Part II

FEASIBILITY STUDY

CHAPTER 1 SCOPE OF PRIORITY PROJECTS

Central wastewater treatment plant as well as trunk sewer connecting the existing two main outlets with the central WWTP is selected as priority projects. The F/S is conducted for the selected priority projects.

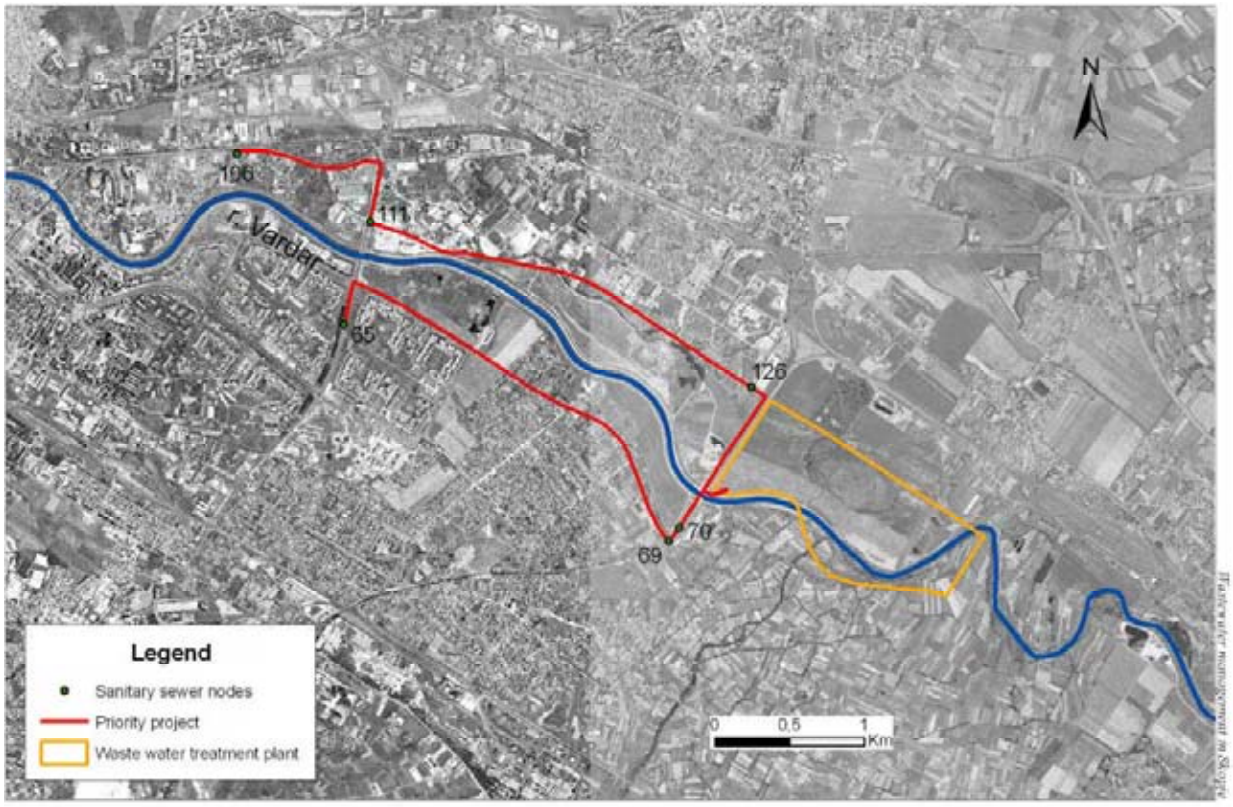


Figure 1.1 Priority Projects

1.1 Scope of Trunk Sewer

The target year of main collectors is 2030.

Table 1.1 Specifications of the Trunk Sewer

	Pipe material	Diameter (mm)	Length (m)	Route (Node No.)
Right Bank	R. C.	1,000	130	Siphon (Crossing River)
	R. C.	1,800	3,770	65 – 69 – 70 - WWTP
Sum			3,900	
Left Bank	R. C.	1,500	1,400	106 – 111
	R. C.	1,600	2,890	111 – 126
	R. C.	1,800	940	126 - WWTP
Sum			5,230	
Total			9,130	

Note: The length in the table is different from the length in B/P.

1.2 Scope of Central Wastewater Treatment Plant

The target year of central wastewater treatment plant is 2020.

Table 1.2 Basic Condition of Central WWTP (1)

	Population (person)	Per Capita Flow (lpcd)	Flow (m^3/d)		
			Average	Peak Factor	Hourly Maximum
Domestic Wastewater	513,570	200	102,720	2.0	205,440
Industrial Wastewater	-	-	32,300	1.5	48,450
Stormwater	-	-	31,000	-	-
Total	513,570	-	166,020 ≒166,000	-	253,890

Table 1.3 Basic Condition of Central WWTP (2)

	Popula-tion (person)	Per Capita Flow (lpcd)	Average Flow (m^3/d)	Per Capita Load (g/capita-d)		Pollution Load (kg/d)		Water Quality (mg/l)	
				BOD	SS	BOD	SS	BOD	SS
Domestic Wastewater	513,570	200	102,720	60	45	30,814	23,111	300	225
Industrial Wastewater			32,300			5,399	9,175	167	284
Stormwater			31,000			3,410	12,400		
Total			166,020 ≒166,000			39,623	44,686	239 ≒240	269 ≒270

Note: Population Equivalent based on pollution load is 660,380 persons, using 60 g/capita-day

Table 1.4 Target Water Quality

Parameter	Quality	Remarks	Stage
BOD	25 mg/l	EU directives for urban wastewater: (1) Population Equivalent of Central WWTP sewer district is over 2,000 (2) Skopje is not located in “Less Sensitive Area” nor “Sensitive Area”	Target Year 2020 (as a first stage)
SS	35 mg/l		
COD	125 mg/l		
N	10 mg/l	EU directives for urban wastewater: (1) Population Equivalent of Central WWTP sewer district is over100,000 (2) In case of “ Sensitive Area”, this Directives governs WWTP effluent	After 2020 (as a second stage)
P	1 mg/l		

CHAPTER 2 PRELIMINARY DESIGN OF TRUNK SEWER

2.1 Review of Design Framework

Design framework is reproduced as follows, which is determined in the B/P (refer to 6.2 Plan of Trunk sewer in the B/P):

Target year: 2030
Sewer district area: 36.34 km^2 at the right bank side and 36.53 km^2 at the left bank side, which sum up to 72.87 km^2

Domestic wastewater: 2.57 m^3/s (222,260 m^3/d)
Industrial wastewater: 0.60 m^3/s (52,260 m^3/d)
Total: 3.17 m^3/s (274,520 m^3/d)

2.2 Design Criteria

Design criteria is reproduced as follows, which is determined in the B/P (refer to 6.2 Plan of Trunk sewer in the B/P):

- Flow calculation: Manning formula

$$Q = \frac{1}{n} \times R^{2/3} \times I^{1/2} \times A$$

Where,
Q is flow rate in m^3/s,
n is roughness coefficient of 0.013,
R is hydraulic radius in meter,
I is gradient
A is flow section in m^2.

- Velocity: 0.8 m/s[1] at minimum and 3.0 m/s at maximum

- Manhole interval

Table 2.1 Manhole Interval

Diameter (mm)	Smaller than 600	600 - 999	1,000 – 1,499	Greater than 1,500
Maximum Interval (m)	75	100	150	200

Source: Sewerage Facilities Plan/Design Guidelines by Japan Sewage Works Association

2.3 Route and Longitudinal Section of Trunk sewer

Topographic survey was done at every 50 m interval and remarkable bending points along the trunk sewer route (see Figure 2.1) determined in the B/P. Its results were used to plan longitudinal profile of the trunk sewer. The trunk sewer is planned to be laid beneath the planned road and the elevation of the planned road is vitally important in planning the trunk sewer.

However, the road elevation will be determined only after its detail design is done. It can be judged from the past experience that two years or more will be needed for design work and its approval. The current status of the road implementation being as such, it was assumed that the current ground level obtained through the topographical survey would be the lowest level of the planned road surface. Consequently, the longitudinal profile of the trunk sewer is determined supposing the minimum earth

[1] This minimum velocity, which is usually employed for a stormwater sewer is applied to the trunk sewers as well because they will continue to function as stormwater sewers for the time being.

cover of the trunk sewer is one meter to the road surface. A lot of small depressions are found along the trunk sewer route, but they are not taken into account in determining the longitudinal profile supposing they will be leveled by the time of trunk sewer implementation.

The trunk sewer has to be laid staying out of existing underground structures. The trunk sewer at the left bank side will cross three existing sewers with diameters of 500, 1,000 and 1,200 mm at its most downstream. It is needed to lay the trunk sewer five meters lower to stay out of these sewers compared with the situation in which there were no existing sewers. If the existing sewer of 500 mm diameter is relocated by 1.6 m deeper and 130 m away, the trunk sewer can be laid 1.1 m lower only, not 5 m lower. Since the horizontal relocation of 105 m out of 130 m will be done in parallel with trunk sewer laying, the earth work needed for the relocation can be minimized. From the above discussion, it is concluded to lay the trunk sewer as shallow as possible by relocating the existing sewer of 500 mm diameter.

Figures 2.2 and 2.3 show the longitudinal profile of the trunk sewer. The details of the points where the trunk sewer crosses three existing sewers are shown in Appendix 2.1, Part Ⅱ (F/S).

2.4 Considerations in Trunk sewer Laying

2.4.1 Connection of the Trunk sewer with Existing Trunk Sewers

At the right bank side
Existing trunk sewers were planned and constructed as sanitary sewers, but the collected sewage is currently discharged to the Vardar River through storm sewer (between No. 1 and No.2 in Figure 2.1). It is possible to use the existing storm sewer up to the planned road to convey the collected sewage where the trunk sewer is supposed to start, but the City of Skopje has implemented sewers targeting complete separate system. Hence, a new trunk sewer in parallel with existing storm sewer is to be laid instead of converting the storm sewer to trunk sanitary sewer. The most upstream point of the new trunk line is regarded as the starting point of the trunk sewer. The trunk sewer will be equipped with stormwater overflow weir from which wastewater is conveyed to a sewage treatment plant and stormwater is discharged to the river. Next chapter details the stormwater overflow weir and section 2.2 of Appendix Part 2 shows detailed figure of how the existing sewer is connected to the trunk sewer.

At the left bank side
Existing trunk sewer was designed as sanitary sewer and the collected sewage is discharged to the Vardar River with no treatment. The weir will be added in the existing manhole (Node 106 in Figure 2.1) as the starting point of the trunk sewer to divert the flow exceeding the design value to the river. The connection of the trunk sewer with the existing sewer at the left bank side of the river is detailed in section 2.2, Appendix Part 2.

2.4.2 Stormwater Overflow Weir

Though the City of Skopje has constructed sewers aiming at the complete separate system, storm sewers have been installed at only 30 % of the central sewer district to date. Rain fallen in the area where no storm sewers are laid possibly flows into sanitary sewers. The trunk sewer is designed for maximum hourly flow and the stormwater flowing into the trunk sewer has to be separated and diverted to the river. Some apparatus such as stormwater overflow weir needs to be installed where other sewers are connected to the trunk sewer.

At the right bank side, three stormwater overflow weirs are to be installed at its starting point (65 in Figure 2.1) and point (70) prior to river crossing. At the left bank side, on the other hand, another three chambers are to be installed at its starting point (106), at some one and a half kilometers downstream (111) and for another three kilometers downstream (126). Section 2.2, Appendix Part 2 shows the conceptual figure of respective chambers.

The topographic survey identified the levels of manhole invert as well. The F/S determined the level of stormwater separation weir referring to the results of the survey and the invert level data available at Vodovod. It is recommended to measure the bottom levels of related sewers and to determine the weir level in the detail design.

2.4.3 River crossing

Siphon structure is installed in river crossing. It is planned as follows according to the Sewerage Facilities Planning and Designing Guidelines by Japan Sewage Works Association.

1) Multiple units of siphon structure are generally recommended to install. The F/S recommends the installation of two units with the same diameter.
2) Siphon box is to be equipped with either gate or sliding weir.
3) The velocity in the siphon structure should be greater than the upstream part of the sewer by 20 to 30 %.

Since siphon structure is to be constructed under important facilities such as rivers or railways, it has to be strong enough to resist outer pressures. At the same time, no leakage is allowed in order to prevent pollution of the Vardar River. From these viewpoints, siphon structure is to be a circumferentially closed concrete structure.

Siphon structure needs to be installed at the level lower than the possible lowest river bed in order not to lessen the flow capacity of river. Topographic survey shows that the present river bed level of +229.33 is lower than the planned river bed level of +230.58. Siphon structure, in general, is installed at the level lower than the river bed to avoid corrosion and/or breakage caused by stones and sand contained in the flowing river water. Since the current river bed is lower than the planned river bed, siphon structure is to be installed lower than the current one.

Surface of concrete surrounding the siphon structure might be damaged by stone and sand as well. To avoid such situations, it is concluded that the concrete surface level is to be set at 50 cm lower than the current river bed level.

Siphon structure is constructed in Skopje in the period between July and September when the river flow is lowest in a year. It is recommended to prepare the construction plan in which the siphon structure proposed in F/S will be installed in the same period.

2.5 Flow Calculation

Each of domestic and industrial wastewaters flowing into the trunk sewer is calculated based on the criteria shown in 2.2 Design Criteria, whose result is shown in Table 2.2**.**

Table 2.2 Calculated Flow

Flow rate calculation in 2030

Node	dia	municipality	catchment Total area of service	pipe covered	Sewerage service area (= residential	ratio. b/a	service population pop density in service	in service area	unit load	peak factor	Qh, domestic	industry	Q		cumulative flow	Pipe design dia	gradient	veroeity	quantitiy	remarks ratio extra
	(mm)		(km^2)	(km^2)	(km^2)		pop/km^2		(L/Pl/d)		(m^3/d)	(m^3/d)	(m^3/d)	(m^3/s)	(m^3/s)	(mm)	(‰)	(m/s)	(m^3/s)	(%)
Right Bank																				
65	1200/1800	Aerodom	2.64	2.34	1.84	0.79	14,236	26,249	200	2.0	10,499	2,504	13,004							
		Kisela Voda	3.80	3.31	3.17	0.96	16,820	53,315	200	2.0	21,326		21,326							
		Centar	5.06	4.78	4.41	0.92	11,160	49,227	200	2.0	19,691	5,542	25,233							
		Karpos	7.67	5.91	6.06	0.99	11,772	71,418	200	2.0	28,567	4,286	32,853							
		Gerce Petrov	5.55	4.63	3.79	0.82	10,903	41,300	200	2.0	16,520	4,928	21,448							
		sub total	24.72	20.98	19.28			241,508			96,603	17,261	113,864	1.32	1.32	1,800	1.00	1.43	3.63	175
69	1800 (incl. 1200/1800)	Aerodom	1.78	0.91	0.82	0.89	14,236	11,608	200	2.0	4,643		4,643							
		sub total	1.78	0.91	0.82			11,608			4,643		4,643	0.05	1.37	1,800	1.00	1.43	3.63	165
70	1000	Aerodom	5.06	4.63	3.48	0.75	14,236	49,494	200	2.0	19,798		19,798							
		Kisela Voda	4.78	1.31	0.92	0.70	16,820	15,485	200	2.0	6,194	3,541	9,735							
		sub total	9.84	5.94	4.40			64,979			25,992	3,541	29,533	0.34	1.71	1,800	1.00	1.43	3.63	112
Sub total			36.34	27.83	24.49	0.87		318,095			127,238	20,802	148,040	1.71						
Left Bank																				
106	1200/1800	Centar	1.48	1.11	0.71	0.64	11,160	7,973	200	2.0	3,189		3,189							
		Karpos	1.87	0.11	0.12	1.00	11,772	1,382	200	2.0	553		553							
		Gazi Baba	2.20	1.37	0.66	0.56	12,151	8,034	200	2.0	3,214	8,510	11,724							
		Cair	3.43	3.21	3.20	1.00	25,445	81,500	200	2.0	32,600	613	33,213							
		Butel	9.51	3.11	3.11	1.00	14,611	45,500	200	2.0	18,200	1,956	20,156							
		Suto Orizari	2.20	1.77	1.77	1.00	15,672	27,700	200	2.0	11,080	841	11,921							
		sub total	20.68	10.68	9.38			172,089			68,836	11,919	80,755	0.93	0.93	1,500	1.00	1.26	2.24	140
111	500	Gazi Baba	1.25	0.10	0.44	0.00	12,151	5,382	200	2.0	2,153		2,153							
	1500 (incl. 500)	Gazi Baba	2.93	1.1								12,376	12,376							
		sub total	4.18	1.20	0.44			5,382			2,153	12,376	14,529	0.17	1.10	1,600	1.00	1.32	2.66	141
126	500	Gazi Baba	1.53	1.53	0.26	0.19	12,151	3,146	200	2.0	1,258	2,840	4,098							
126	1000	Gazi Baba	9.35	5.07	4.65	1.06	12,151	56,493	200	2.0	22,597	2,135	24,732							
126	1600(incl. 500)	Gazi Baba	0.78	0.44	0.04	0.10	12,151	445	200	2.0	178	2,187	2,365							
		sub total	11.67	7.04	4.94			60,084			24,034	7,162	31,195	0.36	1.46	1,800	1.00	1.43	3.63	148
Sub total			36.53	18.92	14.97	0.84		237,555			95,022	31,458	126,480	1.46						
Total		WWTP	72.87	46.75	39.45	0.86		555,650			222,260	52,260	274,520	3.18	3.18	1,800	1.00	1.43	3.63	14

2.6 Layout Plan, Longitudinal Profile and List of Major Facilities

Figure 2.1**,** Figure 2.2 and Figure 2.3 show layout plan ,longitudinal profiles of the trunk sewer and stormwater overflow weir proposed in F/S, respectively. Table 2.3 shows specifications of the trunk sewer and its relevant facilities.

Table 2.3 Specifications of the Trunk Sewer

	Pipe material	Diameter (mm)	Length (m)	Route (Node No.)
Right Bank	R. C.	1,000	130	Siphon (Crossing River)
	R. C.	1,800	3,770	65 – 69 – 70 - WWTP
Sum			3,900	
Left Bank	R. C.	1,500	1,400	106 – 111
	R. C.	1,600	2,890	111 – 126
	R. C.	1,800	940	126 - WWTP
Sum			5,230	
Total			9,130	

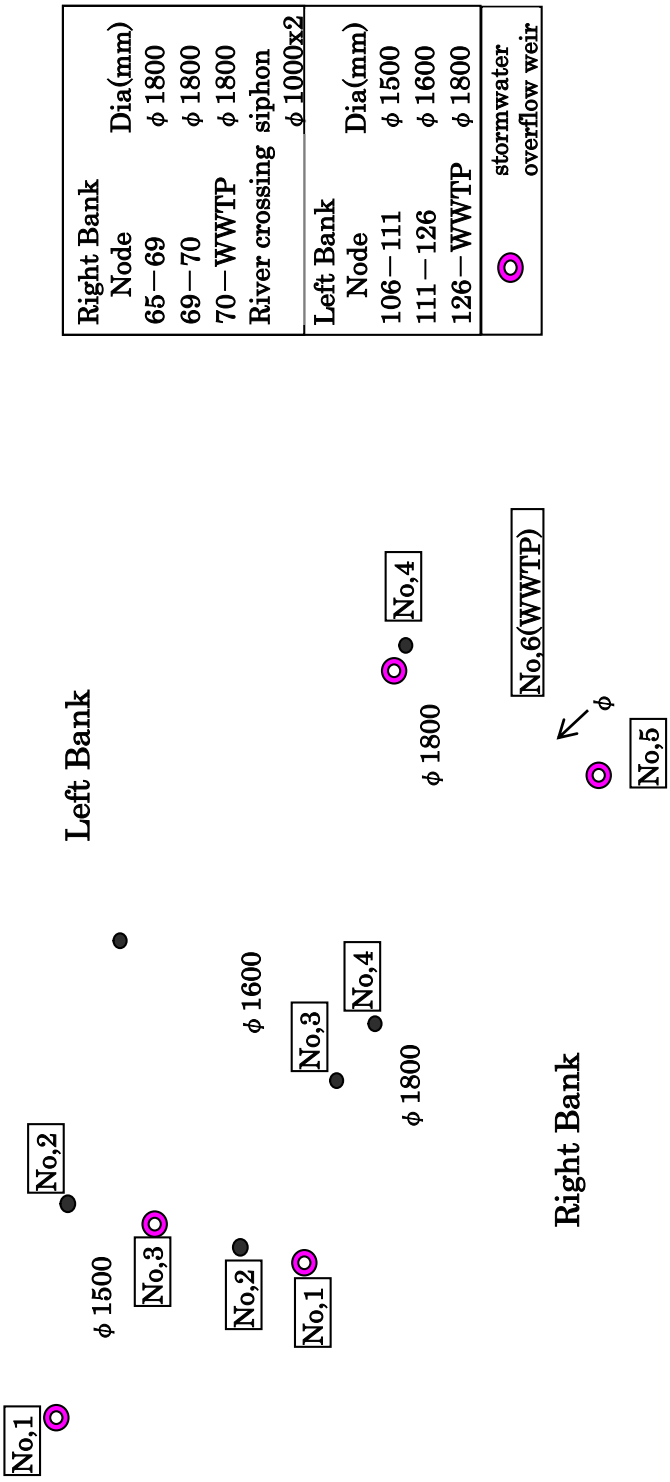


Figure 2.1 Layout Plan

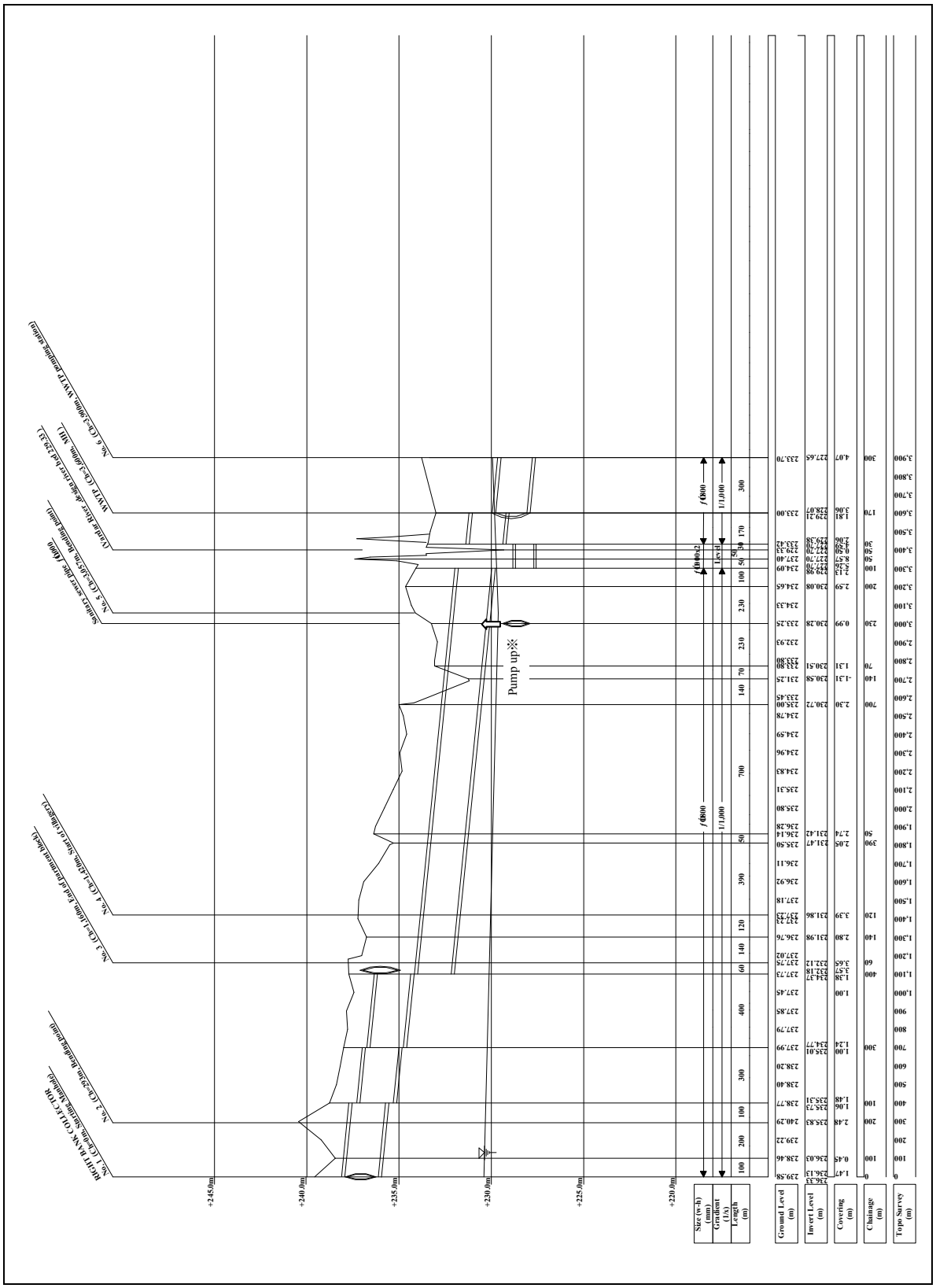


Figure 2.2 Longitudial Profile (Right Bank)

* out of the scope of the Study

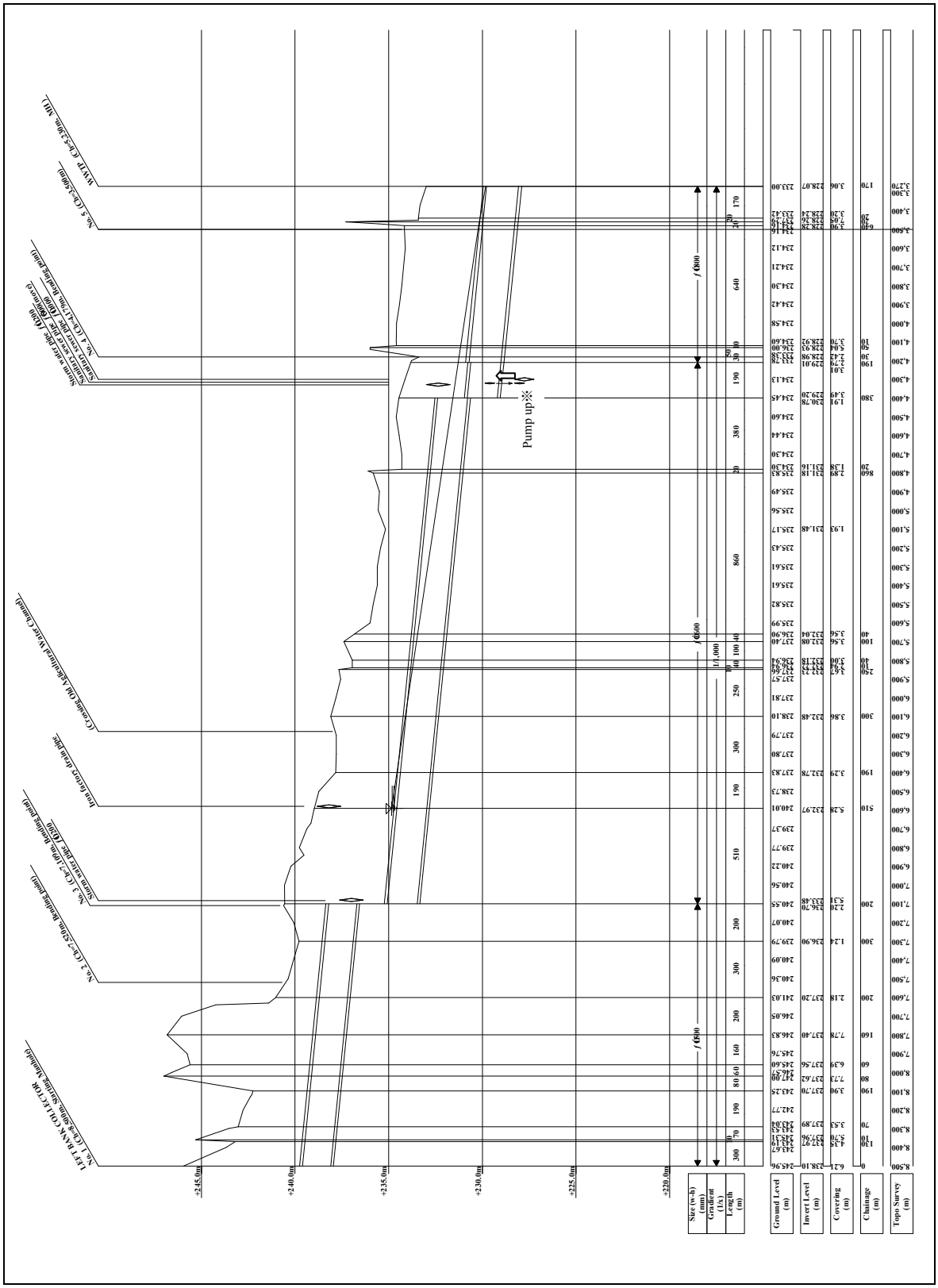


Figure 2.3 Longitudial Profile (Left Bank)

*out of the scope of the Study

CHAPTER 3 PRELIMINARY DESIGN OF CENTRAL WWTP

3.1 Design Parameter

The target year of this F/S for Central WWTP is 2020. The basic conditions for the design are shown in Tables 1.2 and 1.3 of this Part II. Treated wastewater is planed to be discharged into the Vardar River which flows in proximity to Central WWTP site. Water quality standard for treated wastewater discharge into rivers are shown in Table 1.4. This standard is defined in EC directives for urban wastewater.

Stormwater that possibly infiltrates to sanitary sewers is supposed to be covered by the difference between maximum hourly and average daily flows. The wastewater treatment plant is designed to treat stormwater and industrial wastewater on average daily basis and domestic wastewater on maximum daily basis.

3.2 Design Criteria

B/P selects conventional activated sludge process for wastewater treatment process and gravitational thickening followed by anaerobic digestion and natural drying for sludge treatment process. Table 3.1 summarizes design parameters of these unit processes. Design guidelines of Japan are referred to in determining design parameters, since Macedonia has not operated any activated sludge plants.

Table 3.1 Design Criteria for Treatment Facilities

Facility	Item	Criteria	
			Range
A. Wastewater Treatments (for BOD Removal)			
(1) Grit Chamber		1,800 $m^3/m^2/d$	
(2) Primary Settling Tank	Overflow Rate	50 $m^3/m^2/d$	35 – 70
(3) Reactor	Hydraulic Retention Time	6.0 hr	6.0 – 8.0
(4) Secondary Settling Tank	Overflow Rate	25 $m^3/m^2/d$	20 - 30
(5) Chlorine Contact Tank	Contact Time	15 min	
B. Sludge Treatment			
(1) Gravity Sludge Thickener	Solids Surface Loading	75 $kg/m^2/d$	60 - 90
(2) Anaerobic Sludge Digester	Hydraulic Retention Time	20 days	
(3) Sludge Drying Bed	Drying Days	14 days	
(4) Gas Holder	Storage Time	12 hr	
(5) Temporary Sludge Storage Yard	Storage Volume	1 year	

Table 3.2 shows proposed processes for wastewater treatment and sludge treatment.

Conventional activated sludge process is proposed to remove organic pollutants measured as BOD for the target year 2020 considering the urban wastewater directives of EU, constraints on the WWTP site and the project and maintenance costs.

Table 3.2 Proposed Treatment Process

	Stage	Proposed Process
Wastewater Treatment	Stage I (2020)	Conventional activated sludge process for BOD removal
	Stage II (after 2020)	Nitrification/Denitrification for nitrogen removal and chemical addition for phosphorous removal
Stormwater Treatment	Stage I (2020)	Secondary treatment for certain amount of stormwater regarded as first flush
	Stage II (after 2020)	Check whether detention reservoir is needed or not through qualitative and quantitative survey on stormwater
Sludge Treatment		Sludge Thickening, Sludge Digestion and Sludge Drying

Note: Stage II in case "Sensitive Area"

3.3 Process Calculation and Hydraulic Calculation

3.3.1 Process Calculation

Table 3.3 outlines the results of process calculation done based on F/S Ch1.

The magnitude of facilities is determined to include stormwater regarded as first flush.

Process calculation is detailed in Appendix 3.1, Part II (F/S).

Table 3.3 Summary of Proposed Facilities

Facility	Dimension / Number	Remarks
A. Wastewater Treatment		
(1) Grit Chamber		
(2) Main Pumps	166 m^3/min in total	For maximum hourly flow
(3) Primary Settling Tank	Dia. 24.0m × 8 tank	
(4) Reactor	16.0m × 67.0m × 5.0m × 8 tanks	
(5) Secondary Settling Tank	Dia. 24.0m × 16 tanks	
(6) Chlorine Contact Tank	10.0m × 86.0m × 2.0m × 1 tank	
B. Sludge Treatment		
(1) Gravity Sludge Thickener	Dia. 21.0m × 2 tanks	
(2) Anaerobic Digestion Tank	Dia. 26.0m × 14.0m × 4 tanks	
(3) Gas Holder	Dia. 16.0m × 10.0m × 4 tanks	
(4) Sludge Drying Bed	18.0 ha	Including transportation aisle
(5) Temporary Sludge Storage Yard	80m × 200m	

3.3.2 Hydraulic Calculation

Basic conditions for hydraulic calculation are shown below.
Effluent receiver: Vardar River

Its water level: +233.3m(Level of lower dyke at 187 km of the river
Highest experienced water level of the river is not available since no measurement has been done. Hence, the level of lower dyke that was constructed to cope with 300 year return period flood is the permissible highest water level. The level of higher dyke was measured by the Study Team.

Level of WWTP site: The level is determined to be +234.0 m as shown in Figure 3.1 judging from the current site level.

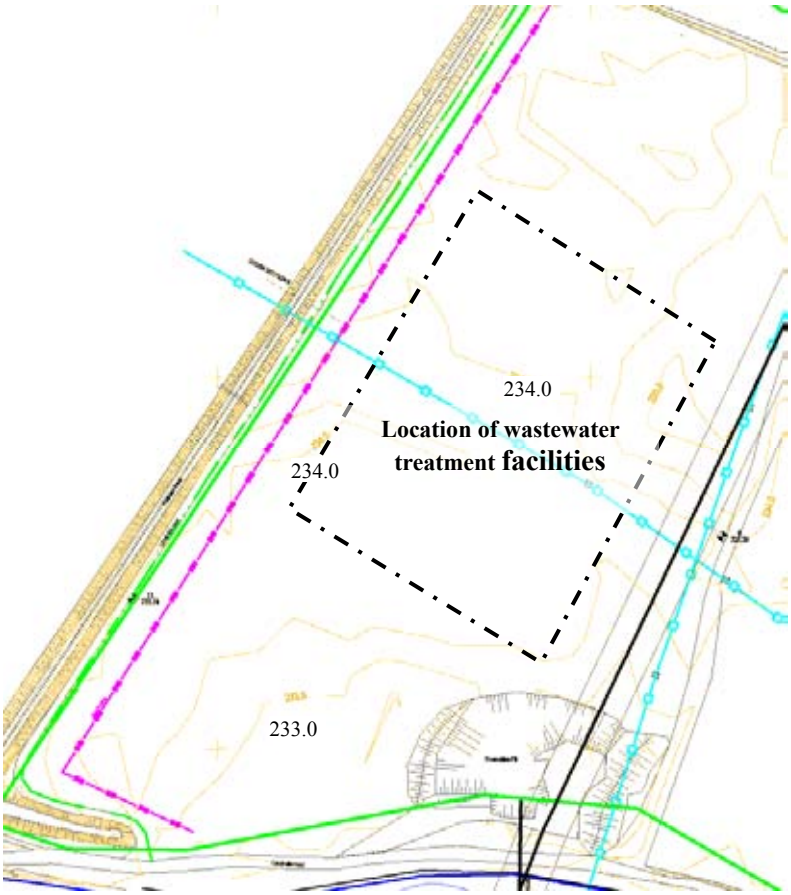


Figure 3.1 Location of Wastewater Treatment Facilities

Table 3.4 shows design flows used for hydraulic calculation. The results of hydraulic calculation are shown in Appendix 3.2, Part II (F/S) and the hydraulic profile is shown in Figure 3.10. Water level in each facility is decided so as not to overflow even in case of emergency flow. Under the emergency flow, all pumps including stand-bys are operated.

Table 3.4 Summary of Proposed Facilities

	Design Flow				Remarks
	m^3/d	m^3/hr	m^3/min	m^3/sec	
Emergency Flow	338,400	14,100	235.0	3.917	$44m^3/min \times 5nos$
Maximum Hourly Flow	253,890	10,579	176.3	2.939	Design of sewer
Average Daily Flow (for wet weather)	166,000	6,917	115.3	1.922	Design of water level
Average Daily Flow (for dry weather)	135,000	5,625	93.8	1.563	

3.4 Layout of Facilities and Flood Protection

3.4.1 Present Conditions

Table 3.5 outlines the site of Central WWTP. Available area for Central WWTP is about only 57 ha taking those into account such as river area, protected area for conservation of nature and planed road. These areas are grey painted area in Figure 3.2. The available area is divided by planned road into two parts.

Table 3.5 Area of Central WWTP Site

	Area	Remarks
Water Economy Facility Area (GUP designated)	106 ha	Total area for Central WWTP Based on the plane table survey
Present Vardar River area	-8 ha	Not available until the river improvement schedule is fixed.
Right bank side of present Vardar River	-18 ha	
Planned road area	-3 ha	Not available
Protected area for conservation of nature	-20 ha	Not available
Available area for WWTP facilities	57 ha	

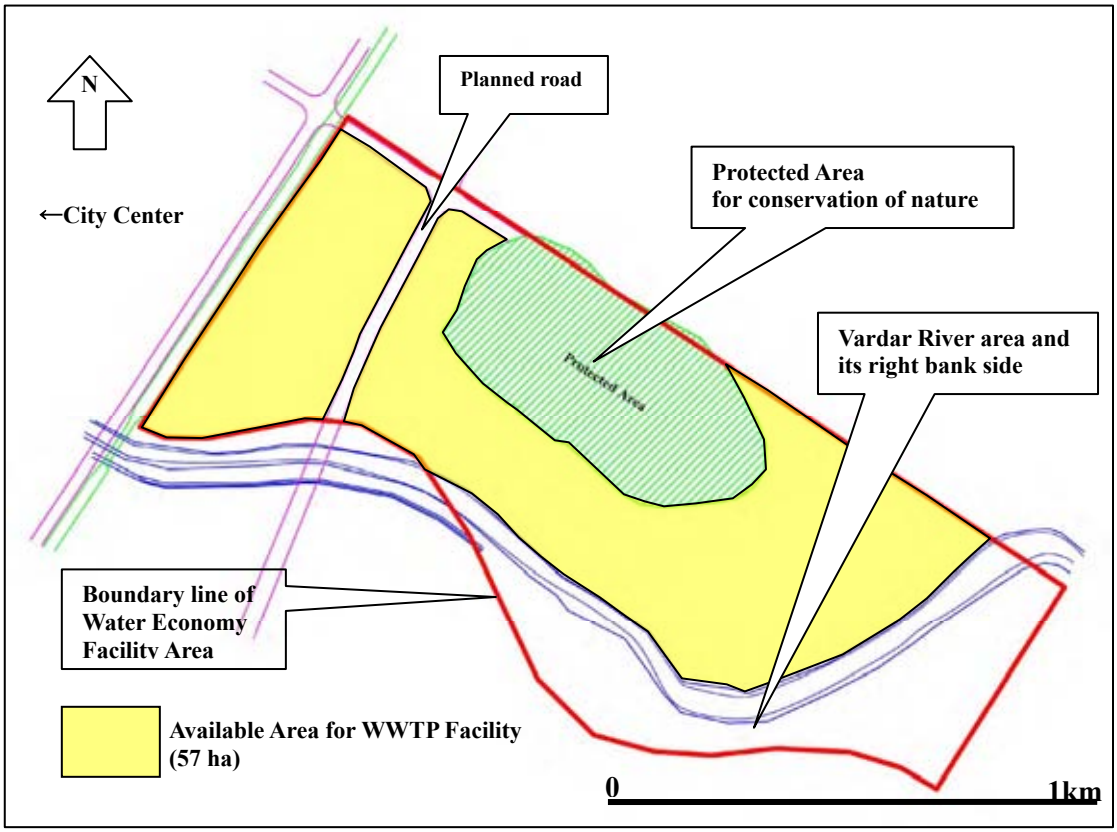


Figure 3.2 Present Condition of Central WWTP Site

3.4.2 Facility Layout Plan

Figure 3.3 shows part of facility layout plan of Central WWTP, and Figure 3.4 illustrates the whole area. The facility layout plan is prepared considering the followings:

- As planned trunk sewer coming from city centre are located in the south side of WWTP site, water treatment facilities such as main pumps, settling tanks, reactors are planned in the west part of available area.
- Sludge treatment facilities such as sludge thickeners and sludge digesters are planned in the east part of the planned road.
- Sludge drying beds are planned in the east part because the beds cannot be located in the west part. Required area for the sludge drying beds is about 18 ha for the beds itself and related facility like transportation aisle.
- Sludge drying beds are surrounded by green buffer zone to minimize odour emission
- Temporary, or emergency dried sludge storage space for one year production is reserved.

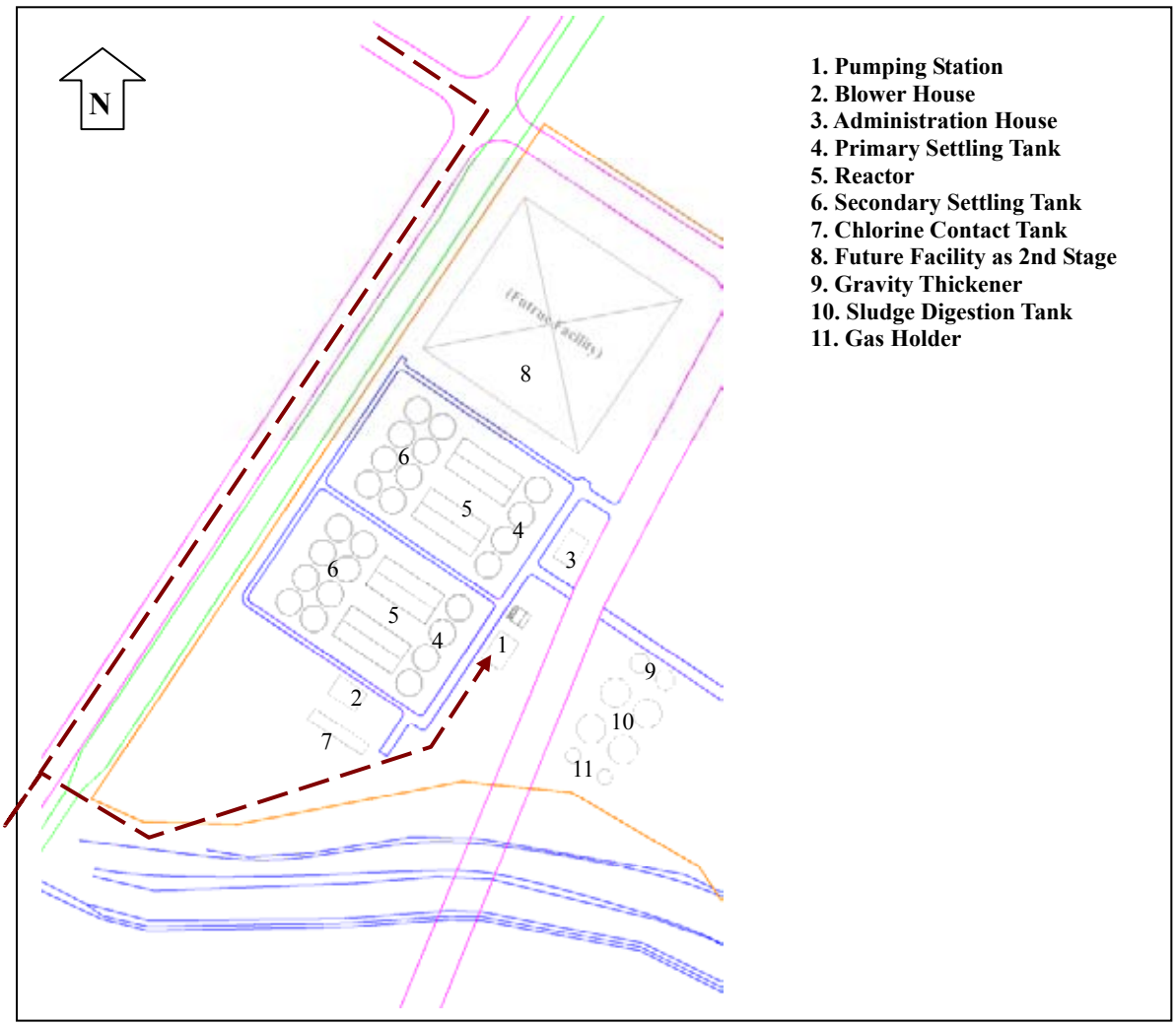


Figure 3.3 Layout of Treatment Facilities (1)

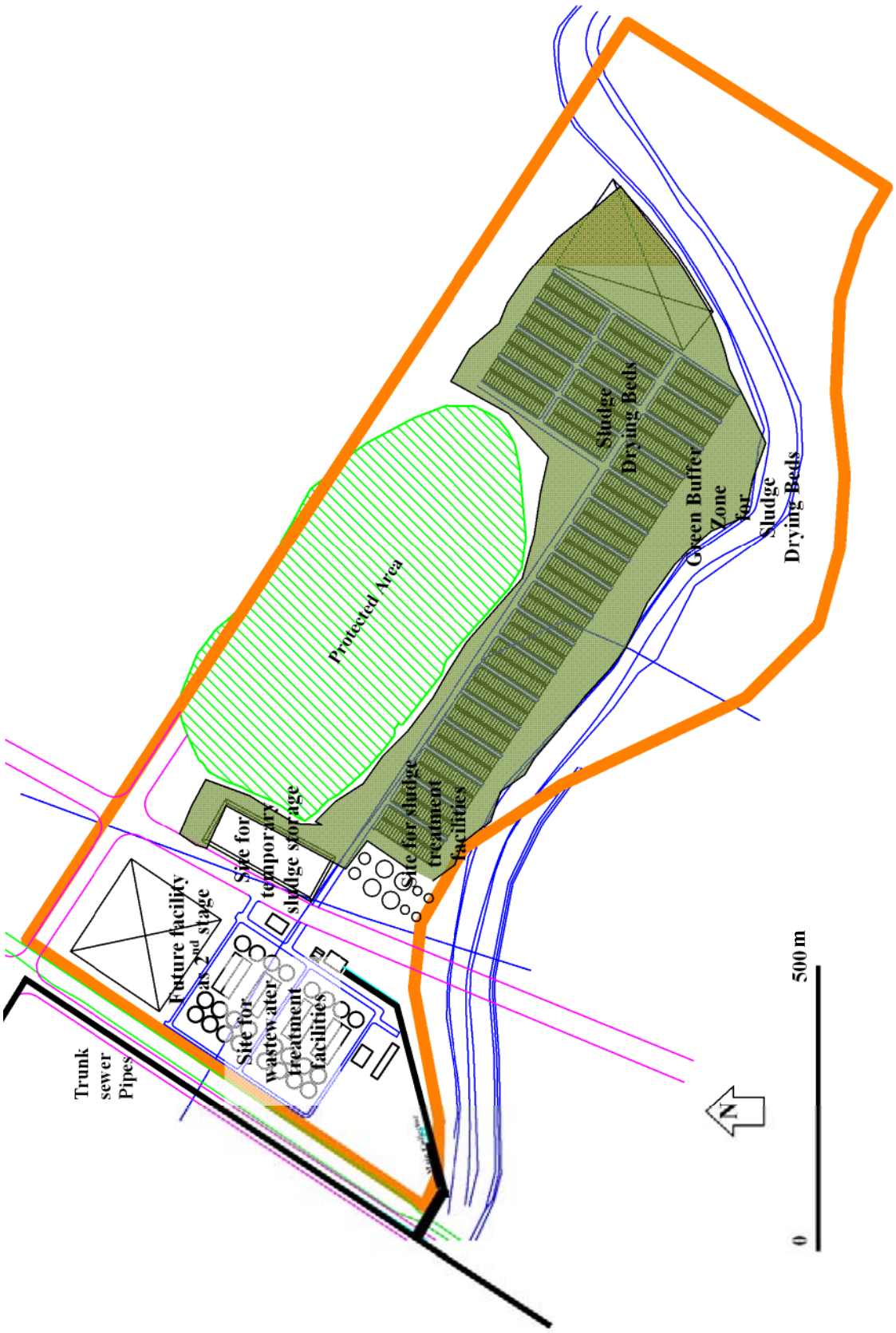


Figure 3.4 Layout of Treatment Facilities (2)

3.4.3 Flood Protection

Based on the river plan prepared by the City of Skopje, the dyke to cope with 1,000 year return period flood has been constructed between Vlae bridge and near the proposed WWTP site. However, the dyke near the WWTP site is only partly constructed, and it is needed to extend it in order to protect the staff members of operation and maintenance of the WWTP as well as the WWTP facilities.

Figure 3.5 shows the location of the dyke extension and Figure 3.6 shows the typical section of the Vardar River near there. The portion of the dyke to extend on 1,000 year return period basis is situated between the railway on the western side of WWTP site and the existing dyke at the downstream of the river. The elevated railway line running the western border functions as a dyke. The elevated road running on the north of the WWTP site was a former dyke against the former river course and is still used as a dyke surrounding the WWTP site.

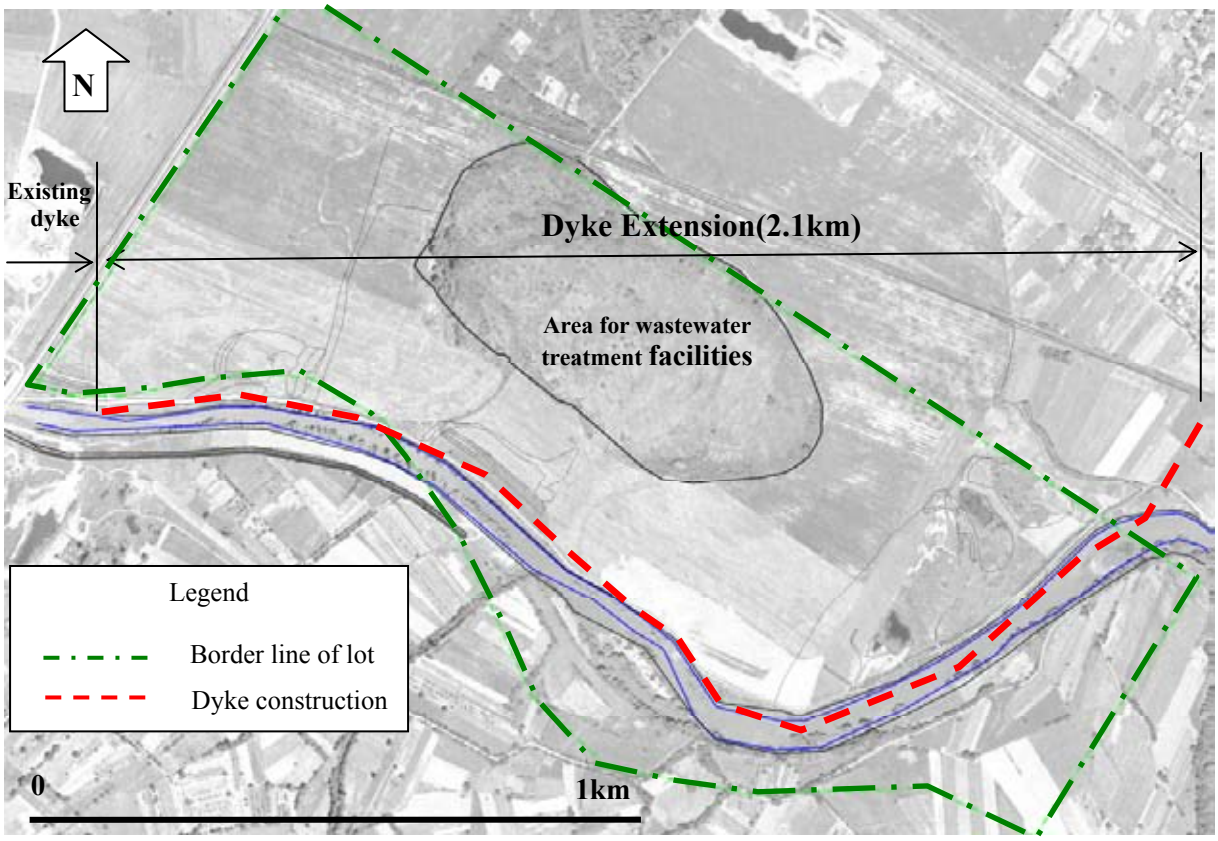


Figure 3.5 Dyke Construction Section

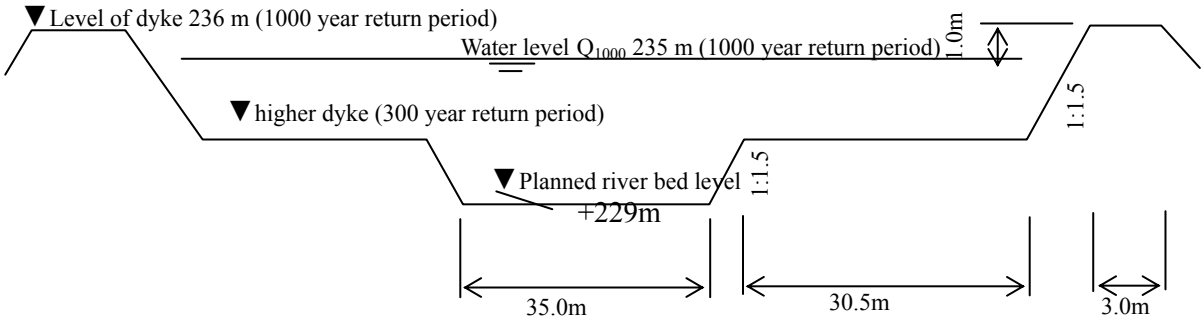


Figure 3.6 Planned River Section (Vardar River at +187km)

The planned river water level of Q_{1000} is＋235 m where the WWTP site is situated, and the level of planned dyke is set to be +236 m. Figure 3.7 shows the profile of the planned dyke.

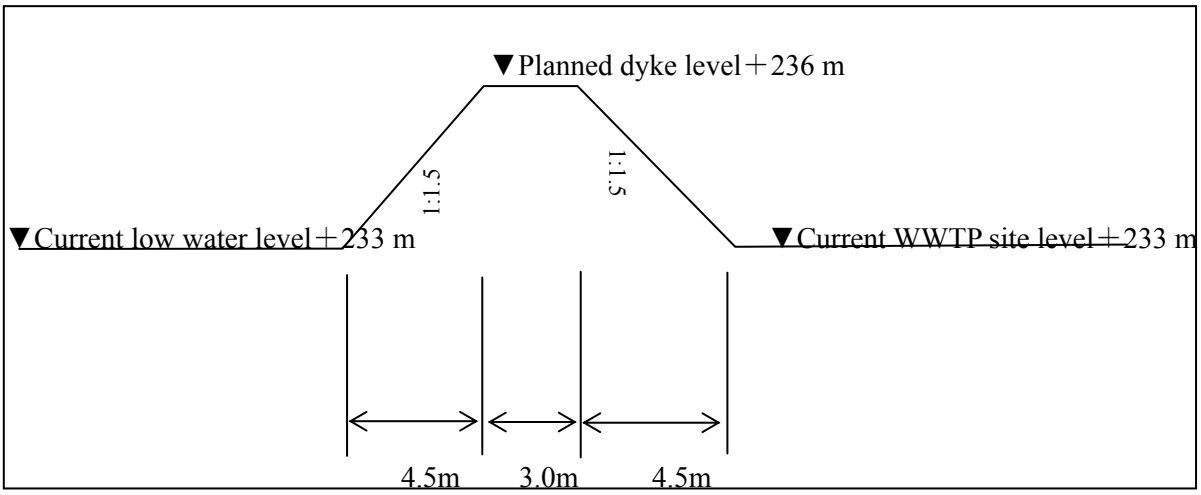


Figure 3.7 Section of Planned Dyke

3.5 Facility Construction and Temporary Structure Construction Methods

3.5.1 Geological Conditions

The WWTP site is located along the Vardar River. Geological survey shows that the ground of the site including the surrounding areas consists of gravels in general.

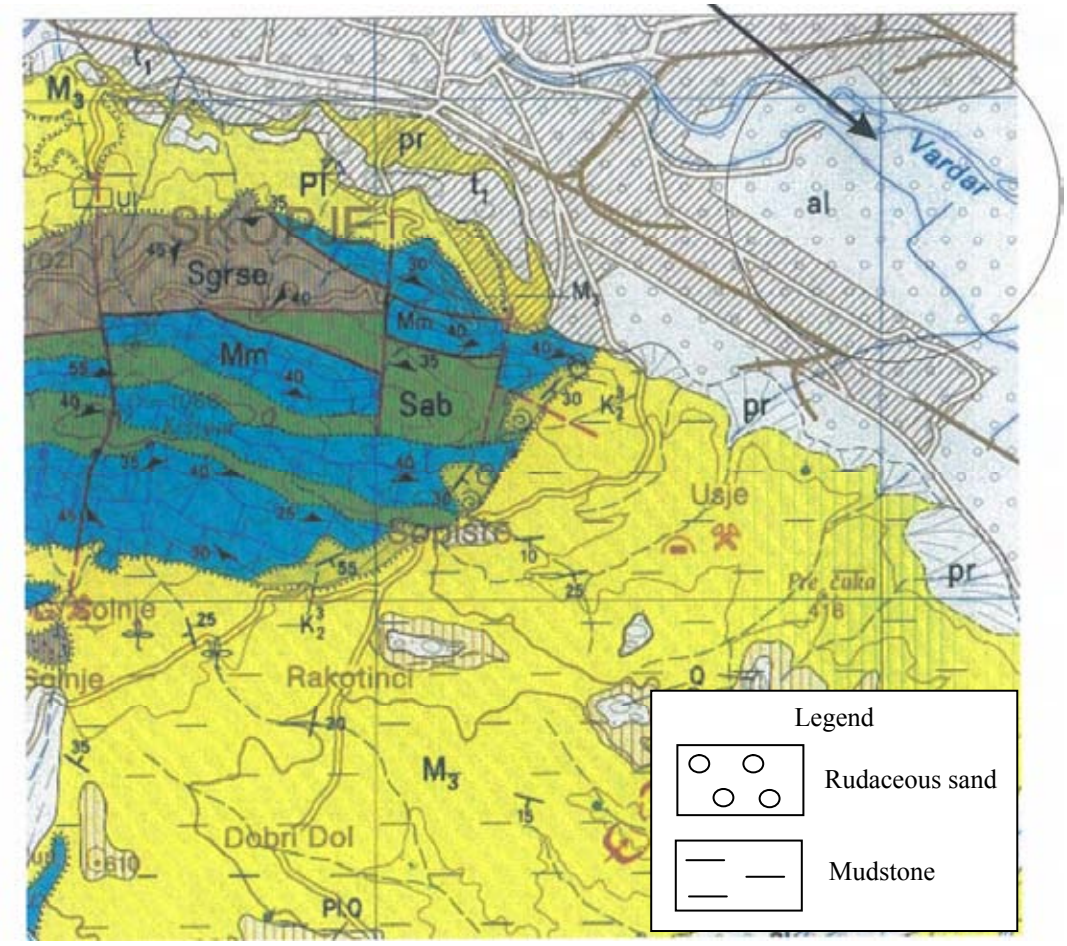


Figure 3.8 Geological Map

3.5.2 Results of Boring Survey

Geological survey using boring shows that the ground consists of silt layer from the surface to 2 meters below GL and of gravel layer 2 m beneath with N-value of greater than 30 from the surface. Groundwater level is at around 4 m below the surface.

3.5.3 Foundation

The soil with N-value of greater than 20 for clay to silt and 30 for sand is regarded as the soil with sufficient strength. The soil of WWTP site is classified into strong one. Hence, it has sufficient bearing strength and causes no harmful uneven sinking. No foundation is judged to be needed.

3.5.4 Selection of Excavation Method

Temporary structure is classified into two as follows.

- Open cut method in which the soil is excavated with certain slope from the surface to the bottom
- Earth retaining method in which retaining walls of wood or steel sheet piles are used to prevent earth wall from collapsing

Open cut method is adopted for the following reasons.

Soil conditions	Safe and stable excavation with the slope of one to two has been practiced in Skopje.
	The excavation under the groundwater level with lifting pump has been practiced in Skopje.
	The soil is rather uniform.
Natural conditions	No landslide is expected to occur.
	Rainfall is light.
	Few earthquakes are expected to occur.
Environment	Sufficient site area is available.
	Enough land is available for temporary soil storage and residual soil disposal.

However, since the excavation below groundwater level is partly needed, methods of earth retaining walls and groundwater pumping are to be carefully selected.

3.6 Drawings

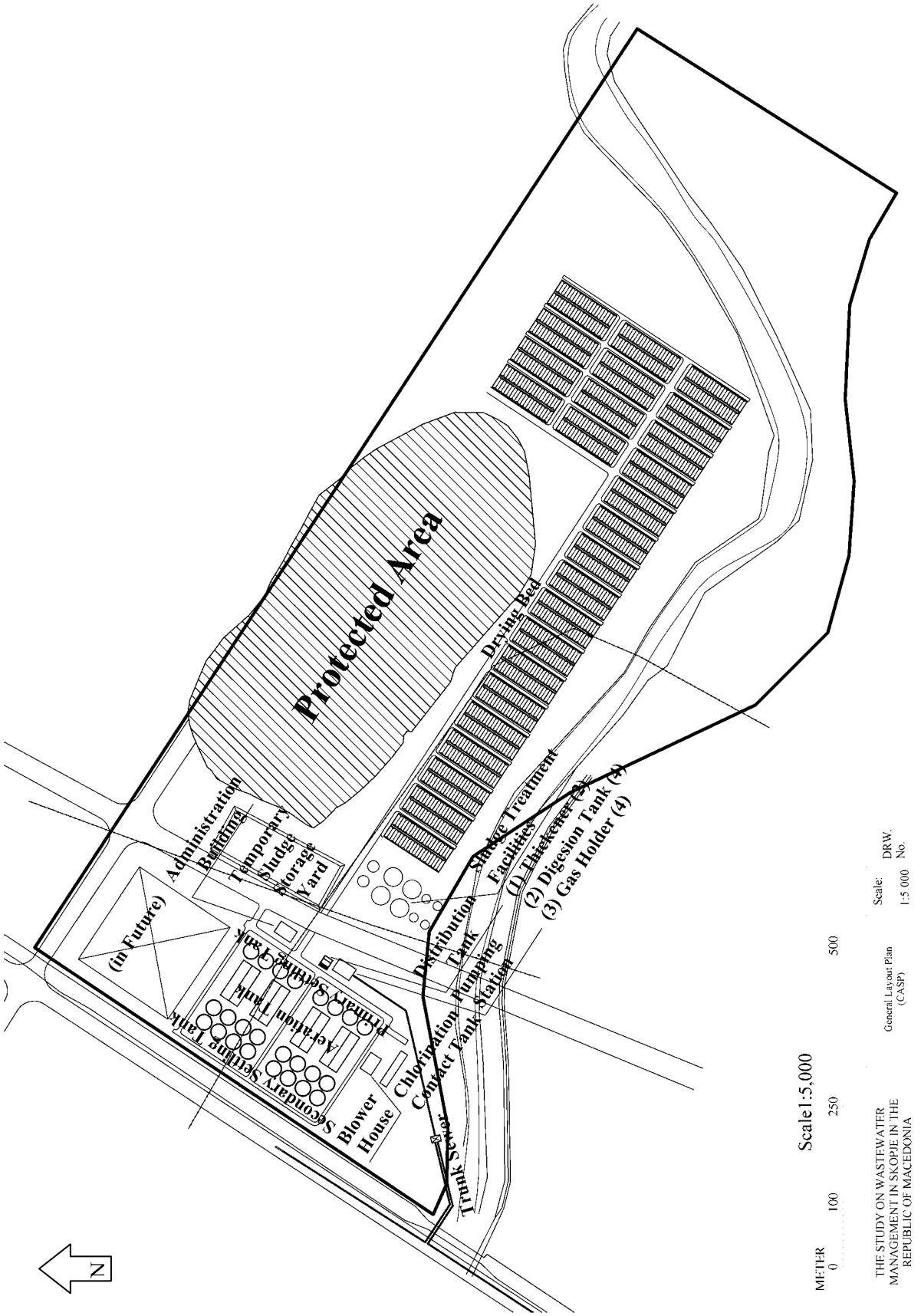


Figure 3.9 No.1 General Layout Plan

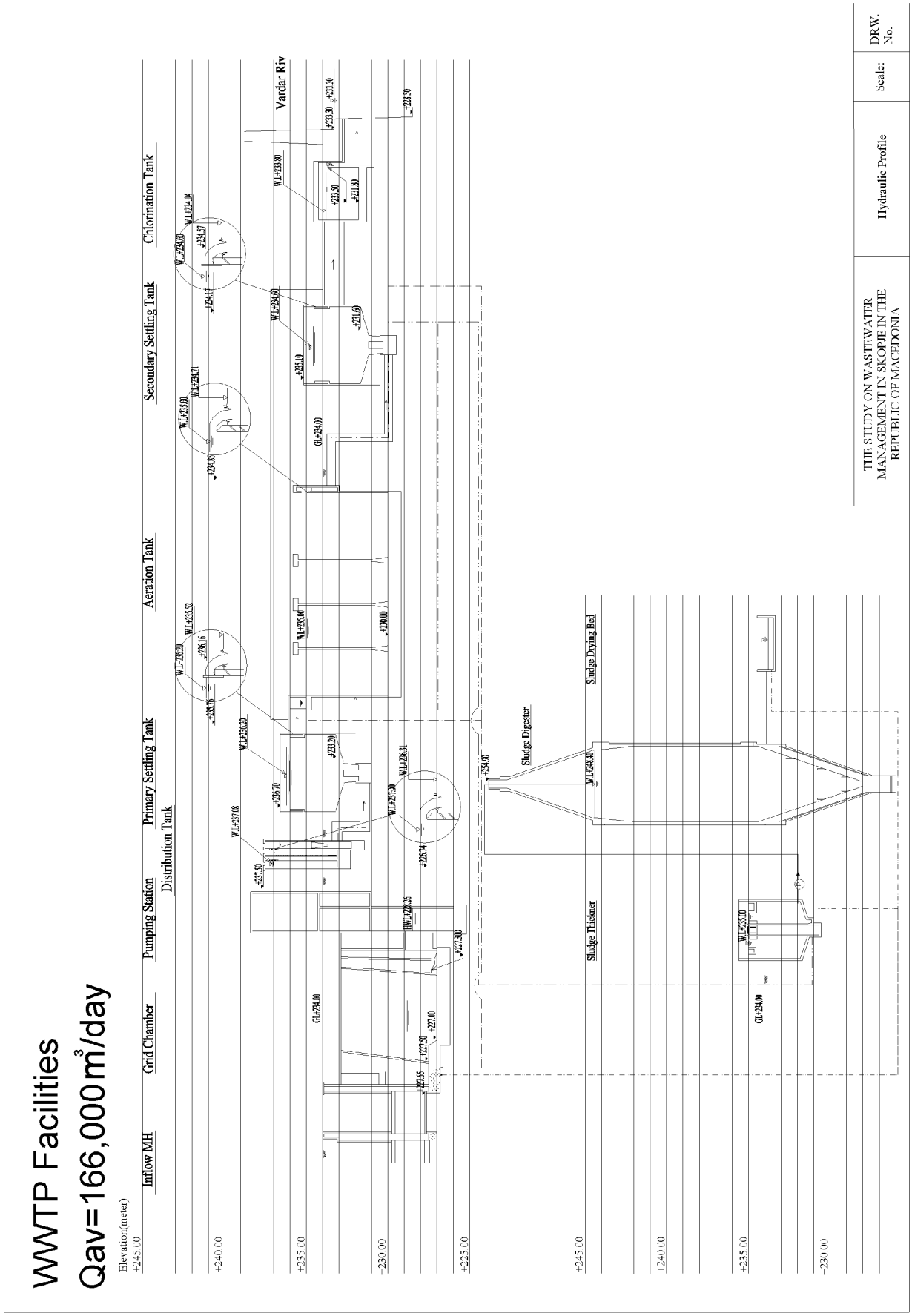


Figure 3.10 No.2 Hydraulic Profile

3.7 Clean Development Mechanism

3.7.1 Abstraction of Technical Application of CDM

Clean Development Mechanism (CDM) is the regulation in the provision of article 12 of Kyoto Protocol which was enforced in February 2005. In this article, it is approved that Certified Emission Reduction (CER) can be attained by the participants of host and investing countries which are contributed to projects for reducing greenhouse gas (GHG) inside of developing countries (Annex I country). Macedonia ratified United Nation Framework Convention on Climate Change (UNFCCC) in January 1998 and Kyoto Protocol in November 2004. Therefore, Macedonia can implement CDM projects due to the registration as Annex I country regardless of no experience.

There are two methodologies approved by CDM Executive Board in the field of wastewater treatment. These methodologies are ACM0014[1]: Avoided methane emissions form wastewater treatment (see Appendix 3.4.1, Part II (F/S)) and AMS-III.H[2]: Methane recovery in wastewater treatment (see Appendix 3.4.2, Part II (F/S)). Application of the project activity is investigated based on those approved methodologies. Scenarios applicable to these methodologies are listed in the Table 3.6. The scenario of the project activity, that untreated wastewater is directly discharged to water body at present and aerobic treatment system for wastewater and anaerobic treatment system for sludge is introduced in the project, is not defined on the lists.

Table 3.6 Scenarios Applicable to the Methodology

Methodology	Scenario
ACM0014	<Description of the historical situation> The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions. < Description of the project activities> The wastewater is treated in a new anaerobic digester. The biogas extracted from the anaerobic digester is flared and/or used to generate electricity and/or heat. The residual from the anaerobic digester after treatment is directed to open lagoons or is treated under clearly aerobic conditions (e.g. dewatering and land application).
	<Description of the historical situation> The wastewater is treated in a wastewater treatment plant. Sludge is generated from primary and/or secondary settling tanks. The sludge is directed to sludge pit(s) that have clearly anaerobic conditions. < Description of the project activities> The wastewater continues to be treated in the same wastewater treatment plant. The sludge from primary and/or secondary settling tank is treated in one or both of the following ways: (a) The sludge is treated in a new anaerobic digester. The biogas extracted from the anaerobic digester is flared and/or used to generate electricity and/or heat. The residual from the anaerobic digester after treatment is directed to open lagoons or is treated under clearly aerobic conditions (e.g. dewatering and land application). (b) The sludge is treated under clearly aerobic conditions (e.g. dewatering and land application).
AMS-III.H	Substitutions of the aerobic wastewater treatment or sludge treatment systems with anaerobic systems with methane recovery and combustion.
	Introduction of anaerobic sludge treatment system with methane recovery and combustion to an existing wastewater plant without sludge treatment.
	Introduction of methane recovery and combustion to an existing sludge treatment system.
	Introduction of methane recovery and combustion to an existing anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on site industrial plant.
	Introduction of anaerobic wastewater treatment with methane recovery and combustion, with or without anaerobic sludge treatment, to an untreated wastewater stream.
	Introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without anaerobic sludge treatment, to an existing wastewater treatment system without methane recovery (e.g. introduction of treatment in an anaerobic reactor with methane recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).

Source: ACM0014: Avoided methane emissions form wastewater treatment
AMS-III.H: Methane recovery in wastewater treatment

[1] Approved Consolidated Methodologies (UNFCCC)
[2] Approved Small-scales Methodologies (UNFCCC)

Because the project activity does not fall under the above-defined scenarios, the most probable future situation in case that the project activity would not be implemented is defined as the baseline. Therefore, the situation of the exiting plan, Sewerage M/P 99 prepared in 1999 by Kruger, is defined as the baseline.

In Sewerage M/P, the process of anaerobic digestion was included in the sludge treatment system form the aspect of reduction and stabilization of sludge and environmental consideration such as odour, soil contamination and so on. The process of anaerobic digestion is essential to the project activity from the aspect of stabilization of organic constituent and diminishing odour because the treatment of sludge is by drying in the sun. Hence, introduction of anaerobic digestion can not be certified as the application of CDM because the baseline already includes the process. And also, the project activity can not demonstrate the additionality which is mandatory to be certified as CDM project because the introduction of anaerobic digestion is technically inevitable.

The potential application of CDM in the project activity is utilization of digested gas by generating electricity. It results in the reduction of CO_2 emission by replacing power supply generated by fossil fuel with electricity generated by biogas.

Previously, a small amount of siloxane which is contained in the digested gas could possibly damage gas engines. Once this component was burned in the combustion chamber of gas engine, white and hard material was formed and accumulated in it. This led to unstable operation and degradation of the gas engine. Therefore, digested gas generator system was not so much practicable. Recently, however, the method of siloxane removal has been established and its application has started on practical scale of the system. Therefore, introduction of digested gas generator system is investigated as a promising candidate to CDM application.

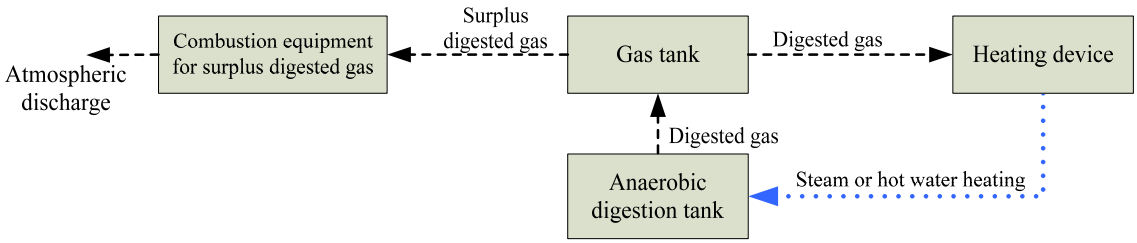
3.7.2 Feasibility Study on Introduction of Digested Gas Generator System

Digested gas generated from anaerobic digestion is usually used as heat resource to keep digesters at the adequate temperature while the excess gas is flared. In this feasibility study, two systems to utilize digested gas sated below are investigated. Schematic figures of the two systems together with the common system (practice) are shown in Figure 3.11.

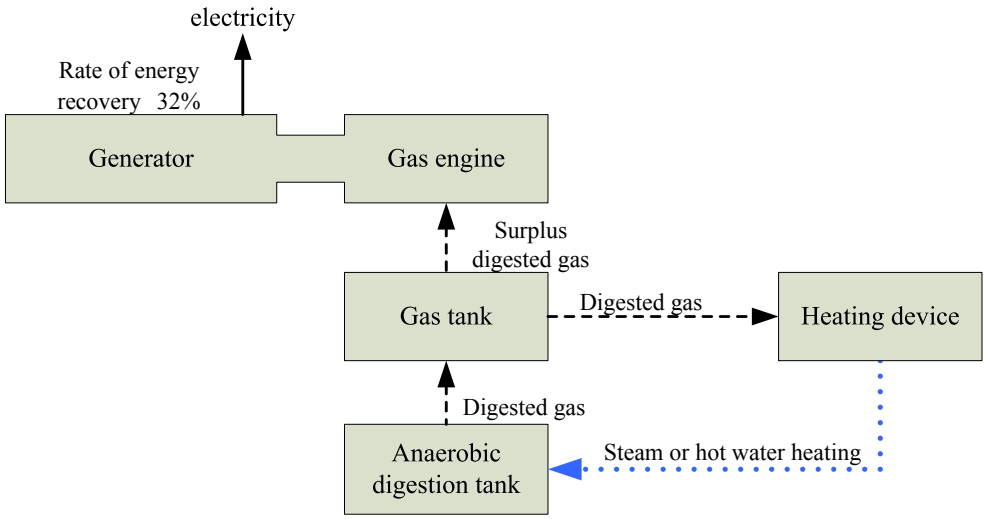
Firstly, application of co-generation system is investigated because of its high total efficiency. Then the heater and gas engine generator system is evaluated. Efficiency of generator is almost the same in both systems while efficiency of heat recovery is higher in the co-generation system which recovers waste heat.

Table 3.7 Salient Features of Digested Gas Generator Systems

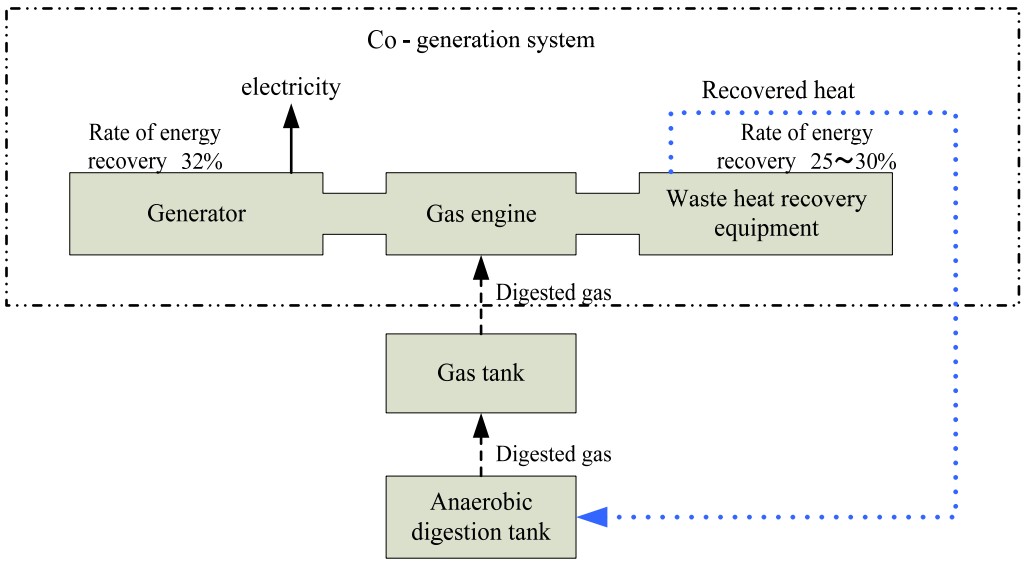
System	Description of System	Heat Efficiency
Co-generation System	Electricity is generated by gas engine which is driven by digested gas. Simultaneously, anaerobic digester is warmed by heat energy recovered form exhaust gas and cooling water through heat recovery device.	32% of calorific energy is transformed into electricity and 25% - 30% of calorific energy is utilized as heat energy. Total efficiency of energy recovery is 57% - 62%.
Heater and Gas engine Generator	Anaerobic digester is warmed by heating device by utilizing digested gas. Electricity is generated by gas engine using surplus digested gas.	Efficiency of heating device is comparatively high. Efficiency of gas engine is the same. However total efficiency is inferior because it does not recover heat energy.



Common practice



Heater and Gas engine Generator



Co-generation System

Figure 3.11 System Configuration

Required calorie for heating anaerobic digesters and calorie recovered by waste energy are summarized in the Table 3.8. The calculation of calorie energy is shown in Appendix 3.4.3, Part II (F/S).

Table 3.8 Heat Balance of Co-generation System

	Jun	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Required Calorie (10^3MJ/day)	171	161	148	136	123	112	101	110	123	135	149	161
Recovered Calorie (10^3MJ/day)	86	86	86	86	86	86	86	86	86	86	86	86
Shortage of Calorie (10^3MJ/day)	85	75	62	50	37	26	15	24	37	49	63	75

Even during summer, calorie recovered from waste energy is not sufficient to heat anaerobic digester. Therefore, fuel such as crude oil is additionally required at all time of the year.

Use of additional fuel inevitably emits CO_2 so that co-generation system is not appropriate from the aspect of reducing CO_2 emission of CDM concept. Therefore, introduction of co-generation system is not considered in the Study.

Then, the other system, in which anaerobic digester is warmed by a heating device and electricity is generated by using surplus digested gas, is investigated.

Production of electricity and reduction of CO_2 emission in case of introduction of digested gas generator system is summarized in Table 3.9. The calculation of production of electricity and reduction of CO_2 emission is shown in Appendix 3.4.4, Part II (F/S). Reduction of CO_2 emission is calculated base on the approved methodology, ACM0014: Avoided methane emissions form wastewater treatment.

Table 3.9 Production of Electricity and Reduction of CO_2 Emission

	Jun	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Production of Electricity (MWh/day)	7.6	8.7	10.0	11.3	11.3	11.3	11.3	11.3	11.3	11.3	9.9	8.7
Reduction of CO_2 Emission (ton/day)	6.1	6.9	8.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.9	6.9

Estimation in case of introduction of digested gas generator system is summarized in Table 3.10.

Table 3.10 Estimation of Parameters of Digested gas Generator System

Item	Cost	Remark
Initial Investment	1,712,000 Euro (Local currency: 1,133,000 Euro, Foreign currency: 579,000 Euro)	Digested gas generator: 470kW 1nos Accessories, electrical panel and building
Operation and Maintenance Cost	34,722 Euro/year (2,154,000 MKD)	Maintenance expense of equipment Salary
Benefit from Electricity	94,023 Euro/year (5,832,000 MKD)	Production: 3,763 MWh/year (Reduction of power consumption is accounted)
Benefit from Certified Emission Reduction	CER credit 12 Euro/tonCO_2 36,122 Euro/year	Grid coefficient: 0.8kgCO^2/kWh Reduction of CO_2 emission: 3,010ton/year
Operating Revenue	<In case including benefit form CER> =95,423 Euro <In case excluding benefit from CER> =59,301 Euro	Operation revenue = Benefit – O&M cost

Payout time of initial investment is 29 years in case of excluding benefit from CER and 18 years in case of including benefit from CER. It is impossible to payout initial investment within economic life of equipment since the standard economic life of mechanical and electrical equipment which

constitute digested gas generator system is 15 years.

In order to analyze financial aspect of introduction of digested gas generator system, internal return ratio (IRR) and sensitivity analysis is calculated and results are summarized in Table 3.11. FIRR is calculated on the condition of including the benefit generated form CER. Sensitivity analysis is done on the fluctuation from minus 20% to plus 20% of benefit and cost.

Table 3.11 Sensitivity Analysis of Financial Internal Return Ratio

		Benefit				
		-20%	-10%	0%	+10%	+20%
Cost	+20%	negative	negative	negative	negative	negative
	+10%	negative	negative	negative	negative	negative
	0%	negative	negative	negative	negative	negative
	-10%	negative	negative	negative	negative	0.9
	-20%	negative	negative	negative	1.7	2.8

Financial internal return ratio (FIRR) is negative and the figure in the most advantageous condition of 20% increased benefit and 20% decreased cost in sensitivity analysis is 2.8%.

This result shows that this investment is obviously not interesting in terms of financial aspect since opportunity cost of capital, which is generally substituted by the interest rate of government bond in host country (average interest rate during 2007-2008: 7.5%), is much higher than calculated figure of FIRR.

Introduction of digested gas generator system is not applicable based the results of investment analysis. It is required to be assured that the project activity contributes to the sustainable development of the host country in order to be certified as CDM activity. Furthermore, the financial aspect is not sustainable based on financial analysis.

Therefore, the utilization of digested gas is limited to heat resource to keep digesters at the adequate temperature in this Project. The excess gas is flared in order to reduce emission of greenhouse gas.

CHAPTER 4 OPERATION AND MAINTENANCE PLAN

4.1 Organizational Strengthening of the Sewerage Sector

Vodovod has a long history since its foundation in 1907. Starting from a small water supply facility which served a small central part of Skopje City, it has grown to cover almost entire population of the City. It also provides sewer network covering a large area of the City.

Under the Law on Waters, which was revised in 2008, the administration of water supply and sewerage sector is vested in the two ministries, namely, (i) MEPP, and (ii) MTC. The MEPP is responsible for, among other things, planning the development of the sector as a whole, providing drinking and wastewater quality standards, and supervising the performance of water utilities. The MTC assumes the financing (budget allocation) of the development activities in the sector, and the provision of design criteria for the water supply and sewerage facilities. The MEPP also assumes the authority of developing and exploiting water resources as a whole including licensing of water right not only for city water uses but also for irrigation purposes, and the construction of hydrological facilities such as dams and canals.

Under the old Law on Waters, the MTC used to provide long-term sector development plans. Such function will be transferred to the MEPP under the revised Law. It is unclear whether or not the expertise needed for such a work has been acquired by the MEPP.

Historically the City and Municipalities have been undertaking water supply and sewerage projects with a combination of their own capital resources and government fund. The completed facilities are operated by the municipality or a public enterprise if existing. After Macedonia's independence in 1991, a couple of water supply and sewerage projects have been implemented in other municipalities with grant assistance extended from international lending agencies. Since external grant assistance is normally small in amount, it cannot meet the capital requirement for large projects. It is obvious for the sector to rely on external loans for financing large projects. The government intends to promote the financial self-reliance of municipalities (city) and public utilities. Nonetheless, it is still uncertain whether or not the above sector financing practice continues in the future.

Vodovod is a large utility providing water supply and sewerage services. Its major strength is its ability to handle all the water utility activities only using its own human resources and equipment including operation and maintenance of water supply and sewerage facilities and construction work for their expansion and replacement. On the other hand, its organization appears to be rigid for change. Considerable parts of Vodovod's activities can be outsourced if such services are available. Vodovod says that the reduction in staff size is difficult since such third party services are unavailable. However, it appears that Vodovod is reluctant to positively discuss among themselves such a matter due to resistance from the labor union. In addition, there is a negative notion that Vodovod was originally created by Skopje City, so it is not easy for it to change its organization. All the same, as understood by the management of Vodovod, Vodovod needs to strengthen its capacity to carry out the work after the completion of the Project, which is bigger in volume and higher in technology. In other words, more efficient operating system should be established.

4.1.1 Necessity for Capacity Development

Required organization in the Vodovod is proposed to operate additional works of the wastewater treatment plants. In parallel, the Vodovod should be a financially and administratively sound organization to manage it. After the tariff hike in 2007 by almost 100%, the Vodovod has become a financially sound entity. And even the raised tariff is still within an affordable level. Thanks to the existing water supply facilities, the Vodovod operates the facilities without investing lots of money. However, on the other hand, it has resulted in, for example, huge water losses. It unnecessarily wastes energy. Rectifying this will require a considerable investment. A study on balancing investment and expenditure is out of this Study. However, at least the Study Team considers, if financial and administrative improvements are made on the Vodovod, financially the situation will

improve. Thus, required tariff increase can be minimized. Therefore, the institutional and financial capacity development of Vodovod was studied and assessed in the Study. As a result, action plans and other recommendations are developed and presented in the separate part of the Report. Identified/ required areas include the organizational structure, financial management, human resources management, financial operation, and operation and maintenance of the facilities. And they are reproduced in this section.

(1) Organizational structure
1) The terms of reference of each Sector and its divisions should be clearly redefined
2) If possible, mutually related activities should be organized into one Sector
3) There may be a need to reform the organizational structure, especially considering the creation of a new unit for O&M of the new WWTP.

(2) Financial management
1) The collection rate of water and sewer services charges should be improved up to 90% or more.
2) A special measure should be taken for low income households such as a low water tariff for the lowest block of water consumption, or government/City subsidy on water charges for low income families.
3) Certain measures should be taken for reduction in expenditure. As an example, efficiency of pumps can be improved by repair or replacement of their motors, which will reduce the power cost.
4) Reduction in the staff size: Although this seems to be very effective for reduction in expenses, it is not easy to be realized soon due to various constraints. However, this issue needs to be resolved in the foreseeable future.
5) Long-term projections should be made for personnel expenses, energy cost, repair cost, maintenance cost, overhead, depreciation and capital costs so that they form a firm base for the rate policy.

(3) Rate policy
1) The need for revision of the rate should regularly be checked since the Vodovod's financial environment changes year by year including various cost components, e.g., energy cost, salaries and wages, cost for renovation of the IT system and so forth.
2) Consumer's support or understanding is essential in the course of setting the new rate. In between Vodovod's proposal of a new rate and its deliberation in the City council, Vodovod can appeal to the public for the need of the new rate through consumer dialogues including the establishment of a rate council and the implementation of public hearings.

(4) Staff recruitment and training

The Vodovod's present staff size is large. After completion of the Project Vodovod should manage the utility which will augment in terms of both quantity and quality while keeping the operating cost at the minimum including personnel cost. Vodovod needs to set goals for staffing in terms of the staff size in each trade with classification for the level of competence. Therefore, Vodovod is required to recruit competent personnel, reposition staff with specific expertise or redundant personnel to a new division and train them to fit to the forthcoming new technologies related to the Project and adjust to the renovated operating environment. For some particular areas, e.g., IT technology, SCADA and water quality analysis, employment of new highly qualified personnel will be required.

(5) Improvement in the O&M system

The present organization of Vodovod does not contain a unit for O&M of the WWTP. The O&M of the sewer network and sewage pumping stations (including storm water drainage system) is carried out by Sector Sewerage for the sewer network and Sector O&M for pumping stations. There are no terms of reference (TORs) for each Sector in Vodovod. Instead there is the "Book of Regulations" in Vodovod, which basically prescribes responsibilities and duties of

each position of the personnel such as Sector Director, Technical Manager, electrician, mechanic etc. There will be a need to redefine the TORs of the Sector Sewerage assuming it carries out all the necessary O&M activities for the sewer network and the WWTP. The table attached in the Part Ⅲ shows the present TORs of Sector Sewerage and Sector O&M of Vodovod in comparison with the future TORs in accordance with a sewerage division of an average city in the market-oriented economy, e.g., Japan.

4.1.2 Existing Organization

Vodovod is a statutorily and financially independent body. The General Director of Vodovod is appointed by the council of the City. He reports to the City council on Vodovod's performance. Vodovod is not basically entitled to have subsidies or transfer of budget for its operation from the City.

The organization of Vodovod is large with a staff size of 1,120 as of end March 2008. Since the number of Vodovod's customers is approximately 168,000, the number of employees stands at 6.7 employees per 1,000 households, which is compared with similar water utilities elsewhere in a market-oriented economy like Japan (1.0 to 1.5 employees per 1,000 households). However, the Vodovod considers that it is not so overstaffed compared with other Balkan countries, and that it is not easy to reduce the staff size since Vodovod has many labor intensive site works for which mechanization and automation have been insufficient. It also says that outsourcing of its activities is difficult since there are no reliable entities in the domestic market for commissioning of Vodovod's work.

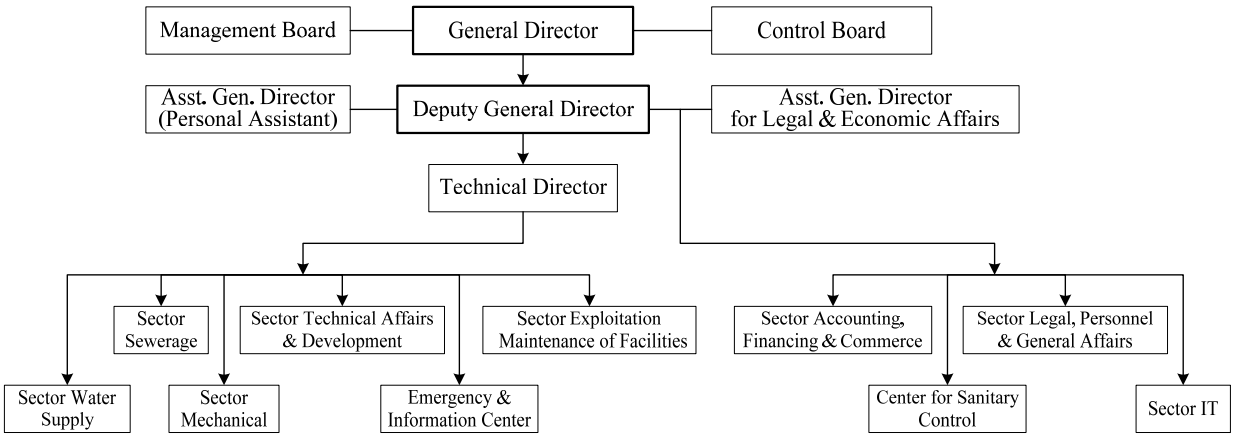


Figure 4.1 Existing Organizational Structure of Vodovod

Vodovod has all the divisions (Sectors) and sections required to perform day-to-day operations (See Figure 4.1). The scopes of work and lines of order of the Sectors are rather complicated even though there appears to be no significant duplications. For example, (1) water intake, transmission and treatment are operated by Sector Exploitation and Maintenance of facilities (O&M); (2) distribution mains are maintained by Sector Water Supply; (3) pumping stations by Sector O&M; (4) leakage detection by Emergency & Information Center; (5) leakage repair by Sector Water Supply, (6) receipts of application for new services by Sector Technical Affairs and Development, (7) installation of services by Sector Water Supply, (8) installation, replacement and repair of water meters by Sector Water Supply and so forth. Another example of this intricacy: after the construction of sewerage facilities by the City or one of municipalities, Sector Sewerage assumes the duty of maintenance of the sewers while design of new (minor) sewers and repair of the existing sewers is performed by Sector Technical Affairs & Development; and the sewage pumping stations are operated and maintained by Sector O&M. All in all, the capacity of Vodovod may become more functional if it would streamline the above activities.

4.1.3 Proposed Organizational Structure – Project Implementation Stage

Who will be the executing agency of the Project is an important issue. The executing agency must be

capable of handling various activities related to the preparation and implementation of the Project. They include, inter alia, (1) review of Project plan and feasibility reports, (2) preparation for PQ (pre-qualification) and bidding in accordance with the Guidelines for Procurement under a loan from the lending agency, (3) procedures of application and withdrawal of loan proceeds, (4) recruitment of consultants, (5) review of detailed design work, (6) construction supervision, (7) commissioning of Project facilities, etc.

There may be three alternatives for the executing agency, namely, (1) MTC, (2) Skopje City, or (3) Vodovod. The MTC does not seem to be suitable for the above items of Project administration due to lack of technical personnel who are familiar with such types of job. Skopje City is not suitable for the executing agency either although it possesses a department for construction of minor roads and other public civil work, but it has little expertise for design, construction and O&M of sewerage facilities. Vodovod has long experience in planning, design and construction of water supply and sewerage facilities, so is capable of providing the expertise for undertaking the above items of work. Of course, since Vodovod's personnel have sufficient experience in domestic procurement and construction, but thin experience in international procurement, especially procurement under the Procurement Guidelines under a loan from an external lending agency, they need to acquire such knowledge prior to the commencement of the Project.

It is recommended for the executing agency, namely, Vodovod[1], to establish a special unit for the implementation of the Project under its General Director. The unit may be named Project Management Unit (PMU) and positioned as shown in Figure 4.2.

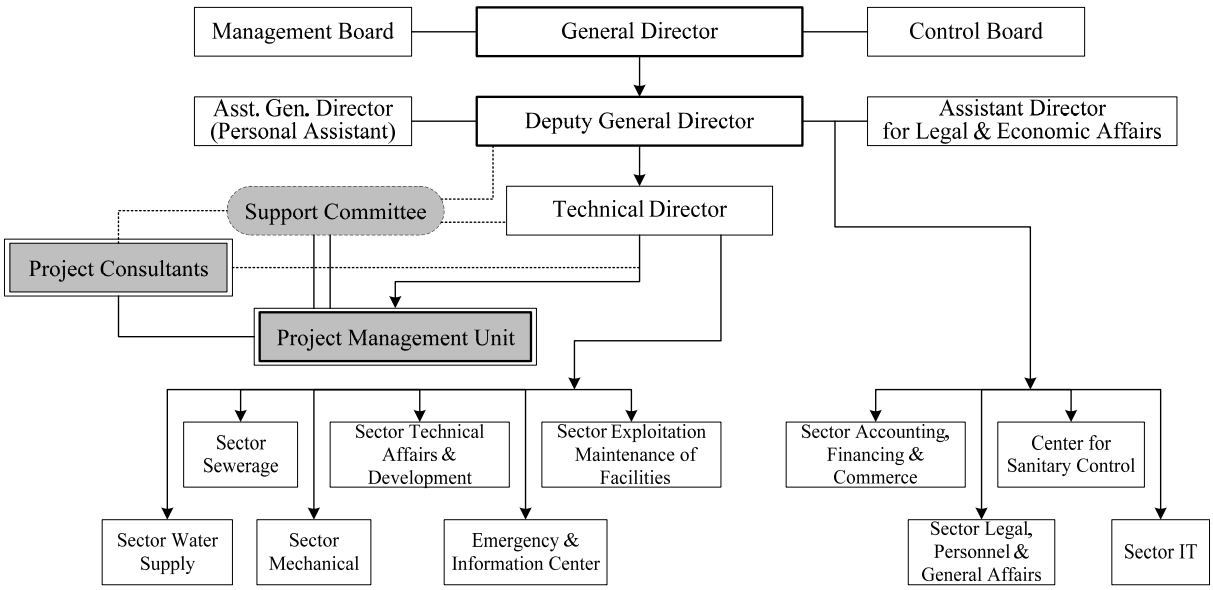


Figure 4.2 Organizational Structure in the Project Implementation Stage

It is also proposed to add a Support Committee, which assists the PMU in technical, administrative and financial aspects of the Project implementation. The PMU shall be composed of a Project Director, Technical Manager, Procurement Manager, Project Coordinator, and engineers and clerks. The Support Committee members shall consist of Deputy General Director, Technical Director, Sector Directors for Sewerage, Water Supply, Mechanization, Technical Affairs & Development, O&M, Accounting, Financing & Commerce, Legal, Personnel & General Affairs, and one or two representatives from Skopje City.

[1] During the Study, other form of operation was discussed such as private-partnership, creation of central Public Enterprise other than Vodovod. However, Vodovod is assumed to operate the proposed wastewater treatment plant in the Study according to the agreed scope of work between the two governments. The Study Team believes that it is better operated technically together with sewers and pumping stations and that Vodovod can have a power to force beneficiaries to disconnect water supply services if they do not pay the sewerage tariffs.

4.1.4 Proposed Organizational Structure –O&M Stage

There will be an absolute need to establish an independent or additional organizational unit for the O&M of the WWTP since there is no such unit in the Vodovod's present organization.

If it is assumed for Sector Sewerage to stand itself for not only O&M of sewers but also of pumping stations, Sector Water Supply shall have the equivalent TORs to do O&M of not only water mains but also drinking water pumping stations. In such a scenario, Sector O&M will only carry out maintenance of buildings and offices. If such functions (maintenance of buildings and offices) can be transferred to Sector Sewerage and Sector Water Supply, Sector O&M can be eliminated from Vodovod's organization.

Given the above consideration, alternative organizational structures are proposed as follows:

Alternative 1: Sector Wastewater Treatment is newly added to Vodovod directly under Technical Director. The function of the Sector is only the operation of WWTP, not including maintenance of facilities, which shall be carried out by Sector O&M.

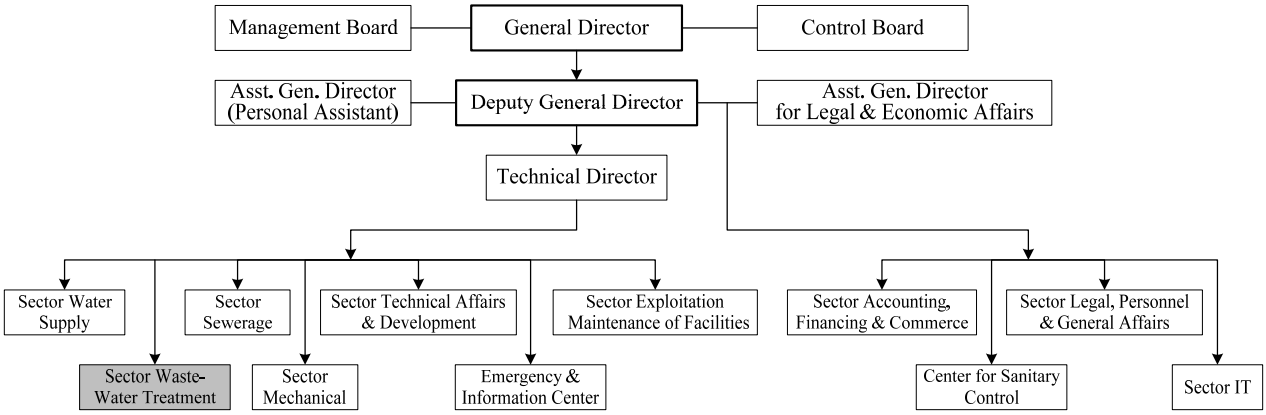


Figure 4.3 Organizational Structure of Vodovod with WWTP (Alternative 1)

Alternative 2: Sector Sewerage assumes not only maintenance of sewers but also O&M of the WWTP. Under the same concept, Sector Water Supply will perform not only maintenance of water mains but also O&M of water intake facilities, chlorination plant and pumping stations (including service reservoirs).

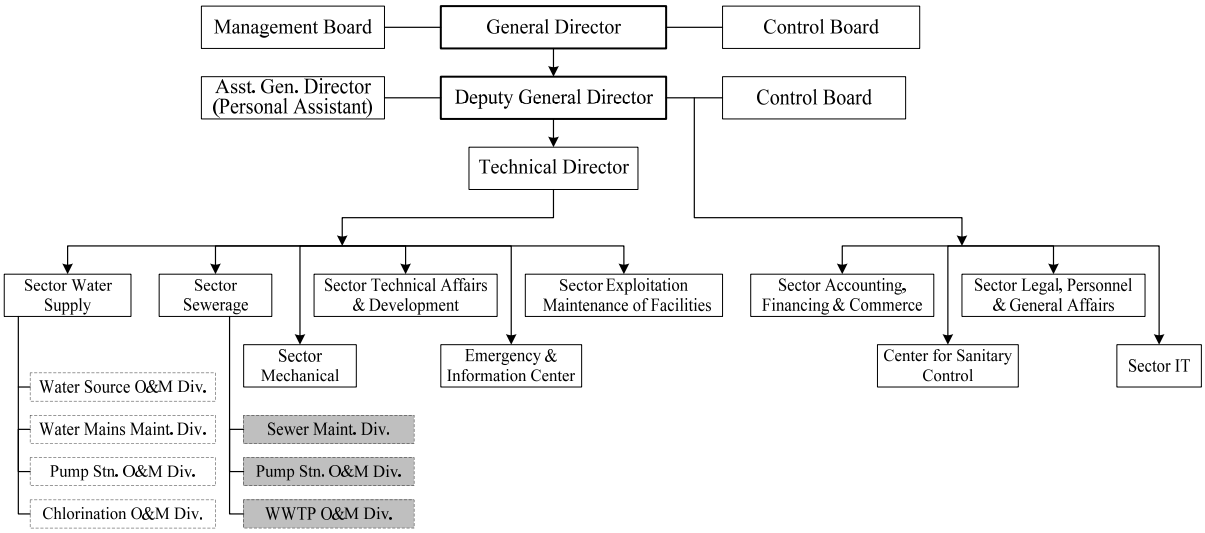


Figure 4.4 Organizational Structure of Vodovod with WWTP (Alternative 2)

Alternative 3: Vodovod is reorganized to have four departments, namely, Water Supply Department, Sewerage Department, Technical Department, and Administration Department. Technical Department will contain Sector Mechanical, Sector Technical Affairs & Construction, and Sector Information and IT. Administration Department will consist of Sector Accounting, Finance & Commerce, and Sector Legal, Personnel & General Affairs. All the functions of the former Sector O&M will be moved to either Water Supply Department or Sewerage Department. Division for Design and Construction will be newly added to Sector Technical Affairs & Construction. The function of leakage detection will move to Water Supply Department as a special unit. Sector IT and Emergency and Information Center will be agglomerated to form a new Sector Information and IT. The functions of Sanitary Control Center will be transferred to Water Supply Department and Sewerage Department as Drinking Water Laboratory and Wastewater Laboratory, respectively. This alternative was briefly discussed at the workshop on the improvement in the O&M system, but was not presented in a chart (See Section 3.3.2, Part III).

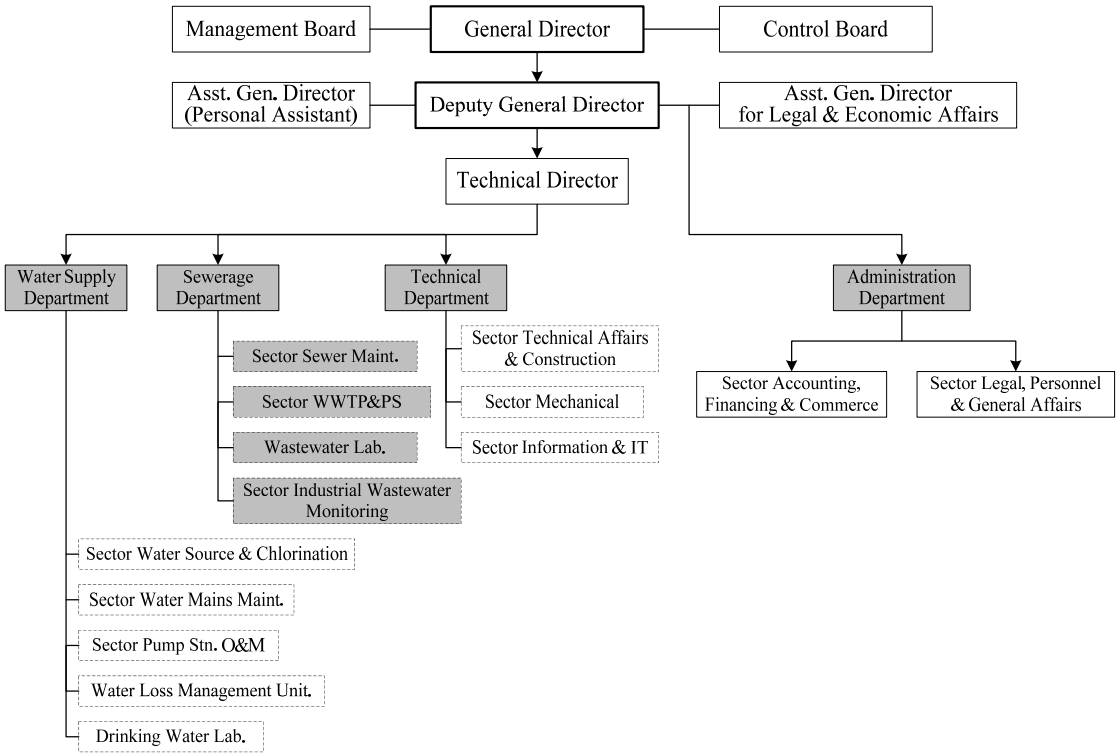


Figure 4.5 Organizational Structure of Vodovod with WWTP (Alternative 3)

Alternative 1 has a merit in that the required change in the Vodovod's organization is minimal. Its demerit is not to have maintenance forces within the WWTP, which may cause inconvenience in timely maintenance work, especially in an emergency case.

Alternative 2 has a merit in that the major operating sectors – Sector Water Supply and Sector Sewerage – are self-reliant and can carry out all operating and maintenance works by themselves. The demerits are that the function of construction is not defined in any of Sectors; that the function of Sector O&M is not well defined after transfer of the O&M functions of water supply and sewerage to Sectors Water Supply and Sewerage; and that the functions of Emergency & Information Center and Sector IT are not well prescribed and there appear to be redundancy in their responsibilities.

Alternative 3 embodies a significant merit in that Sewerage Department and Water Supply Department can handle maintenance work as well as operation of facilities by themselves even including water quality control functions; that Sector Technical Affairs and Construction, Sector Mechanical and Sector Information and IT are grouped in Technical Department, which will make the management of technical activities systematic and rational; and that administrative Sectors of "Accounting, Finance

and Commerce" and "Legal, Personnel and General Affairs" are Grouped in Administrative Department. It is specifically noted that construction activities for both water supply and sewerage are redefined for new Sector Technical Affairs and Construction, which have only been thinly prescribed for some personnel of Sector Water Supply and Sector Sewerage in the Book of Regulations. The demerit of this Alternative is that it will take time for Vodovod to make such a change in its organizational structure since the change to be made is significantly large.

(Conclusions and Recommendations)
It appears advantageous for Vodovod to renovate its organization towards Alternative 3. However, it seems to be difficult to complete such renovation well before the commissioning of the Project, which is expected to take place in around 2015. Considering the time factor and effectiveness of organizational renovation, Alternative 2 appears to be suitable to implement for the time being with an aim to shift towards Alternative 3 in future.

4.2 Laws and Regulations regarding Sewerage O&M

The operation and maintenance of wastewater facilities are regulated by various laws and ordinances. It is necessary for the sewerage administrator to observe these related laws/ordinances and to perform appropriate operation/maintenance. In laws and ordinances about the operation/maintenance of the wastewater facilities in Macedonia, there are "Law on Environment" and "Law on Water Supply, Drainage of Urban Wastewater" other than the new "Law on Waters".

The Law on Waters (Official Gazette 87/08) established in 2008 is an epoch-making law to take Water Framework Directive (2000/60/EC) of EU in, as described in 1.8 Regulation on Environment and Water, Chapter 1, B/P. According to the new Law on Waters, the water management shall be performed every basin and a wastewater facility (collection/treatment) is installed in the agglomerate more than 2000 PE (population equivalent). In addition, the effluent regulation/standard of wastewater facilities is going to be established as a government ordinance/regulation in future, based on Urban Waste Water Directive (91/271/EEC) of EU.

In addition, the effluent regulation for the discharges from factories will be made by the Integrated Pollution Prevention and Control (IPPC) system (cf. Part Ⅳ) based on Law on Environment, and the wastewaters discharged from factories to sewer are also regulated by IPPC system.

On the other hand, the Law on Water Supply, Drainage of Urban Wastewater (Official Gazette 68/04, 28/06, 103/08) prescribes contents of water and sewage business service, an enterprise (public corporations) offering the service, and water/sewage service charge for the management cost of the enterprise. The Law also mentions a) house connection, b) prohibitions on illegal use and connection to sewer and c) acceptance of industrial wastewater including wastewater from business establishment to sewer and the appropriate pretreatment.

As for the law on water environmental conservation in Macedonia, it has been progressing steadily in a model of EU Directives such as the water management structure of public waters and the necessity of the setting of wastewater facilities as above. However, as for the current Law on Water Supply, Drainage of Urban Wastewater, because it does not reflected these new movements, it is necessary to amend it in the new legislation which includes the construction, maintenance and management of the sewerage facilities, to harmonize with the new Law on Waters.

It seems that it is necessary to examine the following prescripts in the planned establishment of a government ordinance/regulation of the Law on Waters or amendment of the current Law on Water Supply and Drainage of Urban Wastewater from comparison with the Sewerage Law in Japan.

a) Establishment of improvement target of water quality in each basin and basin wide sewerage implementation program
b) Uniform effluent standard and severer standard for discharge from WWTP

c) Effluent standards of pretreatment facility for industrial wastewater discharging to sewer and its monitoring/inspection
d) Terms necessary for implementation and operation/maintenance of sewerage facilities to be ordained in municipal ordinance
e) Sewage sludge control to be reduced as much as possible and effectively utilized/ appropriately disposed of
f) Financial sources on construction cost of sewerage facilities (subsidy from state government and the other)
g) Certification system for skilled personnel, and so on.

In addition there is the Book of Regulations for Water Supply and Sewerage in Vodovod which prescribed the duties of the public works enterprise "Komunalec", that is the forerunner of Vodovod. This is equivalent to the water supply and sewerage ordinance/regulation, made in 1989 based on the resolution for the Law on Water Supply and Drainage of Urban Wastewater. The terms of design, construction, reconstruction, supervision and maintenance of the sewerage network, as well as the terms of prohibitions on illegal use and connection to sewer, house connection, acceptance of industrial wastewater with the appropriate pretreatment, and the means for calculating services used are regulated in detail in this Book.

In this public enterprise, it will be necessary to establish the original water supply and sewerage ordinance/regulation in future while watching the establishment of a government ordinance/regulation of the Law of Waters and the amendment of the Law on Water Supply, Drainage of Urban Wastewater.

Furthermore there are related laws and regulations on 1) necessary qualifications for O&M work in WWTP, 2) sewage sludge treatment, utilization and disposal, and 3) air pollution, noise/vibration and foul smell control. It is necessary for sewerage administrator to observe these, and to perform appropriate O&M. These are mentioned later in this section.

4.3 O&M Work and the Executive System

4.3.1 Purpose of O&M

The purpose of the operation and maintenance of sewerage is to maintain the facilities in an appropriate technical level and to operate it adequately and effectively, showing the function of facilities enough. Then the function lasts a long time with maintenance, and we can prepare for future rehabilitation and reconstruction. For this purpose it is necessary to draw up a maintenance plan from a long-term and comprehensive point of view, and to perform maintenance premeditatedly.

A concept of planned/proactive O&M is shown in Figure 4.6 compared with a concept of ex-post/reactive O&M. This shows that performing premeditated maintenance contributes to the prolongation of facilities' lifetime and the reduction of the total cost.

The planned/proactive O&M is a maintenance technique aiming at the prolongation of facilities' lifetime through the early detection of abnormal point and the preventive measures of sudden accident by the analysis of premeditated machinery investigation/check and repair record in WWTP/PS. By this planned/proactive O&M, operation and maintenance cost is paid out premeditatedly in a preventive manner, expenditure by sudden trouble/accident is controlled and as a result it aims at reducing the O&M total sum. This technique is based on an idea of life cycle cost (LCC) from the beginning of commencement, operation, maintenance, repair, and disposal.

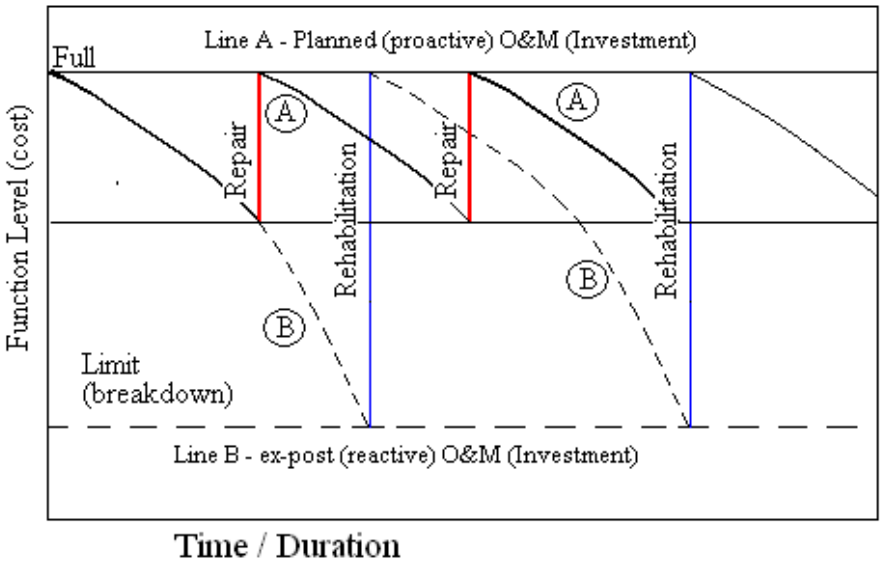


Figure 4.6 Concept of Planned (Proactive) O&M

4.3.2 Contents of O&M Work

Operation and maintenance work related to sewerage management consists of the following work fields;

1. Legal matter/Budget/Accounting/General affairs
2. Execution of budget/Contract
3. Asset management
4. Public relations/awareness
5. Estimate/collection of sewer service charge
6. Guidance on house connection
7. Monitoring of industrial wastewater and guidance to the industries
8. O&M of sewer network
9. O&M of wastewater treatment plant and pumping stations
10. Water quality control
11. Management of sewerage registers
12. Environmental conservation
13. Management for safety and health

The classification of operation and maintenance work are shown in Table 4.1.

Table 4.1 Classification of O&M Work related to Sewerage Management

Work Field	Major Work
1. Legal matter/Budget/ Accounting/General affairs	1) Enactment of the sewer service code, Legal support for monitoring of industrial wastewater 2) Budget planning and accounting 3) Personnel management; Social security and welfare, Staff training
2. Execution of budget/ Contract	1) Purchase and logistic management of materials and supplies (fuel, chemicals, consumables) 2) Contract of construction works、contract of other jobs assigned
3. Asset management	1) Management of fixed assets, and their maintenance 2) Building maintenance
4. Public relationship/ awareness	1) Announcement of the commencement of services 2) Public awareness enlightenment
5. Estimate/collection of sewer service charge	1) Investigation of customers, estimate of sewer service charges, collection of the charges 2) Investigation of unpaid charges, and approach
6. Guidance of house connection	1) Investigation of house connection 2) Guidance for installation of house connection, and their inspection
7. Monitoring of industrial wastewater and guidance to the industries	1) Procedures for installation of specified facilities by industries 2) Guidance for installation of pretreatment facilities 3) Monitoring and water quality analysis 4) Site inspection for industries on the regulation of wastewater 5) Guidance for O&M and improvement of such pretreatment facilities
8. O&M of sewer network	1) Check and survey of the sewer network 2) Cleaning and dredging of sewers 3) Repair and improvement of sewers 4) Protection and security of sewers
9. O&M of wastewater treatment plant and pumping stations	
(1) Operation	1) Planning of sewage and sludge treatment activities 2) Planning of operation of mechanical facilities 3) Implementation of operation plan 4) Planning/implementation of transportation and disposal of grit, screenings, sludge cake 5) Cleaning of buildings, treatment facilities etc. 6) Recording and reporting of the sewage/sludge treatment activities, dairy, monthly, yearly 7) Preparation of plan/system in advance, and instruction, action and operation in emergency cases
(2) Maintenance	1) Preparation of maintenance plan and manuals of mechanical/electrical facilities 2) Check and maintenance of mechanical/electrical facilities
(3) Repair and improvement	1) Preparation of repair plan, and the implementation 2) Preparation of improvement/renewal plan, and design/order/supervision of the work
10. Water quality control	1) Planning of water quality analysis, survey, research 2) Quality analysis of sewage/sludge 3) water quality analysis of industrial wastewater 4) Compiling and analysis of data and preparation of a report 5) Preparation of instructions on O&M, and direction for a change of control rule 6) Implementation of survey and research 7) Response and action in emergency cases 8) Adjustment and calibration of water quality instruments
11. Management of sewerage registers	1) Preparation, keeping and updating of registers、and the access services 2) Management of drawings and documents related to sewerage plans, drainage district, facilities in WWTP and so on
12. Environmental conservation	1) Planning and implementation of ambient air monitoring 2) Planning and implementation of noise and vibration measurement 3) Planning and implementation of odor measurement 4) Planning and implementation of water quality analysis of the river where treated sewage is discharged 5) Report to the supervising agencies on effluent water quality, sludge properties, and so on
13. Management for safety and health	1) Examination of safety and hygienic protection at work place, and their improvement

4.3.3 O&M based on Public Authority

The operation and maintenance works are divided into duties using public authority, such as collection of sewer service charge, guidance of house connection and monitoring of industrial wastewater, and the other duties related to operation and maintenance of sewer network, pumping station and wastewater treatment plant.

These duties using public authority are shown in Table 4.2 in detail. In Skopje, authority concerning collection of sewer service charge/guidance of house connection is given to Public Enterprise "Vodovod" Skopje by Law on Water Supply, Drainage of Urban Wastewater, Law on Local Self-Government and Ordinance of Skopje City. However, authority concerning monitoring / regulation of industrial wastewater discharged to sewer is not given to Vodovod.

In Macedonia, effluent regulation for effluent from factories is carried out by IPPC system (cf. Part Ⅳ) under the jurisdiction of the Ministry of Environment and Physical Planning (MEPP). In other words guidance to the setting of industrial wastewater treatment facility, monitoring of the treated wastewater and inspection of the facility on-the-spot are implemented under the jurisdiction of MEPP.

However, the industrial effluent discharged to sewer which includes wastewater from business establishment such as gas station, laundry, laboratory, etc. should be monitored and regulated by a sewerage administrator from the viewpoint of protecting sewerage facilities and maintaining effluent water quality in a standard. Therefore, it is necessary to give the sewerage administrator authority to regulate (monitor, inspect, etc.) factory effluent bringing bad influence in a sewerage facility and including a material which is difficult to treat in WWTP and/or is possible to treat in WWTP but more than setting standards.

This matter is a problem to examine hereafter, because adjustment with the authority of MEPP or cooperation of both does not become clear.

Table 4.2 O&M Work based on Public Authority

Work Field	O & M Work
O&M based on public authority	・Guidance/supervision/action of connection ・Regulation of factory effluent discharged to sewer (Monitoring of industrial wastewater, guidance to industrial wastewater treatment facility and inspection of the facility) ・Collection of sewer service charge ・Permission for occupancy of sewerage facility
O & M of sewer network and pumping	・Check and operation of pumping stations ・Cleaning and dredging of sewers ・Repair and improvement
O & M of wastewater treatment plant	・Operation of sewage and sludge treatment facilities ・Maintenance of mechanical/electrical facilities ・Water quality control ・Sludge property control ・Assent management

4.3.4 Function and Role of Wastewater Treatment Management

It is necessary to make the system of wastewater treatment plant which can show a function enough any time day or night. Maintenance functions and the role of the WWTP management are described bellow and shown in Figure 4.7.

a) Operation by mechanical and electrical engineer/technician
   - Operation/control of treatment facilities
   - Patrol/observation of the facilities and record/report
b) Maintenance by mechanical and electrical engineer/technician

- Regular check for mechanical and electrical equipment
- Repair and maintenance for the equipment

c) Water quality analysis by chemist and biologist
- Routine and diurnal water quality analysis for influent, effluent and treatment process
- Sludge property analysis for sludge treatment process, dewatered sludge
- Water quality analysis for industrial wastewater discharged to sewer
- River water quality analysis
- Record/report
- Direction concerning operation/control rule for operation part

d) Building Maintenance
- Patrol and regular check for building/equipment
- Repair and maintenance for building/equipment

e) General Affaires
- Account and Budget
- Asset Management
- Personnel and general affairs

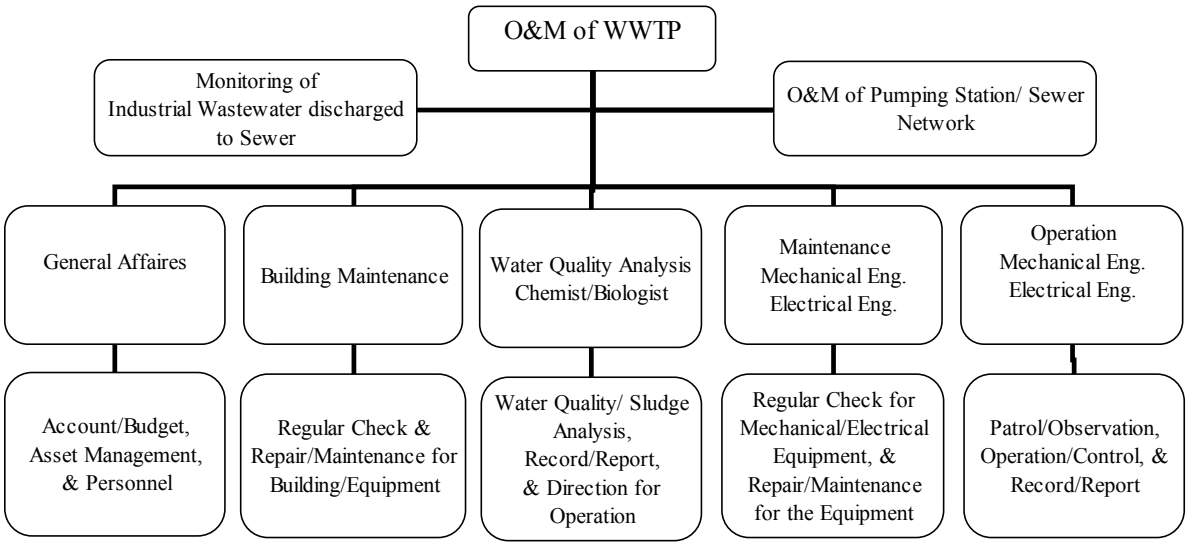


Figure 4.7 Function/role of Wastewater Treatment Management

The main operation and maintenance work of wastewater treatment is performed in the day. It is carried out a periodical activities based on a predetermined plan of operation and maintenance weekly, monthly, quarterly and yearly, other than daily work such as operation/control and patrol/observation of treatment facilities. In the night, it is common to carry out a minimum activity such as usual operation and observation of the treatment facilities, and emergency response at the time of trouble or accident. The troubled machinery and equipment are repaired and adjusted in the daytime there are many staffs working usually.

In addition, the general affaires part and building maintenance part (security guard) are desirable to be handled by persons dispatched from common sector of the headquarters of Vodovod. Alternatively persons belonging to the common sector of the headquarters of Vodovod can assume the above duties additionally.

The other works that is desirable to manage in a unified manner with wastewater treatment of Central WWTP are the followings;

f) O&M of pumping station
- Patrol/observation and operation/control
- Regular check and repair/maintenance

g) Monitoring of industrial wastewater discharged to sewer
- Monitoring and water quality analysis

- Guidance for installation of pretreatment facilities
- Site inspection of the industries

The Vodovod, Public Enterprise of Skopje City, now patrols, operates and maintains eleven (11) pumping stations, of which eight (8) are sanitary sewage pumping stations and three (3) are rainwater pumping stations, shown in Chapter 2 of B/P. After the startup of the wastewater treatment plant, sanitary sewage pumping stations are required to be managed in a unified manner with the Central WWTP due to unity of sewerage system. Furthermore the rainwater pumping stations are also required in unified management with the WWTP from the view point of efficient and unified maintenance for pumps, almost same size of the sanitary pumps. From such considerations, O&M of Pumping Station Part should be put in the WWTP.

In addition, after the startup of wastewater treatment plant, it is required to monitor and regulate industrial effluent discharged to sewer which includes wastewater from business establishment such as gas station, laundry, laboratory, etc. by the sewerage administrator from the viewpoint of protecting sewerage facilities and maintaining effluent water quality within a standard. In this case, it is efficient for water quality analysis part in WWTP to implement sampling and water quality analysis work. On this account it is desirable to put a monitoring of industrial wastewater part in the WWTP.

4.3.5 Required Personnel for O&M of WWTP (Rough estimation)

On examining O&M system of treatment plant, it is necessary to take the possibility of personnel acquisition, such as specialized personnel and number of O&M staff, and the expense into consideration in a comprehensive manner. The O&M system is in particular different greatly by direct management form or outsourcing form.

Almost of all municipalities in Japan utilize some kind of outsourcing to streamline O&M system. In late years, based on a way of the performance ordering system, some of the municipalities are planning promotion of efficiency by comprehensive privatization.

On the other hand, Public Enterprise Vodovod performs current water and sewage business by the direct management, administers an independent machine repair shop and employs enough staffs, security guards, and so on. In sewerage Vodovod has sewer network O&M sector of the direct management, and all of the five maintenance district offices under the sector implements cleaning and dredging of sewers by their own staff and machines.

In Macedonia, Struga/Ohrid WWTP, Kumanovo WWTP and others are operating. As shown in Table 4.3 both of the municipalities operate and maintain their plants by the direct management while taking the support of European countries.

Table 4.3 Outline of WWTP in Macedonia

Name of WWTP	Struga/Ohrid WWTP	Kumanovo WWTP
Planning Population	120,000 P.E.(population equivalent) = 100,000(residential) + 20,000(tourism)	120,000 P.E.
Capacity	Influent quantity 43,000m^3/day(dry weather) ~ 86,000m^3/day(wet weather)	Influent quantity : 18,000 m^3/day
Treatment Process	Oxidation Ditch Process	Oxidation Ditch Process
Commencement	in 1988	in 2006
O & M staffs	Around 40 people, 7 engineers (2 mechanical, 2 electrical, 3 chemists) and others	Total 13 people = 4 engineers (1 mechanical, 1 electrical, 2 chemists), 4 workers and 5 security guards (3 engineers moved inside. 1chemist is employed newly and trained one year.)

There is no reliable private company for outsourcing in Macedonia, even if privatization is opted,

because history of the direct management is long, then a market does not grow up. In addition, judging from the past performance or the current O&M system of the direct management, PE Vodovod has ability to operate and maintain the first WWTP in Skopje City by the direct management.

From the above-mentioned examination and the direct management performance of a Japanese similar WWTP, necessary O&M personnel at the start-up of Central WWTP are roughly estimated as shown in Table 4.4. Specialized personnel are shown in this table as M is mechanical engineer/technician, E is electrical engineer/technician, C is chemist and B is biologist.

Table 4.4 O&M Personnel of Central WWTP (Rough Estimation)

Part	Jobs	Estimated Number	Estimation Base (M:Mechan., E:Elec. C:Chem., B:Biol.)	Target Number
1. Operation	Patrol/Inspection, Operation/Control, & Record/Report	12	Day work: M2+E2 Shift work: (M1+E1)×4shifts	12
2. Maintenance	Regular Check for Mechanical/Electrical Equipment, & Repair/Maintenance	8	Day work: M4+E4	6
3. O&M of Pumping Station	11Pumping Stations= 8SanitaryPS+3RainyPS	6	Day work: (M1+E1)×3teams	4
4. Water Quality Analysis	Water Quality/Sludge Analysis, Record/Report & Direction for Operation	8	Routine Analysis (C4+B2)＋ Industrial wastewater(C2)	7
5. Building Maintenance & General Affaires	Account/Budget, Asset & personnel Regular Check & Repair/Maintenance for Building/Equipment	6	2 4=Security guard 1×4shifts	5
6. Field Work	Scraping/Storage/Transport of Dried Sludge Cleaning Works at Treatment Facilities, Building and Laboratory	14	8=(Tractor Driver1+ Worker1)×4teams 6	14
7. Monitoring of Industrial Wastewater	Target sites: 250= FactoryA:50+FactoryB:100+Others:100 Monitoring number of times: 700sites/year=3.5sites/day	6-4=2	6=(C1+M/E1+Worker1)×2teams Chemists and M/E double as Water Quality Analysis Part and Operation Part. Support necessary from legal section	2
Total		56	M:13+E:13+C:6+Bio:2=34	50

In this table, necessary personnel in each part are estimated as follows.

a) Operation: 12 people (includes night shift)
   - Day work (Mechanical 2+Electrical 2)
   - Night work (M1+E1) ×4shifts
b) Maintenance: 8 people
   - Day work (M4+E4)
c) Pumping Station O&M: 6 people
   - (M1+E1) ×3team
   - 11 Pumping stations (8 sanitary sewage stations and 3 storm water stations)
d) Water Quality Analysis: 8 people
   - Routine and Diurnal Examination (Chemist 4+Biologist 2)
   - Industrial wastewater analysis (Chemist 2)
e) Building Maintenance: 6 persons (includes night shift)
   - General affaires 2
   - Security guards 1 ×4shifts
f) Field work: 14 people
   - Scraping/storage/carrying dried sludge: 2×4 teams (transportation is outsourcing)
     (1 team=tractor operator 1+ worker 1)
     (50 lines ×10 beds=500beds/14days =36beds/day, 36×2/3hrs/7hrs=4 teams)

(10m×20m=200 ㎡/bed, 40 minutes/bed (scraping 30 + leveling 10 minutes))
- Cleaning work: 6
  (Screenings/ grit chamber/ water treatment/ water quality analysis/ building)

g) Monitoring of Industrial Wastewater discharged to Sewer: 6 people
- (Chemist 1 +Mechanical/Electrical 1+Worker 1) ×2 teams
- 200 sites: Factory category A: 50, factory category B: 100, small industries 100
- Monitoring: 50×4 times/year+100×3+100×2=700 sites/year=3.5 sites/day
- Chemist and M/E double as Water Quality Analysis Part and Operation Part.
- Support necessary from legal section

The number of necessary O&M personnel totals to 56 people. It may be said that this is the start-up original lineup which reflects the existing system of PE Vodovod. Afterwards if they acquire experience of the operation and maintenance of WWTP and become familiar with duties, operation part and maintenance part may also take the operation and maintenance duties of the pumping station partly, and the reduction of the security guard will be enabled by the promotion of efficiency of the night shift system. With above expectation, 50 people are assumed as the target number of personnel for O&M.

In addition, specialized personnel are estimated as 13 mechanical engineers/technicians, 13 electrical engineers/technicians, 6 chemists and 2 biologists, in total 34 people. Almost all of these seem to be possible to be filled up by internal transfer within Vodovod. But some personnel for water quality analysis may be employed newly from outside. At all events the premeditated training for the operation and maintenance staff is important because the O&M of the large-scale wastewater treatment plant is the first time for Macedonia.

Separately from the existing water experiment center, "Sanitary Control Center", of PE Vodovod, a wastewater laboratory will be installed in the Central WWTP to perform the water quality control tasks mentioned above. Main water quality analyzing equipment are listed up in Table 4.5, which seem to be necessary in operation/maintenance and water quality control in Central WWTP, based on a request from the Sanitary Control Center. In addition, various water quality analyzers are enumerated in an attachment of the sewerage M/P 99 of Skopje City reported in October, 1999.

Table 4.5 Main Equipment for Water Quality Analysis

・ pH meter	・ DO meter	・ EC meter
・ ORP meter	・ Flow meter	・ Balance
・ Dryer	・ Water bath	・ Magnet mixers
・ Vacuum pump	・ Centrifuge	・ Thermo-chamber
・ Incubator	・ Heating furnace	・ Composite sampler
・ Spectrophotometer	・ AAS	・
・ Gas chromatograph or iron chromatograph		・ TOC/N

Note:
AAS: Atomic absorption spectro photometer,
TOC/N: Total organic carbon and total nitrogen analyzer

As mentioned above, five maintenance district offices under the sewerage sector of Vodovod implement cleaning and dredging of sewers by their own staff and machines. The new trunk sewers with diameter from φ1,000 to φ1,800 are proposed in this Study and the Vodovod has experience in the maintenance of large diameter sewers. The sediment is to be dredged by man-power and high pressure water jetting and removed by vacuum car, similar to the practices in Japan. These machines for cleaning/dredging are aging; even the latest one passed more than 20 years. As of now they are using those machines while repairing in their machine shop. Therefore it is necessary to update these dredging machines which are already deteriorated remarkably, and improve the work efficiency. A list of machines to be replaced by purchase is shown in Table 4.6.

Table 4.6 Machine and Equipment for Sewer Cleaning

Machine or Equipment	Units
Wheel Camera and Portable Video Camera for checking sewer inside	1 set × 5 offices = 5 units
High-pressure Water Jet Sewer Cleaner with several types of nozzle	1 set × 5 offices = 5 units
Mini Jet Cleaner of portable type	1 set × 5 offices = 5 units
High-power Vacuum Car	1 set × 5 offices = 5 units
Bucket Wheel Excavator	1 set × 5 offices = 5 units
Mini Wheel Loader for Bucket Wheel Excavator	1 set × 5 offices = 5 units

4.3.6 Necessary Qualifications for O&M Work in WWTP

The placement of many qualifications established in laws and ordinances is needed on managing the WWTP. Because the qualifications should be prepared at the WWTP start-up, it is necessary to foster the resources with the qualifications beforehand. A series of examples of qualifications in Japan (cf. Table 4.7) is introduced to Macedonia government and PE Vodovod, and as a consequence they decided to investigate the kind/level of the qualification found in related laws and ordinances of Macedonia.

The qualifications required on the commencement of WWTP are classified as follows.

a) A qualification required regardless of WWTP scale and the kind of facilities
b) A qualification needed in conjunction with the scale of facilities and installations in WWTP
c) A qualification necessary when specified facility is installed or is used in WWTP
d) A qualification necessary when specified work is performed in WWTP

The following qualifications are usually required for a large scale WWTP in Japan.

a) A qualification required regardless of WWTP scale and the kind of facilities

There are "Qualified sewerage engineer" by Sewerage Law and "Oxygen deficiency danger work chief" by Industrial Safety and Health Law to this category of qualification in Japan.

Sewerage Law provides only a qualified person can operate and maintain wastewater treatment plant and pumping station, and it also defines the necessary qualifications.

There are many facilities and places in sewer system which fall under the category of oxygen deficiency danger place such as a sewer, a manhole, a grit chamber, a pump well, a channel, a sedimentation tank, a sludge storage tank, a digestion tank, etc. It is necessary for "Oxygen deficiency danger work chief" to make "Security control outline for oxygen deficiency danger work preservation" and put an attention mark in such a dangerous place and measure the hydrogen sulfide density before the work.

b) A qualification needed in conjunction with the scale of facilities and installations in WWTP

The installer of household electric facility must be able to make a maintenance code before starting the use of electric facility, elect a "Chief electric engineer" and notify the Minister of Economy Trade and Industry. Furthermore, a qualification of "Electric work technician" is required in case of work on the household electric facility less than 500 kw of maximum electricity.

In addition, an emergency electric generator and the fuel storage facility are usually installed in WWTP. In case of handling heavy oil there, the observation of "Dangerous material handler" is required according to the Fire Defense Law.

"Safety and hygiene administrator" must be elected for WWTP of 50 employees and more, and notified to the Labor Standards Supervision Office of the jurisdiction. In case of less than 50 to 10 employees, it is necessary to elect "a safety hygiene promoter".

c) A qualification necessary when specified facility is installed or is used in WWTP

In case of installing and operating a heating type anaerobic digestion tank, "Boiler handling technician" or "Boiler handling chief" as to work classification must be elected and notified to the

Labor Standards Supervision Office of the jurisdiction.

In case of installing a specific high-pressure gas cylinder containing 50 kg and more than 20 of them at the chlorine disinfection facilities, "Specified high-pressure gas handling chief" must be elected and notified to the Prefecture Governor. In addition, "Specified chemical material work chief" must be elected in case of handling the specified chemical substance such as chlorine, and hydrogen sulfide.

d) A qualification necessary when specified work is performed in WWTP

In case of working on acetylene welding in WWTP, "Gas welding work chief" must be elected and let him work. Also in case of crane operation for more than 1 ton of lifting load, "Crane technician" must be elected and let him work

In the WWTP which produce specified control industrial waste (acid, alkali, waste oil, etc.) during water quality analysis in particular, "Specified control industrial waste chief administrator" must be employed.

The following qualifications are not usually required for WWTP in Japan.

e) Radiation handling chief for gas chromatography of water quality equipment is not required for certification equipment (ECD for gas chromatography).
f) Specified poisonous material researcher for Parathion/methyl parathion/ methyl demeton for analysis of organic phosphorus is not required for usual water quality analysis.

Table 4.7 Necessary Qualifications for O&M work in WWTP in Japan

The following qualifications are usually required for large scale WWTP in Japan.

	Qualifications	Intended facility/equipment/material/work	Role	Law/Ordinance/Regulation in Japan
1	Qualified sewerage engineer	O&M of WWTP		"Sewerage Law"
2	Safety and hygiene administrator	Workshop of 50 workers and more	Safety and hygiene control at the site	"Industrial Safety and Health Law"
3	Oxygen deficiency danger work chief	Oxygen deficiency danger place; Sewer, Pumping well, Digestion tank, Sludge storage tank, etc.	Work direction, gas measurement, detector check, etc.	"Industrial Safety and Health Law" and "Ordinance on Prevention of Anoxia"
4	Chief electrical engineer	Electric facility	Safety inspection for O&M	"Electric Utility Law"
5	Electric work technician	Electric facility/work	Electric work	"Electric Work Technician Law"
6	Dangerous material handler	Oil storage/handling place; Oil storage tank, Generator	Oil handling and the inspection/direction	"Fire Defense Law"
7	Boiler handling chief	Boiler for heating type digestion tank	Boiler handling work	"Industrial Safety and Health Law" and "Ordinance on safety of boiler and pressure vessel"
8	Specified high-pressure gas handling chief	20 and more units of high-pressure gas cylinder (50kg/unit) for chlorine disinfection facility	Safety of high-pressure gas use	"High Pressure Gas Safety Law"
9	Specified chemical material work chief	Production/handling of HCl, H_2SO_4, H_2S, etc. for chlorine disinfection facility, except examination/research	Work direction	"Industrial Safety and Health Law"
10	Gas welding work chief	Welding equipment	Work direction, inspection, etc.	"Industrial Safety and Health Law"
11	Crane technician	Crane of 1ton and more	Crane operation	"Industrial Safety and Health Law"
12	Specified control industrial waste chief administrator	Waste acid/alkali/oil from heavy metal analysis and specified control industrial waste from sludge treatment process	Appropriate treatment of specified control industrial waste	"Waste Disposal and Public Cleansing Law"

The following qualifications are not usually required for WWTP in Japan.

	Qualifications	Intended facility/equipment/material/work	Role	Law/Ordinance/Regulation in Japan
13	Radiation handling chief	Not required for certification equipment (ECD for gas chromatography)	Radiation hazardous prevention	"Laws concerning the Prevention from Radiation Hazards due to Radioisotopes and Others"
14	Specified poisonous material researcher	Parathion/ methyl parathion/ methyl demeton for analysis of organic phosphorus.Not required for usual water quality analysis.	Handling specified poisonous material	"Poisonous and Deleterious Substances Control Law"

4.3.7 Training of operation and Maintenance Engineers

If the construction schedule of WWTP is fixed, it is necessary to start various preparations targeting the commencement of WWTP for several years. The followings are to be concrete.

a) Preparation of laws, ordinances and regulations related to sewerage and sewage treatment
b) Establishment of the O&M structure
c) Securing and training the O&M engineers/technicians
d) Securing and training the personnel with necessary qualifications
e) Securing the budget
f) Preparation of regulations, rules and codes related to sewerage and sewage treatment in P.E.
g) Preparation of sewerage registers and dairy, monthly, yearly report
h) Purchase of equipment and expendable supplies
i) Public information to citizens and the users

Of these, securing O&M engineers/technicians and personnel with necessary qualifications is the most important issue. In the operation and maintenance of WWTP, expertise and technology for many fields are necessary such as mechanical/electrical engineering, chemistry, biology, civil engineering and legal/management of the sewerage. For the startup of the Central WWTP of Skopje City several years later, the training of staff to be engaged in O&M has to be implemented in advance and effectively to develop and improve their ability.

The training plan is made in consideration of the following points.
a) Object technology（specialized training, qualification training, specialized skill training）
b) Target person（managerial level, specialist personnel, incoming/transfer employee）
c) Measures (group training, specialized training organization, skill training at field, in foreign countries/in the country）
d) Curriculum, frequency, period and the time
e) Evaluation method

As for the operation and maintenance, work experience accumulation at the site is important in particular. Therefore it is necessary to incorporate on-the-job training in a training plan, which is the practical training in WWTP to be able to learn theory and practical issues concurrently.

The main points of training plan are considered roughly as follows.
a) Object technology and target personnel
   - Operation/maintenance training for Mechanical/Electrical (Chemist/Biologist)
   - Water quality analysis training for Chemist/Biologist
   - Industrial wastewater monitoring training for Chemist/Mechanical/Electrical/ Legal
   - Manager training for Candidates of WWTP manager/chief and managers of PE
   - Qualification training based on the related laws/ordinances to the necessary qualifications.

b) Measures and period / the time
   - Manager training in Japan for around ten managers in two weeks, two years before the WWTP commencement

- WWTP training in Europe for 34 specialized personnel in two weeks, one year before the commencement
- Water analyst training for around three beginners in 2 months, one year before the commencement
- OJT of WWTP work for all specialized personnel and workers.

Four experts (lecturers) in mechanical, electrical, water quality analysis and industrial wastewater will be dispatched for eight man months (M/M) in two years, from one year before to one year after the WWTP commencement.

4.4 Water Quality Control and Sludge Control

4.4.1 Effluent quality control of wastewater treatment plant

The effluent quality of WWTP is/will be regulated by the Law on Waters and a government ordinance/ regulation of the law to be established in future.

According to the law, effluent of WWTP is monitored and analyzed by a notified water analysis body or their own laboratory authorized officially. In case of not meeting water quality standards of the Law on Waters, a penalty clause is applied.

The effluent quality standard of the Law on Waters is going to be established as a government ordinance/regulation of the law by the year 2010, based on "Urban waste water treatment, EU Directive 91/27/EEC". The effluent quality standard in the EU Directive which is slated for application to the Central WWTP is shown in Table 4.8. In addition, the water quality standard for effluent from WWTP to "sensitive area" which is already eutrophied or could be eutrophied is shown in Table 4.9 for reference.

Table 4.8 Effluent Quality Standard from Urban Wastewater Treatment Plant (91/271/EEC)

Parameters	Concentration	Reduction ratio
BOD （20 ℃, without nitrification）	25 mg/l	70-90 %
COD	125 mg/l	75 %
TSS	35 mg/l	90 % (optional)

Remarks: Values for concentration or reduction ratio shall apply.
（Other remarks and measurement method are omitted.）

Table 4.9 Effluent Quality Standard from WWTP to "Sensitive Area" Eutrophied or be Eutrophied (91/271/EEC)

Parameters	Concentration （P.E.: population equivalent）	Reduction ratio
TP	2 mg/l (10,000 - 100,000 P.E.) 1 mg/l (more than 100,000 P.E.)	80 %
TN	15 mg/l (10,000 - 100,000 P.E.) 10 mg/l (more than 100,000 P.E.)	70-80 %

Remarks: One or two parameters shall apply.
Values for concentration or reduction ratio shall apply
（Other remarks and measurement method are omitted.）

On the other hand, in the IPPC system, MEPP, the main control organization, gets control over a large scale factory or a factory to treat high hazardous substance categorized as "A", and local government gets control over a factory to treat the other hazardous substance categorized as "B". Industrial wastewater is regulated by effluent standard of hazardous substance including heavy metal, being determined by this IPPC system. In case of violation, the penal regulations of IPPC system are applied. The wastewater treatment plant is not appointed with category A or the category B either, though the urban waste facility is now appointed for a category A among public facilities. Therefore, it is necessary to appoint a wastewater treatment plant in the IPPC system if it will be the regulation

object of the system.

When a wastewater treatment plant receiving industrial wastewaters does not become the object of the IPPC system, it will be necessary to prescribe items about the hazardous substance in planned effluent quality standard being established in a government ordinance/regulation of the Law on Water in future, in order to close a loophole of the hazardous substance effluent regulation.

A tentative Effluent Standard from Wastewater Treatment Plant assumed to be applied to the Central WWTP as water quality control target is shown in Table 4.10. This is a table except the parameters (BOD, COD, TSS, TN and TP) of Table 4.8 and Table 4.9 from the parameters of the wastewater regulations in the Japanese Water Pollution Control Law.

However, the water pollution control for the wastewater treatment plant in Japan is made by the Sewerage Law and Water Pollution Control Law.

Under the Sewerage Law, the effluent from wastewater treatment plant is required to meet a "Technical Standard" established in a government ordinance. As the “Technical Standard”, there are a uniform effluent quality standard (pH:5.8 to 8.6, coliform bacteria count: less than 3,000/cm^3, SS: less than 40mg/l), a planed effluent quality standard designated by a sewerage administrator (BOD: less than 10mg/l / less than 15mg/l, Nitrogen content: less than 10mg/l / less than 20mg/l, Phosphorus content: less than 0.5mg/l / less than 1mg/l / less than 3mg/l) and a effluent standard of combined sewer overflows.

Under Water Pollution Control Law, the wastewater treatment plant is object that regulation is applied to, and effluent quality standards concerned with the hazardous substances including heavy metals and concerned with other parameters are provided as Table 4.11. In addition, depending on the local conditions such as lakes and closed water body, the Prefectural Governor can establish severer effluent quality standard (an addition standard) in the local ordinance. In case of discharging effluent which does not meet these standards of the Water Pollution Control Law, a penalty clause is applied.

The SS, BOD, Nitrogen content and Phosphorus content of the technical standard established in a government ordinance of the Sewerage Law are severer than the effluent quality standard (Table 4.11) of the Water Pollution Control Law.

In addition, concerning the above parameters of the technical standard (uniform standard and the planed standard designated by a sewerage administrator), in case that severe effluent quality standards are established by the additional standard of the Water Pollution Control Law or new parameters are determined besides the above technical standard, those severe standards or new parameters become the effluent quality standard.

Table 4.10 Tentative Effluent Standard from Wastewater Treatment Plant

Parameter			Unit	Permissible limit
General parameter	pH			5.8 to 8.6
	Coliform group bacteria count	CFU	N/cm^3	3,000
	n-hexane extract	Mineral oil	mg/l	5
		Animal and vegetable oil	mg/l	30
	Phenol		mg/l	5
	Cupper (Cu)		mg/l	3
	Zinc (Zn)		mg/l	2
	Iron (Fe)		mg/l	10 (soluble)
	Manganese (Mn)		mg/l	10 (soluble)
	Total chromium (Cr)		mg/l	2
Toxic substances	Cadmium (Cd)		mg/l	0.1
	Cyanide (CN)		mg/l	1
	Organic phosphorus		mg/l	1
	Lead (Pb)		mg/l	0.1
	Hexavelent chromium (Cr^{6+})		mg/l	0.5
	Arsenic (As)		mg/l	0.1
	Total mercury (T-Hg)		mg/l	0.005
	Alkyl-Hg		mg/l	N.D.
	Poly Biphenyl Chloride (PCB)		mg/l	0.003
	Tri-chloroethylene		mg/l	0.3
	Tetrachloroethylene		mg/l	0.1
	Di-chloromethane		mg/l	0.2
	Butyl chloride carbon (CCl_4)		mg/l	0.02
	1.2-dichloroethane		mg/l	0.04
	1.1-dichloroethylene		mg/l	0.2
	cis-1.2-dichloroethylene		mg/l	0.4
	1.1.1-trichroroethane		mg/l	3
	1.1.2-trichroroethane		mg/l	0.06
	1.3-dichloropropene		mg/l	0.02
	Thriuram		mg/l	0.06
	Simazine		mg/l	0.03
	Thiobencarb		mg/l	0.2
	Benzene		mg/l	0.1
	Selenium (Se)		mg/l	0.1
	Boric acid (B)		mg/l	10
	Fluorine (F)		mg/l	8

(Note)
1. Discharge volume is the daily average
2. The criteria of each parameter is possible to change more strict or add parameters by local government.
3. "N.D." stand for not detectable

Table 4.11 Effluent Standard based on Ordinance of Water Pollution Control Law

Parameter			Unit	permissible limit
Hazardous substance	Cadmium (Cd)		mg/l	0.1
	Cyanide (CN)		mg/l	1
	Organic phosphorus	confined to 4 compounds [1)]	mg/l	1
	Lead (Pb)		mg/l	0.1
	Hexavelent chromium (Cr^{6+})		mg/l	0.5
	Arsenic (As)		mg/l	0.1
	Total mercury (T-Hg)		mg/l	0.005
	Alkyl-Hg		mg/l	N.D.
	Poly Biphenyl Chloride (PCB)		mg/l	0.003
	Tri-chloroethylene		mg/l	0.3
	Tetrachloroethylene		mg/l	0.1
	Di-chloromethane		mg/l	0.2
	Butyl chloride carbon (CCl_4)		mg/l	0.02
	1.2-dichloroethane		mg/l	0.04
	1.1-dichloroethylene		mg/l	0.2
	cis-1.2-dichloroethylene		mg/l	0.4
	1.1.1-trichroroethane		mg/l	3
	1.1.2-trichroroethane		mg/l	0.06
	1.3-dichloropropene		mg/l	0.02
	Thriuram		mg/l	0.06
	Simazine		mg/l	0.03
	Thiobencarb		mg/l	0.2
	Benzene		mg/l	0.1
	Selenium (Se)		mg/l	0.1
	Boric acid (B)		mg/l	10 (230) [2)]
	Fluorine (F)		mg/l	8 (15) [2)]
	NH_3, NH_4^-, NO_2^-,NO_3^-		mg/l	100 [3)]
The other parameter [4)]	pH			5.8 to 8.6 (5.0 to 9.0) [2)]
	Biological oxygen demand (BOD) [5)]		mg/l	160 (daily average120)
	Chemical Oxygen Demand (COD_{Mn}) [6)]		mg/l	160 (daily average120)
	Suspended solid (SS)		mg/l	200 (daily average150)
	Coliform group bacteria count		N/cm^3	3,000
	n-hexane extract	Mineral oil	mg/l	5
		Animal and vegetable oil	mg/l	30
	Phenol		mg/l	5
	Cupper (Cu)		mg/l	3
	Zinc (Zn)		mg/l	2
	Iron (Fe)		mg/l	10 (soluble)
	Manganese (Mn)		mg/l	10 (soluble)
	Total chromium (Cr)		mg/l	2
	Coliform group bacteria count		N/cm^3	daily average 3,000
	Nitrogen content [7)]		mg/l	120 (daily average60)
	Phosphorus content [7)]		mg/l	16 (daily average8)

(Note)
1) Parathion/Methyl parathion/Methyl demeton/EPN only
2) Value in parentheses is used in case of effluent to the sea
3) This value is total of NH_4-N*0.4, NO_2-N and NO_3-N
4) These parameters are applied to the industries of discharges more than $50m^3$/day
5) Criteria of BOD is applied to the effluent discharged to public water body except sea and lake
6) Criteria of COD is applied to the effluent discharged to the sea and lake
7) Criteria of N and P content are applied to the designated lakes and seas where could be eutrophied

4.4.2 The water quality measurement of the WWTP effluent

The "Urban waste water treatment, EU Directive 91/27/EEC" provides the water quality measurement to monitor whether it observes effluent quality standard as follows.

a) Sampling
   - Flow-proportional or time-based 24-hour samples shall be collected at the same well-defined point in the outlet and if necessary in the inlet of the treatment plant.

b) The minimum annual number of samples
   - The number shall be determined according to the size of the treatment plant and the samples shall be collected at regular intervals during the year.
   - The minimum number is 12 samples for 2 000 to 9 999 P.E., 12 samples for 10 000 to 49 999 P. E. and 24 samples for 50 000 P. E. or over during the first year.
   - The minimum number is four samples in subsequent years, if it can be shown that the effluent during the first year complies with the provisions of the Directive.
   - If one sample of the four fails, 12/24 samples must be taken in the year.

c) Judgment whether the effluent quality satisfied the effluent standard value or not
   - Maximum permitted number of samples which fail to the standard value depending on the series of samples taken in any year is defined.
   - 25 samples in case of daily measurement (365 times/year), 10 samples in case of every three days, five samples once a week, two samples once a month and one sample once a year.

4.4.3 Industrial wastewater monitoring and regulation

In the commencement of wastewater treatment plant, industrial wastewater from factory and other business establishment in the service area flows into the WWTP as far as circumstances permit. In case that the industrial wastewater includes the materials which damage sewerage facilities and adversely affect the treating function of the WWTP, they cause a serious trouble for the security of sewerage facilities and effluent quality control of WWTP.

For this purpose the Law on Waters and the Law on Water Supply, Drainage of Urban Wastewater in Macedonia provide the monitoring and regulation for industrial wastewater which gives the sewer system bad influence, and the obligation to set the pretreatment facility. The Public Enterprise Vodovod has the discharge criteria to sewer system, which is not fitting with the times, shown in table 4.12.

Table 4.12 Permissible Industrial Wastewater Effluent to Public Sewerage

Parameter	Unit	Maximum Allowed concentration
BOD	mg/l	1,000
COD	mg/l	2,000
pH	-	6-8.5
pH at waters that consist of metal	-	7-10
Temperature	^{o}C	40
All matters (dry matters)	mg/l	3,000
Precipitation 1 by 3 sediments	m^3/l	200
Oil and derives of oil	mg/l	50
Fat	mg/l	55
Total soap	mg/l	10
Phenol and its derivatives	mg/l	30
Mercury	mg/l	0.005
Copper	mg/l	0.5
Nickel	mg/l	0.1
Chromium Cr^{3+}	mg/l	0.5
Chromium Cr^{6+}	mg/l	0.1
Lead	mg/l	0.5
Varium	mg/l	4
Iron	mg/l	55
Potassium	mg/l	4
Fluor	mg/l	50
Arsenic	mg/l	0.5
Zinc	mg/l	2.0
Selenium	mg/l	0.1
Cadmium	mg/l	0.3
Silver	mg/l	0.1
Free chlorine	mg/l	0.5
Cyanide	mg/l	0.2
Calcium Carbide (CaC_2)	mg/l	0
Magnesium	mg/l	200

Parameter	Unit	Maximum Allowed concentration
Chloride	mg/l	400
Sulphate	mg/l	300
Sulfide	mg/l	1
Thiocyanide	mg/l	50
Nitrate	mg/l	50
Nitrite	mg/l	30
Hydrogen sulfide	mg/l	0
Tetra-Chlorethylene	mg/l	0
Tri-Chlorethylene	mg/l	0
Chloroform	mg/l	0
Ether	mg/l	0

Source: Vodovod

In Macedonia, the regulation, monitoring and inspection for discharges from factories is under the jurisdiction of the Ministry of Environment and Physical Planning (MEPP). However, it is necessary to give sewerage administrator the authority to regulate, monitor and inspect factory discharge and pretreatment facility from the viewpoint of protecting sewerage facilities and maintaining effluent water quality within a standard.

By the startup of the WWTP, the discharge criteria should be established and modified to harmonize with the new Law on Waters. In this study the discharge criteria is proposed in the Seminar on Industrial Wastewater Control and Monitoring in reference to the above discharge criteria of PE Vodovod and the discharge criteria of Okayama City in Japan.

Table 4.13 Pre-Treatment Criteria (Okayama City)

		Parameter		Unit	Specified enterprise		Other enterprise	
					More than 50 m^3/day	Less than 50 m^3/day	More than 50 m^3/day	Less than 50 m^3/day
Criteria by local ordinance	General parameter	Temperature		°C	45	45	45	45
		pH		-	5 to 9	5 to 9	5 to 9	5 to 9
		BOD		mg/l	600	-	600	-
		Suspended solid (SS)		mg/l	600	-	600	-
		n-hexane extract	Mineral oil	mg/l	5	5	5	5
			Animal and vegetable oil	mg/l	30	-	30	-
		Indine (I_2) consumption		mg/l	220	220	220	220
Criteria by governmental law		Phenol		mg/l	5	5	5	5
		Cupper (Cu)		mg/l	3	3	3	3
		Zinc (Zn)		mg/l	2	2	2	2
		Iron (Fe)		mg/l	10 (soluble)	10 (soluble)	10 (soluble)	10 (soluble)
		Manganese (Mn)		mg/l	10 (soluble)	10 (soluble)	10 (soluble)	10 (soluble)
		Total chromium (Cr)		mg/l	2	2	2	2
	Toxic substances	Cadmium (Cd)		mg/l	0.1	0.1	0.1	0.1
		Cyanide (CN)		mg/l	1	1	1	1
		Organic phosphorus		mg/l	1	1	1	1
		Lead (Pb)		mg/l	0.1	0.1	0.1	0.1
		Hexavelent chromium (Cr^{6+})		mg/l	0.5	0.5	0.5	0.5
		Arsenic (As)		mg/l	0.1	0.1	0.1	0.1
		Total mercury (T-Hg)		mg/l	0.005	0.005	0.005	0.005
		Alkyl-Hg		mg/l	ND	ND	ND	ND
		Poly Biphenyl Chloride (PCB)		mg/l	0.003	0.003	0.003	0.003
		Tri-chloroethylene		mg/l	0.3	0.3	0.3	0.3
		Tetrachloroethylene		mg/l	0.1	0.1	0.1	0.1
		Di-chloromethane		mg/l	0.2	0.2	0.2	0.2
		Butyl chloride carbon (CCl_4)		mg/l	0.02	0.02	0.02	0.02
		1.2-dichloroethane		mg/l	0.04	0.04	0.04	0.04
		1.1-dichloroethylene		mg/l	0.2	0.2	0.2	0.2

		Parameter		Unit	Specified enterprise		Other enterprise	
					More than 50 m^3/day	Less than 50 m^3/day	More than 50 m^3/day	Less than 50 m^3/day
		Cis-1.2-dichloroethylene		mg/l	0.4	0.4	0.4	0.4
		1.1.1-trichroroethane		mg/l	3	3	3	3
		1.1.2-trichroroethane		mg/l	0.06	0.06	0.06	0.06
		1.3-dichloropropene		mg/l	0.02	0.02	0.02	0.02
		Thiuram		mg/l	0.06	0.06	0.06	0.06
		Simazine		mg/l	0.03	0.03	0.03	0.03
		Thiobencarb		mg/l	0.2	0.2	0.2	0.2
		Benezene		mg/l	0.1	0.1	0.1	0.1
		Selenium (Se)		mg/l	0.1	0.1	0.1	0.1
		Boric acid (B)		mg/l	10 (230)	10 (230)	10 (230)	10 (230)
		Fluorine (F)		mg/l	8 (15)	8 (15)	8 (15)	8 (15)
		T-N as N		mg/l	240	-	240	-
		T-P as P		mg/l	8 (32)	-	8 (32)	-
		Dioxin		pg-TEQ/l	10	10	10	10

Note:
1. Column ▭ : direct punishment, ▭ : regulated criteria for pre-treatment facility
2. Discharge volume is the daily average
3. Criteria in parentheses for boronic acid, fluorine is used in case municipal wastewater discharges its effluent to the sea or for designated areas.
4. Criteria of T-N and T-P the criteria in designated areas
5. The criteria of each parameter is possible to change more stricter or add parameters by local government.

The sewerage law in Japan establishes the discharge criteria and gives sewerage administrator the authority to regulate, monitor and inspect factory discharge and pretreatment facility. An outline of the water quality regulation by the sewerage law is shown in Table 4.14 and explained below.

Table 4.14 Industrial Wastewater Regulation by the Sewerage Law in Japan

Purpose of the regulation	Means of the regulation	Discharge criteria	Target factory and other business establishment
Protection of sewerage facilities	Setting of pretreatment facility	Criteria by ordinance of local government	Factory and other business establishment in the drainage area
Securing effluent water quality	Discharge regulation by direct punishment	Criteria by government ordinance (for the materials which are difficult to treat in WWTP)	Specified factory and other business establishment in the treatment area
		Criteria by ordinance of local government (for the materials which are possible to treat in WWTP)	
	Setting of pretreatment facility	Criteria by ordinance of local government	Factory and other business establishment in the treatment area

a) Discharge criteria for sewerage facilities protection

The industrial wastewater regulation for sewerage facilities protection aims at preventing damage or decrease in function of sewer, pumping station and treatment plant.

The sewerage administrator can regulate the industrial discharge for all business establishments which use the sewer system, by their ordinance in the range of the discharge criteria established in a government ordinance. The discharge criteria established in government ordinance are temperature: more than 45 degrees, pH: less than 5 and more than 9, n-hexane extract for mineral oil: more than 5mg/l and for animal and vegetable oil: more than 30mg/l, and iodine consumption: more than 220mg/l, which are not permitted.

b) Discharge criteria for securing effluent quality

The industrial wastewater regulation for securing effluent quality aims at preventing inflow of the materials which are difficult to treat in WWTP and which aggravate the effluent water quality by obstruction of treatment function of WWTP.

For this purpose the sewerage administrator can apply the penal regulations directly without performing an administrative order, when industrial wastewater that does not meet discharge criteria is discharged. The target business establishments of this direct punishment are as follows.
- Specified business establishments which discharge more than 50m^3/day
- Specified business establishments which treat hazardous substances

For this purpose the discharge criteria divides the materials into two groups; which are difficult to treat and which are possible to treat in WWTP.

The discharge criteria for materials which are difficult to treat in WWTP (there are 33 parameters in this category) is established in a government ordinance as a uniform standard. Included in these these 33 are 26 parameters from cadmium to fluorine of hazardous substance, six parameters from phenol to total chromium of the others in Table 4.11, and dioxins 10pg-TEQ/l.

In addition, the sewerage administrator can establish the discharge criteria for materials which are possible to treat in WWTP, by their ordinance according to the discharge criteria established in a government ordinance.

But it is said that the discharge criteria established in the ordinance must not impose unfair duty on a sewer user by severer criteria than the criteria established in a government ordinance. In case of manufacturing industry and gas supply industry, the discharge criteria can be reinforced if requirements are satisfied.

c) Discharge criteria for setting of pretreatment facility

It is assumed that the discharge criteria for setting of pretreatment facility follow the criteria mentioned above.

The sewerage administrator performs monitoring duties for industrial wastewater discharging to sewer and the pretreatment facility as follows. In these duties participation not only from the water quality analysis and operation/maintenance sections of WWTP in the technical field but also from legal and user charge sections in business affaires are indispensable.
- Investigation/understanding of the industries coming under the scope of regulation
- Procedures for installation of specified facilities by industries
- Guidance for installation of pretreatment facilities
- Monitoring and water quality analysis
- Site inspection of the industries on the regulation of wastewater
- Guidance for O&M of such pretreatment facilities
- Guidance for improvement of such pretreatment facilities

4.4.4 Sewage sludge Management and the Management of Environmental Item

a) Disposal of sewage sludge and others

As the result of wastewater treatment grit, screenings and sewage sludge are generated. It is the most important matter in operation/maintenance of WWTP to dispose the generated grit, screenings and sewage sludge appropriately, in concurrence with observance of effluent standard of WWTP. For this purpose it is necessary to make a plan of transportation and disposal of grit, screenings and sludge cake at the startup of WWTP.

In disposal methods of these grit, screenings and sludge cake are;
- Landfill disposal as urban wastes,
- Landfill disposal as the industrial waste, and
- Agriculture use.

In Macedonia how to handle or how to regulate the sewage sludge is not clear at this moment in the related laws such as Waste Disposal Law or Fertilizer Regulatory Law. But in the near future, they are going to establish a standard for regulation of the landfill disposal and agriculture use of sludge

using examples from the related EU Directives, and apply them to the sewage sludge disposal or utilization. The regulation standards of EU Directives are shown in section 3.1.7, B/P.

It seems that landfill disposal is possible for the grit and screenings, but for sewage sludge regulation of industrial wastewater becomes the key to appropriate and effective disposal. At first, in the making of the sewage sludge disposal plan, dewatered sludge properties have to be examined, and then it becomes possible to judge by the contents such as the heavy metal whether to utilize the sludge as a soil conditioner/fertilizer, dispose at the urban wastes landfill site or dispose at a planned hazardous waste disposal site.

If it is possible to dispose the dewatered sewage sludge at the Drisla urban wastes disposal site, the expenditure is estimated as about 21 million MKD/year (55 million yen/year); that is 680MKD (tax-included 714MKD)/ton of disposal rate at Drisla and 80ton/day of dewatered sludge generation. In this case it will also be possible to develop the way of agricultural use.

If it becomes impossible to dispose the sewage sludge at the Drisla, it will be forced to spend more than above, and also shutting the way of the utilization of the sludge. This implies that it is important to strengthen the monitoring of industrial wastewater discharge, regulate the hazardous substance (heavy metal) mixture, and implement the sludge quality control, from the view point of O&M cost reduction and improvement of the sewerage management.

Careful attention and periodical monitoring is required to prevent from infiltration of water which is generated from the sludge drying bed, to groundwater and soil because the treatment plant is located next to the protected areas. Water infiltration is prevented by putting concrete on the bottom of the sludge drying bed and temporary sludge storage site. Dust is not usually generated from the sludge which has high water content. However, sludge surface becomes too dry and becomes dust if sludge remains long in the bed. In order to prevent dust scattering to particularly the protected areas, water contents should be periodically monitored and the dried sludge should be disposed off before it becomes too dry. In the case of temporary sludge storage, cover sheets etc. should be covered on the sludge.

b) The management of environmental item

The facilities of WWTP should be operated and maintained carefully to control air pollution, noise/vibration and odor, so that there is no or minimal influence on inhabitants around the plant in particular. Therefore it is important to investigate the facilities which are likely the source, to make plans of ambient air monitoring, noise/vibration measurement and odor measurement, and to monitor regularly.

It seems that there is a boiler of the digestion tank as the source of air pollution, there are construction machine and blowers as noise/vibration source, and there are many places such as grit chamber, screen and digestion tank as main sources of odor. The operators of WWTP should monitor these sources, confirm whether the regulation criteria at the regulation point such as site borders are satisfied, and report them to the supervising authorities if necessary.

4.5 Sewer Ledger and Records with GIS

4.5.1 Current Sewer Ledger and GIS System

Vodovod has maintained sewer ledger and introduced GIS system in 2007. Its importance and information required therein are described in this section for the reference even though they are not related in F/S.

4.5.2 Importance of Sewer Ledger

The sewer ledger is the basic needs for proper O&M. It helps to formulate records and to grasp a correct perception of the present situation of existing sewer facilities. The ledger is also needed to provide public with information and to provide related institutions with data in response to requests.

In order to prevent accidental troubles as much as possible and at the same time, to promote life-extension of facilities, it is required to carry out necessary repair and cleaning in accordance with planned maintenance and accumulated information in the ledger.

4.5.3 Contents of Ledger

(1) Document

At least the following contents should be included in the ledger.

1) Areas, population served and name of places of each treatment district.
2) Date of commencement of service.
3) Location of discharge points and name of receiving waters.
4) Length of sewer, number of manhole and house connection pit of sanitary sewage and stormwater.
5) Location, area of site, configuration and capacity of treatment plants.
6) Location, area of site, configuration and capacity of pumping stations.

(2) Drawing

1) General Plan
   i) Administrative boundary.
   ii) Name and boundary of treatment district, sub-district of treatment district or drainage district.
   iii) Location of sewer and discharge point and name of receiving water.
   iv) Location and name of treatment plants and pumping stations.
   v) Direction, scale, legend and date of drawing.

2) Plan View of Facilities
   i) Above mentioned contents of i)~iii) and vi).
   ii) Location, shape, inner size, slope and direction of flow of sewer.
   iii) Location, shape and inner size of house connection pipe.
   iv) Location, type and size or diameter of manhole.
   v) Location and type of sanitary sewage and run-off rain house connection pit.
   vi) Location of outfall and name of receiving water together with high, middle and low water levels.
   vii) Location, shape, inner size and name of point at which gutter or open channel is connected to drainage facilities.
   viii) Boundary and name of treatment plant and pumping station.
   ix) Location, shape, size and water level of major facilities in the site of treatment plant and pumping station.
   x) Name and location of relevant facilities, except sewerage system, constructed with the permission of or in consultation with administrator of sewerage system.
   xi) Location of road, river and rail way, etc, located near by.

4.5.4 Application of GIS

O&M could be carried out more easily with application of GIS. GIS allows us to view, understand and visualize data in the form of map.

Vodovod has conducted maintenance based on the existing ledger, therefore in this section only essential features are described as reference.

4.6 Maintenance of sewer system

4.6.1 Current Sewer Maintenance

Sector Sewerage which has about 120 staffs is responsible in sewer maintenance. Maintenance is rather not carried out by planned basis but by demand basis: upon request or information by residents,

repair works start. It has 5 area branches to respond repair demand effectively. Further, in order to respond a repair demand even during off-working hours and days, Vodovod has emergency and information center which deals with sewerage and water supply works as well.

In total, Vodovos has the following equipments for sewer cleaning:

- Many manual-operated devices like bucket
- 8 vacuum-driven cars
- 6 high-pressure-driven cars
- Miller
- Lathe
- Drill

They are about 30 years-old but is said keeping in good working condition.

The repaired points and causes are not sufficiently analysed yet for future maintenanve works. Therefore, proper maintenance systems are introduced for the reference.

4.6.2 Purpose of Sewer Maintenance

Sewer maintenance is carried out, with sufficient information of facilities, to achieve following objectives.

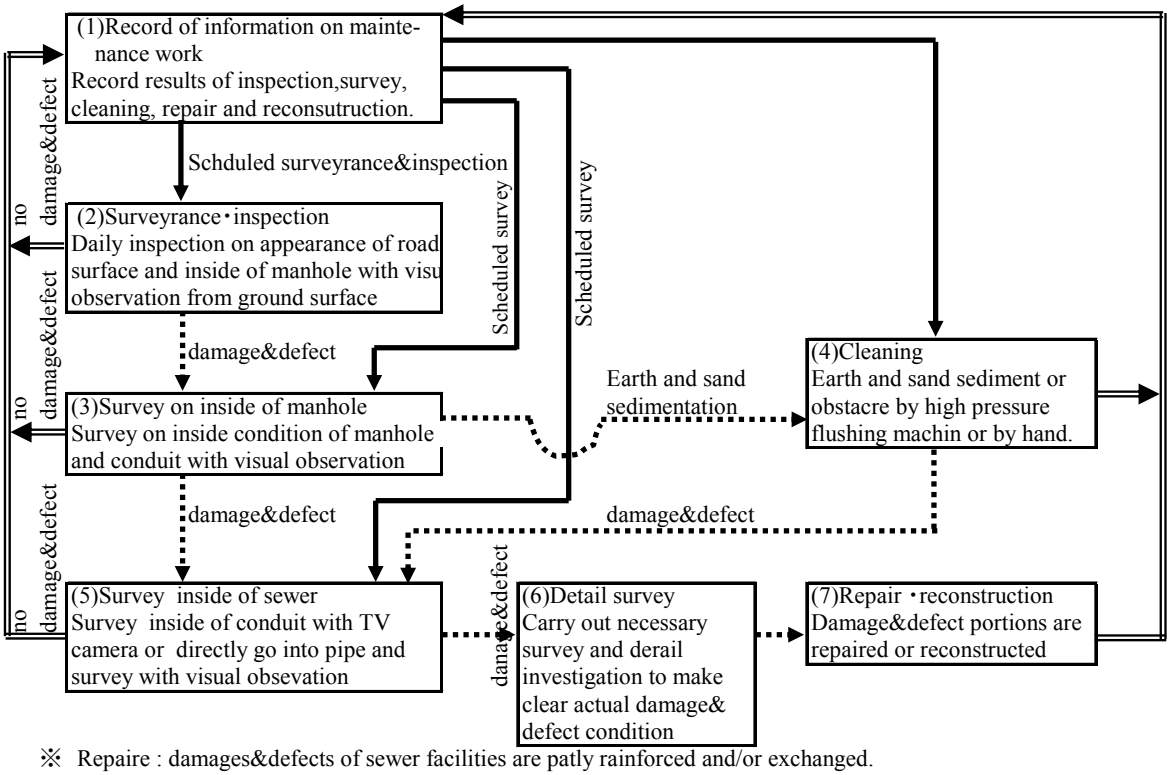
(a) to maintain functional capability of facilities
(b) to extend the life of facilities (decrease life cycle cost)
(c) to prevent adverse effect to other facilities and to prevent damages or defects due to other construction works.

4.6.3 Planned Maintenance Work

In order to utilize fully the functional capability of facilities, it is necessary to define the capabilities reasonably and to apply appropriate measures for keeping the function by means of planned surveillances and inspections.

(1) the necessity of scheduled maintenance

Planned maintenance flow is shown in Figure 4.8.



※ Repaire : damages&defects of sewer facilities are patly rainforced and/or exchanged.
reconstruction : sewer between two manholes is reconstructed.

Figure 4.8 Flow of Planned Maintenance

4.6.4 Establishment of Sewer Maintenance Plan

The sewer maintenance plan is to be established using flow chart, as shown in Figure 4.9, from the time of new construction until reconstruction due to completion of useful life.

At the time of planning maintenance, following contents are to be taken into account.

i) Divide considered district into sub-district (block) that is going to be surveyed and/or inspected in one year.
ii) Basic work is routine work of daily checking (surveillance and inspection) and scheduled survey (with eye, portable camera survey and TV camera survey).
iii) Detail survey (flow measurement) is planned in case much infiltration is observed as a result of inspection in ii).
iv) Surveillance and inspection are to be carried out several blocks at a time and if possible entire district be covered in one year.
v) Make the area covered in one year through survey with eye, by potable camera and by TV camera, one unit block and after entire block is covered by survey, return to the first block and continue again.
vi) Make the execution plan on yearly base on each block in accordance with priority of countermeasures (urgently need, early need, future plan and observation on a regular basis) and reconstruction on the basis of diagnosis based on survey result.
vii) With accumulation of experiences of maintenance works such as surveillance, cleaning, repair and reconstruction, it is necessary to arrange and conduct detail analysis of accumulated data to make improved maintenance plan.
viii) As to effectiveness of non-open excavation construction methods applied for repair or reconstruction, it is necessary that the methods be evaluated with regular reconfirmation with the span of one or several years later or at the time of different environmental condition (considerable fluctuation of ground water etc.).

The daily and properly scheduled surveillances and inspections, based on the long- term perspective,

are the basic requirements of sewer maintenance work, which enable to figure out existing situation of facilities. An example of scheduled surveillance and inspection is shown in Table 4.15.

Table 4.15 Scheduled Surveillance and Inspection (Example in Japan)

clarification / service		Manhole & sewer	Siphon	Manhole pump	Storm water outlet	Outfall	Sewage pit	Storm water pit	Gate
Inspection	0～30yeras in service	once every 3 years	once a year	once a month	once every 2 years	once a year	once every 3 years	once every 3 years	once a half year
	More than 30 years in service	once a year	once a year	once a month	once a year	once a year	once every 3 years	once every 3 years	once a half year

Almost all of unusual or abnormal situations can be surveyed with eyes. However, water-tightness inside small size pipes can be confirmed only by TV camera. The cycle of survey is shown in Table 4.16 as an example in Japan.

Table 4.16 Survey Cycle of Manhole and Pipe (Example in Japan)

Article	Place	Service year	Survey cycle	Remarks
Inside of manhole visual survey	Inside of manhole and pipe of up and down	0 ~ 30	once every 5 year	
		more than 30	once every 3 year	
Inside of pipe visual survey	Pipe diameter ≧ 800mm	0 ~ 30	once every 10 year	include house connection
		more than 30	once every 7 year	include house connection
TV camera	Pipe diameter ＜ 800mm	0 ~ 30	once every 10 year	include house connection
		more than 30	once every 7 year	include house connection

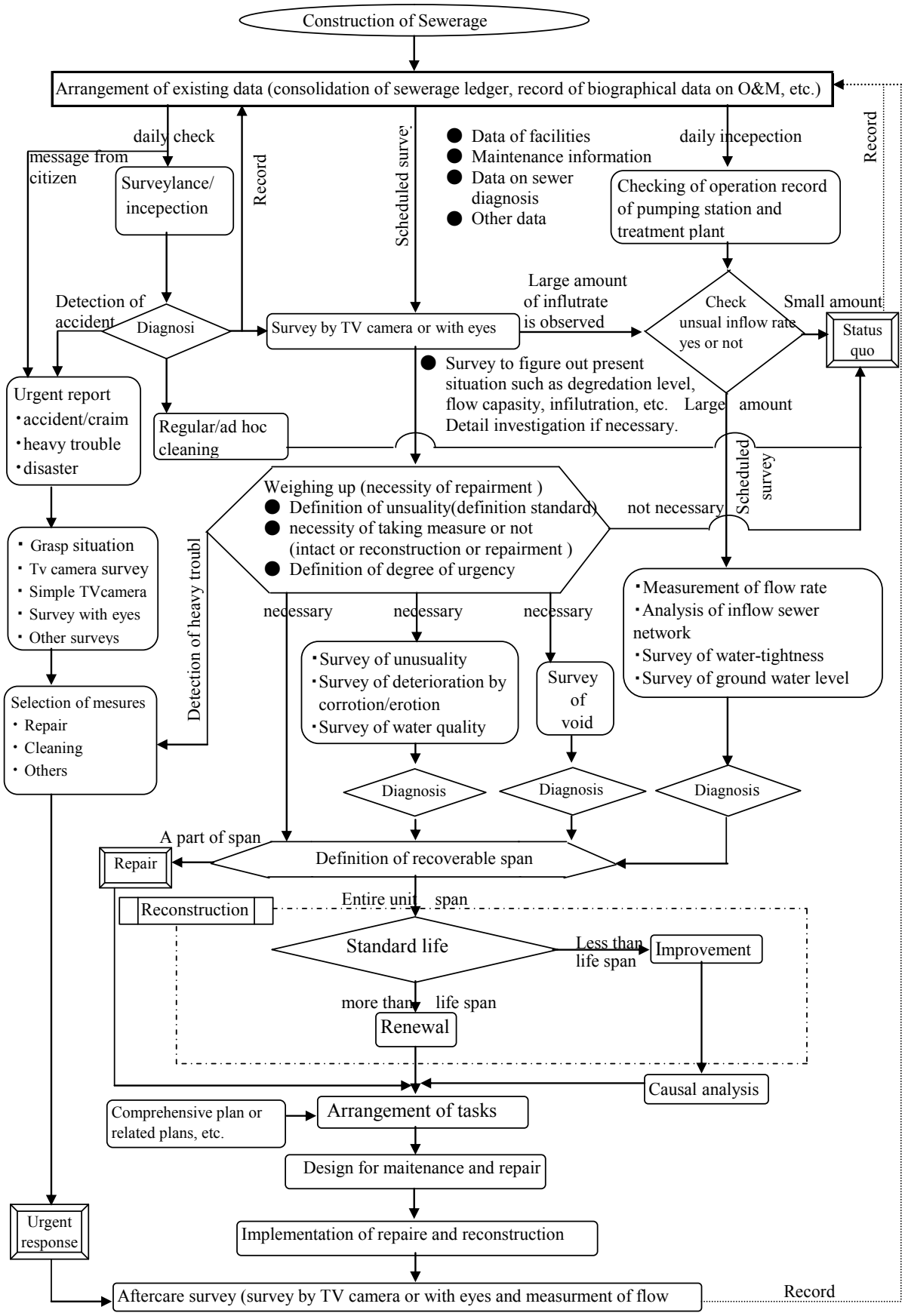


Figure 4.9 Sewer Maintenance Flow Chart

4.6.5 Effect on Reduction of O&M Cost resulted from Planned Maintenance

It is expected that if maintenance of sewer is conducted in accordance with the previously prepared plan, accidental depression of road surface due to damage /defect of underground sewers would be reduced.

And also finding out obstacles in sewers could prevent overflow of sewage and defuse or eliminate odor originated from stagnant wastewater. The planned and scheduled maintenances could contribute largely for prevention of ground water from infiltration to sewer and, at the same time, sewage leakage to under ground.

The operation of planned and positive maintenances since early stage of a service, rise up B/C ratio and could result in low maintenance cost.

For reference, the comparison of B/C ratio between the cases with active/planned maintenances work and without ones is shown in Table 4.17.

Table 4.17 Cost Benefit Ratio (example in Japan)

Article	Stance to maintenance	①Maintenance cost (yen/m)		②Benefit (yen/m)					B/C ratio ②/①
		cost	increase cost	cost of damage repair	sealing off infiltrated water	construc-tion cost	sub-total	benefit	
H city: ave. 10 year after construction	positive	2,123	1,207	286	409	93	788	1,987	1987/1207 ≒1.6
	present status	916		532	1,989	254	2,775		
K city: ave.16 year after construction	positive	2,119	1,151	295	919	147	1,361	1,641	1641/1151 ≒1.4
	present status	968		569	2,120	313	3,002		
P city: ave.19 year after construction	positive	2,119	1,127	363	1,154	174	1,691	1,430	1430/1127 ≒1.3
	present status	992		601	2,178	342	3,121		

4.6.6 Collection, arrangement and utilization of data/information.

In order to implement planned maintenance work, it is necessary to collect data in accordance with prepared schedule, to arrange systematically and to utilize effectively. The data concerning maintenance include the followings:

- Figures made at the time of completion of construction.
- Data resulted from surveillance, inspection, cleaning and repair work.
- Implementation reports of counter measures taken in response to claims or reports from citizen.
- Reports on accident such as flooding and road sagging.

It is important not only to apply these data for repair work on site but also to compile them as records. The compiled data could be utilized effectively through arrangement and analysis.

4.7 O&M of pumping station

O&M of pumping station can be classified generally into daily routine work, one of at the time of heavy rain and in case of machine trouble. O&M consists of following components.

(1) Maintenance of grit chamber
(2) Manipulation of inflow gate
(3) Operation of screening equipment
(4) Operation of grit removal equipment
(5) Operation of lift pump
(6) Manipulation of discharge gate
(7) Maintenance and checking of machine and electric equipment

The components mentioned above are explained in more detail as follows;

4.7.1 Maintenance of grit chamber

Although it is desirable in the operation of grit chamber to keep designed flow velocity constant irrespective of the sewerage inflow rate, it is practically difficult to adjust flow velocity due to fluctuation of flow between day time and night as well as depending upon the rainfall intensity. Therefore, it is usual that not only a designed size of particles but un-designed particles will settle. It must be kept in mind that the quality and quantity of settled grit change greatly due to different characteristics of the surface area of treatment district.

4.7.2 Manipulation of inflow gate

(1) Objective of Manipulation

The objectives of manipulation of inflow gate are to control sewerage inflow rate, and to select number of grit chambers to be used.

(2) Advisory on Manipulation

When the inflow pipe is running full or almost full, and the inflow gate is quickly narrow downed or completely closed the air and/or sewage would be blown out of manhole in case there are siphons in near by or high land area in the upstream.

In the pumping station into which stormwater inflows, there is a danger that if the inflow gate is narrow downed or shut during rainy time, surrounding area can be inundated even if pumps are in good conditions. This happens due to the time lag between the time necessary for closing gate which is relatively a time consuming work and one of rapid increase in rate of stormwater inflow. When the gate is narrow downed or shut, the change of inflow rate should be carefully observed. And in case inflow gate is narrow downed or shut, monitor water level in sewer by level gage and when water level rises to dangerous level, promote awareness by alarm call, etc. In this case it is necessary to be careful about pumps and my require their stopping because of lowering water level in pump pit due to narrow downed or shut gate as mentioned above.

4.7.3 Operation of Screen Equipment

Make it sure that water level in inflow side dose not raise abnormally by eliminating screen trash timely so as to reduce water level difference between upstream and downstream of screen.

At the pumping station which receives stormwater, one should be careful not to allow built-up of trash on the screen from first flood after a dry period. Because of this, it is considered to be safe ifthe screen equipment is operated continuously during the pumps for stormwater is in operation. When the volume of screen trash becomes larger than usual or some bulky trash appears, operator should report to manager and at the same time investigate the cause. In accordance with the survey result it is necessary to take counter measures like improvements, etc. It is preferable to take out the screen trash from the site as fast as possible, but with unavoidable reason if the trashes have to be kept inside the site for considerable time spraying of antiseptic agent should be considered to prevent odor.

4.7.4 Operation of sand removal equipment

In general the deposited sand piled up in sand pit is not always the one of designed diameter. In the grit chamber with the velocity less than the designed one, fine sand, small size trash and even suspended material settle. On the other hand, in the chamber with velocity faster than the design velocity only the larger materials settle. In the stormwater grit chamber large amount of sand is compiled. And in case of the combined system, at the time of heavy rain following a long dry weather unusually large amount of sand might be observed. As described above, the volume of sand differs based on the velocity and quality of inflow sewages in the grit chamber. It is important to remove deposited sand in accordance with the character of the pumping station.

Although it is a basic requirement to take out and dispose the deposited sand as fast as possible, it is preferable to wash and leave it temporally within the site or deposit it in the hopper in order to remove

water before taking out of the site. When the volume of deposited sand is enormously large compared with usual cases or the bulky sediment is recognized, operator should report to manager and at the same time investigate the cause. In accordance with the survey result it is necessary to take counter measures like improvements, etc.

4.7.5 Operation of Lift pump

There are two types of pump, pump for sanitary sewage and for stormwater.

(1) Operation of sanitary sewage

The operation of pump for sanitary sewage differs at the time of dry and rainy weather.

Operation under dry weather

a) Hourly variation of inflow rate

The inflow rate increases from the time from which people start daily activities and peaks at around 8~10 o'clock due to the addition from factory and commercial operations. In case the domestic wastewater occupies large proportion of the total flow; the inflow rate increases again in the evening and decreases late at night until morning. There are weekly change and seasonal change. On holiday inflow rate decreases compared with weekday and in the summer water consumption increase generally resulting in increased sewage flow. The scale of treatment area influences the peak factor; the smaller the area the higher is the peak factor.

b) Control operation of pump

Although inflow rate fluctuates largely by hour, the operation of pump should be carried out taking into account not only fluctuation of inflow rate but also water level fluctuation in grit chamber and pump pit. In other words, it is ideal to operate pump based on fluctuation of water level in grit chamber and pump pit resulted from change of flow rate. This helps to maintain the grit chamber and/or pump pit and also to prevent sedimentation of earth or sand in the sewer. But in general, range of water level in grit chamber and pump pit is set and within the range pump is operated by means of control. The pump control may be achieved by changing the number of pumps on duty or rotational speed or degree of valve opening. As mentioned above the water level in grit chamber is vital, it should be monitored by water-level gauge and alarmed by call in case if the level goes beyond the design high or low levels. In order to prevent sedimentation of sand in sewers, it is recommended to flush sewers with high velocity of flow by low water level operation of pump. In case of removing sands already piled up in sewers the same low water level operation is applied. In order to operate the treatment process properly it may sometimes be necessary to operate the pumps by limiting their discharge volume and temporarily storing the sewage in the sewers.. The operation mentioned above is for the purpose of coping with steep fluctuation of the flow in the daytime which result in the situation of remarkable differences in flow rate between daytime and nighttime. However, in the combined system one should be careful not to let over flow from rainwater overflow outlet. And at night even if the flow rate becomes extremely small, pump should be operated continuously as much as possible.

The control of pump's discharge rate is carried out by changing number of pumps on duty to cope with sizable fluctuation of flow rate and changing the degree of opening of discharge valve or rotational speed of the pump.

Frequent intermittent operations of the large size high power pumps operated automatically by water level censers should be avoided. The frequent intermission would cause burnout of motor due to high temperature and/or accelerate wear of breaker and/or starting system of pumps. Pumps should be operated for a long period, as much as possible, in one start-stop cycle by adjusting degree of opening of discharge valve, etc.

c) Care and attention on pump operation

Under the condition that the outlet pipe is full or almost full and in case there are siphon near

by, if the number of pumps on duty are increased, the air and/or sewage would be blown out of manhole. In that case the valve of pump which starts operation should be slowly opened and prevent rapid increase in outflow rate.

Under the situation of conveying sewage by pressure pipes, if the pumps under operation are suddenly stopped, there might be transient phenomena in which the pressure of pipes fluctuates very much. The same kind of phenomena might occur under the situation of sudden start of pumps and rapid opening of outlet valve.

Operation under rainy weather

The water quality during first flush period becomes generally worse compared with that in dry weather. The phenomena are changed depending on the situation through which sewages flow. The cause of phenomena is that under the dry weather condition, flow velocity is not enough to convey earth and sand and result in sedimentation. At the time of rain those deposited earth and sand are flushed by the increased flow.

It is generally practiced that first flush stormwater is conveyed to treatment plant and receive mechanical treatment in order to prevent adverse impact to receiving waters.

In case the water level in pump pit is surged even if the sanitary sewage pumps are operated with full design capacity, start to operate pumps for stormwater.

(2) Operation of stormwater pump

At the time of operating stormwater pump under the rainy weather, following points should be taken into account.

a) When the rainfall is predicted, be careful about weather forecast and prepare for rain by reducing water level in sewer and stand by for operation of stormwater pump.
b) Depending on the situation of rainfall, it is expected that inflow rate would rapidly increase and it may be necessary to prepare for a quick start of pump or additional pump operation.
c) It is necessary for stormwater pump to operate in trial with the assumption of blackout and rainfall in usual day. It is preferable to grade up technical skill of operators by repeated training.
d) The practical training of manual operation is important for equipment operated automatically as preparation for defect in automation circuit.

4.7.6 Manipulation of Discharge Gate

To control discharge volume from pumping station and to select receiving water body or facilities.

4.7.7 Maintenance and Checking of Machine and Electric Equipment

The breakdown of main machine and electric equipment would result in total malfunction of pumping station and might give substantial damage to residents and facilities of pumping station.

Therefore, in order to keep machine and electric facilities in order, the followings are required:

- maintenance, checking and repair on daily base
- trial operation on regular base
- prevention and early detection of failure

In case of inspection of machine, it is important to cut electric current source of main circuit and put a card “under inspect and do not run”.

In the sewerage facilities there are places in which corrosive gas is generated, humidity is very high and thus deterioration by corrosion is serious. This may cause troubles and especially trouble due to insulation defect in electric facilities.

It should be kept in mind that machine and electric facilities are regularly dissembled and maintained. Change consumable parts regularly.

4.8 Public Relations on Wastewater Treatment

4.8.1 Necessity of Public Relations

The contents of the wastewater treatment service has the characteristic of invisibility, compared with the water supply and solid waste collection services, as the wastewater is collected through the pipelines laid underground and treated in the WWTP which is generally located away from the city centre. Wastewater treatment service with such characteristic needs to obtain the residents' support and understanding on its necessity and importance, and the structure of the finance and increased tariff. Thus the public relation is necessary.

Generally, as for the public relation of administration, emphasis tends to be put on the public announcement as a communicative function which asks residents for an understanding and cooperation by offering information. However, it is important to enrich public hearing as an information gathering function in which the administration also hears the opinion of the residents.

4.8.2 Methods of Public Relations

Typical Public Relations methods are shown below.

(1) Public announcement

The target of the public announcement is the residents of Skopje City.

a) General announcement

- Publicity（TV, radio, newspaper）
- Printed material（brochure, poster, booklet）
- Image（movie, video, CD-ROM）
- Information offered by municipality（public relations magazine）
- Various occasions（visiting of facility, event, campaign）
- Interactive media（homepage）
- Others（signboard of construction etc.）

b) Individual announcement

- Briefing（about construction, about house connection, about payment by beneficiary）
- Individual information service

c) Others

Resident correspondence in daily work

(2) Public hearing

The target of the public hearing is the residents of Skopje City.

a) General hearing

- Gathering（town meeting）
- Research（questionnaire, monitor survey）
- Consultation（complaint report, resident proposal）
- Interactive media（homepage）
- Others (conversazione etc.）

b) Individual hearing

- Briefing（about construction, about house connection, about payment by beneficiary）
- Individual information service

c) Others

Resident correspondence in daily work

(3) Environmental Education

The target of environmental education is teachers and students. The education to young generation is effective as they are the next leader to bear the future. The environmental education should cover the contents mentioned below.

- Sewerage system, necessity and roles of sewerage,
- Cost and benefit of sewerage system,
- Introduction of the works of Vodovod,
- To do/Not to do things for sewerage system (such as "do not dispose the garbage and oils into sewer"),
- Site visit to WWTP.

4.8.3 Procedure of Public Relations

It is important to care about the following point in implementation of public relations.

(1) Effective and efficient public relations

It should be carried out utilizing bilateral work with other public service such as a water supply service, cooperation with a civic organization or a volunteer, cooperation request to a school, etc.

(2) Clarification of purpose and object

It should be carried out after clarifying what should be transmitted to whom.

(3) Planned public relations

It should be carried out from long-term viewpoints, such as a check of implementation timing or frequency, and selection of effective methods.

CHAPTER 5 COST ESTIMATION AND IMPLEMENTATION SCHEDULE

5.1 Conditions of Cost Estimation

The project cost is estimated based on the conditions stated below.

- Project cost is estimated for each of LC (local currency portion) and FC (foreign currency portion).
- The exchange rate of Japanese Yen to Euro is 163.11 based on the latest average rates in the period between May and August 2008. The exchange rate of Macedonian Denar to Euro is 62.03 based on the average value in the same period.
- The present currency of Macedonia is Denar. However, economy of Macedonia is based on Euro due to its strong dependency on EU countries.

5.2 Estimation of Capital Cost

5.2.1 Conditions of Estimation for Trunk Sewer

The construction cost for trunk sewer is estimated based on the following conditions.

- Civil and architectural materials, labor and general construction machineries are domestically procured in principle.
- No pumping station is needed along the interceptor route because the available elevation data shows that sewage can be conveyed to WWTP site by gravity.
- Excavation for installation of pipes is done by open cut method.

5.2.2 Estimation of Construction Cost for Trunk Sewer

The estimated costs for the inceptor are summarized in Table 5.1 and the breakdowns are given in Appendix 5.1, Part II (F/S).

Table 5.1 Construction Cost for Trunk Sewer

Item	Local Currency (Euro)	Pipe Diameter (mm)
Trunk Sewer	**7,700,000**	
Right Bank	3,386,000	ϕ 1000,1800
Left Bank	4,314,000	ϕ 1500,1600,1800

5.2.3 Conditions of Estimation for WWTP

The construction cost is estimated based on the following conditions.

- Civil and architectural materials, labor and general construction machineries are domestically procured in principle.
- Mechanical and electrical equipment are not manufactured in Macedonia and it is assumed that the equipment is imported in principle.
- The soil of WWTP site is classified into strong one. No foundation is judged to be needed because it has sufficient bearing strength and causes no harmful uneven sinking.
- Open cut method, in which the soil is excavated with certain slope from the surface to the bottom, is adopted for the excavation for WWTP in principle. However, methods of earth retaining walls and groundwater pumping are considered for the limited facilities which partly require for the excavation below the groundwater level.

5.2.4 Estimation of Construction Cost of WWTP

The estimated costs for the WWTP are summarized in Table 5.2 and the breakdowns are given in Appendix 5.2, Part II (F/S).

Table 5.2 Construction Cost for WWTP

Item	Local Currency (Euro)	Foreign Currency (Euro)	Total (Euro)
Treatment System	**26,990,000**	**21,160,000**	**48,150,000**
1. Wastewater Treatment Facilities	**15,182,000**	**14,605,000**	**29,787,000**
1.1 Grit Chamber/Pumping Station	898,000	1,087,000	1,985,000
1.2 Primary Settling Tank	1,687,000	2,798,000	4,485,000
1.3 Aeration Tank	5,689,000	4,104,000	9,793,000
1.4 Secondary Settling Tank	3,403,000	5,472,000	8,875,000
1.5 Chlorination	458,000	138,000	596,000
1.5 Connection and Effluent Chanel	535,000	0	535,000
1.6 Administration Facility	2,512,000	1,006,000	3,518,000
2. Sludge Treatment Facilities	**11,808,000**	**6,555,000**	**18,363,000**
2.1 Gravity Thickener	394,000	552,000	946,000
2.2 Sludge Digester Tank	5,807,000	6,003,000	11,810,000
2.3 Drying Beds	5,607,000	0	5,607,000

The percentage of the estimated construction cost by facilities is analyzed as shown in Figure 5.1 and the percentage of the estimated construction cost by categories as shown in Figure 5.2.

The construction costs of inlet facilities including grit chamber and pumping station occupy 4% of the construction cost of WWTP. The sewage treatment facilities including primary settling, aeration, secondary settling tank and chlorination occupy 49%. The sludge treatment facilities including gravity thickener, anaerobic digester and drying bed occupy 40%. The communal facilities including administration building occupy 7%.

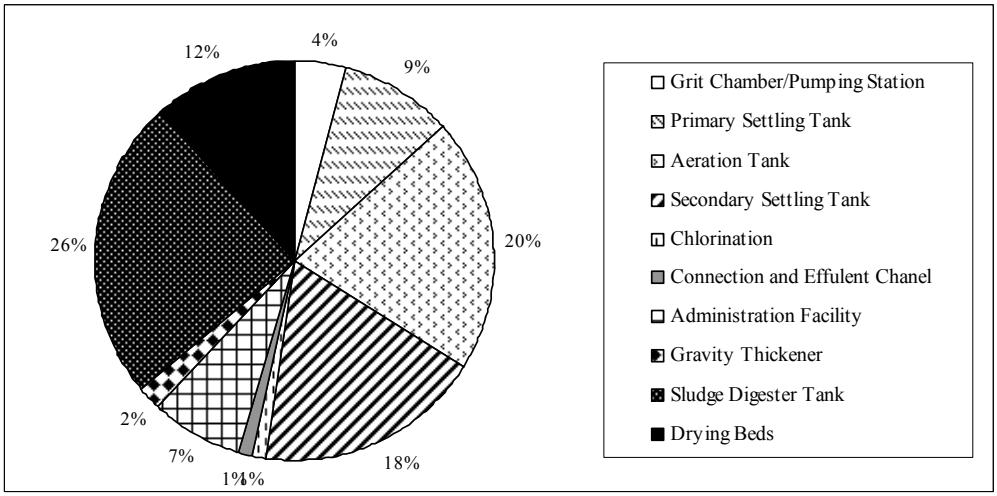


Figure 5.1 Percentage of Facilities of the Construction Cost

By category, the construction cost of civil and architectural works occupies 49% of the construction cost of WWTP and the construction cost of mechanical and electrical works occupies 51%.

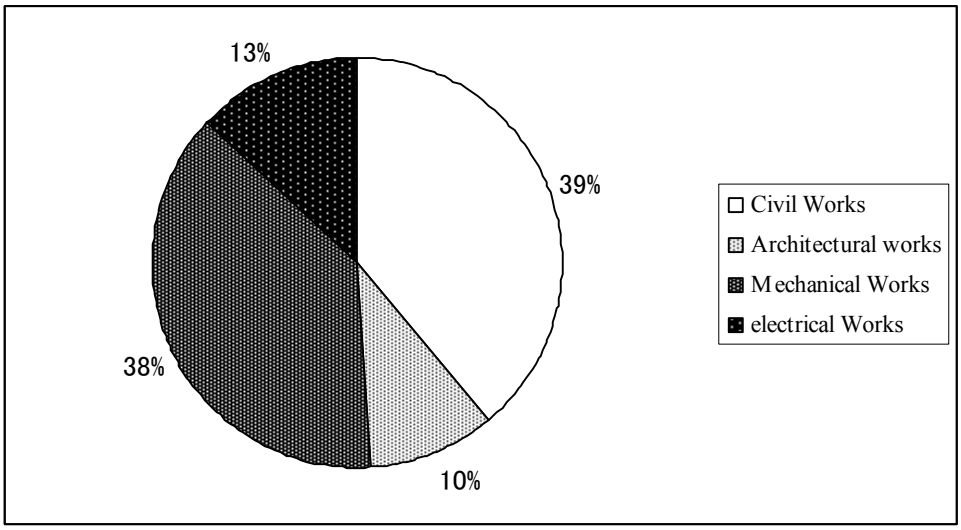


Figure 5.2 Percentage of Categories of the Construction Cost

5.2.5 Estimation of Project Capital Cost

The capital cost of the project is estimated based on the following conditions.

- Project capital cost consists of construction cost, administration cost, engineering cost, contingencies (physical and price escalation), land acquisition and compensation cost, other cost, relevant taxes and interest during construction.
- Project administration cost of Macedonia side is 2% of construction cost.
- Engineering cost is 10% of construction cost.
- Physical contingency is 10% of the total of construction cost, administration and engineering cost, since civil works account for the major part of the construction cost.
- Price contingency is 2.3% per year; 3.2% for local currency portion taking annual price increase index in Macedonia into account and 2.3% for foreign currency portion taking the index in EU countries into account.
- Customs rate is in the range between 3 and 15% for imported goods taking import tax rate applied in Macedonia into account. Tax ratio is 18% which is the same as VAT (value added tax) in Macedonia.
- The exchange rate of Japanese Yen to Euro is 163.11 based on the latest average rates in the period between May and August 2008. The exchange rate of Macedonian Denar to Euro is 62.03 based on the average value in the same period.
- Land acquisition and compensation cost is estimated for the area of 57 ha including the one for future extension.
- Other cost needed for additional construction works including river embankment, access road and the transfer of pylons are estimated.
- Interest during construction is estimated taking into consideration that the project cost is financed by loan.

The total capital cost of the project is 116.6 million Euros (19.0 billion Yen) including customs and tax and 98.1 million Euros (16.0 billion Yen) excluding customs and tax, respectively. The estimated costs are summarized in Table 5.3 and the breakdowns are given in Appendix 5.3, Part II (F/S).

The percentage of the components of the estimated project capital cost is analyzed as shown in Figure 5.3. The direct construction cost occupies 48 % of the total capital cost and the indirect construction cost including the remaining costs is 52%.

The local currency portion occupies 72% of total capital cost and the foreign currency portion occupies 28%. The construction cost of interceptor occupies 14% of the total construction cost and the construction cost of WWTP occupies 86%.

Table 5.3 Capital Cost of the Project

No.	Item	Local Currency (Euro)	Foreign Currency (Euro)	Total (Euro)
1.	Construction Cost			
A	Collection System			
A.1	Trunk Sewer	7,700,000	0	7,700,000
B	Treatment System			
B.1	Wastewater Treatment Facilities	15,182,000	14,605,000	29,787,000
B.2	Sludge Treatment Facilities	11,808,000	6,555,000	18,363,000
	Subtotal (1)	**34,690,000**	**21,160,000**	**55,850,000**
2.	Administration Cost	1,441,000		1,441,000
3.	Engineering Cost	4,474,000	2,610,000	7,084,000
4.	Physical Contingency	3,469,000	2,116,000	5,585,000
5.	Price Contingency	8,699,000	3,716,000	11,836,000
6.	Land Acquisition & Compensation Cost	8,550,000	0	8,550,000
7.	Others (Access Road and Others)	948,000	0	948,000
8.	Customs/Tax	18,447,000	0	18,447,000
9.	Interest during Construction	4,936,000	1,875,000	6,811,000
	Subtotal (2)	**49,771,000**	**10,931,000**	**60,702,000**
	Total (including customs/tax)	**84,461,000**	**32,091,000**	**116,552,000**
	Total (excluding customs/tax)	**66,014,000**	**32,091,000**	**98,105,000**

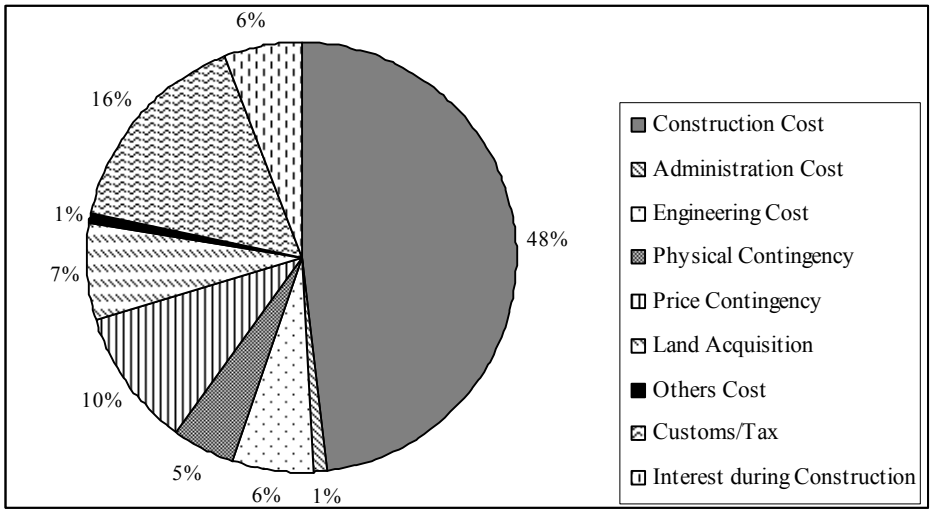


Figure 5.3 Percentage of Components of the Estimated Project Capital Cost

5.3 Operation and Maintenance Cost

The operation and maintenance cost is estimated based on the following conditions.

- Personnel cost is estimated for the staff members needed for the operation and maintenance of the facilities proposed in the Basic Plan.
- Consumables include electricity, chemicals and so on.
- Maintenance cost includes spare parts of mechanical and electrical equipment.
- Sludge disposal cost is estimated supposing all the dried sludge is disposed of at the designated sludge disposal site.
- Sewer cleaning is to be done for the sewers proposed in the Basic Plan.

The annual maintenance and operation cost, which is additionally required for the facilities constructed by the project, is 1.53 million Euros (0.25 billion Yen). The estimated costs are summarized in Table 5.4.

Table 5.4 Annual Operation and Maintenance Cost

Item	O&M Cost (Euro/year)
Personnel Cost	165,000
Consumables Cost	753,800
Sludge disposal Cost	320,100
Maintenance Cost	285,600
Sewer Cleaning Cost	2,200
Total	**1,526,700**

5.4 Implementation Schedule and Disbursement Schedule of the Project

5.4.1 Implementation Schedule

The project is planned to start from loan arrangement in 2009, followed by selection of consultant in 2010, detailed design in 2011, and tendering and evaluation for selecting the contractor in 2012. Land acquisition is required to be completed by 2010 since it is vital and basic condition for the detailed design. Additional construction works including river embankment, access road and transfer of pylons are planed to be implemented in 2011 since it is necessary for these works to be completed before the commencement of the construction of WWTP.

The implementation of the construction is planned in a manner to ensure proper execution of the work considering the conditions including the construction procedure of each facility, capabilities of contractors and suppliers, and procurement of materials and labor force.

As a result, the implementation schedule has been prepared as shown in Figure 5.4.

Item	2009		2010		2011		2012		2013		2014		2015		2016	
Loan Arrangement																
Selection of Consultant																
Detailed Design																
Tendering and Evaluation																
Land Acquisition																
River Embankment, Access Road and Transfer of Pylons																
Construction of Interceptor																
Construction of Civil and Architectural Works of WWTP																
Construction of Mechanical and Electrical works of WWTP																

Figure 5.4 Implement Schedule

5.4.2 Disbursement Schedule

The disbursement schedule based on the above implementation schedule has been prepared as shown in Table 5.5.

Table 5.5 Disbursement Schedule

Item		2009	2010	2011	2012	2013	2014	2015	2016	Total
Direct Construction Cost	Local Currency (Million Euro)	0.0	0.0	0.0	0.0	15.7	15.7	1.7	1.7	34.7
	Foreign Currency (Million Euro)	0.0	0.0	0.0	0.0	0.0	0.0	10.6	10.6	21.2
	Total	0.0	0.0	0.0	0.0	15.7	15.7	12.2	12.2	55.9
Indirect Construction Cost	Local Currency (Million Euro)	0.0	11.8	1.7	3.0	12.7	13.6	3.4	3.6	49.8
	Foreign Currency (Million Euro)	0.0	0.0	0.7	0.7	0.3	0.4	4.3	4.6	10.9
	Total	0.0	11.8	2.3	3.7	13.0	13.9	7.7	8.2	60.7
Total	Local Currency (Million Euro)	0.0	11.8	1.7	3.0	28.4	29.3	5.1	5.2	84.5
	Foreign Currency (Million Euro)	0.0	0.0	0.7	0.7	0.3	0.4	14.9	15.2	32.1
	Total	0.0	11.8	2.3	3.7	28.7	29.6	19.9	20.4	116.6

CHAPTER 6 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

6.1 Implementation of the EIA Study

The Environmental Impact Assessment (EIA) is the obligation for the project which includes the wastewater treatment plant with capacity of more than 100,000 population equivalent by "the Law on Environment" and "Decree determining the projects for which an EIA shall be carried out" (see Section 6.2). The Study is categorized as "Category A[1]" which requires the EIA level study at F/S stage according to the "JICA's Guidelines for Environmental and Social Considerations". Therefore the EIA shall be conducted during the F/S stage.

The purpose of the EIA is to ensure that development options under consideration are environmentally and socially sound and sustainable and that the environmental consequences of the project are recognized early and taken into account in the project design.

The major objectives of this study are to establish present environmental and social conditions of the project area, to predict the impacts on relevant environmental and social attributes due to the construction and operation of the proposed wastewater treatment facilities and trunk sewers, to suggest appropriate and adequate mitigation measures to minimize / reduce adverse impacts, and to prepare an EIA report.

6.2 Laws, Regulations and Standards related to Environmental and Social Issues

6.2.1 Law on Environment

The Law on Environment (Official Gazette No. 53/2005, 81/2005) shall regulate the rights and the responsibilities of Macedonia, municipalities, the City of Skopje and the municipalities of the City of Skopje as well as the rights and the responsibilities of legal entities and natural persons, in the provision of conditions required to ensure protection and improvement of the environment, for the purpose of exercising the right of citizens to a healthy environment.

6.2.2 EIA Procedures

The articles 74 to 94 describe the EIA system and the projects which are subject to conduct EIA are specified in the "Decree for determining projects for which an environmental impact assessment shall be carried out". The wastewater treatment plants with a capacity exceeding 100,000 person equivalents are subjects to EIA and EIA should be carried out in the Feasibility Study stage[2]. The priority project(s) which is selected at the end of the Basic Plan stage include the wastewater treatment plant with capacity more than 100,000 persons equivalent, thus EIA level study[3] should be carried out at the Feasibility Study stage according to Macedonian laws and regulations.

The EIA procedure consists of several steps or phases as follows:

(1) Notification on the intention for project implementation

The responsible organization of EIA is Skopje City[4] and the Skopje City submitted the notification documents to MEPP with the opinion of the need of EIA, screening checklist and draft scoping on 30th June 2008. The information which should be included in the notification documents is decided by

[1] Based on the JICA Guidelines, the proposed projects are classified into one of three categories: A, B or C. The project classified as Category A is likely to have significant adverse impacts, and EIA level study is required for Category A project.

[2] The timing of EIA is mentioned as "Projects that are subject to environmental impact assessment before development consent can be given", and "EIA shall be carried out before decision on approval or non approval of the application for project realization is taken by the MEPP". JICA Study Team discussed with MEPP about the timing of EIA for this project and it is concluded that EIA should be conducted during F/S stage.

[3] "Environmental Impact Assessment (EIA) level study" means a study including analysis of alternative plans, prediction and assessment of environmental impacts, and preparation of mitigation measures and monitoring plans on the basis of detailed field surveys.

[4] The investor of the Project is not decided. It is agreed, however, that the responsible organization of environmental and social considerations is Skopje City at S/C in November 2007 and February 2008.

the ordinance and if the information is not sufficient, MEPP informs the Skopje City within 10 days from the date of the receipt of the notification on the need for supplementing data and information. MEPP, within five working days of the receipt of the full notification, is obliged to publish the notification in at least one daily newspaper available throughout the territory of Macedonia, and on the website of the MEPP.

(2) Screening (determining whether an EIA is required)

MEPP should conduct screening to determine whether an EIA is required for the project based on the screening checklist which is submitted by the Skopje City. After receiving a full notification the MEPP is supposed to complete the screening procedure within 30 days from the date of receipt, and inform the Skopje City about its decision whether an EIA should be carried out or not. The decision is to be published, within five days from the date of issuance, in at least one daily newspaper and on the website of MEPP. Within eight days from the date of publication of the decision, the Skopje City, the legal entities or natural persons concerned as well as the citizens' associations established for the purpose of environmental protection and improvement may lodge an appeal against the decision to the Second Instance Commission of the Government of Macedonia that is responsible for resolution of administrative matters in the area of the environment.

(3) Scoping

The scoping stage is the process during which the MEPP determines the content and extent of the matters which should be covered in the EIA report. To shorten the duration of the procedures, the draft scoping is submitted by the Skopje City to MEPP according to the suggestion of MEPP and MEPP will conduct the scoping based on the draft scoping. In drafting the contents on the scope of EIA study, the MEPP shall take into account the opinions of the investor and the opinions obtained after publication of the decision for screening. The opinion of scoping is issued by MEPP to Skopje City on 14th October 2008.

(4) Implementation of EIA Study

The Skopje City prepared EIA report and submitted it in 3rd November 2008 to the MEPP in written and electronic forms. The Skopje City is obliged to engage at least one person from the List of Experts, who shall sign the study as a responsible person with regard to its quality, however, the list is not prepared yet as of the end of June 2008. Based on the discussion with the MEPP, the EIA study should be conducted by the company which is certified by the former Law on Environment.

Within five days from the receipt or completion of EIA report, the MEPP publishes the EIA report and announces that the EIA study has been prepared and is available to the public. Any person may submit their opinion in written form to the MEPP within 30 days from the date of publication of the EIA report. If the submitted report does not contain the requirements, the MEPP shall return the study to the investor and shall set a term for its supplement or revision which may not be longer than 40 days from the date of receipt of the study.

(5) Review

MEPP should appoint the persons from the List of Experts to prepare the adequacy report of the EIA study within 60 days. The report on the adequacy states whether the EIA study fulfils the requirements, proposes the conditions which should be set out in the permit for the project implementation, as well as measures for prevention and reduction of harmful impacts.

(6) Public Hearing

The MEPP shall provide a public hearing (scheduled in January 2009) during the preparation of the report on adequacy of EIA study, and ensure availability of information needed to the public for participation in the public hearing. This information on public hearing should also be provided to citizens' associations established for the purpose of environment protection and improvement in the project area. The MEPP shall prepare minutes of the public hearing containing the list of participants as well as the conclusions, and stenographic notes and video or audio records of the hearing should be attached to the minutes. Information protected under special regulations shall not be discussed in the

public hearing.

(7) Decision

On the basis of the EIA report, the report on the adequacy of the EIA Study, the public debate and the opinions obtained, the MEPP issues a decision on whether or not to grant consent for the application of the project implementation within 40 days from the date of submission of the report on the adequacy of EIA study. The decision has to be published in at least one daily newspaper available throughout the country, on the website as well as on the notice board of the MEPP. This decision ceases to have a legal effect within two years from the date of its issuance if the project implementation has not commenced. Upon request by the Skopje City, the validity of the decision may be extended, provided that no significant changes have occurred in the conditions in the area affected, new information related to the main content of the study and the development of new technology that may be used in the project.

6.2.3 Information Disclosure

The access to environmental information is described in the articles 51 to 58 of Law on Environment. According to the law, everyone shall have the right to request validated environmental information and data from public authorities and legal entities and natural persons that have been entrusted in accordance with the law to perform public authorisations, including special environmental duties, activities and services, and legal entities and natural persons performing on the bases of the law or an agreement, environmental activity or service of public interest without having to prove their interest. The law also describes the requirements applicable to request for information, refusal of request for environmental information etc.

6.2.4 Emission Standards in Macedonia

(1) Water

Regulation for Classification of Water (Official Gazette No. 18/99) classifies waters into five categories and the Regulation for Categorization of Water Courses and Lakes (Official Gazette No. 18/99) decides the category of the water courses in individual watershed. The Vardar River in the territory of Skopje City is classified as Category II and it changes to Category III at the outlet of the Skopje municipal sewage canal (near the proposed location of WWTP).

- From inflow of Lakavichka River until Skopje / outlet of the Skopje municipal sewage canal: II
- From Skopje / outlet of the Skopje municipal sewage canal until inflow into River. Pchinja: III

The limit values of each category are described in Chapter 2 of Part I (B/P) and 1.6 of Appendix 6.3.

(2) Effluent standards

There is no effluent standards in Macedonia at present. The new Law on Waters (Official Gazette No. 87/08) is adopted in August 2008 and the effluent standards will be established as second legislation under the new Law on Waters. In this Study, EU effluent standards are adopted as the Macedonian laws and regulations are formulated according to the EU legislation (see Table 4.8 and 4.9 of Chapter 4, Part II (F/S)). The permissible industrial wastewater effluent to public sewerage is decided by Vodovod (see Table 4.12 of Chapter 4, Part II (F/S)).

(3) Air

For the purpose of achieving the ambient air quality targets, Law on Ambient Air Quality (Official Gazette No. 67/04) and Decree on limit values (Official Gazette No. 50/05) specify the terms for achievement of limit values for individual pollutants, limit values for levels and types of pollutants in the ambient air and alert thresholds, target value and long-term targets for individual pollutants etc. See the detail in 1.6 of Appendix 6.3.

(4) Noise

Law on Noise Protection (Official Gazette No. 75/07), Rulebook on Noise in working conditions (Official Gazette No. 29/97) and Decision on terms and conditions for noise annoyance on citizens (Official Gazette No. 64/93) set noise emission limit values. See the detail in 1.6 of Appendix 6.3.

(5) Vibration
There is no limit value regarding vibration in Macedonia.

(6) Odour
There is no limit value regarding odour in Macedonia.

(7) Soil
The Law on Agricultural Land tackles the issue for soil protection, however currently there is no subsequent legislation regarding emission standards for soil.

6.2.5 Expropriation of Private Property

The Law on Expropriation (Official Gazette No. 33/95, 20/98, 40/99, 31/03, 46/05) regulates the expropriation of the property ownership and rights (real-estate) for the purpose of construction of facilities and other issues of public interest, establishment of the public interest and assigning the righteous compensation for the expropriated realty, calculated based on the market value of the real-estate.

Public interest means the organization, rational use and special humanization, as well as the protection and improvement of the environment by construction of facilities according to the special plans, among which are the wastewater treatment plants.

The procedures start with the submission of a request of expropriation by the user of the expropriated land (investor) to special department of land and property of MOF (the branch office in Gazi Baba for this project). Before the submission of a request, the information on the land owner, parcel number, area etc. should be clarified though the Cadastre Department. The MOF negotiates with the land owners about the compensation based on the compensation price proposed by the investor.

If the land for expropriation is owned by the State, then the lease agreement will be held with MTC for the use of the land (without cost, for 99 years period). If the state land is already leased by the private, the investor asks to revoke the lease agreement to MTC and the user cannot reject the request. Ninety percent (90 %) of the land within the proposed WWTP site belong to the State but under claim for the de-nationalization (see the detail in chapter 6.4). The investor requests to the commission for de-nationalization not to accept the claim for the de-nationalization. The compensation to the claim is necessary. For private land, the land owner cannot reject the expropriation for the public interests, but they can complain about the amount of compensation if they are not satisfied with the proposal. If the land owner cannot accept the amount of compensation, they can claim to the government commission (second degree). The government commission provides the decision and the investor can start construction by providing the bank guarantee against the compensation amounts.

The compensation for expropriated land is settled by providing land that represents a suitable replacement for the expropriated land in terms of size, quality and location. In cases when expropriation beneficiaries are unable to provide suitable land or in some other circumstances (such as massive expropriations, expropriation of small lot portions), the compensation shall be settled in cash.

6.3 Proposed Project

6.3.1 Proposed Project

The proposed project for F/S is described below. See more detail in Chapter 2 and Chapter 3 of Part II (F/S).

Table 6.1 Components of F/S

	2020	2030
District area (km^2)	72.8	72.8
Population	513,570	555,650
Population Equivalent	660,380	691,350
Sewage Flow (average daily) (m^3/d)	166,020 ≒166,000	176,970 ≒177,000
Domestic	102,720	111,130
Industrial	32,300	34,840
Stormwater	31,000	31,000
Influent Concentration (mg/l)		
BOD	239 ≒240	234 ≒230
SS	269 ≒270	257 ≒260
Effluent Concentration (mg/l)		
BOD	25	25
SS	35	35
Wastewater Treatment Process	Conventional activated sludge process (CASP)	
Sludge Treatment Facilities	Thickening, digestion, drying bed	

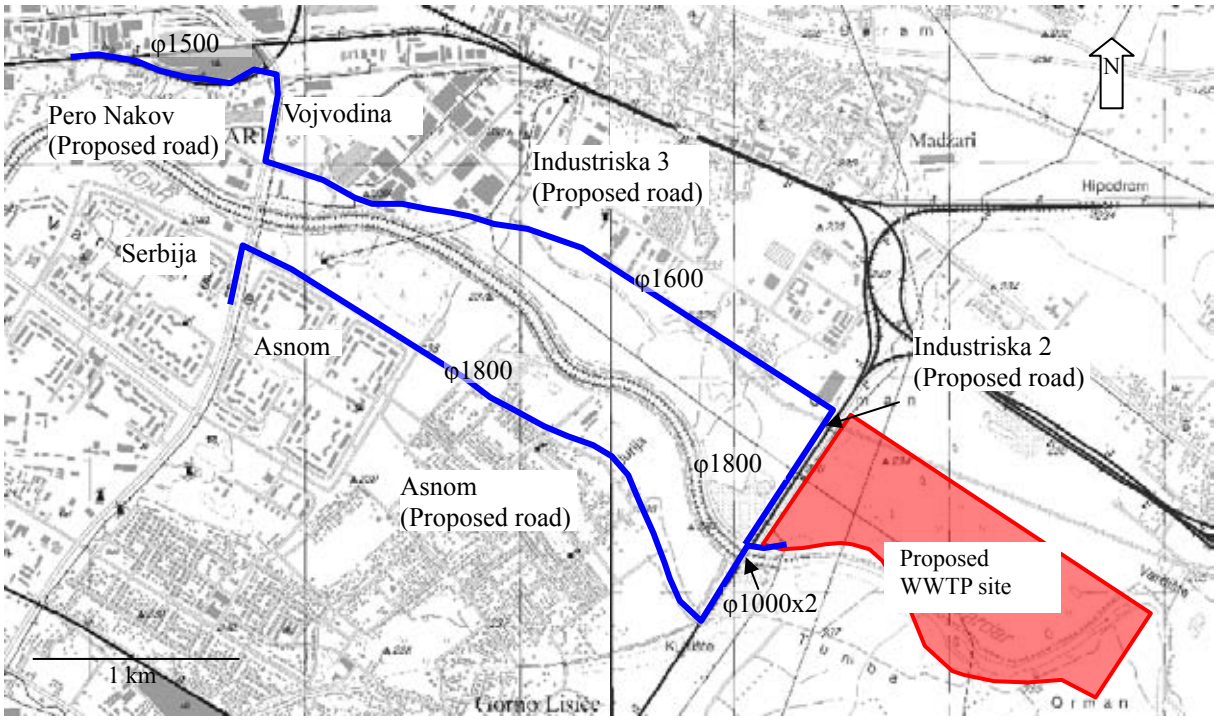


Figure 6.1 Proposed Facilities of Feasibility Study

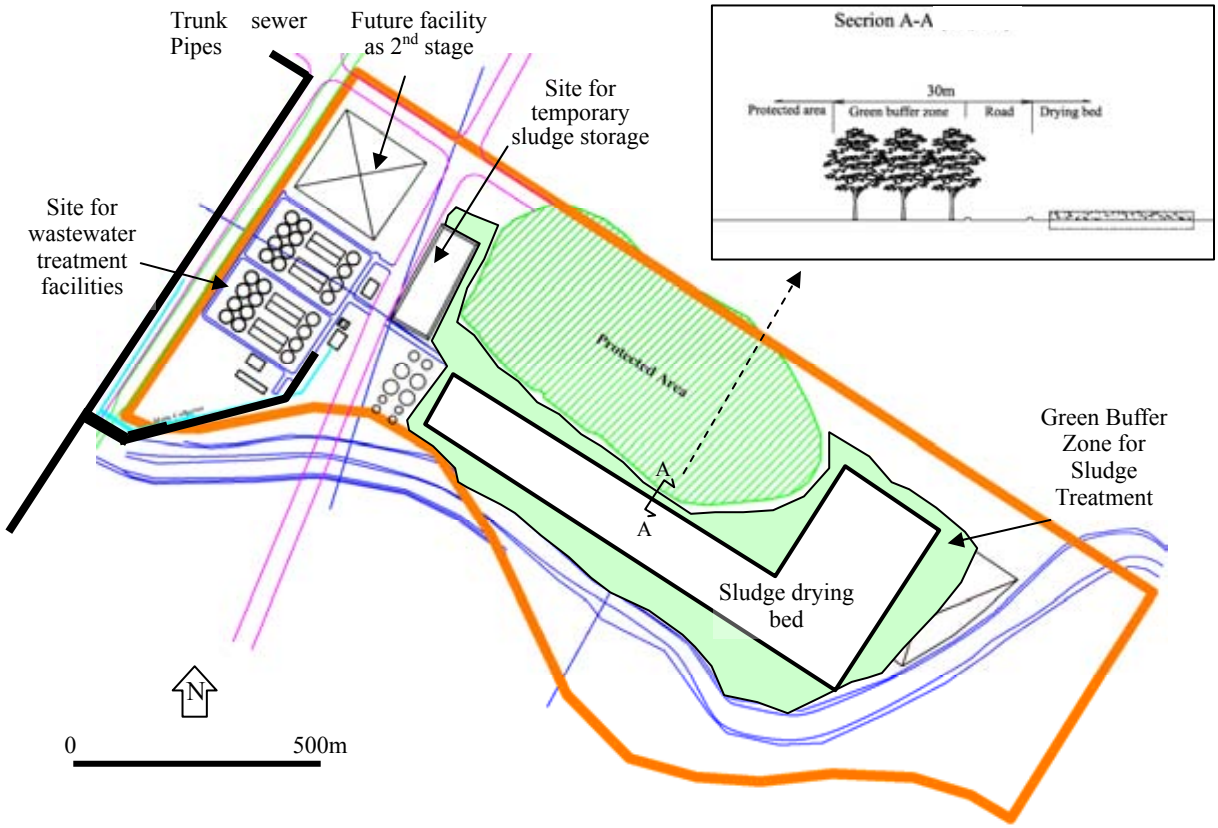


Figure 6.2 Layout of Treatment Facilities

6.3.2 Implementation Schedule and Cost Estimation

The total capital cost of the project is 116.6 million Euros (19.0 billion Yen) including customs and tax and 98.1 million Euros (16.0 billion Yen) excluding customs and tax, respectively.

Table 6.2 Capital Cost of the Project

No.	Item	Local Currency (Euro)	Foreign Currency (Euro)	Total (Euro)
1.	Construction Cost			
A	Collection System			
A.1	Interceptor	7,700,000	0	7,700,000
B	Treatment System			
B.1	Wastewater Treatment Facilities	15,182,000	14,605,000	29,787,000
B.2	Sludge Treatment Facilities	11,808,000	6,555,000	18,363,000
	Subtotal(1)	**34,690,000**	**21,160,000**	**55,850,000**
2.	Administration Cost	1,441,000		1,441,000
3.	Engineering Cost	4,474,000	2,610,000	7,084,000
4.	Physical Contingency	3,469,000	2,116,000	5,585,000
5.	Price Contingency	8,699,000	3,716,000	11,836,000
6.	Land Acquisition Cost	8,550,000	0	8,550,000
7.	Others (access road and others)	948,000	0	948,000
8.	Customs/Tax	18,447,000	0	18,447,000
9.	Interest during Construction	4,936,000	1,875,000	6,811,000
	Subtotal (2)	**49,771,000**	**10,931,000**	**60,702,000**
	Total (including customs/tax)	**84,461,000**	**32,091,000**	**116,552,000**
	Total (excluding customs/tax)	**66,014,000**	**32,091,000**	**98,105,000**

Table 6.3 O&M Cost

Item	O&M Cost (Euro/year)
Personnel Cost	165,000
Consumables Cost	753,800
Sludge Disposal Cost	320,100
Maintenance Cost	285,600
Sewer Cleaning Cost	2,200
Total	**1,526,700**

The project is planned to start from loan arrangement in 2009, followed by selection of consultant in 2010, detailed design in 2011, tendering and evaluation for selecting the contractor in 2012. Land acquisition is required to be completed by 2010 since it is vital and basic condition for the detailed design. Additional construction works including river embankment, access road and the transfer of pylons are planed to be implemented in 2011 since it is necessary for these works to be completed before the commencement of the construction of WWTP.

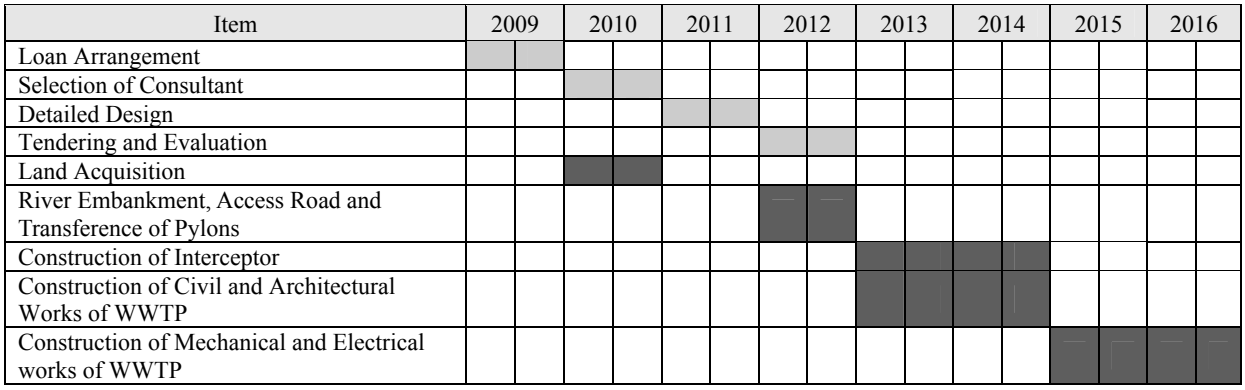


Figure 6.3 Implementation Schedule

6.4 Baseline Environmental Data

The baseline data regarding natural, biological and social environment is collected. The detail data and explanation are described in chapter 3 of Appendix 6.3 and this is the summary of environmental data closely related to the Project.

(1) Geology

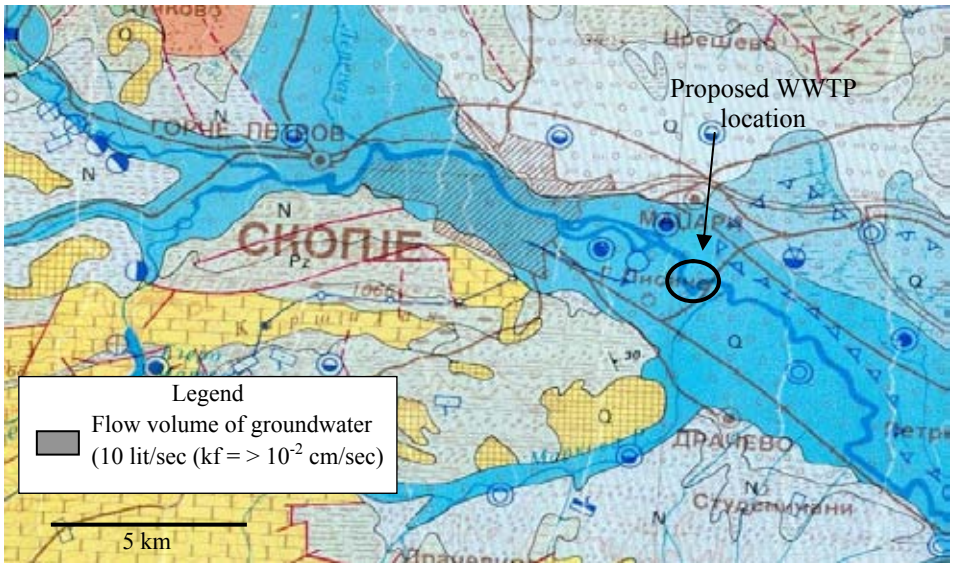
During June 2008, the geo-technical survey was conducted in vicinity of Trubarevo at the location of the proposed WWTP site. Twelve (12) boreholes were drilled and the soil geology was analyzed.

In general the location consists of silt and sand depth from ground surface to maximum 2.5m and sandy and silty gravel, well size distribution to the investigation depth.

(2) Groundwater

Two main aquifers characterise the groundwater below Skopje valley: high yield semi-confined aquifer of superficial sand and gravel with clay horizons and low yield aquifer in underlying marls.

During June 2008, the geo-technical survey was conducted in vicinity of Trubarevo at the location of the proposed WWTP site. Twelve boreholes were drilled and the groundwater level was measured. It can be concluded that the groundwater level at the location of the WWTP varies from -3.5 m to -7.0 m. The groundwater flow direction is similar to the flow of the Vardar River. This is rather common situation when the river and the groundwater flow through alluvial environment consisted of gravely sands, characterized with high inter-granular porosity.



BOREHOLE	UGWL[m]
B-1	-4.6
B-2	-7.0
B-3	-4.2
B-4	-5.7
B-5	-4.4
B-6	-5.0
B-7	-3.8
B-8	-3.9
B-9	-4.2
B-10	-3.5
B-11	-3.8
B-12	-3.5

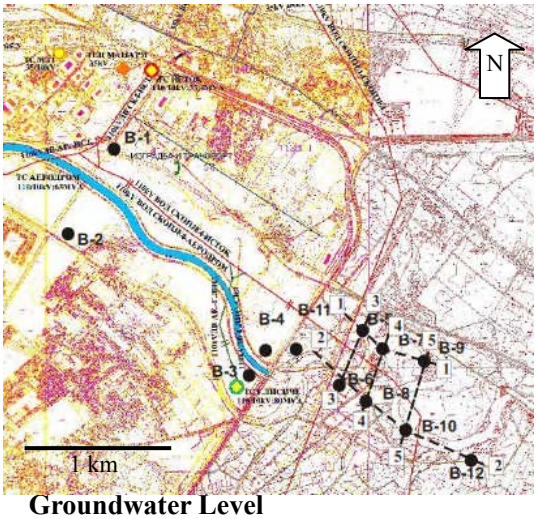


Figure 6.4 Groundwater Level

(3) Protected Area

There is one protected area in the proposed WWTP site and one near the proposed WWTP site which is shown in the Figure 6.5.

According to the Law on Nature Protection (Official Gazette No. 67/2004), the protected areas that have been under protection since before the enactment of this Law shall be revalorized for proclamation of the protected area within 3 years after the date of the commencement of the application of this Law. The period of the revalorization is extended to six years (till year 2010) and the list of the protected area is not prepared yet by MEPP. During the transition period, the protected areas that have been under protection since before the enactment of this Law are under protection.

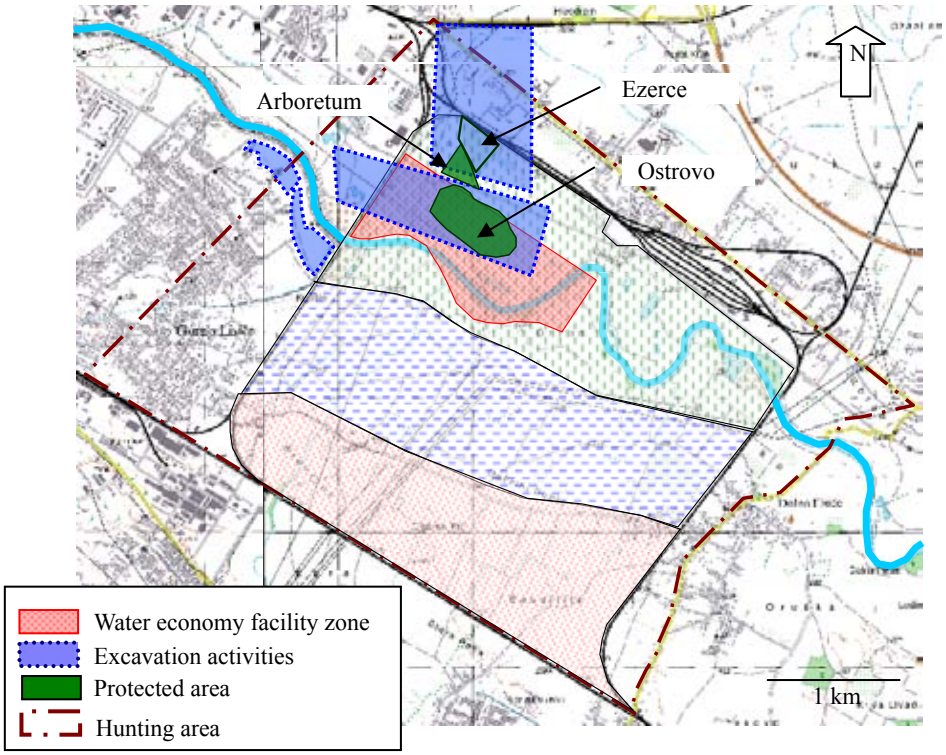


Figure 6.5 Protected Area and Land Use in and around the Proposed WWTP Site

a) Arboretum

The Arboretum is managed by Faculty of Agriculture, Skopje University and is located near the proposed WWTP site in Trubarevo. The Arboretum is protected in 1965 and the area is around 3.3 ha. In Arboretum, various different trees and plants are grown for research purposes.

b) Ostrovo

Ostrovo area is located within the Water Economy Facility Zone and the area is around 33 ha. This is the unique bird resort in the Skopje region.

The survey for revalorization of Ostrovo is conducted as part of the EIA study and the species of reptiles, birds which are protected under Wild Bird Directive, Bern Convention and Bonn Convention are found in this area. Considering the situation, the Ostrovo is recommended to be protected area.

(4) Land Use

a) Hunting Area

The area including the water economy facility zone is used as hunting area for hare, partridge and pheasant. These are not endangered species and the area is not protected. This is not the commercial hunting area but closed type for scientific and educational purpose and the hunting is conducted 3 to 4 times per year.

b) Excavation Activities

Excavation activities are conducted in and around the proposed WWTP site. The concession for the excavation of sand and gravel in the area shown in Figure 6.5 is given to "Vardar Gradba" from MOE in 2002 for 15 years period. The procedures of concession are (i) the company make the request to MOE, (ii) MOE ask the opinions of concession to MTC, MAFWE and MEPP, (iii) if there is no objection from related organizations, the request is discussed in the Government, and (iv) the Government make the decision of the approval and the agreement of concession is made between the MOE and the company. The excavation area includes the protected area, Arboretum and Ostrovo, however, MEPP did not oppose this excavation

activities.

There are some cases of reduction of concession area and the cancellation of concession right. For this case, the Skopje City has to negotiate with the "Vardar Gradba" regarding the concession of excavation within the proposed WWTP site, or the Government can cancel the concession agreement.

c) Agriculture

The land of the water economy facility zone except Ostrovo is used as the agricultural field and the production is cereal crops (wheat and barley mainly). Some parts which seem inappropriate for farming have remained uncultivated.

d) Wetland (Ezerce)

This is used to be the flooded area of the Vardar River and the groundwater is higher, which results into creation of conditions for development of marsh-vegetation.

(5) Land Ownership

The status of land ownership is shown in Figure 6.6.

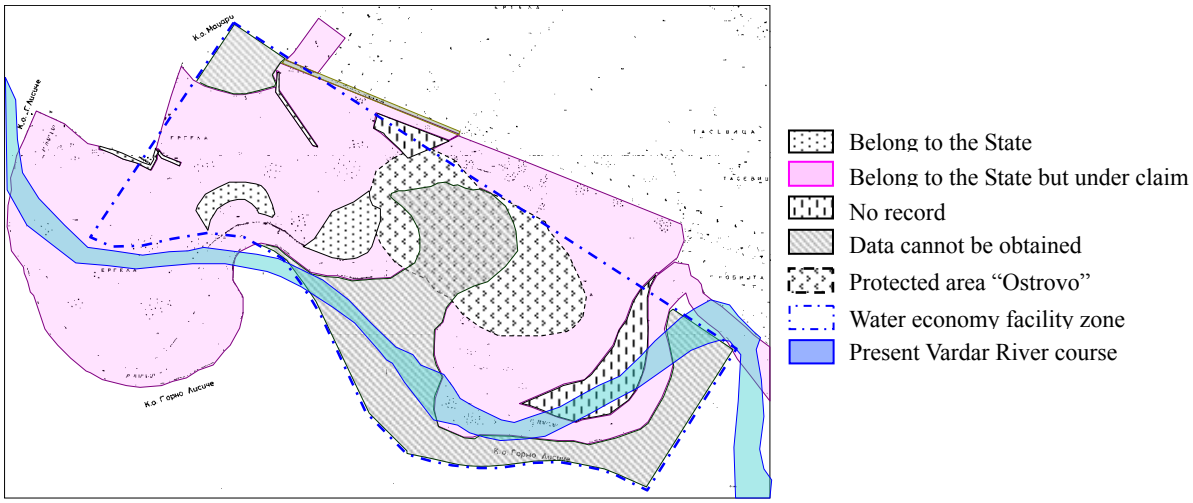


Figure 6.6 Status of Land Ownership

Most of the land within the water economy facility zone belongs to the state but under claim of de-nationalization. The detail land use is shown in Table 6.4.

Table 6.4 Land Use

Owner	Land use	Area (m^2)	%
State ($89,041\ m^2$, 9.1 %)	meadow	24,305	2.5
	un-fertile	28,415	2.9
	road	17,822	1.8
	waters	18,499	1.9
State owned (under claim) ($879,636\ m^2$, 90.3 %)	agriculture	188,533	19.4
	meadow	397,430	40.8
	road	5,760	0.6
	waters	287,888	29.6
	under object	25	0.0
Private ($5,373\ m^2$, 0.6 %))	meadow	5,373	0.6
		974,050	100

(6) Flora and Fauna

a) Flora

The area including the Arboretum, Ostrovo and Ezerce (shown in Figure 6.5) is used to be the rich forest vegetation beside the river riparian vegetation which had in the past flourished beside the Vardar River, before shifting its course, as well as before the land-reclamation measures taken in the swamps in Skopje Ravine. The forest is used to be one of the few resting sites for the migratory birds in the lowland parts of Skopje Ravine nearby Skopje. However due to the shift in the course of the Vardar River, changes in the level of the groundwater, the fires that had taken place in the past, and inappropriate foresting, this area has lost quite a lot of its flora-vegetation values.

b) Fauna

The area including the bank of the Vardar River, the protected area Ostrovo, the wetland Ezerce, the Arboretum Forest and the agricultural land has the importance for the bird diversity. Many numbers of bird species are present within the Ostrovo during the whole year, especially during the spring and autumn for migratory birds. Some species from amphibians and reptiles groups are registered as protection species (kinds of snake, lizard and turtles). The detail explanation is described in the chapter 3.12 of Appendix 6.3.

6.5 Alternatives

6.5.1 With/Without Project

With the project, it is expected that following positive impacts would result.

- The collection and treatment of untreated sewage before entering the Vardar River will improve water quality of the river and river environment.
- A proper sewage handling and disposal arrangement will minimize the chances of contamination of ground and surface water.
- Such provisions would assist to maintain ecological balance by reducing damages to flora and fauna.
- Development of the project will encourage increased economic activities like commercial, industrial, etc. and will generate enhanced employment opportunities and economic growth for the area.
- Improvement in the existing sewerage facilities will help tourism and boost the economy of the area.
- The construction activity can provide opportunities to the local population and residents of the neighbouring area to earn. They may come to provide labour or their service for the construction works under the Project.
- One of the conditions to join EU will be met through improvement of sewerage system and it will enhance the possibility of the country to join EU.

If the project is not implemented, the water quality of the Vardar River in 2020 will deteriorate due to the continuous discharge of untreated wastewater and increased amount of wastewater from increased inhabitants. The polluted water would continue to affect the ground water quality, threatening irrigation activities and drinking water safety (usually drawn from the groundwater) affecting the health of urban and rural residents. As a consequence, the quality of life and the standards of living of residents in the proposed project area will deteriorate. In addition, the Vardar River is the transboundary water body that is shared between Macedonia and Greece. Therefore, the river water quality is one of the essential environmental issues discussed between neighbouring countries during the transboundary water management negotiations. In 2005 Macedonia has been granted EU candidate status and one of the conditions for EU membership is that the candidate country aligns its national legal system with EU legislation. The transposition of the EU water related directives has been started and the provisions of wastewater treatment plant related EU Directives should also be enhanced. Hence, the pressure from legal obligations on national and transboundary level will be very strong and the alternative of no project seems to be not realistic under these conditions. The figure below shows the river water quality in cases of with project and without project scenario.

The comparison between cases of with project and without project has been carried out and is presented in Table 6.5 and Figure 6.7 (see more detail analysis in Chapter 4 of Part I (B/P)).

Table 6.5 Estimated Water Quality (BOD, 2020)

(mg/l)

	Rasce	Main Load discharge point							Taor
		Treska	Lepenec	Left-bank Outlet	Right-bank Outlet	Steel Outlet	WWTP	Trubarevo Bridge	
Current	2.5	2.6	2.5	5.7	7.9	9.7	9.3	7.1	5.8
Without*	4.0	4.1	4.1	8.2	11.6	11.9	11.5	8.8	7.5
With**	4.0	4.1	3.8	3.0	3.0	3.6	4.6	3.4	2.8
Water Quality	Class II				Class III				
	4	4	4	4	7	7	7	7	7

* Without situation: Without central and other WWTPs but with industrial wastewater management (Case-2 of Chapter 4, Part I (B/P))

** With situation: With central WWTP and industrial wastewater management but no other WWTPs (Case-4 of Chapter 4, Part I (B/P))

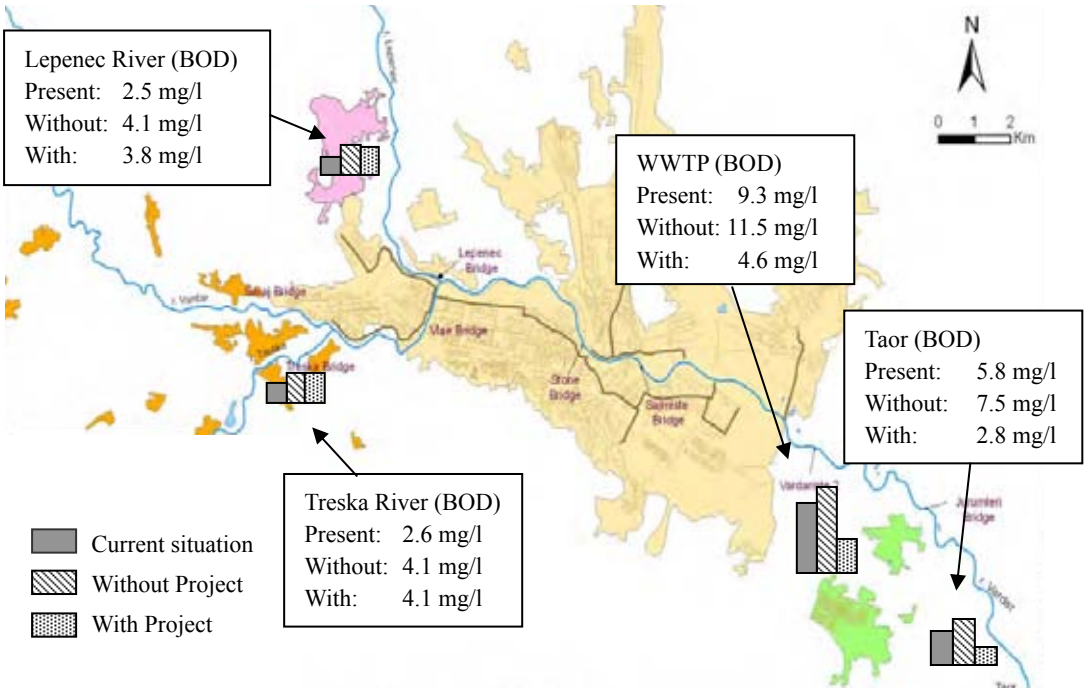


Figure 6.7 River Water Quality of Present / With / Without Project Scenario

6.5.2 Location of WWTP

The alternatives of the WWTP site are analyzed. It is recommended that the WWTP should be located:

- downstream of the sewer network in Skopje to collect all the wastewater,
- along the river side to discharge the effluent.

The sewer outlet, which is located downstream of Skopje sewer network, and the settlements are shown in Figure 6.8. Alternative locations are selected with the above mentioned characteristics.

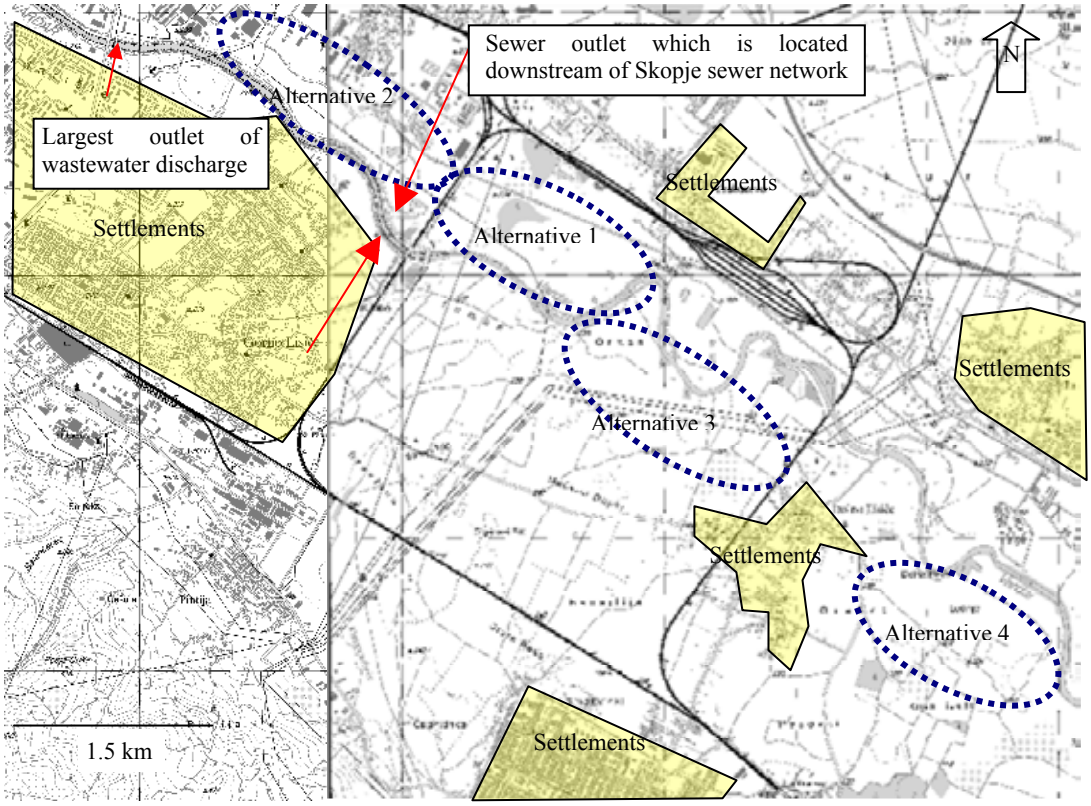


Figure 6.8 Alternatives for WWTP Location and Settlements

(1) Alternative 1: Water Economy Facility Zone in GUP

This area is designated as "water economy facility zone" in GUP and Sewerage M/P. The location is decided based on the information of Vodovod with the following reasons:

- Downstream of the Vardar River,
- Out of the city boundary,
- No residential area near the proposed site,

In addition to this, the proposed location has these advantages:

- The sewer network is installed upstream of the proposed site and the main outlet of collected wastewater is 3-4 kms upstream of proposed site. It is easy to bring the collected wastewater to the WWTP,
- The proposed site is located along the river and it is easy to discharge the effluent to the river,
- The wind blows along the river and the odour will be swept away downstream of the Vardar where there is no residential area,
- There is no house/structure within the area and no involuntary resettlement might be required,
- The area is designated as "water economy facility zone" in GUP and approved by the relevant administrative bodies for its use.

During the F/S study, however, it is identified that the water economy facility zone includes the protected area named "Ostrovo" which is the unique bird resort in Skopje region. If this zone is decided as the WWTP site, the protected area should be excluded from the WWTP site. This area is also used for the agriculture, excavation activities and hunting.

(2) Alternative 2: Former Waste Disposal Site

This area is located upstream of the sewer outlet which is located downstream of Skopje sewer network. This location is the former waste disposal site and it is proposed in GUP as the green area but not used for any purpose at present. As the area was used for the waste dumping site, the ground

is not solid and stable. Some facilities of treatment plant such as collectors and pumping system should be installed underground and this area is not suitable for such facilities.

(3) Alternative 3

Alternative 3 is located downstream of Alternative 1 along the Vardar River. This area is used for agriculture and is divided into small parcels. This area also has the advantages like the downstream, river side, and no possibility of resettlement. However, the settlement is located near this area and there might be the impacts by the odour. In addition to this, collectors should be installed to the WWTP but there is neither existing road nor planned road where the collectors can be installed, thus the additional land acquisition and construction of road will be necessary.

(4) Alternative 4

Alternative 4 is located downstream of other alternatives along the Vardar River. This area is used for agriculture and is divided into small parcels. This area also has the advantages like the downstream, river side, no possibility of resettlement, and no settlement downstream of this site. However, this area is around 5 km away from the sewer outlet which is located downstream of Skopje sewer network, and the extension of two large collectors (1600 and 1800 mm diameter) on both banks of the river and the additional crossing of railway are necessary. Same with the Alternative 3, there are no roads under which the trunk sewers can be installed and the additional land acquisition and construction of road will be necessary.

Considering the above alternatives, Alternative 1 is the most appropriate location for WWTP but it is important that protected area "Ostrovo" should be excluded from the WWTP site and the mitigation measures to Ostrovo should be considered.

6.5.3 Alternative Route for Trunk Sewers

As discussed in the Basic Plan (see chapter 7 of Part I), the trunk sewers are proposed to be installed under the proposed roads in GUP. The roads are not constructed yet and some houses are located in the proposed site. The alternatives for trunk sewers are studied in case if the roads are not constructed before the construction of trunk sewers and WWTP.

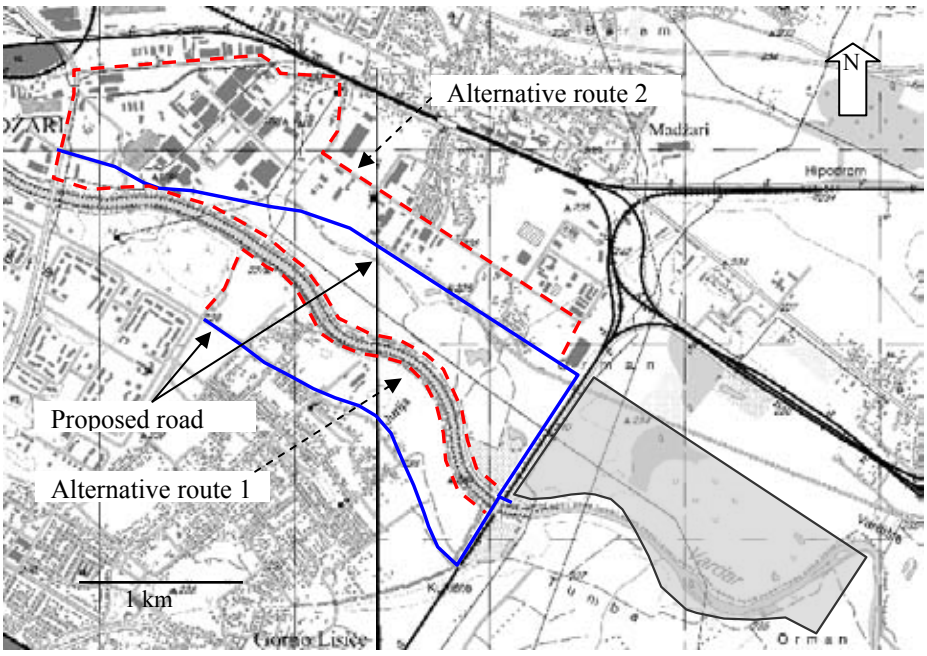


Figure 6.9 Alternative Routes for Trunk Sewers

The full lines show the proposed roads under GUP. Some sections of proposed roads are existing roads but they are narrow and the widening is necessary.

- There are no roads connecting to proposed treatment plant site on both banks of the Vardar River,
- Installation of collector in the banks of river is not allowed,
- Installation of collector along the river is difficult due to the problem of O&M as there is no roads (alternative route 1 in Figure 6.9) and it is not recommended,
- There is an existing road which comes to near the WWTP site on left bank (alternative route 2). This route is 400 m longer than proposed road and it leads to the increase in construction cost. In addition to this, the existing pipeline is installed under this road and the road is rather narrow, thus the construction work is much more difficult than the proposed road.
- If the other roads are selected, new construction, widening and extension are necessary.

Considering the above factors, using the proposed roads under GUP seems to be the best option. The responsible organization for road construction is Skopje City and the budget of year 2008 for design of these roads is approved by City Council. Thus, it is recommended to install the trunk sewer under the proposed roads in GUP.

6.5.4 Alternatives for Sludge Disposal

Considerable amount of sludge will be generated from treatment plant and the disposal method should be analyzed for the generated sludge.

The waste is categorized in the "List of Types of Waste" in Macedonia.

Table 6.6 List of Types of Waste

Serial No.	Category
19 08	wastes from wastewater treatment plants not otherwise specified
19 08 01	screenings
19 08 02	waste from desanding
19 08 05	sludges from treatment of urban waste water
19 08 06*	saturated or spent ion exchange resins
19 08 07*	solutions and sludges from regeneration of ion exchangers
19 08 08*	membrane system waste containing heavy metals
19 08 09	grease and oil mixture from oil/water separation containing only edible oil and fat
19 08 10*	grease and oil mixture from oil/water separation other than those mentioned in 19 08 09
19 08 11*	sludges containing dangerous substances from biological treatment of industrial waste water
19 08 12	sludges from biological treatment of industrial waste water other than those mentioned in 19 08 11
19 08 13*	sludges containing dangerous substances from other treatment of industrial waste water
19 08 14	sludges from other treatment of industrial waste water other than those mentioned in 19 08 13
19 08 99	wastes not otherwise specified

Note: Any waste marked with an asterisk (*) is considered as a hazardous waste
Source: List of Types of Waste, Br.07-4622/1

According to the list, sludge from the treatment of urban wastewater is non-hazardous waste and this can be disposed to the existing landfill (Drisla) in Skopje. However, the proposed WWTP will receive the industrial wastewater as the industrial wastewater is currently discharged into the sewers and it is difficult to separate.

Under the Law on Environment, the IPPC system has come into force and the prevention measures of water, air and soil pollution will be the obligation of each industry before discharge. Under the system, the activities of new installations or substantial changes on existing installations shall be performed only upon prior obtained integrated environmental permit and the existing facilities have to submit the reasonable plan for its improvement. Each industry is required to implement the prevention measures by 2014 and the hazardous substances should be pre-treated before the wastewater is discharged into the collectors. By implementation and compliance of IPPC system, any dangerous substances will not be discharged into the sewers and the sludge can be disposed of at

the existing landfill or used for the agriculture (See the details regarding the IPPC system in Part IV).

However, considering the situation that the deadline for complete introduction of IPPC system is extended to 2014 from 2007, and the capacities of MEPP which has the obligation to evaluate the application of industries, provide the permission and inspect the industrial activities, it is difficult to say that by the time of WWTP is operated the industrial wastewater which will be discharged into the sewers will be completely pre-treated and any dangerous substances will not included in the sludge.

During the Study period, there is the limitation to conclude the disposal method of sludge as the quality of the sludge will depend on the future progress of IPPC system and the detail criteria of type of the waste is not established yet in Macedonia.

Thus, the several possible scenarios are proposed for the sludge disposal.

(1) Re-use for agriculture

The EU encourages using the sludge for agriculture as a fertilizer or an organic soil improver if suitable. The Council Directive on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (86/278/EEC) regulates the use of sewage sludge in agriculture in such a way as to prevent harmful effects on soil, vegetation, animals and man, while encouraging its correct use (see the limit values in Chapter 3.1.7 of Part I (B/P)). The sludge can be used for the agriculture if the quality of the sludge meets these criteria.

(2) Disposal at the existing Drisla Landfill

Skopje City has the landfill for municipal and non-hazardous waste, Drisla which is located 14 km south-east of the centre of Skopje. PE "Communal Hygiene" agreed that the quantity of sludge can be acceptable at Drisla Landfill but their concern is the quality of the sludge.

There are no criteria of heavy metal concentration to identify the waste as hazardous or non-hazardous. As Waste Management Strategy (2008-2020) sets the high priority of transposition and incorporation of EU Directives into the Macedonian legislation, the criteria on waste of EU is applied for this Study.

In the Council Decision establishing criteria and procedures for the acceptance of waste at landfills (2003/33/EC), there are the criteria for landfills for non-hazardous waste and criteria for hazardous waste acceptable at landfills for non-hazardous waste. The criteria for landfills for non-hazardous waste fix the limit values for such as As, Cd, Cu and Pb, and the criteria for hazardous waste acceptable at landfills for non-hazardous waste fix the leaching limit values and other criteria (TOC (total organic carbon), pH and ANC (acid neutralization capacity)).

If the quality of sludge is below the limit values, the sludge can be categorized as non-hazardous waste and the disposal at Drisla Landfill will be acceptable.

(3) New construction of disposal site

If the sludge can be acceptable in the existing landfill site, the new construction of disposal site is not feasible as the new construction requires the large area in outskirts of the city that might cause large impacts on land use and resettlement. It also will result into increased cost for construction and O&M and this cannot be covered by user charges.

(4) Planned Landfill for Hazardous Waste

If the sludge cannot be disposed of at the existing landfill for municipal and non-hazardous waste, then the sludge should be disposed of at the landfill for hazardous waste. Macedonia does not have the landfill for hazardous waste at present. The responsibility of construction and management of landfill for hazardous waste lies with the State (MEPP). According to the Waste Management Strategy 2008-2020, the design of industrial hazardous waste management plants and landfills is planned to conduct in the year 2 to 4 (2009-2011), and the construction / operation of industrial

hazardous waste management plants and landfills is planned to implement in the year 4 to 6 (2011-2013) as shown in Table 6.7.

Table 6.7 Outline of the Waste Management Strategy Action Plan
(related to the industrial hazardous waste)

Measures	Stakeholders	Scope of main tasks and activities	Year of implementation					
			1	2	3	4	5	6
Design of industrial hazardous waste management plants and landfills	MEPP, hazardous waste generators	Application for financing from local and international funds. Preparation of technical, space managing and investment documents for establishment of the industrial hazardous waste management system (collection of segregated fractions at their sources, intermediate storage, recovery, pre-treatment, construction / reconstruction of landfills or other safe final disposal techniques in state or abroad)		×	×	×		
Construction/operation of industrial hazardous waste management plants and landfills	MEPP and/or licensed specialized enterprises	Construction of new common industrial hazardous waste landfill / reconstruction of existing industrial hazardous waste landfills /operation of landfills applying adequate pre-treatment facilities				×	×	×

Source: Waste Management Strategy of the Republic of Macedonia (2008-2020)

When the sludge contains the hazardous waste and cannot be disposed of at the existing landfill for municipal and non-hazardous waste, the planned industrial hazardous waste management plants and landfills could be the option for disposal of the sludge.

(5) Temporary Storage at the WWTP Site

The temporary storage of the sludge at the WWTP site could be one option if the above mentioned planned industrial hazardous waste management plants and landfills cannot be operated by the time of operation of the WWTP and the sludge includes the dangerous substances. This is only for the temporary measures, because if the untreated industrial wastewater with dangerous substances mixes with the domestic wastewater, Vodovod will inform the MEPP for inspection of the wastewater from the industries and MEPP has the power to order the industries to treat the industrial wastewater.

As the conclusion, on the premise of complete introduction of IPPC system, the sludge should be disposed of at the existing Drisla landfill site. In case of the dangerous substances are included in the sludge, it should be disposed of at the landfill for hazardous waste which is planned to be operated in 2013, and if the landfill for hazardous waste is not constructed, the sludge should be stored in the temporary storage at the WWTP site until a solution is found.

6.6 Impact Identification and Mitigation Measures

Steps stipulated in the EIA procedure (Law on Environment) have been undertaken, as notification, screening and scoping. On the prepared scoping checklist, the MEPP issued the opinion for the content of the study. This assessment of the environmental impacts was made on the basis of the above mentioned checklist and opinion.

In order to assess the possible impacts during construction and operation in more details, following activities in each phase have been taken into considerations:

(1) Construction phase

- Construction of the access roads and trunk sewers,
- Construction of the siphon structure across the Vardar River,
- Preparatory works at the location of the WWTP and excavation works,
- Transport and disposal of surplus excavated material,
- Construction of the structures of the WWTP,
- Disposal of construction waste,

- Installation of the equipment,
- Construction of accommodation facilities for the workers.

(2) Operation phase
- Treatment technology / operation of the equipment for wastewater treatment and effluent production,
- Operation of equipment for sludge production,
- Sludge disposal on temporary storage at WWTP site.

The impacts are assessed using qualitative assessment of the following parameters:

Type:	Positive (+), Negative (-)
Magnitude:	A- large, B- medium, C-low
Extent:	Local impact (at the site), Wider impact (in the surrounding area)
Duration:	Permanent impact, Temporary impact
Timing:	Immediate, Delayed
Reversibility:	Reversible, Irreversible

The detail assessment is described in the chapter 5 of Appendix 6.3 and the main impacts are summarized here.

6.6.1 Construction Phase

(1) Topography and Geology

Construction of access road and siphon, excavation works for trunk sewers, and WWTP facilities will affect topography and geology such as land slips and land slides due to alluvium geology of the construction sites. Especially at the WWTP site, the ground is of poor geo-mechanical features and low bearing capacity of the clay sandy silts on surface layers, there should be no foundation of the WWTP facilities on these layers at depth from 1 to 3 m.

Depending of the geo-mechanical features and bearing capacity of the soil, ground subsidence of the soil with material with better characteristics should be foreseen. The detail design must include technical measures for improvement of the bearing capacity of the soil when needed (appropriate type of foundation, replacement of the soil with better material, compacting and etc.). During the preparation of detail design, the local topographical conditions to be considered in order to minimize the disturbance of the topography.

(2) Water Quality (Groundwater and River Vardar)

During construction of siphon, excavation works for trunk sewers and WWTP, large negative impact is expected on the groundwater as groundwater level is relatively high in the location of construction. The construction work will affect the groundwater level and cause the turbidity through excavation and evacuation of groundwater. There is another possibility of pollution by the leakage of fuels and oils from the heavy vehicles and machinery used for construction and due to applied chemicals during this phase.

Some of the mitigation measures for prevention of the pollution of the groundwater and water in the river through the contact with the groundwater shall be integrated in the detail design and shall be fully applied during the construction phase. At the site, refuelling or servicing and treatment of oils shall be done only on specially designed places on an impermeable ground. Special measures shall be foreseen in order to avoid potential spills or leaks and adequate erosion control and soil conservation practices shall be applied.

(3) Hydrology

During construction, the hydrology of the Vardar River will be impacted by the construction of the siphon. In order to construct the siphon across the Vardar River, different river diversion structures and tail dams shall be constructed, thus there will be negative impact on the river flow and direction.

Mitigation measures in a form of solution for the river diversion with minimum disruption of the riverbed shall be defined in the detail design. During construction, all proposed protection measures related to the technology to the construction shall be fully respected.

(4) Protected Area / Flora and Fauna

As mentioned in the alternatives for WWTP location in chapter 6.5.2, the water economy facility zone in GUP is selected as the WWTP site, however, the area includes the protected area for migratory birds "Ostrovo" as shown in Figure 6.5. It is concluded that Ostrovo is excluded from the WWTP site in order to avoid the large negative and direct impacts to the protected area (see Figure 6.2).

The construction activities will have impact on the flora and fauna in the location of the WWTP, protected area Ostrovo, wetland Ezerce and the protected area Arboretum. As mentioned in the 6.4, birds especially migratory birds, reptiles and mammals make their habitat in this area, the negative impacts on the inhabitants are expected by noise/vibration of construction activities, frequent movement of people and vehicle.

The proposed mitigation measures include:

- No activities performed in the locations: Ostrovo, Ezerce and Arboretum,
- To plan construction works carefully to minimize impact on habitats, flora and fauna,
- To design associated infrastructure in such a way to minimize impacts (crossing way for animals),
- Careful selection of sites which will not affect the protected areas Ostrovo (stock place for the construction materials, construction waste disposal site, etc.).

(5) Air Quality

The construction phase will provoke air pollution due to dust emission and by components of combustion gases of construction machinery and vehicles (CO_2, NO_X, SO_X, CO, CH_4). This negative impact is assessed with medium magnitude.

To mitigate the impacts, careful planning of the construction works in residential areas, strict control of the construction methods, used machinery and other equipment, spraying with water to reduce the dust emission, and maintenance of vehicles should be taken as mitigation measures.

(6) Landscape

During construction, the landscape will be impacted negatively by damage of the vegetation along the construction sites, loss of trees, and presence of dust, waste and construction debris. The possible cluttering of waste and dug up roads and pavements will worsen the landscape and will cause visually unaesthetic conditions.

Applying good design and construction practices such as, careful maintenance and proper housekeeping of the site including the quick disposal of the construction waste at the approved sites, using excavated materials for backfilling of borrows and gravel pits as far as possible, repairing the pavements and roads immediately after the installation of collectors will mitigate the impacts.

(7) Land Acquisition and Land Use

The negative impacts will be expected on land use by land acquisition. As mentioned in 6.4, the land is used for the agriculture, excavation activities of sand and gravel and hunting, which are owned by the private, the state and under the request of de-nationalization, the large negative impact on land use will be expected.

The land acquisition should be conducted strictly following the laws rerated to the land acquisition (the procedures are mentioned in 6.2.5). Based on the related laws, adequate compensation with alternative land or cash should be provided to those who will be affected by the land acquisition. It is recommended to organize awareness campaign for the concerned people for the importance of the

project, and benefits from the project to obtain their understanding to the project.

(8) Public Infrastructure and Services

The construction phase will provoke the negative impact on medium magnitude on the existing public infrastructure and services by re-direction of the traffic, disturbed movement of the pedestrians and bicycles, disturbance of the traffic infrastructure, possibility for increased number of traffic accidents.

To mitigate the impacts:

- Setting up adequate signals for re-direction of the traffic,
- Timely rehabilitation of the damages done on the roads by the transport vehicles and other construction vehicles and machinery during the construction phase,
- Implementation of preventive measures against air pollution, noise and vibration.

(9) Noise and Vibration

During construction phase, the impact by the noise and vibration is negative with medium magnitude, due to the produced noise pollution and vibrations from transport vehicles, operating machinery and equipment for construction. It is estimated that the average SPLs will range between 65 db to 70 db, although there might be cases of increased level up to 90 db in short time intervals.

The mitigation measures should include:

- Careful planning of the preparatory works in order to minimize acoustic pollution,
- Equipment emitting noise over 90 db should be avoided,
- Careful timing of works in residential areas,
- Avoiding loud beep signals in settlements to minimize disturbance to residents.

(10) Waste

During excavation and construction of the facilities the waste will be generated. Regarding the impacts of the waste, the mitigation measures in general is to respect good waste management practices and to dispose the generated waste on designated location.

6.6.2 Operation Phase

(1) Water Quality (Groundwater and River Vardar)

Operation of the WWTP will have large positive impact on the quality of the river water, as there will be no direct discharges of wastewater into the Vardar River. The pollution of groundwater in Skopje area is mainly due to polluted water from the Vardar River through strong connection with the groundwater and river water, thus the improvement of groundwater quality will also be expected.

However, during operation of the WWTP, there are also negative impacts on the groundwater due to the leakages from the system of WWTP, infiltration of sludge drying bed and temporary storage for sludge at the site. The system of wastewater treatment should ensure minimization of the risks of leakages to groundwater, sludge drying beds and temporary storage should be provided water impermeable bases, drainage system for leachate, e.g. pave the concrete at the bottom, put the gravel over the concrete for filtration and install the drainage pipe), and flood protection structures should also be provided.

The WWTP will treat the industrial wastewater which is pre-treated to acceptable level at WWTP. If the industrial wastewater is not pre-treated to appropriate quality and contains the hazardous substance, this will affect the effluent quality. The pre-treatment of industrial wastewater before discharging to the sewer is the obligation of each factory under IPPC system, the risk of contamination is not high. When the contamination of effluent by industrial wastewater is identified through monitoring, the WWTP should report the fact to MEPP or Skopje City which have the authority of inspection to make the factories pre-treat their wastewater or Vodovod whom the authority of inspection to factories is given to according to the proposal of this Study should force the factories to follow the effluent standards of factories.

(2) Protected Area / Biodiversity / Flora and Fauna

The operation of the WWTP will have positive impact of high magnitude on the restoration and improvement of the aquatic fauna in the Vardar River because of the improvement of river water quality.

The impacts on protected area might be expected through contamination of groundwater and soil due to the operation of sludge drying bed and temporary storage for sludge. The mitigation measures for groundwater through infiltration of sludge treatment facilities are described in the above chapter. The impact on soil might be happened due to the spreading of sludge which contains the heavy metals by wind. To prevent the spreading of the sludge to the protected area, the green buffer zone between the sludge treatment facilities and protected area is proposed (see Figure 6.2). The width of green buffer zone is 30 m at minimum and this will prevent/mitigate the contamination of soil by diffusion. Another mitigation measure is appropriate operation of the sludge drying bed and temporary storage. There is the possibility of diffusion of excessive dried sludge from the drying bed. To mitigate this impact, as mentioned in section 4.4.4 of Chapter 4 (Part II (F/S)), the effective measure is proper operation of drying bed. For the diffusion from the temporary storage, the cover should be provided.

The operation of WWTP will increase human presence and vehicle movement and will cause another negative impact on the fauna of the birds and large mammals as they are relatively sensitive on the disturbances caused by frequent close contact with human. The impact is assessed as of low magnitude because during operation phase vehicular and human movement will be less frequent. However, if certain mitigation measures mentioned below are properly implemented, the impact will be lower or even only positive impact on the conservation of the fauna.

The suggested mitigation measure in order to reduce the negative impacts on the fauna is to discharge the effluent from both sides of the protected area Ostrovo, that will have the role of barrier. As the birds are much more tolerant on human approach when they are isolated by water barrier, the impact will be mitigated. The green buffer zone around the sludge treatment facilities will also mitigate the negative impact on fauna.

(3) Livelihood and Local economy

The main negative impact on the livelihood and local economy caused by the operation of the WWTP is the increase of the water and wastewater tariff due to the increased operation and maintenance cost. According to the financial evaluation, the tariff should be increased by at least 20 % to cover the O&M cost (see more detail in Chapter 7.1). In order to mitigate the negative impact, the public awareness campaigns are needed to explain to the population the importance of the WWTP, treatment system and O&M cost.

(4) Waste

Operation of WWTP generates large quantities of sludge (72.4 m^3/d) that provokes large negative impact. As discussed in the alternative study (see 6.5.4), the sludge can be disposed of at the existing landfill site, Drisla if the sludge is categorized as non-hazardous waste according to the EU Directives. The sludge also can be used for agriculture if the quality of sludge and the conditions of soil will meet the criteria which is defined in the Council Directive on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (86/278/EEC).

If the sludge is categorized as hazardous waste, the sludge can neither be disposed of at the existing landfill nor re-used for agriculture. As MEPP has the plan to construct the landfill for hazardous waste by 2013 which should facilitate the prevention measures for soil and groundwater, the sludge can be disposed of at the planned landfill for hazardous waste.

(5) Offensive Odour

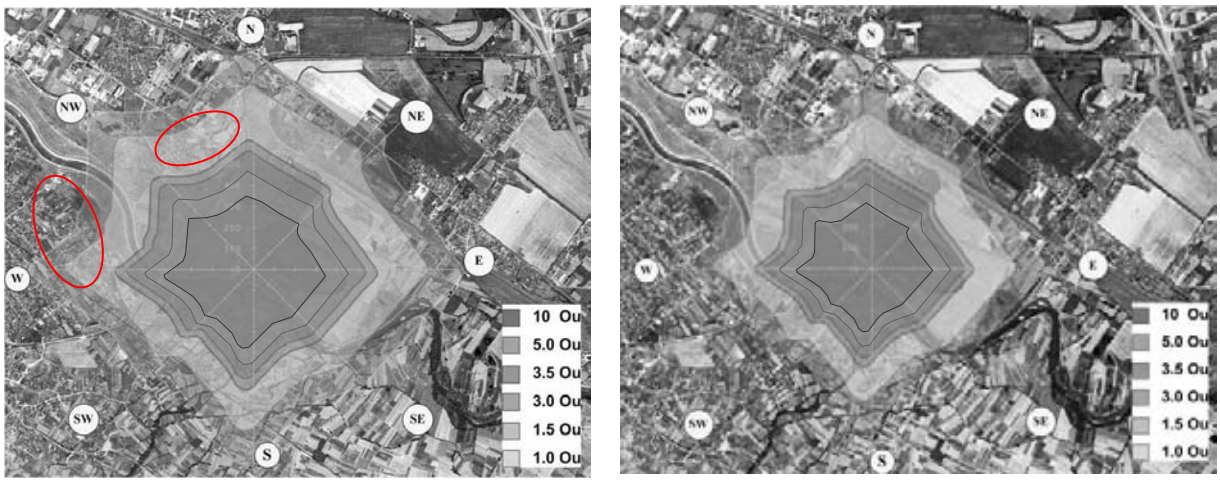
The operation of the WWTP can be expected to generate odour emissions which may cause certain

level of annoyance within the surrounding area. Odour from the WWTP is caused by the presence of one or more compounds in wastewater. Most odorous compounds found in wastewater and bio solids are by-products of anaerobic biological activity that consumes organic material, sulphur, and nitrogen in the wastewater. The main odour sources are associated with the operation of wastewater collection, treatment and sludge treatment systems.

An odour assessment has been performed and the results of odour diffusion are presented in Annex 20 of Appendix 6.3. The result of simulation indicates that the operation of WWTP will provoke negative impact of medium magnitude in terms of the odour annoyance. Proposed mitigation measures should be taken into consideration for mitigation of odour impacts in detail design stage:

- Select locations of major sources away from sensitive receptors at the detail design stage,
- Good housekeeping and raw material handling practices,
- Preparation of Odour Management Plan,
- The inlet facilities which is the main odour source should be covered,
- Avoiding anaerobic conditions and preventing creation of septic conditions.

By taking these mitigation measures, the odour diffusion area will be decreased shown in figure below and the impact to the residential area near proposed WWTP will be mitigated.



(left: without mitigation measures, right: with mitigation measures)

Figure 6.10 Result of Odour Assessment

6.7 Monitoring Plan

The monitoring plan is prepared with the objectives:

- To confirm that the conditions of project approval are implemented satisfactory,
- To verify that impacts are within predicted or permitted limits,
- To manage unforeseen impact or changes, and
- To ensure that environmental benefits are maximized through good practice.

In the construction phase, surface water, groundwater, air, noise and vibration will be monitored, while in the operation phase, the following parameters will be added in the monitoring system: wastewater, effluent, sludge, offensive odour, biogas production and energy generation.

For the monitoring and reporting requirements from the national legislation, National Monitoring Strategy and concerning EU Directives shall be fully respected.

Monitoring of the surface water (the Vardar River) and groundwater during both phases shall be the responsibility of the City of Skopje as part of the local monitoring network.

During construction, monitoring of parameters for air and noise are the obligation of the contractor /

investor as it is defined in the Laws. During operation, monitoring of parameters for air, noise and vibration, offensive odour, wastewater, effluent, sludge, biogas production and energy generation are under responsibility of the operator. Reporting for monitoring of all parameters during construction and operation phase should be done by the City of Skopje, Contractor and Operator towards the MEPP. The detail monitoring plan is shown in chapter 6.3 of Appendix 6.3.

Table 6.8 Monitoring Plan (Construction Phase)

Item	Parameter monitored	Location	Frequency	Responsible
Surface Water (Vardar River)	- Quantity - Quality (BOD, COD, SS, pH)	- Upstream of WWTP - Downstream of WWTP	- Quantity: once per month - Quality: one per month	Skopje City (Construction company)
Groundwater	- Water level - Quality (BOD, COD, SS, pH)	- 5 locations within WWTP	- Water level: once per month - Quality: one per month	Skopje City (Construction company)
Air		Within WWTP and surrounding area	- Once per month	Construction company
Noise and Vibration		Within WWTP and surrounding area	- Once per month	Construction company

Table 6.9 Monitoring Plan (Operation Phase)

Item	Parameter monitored	Location	Frequency*	Responsible
Surface Water (Vardar River)	- Quantity - Quality (BOD, COD, SS, pH, NH_4-N, NO_2-N, NO_3-N, T-N, T-P, heavy metals, colour, turbidity)	- Upstream of WWTP - Downstream of WWTP	- Quantity: once a week - Quality: once a week	Skopje City MEPP
Groundwater	- Water level - Quality (BOD, COD, SS, pH)	- 5 locations within WWTP (including near the sludge drying bed)	- Water level: once per month - Quality: once a week	Skopje City Operator (Vodovod)
Air		Within WWTP and surrounding area	- Quality: four times per year - air emission: four times per year	Operator (Vodovod)
Noise and Vibration		Within WWTP and surrounding area	- twice per year	Operator (Vodovod)
Odour		Within WWTP and surrounding area	- one per month at the borders of the WWTP - If necessary, in the surrounding area	Operator (Vodovod)
Wastewater (Influent)	- Quantity - Quality**	At the inlet structure at the WWTP	- Twice a month	Operator (Vodovod)
Effluent	- Quantity - Quality**	At the outlet structure into the Vardar River	- Twice a month	Operator (Vodovod)
Sludge	- Quantity - Quality**	At the sludge drying bed	- Once a month	Operator (Vodovod)

* The monitoring frequency is the minimum requirement

** BOD, COD, TSS, pH, coliform, n-hexane extract, Phenol, Cupper, Zinc, Iron, Manganese, Total chromium, Cadmium, Organic phosphorus, Lead, Hexavelent chromium, Arsenic, Total mercury, Alkyl-Hg, Poly biphenyl Chloride (PBC), Tri-chloroethylene, tetrachloroethylen, Di-chloromethane, Butyl chloride carbon (CCl4), 1.2-dichloroethane, 1.1-dichloroethylen, cis-1.2-dichloroethylene, 1.1.1-trichroroethane, 1.1.2-trichroroethane, 1.3-dichloropropene, Thriuram, Simazine, Thiobencarb, Benzene, Selenium, Boric acid, Fluorine (same parameter with Table 4.10, Part II (F/S))

6.8 Contingency Plan

The Contingency Measures Plan (CMP) is defined as a plan of actions that should be taken when emergencies that may involve risks of serious environmental contamination could happen. The CMP has been prepared for:

- Wastewater treatment works that could reasonably be expected to cause significant environmental impacts as a consequence of operational disruption (e.g. maintenance, breakdown, repair etc.), including access roads and trunk sewers,
- Accidents which may occur while laying collectors or during construction of the WWTP,
- Accidents which may occur during operational phase (e.g. discharge of effluent which does not meet the standards) which could cause a significant public health impact and which therefore requires a continuous system of influent/effluent monitoring to identify potential problems as and when they arise.

6.9 Stakeholder Meeting

6.9.1 Approaches

The stakeholder meeting for public consultation were planned two times during Basic Plan stage and one time in F/S stage according to the JICA's Guidelines (see the detail of first and second stakeholder meetings in Chapter 7 and Appendix 7 of Part I (B/P).

Table 6.10 Schedule and Objectives of Stakeholder Meeting

	Date	Objectives
First Meeting	9th November 2007	(1) Introduction of JICA Study (objectives, contents, schedule) (2) Explanation of procedures and schedule of environmental and social considerations (3) Draft scoping of IEE level study
Second Meeting	22nd February 2008	(1) Contents of Basic Plan and result of IEE (2) Results of IEE (3) Priority projects in F/S and scoping of EIA
Third Meeting[5]	16th October 2008	(1) Contents of F/S (2) Results of EIA

The organizer is Skopje City in cooperation with MTC and MEPP.

6.9.2 Selection of Stakeholders

The selection of stakeholders is carried out by Skopje City in collaboration with JICA Study Team, and the stakeholders are categorised as follows.

- People in the Study area and people who will be affected by the proposed projects, including socially vulnerable people
- Ministries and relevant governmental agencies (MTC, MEPP, MAFWE, MOF etc.)
- Skopje City and 10 municipalities
- Research institute and universities (public health, hydrometeorology, etc.)
- Main Industries
- NGOs working in the environmental field
- International Organizations and Donors
- Industries

6.9.3 Third Stakeholder Meeting

Third stakeholder meeting was held on 16th October 2008 by Skopje City at City Hall and 47 persons are participated in this meeting.

[5] The third stakeholder meeting is held during F/S stage. The detail information is described in the section 6.9.3 of Part II (F/S).

Table 6.11 Participants in the Third Stakeholder Meeting

Ministries	3	NGO	1
Skopje City, Municipality	16	International organizations	2
Research institutes, University	13	Factories	3
Others	9	Total	47

During this meeting, the questions and comments mentioned below were raised.

- Sewerage district Saraj and Dracevo are separated from the central WWTP in the plan. These should be included in the central district.
- Sludge drying beds are very primitive method. I believe that drying beds are inappropriate for Skopje, since it would mean open beds where fecal waters are to be dried outdoors and with negative environmental effects on the immediate surrounding.
- This model for treating wastewaters can be used in other urban areas alongside the river Vardar and its tributaries. I recommend using the effluent and the sludge if it is not hazardous for agriculture.

The detail information is described in 6.4 of Appendix 6, Part II (F/S).

6.10 Public Hearing

The public hearing by MEPP is the obligation according to the laws and regulations on EIA in Macedonia. The announcement of public hearing was published in December 2008 on websites of MEPP and City of Skopje and the public hearing was held on 23rd January 2009. It started with the opening remarks and explanation of the EIA system by MEPP, explanation of the project and results of EIA by City of Skopje and JICA Study Team, held by questions and answers session. The participants ware around 10 persons except MEPP, City of Skopje and JICA Study Team.

CHAPTER 7 EVALUATION OF PRIORITY PROJECT AND RECOMMENDATIONS

7.1 Financial Evaluation

7.1.1 Methodology of Financial Evaluation

The Project, which will provide a WWTP and trunk sewers, will form a large component of the Vodovod's sewerage system, so will become fully functional provided all other components of the system work satisfactorily. Vodovod carries out all financial transactions in the same books for water supply and sewerage operation. Vodovod has no intention to separate the financial operation of water supply and sewerage at this moment, and does not see a significant merit to separate them in the future. Given this, financial evaluation of the Project shall be carried out base on the financial performance of Vodovod as a whole.

Financial evaluation of a project is a process to find the profit (or deficit) to be obtained from an investment. Vodovod has income statements and balance sheets. However, no cash flow statements have been provided. For financial evaluation of a Project, (1) income statements forecast and (2) cash flow statements forecast for the life of the project shall be provided. The income statements forecast examine how much profit (or deficit) can be obtained from the operation. The cash flow statements forecast test if the available sources of funds can meet funds required for initial investments, reinvestment for replacement of equipment and repayment of a loan (loans) borrowed for the Project.

7.1.2 Financial Costs

Financial costs of the Project are categorized into two: (1) operating costs including all the expenses accruing in the operation of the Project; and (2) capital costs, which consist of initial investment capital, reinvestment capital for replacement of facilities during the life of the Project and funds required for repayment of a loan (loans) for the Project.

(1) Operating Costs

The following items of costs comprise the operating costs:

a) Material expenses
   Material expenses include raw materials, energy expenses, spare parts, etc.
b) Depreciation
c) Non-material expenses
   Non-material expenses consist of staff allowances and travel expenses, transportation fees, staff fringe benefits (food, clothing etc.), vacation and retirement aid, Ad and PR expenses, insurance premiums, taxes (VAT and income taxes of Vodovod not included), banking services, staff medicare, training and seminar, etc.
d) Gross payment of salaries
e) Procured value of goods
   Procured value of goods are composed of transportation and communication services, regular maintenance (e.g., repair of roads after digging), rental fees, etc.
f) Dismissal of uncollectible receivable accounts (non-paid bills)
g) Expenses from interest rates
h) Taxes
   5% VAT on total amount of issued bills for water services; 10% income tax on net income

The financial costs must amount less than the financial benefits on the income statements in the long run.

(2) Capital Costs

The capital costs consist of the following:

a) Initial cost of the Project
   In terms of the cash flow, the Project component to be financed by a government grant

constitutes part of the initial cost of the Project as well as the component to be financed by an external loan.

b) Loan amortization
The proceeds of the loan repayment will form a component of the cash flow of capital expenditure.

c) Cost of reinvestments
Reinvestments required for replacement of mechanical and electrical equipment can be financed internally, namely, from accumulated depreciation and retained earnings.

The capital cost should be equal to or less than capital resources available from the cash flow statements.

7.1.3 Financial Benefits

Financial benefits are basically derived from financial operation of the utility, namely in this case, Vodovod. Financial operation of a water utility will produce certain surpluses (or from time to time, deficits). In effect, the financial benefits are defined as the agglomeration of the balance between the operating revenue and the operating expenses including depreciation in the base year, namely, the previous year of Project implementation; and those in each year after the base year for the life (30 years) of the Project. The government or city subsidies, if any, may be included in the income streams. For Project financing, an external borrowing is an important source of fund in the capital account.

Future net profits (retained earnings) are calculated using income statements forecast for the life of the Project, i.e., 30 years. Sources and uses of funds are forecast by cash flow statements for the same period. Typical income statements forecast and cash flow statements forecast shown in Table 7.1 and Table 7.2 are with assumption that the Project is financed by the JICA for 80% of the Project cost and 20% by a government grant (half of which may be financed by the Instrument for Pre-Accession [IPA] fund).

Table 7.1 Income Statements Forecast (Portion)

PE Income Statements 2007-46 ('000) — Variable Rate hike %: 20 (Scenario-3: JICA80%; IPA10%; EU0%; Gov.10%; +20% Tariff; 100% Dpr.)
Depreciation accounted % 100 O&M cost change % 0

No	Description	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	Water demand 1000 m^3/yr	39,419	39928	40444	40968	41499	42038	42585	43140	43673	44079	44489
	Av. Water rate MKD/m^3	32.11	32.03	31.96	31.88	31.80	31.72	31.64	31.56	37.77	37.78	37.79
1	Total revenue	**1,219,396**	1,319,271	1,333,063	1,346,999	1,361,082	1,375,312	1,389,692	1,404,223	1,688,278	1,703,909	1,719,689
1.1	Revenue from selling services 1)	1,265,804	1,279,054	1,292,444	1,305,975	1,319,647	1,333,463	1,347,425	1,361,533	1,649,705	1,665,336	1,681,116
1.2	Revenue from financing - interest 2)	5,781	5,839	5,897	5,956	6,016	6,076	6,137	6,198	1,716	1,716	1,716
1.3	Other income 3)	34,037	34,377	34,721	35,068	35,419	35,773	36,131	36,492	36,857	36,857	36,857
2	Total expenses	**1,169,777**	1,146,433	1,195,741	1,199,345	1,202,805	1,206,397	1,210,130	1,214,009	1,291,889	1,289,560	1,566,835
2.1	Total material expenses 4)	133,476	140,150	147,157	151,572	156,119	160,803	165,627	170,596	174,008	177,488	228,388
2.2	Depreciation 5)	168,485	173,540	178,746	182,321	185,967	189,686	193,480	197,350	201,297	205,323	426,452
2.3	Non-material expenses 6)	159,384	167,353	175,721	180,992	186,422	192,015	197,775	203,709	207,783	211,938	231,458
2.4	Gross payment of salaries 7)	346,955	381,651	419,816	419,816	419,816	419,816	419,816	419,816	461,797	461,797	461,797
2.5	Procured value of goods 8)	26,145	26,929	27,737	28,569	29,141	29,724	30,318	30,924	31,543	32,174	32,817
2.6	Dismissal of uncollectible receivable accounts (non-paid bills) 9)	334,332	255,811	245,564	235,075	224,340	213,354	202,114	190,615	214,462	199,840	184,923
2.7	Expenses from interest rates	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
3.2	Gross income	49,619	172,837	137,321	147,654	158,277	168,915	179,563	190,215	396,389	414,349	152,854
4	Income tax	43,857	81,236	78,354	80,064	81,810	83,565	85,328	87,098	122,124	124,702	99,341
3.2	Income after tax (Retained earnings)	**5,762**	**91,601**	**58,967**	**67,590**	**76,467**	**85,350**	**94,235**	**103,116**	**274,265**	**289,648**	**53,513**
Tax	VAT (%)	5	Income Tax	10								

Table 7.2 Cash Flow Statements Forecast (Portion)

Cash Flow Statements - 2007-2045 (Scenario-3: Drying bed: JICA80%; EU0%;IPA10; Gov.10%; 20% tariff Increase; 100% Dpreciation)
(Rate increase %:)

Sources of funds		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	Depreciation	168,485	173,540	178,746	182,321	185,967	189,686	193,480	197,350	201,297	205,323	426,452
	Retained earnings	5,762	91,601	58,967	67,590	76,467	85,350	94,235	103,116	274,265	289,648	53,513
	Loan					321737	321737	1286947	1608684	1608683.8	1286947.1	
	Total sources	174,247	265,140	237,713	249,910	584,171	596,774	1,574,662	1,909,150	2,084,246	1,781,917	479,965
Application of funds							1	2	3	4	5	6
	Construction					321737	321737	1286947	1608684	1608683.8	1286947.1	
	Loan repayment 1						0	0	0	0	0	0
	Loan repayment 2											
	Total uses	0	0	0	0	321737	321737	1286947	1608684	1608684	1286947	0
Balance		174,247	265,140	237,713	249,910	262,434	275,037	287,715	300,466	475,562	494,970	479,965
Accumulated balance		174,247	439,387	677,100	927,010	1,189,445	1,464,481	1,752,197	2,052,663	2,528,225	3,023,195	3,503,160

7.1.4 Affordability Assessment

Affordability of the water and sewerage rates are defined as the maximum amount of water and sewerage rates at which a family can be affordable to pay the water and sewerage charges from its disposable income. A household, which has the average disposable income, is considered to be the objective household.

(1) Water and Sewerage Charges

Water rates and sewerage rates Vodovod charges to its customers are as follows:

Table 7.3 Existing Water and Sewer Service Rates

	Household (MKD/m^3)	Business (MKD/m^3)
Water Supply	17.25	46.63
Sewerage	12.12	19.17
Total	29.39	65.80

According to the social survey conducted under this study the water consumption by an average household is approximately 17.5 m^3/month; and by a low income household (25-percentile income level) is about 8.0 m^3/month.(Figure 7.1) Therefore, the water and sewerage charges are found as follows:

Table 7.4 Water and Sewer Service Charges by Income Group

Household Category	Water consumption (m^3)	Water Supply (MKD/ m^3)		Sewerage (MKD/ m^3)		Total (MKD)
		Rate	Charge	Rate	Charge	
Low income	8.0	17.25	138	12.12	97	235
Average income	17.5	17.25	302	12.12	212	514

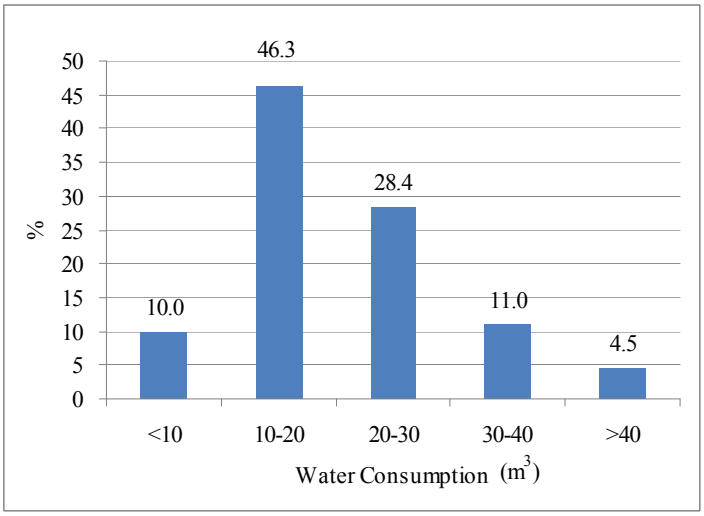


Figure 7.1 Monthly Water Consumption Distribution among Households

(2) Household Income

The social survey shows that the 25-percentile disposable income level was at 8,000 MKD/month and that of the 50-percentile income level was at 16,000/month in Skopje City.

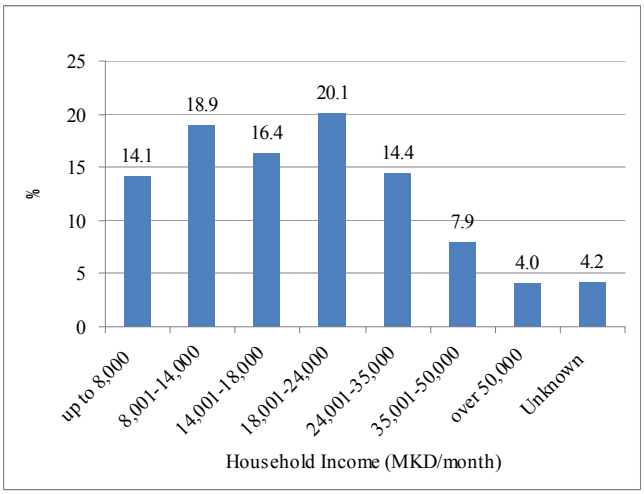


Figure 7.2 Household Income Distribution

(3) Affordability

The combined water and sewerage charges of the average income household is 514 MKD/month, which constitutes 3.2 % of their disposable household income (16,000 MKD/month). On the other hand the ratio is 2.9% for the low-income household. According to the Statistics Yearbook of the Republic of Macedonia (2007), the annual expenditure of the average household was 379,378 MKD (31,615 MKD/month) whereas its available funds were 267,523 MKD (22,294 MKD/month). The former is 42 % larger than the latter. Therefore it is considered that households in general in Macedonia can afford to pay their cost of living more than the officially stated income, most probably, thanks to the unofficial economy.

The maximum affordability to pay for water and sewerage services is considered to be 4% of household disposable income according to WHO and other international development bank guidelines[1]. Based on this guideline, the affordable water rate for the average income group is 640 MKD/m^3; and that for the low income group is 320 MKD/m^3.

7.1.5 Willingness-to-pay Assessment

According to the same survey, the willingness-to-pay of consumers in excess of their present payment of sewer services charges for improved services is illustrated in Figure 7.3.

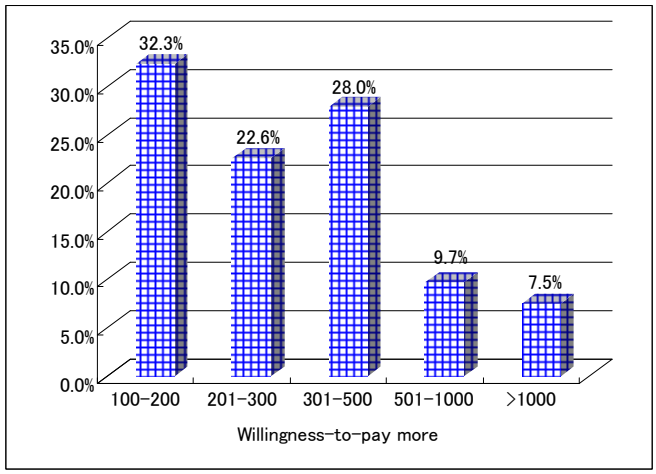


Figure 7.3 Willingness-to-pay for Improved Sewerage Services (MKD)

[1] It is noted that this percentage might be high in Macedonia because of large number of populations of about 90% own their houses. However, 4% is used in the Study.

The average willingness-to-pay in excess of their present payment is estimated at 432 MKD per month per household. The willingness-to-pay of low income group (25-percentile) in excess of their present payment is estimated at 220 MKD per household. Accordingly the total willingness-to-pay is computed as shown in Table 7.5.

Table 7.5 Total Willingness-to-pay for Water and Sewerage Services per Household

Household Category	Current payment for water (MKD)	Current payment for sewer service (MKD)	Willingness-to-pay for extra payment for improved sewer service (MKD)	Total (MKD)
Low income	138	97	220	455
Average income	302	212	432	946

It is noted that the total willingness-to-pay of both income groups is significantly high. The respective values for the average and low income groups are equal to 5.9% and 5.7% respectively. Although the "willingness-to-pay" and "affordable-to-pay" do not normally equal to each other, this result shows considerably strong aspiration of residents for the improvement in their living environment.

7.1.6 Scenarios of Financial Evaluation

(1) General

There are generally two ways to improve the financial performance, namely, (1) increase in revenue, and/or (2) reduction in expenditure. The measures to raise the revenue are the followings:

1-1) Increase in sales volume
1-2) Increase in the number of customers
1-3) Reduction in unpaid bills
1-4) Increase in water and sewer service rates

1-1) Increase in sales volume

Increase in sales volume is possible where there is unsatisfied demand and if there are measures to satisfy the demand by either developing a new source or reducing the water loss from the distribution network. In Skopje water source has enough capacity and all the demand has been satisfied even though there are considerable water losses. Thus there is no room for increasing the water demand although there may be gradual increase in demand due to minor growth in population served.

1-2) Increase in the number of customers

Increase in the number of customers is also impracticable since almost entire households are served by Vodovod. On the other hand the revenue from sewer services can be augmented since the households covered with the sewer network is at present about 80% of the total number of households, so there is certain room to increase.

1-3) Reduction in unpaid bills

The rate of unpaid bills is outstanding at 20 % or so although Vodovod has been making efforts to increase the rate of bill collection. It appears possible to further reduce the rate of unpaid bills. Further efforts must be made to increase the paid bills rate at least to 90 %. It is noted that the average water utilities in Japan collect more than 99% of their water bills.

1-4) Increase in water and sewer service rates

Increase in water and sewer service rates may be the last, but most effective measure to increase the revenue. However, the extent of rate increase must be limited to the affordability and willingness-to-pay of customers. As stated earlier, there seems to be certain room for the rate to be raised.

The measures to reduce the expenditure are the following:

2-1) Reduction in personnel costs
2-2) Reduction in tangible costs

2-3) Reduction in intangible costs
2-4) Reduction in non-material expenses such as interest paid and taxes
2-5) Reduction in dismissal (write-off) of accounts uncollectable
2-6) Reduction in capital cost

2-1) Reduction in personnel costs
Whenever there is redundancy in staffing, the reduction in personnel cost seems to be easy. However, the reduction in the staff size of a public utility is a very delicate and difficult task. The management of Vodovod recognizes that Vodovod has relatively large staff size. However, it thinks that the reduction in the staff size is difficult since Vodovod's operation has not fully been automated, and it still runs labor-intensive activities such as security guard.

2-2) Reduction in tangible costs
Reduction in tangible costs, namely, costs for energy, fuel, chemical, repair cost, spare parts and other supplies is possible depending on the situation. For example, if the energy cost, which constitutes 7.2% of the total operating expenditure (2006), can be reduced by 20%, it will significantly (1.5% of the total operating cost) contribute to the financial operation of Vodovod. Such reduction can be achieved by replacing pump runners or pumps themselves, or reducing the distribution pump delivery pressure during the nighttime.

2-3) Reduction in intangible costs
Reduction in intangible costs, namely, travel expenses, employee's allowances, insurance premium, taxes etc. is uncertain since such items of cost are not always directly related to the volume of Vodovod's services.

2-4) Reduction in non-material expenses such as interest paid and depreciation
Reduction in non-material expenses such as interest paid and depreciation also seems to be possible. For instance, depreciation can be reduced with an assumption that the construction cost of the new future Project facilities would be financed partly or entirely by grant funding.

2-5) Reduction in dismissal (write-off) of accounts uncollectable
Reduction in dismissal (write-off) of accounts uncollectable, although difficult, can and should be attained with strenuous efforts. The dismissal of accounts uncollectable amount to 17.9% of the water and sewer services revenue in 2006, which is considered too large.

2-6) Reduction in capital cost
Reduction in capital cost, if applicable, is effective measure to reduce the expenditure on the capital side of the operation. One way is to finance the Project with grant fund sources; another one is to obtain a soft loan.

(2) Scenarios
Financial viability of the Project is tested based on the following scenarios with various combinations of fund sources, their lending conditions, magnitude of tariff increase and different rate of capital cost recovery in terms of depreciation.

1) Factor of money source[2]

Table 7.6 Factor of Money Source

	Type	Repayment Term	Grace Period	Interest rate
EU fund: EIB	Loan	20 years	0 year	4.00 %
Japan fund: JICA	Loan	40 years	10 year	0.75 %[3]
EU fund: IPA fund	Grant	-	-	-
Government	Grant	-	-	-

[2] The terms of lending of the respective lending institutions are those which were prevailing at end 2007.
[3] As to lending by JICA, the conditions for a project on environment in a middle income country will apply.

2) Factor of fund combination
   (a) EIB fund: 90%, 50% or 0% of the total Project cost
   (b) JICA fund: 80%, 50% or 0%
   (c) IPA fund: 10% or 0%
   (d) Government fund: 100%, 10% or 0%
3) Factor of cost recovery
   (a) Operation and maintenance (O&M) costs: 100%
   - The Vodovod's present financial position is considered to be not as bad as recovery of less than 100% of O&M is required.
   (b) Capital cost (as depreciation): 100%
4) Factor of rate increase: 20%

Selected scenarios are tabulated as follows: (%)

Table 7.7 Scenarios for Financing and Financial Evaluation (%)

Scenario	EIB	JICA	IPA	Government	Tariff hike	Depreciation
1	90	0	0	10	20	100
2	50	50	0	0	20	100
3	0	80	10	10	20	100
4*	0	0	0	100	20	100

* The project is financed by JICA. Repayment will be done by government and facilities will be transferred to Vodovod.

(3) Financial Performance of the Project

The financial performance of the Project is computed based on financial benefits defined as the increment of revenue from the base year (without Project) and each year thereafter for the Project life. The same concept applies to expenses side, which includes not only the incremental operating expenses but the initial and reinvestment (for replacement of mechanical and electrical equipment) capital outlays. The results are presented according to the above financing scenarios hereunder.

Based on the demand analysis carried out separately under the Study, assumptions are made for: (1) domestic water demand to grow 1% p.a. for 2008-2015 and 0.9% p.a. for 2016-2020 and flat thereafter; (2) industrial water demand to grow 1.1% p.a. for 2008-2015 and 1% p.a. for 2016-2020 and flat thereafter. The expenditures are assumed to rise 3 to 5% p.a. for 2008 and 2009; and 2 to 3 % for 2010 to 2015 depending on the nature of the expenditure items. Depreciation of the Project assets is added to the expenditure from 2015 when the Project is expected to be operational.

(Scenario 0) Base case (without the Project); Assumption: No tariff increase made.

Prior to the evaluation of the Project, the financial performance of Vodovod without the Project is tested.

The result shows that Vodovod can make operating profits throughout the Study period of 2007-2045 except for 2005 and 2006; the cash balance is also always in surplus in the same period; and cumulative cash balance will amount to 11,000 million MKD towards the end of the Study period.

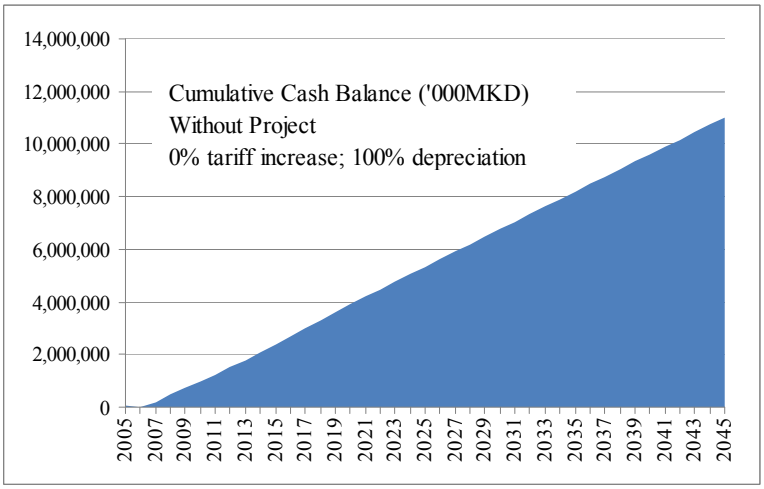


Figure 7.4 Cash Balance (Scenario 0)

The financial performance of the Project is presented according to the above financing scenarios hereunder.

Table 7.8 Scenario 1

Scenario 1				
Lending agency	EU (EIB) fund	IPA fund (grant)	JICA	Government (grant)
Funding share (%)	90	0	0	10
Interest (%) / term (yr) / grace (yr)	4.00/20/0	-	0.75/40/10	-
Condition	Tariff increase (%)		20	
	Depreciation (%)		100	

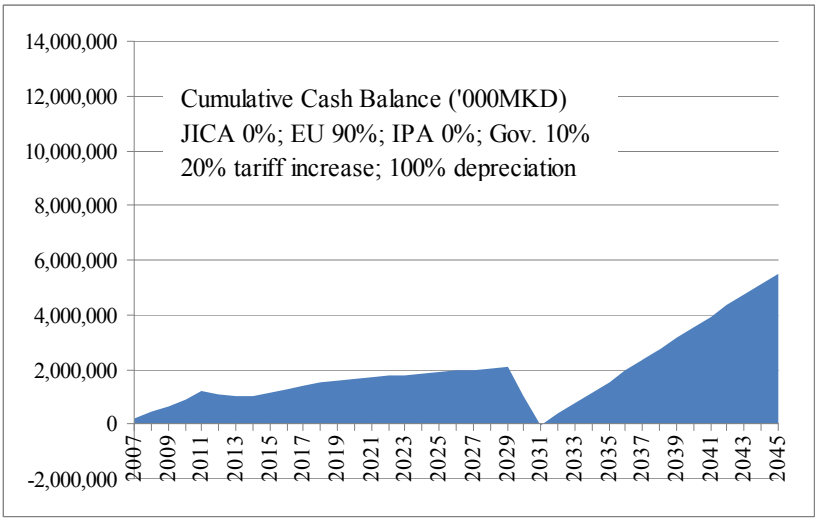


Figure 7.5 Cash Balance (Scenario 1)

Table 7.9 Scenario 2

Scenario 2				
Lending agency	EU (EIB) fund	IPA fund (grant)	JICA	Government (grant)
Funding share (%)	50	0	50	0
Interest (%) / term (yr) / grace (yr)	4.00/20/0	-	0.75/40/10	-
Condition	Tariff increase (%)		20	
	Depreciation (%)		100	

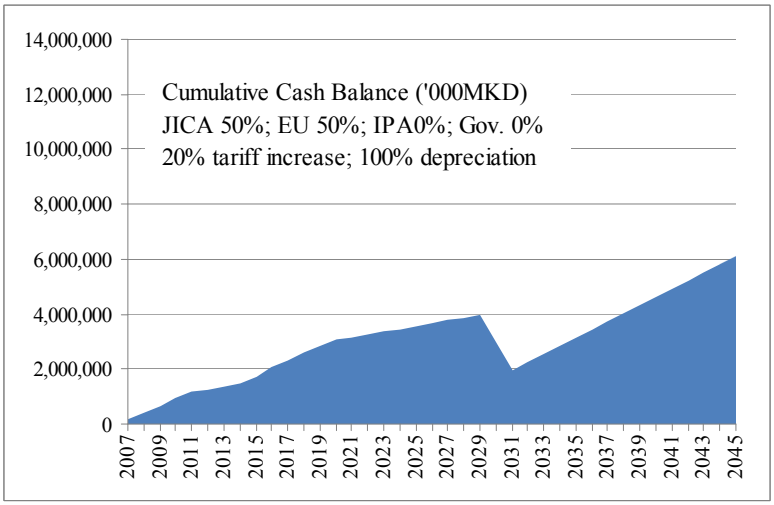


Figure 7.6 Cash Balance (Scenario 2)

Table 7.10 Scenario 3

Scenario 3				
Lending agency	EU (EIB) fund	IPA fund (grant)	JICA	Government (grant)
Funding share (%)	0	10	80	10
Interest (%) / term (yr) / grace (yr)	4.00/20/0	-	0.75/40/10	-
Condition	Tariff increase (%)		20	
	Depreciation (%)		100	

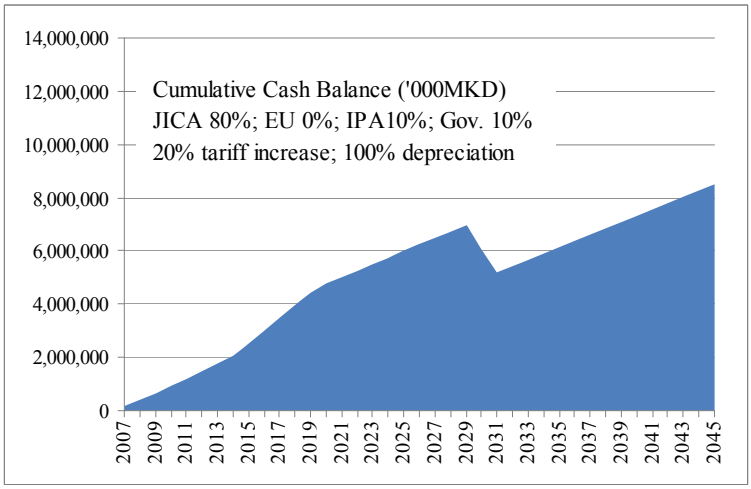


Figure 7.7 Cash Balance (Scenario 3)

Table 7.11 Scenario 4

Scenario 4				
Lending agency	EU (EIB) fund	IPA fund (grant)	JICA	Government (grant)
Funding share (%)	0	0	0	100
Interest (%) / term (yr) / grace (yr)	4.00/20/0	-	0.75/40/10	-
Condition	Tariff increase (%)		20	
	Depreciation (%)		100	

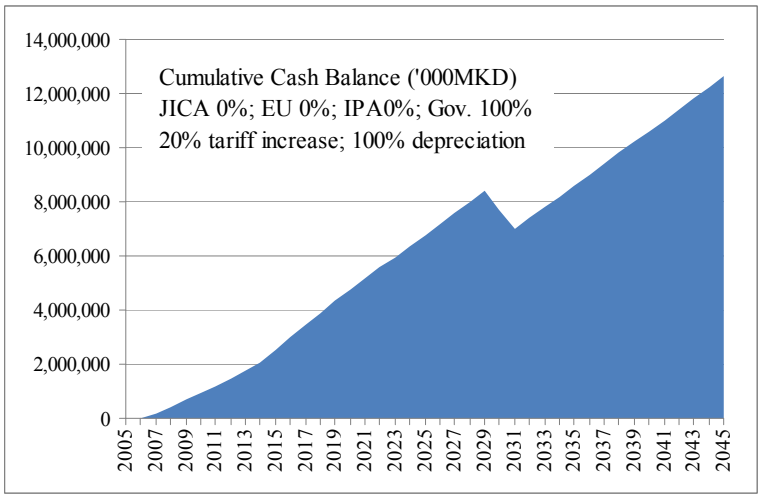


Figure 7.8 Cash Balance (Scenario 4)

The Project will be financially viable with all the scenarios of financing with a tariff increase of 20% from the present level since the cumulative net profit (retained earnings) are always positive almost towards the end of the Project life, and the cash flow will also be in surplus except for Scenario 1, which will have minor fund deficit after the time of reinvestment for the replacement of mechanical and electrical equipment to be made in 15th and 16th year after the commission of the Project. The replacement of the mechanical and electrical equipment can internally be financed, namely, without external borrowings.

A financial analysis was also made for the Scenario with a tariff increase by 15%. However, the Scenario is not feasible since the deficit on the operating side is too large.

As to the tariff level, the average income households presently consume about 17.5 m$^{3/}$month and pay 514 MKD/month of charges for water and sewer services based on the rate of 29.37MKD/m^3 (water and sewer services combined) (excluding VAT 5%), which is equivalent to 3.2% of their disposable household monthly income. If the above rate is raised 20%, the payment will become 3.8%, which is considered to be close to the generally affordable limit of 4%, but seems to be still affordable.

(4) Present Value of the loan repayments

The total present value (PV) of the loan repayments are illustrated for the discount rates of 10% and 8% respectively as follows (Figure 7.9 and Figure 7.10).

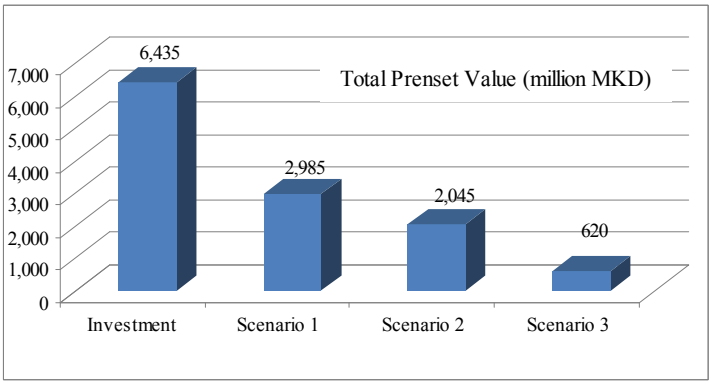


Figure 7.9 Total of Discounted Repayments at 10%

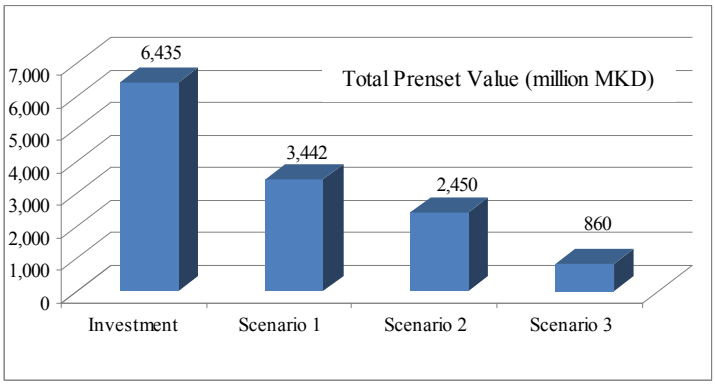


Figure 7.10 Total of Discounted Repayments at 8%

The total PV of loan repayments will be 2,985 million MKD on 90% EIB financing; 2,146 million MKD on 50% EIB and 50% JICA financing; and 752 million MKD on 80% JICA financing at the discount rate of 10%. They are 3,442 million MKD, 2,600 million MKD and 1,043 million MKD respectively at the discount rate of 8%.

7.1.7 Recommended Scenario with the proposed water supply and sewerage tariffs

The Project will have the largest financial benefits when it is financed with a JICA loan for 80% of the Project cost and grant assistance from IPA fund and/or the government for 20% of the cost, i.e., 10% from IPA fund and 10% from the government. In addition, this will result in the lowest present value of loan amortization among the all alternative scenarios.

Given the above, recommended Project funding scenario is Scenario 3 (JICA loan 80% IPA fund 10% and government grant 10% with 20% tariff increase).

7.1.8 FIRR

Cash flows were prepared for capital income (borrowings) and retained earnings for the period from the start of the Project in 2011 to the end of the Project life in 2046 as in excess of the status without the Project in 2010 on the revenue side; and another cash flow for investment and operating expenditure for the same period in the same manner as above. Depreciation is added back to the retained earnings since depreciation is reserved from the revenue, but is considered part of the Project's potential to earn profit. The financial internal rate of return (FIRR) is computed as the discount rate which makes the balance of above cash flows zero. The FIRR of the recommended Scenario is 5.2%.

Sensitivity analysis was conducted using different parameters as follows:

(1) A rise or reduction in the Project cost by ±10%
(2) Change in tariff increase (base case: +20%): 20%±2.5%
(3) Change in the method of sludge dewatering from drying bed to mechanical dewatering method

The results are summarized as follows:

Table 7.12 Sensitivity Analysis

Parameter	Change	FIRR	Sludge disposal method
Base case	-	5.2 %	Drying beds
Project cost	+10%	4.2 %	(ditto)
(ditto)	-10%	6.3 %	(ditto)
Tariff hike	20%+ 2.5%	6.1 %	(ditto)
(ditto)	20% - 2.5%	4.2 %	(ditto)
Sludge dewatering	Drying bed to Mechanical method	3.1 %	Mechanical

7.2 Economic Evaluation

7.2.1 Methodology of Economic Evaluation

(1) The Economic Rationale of the Project

A sewerage project is implemented to raise the amenity of the residents by providing healthier or more comfortable living and improve natural environment. In Skopje City at present, the sewer network is not functioning satisfactorily due to its collapsed or clogged sections. The most serious issue is the pollution of the Vardar River, an international river, since there is no wastewater treatment plant (WWTP). While Macedonia has strong intention to join the EU, Macedonia has been required to solve environmental problems, among other things, especially the treatment of wastewater. The construction of wastewater treatment facilities will make residents' lives more comfortable and healthier, improve the environment in and around the Vardar River, and eventually help Macedonia for its admission to the EU, which will bring about more lively commercial and economic activities as well.

The present Project will improve the Skopje's sewerage by providing trunk sewer and a wastewater treatment plant (WWTP). The Project will cover approximately 7,280 ha of service area with a population served of 514,000 persons in the design year of 2020. The Project will cost 7,230 million MKD (including contingencies) with the L.C. cost of 5,240 million MKD and the F.C. cost of 1,990 million MKD.

Vodovod presently collects sewer service charges as well as water supply charges. The domestic sewer service charges is 12.12 MKD/m^3, which stands for 70% of domestic water rate 17.25 MKD/m^3; and commercial sewer service charges is 19.17 MKD/m^3, which is equal to 41% of commercial water rate of 46.63 MKD/m^3. While the present project will furnish the Skopje citizens with more comfortable living environment, Vodovod needs to raise the sewer service charges due to the capital and operating costs after the commissioning of the Project. Based on the social survey conducted under the Study, the average income household use 17.5 m^3/month and pay 302 MKD for water and 214 MKD (except for 5% VAT) for sewerage services, totaling 514 MKD, which constitutes approximately 3.2% of its disposable household income of 16,000 MKD/month. Considering the maximum affordability of a family to pay the water charges to be 4 % of its disposable household income according to the WHO and other international lending agency guideline, there seems to be certain room for the average family to pay more than the above rates if the sewerage services should be improved with a new wastewater treatment facility. What is more, according to the above social survey, citizens are willing to pay substantially more for improved sewerage services.

Project proposals should be derived from, and placed in the context of, broader development objectives. In effect these objectives are explicitly stated in the national development plan and also presented through the public investment program. A statement is given in the newly revised Law on Waters on the main development objectives of a country to which a proposed project will contribute.

(2) Macroeconomic and Sectoral Considerations

The government has been involved in the development of the water and sewerage sector in that the government has been providing budget as grants for the construction of water supply and sewerage facilities, and that the Ministry of Transport and Communications presides the steering committee of the Study on the Project.

Under the Study, the framework of sector development has been outlined as follows:

- Forecast has been made of future demand: The present population served by the sewerage 447,000 will grow to 514,000 in 2020; the present domestic sewage flow of 89,500 m^3/day will increase to 102,700 m^3/day in 2020; the present industrial wastewater flow of 24,300 m^3/day will grow to 32,300 m^3/day in 2020.
- Existing sources of water supply with an output of 450,000 m^3/day is considered sufficient to

meet the foreseeable future water demand.
- The Project can meet the demand for wastewater treatment up to 2020, and the trunk sewer can meet the flow capacity up to 2030.

It is provisionally assumed that 80% of the project cost will be financed under a bilateral loan; and that 10% will be provided by government's direct investment and the remaining 10% by Skopje City or EU's grant financial assistance through the IPA-fund.

(3) Scope of Economic Analysis

For an indirectly productive project, where the output is not sold in a competitive environment, choices are made within the project between different means of achieving the same objectives. Economic analysis is therefore used to choose the means of using the least resources for a given output. Under this study, the activated sludge method was chosen after alternative methods of wastewater treatment were compared for technical and financial benefits (See Basic Plan).

(4) Project Framework

In the project framework, this project is made up of a series of means-ends relationships, namely providing collector sewers to ease the drainage of sewage from the sewer network, and the WWTP to treat wastewater. What is more, the drainage of sewage will benefit the residents with improved living environment; and the treatment of sewage contributes to the improvement in water environment of the Vardar River. The project framework is thus both an appraisal tool and a means by which the Project can be monitored for:

- Implementation efficiency --- testing the input-output linkage;
- Operational effectiveness --- testing the input-output-purpose linkage;
- Impact significance --- input-output-purpose-goal linkage.

The application of the project framework approach to project design provides analytical framework for both the economic and social analysis of the Project ensuring transparency and accountability, and promoting efficient resource use.

(5) Financial and Economic Analysis

Economic analysis of projects is similar in form to financial analysis: both appraise the profit of an investment. The financial analysis of a project estimates the profit accruing to the project-operating entity or project participants, whereas economic analysis measures the effect of the project on the national economy. An economically viable project must also be financially sustainable. Financial analysis and economic analysis are therefore two sides of the same coin and complementary. In financial analysis all expenditures incurred under the Project and revenues resulting from it are taken into account. It is therefore needed to:

- Assess the degree to which the Project will generate revenues sufficient to meet its financial obligations,
- Estimate the incentives for the producer, namely Vodovod, and
- Ensure demand forecasts on which the economic analysis is based are consistent with financial charges or available resources.

In contrast, economic analysis attempts to assess the overall impact of the Project on improving the economic welfare of the citizens of the country concerned. In other words the Project is assessed in the context of the national economy, rather than for the Project participants, i.e., Vodovod's customers, or the Project entity, namely, Vodovod. Economic analysis measures the Project's positive and negative impacts not in terms of actual payments but in terms of willingness to pay for units of increased consumption, and to accept compensation for foregone units of consumption. It is because:

- many of the Project impacts that are to be included in economic analysis be nonmarketed, for

example, biodiversity preservation, or incompletely marketed such as water supply and sanitation benefits.

- many Project impacts that are marketed will be bought and sold in markets where prices are distorted if various government interventions, or imperfect competition exist.

Shadow prices may be used in estimating the willingness to pay and willingness to accept compensation values in the face of these absences and market imperfection. Although Macedonia is broadly known for its apparent shadow economy, there has been no survey on the shadow rates.

The costs of the Project are represented by the consumption elsewhere in the society sacrificed for diverting the resources for the Project from other uses. Economic net benefits from the Project will reflect the summation of changes in the income of the society as a whole resulting from the situation with and without the Project.

7.2.2 Economic Costs

(1) Identification and Quantification of Costs and Benefits

The balance between the expenses of the operation with addition of the Project facilities and those without the Project shall be the economic cost with the downward adjustment to the cost of unskilled labor and upward adjustment to the power cost, which is regulated by the government. Wastewater flow will increase because of the Project (together with service ratio increase), so, as a result, the water consumption will also increase. The operating expenses, which increase due to the increase in water demand, shall be accounted in the economic analysis.

Some benefits of the Project cannot be quantified, for example, economic value of joining the EU which the Project would indirectly enables Macedonia to realize as a result of the improved water environment of the Vardar River; or increase in tourism attraction because of esthetical improvements in the Vardar River basin.

Project benefits shall also include certain amounts of consumer surplus. The savings to existing consumers, because of the difference between what they are willing to pay and what they will now have to pay for disposal of wastewater, are not reflected in the financial effects. In Skopje some consumers treat their wastewater before discharging it out to the sewer or the river. The cost of such treatment may be higher than the sewerage rate to be charged after the commissioning of the Project. Such difference is considered consumer surplus.

When considering projects costs for economic analysis, some types of financial cost must be excluded. Project costs comprise the difference in costs between with and without project situation, that is, the extra use of resources necessary to achieve the corresponding benefits.

a) System Costs

The present Project is part of a large sewerage system of Skopje. The WWTP, which is the major component of the Project, can effectively work if other components work satisfactorily. If the total system is viable, the Project can also be viable. Therefore, the cost of the other parts of the system in terms of the present value must be incorporated in the economic analysis.

b) Sunk Cost

The sunk cost such as the investment for a WWTP, if any which was constructed but abandoned, should not be included in the Project cost.

c) Transfer Payments

Some of the items included in the financial costs of a project are not economic costs. These costs, however, affect the distribution of financial costs and benefits between the project entity and other entities, and among project beneficiaries.

They are thus referred to as transfer payments as they only transfer certain resources from one

party to another without reducing or increasing the amount of resources available. Vodovod pays tax on its operating profits, which is considered a transfer payment so must be excluded from the Project costs.

d) Depreciation

Depreciation is practiced on a project account, which is necessary for the future replacement of the project facilities or repayment of the loan for the project. The reinvestment on the project will contribute the performance of the project, but depreciation is not directly related to the viability of the project. Therefore, depreciation must be excluded from the Project costs.

e) External Costs

Some external effects, namely, negative externalities, may include significant costs that must be accounted for in an economic analysis from the national perspective. As a result of the Project, however, no significant negative externalities are expected to arise.

(2) Valuation of Economic Costs and Benefits

Costs and benefits need to be valued at economic prices that their value from the national economic perspective. If some cost and benefit components are distorted from the national economic point of view, such distortion should be corrected at their valuation. The prices in Macedonia are considered to be fairly reflecting real opportunity value of goods and services in the country with a few exceptions.

Costs and benefits must be valued in constant prices in terms of price level prevailing in the year of project appraisal. Any expected changes in general price level can be ignored. The general prices in Macedonia appear to moderately rise. Such changes appearing in the cost streams for the economic analysis under the Project should be eliminated.

In an economic analysis, market prices are to be adjusted to account for the effects of government intervention and market structure, which result in shadow price. Where project output is incremental like this Project, since the Project provides additional output, namely, wastewater treatment, the shadow price is based on the demand price for that output on the market price inclusive of any consumption tax and exclusive of any subsidy falling on the consumer.

The use of world prices is considered inappropriate since sewerage services, that are the output of the Project, are not tradable.

(3) Conversion Factors

There are no reported surveys of price levels of labor and commodities in Macedonia compared with those in the international market. Thus it is difficult to estimate the standard conversion factor. However, using limited survey of commodities and labor closely related to the Project, their opportunity costs were studied.

Construction of the Project will be contracted under international competitive bidding. Therefore the prices of major components of commodities are considered to be set at world prices. However, the unskilled labor component, which will be purchased from the domestic market where the unemployment rate is as high as 33%, is assumed to have a shadow rate of 1.33, namely, a conversion factor of 0.75. The conversion factors for each element of the operating cost of the Project vary by its category. The conversion factor for the skilled labor, which consists about 60% of the total labor cost (24% of the total operating cost), is assumed to be 1.0 based on its competitiveness. That for the unskilled labor, which constitutes about 40% of the total labor cost (16 % of the total operating cost), is considered to be 0.8. The energy cost, which is controlled by the government, appears to have a conversion factor larger than 1.0, say 1.2. Imported goods such as computers and pumps have a conversion factor of 1.0 since they are purchased at the world price. Other supplies consumed in operation are bought from the competitive domestic market, so their conversion factor is 1.0. The cost items and their conversion factors are tabulated in Table 7.13.

Table 7.13 Conversion Factors from Breakdown of Operating Cost for the Project

Item	Proportion (%)	Conversion Factor
Skilled labor	24	1.0
Unskilled labor	16	0.8
Energy cost	20	1.2
Materials and supplies	25	1.0
Other costs	10	1.0
Net taxes	5	0.0
Total	100	0.942

The conversion factor of unskilled labor for construction work is set at 0.75.

7.2.3 Economic Benefits

(1) General

Financial revenues of the Project basically form economic benefits after adjustments for transfer payments, such as taxes and interest received. Although depreciation is necessary for future reinvestments and the repayment of loans, transaction is made for depreciation as cost. However, it is part of Project's ability to earn revenue, so it must be added back to the benefit stream for economic evaluation of the Project.

(2) Consumer's surplus

Citizens who live in areas outside of the service area of the sewerage system will connect their domestic drainage to the sewer network some time prior to the commencement of the Project or thereafter. Although they will pay the sewerage service charges after such connection, the charges may be lower than the annual cost of their septic tank for disposal of domestic sewage. Such difference in cost is regarded as consumer's surplus, and it shall be incorporated in the economic analysis. The annual amount of such consumer's surplus is estimated at 5,450 MKD/household (See Appendix 7.1). This benefit will accrue when the household has been newly connected to the sewer network. Some 20% of households in Skopje do not at present receive sewerage services. All of them are expected to progressively have connection to the sewer network starting from the commencement of the Project within 10 years. The above consumer's surplus will continue for ten years from the year when the connection is made. To make computation simple, it can roughly be assumed that all the connections are made at the end of the 5^{th} year, and all the households can receive the above benefit from the 6^{th} year to 15^{th} year since the initial connection fee will be repaid in 10-year installments.

In the next section, the economic internal rate of return (EIRR) is computed using the above tangible benefits and the consumer's surplus which is intangible but quantifiable. The resulting EIRR is considered moderately high. However, the EIRR can be significantly higher if other potential benefits be accounted for.

Other items of potential economic benefits are reviewed as follows:

(i) Reduction in drinking water treatment cost due to improvement in water source quality
The source of Skopje's water supply is springs on a hillside located upstream of the Vardar River. The improvement in the quality of river water does not affect the quality of the spring water.

(ii) Increase in the productivity of agriculture and fishery
The agricultural activity, which affects the productivity of agriculture, is irrigation. There is no irrigation head-works in the vicinity downstream of the proposed WWTP. Although there is a weir which appears to be an intake weir, it looks very old and devastated; it seem to have been abandoned for a long time. Even though the water can be used for irrigation, its quality does not appear to so bad for irrigation use. When it comes to the productivity of irrigation water, there is

possibility for the water to be more productive when it contains certain amount of sewage (contents of turbidity (SS), N, P etc.). The irrigation by primary-treated sewage is rather common in such countries as India and Pakistan. In the Skopje area the precipitation is rather evenly distributed throughout the year. Therefore, vegetable farmers in Skopje do not feel much need for artificial irrigation. When irrigation is needed, they use groundwater rather than river water.

Fishery does not seem to be a productive activity on the Vardar River since neither fishing boats nor fishermen drawing fishing nets are not seen on the Vardar River. The influence of the Project to fishery, if any, can be ignored.

(iii) Avoidance of damage caused by stagnation of inland water
There have been localized cases of inundation in Skopje at the times of record rainfall. However, such inundation occurs not at every occasion of rainfall of high intensity. To actually calculate the amount of damage, such items of huge volume of information and their cause-and-effect functions should be available as not only the return period of heavy rainfall but also estimated area(s) of inundation, its magnitude, cases of human injuries and the amounts of their damage (death, injury and diseases) in terms of payments of insurance money, medical treatment costs etc., estimates of assets affected (land, houses and buildings, household effects, liquid asset documents, etc.), estimates of the magnitude of their damage, estimates of damages on infrastructures (roads, bridges, power supply, transportation, telecommunications, internet circuits etc.), loss of production due to halted traffic caused by flooded roads, and so forth. Quantification of benefits to be derived from avoidance of such damages can not be made since no such reliable information is available in Macedonia.

(iv) Alleviation of diseases and damage to health (decline in mortality, reduction in the cost of medical care, and avoidance of labor absentees)
The effect of the WWTP on reduction in the morbidity rate seems to be negligible. Almost all the households in Skopje even outside of the sewer service area have flush toilets. Those which have no connection to sewer are equipped with a septic tank and flush toilet. There will be no change in the style of toilets before and after the completion of the Project. In other word, the condition of household sanitation will remain unchanged.

It is possible that the chance of infection when swimming and bathing can be reduced due to the improvement in river water quality. However, no one is seen bathing even upstream of the Vardar River where the water is not polluted by outfall of wastewater. All those who wish to swim use swimming pools. Therefore, decline in mortality, reduction in the cost of medical care, and avoidance of labor absentees are not counted as economic benefits in this case.

(v) Saving in resources (reuse of treated wastewater)
As noted above, farmers are not much feeling the need for irrigation. When they should need to draw water, they will intake directly from the river, not from the WWTP. The cost of transmitting treated wastewater from the WWTP will be much higher than the direct intake from the river. The use of the treated wastewater for industries appears to be impracticable.

(vi) Effect of reduction in substances which cause pollution of resources
The resource which is polluted by wastewater is river water. Reference is made to Chapter 3 of this report on the magnitude of reduction by the WWTP in the pollutants such as turbidity (SS), N, P and so forth. The entity which can benefit from the reduction in such pollutants is water supply. Nonetheless, there is no major water supplies downstream of the WWTP of which source is the Vardar River.

(vii) The effect on the promotion of tourism and recreation industries
It appears that tourists visiting Macedonia are increasing recently. However, their destination is not Skopje but rather Ohrid, which has been registered as World heritage with the UNESCO. The effect of the Project seems to be negligible on the promotion of tourism and recreation industries

by the improvement in the Vardar River water quality.

(viii)Promotion of local industries

There will be temporary promotion effect of the Project on local industries such as the employment of laborers, and procurement of raw material (sand, gravel, wood etc.). Such costs (and benefits) have been incorporated in the cost estimates of the Project.

All the above potential economic benefits are not currently quantifiable due to lack of practical data or dearth of cost functions for such potential benefits. However, the magnitude of the EIRR will get considerably larger once such data and const functions become available in future.

7.2.4 EIRR

For finding the economic internal rate of return (EIRR), two cash flows are prepared, namely, (1) benefit cash flow; and (2) cost cash flow. Under the financial set-up of the Project, the benefit cash flow is defined as the incremental revenue throughout the Project life compared with the revenue in the base year (2010). The revenue is expected to grow depending on the increase in water demand and wastewater flow. In addition, the consumer's benefits shall be added to the benefit stream.

On the other hand, the incremental cost cash flow is found as the difference between the expenditure in each year and that in the base year. Furthermore, the initial investments and reinvestment for the replacement of mechanical and electrical equipment are added to the cost cash flow. It is assumed that the initial investment is made for 6 years from 2011, i.e., the first two years for Project design work and procurement with 5% each of the Project cost, and another four years for construction with 20%, 25%, 25% and 20% of the Project cost in the respective year. The EIRR is defined as the discount rate which makes the balance of the net present values of the benefit cash flow and the cost cash flow zero.

The incremental revenue and cost are computed using part of the income statement as in Table 7.14.

Table 7.14 Forecast Income Statement for EIRR Computation (Portion)

PE Income Statements 06-46 ('000) - Economic — Rate hike % <u>20</u> (Scenario-3: JICA80%; IPA10%; EU0%; Gov.10%; +20% Tariff; 100% Dpr.)
Depreciation accounted % 100

No	Description	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	Water demand 1000 m3/yr	39,419	39928	40444	40968	41499	42038	42585	43140	43673	44079	44489
	Av. Water rate MKD/m3	32.11	32.03	31.96	31.88	31.80	31.72	31.64	31.56	37.77	37.78	37.79
1	Total revenue	**1,219,396**	1,313,432	1,327,165	1,341,043	1,355,066	1,369,237	1,383,556	1,398,025	1,686,562	1,702,193	1,717,973
1.1	Revenue from selling services 1)	1,265,804	1,279,054	1,292,444	1,305,975	1,319,647	1,333,463	1,347,425	1,361,533	1,649,705	1,665,336	1,681,116
1.2	Revenue from financing - interest											
1.3	Other income 3)	34,037	34,377	34,721	35,068	35,419	35,773	36,131	36,492	36,857	36,857	36,857
2	Total expenses	**1,064,719**	1,035,053	1,077,616	1,078,453	1,079,062	1,079,718	1,080,425	1,081,189	1,237,211	1,256,377	1,504,310
2.1	Total material expenses 4)	115,406	121,176	127,235	131,052	134,983	139,033	143,204	147,500	197,803	224,488	251,234
2.2	Depreciation 5)	168,485	173,540	178,746	182,321	185,967	189,686	193,480	197,350	201,297	205,323	426,452
2.3	Non-material expenses 6)	93,771	98,459	103,382	106,484	109,678	112,969	116,358	119,848	157,760	160,205	174,537
2.4	Gross payment of salaries 7)	325,580	358,138	393,952	393,952	393,952	393,952	393,952	393,952	433,347	433,347	433,347
2.5	Procured value of goods 8)	26,145	26,929	27,737	28,569	29,141	29,724	30,318	30,924	31,543	32,174	32,817
2.6	Dismissal of uncollectible receivable accounts (non-paid bills) 9)	334,332	255,811	245,564	235,075	224,340	213,354	202,114	190,615	214,462	199,840	184,923
2.7	Expenses from interest rates	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
3.2	Gross income	154,677	278,379	249,549	262,590	276,005	289,519	303,130	316,836	449,350	445,816	213,663
4	Taxes	43,857	91,791	89,577	91,558	93,583	95,625	97,684	99,760	127,420	127,848	105,422
3.2	Income after tax (Retained earnings)	**110,820**	**186,588**	**159,972**	**171,032**	**182,422**	**193,894**	**205,446**	**217,076**	**321,930**	**317,967**	**108,241**
Tax	VAT (%)	5	Income Tax	10								

Project assets(Eu/MKD):'000			5,455,496		Deprciat.
Civil works	56%	3055077.5	Depr. Rate	0.02	61102
Mech/elec.	44%	2400418.04	Depr. Rate	0.06666667	160028
Total depre. p.a.					221129
Composite depreciation rate:				0.03726667	
Reinvestment-Elec/Mec (MKD'000)		2,208,235			147,216
New depreciation=168000+71783+176142					405,667
Inc cost'13	3,086				1.1

1)-1 See Sheet "Revenue"
2) 1% increase/yr from 2008 to 2015, flat thereafter
3) +1% each in '08 - '15, flat thereafter
4)-1 Conversion factors applied (See Sheet "Convert")
4)-2 5% increase for '08-'09; 3% increase from '10-'14, +2% in '14-'20 See below:
4)-3 In addition, O&M cost of the Project is added from 2015 onward
5)-1 +3% each in '08-'09; 2% for '10-'14; +depreciation on new assets in '15 onward
5)-2 Depreciation on reinvestment from 2032 for 15-year life, but not affecting cash balance
6)-1 5% increase in '08; 3% increase in '09-'14; 2% increase in '15-'20, See below:
6)-2 In addition, 50% of O&M cost under the Project in 2015, 2016 and 2017, flat onward
7)-1 +10% in '08-'09, another +10% in '15 and '20
8) +3% for '08-'10, +2% for '11-'20
9) 20% of Water sales revenue for '08, decreasing by 1% for each of '09-'16, 10% thereafter

The EIRR is computed using the incremental benefits (= incremental revenue – incremental operating expenses), the consumer's benefit and initial investments and reinvestments as follows (Portion):

Table 7.15 Computation of EIRR

ECONOMIC INTERNAL RATE OF RETURN CALCULATIONS ('000 MKD)

No.		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Calculation of Net Incremental Revenue										
1	Incremental Revenue	17,670	35,559	53,672	72,011	364,495	384,152	621,061	636,991	653,073	669,307
2	Consumer's surplus	0	0	0	0	0	31,962	31,962	31,962	31,962	31,962
3	Incremental Operating Cost [a)]	-3,038	-6,101	-9,187	-12,293	139,782	154,922	181,726	172,838	180,904	232,448
4	Net Incremental Benefits	20,708	41,661	62,859	84,304	224,713	261,192	471,297	496,115	504,131	468,821
5	Project Investment	258,564	258,564	1,034,254	1,292,818	1,292,818	1,034,254	0	0	0	0
6	Balance	-237,856	-216,903	-971,395	-1,208,513	-1,068,105	-773,062	471,297	496,115	504,131	468,821
7	EIRR	6.21%									
	Revenue from sales 2010	1,488,295	(Depreciation added)		(Depreciation added)						
	Other income 2010	35,068									
	Revenue from sales 2011-46	1,319,647	1,333,463	1,347,425	1,361,533	1,649,705	1,665,336	1,681,116	1,697,046	1,713,127	1,729,361
	Depreciation added back	185,967	189,686	193,480	197,350	201,297	205,323	426,452	426,452	426,452	426,452
	Other income 2011-46	35,419	35,773	36,131	36,492	36,857	36,857	36,857	36,857	36,857	36,857
	Total revenue 2011-46	1,541,033	1,558,923	1,577,036	1,595,375	1,887,859	1,907,516	2,144,425	2,160,355	2,176,436	2,192,671
'1	Total incremental revenue	17,670	35,559	53,672	72,011	364,495	384,152	621,061	636,991	653,073	669,307
	Total expenses 2010	896,132	(Depreciation deducted)								
	Interest paid 2010	1,000									
	Expenses from operation '11-46	893,094	890,031	886,945	883,839	1,035,915	1,051,055	1,077,858	1,068,971	1,077,036	1,128,580
	Interest paid '11-46	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
'2	Total Incremental op. expenses	-3,038	-6,101	-9,187	-12,293	139,782	154,922	181,726	172,838	180,904	232,448

The EIRR is computed at 6.2%. This figure is considered moderate, which may rise if implicit economic benefits such as more productive labor due to healthier living environment can be quantified although such quantification was not attempted because of lack of information. However, sensitivity analysis was conducted using different parameters as follows:

(1) A rise or reduction in the Project cost by ±10%
(2) Change in tariff increase (base case: +20%): 20%±2.5%
(3) Change in the method of sludge disposal: from drying beds to mechanical dewatering

The results are summarized as follows:

Table 7.16 Sensitivity Analysis

Parameter	Change	EIRR	Sludge disposal method
Base case	-	6.2%	Drying beds
Project cost	+10%	5.3%	(ditto)
(ditto)	-10%	7.3%	(ditto)
Tariff hike	20%+ 2.5%	7.1%	(ditto)
(ditto)	20% - 2.5%	5.3%	(ditto)
Sludge dewatering	Drying bed to Mechanical method	4.3%	Mechanical

7.3 Evaluation of Environmental and Social Considerations

The implementation of the project will have the large positive impacts especially on water quality of the Vardar River and groundwater, in the other hands, the negative impacts are also expected. The impacts on society and environment caused by construction and operation of the proposed projects (WWTP and trunk sewers) are assessed in the EIA Study and the results are summarized below.

(1) Impacts during Construction Phase

The large and medium negative impacts during construction phase are expected on:

- Topography and geology: land slides and slips during construction due to the poor geo-mechanical features of the sites; presence of sand and gravel and due to ground water level of 4 m below the ground level,
- Water quality of the Vardar River and groundwater: surface runoff by rainwater and soil erosion during excavation, leakages and spills of fuels and oils,
- Hydrology of the Vardar River: different river diversion structures and tail dams for the construction of siphon,
- Protected Area/Biodiversity/Flora and Fauna: due to increase of human approach, traffic movements, noise and vibration,
- Air quality/Noise and Vibration: due to the increased vehicles for transportation of the materials, operation of machineries and equipment in the construction sites,
- Involuntary resettlement/land acquisition/land use: due to the expropriation of land for WWTP and trunk sewers,
- Public infrastructure and services: due to the increased vehicle movements, re-direction of the traffic,
- Waste: due to the excavation and preparation of the sites.

(2) Impacts during Operational Phase

The large and medium negative impacts during operational phase are expected on:

- Water quality of the Vardar River and groundwater: due to the leakages of the system, infiltration of drying beds and temporary sludge storage leachete,
- Protected Area/Biodiversity/Flora and Fauna: due to the human approach and increased noise/vibration,
- Water: due to the generation of the large quantities of sludge,
- Offensive odour: due to the operation of the WWTP and sludge treatment.

In total, the identified negative impacts during construction and operational phase can be mitigated, minimized and prevented if the proposed mitigation measures are appropriately taken during the construction and operation. Also the monitoring system proposed will confirm and ensure that the environmental impacts are minimized and the benefits are maximized through good practice.

7.4 Evaluation of Technical Feasibility

Vodovod has long history of laying large length of sewer pipes and constructing siphons. Therefore, Vodovod will have no difficulty in constructing the trunk sewers and siphon. On the other hand, the wastewater treatment plant is new to Vodovod. Recently, many wastewater treatment plants have been constructed in Macedonia. The Study Team had chances to observe the three wastewater treatment plants. For Ohrid and Struga cities with about 20 year operation, the staff members have managed to operate their plants against a relatively overloaded inflow. The Kumanovo wastewater treatment plant inaugurated its plant in the early 2008. With a small number of staff, it seems to have operated sufficiently judging from the three times visits and its daily water quality data.

The two plants are of oxidation ditch process. It has long detention time and relatively free from flow and quality variation. The project recommends an activated sludge process which has short detention time, requiring more careful attention than an oxidation ditch process. However, the Vodovod can manage the plant operation if adequate training is provided. Vodovod has long technical history of more than 100 years and capable staff members of more than 1,000. During the study, some capacity development programs were conducted and short lectures were provided in Japan. This is a first step. In order to enhance the staff members' capability, the Study recommends more detailed training similar to Kumanovo case which provided 1 year training to its staff members.

As a sludge treatment, the study recommends sludge drying bed after confirmation of no odor impact in the surrounding area. This is thanks to relatively large area designated in the edge of the city by the GUP, resulting in large savings in cost.

As a whole, the technical feasibility is confirmed.

7.5 Project Effect Indicator

The Project is likely to be financed by loans either entirely or partially. Lending agencies usually need to assess the Project after its lending. The Project is not intending to increase service ratio, service population etc. but to improve the water quality of the Vardar River. Therefore, most appropriate project effect indicators are as follows:

Table 7.17 Project Effect Indicator

Proposed Indicator	Current Level	Target Level
・ Treated Wastewater Amount (m^3/day)	・ 0	・ 166,000
・ Treated Wastewater Quality (BOD) against Designed Wastewater Quality (mg/l)	-	・ BOD 25 mg/l
・ Water Quality (BOD) at Taor of the Vardar River (mg/l)	・ BOD Exceeding 7 mg/l	・ BOD 7 mg/l

7.6 Overall Evaluation and Recommendations

The project is of great value towards improving water quality in the Vardar River even though some negative impacts as well as necessity of additional measures as follow will occur:

- ✓ Water and sewerage rate hike
- ✓ Impact on flora and fauna
- ✓ Impact on sludge generation
- ✓ Impact on odour generation
- ✓ Upgrade of technical skills for operation and maintenance of the treatment plant

✓ Control on industrial wastewater effluent

However, as mentioned in the Report, these issues can be solved/ mitigated with appropriate measures which are recommended in the study. They are public relations, mitigation measures, monitoring plans, capacity development and so on.

City of Skopje is a major actor of Macedonian economic and industrial activities with the population of around 520,000. Its activities are accompanied by a lot of domestic and industrial wastewaters. Some 80% of the central area of the city is assumed to be sewered. At present, collected sewage, however, is mostly discharged to the river or channels untreated except for a small part of Saraj. The Vardar River, the largest river in Macedonia as well as an international river, passes through the city. The water qualities monitored at After Ohis and Trubarevo Bridge located in the downstream of the river sometimes do not comply with the standard, which is to deteriorate environmental and public sanitary conditions at the downstream. Further development of the city will surely increase domestic and industrial wastewaters in the future.

If the project is undertaken, the water qualities of the Vardar River as well as the living and water environment of the city will be remarkably improved.

Macedonia, on the other hand, has progressed the implementation of environment related laws and regulations in compliance with EU directives in order to be one of EU member countries. With the revision of Law on Waters, all the environmental related laws are now in conformity with the EU related laws. The next steps are provision of many by-laws and actual implementation of the measures like the sewerage projects. Industrial hazardous waste disposal site is also planned as one of the next steps. It is planned after the study (Donor is being requested), it will be completed by the year 2015. The Study Team emphasizes that it should be completed as scheduled. Otherwise, treated wastewater and treated sludge cannot be utilized. In that sense, IPPC system is also recommended to implement as scheduled: full implementation by the year 2014.

The project is estimated to complete in around 2015. So, with all measures, wastewater will be treated safely and treated by-products would be utilized.

However, when a wastewater treatment plant is constructed, attention should be paid to the following industrial wastewater issues because of its large effect on the water quality in the Vardar River:

- IPPC system implementation
- Hazardous waste disposal plant construction
- Pre-treatment industrial effluent standard discharging to the sewerage system
- Authority to grant to Vodovod for monitoring and correcting