Directorate General of Water Resources,
Ministry of Public Works
Republic of Indonesia

THE PROJECT FOR CAPACITY DEVELOPMENT OF JAKARTA COMPREHENSIVE FLOOD MANAGEMENT IN INDONESIA

TECHNICAL COOPERATION REPORT

COMPREHENSIVE FLOOD MANAGEMENT PLAN ANNEX-2 SPATIAL PLANNING

OCTOBER, 2013

JAPAN INTERNATIONAL COOPERATION AGENCY
YACHIYO ENGINEERING CO., LTD.

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Exchange Rate applied in this Report

As of September, 2013

USD 1.00 = IDR 10,929.766

USD 1.00 = JPY 98.04

The Project for Capacity Development of
Jakarta Comprehensive Flood Management
in Indonesia

Technical Cooperation Report
Comprehensive Flood Management Plan
Annex-2 Spatial Planning

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CHAPTER 1 SOCIO ECONOMY

1.1 Social Condition

1.1.1 Administrative Divisions and Population

Jabodetabekpunjur (Jakarta, Bogor, Depok, Tangerang, Bekasi, Puncak and Cianjur) area consists of DKI Jakarta, West Java Province and Banten Province, and its population reaches at 30 million as of Year 2010.

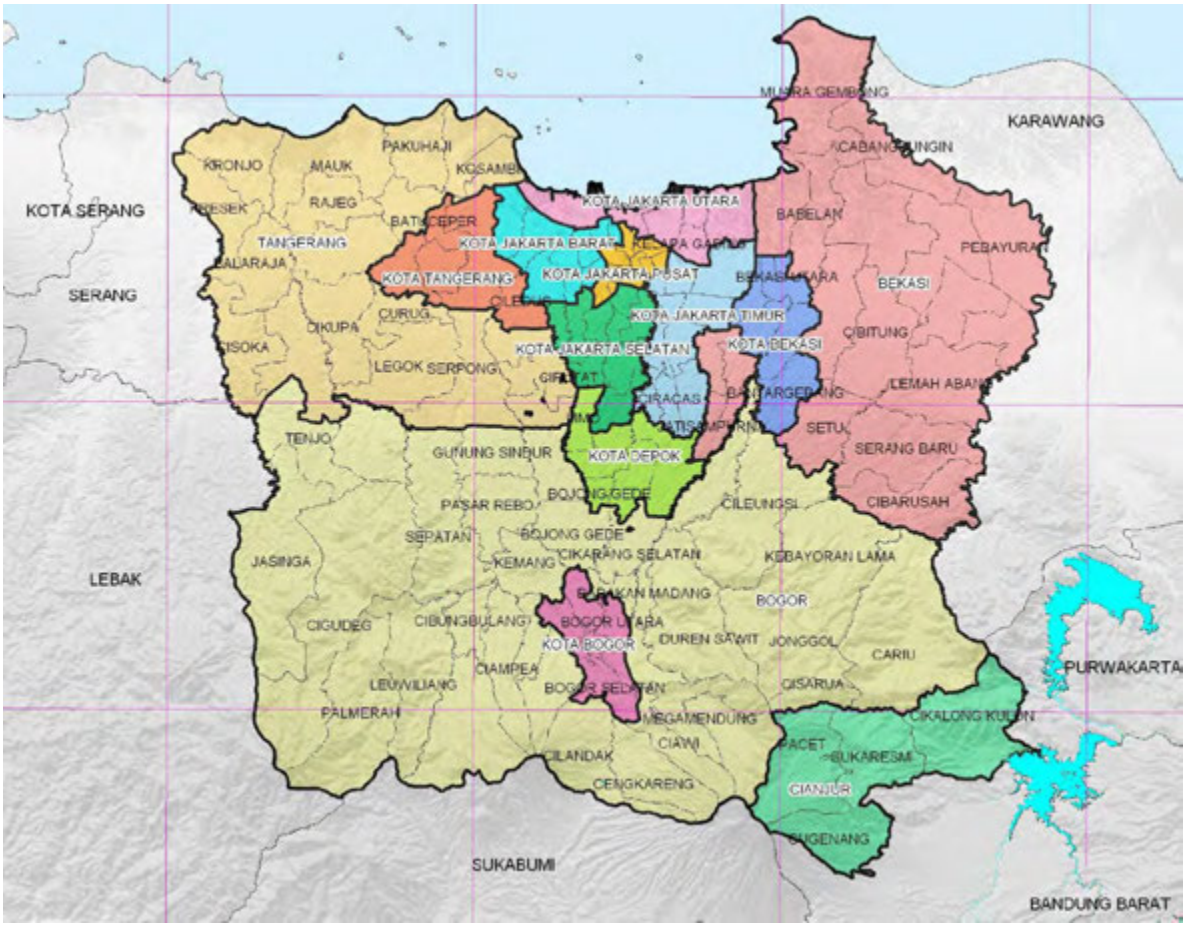


Figure 1.1-1 Administrative Divisions in Jabodetabekpunjur Area

Table 1.1-1 Provincial Population in Jabodetabekpunjur Area

Province	Population	Ratio of Province (%)	Regencies (Kab.)/Cities (Kota)
DKI Jakarta	9,567,127	31.8	Selatan, Timur, Pusat, Barat, Utara
Jawa Barat	14,583,394	48.5	Kab. Bogor, Cianjur, Bekasi Kota Bogor, Bekasi, Depok
Banten	5,939,876	19.7	Kab. Tangerang, Kota Tangerang, Kota Tagerang Selatan
Total	30,090,397	100	

Source: Census Indonesia (BPS, 2010)

Among the above mentioned administrations, the administrative provinces, regencies (Kab.) and cities (Kota) related to the Ciliwung River Basin are DKI Jakarta (except for Thousands islands (Kepulauan Seribu)), Depok City, Bogor District (Kab.) and Bogor City (Kota) in West Java (Jawa Barat).
Administrative boundaries and population for each regency and city are shown in the following figure and table.

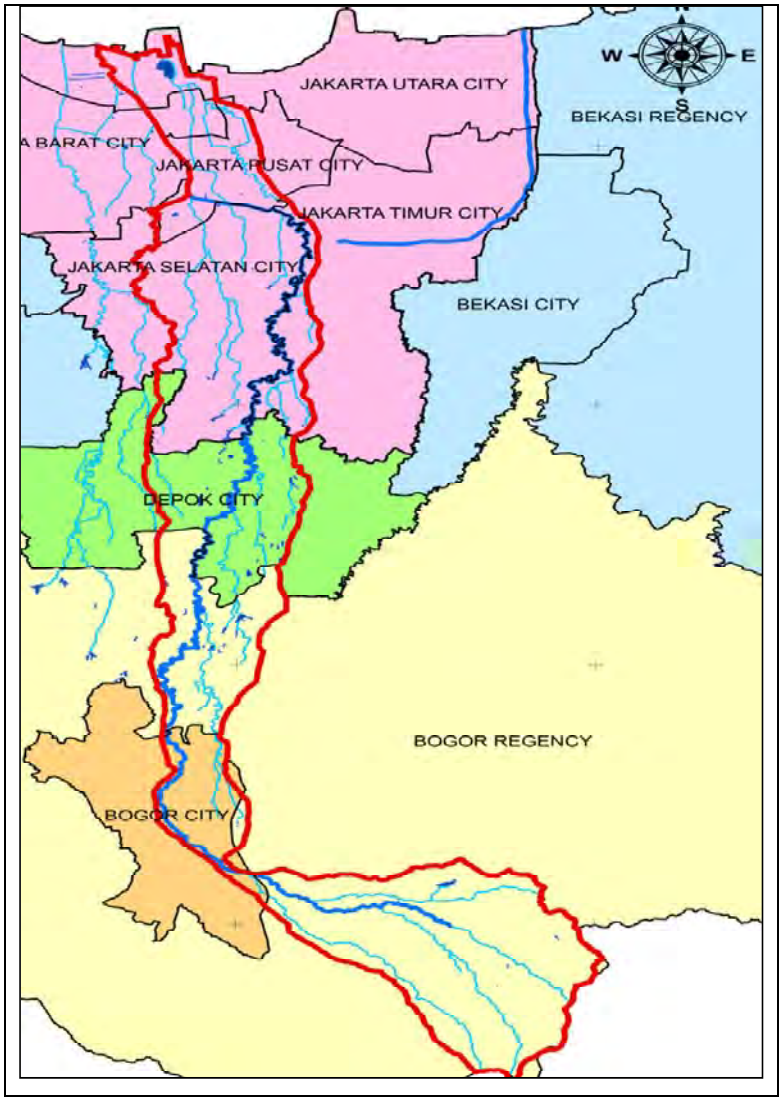


Figure 1.1-2 Administrative Boundaries in Jabodetabekpunjur Area

Table 1.1-2 Population in the Ciliwung River Basin

Province/Regency/City	Area (Km^2)	Population	P. Density (People/ Km^2)
DKI Jakarta	176.06	2,744,335	15,587
Depok City	69.44	537,244	7,737
Bogor Regency	207.60	844,251	4,067
Bogor City	32.03	273,743	8,546
Total	485.13	4,399,573	9,069

Source: JICA Project Team Calculation based on the GIS and Census Indonesia (BPS, 2010)

Approximately 4,400,000 people live in the four administrative districts belonging to the Ciliwung River Basin. Also, average population density reaches 9,000 people per 1 km^2.

1.1.2 Employment

Working age population more than 15 years old in DKI Jakarta is shown in the following table. Unemployment rate including applicant made up 40% of total population. Unemployment rate has been decreasing over 5 (five) years.

Table 1.1-3 Employment in DKI Jakarta

項　目	2004	2005	2006	2007	2008
Person with a job (a)	3,497,359	3,565,331	3,531,799	3,842,944	4,191,966
Applicant for a job(b)	602,741	615,917	590,022	552,380	580,511
Jobless people (c)	2,520,129	2,447,567	2,449,913	2,371,699	2,176,604
Unemployment Rate ((b+c)/d,%)	47.1	46.2	46.2	43.2	39.7
Total (d)	6,620,229	6,628,816	6,571,734	6,766,923	6,949,081

Source: Sakernas (2008)

Of this working age population more than 15 years old in DKI Jakarta, number of working population by gender and occupation is shown in the following table. As population by occupation, warehousing (37%) is rank at top with ratio of 37%, followed by other services (24%), and industry (16%).

Table 1.1-4 Working Age Population by Gender and Occupation in DKI Jakarta

Occupation	Male	Female	Total & Ratio (%)	
1) Agriculture	15,171	4,497	19,668	(0.5)
2) Mining	11,128	2,366	13,484	(0.2)
3) Industry	414,884	260,065	674,949	(16.1)
4) Electricity, Gas, Water Supply	12,093	1,645	13,738	(0.2)
5) Building, Hotel	162,736	15,932	178,668	(4.3)
6) Warehousing	862,170	693,636	1,565,806	(37.4)
7) Communication, Finance, Bank	351,405	65,274	416,679	(9.9)
8) Office Services	198,026	103,467	301,493	(7.2)
9) Other Services	504,760	512,711	1,017,471	(24.3)
Total	2,532,373	1,659,593	4,191,966	(100.0)

Source: Sakernas (2008)

1.1.3 Poverty Rate

Although the poverty line in DKI Jakarta varies by at different periods, it was set at Rp. 197,000 (person/month) in 2004, and it became Rp. 298,000 (person/month) in 2008. Although the population which is less than a poverty line fell temporarily in 2007, it increased again in 2008.

Table 1.1-5 Poverty Line and Poverty Rate in DKI Jakarta

Items	2004	2005	2006	2007	2008
Poverty Line (Rp/person/month)	197,306	237,736	250,298	237,735	298,237
Poverty Ratio (%)	3.18	3.61	4.57	3.61	3.86

Source: DKI Jakarta 2009 (BPS)

1.2 Economic Activities

1.2.1 Gross Domestic Product

The Gross Domestic Product (GDP) of three provinces including DKI Jakarta is shown in the following table. According to the table, GDP of three provinces amounts to 746 trillion in Rupiah as of 2009, and the average growth rate from 2005 to 2009 has become 5.9 %. GDP of Jabodetabekpunjur area reaches at 538 trillion in Rupiah and the average growth rate has become 6.4% exceeding 3 provinces averages.

Table 1.2-1 Gross Domestic Product in 3 Provinces and Jabodetabekpunjur Area

(Unit: Billion Rp.)

Province/Area	2005	2006	2007	2008	2009	G. Rate (%)
Jabodetabekpunjur	419,749	446,623	475,219	505,645	538,019	6.4
DKI Jakarta	295,271	312,827	332,971	353,694	371,399	5.9
Jawa Barat	242,884	257,499	274,180	290,180	302,630	5.7
Banten	58,107	61,342	65,047	68,803	72,031	5.5
Total (3 Provinces)	596,262	631,668	672,198	712,677	746,060	5.8
Indonesia	1,750,815	1,847,127	1,964,327	2,082,316	2,176,976	5.6

Source: BPS (2009)

GDP of every province and city which constitute Jabodetabekpunjur area is shown in the following table. The city whose GDP is the largest is Central Jakarta (Jakarta Pusat) with 91 trillion in Rupiah (percentage of 18%). Concerning the annual growth rate, Bogor Regency (Kab. Bogor) shows with 8 % of growth rate and Tangerang City (Kota Tangerang) shows with more than 7 % exceeding an average growth rate of Jabodetabekpunjur area.

Table 1.2-2 Gross Domestic Products for each City/Regency

(Unit: Billion Rp.)

Regency/City	GDP(Million, Rp.)	Percentage (%)	G. Rate (%)
1.Kota Jakarta Selatan	78,997,463	15.6	6.30
2.Kota Jakarta Timur	60,123,980	11.9	5.99
3.Kota Jakarta Pusat	**91,228,665**	**18.0**	**6.29**
4.Kota Jakarta Barat	52,735,542	10.4	6.09
5.Kota Jakarta Utara	66,535,641	13.2	6.02
6.Kab. Bogor	29,720,902	5.9	**8.10**
7. Kab. Cianjur	7,639,658	1.5	3.85
8. Kab. Bekasi	49,302,485	9.8	7.28
9. Kota Bogor	4,252,822	0.8	6.04
10. Kota Bekasi	14,042,404	2.8	6.17
11. Kota Depok	5,770,828	1.1	6.77
12. Kab. Tangerang	19,227,166	3.8	5.91
13. Kota Tangerang	26,066,993	5.2	**7.45**
Jabodetabekpunjur	**505,644,549**	**100**	**6.40**

Source: Provincial GDP (2005-2009, BPS)

1.3 Spatial Plan and Land Use

1.3.1 Space Utilization Pattern in Jabodetabekpunjur Area

According to Presidential Regulation No.54/2008 on Spatial Utilization Pattern for Jabodetabekpunjur Area, lands in the area shall be divided into several zones shown below. Based on the space utilization pattern, cultivation-1 zone including the urban high-density housing as well as trading and service occupies the rate of 21%, whereas cultivation -2 zone including low rural residential housing occupies 15%, and cultivation-4 zone including agricultural area and plantation occupies 41%.

Table 1.3-1 Zoning for Space Utilization Pattern in Jabodetabekpunjur Area

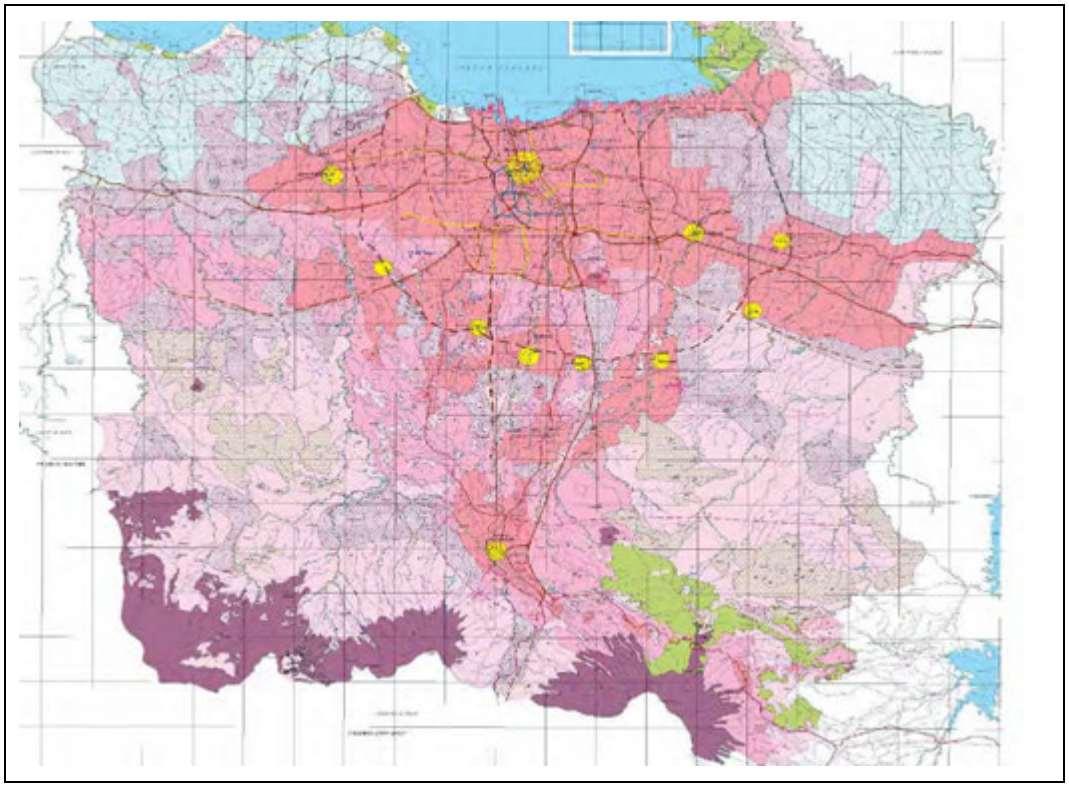
Code	Zoning	Area (Ha)	Percentage (%)	Explanation
B-1	Cultivation-1	132,886.3	19.64	a. High-density housing (urban) b. Trading and services c. Non-pollutant light industry and market-oriented
B-2	Cultivation-2	102,513.5	15.15	a. Low residential housing (rural) b. Agricultural / field c. Labor-oriented industries
B-3	Cultivation-3	41,370.6	6.11	a. Low residential housing (rural) b. Agricultural / field
B-4	Cultivation-4	283,242.1	41.85	a. Low residential housing (rural) b. Agriculture wetland/ upland crop c. Plantation, fishery, livestock, agro-industry
B-5	Cultivation-5	69,480.5	10.27	a. Agriculture (irrigation technical)
(N1)	Protected Areas	29,261.2	4.32	a. Not permitted for cultivation activities b. Functioned as a safety area of the elements of geography and ecosystems c. Cultivation activities that have already, in the long term should be excluded from this zone d. Protected forest e. Tourism forest f. Forest research g. Forest wildlife reserve h. Marine national parks
(N2)	Nature reserves / Cultural area / Historical area	18,025.3	2.66	a. Not permitted for cultivation activities b. Demarcation of forest rivers, lakes, seas and steep slopes c. Forest protection of water agency d. Limited arable crops (annual) with the type of commodity in accordance with safety function e. Preservation and conservation areas
	National Activity Center			Region urban center to serve the activities of international scale, national, or several provinces.
Total		656,879.5	100	

Source: RTRW Jabodetabekpunjur

Based on the legend shown in above, Space Utilization pattern in Jabodetabekpunjur is shown in Figure. According to the pattern, the northern part of the zone serves as a high-density housing (B-1), and the low layer residential area (B-2) spreads out in the outer edge of B-1 area. The National Activity Centers (NAC) which play a role as central core in the area are designated in Seropong, Depok, Cimanggi, Bekasi located along Inner Ring Road and Outer Ring Road with a central focusing on MONAS (Independent Commemoration Tower). Bogor is also positioned as one of the NAC.

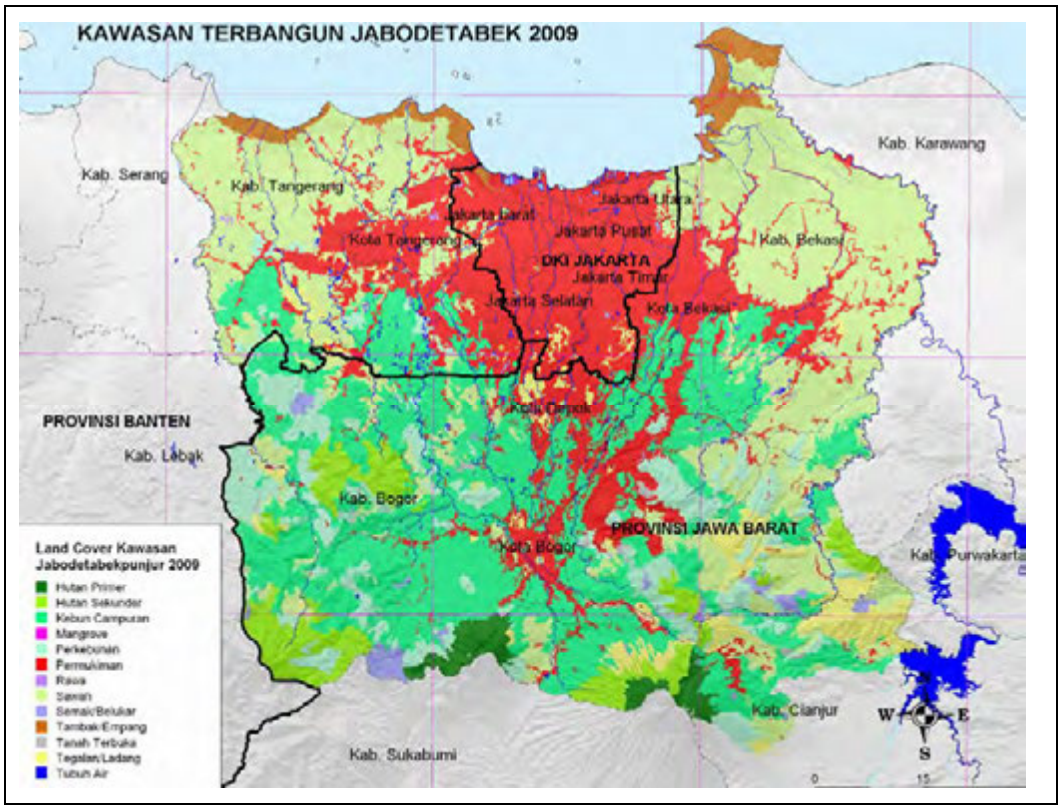
1.3.2 Land Use in Jabodetabekpunjur Area

Land use condition (2009) in Jabodetabekpunjur area including the Ciliwung River Basin is shown in th following figure. The urban area spreads out to almost whole the areas of DKI Jakarta, and reaches to the Tangerang City, the Depok City and Bekasi City. Forest area exists in southern part.



Source: RTRW Jabodetabekpunjur

Figure 1.3-1 Zoning for Space Utilization Pattern in Jabodetabekpunjur Area



Source: Environment Ministry Analysis

Figure 1.3-2 Land Use in 2009 in Jabodetabekpunjur Area

1.4 Land Transportation System

1.4.1 Road System in DKI Jakarta

Inner Ring Road and the Outer Ring Road are major roads consisting of road system in DKI Jakarta. According to the data in 2008, the total length of the road reaches 6,543 km, the secondary roads (state highways) and the regional roads occupy 96% of these, while toll roads (highways) with the length of 113 km and primary roads (national road) with the length of 164km occupy 4%.

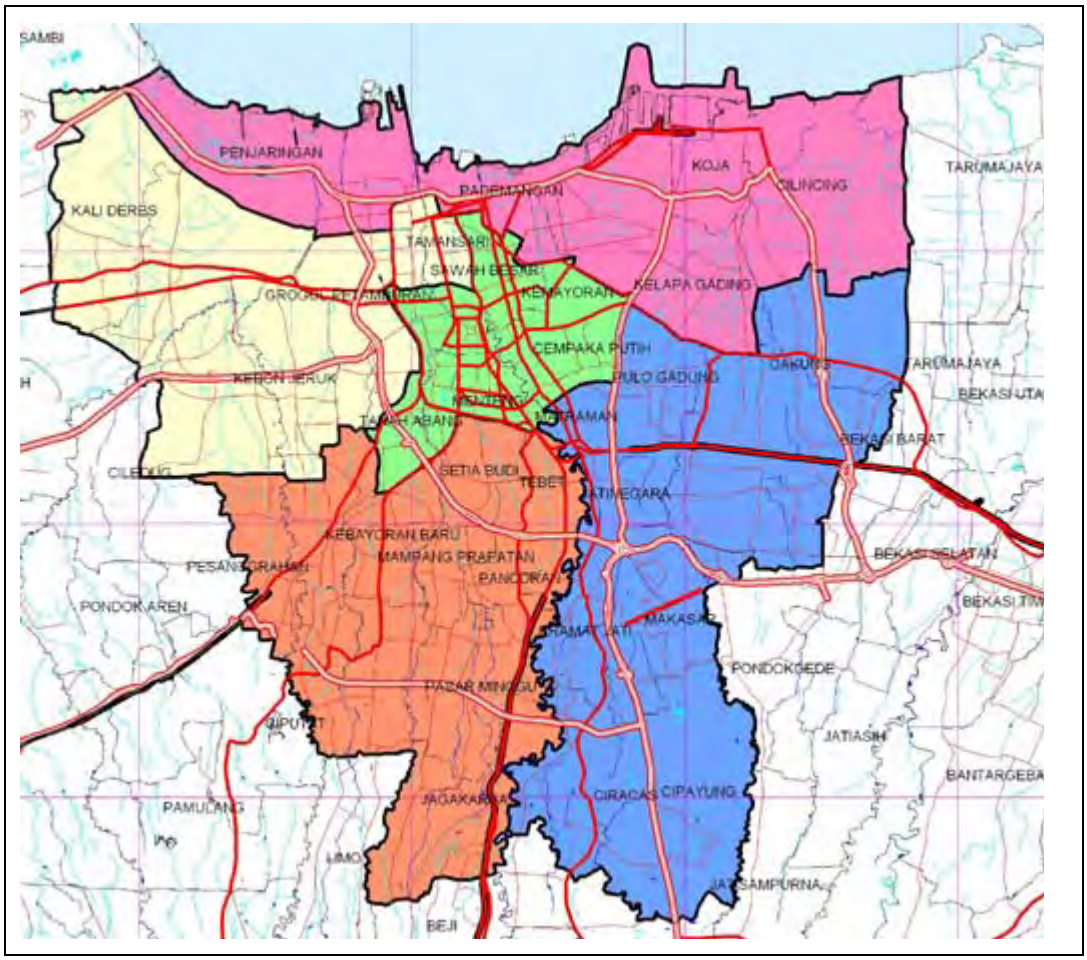


Figure 1.4-1 Roads System in DKI Jakarta

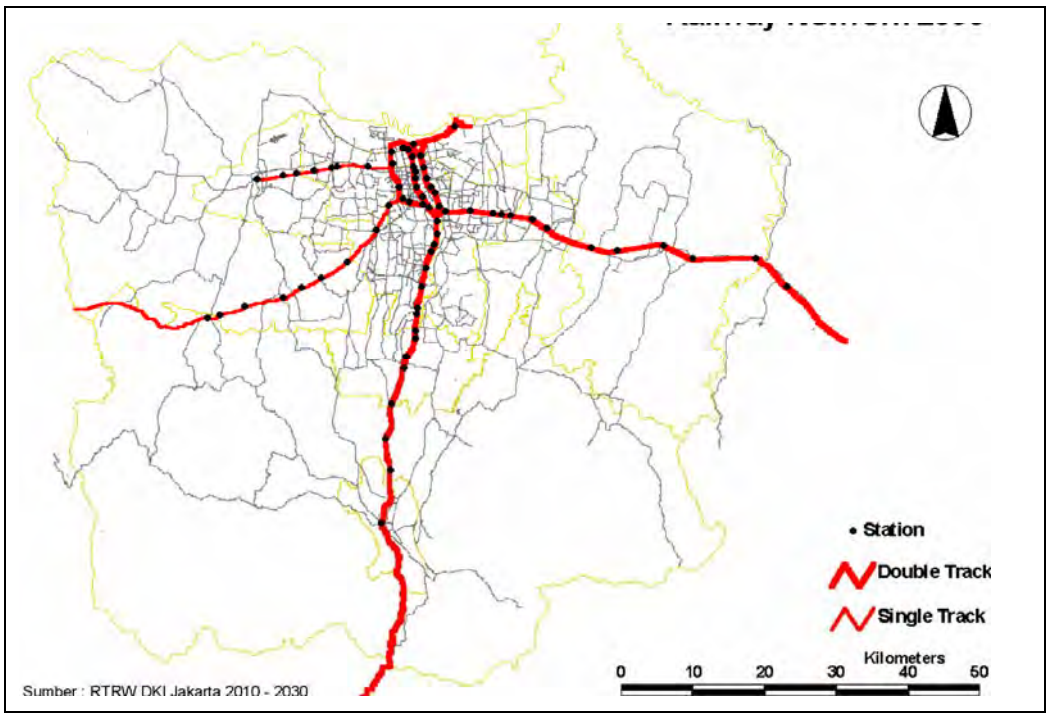
Table 1.4-1 Roads Classification and its Length

Classification	Length (Km)	Ratio (%)	Operation & Maintenance
1) Toll Road	113.0	1.7	Jasa Marga & Private Company
2) Primary Road	163.8	2.5	Central Government
3) Secondary Road	1,330.3	20.4	Provincial Government
4) Local Road	4,937.0	75.4	City Government
Total	6,544.1	100	-

Source: BPS (2008)

1.4.2 Railway System

The railway system centering on DKI Jakarta has seven lines, and the total extension is 160 km. The number of passengers in main areas is shown in the following table.



Source : RTRW DKI Jakarta

Figure 1.4-2 Railway System in Jabodetabekpunjur Area

Table 1.4-2 Number of Passengers in and around DKI Jakarta

Classification	1996	1997	1998	2000
1) DKI Jakarta	73,251	87,918	95,661	91,600
2) DKI-Botabek	169,963	196,873	240,195	290,095
3) Botabek-Botabek	17.170	19,723	22,749	40,546
Total	260,384	304,514	358,605	422,241

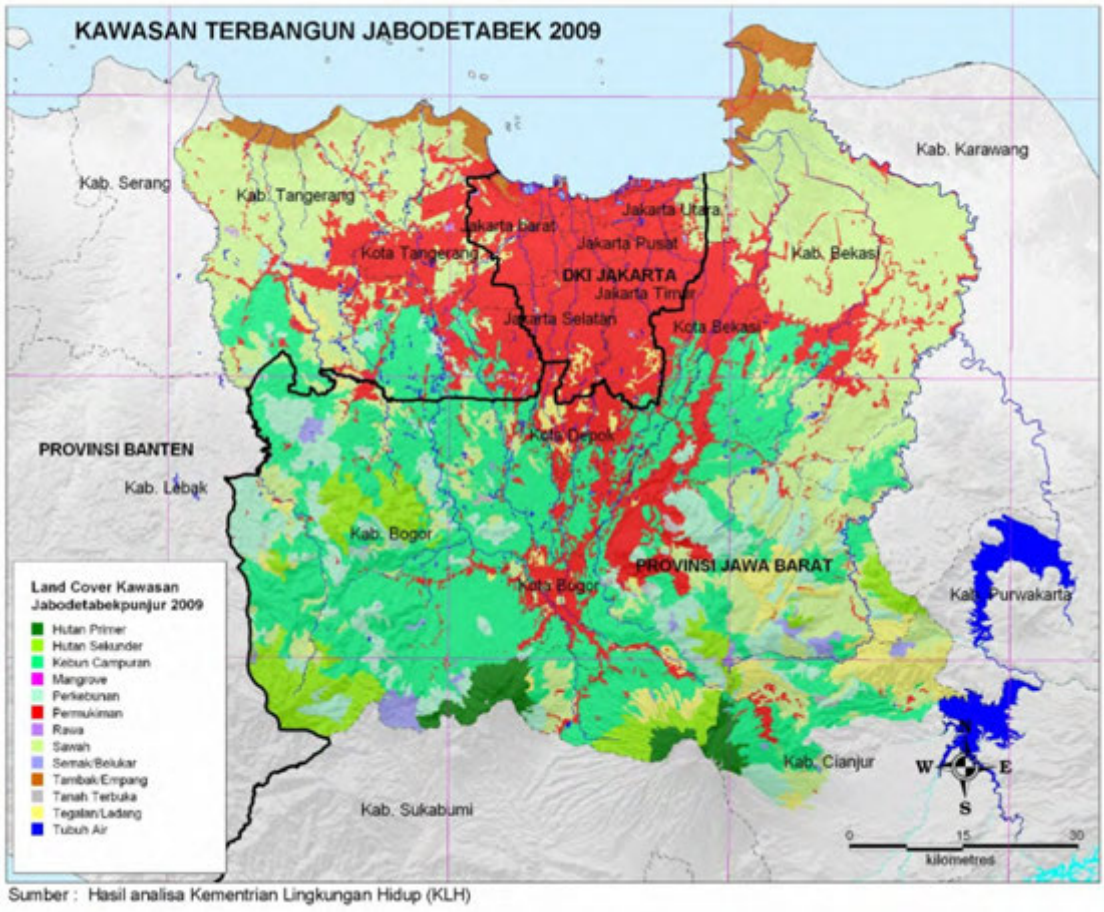
Source: ATLAS (Draft, 2011)

CHAPTER 2 ANALYSIS FOR DEVELOPMENT AND FUTURE PLAN

The changes in development from the past to the present were grasped focusing on distribution of urbanized areas (built-up areas) and changes in population. Spatial plan and projected population in the Ciliwung River Basin for the target Year of 2030 were summarized as follows.

2.1 Changes in Land Use

The following figure shows land use as of 2009 based on the land cover map in Jabodetabek area. Areas in the red color are urbanized areas. The urbanized areas have spread across DKI Jakarta and even Bekasi City located in the east of DKI Jakarta as well as Tangerang City located in the west, and the Depok City located in the south. The urbanized areas are also developed along the road which connecting Bekasi City and Bogor City.

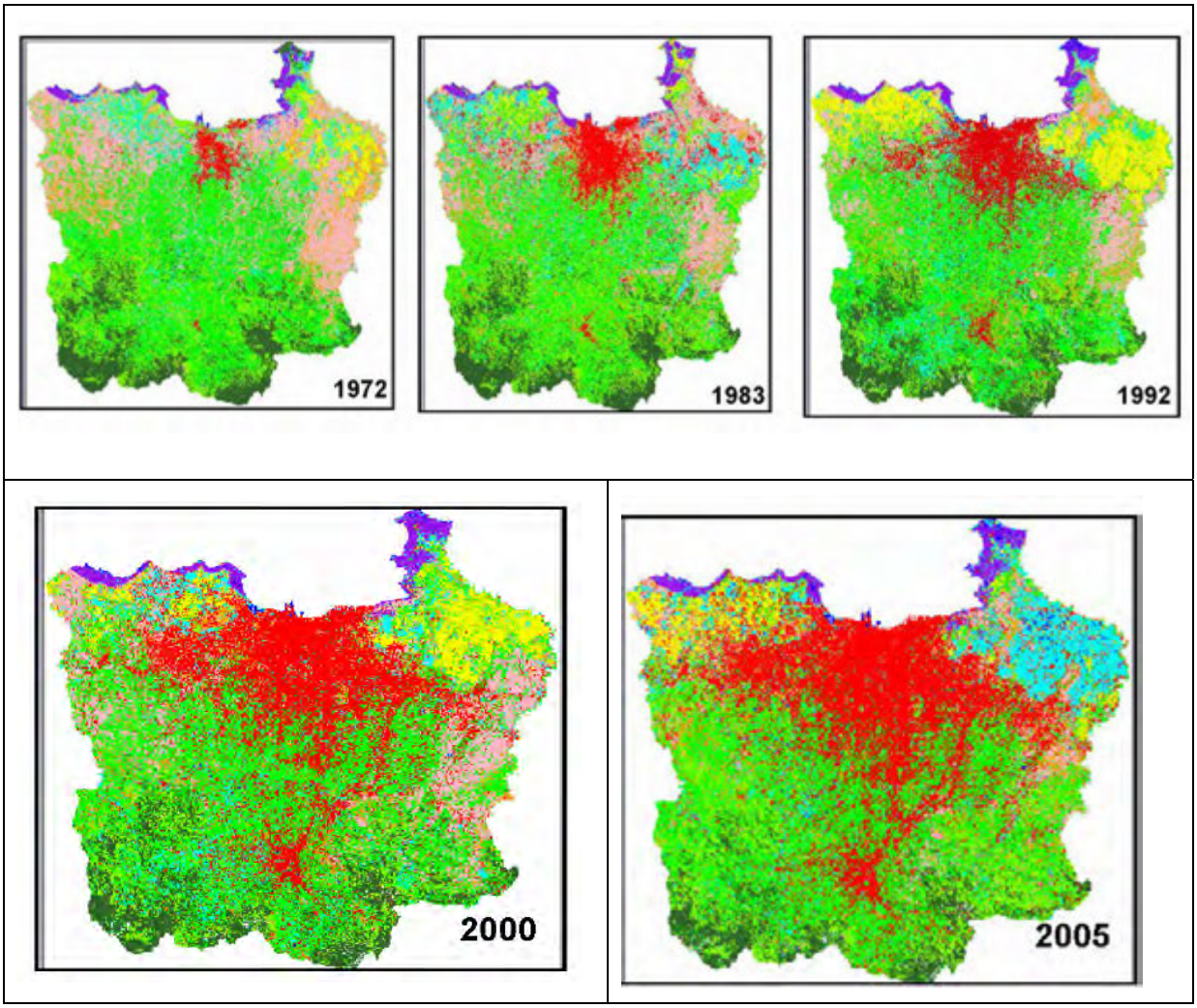


Sumber : Hasil analisa Kementrian Lingkungan Hidup (KLH)

Source : Analysis results by Environment Ministry

Figure 2.1-1 Land Use in Jabodetabek Area (2009)

The following figure shows the changes in land use in Jabodetabek area from 1972 to 2005. According to the figures, distribution of the urbanized area remains in DKI Jakarta until 1983, while the tendency which the urbanized areas expanded in the direction of east and west and the direction of a southern part of Jakarta has begun in 1992. The expansion tendency of the urbanized area in 2005 and afterwards is the almost same tendency as the present tendency, and showing spread to the outer edge of the area. Especially in 2005 and afterwards, the tendency of expansion in Depok City and Bogor City has been remarkable.



Source : Working Group LUCC P4W IPB

Figure 2.1-2 Changes in Land Use in Jabodetabek Area (1972-2005)

Based on the changes in land use, paying attention to the expansion of urbanized areas from 1972 to 2009, total area of urbanized area in Jabodetabek area and that in the Ciliwung River Basin are summarized as follows.

Table 2.1-1 Urbanized Areas in Jabodetabek Area and the Ciliwung River Basin (ha)

Year	Jabodetabek (1972:100)	Ciliwung River Basin in Jabodetabek (1972:100)
1972	11,414 (100)	6,551 (100)
1983	31,734 (278)	10,858 (166)
1991	50,151 (439)	13,316 (203)
2000	101,094 (886)	19,161 (292)
2005	136,987 (1200)	24,401 (372)
2009	150,522 (1319)	26,686 (407)

Source: Study Team Calculation based on the GIS Data

Also, changes in land use in Jabodetabekpunjur area in 2000 and 2010 are summarized as follows based on the draft “POLA 6 Ci’s (2011)”.

Table 2.1-2 Land Use in 2000 and 2010 in Jabodetabekpunjur Area (ha)

Land Use Type	Year 2000	Year 2010	Area Changed (%)
1) Vacant land	1,400	705	-695 (50.3%)
2) Plantation	49,238	30,982	-18,256 (62.9%)
3) Grass	2,420	1,573	-847 (65.0%)
4) Bush	89,412	61,055	-28,357 (68.3%)
5) Forest	103,417	92,079	-11,338 (89.0%)
6) Swamp	102	57	-45 (55.9%)
7) Mangrove	0	0	0 (-)
8) Water	3,061	3,061	0 (-)
9) Settlement	161,728	229.834	68,106 (142.1%)
10) Other buildings	27,545	34,221	6,676 (124.2%)
11) Rice field	58,771	43,527	-15,244 (74.1%)
Total	497,094	497,094	0 (-)

Source : Draft POLA 6 Ci's (2011)

According to the table, settlement area has increased in 68,100 ha (increase rate in 42%) and other buildings area has increased in 6,700 ha (+24%), while plantation area and bush area have decreased in 28,400 ha (-32%) and 18,200 ha (-37%), respectively. Area of paddy field has served as reduction of 15,200 ha (-26%) and area of forest has also served as reduction of 11,300 ha (-11%). Based on the above table, settlement area and other building area are, those can be categorized as urbanized area, was extracted as follows. The urbanized area rate shows 38% in 2000 and 53% in 2010.

Table 2.1-3 Urbanized Area in Jabodetabekpunjur Area (ha)

Land Use Type	Year 2000	Year 2010
Urbanized Area (A)	189,273	264,055
1)Settlement	161,728	229.834
2)Other buildings	27,545	34,221
Total Area (B)	497,094	497,094
Urbanized Area Rate (A/B,%)	38.1	53.1

Source: JICA Project Team

Moreover, in order to grasp the green space rate, forest area was summarized as follows. Green space rate indicates 21% in 2000 and 19% in 2010.

Table 2.1-4 Green Space Area in Jabodetabekpunjur (ha)

Land Use Type	Year 2000	Year 2010
Forest (A)	103,417	92,079
Total **Area (B)**	497,094	497,094
Green Space Rate (A/B,%)	20.8	18.5

2.2 Changes in Population

Based on population data in Central Statistical Bureau (BPS in Indonesian), the tendency on changes in population from 1971 to 2010 in three provinces was summarized as follows.

Table 2.2-1 Changes in Population in Three Provinces

Year	DKI Jakarta (1971:100%)	Jawa Barat Province (1971:100%)	Banten Province (2000:100%)
1971	4,570,303 (100)	21,623,529 (100)	-
1980	6,503,449 (142)	27,453,525 (127)	-
1990	8,259,266 (181)	35,383,352 (164)	-
1995	9,112,652 (199)	39,206,787 (181)	-
2000	8,389,443 (184)	35,729,537 (165)	8,098,780(100)
2010	9,607,787 (210)	43,053,732 (199)	10,632,166(131)

Source: BPS web site

In DKI Jakarta, population of 4,570,000 in 1971 increased up to 9,670,000 and 2.1 times in 2010. In West Java Province, population of 22 million in 1971 increased up to 43 million and twice in 2010. Changes in population over 10 years starting in 2000 in Jabodetabekpunjur area are shown in the following table.

Table 2.2-2 Changes in Population in Jabodetabekpunjur Area

Province/Regency/City	2000	2008	2010	Annual Growth Rate
DKI Jakarta	**7,798,679**	**7,520,801**	**9,567,127**	**2.06 %**
JKT Barat	1,531,636	1,567,991	2,278,825	4.05
JKT Pusat	1,107,306	813,541	898,883	-2.06
JKT Selatan	1,956,491	1,742,820	2,057,080	0.50
JKT Timur	2,029,413	2,171,940	2,687,027	2.85
JKT Utara	1,173,833	1,224,500	1,645,312	3.43
Banten	**3,552,723**	**793,014**	**5,939,876**	**5.27%**
Kab. Tangerang	2,326,985	533,636	2,838,592	2.0
Kota Tangerang	1,225,738	259,378	1,797,715	3.9
Kota Tangeranr Selatan	-	-	1,303,569	-
Jawa Barat	**9,298,777**	**12,365,120**	**14,583,394**	**4.60%**
Kab. Bekasi	1,330,389	2,117,000	2,629,551	**7.05**
Kab. Bogor	3,059,547	4,219,324	4,763,209	4.53
Kab. Cianjur	1,960,183	2,140,339	2,168,514	1.02
Kota Bekasi	1,294,258	1,807,740	2,336,489	**6.09**
Kota Bogor	691,421	850,868	949,066	3.22
Kota Depok	962,979	1,235,849	1,736,565	**6.07**
Jabodetabekpunjur	**20,650,179**	**24,684,976**	**30,090,397**	**3.84**

Source: ATLAS (p-2-6)

From the above table, the annual growth rate of population in Jabodetabekpunjur area is 3.84% on average. The Regencies (Kabupaten) and Cities (Kota) exceeding this growth rate (3.84%) are Jakarta Barat in DKI Jakarta, Kota Tangerang in Banten Province, Bekasi Regency, Bogor Regency, Bekasi City and Depok City in West Java Province. Growth Rate of Depok City located in south of DKI Jakarta and Bekasi City as well as Bekasi Regency located in the east of DKI Jakarta shows remarkable increasing with the rate over 6% among regencies and cities.

2.3 Large-scale Development Project

Large-scale development projects in coastal area of DKI Jakarta are shown below. Although Northern Jakarta Bay Reclamation Plan started in 1995 and 1997, the implementation was interrupted because of monetary crisis, and then in 2005, the implementation started again but interrupted by the enforcement of new law. This plan resumed in 2008 in accordance with the Presidential Decree No. 54, and it aims at providing value-added structuring in the North Coast Area in Jakarta. Reclamation area can be done with the depth of -8 feet below the sea level and area of 2,700 ha.

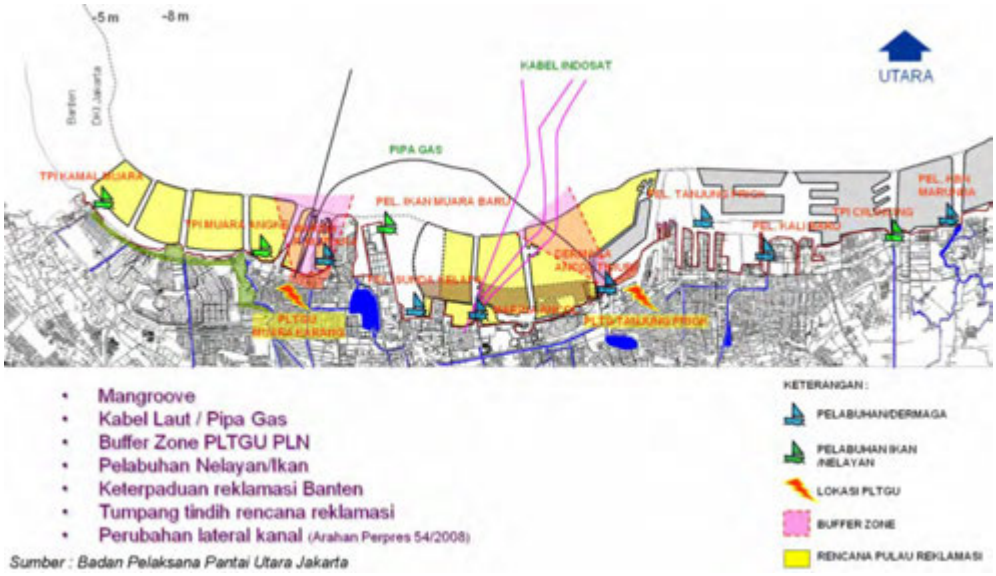


Figure 2.3-1 Northern Jakarta Bay Reclamation Plan (Spatial Plan 2010-2030)

According to the spatial plan (2010-2030), the western part in the above-mentioned project area is also planned to implement the northern coast Jakarta reclamation plan.

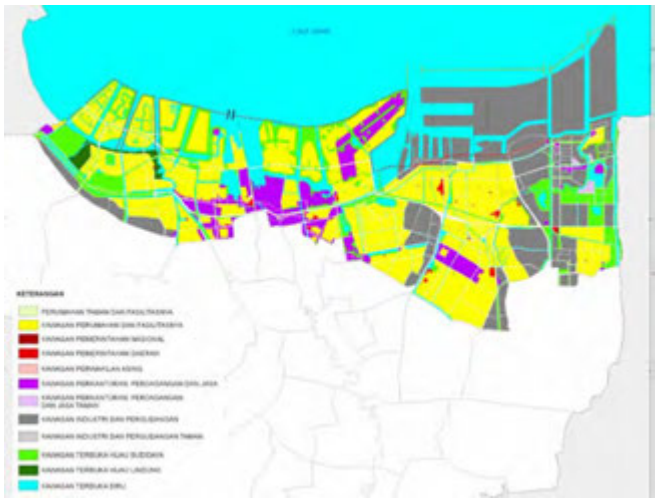


Figure 2.3-2 Northern Coast Jakarta Reclamation Plan (Spatial Plan 2010-2030)

2.4 Analysis on Condition of Development

2.4.1 Comparison of Land Use between 2030 and 2010

Since every local government in the Ciliwung River Basin, namely DKI Jakarta, Depok City, Bogor Regency and Bogor City, use different land use classification, the JCFM Project set the following unified land use classification in order to summarize land use condition in the whole Ciliwung River Basin.

Table 2.4-1 Unified Legend for Land Use in the Ciliwung River Basin

No.	Color of Legend	Description in English	Description in Indonesian
1		Forest	Hutan
2		Upland Crops	Datran Tnnggi Tanaman
3		Paddy Field	Sawah
4		Water	Tubur Air
5		Urban Area	Daerah Perkotaan
6		Settlement	Pumukiman
7		Road, Railway	Jalan, Jalan Kreta Api
8		Open space	Terbuka Ruang

Original land use classification in every local government is shown as follows.

Table 2.4-2 Land Use Classification in Every Local Government and Unified Legend

Color	Land Use	DKI Jakarta	Depok City	Bogor City	Bogor Regency
1	**Forest**	-	Forest	City Forest	Conservation Forest, Protected Forest, Production Forest, Limited Production Forest
2	**Upland Crop**	-	Other Agriculture, Slaughterhouses		Dry land Agriculture, Plantation, Annual Plant
3	**Paddy Field**	-	Paddy Field, **Wetland Agriculture**	-	Wetland Agriculture
4	**Water**	Pond, Reservoir, Blue Open Area, River, Water Channel, Lake	River, Lake/Situ, Fish Pond	Lake, Main River	River, Reservoir, leke
5	**Urban**	Horizontal Housing and Its Facilities, Vertical Housing and Its Facilities, Housing with Protection Function and Its Facilities, Industry and Warehouse Area, Low Density Industry and Warehouse Area, National Government Area, Office, Commerce and Service Area, Office, Commerce and Service with protected function, Foreign Representative Area, Residence with protected Function	Commerce and City Sub-center, Commerce and Culture Center, High Density Housing (KDB 60%-70%),Particular Area , Higher Education Area, Industry, Industry and Service (Plan), Medium Density Housing (KDB 45%-60%), Office and Public Service, Public Works, Service, Commerce, and City Center	City Infrastructure, Commerce, Educational Facilities, Government, Health Facilities, Medium Density Housing, High Density Housing, Industry, Military, Public Facilities, Recreational and Sport Facilities, Service, Worship Facilities	Industry, Industrial Zone
6	**Settlement**	-	Low Density Housing (KDB 35%-45%), Very Low Density Housing (KDB <35%)	Low Density Housing	**Urban Housing (High Density), Urban Housing (Medium Density),**Urban Housing (Low Density), Rural Housing (Low), Rural Housing (Very Low)
7	**Road**	Road, Railway	Road, Road Plan, Toll Road	Primary Artery Road, Primary Collector Road, Primary Collector Road (Plan), Primary Local Road, Secondary Artery Road, Secondary Artery Road (Plan), Secondary Collector Road,	Railway, Road (Plan), Road
8	**Open Space**	Green Open Area, Protected Green Open Area	Landfill, Boundary of lake/Situ,Boundary of River, Golf Field,	Green Open Space, TPU	-

Current land use in 2008 and land use plan in 2030 based on the above-mentioned classification are shown below.

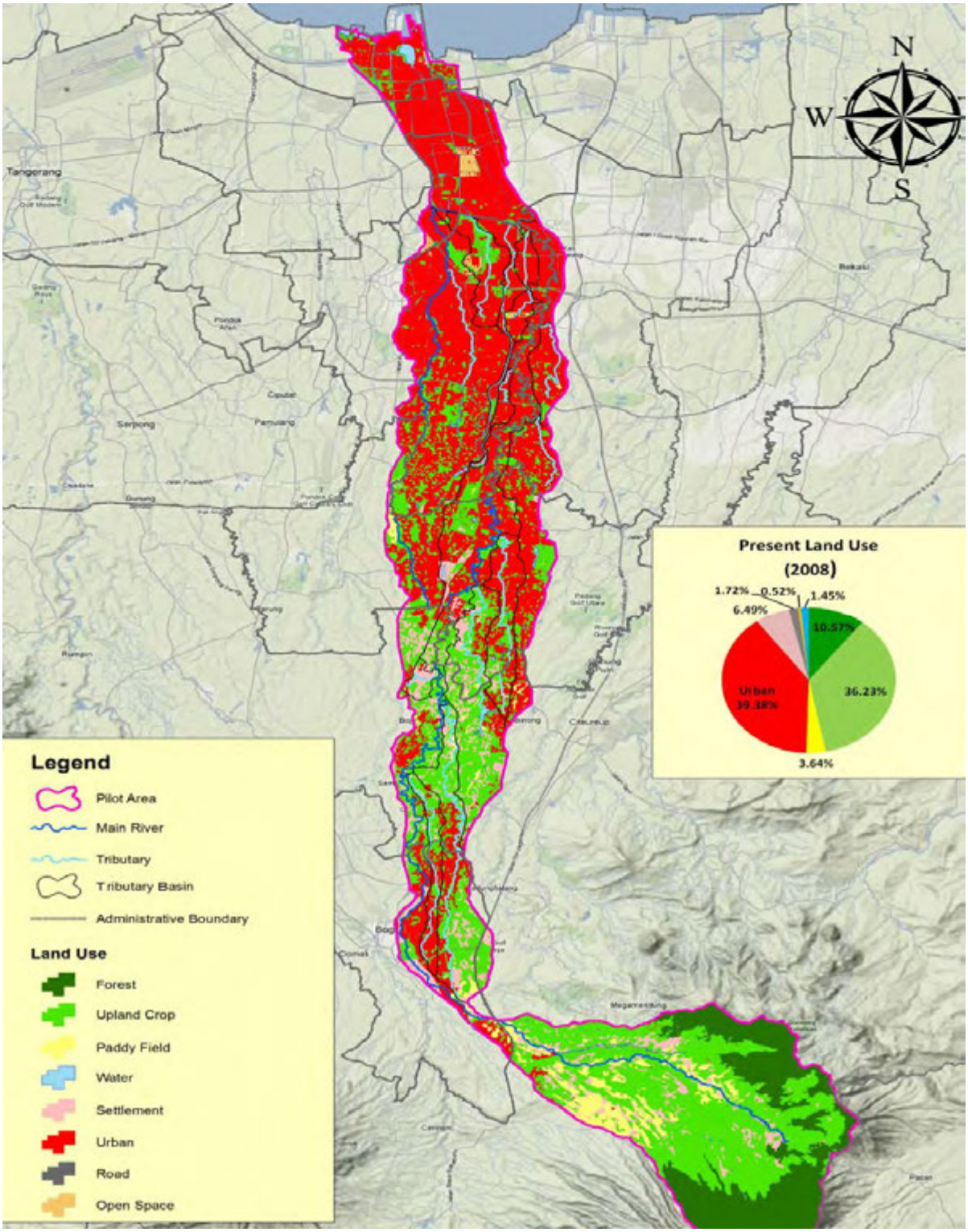


Figure 2.4-1 Current Land Use in the Ciliwung River Basin (2008)

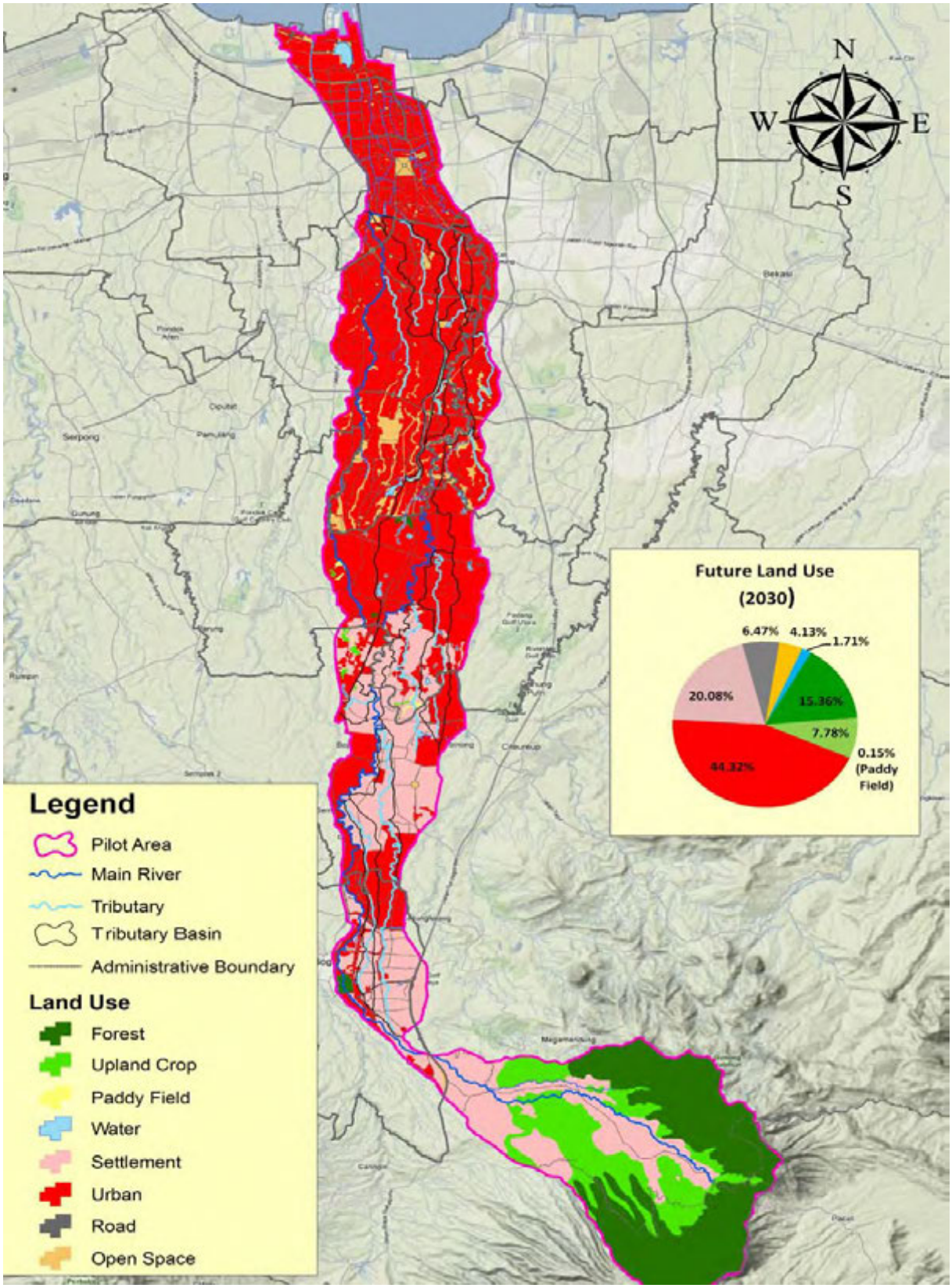


Figure 2.4-2 Land Use Plan for 2030 in the Ciliwung River Basin

The ratio of every land use category in the Ciliwung River Basin in 2008 and 2030 is shown below.

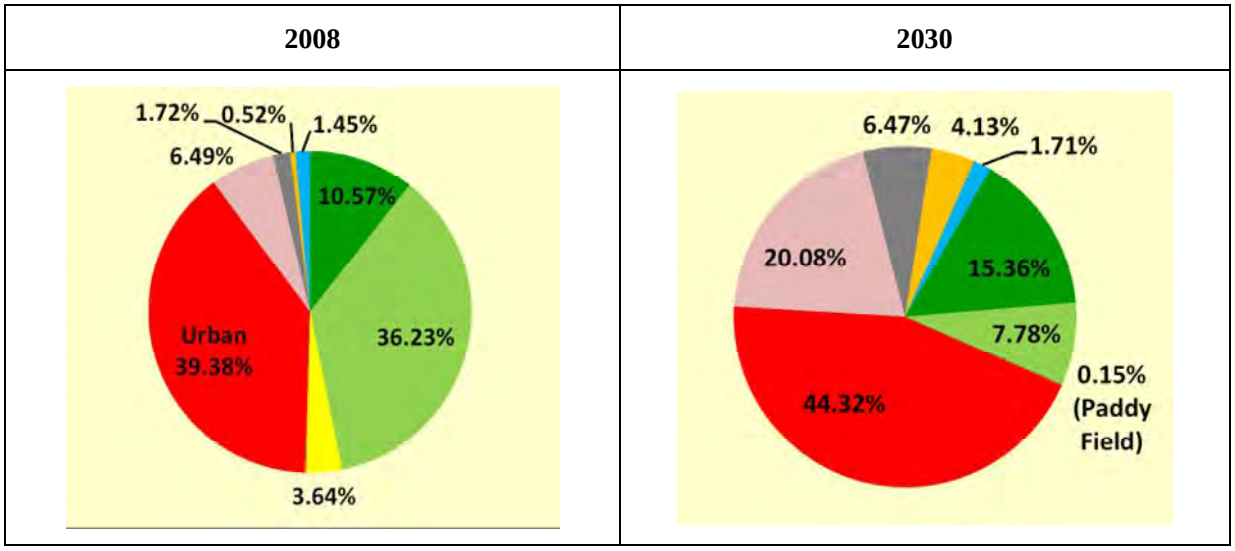


Figure 2.4-3 Comparison of Current Land Use (2008) and Land Use Plan (2030)

Table 2.4-3 Percentage of Land Use in 2008 and 2030

Color of Legend	Land Use	2008	2030	Increasing/Decreasing
	Forest	10.57 %	15.36 %	1.453
	Upland Crops	36.23	7.78	0.213
	Paddy Field	3.64	0.15	0.041
	Water	1.45	1.71	1.179
	Urban Area	39.38	44.32	1.125
	Settlement	6.49	20.08	3.094
	Road, Railway	1.72	6.47	3.762
	Open Space	0.52	4.13	7.942
Total		100	100	1.000

Note: Total Area of Ciliwung (485.13 km^2)

According to the above table, comparing with 2008 and 2030, upland crops and paddy field decrease in 2030, while settlement and open space increase. There are no big changes for water body and urban area. As for the major land use in 2030, the upper part of the basin will be planned mainly for forest area and upland crops area, while the middle part of the basin will be utilized as settlement area, and the downstream part of the basin will be mainly utilized as urban area.

2.4.2 Population Changes between 2030 and 2010

Based on the Regional Development Planning Agency (BAPPEDA) in DKI Jakarta and ATLAS (Draft) prepared by Jakarta Coastal Defense Strategy project (JCDS), projected population as of 2030 in related regencies/cities located in the Ciliwung River Basin was summarized as follows.

Table 2.4-4 Population Projection for the Year of 2030

Regency/City	Year 2010 (A)	Year 2030 (B)	Increase Rate (B/A)
DKI Jakarta	9,718,296	12,665,282	1.303
Kab. Bogor	4,763,209	5,337,696	1.121
Kota Depok	1,736,565	1,942,164	1.128
Kota Bogor	949,066	1,039,850	1.096
Total	17,167,136	20,984,992	1.222

Source: DKI Jakarta & ATLAS (Draft, p-2-7) except for DKI Jakarta

On the basis of the result of population projection and the increase rate shown in the above table, population projection for the Ciliwung River Basin in 2030 was calculated as shown below. Population in the Ciliwung River Basin was estimated at 4.4 million as of 2010, and it may increase up to 5.4 million in 2030.

Table 2.4-5 Population Projection in the Ciliwung River Basin (2030)

Regency/City	Year 2010 (A)	Year 2030 (B)	Increase Rate (B/A)
DKI Jakarta	9,718,296	12,665,282	1.303
Ciliwung Basin	**2,744,335**	**3,575,869**	
Kab. Bogor	4,763,209	5,337,696	1.121
Ciliwung Basin	**537,244**	**602,251**	
Kota Depok	1,736,565	1,942,164	1.128
Ciliwung Basin	**844,251**	**943,873**	
Kota Bogor	949,066	1,039,850	1.096
Ciliwung Basin	**273,743**	**300,022**	
Total	17,167,136	20,984,992	1.222
Ciliwung Basin	**4,399,573**	**5,422,014**	**1.232**

Source: Calculation data based on the Table 6.4-4 by JICA Project Team

2.4.3 Changes in Land Use and Population between 2030 and 2010

Changes in land use and population in 2030 and 2010 can be summarized as follows.

(1) Land use

a) 39.4% (191 km^2) of the urbanized area in 2008 may increase up to 44.3% (215 km^2) in 2030.
b) Percentage of settlement may increase up to 20.1% (98 km^2) in 2030.
c) Percentage of the total of the urbanized area and settlement may reach 60 % of the whole area in 2030.
d) According to land use maps in 2030, although forest area remains in upstream of basin, almost all middle stream area of the basin (Bogor City - Depok City) may become urbanized area and settlement. Downstream area of the basin (Depok - DKI Jakarta) may become urbanized area.
e) Areas where secured for the comparatively large space as an open space in 2030 in downstream area are MONAS, Ragunan Zoo, and right bank area of the Krukut River near Cipedak.

(2) Population

a) According to ATLAS (Draft), total population in DKI Jakarta, Bogor Regency, Depok City, and Bogor City is projected to be about 21 million in 2030.
b) On the basis of the result of population projection and the increase rate for each region/city, population of 4.4 million in the Ciliwung River Basin in 2010 may increase up to 5.4 million in 2030. This serves as about 1(one) million increase in population as compared with 2010.

2.5 Future Plan in the Ciliwung River Basin

On the basis of arrangement in land use and population, future plan in the Ciliwung River Basin is summarized and made comments as follows.

a. Urbanization rate based on land use

Urban area occupies 39% of the basin in 2008, and 44% in 2030. If settlement area and roads are

added to urban area and urbanization rate is calculated with these sum total rate, it is 48% as of 2008, while it is 71% as of 2030.

b. Future population

Future population in the Ciliwung River Basin may be 5.4 million in 2030 about 1 million increase in number compared with in 2010.

c. Large-scale development

Along the coastal area of DKI Jakarta at the north end of the Ciliwung River Basin, large-scale development and reclamation project is planned.

d. Areas to be preserved for open space

According to land use plan in 2030, open spaces are planned and secured in MONAS area, Ragunan Zoo area, and in Cipedak area located in the right bank of the Krukut River. Forest and upland crops will be planned in upper part of the basin.

CHAPTER 3 AREA CLASSIFICATION FOR FLOOD CONTROL PLAN

3.1 Area Classification in Consideration of Topographic Condition and Land Use

In accordance with the topographic conditions and inundation characteristic, the river basin area can be classified in to 3 categories: retention area, retarding area and lowland area. The followings are definitions for the categorized 3 areas.

Table 3.1-1 Area Classification in Consideration of Topographic Condition

Name of Area	Topographic Features	Description
a. Retention Area	・Upland or hilly area, plateau	Area where originally has function to retain the rainwater for a certain period
b. Retarding Area	・Low-lying area along rivers in upstream or mid-stream area	Low-lying area along the river which frequently suffers from the inundation and functions as retarding basin
c. Lowland Area	・Flat area	Flat area where rainwater tends to be maintained and difficult to be drained to the river

3.2 Area Classification in the Ciliwung River Basin

The JCFM Project classified the Ciliwung River Basin into the 3 kinds of areas in consideration of the topography and inundation characteristics. The flood mitigation measures except for the flood control measures in the river and runoff control measures in the basin are proposed as follows.

- Retention Area
  - Preservation of green space and agricultural area
- Retarding Area
  - Preservation of green space and agricultural area
  - Restriction of embankment
  - Dissemination of piloti type building
- Lowland Area
  - Dissemination of flood resistance building

For the further examination of flood disaster mitigation measures in each area, it will be required to classify the basin area based on large scale topographic map.

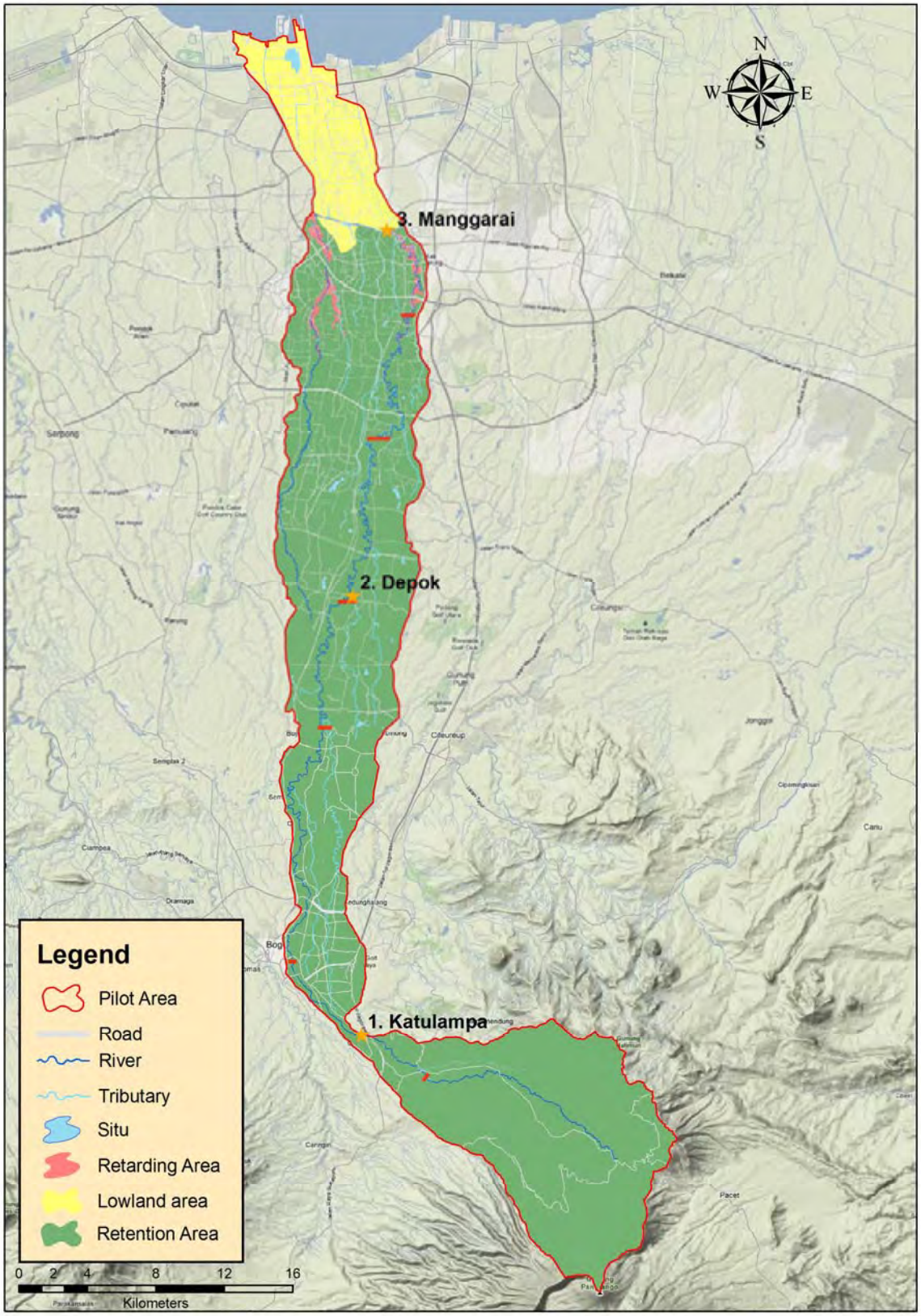


Figure 3.2-1 Area Classification in the Ciliwung River Basin

CHAPTER 4 FLOOD MANAGEMENT IN DEVELOPMENT PLAN AND SPATIAL PLAN

4.1 Development plan and Spatial Plan

4.1.1 National and Regional Development Plan

On-going system of national development plan was built up in accordance with the Law No.25/2004 on National Development Planning System which was established by the Yudhoyono Administration in 2004. The law requires that 20 years' long-term plan, 5 years' medium-term plan for 5 years and one-year short-term plan shall be prepared under the editorship of BAPPENAS.

The national long-term development plan defines a direction of vision, missions and policies on national development for 20 years, while the national medium-term development plan defines national development strategy, macroeconomic framework, and preferable measures and policies for 5 years in accordance with administrative policy of newly elected president within 3 months after the inauguration. The national medium-term development plan, which will be basis for strategic plans of ministries and government agencies, is formulated taking into account the consistency with the national long-term development plan. The national short-term development plan which establishes annual development priorities is formed on the basis of the national medium-term development plan.

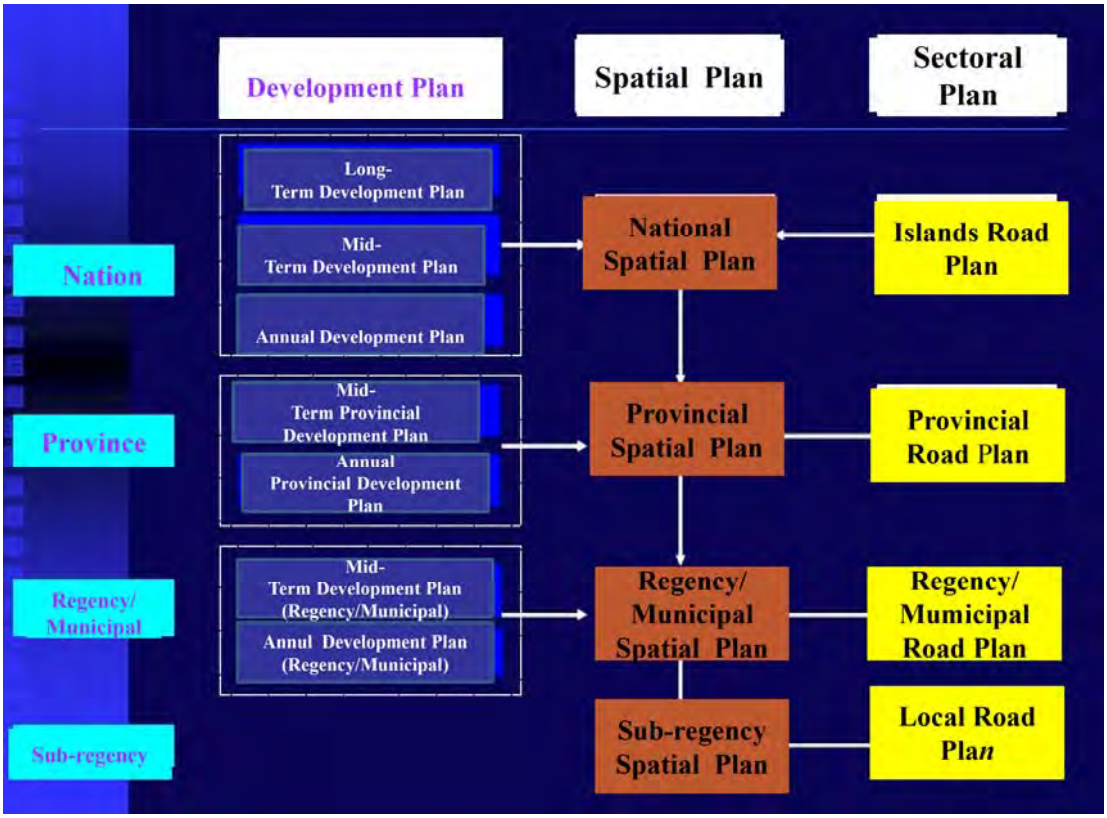
The regional development plans which are prepared under the editorship of BAPPEDA are also established as local regulation. As in the national medium-term development plan, a regional medium-term development plan defines preferable measures and policies for 5 years in accordance with administrative policy of newly elected head of local government.

Table 4.1-1 National Development System

Classification	Term for the Plan	Contents of the Plan
Long-term Plan	20 years	Visions, Missions and Policies
Medium-term Plan	5 years	Development strategies, macroeconomic frameworks and priority policies for 5 years
Short-term Plan	1 year	Annual development plan

4.1.2 Relationship between Development Plan and Spatial Plan

It is stipulated that a development plan and a spatial plan for one administrative body shall be established as mutually- referenced manner. As for a sectoral development plan such as roads and rivers, its development direction and policy are incorporated into spatial plan, while its specific plan/program is provided by sectoral master plan. The following figure shows the schematic diagram of relationship between development plan and spatial plan.



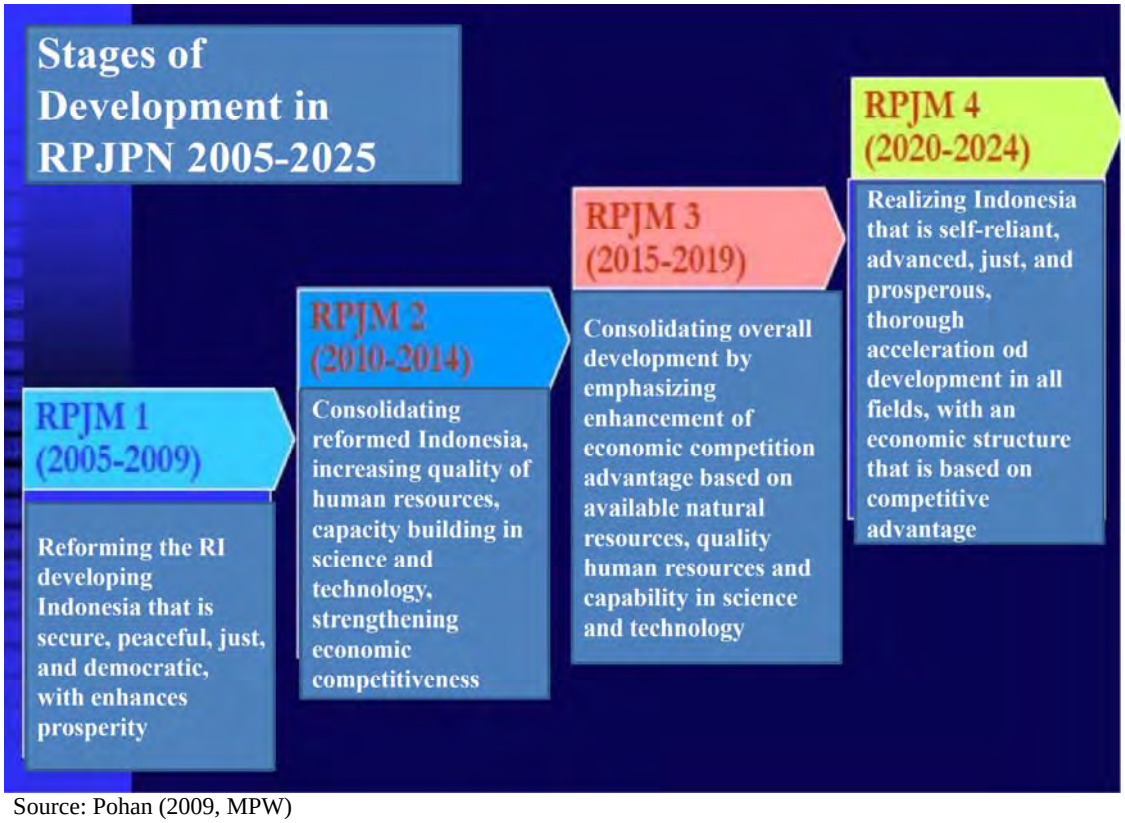
Source: Pohan (2009, MPW)

Figure 4.1-1 Relationship between Development Plan and Spatial Plan

4.1.3 National Development Plan

The Law No.17/2007 on 2005-2025 National Long-Term Development Plan describes the vision as follows; Indonesia that is self-reliant, advanced, just, and prosperous. The strategy to implement the vision and the missions is specified in five year stages into the Medium-Term Development Plans (RPJMs). Each of the stages has a scale of priorities and development strategy that constitute a continuity of scale of priorities and development strategies of preceding periods. The basic scale of priorities and strategies of the respective PRJMs are summarized as follows:

1) **The First RPJM (2005-2009)** is directed at reforming and developing Indonesia in all fields that are aimed at creating an Indonesia that is safe and peaceful, just and democratic, and that has an increasingly prosperous population.
2) **The Second RPJM (2010-2014)** aims at the greater consolidation of the reform of Indonesia in all fields by emphasizing endeavors for increasing the quality of human resources, including the promotion of capacity building in science and technology and the strengthening of economic competitiveness.
3) **The Third PRJM (2015-2019)** is aiming for the greater consolidation of development in a comprehensive manner in all fields by emphasizing attainment of economic competitiveness on the basis of competitiveness of natural resources and the quality of human resources and by the increasing capability to master science and technology.
4) **The Fourth RPJM (2020-2025)** aims to realize an Indonesian society that is self-reliant, advanced, just, and prosperous through the acceleration of development in various fields by emphasizing the realized economic structure that is more solid on the basis of competitive advantage in various regions, and is supported by quality and competitive human resources



Source: Pohan (2009, MPW)

Figure 4.1-2 Strategies of the Respective PRJMs

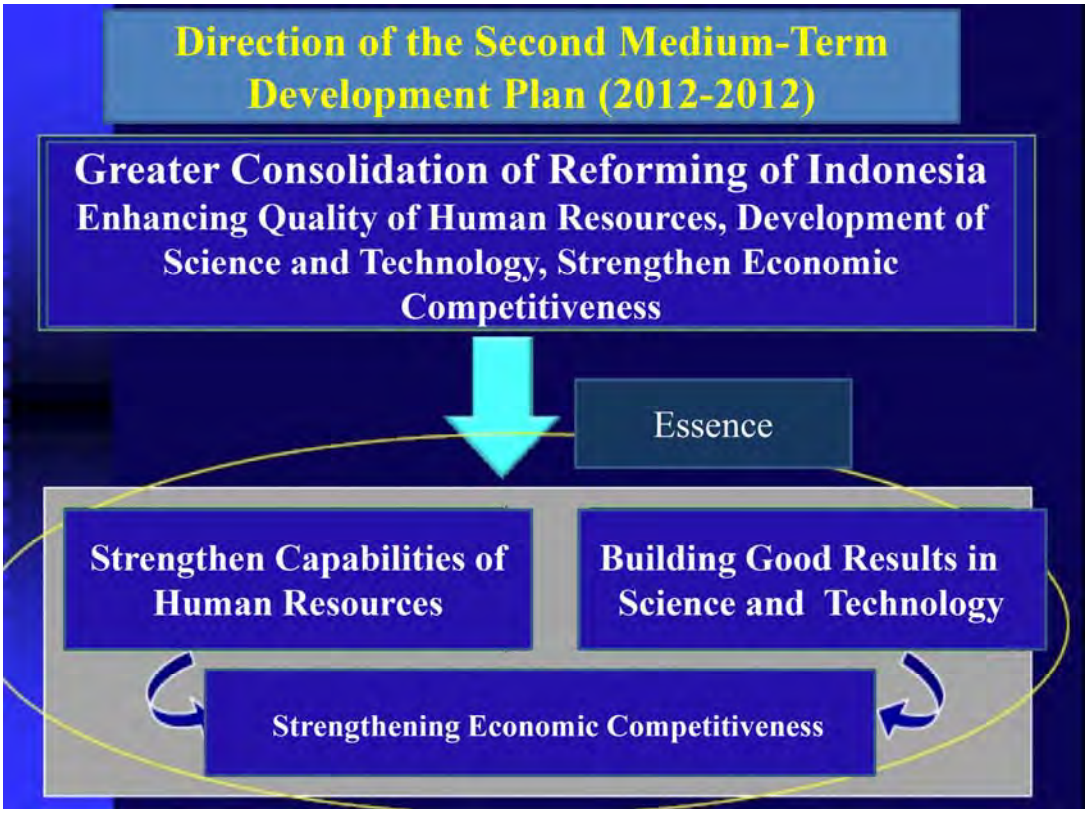
4.1.4 National Medium-Term Development Plan

The Second RPJM which formulates the basic policy for 5 years' national development from 2010 to 2014 was come into force as Presidential Regulation No.5/2010, built upon the outcomes of the First RPJM. The Second RPJM describes the missions as follows; continuing of development towards a prosperous Indonesia, strengthening of the pillars of democracy, and strengthening of dimension of justice in all fields. In order to achieve those missions, the following measures are adopted.

1) Economic development and increase of welfare of the people
2) Enhancement of good governance
3) Strengthening of the pillars of democracy
4) Enforcement of the law and eradication of corruption
5) Development that is inclusive and just

In addition, the major macroeconomic goals are as follows.

1) Average annual economic growth rate : 6.3% - 6.8%
2) Average annual inflation rate : 4% - 6%
3) Open unemployment rate at the end of 2014 : 5% - 6%
4) Poverty rate at the end of 2014 : 8% -10%



Source: Pohan (2009, MPW)

Figure 4.1-3 Directional Character of the Second RPJM

It should be noted that invest any locations are not specifically mentioned in mid-term development plans, it is being written in spatial planning. In addition, undeveloped areas are also clearly shown in spatial planning.

4.2 Spatial Planning and Flood Management

4.2.1 Legal System on Spatial Planning

Spatial control in Indonesia was systemized for the first time when the Law No.24/1992 on Spatial Planning was established in 1992. The Law No.22/1999 on Regional Administration was established in the end of 1990s. And since that time, administrative system had been modified and decentralization had progressed in the every administrative hierarchy. In accordance with the progress of decentralization, review of the manner on spatial planning process and enforcement of spatial plan had become essential. Consequently, the Law No.26/2007 on Spatial Planning and Management was established in order to substitute for the Law No.24/1992.

The Law No.26/2007 provides that every spatial plan has 20 years' planning period, 5 years' mid-term program for objective of spatial utilization and requirement of every 5 years' re-evaluation. As a framework for environmental conservation, the Law No.26/2007 defines that forest area shall cover at least 30% of the river basin in the regional spatial plan and, moreover, the proportion of open green space in municipal administrative area shall be no less than 30% and the proportion of public open green space in the municipal area shall be no less than 20%.

In comparison with the old law, the other remarkable characteristics such as improvement of administrative hierarchy, clarified authority of each administrative hierarchy and introduction of framework of spatial planning management are shown in the Law No.26/2007.

Commencing with the Law No.26/2007, the related legal system on spatial planning is tabulated as shown in the table below.

Table 4.2-1 Related Legal System on Spatial Planning

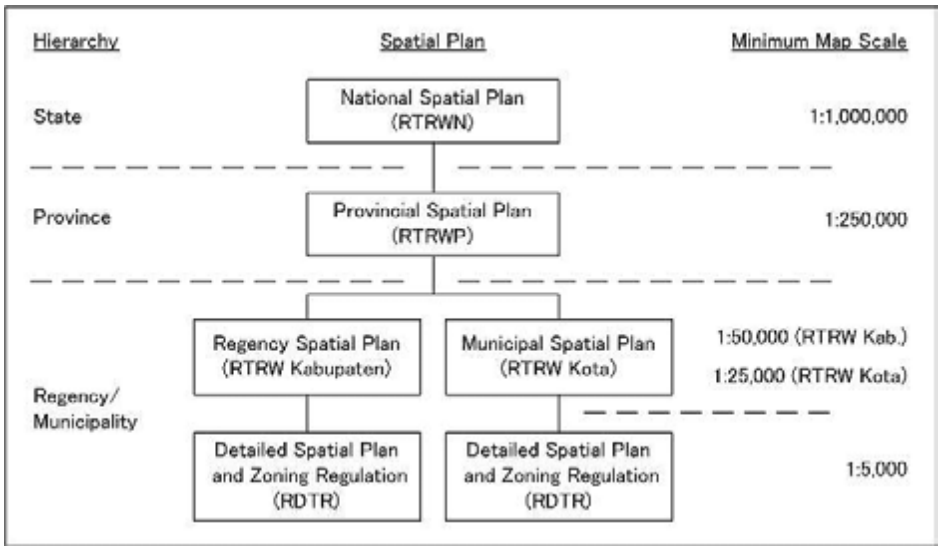
Law
• Law No.26 of 2007 on Spatial Planning and Management
Presidential Decree
• Presidential Decree No.4 of 2009 on Coordinating Body of National Spatial Planning
Presidential Regulation
• Presidential Regulation No.54 of 2008 on Spatial Planning in Jakarta, Bogor, Depok, Tangerang, Bekasi, Puncak and Cianjur Area
Government Regulation
• Government Regulation No.15 of 2010 on the Implementation of Spatial Planning and Management • Government Regulation No.26 of 2008 on the National Spatial Planning
Ministerial Regulation
• No.11/PRT/M/2009 on Substantial Guideline for Determination of Provincial, Regency and Municipal Spatial Plans • No.15/PRT/M/2009 on Preparation Guideline for Provincial Spatial Planning • No.16/PRT/M/2009 on Preparation Guideline for Regency Spatial Planning • No.17/PRT/M/2009 on Preparation Guideline for Municipal Spatial Planning • No.20/PRT/M/2007 on Technical Guideline for Analysis of Physical, Environmental, Economic, Social and Cultural Aspects in Preparation of Spatial Plans • No.22/PRT/M/2007 on Guideline for Spatial Planning of Landslide Prone Areas

Source: Directorate General of Spatial Planning, Ministry of Public Works, et al.

4.2.2 Formulation of Spatial Plan

(1) Hierarchical Framework of Spatial Plan

The following figure shows the hierarchical framework of spatial plan in accordance with the Law No.26/2007.



Source: Directorate General of Spatial Planning

Figure 4.2-1 Hierarchical Framework of Spatial Plan

Moreover, when general spatial plan and detailed spatial plan are classified into the area and municipal (city), and classified plans are shown in the following figure.

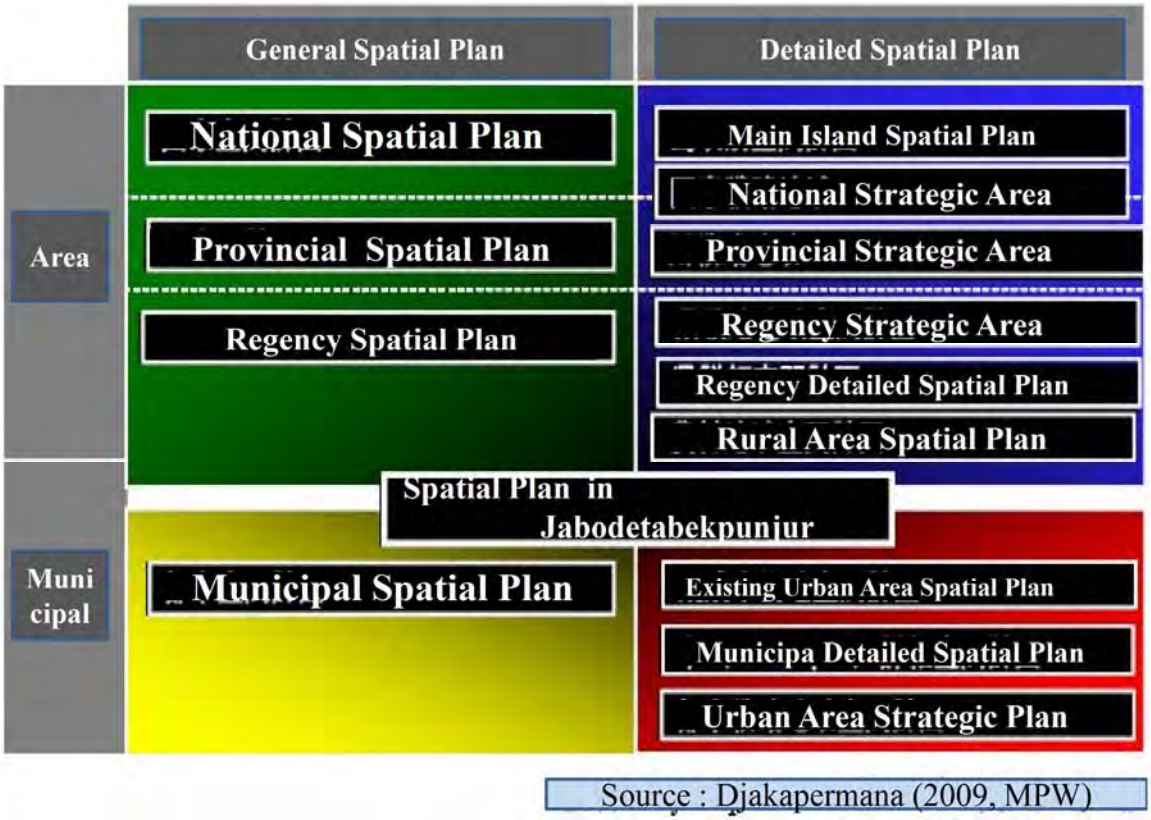
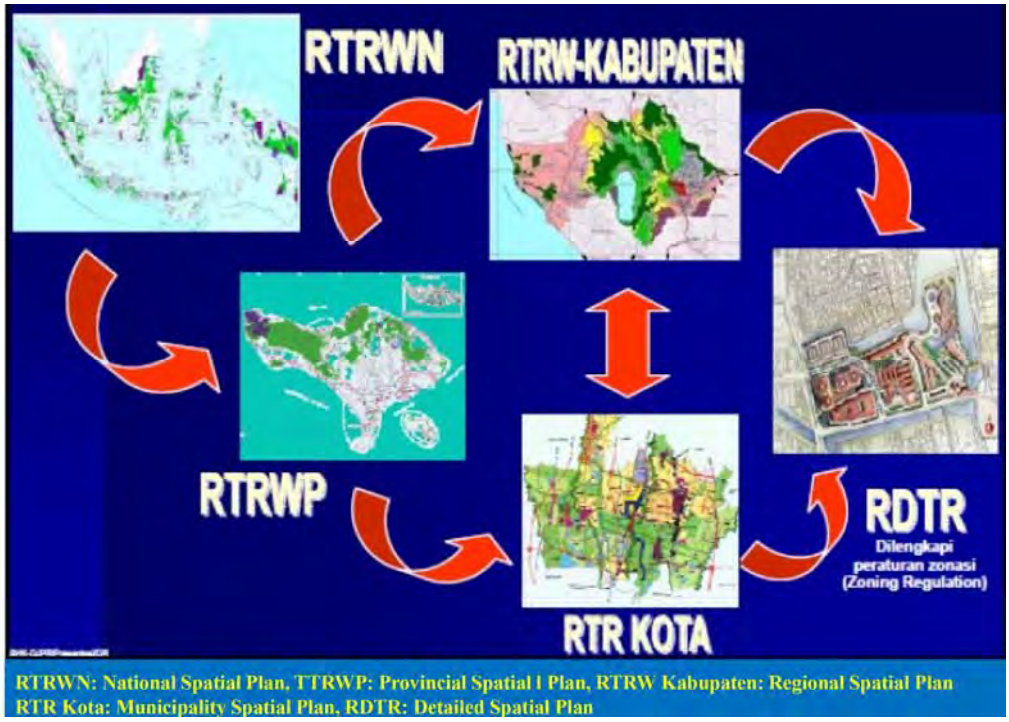


Figure 4.2-2 Spatial Plan System

The national spatial plan, which shall be established as a government regulation and its bill shall be prepared by BAPPENAS with substantial support from DGSP of the Ministry of Public Works, will be a guiding principle for spatial planning of local government. The national spatial plan is the strategy for national spatial development and includes objectives and strategies on spatial planning, structure plan of the national spatial utilization including urban hierarchy and infrastructure network at national level, and designation of the national strategic areas in accordance with the degree of importance in terms of economy, environment and so on.

The provincial spatial plan shall be established as a provincial regulation under the editorship of BAPPEDA. The provincial spatial plan will be a guiding principle for spatial planning of regency/ municipality, and includes mutual adjustment with spatial plans of adjacent provinces in addition to the rules and regulations for its enforcement. Drawings for the provincial spatial plan shall be prepared with the minimum scale of 1/250,000.

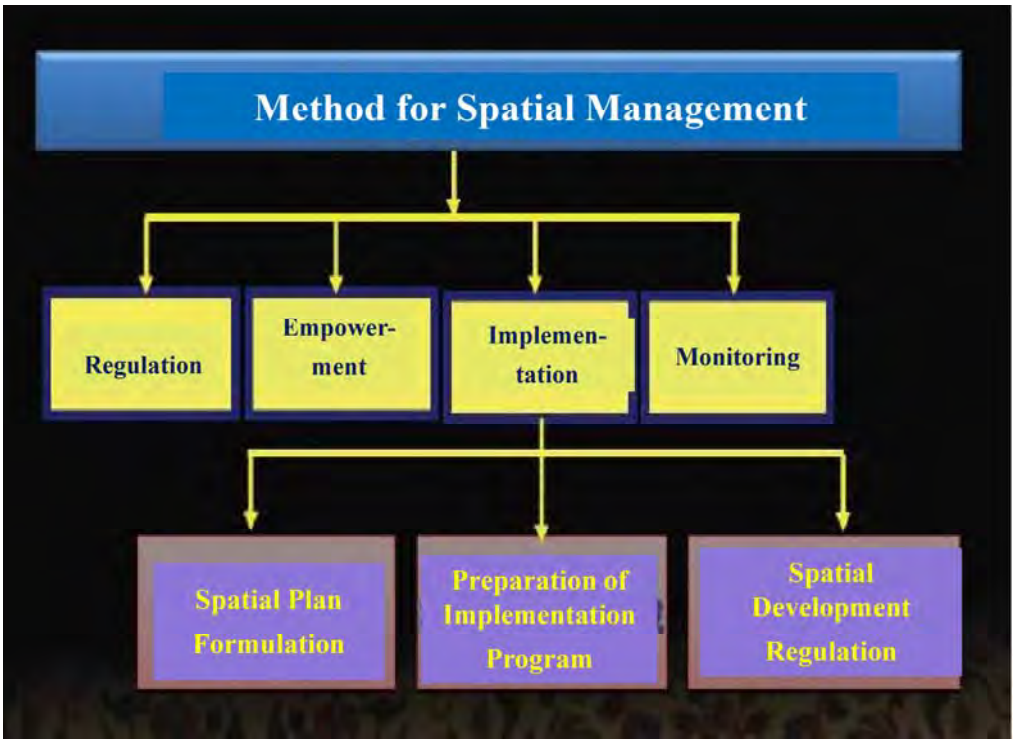
The regency/municipal (city) spatial plan shall be established as a regency/municipal regulation. The regency spatial plan and the municipal spatial plan are defined as the same administrative hierarchy and divided into general spatial plan and detailed spatial plan. Drawings of general spatial plan are prepared with the minimum scale of 1/50,000 for regency, and 1/25,000 for municipality. On the other hand, drawings of detailed spatial plan are prepared with the minimum scale of 1/5,000. The general spatial plan establishes spatial structure, land use plan and strategy for its enforcement, while the detailed spatial plan which is a tool in order to realize the general spatial plan defines rules and regulations such as zoning regulation, administrative procedures of development permission, prescription of incentive and disincentive, administrative punishment.



Source: DKI Jakarta

Figure 4.2-3 Image of Spatial Plan for each Government Level and Detailed Spatial Plan

From the above, it is arranged as shown in the following figure as a tool (the method of spatial management) concerning “the structure of spatial management”.



Source: Djakapermana, 2009, MPW

Figure 4.2-4 Method of Spatial Management

In above mentioned figure, meaning of formulation of spatial plan, preparation of implementation program and regulation on spatial development is shown as follows. (Djakaperman, MPW)

- **Formulation of Spatial Plan:**
  Measures for regulation to implement spatial plan and structure of spatial plan including the policy, and arrangement of spatial composition side
- **Preparation of Implementation program:**
  Measures to carry out spatial plan through main program and budgetary process
- **Regulation on Spatial Development:**
  Measures on zoning regulation, permission system, incentive and disincentive techniques and penalty regulations

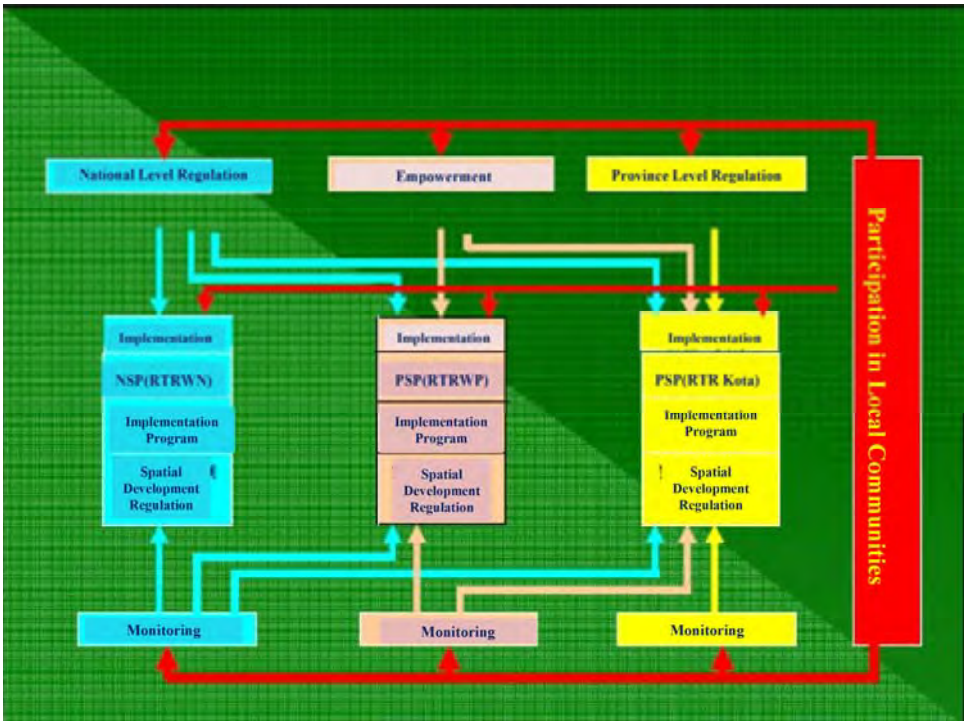
Central government, provincial government, regency government, and city government share responsibility in the regulation, empowerment, Implementation and monitoring in the spatial management. The central government's role in each field of these regulation, empowerment, implementation and monitoring is as the following table.

Table 4.2-2 Role of Central Government in Spatial Planning

Role, Field	Explanation
1.Regulation	- Government regulation, technical guideline, national spatial plan, designation on national area strategy area, preparation of minimum standard related to spatial planning, promotion of adjustment of spatial plan among the local governments.
2.Empowerment (Capacity Development)	- Technical guideline, Dissemination of standard - Discussions and supervising to the local government - Training, implementation of research and development - Information service about national spatial plan - Determination of the result which spatial plan gives to communities - Promotion of participation from the community to the planning - Adjustment about border region between two or more provinces and with neighboring country
3.Implementation	- Planning for national spatial plan, national strategic areas and detailed spatial plan in the main islands. (Sumatra, Kalimantan, Celebes, Java) - Promotion of legislation - Preparation of the program implementation at national level - Adjustment of the program between the local government and sector - Control of development in strategic areas
4.Monitoring	- Monitoring and evaluation of spatial management implementation

Source: Djakapermana, 2009, MPW

The relationship of influences on regulation, empowerment, implementation and monitoring at central government level and local government level is shown in the following schematic figure.



Source: Ernawi, 2008, MPW

Figure 4.2-5 Relationship of Influences on Regulation, Empowerment, Implementation and Monitoring

(2) National Spatial Plan

Based on the Law No.26/2007, the Government Regulation No.26/2008 on the National Spatial Plan was established. The National Spatial Plan of 20 years' planning period is the strategic plan at the macro level regarding to the national spatial utilization, and includes the following contents. The national spatial plan, which shall be established as a government regulation and its bill shall be prepared by BAPPENAS with substantial support from DGSP of the Ministry of Public Works, will be a guiding principle for spatial planning of local government. This plan reviews every five (5) years.

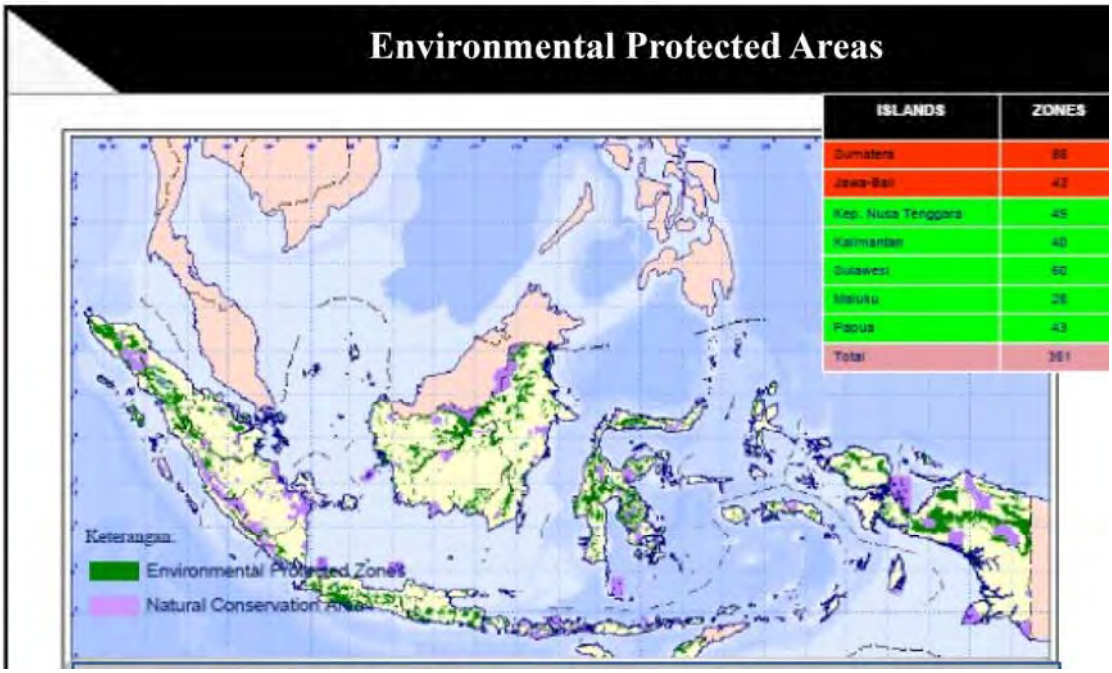
1) Ultimate target, policies and strategies of the National Spatial Plan
2) National spatial structure plan including national urban system and primary infrastructure network
3) National spatial pattern plan including national reserves, economically-important regions
4) Determination of national strategic regions
5) Implementation guideline including 5 years' medium-term programs for major developments
6) National guideline of development control including zoning regulation, development permission system, incentives/disincentives, administrative penalty

"Spatial structures" is the structure of settlement center and the system of infrastructures and facilities which function as the support to social and economic activities. On National level, city system, transportation network, energy network, water resources network, etc. are drawn by scale in 1:1,000,000. Among these, water resources network is shown in the following figure.

Source:Ernawai (2008)

Figure 4.2-6 Water Resources Network

Environmental protection areas, cultivation areas, and national strategic areas (75 areas) are shown in national spatial pattern plan. As related to the flood control, the protected areas consisting of natural conservation area, flood plain, disaster potential area and biodiversity area are shown in the following figure.



Source:Ernawai(2008)

Figure 4.2-7 Environmental Protected Area

National strategic area is designated in order to protect and maintain area for culture, economy,

environment, and national defense. National strategic areas of 75 are classified as the following table.

Table 4.2-3 Classification of National Strategic Areas

Classification of Importance and Priority	Number of Areas
1.Social and Culture	5
2.Economic Growth	26
3.natural Resource and Advanced Technology	13
4.Nation Security and Soundness	9
5.Carrying Capacity od Environment and Sustainability	21
6.Protection Function and Self Defence	1
Total	75

Source: Ernawi, 2008, MPW

Mechanism of regulation policy on development control in national spatial plan is shown in the following table.

Table 4.2-4 Mechanism of Regulation Policy on Development Control

Regulation Policy	Explanation
1.Zoning regulation in national level	Permission, prohibition and regulation on: a. Implementation of national spatial structure b. Implementation of national spatial pattern
2.Direction of development permission	Regulation on development permission
3.Direction for incentive and disincentive	Framework of incentives and disincentives in the national system
4.Direction of sanction by government	Regulation on infractions and administrative penalties

Source: Ernawi, 2008, MPW

Among upper tables, as for zoning regulation, what is permitted to specific area, what is forbidden, what is permitted depending on the conditions are defined. Development permission is based on either general spatial plan or detailed spatial plan. Implementation of incentive and disincentive technique, financial and un-financial technique exists. Administration penalties are given about violations of planned by intentionally. Comparison with old and new law on spatial planning are summarized as follows:

1) The measures of preparing plan effectively are not indicated in old law, while the measures to control implementation of a plan are indicated in new law.
2) It specified that detailed spatial plan should be formulated by each local government (province, Regency, city) for effective implementation of spatial plan.
3) Spatial management process is caught on four viewpoints of regulation, implementation, empowerment and monitoring, and allocation of roles for central, province and regency/city is defined.
4) As a tool which controls development, zoning regulation, development permission, incentives and disincentives and sanction regulations were defined.
5) For planning period is unified as 20 years at any administration level and aims at consistency with the period of development plan.
6) Policy for control of city development progress and preservation of farmland is set forth as important.

(3) Spatial Plan for Jabodetabekpunjur Area

The Presidential Regulation No.54/2008 on Spatial Planning in Jakarta, Bogor, Depok, Tangerang, Bekasi, Puncak and Cianjur (Jabodetabekpunjur) Area was established for the following purposes.

1) To implement the spatial plans of those local governments as one united planning area taking into account balance of prosperity and endurance

2) To materialize supporting system within Jabodetabekpunjur area in order to ensure water and land conservation continually, ensure provision of groundwater and surface water, and overcome flood
3) To develop economy as a productive, effective and efficient area on the basis of prosperity of communities, and a just and sustainable development

Among the five local governments relating to the Ciliwung River Basin, regional general spatial plan (RTR in Indonesian) on the basis of the Law No.26/2007 has been formulated. Concerning "Detailed Spatial Planning (RDTR in Indonesian)", the DKI Jakarta is almost prepared and other governments are in the process of under preparation as shown below.

Table 4.2-5 Progress of Formulation on Spatial Plan in Local Governments

Local Government	West Java Province	DKI Jakarta	Depok City	Bogor Regency	Bogor City
Planning Period	2010 - 2029	2011 - 2030	2011 - 2030	2005 – 2025	2011 – 2030
Approval by Parliament	Approved	Approved	Unapproved	Approved	Approved
Incorporation of Zero Delta Q Policy	Incorporated	Incorporated	Incorporated	Incorporated	Incorporated
Progress of Detailed Spatial Planning	-	Draft is formulated	Under preparation	Under preparation	Under preparation
Progress in Preparation of Detailed Regulations [1)]	-	Under preparation	Under preparation	Under preparation	Under preparation

1) Detailed Regulations are local regulations including incentives/disincentives, administrative penalties and so on, in order to enforce spatial plan.

Sources: DKI Jakarta, Depok City, Bogor Regency and Bogor City & JICA Expert Team

(4) Regional Spatial Plan for DKI Jakarta

The RTRW (Spatial Plan Bylaw) 2030 of DKI Jakarta was approved by the provincial parliament on 24 August 2011. At the front of the RTRW, the vision is declared as follows, "Jakarta as the comfortable, sustainable and unified capital with a prosperous society". In line with this vision, the missions stated in the RTRW 2030 are as follows.

a. To build infrastructure and humane city
b. To optimize productivity of the capital city
c. To develop urban culture
d. To mainstream disaster mitigation based development
e. To create life of a prosperous and dynamic city
f. To harmonize urban life with environment

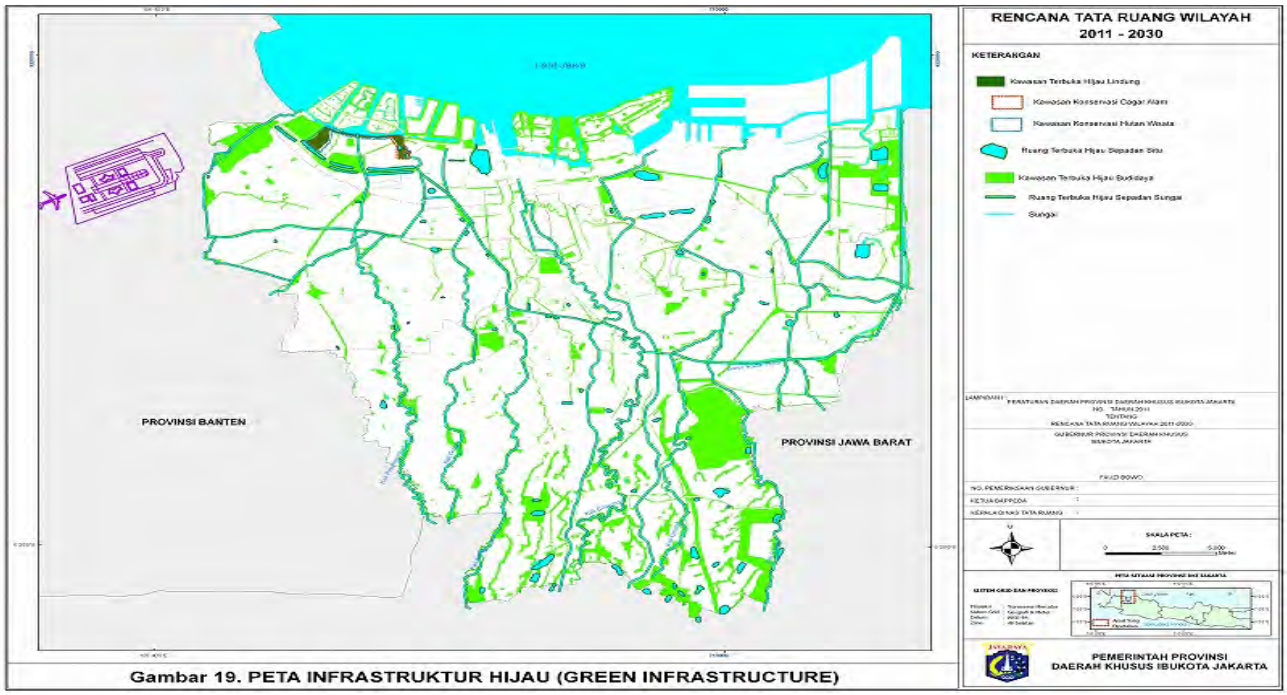
The RTRW 2030 includes general spatial plans of the five municipalities and one Kabupaten (Seribu Islands) as previously described. The general spatial plan shows only guiding principle of medium-to-long term development plan of each local government. Specific plan of infrastructure development is generally shown in a sector plan, and zoning regulation which is used for the administrative procedures of spatial utilization is shown along with the detailed spatial plan of each Kecamatan. That is, administrative service on development permission cannot be performed only by the general spatial plan. Although the general spatial plans of those local government was passed in the provincial parliament of DKI Jakarta, the authorities in charge of development permission have to await establishment of detailed spatial plan in accordance with the general spatial plan and establishment of detailed enforcement regulations which enable enforcement of incentives, administrative penalties and so on.

Table 4.2-6 Development Policies/Strategies on Flood Control in the RTRW 2030

Development Policy	Development Strategy
1) Control of development of which magnitude exceeds environmental capacity (Refer to Article 5(2)c)	1) To prioritize urban development to the east, west and north, and restrict development to the south 2) To implement reclamation and revitalization of the North Coast area 3) To limit utilization of groundwater in development activities 4) To direct utilization of underground spaces for limited development activities 5) To control, limit and reduce ribbon developments 6) To develop the pattern of controlling area according to development promotion zones, development controlling zones and redevelopment zones (Refer to Article 7(3)a-f)
2) Hierarchical improvement of infrastructure and urban utilities (Refer to Article 5(3)b)	1) To provide integrated drainage system hierarchically 2) To develop infrastructure of water resource to maintain existing water resources (Refer to Article 8(3)a.d)
3) Conservation/maintenance of area that has a strategic value and/or environmental value (Refer to Article 5(5)d)	1) To manage river border to secure river flows and embankments 2) To maintain water balance 3) To protect main rivers/canals 4) To make preparations against rising sea levels 5) To improve quality of environment (Refer to Article 10(1)a,10(4))
4) Integration of water system with the upstream and/or surrounding areas (Refer to Article 5(6)b)	1) To develop infrastructure and facilities for the flood control by recovering/ developing of lakes and reservoirs as well as normalization of rivers 2) To maintain the quality, quantity and continuity of surface water 3) To implement cooperation in development and management of infrastructure, facilities and utilities with surrounding areas (Refer to Article 11(2)a-c, 11(3)a)
5) Development of infrastructure and facilities for reduction of natural disaster risks (Refer to Article 5(8)a)	1) To develop infrastructure and facilities for flood control 2) To repair/develop drainage system 3) To develop spaces for disaster evacuation 4) To construct sea dikes in order to anticipate rising sea levels (Refer to Article 13(1)a-d)
6) Adaptation to global warming and climate change (Refer to Article 5(8)c)	1) To improve adaptability of disaster-prone areas 2) To reduce disaster risks through introduction of countermeasures in terms of technology and engineering 3) To develop the northern coast area (Pantura) as efforts to climate change 4) To improve provision of blue open space to anticipate high rainfall intensity 5) To improve urban environment which pay attention to the availability of space for water 6) To build adaptability against disaster impact 7) To mainstream waterfront development as an urban development (Refer to Article 13(3)a-f,14(1)b)

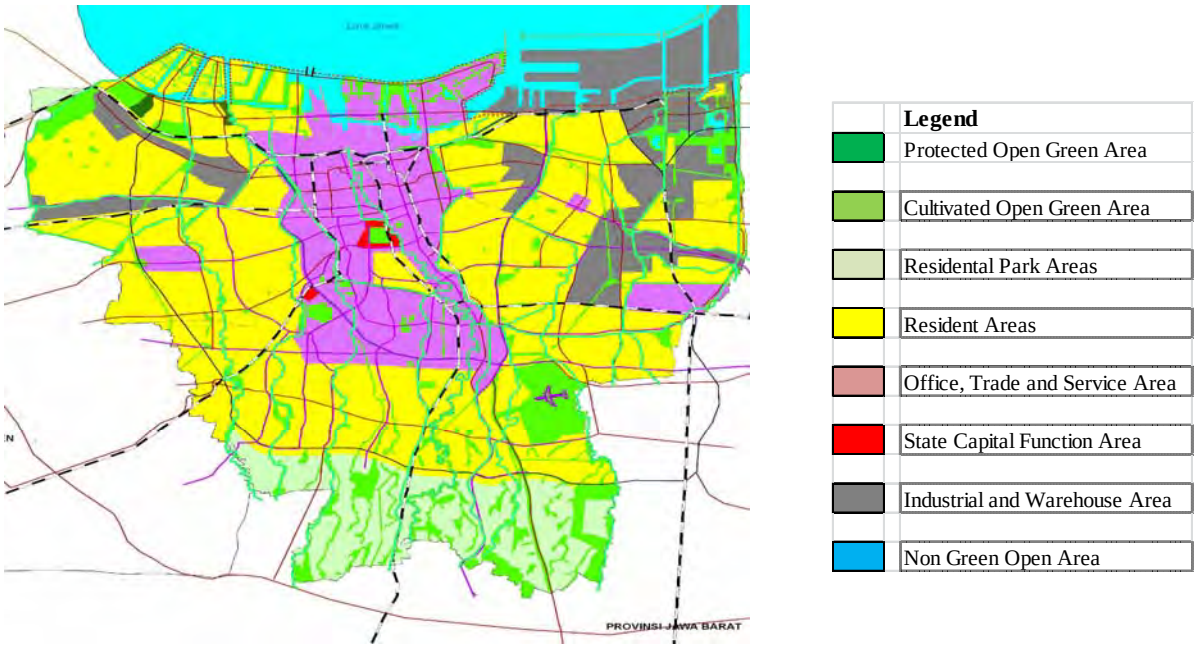
Source: Regional Spatial Planning 2011-2030 of DKI Jakarta

Distribution of open green spaces and land use plan in Jakarta are shown in the following figure.



Source: Regional Spatial Planning 2011-2030 of DKI Jakarta

Figure 4.2-8 Distribution of Green Space



Source: Regional Spatial Planning 2011-2030 of DKI Jakarta

Figure 4.2-9 Land Use Plan in DKI Jakarta

4.2.3 Flood Management in Spatial Plan

Position of flood management and flood control plan in spatial plan is summarized as follows.

(1) Flood Control Policy in National Spatial Plan

"*zero delta Q*" policy, of which concept was, for the first time, publicized in Government Regulation No.26/2008 on the National Spatial Plan, is the national policy on flood control. The policy requires that

zoning regulation for groundwater recharge areas shall be established taking into account the following points.

- Discouraging of development which causes decrease of inherent runoff control function of the site
- Promotion of development of rainwater infiltration facility and/or flood control reservoir in built-up areas
- Applying of the "*zero delta Q*" policy to development permission administration

In addition, the glossary in the Government Regulation No.26/2008 describes as follows; "*zero delta Q*" policy is the principle that any development must not cause increase of storm water runoff into surrounding water system and/or drainage system.

(2) Flood Management in Jabodetabekpunjur Spatial Plan

Development policies in the fields of drainage and flood control which are described in the Presidential Regulation No.54/2008 are shown as follows.

1) Drainage and flood control in Jabodetabekpunjur shall be materialized through an integrated river management along with enhancement of capacities of river channels and reservoirs, precise management of spatial utilization of protected areas and farmlands in upper river basins, improvement of drainage system, and development control of adjacent areas of rivers/canals.
2) Drainage and flood control in Jabodetabekpunjur shall be materialized through improvement of drainage system, development of flood control reservoirs, preservation of rainwater retention areas, improvement of rivers/canals, determination of boundaries of rivers/canals, and rehabilitation of forests/farmlands.

(3) Flood Management in DKI Jakarta Spatial Plan

As for the infrastructure network of water resources, development of facilities to control water destructive power is defined as the top priority issue. The development of infrastructure network of water resources, which aims maximizing of capacities of rivers, canals, reservoirs and so on, includes the following developments.

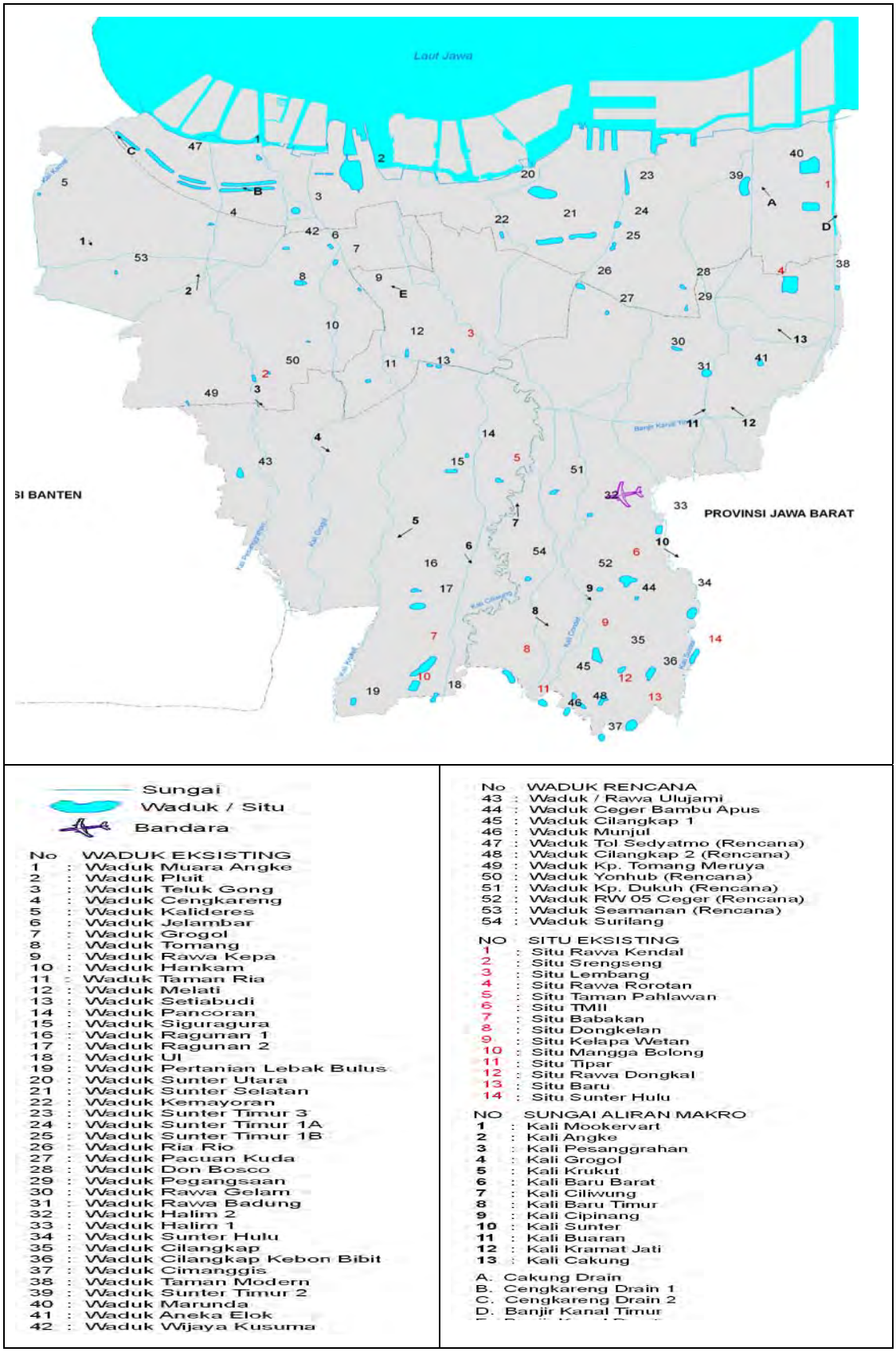
1) Construction of reservoirs at precise locations within the Ciliwung River Basin and the other watersheds in order to reduce rainfall runoff volume into the rivers
2) Normalization of rivers, canals, dams and reservoirs
3) Installation of infiltration well or Biopori, especially in water catchment areas
4) Improvement/expanding of polder system in flood plains
5) Enhancement of community participation in flood control through community-based development of polder system
6) Increasing of flow capacity of West Flood Canal and Cengkareng Drain, and development of Cengkareng Drain II for the eastern region
7) Increasing of flow capacity of Cakung Drain, Sunter River, and development of East Flood Canal for central and eastern regions
8) Interconnection of West Flood Canal and East Flood Canal
9) Development of drainage infrastructure to improve channel capacity of micro, sub-macro and macro channel in anticipation of rainfall intensity with return period of 2-10 years for micro channel, 10-25 years for sub-macro channel and 25-100 years for macro channel
10) Conducting of regular inspections in order to maintain flow capacity of existing channels
11) Implementation of waterfront development through construction/maintenance of inspection road
12) Phased construction of seawall with 1,000 years' security level
13) Widening and deepening of river estuaries in Jakarta Bay
14) Synchronized development of the new reclamation area and water management system in the municipality of North Jakarta

In addition, because of the necessity to fix the boundaries of water bodies (river, canal, reservoir and so on) according to the functions such as flood control, drainage, conservation of water resources, marine

transport, the above-mentioned developments shall be implemented along with the following measures.

- Expanding of water body
- Prohibition against land use conversion of designated water body
- Maintain border of river/canal as green open space and/or for the function of flood control

Among the drawings regarding infrastructure network of water resources in the RTRW 2030 of DKI Jakarta, the distribution of water body such as rivers, situ (small lakes) and waduk (dams) is shown in the following figure.



Source: DKI Jakarta Spatial Planning 2011-2030

Figure 4.2-10 Locations on Rivers, Situ and Dams

4.3 Spatial Planning in *Pola* for 6 Ci

4.3.1 Issues on Water Resources Management and Spatial Planning

River Basin Water Resources Management Pattern or "*Pola Pengelolaan Sumber Daya Air Wilayah Sungai*" (hereinafter referred to as "*Pola*") is formulated for every river basin by Ministry of Public Works based on the Law No. 7/2004 on Water Resources. Every local government refers the Pola before the formulation of regional spatial plan and development plan to keep a consistency between them. This section describes overview of *Pola* for 6 river basin, namely Cidanau, Ciujung, Cidurian, Cisadane, Ciliwung and Citarum River Basin. Issues on spatial plan discussed in the *Pola* are as follows.

- Transfer function of agricultural land (for urban, industrial).
- Regions that functions as a body of water and catchment areas (basins, swamps, and lakes)
- The area of agriculture (particularly rice fields) that irrigated primarily technical in metropolitan areas Bogor, Depok, and Jakarta.
- Along the border of the river, along the banks of either side of the river that located in urban areas.

4.3.2 National Policy of Spatial Planning on Development of 6 Ci River Basins

The spatial planning policy should be considered and related to the development of 6 Ci rivers, include as followings.

1) National policy of spatial planning policy which is a detailed plan of the national level
2) Provincial policy of spatial planning
3) Policy of spatial structuring of the island-scale , which is a detailed plan of the national level
4) Policy of spatial planning at the District/City)

4.3.3 Structure Utilization of Space/ Space Structural Plan

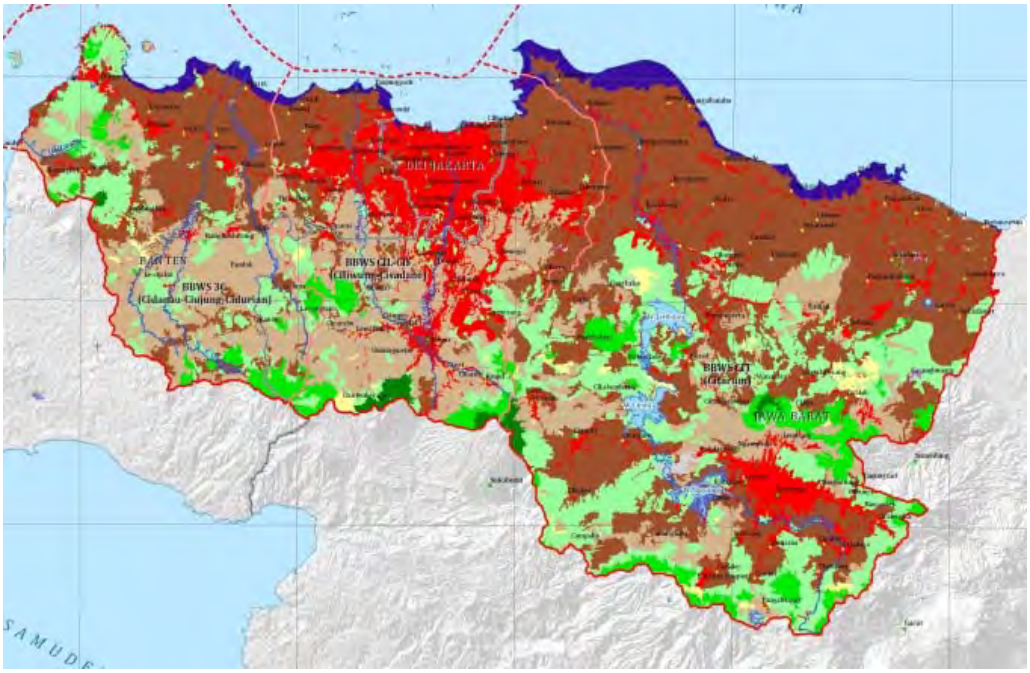
Referral structure utilization of space/space structural plan in 6 Ci rivers is shown in the figure below.

Source: Pola Pengelolaan Sumber Daya Air Wilayah Sungai 6 Cis (2012)

Figure 4.3-1 Space Structural Plan in 6 Ci Rivers

As direction of spatial use in POLA, based on plotting of Spatial plan bylaw (RTRW) Java Bali Island and spatial plan bylaw Province (Banten, DKI Jakarta and West Java), indicated that at the end of the plan year (in year 2030) the pattern that seen from spatial plan, usage spatial plan on 6 Ci rivers will be dominated by the residential / urban, agricultural areas (mainly agricultural wetlands / technical irrigation and protected areas.)

The figure below shows that a residential area (urban), industrial and rural settlements will be approximately 32% of the total area of 6 Ci rivers (approximately one-third the area of 6 Ci rivers).



Source: POLA Pengelolaan Sumber Daya Air Wilayah Sungai 6 Ci's (2012)

Figure 4.3-2 Spatial Use Condition in 2009

Thus the need for raw water for urban and industrial settlements will increase, while the water demand for irrigation is likely to decline / decrease. In addition, in order to maintain national food security it is necessary to avoid the development of a residential area on the technical irrigation.

4.3.4 Zoning for Spatial Planning

Referring to the Law No. 26 Year 2007 on Spatial Planning, in establishing zoning in the 6 Ci rivers harmonize with aspects of the Law No. 7 of 2004 on Water Resources are: Conservation of Water Resources, Water Resource Utilization and Flood Control.
Zoning is one of the potential instruments for the integration between spatial planning and management of water resources. Network system of water resources in Java related to 6 Ci rivers, an indication of the direction of zoning regulations for water resources system are summarized as follows.

1) Management inter Province River
2) Network development of water resources consist of national irrigation, and dams and weirs.

River network system infrastructure on inter regency/city and rivers in regency/city determined respectively by provincial regulation on spatial planning and spatial planning of regency/ city

4.3.5 Analysis of Spatial Use and Planning

(1) IWRM on Spatial Planning

Based on spatial planning, both at the Provincial Spatial Plan and Regency/City Spatial Plan obtained description as follows:

a. Compiled Spatial plan in spatial plan bylaw should have loaded/showing the location (zoning) including retention area, catchment area, retention area where provide protection to its subordinates, not stated in the Spatial Plan.

b. Spatial structure plan which compiled on spatial plan bylaw should have been propose an idea of watershed plans such as dams / reservoirs for each dam site plan, but apparently yet listed in spatial plan bylaw.

(2) Inter Regional and Inter Sectorial Dispute

In land use are often found land use conflicts in the border areas between the towns (the administrative area of the city) to the administration area of regency.

Related to inter-sectorial, Plot spatial plan bylaw on 6 Ci rivers found several conflicts both land use and infrastructure, such as land (area) and the Spatial Plan allocated as a potential reservoir locations Limo in Depok, current location has developed into cultivation area (residential and other cultivation).

4.3.6 Issues on Spatial Planning in 6 Ci River

According to the issues mentioned above, issues on spatial planning related to 6 Ci's are summarized as follows.

(1) Conservation of Agricultural Land

The following land use changes are remarkable in the Ciliwung River Basin. It is necessary to protect agricultural land which decreases in number especially

a. Transfer function on agricultural land for urban and industrial activities
b. Transfer area of agricultural land that irrigated primarily technical in Jakarta
c. Transfer to urban and commercial land along the border of river

(2) Compiled Spatial Planning showing Watershed Plans and Network System Infrastructure

Compiled Spatial plan in spatial plan bylaw should have loaded/showing the location (zoning) including retention area, catchment area, retention area where provide protection to its subordinates, not stated in the Spatial Plan. Spatial structure plan which compiled on spatial plan bylaw should have been propose an idea of watershed plans such as dams / reservoirs for each dam site plan, but apparently yet listed in spatial plan bylaw.

(3) Inter Regional and Inter Sectorial Dispute

Land use conflicts are often found around the border areas between the towns (the administrative area of the city) and the administration area of regency. Interregional and inter sectorial dispute above mentioned should be identified and arranged by among related agencies.

CHAPTER 5 BUILINDING CONSTRUCTION AND FLOOD MANAGEMENT

5.1 Building Construction and Permission

5.1.1 Legal System on Building Construction and Building Permission

Related legal system on building construction is summarized in the following table.

Table 5.1-1 Related Legal System on Building Construction

Law
• Law No.28 of 2002 on Building Construction
Presidential Regulation
• Presidential Regulation No.36 of 2005 on Land Procurement for Development Implementation for Public Interest • Presidential Regulation No. 65 of 2006 on Amendment to Presidential Regulation No.36 of 2005 on Land Procurement for Development Implementation for Public Interest
Government Regulation
• Government Regulation No.36 of 2005 on Implementation of the Law No.28/2002 on Building Construction
Ministerial Regulation
• No.29/PRT/M/2006 on Guideline for Technical Requirement of Building Construction • No.45/PRT/M/2007 on Technical Guidance of State Building Construction
Governor Decree/Regulation
• Governor Decree No.Da.11/3/11/1972 on Improvement of Application Procedures of Permit of Land Use and Designation (SIPPT), and Procedures of Land Acquisition for Public/Private Interest in DKI Jakarta • Governor Decree No. 540 of 1990 on Implementation Guidelines for Issuance of Principle Approval Letter for Land Acquisition (SP3L) of Parcels of Land for Urban Physical Development • Governor Decree No. 640 of 1992 on Provision regarding Land Acquisition without Permit from the Governor of DKI Jakarta • Governor Decree No.76 of 2000 on Procedure to get IMB, IPB and KMB in DKI Jakarta • Governor Decree No. 41 of 2001 on Procedures of Acceptance of Liability from Holder of SIPPT to the Provincial Government of DKI Jakarta • Governor Decree No. 1934 of 2002 on Provision regarding Calculation of Liability for Providing of Low-cost Housing by Holder of SIPPT • Governor Regulation No. 76 of 2008 on Exception of SIPPT
Provincial Regulation
• Provincial Regulation No.7 of 1991 on Building Structure in DKI Jakarta • Provincial Regulation No.7 of 2010 on Building in DKI Jakarta
Others
• Regulation of Head of Bappenas No.3 of 2007 on Implementation Provision of Presidential Regulation No.36 of 2005 and Presidential Regulation No.60 of 2006

Source: Bureau of Spatial Planning and Environment, DKI Jakarta

The governing agency of development permission in DKI Jakarta depends on the development scale as shown in the following table.

Table 5.1-2 Governing Agency of Development Permission on Land

Scale (Area) of Development	Governing Agency
5,000 m^2 ≤ Area	DKI Jakarta
500 m^2 ≤ Area < 5,000 m^2	Municipality
Area < 500 m^2	District (Kecamatan)

Source: Spatial Planning Agency, DKI Jakarta

Development of which area is 5,000 m^2 and over requires an approval on land acquisition (SP3L) and/or land utilization (SIPPT) from the Governor as described later. The secretariat of the "Consideration Team for Land Affaires (TPUT)", which is established with the Spatial Planning Agency, is the receiving office of those applications on land. TPUT, which is an ad hoc committee consisting of heads of relevant organizations to each accepted application, examines the application in terms of spatial utilization in accordance with the spatial plan, and submits a report on approval to the Governor.

5.1.2 Land permit and Building Construction

Development permit in DKI, which is roughly classified into development permission on land and development permission on building, is performed in line with the above-mentioned legal system. The development permission on land consists of "Principle Approval Letter of Land Acquisition" and "Permit of Land Use and Designation", while the development permission on building consists of "Building Construction Permit" and "Certificate for Suitability of Functions". Assuming a series of development activities starts with land acquisition, the necessary permits in sequence are shown in the following table.

Table 5.1-3 Development permission in DKI Jakarta

Items	Permission	Explanation
Land Permit	SP3L (Principle Approval Letter of Land Acquisition)	Only required when applicant intends to develop a land of which area is 5,000 m^2 and over, and the applicant have to complete the land acquisition within 6 months from the date of issue. The SP3L is commonly known as "Location Permit".
	SIPPT (Permit of Land Use and Designation)	Certificate that Intended land use of a development is in compliance with detailed spatial plan and zoning regulation. This permit is only required when the area of development is 5,000 m^2 and over.
Building Permit	IMB (Building Construction Permit)	Gives applicant a permission to construct building. Drawing and specification provided by the applicant are examined by the concerned authorities regarding restrictions on land, infrastructure development by applicant's expense, structure of building, ancillary facilities, environmental conditions and so on.
	SLF (Certificate for Suitability of Functions)	Will be issued when construction of a building is completed, if the status of building meets requirements of IMB and technical standards. It also gives applicant a permission to use building.

Source: Government Regulation No.36 of 2005 on Implementation of the Law No.28/2002 on Building Construction

SP3L is essential for a development of which area is 5,000 m^2 and over to get SIPPT, IMB and SLF in order to bring the development to completion. However, it will be unnecessary to get SP3L, if a developer intends to acquire a land of which permits have been already issued and respect those given conditions. In case when land acquisition is necessary to develop a public infrastructure by the provincial government and/or provincial agency, SP3L and SIPPT are not required. On the other hand, the central government shall obtain those permits when they develop infrastructure or public facility within the administrative area of DKI Jakarta.

In the same way, SIPPT is required to develop a land of which area is 5,000 m^2 and over. On the occasion when an applicant applies for a SIPPT, TPUT will mainly examine whether the intended spatial utilization is compliant with detailed spatial plan and zoning regulations or not. Based on the applications, TPUT confirms the project site with implementation of land survey. In this regard, the applicant will be required to give over a portion of land to the provincial government, if it is overlapped with planned right of way in the spatial plan. As for the conformity with the spatial plan, TPUT examines building coverage ratio (KDB), floor-area ratio (KLB), green coverage ratio (KDH), number of stories and building setback, on the basis of the block plan which shall be prepared by the applicant.

Review of application document on SIPPT is implemented by TPUT in terms of conformity with spatial plan, but not for technical requirements of ancillary facilities such as wastewater treatment facility. Review of the technical requirements of those facilities will be done in the administrative procedure of IMB (Building Construction Permit), and/or environmental assessment in advance of IMB. As for land development of which area is less than 5,000 m^2, the developer is not required to obtain SIPPT. However, the developer has to submit a block plan to municipal office or district office depending on scale of the development, and obtain permission from the authority.

In regard to development permission on building, the receiving office of application differs by the type of building and scale of its land area, as shown in the following table.

Table 5.1-4 Governing Agency of Development Permission on Building

Type of Building and Land Area	Governing Agency
Building of which no. of aboveground stories is more than 8 and/or land with SIPPT (5,000 m^2 ≤ Land Area)	Provincial Agency of Building Control & Monitoring (DP2B)
Building of which no. of aboveground stories is between 1 and 8, with underground floor(s) and/or structures on rooftop	Sub-agency of Building Control & Monitoring in Municipality (SDP2B)
Building of which no. of aboveground stories is between 1 and 8, without underground floor(s) or structures on rooftop	Unit of Building Control & Monitoring in District (P2B)

Source: Provincial Agency of Building Control & Monitoring, DKI Jakarta

The provincial agency of building control & monitoring (DP2B) is responsible for development permission on building of which number of aboveground stories is more than 8 and/or its site area has SIPPT. According to DP2B, site surveys are generally carried out three (3) times after acceptance of application of IMB, that is, site identification shortly after the acceptance of application, confirmation of permit requirements at the start of construction work and on-site inspection at the end of construction work. However, the on-site inspection is only carried out about commercial/office building and large-scale housing development due to shortage of manpower. Except for the large-scale housing development, site survey for housing development is carried out only once, that is site identification shortly after acceptance of application. This means, housing of which on-site inspection at the end of construction work is not carried out by DP2B cannot obtain SLF.

On the other hand, sub-agency of building control & monitoring in municipality (SDP2B) is responsible for development permission on building of which site area is less than 5,000 m^2 and the number of aboveground stories is between 1 and 8 with underground floor(s) and/or structures on rooftop. As in the case of development permission administration of DP2B, on-site inspection at the end of construction work is carried out only about commercial/office buildings due to shortage of manpower.

As for the building of which area is less than 5,000 m^2 and the number of aboveground stories is between 1 and 8 without any underground floor or any structures on rooftop, unit of building control & monitoring in Kecamatan office (P2B) is the receiving office of those applications for IMB and SLF. Although P2B examines the applications, the final decision on permission is handed to SDP2B in municipal office. According to the P2B of Kecamatan Menteng in the municipality of Central Jakarta, they have carried out necessary site surveys including on-site inspection about every permitted housing development with IMB, unlike DP2B and SDP2B. In this regard, however, the objects of inspection are mainly building itself and rainwater infiltration facility, but sewerage treatment facility such as septic tank is usually not inspected.

5.2 Technical Guideline for Rainwater Management

Directorate General of Human Settlement in MPW is summarizing technical guideline for rainwater management on building environment. This guideline shows the plans, execution method, and monitoring and evaluation method on various rainwater management facilities in private building site. According to the guideline, criteria for rainwater management volume per hectare are classified depending on the area of site. From the table, rainwater management volume shows as 1,200 m^3/ha.

Table 5.2-1 Criteria for Rainwater Management Volume

Area of Site	Name of Site Size	Management Volume
<1,000 m^2	Small	< 120 m^3
1,000 m^2 - 5,000 m^2	Relative Small	120m^3 - 600 m^3
5,000 m^2 - 10,000 m^2	Medium	600 m^3 - 1,200 m^3
10,000 m^2 - 50,000 m^2	Relative Large	1,200 m^3 - 6,000 m^3
> 50,000 m^2	Large	> 6,000 m^3

Source: Technical Guidelines for Rainwater Management on Building Environment (2011, Draft)

Regarding rainwater infiltration well in a housing site, the following regulation and standards can be referred.

- *PerGub No. 20/2013 Tentang Sumur Resapan*
  (Governor Regulation No. 20/2013 on Rainwater Infiltration Well)
- *SNI* 03-2453-2002: *Tata Cara Perencanaan Sumur Resapan Air Hujan untuk Lahan Pekarangan*
  (Indonesian National Standard on Planning of Rainwater Infiltration Well in a Housing Site)
- *SNI* 06-2459-2002: *Spesifikasi Sumur Resapan Air Hujan untuk Lahan Pekarangan*
  (Indonesian National Standard on Specification of Rainwater Infiltration Well in a Housing Site)

CHAPTER 6 SPATIAL UTILIZATION CONTROL BASED ON THE SPATIAL PLANNING

6.1 Necessity of Land Use Control

In the CFMP, the unregulated peak discharge in 2030 at Manggarai Water Gate point is estimated based on the available data of spatial plans in 2011 for the examination of structural measures for flood control. Therefore, if the projected urbanization ratio in 2030 exceeds that in the spatial plans, it is necessary to re-estimate the unregulated peak discharge at Manggarai Water Gate point and to review the plan, location and scale of structural measures based on this re-estimation, which might require the additional investment to structural measures.

In order to avoid the above, it is required to properly regulate the land use in the basin in accordance with the spatial plans from the following viewpoints.

- Prevention from unregulated development of urban area and settlement area
- Achievement of target areas of open green space
- Preservation of border areas of river and pond (*Situ*) and other protected areas

6.2 Issues

Including the Presidential Regulation No. 54/2008 on Spatial Planning in Jabodetabekpunjur, the existing regulations regarding the formulation of spatial plans are consistent with the regulations for the preservation of the related protected areas and border areas of river and pond (*Situ*). In addition, those regulations stipulate the necessity to secure a certain area of open green spaces and other non-utilized areas. Therefore, it is recognized that the regional spatial plans prepared by the local governments based on those regulations have effectiveness for the runoff control as well. Besides, the Government Regulation No.26/2008 on National Spatial Planning stipulates "*zero delta Q*" policy which requires runoff control at developed lands.
On the other hand, several issues are identified to disturb the smooth practice of the land use control based on the spatial plans. The followings are the identified issues.

- Each local government in the Ciliwung River Basin has used the different land use classification in spatial plan. Therefore, it is difficult to compare the planned land use between several local governments. Also, information on watershed boundary is not included in the spatial plan.
- Detailed spatial plans which are utilized as a base for land use control have not been formulated. Therefore, regional development plan or basis of housing permission may not consistent with regional spatial plan.
- Border areas of rivers and ponds (*Situ*) have not been determined and indicated at sites.
- Even though incentives, disincentives and penalties for strict land use control were stipulated in the Law No. 26/2007 on Spatial Planning, Local regulations or guidelines for implementation of land use control by local governments have not been formulated.
- Observation and monitoring activities to find and correct the inappropriate land use are not fully implemented by staff of local government.

6.3 Proposal for Smooth Implementation of Land Use Regulation

For the implementation of the CFMP, the further measures for proper land use control are proposed as follows.

a) In order to evaluate the land use plan prepared by each local government in a unit of river basin, the common standard of land use classification in JABODETABEKPUNJUR area shall be formulated.

b) It is necessary to complete the formulation of detailed spatial plans promptly which is utilized as a base for land use regulation.

c) For the clarification of areas to be preserved, the border areas of rivers and ponds (*Situ*) shall be

clarified and indicated at sites.

d) Local governments are required to make further efforts to enhance the consistence of land use policy in regional development plans (mid-term regional development plan (RPJMD) and annual regional development plan (RKPD)) with spatial plans (general spatial plan (RTRW) and detailed spatial plan (RDTR)).

e) Regarding the issuance of building permits by the local governments, it is necessary to formulate the guidelines and implementation regulations including the following subjects for the strict operation of existing laws and regulations:
   - Procedures regarding the reference of land use plans and the confirmation of rainwater storage and infiltration facility installation
   - Penalty in case of land use change without prior approval
   - Provision of incentive/disincentive to the private sector for the smooth land use control

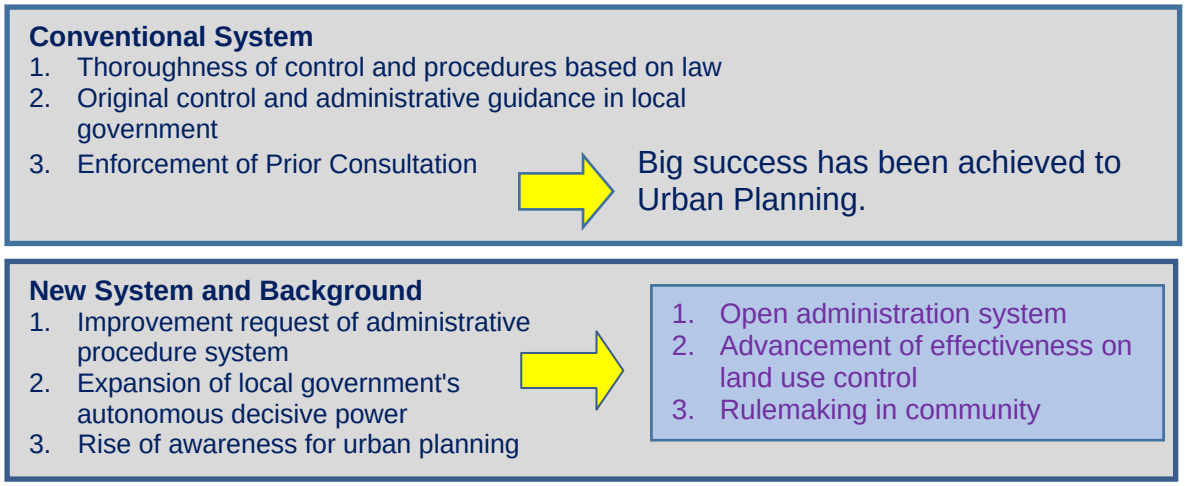
f) It is necessary to strengthen the monitoring activities to find and correct the undesignated land use.

CHAPTER 7 LAND USE CONTROL IN JAPAN

7.1 Land Use Control System

System of the land use control in Japan is summarized as follows. In this section, conventional control system and new control system which reflected the delegation of power from the central government to the local government are shown and explained.

In conventional implementation system, law and its original regulation guideline based on the law in each regional government were formulated and instructed. When developers apply to the local government for a large scaled facility and building stipulated in guideline, they have to carry out a procedure on consultation with the local government in advance of legal procedure based on the law. In recent years, from growing interests among communities in urban development plan and requests for improvement of administrative procedures, open administration system, and advancement of effectiveness on land use control as well as rulemaking among communities have been developed at community level.



Source: Revised based on Toyonaka City Planning (On the web-site)

Figure 7.1-1 Conventional System and New System on Land Control System in Japan

In new system, the local regulation about a new land use control is newly enacted on the basis of higher plans, such as city planning law. The directions and the contents of land use control system are shown in the following table.

Table 7.1-1 Directions and Descriptions on Land use control System

Directions for System	Description of System
1.Appropiate control and guidance on development activities	1) Making system for prior consultation
	2) Making system on prevention of disputes and adjustments
	3) Making system on appropriate control and guidance
2.Dissemination on land use information	1) Implementing land use basic investigation
	2) Dissemination on land use plan on the web-site
	3) Restriction on development activities, input from residents on illegal activities
3.Promotion of rulemaking among communities on land use (Public participation)	1) Support towards formulation on land development plan
	2) Reflection of resident opinion in development plan

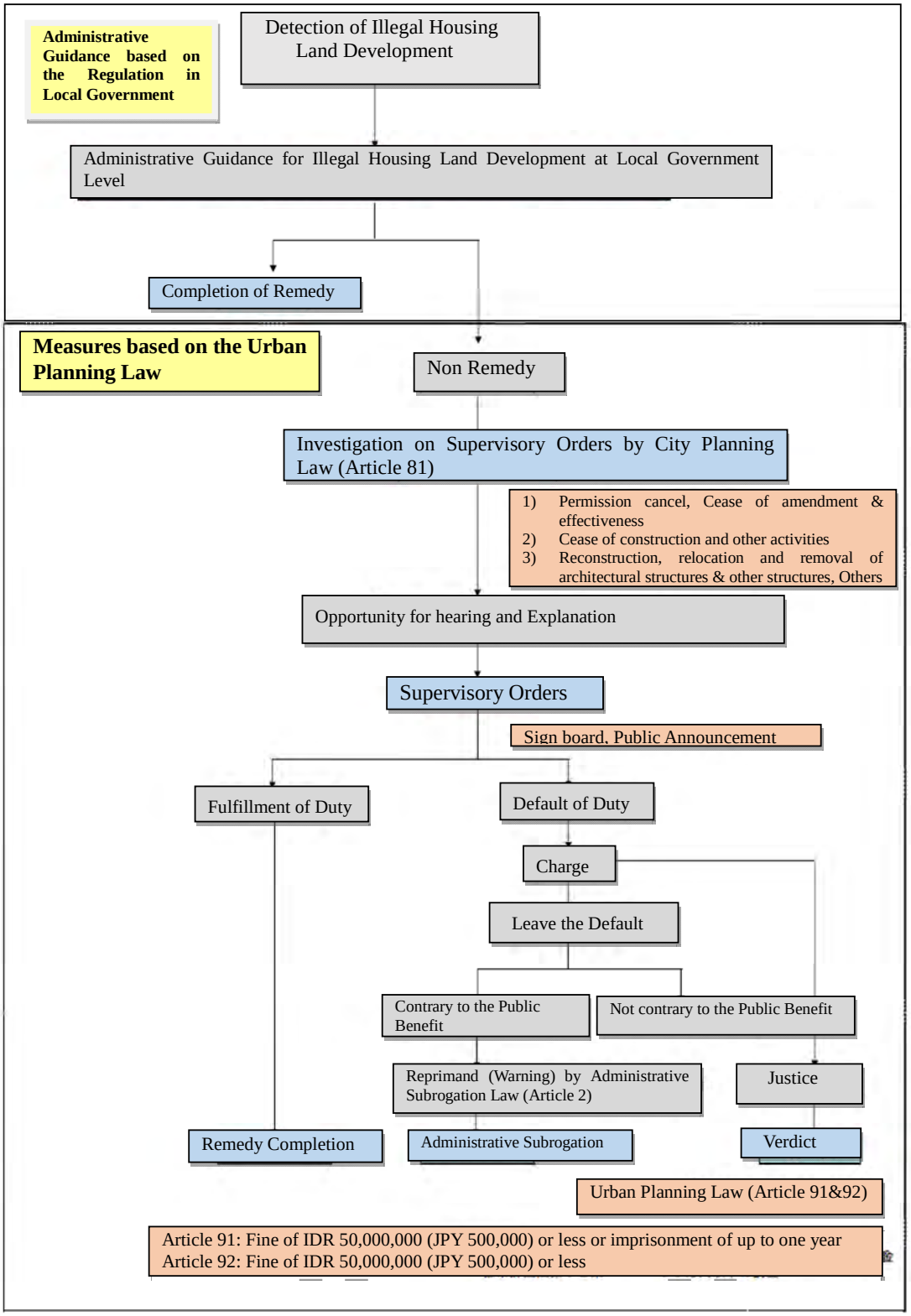
Source: Revised based on Toyonaka City Planning (On the web-site)

7.2 Regulations for Land Use Control

7.2.1 Criminal Sanctions and Administrative Direction

The correspondences against illegal activities on development activities in Japan are shown as follows. As major illegal activities, they are the unapproved construction, change of construction conditions after permission of construction and construction without permission. In the Urban Planning Law in Japan, criminal provisions are stipulated and subjected as supervisory orders for illegal activities, and cancellation of permission, cancellation of effect, and orders for improvement and reconstruction. Furthermore, when not following these orders, it is the regulation which can impose criminal sanction of imprisonment and can collect a fine.

Taking into account such conditions, illegal activities have been occurred resulting from not only intentional activities but not having full knowledge of negligence of system. Accordingly, the system which gives priority to correction by administrative guidance is first taken before imposing legal sanctions. This system gives administrative guidance, before imposing legal sanctions, and it is defined as regulation in local government. Procedures of the administrative guidance by the urban planning law and the regulation in local government are shown in the following figure.



Source: Kogoshima City Handling Manual for Illegal Land Development Activities

Figure 7.2-1 Positioning of Administrative Guidance and Application Procedures for Criminal Sanction in Urban Planning Law in Japan

In the above-mentioned flow, it is a criminal clause about those who broke orders (cancellation of permission, change, the stop of effects, prohibition of construction, etc.) based on the regulation of Article

81 of Urban Planning Law, and one or less year of imprisonment or IDR 50 million or less fine shall be subjected according to the violation code.

7.2.2 Regulation of Restoring on Development Activities

With progress in urbanization, by rapid expansion in urban areas, open green space had been decreased and residential environment had been also getting worse in 1970's in Japan, In order to improve these phenomena, law on greening in urban area "Urban Greening Law" was enacted in 1973, and stipulated to regulate development activities in open green conservation spaces within designated urban planning areas.

According to article 8th in urban greening law, when performing activities, such as buildings and other structures, reconstruction, an extension, housing development, extraction of soil and stones, change of the land characteristics land, and felling of woods, it is stipulated that developer must be obtained the local government's permission. In the 2nd clause of same article, when it is admitted that there is necessity for conservation of open green space concerned, the local government can order forbidden, restricted actions, and required measures. When the above-mentioned matter is violated, the local government can order restoring with a considerable term. (in 9th article) The laws stipulating on restoration in Japan are shown in the following table.

Table 7.2-1 Article stipulated in Law on related Urban Planning

Name of Law	Article stipulated	Subjects & Facilities
Urban Park Law	27th Supervisory orders	Urban Park
Agricultural Land Law	51st Order for violate land transfer	Agricultural land(Transfer for housing、car space、road)
Natural Park Law	14th Order for restoring	National Park
Landscape Law	23rd Order for restoring	Excellent landscape for important building (Designs for form and color, height, area)
Waste Management Law	19th Investigation 19-3 Order for improvement 19-5,6 Order for taking measures	Illegal dumping

Sources: Ministry of Land, Infrastructures, Transportation and Tourism Ministry of Environment, Ministry of Agriculture, Forestry and Fisheries

In addition, when restoring is not made, each law also provides that the local government executes the administrative subrogation.

7.2.3 Measures for Securing Open Green Space in Built-up Area

In Japan, there are examples which are attaining roof greening, wall greening in building as well as tree planting in vacant lots. Although green area such as park and roadside trees was newly secured for 20 years from 1990 to 2010 in Nagoya of Japan, in the whole city region, open green space with area 2,140 ha was lost by land transfer in private land for 20 years. Greening (or tree planting) rate was 29.8% (9,730 ha in area) in 1990, it had become 23.3% (7,590 ha) in 2010. From the background of these, it is to enforce mandatory greening in private land, to carry out new construction of the building with site over a certain size of the “greening area system”.

(Built-up Area, Before Greening) (Built-up Area, After Greening)

Figure 7.2-2 Image for Greening Promotion Project (Nagoya City)

The method of greening is introduction of roof greening, wall greening, tree planting and ground cover ground, etc. These images are shown in the following figure.

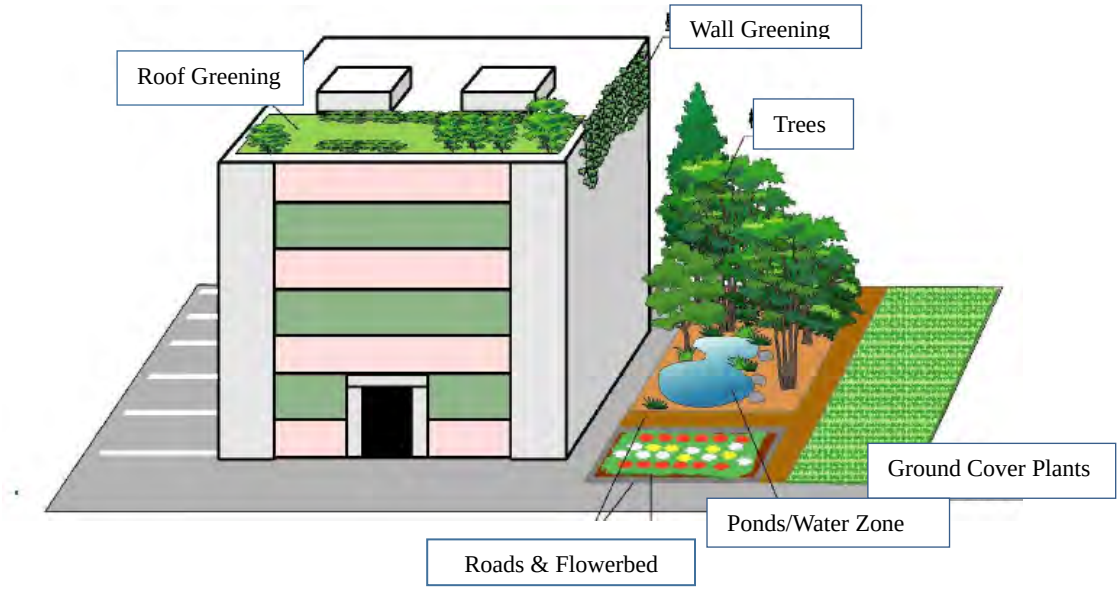


Figure 7.2-3 Implementation Example for Greening in Building Area (Nagoya City)

The details of regulation in green area system are as follows, and have imposed duty of greening about area of 300 m^2 or more in general. In the range which does not impose by law, it has imposed a duty of greening with the regulation so called “green city planning regulation”.

Table 7.2-2 Securable Measures for Open Green Space in Built-up Area (Nagoya City)

Classified Area by Law	Building Coverage (BC, %)	Area (A,m^2)	Required Greening Area (RGA, %)	Legal Ground
Urbanization Promotion Area	50≧BC	A≧300	More than 20%	Urban Greening Law
	60≧BC≧50	A≧300	More than 15%	Urban Greening Law
	80≧BC≧60	A≧500	More than 10%	Urban Greening Law
	BC≧80	A≧500	More than 10%	Local Regulation
Urbanization Control Area	—	A≧1,000	More than 20%	Local Regulation

Source: Greening Area System (Nagoya City in Japan)

In order to disseminate and support greening planning, the following support systems and lending systems

are started by the regulation in Nagoya City.

Table 7.2-3 Subsidy, Tax Reduction and Loan for Greening Promotion

Classification	Name of Programs	Descriptions
Public Subsidies	Subsidies of greening	Less than 1/2 of assistance for the expense of roof greening, wall greening, and ground tree planting (less than IDR 10,000,000 not more than IDR 500 million)
	Greening support project in Buildings	Less than 1/2 of assistance for the expense of roof greening, wall greening, and ground tree planting in building area (more than IDR 80 million)
	Greening support project in encouragement model type buildings	Less than 1/2 of assistance for the expense of roof greening, wall greening, and ground tree planting in office and stores (more than IDR 500 million)
	Hedge works support project	IDR 5,000 – 10,000/m2
Public Loans	Environmental conservation facilities fund loan	Money loan from the banking institutions to medium and small companies
Private Financing Cooperation	Housing Loan	Interest preferential treatment system in a loan

Source: Greening Area System (Nagoya City in Japan)

7.2.4 Subsidy System for Recovering Retention Function

Many local autonomies in Japan make it obligatory to implement runoff control measures in developed lands. The followings are some examples of those.

Table 7.2-4 Description on Duties for Installation of Runoff Control Facilities

Descriptions	Explanation/Condition to Apply
1. Prohibition of Increasing Activities for Runoff	Installation of runoff control facilities which develop 1ha or more
2. Prohibition of Land Filling	Notification on land filling which develop 1ha or more
3. Maintenance of Function for Runoff Control Facilities	Periodical appropriate maintenance works for facilities

Source: Saitama Prefecture

There are systems for supporting to install runoff control facilities such as a infiltration well and a storage tank in Japan. The implementation examples on subsidy systems by local autonomies in Japan are shown as follows. This subsidy system differs in the target area, condition of support and the ceiling of the subsidy depending on the government.

Table 7.2-5 Examples of Subsidy Systems by Local Governments in Japan

Name of the Government	Target Building for Subsidies	Target Facilities	Ceiling of Subsidies (IDR) IW: Infiltration Well SF: Storage Facility	Achievement
Ichikawa City(Chiba)	House (Existing & New Construction)	Infiltration well(IW), Storage Facilities(SF)	IW: 20,0000,000 SF: 2,500,000	IW: 123 SF: 41 (As of 2005)
Koganei City (Tokyo)	Existing house	Infiltration well(IW)	IW: 40,0000,000	IW: 2,820 (As of 2005)
Sagamihara City (Kanagawa)	House (Existing & New construction)	Infiltration well(IW)	IW: 1,000,000/well (for Existing house) IW: 700,000/well (for New construction)	IW: 1,192 (As of 2005)
Iwaki City (Fukushima)	House (Existing & New construction)	Infiltration well(IW) Storage Tank(ST) Storage Tank Transfer from Septic Tank (STT)	IW: 2,500,000 (for 4 wells) ST: 5,000,000 STT: 20,000,000	

Source: Manual on Installation of Rainfall Storage Infiltration Facilities in Housing (ARSIT, 2006)
Conversion Rate for IDR (Indonesian Rupiah) from JPY (Japanese Yen): 100 IDR= 1 JPY

As of 2011, 205 local autonomies introduce this kind of subsidy system for assisting the installation of rainwater storage and infiltration tank, infiltration well, infiltration trench and permeable pavement. Establishment of a fund for basin management is another way of assistance from the government. Kumamoto City government established the fund to promote groundwater conservation measures for neighboring 15 towns and villages. Description of the fund is shown as follows.

Table 7.2-6 Kumamoto City Groundwater Conservation Fund

1.Name of Fund	Kumamoto City Groundwater Conservation Fund
2.Purpose of Foundation	Conservation of groundwater and spring water
3.Owner and Reserve	Kumamoto City IDR 95,000,000,000 (for 10 years)
4.Components of the program	1) Countermeasures for groundwater conservation (Achieved subsidy for installation of infiltration well, IDR 691,000,000 for 1,493 wells)
	2) Reforestation project for recharge of water
	3) Land Acquisition of Forest Area
	4) Educational campaign and dissemination activities on groundwater conservation

Source: Web sites and Manual on Installation of Rainfall Storage Infiltration Facilities in Housing (ARSIT, 2006)
Conversion Rate: 100 IDR= 1 JPY

7.3 Applicable Measures for the Ciliwung River Basin

7.3.1 Securing Open Green Spaces

Procuring lands for open green spaces in the urbanized the Ciliwung River Basin takes an extended period. In order to cope with the problem, roof greening, wall greening and tree planting in vacant lots for existing buildings may be promoted. For dissemination of these measures in private sector, subsidization scheme and preferential tax treatment need to be established.

7.3.2 Disseminating Rainwater Storage and Infiltration Facility

In order to promote the installation of rainwater storage and infiltration facilities, the existing subsidization scheme for rainwater infiltration well (*sumur resapan*) installation managed by Development Coordination Agency of JABODETABEKJUR (*BKSP*) needs to be disseminated. Also, the scheme's range of application needs to be expanded to promote installation of the other runoff control facilities such as a rainwater storage tank. Besides, preferential tax treatment needs to be established for dissemination of the runoff

control measures in private sector.

7.3.3 Supervising Development Action

For supervising development action and imposing a penalty for inappropriate development, the guidelines and implementation regulations discussed in section 6.3, and a system for supervising land use situation need to be established as soon as possible.

Directorate General of Water Resources,
Ministry of Public Works
Republic of Indonesia

THE PROJECT FOR CAPACITY DEVELOPMENT OF JAKARTA COMPREHENSIVE FLOOD MANAGEMENT IN INDONESIA

TECHNICAL COOPERATION REPORT

COMPREHENSIVE FLOOD MANAGEMENT PLAN
ANNEX-3
RUNOFF CONTROL

OCTOBER, 2013

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

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Directorate General of Water Resources,
Ministry of Public Works
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Exchange Rate applied in this Report

As of September, 2013

USD 1.00 = IDR 10,929.766

USD 1.00 = JPY 98.04

The Project for Capacity Development of
Jakarta Comprehensive Flood Management
in Indonesia

Technical Cooperation Report
Comprehensive Flood Management Plan
Annex-3 Runoff Control

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CHAPTER 1 RUNOFF CONTROL MEASURES IN THE BASIN

1.1 Outline of Runoff Control Measures in the Basin

The outlines of runoff control measures proposed in the CFMP are summarized as follows.

- In order to minimize the additional runoff discharge from the new development areas in the Ciliwung River Basin, in accordance with the "*zero delta Q*" policy stipulated in the Government Regulation No. 26/2008, all the applicable runoff control measures shall be actively implemented.
- The runoff control facilities are mainly composed of "Rainwater Storage Facility" which temporarily stores the rainwater or river water and gradually flows the stored water to the downstream, "Rainwater Infiltration Facility" which recharges the rainwater into the ground, and "Rainwater Storage and Infiltration Facility" which has the combined functions of both.
- The small scale storage facility does not function to reduce the peak discharge sufficiently since it will be filled by the water before the peak discharge in the 50-year return period rainfall. Therefore, in the CFMP, the Target Volume for the runoff control facility in the Ciliwung River Basin is set based on the rainwater infiltration facility and rainwater storage and infiltration facility to secure the rainwater infiltration even after the facility is filled by the rainwater. The flood control effect of those facilities is estimated at the Manggarai Gate point.
- In accordance with the existing legislatives (Governor Regulation of DKI Jakarta No. 20/2013) and case studies, the applicable Unit Amount and the Target Volume for the installation of runoff control facilities from 2008 to 2030 are estimated. As a result, it is clarified that the expected flood control effect at Manggarai Water Gate point is approximately 70 m^3/s in case that the rainwater infiltration facility and rainwater storage and infiltration facility with the total volume of about 2.9 million m^3/s are installed in the Ciliwung River Basin.

1.2 Outline of Runoff Control Facility

Even though the various runoff control facilities exist, they can be categorized to 2 types: storage facility and infiltration facility.

The storage facility is the facility to control the runoff discharge by storing the rainwater temporarily and releasing the stored water to the downstream gradually. The infiltration facility functions to recharge the rainwater into the ground.

Storage facility is also divided into the following two categories.

- Off-site storage facility which collects and stores rainwater through channel or river
- On-site storage facility which stores rainwater directly consisting of storage facility and infiltration facility

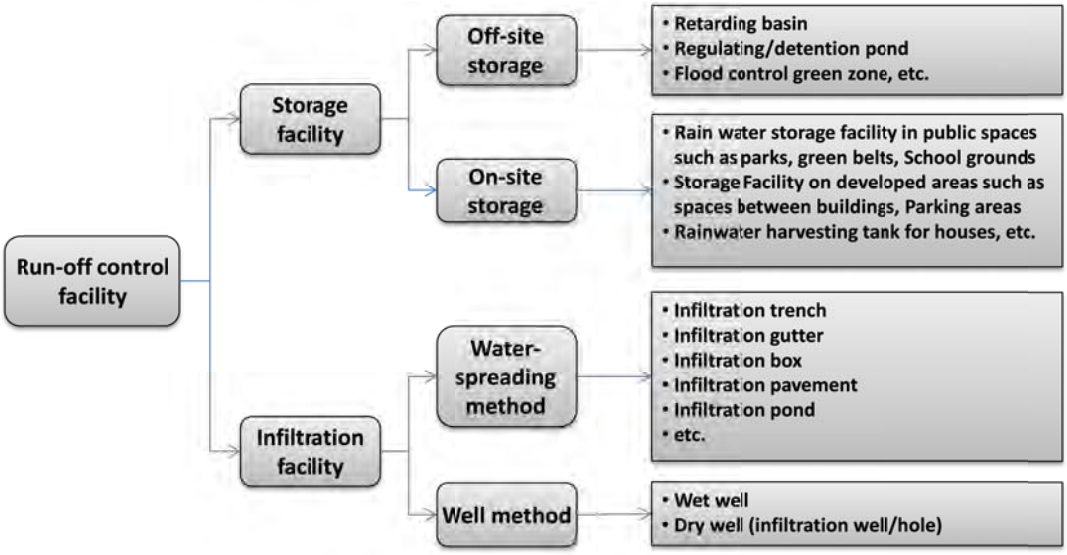


Figure 1.2-1 Runoff Control Facility

The examples of major runoff control facilities are shown below.

Utilized as Tennis Court during Normal Time | Storage Facility in Jakarta

Figure 1.2-2 Examples of Off-site Storage Facility

Example of On-site Storage Facility

Figure 1.2-3 Examples of On-site Storage Facility

Infiltration Inlet and Trench
(Example in Japan)

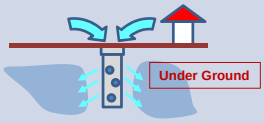
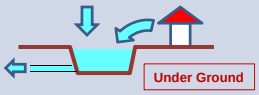
Infiltration Facility
(Example in Bogor)

Figure 1.2-4 Examples of Rainwater Infiltration Facility

1.3 Target Facility for Evaluation of Flood Control Effect in CFMP

The functions of storage facility and infiltration facility are summarized as follows.

Table 1.3-1 Characteristics of Infiltration Facility and Storage Facility

Item	Infiltration Facility	Storage Facility
Schematic Diagram		
1. Major Function	• To reduce the runoff volume by accelerating the infiltration of rainwater to underground. • To contribute to recharge of groundwater	• To reduce the runoff volume by storing the rainfall temporarily.
2. Key Consideration for Planning	The following places needs to be avoided. • A place where water is difficult to infiltrate • A steep terrain where ground may become loose and cause landslide	Except for small facility such as a rainwater harvesting tank, a downstream channel has sufficient flow capacity .
3. Ceiling on Performance	Even if the facility is filled up, the amount of infiltration can be taken into account as runoff control effect.	The facility is effective until it is filled up.
4. Type of Facilities	• Infiltration Well (*Sumur Resapan*) • Infiltration Pond (*Kolam Resapan, Situ*) • Infiltration Hole (*Biopori*) • Rainwater Storage Infiltration Facility proposed by JICA, etc.	[Off-site Facility] • Regulating Pond (Improved *Situ*) • Retarding Basin, etc. [On-site Facility] • Rainwater Harvesting Tank • Storage area at schoolyards and parks (in Japan), etc.
Evaluation Policy of Runoff Control Function	Even if the facility is filled up, the amount of infiltration can be taken into account as runoff control effect. Therefore, runoff control function of the infiltration facility can be considered in the CFMP for the Ciliwung River	With a large scale rainfall in the flood, the storage facilities may be filled up before the peak inflow. Therefore, runoff control function of the storage facilities shall be taken into account only in case of a small-medium scale rainfall with 1 to 10-year return period.

In order to minimize the additional runoff discharge from the new development areas in the Ciliwung River Basin, in accordance with the “zero delta Q policy” stipulated in the Government Regulation No. 26/2008, all the applicable runoff control measures shall be actively implemented.

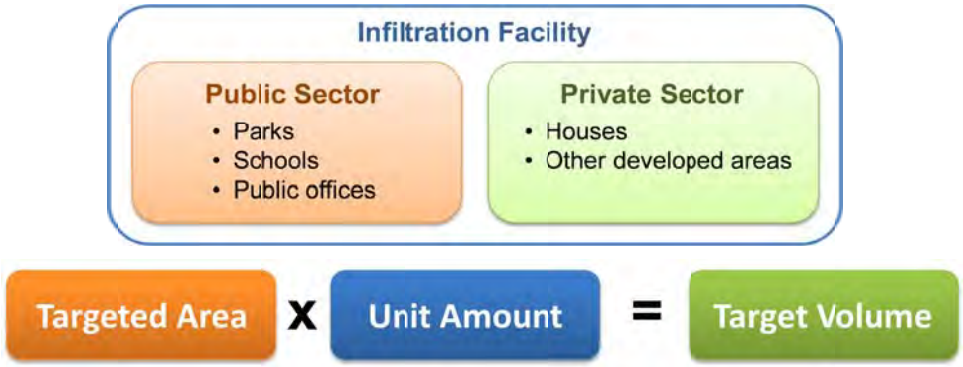
The small scale storage facility does not function to reduce the peak discharge sufficiently since it will be filled by the water before the peak discharge in the 50-year probable rainfall. Therefore, in the CFMP, the Target Volume for the runoff control facility in Ciliwung River Basin is set based on the rainwater infiltration facility and rainwater storage and infiltration facility to secure the rainwater infiltration even after it is filled by the rainwater. The flood control effect of those facilities is estimated at the Manggarai Water Gate point.

1.4 Target Volume of Infiltration Facility in Ciliwung River Basin

1.4.1 Estimation Method of Target Volume

(1) Estimation Method

With assumption that the land use by 2030 is equivalent to the projection set in the existing spatial plans, the target volume of infiltration facility in the Ciliwung River Basin is estimated as follows:.



1) The Target Volume of infiltration facility is set separately for public sector and private sector.
2) Park, school and public offices which have certain open areas are treated as public sector.
3) Houses and other areas to be developed privately are treated as private sector.
4) The target volume per ha is called as "Unit Amount", and the Unit Amount is determined separately for the public sector (public office, parks, school) and the private sector.
5) The available area for the installation of infiltration facility in consideration with the land use until the target year of 2030 is called as the "Targeted Area". The Target Volume is estimated by multiplying the Unit Amount by the Targeted Area.

Target Volumes for public sector and private sector are estimated as follows.

1) Public Sector

- Since the available spaces in park, school and public offices are different for each, the Unit Amount is estimated based on site survey (see in Table 1.4 2, Figure 1.4 2 and Table 1.4 3).
- Targeted Area by 2030 is estimated as follows (see Table 1.4 4).
  - Area where infiltration facility can be installed is estimated out of current public sector area.
  - Future public facility area is estimated assuming that population growth rate of each city/regency is same as increasing rate of the public sector.
- Target Volume is estimated by multiplying the Unit Amount by the Targeted Area (see Table 1.4-6).

2) Private Sector

- Residential and other areas to be developed by the private sector are selected as target facility for infiltration facility installation.
- Unit Amount is set based on the Governor Regulation of DKI Jakarta No. 20/2013 on the controlled rainwater volume by infiltration well (*Sumur Resapan*) depending on the roof area of the building (see Figure 1.4-4).
- Targeted Area by 2030 is planned in the development area of the urbanization (urban area and settlement area) from 2008 to 2030 (see Table 1.4-6).
- Target Volume is estimated by multiplying the Unit Amount by the Targeted Area in each local government area (see Table 1.4-8).

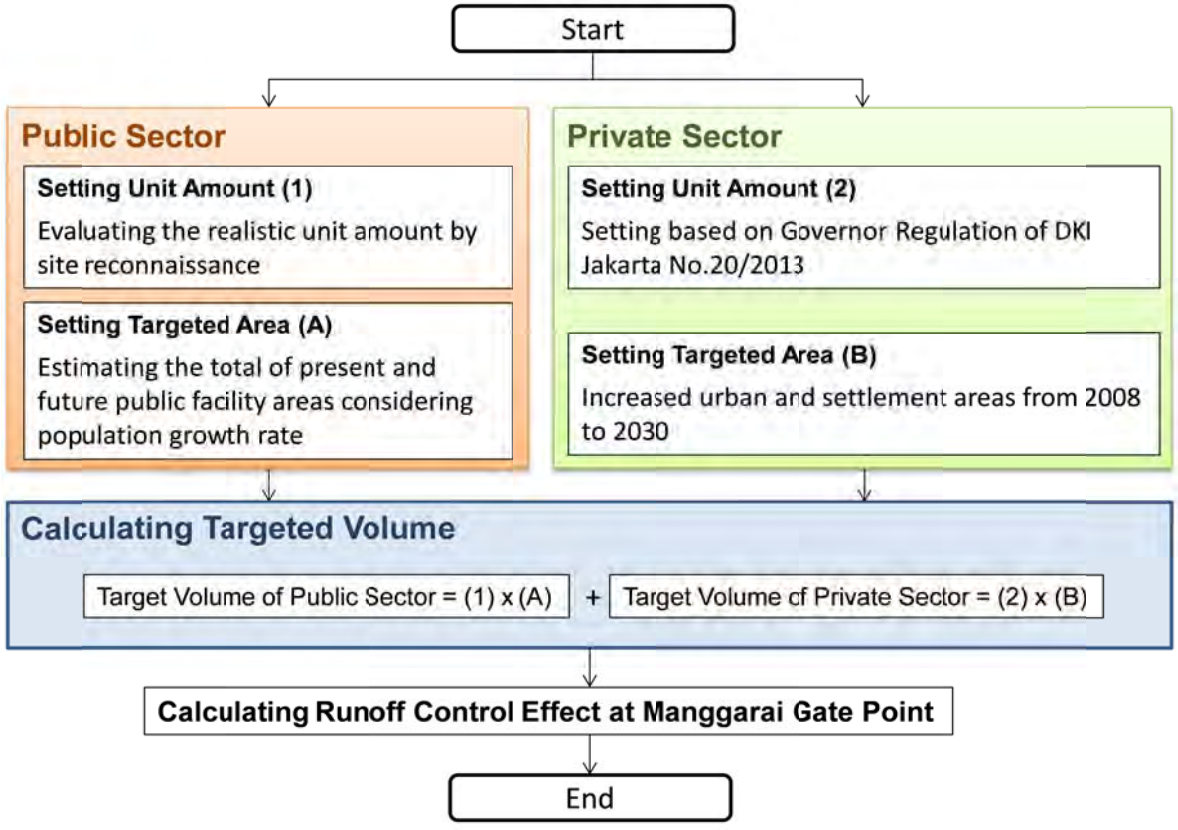


Figure 1.4-1 Workflow of Estimation of Target Volume of Infiltration Facility

(2) Estimation Condition

The original unit and the area for facilities planning utilized in calculation are set up shown below.

Table 1.4-1 Conditions for Estimation of Target Volume of Infiltration Facility

Public Sector	Unit Amount	Based on the site reconnaissance
		School: 140 m^3/ha, Public office: 100 m^3/ha, Park: 150 m^3/ha
	Targeted Area	(Present Area) × (1 + population growth rate by city/regency)
Private Sector	Unit Amount	Scenario 1：Values are set up based on the installed results of Infiltration Facilities in DKI Jakarta
		160 m^3/ha
		Scenario 2：Intermediate value of Scenario 1and Scenario 3
		220 m^3/ha
		Scenario 3 : Based on Governor Regulation of DKI Jakarta No. 20/2013
		280 m^3/ha
	Targeted Area	Increased urban and settlement areas from 2008 to 2030

1) Estimation of Unit Amount

a) Public Sector

○School

Table 1.4-2 Estimation of Unit Amount (School: Case Study in South Jakarta)

Name of School	Area (m^2) (a)	Infiltration Well (Number)	Volume for Infiltration Well (m^3) (b)	Unit Amount (m^3/ha) (1)= (b)/(a) x 1,000
SMK NGGERI 30	5,200	7	42	81
SMPN 11	4,800	4	24	50
SMPN 2 SSN	4,000	5	30	75
SMPN 28	4,000	7	42	105
SDN Bambu Apus	5,450	10	60	110
SDN Kp. Tengah	8,480	42	252	297
SDN Percontohan Lubang Buaya	3,830	11	66	172
Average				140

Source: JCFM Project

○Public office

Figure 1.4-2 Estimation of Unit Amount (Public Building: Case Study in Bogor Regency)

○Park

Table 1.4-3 Estimation of Unit Amount (Park: Case Study in South Jakarta)

Name of Park	Area (m^2) (a)	Infiltration Well (Number)	Volume for Infiltration Well (m^3) (b)	Unit Amount (m^3/ha) (1)= (b)/(a) x 1,000
Taman Eks SPBU Jl. Mataram	1,929	4	24	124
Taman Eks SPBU Jl. Mataram	1,285	4	24	187
Taman Rumah Dinas Jabatan Wagub	797	2	12	151
Average				150

Source: JCFM Project

Figure 1.4-3 Layout of Infiltration Facility in Park (Case Study)

Taman Rumah / Dinas Jabatan Wagub

b) Private Sector

○**Scenario1**

・Values are set up based on the installed results of percolation wells in DKI Jakarta.

Unit Amount：Implemented Volume(m3) / Implemented Area(m^2) = 405,222 / 25,803,746
= 157 m^3/ha≒160m^3/ha

Table 1.4-4 Values of the infiltration wells installed in DKI Jakarta

Kecamatan	Implemented Volume （m^3）	Implemented Area （m^2）
Jakarta Pusat	328,118	3,997,031
Jakarta Timur	75,885	14,743,825
Jakarta Selatan	1,219	7,062,890
Total	405,222	25,803,746

○**Scenario3**

- Unit Amount is estimated based on runoff control volume by roof area stipulated in Governor Regulation of DKI Jakarta No. 20/2013.
- Applying 6 m^3 control volume for roof area of 125 m^2, Unit Amount is 288 m^3/ha assuming building coverage ratio of 60 %.

Unit Amount: $V(m^3)/Area(m^2)= 6/(125/0.6)$
$= 288\ m^3/ha \fallingdotseq 280 m^3/ha$

Runoff Control Amount by Roof Area

No.	Roof Area (m^2)	Volume (m^3)
1	= 50	2
2	51 - 99	4
3	100 - 149	6
4	150 - 199	8
5	200 - 299	12
6	300 - 399	16
7	400 - 499	20
8	500 - 599	24
9	600 - 699	28
10	700 - 799	32
11	800 - 899	36
12	900 - 999	40

Figure 1.4-4 Unit Amount of Private Facility

2) Estimation of Targeted Area

a) Public Sector

Table 1.4-5 Estimation of Targeted Area for Public Sector by City/Regency

Regencies(Kec, Kota, Kab.)	Present Area (km^2)				Population Growth Rate	Future Area (km^2)			
	Public Offices	Parks	Schools	Total		Public Buildings	Parks	Schools	Total
Jakarta Pusat	0.037	2.037	0.088	2.162	1.303	0.048	2.654	0.115	2.818
Jakarta Timur	0.022	1.363	0.472	1.858	1.303	0.029	1.777	0.615	2.421
Jakarta Selatan	0.061	2.661	1.961	4.683	1.303	0.079	3.467	2.556	6.102
Kota Depok	0.052	0.186	0.924	1.162	1.128	0.059	0.210	1.043	1.311
Kab. Bogor	0.081	0.561	0.232	0.874	1.121	0.090	0.629	0.261	0.980
Kota Bogor	0.046	0.088	0.209	0.343	1.096	0.051	0.096	0.229	0.375
Total in Basin	0.299	6.896	3.887	11.082	1.232	0.357	8.832	4.817	14.006

○Public Sector

Table 1.4-6 Estimation of Targeted Area for Private Sector by City/Regency

Regencies	Urbanization Area（km^2）		
	2008 (at Present)	2030 (in future)	Increasing Area
Jakarta Pusat	21.630	21.630	0.000
Jakarta Timur	17.990	20.114	2.124
Jakarta Barat	8.800	8.800	0.000
Jakarta Selatan	71.610	73.374	1.764
Jakarta Utara	9.560	9.560	0.000
Kota Depok	40.930	58.823	17.893
Kab. Bogor	18.300	80.944	62.644
Kota Bogor	33.660	44.756	11.096
Total in Basin	222.480	318.001	95.521

(3) Target Volume of Infiltration Facility

The calculated results of the maintenance target volume for the percolation facilities are shown below. As land use change and the progress of flood control plans will not be certain in future, the maintenance target volume for private facilities at present adopts the value in the scenario 3 which has the largest amount among the scenarios. The maintenance target volume for each administrative agencies is shown in Table 1.4-9.

Table 1.4-7 Estimation of Target Volume of Infiltration Facility for Public Sector by City/Regency

Item		Jakarta Pusat	Jakarta Timur	Jakarta Selatan	Kota Depok	Kab. Bogor	Kota Bogor	Total Basin
Target Area (m^2)	Public offices	48,472	29,187	79,222	58,769	90,465	50,690	356,805
	Parks	2,654,195	1,776,582	3,466,680	209,884	628,699	96,135	8,832,174
	schools	114,958	614,843	2,555,651	1,042,517	260,585	228,562	4,817,116
Unit Amount (m^3/ha)	Public Offices	100m^3/ha						
	Parks	150m^3/ha						
	schools	140m^3/ha						
Target Volume (m^3)	Public offices	480	290	790	580	900	500	3,540
	Parks	39,810	26,640	52,000	3,140	9,430	1,440	132,460
	schools	1,600	8,600	35,770	14,590	3,640	3,200	67,400
	Total	41,890	35,530	88,560	18,310	13,970	5,140	203,400

Table 1.4-8 Estimation of Target Volume of Infiltration Facility for Private Sector by City/Regency

Item		Jakarta Pusat	Jakarta Timur	Jakarta Selatan	Kota Depok	Kab. Bogor	Kota Bogor	Total Basin
Target Area (km^2)	Settlement	0.000	1.184	1.646	6.734	51.708	7.781	66.223
	Urban	0.000	0.940	0.118	11.159	10.936	3.315	2.585
	Total	0.000	2.124	1.764	17.893	62.644	11.096	95.521
Unit Amount (m3/ha)	Scenario1				160m^3/ha			
	Scenario2				220m^3/ha			
	Scenario3				280m^3/ha			
Target Volume (m^3)	Scenario1	0	35,900	29,800	302,400	1,058,700	187,500	1,614,300
	Scenario2	0	46,700	38,800	393,600	1,378,200	244,100	2,101,400
	Scenario3	0	59,500	49,400	501,000	1,754,000	310,700	2,674,600

Table 1.4-9 Estimation of Target Volume of Infiltration Facility by City/Regency

Item		Jakarta Pusat	Jakarta Timur	Jakarta Selatan	Kota Depok	Kab. Bogor	Kota Bogor	Total Basin
Target Volume (m^3)	Public facilities	41,890	35,530	88,560	18,310	13,970	5,140	203,400
	Private Facilities	0	59,500	49,400	501,000	1,754,000	310,700	2,674,600
	Total	41,890	95,030	137,960	519,310	1,767,970	315,840	2,878,000

1.4.2 Flood Control Effect by Runoff Control Facility

<Summary>

- By installing a number of rainwater storage and infiltration facilities including infiltration well (*Sumur Resapan*) whose total target volume is equivalent to 2,878,000 m^3 in the Ciliwung River Basin, the runoff control volume at Manggarai Water Gate point will be approximately 70 m^3/s.

<Explanation>

In accordance with the following method, the runoff control volume at Manggarai Water Gate point is estimated through the installation of a number of rainwater storage and infiltration facilities in the Ciliwung River Basin with infiltration volume of 2,878,000 m^3 in total (equivalent to the target volume in previous section).

(1) Runoff Calculation

a) It is assumed that most of the rainwater storage and infiltration facilities to be installed in the Ciliwung River Basin are infiltration well (*Sumur Resapan*). In addition, those wells are collectively simplified as one large rainwater infiltration facility which equally infiltrates the rainwater from the ground in the whole basin.

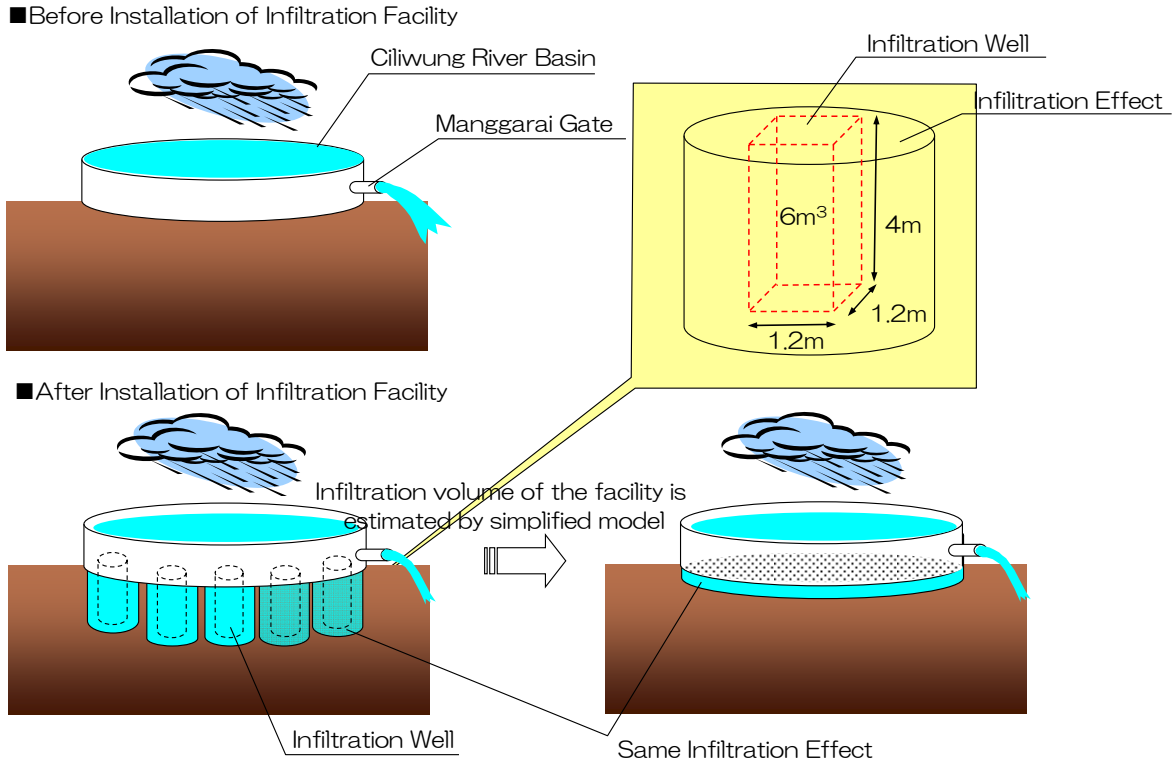


Figure 1.4-5 Conceptual Diagram for Evaluation of Runoff Control Effect by Several Infiltration Wells in the Basin

b) 24-hour infiltration volume by the above simplified facility (V_{p24}) is estimated based on the rainfall amount to be infiltrated from the ground (R_p) and basin area (A) as follows.

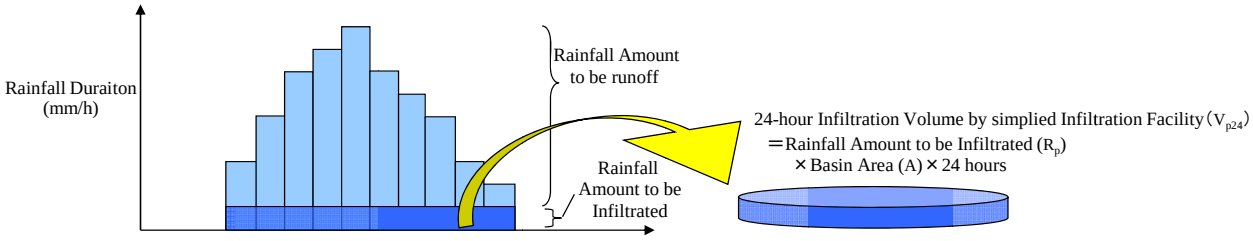


Figure 1.4-6 Estimation of 24-Hour Infiltration Volume by Simplified Rainwater Infiltration Facility

c) Several cases of rainfall amount to be infiltrated are assumed, and the runoff calculation is conducted for each case. Moreover, the relations among the following coefficients are examined: rainfall amount to be infiltrated (R_p), 24-hour infiltration volume by simplified infiltration facility (V_{p24}), runoff control volume at Manggarai Water Gate (Q_r), and controlled volume at Manggarai Water Gate (V_r). The controlled volume at Manggarai Water Gate is equivalent to the 24-hour discharge volume including the occurrence time of peak discharge.

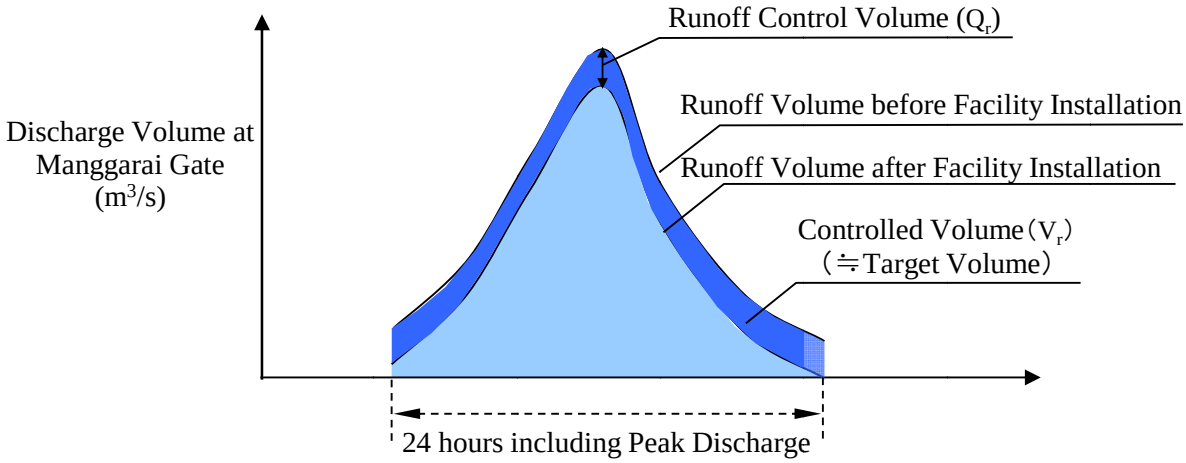


Figure 1.4-7 Conceptual Diagram of Runoff Control Effect by Infiltration Well

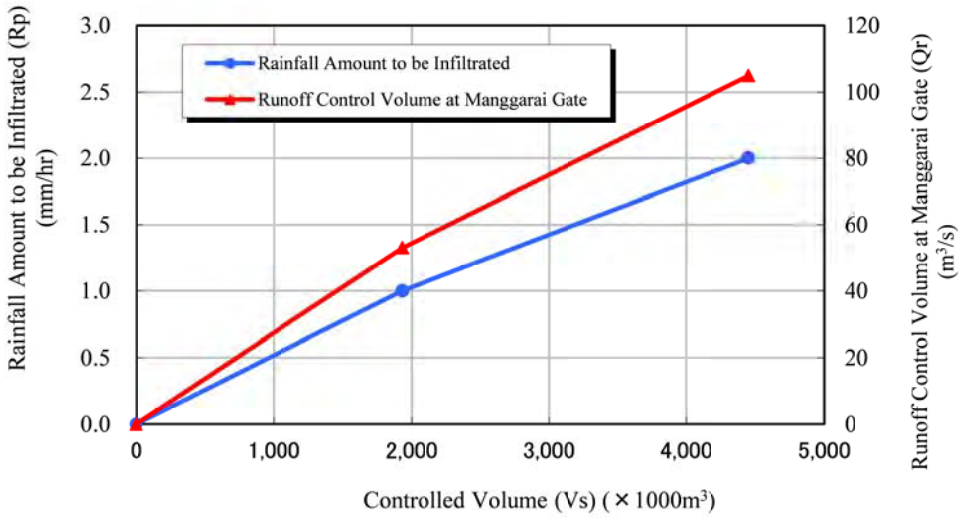


Figure 1.4-8 Relation between Runoff Control Volume at Manggarai Gate Point and Rainfall Amount to be Infiltrated

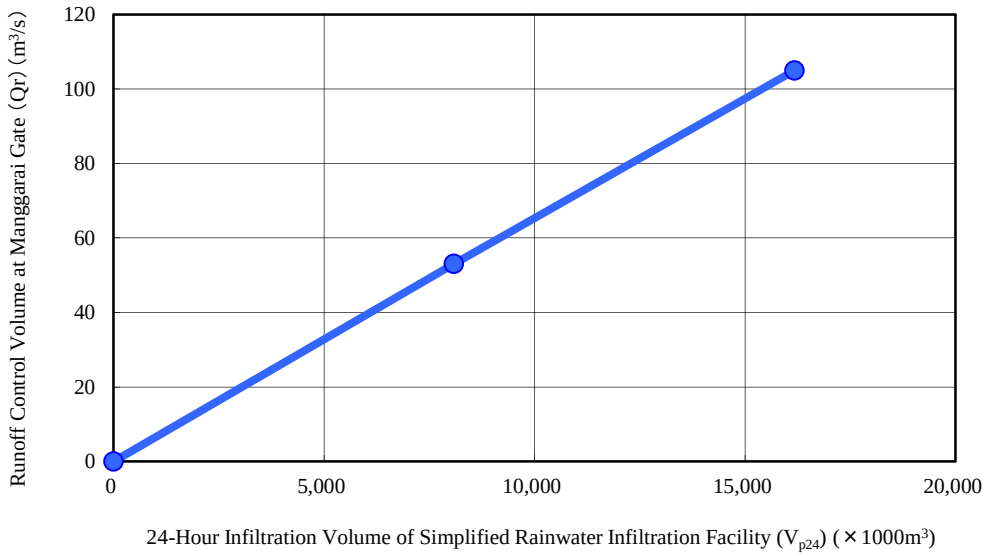


Figure 1.4-9 Infiltration Volume by Simplified Facility and Runoff Control Volume at Manggarai Gate Point

(2) Estimation of Runoff Control Volume

a) In case that the target volume of rainwater storage and infiltration facilities to be installed in the Ciliwung River Basin as set previously (2,878,000 m^3) is filled by the rainwater, it is considered the total controlled volume at Manggarai Water Gate (V_r) will be equivalent to this volume. Therefore, based on Figure 1.4-8and calculation, the runoff control volume at Manggarai Water Gate (Q_r) is estimated as "Q_r = 72 m^3/s", which is equivalent to 2,878,000 m^3 of runoff control volume (see Table 1.4-10).

(3) Confirmation of Infiltrated Volume by Rainwater Storage and Infiltration Facility

a) With the assumption that all the facilities are infiltration well, based on the average size and infiltration volume, the total infiltration volume from inside of infiltration well to surrounding underground areas is estimated by the following formula.

Total Infiltration Volume (V_f) = 2,878,000 m^3 (target volume) / 6 m^3 (volume of each infiltration well)
x 1.48 m^3 (permeability of each infiltration well*) x 24 hours

* permeability of each infiltration well is surveyed by JCFM project.

b) It is confirmed that the estimated total infiltration volume (V_f) is larger than the 24-hour infiltration volume by simplified rainwater infiltration facility (V_{p24}) which is equivalent to runoff control volume at Manggarai Water Gate (Q_r) estimated based on Figure 1.4-8 (see Table 1.4-10).

Table 1.4-10 Flood Control Effect by Runoff Control Facility

	Target Volume (×1,000m3)	Rainfall Amount to be Infiltrated (Rp) (mm/h)	Runoff Control Volume at Manggarai Gate (Qr) (m3/s)	Required Volume for Infiltrated Rainfall（Rp) (Vp24) (×1000m3)	Total Infiltration Volume (V_f) (×1,000m3)	Total Infiltration Volume (V_{p24}) > Required Infiltration Volume (V_f)
Rainwater Infiltration/Storage Facility	2,878	1.4	72	11,326	17,038	O.K.

1.5 Target for Installation of Storage Facility and Infiltration Facility per Unit Amount

In order to plan the installation of runoff control facility in a catchment area, the total facility volume shall be targeted as 500 m^3/ha.

According to the Japanese standard, the targeted volume for the installation of storage facility and infiltration facility in a developed catchment area is as follows. The targeted volume is set from the viewpoint of the realistic volume in the developed land.

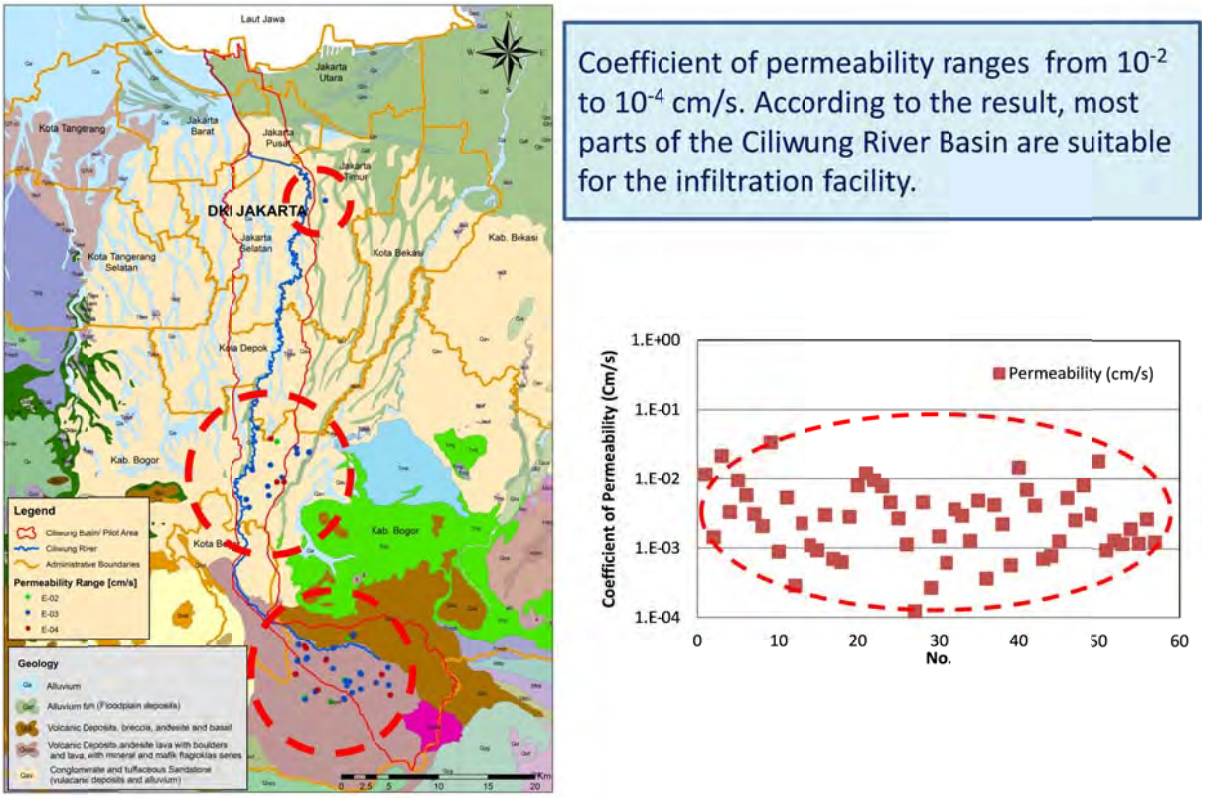
Table 1.5-1 Japanese Standard of Targeted Volume for Storage/Infiltration Facility

Catchment Area (ha)	0.05	0.10	0.30	0.50	1.00	>1.0
River Name						
Draft Guideline by *Cipta Karya* [1)]	1,200 m^3/ha					
Nakagawa&Ayase River	No Regulation	500 m^3/ha				950 m^3/ha
Shingashi River	No Regulation	500 m^3/ha				950 m^3/ha
Sakai River (Kanagawa)	No Regulation	Depend on Regulation for each Municipal/City				
Turumi River	No Regulation	600 m^3/ha				
Shinkawa River	600 m^3/ha					
Sakai River (Aichi)	600 m^3/ha					
Yamato River	No Regulation				300 m^3/ha	585 m^3/ha
Ina River	No Regulation					600 m^3/ha
Neya River	No Regulation	300 m^3/ha	400 m^3/ha			600 m^3/ha

Source:
1) Pedoman Teknis Pengelolaan Genangan Air Hujan pada Lingkungunan Bangunan Gedung (Draft), Directorate General of Human Settlements, 2010
2) Ministry of Land Infrastructure, Transportation and Tourism, Japan

1.6 Applicable Area for Installation of Rainwater Storage and Infiltration Facility

The installation location of infiltration well will be determined through the investigation of groundwater level and permeability in accordance with existing technical standard (Indonesian National Standard: SNI 03-2453-2002 for planning method of rainwater infiltration well in settlement areas). Besides, based on the survey results on the ground permeability in the Ciliwung River Basin conducted by the JCFM Project, it was identified that most areas in the basin are suitable for the installation of rainwater storage and infiltration facility.



Source: JCFM Project

Figure 1.6-1 Result of Permeability Test in Ciliwung River Basin

CHAPTER 2 BASICS STUDY for RUNOFF CONTROL MEASURES

2.1 The situation of the runoff control facilities preparation

2.1.1 The situation of the facilities preparation in Ciliwung River Basin

Many facilities are prepared in Ciliwung River Basin, such as situ (improvement) as the off-site facility and infiltration wells, regulating ponds and biopori as the on-site facility.

(1) Situ Improvements

There are many situs (in Indonesian for ponds) for water supply of irrigation, fish culture and domestic water supply in Ciliwung River. In progress of urbanization, paddy field areas have been decreased, such situs for irrigation have a possibility to transfer other purposes. In addition to the intended purpose for supply of irrigation, situs have also important roles such as place to provide space creation as a place of recreation for residents (fishing, boating), groundwater recharge and the preservation of the natural environment, and a multipurpose utilization is assumed.

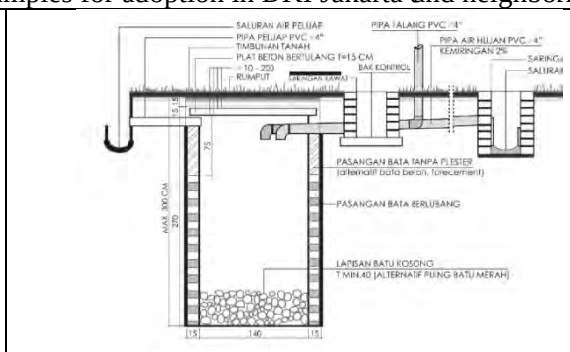
Source: Ciliwung-Cisadane River Basin Organization

Figure 2.1-1 Situ Improvement before and After (Situ Kelapa Dua)

(2) Infiltration Well

Infiltration well controls runoff by rainfall by making a well and making it permeable the shallow place of underground. While it carrying out runoff control, there is an effect also for recharging groundwater. There are most installation examples for adoption in DKI Jakarta and neighborhood.

Infiltration Well (Bogor)



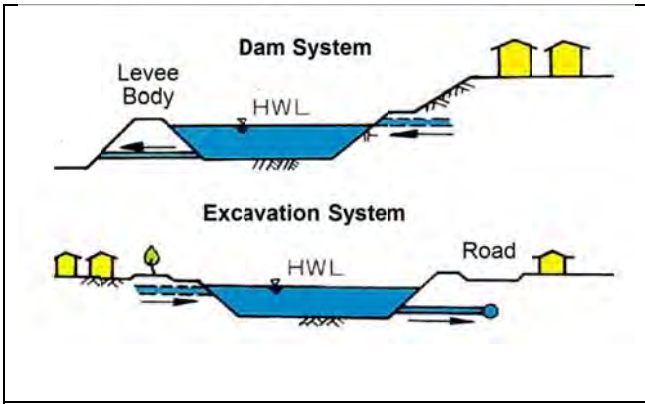
Schematic Drawing of Infiltration Well

Source: 1) Technical Guidelines for Rainwater Management on Building Environment (2011, Draft, Cipta Karya)
2) Total Solution, BBWS Cil-Cis, MPW, Indonesia

Figure 2.1-2 Infiltration Well

(3) Regulating Pond

Regulation pond is a facility which controls the increase of discharge to downstream in the river by storing temporarily runoff volume accompanying with development. In development areas, since storage and infiltration functions for runoff discharge decreases, then runoff increases. Therefore, by installing these facilities and influence of increasing runoff is reduced.



Type of Rainwater Regulating Pond

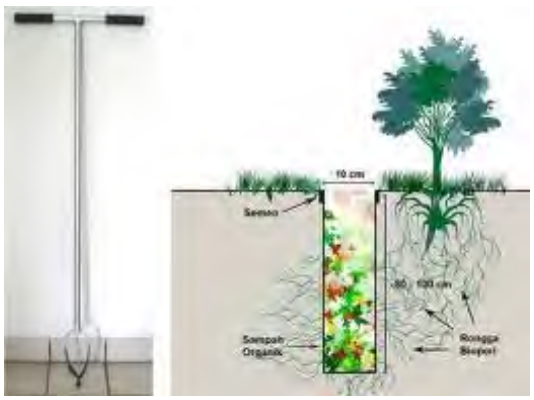
Regulating Pond (Jakarta Selatan)

Figure 2.1-3 Regulating Pond

(4) Biopori

Biopori is recommended as runoff control facilities in an individual residence or a park, and is infiltration hole with specifications 10cm in diameter, and 100cm in depth. It has the features that the structure is simple, digging instrument for hole being prepared, and kitchen garbage can been buried, recharging function for groundwater by storing and infiltration of rainwater.

Biopori (Small Hole)



Structure of Biopori and Digging Instrument

Figure 2.1-4 Biopro and Digging Instrument

2.1.2 Measures in DKI Jakarta

The outline about installation of infiltration well by the Regulation of Governor General Provisions on Development of Infiltration Well, DKI Jakarta No.68, 2005,(Peraturan Gubernur Provinsi DKI Jakarta Nomor 68 Tahun 2005 Tentang Perubahan Keputusan Gubernur Provinsi DKI Jakarta Nomor 115 Tahun 2001 Tentang Pembuatan Sumur Resapan) upon which it was formulated in 2005 is arranged below. In addition, although this regulation is reformed in 2013, there are little changes of contents. The outline of regulations and the facilities preparation situation are described below.

(1) Aims and Objectives

According to article 1, infiltration wells defined as artificial infiltration system that can collect rain water resulted from the land closure both the building floors and plastered or paved courtyard. The aim and objectives are the formulation of governor rule in order to optimize the manufacture of infiltration wells in the community which aims to hold, store and supply ground water and reduce storm water runoff to sewers and other water bodies. (Article 2)

(2) Obligation of Making the Infiltration Well

In article 4, the obligation of infiltration well construction is dealt, following persons have to construct well. Developers who will build on an area of over 5,000m^2 are required to prepare 1(one) percent (%) of the land to be used for an infiltration pond (Kolam Resapan).

a. every person in charge of building to cover the ground surface
b. each applicant for deep well users
c. every owners to construct building
d. user for groundwater more than 40 m (in depth from the ground)
e. every business industry that use groundwater.
f. developers who build an area of over 5,000m^2 required 1.0% of the land to be used for infiltration pond

In case of the location is not possible for construction, the local government will specify the replacement location of well. Each applicant for getting building permit (IMB) should make infiltration well. For the people who are not able to construct a well, local government can make a infiltration well communally. (Article 5 & 6)

(3) Installation of Well

For the construction of infiltration well, location requirements are shown in Article 7.

a. Infiltration well should be made in the area of the related building
b. Drainage channels leading to infiltration wells should be separate from the sewer.
c. Infiltration wells should be constructed in a location that stable soil structure and/or not steep.
d. Infiltration wells to be made off-site of landfill waste, the former landfill waste or soil containing pollutants.

If technically, the location to build the infiltration well cannot meet the requirements, then to the individuals and legal entities as well as Building Permit applicants shall provide compensation to the local governments. In case that the requirements are not fulfill as the requirements as the site of the infiltration wells because the buildings located on the site have a shallow water table less than 1 meter, make replacement infiltration wells in locations and greening tree planting in order to conserve water resources and another technology making replacement infiltration wells are recommended.

(4) Related Offices and Aegencies on Infiltration Wells

Related offices and agencies on installation of infiltration wells are shown in the following Table.

Table 2.1-1 Related offices and Agencies on Installation of Infiltration Well

Name of Relative Office (English)	Name of Relative Office (Indonesian)	Tasks or Duties
City Planning Office of Province DKI Jakarta & City Planning Office of Municipality	DTK, Dinas Tata Kota Provinsi DKI Jakarta, Suku Dinas Tata Kota Kotamadya	Task to publish: 1) Plan of City Planning(RTK, Rencana Tata Kota) 2) Building Layout Plan (RTLB, Rencan Tata Letak Bangunan) 3) Site Plan 4) Block Plan
Department of Planning and Building Control & Planning and Building Control Agency of Municipality	DP2B(Dinas Penataan dan Pengawasan Bangunan), Suku Dinas Penataan dan Pengawasan Bangunan Kotamadya	Task to issue: 1) Building Permit (IMB, Izin Mendirikan Bangunan) with obligation of making for Infiltration Well (IW) 2) Monitor the creation of IW
Department of Mines	Dinas Pertambangan	Implement: 1) Technical guidance for groundwater surface elevation maps 2) Monitoring of groundwater level fluctuation
Department of Public Works & Sub-Department of Public Works	DPU,(Dinas Pekerjaan Umum) Suku Dinas Perkerjaan Umum	Assess: 1) Environmental geological conditions of the area 2) Location of construction of IW
Administrative Office for Building and Local Government Building and its Municipality	KTBGP (Kantor Tata Bangunan dan Gedung Pemda), KTBGP Kotamadya	Assess: 3) Environmental geological conditions of the area Location of construction of IW
Environmental Management Agency and its Municipality	BPLHD (Badan Pengelilaan LIngkungan Hidup Daerah), BPLHD Kotamadya	Contribute to control and coordinate with the Municipality under the supervision of construction of IW.
Urban Administration Bureau	Biro ASP (Biro Adminisrrasi Sarana Perkottann)	Collects: 1) Data in the construction of IW 2) Provide guidance and direction 3) Solve problems related to the construction

Source) Regulation of Governor General Provisions on Development of Infiltration Well, DKI Jakarta No.68, 2005
IW: Infiltration Well

According to the above Table, in addition to the departments such as City Planning Office and Planning and Building Control Department (DP2B) related with urban planning, and issuing of the building permit, the Mine Department has tasks to implement technical guidance and advice related to groundwater, and the Public Works Department have to evaluate environment of geological condition of the area as well as location of infiltration wells. The Environmental Management Agency (BPLHD) contributes to control and coordinate with the Municipality under the supervision of construction of infiltration wells. Urban Administration Bureau (ASP) collects data on construction of infiltration wells and provides guidance for construction. They solve problems in times of conflict on construction of infiltration well.

Any person, legal entity and IMB applicant who does not carry the obligation for making wells are subjected to administrative sanctions in accordance with the legislation in force. (Article 13)

(5) Infiltration Facilities Installed in DKI Jakarta

The installation record arranged by Environmental Management Bureau is shown below. In addition, although carried out within each organization (Walikota) for installation, it is in the situation where data for installation reports do not gather easily. Number of Infiltration well is about 127,000 and the total capacity is 410,000m3 in volume. Infiltration ponds are concentrated in the north in Jakarta.

Table 2.1-2 Infiltration Facilities Record for Installation (DKI Jakarta, 2001-2010)

No.	Region	No. of Kecamatan	Infiltration Wells (SR)			Infiltration Ponds (KR)		
			Number	Volume(m3)	Volume per Site (m3/site)	Number	Volume(m3)	Volume per Spot
1	Jakarta Pusat	8	93,945	328,118	3.49	0	0	0
2	Jakarta Timur	10	32,993	75885	2.30	9	16,848	1,872
3	Jakarta Barat	8	418	3912	9.36	0	0	0
4	Jakarta Utara	6	168	166	0.99	15	19,478	1,299
5	Jakarta Selatan	10	378	1219	3.22	0	0	0
	Total/Mean	42	127,902	409,300	3.20	24	36,326	1,514

Source: Environment Management Office, DKI Jakarta (Badan Pengelolaan Lingkungan Hidup Daerah, BPLHD)

The installation record by Department of Industry and Energy (DIE) is shown below. Sites of infiltration well have been subjected at schools.

Table 2.1-3 Infiltration Facilities Record for Installation by DIE (DKI Jakarta, 2010-2012

Year	SDN		SMPN		SMAN		SMKN		Others		Total		Well Number per Site
	Sites	Wells	Sites	Wells	Sites	Wells	Sites	Wells	Sites	Wells	Sites	Wells	
2010	70	419	12	76	0	0	3	40	12	115	97	650	6.70
2011	32	137	1	3	0	0	0	0	1	10	34	150	4.41
2012	27	101	7	24	3	13	0	0	3	57	40	195	4.88
Total	129	657	20	103	3	13	3	40	16	182	171	995	5.82

Note) Others include mosques and public facilities like road infiltration facilities SDN: Public Primary School, SMAN：Public High School, SMPN: Junior High School, SMKN: Vacational High School
Source) Department of Industry and Energy, Dinas Preindustri dan Energi (DPE, May, 2013)

Figure 2.1-5 Infiltration Well at School (DPE, SMPN11, Jakarta Selatan)

Figure 2.1-6 Infiltration Well at School (DPE, SMK Negri 30, Jakarta Selatan)

2.1.3 Measures in Bogor Regency

In Bogor Regency, Building and Resident Planning Office (Dinas Tata Bangunan dan Pemukiman Kabupaten Bogor) has been implemented to construct infiltration wells in local government office yards and local resident yards in coordination with local villages since 2012 by the fund of DKI Jakarta adding the local budget (APBD). The name of the program is called as Development Program on Strategic and Fast Growing Area (Program Pengenbangan Wilayah Strategis dan Cepat Tumbuh, in Indonesian). This program intends to provide guidance in the development activities for infiltration wells in their yards by using local materials and labors. While, this program aims at minimize the occurrence of floods during the rainy season and increase supply of water resources during the dry season.

Part of the construction budgets is funded by the DKI Jakarta aiming at flood reduction in Jakarta area, and it serves to Bogor Regency under controlled by the Development Cooperation Agency of Jabodetabekjur (Badan Kerja Sama Provinsi Jabodetabekjur, BKSP Jabodetabekjur).Target location was selected in the buildings and public spaces such as village office (Kantor Desa in Indonesian), district office (Kantor Kecamatan), school and community leader house.

Related organizations for installation (construction) are made in each administrative unit. For example, at regency (Kabupaten) level, two implementation teams such as LPM for coordination agency and PPTK for installation are formed. LPM (Community Empowerment Agency) is responsible for prepare communities in the implementation of development activities, identify issues at the village level and hold preparatory meeting. PPTK (Filed Supervisor Personnel) has a duty on provide guidance for implementation, verification of the intended use of funds and monitoring and supervision.

As shown in the following Table, 300 sites are constructed/planned for infiltration wells. Budget for construction estimates 540 Million IDR. The unit cost of the construction per well is about 1.8 Million IDR. Pictures showing before installation, under installation and after completion are shown in following figures.

Table 2.1-4 Infiltration Well Implemented by Bogor Regency (Bogor R2012-2013)

No.	Kecamatan	Completed /Under Construction			Planning			Total		
		Sites	Unit Cost (Rp. Million)	Total Cost (Rp. Million)	Sites	Unit Cost (Rp. Million)	Total Cost (Rp. Million)	Sites	Unit Cost (Rp. Million)	Total Cost (Rp. Million)
1	Ciawi	45	1.80	81.00	29	1.80	52.20	74	1.80	133.20
2	Megamendung	54	1.80	97.20	12	1.80	21.60	66	1.80	118.80
3	Cisaruna	22	1.80	39.60	42	1.80	75.60	64	1.80	115.20
4	Cibinong	36	1.80	64.80	8	1.80	14.40	44	1.80	79.20
5	Babakanmadang	18	1.80	32.40	0	1.80	0.00	18	1.80	32.40
6	Sukaraja	34	1.80	61.20	0	1.80	0.00	34	1.80	61.20
	Total	209	1.80	376.20	91	1.80	163.80	300	1.80	540.00

Source: Building Management & Settlement Agency, Bogor (Dinas Tata Bangunan dan Pemukiman Kabupaten Bogor)

Before Installation (Construction)

Under Installation

After Installation

Figure 2.1-7 Installation of Infiltration Well (Desa Sukagalih, Bogor)

Before Installation(Construction)

Under Installation

After Installation

Figure 2.1-8 Installation of Infiltration Well (Kulurahan Karadenan, Bogor)

Specifications for infiltration well are shown as follows.

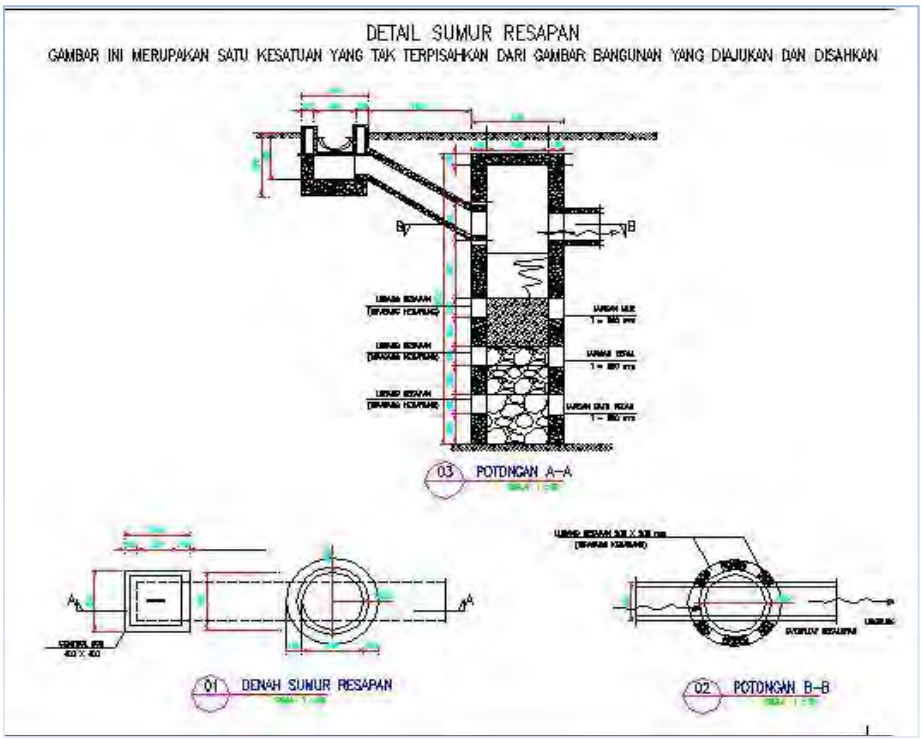


Figure 2.1-9 Specification for Infiltration Well (Bogor)

2.2 Survey of Sub-Basin

According to the primary sub-basin, the conditions of tributary and sub-basin are surveyed and sub-basin map is formulated.

2.2.1 Sub-Basin

The sub-basin map is formulated for the 12 primary tributaries as shown in Figure 2.2-1.

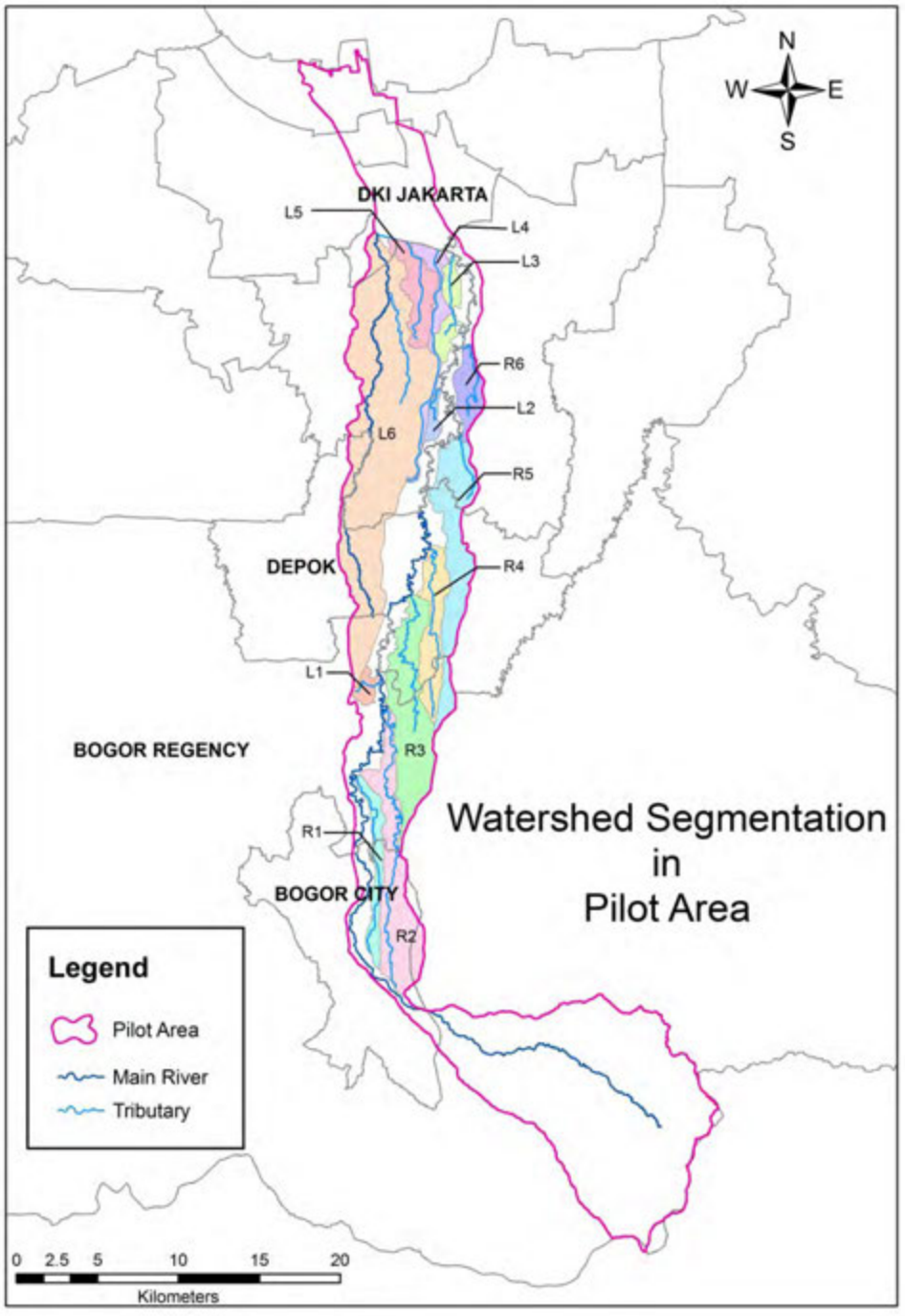


Figure 2.2-1 Map of Sub-Basin

2.2.2 Characteristics of Sub-Basin

The specifications of each sub-basin are shown in Table 2.2-1.The specification is analyzed based on the 1/25,000 digital map.

Table 2.2-1 Specification of Tributary

Tributary	Catchment Area (km^2)	Specification of Channel				Regency/Cities
		Length (km)	High Point (m)	Low Point (m)	Slope 1/n	
L1 (no name)	2.438	2.54	112.5	62.5	51	Bogor Regency
L2 (no name)	2.074	3.01	250	125	24	DKI Jakarta
L3 (Persoja)	5.634	5.79	25	12.5	463	DKI Jakarta
L4 (Kali Baru)	6.969	16.02	53	6.3	343	DKI Jakarta
L5 (Cideng)	10.019	7.34	25	6.3	393	DKI Jakarta
L6 (Krukut)	84.96	31.93	62.5	6.3	568	DKI Jakarta/Depok City/Bogor Regency
R1 (Cipangi)	8.049	12.73	310.1	125	69	Bogor Regency/Bogor City
R2 (Ciluar)	26.534	25.28	323.6	100	113	Bogor Regency/Bogor City
R3 (Cikumpa)	26.679	12.78	125	62.5	204	Depok City/Bogor Regency
R4 (Sugutamu)	13.231	13.74	118.5	50	201	Depok City/Bogor Regency
R5 (Gongseng)	24.224	5.51	52.1	25	203	DKI Jakarta/Depok City/Bogor Regency
R6 (Condet)	6.894	7.36	37.5	12.5	294	DKI Jakarta

The following photos show the current conditions of tributaries and surrounding areas.

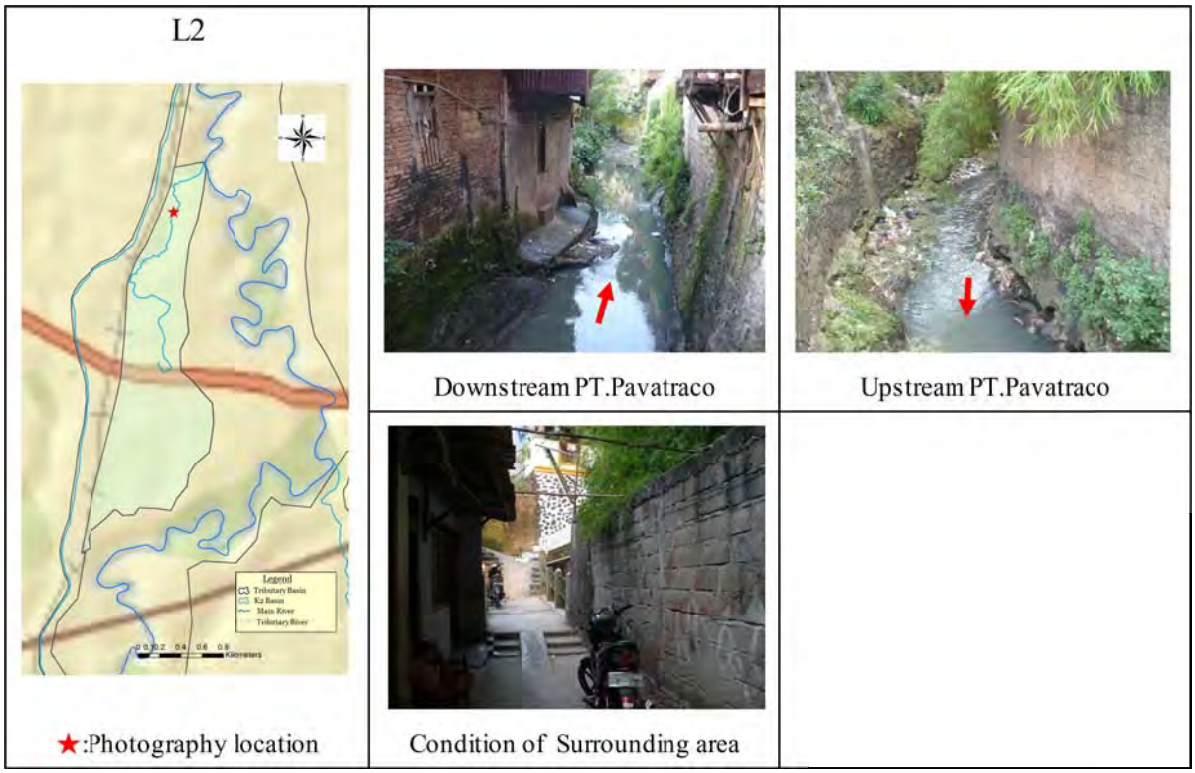


Figure 2.2-2 Condition of Sub-Basin (L2)

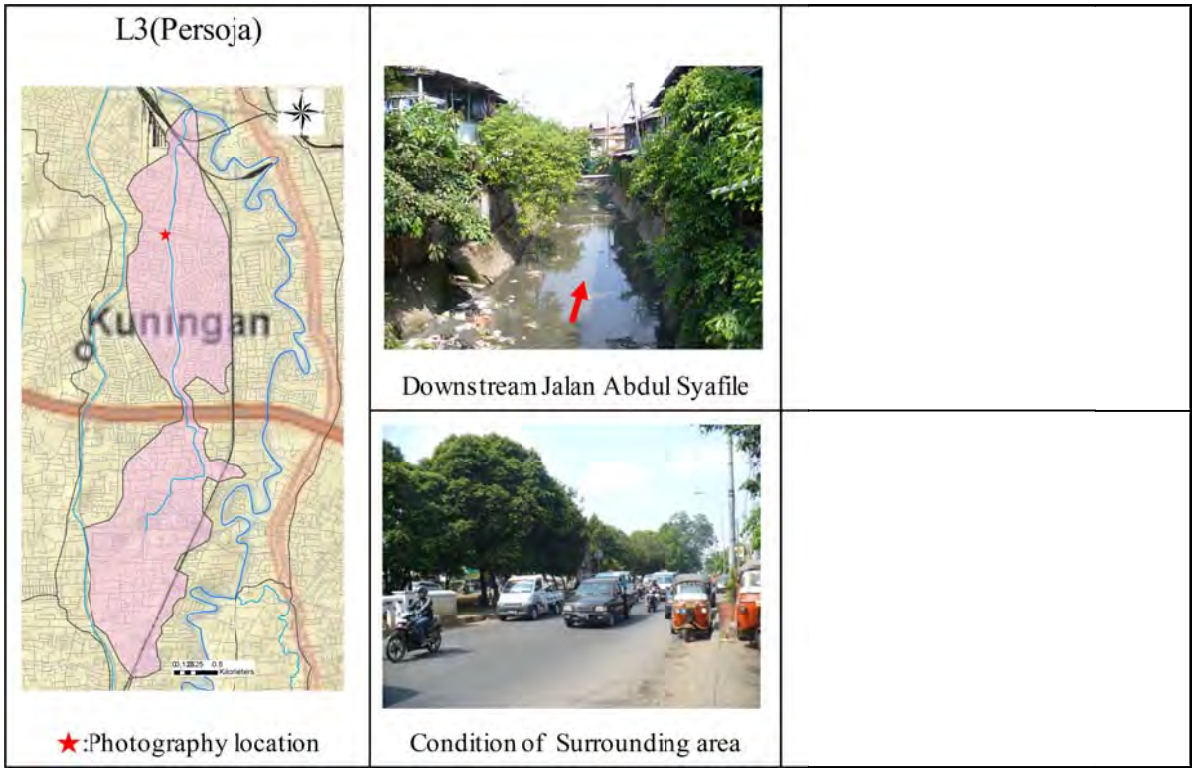


Figure 2.2-3 Condition of Sub-Basin (L3)

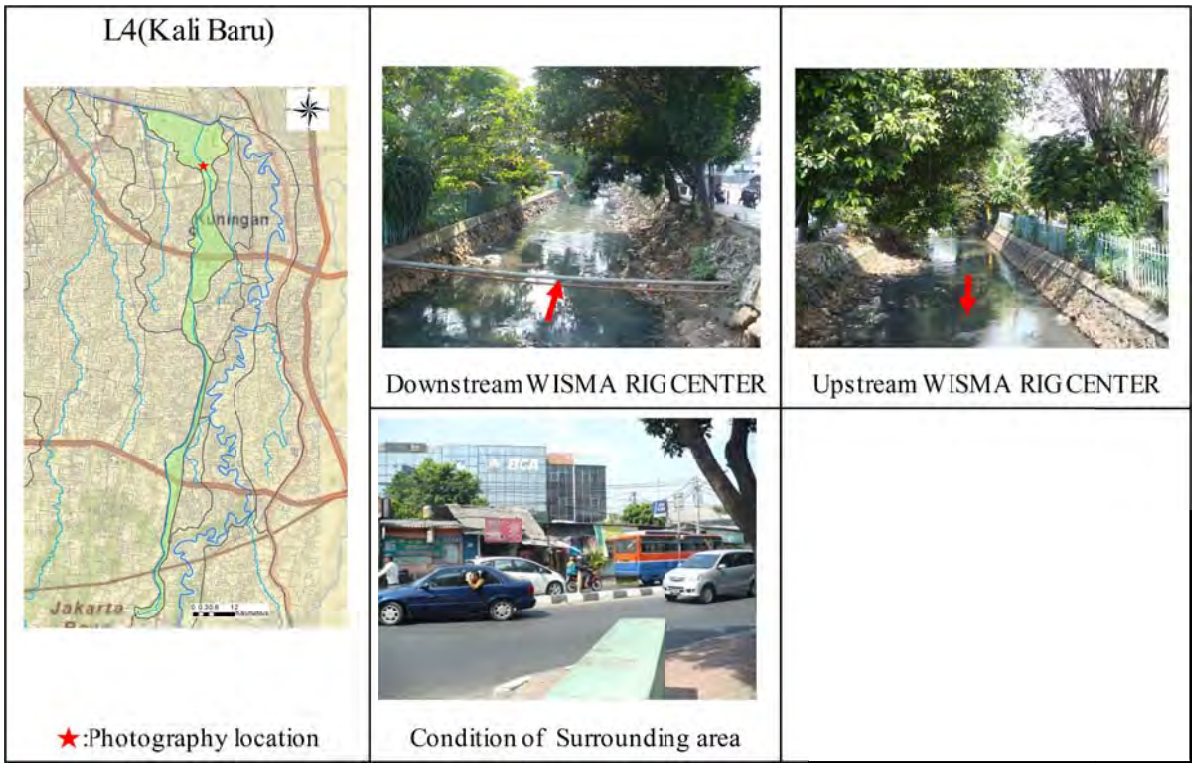


Figure 2.2-4 Condition of Sub-Basin (L4)

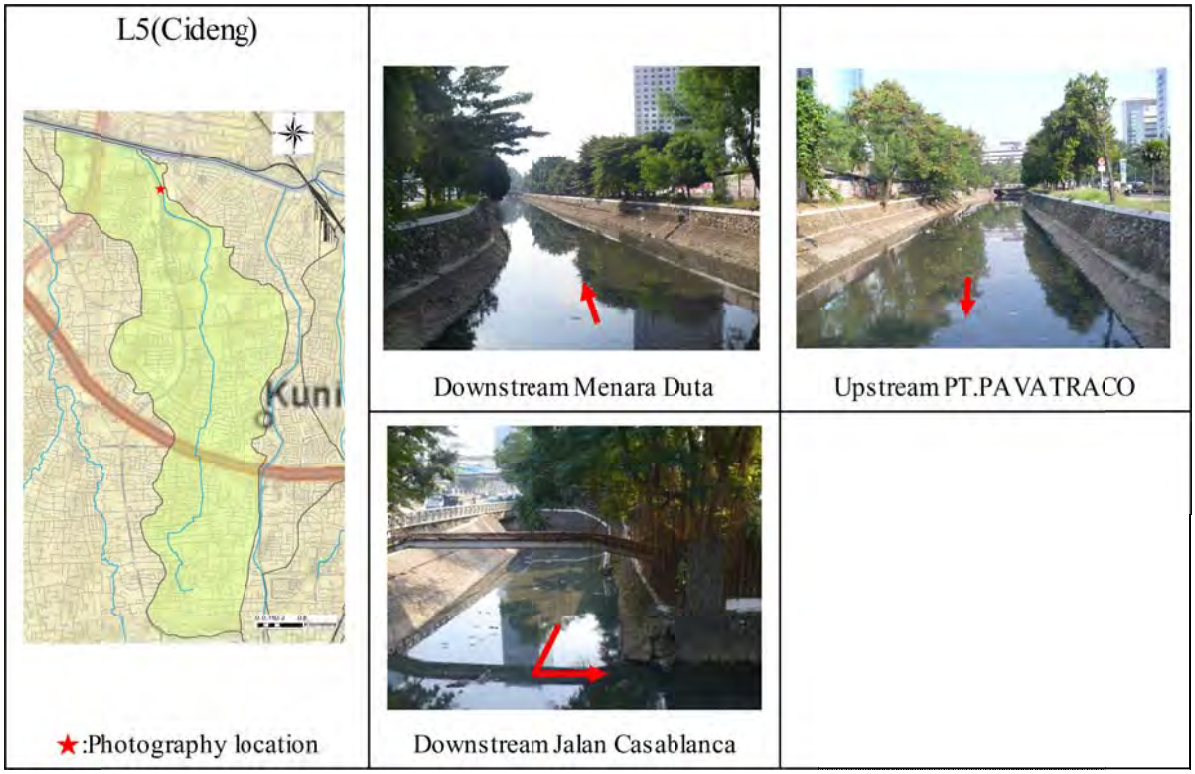


Figure 2.2-5 Condition of Sub-Basin (L5)

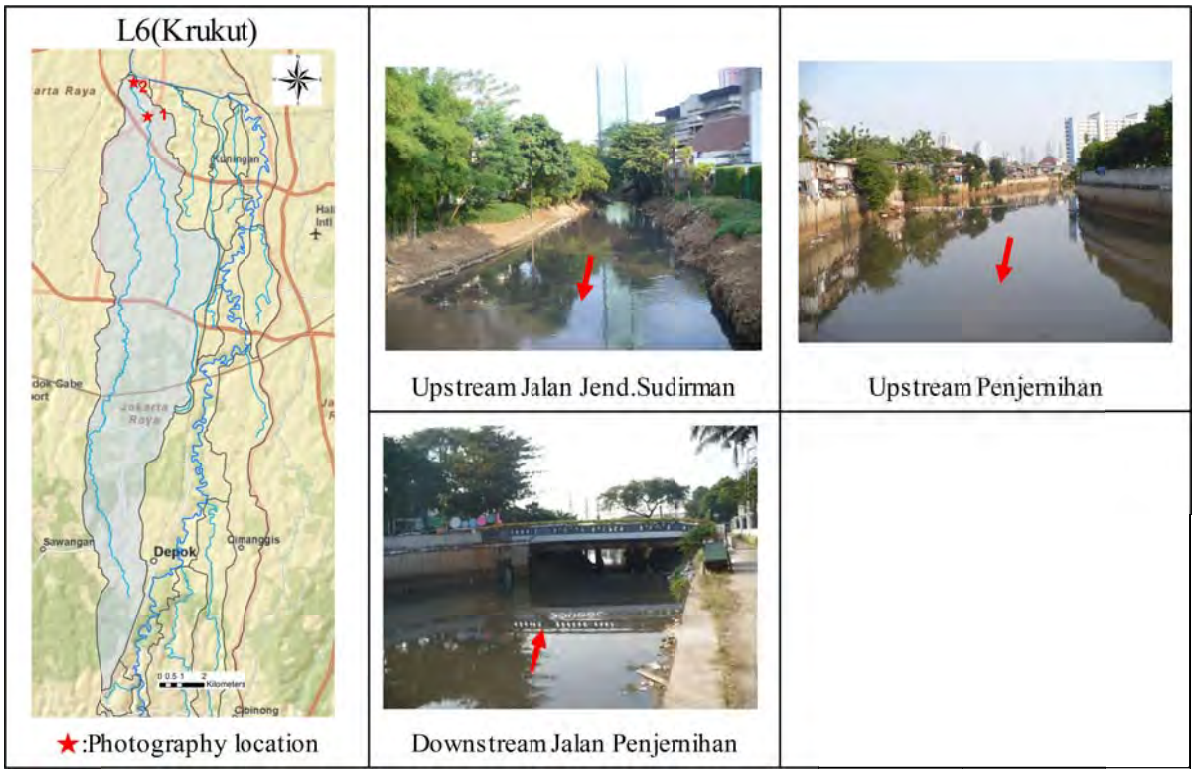


Figure 2.2-6 Condition of Sub-Basin (L6)

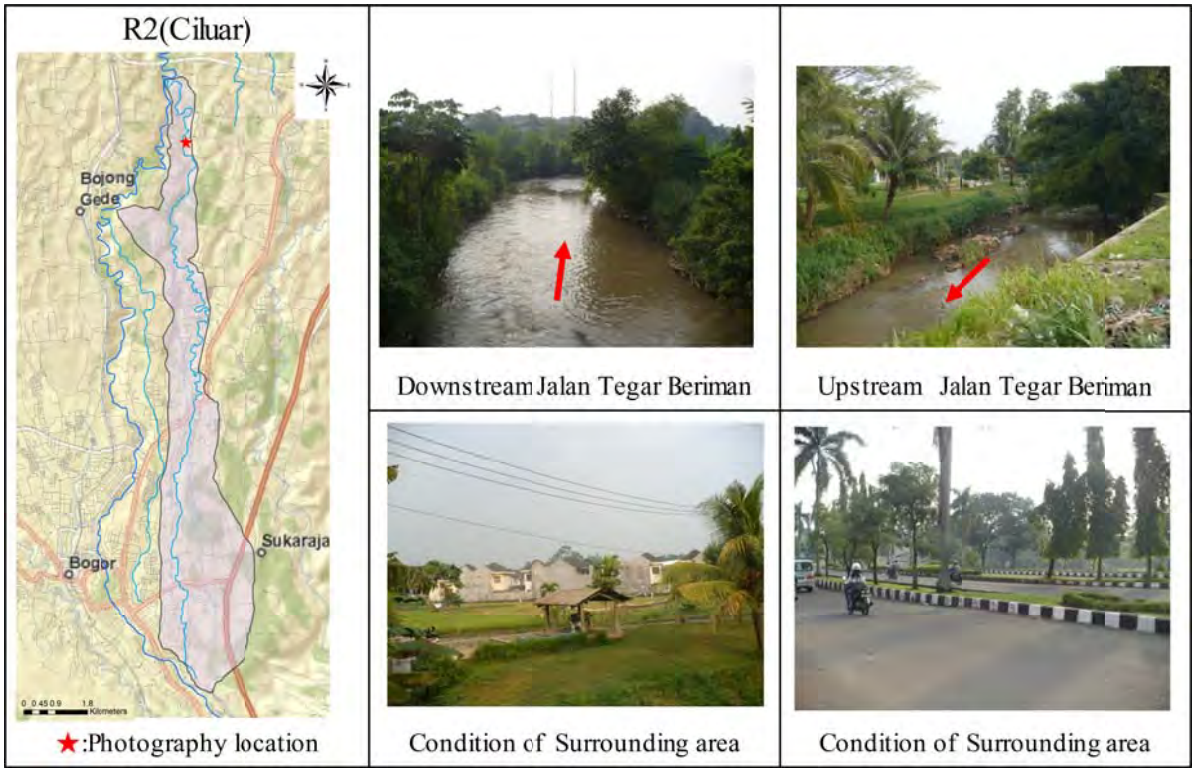


Figure 2.2-7 Condition of Sub-Basin (R2)

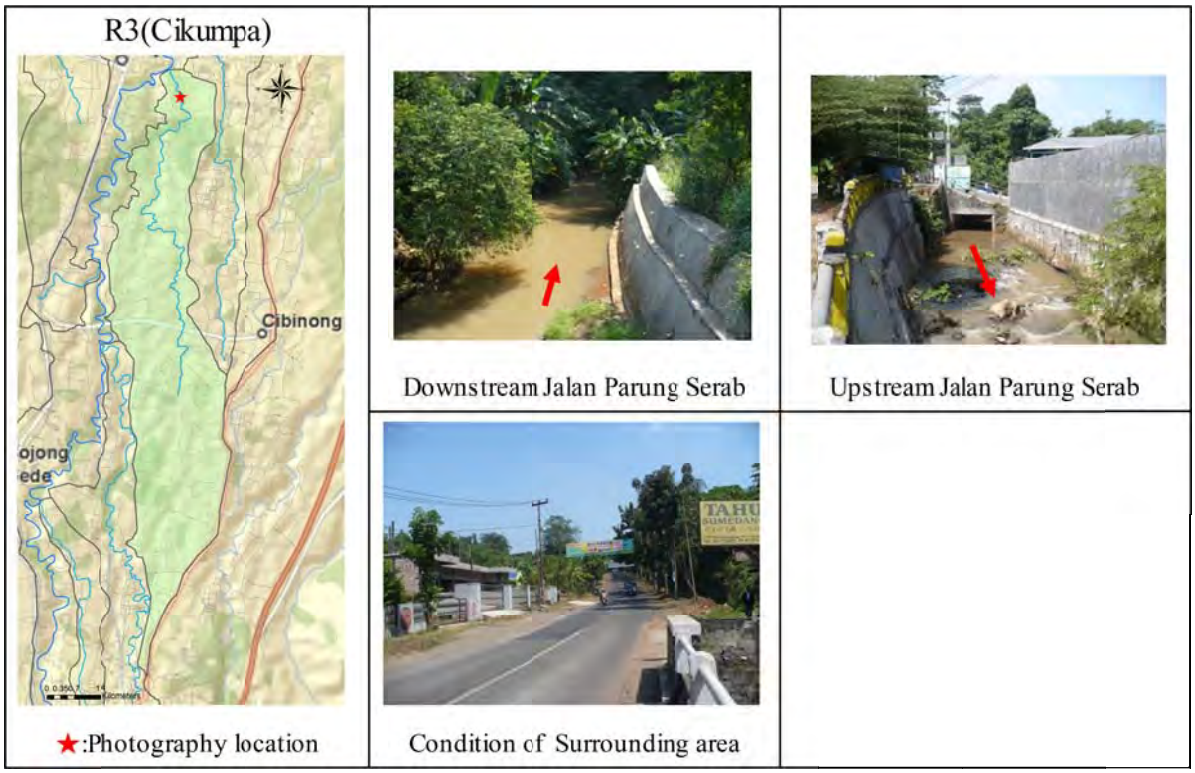


Figure 2.2-8 Condition of Sub-Basin (R3)

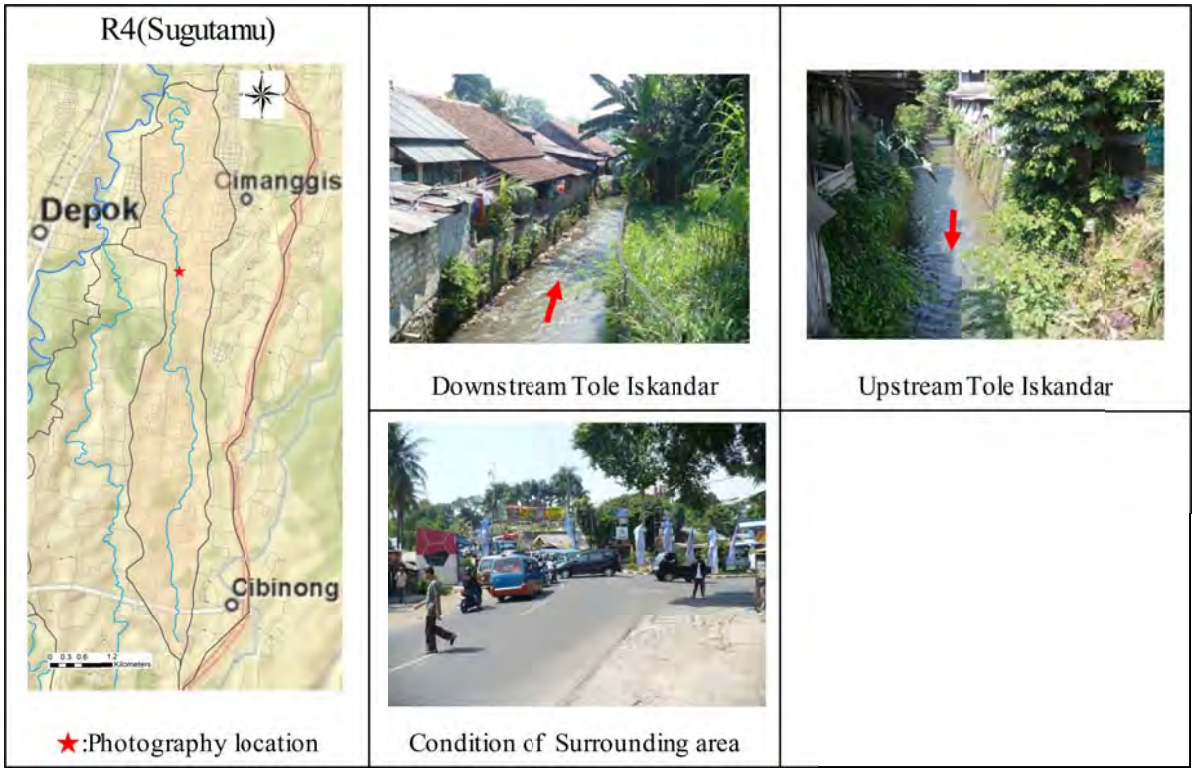


Figure 2.2-9 Condition of Sub-Basin (R4)

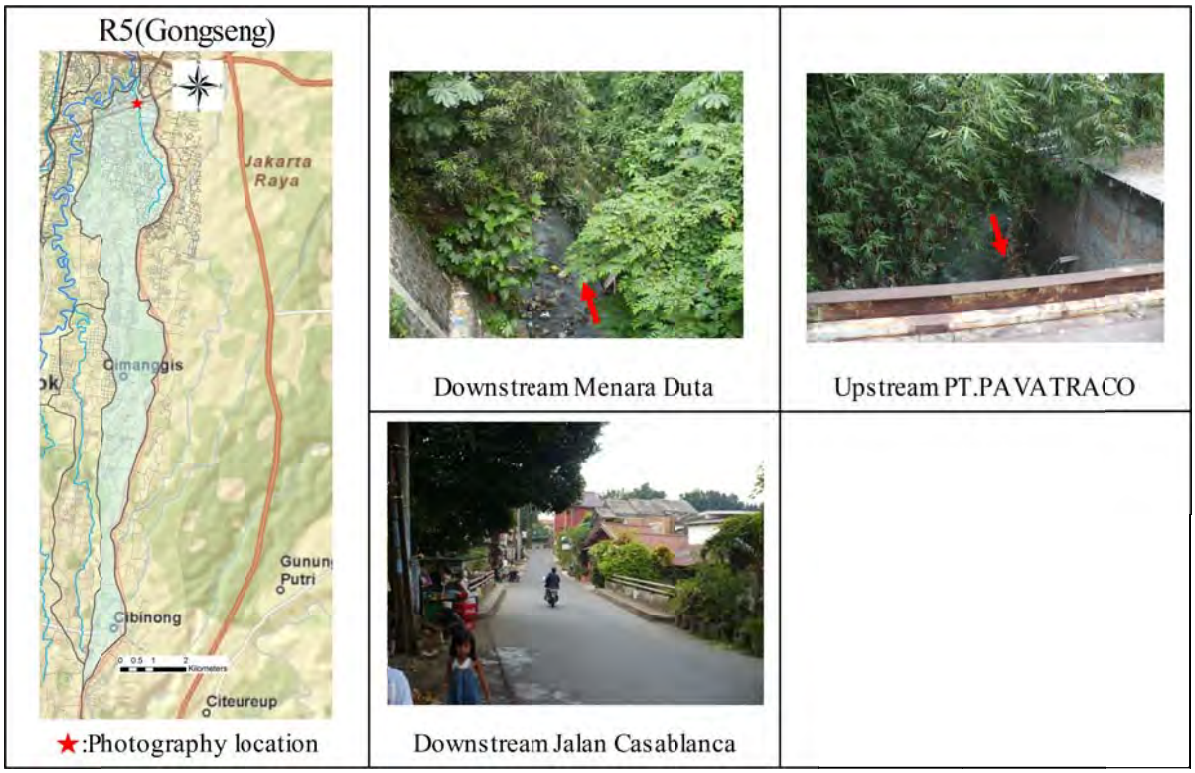


Figure 2.2-10 Condition of Sub-Basin (R5)

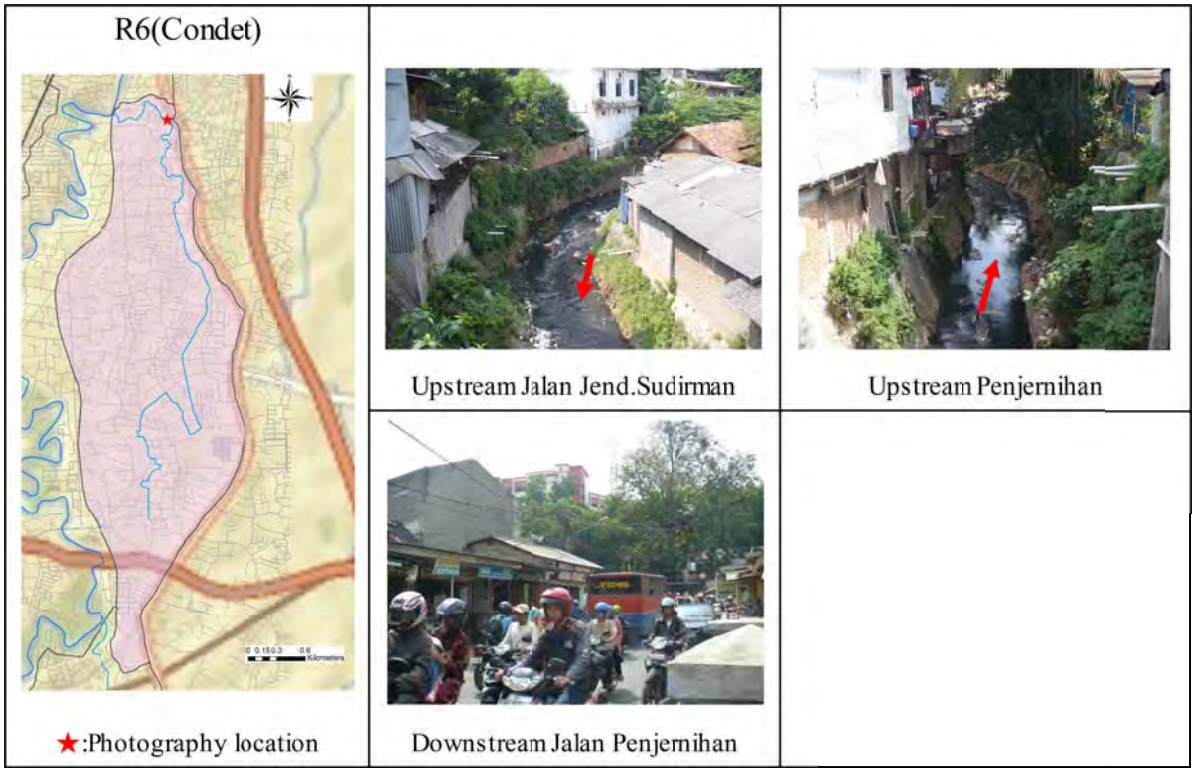
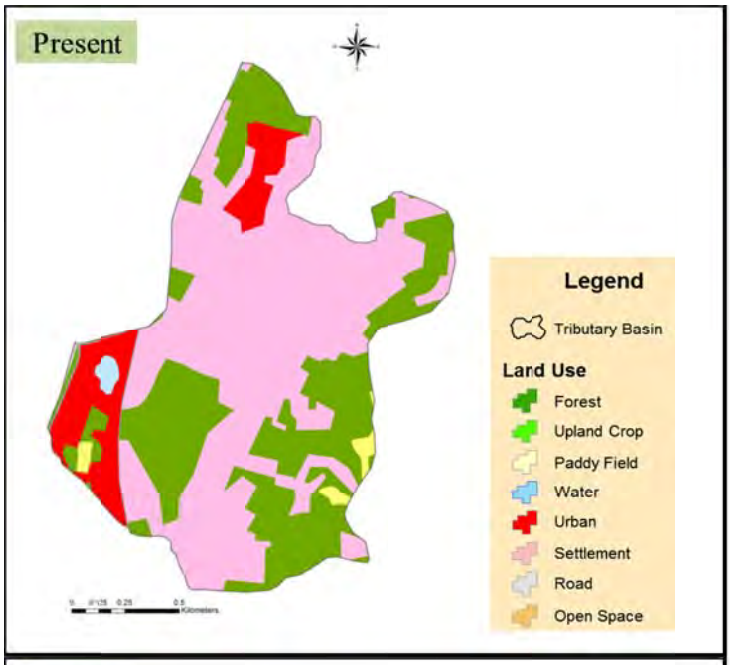


Figure 2.2-11 Condition of Sub-Basin (R6)

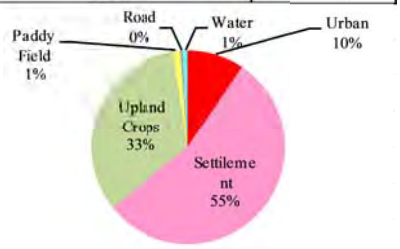
2.3 Land Use Condition of Tributary Sub-Basin

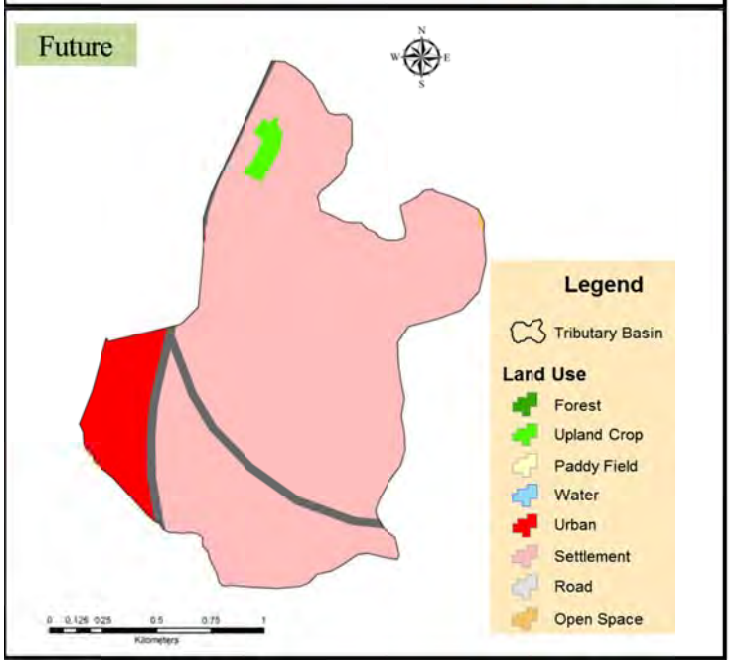
The current land use status (2008) and the prediction of future land use are examined in each sub-basin.

Based on the spatial plans in DKI Jakarta, Depok city, Bogor regency and Bogor city, the future land use is categorized in accordance with land use classification for run-off analysis.



Surface Characteristic	Area(km^2)
Urban	0.230
Settilement	1.335
Upland Crops	0.815
Paddy Field	0.029
Open Space	0.000
Forest	0.000
Road	0.010
Water	0.019
Total	2.438





Surface Characteristic	Area(km^2)
Urban	0.200
Settilement	2.108
Upland Crops	0.030
Paddy Field	0.000
Open Space	0.000
Forest	0.000
Road	0.100
Water	0.000
Total	2.438

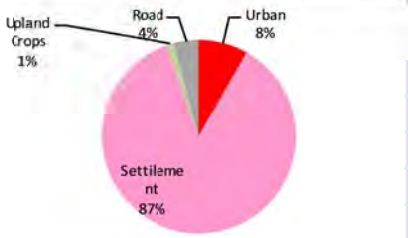
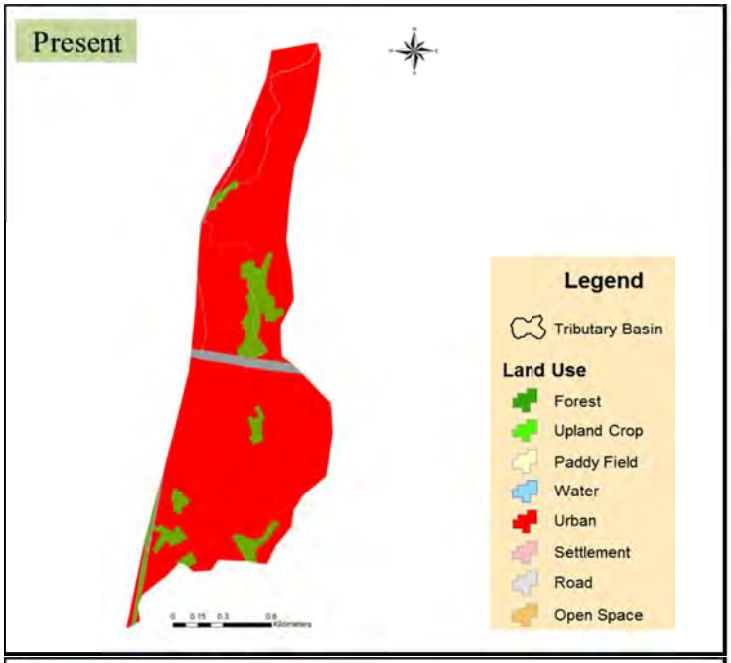
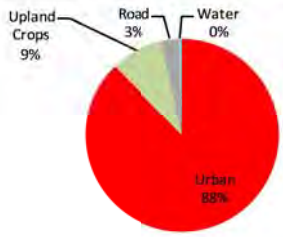
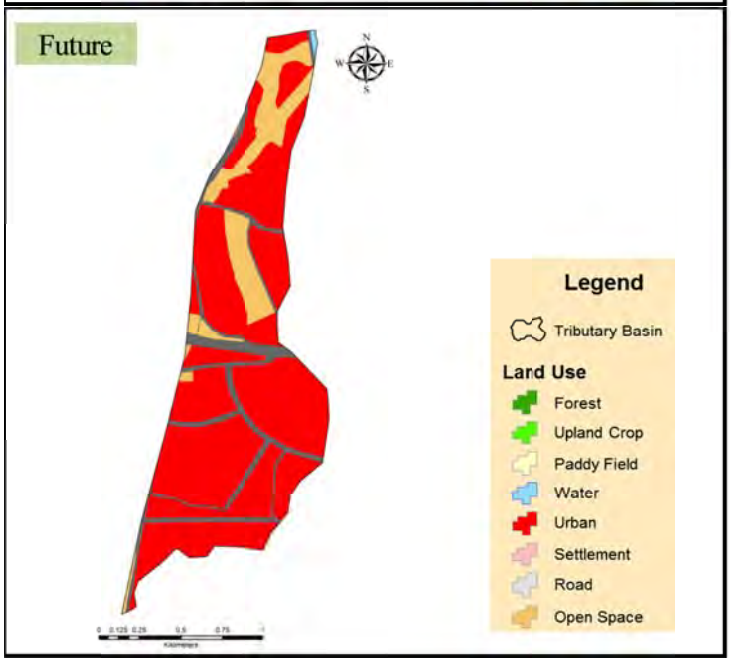


Figure 2.3-1 Land Use Condition in Sub-Basin (L1)



Surface Characteristic	Area(km^2)
Urban	1.819
Settlement	0.000
Upland Crops	0.186
Paddy Field	0.000
Open Space	0.000
Forest	0.000
Road	0.061
Water	0.008
Total	2.074





Surface Characteristic	Area(km^2)
Urban	1.554
Settlement	0.000
Upland Crops	0.000
Paddy Field	0.000
Open Space	0.290
Forest	0.000
Road	0.230
Water	0.000
Total	2.074

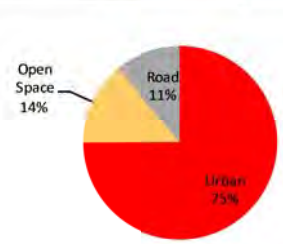
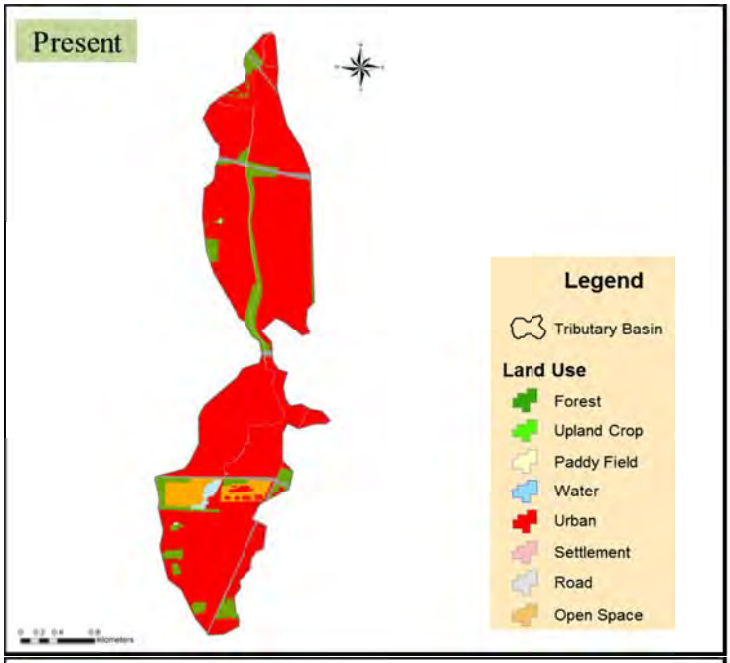
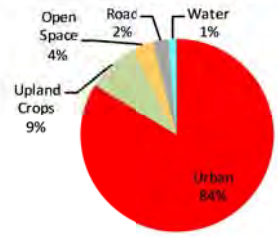
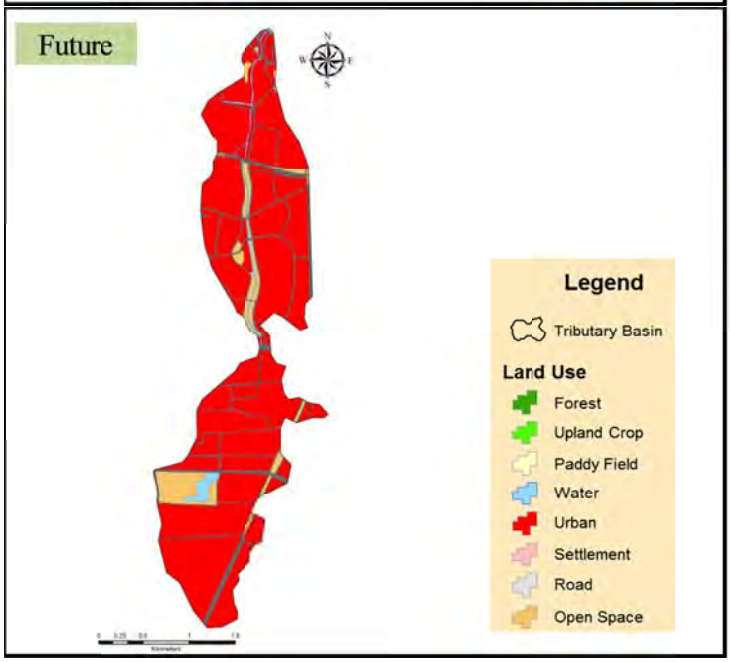


Figure 2.3-2 Land Use Condition in Sub-Basin (L2)



Surface Characteristic	Area(km^2)
Urban	4.715
Settlement	0.000
Upland Crops	0.497
Paddy Field	0.000
Open Space	0.204
Forest	0.000
Road	0.146
Water	0.072
Total	5.634





Surface Characteristic	Area(km^2)
Urban	4.574
Settlement	0.000
Upland Crops	0.000
Paddy Field	0.000
Open Space	0.380
Forest	0.000
Road	0.580
Water	0.100
Total	5.634

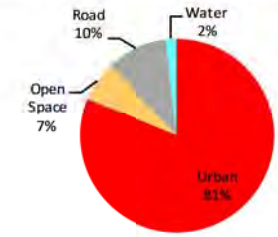
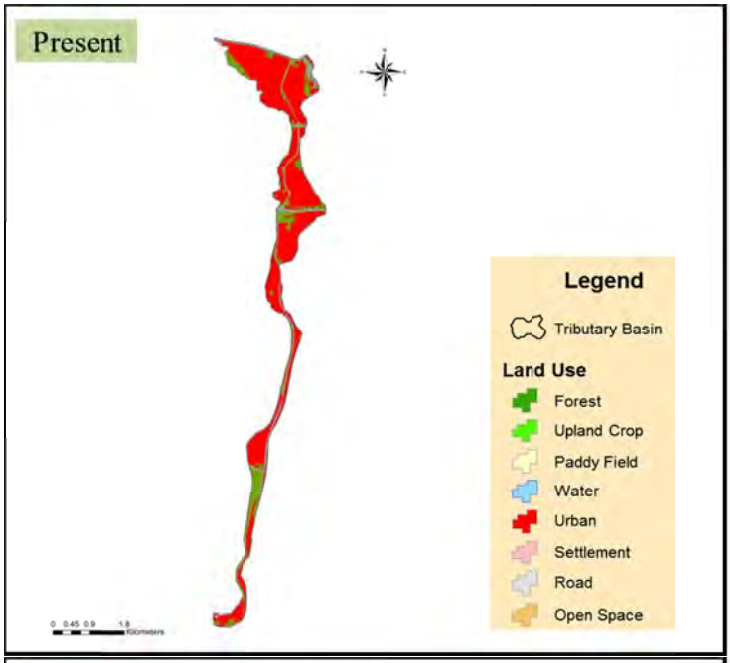
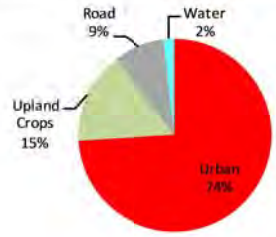
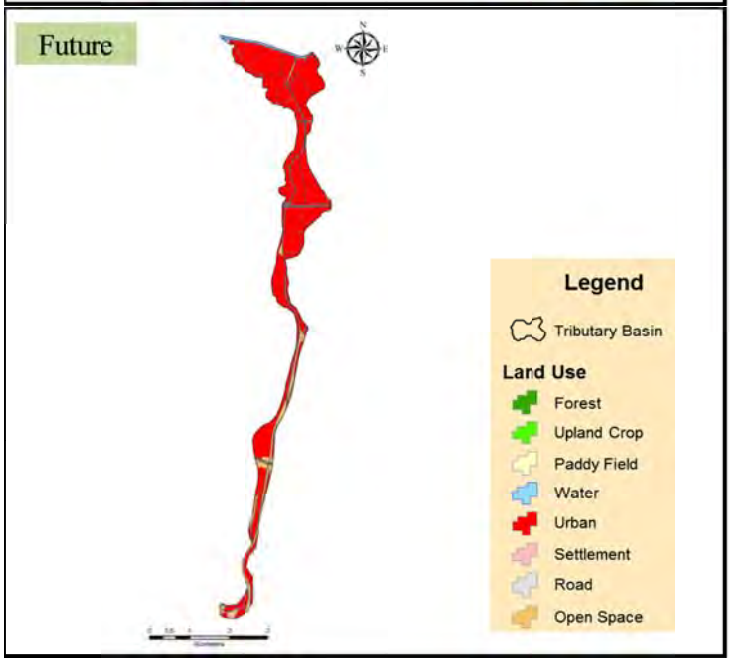


Figure 2.3-3 Land Use Condition in Sub-Basin (L3)



Surface Characteristic	Area(km^2)
Urban	5.156
Settlement	0.000
Upland Crops	1.088
Paddy Field	0.000
Open Space	0.000
Forest	0.000
Road	0.601
Water	0.124
Total	6.969





Surface Characteristic	Area(km^2)
Urban	5.389
Settlement	0.000
Upland Crops	0.000
Paddy Field	0.000
Open Space	0.410
Forest	0.000
Road	1.070
Water	0.100
Total	6.969

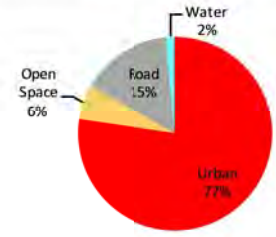
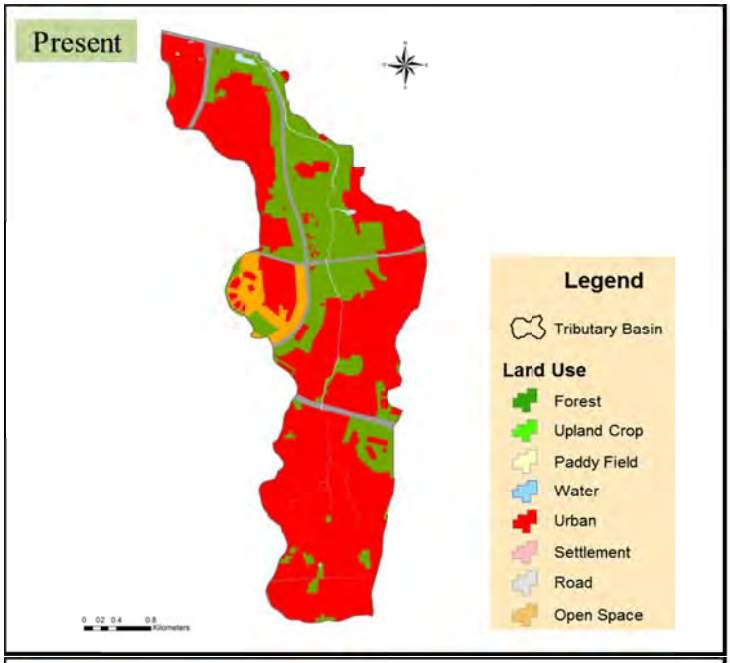
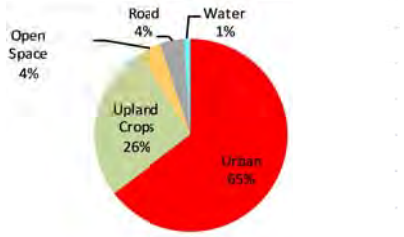
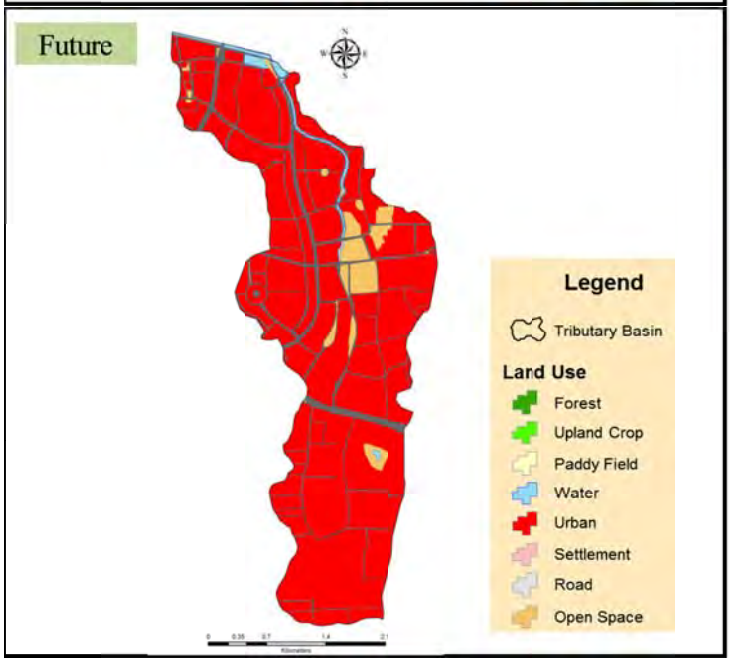


Figure 2.3-4 Land Use Condition in Sub-Basin (L4)



Surface Characteristic	Area(km^2)
Urban	6.478
Settlement	0.000
Upland Crops	2.667
Paddy Field	0.000
Open Space	0.368
Forest	0.000
Road	0.407
Water	0.099
Total	10.019





Surface Characteristic	Area(km^2)
Urban	8.199
Settlement	0.000
Upland Crops	0.000
Paddy Field	0.000
Open Space	0.480
Forest	0.000
Road	1.210
Water	0.130
Total	10.019

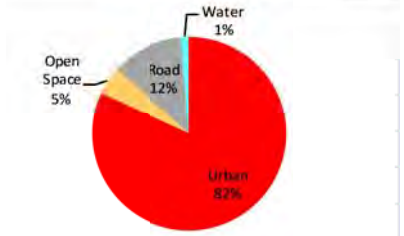
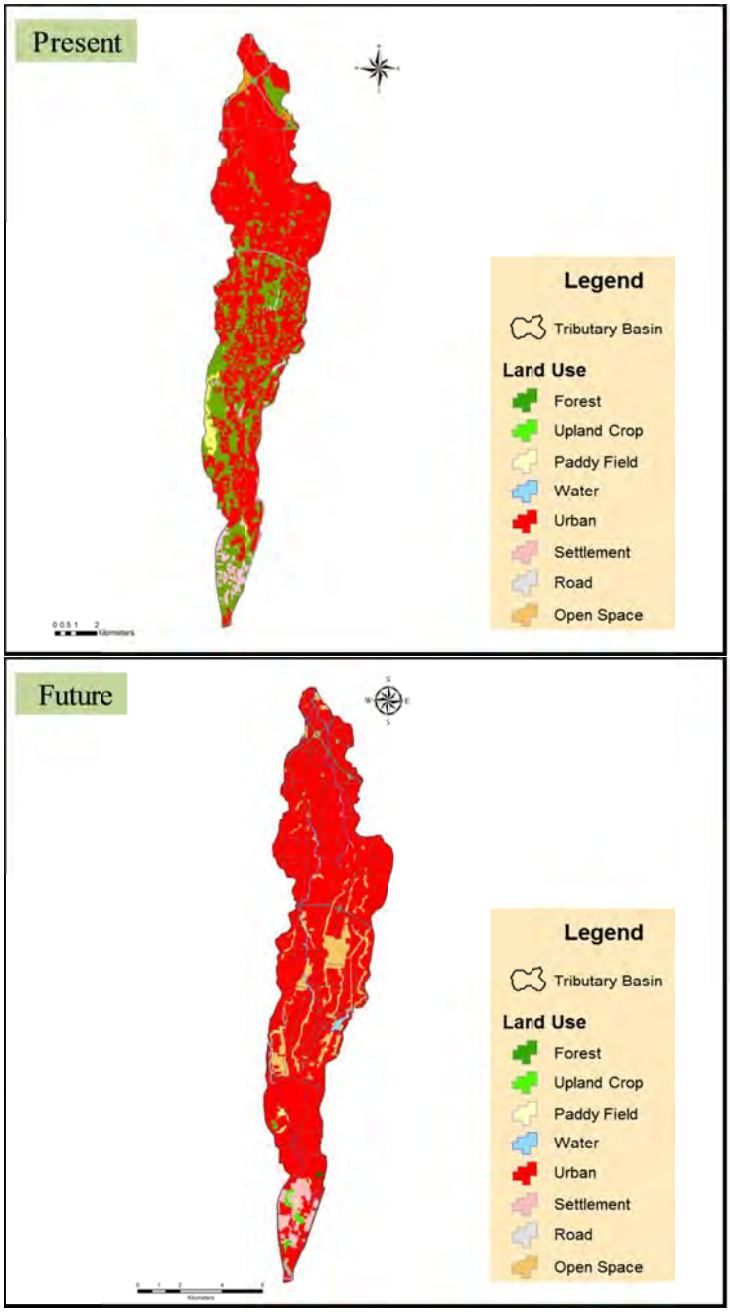
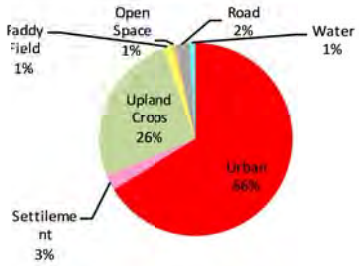


Figure 2.3-5 Land Use Condition in Sub-Basin (L5)



Surface Characteristic	Area(km^2)
Urban	56.266
Settlement	2.130
Upland Crops	22.116
Paddy Field	1.128
Open Space	0.520
Forest	0.000
Road	1.996
Water	0.804
Total	84.960



Surface Characteristic	Area(km^2)
Urban	66.060
Settlement	2.630
Upland Crops	0.550
Paddy Field	0.360
Open Space	7.810
Forest	0.070
Road	6.490
Water	0.990
Total	84.960

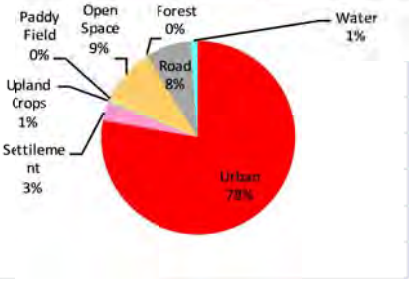
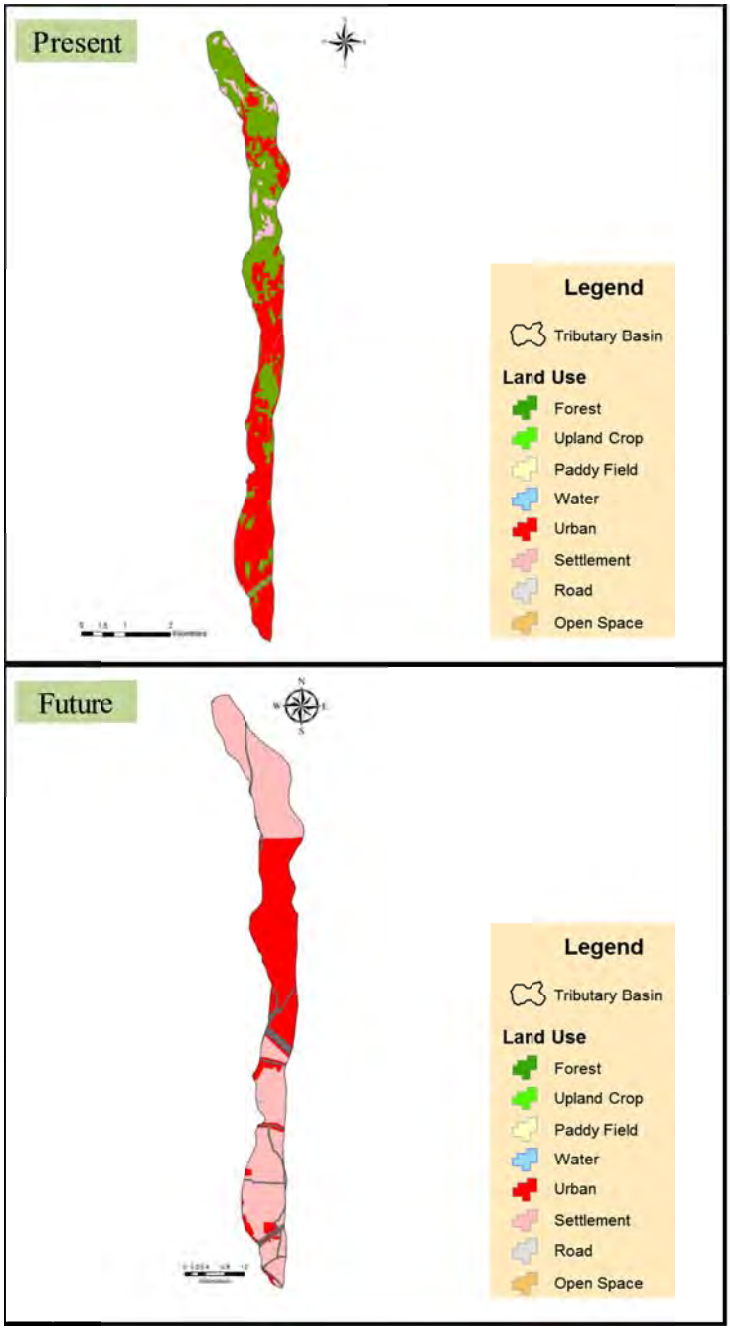
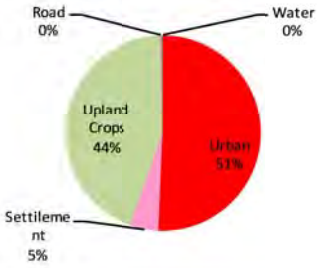


Figure 2.3-6 Land Use Condition in Sub-Basin (L6)



Surface Characteristic	Area(km^2)
Urban	4.079
Settilement	0.373
Upland Crops	3.559
Paddy Field	0.000
Open Space	0.000
Forest	0.000
Road	0.037
Water	0.001
Total	8.049



Surface Characteristic	Area(km^2)
Urban	2.899
Settilement	4.610
Upland Crops	0.000
Paddy Field	0.000
Open Space	0.000
Forest	0.000
Road	0.540
Water	0.000
Total	8.049

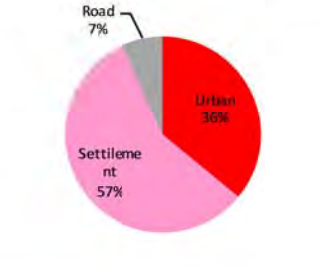
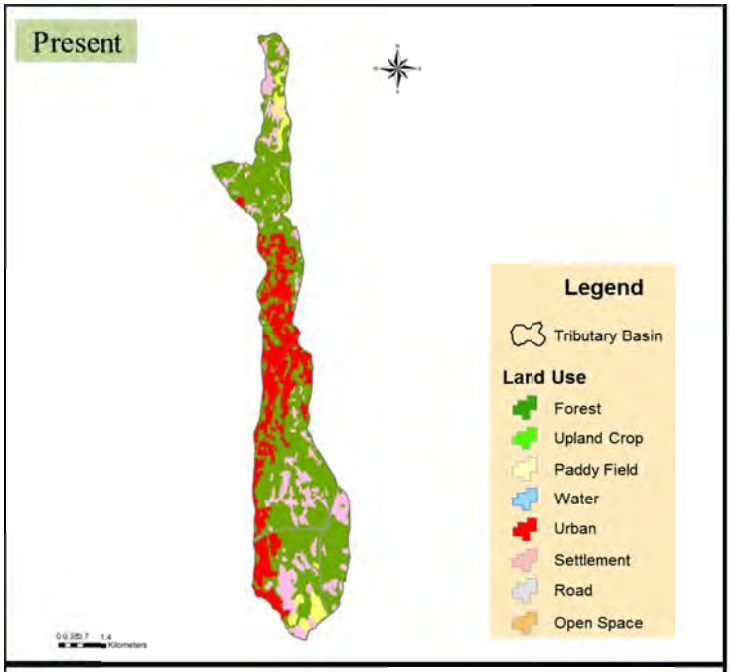
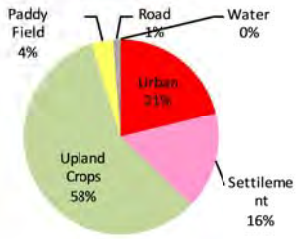
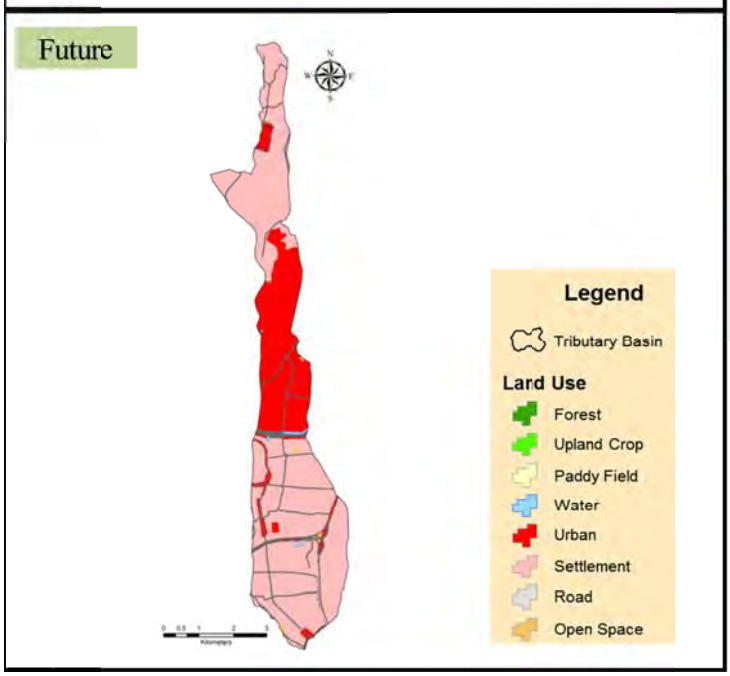


Figure 2.3-7 Land Use Condition in Sub-Basin (R1)



Surface Characteristic	Area(km^2)
Urban	5.607
Settilement	4.254
Upland Crops	15.405
Paddy Field	0.952
Open Space	0.000
Forest	0.000
Road	0.308
Water	0.009
Total	26.534





Surface Characteristic	Area(km^2)
Urban	6.710
Settilement	17.524
Upland Crops	0.000
Paddy Field	0.000
Open Space	0.140
Forest	0.000
Road	2.090
Water	0.070
Total	26.534

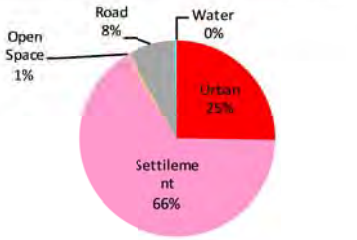
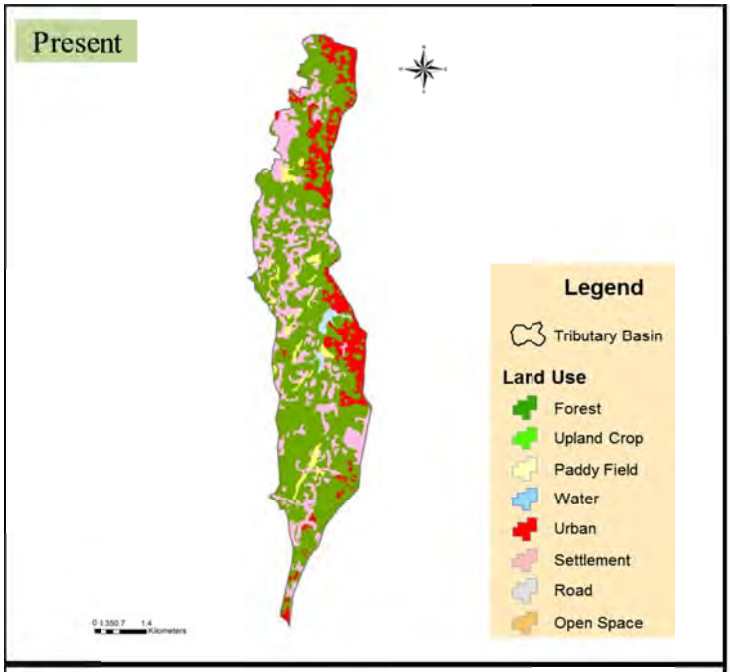
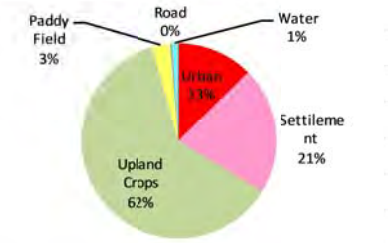
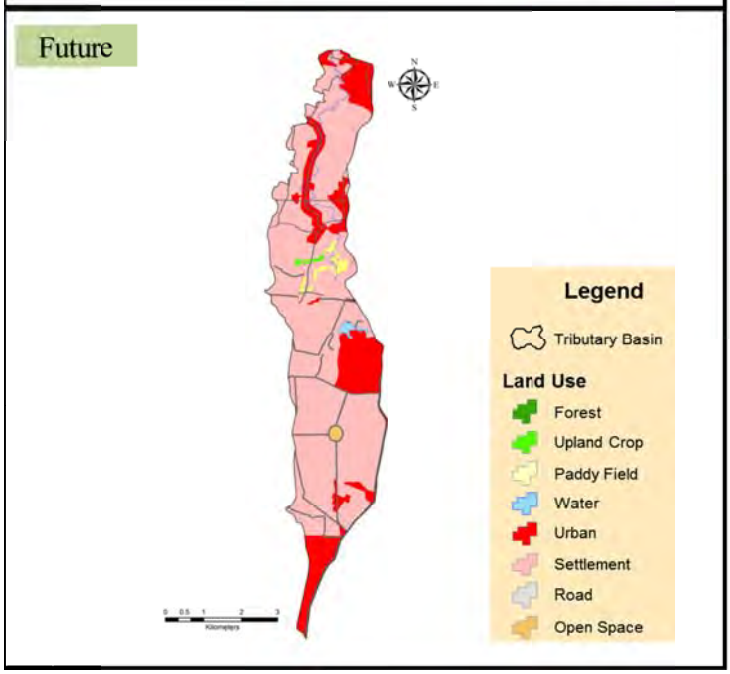


Figure 2.3-8 Land Use Condition in Sub-Basin (R2)



Surface Characteristic	Area(km^2)
Urban	3.357
Settilement	5.634
Upland Crops	16.540
Paddy Field	0.786
Open Space	0.000
Forest	0.000
Road	0.098
Water	0.265
Total	26.679





Surface Characteristic	Area(km^2)
Urban	5.380
Settilement	19.039
Upland Crops	0.080
Paddy Field	0.320
Open Space	0.100
Forest	0.000
Road	1.590
Water	0.170
Total	26.679

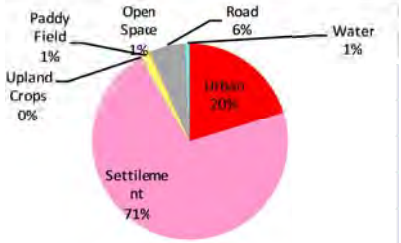
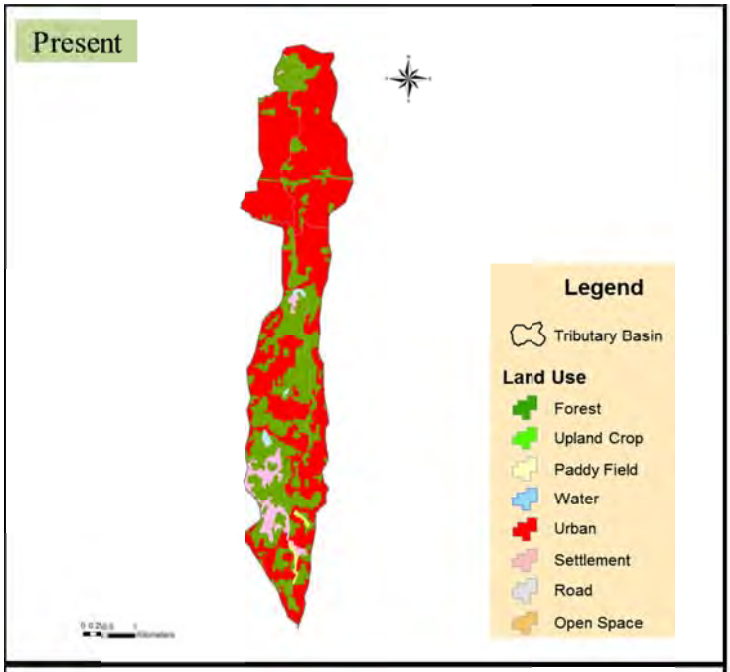
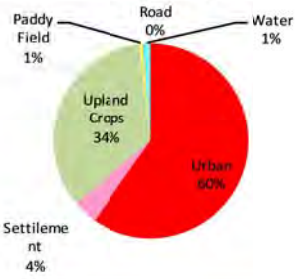
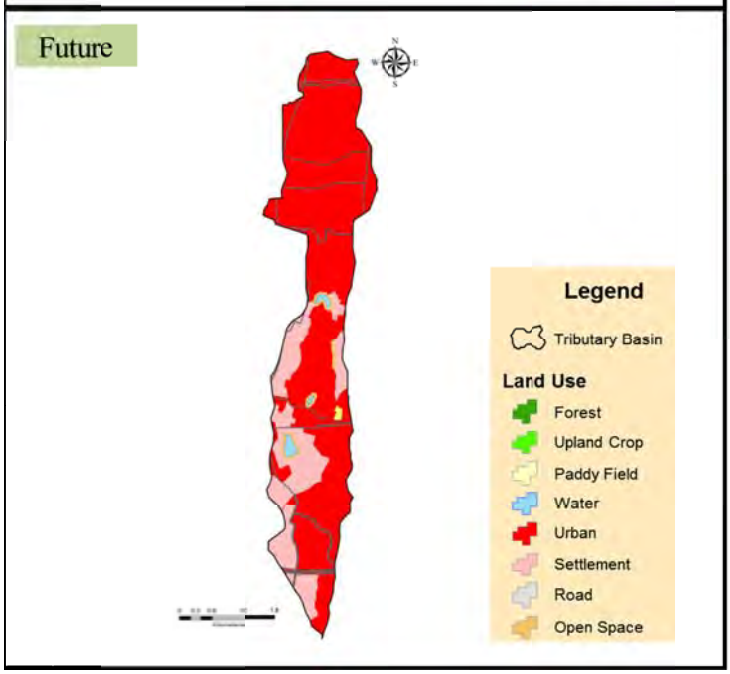


Figure 2.3-9 Land Use Condition in Sub-Basin (R3)



Surface Characteristic	Area(km^2)
Urban	7.915
Settilement	0.535
Upland Crops	4.549
Paddy Field	0.067
Open Space	0.000
Forest	0.000
Road	0.022
Water	0.142
Total	13.231





Surface Characteristic	Area(km^2)
Urban	9.761
Settilement	2.490
Upland Crops	0.000
Paddy Field	0.030
Open Space	0.200
Forest	0.000
Road	0.640
Water	0.110
Total	13.231

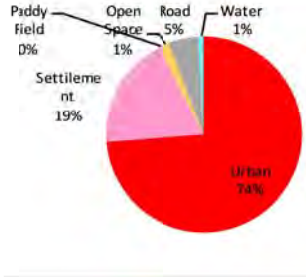
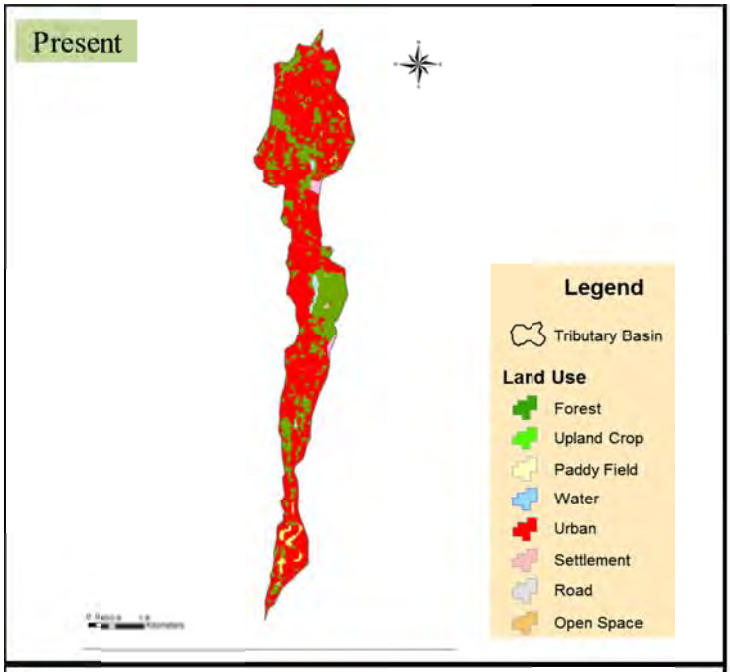
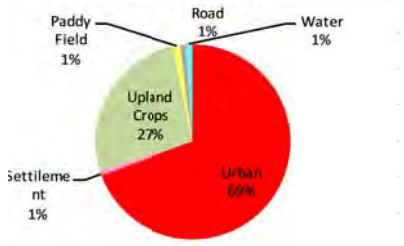
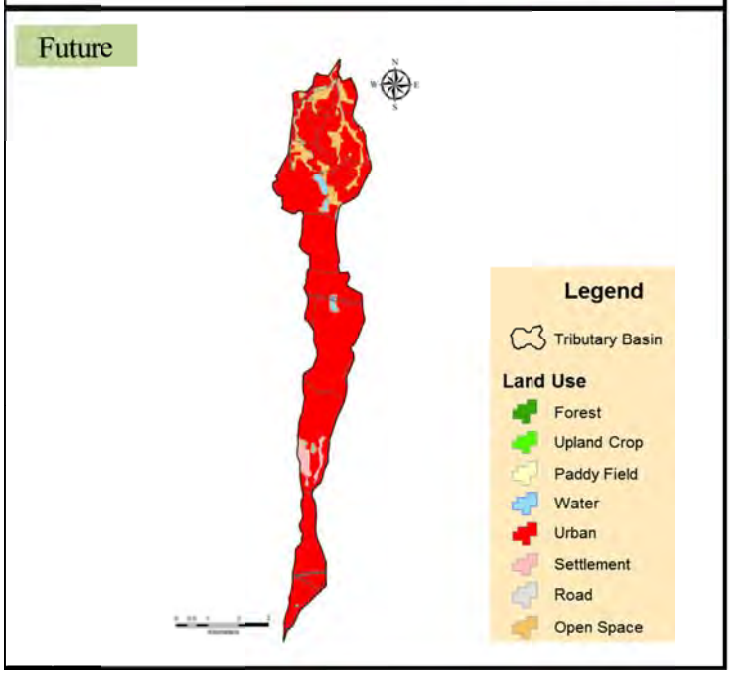


Figure 2.3-10 Land Use Condition in Sub-Basin (R4)



Surface Characteristic	Area(km^2)
Urban	16.802
Settilement	0.196
Upland Crops	6.441
Paddy Field	0.310
Open Space	0.000
Forest	0.000
Road	0.230
Water	0.246
Total	24.225





Surface Characteristic	Area(km^2)
Urban	19.945
Settilement	0.550
Upland Crops	0.000
Paddy Field	0.000
Open Space	2.260
Forest	0.000
Road	1.100
Water	0.370
Total	24.225

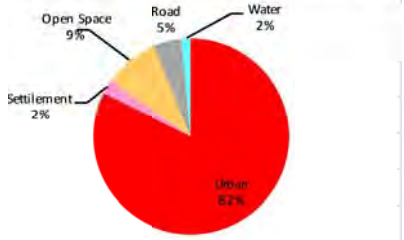
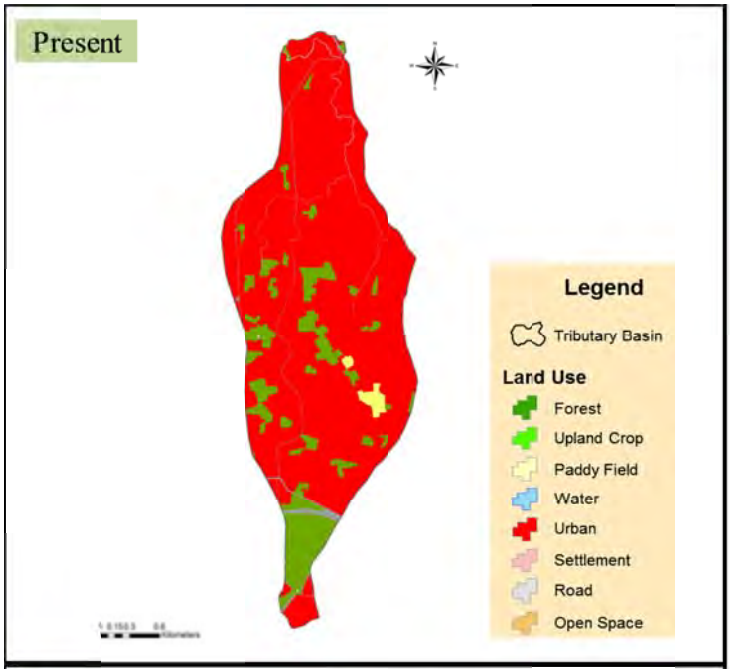
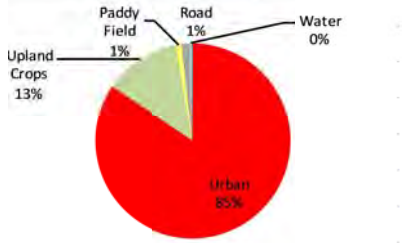
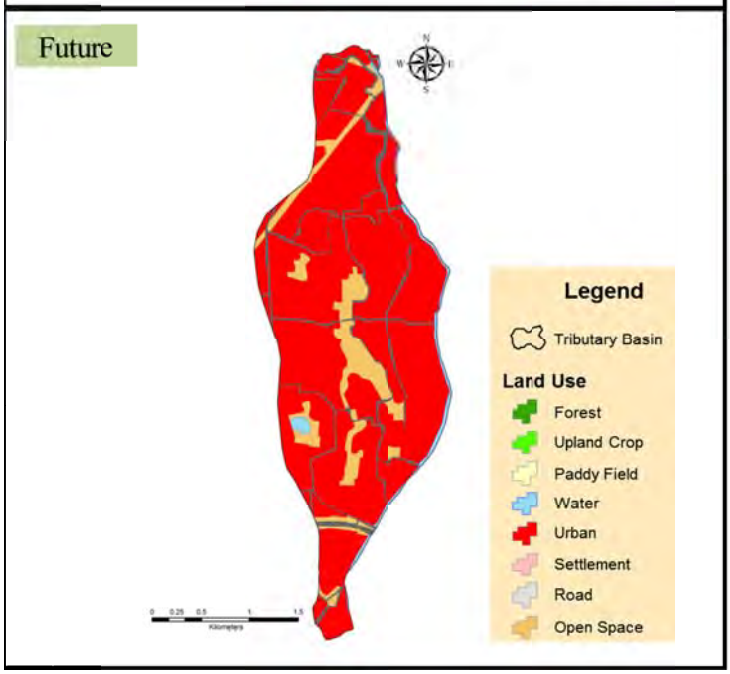


Figure 2.3-11 Land Use Condition in Sub-Basin (R5)



Surface Characteristic	Area(km^2)
Urban	5.823
Settlement	0.000
Upland Crops	0.886
Paddy Field	0.064
Open Space	0.000
Forest	0.000
Road	0.094
Water	0.027
Total	6.894





Surface Characteristic	Area(km^2)
Urban	5.554
Settlement	0.000
Upland Crops	0.000
Paddy Field	0.000
Open Space	0.720
Forest	0.000
Road	0.490
Water	0.130
Total	6.894

Figure 2.3-12 Land Use Condition in Sub-Basin (R6)

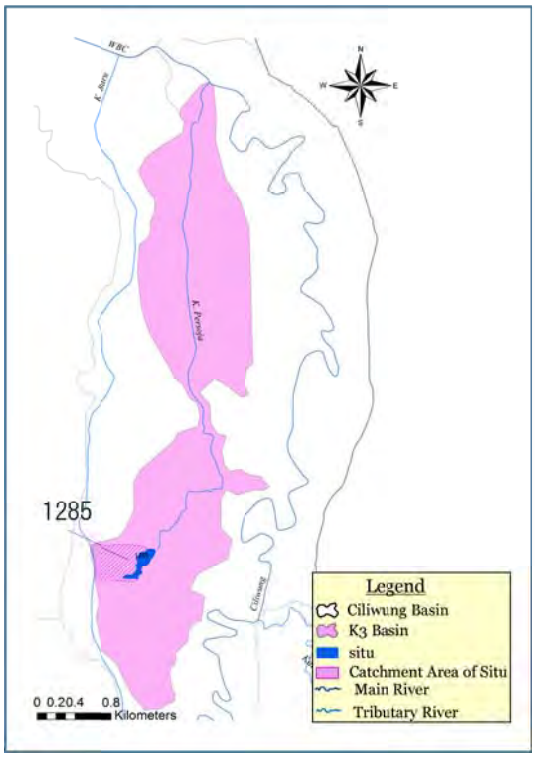
2.4 Current Condition of Situ in Sub-Basin

The current conditions of Situ in each sub-basin are examined based on the inventory prepared by BBWS Ciliwung-Cisadane in 2010.

The list and specification of Situ is summarized in Table- 2.4-1.

Table- 2.4-1 List of Situ in Each Sub-Basin

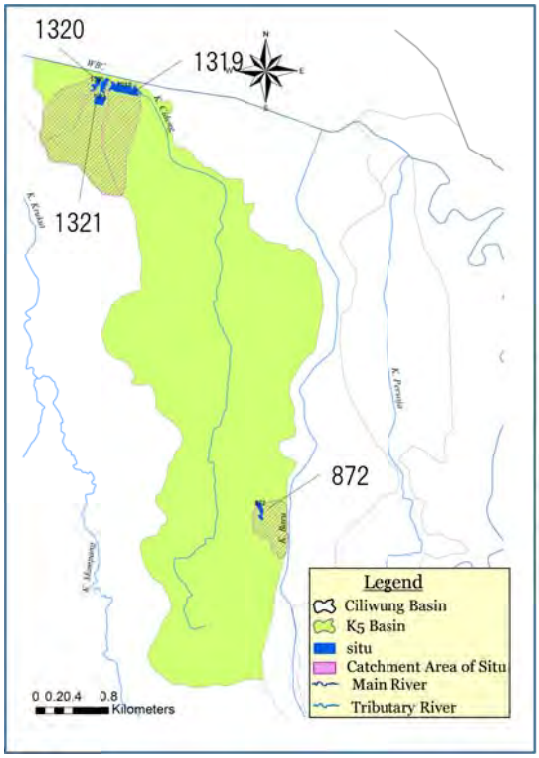
Tributary Basin	Number of Situ	Total Surface Area (ha)	Total Catchment Area (ha)
L1	0	0.00	0.00
L2	0	0.00	0.00
L3	1	4.00	22.09
L4	0	0.00	0.00
L5	4	6.51	115.98
L6	10	24.75	1,108.70
R1	1	0.77	25.32
R2	5	14.32	74.18
R3	5	24.56	1,156.12
R4	4	4.38	709.92
R5	8	24.80	1,477.45
R6	0	0.00	0.00
Total	38	104.09	4,689.77



Number of SITU : 1
Total Surface Area : 4.00 (ha)
Total Catchment Area : 22.09(ha)

ID	Name of Situ	Surface Area (Ha)	Catchment Area(Ha)
1285	TMP Kalibata	4.00	22.09

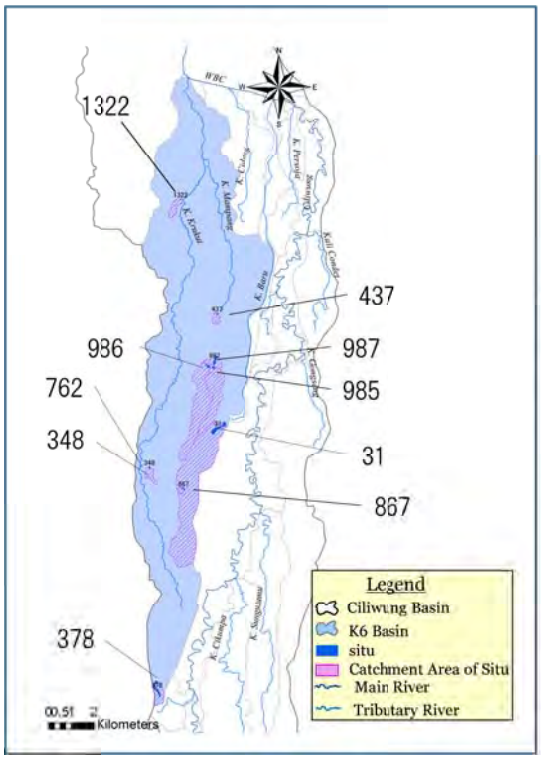
Figure 2.4-1 Location and Specification of Situ in Sub-Basin (L3)



Number of SITU : 4
Total Surface Area : 6.51 (ha)
Total Catchment Area : 115.98(ha)

ID	Name of Situ	Surface Area (Ha)	Catchment Area(Ha)
1319	W. Setiabudi 1	2.68	32.19
1321	W. Setiabudi 3	2.23	44.81
872	Pancoran 3	0.88	17.02
1320	W. Setiabudi 2	0.72	21.96

Figure 2.4-2 Location and Specification of Situ in Sub-Basin (L5)

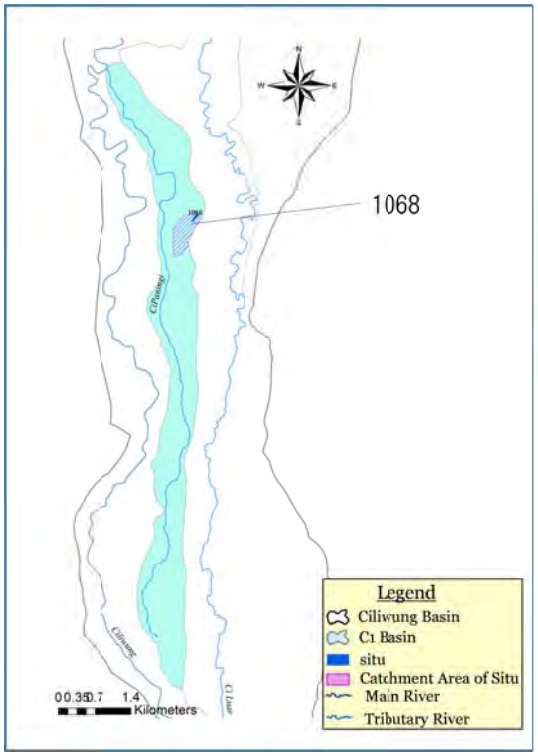


Number of SITU : 10
Total Surface Area : 24.75 (ha)
Total Catchment Area : 1108.70(ha)

ID	Name of Situ	Surface Area (Ha)	Catchment Area(Ha)
31	Babakan 6	9.74	604.21
378	Citayam 1	6.73	38.97
987	Ragunan 3	3.74	29.75
986	Ragunan 2	1.96	228.50
985	Ragunan 1	0.97	148.22
867	Paladen I	0.91	5.40
437	Dep Pertanian	0.54	14.51
348	CIPEDAK	0.54	20.41
1322	Walikota Jaksel	0.28	23.26
762	Matoa Golf	0.25	0.86

＊ID 31 Catchment area include ID 867 Catchment Area

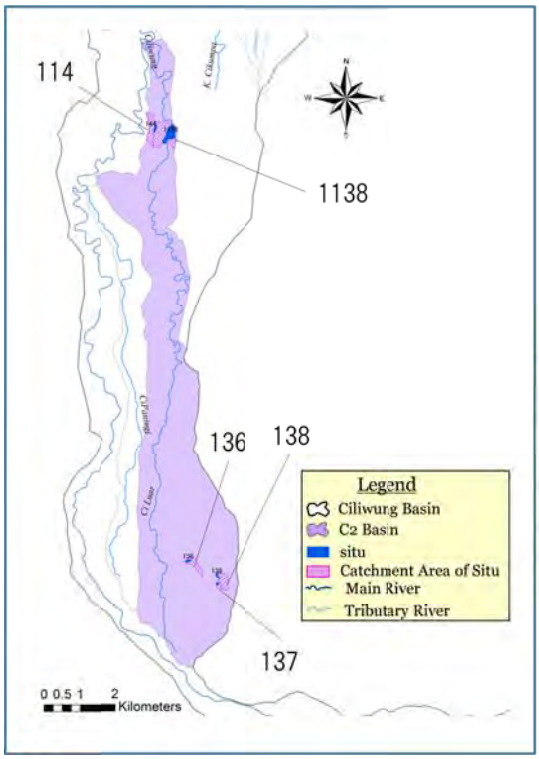
Figure 2.4-3 Location and Specification of Situ in Sub-Basin (L6)



Number of SITU : 1
Total Surface Area : 0.77 (ha)
Total Catchment Area : 25.32(ha)

ID	Name of Situ	Surface Area (Ha)	Catchment Area(Ha)
1068	Salam	0.77	25.32

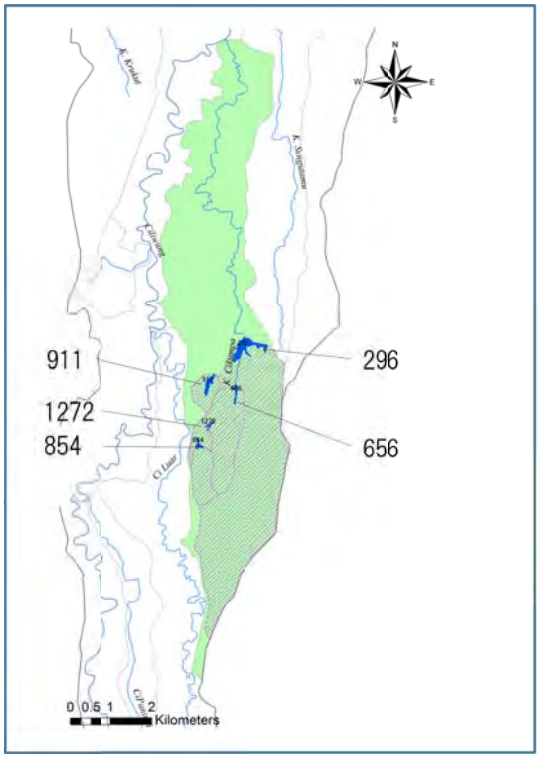
Figure 2.4-4 Location and Specification of Situ in Sub-Basin (R1)



Number of SITU : 5
Total Surface Area : 14.32 (ha)
Total Catchment Area : 74.18(ha)

ID	Name of Situ	Surface Area (Ha)	Catchment Area(Ha)
1138	SUKAHATI	10.45	35.67
144	BOJONG BARU	1.24	14.91
136	Bogor Raya	1.04	9.61
138	Bogor Raya Golf 2	0.99	11.75
137	Bogor Raya Golf 1	0.60	2.23

Figure 2.4-5 Location and Specification of Situ in Sub-Basin (R2)

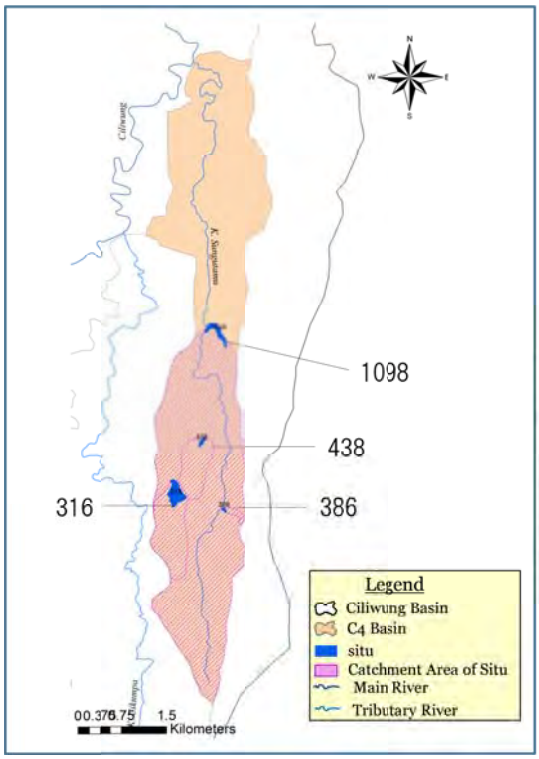


Number of SITU : 5
Total Surface Area : 24.56 (ha)
Total Catchment Area : 1156.12(ha)

ID	Name of Situ	Surface Area (Ha)	Catchment Area(Ha)
296	Cikareat	18.91	1113.68
911	Pemda	5.65	42.44
656	Kebantenan	3.06	268.66
854	PAKANSARI	2.32	68.02
1272	TENGAH	1.40	30.11

＊ID 296 Catchment area include ID 656, 854, 1272 Catchment area

Figure 2.4-6 Location and Specification of Situ in Sub-Basin (R3)

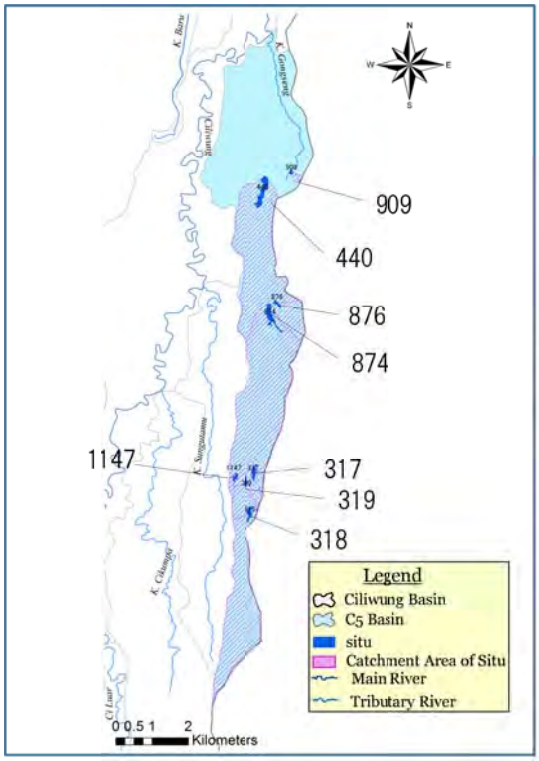


Number of SITU : 4
Total Surface Area : 4.38 (ha)
Total Catchment Area : 709.92(ha)

ID	Name of Situ	Surface Area (Ha)	Catchment Area(Ha)
316	Cilodong 1	8.11	71.49
1098	Sidomukti/Baru 2	4.38	709.92
438	Div Infantri Cilodong	0.98	43.47
386	Cjantung/Kibing	0.41	4.02

＊ID 1098 Catchment area include ID 438, 316, 386 Catchment area

Figure 2.4-7 Location and Specification of Situ in Sub-Basin (R4)



Number of SITU : 8
Total Surface Area : 24.80 (ha)
Total Catchment Area : 1477.45(ha)

ID	Name of Situ	Surface Area (Ha)	Catchment Area(Ha)
440	Dongkelan/Aman	12.41	417.89
909	Pekayon 1	0.82	5.87
874	Pangarengan 1	9.57	989.76
318	Cilodong 3	3.98	328.09
317	Cilodong 2	3.69	22.76
319	Cilodong 4	2.33	52.13
876	Pangarengan 3	2.00	63.93
1147	SUKAMAJU 4	1.86	8.84

＊ID 874 Catchment area include D 1147, 319, 317, 318 Catchment area

Figure 2.4-8 Location and Specification of Situ in Sub-Basin (R5)

CHAPTER 3 SELECTION OF PILOT PROJECT

3.1 Proposal of pilot project

Ciliwung River Basin has been urbanized. So water retention and retarding function in the Ciliwung River Basin was decreased.

We propose the construction of small-scale run-off control facilities as a measure with the objective of demonstration the Runoff Control Measures in the Basin and conducting technology transfer on monitoring and assessing the effects.

3.1.1 Category and Type of Runoff Control Facilities

Category and Type of Runoff Control Facilities are as shown in Figure 3.1-1.

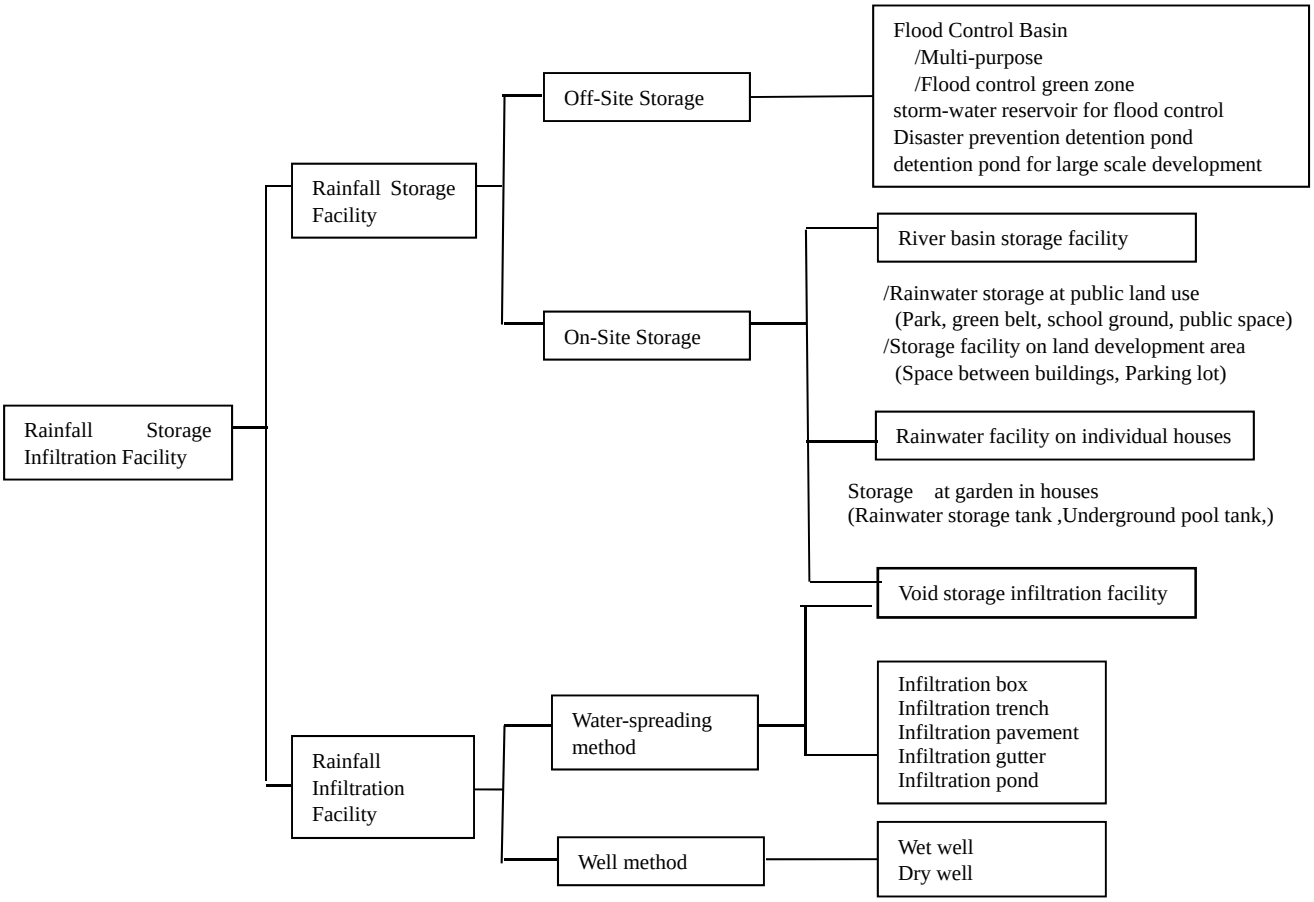


Figure 3.1-1 Category and Type of Runoff Control Facilities

3.1.2 Proposal of Pilot project

In order to incorporate the run-off control effect into CFMP, it is necessary to secure the following items.

- A stable and definite run-off control effect is displayed at times of flooding (clarification of where responsibility lies).
- The run-off control function is definitely secured into the future.
  Conditions for run-off control measure facilities are as follows.
- Facilities shall be controlled on public premises. (National, provincial, regency or municipal)
- Certainty of operation: Structures do not require gate operations. (Facilities shall be natural regulation method).
- Management responsibility: Clarify where responsibility lies for installment of run-off control facilities.

Under the above conditions, we propose three types of run-off control facilities as a pilot project in Ciliwung River Basin.

(1) Improvement of Situ

Some portion of water use capacity of existing Situ-Situ will be converted to flood control capacity. It is possible to reduce the flood peak discharge by utilizing the flood control capacity.

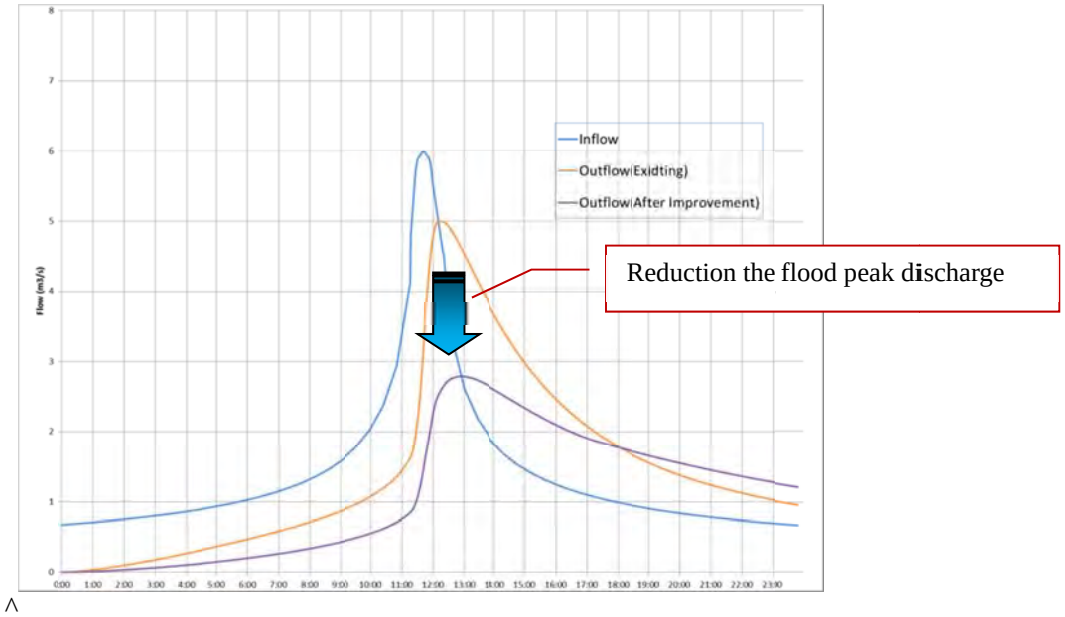


Figure 3.1-2 Effect of Improvement of Situ Spillway(Image)

The figure of Facility is shown in Figure 3.1-3.

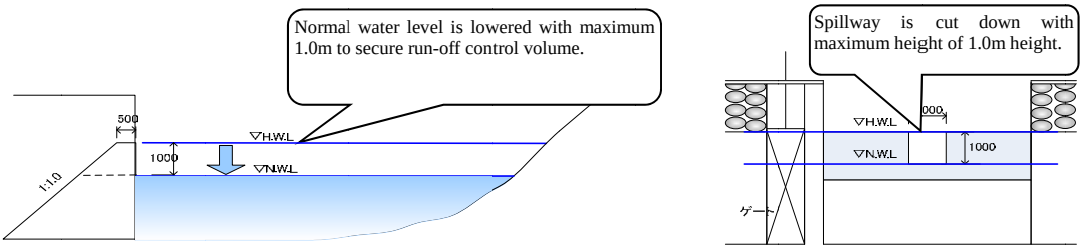


Figure 3.1-3 Improvement of Situ Spillway (Image)

(2) Park Storage Pond

We reserve the storage capacity by constructing the small bank around the Public **P**ark or public ground or by excavating in the public park. and to do run-off control We are using temporary flood storage capacity. The figure of Facility is shown in Figure 3.1-4.

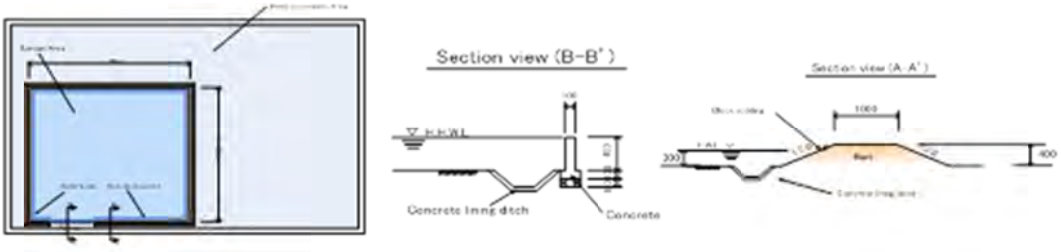


Figure 3.1-4 Park Storage Pond (Image)

(3) Infiltration Pond

In order to do run-off control, underground storage tank (Infiltration pond) in the s**i**te should be installed in the flood aqueduct.

The figure of (3) Infiltration Pond is shown Figure 3.1-5.

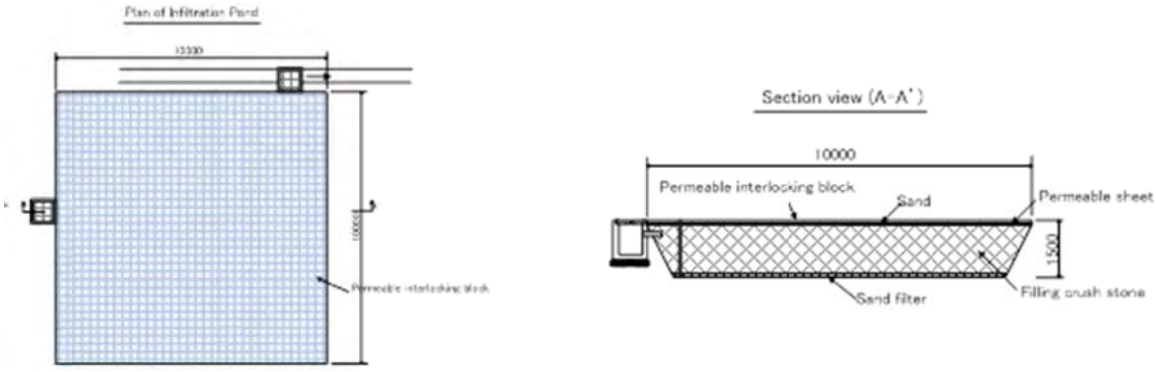


Figure 3.1-5 Infiltration Pond (Image)

3.2 Selection of project site

A suitable site for the facility proposed in the foregoing paragraph as a pilot project was selected through conducting a field survey. Rainwater storage permeating facility was selected as a pilot project in consideration for the result of the field survey and the consultation with the Indonesian Government, and the budget for the pilot project. This facility has the advantage of being installed within at both the time for completion and the budget. Furthermore, this facility is requested to be installed by the Indonesian Government. The details information of investigation, design and monitoring for the rainwater storage permeating facility is descried in the fourth chapter.
Situ improvement has not been adopted for the pilot project because that it is difficult to ensure safety of the downstream of the situ and to take long time to coordinate with relevant organizations. The detailed investigation method of the situ improvement is described in the fifth chapter.
Storage-at-park has also not been adopted for the pilot project because that quite a lot of difficulty is expected for facility construction using of existing park.
The details of selection are described below.

(1) Improvement of Situ

1) Site Reconnaissance

In order to grasp general features of *situ-situ* and related channel system in the Project area, the Project team carried out site reconnaissance around five (5) *situ-situ* located in the middle Ciliwung River Basin. The surveyed *situ-situ* were chosen based on a proposal from Ciliwung Cisadane River Basin Organization (Balai Besar Wilayah Sungai Ciliwung-Cisadane) and *situ-situ* inventory. Basic information and location of these are summarized in Table 3.2-1 and Figure 3.2-1 respectively.

Table 3.2-1 Basic Information of Surveyed *Situ-Situ*

Code	*Situ*	Basin	Sub-basin	Surface Area as of 2008 (ha)	Catchment (ha)	Village	District	Regency	Revitalization
656	Kebantenan	Ciliwung	R3	4.5	269	Pakansari	Cibinong	Kab. Bogor	1998
296	Cikaret	Ciliwung	R3	29.5	1,114	Harapan Jaya	Cibinong	Kab. Bogor	2002
316	Cilodong	Ciliwung	R4	9.5	71	Kalibaru	Sukma Jaya	Kota Depok	1998
378	Citayam	Krukut	L6	7.2	39	Bojong Pondok Terong	Pancoran Mas	Kota Depok	2003
868	Pladen	Ciliwung	-	1.5	39	Beji Timur	Beji	Kota Depok	2007

Note: Numbers indicated in the column of "Revitalization" means implementation year of a *situ* revitalization work consisting of dredging and improvement of environment around a *situ*.

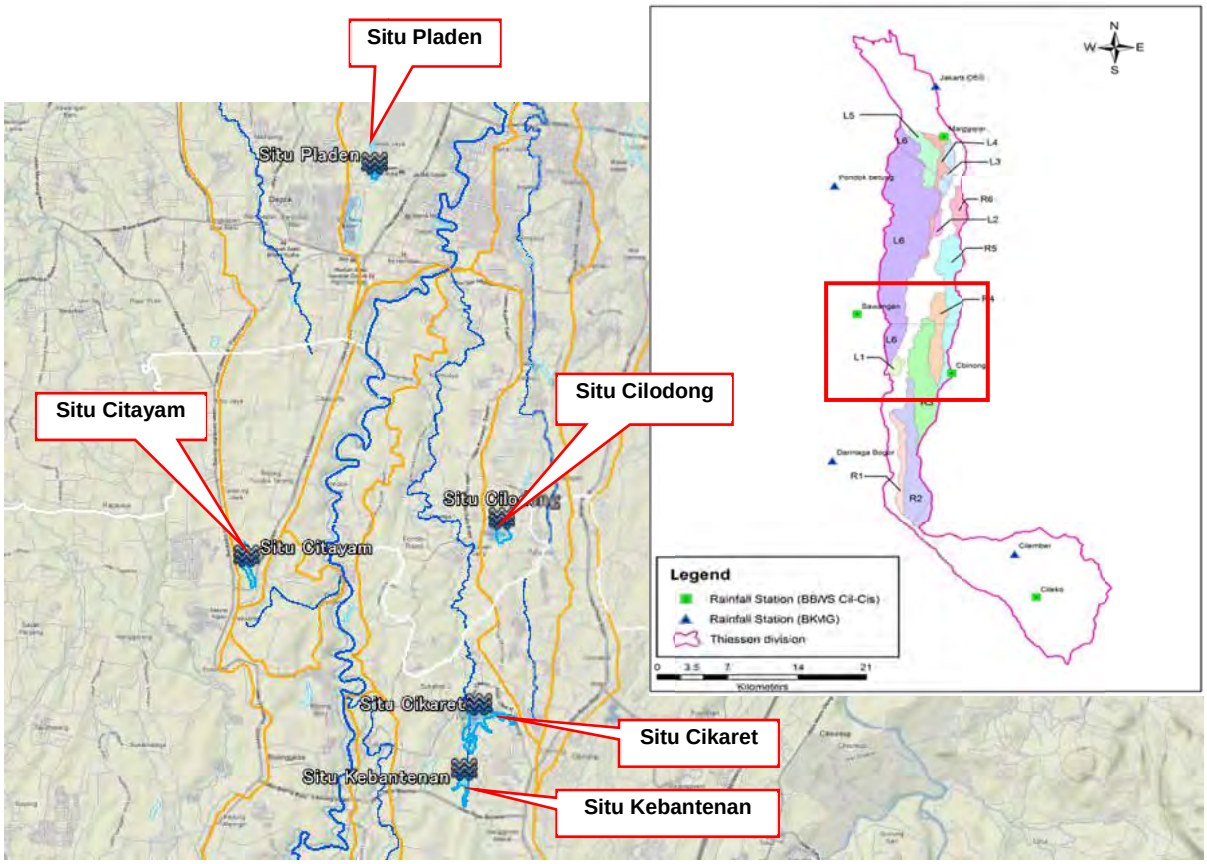


Figure 3.2-1 Location of Surveyed Situ-Situ

2) Result of The Field Survey

As a result of the field survey, some issues shown below for the situ improvement become clear and it is quite difficult to solve those issues during this study term. So the situ improvement has not been adopted for the pilot project.

○ Major issues

- It is necessary to improve downstream channel because that most discharge from it flows into irrigation ditch and the channel has poor discharge capacity.
- Adjustment of the people concerned is needed owing to the water from the situ being utilized for fish farming and irrigation.
- Purchase of land is necessary to improve the situ in view of the fact that there are many houses lining the lakeshore.

After having information for the present condition of the situ, the Indonesian Government also comes to conclusion that the situ improvement including spillway improvement would be in difficult to ensure safety of the downstream of the situ and to make an adjustment of the people concerned. And the Indonesian Government requests to JICA Study Team more investigation on the way of thinking and the method for the situ improvement, and the integrated flood control in tributaries. The results for these items are described in the fifth chapter and the sixth chapter.

(2) Park Storage Pond

1) Site Reconnaissance

We chose park and vacant ground, is more than 2500m^2 based on the interview with "Park and Cemetery Agency" and aerial photo. And we carried out a field survey.
The result of the survey is shown in Table 3.2-2.
We selected "Taman Banteng" as a candidate site. Because this park is public space and no inundation area and can be rebuild.

Table 3.2-2 Results of the study

No.	Code	River Basin	Location	Catchment Area [Ha]	Remark
1	PSP1	Krukut	Jl. Lapangan Tembak, Cilandak KKO	3.70	Military Area
2	PSP2	Ciliwung	Jl. Tebet Barat	2.00	Public park (Similar Natural Pond)
3	PSP3	Ciliwung	Ciparigi, Bogor	1.60	Military Area
4	PSP4	Ciliwung	Kalimulya, Depok	3.30	Private Land
5	PSP5	Ciliwung	Jl. Margonda, Depok	3.00	Private Land, Graveyard, Farm
6	PSP11	Cideng	Jl. Patra Kuningan	1.60	Private Land
7	Taman Banteng	Ciliwung	Jl. Lapangan Banteng Selatan	2.00	Public Park

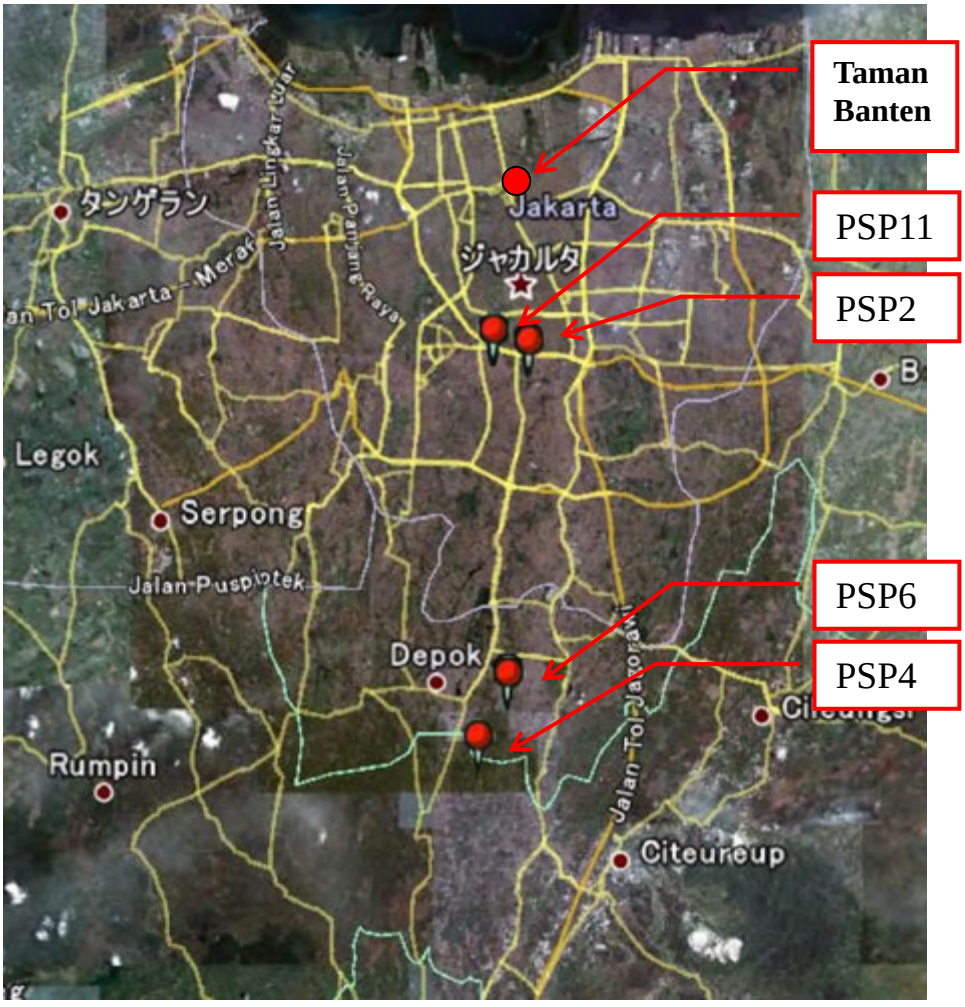


Figure 3.2-2 Location of Candidate Site of Park Storage Pond

2) Result of The Field Survey

Many issues such as, discharging point in downstream being not clear, sedimentation problem and accumulation of garbage, are revealed through the field survey. At a recent deliberation, the contact

person of the Indonesian Governmental department expressed disapproval for the improvement of the existing facilities even in “Taman Banteng” where facility is conceivable to be installed because that it is a land for public and it is beyond the scope of flood-stricken district. Therefore, the storage-at-park is excluded for the pilot project due to being restricted by time constraints. It is required to propose the storage-at-park considered when establishing park newly or improving existing park.

Taman Banteng

	Conditions of park (Entrance)
	Conditions of park (Candidate site)
	Conditions of park （drainage at downstream）

Figure 3.2-3 Photos of Candidate site of Park Storage Pond (Taman Banteng)

(3) Infiltration Pond

1) Result of The Field Survey

The site of PU and the site of BBWS Ciliwung-Cisadane Office have been selected for the rainwater storage permeating facility site because of easy construction management and maintenance, and the field survey both in those site and the consultation with the organization concerned were carried out.

As a result, the facility is to be installed at BBWS Ciliwung-Cisadane Office, which is requested by the Indonesian Government, for the reason that the procedure of surveying and construction do not need a long period and will be able to be completed within this study.

Location map of candidate site is shown Figure 3.2-4.

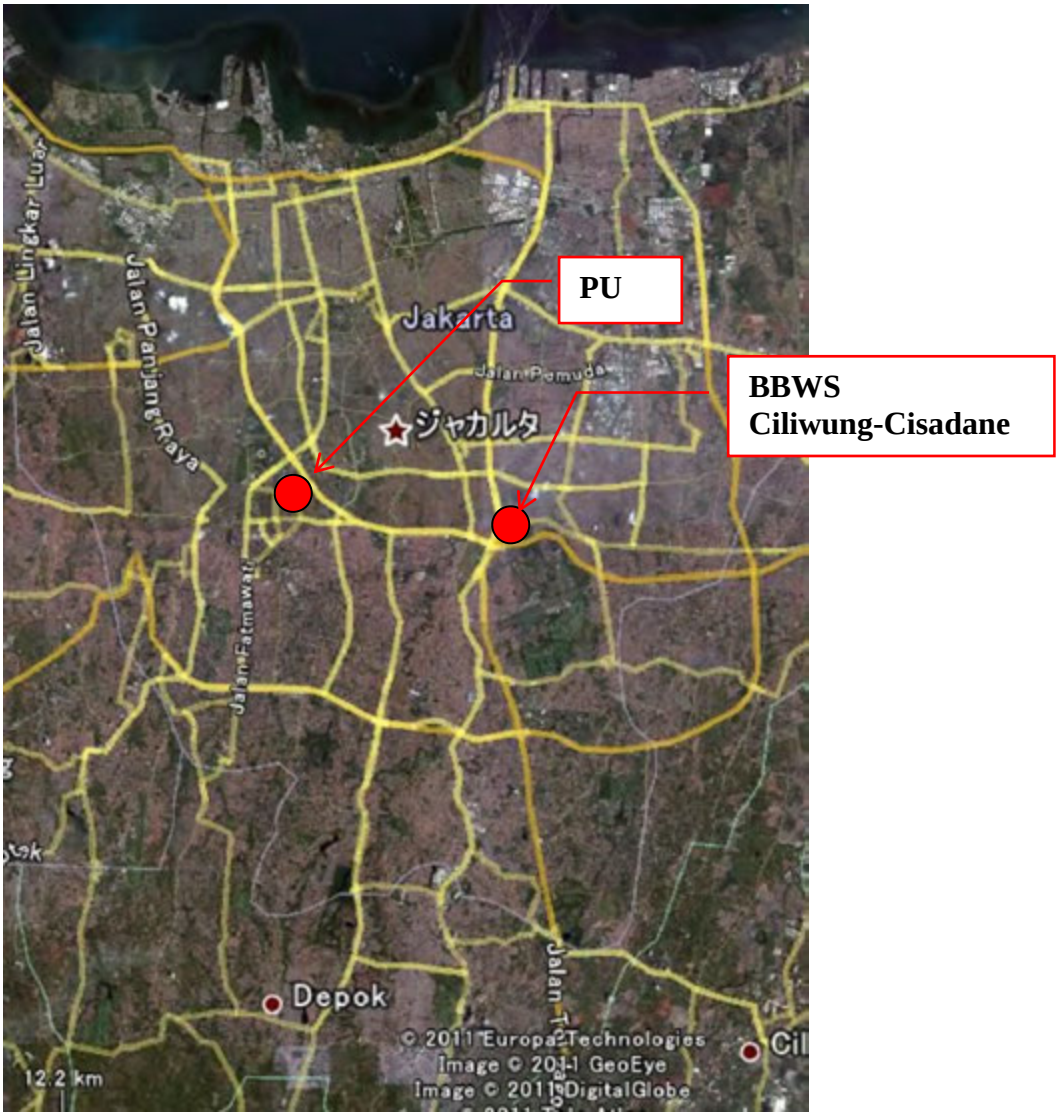


Figure 3.2-4 Location map of candidate site

2) Select of Infiltration Pond Construction Site

We selected two places in the BBWS Ciliwung - Cisadane office site from result of the field survey.
As a result of comparison, we selected an A spot as the infiltration pond construction site because a catchment area is wide and it was near to existing drainage.

Figure 3.2-5 Location map of Candidate site of Infiltration Pond

	A Spot (From upstream)
	A Spot (From downstream)
	B Spot (parking space in front of mosque)

Figure 3.2-6 Photos of candidate site (BBWS CIL-CIS office site)

		Down stream of PU office site
		Central parking space (1)
		Central parking space (2)

Figure 3.2-7 Photos of candidate site (PU office site)

CHAPTER 4 PLAN AND CONSTRUCTION OF INFILTRATION FACILITY

4.1 The Purpose of the Pilot Project

With the urbanization of the Ciliwung River Basin, the retention/retarding function of the Ciliwung River Basin has decreased, the discharge flow has increased and flooding damage has increased remarkably. Consequently, it is urgently required to implement flood prevention measures.

The purpose of this Pilot Project is to install Rainwater Storage Infiltration Facilities on a experimental basis, those are applied in Japan as a flood prevention measure, and to transfer of technology about the planning, design and evaluation method of the flood prevention facilities through monitoring effect for flood prevention.

The rainwater percolates down through the soil and evaporate to the air or discharges to rivers for many years. When the ground surface is covered with concrete or asphalt with urbanization, this causes flooding in urban areas owing to the detraction of rainwater infiltration in a localized downpour. Rainwater Storage Infiltration Facility which is one of the Void storage infiltration facility having received attention recently to improve these serious situation. These facilities prevent the rainwater from overflowing on the ground by getting the rainwater to sink into the soil and by retaining the rainwater on the land surface or in the underground.

These facilities get people's attention from the point of making efficient use of water resources in addition to the disaster damage prevention function.

4.2 Select and Size of Pilot Facility

4.2.1 Category and Type of Runoff Control Facilities

Flood Prevention Facility is divided into two (2) groups, Storage Facility and Infiltration Facility, and Storage Facility is classified into two (2) types, Onsite Storage Facility and Off-site Storage Facility, by the difference of location. Infiltration Facility as the onsite facility is classified into two (2) types, Water-spreading Method which spreads rainwater into the underground, and Well Method.

The purpose of the storage facility is to reduce discharge flow by time differential discharge to sewers /rivers through retaining of the rainwater on the land surface or in the underground. This facility includes Surface Storage type and Underground Storage type. The surface storage type temporarily retains the water using an open space such as a parking lot/a playground, and releases the water after rains. The underground storage type uses concrete or plastic storage tanks constructed below a building/a parking lot.

Infiltration Facility releases the water into the underground. There are two (2) ways to release the water into the underground, one of them from the land surface plane such as water-permeable paving, infiltration pond and gravel void infiltration, and the other from points/lines on the land surface such as infiltration box, infiltration trench, road infiltration box and infiltration side ditch. These facilities are useful for flood prevention and moreover, there are some facilities to solve the temperature rising on roads surface such as an urban heat island phenomenon in summer.
Flood Prevention Facilities are classified into two (2) types, the storage facilities and the infiltration facilities as shown in Figure 4.2-1,

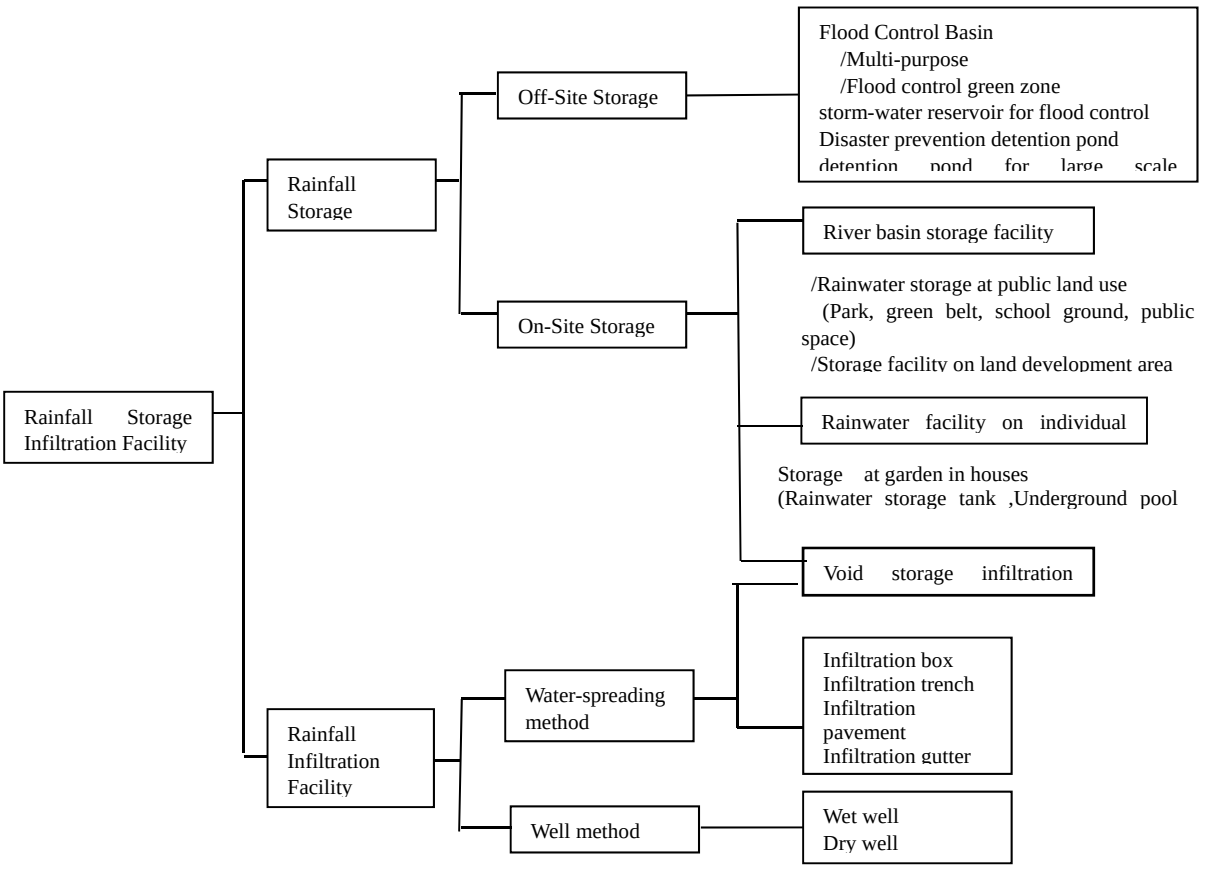


Figure 4.2-1 Category and Type of Runoff Control Facilities

4.2.2 Select of Pilot Facility

Gravel Void Storage Infiltration Facility (Rainwater Storage Infiltration Facility), which has both the water storage function and the infiltration function in addition to a relatively high flood prevention effectiveness, is selected as the pilot facility in this project. Rainwater Storage Infiltration Facility leads the water into crushed stone tanks below the ground and percolates the water into the soil through the side faces and the undersurface. There are some cases in which storage tanks constructed in the gravel space utilize rainwaters effectively. Recently the tank built of plastic materials with high porosity (more than 90 percent) has increased. The underground gravel void storage infiltration facility built of plastic materials has become widespread rapidly in Japan, and also the technical development on it has progressed. With due regard to this situation, the rainwater storage infiltration facility built of plastic materials is selected as the flood prevention pilot facility in this project with the object of introducing Japanese up-to-date technology. The record performance of the rainwater storage infiltration facility built of plastic materials in Japan reached to 160 million m^2 (as of the 2007 fiscal year) and is increasing year by year. According to the classification by application on the execution ratio of this facility, the largest one is commercial facilities with one third of the total, and after that the housing, the school, the park and the road. This facility has spread over wide-ranging field as the others amount to one third of the total.

The storage infiltration facility to be constructed in this project has its own unique character, that is the utilization of recycling of plastics. As a result of this, it is possible to secure 90 percent or more porosity and to be expected to obtain a high degree of effectiveness with the small scale facility. This means that the new type facility can obtain the same effectiveness at one third scale of the old type in the past, which used gravel/glass block and have about 30 percent of porosity. And moreover, it is a distinguishing feature to make use of the upper part of the facility for a park or a parking lot. The features of plastic materials are shown below.

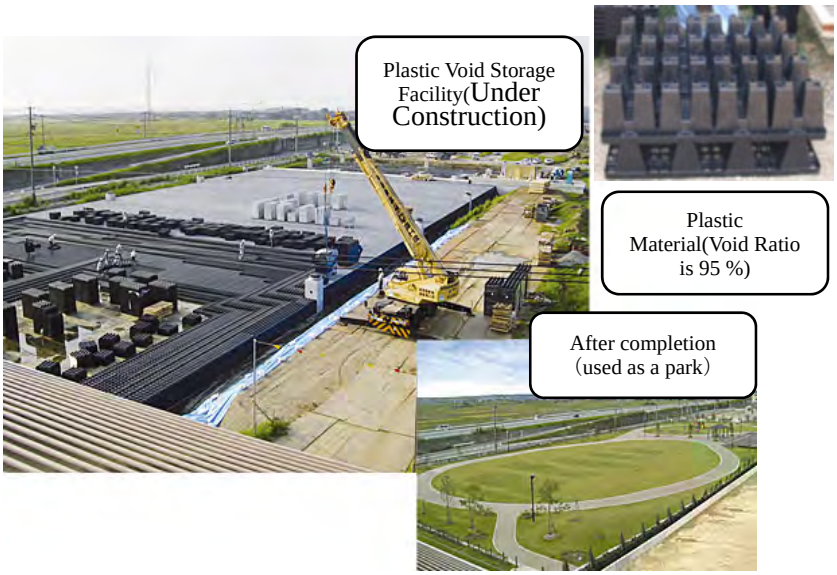


Figure 4.2-2 Plastic Rainwater Storage Infiltration Facility

Table 4.2-1 Features of Plastic Rainwater Storage Infiltration Facility

Item	Contents
a) High Void Ratio	・High Void Ratio can be maintained by intersecting it. ・Reduce the amount of digging. ・Digging is small.
b) Time saving	・Installation can be done only by hand. ・Compared to using concrete no need curing time. ・No need heavy equipment
c) Heavy load capacity design	・Load of 25 ton truck in vertical direction
d) Easy installation	・No fixing material is required. ・Installation speed is quick.
e) NO pollution	・Excellent chemical and water resistant, do not pollute the water.
d) Compact Storage	・It can be easily stored and reduces storage space at the site.

4.2.3 The Size of Pilot Facility

The size and form of pilot facility is shown below.

The pilot facility is to be constructed as a tentative facility with 10 m (B) x 10 m (W) x 1.0 m (H), and it has a purpose of transferring of technology about the design and construction method for the storage infiltration facility, and monitoring effectiveness.

The earth covering of the upper of the facility is 60 cm or more in thickness to enable a 25ton truck/a heavy machine to pass on it.

The waterway and drainage will be constructed around the facility, the waterway leads floods to the facility and the drainage drains water to the lower from it.

Because that the depth of the drainage is 50 cm and that of facility bottom is 1.5 m, the water cannot be drained in free fall. The floodwater is to be discharged from the facility bottom.

In case of leading floods in their early stages, it cannot control floods effectively because of the facility being full of water before floods reaching the peak. Therefore, a side overflow weir is to be set up to bring in the floodwater upwards undeveloped floodwater and that not exceeding undeveloped floodwater is bypassed to the lower.

The required volume of the facility is 250 m^3 on the assumption that this facility deals with 50 mm/hr. However this time, the facility volume is determined 100 m^3, which treats 20 mm/hr.

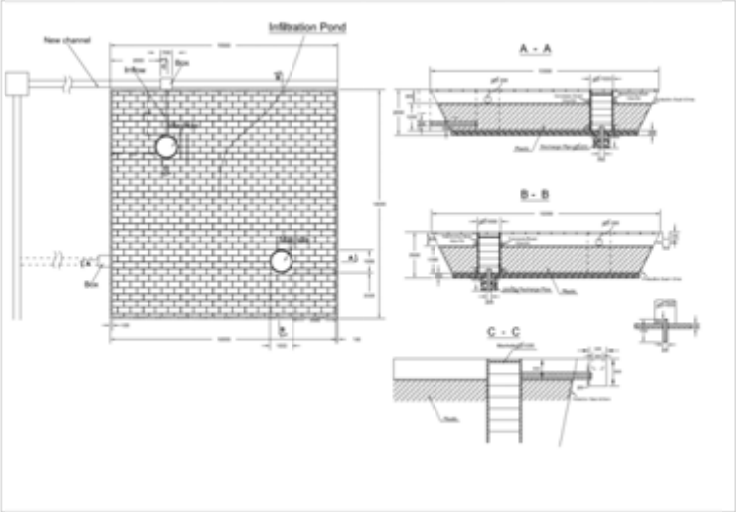


Figure 4.2-3 Design of Rainwater Storage Infiltration Facility

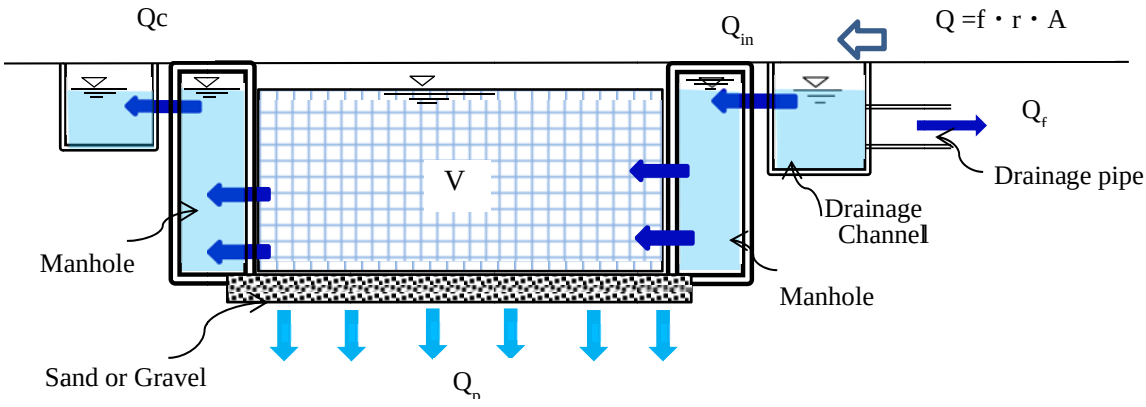


Figure 4.2-4 Rainwater Storage Infiltration Facility (Image)

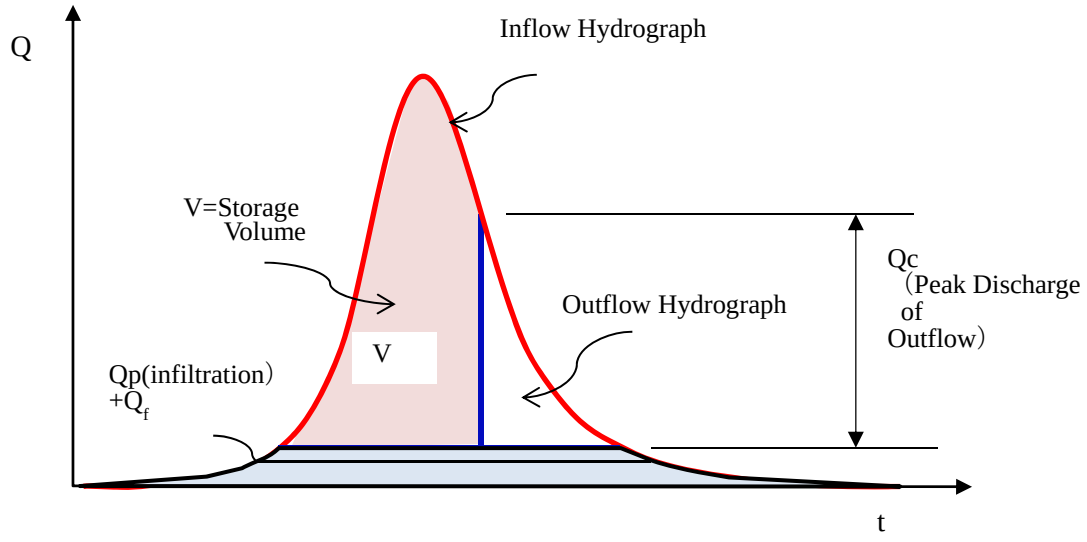


Figure 4.2-5 General Idea of Hydrology and Hydraulics of Runoff Control

In consideration that the rainwater storage infiltration facilities are to be spread over the catchment area, it is required to design the facility, at the same time it is necessary to evaluate the flood prevention effect on a river engineering project.

The general idea for inflow, rainwater storage, infiltration and outflow in the catchment area are shown in. Figure 4.2-5. Each facility conducts flood prevention in their assigned area.

4.3 Foundation Spot of Pilot Facility

The pilot facility is to be founded at the site of Ciliwung-Cisadane River Basin Organization Office (BBWS Ciliwung – Cisadane). The location of BBWS Ciliwung – Cisadane Office is shown in Figure 4.3-1.

Figure 4.3-1 Location of BBWS Ciliwung – Cisadane Office

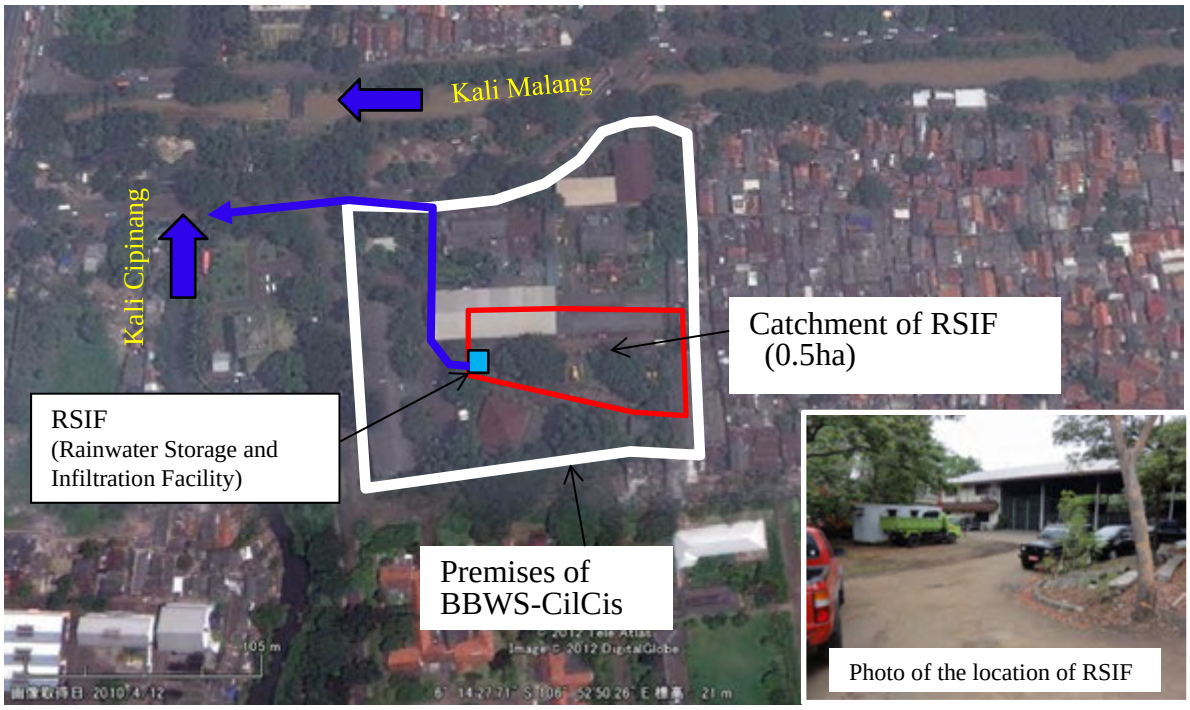


Figure 4.3-2 Location of BBWS Ciliwung – Cisadane Office and RSIF

4.4 Plan and Design of Facility

4.4.1 Hydrology and plan of facility

The flow of survey and planning for a plan of Rainwater Storage Infiltration Facilities is shown in Figure 4.4-1 .Contents of survey and planning are shown below.

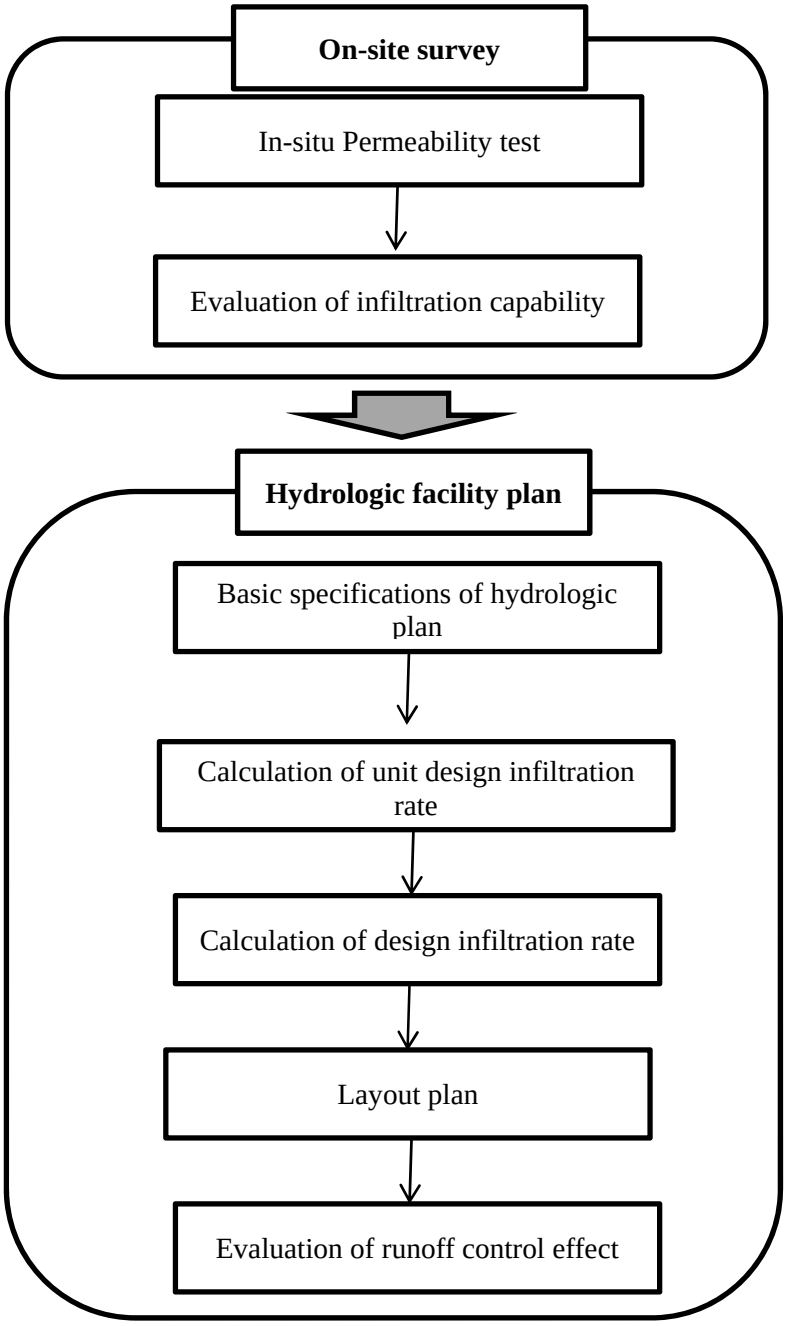


Figure 4.4-1 Survey and Planning Flow of Infiltration Facility

4.5 In-situ Permeability Test

4.5.1 Plan of Test

(1) Selection of Field Infiltration Test Methods

It is desirable that the equipment for test is easy to be set up and to save the injection volume, and the forecastable infiltration capability from the examination result is high accurate and reliable
.
There are two (2) methods for simplified test, those are the cylindrical full infiltration method (Borehole method) and the cylindrical undersurface method. In this project, the cylindrical full infiltration method, which keeps the configuration of the equipment bottom soil, is adopted because that this test will be carried out on the undersurface of the equipment and the soil is a unitary clayey soil.

Table 4.5-1 Comparison of Field Infiltration Test Methods

Method	the cylindrical full infiltration method (Borehole method)	the cylindrical undersurface method
Outline of Test Equipment	1 Exploitation of Auger Pit of 20 cm in diameter 2 Infiltration surface is underwater portion (side faces and undersurface	1 The cylinder of 30 cm in diameter is buried in a excavated pit 2 Infiltration surface is the undersurface of the cylinder
Advantages and Disadvantages for Equipment	1 Excavation volume is small 2 Easy to set up 3 Infiltration character of the bottom is stable 4 Maintenance of infiltration face is difficult 5 Set up of Equipment in the sedimentary layer with gravel and rounded stone is not easy	1 Excavation volume is a rather large 2 Surrounding foundation soil of Equipment can be disturbed by excavation and refilling 3 Maintenance of infiltration face is easy 4 No restrictions for set up on soils
Advantages and Disadvantages for Method	1 Injection volume is small 2 Average capability from vertical and horizontal infiltration can be obtainable 3 Anisotropy (difference between horizontal direction and vertical direction) Water permeability can be analyzed in 2-waterhead test	1 Injection volume is small 2 Evaluation of the capability is only vertical infiltration 3 Refilled area can be affectable by the injection
Adoption	○	

(2) Procedure of In-situ Permeability test

During facility execution the project team performed the Permeability test at digging surface by bore-hole method.
A summary of a test method and test condition are as follows.

a) Condition of test

- Method of test：bore-hole method
  Constant head test method and falling head test method
- Test point number：3 points, Test locations are as follows.

b) Method of test

The method of test of bore-hole method is as follows.

Table 4.5-2 In-situ Permeability Test Method by Bore-hole Method

Test Procedure	Summary
Excavation of borehole	a) A borehole is excavated to the specified depth with a hand auger. b) A diameter of borehole assumes about 20~30cm and depth assumes around 1m a standard.
Soil check and sampling	a) During excavation, soil type is identified. A soil sample representing the infiltration area is taken as required for the laboratory test.
Maintenance of infiltration surface	a) ・The condition in the hole should be observed closely. The infiltration surface should be scraped with a rake or a wire brush as required. Excavated debris should be removed carefully.
Insertion of filling material	a) After excavation of borehole, gravel or crash crushed stone are filled, while paying attention so that the infiltration surface is not damaged.
Constant head test method	a) Recharge water up to the level equivalent to the design ponding depth and use it as the initial condition. b) Maintain the ponding depth above. c) Measure the recharge amount over time with an instrument such as a flowmeter. The guideline for measurement interval is 10 minutes. If the variation is large, reduce the interval. d) Continue b) to c) until the recharge amount is almost constant. Test time is around 2 hours.
- Falling head test method	a) Recharge water up to the level equivalent to the design ponding depth and use it as the initial condition. After Constant head permeability test stop the recharge. b) After recharge water up to the level equivalent to the design ponding depth measure the change of water level in a test hole. Measurement interval is 1 minutes. c) It passes from an test start for around 1 hour and just continues when an test is not finished.

Figure 4.5-1 Location of Test Points

- Dimensions of test holes：

Dimensions of test holes are shown in Table 4.5-3.

Table 4.5-3 Dimensions of Test Holes

(cm)

No.	A :Diameter	B:Depth (from crushed stone bottom)	C:Depth (from crushed stone surface)	D:Depth of constant water level (from crushed stone surface)
1	35	97	89	70
2	35	95	84	70
3	35	95	83	70

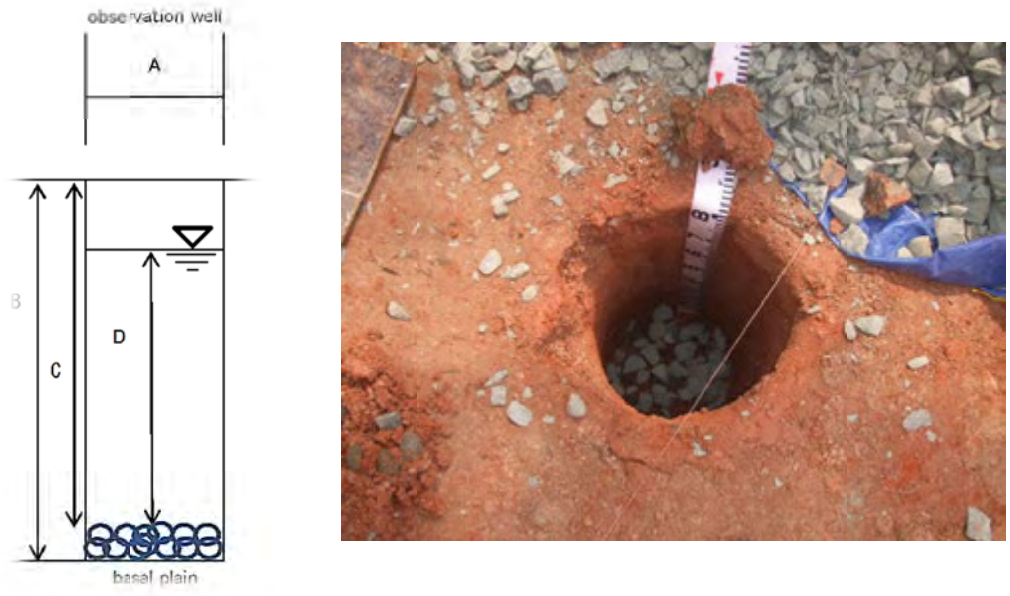


Figure 4.5-2 Photo of Test Hole

- Test time：Constant head test method；around 2.0 hours / point
Falling head test method：around 0.5-1.0 hours / point

The state of test is shown in Figure 4.5-3.

Figure 4.5-3 State of Test

4.5.2 Result of Test

(1) Result of permeability test by Constant head test method

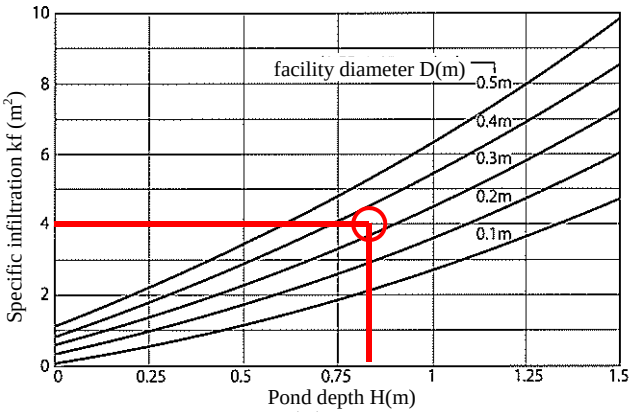
1) Calculation method of coefficient of permeability

The saturated hydraulic conductivity is calculated using the formula below based on the final steady-state infiltration rate that is compatible with the test facility shape and the ponding depth obtained from the in-situ permeability test.

$K_0=Qf/Kf$

where

K_0 : Saturated hydraulic conductivity (m/hr)
Qf : Final steady-state infiltration rate at in-situ permeability test (m^3/hr)
Kf : Specific infiltration of test facility(m^2) (Constant determined by the test hole. Cf.Figure 4.5-4)
Kf = 4.0 is decided by facility diameter is 0.35m and ponding depth is 0.78~0.82m.$K_0=Qf/Kf$



source : Engineering Guideline for Rainwater Infiltration Facilities Survey and Planning / Association for Rainwater Storage and Infiltration Technology and Infrastructure Development Institute - Japan

Figure 4.5-4 Specific Infiltration of Borehole Method

2) Calculation result of coefficient of permeability

The result of test is shown in Table 4.5-4.

A coefficient of permeability of this site is estimated with $K_0=1.2 *10^{-3}$ (cm/sec) from result of test.

Table 4.5-4 Calculation Result of Coefficient of Permeability

	No.1	No.2	No.3	Average
Qf(L/min)	2.35	2.55	4.00	
Qf(m^3/hr)	0.141	0.153	0.240	
Kf(m^2)	4	4	4	
K_0(m/hr)	0.03525	0.03825	0.06000	0.0445
K_0(cm/sec)	0.98×10^{-3}	1.06×10^{-3}	1.67×10^{-3}	1.2×10^{-3}

The data sheet of the result of test are shown in Annex.

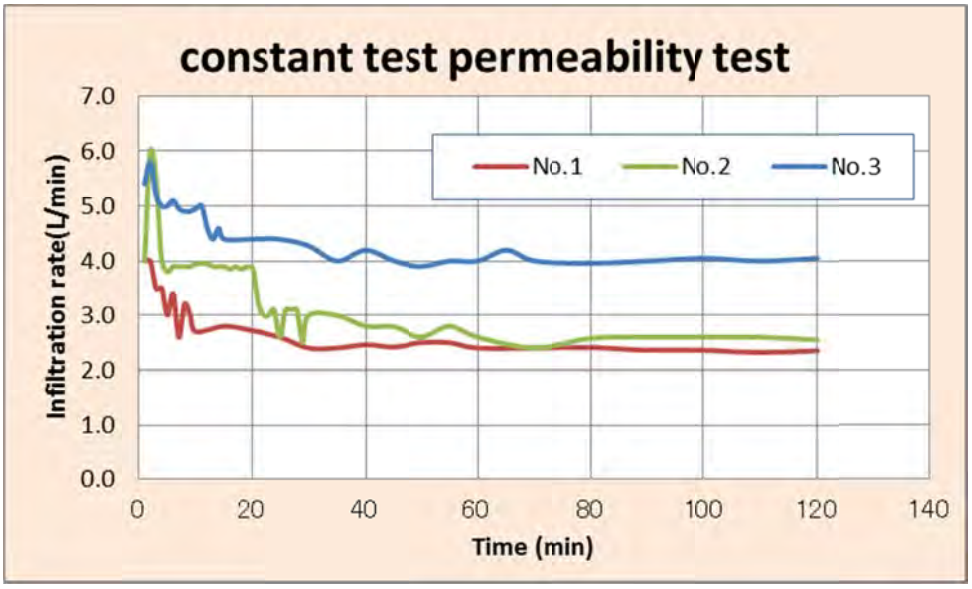


Figure 4.5-5 Change of Infiltration Rate (Constant Head Test Method)

(2) Result of permeability test by Falling head test method

1) Calculation method of coefficient of permeability

The saturated hydraulic conductivity is calculated using the formula below from the in-situ permeability test.

$K_0=\gamma*a$

where

K_0 : saturated hydraulic conductivity(m/s)

a : coefficient of infiltration capacity

γ : The constant number to affect borehole diameter and ponding depth.

γ=0.078 to see a safe side

a=ΔH/H(ave)

ΔH=(H1-H2)/Δt

H(ave)=(H1+H2)/2

H1 : start water level

H2 : final water level

Δt : test time

2) Calculation result of coefficient of permeability

The result of test is shown in Table 4.5-5.

A coefficient of permeability of this site is estimated with $K_0=5.2*10^{-3}$ (cm/sec) from result of test.

Table 4.5-5 Calculation Result of Coefficient of Permeability (Falling Head Test)

	No.1	No.2	No.3	average
H1(m)	0.70	0.70	0.70	
H2(m)	0.065	0.232	0.044	
Δt (min)	60	30	30	
a	0.000461	0.000558	0.000991	
γ	0.078	0.078	0.078	
K_0(m/sec)	3.60×10^{-5}	4.35×10^{-5}	7.73×10^{-5}	5.2×10^{-5}
K_0(cm/sec)	3.60×10^{-3}	4.35×10^{-3}	7.73×10^{-3}	5.2×10^{-3}

(3) Evaluation infiltration rate (test result)

The result of test is shown below

A coefficient of permeability of this site is estimated with $K_0=1.2 * 10^{-3}$ (cm/sec) from constant head test.

In addition, the project team calculates a coefficient of permeability from result of falling head test. The result of calculate is 1.0×10^{-3} cm/s order, that is higher than Calculation result of coefficient of permeability from constant head test.

From these result, a coefficient of permeability of this site is decided to $K_0=1.2 * 10^{-3}$ (cm/sec) .

Table 4.5-6 Result of permeability test

（unit cm/s）

Method of test	No.1	No.2	No.3	average
constant head test	0.98×10^{-3}	1.06×10^{-3}	1.67×10^{-3}	1.2×10^{-3}
falling head test	3.60×10^{-3}	4.35×10^{-3}	7.73×10^{-3}	5.2×10^{-3}

(4) Laboratory test

The Laboratory test (grain size analysis and specific gravity test) was carried out by using the sample soil taken from the point where the infiltration test was done.

The grade distribution is shown in Figure 4.5-6. The soil is analyzed silty clay with a mixture of sand and gravel. Though the water permeability of the silty soil is estimated under 1.0×10^{-4} cm/s, the result of this time showed 1.0×10^{-3} cm/s corresponding to sand and gravel. There is a reason to believe that the sample soil has crumb structure and it is rich in air-permeability and permeability.

The gravity of the soil is 2.686.（CF . to Annex1）

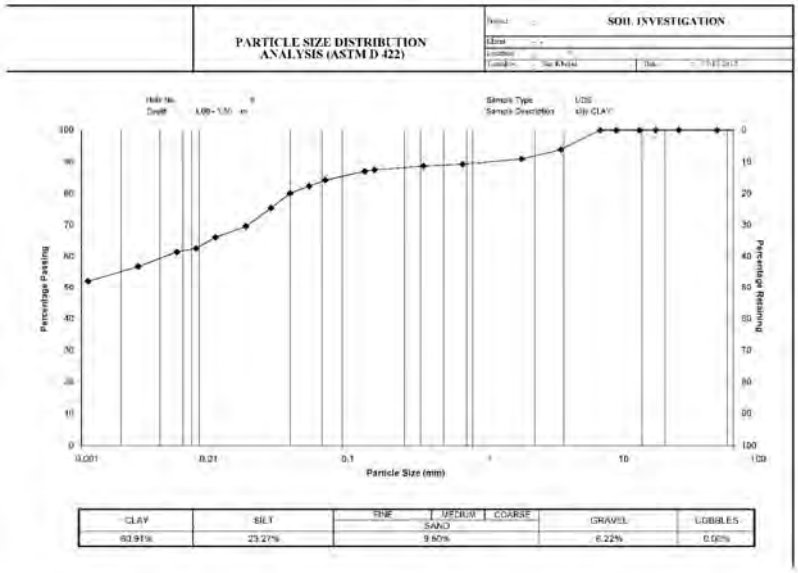


Figure 4.5-6 Result of Grading Analysis

Crumb Structure: Crumb is solidified of particles of clay and sand and humus derived from organic matter. The soil consisting of this crumb has a proper vacant space in it and it has a high flexibility with a high drainage/retention capability.

Table 4.5-7 Approximate Value of Saturated Hydraulic Conductivity for Each Grain Diameter

	Clay	Silt	Very minute grain sand	Fine grain sand	Medium grain sand	Coarse sand	Small gravel
Grain diameter (mm)	0 - 0.01	0.01 - 0.05	0.05 - 0.10	0.10 - 0.25	0.25 - 0.50	0.50 - 1.0	1.0 - 5.0
k (cm/s)	3×10^{-6}	4.5×10^{-4}	3.5×10^{-3}	0.015	0.085	0.35	3.0

Source: Draft proposal of site permeability survey manual of infiltration type runoff control facility, Public Works Research Institute, Ministry of Construction

Table 4.5-8 Approximate Value of Saturated Hydraulic Conductivity and Determination Method

k (cm/s)	10^{2} 1.0 10^{-2}	10^{-4} 10^{-6} 10^{-8}
Soil type	Clean gravel Clean sand Sand with clean gravel	Fine grain sand, silt, mixture of sand and silt Barely permeable soil Clay
Determination method	Pumping test, constant head method, test formula	Falling head method

Source: Draft proposal of site permeability survey manual of infiltration type runoff control facility, Public Works Research Institute, Ministry of Construction

4.6 Design of Facility

The first infiltration facilities was planned with 10m (width) *10m (length) *1.14m (6 levels deep) scale.
But, as a result of surveying, Facilities construction of above scale came to a conclusion for the reason that there were a radio tower foundation in the north side of facilities area and so hard to excavate around that foundation, and it was difficult to secure a access for a heavy industrial machine.
So the scale has to be changed with downsizing of plan and deepening depth.
Facilities scale after a change is 9m (width) *9m (length) *1.33m (7 levels deep).

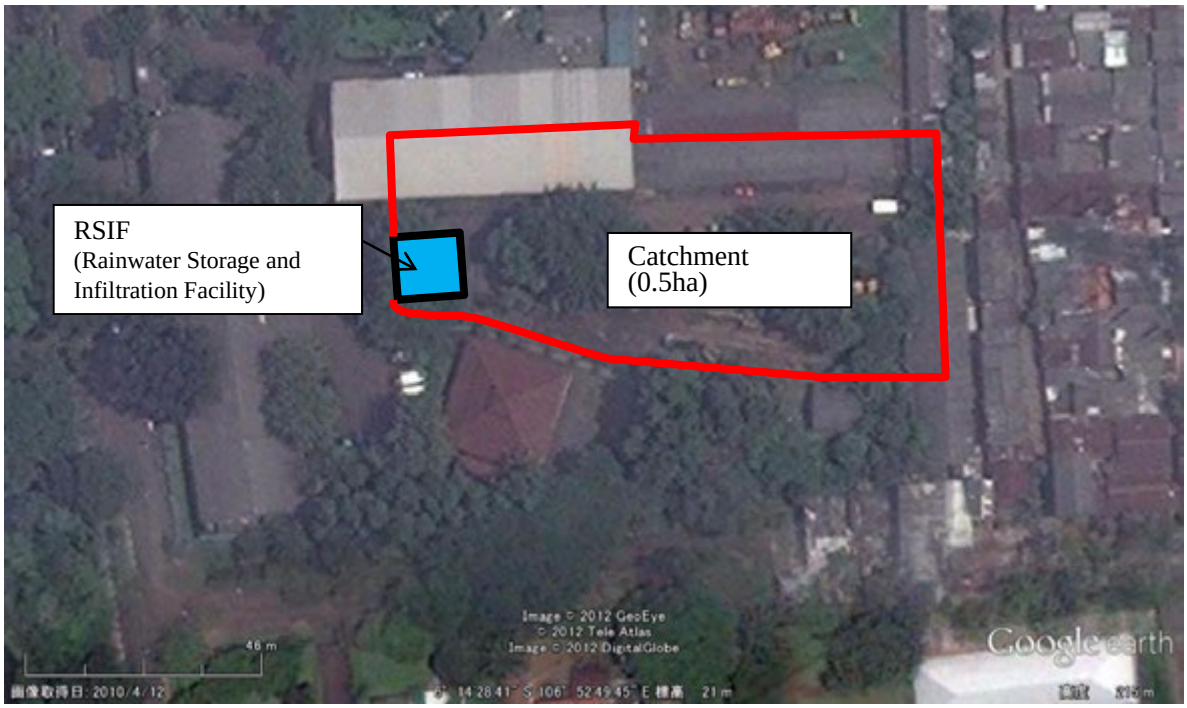


Figure 4.6-1 RSIF Construction Area (outline)

Figure 4.6-2 Situation of Surveying

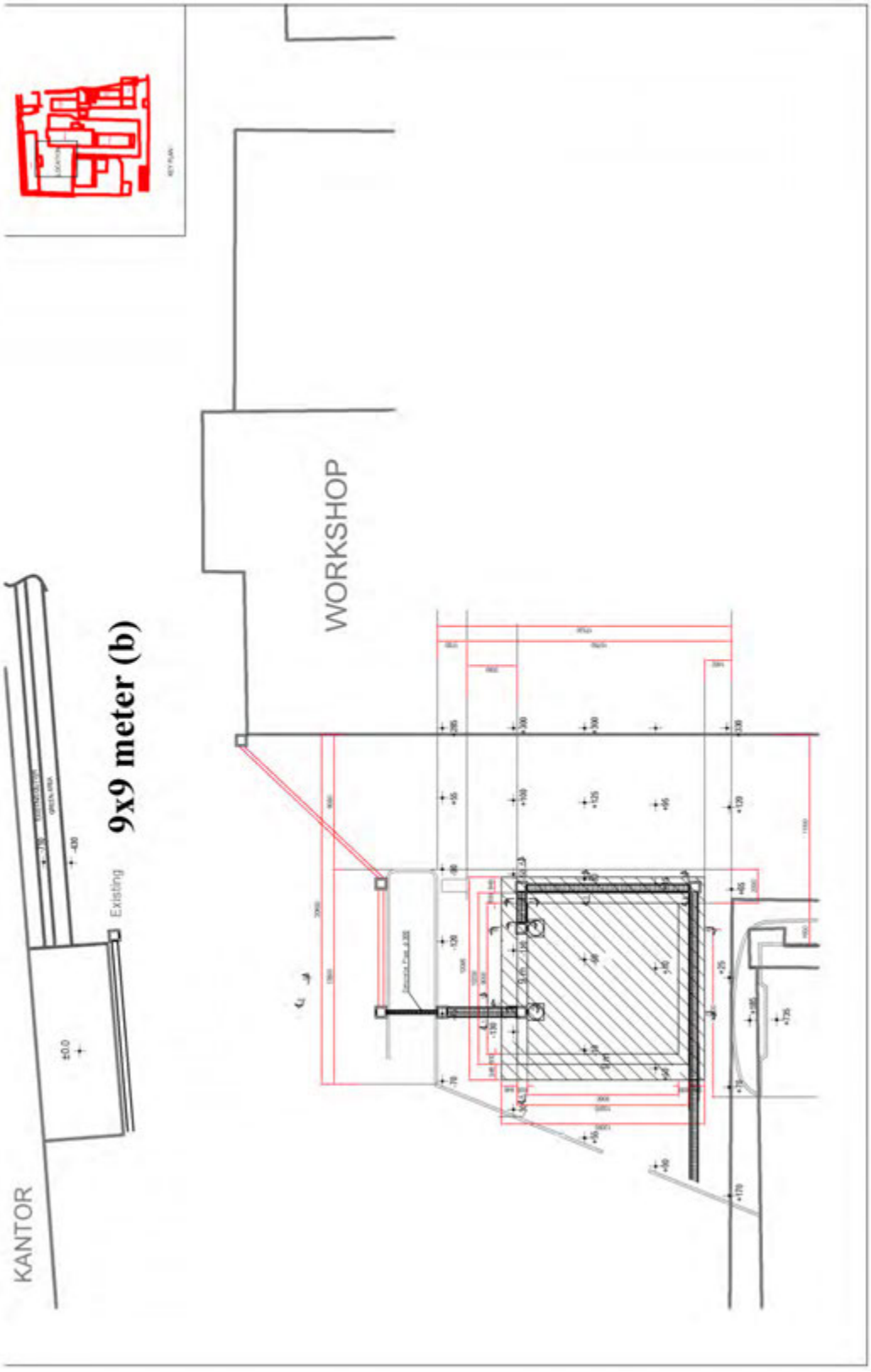


Figure 4.6-3 Plan

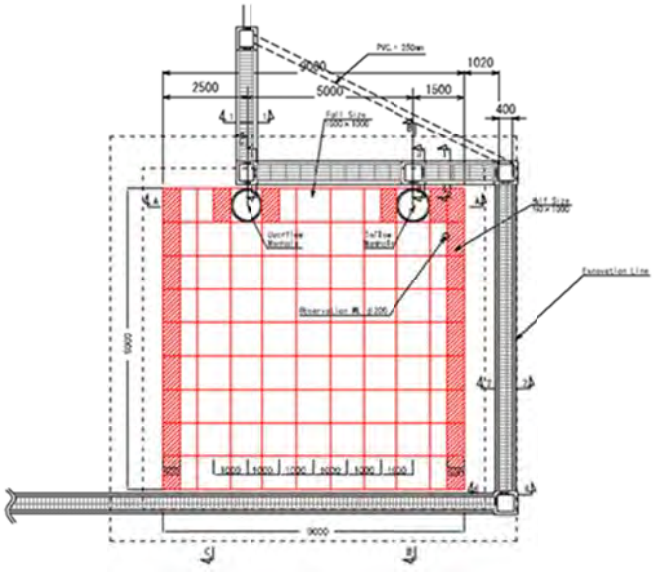


Figure 4.6-4 Plan（Detail）

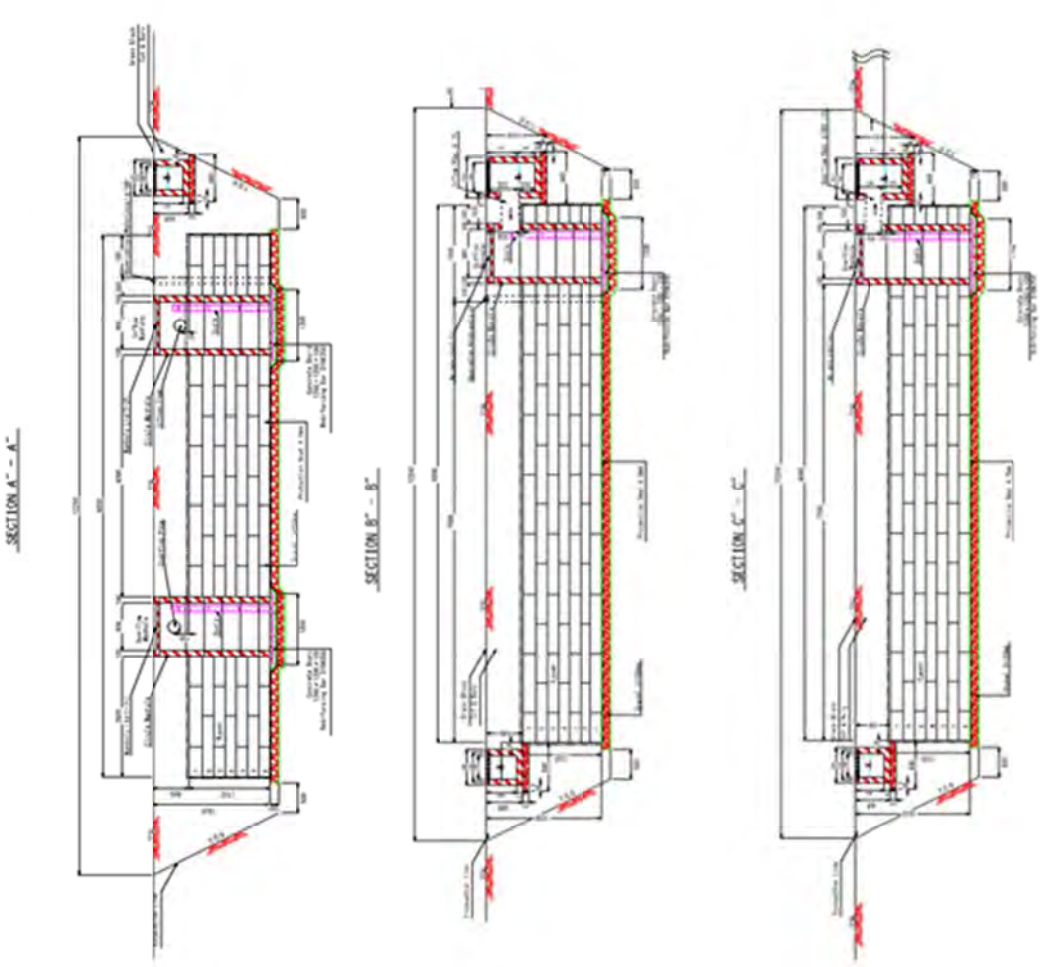


Figure 4.6-5 Cross Section

4.7 Plan of Execution Scheme

Plan of execution scheme is shown below. Construction period is almost scheduled for one month.

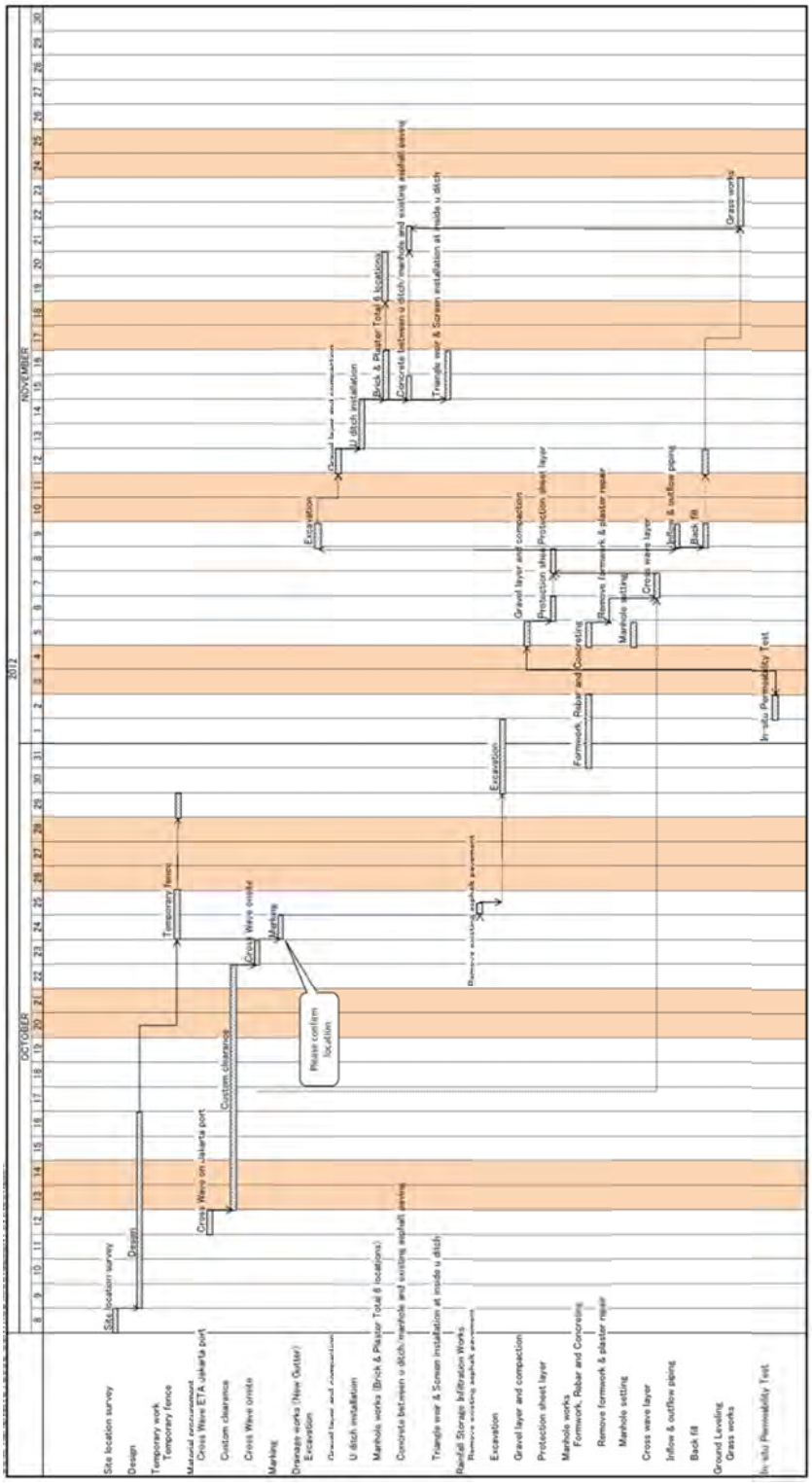


Figure 4.7-1 Plan of Execution Scheme

4.8 Estimation of Unit Design Infiltration Rate

4.8.1 Estimate Method of Unit Design Infiltration Rate

The unit design infiltration rate of infiltration facilities is estimated by multiplying the standard infiltration rate (Qf) obtained by In-situ permeability test and facility's form by various influence coefficients (C).

(1) Estimate of the unit design infiltration rate

Unit design infiltration rate of infiltration facilities is estimated using the following formula:

$Q=C\times Qf$

Q：Unit design infiltration rate of infiltration facilities

Qf：Standard infiltration rate of infiltration facilities

C：Various influence coefficient (usually 0.81)

Various influence coefficient is as follow.
Various influence coefficient is C=0.9*0.9=0.81 from the influence of Groundwater Level and Clogging.

Various influence coefficient

Item of influence	Point of view of influence coefficient
a) Groundwater Level	The need for such compensation is minimal, because the infiltration value obtained from in-situ permeability tests already actual facilities. If simple tests (borehole method or PWRI method) are perfprmed on small-scale facilities, the standard method is to multiply the value by a correction coefficient of 0.9 to be on the safe side.
b) Clogging	We projects a 10％ decrease of infiltration as a safety margin, and uses an influence coefficient of 0.9 , in consideration of limited long-term experience of infiltration facilities.
c) Temperature of pouring water	No correction is made for water temperature.
d) Antecedent (preliminary) precipitation	No correction is made for Antecedent precipitation.

(2) Estimate of the standard infiltration rate

The standard infiltration rate Qf for individual facilities is estimated using the following formula:
Qf=k×kf

Qf：Standard infiltration rate of installed facilities
(m^3/hr per 1 m, 1 unit, or 1 m^2 of infiltration facilities)
k：Saturated hydraulic conductivity of soil (m/hr)
Kf：Specific infiltration of installed facilities (m^2)

terms	meaning
Unit design infiltration rate	This is the infiltration per unit facility determined by the standard infiltration rate obtained from the final steady-state infiltration rate, considering reduction of infiltration capacity due to clogging. Infiltration box, road infiltration box m^3/hr/piece (per unit facility) Infiltration trench, infiltration gutter m^3/hr/m (per unit extension) Permeable (plane table) pavement, m^3/hr/m^2 (per unit area) permeable block Infiltration pond m^3/hr/m^2 (per unit area)
Design infiltration rate	This is the total infiltration rate of all infiltration facilities installed in the area concerned. It is calculated by multiplying unit design infiltration rate by facility quantity.
Design infiltration capacity	This is the design infiltration rate divided by the catchment area. The unit is mm/hr.
Design head	This is the water depth of an infiltration facility used for calculating the unit design infiltration rate.
Porosity ratio	This is the ratio of the apparent volume of filling including gravelto the remaining volume (void) by subtracting the true volume of filling from the apparent volume.
Void storage volume	This is the volume stored in a void of filling including gravel

4.8.2 Estimate of Unit Design Infiltration Rate of Pilot Facility

(1) Condition of estimate

The Condition of estimate is shown as follows.

Table 4.8-1 Condition of Estimate

Item	Value	Remarks
k_0: Saturated hydraulic conductivity of soil	1.2×10^{-3}cm/s $=4.3\times10^{-2}$m/hr	From result of In-situ Permeability test
H:Design head	H=1.33m	
L:Facility length	L=9.0m	
W:Facility width	W=9.0m	
C: Various influence coefficient	C=0.81	

(2) Estimation of unit design infiltration rate of infiltration facilities(Q)

Unit design infiltration rate of infiltration facilities is estimated using the following formula:
The result of estimate is as follows

Q=C×Qf

Q：Unit design infiltration rate of infiltration facilities
Qf：Standard infiltration rate of infiltration facilities
C：Various influence coefficient (usually 0.81)

Qf=k×kf

Qf：Standard infiltration rate of installed facilities (m^3/hr per 1 m, 1 unit, or 1 m^2 of infiltration facilities)
k：Saturated hydraulic conductivity of soil (m/hr)
Kf：Specific infiltration of installed facilities (m^2)

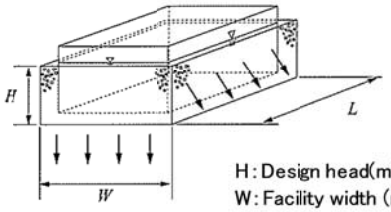
Q (m^3/hr) = C* Qf= C* K_0 * Kf
= 0.81 * 4.3×10^{-2}m/hr * 210.0
= 7.3 (m^3/hr)

Specific infiltration of installed facilities of pilot facility is calculated by a value of a W=5 m and W=10 m cases than the following formula, so a value of W=9 m case is calculated by distributing two values proportionally. （Cf.Table 4.8-3）

Table 4.8-2 Calculation Result of Specific Infiltration (1)

Facility Width(m)	W=5m	W=10m	W=9m
Basic formula	Kf=(aH+b)*L		
a	a=8.83*X-0.461 X=L/W=9m/9m =1.0 a = 8.83	a=7.88*X-0.446 X=L/W=9m/9m =1.0 a = 7.88	
b	b = 7.03	b = 14.00	
Kf	(8.83*1.33+7.03)*9 = 169.0	(7.88*1.33+14.00)*9 =220.3	=169.0+(220.3-169.0)*(9-5)/(10-5)=210.0
Remarks			Calculated by W= 5 and 10

Table 4.8-3 Calculation Formulas for Specific Infiltration (1)

Facility		Large-scale storage pond					
Infiltration faces		side and bottom					
Illustration		 H : Design head(m) L : Design head (m) W : Facility width (m)					
Guideline of applicable range of formulas	design head	1m ≦ h ≦5m					
	Facility scale	W =5m	W =10m	W =20m	W =30m	W =40m	W =50m
Basic formula		Kf = (aH + b) L					
Coefficient	a	$8.83X^{-0.461}$	$7.88X^{-0.446}$	$7.06X^{-0.452}$	$6.43X^{-0444}$	$5.97X^{-0.440}$	$5.62X^{-0.442}$
	b	7.03	1400	27.06	39.75	52.25	64.68
	c	—	—	—	—	—	—
Remarks		X=L/W Coverage of X : 1～5					

source : Engineering Guideline for Rainwater Infiltration Facilities Survey and Planning / Association for Rainwater Storage and Infiltration Technology and Infrastructure Development Institute - Japan

＜reference＞

Standard infiltration rate of infiltration facilities which is case of infiltration only facilities base is calculated for reference .

The result of calculation is as follows. An infiltration rate is 67% when considering side infiltration.

$Q\ (m^3/hr) = C^* Qf = C^* K_0 * Kf$

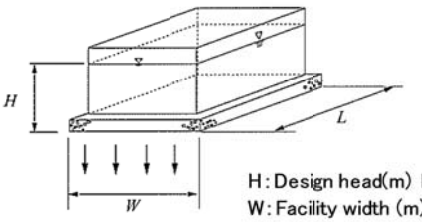
$= 0.81 * 4.3\times10^{-2} m/hr * 139.9 = 4.9\ (m^3/hr)$

Specific infiltration of installed facilities of pilot facility is calculated by a value of a W=5 m and W=10 m cases than the following formula, so a value of W=9 m case is calculated by distributing two values proportionally.（Cf.Table 4.8-5）

Table 4.8-4 Calculation Result of Specific Infiltration (2)

Facility Width(m)	W=5m	W=10m	W=9m
Basic formula	Kf=(aH+b)*L		
a	a=1.94*X-0.328 X=L/W=9m/9m =1.0 a = 1.94	a=2.29*X-0.397 X=L/W=9m/9m =1.0 a = 2.29	
b	b = 7.57	b = 13.84	
Kf	(1.94*1.33+7.57)*9 = 91.4	(2.29*1.33+13.84)*9 =152.0	=91.4+(152.0-91.4)*(9-5)/(10-5) =139.9
Remarks			Calculated by W= 5 and 10

Table 4.8-5 Calculation Formulas for Specific Infiltration (2)

Facility		Large-scale storage pond					
Infiltration faces		bottom					
Illustration		 H: Design head(m) L: Design head(m) W: Facility width (m)					
Guideline of applicable range of formulas	design head	1m ≦ h ≦5m					
	Facility scale	W =5m	W =10m	W =20m	W =30m	W =40m	W =50m
Basic formula		Kf = (aH + b) L					
Coefficient	a	$1.94X^{-0.328}$	$2.29X^{-0.397}$	$2.37X^{-0.488}$	$2.17X^{-0.518}$	$1.96X^{-0.534}$	$1.76X^{-0.609}$
	b	7.57	1384	26.36	38.79	51.16	63.50
	c	—	—	—	—	—	—
Remarks		X=L/W Coverage of X : 1～5					

source：Engineering Guideline for Rainwater Infiltration Facilities Survey and Planning / Association for Rainwater Storage and Infiltration Technology and Infrastructure Development Institute – Japan

4.9 Evaluation of Runoff Control Effect

4.9.1 Summary of Effect of Facility

The storage infiltration facility is set up purposely to prevent the peak of a floodwater increases hand in hand with land-use change etc. Therefore an inspection of the flood prevention effectiveness of the pilot facility is as follows.

(1) Evaluation method of an effect

The effectiveness of the facility can be inspected to compare the uncontrolled inflow (Qin:flow without facility) and the controlled outflow (Qout) at flooding time using below equation.
The pilot facility in this project bypasses the flow not exceeding undeveloped floodwater to the lower. The inspection considers this bypass flow.

Inflow(Qin) is calculate by rational formula.
Out flow of after runoff control is calculated by following formula.

Qout = Qout1 + Qout2
Qout2 = (Qin - Qout1) – Qi – Vi

Qin：Inflow(m^3/s)
Qout：Outflow after runoff control(m^3/s)
Qout1：bypass flow(m^3/s)
Qout2：Outflow of at immediate down stream of Pilot facility(m^3/s)
Qi：unit design infiltration rate（m^3/s）
Vi：Storage（m^3/s）
Vi≦Qi when Total of Storage Capacity is beyond facilities capacity. V is assumed V=0

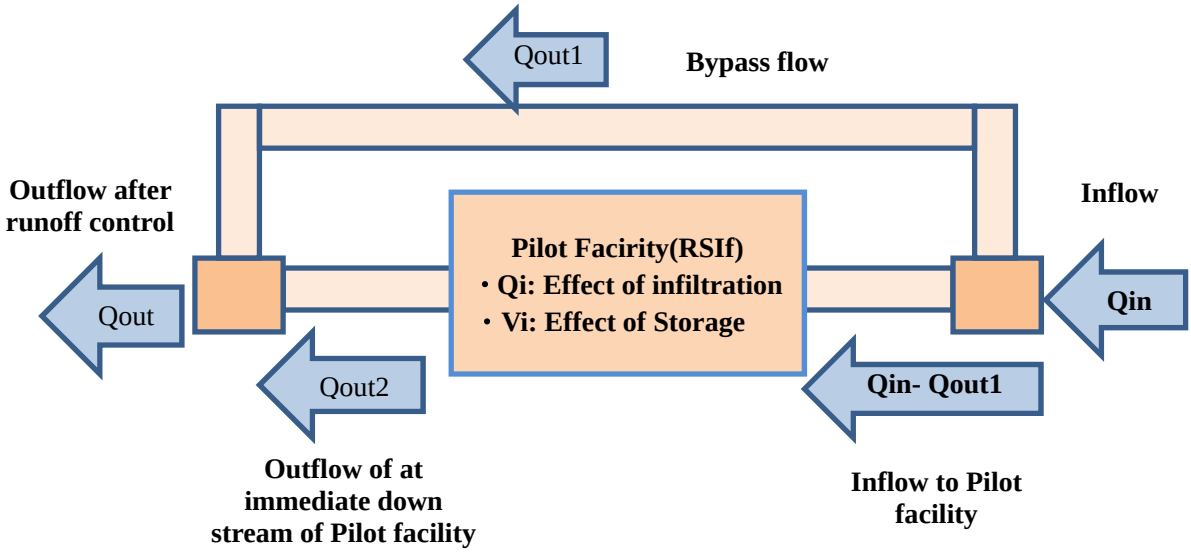


Figure 4.9-1 Image of Evaluation Method of Effect

(2) condition of calculate

Condition of calculation is as follows.

・Catchment Area : 0.5ha
・Run-off Coefficient : past 0.5(settlement)
present 0.8(urban)

- Flood Arrival Time : tc=10minutes （because catchment area is extremely small.）
- Rainfall Curve: 12-hour middle concentration curve
- Return Period : 1/2、1/5、1/10、1/25、1/50
- Rainfall Intensity curve : Pondok Betung Cileduk（Cf. Figure 4.9-3）

Return Period	1/2	1/5	1/10	1/25	1/50
Rainfall Intensity curve	7122.2 t+55.264	4977.6 t0.9+24.497	2798.5 t0.8+6.736	3286.7 t0.8+8.817	2582.8 t3/4+3.803
Rainfall rate (10minutes)	109.1mm/hr	153.4 mm/hr	214.5 mm/hr	217.3 mm/hr	274.0 mm/hr

- Strage capacity : 102m^3＝9m × 9m × 1.33m × 0.95 (Void rate = 95％)
- Unit design infiltration rate : 0.00203m^3/s
- Method of Runoff Analysis : Rational method
- Model of Infiltration Facility : Fixed amount deduction model
- Bypass flow : 0.038m^3/2（Maximum）

The condition of bypass pipe is as follows.
Pipe diameter: φ250(mm)
Pipe material : vinyl chloride pipe (Manning roughness coefficient=0.001)
Gradient of pipe : 1/500
Discharge condition : full bobbin, maximum outflow =0.038m^3/s (by Manning formula)

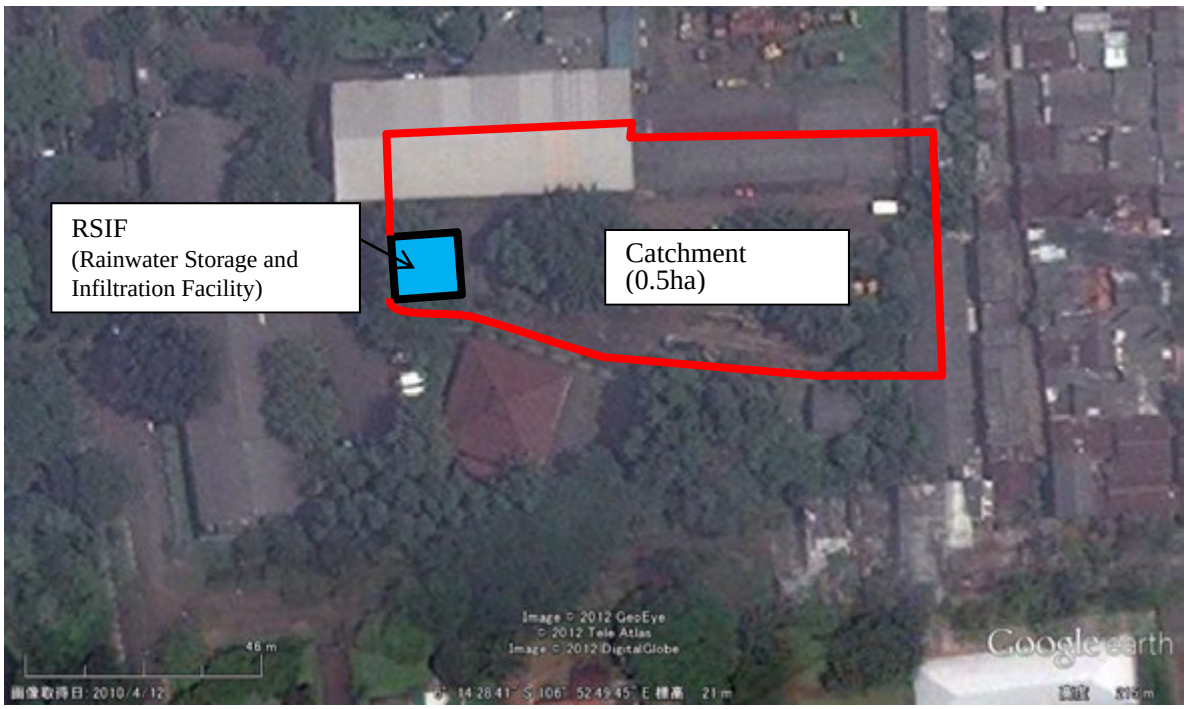


Figure 4.9-2 Basin Figure

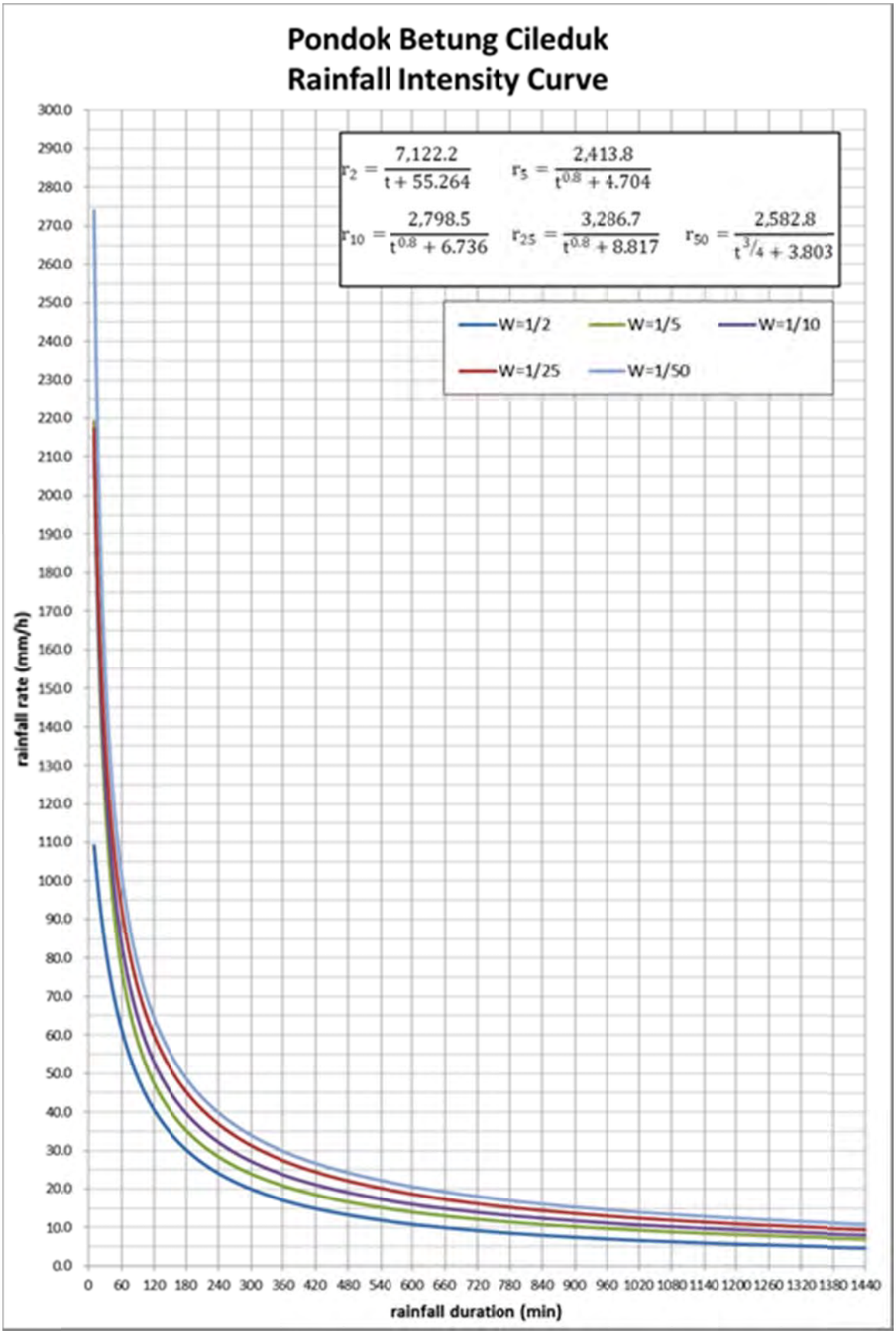


Figure 4.9-3 Rainfall Intensity

(3) Result of calculation

Result of calculation of effect of facility is shown in Table 4.9-1 and Figure 4.9-4～Figure 4.9-6.
Pilot facility is effective in reducing peak flow in 0.068(m^3/s) from 0.121(m^3/s) for the return period for future 2 years rainfall.
A reduction effect rate is 43,8%.
Outflow after runoff control (=0.068(m^3/s)) is less than 0.076(m^3/s) of peak flow quantity before development. So, ΔQ=0 policy is secured.
In addition, there is no runoff control effect for the rain higher than 5 years return period, because facility becomes filled with water before peak discharge outbreak.
Facility effect is calculated by different condition in this time. Result of calculation is shown in the end of a volume.

Table 4.9-1 Result of Calculate

year	2	5	10	25	50
①Inflow (m^3/s)	0.12125	0.17049	0.23835	0.24142	0.30444
②outflow after runoff control(m^3/s)	0.06814	0.17049	0.23835	0.24142	0.30444
③effect (m^3/s) ①-②	0.05311	0.00000	0.00000	0.00000	0.00000
④effect (%) ③/①*100	43.8	0.0	0.0	0.0	0.0

Rainfall Storage Infiltration Facility + Bypass										Downstream of RSIF			
			RSIF					RSIF+Bypass					
① Inflow before Runoff Control	② Bypass flow	③ Infiltration Volume	④ Inflow to RSIF	⑤ Outflow After Runoff Control	⑥ Effect 1 ④-⑤	⑦ Effect 1(%) ⑥/④ *100	⑧ Storage Volume	⑨ Effect 2 ①-⑤	⑩ Effect 2(%) ⑨/① *100	① Inflow before Runoff Control	⑪ Outflow after runoff control(RSIF+Bypass)	⑫ Total Effect ①-⑪	⑬ Total Effect(%) ⑫/① *100
m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	(%)	(m3)	m3/s	(%)	m3/s	m3/s	m3/s	(%)
0.12125	0.03460	0.00203	0.08462	0.03151	0.05311	62.8%	102.0	0.08974	74.0%	0.12125	0.06814	0.05311	43.8%

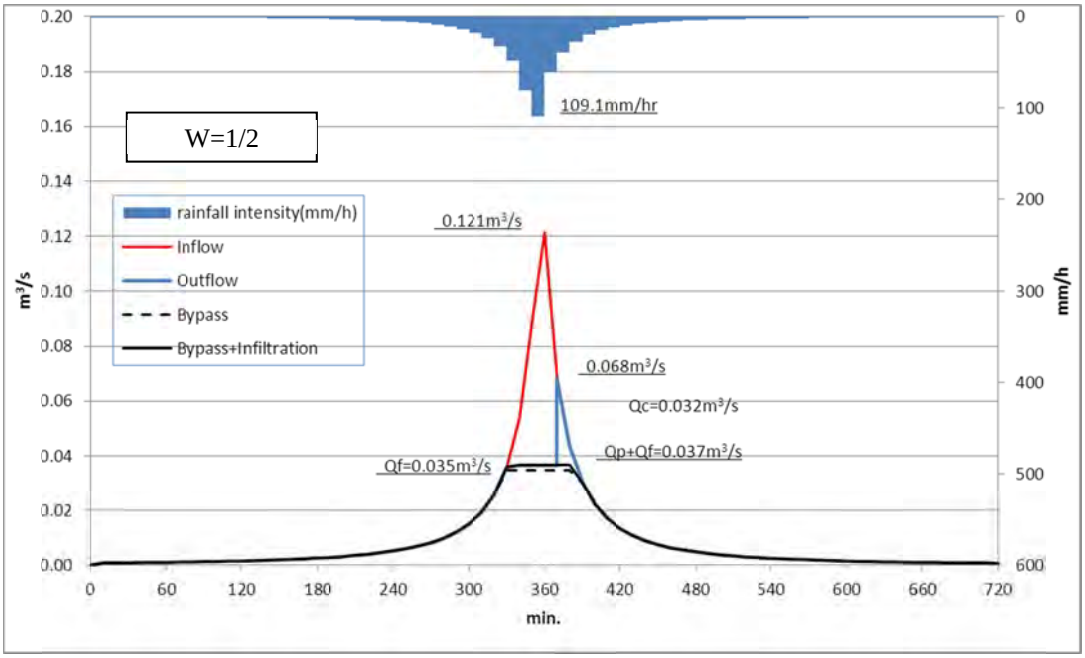
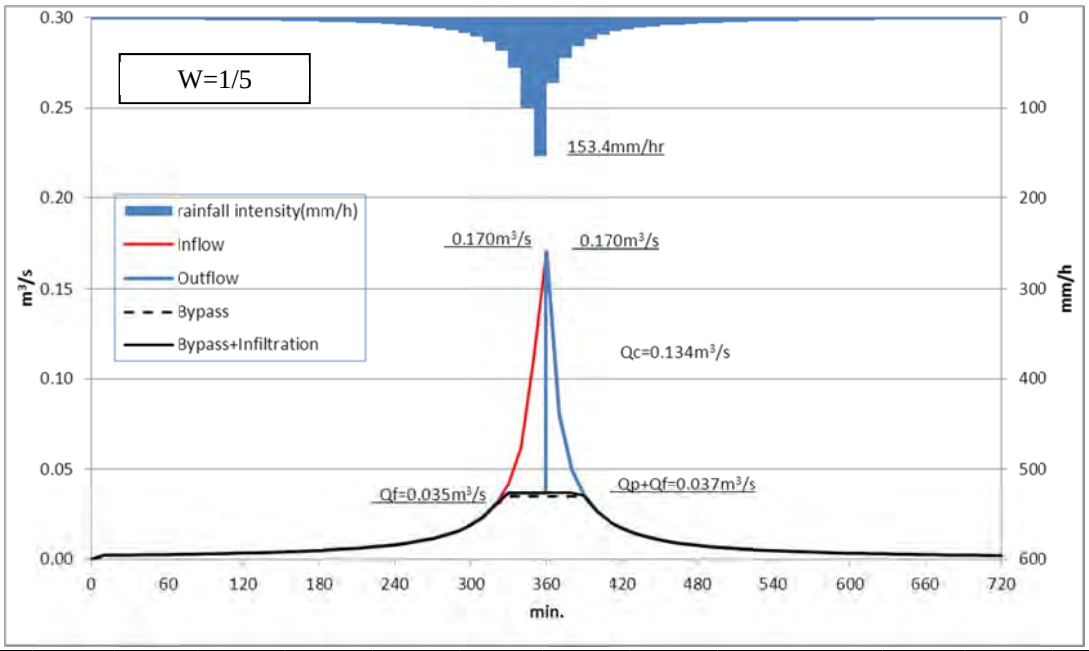


Figure 4.9-4 Result of Runoff Control Analysis (1)
(W=1/2, Bypass flow Q=0.0346m^3/s, D250, I=1/500)

Rainfall Storage Infiltration Facility + Bypass										Downstream of RSIF			
			RSIF					RSIF+Bypass					
① Inflow before Runoff Control	② Bypass flow	③ Infiltration Volume	④ Inflow to RSIF	⑤ Outflow After Runoff Control	⑥ Effect 1 ④-⑤	⑦ Effect 1(%) ⑥/④ *100	⑧ Storage Volume	⑨ Effect 2 ①-⑤	⑩ Effect 2(%) ⑨/① *100	① Inflow before Runoff Control	⑪ Outflow after runoff control(RSIF+Bypass)	⑫ Total Effect ①-⑪	⑬ Total Effect(%) ⑫/① *100
m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	(%)	(m3)	m3/s	(%)	m3/s	m3/s	m3/s	(%)
0.17049	0.03460	0.00203	0.13386	0.13386	0.00000	0.0%	102.0	0.03663	21.5%	0.17049	0.17049	0.00000	0.0%



Rainfall Storage Infiltration Facility + Bypass										Downstream of RSIF			
			RSIF					RSIF+Bypass					
① Inflow before Runoff Control	② Bypass flow	③ Infiltration Volume	④ Inflow to RSIF	⑤ Outflow After Runoff Control	⑥ Effect 1 ④-⑤	⑦ Effect 1(%) ⑥/④ *100	⑧ Storage Volume	⑨ Effect 2 ①-⑤	⑩ Effect 2(%) ⑨/① *100	① Inflow before Runoff Control	⑪ Outflow after runoff control(RSIF+Bypass)	⑫ Total Effect ①-⑪	⑬ Total Effect(%) ⑫/① *100
m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	(%)	(m3)	m3/s	(%)	m3/s	m3/s	m3/s	(%)
0.23835	0.03460	0.00203	0.20172	0.20172	0.00000	0.0%	102.0	0.03663	15.4%	0.23835	0.23835	0.00000	0.0%

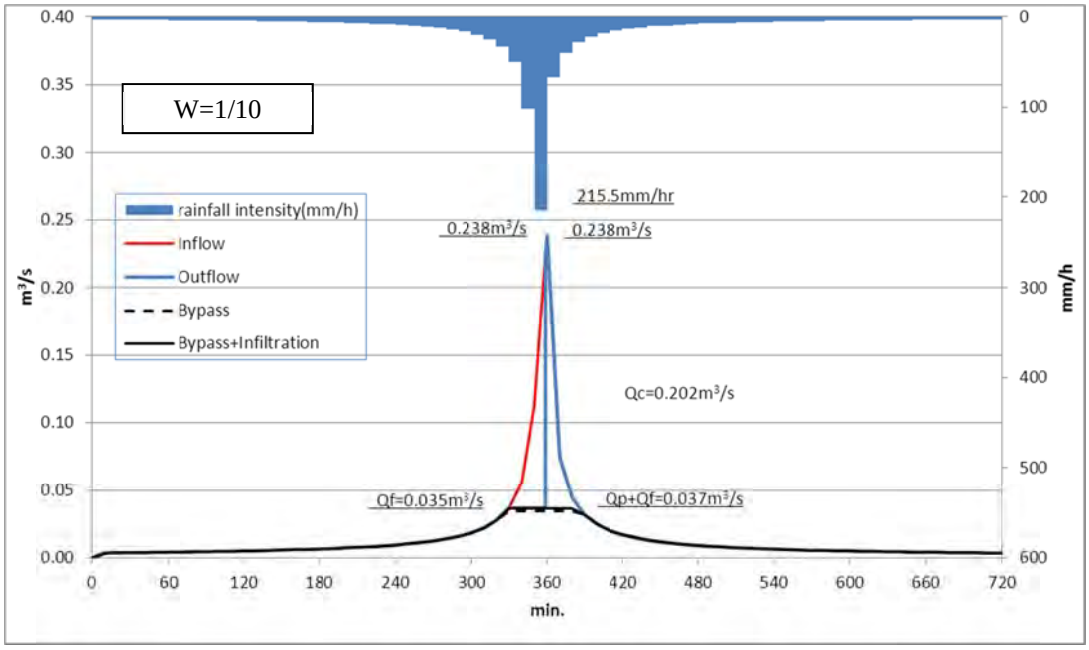
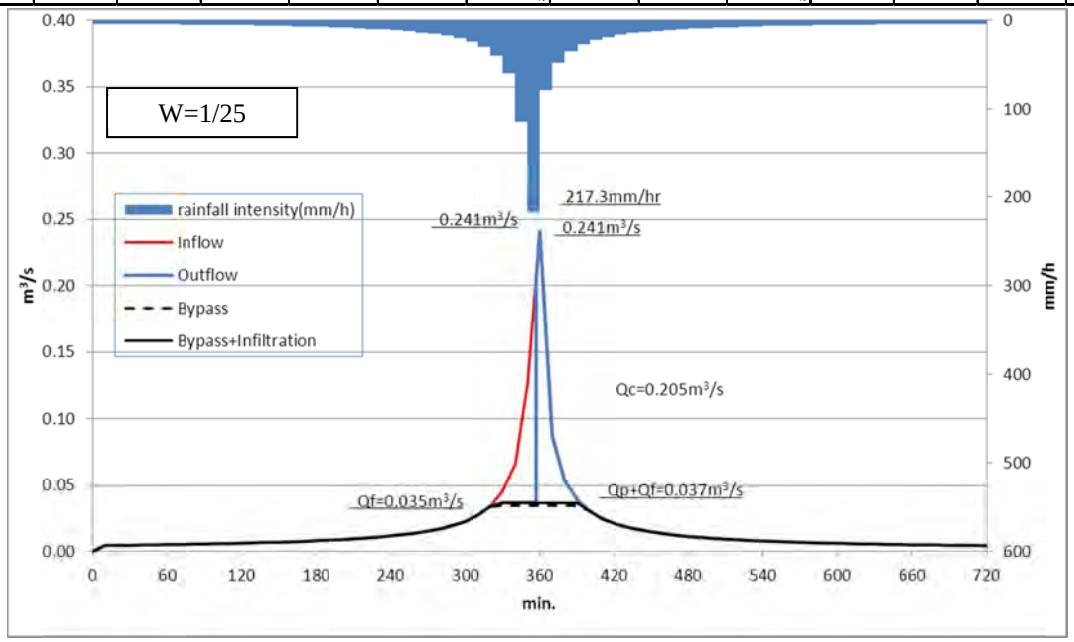


Figure 4.9-5 Result of Runoff Control Analysis (2)
（W=1/5,1/10 Bypass flow Q=0.0346m³/s、D250、I=1/500）

Rainfall Storage Infiltration Facility + Bypass										Downstream of RSIF			
			RSIF					RSIF+Bypass					
① Inflow before Runoff Control	② Bypass flow	③ Infiltration Volume	④ Inflow to RSIF	⑤ Outflow After Runoff Control	⑥ Effect 1 ④-⑤	⑦ Effect 1(%) ⑥/④ *100	⑧ Storage Volume	⑨ Effect 2 ①-⑤	⑩ Effect 2(%) ⑨/① *100	① Inflow before Runoff Control	⑪ Outflow after runoff control(RSIF+Bypass)	⑫ Total Effect ①-⑪	⑬ Total Effect(%) ⑫/① *100
m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	(%)	(m3)	m3/s	(%)	m3/s	m3/s	m3/s	(%)
0.24142	0.03460	0.00203	0.20479	0.20479	0.00000	0.0%	102.0	0.03663	15.2%	0.24142	0.24142	0.00000	0.0%



Rainfall Storage Infiltration Facility + Bypass										Downstream of RSIF			
			RSIF					RSIF+Bypass					
① Inflow before Runoff Control	② Bypass flow	③ Infiltration Volume	④ Inflow to RSIF	⑤ Outflow After Runoff Control	⑥ Effect 1 ④-⑤	⑦ Effect 1(%) ⑥/④ *100	⑧ Storage Volume	⑨ Effect 2 ①-⑤	⑩ Effect 2(%) ⑨/① *100	① Inflow before Runoff Control	⑪ Outflow after runoff control(RSIF+Bypass)	⑫ Total Effect ①-⑪	⑬ Total Effect(%) ⑫/① *100
m3/s	m3/s	m3/s	m3/s	m3/s	m3/s	(%)	(m3)	m3/s	(%)	m3/s	m3/s	m3/s	(%)
0.30444	0.03460	0.00203	0.26781	0.26781	0.00000	0.0%	102.0	0.03663	12.0%	0.30444	0.30444	0.00000	0.0%

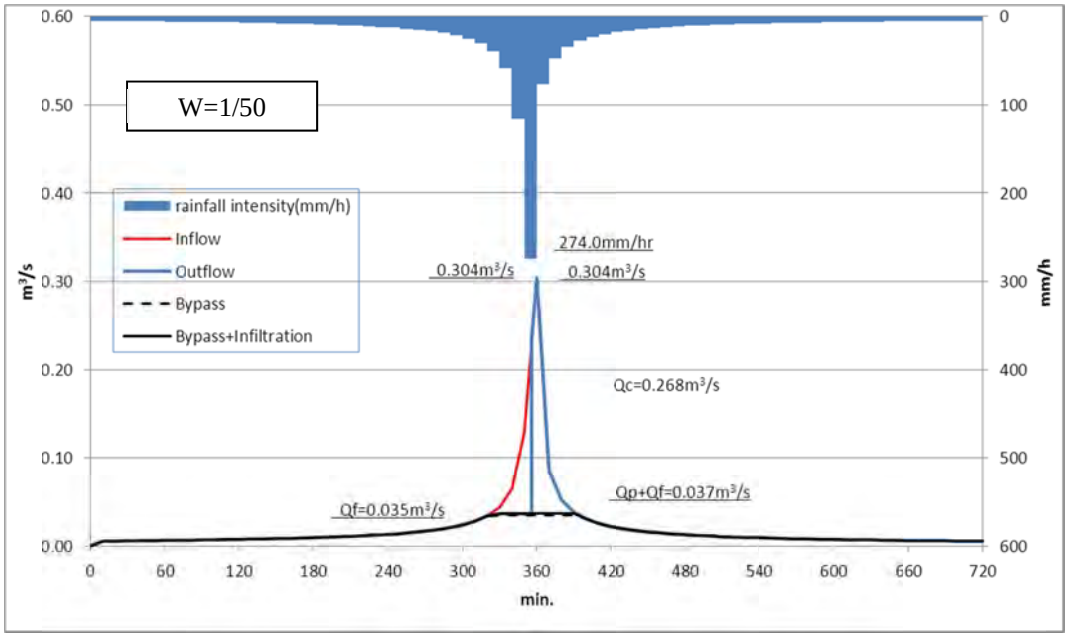


Figure 4.9-6 Result of Runoff Control Analysis (3)
(W=1/25,1/50 Bypass flow Q=0.0346m3/s、D250、I=1/500)

4.10 Monitoring（Rainwater Storage Infiltration Facility）

4.10.1 Plan Development of Monitoring

The purpose of monitoring is to identify storage and infiltration effects on the rainwater storage infiltration facility called as “RSIF” constructed at the BBWS Ciliwung-Cisadane Office.

(1) Monitoring (observation) item

Monitoring items are shown as follows.

a. Rainfall
b. Discharge Inflow：Qin(Q1,Q2)
c. Discharge Outflow：Qout(Q3)
d. Storage Volume by measuring water level changes in the RSIF：ΔV

General monitoring plan and typical section for RSIF are shown as follows.

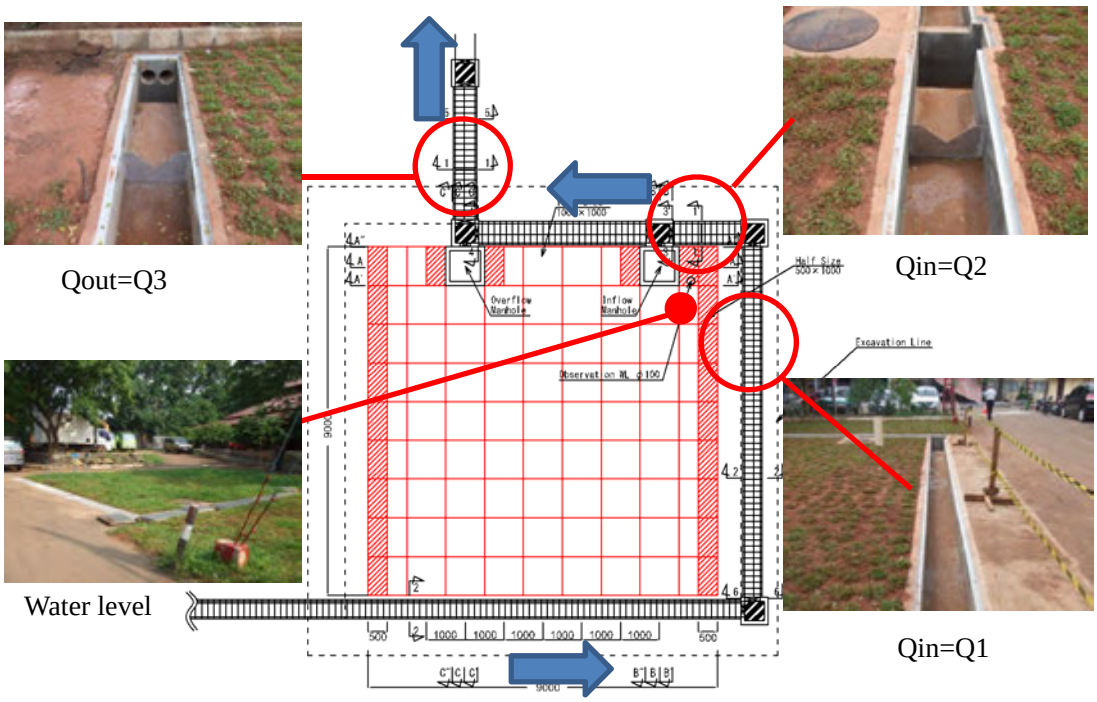


Figure 4.10-1 General Monitoring Plan for RSIF

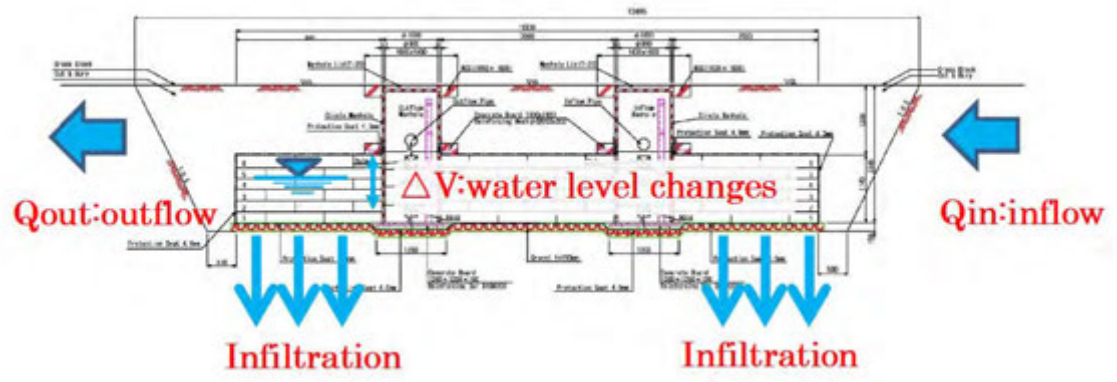


Figure 4.10-2 Observation summary (Image)

(2) Method of Monitoring

1) Rainfall

Rainfall shall be monitored at periodic intervals in the site of the BBWS Ciliwung-Cisadane Office. Taking into account the arrival time of the flood, rainfall data shall be monitored with time interval for one hour.
The example of rainfall record sheet is shown in the attachments.

2) Discharge Inflow (Q1, Q2) and Discharge Outflow (Q3)

Discharge inflow (Q1,Q2) shall be monitored by measuring water level of scale and triangle notch located at the inflow channel as shown in Figure 4.10-1. Discharge outflow (Q3) shall be also monitored by measuring of water level at the triangle notch located drainage channel. Measuring water level shall be converted to discharge. Monitoring method for discharge is shown as follows. The example of discharge observation record sheet is shown in the attachments.

a) Monitoring period : From start time of rainfall to decreasing water level at the drainage channel after the end of rainfall or about 2 hours after the end of rainfall.
b) Interval of Monitoring : 10 minutes
c) Monitoring Method : Visual monitoring
d) Monitoring Procedure : Method of procedure in the case of visual monitoring is shown below.
   1) If it rain, going to the point of the channel and triangle notch located at the inflow channel and drainage channel.
   2) Monitoring of water level shall be started at the channel (scale) and the notches.
   3) Time for monitoring and water level with time interval 10 minutes at the channel and the both notches shall be indicated on the recording form.
   4) Monitoring shall be continued until decreasing water level after the end of the rainfall.

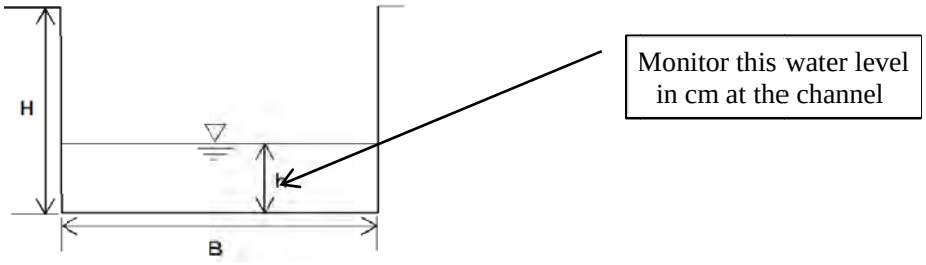


Figure 4.10-3 Monitoring Water Level at Channel (Q1)

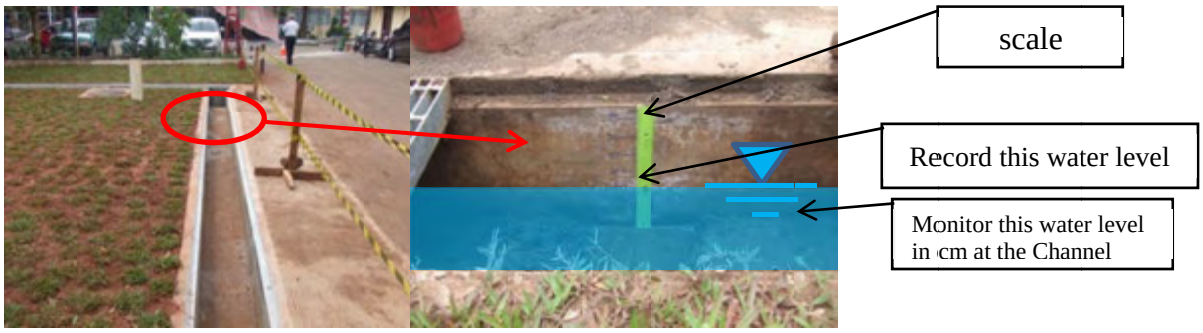


Figure 4.10-4 Installation Condition of Channel

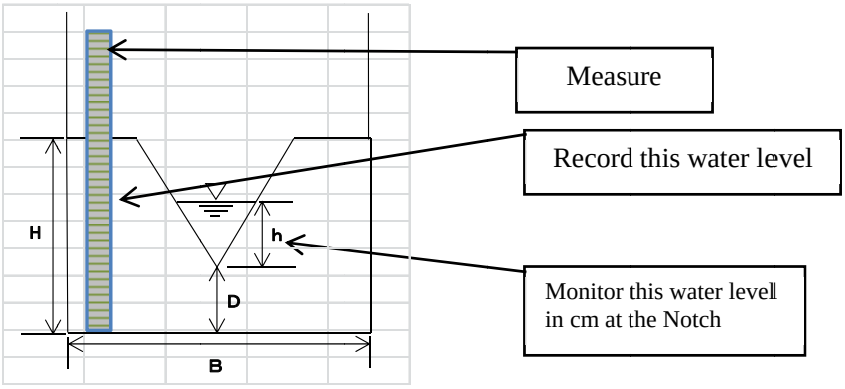


Figure 4.10-5 Monitoring Water Level at the Notch Located in Channel (Q2,Q3)

Figure 4.10-6 Installation Condition of Triangle Notch (Right: Inflow, Left: Outflow)

○Conversion method from water level to discharge:

Conversion method of water level to discharge shall be used by the following formula

a) Channel

Conversion method of water level to discharge shall be used by the Manning formula.

Discharge Q=A*v

A: Discharge area

V: Velocity

The discharge area is calculated by the following formula

A = B*h

B = 400mm

H = Observation water level

The velocity (V (m/s)) is calculated by the following formula.

$V=1/n*R^{2/3}*I^{1/2}$

n : Manning roughness coefficient=0.013 (Channel with lining/mortar)

I : Incline=0.5%(1/200)（survey result）

R : hydraulic radius = A /S (m)

A : Discharge area (m^2)=B*h

S :wetted perimeter (m)=B+2*h

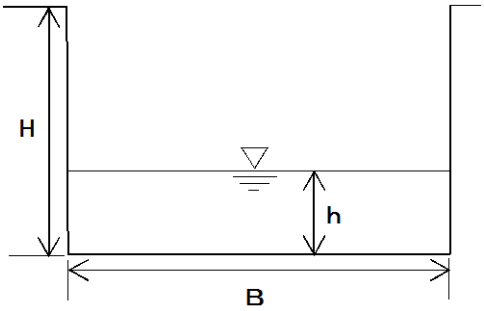


Figure 4.10-7 Schematic Figure for Explanation from Water Level to Discharge Condition on Channel

b) Triangle Notch

Discharge Q = Qa + Qb

Section ①

$Qa=C*h^{5/2}$

C=1.350+0.004/h+(0.14+0.2/W1/2)*(h/B-0.09)2

Section ②

$Qb=C*B*(h-W2)^{3/2}$

C=1.785+(0.0295/(h-W2) + 0.237*(h- W 2)/W)*(1+ε)

In addition, it is (W+W2) <1.0, ε=0

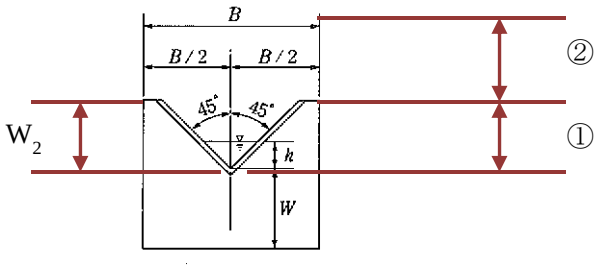


Figure 4.10-8 Schematic Figure for Explanation from Water Level to Discharge Condition on Triangle Notch (Angle: 45 Degrees)

3) Water Level variation in the RSIF

Water level variation shall be monitored at the monitoring well in the RSIF.

a) Monitoring Period：During rainfall and period with stored water in the RSIF.
(24 hours later after the end of rainfall)

b) Interval of Monitoring：
During rainfall : 10 minutes from the start of rainfall to about 2 hours after the end of rainfall
No rainfall : 1 hour, period with stored water in the RSIF.

c) Monitoring method : Using monitoring instrument shown in Figure 4.10-9.

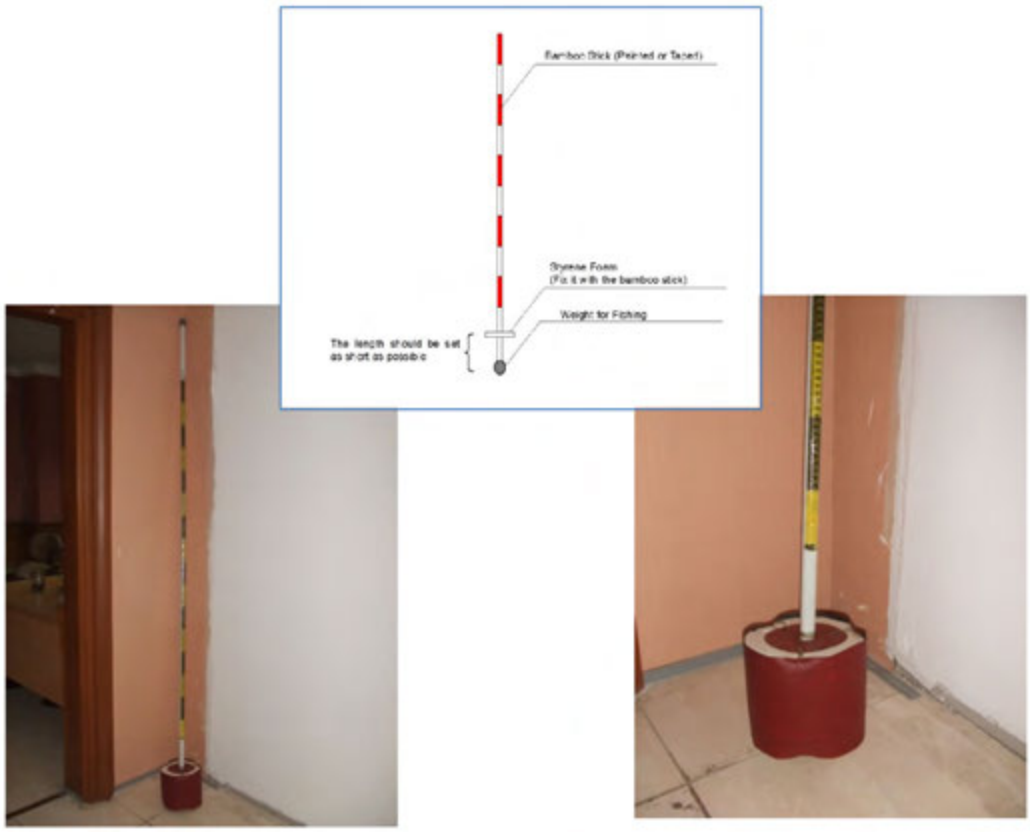


Figure 4.10-9 Measuring Instrument for Water Level

d) Monitoring Procedures：Monitoring procedures are shown below.

① Going to the point of the monitoring well
② Monitor the water level before rainfall. (When there is storage of water in the RSIF, monitor water level until rainfall starting with one-hour interval)
③ Start monitoring of the water level in the RSIF, including discharge monitoring, simultaneous with rainfall starting.
④ Monitor the water level at 10 minutes intervals and record figures on the recording paper.
⑤ Monitor the water level till the water level decreasing after rainfall.
When there is no inflow from drainage after rain (after about 2 hours), monitor the water level with one-hour interval .

○Conversion method from water level to discharge flow:

For converting water level to discharge, the following formula shall be used.

$$\triangle V = \triangle h * (9*9*\alpha)$$

ΔV：Change of storage capacity（m^3）
Δh ：Change of water level (m)
α：Void rate（= 0.95）

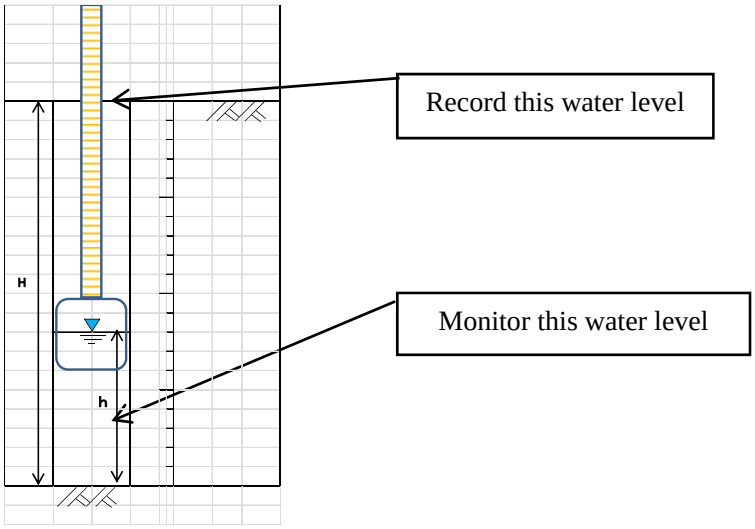


Figure 4.10-10 Monitoring Water Level in Monitoring Well at RSIF

Figure 4.10-11 Location of Monitoring Well

4) Recording Paper of Monitoring

Result of monitoring is written down on the recording paper of monitoring. Exampled recording paper is shown in the attachment.

4.10.2 Method of Effect Evaluation

(1) Evaluation on Effect of Decrease for Peak Discharge

The effect of decrease for peak discharge shall be evaluated based on the inflow and the outflow after runoff control.

Qin=Q1
Qout=Q1-(Q2-Q3)

Effect of decrease for peak discharge = Qinp – Qoutp
Qinp : Peak Inflow before runoff control (m^3/s)
Qoutp : Peak Outflow after runoff control(m^3/s)
Rate of decrease for peak discharge = (Qinp – Qoutp) / Qinp

The example of calculation form of decrease effect for the peak discharge is shown in the attachments.

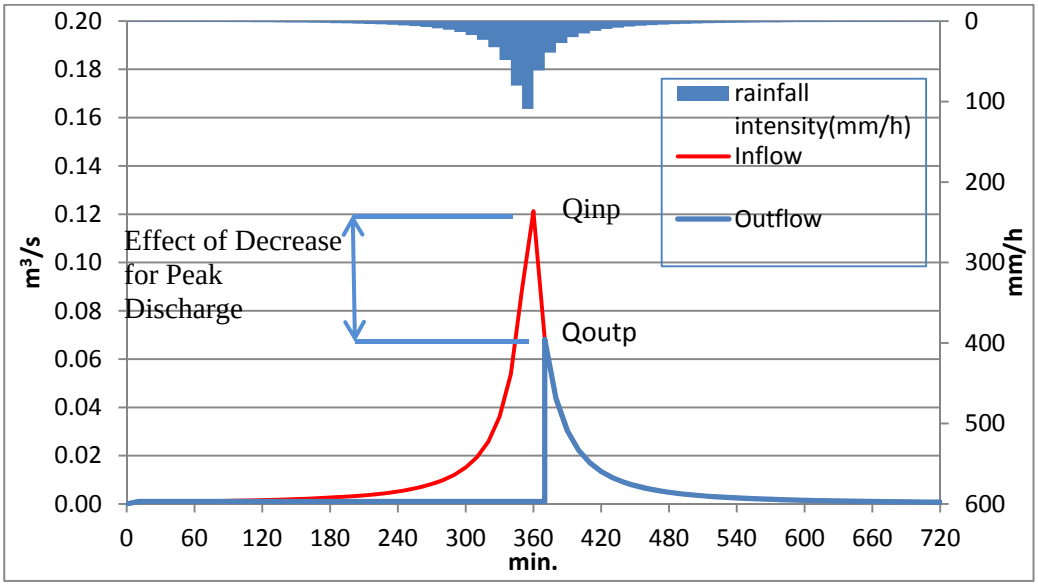


Figure 4.10-12 Effect of Decrease for Peak Discharge (Image by Simulation)

(2) Verification of the effectiveness for the storage and infiltration (the effectiveness for the total flow amount reduction)

The effectiveness for the storage and infiltration is estimated based on the inflow into the infiltration facility and the regulated outflow.

Effectiveness for the storage and infiltration (%)
= Reduction amount of the total outflow / the inflow from upstream of the facility
= △V1 / △Va
Reduction volume (m^3) : △V1 = (Σ Qin － Σ Qout)
where;
Σ Qin : Total inflow volume (m^3)
Σ Qout : Total regulated outflow volume (m^3)
△V1 : Outflow from upstream of the facility
△Va : Mean Rainfall in the basin of the facility (mm) * Catchment Area (ha)

(3) Verification of the effectiveness for the infiltration (the groundwater recharge volume)

The effectiveness for the infiltration is estimated by using the equation shown below based on the difference of the facility water level in no rainfall time

Effectiveness for the infiltration (the groundwater recharge volume) (m^3/hr)
= V 2 - V3 / observation time
where ;
V2 : Maximum storage volume after rainfall (m^3)
V3 : Storage volume at a few hours after rainfall (m^3)

The change over time should be grasped through the calculation of hourly infiltration.

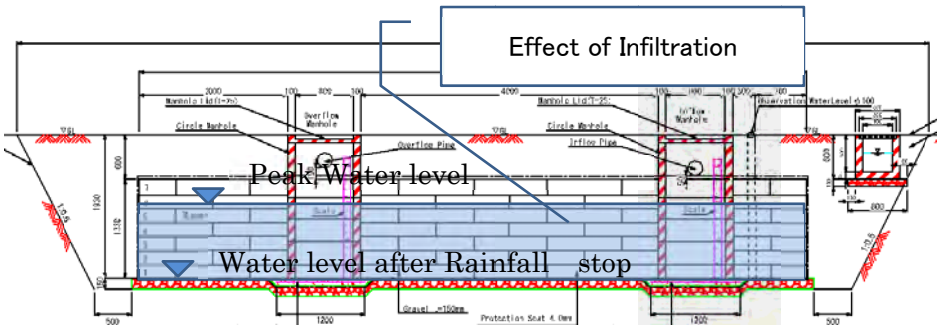


Figure 4.10-13 Image of Verification for the effectiveness

(4) Verification for the runoff coefficient variation

It can be expected that the discharge flow will increase together with the land use change by the strenuous urbanization increasing in Jakarta. Therefore, it is important to monitor the discharge flow (the runoff coefficient through the observation. The runoff coefficient is estimated by using the equation below.

runoff coefficient f = 3.6*QinP/(r*A)
Where ;
f : runoff coefficient
QinP : peak flood discharge (m^3/s) (observation data)
r : Peak rainfall (observation data)
A : catchment area (km^2)

4.10.3 Verification for the effectiveness on floods

(1) Observation Data

The observation data are arranged and shown in Table 4.10-1.

Table 4.10-1 Observation Time

No.	Day	Observation time	Remarks
1	2013/05/01	18:30~22:30	
2	2013/05/11	14:14~20:30	
3	2013/05/15	11:45～13:30	
4	2013/05/17	16:55～22:00	
5	2013/05/22	13:30～13:50	
6	2013/05/29	12:20～13:50	
7	2013/5/30 9:00~5/31 17:00		Observation only water level

The monitored data are arranged and shown in the supplement. One of the diagrams of monitored data is shown below.

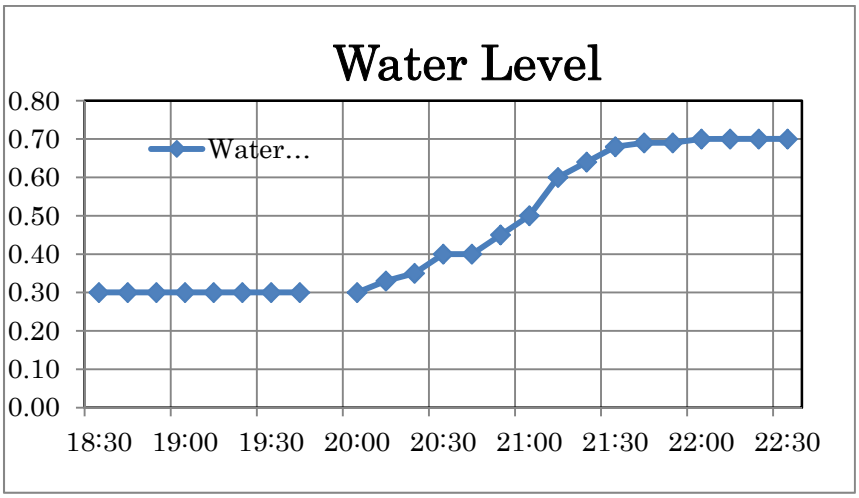


Figure 4.10-14 Example of the variation of water level in a rainwater storage infiltration facility （1st May 2013）

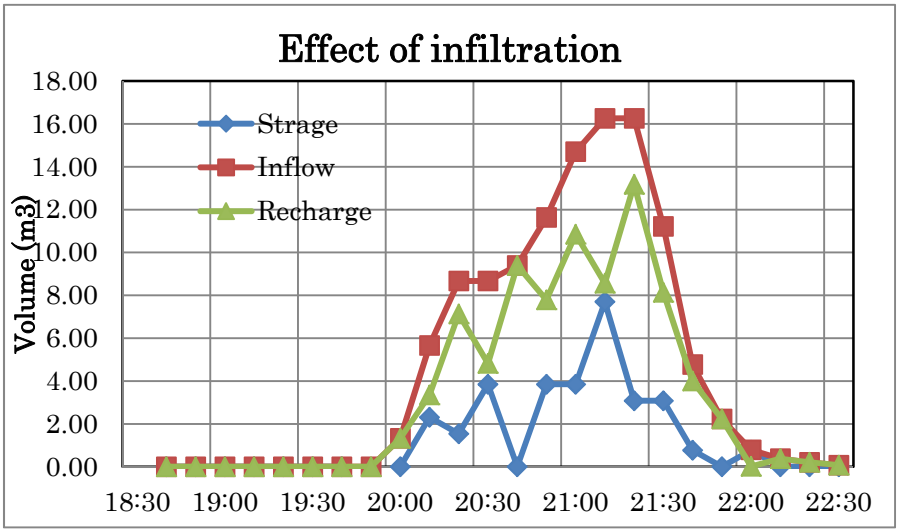
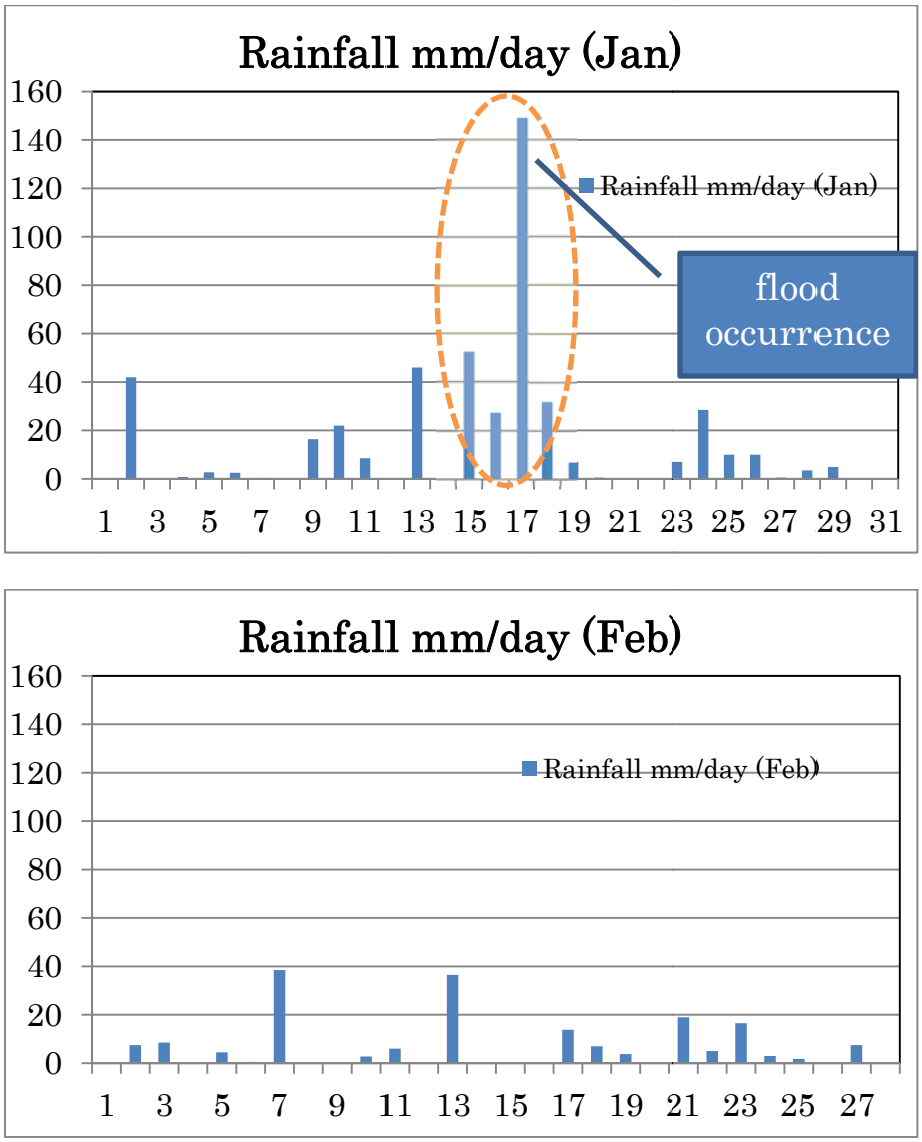


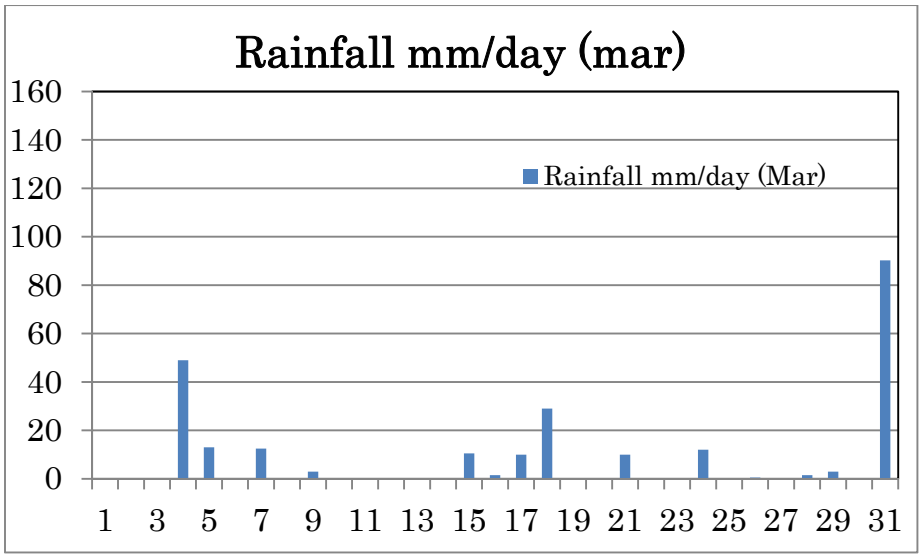
Figure 4.10-15 Example of the monitored infiltration capacity（1st May 2013）

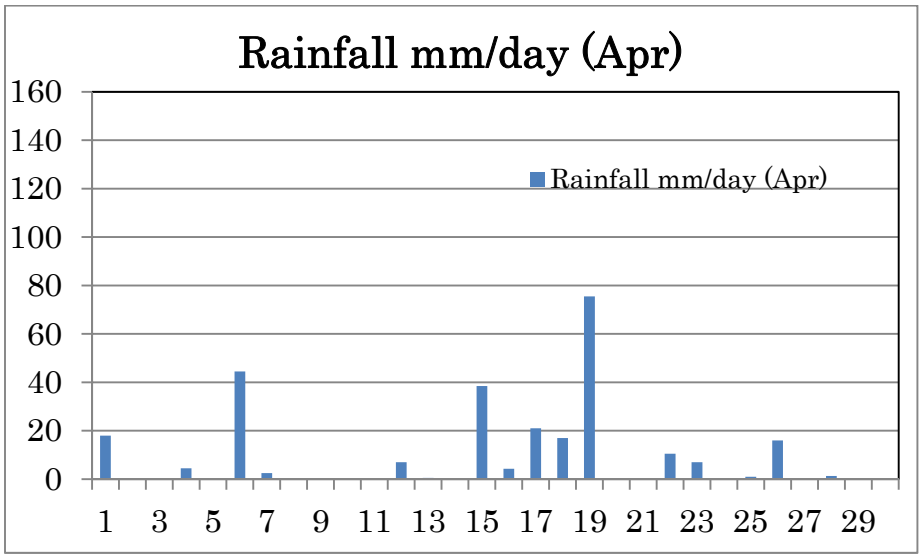
(2) Result of Observation

1) Rainfall

The observed daily rainfall amount at BBWS Ciliwung – Cisadane office is shown in Figure 4.10-16. The daily rainfall amount caused a flood is 147mm, that is equivalent to 2-year return period of 24-hour rainfall.







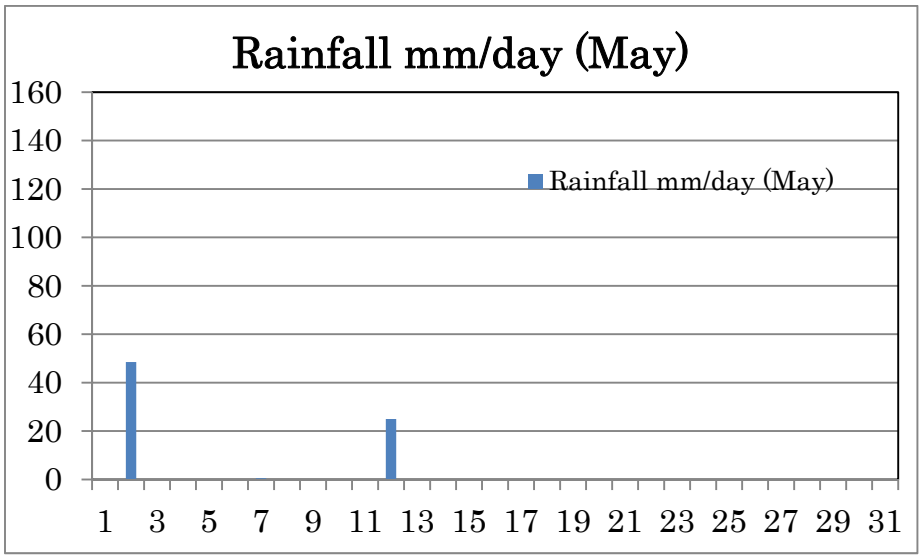


Figure 4.10-16 Daily rainfall amount

2) Verification for the effectiveness of the peak flow reduction

① Methodology

The verification for the effectiveness of the peak flow reduction is carried out using the equation below based on the monitored data.

Discharge before runoff control = Q1

Discharge after runoff control = Q1 – Q2 + Q3

Effectiveness of the peak discharge reduction

= Discharge before runoff control– Discharge after runoff control = Q2 - Q3

Q1 , Q2, Q3 : refer to Figure4.10-1

② Results of verification

The results of verification, taking the value on 1st May 2013 as an example, is shown in Figure 4.10-17. The peak flow of 1st May 2013 decreased 0.142 m^3/s from 0.166 m^3/s, this means about 14 % of reduction rate. The effectiveness of the peak flow reduction is shown in Table 4.10-2. As seen in this table, the average reduction rate is 11.4 % through 5-time observation.

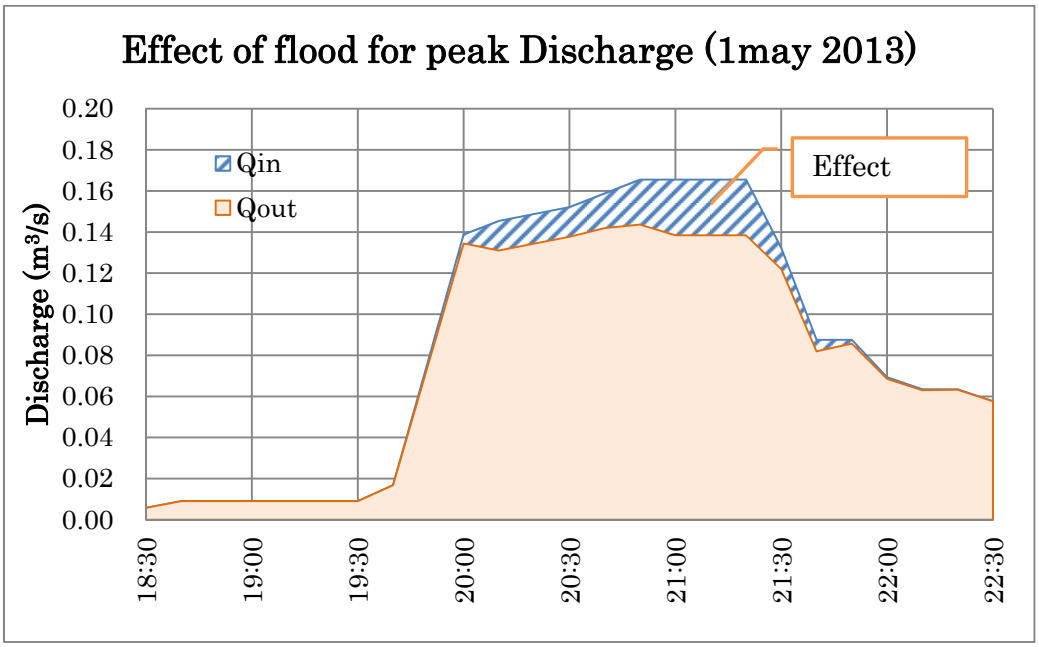


Figure 4.10-17 Example of the effectiveness of the peak flow reduction (1st May 2013)

Table 4.10-2 Effectiveness of the peak flow reduction

No.	Day	Discharge before runoff control (m^3/s)	Discharge after runoff control (m^3/s)	Effectiveness of the peak discharge reduction (m^3/s)	Reduction rate (%)
1	2013/05/01	0.166	0.142	0.024	14
2	2013/05/11	0.132	0.105	0.027	20
3	2013/05/15	0.126	0.117	0.009	7
4	2013/05/17	data deficiency			
5	2013/05/22	0.159	0.137	0.022	14
6	2013/05/29	0.100	0.092	0.002	2
AVE.					11.4

3) Effectiveness of Storage

① Methodology

The effectiveness of storage is estimated based on the water level variation in infiltration facilities.

Storage volume △V = peak storage volume after rainfall – storage volume before rainfall
Effectiveness of storage (%) = △V / rainfall amount in the basin
Rainfall amount in the basin = rainfall amount in observation time(mm) × catchment area
catchment area =0.5ha

② Results of verification

Although some rainfall data has not collected, an obvious effectiveness of flow reduction can be seen from the below table.

Table 4.10-3 Results of the effectiveness of storage

No.	Observation data				Effectiveness of Storage		
	Day and Time	(1)Water level (m)	Day and Time	(2) Water level (m)	Storage volume (3)=(2)-(1) (m^3)	Rainfall amount in observation time (mm)	Effectiveness of storage (%)
1	2013/05/1 18:30	0.30	2013/05/1 22:30	0.70	30.8	48.5	12.7
2	2013/05/11 14:14	0.29	2013/05/11 18:30	0.49	15.4	25.0	12.3
3	2013/05/15 11:45	0.37	2013/05/15 13:30	0.40	2.3	-	
4	2013/05/17 10:00	0.30	2013/05/17 22:00	0.78	36.9	49.0	15.6
5	2013/05/22 13:30	0.42	2013/05/22 13:50	0.46	3.1	8.5	7.3
6	2013/05/27 12:20	0.41	2013/05/27 13:40	0.42	0.8	-	

4) Effectiveness of infiltration

① Methodology

The effectiveness of infiltration is estimated based on the water level variation in infiltration facilities.

Infiltration capacity (the groundwater recharge volume) ΔV (m^3)
= storage volume just after rainfall – storage volume after few hours
Effectiveness of infiltration capacity (m^3/hr) = ΔV / observation time

② Results of verification

The verification is done based on the 2-time observation those could provide data. The result is shown in Table 4.10-4. The average infiltration capacity of 1.00 m^3 per hour is confirmed in this study. This figure is equivalent to the capacity of about 30 cm per day and cannot be negligible quantity for groundwater replenishment.

Infiltration capacity per unit area = infiltration capacity x 24 hours / the base area of the facility
= 1.00m^3/hr×24 hrs / (9m×9m) = 0.296m / day

On the other hand, the unit infiltration of the facility (Q1) is estimated 6.4 m^3 per hour (saturated permeability coefficient k=1.2×10^{-3}cm/s, design head ; 0.97 m) using the permeability coefficient of

the soil of the facility surroundings, which was obtained before the facility installation.. The permeability obtained in this study corresponds to 15.6 % (=1.0 / 6.4) of Q1. The permeability coefficient (k) of the facility surroundings is 2.0 x 10^{-4} cm per second by calculating backwards from this figure.

Items below are conceivable for the cause of the drop in the permeability coefficient though the corroborative details have not been cleared.

- Influence of the sediment accumulation, that sediment flowed into the facility after rainfall and that causes the facility base clogging.
- Influence of the base compaction to install the facility after excavation.
- Influence of the facility surroundings backfilling with poor permeability soil.

Table 4.10-4 Result of the verification of the permeability effect

No.	Observation data				Effectiveness of infiltration	
	Day and Time	(1)Water level (m)	Day and Time	(2)Water level (m)	Infiltration capacity (3)=(1)-(2) (m^3)	Effectiveness of infiltration capacity (m^3/hr)
1	2013/05/30 10:00	0.93	2013/05/30 16:00	0.85	6.2	1.03
2	2013/05/30 17:00	1.00	2013/05/31 17:00	0.70	23.1	0.96
Ave.		0.97				1.00

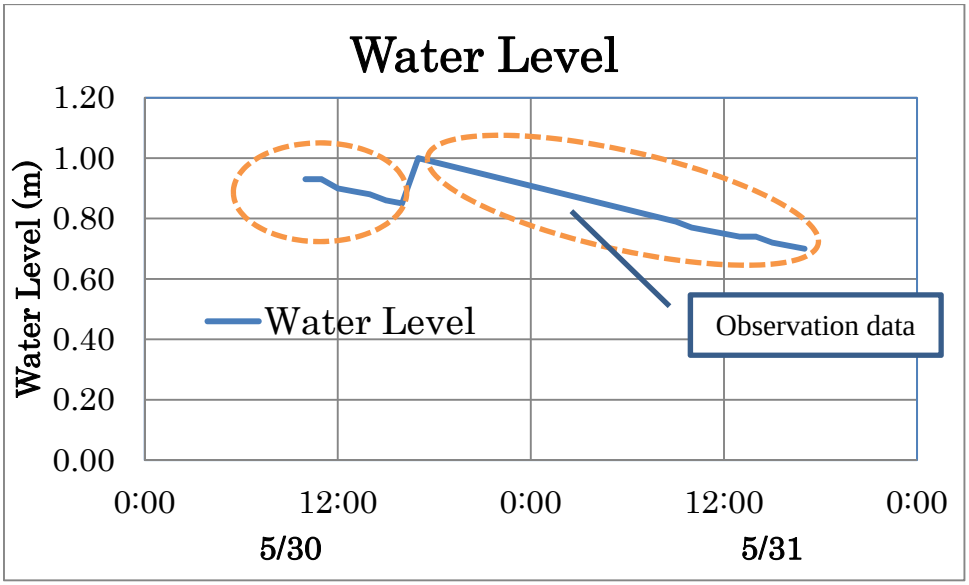
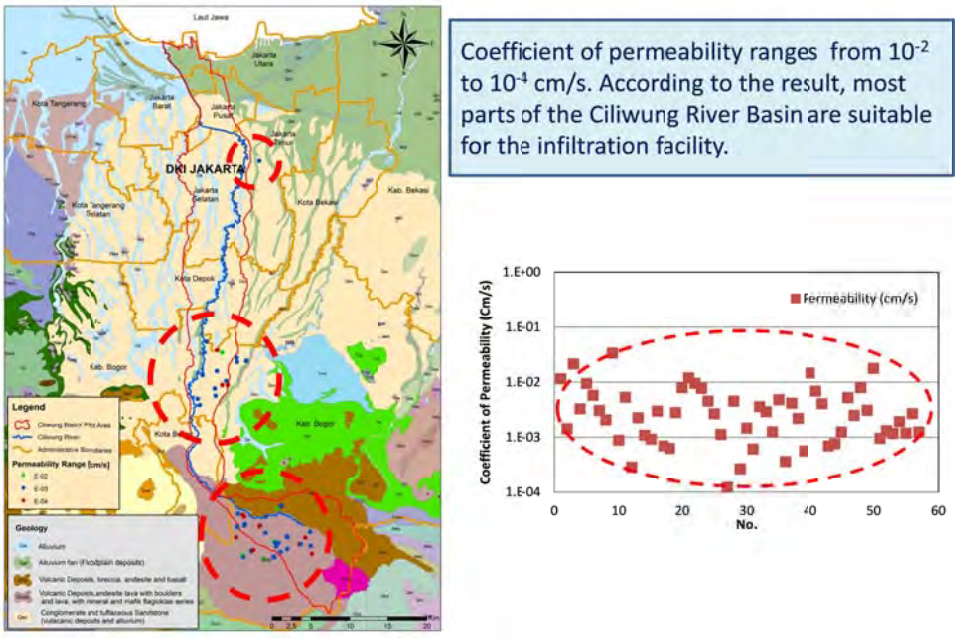


Figure 4.10-18 Example of infiltration effect (30th to 31st May 2013)

(3) Consideration

The peak flow reduction effect and permeability effect are confirmed in the rainwater storage permeating facility through the monitoring. Ciliwung River Basin is suitable for the installation of the rainwater storage permeating facility because that JCFM Project investigated and obtained the permeability coefficient in most this basin is from 1×10^{-2} to 1×10^{-4} cm per second in the basin. (refer to Figure 4.10-19)
Judging from these facts, the rainwater storage permeating facility is suited to the runoff control facilities in the basin. Therefore this facility should be more examined for the planning runoff control facilities in Ciliwung River Basin and the spread of this facility will be expected in future.



source : JCFM Project Team

Figure 4.10-19 Result of the infiltration test in Ciliwung River Basin

The improvements of facility design and monitoring scheme are shown below, these are obtained from this result. It is required to consider these items below in case of the rainwater storage permeating facility planning.

1) Facility Design

Facility design are requested to pay attention to the following points in view of that the drop in the permeability coefficient was confirmed in this study.

- In selecting candidate sites for facilities, the confirmation of land use of upstream and surroundings is needed. (places where sediment inflow is forecasted or fallen leaves are found should be avoided for them.)
- Installation of filters and sand traps.
- Selection of good materials for backfilling (Poor permeability materials, such as red soils, should not be accepted.).
- Instruction not to throw away trash to facility surroundings is needed.

From the point of view of environmental improvement for facility surroundings

- To make stormwater inlet at and around facility permeable (Rainwater gathered in depressions is unsanitary because of causing the breeding of mosquitoes.)
- To select some kind of grass that hard to grow with weeds in case of sodding on the upper part of facility

2) Maintenance

・It is necessary to measure the water level variation in facility even after rainfall in order to verify the effect of permeability. And measurement should last in a few hours after rainfall or measurement of water level in the early morning of the following day.

- Regular cleaning of filters etc. is needed for fear that filters will be clogged considering observation data, no clogging found in filters for the time being.
- Cleaning should be done every two weeks at places with a lot of sediment inflow in rainy season, particularly, cleaning of filters is essential.
- To make photographic records in observation.
- To put on records of the status of maintenance.

4.11 Maintenance for RSIF

4.11.1 Purpose

The RSIF must be appropriately, efficiently, and economically maintained considering continuity and stability of permeability. At the RSIF, degraded infiltration function due to clogging can cause a facility to be submerged for a long time or cause an overflow outside the facility. When an overflow pipe is connected to the facility, it is difficult to evaluate degradation of function from appearance. To prevent this, facility structure and land use of the installation area must be well understood for maintaining the RSIF. In this way, degradation of permeability due to clogging must be prevented, and the function must be kept effective.

The items to be considered for maintenance are as follows:

1) Maintenance of permeability
   Measures to prevent clogging, cleaning method, frequency, and extending service life
2) Maintenance of infiltration facility
   Inspection frequency, correcting displaced cover, repairing damage, repairing sunken ground, etc.
3) Economical maintenance
   Easy inspection, low cleaning frequency, easy cleaning, etc.

Considering the above, it is important to establish an appropriate control method and maintenance system.

4.11.2 Items to be Considered for Maintenance

(1) Functional Inspection and Safety Inspection

Two inspection methods which are functional inspection and safety inspection shall be considered in this manual. The purpose of the former is to check for conditions that might disturb the infiltration function, and the latter is performed to eliminate adverse influences on peripheral facilities as well as to keep the safety of users, walkers and traffic vehicles. In principle, periodic inspections should be performed once a year or more, before rainy season.
If it is physically impossible to check all infiltration facilities, areas where sediment or water tends to gather are selected to reduce the frequency or the number of inspections. In this way, it is important to save manpower for inspections.

Table 4.11-1 shows the classification of functional inspection and safety inspection.

Table 4.11-1 Description of Functional Inspection and Safety Inspection

Details / Type	Functional Inspection	Safety Inspection
Inspection Items	•Depositing of sediment, dirt, fallen leaves •Clogging of dirt-removing filter •Submerging status •Sediment runoff status •Presence of intruding tree root	•Displacement of cover •Damage or deformation of facility •Sinking or depression of ground surface
Inspection Method	•Accumulation of sediment, dirt, etc. by visual check •Sediment deposition •Infiltration status	•By visual check

Period for Inspection	(Periodical inspection) •Inspection must be performed once a year or more before rainy season. •Inspection must be performed once for two weeks as rainy season. (Emergency inspection) •Period with heavy rainfall such as rainy season. •Warning issued of heavy rains and local flooding •After completion of earth work around the facility •Report from users is received.

Note: Arranged for this manual based on the Japanese Guideline for RISF (1997)

(2) Faclity Cleaning for Function Recovery

Periodical cleaning for RSIF shall be performed to recover the functions of the RSIF according to the inspection results.

Details of cleaning are removal of sediment, dirt, fallen leaves, etc., removal of clogging substances from the anti-clogging device, and removal of tree roots. It is also important to clean peripheral areas of the facility. Attention shall be paid so that washing water does not enter the facility during cleaning.

Table 4.11-2 shows cleaning method in facilities or parts of the RSIF.

Table 4.11-2 Facility Cleaning for Function Recovery

Facility/Part	Method in Details	Period for cleanibg	Explanation with Picture
Channel & Box	Cleaning Digging out of sands and gravels, deposits and fallen leaves	Cleaning must be performed once a year before rainy season. Cleaning must be performed when the sands sediment more than 3cm as rainy season.	
Screen	Remove deposits and fallen leaves by brushing	Cleaning must be performed once a year before rainy season. Cleaning must be performed once for two weeks when the inspection is performed at the same time as rainy season.	 
Grating and Cover	Cleaning Remove deposits and fallen leaves by brushing	Cleaning must be performed once a year before rainy season. Cleaning must be performed once for month as rainy season.	

(3) Facility Repairing for RSIF

If the facility is damaged or depression or sinking of the ground occurs, it must be repaired. There are two cases requiring immediate repair to maintain safety and functions, and cases of later repair after monitoring conditions for a certain period. Items that cannot be repaired should be replaced or newly installed.

If depression or sinking of the ground occurs, the cause and the affected area must be investigated, and appropriate countermeasures must be taken. Depression or sinking of the ground is often caused by incorrect backfilling or compaction after excavation, not by the infiltration facility itself. Attention must be paid so that identifying the cause is not limited only to the infiltration facility.

(4) Facility Inventory for RSIF

Facility inventory for RSIF shall be prepared by BBWS Ciliwung-Cisadane Office. Data on monitoring, drawings with design report for construction, pictures during construction and other information such as BQ and Cost estimate as well as unit price shall be arranged and filed. (Refer to Table-5 in Attachements)

(5) Maintenance Records

To correctly maintain the functions of the infiltration facility of the RSIF, it is important to continue the maintenance work. For this purpose, it is desirable to store inspection, cleaning, and repairing records as maintenance records.

CHAPTER 5 Situ Improvement

5.1 Policy for Rehabilitation and Improvement of Various Types of Situ

At present, there are various types of Situ in the river basin. Those types of Situ have control effects against the small or medium scale of flood. However, due to the land use change led by the rapid economic growth in Indonesia, the number of Situ tends to decline. Thus, the basic policies for rehabilitation, conservation and improvement of Situ were clarified.

5.1.1 Policy for Rehabilitation and Improvement of Situ

The policies for the rehabilitation and improvement of Situ in step are as follows.

(1) Rehabilitation of Situ

Purpose	: to avoid the reduction and/or disappearance of Situ, and to maintain the function of Situ as water source
Method	: dredging, construction of dike, improvement of surrounding areas
Flood Control Effect	: not to increase the flood control effect more than before works

(2) Improvement of Situ to enhance Runoff Control Effect

Purpose	: to increase temporary storage capacity (flood control volume) of rainfall
Method	: current water use, land use in surrounding areas, and improvement of spillway
Flood Control Effect	: to be planned to increase a certain level of flood control effect
Concerns	: as a result of spillway improvement, the following concerns shall be taken into account: - To degrade the water use of Situ - To increase flow volume to the downstream - To make the dike unstable - To rise water level causing inundation in the surrounding areas

(3) Improvement of Situ to increase Flood Safety Level against Large Scale Rainfall

Purpose	: to ensure the safety of Situ in case of large scale rainfall
Method	: to construct dike and spillway with the same safety level as dam, to improve downstream river sections and surrounding areas of Situ
Flood Control Effect	: to be planned to increase a certain level of flood control effect
Concerns	: it might cause a large impact to the current water use and land use in surrounding areas. Thus, it is necessary to examine the facility plan on design water level, specifications of structures, improvement of downstream river section, and influenced surrounding areas in coordination with the related stakeholders sufficiently. The detail design shall be in line with the dam construction.

Among the above, item (1) has been carried out by the Indonesian government, and item (3) can be examined in line with dam planning. Therefore, in this chapter, item (2) for the improvement of Situ for the enhancement of runoff control effect will be described.

5.1.2 Situ Improvement for Increasing Flood Control Capacity

(1) Situ Improvement Policy

By converting some portion of water use capacity of an existing *Situ* into flood control capacity, the *Situ* is able to reduce the flood peak discharge.

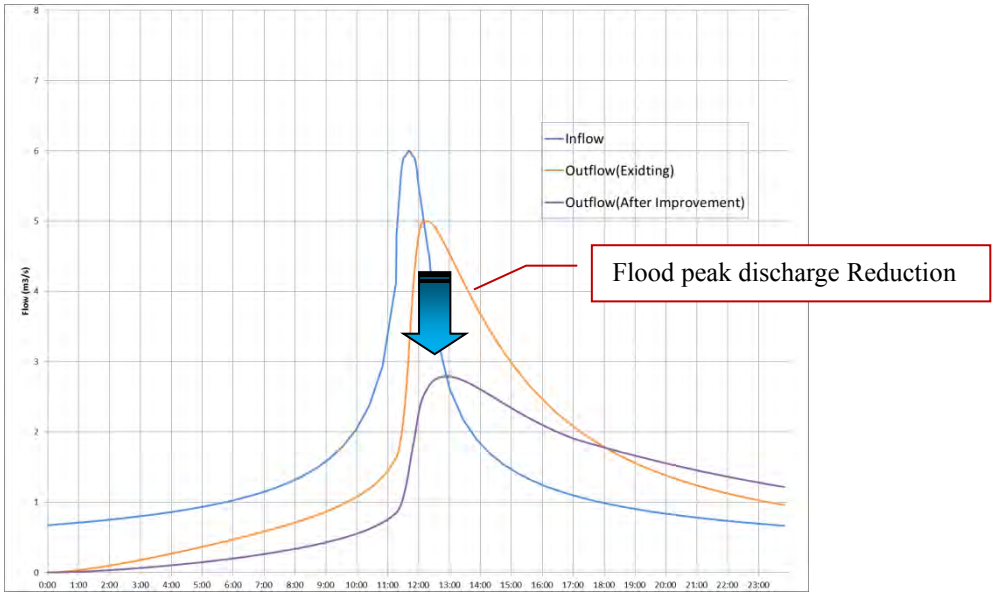


Figure 5.1-1 Conceptual Diagram on Peak Discharge Reduction by Situ Improvement

There are several ways to increase flood control capacity of *Situ* as shown below. Alternative (a) seems to be the easiest measure from the viewpoint of land acquisition.

(a) Lowering the water level in normal times by adding an opening on the spillway
(b) Increasing the water level in flood times by spillway and dike heightening
(c) Increasing the storage capacity by Situ-area expansion work

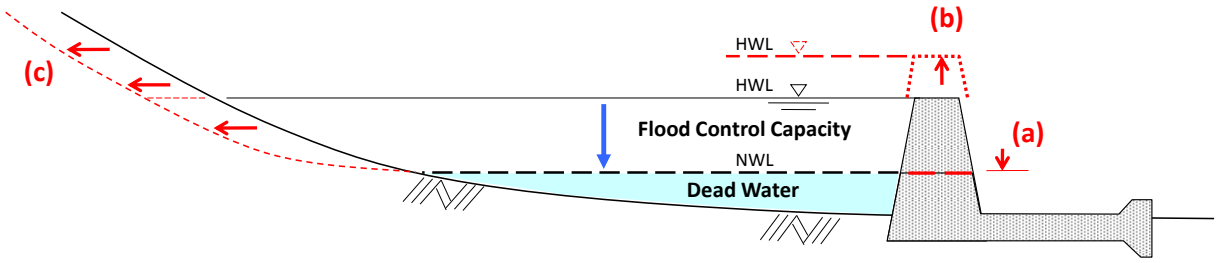


Figure 5.1-2 Conceptual Diagram on Methodology of Situ Improvement

(2) Planning and Effect Evaluation

1) Design Scale

Since a spillway of *Situ* was designed only for irrigation use, it does not have enough flow capacity against flood flows. Therefore, set the design scale in relation to maximum flow capacity of the existing spillway.

2) Runoff Calculation and Flood Control Calculation

i) Basic Concept

- Flood control effect by *Situ* improvement shall be evaluated at just downstream point from the spillway.
- In CFMP for decreasing the damage from a flood with 50-year return period in the Ciliwung River, flood control effect by individual *Situ* shall not be evaluated.

- In a flood control plan for a sub-basin, flood control effect by Situ improvement is taken into account.

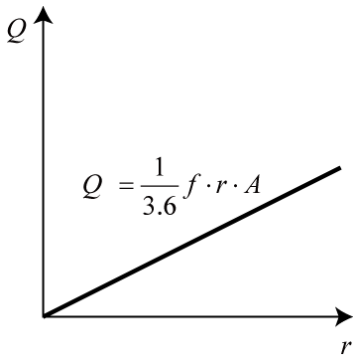
ii) Runoff Calculation

Runoff calculation shall use a basic rational formula.

(a) Rational Formula

Considering the Situ basin being relatively narrow, the runoff calculation for Situ shall employ a rational formula generally used as the runoff analysis method that immediately converts rainfall into the flow rate and is suitable for medium and small rivers and urban areas.

$$Q = \frac{1}{3.6} f \cdot r \cdot A \quad \text{..... (1)}$$



where,

Q : maximum flood discharge (m^3/s)
f : dimensionless runoff coefficient
r : rainfall intensity within time t_c
A : catchment area (km^2)

(b) Flood Concentration Time

Flood concentration time (t_c) is the sum of inlet time (t_i) and flow time (t_f). Inlet time is a length of time taken to transport a rainfall at the most upstream in a basin to its river channel. Flow time is a length of time taken to discharge a floodwater at the most upstream river channel to a downstream reference point.

$$t_c = t_i + t_f \quad \text{..... (2)}$$

where,

t_i : inlet time (min)
t_f : flow time (min)

Inlet time (t_i) was calculated as follows.

(i) Find the inlet point, catchment area of which is 2 km^2
(ii) Set the inlet time as follows.
$t_i = 30$ (min)
(iii) When the catchment area (A) at the farthest point of the channel is clearly judged to be less than 2 km^2, calculate the inlet time using the following formula.

$$t_i = \frac{30\sqrt{A}}{\sqrt{2}} \quad \text{..... (3)}$$

Flow time (t_f) was calculated by means of Kraven's Formula, which gives relations between riverbed slope and flow velocity shown below.

$$t_f = L \Big/ (V \times 60) \quad \text{..... (4)}$$

where,

L: length of river channel from its outlet point to the farthest point (m)

V: flow velocity (m/s)

Table 5.1-1 Relationship between Riverbed Slope and Flow Velocity

Riverbed Slope (I_b)	I_b > 1/100 (steep slope)	1/100 >I_b > 1/200	I_b< 1/200 (mild slope)
Flow Velocity (V)	3.5 m/s	3.0 m/s	2.1 m/s

(c) Rainfall Intensity Formula

Rainfall intensity calculation shall use the existing rainfall intensity formula at the observing station near Situ.

(d) Flood Control Calculation

The following equation describing relation (outflow discharge) = (inflow) – (storage) was used for flood control calculation.

$$\frac{V_2}{\Delta t}+\frac{Q_{o2}}{2}=\frac{V_1}{\Delta t}-\frac{Q_{o1}}{2}+Q_{in} \quad \cdots\cdots (5)$$

where,

V_1 : storage (m^3)
V_2 : storage after Δt (m^3)
Q_{in} : inflow (m^3)
Q_{o1} : outflow discharge in relation to V_1 (m^3)
Q_{o2} : outflow discharge in relation to V_2 (m^3)

Also, outflow discharge was obtained by the following formula.

$$Q = C \cdot B \cdot H^{1.5} \quad \cdots\cdots (6)$$

where,

C : overflow coefficient (C = 1.8)
B : overflow width (m)
H : overflow depth (m)
(Overflow depth is obtained from $H – V$ curve.)

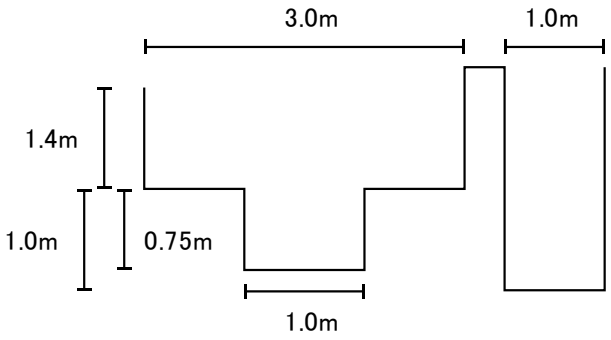
(3) Example of Calculation and Preliminary Design

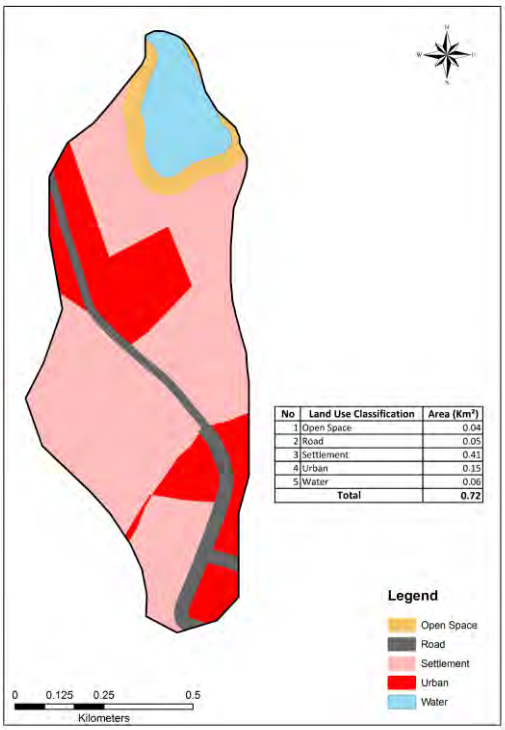
The example of calculation and preliminary design is shown below.

1) Design Criteria

(a) Condition for Analysis

- Return Period: 1/25
- Rainfall Curve: 24-hour middle concentration curve
- Spillway: the existing spillway consists of effluent outlet with 3.0m×1.4m and water supply gate. For the modification of spillway, the effluent outlet will be cut off with 1.0m×0.75m.





(b) Specification of Sub-Basin

- Catchment Area: 71.5ha
- Storage Area: 9.5ha
- Length of River Channel: 1,370m
- Slope of River Channel: (112.5-105.03)/1370=1/183
- Run-off Coefficient: 0.61 (future land use)
- Flood Arrival Time

: Inlet Time=$\sqrt{0.715}/\sqrt{2}\times30$=18min
: Reaching Time=1370/3/60=8min
: Flood Arrival Time=18+8=26min

(c) Rainfall Intensity Formula

Jakarta OBS $r_{25}=1086.9/t^{0.6}-0.884$

(d) Water Level

In accordance with the site survey, it is realized to lower the water level maximum no less than 75cm.

2) Verification of Effect

The effect of the facility against the 1/25 rainfall is shown as follows.

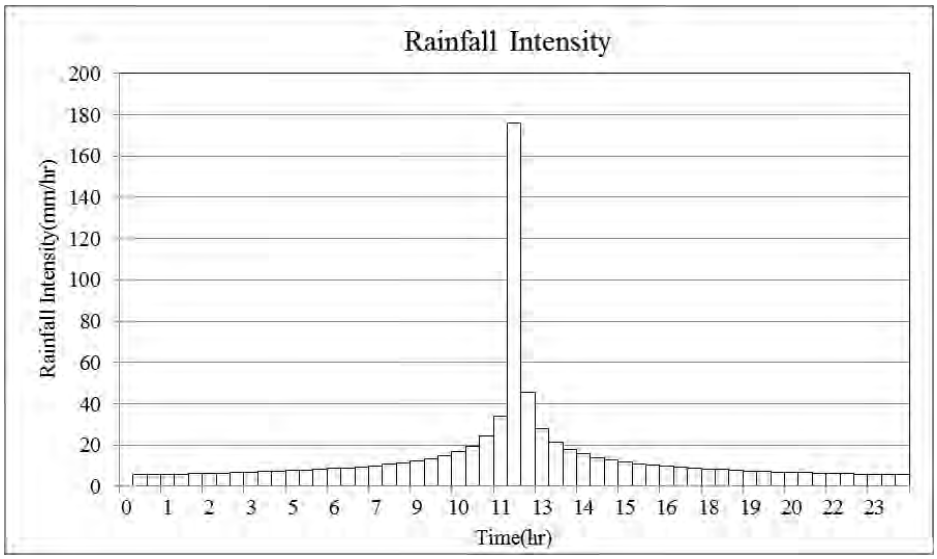


Figure 5.1-3 Rainfall Distribution (24-hour Middle Concentration)

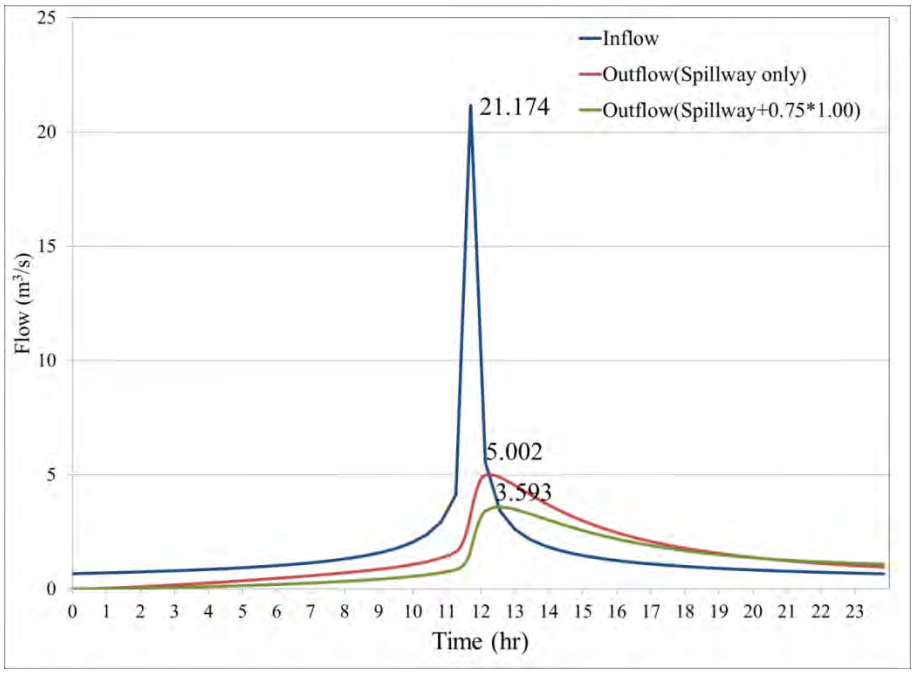


Figure 5.1-4 Deduction Effect of Outflow Discharge by Cutting Off Spillway

As shown in Figure 5.1-4, the maximum outlet discharge will decrease from 5.0 m^3/s to 3.6 m^3/s.

(4) Preliminary Design

Based on the above analysis, the preliminary design is conducted. The crown of the dike of downstream spillway will be cut off with width of 100cm×height of 75cm. The preliminary design drawing is shown in Figure 5.1-5.

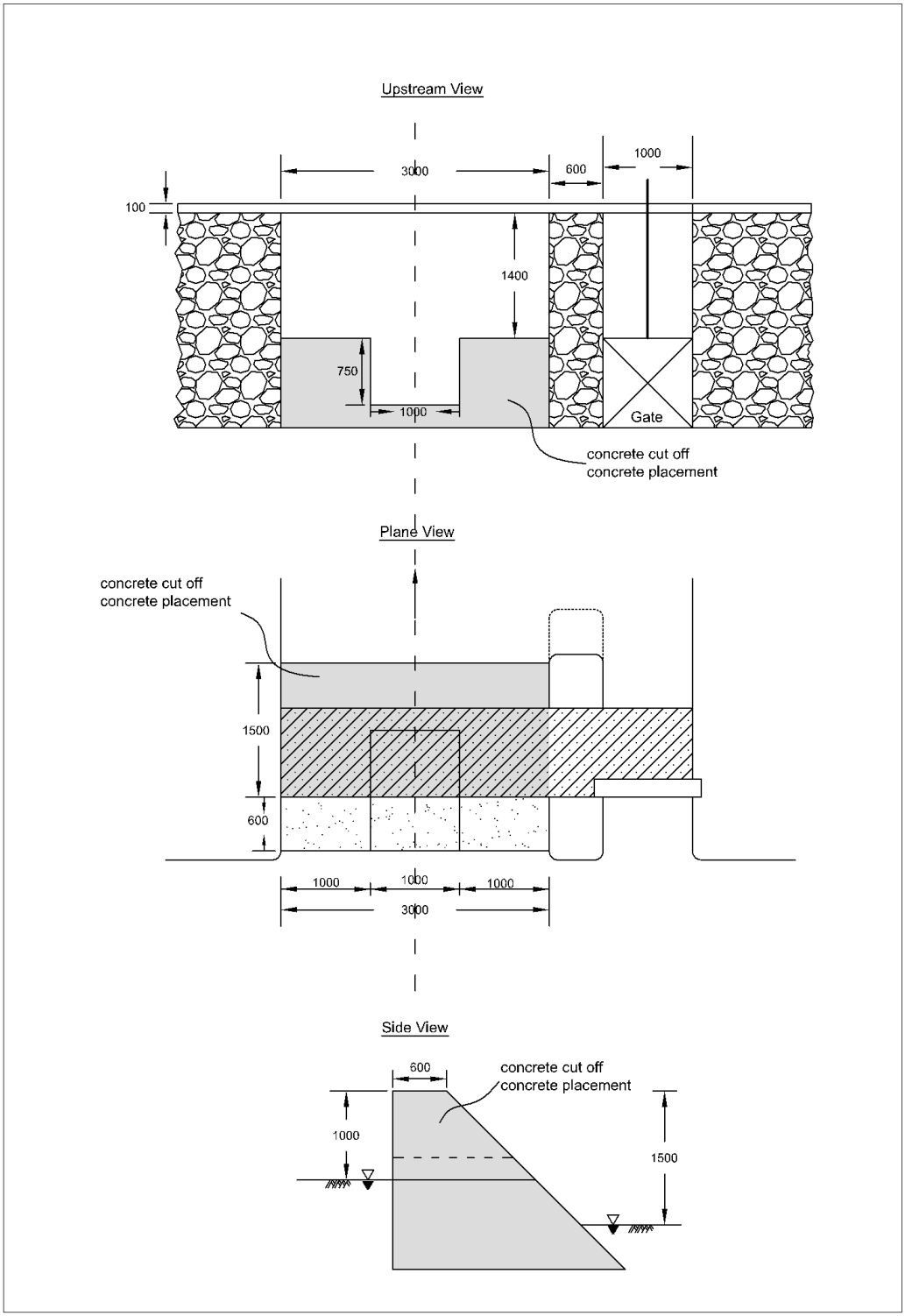


Figure 5.1-5 Modification of Spillway

(5) Consideration

The following subjects shall be considered for the improvement of Situ to increase the runoff control effect.

a) In case that there is no significant difference of water level between Situ and downstream river by improvement of downstream river channel of Situ, it is not appropriate to reduce the normal water level. For ensuring the flood control volume by reducing the water level in flood, it is necessary to

conduct overall improvement works of dike and spillway to resist against the increase of normal hydrostatic pressure.

b) In case there is inflow from the outside of the basin through the irrigation channel, this inflow volume shall be evaluated in the calculation of flood control effect.

c) If aquiculture or water transportation can be identified in Situ, it is necessary to determine the water level in consideration of the impact of water level reduction by the improvement works, and to make consensus among the related stakeholders.

d) Normalization work for an upstream river course from a *Situ* may increase peak inflow. In a worst-case, it causes dike overtopping of Situ. As measures against the overtopping, it is necessary to consider necessary measures including a) removal of *Situ*, b) reconstruction of *Situ* as a dam, c) construction of bypass channel, and d) no river improvement at upstream of *Situ*.

5.1.3 Maintenance

(1) Spillway

The regular inspection shall be conducted to avoid the block out of notches of spillway by garbage, and to check the damage conditions of spillway.

(2) Boundary Area

Conservation/boundary area around *Situ* stipulated in existing regulations shall be maintained in a good condition after the determination of the area and installation of concrete markers to indicate the area. Summary of the regulations about the conservation/boundary area is shown below.

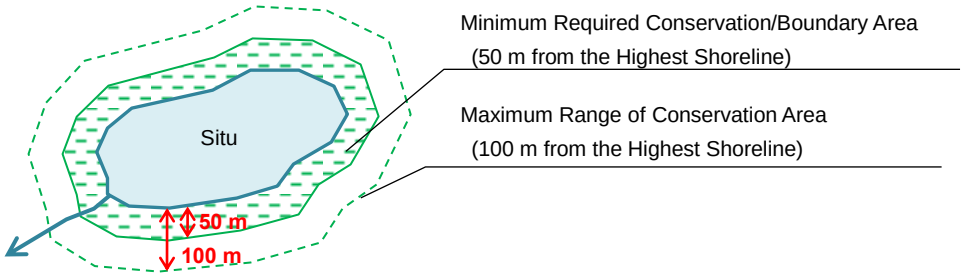


Figure 5.1-6 Range of Conservation/Boundary Area around Situ-Situ

Table 5.1-2 Presidential Decree on Management of Conservation Area

Items	Bahasa Indonesia	English
Name of Regulation	Keputusan Presiden Republik Indonesia Nomor : 32 Tahun 1990 Tentang Pengelolaan Kawasan Lindung	Presidential Decree of the Republic of Indonesia Number: 32 Year 1990 on Management of Conservation Areas
Definition and Purpose of Conservation Area	Kawasan lindung adalah kawasan yang ditetapkan dengan fungsi utama melindungi kelestarian lingkungan hidup yang mencakup sumber alam, sumber daya buatan dan nilai sejarah serta budaya bangsa guna kepentingan pembangunan berkelanjutan. (BAB I, Pasal 1, 1.) Kawasan lindung meliputi kawasan perlindungan setempat dll. (BAB III, Pasal 3, 2.) Kawasan perlindungan setempat terdiri dari kawasan sekitar danau/waduk. (BAB III, Pasal 5, 3.) Perlindungan terhadap kawasan sekitar danau/waduk dilakukan untuk melindungi danau/waduk dari kegiatan budi daya yang dapat menggangu kelestarian fungsi danau/waduk. (BAB IV, Pasal 17)	Conservation area is a area where is defined that its primary function is to protect environmental sustainability covering natural resources, artificial resources, and historical value with ethnic culture for the purpose of sustainable development. (Chapter I, Clause 1, 1) Conservation area includes local conservation area and so on. (Chapter III Clause 3, 2) The local conservation area consists of the area around a lake/reservoir. (Chapter III, Clause 5, 3) Conservation of the area around a lake/reservoir is done to protect the lake/ reservoir from utilization activities that may interfere with preservation of the lake/reservoir's function. (Chapter IV, Clause 17)
Extent of Conservation Area	Kriteria kawasan sekitar danau/waduk adalah daratan sepanjang tepian danau/waduk yang lebarnya proporsional dengan bentuk dan kondisi fisik danau/waduk antara 50-100 meter dari titik pasang tertinggi ke arah darat. (BAB IV, Pasal 18)	Criteria for the area around lake/ reservoir is the ground along the lakeside whose width is proportional with the shape and physical condition of lakes/reservoirs and between 50-100 meters from the water's edge at the time of the highest tide to landward. (Chapter IV, Clause 18)
Allowed Activities in Conservation Area	-	-
Prohibited Activities in Conservation Area	Di dalam kawasan lindung dilarang melakukan kegiatan budi daya, kecuali yang tidak mengganggu fungsi lindung. (BAB VI, Pasal 37, (1)) Kegiatan budi daya yang sudah ada di kawasan lindung yang mempunyai dampak penting terhadap lingkungan hidup dikenakan ketentuan-ketentuan yang berlaku sebagaimana dimaksud dalam Peraturan Pemerintah Nomor 29 Tahun 1986 tentang Analisis Mengenai Dampak Lingkungan. (BAB VI, Pasal 37, (3))	In the conservation area, performing utilization activities, except for activities which do not impair the function of protection, is prohibited. (Chapter VI, Clause 37, (1)) Regarding utilization activities which already exist in the conservation area and have significant impacts on the environment, provisions in the Government Regulation No. 29 year 1986 about Analysis of Environmental Impact will be applicable. (Chapter VI, Clause 37, (3))

Table 5.1-3 Decree of the Minister of Public Works on Boundary Line of River (1/2)

Items	Bahasa Indonesia	English
Name of Regulation	Peraturan Menteri Pekerjaan Umum Nomor : 63/PRT/1993 Tentang Garis Sempadan Sungai, Daerah Manfaat Sungai, Daerah Penguasaan Sungai dan Bekas Sungai	Decree of the Minister of Public Works Number : 63/PRT/1993 on Boundary Line of River, River Utilization Areas, Controlled Areas of River and Former River
Definition and Purpose of Boundary Area	Daerah sempadan danau/waduk adalah kawasan tertentu disekeliling danau/waduk yang mempunyai manfaat penting untuk mempertahankan kelestarian fungsi sungai. (BAB I, Pasal 1, 12)	Boundary area of lake/reservoir is a certain area around a lake/reservoir which has important benefits to maintain sustainability of functions of a river. (Chapter I, Clause 1, 12)
Extent of Boundary Area	Penetapan garis sempadan danau, waduk, mata air dan sungai yang terpengaruh pasang surut air laut mengikuti kriteria yang telah ditetapkan dalam keputusan Presiden R.I Nomor: 32 Tahun 1990 tentang Pengelolaan Kawasan Lindung, sebagai berikut: a. Untuk danau dan waduk, garis sempadan ditetapkan sekurang-kurangnya 50 (lima puluh) meter dari titik pasang tertinggi kearah darat. (BAB II, Pasal 10)	As for the establishment of a boundary line of a lake,a reservoir, a spring, and a river which is affected by tidal change, follow the established criteria in Presidential Decree of the Republic of Indonesia Number: 32 Year 1990 on Management of Conservation Areas, as follow: a. For lakes and reservoirs, a boundary line shall be set at least 50 (fifty) meters from the point of the highest tide to landward. (Chapter II, Clause 10)
Allowed Activities in Boundary Area	Pemanfaatan lahan di daerah sempadan dapat dilakukan oleh masyarakat untuk kegiatan-kegiatan tertentu sebagai berikut: a. Untuk budidaya pertanian dengan jenis tanaman yang diijinkan. b. Untuk kegiatan niaga, penggalian dan penimbunan. c. Untuk pemasangan papan reklame, papan penyuluhan dan peringatan, serta rambu-rambu pekerjaan. d. Untuk pemasangan rentangan kabel listrik, kabel telepon dan pipa air minum. e. Untuk pemancangan tiang atau pondasi prasarana jalan/jembatan baik umum maupun kreta api. f. Untuk penyelenggaraan kegiatan-kegiatan yang bersifat social dan masyarakat yang tidak menimbulkan dampak merugikan bagi kelestarian dan keamanan fungsi serta fisik sungai. g. Untuk pembangunan prasarana lalu lintas air dan bangunan pengambilan dan pembuangan air. (BAB II, Pasal 11, (1))	As for the land use of the boundary area, following certain activities can be done by people: a. Cultivation by means of allowed types of plants b.Commercial activities, excavation and landfilling c. Installation of billboards, information and notice boars, also work signs d. Instalation of electric wires, telephone cables and water pipes e. Piling pillars or foundations of road/bridge and railway infrastructures f. Implementation of social and community activities which does not have adverse affects on sustainability and safety of physical function of rivers g. Construction of water traffic infrastructure, and intake and drainage facilities (Chapter II, Clause 11, (1))

Table 5.1-4 Decree of the Minister of Public Works on Boundary Line of River (2/2)

Items	Bahasa Indonesia	English
Prohibited Activities in Boundary Area	Pada daerah sempadan dilarang: a. Membuang sampah, limbah padat dan atau cair b. Mendirikan bangunan permanen untuk hunian dan tempat usaha (BAB II, Bagian Keempat, Pasal 12)	In the border areas is prohibited: a. Disposing of garbage and solid waste or liquid b. Establishing permanent buildings for residential and business premises
Others	Pejabat yang berwenang dapat menetapkan suatu ruas di daerah sempadan untuk membangun jalan inspeksi dan/atau bangunan sungai yang diperlukan, dengan ketentuan lahan milik perorangan yang diperlukan diselesaikan melalui pembebasan tanah. (BAB II, Pasal 11, (3))	A competent authority can designate a segment in a bounary area to build required inspection roads and/or river structures, with provisions of private properties which need to be resolved through land acquisition. (Chapter II, Clause 11, (3))

Table 5.1-5 Presidential Decree on Spatial Planning of JABODETABEKPUNJUR (1/2)

Items	Bahasa Indonesia	English
Name of Regulation	Peraturan Presiden Republik Indonesia Nomor 54 Tahun 2008, Tentang: Penataan Ruang Kawasan Jakarta, Bogor, Depok, Tangerang, Bekasi, Puncak, Cianjur	Presidential Decree of the Republic of Indonesia Number 54 Year 2008, on Spatial Planning of Jakarta, Bogor, Depok, Tangerang, Bekasi, Puncak, and Cianjur Area
Definition and Purpose of Conservation Area	Kawasan lindung adalah wilayah yang ditetapkan dengan fungsi utama melindungi kelestarian lingkungan hidup yang mencakup sumber daya alam dan sumber daya buatan. (BAB I, Pasal 1, 6) Situ adalah suatu wadah genangan air di atas permukaan tanah yang terbentuk secara alami maupun buatan yang airnya berasal dari tanah atau air permukaan sebagai siklus hidrologis yang merupakan salah satu bentuk kawasan lindung (BAB I, Pasal 1, 12) Sasaran penyelenggaraan penataan ruang Kawasan Jabodetabekpunjur adalah: b. terwujudnya peningkatan fungsi lindung terhadap tanah, air, udara, flora, dan fauna dengan ketentuan: 4) situ berfungsi sebagai daerah tangkapan air, sumber air baku, dan sistem irigasi. (BAB I, Pasal 2, (2)) Dalam perencanaan kawasan lindung ditetapkan kawasan lindung prioritas dengan kriteria sebagai ruang terbuka hijau regional, kawasan konservasi, dan/ atau daerah resapan air. (BAB IV, Pasal 32, (1)) Kawasan lindung prioritas meliputi: b. Situ. (BAB IV, Pasal 32, (2))	Conservation area is a area where is defined that its primary function is to protect environmental sustainability covering natural resources dan artificial resources. (Chapter I, Clause 1, 6) *Situ* is a place of water pool on the ground which is formed naturally or artificially and whose water comes from under the ground or surface as hydrological circulation which is one of form of conservation areas (Chapter I, Clause 1, 12) Implementation target of spatial planning in Jabodetabekpunjur Area is: b. Embodiment of improvement of conservation fuction on soil, water, air, flora, and fauna with conditions: 4) *situ* which functions as a reservoir area, water source, and irrigation system. (Chapter I, Clause 2, (2)) In the planning of conservation areas, a priority conservation area is defined by the criteria as regional green open space, conservation area, and/or water source areas. (Chapter IV, Clause 32, (1)) Priority conservation areas include: b. Situ. (Chapter IV, Clause 32, (2))

Table 5.1-6 Presidential Decree on Spatial Planning of JABODETABEKPUNJUR (2/2)

Items	Bahasa Indonesia	English
Extent of Conservation Area	Ruang untuk kawasan lindung dikelompokkan dalam zona nonbudi daya sebagai berikut: a. Zona Non-Budi Daya 1 yang selanjutnya disebut Zona N1. (BAB II, Pasal 11, (2)) Zona N1 terdiri atas: f. kawasan sekitar danau, waduk, dan situ. (BAB IV, Pasal 25, (1))	Space for conservation area is grouped into a non-utilization zone as follows: a. Non-utilization Zone 1, hereafter referred to as "Zone N1". (Chapter II, Clause 11, (2)) Zone N1 consists: f. areas around a lake, a reservoir, and a *situ*. (Chapter IV, Clause 25, (1))
Allowed Activities in Conservation Area	Pengembangan prasarana air baku dapat dilakukan dengan pembangunan dan pengelolaan waduk multiguna, saluran pembawa, pengelolaan situ, dan pemeliharaan sungai (BAB IV, Pasal 18, (3))	Development of raw water infrastructure can be implemented with development and management of multipurpose reservoir, bearer channels, management Situ, and maintenance of river (Chapter IV, Clause 18, (3))
Prohibited Activities in Conservation Area	Di kawasan sekitar danau, waduk, dan situ dilarang menyelenggarakan: a. Pemanfaatan ruang yang mengganggu bentang alam, mengganggu kesuburan dan keawetan tanah, fungsi hidrologi dan hidraulis, kelestarian flora dan fauna, serta kelestarian fungsi lingkungan hidup; b. Pemanfaatan hasil tegakan; dan/atau c. Kegiatan yang menyebabkan penurunan kualitas air danau, waduk, dan situ, menyebabkan penurunan kondisi fisik kawasan sekitar danau, waduk dan situ, serta mengganggu debit air. (BAB IV, Pasal 30, (6))	In the area around a lake, a reservoir, and a *situ*, prohibited activities are: a. Space utilization which disturbs natural landscape, fertility and preservation of soil, hydrologic and hydraulic functions, sustainability of flora and fauna, and sustainability of environment functions; b. Utilization of yield; and/ or c. Activities which cause a decrease in water quality of lakes, reservoirs, and *situ*, and cause a decrease in physical condition of areas around lakes, reservoirs and *situ*, also disturb water discharge. (Chapter IV, Clause 30, (6))
Others	Pemerintah dan pemerintah daerah sesuai dengan kewenangannya melakukan rehabilitasi hutan dan lahan serta penghijauan di kawasan lindung dengan tutupan tumbuhan tetap. (BAB IV, Pasal 29)	The government and the local governments which have authority shall carry out forest and land rehabilitation with planting in conservation areas with constant vegetative cover.(Chapter IV, Clause 29)

5.2 Feature of *Situ-Situ* and Related Channel System

5.2.1 Site Reconnaissance

In order to grasp general features of *situ-situ* and related channel system in the Project area, the Project team carried out site reconnaissance around five (5) *situ-situ* located in the middle Ciliwung River basin. The surveyed *situ-situ* were chosen based on a proposal from Ciliwung Cisadane River Basin Organization (Balai Besar Wilayah Sungai Ciliwung-Cisadane) and *situ-situ* inventory. Basic information and location of these are summarized in

Table 5.2-1 and Figure 5.2-1 respectively.

Table 5.2-1 Basic Information of Surveyed *Situ-Situ*

Code	*Situ*	Basin	Sub-basin	Surface Area as of 2008 (ha)	Catchment (ha)	Village	District	Regency	Revitalization
656	Kebantenan	Ciliwung	R3	4.5	269	Pakansari	Cibinong	Kab. Bogor	1998
296	Cikaret	Ciliwung	R3	29.5	1,114	Harapan Jaya	Cibinong	Kab. Bogor	2002
316	Cilodong	Ciliwung	R4	9.5	71	Kalibaru	Sukma Jaya	Kota Depok	1998
378	Citayam	Krukut	L6	7.2	39	Bojong Pondok Terong	Pancoran Mas	Kota Depok	2003
868	Pladen	Ciliwung	-	1.5	39	Beji Timur	Beji	Kota Depok	2007

Note: Numbers indicated in the column of "Revitalization" means implementation year of a *situ* revitalization work consisting of dredging and improvement of environment around a *situ*.

Conditions of the following items were surveyed at the sites.

- Existing structures
- Land use around *situ-situ*
- Downstream channel
- Water-level difference between surface of *situ-situ* and downstream channel
- Water use

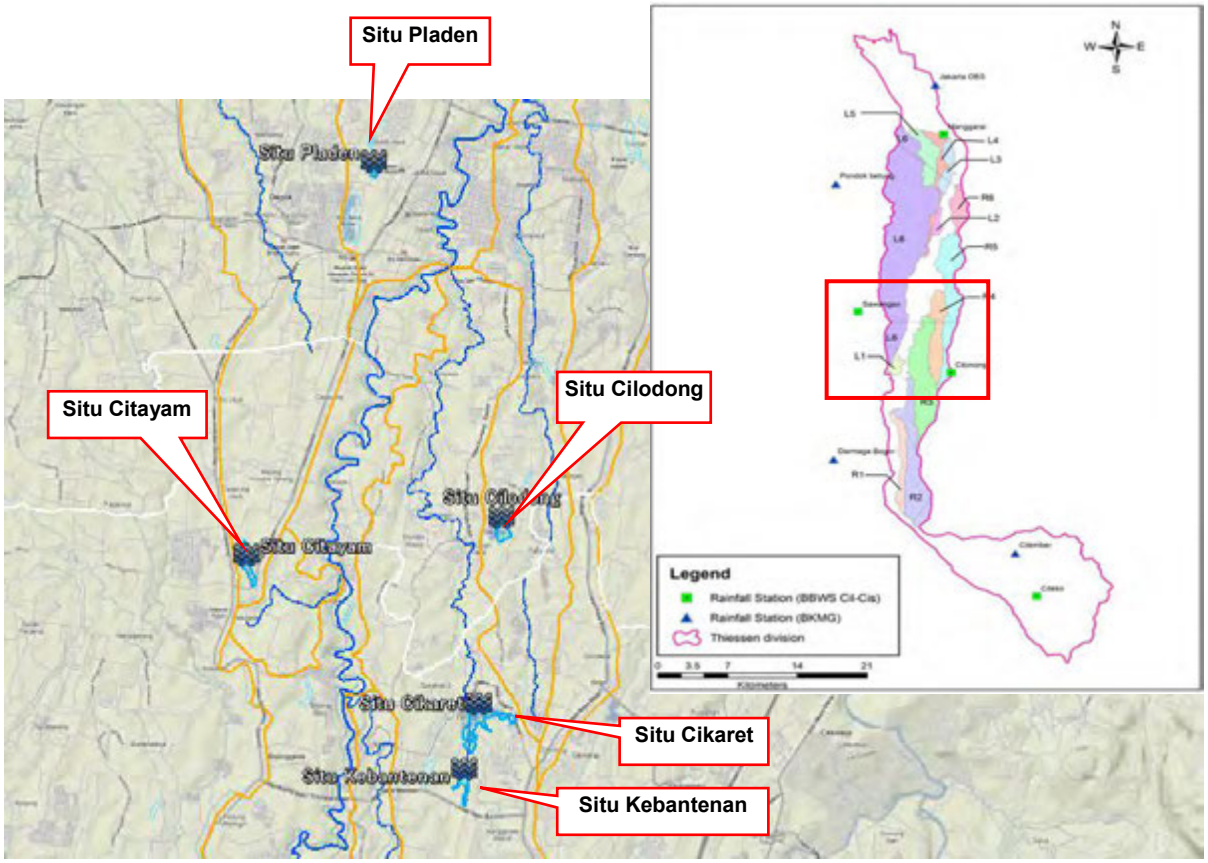


Figure 5.2-1 Location of Surveyed *Situ-Situ*

5.2.2 Common Feature of *Situ-Situ*

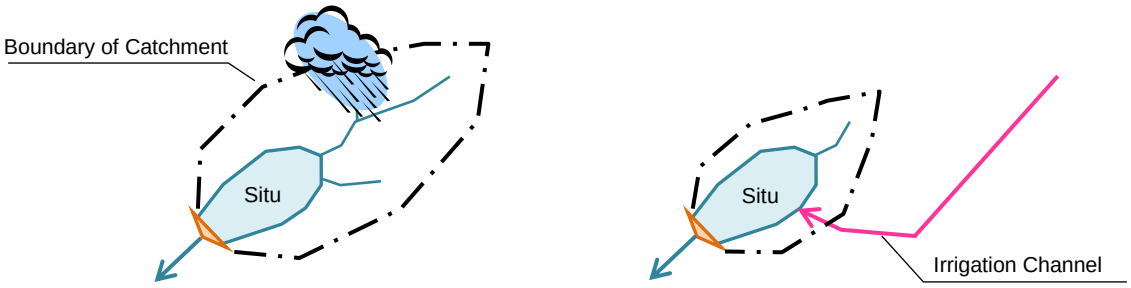
Common features observed at the *situ-situ* are summarized in Table 5.2-2 based on result of the site reconnaissance. These features are considered as preconditions for discussing measures to improve *situ-situ*.

Table 5.2-2 Common Features observed at Surveyed *Situ-Situ*

Items	Features
Existing Structures	a) Most earth dikes have not been maintained in good condition. Artificial destruction, water leakage, and dike occupancy by residents were observed in three (3) of surveyed four (4) earth dikes. b) Most outlets have not been maintained in good condition. Of the surveyed five (5) *situ*, two (2) damaged spillways which have not functioned properly and one (1) submerged spillway were observed.
Land Use around *Situ*	Almost all surrounding lands of the five (5) *situ* have been used as residential areas.
Downstream Channel	Four (4) of the five (5) *situ* discharge almost all water to irrigation channels different from original river courses.
Water-level Difference between *Situ* and Channel	In three (3) of the five (5) *situ*, water-level between a *situ* and a downstream channel is almost same. Backwater by narrowed downstream channel or the other weir on a downstream channel causes the problem.
Water Use	Water supplied from three (3) of the five (5) *situ* has been used for fish farms and small-scale agriculture.

5.2.3 Water Source

Water source of individual *situ-situ* can be divided into two (2) categories, namely rainwater on the catchment and external water source such as an irrigation channel as shown in Figure 5.2-2. In some cases, water from outside of the catchment accounts for an important percentage of total inflow water.



a) Rainwater on Catchment **b) External Water Source**

Figure 5.2-2 Water Source of *Situ-Situ*

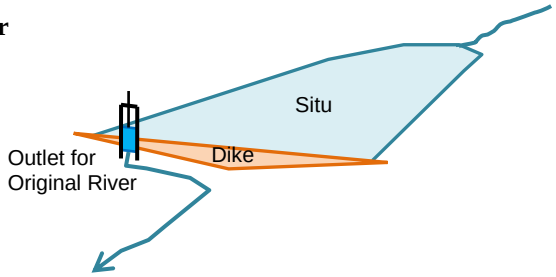
5.2.4 Outlet Layout

From a viewpoint of outlet layout, *situ-situ* can be divided into the following three (3) types.

a) *Situ-Situ* with an Outlet for Original River

This type of *situ-situ* is designed for a steady water supply to the downstream river.

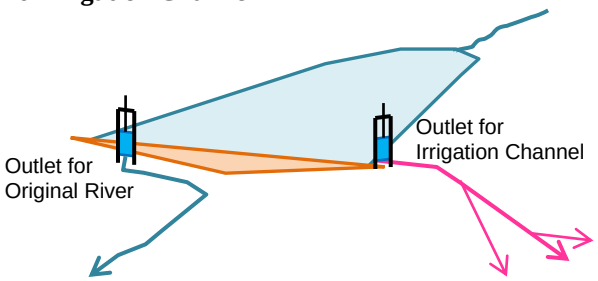
Situ Kebantenan and Situ Pladen can be categorized into this type.



b) *Situ-Situ* with Outlets for Original River and Irrigation Channel

This type of *situ-situ* has several outlets to supply water mainly to the irrigation channels. One of the outlet functions to maintain river water.

Spillway for this type of *situ-situ* varies in layout. For example, Situ Cikaret has only one spillway to the irrigation channel. In this case, almost all floodwaters flow into the irrigation channel.



c) *Situ-Situ* with an Outlet for Irrigation Channel

This type of *situ-situ* has an outlet to supply all water to the irrigation channel. Usually, no trace of original river course remains in the downstream.

Situ Cilodong and Situ Citayam can be categorized into this type.

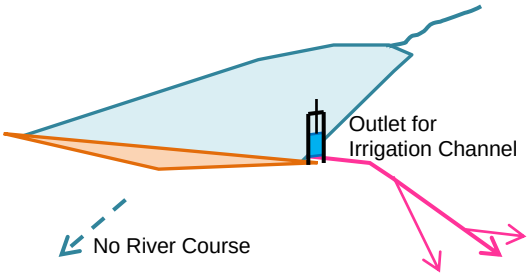


Figure 5.2-3 Outlet Layout of *Situ-Situ*

Detailed results of the site reconnaissance is summarized in Table 5.2-3~ Table 5.2-7.

Table 5.2-3 (1/2) Conditions of Situ Kebantenan

Name (Code)	Situ Kebantenan (656)	Location	Desa Pakansari, Kec. Cibinong, Kab. Bogor			
Survey Date	October 1, 2012	Basin	Ciliwung	Sub-basin	R3	Cikumpa
Surface Area	4.5 (ha)	Catchment	269 (ha)		Revitalization	1998

Facilities/ Conditions

- Earth Dike : The right side bank is partially destroyed.
- Outlet : The outlet consists of a spillway and a control gate. Water leaks from the damaged spillway.
- Revitalization : Dredging and environmental improvement work around the *situ* were completed.
- Others : Because of the damaged earth dike and a weir on the downstream river channel mentioned below, water-level difference between the *situ* and the downstream channel becomes almost same.

Major Water Source for *Situ*

- All water of the *situ* comes from the catchment.

Downstream Channel/ Its Conditions

- All water from the *situ* is released toward the downstream river channel.
- The released water is mainly used for fish farms.
- There is a weir on the downstream river channel to keep water-level high for the fish farms.

Land Use of Surrounding Area of *Situ*

- Lands around the *situ* have been used for farming, fish farming, and housing sites.
- There are at least three (3) houses around the *situ* , floor level of which is approximately 1 meter avobe the maximum *situ* level.

Possible Measures to Improve Runoff Control Function

There are two (2) measures to ensure flood control capacity as follows.

a) Demolishing the downstream weir to decrease downstream river level, and repairing the damaged earth dike.
b) Heightening the spillway and earth dikes to increase *situ* level.

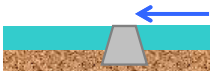
For implementation of the measure a), consensus development with fish farm owners and compensation for their business are required. As for the measure b), relocation of the houses near the *situ* is required. Therefore, it needs a long time to improve the *situ* .

Table 5.2-3(2/2) Conditions of Situ Kebantenan

Name (Code)	Situ Kebantenan (656)	Location	Desa Pakansari, Kec. Cibinong, Kab. Bogor			
Survey Date	October 1, 2012	Basin	Ciliwung	Sub-basin	R3	Cikumpa
Surface Area	4.5 (ha)	Catchment	269 (ha)		Revitalization	1998

Photos

(1) Water-level difference between the *situ* and the downstream channel is almost same.



(2) Partinal destruction of the earth dike

(3) Post-*situ*-revitalization situation

(4) A house near the *situ*

(5) Fish farms around the downstream channel

Table 5.2-4 (1/2) Conditions of Situ Cikaret

Name (Code)	Situ Cikaret (296)	Location	Desa Harapan Jaya, Kec. Cibinong, Kab. Bogor			
Survey Date	October 1, 2012	Basin	Ciliwung	Sub-basin	R3	Cikumpa
Surface Area	29.5 (ha)	Catchment	1,114 (ha)		Revitalization	2002

Facilities/ Conditions

- Earth Dike : Crown of the dike is used for a major road. Many houses occupy the dike's downstream surface.
- Outlet : There are two outlets. one is for the original river, and the other is for an irrigation channel. The former does not have a spillway.
- Revitalization : Dredging and environmental improvement work around the *situ* were completed.
- Others : Water-level difference between the *situ* and the downstream irrigation channel is about 1 meter.

Major Water Source for *Situ*

- All water of the *situ* is supplied from the catchment which includes Situ Kebantenan.

Downstream Channel/ Its Conditions

- Most water from the *situ* is discharged toward the irrigation channel.
- The irrigation channel branches off several times and becomes narrow to the downstream. The water is mainly used for fish farms.
- The original river has been narrowed due to housing land development.

Land Use of Surrounding Area of Situ

- Lands around the *situ* have been used for farming, fish farming, housing, commercial and industrial sites.
- There are dozens of houses around the *situ* , floor level of which is approximately 1 meter avobe the *situ* level.

Possible Measures to Improve Runoff Control Function

In order to improve runoff control function safely, all the following works need to be implemented.

1) Modifying the outlet for the irrigation channel
2) Installing a new spillway to the outlet for the original river
3) Improving the downstream river course to secure flow area

It needs a long time to realize the item 2) and 3) because a wide area of land acquisition is required.

Table 5.2-4 (2/2) Conditions of Situ Cikaret

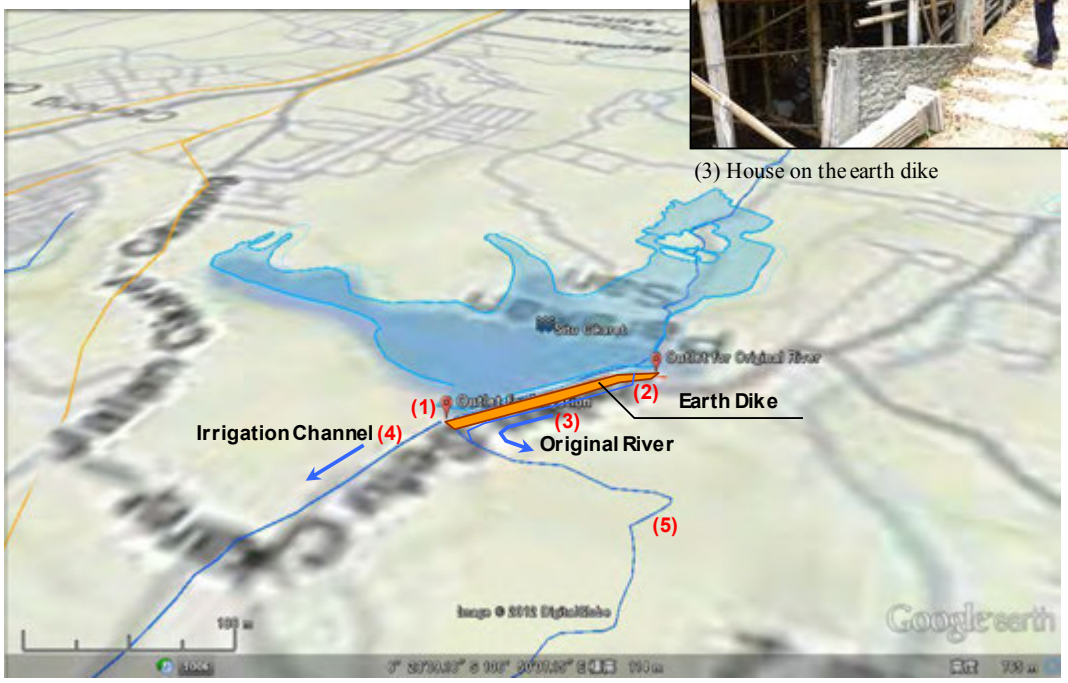
Name (Code)	Situ Cikaret (296)	Location	Desa Harapan Jaya, Kec. Cibinong, Kab. Bogor			
Survey Date	October 1, 2012	Basin	Ciliwung	Sub-basin	R3	Cikumpa
Surface Area	29.5 (ha)	Catchment	1,114 (ha)		Revitalization	2002

Photos

(1) Outlet for irrigation channel (with spillway)

(2) Outlet for original river (No spillway)

(3) House on the earth dike



(4) Downstream irrigation channel

(5) Downstream original river course

Table 5.2-5(1/2) Conditions of Situ Cilodong

Name (Code)	Situ Cilodong (316)	Location	Desa Kalibaru, Kec. Sukma Jaya, Kota Depok			
Survey Date	October 2, 15, 2012	Basin	Ciliwung	Sub-basin	R4	Sugutamu
Surface Area	9.5 (ha)	Catchment	71 (ha)		Revitalization	1998

Facilities/ Conditions

- Earth Dike : The dike is relatively in good condition. The dike crown is used for a road.
- Outlet : The outlet consists of a spillway and a control gate with in good condition.
- Revitalization : Dredging and environmental improvement work around the *situ* were completed.
- Others : Water-level difference between the spillway crown and the downstream irrigation channel is about 1 meter.

Major Water Source for *Situ*

- Major water is supplied from Situ Cikaret through an irrigation channel.

Downstream Channel/ Its Conditions

- All water is released to the irrigation channel.
- The released water is mainly used for fish farms.
- The irrigation channel branches off several times and becomes narrow to the downstream.
- There is no outlet for original river.
- Base level of the *situ* and the downstream channel is almost same.

Land Use of Surrounding Area of Situ

- Lands around the *situ* have been used for farming, fish farming, housing, commercial and industrial sites.
- There are dozens of houses around the *situ* , floor level of which is approximately 1 meter or less than that avobe the *situ* level.

Possible Measures to Improve Runoff Control Function

In order to improve runoff control function safely, all the following works need to be implemented.

1) Modifying the outlet for the irrigation channel
2) Installing a new spillway to the outlet for the original river
3) Improving the downstream river course to secure flow area

It needs a long time to complete land acquisition for the item 2) and 3). However, realization of these seems to be easier than that for Situ Cikaret, because most lands in the downstream area is rice fields and fish farms.

Table 5.2-5 (2/2) Conditions of Situ Cilodong

Name (Code)	Situ Cilodong (316)	Location	Desa Kalibaru, Kec. Sukma Jaya, Kota Depok			
Survey Date	October 2, 15, 2012	Basin	Ciliwung	Sub-basin	R4	Sugutamu
Surface Area	9.5 (ha)	Catchment	71 (ha)		Revitalization	1998

Photos

(1)-1 Outlet in dry condition (Oct. 2, 2012)

(1)-2 Outlet in rainy season (Feb. 4, 2013)

(2) Lakeside situation after revitalization

(3) Earth dike situation

(4) Downstream irrigation channel

Table 5.2-6 (1/2) Conditions of Situ Citayam

Name (Code)	Situ Citayam (378)	Location	Desa Bojong Pondok Terong, Kec. Pancoran Mas, Kota Depok			
Survey Date	October 2, 2012	Basin	Krukut	Sub-basin	L6	Krukut
Surface Area	7.2 (ha)	Catchment	39 (ha)		Revitalization	2003

Facilities/ Conditions

- Earth Dike : Water leaks from the bottom of the dike. The damage needs to be repaired immediately.
- Outlet : The outlet consists of a spillway and a control gate. Water leaks from the damaged spillway.
- Revitalization : Dredging and environmental improvement work around the *situ* were completed.
- Others : Water-level difference between the situ and the downstream channel is almost same because of backwater.

Major Water Source for *Situ*

- Major water is supplied from a main irrigation channel coming from the Cisadane River basin.
- Since the intake leading water from the main irrigation channel has a control gate, flood flow cannot flow into Situ Citayam directly. (see Photo (2))

Downstream Channel/ Its Conditions

- All water from the *situ* is discharged toward the irrigation channel passing through residential areas.
- The irrigation channel branches off several times and becomes narrow to the downstream.
- There is no outlet for original river.

Land Use of Surrounding Area of Situ

- Lands around the *situ* have mainly been used as housing sites.
- There are dozens of houses around the *situ*, floor level of which is approximately 1 meter or less than that avobe the *situ* level.

Possible Measures to Improve Runoff Control Function

Before everything else, the damaged earth dike needs to be repaired immediately to avoid dike break.

In order to improve runoff control function safely, all the following works need to be implemented.
1) Modifying the outlet for the irrigation channel
2) Installing a new spillway to the outlet for the original river
3) Improving the downstream river course to secure flow area

However, the *situ* has limited effectiveness for runoff control because catchment of the *situ* is relatively small and flood flows from the upstream irrigation channel can be controlled by the control gate.

Table 5.2-6 (2/2) Conditions of Situ Citayam

Name (Code)	Situ Citayam (378)	Location	Desa Bojong Pondok Terong, Kec. Pancoran Mas, Kota Depok			
Survey Date	October 2, 2012	Basin	Krukut	Sub-basin	L6	Krukut
Surface Area	7.2 (ha)	Catchment	39 (ha)		Revitalization	2003

Photos

(1) Residential area surrounding the *situ*

(2) Control gate at the intake from the major irrigation channel

(3) Damaged spillway

(4) Downstream channel situation

(5) Water leakage from the bottom of the dike

Table 5.2-7 (1/2) Conditions of Situ Pladen

Name (Code)	Situ Pladen (868)	Location	Desa Beji Timur, Kec. Beji, Kota Depok			
Survey Date	October 2, 2012	Basin	Ciliwung	Sub-basin	-	
Surface Area	1.5 (ha)	Catchment	39 (ha)		Revitalization	2007

Facilities/ Conditions

- Earth Dike : This *situ* does not have a dike.
- Outlet : The outlet consists of a spillway and a control gate. The outlet has submerged completely because of backwater.
- Revitalization : Dredging and environmental improvement work around the *situ* were completed.
- Others : Household drainage from the upstream overcrowded area flows into the *situ*. Also, accumulation of solid waste is observed.

Major Water Source for *Situ*

- All water of the *situ* comes from the catchment.

Downstream Channel/ Its Conditions

- All water from the *situ* is discharged toward a channel passing through residential areas.
- The channel has been narrowed due to the trend towards urbanization, and become a ditch for domestic drainage.

Land Use of Surrounding Area of Situ

- Lands around the situ have mainly been used as housing sites.
- There are dozens of houses around the situ, floor level of which is approximately 0.5 meter avobe the situ level.

Possible Measures to Improve Runoff Control Function

Firstly, waste dumping and household drainage problem needs to be solved to maintain functions of the *situ* .
In order to improve runoff control function, the downstream channel improvement is required to secure flow area and reduce backwater.

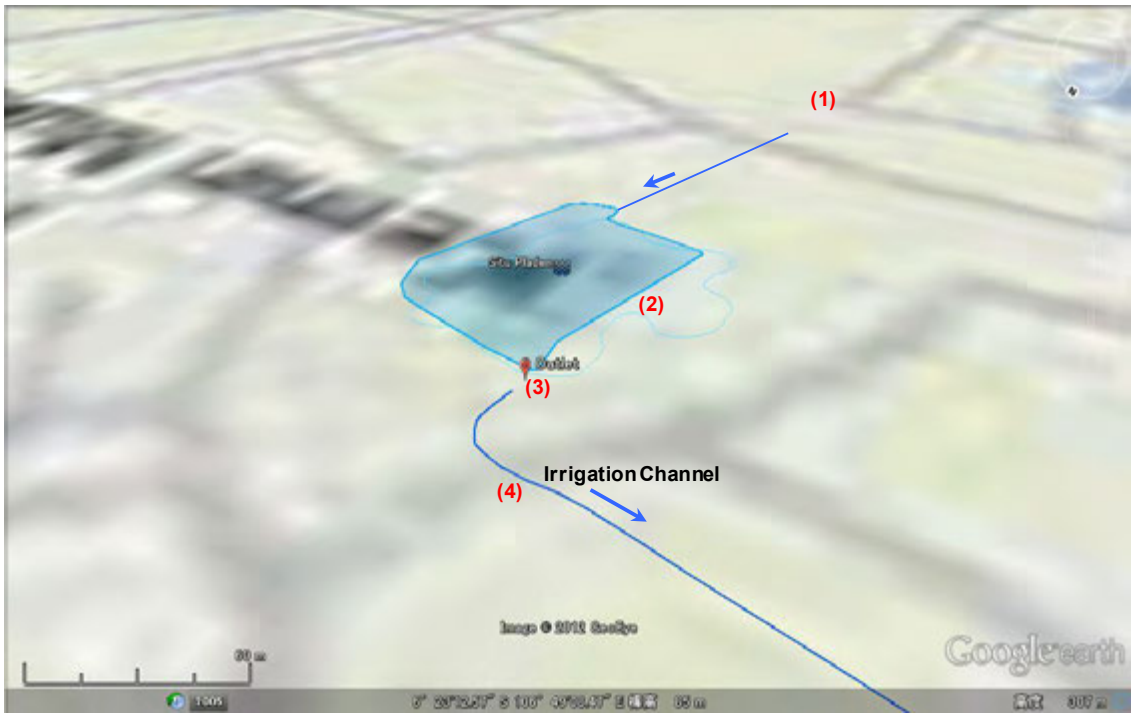
Table 5.2-7 (2/2) Conditions of Situ Pladen

Name (Code)	Situ Pladen (868)	Location	Desa Beji Timur, Kec. Beji, Kota Depok			
Survey Date	October 2, 2012	Basin	Ciliwung	Sub-basin	-	
Surface Area	1.5 (ha)	Catchment	39 (ha)		Revitalization	2007

Photos

(1) Upstream channel situation

(2) Lakeside situation after



(3) Submerged outlet of the *situ*

(4) Downstream channel situation

5.2.5 Channel System

Major channel system in the Project area was designed in the colonial era of the Dutch. Irrigation channels are basically arranged along ridge lines so that it can distribute waters efficiently. The irrigation channels become smaller each time it branch. *Situ-situ* reserve water for a steady water supply to downstream irrigation channel. Finally, used water from fields is drained to rivers. Schematic diagram explaining this process is shown in Figure 5.2-4.

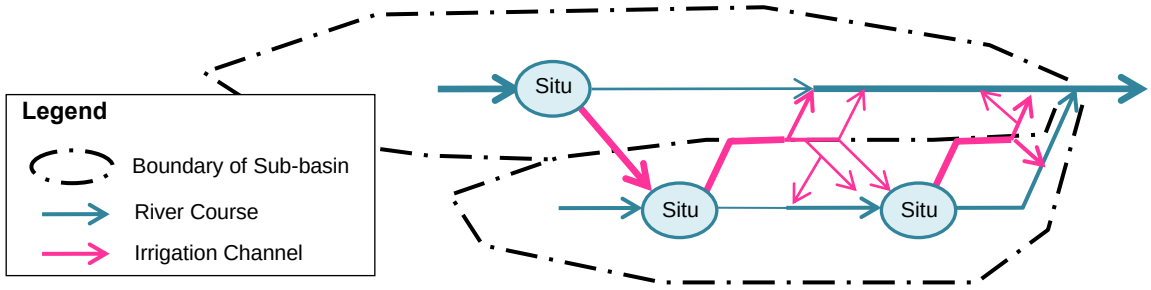


Figure 5.2-4 Schematic Diagram of Channel System

Most irrigation channels in the Project area are no longer used for its original purpose due to advancement of urbanization. In some cases, water in the irrigation channels is still used for fish farming. However, many sections of the irrigation channels have become drainage of domestic wastewater.

Irrigation-related law and ordinances such as “Law No. 7 Year 2004 on Water Resources” and “Presidential Decree of the Republic of Indonesia Number: 20 Year 2006 on irrigation” do not stipulate management and maintenance of this kind of “abandoned” irrigation channels. Besides, there is no detailed register of those channels.

5.3 Example of Situ Improvement (Situ Cilodong)

5.3.1 Sugutamu Sub-basin

(1) Channel System

Situ Cilodong is located in the upper area of the Sugutamu sub-basin, a right tributary of the Ciliwung River. Figure 5.3-1 shows distribution of river course, irrigation channel and *situ-situ* in the sub-basin. There are two (2) major *situ-situ*, namely Situ Cilodong and Situ Sidomukti. Feature of channel system is summarized below.

Feature of Channel System

- Water of Situ Cilodong is mainly supplied from Situ Cikaret in Cikumpa sub-basin through the irrigation channel between those.
- All released water from Situ Cilodong flows not into river channel but irrigation channel toward Cikumpa sub-basin.
- The irrigation channel from Situ Sidomukti has already not functioned.

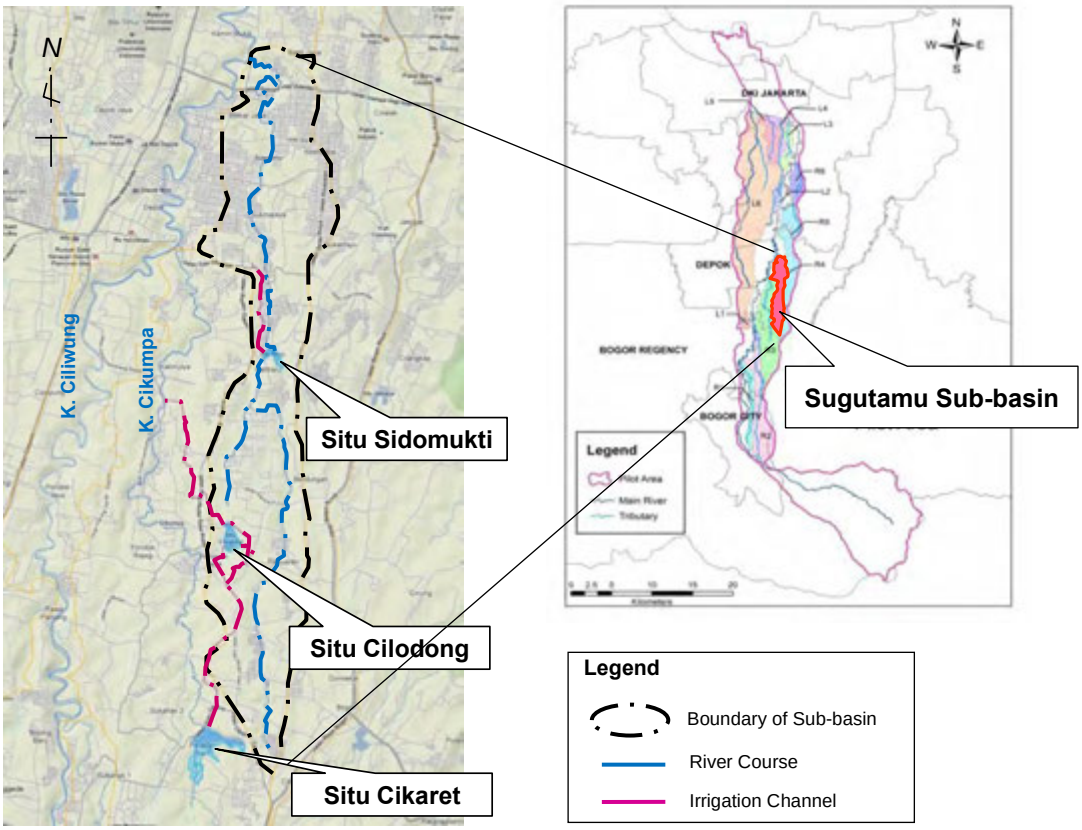


Figure 5.3-1 Situ-Situ and Channel System in Sugutamu Sub-basin

(2) Administrative Boundary

Figure 5.3-2 shows administrative boundary of Sugutamu sub-basin. Most part of the sub-basin is located in Depok City, while the upstream area is located in Bogor Regency.

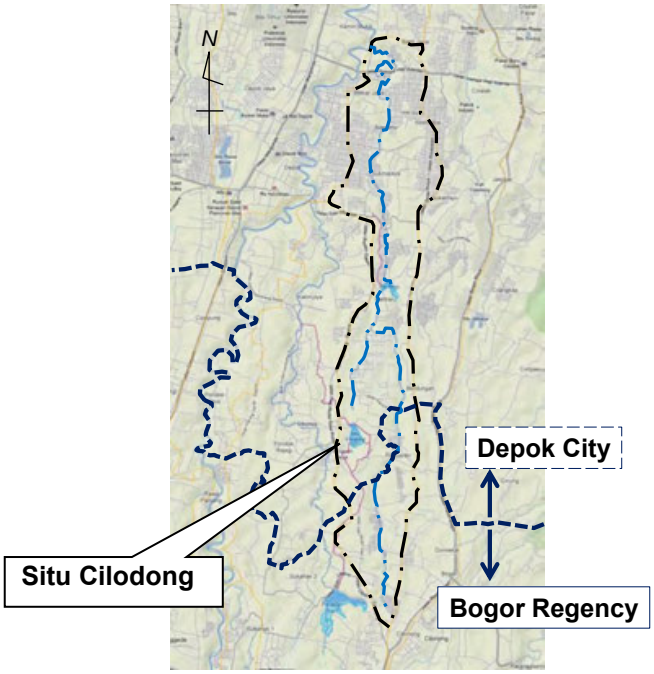


Figure 5.3-2 Administrative Boundary around Situ Cilodong

(3) Changes in Land Use

This figure shows chronological change of land use in Sugutamu sub-basin. As of 2008, approximately 60 % of the sub-basin became urban area. It is estimated that the urban area may be increased up to 75 % in 2030. It is expected that the changes in land use will cause increase in peak flood discharge in the future.

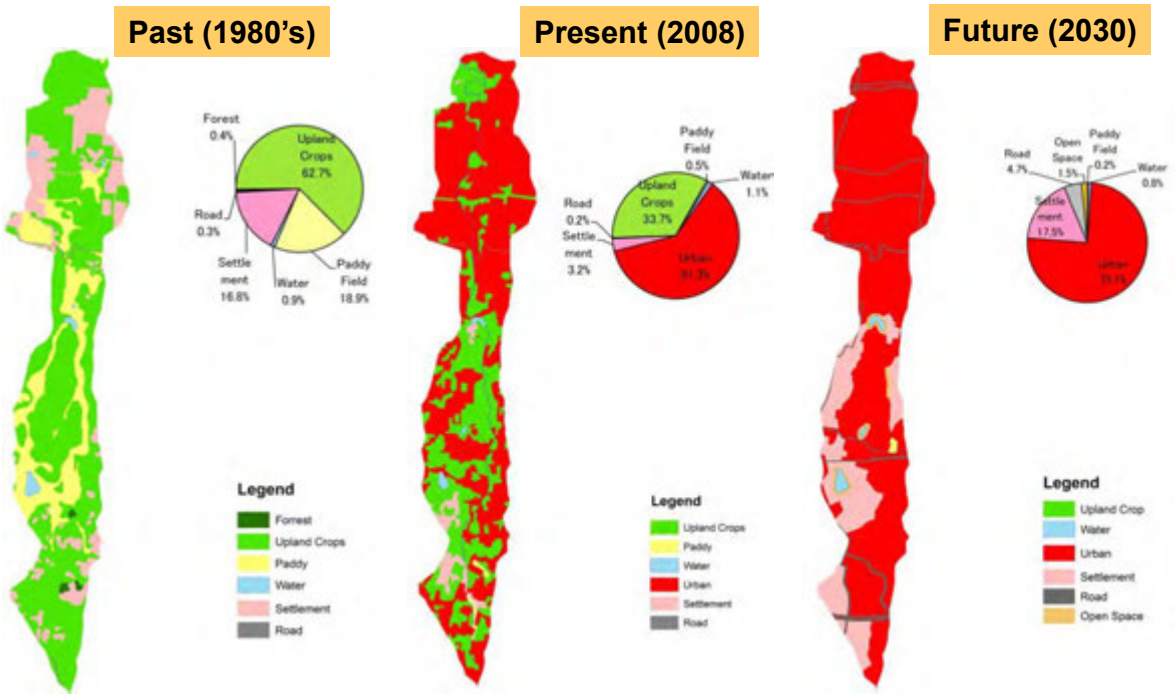


Figure 5.3-3 Changes in Land Use in Sugutamu Sub-basin

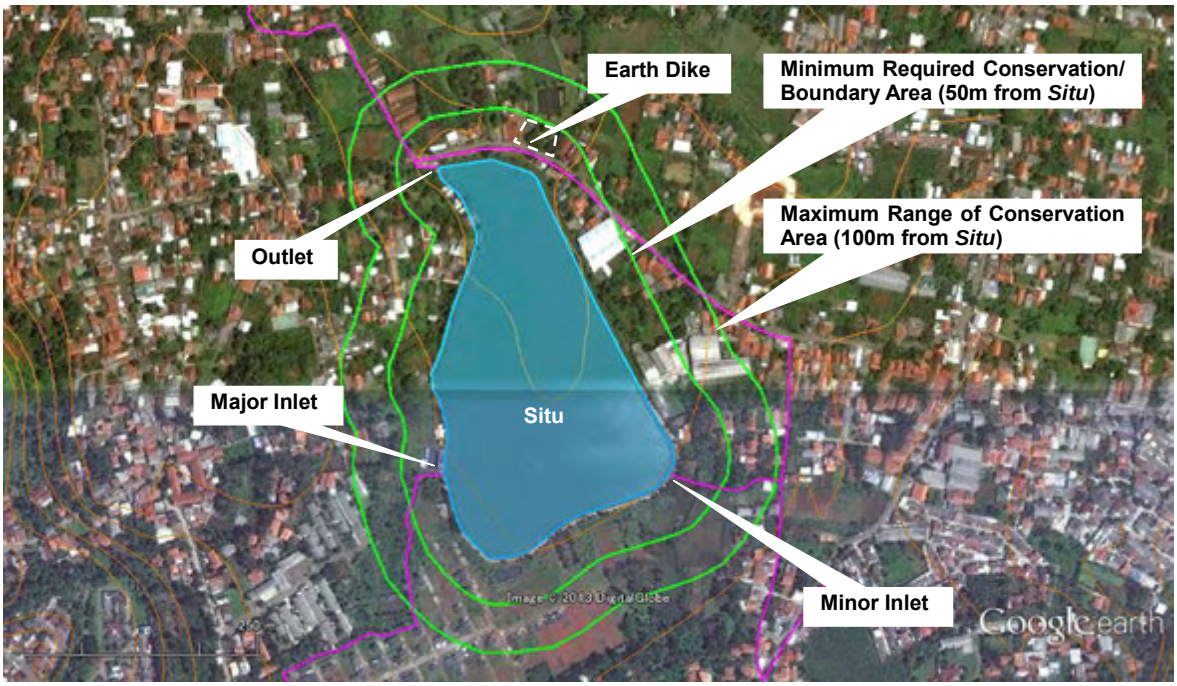
5.3.2 Situ Cilodong

(1) Situ Cilodong and Related Facility

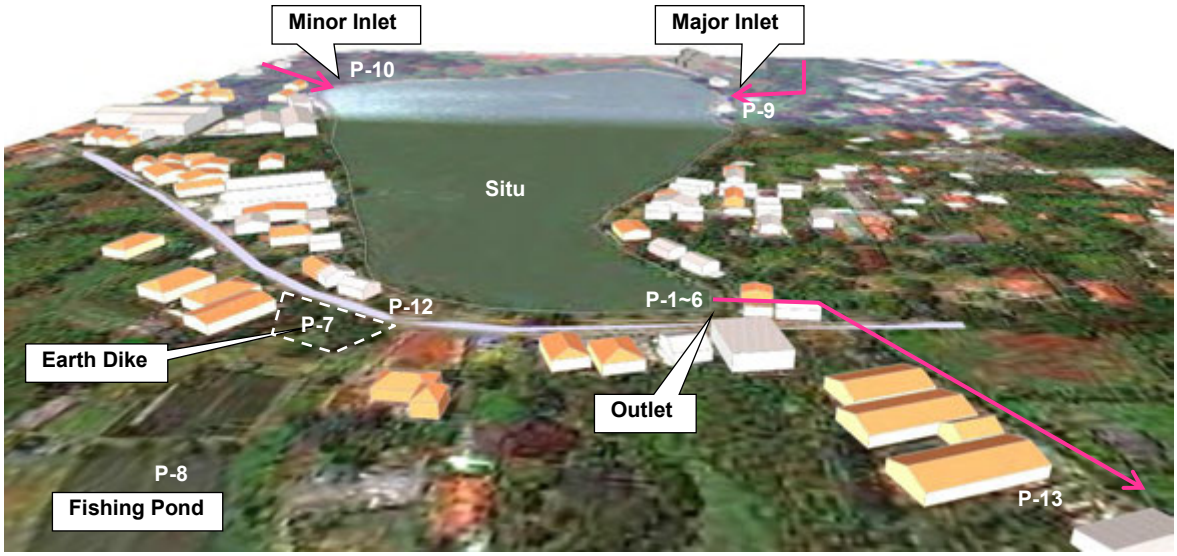
Situ Cilodong is an artificial lake in a flat land closed by means of an earth dike. The *situ* has only one outlet releasing water to an irrigation channel on the left bank side. Flow of water to the downstream valley has been blocked by the earth dike completely. At present, land of the downstream valley does not have a river channel, and is used for fishing ponds. Usually, the *situ* water is used for recreational activities such as fishing and swimming. When the water supply is cut off in a dry season, the *situ* often dry up. The followings are basic information and present situation of Situ Cilodong and its surrounding area.

Table 5.3-1 Basic Information of Situ Cilodong

Items	Data	Items	Data
Catchment Area	71.7 ha	EL. of Spillway (Non-overflow section)	EL.108.300 m
Water Area of *Situ*	9.5 ha	Height of Spillway	1.05 m
EL. of Earth Dike	EL.107.530 m	Spillway Width	2.95 m
EL. of *Situ* Bed	EL.105.850 m	Height of Control Gate	1.40 m
EL. of Spillway Crest	EL.106.900 m	Control Gate Width	0.95 m



a) Plane View



b) Bird's-eye View from North

Figure 5.3-4 Situ Cilodong and its Surrounding Area

5.3.3 Current Flood Control Benefit

(1) Object

Current flood control benefit of Situ Cilodong was examined by runoff calculation and flood control calculation. Object of the calculations is Sugutamu sub-basin including Situ Cilodong and Situ Sidomukti. Since major water in Situ Cilodong is supplied from Situ Cikaret in Cikumpa sub-basin through the irrigation channels between those, inflow water from the catchment of Situ Cikaret was taken into account. Segmented basin for the calculations is shown below.

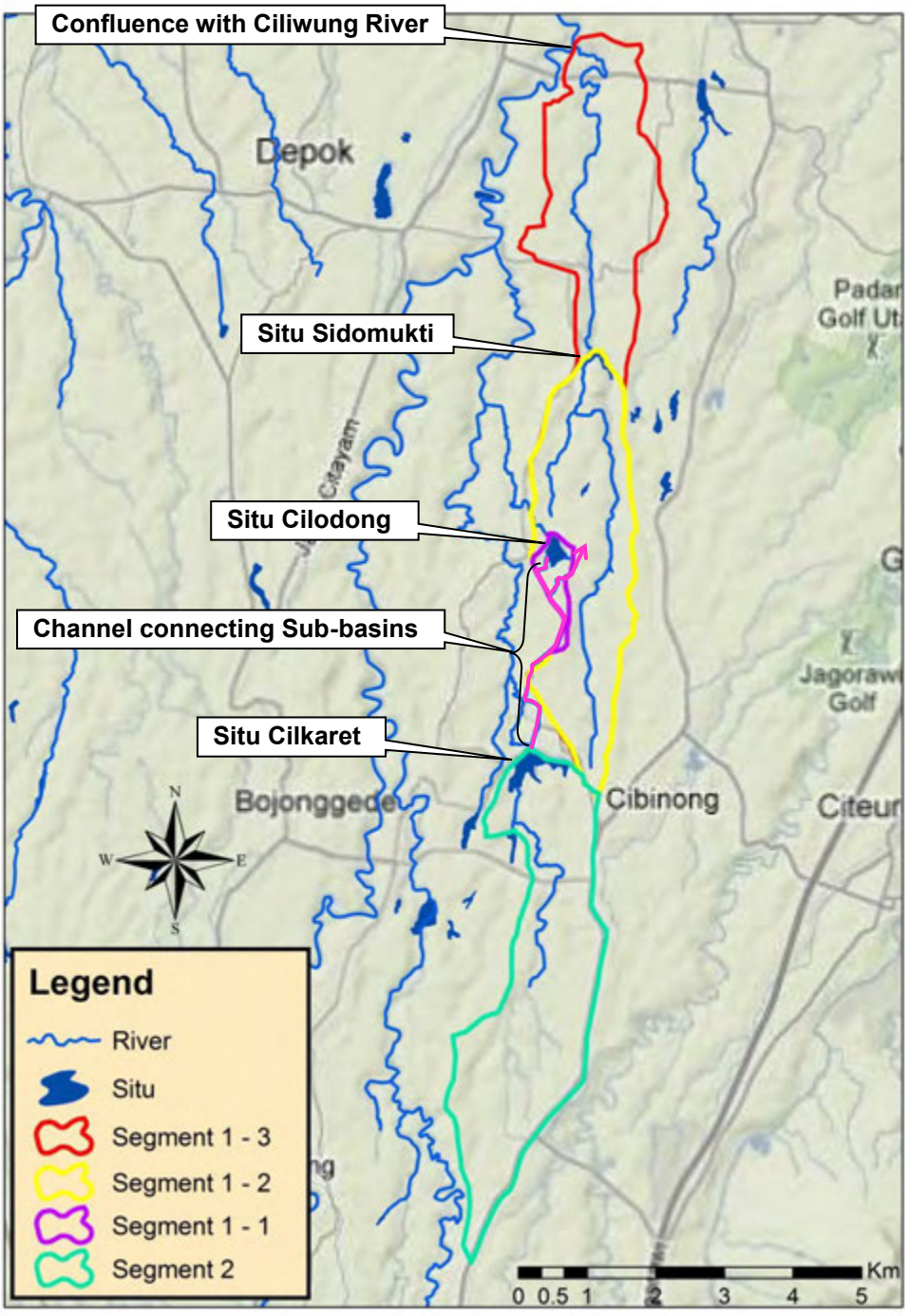


Figure 5.3-5 Segmented Basin

Table 5.3-2 shows basic information of every basin segment.

Table 5.3-2 Basic Information of Basin Segment

Segment	Area (km^2)	Channel Length (km)	Slope ($1/n$)	Flood Concentration Time (min)
Segment 1 (Sugutamu Sub-basin)	12.901	13.74	201	139.0
Segment 1-3 (Residual Basin 2)	5.788	6.42	171	65.7
Segment 1-2 (Residual Basin 1)	6.396	7.32	165	50.6
Segment 1-1 (Catchment of Situ Cilodong)	0.717	1.85	435	32.6
Segment 2 (Catchment of Situ Cikaret)	11.140	7.53	122	71.8

Table 5.3-3 shows standard values of runoff coefficient in relation to every surface characteristic. These were used for obtaining average runoff coefficient of every basin segment shown in Table 5.3-4 ~ Table 5.3-8. Land use information as of 2008, namely present value, was used for the calculation because increase in runoff from future development areas will be reduced individually based on "Zero Delta Q Policy".

Table 5.3-3 Runoff Coefficient

Surface Characteristic	Runoff Coefficient f
Urban	0.80
Settlement	0.50
Upland Crops	0.30
Paddy Field	0.10
Open Space	0.35
Forest	0.30
Road	0.65
Water	1.00

Table 5.3-4 Land Use and Mean Runoff Coefficient of Segment 1

Surface Characteristic	Area(km^2) (a)	Runoff Coefficient (f)	(a)×(f)
Urban	9.431	0.80	7.545
Settlement	2.490	0.50	1.245
Upland Crops	0.000	0.30	0.000
Paddy Field	0.030	0.10	0.003
Open Space	0.200	0.35	0.070
Forest	0.000	0.30	0.000
Road	0.640	0.65	0.416
Water	0.110	1.00	0.110
Total	12.901		9.389
Mean Value		0.728	

Table 5.3-5 Land Use and Mean Runoff Coefficient of Segment 1-3

Surface Characteristic	Area(km^2) (a)	Runoff Coefficient (f)	(a)×(f)
Urban	5.665	0.80	4.532
Settlement	0.102	0.50	0.051
Upland Crops	0.000	0.30	0.000
Paddy Field	0.000	0.10	0.000
Open Space	0.029	0.35	0.010
Forest	0.000	0.30	0.000
Road	0.304	0.65	0.197
Water	0.003	1.00	0.003
Total	6.103		4.794
Mean Value		0.786	

Table 5.3-6 Land Use and Mean Runoff Coefficient of Segment 1-2

Surface Characteristic	Area(km^2) (a)	Runoff Coefficient (f)	(a)×(f)
Urban	3.925	0.80	3.140
Settlement	1.976	0.50	0.988
Upland Crops	0.000	0.30	0.000
Paddy Field	0.031	0.10	0.003
Open Space	0.134	0.35	0.047
Forest	0.000	0.30	0.000
Road	0.288	0.65	0.187
Water	0.043	1.00	0.043
Total	6.396		4.407
Mean Value		0.689	

Table 5.3-7 Land Use and Mean Runoff Coefficient of Segment 1-1

Surface Characteristic	Area(km^2) (a)	Runoff Coefficient (f)	(a)×(f)
Urban	0.155	0.80	0.124
Settlement	0.413	0.50	0.206
Upland Crops	0.000	0.30	0.000
Paddy Field	0.000	0.10	0.000
Open Space	0.037	0.35	0.013
Forest	0.000	0.30	0.000
Road	0.049	0.65	0.032
Water	0.064	1.00	0.064
Total	0.717		0.438
Mean Value		0.612	

Table 5.3-8 Land Use and Mean Runoff Coefficient of Segment 2

Surface Characteristic	Area(km^2) (a)	Runoff Coefficient (f)	(a)×(f)
Urban	2.246	0.80	1.797
Settlement	7.950	0.50	3.975
Upland Crops	0.033	0.30	0.010
Paddy Field	0.134	0.10	0.013
Open Space	0.042	0.35	0.015
Forest	0.000	0.30	0.000
Road	0.664	0.65	0.432
Water	0.071	1.00	0.071
Total	11.140		6.312
Mean Value		0.567	

(2) Runoff Calculation and Flood Control Calculation

1) Calculation Principle

Figure 5.3-6 shows runoff calculation model. The Project carried out the calculation based on the following principle.

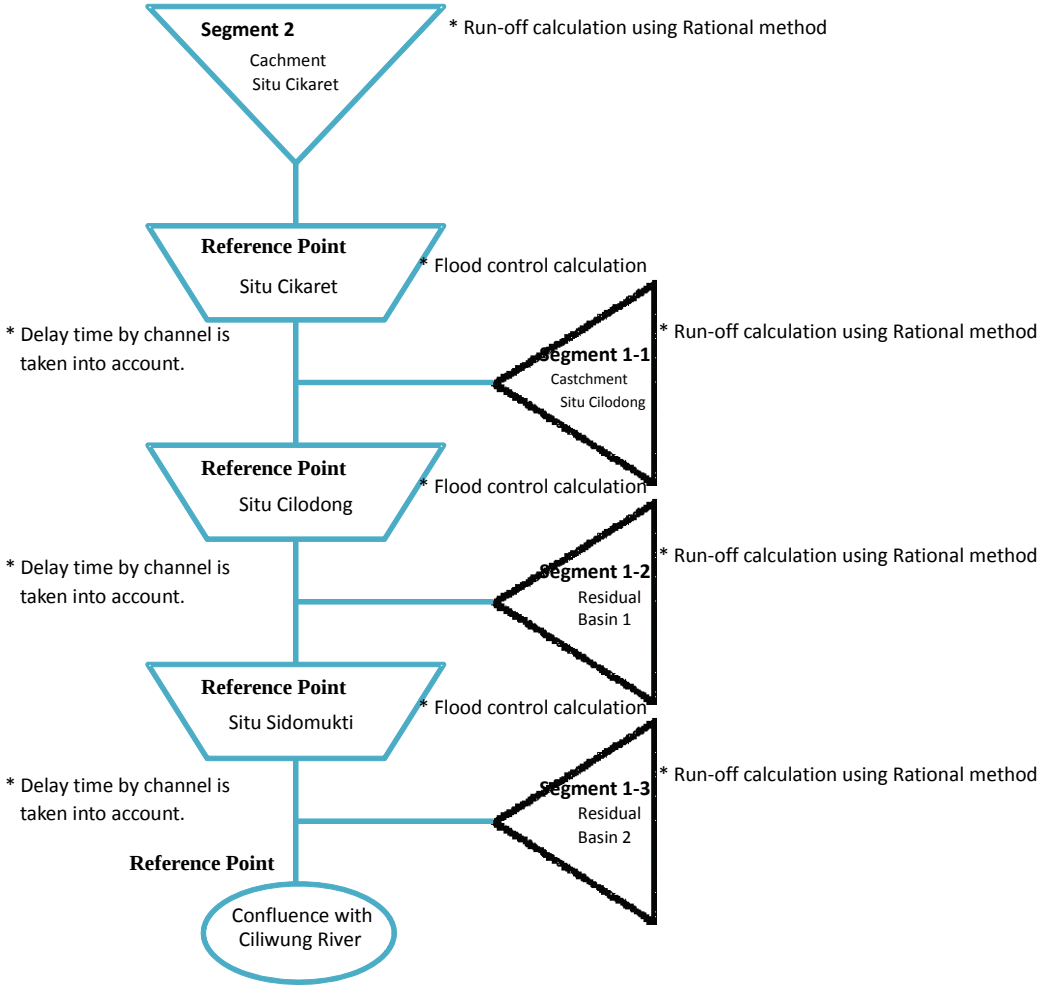


Figure 5.3-6 Runoff Calculation Model

- Rational formula is applied to runoff calculation in Sugutamu sub-basin.
- Flood control effect of every *situ* is calculated.
- Following items are taken into account.
  - Inflow water from Situ Cikaret in Cikumpa sub-basin through irrigation channels
  - Outflow discharge from every *situ*
  - Delay time by channels between reference points

2) Design Scale

Following rainfalls were applied to design scales.

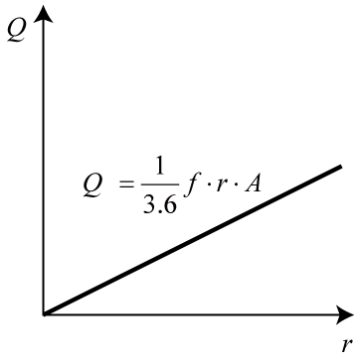
- Rainfall with 10-year return period for river planning
  (Same as design scale for river improvement in Depok City)
- Rainfall with 200-year return period for an emergency spillway of *situ-situ*

3) Runoff Calculation

i) Rational Formula

Peak discharge of a flood can be calculated by the rational formula, which explains linear response between discharge (Q) and rainfall intensity as shown below. Rainfall is directly changed to discharge without delay by basin storage function. Therefore, the rational formula is usually used for discharge analysis for medium or small rivers.

$$Q = \frac{1}{3.6} f \cdot r \cdot A \quad \text{.....(5.3.1)}$$



where,

Q	: maximum flood discharge (m^3/s)
f	: dimensionless runoff coefficient
r	: rainfall intensity within time t_c
A	: catchment area (km^2)

ii) Flood Concentration Time

Flood concentration time (t_c) is the sum of inlet time (t_1) and flow time (t_2). Inlet time is a length of time taken to transport a rainfall at the most upstream in a basin to its river channel. Flow time is a length of time taken to discharge a floodwater at the most upstream river channel to a downstream reference point.

$$t_c = t_i + t_f \quad \cdots\cdots (5.3.2)$$

where,

t_i	: inlet time (min)
t_f	: flow time (min)

Inlet time (t_i) was calculated as follows.

(iv) Find the inlet point, catchment area of which is 2 km^2

(v) Set the inlet time as follows.
t_i = 30 (min)

(vi) When the catchment area (A) at the farthest point of the channel is clearly judged to be less than 2 km^2, calculate the inlet time using the following formula.

$$t_i = \frac{30\sqrt{A}}{\sqrt{2}} \quad \cdots\cdots (5.3.3)$$

Flow time (t_f) was calculated by means of Kraven's Formula, which gives relations between riverbed slope and flow velocity shown below.

$$t_f = L \Big/ (V \times 60) \quad \cdots\cdots (5.3.4)$$

where,

L : length of river channel from its outlet point to the farthest point (m)
V : flow velocity (m/s)

Table 5.3-9 Relationship between Riverbed Slope and Flow Velocity

Riverbed Slope (I_b)	I_b > 1/100 (steep slope)	1/100 > I_b > 1/200	I_b < 1/200 (mild slope)
Flow Velocity (V)	3.5 m/s	3.0 m/s	2.1 m/s

iii) Rainfall Intensity Formula

Existing rainfall intensity formula for Damaga observatory shown in Figure 5.3-7 was applied to obtain the value of rainfall intensity (r).

iv) Hyetograph and Runoff Calculation

12-hour centralized hyetograph was used in the runoff calculation. Table 5.3-10 and Table 5.3-11 show examples of calculation results when the following calculation condition is applied.

Calculation Condition

- Rainfall Intensity Formula : Damaga rain gauge station
- Design Scale : Rainfall with 10-year return period
- Catchment Area : 3.4 (km^2)
- Mean Runoff Coefficient : 0.72
- Flood Concentration Time : 30 (min)

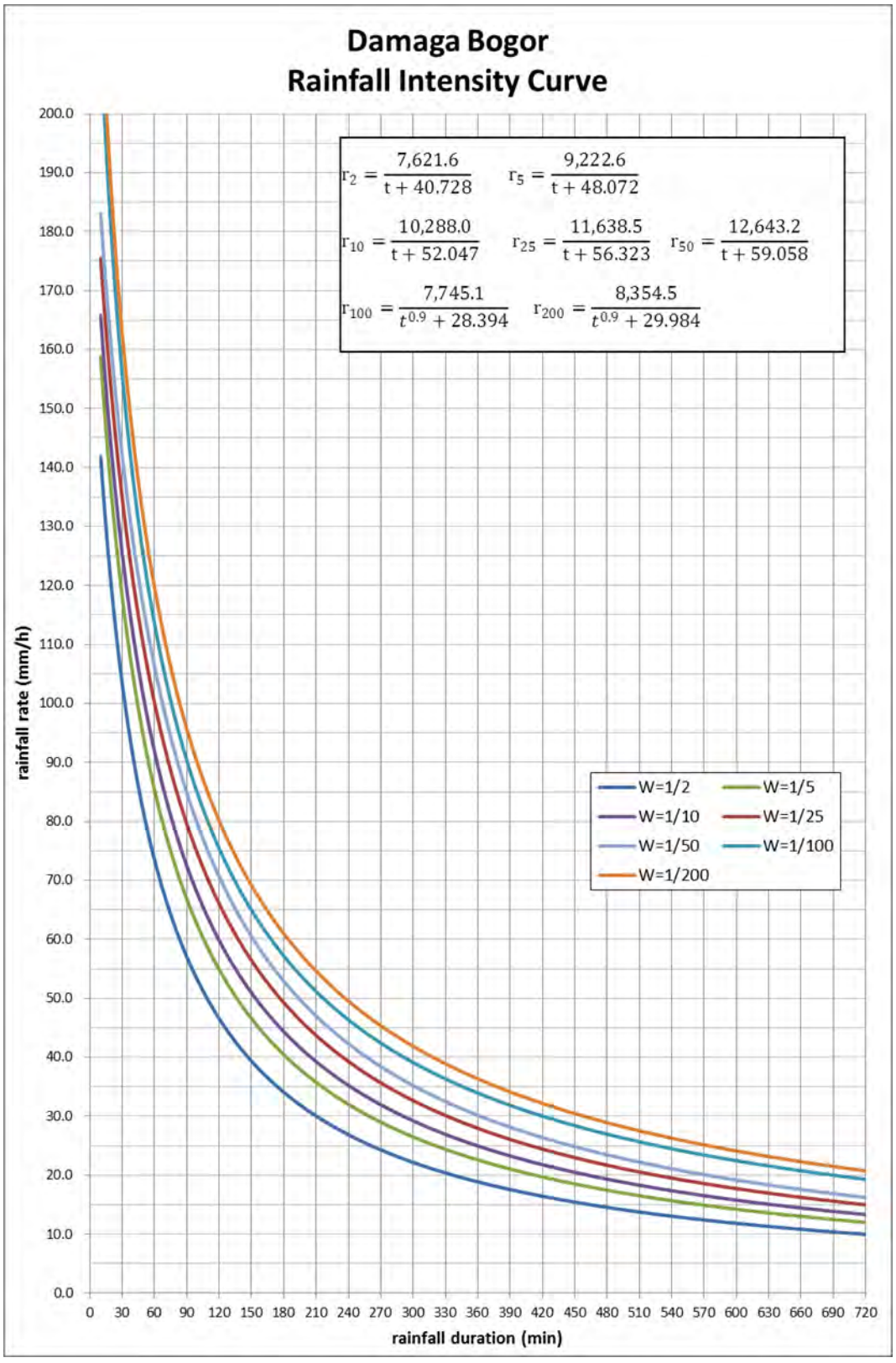


Figure 5.3-7 Rainfall Intensity Formula for Damaga Rain Gauge Station

Table 5.3-10 Example of Hyetograph Calculation Result

n	Duration of rainfall(min) t	Rainfall (mm/hr) r	n・r	Rainfall rate (mm/hr)
0	0	0.00	0.00	0.00
1	30	125.39	125.39	125.39
2	60	91.82	183.64	58.25
3	90	72.43	217.28	33.64
4	120	59.80	239.19	21.91
5	150	50.92	254.59	15.40
6	180	44.34	266.02	11.42
7	210	39.26	274.82	8.81
8	240	35.23	281.82	7.00
9	270	31.95	287.51	5.69
10	300	29.22	292.23	4.72
11	330	26.93	296.21	3.98
12	360	24.97	299.62	3.40
13	390	23.27	302.56	2.94
14	420	21.79	305.12	2.57
15	450	20.49	307.38	2.26
16	480	19.34	309.39	2.00
17	510	18.30	311.18	1.79
18	540	17.38	312.79	1.61
19	570	16.54	314.24	1.45
20	600	15.78	315.56	1.32
21	630	15.08	316.76	1.20
22	660	14.45	317.87	1.10
23	690	13.86	318.88	1.01
24	720	13.33	319.81	0.93

⇒ Sorting

Duration of rainfall(min) t	Rainfall rate (mm/hr)	n before sorting
0	0.00	0
30	0.93	24
60	1.10	22
90	1.32	20
120	1.61	18
150	2.00	16
180	2.57	14
210	3.40	12
240	4.72	10
270	7.00	8
300	11.42	6
330	21.91	4
360	58.25	2
390	125.39	1
420	33.64	3
450	15.40	5
480	8.81	7
510	5.69	9
540	3.98	11
570	2.94	13
600	2.26	15
630	1.79	17
660	1.45	19
690	1.20	21
720	1.01	23

Table 5.3-11 Example of Runoff Calculation Result

Duration of rainfall(min) t	Rainfall rate (mm/hr)	Discharge (m^3/s)	Duration of rainfall(min) t	Rainfall rate (mm/hr)	Discharge (m^3/s)
0	0.00	0.00	390	125.39	85.27
30	0.93	0.64	420	33.64	22.88
60	1.10	0.75	450	15.40	10.47
90	1.32	0.90	480	8.81	5.99
120	1.61	1.09	510	5.69	3.87
150	2.00	1.36	540	3.98	2.71
180	2.57	1.74	570	2.94	2.00
210	3.40	2.31	600	2.26	1.54
240	4.72	3.21	630	1.79	1.22
270	7.00	4.76	660	1.45	0.99
300	11.42	7.77	690	1.20	0.82
330	21.91	14.90	720	1.01	0.69
360	58.25	39.61			

4) Flood Control Calculation

The following equation describing relation (outflow discharge) = (inflow) – (storage) was used for flood control calculation.

$$\frac{V_2}{\Delta t}+\frac{Q_{o2}}{2}=\frac{V_1}{\Delta t}-\frac{Q_{o1}}{2}+Q_{in} \quad \cdots\cdots (4.4.5)$$

where,

V_1 : storage (m^3)
V_2 : storage after Δt (m^3)
Q_{in} : inflow (m^3)
Q_{o1} : outflow discharge in relation to V_1 (m^3)
Q_{o2} : outflow discharge in relation to V_2 (m^3)

Also, outflow discharge was obtained by the following formula.

$$Q = C \cdot B \cdot H^{1.5} \quad \cdots\cdots (4.4.6)$$

where,

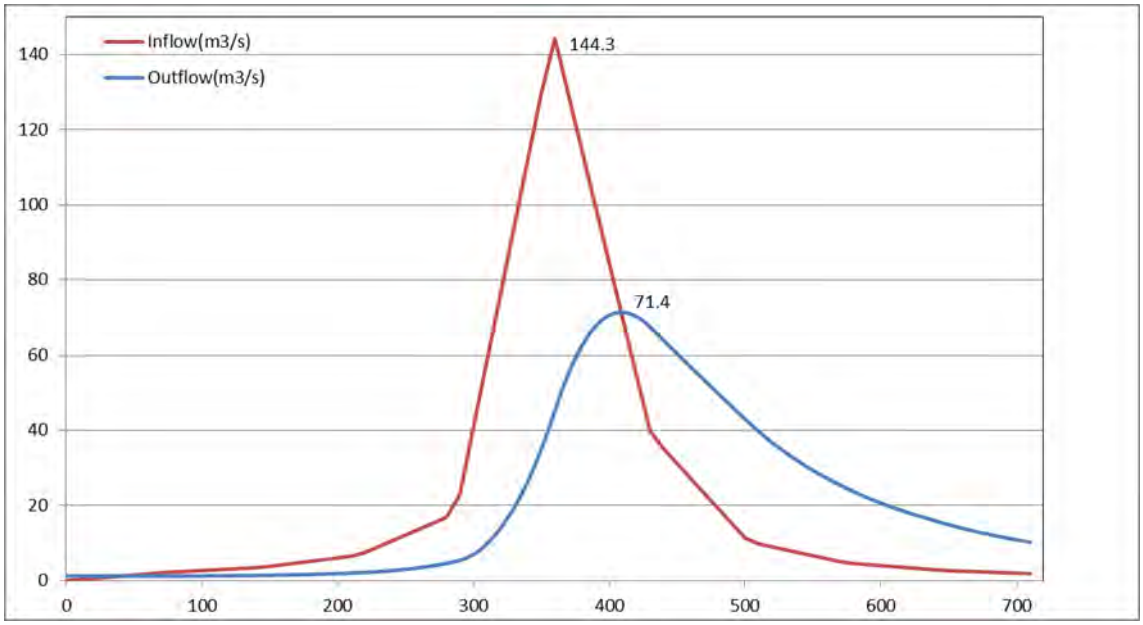
C : overflow coefficient (C = 1.8)
B : overflow width (m)
H : overflow depth (m)
(Overflow depth is obtained from $H - V$ curve.)

(3) Result of Runoff and Flood Control Calculation for Segment 2 (Situ Cikaret)

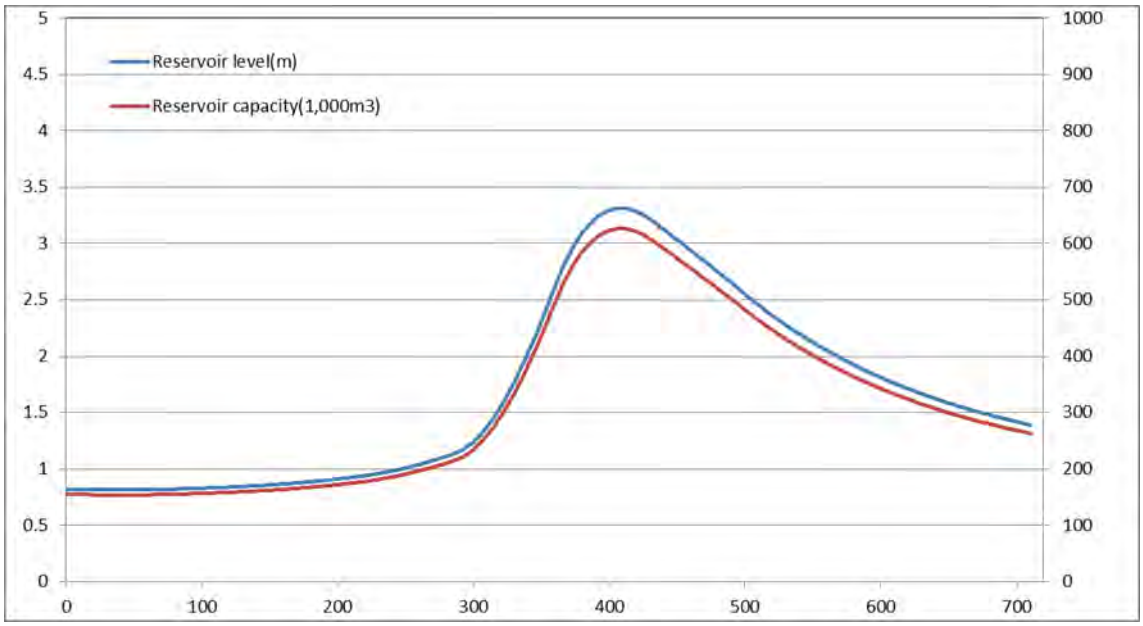
Runoff calculation and flood control calculation for the Segment 2, namely catchment of Situ Cikaret, was carried out using the following calculation condition. Results of those are shown in Figure 5.3-8 and Figure 5.3-9.

Calculation Condition

- Catchment Area : 11.140 (km^2)
- Mean Runoff Coefficient : 0.567
- Flood Concentration Time : 71.8 (min)
- Overflow Width : 9.24 (m)
- Water Area of the *Situ* : 189,089 (m^2)

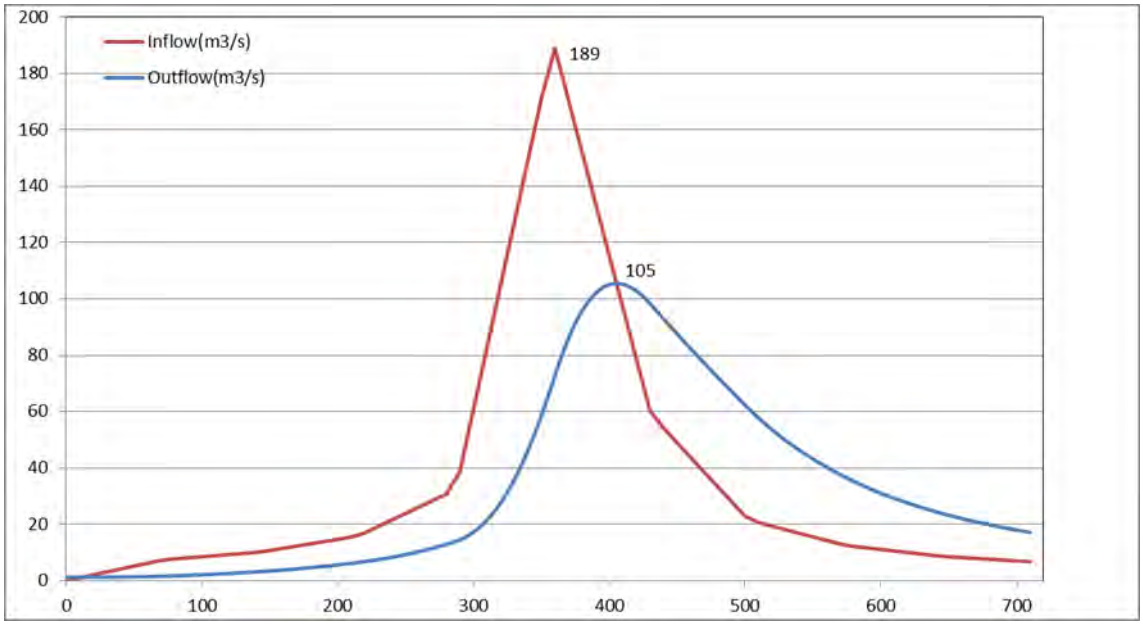


a) Relationship between Inflow and Outflow Discharge

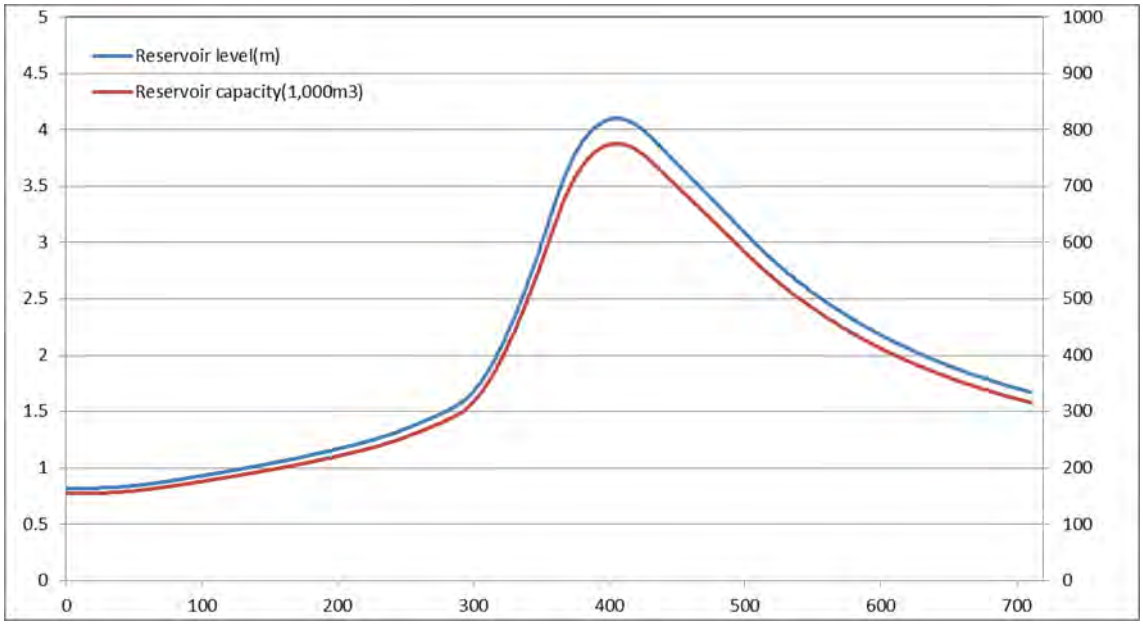


b) Changes in Level and Capacity of *Situ* Water

Figure 5.3-8 Result of Runoff and Flood Control Calculation at Situ Cikaret (w = 1/10)



a) Relationship between Inflow and Outflow Discharge



b) Changes in Level and Capacity of *Situ* Water

Figure 5.3-9 Result of Runoff and Flood Control Calculation at Situ Cikaret (w = 1/200)

(4) Result of Runoff and Flood Control Calculation for Segment 1-1 (Situ Cilodong)

Runoff calculation and flood control calculation for the Segment 1-1, namely catchment of Situ Cilodong, was carried out using the following calculation condition.

Calculation Condition

- Catchment Area : 0.717 (km^2)
- Mean Runoff Coefficient : 0.612
- Flood Concentration Time : 32.6 (min)
- Overflow Width : 2.95 (m)
- Water Area of the *Situ* : 81,056 (m^2)

Regarding the water area, the value as of 2007 was applied because formal value 95,000 m^2 is quite different from actual condition.

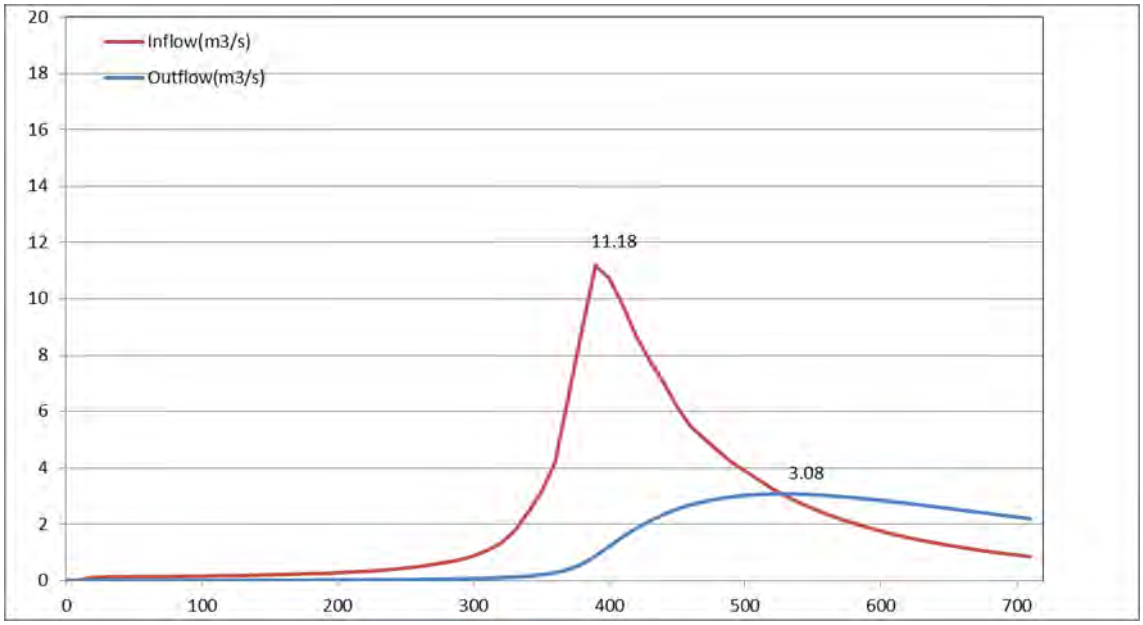
Inflow from Situ Cikaret where is the outside of the catchment was taken into account in the way hereinafter prescribed.

- Since the main irrigation channel with 6.8 m^3/s of discharge capacity from Situ Cikaret diverges in two channels, namely a channel connecting to Situ Cilodong and a channel flowing into the residual basin 1 of Sugutamu. Discharge capacity of those diverged channels was estimated at 3.4 m^3/s each considering current flow area of those. Therefore, inflow through the channel from Situ Cikaret was calculated based on the result of the flood control calculation for Situ Cikaret up to a ceiling of the channel's discharge capacity 3.4 m^3/s.
- Additional value of inflow through the channel from Situ Cikaret and inflow from Situ Cilodong's catchment was used as total inflow to Situ Cilodong.
- 15 minutes of delay time by the channel from Situ Cikaret was considered. Roughness coefficient of the channel was set at 0.017 which is a common value for a channel with concrete revetment and gravel riverbed.

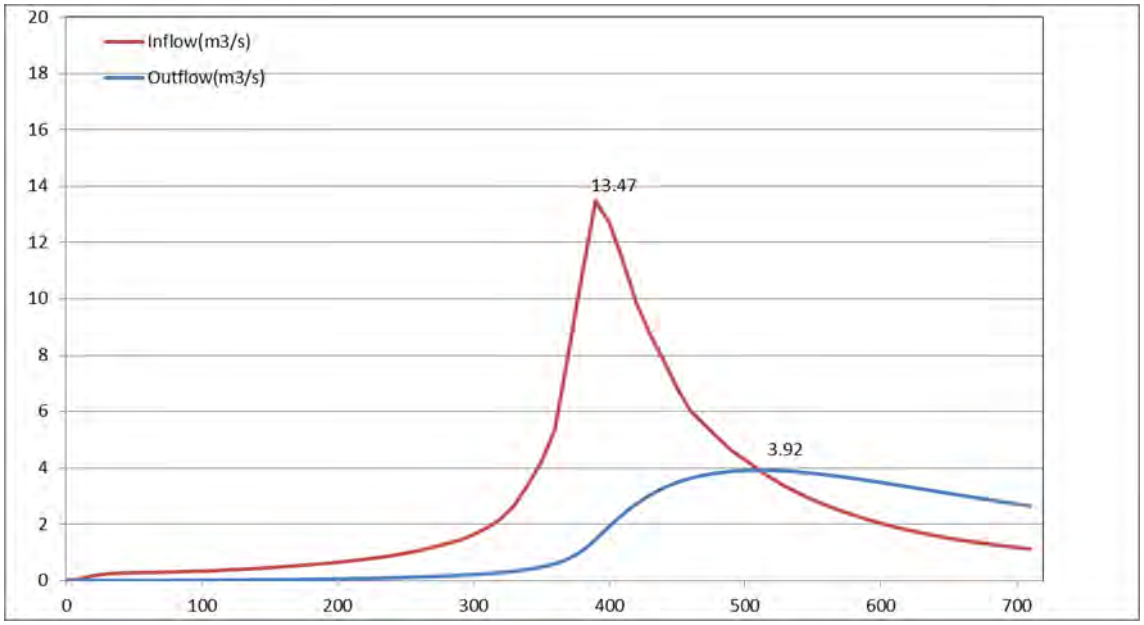
Overflow depth in relation to the peak discharge and flood control effect by Situ Cilodong under present condition are shown below.

Table 5.3-12 Overflow Depth in relation to Peak Discharge at Present Condition

Design Scale		Outflow (w = 1/10)	Outflow (w = 1/200)
Peak Discharge	Q (m^3/s)	3.08	3.92
Overflow Coefficient	C	1.80	1.80
Overflow Width	B (m)	2.95	2.95
Overflow Depth	H (m)	0.70	0.82



a) Relationship between Inflow and Outflow Discharge (w= 1/10)



b) Relationship between Inflow and Outflow Discharge (w= 1/200)

Figure 5.3-10 Flood Control Effect by Situ Cilodong under Present Condition

Existing spillway of Situ Cilodong and design flood level are shown below. The existing spillway can release a floodwater about equal to 10-year return period flood.

5.3.4 Detailed Design

Based on the situ improvement policy discussed in the previous section, the Project carried out topographic survey, detailed design and cost estimation for the existing spillway improvement. Result of those are summarized in the Attachment. Estimated cost for the improvement work is Rp. 168,219,352 (approximately ¥ 1,700,000 in case 1 yen is equal to 100 Indonesia Rupiah).

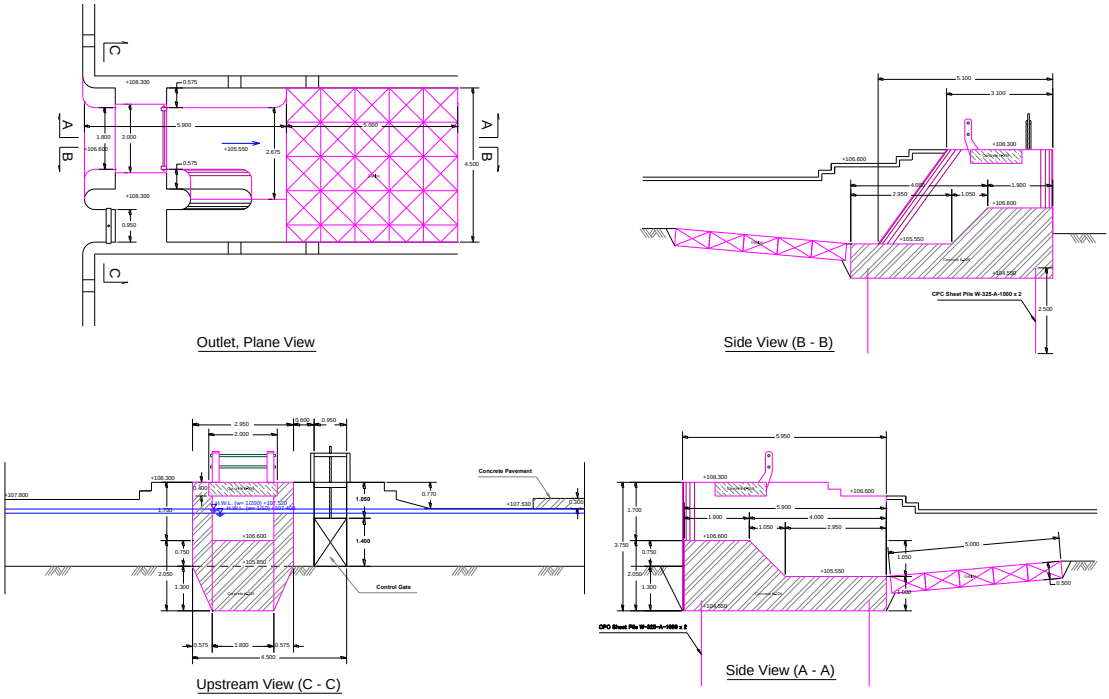


Figure 5.3-11 Improved Spillway of Situ Cilodong

CHAPTER 6 COMPREHENSIVE FLOOD MANAGEMENT IN PILOT SUB-BASIN

6.1 Basic Policy for Comprehensive Flood Management in Pilot Sub-Basin

The basic policies for the comprehensive flood management in the pilot sub-basin of Ciliwung River Basin are as follows.

6.1.1 Design Scale

The design scale is set based on Flood Control Manual (1993) published by the Ministry of Public Works, which is used for the design scale of Ciliwung Main River.

6.1.2 Design Peak Discharge

In the sub-basin of Ciliwung River, the sufficient data of rainfall, water level and flow discharge are not available at present. Thus, the design peak discharge of pilot sub-basin is estimated by Rational Formula at the confluence to Ciliwung River. In addition, inflow volume from other basin through the irrigation channel is considered in the design peak discharge by identifying the flow capacity of inflow channel and setting the flood inflow volume. Moreover, outflow volume to other basin is taken into account to design peak discharge by recognizing the diverted volume in the flood.

6.1.3 Evaluation of Runoff Control Effect in Sub-Basin

Assuming that the rainfall amount to be infiltrated shown in the section 1.4 can be cut by rainwater storage and infiltration facility in the basin, the peak discharge volume at confluence to Ciliwung River is estimated in consideration of base cut amount of rainfall. The difference between the design peak discharge and peak discharge volume with base cut is evaluated as runoff control effect in the basin. Besides, the design scale in sub-basin is set as 10 years probable rainfall which is comparatively high frequency of rainfall. Therefore, the control volume of runoff control facility in sub-basin is maintained as a margin against the excess flood, and it is not considered in the flood control effect for the comprehensive flood management in pilot sub-basin.

6.1.4 Improvement of Pond (*Situ*)

The flood control effects of existing ponds (*Situ*) are taken into account in the CFM of sub-basin. In order to improve the current flood control effects, the possibility for *Situ* improvement is examined. The flood control effects of *Situ* before improvement are evaluated by flood control calculation.

6.1.5 River Improvement

The riverbed gradient will be stable for a long time. Therefore, the design riverbed gradient is determined based on the current average riverbed gradient. Since the vertical direction excavation will cause the remarkable increase of water level at inflow points to Ciliwung River and *Situ*, it shall be avoided as long as possible, and the widening of river course is considered as the principle method for river improvement. In this case, in order to avoid the expansion of inundation damage in the surrounding areas of the river course, the river width shall be determined by securing that the high water level is lower than the elevation of surrounding areas.

If the freeboard is set during the river section without the dike, inundation risk will be higher in the section with the dike. Thus, the freeboard shall not be set during the river section without dike for considering the safety.

6.2 Case Study in Pilot Sub-basin

Based on the above policies, the case study of the comprehensive flood management is conducted in Sugutamu basin as pilot sub-basin.

6.2.1 Situation of Pilot Sub-basin

- Pilot Sub-basin : Sugutamu Sub-basin at the middle of the Ciliwung River Basin
- Basin Area : A= 13.23 km^2
- Major *Situ-Situ* : Situ Cilodong at middle-stream and Situ Sidomukti at downstream
- Inflow from other Basin : There is the channel flowing into Situ Cilodong from Situ Cikaret

Table 6.2-1 Specification of Sugutamu Sub-basin

Tributary	Catchment area (km^2)	Channel lenght (km)	Slope (1/*n*)	Flood consentration time (min)
Sugutamu	13.231	13.74	201	139.0

Table 6.2-2 Land Use and Applied Runoff Coefficient

Surface Characteristic	Area(km^2) (a)	Runoff coefficient (f)	(a)×(f)
Urban	9.661	0.80	7.729
Settlement	2.490	0.50	1.245
Upland Crops	0.000	0.30	0.000
Paddy Field	0.030	0.10	0.003
Open Space	0.250	0.35	0.088
Forest	0.000	0.30	0.000
Road	0.640	0.65	0.416
Water	0.110	1.00	0.110
Total	13.181		9.590
Average		0.728	

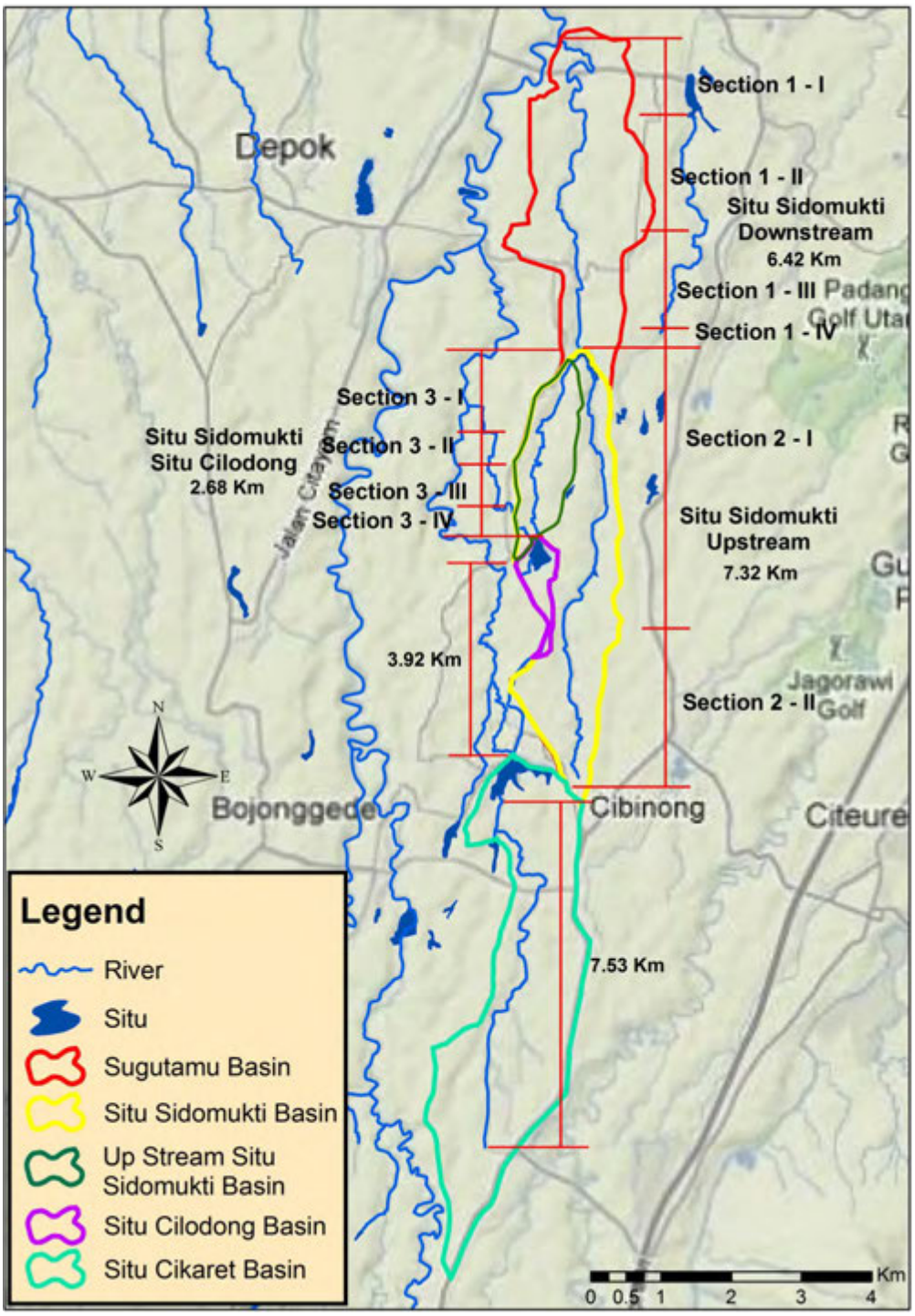


Figure 6.2-1 River Section of Sugutamu Sub-Basin

6.2.2 Condition on Design Discharge Calculation

a) Design Scale : Rainfall with 10-year return period

b) Runoff Calculation Method : Rational Formula

c) Rainfall Intensity : Rainfall intensity formula at Damaga Bogor observatory near the pilot sub-basin

d) Runoff Coefficient : Average runoff coefficient in the basin considering the land use condition

e) Inflow from the other Sub-Basin :

Inflow from Situ Cikaret through the irrigation channel was taken into account considering flow capacity of the channel.

f) Outflow to the other Basin :

Outflow volume from Situ Cilodong to other basin is small, so that the flood discharge from Situ Cilodong is considered to inflow to Sugutamu basin. The outflow to the other basin is not included.

6.2.3 Outline of Case Study Results

- Since the current river course does not have sufficient flow capacity against the design scale of flood, the significant river improvement is required in all the river section.
- In case of the above river improvement, since the flood flow will not overflow but flow to the downstream, it is recognized that the inflow volume to Situ Sidomukti will increase, and the flood flow will overflow the dike of *Situ* causing the dike break. Originally, *Situ* is established for the water use, so that the scale of *Situ* is not consistent with the river basin area. As measures against overflow, it is necessary to determine the necessary measures including;
  a) Removal of *Situ*,
  b) Reconstruction of *Situ* as a dam,
  c) Construction of bypass channel.

- Through the installation of rainwater storage and infiltration facilities with targeted volume in Sugutamu basin, the flood control effect against 10 years design flood at confluence to Ciliwung River is expected as 7.4 m^3/s (equivalent to 5.3 % of design peak discharge).

6.2.4 Runoff Calculation

(1) Methodology

Runoff calculation model for Sugutamu sub-basin is shown below. Inflow from Situ Cikaret in Cikumpa sub-basin is taken into account.

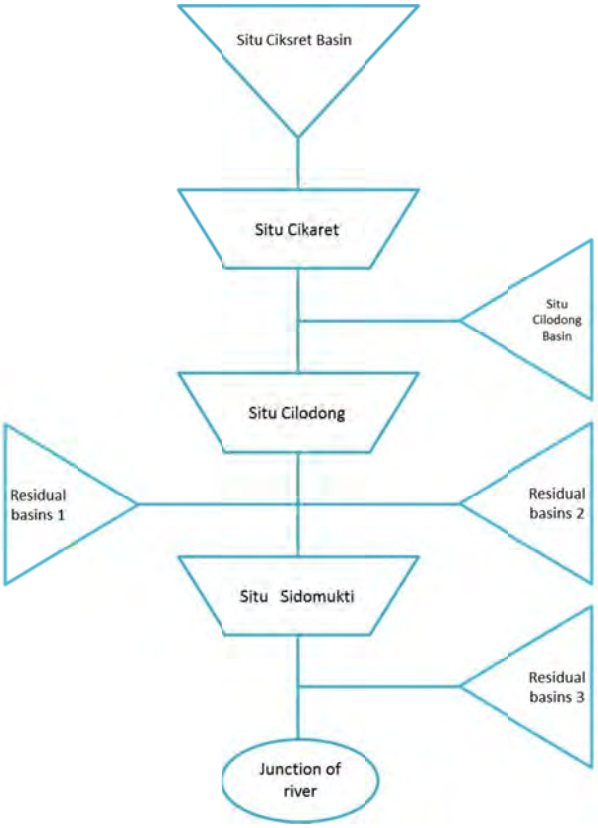


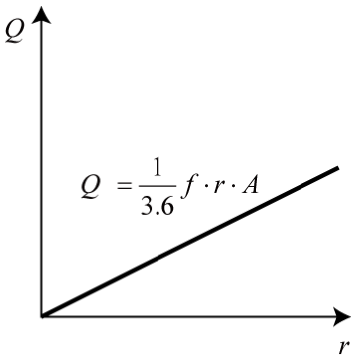
Figure 6.2-2 Runoff Calculation Model

(2) Runoff Calculation

1) Rational Formula

Peak discharge of a flood can be calculated by the rational formula, which explains linear response between discharge (Q) and rainfall intensity as shown below. Rainfall is directly changed to discharge without delay by basin storage function. Therefore, the rational formula is usually used for discharge analysis for medium or small rivers.

$$Q = \frac{1}{3.6} f \cdot r \cdot A \quad \text{.....(6.2.1)}$$



where,

Q	: maximum flood discharge (m^3/s)
f	: dimensionless runoff coefficient
r	: rainfall intensity within time t_c
A	: catchment area (km^2)

2) Flood Concentration Time

Flood concentration time (t_c) is the sum of inlet time (t_i) and flow time (t_f). Inlet time is a length of time taken to transport a rainfall at the most upstream in a basin to its river channel. Flow time is a length of time taken to discharge a floodwater at the most upstream river channel to a downstream reference point.

$$t_c = t_i + t_f \quad \cdots\cdots (6.2.2)$$

where,

t_i : inlet time (min)
t_f : flow time (min)

Inlet time (t_i) was calculated as follows.

(vii) Find the inlet point, catchment area of which is 2 km^2

(viii) Set the inlet time as follows.
t_i = 30 (min)

(ix) When the catchment area (A) at the farthest point of the channel is clearly judged to be less than 2 km^2, calculate the inlet time using the following formula.

$$t_i = \frac{30\sqrt{A}}{\sqrt{2}} \quad \cdots\cdots (6.2.3)$$

Flow time (t_f) was calculated by means of Kraven's Formula, which gives relations between riverbed slope and flow velocity shown below.

$$t_f = L \Big/ (V \times 60) \quad \cdots\cdots (6.2.4)$$

where,

L : length of river channel from its outlet point to the farthest point (m)
V : flow velocity (m/s)

Table 6.2-3 Relationship between Riverbed Slope and Flow Velocity

Riverbed Slope (I_b)	I_b > 1/100 (steep slope)	1/100 > I_b > 1/200	I_b < 1/200 (mild slope)
Flow Velocity (V)	3.5 m/s	3.0 m/s	2.1 m/s

3) Rainfall Intensity Formula

Existing rainfall intensity formula for Damaga Bogor observatory shown below was applied to obtain the value of rainfall intensity (r).

4) Hyetograph and Runoff Calculation

12-hour centralized hyetograph was used in the runoff calculation.

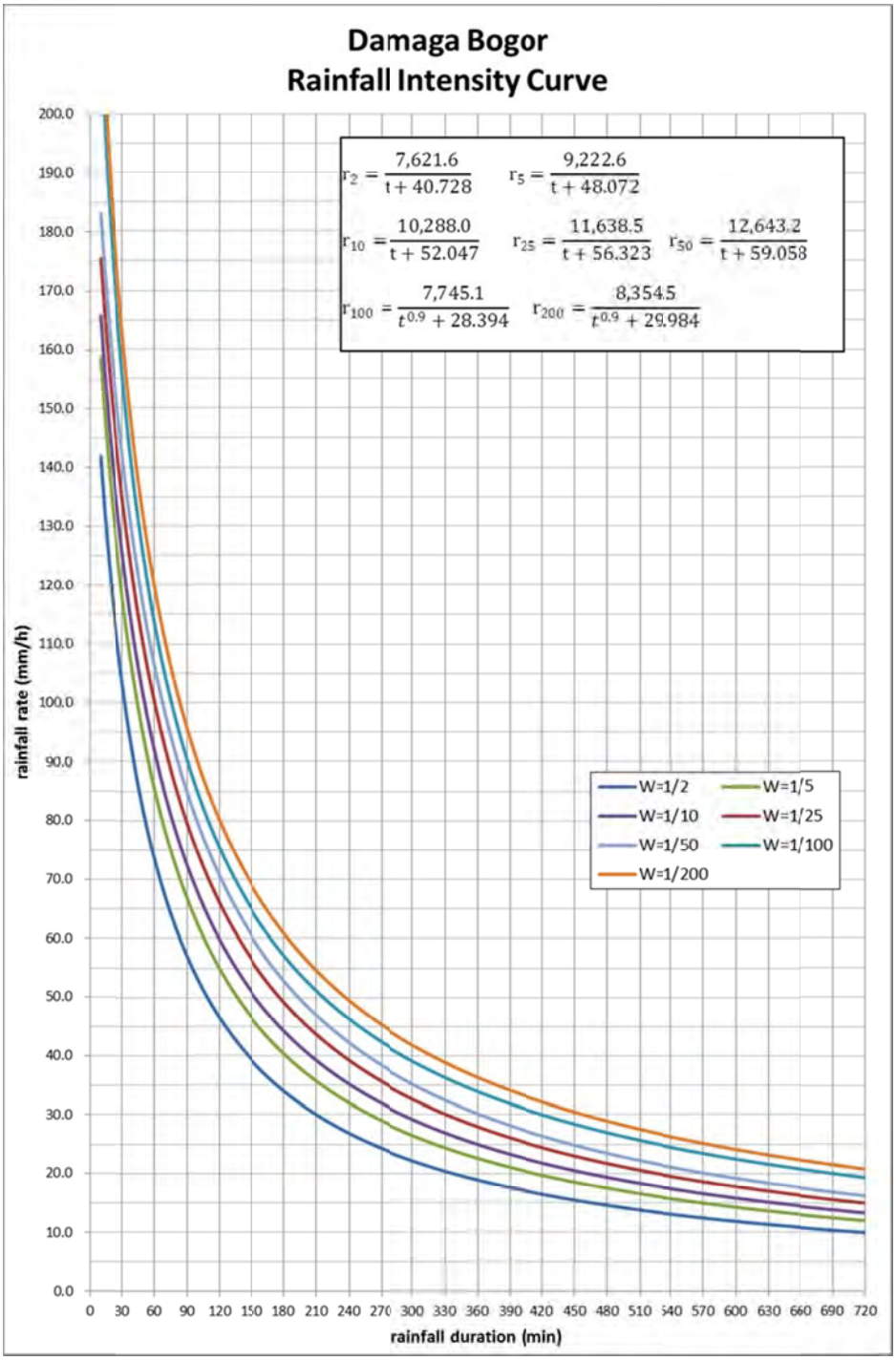


Figure 6.2-3 Rainfall Intensity Formula for Damaga Bogor Rain Gauge Station

(3) Flood Control Calculation

The following equation describing relation (outflow discharge) = (inflow) – (storage) was used for flood control calculation.

$$\frac{V_2}{\Delta t} + \frac{Q_{o2}}{2} = \frac{V_1}{\Delta t} - \frac{Q_{o1}}{2} + Q_{in} \quad \cdots\cdots (6.2.5)$$

where,

V_1 : storage (m^3)
V_2 : storage after Δt (m^3)
Q_{in} : inflow (m^3)
Q_{o1} : outflow discharge in relation to V_1 (m^3)
Q_{o2} : outflow discharge in relation to V_2 (m^3)

Also, outflow discharge was obtained by the following formula.

$$Q = C \cdot B \cdot H^{1.5} \quad \cdots\cdots (6.2.6)$$

where,

C : overflow coefficient (C = 1.8)
B : overflow width (m)
H : overflow depth (m)
(Overflow depth is obtained from $H - V$ curve.)

(4) Result of Runoff Control Calculation

Peak flood discharges of every return period at major reference points are shown below.

Table 6.2-4 Runoff Calculation Result

Return period	Situ Cilodong		Situ Sidomukti			Janction of Ciliwung
	Inflow	Outflow	Inflow from Situ Cilodong	Infolw from Residual Basins1	Outflow	
2	6.7	2.4	14.7	40.9	55.6	110.2
5	7.4	2.7	17.1	47.5	64.7	128.1
10	7.9	3.0	18.7	51.9	70.6	140.0
25	8.4	3.2	20.8	57.4	78.2	154.9
50	8.8	3.4	22.3	61.5	83.8	166.0
100	9.3	3.9	24.1	65.9	90.0	178.0

6.2.5 Current Flow Capacity

Current flow capacity of river courses was calculated by means of non-uniform flow calculation under the following conditions

- Conditions for non-uniform flow calculation
  - Water level at the downstream end : Normal depth
  - Discharge at the upstream end : 10 cases in consideration of river condition
  - Roughness coefficient : n= 0.028
- Conditions for flow capacity calculation
  - Evaluated by means of discharge rating curve in consideration of existing bank height
  - Discharge rating curve was calculated by means of least square method with the result of non-uniform flow calculation

The followings are summary of flow capacity calculation result

- Section 1: Confluence with the Ciliwung River ~ Situ Sidomukti
  Except for the section with 1.2 km from the downstream end, existing river course does not have sufficient flow capacity against 140 m^3/s of design flood discharge.
- Section 2: Situ Sidomukti ~ Upstream end
  All of river sections do not have sufficient flow capacity against 52 m^3/s of design flood discharge.

- Section 3: Situ Sidomukti ~ Situ Cilodong

  All of river sections do not have sufficient flow capacity against 19 m^3/s of design flood discharge.

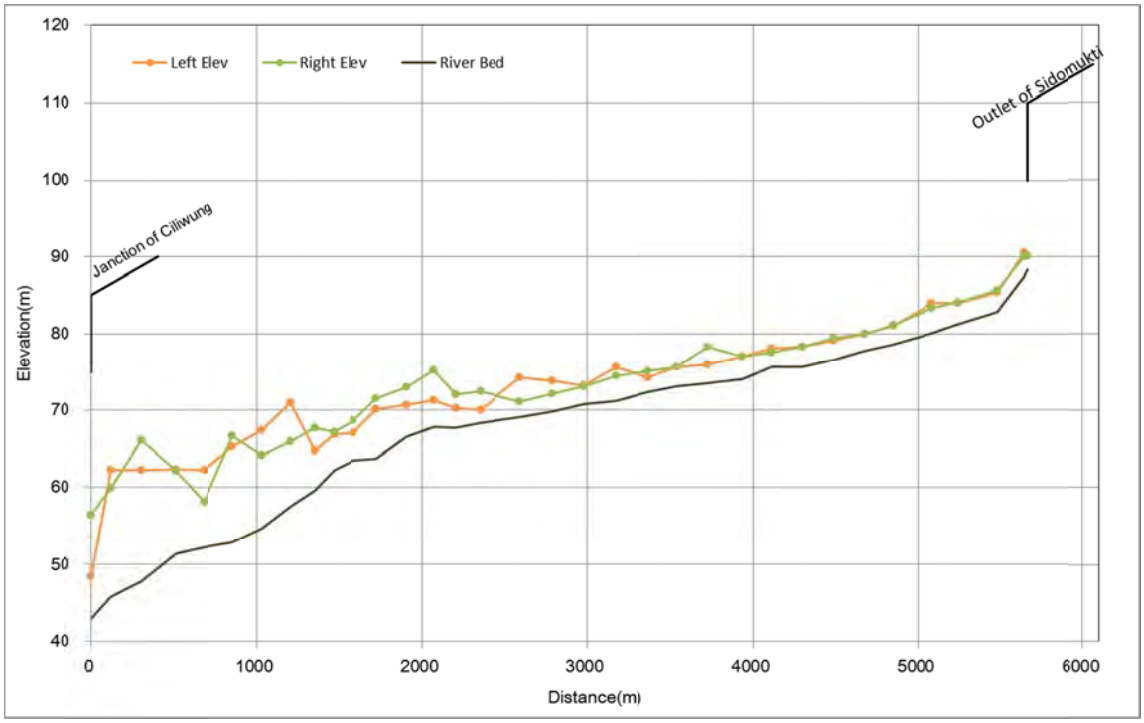


Figure 6.2-4 Longitudinal Profile (Confluence with Ciliwung River ~ Outlet of Situ Sidomukti)

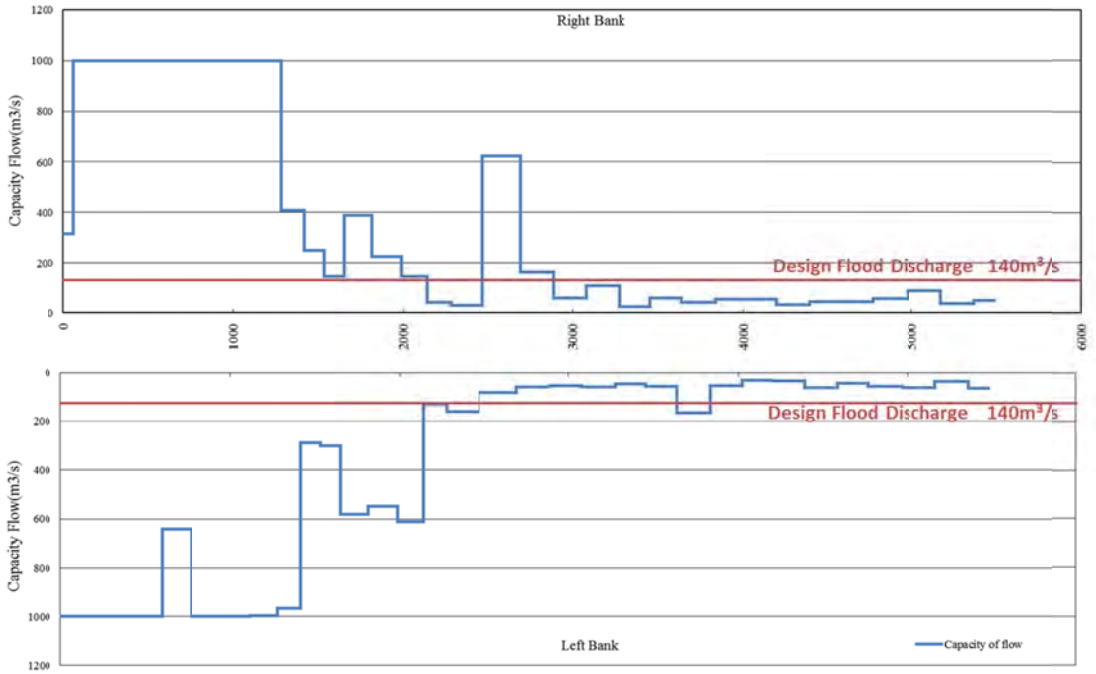


Figure 6.2-5 Flow Capacity (Confluence with Ciliwung River ~ Outlet of Situ Sidomukti)

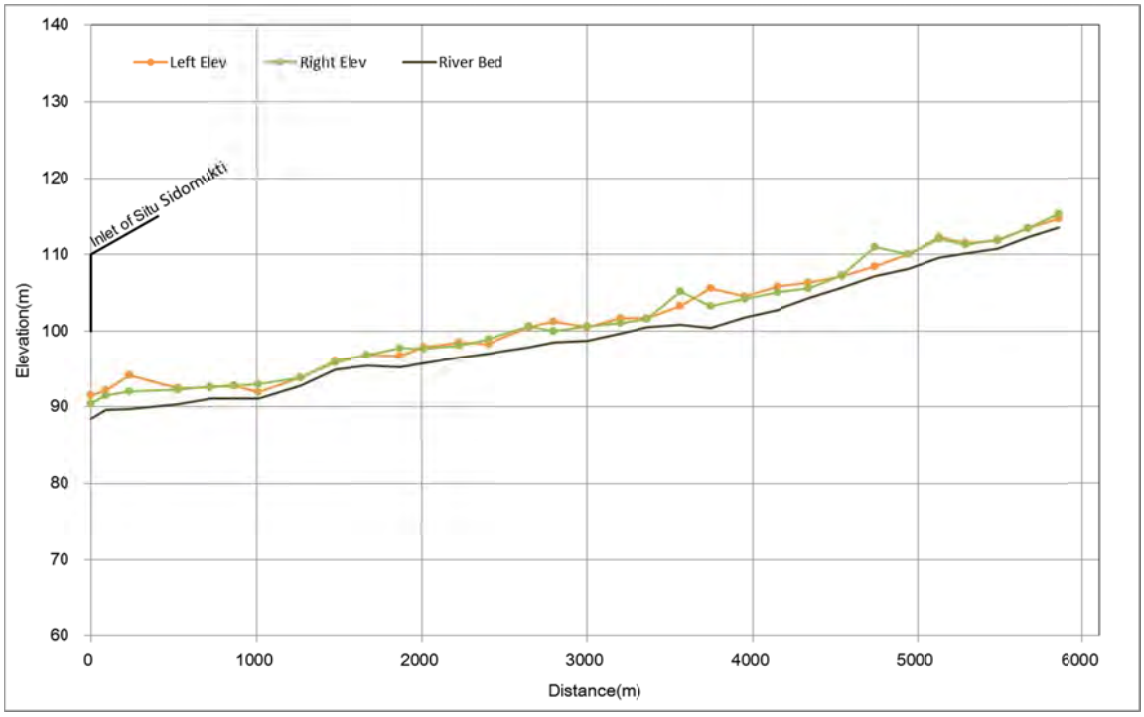


Figure 6.2-6 Longitudinal Profile (Inlet of Situ Sidomukti ~ Upstream End)

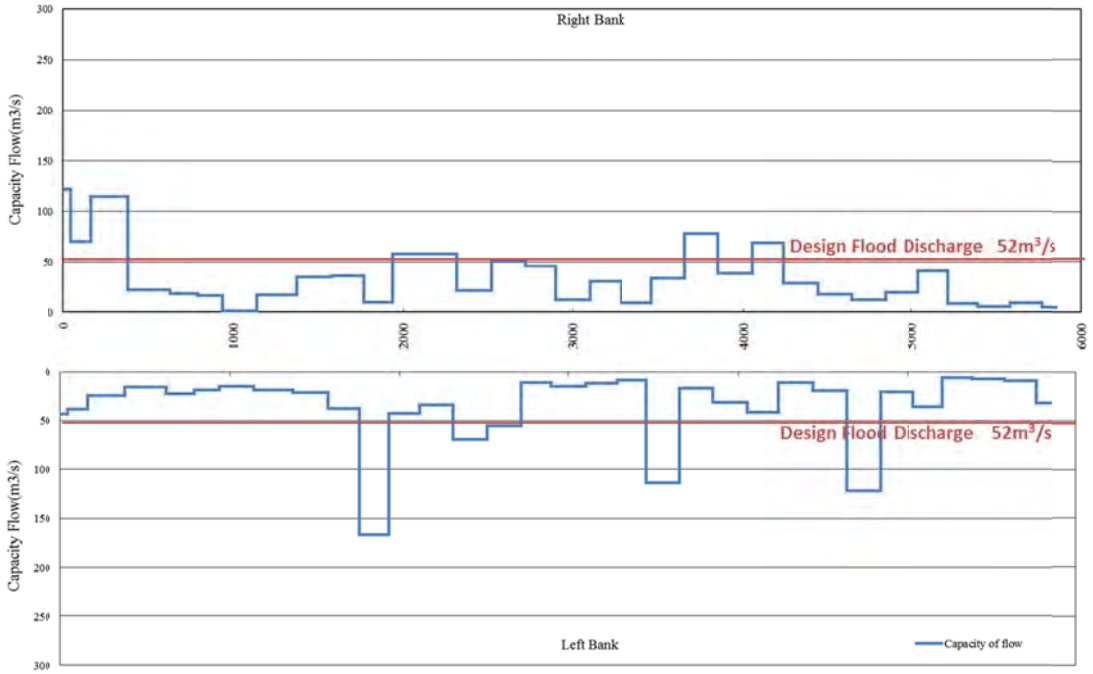


Figure 6.2-7 Flow Capacity (Inlet of Situ Sidomukti ~ Upstream End)

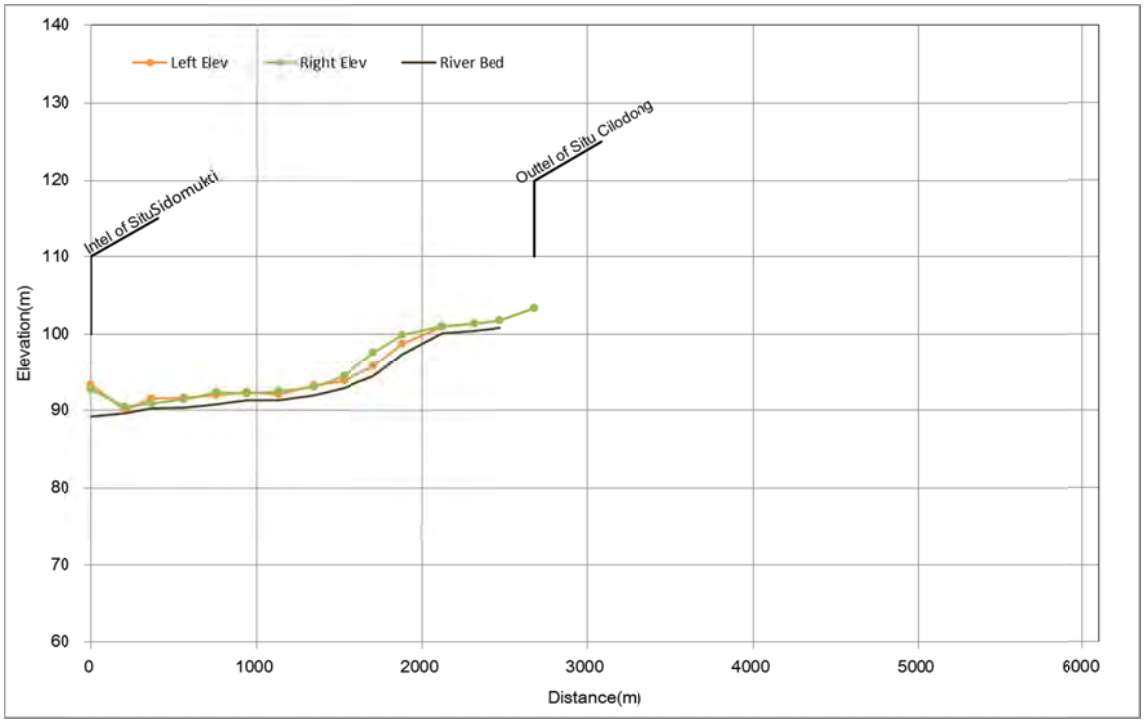


Figure 6.2-8 Longitudinal Profile (Inlet of Situ Sidomukti ~ Situ Cilodong)

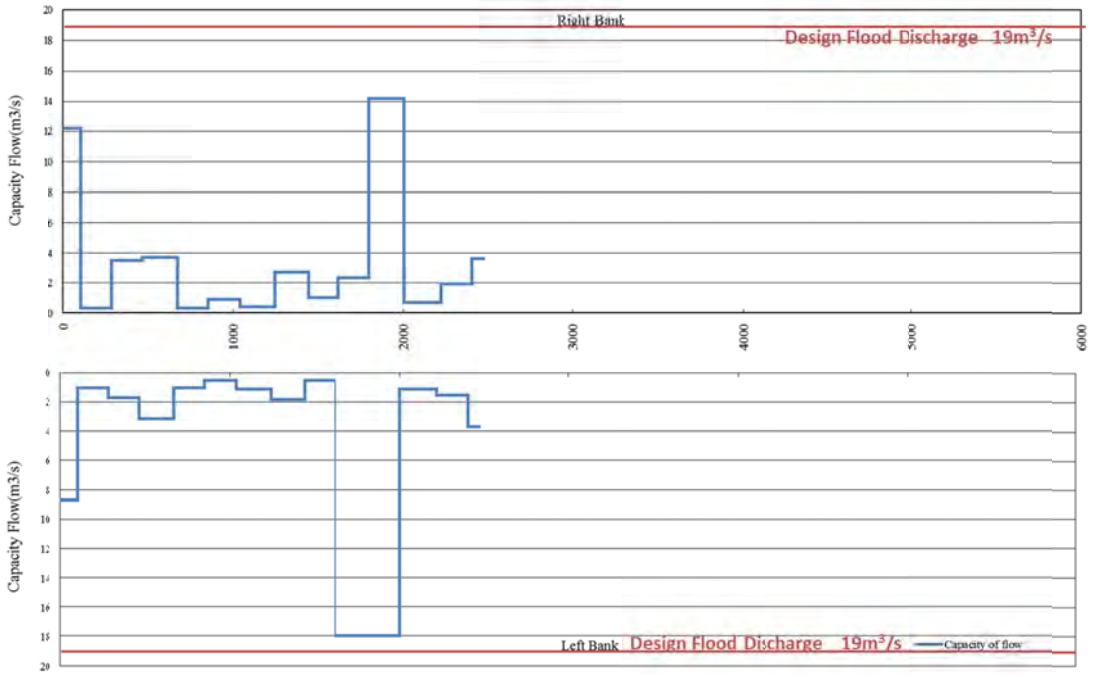


Figure 6.2-9 Flow Capacity (Inlet of Situ Sidomukti ~ Situ Cilodong)

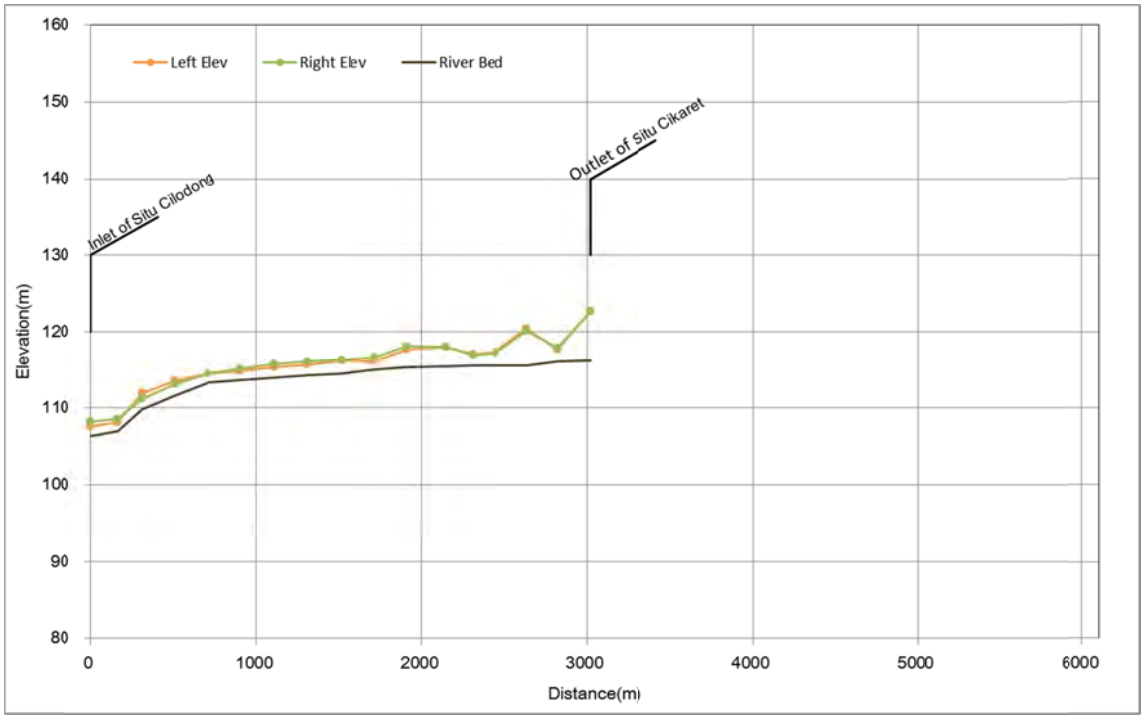


Figure 6.2-10 Longitudinal Profile (Inlet of Situ Cilodong ~ Situ Cikaret)

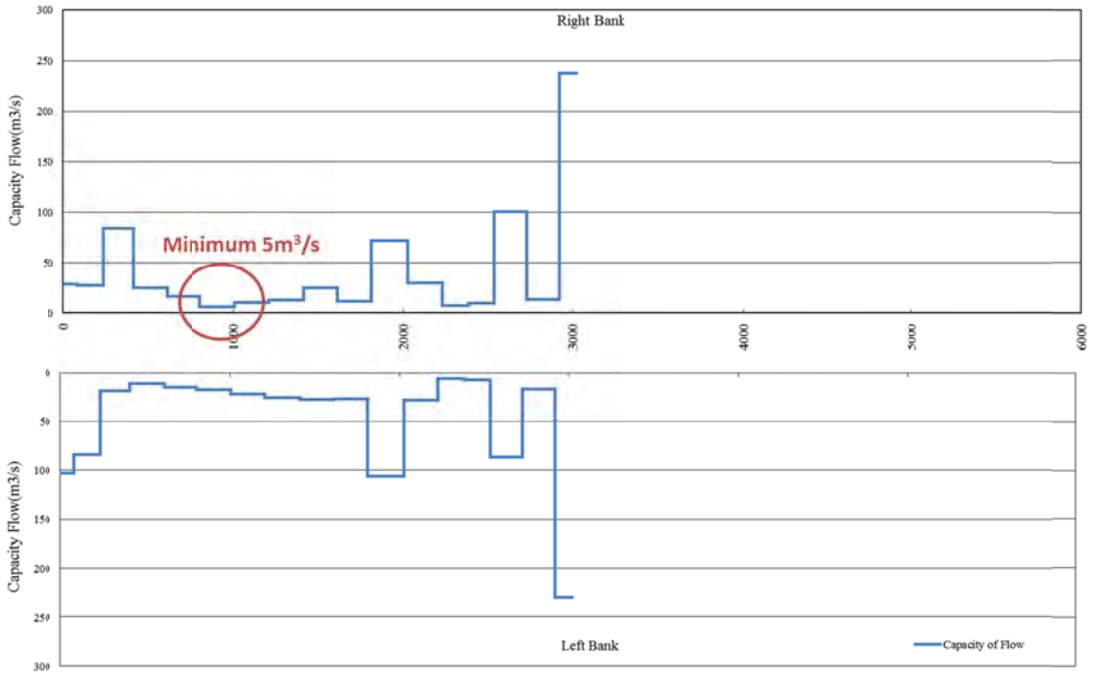


Figure 6.2-11 Flow Capacity (Inlet of Situ Cilodong ~ Situ Cikaret)

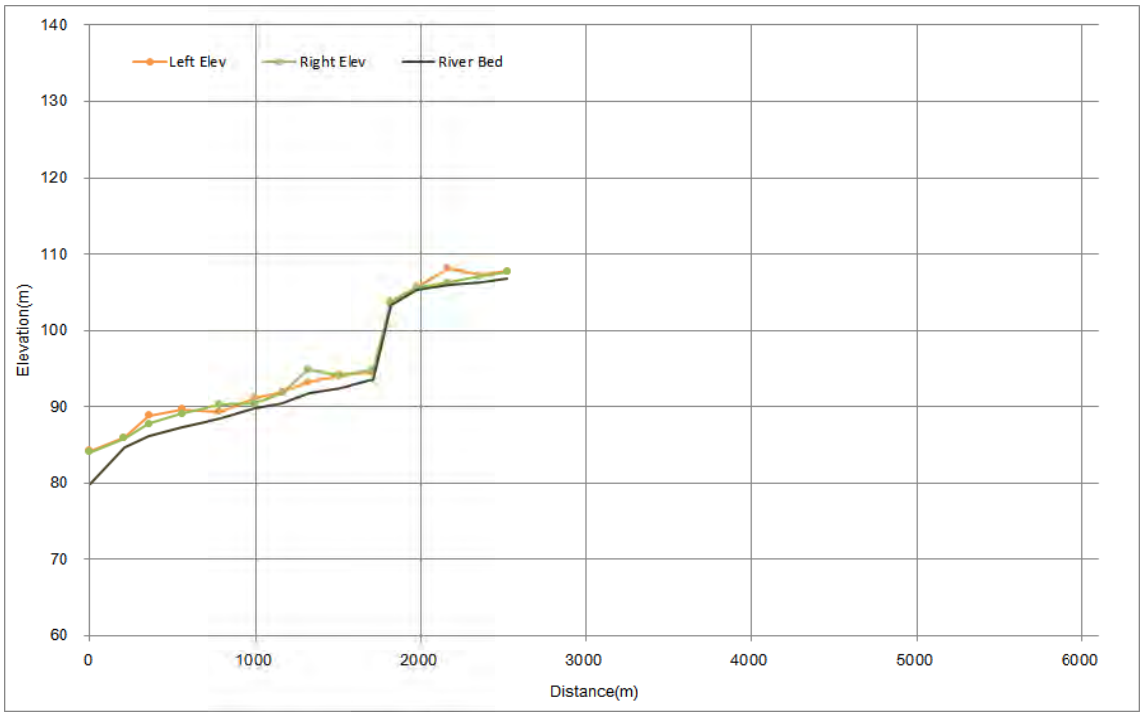


Figure 6.2-12 Longitudinal Profile (Outlet of Situ Cilodong ~ Irrigation Channel)

Figure 6.2-13 Flow Capacity (Outlet of Situ Cilodong ~ Irrigation Channel)

6.2.6 River Channel Planning

River channel planning was carried out based on the following concepts.

a) Design riverbed gradient is determined based on the current average riverbed gradient.

b) Since river improvement by vertical excavation may cause the remarkable increase of water level at inflow points to the Ciliwung River and *Situ*, it shall be avoided as long as possible, and the widening of river course is considered as the principle method for river improvement.

c) In this case, in order to avoid the expansion of inundation damage in the surrounding areas of the river course, the river width shall be determined by securing that the high water level becomes lower than the elevation of surrounding areas.

d) If the freeboard is set during the river section without the dike, inundation risk will be higher in the section with the dike. Thus, the freeboard shall not be set during the river section without dike for considering the safety.

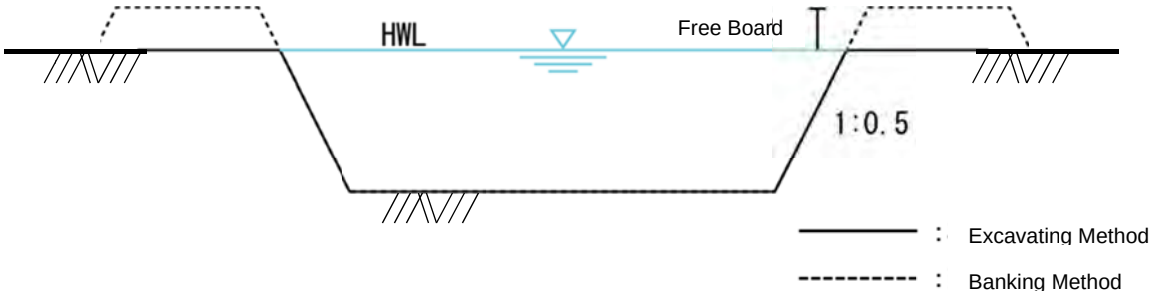


Figure 6.2-14 Cross-sectional River Improve Method

The followings are proposed cross-sectional and longitudinal channel shape

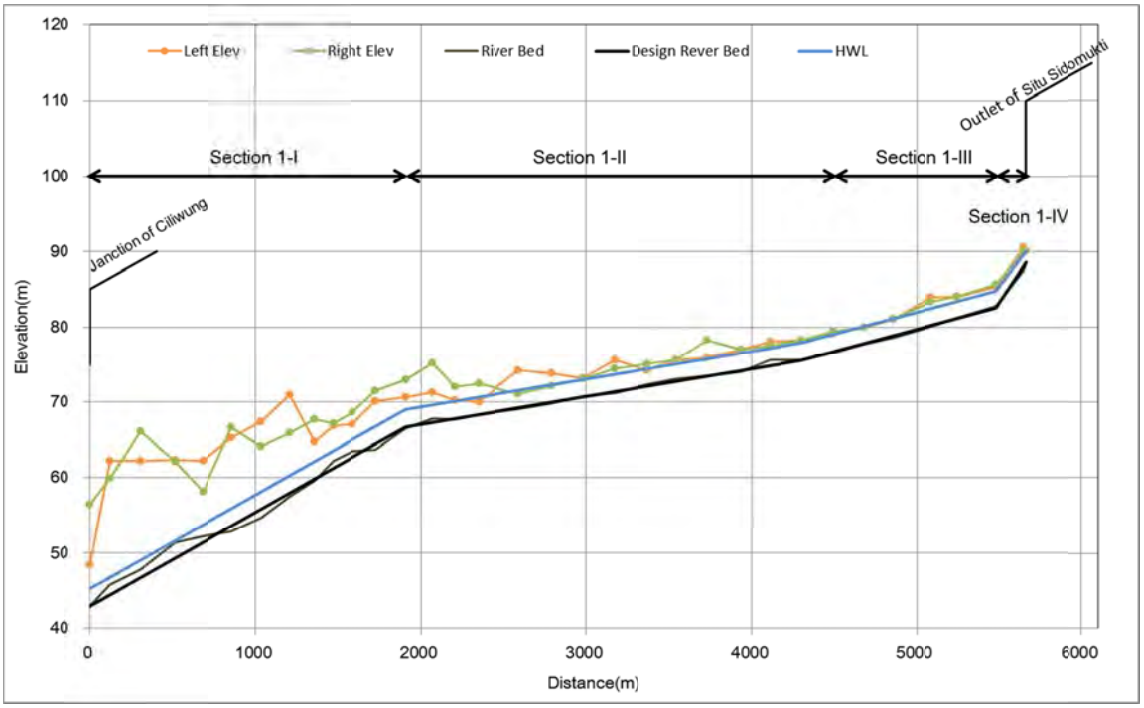


Figure 6.2-15 Longitudinal Profile (Confluence with Ciliwung River ~ Outlet of Situ Sidomukti)

Section	Design Discharge (m^3/s)	Slope of River Bed	Coeffcient of Roughness	River width (m)	Depth (m)
1-I	140	1/80	0.028	16.5	2.5
1-II		1/270			
1-III		1/170		13.5	
1-IV		1/30		12.0	1.5

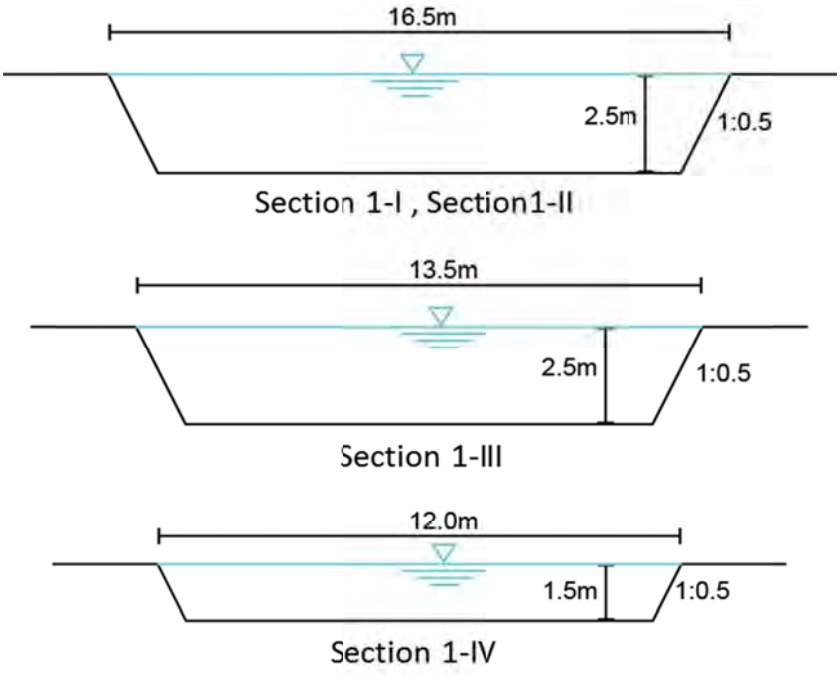


Figure 6.2-16 Cross-sectional Shape (Confluence with Ciliwung River ~ Outlet of Situ Sidomukti)

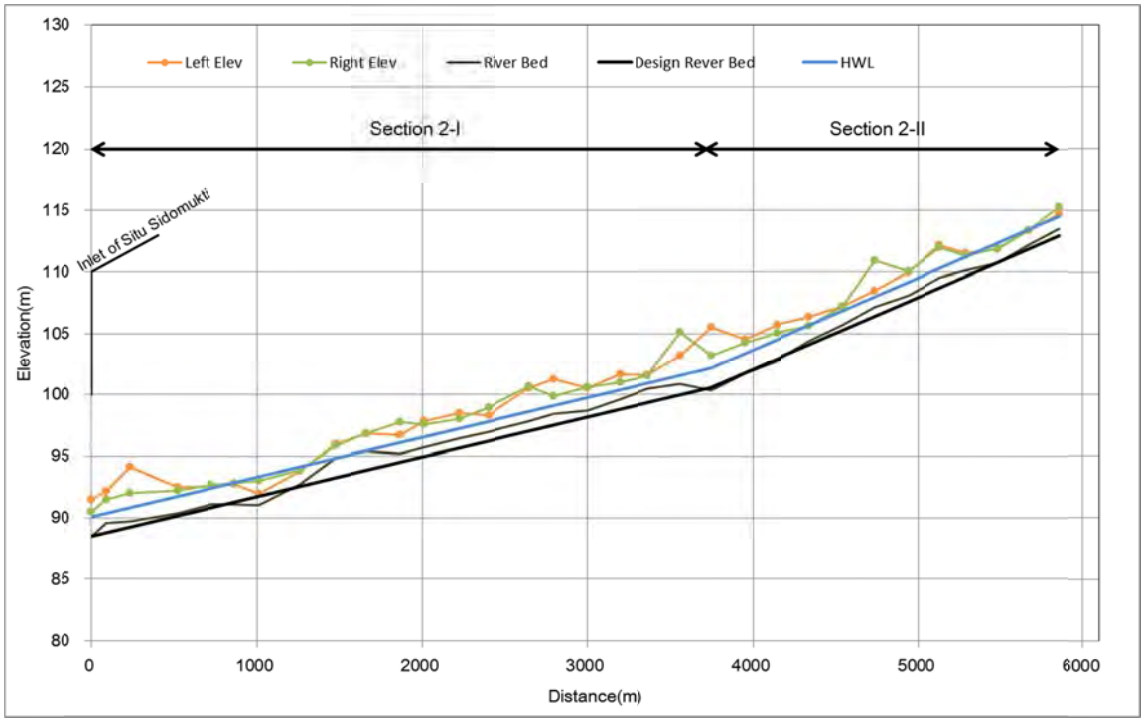


Figure 6.2-17 Longitudinal Profile (Inlet of Situ Sidomukti ~ Upstream End)

Section	Design Discharge (m^3/s)	Slope of River Bed	Coeffcient of Roughness	River width (m)	Depth (m)
2-I	52	1/310	0.028	13.1	1.6
2-II		1/170		10.1	

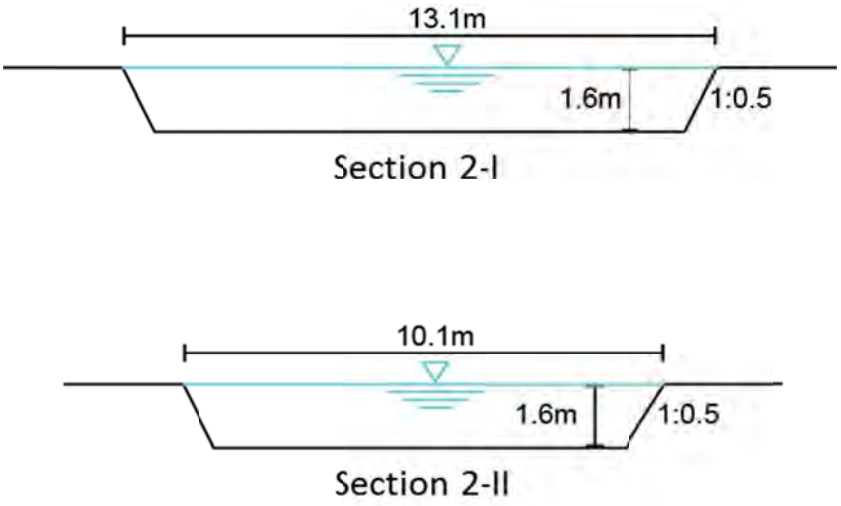


Figure 6.2-18 Cross-sectional Shape (Inlet of Situ Sidomukti ~ Upstream End)

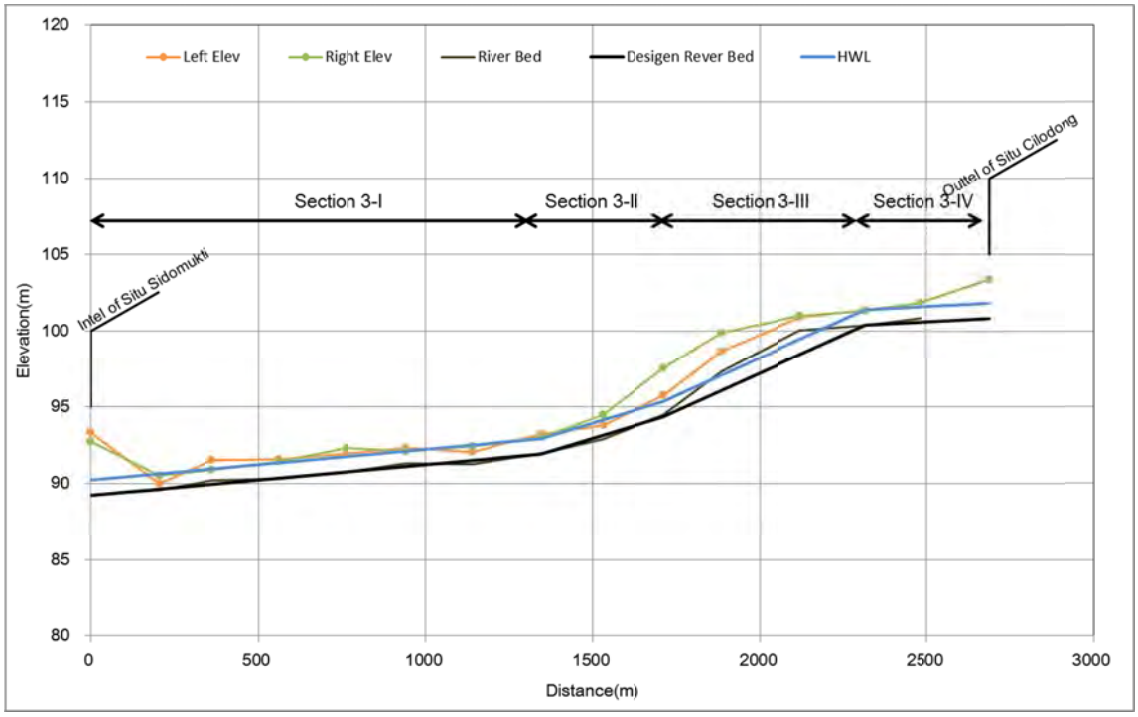


Figure 6.2-19 Longitudinal Profile (Inlet of Situ Sidomukti ~ Situ Cilodong)

Section	Design Discharge (m^3/s)	Slope of River Bed	Coefficient of Roughness	River width (m)	Depth (m)
3-I	19	1/500	0.028	12.0	1.0
3-II		1/150		7.0	
3-III		1/100		6.0	
3-IV		1/400		11.0	

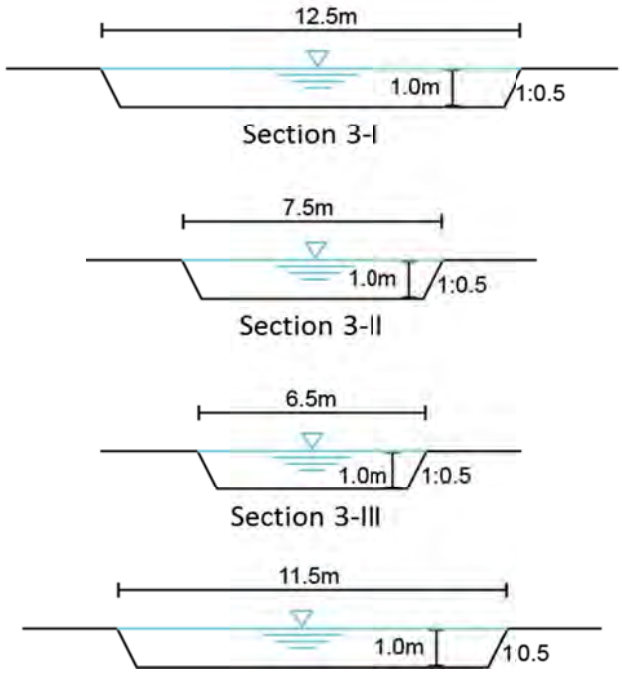


Figure 6.2-20 Cross-sectional Shape (Inlet of Situ Sidomukti ~ Situ Cilodong)

6.2.7 How to Improve *Situ-Situ*

(1) Situ Sidomukti

Originally, *Situ-situ* were established only for irrigation use, so that capacity of *Situ* is not consistent with discharge in flood times. Situ Sidomukti also cannot release total 70.6 m^3/s of design flood discharge at this moment. Most of the design flood discharge may overtop on the earth dike at the time of the design flood. Therefore, flood control function of Situ Sidomukti was not taken into account in calculation of the design flood discharge.

In order to cope with the lack of capacity, the following countermeasures can be considered.

a) Removal of the *Situ*
b) Reconstruction of the *Situ* as a dam
c) Construction of bypass channel

In order to avoid the discharge concentration to Situ Sidomukti, normalization work for upstream river courses from Situ Sidomukti needs to be implemented after the completion of the countermeasures for the *Situ*.

(2) Situ Cilodong

1) Addition of Spillway for Safety Improvement

In order to avoid inundation from the existing irrigation channel from Situ Cilodong, a new spillway needs to be added so that it can safely release the design flood discharge to the downstream river Section 3, while function of existing sluice gate is maintained.
This measure can be implemented after the completion of Situ Sidomukti improvement work and river normalization for Section 3.

2) Addition of Opening for Improving Flood Control Function

If the water level in normal times of the *Situ* can be lowered by means of an opening with 0.3 meter-deep and 0.3 meter- wide, 2.96 m^3/s of the design flood discharge can be reduced to 2.22 m^3/s (declining rate: 25%).

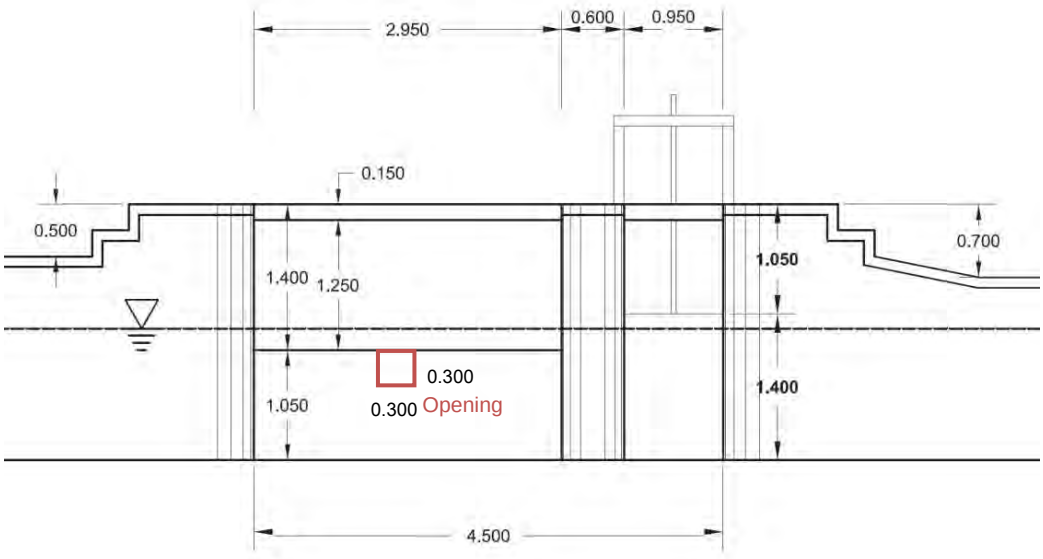


Figure 6.2-21 Additional Opening on Existing Spillway of Situ Cilodong

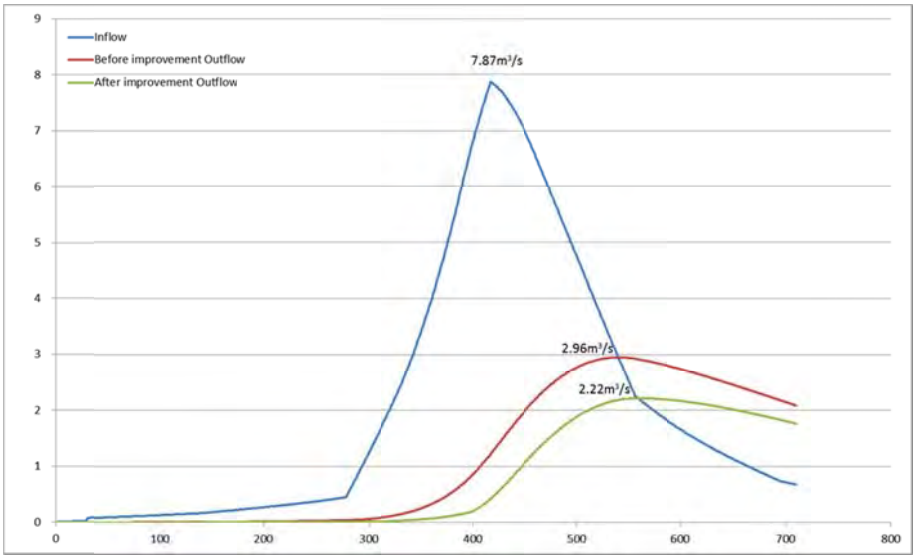


Figure 6.2-22 Flood Control Effect by Situ Cilodong

Effect of the improvement of Situ Cilodong to major points of the Sugutamu River was evaluated as follows. Because catchment area of Situ Cilodong is relatively small (4% of whole catchment area), its flood control effect at the confluence with the Ciliwung River is very limited.

Table 6.2-5 Effect of Spillway Improvement Work for Situ Cilodong

Return period		Situ Cilodong		Situ Sidomukti			Janction of Ciliwung
		Inflow	Outflow	Inflow from Situ Cilodong	Infolw from Residual Basins1	Outflow	
2	Before improvement	6.7	2.4	14.7	40.9	55.6	110.2
	After improvement	6.7	1.4	13.7	40.9	54.6	109.2
	Effect(m^3/s)	0.0	1.0	1.0	0.0	1.0	1.0
	Effect(%)	0.00%	41.53%	6.82%	0.00%	1.80%	0.91%
5	Before improvement	7.4	2.7	17.1	40.9	64.7	128.1
	After improvement	7.4	1.8	16.2	40.9	63.7	127.2
	Effect(m^3/s)	0.0	0.9	0.9	0.0	0.9	0.9
	Effect(%)	0.00%	34.00%	5.44%	0.00%	1.44%	0.73%
10	Before improvement	7.9	3.0	18.7	40.9	70.6	140.0
	After improvement	7.9	2.2	18.0	40.9	69.9	139.2
	Effect(m^3/s)	0.0	0.8	0.7	0.0	0.7	0.7
	Effect(%)	0.00%	25.44%	3.93%	0.00%	1.04%	0.53%
25	Before improvement	8.4	3.2	20.8	40.9	78.2	154.9
	After improvement	8.4	2.5	20.1	40.9	77.5	154.2
	Effect(m^3/s)	0.0	0.7	0.7	0.0	0.7	0.7
	Effect(%)	0.00%	22.00%	3.22%	0.00%	0.85%	0.43%
50	Before improvement	8.8	3.4	22.3	40.9	83.8	166.0
	After improvement	8.8	2.8	21.7	40.9	83.2	165.4
	Effect(m^3/s)	0.0	0.6	0.6	0.0	0.6	0.6
	Effect(%)	0.00%	18.00%	2.58%	0.00%	0.69%	0.35%
100	Before improvement	9.3	3.9	24.1	40.9	90.0	178.0
	After improvement	9.3	3.5	23.7	40.9	89.6	177.6
	Effect(m^3/s)	0.0	0.4	0.4	0.0	0.4	0.4
	Effect(%)	0.00%	9.78%	1.68%	0.00%	0.45%	0.23%

6.2.8 Effect of Rainwater Storage and Infiltration Facilities in the Basin

JCFM Project calculated the flood control effect of all Rainwater Storage and Infiltration Facilities (RSIF) proposed in CFMP in the Sugutamu Sub-basin, assuming the all runoff control facilities can infiltrate 1.2 mm/h of rainwater based on the case study for CFMP.

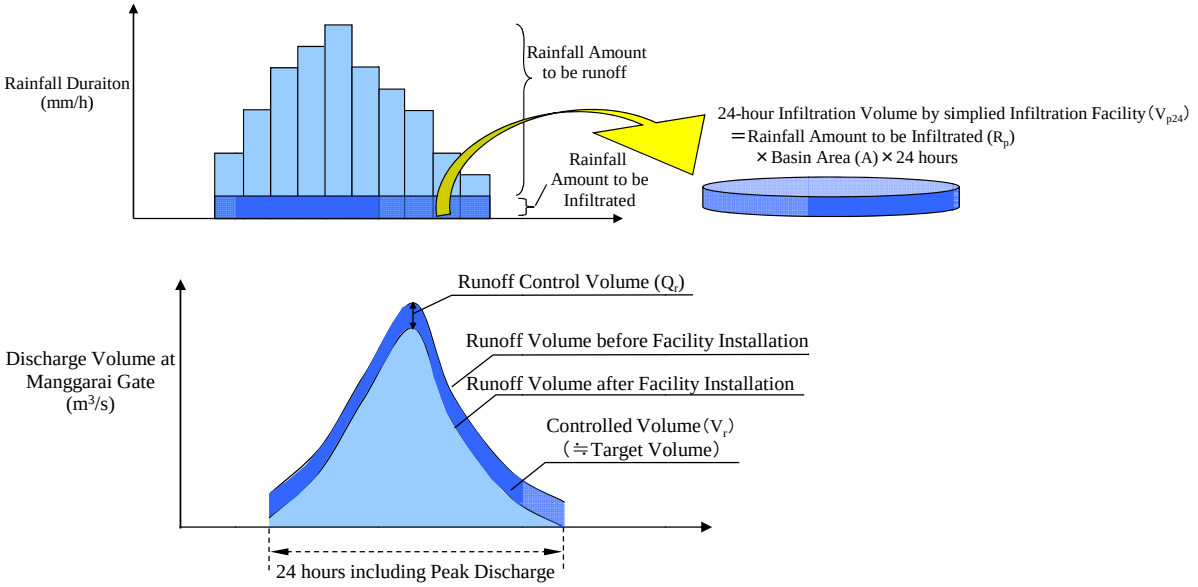


Figure 6.2-23 Conceptual Diagram of Runoff Control Volume by Infiltration Facility

The followings are the evaluated flood control effect at major points of the Sugutamu River by RSIF. Flood control effect against the design flood discharge with 10-year return period at confluence with the Ciliwung River is expected as 7.4 m^3/s (equivalent to 5.3 % of design peak discharge).

Table 6.2-6 Flood Control Effect by Installed RSIF in the Basin

(Before Installation of Rainwater Storage and Infiltration Facilities)

Return period	Situ Cilodong		Situ Sidomukti			Janction of Ciliwung
	Inflow	Outflow	Inflow from Situ Cilodong	Infolw from Residual Basins1	Outflow	
2	6.7	2.4	14.7	40.9	55.6	110.2
5	7.4	2.7	17.1	47.5	64.7	128.1
10	7.9	3.0	18.7	51.9	70.6	140.0
25	8.4	3.2	20.8	57.4	78.2	154.9
50	8.8	3.4	22.3	61.5	83.8	166.0
100	9.3	3.9	24.1	65.9	90.0	178.0

(After Installation of Rainwater Storage and Infiltration Facilities)

Return period	Situ Cilodong		Situ Sidomukti			Janction of Ciliwung	Effect(Janction of Ciliwung)
	Inflow	Outflow	Inflow from Situ Cilodong	Infolw from Residual Basins1	Outflow		
2	6.5	2.2	13.7	38.2	51.9	102.9	7.3 (6.6%)
5	7.1	2.5	16.0	44.8	60.9	120.8	7.3 (5.7%)
10	7.6	2.7	17.6	49.2	66.9	132.6	7.4 (5.3%)
25	8.1	3.0	19.7	54.8	74.4	147.5	7.4 (4.8%)
50	8.5	3.2	21.2	58.9	80.0	158.6	7.4 (4.4%)
100	9.0	3.6	22.9	63.2	86.2	170.6	7.4 (4.2%)

6.2.9 Identification in Case Study

In accordance with the results of case study, the following concerns are identified for the comprehensive flood management in pilot sub-basin.

(1) Determination of River Administration Area

- In the case study, several cases are identified that private developer and/or others change the river course without approval. It can be avoidable if the river administration area is designated. Therefore, in order to avoid this practice, it is recommendable to set and regulate the river administration area urgently.

(2) Consideration for Improvement of *Situ* and River at Upstream of *Situ*

- Originally, *Situ-situ* were established only for irrigation use, so that capacity of *Situ* is not consistent with discharge in flood times. Situ Sidomukti also cannot release total 70.6 m^3/s of design flood discharge at this moment. Most of the design flood discharge may overtop on the earth dike at the time of the design flood. Normalization work for the upstream rive course from Situ Sidomukti will cause concentration of flood discharge. It will increase the dike overtopping risk.
- Moreover, there is other case that all flow volume from *Situ* flow to the other basin through the irrigation channel with small flow capacity, resulting in the overflow of irrigation channel during the flood (Situ Cilodong).
- Considering the above-mentioned facts, the flood control plan needs to take into account of the impacts between *Situ* improvement and river improvement.

CHAPTER 7 PREPARETION OF MEASURE AND OPERATION MANUAL FOR RUNOFF CONTROL FACILITY

"Measure and Operation Manual for Runoff Control Facility" includes the way of thinking, planning and design of the runoff control facilities based on the investigation results in this project in order to contribute to forward the runoff control measures, that occupy one position among comprehensive flood management measure those are carried out to reduce the disasters caused by floods. This manual will be submitted as a outcome of this technical cooperation.

This manual mentions design, execution and maintenance of "Rainwater Storage Infiltration Facility with plastic materials for inner parts" and a way of thinking for "the Situ improvement".
The table of contents for this manual is as follows.