Characteristics of pollutants discharged into rivers/streams & Plan to reduce CSOs in Urban Area when Raining

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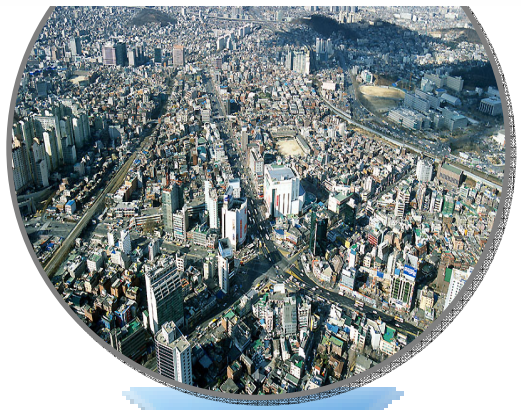
1. PROBLEM STATEMENT

- WHY REDUCING AND MANAGING CSOs

1) Impact of Urbanization and Pollutant Discharge

Urbanization & Water Cycle

Population increase with urbanization
Adverse impact on water cycle by increased impermeable surface



Flows in Nature

•Increase in impermeable surface by urbanization
•Precipitation, evaporation, surface drainage, infiltration, storage etc.

• Distorted water cycle due to increased impermeable surface
• Urban flood by increased peak flow when concentrated precipitation
• Stream water contamination when raining

Flows in Society

•Increased population density by urbanization
•River water intake, groundwater use, cut-off rain and wastewater
•Water cycle related with citizens daily lives

• Increased surface drainage by increased demand for water and facilities for rain and wastewater drainage
• Decreased natural storage
• Dry stream and reduction of habitat
Increased discharge of urban pollutant

Recovering Water Cycle by Reducing impermeable surface, Rain water manag Water demand management, and Pollution managment

1) Impact of Urbanization and Pollutant Discharge

anization

• Natural Water Cycle

• Distorted natural water cycle due to increased impermeable surface area

- Flood
- Base flow decrease
- Groundwater decrease
- Decreased evaporation
- Impact on ecosystem

Structural measures

- **Infiltration facilities**
- **Flood prevention facilities**
- **Water supply facility for streams**

Non-structural measures

- **Permeable surface**
- **Conservation of ecosystem**

• Artificial Water Cycle

•Changed water cycle by population increase

- Increased water demand
- Increased discharge of pollutants

Structural measures

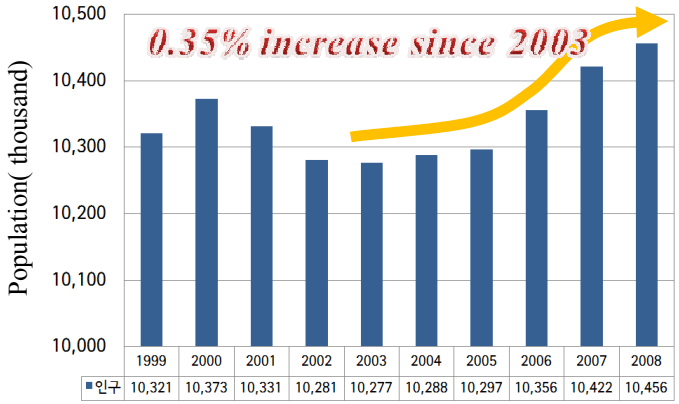
- **Advanced wastewater treatment facilities**
- **Storm water treatment facilities**
- **CSOs treatment facilities**

Non-structural measures

- **Basin management(non-point source)**
- **Water management based on demand**

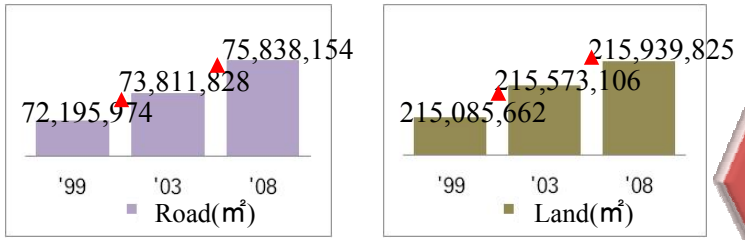
1) Impact of Urbanization and Pollutant Discharge

• Increased Population



Population of 10,456,034 (As of 2008)

• Increased impermeable surface



Paved road area increase by 5.04%

Land area increase by 0.40%

Increased impermeable surface area including roads and lands by urbanization

Population increase Industrialization

Increased pollutants

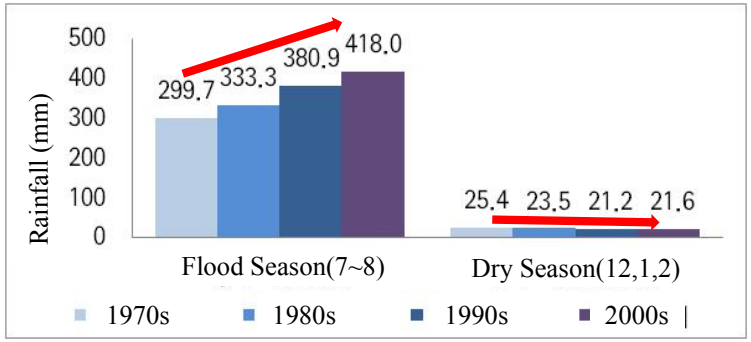
Discharge of high concentration pollutants into streams after dry season due to climate change

Increased area of impermeable surface

Increased amount and frequency of discharge of pollutants into streams

Deterioration of aquatic ecosystem by CSOs discharge when raining

• Decreased precipitation in dry season



• Decrease in amount and frequency of precipitation in dry season – non-point source pollutants accumulation – Discharge of high concentration pollutants in Spring with small amount of rain

• Deterioration of stream ecosystem

CSOs discharge into streams when raining (May ~ August)

Fish kills by water quality deterioration due to temporary DO exhaustion

10 cases of fish kills during the recent 5 years since 2006

2) Definition and characteristics of pollutants discharge when raining

Non-point source pollution

"Discharging pollutants from dispersed sources such as roads, farms, land, and construction sites.


Influx of soil


Livestock waste


Solid waste

CSOs

Wastewater overflowed from combined sewers through storm overflow outlet

City area

- Sediments from buildings and impermeable surfaces
- Pollutants from industrial area
- Intensive discharge into stream through sewer pipe when raining
- CSOs

Road

- Pollutants including heavy metals accumulated on surface by precipitated pollutants from atmosphere and emission from vehicles
- Soil from construction

Stream area

- Collection of sand and gravel around stream shore
- Construction for shore protection
- Development in upstream area

Agriculture

- Pesticide and fertilizer
- Cattle excretion around cattle shed
- Erosion of soil and suspended materials

Deterioration of water quality and aquatic ecosystem by intensive discharge into stream when raining

3) Management of pollutants discharge when raining

Streams in dry period

Bright side

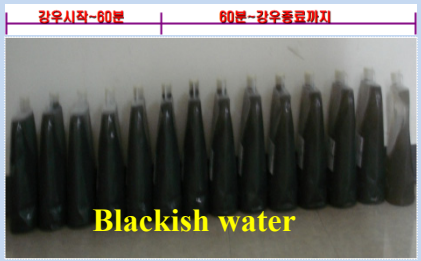
Providing water-friendly culture and resting area for citizens



Streams during wet period

Dark side

Deterioration of aquatic ecosystem by influx of pollutants



WHY?

Pollutants accumulated in city, road, and construction site washed out by rain and flow into sewer pipe (non-point source)

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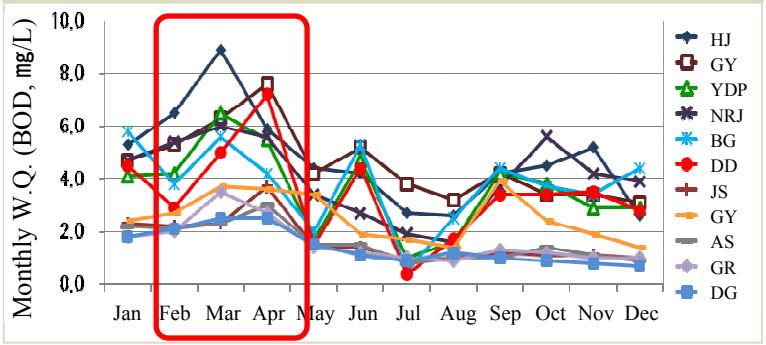
High concentration of wastewater directly discharged into streams when the amount is much larger than the capacity of wastewater treatment plant ※ CSO

3) Management of pollutants discharge when raining

Monthly water quality of the Han river



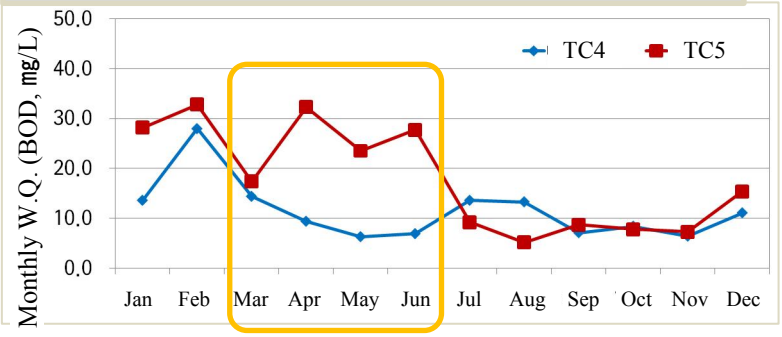
Water quality deterioration with storm water

Lack of water flow during dry season and increased amount and frequency of pollutants discharge due to CSOs

Deterioration of water quality of the Han river and the 4 main streams in Spring

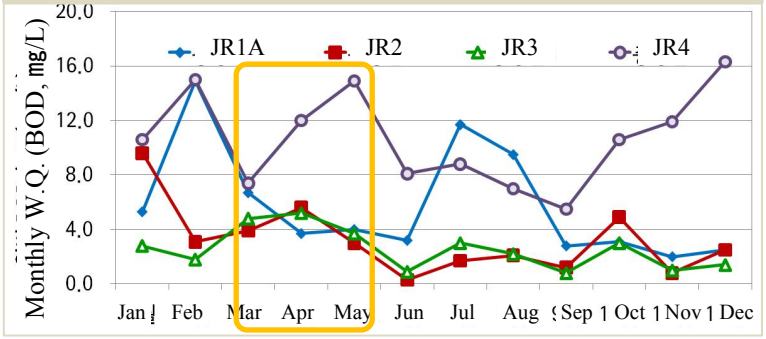
Water quality management plan needed according to characteristics of pollutants discharge when raining in Spring

Monthly water quality of Tanchun stream



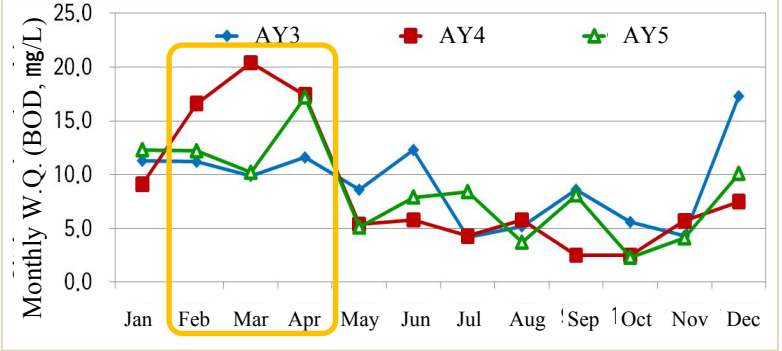
Deteriorated water quality in February

Monthly water quality of JoongRang stream



Deteriorated water quality

Monthly water quality of Anyangchun stream



Deteriorated water quality in March

4) Management of Pollutant Discharge when raining

Management of Pollutant Discharge when raining

Paradigm shift in policy of water quality management

Measurement for non-point source pollutants

High ratio of treated point source pollutants

Limits in improvement of water quality through advanced treatment project

VS

Lack of treatment for non-point source pollutants

- Pollutants from non-point sources (first flush water and CSO) discharged directly into streams when raining
- Pollutants when raining (77 day/yr) are 2.5 times more pollutants of normal days (288 days/yr)

Implementation of total pollutant load control system

Implementation of the rule to the Han river basin from June 2013

Measurement for non-point source pollutant required

Measurement to achieve water quality goal due to implementation of the regulation is urgently required

Pollutants control required due to limit of water quality goal achievement through advanced treatment at WWTP

Projects on non-point source pollutants required to reduce CSOs and storm water

"National River Rehabilitation Project" Ministry of Environment

Maximization of "4 Big Rivers Project" Providing healthy and safe stream environments

Branch stream water quality improvement project from 2011 ("National River Rehabilitation Porject")

Project Plan

- All the branch streams – less than BOD 5 mg/L
- Continuous investment of government subsidies by 2020
- Main investment project: CSOs reduction project

Non-point source pollutants reduction project of Seoul supported by government subsidies

4) Management of Pollutant Discharge when raining

Implementation of policy to reduce non-point source pollutants

'98~'00 — Comprehensive measurement on water management for the 4 Big Rivers

- Estimation and measurement on the load from non-point sources
- Non-point source pollutant: the Han river (30.7%), Nakdong River (25.4%), Youngsan River (37.4%), Keum River (21.7%)

'04.03 — Comprehensive measurement for non-point source pollutants in the 4 Big Rivers

- Government measurement for non-point source pollutant by 2020
- Measurement by joint departments - 7 departments including Ministry of Environment and Ministry of Construction and Transportation
- First comprehensive non-point source pollutants reduction measurement including improvement of regulation by stages, project drive, investigation

'06.09 — Main plan for management of water environments

- Detailed project plan for non-point source pollutants
- Non-point source pollutants (as of 2003): the Han river (42.2%), Nakdong River (50.3%), Youngsan River (67.8%), Keum River (59.7%)

Regulations for management of CSOs and non-point source pollutants

Law of sewerage (implemented July 1, 2009, No. 335 ME)

According to the provision of 1:2:25 (standards and procedure for public announcement on sewer pipe maintenance zone) of Chapter 3 (installation and maintenance of private sewerage system), it is regulated to control the concentration of BOD of overflows less than 40 mg/L.

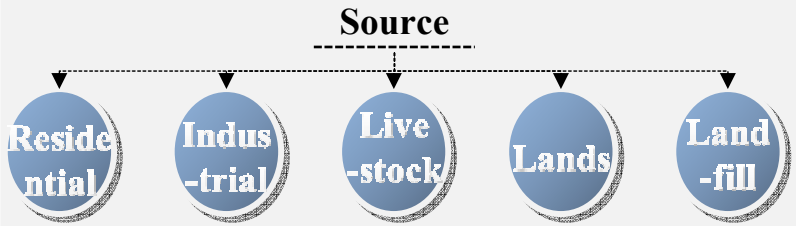
2. CSO MANAGEMENT TARGET AND DISCHARGE CHARACTERISTICS

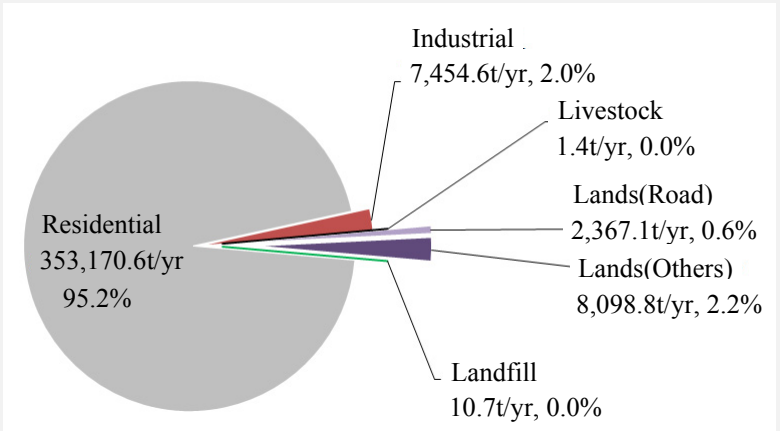
Plan to reduce CSOs in Seoul

1) CSOs Management Targets and Loads Discharged

① Pollutants

Load by Pollutant Source





Residential

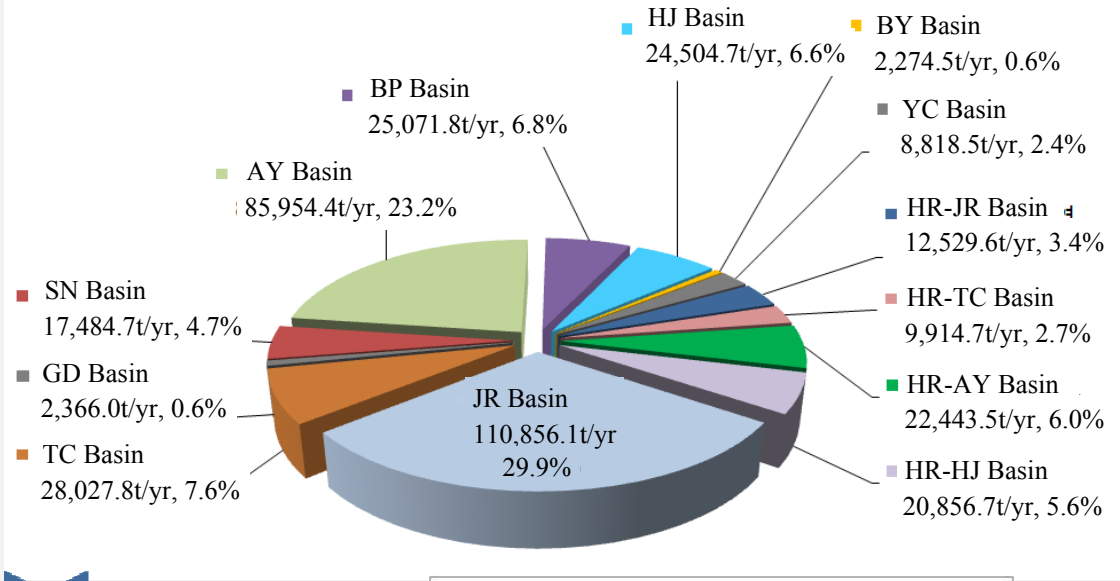
- 95.2% of total loads, 353,170,600 t/yr

Lands

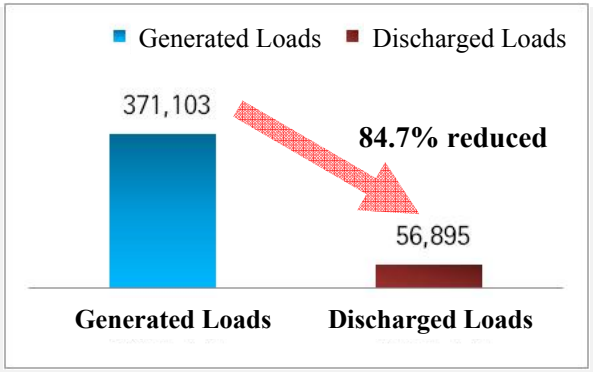
- 0.6% of total load from road. 2,367,100 t/yr

Pollutants loads by basin

Total Generated Loads of BOD in Seoul : 371,103.2t/yr



Total Loads Discharged : 56,894,800 t/yr



1) CSOs Management Targets and Loads Discharged

② Management Targets: Non-point source

Total Loads Discharged

- Effluent from WWTP
- Individual discharge
- CSOs (Discharge to streams from Storm overflow outlets)
- Untreated discharge (Discharge from the intercepted 3Q in front of WWTP)

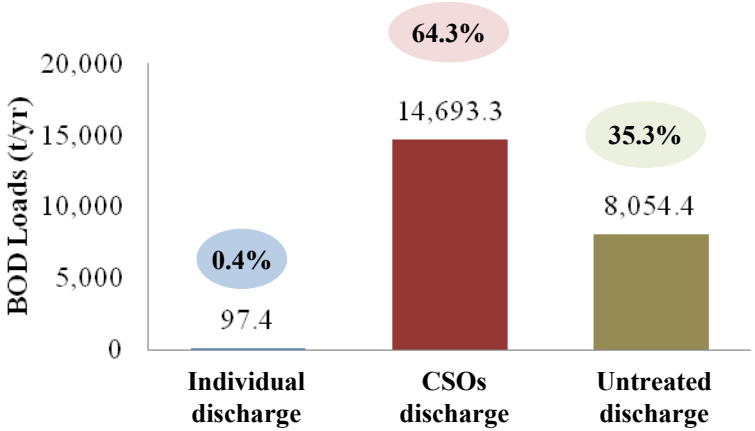
Excluded from management targets pollutants from non-point sources

•Sediments in sewer pipes
•Wastewater

Management targets pollutants from non-point sources

Analyses on the amount of loads discharged for 5 years (2005-2009)

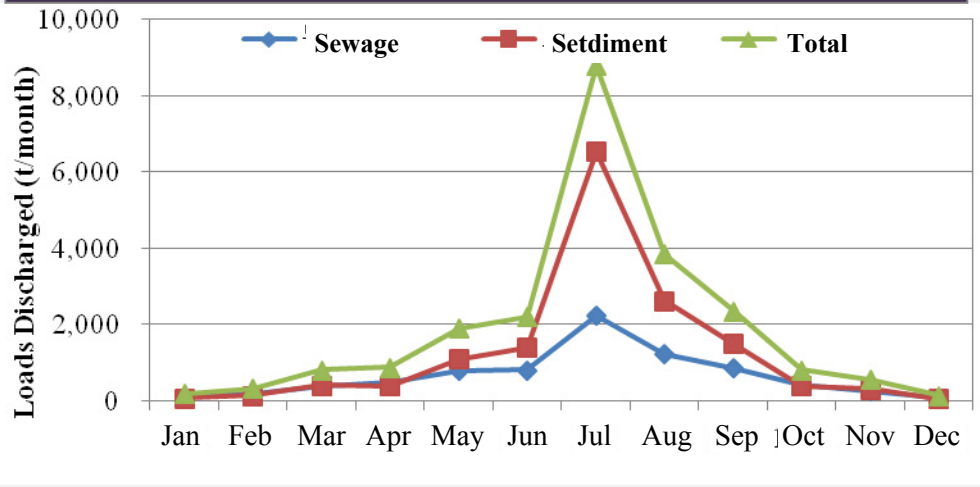
5-year average loads discharged: ~ 23,000 t/yr



Average Loads Discharged(t/yr)

Class.	Residen-tial	Indus-trial	Live-stock	Lands (road)	Lands (others)	Total
Individual	0.0	0.0	0.1	48.7	48.6	97.4
CSOs	14,115.9	12.5	0.0	124.8	440.0	14,693.3
Untreated	7,572.8	7.5	0.0	96.7	377.4	8,054.4
Total	**21,688.7**	**20.1**	**0.1**	**270.2**	**866.0**	**22,845.1**
Ratio (%)	94.9	0.1	0.0	1.2	3.8	100.0

Loads Discharged (Monthly Average)



1) CSOs Management Targets and Loads Discharged

③ Loads Discharged by Management Targets: Pollutants from Non-point sources

5-year averaged total BOD loads discharged from non-point sources in Seoul: 23,000 t/yr

	Wastewater (BOD loads t/yr)						Sediments in sewer pipes (BOD loads t/yr)						Total (t/yr)	Ratio (%)
	Residential	Industrial	Livestock	Lands (road)	Lands (others)	Sub Total	Residential	Industrial	Livestock	Lands (road)	Lands (others)	Sub Total		
Individual	0.0	0.0	0.1	48.7	48.6	97.4	0.0	0.0	0.0	0.0	0.0	0.0	97.4	0.4
CSOs	2,970.7	3.1	0.0	102.2	419.0	3,494.9	11,145.2	9.4	0.0	22.7	21.1	11,198.4	14,693.3	64.3
Untreated	3,843.9	4.2	0.0	89.6	370.9	4,308.6	3,728.9	3.4	0.0	7.0	6.4	3,745.7	8,054.4	35.3
Total	6,814.6	7.3	0.1	240.5	838.5	7,900.9	14,874.1	12.8	0.0	29.7	27.5	14,944.1	22,845.1	100.0
Ratio (%)	29.8	0.0	0.0	1.1	3.7	**34.6**	65.1	0.1	0.0	0.1	0.1	**65.4**	100.0	

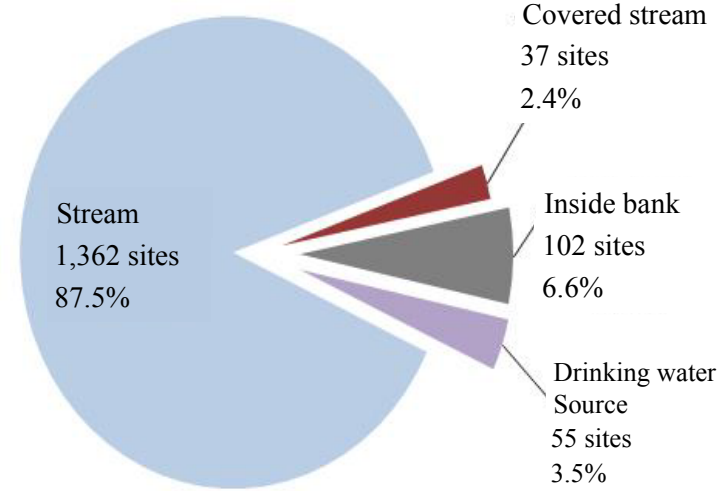
- Sediments took 65.4% (15,000 t/yr) of total loads discharged. Management on pollutants from non-point sources required, i.e., dredging sediments from sewer pipes
- Non-point source pollutants from road took 1.2% (270 t/yr)

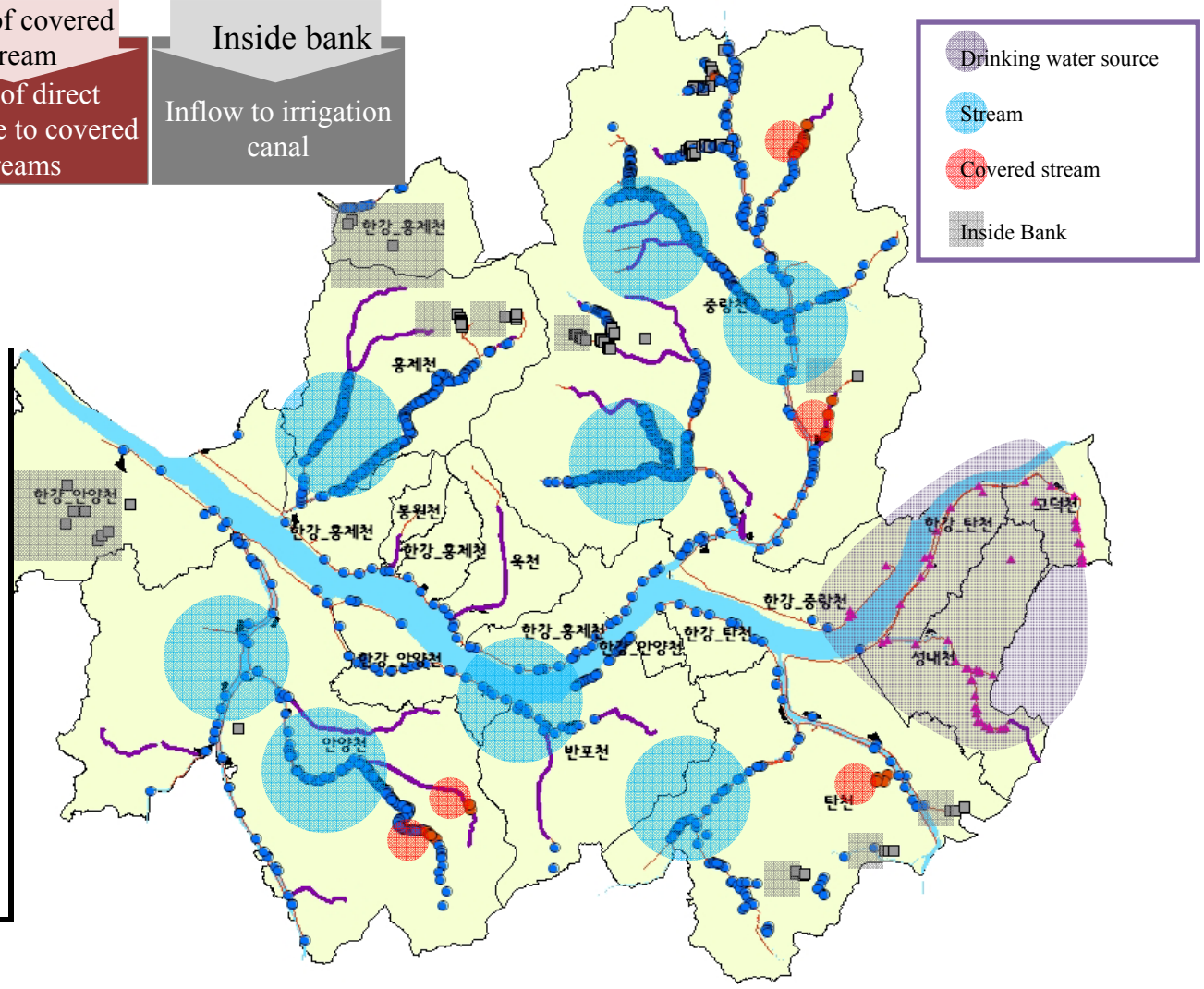
2) Pollutant discharge path in stream basin

Characteristics of storm overflow outlets

Zone of water source	Zone of stream	Zone of covered stream	Inside bank
Zone of direct impact on drinking water source	Zone of direct discharge to streams	Zone of direct discharge to covered streams	Inflow to irrigation canal

Storm overflow outlets: 1,556





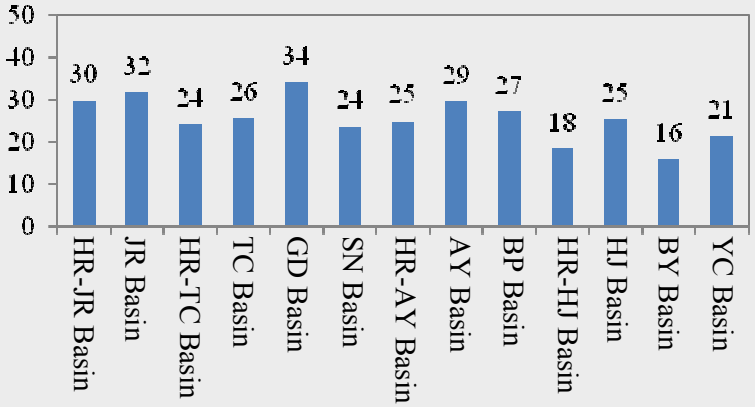
3) Characteristics of CSOs Discharge

① Number of Events: CSOs and Untreated Wastewater

Number of events over BOD 40 mg/L (Standards for CSOs in stream)

• CSOs: Discharged to streams 25.4 times/yr

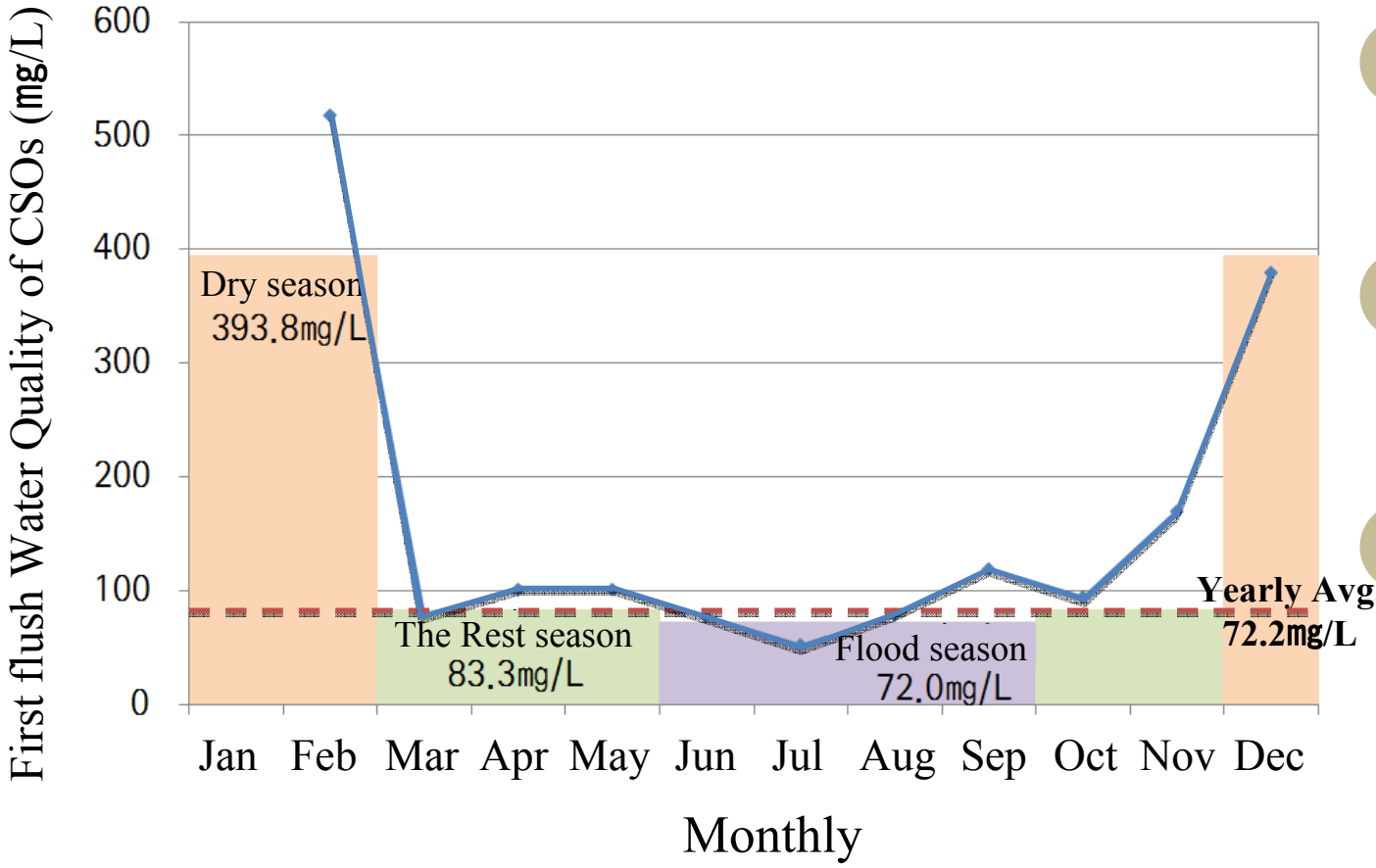
• 32 times/yr in Joongrangchun basin(JR Basin)



3) Characteristics of CSOs Discharge

② Average Influent Water Quality of CSOs within 10 minutes

CSOs water quality by month



Dry season

Water quality 393.8 mg/L
Low flow in stream

The Rest season

Water quality 83.3 mg/L
Medium stream flow

Flood season

Water quality 72.0 mg/L
Abundant flow in stream

3. TREATMENT PLAN FOR CSOs

Plan to reduce CSOs in Seoul

1) Goal and Approach of CSOs Management Plan

Approach

More practical and economical CSOs management system establishment through integrated management of river (streams) and basins

- Reducing overflows through management on sources of pollutants
  - ▸ Dredging sewer pipes, rain water management, road wash with water, reducing infiltration water in sewer pipes
- Treatment of CSOs
  - ▸ Reducing discharge load: water quality of overflow, less than BOD 40 mg/L
  - ▸ Selecting project by priority: installing eco-stream, protection zone for source of drinking water, zone for water entertainment
  - ▸ Using existing facilities: installation of underground storage tanks in rainwater detention reservoir

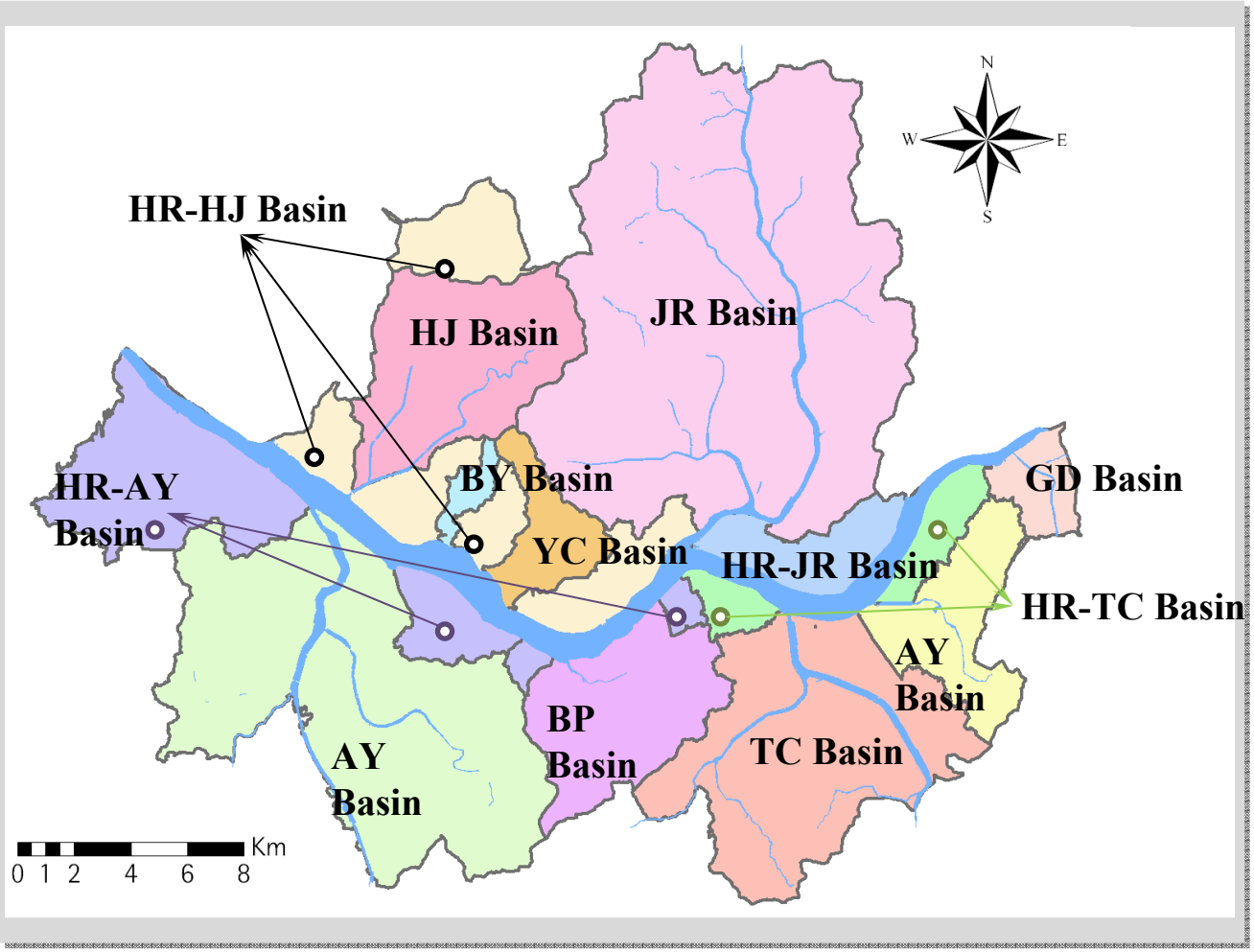
Laws on wastewater, rule for practice (2009.7.1., ME 335)

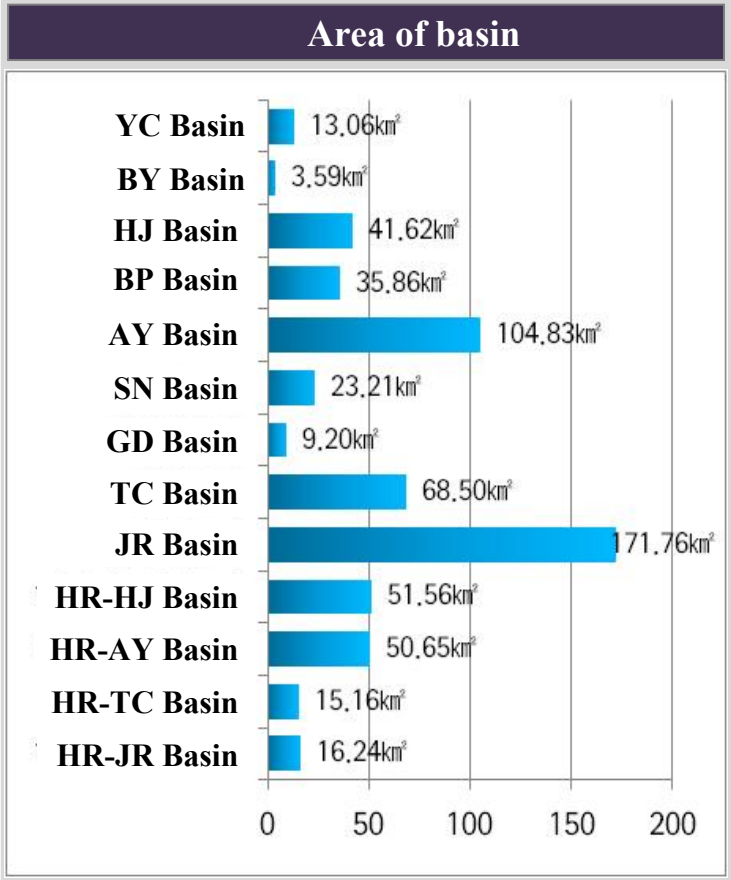
- According to the provision of 1:2:25 (standards and procedure for public announcement on sewer pipe maintenance zone) of Chapter 3 (installation and maintenance of private sewage system), it is regulated to control the concentration of BOD of overflows less than 40 mg/L.

2) Unit of CSOs Management

CSOs management zones in Seoul

Division by stream basin 3 stream basins according to the characteristics of pollutants discharged





• The area of JR basin is the largest, 28.4%

2) Unit of CSOs Management

CSOs management zones in Seoul

Zones for effective management of CSOs

Zones divided considering 1,027 storm overflow outlets, network of sewer pipes, and geography

36 and 13 stream basins (considering up-, mid-, and down-stream characteristics)

CSOs management zones: 13 stream basins, 70 management zones

Zone by WWTP

- NJ • 12 zones
- JR • 25 zones
- SN • 19 zones
- TC • 14 zones

3) Order of Priority of CSOs Management

① Management zones installed CSOs reducing facilities with priority

Order of project by priority

- Citizens' use
- Reducing pollutants loads
- Achieving water quality goal
- Importance of stream function

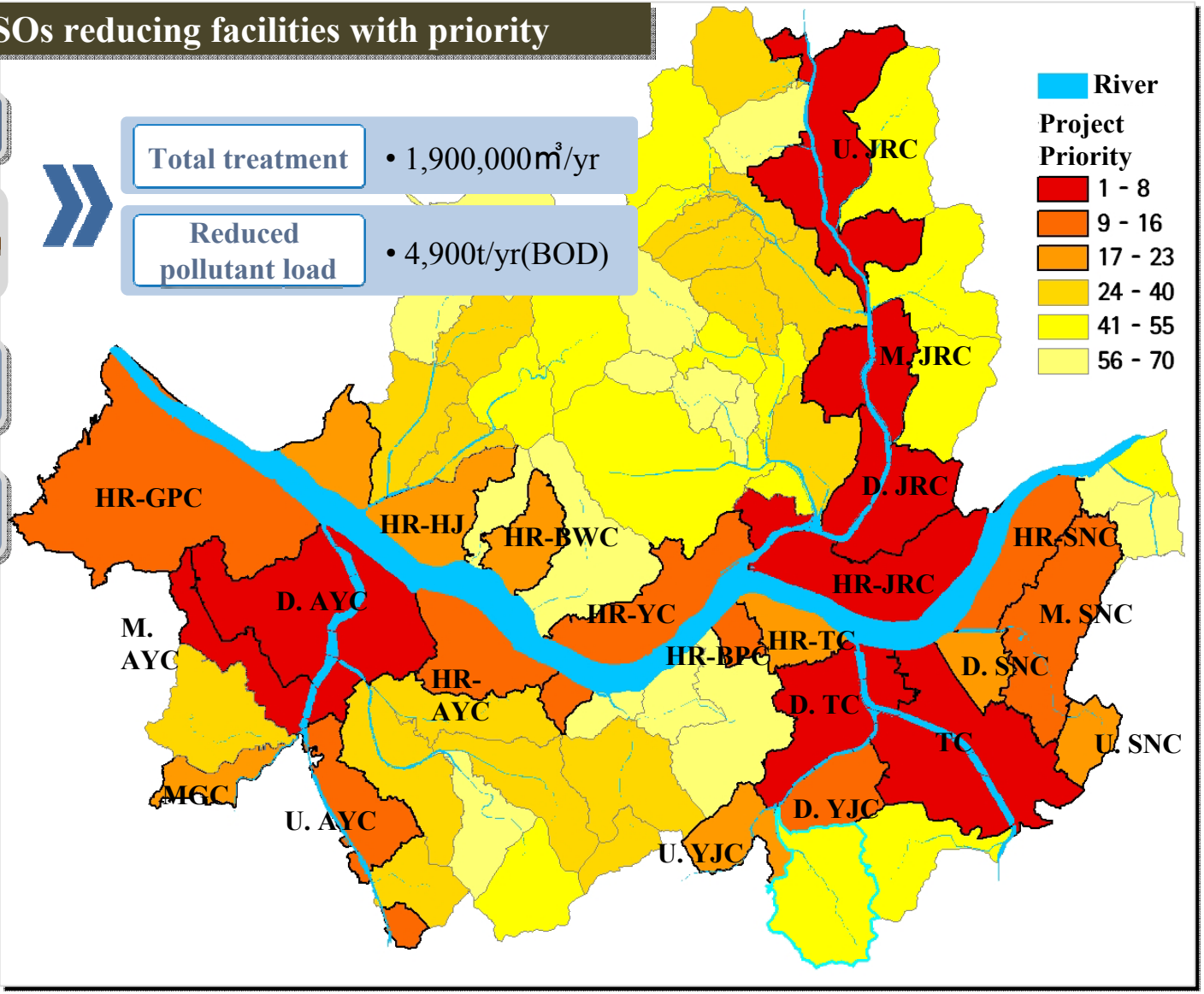
Excluding dry streams

23 prior CSOs management zones to maintain function of streams for entertainment and utilization

Zone 1~8	Zone 9~16	Zone 17~23
D. JRC	M. SNC	D. SNC
M. JRC	D. YJC	HR-HJ
TC	U. AYC	U. SNC
D. AYC	HR-UC	HR-TC
U. JRD	HR-AYC	MGC
HR-JRC	HR-SNC	HR-BW
M. AYC	HR-GPC	U. YJC
D. TC	HR-BPC	

Total treatment • 1,900,000㎥/yr

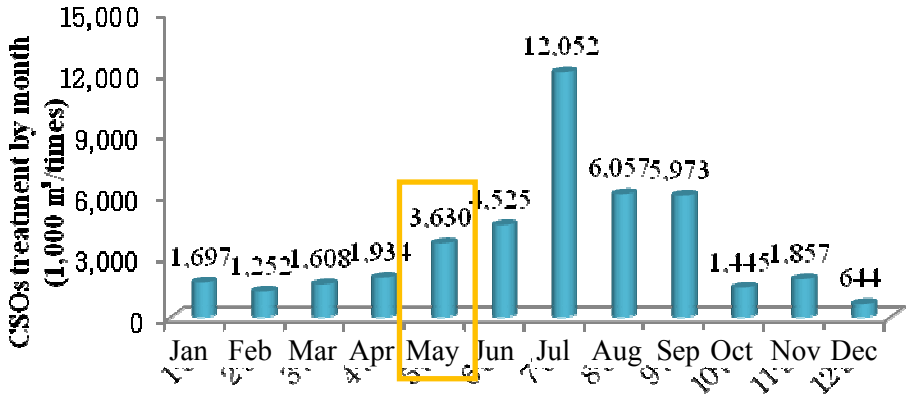
Reduced pollutant load • 4,900t/yr(BOD)



4) CSOs Treatment Plan by Basins

CSOs treatment over BOD 40 mg/L by month

CSOs treatment by month



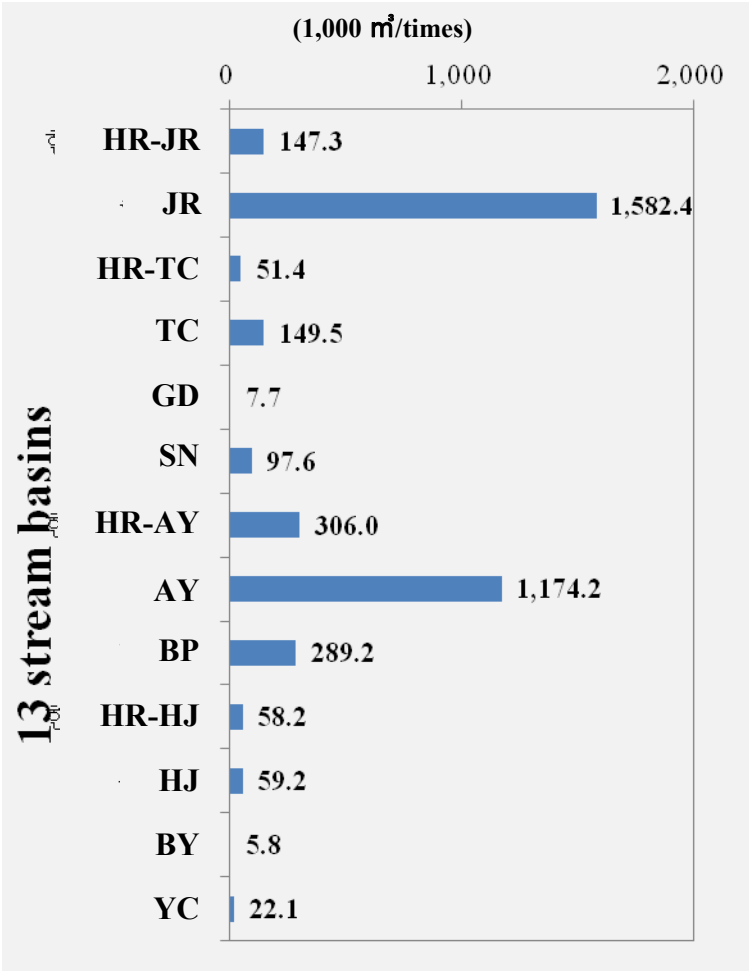
• CSOs treatment (excluding flood season of June~Sept.)

- 3,950,600 ㎥/times

(unit: 1,000㎥/times)

Month	Residen-tial area	Com-mercial area	Industrial area	Road	Green belt	etc	Total
Year	900.2	54.8	32.2	20.9	1,379.6	2,603.3	4,991.2
Dry(12-2)	168.9	15.4	8.7	7.2	355.8	550.5	1,106.5
Rest(3-5,10,11)	345.2	28.3	20.6	10.8	647.9	1,118.1	2,171.0
flood(6-9)	1,406.2	82.5	46.2	28.8	2,055.7	3,964.5	7,583.7

CSOs treatment of 13 stream basins



4. CSOs TREATMENT PLAN AND ITS EFFECT

Plan to reduce CSOs in Seoul

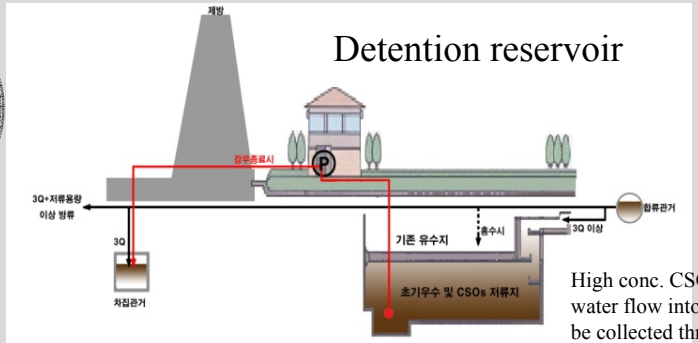
1) Treatment plan on pollutants discharged with rain

Approach to treat non-point source pollutants → CSOs treatment → CSOs :3,950,000㎥

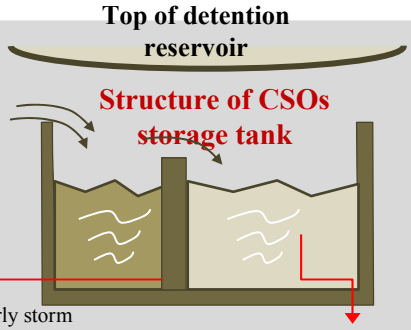
Approach to treat pollutant discharged with rain	**CSOs treatment**	Plan for management of storage tank (storage tank installation at detention reservoir) -To treat at WWTP within its capa. -To treat on-site over WWTP treatment capa.	Plan to manage mechanical type facilities - To install the equipment at storm overflow outlet

① Treatment plan for CSOs

Reservoir type



High conc. CSOs of early storm water flow into storing tank will be collected through intercepting sewer and treated at WWTP



Storage tank: to treat by on-site facilities up to BOD 40 mg/L

Mechani -cal type

- Filtration
- Vortex
- Screen
- Coagulation-Settling
- Biological treatment

1) Plan to discharge pollutants when raining

② Plan for Storing CSOs and Treatment at WWTP

Review on CSOs treatment capacity of WWTP

• Storing and treatment plan for CSOs

• Storing plan: settling tank + storing tank

• Treatment plan: high concentration of pollutants in settling tank – treated at WWTP, low conc. Pollutants in storing tank – treated at on-site treatment facilities

• CSOs treatment plan of WWTP

•Normal: daily max. capacity

•Rain : hour max. capacity

Room between hour max. and daily max. capaicities

•Estimation of storing capacity for CSOs: independent rainfall event (rainfall influence day = 24 hr.)

•Min. 1 day interval between end of independent rainfall and next storing event

High conc. CSOs of early storm water event flow into storing tank will be collected through intercepting sewer and treated at WWTP

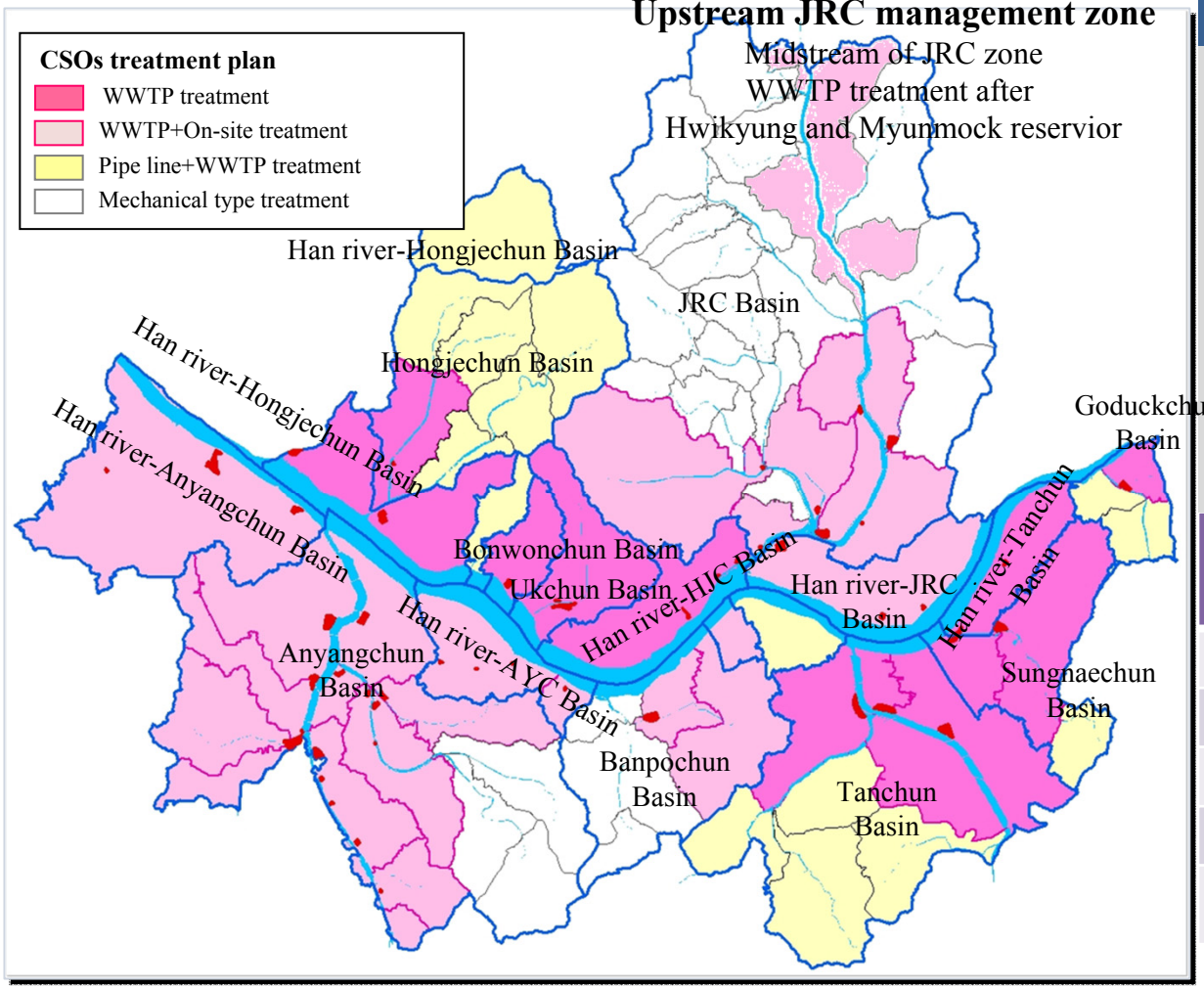
• CSOs treatment capacity of WWTP

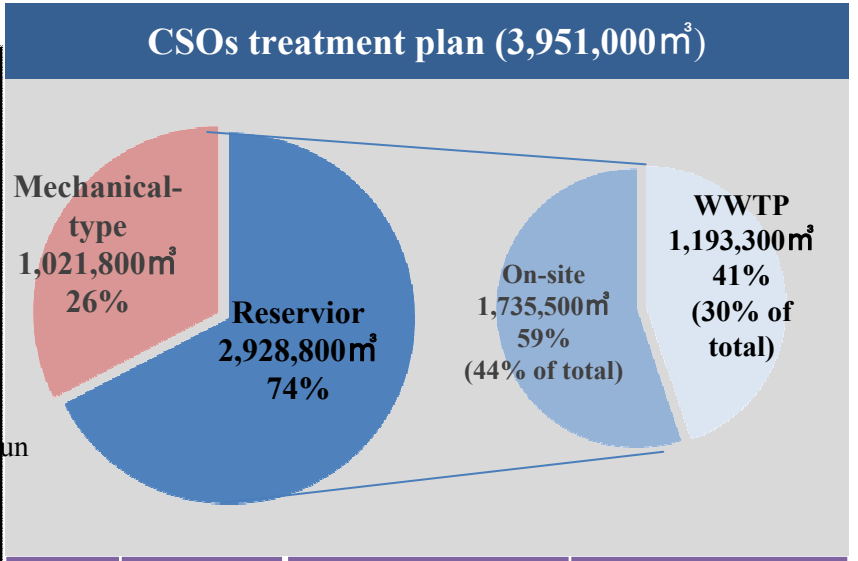
WTTP	CSOs capa. (1,000 ㎥)	Storage (1,000㎥)	Treat. In WWTP (1,000㎥)	Ratio of WWTP (%)
JR	1,730	1,019	261	26
TC	306	306	356	100
SN	1,769	1,459	481	33
NJ	145	145	158	100
total	3,950	2,929	1,256	41

All of CSOs is treated at WWTPs in Tanchun and Nanji areas

1) Plan to discharge pollutants when raining

③ CSOs management and treatment plan





WWTP	CSOs Treatment (1,000 ㎥)	Managing Plan (1,000㎥)		Storing Plan (1,000㎥)	
		Reservoir	Mecha.	WWTP	On-site
JR	1,729.7	1,018.4	711.3	261.0	757.4
TC	306.2	306.2(71.2)		306.1	
SN	1,769.5	1,459.0	310.5	481.0	978.0
NJ	145.2	145.2(92.7)		145.2	
Total	3,950.6	2,928.8	1,021.8	1,193.3	1,735.5
		3,950.6		2,928.8	

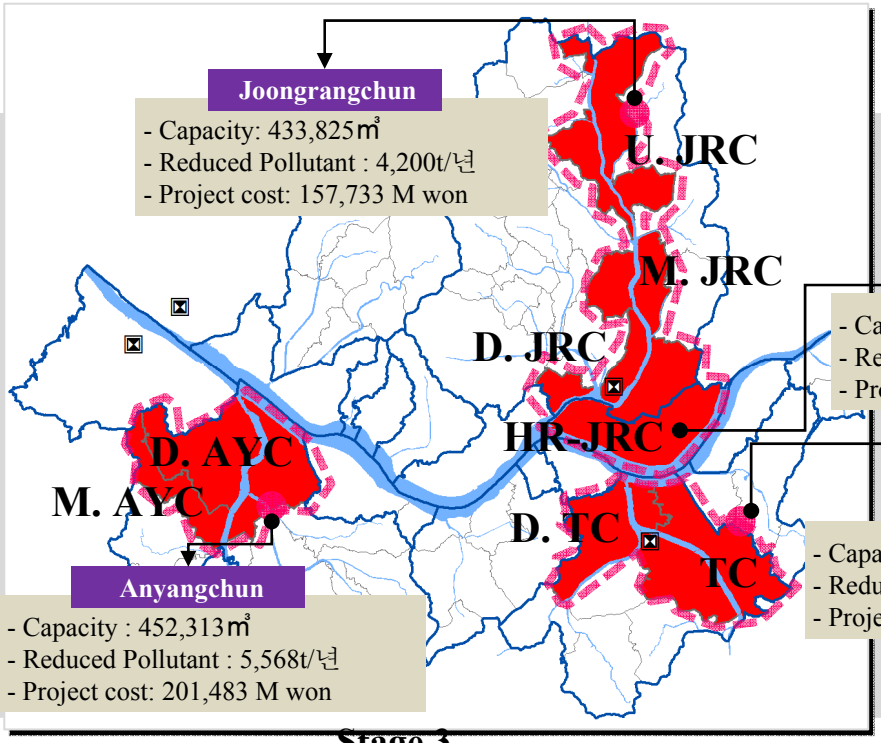
2) Project Plan to Divide CSOs Management Zone in 2020

① Project Plan of CSOs treatment facilities installation in 2020

Start CSOs project before Zone management

1~8 CSOs Management Zones: Capacity of treatment and Project Cost

Capacity	• 1,157,325㎥/yr
Reduced Pollutants	• BOD 17,511t/yr
Project cost	• 505,839 M won



Stage 1

2012 — 2013 — 2014

- Capacity : 343,683㎥
- Acc. BOD reduction : 2,380t/yr
- Project cost : 172,246 M won

Stage 1 : 1~3

Mid- and Down stream of Joonrangchun, Tanchun

Stage 2

2015 — 2016 — 2017

- Capacity : 476,056㎥
- Acc. BOD reduction : 4,841/yr
- Project cost : 162,637 M won

Stage 2 : 4~5

Downstream of Anyangchun, Upstream of Joongrangchun

Stage 3

2018 — 2019 — 2020

- Capacity : 337,586㎥
- Acc. BOD reduction : 10,290t/yr
- Project cost : 170,956 M won

Stage 3 : 6~8

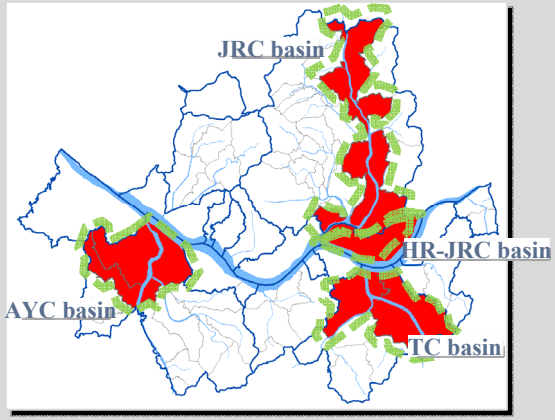
Han river-JR, Midstream of Anyangchun Downstream of Tanchun

3) 2020: Effects of CSOs treatment facilities and Disaster Prevention Facility Transforming Project

Transformed into Disaster Prevention Facilities in July~August

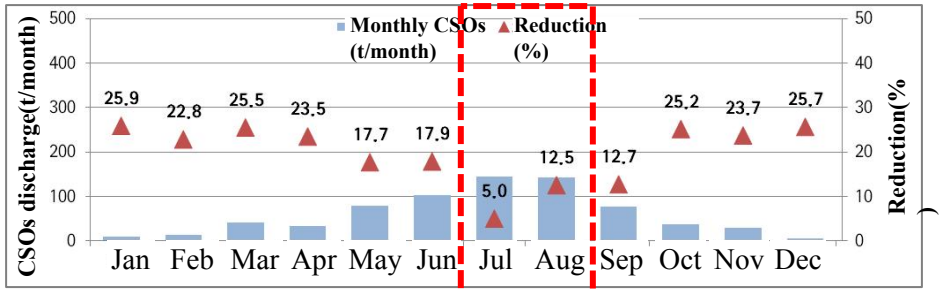
① Effects of the Project to install CSOs treatment facilities

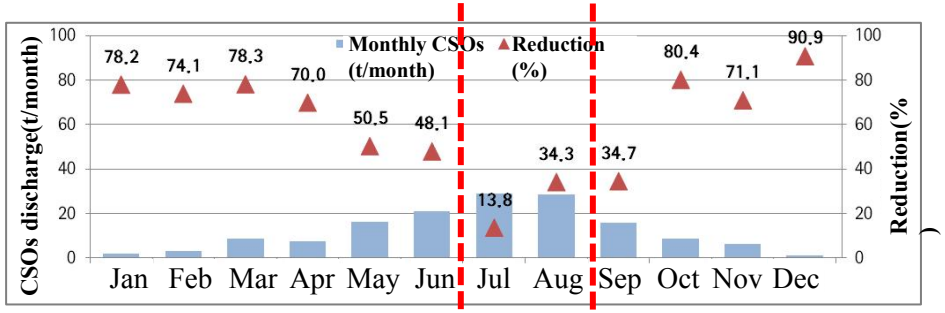
Pollutants discharge reduction after installation of facilities

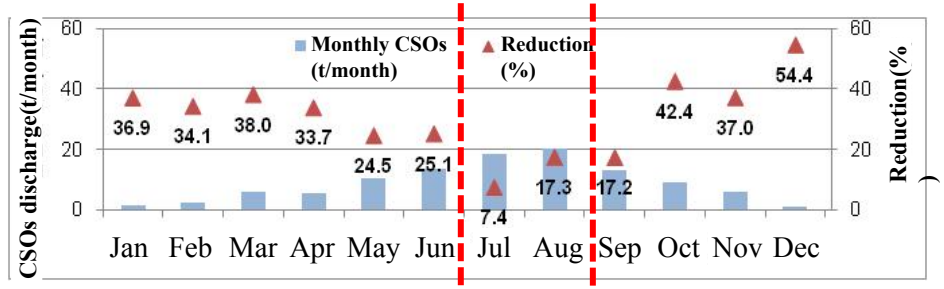


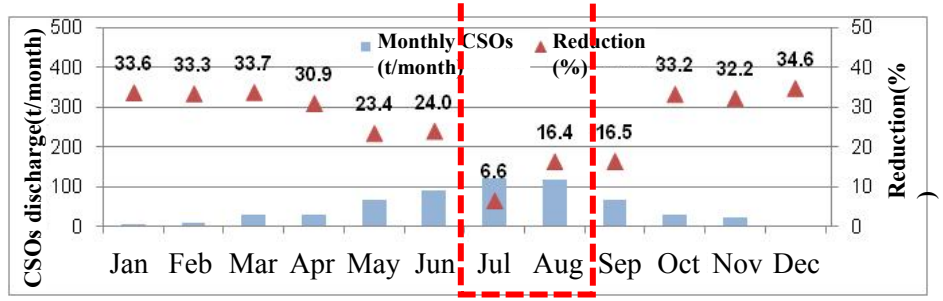
- **Joongrang** — *31.8%* (502,500 ㎥/1,582,400㎥)
- **Han river – Joongrang** — *100%* (147,300 ㎥/147,300 ㎥)
- **Tanchun** — *82.9%* (123,900㎥/149,400㎥)
- **Anyang chun** — *38.5%* (452,300㎥/1,174,200㎥)

- **Joongrang** — *11.3% Reduction*
- **Han river – Joongrang** — *32.0% Reduction*
- **Tanchun** — *17.3% Reduction*
- **Anyang chun** — *14.9% Reduction*









4) Effect of Treatment of Non-point Source Pollutants in 2020

Effect of the Project

Water Quality Improvement

- Target water quality management goal of Total Pollutant Control regulation: BOD 4.1 mg/L, T-P 0.236 mg/L at Hangjoo point by 2020.
- Stable water quality goal achievement through advanced treatment at WWTP and CSOs reduction

Flood reduction ⇒ Prevention of flood damage

- Flood prevention by rain water storing during July – August (Operation of facilities for disaster prevention)
- Increasing capacity of rain water reservoir 230%
- Currently operated facilities: 365 reservoirs with capacity of 240,000 m^3

Customer satisfaction

- Water-friendly environments for the citizens by improving water quality of branch streams and restoring aquatic ecosystem
- Improved happiness index of the citizens by reducing odor by pollutants when raining

THANK YOU