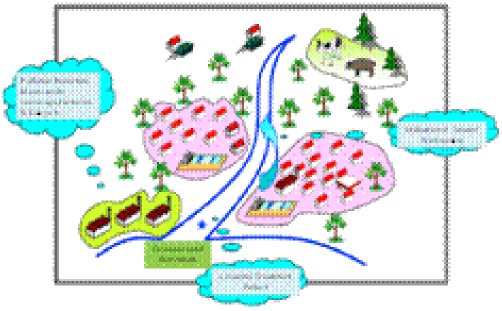
Former Yugoslavia Republic of Macedonia

Macedonia and Albania facing at Ohrid Lake

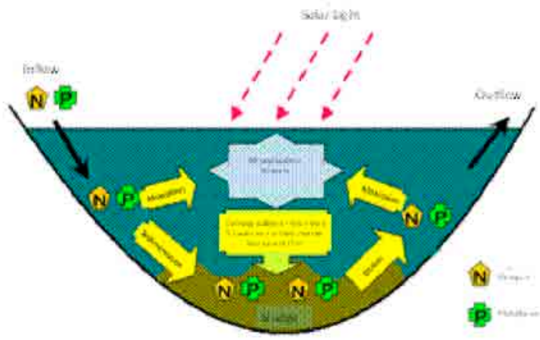
Ohrid Lake Sub-basin

Extended Basin of Black Drim River flowing into the Adriatic Sea

Ohrid-Struga Sewerage System Serving for Ohrid and Struga cities



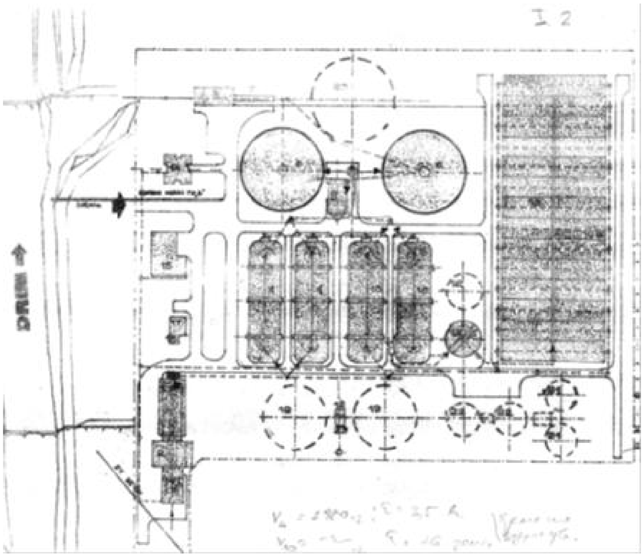
Schematic Diagram showing the River basin to connect with various activities



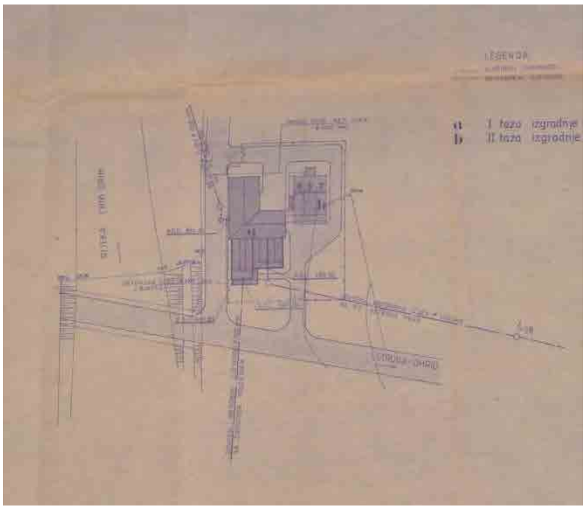
Natural Circulation of Nutrients within the Lake with inflow and outflow of water

Sewerage Network in Struga City

Sewerage Network in Ohrid City



Wastewater Treatment Plant (WWTP) at Vranista
(Oxidation Ditch Process)



Pump Station of Struga III

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Measurements

(Length)

mm : millimeter(s)
cm : centimeter(s)
m : meter(s)
km : kilometer(s)

(Area)

mm^2 : square millimeter(s)
cm^2 : square centimeter(s)
m^2 : square meter(s)
km^2 : square kilometer(s)
ha : hectare(s)

(Weight)

g, gr : gram(s)
kg : kilogram(s)
ton : ton(s)

(Time)

s, sec : second(s)
min : minute(s)
h, hr : hour(s)
d, dy : day(s)
y, yr : year(s)

(Volume)

cm^3 : cubic centimeter(s)
m^3 : cubic meter(s)
L, ltr : liter(s)
mcm : million cubic meter(s)

(Speed / Velocity)

cm/s : centimeter per second
m/s : meter per second
km/h : kilometer per hour

Abbreviations

BOD	:	Biochemical Oxygen Demand
C/P	:	Counterpart
COD	:	Chemical Oxygen Demand
DF/R	:	Draft Final Report
EBRD	:	European Bank for Reconstruction and Development
EIA	:	Environmental Impact Assessment
EIB	:	European Investment Bank
EU	:	European Union
EUR	:	Euro
F/R	:	Final Report
FYROM	:	Former Yugoslav Republic of Macedonia
HBI	:	Hydro Biological Institute
HMI	:	Hydro Metrological Institute
IC/R	:	Inception Report
IT/R	:	Interim Report
JICA	:	Japan International Cooperation Agency
JPY	:	Japanese Yen
KfW	:	Kreditanstalt für Wiederaufbau
MEPP	:	Ministry of Environment and Physical Planning
MOF	:	Ministry of Finance
MKD	:	Macedonian Denar
MOH	:	Ministry of Health
MTC	:	Ministry of Transport and Communications
NDP	:	National Development Plan
NEAP	:	National Environmental Action Plan
O/M	:	Operation and Maintenance
PE	:	Polyethylene (Pipe)
PHARE	:	Poland and Hungary Assistance for Reconstruction of Economy
PVC	:	Polyvinyl Chloride (Pipe)
RC	:	Reinforced Concrete (Pipe)
SDC	:	Swiss Agency for Development and Cooperation
SECO	:	State Secretariat for Economic Affairs
SEA	:	Secretariat for European Affairs
SF	:	Swiss Francs
SS	:	Suspended Solid
S/W	:	Scope of Work
T-N	:	Total Nitrogen
TOR	:	Terms of Reference
T-P	:	Total Phosphorus
USD	:	US Dollar
VAT	:	Value Added Tax
WB	:	World Bank
WWTP	:	Wastewater Treatment Plant

Executive Summary

Ohrid Lake, one of the most ancient lakes in Europe, is the pride of the Macedonian people, and located on the Southern border with Albania. Because of its beauty and historical importance, Ohrid Lake was awarded World Heritage status in 1980 by UNESCO. Since then it has been attracting ever-increasing tourists domestically as well as from all over the world. However the sewerage system, which was constructed more than half a century ago in the era of Yugoslavia, has become quite old, and some parts are already obsolete. In recent years, the Government of Macedonia has been concerned over its condition. There is significant ingress of unidentified water into the sewer pipes, forcing the pump stations to run non-stop, which shortens their service lives and results in frequent stoppages. The wastewater treatment plant located at Vranista/Struga cannot treat the sewage properly due to largely diluted influent.

The present government policy involves targeting membership of NATO and the EU. In December 2005, Macedonia was welcomed to join the EU Board Meeting at Brussels, and was confirmed as an eligible candidate for membership. In November 2011, the prime minister of Macedonia, Mr. Gruevski, visited Japan to meet his counterpart Mr. Noda and the president of JICA, and made a special request to improve the Ohrid Lake environment. Accordingly, JICA decided to dispatch a consultant to conduct a survey and collect data in the country. This is the Final Report of the same, to be presented and explained to the relevant organizations of the Macedonian Government. During the Joint Meeting of MEPP, MOF, SEA and others a series of discussions was held to clarify the comments and questions of the Macedonian side. After JICA Survey Team has obtained all the comments from the Macedonian side, the Final Report will be completed in consultation with JICA, and sent to the Macedonian Government.

This FR consists of 8 chapters. Chapter 1 explains the background to the Survey and general information about Ohrid and Struga cities and surrounding areas, and the existing systems. Chapter 2 explains the existing conditions in more detail such as the natural conditions (topography, water environment and meteorology), social conditions (population, regional economy and land use), and sewerage & sanitation management, conducted site survey and pollution load to Ohrid Lake. The daily water consumption in the sewerage-served area is about 13,000 m^3/day against water usage for connected sewers of about 9,600 m^3/day, or about 74%. The site survey revealed that some pipes had been damaged for various reasons. However, the problem is that PROAQUA did not recognize them properly, and they were occasionally not repaired. Based on water sampling and analysis, the dilution levels vary by area, hence repair works could be prioritized. The pollution loads are estimated at 5,109 and 2,951 kgBOD/day from sewerage-served and -unserved areas respectively, totaling 8,060 kgBOD/day. The current load is therefore calculated at 2,577 kgBOD/day, or a removal rate of 68.0%.

Chapter 3 summarizes the EU Directives in relation to the sewerage sector, and sewerage and sanitation management. The lake is divided into 5 water categories with repressive parameters of pH value, DO, BOD_5, COD, Total Dissolved Solid, Total Phosphorus, Total Nitrogen, Chlorophyll and Fecal Coliform. Chapter 4 explains the institutional set-up of the Macedonian Government for policy decisions on environmental improvement, and of Ohrid and Struga cities for operation and maintenance. The former PROAQUA was divided into Niskogradba, responsible only for sewage collection in Ohrid City, with treatment is carried out in the WWTP at Vranista/Struga.

Based on the circumstances faced by the Ohrid-Struga sewerage system, effective approaches are discussed for Ohrid Lake Improvement in Chapter 5. Following the general explanations, various problems are discussed involving the sewerage network, pump stations and WWTP, as well as further potential problems occurring with the expansion of the sewerage areas and new network in unserved areas. Finally some improvements are proposed such as:

- Eliminating the risk of discharging raw sewage into Ohrid Lake
- Reducing incoming sewage by performing stable treatment
- Reducing energy consumption in terms of sustainable operations
- Completing wastewater treatment in unserved area
- Alleviating ingress into the existing sewer network

Chapter 6 discusses all the findings by JICA Survey Team in its activities in the field in 4 different aspects: institutional, financial, technical and social. The problems tend to be interrelated, and generally concern the capacity of PROAQUA and Niskogradba. Accordingly, instead of individual solutions to issues, the problem should be tackled collectively. Eight projects were selected to be implemented in the short term (about 2 years from 2013), medium-term (about 3 years) and long term (about 5 years) depending upon emergency and fund requirement. Their costs are roughly estimated based on Macedonian and Japanese methods, with Japanese unit costs almost equivalent to those of Europe. JICA Study Team judges that another WWTP will not be required, because the existing facility has sufficient capacity to treat the wastewater of this area.

Chapter 7 summarizes and groups those eight projects into 4 as follows:

- Awareness campaign: about 1.6 million EUR (short-term)
- Arrangement of sewerage ledger: about 14.2 million EUR (short-term) with some repairs
- Small sewerage system construction: about 5.4 million EUR (medium-term)
- Current sewerage system improvement: about 33.2 million EUR (long term)

Finally Chapter 8 summarizes the roadmap for Ohrid Lake environment improvement, so that the sewerage sector of this area will be substantially improved by 2020, with total investment of about 54.4 million EUR.

Chapter 1 Background

1.1 Introduction

The Former Yugoslavia Republic of Macedonia (hereafter referred to as “FYR of Macedonia” or simply “Macedonia”) has a population of 2.06 million (2010) within an area of 25,713 km^2 and is located in the Balkan Peninsula. Its capital, Skopje, is located slightly north of the center of the country, which is bordered with Bulgaria to the East, Greece to the South, Albania to the West and Serbia and Kosovo to the North.

Macedonia had limited development in the former Yugoslavia during the period 1945 to 1991 and is therefore currently facing many difficulties in terms of infrastructure development, especially in the sewerage sector. In addition to such disadvantages, the country lost a stable market following its independence in 1991 at once. However since then the country made stable development due to its political situations and people’s diligence, so that the country was ranked at 16^{th} based on the WB business index. The main national industries are agriculture, textiles and mining, and the country is now struggling to develop alongside other European countries, despite a per capita GNI (Gross National Income) as low as 4,431 USD (2010, IMF) in comparison with other countries.

Incidentally, Macedonia concluded and signed a “Stabilization and Association Agreement” with the EU in 2005 whereupon its status was elevated to a candidate EU member. The country has therefore set joining the EU as its one of the top priority according to the National Environmental Investment Strategy 2009 – 2013. In the environmental field, the country has set acceptance of the EU Directives, particularly improvement of the sewerage sector, as one of its highest priorities.

Though the capital, Skopje, and the Ohrid Lake areas are anticipating increased domestic sewage due to the soaring population, the sewage facilities fall far short of what is required. For the capital, Skopje, JICA conducted a development study entitled the “Skopje Sewerage Improvement Project” in 2009, in which a sewage treatment plant with a capacity of 166,000 m^3 per day and a sewer networks along both sides of the Vardar River were proposed. The country is expected to implement the project as soon as practical.

Conversely, the Ohrid Lake and surrounding areas and only central areas of both Ohrid and Struga cities are served with sewer systems, details of which are as follows:

- Collection system: Mixture of separate and combined systems
- Total length of trunk sewers; approx. 40 km (φ500-1200 mm, PVC, reinforced concrete, PE)
- Sewer network: Ohrid City; approx. 108 km, Struga City; approx. 59 km (φ200 - 600 mm)
- Pump stations: 17 (Lifting capacity: approximately 50-2,300 L/sec)
- Treatment plant: 1 (Oxidation ditch process in Struga City)
- Discharge: Black Drim River

Ohrid Lake, one of the most ancient in Europe, has been enjoying an increased number of tourists from other parts of Europe and elsewhere, and was finally registered as a World Heritage site by UNESCO in 1980.
The information of Ohrid Lake is summarized as follows:

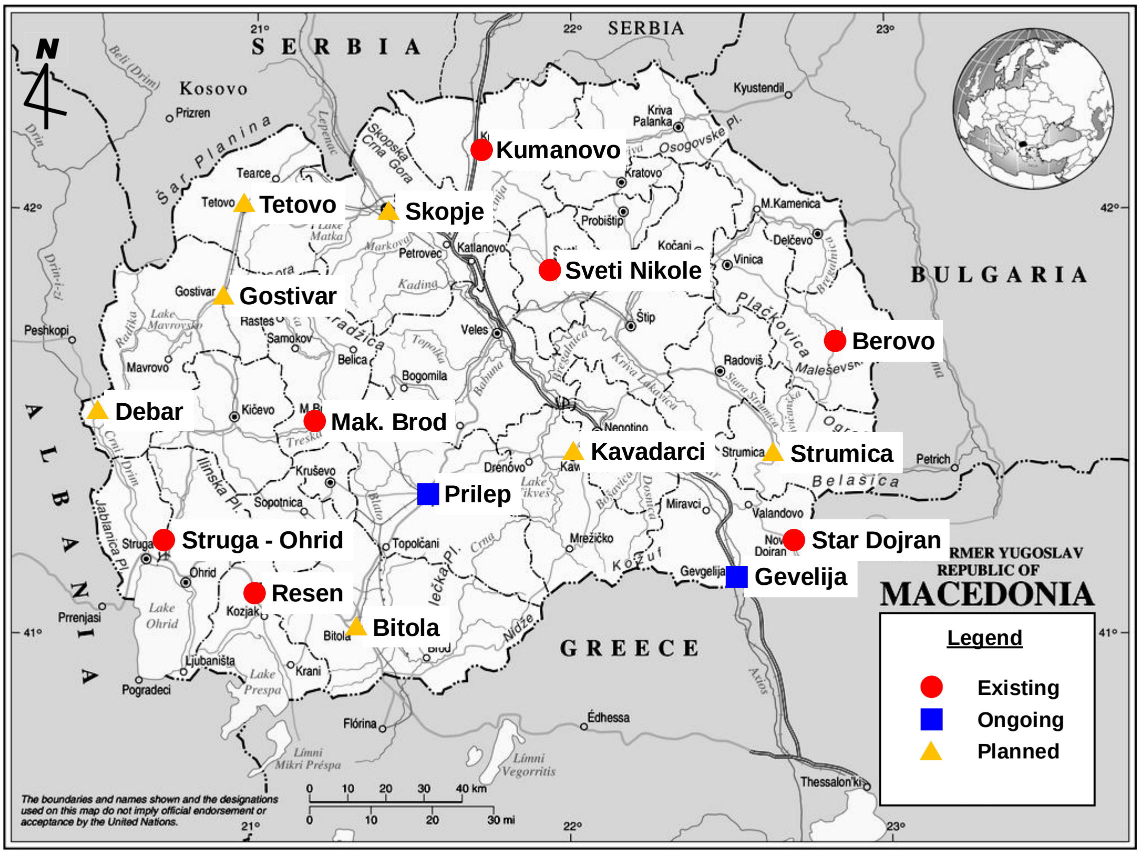
- Area: 358.2 km^2
- Altitude: 695 m
- Volume: 50.7 x 109 m^3
- Depth: 289 m deepest point, average of 164 m
- Lake line length: 87.53 km (Macedonia: 56.02 km, Albania: 31.51 km)
- Inflow volume: 14.47 m^3/s (average)
- Spring volume: 10.26 m^3/s (average)
- Lake retention time: about 60-70 years

This sewage treatment plant, located at Vranista, handles an inflow beyond its design capacity, due to the large volume of unidentified underground water, storm water and lake water flowing into the sewers, resulting in the subsequent outflow of wastewater from the sewer into the lake. Such flow fluctuation is sometimes seasonal or unpredictable and results in sewage escaping from the plant and polluting the lake.

In Macedonia, the public service of local government also remains far from satisfactory and while maintaining a certain standard in urban areas, it falls short in rural areas. In small communes in particular, infrastructure is lacking: for example the water supply has only penetrated about 70% of the whole country. Almost 100% of residents in urban areas enjoy a private water supply, but this is only available to 28% of residents in rural areas.

Conversely, only a limited number of areas are equipped with sewerage systems and wastewater treatment plants, such as Berovo, Sveti Nikole, Kumanovo, Star Dojran, Resen, Makedonski Brod and Struga-Ohrid. The sewerage service will have to be expanded to provide a more adequate service and its affordability for residents is also considered to be limited.

Against this background, the Government of Macedonia has selected the issues of the Ohrid Lake sewerage sector within the scope of environmental measures for Ohrid Lake. In response to the request concerning Ohrid Lake Environmental Improvement, JICA has decided to dispatch a consultant team to the country to collect data for comprehensive analysis of the Ohrid Lake for the sake of Macedonia.



Source: Ministry of the Environment and Physical Planning, Macedonia

Figure 1.1 Locations of Sewerage Projects in Macedonia

The sewerage systems in Ohrid and Struga cities were developed nearly 50 years ago, except for an ancient system constructed during the Roman period in the ancient town of Ohrid. The current sewerage system, meanwhile, which includes a wastewater treatment plant, has been installed since the 1970s and has suffered from many malfunctioning elements. In 2000 and 2005, German aid was provided by the KfW (Kreditanstalt für Wiederaufbau) to support the revitalization of existing sewerage facilities by conducting a series of studies for review and preparing visions for future developments and expansion of the served area. Their project involved connecting the rural surrounding areas of Ohrid Lake and rehabilitating the program and project.

Conversely, in 1997 and 2009, governmental assistance from Switzerland (SDC: Swiss Agency for Development and Cooperation) supported the sewerage entities by replacing equipment and installing remote sensors, including motors at pump stations and mechanical and electrical equipment at wastewater treatment plants, etc.

However, the sewerage system still faces concerns such as unexpected water ingress due to abundant underground and lake water flowing into the wastewater treatment plant far beyond its original capacities, resulting in electricity wastage due to obsolete equipment, etc. Moreover, the final installation of sewerage treatment is also key in terms of protecting the environment in Ohrid Lake. The ingress of untreated wastewater from rural communes must be stopped in the vicinity of the areas surrounding the Ohrid Lake.

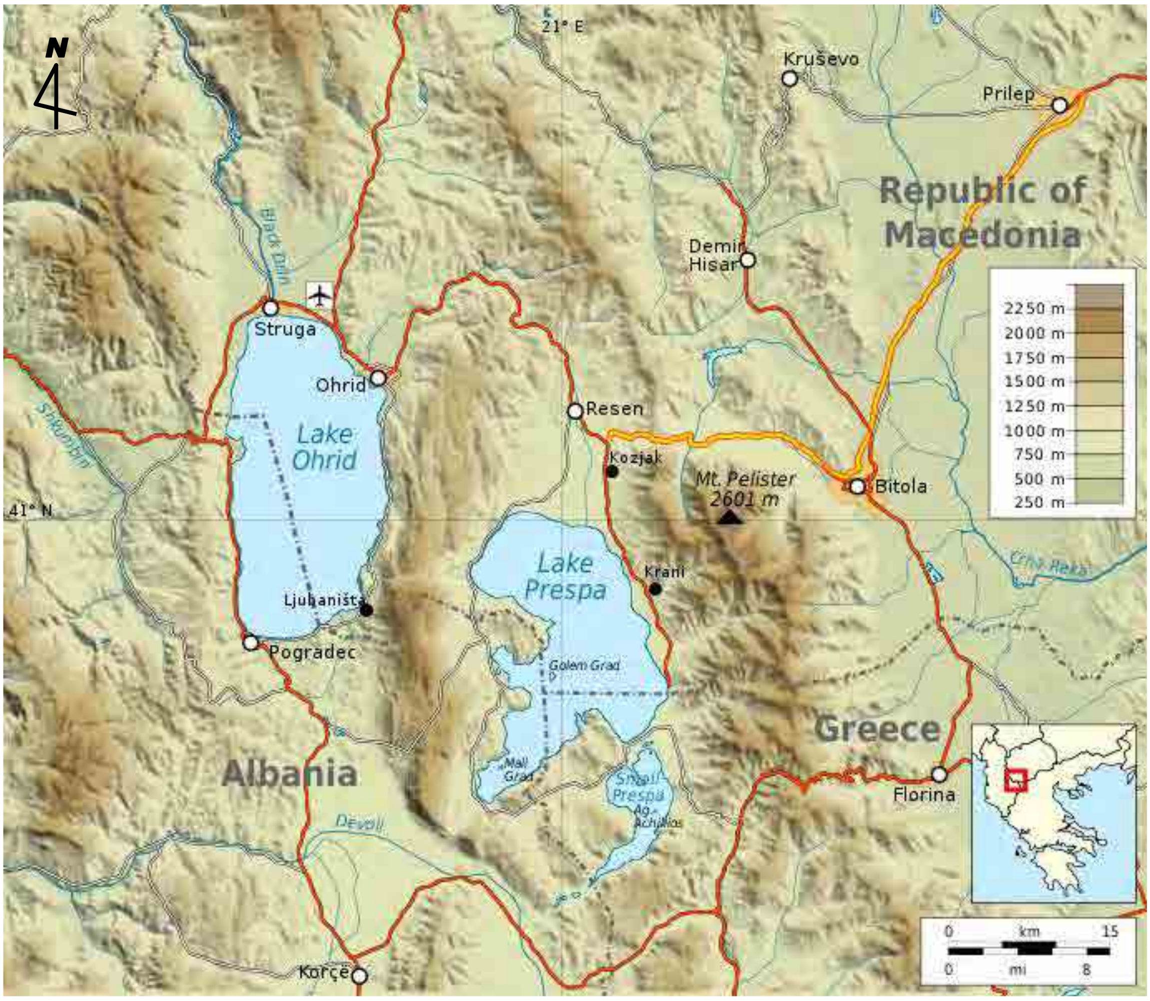
1.2 Objectives of this Survey

The survey has the following objectives:

- To identify the issues related to the sewerage sector in the areas of Ohrid Lake and its vicinity,
- To collect relevant data to determine what kind of assistance will be most useful, including Japanese sewerage technology, and
- To verify the contents of the Survey.

1.3 Survey Area

The survey area is defined as the relevant areas of urban and rural communes and tourist destinations at risk of the discharge of pollutants via wastewater. This is why the survey determined the survey area as the following four (4) elements surrounded by the lake, namely: (1) the urban area of Ohrid City, (2) that of Struga City, (3) the rural communes surrounding Ohrid Lake on the Ohrid side, and those of the Struga side (4) within both cities.



Source: JICA Study Team

Figure 1.2 Survey Area with Neighboring Prespa Lake

1.3.1 Urban Area of Ohrid City

The center of Ohrid City is located on the northeastern side of Ohrid Lake. The population of the central area was 42,705 according to the existing Figure in the preliminary KfW project report in 2001, and the populated area exceeded an area of 1,100 ha. Typical ground elevation ranges between 690-730 m above sea level (ASL).

Tourist functions are mainly located on the lakeside, while hotels are established along the bay side to the east of the center and an old historic zone settled in the center of the city. Private accommodation is also offered by residents for travelers visiting during holiday seasons.

A sewerage system has been installed since the late 1950s. The system employed a combined sewerage system in part of the area (mainly sewers constructed beforehand), allowing both domestic wastewater and storm water to flow. This system had been established previously, which led to fundamental difficulty for the Ohrid-Struga sewerage system, because other areas were handled with a separate system, which only allowed domestic wastewater to flow. However, storm water sewers have been established in only limited streets, with the remaining sewers having to collect storm water when storms occur. There were some famous textile industries operating on the north side of the city but they have currently ceased operations.

Primary Sewer in the Main Street | Stone Paved Street in the Ancient Area

Source: JICA Study Team

Figure 1.3 Scenery in Ohrid City Downtown

1.3.2 Urban Area of Struga City

The center of Struga City is located to the north of Ohrid Lake. The population of the central area is 17,000 according to the existing Figure in the preliminary report by the KfW project in 2001, and the populated area exceeds 350 ha. The land is very plain and the typical ground elevation is approximately 690-700 m ASL. Tourist functions are also mainly on the lakeside, with hotels established along the bay side.

A combined sewerage system has been installed, as in Ohrid City, the area in which the system was established previously.

There were some famous textile industries operating to the north of the city but they have now ceased operations, similar to Ohrid City.

Downtown Area | Marketplace

Source: JICA Study Team

Figure 1.4 Scenery in Struga City Downtown

Source: JICA Study Team

Figure 1.5 Locations of Ohrid and Struga cities

1.3.3 Other Communes in Ohrid City

Ohrid City has 18 other main settlements (which have been organized by KfW's study in 2000) besides Ohrid central, and roughly 9 groups of communes (Ljubanista, Trpejca, Pestani, Elsani-Elesec Lagadin, Konjsko-Dolno Konjsko-Istok, Sipokno-St. Stefan, Podmolje and Orovnik) are situated along the shore of the lake.

The shore communes are each populated by about 200-1,400 people (4,497 in total according to the sewerage project by KfW in 2001), while those in the south are divided by hilly terrain. In addition, campsites and beaches are located nearby.

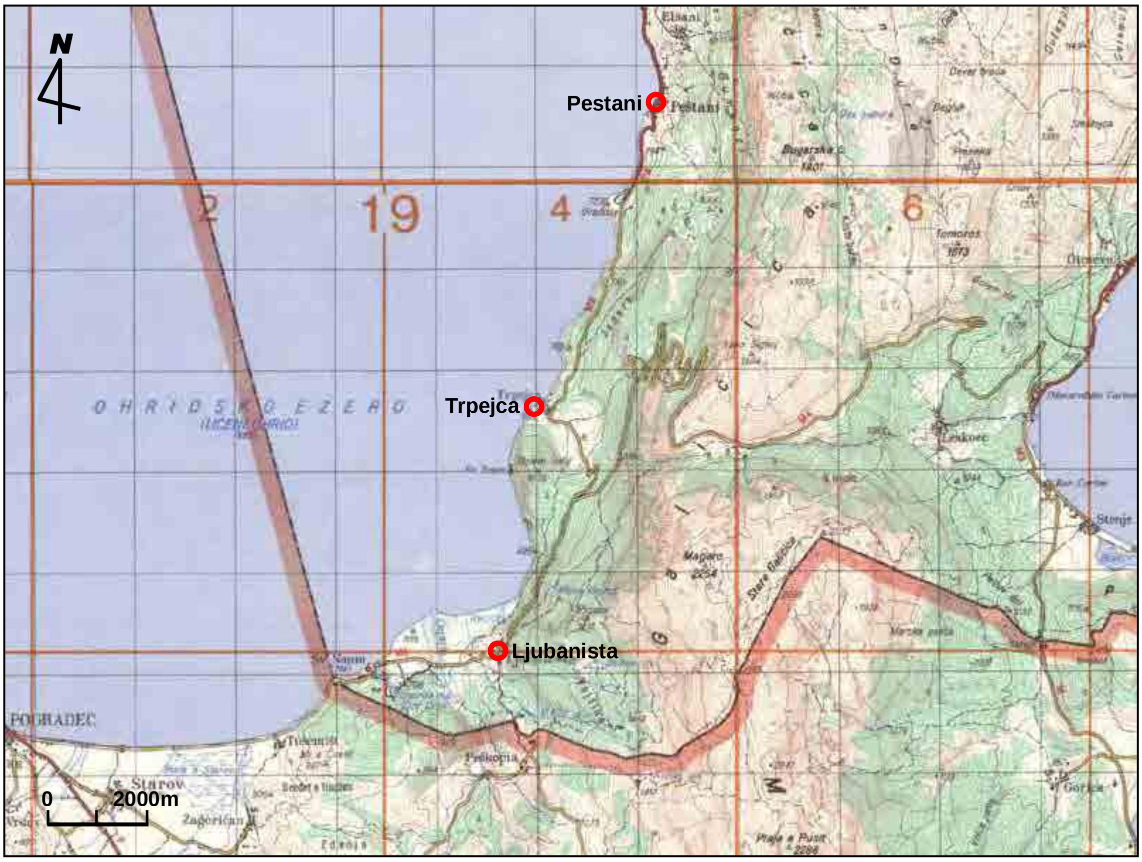
In relation to sewerage connections, the southern primary sewers between Pestani-Ohrid are currently installed (extension works between Pestani-Dolno Konjsko were completed as part of the recent KfW project) and smaller communes and tourism functions have just started connecting to the system.

Lake Side Beach

Newly Built Pump Station

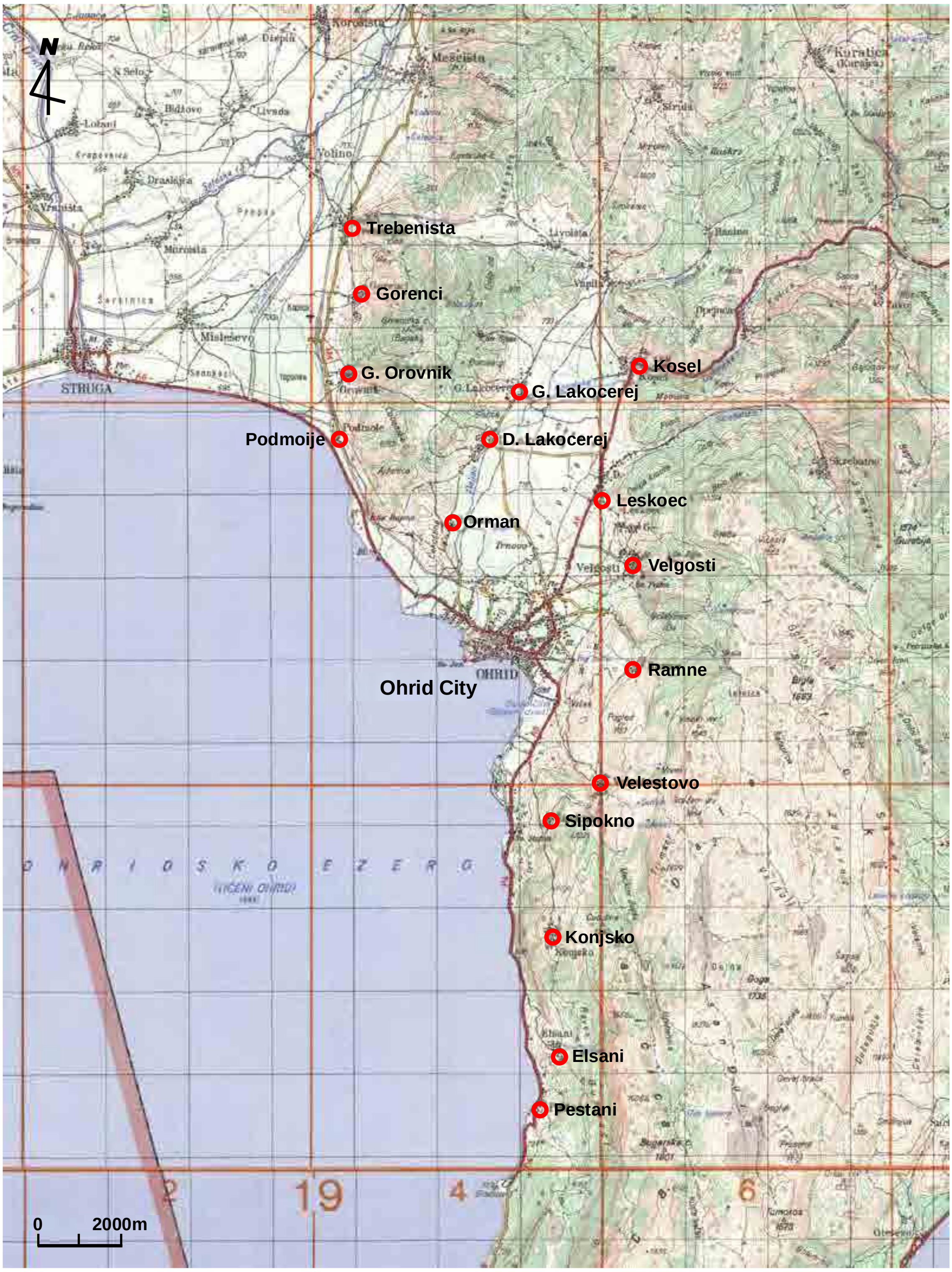
Source: JICA Study Team

Figure 1.6 Scenery taken in Southern Ohrid



Source: JICA Study Team

Figure 1.7 Southern Ohrid Municipality



Source: JICA Study Team

Figure 1.8 Southern and Northern Ohrid Municipality

1.3.4 Other Communes in Struga City

The city has 19 other main settlements (which have been organized by KfW's study in 2000) besides Struga central. In addition, roughly 6 groups of communes (Sum-Zagracani, Radolista, Kalista, Frangovo, Radozda and Mali Vlaj) are connected to the protection of Ohrid Lake and potentially, wastewater (also pre-treated wastewater) is allowed to flow into the lake based on the characteristics of the terrain.

The communes' each house 160-3,000 people (8,600 in total according to the sewerage project by KfW in 2001) while shore side communes are divided by hilly terrain. The tourist functions such as campsites and beaches are located near the communes between Kalista and Radozda.

In terms of sewerage connections, the southern portion of the primary sewers between Elen Kamen (small communes to the south of Kalista)-Struga had a system installed but it is currently out of order for various reasons. Radolista has also started its connections but connectivity remains insufficient.

Lakeside Commune in Radozda | Campsite in Radozda

Source: JICA Study Team

Figure 1.9 Scenery taken in Southern Struga

Source: JICA Study Team

Figure 1.10 Remaining Part of Struga Municipality

1.4 Scope of the Survey

The general scope of the survey is as follows:

(1) To determine the issues of the sewerage sector of Ohrid Lake and surrounding areas:

1) To confirm the contents and appropriateness of the long-term plans of Macedonia
2) To identify intrusive and unidentified water in existing sewer networks
3) To investigate the operation of the sewage treatment plant (oxidation ditch process) at Struga City
4) To summarize water quality and related trends at Ohrid Lake
5) To confirm the coverage, role and capacity of the agencies for sewerage and hygienic sanitation including MEPP (the Ministry of the Environment and Physical Planning) and its Ohrid Office, PROAQUA (a municipal enterprise taking charge of the operation and maintenance of the water supply and sewerage service), the municipality office of Ohrid and Struga cities and other relevant agencies.

(2) To confirm the assistance status of other donors:

(3) To recommend the assistance direction to JICA:

1) Management of project implementation (appropriateness of the proposed implementation organization)
2) Related financial and administrative system
3) Appropriate technology available for sewage treatment system
4) Remarks in extracting concrete issues

Moreover, the scope of surveys in the relevant sectors is summarized as below.

1.4.1 Sewerage, Sanitation and Drainage

(1) Sewerage

The scope of the survey on sewerage facilities is itemized as follows:

1) To review the current conditions of all installed sewers, principally the primary and secondary sewers in Ohrid and Struga cities. The points of the review are mainly:

- Coverage of sewer facilities in urban areas and rural sites in detail
- Condition of these facilities in terms of performance, function, etc.

2) To review the current conditions of constructed sewerage facilities for the sewerage system, including 17 sewage pumping stations and Vranista Wastewater Treatment Plant. The points of the review are mainly:

- Condition of equipment, installation, water flows, etc.
- Condition of daily operation at the wastewater treatment plant

3) To collect and confirm the current situation of operation maintenance including:

- Condition in which records and installation histories are kept
- Current situation of running operation (unit tariff, organization structures, etc.)

(2) Sanitation

The sanitation sector has been reviewed to understand the situation of small scale wastewater treatment facilitates and satellite wastewater treatment plants to protect against discharging of untreated wastewater into the lake.

(3) Drainage

The purpose of the survey was to identify the current drainage system and separate sewer system if the sewer system is employed in cities, including modified areas which were originally established as combined sewer systems under a sub-project of rehabilitating the existing system to reduce the ingress of groundwater into the sewers.

1.4.2 Other Related Sectors

The scope of other related sectors is principally to collect current information relating to wastewater treatment, summaries of which are given as below.

(1) Water Supply

The purpose of collecting information is mainly to evaluate the current condition of the water supply system in terms of the supplied water volume and served population under a supply system which would be directly connected to the performance and demand of the sewerage system.

(2) Solid Waste Management

The sector of solid waste management will be surveyed to collect current information concerning sludge treatment if the produced sludge is treated on-site or at the facility under sanitation sectors.

(3) Others

Statistical data were collected from the relevant agencies to identify the natural and social status of the cities, including the temperature, precipitation and typical water quality measured in the Ohrid Lake and other related social data such as population, number of tourists, etc.

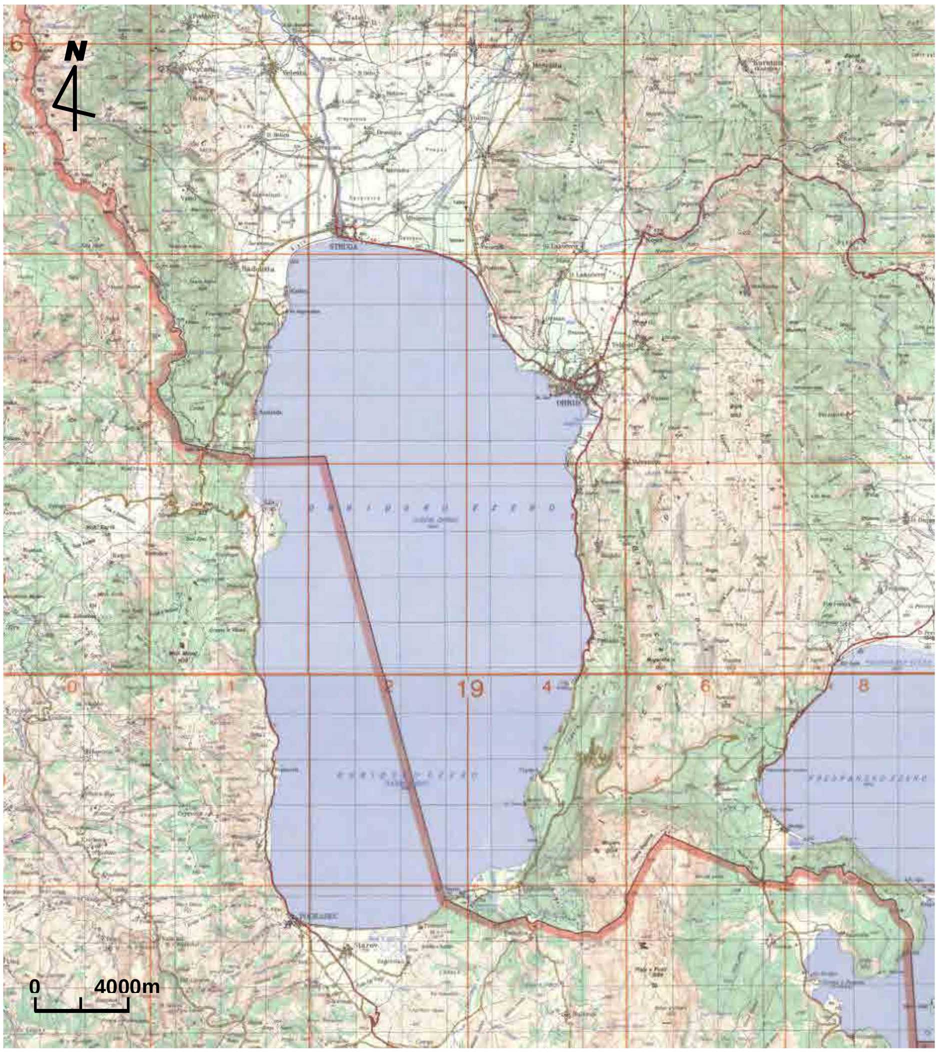
Chapter 2 Existing Conditions

2.1 Natural Conditions

2.1.1 Topography

Ohrid Lake is the one of the oldest lakes in the world, and located in the south-west of the country; its latitude and longitude are 41°05' north and 20°45' east and the altitude of its average water level is 693.7m above sea level (ASL).

Ohrid Lake is the deepest lake of the Balkans, with a maximum depth of 288 m and a mean depth of 155 m. It covers an area of 348.8 km² and contains an estimated 55.28 km³ of water. It is 30.4 km long by 14.8 km wide at its maximum extent with a shoreline length of 87.53 km, shared between Macedonia (56.02 km) and Albania (31.51 km).



Source: Center of South-West Planning Region

Figure 2.1 Ohrid Lake

The geographical and topographical conditions surrounding the lake are shown below:

Table 2.1 Topographical Features Surrounding the Lake

Location	Geographical Feature	City / Commune	Note
North	Flatland	Struga, Ohrid, Kalista	
North-East	Flatland & Gentle hills	Konjsko, Pestani	
North-West	Precipitous Terrain near the lake	Podmilje, Radozda	
South-East	Precipitous Terrain near the lake	Gradiste, Trpejca, Liubanista, St.Naum	
South & South-West	Flatland	Pogradec, Hudenist	in Albania

Source: JICA Study Team

There are about 40 tributaries (23 and 17 on the Albanian and Macedonian sides respectively) feeding Ohrid Lake. However, the lake stands out since it is mostly fed by spring water, from numerous surface and sublacustrine springs. The major tributaries on the Macedonian side are: River Velgoska, River Koselska, Sateska River, River Drim, Cerava River and the springs in the St. Naum area and these rivers supply water sources into Ohrid Lake as feeders and Black Drim River has its downstream connected at the north side of the lake in the center of Struga City and the river is the only one effluent river which flows to the Adriatic.

2.1.2 Water Environment

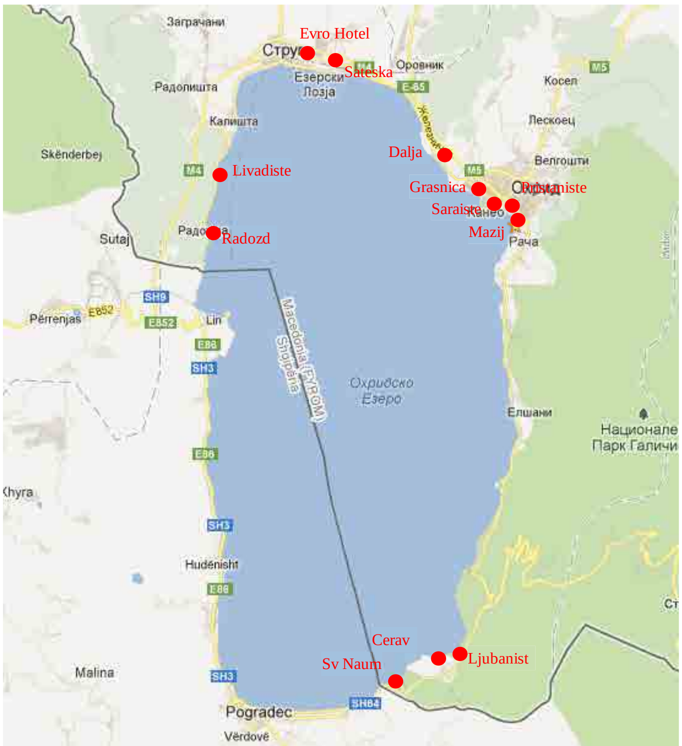
(1) Water Quality in Ohrid Lake

Ohrid Lake is one of the cleanest lakes in Macedonia. Considering the fact that the lake lies among international waters, activity to preserve the water quality should be undertaken on an international level for overall protection and the part in Albania as well. The quality of the lake water is worst at the mouth of the Sateska River.

The water quality examinations of the lake were conducted by the Hydrobiological Institute in Ohrid to establish its trophic state from the littoral zone at the Macedonian part of Ohrid Lake, during the period 2004-2005[1]. The sampling points of this survey and the results of the study by the Hydrobiological Institute are shown below:

JICA Study Team confirmed that the surveys were not regularly done by the Hydrobiological Institute and the newest summary was used in this report.
The water quality examinations of the lake are conducted by the Public Health Institute every month in 30 sampling points, and JICA Study Team could get the monthly reports from the institute. However the reports don’t have any specific value, but they only have the qualitative descriptions by the category. JICA Study Team did not have the specific water quality analysis data from the Public Health Institute in this survey.

[1] “Littoral Zone Trophic State at the Macedonian Part of Lake Ohrid” (2006) , Hydrobiological Institute Ohrid

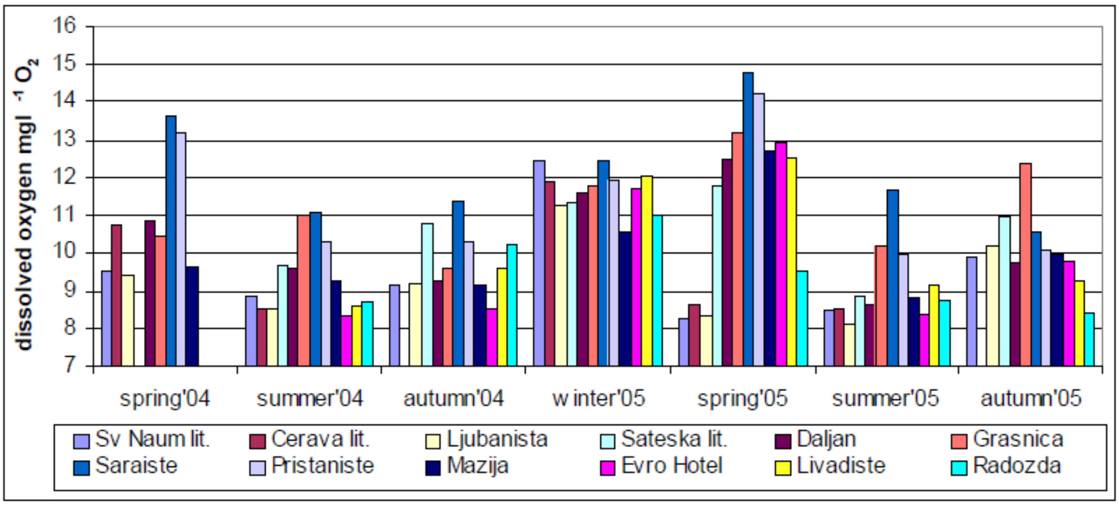


Source: JICA Study Team

Figure 2.2 Sampling Points

1) Dissolved Oxygen

Dissolved oxygen is a key indicator of the ability of the water body to maintain aquatic life and a sensitive indicator of physical and chemical processes within a single aquatic ecosystem. Generally, the higher the dissolved oxygen concentration, the better the overall condition. Over 8mg/LO_2 is classed as Type I (the primary classification in Macedonia) according to the Regulation for Classification of Water (Official Gazette No. 18/99). The concentrations of dissolved oxygen in seasonal distribution and good oxygen supply in all investigated areas as shown below.

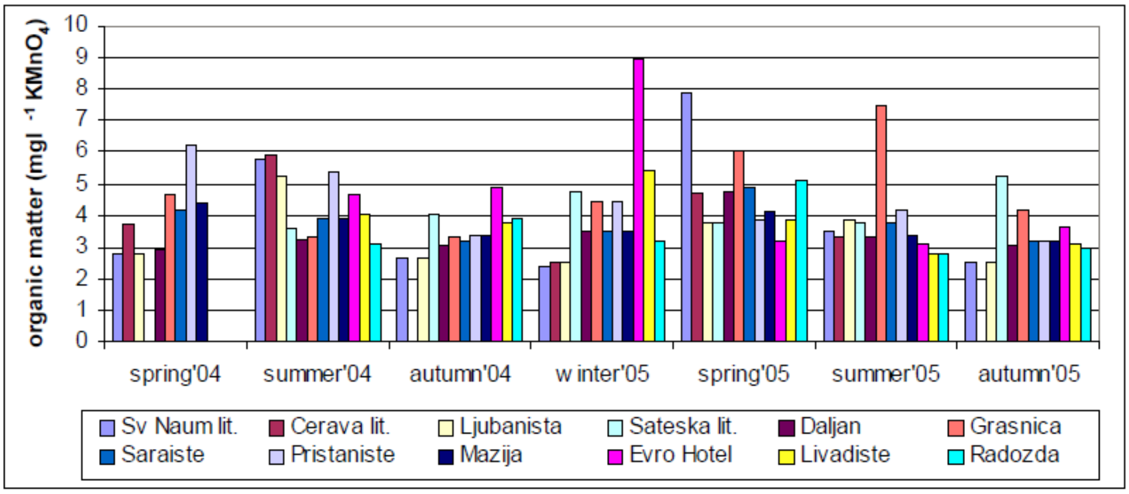


Source: Hydrobiological Institute Ohrid

Figure 2.3 Sasonal Changes in the Concentration of Dissolved Oxygen

2) Organic Matter

During the autumn-winter investigation period, the concentration of dissolved oxygen increased and subsequently declined during summer, which correlates with the presence of biodegradable organic matter at the investigated locations. Generally, the higher the concentration of organic matter, the worse the condition. Areas with concentrations exceeding 4mg/L BOD are graded Class III (also classified by COD between 5 to 10 mg/L), and swimming is prohibited according to the Regulation for Classification of Water (Official Gazette No. 18/99). Concentrations of biodegradable organic matter are presented in Figure 2.1.4. Reflecting the fact that the oxygen is used to mineralize biodegradable organic material, the concentrations of which are shown to increase during the spring-summer period, a greater oxygen consumption during that period is normal, i.e. a decline decrease in oxygen concentration in the water at the investigated locations.

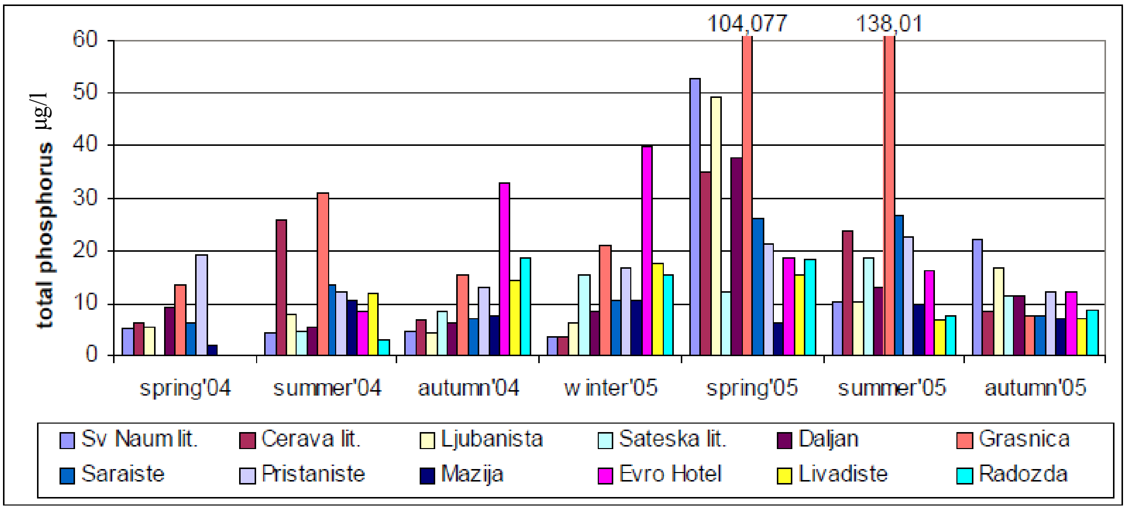


Source: Hydrobiological Institute Ohrid

Figure 2.4 Seasonal Change in Biodegradable Organic Matter

3) Nutrients

Investigations of the dynamics and effects of nutrients (nitrogen and phosphorus in this case) in the lakes are among the most important subjects in modern limnology. Actually, the trophic state can be freely defined as the nutrient state of a lake, revealing insights into its productivity and health. Since the formation of the lake itself, the natural aging process of the ecosystem, or its eutrophication process, also begins. An anthropogenic impact may be felt with the disturbance of the ecosystem, decreasing immunity and biodiversity. Eutrophication mainly involves the nutrient enrichment of aquatic ecosystems, especially with nitrogen and phosphorus. Generally, the higher the concentration of nutrients (nitrogen, phosphorus), the worse the condition.

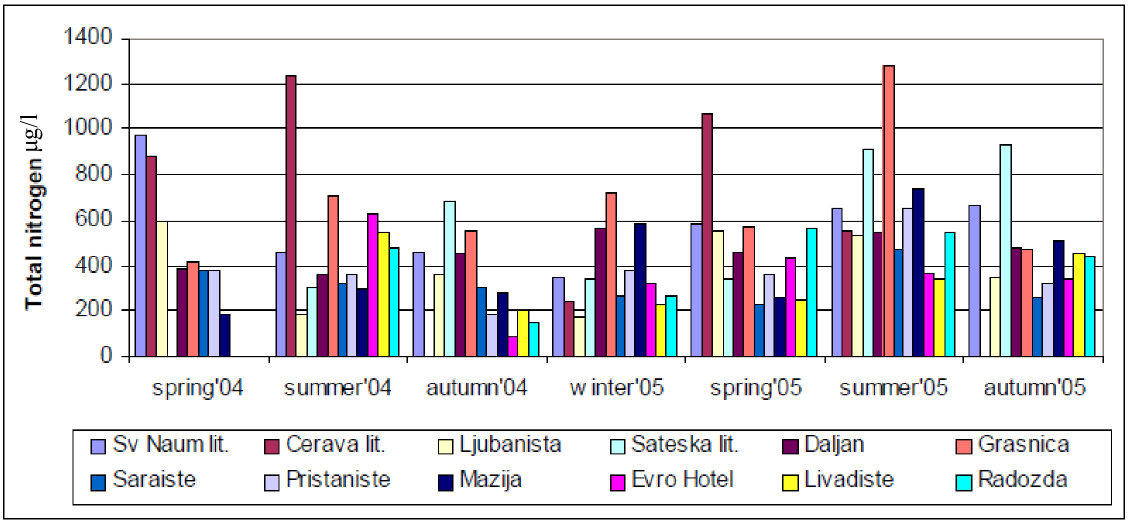


Source: Hydrobiological Institute Ohrid

Figure 2.5 Seasonal Changes in Total Phosphorus Concentration

According to the concentrations obtained for both biogenic elements, higher values could generally be ascertained during the summer period at all investigated localities. Significantly higher concentrations of both nutrients were registered in samples collected near the mouth of the rivers, during the overall investigated period (Veljanoska-Sarafiloska, 2004; Lokoska, 2003).

For example, the maximum values of total phosphorus concentration at littoral Grasnica, which were registered during the spring-summer period 2005, were 104.08 and 138 µg/L T-P consequently.



Source: Hydrobiological Institute Ohrid

Figure 2.6 Seasonal Changes in Total Nitrogen Concentration

The results obtained for total nitrogen concentration registered in water at the littoral near the Rivers Cerava, Sateska and Grasnica, during the overall investigation period showed higher values than other localities, within the range 500 to 1,300 µg/L T-N.

According to the mean annual values obtained for total nitrogen and phosphorus concentrations, based on the water act of R.M. (Directive for water classification, 1999) and OECD regulations (OECD, 1982), the water was categorized at the respective measuring points.

According to the total nitrogen concentration, the water at the investigated location over the 2-year period was mainly oligotrophic, except the water in the littorals near the rivers (Sateska littoral, Cerava littoral, Daljan), which had been transformed to become mezotrophic. It should be mentioned that according to this parameter, the water in the Grasnica littoral indicated a transformation to a eutrophic state.

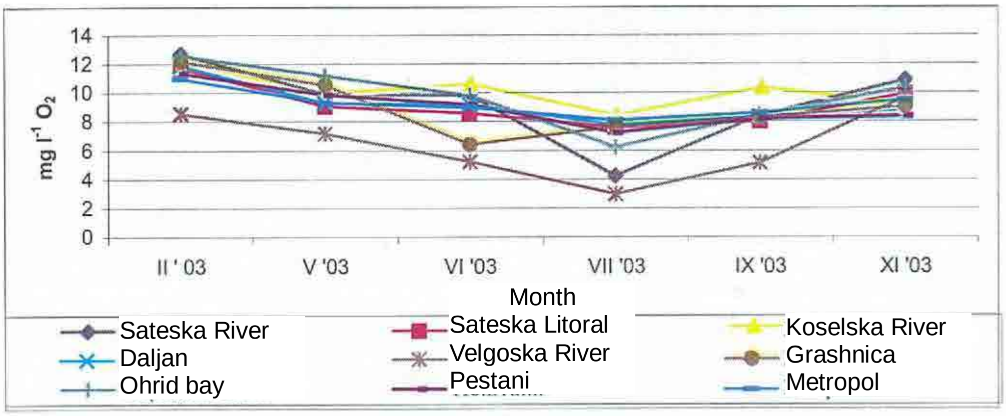
However, according to the collected information, current situations have been very stable and the influences of nutrients would not cause any serious conditions to the lake. However it is also mentioned by the specialists noted the completion of wastewater treatment is highly important and required factor to maintain good condition of the lake.

(2) Rivers

There are 17 tributaries on the Macedonian side feeding Ohrid Lake. Some of the rivers were investigated to analyze the water quality by the Hydrobiological Institute. The latest information, JICA Study Team was able to obtain from the institute, was water quality survey data for 2002 and 2005. The results of the survey are shown below:

1) Dissolved Oxygen

The results of the survey of dissolved oxygen (DO) in the rivers in the investigation year of 2003 are shown below. The maximum concentration of DO in the river was recorded during the winter period, as follows: 12.72 mg/L in the River Sateska (February). In other rivers, slightly lower maximum concentrations of DO were recorded. The same diagram shows that the minimum quantities of DO were within the range 8.2 (River Koselska) to 2.98mg/L (River Velgoska) in July.

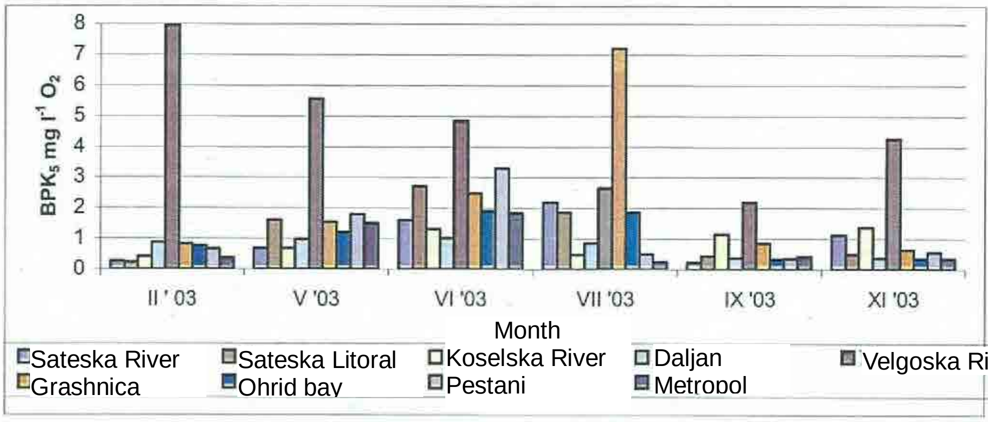


Source: Hydrobiological Institute

Figure 2.7 Concentration of DO in the Rivers and Littoral Zone

2) Biochemical Oxygen Demand

The results of the survey of biochemical oxygen demand over five days (BOD_5) in the rivers are shown below. The survey report in 2005 revealed no significant changes in this investigation year compared to previous measurements of BOD_5. The results are mainly within the same ranges as previous years, which indicate that no significant steps have been undertaken to improve the quality of water in rivers.
The largest number of the records is found at the loading of River Velgoska and its littoral zone in the Ohrid region.

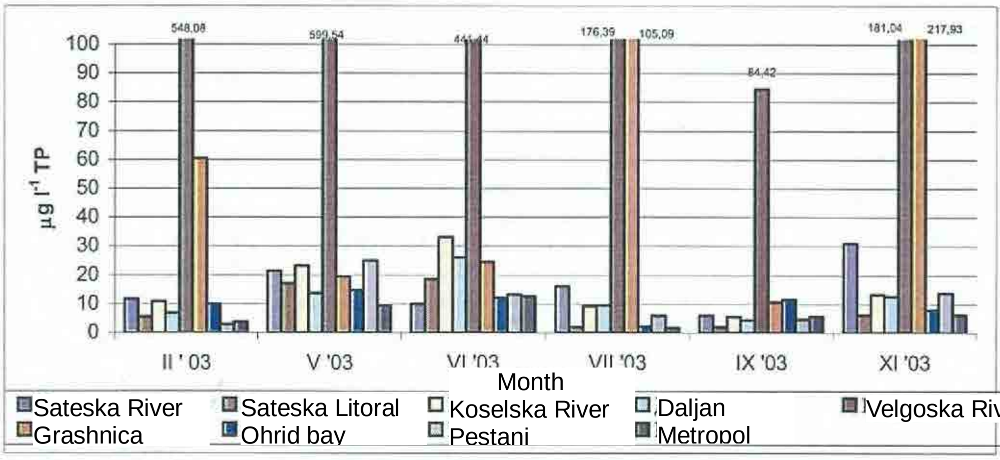


Source: Hydrobiological Institute

Figure 2.8 Concentration of BOD_5 in the Rivers and Littoral Zone

3) Phosphorus

According to the survey report in 2005, total phosphorus (T-P) concentrations recorded in 2003 in the River of Velgoska are extremely high. After the maximum recorded concentration of 599.5μg/L, it is questionable whether this tributary can carry the title river. With the other two rivers in the Ohrid region, concentrations of T-P are within the range 5.89μg/L (River Sateska, September) and 33.17μg/L (River Koselska, June).



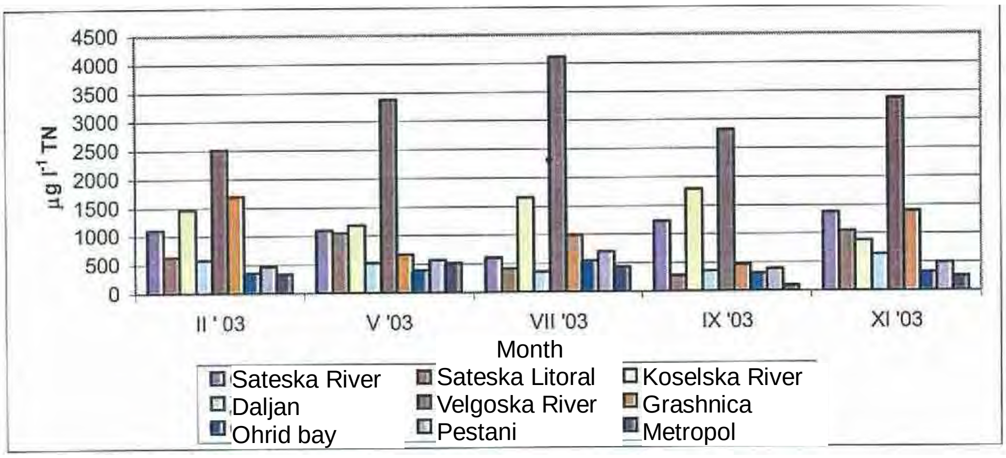
Source: Hydrobiological Institute

Figure 2.9 Concentration of T-P in the Rivers and Littoral Zone

4) Nitrogen

The results of the survey of total nitrogen (T-N) taken from the rivers are shown below. The data showed that the most loaded among the rivers in Ohrid Lake was Velgoska. With a maximum obtained value of 4,106g/L, further conclusions on the organic and phosphorus loading of this river could be made.

Ohrid Lake remains oligotrophic. However, the question is until this will be sustained considering the vast quantities of introduced phosphorus and nitrogen, due to the unresolved problem of protection.



Source: Hydrobiological Institute

Figure 2.10 Concentration of T-N in the Rivers and Littoral Zone

According to this survey report, investigations of rivers indicate an unchanged situation compared to former investigation periods. The most loaded tributary was the River Velgoska, for which the water quality ranged between II - IV class (according to the Decree on water classification of FYROM, Official gazette No. 18/99). The River Koselska remains mostly in the I - II class, with certain time intervals in case of collection system overflow when reaching III class. The water in River Sateska is within the range of I - III class.

2.1.3 Meteorology

Based on the geography of the Ohrid Lake region, this region was determined as having a subtropical climate, but one also influenced by winds of the continental climate. Mountains surrounding the lake with Jablanica to the west, Karaorman to the north-east, Galichica to the south-east and the openness of the north flatland (Struga & Ohrid) along the valleys of the rivers Black Drim and Sateska to the north result in lower annual temperatures.

(1) Air Temperature

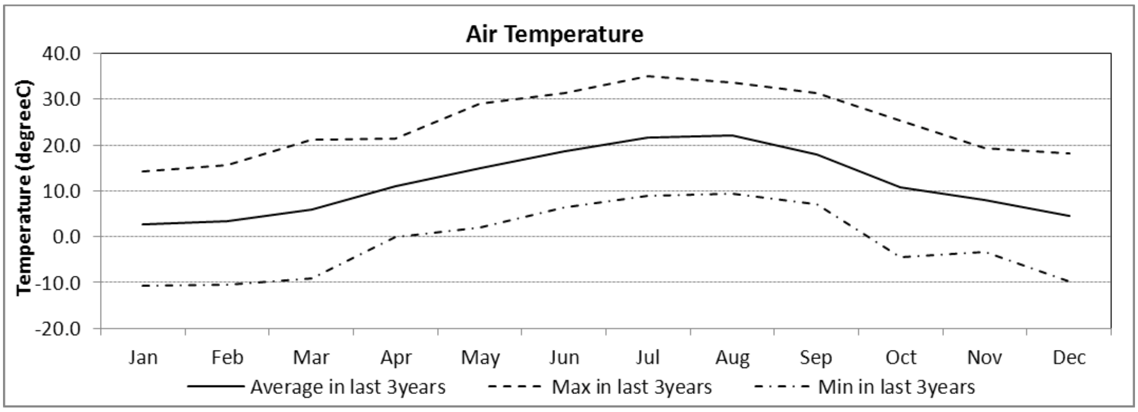
Maximum air temperatures can vary from 28 ⁻35 ^{o}C in July and August, while the water temperature during the same period can reach 26 ^{o}C.

The average number of days with summer temperature exceeding 25 ^{o}C and that of the lake surface exceeding 20 ^{o}C is 73 - 78, peaking in July and August.
During the winter period, the average monthly temperature is above zero (0).
In mountainous areas 1,600 m above sea level, temperatures below zero begin from December and continue until the end of March.

The air temperature in the last three years in Ohrid is shown below:

Air Temperature (unit: dregree C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
average	2.7	3.3	5.9	11.0	14.9	18.6	21.7	22.2	18.0	10.8	7.9	4.5
max	14.2	15.7	21.2	21.5	29.1	31.4	35.1	33.6	31.3	25.4	19.4	18.1
min	−10.7	−10.5	−9	0	2.1	6.3	8.9	9.4	7	−4.4	−3.4	−9.7



Source: Hydrometeorological Institute

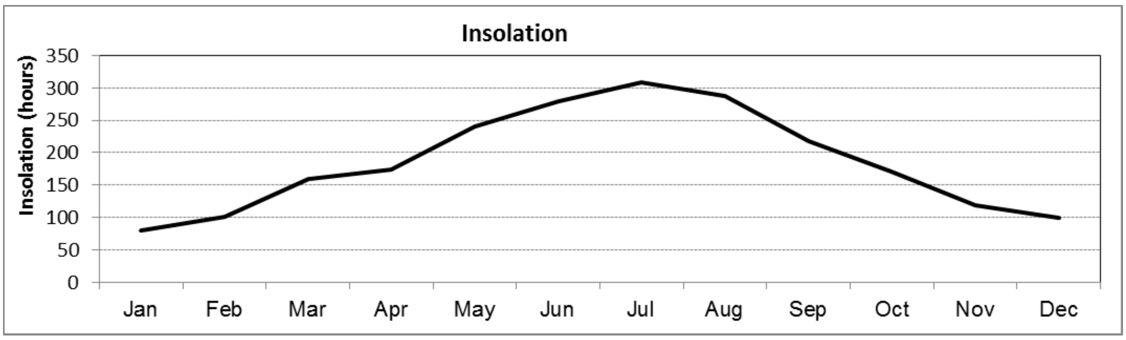
Figure 2.11 Monthly Average Temperature

(2) Insolation

Insolation in Ohrid Lake region is very high. With 2,200 hours a year, the region of Ohrid has the longest hours of insolation among all of Macedonia. This region has different insolation by seasonally. For example, from December to August and August to December, the insolation is respectively longer and shorter. In July and August the average insolation ranges from 10 - 12 hours, which positively influences the general climate of this region.

Insolation (unit: hours)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80	101	160	174	240	279	308	288	217	171	118	99



Source: A. Lazarevski, the Climate in Macedonia, Kultura, Skopje

Figure 2.12 Monthly Average Insolation

(3) Cloudiness

Statistical data shown that the cloudiness in this region is highest in December and is 7.2 hours, and the lowest in August 1.4 hours.

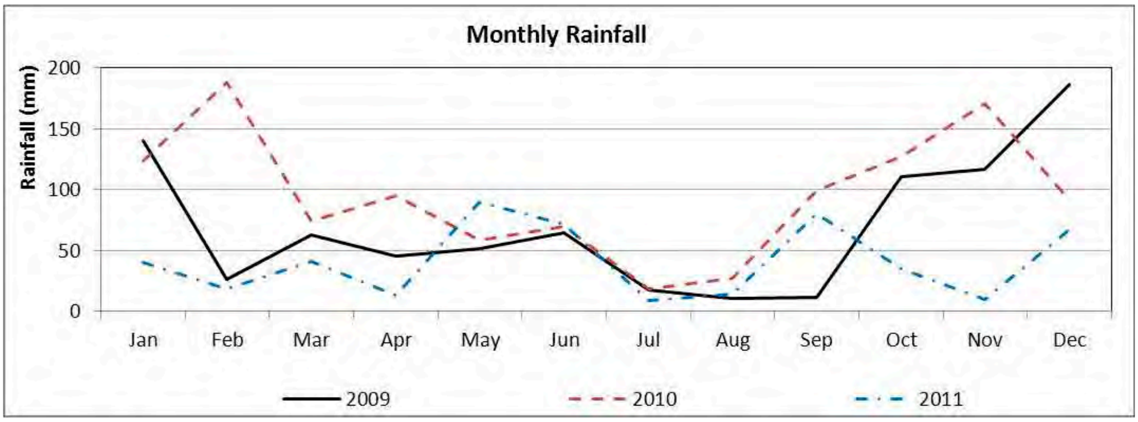
(4)Precipitation

Rainfall in this region is poor. The average amount of rain is 600 – 700 mm. in the surrounding mountains it reaches 2,000 – 2,500 mm, and a good example is mountain Jablanica. There are 100 - 160 rainy days a year, with a minimum rainfall in the summer months.

The average monthly rainfall in the last 3 years in Ohrid is shown below:

Average Monthly Rainfall (unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Rain days
2009	140.1	26.3	62.4	45.2	51.7	64.5	17.2	10.8	11.6	110.6	116.5	186.2	139
2010	123.8	187.9	74.5	94.7	58.8	69.6	18.9	26.9	99.3	127	170.5	91.9	163
2011	39.9	18.2	41.4	13.6	89.5	71.7	8.5	14.4	80.1	34.7	10.1	67.6	102

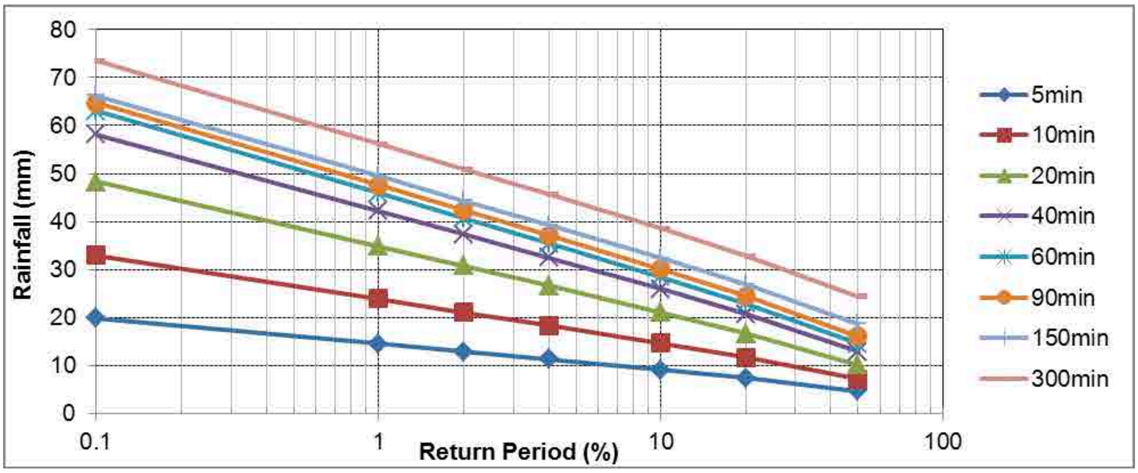


Source: Hydrometeorological Institute

Figure 2.13 Monthly Average Rainfall Quantities

From the Hydrometeorological institute, the rainfall intensity data was collected in the survey. This rainfall intensity data was calculated in 1989 with the quite old rainfall data, but the general condition about rainfall intensity is not changed (interview from the hydrologist in the institute).

The rainfall intensity in Ohrid is shown below:



Source: Hydrometeorological Institute

Figure 2.14 Rainfall Intensity in Ohrid

2.2 Socioeconomic Conditions

2.2.1 Population

It is common to conduct a national census every decade in Macedonia, with the last one conducted in 2002.

When JICA Study Team asked about the population in Ohrid and Struga cities, they responded that population data in 2002 was available. However, this sounded very strange-considering the fact they operated the sewerage system on a daily basis and collected the tariff every month, they should update the number of users regularly. Finally, the relevant data was submitted to JICA Study Team.

According to the National Statistical Bureau the total population was 2,058,539 as of 30 June, 2011, comprising 1,031,403 males (50.1%) and 1,027,136 females (49.9%), as shown below:

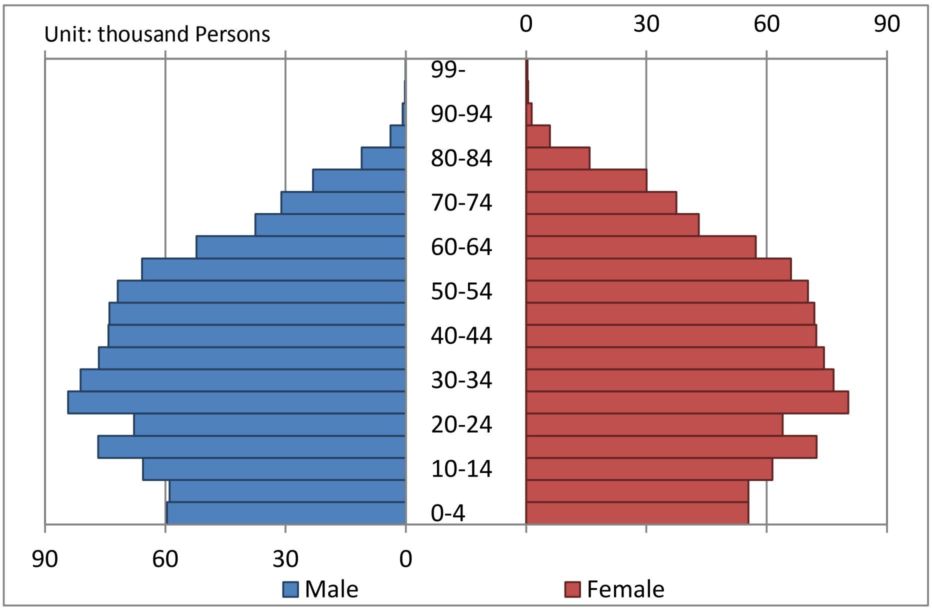
Table 2.2 Population of Macedonia

Unit: People

Age	Male	Female	Total	Age	Male	Female	Total
0	12,100	11,269	23,369	51	14,677	14,488	29,165
1	12,335	11,397	23,732	52	14,384	14,083	28,467
2	11,917	11,117	23,034	53	14,156	13,752	27,908
3	11,650	10,890	22,540	54	14,031	13,658	27,689
4	11,524	10,795	22,319	55	13,890	13,508	27,398
5	11,339	10,833	22,172	56	13,743	13,538	27,281
6	11,597	10,935	22,532	57	13,286	13,338	26,624
7	11,958	11,143	23,101	58	12,898	13,136	26,034
8	11,874	11,163	23,037	59	11,961	12,537	24,498
9	12,159	11,406	23,565	60	11,343	12,091	23,434
10	12,827	12,053	24,880	61	11,135	12,112	23,247
11	12,807	11,978	24,785	62	10,844	12,014	22,858
12	12,819	12,006	24,825	63	10,211	11,383	21,594
13	13,253	12,434	25,687	64	8,650	9,700	18,350
14	13,831	12,939	26,770	65	7,748	8,708	16,456
15	14,558	13,546	28,104	66	7,668	8,631	16,299
16	15,049	14,170	29,219	67	7,501	8,595	16,096
17	15,292	14,589	29,881	68	7,532	8,812	16,344
18	15,599	14,827	30,426	69	7,102	8,329	15,431
19	16,201	15,336	31,537	70	6,852	7,946	14,798
20	16,345	15,392	31,737	71	6,745	7,920	14,665
21	16,233	15,291	31,524	72	6,037	7,351	13,388
22	16,610	15,711	32,321	73	5,671	7,122	12,793
23	1,745	1,651	3,396	74	5,760	7,136	12,896
24	16,843	15,988	32,831	75	5,607	6,985	12,592
25	16,683	16,058	32,741	76	5,201	6,616	11,817
26	16,856	16,178	33,034	77	4,788	6,136	10,924
27	16,871	16,049	32,920	78	4,173	5,535	9,708
28	16,967	16,026	32,993	79	3,416	4,821	8,237
29	16,882	16,013	32,895	80	3,041	4,371	7,412
30	16,659	15,773	32,432	81	2,578	3,728	6,306
31	16,534	15,532	32,066	82	2,094	2,983	5,077
32	16,267	15,223	31,490	83	1,810	2,562	4,372
33	15,873	15,001	30,874	84	1,495	2,195	3,690
34	15,817	15,141	30,958	85	1,185	1,773	2,958
35	15,856	15,196	31,052	86	947	1,422	2,369
36	15,489	15,020	30,509	87	727	1,176	1,903
37	15,167	14,776	29,943	88	551	926	1,477
38	15,094	14,721	29,815	89	380	671	1,051
39	14,938	14,573	29,511	90	303	528	831
40	14,618	14,236	28,854	91	224	382	606
41	14,730	14,421	29,151	92	120	209	329
42	14,947	14,653	29,600	93	83	133	216
43	14,858	14,584	29,442	94	56	104	160
44	15,004	14,453	29,457	95	35	99	134
45	15,151	14,632	29,783	96	52	99	151
46	15,170	14,905	30,075	97	46	79	125
47	14,946	14,667	29,613	98	34	52	86
48	14,427	13,947	28,374	99	82	194	276
49	14,259	13,758	28,017	Over 99	106	346	452
50	14,616	14,328	28,944	Total	1,016,103	1,012,736	2,028,839

Source: State Statistical Office, Macedonia

The age pattern of the Macedonia population is shown in the following figure.



Source: State Statistics State Statistical Office, Macedonia

Figure 2.15 Age Patten of the Macedonian Population

As for the population in Ohrid and Struga area, KfW conducted study during 2000 and 2001 for preparing preliminary design report in advance of the sewerage project under KfW. Total population in 2000 was sorted in detail based on existing data and the projection was made to the target year of the design report to 2025.

According to the projection made by KfW, total population of Ohrid and Struga municipalities included in the sewerage project area was recorded at 100,662 and the future projections considered increases based on the assumption that the population would increase with the increase in tourism industry. The projected population in 2025 was calculated at 131,835 and 117,205 in 2010 which included increase at 31% and 16% compared with total existing population in 2000.

Table 2.3 Projected Population in Ohrid-Struga Region by KfW

No.	City	City / Commune	Population (Person)					
			Existing	Projection				
			2000	2005	2010	2015	2020	2025
1	Ohrid	Ohrid	42,705	45,820	48,350	50,000	51,270	52,600
2	Ohrid	Ljubanista	482	700	840	845	870	890
3	Ohrid	Trpejca	368	494	620	746	872	1,000
4	Ohrid	Pestani	1,400	1,450	1,500	1,545	1,607	1,670
5	Ohrid	Elsani, Elesec Lagadin	674	920	1,220	1,280	1,344	1,415
6	Ohrid	Konjsko, Dolno Konjsko, Istok	590	990	1,410	1,640	1,700	1,760
7	Ohrid	Sipokno, St. Stefan	212	310	420	441	463	490
8	Ohrid	Velestovo, Raca	435	465	490	513	526	550
9	Ohrid	Ramne	20	70	120	170	220	280
10	Ohrid	Velgosti	2,241	2,410	2,780	2,920	3,066	3,220
11	Ohrid	Leskoec	2,668	2,760	2,850	2,992	3,142	3,300
12	Ohrid	Orman	130	136	143	150	155	160
13	Ohrid	G. Lakocerej	582	611	630	649	670	690
14	Ohrid	D. Lakocerej	646	678	700	721	743	765
15	Ohrid	Kosel	657	760	860	886	913	940
16	Ohrid	Podmolje	282	486	690	724	760	800
17	Ohrid	Orovnik	489	525	560	588	618	720
18	Ohrid	Gorenci	390	410	430	452	475	500
19	Ohrid	Trebenista	589	643	700	721	743	770
20	Struga	Struga	17,000	17,800	18,600	19,400	20,200	21,000
21	Struga	Mislesevo	3,246	3,560	3,870	3,986	4,106	4,230
22	Struga	Moroista	937	1,000	1,070	1,123	1,180	1,240
23	Struga	Volino	540	567	595	625	656	690
24	Struga	Livada	1,424	1,516	1,610	1,730	1,860	2,000
25	Struga	Draslajca	810	955	1,100	1,155	1,213	1,270
26	Struga	Bidzovo	470	570	670	700	735	780
27	Struga	Novo Selo	230	241	253	266	280	300
28	Struga	Lozani	760	800	850	892	937	985
29	Struga	Vranista	1,540	1,792	1,882	1,976	2,075	2,180
30	Struga	D. Belica	950	1,125	1,300	1,365	1,435	1,500
31	Struga	Velesta	5,370	5,700	6,063	6,330	6,646	6,850
32	Struga	Visni	25	135	245	355	465	575
33	Struga	Sum. Zagracani	2,000	2,245	2,490	2,614	2,744	2,880
34	Struga	Radolista	2,930	3,075	3,230	3,390	3,460	3,630
35	Struga	Kalista	1,000	1,077	1,100	1,133	1,167	1,200
36	Struga	Frangovo	1,660	1,760	1,848	1,940	2,037	2,130
37	Struga	Radozda	850	920	948	976	1,006	1,040
38	Struga	Oktisi	3,200	3,600	4,000	4,200	4,425	4,645
39	Struga	Mali Vlaj	160	165	170	175	180	190
	Sub Total (Ohrid)		55,560	60,638	65,313	67,983	70,157	72,520
	Sub Total (Struga)		45,102	48,603	51,894	54,331	56,807	59,315
	Total		100,662	109,241	117,207	122,314	126,964	131,835

Source: Conceptual Plan Report, Ohrid and Struga Sewerage Project (2000, PROAQUA)

In the survey, JICA Study Team confirmed that the statistical data on current population (including past yearly population) haven't recorded nor registered by the both of municipalities of Ohrid and Struga, therefore the

correct number of population resided in the city area and satellite communes are also not available.
In the review of current situations on the sewerage facilities, the population will be quoted by the table which was provided by the study under KfW project about current population.

2.2.2 Regional Economy

The former Socialist Republic of Macedonia was predominantly situated in the lower developed area within Yugoslavia and benefited from the development fund of the Federal Republic. However, following the collapse of Yugoslavia, Macedonia lost its relatively stable market along with the development fund, which is why it suffered from economic crisis for some years after 1990, whereby the Macedonian economy declined until 1996 with negative GDP. Since then, the country rebounded with positive economic development and stabilized the surrounding circumstances since 2003. Membership of the WTO in 2003 and an improved relationship with Greece boosted the stable development of the country and Greece is now its biggest trade partner. The Government of Macedonia is eagerly promoting tourism, because the country enjoys beautiful scenery and attractive Ohrid Lake, or a UNESCO World Heritage site.

According to the 2007 statistics, 19.8% of all employment was in the primary industry of agriculture and 30.4 and 49.8% in the second and third respectively. The unemployment rate was said to be 34.9%, reflecting the fact that around 20% of GDP is linked to the black market.

- Main industries: agriculture (tobacco, wine, mice, rice), textile, mining (iron etc.)
- Per capita GNP: 4,431 USD (2010, IMF)
- Economic growth rate: 0.7% (2010, IMF)
- Commodity price increase rate: 1.5% (2010, IMF)
- Unemployment rate: 32% (2010, IMF)
- Trade (volume and items, 2009: National Statistical Bureau)
  - Exports: 2,691 million USD (textiles, food, beverages, tobacco, fuel, chemicals)
  - Imports: 5,043 million USD (textiles, machines/equipment, food, beverages, tobacco, fuel)
- Trading countries (2009: National Statistical Bureau)
  - Exports: Germany (16.7%), Serbia (12.5%), Kosovo (11.6%), Greece (10.7%), Italy (8.0%) and Bulgaria (8.0%)
  - Imports: Holland (10.2%), Russia (9.8%), Greece (8.7%), Italy (7.1%), Turkey (4.9%) and Bulgaria (4.8%)

2.2.3 Land Use

The sewerage system shall be designed and constructed within the land use plan to collect the wastewater from domestic and industrial sources most effectively. Conversely, the rain water shall be collected along taking topographical and geographical conditions into account, because it is a natural phenomenon.
The land use pattern is generally determined on the following steps:

Step 1: dividing the planning area into used and unused land,
Step 2: dividing the used land into urban areas, productive green areas and others,
Step 3: dividing the urban area into construction areas, green areas and transportation areas, and
Step 4: dividing the construction area for different forms of use such as residential, public, industry, business and commerce.

Theses use patterns differ by countries, depending upon their historical and social backgrounds. Accordingly, JICA Study Team investigated related documents but were unable to find clear sources. It would therefore seem rather difficult for the Team to examine the appropriateness between the existing sewerage system and effective land use. Generally, since urban areas tend to expand or shrink according to economic development, the sewerage system shall be overall in line with urban development, despite being capital-heavy infrastructure. The sewerage system shall be designed and constructed with the utmost care.

2.3 Sewerage and Sanitation Management

2.3.1 General Conditions

The current operational and management circumstances of the sewerage sector in the survey area are handled by two management bodies. One of the management enterprises is PROAQUA, which was established in 2000 to deal with operation and maintenance works under the two municipalities of Ohrid and Struga, and maintaining both water supply and sewerage works. In 2010, the other management body was founded by splitting the existing functions for sewerage management in Ohrid City by Niskobradba. This corporation takes charge of the operation and maintenance of sewerage works, including sewer pipes, relevant pump works, and the drainage system, hence the wastewater treatment function is handled by PROAQUA.

Through site visits conducted within the survey, JICA Study Team visited some private wastewater facilities principally owned and maintained by private owners, which function for tourist destinations to protect the water environment at Ohrid Lake.

2.3.2 Sewerage Facilities

(1) Sewers

The sewerage system consists of a primary sewer system, which mainly covers the shoreline of the lake to connect communes and major tourist destinations, including beaches and accommodation, and finally reaches the Vranista WWTP.

Table 2.4 Outline of Primary Sewers

City (Water Source)	Location		Length (m)	Diameter (mm)	Slope (%)	Material
	Origin	Destination				
Ohrid	Desaret	Krausa PS	1,717	500	0.18	PVC
Ohrid	Krausa PS	Elsec PS	1,576	600	0.18	PVC
Ohrid	Elsec PS	Metropol PS	1,852	600	0.20	PVC
Ohrid	Metropol PS	Granit PS	1,400	600	0.15	RC
Ohrid	Granit PS	Orce Nikorov PS	1,550	800	0.15	RC
Ohrid	Orce Nikorov PS	Ohrid 1 PS	3,000	800	0.10	RC
Ohrid	Ohrid 1 PS	Ohrid 2 PS	1,045	1,000	0.10	RC
Ohrid	Ohrid 2 PS	Dalian PS	3,337	1,200	0.15	RC
Ohrid	Dalian PS	Podmojle PS	5,006	1,200	0.08	RC
Ohrid	Podmojle PS	Sateska PS	2,404	1,200	0.17	RC
Ohrid	Sateska PS	Struga 3 PS	4,267	1,200	0.10	RC
Struga	Elen Kamen PS	Struga 3 PS	9,102	150 - 600	Pressure	PE
Ohrid/Struga	Struga 3 PS	Vranista WWTP	3,934	1,200	0.08	RC
Total	-	-	40,190	-	-	-

Source: PROAQUA

The primary sewers usually connect intermediate pump stations and most of the lines employed a gravity sewer system except the newly extended line in the southern Struga City. The current total length of lines is about 40 km and the diameter ranges between 500 - 1,200 mm for gravity pipes and 150 - 600 mm for the pressure lines. The original system was designed as separate sewerage system to collect wastewater from secondary and tertiary sewers, however currently a bunch of unidentified infiltration has reached to the primary system and it causes serious shortage of capacity in the storm events.

A secondary sewer system has also been established to collect sewage from households and industrial functions, including accommodation and other commercial facilities, with pipes normally made from reinforced concrete, PVC (polyvinyl chloride), PE (polyethylene) and asbestos cement.
The secondary system mainly uses a gravity system and most of the pipes installed in the earlier stages have functioned as a combined sewer in both municipalities. The total length of the sewer lines reached approximately 170 km and Ohrid City developed a drainage network in the main streets of the central zone thanks to reducing sewage volume. This was done by dividing storm water components from existing combined sewers.

Table 2.5 Outline of the Secondary System

Item	Length (km)			Typical Diameter	Material
	Ohrid	Struga	Total		
Combined Sewerage Network	54	59	113	200-600 mm	Asbestos Cement/PVC/PE/ Concrete
Separate Sewerage Network	43		43		
Drainage Network	15	7	22	250-1000 mm	
Total	112	66	178	-	-

Source: PROAQUA

The design criteria for sewer lines are basically as stipulated in the guidance widely been applied to design works in Macedonia; the main parameters of which are shown as follows:

Table 2.6 Main Design Criteria for Sewers

Item	Description	Remarks
Minimum Diameter	200 mm	
Slope	1/D (mm)	
Minimum Flow Velocity	0.7 m/s	
Minimum Clearance	0.8 m from ground level	
Maximum Depth	4-5 m from ground level	In total depth
Ratio of Height/Water Depth	0.6-0.8 or smaller	Determined by diameter
Distance between Manholes	Typically 50 to 100 m	

Source: PROAQUA

Some remarkable characteristics of installations observed at the site visits are introduced as follows:

1) Installation inside the Shoreline in the Lake

In Southern Ohrid City, the sections between Granit and Pestani and the primary sewers are installed along the shoreline of the lake and some are submerged in the lake itself. One significant factor observed in the sewerage system is the unexpected ingress of fresh water into the existing sewers, which dilutes sewage. The volume involved has also hampered proper operations in the wastewater treatment plant and the relationship causing this situation must be carefully observed to determine plausible reasons when the reduction of the incoming sewer quantities to improve the operational condition.

Manhole Erected on the Shore Side

Placed inside the Lake

Source: JICA Study Team

Figure 2.16 Primary Sewers along the Southeastern Side

2) Ancient Sewers

The old town of Ohrid City includes ancient sewers, which still function as collection pipes and featuring a rectangular shaped canal laid under the stone pavement. The rehabilitation work and replacements are carefully planned and chosen to minimize the impact of construction work amidst the most famous tourism destinations in the city, and the construction works will require special attentions to recover as original shape not to spoil the landscape of the scenic places from the viewpoints of preserving original sewer system and method of installations.

3) Old Combined Sewers in Struga

Neither of Ohrid or Struga cities had previously prepared inventories of their installed sewer facilities, meaning details of the age of installed pipes and cross-sectional information was very limited, especially in the city center area. Some sections of existing sewers functioned as part of a combined sewer network and an overflow weir for overflow storm water was found during site visits.

4) Drainage Sewers

The drainage sewer is constructed in the part of Ohrid City and Struga City, and the drainage construction works are promoting constantly as the separate sewerage system by PROAQUA (for Struga) and Niskogradba (for Ohrid).
However, the part of the sewer network is operated as the combined system, especially for the sewer which was built at the beginning. (The combined sewerage network in Macedonia is similar as combined sewerage network in Japan.)

From the results of interview from PROAQUA, as for the rainfall drainage system in Ohrid City, the gutters, which are the drainage pipe from the roof and balcony, are connected in the separated drainage sewer (20%), part from the gutters are discharged to the streets (30%) , and part of the gutters are connected in the combined system (50%).
Meanwhile the rainfall drainage system in Struga City, the constructed gutters are connected in the separated drainage sewer (15%), part from the gutters are discharged to the streets (60%), an part of the gutters are connected in the combined system (25%).

(2) Pump Stations

Pump stations were included in the Ohrid and Struga sewerage system in the late 1980s to connect the existing sewer system with the wastewater treatment plant. Except for the facilities established via German aid, screw pumps are used to lift wastewater carried by gravity primary sewers.

Generally the pumps are currently manually controlled at the screw pump stations and the motors run non-stop all day long. Even though the original system was built as separate system, the inflows exceed designed level of capacity and it causes continuous operation incessantly even in the midnight, the minimum sewer flows are expected time in general. According to the maintenance workers from PROAQUA, the stations are monitored periodically (basically twice a week, twice each time) to check the water level of the inlet chamber functioning as a reservoir to regulate the water inflow.

Rotating motors are sometimes abandoned and malfunctioned motors have been replaced with modern equipment thanks to assistance in the form of Swiss governmental aid.

Screw Pump Station　　　　Replacement Equipment

Source: JICA Study Team

Figure 2.17 Typical Pump Station in the Sewerage System

Table 2.7 Outline of Pump Stations

<table>
<tr><th>City (Water Source)</th><th colspan="2">Location</th><th>Type of Pump</th><th>Installed Unit (pcs.)</th><th>Capacity per Unit (L/sec)</th><th>Capacity (L/sec)</th><th>Capacity (m³/min)</th><th>Capacity (m³/day)</th><th>Remarks</th></tr>
<tr><td>Ohrid</td><td colspan="2">Krausa PS</td><td>Submersible</td><td>2</td><td>40</td><td>80</td><td>4.800</td><td>6,912</td><td></td></tr>
<tr><td>Ohrid</td><td colspan="2">Elsec PS</td><td>Submersible</td><td>2</td><td>40</td><td>80</td><td>4.800</td><td>6,912</td><td></td></tr>
<tr><td>Ohrid</td><td colspan="2">Metropol PS</td><td>Submersible</td><td>2</td><td>85</td><td>170</td><td>10.200</td><td>14,688</td><td></td></tr>
<tr><td>Ohrid</td><td colspan="2">Granit PS</td><td>Submersible</td><td>2</td><td>130</td><td>260</td><td>15.600</td><td>22,464</td><td></td></tr>
<tr><td>Ohrid</td><td colspan="2">Orce Nikorov PS</td><td>Submersible</td><td>2</td><td>170</td><td>340</td><td>20.400</td><td>29,376</td><td></td></tr>
<tr><td>Ohrid</td><td colspan="2">Ohrid 1 PS</td><td>Screw Pump</td><td>3</td><td>315</td><td>945</td><td>56.700</td><td>81,648</td><td></td></tr>
<tr><td>Ohrid</td><td colspan="2">Ohrid 2 PS</td><td>Screw Pump</td><td>3</td><td>425</td><td>1,275</td><td>76.500</td><td>110,160</td><td></td></tr>
<tr><td>Ohrid</td><td colspan="2">Dalian PS</td><td>Screw Pump</td><td>4</td><td>400</td><td>1,600</td><td>96.000</td><td>138,240</td><td></td></tr>
<tr><td>Ohrid</td><td colspan="2">Podmojle PS</td><td>Screw Pump</td><td>4</td><td>410</td><td>1,640</td><td>98.400</td><td>141,696</td><td></td></tr>
<tr><td>Ohrid</td><td colspan="2">Sateska PS</td><td>Screw Pump</td><td>4</td><td>410</td><td>1,640</td><td>98.400</td><td>141,696</td><td></td></tr>
<tr><td rowspan="3">Ohrid/Struga</td><td rowspan="3">Struga 3 PS</td><td>Ohrid</td><td>Screw Pump</td><td>4</td><td>412</td><td>1,648</td><td>98.880</td><td>142,387</td><td></td></tr>
<tr><td>Struga</td><td>Screw Pump</td><td>3</td><td>225</td><td>675</td><td>40.500</td><td>58,320</td><td></td></tr>
<tr><td>Sub-Total</td><td>-</td><td>7</td><td>-</td><td>2,323</td><td>139.380</td><td>200,707</td><td></td></tr>
<tr><td>Ohrid/Struga</td><td colspan="2">Vranista WWTP</td><td>Screw Pump</td><td>4</td><td>560</td><td>2,240</td><td>134.400</td><td>193,536</td><td>Influent PS inside WWTP</td></tr>
<tr><td>Struga</td><td colspan="2">Industrial Zone PS</td><td>-</td><td>2</td><td>220</td><td>440</td><td>26.400</td><td>38,016</td><td></td></tr>
<tr><td>Struga</td><td colspan="2">Kalista PS</td><td>Horizontal</td><td>2</td><td>24.4</td><td>49</td><td>2.928</td><td>4,216</td><td></td></tr>
<tr><td>Struga</td><td colspan="2">Elen Kamen PS</td><td>Horizontal</td><td>2</td><td>24.4</td><td>49</td><td>2.928</td><td>4,216</td><td></td></tr>
<tr><td>Total</td><td colspan="2">13 pcs.</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Source: PROAQUA

Table 2.8 Outline of Other Pump Stations

City	Item	Number of Pump Stations
Ohrid	Secondary PS	6
Struga	Secondary PS	7
Total	-	13

Source: PROAQUA

There are pump stations at 28 locations in the system, including the secondary network system.

1) Pump Stations Out of Order in South Struga

The new pump stations, which were established under German assistance via KfW in the south extension lines in Struga, are now out of order, and the section supported by a pressure system driven by pump stations is not functioning.

The problem started in two pump stations at Elen Kamen and Kalista, in which both the installed horizontal pumps were automatically operated and two pump stations had a pressure system to connect neighboring communes in 2005. However the bankruptcy of the hotel in which the transformer was located inside the boundary saw operation at Elen Kamen pump station suddenly cease, with equipment stolen during the stoppage. The electrical equipment of the other pump station, Kalista, malfunctioned and ultimately, the entire system has failed to function since the accident.

Along the sewer lines, some households and hotels are connected to the system, which means that currently, untreated wastewater is discharged into the lakeside via an emergency outfall from the pump station at both stations.

Pump House without Machinery in Elen Kamen PS   Manhole Lids also Suffered from Property Losses

Source: JICA Study Team

Figure 2.18 Abandoned pump station in South Struga

For the rehabilitations of these pump stations, PROAQUA is working on applying spare parts for broken machineries in Kalista Pump Station and for Elen Kamen Pump Station, currently rebuilding transformer station is an important factor to access electricity.

2) Emergency Overflow at the Pump Stations

Podmolje pump station is the primary intermediate pump station connecting the main sewers from Ohrid City. Here, there is an emergency overflow to discharge untreatable sewage due to the lack of capacity in the downstream system, mainly in the event of increased sewage, i.e. when rainy. The information of the emergency overflow is not collected in this survey. It is presumed that there might be more than 100 days in every year of the overflow event from the rainfall data. The overflow events are mainly occurred in rainy season (October - May).

The overflow channel leads to a nearby outlet into the lake. Use of the overflow system ultimately forces untreated wastewater to be discharged, which impairs the performance of the wastewater treatment facilities.

Overflow Channel (in Operation)   Outlet into the Lake (Dry Condition)

Source: JICA Study Team

Figure 2.19 Emergency Outlet in Podmolje Pump Station

3) Vranista Wastewater Treatment Plant

According to the stored design document, the Vranista Wastewater Treatment Plant (hereinafter called as WWTP) was designed in 1986, with an original design capacity of 120,000 people, equivalent to a nominal water capacity of 40,000 m^3/day.

The design criteria of the effluent are set at 25 mg/L or less in BOD and 30 mg/L in SS.

Table 2.9 Outline of the Vranista WWTP

Item	Unit	Value
Nominal Capacity	Population Equivalent	120,000
Average Daily Influent	m^3/day	40,000
Average Daily Load	$kgBOD_5$/day	7,300
Effluent Quality (BOD)	mg/L	25 or less
Effluent Quality (SS)	mg/L	30 or less
Effluent Quality (pH)	-	Between 6.5 and 8.5

Source: PROAQUA

a) Water Treatment Process

The Vranista WWTP employs an oxidation ditch process and two units are used for the reactors of the water treatment process in a cycle. Influent is mixed from both volumes of wastewater at the Struga 3 pump station from the Ohrid and Struga sides. Subsequently, an influent pump station inside the plant lifts the wastewater to a mechanical screen unit and pre-treatment channels. Two spherical reactors are followed by channels and the influent is biologically treated using activated sludge.

After the biological process, water is conveyed to the clarifiers to settle activated sludge by gravity, whereupon the treated water is discharged into a nearby waterway. Equipped chlorination channels are usually used for final disinfection before discharging, but the WWTP does not use this facility due to the budgetary problem in ensuring a constant supply of chemicals.

Overview of Oxidation Ditch Reactors

Final Settling Clarifiers

Source: JICA Study Team

Figure 2.20 Water Treatment Process at the Vranista WWTP

b) Sludge Treatment Process

Excessive sludge is regularly extracted from the water treatment process and treated to stabilize its condition using a gravity thickener and belt filter press.

The WWTP currently uses two reactors to mature the condition of the activated sludge and a gravity thickener is used to separate the sludge component by settling. After the thickening process, a dual-unit belt filter press is used to dewater the thickened sludge using a polymer coagulant for a dewatering aid. Finally, the dewatered sludge is placed onto sludge drying beds under sunlight.

In the WWTP, the dewatered sludge is given to nearby farmers free of charge, which functions well and eliminates the need to find a final dumping site for the dried sludge.

Belt Filter Press

Farmers waiting to load Sludge

Source: JICA Study Team

Figure 2.21 Sludge Treatment Process at the Vranista WWTP

c) Water Quantity

The total quantities of effluent at the Vranista WWTP were recorded at 3,145,280 m^3/year in 2005 and 3,360,717 m^3/year in 2006 according to annual reports submitted to the EU council, while the percentage of sewage collected via the wastewater collection system reached up to 70% in the total city area served.
As for the sludge treatment, 135 m^3/day of sludge was extracted from the water treatment process and 9 - 12 m^3/day of sludge cake produced at 80% of water content according to PROAQUA.

Table 2.10 Treated Wastewater Quantities at the Vranista WWTP

Item	Unit	2005	2006	2007
Served Population by Wastewater Collection System	People	N/A	N/A	58,000
Total Quantity of Wastewater Generated	m^3/year	4,614,567	4,525,705	N/A
Total Quantity of Wastewater Collected	m^3/year	3,133,765	3,211,632	N/A
Total Quantity of Wastewater Reaching WWTP	m^3/year	3,133,765	3,211,632	N/A
Total Quantity of Treated Effluent	m^3/year	3,145,280	3,360,717	N/A
Amount of Wastewater Sludge Generated (wet)	m^3/day	135	135	N/A
Wastewater Leakage/Wastage Oriented	%	N/A	N/A	N/A
Percentage of Collected Wastewater	%	67.9%	71.0%	N/A

Source: PROAQUA

Table 2.11 Outline of Sludge Treatment

Item	Description	Remarks
Processed Sludge Cake Volume	9 - 12 m^3/day	from Belt Filter Press
Water Content in Sludge Cake	80%	

Source: PROAQUA

According to the yearly summaries of water consumptions and assumed total volume flowing into sewerage based on the percentages of sewerage served area, the percentage of served area has increased constantly year by year in the both cities, approximately 81% in Ohrid City, 61% in Struga City respectively and the total ratio reaches at 74% as of 2011 (The comparison was made based on total water supplied area by PROAQUA).
And yearly supplied water quantity is totally at 3,500,193 m^3 in 2011, equivalent to 9,590 m^3/day, is accounted for the basic amount of current sewerage system without considering fluctuation of seasonal changes and ground water infiltrations including influence from intrusions of lake water and storm water.

Table 2.12 Water Consumption in Sewerage-Served Area

City	Item	Sewerage	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ohrid	Domestic Water Consumption (m^3/year)	Served	1,354,435	1,406,010	1,415,489	1,571,599	1,672,051	1,779,234	1,943,247	1,943,247	1,868,902	2,009,557
		Not Served	667,332	773,996	632,795	557,579	396,516	513,218	561,251	561,251	561,251	351,296
		Sub-Total	2,021,767	2,180,006	2,048,284	2,129,178	2,068,567	2,292,452	2,504,498	2,504,498	2,430,153	2,360,853
		Served%	66.99%	64.50%	69.11%	73.81%	80.83%	77.61%	77.59%	77.59%	76.90%	85.12%
	Industrial Water Consumption (m^3/year)	Served	831,079	833,032	765,827	727,558	658,887	698,239	547,374	547,374	362,451	459,670
		Not Served	211,116	174,448	215,995	143,849	178,375	263,625	240,268	240,268	240,268	240,268
		Sub-Total	1,042,195	1,007,480	981,822	871,407	837,262	961,864	787,642	787,642	602,719	699,938
		Served%	79.74%	82.68%	78.00%	83.49%	78.70%	72.59%	69.50%	69.50%	60.14%	65.67%
	Total	Served	2,185,514	2,239,042	2,181,316	2,299,157	2,330,938	2,477,473	2,490,621	2,490,621	2,231,353	2,469,227
		Not Served	878,448	948,444	848,790	701,428	574,891	776,843	801,519	801,519	801,519	591,564
		Sub-Total	3,063,962	3,187,486	3,030,106	3,000,585	2,905,829	3,254,316	3,292,140	3,292,140	3,032,872	3,060,791
		Served%	71.33%	70.24%	71.99%	76.62%	80.22%	76.13%	75.65%	75.65%	73.57%	80.67%
Struga	Domestic Water Consumption (m^3/year)	Served	565,148	553,878	568,619	575,388	575,579	687,280	682,061	666,944	710,923	728,030
		Not Served	593,167	588,979	569,058	580,528	599,062	708,283	636,483	562,838	616,764	614,507
		Sub-Total	1,158,315	1,142,857	1,137,677	1,155,916	1,174,641	1,395,563	1,318,544	1,229,782	1,327,687	1,342,537
		Served%	48.79%	48.46%	49.98%	49.78%	49.00%	49.25%	51.73%	54.23%	53.55%	54.23%
	Industrial Water Consumption (m^3/year)	Served	282,110	318,623	306,518	297,562	305,116	382,556	358,508	329,288	308,812	302,936
		Not Served	153,412	108,957	140,267	115,734	140,118	20,305	35,458	56,154	54,290	42,874
		Sub-Total	435,522	427,580	446,785	413,296	445,234	402,861	393,966	385,442	363,102	345,810
		Served%	64.78%	74.52%	68.61%	72.00%	68.53%	94.96%	91.00%	85.43%	85.05%	87.60%
	Total	Served	847,258	872,501	875,137	872,950	880,695	1,069,836	1,040,569	996,232	1,019,735	1,030,966
		Not Served	746,579	697,936	709,325	696,262	739,180	728,588	671,941	618,992	671,054	657,381
		Sub-Total	1,593,837	1,570,437	1,584,462	1,569,212	1,619,875	1,798,424	1,712,510	1,615,224	1,690,789	1,688,347
		Served%	53.16%	55.56%	55.23%	55.63%	54.37%	59.49%	60.76%	61.68%	60.31%	61.06%
Total	Domestic Water Consumption (m^3/year)	Served	1,919,583	1,959,888	1,984,108	2,146,987	2,247,630	2,466,514	2,625,308	2,610,191	2,579,825	2,737,587
		Not Served	1,260,499	1,362,975	1,201,853	1,138,107	995,578	1,221,501	1,197,734	1,124,089	1,178,015	965,803
		Sub-Total	3,180,082	3,322,863	3,185,961	3,285,094	3,243,208	3,688,015	3,823,042	3,734,280	3,757,840	3,703,390
		Served%	60.36%	58.98%	62.28%	65.36%	69.30%	66.88%	68.67%	69.90%	68.65%	73.92%

City	Item	Sewerage	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	Industrial Water Consumption (m³/year)	Served	1,113,189	1,151,655	1,072,345	1,025,120	964,003	1,080,795	905,882	876,662	671,263	762,606
		Not Served	364,528	283,405	356,262	259,583	318,493	283,930	275,726	296,422	294,558	283,142
		Sub-Total	1,477,717	1,435,060	1,428,607	1,284,703	1,282,496	1,364,725	1,181,608	1,173,084	965,821	1,045,748
		Served%	75.33%	80.25%	75.06%	79.79%	75.17%	79.20%	76.67%	74.73%	69.50%	72.92%
	Total	Served	3,032,772	3,111,543	3,056,453	3,172,107	3,211,633	3,547,309	3,531,190	3,486,853	3,251,088	3,500,193
		Not Served	1,625,027	1,646,380	1,558,115	1,397,690	1,314,071	1,505,431	1,473,460	1,420,511	1,472,573	1,248,945
		Sub-Total	4,657,799	4,757,923	4,614,568	4,569,797	4,525,704	5,052,740	5,004,650	4,907,364	4,723,661	4,749,138
		Served%	65.11%	65.40%	66.23%	69.41%	70.96%	70.21%	70.56%	71.05%	68.83%	73.70%

Source: PROAQUA

Table 2.13 Summary of Water Consumption in Sewerage-Served Area

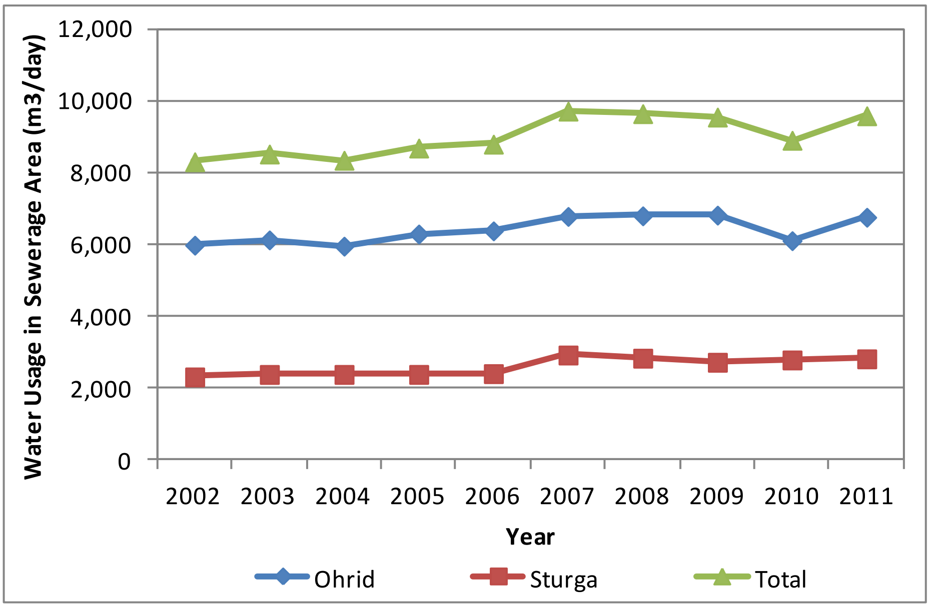
Item	City	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Water Consumption (m^3/year)	Ohrid	3,063,962	3,187,486	3,030,106	3,000,585	2,905,829	3,254,316	3,292,140	3,292,140	3,032,872	3,060,791
	Struga	1,593,837	1,570,437	1,584,462	1,569,212	1,619,875	1,798,424	1,712,510	1,615,224	1,690,789	1,688,347
	Sub-Total	4,657,799	4,757,923	4,614,568	4,569,797	4,525,704	5,052,740	5,004,650	4,907,364	4,723,661	4,749,138
Connectivity to Sewerage	Ohrid	71.33%	70.24%	71.99%	76.62%	80.22%	76.13%	75.65%	75.65%	73.57%	80.67%
	Struga	53.16%	55.56%	55.23%	55.63%	54.37%	59.49%	60.76%	61.68%	60.31%	61.06%
Water Usage for Connected Sewer (m^3/year)	Ohrid	2,185,514	2,239,042	2,181,316	2,299,157	2,330,938	2,477,473	2,490,621	2,490,621	2,231,353	2,469,227
	Struga	847,258	872,501	875,137	872,950	880,695	1,069,836	1,040,569	996,232	1,019,735	1,030,966
	Sub-Total	3,032,772	3,111,543	3,056,453	3,172,107	3,211,633	3,547,309	3,531,190	3,486,853	3,251,088	3,500,193

Source: PROAQUA

Table 2.14 Daily Water Consumption in Sewerage-Served Area

Item	City	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Water Consumption (m^3/day)	Ohrid	8,394	8,733	8,279	8,221	7,961	8,916	8,995	9,020	8,309	8,386
	Struga	4,367	4,303	4,329	4,299	4,438	4,927	4,679	4,425	4,632	4,626
	Sub-Total	12,761	13,035	12,608	12,520	12,399	13,843	13,674	13,445	12,942	13,011
Water Usage for Connected Sewer (m^3/day)	Ohrid	5,988	6,134	5,960	6,299	6,386	6,788	6,805	6,824	6,113	6,765
	Struga	2,321	2,390	2,391	2,392	2,413	2,931	2,843	2,729	2,794	2,825
	Sub-Total	8,309	8,525	8,351	8,691	8,799	9,719	9,648	9,553	8,907	9,590

Source: PROAQUA



Source: PROAQUA

Figure 2.22 Daily Water Consumption in Sewerage-Served Area

d) Water Quality Analyses

In the WWTP, the water laboratory regularly analyzes samples taken to monitor the condition of daily operations.
According to the chemists working at the lab, the basic water quality components are analyzed periodically including pH (once daily), dissolved oxygen (DO, five times a week), COD (three times a week), BOD (twice a week) and SS (once a week). Other chemical components such as metals and nutrient components, which are also stipulated in EU Directives, are analyzed during the tourism season in summer, during June, July and August once a month, while in other seasons, samples are taken in November, January and April. Due to the lack of chemicals and relevant materials, some water quality items were missed to determine in the past water tests. Some of the equipment was replaced with the assistance of the Switzerland Government.

Table 2.15 Effluent Criteria at the Vranista WWTP

No.	Item	Unit	Value	Minimum Reduction	Remarks
1	BOD_5	mg/L	25	70 - 90%	Without Nitrification
2	COD_{Cr}	mg/L	125	75%	
3	SS	mg/L	35	90%	
4	Total Nitrogen (T-N)	mg/L	10	78 - 80%	
5	Total Phosphorus (T-P)	mg/L	1	80%	

Source: Council Directive 91/271/EEC of 21 May, 1991 concerning urban wastewater treatment

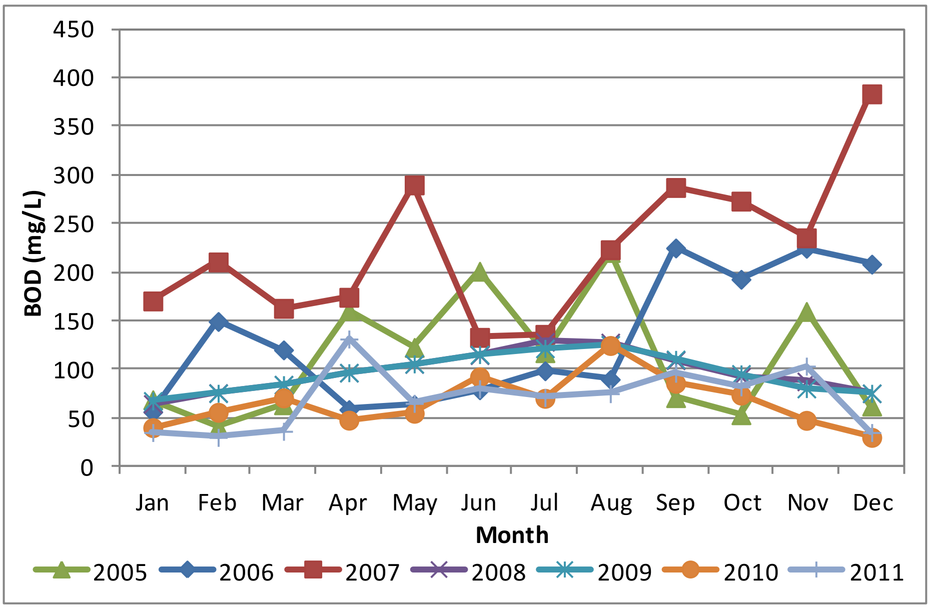
The actual monthly analyses show unstable characteristics mainly in older period of data, especially the values in 2007 is relatively much higher than the other years and the seasonal variation is small however the values since 2008 became more stable than ever.

Table 2.16 Monthly Analysis Record at Influent (BOD)

Unit: mg/L

Month	2005	2006	2007	2008	2009	2010	2011
January	68.75	56.33	170.43	64.35	67.52	40.00	35.00
February	40.62	149.29	210.56	75.69	75.36	55.77	30.00
March	63.54	120.05	162.81	84.21	84.23	70.62	36.25
April	160.47	58.58	174.19	96.57	96.56	47.68	131.25
May	122.58	63.73	289.87	105.48	105.65	54.80	65.00
June	200.99	78.98	132.93	114.57	115.24	92.26	80.00
July	117.15	98.53	136.02	128.34	121.57	70.19	71.00
August	220.34	89.70	223.15	127.64	125.36	124.56	75.00
September	70.89	224.94	287.24	109.34	110.26	85.65	96.00
October	53.30	192.70	273.20	92.37	95.32	73.46	82.00
November	159.62	224.60	235.40	87.54	80.23	47.50	103.33
December	62.30	208.30	383.60	75.32	75.36	30.00	35.00
Average	111.71	130.48	223.28	96.79	96.06	66.04	69.99
Maximum	220.34	224.94	383.60	128.34	125.36	124.56	131.25
Minimum	40.62	56.33	132.93	64.35	67.52	30.00	30.00

Source: PROAQUA



Source: PROAQUA

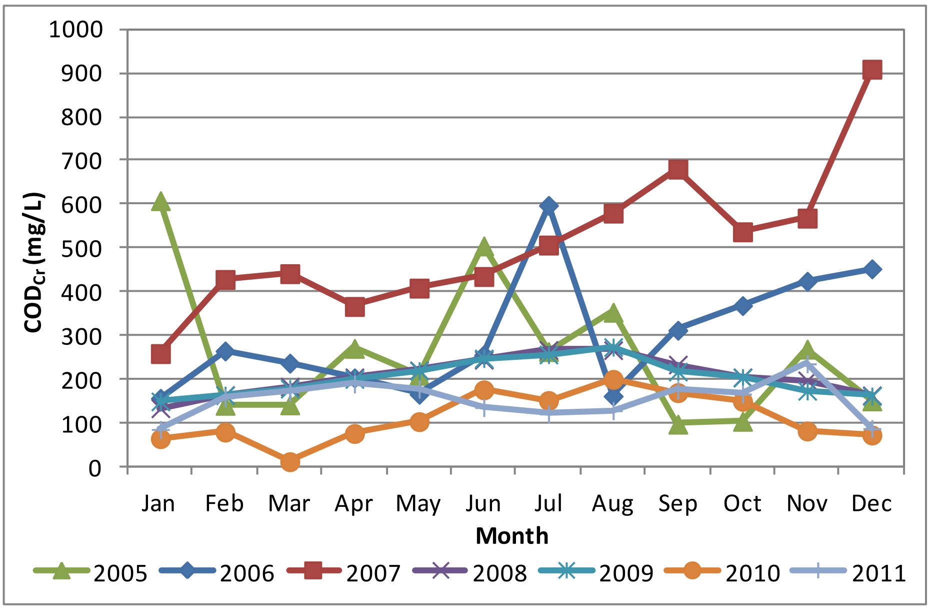
Figure 2.23 Monthly Analysis Record at Influent (BOD)

Table 2.17 Monthly Analysis Record at Influent (COD_{Cr})

Unit: mg/L

Month	2005	2006	2007	2008	2009	2010	2011
January	608.92	157.21	259.55	134.50	150.24	65.23	86.18
February	141.42	265.44	428.79	164.84	164.28	80.24	158.57
March	142.48	237.58	442.11	184.23	179.32	12.57	171.96
April	271.41	204.03	367.15	205.34	201.54	77.04	190.01
May	210.02	166.60	409.11	221.34	220.34	104.07	178.50
June	505.44	256.80	435.60	245.31	248.36	176.66	136.27
July	264.13	598.00	507.45	267.85	257.35	152.31	121.68
August	353.95	162.43	580.45	267.34	274.36	200.54	129.02
September	98.36	312.75	680.89	234.51	218.37	170.28	176.29
October	104.88	369.12	537.67	205.45	204.58	150.47	167.11
November	269.67	424.71	569.00	198.47	174.36	82.74	236.16
December	151.47	453.14	909.10	164.25	162.38	73.56	88.20
Average	260.18	300.65	510.57	207.79	204.62	112.14	153.33
Maximum	608.92	598.00	909.10	267.85	274.36	200.54	236.16
Minimum	98.36	157.21	259.55	134.50	150.24	12.57	86.18

Source: PROAQUA



Source: PROAQUA

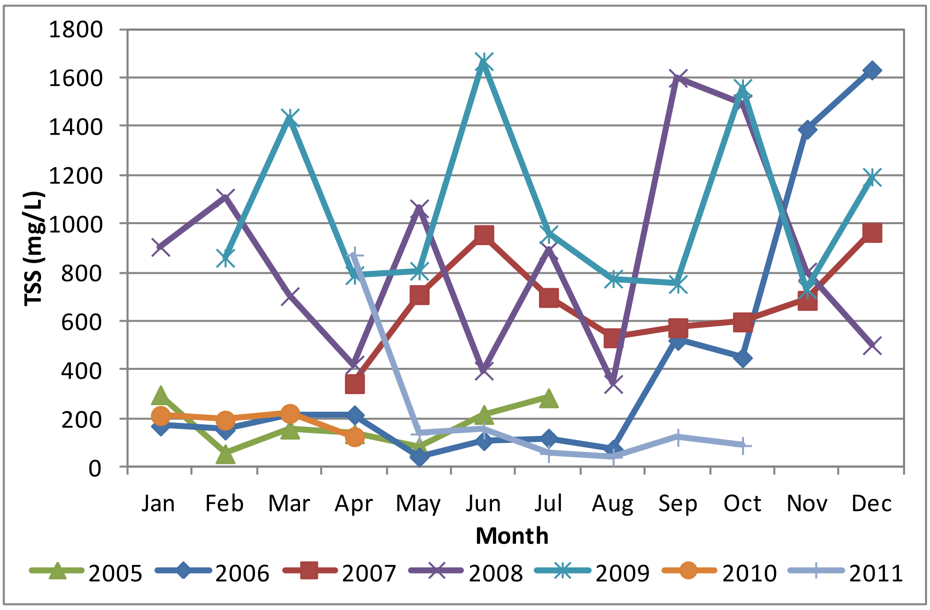
Figure 2.24 Monthly Analysis Record at Influent (COD_{Cr})

Table 2.18 Monthly Analysis Record at Influent (Total Suspended Solids)

Unit: mg/L

Month	2005	2006	2007	2008	2009	2010	2011
January	297.90	169.51		905.80		212.56	
February	55.55	152.75		1,108.60	861.00	193.54	
March	156.58	217.72		703.50	1,437.90	221.10	
April	137.41	215.18	343.61	422.00	789.50	125.40	872.50
May	84.15	42.03	709.55	1,064.20	807.40		136.50
June	217.03	109.10	956.00	397.00	1,669.70		152.60
July	285.45	119.20	697.87	893.20	957.90		56.43
August		74.25	532.10	342.20	775.50		41.27
September		521.40	573.43	1,600.80	753.16		122.80
October		450.16	597.30	1,496.50	1,559.90		89.10
November		1,389.50	686.00	804.30	730.90		
December		1,633.47	965.40	501.60	1,193.86		
Average	176.30	424.52	673.47	853.31	1,048.79	188.15	210.17
Maximum	297.90	1,633.47	965.40	1,600.80	1,669.70	221.10	872.50
Minimum	55.55	42.03	343.61	342.20	730.90	125.40	41.27

Source: PROAQUA



Source: PROAQUA

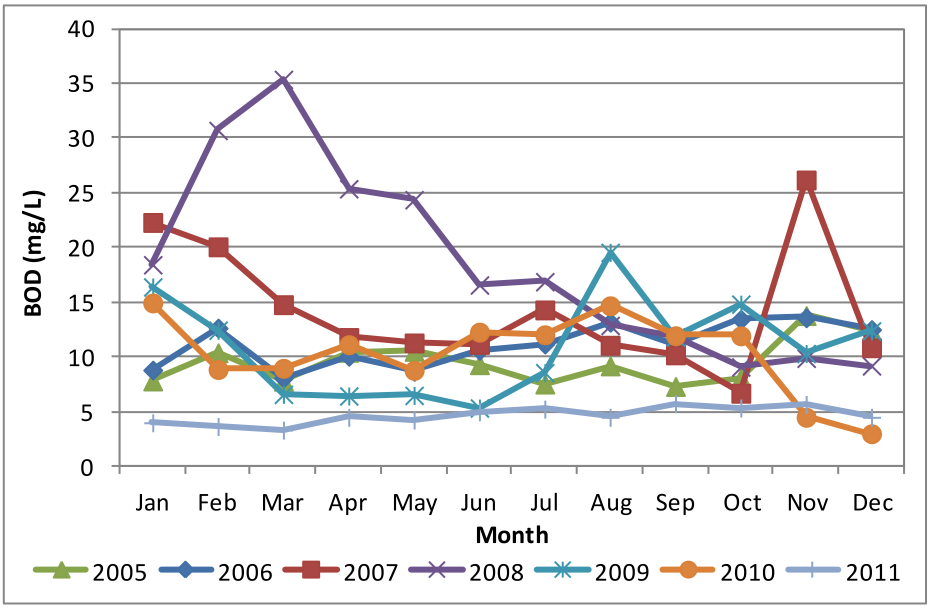
Figure 2.25 Monthly Analysis Record at Influent (Total Suspended Solids)

Table 2.19 Monthly Analysis Record at Effluent (BOD)

Unit: mg/L

Month	2005	2006	2007	2008	2009	2010	2011
January	7.82	8.82	22.32	18.45	16.42	14.96	4.00
February	10.40	12.66	20.09	30.73	12.46	8.87	3.66
March	7.80	8.10	14.80	35.40	6.60	8.98	3.33
April	10.44	10.08	11.80	25.40	6.45	11.14	4.50
May	10.53	8.70	11.30	24.40	6.50	8.79	4.25
June	9.31	10.63	11.17	16.60	5.35	12.29	5.00
July	7.54	11.20	14.32	16.90	8.58	12.05	5.25
August	9.20	13.19	11.09	12.90	19.58	14.70	4.50
September	7.32	11.11	10.21	11.85	11.84	11.96	5.75
October	8.10	13.46	6.70	9.10	14.85	11.95	5.35
November	13.80	13.60	26.20	9.90	10.33	4.50	5.67
December	12.38	12.52	10.86	9.20	12.40	3.00	4.50
Average	9.55	11.17	14.24	18.40	10.95	10.27	4.65
Maximum	13.80	13.60	26.20	35.40	19.58	14.96	5.75
Minimum	7.32	8.10	6.70	9.10	5.35	3.00	3.33

Source: PROAQUA



Source: PROAQUA

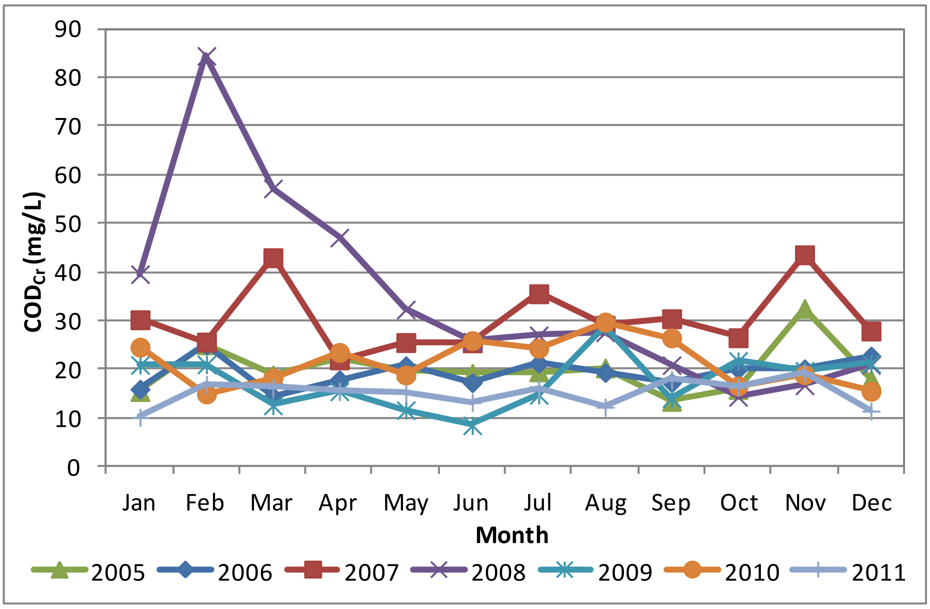
Figure 2.26 Monthly Analysis Record at Effluent (BOD)

Table 2.20 Monthly Analysis Record at Effluent (COD_{Cr})

Unit: mg/L

Month	2005	2006	2007	2008	2009	2010	2011
January	15.43	15.90	30.20	39.57	20.90	24.56	10.11
February	25.06	24.97	25.60	84.50	20.99	14.94	16.88
March	18.86	14.40	42.96	57.20	12.55	18.23	16.25
April	22.06	17.86	21.95	47.10	15.46	23.49	15.50
May	19.90	20.74	25.51	32.30	11.60	18.83	15.06
June	19.17	17.23	25.45	25.70	8.47	25.90	13.16
July	19.49	21.26	35.55	27.00	14.73	24.32	15.96
August	20.29	19.33	29.07	27.60	28.88	29.73	12.20
September	13.41	17.26	30.41	20.85	14.05	26.47	17.88
October	15.87	20.04	26.50	14.32	21.72	16.56	16.30
November	32.54	20.10	43.56	16.70	19.68	18.88	19.26
December	17.91	22.73	27.89	20.90	21.17	15.49	11.40
Average	20.00	19.32	30.39	34.48	17.52	21.45	15.00
Maximum	32.54	24.97	43.56	84.50	28.88	29.73	19.26
Minimum	13.41	14.40	21.95	14.32	8.47	14.94	10.11

Source: PROAQUA



Source: PROAQUA

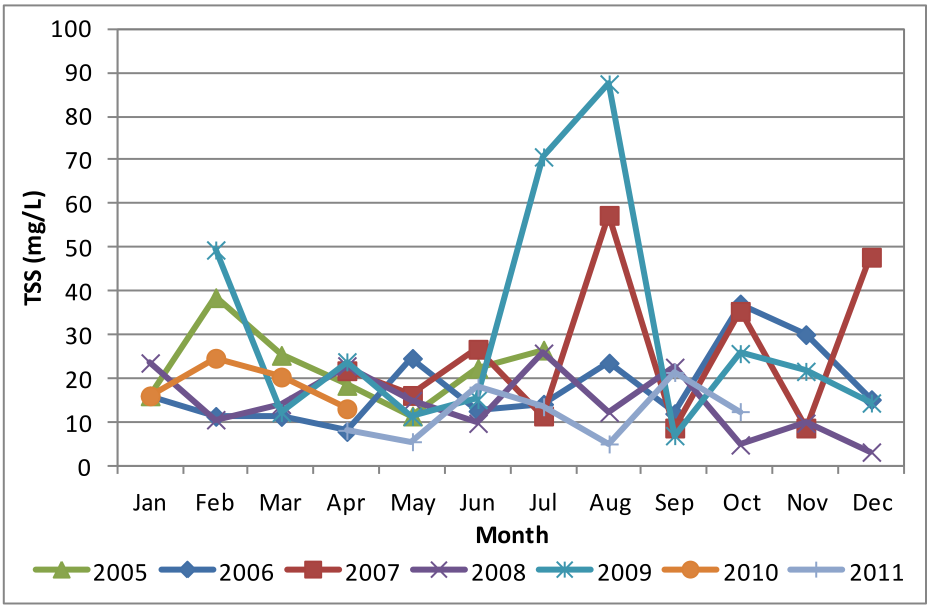
Figure 2.27 Monthly Analysis Record at Effluent (COD_{Cr})

Table 2.21 Monthly Analysis Record at Effluent (Total Suspended Solids)

Unit: mg/L

Month	2005	2006	2007	2008	2009	2010	2011
January	16.16	16.17		23.67		16.15	
February	38.60	11.46		10.70	49.50	24.75	
March	25.41	11.44		14.20	12.37	20.46	
April	18.54	8.00	21.90	23.00	23.92	13.20	8.27
May	11.55	24.72	16.25	15.05	11.44		5.67
June	22.44	12.67	26.81	9.90	15.31		18.15
July	26.61	14.25	11.55	25.90	70.78		13.67
August		23.65	57.42	12.40	87.45		5.16
September		12.10	8.80	22.67	7.06		21.50
October		37.16	35.47	4.95	25.80		12.55
November		30.15	8.80	9.90	21.75		
December		15.29	47.85	3.30	14.52		
Average	22.76	18.09	26.09	14.64	30.90	18.64	12.14
Maximum	38.60	37.16	57.42	25.90	87.45	24.75	21.50
Minimum	11.55	8.00	8.80	3.30	7.06	13.20	5.16

Source: PROAQUA



Source: PROAQUA

Figure 2.28 Monthly Analysis Record at Effluent (Total Suspended Solids)

According to the data collected, the signature components taken at the influent showed significant fluctuations throughout the year, but when only data for recent years are compared, influent records showed a relatively constant tendency for the influent contents to be more concentrated during the summer and less in the winter.
The BOD in the influent tended to peak in July and August, ranging around 125-131 mg/L during 2008-2011 (2011 peaked in April instead). COD is usually analyzed as COD_{Cr} and usually peaked in the summer, generally in July and August, ranging around 200-274 mg/L during 2008-2011 (2011 peaked in November). Total suspended solids showed no clear seasonal tendencies, with the values recorded fluctuating significantly.

With regard to the water quality components in the effluent, BOD remained below the criteria regulating at 25 mg/L or less throughout the year except 2007 and 2008. COD showed below the limit at 125 mg/L throughout the year between 2005 and 2010. Total suspended solids sometimes exceeded the limit of 35 mg/L but averaged between 12 and 31 mg/L.

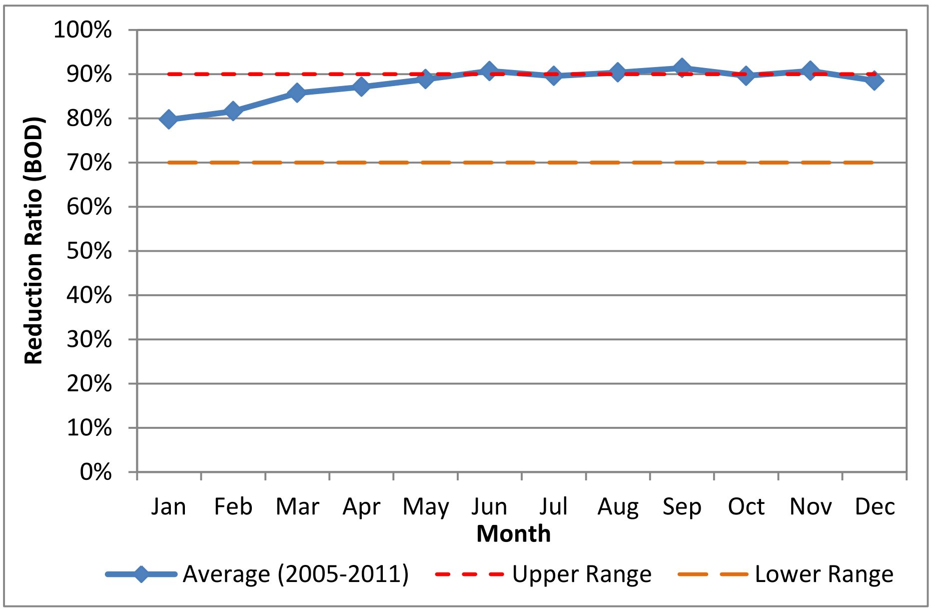
Finally total removal ratios of major water quality contents (BOD, COD and SS) were summarized and the average of the removal ratio in BOD, which represented the ratio of effluent by influent, was typically ranged between 80 and 93%. According to the typical trend from the data, the removal ratios in winter time (or rainy season) fell down to the lower end but the lowest value in each year wasn't almost within the criteria provided by EU except 2008 and 2010. This trend showed that the influent quality goes down in winter time (rainy season) but the total removal ratio retains within the criteria provided and it means WWTP works almost properly according to the reported figures.

Table 2.22 Reduction Ratio at the Vranista WWTP (BOD)

Unit: %

Month	2005	2006	2007	2008	2009	2010	2011
January	88.6%	84.3%	86.9%	71.3%	75.7%	62.6%	88.6%
February	74.4%	91.5%	90.5%	59.4%	83.5%	84.1%	87.8%
March	87.7%	93.3%	90.9%	58.0%	92.2%	87.3%	90.8%
April	93.5%	82.8%	93.2%	73.7%	93.3%	76.6%	96.6%
May	91.4%	86.3%	96.1%	76.9%	93.8%	84.0%	93.5%
June	95.4%	86.5%	91.6%	85.5%	95.4%	86.7%	93.8%
July	93.6%	88.6%	89.5%	86.8%	92.9%	82.8%	92.6%
August	95.8%	85.3%	95.0%	89.9%	84.4%	88.2%	94.0%
September	89.7%	95.1%	96.4%	89.2%	89.3%	86.0%	94.0%
October	84.8%	93.0%	97.5%	90.1%	84.4%	83.7%	93.5%
November	91.4%	93.9%	88.9%	88.7%	87.1%	90.5%	94.5%
December	80.1%	94.0%	97.2%	87.8%	83.5%	90.0%	87.1%
Average	88.9%	89.6%	92.8%	79.8%	88.0%	83.5%	92.2%
Maximum	95.8%	95.1%	97.5%	90.1%	95.4%	90.5%	96.6%
Minimum	74.4%	82.8%	86.9%	58.0%	75.7%	62.6%	87.1%

Source: PROAQUA



Source: JICA Study Team

Figure 2.29 Reduction Ration at Vranista WWTP (BOD)

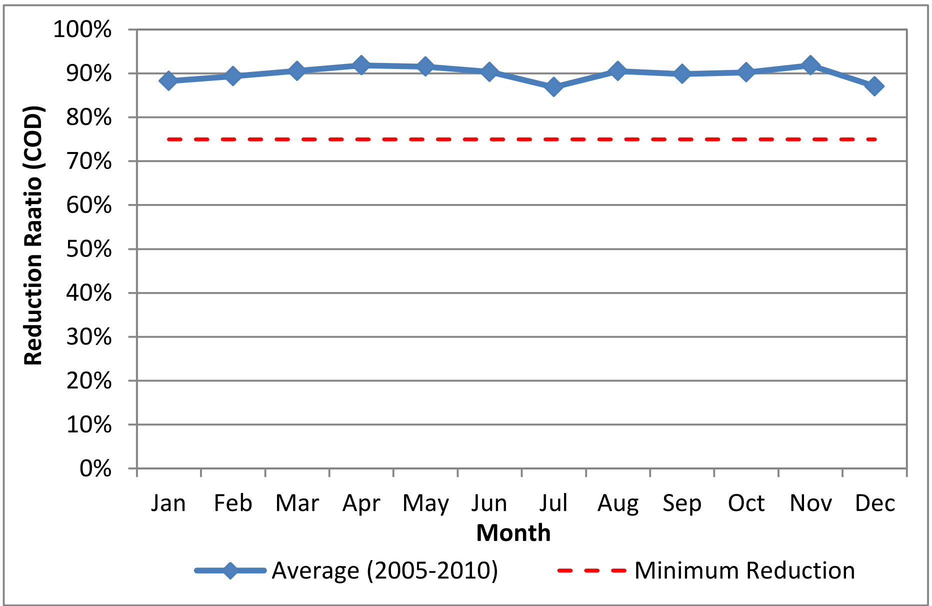
On the contrary to the results in BOD, COD showed different trend and the averaged ratios didn't drop in winter time and remained rather constant compared to BOD.

Table 2.23 Reduction Ratio at the Vranista WWTP (COD_{Cr})

Unit: %

Month	2005	2006	2007	2008	2009	2010	2011
January	97.5%	89.9%	88.4%	70.6%	86.1%	62.3%	88.3%
February	82.3%	90.6%	94.0%	48.7%	87.2%	81.4%	89.4%
March	86.8%	93.9%	90.3%	69.0%	93.0%	-45.0%	90.6%
April	91.9%	91.2%	94.0%	77.1%	92.3%	69.5%	91.8%
May	90.5%	87.6%	93.8%	85.4%	94.7%	81.9%	91.6%
June	96.2%	93.3%	94.2%	89.5%	96.6%	85.3%	90.3%
July	92.6%	96.4%	93.0%	89.9%	94.3%	84.0%	86.9%
August	94.3%	88.1%	95.0%	89.7%	89.5%	85.2%	90.5%
September	86.4%	94.5%	95.5%	91.1%	93.6%	84.5%	89.9%
October	84.9%	94.6%	95.1%	93.0%	89.4%	89.0%	90.2%
November	87.9%	95.3%	92.3%	91.6%	88.7%	77.2%	91.8%
December	88.2%	95.0%	96.9%	87.3%	87.0%	78.9%	87.1%
Average	89.9%	92.5%	93.5%	81.9%	91.0%	69.5%	89.9%
Maximum	97.5%	96.4%	96.9%	93.0%	96.6%	89.0%	91.8%
Minimum	82.3%	87.6%	88.4%	48.7%	86.1%	-45.0%	86.9%

Source: PROAQUA



Source: JICA Study Team

Figure 2.30 Reduction Ration at Vranista WWTP (COD_{Cr})

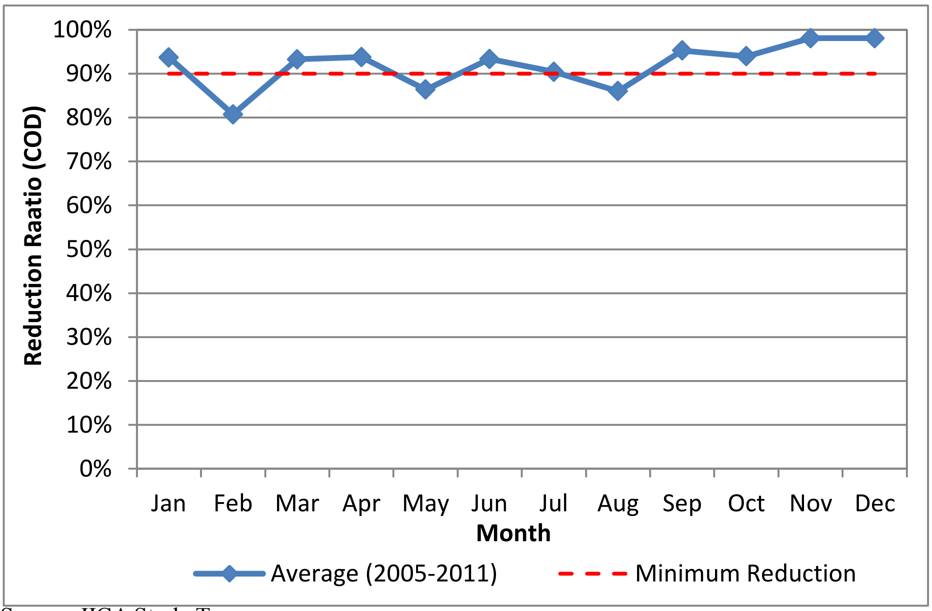
Total suspended solid showed unstable profiles than other two components but most of the removal ratios were above the lower limit of the criteria.

Table 2.24 Reduction Ratio at the Vranista WWTP (Total Suspended Solids)

Unit: %

Month	2005	2006	2007	2008	2009	2010	2011
January	94.6%	90.5%		97.4%		92.4%	
February	30.5%	92.5%		99.0%	94.3%	87.2%	
March	83.8%	94.7%		98.0%	99.1%	90.7%	
April	86.5%	96.3%	93.6%	94.5%	97.0%	89.5%	99.1%
May	86.3%	41.2%	97.7%	98.6%	98.6%		95.8%
June	89.7%	88.4%	97.2%	97.5%	99.1%		88.1%
July	90.7%	88.0%	98.3%	97.1%	92.6%		75.8%
August		68.1%	89.2%	96.4%	88.7%		87.5%
September		97.7%	98.5%	98.6%	99.1%		82.5%
October		91.7%	94.1%	99.7%	98.3%		85.9%
November		97.8%	98.7%	98.8%	97.0%		
December		99.1%	95.0%	99.3%	98.8%		
Average	80.3%	87.2%	95.8%	97.9%	96.6%	90.0%	87.8%
Maximum	94.6%	99.1%	98.7%	99.7%	99.1%	92.4%	99.1%
Minimum	30.5%	41.2%	89.2%	94.5%	88.7%	87.2%	75.8%

Source: PROAQUA



Source: JICA Study Team

Figure 2.31 Reduction Ration at Vranista WWTP (Total Suspended Solid)

Detailed water quality tests are conducted periodically based on the internal regulations and major trace metal components and other chemical items are mainly taken every three months.

Table 2.25 Water Analysis Records at the Vranista WWTP (Detailed Test)

No.	Item	Unit	Date							
			27/01/2011		08/04/2011		21/07/2011		01/06/2012	
			Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
1	Water Temperature	deg.C	8.9	9.0	12.2	13.6	14.6	18.5	16.6	16.6
2	Color	-	Brown	None	Brown	None	Brown	None	Brown	None
3	Odor	-	Fecal	None	Fecal	None	Fecal	None	Fecal	None
4	COD_{Mn}	mg/L	89.46	5.10	226.05*	18.01*	111.97	18.01	77.00*	43.60*
5	BOD_5	mg/L	25.0	2.0	120.0	5.0	-	-	50.0	4.0
6	pH	-	7.77	7.63	7.86	7.79	8.07	7.89	8.15	8.06
7	Dissolved Oxygen (DO)	mg/L	7.14	3.19	2.91	2.38	1.06	1.44	2.48	2.19
8	Electrical Conductivity	µS/cm	573	555	570	558	624	565	564	547
9	Cr	mg/L	0.09	0.05	0.08	0.05	0.14	0.07	0.05	0.04
10	Mn	mg/L	0.52	0.18	0.52	0.26	0.69	0.45	0.43	0.21
11	PO_4-P	mg/L	1.67	0.30	1.38	0.57	1.16	2.87	0.80	0.59
12	Pb	mg/L	-	-	-	-	-	-	-	-
13	Cd	mg/L	-	-	-	-	-	-	-	-
14	Cl	mg/L	21.0	18.0	25.0	19.0	38.0	26.0	18.0	23.0
15	Cu	mg/L	0.28	0.15	0.16	0.08	0.31	0.18	0.11	0.05
16	NH_4	mg/L	0.02	<0.005	0.02	0.02	0.02	0.02	0.03	0.01
17	Ni	mg/L	0.72	0.14	0.31	0.22	0.60	0.30	0.33	0.22
18	Al	mg/L	0.07	0.02	0.01	0.01	0.03	<0.01	0.01	<0.01
19	Cl_2	mg/L	0.45	0.26	0.24	0.17	0.59	0.30	0.31	0.21
20	SO_4	mg/L	-	-	-	-	-	-	-	-
21	NO_3-N	mg/L	-	-	-	-	-	-	-	-
22	NO_2-N	mg/L	0.15	0.08	0.04	0.26	0.06	0.11	0.07	0.03
23	Zn	mg/L	-	-	-	-	-	-	-	-
24	CN	mg/L	0.019	0.012	0.007	0.004	0.016	0.008	0.009	0.007
25	Suspended Solid (SS)	mg/L	-	-	1,732.5	6.7	-	-		

*Analyzed as COD_{Cr}

Source: PROAQUA

Table 2.26 Other Water Analysis Components Monitored at the Vranista WWTP

No.	Item	Location	Frequency
1	Air Temperature	Reactor Nos. 1 & 2	Weekly
2	Water Temperature	Reactor Nos. 1 & 2	Weekly
3	pH	Reactor Nos. 1 & 2	Weekly
4	Electrical Conductivity	Reactor Nos. 1 & 2	Weekly
5	Dissolved Oxygen (DO)	Reactor Nos. 1 & 2	Weekly
6	Sludge Component	Reactor Nos. 1 & 2	Weekly
7	Effluent Volume	Near Outlet	Constant

Source: PROAQUA

2.3.3 On-Site Treatment Facilities

Outside the sewerage area, privately owned wastewater treatment facilities are located, which target the treatment of wastewater from tourism destinations.
During the on-site visits, JICA Study Team visited three locations as follows:

- Army campsite in St. Naum, South of Ohrid (capacity: 600 people)
- Camping site in Radozda, South of Struga (capacity: 2,000 people)
- Biser Hotel in Radozda, South of Struga (capacity: 200 people)

These facilities are maintained by private owners, but PROAQUA worked with the facility for the campsite in Radozda previously and cleaning and consulting services were cited as their professional services. The newest facility in the army campsite in St. Naum commenced operation from June 2012, and the construction cost of the treatment facility was approximately 60,000 EUR, according to the workers at the site.

New Facility in the Army Campsite

Campsite at Radozda

Source: JICA Study Team

Figure 2.32 On-Site Treatment Facilities

2.4 Conducted Site Survey

2.4.1 Purpose of the Survey

The purpose of the survey was to determine the current status of the existing sewer facilities laid in Ohrid and Struga cities. The results of the survey serve as the basis to identify potential reasons for the generation of unidentified sewage inflow and improve wastewater treatment functions for utilities.

2.4.2 Objectives of the Survey

The survey objectives are as follows:

(1) To predict possible mechanisms (reasons) for unidentified infiltration which impact on the existing sewerage system.

(2) To locate the potential scope and sections which cause some troubles in sewer facilities such as breakages, erosions and misconnections, etc. that produce inflow of unidentified sewage into sewer system.

(3) To evaluate prioritizations for the necessary countermeasures based on the results.

2.4.3 Contents of the Survey

The survey to nominate the sections of sewers being surveyed on the survey and the survey was taken based on the selections in that stage.

1. Data on Existing Sewers
- Inventories (Diameter, Depth, etc.)
- Combined / Separate System
- Overflow weirs
- Repair Records, etc.

↓

2. Site Survey
- Water Depth at Manhole
- COD Test (Simplified Method)
- Visual Observation (Pavement)
- Visual Observation (Manhole)
- Visual Surveillance (Sewer Pipe)
  - Superficial Condition
  - Precipitants from Pipes
  - Gaps in Pipe Connections
  - Breakage in Pipe / Manholes
  - Weirs in Overflow Chambers

↓

3. Evaluation of Results

Source: JICA Study Team

Figure 2.33 Presumed Procedures

2.4.4 Procedures for the Survey

(1) Data Collection on Existing Sewer Pipes

The collected data are utilized for the site survey by understanding the routes of the network and current given status:

- Available inventory data (such as diameter (dimensions), depth, slope, material, year of installation)
- Type of sewage collection system (combined/separate)
- Installation method (main pipe/connection pipe between households (including typical connections from rain gutter))
- Overflow weirs (applicable only to combined sewerage systems)
- Maintenance records (rehabilitation/replacement of pipes, covered soil and pavement over sewers)

(2) Site Survey on Sewer Facilities

The site survey covers a fundamental review on the existing system covering the entire network to determine the candidate area and sections causing unidentified infiltrations.

The selection of survey points (manholes) is based on the following criteria:

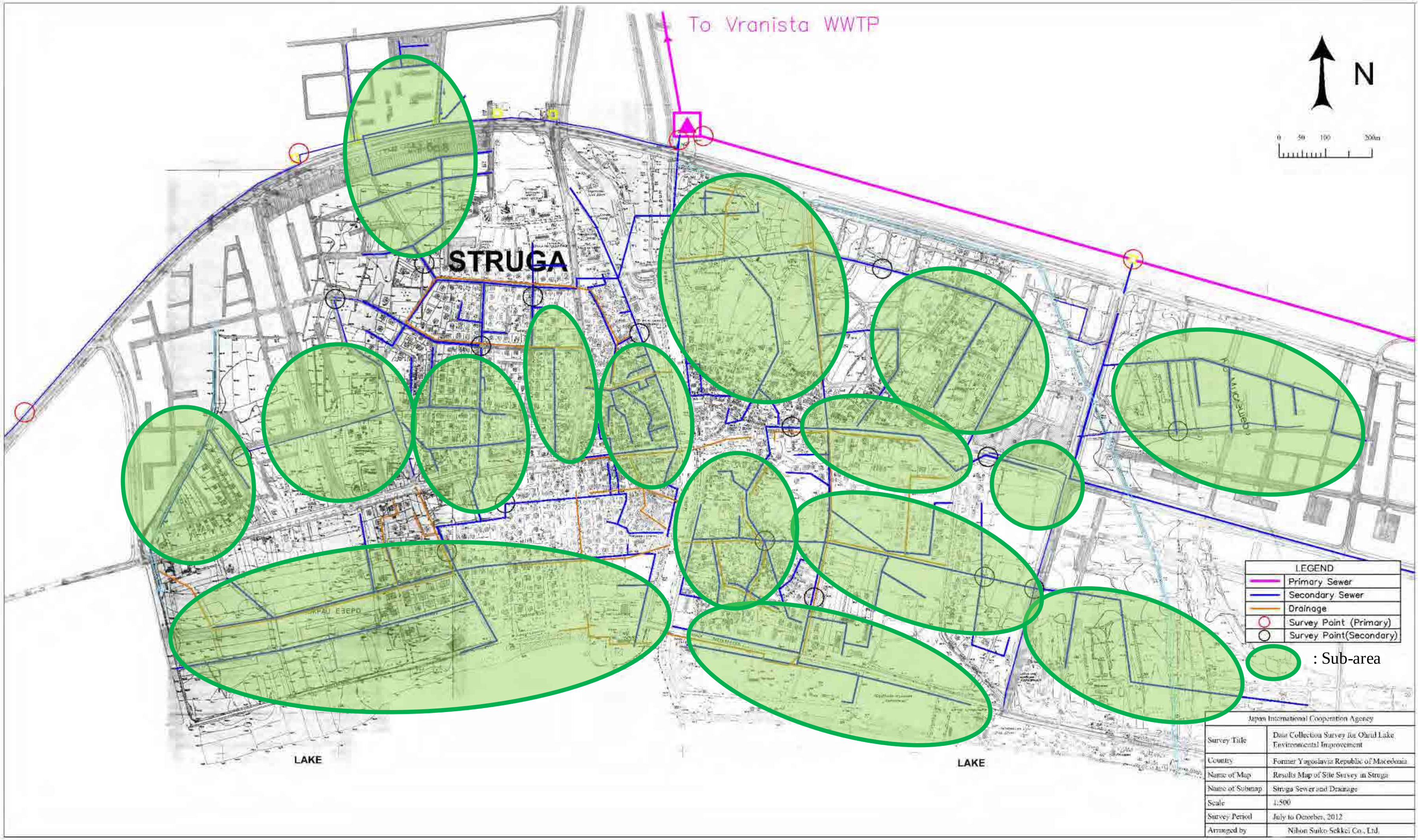
- The points at the primary sewer to know the sewage flow in the primary. (ex. at the start points of each sewer, at the pump stations and the points which are changed the area's characteristics)

- The points at the secondary sewer should be near the primary sewer to cover the separate appropriate sub-area largely. (The divided sub-area must be covered the entire sewerage area.)
- The sub-area should be selected to know each area's characteristics (ex. the area near the lake, the residential area, commercial area, or the adjacent to the city, etc.)
- The points should be selected with consideration of the sewage flow of the whole network.
- The point could be conducting the site survey safely.

From the criteria shown above, the points of the site survey and divided sub-area by the survey points are shown in the following drawings:

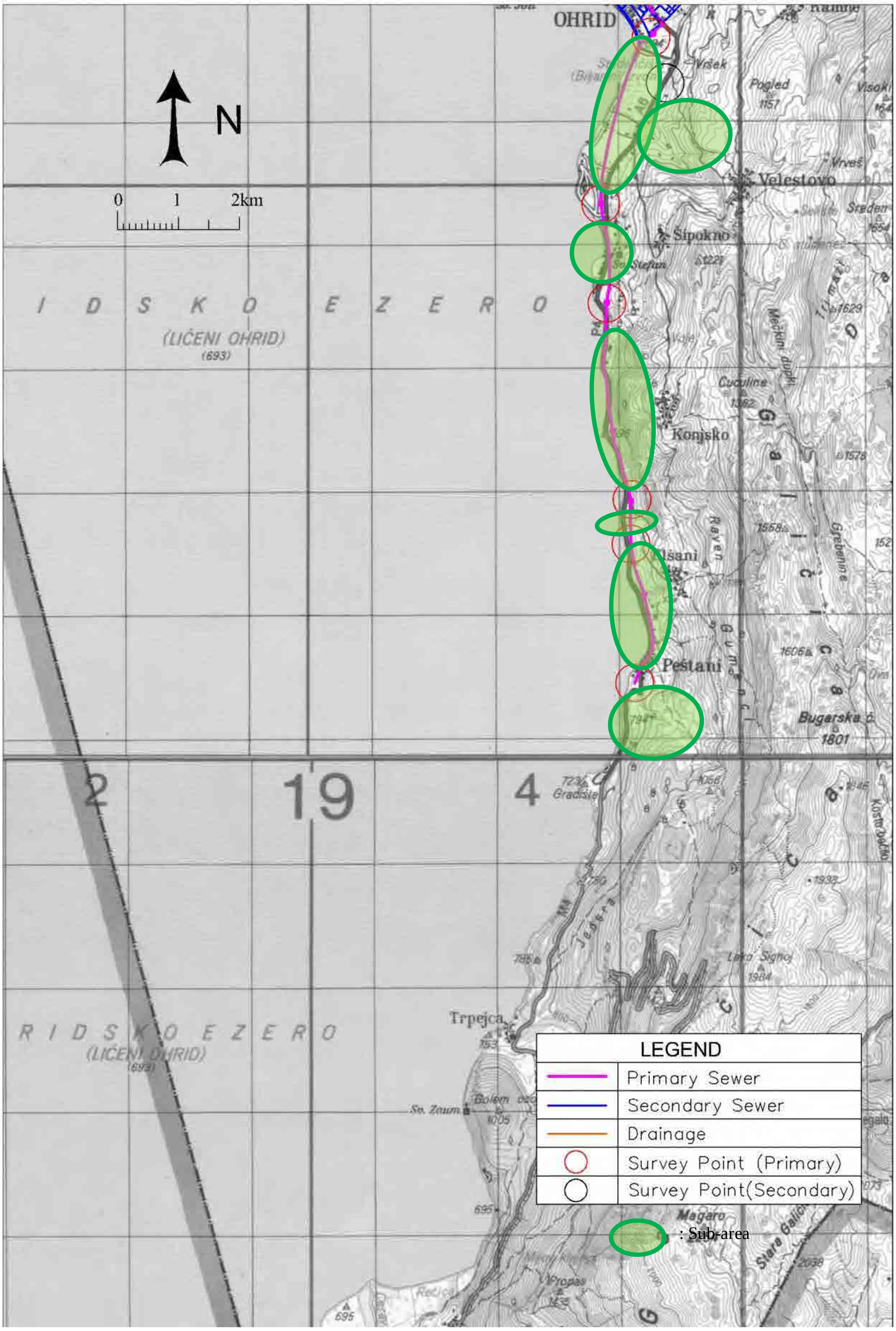
Source: JICA Study Team

Figure 2.34 Site Survey Points and Divided Sub-Area (Ohrid)



Source: JICA Study Team

Figure 2.35 Site Survey Points and Divided Sub-Area (Struga)



Source: JICA Study Team

Figure 2.36 Site Survey Points and Divided Sub-Area (Ohrid-South)

Source: JICA Study Team

Figure 2.37 Site Survey Points and Divided Sub-Area (Struga-West)

1) Water Depth of Major Locations

The water depth is obtained visually at the manholes at major locations chosen in the system fundamentally as follows:

- Intersections of trunk sewers
- Influent on the pumping stations and the wastewater treatment plant
- Some points of existing sewers along the Ohrid Lake
- Suggested locations from the counterpart

The total number of locations was 70.

2) Simplified Water Quality Test

A simplified water quality test is conducted using simplified colorimetric paper, which represents COD content ("PACK TEST": Oxidation with Potassium Permanganate in Alkalinity and the Visual Colorimetric Method). Up to 50 locations are selected based on the following criteria:

- Intersections of trunk sewers
- Influent on the pumping stations and the wastewater treatment plant
- Random points representing typical raw sewage contents
- Suggested locations from the counterpart

Images of water sampling from the sewer are shown below:

Source: JICA Study Team

Figure 2.38 Typical Images of the Water Sampling Survey

Generally, the existence of higher COD content represents sewer components and lower content is assumed to reveal the potential for a mixture of infiltration. The metric paper can cover 0-250 mg/L and the simplified test can support the selection of suspicious sections during the survey. Images of the water quality examination are shown below:

Source: JICA Study Team

Figure 2.39 Water Quality Examination

The tests conducted during the survey used simplified method which is based on the measurement as COD_{Mn}, therefore the results were used only to observe general phenomenon of dilutions in all over the sewer network and it is necessary that the results are not compatible to the results from water quality tests regularly done by WWTP which are done in accordance with effluent criteria because they sometimes represent COD_{Cr}.

3) Visual Surveillance

According to information accumulated over years of installing sewer pipes along the lake, visual observations were taken while the water depth and samples were determined from manholes. The total number was 50 and the observation items are listed as follows:

a) Pavement

- Bumps in longitudinal directions along main pipes, any instability at the surface
- Gaps on the surface of manholes between the pavement and the lid
- Bumps on the surface around the connection pipes from the main pipes

b) Manhole, Edges of Pipes Connected to Manholes

- Any residuals inside the manhole, especially sand and rocks
- Evidence of leakage from the inner surface
- Gaps in the connecting point between the manhole and pipe
- General conditions of materials such as breakage
- Level of deterioration (inner walls of manhole, pipe, joints, smoothness of the surface, etc.)
- Depreciation of pipes (fluctuation in connections)
- Current condition and functions in overflow weirs (only combined sewer system)
- Major failures (such as breakage, intrusion of tree root)

c) Other Viewpoints

- Odors from sewers
- Color of sewage

All the results are organized in a table which clearly distinguishes the defects observed during the surveillance.
Visual surveillance is conducted from manholes using a digital camera
Images of this visual surveillance are shown below:

Source: JICA Study Team

Figure 2.40 Typical Images of Visual Surveillance

2.4.5 Survey Results

From the data collection survey, JICA Study Team had the information listed below:

- General sewer network map for whole area (only primary sewer)
- Drawings of sewer and drainage network map in Ohrid and Struga city. (Ohrid drawing has not only the network figure but also pipe diameter data on the map, but Struga one doesn't have the diameter data, just network figure.)
- Longitudinal drawings of newly constructed sewer and drainage in Ohrid city, Struga city, and Struga western region (partially).
- The drawings of Struga III Pumping Station (hard copy of layout map and sections)
- The drawings of intermediate pumping stations at Struga west region. (Elen Kamen Pump Station and Kalista Pump Station)
- General layout map of Vranista wastewater treatment plant.
- The maintenance records for the facilities.

The data which were need for further inspections, but JICA Study Team could not collect during this survey is listed below:

- The ground water level data in Ohrid and Struga region
- The inventory data (such as diameter, depth, slope, material, year of installation) for whole area (just partially data could be collected)
- The clear defined classification area map where the combined sewerage system or separate.
- The sewer network drawings of Ohrid south region (Pestani – Ohrid city)

The results of the site survey are organized as shown below:

- Location, date and time (sorted by ID of the location, CAD drawing attached)
- Water depth (converted into elevation so that values can be compared with the water level at the lake)
- COD content (only applicable locations)
- Observation on pavement, manhole and edges of sewers
- Pictures (every visually observed location)

Table 2.27 Results of Site Survey (Ohrid)

Ser	ID	Date	Time	Location	Category of Sewer	Road Depression	Superficial Condition		Water Depth (mm)	Precipitation in Manhole		COD (Mn-eq) (mg/L)	Taking Photograph		Other Examined Condition
							MH	Sewer		Stones	Gabage		MH	Sewer	
1	OH-X1	16/08	10:30	WWTF for camping site in St. Naum	-	N/A	N/A	N/A	N/A	N/A	N/A	18	Done	N/A	Cold, clean colored
2	OH-01	16/08	12:00	Upstream manhole in Pestani	Secondary	Lake Side	Good	Good	100	None	None	80	Done	Done	Sewage from Hotels
3	OH-02	16/08	12:10	Krusha Pump Station (Newly built in 2011)	Primary	Lake Side	Good	Good	N/A	N/A	N/A	N/A	N/A	N/A	Funded by municipality of Ohrid
4	OH-03	16/08	12:20	Pestani	Primary	Lake Side	Good	Good	N/A	N/A	N/A	N/A	N/A	N/A	
5	OH-04	16/08	12:35	Between Pestani and Elshani Pump Station	Primary	Lake Side	Good	Good	100	None	None	20	Done	Done	Cold, clean colored
6	OH-05	16/08	12:50	Elshani Pump Station	Primary	Lake Side	Good	Good	N/A	None	None	20	Done	Done	Cold, clean colored
7	OH-06	16/08	13:10	Granit Pump Station	Primary	Lake Side	Good	Good	100	None	None	20	Done	Done	Cold, slightly dark colored
8	OH-07	16/08	13:30	St Stdan Pump Station	Primary	Lake Side	Good	Good	100	None	None	20	Done	Done	Cold, slightly dark colored
9	OH-08	16/08	13:50	Pump Station in Ohrid Center	Secondary	Rd Side	Good	Good	N/A	None	None	80	Done	Done	Sewage, smelly water
10	OH-09	16/08	14:10	Ohrid 1 Pump Station	Primary	N/A	Good	Good	N/A	None	None	20	Done	Done	Cold, slightly dark colored
11	OH-10	16/08	14:20	Ohrid 2 Pump Station	Primary	N/A	Good	Good	N/A	None	None	20	Done	Done	Cold, slightly dark colored
12	OH-11	16/08	14:35	Ohrid 5 Pump Station	Primary	N/A	Good	N/A	300	None	None	22	Done	Done	Cold, slightly dark colored
13	OH-12	21/08	12:50	Ohrid center, millenimum hotel	Secondary	None	Good	Good	50	None	None	70	Done	Done	Cold, clean colored
14	OH-13	21/08	12:55	Ohrid center, millenimum hotel	Secondary	None	Good	Good	170	None	None	30	Done	Done	Cold, clean colored
15	OH-14	21/08	13:05	Ohrid center, east MH of MC1	Secondary	None	Fair	Good	100	None	None	80	Done	Done	Cold, dark
16	OH-15	21/08	13:15	Ohrid center, Downstream of Ohrid 1 PS	Primary	None	Fair	Good	1000	None	None	30	Done	Done	Cold, clean colored
17	OH-16	21/08	13:20	Ohrid center, north of MC12	Secondary	None	Good	Good	150	None	None	90	Done	Done	Cold, dark
18	OH-17	21/08	13:30	Ohrid center, downstream of Ohrid 2 PS	Primary	None	Good	Good	N/A	None	None	60	Done	N/A	Cold, little

Ser	ID	Date	Time	Location	Category of Sewer	Road Depression	Superficial Condition		Water Depth (mm)	Precipitation in Manhole		COD (Mn-eq) (mg/L)	Taking Photograph		Other Examined Condition
							MH	Sewer		Stones	Gabage		MH	Sewer	
19	OH-18	21/08	13:40	Ohrid center, east of MC16	Secondary	None	Good	Good	200	None	None	30	Done	Done	Cold, clean colored
20	OH-19	21/08	13:50	Ohrid center, north of MC25	Secondary	None	Good	Good	200	None	None	35	Done	Done	Cold, clean colored
21	OH-20	21/08	13:55	Ohrid center, south of MC25	Secondary	None	Good	Good	50	None	None	100	Done	Done	Cold, little
22	OH-21	21/08	14:10	Ohrid center, west center	Secondary	None	Good	Good	50	None	None	20	Done	N/A	Cold, dark
23	OH-22	21/08	14:20	Ohrid center, DS of OH-21	Secondary	None	Fair	Fluctuation	50	None	None	20	Done	Done	Cold, clean colored
24	OH-23	21/08	14:30	Ohrid center, north of MC43	Secondary	None	Fair	Good	N/A	None	None	18	Done	Done	much water stand in MH
25	OH-24	21/08	14:30	Ohrid center, north of MC43	Secondary	None	Fair	Good	N/A	None	None	7	Done	Done	Water from Condominium
26	OH-25	21/08	14:40	Ohrid center, MC44	Primary	None	Fair	Good	N/A	None	None	50	Done	Done	Cold, clean colored (water level is 2.0m from GL)
27	OH-26	22/08	09:10	Ohrid center, north of MC11	Secondary	None	Good	Good	50	None	None	100	Done	Done	Cold, slightly turbid
28	OH-27	22/08	09:15	Ohrid center, next to OH-26	Secondary	None	Good	Good	50	None	None	N/A	Done	Done	
29	OH-28	22/08	09:25	Ohrid center, south of MC12	Secondary	None	Good	Good	50	None	None	N/A	Done	Done	
30	OH-29	22/08	09:30	Ohrid center, next to OH-28	Secondary	None	Good	Good	150	None	None	30	Done	Done	Cold, slightly turbid
31	OH-30	22/08	09:40	Ohrid center, north of MC22	Secondary	None	Good	Good	50	None	None	100	Done	Done	Not so cold, slightly turbid
32	OH-31	22/08	09:50	N/A	N/A	None	N/A	N/A	N/A	None	None	N/A	N/A	N/A	No picture
33	OH-32	22/08	09:55	Ohrid center, entrance of the bayroad	Secondary	None	Good	Bad Connection	30	Grease	None	40	N/A	Done	Grease piles
34	OH-33	22/08	10:05	Ohrid ancient town, besides the north gate	Secondary	None	Old	Good	50	None	None	100	Done	Done	Old, turbid
35	OH-34	22/08	10:15	Ohrid ancient town, downstream of the town	Secondary	None	Old	Good	40	None	None	90	Done	Done	Old, cold, clean
36	OH-35	22/08	10:30	Ohrid ancient town, nest to the St.Sophia	Secondary	None	Old	Good	0	None	None	N/A	Done	Done	downstream of pressure pipe, no flow
37	OH-36	22/08	10:50	Ohrid center, north of MC27	Secondary	None	Good	Good	120	None	None	20	Done	N/A	interflow with 3ways, next to car wash shop

Ser	ID	Date	Time	Location	Category of Sewer	Road Depression	Superficial Condition		Water Depth (mm)	Precipitation in Manhole		COD (Mn-eq) (mg/L)	Taking Photograph		Other Examined Condition
							MH	Sewer		Stones	Gabage		MH	Sewer	
38	OH-37	22/08	11:05	Ohrid center, north of MC34a	Secondary	None	Good	Good	50	None	None	250	Done	Done	Red water, no smell
39	OH-38	22/08	11:05	Ohrid center, next to OH-37, From the channel	channel	None	N/A	N/A	N/A	None	None	5	Done	N/A	From the channel
40	OH-39	22/08	11:15	Ohrid west, upstream of Daljan PS	Secondary	None	Good	Good	N/A	None	None	40	Done	Done	
41	OH-40	22/08	11:25	Ohrid north, interflow from 2villeges	Secondary	None	Good	Good	130	None	None	110	Done	Done	interflow with 2ways, turbid
42	OH-41	22/08	11:45	Ohrid north, former fabric factory	Secondary	None	Fair	Good	20	None	None	18	Done	Done	former fabric factory, cold, clean
43	OH-42	22/08	12:00	Podmoije PS	Primary	None	N/A	Good	N/A	N/A	N/A	40	N/A	N/A	No overflow in this time
44	OH-43	22/08	12:00	Podmoije PS overflow channel	Overflow	None	N/A	Good	N/A	N/A	N/A	N/A	N/A	N/A	Overflow conduit
45	OH-44	22/08	12:20	Sateska PS	Primary	None	N/A	Good	N/A	N/A	N/A	40	N/A	N/A	Pump Station

Source: JICA Study Team

Table 2.28 Results of Site Survey (Struga)

Ser.	ID	Date	Time	Location	Category of Sewer	Road Depression	Superficial Condition		Water Depth (mm)	Precipitation in Manhole		COD (Mn-eq) (mg/L)	Taking Photograph		Other Examined Condition
							MH	Sewer		Stones	Gabage		MH	Sewer	
1	ST-01	14/08	09:25	Upstream of Radolishta Village	Secondary	None	Good	Good	10	None	None	20	Done	Done	Cold, clean colored
2	ST-02	14/08	09:40	Center of Radolishta Village	Secondary	None	Good	Good	50	None	None	120	Done	Done	Turbid, sewage
3	ST-03	13/08	14:30	Primary sewer to Struga center	Primary	Rd Side	Good	Good	100	None	None	25	Done	Done	Cold, clean colored
4	ST-04	14/08	10:00	Primary sewer to Struga center	Primary	Rd Side	Good	Good	200	None	None	15	Done	Done	Cold, clean colored
5	ST-05	14/08	10:10	Pump Station	Secondary	Rd Side	N/A	N/A	N/A	N/A	N/A	N/A	Done	N/A	
6	ST-06	14/08	10:30	Struga center, northwest, 1	Secondary	None	Fair	Fair	100	None	Little	60	Done	Done	Turbid, sewage
7	ST-07	14/08	10:40	Struga center, northwest, 2	Secondary	None	Fair	something intrusion	70	None	Little	120	Done	Done	Turbid, sewage, something is inside the sewer
8	ST-08	14/08	10:50	Struga center, southwest	Secondary	None	Fair	Fair	100	None	Little	100	Done	Done	Turbid, sewage
9	ST-09	14/08	11:00	Struga center, in front of PROAQUA	Secondary	None	Fair	Fair	50	None	Little	60	Done	Done	Cold, clean colored
10	ST-10	14/08	11:20	Struga center, north of Ohrid lake	Secondary	None	Fair	Fair	80	None	Little	100	Done	Done	Turbid, sewage
11	ST-11	14/08	11:30	Struga center, north	Secondary	None	Fair	Fair	50	None	Little	50	Done	Done	Cold, clean colored
12	ST-12	14/08	11:40	intermediate Pump Station (No Sampling)	Secondary	Rd Side	N/A	N/A	N/A	N/A	N/A	N/A	Done	N/A	
13	ST-13	14/08	11:55	Struga 3 Pump Station, Influent from Struga	Primary	N/A	N/A	N/A	N/A	N/A	N/A	30	N/A	N/A	Turbid, sewage
14	ST-14	14/08	11:55	Struga 3 Pump Station, Influent from Ohrid	Primary	N/A	N/A	N/A	N/A	N/A	N/A	13	N/A	N/A	Turbid, sewage
15	ST-15	14/08	12:15	Vlanista WWTP, Influent	WWTP	N/A	N/A	N/A	N/A	N/A	N/A	20	N/A	N/A	Cold, clean colored
16	ST-16	14/08	12:25	Vlanista WWTP, Effluent	WWTP	N/A	N/A	N/A	N/A	N/A	N/A	5	N/A	N/A	Clean colored
17	ST-17	24/08	11:55	Primary sewer to Struga center (same as ST-04)	Primary	Rd Side	Good	Good	60%	N/A	N/A	50	Done	Done	Slight Turbid (same point as ST-04)
18	ST-18	24/08	12:00	Pump Station (same as ST-05)	Primary	Rd Side	Good	Good	70%	N/A	N/A	17	Done	N/A	Slight Turbid (same point as ST-05)
19	ST-19	24/08	12:20	Temporary Pump Station	Secondary	N/A	Good	N/A	stagnate	N/A	N/A	60	Done	N/A	Sewage, slight turbid
20	ST-20	24/08	12:25	Downstream of Temp. PS	Secondary	N/A	Good	Good	N/A	N/A	N/A	N/A	Done	N/A	Smell (H2S)
21	ST-21	24/08	12;40	Upstream of Temp. PS	Secondary	N/A	Good	Good	30	N/A	N/A	100	Done	Done	Dirty, Smell

Ser.	ID	Date	Time	Location	Category of Sewer	Road Depression	Superficial Condition		Water Depth (mm)	Precipitation in Manhole		COD (Mn-eq) (mg/L)	Taking Photograph		Other Examined Condition
							MH	Sewer		Stones	Gabage		MH	Sewer	
22	ST-22	24/08	12:50	Near Market	Secondary	Fair	Good	Good	30	N/A	N/A	90	Done	Done	Smelly, slight turbid
23	ST-23	24/08	13:05	Struga center, east; with Overflow Manhole	Secondary	None	Good	Good	100	N/A	N/A	90	Done	Done	browny
24	ST-24	24/08	13:20	Struga center, east; near fabric factry	Secondary	None	Good	Good	30	N/A	N/A	180	Done	Done	with black silt (COD=100 as supernatant)
25	ST-25	24/08	13:25	Struga center, east; near apartment buildings	Secondary	Fair	Good	Good	50	N/A	N/A	60	Done	Done	Cold, slight turbid
26	ST-26	24/08	13:30	Struga center, east; from apartment buildings	Secondary	Good	Good	Good	N/A	N/A	N/A	100	Done	Done	Turbid
27	ST-27	24/08	13:44	Sturga center, east; near Apolonia hotel	Secondary	Fair	Good	Partially collapse	30	N/A	N/A	100	Done	Done	browny
28	ST-28	24/08	13:50	Struga center, east; new residental area	Secondary	Good	Good	Good	30	N/A	N/A	60	Done	Done	Clean, slight turbud
29	ST-29	24/08	14:05	Struga center, north;	Secondary	Good	Good	Good	30	N/A	N/A	110	Done	Done	Clean, slight turbud

Source: JICA Study Team

(1) Results of Visual Surveillance

As the results of visual surveillance from the manholes, some sewer pipes were damaged, had intrusions (tree roots, etc.) or fluctuations in connection. The damaged / defective sewer pipes are listed in the following table and the related images are shown below:

Table 2.29 Damaged/Defective Sewers

City	ID	Location	Conditions
Ohrid	OH-22	West of Ohrid Center	Subsidence
	OH-32	Ohrid Center	Badly connected
	OH-36	Ohrid center, north of MC27	Subsidence
Struga	ST-07	Northwest of Struga Center	Tree root? Intrusion
	ST-25	Near Apolonia Hotel	Partially collapsed

Source: JICA Study Team

OH-22: Subsidence

OH-32: Badly Connected

OH-36: Subsidence

Source: JICA Study Team

Figure 2.41 Damaged/Defective Sewers (Ohrid)

ST-07: Root Intrusion

ST-25: Partially Collapsed

Source: JICA Study Team

Figure 2.42 Damaged/Defective Sewers (Struga)

Based on the results of visual surveillance shown above, the bigger problems seem to be at the connections of the pipes, e.g. bad connections and subsidences, etc. Based on the interview to PROAQUA, there is no special inspection after pipes and connections are constructed, as would normally be the case in Japan.

Furthermore, PROAQUA said that there were many connections without any official approval from PROAQUA (known as "wild connection") whereas applications were needed to connect to the sewer pipe from the wastewater of the houses. These connections are also due to problems of misconstruction or failure, and may lead to ingress of unidentified water into the sewer pipe.

JICA Study Team proposed that an arrangement of framework for the exhaustive application would be needed before the construction and post-construction inspection to prevent failure and misconstruction.

(2) Results of Water Quality Analysis

The results of the water quality analysis of wastewater samples from the manholes can be used to make presumptions on any unidentified infiltration of each small area. The sampling points are selected by considering the sub-area to cover the whole area of each city, so JICA Study Team can presume the condition as follows:

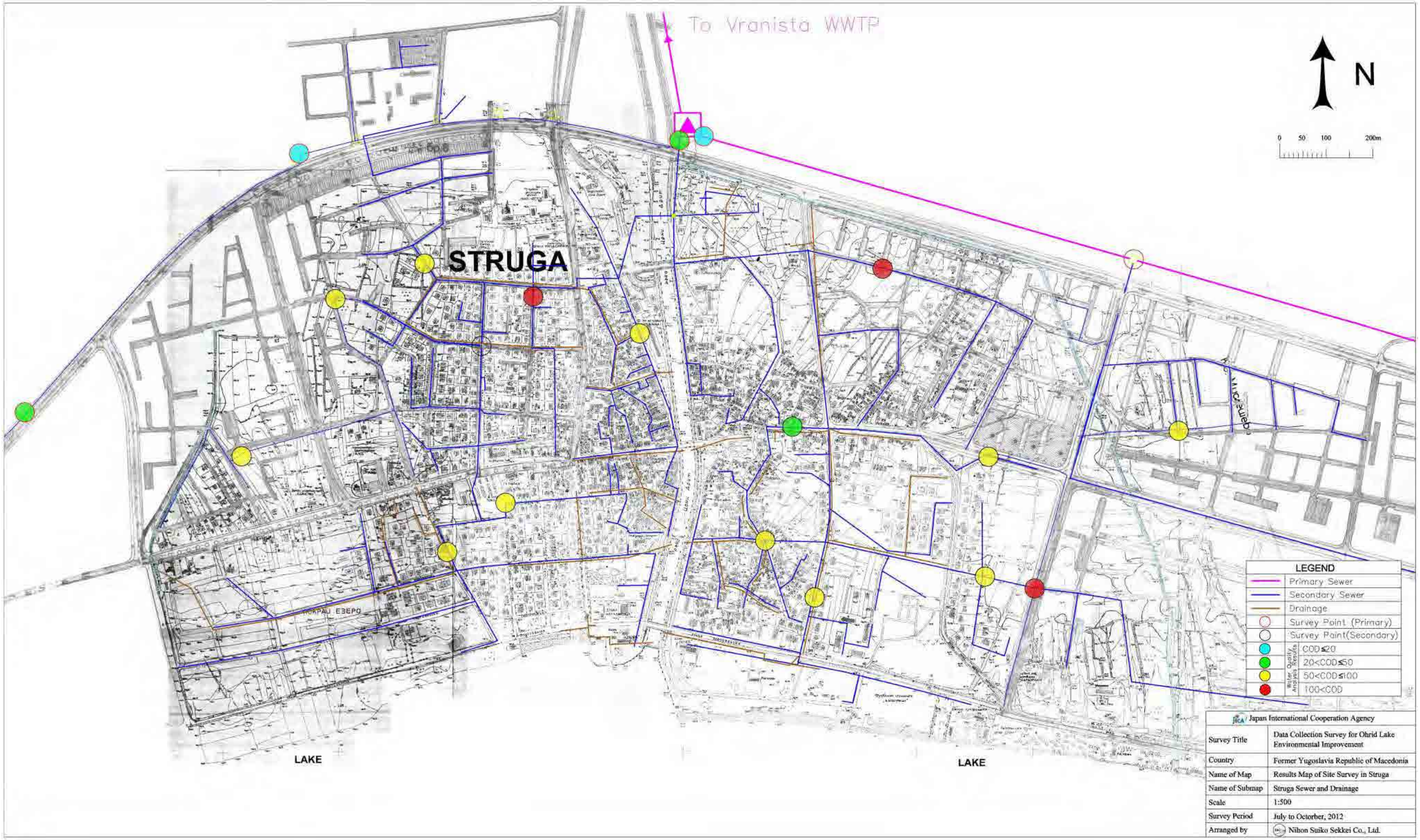
- Higher COD (Red/Yellow points) means the water is not significantly diluted; the major component is from wastewater.
- Lower COD (Green/Blue points) means the water is diluted; much groundwater / storm water / lake water is mixed with the wastewater.

From the results of visual surveillance and the water quality analysis, the correlations between the damaged / defective sewer points and diluted water section are not significant; there are some points which have damaged sewer in Struga, but the points don't show the diluted water results.
Moreover, the correlations between the water level in the sewer and the water analysis are not significant either.

Unfortunately, JICA Study Team could not determine the exact points of the infiltration of unidentified water, but JICA Study Team presumes the areas affected by groundwater / storm water / lake water based on the results of the analysis.
The sampling points and the results of the water quality analysis are shown on the map in the following pages:

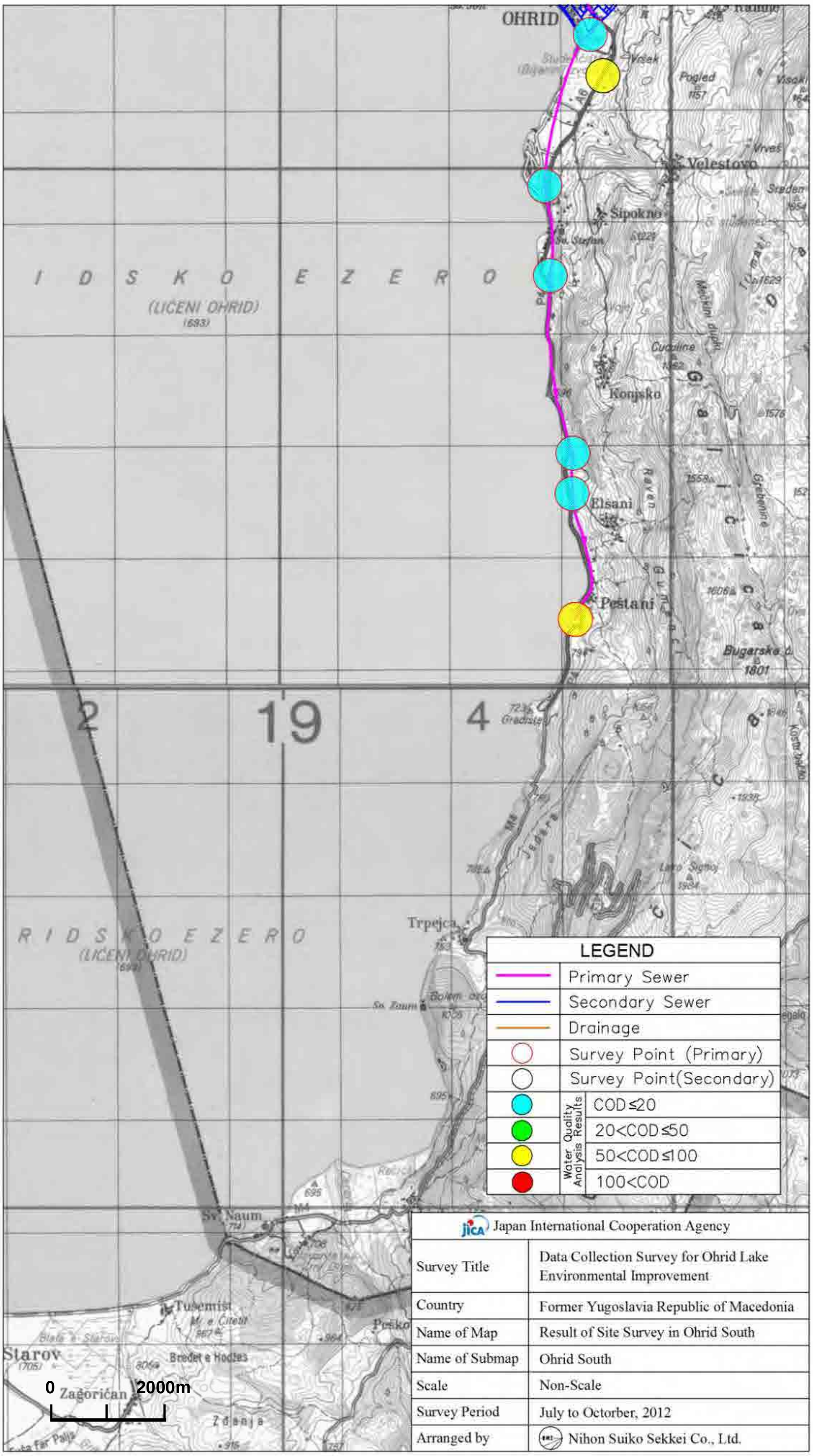
Source: JICA Study Team

Figure 2.43 Results of Water Quality Analysis (Ohrid)



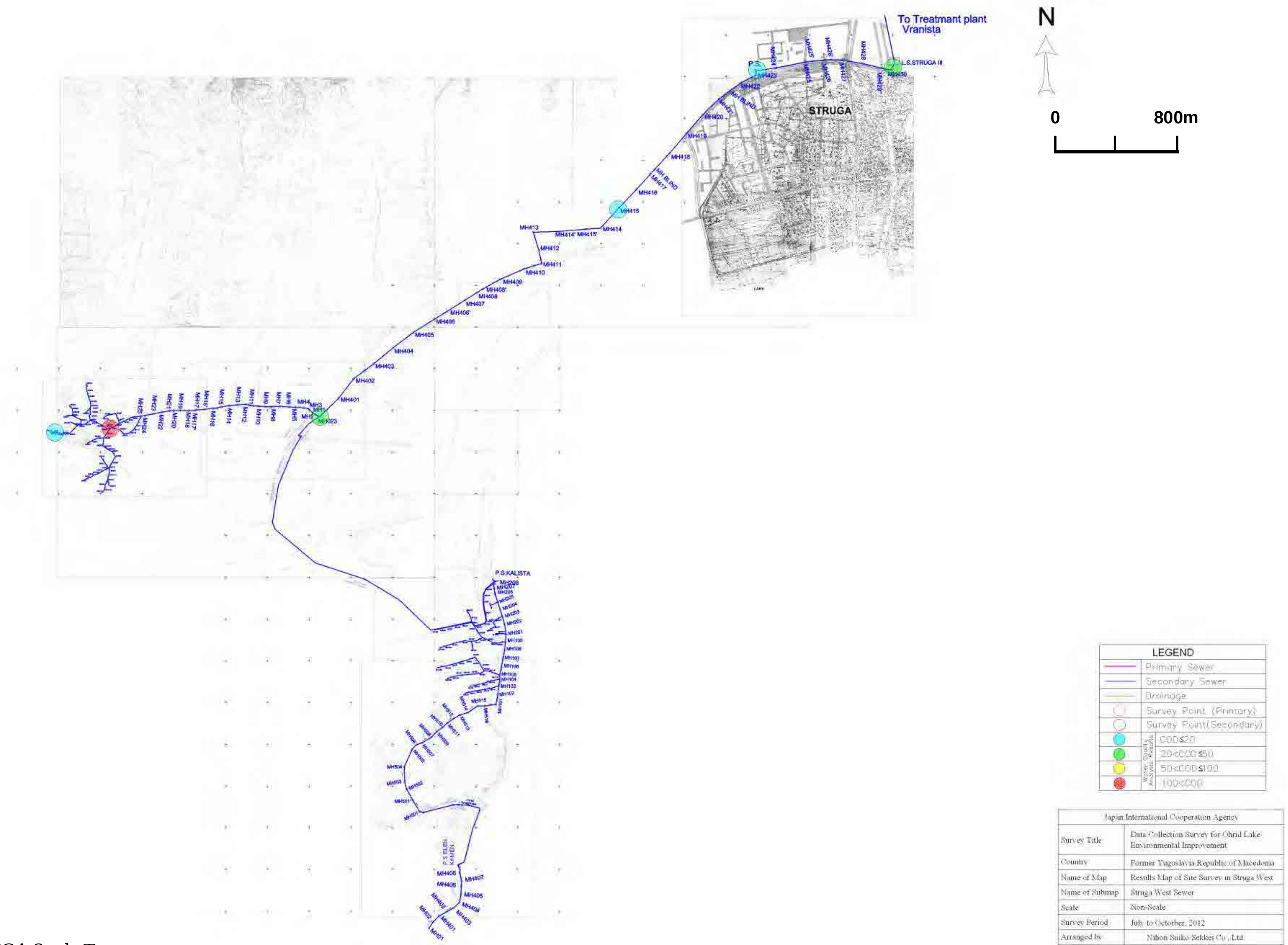
Source: JICA Study Team

Figure 2.44 Results of Water Quality Analysis (Struga)



Source: JICA Study Team

Figure 2.45 Results of Water Quality Analysis (Ohrid-South)



Source: JICA Study Team

Figure 2.46 Results of Water Quality Analysis (Struga-West)

1) Ohrid City

From the maps with the analysis results shown above, there are many blue and green points in Ohrid, while yellow and red points dominate on the Struga side; the sampling waters from the secondary sewer in Ohrid generally have lower COD concentrations than those on the Struga side.

The water quality in the primary sewer in Ohrid is relatively lower and the water level in the sewer is high from the results of visual surveillance. This result means that the water in the primary sewer in Ohrid is diluted and has much unidentified water.

2) Struga City

On the Struga side, the water qualities of the samplings are generally bad; it means that the water in the sewer is not diluted very much. The sewer condition in Struga city is relatively better than that in Ohrid.

3) Ohrid South Region

As for the Ohrid South region, COD concentrations in the primary sewers (along the coast of the lake) are relatively low (COD < 20 mg/L). It could be presumed that the primary sewers in this region are affected by lake water, and that the wastewater is diluted.

On the other hand, the secondary sewers in the Ohrid South region have high COD value, so it means that the sewers are not significantly affected by the unidentified water. The reason is presumed that the scale of the secondary sewer in this region is small and the relatively newly constructed, so the sewer connection is tighter than the older sewer.

4) Struga West Region

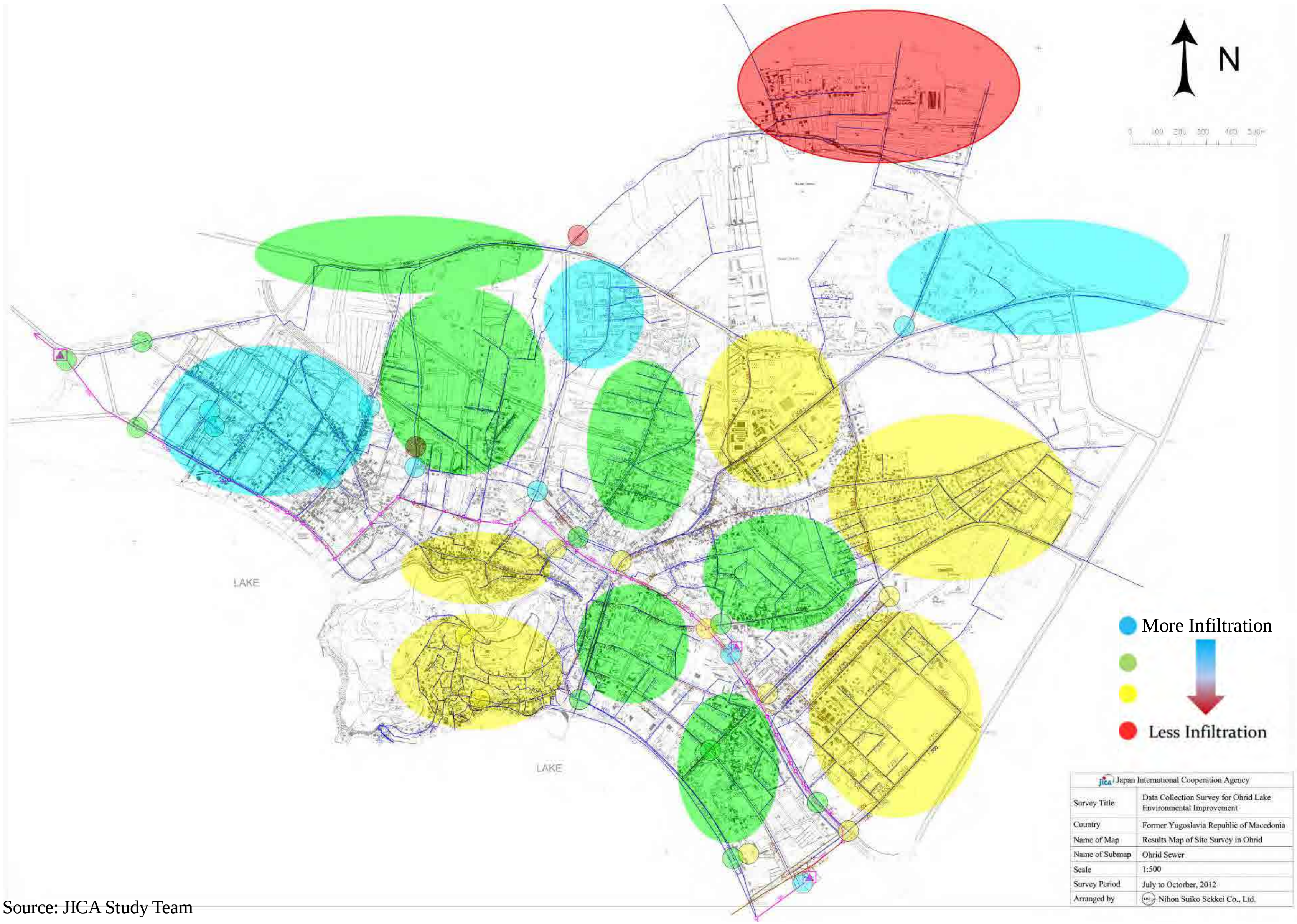
As for the Struga West region, the uppermost stream point (ST-01) of this network (in Radolista commune) shows a low COD concentration. This means that the water is not wastewater from houses themselves because the uppermost stream point is not connected to the houses yet, and the water might originate from the spring water in the vicinity.

The second uppermost stream point (ST-02: the center of Radolista commune) shows a relatively high COD concentration (COD > 100 mg/L), but the concentrations decline as it goes gradually downstream. This pipe network has few connections along this line, so the groundwater could have infiltrated this primary sewer.

Based on the results of the water quality analysis of each of the sampling points, JICA Study Team presumed the level of unidentified water infiltration volume for each sub-area. The criteria to presume for the level of water infiltration are shown below:

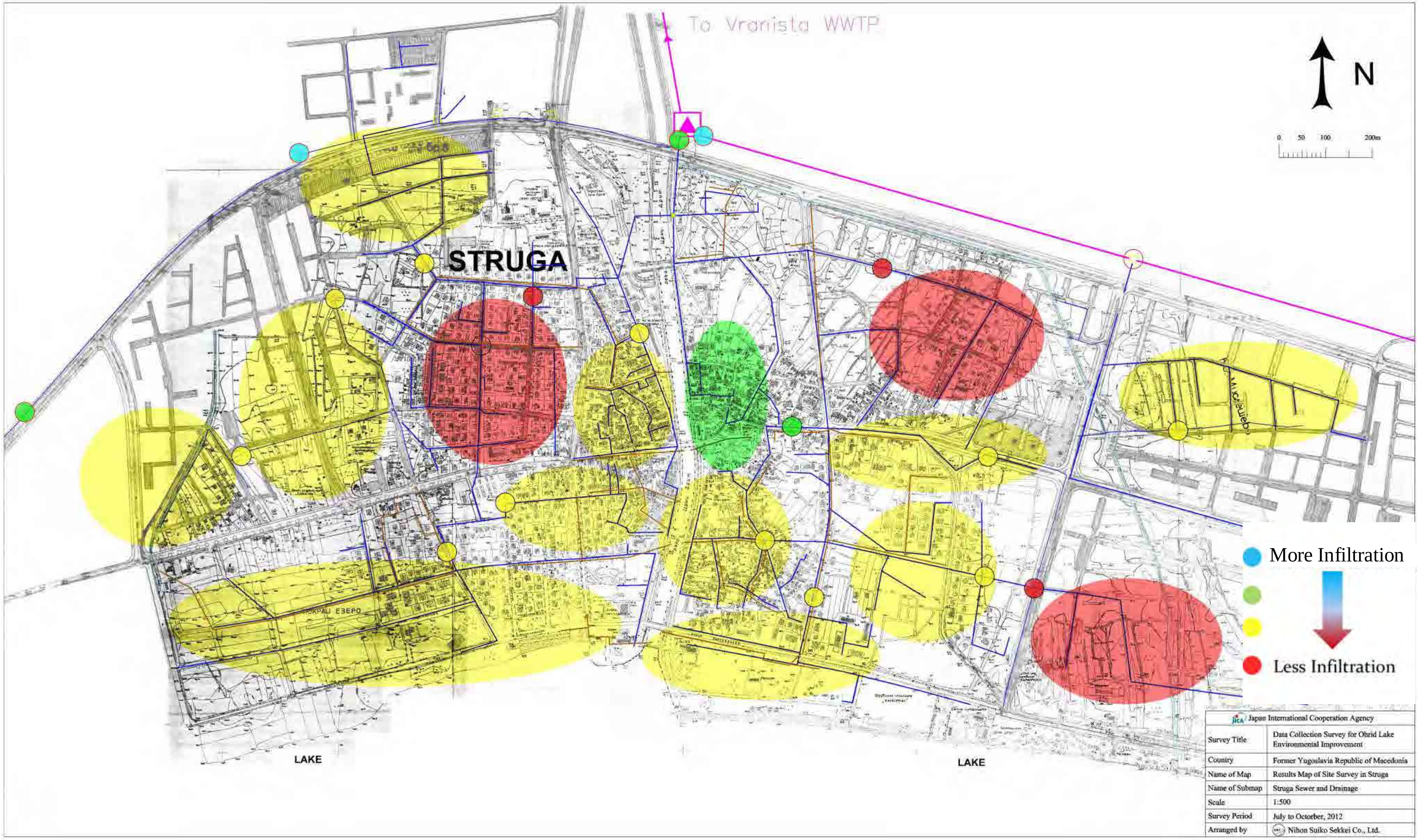
- Higher COD area (Red/Yellow hatched area) means that the sub-area is less affected by the unidentified water (ground water, storm water, lake water, etc.); the pipe network in this area would be in good condition.
- Lower COD area (Green/Blue hatched area) means that the sub-area is considerably affected by the unidentified water; the pipe network in this area might be in poor condition and infiltrated by unidentified water.

The presumed results for the level of unidentified water infiltration are shown on the map in the following pages.



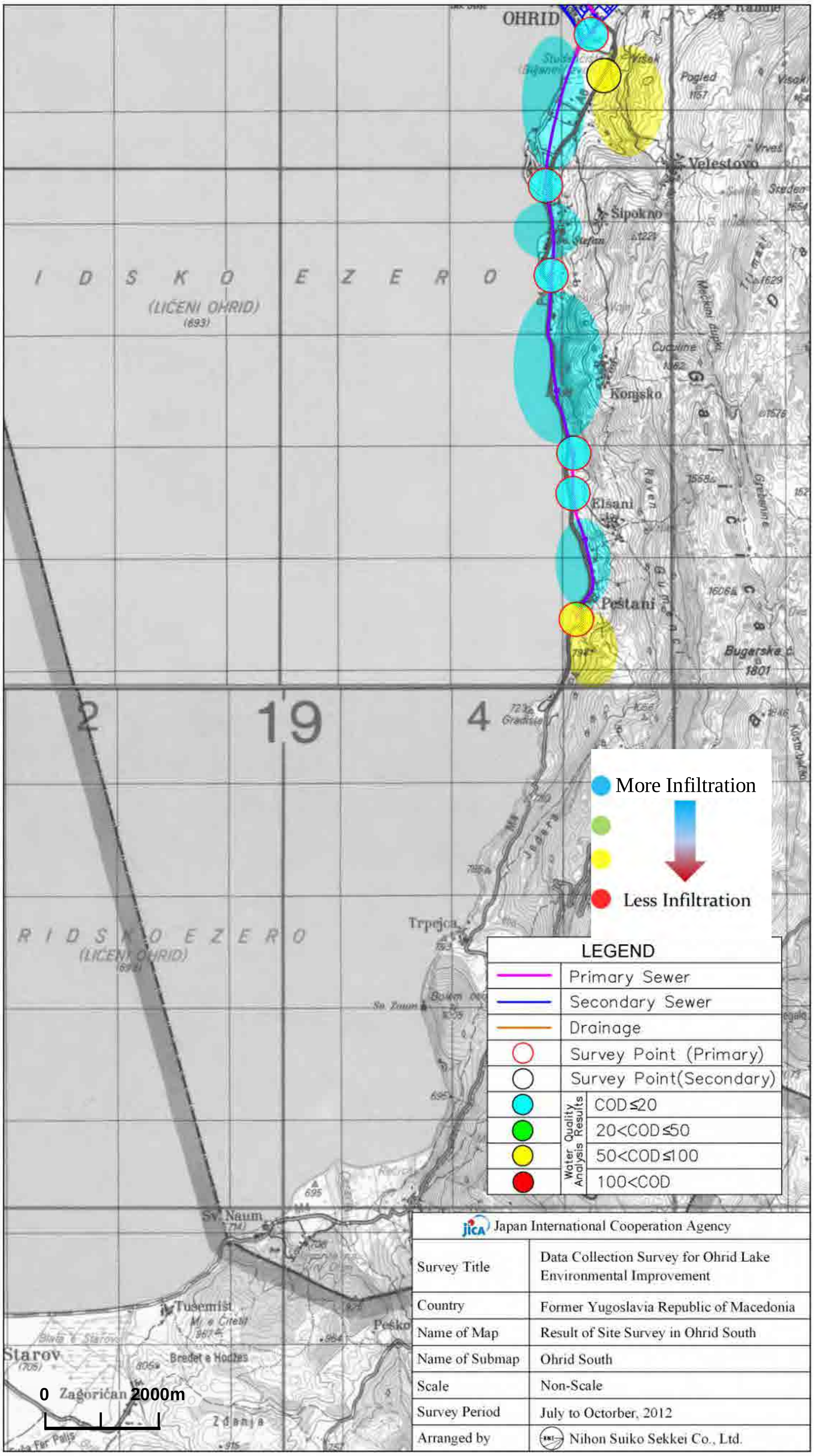
Source: JICA Study Team

Figure 2.47 Level of Unidentified Water (Ohrid)



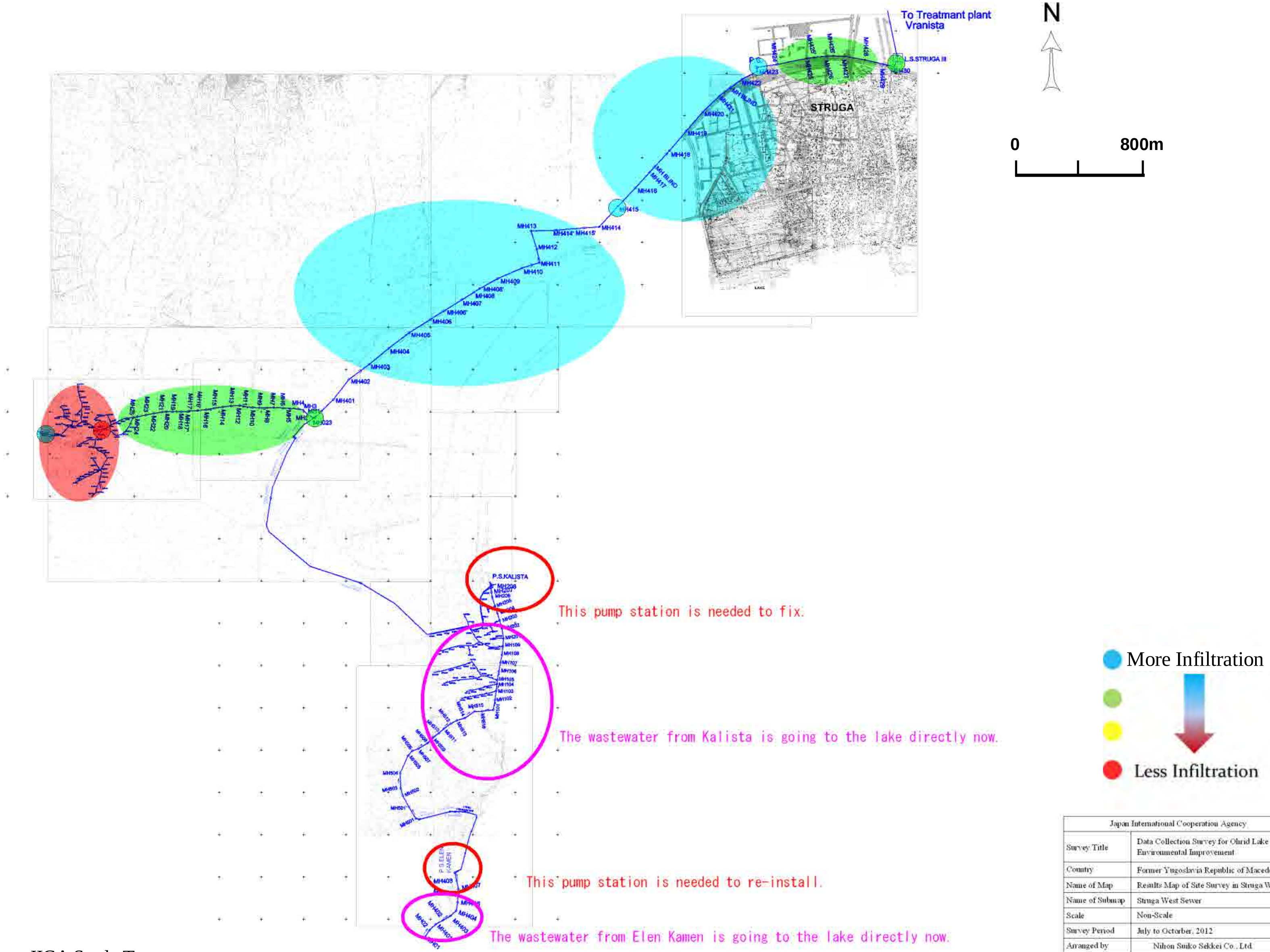
Source: JICA Study Team

Figure 2.48 Level of Unidentified Water (Struga)



Source: JICA Study Team

Figure 2.49 Level of Unidentified Water (Ohrid-South)



Japan International Cooperation Agency	
Survey Title	Data Collection Survey for Ohrid Lake Environmental Improvement
Country	Former Yugoslavia Republic of Macedonia
Name of Map	Results Map of Site Survey in Struga West
Name of Submap	Struga West Sewer
Scale	Non-Scale
Survey Period	July to October, 2012
Arranged by	Nihon Suiko Sekkei Co., Ltd.

Source: JICA Study Team

Figure 2.50 Level of Unidentified Water (Struga-West)

From the maps with the level of unidentified water shown above, JICA Study Team can see that there are many blue and green areas in Ohrid, and while yellow and red points dominate on the Struga side; the infiltration volume of unidentified water in Ohrid generally exceeds that on the Struga side. This means that the sewer network in Ohrid might have an extensive damaged/defective portion, meaning more detailed inspection and rehabilitation works to prevent infiltration are needed in Ohrid than in Struga.

The greater dilutions of the water in Ohrid than that in Struga could be attributable to the primary sewer pipe being located nearer the lake shore in Ohrid City, whereas the primary sewer is at the edge of the north side and far from the shore. Therefore, the primary sewer pipe is affected by the lake water and diluted more in the Ohrid sewer.
Based on this hypothesis, the nearer the lakeshore where the primary sewer is located, the more urgent the inspections and rehabilitation work that may be required.

As for the Ohrid South region, it could be presumed that the primary sewers here are affected by lake water, so more detailed inspections and rehabilitation works to prevent infiltration are needed.

As for the Struga West region, since the pipe network could be infiltrated with unidentified water, more detailed inspections and rehabilitation works to prevent infiltration are needed.

The method of analyzing water quality to find infiltration points is very simple – requiring only a simplified water quality analysis kit and bottles to take samples. However, the survey process is very simple to imitate, and the results are clear to understand. During this survey, JICA Study Team included only 70 points due to limited time, but more locations should have been included to ensure a specific area for rehabilitation.
JICA Study Team proposes that PROAQUA should conduct the same survey at more points all year round and accumulates the data for a more comprehensive understanding of network damage / failures.

Moreover, as mentioned in Chapter 2.2, since the Elen Kamen and Kalista pump stations are currently out of order, the wastewater from each region is going to the lake directly without any treatment. This pumping equipment must thus be re-installed / fixed to restart operations as soon as possible.

2.5 Pollutant Load to Ohrid Lake

The pollutant load, which affects the environmental impact, is estimated by calculating the sewerage-served population, the number of tourists and the unit pollutant load (represented as BOD) to evaluate the effectiveness of the proposed project in terms of the overall contribution to protecting the environment of Ohrid Lake.

2.5.1 Population

(1) Domestic Population

The domestic population is identified based on the following methodology:

- The target year was set as 2010 to represent current circumstances
- The total population was projected using a growth rate of 0.4%/year, as quoted from the feasibility study on rural wastewater treatment in the Ohrid region prepared by the Center for Development of the Southwest Planning Region in 2011
- Subsidized population, which represents the current sewerage-served (prepared) population by considering the actual coverage of the sewerage system in the use of the current area supplied with water provided by PROAQUA

Table 2.30 Projection of Domestic Population

No.	City	City / Commune	Existing	Projection				
			2000	2005	2010	2015	2020	2025
1	Ohrid	Ohrid	42,705	43,566	44,444	45,340	46,254	47,187
2	Ohrid	Ljubanista	482	492	502	512	522	533
3	Ohrid	Trpejca	368	375	383	391	399	407
4	Ohrid	Pestani	1,400	1,428	1,457	1,486	1,516	1,547
5	Ohrid	Elsani, Elesec Lagadin	674	688	702	716	730	745
6	Ohrid	Konjsko, Dolno Konjsko, Istok	590	602	614	626	639	652
7	Ohrid	Sipokno, St. Stefan	212	216	220	224	229	234
8	Ohrid	Velestovo, Raca	435	444	453	462	471	480
9	Ohrid	Ramne	20	20	20	20	20	20
10	Ohrid	Velgosti	2,241	2,286	2,332	2,379	2,427	2,476
11	Ohrid	Leskoec	2,668	2,722	2,777	2,833	2,890	2,948
12	Ohrid	Orman	130	133	136	139	142	145
13	Ohrid	G. Lakocerej	582	594	606	618	630	643
14	Ohrid	D. Lakocerej	646	659	672	686	700	714
15	Ohrid	Kosel	657	670	684	698	712	726
16	Ohrid	Podmolje	282	288	294	300	306	312
17	Ohrid	Orovnik	489	499	509	519	529	540
18	Ohrid	Gorenci	390	398	406	414	422	431
19	Ohrid	Trebenista	589	601	613	625	638	651
20	Struga	Struga	17,000	17,343	17,693	18,050	18,414	18,785
21	Struga	Mislesevo	3,246	3,311	3,378	3,446	3,515	3,586
22	Struga	Moroista	937	956	975	995	1,015	1,035
23	Struga	Volino	540	551	562	573	585	597
24	Struga	Livada	1,424	1,453	1,482	1,512	1,542	1,573
25	Struga	Draslajca	810	826	843	860	877	895
26	Struga	Bidzovo	470	479	489	499	509	519
27	Struga	Novo Selo	230	235	240	245	250	255
28	Struga	Lozani	760	775	791	807	823	840
29	Struga	Vranista	1,540	1,571	1,603	1,635	1,668	1,702
30	Struga	D. Belica	950	969	989	1,009	1,029	1,050
31	Struga	Velesta	5,370	5,478	5,588	5,701	5,816	5,933
32	Struga	Visni	25	26	27	28	29	30
33	Struga	Sum. Zagracani	2,000	2,040	2,081	2,123	2,166	2,210
34	Struga	Radolista	2,930	2,989	3,049	3,110	3,173	3,237
35	Struga	Kalista	1,000	1,020	1,041	1,062	1,083	1,105
36	Struga	Frangovo	1,660	1,693	1,727	1,762	1,798	1,834
37	Struga	Radozda	850	867	884	902	920	939
38	Struga	Oktisi	3,200	3,265	3,331	3,398	3,467	3,537
39	Struga	Mali Vlaj	160	163	166	169	172	175
	Sub-Total (Ohrid)		55,560	56,681	57,824	58,988	60,176	61,391
	Sub-Total (Struga)		45,102	46,010	46,939	47,886	48,851	49,837
	Total		100,662	102,691	104,763	106,874	109,027	111,228

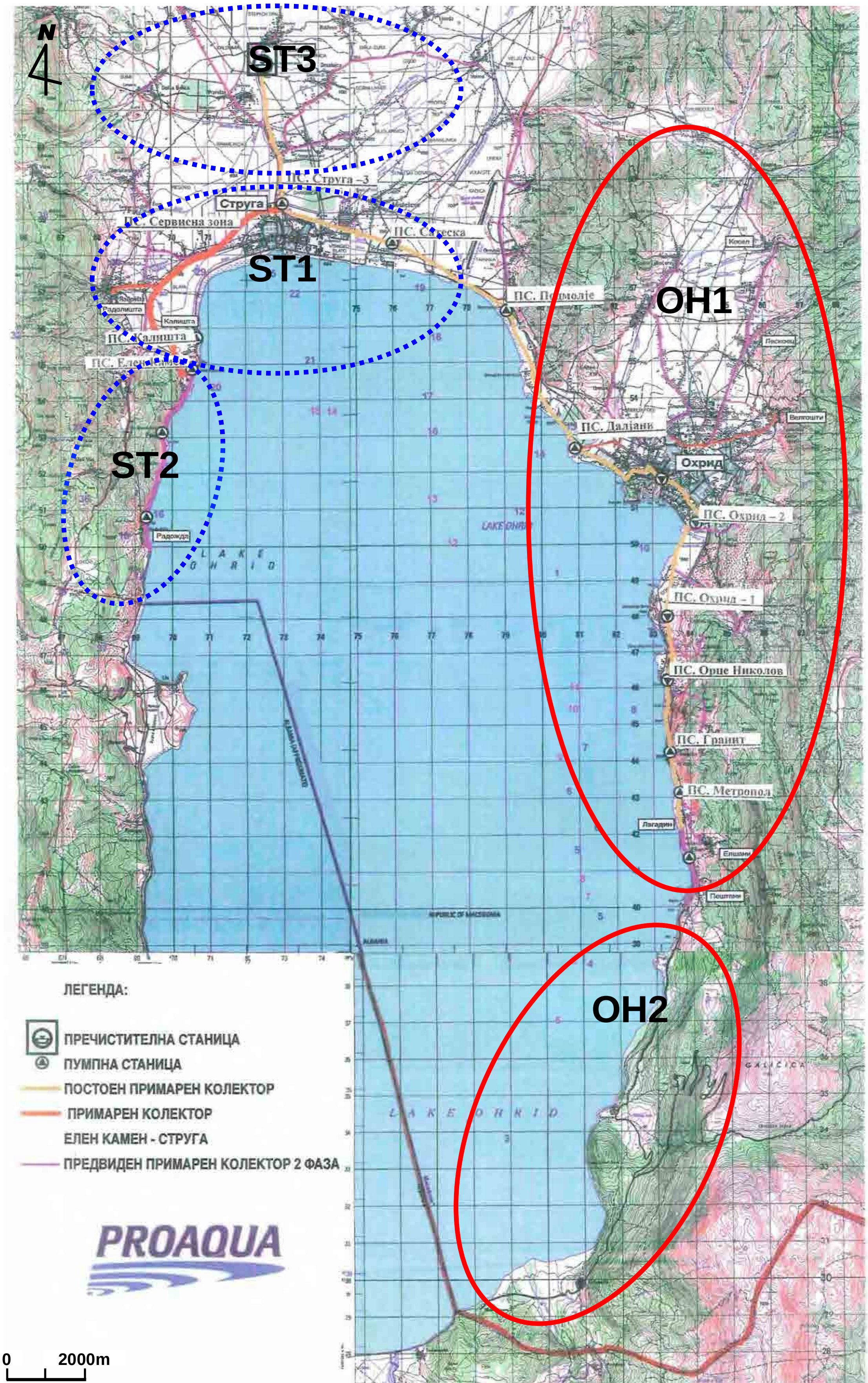
* Future projections are calculated by the JICA Study Team (based on a yearly growth rate of 0.4%)

Source: Conceptual Plan Report, Ohrid and Struga Sewerage Project (Existing Data as of 2000)

Before the distributing sewerage-served population, zoning is determined based on the current coverage of the

sewerage system and the topographical characteristics of the entire area.
Zones are divided by characteristics as shown below:

- OH1: Current center of Ohrid and established area with primary system toward the South, plus an uncovered area in the northern part
- OH2: Uncovered by a sewerage system to the south of Ohrid containing Trepejca, Ljubanista, St. Naum, etc.
- ST1: Current center of Struga and neighboring communes where the wastewater pours into the lake
- ST2: Southern Struga, including Radozda, and Elen Kamen, Kalista, etc.
- ST3: Northern Struga, where the wastewater flows downstream into the Black Drim River, not having a direct impact on the Lake



Source: JICA Study Team

Figure 2.51 Zoning

Table 2.31 Summary of Zoning

Zoning	City	City / Commune	Remarks
OH1	Ohrid	Ohrid, Pestani, Elsani, Elesec Lagadin, Konjsko, Dolno Konjsko, Istok, Sipokno, St. Stefan, Velestovo, Raca, Ramne, Velgosti, Leskoec, Orman, G. Lakocerej, D. Lakocerej, Kosel, Podmolje, Orovnik, Gorenci, Trebenista	Containing central part of the city and surrounding communes streatched southwarad along the lake. Primary sewer system was installed along the lake side
OH2	Ohrid	Ljubanista, Trpejca	Southernmost area of Ohrid Municipality isolated by hilly topography
ST1	Struga	Struga, Mislesevo, Visni, Sum. Zagracani, Radolista	Containing central part of the city and surrounding communes
ST2	Struga	Kalista, Frangovo, Radozda, Mali Vlaj	Southernmost area of Struga containing recently extended sewerage system but out of function
ST3	Struga	Moroista, Volino, Livada, Draslajca, Bidzovo, Novo Selo, Lozani, Vranista, D. Belica, Velesta, Oktisi	North part of Struga and naturally these communes discharge toward Black Drim River

Source: JICA Study Team

Secondly, currently served population of sewerage system was assumed based on the information provided by PROAQUA and Niskogradba based on their sewerage area and installed sewer network. Ratios for served population were given by roughly to grasp frame of pollutant load.
Current total population was projected using KfW's current existing population which was listed in 2000 and population growth was applied at 0.4% per year according to the opinions from municipality offices and the Feasibility Study of the Sewerage Development done by Center for Southwest Planning Region, and the new values were set for 2010.

Table 2.32 Distribution of the Sewerage-Served Population (2010)

No.	City	City / Commune	Total Population	Sewerage		Sewerage-Served Population (2010)		Zoning
			2010	Served Area	Ratio (%)	Served	Unserved	
1	Ohrid	Ohrid	44,444	x	100%	44,444	0	OH1
2	Ohrid	Ljubanista	502		0%	0	502	OH2
3	Ohrid	Trpejca	383		0%	0	383	OH2
4	Ohrid	Pestani	1,457	x	30%	437	1,020	OH1
5	Ohrid	Elsani, Elesec Lagadin	702	x	30%	211	491	OH1
6	Ohrid	Konjsko, Dolno Konjsko, Istok	614	x	30%	184	430	OH1
7	Ohrid	Sipokno, St. Stefan	220		0%	0	220	OH1
8	Ohrid	Velestovo, Raca	453	x	50%	227	226	OH1
9	Ohrid	Ramne	20		0%	0	20	OH1
10	Ohrid	Velgosti	2,332	x	30%	700	1,632	OH1
11	Ohrid	Leskoec	2,777	x	30%	833	1,944	OH1
12	Ohrid	Orman	136		0%	0	136	OH1
13	Ohrid	G. Lakocerej	606		0%	0	606	OH1
14	Ohrid	D. Lakocerej	672		0%	0	672	OH1
15	Ohrid	Kosel	684		0%	0	684	OH1
16	Ohrid	Podmolje	294	x	30%	88	206	OH1

No.	City	City / Commune	Total Population	Sewerage		Sewerage-Served Population (2010)		Zoning
			2010	Served Area	Ratio (%)	Served	Unserved	
17	Ohrid	Orovnik	509		0%	0	509	OH1
18	Ohrid	Gorenci	406		0%	0	406	OH1
19	Ohrid	Trebenista	613		0%	0	613	OH1
20	Struga	Struga	17,693	x	100%	17,693	0	ST1
21	Struga	Mislesevo	3,378		0%	0	3,378	ST1
22	Struga	Moroista	975		0%	0	975	ST3
23	Struga	Volino	562		0%	0	562	ST3
24	Struga	Livada	1,482		0%	0	1,482	ST3
25	Struga	Draslajca	843		0%	0	843	ST3
26	Struga	Bidzovo	489		0%	0	489	ST3
27	Struga	Novo Selo	240		0%	0	240	ST3
28	Struga	Lozani	791		0%	0	791	ST3
29	Struga	Vranista	1,603		0%	0	1,603	ST3
30	Struga	D. Belica	989		0%	0	989	ST3
31	Struga	Velesta	5,588		0%	0	5,588	ST3
32	Struga	Visni	27		0%	0	27	ST1
33	Struga	Sum. Zagracani	2,081		0%	0	2,081	ST1
34	Struga	Radolista	3,049	x	100%	3,049	0	ST1
35	Struga	Kalista	1,041	x	20%	208	833	ST2
36	Struga	Frangovo	1,727		0%	0	1,727	ST2
37	Struga	Radozda	884		0%	0	884	ST2
38	Struga	Oktisi	3,331		0%	0	3,331	ST3
39	Struga	Mali Vlaj	166		0%	0	166	ST2
	Sub-Total (Ohrid)		57,824		81%	47,124	10,700	
	Sub-Total (Struga)		46,939		45%	20,950	25,989	
	Total		104,763		65%	68,074	36,689	

* Future projections are calculated by the JICA Study Team (based on a yearly growth rate of 0.4%)

Source: Conceptual Plan Report, Ohrid and Struga Sewerage Project (Existing Data as of 2000)

The estimated sewerage-served population represents the population for which primary and secondary sewers have already been installed in the area and includes that currently unconnected to the sewerage system.

(2) Tourist Population

The tourist population is identified based on the following methodology:

- The target year was set in 2010 to represent current circumstances
- The current tourist population is calculated by the monthly distribution of tourists in Ohrid Lake, which was studied via a feasibility study on rural wastewater treatment in the Ohrid region, prepared by the Center for Development of the Southwest Planning Region in 2011
- The total tourist population was distributed using the preliminary design document from PROAQUA under the KfW project in 2001 and the overall population calculated by the procedure above
- The subsidized population, which represents the current sewerage-served (prepared) population by considering the actual coverage of the sewerage system in the use of the current water supplied area provided by PROAQUA, and Zoning was considered to be the same as the domestic population

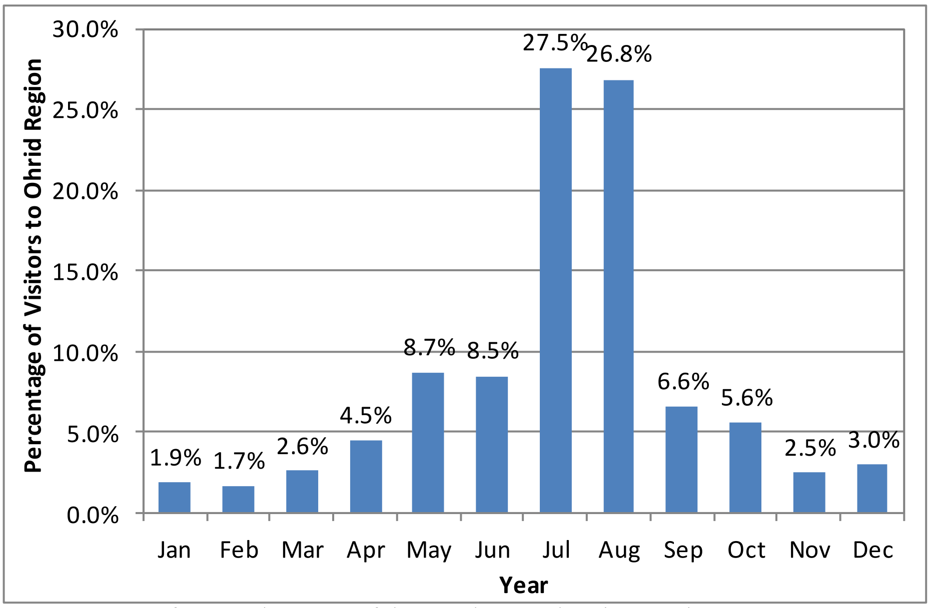
1) Existing Data on Tourists to the Ohrid Region

Existing data on the distribution of the current tourist population included a feasibility study on rural wastewater treatment in the Ohrid region, more than 50% of the total tourists visit Ohrid Lake during the summer period and the figure peaks at 27.5% in July, as calculated from existing statistical data.

Table 2.33 Distribution of Monthly Tourists to Ohrid Lake

Month	Ratio
January	1.9%
February	1.7%
March	2.6%
April	4.5%
May	8.7%
June	8.5%
July	27.5%
August	26.8%
September	6.6%
October	5.6%
November	2.5%
December	3.0%
Total	100.0%

Source: Center for Development of the Southwest Planning Region



Source: Center for Development of the Southwest Planning Region

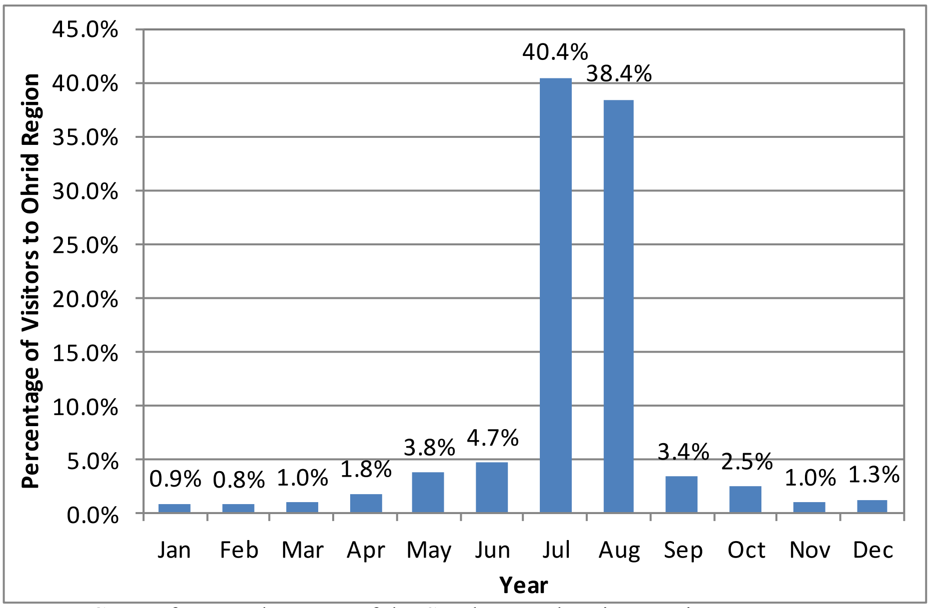
Figure 2.52 Distribution of Monthly Tourists to Ohrid Lake

In this study, the ratio of overnight visitors of overall tourists to Ohrid Lake was also calculated using existing turnouts of tourists visiting the region. The data shows that nearly 80% of tourists stay during the summer period. This means most tourists stay overnight for summer holidays and this data collection survey treats all the tourist turnouts recorded in the summer period (July and August) as simply overnight visitors staying in the Ohrid region.

Table 2.34 Distribution of Overnight Visitors to Ohrid Lake

Month	Ratio
January	0.9%
February	0.8%
March	1.0%
April	1.8%
May	3.8%
June	4.7%
July	40.4%
August	38.4%
September	3.4%
October	2.5%
November	1.0%
December	1.3%
Total	100.0%

Source: Center for Development of the Southwest Planning Region



Source: Center for Development of the Southwest Planning Region

Figure 2.53 Distribution of Overnight Visitors to Ohrid Lake

2) Peak Factor

To evaluate the current status of pollutant load to the public bodies, the peak tourist population should be identified. The survey summarized typical holidays, which include weekends (Saturday and Sunday), Macedonian public holidays and typical holiday terms for summer and winter vacations. The peak factor represents peak turnouts on holiday and the survey calculates this factor by splitting days of months by days of holidays, so that the likely trend can be expressed in terms of general visitors visiting there during holidays. For the summer period in July and August in particular, entire days are allotted for holidays with typical vacations in mind.

Table 2.35 Peak Factor for Daily Tourist Population

Month	Days of Month	Weekend/ Holiday	Peak Factor	Remarks
	(1)	(2)	(3)=(1)/(2)	
January	30	12	2.5	Winter Vacation
February	28	8	3.5	
March	31	9	3.4	
April	30	9	3.3	
May	31	11	2.8	
June	30	8	3.8	
July	31	31	1.0	Summer Vacation
August	31	31	1.0	Summer Vacation
September	30	9	3.3	
October	31	11	2.8	
November	30	8	3.8	
December	31	13	2.4	Winter Vacation

Source: JICA Study Team

3) Yearly Tourists

The reference for yearly tourists is taken from the feasibility study by the Center for Development of the Southwest Planning Region by 2010, and future trend is given at 0.5 % of growth rate per year and the population was projected by 2025 for reference. The yearly tourist record in 2010 is approximately 156,300.

Table 2.36 Yearly Tourists to the Ohrid Region

Unit: People

Item	2000	2005	2010	2015	2020	2025
Yearly Tourists	215,000	50,000	156,300	160,200	164,200	168,300

* Growth Rate: 0.5%/year is applied for future projections after 2010 by the JICA Study Team

Source: Center for Development of the Southwest Planning Region

4) Calculation of Tourist Population

To estimate load, the peak tourist population was used on a year-round basis. The survey identified the days spent at each individual tourist location so that the maximum population could be expressed by considering the overlap of visitors. Moreover, the survey applied 10 days of stay for the summer period during July and August considering this to be the typical length of stay of a summer vacation.
The overall tourist population was identified by the following procedures:

- Daily tourists were identified from the monthly totals,
- Daily total tourists were calculated by multiplying the daily tourists by the days of stay
- The overall tourist population was determined by multiplying the total tourists with the peak factor identified from the typical number of holidays.

For the peak condition, the July population was chosen and distributed into a breakdown of tourism functions in the region. The population under peak condition of 13,880 was less than half the projection prepared for the preliminary design in the KfW project, but a more reasonable value using recent actual data.

Table 2.37 Overall Tourist Population in the Ohrid Region (2010)

Unit: People

Month	Tourists		Days of	Total	Peak	Tourist
	Monthly	Daily	Stay	Tourists	Factor	Population
	(1)	(2)	(3)	(4)=(2)x(3)	(5)	(6)=(4)x(5)
January	2,973	99	5	495	2.5	1,238
February	2,660	95	2	190	3.5	665
March	4,068	131	2	262	3.4	891
April	7,041	235	2	470	3.3	1,551
May	13,612	439	2	878	2.8	2,458
June	13,299	443	2	886	3.8	3,367
July	43,025	1,388	10	13,880	1.0	13,880
August	41,929	1,353	10	13,530	1.0	13,530
September	10,326	344	2	688	3.3	2,270
October	8,762	283	2	566	2.8	1,585
November	3,911	130	2	260	3.8	988
December	4,694	151	5	755	2.4	1,812
Total	156,300	5,091	-	-	-	-
Average	13,025	424	-	2,738	2.8	3,686
Maximum	43,025	1,388	-	13,880	3.8	13,880
Minimum	2,660	95	-	190	1.0	665

Source: JICA Study Team

Table 2.38 Comparison of Tourist Populations

Unit: People

Item	2000	2005	2010	2015	2020	2025
Design Report (2001, KfW Project)	22,285	26,255	33,165	35,515	38,105	40,050
This Survey	19,092	4,440	13,880	14,226	14,581	14,945

Source: JICA Study Team

Like the domestic population, the tourist population was calculated by considering the actual sewerage-served area. The individual capacities of tourism sites were calculated using the distribution in the capacity of tourists, which were identified in KfW's preliminary design by distributing the tourist population identified by the survey.

Table 2.39 Distribution of Sewerage-Served Tourist Population

No.	City	Tourist Function	Total Population 2010	Sewerage Served Area	Sewerage Ratio (%)	Sewerage-Served Population (2010) Served	Sewerage-Served Population (2010) Unserved	Zoning
1	Ohrid	St. Naum, Campsite	458	x	100%	458	0	OH2
2	Ohrid	St. Naum	55		0%	0	55	OH2
3	Ohrid	Ljubanista, Campsite	1,815		0%	0	1,815	OH2
4	Ohrid	Ljubanista Pole	316		0%	0	316	OH2
5	Ohrid	Gradiste, Campsite	2,368		0%	0	2,368	OH2
6	Ohrid	Desaret	422	x	100%	422	0	OH1
7	Ohrid	Lagadin-Pestani, Campsite	79	x	100%	79	0	OH1
8	Ohrid	Elesac, Campsite	631	x	100%	631	0	OH1
9	Ohrid	St. Stephan	3,078	x	100%	3,075	0	OH1
10	Ohrid	Gorica-Istok	16	x	100%	16	0	OH1
11	Ohrid	Gorica-Sever	63	x	100%	63	0	OH1
12	Ohrid	Spec. Hospital Ortopedija	395		0%	0	395	OH1
13	Ohrid	AS, Campsite	158		0%	0	158	OH1
14	Struga	Andon Dukov	1,579		0%	0	1,579	ST1
15	Struga	Ezerski Lozja	316		0%	0	316	ST1
16	Struga	Kalista	774	x	100%	774	0	ST2
17	Struga	Livadista, Campsite	868	x	100%	868	0	ST2
18	Struga	Elen Kamen	95	x	100%	95	0	ST2
19	Struga	Radozda	395	x	100%	395	0	ST2
	Sub-Total (Ohrid)		12,359	9,855		4,744	5,108	
	Sub-Total (Struga)		5,049	4,025		2,132	1,896	
	Total		17,408	13,880		6,876	7,004	

* Including private treatment facilities in the Ljubanista army camp and Radozda

Source: Conceptual Plan Report, Ohrid and Struga Sewerage Project (Existing Data as of 2000)

The estimated sewerage-served tourist population represents the population for which primary and secondary sewers have already been installed in the area and includes that currently unconnected to the sewerage system.

2.5.2 Unit Load

(1) Unit BOD load

Unit load was identified from a review of the existing design criteria of the WWTP and determined at 60 gpcd (gram per capita day) as the typical pollutant load represented by BOD.
As for industrial activity, mainly commercial wastewater arising from daily merchandise was considered at 15% of domestic load determined by JICA Study Team.

The unit load for tourists was set with a value equivalent to the domestic load because overnight visitors were almost similar in terms of generation of pollutant load as domestic patterns.

Table 2.40 Unit BOD Load

Item	Type	Unit	Value
BOD	Domestic	gpcd	60
	Industry	gpcd	9
	Tourist	gpcd	60

* gpcd: gram per capita day
* Industry was assumed at 15% of Domestic by JICA Study Team
Source: PROAQUA

(2) Removal Ratio by Wastewater Treatment

When the generated load is discharged into environmental bodies, it has usually been subject to some sort of water treatment processes (including pre-treatment like septic tanks) to reduce pollutant loads before it reaches the Lake. In this survey, the removal ratio of the Vranista WWTP was assumed at 90% based on the actual performance of averaged removal ratio in BOD between 2005 and 2010. For the households and utilities outside the sewerage area, the removal ratio of septic tanks is applied at 30% based on the typical practice (also coinciding with the primary treatment process (gravity sedimentation) in WWTP). The value of the removal ratio at 30% was given by applying the lower value of the range, based on the typical removal ratio of septic systems ranging between 30 and 50% in consideration of the poorer conditions of actual usage of some septic systems.

Table 2.41 Removal Ratio

Item	Unit	Value	Remarks
Sewerage System	%	90	
Pre-Treatment	%	30	Using Septic Tank

Source: JICA Study Team

The use of septic tanks is mandatory among the communities which haven't introduced sewerage system in the country. The typical septic tanks in Macedonia treat both of domestic wastewater from kitchens and wastewater from toilets. During the use of septic tanks, generated sludge is requested to be pulled and disposed regularly, and usually public enterprises including PROAQUA and other waste haulers will remove them from households and damp them at landfill site. The frequency of typical disposal of the sludge is desirably every six months to a year, but actually managements are not ideally conducted, according to the interviews during the site visits at unserved communes along Ohrid Lake.

2.5.3 Estimation of Load

(1) Potential Load

The potential load was calculated to express the original load untreated by applying a removal ratio of 0 % to the total domestic and tourist populations. According to the results, the load components in the sewerage-served area are currently 63.4 %.

Table 2.42 Potential Load

Zoning	Population				Unit Load (BOD)		Potential Load (kgBOD/day)		
	Residential		Tourist		Resi dential	Tourist			
	Served	Unserved	Served	Unserved			Served	Unserved	Total
OH1	47,124	9,815	4,286	554	69(gpcd)	60(gpcd)	3,509	710	4,219
OH2	0	885	458	4,555	69(gpcd)	60(gpcd)	27	334	361
ST1	20,742	5,486	0	1,894	69(gpcd)	60(gpcd)	1,431	492	1,923
ST2	208	3,610	2,132	1	69(gpcd)	60(gpcd)	142	249	391
ST3	0	16,893	0	0	69(gpcd)	60(gpcd)	0	1,166	1,166
Ohrid	47,124	10,700	4,744	5,108	69(gpcd)	60(gpcd)	3,536	1,044	4,580
Struga	20,950	25,989	2,132	1,896	69(gpcd)	60(gpcd)	1,573	1,907	3,480
Total	68,074	36,689	6,876	7,004	69(gpcd)	60(gpcd)	5,109	2,951	8,060

Removal Ratio: 0%

Source: JICA Study Team

(2) Current Load

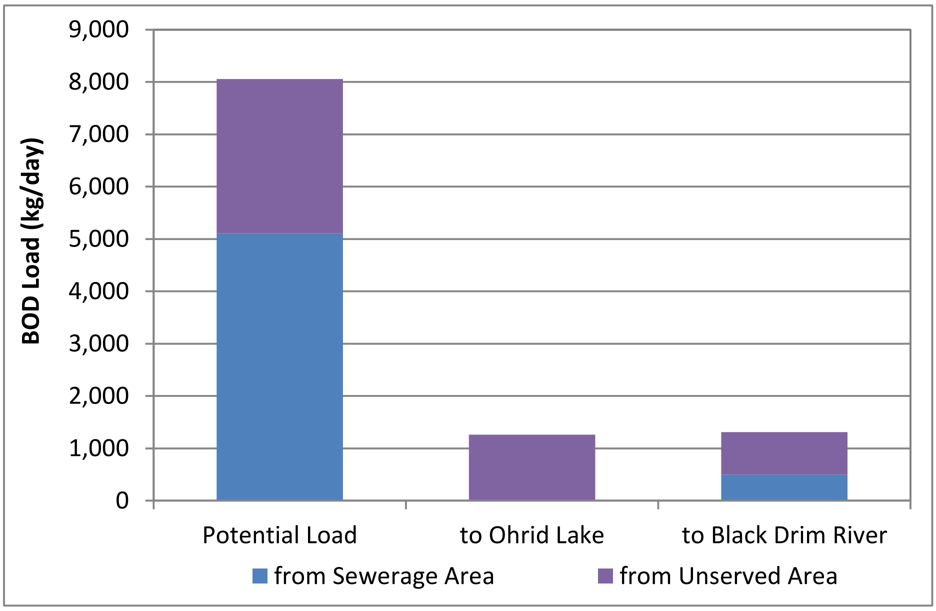
The current load of wastewater was calculated by applying removal ratios at 90% into sewerage-served areas and 30% for current sewerage-unserved areas as preliminary treatment using a septic tank system. The result shows a total reduction ratio of 68.0% was attained for the preliminary treatment process and approximately 20% of the load in the sewerage-served area is discharged into the Black Drim River via the Vranista WWTP.

Table 2.43 Current Load

Zoning	Population				Unit Load (BOD)		Load to Public Body (kgBOD/day)			Total Removal Ratio
	Residential		Tourist		Resi dential	Tourist				
	Served	Unserved	Served	Unserved			Served	Unserved	Total	
OH1	47,124	9,815	4,286	554	69(gpcd)	60(gpcd)	351	497	848	79.9%
OH2	0	885	458	4,555	69(gpcd)	60(gpcd)	3	234	237	34.3%
ST1	20,742	5,486	0	1,894	69(gpcd)	60(gpcd)	143	345	488	74.6%
ST2	208	3,610	2,132	1	69(gpcd)	60(gpcd)	14	174	188	51.9%
ST3	0	16,893	0	0	69(gpcd)	60(gpcd)	0	816	816	30.0%
Ohrid	47,124	10,700	4,744	5,108	69(gpcd)	60(gpcd)	354	731	1,085	76.3%
Struga	20,950	25,989	2,132	1,896	69(gpcd)	60(gpcd)	157	1,335	1,492	57.1%
Total	68,074	36,689	6,876	7,004	69(gpcd)	60(gpcd)	511	2,066	2,577	68.0%

Removal Ratio (Sewerage System): 90% , Removal Ratio (Pre-Treatment): 30%

Source: JICA Study Team



* Potential load includes an area belonging to the basin of the Black Drim River (14% of the total)
Source: JICA Study Team

Figure 2.54 Source of Loads Discharged into Public Bodies

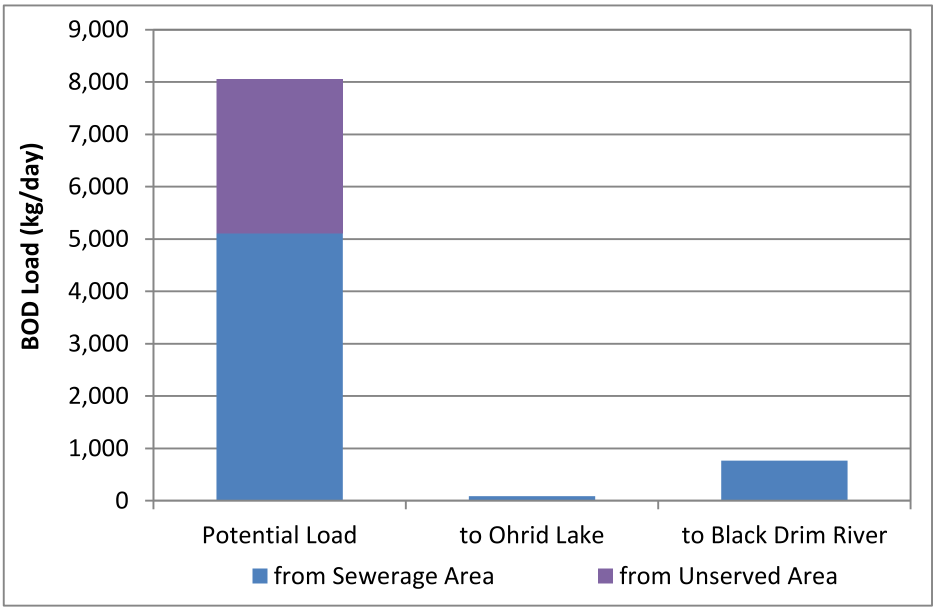
(3) Estimation of Load after introducing Sewerage System

The load after completion of the sewerage system (including small scale wastewater treatment facilities) was estimated and the load discharged into Ohrid Lake was minimized to 31% of the current situation.

Table 2.44 Load after Completion of the Sewerage System

Zoning	Population				Unit Load (BOD)		Load to Public Body (kgBOD/day)			Total Removal Ratio
	Residential		Tourist		Resi dential	Tourist				
	Served	Unserved	Served	Unserved			Served	Unserved	Total	
OH1	56,939	0	4,840	0	69(gpcd)	60(gpcd)	422	0	422	90.0%
OH2	885	0	5,013	0	69(gpcd)	60(gpcd)	36	0	36	90.0%
ST1	26,228	0	1,894	0	69(gpcd)	60(gpcd)	192	0	192	90.0%
ST2	3,818	0	2,133	0	69(gpcd)	60(gpcd)	39	0	39	90.0%
ST3	16,893	0	0	0	69(gpcd)	60(gpcd)	117	0	117	90.0%
Ohrid	57,824	0	9,852	0	69(gpcd)	60(gpcd)	458	0	458	90.0%
Struga	46,939	0	4,028	0	69(gpcd)	60(gpcd)	348	0	348	90.0%
Total	104,763	0	13,880	0	69(gpcd)	60(gpcd)	806	0	806	90.0%

Removal Ratio (Sewerage System): 90%
Source: JICA Study Team



* Potential load includes an area belonging to the basin of the Black Drim River (14% of the total)
Source: JICA Study Team

Figure 2.55 Source of Loads after Completion of the Sewerage System

(4) Summary of Results

With the completion of the sewerage system in the sewerage area surrounding Ohrid Lake (except ST3 in Zoning), the destinations of individual wastewater currently discharged into Ohrid Lake via private septic tanks are diverted to the Black Drim River via the Vranista WWTP. Therefore the incoming discharge will be dramatically reduced except for small scale utilities, which are assumed to be located in southern Ohrid. To estimate the effectiveness of the Expansion of the Sewerage Network, a summary of the load was prepared and sorted by Zoning.

Table 2.45 Summary of Potential Load (Arranged by Discharged Bodies)

Public Body	Treatment Process	Load (kgBOD/day)						Proportion of Contributions (%)					
		OH1	OH2	ST1	ST2	ST3	Total	OH1	OH2	ST1	ST2	ST3	Total
Ohrid Lake	Sewerage System	0	27	0	0	0	27	0%	0%	0%	0%	0%	0%
	Pre-Treatment (Septic Tank)	710	334	492	249	0	1,785	9%	4%	6%	3%	0%	22%
	Total	710	361	492	249	0	1,812	9%	4%	6%	3%	0%	22%
Black Drim River	Sewerage System	3,509	0	1,431	142	0	5,082	44%	0%	18%	2%	0%	63%
	Pre-Treatment (Septic Tank)	0	0	0	0	1,166	1,166	0%	0%	0%	0%	14%	14%
	Total	3,509	0	1,431	142	1,166	6,248	44%	0%	18%	2%	14%	78%
Total	Sewerage System	3,509	27	1,431	142	0	5,109	44%	0%	18%	2%	0%	63%
	Pre-Treatment (Septic Tank)	710	334	492	249	1,166	2,951	9%	4%	6%	3%	14%	37%
	Total	4,219	361	1,923	391	1,166	8,060	52%	4%	24%	5%	14%	100%

Source: JICA Study Team

Table 2.46 Summary of Potential Load (Arranged by Original Basin without Diversion)

Public Body	Treatment Process	Load (kgBOD/day)						Proportion of Contributions (%)					
		OH1	OH2	ST1	ST2	ST3	Total	OH1	OH2	ST1	ST2	ST3	Total
Ohrid Lake	Sewerage System	3,509	27	1,431	142	0	5,109	44%	0%	18%	2%	0%	63%
	Pre-Treatment (Septic Tank)	710	334	492	249	0	1,785	9%	4%	6%	3%	0%	22%
	Total	4,219	361	1,923	391	0	6,894	52%	4%	24%	5%	0%	86%
Black Drim River	Sewerage System	0	0	0	0	0	0	0%	0%	0%	0%	0%	0%
	Pre-Treatment (Septic Tank)	0	0	0	0	1,166	1,166	0%	0%	0%	0%	14%	14%
	Total	0	0	0	0	1,166	1,166	0%	0%	0%	0%	14%	14%
Total	Sewerage System	3,509	27	1,431	142	0	5,109	44%	0%	18%	2%	0%	63%
	Pre-Treatment (Septic Tank)	710	334	492	249	1,166	2,951	9%	4%	6%	3%	14%	37%
	Total	4,219	361	1,923	391	1,166	8,060	52%	4%	24%	5%	14%	100%

Source: JICA Study Team

Table 2.47 Summary of Discharged Load under Current Condition

Public Body	Treatment Process	Load (kgBOD/day)						Proportion of Contributions (%)					
		OH1	OH2	ST1	ST2	ST3	Total	OH1	OH2	ST1	ST2	ST3	Total
Ohrid Lake	Sewerage System	0	3	0	0	0	3	0%	0%	0%	0%	0%	0%
	Pre-Treatment (Septic Tank)	497	234	345	174	0	1,250	19%	9%	13%	7%	0%	49%
	Total	497	237	345	174	0	1,253	19%	9%	13%	7%	0%	49%
Black Drim River	Sewerage System	351	0	143	14	0	508	14%	0%	6%	1%	0%	20%
	Pre-Treatment (Septic Tank)	0	0	0	0	816	816	0%	0%	0%	0%	32%	32%
	Total	351	0	143	14	816	1,324	14%	0%	6%	1%	32%	51%
Total	Sewerage System	351	3	143	14	0	511	14%	0%	6%	1%	0%	20%
	Pre-Treatment (Septic Tank)	497	234	345	174	816	2,066	19%	9%	13%	7%	32%	80%
	Total	848	237	488	188	816	2,577	33%	9%	19%	7%	32%	100%

Source: JICA Study Team

Table 2.48 Summary of Discharged Load after Completion of the Sewerage System

Public Body	Treatment Process	Load (kgBOD/day)						Proportion of Contributions (%)					
		OH1	OH2	ST1	ST2	ST3	Total	OH1	OH2	ST1	ST2	ST3	Total
Ohrid Lake	Sewerage System	0	36	0	0	0	36	0%	4%	0%	0%	0%	4%
	Pre-Treatment (Septic Tank)	0	0	0	0	0	0	0%	0%	0%	0%	0%	0%
	Total	0	36	0	0	0	36	0%	4%	0%	0%	0%	4%
Black Drim River	Sewerage System	422	0	192	39	117	770	52%	0%	24%	5%	15%	96%
	Pre-Treatment (Septic Tank)	0	0	0	0	0	0	0%	0%	0%	0%	0%	0%
	Total	422	0	192	39	117	770	52%	0%	24%	5%	15%	96%
Total	Sewerage System	422	36	192	39	117	806	52%	4%	24%	5%	15%	100%
	Pre-Treatment (Septic Tank)	0	0	0	0	0	0	0%	0%	0%	0%	0%	0%
	Total	422	36	192	39	117	806	52%	4%	24%	5%	15%	100%

Source: JICA Study Team

(5) Anticipated Contributions in South Part of Ohrid City

The anticipated effects after introducing sewerage facilities in the southern Ohrid City using small scale facilities were summarized and the total contribution in terms of reduction ratio of load to Ohrid Lake is estimated at 15.9 % from current situations.

Table 2.49 Anticipated Contributions in Southern Ohrid City

Location	Discharge	Population		Load (kgBOD/day)		Contribution of Total Load to Ohrid Lake
		Resi dential	Tourist	Current Condition	Sewerage Developed	
Ljubanista - St. Naum	Ohrid Lake	502	2,186	116	17	-7.9%
Trpejca	Ohrid Lake	383	2,368	118	17	-8.0%
Total		885	4,554	234	33	-15.9%
Total Load to Ohrid Lake				1,264		

Removal Ratio (Pre-Treatment): 30%

Removal Ratio (Sewerage System): 90%

Total Load (1,264 kgBOD/day): Total of current discharging Load in unserved area (OH1+OH2+ST1+ST2) + served area (ST2, considering individual treatment facilities)

Source: JICA Study Team

Chapter 3 Laws and Regulations

3.1 EU Directives

Following the internal political disputes and postponing of EU membership for Macedonia at the NATO Summit in April 2008 and others, the parliament was disbanded and an advanced election was held in July. The ruling party VMRO-DPMNE swept to an overwhelming victory by obtaining the majority of seats. VMRO-DPMNE then formed a coalition with the first party of Albania, DUI, and Mr. Gruevski was elected as prime minister. The cabinet targeted economic development by public projects, foreign investments and industrial subsidies. Conversely the cabinet claimed that countermeasures to combat corruption, legal establishment and intimate relationship between races were relatively backward.

In the presidential election held in April 2009, Ph.D Ivanov of VMRO-DPMNE was erected as president of Macedonia. In January 2011 most of the opposition parties boycotted the parliament because the government stressed pressure on mass media. In April, the parliament was disbanded and an advanced election was held in June. As a result VMRO-DPMNE maintained first position in the parliament, and a coalition government was formed with the DUI. In the new government Mr. Gruevski has retained the position of prime minister.

The present government policy involves becoming a member of NATO and the EU. In December 2005, Macedonia was welcomed in the EU Board Meeting at Brussels, and ranked as an eligible candidate for membership. Concerning NATO membership, Macedonia participates in ISAF to fight against terrorists in Afghanistan.

In relate to the environmental criteria in Macedonia, the sewerage system in Ohrid and Struga has been stipulated to the regulations in accordance with EU directives, and the environmental items for effluent quality are regularly sampled and reported to EU.

Table 3.1 Summary of Effluent Criteria of Vranista WWTP

No.	Item	Unit	Value	Minimum Reduction	Remarks
1	BOD_5	mg/L	25	70-90%	Without Nitrification
2	COD_{Cr}	mg/L	125	75%	
3	SS	mg/L	35	90%	
4	Total Nitrogen (T-N)	mg/L	10	78-80%	
5	Total Phosphorus (T-P)	mg/L	1	80%	

Source: Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment

3.2 Sewerage and Sanitation Management

The Republic of Macedonia has a Law on Waters to solve water-related legal matters. The basic provision states the following under the law:
This Law shall regulate matters related to: surface waters, including permanent watercourses or watercourses through which water flows occasionally, lakes, reservoirs and springs, ground water and storm water coponents, the riparian lands and wetlands; management of waters, riparian lands and wetlands, also including the water resources distribution, water protection and conservation, as well as the protection against harmful impact of waters; water management structures and services; organizational arrangements and financing of water management; as well as the manner, conditions and procedures under which water can be used or discharged.
Unless specifically laid down in this law, the Law on environment shall apply to the administration of issues regarding: access to environmental information, public participation in water management decision-making,

assessment of the environmental impact of certain strategies, plans and programs, environmental impact assessment from certain projects, prevention and control of accidents with the presence of dangerous substances, environmental liability and integrated environmental permits for the operation of certain installations affecting the environment.
The Law on General Administrative procedure shall apply to the procedures set out in this law, unless specifically laid down herein.

The rivers and lakes in Macedonia are categorized into 5 types based on the purpose to use, to protect the water as shown below:

Table 3.2 Water Category of Lake

Parameter		Permissible concentration				
		I	II	III	IV	V
pH value		6.8 - 8.5	6.5 - 6.3	6.3 - 6.0	6.0 - 5.3	< 5.3
DO (mg/L)		> 8	6.0 - 8.0	4.0 - 6.0	2.0 - 4.0	< 3.0
DO/Saturation (%)		90 - 105 -	75 - 90 105 - 115	50 - 75 115 - 125	30 - 50 125 - 130	< 30 > 150
BOD_5 (mg/L)		< 2	2 - 4	4 - 7	7 - 15	> 15
COD_{Mn} (mg/L)		< 2.5	2.5 - 5.0	5.0 - 10.0	10.0 - 20.0	> 20.0
Total Organic Carbon (mg/L)		< 2.5	2.5 - 4.2	4.2 - 6.7	6.7 - 10.0	> 10.0
SS (mg/L)		< 10	10 - 30	30 - 60	60 - 100	> 100
Total Dissolved Solid	Surface (mg/L)	350	500	1,000	1,500	> 1,500
	Ground water - karstic (mg/L)	350	500	1,000	1,500	> 1,500
	Ground water - not karstic (mg/L)	800	1,000	1,500	1,500	> 1,500
T-P (mg/L)		< 0.01 < 0.015*	0.01 - 0.025 0.015 - 0.04	0.025 - 0.050 0.04 - 0.07	0.05 - 0.125 0.075 - 0.19	> 0.125 > 0.19
T-N (mg/L)		0.2	0.2 - 0.325	0.325 - 0.450	> 0.450	> 0.450
Chlorophyll ” a” (mg/L)		< 0.002	0.002 - 0.0379	0.0379 - 0.075	0.075 - 0.010	> 0.010
Fecal Coliform (MPN100mL)		5	5 - 50	50 - 500	> 500	> 500
Saprogenic		Oligo-saprogenic	Mesosaprogenic Beta - Alpha	Mesosaprogenic Alpha - Beta	Alpha - mesosaprobic-polisabrobic	Polisaprogenic
Saprobic Index		< 1.5	1.5 - 2.5	2.5 - 3.5	3.5 - 4.5	> 4.5

*Given values on brackets refer only on lakes and reservoirs
Source: Sab-law for classification of waters

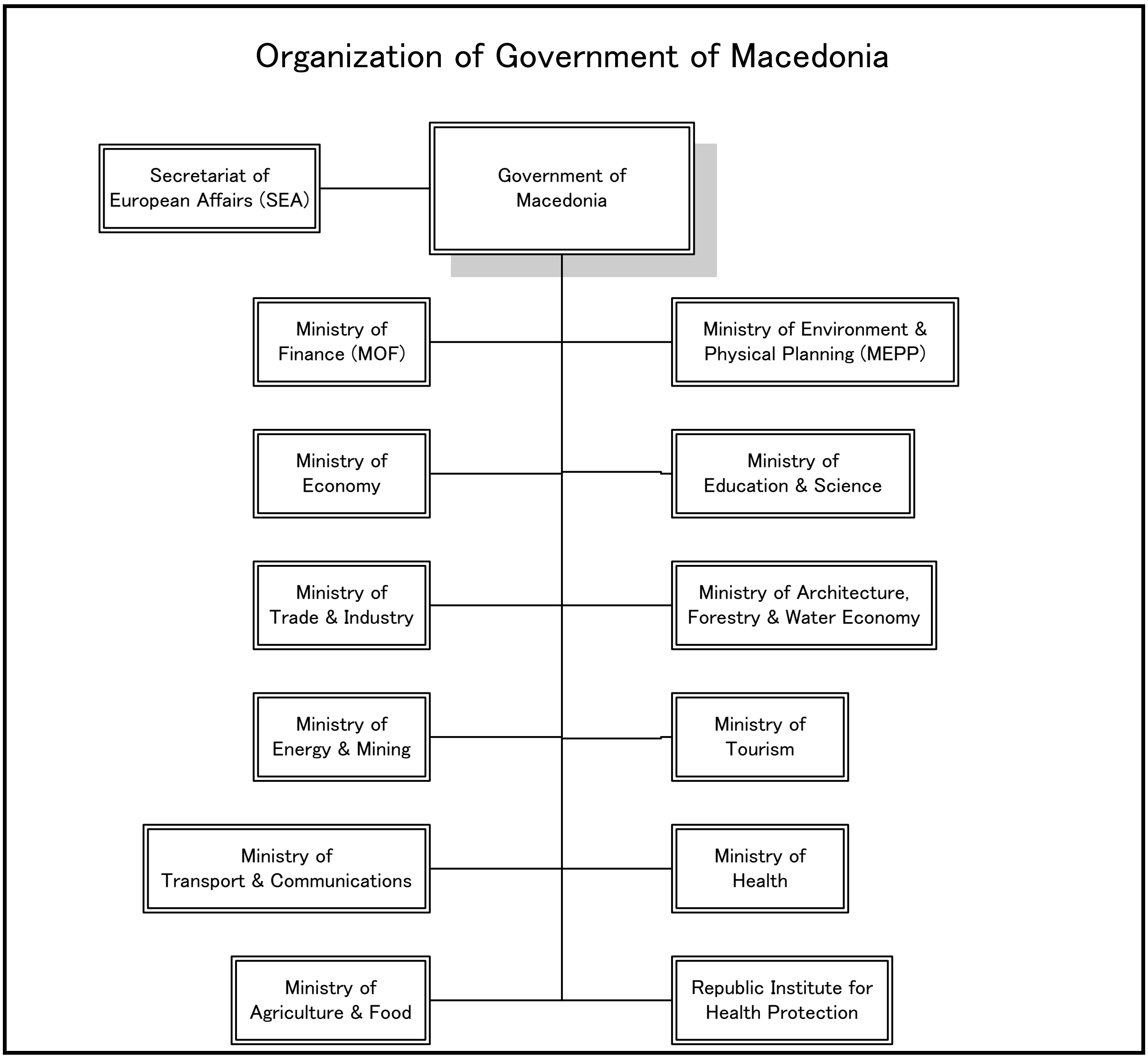
Chapter 4 Institutional and Financial Aspects

4.1 Institutions

4.1.1 Government of Macedonia

The organizations of the Macedonian Government related to water are the Ministry of Finance (MOF), Ministry of the Environment and Physical Planning (MEPP), Secretariat for European Affairs (SEA) and the Ministry of Health (MOH) at the central level. There are also several organizations, of which some departments are related to water, such as the Ministry of Agriculture (MOA), when the dewatered sludge is applied as organic fertilizer. These organizations are omitted here. Those at Ohrid and Struga cities are PROAQUA and Niskogradba, which are mainly responsible for the operation and maintenance of the Ohrid-Struga Sewerage System.

The following figure shows the overall organization of the Macedonian Government. There are 12 ministries and one secretariat, while other organizations such as courts are omitted.



Source: Macedonian Government

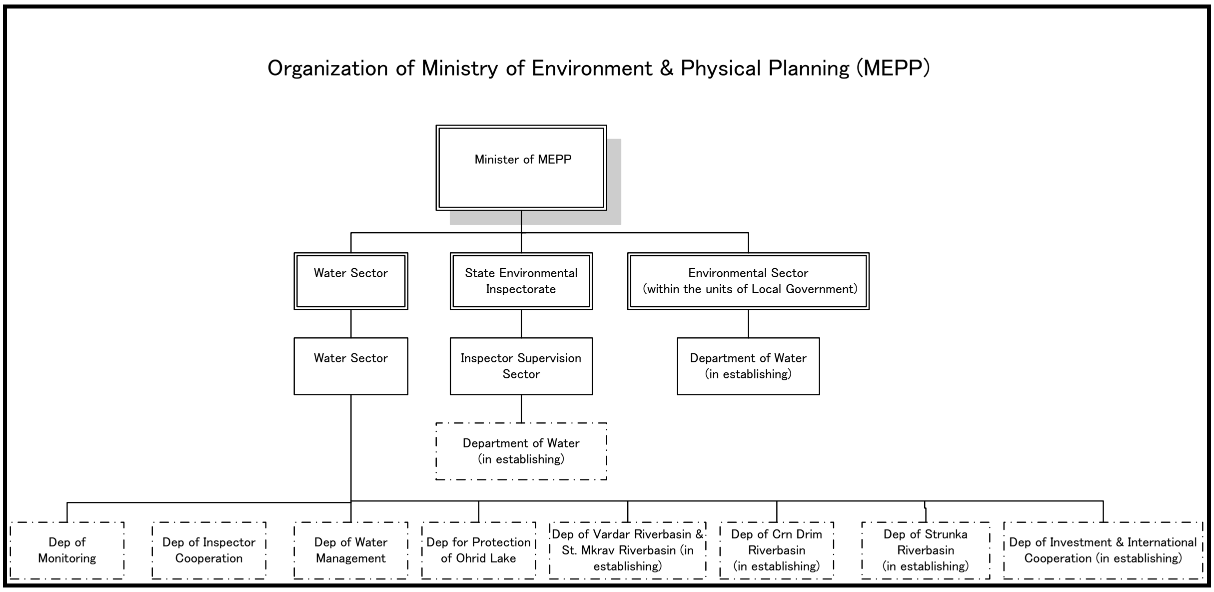
Figure 4.1 Organization Chart of the Macedonian Government

(1) Ministry of Finance (MOF)

The main functions of the MOF are to arrange the budgets for public investment plans (PIP) and projects based on documents submitted from the relevant ministries, and allocate the general budget to local governments by organizations within the latter, so that the local governments can formulate their infrastructure investment plans. The MOF is to finance the plans and projects of local government on lending, but not direct financing.

(2) Ministry of the Environment and Physical Planning (MEPP)

The MEPP aims to promote the Macedonian environment to set up the legal frameworks and required standards, to establish a monitoring system and promote the establishment of the framework required for organizations wishing to join the EU. The organization of the MEPP is shown in the following Figure. The MEPP monitors the quality of water discharged into rivers, municipal wastewater, and industrial wastewater etc. as well as regulating discharges. The MEPP is also authorized to examine the EIA and approve it, so that the MEPP can screen the EIA based on the Environmental Law. Aspects related to sewerage came under MEPP as of January 2011.



Sourve: MEPP

Figure 4.2 Organization Chart of the MEPP

The main responsibility of the MEPP is to formulate the legal system, support and promote the management capacity of local governments, and assist in planning, designing and operating the related facilities. The Department of Communal Works and Housing Infrastructure is responsible for them, while local governments are responsible for the actual plan, design and operation of the facilities.

The financing schemes and procedures differ in size. When international organizations are involved or projects are included in international assistance, the MEPP is responsible for them, whereas local governments are responsible for other cases.

The MEPP encompasses 4 departments such as the Department of Regulation & Standards, Department of Sustainability, Department of European Affairs and Centre of the Environmental Information, as well as 2 divisions for implementation such as Ohrid Lake Environmental Improvement and Dojran Lake Dredging, which are responsible for the fund management of environmental monitoring and natural protection.

(3) Secretariat for European Affairs (SEA)

The main function of the SEA is to liaise with the EU concerning the Macedonian Government, because the country is prioritizing EU membership. EU Directives are applied for environmental improvement, including the Ohrid Lake.

(4) Ministry of Health (MOH)

The MOH is involved in aspects of water management like drinking water, bathing water and others in Macedonia, surveys of water-borne diseases and their countermeasures. The MOH has a branch office in Ohrid City, known as a Public Health Institute, which regularly analyzes the water quality of rivers flowing into and from the lake.

The frequency of analysis involves taking samples twice a month at 24 points (60 cm deep) on the Macedonian side, and analyzing a total of 160 samples for 24 parameters. The inflowing rivers are sampled 5 times a month at the mouth, and 500 and 1,000m upstream respectively for analysis, because water is extracted for drinking during the period April to September. The water quality results are reported to the State Secretary to assess the potential for water consumption and swimming.

4.1.2 PROAQUA

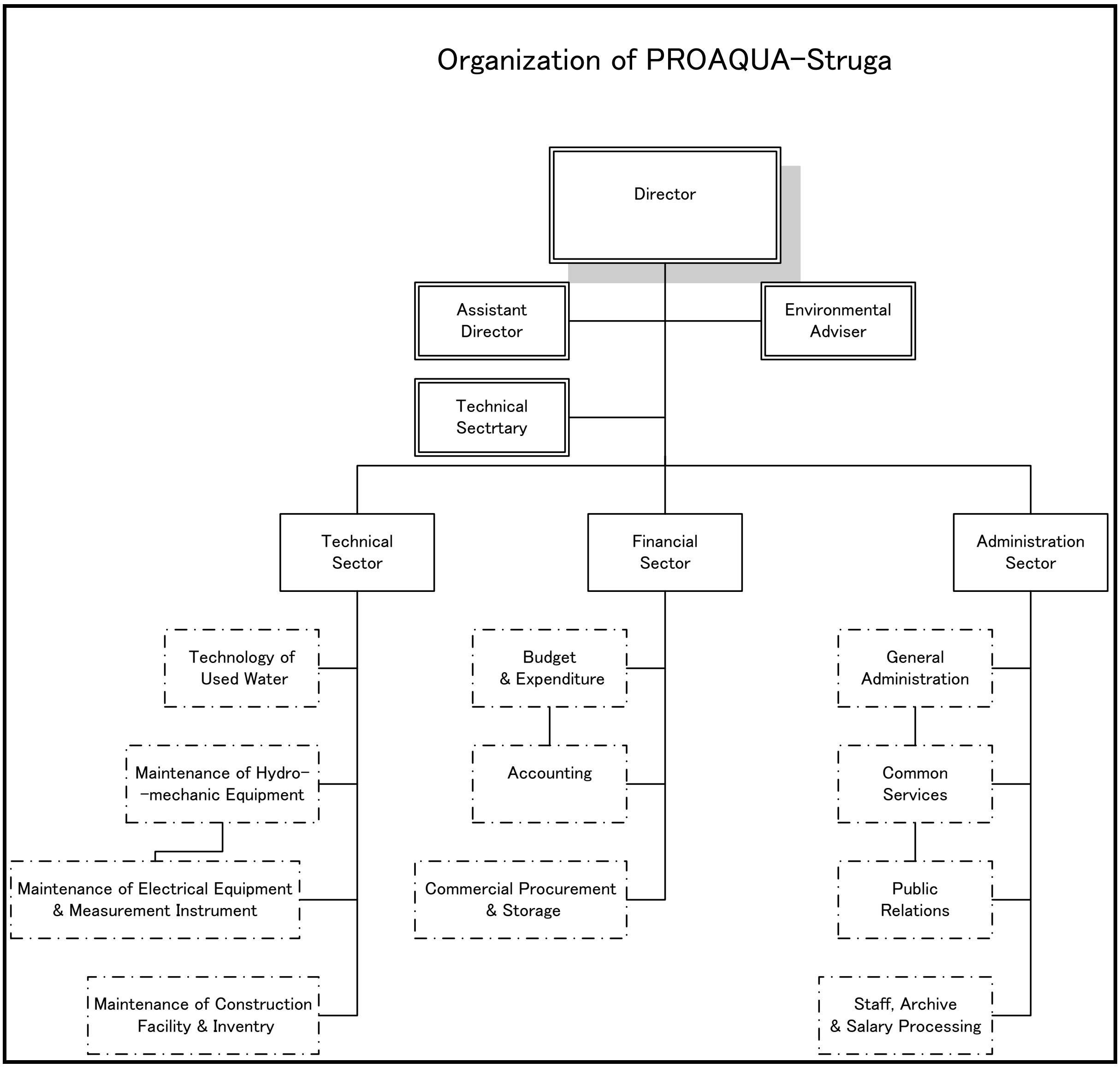
PROAQUA was established some 12 years ago to operate the Ohrid - Struga Water and Sewerage System, as shown in the following Figure. Two years ago, Niskogradba was separately tasked with operating the sewage collection in Ohrid City only for some political reasons, meaning PROAGUA is now responsible for the water supply, sewage collection and treatment in Struga City, and the water supply and sewage treatment for Ohrid City.
It was explained that about 500 staff are working in PROAQUA’s 3 sectors: technical, financial and administrative.
In relate to the operation and management of the public enterprise in sewerage works, JICA Study Team confirmed the frameworks of the service summarized as follows.

(1) Sewer Network

- The designing works are usually done by PROAQUA under local budget projects such as installation works for secondary and tertiary network, drainage works, etc.
- The managements in construction works are also conducted by PROAQUA under local construction project.
- In the local construction projects, fundamentally the budgets were prepared by the municipalities of Ohrid (when the construction is done in Ohrid area) and Struga (when the construction is done in Struga) and construction supervisions and inspections are covered by PROAQUA.
- Rehabilitation and repairing works are also conducted by PROAQUA and the budget is fundamentally allotted from municipalities.
- Drawings and other deliverables under the construction projects in relate to the sewerage works, PROAQUA basically stores all the materials.
- Currently management using GIS has started and a part of sewer lines which were recently installed under municipal projects have been incorporated into the system. The geographical data was obtained from Agency For Real Estate Cadastre and the agency can provide electrical data for the purposes of mapping information up to the scale of 1:1,000 in resolution.

(2) Wastewater Treatment Plant (Vranista WWTP)

- As for the repairs and rehabilitation plans, PROAQUA assesses the conditions of owned assets and the budgetary plans are submitted to the municipalities for requests. Minor levels of repairing works can be maintained under individual budget under PROAQUA.

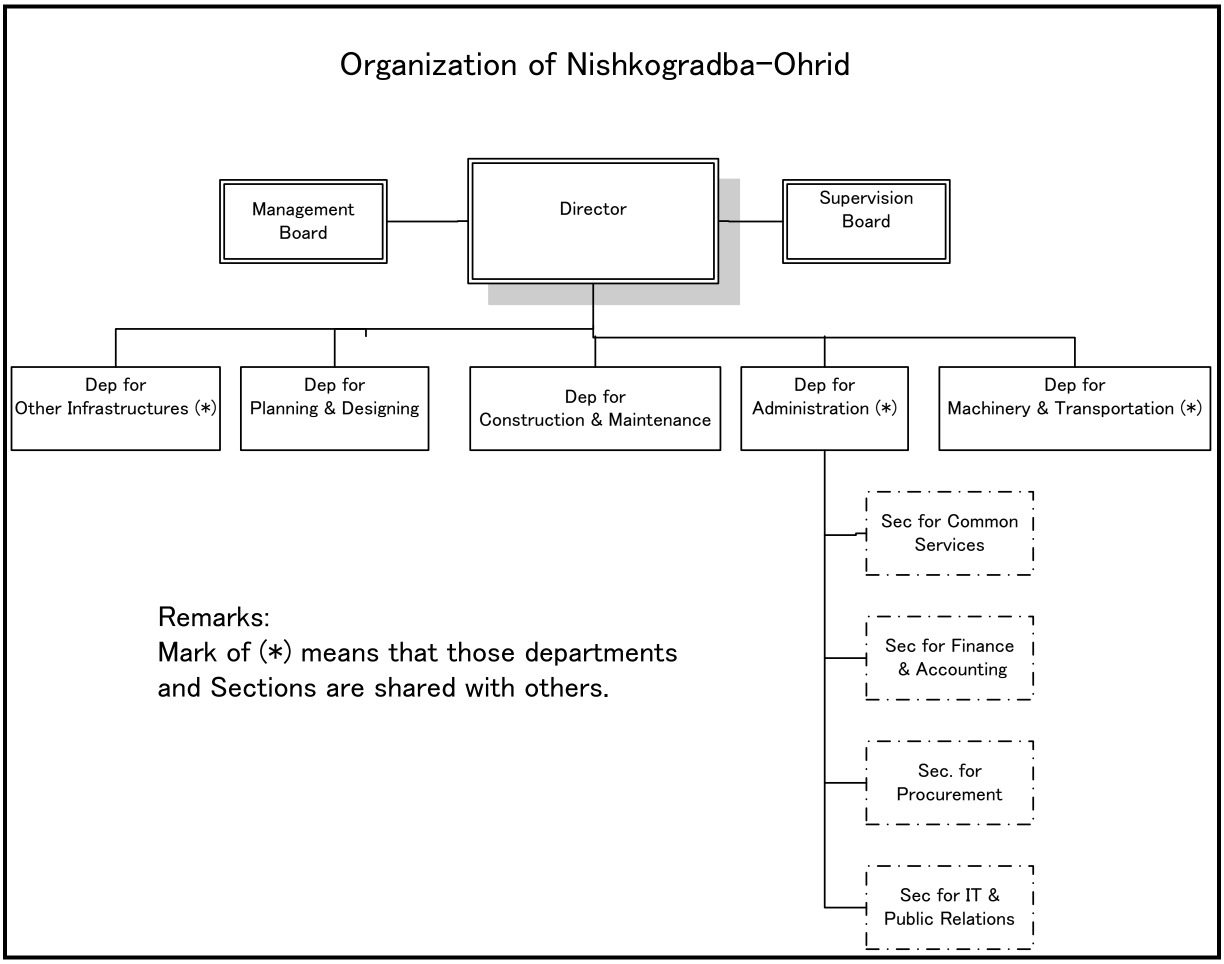


Source: PROAQUA

Figure 4.3 Organization Chart of PROAQUA

4.1.3 Niskogradba - Ohrid

As mentioned above, this organization was established 2 years ago and is responsible for collecting sewage generated in Ohrid City only, as shown in the following Figure.
The residents have to make two payments in Ohrid City, for water supply to PROAQUA and sewage collection to Niskogradba respectively, while those in Struga make a single payment to PROAQUA.
When the management costs are carefully monitored, some complications emerge, because the wastewater treatment is only applied in Struga City, which does not generate revenue. The cost of the WWTP operation shall also be shared by the residents of Ohrid City.



Source: Niskogradba

Figure 4.4 Organization Chart of Niskogradba

4.2 Financial Management

The balance sheet of PROAQUA is shown in the following table.

According to the sheet, the main components of income derived from operations are sorted into three categories, tariff income from water supply, tariff income from wastewater treatment and tariff income from sewage collection. The total amount of the income shows about 82% of the income was collected tariffs (185,289 thousand MKD in 2011, 296,884 thousand JPY, 3,012,829 EUR respectively) and among the total tariffs, about 27% is the share from sewerage tariff (total of wastewater and collection). In 2011, a large amount of loss was recorded at -78,430 thousand MKD, 125,667 thousand JPY, 1,275,285 EUR) and this was mainly caused in other operation loss according to the balance sheet.

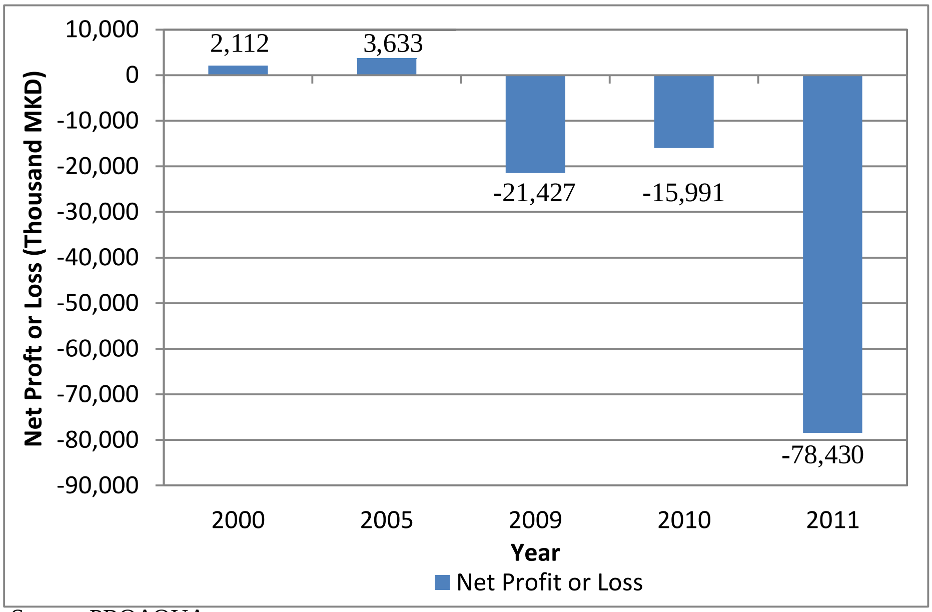
The net loss of the public enterprise including PROAQUA is compensated from general revenues of the municipalities and the ratio of this amount was occupied at approximately 27%.

Table 4.1 Balance Sheet of PROAQUA

Unit: Thousand MKD

Category	Item	2000	2005	2009	2010	2011	Remarks
Income	Income from Water Tariff	97,082	134,130	134,489	134,280	136,280	(1)
	Income from Sewerage Tariff (Treatment)	19,924	26,696	27,231	22,355	8,437	(2)
	Income from Sewerage Tariff (Sewer)	29,321	40,910	42,132	41,841	40,572	(3)
	Sub Total	146,327	201,736	203,852	198,476	185,289	(4)=(1)+(2)+(3)
	Operating Income	18,525	10,678	42,411	31,781	10,723	(5)
	Other Operating Income	12,613	13,571	36,218	37,092	29,163	(6)
	Sub Total	31,138	24,249	78,629	68,873	39,886	(7)=(5)+(6)
	Total	177,465	225,985	282,481	267,349	225,175	(8)=(4)+(7)
Expense	Material Costs	-22,986	-22,275	-21,105	-25,119	-13,686	(9)
	Electricity	-20,890	-23,827	-30,121	-31,752	-33,756	(10)
	Services	-13,857	-9,086	-6,195	-18,388	-12,386	(11)
	Salaries	-96,620	-80,240	-140,830	-111,339	-126,886	(12)
	Food Allowances	-9,627	-12,252				(13)
	Gross Contracted Activities	-1,706	-5,878	-2,422	-2,234	-2,947	(14)
	Amortization	-21,989	-36,833	-45,493	-45,676	-27,989	(15)
	Valued Adjustment of the Regulations	-1,591	-9,862	-322	-3,253	-27,751	(16)
	Other Operating Expenses	-12,050	-16,400	-51,653	-39,142	-46,793	(17)
	Total	-201,316	-216,653	-298,141	-276,903	-292,194	(18)=(9)+…+(17)
Income from Capital (Interest, etc.)		677	2,017	2,254	564	1,053	(19)
Loss from Capital (Interest, etc.)		-7,949	-7,446	-7,484	-7,001	-8,975	(20)
Balance from Regular Operation		-31,123	3,903	-20,890	-15,991	-74,941	(21)=(8)+(18)+(19)+(20)
Associate Income		39,397	0	0	0	0	(22)
Associate Loss		-5,640	0	0	0	0	(23)
Balance before Taxation		2,634	3,903	-20,890	-15,991	-74,941	(24)=(22)+(23)
Income Tax		-522	-270	-537	0	-3,489	(25)
Net Profit or Loss		2,112	3,633	-21,427	-15,991	-78,430	(26)=(24)+(25)
Gross Income		217,539	228,002	284,735	267,913	226,228	(27)=(8)+(19)+(22)
Gross Expenditure		-214,905	-224,099	-305,625	-283,904	-301,169	(28)=(18)+(20)+(23)
Tax		-522	-270	-537	0	-3,489	(29)
Balance		2,112	3,633	-21,427	-15,991	-78,430	(30)

Source: PROAQUA



Source: PROAQUA

Figure 4.5 Net Profit or Loss of PROAQUA

Table 4.2 Balance Sheet of PROAQUA (Different Currencies, 2011)

Category	Item	Thousand JPY	EUR	Thousand MKD	Remarks
Income	Income from Water Tariff	218,358	2,215,935	136,280	(1)
	Income from Sewerage Tariff (Treatment)	13,518	137,187	8,437	(2)
	Income from Sewerage Tariff (Sewer)	65,008	659,707	40,572	(3)
	Sub Total	296,884	3,012,829	185,289	(4)=(1)+(2)+(3)
	Operating Income	17,181	174,358	10,723	(5)
	Other Operating Income	46,727	474,195	29,163	(6)
	Sub Total	63,908	648,553	39,886	(7)=(5)+(6)
	Total	360,793	3,661,382	225,175	(8)=(4)+(7)
Expense	Material Costs	-21,929	-222,537	-13,686	(9)
	Electricity	-54,086	-548,878	-33,756	(10)
	Services	-19,846	-201,398	-12,386	(11)
	Salaries	-203,306	-2,063,187	-126,886	(12)
	Food Allowances	0	0	0	(13)
	Gross Contracted Activities	-4,722	-47,919	-2,947	(14)
	Amortization	-44,846	-455,106	-27,989	(15)
	Valued Adjustment of the Regulations	-44,465	-451,236	-27,751	(16)
	Other Operating Expenses	-74,975	-760,862	-46,793	(17)
	Total	-468,176	-4,751,122	-292,194	(18)=(9)+…+(17)
Income from Capital (Interest, etc.)		1,687	17,122	1,053	(19)
Loss from Capital (Interest, etc.)		-14,380	-145,935	-8,975	(20)
Balance from Regular Operation		-74,941	-74,941	-74,941	(21)=(8)+(18)+(19)+(20)
Associate Income		0	0	0	(22)
Associate Loss		0	0	0	(23)
Balance before Taxation		-74,941	-74,941	-74,941	(24)=(22)+(23)
Income Tax		-5,590	-56,732	-3,489	(25)
Net Profit or Loss		-80,531	-131,673	-78,430	(26)=(24)+(25)
Gross Income		362,480	3,678,504	226,228	(27)=(8)+(19)+(22)
Gross Expenditure		-482,556	-4,897,057	-301,169	(28)=(18)+(20)+(23)
Tax		-5,590	-56,732	-3,489	(29)
Balance		-125,667	-1,275,285	-78,430	(30)

1EUR=98.54JPY

1EUR=61.50MKD

Source: PROAQUA

In reality, the financial structure of PROAQUA has shifted into divided managements governed by PROAQUA and Niskogradba since 2010 and the allotment of their assets will be clearly separated and Niskogradba will pay for operational cost of wastewater treatment costs in a form of treatment tariff to PROAQUA (the table didn’t clarify individual statements), in other word, Niskogradba will individually manage their sewer property under their independent tariff collection system in separate financial basis.

In relate to the tariff system of the sewerage service, PROAQUA and Niskogradba collect monthly and the unit rates are regulated based on the approvals under councils of both municipalities. Current unit rates were

determined in December of 2001 and the rates are set from 42.50 MKD (72.10 JPY, 0.73 EUR) for domestic water users and 68.00 MKD (108.95 JPY, 1.11 EUR) for industrial users per unit water amount (1 m^3).
Niskogradba, started its operation from 2010, are currently collect only sewerage (including drainage accounts) tariffs from users populated in Ohrid area and the costs for wastewater treatment and relevant utilities are transferred as operation costs to PROAQUA and currently the unit cost of water and sewerage tariffs are same both in Ohrid and Struga.

Table 4.3 Tariff System for Water / Sewerage Services

Unit: MKD/m^3

Item		Domestic (< 30 m^3)	Industrial (< 62.5 m^3)	Remarks
Water Supply		25.50	39.20	Current tariff system from December 2001
Sewerage System	Wastewater	6.80	11.80	
	Drainage	10.20	17.00	
Total		42.50	68.00	

Progressive tariff applied for bulk uses

Source: PROAQUA

Chapter 5 Approaches for Ohrid Lake Improvement

5.1 General

By reviewing the current sewerage system using on-site inspections and surveys conducted on the existing sewer systems in both Ohrid and Struga cities, the damaged sewer pipes which are proposed to be repaired or replaced have been identified as part of efforts to upgrade the current system into a more sustainable conditions in terms of the wastewater treatment plant (WWTP) at Vranista, Struga because the onsite survey proved that the existence of dilutions would cause significant burdens on daily operation of collection system which is represented by the primary sewer system and wastewater treatment in terms of gap in quantity of influent..

Firstly, the problem with the sewer system is the most significant and difficult element to resolve, because it is generally difficult to locate damaged sewer pipes without proper site investigations. Malfunctions in the sewage collection system force the pump stations to operate non-stop, shortening their service life or meaning wasteful operation of the pump stations. This situation ultimately means vast quantities of diluted wastewater enter the WWTP, resulting in poor operational records and the large-scale discharge of pollution into the Black Drim River, an international river, and then the Adriatic Sea.

5.2 Problems exposed by the survey

By reviewing the existing conditions of the sewerage system in the Ohrid and Struga regions, the following problems were indicated and must be taken into consideration to improve and retain the system operation.
The problems observed in the existing sewerage system basically concern the infiltration of ground water and storm water (in some occasions also lake water) into the sewerage system.

5.2.1 Existing Problems in the Sewerage Network

(1) Significant Infiltration of Groundwater

Infiltration to an unexpected extent results in increased wastewater and would accelerate the pace at which materials wear out. The specific reasons and location of the infiltration have not been specified during the survey and the causes would be wide-ranging and go beyond the sewerage area alone.
Generally, the volume of the unidentified water in the sewer is related with the groundwater, but the information about the groundwater (groundwater level in this region, seasonal variation, and flow pattern of the groundwater, etc.) could not be collected in this survey.

(2) Intrusion of Storm Water

The sewerage system was designed as a separate system, but some older assets were installed in the form of a combined system receiving storm water during heavy rain.
The lack of a dedicated storm water collection (drainage) system means existing separate sewers are prone to receiving storm water from pavements.

(3) Lack of Information in Existing Inventories

It is difficult to review the current sewer network due to the lack of a cross-sectional view and detailed system profile in terms of the identification of sections requiring rehabilitations and upgrades.

If the sewer information inventory (sewage ledger) such as the depth of each pipe and maintenance records is available, the points of the unidentified water intrusion could be presumed with the groundwater level or the lake water level.

It is hard to use track records to determine candidate locations for rehabilitation from reliable profiles such as the year of construction, material, history of repairs, etc.
The sewer ledger should be prepared for more detailed survey in the future. For the sake of preparation of the sewer ledger, the information which the ledger should have is listed below:

Table 5.1 Sewage Ledger Information List

No.	Items	Contents
1	Regional info.	The boundary of the cities and of the treatment area
2	Sewer info.	Sewer name (number), location, shape, scale (diameter), slope, length, depth, material, etc.
3	Tertiary sewer info.	Name, location (connection points), shape, scale, slope, length, depth, material
4	Manhole info.	Location, ground level, scale, shape (normal or overflow manholes), invert depth, material
5	Inlets	Location and type of wastewater inlets, street inlets
6	Records	Construction year, maintenance record (cleanings, repair, rehabilitation, etc.)

*The information listed above would be linked with the sewer network map drawings
Source: Sewage Maintenance Guide (Japan Sewage Works Association)

5.2.2 Existing Problems in the Pump Stations

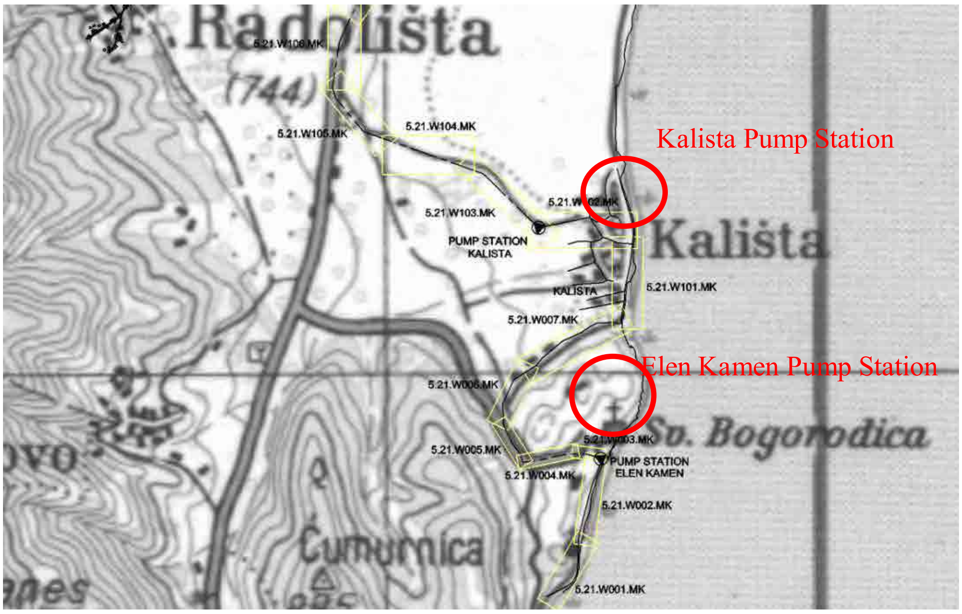
(1) Significant Incoming Wastewater via Sewer Network

Infiltration to an unexpected extent causes an increase in wastewater and means operation costs escalate, especially energy consumption.
The constant bulk inflow of sewage into the stations means they have to operate non-stop and results in the equipment and relevant structures wearing out.
The lack of capacity of facilities, including pump stations located downstream and the WWTP increases the risk of discharging untreated raw sewage into public bodies in the event of heavier rainfalls.

(2) Broken Pump Stations

- Kalista and Elen Kamen pump stations are currently out of order, meaning the connected sewer network is forced to discharge raw sewage into Ohrid Lake from nearby emergency outfalls.
- The reason for the malfunction of the Kalista pump station is the failure of the pump unit and there are currently plans to replace it with a spare unit.
- Elen Kamen pump station stopped working due to the lack of feeding electricity caused by a problem at the hotel in which the transformer was placed to connect electricity to the station. Following the stoppage, pump units and other metal materials such as manhole lids were stolen.

The locations of the defunct pump station are shown in the map below, and the pictures of the pump station are shown below.



Source: JICA Study Team

Figure 5.1 Location of the Defunct Pump Stations

Source: JICA Study Team

Figure 5.2 Defunct Pump Stations

5.2.3 Existing Problems in the Wastewater Treatment Plant

(1) Significant Incoming Wastewater via Sewer Network

- Infiltration to an unexpected extent causes an increase in wastewater and means operation costs escalate, especially energy consumption.
- The constant bulk inflow of sewage into the stations means they have to operate non-stop and results in the equipment and relevant structures wearing out.

(2) Inefficient Operation due to Variation of Influent Qualities

- The influent quality is regularly lower than the designed profile and daily operations have to take lower loading conditions into consideration to maintain adequate treatment.
- Fluctuation in influent water quality results in inefficient operations. It is difficult to perform operations

optimally in terms of attaining constant effluent as stipulated in the criteria.

5.3 Views on Expansion of the Sewerage Network

The municipalities of Ohrid and Struga both wish to expand the wastewater treatment in the Ohrid Lake region is one of the primary target for the development of the sewerage system in the area. JICA Study Team visited all the surrounding areas of the lake and its views on expanding the sewerage area are summarized below:

(1) Communes adjacent to the Primary Sewers

Unconnected smaller communes along the lakeside, which already have access to primary sewer lines, are principally ready for connections via the secondary and tertiary sewer networks to access individual households and utilities.

(2) South Side of Ohrid, Ljubanista and Trpejca

The two communes located on the south side of the lake both face the lakeside. However the distance from Pestani, the southernmost point of the existing sewer system which was provided under the KfW project recently finished means road access to these communes is very hilly (The highest point is 100 m higher than Pestani). Based on the characteristics of the location, the feasibility study prepared by the Center for Development of the Southwest Planning Region recommended small scale wastewater treatment facilities located in both communes.
JICA Study Team also recommends small scale treatment facilities.

(3) South Side of Struga, Radozda

Radozda is located approximately 4 km south of Elen Kamen, the southernmost point of the existing sewer system also provided under the KfW project. Access from Elen Kamen to Radozda is connected via a lakeside road and by providing a primary sewer line along the lake, adjacent small communes can also be covered via the sewerage system, meaning satisfactory development of wastewater treatment by connecting the sewerage system.

5.4 Proposed Improvements

To improve the current problems, the following key factors are emphasized:

- Eliminating the risk of discharging raw sewage into Ohrid Lake
- Reducing incoming sewage by applying stable treatment
- Reducing energy consumed based on sustainable operations
- Completing wastewater treatment in unserved area
- Alleviating infiltration into the existing sewer network

Moreover, with the accomplishment of those improvements, the anticipated increase in benefits is mainly linked to the following items:

Table 5.2 Anticipated Main Benefits

Item	Descriptions	Example of Value
Improvement in the Living Environment	By developing the sewerage system, pre-treated wastewater is diverted into the sewerage system and the environment for residential people can be enhanced in terms of their residential area and adjacent atmosphere	Enhanced scenery, elimination of odor from sewage, alleviation of risks including infectious disease/improvement of property assets, etc.
Accomplishment of Environmental Protection in Public Water Bodies	By developing/improving the sewerage system, environmental protection in the public water bodies will be attained, which will increase the environmental value in the area	Maintaining the value of public bodies/maintaining fishery industries/improving values for tourism, etc.

Source: JICA Study Team

Proposed Improvements nominated include reducing unexpected infiltration, expanding the sewerage system, and establishing small scale wastewater treatment facilities, the individual components of which are summarized below:

Table 5.3 Proposed Improvements

Proposed Option	Main Beneficiaries	Anticipated Benefits
(1) Reduction of Unexpected Infiltration		
Rehabilitation of Existing Primary Sewer	All citizens	Attainment of criteria Alleviation of emergency discharge
	Tourists (near outfall)	Improvement of values for tourism
Rehabilitation of Existing Secondary / Tertiary Sewer	All citizens	Attainment of criteria Alleviation of emergency discharge
	Tourists (near outfall)	Improvement of values for tourism
(2) Expansion of Sewerage System into Unserved Area		
Expansion in Radozda, Struga	Residential Locals / Tourists	Improvement of living environment / Improvement of values for tourists
Expansion in Adjacent Communes, Ohrid	Residential Locals	Improvement of living environment
Expansion in Adjacent Communes, Struga	Residential Locals	Improvement of living environment
(3) Establishment of Small Scaled Wastewater Treatment Facilities		
Wastewater Treatment Facility in Ljubanista	Residential Locals / Tourists	Improvement of living environment / Improvement of values for tourists
Wastewater Treatment Facility in Trpejca	Residential Locals / Tourists	Improvement of living environment / Improvement of values for tourists

Source: JICA Study Team

To evaluate the feasibility of the proposed options, cost estimates and cost per benefits were calculated based on the following procedures:

1) The cost of each option was determined based on the review by prioritizing and making assumptions to accomplish the required performances.
2) To estimate the cost of conducting these options, the number of beneficiaries and anticipated reductions in BOD load were separately prepared beforehand.
3) Cost estimates were calculated by applying a unit cost per activity and summarized.
4) The cost per benefit was compared by the reduction in BOD load and the cost required for the activities.

Other relevant elements such as the number of beneficiaries were also summarized for reference.

The cost estimates consider the construction costs for each option and operation. Maintenance costs were not compared based on the assumption that each activity would be maintained by the same entities and the unit cost will be similar to maintain an equivalent quality.

5.5 Details of Candidate Options and Summary of Components

5.5.1 Reduction of Unexpected Infiltration

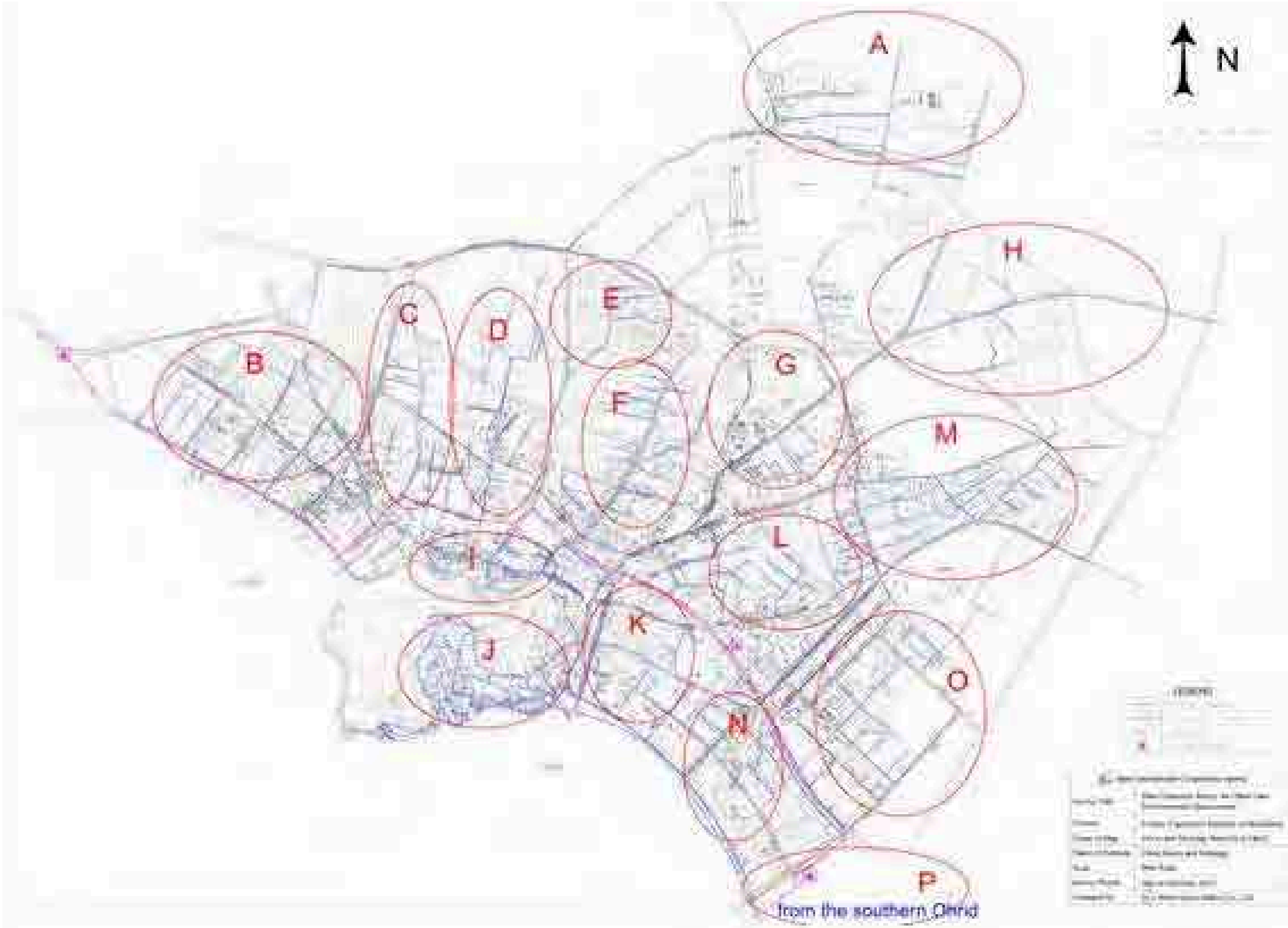
(1) Review of the Current Situation and Proposed Candidates

Based on the results of the site survey (water quality analysis and visual surveillance), JICA Study Team reviewed the current situation in terms of the sewer flow and condition, and determined the priority for improvements based on the following criteria:

- Construction periods
  The older sewers might have damages or defects.
- The results of the water quality analysis
  Low COD concentrations indicate that the sewer might be affected by groundwater, storm water and lake water.
- The results of visual surveillance
  The damaged/defective sewers should be repaired or rehabilitated.

The arranged lists for improvement priorities in Ohrid and Struga cities are shown in the following pages.

Based on the results shown below, the infiltration volume of unidentified water in Ohrid City generally exceeds that on the Struga side. This means that the sewer network in Ohrid might suffer from considerable damage/defects, hence more detailed inspections and rehabilitation works to prevent infiltration are needed in Ohrid than in Struga.
As for the Ohrid South region, it could be presumed that the primary sewers in this region are affected by lake water, hence more detailed inspections and rehabilitation works to prevent infiltration are needed.



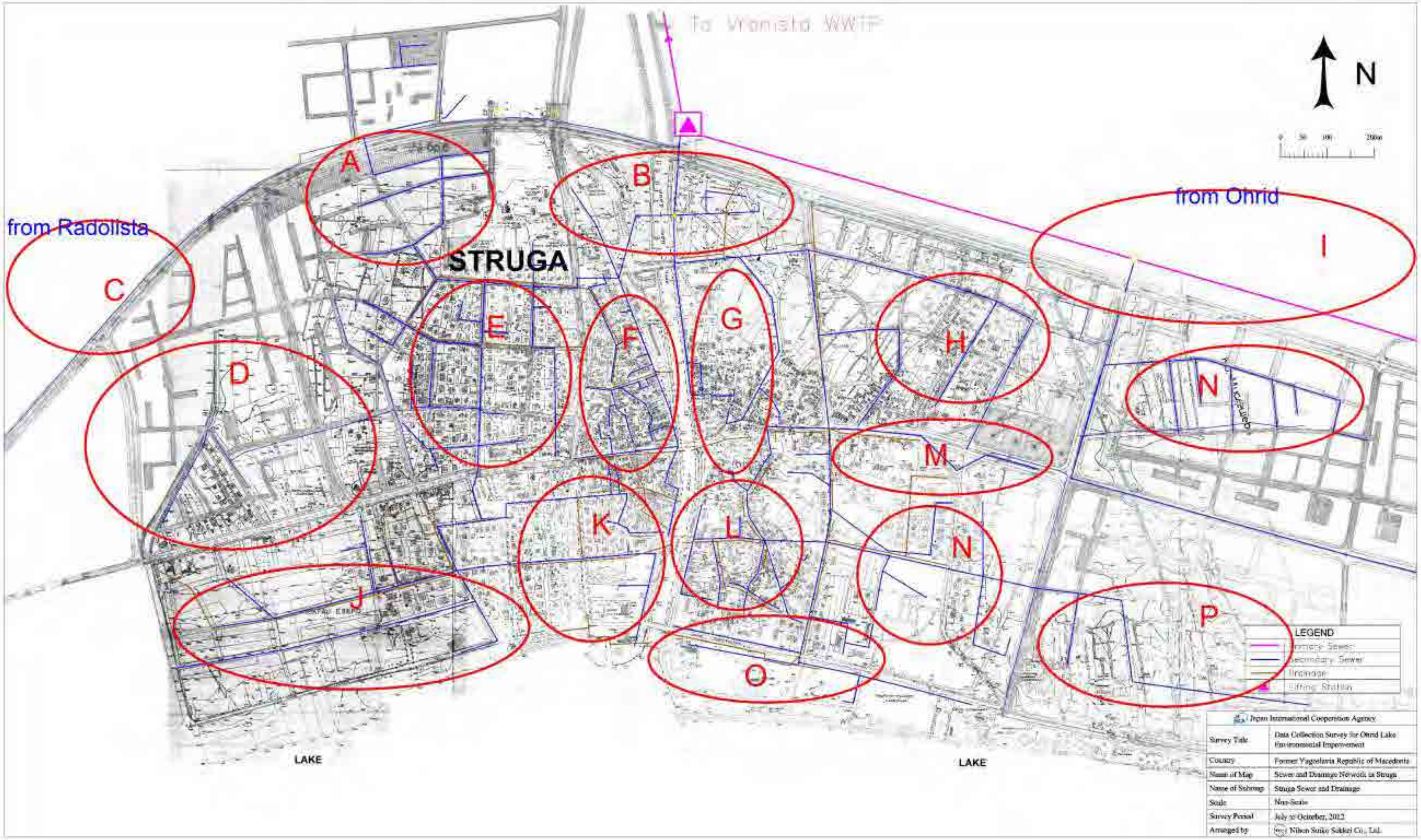
Source: JICA Study Team

Figure 5.3 Sub-Area Basin Map (Ohrid)

Table 5.4 Improvement Priority (Ohrid)

Basin	Sewer Length	Drainage Length	Differ. Length Sewer-Drainage	Diameter	Construction Period *1		from WQ analysis *2		from Visual Servey *3		Priority *4
unit	m	m	m	mm	-		-		-		-
A	15,444	1,792	13,652	200-500	2007-	1	(1)	1			**D**
B	4,664		4,664	200-300	1990-1997	2	(4)	4	X	2	**A**
C	2,346		2,346	200-500	1990-1995	2	(3)	3			**C**
D	4,591	402	4,189	200-400	1980- (80%in PFRPOL)	3	(3)	3			**B**
E	3,268	352	2,916	200-500	2000-2006	1	(4)	4	X	2	**B**
F	3,757		3,757	200-500	-1970	4	(3)	3			**B**
G	3,014	1,369	1,645	200-400	-1980	3	(2)	2			**C**
H	5,241		5,241	200-300	1995-2000	2	(4)	4			**B**
I	3,677		3,677	200-400	1999-2000	2	(2)	2			**C**
J	6,347	339	6,008	200-300	1978- (30%in PFEPOL)	4	(2)	2			**B**
K	3,609	1,857	1,752	200-500	1965-1970 (some part in PFEPOL)	4	(3)	3	X	2	**A**
L	3,313	1,862	1,451	200-400	2000-2008	1	(3)	3			**C**
M	6,994	1,495	5,499	200-400	1978-1995	3	(2)	2			**C**
N	3,414	1,715	1,699	200-500	-1970 (some part in PFRPOL)	4	(3)	3			**B**
O	5,827	3,818	2,009	200-300	-1980 (some part in PFRPOL)	3	(2)	2			**C**
P-1	1,717			500	Desaret-Krausa PS	1	(4)	4			**C**
P-2	1,576			600	Krausa PS-Elsec PS	1	(4)	4			**C**
P-3	1,852			600	Elsec PS-Metropol PS	2	(4)	4			**B**
P-4	1,400			600	Metropol PS-Granit PS	2	(4)	4			**B**
P-5	1,550			800	Granit PS-Orce Nikorov PS	2	(4)	4			**B**
P-6	3,000			800	Orce Nikorov PS-Ohrid 1 PS	2	(4)	4			**B**
P-7	1,045			1000	Ohrid 1 PS-Ohrid 2 PS	3	(4)	4			**A**
P-8	3,337			1200	Ohrid 2 PS-Dalian PS	3	(4)	4			**A**
P-9	5,006			1200	Dalian PS-Podmojle PS	3	(3)	3			**B**
P-10	2,404			1200	Podmojle PS-Sateska PS	3	(3)	3			**B**
P-11	4,267			1200	Sateska PS-Struga 3 PS	3	(3)	3			**B**

PFRPOL: Project for Ecological Protection of Ohrid Lake financed by KfW
*1) score 1 in 2000-, score 2 in 1990-1999, score 3 in 1980-1989, score 4 in -1979
*2) Range of the results of water quality analysis:
(1): COD > 100 mg/L, (2): 100 mg/L > COD > 50 mg/L, (3): 50 mg/L > COD > 20 mg/L, (4): COD < 20 mg/L
*3) Marked "X" when there is a damaged sewer or defected sewer in the basin, and it score 2 points
*4) The priority A : total score ≥ 8, B: total ≥ 6, C: total ≥ 4, D: total < 4
Source: JICA Study Team



Source: JICA Study Team

Figure 5.4 Sub-Area Basin Map (Struga)

Table 5.5 Improvement Priority (Struga)

Basin	Sewer Length	Drainage Length	Differ. Length Sewer-Drainage	Construction Period *1		from WQ analysis *2		from Visual Servey *3		Priority *4
-	m	m	m	-		-		-		-
A	2,283		2,283	1991-2000	2	(2)	2			**C**
B	1,048	344	704	1971-1990	3	(2)	2			**C**
C	7,971	-	-	2000-	2	(4)	4			**B**
D	767		767	2001-2010 (PFRPOL)	1	(2)	2			**D**
E	7,732	843	6,889	1965-1979	4	(1)	1	X	2	**B**
F	2,086	436	1,650	1971-1990	3	(2)	2			**C**
G	1,318		1,318	1971-1990	3	(3)	3			**B**
H	1,874	442	1,432	1991-2000	2	(1)	1			**D**
I	see Ohrid Table			1971-1990	3	(2)	2			**C**
J	2,012	1,226	786	1991-2000	2	(2)	2			**C**
K	1,395	1,170	225	1971-1990	3	(2)	2			**C**
L	2,019	951	1,068	1971-1990	3	(2)	2			**C**
M	2,367	1,192	1,175	1991-2000	2	(2)	2	X	2	**B**
N	2,783		2,783	2000-2010	1	(2)	2			**D**
O	1,506	394	1,112	1971-1990	3	(2)	2			**C**
P	1,418		1,418	1971-2000	3	(1)	1			**C**

PFRPOL: Project for Ecological Protection of Ohrid Lake financed by KfW
*1) score 1 in 2000-, score 2 in 1990-1999, score 3 in 1980-1989, score 4 in -1979
*2) Range of the results of water quality analysis:
(1): COD > 100 mg/L, (2): 100 mg/L > COD > 50 mg/L, (3): 50 mg/L > COD > 20 mg/L, (4): COD < 20 mg/L
*3) Marked “X” when there is a damaged sewer or defected sewer in the basin, and it score 2 points
*4) The priority A : total score ≥ 8, B: total ≥ 6, C: total ≥ 4, D: total < 4
Source: JICA Study Team

(2) Summary of Candidates

1) Rehabilitation of the Existing Primary Sewer

The rehabilitation work to the existing primary sewer to reduce unidentified water is the candidate. However, as mentioned later, the costs of the renewal rehabilitation method are generally slightly lower than the cost of pipe construction in Japan, whereas the pipe construction cost in Macedonia is much lower than that in Japan. Therefore the renewal rehabilitation cost exceeds the pipe construction cost in Macedonia because the renewal method is imported from Japan and the price may therefore remain unchanged.

2) Rehabilitation of the Existing Secondary/Tertiary Sewer

Since the sewerage system was not designed to handle a combined sewer system, the intrusion of storm water is completely beyond coverage. This means heavily affected connections must be alleviated by providing a separate sewer (or drainage) to divide the storm water from the wastewater system.

a) Review on the Impacts on the Intrusion of External Water Source into the Sewer System

To understand the current situation of the sewer system that has suffered from unexpected infiltration of external sources such as ground water and storm water (by rainy events and in some cases lake water), the impacts on the intrusive water against the performance of wastewater treatment process was simulated based on the method of estimating load into the public bodies.

b) Dilution Ratio from Actual Records

Using statistical records on the daily performance of wastewater treatment at the Vranista WWTP and the report on the water supply data which was accumulated records from metered water quantities supplied to users, the dilution ratio of wastewater reaching the WWTP was compared.
According to the monthly record of discharged effluent which was accumulated data taken at Vranista WWTP, it is clear that the flow quantity is really flat and the daily converted wastewater flow ranged from around 37,000-45,000 m^3/day. On the contrary, the daily supplied water quantity from the yearly data ranges between 8,900-9,700 m^3/day, hence the gap between wastewater flows exceed more than 400%.

Table 5.6 Dilution Ratio from the Actual Performance Record

Item	Unit	2007	2008	2009	2010	2011	Remarks
Average Supplied Water Quantity (Sewerage Area)	m^3/day	9,719	9,648	9,553	8,907	9,590	(1)
Average Treated Wastewater at WWTP	m^3/day	42,111	45,258	44,667	37,029	38,812	(2)
Ratio of Dilution at WWTP	%	433%	469%	468%	416%	405%	(3)=(1)/(2)

Source: PROAQUA

c) Estimation of Population (Variation of Tourist Population)

To estimate the impact on infiltration, the performance during the rainy season must be simulated and the fluctuation of tourist population is a key factor used to elaborate the model.
In the simulation, only the sewerage-served area is targeted, hence the proportion of tourist population in the served area is given as below to estimate the population during the rainy season at 49.5%.

Table 5.7 Proportion of Tourist Population in the Sewerage Area

Unit: People

Tourist Population	Distribution		Proportion	
	Sewerage	Unserved	Sewerage	Unserved
13,880	6,876	7,004	49.5%	50.5%

Source: JICA Study Team

Using the proportion identified, the tourist population under peak condition and the rainy season were determined. The population under peak condition is set based on the population using the same value when the load of BOD was calculated (data in July), and the rainy season was determined from the date in December chosen due to having the highest rainfall and lowest record in terms of influent water quality in the influences at the Vranista WWTP, which might be caused by dilution with storm water.

Table 5.8 Estimated Population (2010)

Unit: People

Item	Domestic	Tourist	Total
Peak Condition	68,074	6,876	74,950
Rainy Season	68,074	898*	68,972
Yearly Average	68,074	1,826*	69,900

* Tourist Population (Rainy Season):
= [Tourist Population (December)] x [Proportion of Sewerage Area (%)]
* Tourist Population (Yearly Average):
= [Tourist Population (Average)] x [Proportion of Sewerage Area (%)]
Source: JICA Study Team

d) Unit Wastewater Quantity

The unit wastewater quantity is one of the unknown factors and was calculated by assuming other sources of water contained in sewage. In the survey, other sources of water components are assumed by considering two main factors, one of which is infiltration (at 15%, the tolerable extent for typical utilities) and the other public water usage (unaccountable water for private users also at 15%), comprising 30% of the supplied water quantity in total. The survey applies the unit wastewater quantity at 180 Lpcd.

Table 5.9 Estimation of Wastewater Quantity per Capita

Item	Total Population* (People)	Wastewater Flow (m^3/day)				per Capita (Lpcd)
		Supplied Water**	Other Sources***		Assumed Wastewater	
			%	Quantity		
Peak Condition	74,950	10,282	30%	3,085	13,367	178
Yearly Average	69,900	9,590	30%	2,877	12,467	178

* Population includes tourist population
** Supplied Water (Peak Condition): Calculated in terms of proportion of population
*** Other Sources assume 50% of other components of water such as proper infiltration (15%) and public usage etc. (15%)
Source: JICA Study Team

e) Actual Water Qualities and Reduction Ratios at WWTP

The actual water quality is the key element on account of evaluating the dilution ratios, which will be the key factor impacting on dilutions. In the highest profiles throughout the year, data in July and August were selected which mostly exceeded 120 mg/L in BOD, while the lowest period was represented with data from January and December. They coincide with the peak condition and rainy season respectively.

Table 5.10 Average Water Qualities (BOD)

Unit: mg/L

Item	Highest Period			Lowest Period		
	July	August	Average	January	December	Average
BOD at Influent	124.96	125.85	125.40	51.72	53.92	52.82
BOD at Effluent	10.70	12.92	11.81	13.46	7.28	10.37

Source: JICA Study Team

Table 5.11 Averaged Influent in Recent Years

Unit: mg/L

Month	2008	2009	2010	2011	Average
January	**64.35**	**67.52**	**40.00**	**35.00**	51.72
February	75.69	75.36	55.77	30.00	59.21
March	84.21	84.23	70.62	36.25	68.83
April	96.57	96.56	47.68	131.25	93.02
May	105.48	105.65	54.80	65.00	82.73
June	114.57	115.24	92.26	80.00	100.52
July	**128.34**	**121.57**	70.19	71.00	124.96
August	**127.64**	**125.36**	**124.56**	75.00	125.85
September	109.34	110.26	85.65	96.00	100.31
October	92.37	95.32	73.46	82.00	85.79
November	87.54	80.23	47.50	103.33	79.65
December	**75.32**	**75.36**	**30.00**	**35.00**	53.92

* Influent in Peak Condition (July & August) excluded some data which showed lower values than usual situations
July: excluded data in 2010 and 2011, August excluded in 2011
source: PROAQUA

Table 5.12 Averaged Effluent in Recent Years

Unit: mg/L

Month	2008	2009	2010	2011	Average
January	**18.45**	**16.42**	**14.96**	**4.00**	13.46
February	30.73	12.46	8.87	3.66	13.93
March	35.40	6.60	8.98	3.33	13.58
April	25.40	6.45	11.14	4.50	11.87
May	24.40	6.50	8.79	4.25	10.99
June	16.60	5.35	12.29	5.00	9.81
July	**16.90**	**8.58**	**12.05**	**5.25**	10.70
August	**12.90**	**19.58**	**14.70**	**4.50**	12.92
September	11.85	11.84	11.96	5.75	10.35
October	9.10	14.85	11.95	5.35	10.31
November	9.90	10.33	4.50	5.67	7.60
December	**9.20**	**12.40**	**3.00**	**4.50**	7.28

Source: PROAQUA

f) Wastewater Flow and Design Water Quality

The wastewater flow and design water quality were calculated for the basis of the comparison in the simulation. The wastewater flow was identified by determining the population and unit wastewater flow and the flows were set at 13,346 m³/day under peak condition and 12,270 m³/day during the rainy season respectively. By applying unit loads which were used in the review on load (60 gpcd for domestic/tourist, 9 gpcd for industry), the design wastewater qualities were determined.

Table 5.13 Wastewater Flow and Design Water Quality

Item	Population			Unit Flow* (Lpcd)	Wastewater Flow (m³/day)			Load in BOD (kg/day)	BOD (mg/L)
	Residential	Tourist	Total		Residential	Tourist	Total		
Peak Condition	68,074	6,876	74,950	178	12,117	1,224	13,341	5,110	383
Rainy Season	68,074	898	68,972	178	12,117	160	12,277	4,751	387

* Unit flow is assumed to include other sources such as infiltration and public usage etc.
* Unit Load (in BOD): Domestic (including Industrial) = 69 gpcd, Tourist = 60 gpcd

Source: JICA Study Team

g) Evaluations of Dilution Ratio and Treatable Quantity of Original Sewage Component

The results of the comparison between the calculated BOD load unaffected by unexpected infiltration and actual influent revealed a dilution ratio of 302% under peak condition and 724% during the rainy season. The removal ratios identified from actual data were 91% under peak condition and 80% during the rainy season, both of which were within the criteria of the EU directives.

Table 5.14 Water Quality and Dilution Ratio

Item	Calculated BOD (mg/L)	Actual BOD at WWTP			Dilution Ratio (%)
		Influent (mg/L)	Effluent (mg/L)	Removal Ratio	
	(1)	(2)	(3)	(4)=1-(3)/(2)	(5)=(1)/(2)
Peak Condition	383	125.40	11.81	91%	305%
Rainy Season	387	52.82	10.37	80%	733%

Source: JICA Study Team

Using the assumed original sewage (unaffected by unexpected infiltration) and dilution ratio, the diluted sewage quantity was calculated and the treatable sewage component at the WWTP was distributed based on the nominal capacity of the WWTP (40,000 m^3/day). According to the results, under the peak condition, virtually the whole of the original sewage component was covered by the WWTP, however during the rainy season, the diluted sewage rose to nearly 89,000 m^3/day (2.2 times larger than the nominal capacity of the WWTP) and only 45% of sewage component was covered by the WWTP.

Table 5.15 Water Quality and Dilution Ratio

Item	Original Sewage (m^3/day)	Capacity of WWTP (m^3/day)	Dilution Ratio (%)	Diluted Sewage (m^3/day)	Sewerage Component		
					to WWTP (m^3/day)	Untreated (m^3/day)	Treatable (%)
	(1)	(2)	(3)	(4)=(1)*(3)	(5)=(2)/(1)*(4)	(6)=(1)-(5)	(7)=(5)/(1)
Peak Condition	13,341	40,000	305%	40,746	13,097	244	98.2%
Rainy Season	12,277	40,000	733%	89,949	5,460	6,817	44.5%

Source: JICA Study Team

h) Summary of Discharged Load into Public Bodies

If the incoming wastewater can be treated properly at the Vranista WWTP, sewage is completely diverted into the Black Drim River without being discharged into Ohrid Lake. However the capacity of the WWTP (equivalent to intermediate pump stations and primary sewers) is exceeded due to the ingress of unexpected infiltration into the system, hence the diluted sewage is subject to the risk of overflow during rainy events.
The summary table indicates that the discharged load is reduced down to 0.7% of potential load before treatment into the lake under peak condition (or supposedly under other moderate weather conditions), but during the rainy season, in the worst case and as far as existing data suggests, the discharged load increased by around 70 times and the overall removal ratio declined to 45%.

Table 5.16 Distribution of Discharged Load

Item	Category	Unit	Peak Condition	Rainy Season	Remarks
Sewerage Quantity	-	m³/day	13,341	12,277	(1)
Treatable Capacity	-	%	98.2%	44.5%	(2)
Distributed Sewage Quantity	Treated	m³/day	13,097	5,460	(3)=(1)*(2)
	Untreated	m³/day	244	6,817	(4)=(1)*(1-(2))
Potential Load	-	kgBOD/day	5,110	4,751	(5)
Incoming Load to Sewerage	Treated	kgBOD/day	5,018	2,114	(6)=(5)*(2)
	Untreated	kgBOD/day	92	2,637	(7)=(5)-(1-(2))
Reduction Ratio through Treatment	Treated	%	90.6%	80.4%	(8), from Actual Performance
	Untreated	%	0.0%	0.0%	(9), No pre-treatment
Discharged Load to Public Bodies	Treated	kgBOD/day	472	415	(10)=(6)*(1-(8))
	Untreated	kgBOD/day	92	2,637	(11)=(7)*(1-(9))
	Total	kgBOD/day	564	3,052	(12)=(10)+(11)
Proportion of Discharged Load to Public Bodies	Treated	%	83.8%	13.6%	(13)=(10)/(12)
	Untreated	%	16.2%	86.4%	(14)=(11)/(12)
	Total	%	100.0%	100.0%	(15)=(13)+(14)
Destination of Discharged Load	Treated	-	Black Drim River		
	Untreated	-	Ohrid Lake		
Discharged Load to Public Bodies (by Destination)	Ohrid Lake	kgBOD/day	92	2,637	(16)=(11)
	Drim River	kgBOD/day	472	415	(17)=(10)
	Total	kgBOD/day	564	3,052	(18)=(16)+(17)

Source: JICA Study Team

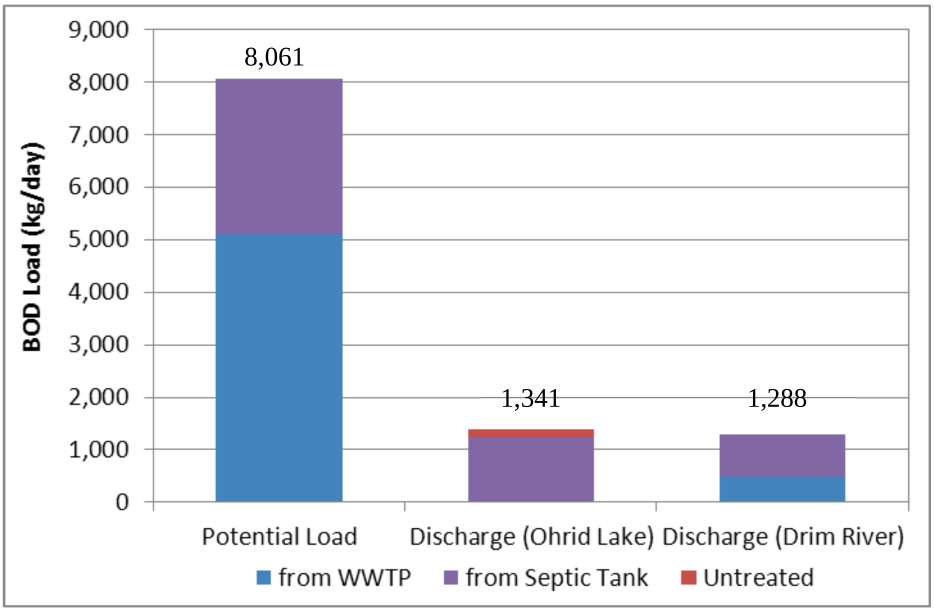
Table 5.17 Summary of Peak Discharged Load

Unit: kg/day

Item		from Sewerage Area: Treated	from Sewerage Area: Untreated	from Sewerage Area: Total	from Unserved Area	Total
Potential Load		5,110	-	5,110	2,951	8,061
Discharging Bodies	Ohrid Lake	0	92	92	1,250	1,342
	Black Drim River	472	0	472	816	1,288
	Total	472	92	564	2,066	2,630
Reduction Ratio		-	-	89.0%	30.0%	67.4%

* Existing impacts of individual WWTPs excluded (considered negligible)

Source: JICA Study Team



* Potential load includes an area belonging to the basin of the Black Drim River (14% of the total)
Source: JICA Study Team

Figure 5.5 Summary of the Peak Discharged Load

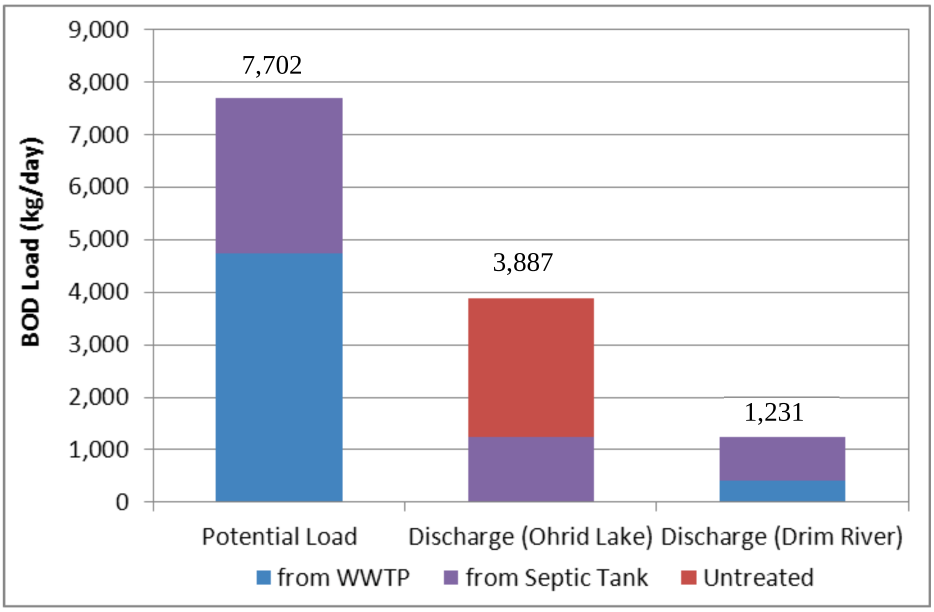
Table 5.18 Summary of Discharged Load during the Rainy Season

Unit: kg/day

Item		from Sewerage Area			from Unserved Area	Total
		Treated	Untreated	Total		
Potential Load		4,751	-	4,751	2,951	7,702
Discharging Bodies	Ohrid Lake	0	2,637	2,637	1,250	3,887
	Black Drim River	415	0	415	816	1,231
	Total	415	2,637	3,052	2,066	5,118
Reduction Ratio		-	-	35.8%	30.0%	33.6%

* Existing impacts of individual WWTPs excluded (considered negligible)

Source: JICA Study Team



* Potential load includes an area belonging to the basin of the Black Drim River (14% of the total)
Source: JICA Study Team

Figure 5.6 Summary of Discharged Load during the Rainy Season

The following table focuses on the impact only to Ohrid Lake and an overall reduction ratio of 80.8% under peak conditions (including septic tanks) would decrease to 39.6% during storm events. Enhancement of the current operation, especially at the WWTP and neighboring pump stations, to an optimal state is thus ultimately implied to cope with a reduction in the unexpected extent of infiltrations.

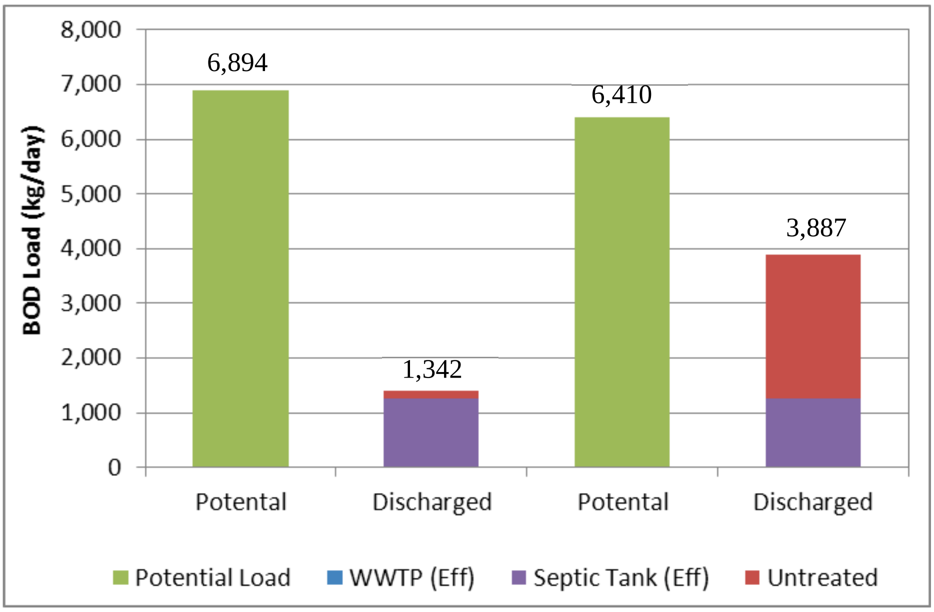
Table 5.19 Summary of Load into Ohrid Lake

Item		Load (kgBOD/day)		Remarks
		Peak Condition	Rainy Season	
Potential Load to Ohrid Lake	Sewerage Area	5,110	4,751	
	Unserved Area	1,785	1,785	
	Sub-Total	6,894 (100.0%)	6,410 (100.0%)	(a)
Discharged Load into Ohrid Lake	from WWTP	0 (0.0%)	0 (0.0%)	
	from Septic Tank	1,250 (18.1%)	1,250 (19.5%)	
	Untreated	92 (1.3%)	2,637 (41.1%)	Chance of Overflow*
	Total	1,342 (19.5%)	3,887 (60.6%)	(b)
Overall Reduction Ratio		80.5%	39.4%	(c)=1-(b)/(a)

* Existing impacts of individual WWTPs excluded (considered negligible)

* Potentially there are chances of being discharged from emergency outfall before reaching the WWTP during storm events

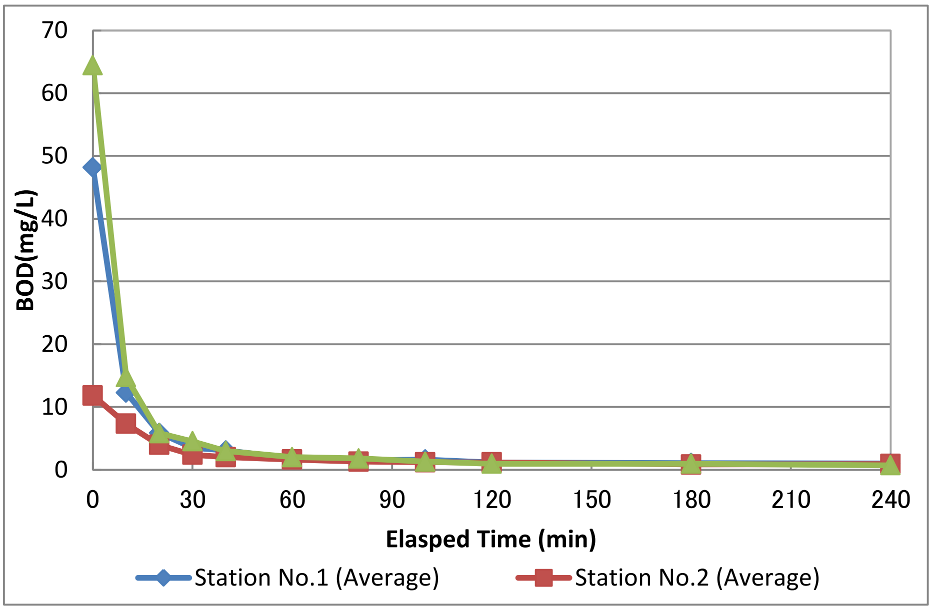
Source: JICA Study Team



* Existing impacts of individual WWTPs excluded (considered negligible)
Source: JICA Study Team

Figure 5.7 Summary of Load into Ohrid Lake

In relate to the impacts on discharged storm water component into the lake, actually storm water contains pollutant load which is attributed from pollutants piled up on the road and substances attached to the walls of gutters and the load is mainly discharged at the beginning of each rain falls.
However the load generally becomes emptied within 30 minutes, and the averaged load will be equivalent to 5 – 10 % of the load contained in the domestic wastewater. This is why the impact from storm water is much lower than the impact of the sewage components which are overflown during the rainy events.



Source: National Institute for Land and Infrastructure Management, Japan

Figure 5.8 Example of Impacts of Pollutant Load contained in Storm Water

j) Summary and Proposed Countermeasure

According to the results of the review on the presumed impacts of the chance of discharge of pollutants in the rainy events because of the excessive infiltration, the magnitude of this impact isn't negligible.
From the viewpoint of alleviating the chance of the impact, the following options are come up.

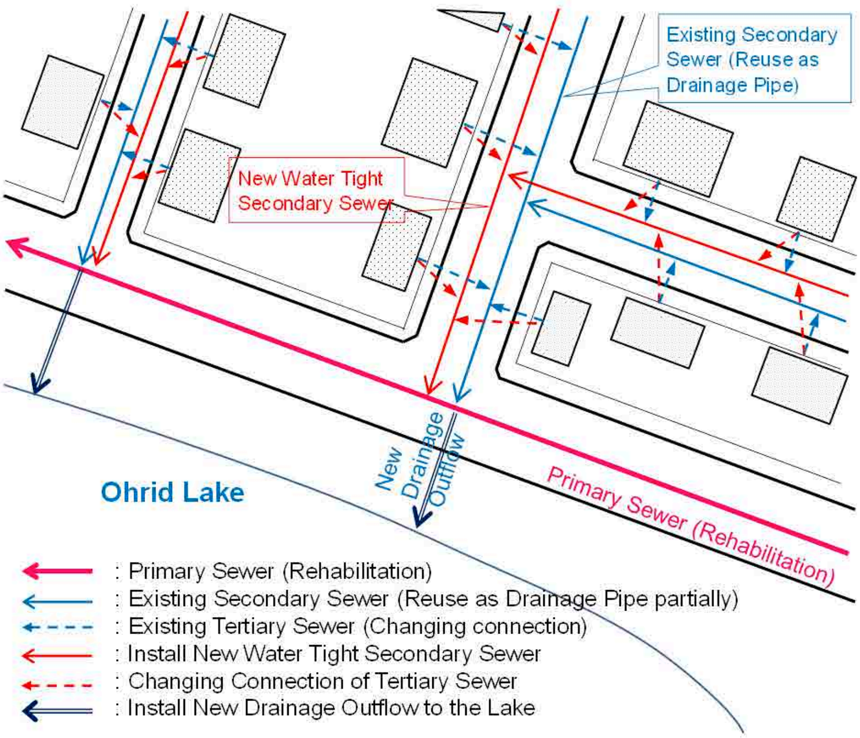
Option 1: Increasing capacity of wastewater treatment plant
To cover the excessive inflow from existing secondary and tertiary sewer system, the capacity of the wastewater treatment plant as well as installing additional capacities in pump stations and existing primary sewer system. However the existing collecting system was designed separate system and the additional investment will be very large, Moreover, the excessive energy consumption will not be alleviated.

Option 2: Installing New Secondary Sewer
To alleviate the excessive infiltration, installing water tight sewer pipes will be the most valueable option in terms of reducing unexpected intrusion of ground water, storm water and lake water. While the new pipes are installed, resin made pipes and rubber fitting can work properly to protect from intruding external water into sewer system and wild connections are also inspected and corrected. Existing sewer pipes are also utilized as a part of drainage pipe line if the depth and the capacity can fit to required conditions. Existing house connection pipes are basically connected to rebuilt tertiary sewers.

Option 3: Installing Separate Drainage
To reduce infiltration, completion of separating system is also one of major countermeasures to drain out storm water component by drainage network and infiltration of storm water can be alleviated. This method is easier in terms of construction works when a comparison is made with installing sewers because the construction doesn't require restructuring house connections but the effectiveness will be smaller than installing sewers because the existing sewer system still has problems in condition of materials and connections.

After the comparisons of these three options, JICA Study Team reached that the proposed option is to install new water tight sewer instead of existing sewers and it can stop unexpected excessive infiltration which suffers functions of existing wastewater collection system and its treatment process in rainy seasons.

The image of rehabilitation of primary sewer and secondary / tertiary sewer is shown below;



Source: JICA Study Team

Figure 5.9 Image of rehabilitation sewers

The advantage and disadvantage points for each method of existing sewer rehabilitation is listed below;

Table 5.20 Comparison of rehabilitation method

No.	Activity	Advantageous Point	Disadvantageous Point
1	Installing New Water Tight Sewer	Most effectively work to control infiltration	Complexity of Connecting Works
		Mild construction cost (Shallow, Small Pipes)	Longest construction period necessary
		Infiltration being less by changing manhole lids	
		Remaining pipe utilized as Drainage (Storm Water Pipe, if Applicable)	
2	Installing Drainage to Complete Separate Sewer	Attaining full coverage of separate sewer system	Elimination of the infiltration is not assured
		No change of house connection required	Quality of existing sewer is not upgraded
		Slightly expensive construction cost	Inflow from Manhole Lids also necessary to be considered
3	Rehabilitating Existing Sewer with Renewal / Repair Method	No change of house connection required	Most expensive work if renewal method applied
		No cut - cover works necessary during construction	Difficult to detect the right points to be fixed
			Inflow from Manhole Lids also necessary to be considered

*Environmental aspect is basically same if infiltration is controlled at same degree to eliminate any risk of discharging raw sewage from primary sewers
Source: JICA study team

(3) Introduction of Sewer Repair and Rehabilitation Method

As prevention from intrusion of the unidentified water, the typical repair method and rehabilitation method which are broadly used in Japan are introduced below:

The sewer repair and rehabilitation method which is used in Japan is classified some types by the constraints of construction and economic efficiency. The list of the sewer repair and rehabilitation method is shown below:

Table 5.21 Sewer Repair & Rehabilitation Method

Type			Name
Rehabilitation	Pipe frame construction in existing pipe	Stand-alone pipe	Cured-in-place pipe inversion method
			Fold and formed method
		Composite pipe	Spiral liner method
		Dual layer pipe	Cured-in-place pipe inversion method
			Formation method
		Others	Slipling method
Repair	Waterproof element		Impregnation method
			Ring method
	Pipe coating		Lining method
(Reconstruction)			Pipe reconstruction

Source: Planning Manual of the Influx Water Prevention for the Separate Sewage System, JIWET

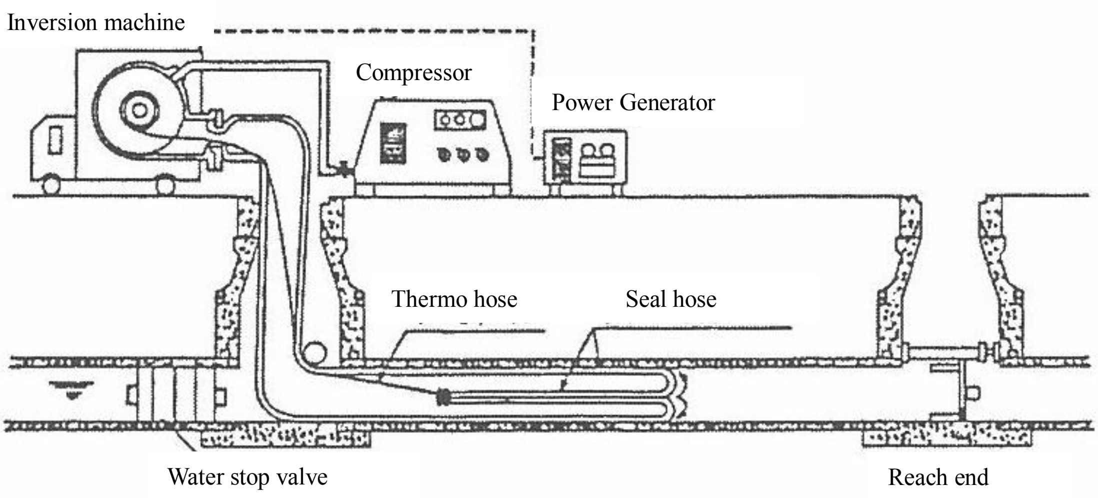
1) Sewer Rehabilitation Method

The sewer rehabilitation method is conducted when the pipe gets seriously damaged or the life period of the pipe doesn't remain. The rehabilitated pipe will have the original strength (it could be a stand-alone), and the

life period will be restored.
The examples of the sewer rehabilitation method are shown below:

a) Cured-in-Place Pipe Inversion Method

The repairing tube which material is the hardening resin with heat or light is inserted to the existing pipe with water / air pressure, and the inversion tube will be formed as the new constituent inside the existing pipe. Even if the pipe is heavily damaged or cracked without retaining the original pipe shape, this method would be appropriate.

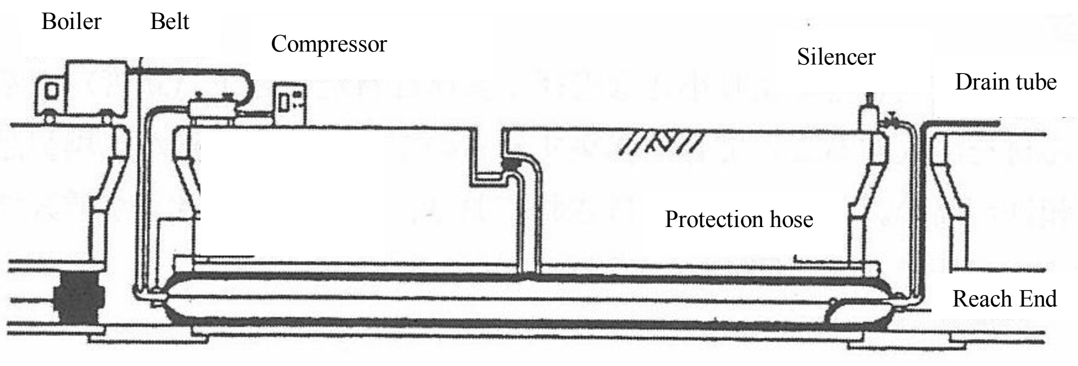


Source: Sewer Facility Maintenance Manual, 1997, Japan Sewer Collection System Maintenance Association

Figure 5.10 Cured-in-Place Pipe Inversion Method

b) Fold and Formed Method

This is a repairing method by inserting the repairing pipe which contents fibers impregnated with a hardening resin. The hardening process is that the repairing pipe would be extended and crimped by water or air pressure, and formed as the new constituent pipe. It is possible to load and unload the required equipment from the existing manholes; this method could be constructed without digging.

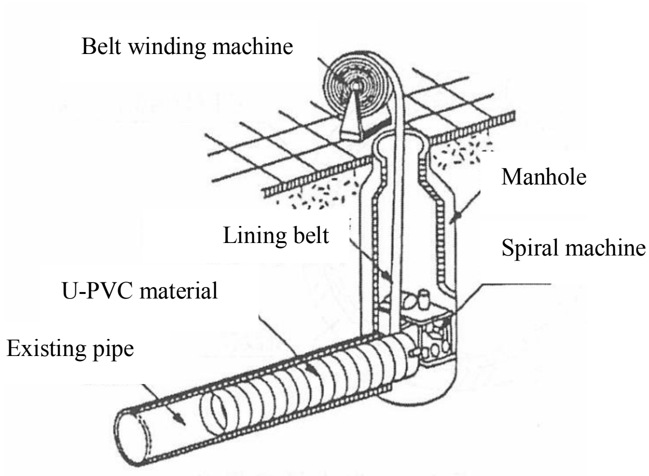


Source: Design and Construction Management Manual for Sewer Rehabilitation, Japan Sewage Works Association

Figure 5.11 Fold and Formed Method

c) Spiral Liner Method

This method entails constructing a rehabilitating pipe made by rigid U-PVC profile inside aged concrete-made pipeline, and integrates by injecting SPR back filling material into annular spaces between host and rehabilitating pipe to make the composite pipe.

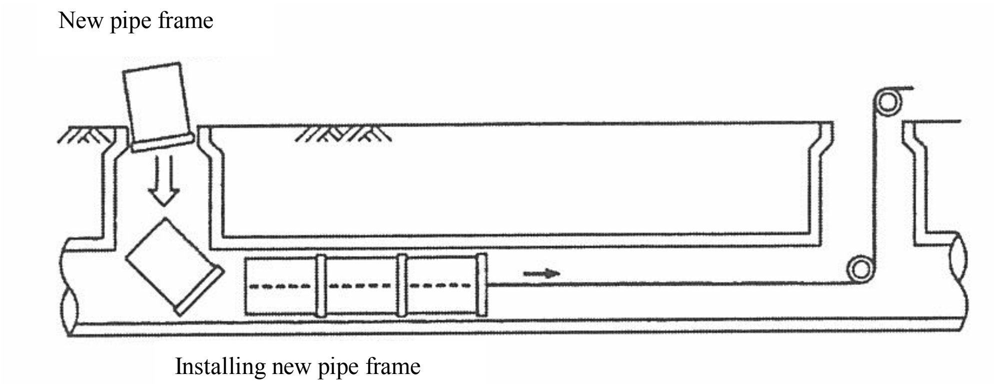


Source: Design and Construction Management Manual for Sewer Rehabilitation, Japan Sewage Works Association

Figure 5.12 Spiral Liner Method

d) Slipling Method

This method that entails the casing of pipes using self-standing pipes that are superior in lightweight, high strength, earthquake resistance characteristics. Enable long-distance installation via conveyance without rack rails.



Source: Design and Construction Management Manual for Sewer Rehabilitation, Japan Sewage Works Association

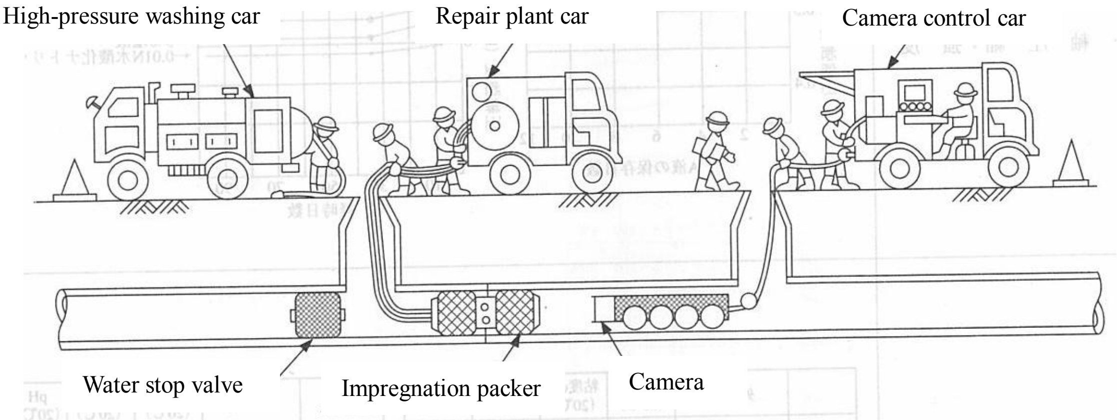
Figure 5.13 Slipling Method

2) Sewer Repair Method

The sewer repair method is conducted when the pipe gets partially damaged and the life period of the pipe still remains long. This method is to repair partially, so the life period of the pipe will not be changed.
The examples of the sewer repair method are shown below:

a) Impregnation Method

This method is that the water proof material will be impregnated to the crack and loose joint points. This method is valid for the loose joint, missing the rubber ring, and crack of the sewer.

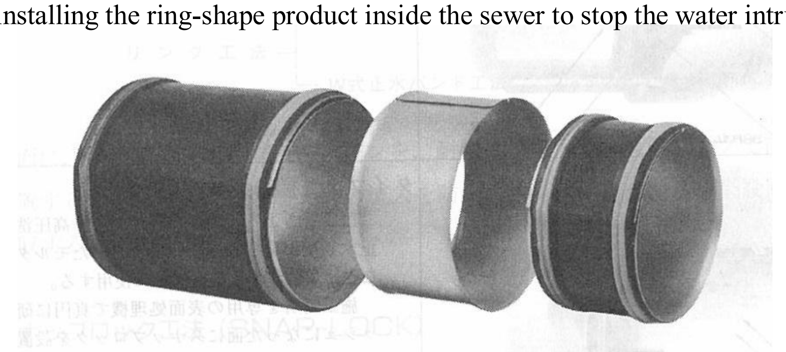


Source: Sewer Facility Maintenance Manual, 1997, Japan Sewer Collection System Maintenance Association

Figure 5.14 Impregnation Method

b) Ring method

This method is that installing the ring-shape product inside the sewer to stop the water intrusion

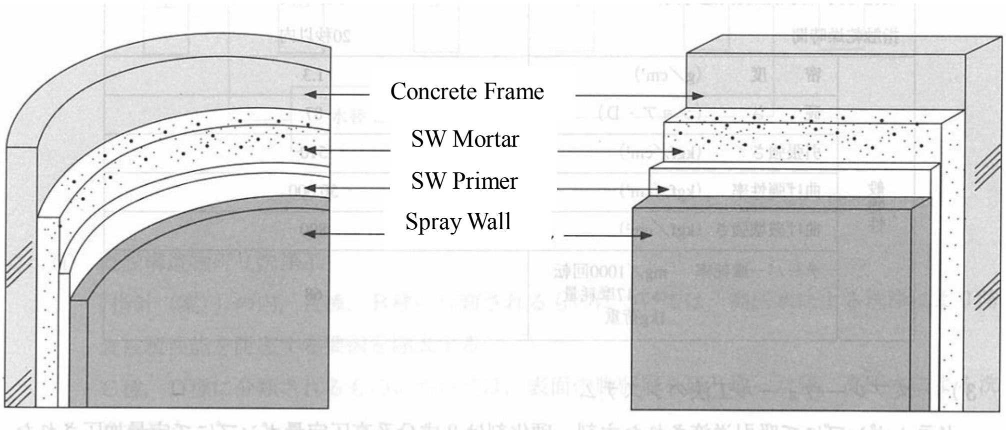


Source: Sewer Facility Maintenance Manual, 1997, Japan Sewer Collection System Maintenance Association

Figure 5.15 Ring method

c) Lining method

This method is that rigid urethane resin will be sprayed to the damaged points and the sewer will be recovered its durability. This could be protected against corrosion.



Source: Sewer Facility Maintenance Manual, 1997, Japan Sewer Collection System Maintenance Association

Figure 5.16 Lining method

3) Pipe reconstruction

This method is that the damaged pipe would be reconstructed to partially exchange to the new pipe. This is the fundamental method to repair the damaged pipe, but sometimes it is difficult to reconstruct because of the condition of the existing pipe or the traffic condition. And this method might cost more than the other repair method, so the other method would be adopted.

5.5.2 Expansion of the Sewerage System into Unserved Area

(1) Review of the Current Situation and Proposed Candidates

Some communities and communes remain outside the sewerage area, and the domestic and commercial/industrial wastewater from their communities might be influenced by the lake environment.
In line with regulations in Macedonia, all houses and buildings without sewerage connections must have a septic tank installed, so all wastewater is subject to minimum treatment processes in some sense. Since unserved communes have few residents and the impact of the wastewater on the environment is considered small, this method would be sufficient for the water environment of Ohrid Lake. However, if the impact to the environment might be considered not to be negligible, development of sewerage system has to be carried out even in this area. By developing the system, sludge treatment and costs which are currently posed on to the establishment of septic tanks will be reformed and proper maintenance will contribute to the environment of the lake eventually.

In this section, JICA Study Team proposes candidates for environmental improvement facilities, such as small wastewater treatment facilities or connections to the existing sewerage network and estimates their approximate costs in the following sections.

To improve the water environmental improvement of Ohrid Lake, the following candidates exist, as listed below:

1) Connecting to the existing sewerage network to treat in the Vranista WWTP

The sewer network could be expanded to connect with houses and buildings in the surrounding sewerage area, and the wastewater would be gathered and treated in the Vranista WWTP. This method would incur the cost of expanding the pipe network. Moreover, additional cost might be needed to expand the treatment plant if the plant capacity is restricted.

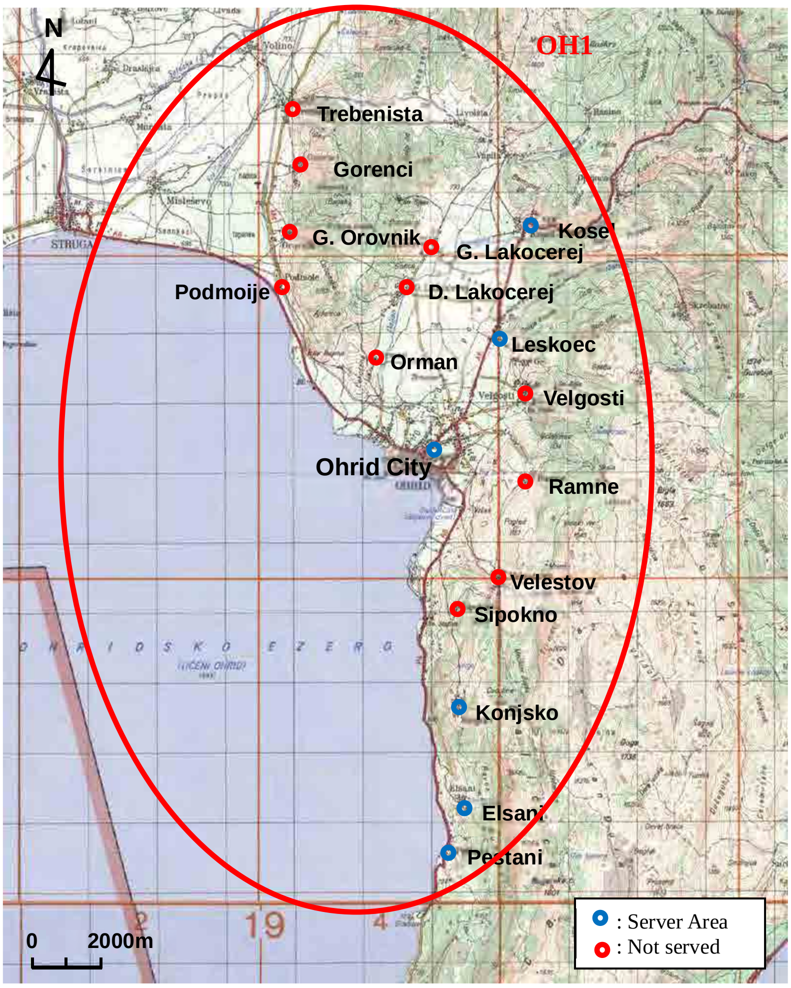
2) Constructing of small treatment facilities in each community

This is the treatment method involving the construction of small treatment facilities for each independent community, such as the on-site facility in the army campsite in St. Naum and the campsite in Radozda. This method will incur the cost of constructing the treatment plant and a pipe network for each community, but the scale of the plant would be small, thus making it cost-effective. Moreover, the method can be coordinated to suit the characteristics of each community and region, e.g. taking account of geographical and social issues.

The potential of each method listed in the previous section should be discussed, taking into account regional and geographical characteristics. The contents of the discussions and the potential for each region's treatment method are shown below:

(2) Area adjacent to Ohrid City

As mentioned in the previous chapters, there is a sewer network from Pestani - Ohrid - Podmoije PS - SateskaPS to Struga III PS in this region (OH1). This region also features a relatively flat or gentle slope. The existing primary sewer pipe is generally located at the lowest point and there is a downward slope to the primary sewer pipe (see Figure below). This facilitates the connection of the pipeline to the existing network.
Ohrid City is trying to expand the sewage area with the city's general tax revenue and although the pace of the expansion is relatively slow, steady progress is possible.
From a comprehensive viewpoints, JICA Study Team reached that the recommended option is to develop these sites under the helps by local municipalities.



Source: JICA Study Team

Figure 5.17 Area adjacent to Ohrid City

Table 5.22 The pipe length in Unserved Sewerage Area

City / Village	Area (ha)	Sewerage		Sewerage Served Area (2010)		Zoning	Pipe Density (m/ha)	Pipe Length (m)
		Served Area	Ratio (%)	Served	Unserved			
Ohrid	1,200.00	x	100%	1,200.00	0.00	OH1	150	0
Pestani	41.30	x	30%	12.39	28.91	OH1	150	4,337
Elsani, Elesec Lagadin	44.00	x	30%	13.20	30.80	OH1	150	4,620
Konjsko, Dolno Konjsko, Istok	47.68	x	30%	14.30	33.38	OH1	150	5,007
Sipokno, St. Stefan	10.00		0%	0.00	10.00	OH1	150	1,500
Velestovo, Raca	17.38	x	50%	8.69	8.69	OH1	150	1,304
Ramne	16.20		0%	0.00	16.20	OH1	150	2,430
Velgosti	112.10	x	30%	33.63	78.47	OH1	150	11,771
Leskoec	110.00	x	30%	33.00	77.00	OH1	150	11,550
Orman	15.50		0%	0.00	15.50	OH1	150	2,325
G. Lakocerej	30.85		0%	0.00	30.85	OH1	150	4,628
D. Lakocerej	56.40		0%	0.00	56.40	OH1	150	8,460
Kosel	90.48		0%	0.00	90.48	OH1	150	13,572
Podmolje	41.50	x	30%	12.45	29.05	OH1	150	4,358
Orovnik	31.70		0%	0.00	31.70	OH1	150	4,755
Gorenci	14.15		0%	0.00	14.15	OH1	150	2,123
Trebenista	39.37		0%	0.00	39.37	OH1	150	5,906

Source: JICA Study Team

(3) Area adjacent to Struga City

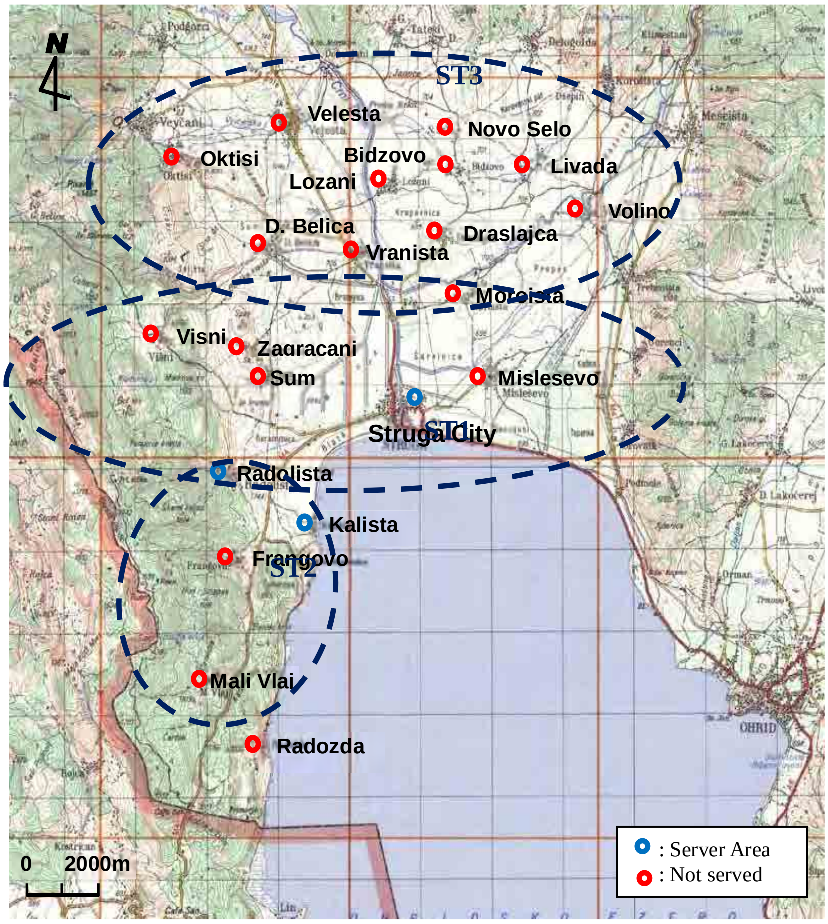
As mentioned in the previous chapters also, there is a sewer network from Elen Kamen - Kalista - Radolista - to Struga in this region (ST1). The system from Elen Kamen - Kalista does not currently function in the upstream area now due to failures of pumping stations. This region includes a relatively flat portion of land (see Figure below), which facilitates the connection of the pipeline to the existing network.

In the northern part of Struga municipality (ST3), the water does not go to Ohrid Lake directly but to the Black Drim River based on the geographical incline, so the wastewater from this area does not impact on the lake environment. However, the load from this area affects the Black Drim River and the downstream environment of the river.

In the south-western part of Struga municipality (ST2), there are relatively few residents and an on-site treatment facility for the campsite at Radozda, meaning little impact from the loads in this area on the lake environment (-0.5% after completion of the sewerage system: see previous Chapter).
Struga City is also trying to expand the sewage area with the city's general tax revenue, and despite the slow pace of expansion, it is proceeding slowly and steadily.
From a comprehensive viewpoints, JICA Study Team reached that the recommended option is to develop these sites under the helps by local municipalities.

The area adjacent to Struga city is shown below and the sewer pipe length which needs to be constructed in the unserved sewerage area (ST1 & ST2) is listed in the table below:

(ST3 area is not the direct Ohrid Lake basin but the Black Drim River basin, so this area is excepted the urgent sewerage area.)



Source: JICA Study Team

Figure 5.18 Area adjacent to Struga City

Table 5.23 The pipe length in unserved sewerage area

City / Village	Area (ha)	Sewerage		Sewerage Served Area (2010)		Zoning	Pipe Density (m/ha)	Pipe Length (m)
		Served Area	Ratio (%)	Served	Unserved			
Struga	380.00	x	100%	380.00	0.00	ST1	150	0
Mislesevo	108.00		0%	0.00	108.00	ST1	150	16,200
Moroista	90.44		0%	0.00	90.44	ST3	150	13,566
Volino	33.88		0%	0.00	33.88	ST3	150	5,082
Livada	130.00		0%	0.00	130.00	ST3	150	19,500
Draslajca	50.00		0%	0.00	50.00	ST3	150	7,500
Bidzovo	51.28		0%	0.00	51.28	ST3	150	7,692
Novo Selo	10.30		0%	0.00	10.30	ST3	150	1,545
Lozani	42.70		0%	0.00	42.70	ST3	150	6,405
Vranista	89.70		0%	0.00	89.70	ST3	150	13,455
D. Belica	55.00		0%	0.00	55.00	ST3	150	8,250
Velesta	236.26		0%	0.00	236.26	ST3	150	35,439
Visni	24.01		0%	0.00	24.01	ST1	150	3,602
Sum. Zagracani	110.56		0%	0.00	110.56	ST1	150	16,584
Radolista	142.88	x	100%	142.88	0.00	ST1	150	0
Kalista	47.18	x	20%	9.44	37.74	ST2	150	5,661
Frangovo	65.00		0%	0.00	65.00	ST2	150	9,750
Radozda *	37.00		0%	0.00	37.00	ST2	150	5,550
Oktisi	150.00		0%	0.00	150.00	ST3	150	22,500
Mali Vlaj	11.40		0%	0.00	11.40	ST2	150	1,710

Source: JICA Study Team

(4) Summary of Candidates

1) Expansion in Radozda, Struga

Constructing a primary pipe to connect to the existing network is the candidate in the Radozda area, and a pump facility might be needed to connect the existing network.

2) Expansion in Adjacent Communes, Ohrid

Constructing a sewer pipe to connect to the existing network is the candidate in communes adjacent to Ohrid city (OH1).

3) Expansion in Adjacent Communes, Struga

Constructing a sewer pipe to connect to the existing network is the candidate in communes adjacent to Struga city (ST1).

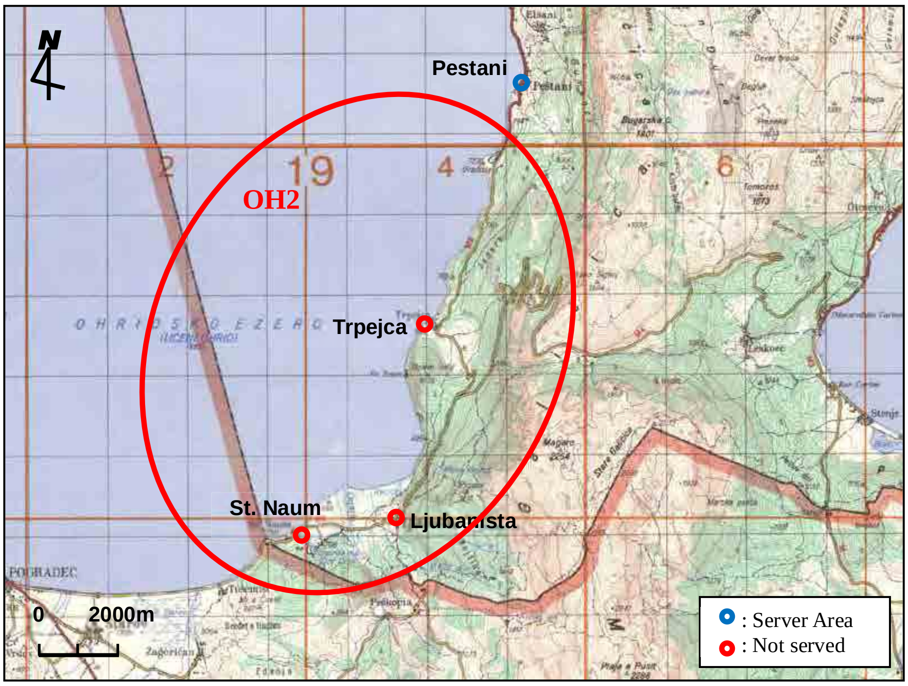
5.5.3 Establishment of Small Scale Wastewater Treatment Facilities

(1) Review of the Current Situation and Proposed Candidates

The Southern Ohrid municipality region (OH2) includes steep hills and height differences between St. Naum, Ljubanista - Trpejca - Pestani (Southern Ohrid municipality: See Figure below), and the soil here is karst and mainly rock and hard soil. This means constructing a pipe network to connect to the existing network is difficult and costly, and a pressurized system is needed to flow over the hill. Since connecting to the existing sewer network is geographically inefficient and uneconomical, JICA Study Team does not recommend this method for southern Ohrid municipality.

Conversely, although Ljubanista and Trpejca have relatively small populations (502, 383 people respectively in 2010), this region is close to the lake shore and there are many hotels/guesthouses, so the tourist population is large. Besides, the wastewater from the houses and buildings is directly affected by the lake environment because of the location, so centralized treatments (small treatment facilities) for each community are recommended to maintain the facilities easily and appropriately.
Moreover, since there are existing sewers and drainage pipes in Trpejca, the facilities could be used to convey the wastewater and rainwater.

In addition, a feasibility study performed by the South-West Planning Region and supported by KfW was concluded to have small treatment facilities as well.
To improve the water environmental of Ohrid Lake, constructing small treatment facilities in each community is the candidate. This is the treatment method involving the construction of small treatment facilities for each independent community, such as the on-site facility in the army campsite in St. Naum and the campsite in Radozda. This method will incur the cost of constructing a treatment plant and pipe network for each community, but the scale of the plant and its cost would be small. Moreover, the method can be coordinated with the characteristics of each community and region, such as geographical and social issues.



Source: JICA Study Team

Figure 5.19 Southern Ohrid Municipality

From the population and wastewater volume in Ljubanista and Trpejca, the parameters of the wastewater facility in both areas are shown below:

Table 5.24 Wastewater Facility Parameter in Southern Ohrid Municipality

Items	Unit	Ljubanista	Trpejca
Population	people	502	383
Tourist population	people	2,742	2,970
Total population	People	3,244	3,353
Area	ha	37	18
Wastewater flow	m^3/s	600	650
Treatment method	-	Activated sludge method	Activated sludge method
Pipe length	m	5,670	5,291
Occupation area	m^2	3,400	3,600
Sludge treatment	-	Thickening at the site & take it to Vranista	

Source: JICA Study Team

(2) Summary of Candidates

1) Wastewater Treatment Facility in Ljubanista

The small wastewater treatment facility for Ljbanista is the candidate.

2) Wastewater Treatment Facility in Trpejca

The small wastewater treatment facility for Trpejca using the existing sewer network is the candidate.

5.6 Cost Estimations

5.6.1 Reduction of Unexpected Infiltration

(1) Repair and Rehabilitation of the Existing Primary Sewer

The phenomenon of unexpected inflow caused by the malfunctioning of the system can only be detected under dry conditions; hence inspections will be carried out in summer before the rainy season, which will result in indecision based on the storm water carried by the combined system

1) Surveillance using mobile flow meters to determine dominant sections
2) Surveillance using an in-pipe video camera to identify the causes of malfunctioning
3) Rehabilitation and replacement works based on examinations
4) An inventory survey to identify the history of an installation area

The cost estimation table for the primary sewer repair and rehabilitation is shown below:

Table 5.25 Estimated Cost of Primary Sewer Repair and Rehabilitation

Priority		Length (m)	Rep. Diam (mm)	Repair & Rehabilitation Cost (thousand)		
				JPY	EUR	MKD
Primary Sewer of Priority A	Sewer Repair Work in Ohrid	1,045	1000	11,886	121	7,442
		3,337	1200	53,406	542	33,333
	Rehabilitation*	2,191	-	793,299	8,051	495,137
Primary Sewer of Priority B	Ohrid South	3,252	600	16,916	172	10,578
		4,550	800	10,411	106	6,519
	Ohrid – Struga	11,677	1200	186,880	1,896	116,604
	Struga – Radolista	7,971	500	35,197	357	21,956
Primary Sewer of Priority C	Ohrid South	1,717	500	7,582	77	4,736
		1,576	600	8,198	83	5,105
All Primary		35,125		1,123,774	11,404	701,346
Primary Sewer of priority A		4,382		858,591	8,713	535,850
Primary Sewer of priority A + B		31,832		1,107,994	11,244	691,507

*Sewer rehabilitation (Spiral liner method) will be conducted in the half length of the primary sewer in the Priority A
Source: JICA Study Team

The primary sewer requiring repair and rehabilitation work is based on the results of the site survey in previous chapters.
For rehabilitation and repair of the primary sewer, the spiral liner method and impregnation method will be appropriate in this case. However, the construction year of the primary sewers are not very old (~ 1970), so the all section of the primary sewer don't need the spiral liner method because this method will be adopted for aged or heavily damaged pipe, such as the pipe over the life period (the period of a pipe is around 50-70 years), to be higher its waterproof performance and to be extended its life period.

Therefore, the primary sewer might be rehabilitated with using both the spiral liner method and the impregnation method in order with a priority level, and most high priority area (heavily damaged pipe) should be used the spiral liner method more and the less priority section would be used just the impregnation method.

(For the cost estimation in this section, the repair cost is calculated for 4 % of the cost for which all the section is rehabilitated with the spiral liner method: the rehabilitation cost of spiral liner method is based on the cost in Japan.)

In this cost estimation, all of the primary sewer is considered to repair with the impregnation method or the waterproof half method, however, the primary sewers in the highest priority section (priority A) will be considered to adopt the spiral liner method in the half of the section length (4,382m / 2 = 2,191m) because the sewer pipe in this section might be damaged heavily according to the site survey.

Almost all sections of the primary sewer require repair and rehabilitation with some priority; however, there is little difference between the water quality analysis results of Struga III PS and the Vranista WWTP, so JICA Study Team determined that this section was not significantly impacted by unidentified water.
Moreover, in the area upstream of Radolista, the pump stations urgently need reinstallation and rehabilitation, so JICA Study Team considered the repair and rehabilitation of the primary sewer in this section to be relatively non-urgent work.

The repair and rehabilitation work for the entire primary sewer would cost about 1,124 million JPY (11,404 thousand EUR: 701 million MKD), whereas 859 million JPY (8,713 thousand EUR: 536 million MKD) would be required for the repair and rehabilitation work in the highest priority section, as determined by the site survey in the previous chapters.

To narrow down which is the priority section of the primary sewer and identify the rehabilitation points, more detailed surveillance will be needed. The repair and rehabilitation work should be planned and conducted effectively with more detailed surveillance, and the cost of the rehabilitation work will be narrowed down.

(2) New Construction of Secondary/Tertiary Sewers

The cost estimation table for the new construction of a secondary/tertiary sewer is shown in the following section.
This cost assumes that the new watertight sewer pipe, such as a PV pipe with careful construction work, will not infiltrate unidentified water, and may enable the use of the existing sewer pipe network as a drainage facility (drainage network).

The rehabilitation cost of newly construction sewer was roughly estimated based on the direct construction cost in Ohrid which JICA Study Team got the data from Niskogradba in this survey and the average breakdown ratio in Japan because the given cost was not included the temporary construction cost, the recovery cost and etc. Moreover it may cost more when the open-cut construction method would be conducted at the historic area, but the additional cost was not taken into account in this rough estimation.

The cost of reconstructing the entire sewer is about 2,058 million JPY (20,882 thousand EUR: 1,284 million MKD) in Ohrid City and about 728 million JPY (7,391 thousand EUR: 455 million MKD) in Struga City.

Since the construction priorities have been decided with the results of this site survey, JICA Study Team can now discuss the actual construction after the detail survey.

From the interview in this survey, the significant flood damage did not happen, so it could be said that the drainage performance as the combined system is enough for the rainfall. Therefore after new secondary sewer constructed beside the existing sewer, the existing sewer might be able to use as the drainage sewer partially. This method could be help for the efficiency of the drainage network construction.
In order to reuse the secondary sewer as the drainage sewer, they will have the drainage out let to the lake, so the construction cost of the outlet is also calculated in this section.

Table 5.26 Estimated Cost of Rehabilitation of Existing Sewer Network in Ohrid City

Basin	Sewer Length	Site Survey Results*	Construction Cost of New Secondary sewer			Connection Pipe Length	Construction Cost of Connection sewer			Construction Cost of New Sewer (total)		
Unit	m	-	thousand JPY	thousand EUR	thousand MKD	m	thousand JPY	thousand EUR	thousand MKD	thousand JPY	thousand EUR	thousand MKD
A	15,444	(1)	287,355	2,916	179,342	8,108	133,525	1,355.03	83,334	420,880	4,271	262,676
B	4,664	(4)	86,780	881	54,160	2,449	40,324	409.21	25,166	127,103	1,290	79,327
C	2,346	(3)	43,650	443	27,243	1,232	20,283	205.83	12,659	63,933	649	39,901
D	4,591	(3)	85,421	867	53,312	2,410	39,693	402.81	24,773	125,114	1,270	78,085
E	3,268	(4)	60,805	617	37,949	1,716	28,254	286.73	17,634	89,059	904	55,583
F	3,757	(3)	69,904	709	43,628	1,972	32,482	329.63	20,272	102,386	1,039	63,900
G	3,014	(2)	56,079	569	35,000	1,582	26,058	264.44	16,263	82,137	834	51,263
H	5,241	(4)	97,515	990	60,861	2,752	45,312	459.84	28,280	142,828	1,449	89,140
I	3,677	(2)	68,415	694	42,699	1,930	31,790	322.61	19,841	100,206	1,017	62,539
J	6,347	(2)	118,094	1,198	73,704	3,332	54,874	556.87	34,248	172,968	1,755	107,952
K	3,609	(3)	67,150	681	41,909	1,895	31,202	316.65	19,474	98,352	998	61,383
L	3,313	(3)	61,643	626	38,472	1,739	28,643	290.68	17,877	90,286	916	56,348
M	6,994	(2)	130,132	1,321	81,217	3,672	60,468	613.64	37,739	190,600	1,934	118,956
N	3,414	(3)	63,522	645	39,645	1,792	29,517	299.54	18,422	93,038	944	58,066
O	5,827	(2)	108,419	1,100	67,665	3,059	50,379	511.25	31,442	158,797	1,612	99,107

*: Range of the results of water quality analysis

(1): COD>100mg/L, (2):100mg/L>COD>50mg/L, (3):50mg/L>COD>20mg/L, (4):COD<20mg/L

Source: JICA Study Team

Table 5.27 Estimated Cost of Rehabilitation of Existing Sewer Network in Struga City

Basin	Sewer Length	Site Survey Results*	Construction Cost of New Secondary sewer			Connection Pipe Length	Construction Cost of Connection sewer			Construction Cost of New Sewer (total)		
unit	m	-	thousand JPY	thousand EUR	thousand MKD	m	thousand JPY	thousand EUR	thousand MKD	thousand JPY	thousand EUR	thousand MKD
A	2,283	(2)	42,478	431	26,511	719	11,843	120	7,391	54,321	551	33,902
B	1,048	(2)	19,499	198	12,170	330	5,436	55	3,393	24,936	253	15,563
D	767	(2)	14,271	145	8,907	242	3,979	40	2,483	18,250	185	11,390
E	7,732	(1)	143,864	1,460	89,787	2,436	40,109	407	25,033	183,973	1,867	114,820
F	2,086	(2)	38,813	394	24,223	657	10,821	110	6,754	49,634	504	30,977
G	1,318	(3)	24,523	249	15,305	415	6,837	69	4,267	31,360	318	19,572
H	1,874	(1)	34,868	354	21,762	590	9,721	99	6,067	44,589	453	27,829
I	2,012	(2)	37,436	380	23,364	634	10,437	106	6,514	47,873	486	29,878
J	1,395	(2)	25,956	263	16,199	439	7,236	73	4,516	33,192	337	20,716
K	2,019	(2)	37,566	381	23,445	636	10,473	106	6,537	48,039	488	29,982
L	2,367	(2)	44,041	447	27,487	746	12,279	125	7,663	56,320	572	35,150
M	2,783	(2)	51,781	525	32,317	877	14,437	147	9,010	66,218	672	41,327
N	1,506	(2)	28,021	284	17,488	474	7,812	79	4,876	35,833	364	22,364
O	1,418	(2)	26,384	268	16,466	447	7,356	75	4,591	33,739	342	21,057

*: Range of the results of water quality analysis

(1): COD>100mg/L, (2):100mg/L>COD>50mg/L, (3):50mg/L>COD>20mg/L, (4):COD<20mg/L

Source: JICA Study Team

Table 5.28 Summary of Cost Estimation for Rehabilitation in Ohrid

Priority	Sewer Length	Survey Results	Construction Cost of New Sewer		
-	m	-	thousand JPY	thousand EUR	thousand MKD
A	13,173	(4)	358,990	3,643	224,050
B	21,030	(3)	573,109	5,816	357,684
C	25,859	(2)	704,709	7,152	439,817
D	15,444	(1)	420,880	4,271	262,676
A+B	34,203		932,099	9,459	581,735
A+B+C	60,062		1,636,808	16,611	1,021,552
All	75,506		2,057,688	20,882	1,284,228

Source: JICA Study Team

Table 5.29 Summary of Cost Estimation for Rehabilitation in Struga

Priority	Sewer Length	Survey Results	Construction Cost of New Sewer		
-	m	-	thousand JPY	thousand EUR	thousand MKD
A	0	(4)	0	0	0
B	1,318	(3)	31,360	318	19,572
C	19,684	(2)	468,355	4,753	292,306
D	9,606	(1)	228,562	2,319	142,648
A+B	1,318		31,360	318	19,572
A+B+C	21,002		499,715	5,071	311,878
All	30,608		728,277	7,391	454,527

Source: JICA Study Team

Table 5.30 Cost Estimation for Drainage Outlet Construction

City	Drainage Length	Diameter	Construction Cost of Drainage Outlet		
-	m	mm	thousand JPY	thousand EUR	thousand MKD
Ohrid	2,100	1000	87,803	891	54,799
Struga	1,500	500	43,909	446	27,404

Source: JICA Study Team

5.6.2 Expansion of the Sewerage System into Unserved Area

The listed candidates of the wastewater in the previous section for the area adjacent to Ohrid and Struga cities, the construction cost of pipe network in each commune and the connection to the existing sewer network are estimated as shown below:

Table 5.31 Estimated Cost of Connection to the Existing Sewer Network

No.	Municipality	City / Village	Zoning	Sewage served area	Pipe Length (m)	Cost Estimation (thousand)		
						JPY	EUR	MKD
1	Ohrid	Ohrid	OH1	x	0	0	0	0
2	Ohrid	Ljubanista	OH2		0	0	0	0
3	Ohrid	Trpejca	OH2		0	0	0	0
4	Ohrid	Pestani	OH1	x	4,337	0	0	0
5	Ohrid	Elsani, Elesec Lagadin	OH1	x	4,620	0	0	0
6	Ohrid	Konjsko, Dolno Konjsko, Istok	OH1	x	5,007	0	0	0
7	Ohrid	Sipokno, St. Stefan	OH1		1,500	24,702	251	15,417
8	Ohrid	Velestovo, Raca	OH1	x	1,304	0	0	0
9	Ohrid	Ramne	OH1		2,430	40,017	406	24,975
10	Ohrid	Velgosti	OH1	x	11,771	0	0	0
11	Ohrid	Leskoec	OH1	x	11,550	0	0	0
12	Ohrid	Orman	OH1		2,325	38,288	389	23,896
13	Ohrid	G. Lakocerej	OH1		4,628	76,206	773	47,561
14	Ohrid	D. Lakocerej	OH1		8,460	139,320	1,414	86,951
15	Ohrid	Kosel	OH1		13,572	223,504	2,268	139,492
16	Ohrid	Podmolje	OH1	x	4,358	0	0	0
17	Ohrid	Orovnik	OH1		4,755	78,306	795	48,871
18	Ohrid	Gorenci	OH1		2,123	34,953	355	21,815
19	Ohrid	Trebenista	OH1		5,906	97,252	987	60,696
20	Struga	Struga	ST1	x	0	0	0	0
21	Struga	Mislesevo	ST1		16,200	266,782	2,707	166,502
22	Struga	Moroista	ST3		13,566	223,406	2,267	139,430
23	Struga	Volino	ST3		5,082	83,691	849	52,232
24	Struga	Livada	ST3		19,500	321,127	3,259	200,419
25	Struga	Draslajca	ST3		7,500	123,510	1,253	77,084
26	Struga	Bidzovo	ST3		7,692	126,672	1,285	79,058
27	Struga	Novo Selo	ST3		1,545	25,443	258	15,879
28	Struga	Lozani	ST3		6,405	105,478	1,070	65,830
29	Struga	Vranista	ST3		13,455	221,578	2,249	138,289
30	Struga	D. Belica	ST3		8,250	135,861	1,379	84,793
31	Struga	Velesta	ST3		35,439	583,611	5,923	364,239
32	Struga	Visni	ST1		3,602	59,310	602	37,016
33	Struga	Sum. Zagracani	ST1		16,584	273,106	2,772	170,449
34	Struga	Radolista	ST1	x	0	0	0	0
35	Struga	Kalista	ST2	x	5,661	0	0	0
36	Struga	Frangovo	ST2		9,750	160,563	1,629	100,210
37	Struga	Radozda *	ST2		5,550	99,398	1,009	62,035
38	Struga	Oktisi	ST3		22,500	370,531	3,760	231,253

No.	Munici pality	City / Village	Zoning	Sewage served area	Pipe Length (m)	Cost Estimation (thousand)		
						JPY	EUR	MKD
39	Struga	Mali Vlaj	ST2		1,710	28,160	286	17,575
Sub Total (Ohrid)					88,643	**752,549**	**7,637**	**469,675**
Construction Required area (OH1)					88,643	**752,549**	**7,637**	**469,675**
Sub Total (Struga)					199,991	**3,208,228**	**32,558**	**2,002,294**
Construction Required area (ST1)					36,386	**599,198**	**6,081**	**373,967**
Total					288,634	**3,960,776**	**40,195**	**2,471,968**

*The construction cost was estimated includes the pump facilities
Source: JICA Study Team

In this cost estimation, the sewage served areas but not completely constructed the all sewer in it are not calculated the construction cost of the rest area because the served area could be constructed with their efforts. (ex. In Pestani, the sewer network is now constructed, so the cost estimation of expanding the sewage system is not earmarked in this survey.)

From the cost estimation arranged above, the total estimated costs for pipe construction (both the connection from every commune surrounding Ohrid City and Struga City except southern Ohrid municipality to the existing sewer network and the second sewer network in the communes) are 753 million JPY (7,637 thousand EUR: 470 million MKD) in Ohrid municipality and 599 million JPY (6,081 thousand EUR: 374 million MKD) in Struga municipality respectively.

(1) Expansion in Radozda, Struga

The construction cost of the expansion in Radozda, Struga is 99 million JPY (1,009 thousand EUR: 62 million MKD); which includes the pump facility to connect the existing network with the pipe in Elen Kamen.

(2) Expansion in Adjacent Communes, Ohrid

The construction cost of the expansion in adjacent communes to Ohrid city (OH1) is about 753 million JPY (7,637 thousand EUR: 470 million MKD).

(3) Expansion in Adjacent Communes, Struga

The construction cost of the expansion in adjacent communes to Struga city (ST1) is about 599 million JPY (6,081 thousand EUR: 374 million MKD).

5.6.3 Establishment of Small Scale Wastewater Treatment Facilities

The listed candidate of the wastewater in the previous section for the southern Ohrid municipality, which is Ljubanista and Trpejca, the construction cost of small treatment facilities for each of the communes and the connection to the existing sewer network is estimated as shown below:

Table 5.32 Cost Estimation in Southern Ohrid Municipality

Village	Total Population	Sewer Flow	TreatPlant Const.Cost	Sewer Pipe Length	Pipe Const. Cost	Total Const.Cost		
Unit	people	m^3/day	thousand JPY	m	thousand JPY	thousand JPY	thousand EUR	thousand MKD
Ljubanista	3,175	600	124,919	5,670	93,374	**218,293**	**2,215**	**136,239**
St.Naum	69							
Trpejca	3,353	650	130,542	5,291	87,132	**217,674**	**2,209**	**135,853**
Total	6,597		255,461	10,961	180,506	**435,967**	**4,424**	**272,092**

*The treatment plant construction cost is estimated with cost equation in Japan.
Source: JICA Study Team

(1) Wastewater Treatment Facility in Ljubanista

The construction cost of the small treatment facility in Ljubanista is about 218 million JPY (2,215 thousand EUR: 136 million MKD).

(2) Wastewater Treatment Facility in Trpejca

The construction cost of the small treatment facility in Trpejca is about 218 million JPY (2,209 thousand EUR: 136 million MKD).

5.6.4 Cost Benefit Comparisons for Candidate Options

The activities identified as candidate options were compared by dividing by the number of beneficiaries and benefits (represented by the removed BOD load) so that the "unit cost" of each activity could be referenced. According to the results, a reduction in unexpected infiltration by rehabilitating the existing sewer network (rehabilitation of the primary sewer using renewal works and waterproof repairs, installing new watertight sewers instead of an existing secondary/tertiary network) is the lowest investment per beneficiary and removed BOD load so that the risk of discharging raw sewage could be eliminated in accordance with the criteria. The comparison was made using construction costs without considering O&M costs because it is difficult to compare on the same line the cost of rehabilitating existing system and expansions of new sewerage area.

(1) Beneficiaries

Beneficiaries were calculated based on the size of candidate options and summarized as follows.

Table 5.33 Summary of Beneficiaries

Unit: Person

Activity	Beneficiary (Population)			Remarks
	Resi dential	Tourist	Total	
(1) Reduction of Unexpected Infiltration	68,074	6,418	74,492	Sewerage Area
Rehabilitation of Existing Primary Sewer	-	-	-	
Rehabilitation of Existing Secondary / Tertiary Sewer	-	-	-	
(2) Expansion of Sewerage System in Unserved Area	11,616	2,843	14,459	
Expansion in Radozda, Struga	884	395	1,279	
Expansion in Adjacent Communes, Ohrid	5,246	554	5,800	OH1 (Zoning)
Expansion in Adjacent Communes, Struga	5,486	1,894	7,380	ST1 (Zoning)
(3) Small Scaled Wastewater Treatment Facilities	885	4,554	5,439	
Wastewater Treatment Facility in Ljubanista	502	2,186	2,688	
Wastewater Treatment Facility in Trpejca	383	2,368	2,751	

Tourist Population is applied at Peak Condition

Source: JICA Study Team

(2) Benefits represented by removed BOD

Benefits were calculated using potential loads and anticipated reduction of loads after the establishment of candidate options and summarized as below.

Table 5.34 Summary of Benefits

Unit: kgBOD/day

Activity	Potential Load			Effluent Load	Removed Load
	Resi dential	Tourist	Total		
(1) Reduction of Unexpected Infiltration	4,697	385	5,082	508	4,574
Rehabilitation of Existing Primary Sewer	-	-	-	-	-
Rehabilitation of Existing Secondary / Tertiary Sewer	-	-	-	-	-
(2) Expansion of Sewerage System in Unserved Area	802	57	858	86	772
Expansion in Radozda, Struga	61	24	85	8	77
Expansion in Adjacent Communes, Ohrid	362	33	395	40	355
Expansion in Adjacent Communes, Struga	379	0	379	38	341
(3) Small Scaled Wastewater Treatment Facilities	61	273	334	34	300
Wastewater Treatment Facility in Ljubanista	35	131	166	17	149
Wastewater Treatment Facility in Trpejca	26	142	169	17	152

Source: JICA Study Team

(3) Construction Costs

Construction costs for each candidate option were listed based on the cost estimate. For the assumption of the estimate, components of Reduction of Unexpected Infiltration were calculated from;

1) Rehabilitatioin of Primary Sewer

- Renewal Method (such as SPR): app 2.0 km (6% of Priority A classified)
- Waterproof Method : 35 km equivalent

2) Rehabilitatioin of Secondary / Tertiary Sewer

- Installing New Water Tight Secondary Sewer: 106 km
- Installing New Water Tight Tertiary Sewer: approximately 50 km (to connect existing house connections)

Table 5.35 Summary of Costs for Candidate Options

Activity	Construction Cost		
	Thousand JPY	Thousand EUR	Thousand MKD
(1) Reduction of Unexpected Infiltration	4,041,450	41,013	2,522,303
Rehabilitation of Existing Primary Sewer	1,123,774	11,404	701,346
Rehabilitation of Existing Secondary / Tertiary Sewer	2,917,677	29,609	1,820,957
(2) Expansion of Sewerage System in Unserved Area	1,451,145	14,726	905,677
Expansion in Radozda, Struga	99,398	1,009	62,035
Expansion in Adjacent Communes, Ohrid	752,549	7,637	469,675
Expansion in Adjacent Communes, Struga	599,198	6,081	373,967
(3) Small Scaled Wastewater Treatment Facilities	435,967	4,424	272,092
Wastewater Treatment Facility in Ljubanista	218,293	2,215	136,239
Wastewater Treatment Facility in Trpejca	217,674	2,209	135,853
Total	5,928,562	60,164	3,700,072

Source: JICA Study Team

(4) Cost Benefit Comparisons

Cost benefit comparisons were made and the results were summarized as below.

1) Cost Benefit Comparisons (Beneficiaries)

From the results, Reduction of Unexpected Infiltration were the most beneficial project by comparing construction costs and beneficiaries. In this case, the beneficiaries are consisting of residential people living in the city central area and the investment will be concentrated than rural part of cities. On the contrary, the most costly option in the results was expansion (installing) secondary sewer system in Struga, it contains a large number of construction works in unserved area and compared by the population, unit cost will be raised due to population density. Same tendency was viewed in the expansion works for rest of Ohrid City area.

2) Cost Benefit Comparisons (Benefits represented by removed BOD)

Similar tendencies were calculated compared with beneficiaries because anticipated removed BOD loads are calculated based on the population which is counted as beneficiaries. Therefore the most cot efficient option was the Reduction of Unexpected Infiltration.

Table 5.36 Summary of Cost Benefit Comparisons for Candidate Options (Beneficiaries)

Activity	Construction Cost			Beneficiary (Person)	Cost / Benefit		
	thousand JPY	thousand EUR	thousand MKD		JPY/ Person	EUR/ Person	MKD/ Person
(1) Reduction of Unexpected Infiltration	4,041,450	41,013	2,522,303	74,492	54,253	551	33,860
Rehabilitation of the Existing Primary Sewer	1,123,774	11,404	701,346	-	-	-	-
Rehabilitation of Existing Secondary/Tertiary Sewer	2,917,677	29,609	1,820,957	-	-	-	-
(2) Expansion of the Sewerage System in Unserved Area	1,451,145	14,726	905,677	14,459	100,363	1,018	62,638
Expansion in Radozda, Struga	99,398	1,009	62,035	1,279	77,715	789	48,503
Expansion in Adjacent Communes, Ohrid	752,549	7,637	469,675	5,800	129,750	1,317	80,978
Expansion in Adjacent Communes, Struga	599,198	6,081	373,967	7,380	81,192	824	50,673
(3) Small Scale Wastewater Treatment Facilities	435,967	4,424	272,092	5,439	80,156	813	50,026
Wastewater Treatment Facility in Ljubanista	218,293	2,215	136,239	2,688	81,210	824	50,684
Wastewater Treatment Facility in Trpejca	217,674	2,209	135,853	2,751	79,125	803	49,383
Total	5,928,562	60,164	3,700,072	94,390	62,809	637	39,200

Source: JICA Study Team

Table 5.37 Summary of Cost Benefit Comparisons for Candidate Options (Removed BOD Load)

Activity	Construction Cost			Removed BOD (kg/day)	Cost / Benefit		
	thousand JPY	thousand EUR	thousand MKD		JPY/ kgBOD	EUR/ kgBOD	MKD/ kgBOD
(1) Reduction of Unexpected Infiltration	4,041,450	41,013	2,522,303	4,574	883,534	8,966	551,424
Rehabilitation of the Existing Primary Sewer	1,123,774	11,404	701,346	-	-	-	-
Rehabilitation of Existing Secondary/Tertiary Sewer	2,917,677	29,609	1,820,957	-	-	-	-
(2) Expansion of the Sewerage System in Unserved Area	1,451,145	14,726	905,677	772	1,878,739	19,066	1,172,543
Expansion in Radozda, Struga	99,398	1,009	62,035	77	1,296,346	13,156	809,065
Expansion in Adjacent Communes, Ohrid	752,549	7,637	469,675	355	2,118,696	21,501	1,322,304
Expansion in Adjacent Communes, Struga	599,198	6,081	373,967	341	1,759,584	17,857	1,098,178
(3) Small Scale Wastewater Treatment Facilities	435,967	4,424	272,092	300	1,451,656	14,732	905,996
Wastewater Treatment Facility in Ljubanista	218,293	2,215	136,239	149	1,466,813	14,885	915,455
Wastewater Treatment Facility in Trpejca	217,674	2,209	135,853	152	1,436,767	14,581	896,704
Total	5,928,562	60,164	3,700,072	5,647	1,049,877	10,654	655,241

Source: JICA Study Team

5.7 Selection of Candidate Projects

Candidate projects were selected from identified components as follows.

(1) Repair & Rehabilitation of Damaged Sewer Pipes

Repair & Rehabilitation of Damaged Sewer Pipes was selected as the most urgent component must be updated to alleviate current infiltrations by applying water proof materials to fix water tightness and repairing methods. This covers entire section of existing primary sewers.
Proposed components are inclusive of;

- Rehabilitation works using water stop methods covering entire sections of primary sewer system which will mainly be applied to joints of pipes
- Reparing works covering damaged pipes using repair methods, a part of primary sewer system

(2) On-Site Sewerage Facilities in Southern Ohrid

On-Site Sewerage Facilities in Southern Ohrid will construct small scaled wastewater treatment plants in the southernmost part of Ohrid Lake to complete wastewater treatment system in that part of area where it was recommended to cover by establishing decentralized system instead of expansion of sewerage system from Ohrid-Struga central area due to the difficulty of construction.
Proposed components are inclusive of;

- Small scaled wastewater treatment plants, totally two sites in Ljubanista and Trpejca
- Collecting sewer system covering residential area and access pipes to main tourist functions (In Trpejca, existing sewer lines will be used as sewer primary system

(3) Rehabilitation of Existing Sewer System

After the reviews on existing sewerage system, infiltration of external water sources causes serious lack of original capacity because the wastewater collection system which might lead discharging untreated wastewater into Ohrid Lake. JICA Study Team recommended that the installation of new water tight sewers instead of existing secondary and tertiary system.
Proposed components are inclusive of;

- Installation of secondary and tertiary sewers (resin pipes with rubber fittings)
- Construction of outlets for drainage system, utilizing existing sewer pipe if applicable
- Connection works of existing house connection pipe changed from existing tertiary system

Table 5.38 Summary of Candidate Projects

Item	Sewer Pipe		Pump Station	WWTP	Remarks
	Primary	Secondary			
(1)Repair & Rehabilitation of Damaged Sewer Pipes					
Renewal of Existing Primary Sewer	2 km	0 km	-	-	Considered by SPR method, 50% of Priority A (4.38 km)
Rehabilitation of Existing Primary Sewer	35 km	0 km	-	-	4% of rehabilitation is estimated (water stop method)
(2)On-Site Sewerage Facilities in Southern Ohrid					
Construction of WWTP	-	-	-	2 nos	600 m^3/d (Ljubanista) 650 m^3/d (Trpejca)
Secondary Sewer	-	11km	-	-	Roughly calculated
Tertiary Sewer	-	*	-	-	Considered in Unit Price
(3)Rehabilitation of Existing Sewer System					
Rehabilitation of Existing Secondary / Tertiary Sewer	-	106 km	-	-	Total length of Existing Secondary Sewers (tertiary is considered in Unit Price)

Source: JICA Study Team

Based on the reviews and comparisons of cost benefit, expansion of remaining sewer network in both Ohrid and Struga cities were excluded from candidate projects because of the following reasons;

- Expansion of sewer network in the central area has been conducted by PROAQUA under local finance and city area can be widened by their efforts because of higher population densities and accessibility from existing primary and secondary system
- Many of remaining smaller scaled communes are located near the existing primary sewer system which have potentiality of discharging pollutants to Ohrid Lake

Moreover, JICA Study Team also reached a conclusion that the expansion of the capacity of Vranista Wastewater Treatment Plant (or establishment of new wastewater treatment plant in order to cover excessive capacity of wastewater) because of the following reasons;

- Potentiality of discharging pollutants in rainy season is assumed more than three times larger than originally designed capacity based on separate system in volume of influent. It means that the larger scaled establishment is necessary if the potentiality of discharging untreated sewage in rainy events is fully controlled.
- Without any fundamental measurement to reduce containment of infiltration and storm water into sewerage system, energy consumption and operations will not be optimized to make them more stable even additional treatment facility is established to cover additional capacity
- Even if a new treatment plant is located in other location near from Ohrid City, effluent must be sent to the Black Drim River as same as current wastewater treatment system, this implies installation of long outlet which length is equivalent to current primary system and pump stations will also be required
- Therefore reduction of these external water components, rehabilitation works for sewer system was proposed

5.8 Estimated Loads from Albania

Ohrid Lake is an international lake sharing its border with Albania and roughly one third of the shoreline is Albania. The risk of generating pollutant loads derived from human activities from surrounding cities and communes throughout the entire Ohrid region makes it important to understand the contribution of the

Macedonian side in terms of activities against environmental protection, which can also justify the need to complete wastewater treatment in the area together with progress, even from Albanian sites.

5.8.1 Outline of Surrounding Cities and Communes in Albanian Sites

On the south side of Ohrid Lake, there are some cities and communes surrounding the lakeside belonging to Albania namely Pogradec, Udenisht, Trushmisht, Lin, etc. and all the sites share Ohrid Lake in terms of discharging pollutant loads via streams and the local sewerage system, the former function of which was merely to discharge untreated sewage into the lake.
According to the available information gathered through the survey, the potential population, including tourist activities, is about 60,000 people except for small-sized communes. Pogradec is the biggest city on the Albanian side, currently with nearly 40,000 people and the city has implemented a water and sewerage project with the assistance of donors mainly including SECO, the Swiss State Secretariat for Economic Affairs, and KfW, the German Government through its Development Bank. The wastewater treatment plant in Pogradec was built with assistance from the German side of 5 million EUR and capable of handling waste from a population of 54,000. The process of wastewater treatment employs trickling filters and an anaerobic pond for the main treatment streams, while wetland is utilized to refine the treated wastewater before it is discharged into a nearby canal headed for Ohrid Lake.

Table 5.39 Outline of the Sewage Treatment Plant in Pogradec

Item	Description	Remarks
Capacity	54,000 Population Equivalent	
Fund	KfW	5 million EUR
Preliminary Treatment	Mechanical grit removal, etc.	
Primary Treatment	Anaerobic Pond	
Secondary Treatment	Trickling Filters	
Clarification Process	Constructed Wetlands	
Sludge Treatment	Constructed Wetlands	

Source: KfW, University of Tirana, Albania

Table 5.40 Outline of the Population in Major Cities

No.	Name of City	Total Population	Sewerage		Sewerage-Served Population	
		Existing	Served Area	Ratio (%)	Served	Unserved
1	Pogradec	54,000	x	30%	16,200	37,800
2	Udenisht	6,000		0%	0	6,000
Total		60,000		0%	16,200	43,800

*Population of Pogradec contains tourists components

Source: JICA Study Team (Population taken from SECO, KfW, etc.)

5.8.2 Estimation of Pollutant Loads to Ohrid Lake

When estimating the pollutant load from Albanian sites, the technique used to estimate the potential and actually discharged loads was the same as that used to evaluate the pollutant loads in Chapter 2.
The potential load was calculated using the unit load (in BOD) as 60 gpcd, as the value used in the

assumptions for Ohrid-Struga. The distribution of sewerage-served population in Pogradec (at 30%) was applied based on existing operating conditions. The plant has newly built utilities and a connected network installed and newly constructed under the project, and sewage diverted from interceptors connected with the existing sewerage system which covers roughly 30% of the urban area of the city. In this calculation, the unit load for industrial use was not considered because the situation of industrial condition is unknown to set its proper value.

Table 5.41 Potential Load from the Albanian Site

No.	Name of City	Population			Unit Load (BOD)	Potential Load (kgBOD/day)		
		Residential		Total				
		Served	Unserved			Served	Unserved	Total
1	Pogradec	16,200	37,800	54,000	60(gpcd)	972	2,268	3,240
2	Udenisht	0	6,000	6,000	60(gpcd)	0	360	360
Total		16,200	43,800	60,000	60(gpcd)	972	2,628	3,600

Removal Ratio: 0%

Source: JICA Study Team

The discharged load into Ohrid Lake was identified by applying the same reduction ratios which were used in the estimation in Ohrid-Struga in the survey, 90% for sewerage systems and 30% for septic tanks.

Table 5.42 Discharged Load into Ohrid Lake

No.	City	Potential Load (kgBOD/day)			Reduction Ratio (%)		Assumed Discharged Load (kgBOD/day)		
		Served	Unserved	Total	Served	Unserved	Served	Unserved	Total
1	Pogradec	972	2,268	3,240	90%	30%	97	1,588	1,685
2	Udenisht	0	360	360	90%	30%	0	252	252
Total		972	2,628	3,600	-	-	97	1,840	1,937

Source: JICA Study Team

Based on the results of the estimation, Albania has a potential BOD load of approximately 3,600 kg/day and the discharged load was calculated at 1,937 kg/day, equating to an overall reduction ratio of around 46%. However the capacity of wastewater treatment plant is already ready for connection from the entire project area and the influent quantity will be increased by the progress of connections from the newly made sewer network system.

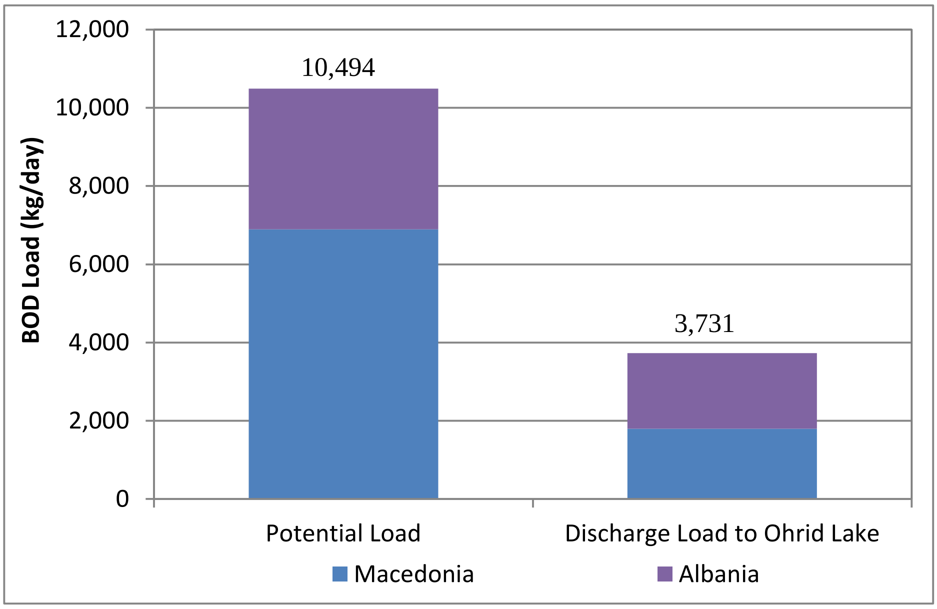
Currently, the potential pollutant load rooted in human activities in the surrounding Ohrid Lake is approximately 10,500 kg/day, 34% of which is sourced from Albania and the overall discharged load is calculated at 3,731 kg/day, with a general reduction ratio of 65%. Among the total load discharged, the share of the Albanian side is 52%.

Table 5.43 Summary of Impact on Ohrid Lake

Country	City	Total Population (People)	Potential Load (kgBOD/day)	Discharged Load e (kgBOD/day)			Impact to Ohrid Lake	
				Served	Unserved	Total	Potential (%)	Discharge (%)
Macedonia	Ohrid	67,676	4,580	348	770	1,118	43.6%	30.0%
Macedonia	Struga	34,074	2,314	157	519	676	22.1%	18.1%
Albania	Pogradec	54,000	3,240	97	1,588	1,685	30.9%	45.2%
Albania	Udenisht	6,000	360	0	252	252	3.4%	6.8%
Sub-Total (Macedonia)		101,750	6,894	505	1,289	1,794	65.7%	48.1%
Sub-Total (Albania)		60,000	3,600	97	1,840	1,937	34.3%	51.9%
Total		161,750	10,494	602	3,129	3,731	100.0%	100.0%

* Total Population and Potential Load of Struga are values applicable to the basin of Ohrid Lake

Source: JICA Study Team



* Potential Load of Struga is the values applicable to the basin of Ohrid Lake
Source: JICA Study Team

Figure 5.20 Summary of Impact on Ohrid Lake

Chapter 6 Remaining Issues and Needs

JICA Study Team conducted extensive fieldwork and interviews along with collection of data and information, and identified the following major issues related to the sewerage sector of the Ohrid-Struga sewerage system. The importance of some have long been ignored due to social and historical factors, while others have yet to be recognized by the management of PROAQUA or Niskogradba, because of subjective and cautious operation and a lack of focus on system maintenance.
JICA Study Team does hope that the management of the sewerage system will consider the following issues sincerely and constructively for improvement step by step.

6.1 Institutional Aspects

Organizations such as PROAQUA or Niskogradba should function collectively like a single organism, because the whole body should include consideration of all its parts. If one part is not working properly, other parts will certainly be affected by the malfunction. For example, if wastage occurs in operation, this will affect the financial soundness of the system and in serious cases, the management will deteriorate. In case the original wastewater is diluted with a large volume of unidentified ground water (also containing possibility of influences caused by lake water and storm water), the pump stations are forced to work non-stop, certainly increasing electricity consumption and leading to shortened service life or frequent stoppages of the pumps. Those increased costs must ultimately be borne by the users of the sewerage system.

Concerning the institutional aspects, JICA Study Team considers the following to be major issues:

- Lack of basic documents such as the sewerage ledger.
  <Reason> the sewerage ledger and the sewer network maps (approximately 500 to 1) are very basic documents which shall be accessible to all PROAQUA / Niskogradba staff, as well as any residents in the interests of information transparency. JICA Survey Team examined the available documents, and found important information was missing such as soil coverage, gradient, pipe materials or repair records, etc.

- JICA Study Team was informed that the original PROAQUA to operate three fields (water supply, sewage collection and treatment for two cities) was divided into two organizations for political reasons two years ago. The newly formed organization was called Niskogradba, and solely tasked with sewage collection in Ohrid City. Therefore the new PROAQUA will deal with three fields for Struga City, and just two for Ohrid City. Due to this division the residents in Ohrid City will have to pay two tariffs, while those in Struga City pay only one.

In the viewpoint of management, regular monetary transactions are requiredand the revenues from general water treatment has to be considered because the sewage treatment can only collect sewerage tariff for the wastewater originally discharged from households and industries which is coincide to the supplied water quantity. Therefore careful calculation will be required to guarantee equal burden for equal service.

6.2 Financial Aspects

There are following financial issues:

(1) The financial statements for both PROAQUA and Niskogradba are incomplete and not comprehensive, meaning the actual cost of water supply and sewage treatment are difficult to calculate.
<Reason> one of the main purposes of the financial statements is to calculate the unit cost to be charged to users. Those who use more water and discharge more wastewater should pay more than those who use less water and discharge less wastewater. This is a fundamental equality from a social perspective. This calculation shall be justified by the financial statement.

(2) Some departments work for other departments of the municipality such as administration, procurement

and transportation etc., hampering efforts to calculate the unit cost.

(3) Utility costs such as electricity shall be properly included in the operation cost.

6.3 Technical Aspects

There are also many technical problems noted by JICA Survey Team noticed during the field survey and interviews:

(1) The sewerage ledger is the key document required to operate the system effectively and appropriately, and should promptly include all details such as repairs or replacements.

(2) The collected sewage is enormously diluted with intruding water from underground or the lake by a factor of tenfold or more. No staff of the organization within the bureaucratic system is aware of the seriousness of this matter. However significant money is lost by operating the pump stations non-stop and ultimately discharging the polluted wastewater into the lake.

(3) The conditions of the sewer pipes shall be visually inspected or using cameras on a regular basis to locate damaged parts and repair them immediately to prevent further intrusion.

(4) Technical training is not given to technical staff regularly and systematically to upgrade their capacity.

(5) The operation of the WWTP should be further improved so that the water sample data can be utilized to improve the operation.

6.4 Social Aspects

JICA Study Team interviewed various organizations closely related to this survey, because it wanted to identify the main issues from different perspectives. A common social problem that they stressed is the fact that most residents and tourists are unaware of the environmental situations of Ohrid Lake. Those people claim that they are unfamiliar with how to protect the Lake and thoughtlessly discharge wastewater from their households, or do not bother to separate solid waste into containers. If they were more conscious of the environment and strove harder to protect the Lake, they could contribute more to protecting the Lake. Their efforts are also considered relatively sporadic, and will need to be integrated for successful environmental protection.

Based on the field interview JICA Study Team has concluded that the population of both Ohrid and Struga cities lack basic knowledge of the sewerage system such as:

(1) How the sewerage system collects, conveys and treats the wastewater and rain water before discharging it into the Black Drim River.

(2) An awareness campaign has not been conducted systematically and regularly with proper trials.

(3) Students shall also be educated on the environmental, hygienic and sewerage importance at school, because they are the individuals most sensitive to the matter and can disseminate correct information to their families and acquaintances.

Chapter 7 Recommendations

7.1 Potential Assistances

JICA has two kinds of assistance for developing countries: technical assistance and financial assistance. The former is designed for technical transfer, so that developing countries can obtain the technical know-how from Japan and then develop themselves further without Japanese assistance independently. The latter financial assistance is designed for capital-heavy infrastructure such as sewerage systems. At the initial stage, significant investment is required until a certain effect can be generated.

Based on the survey, the team has identified the following 8 candidate projects, which are followed by the reason for selection, or why this candidate project was selected.

(1) Survey of unidentified water in sewer networks

<Reason> The field survey found significant ingresses of unidentified water, such as ground water, lake water or storm water into the sewer pipes, resulting in the unexpected dilution of wastewater. However most of the ingresses could not exactly be located in the field survey and JICA Study Team concluded that the priority would be to determine the locations and magnitudes of the intruding unidentified water. The possible sources of intruding unidentified water might be underground water, storm water and lake water and might be found in all the survey area. It is recommended that the detailed survey shall be conducted in advance of practical repair and rehabilitation works by means of primitive visual inspections, mobile electric flow meters and detailed surveillance with video cameras being applied inside the pipes in order to locate and estimate the current conditions. The surveillance data can be utilized to determine the priorities and the methods of the repair works being conducted followed by the survey in the future term.

(2) Arrangement of the sewerage ledger

<Reason> Because the sewerage ledger is the key document for effective operation, it should be compiled first of all, so that all the staff can access the updated data. If some pipes are repaired or replaced, the details shall be included in the sewerage ledger.

(3) Repair and rehabilitation of damaged sewer pipes

<Reason> In the field survey, doubtful areas affected by intrusion of unidentified water have been investigated to find out smaller areas by conducting water quality analysis (COD), but the locations could not be pinpointed due to survey limitations (available time, survey equipment, water quality kit and manpower, etc.) Once the location and magnitude of unidentified water intrusion were identified, it is recommended to repair and replace the damaged sewer pipes, because the significant volume of water is forcing the sewerage system to run continuously, resulting in significant wastage of energy and frequent repair of facilities.

(4) Design of on-site sewerage facilities at communes in Southern Ohrid City

<Reason> There are several isolated communes in Southern Ohrid City, which are difficult to connect to the existing sewerage system due to geographical and topographical restrictions. Those communes shall be served with an independent sewerage system, or an on-site system, because the pollution loads from those communes are significant. This project involves designing a sewerage system in such a commune as an example.

(5) Implementation of on-site sewerage facilities at communes in Southern Ohrid City

<Reason> Once the design of an independent system is completed, it is recommended to construct a sewerage system including a WWTP to start the service for protection of Ohrid Lake.

(6) Design to rehabilitate existing sewer systems in both Ohrid and Struga cities

<Reason> Because the Ohrid - Struga sewerage system appears to be significantly damaged, meaning that unidentified water can easily enter the sewer pipes and dilute the sewage volume significantly. Such a sewerage system shall be repaired or replaced, for which an appropriate and cost-efficient system shall be established.
There are two kinds of remedial design: 1) to repair damaged pipes to prevent intrusion, and 2) to construct pipes for domestic wastewater only. The former involves improving the combined system, while the latter involves the construction of a separate system. In both cases individuals are responsible for the residential house connections within their premises, while the public sector is responsible for public areas to connect with the sewerage system.
The final selection is a factor of the required cost and the pollution load to the lake.

(7) Implementation to rehabilitate the existing sewer systems in both Ohrid City and Struga City

<Reason> Based on the design of (6), the sewerage system of Ohrid shall be improved.

(8) Conducting an awareness campaign to improve environmental awareness

<Reason> Given the low level of environmental awareness among residents and tourists, a proper awareness campaign shall be conducted. Such a campaign shall make the residents aware of importance of their house connections with the sewerage system. Japanese consultants have accumulated such experience in many developing countries, and can provide useful related information. Efficiency of the campaigns shall be monitored and evaluated in a proper manner.

Since some candidate projects can be implemented based on another one, relationships of the candidate projects are shown in the following Figure:

Table 7.1 Implementation Schedule of the 8 Candidate Projects

Project	2013	2014	2015	2016	2017	2018	2019	2020	Project Cost (mil EUR)
(1) Survey of unidentified water in sewer	→	→							2.0
(2) Arrangement of a sewerage ledger	→	→							1.0
(3) Repair & rehabilitation of damaged sewer pipes		→	→	→	→				11.2
(4) Design of on-site sewerage facilities in southern Ohrid			→						1.0
(5) Implementation of on-site sewerage facilities				→	→				4.4
(6) Design to rehabilitate the existing sewer system			→	→					4.0
(7) Implementation to rehabilitate the existing sewer system				→	→	→	→	→	29.2
(8) Conducting of an awareness campaign	→	→	→	→					1.6
Annual cost (mil EUR)	1.9	6.9	6.4	11.6	10.4	6.0	6.0	5.2	

Source: JICA Study Team

As shown above, the 8 candidate projects are not independent, but could be grouped as shown in the following table:

Table 7.2 Grouping of Candidate Projects

Group	Name	Content	Candidate Projects
Group A (3.0 million EUR)	Arrangement of Sewerage Ledger	The sewerage ledger will be arranged based on the survey and repairs.	**(1)+(2)**
Group A' (11.2 million EUR)	Repair & rehabilitation of the damaged sewer	The damaged primary sewer will be repaired and rehabilitated.	**(Group A) +(3)** (Based on the survey & the ledger)
Group B (5.4 million EUR)	Small Sewerage System Construction	A new independent sewerage system will be constructed in the unsewered area.	**(4)+(5)**
Group C (33.2 million EUR)	Current Sewerage System Improvement	The existing sewerage system will be fundamentally improved.	**(6)+(7)** (The sewerage ledger is the basis.)
Group D (1.6 million EUR)	Awareness campaign	The awareness campaign will be carried out systematically.	**(8)**

Source: JICA study team
*Rem.: Numbers in parentheses indicate approximate cost (in million EUR).

7.1.1 Assistance 1

Project Name: “Awareness Campaign” (short-term)

(1) Scope

An awareness campaign will be conducted through mass media such as press, TV, radio and Internet targeting children and adults

(2)Rationales and Objectives

The level of environmental awareness is said to be low among residents and visiting tourists.

(3) Provisions of Laws and Regulations

No requirement.

(4) Institutional Set-up

No requirement.

(5) Coverage

All areas in Ohrid and Struga cities

(6) Timing and Schedule

From 2013 to 2016 (4 years)

(7) Cost Estimate

About 1.6 million EUR

7.1.2 Assistance 2

Project Name: “Arrangement of Sewerage Ledger” (medium-term)

(1) Scope

Areas considered doubtful following the field survey will be investigated with equipment, and as required, the damaged pipes will be repaired or rehabilitated. Finally, the relevant sewerage ledger will be arranged by upgrading.

(2) Rationales and Objectives

In accordance with the sewerage law

(3) Provisions of Laws and Regulations

No additional requirement

(4) Institutional Set-up

No requirement. PROAQUA / Niskogradba can complete the project.

(5) Area of Coverage

Doubtful areas in Ohrid and Struga cities

(6) Timing and Schedule

From 2013 to 2017 (5 years)

(7) Cost Estimate

About 14.2 million EUR

7.1.3 Assistance 3

Project Name: "Small Sewerage System Construction" (short-term)

(1) Scope

A commune will be selected in the unsewered area of Southern Ohrid City for the survey, design and construction of a small sewerage system.

(2) Rationales and Objectives

By constructing a small scale sewage system, the pollution load from the lake can be reduced to a certain extent.

(3) Provisions of Laws and Regulations

No requirement.

(4) Institutional Set-up

No requirement. PROAQUA can implement the project.

(5) Area of Coverage

The whole area of the commune

(6) Timing and Schedule

From 2015 to 2017 (3 years)

(7) Cost Estimate

About 5.4 million EUR

7.1.4 Assistance 4

Project Name: "Current Sewerage System improvement" (long term)

(1) Scope

The current sewerage system of Ohrid City will be designed and improved by rehabilitating or replacing as required.

(2) Rationales and Objectives

Implementing the project will help ease the large amount of pollution loads on the lake.

(3) Provisions of Laws and Regulations

No requirement

(4) Institutional Set-up

No requirement

(5) Area of Coverage

The sewered area in Ohrid City and Struga City

(6) Timing and Schedule

From 2015 to 2020

(7) Cost Estimate

About 33.2 million EUR

7.2 Overall Evaluation

The four projects above are evaluated as shown in the following table:

Table 7.3 Evaluation of Proposed Group Projects

Term	Group Project	Estimated Cost (million EUR)	Advantageous Point	Disadvantageous Point
Short term Target: 2013-16	Awareness Campaign	1.6	It can promote the people' awareness.	Difficult to estimate the effect
Mid-term Target:2013-16	Arrangement of Sewerage Ledger, Survey of Unidentified Water in Sewer, and Repair & Rehabilitation of Damaged Sewer Pipes	14.2	The sewerage ledger can be arranged problems and repair records effectively. The unidentified water can be reduced	None
Short term Target: 2015-17	Small Sewerage System Construction	5.4	A certain pollution reduction can be expected.	The reduction portion is limited with the residential number.
Long term Target:2015-20	Current Sewerage System improvement	33.2	A fundamental improvement can be expected.	The implementation will take a long term..

Source: JICA Study Team

Chapter 8 Roadmap to Ohrid Lake Environmental Improvement

8.1 Project Recommendations

Based on the data and information collected in Macedonia and the field surveys conducted, the consultant has analyzed the results and concluded that the following projects could be recommended as candidates for implementation toward the Ohrid Lake Environmental Improvement:

(1) Survey of the unidentified water in the sewer networks:

The locations, size and scope of the unidentified water are surveyed and prioritized for implementation order.

(2) Arrangement of the sewerage ledger:

The sewerage ledgers, including the sewer networks for both Ohrid and Struga cities, to be arranged based on the information of (1) and (3).

(3) Repair and rehabilitation of damaged sewer pipes:

The damaged sewer pipes identified in (1) to be repaired or replaced according to importance.

(4)Design of on-site sewerage facilities at communes in Southern Ohrid City:

The on-site sewerage system facility for a commune located in the unsewered area of Southern Ohrid City.

(5) Implementation on-site sewerage facilities at communes in Southern Ohrid City:

The on-site sewerage facility designed in (4) is implemented.

(6) Design to rehabilitate the existing sewer systems in both Ohrid and Struga cities:

New watertight sewers are designed to improve unidentified infiltration.

(7) Implementation to rehabilitate existing sewer systems in both Ohrid and Struga cities:

New watertight sewers are designed to improve unidentified infiltration based on the design of (7).

(8) Conducting of an awareness campaign to improve environmental awareness:

An awareness campaign to be conducted to improve environmental awareness in both Ohrid and Struga cities.

8.2 Actions Needed

Considering the significant amount of pollutants is being discharged into the Ohrid Lake, those candidate projects shall be prioritized based on the degree of urgency to be implemented in the short, medium and long term.

- Short-term actions to be implemented immediately within 2 years of 2013 to 2014,
- Medium-term actions to be implemented after the short-term ones within 3 years of 2014 to 2017, and
- Long-term actions to be implemented after the medium-term ones within 3 years of 2018 to 2020.

The candidate projects above mentioned are shown in the following table with their rough cost estimates:

Table 8.1 Candidate Projects with Implementation Period and Roughly Estimated Costs

Project No.	Contents	Term	Implementation Period	Rough Cost (million EUR)
(1)	(see 8.1)	Short-term	2013 to 2014 (2 years)	2.0
(2)	(see 8.1)	Short-term	2013 to 2014 (2 years)	1.0
(3)	(see 8.1)	Short-term	2014 to 2017 (4 years)	11.2
(4)	(see 8.1)	Medium-term	2015 (1 year)	1.0
(5)	(see 8.1)	Medium-term	2016 to 2017 (2 years)	4.4
(6)	(see 8.1)	Long-term	2015 to 2016 (2 years)	4.0
(7)	(see 8.1)	Long-term	2016 to 2020 (5 years)	29.2
(8)	(see 8.1)	Short-term	2013 to 2016 (4 years)	1.6
Total				54.4

Source: JICA Study Team

It is to be noted that the project costs mentioned in the above table are just roughly estimated, and would need to be adjusted for actual implementation based on the terms of reference (T/R).

8.3 Annually required funds to improve the Ohrid Lake environment

Here the total funds of about 54.4 million EUR were roughly estimated by JICA Study Team in the field of Macedonia, and have been scrutinized for confirmation by the relevant documentations and interviews with the related companies in Japan upon the return from Macedonia. Though there would be some differences in cost estimation in Japan and Macedonia, the figures are judged to be within allowable levels as the basic funds required for implementation.

JICA Study Team broke down the total required funds on an annual basis between 2013 through 2020 as follows:

Table 8.2 Annually Required Funds for Project Implementation

Unit: million EUR

Candidate Project		2013	2014	2015	2016	2017	2018	2019	2020
1	Survey of the unidentified water in the sewer networks	1.0	1.0						
2	Arrangement of the sewerage ledger	0.5	0.5						
3	Repair and rehabilitation of damaged sewer pipes		3.0	3.0	3.0	2.2			
4	Design of on-site sewerage facilities at communes in Southern Ohrid City			1.0					
5	Implementation of on-site sewerage facilities at communes in Southern Ohrid City				2.2	2.2			
6	Design to rehabilitate the existing sewer system in Ohrid-Struga cities		2.0	2.0					
7	Implementation to rehabilitate the existing Sewer system in Ohrid-Struga cities				6.0	6.0	6.0	6.0	5.2
8	Conducting of an awareness campaign to improve environmental awareness	0.4	0.4	0.4	0.4				
Total	Annual funding requirement	1.9	6.9	6.4	11.6	10.4	6.0	6.0	5.2
	Total funding requirement	54.4							

Source: JICA Study Team