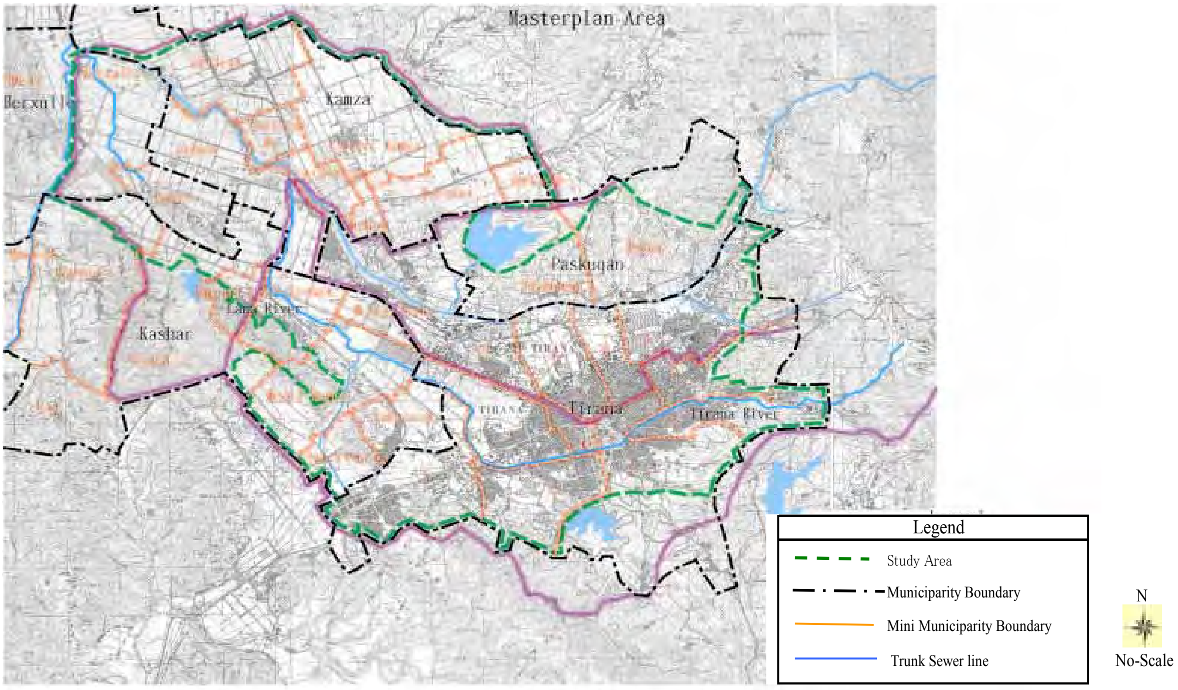


Figure S1.5.1 Planning Area

Table S1.5.1 Present Registered Population and Projected Population

Area	Population in 2001[1)]	Present population in 2005[1)]	Projected Populations in 2022			**Planning population in 2022**		Remarks
			Trend Analysis	Population Density	Develop -ment Plan	Within Territory	**Within Planning Area**	
Tirana	478,424	581,414	1,025,000	724,400		724,400	**700,000**	Density method
Kamza	49,068	75,858	180,000	130,000		150,000	**150,000**	Average figure
Kashar	16,810	18,228	25,670		25,000	50,670	**50,000**	Trend+ Development[2)]
Paskuqan	27,566	34,329	89,800			89,800	**84,000**	Trend figure
Berxulle	6,693	8,439	16,500			16,500	**16,000**	Trend figure
Total	578,561	718,268				1,031,370	**1,000,000**	

Source: 1) Data from "Bulletin Statistikor 2004", INSTAT.
2) Population at residential area of 52ha = 15,000, and around area =10,000.

(3) Sewage unit flow:

Based on the review on the existing water supply plans mentioned above, the current unit water consumption/demand for domestic, commercial, institutional and business users ranges between 150 to 180 L/capita/day in Greater Tirana. The future water consumption/demand will reach 200 to 230 L/capita/day during the target year.

Considering the existing water supply plans, it is assumed that almost all water used will be collected by sewerage facilities and treated at the sewage treatment plant, therefore, the unit sewage generation for domestic, commercial, institutional and business is 150 L/capita/day presently (2005) and will be 200 L/capita/day during the target year of 2022 as shown in *Table S1.5.2*. For planning purposes, the unit sewage generation of 200 lpcd in 2022 could be divided into 150 lpcd for domestic sewage and 50 lpcd for sewage from commercial, institutional and business activities, taken into account of the domestic water demand is 150 lpcd.

Table S1.5.2 Unit Sewage Generation (Unit: L/capita/day)

2005 (Present)	2014	2018	2022
150	176	188	200

It should be noted that the sewage generation excludes industrial wastewater generated from large factories and factories located in industrial estates.

Three types of unit design flow have been set for the target year of 2022. These design flows are based on the unit sewage generation of 200 L/capita/day, 50 L/capita/day of inflow/infiltration water, and flow variation factors.

These three unit design flows are listed below:

Unit Average Daily Flow = 200 + 50 = 250 L/cap./day

Unit Maximum Daily Flow = 200 × 1.3 +50= 310 L/cap./day

Unit Maximum Hourly Flow = 200 × 1.3 × 1.5 +50= 440 L/cap./day

(4) Design Flows

Table S1.5.3 the design flows, and presents the population size and unit design flows that were used to calculate the design flows.

Table S1.5.3 Design Flows in 2022

Municipality/ Commune	Population	Design Daily flow (m^3/d)		Peak flow(m^3/d) (Max. hourly flow)
		Average	Maximum	
Tirana	700,000	175,000	217,000	308,000
Kamza	150,000	37,500	46,500	66,000
Kashar	50,000	12,500	15,500	22,000
Paskuqan	84,000	21,000	26,040	36,960
Beruxlle	16,000	4,000	4,960	7,040
Total	1,000,000	250,000	310,000	440,000

The design average daily flow is used to estimate pollutant loads, treatment effects, and O&M cost. The design maximum daily flow rate is used to design the treatment facilities. The treatment capacity of the STP is expressed as the design maximum daily flow rate. The design maximum hourly flow or peak flow is used to design the sewers and pumping stations.

(5) Design sewage quality

Based on a discussion on a unit pollution load in terms of BOD_5 and SS, considering the way of living in the Tirana area, the design figure in the Albanian Law (No.9115), recommended values for design of sewerage for developing countries, and those of UK and USA's, the unit pollution load of sewage is assumed to be 40 g/(capita day) at present and 50 g/(capita day) at the target year as shown in *Table S1.5.4.*

Table S1.5.4 Unit Pollution Loads

Item	2005 (Present)	2014	2018	2022
Pollution Loads per Capita (g/(capita day))	40	45	48	50

Because the unit design average daily flow is 250 L/capita/day at the target year, the design quality for influent sewage (classified in terms of BOD_5 and SS concentrations) are 200 (=50×1,000/250) mg/L.

The following treated sewage concentrations have been set based on the EU Directives:

- 25 mg/L in BOD_5; and
- 35mg/L in SS as the target treated sewage.

The BOD_5 and SS concentrations in the primary and secondary effluent are shown in *Table S1.5.5*. These concentrations were set with consideration of the treatment efficiency in the primary and secondary treatment facilities. The figures of the secondary effluent quality meet the effluent quality standards stipulated in EU Directives.

Table S1.5.5 Design Sewage Quality in STP

Parameter	Treatment efficiency (%)			Quality (mg/L)		
	Primary Treatment	Secondary Treatment	Overall	Raw Sewage	Primary Effluent	Secondary Effluent
BOD_5	30	83	88	200	140	24
SS	40	75	85	200	120	30

(6) Collection Area

The sewerage planning areas are divided into sub-service areas. Each sub-service area will be covered by a separate trunk sewer. The resulting sub-service areas called "Collection Areas" are shown in *Figure S1.5.2.* The design figures, population and sewage flows for each service area are summarized in *Table S1.5.6.*

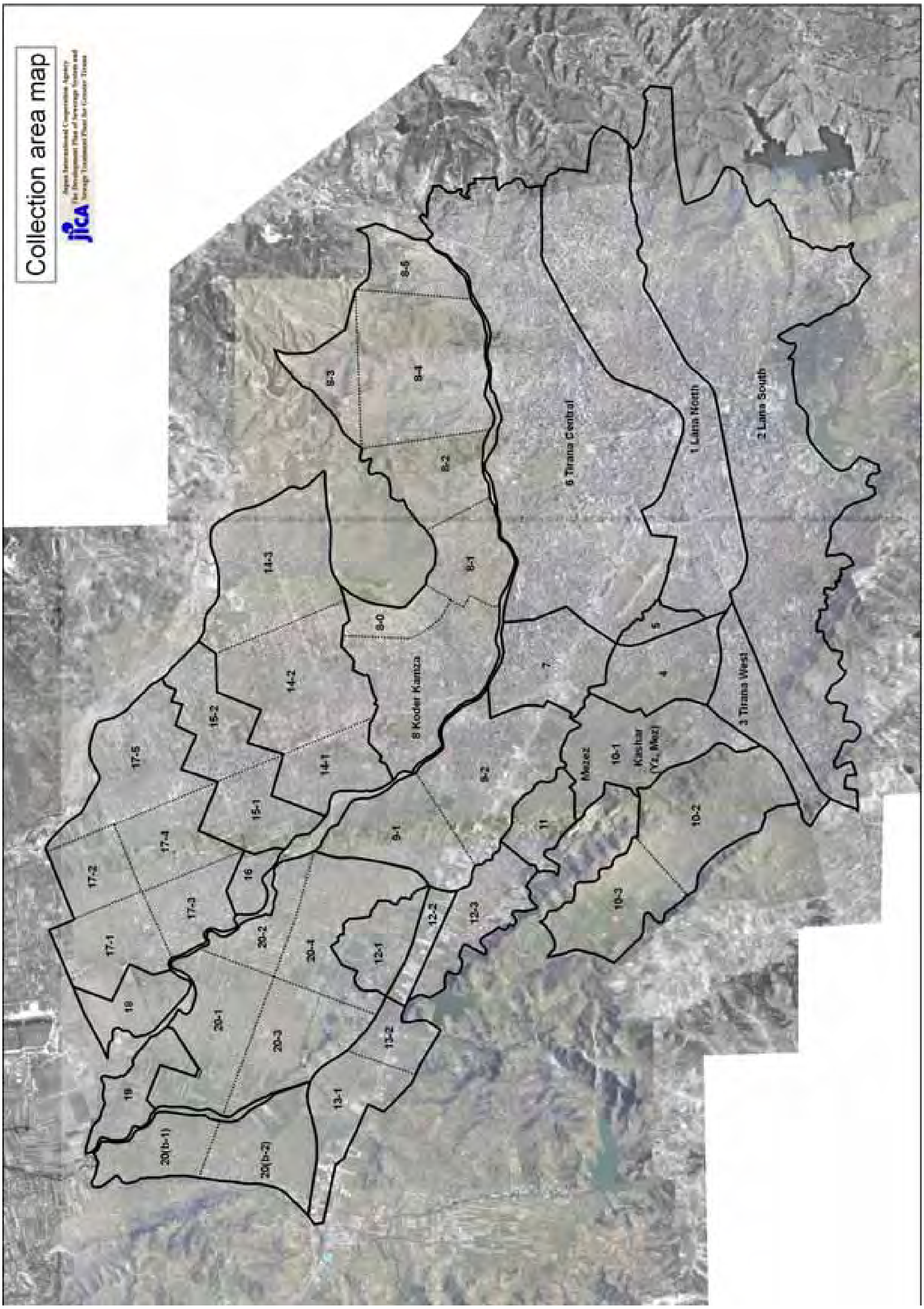


Figure S1.5.2   Collection Area

Table S1.5.6 Planning Bases of Sub-service Area, "Collection Area"

Municipality	Connection Point	area (ha)	2005 Population	2022 Population	Daily average (m3/d)	Daily maximum (m3/d)	Hourly muximum (m3/d)
Tirana	No.1	306.0	72,660	82,262	20,566	25,501	36,195
	No.2	1770.4	211,218	257,654	64,413	79,873	113,368
	No.3	51.9	0	5,192	1,298	1,610	2,284
Kashar	No.4	143.5	1,672	2,293	573	711	1,009
Tirana	No.5	33.3	11,694	11,694	2,924	3,625	5,145
	No.6	1420.7	233,705	302,558	75,640	93,793	133,126
	No.7	169.0	9,386	11,306	2,827	3,505	4,975
Paskuqan	8-0	60.6	2,963	6,043	1,511	1,873	2,659
	8-1	123.5	7,549	12,315	3,079	3,818	5,419
	8-2	146.7	8,967	14,628	3,657	4,535	6,436
	8-3	91.8	5,258	9,154	2,288	2,838	4,028
	8-4	309.0	16,370	30,812	7,703	9,552	13,557
	8-5	110.8	4,515	11,048	2,762	3,425	4,861
	Sub-total	842.4	45,623	84,000	21,000	26,041	36,960
	8KoderKamza	259.6	14,418	17,368	4,342	5,384	7,642
	No.8	1,102.0	60,041	101,368	25,342	31,425	44,602
Kashar	9-1	134.0	3,326	4,188	1,047	1,298	1,843
	9-2	276.4	13,075	27,862	6,965	8,637	12,259
	No.9	410.4	16,401	32,050	8,012	9,935	14,102
	10-1	241.7	2,816	3,862	966	1,197	1,699
	10-2	214.6	5,001	8,429	2,107	2,613	3,709
	10-3	158.3	3,689	7,530	1,882	2,334	3,313
	No.10	614.6	11,506	19,821	4,955	6,144	8,721
	No.11	78.4	913	1,253	313	388	551
	12-1	68.7	1,741	3,250	812	1,007	1,430
	12-2	44.5	518	711	178	220	313
	12-3	128.1	1,493	2,047	512	635	901
	No.12	241.3	3,753	6,008	1,502	1,862	2,644
	13-1	131.4	1,531	2,100	525	651	924
	13-2	78.3	912	1,251	313	388	551
	No.13	209.7	2,443	3,351	838	1,039	1,475
Kamza	14-1	106.7	3,679	7,275	1,819	2,255	3,201
	14-2	263.9	9,099	17,993	4,498	5,578	7,917
	14-3	282.1	9,727	19,234	4,809	5,963	8,463
	No.14	652.7	22,506	44,502	11,126	13,796	19,581
	15-1	119.6	4,124	8,155	2,039	2,528	3,588
	15-2	143.1	4,934	9,757	2,439	3,025	4,293
	No.15	262.7	9,058	17,911	4,478	5,553	7,881
	No.16	39.3	1,355	2,680	670	831	1,179
	17-1	132.9	4,582	9,061	2,265	2,810	3,987
	17-2	94.4	3,255	6,436	1,609	1,995	2,830
	17-3	96.1	3,314	6,552	1,638	2,030	2,883
	17-4	121.6	4,193	8,291	2,073	2,570	3,648
	17-5	205.9	7,100	14,039	3,510	4,352	6,177
	No.17	650.9	22,444	44,379	11,095	13,757	19,525
Pri-T(Km)	No.18	82.9	2,858	5,652	1,413	1,752	2,487
STP (Kamza)	No.19	86.5	2,983	5,898	1,474	1,828	2,595
	20a-1	151.7	4,514	8,857	2,214	2,746	3,897
	20a-2	99.0	3,414	6,750	1,687	2,092	2,970
	20a-3	178.6	6,158	12,177	3,044	3,775	5,358
	20a-4	227.6	2,132	4,043	1,010	1,253	1,780
Berxull	20b-1	133.4	2,499	4,739	1,185	1,470	2,085
	20b-2	157.7	2,955	5,602	1,401	1,737	2,465
	No.20	948.0	21,672	42,167	10,541	13,073	18,555
Total		9,274.2	718,268	1,000,000	250,000	310,000	440,000

1.5.2 Alternative Studies

The appropriate site selection for the STP is a key task for the preparation of an appropriate sewerage system and helps to ensure the system is technically, socially and environmentally sound.

Criteria for the alternative sewerage plans include the following:

1) The plan should aim to begin sewage treatment as soon as possible so that the water quality in the Lana and Tirana Rivers improves. In particular, the plan should aim to treat about 80% of the sewage generated in Tirana municipality, as a priority, so that the system is cost effective.
2) The site must be suitable and there should be enough space for the STP to include required sewage and sludge treatment facilities. The site should allow the system to meet the requirements of low energy consumption, ease of operation, and low O&M costs.

The following two alternatives for the system design were developed:

- **Case A: Single STP System (with two primary treatment plants at 1)Kashar and 2)Kamza); and**
- **Case B: Multi STP System**

Case A is an improved or modified former plan which locates two primary treatment plants (Pri-T) in Kashar and Kamza as shown in *Figure S1.5.3*. Kashar Pri-T treats sewage from Tirana and east part of Kashar as primary level then sends the treated water to STP in Berxulle finally. Kamza Pri-T treats sewage from Kamza central area (northern part of the Tirana River) and sends the treated water to the Berxulle STP. Before completion of the construction of the Berxulle STP, both Pri-Ts discharge primary treated sewage into rivers.

To solve a problem of Case A which takes a long term to reach secondary treatment level, additional STP is proposed to locate in Kashar (named Kashar STP), where sewage from Tirana and east part of Kashar is treated as secondary level in early stage as **Case B**. This plan requires two STPs but shorter trunk sewers. In Kamza, Pri-T in Case A becomes a pumping station. In the first stage, Kashar STP has only primary treatment facilities and in the second stage following facilities like secondary treatment are constructed and facilitated. Further **three Optional alternatives of Case B (namely, B-2, B-3 and B-4)** are made regarding the site of STPs. There are some large spaces in Tirana and/or in Greater Tirana by site investigations. Optional alternatives are 4 cases with different site of STP and trunk sewer routes.

As the result of comparative study, achieving main objects as early start and low cost, Case B: Multi STP System is recommended for the Greater Tirana area. And among the sub-alternatives of Case B, **Case B-3** (*Figure S1.5.4*) was selected as the most prominent alternative due to the highest availability of land space for the STP.

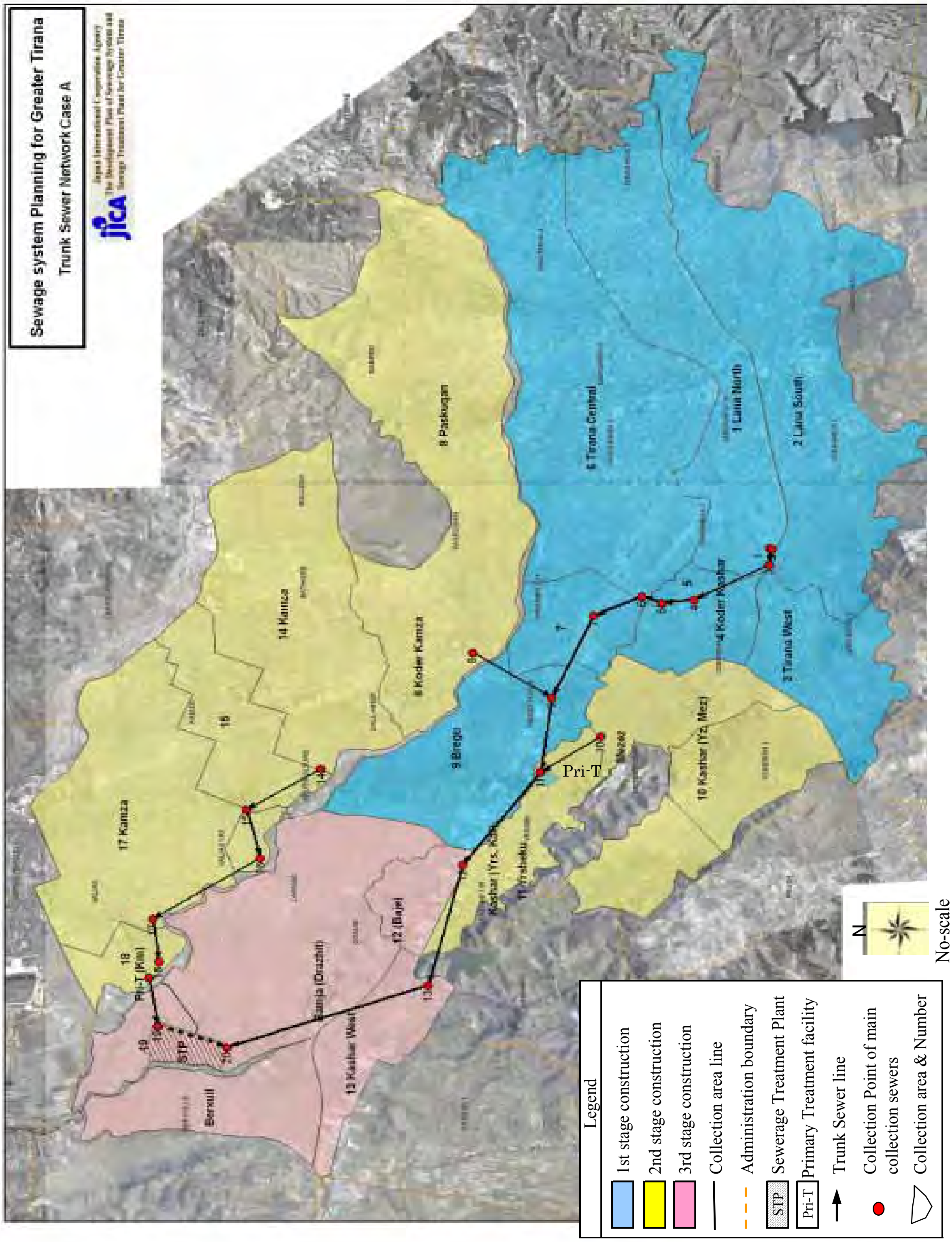


Figure S1.5.3 Case A: Single STP System

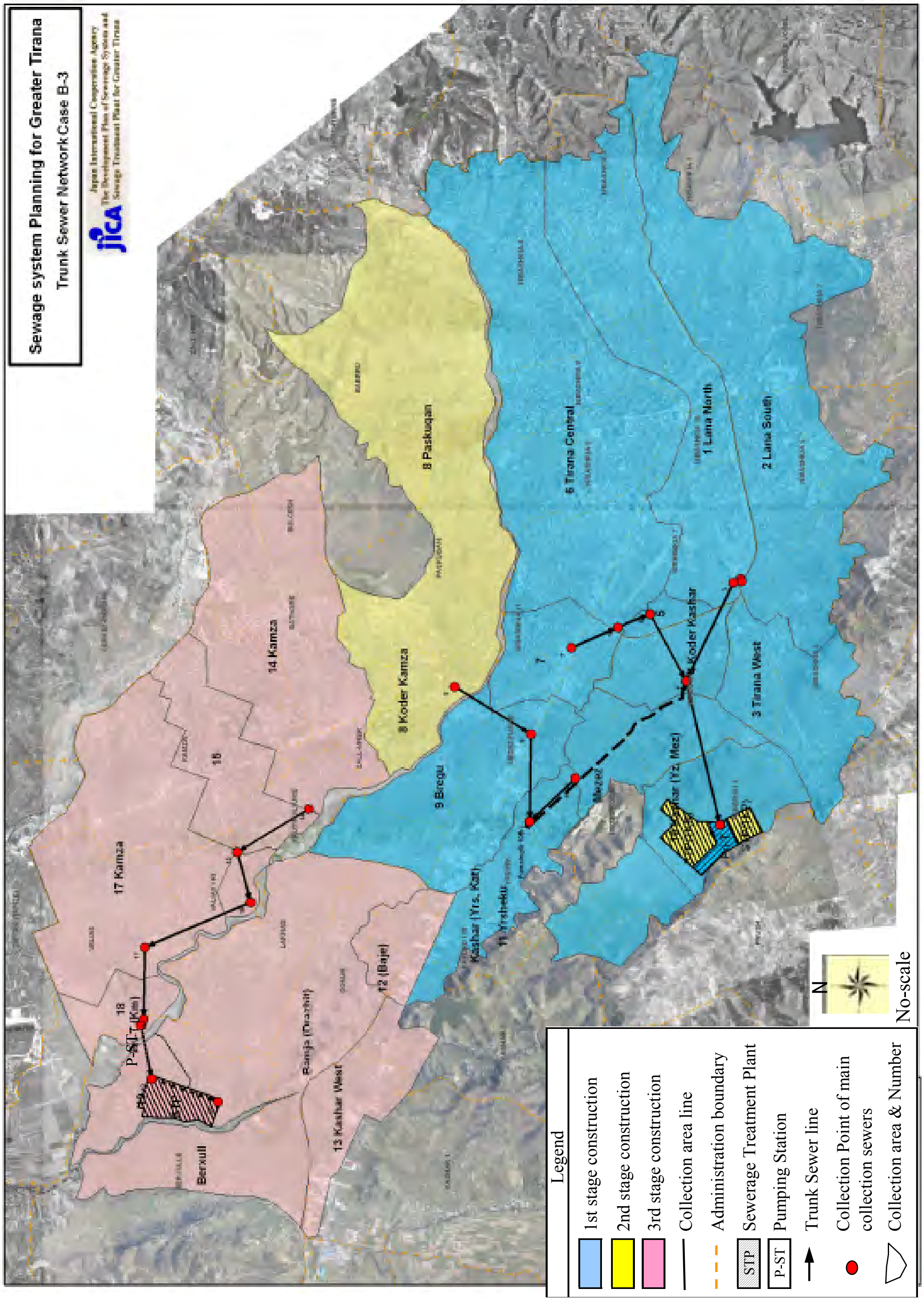


Figure S1.5.4 Case B (B-3): Multi STP System

The Steering Committee selected Case B-3 as the preferred option based on the evaluations above that it would begin treating sewage sooner for the lowest cost. Based on discussions with the Mayors and representatives from the relevant municipality and commune, it seems that the site for B-3 would be available for the STP and is likely to result in less negative environmental impacts on the surrounding area.

1.5.3 Further Study for Systems Conveying Sewage to the STP

The trunk sewers were planned and designed by applying the tunneling shield method and pipe jacking method in the previous alternatives studied. A further options study is planned for the trunk sewer design, and to investigate the possibility of using the open cut method. This is the locally practiced method for sewer laying, and would reduce the construction cost associated with the trunk sewers.

(1) Alternatives for Trunk Sewer System

A survey was undertaken to identify possible routes for laying the trunk sewers using the open cut method. The survey results indicate four possible trunk sewer routes as shown in *Figure S1.5.5* to *Figure S1.5.8.* These options are named **B-3a, B-3b, B-3c** and **B-3d**.

B-3a is an improvement of the original Case B-3. It includes about 8 km of sewers being laid using the open cut method and the remainder (which is most of the route) would be large diameter pipes laid using the shield and jacking methods. At the STP, the inlet to the sewer is more than 20m deep. This means large, high specification pumping facilities would need to be installed. This would increase the operation cost.

B-3b is an improvement on option B-3a. It reduces the construction cost because more of the trunk sewers would be laid using the open cut method. However, this option requires four pumping stations. The O&M cost for the pumping facilities is the highest of the four options. If there were to be a power failure or pumping station malfunction not much sewage could be conveyed to the two STPs.

B-3c includes laying a significant length of the trunk sewers using the open cut method. This means this option would have the lowest construction cost of the four options. All the sewage collected from Tirana municipality, Kashar commune and Paskuqan commune would be conveyed under gravity flow to the Kashar Pumping Station, located at 10b Collection Point. From here the sewage would be pumped to the Kashar STP. This case would face the most significant risks if there were a power failure or if the pumping equipment malfunctioned, because all of the collected sewage would be discharged without any treatment.

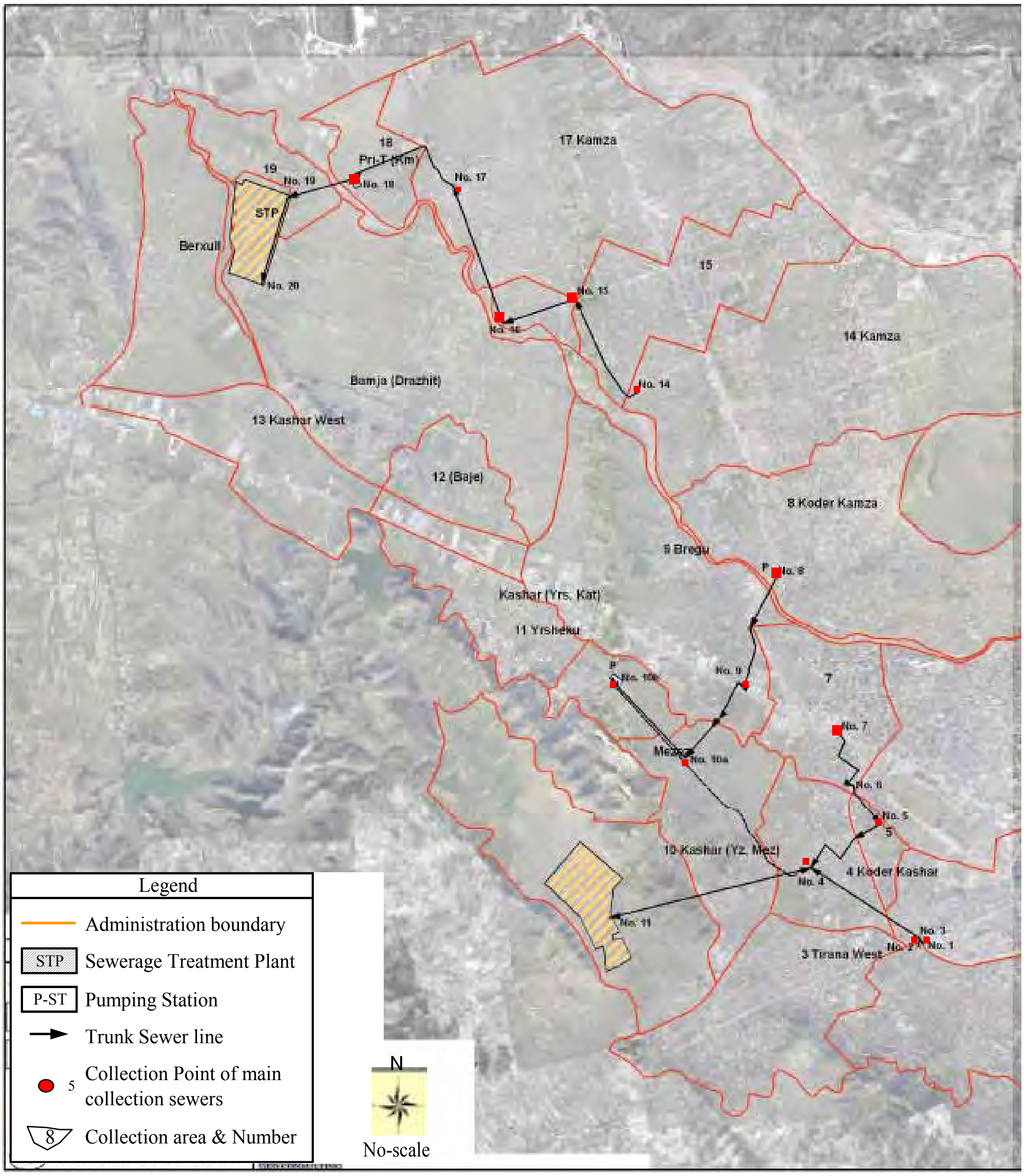


Figure S1.5.5 Trunk Sewer System of B-3a

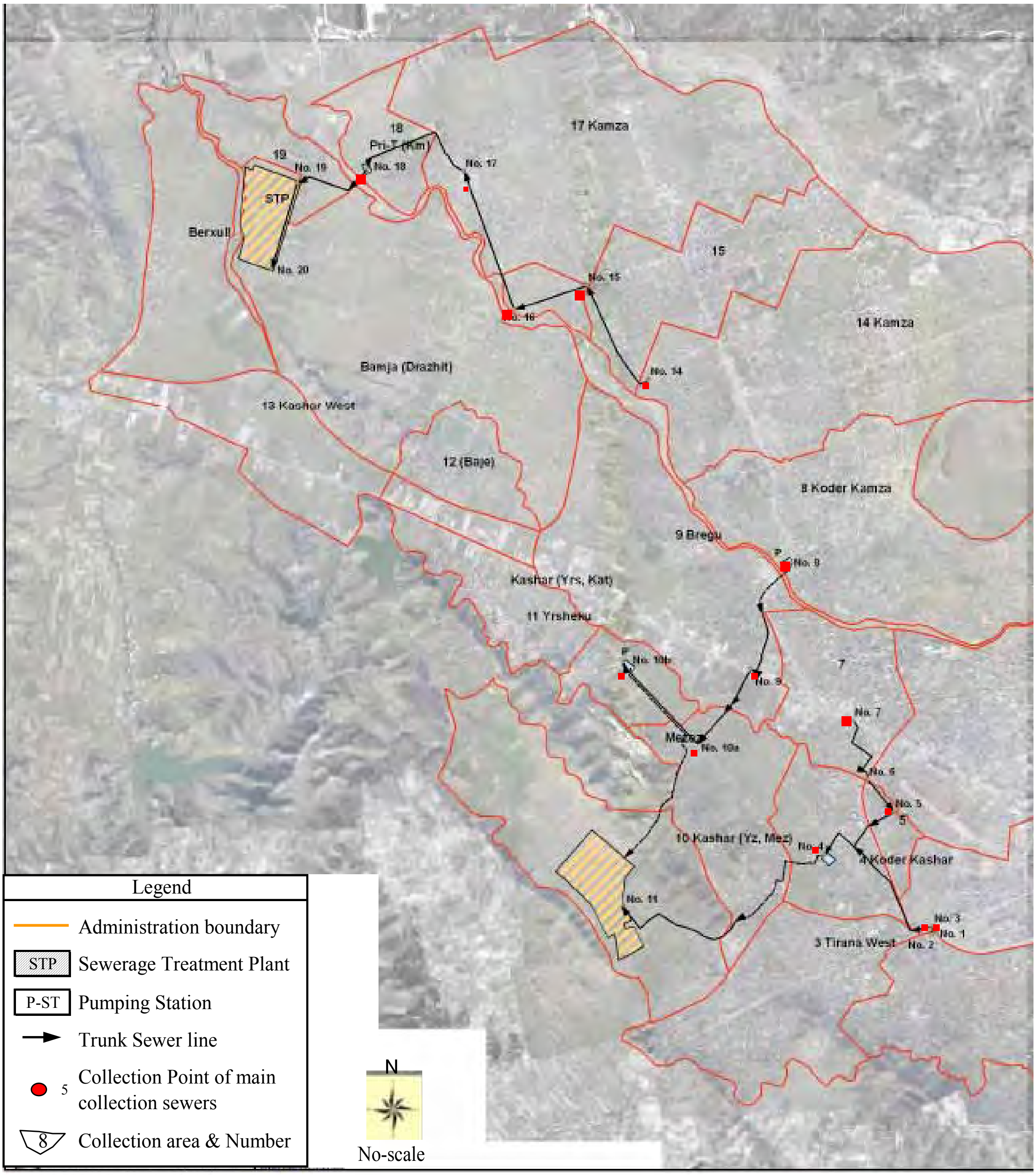


Figure S1.5.6 Trunk Sewer System of B-3b

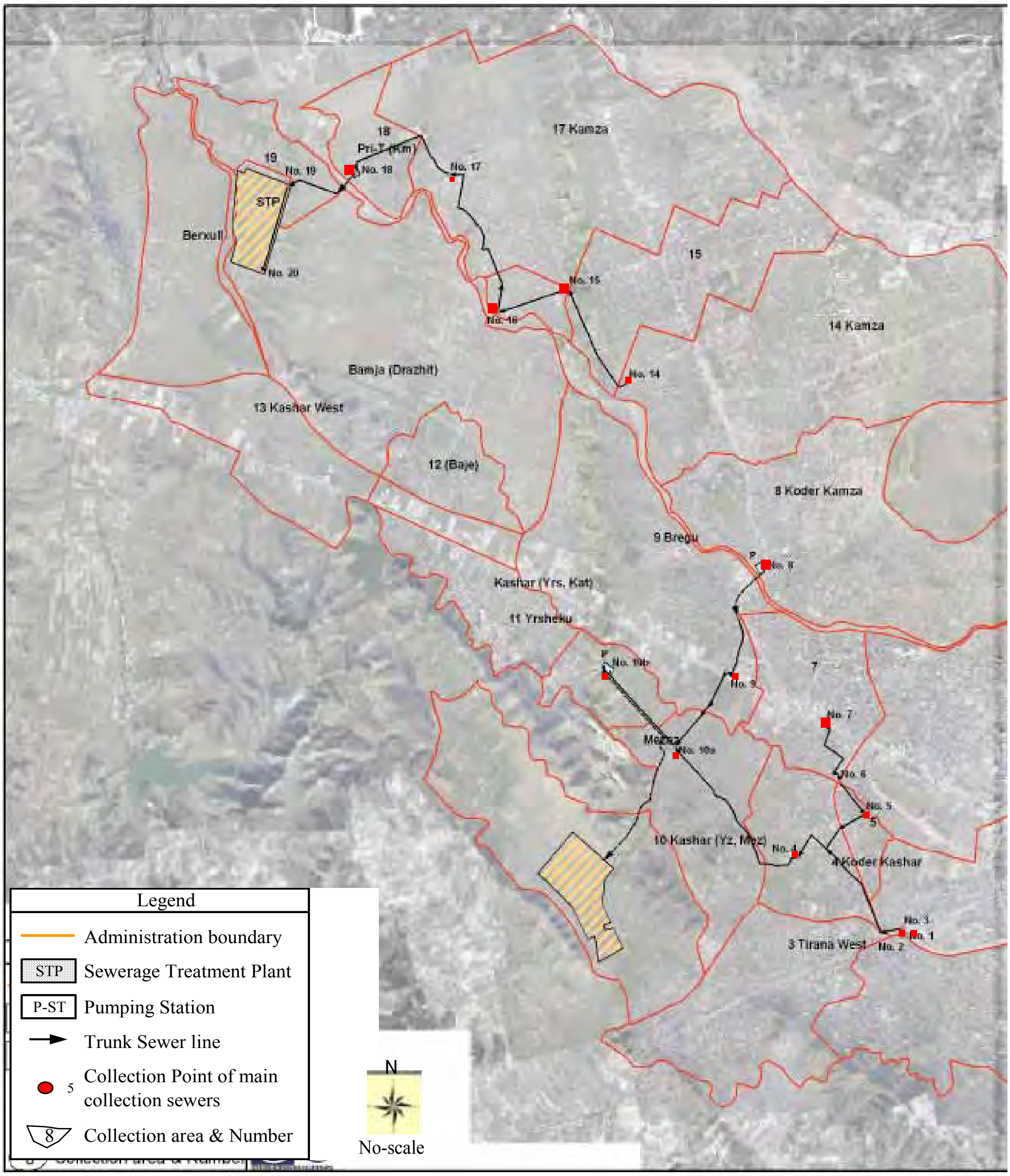


Figure S1.5.7 Trunk Sewer System of B-3c

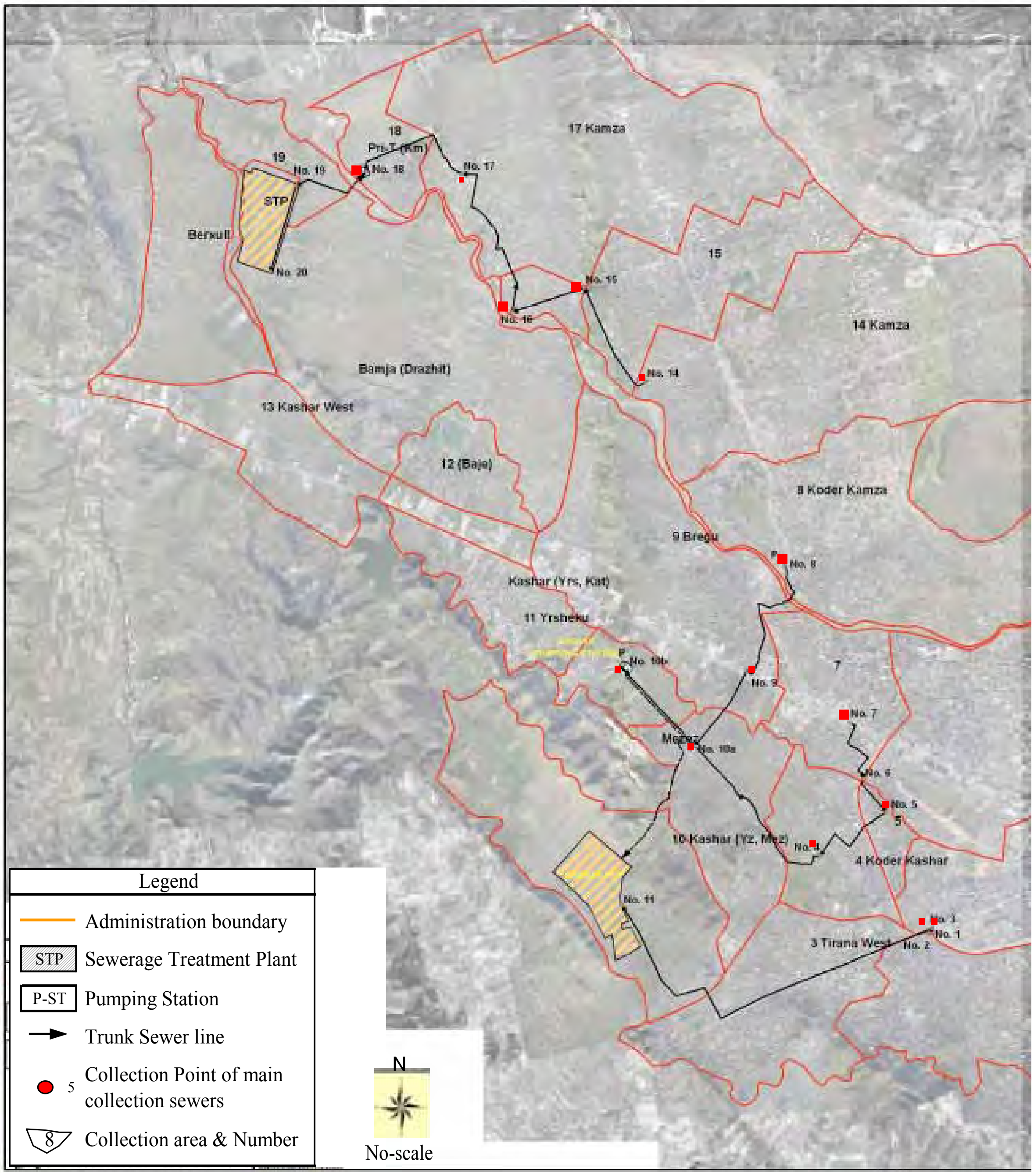


Figure S1.5.8 Trunk Sewer System of B-3d

B-3d was prepared to reduce the risks associated with B-3c in the event of a power failure or malfunctioning of the pump equipment at the Kashar Pumping Station. For this option the sewage generated in Lana Basin would be conveyed through Trunk Sewer No.3 using gravity flow. This sewer would be laid using the jacking method because the sewer would need to be deep when crossing Lana River and the stream near the Kashar STP. Trunk Sewer No.3 is separate and independent from the other trunk sewer system. The other sewer system collects sewage from the remaining area and pumps it using the Kashar pumping station to the Kashar STP. Therefore, this option requires the longest trunk sewers, meaning construction costs could be greater than for options B-3b and B-3c. However, the O&M costs would be the lowest of the four options.

(2) Evaluation and Selection of Trunk Sewer System

The options were evaluated using the criteria shown in *Table S1.5.7* to help select the most appropriate trunk sewer system.

TableS1.5.7 Evaluation Criteria for Trunk Sewer System

Evaluation Criteria	Meaning	Top Result
Cost	Lump sum cost of construction and O&M cost for 50 years	Lower cost is favorable.
Ease of construction	Trunk sewer length laid by open cut method	Longer sections laid using the open cut method are favorable
Availability of land space for the pumping station	Unhindered availability of land for the pumping station	Appropriate and available locations are preferred.
Risks and management measures	Number of pumping stations required, the sewage volume, and the concentration level of the sewage.	Fewer pumping stations, and low volumes of sewage are preferred.

Table S1.5.8 presents the dimensions of the trunk sewers, length of sewer being laid using the different construction methods, number of pumping stations, a brief description of the features of the system, costs, and overall evaluation based on the evaluation criteria. Option B-3c is the lowest in terms of cost, but it has the highest risk. Option B-3d achieves the greatest overall evaluation. Collection Areas No.1, No.2 and No.3 are the main areas generating sewage in Greater Tirana. Sewage collected from these areas can be conveyed to the STP under gravity flow, which helps to avoid risks caused by power failures or malfunctioning of pump equipment.

In summary, the option **B-3d** is identified as the most applicable and reliable trunk sewer system for the M/P up to the year 2022. The Option B-3d is an improved version of the original Case B-3.

TableS1.5.8 Evaluation of Trunk Sewer System of Four B-3 Sub-cases

Items			B-3a	B-3b	B-3c	B-3d
Sewage Conveyance System	Trunk sewer length (m)		18,525	17,966	18,026	20,763
	Diameter (mm)		450 ～ 2000	400 ～ 2000	400 ～ 2000	450 ～ 1650
	Trunk sewer length (m by construction method	Shield	5,271	0	0	0
		Jacking	4,468	2,551	2,381	8,973
		Open Cut	7,930	15,415	15,645	11,790
	No. of umping stations		3	4	3	2
Cost	Construction cost	10^6Lek	6,569	4,056	3,911	5,234
	O&M cost	10^6Lek/year	17.6	18.7	16.9	10.6
	Lump sum cost for 50years		7,448	4,991	4,757	5,766
Evaluation	Cost		×	○	◎	○
	Construction easiness		×	○	◎	○
	Land acquisition for pumping stations		○	×	△	◎
	Risk allocation of operation		△	△	×	◎
	Evaluation		4	7	11	16

Evaluation point ×:0 △:1 ○:3 ◎:5

1.5.4 Selection of the Priority Project

In the previous section it was identified the staged project to be provision of a sewerage service that covers most of the administrative area of Tirana except for Koder, Kamza, and part of Kashar communes. The first stage project provides for primary treatment at the Kashar STP in Kashar commune.

The implementation program proposes that the level of sewage treatment be upgraded in stages. The first stage would be to construct full scale primary sewage treatment facilities, consisting of preliminary treatment facilities. The second stage of the project would be construction of full scale secondary treatment facilities. These facilities would include trickling filters and final sedimentation tanks with sludge treatment facilities.

This section discusses further the first stage project as a Priority Project which would be an appropriate project scale with higher project impacts.

(1) Options for the Priority Project

The following two options for the Priority Project were assessed with consideration of cost, targeted service area, and sewage treatment level:

- Option 1: the first stage of the proposed project, with a primary sewage treatment process; and
- Option 2: a secondary sewage treatment process will be provided for the Lana River Basin.

Option 1 is the project described in the previous section. For Option 2, the capacity of the secondary treatment process would be set so that its construction cost is in the same order of magnitude as for a full scale primary treatment process (Option 1). The Lana River basin was selected as the sewerage planning area because: (a) Lana River is currently heavily polluted due to the direct discharge of sewage, (b) Lana River passes through the urban center of Tirana municipality, which is the capital of Albania, (c) a large part of the area is covered by existing sewer networks, (d) the collected sewage could be conveyed using gravity flow to the proposed Kashar STP, (e) rehabilitation and improvement of existing sewers and interceptors would contribute to early project improvements.

Figure S1.5.9 presents the Sewerage Development Plan for Option 2 and also shows the service area in the Lana River basin. *Figure S1.5.10* shows the options for sewage and sludge treatment facilities at the Kashar STP.

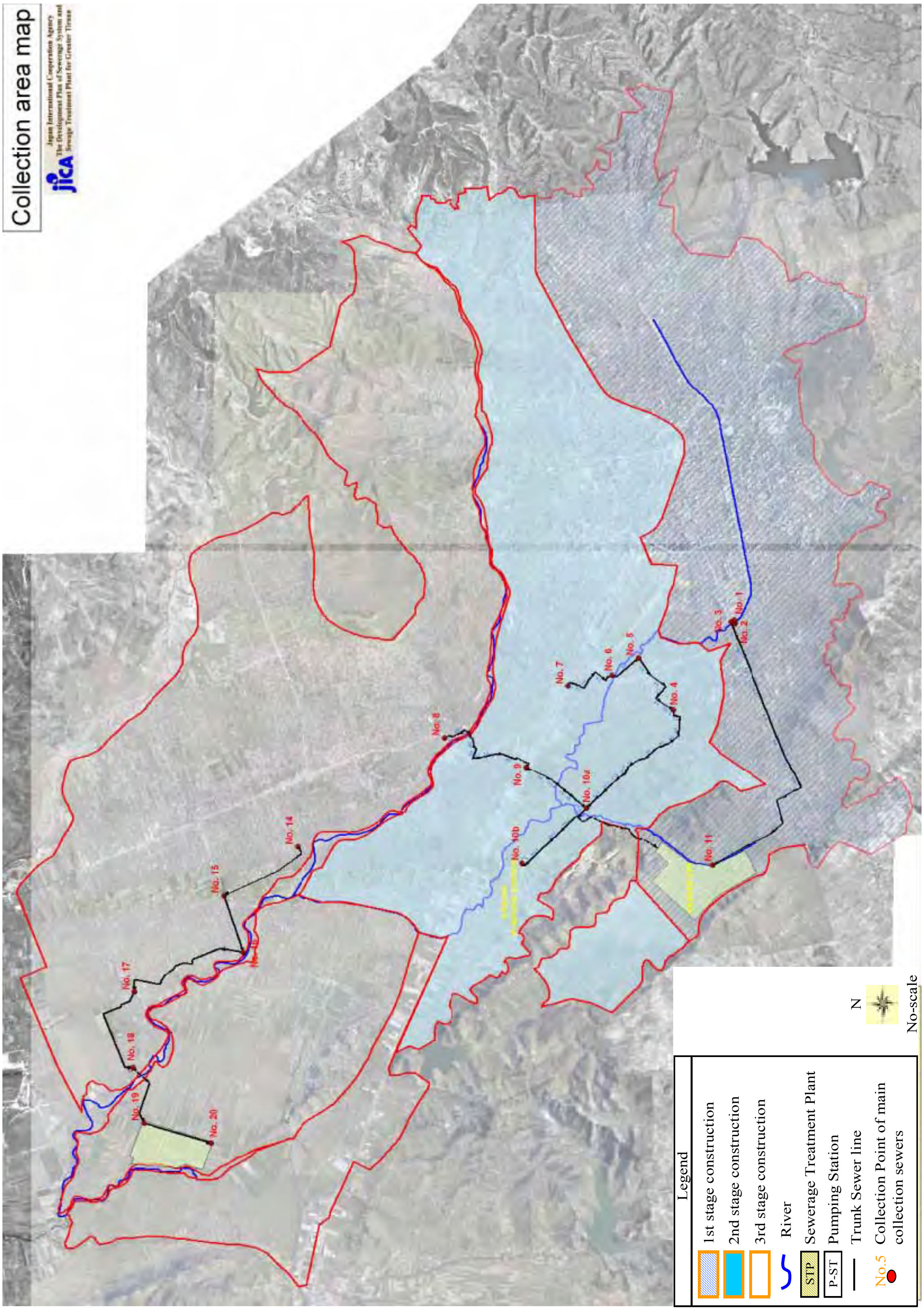
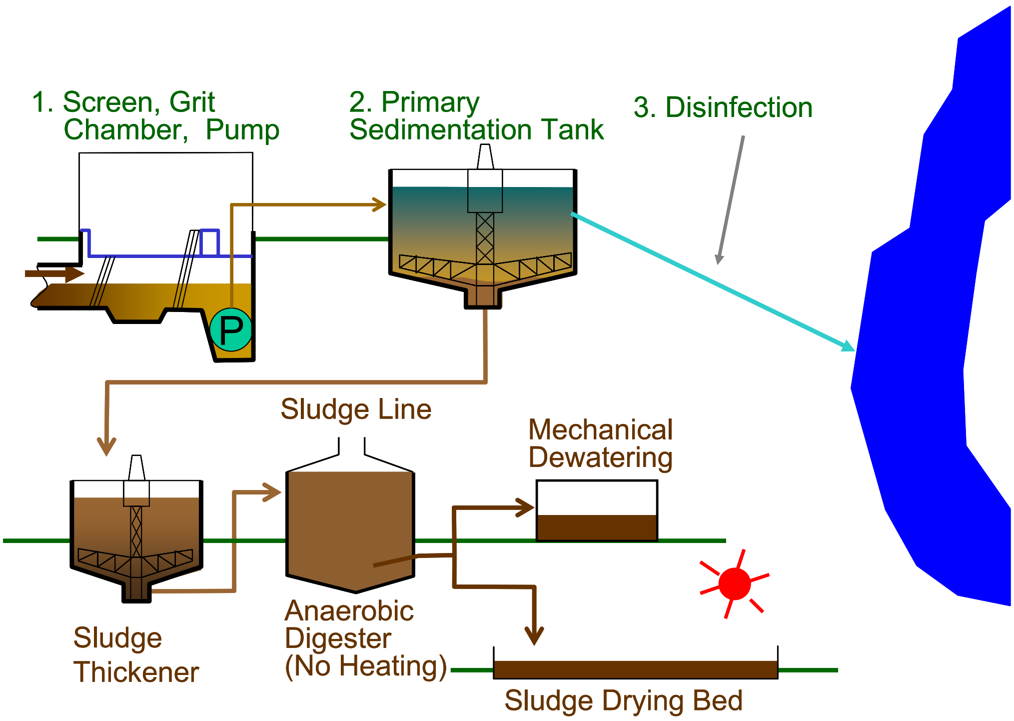
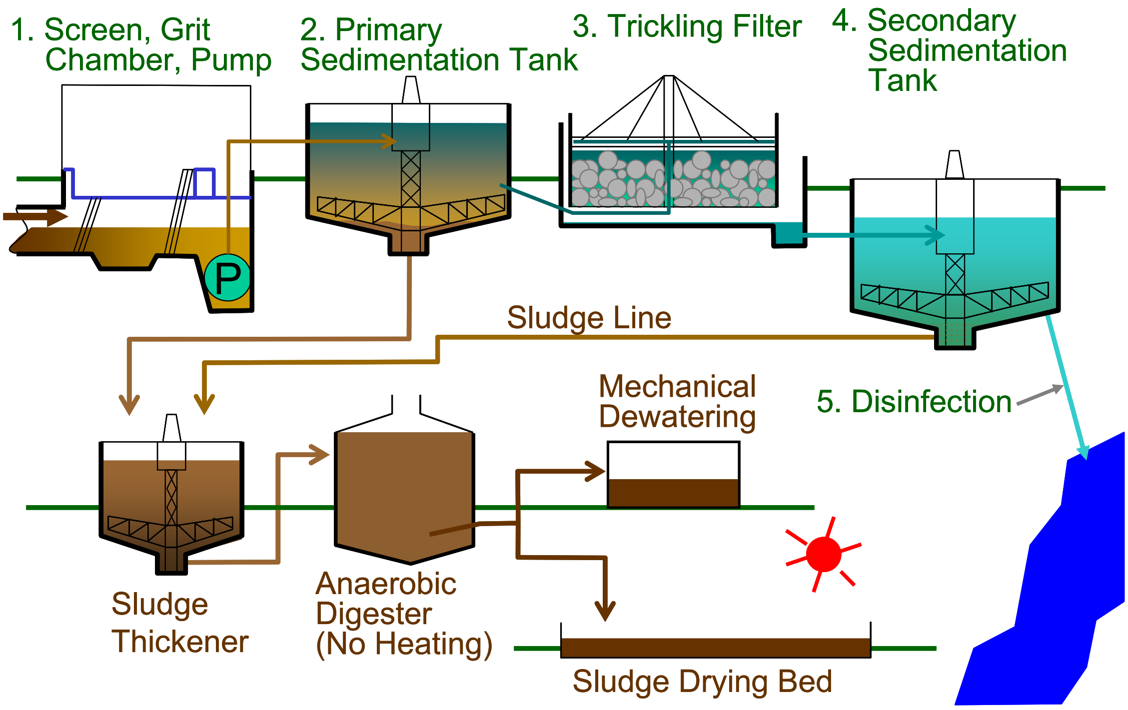


Figure S1.5.9 General Plan of Sewerage Development Plan for Option 2



Sewage Primary Treatment Process and Sludge Treatment: Option 1



Sewage Secondary Treatment Process with Sludge Treatment: Option 2

Figure S1.5.10 General Layout Plan for the Sewage Treatment Facility Options at Kashar STP

(2) Planning Information for the Options

Table S1.5.9 summarizes and compares the main features for each option.

Table S1.5.9 Planning Information for the Two Options for the Priority Project

	Item	Option 1 (Primary Treatment)	Option 2 (Secondary Treatment)	Remarks
1.	**Basic Information**			
1.1	Service Area	6,207 ha	2,343 ha	
1.2	Service Population	695,800	342,500	
1.3	Sewage Flows	Ave. Daily 156,567 m^3/d Max. Daily 194,835 m^3/d	Ave. Daily 77,058 m^3/d Max. Daily 95,893 m^3/d	Target Year 2013
2.	**Outline of Sewerage System**			
2.1	Sewers			
2.1.1	Trunk Sewer	Dia.: 450~1,650 mm Material: Concrete Length: 6.3 km (Open Cut), 7.1 km (Jacking)	Dia.: 900~1,500 mm Material: Concrete Length: 1.0 km (Open Cut), 3.4km (Jacking)	
2.1.2	Main Sewer	Dia.: 200~500 mm Material: Plastic Length: 28 km (Open Cut)	Dia.: 400~600 mm Material: Plastic Length: 1.4 km (Open Cut)	
2.1.3	Branch Sewer	Dia.: 200 mm Material: Plastic Length: 31 km (Open Cut)	Dia. 200 mm Material: Plastic Pipe Length: 28 km (Opent Cut)	
2.2	Pumping Station			
2.2.1	Kashar Pumping Station	Capacity: 148.2 m^3/ min, Pump Head: 32m	-	
2.3	STP:Kashar STP			
2.3.1	Sewage Treatment			
(1)	Treatment Level: BOD and SS Removal Rate	Primary Treatment: 30/40 %	Secondary Treatment: 88/85 %	
(2)	Water Quality, BOD and SS conc.			
	Raw Sewage	200/200 mg/L	200/200 mg/L	
	Treated Sewage	140/120 mg/L	24/30 mg/L	
(3)	Capacity of STP	Max. Daily: 260,000 m^3/d	Max. Daily: 97,000 m^3/d	
(4)	Sewage Treatment Process	Screening + Grit Removal + Primary Sedimentation + Chlorination	Screening + Grit Removal + Primary Sedimentation + Trickling Filter + Final Sedimentation + Chlorination	
(5)	Water Body receiving the Treated Water	Near-by river, upstream of Lana River	Near-by River, upstream of Lana River	
2.3.2	Sludge Treatment			

	Item	Option 1 (Primary Treatment)	Option 2 (Secondary Treatment)	Remarks
	and Disposal			
(1)	Sludge Treatment Process	Thickener + Anaerobic Digester + De-watering (Belt Filter Press and Sludge Drying Bed)	Thickener + Anaerobic Digester + De-watering (Belt Filter Press and Sludge Drying Bed)	
(2)	Sludge Generation for disposal Wet (Dry) basis	22.1 ton/d (8.1 ton/d)	22.6 ton/d (8.2 ton/d)	
3.	**Preliminary Cost Estimate**			Unit: Mil. Lek
3.1	Direct Construction Cost			
3.1.1	Sewers	4,601	2,049	
3.1.2	Pumping Station	548	-	
3.1.3	Sewage Treatment Plant	2,927	3,818	
	Sum of above costs	8,076	5,867	
3.2	Indirect Construction Cost			
3.2.1	Land Acquisition	3,068	3,068	
3.2.2	Administrative Expenses	404	293	5% of Item 3.1
3.2.3	Engineering Services	808	587	10% of Item 3.1
3.2.4	Physical Contigency	808	587	10% of Item 3.1
3.2.5	Capacity Building	147	147	
	Sum of above costs	5,235	4,682	
3.3	Project Cost	13,311 (10,243)	10,549 (7,431)	(without Land Cost)
3.4	Annual O&M Cost	114 Mil Lek/y	91 Mil Lek/y	For comparison, cost for opration of sewerage facilities are estimated

(3) Evaluation of Options

Table S1.5.10 is a summary of the options evaluation. The two options were compared and evaluated using eight criteria.

Table S1.5.10 Evaluation of the Options for the Priority Project

	Evaluation Criteria	Option 1	Option 2
(1)	**Beneficiaries**	The population serviced by the sewerage system are the direct beneficiaries (population size = 695,800). The indirect beneficiaries would be people who visit and work in the center of Trana municipality but live outside of the service area.	The number of direct beneficiaries is 342,500, which is about 50% of those in option 1. There are expected to be more indirect beneficiaries visiting and working in the center of the municipality, than for Option 1.
(2)	**BOD Load Reduction**	A BOD_5 load reduction of about 9.3 ton/day is expected. This is less than that for Option 2.	The BOD_5 load reducion would be about 13.6 ton/d, which is the higher than option 1.
	(Efficicy Index)	The efficiency Index represents the amount of BOD removed per direct construction cost. For Option 1 the Index = 1.1 (=9.3 ton/d / 8.1 Bil. Lek)	Index = 2.3 (=13.6 ton/d / 5.9 Bil. Lek) This is double that for Option 1 and means Option 2 is more efficient.
(3)	**Treated Sewage Quality and Flow**	BOD_5/SS conc.: 140/120 mg/L Ave. Daily Flow: 156,600 m^3/d (Effluent Load of BOD_5/SS: 22/19 ton/d)	BOD_5/SS conc.: 24/30 mg/L, Ave. Daily Flow: 77,100 m^3/d (Effluent Load of BOD_5/SS: 1.9/2.3 ton/d)
(4)	**River Water Quality Improvement**	BOD_5 concentration in mg/L : Expected with project and (without project) at the reference point: Lara River at F1: 13 (101), R5: 125 (128) Tirana River at R4: 23 (39), R6: 59 (60)	BOD_5 concentration in mg/L : Expected with project and (without project) at the reference point: Lara River at F1: 13 (101), R5: 70 (128) Tirana River at R4: 39 (39), R6: 43 (60) Higher improvement would be expected except at R4.
(5)	**Operation and Maintenance (O&M) Requirements**	Pumping Station (PS): Proper operation of the PS is required to convey and treat the sewage at the STP STP: Operation of the primary treatment process (Option 1) is easier than for biological secondary treatment (Option 2), because primary treatement is a physio-chemical process only.	No need to operate PS. STP: Operatation of the full set of sewage and sludge treatment systems requires training of operators. Sludge removal is critical to the proper operation of the STP.
(6)	**Project Cost**	Implementation of this Option would cost about 10 Billion Lek (excluding land acquision). This includes a direct construction cost of 8 Billon Lek.	About 8 Billion Lek (excluding land acquision). This includes a direct construction cost of 6 Billon Lek.
(7)	**O&M Cost**	114 Million Lek/year The ratio of O&M cost to the average planned flow rate is estimated to be 1.8 Lek/m^3 (=114,000,000/365/156,600).	91 Million Lek/year Ratio = 2.9 Lek/m^3 (=91,000,000/365/77,100)
(8)	**Environmental and Social Impacts**	Treated sewage (effluent) discharged into the receiving water body will result in some negative impacts because the	The effuent discharged into the river will be of a higher quality than under the current situation. The hydrologic impact of

	effluent contains pollutant loads. Also, the discharge will be visible in the flow, meaning there is a visual impact.	increased flow needs to be assessed in a future study. Appropriate mitigation and monitoring could help avoid some of the potentially adverse impacts.
(9) **Effects on the Sewerage Project Promotion and Public Awareness**	Option 1 has the more direct beneficiaries than Option 2. It is expected that these people will benefit form an improved living environment and will notice improvements in the quality of the Lana River water. However, it possible that people may incorrectly perceive the appearance of effluent in the river to be a negative impact.	This option will have fewer beneficiaries but it will still contribute to improvements in the living environment within the Lana area. Also, the water quality in the Lana River will improve in the urban center. This option is expected to significantly contribute to improved understanding of sewerage treatment because the public will be able to visit the STP.

(4) Section of Priority Project

Considering the construction and O&M costs, effluent quality, BOD load reduction, environmental and social impacts, and promotion and public awareness, Option 2 is the preferred Priority Project. A feasibility study for the implementation of Option 2 should be undertaken.

There is no sewage treatment in Albania to date. Therefore, most Albanian people have never seen treated sewage. The sewage treatment plant to be constructed in Kashar will be the first one in the Greater Tirana area. Therefore, the effluent is likely to attract great attention and is expected to affect the fate of future sewerage development in the country. It is therefore very important to show high effluent quality. This can only be achieved by using secondary treatment.

The first step is to ensure that the officials in charge and the affected people understand what sewage treatment is and how sewage treatment contributes to an improved water environment. This will facilitate the second and third implementation stages.

1.5.5 Proposed Sewerage System Components

The following sewerage facilities will be constructed in three consecutive stages:

(1) Main and branch sewers;
(2) Intercepting weirs at connection points to trunk sewers;
(3) Connection points to trunk sewers (vertical shafts of trunk sewers);
(4) Trunk sewers;
(5) Pumping stations;
(6) Sewage treatment facilities; and
(7) Sludge treatment facilities.

Figure S1.5.11 shows a general plan of the proposed sewerage facilities. *Tables S1.5.11 through S1.5.15* outline general specification of major facilities. *Figure S1.5.12* shows flow schematic of the STPs. *Figures S1.5.13* and *Figure S1.5.14* present proposed layout plans for the STPs.

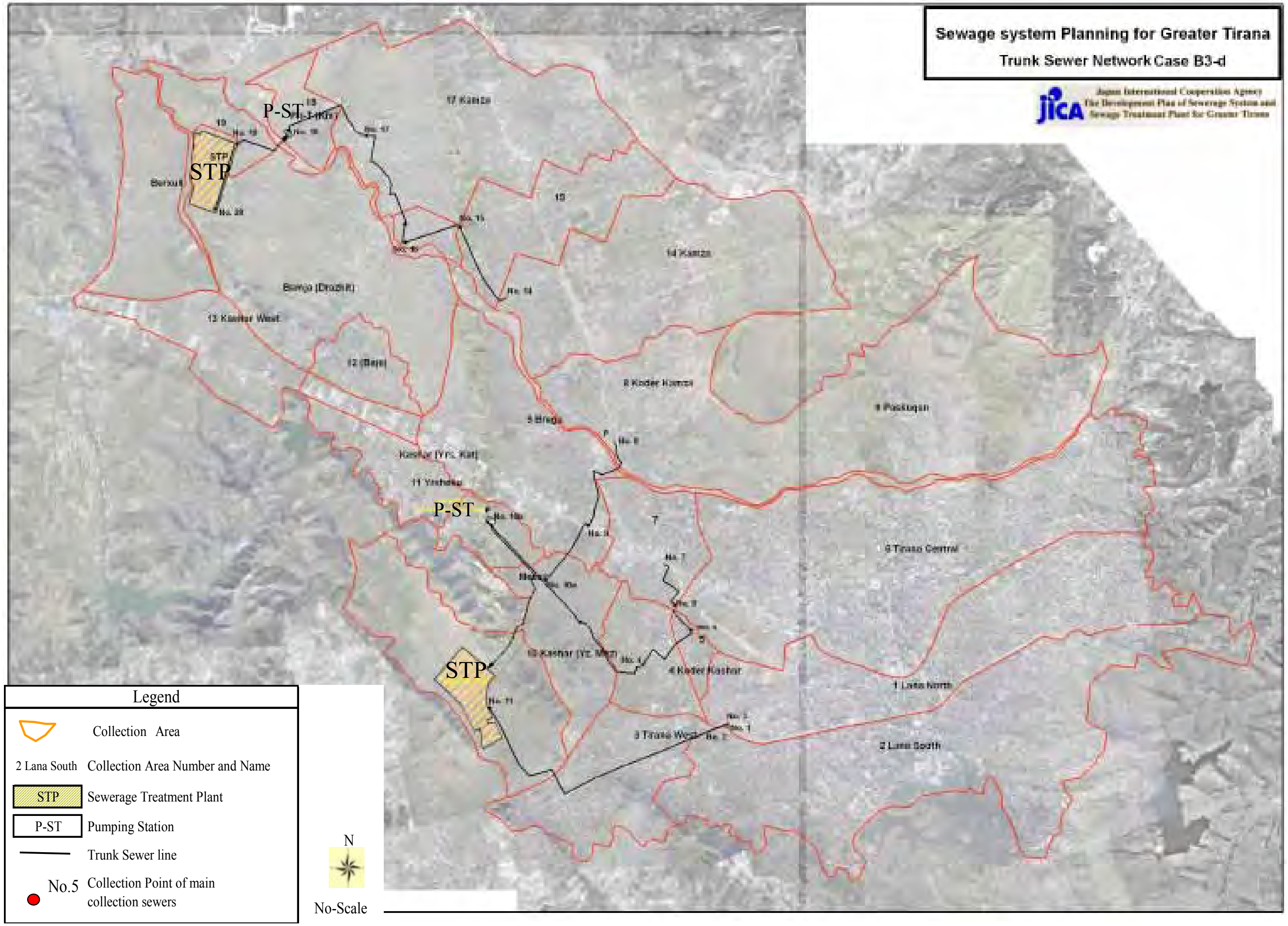


Figure S1.5.11 General Plan of Sewerage System

Table S1.5.11 General Specification of Sewers

Item		Dimensions	Construction Method	Pipe Material
1.	Sewers to Kashar STP			
1.1	Branch Sewer	Diameter:200 mm, Length: 60 km	Open-cut	Plastic
1.2	Main Sewer	Diameter: 200 to 600 mm, Length: 49 km	Open-cut	Plastic
1.3	Trunk Sewer	Diameter: 450 to 1650 mm, Length 14.8 km	Jacking and Open-cut	Plastic or Concrete
2.	Sewers to Berxulle STP			
2.1	Branch Sewer	Diameter:200 mm, Length: 22 km	Open-cut	Plastic
2.2	Main Sewer	Diameter: 200 to 800 mm, Length: 52 km	Open-cut	Plastic
2.3	Trunk Sewer	Diameter: 450 to 1350 mm, Length 5.9km	Jacking and Open-cut	Plastic or Concrete
3.	Total			
3.1	Branch Sewer	Diameter:200 mm, Length: 82 km	Open-cut	Plastic
3.2	Main Sewer	Diameter: 200 to 800 mm, Length: 101 km	Open-cut	Plastic
3.3	Trunk Sewer	Diameter: 450 to 1650 mm, Length 20.7 km	Jacking and Open-cut	Plastic or Concrete

Source: JICA Study Team

Table S1.5.12 Kashar Pumping Station Facilities

Facility	Facility Type	Quality	Size, Capacity, Specs	Remarks
1. Preliminary Facility				
	1.1 Screening chamber	4 units		
	1) Coarse screen	4 units	(W) 1.2m	Manual raking
	2) Fine screen	4 units	Rectangular tank, (W) 1.2m	Mechanical raking
	1.2 Grit chamber	4 units	Rectangular tank, (L)12.0m ×(W) 2.5m, with mechanical grit collector.	Hydraulic loading: 1,800 $m^3/m^2/day$
	1.3 Influent pumps			
	1) Vertical shaft type flow pumps	2 units	(Dia.) 500mm, 25.0 m^3/min	
	2) Vertical shaft type flow pumps	3 units, inc. 1standby	(Dia.) 700mm, 50.0 m^3/min	

Source: JICA Study Team
Note: (W) width; (L) length, (H) height, and (Dia.) diameter.

Table S1.5.13 Kamza Pumping Station Facilities

Facility	Facility Type	Quality	Size, Capacity, Specs	Remarks
1. Preliminary Facility				
	1.1 Screening chamber	2 units		
	1) Coarse screen	2 units	(W) 1.2m	Manual raking
	2) Fine screen	2 units	Rectangular tank, (W) 1.2m	Mechanical raking
	1.2 Grit chamber	2 units	Rectangular tank, (L) 12.0m ×(W) 1.2m, with mechanical grit collector.	Hydraulic loading: 1,800 $m^3/m^2/day$
	1.3 Influent pumps			
	1) Vertical shaft type flow pumps	2 units	(Dia.) 300mm, 9.0 m^3/min	
	2) Vertical shaft type flow pumps	2 units, inc. 1standby	(Dia.) 400mm, 18.0 m^3/min	

Source: JICA Study Team
Note: (W) width; (L) length, (H) height, and (Dia.) diameter.

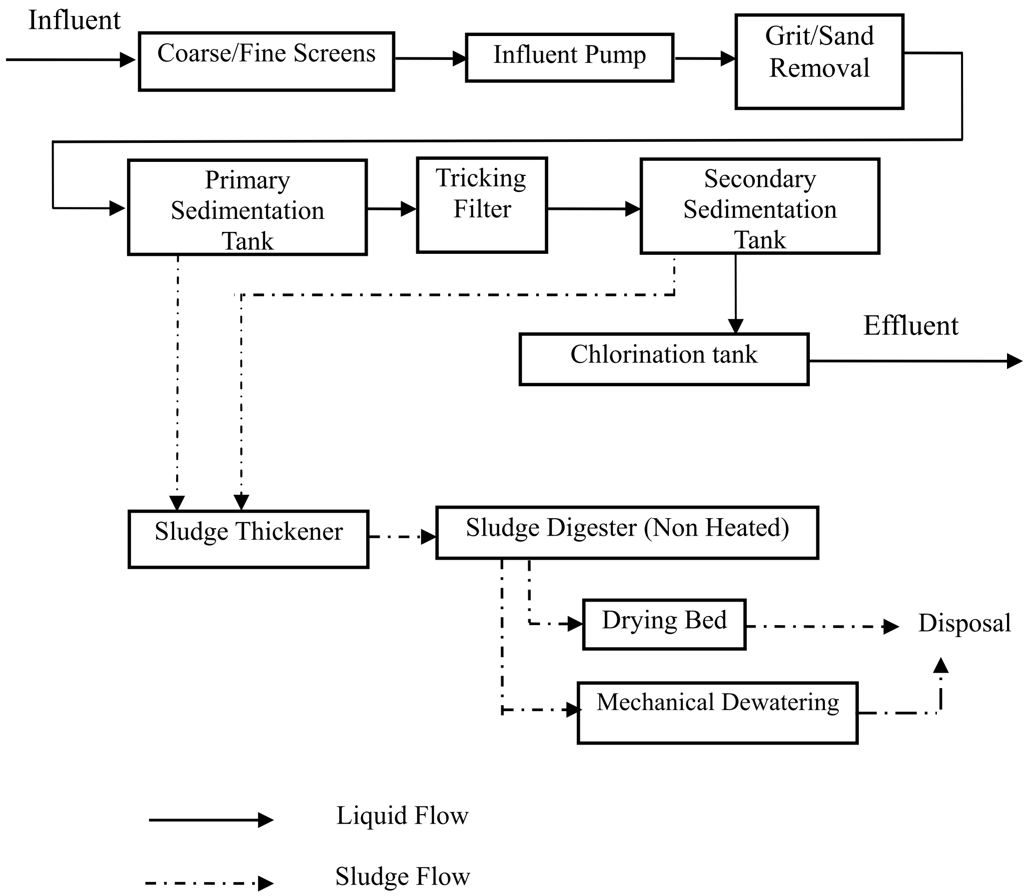


Figure S1.5.12 Flow Schematic of Sewerage Treatment Plants

Table S1.5.14 Kashar STP Facilities

Facility	Facility Type	Quality	Size, Capacity, Specs	Remarks
1. Preliminary Facility				
	1.1 Screening chamber			
	1) Coarse screen	4 units	(W) 1.2m	Manual raking
	2) Fine screen	4 units	(W) 1.2m, with mechanical cleaning equipment.	
	1.2 Grit chamber	4 units	Rectangular tank, (L) 20.5m×(W) 2.5m, with mechanical grit collector.	Hydraulic loading: 1,800 m^3/m^2/day
	1.3 Influent pumps			
	1) Vertical shaft type flow pumps	2 units	300mm dia.,33.0 m^3/min	
	2) Vertical shaft type flow pumps	4 units, inc. 1standby	700mm dia., 63.0 m^3/min	
2.Primary sedimentation tank	Rectangular type	32 units	(L) 40.5m×(W) 4.0m×(H) 3.0m, with a chain-and-flight type sludge collector	Overflow rate: 50 m^3/m^2/day
3.Trickling Filter	Circular type	64 units	(Dia.) 41.5m×(H) 1.5m	BOD_5 Loading: 0.3kgBOD/m^3/day Hydraulic loading: 3.0m^3/m^2/day
4. Secondary sedimentation tank	Circular radial flow type	24units	(Dia.) 26.2m×(H) 3.5m,with mechanical sludge collector	Overflow rate: 20 m^3/m^2/day
5. Chlorination contact tank	Rectangular type	1unit	(L) 224.0m×(W) 4.0m×(H) 3.0m	Contact time: 15minutes
6. Sludge thickener	Circular radial flow type	4 units	(Dia.) 15.0m×(H) 4.0m,with mechanical sludge collector	Solids loading: 60kg/m^2/day
7. Sludge digester	Circular type	16units	(Dia.) 19.6m×(H) 9.8m,without heating system	Retention time: 40 days
8.Sludge drying bed		15units, inc. 3stadby	1unit; (W) 6.0m×(L) 20.0m×(H) 0.2m × 20beds	Drying day:25days
9. Mechanical dewatering	Belt filter press	11units	Filter width: 3m	Filtration rate: 120kg/m/hour Ordinary Operaton: 6 days a week, 6 hours a day (Maximum 12 hours), 312 days/year

Source: JICA Study Team
Note: (W) width; (L) length, (H) height, and (Dia.) diameter.

Table S1.5.15 Berxulle STP Facilities

Facility	Facility Type	Quality	Size, Capacity, Specs	Remarks
1. Preliminary Facility				
	1.1 Screening chamber			
	1) Coarse screen	2 units	(W) 1.2m	Manual raking
	2) Fine screen	2 units	(W) 1.2m with mechanical cleaning equipment	
	1.2 Grit chamber	2 units	Rectangular tank, (L) 17.5m×(W) 1.2m, with mechanical grit collector.	Hydraulic loading: 1,800 $m^3/m^2/day$
	1.3 Influent pumps			
	1) Vertical shaft type flow pumps	2 units	(Dia.) 300mm, 13.0 m^3/min	
	2) Vertical shaft type flow pumps	3 units, inc. 1standby	(Dia.) 500mm, 26.0 m^3/min	
2.Primary sedimentation tank	Circular radial flow type	4 units	(Dia.) 18.5m×(H) 3.0m, with mechanical sludge collector	Overflow rate: 50 $m^3/m^2/day$
3.Tricking filter	Circular type	16 units	(Dia.) 37.5m×(H) 1.5m	BOD_5 Loading: 0.3kgBOD/m^3/day Hydraulic loading: 3.0$m^3/m^2/day$
4.Secondary sedimentation tank	Circular radial flow type	8 units	(Dia.) 20.5m×(H) 3.5m, with mechanical sludge collector	Hydraulic loading rate: 20 $m^3/m^2/day$
5. Chlorination tank	Rectangular type	1unit	(L) 46.0m×(W) 4.0m×(H) 3.0m	Contact time: 15miniute
6. Sludge thickener	Circular radial flow type	4 units	(Dia.) 10.0m×(H) 4.0m, with mechanical sludge collector	Solids loading: 60kg/m^2/day
7. Sludge digester	Circular type	4 units	(Dia.) 18.2m×(H) 9.2m, without heating system	Retention time: 40days
8.Sludge drying bed		12units, inc. 2stadby	1unt; (W) 6.0m×(L) 20.0m×(H) 0.2m×20beds	Drying day: 25days
9. Mechanical dewatering(Emergency)	Belt filter press	2 units	Filter width: 3.0m	Filtration rate: 120kg/m/hour Maximu Operaton: 6 days a week, 12 hours a day, maximum 55 days/year

Source: JICA Study Team
Note: (W) width; (L) length, (H) height, and (Dia.) diameter.

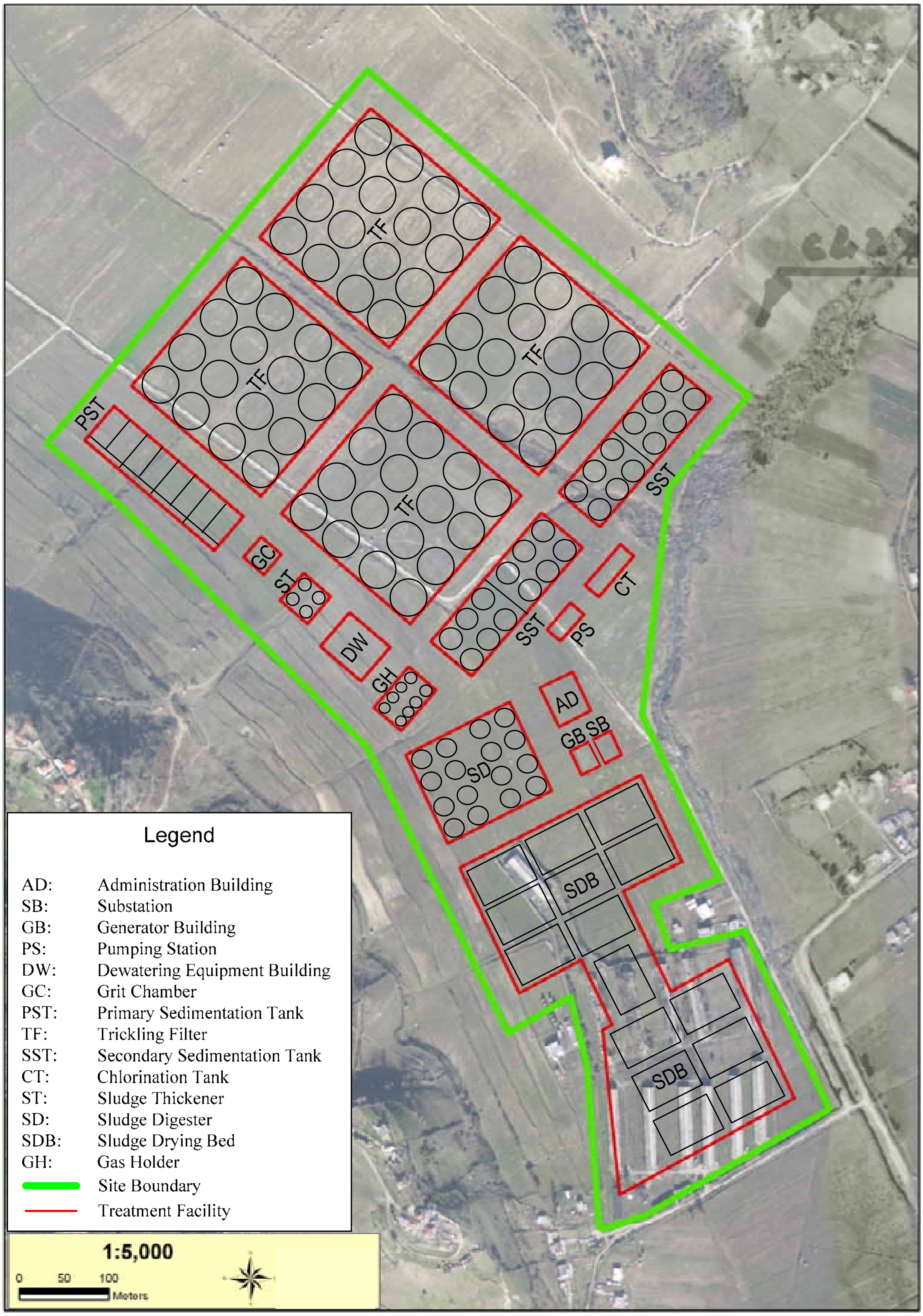


Figure S1.5.13 Layout Plan for Kashar STP

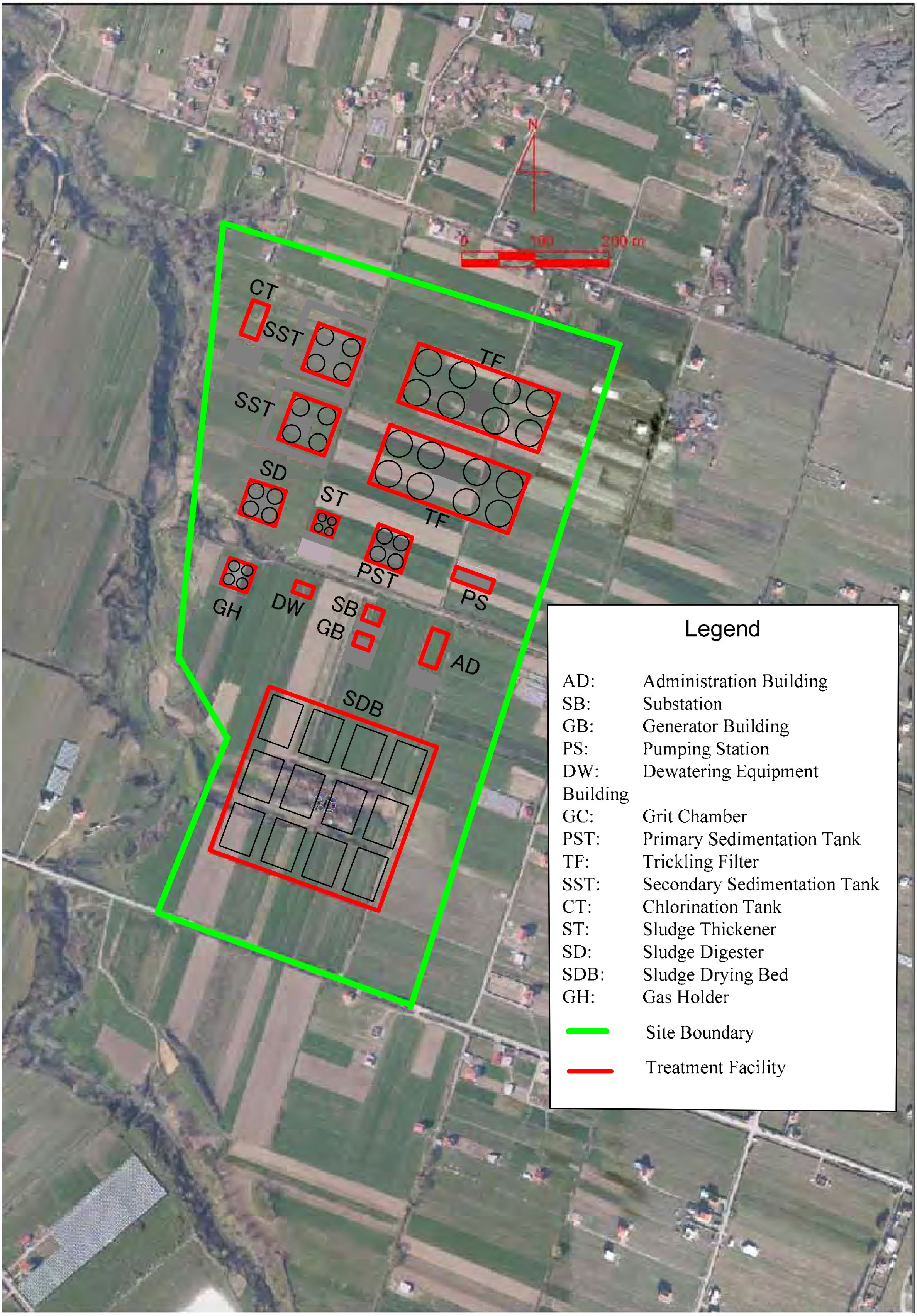


Figure S1.5.14 Layout Plan for Berxulle STP

1.5.6 Implementation Schedule

Staging the construction of the proposed sewerage facilities will mean that the capital expenditure can be spread over a number of years. A 13-year sewerage implementation program has been proposed and is shown in *Figure S1.15.15*. The implementation program consists of three consecutive construction stages beginning (at best) in 2009 and ending in 2021.

			Preparatory			First Stage					Second Stage				Third Stage				
No.	Stage	Item	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
0.		JICA Study																	
1.	**1st**	**Financing Arrangements (Loans, etc.,)**																	
2.1		**Selection of International and Local Consultants**																	
2.2		**Detailed Design and Tendering**																	
3.		**Pre Qualification and Contract**																	
4.		**Execusion of the 1st Stage Project Components**																	
5.		**Construction Supervision**																	
6.	**2nd**	**Financing Arrangements (Loans, etc.,)**																	
7.1		**Selection of International and Local Consultants**																	
7.2		**Detailed Design and Tendering**																	
8.		**Pre Qualification and Contract**																	
9.		**Execusion of the 2nd Stage Project Components**																	
10.		**Construction Supervision**																	
11.	**3rd**	**Financing Arrangements (Loans, etc.,)**																	
12.1		**Selection of International and Local Consultants**																	
12.2		**Detailed Design and Tendering**																	
13.		**Pre Qualification and Contract**																	
14.		**Execusion of the 3rd Stage Project Components**																	
15.		**Construction Supervision**																	

Figure S1.5.15 General Implementation Schedule

1.5.7 Phased Sewerage Development Plan

The construction stages for the sewerage facilities are summarized in *Table S1.5.16*.

Table S1.5.16 Staged Development Plan for Sewerage Facilities

Item	Construction Stage		
	First stage (Target 2013)	Second stage	Third stage (Target 2022)
1. Service Area	2,343 ha	6,090* ha	3,030 ha
2. Service Population	342,500 person	830,320* person	169,680 person
3. Sewage Flow 3.1 Design Average Daily Flow 3.2 Design Maximum Daily Flow	 77,100 m^3/day 95,900 m^3/day	 207,600* m^3/day 257,400* m^3/day	 42,400 m^3/day 52,600 m^3/day
4. Construction of Main and Branch Sewer (Diameter, Length)	200 to 600 mm, 29.4 km	200 to 600 mm,79.6 km	200 to 800 mm,74 km
5. Improvement Measures for the Existing Sewer	Installation of manhole with weirs and other measures related the Lana interceptors	Installation of manhole with weirs and other measures related to the Tirana Interceptors	—
6.Construction of Trunk Sewer (Diameter, Length)	900 to 1,500 mm, 4.4 km	450 to 1650mm, 10.4km	450 to1,350mm, 5.9km
7. Pumping Station Capacity (Maximum Hourly Flow)	No PS required.	Kashar Pumping Station, 213,500 m^3/day	Kamza Pumping Station, 50,700 m^3/day
8. Sewage Treatment Plant	Kashar STP	Kashar STP	Berxulle STP
8.1 Capacity (Maximum Daily Flow)	95,900 m^3/day	257,400 m^3/day (Extension: 161,500 m^3/day)	52,600 m^3/day
8.2 Sewage Treatment Facilities	Secondary sewage treatment facilities, Trickling Filter Process	Extension of the Secondary treatment facilities.	Secondary treatment facilities, Trickling Filter Process
8.3 Sludge Treatment Facilities	Sludge treatment facilities, Anaerobic Digestion, Sludge Drying Beds and Belt Filter Press.	Extension of the sludge treatment facilities	Sludge treatment facilities Anaerobic Digestion, Sludge Drying Beds and Belt Filter Press.

Note: * shows the figures for the ultimate design figures. It means that the planning figures are at the target year of 2022. The sewerage facilities are designed at the planning figures.

1.5.8 Expected River Water Quality Improvements

The main purpose for predicting water quality is to verify and justify the proposed project. The following water quality impacts have been predicted:

- Estimation of pollution load entering the rivers for scenarios with and without the project; and
- River water quality changes based on pollution load and flow rate at each reference point.

Water quality impacts have been estimated for the "with project" (Case B-3d). Since the projects are proposed to be implemented in a staged manner, the water quality impacts have been predicted for the final target year as well as for each stage (2014, 2018 and 2022). BOD was used as the key parameter when predicting water quality.

Reference points for the predicted water quality impacts are summarized in *Table S1.5.17* and *Figure S1.5.15*. The table lists the four reference points that were selected for pollution load estimation and water quality predictions.

Table S1.5.17 Reference Points for Water Quality Projection

River	Location	Description
Lana River	F1	Crossroad of "Rruga Konferenca e Pezes" and "Bulevardi Bajram Curri"
	R5	Before the confluence of Lana & Tirana Rivers, on the Lana River side.
Tirana River	R4	Before the confluence of Lana & Tirana Rivers on the Tirana River side.
	R6	After the discharge point from the proposed STP in Berxulle

(1) Value Setting For Water Quality Projection

The predicted water quality impacts have been determined assuming there is low flow in the river. The flow rate was determined by reviewing the last 10 years of flow record. The Albanian Institute of Hydrometeorology (IHM) has measured flow rates in Lana and Tirana Rivers, as mentioned in *Chapter 4*. However, the study team was not able to obtain the flow data for this study. Therefore, flow rate data presented in the former JICA study report was used.

1) Estimated Low Flow

The low flow at each reference point can be calculated by adding the sewage inflow volume at each reference point to the estimated base flow. The existing (year 2005) low flow rate calculated in this way is presented in *Table S1.5.18*. The future low flow rate is expected to change according to the future sewage inflow volume at each reference point.

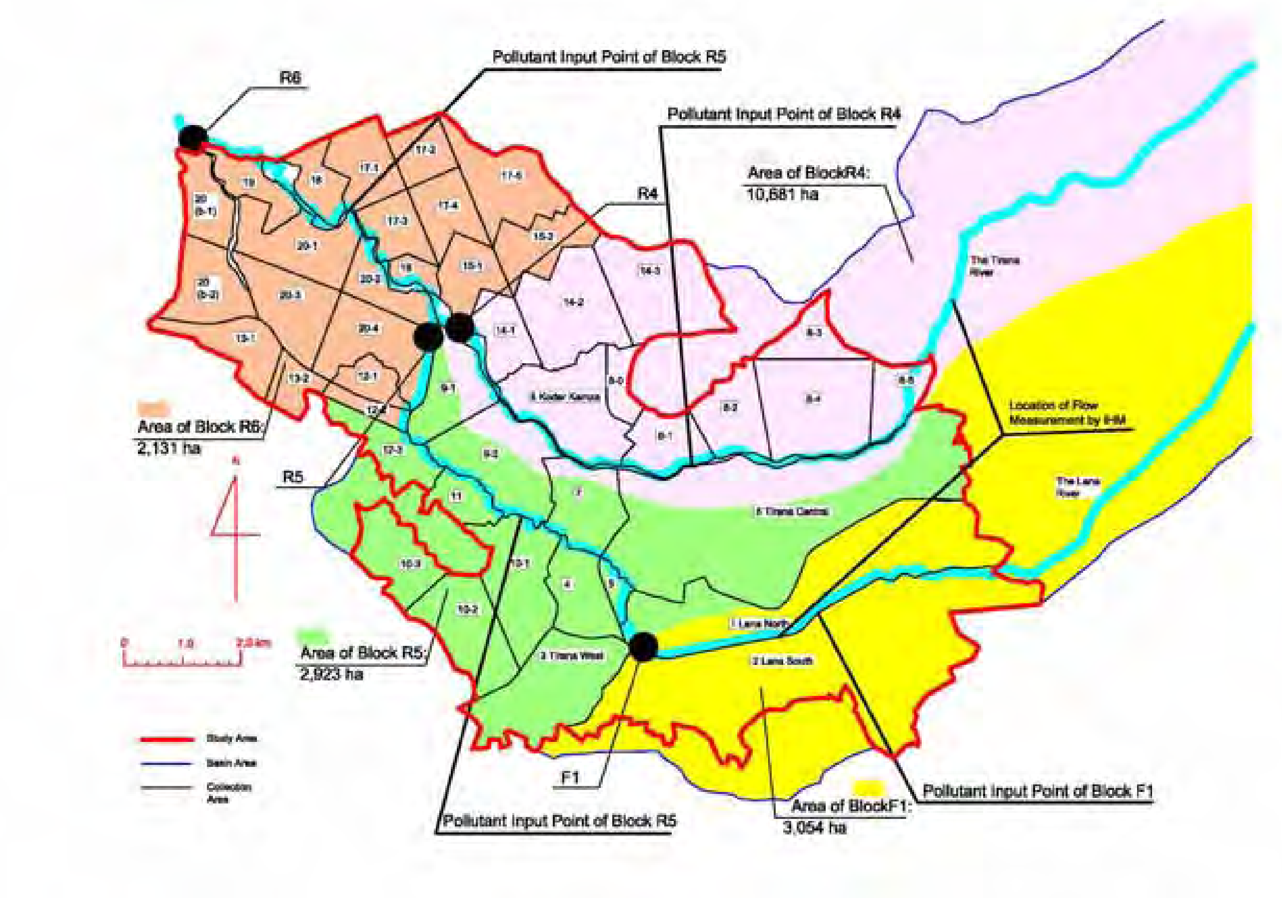


Figure S1.5.16 Area of each Block and Location of each Reference Point

Table S1.5.18 Low Flow Rate at each Reference Point

Name of the River	Reference Point	Total Low Flow (m^3/sec)	Low Base Flow Rate (excluding sewage inflow, m^3/sec)	Sewage Inflow			Industrial Effluent		
				Inflow by Block (m^3/d)	Cummulative (m^3/d)	Cummulative (m^3/sec)	Inflow by Block (m^3/d)	Cummulative (m^3/d)	Cummulative (m^3/sec)
		(a) + (b)	(a)			(b)			(b)
Lana	R1 (=L1)	0.12	0.12	0	0	0.00	0	0	0.00
	F1 (=L2)	0.69	0.23	39,743	39,743	0.46	0	0	0.00
	R5	1.49	0.45	48,437	88,180	1.02	1,500	1,500	0.02
Tirana	R3 (=T1)	1.30	1.30	0	0	0.00	0	0	0.00
	R4 (≒T3)	2.33	1.82	44,270	44,270	0.51	0	0	0.00
	R6	4.31	2.63	11,203	143,654	1.66	0	1,500	0.02

2) Existing Water Quality and Flow Time

The existing water quality (BOD) used to describe the existing condition is presented in *Table S1.5.19* The selection process was explained in Chapter 4 of the Part I of the Main Report. Data for F1 (same as point L2 that was set by IEP), R5 (almost the same as point L3 that was set by IEP), and R4 (almost the same as point T3 that was set by IEP) was taken from the last two years of data provided by IEP. This data represents the dry season when there are low flow conditions. R6 was obtained through subcontract work conducted as part of this study.

Table S1.5.19 Water Quality used in the Existing Condition Analysis

River	Reference Point	Present Water Quality (BOD_5 concentration)
Lana River	Boundary Condition	4.0 mg/L
	F1	95 mg/L
	R5	125 mg/L
Tirana River	Boundary Condition	1.4 mg/L
	R4	31 mg/L
	R6	53 mg/L

The flow time at each reference point was estimated based on the calculated flow velocity and the measured flow distance in each section. The results are presented in *Table S1.5.20*.

Table S1.5.20 Flow Time for each Section

Name of the River	Reference Point	Section	Flowing Time			Total Low Flow (m^3/sec)
				Average Flow Rate	Flow Distance	
			(day)	(m/sec)	(km)	(a) + (b)
Lana	R1 (=L1)	From R1Block Pollutant Input Point to R1				0.12
	F1 (=L2)	From F1 Block Pollutant Input Point to F1	**0.09549**	0.4	3.3	0.69
	R5	From F1 to R5	**0.15818**	0.6	8.2	
		From R5 Block Pollutant Input Point to R5	**0.07909**	0.6	4.1	1.49
Tirana	R3 (=T1)	From R3 Block Pollutant Input Point to R3				1.30
	R4 (≒T3)	From R4 Block Pollutant Input Point to R4	**0.11806**	0.5	5.1	2.33
	R6	From R4 to R6	**0.13503**	0.6	7.0	
		From R5 to R6 (input Lana River)	**0.13503**	0.6	7.0	
		From R6 Block Pollutant Input Point to R6	**0.06752**	0.6	3.5	4.31

3) Runoff Pollution Load Reaching the River

The unit pollution load per capita and sewage volume used in this analysis are shown in *Table S1.5.21*.

Table S1.5.21 Unit Pollution Load and Sewage Volume

Item	2005 (Present)	2014	2018	2022
Pollution Load per Capita (BOD kg/capita/day)	0.040	0.045	0.048	0.050
Sewage Volume per Capita (Liter/Capita/day)	200	226	238	250

The total pollutant load and sewage volume generated from each block under existing conditions and future conditions for the "Without Project" scenario were calculated based on the above unit values. The results of the calculations are shown in *Table S1.5.22*.

Table S1.5.22 Pollution Load and Sewage Volume Generated from each Block (Without Project)

		Population			
		2005	2014	2018	2022
Lana River	F1	198,715	219,482	228,712	237,941
	R5	242,187	281,917	299,574	317,232
Tirana River	R4	221,351	282,439	309,588	336,738
	R6	56,015	83,583	95,836	108,089
		718,268	867,420	933,709	1,000,000
		Generated Pollution Load (kg/d)			
		2005	**2014**	**2018**	**2022**
Lana River	F1	7,949	9,941	10,897	11,897
	R5	9,687	12,769	14,273	15,862
Tirana River	R4	8,854	12,792	14,750	16,837
	R6	2,241	3,786	4,566	5,404
		28,731	39,287	44,486	50,000
		Gemerated Sewage Volume (m^3/d)			
		2005	**2014**	**2018**	**2022**
Lana River	F1	39,743	49,603	54,433	59,485
	R5	48,437	63,713	71,299	79,308
Tirana River	R4	44,270	63,831	73,682	84,185
	R6	11,203	18,890	22,809	27,022
		143,653	196,037	222,223	250,000

The coefficient for the runoff pollution load reaching the river is set at between 0.5 and 0.8. The standard value for the coefficient of pollution load in runoff reaching the river is presented in the "Guidelines for Comprehensive Basin-wide Planning of Sewerage Systems, Ministry of Construction, Japan, 1999" (Japanese Guidelines).

The runoff pollution load reaching the river under existing and future conditions for the "Without Project" scenario was calculated based on the pollution load and runoff coefficient outlined above. The results are presented in *Table S1.5.23*.

Table S1.5.23 Runoff Pollution Load Reaching the River in Each Block (Without Project)

			Pollution Load reaching River (kg/d)			
			2005	2014	2018	2022
Without Project	Lana River	F1	6,359	7,953	8,717	9,518
		R5	7,589	9,988	11,159	12,395
	Tirana River	R4	6,629	9,504	10,932	12,453
		R6	1,215	2,056	2,481	2,938
		Total	21,793	29,501	33,289	37,303

Other pollutants enter the rivers. These originate from industries (whose wastewater is not accepted by the sewerage system), garbage dumping and agriculture. These pollutants are called "unspecified pollution load". Data regarding the amount of these pollutants being generated is not available. Therefore, the unspecified pollution load for the existing conditions was estimated as follows:

- Unspecified pollution load from F1 block is assumed to be 3% of the existing sewage pollution load. F1 block is located in the upper part of the Lana River catchment, in the central part of the urban area of Tirana city. This area is being targeted for the "Green & Clean Project". This project is being assisted by UNDP. This project is expected to reduce the amount of garbage being dumped in the area, hence the lower estimated load.
- Unspecified pollution loads from the R4, R5, and R6 are assumed to be 12.5% of the generated sewage pollution load solid.
- In case of R5, industrial wastewater pollution loads are also considered because in this bloc there are some factories such as meat processing, beer and soft drinks. About 2,200 kg/d are estimated as the current industrial pollution loads based on the estimated water consumption of UKT data available and effluent quality available from reference.

Table S1.5.24 presents the unspecified pollution load values.

Table S1.5.24 Unspecified Pollution Load from each Block

River	Reference Point	Generate BOD Load of Sewage (kg/d)	Assumed Unspecified BOD Load (kg/d)
Lana River	F1	7,949	248
	R5	9,687	3,456
Tirana River	R4	8,854	1,107
	R6	2,241	280

Figure S1.5.17 summarizes the existing condition, based on the above assumptions and calculations.

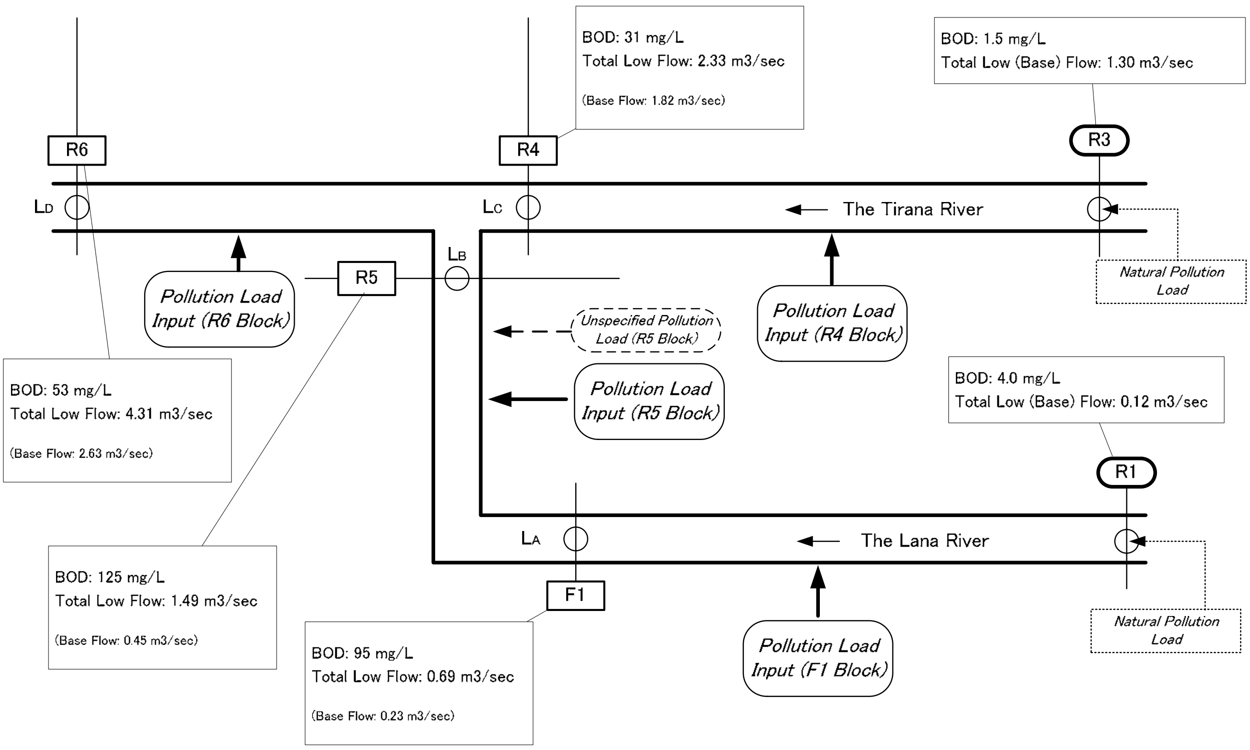


Figure S1.5.17 Schematic Diagram of Existing Conditions

4) Calculation of Self-purification Coefficient

The following model was applied when analyzing the pollution in the rivers.

- **Runoff coefficient reaching river**
  = (Pollution load reaching river) / (Generated pollution load)
- **Self-purification rate**
  = (Runoff pollution load reaching reference point) / (Pollution load reaching river)

The pollution load in runoff reaching the river is naturally purified as it flows downstream. The expected decreases in BOD concentration are calculated using the Streeter-Phelps equation:

- Rate of decrease in BOD concentration: $dC / dt = -k \times C$, where,
  - C: BOD concentration (mg/L)
  - t: Time (day)
  - k: self-purification coefficient (1/day)

The following schematic diagram (*Figure S1.5.18)* presents the self-purification coefficient for each section.

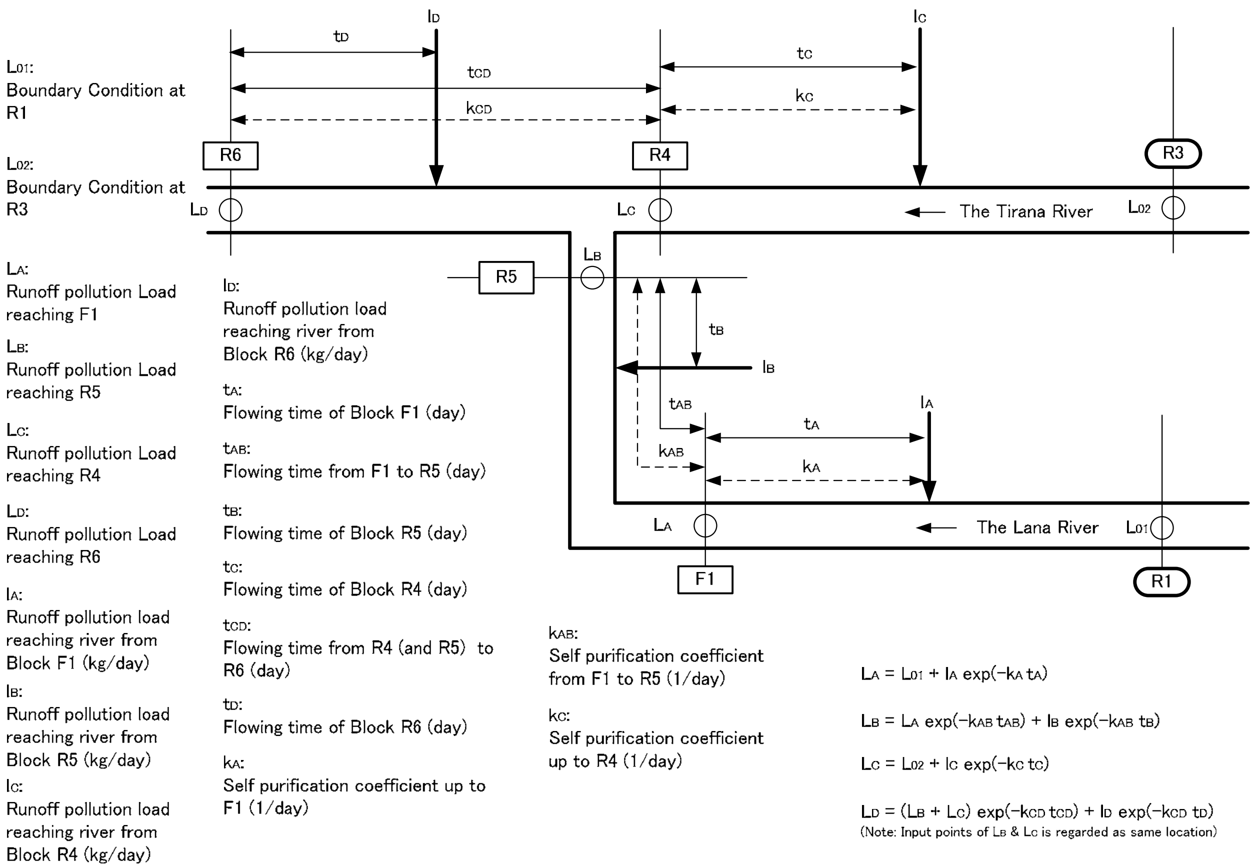


Figure S1.5.18 Calculation Formula for Self-purification Coefficient

The self-purification coefficient for each section was calculated using the above equation. The results are presented in *Table S1.5.25*.

Table S1.5.25 Self-purification Coefficient for each Section

River	Reference Point	Section	Runoff Pollution Load Reaching River (kg/d)				Average Flow Rate	Flow Distance	Flowing Time	Present Water Quality	Total Low Flow	Runoff Pollution Load Reaching Reference Point	Purification Rate	**Self-purification Coefficient**
			Sewage	Unspecified Pollutant	Total	Cummula-tive	(m/sec)	(km)	(day)	(mg/L)	(m3/sec)	(kg/d)		**(1/d)**
			①				②	③	④ = ③/②	⑤	⑥	⑦ = ⑤ x ⑥	⑧ = ⑦/Σ①	
Lana	R1	From R1 Block Pollution Load Input Point to R1					0	0.0	0	4.0	0.12	42		
	F1	R1 to F1			42									
		From F1 Block Pollution Load Input Point to F1	6,359	248	6,607	6,649	0.4	3.3	0.09549	95	0.69	5,683	0.855	**1.644**
	R5	F1 to R5			5,683		0.6	8.2	0.15818					
		From R5 Block Pollution Load Input Point to R5	7,589	3,456	11,045	16,729	0.6	4.1	0.07909	125	1.49	16,122	0.964	**0.350**
Tirana	R3	From R3 Block Pollution Load Input Point to R3					0	0.0	0	1.5	1.30	169		
	R4	R3 to R4			169		0	0.0	0					
		From R4 Block Pollution Load Input Point to R4	6,629	1,107	7,736	7,905	0.5	5.1	0.11806	31	2.33	6,236	0.789	**2.009**
	R6	R4 to R6			6,236		0.6	7.0	0.13503					
		R5 to R6			16,122		0.6	7.0	0.13503					
		From R6 Block Pollution Load Input Point to R6	1,215	280	1,496	23,854	0.6	3.5	0.06752	53	4.31	19,749	0.828	**1.446**

(2) Predicted Future Water Quality

The BOD load expected to reach each reference point during 2014, 2018 and 2022 if the project is not implemented was calculated. The predicted future BOD load originating from sewage (including STP discharge) reaching the river under the scenario of with the project during 2014,2018 and 2022.

Table S1.5.26 summarizes the predicted water quality at each reference point under the estimated low flow conditions. The results (0% reduction of unspecified pollution load) are summarized:

- At F1 of the Lana River in the urban center of Tirana Municipality, the BOD_5 would be decreased to about 13 mg/L after the first stage project, which is higher than 10 mg/L that would be acceptable level for conservation of environment.
- At R5 of the Lana Rive just before joining into the Tirana River, the water quality improvement would be expected after the second stage project. And the expected BOD concentration would be 29 mg/L that is higher than the effluent quality for STPs. This would be caused by that the almost all of river water flow under the low flow conditions would be the treated sewage flow from the Kashar STP and the remained pollution loads are the effluent of Kashar STP and the unspecified pollution loads (mainly of industrial wastewater).
- AT R4 of the Tirana River, the expected BOD_5 concentration would be 14 mg/L after

implementation of the second project which cover the entire area of Tirana Municipality and would be reached to 7 mg/L that would be acceptable level for the conservation of envirnment.

- At R6 of the Tirana River, the expected BOD5 concentration would be 22 mg/L after the second stage project by which the Kashar STP can be operated by full capacity and 17mg/L after the third stage project by which the Berxulle STP will be operated.

To achieve further improvement at each reference point, mitigation measures to address unspecified pollution loads (such as unregulated garbage dumping or direct discharge of industrial wastewater) should be developed and enforced in combination with the sewerage projects.

Table S1.5.26 Effect on Water Quality Improvement Assuming Reduction of Unspecified Pollution Loads by 0 %, 50 % and 66 %

		BOD (mg/L)			
		2005	**2014**	**2018**	**2022**
F1	W/O Project	95	101	103	105
	0%	95	13	13	13
	50%	95	7	7	7
	66%	95	6	6	6
R5	W/O Project	125	128	129	130
	0%	125	70	29	28
	50%	125	59	21	21
	66%	125	55	19	18
R4	W/O Project	31	39	42	45
	0%	31	39	14	7
	50%	31	37	12	4
	66%	31	36	11	3
R6	W/O Project	53	60	62	65
	0%	53	43	22	16
	50%	53	38	18	12
	66%	53	36	16	10

Note: W/O Project: without project, With Project: the figures in percentage show the expected unspecified pollution load reduction.

Trials to estimate water quality for Cases B-3d were undertaken using a simulation model based on the following assumptions:

- No mitigation measures to address unspecified pollution loads (0 % reduction of unspecified pollution load);

- 50 % reduction of unspecified pollution loads; and
- 66 % reduction of unspecified pollution loads.

The results (shown in *Table S1.5.26)* indicate that significant water quality improvements can be expected at F1, R4 and R6. AT R5 additional water sources would be required to expect the further water quality improvement.

1.5.9 Sewerage Operation and Maintenance

(1) O&M Tasks

Sewerage facilities such as sewers, pumping stations and sewage treatment plants only function efficiently if they are operated and maintained appropriately.

Sewers: The operation and maintenance of sewers involves three main tasks: regular inspection, cleaning, and repairing (as required).

Pumping Stations: To enable pumps to operate 24 hours a day, daily (or periodic) inspection and maintenance of the pumping facilities, screens and degriting facilities is required. The removal of screening waste and sands from the facility are required to reduce odor.

Sewage Treatment Plant: STP must operate 24 hours a day. It is therefore necessary for the facilities to be adequately controlled and daily (or periodic) inspections of the mechanical and electrical equipment be undertaken. Also, the water quality of the plant influent and effluent for the primary and secondary treatment facilities must be measured.

(2) O&M Staff

Figure S1.5.19 lists the maintenance staff that would be required to adequately operate and maintain the sewerage facilities. It is estimated that 120 staff would be required to operate and maintain the system.

- The administration section consists of a manager and two engineers who manage all the O&M tasks and manage the operational data (which is prepared by others in the organization).
- The water quality section consists of three chemists who are responsible for the measurement of water quality at the two STPs and provide advise to the STP operation crew .
- The STP operation and maintenance sections are responsible for the performance of STPs in Kashar and Berxulle. The section is also responsible for the disposal of grit and sludge.
- The PS operation and maintenance section is responsible for operation and maintenance of two the pumping stations.
- The sewer maintenance section includes the inspection subsection (responsible for checking the condition of sewers) and the cleaning/repairs subsection (responsible for cleaning and repairing the system).

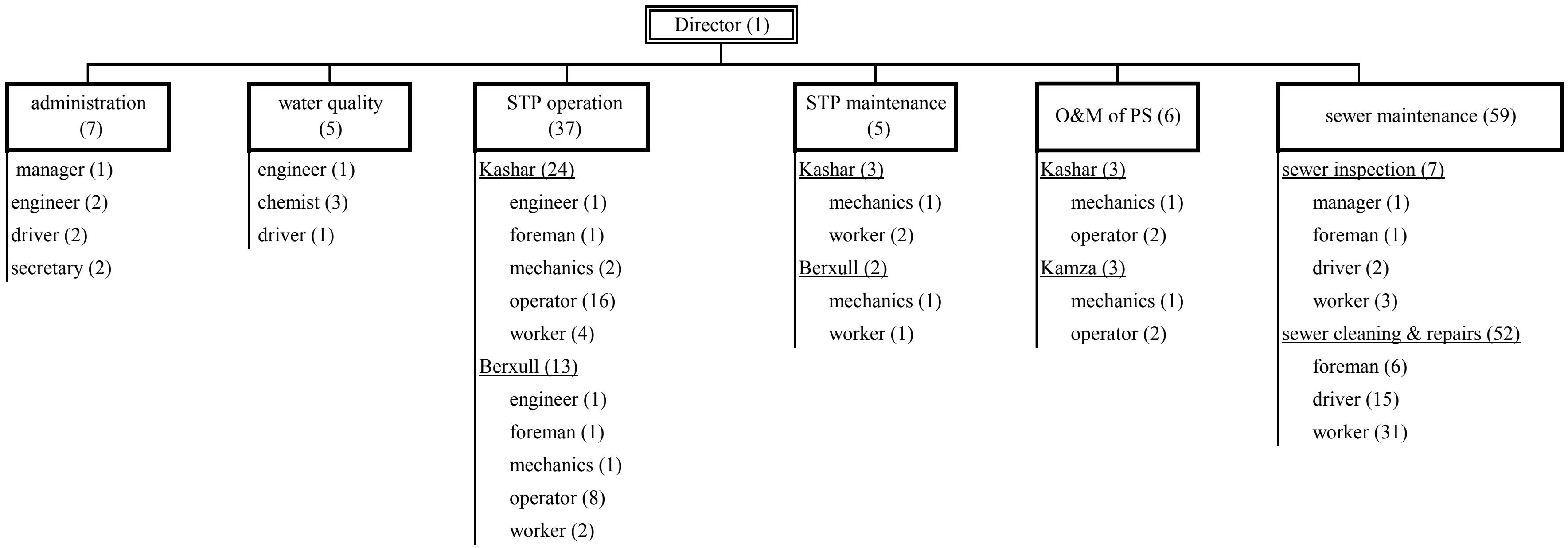


Figure S1.5.19 Organizational Chart for Sewerage Operation and Maintenance

1.5.10 Project Cost

The cost of each project component has been estimated and allocated in accordance with the implementation schedule shown in the *Figure S1.5.15*.

The project cost consists of estimates for the following items:

(1) Direct Construction Cost
(2) Indirect Construction Cost

Prices were estimated based on the exchange rates as at 1st of November, 2005, which were:

1 US Dollar = 107.23 Albanian Lek = 115.74 Japanese Yen
1 Euro = 129.463 Albanian Lek

The project cost includes a Foreign Currency (F.C.) portion and a Local Currency (L.C.) portion. The imported goods and services are estimated in the F.C. portion. The F.C. portion and L.C. portions are allocated applying their assumed ratios for each work item. Both portions are presented in terms of Albanian Leks.

(1) Direct Construction Cost

Because the pipes for construction of main sewers and branch sewers are locally available and can be installed by the open-cut method, the construction cost of main and branch sewers was estimated as as L.C. based on the actual construction cost experienced in Kamza municipality. It should be noted that the costs for branch sewers exclude the costs required to install house connections that are the pipes and accessories carrying the sewage from individual houses or buildings to a common/public sewer. Because it is practiced that the existing house connections are installed by the owners of the buildings and houses in the planning area, this practice shall be also continued, the costs of house connections shall be paid by the private owners. Construction cost required to enhance the existing main sewers by the installation of intercepting structures and to install new trunk sewers is estimated.

The construction cost of new trunk sewers were estimated using the “Cost function” in the “Guidelines and Commentary on the Comprehensive Basin-wide Program for the Development of Sewerage Systems” published by the Japan Sewage Works Association. The estimated cost was modified to reflect a realistic amount that could be applied to facilities within the Albanian Republic.

The construction costs for sewage treatment plants and pumping stations were estimated using Japanese experiences. The construction work for the STPs can be divided into civil/architectural work and mechanical/electrical work. These costs were estimated using a cost ratio of 35% for civil/architectural work and 65% for mechanical/electrical work.

(2) Indirect Construction Cost

The following costs were estimated as the indirect cost:

- Land Acquisition and Compensation;
- Administration;
- Engineering Services;
- Physical Contingency; and
- Capacity Building.

The land acquisition cost was estimated based on the value of land that is dedicated for public use. The cost is included as 100% of the L.C. The administrative costs is estimated to be 5% of the total direct construction cost and is allocated to the L.C. portion. The engineering services include detailed design, preparation of tender documents, bid evaluations, and construction supervision. The costs for engineering services were estimated to be 10% of the direct construction cost of each the F.C. and L.C. portions. The physical contingency is estimated to be 10% of the total direct construction cost. The expenditure required for implementing capacity building programs for each stage of the project have been estimated.

(3) Project Cost

Table S1.5.27 shows the project cost required to implement the whole proposed sewerage system development for case B-3d: Two STP System, including the cost required for each construction stage.

Table S1.5.27 Staged Project Cost for the Sewerage M/P

Unit: Million Lek

Component	1st Stage(2009-2013)			2nd Stage(2014-2017)			3rd Stage(2018-2021)			Projects Total		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
Direct Construction Cost												
Trunk Sewer	1,375	298	1,673	807	1,380	2,187	26	454	480	2,208	2,132	4,340
Main Sewers	0	376	376	0	1,644	1,644	0	1,400	1,400	0	3,420	3,420
Kashar PS	0	0	0	328	221	549	0	0	0	328	221	549
Kashar STP	2,292	1,526	3,818	2,950	1,968	4,918	0	0	0	5,242	3,494	8,736
Kamza PS	0	0	0	0	0	0	208	137	345	208	137	345
Burxull STP	0	0	0	0	0	0	1,419	948	2,367	1,419	948	2,367
Total of Direct Construction Cost	3,667	2,200	5,867	4,085	5,213	9,298	1,653	2,939	4,592	9,405	10,352	19,757
Indirect Construction Cost												
Land Acquisition and Compensation	-	3,068	3,068	-	1,550	1,550	-	0	0	-	4,618	4,618
Administrative Expenses	-	293	293	-	465	465	-	230	230	-	988	988
Engineering Services	367	220	587	409	521	930	165	294	459	941	1,035	1,976
Physical Contingency	367	220	587	409	521	930	165	294	459	941	1,035	1,976
Capacity Bilding Cost	96	51	147	108	36	144	27	9	36	231	96	327
Total of Indirect Cost	830	3,852	4,682	926	3,093	4,019	357	827	1,184	2,113	7,772	9,885
Total Project Cost	4,497	6,052	10,549	5,011	8,306	13,317	2,010	3,766	5,776	11,518	18,124	29,642

Source : JICA Study Team

1.5.11 Operational and Maintenance Cost

The O&M costs include the expenditure needed for the following items:

(1) Personnel;

(2) Power;

(3) Chemicals for disinfection, dewatering and water quality measurement;

(4) Sludge Disposal;
(5) Routine Equipment Repairs; and
(6) O&M of Sewers including inspection, cleaning and repairs.

The O/M cost required to operate and maintain the proposed sewerage facilities is summarized in *Table S1.5.28* and *Figure S1.5.20*.

Table S1.5.28 O&M Cost for the Proposed Sewerage M/P

Unit: $\times 10^3$Lek/year

After the first stage project

Year	2014	2015	2016	2017
Power Consumption	15,573	15,778	15,983	16,188
Chemicals	13,273	13,656	14,040	14、423
Personnel Cost	37,120	37,120	37,120	37,120
Routine Equipment Repair	10,427	10,427	10,427	10,427
Sludge Disposal	6,579	6,739	6,899	7,059
O&M and Repair for sewers	21,072	23,852	27,945	30,808
Total	104,044	107,572	112,414	11,6025

After the second stage project

Year	2018	2019	2020	2021
Power Consumption	68,943	70,998	73,083	75,197
Chemicals	50,943	52,673	54,425	56,199
Personnel Cost	66,340	66,340	66,340	66,340
Routine Equipment Repair	27,849	27,849	27,849	27,849
Sludge Disposal	22,253	22,976	23,708	24,449
O&M and Repair for sewers	33,944	36,857	38,812	40,911
Total	270,272	277,693	284,217	290,945

After the third Stage Project

Year	2022	20223	2024
Power Consumption	93,116	93,116	93,116
Chemicals	64,944	64,944	64,944
Personnel Cost	92,040	92,040	92,040
Routine Equipment Repair	47,129	47,129	47,129
Sludge Disposal	28,838	28,838	28,838
O&M and Repair for sewers	40,911	40,911	40,911
Total	366,978	366,978	366,978

The annual personnel cost estimates required for the staff of administration and economic department for sewerage services are 19 million Lek for the first stage project, 40.6 million Lek for the second stage project and 55.2 million Lek for third stage project. These cost estimates are included in the personnel cost in *Table S1.5.28,* assumed that a share rate of sewerage services against the whole water supply and sewerage service is set considering the connection number and its increase for each stage of the sewerage project: about 32% for first stage, 50% for the second and third stage project.

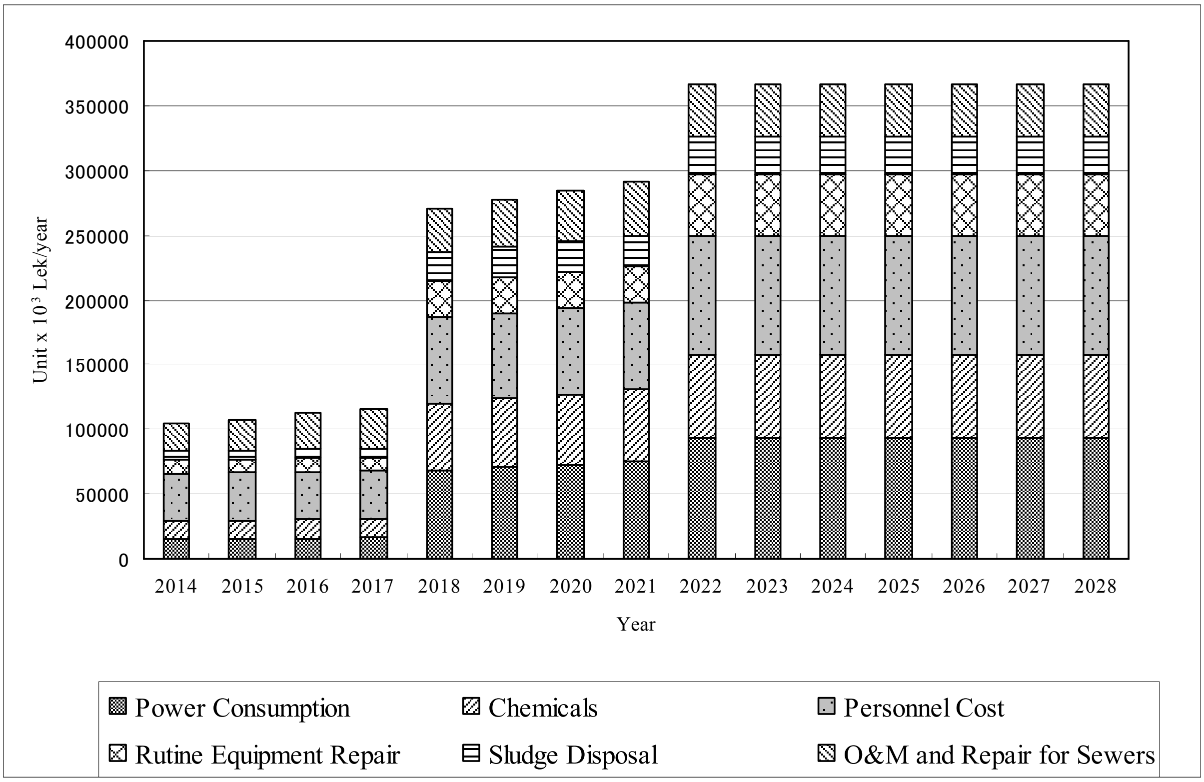


Figure S1.5.20 O&M Cost for the Proposed Sewerage M/P

1.5.12 Replacement Cost

A replacement cost for mechanical and electrical is estimated at Leks 2,482 million for the 1st stage project, Leks 3,552 million for the 2nd stage project and Leks 1,763 million for the 3rd stage project. The replacement cost will be derived at the time of every 15 years after the completion of the works of each construction stage.

1.6. Project Evaluation

1.6.1 Technical Evaluations

The technical evaluation considered the following:

- Appropriateness of technology levels;
- O&M requirements to run the proposed sewerage system; and
- The Project impacts.