NUMERICAL MODELLING STUDY FOR APPLICATION OF HYDRAULIC STRUCTURES FOR FLOOD CONTROL

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TO:

MY FAMILY

&

EMILIA

THANKS FOR YOUR PRAYER, ATTENTION

AND SPIRITUAL.....

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ABSTRACT

Mathematical models have been developed to resolve many problems that are related to water profile evaluation. The flow through weir can be solved using numerical methods and computer techniques. Storage in channel and river could be utilized by installing weir at strategic locations along the river. This approach might be benefited in flood control to the downstream area, but it could also cause flooding in the upstream due to the backwater effect. The problem is whether by the installation of those weirs will produce backwater at the upstream area. By using numerical equation the effective application of hydraulic structures such as weir can be determined. The computer program such as FEWMS Fst2dh is numerical program has ability to simulate the flow in structure hydraulics. The effectiveness of weirs at the upstream Sungai Plentong can be determined by using FESWMS Fst2dh modelling that is enable Surface Water Modelling System (SMS) software. The simulated water surface elevation will be used to identify which areas that are have problem with backwater. The result observed data shows that the existing weir in the channel at the upstream of Sungai Plentong can reduce to 80% of the channel water depth. The simulated of water level results shows that the weir did not producing significant increase effect of water level due a backwater.

ABSTRAK

Model matematik telah lama dibangunkan untuk menyelesaikan banyak masalah dalam penentuan profil permukaan air sungai. Kadar alir pada empangan kecil boleh ditentukan menerusi kaedah berangka dan teknik computer. Pendekatan ini boleh memberi faedah kepada pengawalan banjir di kawasan hilir tetapi juga boleh berlaku banjir disebabkan oleh air balik. Dengan menggunakan kaedah berangka keberkesanan penggunaan empangan kecil di sungai dapat ditentukan. FESWMS Fst2dh adalah perisian yang berupaya menentukan profil permukaan air sungai terutamanya pada struktur hidraulik dengan menggunakan pengiraan keadah berangka. Berdasarkan aras permukaan yang ditentukan oleh Perisian FESWMS Fst2dh dari *Surface Water Modelling System (SMS)* sebagai enjin utama dalam perisian ini kawasan yang akan berlaku air balik dapat dikenalpasti. Daripada data kedalaman air yang dicerap terhadap hulu Sungai Plentong didapati empangan kecil di dalamnya dapat mengurangkan kedalaman air sehingga 80 peratus. Selain itu daripada simulasi yang dilakukan tiada berlaku peningkatan kedalaman air sungai di sebabkan air balik di belakang empangan kecil tersebut.

CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Mathematical models have been developed to resolve many problems for water profile evaluation. A mathematical model consists of a set of differential equations that are known to govern the flow of surface water. Usually, the assumptions necessary to solve a mathematical model analytical are fairly restrictive. To deal with more realistic situations, it is usually necessary to solve the mathematical model approximately using numerical technique.

Hydraulic structures such as weir in urban stormwater drainage can be use as detention facilities for reducing flow peak in the channel. Thus can reduce the frequency and extent of downstream flooding. This facility can also be categorised as on-line storage which is a facility that intercepts flow directly within a conveyances system. On-line storage occasionally is provided as an on-site facility, though it is more often a community or regional facility (Department of Irrigation and Drainage, 2000).

Weir is one of the applications of hydraulic structures in river. Some weirs have sluice gates or orifices which release water at a level below the top of the weir. Jabatan Bekalan Air (JBA) commonly used a weir to raise the level of a small river or stream for water supply. Department of Irrigation and Drainage (DID) normally used a weir to measure river water level. The channel of river traditionally as a conveyance but its also can use as a temporary storage. The detain conveyance

concept which is the system use to optimise storage in river channel using hydraulic structures such as weir to decrease flow and water level .

Rivers are valuable natural resources for human life, environment and national development. There are 150 river systems in this country with 100 of them in the Peninsula Malaysia and 50 in Sabah & Sarawak. These river systems consist of 1800 rivers with a total length of 38,000 km. River conservancy is one of the responsibility of DID since its inception in the year 1932. After the 1971 major flood in the country, DID was given the task to carry out flood mitigation programs. One of the challenge of this department is problem of many river at downstream in this country is not capable to cater the flow. So, one of the solution for this problem is to construct hydraulic structures to control the flow in river channel.

1.2 PROBLEM STATEMENT

Land acquisition for the construction detention or retention ponds is not practical because of the increase of land prices in urban area. The method on this hydraulic structures system (weir and orifices) is to maximized storage in the channel so that it can detain flow temporarily. But it may have risks such as backwater, trap of rubbish and sedimentation. The proper design of weir and orifices system is required to avoid the problem mentioned above. The design also must consider maximum overflow, number of orifices and efficiency to reduce depth of flow in order to come up with the optimum design.

1.3 IMPORTANT OF THE STUDY

For most of this century, open-channel flow and other hydraulic calculation is based on 1-D flow approximations. Although 1-D solutions provide accurate analysis of many problems, the assumptions upon which are based is often strained, therefore the reliability of the solution is compromised. However, 2-D approximation of flow in a horizontal plane often yields solutions of sufficient detail for highly complex hydrodynamic problems. Two dimensional depth average flow solutions have been found to provide excellent descriptions of flow in open channels and flood plains where topography has created unusual flow pattern that are difficult to evaluate using 1D flow approximations such as flow at hydraulic structures.

1.4 OBJECTIVES OF THE STUDY

The objectives of the study are as follows:

a) To study an effectiveness of hydraulic structures for flood quantity control.
b) To evaluate flow characteristics for weir and orifices system in open channel.

1.5 SCOPE OF STUDY

To achieve the above objective, this study will focus on:

a) Sungai Plentong, Taman Pelangi Indah, Johor Bahru. (see Figure 1.1). The location of Sungai Plentong catchment is within Taman Pelangi Indah with minimum elevation of 39.6m above mean sea level. It is just 16 km from the city Johor Bahru centre, along Jalan Tebrau. The site is also near to Pasir

Gudang Highway and North South Highway and is located in the area upstream Sungai Plentong (see Figure 1.2). The study will involve weir and orifices system. The study will concentrate on one weir at the downstream area. The weir was constructed in 2001. All three weirs were constructed in same channel (see Figure 1.3). The catchment area involved is about 0.52 km^2. The size of existing monsoon drain is 11 m width and 3.3 m heights (see Figure 1.4). The maximum flow capacity for this channel is 240 m^3/s and the estimate flow rate base on 100 years ARI from catchments area is about 23.4 m^3/s.

b) The software used to simulate surface water profile is FESWMS Fst2dh (numerical model for hydraulic structures) integrated in Surface Water Modelling System (SMS).

c) Field Work- involved data collection such as flow rate, river water level, river condition and topography

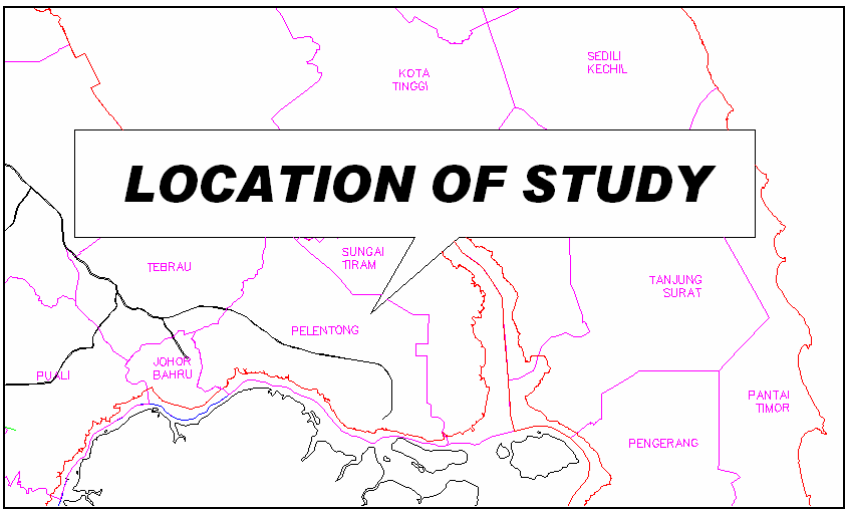

Figure 1.1: The Location of Study Area

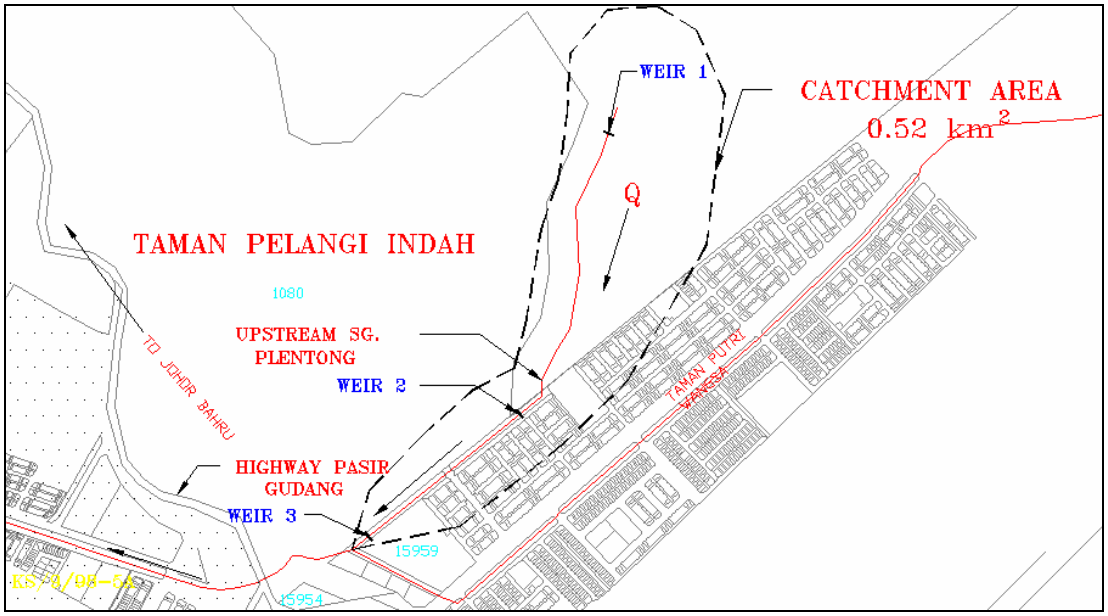

Figure 1.2: Location of Site Area at Upstream Sungai Plentong

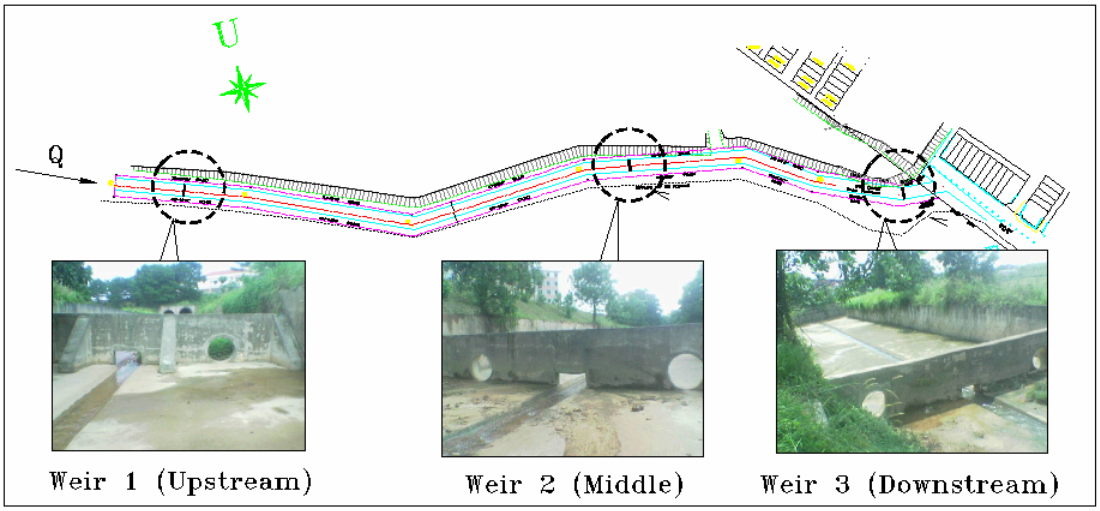

Figure 1.3: Location of Weir in Upstream Sungai Plentong

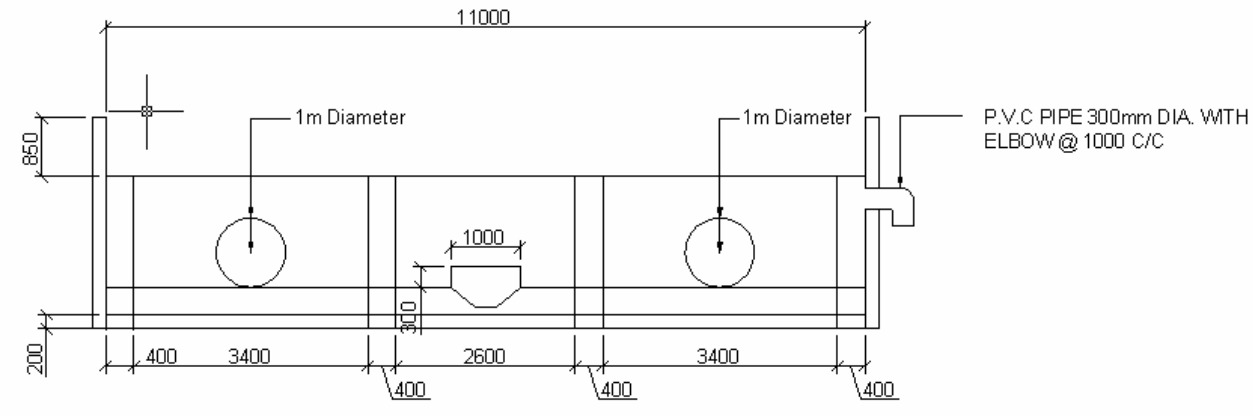

Figure 1.4: Detail of Weir Structures