proved as the base area, in the segments under plan of Ui Chong.

M1 site (No. 59 - 73)

Area to be improved: 4 ha (L = 0.7 km x 2)
Improvement policy:

a. Improve the embankment with lines of tree.s

b. In order to create a water-surface, provide a removable weir and improve its vicinity as a hydrophile space full of amenities.

Major facilities:

Hydrophile plaza (2), resting facilities (bench - 16, shelter - 4), control facilities (staircases - 8 places and trash bins in 8 points)

8.3.4 Facilities

a. Any type of facility and the materials used shall be such that would suffer less damage under the flood.

b. Facilities shall be such that are easy to maintain and control.

c. Only material having natural touch shall be used.

Ui Chong

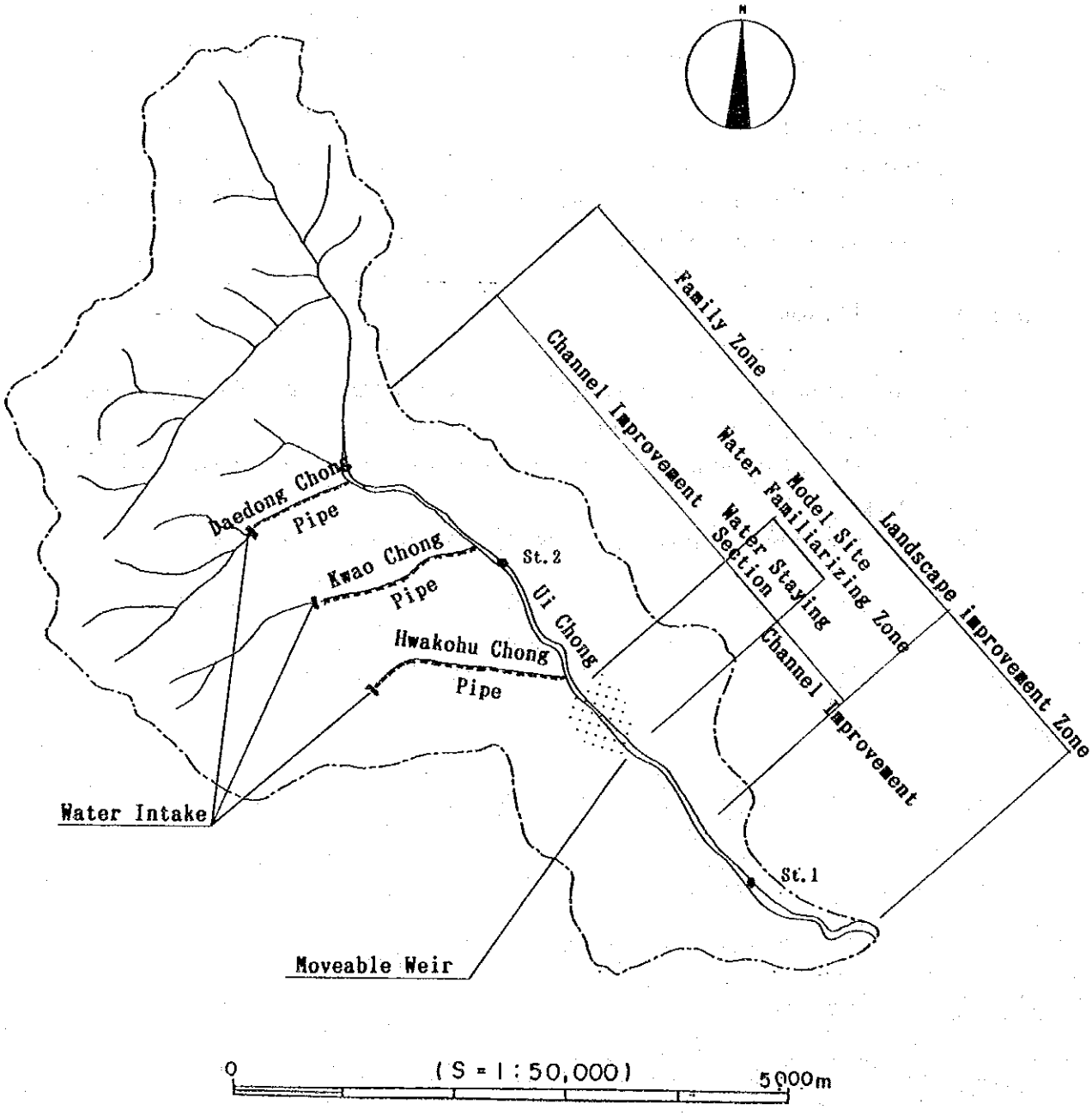
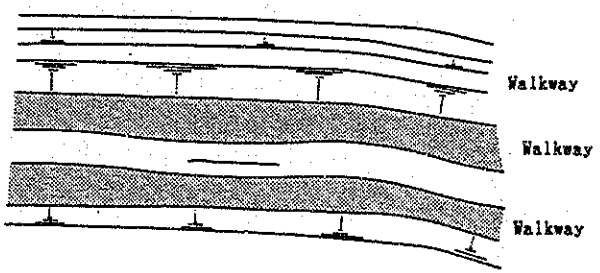
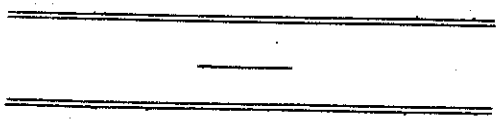
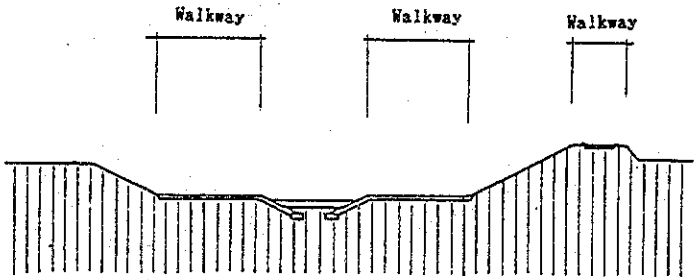


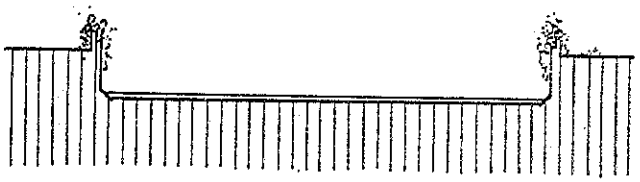
Fig. 8.3-1 River Space Zoning of Ui Chong







Family Zone



Landscape Improvement Zone

Fig. 8.3-2 Space Improvement Plan of Ui Chong on Every Zone

Chapter 9

Chapter 9 The Basic River Environment Improvement Plan for Chungroung Chong

The water quality of Chungroung Chong is bad. Accordingly, people think it should be covered to accommodate the construction of roads and parking lots. However, based on the estimate that the progress in the future standard of living of the residents will result to higher demands for better amenities, the water quality of the river shall be improved and an improvement plan shall be formulated.

The water quality standard desired for Chungroung Chong is Class III, and composite treatment which shall mainly implement contact oxidation with cobble plant shall be the basis of the improvement plan for this river. The installation of treatment facilities was planned at the upstream end of St. 3. However, due to river space restrictions, they shall be installed below the river beds. With the treatment facilities, it is considered that the present condition of the sewerage and intercepting sewers can be maintained, and the desired water quality can be achieved by the year 2010.

According to the survey results conducted in clear days, St. 3 in Chungroung Chong has more flow than St. 2 in Ui Chong, although the flow downstream is extremely poor when the water level is low, due to the large volume of underflow. Furthermore, the flow when the water level is low shall not be secured because there are no inexpensive means of securement at present.

There are many sections in the river space with perpendicular revetments, and these revetments spoil the landscape. The improvement of the landscape, therefore, shall be given emphasis, and the model site of this river shall be improved creating an atmosphere that shall better the attachment of the residents, which is observed to have always been strong, toward the river.

9.1 Problem and Future Outlook on River Environment

In order to establish the basic environment improvement plan, the problems and future look, referred to mainly in Chapters 3 and 4, are summarized in the fields of water quality, flow regime, space utilization and flood control.

9.1.1 Water Quality

(1) This river is apt to lower Class V of the river water quality standards even during the time having good water quality, but no apparent cycle considered to be seasonal variations has been observed.

(2) Seeing it by point of location, St. 3 located where the exit of culvert is provided, the water quality there is in many times interior than the other points. It is obvious that voluminous sewage is mixed in with the river water, from visual observation or the result of analysis of the water quality.

(3) The apparent run-off ratio at St. 3 exceeds 60% and the majority of the load discharged from the basin is presumed to have origin in the communities in the basin.

9.1.2 Flow Regime

(1) The discharge is scarce through the year. Especially, during the low water level season a considerable number of segments have no flow at all or few if had. Probably, this is due to the reasons, 1) Walgok Chong, major tributary has transformed in the river of sewage, and the discharge is intercepted before reaching the confluence with the main river and 2) underground flow of this river is great.

9.1.3 Space Utilization

(1) Since the river space itself constitutes a vital urban axis and the nucleus of the community, many people utilize small roads along the river as their back yards. And, many people are participating in the cleaning of the river bed.

(2) However, low-storied houses line on the both banks from the upstream down, along with the facility transshipping trash, give no charm to the spectacle of the river and makes it monotonous.

(3) The flow of the river becomes less as it downs the stream and there are segments completely lack of water in the river. Also considerable volume of surplus soil from the construction site are dumped, together with the trash, in the river. Besides, sludge deposited around the exit of culvert could be seen. This makes the river bed of many segments look dreary.

(4) The highway (No. 6 line) utilizing the river space between Songsu-dong in Songdong-gu and Wolgye-dong in Songbuk-gu is under construction (Construction period will be July 1991 - December 1993). Besides, at Chegi-dong in Tongdaemun-gu there is a plan to cover up the river over the length of 800 m or more to construct a parking lot on it. The execution of such a plan may bring a number of problems such as noise, scanty sun shine, worsening spectacles, etc. while the utilization of the river space intended to recover and make the best use of the hydrophile function would become all the more difficult.

9.1.4 Flood Control

(1) With the renovation ratio of river channel reaching 100% and the development in the basin coming closer to the point of saturation, the discharge of this river would not increase remarkably hereafter.

(2) Whereas, the probability size of the plan remains at 1/50 which is considered to be insufficient as an urban river; hence the probability size of the plan should be expanded hereafter.

(3) Also, damage caused by the inside water due to the back water of Chonggye Chong are occurring occasionally, so we need to prepare a comprehensive flood control plan including Chungryang Chong and Chonggye Chong, with the increment of capacity of the discharge pump station at Yongdu.

9.2 Water Quality Improvement Plan

9.2.1 Basic Policy

The cause of turbidity of this river is greatly depending on the imperfect construction of the pipe intercepting sewage. Unless it is renovated, the water quality of the river would further corrupt. Further, the occupation ratio of the river space by highway and parking lot would all the more increase and the conditions installing such facilities would become severer.

Under such circumstances, there is an opinion such that we should consider the effective utilization of the river space by covering the whole of river. However, we would improve the water quality on the precondition that we would leave the river space as it is under the reason stated in section 4.5.3.

9.2.2 Target Water Quality

Environmental Bureau is not establishing the water quality standard of this river, however, Chungryang Chong which joins this river is classified as Class III. Accordingly, the target water quality of this river is defined as Class III.

9.2.3 Selection of Applicable Technique

Deposit of sludge around St.3 where the culvert opens exit is very conspicuous and emits stink. Currently, sludge is removed by virtue of Semaul campaign. The supplying source of sludge is considered to be the pipe intercepting sewage having imperfect construction. Therefore, if "dredging of sludge deposited in the river channel" is made at the time the renovation mentioned above was done, we could get a long-term effect.

"Fall works", "sheet flow channel" and "aeration (direct)" will not applied here, because the effects of these facilities are not ascertained yet and that the dissolved oxygen remaining in the river is relatively great.

Since the water quality of the Han River (BOD concentration) which is the only source conceivable of "dilution with water for purification" has 4 - 6 mg/l in the low water level season, it is insufficient to clear the target of Class III (BOD concentration, below 6 mg/l).

Under the circumstances, among the water quality improvement technologies, the only technology applicable to this river channel is contact oxidization with cobble plant.

9.2.4 Design Criteria of Major Facility

(1) Design water quality

With regard to the water quality (BOD concentration) to be made the base of designing facility, Case 1's value shall be used because it is safer in 2 cases provided in Section 4.5. SS concentration shall be worked out from concentration using BOD/SS ratio during the period of investigation. The result is shown in Table 9.2-1.

Table 9.2-1 Designed Water Quality for Water Quality Improvement Facility in Chungroung Chong

Unit:mg/l

Year(Item)	St.1	St.2	St.3
1990(BOD)	14.0	11.2	19.0
(SS)	9.3	5.7	11.4
2002(BOD)	25.5	20.2	34.0
(SS)	28.1	22.2	37.4
2010(BOD)	32.4	26.3	44.5
(SS)	35.6	28.9	49.0

(2) Design discharge

The design water quality described above worked out basing on the average of the measured values every month during January 1990 and May 1991. Accordingly, this could be taken for values approximately to 50%. With regard to the design discharge corresponding to the above, the ordinary discharge (Q185) is adopted , i.e. values approximate to 50%.

Table 9.2-2 Designed Discharge for Water Quality Improvement Facility in Chungroung Chong

Unit:m^3/sec

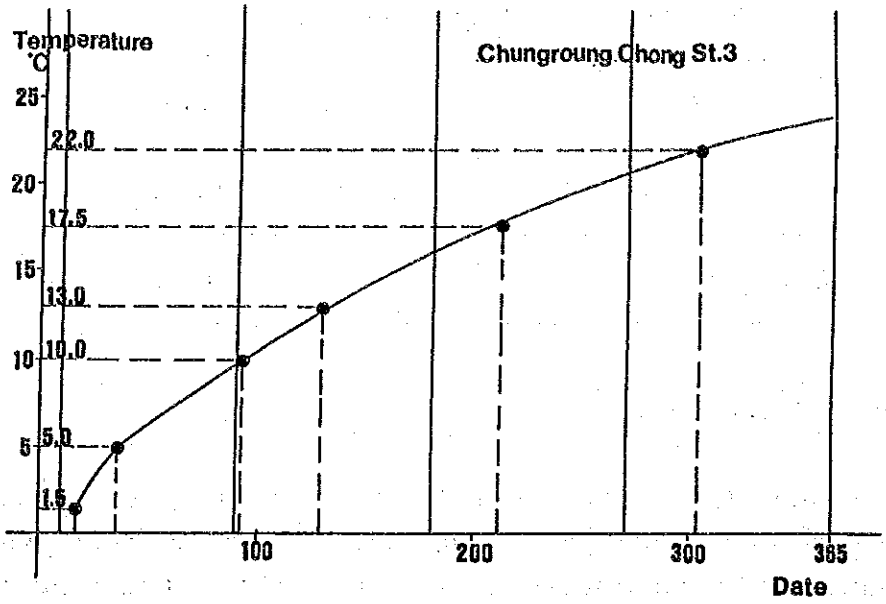
	St.1	St.2	St.3
Q(185-day)	0.244	0.300	0.168

(3) Type of treatment

The water quality purification facility shall be provided at St. 3 on the end of upstream of the segment under plan, where the water quality is considered to be the worst. Granting that the water quality purification facility was provided at such a point and the amount of sludge to be moved to clear the target (BOD concentration 6 mg/l) was calculated, then 407 kg/day in 2002 and 559 kg/day in 2010. Accordingly, Type 4 of Table 4.4-13 shall be adopted as the type of treatment (however, the pond precipitating sand is not required).

(4) Treatment capacity

Fig.9.2-1 represents the relation between the treatment capacity of the proposed contact oxidation with cobble plant at St.3 and the river flow or the water temperature.
The actual river flow exceeds the design discharge for approximately 170 days per year, however, it is expected that the target water quality can be sutisfied in the mixed condition of the treated water and the river flow, because it is recognized that the BOD concentration tends to decrease if the river flow increases. In winter season, the water quality deteriorates and the removal ratio of the plant decreases. However, it is possible to maintein the equivalent removal ratio at the design water temperature by extending the detention time, because the river flow gets lower than the design discharge.



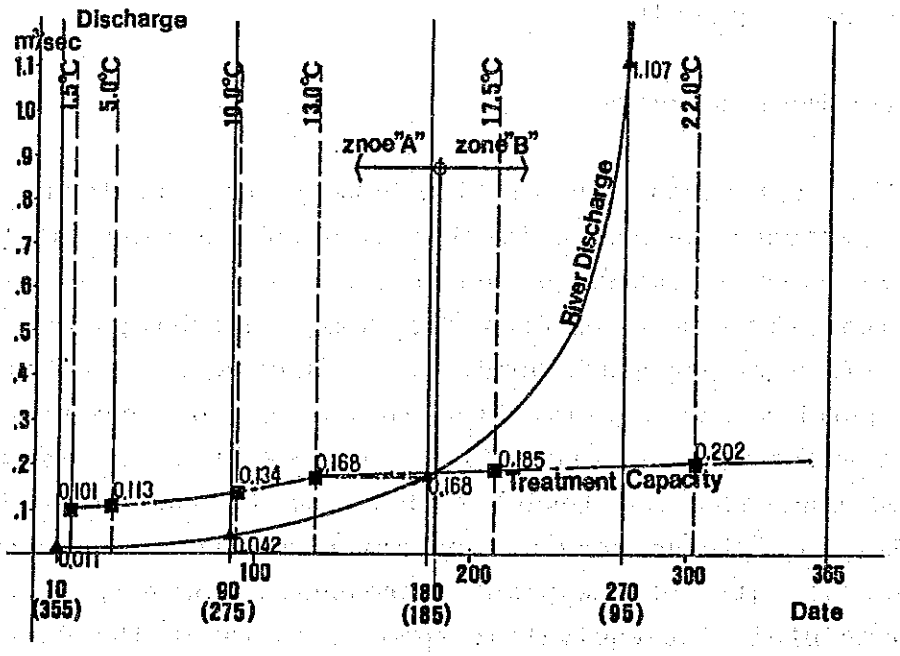


Fig. 9.2-1 Treatment Capacity of Water Quality Improvement Plant at St.3

9.2.5 Expected Effect of Water Quality Improvement

The effect of water quality improvement is indicated with the water quality and the pollution load in Fig.9.2-2 and 9.2-3, respectively.

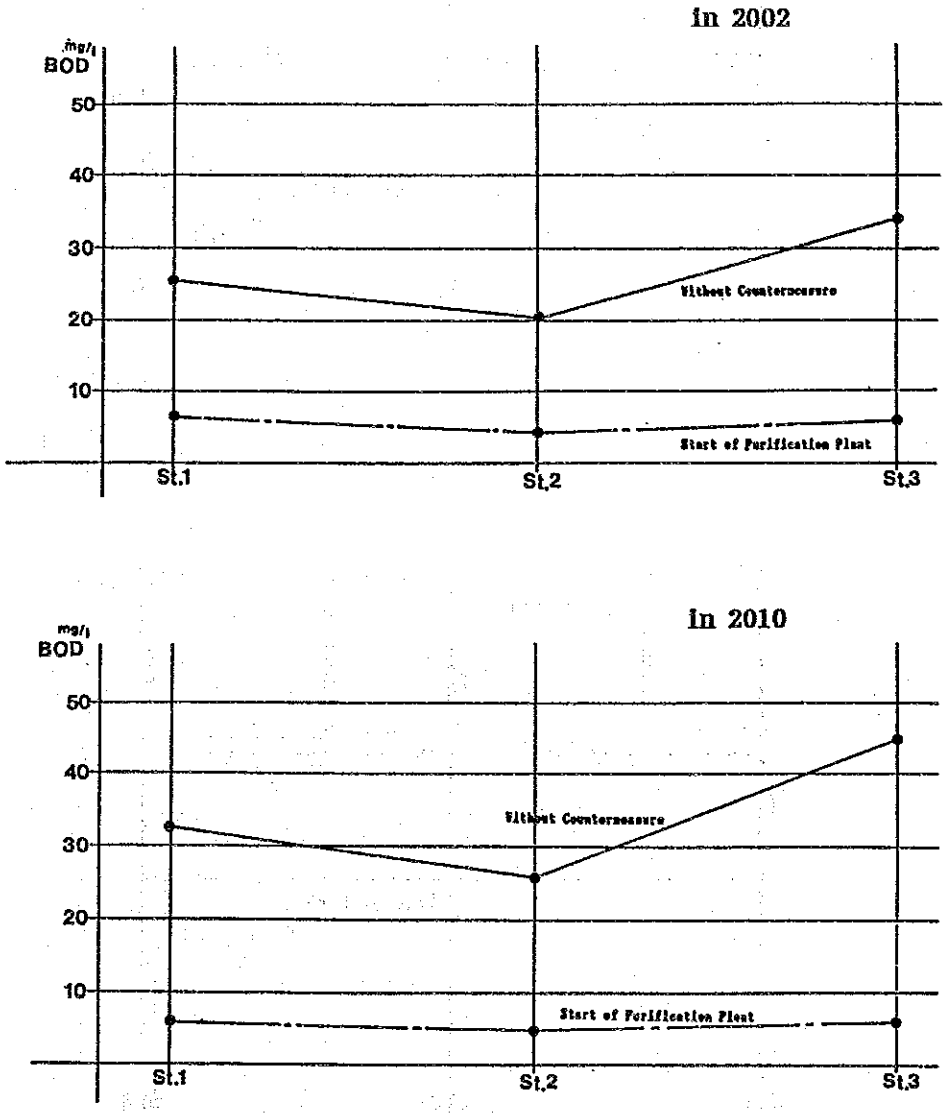
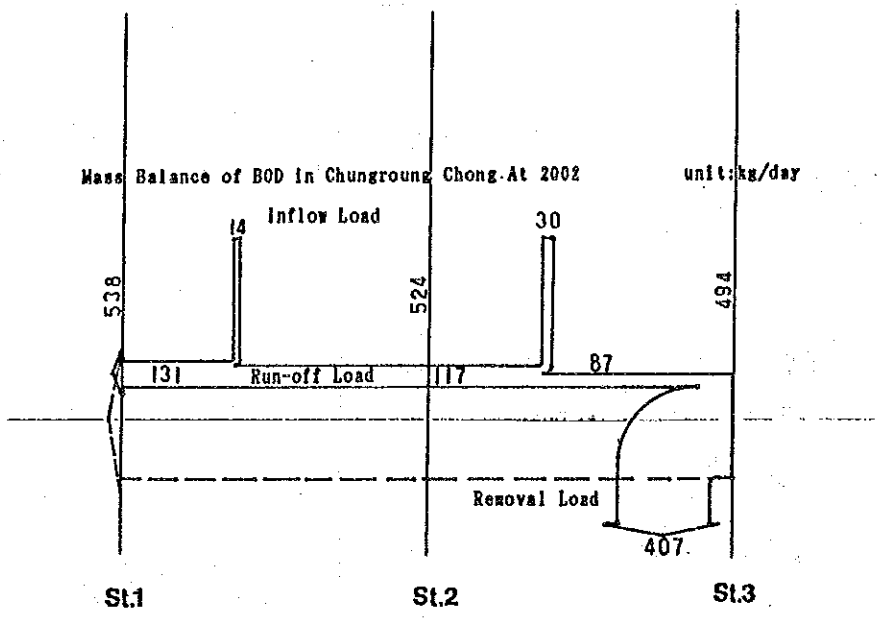


Fig. 9.2-2 Estimation of Water Quality when Water Quality Improvement Plant Installed



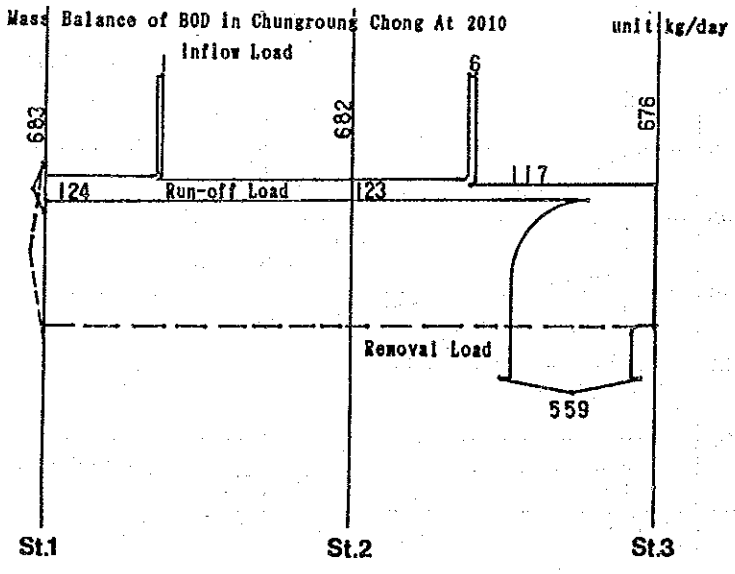


Fig. 9.2-3 Estimation of Pollution Load Balance when Water Quality Improvement Plant Installed

9.3 Space Improvement Plan

9.3.1 Basic Policy

Basing on the problems and future outlook as referred to in the preceding paragraphs, the basic policy of space improvement plan of Chungroung Chong is defined as follows:

(a) As there are a number of segments having dreary spectacles, this should be improved.

(b) Even now, the bond between the inhabitants and river is strong. Further efforts shall be made to enhance the easy association between the inhabitants through river.

9.3.2 Zoning and Improvement Plan in Each Section

Zoning in the planning section is established by the space shown in Section 3.6.1 and in 4.5.1 (Fig. 9.3-1). The established zone is only landscape zone.

Landscape zone

Area to be improved: 1 ha (3.4 km x 2)
Improvement policy:

a. Cover the perpendicular embankment exposing bare concrete with plants to improve the spectacle.
b. Improve the walking road so as to have the segment keep a link with it.

Major facilities:

Park roads, improving-spectacle facilities (plant box), control facilities (staircase, trash bins)

9.3.3 Improvement Plan of the Model Site

In accordance with the comprehensive evaluation made with regard to the demand for utilization and aptitude level of each segment as shown in Section 3.6.1, one section shall be given the priority in the improvement of segments of Chungroung Chong.

M1 site (No. 35 - 45)

Area to be improved: 1 ha (L = 1 km)
Improvement policy:

a. To create hydrophile spaces, wall-fountain utilized the perpendicular embankment shall be provided

b. To modify the perpendicular embankment exposing bare concrete, place plant boxes and juxtapose natural stones.

Major facilities:

Well-fountain (1), resting facilities (bench - 14), control facilities (staircases - 5 places, trash bins in 5 points), planting (plant box- 340) and modified embankment spectacle (2,400 m^2)

9.3.4 Facilities and Planting Plan

(1) Facility plan

a. Any type of facility and the materials used therefore shall be such that would suffer less damage under the flood.
b. Facilities shall be such that are easily maintained and controlled.
c. Only material having natural touch shall be used.

(2) Planting plan

a. The perpendicular embankment shall be covered with ivy and hedera.

Chungroung Chong

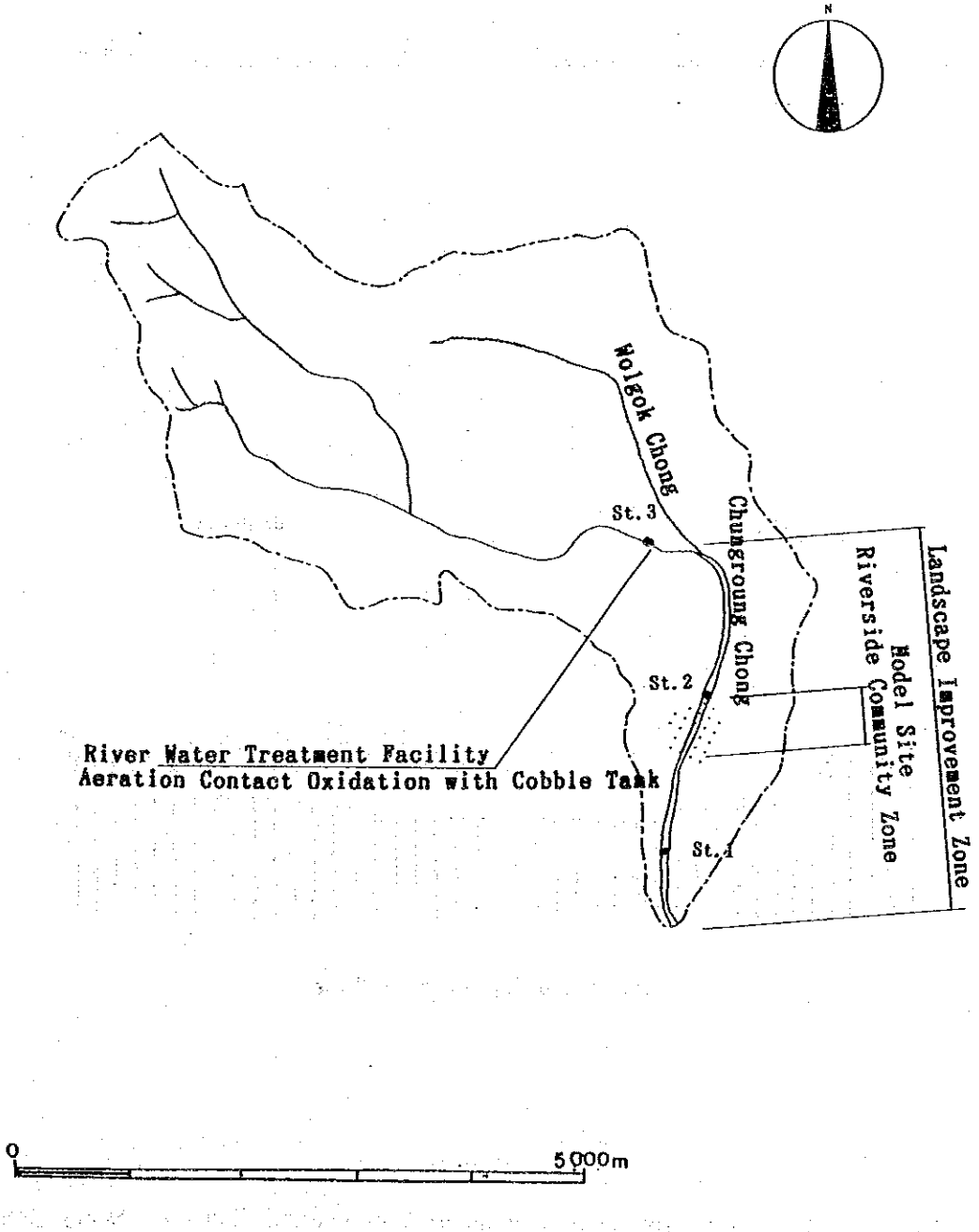
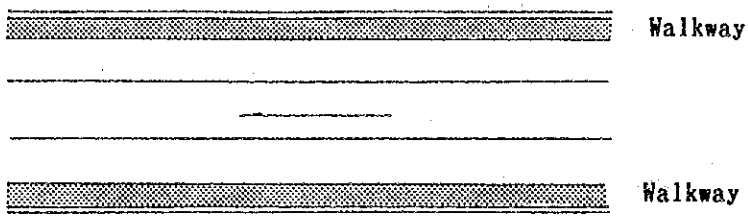


Fig. 9.3-1 River Space Zoning of Chungroung Chong



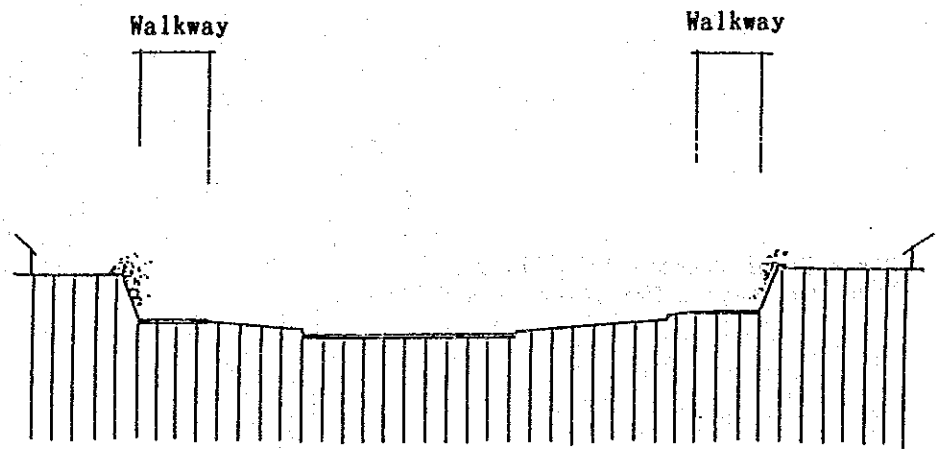


Fig. 9.3-2 Space Improvement Plan of Chungroung Chong on Every Zone

Chapter 10

Chapter 10 Project Outline

In this chapter, a general plan which corresponds to the basic concepts to be completed by 2010 is described and, after the execution priority of various works of this plan is discussed, the works to be carried out in the first project phase (by 2002) are decided. Then the preliminary designs of the main facilities to be included in the first project phase and, the execution and maintenance control plan are proposed. The working expenses are calculated on the basis of the project. Since the preliminary designs will be made on the basis of the water quality and flow regime data obtained from the observations made during the course of the investigation and the working expenses are standard expenses estimated as of 1991, these conditions must be reviewed upon executing the works. Finally, the investable amount of the Seoul Metropolitan government to the river environment improvement work is estimated from the present budget and investment plan of the Metropolitan government and the project promoting system is discussed.

10.1 General Plan

10.1.1 Whole Program of the Project

The general plan formulated based on the basic concepts stated in Chapter 6 to 9 is summarized in Table 10.1-1.

10.1.2 Examination of Priority

The necessity of the water quality improvement project, in terms of the water deterioration, is [1]Anyang Chong, [2]Chungroung Chong, [3]Yangjae Chong and [4]Ui Chong in order. On the other

Table 10.1-1 Basic Plan of River Environmental Improvement

Description		Anyang	Yangjae	Ui	Chungroung	Remarks
①Primary factors of pollution						
Present		①Sewage from upper basin ②Sewage from the retarding basin	①Connecting sewer pipes to stormwater pipes ②Inflow from Yoi Chong	No particular water quality problem	①Sewage leakage from existing pipes	
Future	2002	Sewage leakage from exiting intercepting sewers	①Misconnection of sewer pipe to stormwater pipe	No particular water quality problem	①Sewage leakage from existing pipes	
	2010	Sewage leakage from existing intercepting sewers	①Misconnection of sewer pipe to stormwater pipe	No particular water quality problem	①Sewage leakage from existing pipes	
②Water Quality and Flow Regime Improvement Conceptual Plan						
1. Water quality target	2002	Class V for a certain length	Class III for most length	Class III for whole length	Class III for most length	V : BOD 10 mg/l III : BOD 6 mg/l II : BOD 3 mg/l
	2010	Class V for whole length	Class II for most length	Class III for whole length	Class III for most length	
2. Discharge target	2002	Not specified	Not specified	Forming water face as scenes	Not specified	
	2010	Not specified	Not specified	Forming water face as scenes	Not specified	
3. Countermeasures and improved level (BOD mg/l)						
	2002	①Settling sand, sedimentation, and pre-aeration cobble contact oxidation treatment at St.6 BOD 23.7 → 10.0 mg/l	①Settling sand and pre-aeration cobble contact oxidation treatment at St.2 BOD 13.4 → 10.0 mg/l	①Movable weir at St.1+1600m ②Introduction of water	①Aeration cobble contact oxidation treatment at St.3 BOD 34.0 → 6.0 mg/l	
	2010	①Settling sand, flocculent settling, aeration cobble contact oxidation treatment at St.5 BOD 41.2 → 10.0mg/l ②Settling sand and pre-aeration cobble contact oxidation treatment at St.4 & 2 St.4 BOD 39.8 → 10.0 mg/l St.2 BOD 44.7 → 10.0 mg/l ③Dredging of bed sediment	BOD 15.3 → 6.0 mg/l In case sewage inflow between St.2 and St.1 is stopped, it can attain 3.0 mg/l of BOD.	① Low Water Channel Improvement	BOD 44.5 → 6.0 mg/l	Regarding Anyang Ch. the sewage inflow to the river must be improved.
③River Space Improvement Conceptual Plan						
1. Studied length		28.2 km	13.2 km	14 km	7.8 km	
2. Target improve rate	2002	8.3% (L=2.35km, A=29ha)	33.3% (L=4.4 km, A=18 ha)	10% (L=1.4 km, A=4 ha)	12.8% (L=1 km, A=1 ha)	
	2010	100% (L=28km, A=212ha)	100% (L=13.2 km, A=55 ha)	100% (L=14 km, A=17 ha)	100% (L=7.8km, A=2 ha)	
3. Target improve Plan	2002	3 Improvement Model Sites M1 : 12 ha (L=0.8 km) M2 : 12 ha (L=0.9 km) M3 : 5 ha (L=0.65 km)	2 Improvement Model Sites M1 : 11 ha (L=2.4 km) M2 : 7 ha (L=2.0 km)	1 Improvement Model Site M1 : 4 ha (L=1.4 km)	1 Improvement Model Site M1 : 1 ha (L=1.0 km)	
	2010	Multipurpose Zone L=9.25 km Family Zone L=16.6 km Natural Zone L=0.65 km	Family Zone L=6.1km Natural Zone L=2.2km Nature Preserve Zone L=0.5km	Family Zone L=9.1 km Landscape Improvement Zone L=3.5 km	Landscape Improvement Zone L=7.8 km	

hand, the necessity of the river space improvement project, in terms of the citizen's demand to the park and the green area, is [1]Anyang chong, [2]Chungroung Chong, [3]Ui Chong and [4]Yangjae Chong in order.

The priority of the project implementation shall be determined on the basis of the principles described below.

(1) Priority shall be given to the river space improvement project because there is no need to implement the past observation data on discharge, water quality, etc. to be implemented.

(2) The whole length of the four studied rivers are planned to be improved. The implementation priority shall be given to the model sites and its vicinities taking into consideration the residents of these areas. Among the four rivers, Anyang Chong shall be improved in the earliest because its utilization demand is the largest. However the model site M3 shall be held back until the progress of the flood control project is in progress because its inundation frequency is deemed to be high.

(3) The improvement of Yangjae Chong is expected to efficiently spread the importance of the river environment improvement to citizens because Yangjae Chong has the potential to create high level recreation spaces. In Yangjae Chong, the river space improvement project and the water quality improvement project shall therefore be implemented at the same time so that a harmonious river environment can be created.

(4) The flow regime improvement project in Ui Chong shall be implemented in conformity with the progress of the river space improvement project because its purpose is to create a water face.

(5) The main function of the water quality improvement project is to construct contact oxidation with cobble plants. In order to determine the most appropriate treatment capacity, it is neces-

sary to observe discharge and water quality for five years.

(6) The water purification facilities shall be constructed from small scale plants to large scale plants in order to obtain practical know-how and to conduct the project more effectively.

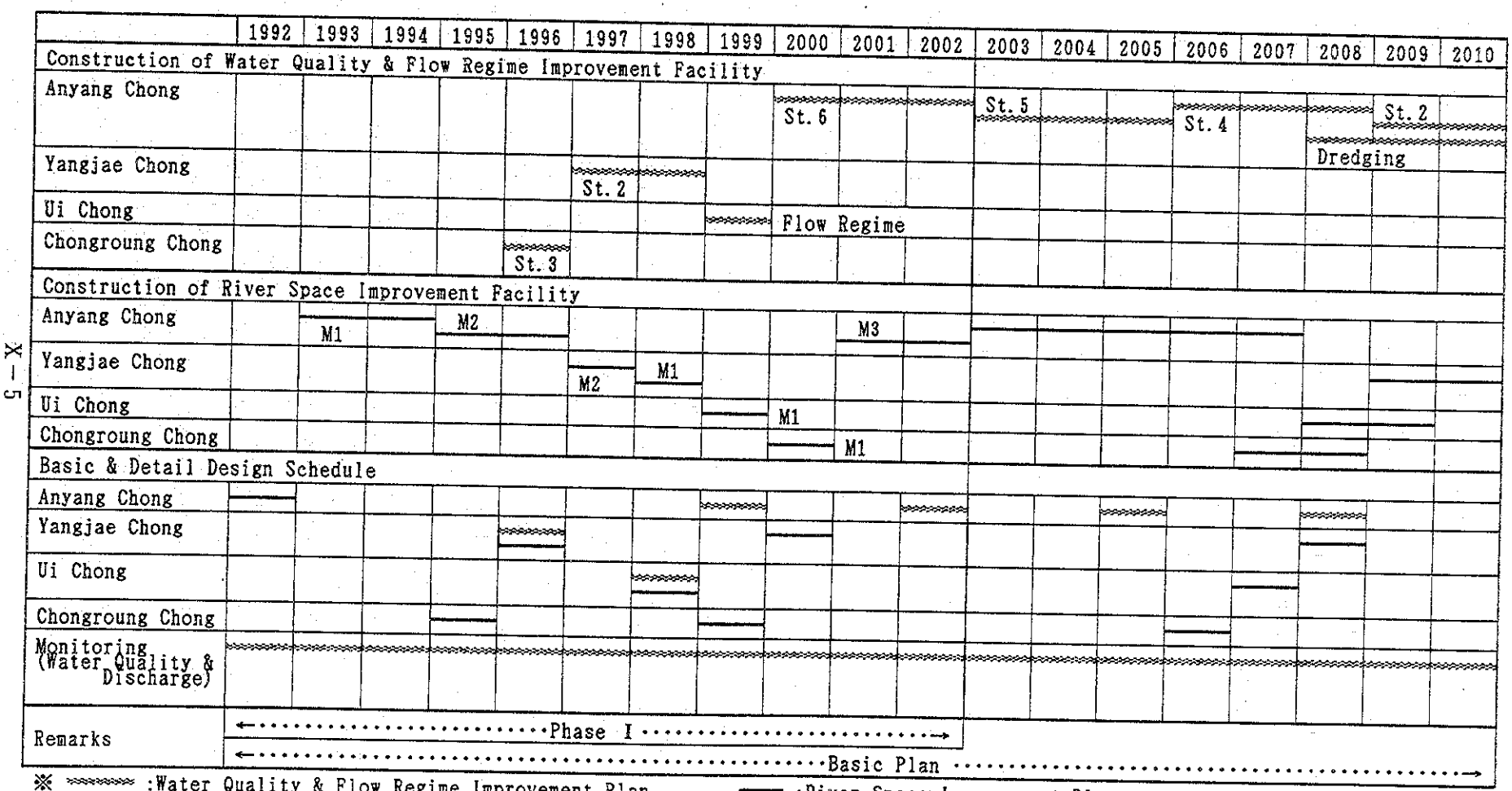
(7) The water quality improvement plants in Anyang Chong shall be constructed from the upper reach to the lower reach because the construction program must proceed in conformity with the effects of the water quality improvement by the sewerage improvement in the upstream basin.

(8) In Anyang Chong, the water quality is estimated to have attained 23.7 mg/l of BOD at St.6 in the year 2001, because of the ongoing sewerage improvement project in the basin. In view of the improvement of the water quality, implementation program of the contact oxidation plants at St.6 shall be started.

(9) Dredging works shall commence at the end of the implementation program because the investment effect is little unless a certain level of water quality is attained.

The implementation program (draft) formulated in view of the above mentioned matters are presented in Table 10.1-2.

Table 10.1-2 Implementation Program of Project



10.1.3 Annual Investment Program

The project expenses, roughly estimated on the basis of the project implementation program described in 10.1.2, are represented in Table 10.1-3. The yearly investments were calculated based on the necessary investment for first project phase of the project shown in 10.6.

Table 10.1-3a Annual Investment Schedule (Overall)

unit:million won

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Sub-total	2003	2004	2005	2006	2007	2008	2009	2010	Sub-total	Total	2011
Construction Cost																							
Anyang		1,459	1,459	1,267	1,267				14,065	15,475	15,475	50,467	35,216	35,216	35,216	27,765	27,763	51,182	30,457	30,457	273,272	323,739	
Yanjgae						9,628	8,144					17,772							4,553	4,552	9,105	26,877	
Ui								5,642				5,642						6,196	6,196		12,392	18,034	
Chongroung					3,066				1,604			4,670					792	792			1,584	6,254	
Sub-total		1,459	1,459	1,267	4,333	9,628	8,144	5,642	15,669	15,475	15,475	78,551	35,216	35,216	35,216	27,765	28,555	58,170	41,206	35,009	296,353	374,904	
Monitoring	200	200	200	200	200	200	200	200	200	200	200	2,200	200	200	200	200	200	200	200	200	1,600	3,800	200
Design	436			245	1,422		452	3,504	226		2,816	9,101			7,411	127	991	5,601			14,130	23,231	
Sub-total	636	200	200	445	1,622	200	652	3,704	426	200	3,016	11,301	200	200	7,611	327	1,191	5,801	200	200	15,730	27,031	200
Total	636	1,659	1,659	1,712	5,955	9,828	8,796	9,346	16,095	15,675	18,491	89,852	35,416	35,416	42,827	28,092	29,746	63,971	41,406	35,209	312,083	401,935	200
Maintenance Cost																							
Anyang			18	36	51	66	66	66	66	66	66	501	1,332	1,416	1,500	4,120	4,204	4,288	6,319	6,319	29,498	29,999	8,894
Yanjgae							70	349	349	349	349	1,466	349	349	349	349	349	349	349	404	2,847	4,313	459
Ui									25	25	25	75	25	25	25	25	25	25	99	99	348	423	99
Chongroung						92	92	92	92	111	111	590	111	111	111	111	111	121	131	131	938	1,528	131
Mainte Total			18	36	51	158	228	507	532	551	551	2,632	1,817	1,901	1,985	4,605	4,689	4,783	6,898	6,953	33,631	36,263	9,583
Total	636	1,659	1,677	1,748	6,006	9,986	9,024	9,853	16,627	16,226	19,042	92,484	37,233	37,317	44,812	32,697	34,435	68,754	48,304	42,162	345,714	438,198	9,783

Table 10.1-3b Annual Investment Schedule (Water quality and flow-regime Improvement project) million won

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Sub-total	2003	2004	2005	2006	2007	2008	2009	2010	Sub-total	Total	2011
Construction Cost																							
Anyang									14,065	14,065	14,065	42,195	28,176	28,176	28,176	20,725	20,725	51,182	30,457	30,457	238,074	280,269	
Yanjgae						3,779	3,778					7,557										7,557	
Ui								3,544				3,544										3,544	
Chongroung					3,066							3,066										3,066	
Sub-total					3,066	3,779	3,778	3,544	14,065	14,065	14,065	56,362	28,176	28,176	28,176	20,725	20,725	51,182	30,457	30,457	238,074	294,436	
Monitoring	200	200	200	200	200	200	200	200	200	200	200	2,200	200	200	200	200	200	200	200	200	1,600	3,800	200
Design				245	605		284	3,376				4,510			7,411			4,873			12,284	16,794	
Sub-total	200	200	200	445	805	200	484	3,576	200	200	200	6,710	200	200	7,611	200	200	5,073	200	200	13,884	20,594	200
Total	200	200	200	445	3,871	3,979	4,262	7,120	14,265	14,265	14,265	63,072	28,376	28,376	35,787	20,925	20,925	56,255	30,657	30,657	251,958	315,030	200
Maintenance Cost																							
Anyang													1,266	1,266	1,266	3,802	3,802	3,802	5,833	5,833	26,870	26,870	8,408
Yanjgae								227	227	227	227	908	227	227	227	227	227	227	227	227	1,816	2,724	227
Ui																							
Chongroung						92	92	92	92	92	92	552	92	92	92	92	92	92	92	92	736	1,288	92
Mainte Total						92	92	319	319	319	319	1,460	1,585	1,585	1,585	4,121	4,121	4,121	6,152	6,152	29,422	30,882	8,727
Total	200	200	200	445	3,871	4,071	4,354	7,439	14,584	14,584	14,584	64,532	29,961	29,961	37,372	25,046	25,046	60,376	36,809	36,809	281,380	345,912	8,927

Table 10.1-3c Annual Investment Schedule (River Space Improvement project)

unit:million won

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Sub-total	2003	2004	2005	2006	2007	2008	2009	2010	Sub-total	Total	2011
Construction Cost																							
Anyang		1,459	1,459	1,267	1,267					1,410	1,410	8,272	7,040	7,040	7,040	7,040	7,038				35,198	43,470	
Yanjgae						5,849	4,366					10,215							4,553	4,552	9,105	19,320	
Ui								2,098				2,098						6,196	6,196		12,392	14,490	
Chongroung									1,604			1,604					792	792			1,584	3,188	
Sub-total		1,459	1,459	1,267	1,267	5,849	4,366	2,098	1,604	1,410	1,410	22,189	7,040	7,040	7,040	7,040	7,830	6,988	10,749	4,552	58,279	80,468	
Design	436				817		168	128	226		2,816	4,591				127	991	728			1,846	6,437	
Sub-total	436				817		168	128	226		2,816	4,591				127	991	728			1,846	6,437	
Total	436	1,459	1,459	1,267	2,084	5,849	4,534	2,226	1,830	1,410	4,226	26,780	7,040	7,040	7,040	7,167	8,821	7,716	10,749	4,552	60,125	86,905	
Maintenance Cost																							
Anyang			18	36	51	66	66	66	66	66	66	501	66	150	234	318	402	486	486	486	2,628	3,129	486
Yanjgae							70	122	122	122	122	558	122	122	122	122	122	122	122	177	1,031	1,589	232
Ui									25	25	25	75	25	25	25	25	25	25	99	99	348	423	99
Chongroung										19	19	38	19	19	19	19	19	29	39	39	202	240	39
Mainte Total			18	36	51	66	136	188	213	232	232	1,172	232	316	400	484	568	662	746	801	4,209	5,381	856
Total	436	1,459	1,477	1,303	2,135	5,915	4,670	2,414	2,043	1,642	4,458	27,952	7,272	7,356	7,440	7,651	9,389	8,378	11,495	5,353	64,334	92,286	856

10.2 First Project Phase

First project phase to be completed by 2002 is shown in Table 10.2-1.

Table 10.2-1 First Phase Project

	Water quality improvement	Flow regime improvement	River space improvement
Anyang Chong	1 facility (St. 6)		3 facilities (M1, M2, M3)
Yangjae Chong	1 facility (St. 2)		2 facilities (M1, M2)
Ui Chong		1 movable weir 3 environmental water conveyances	
Chungroung Chong	1 facility (St. 3)		1 facility (M1)

10.3 Preliminary Design

The facilities being shown in Table 10.2-1 were preliminary designed, and the basic concept to design described as follows.

10.3.1 Water Quality Improvement Facilities

The water quality Improvement facilities proposed at St.6 and St.2 of Anyang Chong and St.3 of Yangjae Chong were preliminary designed in this study. The design policies which were common to these facilities are described as follows, and the design discharge, the design water quality and the structure type are described by the location.

(1) Treatment Process

A water treatment plant is divided into three processes, water intake process, settling sand process (sedimentation treatment) and biological treatment process (contact oxidation with cobble treatment). The design policy of each process is described as follows.

1) Grit Chamber

This facility is a water tank to sediment and separate sandy portion from the inflow water, and this is equipped with a machine room. Much expenses including manpower are being spent to remove deposited sand and to maintain in good conditions around the water intake of the plant under operation in Japan. In this plan, in order to avoid such losses, sand was designed to be flown through the water intake by keeping water flow in the high velocity, and to be at the grit chamber installed before the contact oxidation with cobble tank. The sand removed at the grit chamber was designed to be returned to the river or transported out.

2) Contact Oxidation with Cobble Treatment Plant

As being described in Fig.4.6.2, the contact oxidation with cobble plant is divided into two, with aeration and with pre-aeration. In Japan, the Ministry of Construction recommends the former type for the raw water, of which water quality is more than 25 mg/l of BOD concentration. However, for this project, in case BOD of the raw river water is over 20.0 mg/l, the aeration contact oxidation with cobble treatment was adopted and pre-aeration contact oxidation with cobble treatment was adopted for others.

In the aeration contact oxidation plant, there are diffuser pipes installed under the bottom slab of the tank filled with cobbles, and the machine room, which supply air into the diffuser

pipes, is provided beside the cobble tank. On the other hand, in the pre-aeration contact oxidation plant, there are the tank filled with cobbles and the pre-aeration tank, and the pre-aeration tank are used only for aeration.

The main design parameters were determined referring to the design data of the similar treatment plants which are being operated in Tama River and the Ara River. The basic parameters of the facility design are indicated in Table 10.3-1.

Table 10.3-1 Basic Parameter of Facility Design

		Pre-aeration COC	Aeration COC
Design temperature		13°C (Non-exceed probability : 75%)	13°C
Detention time		2.0 hr	3.0 hr
Air discharge ratio		1.0	2.0
Removal ratio	BOD	75%	90%
	SS	85%	80%

* COC : Contact Oxidation with Cobble Method

The contact oxidation with cobble tank has no post-sedimentation tank, and sludge are sedimented in the cobble tank and removed generally once five years. To determine the tank volume, it is divided into two, for water treatment and for sedimentation sludge. The formula using in Japan is shown below.

$$V = Vp+Vs$$

$$Vp=(Q/24)\times DT \div \gamma$$

$Vs=S/(1-w)\times d\times \gamma$

$S=\Sigma Ci\cdot Qi\cdot Rss(1-Pss)\times 365+Pmax\cdot Pss(1/(1-e^{-k}))$

V :Tank Volume (m^3)

Vp :Tank Volume for Purification (m^3)

Vs :Tank Volume for Sludge Storage (m^3)

Q :Treatment Discharge (m^3/day)

DT :Design Detantion Time (hr)

γ :Void content of Cobble(This Study···Used 0.45)

S :Dry Solid of Sludge(ton/day)

w :Moisture content of Sludge

d :Specific Gravity of Sludge(This Study···Used 1.25)

Ci :SS Concentration (kg/m^3)

Qi :Treatment Discharge (m^3/day)

Rss:Rmoval Ratio of SS

Pss:Volatile Solids of SS

-k :Velocity Constant of Sludge Decrease

(2) Structure Type

The water intake is to introduce river water by damming up with a rubber dam. The grit chamber is to made of reinforced concrete. The contact oxidation with cobble tank has a reinforced concrete wall or a sheet pile wall with a reinforced concrete bottom slab.

(3) Outline of Facility

The outline of the facilities are shown in Table 10.3-2.

Table 10.3-2 Outline of Water Quality Improvement Facility

	Anyang Chong	Yangjae Chong	Chungroung Chon
Site	St.6	St.2	St.3
Treatment Method	Aeration COC	Pre-aeration COC	Aeration COC
Design temperature	13.0°C	13.0°C	13.0°C
Discharge	3.252 m^3/sec	0.645 m^3/sec	0.168 m^3/s
Capacity	2.089 m^3/sec	0.523 m^3/sec	0.168 m^3/s
Removal ratio			
BOD	90%	75%	90%
SS	85%	92%	85%
Design water quality			
Inflow BOD	23.7 mg/l	15.3 mg/l	44.5 mg/l
SS	35.6	61.2	49.0
Treated BOD	2.4	3.8	4.5
SS	7.1	4.6	9.8
River water BOD	10.0	6.0	4.5

*COC : Contact Oxidation with Cobble Method

Water Quality Improvement Facility at St.6 of Anyang Chong

Design Discharge : Q_{185}

Design Raw Water Quality : BOD=23.7 mg/l and SS=35.6 mg/l in 2002 and 2010

Treatment method : Aeration contact oxidation with cobble plant with grit chamber

The river water is conveyed to the aeration contact oxidation with cobble tank after through the grit chamber. The effluent of the treatment plant can attain 2.4 mg/l of BOD. It is however not economical that all river water is purified to this level. We thereby determined the treated discharge so that mixed water of raw river water and the effluent can satisfy 10 mg/l of BOD. The treatment flow and the layout of this plant are shown in Fig.10.3-1 and 10.3-2.

Water Quality Improvement Facility at St.2 of Yangjae Chong

Design Discharge : Q_{185}
Design Raw Water Quality :
BOD=13.4 mg/l, SS=53.6 mg/l in 2002
BOD=15.3 mg/l, SS=61.2 mg/l in 2010
Treatment method : Pre-aeration contact oxidation with cobble plant with a grit chamber and a sedimentation tank

A sedimentation tank is designed to be provided after the grit chamber because this river water contains inorganic SS quite much. The effluent of the treatment plant can attain 4.6 mg/l of BOD. It is however not economical that all river water is purified to this level. We thereby determined the treated discharge so that mixed water of raw river water and the effluent can satisfy 6 mg/l of BOD.
The treatment flow and the layout of this plant are shown in Fig.10.3-3 and 10.3-4.

Water Quality Improvement Facility at St.3 of Chungroung Chong

Design Discharge : Q_{185}
Design Raw Water Quality :
BOD=34.0 mg/l, SS=37.8 mg/l in 2002
BOD=44.5 mg/l, SS=49.0 mg/l in 2010
Treatment method :
Aeration contact oxidation with cobble plant was adopted, because of limited construction site and the low concentration of BOD.

The treatment flow and the layout of this plant are shown in Fig.10.3-5 and 10.3-6.

(4) Countermeasure to Inundation

The water quality facilities excepted a electric room, a control

room and sand washing utility are all constructed under major beds. In order to avoid inundation damages, we designed the entrances and necessary openings of facilities including machineries and electric utilities to be higher than the dam.

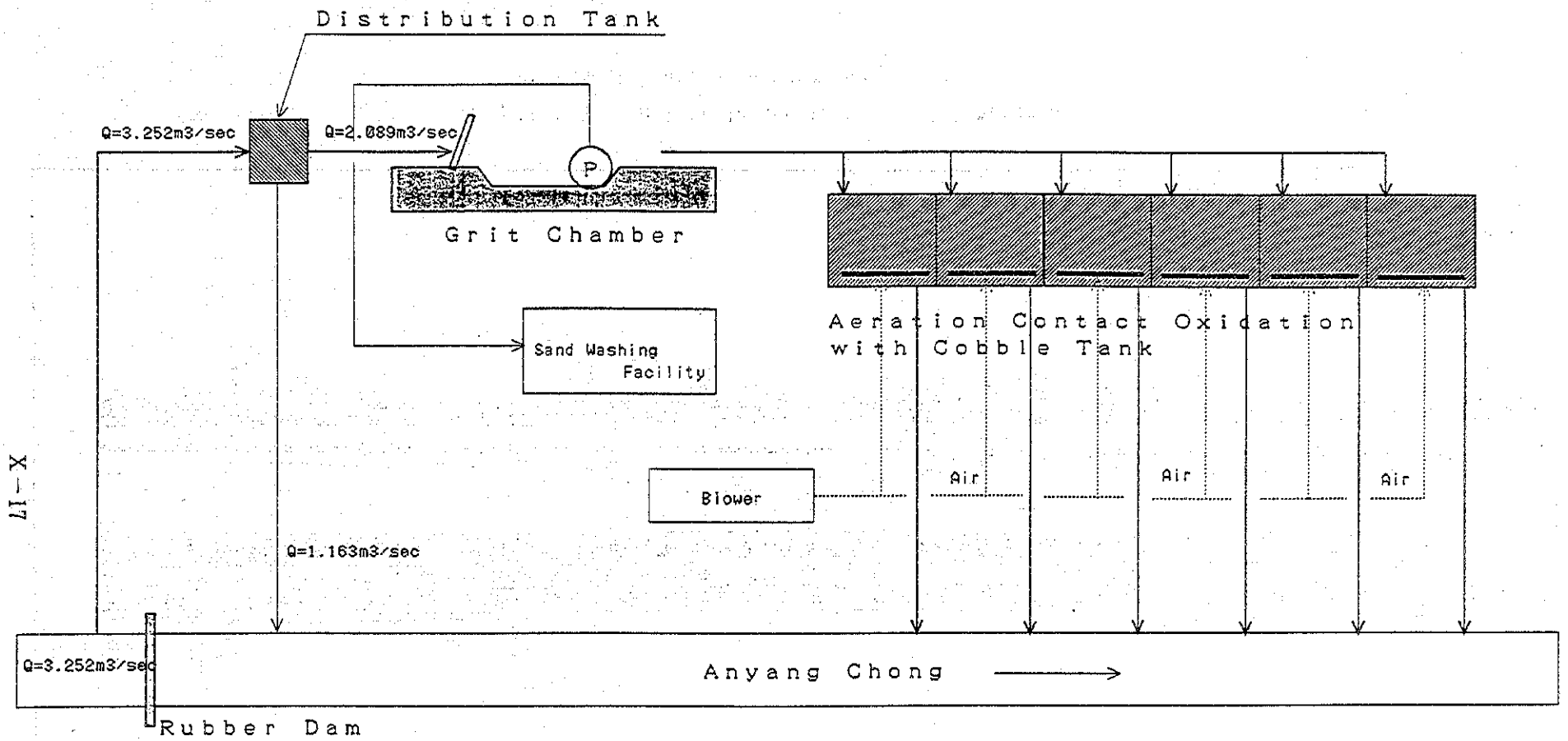


Fig.10.3-1 Treatment Flow of St.6 Water Quality Improvement Plant of Anyang Chong

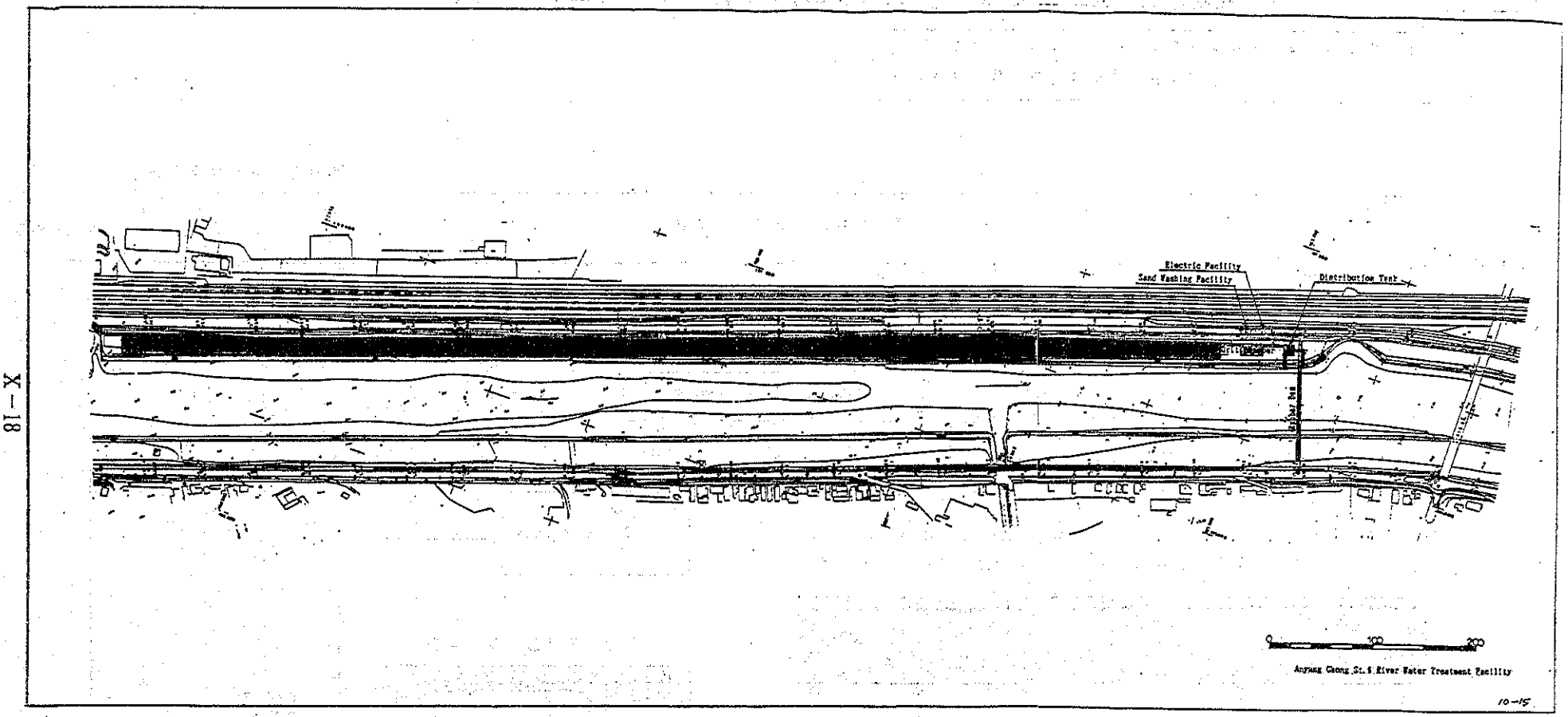


Fig.10.3-2 Facility Arrangement for St.6 Water Quality Improvement Plant of Anyang Chong

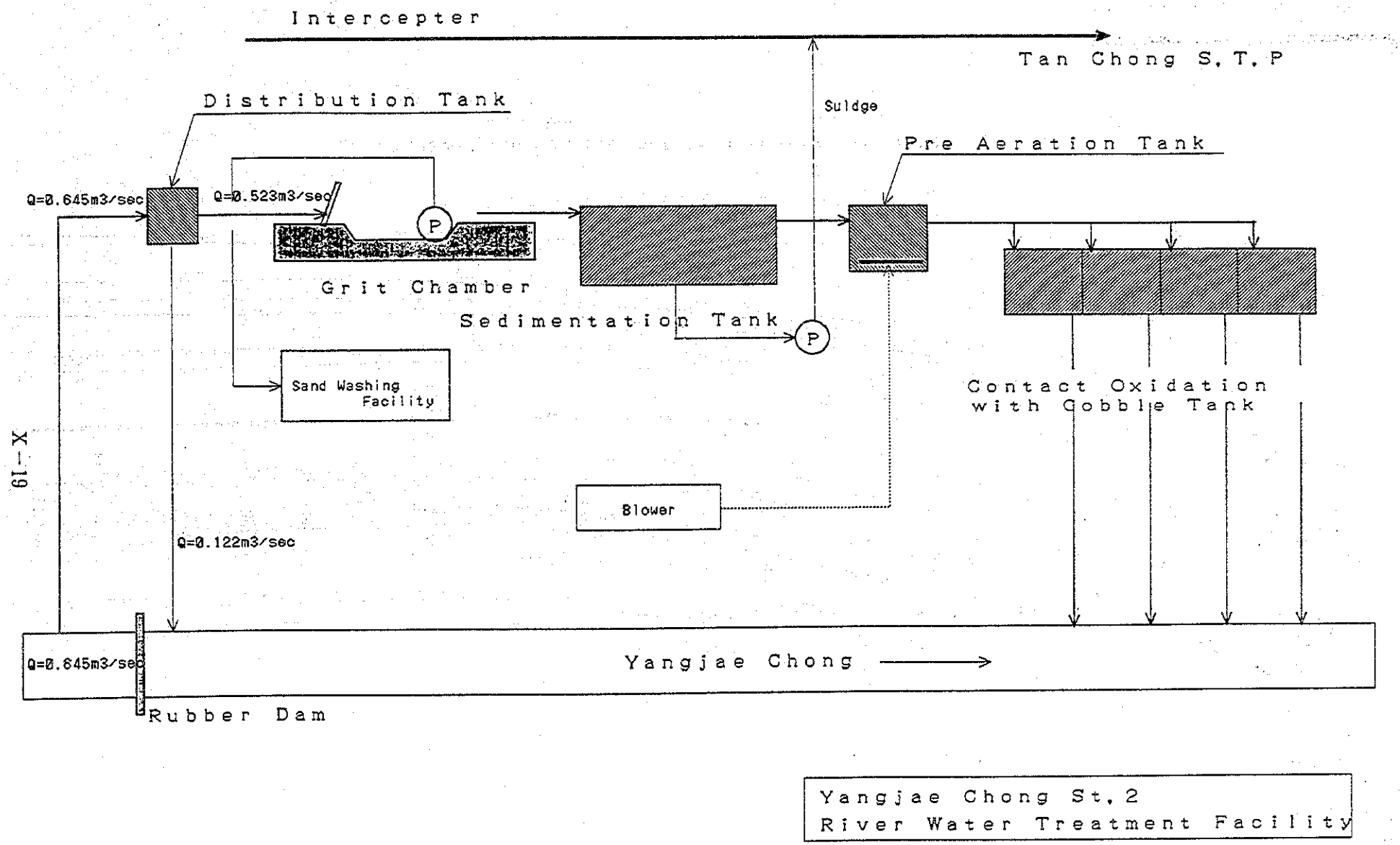


Fig.10.3-3 Treatment Flow of St.2 Water Quality Improvement Plant of Yangjae Chong

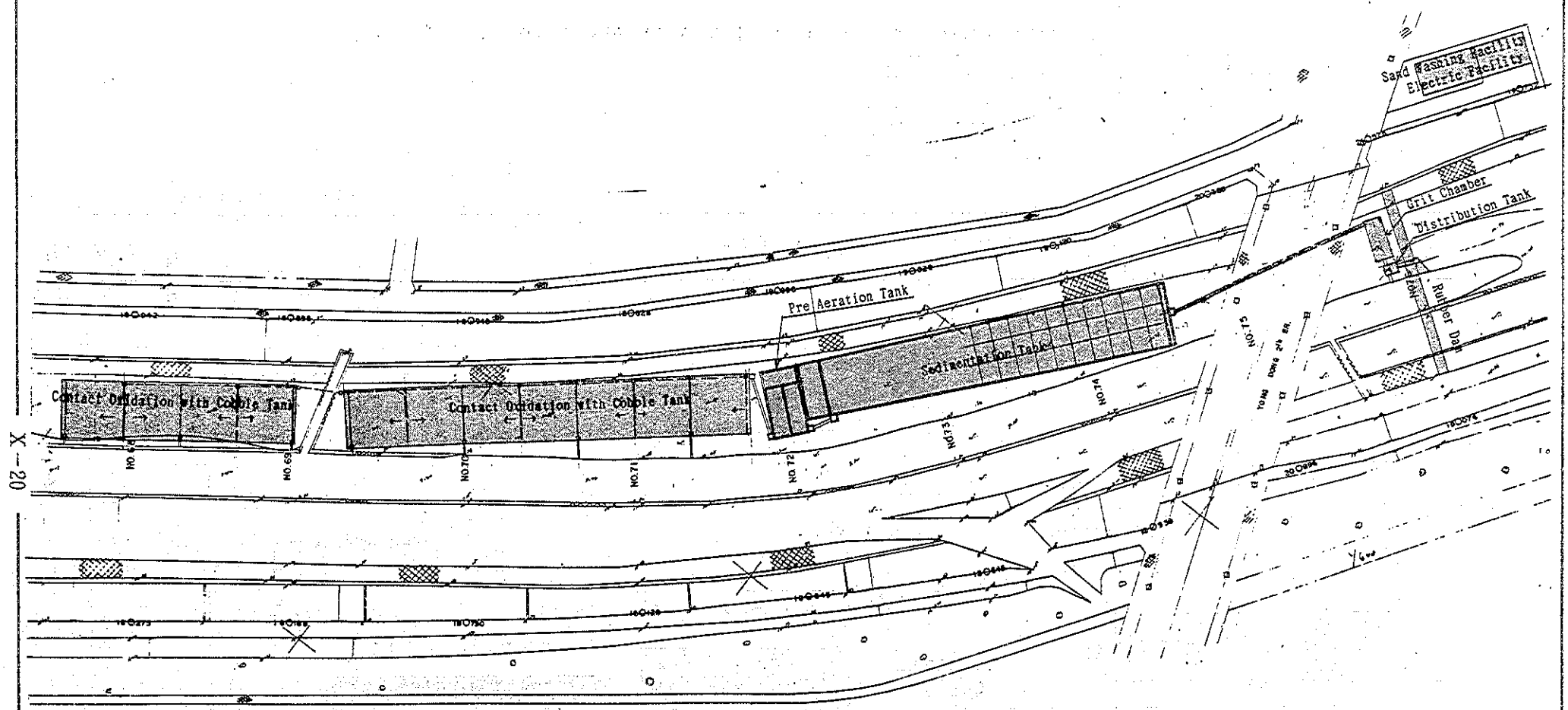


Fig.10.3-4 Facility Arrangement for St.6 Water Quality Improvement Plant of Yangjae Chong

Yangjae Chong St.2 River Water Treatment Facility

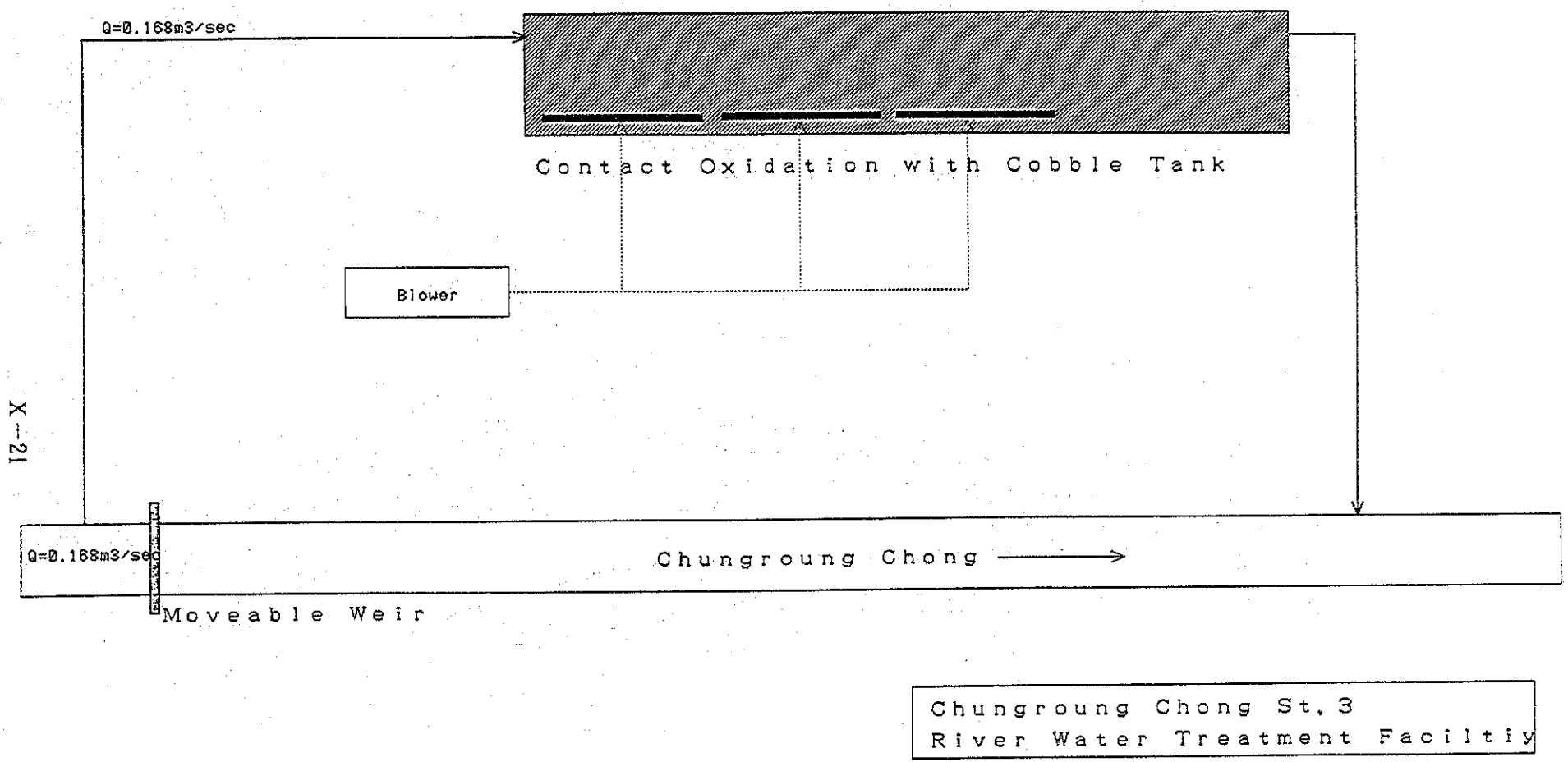


Fig.10.3-5 Treatment Flow of St.3 Water Quality Improvement Plant of Chungroung Chong

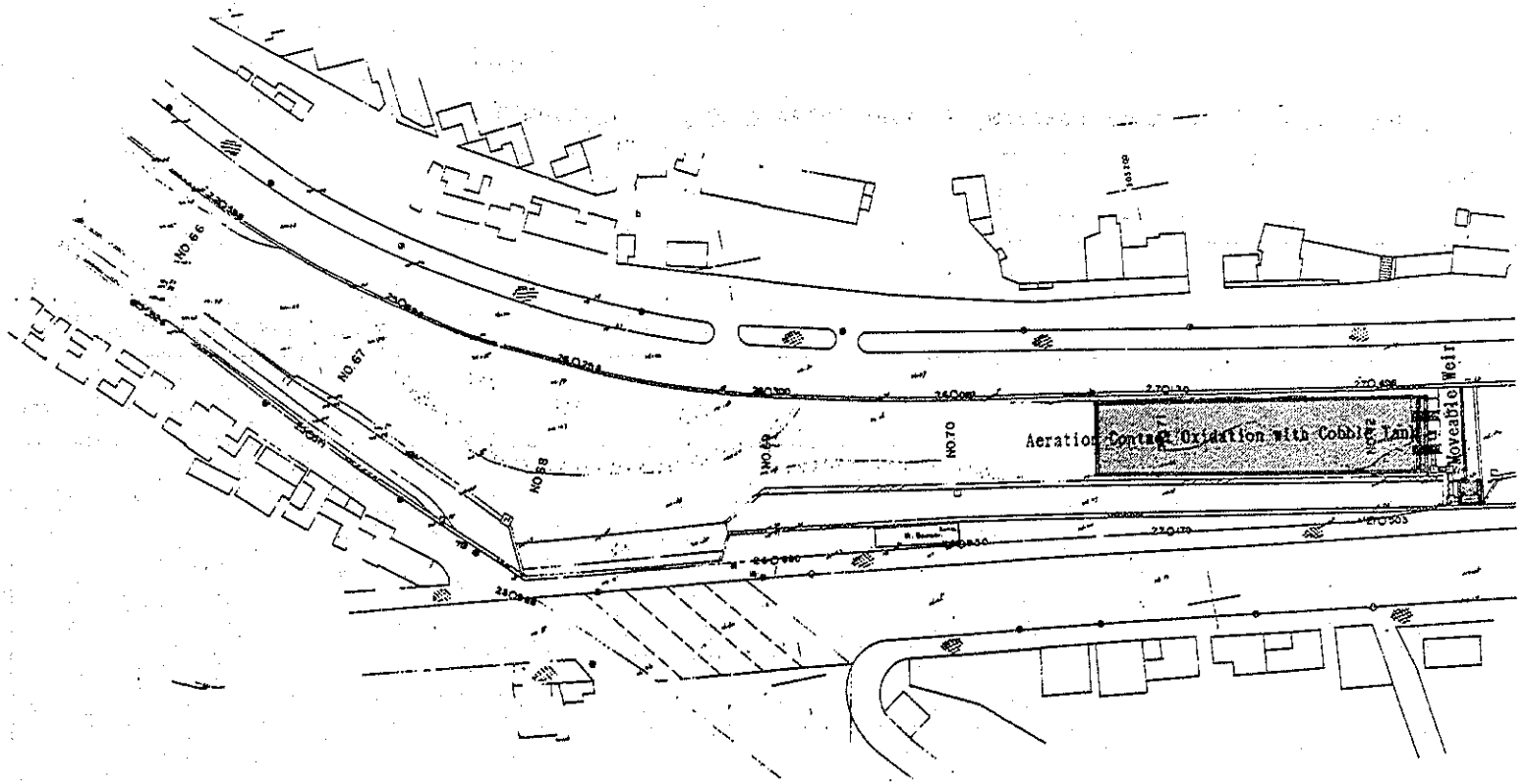


Fig.10.3-6 Facility Arrangement for St.3 Water Quality Improvement Plant of Chungroung Chong

0 50 100

Chungroung Chong St.3 River Water Treatment Facility

10.3.2 Flow Regime Improvement Facilities (Ui Chong)

Movable Weir

This weir is installed for the purpose of creating a water familiarization function and amenity in the certain river segment of the model site. A rubber dam is adopted for this weir because of the following reasons.

[1] Reliable stand and fall function
[2] Simple foundation
[3] Easy construction and short construction period
[4] Easy maintenance
[5] Economic construction expenses
[6] Durability to settlement
[7] Waterproof

Durability of a rubber dam is considered to be similar to one of a steel gate according to the past record.

Design conditions are determined as follows;

a. To assure safety to the force of water below the design flood level
b. To let water flow down safety not to damage other river facilities and not to scour the river bed.
c. To design the rubber dam height at the fall down time to be lower than the lower height either the design bed level or the existing bed level.
d. The rubber dam dimension shall be same as the section area covered by both low revetments and a bed.

Dilution Water Introducing Work

This is a facility to convey clean water from the upstream of Hwakohu Chong, Kwao Chong and Daedong Chong to maintain water area formed by the movable weir in clean condition.
The ground sill type is adopted for all water intakes, as for the conduit material, vinyl chloride is used for a culvert portion

and polyethylene is used for the open area.
The design discharge was calculated by using the specific discharge based on the observation data, and the pipe diameter was calculated by the Ganguille-Kutter formula.

Table 10.3-3 Design Parameter for Water Conveyance Work in Ui Chong

	Hwakohu Chong	Kwao Chong	Daedong Chong
Basin Area	1.3 km^2	0.8 km^2	1.5 km^2
Length of conveyance	2.4 km	0.8 km	1.6 km
Design discharge	0.067 m^3/s	0.041 m^3/s	0.077 m^3/s
Mean slope	50 %	12 %	20 %
Diameter of pipe	200 mm	250 mm	250 mm

Low Water Flow Channel

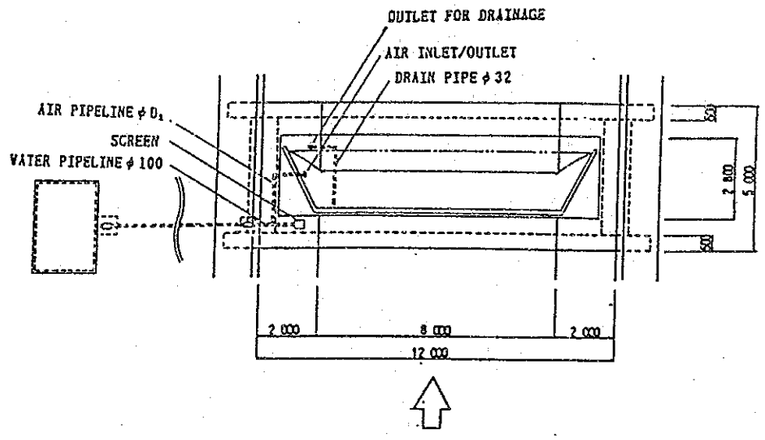
The purposes of this plan are as follows.
By improving the low flow channel revetments,
a. To maintain the admirable flow-regime
b. To protect water quality from deterioration due to water detention

The planned segment is 5.25 km in length, from No.35 to No.140, the design velocity is below 1.0 km and the design depth is 0.2 to 0.5 km. The design parameter and the general plan are shown Table 10.3-4 and Fig.10.3-7.

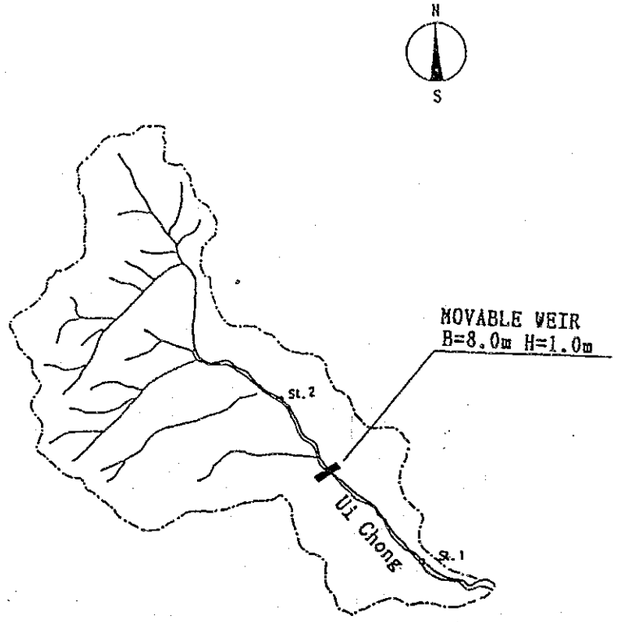
Table 10.3-4 Design Parameter of the Low Flow Channel in Ui Chong

Location	L m	Q m^3/s	I	W m	V m/s	D m	Qa m^3/s
No.35 to No.49+23	723	1.3	1/706	10.0	0.54	0.3	1.71
No.49+23 to No.59	477	1.3	1/378	8.0	0.73	0.3	1.88
No.73 to No.82+39	489	1.3	1/744	9.0	0.52	0.3	1.50
No.82+39 to No.91+16	427	1.3	1/525	8.0	0.62	0.3	1.59
No.91+16 to No.124+32	1666	0.9	1/306	6.0	0.71	0.25	1.16
No.124+32 to No.140	768	0.9	1/153	6.0	0.88	0.25	1.43 *

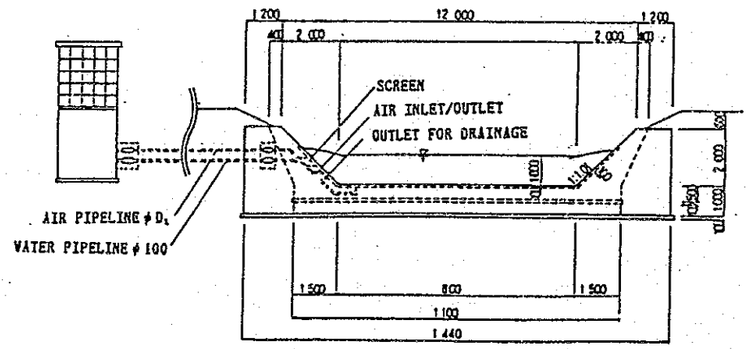
L:Length, Q:Discharge, I:Bed Slope, W:Width, V:Velocity, D:Depth,
Qa:Actual Discharge
*:Roughness coefficient is 0.035, other roughness coefficient is 0.003



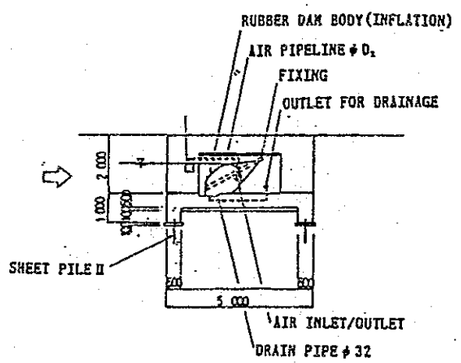
Plan View



Location Map



View-Looking To Downstream



Cross Section

図10.3-7　牛耳川の可動堰の一般図

LEGEND	Fig. 10.3-7
	General Plan of Movable
	Weir for Ui Chong
	SOURCE
	SCALE
	DATE OF DRAWING

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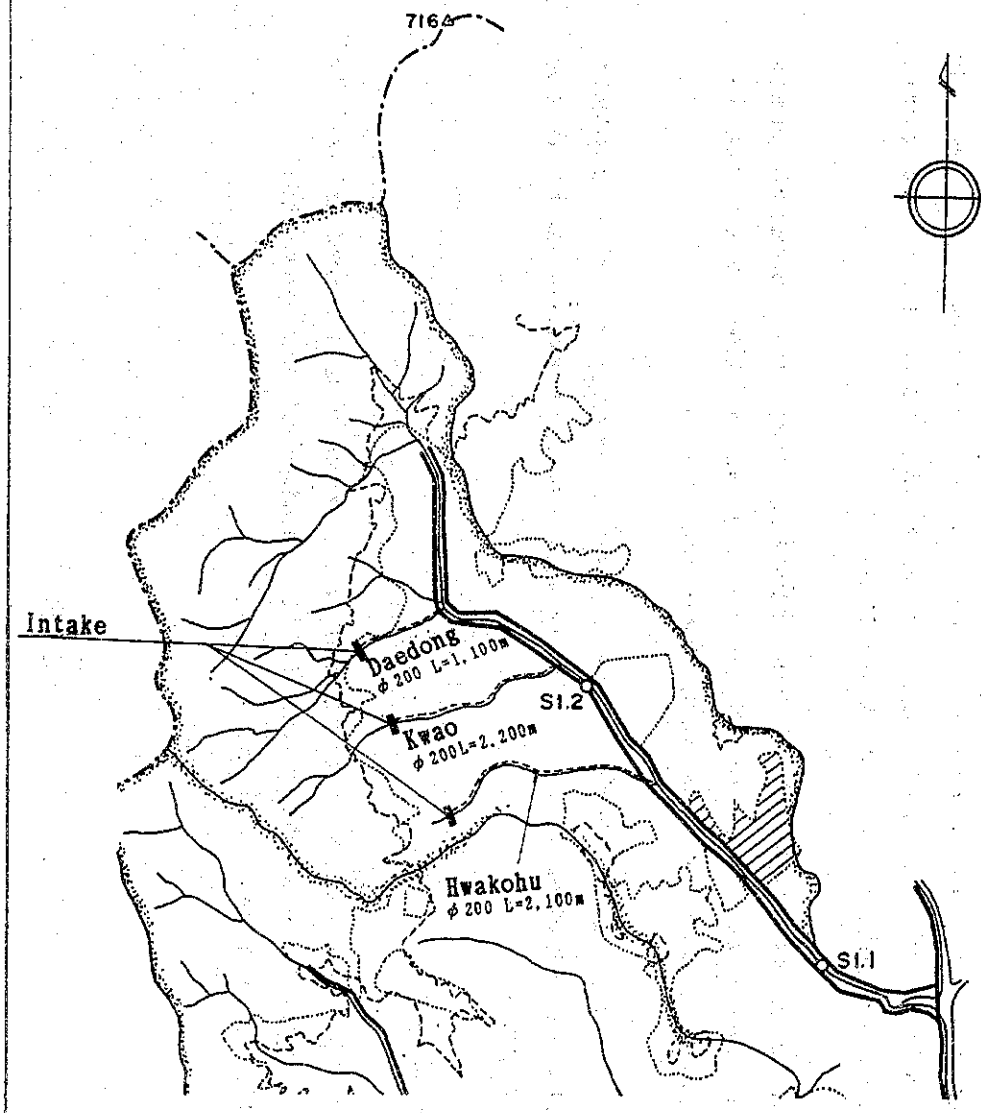
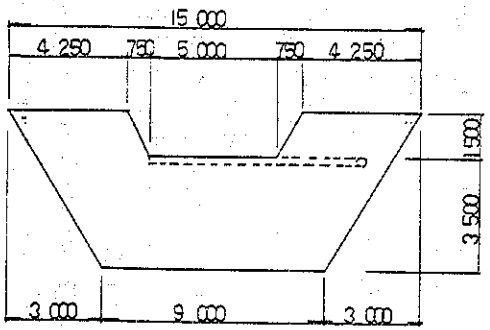
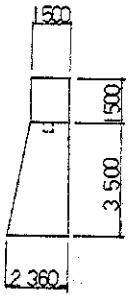


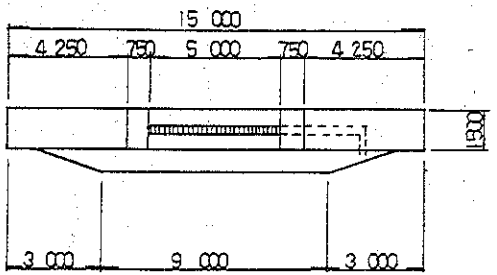
LOCATION MAP



FRONT VIEW



SIDE-VIEW



PLAN

TYPICAL SECTION

Fig.10.3-8 Cross Sections of Intake Weir for the Tributaries of Ui Chong

10.3.3 River Space Utilization Facility

(1) Anyang Chong

The river space utilization facilities to be planned for Anyang Chong are three model sites. M1 and M2 were planned to provide the exercise facilities, and M3 was planned to provide comfortable river space in aim. The plans are shown in Fig.10.3-9 to 11.

In order to simplify restoration after inundation, we planned to provide asphalt pavement for a walk, a concrete plate for a garden square and natural grass for a field.
the supporting poles of a net for a volleyball court and a tennis court, a goal for a football, a shelter and a toilet were designed to be a movable type.

(2) Yangjae Chong

Two model sites are planned for Yangjae Chong. M1 was planned to provide the playing field for the neighboring resident, and M2 was aimed to be utilized together with the adjacent civic park. The plans are shown in Fig.10.3-12 to 13.

The improvement work of M1 was limited only for natural grass yard and walkway, because there is a plan of the water quality improvement facility near Yong dong 2nd Bridge.

To facilitate the restoration after inundation, the asphalt pavement is adopted for a walkway and natural grass is used for natural grass yard.

(3) Ui Chong

One model site was proposed for Ui Chong and it was aimed to provide admirable water space in the center of the downtown.
The plans are shown in Fig.10.3-14.

The walkway is paved with the natural stone, and the intimate square is paved with the stone so that it is harmony with the adjacent landscape and also so to facilitate the restoration due to inundation.

(4) Chungroung Chong

One model site was proposed for Chungroung Chong and it was aimed to provide admirable river space in the center of the downtown. The plans are shown in Fig.10.3-15.

The walkway is paved with the natural stone, and the vertical revetments wall is utilized for waterfall so that it is harmony with the adjacent landscape.

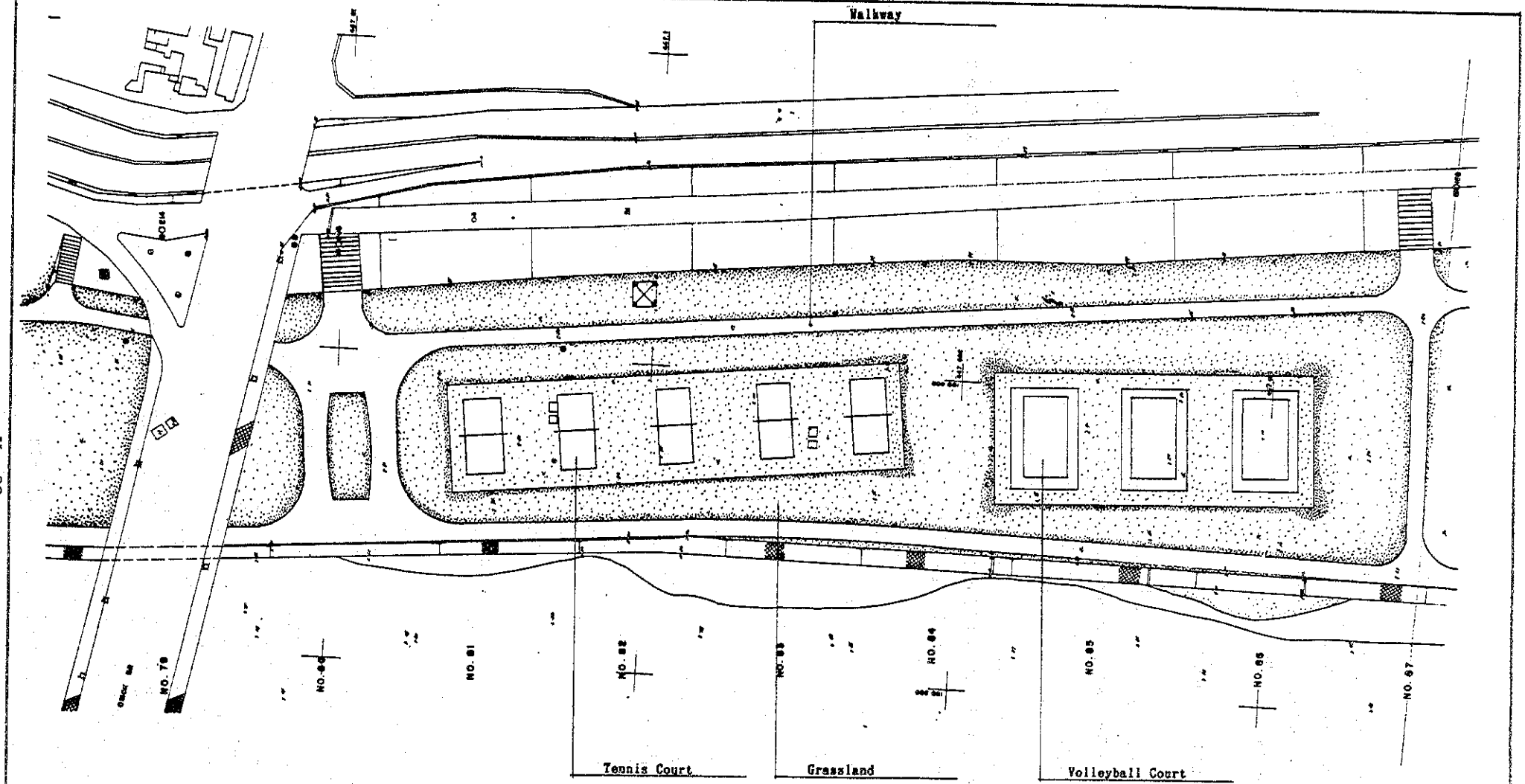


Fig.10.3-9a Facility Arrangement of Model Site M1 in Anyang Chong

LEGEND	FIG Anyang Chong ①
	River Space Improvement
	Model Site 1
	SOURCE
	SCALE
	DATE OF DRAWING

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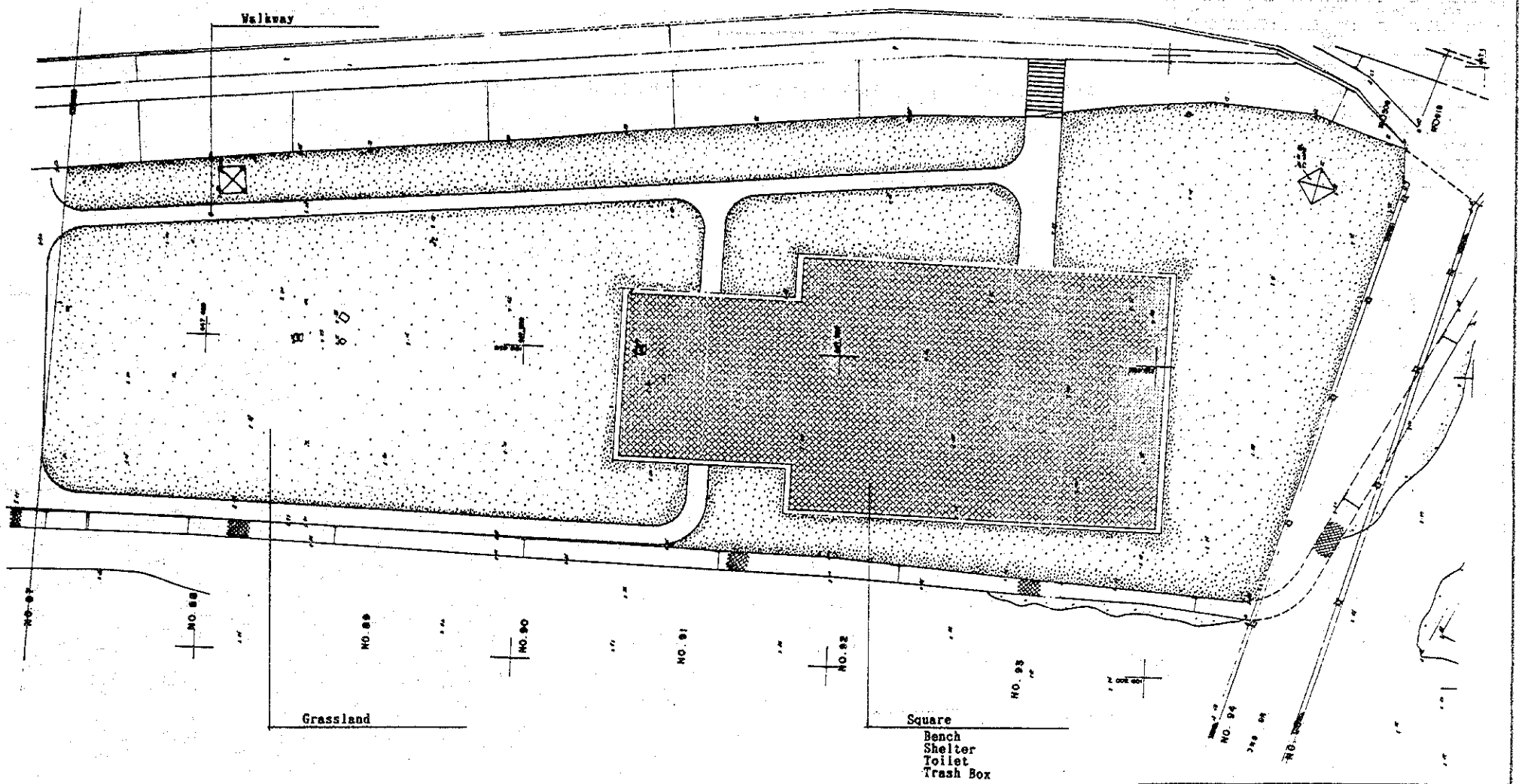

Fig.10.3-9b Facility Arrangement of Model Site M1 in Anyang Chong

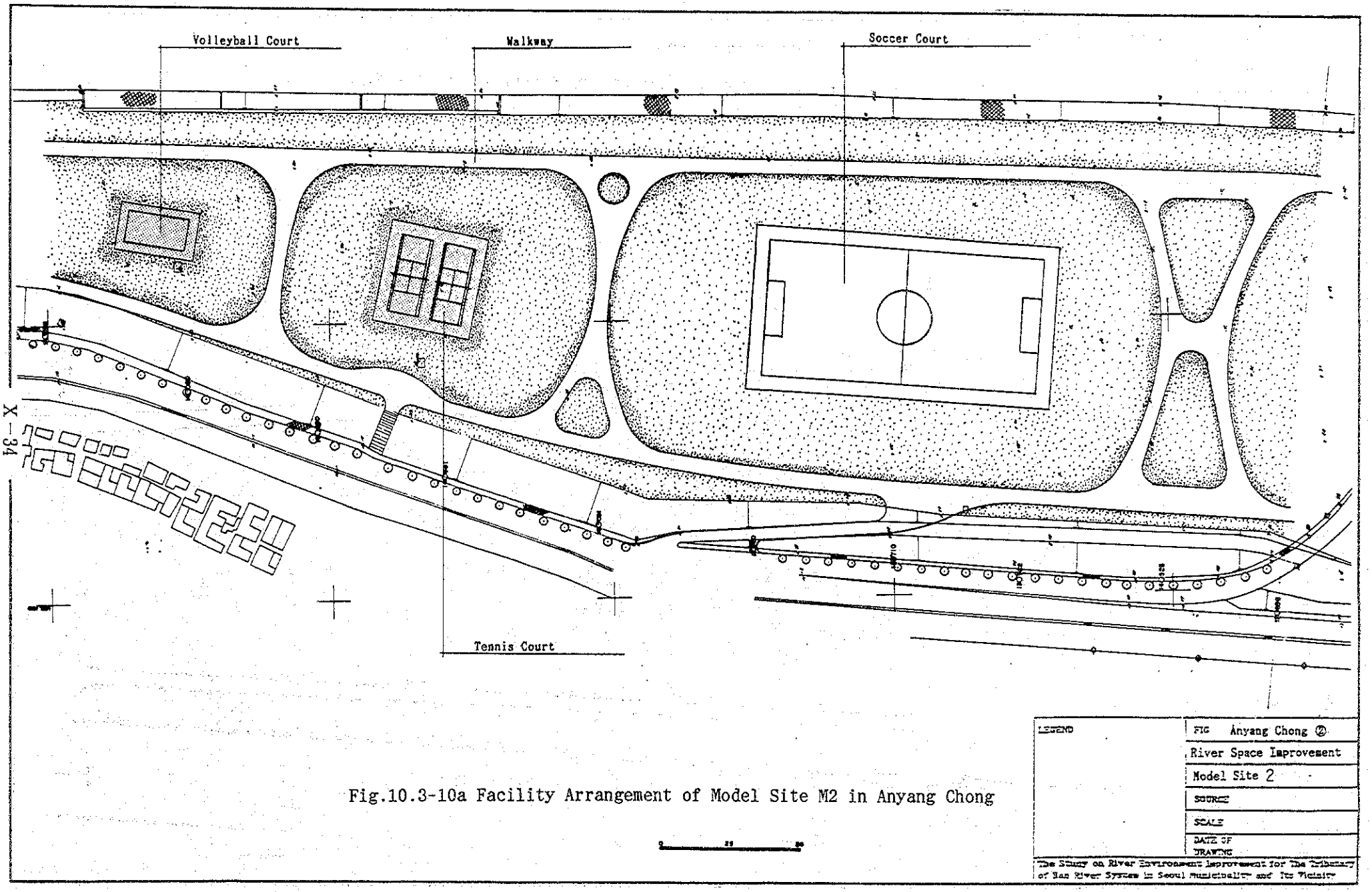

Fig.10.3-10a Facility Arrangement of Model Site M2 in Anyang Chong

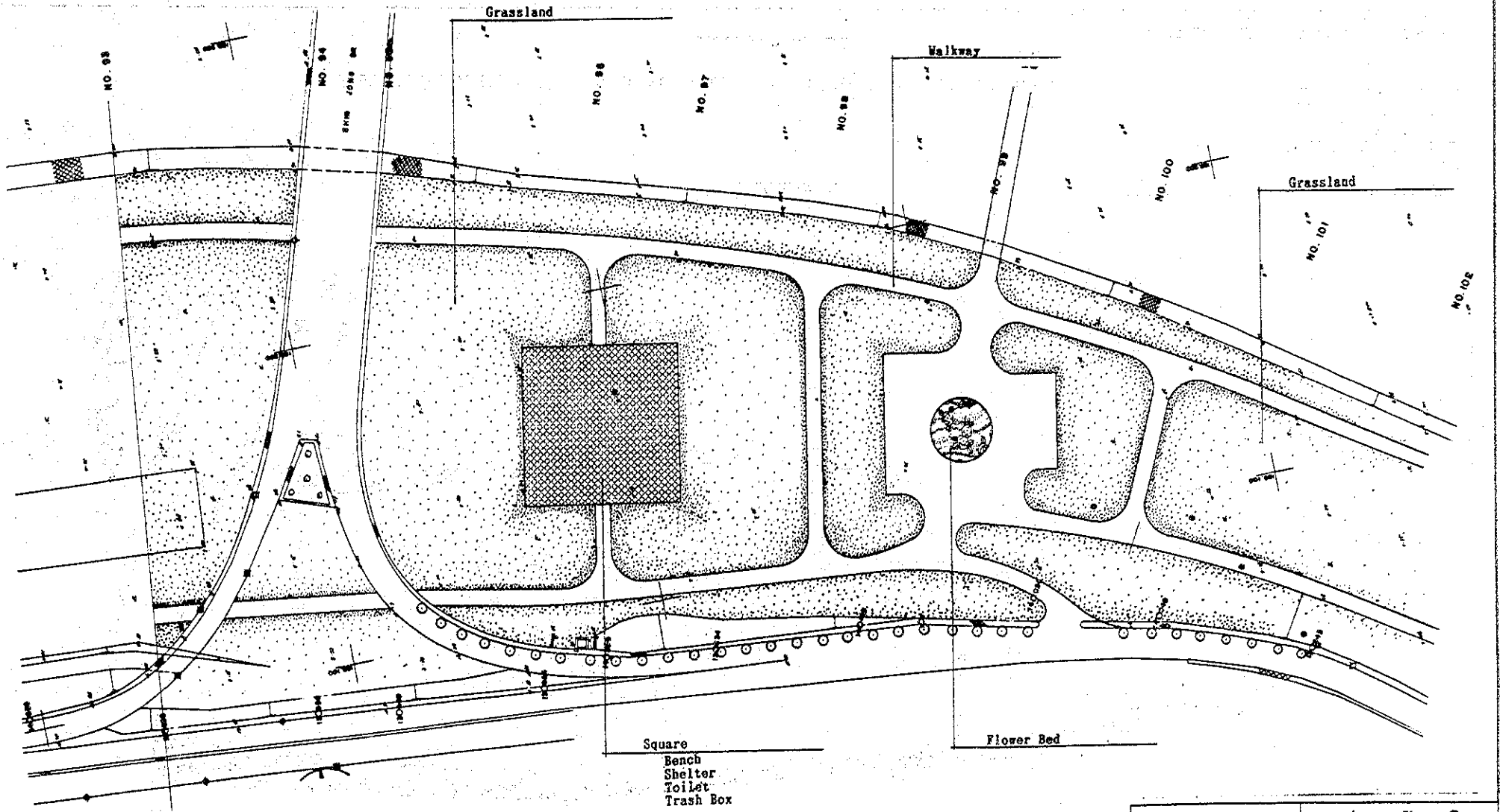

Fig.10.3-10b Facility Arrangement of Model Site M2 in Anyang Chong

LEGEND	FIG Anyang Chong ②
	River Space Improvement
	Model Site 2
	SOURCE
	SCALE
	DATE OF DRAWING

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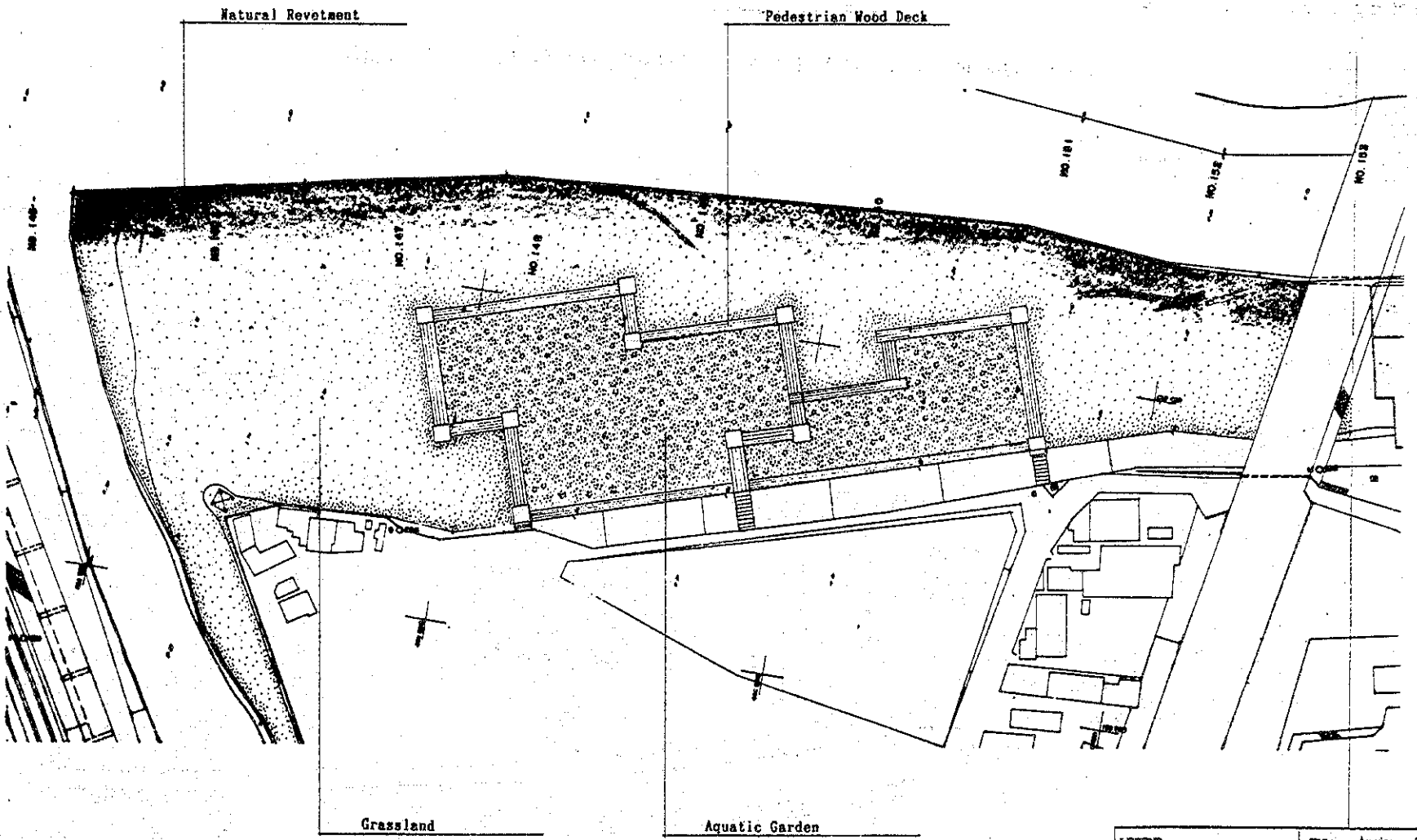

Fig.10.3-11a Facility Arrangement of Model Site M3 in Anyang Chong

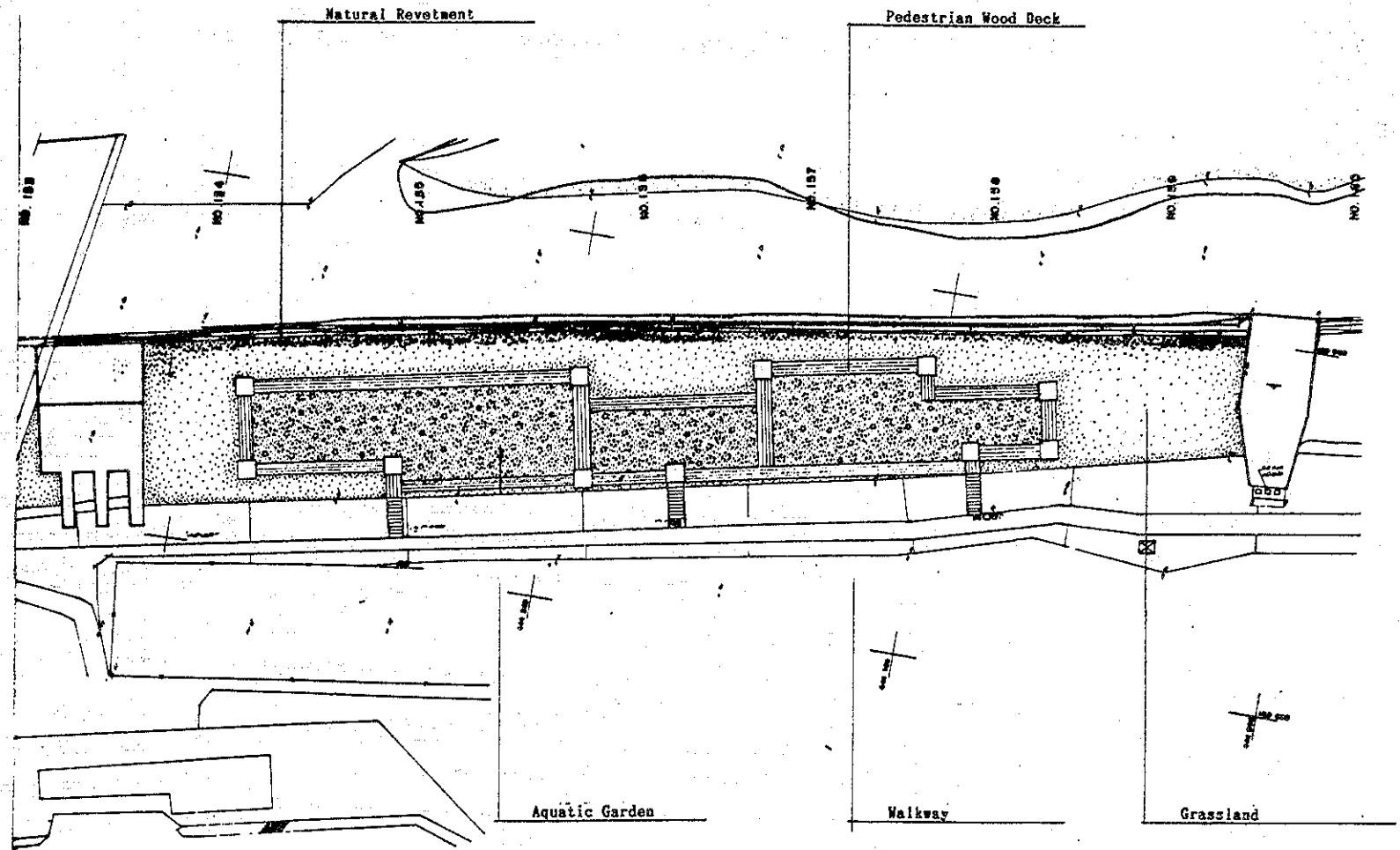

Fig.10.3-11b Facility Arrangement of Model Site M3 in Anyang Chong

LEGEND	FIG Anyang Chong ③
	River Space Improvement
	Model Site 3
	SOURCE
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	DATE OF DRAWING

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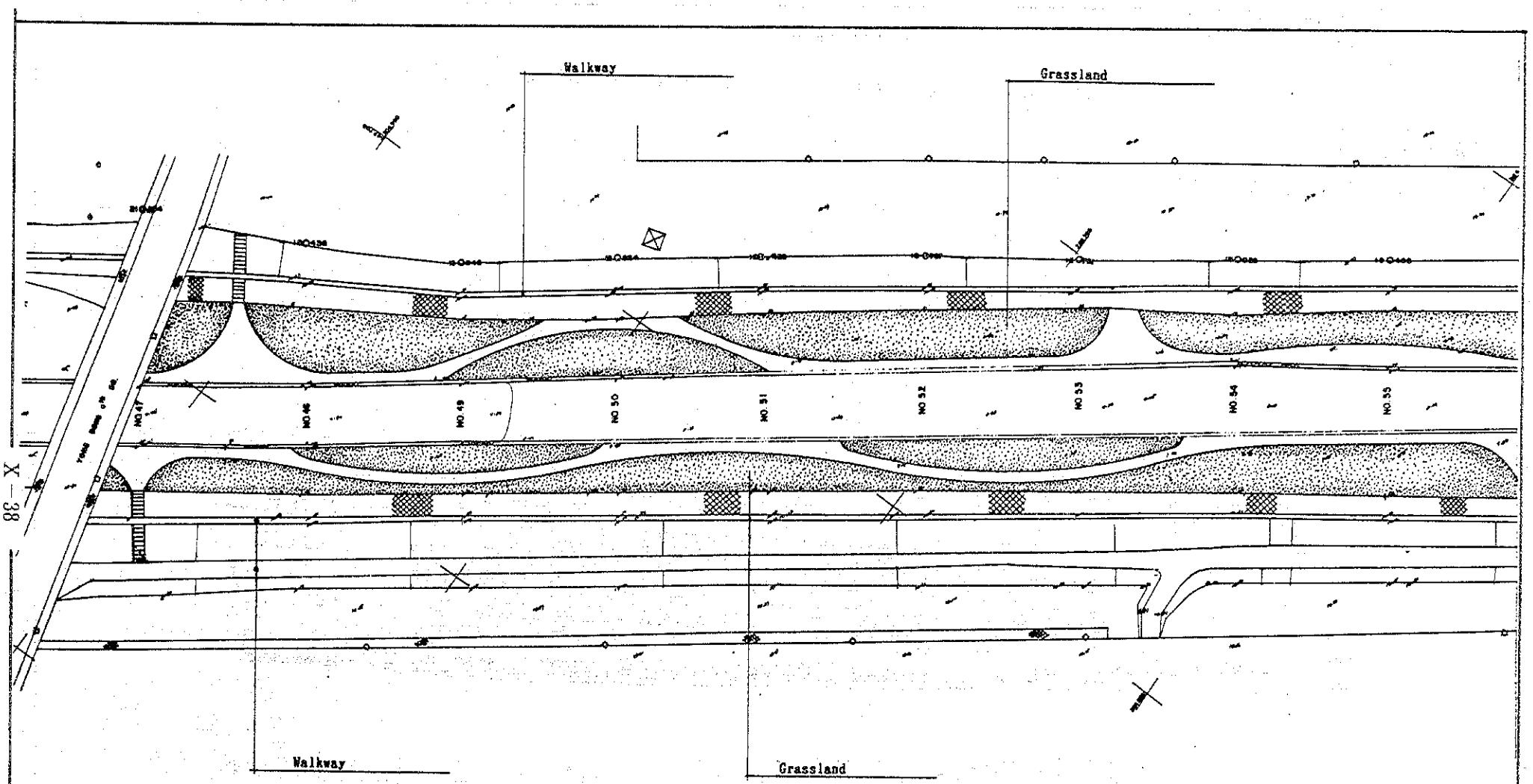

Fig.10.3-12a Facility Arrangement of Model Site M1 in Yangjae Chong

LEGEND	FIG Yangjae Chong ①
	River Space Improvement
	Model Site
	SOURCE
	SCALE
	DATE OF DRAWING

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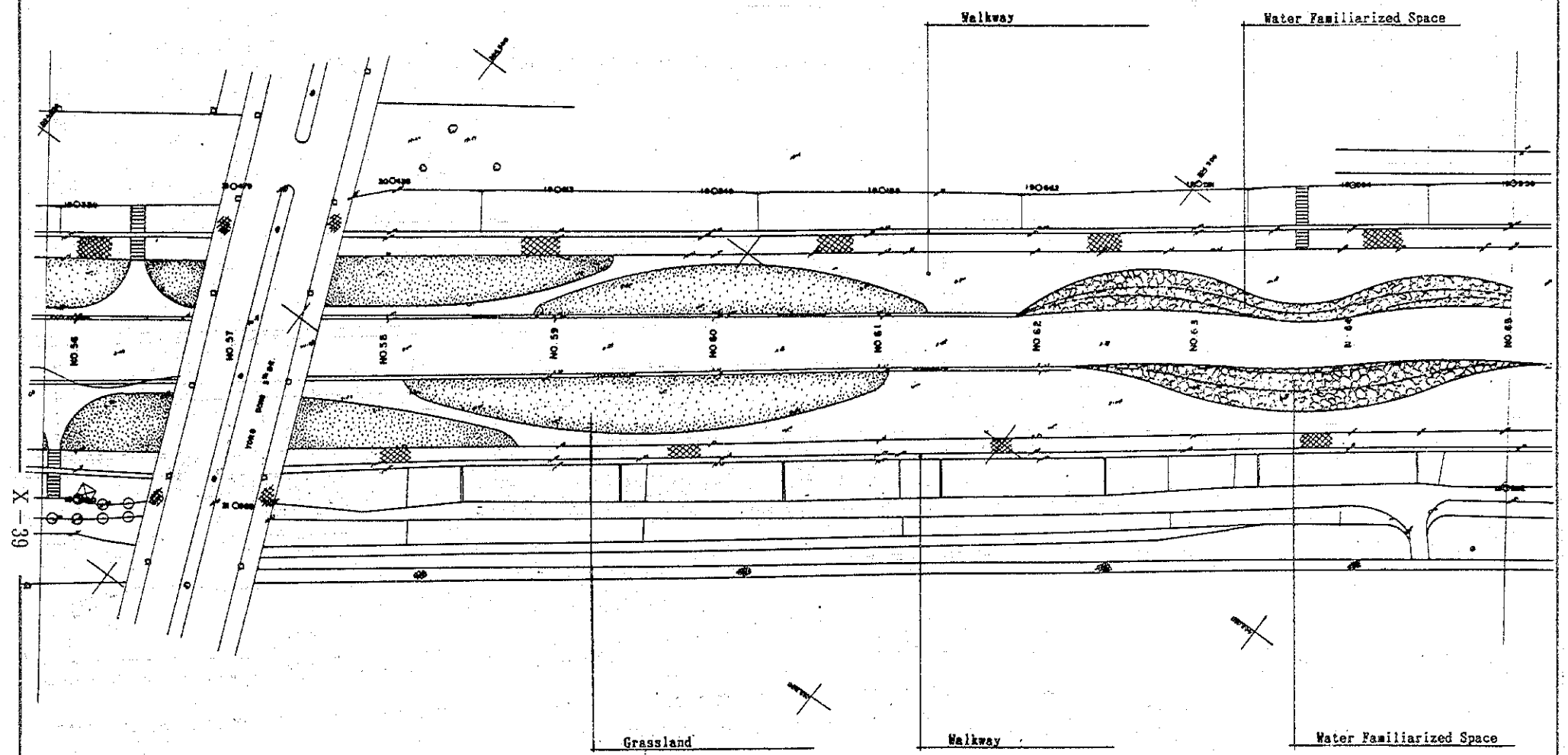

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Fig.10.3-12b Facility Arrangement of Model Site M1 in Yangjae Chong

LEGEND

FIG Yangjae Chong ①

River Space Improvement

Model Site 1

SOURCE

SCALE

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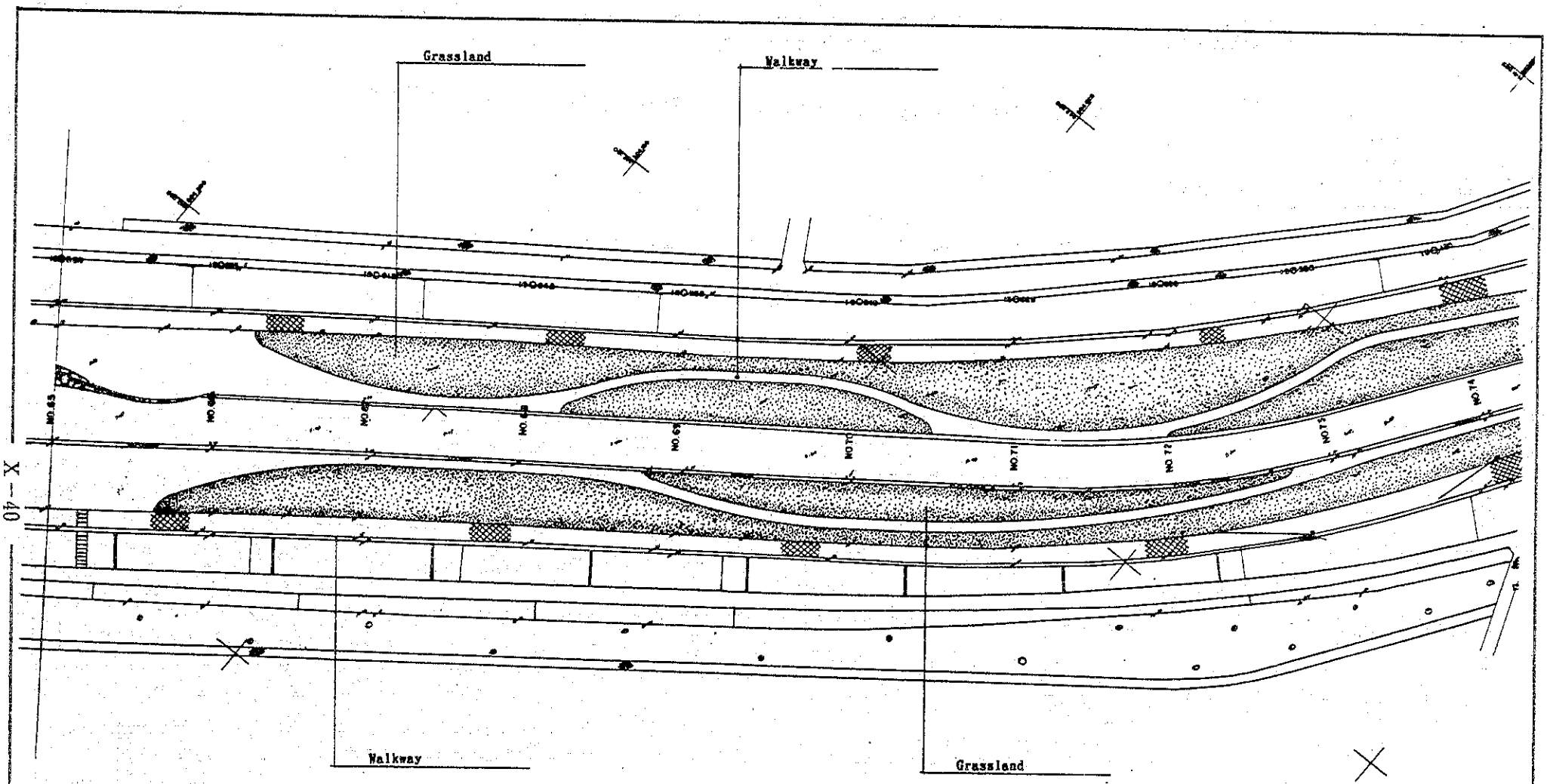
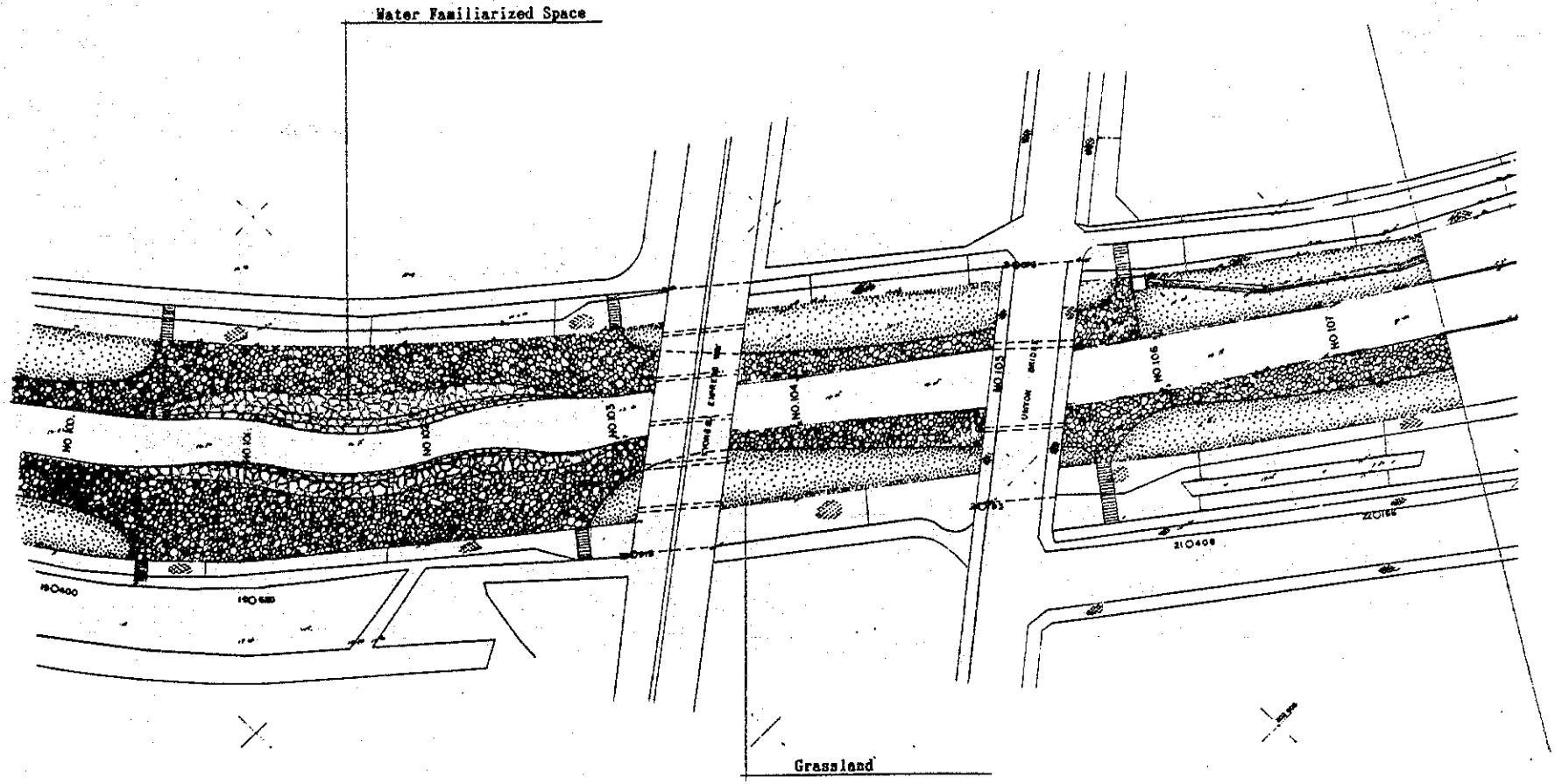


Fig.10.3-12c Facility Arrangement of Model Site M1 in Yangjae Chong



LEGEND	FIG Yangjae Chong ②
	River Space Improvement
	Model Site 2
	SOURCE
	SCALE
	DATE OF DRAWING

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Fig.10.3-13a Facility Arrangement of Model Site M2 in Yangjae Chong

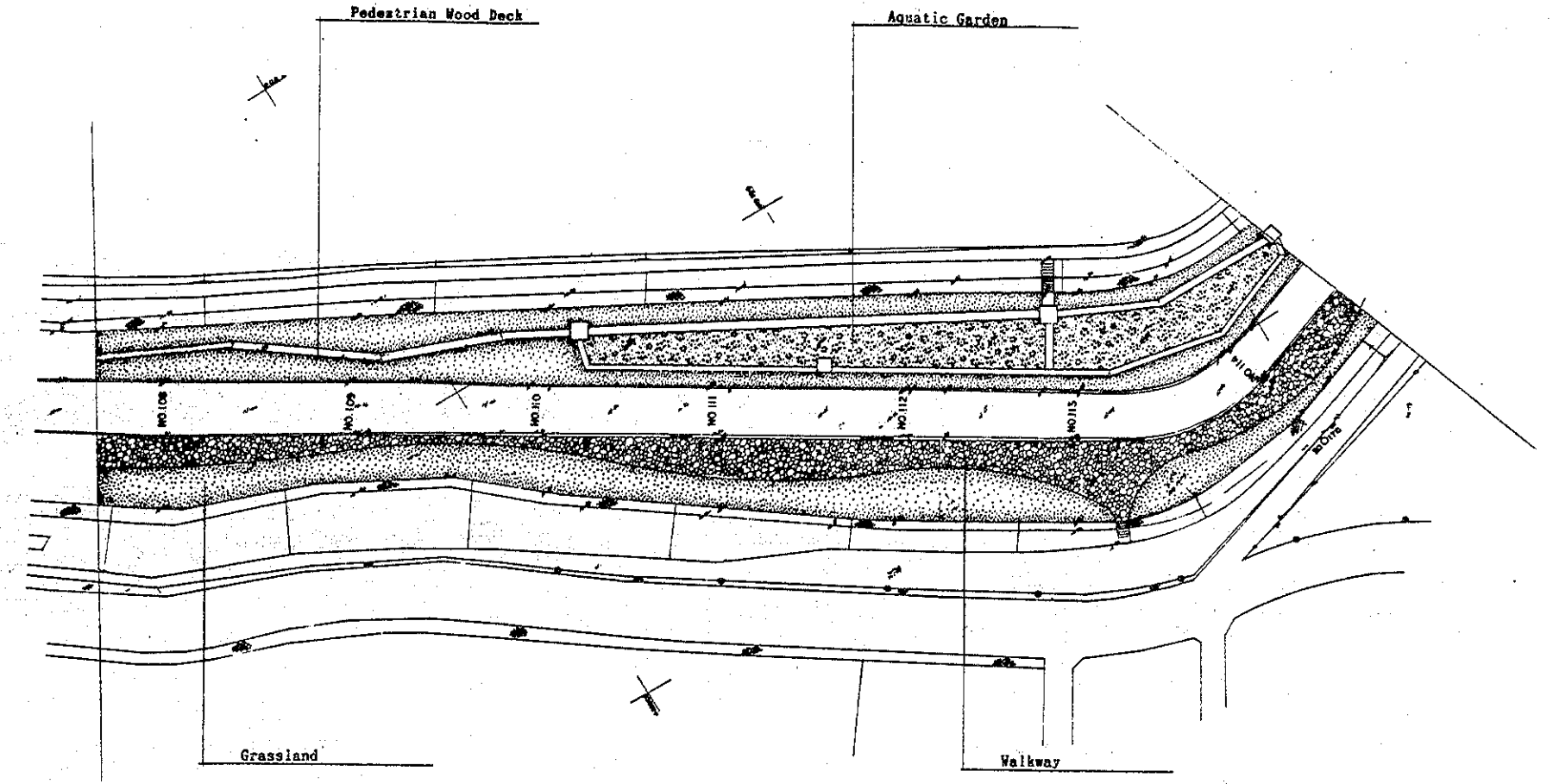

Fig.10.3-13b Facility Arrangement of Model Site M2 in Yangjae Chong

LEGEND	FIG Yangjae Chong ②
	River Space Improvement
	Model Site 2
	SOURCE
	SCALE
	DATE OF DRAWING

The Study on River Environment Improvement for the Tributary of Han River System in Seoul Municipality and Its Vicinity

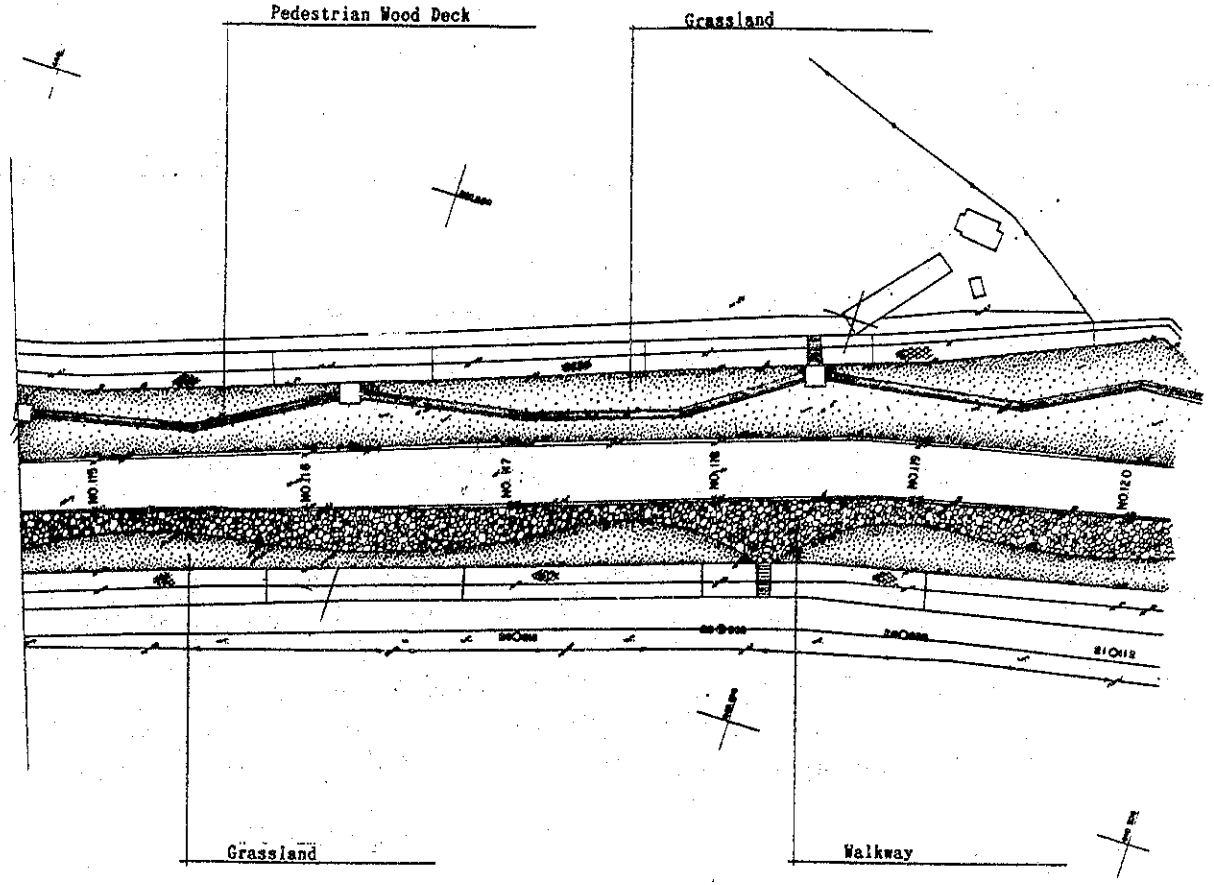

Fig.10.3-13c Facility Arrangement of Model Site M2 in Yangjae Chong

LEGEND	FIG Yangjae Chong ②
	River Space Improvement
	Model Site 2
	SOURCE
	SCALE
	DATE OF DRAWING

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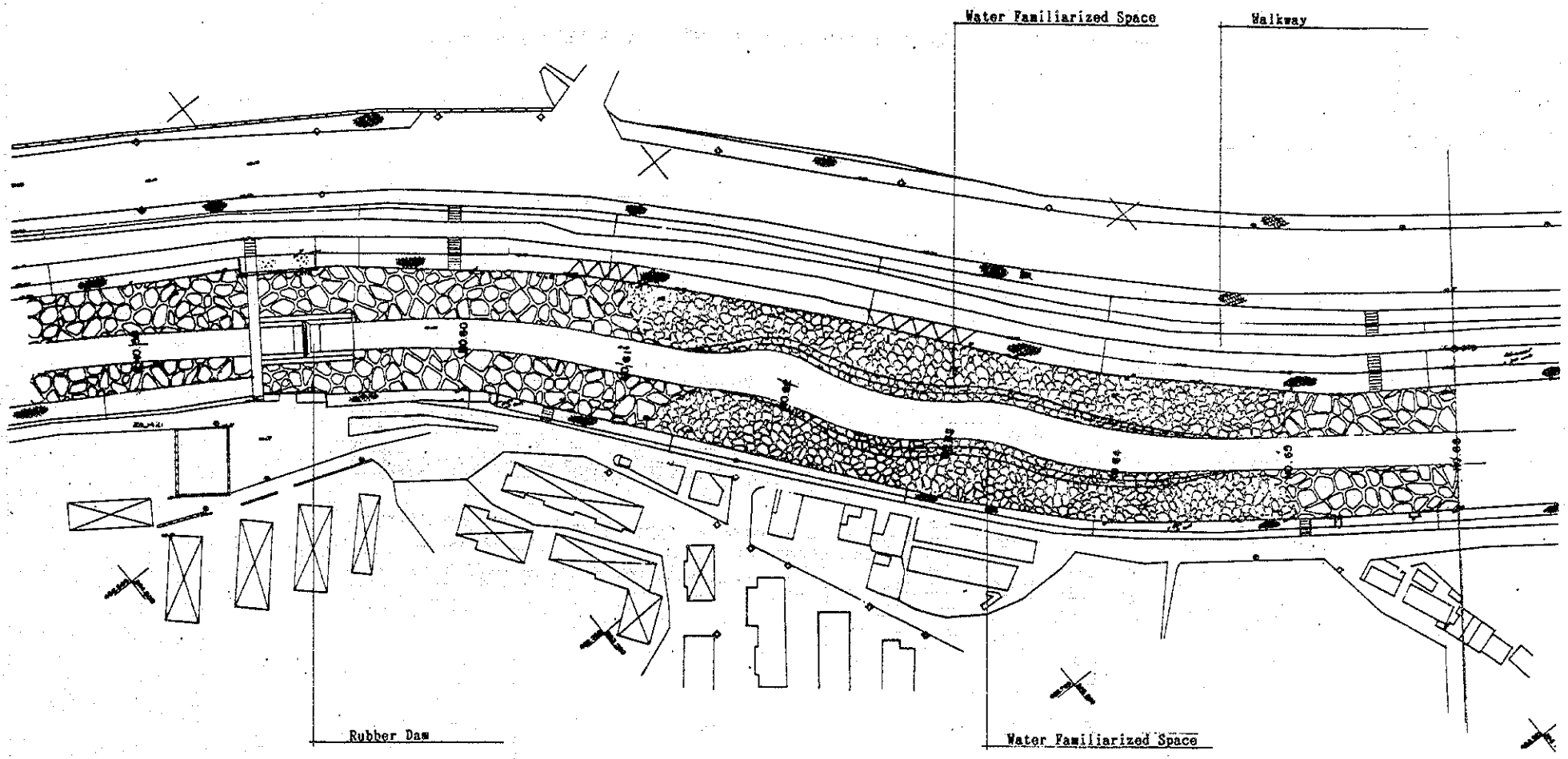

LEGEND	FIG Ui Chong
	River Space Improvement
	Model Site I
	SOURCE
	SCALE
	DATE OF DRAWING

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Fig.10.3-14a Facility Arrangement of Model Site M1 in Ui Chong

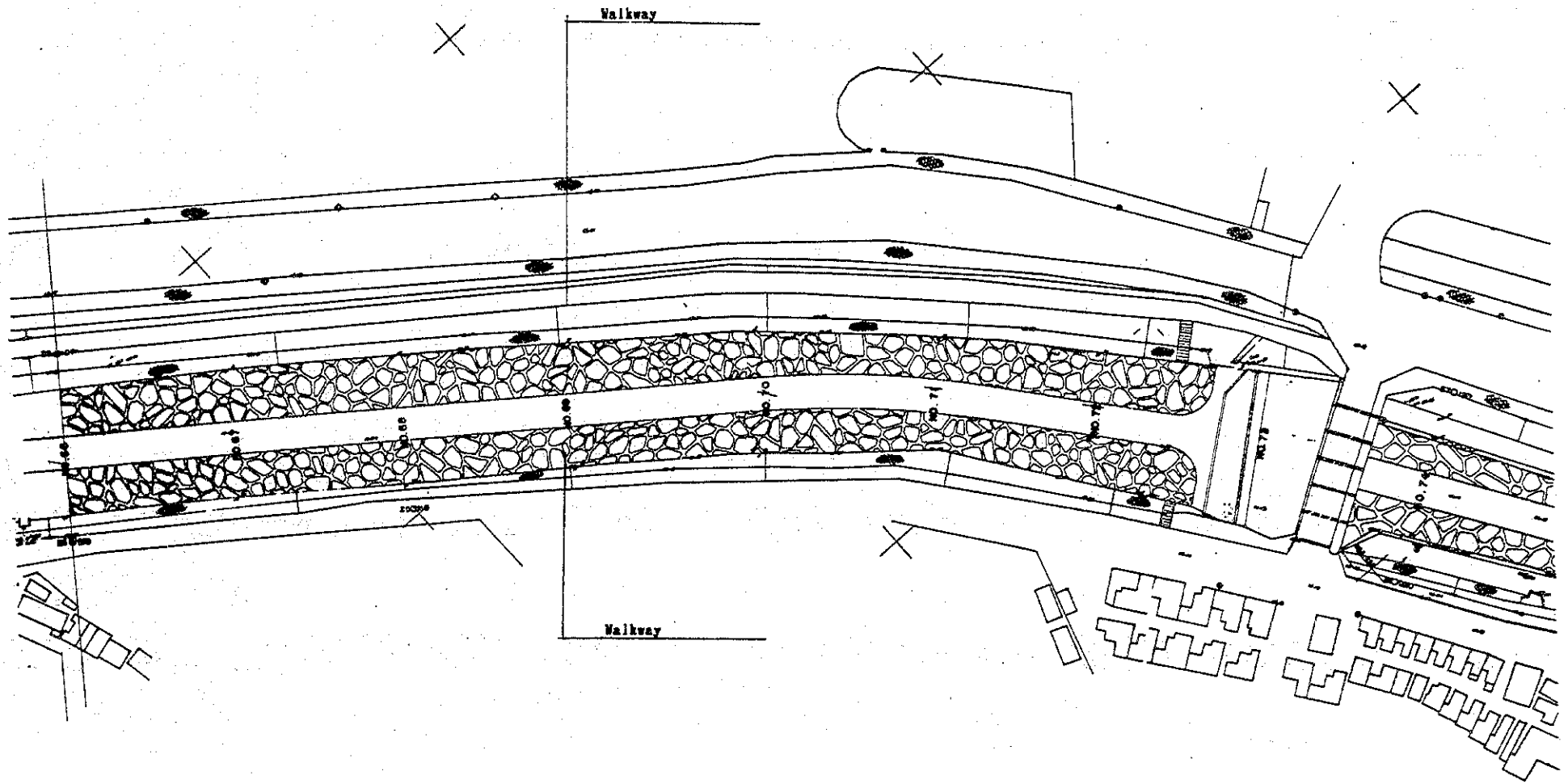

Fig.10.3-14b Facility Arrangement of Model Site M1 in Ui Chong

LEGEND	FIG Ui Chong
	River Space Improvement
	Model Site 1
	SOURCE
	SCALE
	DATE OF DRAWING

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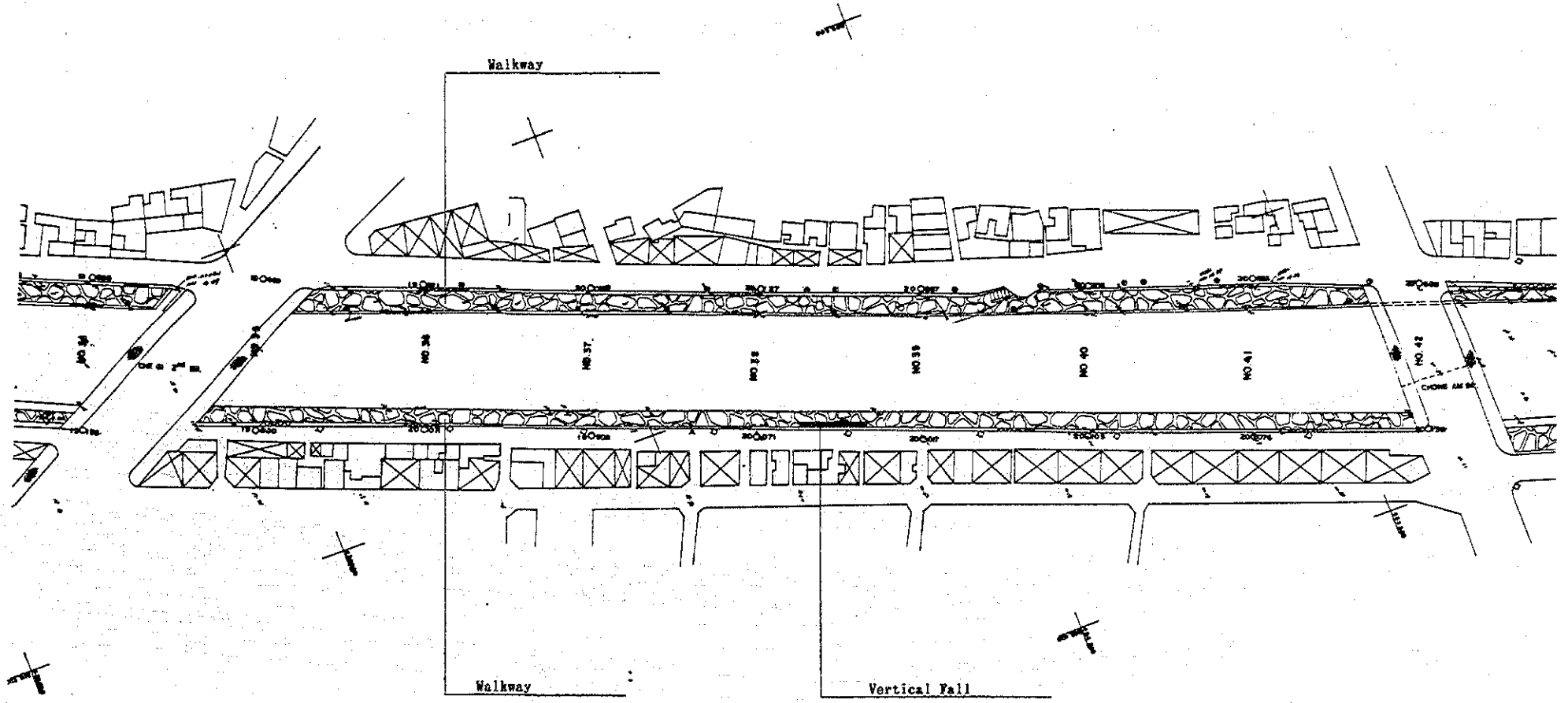

Fig.10.3-15a Facility Arrangement of Model Site M1 in Chungroung Chong

LEGEND	FIG Chungroung Chong
	River Space Improvement
	Model Site I
	SOURCE
	SCALE
	DATE OF DRAWING

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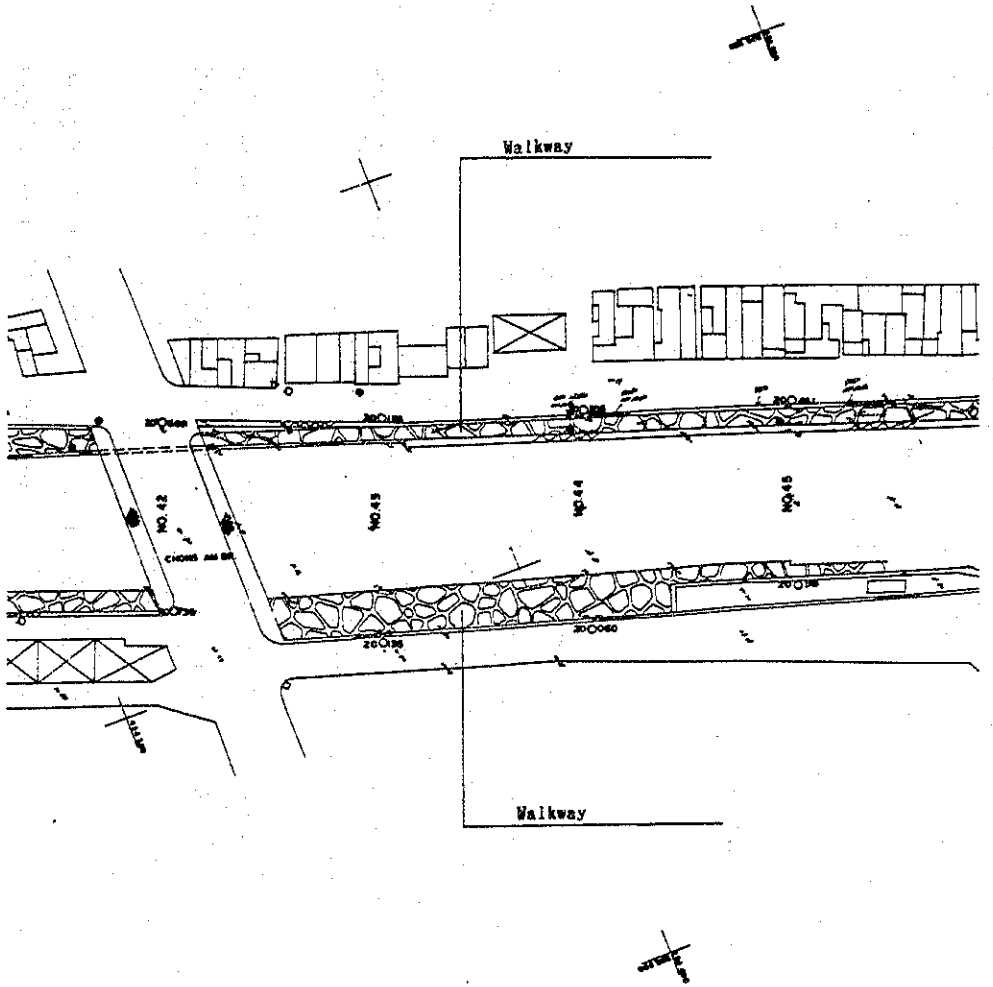

Fig.10.3-15b Facility Arrangement of Model Site M1 in Chungroung Chong

LEGEND	FIG Chungroung Chong
	River Space Improvement
	Model Site 1
	SOURCE
	SCALE
	DATE OF DRAWING

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10.4 Construction Planning

The construction plan was formulated on the basis of the following assumptions, and this shall be reviewed based on the detailed survey prior to the implementation.

(1) Outline of Facility

This facility has a reinforced concrete box filled with cobble with a void ratio of 0.45. On the bottom of the slab, the diffuser pipes to supply air are installed and its blower machine room is located beside the cobble box. It is necessary for this structure to be highly waterproof.

(2) Construction Planning

1) Excavation Works

Sheet piles are driven along the outside of the structure and then excavation works are carried out. If necessary, wailings, struts and intermediate piles are installed.

a. Common construction methods are only adopted for civil works including underground structures.

b. Sheet Piling with Strut method is adopted for excavation works of underground structure constructions. Groundwater is drained up with a water pump.

c. A special wastewater treatment plants for river bed dredging works is not included in this plan. We assumed that dredged materials may be disposed within 10 km of the dredging site.

d. Construction roads are provided within the river land, and in the certain parts a temporary bridge made of H beam is provided where land is limited.

e. Common construction equipment is only employed.

f. We assumed that the construction materials are easily obtained in Korea.

g. Since the geological survey was not conducted in this study, the soil conditions at the proposed facility sites were assumed as follows.

- Bearing capacity is sufficient.
- Driving and extracting piles can be easily done.
- Stability of piles can be sufficiently obtained in case the penetration depth is 1.5 times of the excavation depth.
- Drain water works can be done with water pumps.

10.4.1 Water Quality Improvement Facility

(1) Aeration Contact Oxidation with Cobble Tank

1) Earthwork

After driving piles around the outside of the contact oxidation with cobble tank, excavation will be carried out. Walings and struts are installed where necessary.

2) Structure Works

After excavation works, the ground surface is fully compacted and then lean concrete is placed. On the lean concrete reinforcement works, form works and concrete works are carried out. Concrete works and curing works are carried out in full attention. After the completion water proof tests shall be conducted to confirm leakage.

3) Placing Cobble Works

Diffuser pipes are placed on the slab after structure works and then cobble is carefully placed in order not to damage diffuser pipes and obtain a void ratio of over 0.45.

4) Machinery and Conduit Works

The proposed locations of pipes crossing concrete are opened with sleeve pipes, etc.

5) Electric Works

Conduits are installed in concrete, however conduits are placed in visible areas as much as possible.

(2) Pre Aeration Contact Oxidation with Cobble Plant

1) Outline of Facility

This facility has sheet pile walls with a concrete bottom slab filled with cobble with a void ratio of 0.45. This facility does not have any machineries and pipes inside.

2) Construction Planning

New sheet piles shall be used for this work because it functions as a part of a permanent structure.

(3) Pre Aeration Tank

1) Outline of Facility

This facility has a reinforced concrete tank 7 meters deep and the blower machine room. High water proof is required for this structure.

2) Construction Planning

Excavation works, structure works, machinery and pipe works and electric works are carried out in the same way as the aeration contact oxidation with cobble tank.

(4) Sedimentation Tank

1) Outline of Facility

This facility has a function of separating sludge from water. It has a reinforced concrete water tank 7 meters deep and the machine room to remove sludge. High water proof is required for this structure.

2) Construction Planning

Excavation works, structure works, machinery and pipe works and electric works are carried out in the same way as the aeration contact oxidation with cobble tank.

(5) Grit Chamber

1) Outline of Facility

This facility has a function of separating sand from raw water and it has the equipment to remove sand.

2) Construction Planning

Excavation works, structure works, machinery and pipe works and electric works are carried out in the same way as the aeration contact oxidation with cobble tank.

(6) Distribution Tank

1) Outline of Facility

This facility functions to divide raw water into two, water for treatment and for non-treatment. High water proof is required for this structure.

2) Construction Planning

Excavation works, structure works, machinery and pipe works and electric works are carried out in the same way as the aeration contact oxidation with cobble tank.

(7) Water Intake Facility

1) Outline of Facility

This facility functions to introduce river water into the plant and it consists of a rubber dam and a water intake.

2) Construction Planning

The rubber dam is set up across the river. The construction of the rubber dam shall be executed keeping the water channel, during the dry season.

10.4.2 Flow Regime Improvement Facility

(1) Movable Weir

This facility is a rubber dam to collect water for the purpose of creating a water face.

(2) Water Introduction Works

1) Outline of Facility

This facility functions to divert clean water from the upstream to the downstream in order to supply water to the river space improvement model site. This facility consists of a water intake and a water conveyance pipe.

2) Construction Planning

The rubber dam is set up across the river. The construction of the rubber dam shall be executed, keeping the water channel during the dry season. The conveyance pipes are set up on the concrete foundation tightly.

10.5 Maintenance and Management Plan

10.5.1 Water Quality Improvement Facilities

After the commencement of the plant operation, it is necessary to conduct [1]the water quality control, [2]the operation and the maintenance of plants and equipment and [3]the restoration. It was assumed a precondition of that the maintenance work would be carried out by the government. However, it is expected to be more effective if SMG will directly manage it in case facilities increase.

(1) Water Quality Control

In order to manage the treatment condition of the facilities, water quality must be analyzed periodically at the entrance of the water purification plant, and after each treatment process. Furthermore, it is also necessary to conduct water quality analysis in order to understand the present conditions of river water quality. The necessary water quality tests are as follows:

1) Simple tests conducted daily
2) Periodical tests conducted once a week
3) Detailed tests conducted once every season
4) Tests conducted during irregular hours
5) River water quality tests conducted once a week.

The collection of these data must be given a long period of time, and the results should be filed in the computer so that they can be used for the detailed design of similar facilities, and to overcome obstacles caused by accidents (machine malfunction) etc. The necessary analysis items of the above mentioned tests are represented in Table 10.5-1.

In order to conduct the above said operations, a chief chemical analyst, 3 analysts, 3 water sampling staff and a laboratory with analysis equipment should be provided.

Table 10.5-1 Item Needed for Water Quality Control

Item	①	②	③	④	⑤
Weather	○	○	○	○	○
Air Temp.	○	○	○	○	○
Water Temp.	○	○	○	○	○
pH	○	○	○	○	○
DO	○	○	○	○	○
BOD		○	○	○	○
COD		○	○	○	○
SS		○	○	○	○
TN			○	○	○
NH_4-N			○	○	○
NO_2-N			○	○	○
NO_3-N			○	○	○
TP			○	○	○
PO_4-P			○	○	○
Sludge Vol.	○	○	○	○	
Sludge Conc.	○	○	○	○	
Coli-form			○	○	○
Fecal Coli-form					○ (Seasonal)
Self Purif.					○ (Seasonal)
CN					○ (Seasonal)
Hg					○ (Seasonal)
Cr(+6)					○ (Seasonal)
As					○ (Seasonal)
OP					○ (Seasonal)
Cd					○ (Seasonal)
Pb					○ (Seasonal)

①～⑤ are the same nummbers as shown in the text.

(2) Operation and Maintenance of Equipment

All kinds of water purification facilities are equipped with machineries (water pumps, blowers, etc.), and although they can function automatically, it is important to look out for engine trouble. Furthermore, maintenance must be conducted daily, and the machineries must be overhauled regularly. The following are the required daily and regular maintenance:

1) Removal and screening of settled sand, cleaning and other maintenance necessary to the settling basin.
2) Control of sludge thickness, cleaning of the weir, removal of scum etc., necessary to the maintenance of the sedimentation tank.
3) Removal of the sediment sludge (every 5 years), aeration, etc., for the contact oxidation with cobble tank facility.

The required number of staff for each facility based on the above mentioned conditions are summarized in Table 10.2-3. The removal of the sediment sludge every 5 years must be commissioned from the outside.

Table 10.5-2 Maintenance Personnel for Water Quality Improvement Facilities

Institution	Chief	Operator	1	2	3
Chungroung Chong St.3		1			
Yangjae Chong St.2	1	1		2	
Anyang Chong St.6		2			1
Sub-total (Phase 1)	5			3	
Anyang Chong St.5		2	2		1
St.4		2	3		1
St.2		2	3		1
Sub-total		6	8		3
Total	11			14	

(3) Restoration after an Inundation

The attentive matter of the restoration of each treatment facility after an inundation are described below because they, all installed under the major beds, might be covered with water during the freshet time.

Contact Oxidation with Cobble Plant

This sort of facility is divided into two, with aeration and without aeration. Though both of them are not able to work at the inundation time, they are immediately able to recover after an inundation. However, it is necessary to remove soil deposited on the major beds.

Pre Aeration

This facility constructed under the major beds is a water proof structure. The machine rooms such as the blower machine room are separated from the pre-aeration room. Inflow air opens the inspection entrances but these are not inundated because they are planned to located in higher than a dam. The aeration tanks are equiped with water tight valves in the inflow and outflow outlets. The valves must be closed during inundation in order to avoid the entrance of the water and must be open over it in order to recover. Only the removal of soil is after inundation.

Sedimentation Tank

This facility, constructed under the major beds like the contact oxidation with cobble plant, might be filled with water at the inundation time because inspection entrances must be provided on the major beds. In Yangjae Chong where the grit chamber are proposed to be provided, suspended solid will probably deposit in and out of the grit chamber because inorganic SS is abundant. SS deposited in the grit chamber is sedimented and condensed and conveyed out like sludge. However it must be avoided that SS is

deposited on an effluent weir because it will carry SS to the next process. After inundation it is necessary to blow SS inside a grit chamber with a high washer.

Distribution Tank

This facility is an uncovered tank on the major beds. River water and soil will probably flow in and be deposited inside at inundation. In case soil is deposited it must be removed with a vacuum car.

Grit Chamber

This facility has a similar structure to that of the distribution tank but is equiped with a sand pump to drain sand. SS may be conveyed out with this usual system.

Intake Facility

The intake facility of a rubber dam type may be restored the same way is restored the measure for a movable weir. In case the intake facility is adopted as a pumping system, there is no need to worry about damages on electrical machineries and electrical utilities because they are designed to be set higher than a dam. Problems therefore happen on only a settling sand process by inundation and this is solved with the same measure as the grit chamber.

10.5.2 Flow Regime Improvement Facility

The flow-regime improvement facilities which were proposed in this study are only movable weirs, water conveyance pipes, water intakes, and groundsels in Ui Chong, and these maintenance works do not have much problem. The attentive matters to maintain each facility are described as follows.

Movable Weir

A rubber dam should be checked every six months to one year. The check items are as follows.
Rubber weirs, bolts and nuts, operation units, utilities, valves, concrete structure (base concrete, operation room), others (miscellaneous, bed sediment, boulders, debris)

In Ui Chong, sand is probably deposited on a rubber weir after a freshet. This sand must be carefully removed by hand. However it is possible that the sand deposit be flushed out with the repetitive falling of the weir.

Algae and refuse gathering in front of a weir is expected to happen because the purpose of this weir is to create a water face. Refuse should be removed by hand when necessary and algae should be removed with the repetitive falling of the weir. Water can be filled up in half a day because the storage capacity of this is approximately 5,000 cubic meters.

Water Conveyance Pipes

A screen for the water inflow is easily blocked with rubbish and soil and these must be immediately removed after the freshet. Steel pipes from the intake to a culvert and poly-vinyl-chloride pipes lying through the culvert should be inspected about whether it was damaged after the freshet.

Low Revetment

Removing refuse and soil deposit are to be carried out when. Attention should be paid not to damage a revetment during soil removal operation after the freshet.

10.5.3 River Space Improvement Facilities

We assumed that the maintenance and management work for the river space improvement facilities, like the water quality and flow-regime improvement facilities, would be supervised by SMG.
The items of daily maintenance consist of the following.

1) Maintenance of facilities and preservation of ecosystem
2) Safety Management
3) Major bed management at inundation

(1) Maintenance of Facilities and Preservation of Ecosystem

It is important to always check utilities for damages and these should be repaired immediately.
Repair of asphalt pavement, improvement of troubled play machines, re-painting of signboards and re-tightening bolts should be done frequently.

This plan did not adopt a lawn because it requires many maintenance works. Cutting grass and patching grass works are needed for maintenance.
In order to create an abundant hygrophyte garden, it is necessary to provide drain pipes.

(2) Safety Management

A special attentive matter to use the river space is to avoid water accidents. The following, the instructions must be indicated with a supervisor and a signboard.

1) Prohibition of entering dangerous places
2) Prohibition to use facilities without of purpose
3) Prohibition to use facilities at the freshet time

(3) Major Bed Management at Inundation

At the freshet time, movable facilities shall be immediately dismantled and removed, and also people shall be warned of danger with a wireless speaker. In case of inundation, removal of soil and refuse and repaire of damages shall be carried out immediately.

The necessary staff of maintenance works for the river space utilization facilities are represented in Table 10.2-3.

10.5.4 Maintenance and Management Organization

Daily maintenance is basically supervised by the Gu administrations. The section, called river environmental section, in charge of this work which gives technical instructions and transacts budgets should be established.

10.6 Computation of Construction Cost

The project expenses was computed based on the following assumptions.

1) The standard project expenses are computed using unit price indicated on "Comprehensive Construction Material and Equipment Price Information Book published in July 1991".

2) Landscape works are computed as civil works.

3) Machineries for water quality improvement facilities are estimated based on "Machinery Price List for Water Quality Improvement Facility". Machineries for parks and exercises are estimated based on "Comprehensive Construction Material and Equipment Price Information Book published in July 1991".

Based on the project implementation program, the estimated project expenses are shown in Table 10.6-1.

10.7 The Upper Investment Limits of the River Environment Improvement Project and its Financial Source

According to the project investment program indicated in the Seoul Town Plan, the ratio of the river maintenance budget and the total budget gradually decreases from the highest rate of 3.6%, 95.2 billion won in 1986, to 2.3%, 151.7 billion won in 2001. The budget decrease is believed to result from the progress of the river improvement.
Assuming that it is possible to transfer the decreased portion of the budget to the river environment improvement project, the amount is estimated to increase yearly from 1992 to the year 2002, reaching 500 billion won in 10 years time. Refer to Table 10.7-1.

The project investment program indicated in the Seoul Town Plan is larger than the ordinary budget. The potential amount to be contributed for the river environment improvement project shoul be estimated to reach 250 to 300 billion won within the next ten years.

Table 10.7-1 The Upper Investment Limits of the River Environment Improvement Project

	Year	1986	1991	1996
A. River Maintenance Budget	Bil.won	1502.7	3185.8	4650.2
B. Flood Control	%	3.6	3.0	2.6
C. River Environment	%	0.0	0.6	1.0
D. Investment Limit	Bil.won	0	19.1	46.5
E. Growth of GRDP	%	11.9	7.5	7.5
F. Estimated Ordinary Budget	Bil.won	1151.7	1774.5	2377.1

a."Total Investment" is the intended value shown in "Basic City Planning for Seoul Metropolitan".
b."Possible Investment" is the one for the river environment improvement project when the ratio of investment for it to the total investment were decided as shown in the left column.
c.General Account is the one when the grow ratio of GRDP were decided as shown in the left column.

Since it is too difficult to identify beneficiaries of the river environment projects, we deemed these projects are suitable to be provided with the financial services of the ordinary budget. However it is expected that the whole budget can not be born by it because it is too much.

In such cases, the implementation period is generally prolonged. However it is advisable to look for how to obtain financial sources. For instance, in case of the existing town area with flood problems, the river environmental projects can be conducted by the special budget by inserting a flood control project to a town re-development project, like Mok-dong Project.

On the other hand, since the necessity of the water quality improvement facilities is led by the insufficient sewerage improvement, its budget may to be provided by the sewerage treatment budget of the special budget.

In order to implement these projects, it is desired that the

financial source committee newly established study suitable financing.

10.8 System and Organization for the Implementation of the Project

The purposes of the river improvement are flood control, a water utilization and utilization of water familiarization function. The river environment improvement project is to recover and activate water familiarization functions.

In order to conduct environment improvement projects, it is desired that the river maintenance section of SMG be in charge as a main administrative body and shall cordinate with the other autonomies within the basin, getting technical supports from the sewerage section, the park section and the environment section.

As for the maintenance organization, it is necessary to establish a new organization because special knowledge is necessary.

The appropriate organization is to consist of two kinds. One is that SMG conducts all maintenance works like Han River Park Office, and the other is that SEMAURU conducts all similarly small rivers. The latter is superior to properly supervise maintenance work in harmony with the regional conditions, but it is difficult to restore by inundation and to control water quality.

Therefore, the following measures are recommended.

* A supervisory office of SMG is in charge of the water quality and the flow-regime improvement.
* A civilian organization is in charge of the river space improvement model sites.

Chapter 11

Chapter 11 Project Evaluation

In this chapter, the benefit which may be expected from the proposed river environment works is discussed from the various points of view after the priority of each works is discussed from various points of view after the priority of each work is confirmed on the basis of the administrative subject of the city. Quantitative evaluation is tried to the benefit expected from the increased number and area of parks and improvement living environments by using the land price as a representative variable and the appropriateness of the estimated investment amount to theses works is examined by comparing the amount with the benefits. Regarding the influences of the execution of the works to the environment and countermeasures against the influences, items which are usually considered are listed.

11.1 The Priority of the River Environment Improvement Project in Seoul Metropolitan

The present policies in Seoul are ranked as follows: 1) transportation, 2) housing and 3) environment. As previously stated in Chapter 2, the shortage in large transportation remarkably worsens the city's traffic conditions and solving this problem is a matter of importance. The principal theme of the housing policy, on the other hand, is to construct a common/public housing for low income citizens.

Environmental problems were hardly given a thought when production was given preference, however, present increase in income and comforts in living aroused a strong interest within the citizens, and even the city actively wrestles with concerns such as the improvement of the air and river water quality, improvement of the parks, preservation of nature, etc..

The river environment improvement project is one of the objec-

tives involved in the improvement of the living environment, and the Han Public Park improved for the 1988 Olympic Games in Seoul was a great success. Thirteen (13) of the places in the park were improved and ten (10) out of the 13 have been already opened. Improvements shall be continuously made to accommodate 25 million citizens yearly, and more than 15 million citizens are utilizing the areas now.

With the exception of Han Public Park, however, there are no examples that would indicate the success of the river environment improvement project. The river park which was improved in 3 places of its tributary is not fully used at present owing to bad water quality and problems in its management system. Furthermore, large amounts of money and labor were spent for the removal of wastes and stones which were accumulated in the park due to the big flood in September last year. Based on these circumstances, the difficulty in using the river bed was then acknowledged.

11.2 Project Evaluation

11.2.1 Project Evaluation Methods

Most of the environment improvement projects present the environmental level they aim for before determining the scope of the project based on a minimum cost method. Through this method, a system that shall help achieve the project objectives shall then be selected. However, it is important to fully understand that the benefits which shall be gained from this improvement project shall exceed the project expenses.

Although several methods have been proposed to economically measure the benefits, nothing has been ascertained. These methods include [1] methods that shall measure damages resulting from environmental deterioration, [2] methods that conduct environmen-

tal evaluation through models and measure benefits by using proxy values/variables, and [3] methods that shall study the willingness of the residents to pay and consider payability as an advantage.

Among these methods, the surrogate market price method of item [2] proposes the evaluation of the latent prices of whatever property cost which is out in the market instead of the many environmental elements with no distinct market prices.

In 11.2.3, land prices shall be considered surrogate market prices and the benefits gained from the progress in residential improvement and park area expansion shall be evaluated. However, the evaluation of these benefits, especially those of residential improvement where the data and model are restricted, cannot be considered accurate. Hence, they shall always be considered as important reference values. The other benefits were only qualitatively evaluated. The evaluation procedures are indicated in Fig. 11.2-1.

11.2.2 Evaluation of Social Demerits caused by Deterioration of the River Environment

The use of river water involves two aspects. One is water utilization for irrigation, drinking, etc., and the other is environmental reaction. Among the social demerits brought about by the deterioration of the river environment, some tests are conducted to measure the extent of water utilization loss. Since water utilization is not implemented in the rivers which are the subjects of this study, it is not possible, therefore, to measure water utilization loss in the inner basin. However, if the downstream basin of Han main river is included in the scope of the study, it is possible to estimate losses such as increase in the purification costs due to the deteriorating water quality of the water resources for potable water, decrease in the yield due

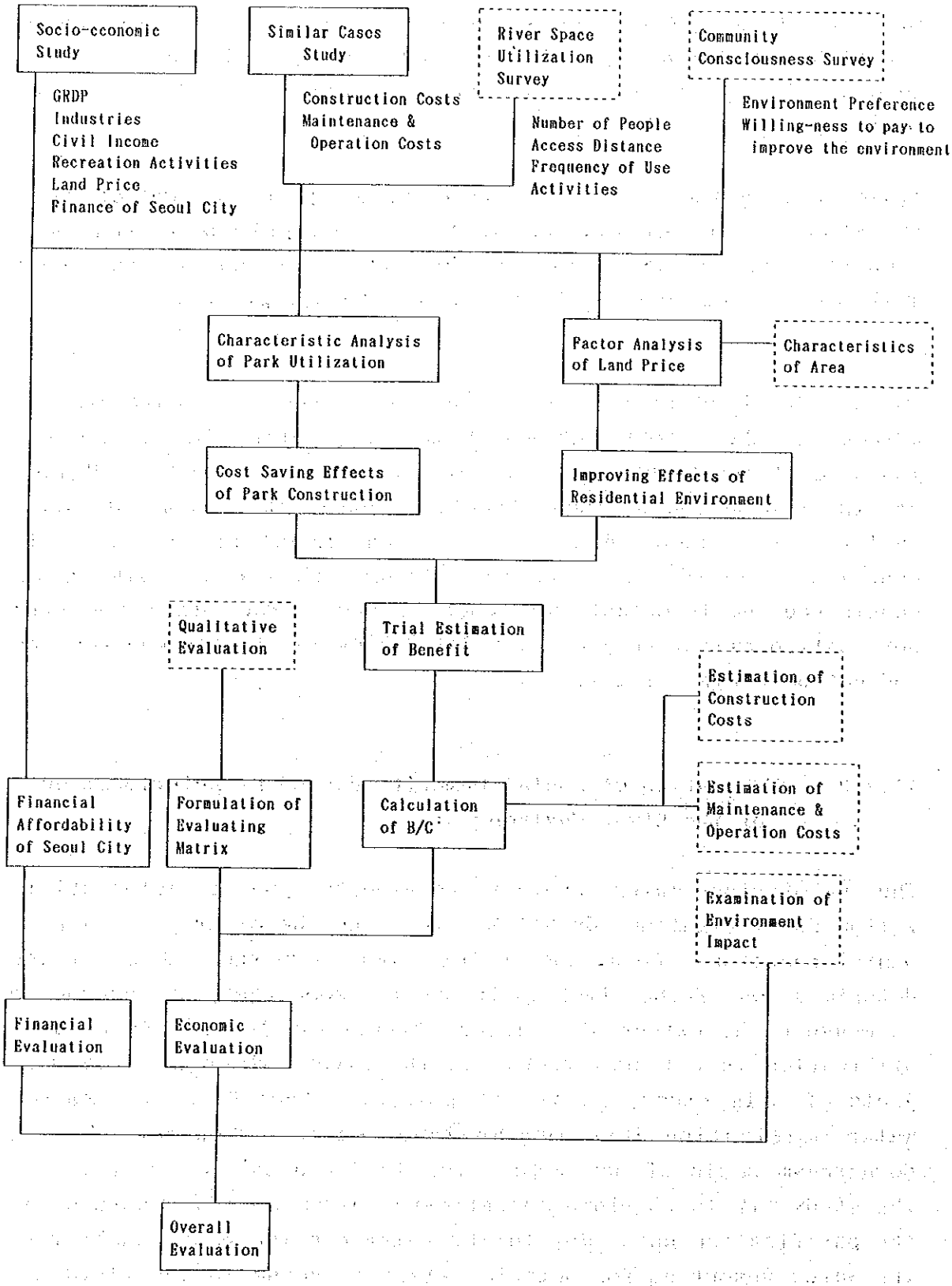

Fig. 11.3-1 Planning order for Project Evaluation