Multi-Use Infrastructures and Flood Mitigation Strategy

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1. INTRODUCTION

Hurricane Harvey has revealed Houston's vulnerability to flooding. Ground subsidence due to groundwater withdrawal is making the situation worse. As the city is planning to accommodate three millions more people in 2040, three major hurdles will have to be overcome: **flooding, surface water shortage and traffic congestion**.

Due to the limitation of public space, multi-use infrastructures seem to be a viable alternative. A multi-use reservoir has been widely used throughout the world. For example, the Lake of Houston is used for fresh water resource and flood control. On the contrary, multi-use channels are less common. This article presents a concept of Super Bayou® that could help solve all three problems above.

2. SUPER BAYOU® CONCEPT

The Super Bayou® is a proprietary engineering concept that uses reinforced concrete conduits (RCCs) to deepen a bayou and retain banks, create enclosed channel(s), and support traffic in bayous during most weather conditions. During periods of extreme precipitations, the traffic is evacuated from the bayou and the entire space is available for water conveyance.

Specifically, the RCCs are embedded into river bank/bed and replace soils with enclosed channels that contribute to an increase in water conveyance. RCC walls can be extended in order to deepen bayous further. Figure 1 shows a trail in a bayou where bikers and pedestrian enjoy clean water and green environment.

Figure 1 Super Bayou with Trail

Alternatively, the road inside the super bayous can be used for high capacity transit such as BRT (bus rapid transit) and LRT (light rail transit). Figure 2 shows light-rail tracks on the top of a RCC while a trail is on the other RCC.

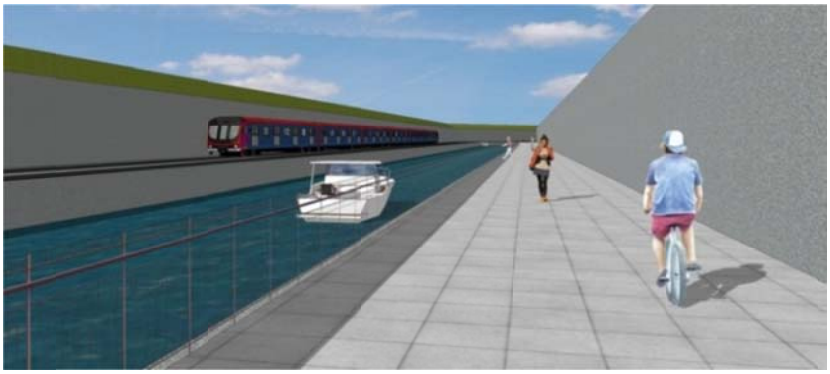

Figure 2 Super Bayou with Trail and Light-Rail Tracks

3. IMPACTS OF SUPER BAYOU®

If implemented, the Super Bayou® concept will have tremendous impacts on the bayou city. Six major impacts are discussed as follows:

Lowering Water Level

When implemented adequately, Super Bayou® can **deepen existing bayous** and triple conveyance capacity without widening. If the Addicks and Barker reservoirs are deepened accordingly, they will have enough storage capacity to hold the entire rail-fall from Hurricane Harvey in their watersheds. Other detention basins can also be deepened. With significant increases in both conveyance and detention capacities, the Super Bayou® could **lower the water level throughout the region** and provide strong flood mitigation once for all.

Securing Surface Water Resources

The Greater Houston region had subsidence of up to 10ft due to withdrawing groundwater from aquifers below in the past. This subsidence has exacerbated the flooding damages. In order to reduce the ground subsidence, surface water needs to be the main source of water supply. Brazos River on the west is at high elevations and often causes flooding. When the Barker and Addicks reservoirs are deepened, abundant water from Brazos River could replenish the reservoirs without pumps. As a retention facility and surface water resources, these two reservoirs will not only cut the cost for water supply to the populated west, but also increase the reliability of water supply to the entire region.

Alleviating Traffic Congestion

RCCs installed in bayous can support high capacity transit in the bayous during normal weather conditions. There are two ways to support traffic: on the top of the RCCs or on the bottom slab of RCCs depending on the elevation of RCCs. For deep bayous such as Brays Bayou and White Oak Bayou, the public transit is on the top of RCC. Using a portion of the existing bayous and ditches with less meanders, several routes of high capacity transit may be established as shown in the red lines of Figure 3. A similar multi-use channel with light rail under a street could be built along Jensen Dr., Bentley St and JFK Blvd. This channel can offer high capacity transit to the George Bush International airport during most weather conditions and divert water during extreme precipitations. The black lines in Figure 3 are existing light rails along streets while the dotted black lines are light rail extension to the Hobby airport according to MetroNext plan.

These high capacity transit services will greatly reduce the traffic congestion in the Metropolitan area during rush hours and operate at a minimum cost with autonomous technology. The high-capacity transit could also be extended to surrounding towns such as Sugar Land/Rosenberg using mostly the space of existing water ways.

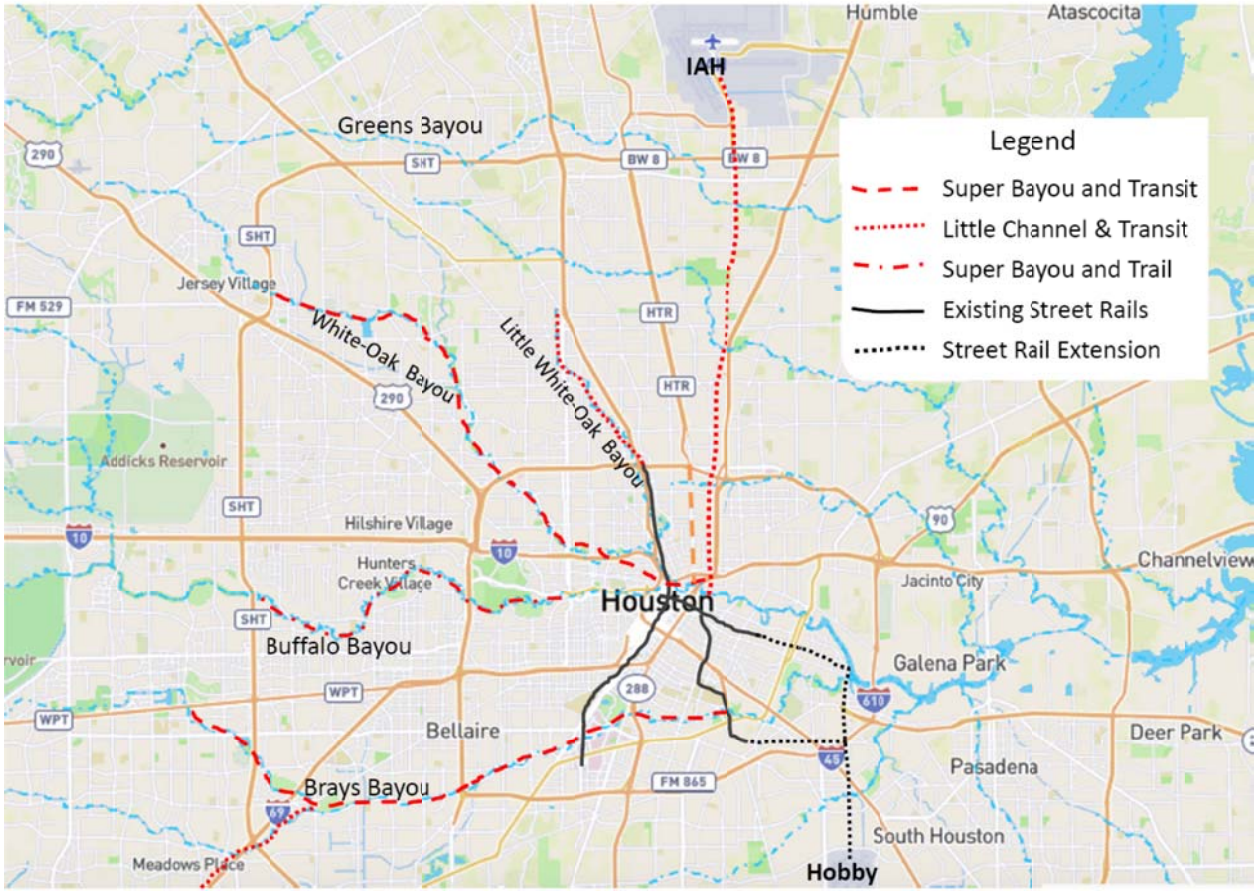

Figure 3 Potential High Capacity Public Transit Using Multi-use Channels

Minimizing Sediments in Shipping Channel

The Harvey flood brought 10 ft of sediments into the shipping channel that affected shipping traffic for six months. When Super Bayou® concept is implemented, bayou beds and banks will be properly protected from soil erosion and bank collapse. As a result, only a small fraction of silts will be carried over and end up in the shipping channel. This will save millions of dollars in dredging operations and avoid delay of shipping. With a road inside a bayou, any trapped debris can be removed easily after a storm.

Reducing Air Pollution and Protecting Environment

Concrete structures do not look good as plants. However, a strong erosion measure such as concrete is needed in order to avoid bank failures and massive soil erosion as observed along many bayous during Harvey. Most importantly, the concrete box supports high capacity public transit that will keep millions cars off the roads each week. This will greatly improve the air quality and benefit the environment overall.

Attracting Tourists and Businesses

During most weather conditions, people can walk or bike along a bayou. Clean water, wildlife and green plants will attract visitors. Similar to the River Walk in San Antonio, the Super Bayou® concept would create boating services in clean water. People of various ages can enjoy life around the bayou. In addition to leisure activities for local Houstonians, the Super Bayou® can link Houston's historic sites and attract tourist businesses.

4. NORTH CANAL AS DEMONSTRATION PROJECT

Reinforced concrete conduits have been widely used either as a buried pipeline or a box culvert at a street/road crossing of a bayou/ditch. However, they have not been used to support traffic inside a bayou. As a north canal has planned at the convergence of Buffalo bayou and White-Oak bayou for decades at Downtown Houston, a 1500ft multi-use channel may be built there for de-bottlenecking.

5. SUMMARY

Residents in the Greater Houston region and visitors could relax beside still waters and enjoy abundant clean surface water, green environments, and convenient public transportation without worrying about flooding or drought. This bright future can be a reality if top leaders embrace multi-function infrastructures and lead the collaboration among related agencies.