# Flood Alleviation in a Heavily Urbanized Area – Kai Tak Nullah, Hong Kong

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**Abstract**

The existing Kai Tak Nullah flows from Po Kong Village Road along Choi Hung Road and Tung Tau Estate into Kai Tak Development Area before discharging into the Victoria Harbour. Historically its upstream has been subject to flooding under storm conditions and this has had serious repercussions for the adjacent urban areas. A study has been commissioned by the Drainage Services Department of the Government of the Hong Kong Special Administrative Region (HKSAR), China to investigate the flood mechanisms and to provide flood alleviation measures by improving the capacity of the Kai Tak Nullah. In addition to flood alleviation, there is a strong public aspiration to rehabilitate the Kai Tak Nullah by a comparatively natural river design. Since the Kai Tak Nullah is located within a heavily urbanized area, traffic and environmental impacts are also highly concerned. The final flood alleviation scheme has thus had to strike a balance among the aforesaid factors with assistance from the hydraulic modelling utilizing InfoWorks Collection Systems (CS) software. This paper presents the public engagement exercise, design considerations, methodologies, and recommendations regarding the reconstruction and rehabilitation of the Kai Tak Nullah.

**Keywords**

Drainage, flood, InfoWorks, hydraulic modelling, Kai Tak Nullah, urbanized catchments

## INTRODUCTION

1. In many Asian cities, rapid urbanization has led to reduce water infiltration into the soil and increasingly fast stormwater run-off as natural streamcourses are channelized and vegetation in catchment areas cleared and replaced with hard surface. This has put considerable strain on downstream drainage capacity. The space available for upgrading the capacity of existing drainage system is often severely limited due to the high density of urban development – this is particularly the case in Hong Kong where the population of about 7 million, with all associated commercial and community development and engineering infrastructure, is accommodated within a comparatively small urbanized area. Accordingly, innovative engineering solutions are generally needed in such conditions to upgrade flood control while, especially during construction activities, minimizing disruption to urban activity and regular impacts on the well being of residents. This paper presents the public engagement exercise, design considerations, hydraulic analysis, and recommendations regarding the reconstruction and rehabilitation of the upstream section of the Kai Tak Nullah (hereafter referred to as "the Nullah" – a major channelized drainage course in East Kowloon of Hong Kong).

## BACKGROUND OF KAI TAK NULLAH

2. The existing Nullah is a concrete lined open channel with a top width of the upstream section varying between 9 and 22 metres. The entire Nullah is about 2.4 km long while it upstream is about 0.6m long. Different sections of the Nullah are shown in **Figure 1**. It is a major drainage channel for East Kowloon catchment area. Its catchment area is about 11.3 $km^2$. The first recorded residential development near the Nullah took place in 1920. Since the 1950s (see **Figure 2**) the pace of urbanization increased rapidly, including high-rise residential development, associated local and district distributor roads and, in parallel,

conversion of the former natural drainage system into an extensively channelized waterway ("Nullah"). The surrounding industrial and residential activities also discharged pollutants into the Nullah. Subsequently the government has implemented a series of measures intended to improve the water quality in the Nullah, including construction of a series of dry weather flow interceptors to collect polluted flows and discharge them into the sewer network; and discharge of effluent from sewerage treatment works to the Nullah so that a constant flow could be provide to the Nullah, even during the dry season. By doing so, a self-cleaning mechanism for the Nullah is provided which has created an attractive habitat for many fish and other aquatic species.


Figure 1 - Plan of Kai Tak Nullah

Figure 2 - Kai Tak Nullah in 1950s

## PUBLIC CONSULTATION AND ENGAGEMENT

3. In the early planning stage, it was originally proposed to deck the upstream section of Kai Tak Nullah. Indeed, in the early years, decking of nullahs was welcomed by District Councils and the local community as a means to improve the environment because of odour from the Nullah. With the implementation of the measures mentioned in paragraph 2, views from the public have been changed. In the recent local consultations, some District Council members and the concerned groups drew reference to some overseas experience in river revitalisation projects which have the effect of uplifting the local city environment and providing leisure ambience to residents.

4. In order to engage the public views on implementation of the project including exploring alternative to decking, the Government started Public Engagement Exercise (PEE) in 2010 to collect views and build consensus wth the public to provide basis for formulation of design guidelines. As part of the PEE, the Stage 1 Public Engagement Workshop was held in end 2010 to gather views from the public. On the basis of the prime improvement objective of Kai Tak Nullah is flood relief, the major views collected in Stage 1 PEE are:

- Provide a green river corridor;
- No nullah decking as far as possible;
- Provide landscape, pedestrian and recreational facilities;
- In harmony with adjoining developments and open spaces; and,
- Improve connectivity along and across the river.

5. The public opinions and views provided an additional dimension as a basis for formulation of design guidelines. There are clear public aspirations for revitalising the Nullah into a special green river and townscape feature to enhance the visual quality and image of the

Nullah. Accordingly, the design was revised to provide an undecked nullah, together with the associated beautification works. After the engineering design, Stage 2 Public Engagement Workshops were conducted in June 2011 to build consensuses with the public on the design of Nullah and facilities along both sides of the river. These workshops provided opportunities for discussion among local residents, community groups, students, academics, engineers, landscape architects, consultants and District Council representatives. Detailed group discussions of the workshops were carried out to gain consensuses on the overall handling for better pedestrian/ traffic connection, ambience and facilities along the river.

6. The nullah will be rehabilitated into a green river corridor without decking in urban area and introduce aesthetic, greening, landscaping and ecological elements at the sides and bottom of the nullah. Upon completion, the proposed works will improve the living environment through enhancement of townscape of the area, provision of a scenic and leisure place for the enjoyment of the public, as well as fostering closer connection with adjacent areas.

## SITE CONSTRAINTS AND ISSUES

7. The drainage capacity of the Nullah is affected by multiple factors; not least the tight site constraints on its size and alignment imposed by the surrounding heavily urbanized area. The drainage capacity is reduced due to numerous utility services (as pipes and cables) running along and across the Nullah. The most serious obstructions to flow was identified to be under the two existing bridges at which the utility services block about 20% of the cross-section of the potential flow area. **Figures 3 and 4** show some of the underground utilities at the existing site. Urban developments also greatly increased the extent of paved areas within the drainage catchment area thus reducing infiltration of storm water run-off into the soil and, instead, channelling run-off into the Nullah whilst at the same time speeding up the rate of concentration and run-off. This introduced further problems for the capacity of the Nullah and led to a high risk of flooding resulting from heavy rainstorms. Recent severe flooding events occurred in June 2006, July 2008 and June 2010, which severely affected the traffic networks of Wong Tai Sin area. As mentioned, both sides of the Nullah are fully occupied by existing developments and roads, thus available land for improvement works is limited. The alignment of the Nullah is parallel to Choi Hung Road which is an important local distributor and dual two traffic lanes will need to be maintained at all times during the course of the construction.

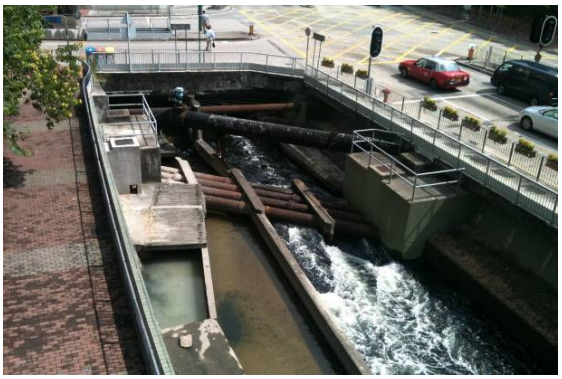

Figure 3 - Existing Utility in Nullah

Figure 4 -
Existing Utility under Nullah Decking

## DESIGN CONSIDERATIONS

8. Given the site constraints and public aspirations for an attractive river, a traditional decking or widening approach to improve the capacity of the Nullah was ruled out. Instead, construction of a box culvert underneath the carriageway of the adjacent Choi Hung Road was proposed to provide supplementary drainage capacity. Construction of the new culvert was proposed in stages so as to maintain the heavy traffic flow with minimal disruption to the road users on Choi Hung Road. Construction of the new culvert and other upgrading works linked to the Nullah would necessitate phased partial or full closure of sections of the traffic lanes of

Choi Hung Road and thus a series of temporary traffic management schemes have to be developed to cater for these scenarios by diverting/shifting traffic flows to maintain vehicular movements and capacities during construction. **Figure 5** shows the cross sectional view of the artist's impression of design arrangement. Other design considerations include resolution of interface projects by means of diversion of watermain, sewerage and landscape works; minimize disturbance to the public by careful planning of construction sequence in particular for the proposed box culvert.

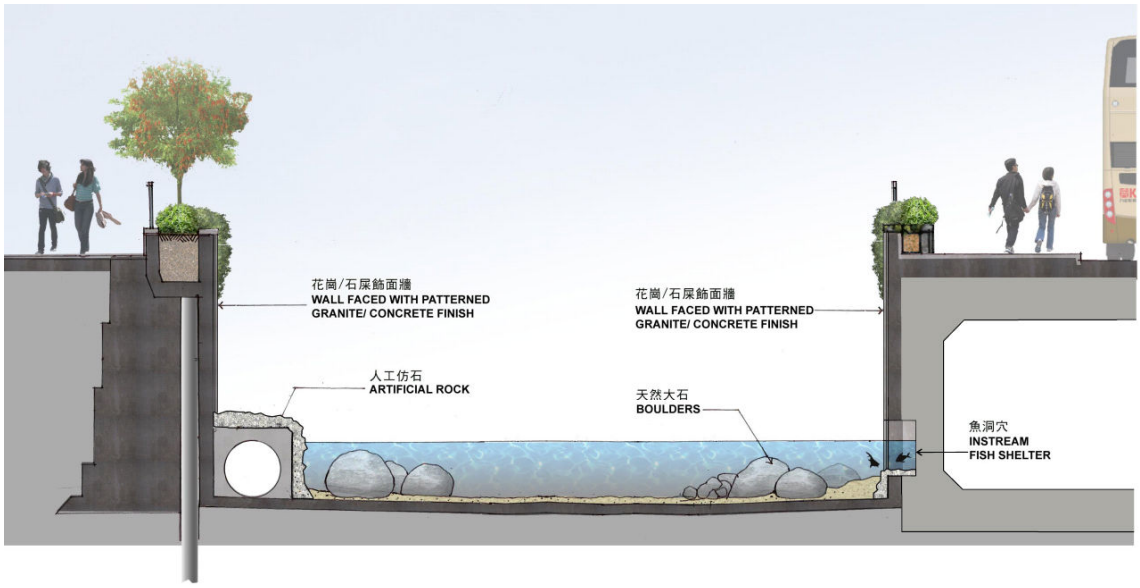


Figure 5 - Artist's Impression of Proposed Works

## SCOPE OF WORKS

9. The scope of works comprises deepening existing Nullah bed at the upstream, construction of a box culvert parallel to the Nullah, relocating the existing utilities intruded into the Nullah and associated landscape works. The landscaping works aim to rehabilitate the Nullah to a green river corridor.

## HYDRAULIC ANALYSIS AND DESIGN

10. During the course of preliminary design, the hydraulic performance of the existing conditions and proposed schemes were investigated, including inspection of historical flood records and field data supplemented by an integrated (1D 2-layer) model using InfoWorks Collection Systems (CS) software for hydraulic modelling. A hydraulic model assessment was carried out to identify the hydraulic issues of the proposed schemes. Taking into account the design considerations, flood alleviation measures were then derived based on the hydraulic analysis by subdividing the overall drainage catchment for the Nullah into three sections (upstream, midstream and downstream). In-depth liaison was held with the relevant interface parties to ensure that the model assumptions and boundary conditions were consistent throughout the Nullah. Issues such as overland flow, surcharge, flood mechanism and utilities intrusion, etc were also studied in the model. The model results facilitated optioneering of possible schemes. Quality assurance processes were implemented throughout the modelling and analysis process. The modelling approach is illustrated in **Figure 6**.

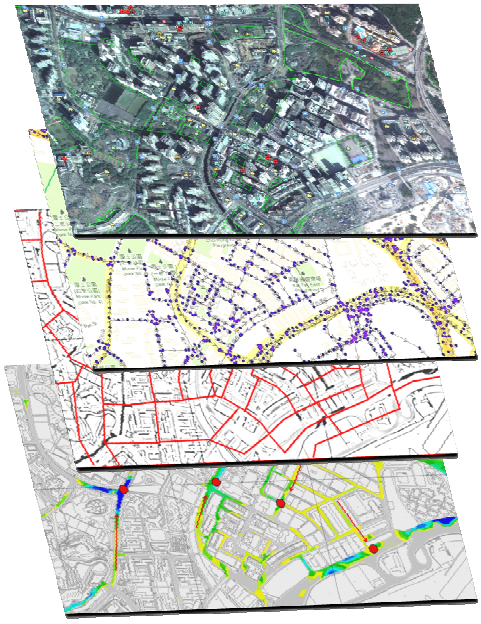


Figure 6 - Modelling Approach

11. The modelling results show that the flood protection level at a section of the Nullah between Shatin Pass Road and Tai Shing Street was generally less than 1 in 10 years return period. It is inadequate to meet the current flood protection standard and the areas in the vicinity of the nullah are susceptible to flooding. To reduce the potential flood risk, there is an urgent need for increasing the drainage capacity by upgrading of the Nullah.

12. The effectiveness of the proposed scheme was then further examined in the integrated drainage network model. The drainage capacity of the Nullah was assessed taking account of the flooding impacts at the drainage system. The model results (flood depth/ hazard mapping, manhole surcharges data and overland flow data) indicated that the Nullah could meet the current design standard after implementation of the proposed scheme mentioned in paragraph 9 above.

**SUMMARY**

13. The drainage capacity of Kai Tak Nullah in Wong Tai Sin is inadequate to meet the current flood protection standards. There is an urgent need to remove the bottlenecks and improve the drainage capacity of Kai Tak Nullah. Taking this opportunity, a PPE was conducted to gather views from the public and the Kai Tak Nullah will also be rehabilitated to meet the public aspiration of a comparatively natural drainage watercourse. The proposed alleviation scheme demonstrated valuable flood risk improvements in Kai Tak Nullah upstream catchment as well as minimised the impacts to the downstream drainage, transport, environment, visual and public. In addition to flood alleviation, rehabilitation and revitalisation elements as shown in **Figure 5** have been adopted to meet the public aspiration.

14. The proposed works are currently under construction. All the works are scheduled for completion in 2017 while the flood relief works are scheduled for completion in phases starting from end 2015. Upon completion, the proposed works will improve the living environment through enhancement of townscape of the area, provision of a scenic and leisure place for the enjoyment of the public as well as fostering closer connection with adjacent areas.

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