

漢江綜合開發事業

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1. Significance of IHRDP

The Han River has been contributed as the resource of drinking water, industrial water, agricultural and hydroelectric power plants . It also provides the natural environment to affect for citizen from the aesthetic point of view.

Especially, Seoul has been rapidly urbanized since the 1960s and industrialized since the 1970s. The increase of demand for urban public services, induced the deterioration of the urban natural environment.

The Han River was polluted by the direct discharge of municipal wastewater and industrial wastewater. By the reason of that, the resource of drinking water and industrial water had to be changed to the Paldang reservoir, the upper part of the Han River . In addition, the river bed was uneven caused by dredging, sediments, weeds and sandbanks made it bad appearance, therefore, it can not be laid as it was from the viewpoint of the urban environment.

The central government and other related agencies have proposed to overcome these problems by the experimental results of hydraulic model for the river, which was the Integrated Han River Development Project(IHRDP). The partial measurements has been done , however, the basic development could not be done by that time.

In 1981, Korea has the turning point the 24th Seoul Olympic

Games as the host country. The significance of the Project is to improve the river as Waterfront Park with clean water running. Park construction induced to enjoy for citizen contributing the citizen health and emotional acclimation. The development of the riverside freeway in the southern part of the Han River led Seoul to get the aspect of the international city.

2. General Concept of the Project

The population and wealth are concentrated in the metropolitan area as the center of Korea. The metropolitan area stands the leading role of political, economic, social and cultural aspects. The reason of its predominant position of them was its having the Han River as the desperate water resource to produce and grow up the cities.

The Han River is a central artery through the Korean peninsula. It is 514km long, has a basin area of 26,218km² as 27% of total area of Korea and touches the Kangwon Province, the Kyounggi Province, and the Seoul area. About 11 million people as the 30% of Korean population live in this area and it shares more than 40% of total GDP of Korea.

Not only it has an important function and the worth for the quantitative aspect but also it has natural factor to get aesthetic effect and the urban space for the function of green area. In addition, the project implies more than its huge open space as emergency control, shunt, pollution control, weather control, recreation, culture, education, health, landscape, aesthetics and maintenance of the natural environment. The summary of IHRDP like these functions can be described to meet the social demand as follows.

First, the improvement for the preparation Seoul Asian Games

in 1986 and the 24th Seoul Olympic Games in 1988,

Second, the creation of new open space, aesthetic promotion of river conservation and the appeasement formation,

Third, the security of the space for the sound citizen recreation with the publicity and the creation of the megacity area,

Fourth, the rehabilitation of its inborn character and economic development of potential resources,

Fifth, the security of flood control and environmental improvement in and around the Han River, settlement of traffic problem through the expansion of riverside freeway.

3. Outlook for the Han River

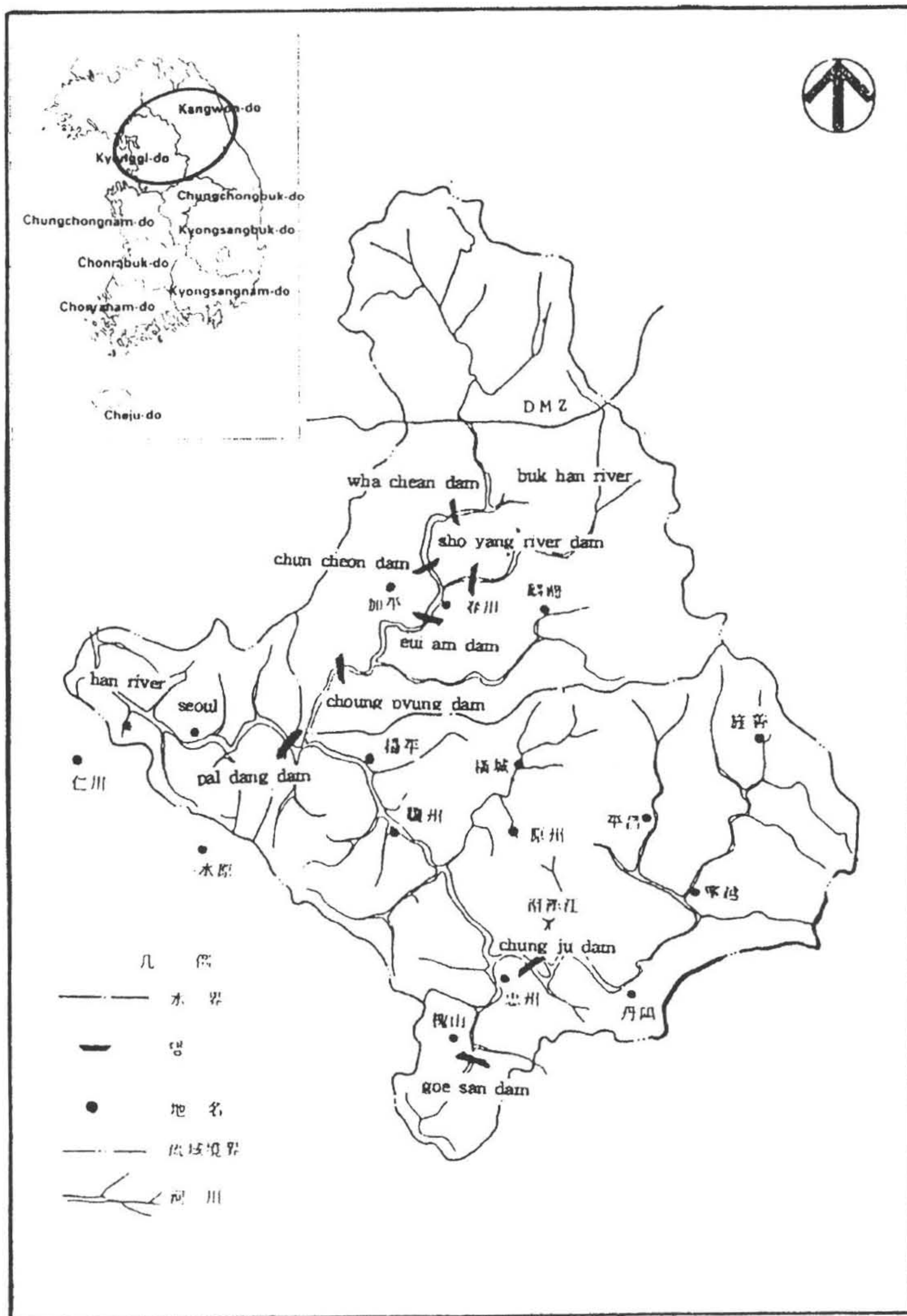
The Han River, the largest river is a central artery through the Korea peninsula. It is composed of two main tributaries, the South Han River which winds Kangwon Province from Ohdae Mt. and the North Han River which touches mainly Kyounggi Province from Keumgang Mt. of North Korea. They are combined altogether at about 40km away from the upper part of Seoul area, then the Han River winds through the Seoul area with 1.1 million population and runs to the Yellow sea. The basin areas and the length of them are presented in Table 1 and the location map of dams for the upper part of the Han River is illustrated in Figure 1.

The predicted flow is 37,000m³/sec in the lower part of the Han River, however, the average flow is 490m³/sec, low flow is 125m³/sec. The precipitation is concentrated in summer time, therefore, the ratio of low flow and high flow comes up to 300. Hydraulic

[Table 1] Basin areas and length for the important point

| Item | Confluence of Im Jin River | Han Gang G.Bridge | Pal Dang Dam | | | Remark |
|----------------------------------|----------------------------|-------------------|-----------------|-----------------|--------|--------|
| | | | South Han River | South Han River | Total | |
| Basin Area (km ²) | 26,218 | 24,753 | 12,910 | 10,700 | 23,610 | |
| River Length (km) | 468 | 444 | 401 | 320 | 401 | |

[Figure 1] Riverine area of the Han River



characteristic of the Han River leads to run through the low water channel and the most floodplains were left unused space through the year except on running way for the flood.

The floodplain environment was very poor to access due to weeds before the IHRDP. The low water channel was deteriorated due to injudicious dredging of gravels from the channel and the water level was also very uneven, therefore, it was difficult to sail. In addition, the water quality was deteriorated due to the direct discharge of the untreated municipal wastewater. Thus the Han River was turned away citizen faces.

[Han riverine area of the Seoul District]



4. Summary of the Project

The area of the IHRDP was 36km long from Ahmsa-dong, Seoul, the upper part of it to the Hangju Bridge, the lower part of it. The period of the project was from September 1982 till September 1986 before the Seoul Asian Games. The project mainly aimed at the riser improvements which were improvement of low water channel, the construction of floodplain and waterfront park. In addition, it contained to construct riverside freeway and to construct wastewater treatment plants, and the total budget for the project was approximately 6 billion Won (7.5 million USD). The project can be summarized as follows.

4.1 Improvement of Streams

Not only it aimed to minimize the variation of low water channel through the river engineering but also it aimed at the formation of waterfront park through the Han River which runs clean water and to remover accumulated sediments on the low water channel. It also has two benefits, one is the improvement of the environment. Another is to use the proceeds from sale of gravels, so that they could be used as the revenue source for the project.

The development of streams was the core project and the water channel can be secured after the development in terms of river engineering and helped the security of flood control. It can be maximized for the utilization of reverine space and gravels from

the low water channel in terms of resource development and flood control. It had plan to construct facilities for rehabilitation of the nature in terms of the environmental conservation.

4.1.1 Streamway

The profile of the river has two aspects. One is the low water channel which was allowed to run river water at ordinary times. However, another is watershed which was allowed to run river water for the flood. The Han River has more than two functions, like as double profiles or triple profiles. The strength of the riverine profile was planned more than 37,000m³/sec, the official notification to the security for the flood control.

The gradient of water surface was determined to minimize the channel variation after development, therefore, the Han River could be kept its own natural streamway. These are shown in Table 2.

[Table 2] Gradient of water surface of the Han River

| Items | Gradient(%) | Height planned (EL. m) |
|-----------------------------|-------------|------------------------|
| Hangju Brdg. ~ Wonhyo Brdg. | 0.003546 | (-)1.22 ~ 0.71 |
| Wonhyo Brdg. ~ Chunho Brdg. | 0.011933 | (-)0.71 ~ 0.87 |
| Chunho Brdg. ~ Ahmsa-dong | 0.015290 | (-)0.87 ~ 2.51 |

The shape and width of the corridor was determined to get feasibility, convenience and economical efficiency to use floodplain for people. It was verified by the hydraulic experiments for the security. The widths of corridors of several main points are shown in Table 1-1-2

[Table 3] The width of low water channel for several points in the Han River

| Locations | Width of the River(m) | Width of corridors(m) |
|-----------------|-----------------------|-----------------------|
| Hangju Brdg. | 1,998 | 1,160 |
| Sungsan Brdg. | 1,486 | 930 |
| Han River Brdg. | 1,038 | 860 |
| Banpo Brdg. | 1,112 | 840 |
| Yongdong Brdg. | 760 | 640 |
| Chamchil Brdg. | 1,185 | 930 |
| Chunho Brdg. | 947 | 770 |

River runs only on floodplains in case of flood but does not run always through the corridors. Therefore, floodplains have to be secured in terms of river engineering. These are kept to improve for the landscape in terms of environmental engineering also these have to be kept to preserve biodiversity in terms of ecological aspects. Therefore, the concept of riverine-space development lies in the utilization of floodplains along the urban river reach.

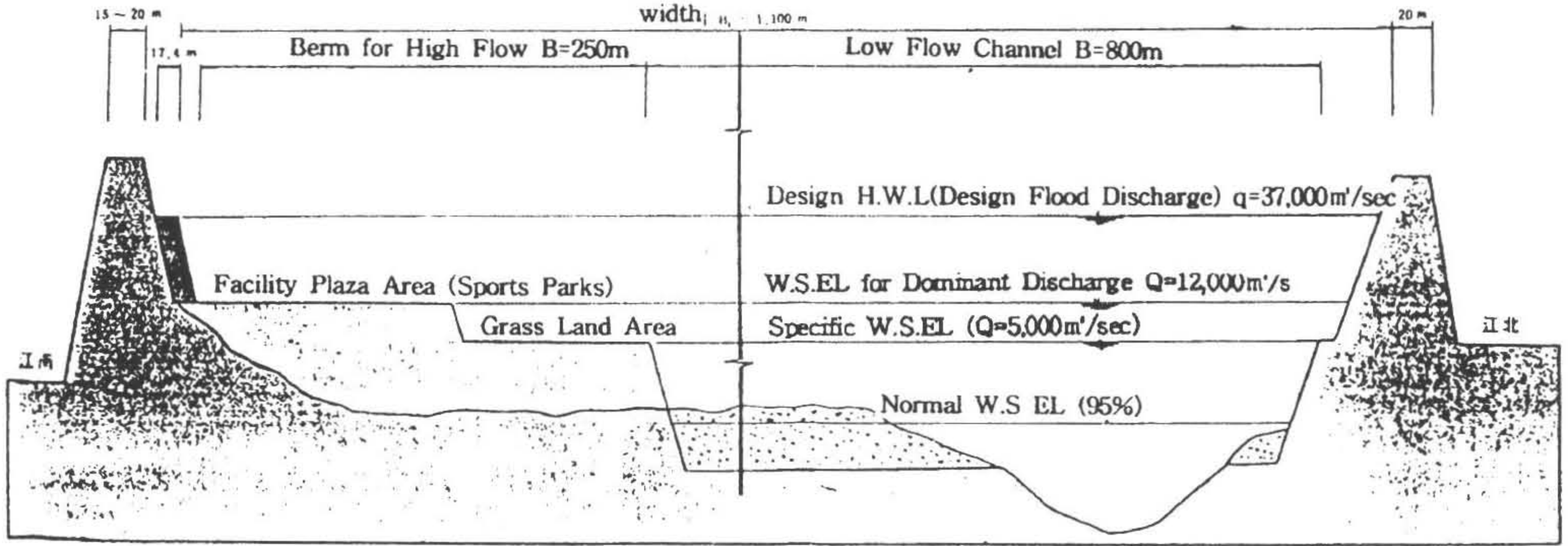
For the consideration of these several aspects, floodplains were divided as a grassy place and sports parks or playgrounds. The heights of these were determined after severe consideration of the security of flood. Meadow was determined after severe consideration of river engineering, as $5,000\text{m}^3/\text{sec}$ (0.6 year frequency) and was also determined not to be submerged for the lower than flood.

The profiles are illustrated in Figure 2 and 3.

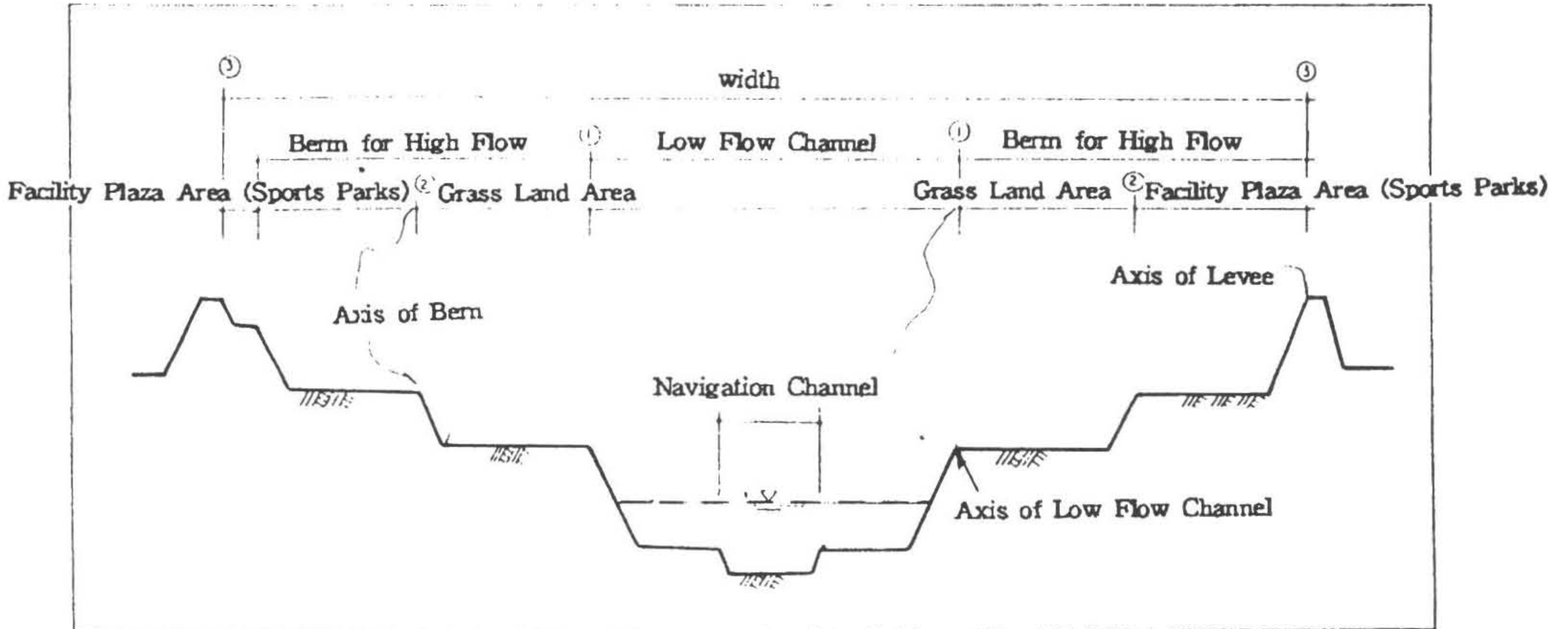
4.1.2 Riverine structures

The riverine structures are embankments, levees, maintenance facilities and other facilities. Not only embankments can enhance the hydraulic securities and maximize the utilization of lands but also a freeway connecting from the east to west in the southern part of the Han River is contributing to solve the traffic issues. The freeway is 10km long from Hangju Brdg. to the Yangwha Brdg. The riverbank can be divided by low water channel for protection of low water line, and semi-low water channel between a grassy place and sports parks, and high water channel for the protection of embankments. Therefore, these were determined by several aspects such as floodcontrol, riverine-friendliness, riverine ecology. Especially, the perforated block for fishes was set in the corridors to preserve the ecological environment. These are illustrated in Figure 4.

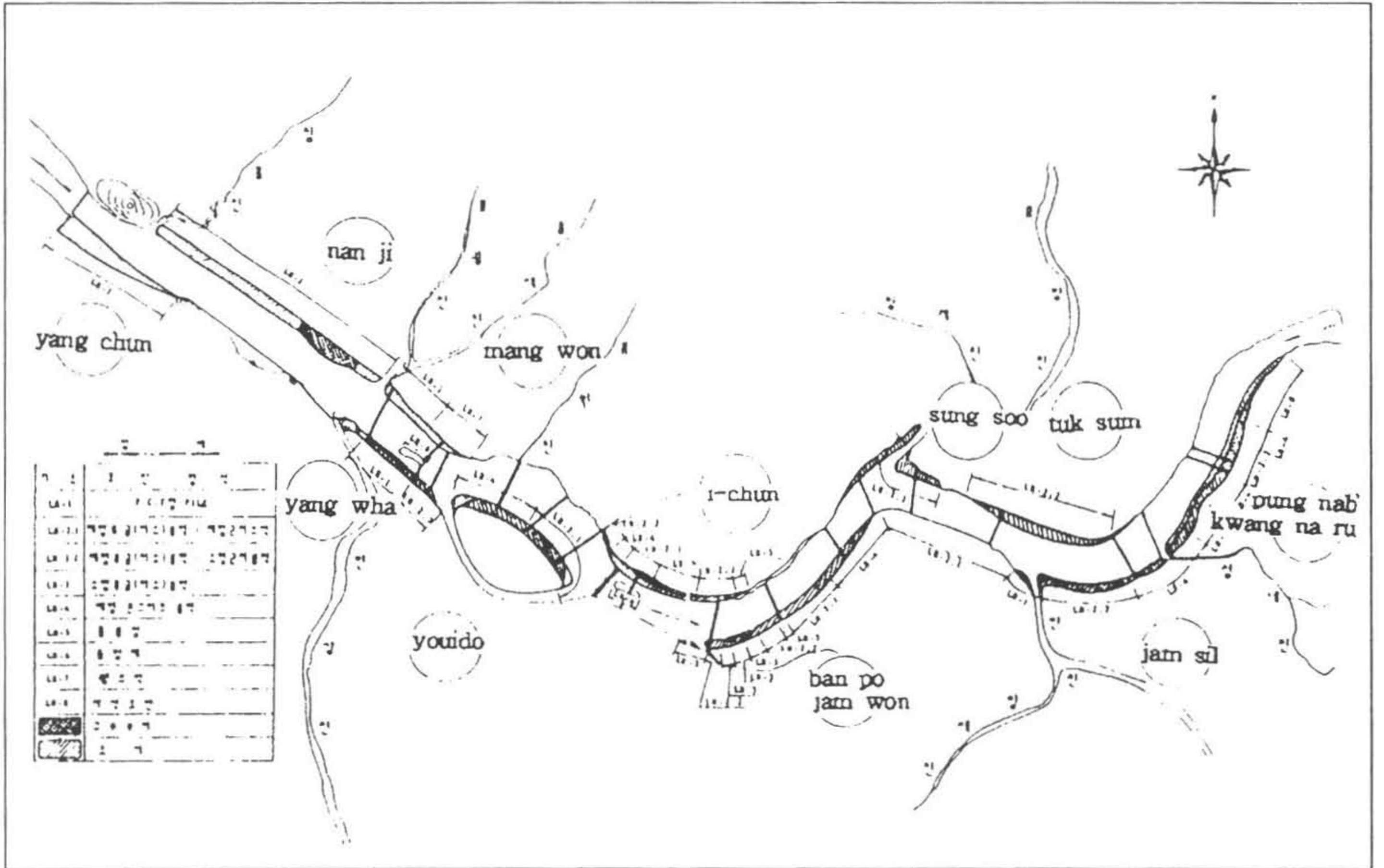
[Figure 2] Typical Section of River



[Figure 3] Typical Section of River



[Figure 4] A plane figure of sectional riverbank.



The reasons of the lowering the normal water level are as follows. First, eight public intake, 24 private intake, second, river navigation in the South Han river, third, ecological variation and the enlargement of variation area for the river bed caused by high tide and low tide, fourth, a civil appeal for the lowering groundwater level, fifth, the deterioration of urban environment due to exposure of riverine-structure. Therefore, these issues were settled by the foundation of two facilities for maintenance of normal water level. These facilities for measuring normal water level are classified the Chamshil submerged dam in

[Table 4] The general summary of maintenance facilities for normal water level.

| Items | | Chamshil SMD | Shingok SMD |
|--------------|-----------|---------------------------|-------------------------|
| location | | under the Chamshil Brdg. | Shingok Pumping station |
| formation | | complex type | complex type |
| movable weir | location | left | right |
| | height(m) | 6.9~7.9 | 2.3 |
| | length(m) | 230.5 | 124 |
| | formation | Roller gate | Sluice roller gate |
| | size(m) | 5 serial of 36×3.7 | 5 serials of 20m×5m |
| | height(m) | EL. 2.9 | EL. (-)5 |
| Fixed weir | location | right | left |
| | formation | concrete gravity type | rock-fill type |
| | height(m) | 11.2~12.2 | 4 |
| | length(m) | 647.5 | 883 |
| | length(m) | EL. 6.2 | EL. 2.4 |
| | size(m) | step formation of 20×28.3 | - |

SMD: Submerged dam

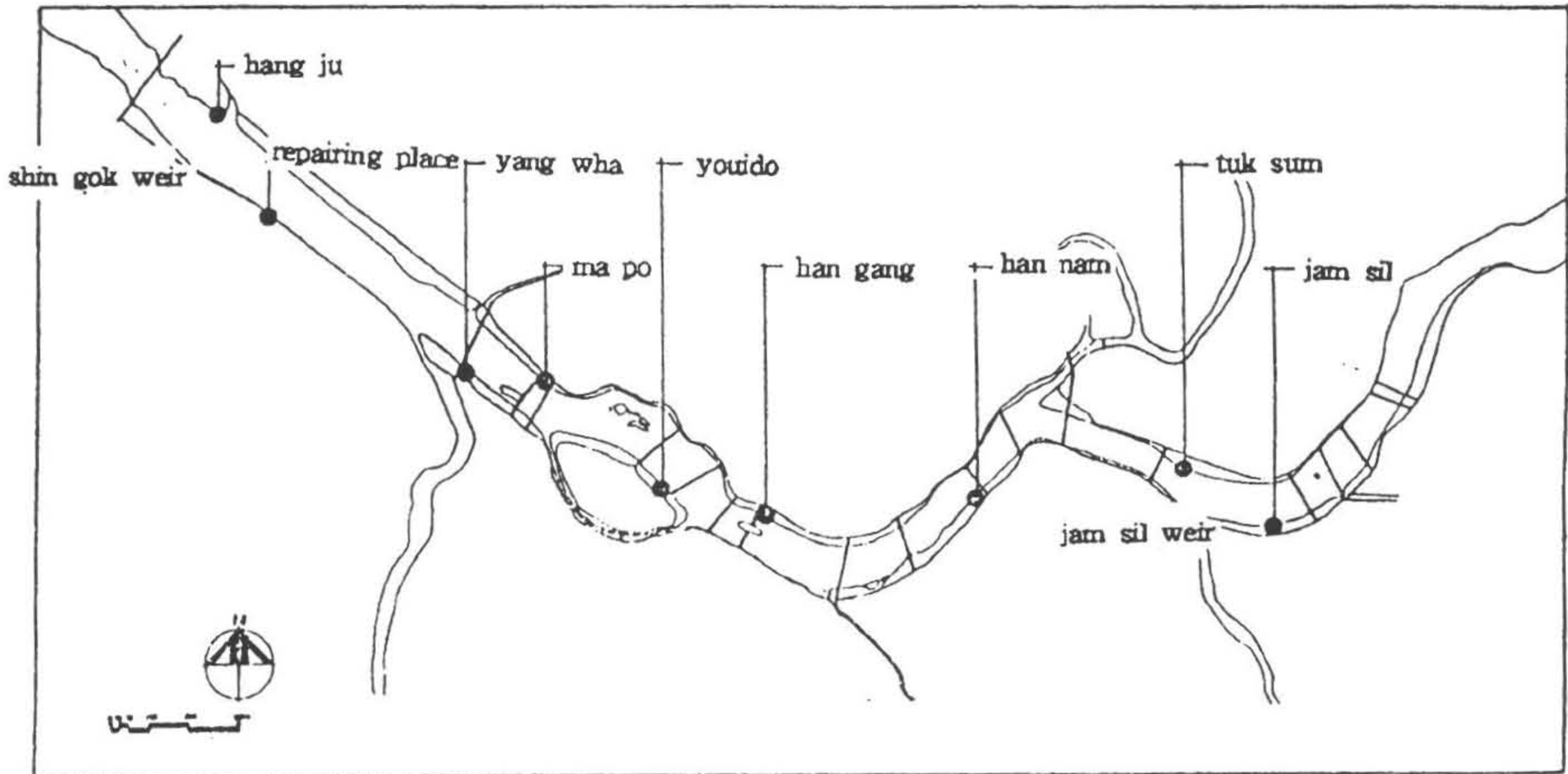
the upper part of the Han River, and Shingok Submerged dam in the lower part of the Han River. The general summary of two facilities is shown in Table 4.

In addition, facilities for tributaries were constructed in the downstream of 7 tributaries for contriving stable stream line, connection of driving system for attracting floodplains, sustaining the cunction for the measuring normal flow. The intermittent submerging bridge was improved to contrive the navigation. Several piers were settled and the scope is shown in Table 5, locations are illustrated in Figure 5.

[Table 5] The scope of piers

| Bridge | Calculation | Hangju | Yangwha | Mapo | youido | Han river | Hannam | Tuksum | Chamshill |
|-----------------------|-----------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| maximum size of ship | | 20m×3 | 20m×3 | 20m×3 | 20m×8 | 20m×3 | 20m×3 | 20m×5 | 20m×5 |
| length necessary | total length of ship×1.5 | 90m | 90m | 90m | 240m | 90m | 90m | 150m | 150m |
| pier area | length×1.5 | 1,485m ² | 1,485m ² | 1,485m ² | 3,630m ² | 1,485m ² | 1,485m ² | 2,310m ² | 1,485m ² |
| using passenger(max) | peak time passenger | 1,056 | 120 | 240 | 2,520 | 1,206 | 360 | 1,200 | 1,140 |
| presumptive passenger | floodpain user×35% | 200 | 200 | 250 | 800 | 400 | 400 | 1,300 | 500 |
| parking lot | 15.5m ² /passenger car | 1,650m ² | 1,650m ² | 1,650m ² | 2,640m ² | 1,650m ² | 1,650m ² | 4,290m ² | 1,650m ² |
| ticket lot | | 660m ² | 660m ² | 660m ² | 660m ² | 660m ² | 660m ² | 660m ² | 660m ² |

[Figure 5] The locations of submerged dams and piers.



4.2 Construction of Waterfront Park

Waterfront parks were constructed to coexist citizen and water considering the efficiency of citizen utilization and the characteristics of the river engineering pertaining its flood control. They were composed of sports parks and learning ground for nature for citizen. Total area is 6.9 million m^2 with 3.1 million m^2 of 9 facility plaza and 3.8 million m^2 of 13 grassy ground. They were constructed on the floodplain with 99 accessing including bicycle lanes and underground sidewalks.

Sports parks as facility plaza were constructed for 1.5 year frequency. There are playgrounds for soccer, volleyball, basketball and tennis and two amusement parks in Dducksum, Kwangnaru.

Natural grassy area for the preservation of natural environment was constructed for 0.6 year frequency. There are fishing places and learning place for nature. Especially these parks were connected the east to the west with bicycle lanes, 98.8km long to contrive the convenience of utilization. The functions and land use of these parks are presented in Table 6.

[Table 6] Functions of riverine parks (unit:Pyong)

| Function Area | Total | Facility Plaza Area | | | | Grass land Area |
|---------------|-----------|---------------------|---------------------------|--------------------------------|----------------------|-----------------------|
| | | Sub total | Sports Park Area(7 Areas) | Amusement Parks Area (2 Areas) | Parking Area(1 Area) | Grass land (13 Areas) |
| Total | 2,100,000 | 940,000 | 650,000 | 250,000 | 40,000 | 1,160,000 |
| YangChun | 218,000 | - | - | - | - | 218,000 |
| NanJi | 383,000 | 127,000 | 127,000 | - | - | 256,000 |
| YangWha | 74,000 | 38,000 | 38,000 | - | - | 36,000 |
| MnagWon | 105,000 | - | - | - | - | 106,000 |
| YouIDo | 214,000 | 157,000 | 157,000 | - | - | 57,000 |
| I-Chun | 150,000 | 73,000 | 73,000 | - | - | 77,000 |
| BanPo | 172,000 | - | - | - | - | 172,000 |
| JamWon | 88,000 | 82,000 | 82,000 | - | - | 6,000 |
| SungSoo | 84,000 | - | - | - | - | 84,000 |
| TukSum | 166,000 | 150,000 | - | 150,000 | - | 160,000 |
| JamSil | 164,000 | 146,000 | 106,000 | - | 4,000 | 18,000 |
| PungNab | 78,000 | 67,000 | 67,000 | - | - | 11,000 |
| kwangNaRu | 204,000 | 100,000 | - | 100,000 | - | 104,000 |

4.2.1 Land use of facility plaza

The facility plaza was constructed 6 sports parks, 2 amusement parks, 1 parking place, which were composed of driving way, plaza, rest area, convenient places, sports ground, amusement place, recreation area.

4.2.2 admission passage

1. Entrance passage for passenger car

Passenger cars are only allowed through the entrance passage using through riverside pavement.

2. Entrance passage for pedestrian

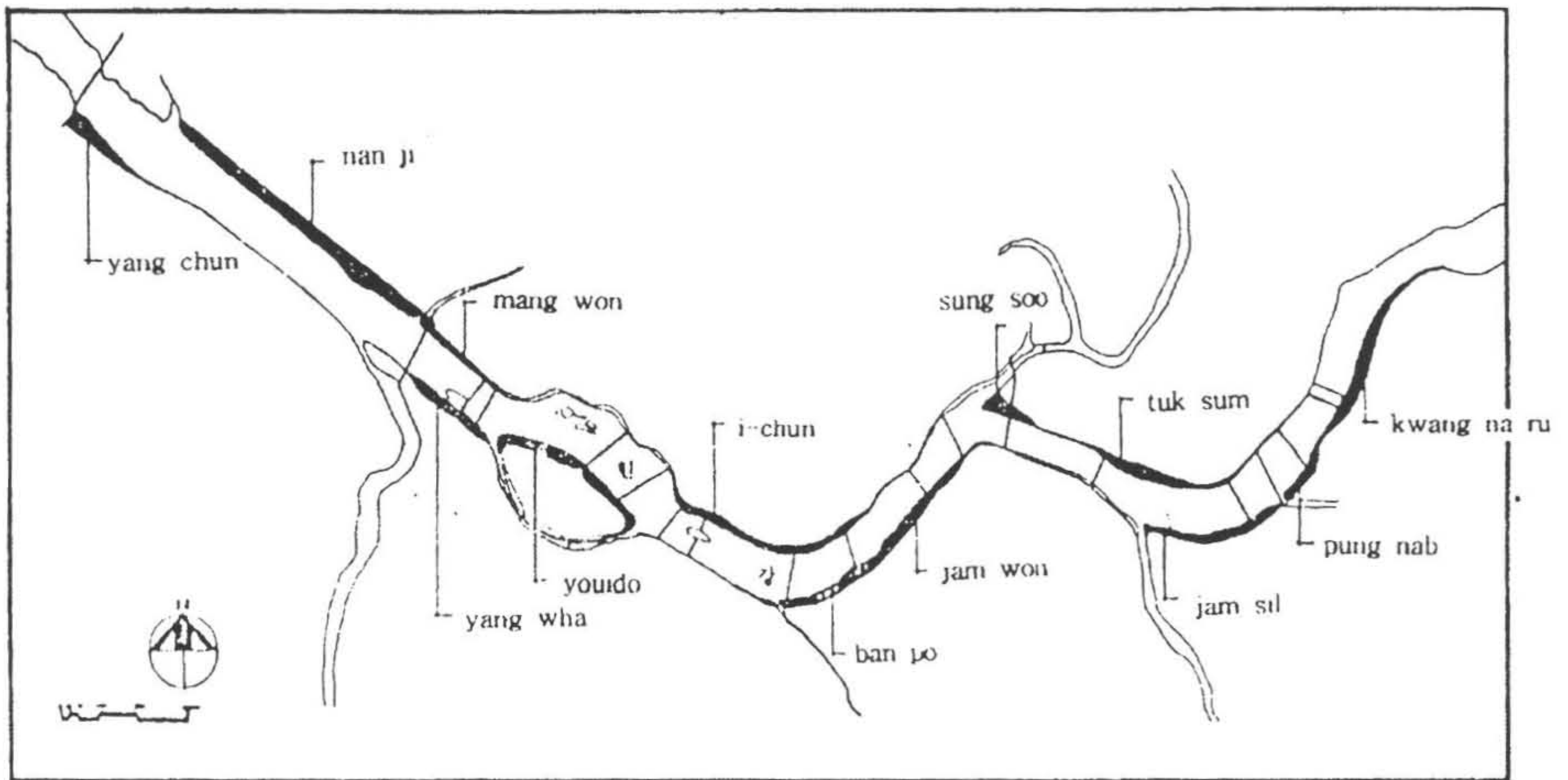
Entrance passage for pedestrian and bicycles was constructed through underground passage as admission passage from the outer part of embankment. This is also allowed to enter riverine-parks for people and several lighting systems were installed through the passage. In addition, Up-Down lamps are allowed to access easily for bicycles, rear car, wheelchair.

3. Lanes for bicycle

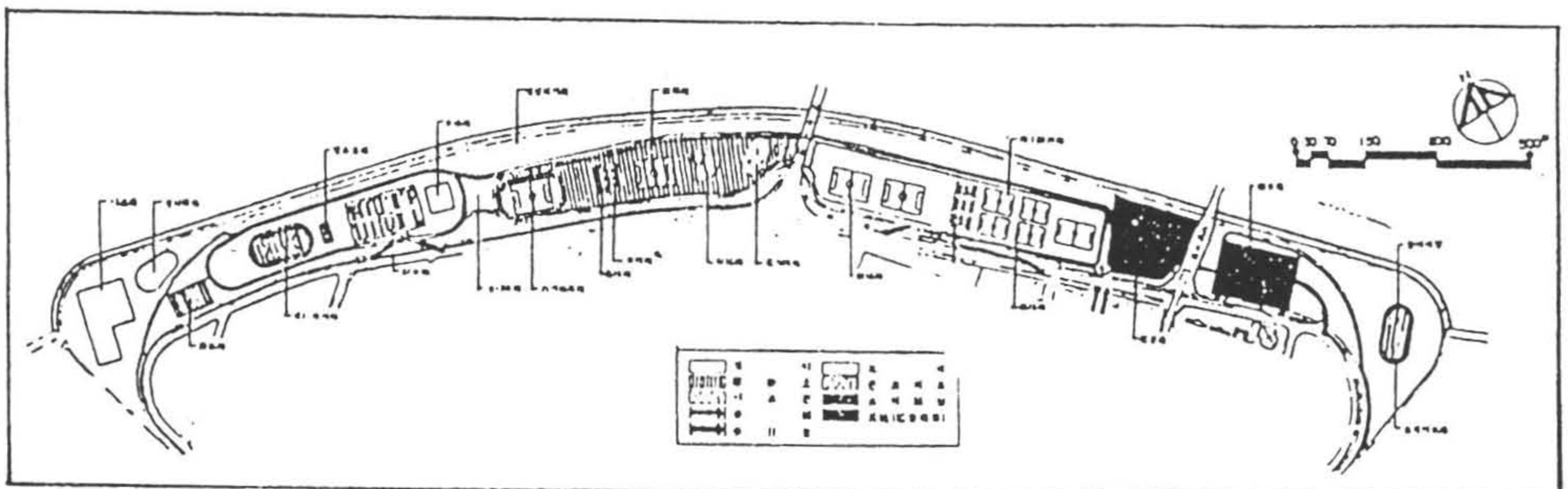
Lanes for bicycles were connected to support the function of axis through east to west connecting riverine green areas of both sides of the Han River. These were constructed in floodplains, especially on the sewer ducts for the areas in the absence of floodplains. The circulation pavement was connected with each

promenade in the grassy areas and on the embankment if the width is allowed to be sufficient for them.

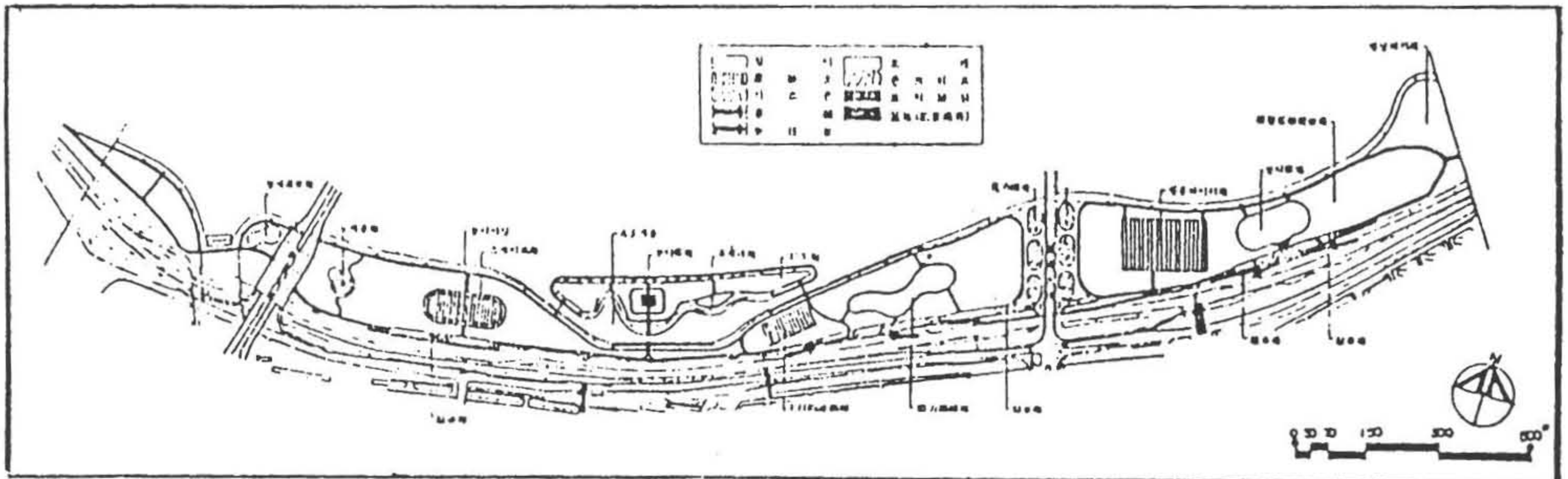
[Locations of civil parks of the Han River]



[YOUIDO District]



[Ban Po District]



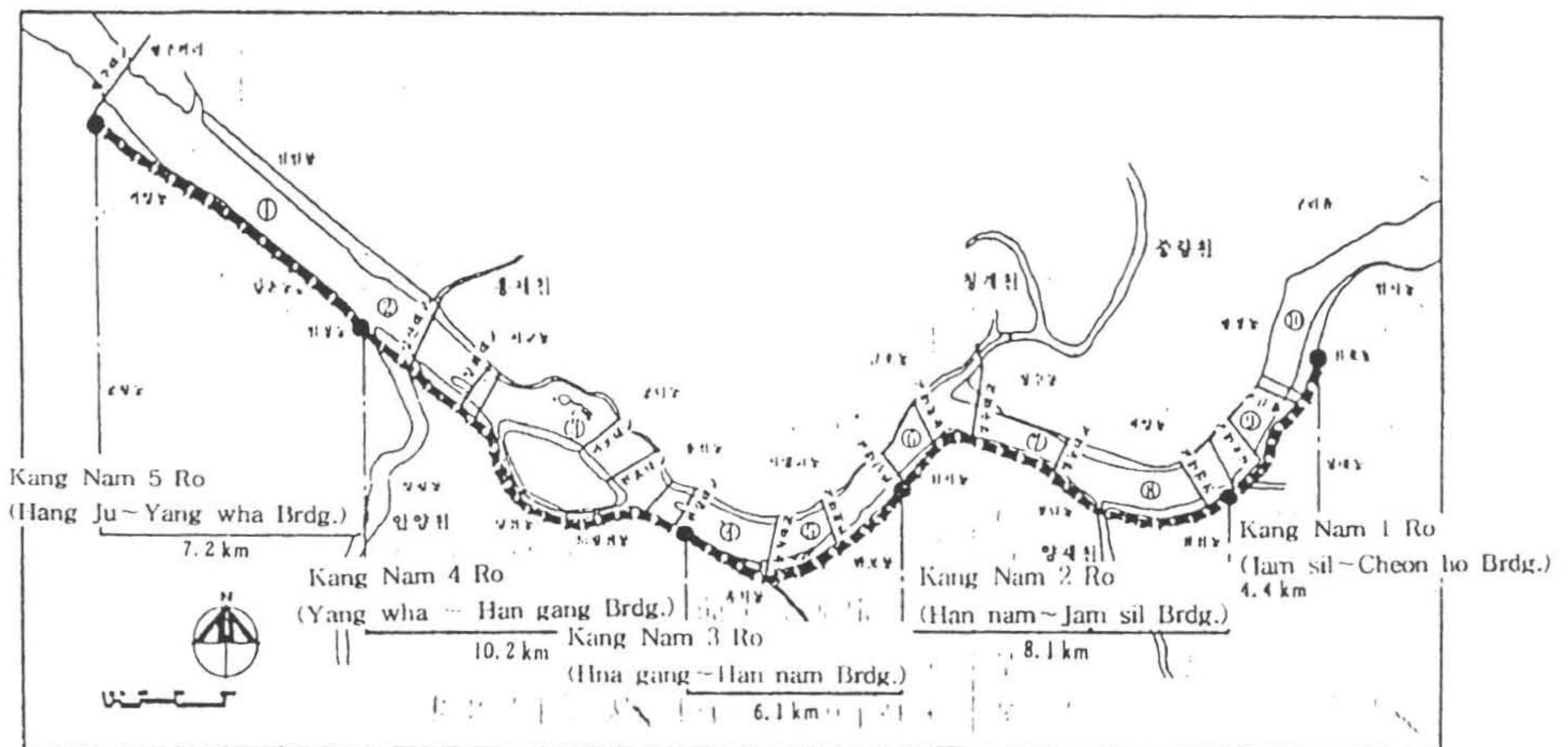
4.3 Aggrandizement of the Olympic Freeway

The urban freeway as riverside road connecting through the east to the west in the southern part of the Han River has a function to solve the traffic issues of the amicable passage. This has contributed the important role for the successful performance of Seoul Asian Games in 1986 and Seoul Olympic Games in 1988 to connect from Kimpo airport to the main stadium in Chamshil.

The Olympic freeway 36km long was constructed under this purpose. The embankment 10km long from Hangju Brdg. to Yangwha Brdg. got 6 lanes after amendment of embankments and the freeway was aggrandized to 8 lanes from Yangwha Brdg. to Ahmsa-dong which is the board of Seoul and Hanam city. The Olympic freeway touches 5 bridges which are Namchang Brdg., Noryang Brdg., the 2nd Dongjak Brdg., the 2nd Cheungdam Brdg. and the 2nd Shinchun Brdg. Interchanges were improved at the five bridges which were Banpo Brdg.,

Hannam Brdg., Sungsu Brdg., Youngdong Brdg. and Chamshil Brdg. Six interchanges were newly constructed at Yangwha Brdg., Euido Brdg., Dongjak Brdg. and the 1st and the 2nd Cheungdam Brdg. These are presented in Figure 6.

[Figure 6] Locations



4.4 Construction of Wastewater Treatment Plants

Wastewater treatment plants has been constructed for this aiming at water quality improvement for the Han River because the river water quality can be improved to treat municipal wastewater and industrial wastewater. From this aspect, the construction of WWTPs was carried out for the IHRDP, which are presented in Table 7.

[Table 7] Wastewater Treatment Plants in Seoul

| Item | | NanJi T.(North of R.) | | GaYang T.(South of R.) | | TanChun T. |
|------------------------|--------|----------------------------|---|-------------------------------|---|---|
| Design Capacity | 1 step | 500,000m ³ /day | 1 step was constructed with Han River Development Project | 1,000,000 m ³ /day | 1 step was constructed with Han River Development Project | 500,000m ³ /day was constructed with Han River Development Project |
| | 2 step | 500,000m ³ /day | | 1,000,000 m ³ /day | | |
| Final Treatment Method | | Advanced T. | | Advanced T. | | Advanced T. |

On the other hand, sewer ducts to collect municipal wastewater are buried with the concrete duct, 54.42km long with 1.5m × 1.5m and 4.0m × 4.0m. The length of sewer ducts of each treatment area are 18.7km long for Anyang treatment area, 20.4km long for Najee treatment area and 15.5km for Tanchun treatment area. These are illustrated in Figure?.

4.5 Project Expenses

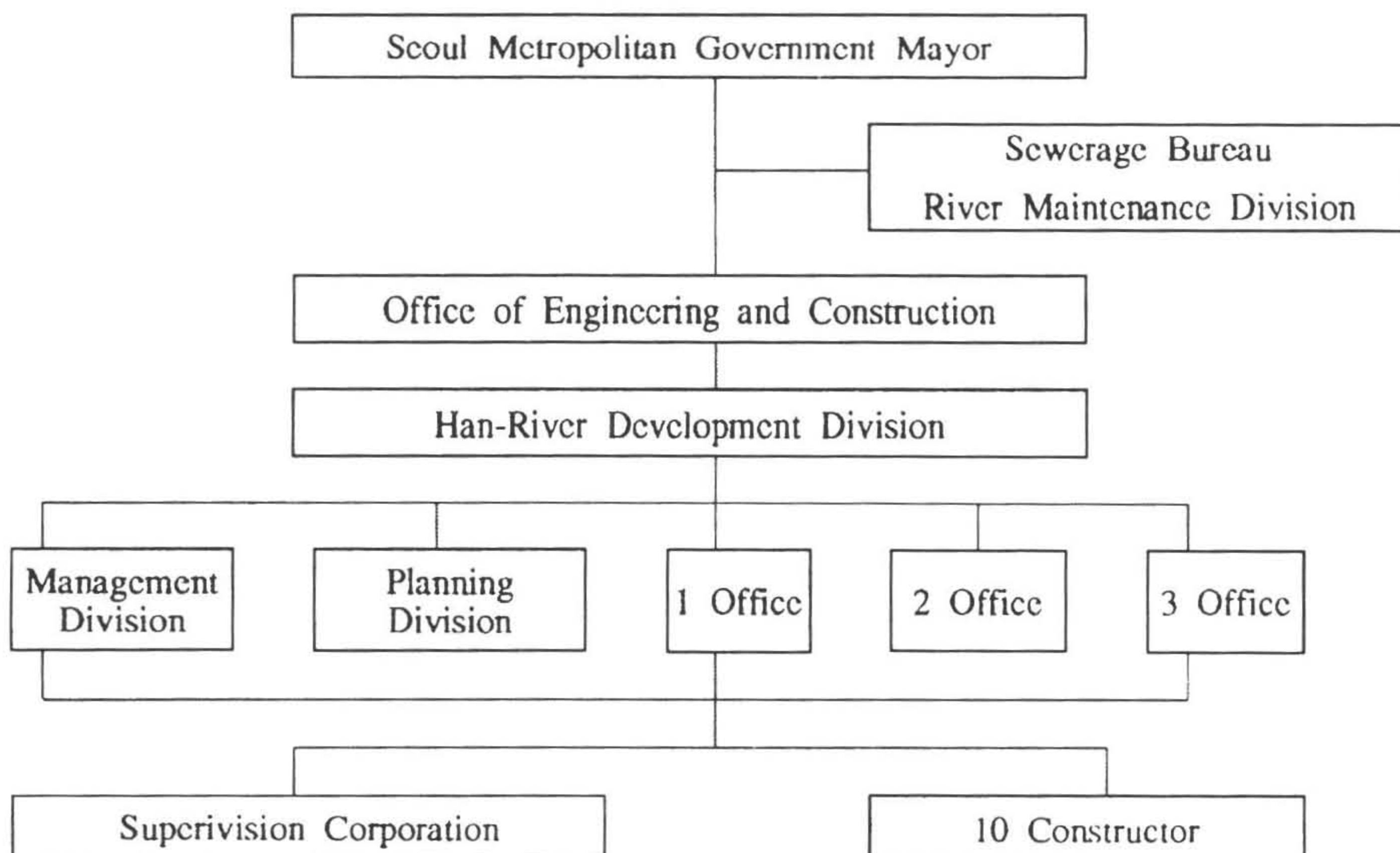
The total revenue for the IHRDP was 687 million USD, which are composed of 494 million USD for IHRDP and 193 million USD for the construction of WWTPs. The charge for gravel sale, 229 million USD was used development of low water channel, construction of river-ine parks, improvement of intermittent submerging bridge, the Olympic freeway construction and enlargement, construction of ducts for wastewater, submerged dams, streets, embankments, interchanges and so on.

5. Operation and Maintenance

5.1 Organization of IHRDP

The Bureau of the Han River Development was organized to perform successfully IHRDP. Liability supervision was applied to support the quality enhancement and technical service. And experts consulted and citizen appeals were also considered. The organization of the IHRDP was as shown in Table 8.

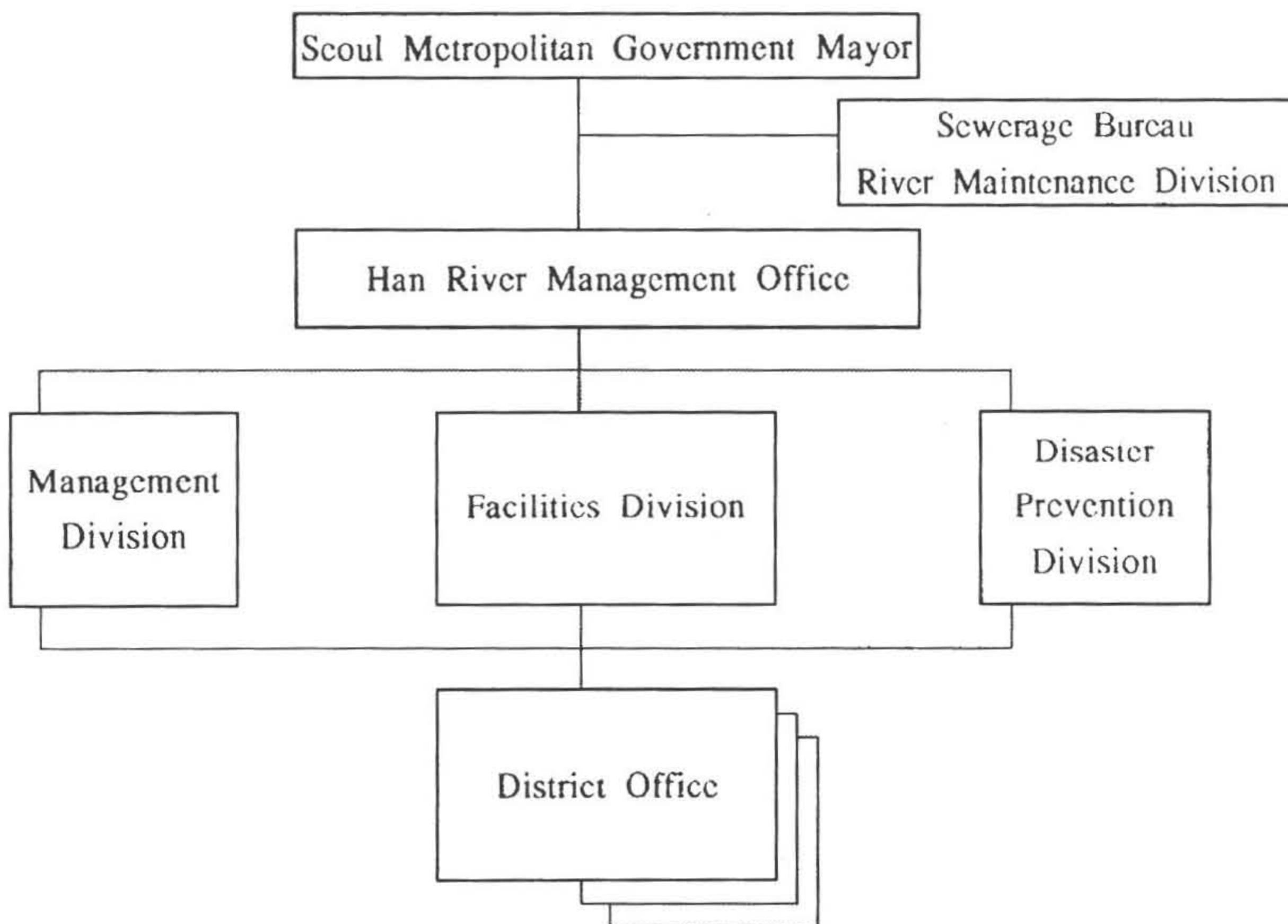
[Table 8] Organization of The Integrated Han-River Development Project



5.2 Organization of the Office of Han River Management

The Office of the Han River management was established to charge exclusively for the maintenance of the Han River after the completion of the IHRDP. It plays important roles of maintenance of riverine parks facilities and dredging sediments. Its organization is presented in Figure 5.2.

[Table 9] The organization of OHRM



6. Effect of the Project

The IHRDP was rehabilitate the river environment which was disregarded by citizen since the beginning of 1960s. The main aspects were streamway improvement, construction of riverine parks , improvement of the river environment and the construction of WWTPs.

The improvement project for the river environment was performed as follows. First, not only dredging the low water channel was induced to make river environment clean but also it allows for the navigation, wind surfing, and water skiing.

The conetxt of the Han River use by citizen is as follows.

Riverine parks: 1,990,000

Excursion ships: 1,017,000

Other facilities: 284,000

Second, The riverine space is used for recreation area, sports parks, nature watching parks in the 693 acres of riverine parks. Third, the water quality was improved after improvement of ducts for the collecting of municipal wastewater and the dredging of the accumulated sediments from the shallow water channel. And tree WWTPs enhanced to improve the water quality as BOD 6.7mg/l in 1984 to BOD3.8mg/l in 1995 at Noryangjin.

We have the prospect of the improvement of water quality by the construction of multi-purpose dams for the sufficient water

supply and the construction of WWTPs. Therefore, the Han River can be The Pleasant Plaza for people and nature, Playground with Water which people are willing to visit. Fourth, The Olympic freeway plays an important role of urban transportation, especially it had contributed for the Seoul Asian Games in 1986 and the 24th Olympic Games in 1988 for fast transportation from Kimpo airport to the main stadium. General effect of the IHRDP can be summarized as follows.

1)Direct effect

the revenue for gravel mining as much as 2.5 million USD flood control
save the budget of the central government by riverine space use

2)Indiirect effect

network development
pleasant landscape
prevention of natural disasters
rehabilitation of natural functions of the Han River
potential green space as the functional space
dispersion of amusement facilities
effective traffic control
recreation

improvement of the amenity

The IHRDP can change the Han River image to River to imply old emotion, River to boat, River to swim, River to fish. The Han River can induce the civil amenity and the Korean unique culture as riverine parks for the present concept.

7. Conclusions

Not only the IHRDP was the project for the flood control as the simple concept but also it gave the turning point for the development of rest area and the preservation of natural environment. It has the remaining issue that the development has to be done all of the area within the river area, also, central government and Seoul metropolitan government have to work altogether to make it better