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LOCAL FLOODING CONTROL PLAN IN BEIJING CENTRAL AREA

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ABSTRACT: In recent years, local flooding has occurred several times in Beijing. This paper take the July 21, 2012 heavy rain occurred in Beijing as an example, summarize the city drainage system planning and implementation in center of Beijing, analyze the main causes of Beijing local flooding. This paper propose perfect local flooding control planning and design standards, improve the urban drainage system construction projects, establish stormwater control systems relative regulations, strengthen urban flood emergency management planning measures, and provide decision support for urban planning and construction of flood control and drainage emergency management.

Key Words: Local flooding, Causes analysis, Strategy

1. INTRODUCTION

In July 21, 2012, Beijing experienced extremely heavy rainfall. The rainfall lasted nearly 16 hours and the average rainfall is 215 mm, which is the most serious rainfall event since the founding of New China. 63 main roads in center of Beijing were lead to traffic jam due to local flooding.

The Fuxingmen Bridge in the second ring road occurred traffic interruption due to local flooding. The Anhua Bridge, Nongzhanguan Bridge, Lotus Bridge, Guantou Bridge, Liuli Bridge and Yuquanying Bridge in the third ring road occurred traffic interruption due to local flooding. The Yuegezhuang Bridge, Wulu bridges, and Dahongmen Bridge in the fourth ring road occurred traffic interruption due to local flooding. Because of these issues above, the community around the urban drainage infrastructure started a heated discussion. In the discussion, someone said the standard of drainage pipes is rather low and someone said the lack of urban rainwater utilization facilities lead to these disasters, and someone said the main problem is management etc.

There is no doubt that all these argument are quite useful and helpful for the planning, construction and management urban stormwater drainage. At the same time, as the urban planners and designers, we are questioning ourselves after "7.21" rainfall event – how are the current drainage system planning and implementation in central of Beijing? Where are the problems? How to deal with these problems?

2. THE DRAINAGE SYSTEM PLANNING AND IMPLEMENTATION IN BEIJING

2.1 Flood Control And Rivers

Beijing belongs to the Haihe River system with five main rivers:Yongding River, Chaobai River, Beiyun River, Juma River and Jucuo River.The Yongding River is located in the upper city, and most of flooding in Beijing occurred by it. The Beiyun River is located downstream of the city and is the way out of drainage system in central city. After the founding of the PRC, in order to control flood and supply water for the city, the goverment have built 85 large, medium, small reservoirs such as Haizi Reservoir, Guanting Reservoir and Miyun Reservoir. The urban flood control standard for the central Beijing is once in 200 years and once in 100 years for the new town.

2.2 Rainwater Pipelines In Beijing Central Area

After the liberation, Beijing began to plan to build a split-flow rainwater piping systems and have planning of rainwater discharge part in each version of master plan. By the end of 2010, rainwater pipeline length is 3709 kilometers. The central Beijing has 2019 kilometers rainwater pipelines and new town have 1690 kilometers rainwater pipelines. The number of existing rainwater drainage pump station is 130, and there are 91in the central Beijing and 39 in new town. The central Beijing has formed more than 500 drainage system and rainwater pipeline service area rate reached about 70%.

2.3 Flood Detention Plants And Facilities in Beijing Central Aera

In order to ensure the safety of the central Beijing and new towns, there are 17 flood detention plants and 683 rainwater utilization facilities and reuse water 12.6 million cubic meters every year.

3. "7.21" LOCAL FLOODING CAUSES ANALYSIS

Analyzing local flooding causes is very helpful to summarize weakness of planning drainage system. Therefore, the government focused on 63 water logging points which are exposed in the "7.21" stormwater. In addition, there are other water logging points which are exposed in 2011 and 2010 years provided by the City Flood-prevention Office and the total number of these water logging points is 91. After field reconnaissance and summary, it is found that most water logging points is because of the following reasons:

3.1 High Rainfall Intensity

This is the major objective reason which caused serious urban local flooding. The "7.21" rainfall showed out the characteristics of high rainfall intensity and long duration. The rainfall intensity per hour of urban area is generally 5 to 10 year return period and some part is even 50 to 100 year return period, which is much more than the current drainage and pumping drainage capacity (once in 1-3 years). Therefore the heavy rainfall which could not be drain out in time flows down to the lower areas (such as sunken bridge area) and causes serious water logging.

3.2 Part of Flood Detention Plants Haven’t Been Constructed

As mentioned above, in the 17 planning flood detention plants, only the Yuyuantan Lake, Shuizhui Lake and Dongsha River flood detention plants are constructed as planning, and the remaining others have not yet been built. When there is a high intensity rainfall, due to the function of flood detention plants is failed to play, it will cause enormous pressure to the drainage system of central Beijing, especially the South moat and North moat.

3.3 Some Small Rivers Are Failed To Implement As Planning

Although the center of Beijing's main river has been implemented in accordance with the planning basically, but there are still some small rivers are not implemented in accordance with the process of urbanization, such as the Fengcao River, Han River, Xiaolong River and other small rivers. Because of status small section and inadequate drainage capacity, these small rivers result in poor urban drainage situation, which is one of the main causes of serious local flooding in urban areas.

3.4 Pipeline Systems Are Imperfect

This issue includes several aspects. (a) Pipeline system receiving capacity is inadequate. The survey found that parts of the overpass area and road intersection have insufficient number of rainwater manhole and could not effectively collect rainwater, resulting serious local flooding for a long time. (b) Drainage system of edge of central Beijing is imperfect, such as Nanyuan, Dingfuzhuang, Wulidian, Shijingshan, Moshikou, Dongsanxiang, Dongba, Fatou districts. (3) Most water pipelines are built with the road construction, but due to road construction timing and investment system and other reasons, often resulting in the drainage works could not be implemented with road construction. Therefore, stormwater pipes of some roads (eg Kangxin road) have non- way out downstream.

3.5 Measures For Excessive Rainfall Need Improve

Urban drainage systems include rainwater pipes, pumping stations, lakes, flood detention, transfer tanks (containing large underground flood storage facilities), penetration pavement, infiltration wells (pits), sunken green space and other facilities. However, the current main flood-preventing task of the central Beijing is carried by the drainage of rainwater pipes, pumping stations and river. After analysis, rainwater pipes and pumping stations can promptly eliminate rainfall runoff within a certain standard range, could not bear the excessive rainfall under urban flood control and drainage tasks. Thus, the system needs to rearrange drainage system of the city center, according to "discharge, storage, retention, infiltration" concept to enhance the control and use of rainwater of constructed areas and new projects and improve the overall capacity of the city drainage system. On the other hand, the central of Beijing needs to build and improve the urban flood emergency plans and strengthen urban flood management.

4. STRATEGY AND RECOMMENDATION

According to the overall objective of building the "three Beijing" and the world class cities, Beijing should improve the planning and construction of urban drainage system, through the whole society participation and strengthening the emergency management and increasing investment of infrastructure facilities to continuously improve standards and drainage of urban

drainage systems and build Beijing into a safe and livable city. Combining the "7.21" storm reflection, there are the following suggestions:

4.1 Improve Urban Planning and Design Standards of Local Flooding Control

The urban storm water standard in developed countries typically contains two levels of standards. The EU standard clearly defines pipeline drainage standards and local flooding control standards. The United States and Australia standard system clearly defines the criteria of small and large storm drainage control standards. Among them, the piple drainage standard of EU and the small drainage system of U.S. and Australia are the same as pipelines drainage planning and design standard in China. In addition, the EU countries also proposed local flooding control standards that stormwater could not flow out of ground based on drainage pipeline standards. United States and Australia also proposed the use of urban open space and roads to exclude excessive rainwater, the purpose of which is to control the water flowing time, water depth and flow rate, in order to avoid disaster. However, there is not yet clear urban local flooding control standards based on the drainage pipe standard in China.
By comparison, the existing Beijing rainwater pipes (including pumping stations) planning and design standards are corresponds to the world class cities. But in addition to the design standard of river, compared with world class cities, Beijing is lack of urban local flooding control standards (Table 1).

Table1: Compare Rainwater Drainage System Standards of Beijing and Other Cities

City/Standard		New York	London	Paris	Tokyo	Beijing
Design Frequency	Return period （once in N year）	10~15	5	5	3	3~5
	Rainfall intensity (mm/hr)	55~60	20	28	50	50~56
Flood Frequency	Return period （once in N year）	100	30~100	50	100	N/A

To ensure the safety of urban drainage, it is imperative to determine Beijing urban local flooding control standards as soon as possible to guide the planning and design of drainage works and co-ordinate construction of small rivers, flood storage area, rainwater pipes, pumping stations, reservoirs and other infrastructure facilities.

By contrast with the world class cities, combined with the economic conditions and storm characteristics and existing infrastructure facilities of Beijing, the urban flood control standard of Beijing is recommended to use once in 50 to 100 years based on the importance of different areas.

4.2 Strengthen Urban Storm Water Control

For all kinds of new projects in urban planning and design process, it is required fully reflecting the Low Impact Development concept to achieve the target that before the rain water and pollutants after development is not greater than the development of construction projects

outside row by using a variety of eco-green engineering measures.

4.2.1 Control rainwater control from source

Make full use of green roofs, permeable paving, low-lying green, tune reservoirs, wells and other measures to effectively control the rainwater flow out of the areas and reduce the drainage pressure of municipal pipeline system, while making full use of rainwater resources.

4.2.2 Solve sunken overpass bridge area local flooding by combining drainage and storage.

It is planning to upgrade storm water pumping station and construct detention plant and build low-green area and low seepage wells and other measures to integrate improve the drainage capacity of sunken overpass bridge area.

4.2.3 Build large detention facilities according to local conditions.

For the important areas and transport sections and overpasses, in order to prevent excessive disasters caused by high intensity rainfall, it is recommended to build high standards underground tunnels or underground reservoirs along the river channel or major road in the areas with proper condition. In addition, it will be better to build an ecological complex functions detention basin combining with parks and green spaces. These facilities can effectively solve the local flooding disasters, and on the other hand, they can also make full use of rainwater resources and improve the urban environment.

4.3 Accelerate The Regulation of Small Rivers In Beijing Central Area

In existing drainage systems of central Beijing, the rivers belong to municipal government have been regulated according to planning, but some small and medium sized rivers belong to district government still have not be regulated as planning. There are 6 rivers in Fengtai District, 3 rivers in Haidian District, 5 rivers in Shijingshan District, 3 rivers in Changping District, 11 rivers in Chaoyang District. It is recommended to regulate Macao River, Fengcao River, Xiaolong River, Han River and other rivers as planning as soon as possible.

4.4 Accelerate The Construction of Urban Flood Detention Plants

According to the "store water in the west, drain water to the east, divers flood from the north and south" flood control and drainage principles which is identified in the overall planning of Beijing, the "store water in the west" project include:

4.4.1 Use the Western Suburbs to store the flood water

Use the Western Suburbs to store the flood water of Xiaoxi Maintain, Badachu and Langhuanggou with a total 26.2 square kilometers area. The flood planning standard is 20-year flood for designing, 100-year flood for checking. The 100 years flood control capacity is 5 million cubic meters and the total storage area is 63 hectares.

4.4.2 Build a sluice in the Nanhan River exit

By using the river and the detention basin ground, the flood could be all controlled to 25 cubic meters per second discharge to central Beijing in 20 years, 50 years, 100 year flood.

4.4.3 Use the Yuyuantan Lake to store flood of the western

Use the Yuyuantan Lake to store flood of the western with a total storage of about 0.6 million cubic meters.

4.5 Formulate Relevant Regulations and Standards of Rainwater Control System

As the extension of Low Impact Development concept and strengthening the control and utilization of rainwater in construction of commercial and residential buildings, it is needed to formulate relevant laws and regulations and technical standards. In the general and detail planning stage, ensure the land use of rainwater control and utilization facilities with the index of land use control, and take these construction of facilities into the Green Building standards to change the previous simple drainage concept and insist the "drainage, storage, detention and infiltration" planning and design principles.

4.6 Establish The Central Beijing Drainage System Simulation Model

In order to promote the scientific and meticulous management level of city planning flood control and drainage system, it is recommended to evaluate the existing drainage system such as pipelines, pumping stations and river facilities and build a simulation model to help the planning and design of city drainage system and risk analysis of ultra standard rainfall and provide technical reference for flood emergency plan.

4.7 Strengthen The Flood Emergency Management

Any flood control projects have construction standard. When the natural conditions exceed construction standards, we need an integrated city emergency management measures to reduce the impact of natural disasters to the life of residents in the city. Therefore, we need to establish a comprehensive emergency management system including the weather, traffic, public service facilities management, social control and other aspects. Therefore, the city can minimize the loss of social and people's life and property in the event of major natural disasters.

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