



Low Impact Development of City Wall-Canal System from Urban Segregator to Green Archival Linkage
-----“Sponge City” Rejuvenation Design of Historic Eastern Water Gate Area of Nanjing

Abstract & Key Words



ABSTRACT: The city wall-canal system forms the structure of Nanjing's landscape pattern. However modern development not only erodes the public space along it, pollutes the Qinhuai River, but also results in urban waterlogging. This article starts from the study of the area inside and around city wall of Nanjing and proposed the "Green Belts" strategy as the green infrastructure to stitch the broken city wall-canal system on urban level. On local level, it zooms in the eastern water gate district as the most contentious site based on a series of site analysis and proposes the "cut-remove-suture-grow" strategy. As to the detailed design, this article proposes the concept of nine water processing systems for storm water and flood management and rainwater harvesting integrated with the conservation of city wall under the low impact development mode. Then the concept is further developed through the detailed design of 4 subdivided sites.

Keywords: City Wall-Canal System, Nanjing, Eastern Water Gate Area, Low Impact Development, Storm Water and Flood Management, Green Infrastructure, Conservative Planning and Design.

1.Introduction



Located in the lower Yangtze River drainage basin and Yangtze River Delta economic zone, Nanjing is recognized as one of the Four Ancient Capitals of China. It has been the capital of China in above ten dynasties and thus prestigious of cultural heritage since the Three Kingdom period including the existing city wall and canal system. Nanjing has gone through the vicissitudes of urban development in parallel to the construction of city wall-canal system.

But in modern times, Nanjing has spread far across the city wall for new development. And the city wall-canal system no longer functions as the traditional military defense, transportation channel and water facilities. Consequently, public space along it is eroded and it leads to many problems, such as culture recession, river pollution, flooding and overflow due to the malfunction of sewage infrastructure, community segregation on two sides of the city wall-canal system.

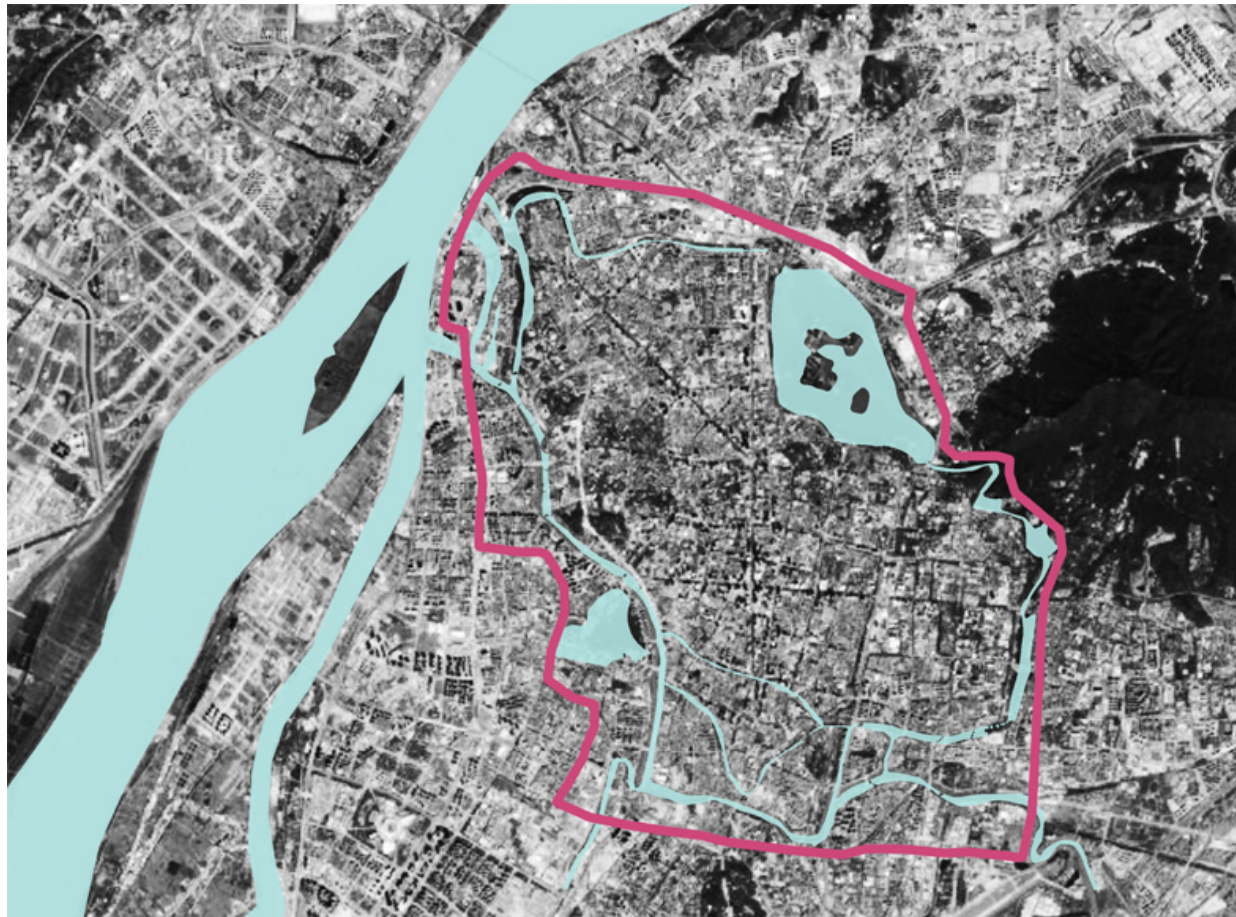


1.Introduction

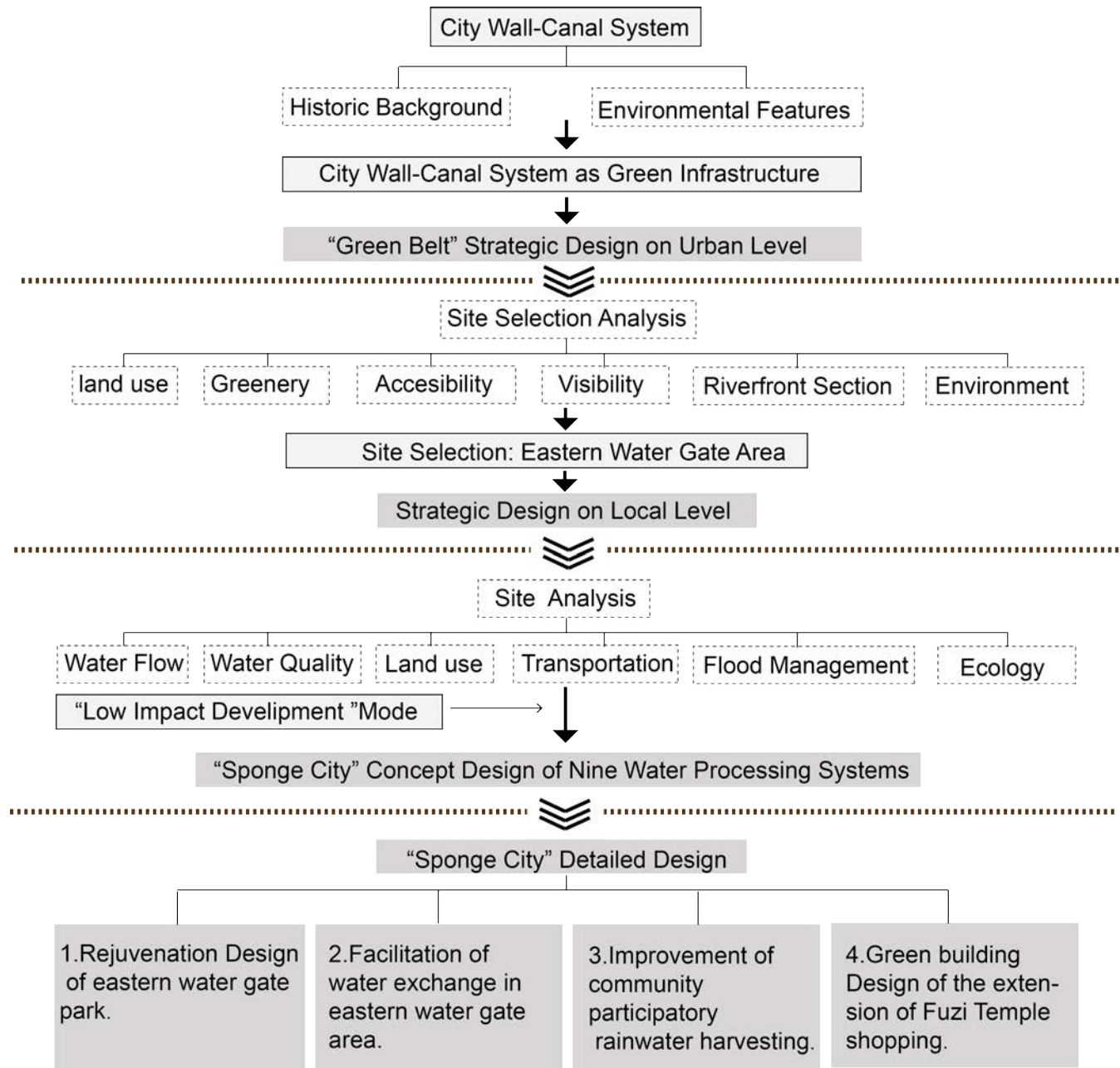


This paper focus on the historic walled city area (figure1) of Nanjing to study the impact of modern development on environment of space along city wall-canal system and proposeS “Low impact development” oriented solutions alternatively to restore the hydrological, ecological and social function of the city wall-canal system.

- Studied area



2.Methods



3. Analysis and strategic design on urban level



3.1 Historic background of city wall-canal system in Nanjing

- City wall and canal system

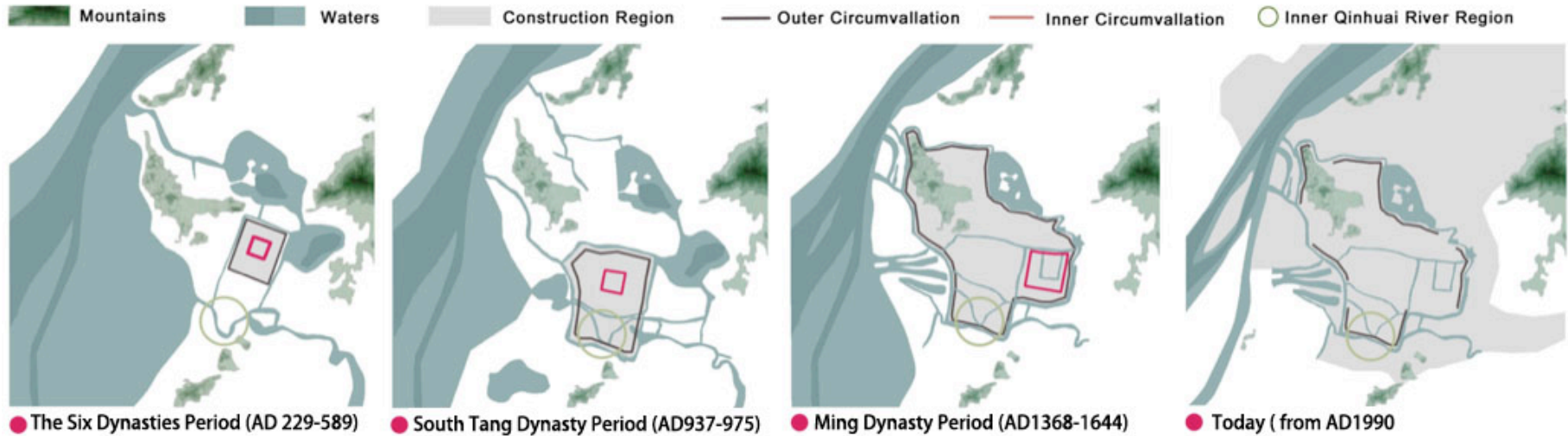


3. Analysis and strategic design on urban level

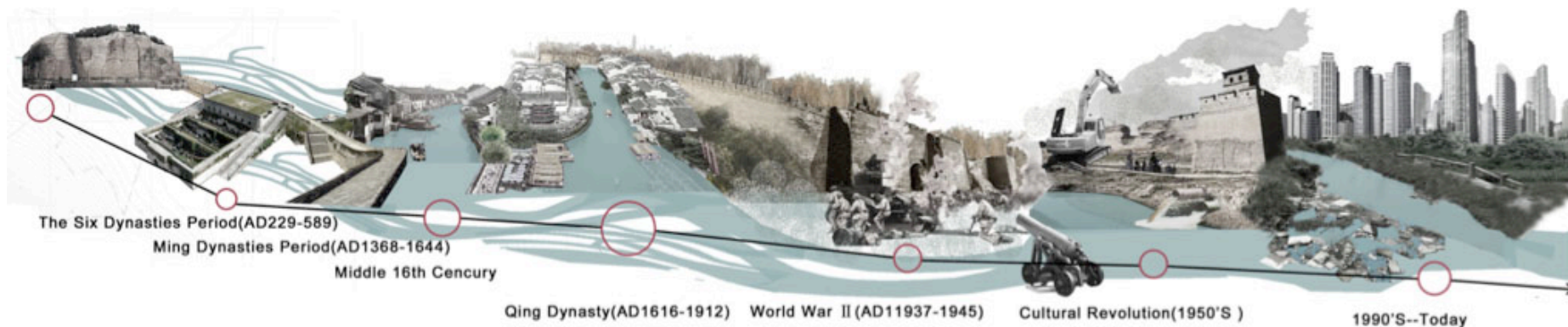


3.1 Historic background of city wall-canal system in Nanjing

- Urban sprawling process of Nanjing.



- Vicissitudes of city wall-canal system.

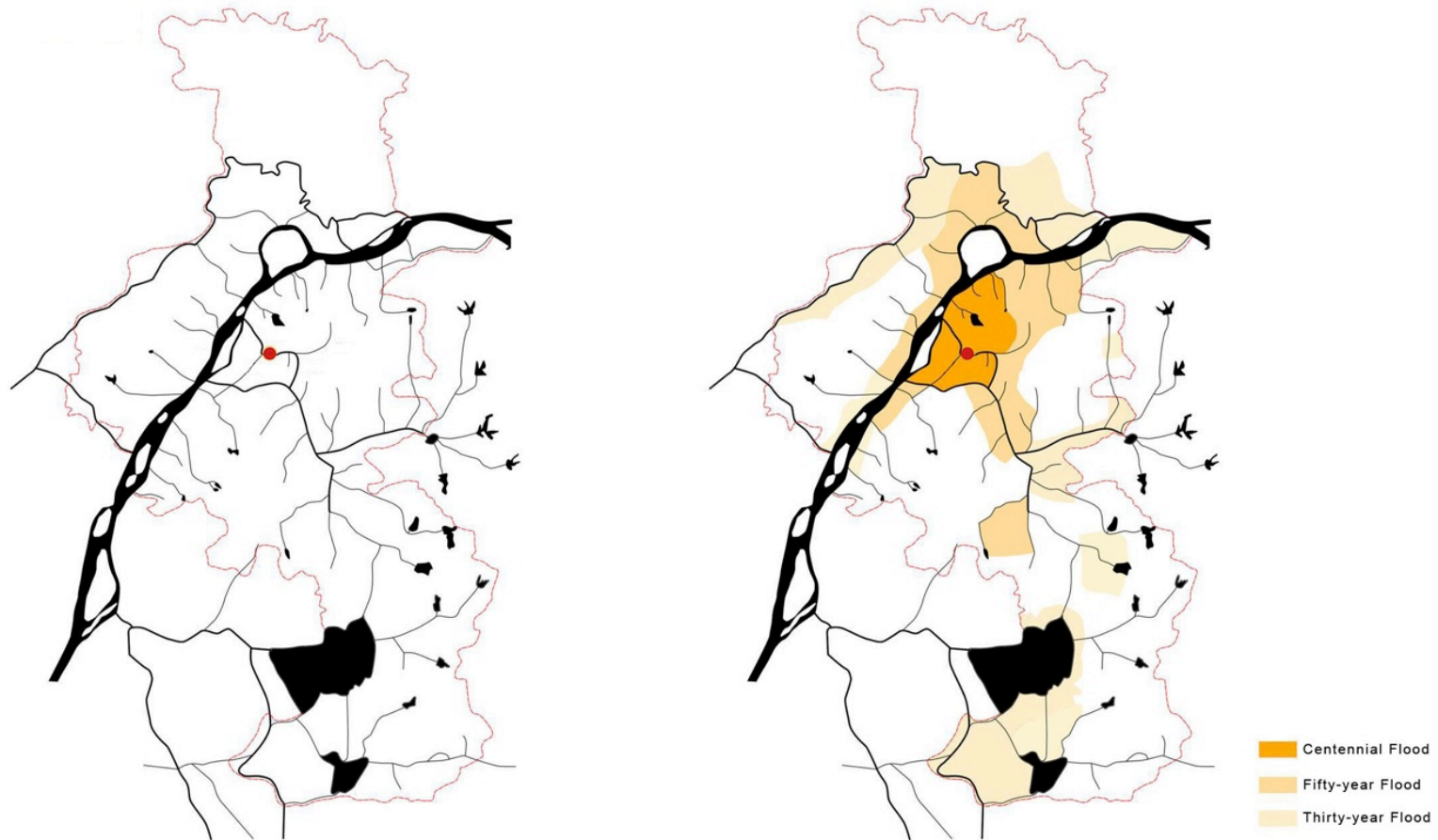


3. Analysis and strategic design on urban level



3.2 Environmental features of city wall-canal system in Nanjing

- Hydrological adjusting function of Qinhuai river .

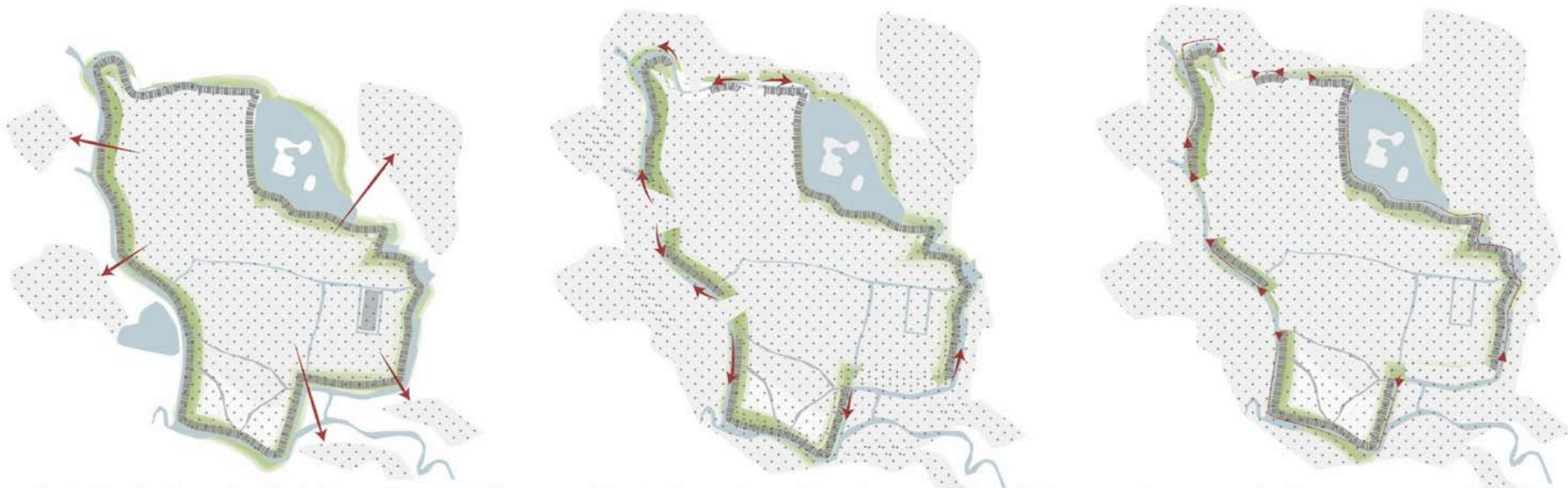


3. Analysis and strategic design on urban level



3.2 Environmental features of city wall-canal system in Nanjing

- Encroachment of the green public space along the city wall-canal system



3. Analysis and strategic design on urban level

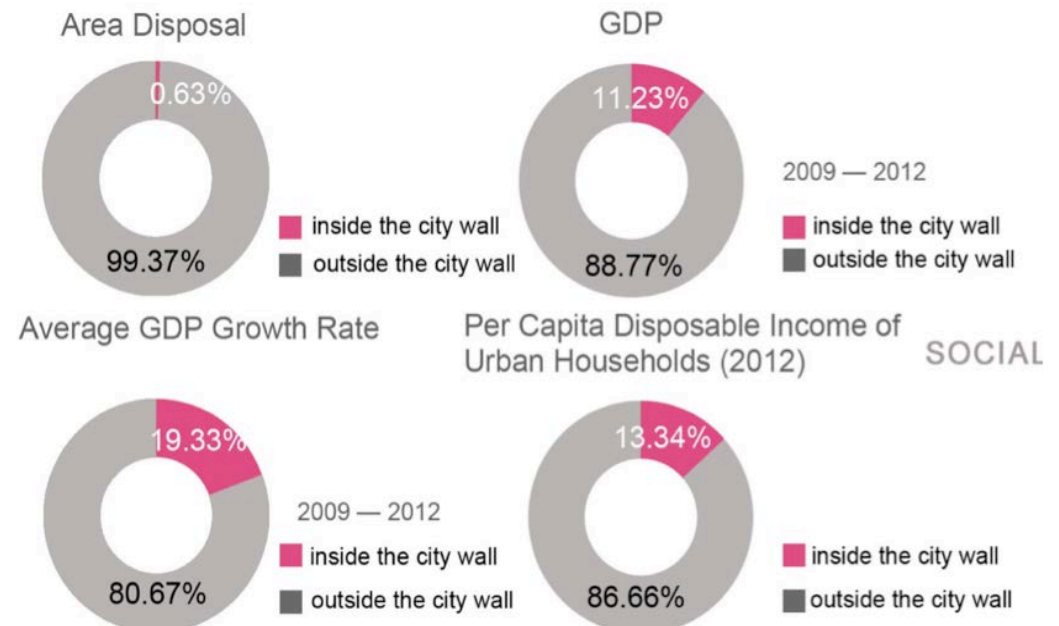


3.2 Environmental features of city wall-canal system in Nanjing

- **Encroachment of the green public space along the city wall-canal system**

This emergency of the city wall-canal system leads to many ensuing problems:

- (1). Fracture of cultural context, disappearance of traditional life and fabric and vandalism of traditional buildings ;
- (2). Inner city waterlogging and the exacerbation of the hydrological environment ;
- (3). Segregation of social groups inside and outside of the city wall-canal system.

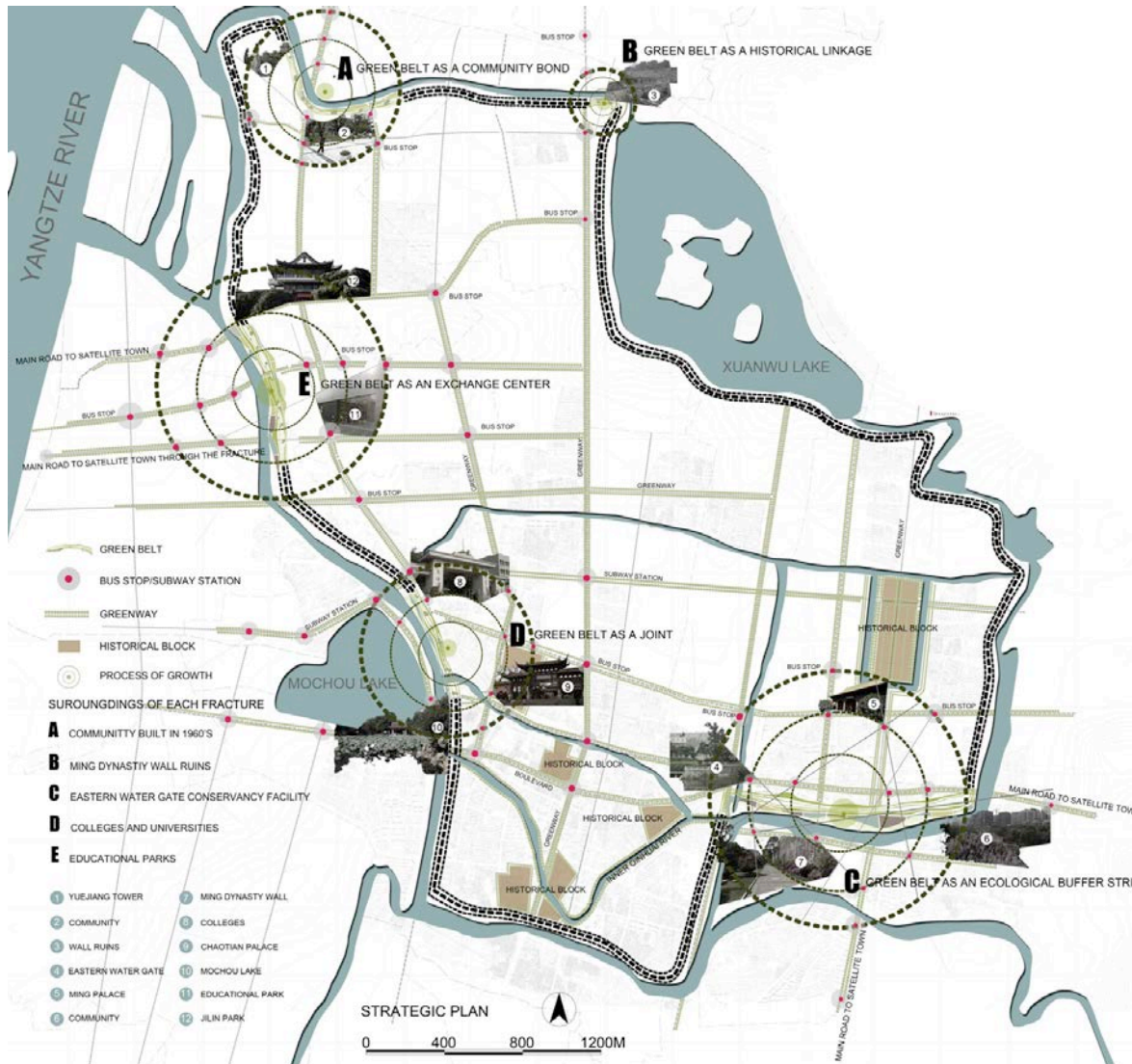


SOCIAL

3. Analysis and strategic design on urban level



3.3 "Green Belt" strategic design on urban level

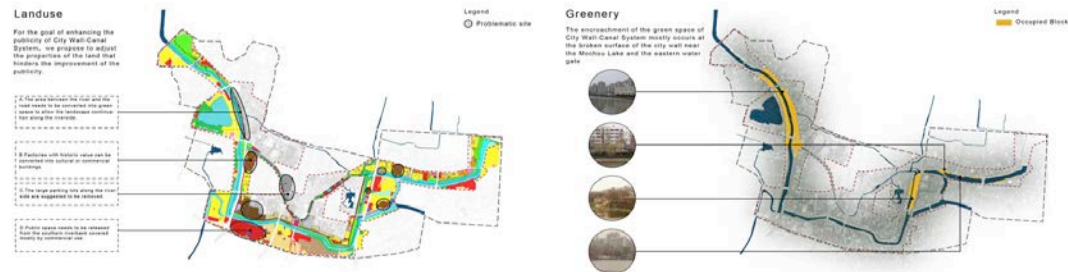


4. Analysis and strategic design on local level

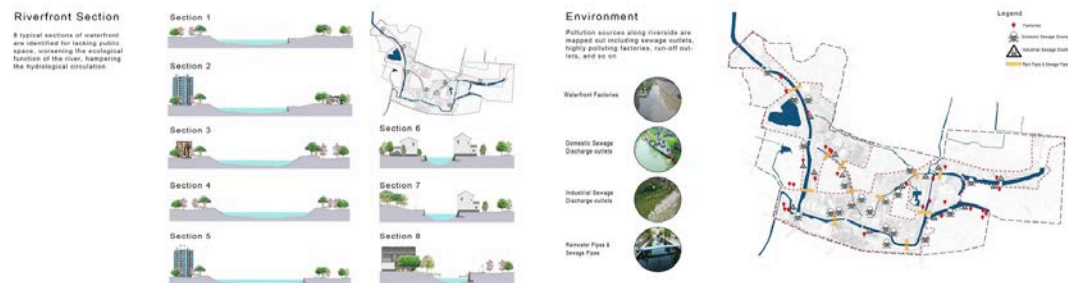
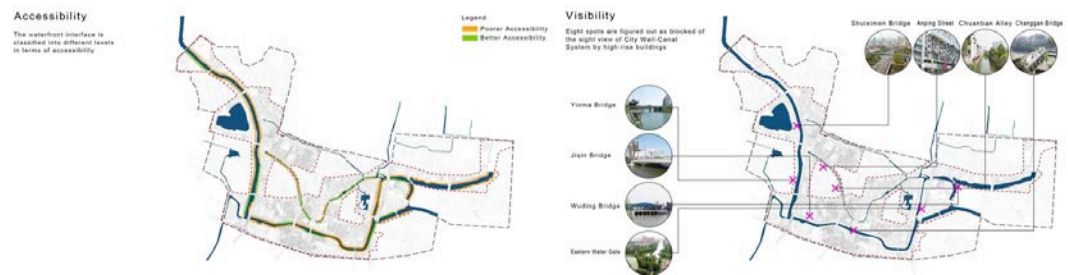


4.1 Site selection analysis for strategic design of critical area on local level

- Single factor analysis



- (1). Landuse
- (2). Greenery
- (3). Waterfront accessibility
- (4). Visibility
- (5). Waterfront section
- (6). Pollution source



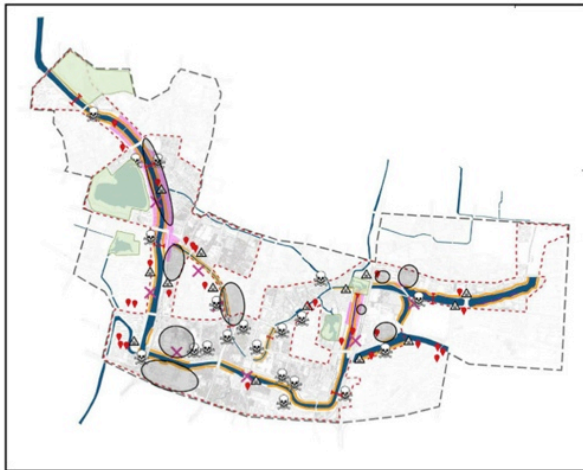
4. Analysis and strategic design on local level



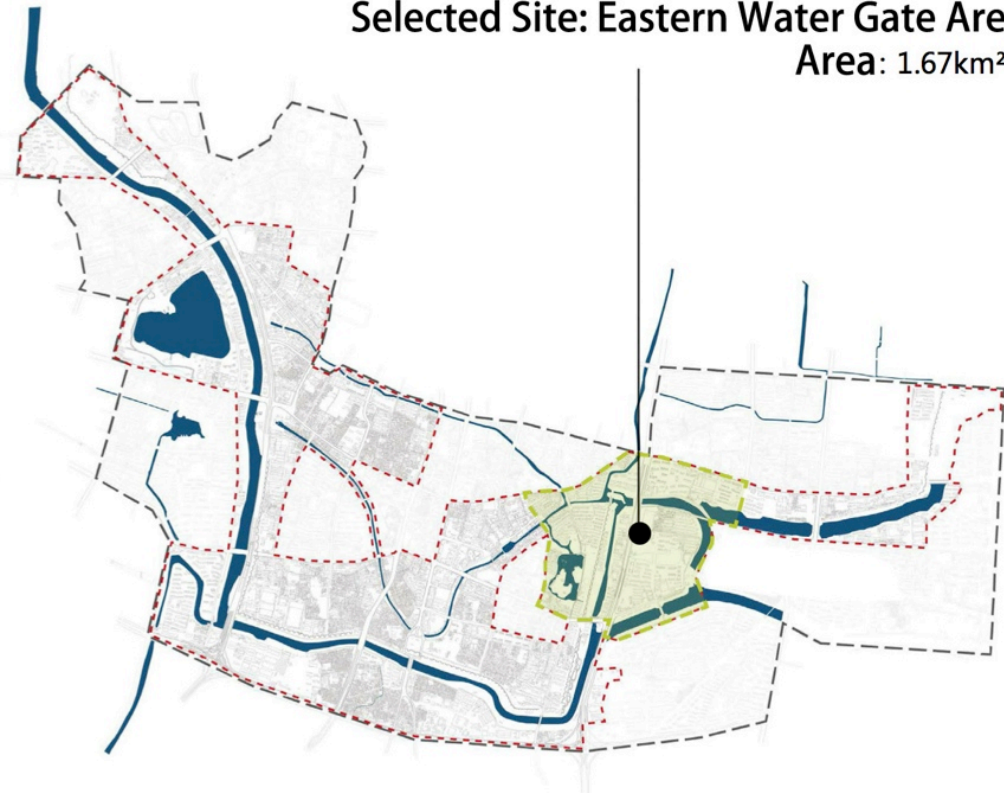
4.1 Site selection analysis for strategic design of critical area on local level

- Superposition of different factors

Superposition of different factors



Selected Site: Eastern Water Gate Area
Area: 1.67km²

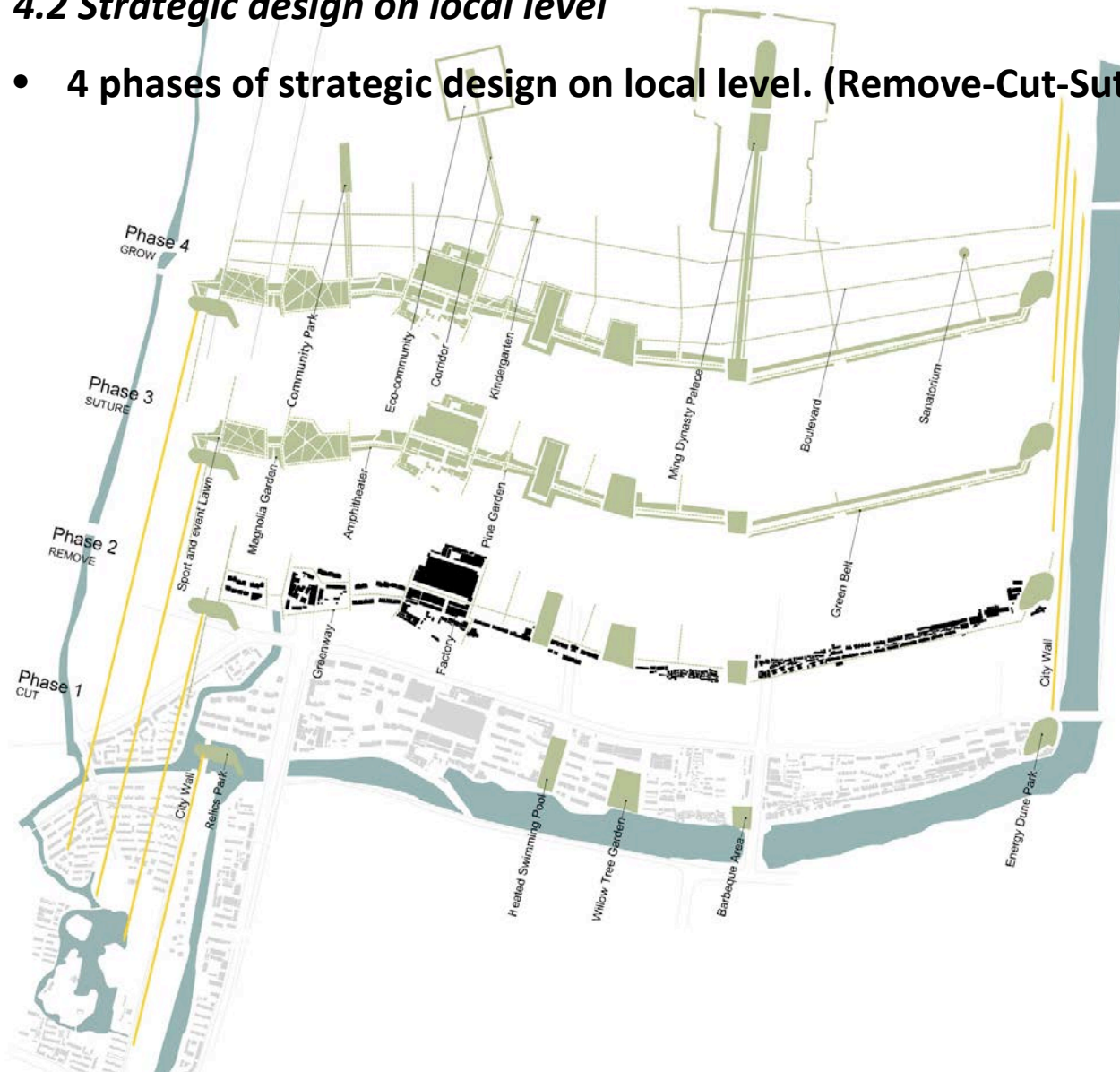


4. Analysis and strategic design on local level



4.2 Strategic design on local level

- 4 phases of strategic design on local level. (Remove-Cut-Suture-Grow)

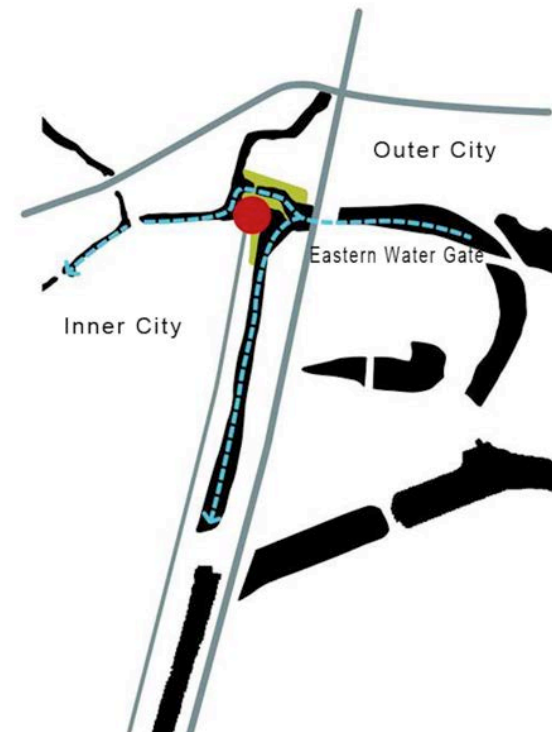


5. Site analysis and concept design of eastern water gate area



5.1 Site analysis of eastern water gate area

- Satellite map of eastern water gate area



- Images of eastern water gate

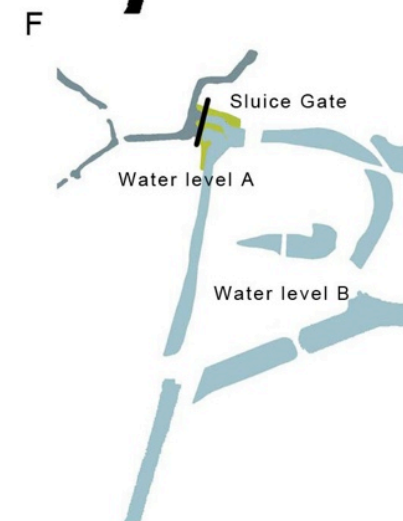
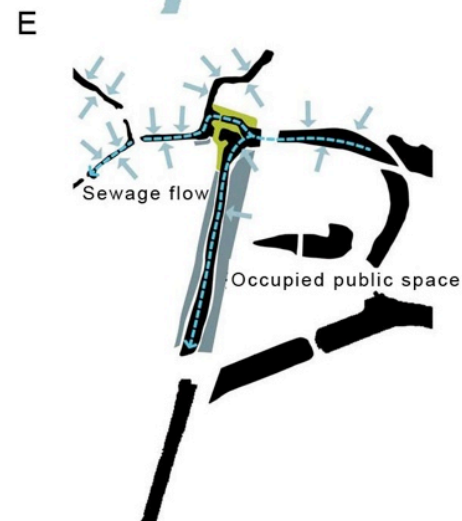
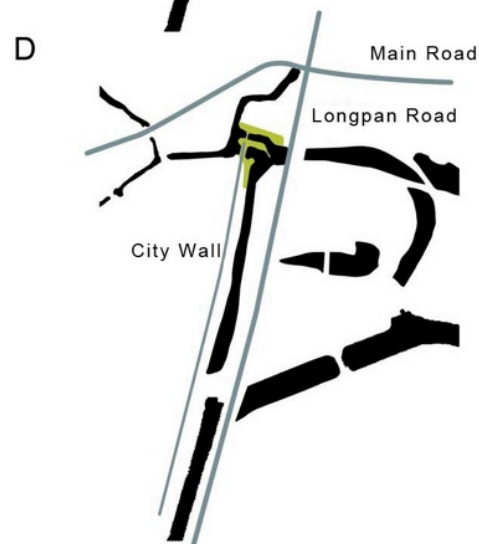
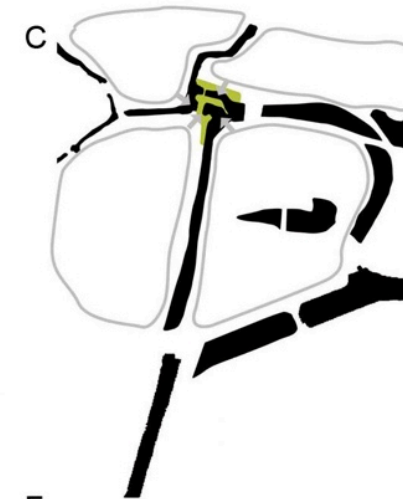
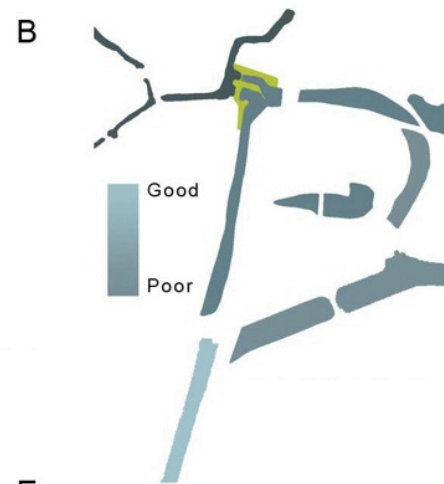
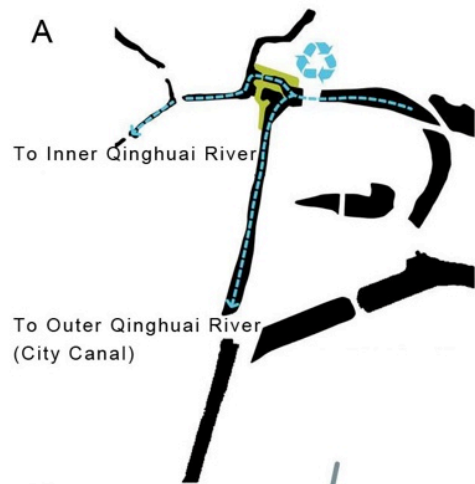


5. Site analysis and concept design of eastern water gate area



5.1 Site analysis of eastern water gate area

- (a) Water flow. (b) Water quality. (c) Accessibility. (d) Transportation. (e) Pollution. (f) Flood control.



5. Site analysis and concept design of eastern water gate area



5.2 Low impact development mode

“Low impact development” mode is an approach to land development or redevelopment which integrates nature to manage urban hydrology to minimize the impact on site. It involves principles such as treating stormwater close to its source, minimizing imperviousness to create functional and promoting site drainage to treat stormwater as a resource instead of a waste product. There are many techniques and green infrastructures integrated into the process of water permeation, retention, storage, recycling and drainage such as bio-retention facilities, water purification pipes, rain gardens, and permeable pavements. By applying “low impact development” mode, urban hydrology is managed in a way that prevents urban waterlogging, reduces runoff pollution, promotes water recycling and restores a watershed's hydrologic and ecological functions which could be further integrated with aesthetic and historic features.

5. Site analysis and concept design of eastern water gate area



5.3 "Sponge City" concept design of nine water-processing systems

1. Bailu Community



2. Bailu Wetland Park



3. Rainwater Harvesting of City Wall



4. Inner Qinhuai River Water Management



5. Outer Qinhuai River Water Management



6. Qingshuitang Community



7. Linear wetland of City Wall



8. Rainwater Harvesting of Green Commercial Complex



9. Biotopes of Green Commercial Complex



5. Site analysis and concept design of eastern water gate area



5.3 “Sponge City” concept design of nine water-processing systems

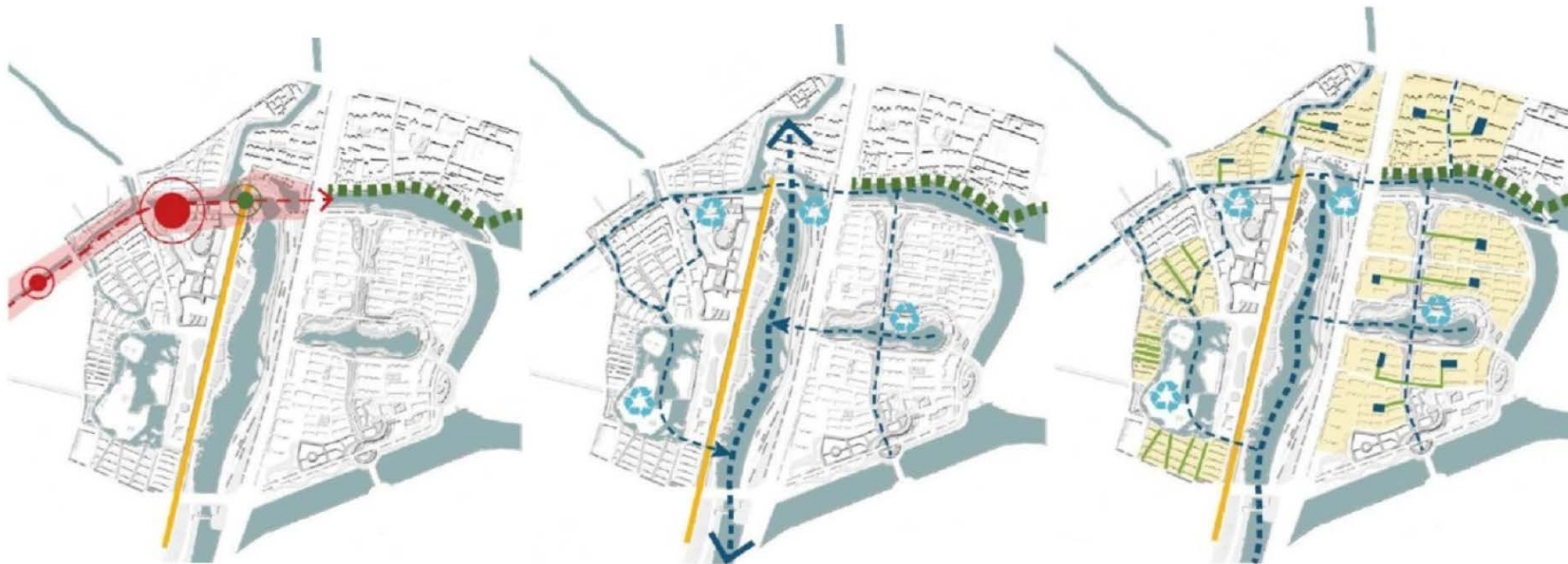
- (1). The flood control and water level adjustment function of eastern water gate is rehabilitated by constructing 3 new water sluice valves for flood control and storm water management in 4 different phases.
- (2). The shopping street in Fuzi temple historic area is extended to the eastern water gate integrated with the water processing and harvesting facilities through vertical greenery and complex design of landscape and amenities.
- (3). Three biotopes are distributed in the green shopping street to purify, recycle the rainwater in sequence.
- (4). The storm water is recycled and reused within the buildings of Bailu community, cleaned of sedimentation when channeled to Bailu park for further purification.
- (5). The rainwater is collected and pumped away to prevent the corrosion of the city wall.
- (6). The water collected from city wall and purified in Bailu park infiltrates through linear wetlands and partly diverted into outer Qinhuai river.
- (7). The purified water of Bailu park is discharged into outer Qinhuai river to be diverted into Qingshui pond.
- (8). Qingshuitang community is reformed gradually for community participatory rainwater harvesting. The green public space is used as play grounds in dry seasons and water cistern in rain seasons and the water from the cistern is further transported into Qingshui pond for bio-purification and sedimentation.
- (9). The water of outer Qinhuai river is exchanged through eastern water gate facilities and flows into inner Qinhuai river before purification through linear wetland along the city wall. The nine water processing systems in this area confluence into the flood detention area in the Qingshui pond and wetland park for further sedimentation, bio-purification and supplement to underground water storage.

6. “Sponge City” detailed design of eastern water gate area



6.1 Design strategies

- Rejuvenation Design of eastern water gate park;
- Facilitation of water exchange in eastern water gate area;
- Improvement of community participatory rainwater harvesting;
- Green building Design of the extension of Fuzi Temple shopping center.

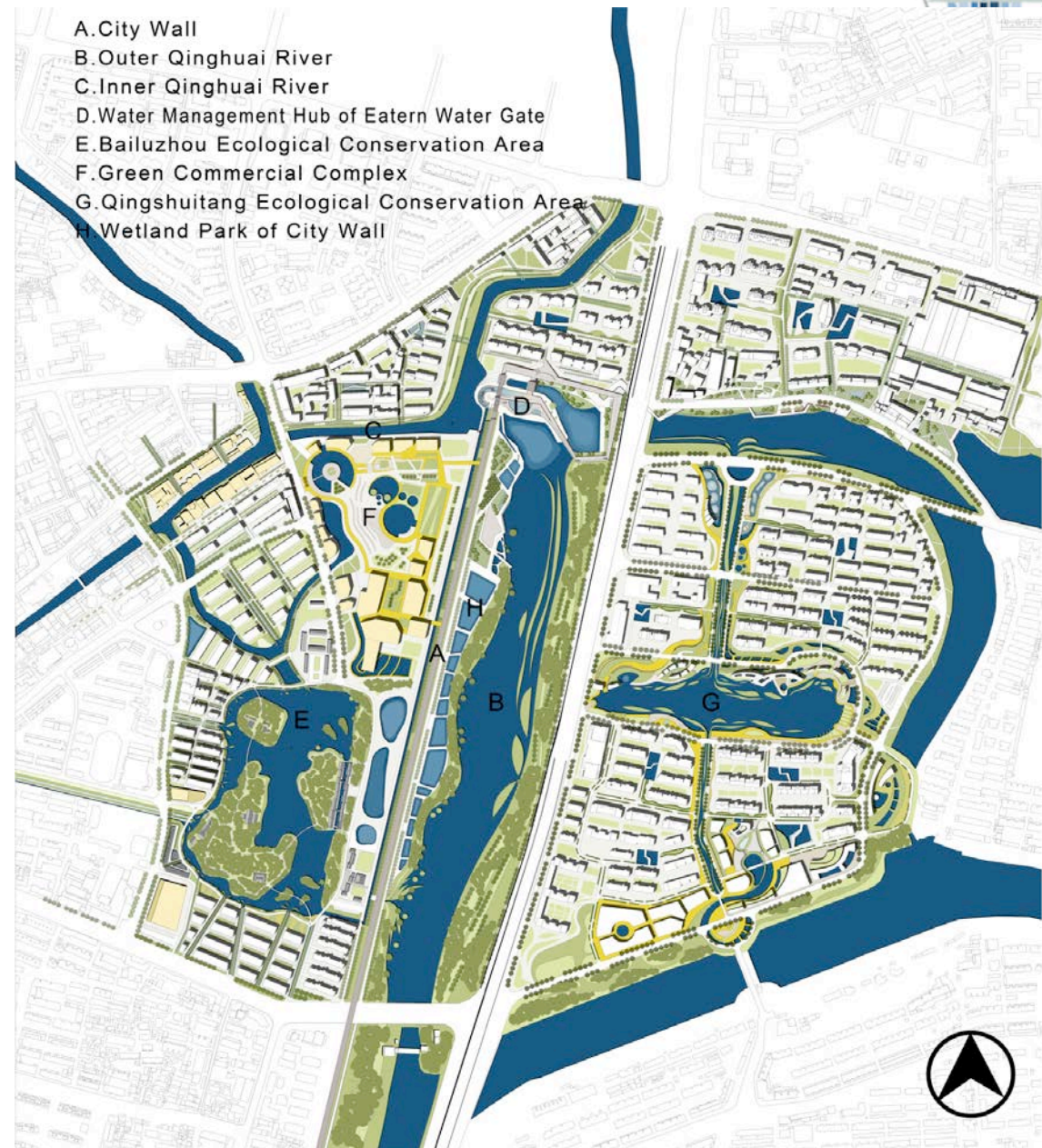


6. “Sponge City” detailed design of eastern water gate area



6.1 Design strategies

- Plan of the “Sponge City” detailed design of eastern water gate area.

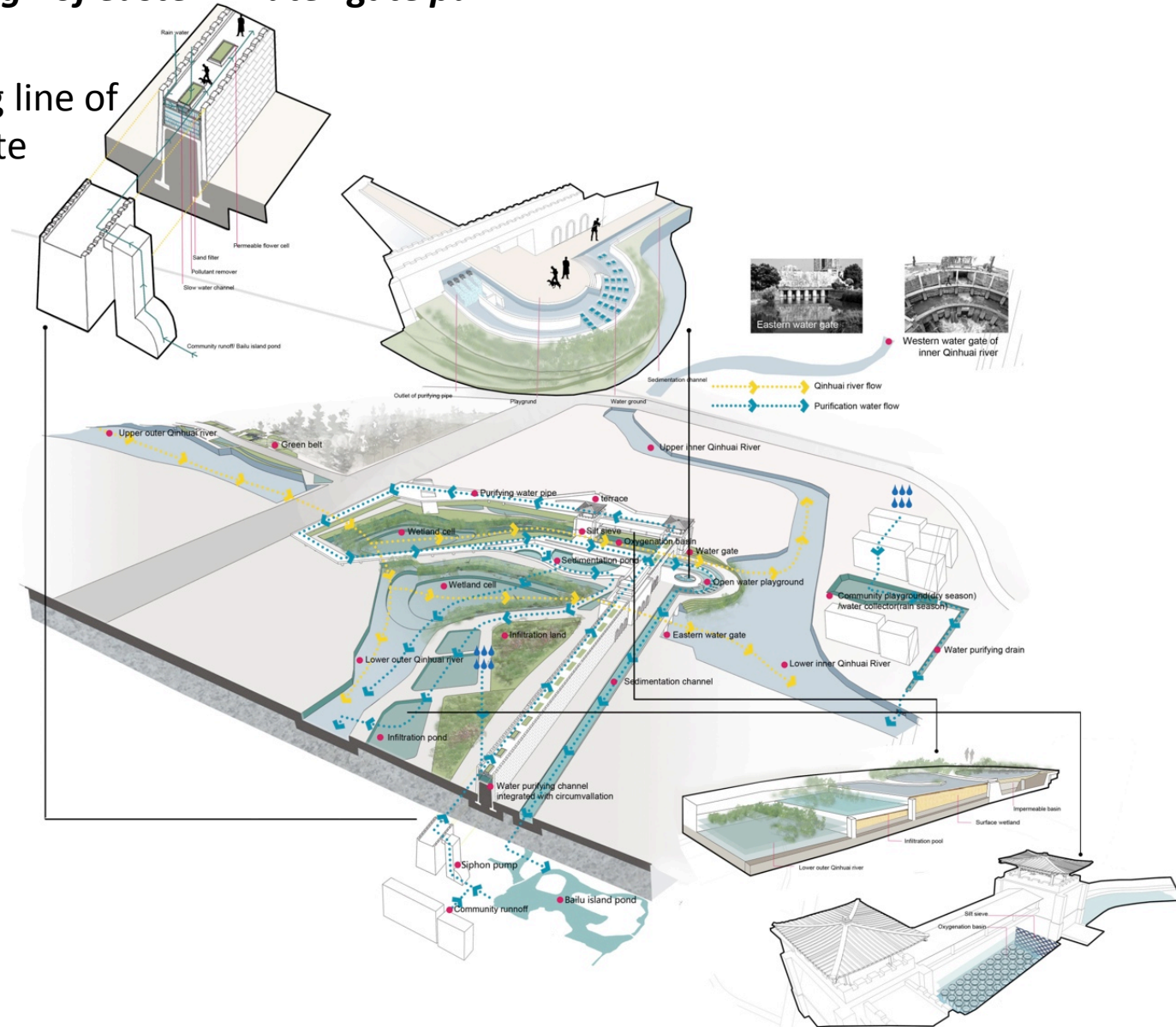


6. "Sponge City" detailed design of eastern water gate area



6.2 Rejuvenation Design of eastern water gate park

- Water processing line of eastern water gate

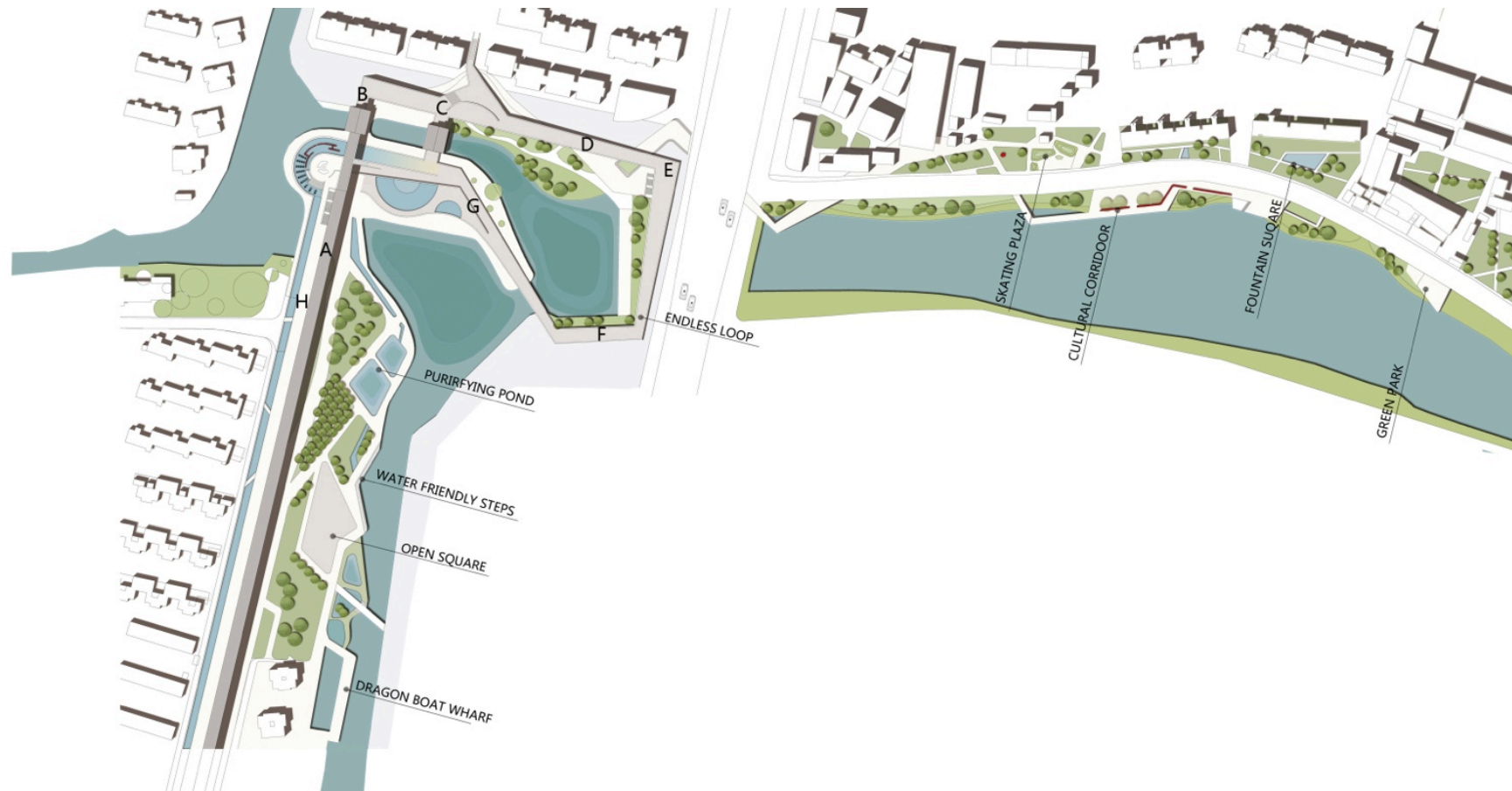


6. “Sponge City” detailed design of eastern water gate area



6.2 Rejuvenation Design of eastern water gate park

- Plan of the eastern water gate park.

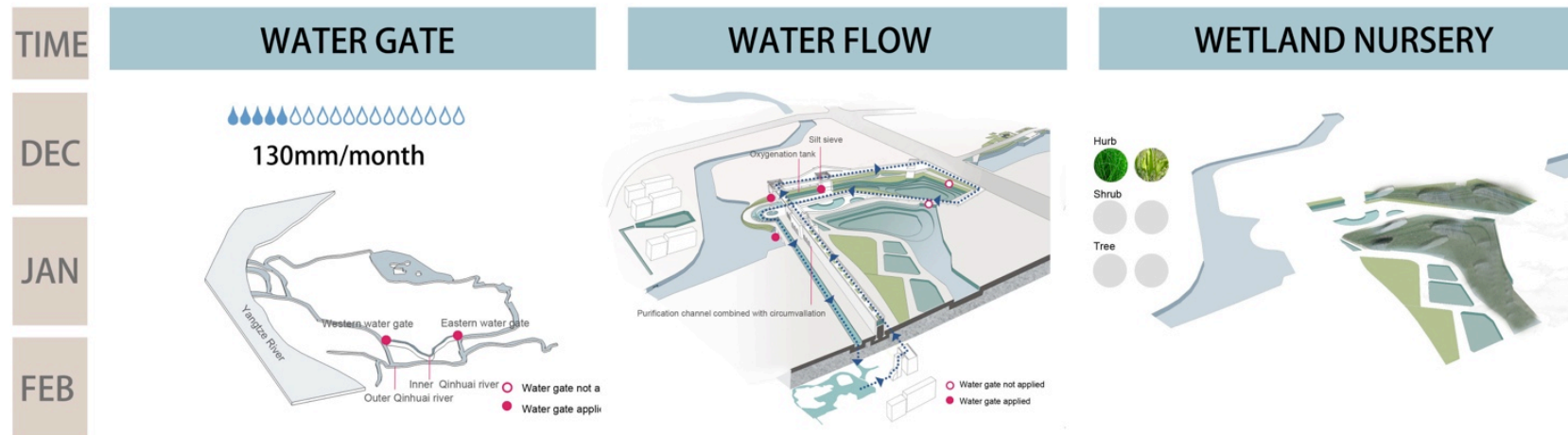


6. "Sponge City" detailed design of eastern water gate area

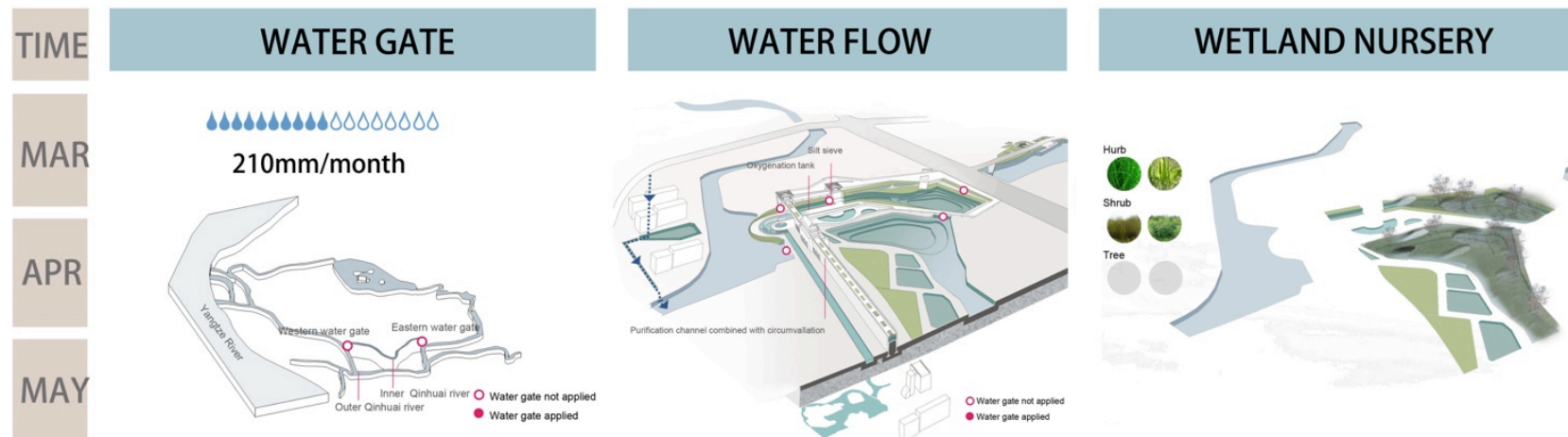


6.2 Rejuvenation Design of eastern water gate park

- Hydrology management in low water period.



- Hydrology management in high flow period.

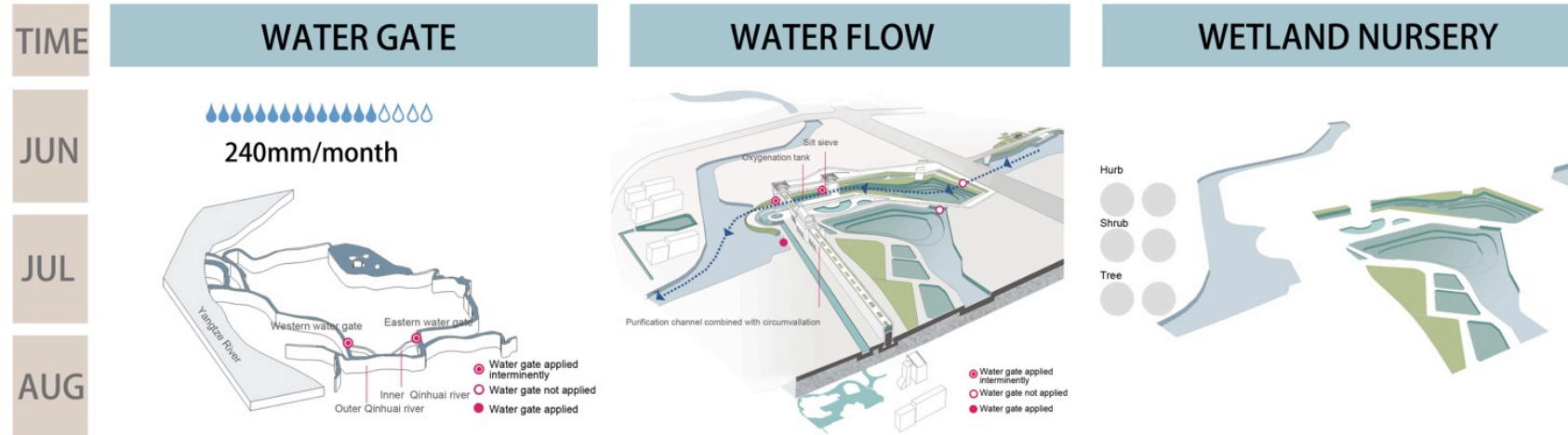


6. "Sponge City" detailed design of eastern water gate area

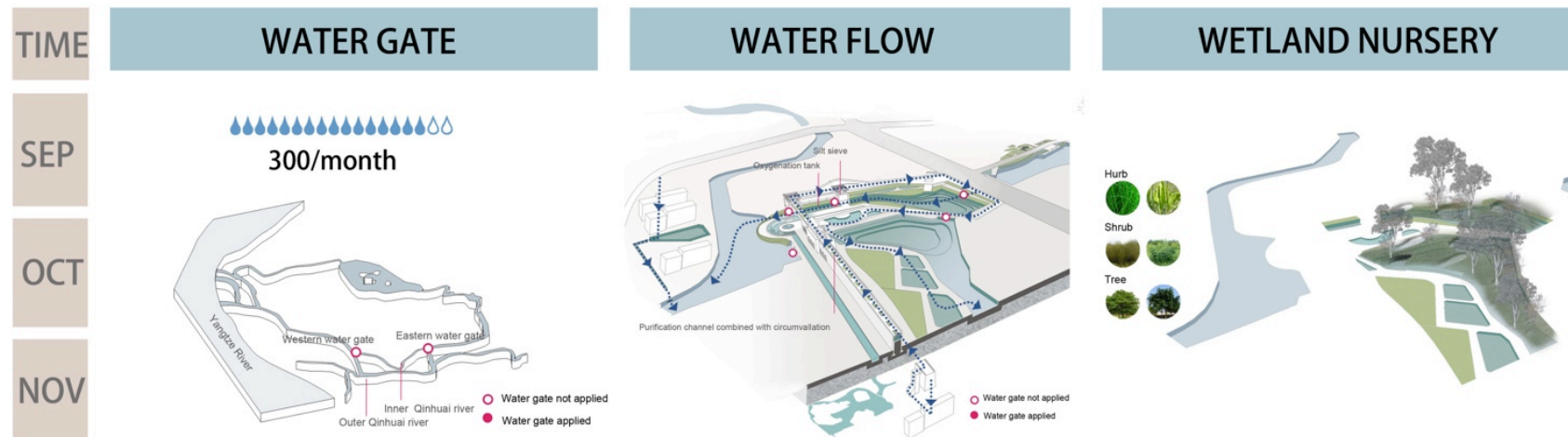


6.2 Rejuvenation Design of eastern water gate park

- Hydrology management in potential flood period.



- Hydrology management in potential heavy rainfall period.

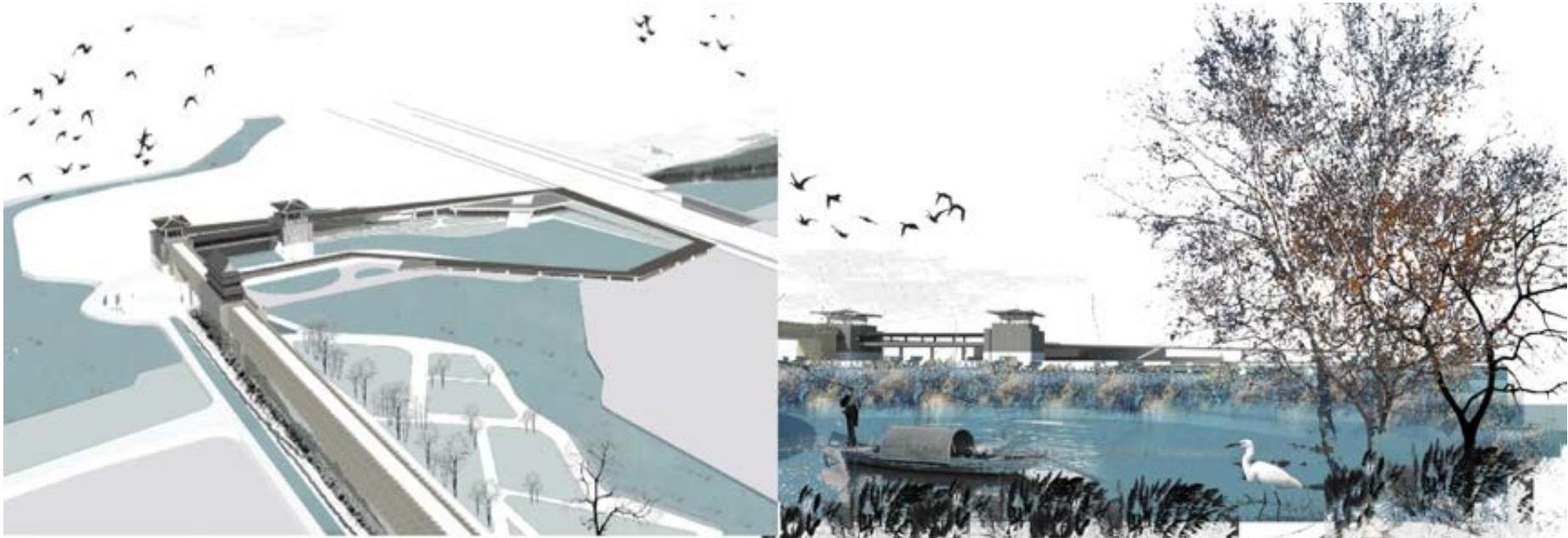


6. “Sponge City” detailed design of eastern water gate area



6.2 Rejuvenation Design of eastern water gate park

- Perspective view of eastern water gate park

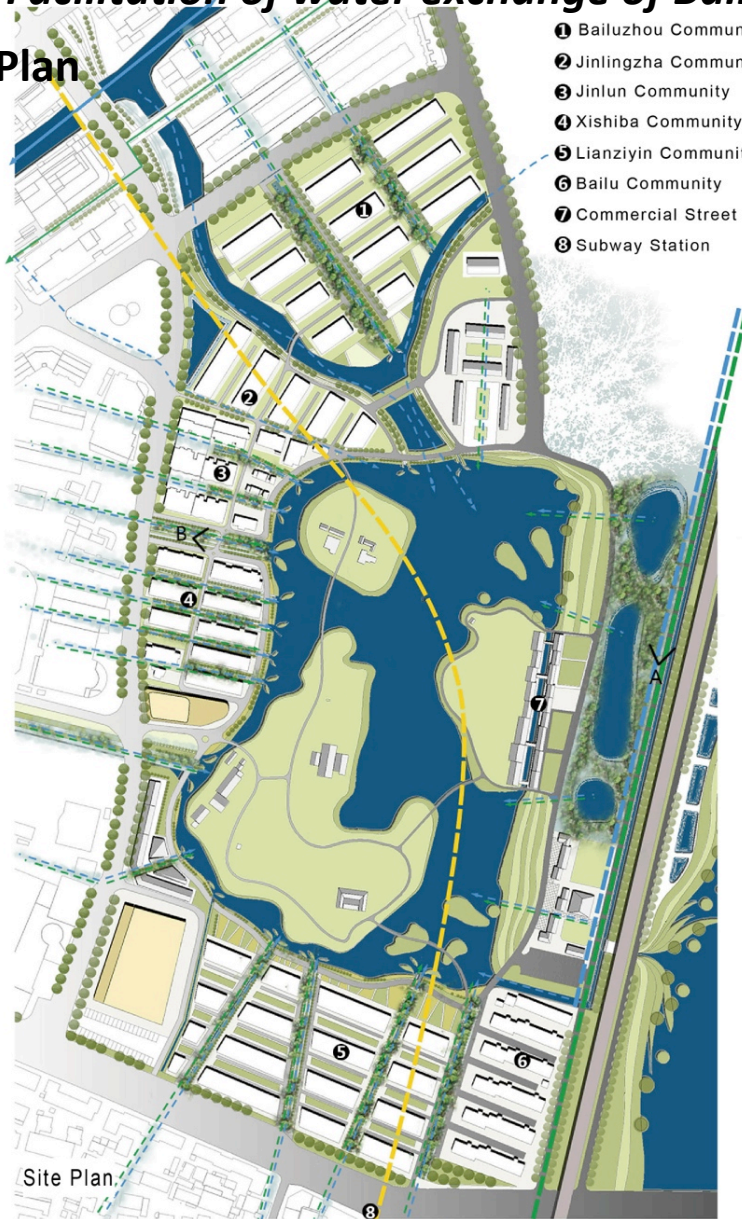


6. "Sponge City" detailed design of eastern water gate area

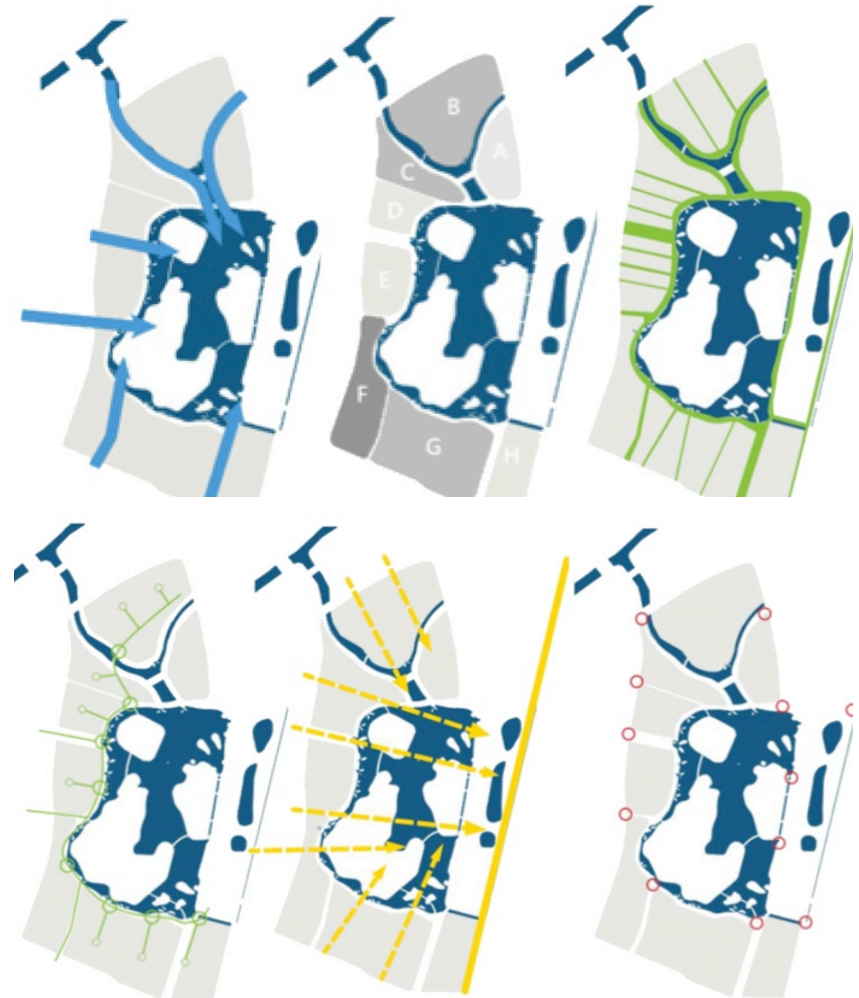


6.3 Facilitation of water exchange of Bailu community in eastern water gate area

- **Plan**



- (a) Water network. (b) Division of subzones. (c) Open interface. (d) Waterfront walkways. (e) Visual corridor. (f) Entrance to Bailu park.



6. “Sponge City” detailed design of eastern water gate area



6.3 Facilitation of water exchange of Bailu community in eastern water gate area

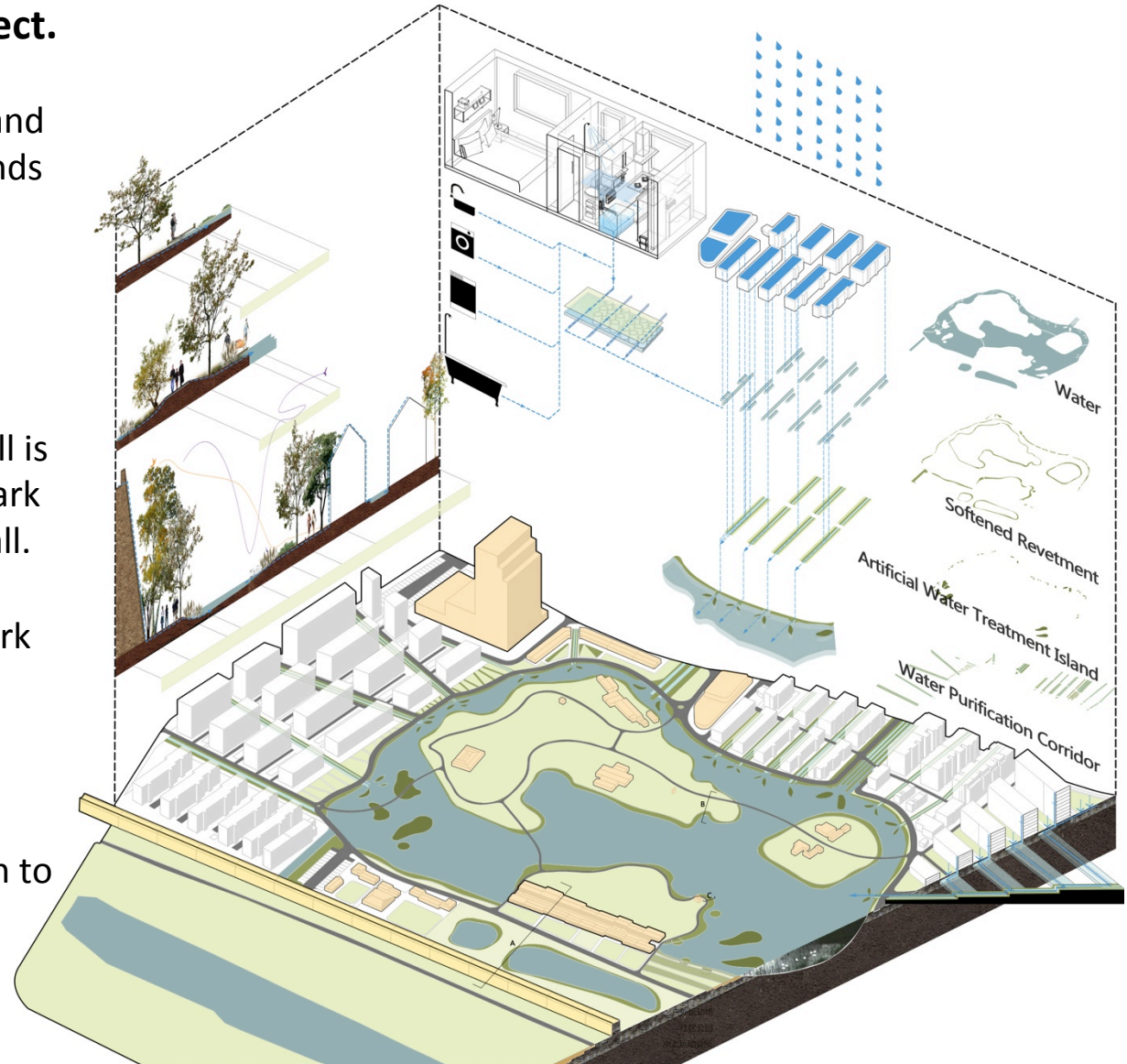
- **Steps of water network project.**

1. Soften the revetment of the park and build some artificial purification islands and corridors.

2. Convert the lakeside roads into permeable pavement to link the wetland and artificial purification islands.

3. Rainwater collected by the city wall is guided into the water pond of the park to prevent the erosion of the city wall. The recycled daily use water of the community is discharged into the park after several layers of purification.

4. The humanity and cultural environment is improved through community activities, cultural experience, and ecological education to make the community more colorful.



6. “Sponge City” detailed design of eastern water gate area



6.3 Facilitation of water exchange of Bailu community in eastern water gate area



- Comparison of images before and after the project.

6. "Sponge City" detailed design of eastern water gate area

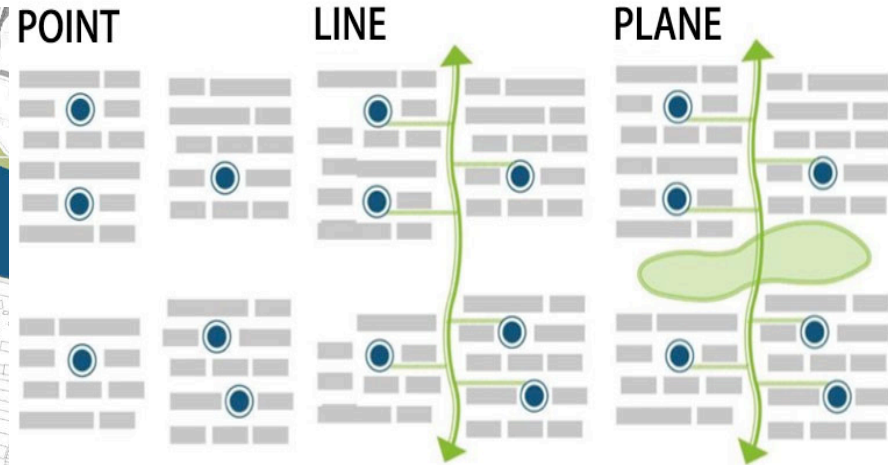


6.4 Improvement of community participatory rainwater harvesting

- Plan



- Structural Strategies



6. “Sponge City” detailed design of eastern water gate area



6.4 Improvement of community participatory rainwater harvesting

- (1) Point – central water plaza of apartment groups

BEFORE THE STORM



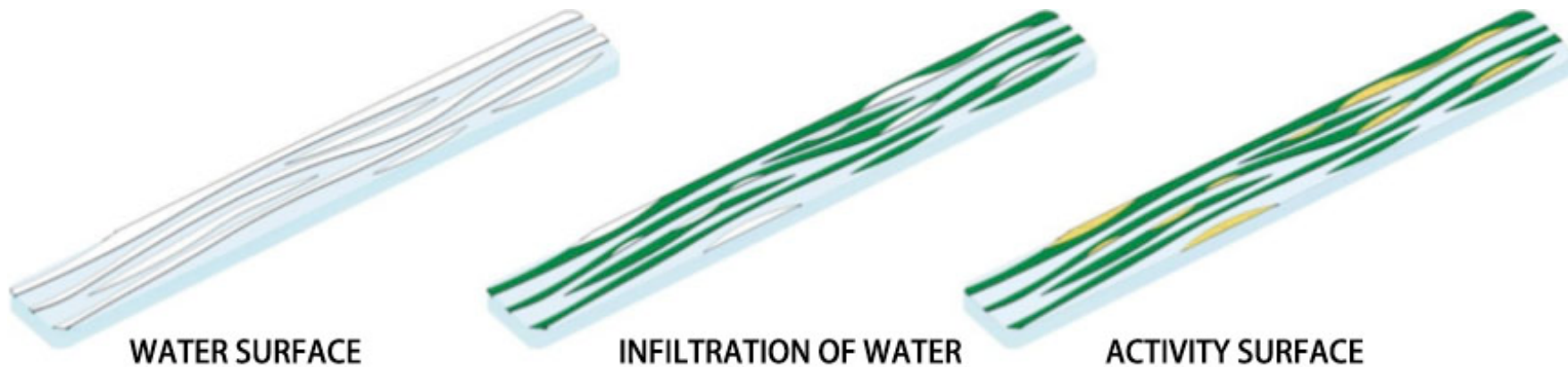
DURING THE STORM



AFTER THE STORM



- (2) Line – ecological water infiltration corridor



6. “Sponge City” detailed design of eastern water gate area



6.4 Improvement of community participatory rainwater harvesting

- (3) Plane – qingshuitang community recreational center



HARD RIVER BANK



SOFT RIVER BANK



SCALARIFORM ISLAND



WATER AFINITY PLATFORM

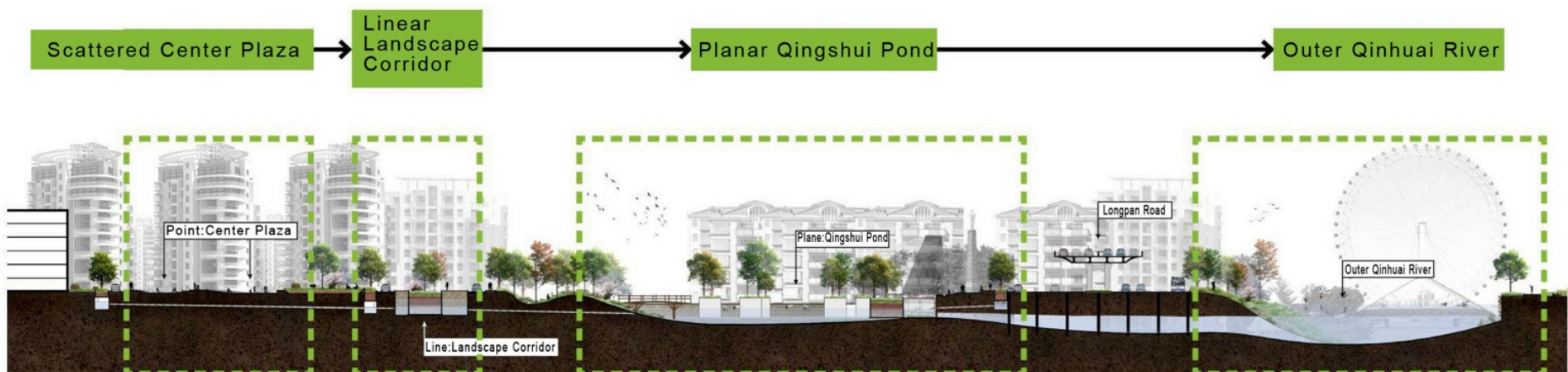
6. “Sponge City” detailed design of eastern water gate area



6.4 Improvement of community participatory rainwater harvesting

- **Water treatment circulation**

By intervening pointed, linear and planar structure, Qingshuitang community forms a water treatment circulation. Water collected in the pointed water plaza is infiltrated through the linear ecological corridor and transported to the central qingshuitang, where water is further treated and finally disposed into outer Qinhuai river (figure 38).

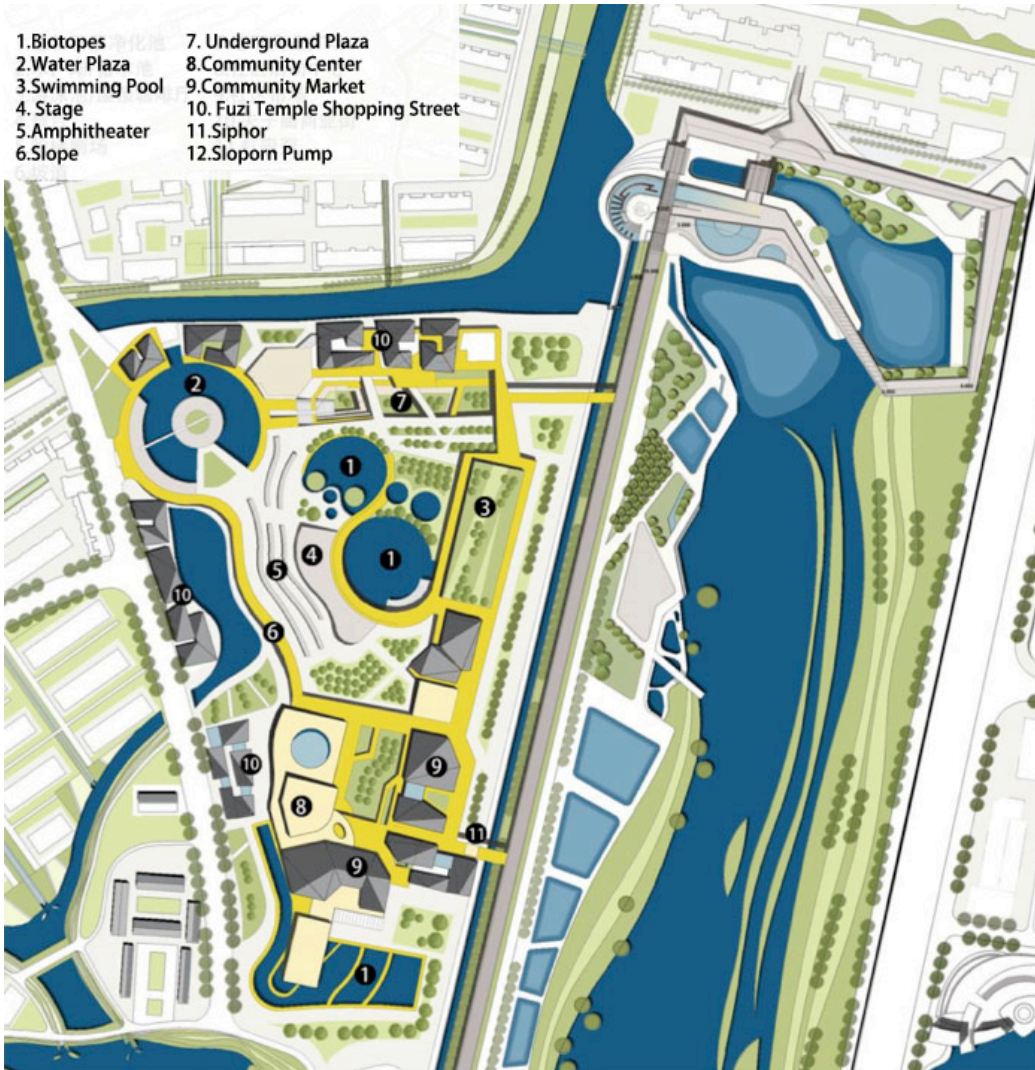


6. "Sponge City" detailed design of eastern water gate area

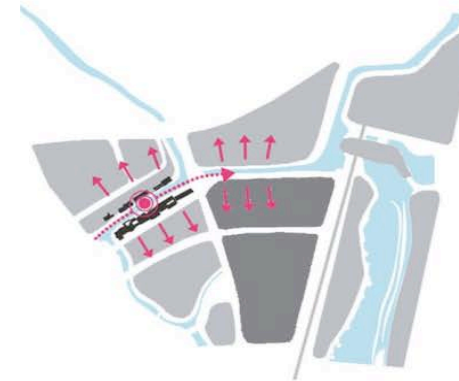


6.5 Green building Design of the extension of Fuzi Temple shopping center

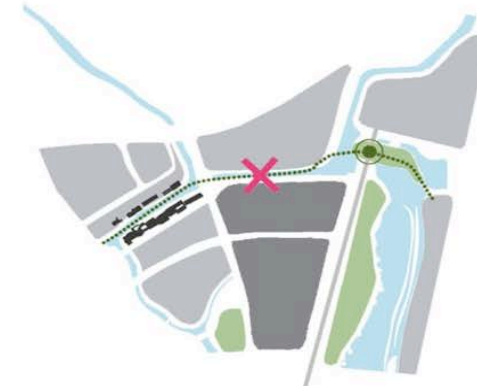
- Plan



- Disturbance to nearby communities by Fuzi temple shopping center.



- Lack of public access to eastern water gate and city wall.

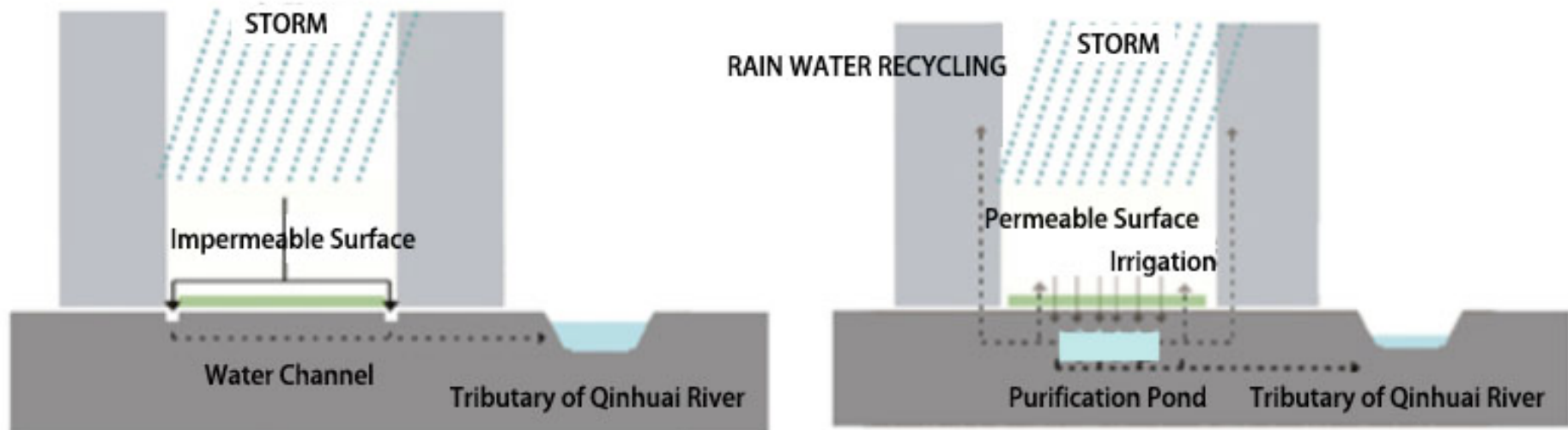


6. “Sponge City” detailed design of eastern water gate area



6.5 Green building Design of the extension of Fuzi Temple shopping center

- Traditional and sustainable way of water management

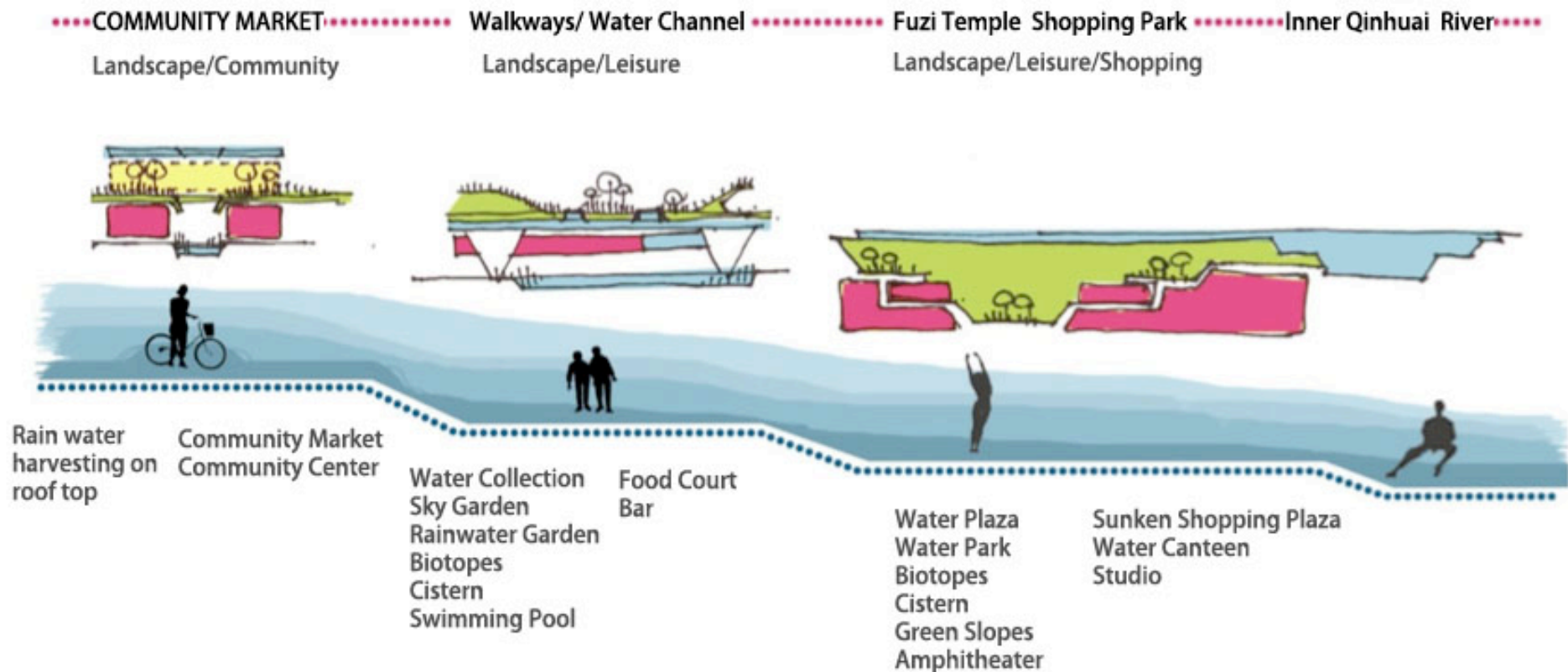


6. "Sponge City" detailed design of eastern water gate area



6.5 Green building Design of the extension of Fuzi Temple shopping center

- Linear public activity platform combined with water processing facilities.

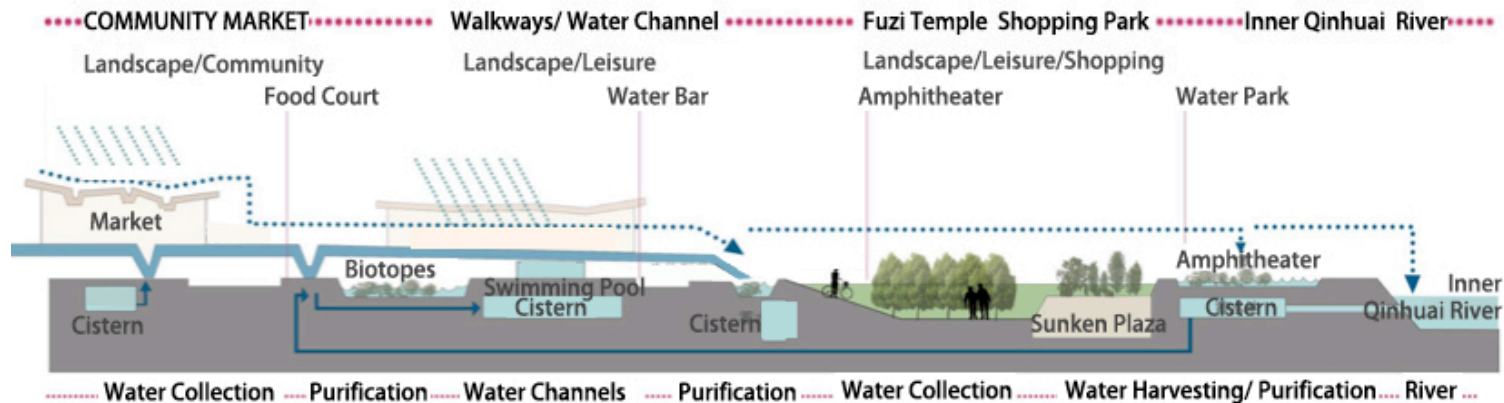


6. "Sponge City" detailed design of eastern water gate area



6.5 Green building Design of the extension of Fuzi Temple shopping center

- Water processing line.

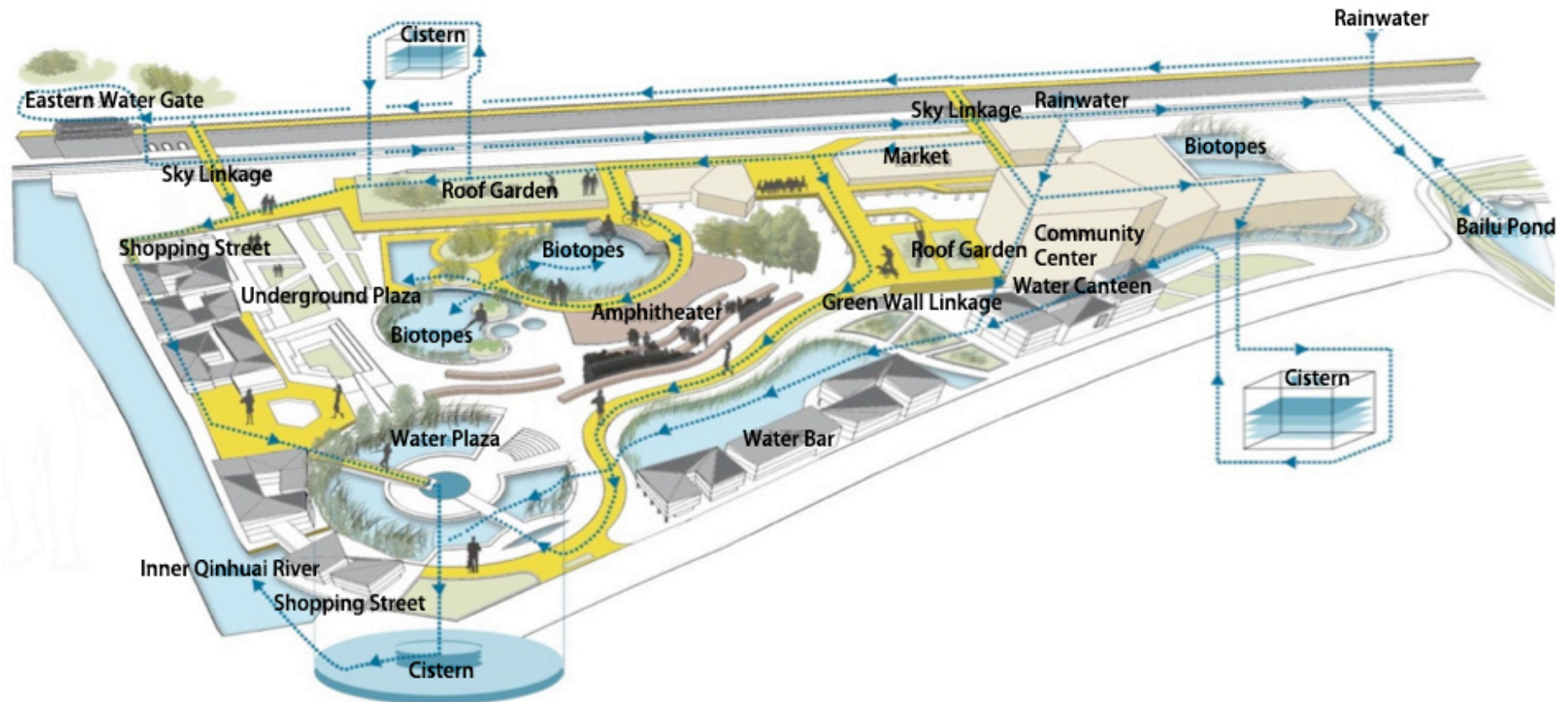


6. "Sponge City" detailed design of eastern water gate area



6.5 Green building Design of the extension of Fuzi Temple shopping center

- 3D water processing line.



7. Conclusion



Reference



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Authors



¹ Cao Zhejing, Graduate Student / Tsinghua University, Beijing, 100084, China.

² Chen Yonghui, Graduate Student / Tianjin University, Tianjin, 300072, China.

³ Hu Xiangyu, Graduate Student/ Delft University of Technology, Delft, 100027, Netherland.

⁴ Haoyu, Landscape engineering/ China Academy of Urban Planning and Design, Beijing 100044, China.

E-Mails: caozhejing1120@163.com; 1152119134@qq.com; 1041792335@qq.com:
717287761@qq.com.

Cao Zhejing; Tel.: +86-131-2671-9132