10.3.2 Comparison of Sub-Alternatives of Case B

(1) Construction and O&M Cost Comparison

Table 10.3.3 presents the construction and O&M cost comparison for the sub-alternatives. There is no significant difference in construction cost between the sub-alternatives. However, the pumping costs result in significant differences for the O&M costs for Cases B-1 to B-3. This is because the ground level elevation at the STP site is highest for Case B-1 and lowest for B-2. The higher O&M costs for Case B-4 are a result of the pumping requirements and the need for mechanical and electrical facilities to treat the sewage and sludge, since the size of the area is limited.

Table 10.3.3 Cost Comparison for Sub-Alternatives

Case	Trunk Sewers		Other Sewers		STPs and PSs.		Total	
	Construction Cost	O&M	Construction Cost	O&M	Construction Cost	O&M	Construction Cost	O&M
B-1	0.916	0.915	1.000	1.000	0.949	1.500	0.964	1.331
B-2	0.952	0.949	1.000	1.000	0.949	0.913	0.974	0.940
B-3	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
B-4	0.951	1.136	1.000	1.000	1.045	1.017	0.999	1.017

(2) Project Impacts on Water Quality Improvements by each Alternative

Water quality impacts have been estimated for the five “with project” options (Case B-1, Case B-2, Case B-3 and Case B-4). 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). Future water quality for Case B-1, Case B-2 and CaseB-3 is expected to be the same, because all of these alternatives have the same collection areas for the proposed STPs, and their discharge points are related to the same reference points.

Therefore, future water quality predictions were made for the following two cases:

- Without Project vs. Case B-1, Case B-2 and CaseB-3; and
- Without Project vs. Case B-4.

BOD_5 was used as the key parameter when predicting water quality at the end of each phase (2014, 2018 and 2022). The predictions assumed a low flow rate, taken from “The Study on the Sewerage System in Metropolitan Tirana in the Republic of Albania, Final Report” (Former JICA Study Report 1998).

Reference points for the predicted water quality impacts are summarized in *Table 10.3.4* and *Figure*

10.3.6. The table lists the four reference points that were selected for pollution load estimation and water quality predictions.

Table 10.3.4 Reference Points for Water Quality Projection

River	Reference Point	Location
The 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.
The 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

Details about the modeling and calculations are provided in Appendix-3 Water Quality, Vol. III Supporting Report.

Table 10.3.5 summarizes the predicted water quality at each reference point under the estimated low flow conditions.

Table 10.3.5 Summary of Estimated Low Flow Rates and Predicted Water Quality at each Reference Point

		Flow Rate (m^3/sec)				BOD_5 (mg/L)			
		2005	2014	2018	2022	2005	2014	2018	2022
F1	W/O Project	0.69	0.81	0.86	0.92	95	101	103	105
	B-1, 2, 3	0.69	0.23	0.23	0.23	95	13	13	13
	B-4	0.69	0.23	0.23	0.23	95	13	13	13
R5	W/O Project	1.49	1.78	1.93	2.08	125	128	129	130
	B-1, 2, 3	1.49	2.18	2.63	2.87	125	125	29	28
	B-4	1.49	2.18	0.87	0.93	125	106	56	53
R4	W/O Project	2.33	2.55	2.67	2.79	31	39	42	45
	B-1, 2, 3	2.33	2.16	1.97	1.82	31	23	14	7
	B-4	2.33	2.16	3.73	3.76	31	24	16	11
R6	W/O Project	4.31	4.92	5.22	5.54	53	60	62	65
	B-1, 2, 3	4.31	4.92	5.22	5.54	53	59	22	16
	B-4	4.31	4.92	5.22	5.54	53	52	23	16

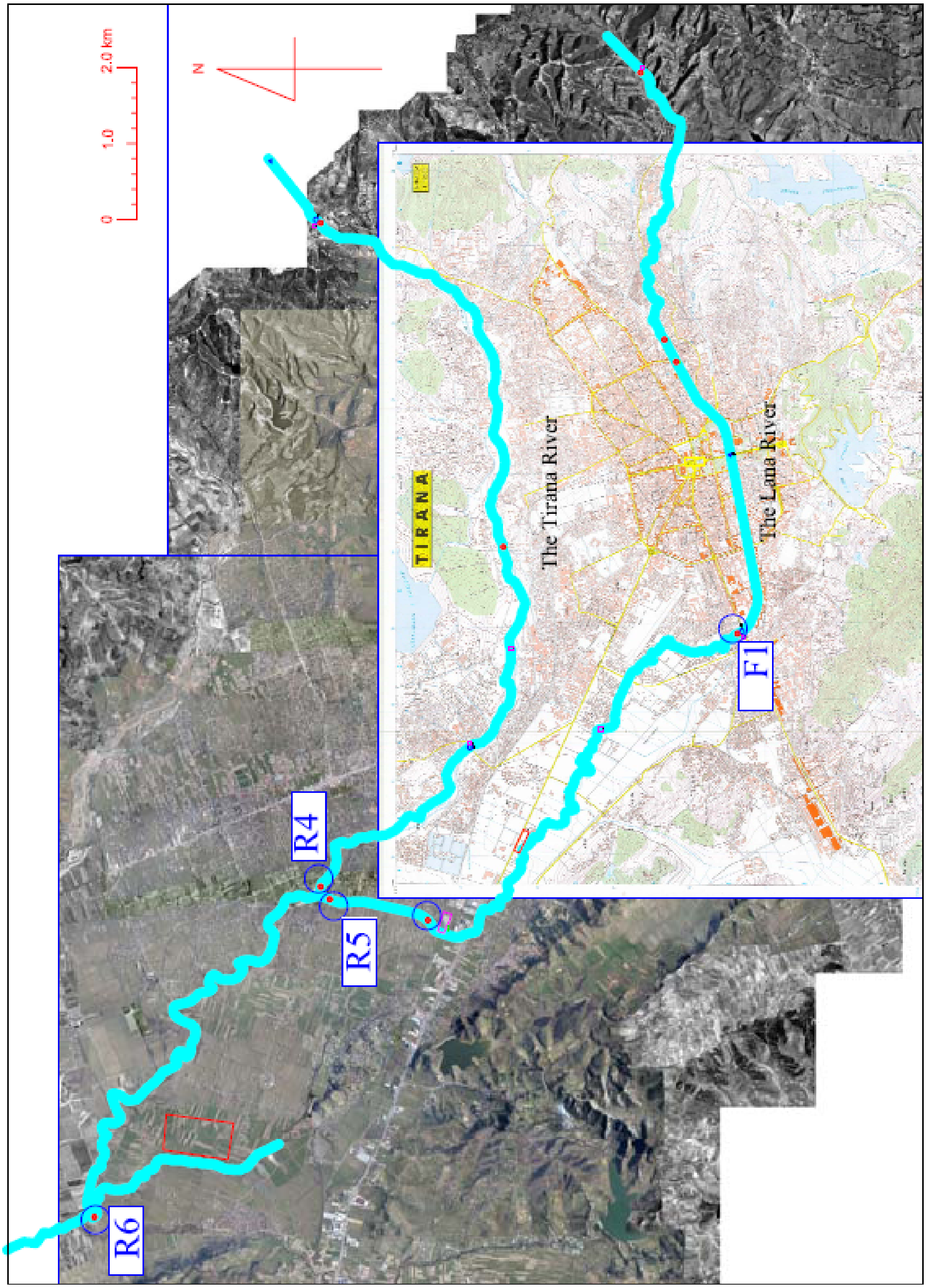


Figure 10.3.6 Reference Points

The results in Table 10.3.5 indicate:

- The flow rate at F1 in Lana River for both cases reduces significantly after 2014 and the BOD_5 concentrations also decrease significantly. These are because the sewage is not directly discharged to the river but conveyed to the Kashar STP.
- The flow rate at R5 in Lana River for Case B-4 reduces more significantly after 2018 than for Cases B-1, 2, 3. This is because the sewage that currently flows directly into Lana River will be forwarded to the proposed STP at Tirana and will then be discharged into Tirana River. The flow rate at R4 in Tirana River for Case B-4 increases after 2018.
- The BOD_5 concentrations during 2022 for Case B-1, 2, 3 and B-4 indicate that:
  - Cases B-1, 2, 3 would result in better water quality at R5 and R4 than Case B-4; and
  - There is no significant difference in BOD_5 concentration between the cases in R6.

Cases B-1, 2, 3 have the following advantages:

- an improved water quality at an earlier stage can be expected at R5 after 2018; and
- The changes in flow rate resulting from project implementation are relatively moderate compared to the other cases.

(3) Selection of Sub-alternative

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.

10.4 Comparison of Case A and Case B-3

In the following the two alternatives as the best options for the sewerage development for the Greater Tirana area will be compared to select the best option.

(1) Pollution Load Index

A Pollution Load Index can be used to evaluate the alternatives. The index is ratio of the average remaining pollution load, calculated using the following equation:

$$\text{Pollution Load Index} = \frac{\text{Total Influent Load - }\Sigma\text{removed by Treatment Process}}{\text{Total Influent Load to the Sewerage System}}$$

$$= \frac{\text{Remained Effluent Loads}}{\text{Total Influent Load to the Sewerage System}}$$

Note: Secodary treatment: 90 % removal in terms of BOD_5
Primary treatment: 30% removal interm of BOD_5

Table 10.4.1 indicates that the pollution load index for Case A is 71 in the second stage and 67 in the third stage. This indicates that Case A would improve the water quality sooner.

Table 10.4.1 Pollution Load Index for Staged Implementation of Treatment: Case A

Stage		Without Project	After 1st Stage Project (2014-17)	After 2nd Stage Project (2018-2021)	After 3rd Stage Project (2022-)
Sewage Treatment Level	Tirana	No treatment	**Primary**	**Primary**	**Secondary**
	Kashar (East)	No treatment	**Primary**	**Primary**	**Secondary**
	Kashar (West)	No treatment	No treatment	No treatment	**Secondary**
	Paskuqan	No treatment	**Primary**	**Primary**	**Secondary**
	Kamza(Central)	No treatment	No treatment	**Primary**	**Secondary**
	Kamza(South)	No treatment	No treatment	No treatment	**Secondary**
	Berxulle	No treatment	No treatment	No treatment	**Secondary**
Pollution Load Index		100	71	67	10

Note: Secondary treatment: 90% removal of BOD_5, Primary treatment: 30% removal of BOD_5
Index is calculated based on planning population/sewage volume.

However, Case A would have the following disadvantages:

- Pollution load reduction remains at about 30% until the third stage of the project.
- Secondary sewage treatment can be realized if a long distance trunk sewer is constructed to the Berxulle STP. This could occur after the third stage of the project.

Table 10.4.2 Pollution Load Index for Staged implementation of Treatment: Case B-3

Stage		Without Project	After 1st Stage Project (2014-17)	After 2rd Stage Project (2018-2021)	After 3rd Stage Project (2022-)
Sewage Treatment Level	Tirana	No treatment	**Primary**	**Secondary**	**Secondary**
	Kashar (East)	No treatment	**Primary**	**Secondary**	**Secondary**
	Kashar (West)	No treatment	**Primary**	**Secondary**	**Secondary**
	Paskuqan	No treatment	**Primary**	**Secondary**	**Secondary**
	Kamza(Central)	No treatment	No treatment	No treatment	**Secondary**
	Kamza(South)	No treatment	No treatment	No treatment	**Secondary**
	Berxulle	No treatment	No treatment	No treatment	**Secondary**
Pollution Load Index		100	71	25	10

Note: Secondary treatment: 90% removal of BOD, Primary treatment: 30% removal of BOD
Index is calculated based on planning population/sewage volume.

The index for Case B-3 during the third stage is much smaller than that of Case A (*Table 10.4.2*). This means that Case B-3 could achieve earlier water quality improvement as a result of the construction of secondary treatment facilities during the second stage of the project.

(2) Cost Comparison

The cost for Case A and Case B-3 is estimated. The estimated cost compared and used for evaluating with an investment index as shown in the following sub-section.

1) Project Cost

The direct construction cost for both cases to develop the major sewerage facilities components has been estimated for comparison and is presented in *Table 10.4.3* and *Table 10.4.4,* respectively.

Table 10.4.3 Project Cost for Case A: Single STP System

(Unit: Million Leks)

Component	First Stage			2nd Stage			3rd Stage			Projects Total		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
Direct Construction Cost												
Trunk Sewer	4,320	0	4,320	4,222	0	4,222	6,378	0	6,378	14,920	0	14,920
Main and Branch Sewers	0	683	683	0	1,490	1,490	0	1,065	1,065	0	3,238	3,238
Primary Treatment Plant: Kamza Pri-T	0	0	0	1,086	194	1,280	0	0	0	1,086	194	1,280
Primary Treatment Plant: Kashar Pri-T	2,978	529	3,507	226	40	266	0	0	0	3,204	569	3,773
Secondary Treatment Plant: Burxulle STP	0	0	0	0	0	0	8,520	1,515	10,035	8,520	1,515	10,035
Total of Direct Construction Cost	7,298	1,212	8,510	5,534	1,724	7,258	14,898	2,580	17,478	27,730	5,516	33,246
Indirect Construction Cost												
Land Acquisiotion and Conpensation	-	562	562	-	1,542	1,542	-	0	0	-	2,104	2,104
Administrative Expenses	-	426	426	-	363	363	-	874	874	-	1,663	1,663
Engineering Services	730	121	851	553	172	725	1,490	258	1,748	2,773	551	3,324
Physical Contigency	730	121	851	553	172	725	1,490	258	1,748	2,773	551	3,324
Total of Indirect Cost	1,460	1,230	2,690	1,106	2,249	3,355	2,980	1,390	4,370	5,546	4,869	10,415
Total Project Cost	8,758	2,442	11,200	6,640	3,973	10,613	17,878	3,970	21,848	33,276	10,385	43,661

Table 10.4.4 Project Cost for Case B-3: Two STP System

(Unit: Million Leks)

Component	1st Stage			2nd Stage			3rd Stage			Projects Total		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
Direct Construction Cost												
Trunk Sewer	6,110	0	6,110	904	0	904	3,848	0	3,848	10,862	0	10,862
Main and Branch Sewers	0	683	683	0	1,490	1,490	0	1,065	1,065	0	3,238	3,238
Kashar PS	548	98	646	0	0	0	0	0	0	548	98	646
Kashar STP	2,365	421	2,786	4,919	875	5,794	0	0	0	7,284	1,296	8,580
Kamza PS	0	0	0	0	0	0	344	62	406	344	62	406
Burxulle STP	0	0	0	0	0	0	2,533	450	2,983	2,533	450	2,983
Total of Direct Construction Cost	9,023	1,202	10,225	5,823	2,365	8,188	6,725	1,577	8,302	21,571	5,144	26,715
Indirect Construction Cost												
Land Acquisition and Compensation	-	3,068	3,068	-	1,550	1,550	-	0	0	-	4,618	4,618
Administrative Expenses*	-	511	511	-	409	409	-	415	415	-	1,335	1,335
Engineering Services	902	120	1,022	582	237	819	673	158	831	2,157	515	2,672
Physical Contingency	902	120	1,022	582	237	819	673	158	831	2,157	515	2,672
Total of Indirect Cost	1,804	3,819	5,623	1,164	2,433	3,597	1,346	731	2,077	4,314	6,983	11,297
Total Project Cost	10,827	5,021	15,848	6,987	4,798	11,785	8,071	2,308	10,379	25,885	12,127	38,012

Land acquisition cost is estimated as presented in *Table 10.4.5*. The unit cost is based on the commercial rate at the proposed sites.

Table 10.4.5 Land Acquisition Cost

Component	Land Space (ha)	Unit Cost (Million Leks/ha)	Cost (Million Leks)	Case A	Case B-3
Kashar PS	0.6	64.73 1)	39		39
Kamza PS	0.4	20.00	8		8
Kashar Pri-T	4.0	129.46 3)	518	518	
Kamza Pri-T	2.2	20.00	44	44	
Kashar STP	46.8	64.73 1)	3,029		3,029
Berxulle STP	39.7	38.40 2)	1,542	1,542	1,542
Total				2,104	4,618

Note: 1) 50 Euro/m^2, 2) 30 Euro/m^2, 3) 100 Euro/m^2
1 Euro = 129.463 Leks

2) O&M Cost

The O&M costs required to operate the proposed sewerage system components have been estimated in *Table 10.4.6* for Cases A and B-3, respectively. The O&M cost is estimated for comparison, the following major items: power cost, chemical cost and personnel cost are selected and estimated.

Table 10.4.6 Comparison of Major O&M Cost for Case A and Case B-3

Case	O&M Cost Component	After First Stage (2014 – 2017) (Million Lek/year)	After Second Stage (2018 – 2021) (Million Lek/year)	After Third Stage (after 2022) (Million Lek/year)
A	Power	28.5 – 35.3	35.5 – 36.1	78.4 – 78.4
	Chemical	52.3 – 68.1	68.3 – 69.7	70.6 – 131.3
	Personnel	16.5 – 16.5	26.5 – 26.5	42.5 – 42.5
	O&M Total	97.3 – 119.9	130.3 – 132.3	191.5 – 252.2
B-3	Power	19.5 – 21.6	24.4 – 24.4	39.3 – 39.3
	Chemical	15.2 – 15.0	15.0 – 15.0	17.6 – 21.1
	Personnel	18.0 – 18.0	24.5 – 24.5	42.5 – 42.5
	O&M Total	52.7 – 54.6	63.9 – 63.9	99.4 – 102.9

Note: Power cost is based on power consumption, chemical cost is based on requirement of hypochlorite for chlorination and polymer required for mechanical sludge dewatering, and personnel cost is O&M staff for the proposed sewerage system for each case.

3) Cost Comparison

Table 10.4.7 compares the construction costs and the O&M costs. Case B -3 has lower costs than Case A, as defined here: 0.80 for construction cost and about 0.50 for O&M cost.

Table 10.4.7 Cost Comparison for Case A and Case B -3

Items		Case A	Case B -3	Remark
Construction Cost (ratio)	Trunk Sewer	1.00	0.73	
	Other Sewers	1.00	1.00	
	STP and PS	1.00	0.84	
	Total	1.00	0.80	A>B
O&M Cost at the ultimate stage (ratio)		1.00	0.45 – 0.52	A>B

(3) Investment Index

Another index called the “Investment Index”, was used to verify the effectiveness of the staged investment to reduce pollution loads. The index is calculated using the following equation:

$$\text{Investment Index} = \frac{\text{Pollution Load removed by Sewerage}}{\text{Cumulative Investment Cost to Sewerage}}$$

This index shows how much pollution load can be removed for the same amount of investment in the sewerage system, for different options. A higher figure means that improvement in water quality can be achieved for a lower investment cost.

Table 10.4.8 and *Table 10.4.9* present the investment index for Case A and Case B-3, respectively. *Table 10.4.10* compares the investment index for both cases. Case A has a higher Investment Index during the first stage. Case B-3 has a much higher Investment Index during the second and third stages. This means that Case A achieves higher performance than Case B-3 during the first stage of implementation. This is because primary treatment can be provided for a lower capital investment. Case B-3 achieves a higher performance once the second stage is implemented, because secondary treatment is introduced. Based on the Investment Index, Case B -3 is the preferred option.

Table 10.4.8 Investment Index for Case A

Item		1st stage	2nd Stage	3rd stage	Target year
		(2010-13)	(2014-17)	(2018-2021)	(2022-)
Pollution Load Index		**100**	**71**	**67**	**10**
Each Investment (10^6 Lek)	Trunk Sewer	4,320	4,222	6,378	
	Other Sewers	683	1,490	1,065	
	STP and Pri-Ts	3,507	1,546	10,035	
	Total	8,510	7,258	17,478	
Cumulative Investment (10^6 Lek)	Trunk Sewer	4,320	8,542	14,920	
	Other Sewers	683	2,173	3,238	
	STP and Pri-Ts	3,507	5,053	15,088	
	Total	8,510	15,768	33,246	
Investment Ratio (%)		26	22	53	
Δ load (point)		29.0	33.0	90.0	
Cumulative investment (point)		8.5	15.8	33.2	
Investment Index (Δ load/cum. investment)		**3.4**	**2.1**	**2.7**	

Table 10.4.9 Investment Index for Case B -3

Item		1st stage (2010-13)	2nd Stage (2014-17)	3rd stage (2018-2021)	Target year (2022-)
Pollution Load Index		100	71	25	10
Each Investment (10^6 Lek)	Trunk Sewer	6,110	904	3,848	
	Other Sewers	683	1,490	1,065	
	STPs and PSs	3,432	5,794	3,389	
	Total	10,225	8,188	8,302	
Cumulative Investment (10^6 Lek)	Trunk Sewer	6,110	7,014	10,862	
	Other Sewers	683	2,173	3,238	
	STPs and PSs	3,432	9,226	12,615	
	Total	10,225	18,413	26,715	
Investment Ratio (%)		38	31	31	

Item					
Δ load (point)		29.0	75.0	90.0	
Cumulative Investment (point)		10.2	18.4	26.7	
Investment Index (Δ load/cum. Investment)		**2.84**	**4.1**	**3.4**	

Table 10.4.10 Comparison of Investment Index for Case A and Case B -3

Item		Case A	Case B-3	Remarks
Investment Index	1st stage	3.4	2.8	A>B
	2nd stage	2.1	4.1	A<<B
	3rd stage	2.7	3.4	A<B

(4) River Water Quality Improvement by Case A and Case B-3

Water quality improvements by the projects are predicted for Case A and for Case B-3, respectively. *Table 10.4.11* summarizes the predicted water quality at each reference point under the low flow conditions.

The results indicate:

- Cases B-3 would result in improved water quality at an earlier stage at R5 and R6 before Case A.
- Case A would result in high BOD_5 concentration at R5 even after the completion of the proposed sewerage projects. This is because that the pollution loads from the industries between F1 and R5 is fixed at the present level and the flow rate decreased by the sewage is conveyed to the proposed Berxulle STP. But the Case B-3 the flow rate is maintained high with the treated sewage from the proposed Kashar STP.

Table 10.4.11 Summary of Estimated Low Flow Rates and Predicted Water Quality at each Reference Point

		Flow Rate (m^3/sec)				BOD_5 (mg/L)			
		2005	2014	2018	2022	2005	2014	2018	2022
F1	W/O Project	0.69	0.81	0.86	0.92	95	101	103	105
	A	0.69	0.23	0.23	0.23	95	13	13	13
	B-1, 2, 3	0.69	0.23	0.23	0.23	95	13	13	13
R5	W/O Project	1.49	1.78	1.93	2.08	125	128	129	130
	A	1.49	2.17	2.62	0.47	125	106	108	88
	B-1, 2, 3	1.49	2.18	2.63	2.87	125	125	29	28
R4	W/O Project	2.33	2.55	2.67	2.79	31	39	42	45
	A	2.33	2.17	1.82	1.82	31	18	7	7
	B-1, 2, 3	2.33	2.16	1.97	1.82	31	23	14	7
R6	W/O Project	4.31	4.92	5.22	5.54	53	60	62	65
	A	4.31	4.92	5.22	5.54	53	49	56	17
	B-1, 2, 3	4.31	4.92	5.22	5.54	53	59	22	16

(5) Selected Alternative

The comparisons and evaluation of the alternatives indicate that Case B-3 is preferred for the Greater Tirana area. Case B-3 in particular is selected as the preferred alternative because it has the largest available site for the STP based on consultation with the mayor for Kashar commune.

10.5 Further Studies for Systems Conveying Sewage to the STP

10.5.1 Sewerage System Development Plan (up to the year 2022)

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.

10.5.2 Alternatives for the Trunk Sewer System

(1) Considerations for the Trunk Sewer Routes

A survey was undertaken to identify possible routes for laying the trunk sewers using the open cut method. The survey checked for the following requirements:

1) Sufficient width for laying of 1000mm or 2000mm diameter pipes using the open cut method;
2) Avoiding gates, private zones, sharp curves, and acute angle corners to prevent interruptions to the sewer laying work;
3) Topographic conditions that minimize the depth of the excavation work;

4) Low density buildings and houses to avoid adverse impacts;
5) Availability of appropriate sites for pumping stations; and
6) Avoiding locations such as rivers, streams, highways, crowded places and other structures to improve the conditions for construction.

(2) Options for the Trunk Sewer System

The survey results indicate four possible trunk sewer routes as shown in *Figure 10.5.1* to *Figure 10.5.4.* 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.

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.

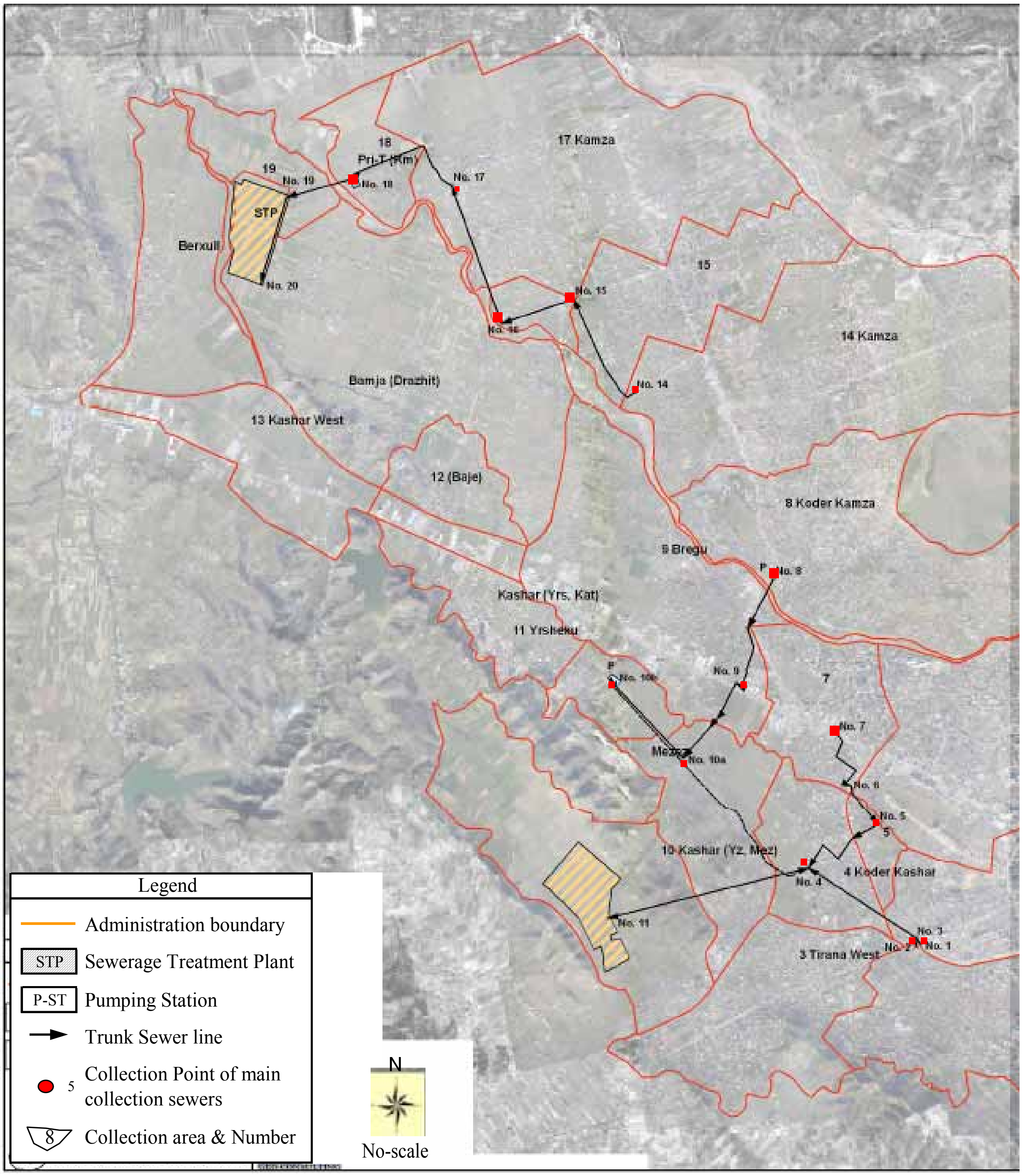


Figure 10.5.1 Trunk Sewer System for Option B-3a

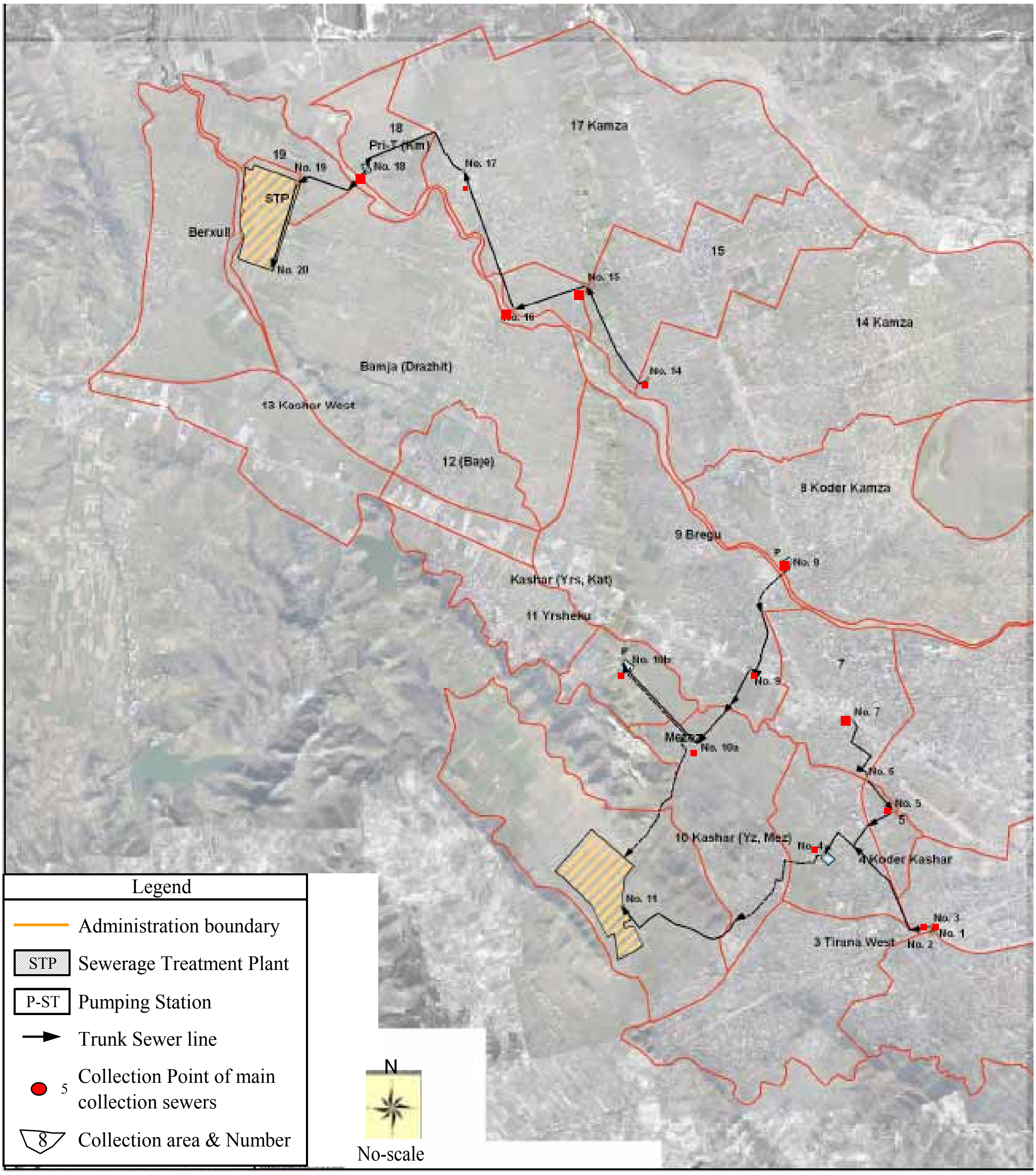


Figure 10.5.2 Trunk Sewer System for Option B-3b

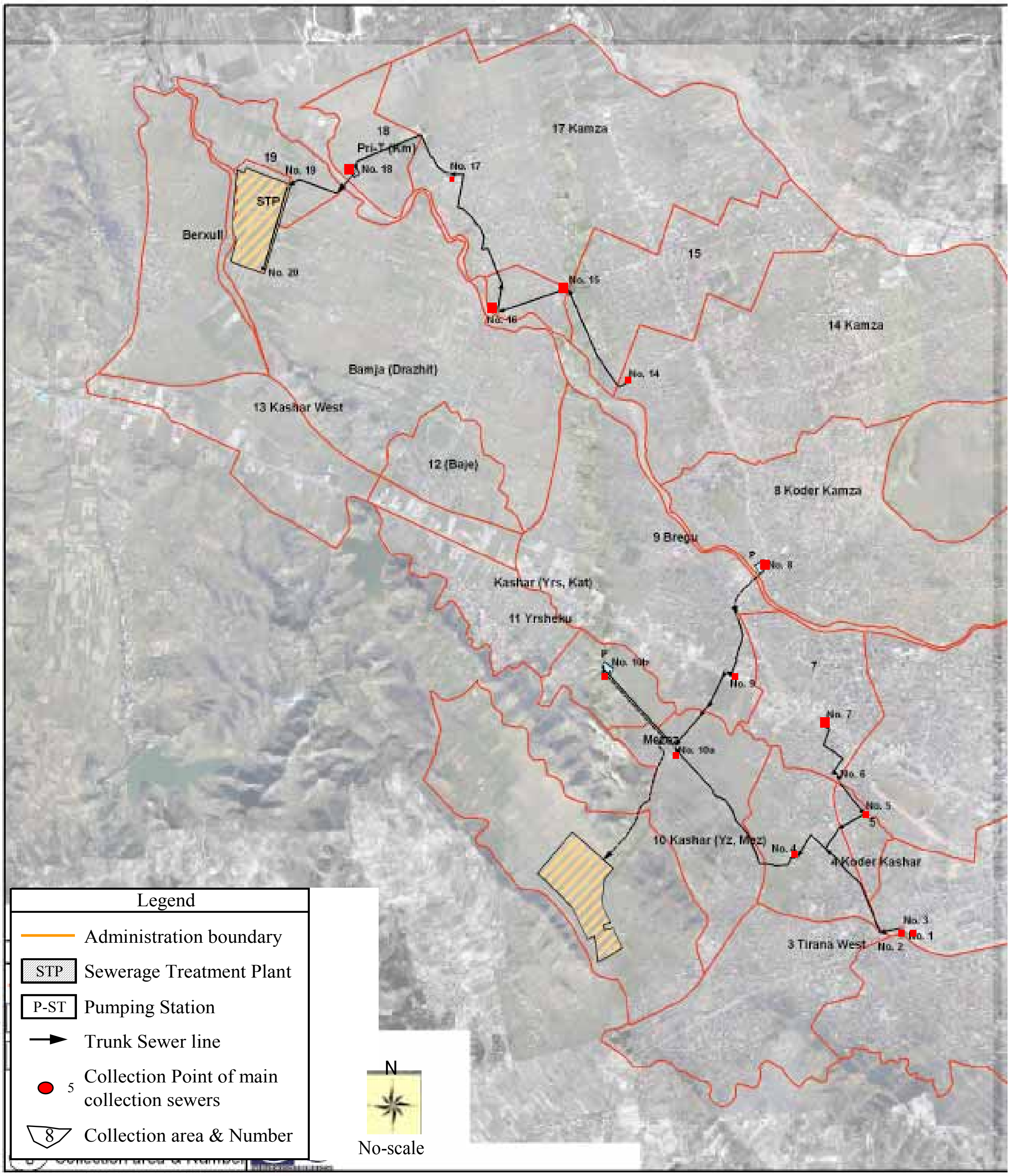


Figure 10.5.3 Trunk Sewer System for Option B-3c

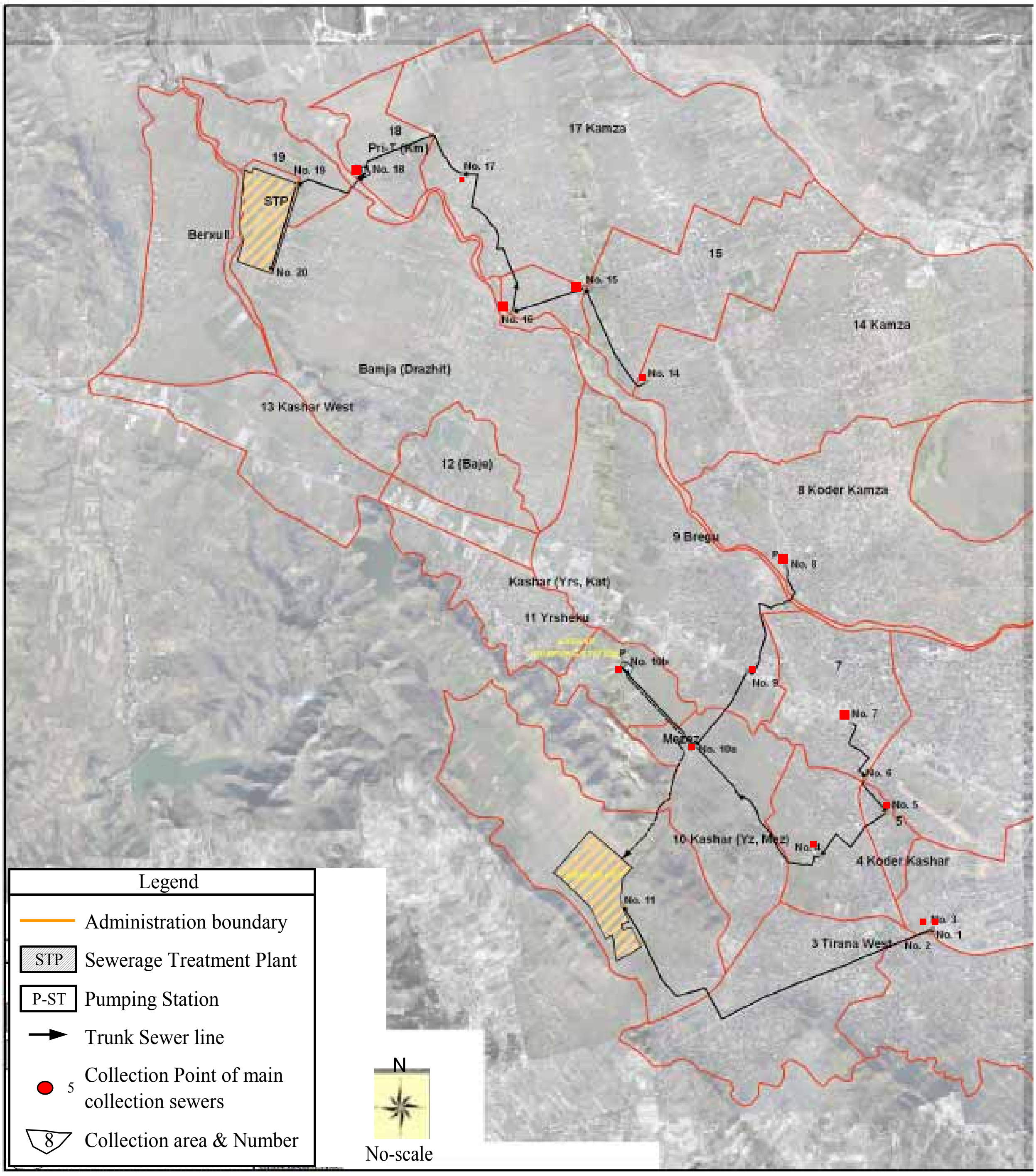


Figure 10.5.4 Trunk Sewer System for Option B-3d

(3) Evaluation

The options were evaluated using the criteria shown in *Table 10.5.1* to help select the most appropriate trunk sewer system.

Table10.5.1 Evaluation Criteria

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.

Table10.5.2 Evaluation of Trunk Sewer System for the Four B-3 Options

Items			B-3a	B-3b	B-3c	B-3d
Trunk Sewer System	Trunk sewer length (m)		18,525	17,966	18,026	20,763
	Diameter (mm)		450 ～ 2,000	400 ～ 2,000	400 ～ 2,000	450 ～ 1,650
	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 pumping stations required		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

(4) Selection of Trunk Sewer System

Table 10.5.2 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.

When Trunk Sewer No.3 was designed, it was expected that it would be laid using the open cut method, at least for the latter half of the route to the Kashar STP. However, the topographic survey for the route found that the ground level was higher than expected, meaning the sewer had to be laid using the jacking method. The fact that the sewer needs to pass at least three meters underneath Lana River is one reason why the sewer needs to be deep. If the clearance beneath the river is less than three meters and the spans used in the jacking method are longer, the construction cost could be reduced. Also, Trunk Sewer No.3 was designed to follow the routes of existing roads, where available. However, if a route that by-passes the hilly area from Kavaja Street to the Kashar STP were selected, the length of the sewer span and number of vertical shafts required could be reduced. This would help to lowering the costs associated with the laying works.

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.

10.6 Options for the Priority Project

10.6.1 Purpose

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 (e.g. grit chambers and screens), primary sedimentation tanks, and sludge treatment facilities (e.g. sludge thickeners, anaerobic digesters and sludge drying beds with mechanical dewatering devices). 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. This section presents two options for the Priority Project. The two options are compared in terms of costs, the area being serviced, and the level of sewage treatment.

10.6.2 Overview of the Options

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 10.6.1 presents the Sewerage Development Plan for Option 2 and also shows the service area in the Lana River basin. *Figure 10.6.2* shows the options for sewage and sludge treatment facilities at the Kashar STP.

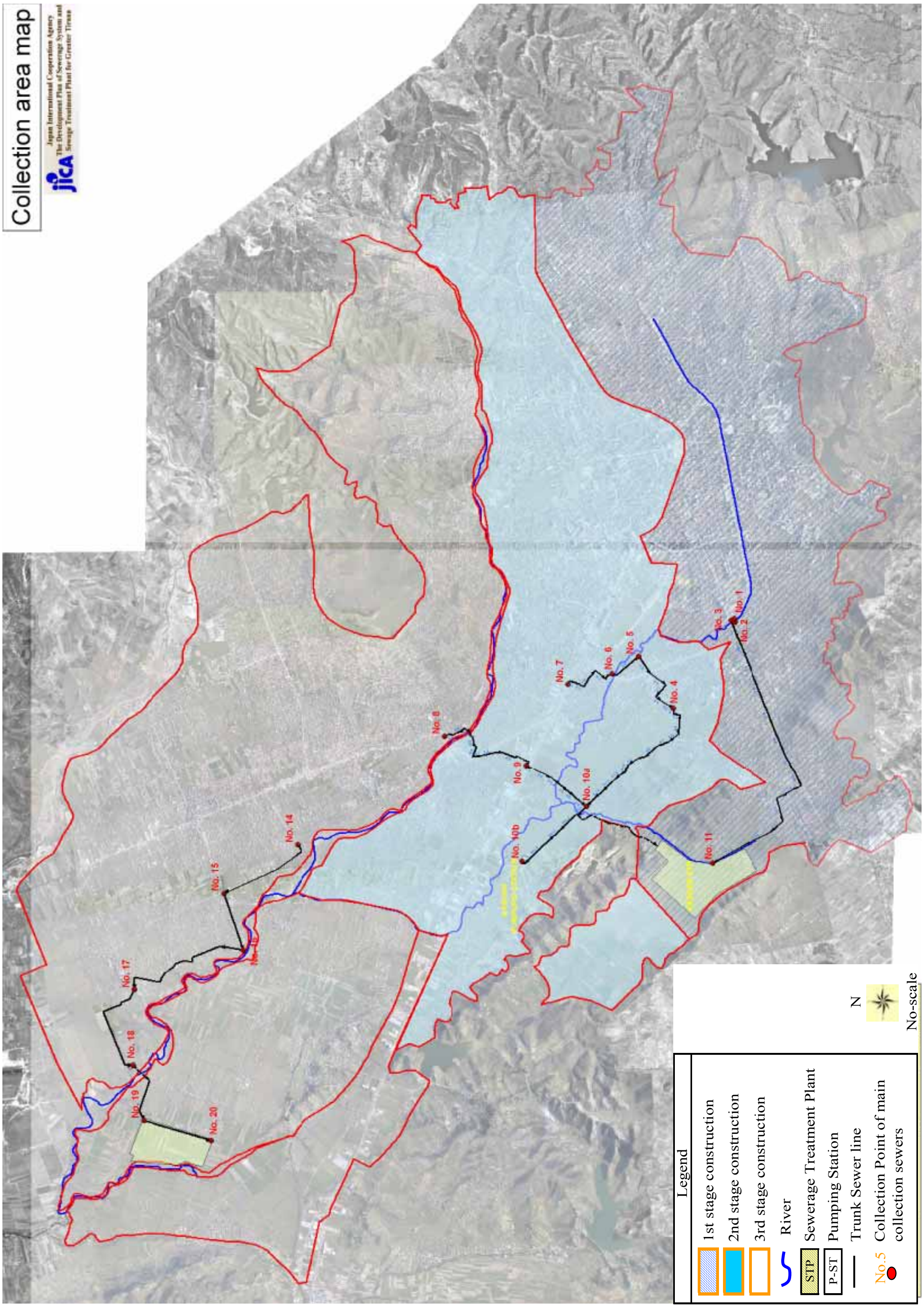
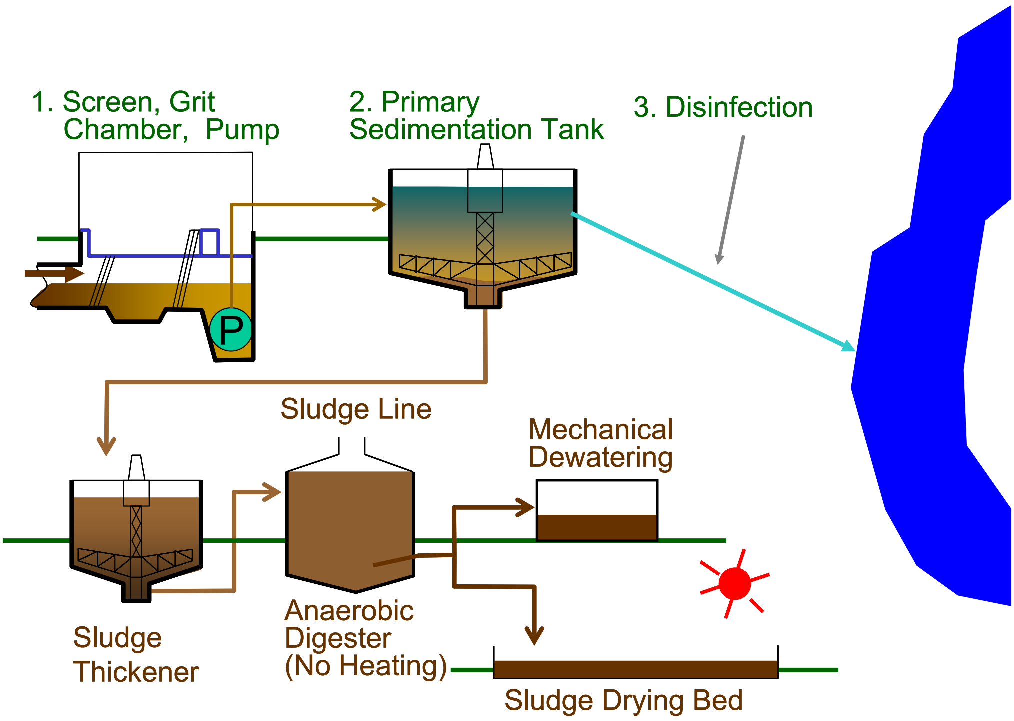
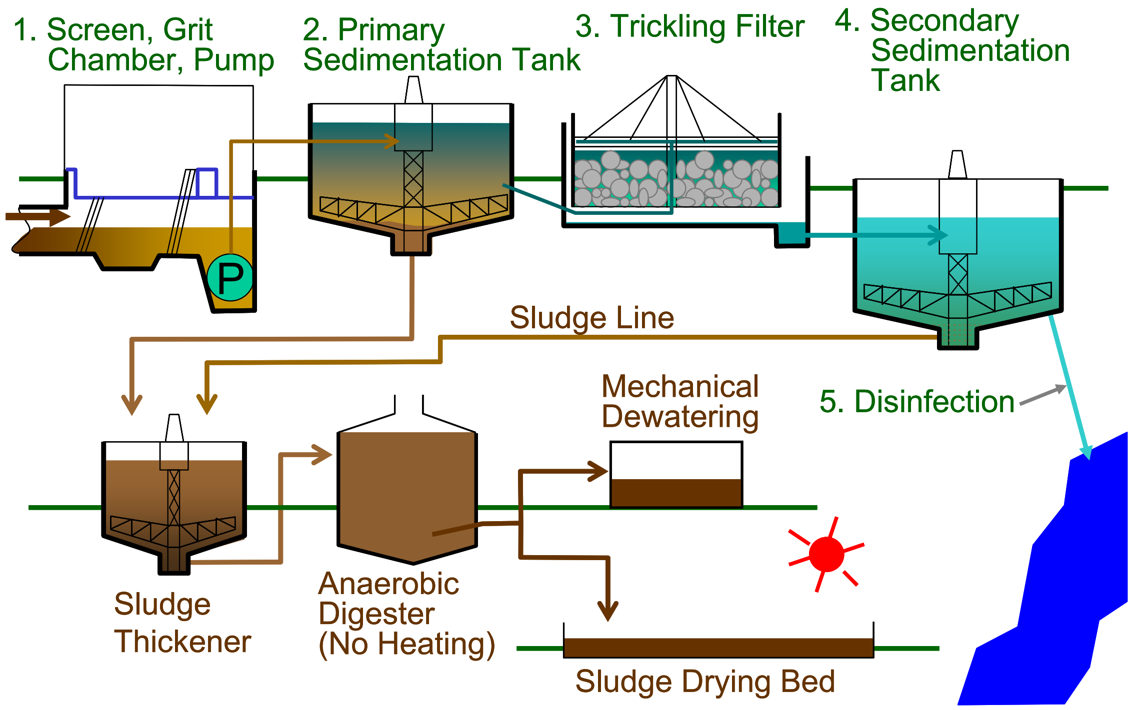


Figure 10.6.1 General Plan of Sewerage Development Plan for Option 2



Sewage Primary Treatment Process and Sludge Treatment: Option 1



Sewage Secondary Treatment Process with Sludge Treatment: Option 2

Figure 10.6.2 General Layout Plan for the Sewage Treatment Facility Options at Kashar STP

10.6.3 Planning Information for the Options

Table 10.6.1 summarizes and compares the main features for each option. The main features are:

- Basic Information: Service Population, Service Area, and Sewage Flows;
- System Outline: Sewers, Pumping Stations, Sewage Treatment Facilities, and Sludge Treatment Facilities; and
- Preliminary Cost Estimate: Direct Construction Cost, Indirect Construction Cost, Project Cost and O& M Cost.

Table 10.6.1 Planning Information for the Two Options

	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	

	Item	Option 1 (Primary Treatment)	Option 2 (Secondary Treatment)	Remarks
(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 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	8,076	5,867	
3.1.1	Sewers	4,601	2,049	
3.1.2	Pumping Station	548	-	
3.1.3	Sewage Treatment Plant	2,927	3,818	
3.2	Indirect Construction Cost	5,235	4,682	
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	
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

10.6.4 Evaluation of the Options

(1) Evaluation Criteria

The two options were compared and evaluated using the following criteria:

- Beneficiaries: Direct and Indirect;
- Pollution Load Reduction;
- Treated Sewage Quality and Flow;
- River Water Quality Improvement
- O&M Requirements;
- Project Cost (Direct and Indirect Cost);
- O&M Costs;
- Environmental and Social Impacts; and
- Promotion of the Sewerage Project and Public Awareness.

(2) Evaluation of the Options

Table 10.6.2 is a summary of the options evaluation.

Table 10.6.2 Evaluation of the Options

	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)**	Pumping Station (PS): Proper operation of the PS is required to convey and treat the sewage at the STP.	No need to operate PS. STP: Operatation of the full set of sewage

	Requirements	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.	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 effluent contains pollutant loads. Also, the discharge will be visible in the flow, meaning there is a visual impact.	The effuent discharged into the river will be of a higher quality than under the current situation. The hydrologic impact of 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.

1) Beneficiaries

The direct beneficiaries for Option 1 are the population (of 695,800) to be served by the sewerage system. There will also be indirect beneficiaries. These are people who visit and work in the center of Tirana municipality but live outside of the service area.

For Option 2, the number of direct beneficiaries (i.e. the population served by the system) will be 342,500, which is about 50% that of Option 1. However, the number of indirect beneficiaries is expected to be much larger than that of Option 1, because the people visiting and working in the center of the municipality will experience an improved water environment in the Lana River.

2) BOD Load Reduction and Efficiency Index

BOD_5 load reduction is estimated based on the balance of influent and effluent load. The efficiency of BOD_5 removal is expressed as an Index (BOD_5 removed per direct construction cost).

For Option 1, the BOD_5 is expected to reduce by 9.3 ton/day and the efficiency index is 1.1. For Option 2, the BOD_5 load reduction is 13.6 ton/d and the index is 2.3. This means Option 2 removes 50% more BOD_5 load and the efficiency almost doubles.

3) River Water Quality Improvement

River water quality in terms of BOD_5 concentration is projected for the several points at the Lana and Tirana Rives for examine the positive impacts with projects. The details of the water quality predictions are referred to the section 11.4. The expected BOD_5 concentrations with the project of Option 1 and Option 2 at the reference points in the Lana and Tirana River are presented in Table 10.6.2 for comparison together with the BOD_5 concentrations without project. The BOD_5 concentrations for Option 1 are presented in Table 10.4.11 (Case B-3) and those for Option 2 are presented in Table 11.4.18 (0%). The table shows that Option 2 would provide better water quality improvement except at R4. Because Option 2 targets only the Lana river basin area.

4) Operation and Maintenance (O&M) Requirements

Option 1 requires a pumping station to convey the sewage to the STP. Failure of the pumping station should be avoided by using a power generator or dual power supply.

Options 1: The primary treatment process has simpler O&M requirements than biological secondary processes (which are part of Option 2) because primary treatment involves physical-chemical processes only. Removal and treatment of primary sludge is required from the primary sedimentation tanks.

Option 2: To operate the full set of sewage and sludge treatment systems extensive operator training is required. Also, for the STP to perform properly, sludge needs to be removed from the primary and secondary sedimentation tanks and treated.

Personnel responsible for the operation and maintenance of the STPs would need to obtain the required knowledge and skills through appropriate capacity development programs.

5) O&M Cost

The O&M cost includes costs required for personnel, power, chemicals, pipe inspection/cleaning, sludge disposal, laboratory, and repairs of mechanical and electrical equipment. An index of O&M cost per average planned flow has been estimated for each option to aid comparison.

The required annual O&M cost is 114 Million Leks/year for Option 1 and 91 Million Leks/year for Option 2. About 60% of the O&M cost for each option is for power and chemicals that are needed to operate the PS and STP.

The index is estimated to be 1.8 Lek/m^3 for Option 1 and 2.9 Lek/m^3 for Option 2.

6) Environmental and Social Impacts

The potential adverse impacts caused by the sewerage projects include discharge of the treated sewage into the receiving water body, sludge production, and odor. The sludge and odor impacts are not expected to vary significantly between the options. It is expected that these impacts can be avoided with proper O&M of the facilities and appropriate mitigation measures and monitoring.

Option 1 would have some adverse water quality impacts resulting from the discharge of treated sewage into the receiving water body. This is because the treated sewage contains pollution loads as shown in the column (3) treated sewage quality and flow in the table. The pollutant loads entering the receiving water body for Option 1 would be higher than that for Option 2. An assessment of the impacts will need to be based on the water quality and flows of the receiving water body. The discharge of effluent for Option 1 would cause visual impact.

7) Promotion and Public Awareness

Implementing Option 1 would improve the living environment for a large number of people in Tirana municipality and Kashar commune. Also, people will notice water quality improvement in the Lana River and will appreciate aesthetic improvements to the river in the urban center.

However, when people visit the STP and see the effluent, they may incorrectly believe that the sewage discharge will pollute the river water. This is because the primary treatment facilities will discharge sewage at an unsatisfactory level, however the second stage of the project (the secondary treatment process) will address this problem.

The number of direct beneficiaries for Option 2 is half that of Option 1. However, the same benefits as for Option 1 in terms of the living environment and water quality in the Lana River (in the urban center) will be realized. It is expected that Option 2 will improve peoples' understanding of the sewerage system and sewage treatment, because they will be able to visit the STP and see the high quality treated sewage being discharged.

10.6.5 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.