

## ⑤BUSAN METROPORITAN CITY

Citizens' Place for Rest and Recreation "Dongcheon"

Master Plan for the Dongcheon Stream

2007. 7

1. Background

- Urban environmental problems caused by the past economic development are a major social issue.
- The project of turning the Dongcheon that cuts across Busan City into a pleasant stream with clean water and walking tracks
  - would meet the demands of citizens and provide a momentum for a sound environment and sustainable urban development.
- To that end, this project will
  - Involve the Dongcheon Committee of 15 members from six civic groups, four experts and five public officials and reflect public opinion.
  - A master plan to improve the environment around the Dongcheon Stream has been produced, by coordinating different views from the private and the public sectors and reflecting recommendations after a series of outsourcing to professional companies between April 2006 and July 2007.

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- 1 Background
- 2 Plans to Improve Water Quality
- 3 Plans to Enhance Surrounding Environment
- 4 Yearly Investment & Funding Source

2. Plans to Improve Water Quality

- 2.1 Current Status and Characteristics
- 2.2 Analysis of Water Quality
- 2.3 Research on Pollutants
- 2.4 Measures to Improve Water Quality

2.1 Current Status (1)

Current Water System

Current Status of Stream

Category	Length (km)	Area (km <sup>2</sup> )	Covered Stream Length (km)	Rate (%)
Dongcheon	7.15	30.60	4.40	61.5
Bujeoncheon	4.26	6.39	4.26	100.0
Hogyecheon	2.60	1.60	1.93	74.2
Gaeyecheon	2.80	4.26	2.50	89.3
Jeonpocheon	3.65	4.99	3.42	93.7

Population

Category	Population along the stream (person)
Busanjin-gu	351,174
Nam-gu	36,288
Dong-gu	27,411
Total	414,873

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2.1 Current Status (2) : Characteristics

Characteristics of Tidal Stream

- The water level of Dongcheon downstream is variable due to a large tidal range (Effects of seawater reaches Gwangmu Bridge)
  - Tidal range: Macrotidal 113.6cm, Microtidal 40.2cm, **Average tidal range 76.9cm**
- Water quality and salinity in this stream can be greatly varied by seawater.
  - The great variation in volume, water quality and salinity makes it difficult for living organism to live.

Ebb tide

Full tide

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2.2 Analysis of Water Quality(1) : By Major Spots

Yearly Water Quality by Major Spots : Consistently Improved

- Better waterworks and the effects of seawater helped improve the water quality of the Dongcheon Stream
- Improved water quality with the operation of Jungang and Wyeongdo Sewage Treatment Plants since 2006 had a positive impact on the Dongcheon Stream.
- In 2006, Gwangmu Bridge 14.6(2.9~32.6), Beomil Bridge 9.4(4.5~22.9), Beomil Bridge 4.0(2.0~5.7)

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2.2 Analysis of Water Quality(2) : Salinity By Seasons

Variations in Salinity By Seasons in Major Spots

- In July, summer heavy rains bring huge inflow of fresh water into the uncovered part of the Dongcheon Stream (Brackish water area).
- Brackish water (0.5~20‰) provides a hospitable environment for living organism, temporarily increasing the population of mullet during summer (ex. Estuaries of the Nakdong River, the Han River, the Geum River etc.).
- Therefore, it is desirable to manage the Dongcheon as a waterfront stream by improving water quality and removing foul odors, not as an ecological stream (a habitat for fish, reed etc.) because fresh water can be flowed in only during the rainy season.

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## 2.2 Analysis of Water Quality (3) : General View

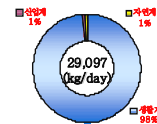
- Water quality of Dongcheon can be greatly affected by seawater.
  - Cleaner seawater helped improve the water quality of the Dongcheon downstream.
  - Dredging the downstream to clean up pollutants had a good impact. → **Continued dredging is required.**
- Many pollutants are flowed into Dongcheon due to a rainfall.
  - Rainfall brings an inflow of pollutants in filthy water from the road surface and overflowing water into the stream.
  - **Measures against a rainfall and regular dredging are required.**
- The shortage of dissolved oxygen caused by the lack of minimum flow makes it difficult for organisms to live.
  - Resulting in whitening, blackening and formation of scum
  - If a level of dissolved oxygen is maintained, living organisms including mullet can survive in the stream.
  - **It is necessary to secure water volume to maintain an appropriate level of oxygen (more than 2mg/L).**

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## 2.3 Research on Pollutants (1) : Amount of Pollutants

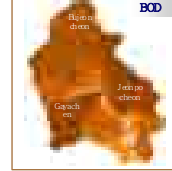
### Amount of Pollutants

#### Amount of BOD



- Research on the amount of pollutants produced by residents and factories
  - Household pollutants including sewage account for 98% of the total pollutants.
  - **Treating household sewage is important**

### Comparison between Dongcheon and other streams

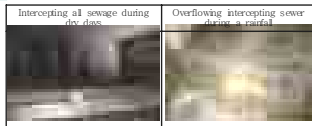


- Severity of pollution in Dongcheon and other streams
  - Gayacheon > Jeonpocheon > Dongcheon-Bujeoncheon > Hogecheon
  - Most streams have been covered.
  - **It is important to retrieve and manage sewage inside the covered section of stream.**

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## 2.3 Research on Pollutants (2): Problems in Covered Section

### Problems of Intercepting Sewer Overflowing during a Rainfall



### Precipitation of sediments and suspended matters on the stream bed



### Problems of Intercepting Culvert Overflow during a rainfall



### Bulkhead leakage

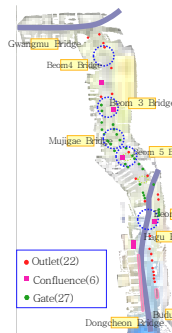


- During dry days, intercepting all sewage can dry up the stream, while during rainy days, sewage can overflow.

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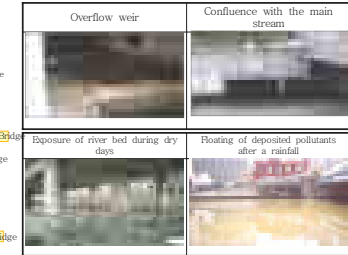
## 2.3 Research on Pollutants (3): Problems in Uncovered Section

### Problems of Uncovered Section



### Current Status and Problems

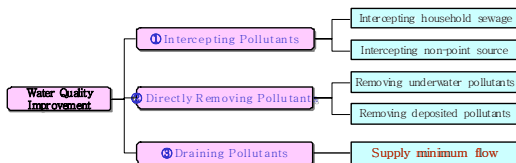
- Sewage is intercepted by the overflow weir in front of the outlet and the confluence, but some are overflowing during a rainfall



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## 2.4 Measures to Improve Water Quality: Direction and Structure

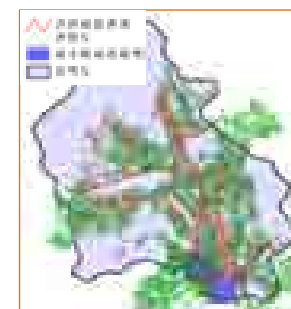
- Direction for water quality : Need to take measures to improve the water quality considering characteristics of Dongcheon
  - Measures to improve the water quality given that Dongcheon is a tidal stream.
  - Difficulties in securing a site due to a concentrated land use should be considered
  - Practical and timely measures considering economic effect, preventions against unpleasant odors should be taken.
- Structure of Water Quality Control
  - Phased approach includes intercepting pollutants, directly removing pollutants from the stream water and draining pollutants.



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## 2.4 Measures to Improve Water Quality: Blocking Pollutants : Current Sewage Treatment

### Current Sewage Treatment

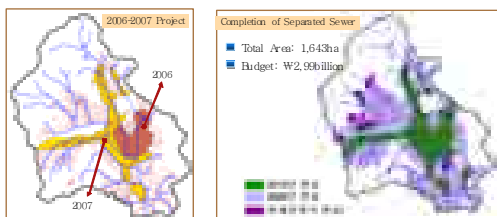


- Combined Sewer : Achieve 88.1% of household sewage (Nambu Sewage Treatment Plant, 340,000 tons of capacity)
- Separated Sewer : Achieve 25%
- Two Effects of Separated Sewer
  - During dry days, securing valley water
  - During rainy days, preventing sewage from flowing into the stream

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## 2.4 Measures to Improve Water Quality: Blocking Pollutants : Future Sewage Treatment

### Planned Project for Intercepting Sewer and Separated Sewer



- As of 2006 : Project completed 91ha(L=35km), Cost ₩75.1billion
- By 2013 : Project proposed 703ha(L=123km), Cost ₩1.62billion
- By 2020 : Project proposed 1,643ha(L=170km), Cost ₩2.98billion

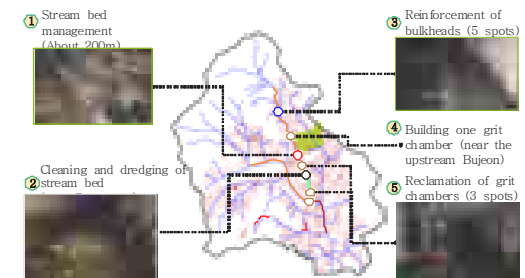
- The Bujeoncheon Stream and its surroundings with the availability of valley water should be managed first.

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## 2.4 Measures to Improve Water Quality: Blocking Pollutants : Cleaning and Reinforcing Sewer

### Cleaning and Reinforcing Sewer

- Measures: Stream bed management, reinforcement of bulkheads, reclamation of the grit chamber in the covered section of the stream (Building an upstream grit chamber), etc.



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## 2.4 Measures to Improve Water Quality: ② Directly Removing Pollutants : Removing Sediments

### Stream Bed Dredging

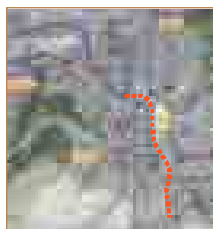
#### Current Dredging Work

- Section : Gwangmu Bridge-Budu Bridge (2,500m)
- Area : 120,000m<sup>2</sup>
- Width : 40~70m
- Period : 2004~2005
- Expenditure : ₩5.96 billion

#### Water Quality Improvement and Considerations

- Directly removing sediments on the bed
- Stream bed dredging for water control
- Dredging intervals to be extended with improved water quality
- Minimizing stream pollution in dredging

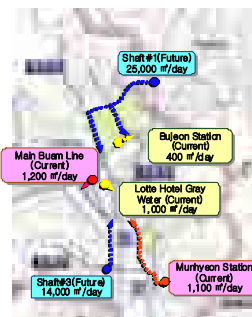
Section to be Dredged (Gwangmu Bridge-Budu Bridge)



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## 2.4 Measures to Improve Water Quality: ③ Draining Pollutants : Securing Minimum Flow (1)

### Measures to Attract Groundwater



#### Current Water (2,300m³/day)

- Groundwater from subway stations (Muriyeon Station, Buium Station)
- Variable depending on seasons and time

#### Obtainable Groundwater (1,400m³/day)

- Lotte Hotel gray water (1,000m³/day)
- Groundwater at Buium Station (400m³/day)

→ This can be a measure to obtain valley water

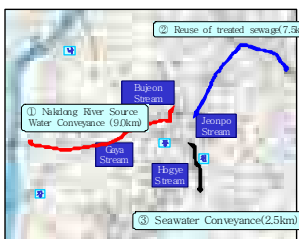
#### Measures to obtain more groundwater (from 2011)

- Groundwater from the shaft of Seod-Buium KIX
- Two shafts : Estimated 39,000m³/day
- Shaft#1(25,000 tons): Flow into the Buium Stream (Introduced after passing through Buium Valley Park)
- Shaft#3(14,000 tons): Bottom of the Gwangmu Bridge

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## 2.4 Measures to Improve Water Quality: ③ Draining Pollutants : Securing Minimum Flow (2)

### Measures to Obtain Additional Water Volume



#### Nakdong River Source Water Conveyance (L=9.0km)

- Excessive construction cost and need to consult with the Korea Water Resources Corporation
- Securing stable inflow

#### Reuse of discharged water from Suyeong Sewage Treatment Plant

- Need for advanced treatment, excessive construction expenditure
- Securing consistent inflow

#### Seawater Conveyance (Bottom of the Gwangmu Bridge)

- Given the characteristics of Dongcheon, it is possible, but unprecedented
- Improved water quality for uncovered section of the stream

\* Raising the height of the Seongjigok Reservoir (H=4m, 1,000 tons/day) : The heightening cannot guarantee the safety of the dike and water volume is not enough.

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## 2.4 Measures to Improve Water Quality: ③ Draining Pollutants : Comparison of Characteristics

### Measures to Secure Minimum Flow and Proposed Projects

Category	Valley Water Groundwater	Groundwater from KIX Line	Seawater Conveyance (2.5km)	Use of Nakdong River Source Water (9km)	Treated Water from Suyeong Sewage Treatment Plant (7.3km)
Supply	Valley Water: 1,000tons/day Groundwater: 1,400tons/day	125,000tons/day 214,000tons/day	3~60,000tons/day	3~60,000tons/day	3~60,000tons/day
Measures	Sewer, Stream Bed Management	Two Pump Stations Conveyance Pipe Installation	Relay Pumping Station Transfer Pipe Installation	Intake Station Installation Relay Pumping Station Installation Transfer Pipe Installation	Relay Pumping Station Installation Transfer Pipe Installation
Cost	₩300million	₩1billion	₩5.5bil (Maintenance: ₩250bil)	₩115bil (Maintenance: ₩300mil User Pay ₩1.4bil)	₩11.9bil (Maintenance: ₩300mil)
Advantage		Linking Public Park Low Construction Cost	Securing stable water volume Early effect of water quality improvement	Securing stable water volume	Securing stable water volume
Disadvantage	Little Water Volume Need to introduce other plans (Long-term)	Difficult to keep Stable Water Volume (Half of the Plan) Need to link other plans (Long-term)	Unproven and uncertain	Excessive construction and intake cost Need for cooperation among related agencies	Need for Advanced Treatment Need to introduce other plans (Long-term)

- Water quality indexes including dissolved oxygen are expected to improve, while restoring the biota
- Better self-purification of Dongcheon can improve the water quality in the North Port
- Freshwater minimum flow goes upward, while conveyed seawater goes downward, improving the overall water system

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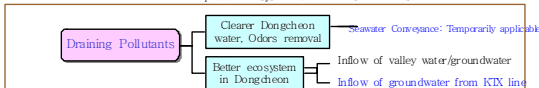
## 2.4 Measures to Improve Water Quality: ③ Draining Pollutants : General Views

### ③ Overall Evaluation of Minimum Flow for Draining Pollutants

Category	Measures to improve	DO Improvement (Quantity)	Bottom Materials Improvement	Economic Feasibility	Prompt Result (Time/ton)	Constructability	Overall	Note
Draining Pollutants	Inflow of valley water/groundwater	×	×	○	△	×	×	Shortage of minimum flow
	Groundwater from KIX line	△	△	○	△	○	○	Not timely Uncertain minimum flow
	Use of Nakdong River source water	○	○	×	○	△	×	Not economically feasible
	Treated water from Suyeong Sewage Treatment Facility	○	○	△	×	△	△	Not economically feasible Hazard of when to introduce the water
	Conveyance of seawater	○	○	○	○	○	○	Early water quality improvement

○ : Very Good ○ : Good △ : Average × : Little

- Securing Minimum Flow : Short-term - Inflow of Seawater → improved water quality and odors  
Long-term - Inflow of groundwater from KIX line  
→ Improved ecosystem with increased trashless area



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## 2.4 Measures to Improve Water Quality: ④ Feasibility Study on Seawater Conveyance : Case(1)

### Seawater Conveyance to a Stream (Toi Stream (土居川) in Sakai City, Japan)

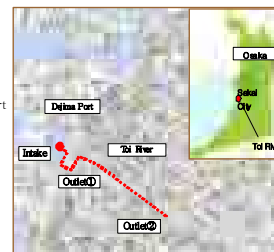
- Why : To reduce or remove blackening, whitening and odors from Toi Stream
- How : Convey seawater to improve the water quality of the stream

Volume : 12,000m³/day

Outlet : Mid and upstream (Two)

Intake : Sakai (Dojima) fishing port

Water Pipe : L=1,660m



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## 2.4 Measures to Improve Water Quality: ④ Feasibility Study on Seawater Conveyance : Case(2)

### Similarities of Water Pollution between Toi Stream and Dongcheon

- A tidal stream, strongly affected by the sea with no natural inflow and stationary water
- Long setting and sedimentation of pollutants on the bed, due to deposited organisms
- Serious upstream pollution and the formation of blackening, whitening and scum
- Stream is oxygen deficient, so inhospitable to biota

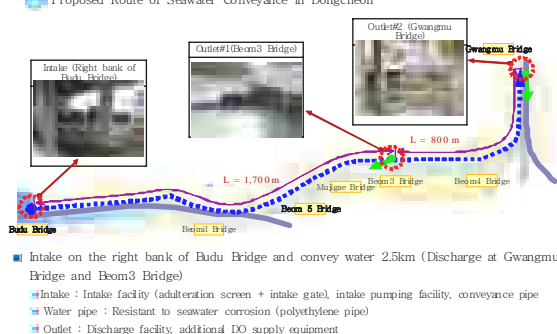
### Cases of Seawater Conveyance (Comparison between Toi Stream (土居川) in Japan and Dongcheon in Korea)

Category	Toi Stream	Dongcheon (Gwangmu - Budu Bridge)
Length	L=2.12km	L=2.5km(Open Zoon)
Width	30~50m	40~70m
Goal	-Summer: Above DO 2.0mg/L	-Summer: Above DO 2.0 mg/L
Water Quality at Intake (ppm)	-DO: 6.3, COD: 4.3, T-N: 1.0, T-P: 0.09 (2006.07~09)	-DO: 5.9, COD: 1.0, T-N: 0.6, T-P: 0.06 (2007.06)
Pipe Length	~1.6km	~2.5km
Volume	~12,000m³/day (Two Outlets)	~30,000m³/day (Two Outlets)
Construction cost	¥400mil (Maintenance ¥10mil+15mil)	₩5.5bil (Maintenance ₩2.5bil)

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## 2.4 Measures to Improve Water Quality: ④ Feasibility Study on Seawater Conveyance

### Proposed Route of Seawater Conveyance in Dongcheon



Intake on the right bank of Budu Bridge and convey water 2.5km (Discharge at Gwangmu Bridge and Beom3 Bridge)

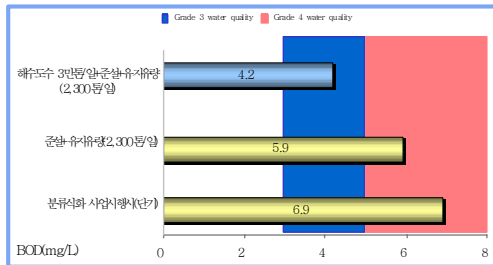
- Intake : Intake facility (adulteration screen + intake gate), intake pumping facility, conveyance pipe
- Water pipe : Resistant to seawater corrosion (polyethylene pipe)
- Outlet : Discharge facility, additional DO supply equipment

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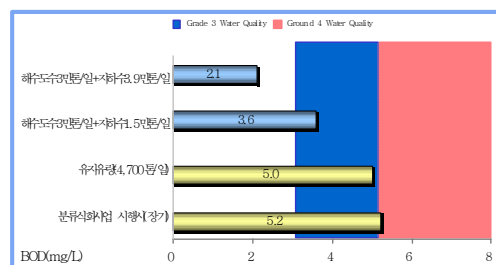
## 2.4 Measures to Improve Water Quality: Short-term Measures

- Short-term Goal for Water Quality (By 2013) : BOD 4~5mg/L, Grade 3 Stream
- Short-term goal focuses on water quality improvement, environment beautification and odors removal ⇒ Aims to become a waterfront stream
- Measures for water quality : Sewerwater conveyance (30,000tons/day), separated sewer installation, dredging works, etc.

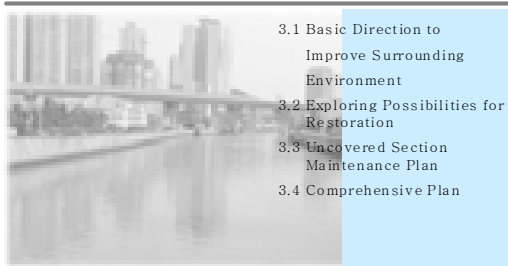


## 2.4 Measures to Improve Water Quality: Long-term Measures

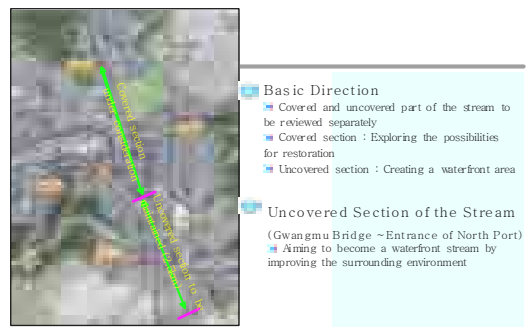
- Long-term Goal for Water Quality (by 2020): BOD 3~4mg/L, Grade 3 Stream
  - Long-term goal focuses on brackish water area where fresh water is mixed with seawater ⇒ Aims to become an ecological stream
  - Measures for water quality: Seawater conveyance (30,000tons/day) + fresh water (39,000tons/day including KIX groundwater), separated sewer installation, etc.



### 3. Plans to Improve Surrounding Environment



### 3.1 Basic Direction to Improve Surrounding Environment



### 3.2 Exploring Possibilities for Restoration : Basic Approaches



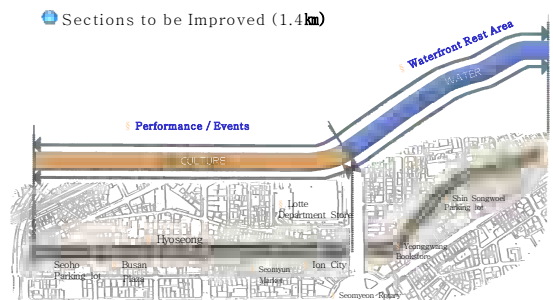
- Improving the surrounding environment by linking a public park with uncovered section of the stream
- Building a walking track from the public park to Seomyeon (Planting trees and flowers and establishing fountains)
- Need to review the transportation system after the creation of a walking track
- Better Transportation System
  - 4 lanes → 2 lanes (sidewalk and road)
- Measures for the closure of roadside parking lot
  - Discouraging to build a parking building
- Given the restoration in the long-term, the roads need to be reduced.

◁Example of a walking track▷



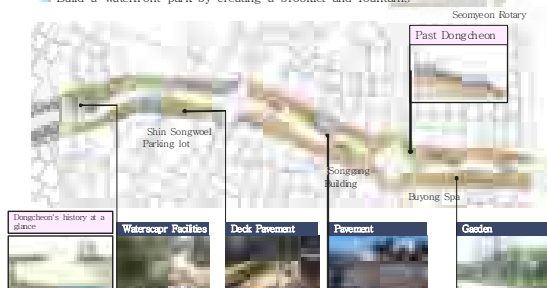
### 3.2 Exploring Possibilities for Restoration: Concepts by Sections

 Sections to be Improved (1.4km)





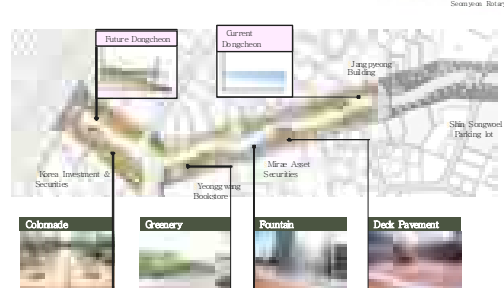
### 3.2 Exploring Possibilities for Restoration: Waterfront Area(1)

- Waterfront Area 1...Waterfront Area
- To assure the coexistence of roads and sidewalk, curved roads and stone pavement are needed.
- Build a waterfront park by creating a brooklet and fountains.
- KEY MAP
- Waterfront Area
- Lotte Department Store



### 3.2 Exploring Possibilities for Restoration: Waterfront Area(2)

-  Waterfront Area 2...Water
-  Create an area of forest and water with greenery and fountains



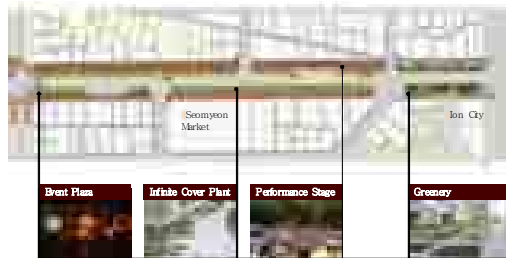


### 3.2 Exploring Possibilities for Restoration: Cultural Area(1)

#### Cultural Area 1...Culture

- Straight roads for smooth vehicle flow
- Create a street with event plaza and outdoor stage for performances

#### KEY MAP



Serve as an **agora** by making the area car-free (a stage for cultural performances)  
ex. Around Daehakno in Seoul

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### 3.2 Exploring Possibilities for Restoration: Cultural Area(2)

#### Cultural Area 2...Culture

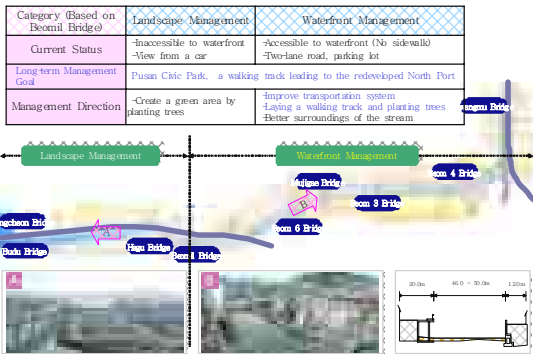
- Create an area for exhibitions and cultural events such as outdoor gallery, exhibition walls, etc.
- Outdoor free market linking Seomyeon Market

#### KEY MAP



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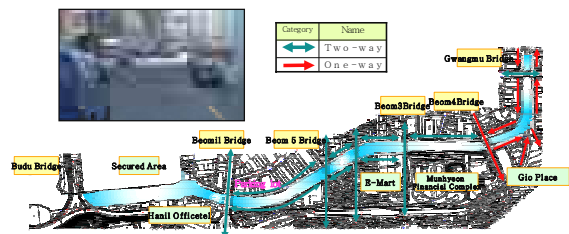
### 3.3 Uncovered Section Management Plan : Current Status and Management Direction



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### 3.3 Uncovered Section Management Plan : Current Transportation System

- Analysis of Current Transportation System to Build a Waterfront Walking Track
- Gwangmu Bridge-Boom4 Bridge : One-way road, difficult to create a walking track on the road
- Boom4 Bridge-Boomil Bridge : Both banks of a stream are two-way, two-lane roads and some sections are being used as parking space.

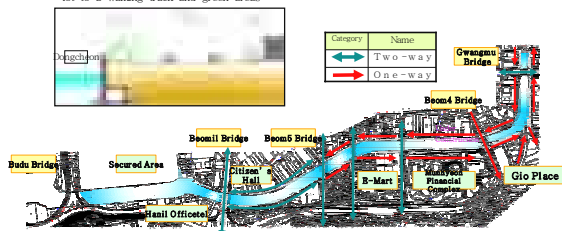


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### 3.3 Uncovered Section Management Plan : Plans for Better Transportation

#### Measures for a Better Transportation to Build a Walking Track

- Gwangmu Bridge-Boom4 Bridge : Difficult to change transportation system, establish a waterfront deck in line with efforts to improve water quality
- Boom4 Bridge-Boomil Bridge : One-way roads on the both sides and phased construction of a walking track
- Boom5 Bridge-Boomil Bridge : Maintain the current two-way roads, transform the parking lot to a walking track and green areas

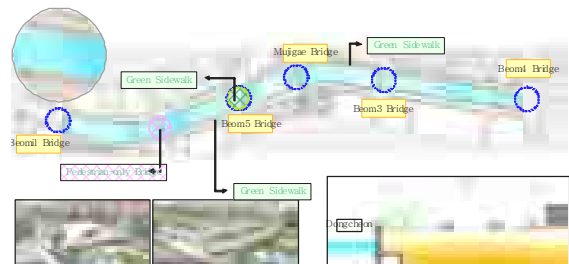


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### 3.3 Uncovered Section Management Plan : Creating and Supplementing a Walking Track

#### Measures to Create and Supplement a Walking Track

- Direction for a new walking track Plan to create a green area and a walking track from Gwangmu Bridge to Boomil Bridge
- Measures to supplement the existing one : Build one bridge exclusive to pedestrians (Boom5 Bridge-Boomil Bridge, L=500m)

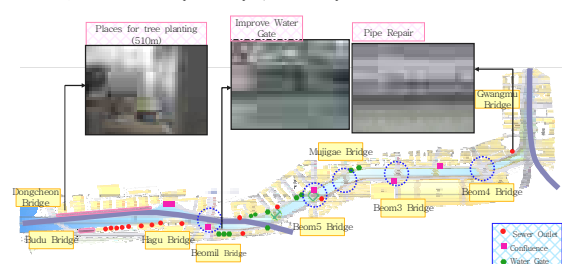


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### 3.3 Uncovered Section Management Plan : Bank Management (1)

#### Develop a Waterfront to Clean the Both Banks of Dongcheon

- ◇ Sewer Pipes : Fix leaking pipes or pipes exposed to the bank (14 spots)
- ◇ Confluence (6 spots) : Regular clean-up
- ◇ Water Gate (11 spots) : Repair, clean and paint sewer outlets



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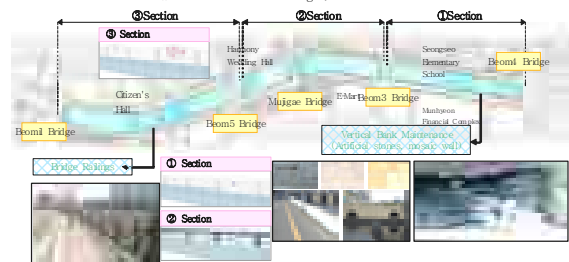
### 3.3 Uncovered Section Management Plan : Bank Management (2)

#### Improve the Surrounding Environment of Vertical Banks

- ◇ Views from a moving car : Artificial stones and mosaic wall

#### Embankment Maintenance

- ◇ Artificial stones and railings (Improve the sidewalk by establishing railings in accordance with the embankment height)

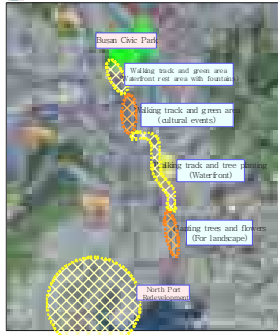


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### 3.4 Comprehensive Plan

#### Maintenance Plan by Sections



- Covered Section (3,4 Sections of Bujoncheon)
  - Walking track and tree planting
    - Section 3 : Waterfront place for rest with fountains and etc.
    - Section 4 : Street for cultural events and performances
- Uncovered Section (Gwangmu Bridge~North Port Entrance)
  - Gwangmu Bridge~Beomil Bridge : Walking track and tree planting (Waterfront Development )
  - Beomil Bridge~North Port Entrance: Planting trees and flowers (Landscape Development)

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### 4. Yearly Investment and Funding Source

#### 4.1 Yearly Plans



#### 4.1 Yearly Plans

														(Unit : million won)	
Category	Short-term (~2013)						Long-term (~2020)								Note
	08	09	10	11	12	13	14	15	16	17	18	19	20		
Water Quality Management	S e w e r M a i n t e n a n c e													Special account for sewage	
			Sewer inflow 5,600						Valley water, KDX groundwater inflow 1,800					Local budget	
														Local budget	
Land Use Plan	S e d i m e n t s D r e d g i n g													National and local budget	
									15,000					Local budget	
														Local budget	
Total	2,100	3,600	4,600	6,100	2,600	3,400	1,700	3,200	2,700	3,200	4,400	4,400	4,400	Total cost 46,400	

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Thank you for your attention

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