2.7.2 WORK PROGRAM FOR OPERATION AND MAINTENANCE

(1) Sewer O & M

There are four major O & M procedures namely; daily inspection, site investigation, pipe cleaning, and rehabilitation of damaged sewers.

Table V.2.61 Work items by type for sewer O & M

O & M Type	Work Items
Daily inspection	- Operation of pumping facilities - Operation of electrical facilities
Site investigation	- Identification of damage and blockage locations - Identification of inflow/infiltration points - Investigation of overflow from manholes - Inspection of new house connections - Measurement of the volume of sediment in the sewer
Pipe cleaning	- Removal of sediment and other foreign matter
Rehabilitation	- Replacement/repair of damaged sewer

In order to perform the above activities, a high-pressure pipe cleaning truck (existing), a sludge vacuum truck, a dump truck, and a pickup truck are required.

The pipe cleaning operation for the wastewater collection system should be performed according to a comprehensive maintenance schedule. The pipe cleaning crew should record the volume and quality of the removed sediment, the method of cleaning and cleaning time in order to make improvements in the future O&M activities.

An annual pipe rehabilitation schedule, based upon the results of the investigation survey should be prepared. The rehabilitation works should be prioritized such that the sewers in most urgent need of repair are rehabilitated first.

(2) Wastewater treatment plant O & M

The proposed method of wastewater treatment at the wastewater treatment plant is the use of aerated lagoons, facultative lagoons and constructed wetlands. This requires relatively simple technology and less manpower for operation and maintenance. Proper operation and maintenance is however indispensable in order to realize the full performance of the equipment and to meet the design life of the equipment.

The O & M works for pump stations and the wastewater treatment plant are classified into two categories, daily and periodical works. The work items for O & M are shown in *Table V.2.62*.

Table V.2.62 Work items by type for wastewater treatment plant O & M

O & M Work	Work Items
Daily work	- Measurement of wastewater flow - Removal of debris at screen - Inspection of operation of pump equipment - Inspection of operation of aerators - Inspection of operation of sedimentation facilities - Inspection of operation of electrical equipment - Analysis of water quality of influent and effluent (basic parameters) - Recording equipment operation data (running time, power consumption) - Inspection of operation of on-site sludge collection
Periodical work	- Removal of sediment at grit chamber (weekly) - Inspection/repair of mechanical/electrical facilities (annually) - Overhaul of mechanical/electrical facilities (every 5 to 10 years) - Removal of dried sludge from sedimentation ponds (every 6 month) - Maintenance of constructed wetlands

As the wastewater treatment plant will discharge the treated water into Lake Titicaca, the treated water will have to comply with the effluent regulations. Because the quality of the treated water will need to be checked immediately on demand, a laboratory will be facilitated within the plant, staffed by a chemist. Complicated water quality analysis will, however, be conducted by specialized organizations outside the company. Some major water quality parameters for wastewater, such as temperature, pH, BOD, COD, SS, number of focal and total coliform colonies and moisture content of sludge should be measured at the treatment plant.

2.7.3 ORGANIZATION FOR OPERATION AND MAINTENANCE

Required personnel for the sewerage operation is proposed as *Table V.2.63*. Administration staffs for EMSAPUNO are not included in the table. Temporal workers are hired for the O & M operation, such as totora cutting for constructed wetlands and sludge removal from sedimentation ponds.

Table V.2.63 Required number of staff for O&M of the proposed sewerage system

(unit: persons)

Field & Position		Phase 1	Phase 2	Phase 3	Duty
Manager		1	1	1	Responsible for wastewater system
Sewer and Pumping Station					
Sewer	Engineer	-	-	-	Responsible for cleaning of sewers
	Foreman	-	-	-	Responsible for site works
	Worker	2	4	6	2 workers/team
	Driver	1	1	1	2 workers/team
					*Vehicle maintenance shall be done by EMSAPUNO
Wastewater Treatment Plant					
Operation	Engineer	1	1	1	Responsible for technical matters
	Foreman	1	1	1	Responsible for operation of each shift
	Operator	1	1	2	1 (2) operator/shift
Maintenance	Technician	1	1	1	Responsible for site works
	Worker	-	-	-	Cleaning
W. Quality Analysis	Chemist	1	1	1	Water quality control
Total		7	9	14	

2.7.4 OPERATION AND MAINTENANCE COST

The operation and maintenance program, as stipulated in the preceding sections, requires the following items and annual funds for proper operation of the wastewater collection system and the wastewater treatment plant.

Table V.2.64 Operation and maintenance cost

(Unit: S/. /year)

Year	2008	2015	2025
- Personnel Expenses	167,802	222,641	294,000
- Electricity Cost	475,114	630,388	832,434
- Chlorine Cost	-	-	-
- Coagulant Cost	-	105,894	139,834
- Totora Cutting	3,853	5,112	6,750
- Repair Cost	87,818	116,518	153,863
Total	734,587	1,080,553	1,426,881

* Figures include IGV.

From the above study, overall implementation and disbursement schedule for the proposed plan is prepared, which is shown in *Table V.2.65.*

Table V.2.65 Implementation and Disbursement Schedule for the Proposed Plan

Item \ Phase / Year	Phase 1											Phase 2							Phase 3									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Implementation Schedule																												
1. Preparation of Project																												
2. Pre-Construction Stage																												
2.1 Detailed Design																												
2.2 Bidding																												
3. Construction																												
3.1 Collection System																												
3.2 Sewage Treatment Plant																												
- Civil Work																												
- Mechanical/Electrical Work																												
4. Procurement of Maintenance Equipment																												
5. Test Operation																												

Disbursement Schedule	Total Cost (Thousand S/.)	Phase 1											Phase 2							Phase 3									
		35,494											17,028							28,743									
1. Land Acquisition	0																												
2. Administration	600			22	22	22	22	22	22	22	22	22	29	29	29	29	29	29	29	20	20	20	20	20	20	20	20	20	20
3. Construction Work	53,553																												
(1) Sewer - civil works	31,639			2,586	2,586	2,586							1,447	1,447	1,447	1,447	1,447	1,447	1,447	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375
- mechanical/electorical	0																												
(2) Pump Station - civil works	34				34																								
- mechanical/electorical	363				181															181									
(2) Sewage Treatment Plant -civil v	7,649				6,969								228							452									
- mechanical/electorical	10,868				8,489								817							4,562									
4. Maintenance Equipment	536					234							112								189								
5. Engineering Service	5,355		1,406		937								670		447					1,137		758							
6. Contingency	8,917		211	388	2,879	423	0	0	0	0	0	0	491	217	284	217	217	217	217	377	986	348	206	206	206	206	206	206	206
7. IGV (18 %) (for 3, 4, 5, 6)	12,305		291	535	3,974	584	0	0	0	0	0	0	678	299	392	299	299	299	299	520	1,360	481	285	285	285	285	285	285	285
Total Project Cost	81,265		1,908	3,531	26,072	3,849	22	22	22	22	22	22	4,471	1,992	2,598	1,992	1,992	1,992	1,992	3,429	8,936	3,172	1,886	1,886	1,886	1,886	1,886	1,886	1,886
8. Equip. Renewal (with IGV & contng.)	26,939			20			235	512						20		11,765	235	512					1,109	20		11,765	235	512	
9. Maintenance (with IGV)	23,896					550	574	599	623	659	696	735	778	913	945	978	1,012	1,046	1,081	1,114	1,149	1,181	1,219	1,256	1,289	1,322	1,357	1,391	1,427
Total Disbursement	132,100		1,908	3,552	26,072	4,400	831	1,133	646	681	718	757	5,249	2,925	3,544	14,735	3,238	3,549	3,072	4,544	10,085	4,354	4,214	3,163	3,175	14,974	3,478	3,790	3,313

2.8 PROJECT EVALUATION

2.8.1 ENVIRONMENTAL ASPECT

(1) Contribution for environmental improvement

Improvement of water quality of the Puno interior bay of Titicaca lake is one of the main objectives of sewerage system development in Puno. Magnitudes of pollution load reduction to the inner Puno bay by each alternative are calculated using the following conditions.

Table V.2.66 Treated wastewater quality discharged to the inner bay

	Year	BOD_5 mg/l	Nitrogen (T-N) mg/l	Phosphorus* (T-P) mg/l
Phase1	2008	10	27	4.0
Phase2	2015	12	31	2.9
Phase3	2025	11	33	2.9

* Values for years 2015 and 2025 are with coagulant addition

Total pollution load reduction to the inner bay is shown in *Table V.2.67*.

Table V.2.67 Pollution load reduction by proposed measures in year 2025

	BOD_5		T-N		T-P	
	Discharge (kg/day)	Reduction (%)	Discharge (kg/day)	Reduction (%)	Discharge (kg/day)	Reduction (%)
Without project	2,541	0 %	1,292	0 %	155	0%
With project	526	79 %	667	48 %	68	56 %

(2) Initial environmental evaluation (IEE)

Table V.2.68 Initial Environmental Evaluation (IEE)

Environmental concern	Evaluation	Remarks
Lake water pollution	B	Treated water reuse can be considered.
Sludge disposal	C	Sludge shall be disposed in the fenced area to prohibit public access outside the catchment area of the Puno inner bay.
Offensive odor and noise generation	B	Offensive odor and noise might be generated at aerated lagoons
Change of landscape	B	Large totora field will change the landscape

A: serious impact is expected
B: minor impact is expected
C: extent of impact is unknown
D: no impact

Only minor environmental impacts are expected from the implementation of the proposed plan.

2.8.2 TECHNICAL ASPECT

The evaluation of technical aspect is summarized in *Table V.2.69*.

Table V.2.69 Technical evaluation of the proposed plan

Criteria	Proposed plan
Previous operation experiences in Peru	○
Appropriateness of technology used	◎
Ease of O&M	◎
Effective implementation schedule for maximum results	○
Ability to respond to new technology	○

The proposed plan is considered technically feasible for implementation in Puno City.

2.8.3 SOCIAL ASPECT

Expectation of improvement of sanitation and lake environment improvement by sewerage system development is very high in Puno City according to the public conscious survey carried out by JICA study team. Implementation of the Master Plan will have the following social effects:

- Improvement of sanitary conditions
- Improvement of tourism development potential by improving the inner lake water quality

The proposed Master Plan is considered socially feasible for Puno City. Social acceptance and effectiveness of the Master Plan will be enhanced through public awareness program.

2.8.4 FINANCIAL ASPECT

(1) Conditions for Finance Analysis

In order to analyze the financial aspect of the proposed plan, there are some conditions as follows,

(a) Inflation rate is omitted.

(b) Profit tax of sewerage project is not counted.

(c) Income of sewerage project will be raised by (1) the increase of Puno population, (2) the increase of wastewater volume, (3) the increase of sewerage service charge (5% up for every 3 year), and (4) the increase of the charge collection rate.

(d) KfW donates 12 million Deutsche Mark (S/. 21,180,000).

(e) The part of construction costs that are not able to be covered by KfW donation will be financed by local loan with 5% interest rate. The local loan will cover contingency of construction work, but will not cover IGV (Impuesto General a las Ventas is equal to General Sales Tax) of construction work.

(f) Maintenance equipment cost, maintenance cost, engineering cost will be financed by local fund without interest.

(g) Civil work for sewerage treatment is depreciated with 40 years.

(h) Maintenance equipment is depreciated with 10 years. After 10 years, the equipment will be purchased again at same price.

(i) Contingency (15%) is considered on the cost of construction work, maintenance equipment and engineering service.

(j) IGV (18 %) is considered on the cost of construction work, maintenance equipment, engineering service, contingency, and maintenance.

(k) Civil work and equipment will be bought out by EMSAPUNO at the remaining value in 2025F/Y.

(l) Renewal costs of existing and proposed equipment are included in order to evaluate financial viability of the entire EMSAPUNO's sewerage service.

(2) Financial Viability of Proposed Project

NPV (Net Present Value) and FIRR (Financial Internal Rate of Return) are used as indicators in order to estimate financial viability of proposed plan. To calculate NPV of proposed plan, discount rate is supposed as 5%, because internal trade rate between banks in Peru was 5% in August 1999 (Banco Central De Reserva Del Peru, August 1999).

Table V.2.70 FIRR and NPV for the proposed plan

(Unit: 1,000 S/.)

	FIRR	NPV
Proposed Plan	6.0%	S/. 2,277

Notice: Discount rate of NPV is 5%

FIRR and NPV are calculated by using the data of project cost, revenue, and donation. The details of these data are shown in *Table V.2.70.*

FIRR (6.0%) is larger than discount rate (5%) and NPV (S/. 2,277) turns out positive, hence the proposed plan is estimated as feasible. However, the feasibility is based on the conditions mentioned in the previous section, so finding sources of local loan with 5% interest and local fund without interest is crucial.

The change of cash balance is shown in the *Figure V.2.22.* The "cash flow out" will expand in 2001 and 2017, because the cost for construction work will swell in these years, and "cash flow out" will increase in 2012 and 2022, because the cost for procurement equipment will expand in 2012 and 2022. While the "cash flow in" will increase in 2001, because of the donation of KfW. Moreover, "cash flow in" will swell in 2025, because it is supposed that all facilities and equipment will be sold out by EMSAPUNO at the remaining value.

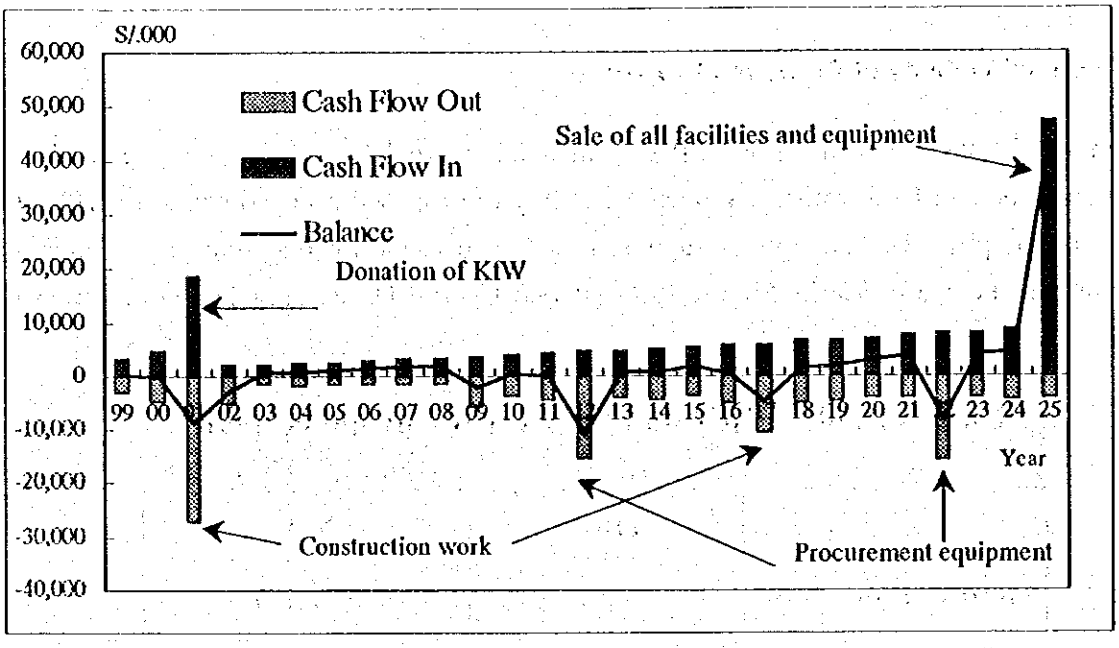

Figure V.2.22 Change of cash balance

(3) Financial Plan

In order that the proposed plan reaches the financially viable level over 5% of FIRR, one of the most effective method is receipt of subsidy or grant. Moreover, not only the financial aspect of the proposed plan but also economic aspect should be considered, because the implementation of the proposed plan for improving water quality of Lake Titicaca will also influence tourism and fish industry in Puno.

To make the proposed plan feasible, the following measures must be taken into account.

(a) Finding a finance source of low interest lower than 5%.

(b) Finding a finance source of no interest.

(c) Increasing a charge collection rate. Present collection rate is approximately 76%.

(d) Increasing a sewerage service charge (5% increase every 3 years). The present sewerage service charge in Puno is approximately 97soles/family/year (EPS EMSAPUNO S.A. MEMORIA ANNUAL 1998). The raise must be regulated and informed well to Puno citizens from the preparation stage of the project.

(c) In order to mitigate the impact of the above raise in the sewerage charge on the lower-income households, a certain type of tariff structure could be considered. For example, progressive tariff system by metering block (usage) with a low basic charge will help lower-income households with small water usage.

Table V.2.71 Cash flow and P/L estimation for the proposed plan

Project expenditure estimation

(Unit : S/.000)

Fiscal Year	Total(99-25)	1999FY	2000FY	2001FY	2002FY	2003FY	2004FY	2005FY	2006FY	2007FY	2008FY	2009FY	2010FY	2011FY	2012FY	2013FY	2014FY	2015FY	2016FY	2017FY	2018FY	2019FY	2020FY	2021FY	2022FY	2023FY	2024FY	2025FY
Land Acquisition	0																											
Proposed project administration expense	601		22	22	22	22	22	22	22	22	22	29	29	29	29	29	29	29	20	20	20	20	20	20	20	20	20	20
Construction work (a)	53,550		2,586	18,259	2,586							2,492	1,447	1,447	1,447	1,447	1,447	1,447	1,375	6,570	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375
Contingency (15%) (b)=(a) x 0.15	8,033		388	2,739	388							374	217	217	217	217	217	217	206	986	206	206	206	206	206	206	206	206
GST (18%) (c)=(a+b) x 0.18	11,085		535	3,780	535							516	300	300	300	300	300	300	285	1,360	285	285	285	285	285	285	285	285
Maintenance Equipment (d)	20,388		15		234	173	377					112	15		8,670	173	377				189	817	15		8,670	173	377	
Contingency (15%) (e)=(d) x 0.15	3,058		2		35	26	57					17	2		1,301	26	57				28	123	2		1,301	26	57	
GST (18%) (f)=(d+e) x 0.18	4,220		3		48	36	78					23	3		1,795	36	78				39	169	3		1,795	36	78	
Engineering Service (g)	5,355	1,406		937								670		447					1,137		758							
Contingency (15%) (h)=(g) x 0.15	803	211		141								101		67					171		114							
GST (18%) (i)=(g+h) x 0.18	1,108	291		194								139		93					235		157							
Maintenance (with GST)	24,901	317	335	354	550	574	599	623	659	696	735	778	913	945	978	1,012	1,046	1,081	1,114	1,149	1,181	1,219	1,256	1,289	1,322	1,357	1,391	1,427
Total	133,103	2,225	3,887	26,425	4,399	831	1,133	645	681	718	757	5,250	2,925	3,544	14,736	3,240	3,551	3,074	4,543	10,084	4,352	4,214	3,162	3,175	14,973	3,478	3,789	3,313

Donation, Loan & Local Fund

Donation up to S/.21,180 (DM12MIL)	21,180	1,617	2,974	16,589	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loan available for construction work	42,030	0	0	4,419	2,974	0	0	0	0	0	0	2,866	1,664	1,664	1,664	1,664	1,664	1,664	1,581	7,556	1,581	1,581	1,581	1,581	1,581	1,581	1,581	1,581
Local Fund of non-construction expense	69,893	608	913	5,417	1,425	831	1,133	645	681	718	757	2,384	1,261	1,880	13,072	1,576	1,887	1,410	2,962	2,529	2,771	2,632	1,580	1,594	13,392	1,897	2,208	1,732
Total	133,103	2,225	3,887	26,425	4,399	831	1,133	645	681	718	757	5,250	2,925	3,544	14,736	3,240	3,551	3,074	4,543	10,084	4,352	4,214	3,162	3,175	14,973	3,478	3,789	3,313

Loan transaction

Loan Receipt	42,030	0	0	4,419	2,974	0	0	0	0	0	0	2,866	1,664	1,664	1,664	1,664	1,664	1,664	1,581	7,556	1,581	1,581	1,581	1,581	1,581	1,581	1,581	1,581
Loan Repayment	8,146	0	0	0	0	0	0	0	0	0	0	0	0	221	370	370	370	370	370	370	370	513	596	679	763	846	929	1,012
Loan Balance	33,884	0	0	4,419	7,393	7,393	7,393	7,393	7,393	7,393	7,393	10,259	11,923	13,366	14,660	15,955	17,249	18,544	19,755	26,911	28,153	29,221	30,206	31,108	31,927	32,662	33,314	33,884

Interest

Interest (5 %)	22,765	0	0	221	370	370	370	370	370	370	370	513	596	668	733	798	862	927	988	1,347	1,408	1,461	1,510	1,555	1,596	1,633	1,666	1,694

Cash Flow

Cash - In :																												
Donation	21,180	1,617	2,974	16,589	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loan for Project Disbursement	42,030	0	0	4,419	2,974	0	0	0	0	0	0	2,866	1,664	1,664	1,664	1,664	1,664	1,664	1,581	7,556	1,581	1,581	1,581	1,581	1,581	1,581	1,581	1,581
Local Fund for Project Disbursement	69,893	608	913	5,417	1,425	831	1,133	645	681	718	757	2,384	1,261	1,880	13,072	1,576	1,887	1,410	2,962	2,529	2,771	2,632	1,580	1,594	13,392	1,897	2,208	1,732
Local Fund for Loan Repayment	8,146	0	0	0	0	0	0	0	0	0	0	0	0	221	370	370	370	370	370	370	370	513	596	679	763	846	929	1,012
Revenue + F/A sold	166,671	1,572	1,783	1,903	2,025	2,259	2,399	2,542	2,875	3,095	3,322	3,740	4,006	4,181	4,584	4,781	4,983	5,456	5,674	5,900	6,426	6,689	6,948	7,548	7,809	8,077	8,771	47,320
Local Fund for Interest Payment	22,765	0	0	221	370	370	370	370	370	370	370	513	596	668	733	798	862	927	988	1,347	1,408	1,461	1,510	1,555	1,596	1,633	1,666	1,694
Cash - Out :																												
Project Disbursement	133,103	2,225	3,887	26,425	4,399	831	1,133	645	681	718	757	5,250	2,925	3,544	14,736	3,240	3,551	3,074	4,543	10,084	4,352	4,214	3,162	3,175	14,973	3,478	3,789	3,313
Loan Repayment	8,146	0	0	0	0	0	0	0	0	0	0	0	0	221	370	370	370	370	370	370	370	513	596	679	763	846	929	1,012
Interest Payment	22,765	0	0	221	370	370	370	370	370	370	370	513	596	668	733	798	862	927	988	1,347	1,408	1,461	1,510	1,555	1,596	1,633	1,666	1,694
EMSAPUNO existing expense	21,249	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787
Repayment of Local Fund	145,422	785	996	1,116	1,238	1,472	1,612	1,755	2,088	2,308	2,535	2,953	3,219	3,394	3,797	3,994	4,196	4,669	4,887	5,113	5,639	5,902	6,161	6,761	7,022	7,290	7,984	46,533
Balance of Cash Fund / -- Local Fund	44,618	177	84	-4,522	-556	271	110	740	1,037	1,220	1,409	56	1,361	625	-10,377	1,250	1,078	1,962	568	867	1,091	1,296	2,474	2,933	-8,729	2,915	3,182	42,095

P/L ESTIMATION

Revenue	128,420	1,572	1,783	1,903	2,025	2,259	2,399	2,542	2,875	3,095	3,322	3,740	4,006	4,181	4,584	4,781	4,983	5,456	5,674	5,900	6,426	6,689	6,948	7,548	7,809	8,077	8,771	9,069
Expense: 1. Administration	22,576	787	809	809	1,127	809	809	809	809	809	809	968	816	816	816	816	816	816	807	807	1,063	807	807	807	807	807	807	807
2. Engineering service	7,267	1,908	0	1,272	0	0	0	0	0	0	0	909	0	607	0	0	0	0	1,543	0	1,029	0	0	0	0	0	0	0
3. Contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Maintenance	24,901	317	335	354	550	574	599	623	659	696	735	778	913	945	978	1,012	1,046	1,081	1,114	1,149	1,181	1,219	1,256	1,289	1,322	1,357	1,391	1,427
5. GST (18%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Interest expense	22,765	0	0	221	370	370	370	370	370	370	370	513	596	668	733	798	862	927	988	1,347	1,408	1,461	1,510	1,555	1,596	1,633	1,666	1,694
7. Depreciation (proposed)	52,314	0	0	0	0	1,677	1,677	1,677	1,677	1,677	1,677	1,677	1,845	1,894	1,943	1,992	2,041	2,090	2,140	2,186	2,892	2,939	2,985	3,032	3,078	3,125	3,172	3,218
8. Depreciation (existing)	9,771	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362
Expense total	139,593	3,374	1,506	3,018	2,408	3,792	3,817	3,841	3,877	3,914	3,953	5,207	4,532	5,292	4,832	4,980	5,128	5,277	6,953	5,851	7,935	6,788	6,920	7,045	7,166	7,284	7,397	7,509
Profit / Loss	-11,173	-1,802	277	-1,114	-383	-1,532	-1,417	-1,299	-1,002	-819	-630	-1,467	-526	-1,110	-248	-199	-144	179	-1,279	48	-1,508	-98	27	503	643	793	1,374	1,560

Assumption

1. Revenue : The rate will be revised every 3 years and 5 % increase is expected.
   Fee collection rate will be increased by 1% annually.

2. Depreciation (construction) civil work will be depreciated for 40 years (every year 2.5 % of acquisition cost is depreciated.)
   mechanical/electrical will be depreciated for 10 years.

3. Depreciation (equipment) items will be depreciated for 10 years (every year 10 % of acquisition cost is depreciated.)

4. Depreciation (EMSAPUNO) Existing fixed asset is for water and sewerage business. According to the 1998 FY detail expense information, 66% of depreciation was for water business, 34% of depreciation was for sewerage business.

5. Local Fund : Non-construction expense loan principal payment & interest payment are funded by Peru/Puno government without interest.

(Unit : S/.000)

Depreciation of proposed fixed asset		1999F/Y	2000F/Y	2001F/Y	2002F/Y	2003F/Y	2004F/Y	2005F/Y	2006F/Y	2007F/Y	2008F/Y	2009F/Y	2010F/Y	2011F/Y	2012F/Y	2013F/Y	2014F/Y	2015F/Y	2016F/Y	2017F/Y	2018F/Y	2019F/Y	2020F/Y	2021F/Y	2022F/Y	2023F/Y	2024F/Y	2025F/Y
sewer civil work (2000-2FY)	6,054					263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263	263
sewer civil work (2009-15FY)	4,468												49	98	147	196	246	295	344	344	344	344	344	344	344	344	344	344
sewer civil work (2016-25FY)	2,099																			47	93	140	187	233	280	327	373	420
pump civil work (2001FY)	23					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
plant civil work (2001FY)	5,438					236	236	236	236	236	236	236	236	236	236	236	236	236	236	236	236	236	236	236	236	236	236	236
plant civil work (2009FY)	124												8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
plant civil work (2017FY)	123																				15	15	15	15	15	15	15	15
pump mechanical (2001FY. 2017FY)	763					25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	49	49	49	49	49	49	49	49
plant mechanical (2001FY)	26,496					1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152	1,152
plant mechanical (2009FY)	1,774												111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
plant mechanical (2017FY)	4,953																				619	619	619	619	619	619	619	619
total depreciation of proposed F/A	52,314					1,677	1,677	1,677	1,677	1,677	1,677	1,677	1,845	1,894	1,943	1,992	2,041	2,090	2,140	2,186	2,892	2,939	2,985	3,032	3,078	3,125	3,172	3,218

Depreciation for existing (EMSAPUNO) fixed asset

Building, Construction (S/.23449 +S/.12450) x 34	8,239	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305
Machine (S/. 874) x 34 %	808	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Transportation equipment (S/. 236) x 34%	216	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Equipment (S/. 43) x 34%	39	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Other (S/. 510) x 34%	468	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
total depreciation of proposed F/A	9,771	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362	362

REVENUE ESTIMATION

wastewater flow estimation (61.3 l/s in 98FY)		65.8	70.4	74.4	78.4	82.5	86.8	91.1	97.2	103.7	110.3	117.2	124.4	128.7	133.2	137.7	142.3	147.1	151.7	156.4	160.9	166.1	171.1	175.6	180.2	184.9	189.7	194.6
increase rate of wastewater (each year / 98FY)A		1.0734	1.1485	1.2137	1.2790	1.3458	1.4160	1.4861	1.5856	1.6917	1.7993	1.9119	2.0294	2.0995	2.1729	2.2463	2.3214	2.3997	2.4747	2.5514	2.6248	2.7096	2.7912	2.8646	2.9396	3.0163	3.0946	3.1746
increase rate of sewerage fee (each year / 98FY)B		1.00	1.05	1.05	1.05	1.10	1.10	1.10	1.16	1.16	1.16	1.22	1.22	1.22	1.28	1.28	1.28	1.34	1.34	1.34	1.41	1.41	1.41	1.48	1.48	1.48	1.55	1.55
increase of collection rate (annually 1 %) C		1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.23	1.24	1.25	1.26	1.27
estimated revenue (S/. 1450 in 1998 x A x B x C)		1,572	1,783	1,903	2,025	2,259	2,399	2,542	2,875	3,095	3,322	3,740	4,006	4,181	4,584	4,781	4,983	5,456	5,674	5,900	6,426	6,689	6,948	7,548	7,809	8,077	8,771	9,069

Administration detail(without contingency and GST)

EMSAPUNO existing administration expense	21,249	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787	787
Proposed project administration expense	601	0	22	22	22	22	22	22	22	22	22	29	29	29	29	29	29	29	20	20	20	20	20	20	20	20	20	20
Proposed project maintenance equipment	726	0	0	0	318	0	0	0	0	0	0	152	0	0	0	0	0	0	0	0	256	0	0	0	0	0	0	0
total	22,576	787	809	809	1,127	809	809	809	809	809	809	968	816	816	816	816	816	816	807	807	1,063	807	807	807	807	807	807	807

IRR (Internal Rate of Return)

Cash Flow In (Donation + Revenue + F/A sold)	187,851	3,189	4,757	18,492	2,025	2,259	2,399	2,542	2,875	3,095	3,322	3,740	4,006	4,181	4,584	4,781	4,983	5,456	5,674	5,900	6,426	6,689	6,948	7,548	7,809	8,077	8,771	47,320
Cash Flow Out (Project dis + EMSAPUNO)	154,352	3,012	4,674	27,212	5,186	1,618	1,920	1,432	1,468	1,505	1,544	6,037	3,712	4,331	15,523	4,027	4,338	3,861	5,330	10,871	5,139	5,001	3,949	3,962	15,760	4,265	4,576	4,100
Balance	33,499	177	84	-8,720	-3,161	641	479	1,110	1,407	1,590	1,778	-2,296	294	-150	-10,939	754	646	1,595	344	-4,972	1,287	1,689	2,999	3,586	-7,951	3,812	4,195	43,220

IRR	5.967
NPR(12%)	-5,333
NPR(10%)	-4,594
NPR(8%)	-3,046
NPR(6%)	-67
NPR(5%)	2,277

2.9 RECOMMENDATIONS

(1) Immediate implementation of sewerage development plan

As eutrophic level of the interior bay of Puno has reached hyper-eutrophic, immediate actions to reduce pollution load inflow to the bay are required. Implementation of sewerage development plan will greatly reduce the contaminants input to the lake as discussed in Section 2.8.

(2) Careful maintenance of constructed wetland

The wastewater treatment system contains the process of a subsurface-flow type artificial wetland. In general, the rate of pollution loads reduction by this facility is varied by local conditions and quality of maintenance. This type of wetland would not realize the expected performance unless a careful maintenance keeps the facility from being clogged. Therefore a pilot study is necessary to examine the efficiency and the proper maintenance of the facility. The study should also be carried out for alternatives such as a surface-flow type wetland or a treatment system using *Lemna,* and the most suitable type should be chosen from the results.

(3) Sanitation promotion

In Puno health sub-region, infant mortality rate is 99 per 1,000 line births, which is much higher than 47, the national average of Peru in 1995. Sanitation promotion through the proposed measures (Section 2.4.2) is urgently required to improve the present sanitary conditions of Puno City.

(4) Inflow control for sanitary sewer system

Large amount of inflow to the sanitary sewer system was observed during rainfall, which causes extreme wet weather flow. This may overload pump stations and treatment plants, resulting in the direct discharge of untreated wastewater to the interior bay of Puno. Enforceable regulations shall be established to prevent devised connections of rainwater sources to the sanitary system.

(4) Enhancement of environmental awareness

The result of the survey shows that people's awareness on deterioration of environmental sanitation is still not very high. This lack of environmental awareness causes misuse of sanitary sewer system and use of drainage ways as toilet. Enhancement of environmental awareness is strongly recommended as a key factor for the environmental improvement.

CHAPTER – VI SOLID WASTE MANAGEMENT

CHAPTER - VI

SOLID WASTE MANAGEMENT

1. PRESENT CONDITIONS

1.1 OUTLINE OF SOLID WASTE MANAGEMENT

Population of the Puno Provincial Municipality in1998 is recorded as 110,013 including those of hillside inhabitants. Generation of waste is 68.4 ton/day in the Municipality, of which 35.7 ton/day is generated by the households, 4.3 ton/day by the commercial sector, 3.6 tons by markets, and 23.3 ton/day by road sweeping waste. The remained 1.5 ton/day is considered to be transported directly by privately owned trucks to the Final Disposal Site (hereinafter referred to as the FDS) in Cancharani.

The collection rate of waste generated in whole area is estimated 52% approximately, which consisted of 35% of household waste, 34% of commercial establishment, 74% of road sweeping waste and 75% of market waste collection rate.

The collection rate of household and commercial waste is lowest which is one of reasons for an uncomfortable lakeside scene of Lake Titicaca as well as for scene of small galley called Micro Cuenca.

The solid waste management of the Provincial Puno Municipality is directly engaged by the City, such as collection and transportation, and treatment of the waste at the FDS in skirt of the Cancharani Hill.

The collect5ion of solie waste finally transported to the FDS starts at 1:00 am up to2 or 3 PM. The municipality owns 9 collection trucks, of which, however, only 4 collection cars are operated at present due to the rest unused from out of order by lack of maintenance organization.

As for the FDS in Cancharani, parts of sanitary landfill facilities such as fence, gate, open channel for run-off of superficial water and biogas drainage are installed. However daily covering by soil is not carried out, and consequently harmful insects such as fly breed are observed. In totally, because of deficit of the

Municipality's budget and lack of trained engineers in charge of sanitary engineering, sufficient solid waste management is not recognized for the benefit of inhabitants.

1.2 EXISTING SOLID WASTE MANAGEMENT

(1) Experiment Data

In order to establishment a solid waste management plan, obtaining the information on the collection population, waste quantity and waste characteristics in the area is the most principal as important issue.

The following field surveys were conducted to exactly understand the present situation of the solid waste management (SWM) in Puno City.

- Time and Motion Study on the collection work
- Survey on the solid waste quantity transported into the final disposal site.
- Survey on the illegal dumping of the waste (location and the quantity)
- Waste quantity and physical component.
- Measurement of the existing final disposal site.

The details of the above surveys are described as follows.

[Objective of The Waste Collection Experiment]

This scope of work for The Waste Collection Experiment is aiming at the analysis for the Solid Waste Management for the Provincial Municipality of Puno. The causes of the contamination at the interior bay of Lake Titicaca are considered that (1) the inflow of the sewage into the lake, (2) the inflow of solid waste into the lake, (3) the sludge at the bottom of the lake caused by sewage.

Of these causes, in order to analyze the cause due to the inflow of solid waste into the lake, this experiment is carried out. The contents of the experiment are

(1) The survey for the consciousness of inhabitants for the present solid waste management carried out by the City.

(2) Solid waste collection experiment for the aim at the quantity and the components of the waste.

(3) Time and Motion survey for the waste collection vehicles.

(4) The survey on quantity of the waste to be carried to the Final Disposal Site.

(5) The quantity and its volume of illegal dumped waste in the City.

In order to carry out the first item, the city area are divided into four areas which are defined as

1) Urban area

2) Residential area in the urban area

3) Residential area

4) Mountain side residential area

The four areas are shown in Figure VI.1.1 of the main report. The sample number of the people's consciousness concerning the present solid waste management became 400 sample, which were 50 households/one point × 2 points/area ×4 areas = 400 households. The objects of the survey included households, restaurants, and stands in markets, stands surrounding of markets. Besides these, several schools, hotels were included as the study object.

In order to carry out the second item, the plastic bag was handed out to the selected 400 households and so on for storing all the waste generated by the inhabitants and so on.

In order to carry out the third item, that is Time and Motion Study, to take the temporal record regarding each work of the movement, collection, transport was carried out. By means of this record, the efficiency of the collection and transportation work was analyzed. The data sheet concerning this survey is as follows.

Data sheet for Time & Motion

Sheet No.

Investigator		Collec. Route No.	
Date of Survey.			
Weather	Fine Cloudy Rainy	No. of collec. Team	

No. of Collec. Point.		Contents of collector activity	oper time
Arrv Time=	1		M S
	2		M S
	3		M S
	4		M S
	5		M S
	6		M S
	7		M S
	8		M S
dept time=	9		M S
distns trck=	10		M S

In order to carry out the fourth item, that is the survey on the quantity of waste to be carried to the Final Disposal Site, the truck scale weighed the each weight of collection vehicle before entering the final disposal site. As for the waste, which was directly carried into the site was also studied by watching at the entrance of the site. This survey was carried out for 1 week.

In order to carry out the fifth item, the locations and their volume of the illegal dumped waste in the city area were surveyed. The study team collected the information regarding the place of illegal dumped waste by hearing and confirmed every place.

(2) Evaluation of the Waste Collection Experiment

1) Specific Gravity of Solid Waste

Experimental data were obtained in November, 1998 in Puno city as shown in table VI.1.2 of the main report. The specific gravity of the waste changes from 0.12 to 0.29 ton/cubic meter. However, those figures are not useful for the activities such as estimation, forecasting for solid waste handling cause too small.

a. In this project, the specific gravity is adapted 0.30 ton/cubic meter. By reason of referenced to following Bolivia's figure of 5 cities.

Oruro	0.276 ton/cubic meter
Potosi	0.316 ton/cubic meter
Tarija	0.261 ton/cubic meter
Trinidad	0.319 ton/cubic meter
El Alto	0.360 ton/cubic meter

b. In general, averaged figure of 0.18 ton/ m^3 (Experimental data) is used in an economically developed country as the solid waste management.

c. In 1994, PES (Instituto Peruano Economia Social) reported to the Puno Provincial municipality that it was approx. 0.27 ton/m^3 for the specific gravity.

2) Basis of Waste Generation and Collection Volume

a. Quantity of Waste Generation

Target year for overall counter-measure for avoidance of contamination of the Lake is set up as 2025. Based on the result of the Study for Solid Waste Management in this Project detailed in the Master Plan with long term of 26 years, the estimation of the future volume of Solid Wastes is projected in the following designated the waste generation zones.

Sources of the generation of the waste are designated by dividing into 4 Zones, which are related to 16 Zones of Sewerage Project (Refer to Figure VI.1.1 in the draft final main report).

The quantity of waste generation in each zone is estimated in accordance with the categories classified in the following two points;

One from the respective areas of A1, A2, B1, B2, C1, C2, D1, D2 allotted according to the research on the volume of generation of Solid Wastes and the other from the Areas introduced at present in the City as administrative areas of Sewerage (numbering as No.1 through No.16).The background of this method introduced is for the sake of unified investigation on the sources of contamination of the Lake and it's surrounding and unified administration of it.

Administrative Areas of SWM (See Figure No.VI-1.1 Zones for Solid Waste Management)

SW Total Generation Volume

SWM Zones	Corresponding Sewerage Areas
A Zone	No.1 & No.2
B Zone	No.4, No.5 & No.6
C Zone	No.7 through No.16
DZone	(Specially designated for SW as Mountainous residential areas)

Each of those SW Zones are at the same time classified according to kinds of Wastes Collection methods such as collection by road sweeping and collection in residential areas.

b. Basis for Estimation of Solid Waste Generation Quantity

(a) Population Forecast (1998-2025, refer to Figure-VI.1.1Zones for Solid waste Management)

The forecast for population growth used for the estimation of waste generation quantity is made on the basis of data obtained in the period of 1972 through 1995 for the years of 1998 to 2025 (See Chapter II-STUDY AREA, Table II-2.1 Population, Families and Households of Puno in the draft final main report).

(b) Forecast of Waste Volume Growth

Based on the data obtained through hearing to Central Bank, Puno Branch for the forecast of Annual Economic Growth Rate as 1% to 2% for the coming 25 years, the growth rate of generation of waste for the same period is estimated annually 1.5%.

(c) Forecast of Road Sweeping Waste Volume

The Road Sweeping Waste Volume for each year are obtained based on the figure of volume of Road Sweeping Waste hauled into the Final Disposal Site in 1998 as 16,413 kg/day. And also the data is obtained that based on ratio of total area of road in Zone 1 through Zone 9 for sewerage against the total area of the road in the City,

As an example in 1998 for method of calculation;

Hauling Volume of Road Sweeping Waste into F.D.S... 16,413 kg/day(a)

Total Area of all road in the City ... ... 82.5ha (b)

Total Area of Sewerage Zone 1 to Zone 9 ... ... 58.8ha (c)

Generation Volume of Road Sweeping Waste ... ... (a)/{(c)/(b)}

= 23,447 kg/day

(d) Number of shops in the Market

The details of the 1700 shops obtained through hearing to the Municipality Cleansing Dept. are as follows;

Central Market :

In the Market ..... Approx. 250 shops

Outside Market ... Approx. 250 shops

Laykakota Market: Approx. 700 shops

Bellavista Market Approx. 500 shops

(e) The Volume of Wastes Generated in Schools and Hospitals

Based on the data by collection survey and number of schools and hospitals, the volume of wastes generated in school and hospitals are obtained.

(f) Direct hauled Wastes

The volumes of direct hauled wastes are obtained through the eye measurement by counting the number of vehicles in the collection survey.

(3) Payload of Collection and Transportation Vehicles

1) Actual Data from Time and Motion Study in Nov.1998, PUNO City

Experimental data (Payload) from Time motion Study are as follows;

Vehicle	Compactor Truck		Open Dump Truck
Handling Waste	12 m^3	7 m^3	5 ton
Street Waste	6.7(t/trip)	3.5(t/trip)	4.8(t/trip)
Domestic Waste	3.8(t/trip)	2.8(t/trip)	3.7(t/trip)
Average	5.3(t/trip)	3.2(t/trip)	3.2(t/trip)

Source; JST, 1998

2) Compaction coefficient of solid waste by Compactor Truck

12 cubic meter : Compaction ratio = (5.3 ton/12 m^3)

= 0.442 ton/m^3

6 cu.m : Compaction ratio =(3.2 ton/ 7 m^3)

= 0.457 ton/m^3

5 ton: Manual compaction : As a collected data

=(3.2 ton/10.7 m^3)

= 0.300 ton/m^3

In addition to the above existing vehicle, the payload for different capacity of 4 cu.m compactor truck and 6.8 cu.m Garbage Dump Truck is necessary to estimate respectively, as a condition for the planning of equipment (Vehicle) capacity.

3) Estimation for Payload of Vehicles (4 cu.m and 6.8 cu.m)

Using above experimental compaction ratio,

Payload of 4 cu.m Compactor Truck = (4 cu.m x 0.45ton/cu.m)

=1.8 ton/trip

Using above manual compaction ratio, i.e. specific gravity of waste.

Payload of 6.8 cu.m Garbage Dump Truck =6.8 x 0.3 ton/cu.m

=2.0 ton/trip

Therefore, payload of each vehicle is summarized as follows;

For planed vehicles,

12 cu.m Compactor Truck 12 x 0.45 = 5.4 ton (per trip)

4 cu.m Compactor Truck 4 x 0.45 = 1.8 ton (per trip)

6.8 cu.m Garbage Dump Truck 6.8 x 0.3 = 2.0 ton (per trip)

For existing vehicles,

12 cu.m Compactor Truck : Same as above 12 cu.m Compactor (6.7 t/trip)

7 cu.m Compactor Truck : Same as above

6.8 cu.m Compactor : (2.0t/trip)

5 ton Dump Truck : (3.2 t/trip) as per the data

(4) Basic data concerned with the Final Disposal Site.

1) On the life span of the existing landfill site.

According to the City Cleansing Department, the Owner of present site does not clarify. Originally, the Ministry of Agriculture owned the land where the site is located at present. But, National congress had decided that contributed the land to the local resident in consideration of the future land use of the periphery including the present Final Disposal Site. After the contribution by the National Congress, the City requested an offer of the land for the establishment of disposal sites to the community.

For this request, the community agreed that they made a promise to offer the 10 ha of land. However, as no documents concerned with the exact location of the land to be purchased by the City were made at that time, the community and the City did not recognize the pin point location of the land of 10 ha. After this negotiation, the City made the plans for establishment of the disposal sites which are shown in Figure VI.1.1 According to the plan, the life span of the sites is calculated in the TableVI. 1.7, this is shown in the Mater Plan in the Draft Final Main Report.

Our survey becomes a trigger, the site for future use for the study (The Study on the integrated water pollution control for Puno interior bay) was discussed between the City and the community. As the discussion result, concrete location of the site which is to be purchased by the City was decided other than the present site. The plan of plain view of the Sanitary Landfill Site shown in the Figure X.2.6 in the Feasibility Study is the site.

2) Actual situation on Reuse and Recycle of the waste at the present Final Disposal Site.

According to the City cleansing Department, several months ago, one woman started collecting reusable or recyclable waste in order to sell them at the Juliaca. Quantity of collecting the waste is small at the present that does not contribute to reduce the hauled waste volume at the disposal site. However, as the fundamental

consideration of the Solid Waste Management, picking reusable and recyclable waste up and selling them is effective for reducing the volume of collection, transportation, and hauling waste to the site if organizations or syndicates exist in order to return them to the market. From the point of view, the City should keep watching the possibility of the reducing waste through this kind of action i.e. confirmation of the presence of the buyer and confirmation of the distributing structure of value waste to the market is necessary.

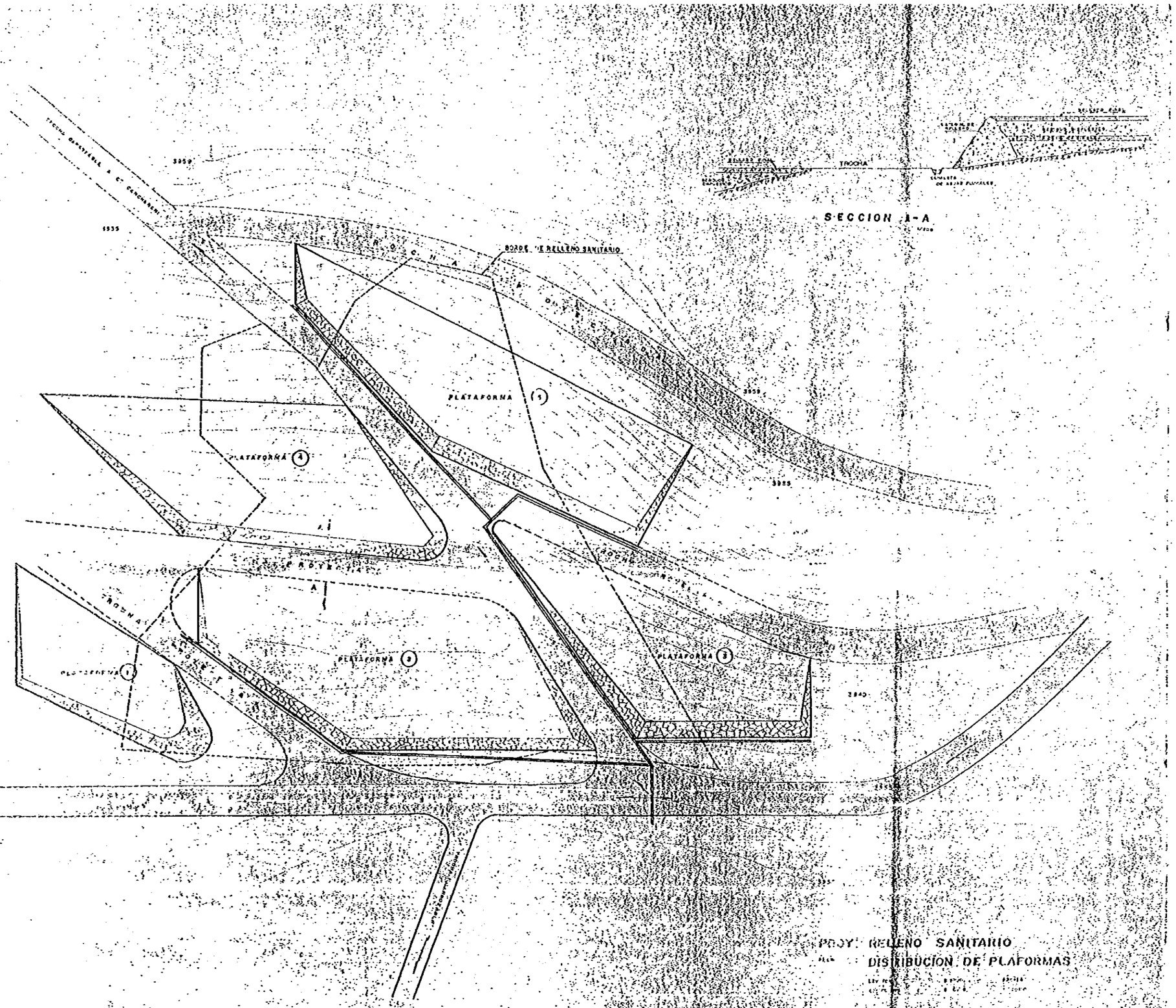

Figure VI.1.1 Final Disposal Site Planed by the City

1.3 EVALUATION OF PRESENT CONDITIONS

(1) Situation of the Scattered Solid Waste inside the City.

Geographical characteristics are described as two areas.

- Hill (slope) Areas
- Flat Area

Those characteristics give affect on policy making for Solid Waste Treatment System due to the severe difficulty in the collection and transportation. Especially in the hill areas, collection vehicles face difficult access to the points of discharge. Because of insufficient collection work mentioned in the above, the wastes are observed in the Micro Cuenca (small valley) or natural or artificial waterways as illegally dumped and flow into shores of Lake Titicaca, mainly at the time of rainy seasons. Thus, natural view of Lake Titicaca was greatly deteriorated.

1) Solid Waste Management System.

The Municipality dominantly manages solid waste treatment – collection, transport and final desposal – in Puno City.

Collection work of the waste is by Road Sweeping starting at 1:00 am and by Bell Collection from 8:00am both utilizing four Collection trucks, of which two are compactors and another two are open trucks. Both of those are greatly old and are unable to perform very often their services sufficiently due to out of order during collection work in 1998. In 1999, the City bought two used 2-ton compactor waste collection cars. This type of car is very useful for waste collection at the narrow and steep slope road.

2) Final Disposal.

No daily compaction of the hauled waste by means of heavy machine and no daily covering with soil on it are carried out at present. Then, present situation of the site is unsanitary and harmful insects are observed. In order to avoid this situation, necessary tools and equipment should be prepared.

New regulation concerned with sanitary landfill site structure is now in mid debate in National Congress. After passing the Congress, future sanitary landfill site's structure should be met with it.

1.4 IDENTIFICATION OF PROBLEMS

Through the evaluation of the existing systems, the following problems are identified.

(1) Short term problems

1) Existence of illegal dump sites.

According to the result of JST survey concerned with the illegal dumped waste sites, 67 illegal dumping waste points were found out. The causes of these points are mainly " Lack of collection frequency", "Due to impossibility of people's access of the collection spot because of the slope", " No collection service".

2) Problems concerned with the Collection vehicles.

In 1999, 6 collection vehicles are in operation. Of 6 vehicles, 4 vehicles are very old and as maintenance is unsatisfied situation, the vehicles stop many times due to mechanical malfunction during work.

3) Unsatisfactory situation of the final disposal site.

No daily covering soil is carried out due to no heavy machine is prepared, then harmful insect is breed. In case of carrying out the covering soil, the city borrows the necessary machine from the other department of the city. But heavy machines such as bulldozer for covering soil, excavator for digging soil and load on it into the dump truck are indispensable.

4) Problems concerned with Administration and organization.

As mentioned on the item (2), there is no system to check the situation of the collection vehicles and to decide the time of renewing the vehicles and

inefficient charging system for the cost for the solid waste management shall be improved.

(2) Intermediate term problems

1) Certainty of land acquisition for future FDS utilization.

For the necessary landfill site area up to 2025, certainty of land acquisition is indispensable.

2) Lack of knowledge to establish a long-term solid waste management plan.

In order to implement the necessary long term solid waste management, the knowledge concerned with the basic plan for the long term solid waste management is indispensable.

2. MASTER PLAN

2.1 TARGET AND STRATEGY

The final target of the study is to establish overall measure to avoid further contamination of water in interior bay of Lake Titicaca and to take action for purification of it.

Three major causes of the contamination in the Lake water, one by sewerage and others by the accumulated sludge in the bottom of the Lake as well as by solid wastes dumped in the upper parts of the Lake in the City reaching to the Lake through Micro Cuenca (small valley) or waterways and scattered waste in the inundation area of the Lake.

In the solid waste management, the target is placed on reduction of volume of illegal dumped waste for the cause of contamination of the Lake by achievement of 100% Collection and Disposal of SW.

The time schedule of final achievement of the Target in 2025, which coincides with time of completion of Sewerage System, should be adjusted, however, to consideration of the gap in the present Collection Rate of 52%. Thereafter, the policy for 100% collection and disposal shall be maintained until 2025, a final year of long terms Target.

Strategic Target

The following three objectives are taken into consideration for the achievement of the above mentioned Target.

(1) Removal of illegal dumped wastes

(Sustainable collection of illegal dumped waste and extraction of hose as final target)

(2) Improvement of Collection Rate of Solid Waste

(Reform of Collection System, Appropriate Supply of Collection Equipment and Enhancement of People's Consciousness over Waste Treatment)

(3) Improvement Efficiency of Final Disposal Site

(Complete Execution of Sanitary Landfill and Acquisition of Appropriate Landfill Site)

The plan is made on the basis of those Targets.

2.2 PLANNING CONDITIONS

(1) Planning Area

Planning area for SWM is defined as Administrative Area of Provincial Municipality of Puno that includes improper area for residing.

(2) Population and Land Use

1) Population

Population in Puno City is increasing year by year and is recorded in 1998 as 110,013, forecasted in 2025, reaching to 186,560, 1.7 times of 1998.

Following Table shows the forecast of growth of population by zones, which are defined as;

Zone A – Central part of the City

Zone B – Residential Area

Zone C – Newly developed Area

Zone D – Improper area for residing purpose

	Zone A	Zone B	Zone C	Zone D	Total
1998	28,615	53,369	26,473	1,556	110,013
2000	28,383	54,982	31,214	1,556	116,135
2005	27,802	59,014	43,072	1,556	131,444
2010	27,221	63,048	54,932	1,556	146,757
2015	26,638	67,081	66,788	1,556	162,064
2020	26,117	70,710	77,460	1,556	175,843
2025	25,710	73,533	85,761	1,556	186,560
Growth	90 %	138 %	324 %	100 %	170 %

According to the figure in the table mentioned above, a variation of among four zones exists. In Zone A, center of the City, the population is forecasted to decrease for 10 %, on the other hand, in Zone C to increase for about 3 times. Accordingly, in the future Plan for Solid Wastes Treatment (Collection and Transportation), the Area for collection is assumed to expand tremendously since the amount of wastes treatment.

2.3 ALTERNATIVE PLANS FOR STRUCTURAL MEASURES

(1) Possible Measures

1) Alternative Plans

The evaluation was set up as the evaluation point is obtained highly in the case that to collect and to transport is advantageous.

- Collection and Transport

The evaluation standard was set up by reason of the following.

a. Topographical shape:

Generally, in the hillside area, roads are narrow and steep gradient that means flat area is easier to collect and transport the waste than hillside area. Thereupon, as for the plane area, the hill area allotted 1 point 2 points respectively.

b. Difficulty of Discharge

b-1) Distance to points of discharge.

According to the result of the questionnaire conducted by the JST in Nov. 1998, the trend of illegal dumping increases as the discharge point become far. Thereupon, in case that the discharge point is near and in case that the discharge point is far from a house, 2 points and 1 point are allotted respectively.

b-2) Restriction of timing for discharge

For the inhabitants, no restriction timing for discharging waste is the best. Thereupon, 2 points were allotted for less restriction timing, and one point was

allotted for high restriction of timing. Generally, as for a timing of Solid Waste discharge, at the moment when a collection car passes, one must carry out the discharge of Solid Waste instantaneously. However in case that some containers are installed, the restriction of timing for discharging is eliminated.

c. Road conditions

2 points were allotted for wide road and 1 point was allotted for narrow road.

As for the central part of the City, the road is narrow, the suburbs wide.

d. Possibility of illegal dumping

Difference between the car collection and the container collection expresses possibility of illegal dumping. Namely, in case of container installation, low possibility of illegal dumping would be occurred. Thereupon, 1 point was allotted for high possibility of illegal dumping and 2 points were allotted for low possibility of illegal dumping.

e. Possibility of repetition of illegal dumping.

The repetition of illegal dumping depends upon difficulty of discharging waste for inhabitants. Then, container collection is low possibility of repetition and car collection is high possibility of repetition of illegal dumping. 1 point was allotted to car collection and 2 points were allotted to the container collection.

Other than above items, the Population weight and construction cost weight are considered.

As for the population weight, the population ratios of 4 zones in 2008 is A: B: C: D= 0.5:1.0: 0.7:0.03 in case that it make B 1.0.

- Final Disposal

As previously mentioned in the main report, no alternative is planed.

- Cost of each Alternative

As mentioned in the main report, three alternatives for technical selection and two alternatives for financial selection were set up. As for the cost of each alternative, following results are obtained.

Cost for A – 1, A – 2, A – 3 is shown in Table VI.2.1And for Cost of F – 1, F – 2 is shown in Table VI.2.2 Obtained Costs of three alternatives (A – 1, A – 2, A – 3)are the costs in case that the achievement of 100% collection by 2008. Cost concerned with F – 1, F – 2, is the cost in case that the achievement of 100 % collection by 2008, and the achievement of 100 % collection by 2025.

Table VI.2.3 shows the calculation sheet to decide the necessary collection vehicles and number of them for the case of alternative – 1, 2 , 3.

Table VI.2.1 Cost for A-1, A-2, A-3 (unit 1000 soles)

		A-1		A-2		A-3
A	Cost of Coll. & Trans	51,128		74,235		85,148
1	Cost of Coll. Vehicles	11,087		14,955		22,653
2	Cost of Operation	40,041		59,280		62,495
	Fuel	13,169		19,050		20,370
	Wages	26,402		36,968		34,561
	Maintenance	470		3,262		7,564
B	Cost of Final Disposal	63,308		63,308		63,308
1	Land acquisition cost	62		62		62
2	Construction Cost	40,453		40,453		40,453
3	Heavy Equipment Cost	4,133		4,133		4,133
4	Engineering Service Cost	1,836		1,836		1,836
5	Contingency	5,163		5,163		5,163
6	Cost of Operation	11,661		11,661		11,661
	Operation	9,294		9,294		9,294
	Maintenance	2,367		2,367		2,367
	Grand Total(1000S/.)	114,436		137,543		148,456
	Ave for 26 years(S/.)	4,401,000		5,290,000		5,710,000

Table VI.2.2 Cost for F-1, F-2 (unit 1000 soles)

		F-1		F-2	
A	Cost of Coll. & Trans	51,128		40,594	
1	Cost of Coll. Vehicles	11,087		8,780	
2	Cost of Operation	40,041		31,814	
	Fuel	13,169		7,921	
	Wages	26,402		23,453	
	Maintenance	470		440	
B	Cost of Final Disposal	63,308		48,639	
1	Land acquisition cost	62		53	
2	Construction Cost	40,453		27,823	
3	Heavy Equipment Cost	4,133		4,133	
4	Engineering Service Cost	1,836		1,391	
5	Contingency	5,163		4,382	
6	Cost of Operation	11,661		10,857	
	Operation	9,294		8,753	
	Maintenance	2,367		2,104	
	Grand Total (1,000S/.)	114,436		89,233	
	Ave for 26 years (S/.) (From 2000-2025)	4,401,000		3,432,000	

The contents of kinds of vehicles and container contents for alternative 1, 2, 3, and F-1, F-2 are as shown in Table VI.2.3.

Table VI2.3(1) Necessary equipment for the case of Alternative – 1
Adoption of the present bell collection system for the whole zones

In case of 2000 Collection Rate 46 % 78%

(1) A & B Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(1) Required Number of vehicles payload	unit	Trip	t/d
1	A	17,307	17.8	2.9	3.5	5.4	1	2	10.8
2		11,076	5.5	1.8	1.1	1.8	2	3	10.8
3	B			2.0	2.8	3.2	1	2	6.4
4		17,648	3	2.9	0.6		26.3	<	28.0
5		18,409	14.5	3.1	2.8				106%
6		7,534	6.5	1.3	0.2				
Total		11,391	6.5	0.1	1.3				
		83,365	53.8	14.0	12.3				
					26.3				

(2) C& D Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(2) Required Number of vehicles payload	unit	Trip	t/d
7	C North	8,050	17.8	2.9	3.5	5.4	0	2	0
8		3,627	5.5	1.8	1.1	1.8	2	3	10.8
9		3,201		2.0	2.8	3.2	1	2	6.4
11		381	3	2.9	0.6		11.98	<	17.2
14		0	14.5	3.1	2.8				144%
16		0	6.5	1.3	0.2				
sub total			6.5	0.1	1.3				
10	C South	8,901	11.8	1.01	2.32				
12		6,863	11.7	0.78	2.30				
13		79	2.9	0.01	0.57	(1)+(2)RequiredNumberof vehicles			
15		112	0	0.01	0.00	payload	unit	Trip	t/d
sub total				1.82	5.19	5.4	1	2	10.8
(-) D		1,556	0	0.30	0.00	1.8	4	3	21.6
sub total				0.30	0.00	3.2	2	2	12.8
Total		32,770	41.4	3.85	8.13		38.28	<	45.2
				Total=12.0					118 %

G. total = **38.3 t/d**

Table VI.2.3(2) Necessary equipment for the case of Alternative – 1

Adoption of the present bell collection system for the whole zones

In case of 2008 Collection rate 100% 100%

(1) A & B Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(1) Required Number of vehicles payload	unit	Trip	t/d
1	A	16,623	17.8	2.9	3.5	5.4	**2**	2	21.6
2		11,179	5.5	1.8	1.1	1.8	**6**	3	32.4
Commercial				2.0	2.8	3.2	**2**	2	12.8
3	B	17,708	3	2.9	0.6		**45.9**	<	**66.8**
4		18,659	14.5	3.1	2.8				**145%**
5		9,154	6.5	1.3	0.2				
6		13,493	6.5	0.1	1.3				
Total		86,816	64.9	29.7	16.3				
					45.9				

(2) C& D Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(2) Required Number of vehicles payload	unit	Trip	t/d
7	C North	8,333	4.3	2.2	0.9	5.4	**0**	2	0
8		3,927	3	1.1	0.6	1.8	**5**	3	27
9		4,097	6.7	1.1	1.3	3.2	**1**	2	6.4
10		12,799	20.3	3.4	4.1		**25.3**	<	**33.4**
12		277	3.8	0.1	0.8				**132%**
13		393	0.9	0.1	0.2				
15	C South	12,692	20.6	3.4	4.1				
11		554	4.9	0.2	0.9				
14		0	0	0.0	0.0	(1)+(2)Required Number of vehicles			
16		1,556	0	0.7	0.0	payload	unit	Trip	t/d
(-)	D	1,556	0	0.3	0.0	5.4	**2**	2	21.6
Total		32,770	41.4	**12.5**	**12.9**	1.8	**11**	3	59.4
						3.2	**3**	2	19.2
							71.3	<	**100.2**
				Total=**25.3**					**141 %**

G. total = **71.3 t/d**

Table VI.2.3(3) Necessary equipment for the case of Alternative – 1
Adoption of the present bell collection system for the whole zones

In case of 2010 Collection rate 100% 100%

(1) A & B Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(1) Required Number of vehicles payload	unit	Trip	t/d
1	A	15,939	20	6.67	3.26	5.4	2	2	21.6
2		11,282	6	4.72	0.98	1.8	6	3	32.4
Commercial				4.25	3.58	3.2	2	2	12.8
3	B	17,769	4.3	7.44	0.70		**52.4**	<	**66.8**
4		18,909	16.3	7.91	2.66				**127%**
5		19,774	18.3	4.51	2.98				
6		15,596	13.6	0.53	2.22				
	Total	99,269	78.5	36.0	16.4				
				Total	**52.4**				

(2) C& D Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(2) Required Number of vehicles payload	unit	Trip	t/d
7	C North	8,617	4.7	2.5	0.8	5.4	0	2	0
8		4,227	3.6	1.2	0.6	1.8	5	3	27
9		4,992	9.9	1.4	1.6	3.2	1	2	12.8
10		16,697	24.5	4.8	5.0		**31.7**	<	**39.8**
12		18,523	31.6	5.3	5.2				**126%**
13		475	4.9	0.1	0.8				
15	C South	727	4.9	0.2	0.8				
11		0	0	0.0	0.0				
14		0	0	0.0	0.0	(1)+(2)Required Number of vehicles			
16		1,556	0	0.8	0.0	payload	unit	Trip	t/d
(-)	D	1,556	0	0.3	0.0	5.4	2	2	21.6
Sub Total				**0.3**	**0.0**	1.8	11	3	59.4
Total		32,770	41.4	**16.9**	**14.8**	3.2	4	2	25.6
							84.1	<	**106.6**
				Total=**31.7**					**127 %**

G. total = **84.1** t/d

Table VI.2.3(4) Necessary equipment for the case of Alternative – 1

Adoption of the present bell collection system for the whole zones

In case of 2012 Collection rate 100% 100

(1) A & B Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(1) Required Number of vehicles payload	unit	Trip	t/d
1	A	15,939	20	6.67	3.26	5.4	2	2	21.6
2		11,282	6	4.72	0.98	1.8	6	3	32.4
Commercial				4.25	3.58	3.2	2	2	12.8
3	B	17,769	4.3	7.44	0.70		52.4	<	66.8
4		18,909	16.3	7.91	2.66				127%
5		19,774	18.3	4.51	2.98				
6		15,596	13.6	0.53	2.22				
Total		99,269	78.5	36.0	16.4				
				Total	52.4				

(2) C& D Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(2) Required Number of vehicles payload	unit	Trip	t/d
7	C North	8,617	4.7	2.5	0.8	5.4	0	2	0
8		4,227	3.6	1.2	0.6	1.8	5	3	27
9		4,992	9.9	1.4	1.6	3.2	2	2	12.8
10		16,697	24.5	4.8	5.0		31.7	<	39.8
12		18,523	31.6	5.3	5.2				126%
13		475	4.9	0.1	0.8				
15	C South	727	4.9	0.2	0.8				
11		0	0	0.0	0.0				
14		0	0	0.0	0.0	(1)+(2)Required Number of vehicles			
16		1,556	0	0.8	0.0	payload	unit	Trip	t/d
(-) D		1,556	0	0.3	0.0	5.4	2	2	21.6
Sub Total				0.3	0.0	1.8	11	3	59.4
Total		32,770	41.4	16.9	14.8	3.2	4	2	25.6
							84.1	<	106.6
				Total=31.7					127 %

G. total = 84.1 t/d

Table VI.2.3(5) Necessary equipment for the case of Alternative -- 1

Adoption of the present bell collection system for the whole zones

In case of 2018 Collection rate 100% 100

(1) A & B Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(1) Required Number of vehicles payload	unit	Trip	t/d
1	A	15,254	21.6	6.88	2.33	5.4	2	2	21.6
2		11,385	6.4	5.13	0.69	1.8	7	3	37.8
Commercial				4.19	2.86	3.2	2	2	12.8
3	B	17,829	5.1	8.04	0.55		**59.6**	<	**72.2**
4		19,160	17.5	8.64	1.89				**121%**
5		12,393	26.4	5.59	2.84				
6		17,699	18.5	7.98	1.99				
Total		93,720	95.5	46.5	13.2				
				Total	**59.6**				

(2) C& D Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(2) Required Number of vehicles payload	unit	Trip	t/d
7	C North	9,156	5.8	3.05	0.69	5.4	**0**	2	0
8		4,797	5	1.60	0.59	1.8	**6**	3	32.4
9		6,693	17.9	2.23	2.12	3.2	**3**	2	19.2
10		23,732	56.5	7.90	6.71		**44.9**	<	**51.6**
12		28,325	58.4	9.43	6.93				**115%**
13		851	7.8	0.28	0.00				
15	C South	1,207	3.7	0.40	0.52				
11		1,055	5.4	0.35	0.64				
14		370	0	0.12	0.00	(1)+(2)Required Number of vehicles			
16		1,274	0	0.42	0.00	payload	unit	Trip	t/d
(-)	D	1,556	0	0.89	0.00	5.4	**2**	2	21.6
Total		79,016	160.5	**26.7**	**18.2**	1.8	**13**	3	70.2
						3.2	**5**	2	32
							104.5	<	**123.8**
				Total=**44.9**					**119 %**

G. total = **104.5** t/d

Table VI.2.3(6) Necessary equipment for the case of Alternative – 1

Adoption of the present bell collection system for the whole zones

In case of 2025 Collection rate 100% 100

(1) A & B Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(1) Required Number of vehicles payload	unit	Trip	t/d
1	A	14,160	25.1	7.41	2.55	5.4	2	2	21.6
2		11,550	7.2	6.04	0.73	1.8	8	3	43.2
Commercial						3.2	2	2	12.8
3	B	17,725	7.1	9.38	0.72		**65.6**	<	**77.6**
4		19,560	20.4	10.23	2.07				**118%**
5		14,985	45	7.84	4.58				
6		21,063	29.7	11.02	3.02				
Total		99,243	134.5	51.9	13.7				
					65.6				

(2) C& D Zone : Vehicle Collection

Project Zone No	SW Zone	Population habitation	Area of Road ha	SW Quantity to be collected Dom (t/d)	Stre (t/d)	(2) Required Number of vehicles payload	unit	Trip	t/d
7	C North	9,354	6.5	3.60	0.78	5.4	**0**	2	0
8		5,007	5.9	1.80	0.60	1.8	**7**	3	37.8
9		7,320	23.4	2.63	2.38	3.2	**3**	2	19.2
10		25,974	74.3	9.32	8.55		**53.4**	<	**57.0**
12		990	9.7	0.36	0.02				**107%**
13		1,404	5	0.50	0.65				
15	C South	856	0	0.31	0.02				
11		30,732	76.9	11.03	7.82				
14		1,176	5.8	0.42	0.59	(1)+(2)Required Number of vehicles			
16		2,948	0	1.06	0.00	payload	unit	Trip	t/d
(-)	D	1,556	0	0.95	0.00	5.4	**2**	2	21.6
Total		87,317	207.5	**32.0**	**21.4**	1.8	**15**	3	81
				Total	**53.4**	3.2	**5**	2	32
							119.0	<	**134.6**
				Total=**119.0**					**113 %**

CHAPTER VI, 2.3 Alternative Plans for Structural Measure

(1) Calculation of Alternative 2 & 3

1) Condition of planning

1) **Time table of roll-on off truck**

Required time for	(min.)
1 Recover	30
2 Traffic	45
3 others	15
total/trip	90

2) Trip per day

5.5	Hr/day
4	Trip/day·unit

3) Container

4	cu.m
100%	Strage
0.35	t/cu.m
1.40	t/container

2) Alternative -2 & 3

2002

(1) A & B Zone: Vehicle Collection **Alternative-2 & 3**

Location of Conta		poulatio	Area of	SWGeneration		SW Quantity to	
Project	MSW	habitant	ha	Domest	Street	Domest	Street
1	A	17,307	17.8	6.24	4.48	2.87	3.49
2		11,076	5.5	3.99	1.38	1.84	1.08
3	B			4.35	3.59	2.00	2.80
4		17,648	3.0	6.36	0.76	2.93	0.59
5		18,409	14.5	6.64	3.65	3.05	2.85
6		7,534	6.5	2.72	0.28	1.25	0.22
	Total	11,391	6.5	0.1	1.6	0.05	1.28
		83365	53.8	30.4	15.8	14.0	12.3
					46.2		26.3
				Collection	Rate	46%	78%

Required Nnumber of vehicles			
payload	units	Trip	t/d
5.4	1	2	10.8
1.8	2	3	10.8
3.2	1	2	6.4
			28.0
			106%

c. Alternataive-3 For C & D Zones By (Container + Roll-on/off Truck)

Zone	SW Zone	poulatio habitant	Area of ha	Domest t/d	Street t/d	Containe Require	Required Vihicle
7	C	8,050	3.90	0.92	0.76	1	
8		3,627	2.60	0.41	0.51	1	1
9		3,201	4.00	0.36	0.79	1	
10		8,901	11.80	1.01	2.32	2	
12		6,863	11.70	0.78	2.30	2	
13		79	2.90	0.01	0.57	0	1
15		112	0.00	0.01	0.00	0	
11		381	4.50	0.04	0.88	1	
14		0	0.00	0.00	0.00	0	
16		0	0.00	0.00	0.00	0	0
(-)	D	1,556	0.00	0.30	0.00	0	
	Total	32,770	41.40	3.85	8.13	8	2
					11.98		

Trucks	2	units
Trips	4	Trip/day
payload	1.4	ton/container
transport	10.3	ton/day
	1.2	
Frequency	1	days

d. Alternative -2 For C & D Zones are divided to Flat and Hills

	Classification Zone numbe	D zone
Flat	(south=10,12,15),(North=	(—)
Hills	(south=13),(north=7,8,9,1	D zone

d-1) Hills Part By container

Location of Conta		poulatio	Area of	Domest	Street	Containe	Required
Project	MSW	habitant	ha	t/d	t/d	Require	Vihicle
7	C	8,050	3.90	0.92	0.76	2	
8	north	3,627	2.60	0.41	0.51	1	1
9		3,201	4.00	0.36	0.79	1	
16	C north	0	0.00	0.00	0.00	0	0
(-)	D	1,556	0.00	0.30	0.00	1	
	Total	14,878	10.5	2.00	2.06	5	1
				Total:	4.06		

Trucks	1	units
Trips	4	Trip/day
payload	1.4	ton/container
transport	5.6	ton/day
	0.7	
Frequency	2	days

CHAPTER VI2.3 Alternative Plans for Structural Measure

Alternative 2 & 3

a. Condition of planning

1) Time table of roll-on off truck

Required time for	(min.)
1 Recover	30
2 Traffic	45
3 others	15
total/trip	90

2) Trip per day

5.5	Hr/day
4	Trip/day · unit

3) Container

4	cu.m
100%	Strage
0.35	t/cu.m
1.40	t/container

b. Alternative -2 & 3

2008

(1) A & B Zone: Vehicle Collectio Alternative-2 & 3

Location of Conta		poulatio n	Area of Road	SW Generation Q'ty		SW Quantity to be colect.	
Project Zone No.	MSW Zone No.	habitant	ha	Domesti c (t/d)	Street (t/d)	Domesti c (t/d)	Street (t/d)
1	A	16,623	18.8	6.46	3.76	5.04	3.42
2		11,179	5.7	4.34	1.14	3.39	1.04
	Commercial			4.3	4.9	3.35	4.46
3	B	17,708	3.6	6.88	0.72	5.37	0.66
4		18,659	15.3	7.25	3.06	5.66	2.78
5		9,154	11.8	3.56	2.36	2.78	2.15
6		13,493	9.7	5.24	1.94	4.09	1.77
	Total	86,816	64.9	38.0	17.9	29.7	16.3
				Total	55.9		45.9
				Collection Rate		78%	91%

Required Nnumber of vehicles			
payload	units	Trip	t/d
5.4	1	2	10.8
1.8	4	3	21.6
3.2	2	2	12.8
			45.2
			100%

d-2) Flat Par Bell collection and Road sweeping

Location of Container		poulation	Area of Road	Domestic	Street	Container	Required
Project	MSW	habitant	ha	t/d	t/d	Required	Vihicle
10		8,901	11.80	1.01	2.32	(-)	(-)
11		381	4.50	0.04	0.88	(-)	(-)
12		6,863	11.70	0.78	2.30	(-)	(-)
13		79	2.90	0.01	0.57	(-)	(-)
14		0	0.00	0.00	0.00	(-)	(-)
15		112	0.00	0.01	0.00	(-)	(-)
	Total	16,336	30.9	1.85	6.07	0	0
					7.92		

Required Nnumber of vehicles			
payload	units	Trip	t/d
5.4	**0**	2	0.0
1.8	**2**	3	10.8
3.2	**0**	2	0.0
			10.8
			136%

e. Summary table of A-2 & A-3

	Area	Containe (set)	Rollon/o (unit)	12 cu.m (unit)	4cu.m (unit)	6.8cu.m (unit)
A-2	Flat:	**0**	**0**	**1**	**4**	**1**
	Hills:	**6**	**1**	**0**	**0**	**0**
A-3	Fla&Hills	**10**	**2**	**1**	**2**	**1**

CHAPTER VI2.3 Alternative Plans for Structural Measure

Alternative 2 & 3

a. **Condition of planning**

1) Time table of roll-on off truck

Required time for tr	(min.)
1 Recovery	30
2 Traffic	45
3 others	15
total/trip	90

2) Trip per day

5.5	Hr/day
4	Trip/day・unit

3) Container

4	cu.m
100%	Strage
0.35	t/cu.m
1.40	t/container

b. **Alternative -2 & 3**

2008

(I) A & B Zone: Vehicle Collection Alternative-2 & 3

Location of Contair		poulatio	Area of	SW Generation		SW Quantity to be	
Project	MSW	habitant	ha	Domesti	Street	Domesti	Street
1	A	16,623	18.8	6.46	3.76	5.04	3.42
2		11,179	5.7	4.34	1.14	3.39	1.04
	Commercial			4.3	4.9	3.35	4.46
3	B	17,708	3.6	6.88	0.72	5.37	0.66
4		18,659	15.3	7.25	3.06	5.66	2.78
5		9,154	11.8	3.56	2.36	2.78	2.15
6		13,493	9.7	5.24	1.94	4.09	1.77
	Total	86,816	64.9	38.0	17.9	29.7	16.3
				Total	55.9		45.9
				Collection Rate		78%	91%

Required Nnumber of vehicles			
payload	units	Trip	t/d
5.4	1	2	10.8
1.8	4	3	21.6
3.2	2	2	12.8
			45.2
			100%

c. Alternataive-3 For C & D Zones By (Container + Roll-on/off Truck)

Zone	SW Zone	poulation habitant	Area of Road ha	Domestic t/d	Street t/d	Container Required set	Required Vihicle unit
7	C	8,333	4.30	2.22	0.86	2	
8		3,927	3.00	1.05	0.60	1	1
9		4,097	6.70	1.09	1.34	2	
10		12,799	20.30	3.41	4.06	5	
12		277	3.80	0.07	0.76	1	
13		393	0.90	0.10	0.17	0	3
15		0	0.00	0.00	0.00	0	
11		12,692	20.60	3.38	4.12	5	
14		554	4.90	0.15	0.94	1	
16		0	0.00	0.00	0.00	0	0
(-)	D	1,556	0.00	0.71	0.00	0	
	Total	44,628	64.50	12.18	12.85	17	5
				Total:	25.03		

Trucks	5	units
Trips	#REF!	Trip/day
payload	1.4	ton/container
transport	23.8	ton/day
	1.1	
Frequency	1	days

d. **Alternative -2** For C & D Zones are divided to Flat and Hills

	Classification Zone number	D zone
Flat	(south=10,12,15),(North=11,	(—)
Hills	(south=13),(north=7,8,9,16)	D zone

d-1) Hills Part By container

Location of Contain		poulation	Area of Road	Domestic	Street	Container	Required
Project Zone	MSW Zone	habitant	ha	t/d	t/d	Required set	Vihicle unit
7	C	8,333	4.30	2.22	0.86	2	
8	north	3,927	3.00	1.05	0.60	1	1
9		4,097	6.70	1.09	1.34	2	
16	C north	0	0.00	0.00	0.00	0	1
(-)	D	1,556	0.00	0.71	0.00	1	
	Total	16,357	14.0	5.07	2.80	6	2
				Total:	7.87		

Trucks	2	units
Trips	#REF!	Trip/day
payload	1.4	ton/container
transport	12.1	ton/day
	0.6	
Frequency	2	days

d-2) **Flat Parts Bell collection and Road sweeping**

Location of Contair		poulatio	Area of	Domesti	Street	Container	Required
Project	MSW	habitant	ha	t/d	t/d	Required	Vihicle
10		12,799	20.30	3.41	4.06	(-)	(-)
11		12,692	20.60	3.38	4.12	(-)	(-)
12		277	3.80	0.07	0.76	(-)	(-)
13		393	0.90	0.10	0.17	(-)	(-)
14		554	4.90	0.15	0.94	(-)	(-)
15		0	0.00	0.00	0.00	(-)	(-)
	Total	26,715	50.5	7.11	10.05	0	0
					17.16		

Required Nnumber of vehicles			
payload	units	Trip	t/d
5.4	**0**	2	0.0
1.8	**3**	3	16.2
3.2	**0**	2	0.0
			16.2
			100%

e. **Summary table of A-2 & A-3**

	Area	Containe (set)	Rollon/o (unit)	12 cu.m (unit)	4cu.m (unit)	6.8cu.m (unit)
A-2	Flat:	**0**	**0**	**1**	**7**	**2**
	Hills:	**8**	**2**	**0**	**0**	**0**
A-3	Fla&Hills	**22**	**5**	**1**	**4**	**2**

CHAPTER VI2.3 Alternative Plans for Structural Measure

Alternative 2 & 3

a. **Condition of planning**

1) Time table of roll-on off truck

Required time for tr	(min.)
1 Recovery	30
2 Traffic	45
3 others	15
total/trip	90

2) Trip per day

5.5	Hr/day
4	Trip/day・unit

3) Container

4	cu.m
100%	Strage
0.35	t/cu.m
1.40	t/container

b. **Alternative -2 & 3**

2010

(1) A & B Zone: Vehicle Collection Alternative-2 & 3

Location of Contair		poulatio	Area of	SW Generation		SW Quantity to be	
Project	MSW	habitant	ha	Domesti	Street	Domesti	Street
1	A	15,939	20.0	6.67	3.26	6.67	3.26
2		11,282	6.0	4.72	0.98	4.72	0.98
	Commercial			4.25	3.58	4.25	3.58
3	B	17,769	4.3	7.44	0.7	7.44	0.70
4		18,909	16.3	7.91	2.66	7.91	2.66
5		19,774	18.3	4.51	2.98	4.51	2.98
6		15,596	13.6	0.53	2.22	0.53	2.22
	Total	99,269	78.5	36.0	16.4	36.0	16.4
		(人)	(ha)	total:	52.4	total:	52.4
					収集率→	100%	100%

Required Nnumber of vehicles			
payload	units	Trip	t/d
5.4	1	2	10.8
1.8	8	3	43.2
3.2	2	2	12.8
			66.8
			127%

c. **Alternataive-3** For C & D Zones By (Container + Roll-on/off Truck)

Zone	SW Zone	poulation habitant	Area of Road ha	Domestic t/d	Street t/d	Container Required set	Required Vihicle unit
7	C	8,617	4.70	2.47	0.77	2	
8		4,227	3.60	1.21	0.59	1	2
9		4,992	9.90	1.43	1.61	2	
10		16,697	24.50	4.79	5.03	7	
12		18,523	31.60	5.31	5.15	7	
13		475	4.90	0.14	0.80	1	4
15		674	1.70	0.19	0.28	0	
11		727	4.90	0.21	0.80	1	
14		0	0.00	0.00	0.00	0	
16		0	0.00	0.00	0.00	0	0
(-)	D	1,556	0.00	0.76	**0.00**	1	1
	Total	56,488	85.80	16.51	15.03	23	7
					31.54		

Trucks	7	units
Trips	#REF!	Trip/day
payload	1.4	ton/container
transport	36.7	ton/day
	0.9	
Frequency	2	days

d. **Alternative -2** For C & D Zones are divided to Flat and Hills

	Classification Zone number	D zone
Flat	(south=10,12,15),(North=11,1	(—)
Hills	(south=13),(north=7,8,9,16)	D zone

d-1) Hills Part By container

Location of Contain		poulation	Area of Road	Domestic	Street	Container	Required
Project Zone	MSW Zone	habitant	ha	t/d	t/d	Required set	Vihicle unit
7	C	8,617	4.70	2.47	0.77	2	
8	north	4,227	3.60	1.21	0.59	1	2
9		4,992	9.90	1.43	1.61	2	
16	C north	0	0.00	0.00	0.00	0	1
(-)	D	1,556	0.00	0.76	0.00	1	
	Total	17,836	18.2	5.87	2.97	6	3
				Total:	8.84		

Trucks	3	units
Trips	#REF!	Trip/day
payload	1.4	ton/container
transport	13.2	ton/day
	0.7	
Frequency	2	days

d-2) **Flat Parts Bell collection and Road sweeping**

Location of Contair		poulatio n	Area of Road	Domesti c	Street	Container	Required
Project Zone	MSW Zone	habitant	ha	t/d	t/d	Required set	Vihicle unit
10		16,697	24.50	4.79	5.03	(-)	(-)
11		727	4.90	0.21	0.80	(-)	(-)
12		18,523	31.60	5.31	5.15	(-)	(-)
13		475	4.90	0.14	0.80	(-)	(-)
14		0	0.00	0.00	0.00	(-)	(-)
15		674	1.70	0.19	0.28	(-)	(-)
	Total	37.096	67.6	10.64	12.06	0	0
					22.70		

Required Nnumber of vehicles			
payload	units	Trip	t/d
5.4	**0**	2	0.0
1.8	**3**	3	16.2
3.2	**5**	2	32.0
			48.2
			212%

e. **Summary table of A-2 & A-3**

	Area Condition	Container (set)	Rollon/off (unit)	12 cu.m compactor (unit)	4cu.m Compactor (unit)	6.8cu.m Dump (unit)
A-2	Flat:	**0**	**0**	**1**	**11**	**7**
	Hills:	**9**	**3**	**0**	**0**	**0**
A-3	Fla&Hills	**30**	**7**	**1**	**8**	**2**

CHAPTER VI2.3 Alternative Plans for Structural Measure

Alternative 2 & 3

a. **Condition of planning**

1) Time table of roll-on off truck

Required time for tr	(min.)
1 Recovery	30
2 Traffic	45
3 others	15
total/trip	90

2) Trip per day

5.5	Hr/day
4	Trip/day - unit

3) Container

4	cu.m
100%	Strage
0.35	t/cu.m
1.40	t/container

b. **Alternative -2 & 3**

2012

(1) A & B Zone: Vehicle Collection Alternative-2 & 3

Location of Contair		poulatio	Area of	SW Generation		SW Quantity to be	
Project	MSW	habitant	ha	Domesti	Street	Domesti	Street
1	A	15,254	21.6	6.88	2.91	6.88	2.33
2		11,385	6.4	5.13	0.86	5.13	0.69
	Commercial			4.19	3.58	4.19	2.86
3	B	17,829	5.1	8.04	0.69	8.04	0.55
4		19,160	17.5	8.64	2.36	8.64	1.89
5		12,393	26.4	5.59	3.55	5.59	2.84
6		17,699	18.5	7.98	2.49	7.98	1.99
	Total	93,720	95.5	46.5	16.4	46.5	13.2
				total:	62.9	total:	59.6
				Collection Rate	→	100%	80%

Required Nnumber of vehicles			
payload	units	Trip	t/d
5.4	2	2	21.6
1.8	8	3	43.2
3.2	2	2	12.8
			77.6
			130%

c. **Alternataive-3** For C & D Zones By (Container + Roll-on/off Truck)

Zone	SW Zone	poulatio habitant	Area of ha	Domesti t/d	Street t/d	Container Required	Required Vihicle
7	C	8,900	5.30	2.75	0.57	2	
8		4,527	4.30	1.40	0.46	1	2
9		5,887	14.00	1.82	1.50	2	
10		20,526	44.00	6.34	4.74	8	
12		24,117	45.30	7.45	4.88	9	
13		673	6.40	0.21	0.69	1	5
15		954	2.70	0.29	0.32	0	
11		900	5.20	0.28	0.56	1	
14		370	0.00	0.02	0.00	0	
16		1,274	0.00	0.07	0.00	0	0
(-)	D	1,556	0.00	0.82	**0.00**	1	1
	Total	69,684	127.20	21.45	13.72	**25**	**8**
					35.17		

Trucks	8	units
Trips	4	Trip/day
payload	1.4	ton/container
transport	40.3	ton/day
	0.9	
Frequency	2	days

d. **Alternative -2** For C & D Zones are divided to Flat and Hills

	Classification Zone number	D zone
Flat	(south=10,12,15),(North=11,	(—)
Hills	(south=13),(north=7,8,9,16)	D zone

d-1) Hills Part By container

Location of Contair		poulatio	Area of	Domesti	Street	Container	Required
Project	MSW	habitant	ha	t/d	t/d	Required	Vihicle
7	C	8,900	5.30	2.75	0.57	2	
8	north	4,527	4.30	1.40	0.46	1	2
9		5,887	14.00	1.82	1.50	2	
16	C north	1,274	0.00	0.07	0.00	0	1
(-)	D	1,556	0.00	0.82	0.00	1	1
	Total	20,588	23.6	6.86	2.54	7	**4**
				Total:	9.40		

Trucks	4	units
Trips	4	Trip/day
payload	1.4	ton/container
transport	18.8	ton/day
	0.5	
Frequency	2	days

d-2) Flat Pa Bell collection and Road sweeping

Location of Co		poulation	Area of	Domestic	Street	Containe	Required
Project Zone No.	MSW Zone No.	habitant	ha	t/d	t/d	Required set	Vihicle unit
10		20,526	44.00	6.34	4.74	(-)	(-)
11		900	5.20	0.28	0.56	(-)	(-)
12		24,117	45.30	7.45	4.88	(-)	(-)
13		673	6.40	0.21	0.69	(-)	(-)
14		370	0.00	0.02	0.00	(-)	(-)
15		954	2.70	0.29	0.32	(-)	(-)
	Total	47,540	103.6	14.59	11.19	0	0
					25.78		

Required Nnumber of vehicles			
payload	units	Trip	t/d
5.4	**0**	2	0.0
1.8	**3**	3	16.2
3.2	**5**	2	32.0
			48.2
			187%

e. Summary table of A-2 & A-3

	Area Condition	Container (set)	Rollon/off (unit)	12 cu.m compa (unit)	4cu.m Compactor (unit)	6.8cu.m Dump (unit)
A-2	Flat:	**0**	**0**	**2**	**11**	**7**
	Hills:	**10**	**4**	**0**	**0**	**0**
A-3	Fla&H	**33**	**8**	**2**	**8**	**2**