SECTOR F

DRAINAGE AND SEWERAGE

VOLUME 3: SUPPORTING REPORT

SECTOR F: DRAINAGE AND SEWERAGE

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SECTOR F DRAINAGE AND SEWERAGE

1. PRESENT CONDITION OF DRAINAGE AND SEWERAGE SYSTEM

There are two kinds of water to be discussed in this section; one is stormwater meaning rain water and another one is sewage (called also "wastewater" or "liquid waste"), which is used water coming form toilet, kitchen, bath room, etc. in the households, offices, institutions etc.

A drainage system is designed to collect and to convey the stormwater through a channel or pipe to the point where it is safely discharged into the public water body, so that the target area can be protected from damage of inundation. In the study area the stormwater shall be safely collected and conveyed through the drainage pipes/channels to Lai Nullah or its tributaries without causing flood damages.

A sewerage system is designed to collect, treat and dispose sewage. Usually the sewage is conveyed through pipes or channels (called as "sewers") to a treatment plant, where the required treatment process reduces the pollution to the acceptable level in the environment. Hence the sensitive area will require a higher water quality than others to prevent form further pollution there.

At present the services of drainage and sewerage systems of the study area are managed by four organizations: Capital Development Authority (CDA), Water and Sanitation Authority (WASA)/Tehsil Municipal Administration (TMA) of Rawalpindi, and Rawalpindi Cantonment Board (RCB), within their administrative jurisdictions as shown in Table R.F.1.

Table R F.1 Administrative Jurisdictions on Drainage and Sewerage system

Area	System	Organization
• Islamabad City	• Drainage System • Sewerage system	Capital Development Authority (CDA),
• Rawalpindi City	• Drainage System	Tehsil Municipal Administration of Rawalpindi (TMA-R)
	• Sewerage system	Water and Sanitation Authority of Rawalpindi (WASA-R)
• Rawalpindi Cantonment Board (RCB) Area	• Drainage System • Sewerage system	Rawalpindi Cantonment Board (RCB)

Source: JICA Study Team 2003

The drainage system to cover the study area is shown in Fig. F.1, while the sewerage system of the same area is shown in Fig. F.2.

In CDA the separate system is employed for handling stormwater and sewage by drainage and sewerage systems, respectively. Although there is one operating sewage treatment plant (STP) in CDA, the incoming flow is so low as about 10% of the total generated sewage in CDA to be treated even partially, and the remaining sewage is discharged into river without any treatment.

This is a major cause of the pollution in the Lai Nullah and its tributaries, followed by the solid waste dumping.

On the other hand the constructed drainage system seems to be generally satisfactory, and thanks to the geographical conditions no sever floods have occurred until June 2001. The flood of June 2001 was a big one, which might occur with a possibility of about once per 100 years, which caused some areas to be inundated, in particular in I-8 and 9 for several hours.

Regarding the administrative jurisdiction area of TMA Rawalpindi, WASA is responsible for design and maintenance of the drainage and sewerage system. TMA Rawalpindi is responsible for maintenance of the drainage system as well as solid waste management (SWM). In the Cantonment area RCB is responsible for both sewage and drainage in respect of design and maintenance. In the both areas, a separate system for drainage and sewerage is applied. However the sewerage system is applied in only about 40 % of the TMA Rawalpindi area. Because there is no STP ever constructed in the area, all the sewage generated in the area is discharged into the rivers without any treatment. Obviously this is causing a major pollution in the Lai Nullah and its tributaries.

In such conditions, the river water of Lai Nullah is heavily polluted and the spot measured water quality is that BOD in CDA is in the range of about 10-60 mg/L and BOD in Rawalpindi is about 30-140 mg/L, which means that the water is already in anaerobic conditions where no oxygen is existent in the river and no fish can survive, producing bad smells and black color due to the generated iron sulfide. Besides bacteriological contamination is serious and any contact with the river water has a high possibility to cause skin eye diseases, etc. Desirable water quality is less than 3 mg/L in BOD and at least the figure of less than 10 mg/L is required for some kind of living things can survive.

When all the sewage is collected and treated to the environmentally acceptable level, the pollution level of the river water would be substantially improved, except solid waste dumping. And when this kind of river condition has been achieved, the people can enjoy recreational activities in and around the river with good water quality.

1.1 Drainage and Sewage in Islamabad

Islamabad has been developed based on the Islamabad Master Plan 1960 since that year, although details of drainage and sewerage systems had not been given and examined in the Master Plan. This was the policy of the Pakistani Government then. Once a realistic development was scheduled with a definite financial source and prepared with other infrastructures like roads, water and electricity, the drainage and sewerage systems were also designed in details at the same time.

In CDA, the sewerage system is designed by the Water and Sanitation Department. The Service Department is in charge with operation and maintenance of the sewerage system. The Financial Department is to collect the sewage tariff (usually called "tax") together with the water one from the users. This administrative set-up appear to be rather fragmented and a good coordination between the departments might be difficult. Never the less this is the Pakistani institutional setup, which would be more suitable for the management.

On the other hand the drainage system in the CDA area is designed by the Road Department, which is also maintaining it, for the drainage system is constructed along the road. Since no revenue is expected to be generated from the drainage system, the maintenance cost shall be covered by the general account of CDA. A shortage of the maintenance budget would deteriorate the drainage system for cleaning and repairing.

Fig. F.3 shows an example of the drainage system of Sector I-8, which is well designed and developed to collect stormwater from the residential areas and to convey it to the river.

The sewerage system was also designed as the urban development was prepared from East to West. Fig. F.4 shows an example of the sewerage system with trunk sewers in Sector I-8. Most of the trunk sewers were said to be installed along the rivers to intercept the sewage generated at households, institutions or others, to convey it to the treatment plant (activated sludge process), located at Sector I-9. However the sewerage system including trunk sewers appear to have been poorly maintained and some broken parts have not been properly repaired. JICA Study Team found out that the documentations of the daily activities such as water sampling and repair records are not well maintained. Even the water quality of the effluent of the STP is largely missing, or not conducted as required.

1.1.1 Drainage System in Islamabad

1) General

The drainage system has been installed in the existing urbanized area in CDA step by step as shown in Fig. F.1, F.3, and F.5.

According to Design Department of CDA, the drainage system was designed based on the Rational Formula, which calculates peak discharge related to runoff coefficient, rainfall intensity and contributing area by the formula:

$$Q = C\ i\ A \qquad \text{(F.1)}$$

Where:

Q: peak discharge

C: non-dimensional runoff coefficient

i : average rainfall intensity

A: contributing area

According to CDA, the average rainfall intensity (75 mm/hr) was used for the design. This figure had been found out to be appropriate on the maximum figures of past 40 to 50 years in Islamabad. However the figure seems to be on a higher side in comparison with the figure of 50 mm/hr of Tokyo, for example.

For the drainage design, the run-off coefficient of 0.8 was considered in CDA, which seems also to be too high to be applied, because the present planned urban areas in Islamabad have a lot of green area for the rainwater to penetrate into ground. The figure of 0.35 would be reasonable to reflect the reality of Islamabad. The ranges of the run-off coefficient can be referred to as summarized in the table below:

Table R F.2 Normal Range of Runoff Coefficients

Characteristics of Surface	Runoff Coefficients
Pavement	
・ Asphalt and concrete	0.70 to 0.95
・ Brick	0.70 to 0.85
・ Roofs	0.75 to 0.95
Lawns, Sandy Soil	
・ Flat (2 %)	0.05 to 0.10
・ Average (2 to 7 %)	0.10 to 0.15
・ Steep (> 7 %t)	0.15 to 0.20
Lawns, Heavy Soil	
・ Flat (2 %)	0.13 to 0.17
・ Average (2 to 7 %)	0.18 to0.22
・ Steep (> 7 %)	0.25 to 0.35

Source: Design and Construction of Urban Stormwater Management Systems (ASCE)

The whole urbanized areas of Islamabad are in principle served with the drainage system. The Study Team obtained that of Sector I-8 as an example, as shown in Fig. F.3 and F.5. Based on this drawing, some sample calculations were carried out to evaluate the drainage system of CDA. The evaluation was conducted on the following steps:

2) Calculation of Existing Drainage Capacity

The capacity of the existing drainage pipes, which had been laid actually in the urbanized area Sector I-8, has been calculated using figures of pipe diameter, material and slop on the following steps:

(a) To calculate the velocity in the pipe by using Manning Formula

$$V = \frac{1}{n} \cdot R^{\frac{2}{3}} \cdot I^{\frac{1}{2}} \qquad \text{(F.2)}$$

Where

V: velocity in sewer(m/sec)

n: roughness coefficient (non-dimensional) -

R: hydraulic radius (R=A/P=Water area/wetted perimeter, m)

I: slope (non-dimensional)

(b) To calculate the flow rate in the pipe as a flow capacity by the following formula

$$Qp = Ap \cdot V = Ap \cdot \frac{1}{n} \cdot R^{\frac{2}{3}} \cdot I^{\frac{1}{2}} \qquad \text{(F.3)}$$

Where

Qp flow rate in the pipe (m3/sec)

Ap: cross-sectional area of the pipe(m2)

3) Evaluation of the Rainfall Intensity

The maximum rainfall intensity that could be discharged through the drainage system is calculated with the following steps:

(a) To determine several catchments areas of the drainage system

(b) To apply the runoff coefficient of 0.35 for site I-8 as residential area with garden

(c) To apply different rainfalls from 10 to 75 mm/hr in order to find out rainfall intensity that corresponds to the above calculated drainage capacity

(d) To compare both of the calculation results.

The evaluation of the existing drainage system in Islamabad was studied and it is found that the existing drainage system is constructed with the rainfall intensity ranged from 15mm/hr to 40mm/hr as shown in the table below,

Table R F.3 Evaluation of the Existing Drainage System (Examples)

Case	Flow capacity of the pipe							Rainfall discharge, Runoff				Evalu-ation
	Dia. of sewer	Area of pipe	Slope	Pipe material	Roughness coefficient	Velocity	Flow capacity	Run off coefficient	Rainfall intensity	Drainage basin	Rainfall discharge	
	D	*Ap*	*I*	-	*n*	*V*	*Qp*	*C*	*I*	*Ar*	*Qr*	*Qp>Qr*
	mm	m^2	1/1000	-	-	m/sec	m3/sec	-	mm/hr	Ha	m3/sec	
1	300	0.071	10	Concrete	0.013	1.368	0.097	0.35	30	3	0.088	OK
2	525	0.216	7	Concrete	0.013	1.662	0.359	0.35	40	9.1	0.354	OK
3	525	0.216	7	Concrete	0.013	1.662	0.359	0.35	20	18.2	0.354	OK
4	525	0.216	7	Concrete	0.013	1.662	0.359	0.35	15	23.4	0.341	OK

4) Discussion on Drainage System in CDA

As shown in the previous section, design criteria (C=0.8 and I=75mm/hr) explained by CDA officials are not corresponding to the actual storm sewer dimension, and the actual stormwater sewer is under the capacity explained by CDA. However CDA has never been flooded except in 2001 flood at area of Sector I-8, I-9 and I-10. The flood condition was about 2-4m flood depth and about 2-6 hours around low lying areas along the rivers. It is understood that the flood might be happened because of backwater from river to drainage system, but the flood does not happen because of shortage of the sewers capacity.

So, generally it is said that the existing drainage system in CDA is capable to drain stormwater for protection against about 15-20mm/hr rainfall strength. However it would be necessary to take some measures to protect against large floods around Sectors of I-8 and I-9, which could be improved by the proposed projects. The proposed counter measures are construction or installation of such as 1) community pond, 2) diversion channel to Kurang River, 3) flood mitigation dam, 4) storage tank in house lot, 5) flood detention wall at public open space and 6) on-site flood detention pond. Counter measures against backwater from Lai Nullah to its tributaries are such as reinforcement/construction of embankment along tributaries and installation of flap gates at outlets of drainage system at connection points with rivers/tributaries.

1.1.2 Sewerage System in Islamabad

1) General

Modern sewerage systems are generally to employ a separate system. As the urban areas are developed, the firstly required facilities are sanitary sewers. The sewerage systems is to collect the sewage generated at households, institutions, factories and others effectively and convey it through sewer pipes to a sewage treatment plant so that the sewage can be treated to the environmentally acceptable level before discharging. The system may usually need some pumping stations between the generation points to the treatment plant in flat geographical conditions. In Islamabad such pumping stations are not required due to favorable geological conditions of the gradual slope form North to South.

According to the drawing prepared by CDA in 1972 the areas spreading form D-12 (North) to I-8 (South), and from Sector 3 (East) to D-12 (West) had been urbanized or would have been urbanized soon. Therefore the Design Department of CDA carried out the detailed design of the sewerage system based on the Master Plan, as shown in Fig. F.7.

There are four (4) trunk sewers to collect sewage in CDA and most of the sewage is transferred to I-9 where out lets of three (3) trunk sewers are placed and sewage treatment plants (STP) of phase I, II and III and IV are placed. The first trunk sewer is covering for F.G-4, 5, 6, 7 and I-8, and the sewage is discharged into STP of phase I & II. The trunk sewers and STP of phase I & II are under operation.

The second trunk sewer is for covering E, F, G, H, I – 8, 9 excluding I-8, and the sewage is discharged into STP of phase III. The trunk sewer is under operation but STP of phase III has never operated since completion of the plant as it had faults in the system.

The third trunk sewer is covering for E, F, G H, I – 10, F-11 and G-11, and the sewage is discharge into river. The trunk sewer is under operation and there is a plan to construct STP phase IV at the outlet of the sewer. 4th trunk sewer is going to cover for H,I-11 and the sewage is discharged into I-11 where STP phase V will be constructed. The sewage management system is shown in Fig. F.2 and Fig. F.7. Basically, all households have sewer connections with the sewerage system in the marked sewerage service area.

At the on going urbanized areas without direct connections with the sewerage system, where is out of the sewerage service area, on-site systems are used such as a septic tank. This system holds the sewage from individual house within its premise and discharge treated sewage from the septic tank into gutter.

The French Government decided to provide with a low-interest loan in 2002 for renovation and new construction of the STP of CDA. The design capacity of the existing and planned STP is shown below,

Table R F.4 Design Capacity of the STP of CDA.

Phase	Design Capacity		Construction Year	Remark	No. of Served Sectors
	MGD	M^3/day			
I	3	13,638	1964-1965	Operational	7
II	3	13,638	1966-1967	Operational	
III	6	27,276	1975-1985	Out of order	10
IV	15	68,190	from 2004	In Planning	9
V	N.A	N.A	N.A	Future Planning	N.A
Total	27	122,742			26

Source: Master Plan of Islamabad (1960)

2) Existing STP Phase I & II

The treatment process of the existing STP of Phase I & II is activates sludge process and the layout and dimension of which are as shown in Fig. F.8. The sludge generated at the STP is dried in the drying bed for sale as fertilizer. The total sewage flow at existing STP of phase I & II is estimated at only 1.5 MGD (6,819 m3/day) based on the record of 11th September 2002. The total design capacity is said 6 MGD (27,276m3/day), i.e. at present only 25% of the capacity is used.

Rough estimation of sewage flow generated at the service area of STP Phase I & II is is calculated based on the estimation of service population: 210,000, unit water consumption: 300L/capita/day, and daily average flow is 63,000 m3/day. Hourly maximum flow is calculated multiplying peak factor (ratio of hourly max. flow and daily average flow): 1.72

calculated by babit formula, and the hourly maximum flow is calculated 108,400 m3/day as shown in Table R.F.5. This means that the out of daily average flow of about 63,000 m3/day only 6,800 m3/day sewage is transferred into the STP Phase I & II, and 90% of sewage generation is discharging into rivers without treatment. This is causing further pollution of the river.

Table R F.5 Estimation of Sewage Flow from Service Area of STP Phase I & II

Item	Unit	Figure
No. of sectors	(sectors)	7
Population in one secotr	(population/sector)	30,000
Rough service population	(population/service area)	210,000
Unit water consumption	(Liter/capita/day)	300
Daily Ave. sewage flow	(m3/day)	63,000
Peak factor (by babit formula)	(-) peak factor = 5/(P/1000)^(1/5), P=population	1.72
Hourly Max. sewage flow	(m3/day)	108,400

Flow capacity of the trunk sewer, rectangular shape of height:39" x width 26", slope:2/1000, is calculated, and the capacity is estimated 63,500 m3/day as shown below,

Table R F.6 Evaluation of Trunk Sewer Capacity of STP Phase I & II

Item	Symbol	Unit	Figure
Height		(m)	0.975
Width		(m)	0.65
Slope	I	(-)	0.002
Area	A	(m2)	0.634
Perimeter	P	(m)	3.25
Hydraulic radius	R =A/P (in full water condition)	(m)	0.195
Roughness coefficient	N	(-)	0.013
Velocity	V = 1/n x R^(2/3) x I^0.5	(m/s)	1.16
Flow rate (capacity)	Qc	(m3/sec)	0.735
Flow rate (capacity)	Qc	(m3/day)	63,500

Remark: Dimension of the trunk sewer = height 39" x width 26", slope = 2/1000

Comparing the hourly maximum flow: 108,400m3/day and capacity of the trunk sewer: 63,500m3/day, capacity of the trunk sewer is smaller than the hourly maximum flow. It is recommended to evaluate the sewage flow accurately. And if necessary, the trunk sewers capacity shall be enlarged. But as the first priority, improvement of the trunk sewers is required to reduce the leakage, that might be happen around junctions.

Capacity of the STP Phase I & II is evaluated in terms of retention time of primary clarifier, aeration tank and secondary clarifier under the design flow and actual flow, comparing with Japanese standard. It is observed that retention time of both clarifiers is holding sufficient retention time that is over the Japanese standard, but retention time of aeration tank is shorter than the Japanese standard. It is recommended to confirm the capacity and performance of the STP Phase I & II as shown below,

Table R F.7 Evaluation of Capacity of STP Phase I & II

Facilities	Volume of phase I	Total volume of Phase I & II	Retention time			Remark
			Design flow	Actual flow in 11Sep'02	Japanese Standard for activate sludge method	
			6MGD (27,300m3/day)	1.5MGD (6,800m3/day)		
	(m3)	(m3)	(hr)	(hr)	(hr)	
Primary clarifier	1300	2600	2.3	9.2	1.5	
Aeration tank	1300	2600	2.3	9.2	6-8	Aeration is applied for only 1-2hrs/day.
Secondary clarifier	2500	5000	4.4	17.6	2.5	

Source: Japanese Design Criteria for Sewerage System 2002

The quality of influent and treated sewage at the STP (Phase I & II) has not been analyzed on regular basis since 1995 because of lack of chemicals, according to the persons in charge. Based on the results of the sewage quality analysis of 30 October 1994, BOD of the influent was 220 mg/L, while that of the effluent was 104 mg/L. This means that the removal rate was only 53%, which is obviously too low for the activated sludge process. The reason is that the aeration time of just 1.5 hours seems to be too short for the expected removal achievement of more than 80%. It is necessary to applying 24hours aeration and capacity of the aeration tank shall be enlarged. And it is suggested that regular frequent water quality analysis of inflow and outflow shall be carried out to monitor the existing treatment process.

3) New Construction and Rehabilitation of STP

According to the newspaper of Dawn / Metro 21 May 2003, a plan to construct a sewage treatment plant and to renovate the existing one is described as sources of CDA,

In May 2003 the French Government has released Rs 913 million for construction and renovation of the sewage treatment plant at I-9 sector. The total cost of the project is Rs. 1296 million, out of which 913 million (70%) will be provide by the French government, while the Pakistan government’s share will be Rs. 383 million (30%). The project includes the construction of STP of phase IV, besides improvement and repair of the remaining STP of phase I, II and III. With the completion of the phase IV STP and renovation of I, II and III, some 23 million gallons per day (103,500m3/day) water will be treated, which could be usable for irrigation and industrial purpose. The project will be started around end of 2003 after the feasibility study is completed. The total capacity of the STP would treat entire sewage produced in 2012, after which a similar plant would have to be installed at another place in CDA jurisdiction.

4) Katchi Abadis

There are 11 recognized slum areas named Katchi Abadis in CDA and the population is counted about 500,000 that is about 7 % of the CDA population. And the total number of slum areas including small ones is about 36. The problem of the slum areas can be summarized as follows: 1) sewage from the slum areas is directly discharged into rivers, and, 2) water is irregularly supply to the slum areas, and the residents does not pay the water charge. Dwellers of major 6 (six) slum areas located at I-10/4, I-11/4 (three slum areas are existed in the sector), I-9/1 and Muslim Colony (F-2) are being shifted to Farash sub-urban center in Shakar Parian. The total number of residential lots constructed at the Farash is about 3,700 and the population is estimated at about 22,200 as six (6) family members are estimated per household.

1.1.3 A Pilot Study

1) Infiltration System at Green Belt

A pilot study of rainwater collection has been conducted since July 2002 by CDA for the purpose to reuse and recycle rainwater in light of scarcity of water resources. The rainwater infiltration well is expected to cultivate groundwater and to reduce the run off water, as shown in Fig. F.9. However it appears that the obtained results are not well analyzed for practical purpose. So CDA explained to JICA Study Team that it would intend to construct those facilities to collect and store rainwater at the green belts, which are located between the Sectors. And there are potential sites to store rainwater at sport grounds by constructing embankment around the sport grounds.

2) Rainwater Retention System Using Roof of Households

In connection with this movement of CDA the Study Team proposed a pilot study of the rainwater retention system in the first field survey. This system aims at reuse and recycling of rainwater at household. A model system was constructed at the administration building of STP located at I-9, as shown in Fig. F.10 at end of September 2002. Outline of the system is as following,

Table R F.8 Outline of Rainwater Retention System of a Pilot Study

Facility	Size	Unit	Remark
Roof area as catchments area	224	m2	
Tank volume	1800	Litter	3pcs of 600 L tank
Washout tank	30	Litter	For discharging first flash rainwaer
Material cost	24,000	Rs	Tank, pipe, joint, tap, cement, etc.
Total cost with worker and design	34,000	Litter	19,000Rs/m3

Source: JICA Study Team 2002

Since first of October 2002 the system has been utilized woks at the STP by the operators and the rainwater reuse system was evaluated based on the performance till end of May 2003 in the viewpoints of the following items,

a) Convenience of the system

The system has been utilized in good condition and operators of the STP are enjoying using the water for washing, cleaning and plantation. Out of three tanks, water quality of first tanks out of three (3) tanks is contained with slight turbidity but it is reduce with several days by sedimentation in tanks. Water quality of 2^{nd} and 3^{rd} tanks is used for washing dishes and cups.

The cost of the system is estimated about Rs.20,000 to 35,000 for households, and the price may be rather expensive comparing to the present water charge about Rs100/household/month, equivalent of about 20 years water charge. In spite of the cost, it is precious to reserve water in the system in draught condition. It is required to study in constructing the system more economically.

b) Efficiency of the system

After the start of the operation of the system, 150 days holds water in tanks and ready to use out of total past days of 240 days. The possible working days is about 62.5%.

1.2 Drainage and Sewerage in TMA Rawalpindi

1.2.1 General

Only about 30-40% of Sewage, which is from toilet, kitchen, bath and others, generated in TMA Rawalpindi is collected by sewers. Besides, at the present, any sewage treatment plants are not constructed and the main sewers are connected directly to Lai Nullah around a junction point of Murree road and railway. The served population is about 2.8 – 3.2 million, that is 35 – 40 % of the total population of TMA Rawalpindi of about 8 million in 2002. The sewers have been constructed since around 1960 from the central area. The system is over loaded caused by population increase. Now the sewers have been rehabilitated with ADB loan.

Toilet sewage is discharged by three (3) ways, that are 1) sewer, 2) septic tank, 3) direct discharge into drainage, and the ratio is about 35%, 30% and 35% respectively as shown below,

Table R F.9 Sewage Discharge Points at TMA-R from Households

Item	Ratio (%)	Population (million)
Sewerage	35	2.8
Septic tank	30	2.4
Direct discharge	35	2.8
Total	100	8.0

Source: JICA Study Team 2002

The sludge settled in septic tank is removed by using buckets and discharged to drainages or rivers. Flood happens as overflow of river water, but drainage system is not sufficient as inundation is occurs in sewerage areas in TMA Rawalpindi.

1) Organization

Under the Tehsil (mayor) of Rawalpindi, there are TMA, WASA (Water and Sanitation) and RDA (Rawalpindi Development Authority).

The drainage system is maintained under the TMA. TMA itself constructs minor drainage systems. Major drainage system is constructed by RDA, and the drainage asset is transferred to TMA after completion. WASA is carrying out management of water supply and sewerage work except the drainage system.

RDA (Rawalpindi Development Authority) works for civil work, such as urban planning, construction of road, building and so on.

PMU (Project Management Unit), that now works water, sewerage and drainage/river work with an ADB fund, is controlled under the Government of Punjab Province. There is coordination between WASA and PMU.

2) Master Plan on Sewerage and Drainage

The Urban Water Supply and Sanitation Project -Rawalpindi (UWSSP-R) Phase 1 was funded by ADB in 1996 in coordination with the budgetary allocation by the Pakistani side in the frame of the Eighth Five-Year Plan (1993-1998). At the early stage of the UWSSP-R, the RDA formulated the Sewage and Drainage Master Plan to improve the sewage and drainage system in all the jurisdiction area of WASA. This objective area of the Master Plan covers an area bounded by Shahrah-e-Islamabad and Kahyaban-e-sir roads in the northeast and northwest of the project area (refer to Fig. F.11)

The Master Plan consists of two (2) components of the Sewage Master Plan and the Drainage Master Plan.

a) Sewerage Master Plan

The Sewerage Master Plan proposed to check the inflow of sewage from the area of WASA to the Lai Nullah through the following three (3) components of measures. The Master Plan is projected to complete in 2020, and upon the completion, the Lai Nullah would be no longer the outlet of the sewage, and its water quality would be remarkably improved.

(i) Improvement/expansion of the Sewage Collection Systems, which collects all sewage throughout the aforesaid objective area of the Master Plan to a downstream point of the objective area, (near the point of “Moti Mahar Cinema”),

(ii) Construction of the Transfer Sewer, which transfers all collected sewage as described above to the under-mentioned treatment plant about, and

(iii) Construction of the Sewage Treatment Plant located at the north bank of Soan River.

b) Drainage Master Plan

As for the Drainage Master Plan, the proposed was the following drainage improvement for the area of RMC, the east side catchments of the Lai Nullah in particular on the premises of the project implementation period of 14 years from 1996 to 2010.

(i) Channel improvement of Lai Nullah as the ultimate destination of the drainage;

(ii) Diversion of the existing primary drains called “Kassi East” and “Kassi West” running the center of the east catchments of the Lai Nullah;

(iii) Improvement of secondary and tertiary collection;

(iv) Transfer strategy options for the primary drains;

(v) Construction of pounding and pumping schemes for protection of low lying areas from the rainwater inundation; and

(vi) Clean Drainage Campaign

1.2.2 Drainage System in Area of TMA Rawalpindi

There are the following three groups of major drains: (a) the drains of 13.2km long with a top width over 1000 mm, (b) the drains of 5.3 km in length with a top width between 750 mm and 1000 mm and (c) the drains of 52.4 km in length with a top width between 500 mm and 700 mm. The total length of all types of drains is approximately 71.0 km. The drainage system and the typical cross section of drainage channel in Rawalpindi are as shown in Fig. F.11 and Fig. F.12, respectively.

Under UWSSP (Urban Water Supply and Sanitation Project for Rawalpindi City) Phase I funded by ADB, a new drainage system of Satellite Town area was constructed and diverted into Lai Nullah. The Asghar Mall Drain also needs to be constructed to improve the drainage system. The west side of the City area drains directly to Lai Nullah from the boundary of the central catchment, which is approximately close to Saidpur Road/ Circular Road/ Murree Road (South). Whereas the side of the City drains to the tributaries of Lai Nullah both called Kassi Nullah. One runs from Satellite Town and the other from Dhoke Kashmirian and they both outfall to Lai Nullah near RDA offices having come together at or near Nadeem Colony.

In the event of 2001 flood, large areas in Rawalpindi were inundated; some of the low–laying areas are always subject to inundation every year. As the detailed information of the design criteria was not available to JICA Study Team, it would be hard to judge how much the ADB-financed drainage improvement works could cope with the magnitude of the 2001 flood. According to the design criteria the food of 25 year occurrence should be protected. However based on JICA Study it is obvious that the present drainage system is far from satisfactory for the purpose to meet the target.

1.2.3 Sewerage System in Area of TMA Rawalpindi

Sewage in the City has been developed since 1953, but more progressively during the last fifteen years following proposals in 1971. Under UWSSP Project, trunk sewers are being laid to cater for the eastern part of the City and finally discharge into Lai Nullah. A portion of area sewers (lateral sewers) is also to be completed. Besides this land acquisition is being done for Sewage Treatment Plant, which will be executed under Phase-II of the Project. The Phase-II is now under preparation: as the first step to select a consulting firm to conduct the technical assistance (TA) for about five (5) months starting in September 2003. The implementation will start based on the outcome of the study around beginning of 2004 with a financial assistance of ADB.

The sewerage system in Rawalpindi is delineated in accordance with the information collected in the first field survey as shown in Fig. F.13.

There are the main gravity sewers of about 11 km in length with more than 300 mm diameter in the City area and 4 km in length in the adjacent Satellite Town. A network of sewers now covers the central city area bounded by Lai Nullah, Ashar, Mall Road and Kassi Nullah, about 30 % of the City area. Sizes of principal sewers range from 225 mm diameter to 1200 mm diameter. The system discharges untreated sewage to Kassi Nullah, which flows into Lai Nullah from the east, just upstream of the confluence of the two Nullahs. The Cantonment is also served by a limited sewerage system. In Phase-II of the Project, the outfall sewers will be designed for taking into account the load of Cantonment area for the sewage treatment plant.

Under the Phase-I priority was given to sewer cleaning equipment and basic rehabilitation of the existing sewerage system, mainly by means of repairs to manholes. Provincial allowance is also included in the main sewage cleaning packages for replacement of damaged sections of sewers as these are identified during the course of the cleaning works.

The scope of the Phase-II sewage development proposals is to include the following components:

(1) Further rehabilitation of the existing sewerage system at key locations throughout the urban area. New trunk sewers will be constructed in the following areas:

Name of District	Name Sewerage System
Central Sewage District:	C-1 South East Area
West 1 Sewage District	W1-1 City Saddar
West 2 Sewage District	W2-2 South
Trunk Sewer serving Satellite Town	C-2
North Eastern Sewage District:	NW-1 and NW-2

(2) New sewerage system in the above areas (excluding Satellite Town, where the adequate sewerage system has been completed)

(3) New house connections in the above areas (except Satellite Town)

1.3 Drainage and Sewage in Rawalpindi Cantonment Area

1.3.1 General

The sewage except toilets (sometimes called “gray water”) is discharged into drainage and river. 85% of households have own toilet and septic tank. The septic tank size is approximately 6’ (1.8m) wide x 8’ (2.4m) long x 6’ (1.8m) deep, with two separated tanks installed of 4’ (1.2m) tall. Sludge settled in the tank is removed by a vacuum truck and transferred and disposed at downstream of Nullah Lai River.

The remaining 15% of total houses in the cantonment area are not installed with septic tanks, and the toilet wastewaters are directly discharged into drainages or rivers, causing a heavy pollution in the down stream. So, the open water is contaminated with the toilet wastewater and the directly discharged gray water (wastewater from kitchen and bathroom and others).

The southern part of the cantonment area was largely inundated in the incident of the flood July 2002.

1) **Findings on Field Survey at Typical Households**

Field survey was carried out in the first field survey, and followings are the findings,

a) **Findings by Interview at household near the river junction of L1 (Dohk Chiraghdin Tributary)**

All kinds of sewage or wastewater are discharged into open ditch along roads. The ratio of household with septic tank and household without septic tank is about 40% and 60% around the area. The ratio is different by areas. Removing sludge work from the septic tanks is not observed. Solid wastes that are not removed by the governments are being taken by the residents and dumped into rivers under bridge and it is drained to Lai Nullah, resulting in clogged solid wastes hindering the smooth river flow.

b) **Findings by Interview at household near the river junction of L3**

All kinds of sewage or wastewater are discharged into open ditch along roads. The ratio of household with septic tank and household without septic tank is about 20% and 80% around the area. The ratio is different by areas. Removing sludge work from the septic tanks has not seen. Solid waste is dumped along the Lai Nullah by residents. The dump sites are not specified along the river but just anywhere along the river.

2) **Sewerage Master Plan for Rawalpindi Cantonment Board**

The Sewerage Master Plan for Rawalpindi Cantonment Board was given to the Study Team. It discusses the present and future (up to year 2030) sewage production, its collection, transportation, treatment and final disposal. It also discusses the problem in monitoring and maintenance of such services so as to maximize the public health, safety & welfare and to minimize any adverse environmental impact. This Master Plan will help to provide the basis for improvements to the necessary facilities for proper disposal of sewage in the Cantonment area. Without such improvements, the incidents of water-related diseases and the occurrence of diarrhea, dysentery etc. may be expected to increase.

1.3.2 Drainage System in Rawalpindi Cantonment Area

Although a drainage system had been planned, no system has been built in the Cantonment area. The surface drainage includes the network of man-made channels within the built-up areas that are intended to convey stormwater with the natural channels draining the region within the Cantonment area.

The storm water and effluent from households flows in small drains discharging into natural deep rivers. The stormwater on the North- Eastern side falls into Lai Nullah, which discharges into the Soan River as shown in Fig. F.11. The existing surface drainage system in the

Cantonment area deemed to be is adequate to drain normal stormwater except for floods in Lai Nullah during heavy monsoon rains. In terms of management, however, more adequate maintenance on the facilities would be required.

Management of the surface drainage requires knowledge of drainage patterns, a record of drainage assets, control of development to prevent encroachment of buildings into the drainage channels, and a citizenship awareness of their responsibilities regarding use of drainage facilities. Prior to the annual monsoon period (July-August), campaign of drain cleaning is generally carried out by RCB to overcome the built-up of silt or debris that has accumulated in the drainage channels.

1.3.3 Sewerage System in Rawalpindi Cantonment Area

There is no definite plan about the drainage system in the Cantonment area. Rawalpindi Cantonment Board (RCB) puts a higher priority on the sewerage system development than the drainage system. RCB completed “Sewage Master Plan for Rawalpindi Cantonment Board” in February 2002. According to the Master Plan, it is proposed to install sewers and three sewage treatment plants as shown in Fig. F.13.

RCB has provided sewerage system at only a part of Chaklala area, constructed in 8-10 years ago, but the system has not operated well, besides STP was not constructed and sewage is discharge without treatment in river. And RCB has not provided any other areas within its jurisdiction with underground piped sewerage system. Where as some residents and army establishments are making use of septic tanks for disposal of sewage, a major problem in the Cantonment area is addressed to the practice of disposing of untreated sewage into Lai Nullah and its tributaries. Materials disposed of in this way contaminate river water quality and results in ultimate blockage. In addition to the above the presence of uncontrolled sewage generates various adverse environmental impacts including the following:

(1) Attracts flies and encourages the communication of diseases thus reducing the likely improvement in general health brought about by improved water supplies.

(2) Encourages a poor standard of cleanliness throughout the Cantonment area.

(3) Detracts from the attractiveness of the Cantonment area.

(4) Decrease the aesthetic charm of the Cantonment area

(5) Creates a safety hazard.

(6) Creates a smell nuisance.

According to the Master Plan, the project area comprises the Cantonment area covering about 75.2 km^2, which is bounded by Rawalpindi City on Northeastern side and Islamabad on Northern side. The main two proposed sewerage systems located east and west of the GT Road, each discharging into an independent sewage treatment plant are identified as STP EAST and STP WEST. There is a plan to rehabilitate/renovate the existing STP Chaklala. Although the Master Plan proposes to plan STP EAST, RCB has a concept to convey sewage collected in the Western side of the RCB area, to WASA sewers instead of treating the sewage at the planned STP EAST. It is likely that WASA will accept the concept.

Planned sewage treatment plant system is lagoon system as it does require only easy maintenance. Aerators, pumping system, high technology to maintain the system is not required and operation cost is low as it does not need a lot of electricity in aerator system.

The sewage flows are summarized in the table below. The flows of average daily flow (ADF) and peak daily flow (PDF) are predicted for three sewerage systems in year 2030.

Table R F.10 STP Flow Prediction in Year 2030

Sewerage system	ADF (m3/day)	PDF (m3/day)
STP West	82,944	165,890
STP East	188,610	377,220
STP Chaklala	4,086	8,172

Source: Sewage Master Plan of RCB (Phase-III) (Feb. 2002)

STP EAST is the largest among the three systems, and STP Chacklala is the smallest. For the prediction of the daily flow the three systems are applied with the same PF (Peak Factor) of 2. The figure of Peak Factor expresses a relationship between daily average flow and hourly flow. The figure is big for small populations like1000 such as about 5 and the figure is small for 1,000,000 population such as about 1.3. In the RCB case, the applied PF is 2 for the three (3) cases, and the idea shall be revised to be reasonable in the view point of the served population or flow rate.

The effluent quality is proposed as follows:

(1) BOD : 40 mg / l

(2) Fecal Coli forms : Less than 1000 organisms /100 ml

For this requirements the following treatment process is proposed for STP WEST and STP Chaklala on small area: 1) screening, 2) raw sewage pumping, 3) grit chamber, 4) primary settling tank, 5) aeration tank, 6) secondary settlement, 7) sludge pumping, 8) sludge digester, and 9) sludge drying and disposal. On the other hand, the oxidation ditch treatment (followed by maturation lagoon) is considered for the site of STP East, because more wide area is available here and cost saving is possible. This site also offers a greater buffer distance from anaerobic lagoons to the existing planned communities. The cost of the project proposed by the Master