Flood Problem at Junction Kg. Sentang : It causes and the Engineering Solutions

by

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5553

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Civil Engineering)

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Universiti Teknologi PETRONAS
Bandar Seri Iskandar
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Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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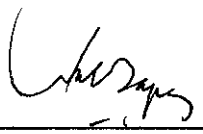
Approved by,



(A.P. DR. NASIMAN BIN SAPARI)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

July 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MOHD ARMAN B. MEOHAN @ ASHAARI

ABSTRACT

A case study was conducted at the development area in Batu Gajah, Perak Darul Ridzuan, (Taman Batu Gajah and Kg. Tersusun Sentang). This particular research covers analytical approaches to the issue of flash flood recurrence at the problem area for the past 5 years with data collected from site investigation, surveys with the local residents and interviews with the responsible authorities. Relevant data was analyzed and the existing drain capacity and peak flow of 0.96 m^3 /s and 1.14 m^3/s respectively were obtained. The study covers a catchment area of 3.7 hectares. The way of the existing drainage design was implemented and constructed could be traced back to the early planning stage of the development in Batu Gajah area namely during early 1970's. The study found that there is a discrepancy between the actual performance and the intended capacity of the drainage system. Application of On-Site Detention storage (OSD) was analyzed for possible alternative to mitigate the flood problem. The OSD was found to be able to reduce the peak flow to 0.15 m^3/s and alleviate the problem.

ACKNOWLEDGEMENT

Grateful to Allah the Most Merciful, I had finished this final year project to fulfill my requirement of Bachelor of Engineering (Hons). I would like to express my sincerest appreciation and deepest gratitude to my final year project supervisor, A. P. Dr. Nasiman B. Sapari for his encouragement, patience, guidance, and very valuable critics throughout this thesis project.

Special thanks go to my family members, my mother, brother and sister, for giving a good support, pray for my success and looked after me from the beginning of this research until it finished.

Same goes to Head of Civil Department, AP Dr. Muhd Fadhil Nuruddin and all the lecturers for the guidance, advice and motivation. Without their continued support and interest, this thesis would never been completed up until here.

In addition, I would like to thanks my colleagues for giving me such a great time during this research. Finally yet very important, I would like to express my gratitude to all personnel that involved and helped giving all the information and support that I needed up to the accomplishment of this study.

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LIST OF ABBREVIATIONS

DID	Department of Irrigation and Drainage, Malaysia
FYP	Final Year Project
HBA	Home and Building Association
IDF	Intensity Duration Frequency
Kg.	kampung
MDKB	Majlis Daerah Kinta Barat
NDP	National Development Policy
OSD	On-Site Detention Storage
PDA	Personal Digital Assistant
Tmn.	Taman

CHAPTER 1

INTRODUCTION

1.1 Background studies

Batu Gajah, Perak, for the past ten years had grown in line with the expansion of major economic activities as emphasized in the National Development Policy (NDP). However, these progressions that concurrently expanding with the construction of housing areas, business complexes, and all the related infrastructures had in a way altered the natural hydrological cycle. Storm water flow from major storm event could not be catered by the existing drainage system, hence several flood events had been recorded trough out the years.

The project area for the study include Taman Batu Gajah, Taman Batu Gajah Baru and Kg. Tersusun Sentang is located at Batu Gajah, Perak Darul Ridzuan. The catchment covers a total area of 100 hectares.

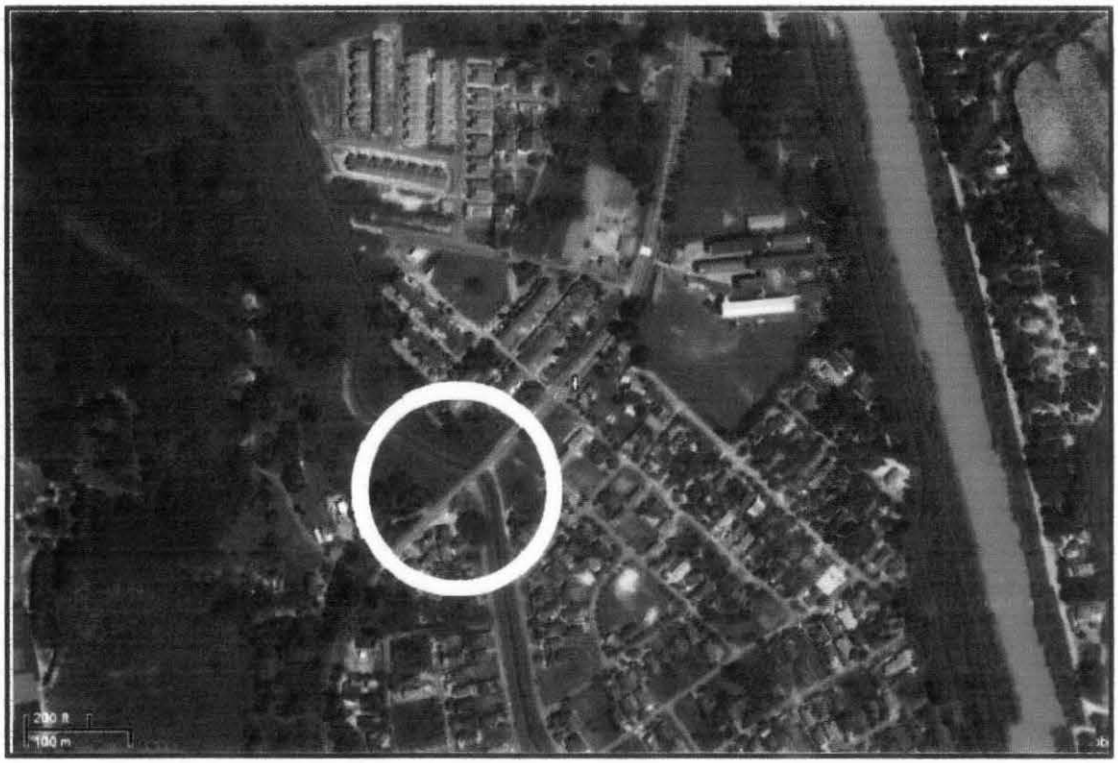


Figure 1 : Vicinity under study at Batu Gajah, perak. Scale 1:8000

1.4 Significance of Project Research

This research had gone trough various aspect related to the issue of flash flood in Batu Gajah. All contributing factor discussed, and all solutions suggested may be the foundation for further studies relevant to the matter if futher research is to be conducted in near future.

Considering other areas in this region with the same issue, this research will be usefull as a basis for solving similar engineering problems.

CHAPTER 2

LITERATURE REVIEW

Flash flood problem had long become an issue of urban planning and development (J. Parkinson, 2005). Factors that continually discussed over are the planning, implementation and regulation itself (related to design) regarding safe design criteria, the drastic rate of urban development, and problem of global warming; that may be linked to the increasing of rainfall intensity troughout the country.

Malaysian Meteorological Department has reported that as recently, rainfall over the country recorded normal to above normal while some parts in Terengganu, Kelantan, Pahang together with eastern parts of Sabah experienced much above normal. Further more, northern to western parts of Peninsular received 50 to 70 mm of rainfall amount. However, eastern parts together with southern parts of Peninsular experienced more rainfall ranging from 70 to 150 mm. Notable 10-day total rainfall amounts ranging from 70 to 200 mm were reported particularly over East Malaysia (Sarawak and eastern parts of Sabah) throughout the period. Elsewhere in the country received 30 to 70 mm amount of 10-day total precipitation. With regard to the temperature, most of the lowland areas in Malaysia recorded normal temperature during this period. This scenario may be related to the commencement of inter-monsoon period at early March, with light and variable wind and humid air, affecting major city and town toward the west coast of Peninsular.

Meanwhile, observation towards recent climate history indicates that the frequency of occurrence of heavy rainfall event is increasing as in research conducted by Ismail M. Nor and S. Awadalla (1991) found that 15% increase in rainfall and 10% in evaporation induced the flood peak from an equivalent of a 28-year flood to that of a 35-year flood.

This is indeed a worrying statistic, and without proper and immediate mitigative measure, serious flood problem may occur.

Two types of flood that reccuring in this region are flash flood and monsoon flood. Flash flood commonly affecting urban areas, due to higher intensity rainfall in a short duration. Several event of flash flood for instance, have been recorded during March 2008, as the result of the continous heavy downpour that had lasted for 2-3 hours. The affected areas on 12th of March include Ayer Hitam, Batu Pahat and Johor Bharu and on 25th of March in Batu Gajah, Perak (Zaili Muhammad, 2008).

On the other hand, monsoon flood usually occurs during the north-east monsoon period and is associated with high intensity rainfall of a few days duration. The heaviest rain recorded at 350mm in less than 24 hours at Johor on December 2006 and caused landslides, burst riverbanks, blocked major roads and disrupted trains trips. The heaviest rainfall in century had leaved 110,000 people displaced and homeless (Raai Osman, 2007).

Taking it to smaller scales, as for the case study area in Batu Gajah, Perak, flooding in urban areas usually occur as the results of overspilling and surface ponding when the stormwater drains become surcharged and overflow. We do notes that in a new townships, the total impervious areas is very high since the housing developers only have to comply to an open space of 10%; the developers normally go for maximum built up areas to maximize land use. With respect to catchment runoff, an increase in area imperviousness from zero to 40% would cut the time to peak discharge by about 50% and increase the discharge magnitude by about 90% (The Stormwater Management Manual by DID, 2000). Before urbanization, rainwater is intercepted by the vegetation, infiltrates into the ground and takes time to travel to the river, but now it is quickly collected from the roofs and other paved grounds and channeled efficiently to public drains, which in turn rapidly brings it to the nearest river.

Although floods are natural phenomena, the effects of rainfall resulting in excess runoff into streams and rivers, uncontrolled development activities in watersheds and along river corridors and high sea level areas can increase the severity of floods, yielding possible harzadous consequences at the concentrated areas. The high rate of sedimentation in the rivers can also lead to serious flooding, as may be related to the new

construction of highway nearby, connecting Ipoh-Lumut highway to Batu Gajah-Gopeng road.

A proper and optimum design of drain system seen here to be a crucial aspect in mitigating all this issue. Looking back to the history of the design system itself, Barry Adams and Fabian Papa (2000) in their research stated that urban drainage system design can be traced back to as early as 1800's. Early drainage design system was based largely on peak discharge rates estimated from observations of runoff rates that occured in the existing systems. In 1852, John Roe published a table of such observations for London sewers, and in 1857, Hawksley fitted analytical expressions to Roe's data to relate the magnitude of discharge to the drainage area. Over the half century that followed, Hawksley's formula began a generation pseudoempirical equations for peak flow estimation, not considering either meteorological variables (such as rainfall intensity) or the frequency of estimated peak discharges. Numerous of such similar formulas appeared for culvert design in the same era. It was not until 1913 that Weston Fuller published the first empirical peak discharge formula which explicitly included an estimate of the frequency or return period of peak discharge. However the reliability of such estimate was questionable.

The research furthermore found that the appearance of the rational formula in the same era did allow for explicit consideration of rainfall frequency through the inclusion of meteorological variable; rainfall intensity. However, early usage of the formula was often based on intensities of unspecified frequency. Consequently, by 1904, there were 26 years of rainfall records at the Chestnut Hill reservoir in Boston from which Metcalf and Eddy created the intensity-duration curves for specific return periods (Metcald and Eddy, 1914). By the 1930's the concept of associating frequencies with rainfall intensities and the derivation of intensity-duration-frequency (IDF) curves from rainfall records had become well known. Hencefor, the use of rational formula, combined with the IDF curves imparted an approach to drainage design practice that still endures up until now.

The next step in the evolution of urban drainage system design methods occurred when digital computers made digital simulation practical. Since the late 1950's rainfall-runoff

simulation models have appeared to capitalize on this computing capability. As a result, there was no longer a practical necessity to restrict the shape of the design storm to a rectangular hyetograph. Although it was technically impossible to simulate a runoff from entire recorded rainfall histories, emphasise was placed on simulating the effects of specific discrete rainfall events or design storms.

Coming back to the issues confronted around urban drainage design in recent years, especially on problem areas, the major factor is the inadequacy of the existing channel particularly the main drains to cater the generated stormwater flow. This could be related back to the issue on significant increment of rainfall and evaporation in the past 20 years (Ismail Mohd Nor and S. Awadalla, 1991). Previous design implementation, going back to the last two decades should have become obsolete, and insufficient to cater for the growing development and global climate changes.

Indiscriminate littering and solid waste dumping are also the contributing factor to flood events. The accumulation of the solid waste in drain has aggravated this problem, and is frequently a source of localized flooding, bringing contaminated drain water into contact with residential areas. Random garbage dumping in waterways impede drainage during rainy season, and contributes to flow stagnation otherwise during dry season.The existing drainage usually found at problem areas are highly silted and the depth of sediment can be noticed to a significant extent. This may be caused by the lack of maintenance by the responsible party (local authority, paid contractor). Sediment deposits in drainage create negative effects on the hydraulic performance of the system and on the environment. Problems that arise include blockage, surcharge, early overflows, and large pollutant discharges (Delleur, 2001)

The rules and regulations related to the drainage system in Malaysia is covered under the STREET, DRAINAGE AND BUILDING ACT 1947 (ACT 133). The act includes the condition where the local authority reasonably suspects there is a defect, deformation or deterioration in the structures which may likely result in the failure, they may issue to the owner/developer and order to review the safety and stability of the structures.

One good example was the case where three housing developers in Kajang during 2004 were ordered to stop their construction works until they build the required siltation and retention ponds at the site to prevent mud floods (National House Buyer Association, 2004). This shows how serious the authority may look into the particular issue related to the developers and consultants. However, the condition and well being of the main drains and irrigation channel, also to mention periodical maintenance of the structures that actually should be under their supervision; clearly may and should be improved.

CHAPTER 3

METHODOLOGY

The purpose of this research is to study, analyze and propose an engineering solution for corrective/mitigative measures to reduce the potential impact of the new and existing developments with respect to surface water discharges, in this case at the problem area of Junction at Kg. Sentang and Taman Batu Gajah, at Batu Gajah, Perak.

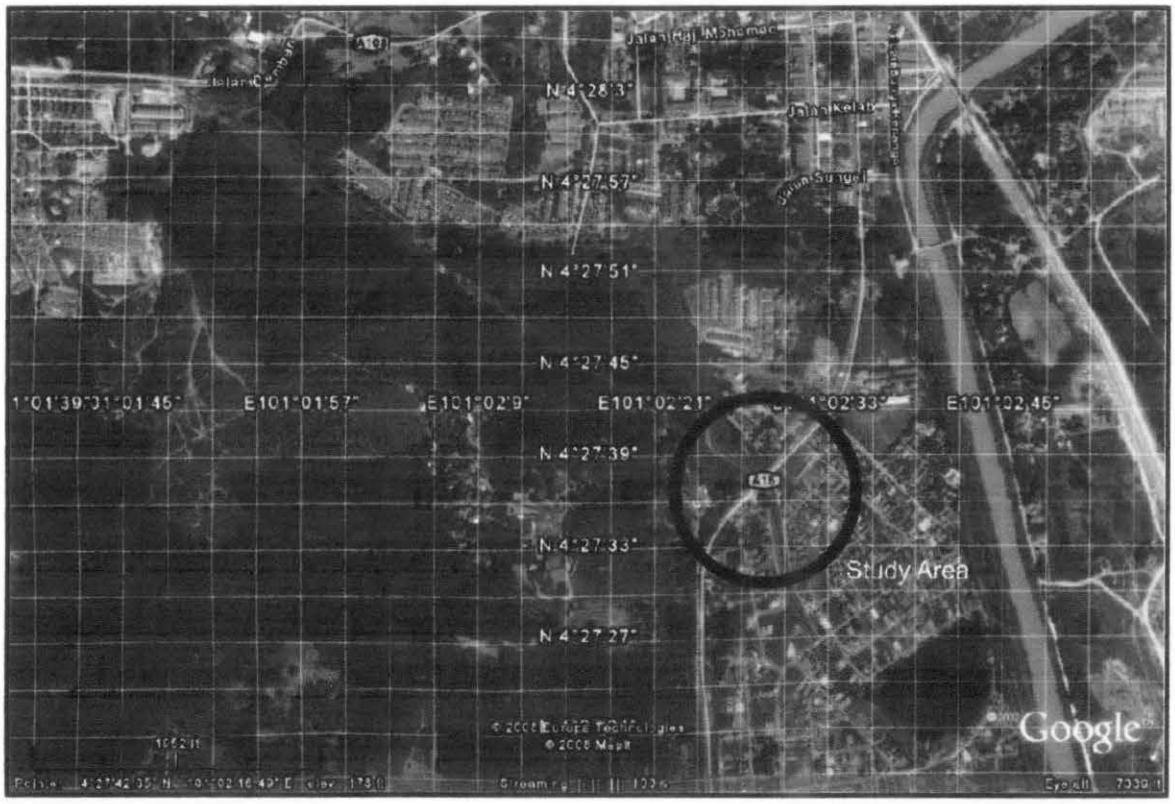
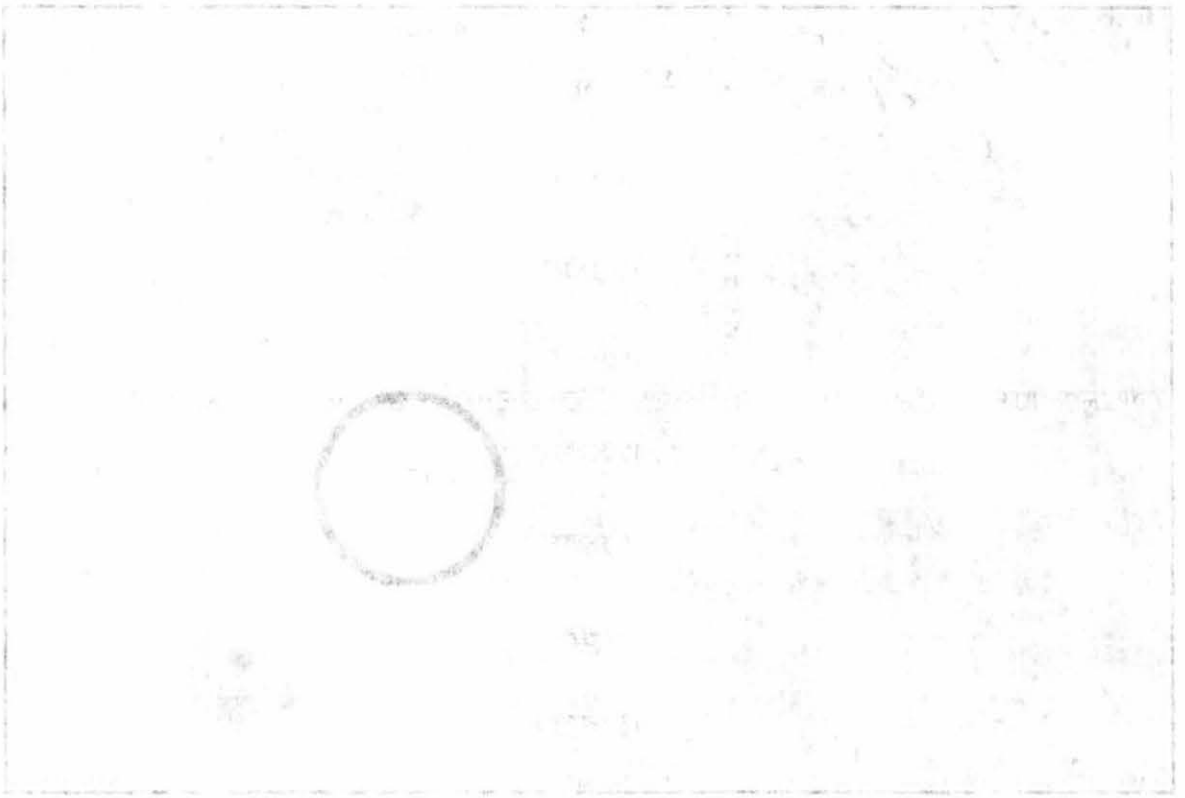


Figure 2 : Study area highlighted in map



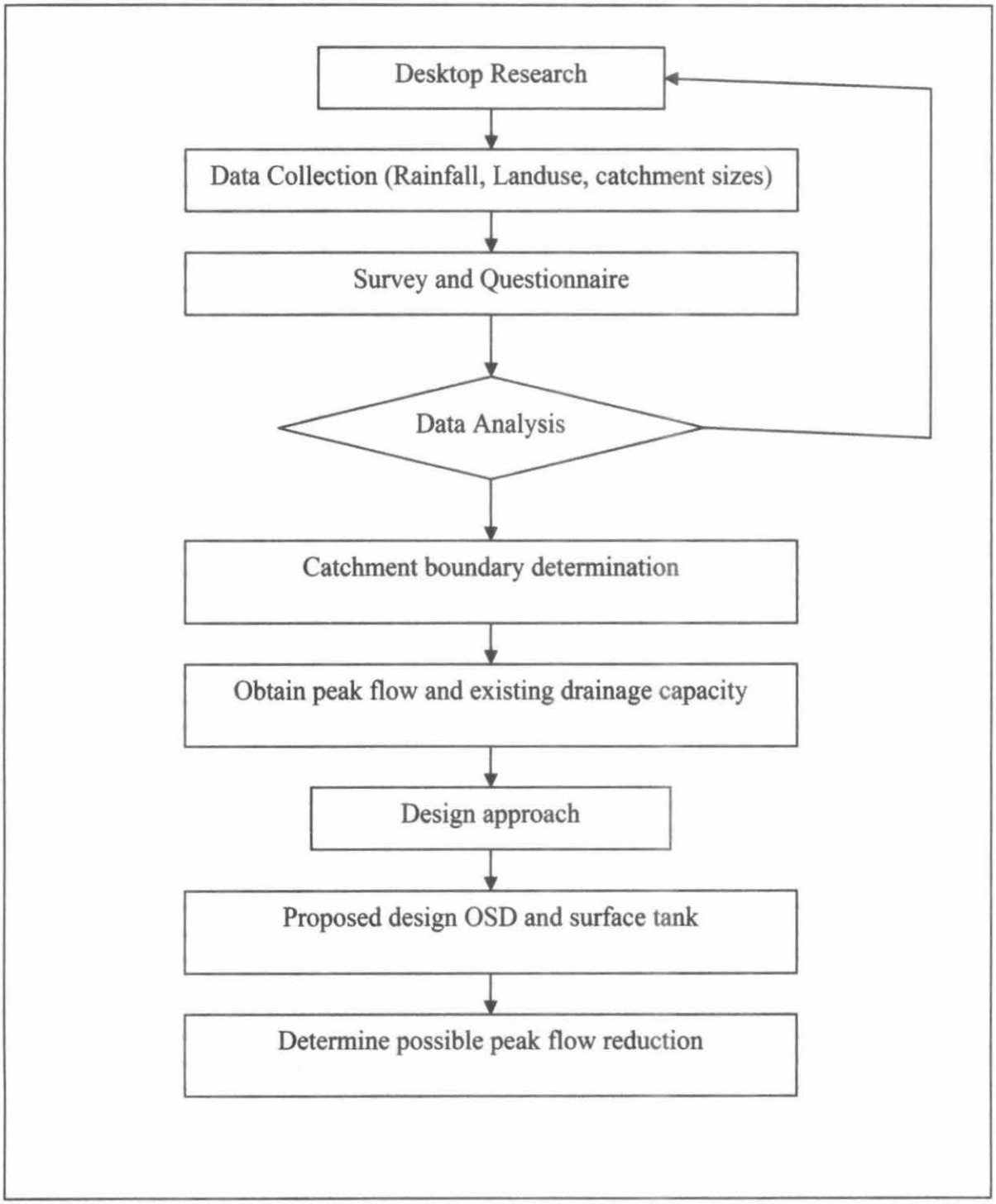


Figure 3 : Methodology flowchart

3.1 Data Collection/Gathering

Several site visits was conducted to the study case area, for the purpose of data collection and questionnaire session. The site inventory was carried out over a period of several month during which a numbers of surveys were conducted. Each survey lasted for a whole day.

Studies on the existing drainage system were carried out, where the drains and culverts that resemble the system were measured. The accuracy of the measurement taken is ±0.1 mm by using a metric measuring tape. Related drainage properties were quantified and recorded, that include perimeter drains for housing area, main drains and culverts exist on site. Tools used includes the measuring tapes, Personal digital assistant (PDA) for recording of data, digital camera, and related equipment (such as umbrella, raincoat etc.)

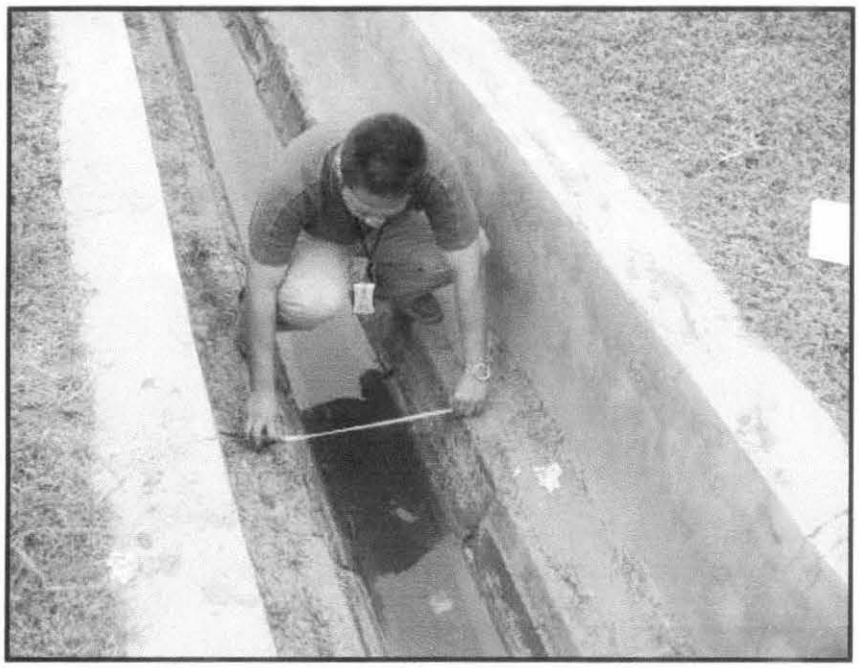


Figure 4 : Measuring the drain properties

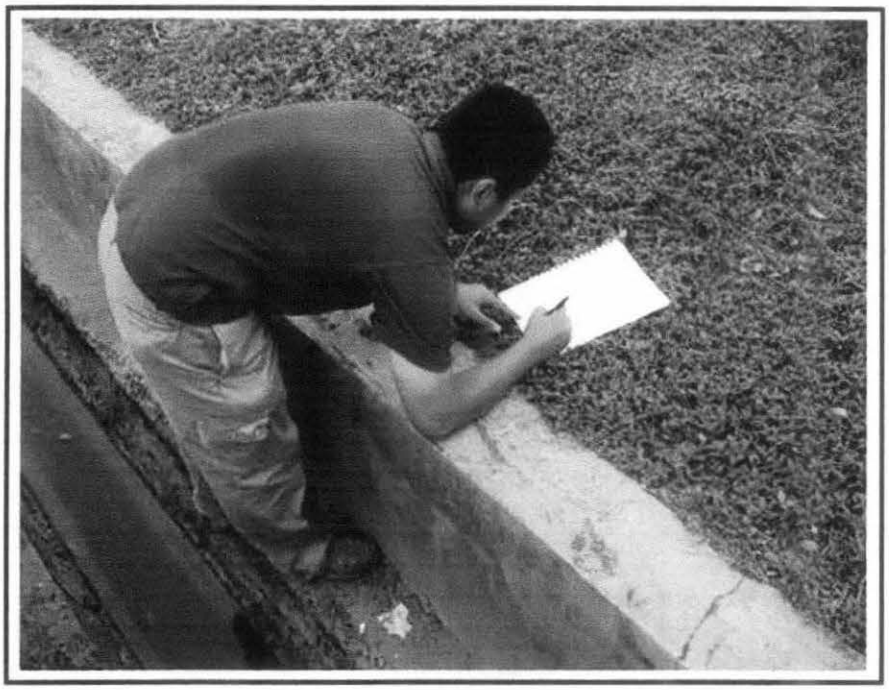


Figure 5 : Average of the measurements obtained and recorded accordingly

Figure 6 : Culvert covered by sediments and vegetation

Figure 7 : Drain structure collapsed at site

All the data obtained pertaining to the survey later discussed in the section on results and discussions. The informations will be used to determine the existing drainage capacity and aids in establishing the catchment boundaries for the study.

Questionnaire and Survey

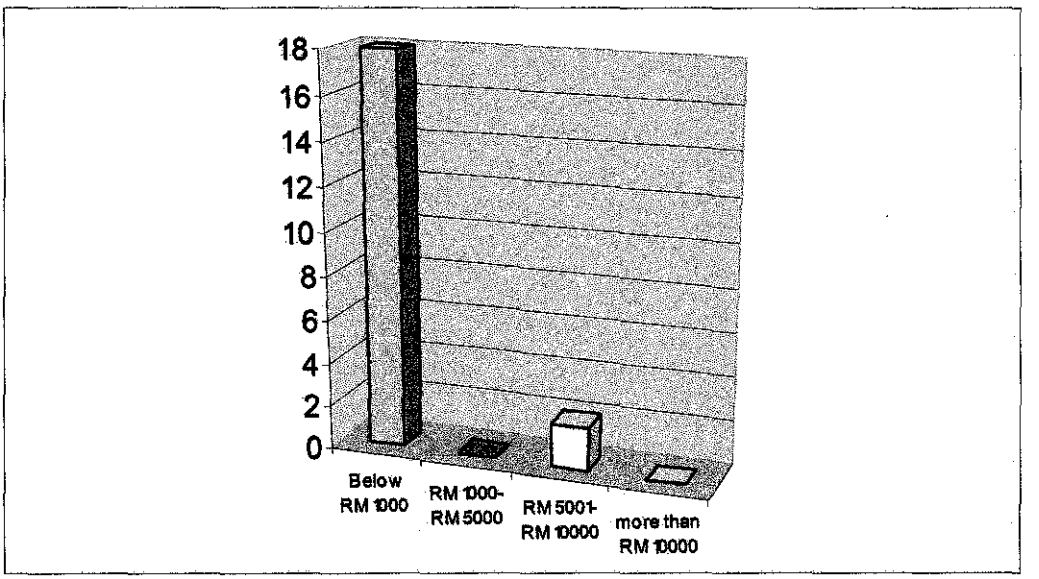
Several site visits and interviews with local communities have been carried out to evaluate the performance of the existing drainage system and how would be the responses from the residents about the flood problems.

50 sets of questionnaire was prepared and posted to the local addresses. The writer also conducted several meet up session during the survey for interviews at the local residences for immediate response related to the questionnaire prepared. The participant had been asked whether their home, contents and other possession had suffered from the flood events. Near 20 respondents had been interviewed for this purpose.

Figure 8 : Survey conducted during a heavy downpour

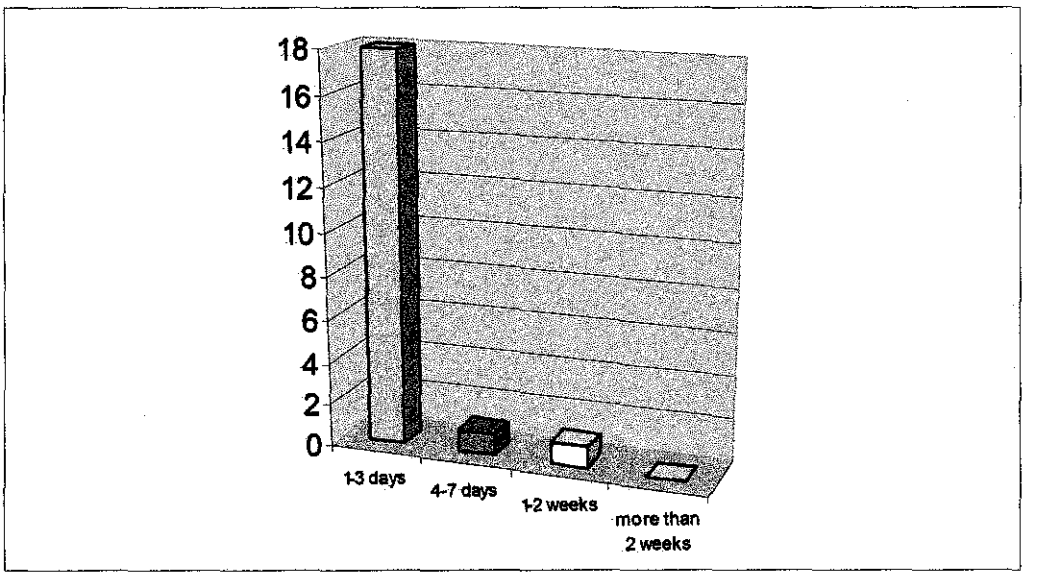
This section provides the product of the survey undertaken to a number of local residents in Batu Gajah, Perak Darul Ridzuan related to the occurrence of flood events at the particular area.

2. If yes, how much is the estimated lost?



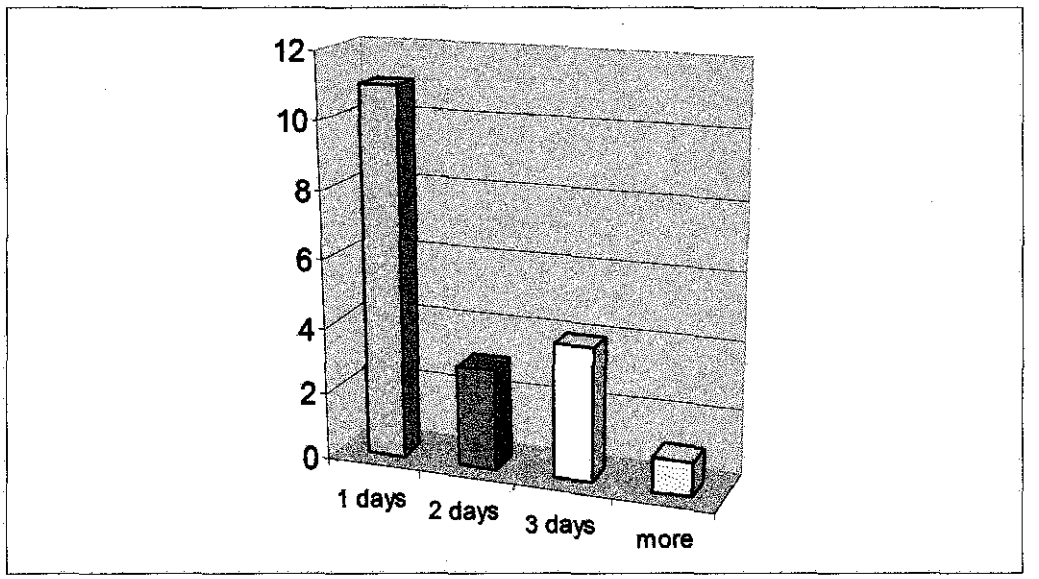
Major resident includes their losses to be no more than RM1000

3. How long it takes to get back to daily routine?



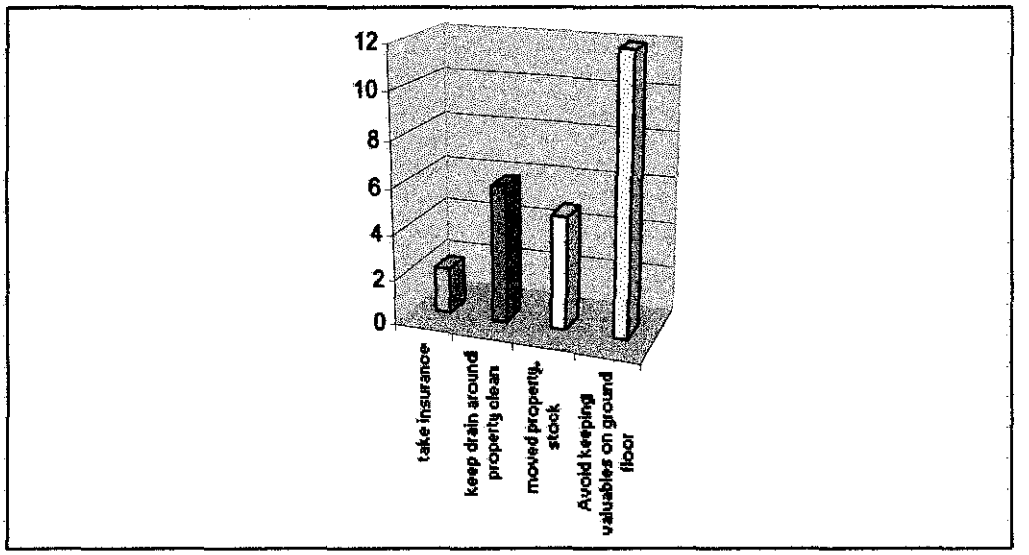
Majority of the respondents stated no more than 3 days to get back to normal life.

4. How much time spent for cleanups?



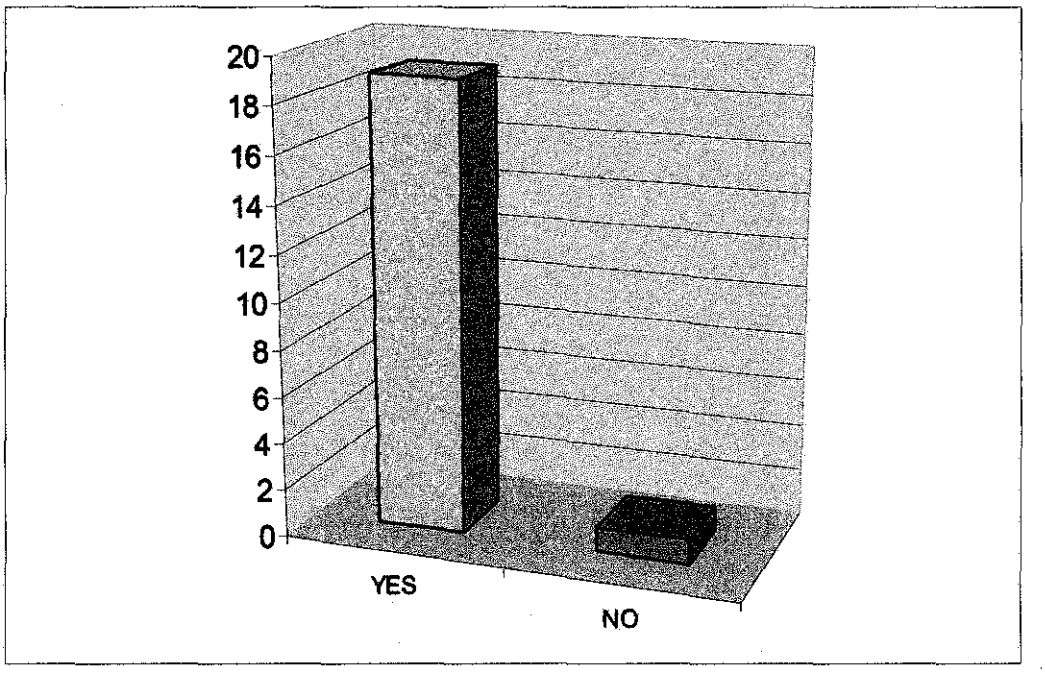
Many stated minimum 1 day needed for cleanups while longer time need to be allocated for the same purpose for bigger houses, premises with larger compound area and backyards.

5. Have you taken any mitigation measures before the floods?

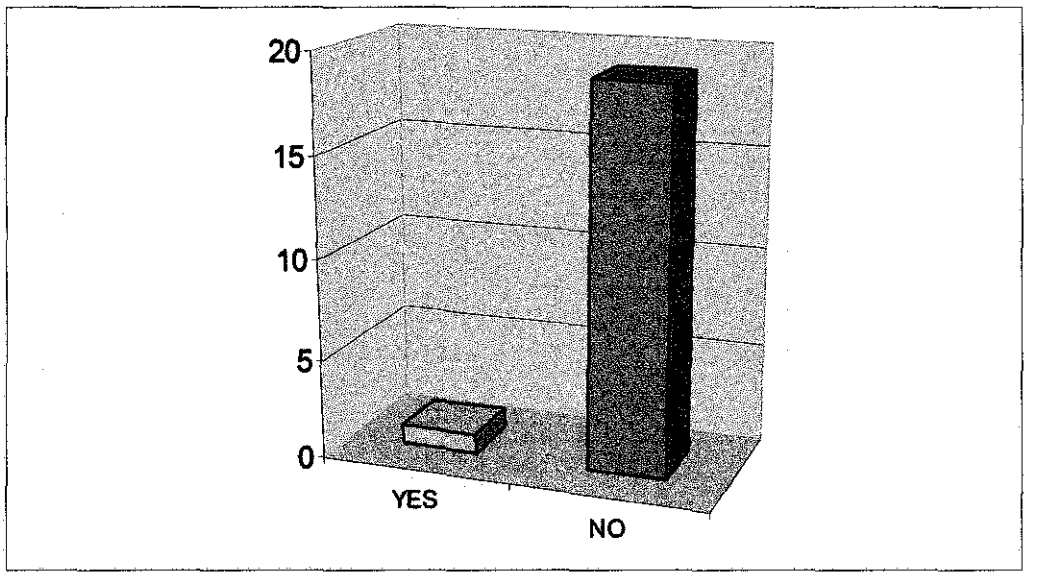


Several options on mitigation approaches prior to flood events listed, where most of the participants responded well, as keeping the valuables off the lower floor is the least to be done.

6. If not, would you intend to take one after this?

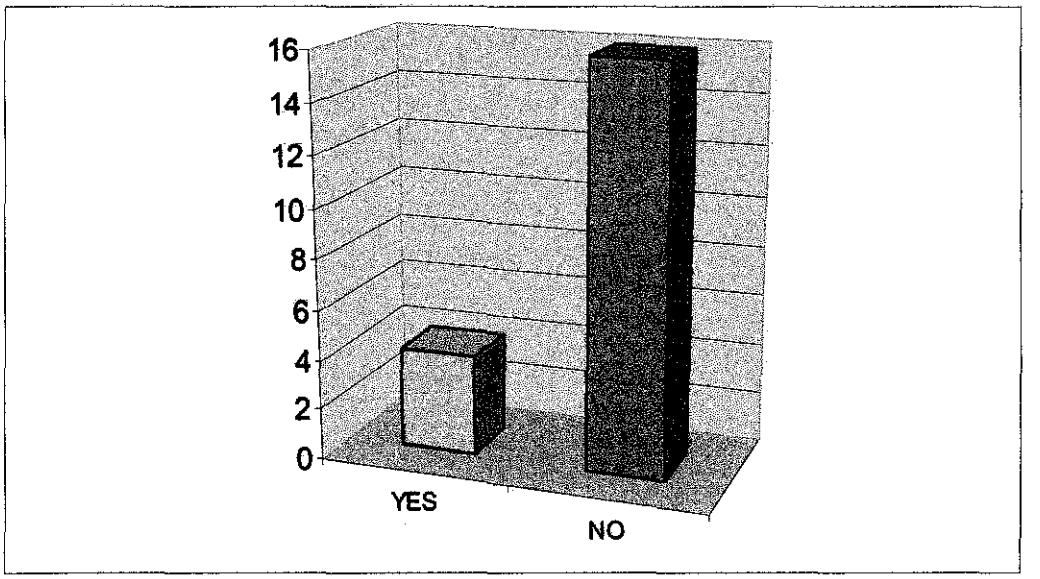


7. Have you been warned or noticed prior to the flood occurrence? if yes, by whom and how?



Only one respondent acclaim that he were informed by flyers and radio announcement while most others claimed no warning announced.

8. Do you notice any corrective, mitigative measure taken by authority subsequent to flood event?



Several residents claimed that there were some infra-works related by the local authority had been worked on regarding the drain and river. One admitted that the river was widen, as well as the drainage facilities. The other two mentioned that the responsible contractor that once cleared up the clogging and solid waste in the drainage system.

Majority of the residents admit the impact of flash flood to their living, economically and socially. Shop lots often closed, while the main road and junction Kg Tersusun Sentang totally inaccessible due to flood events.

They also admit there was an effort by the local authority to increase the height of the road embankment.

The residents, especially at Taman Batu Gajah do emphasize that the main problem is still, the channel and main drain at the problem area. Too small and clogged all year round, as they claim.

This is true as during the survey conducted, the culvert at junction Kg. Tersusun Sentang is partially blocked by sedimentation and hidden by thick vegetation.
Related to this serious issue, the contractor responsible for drainage maintenance, Kuwasa Enterprise had been contacted but unfortunately could not be reached.
The resident reported that the contractor would maintain the drain for sediment clearing/unclogging every three months and sometimes after flood even where deposited sand and soils would have been heavily accumulated.

Data analysis

A map of overall view of area under supervision by Majlis Daerah Kinta Barat, (MDKB) that is the municipal council responsible for Batu Gajah had been obtained. By using AutoCAD®, the area under study was extracted.

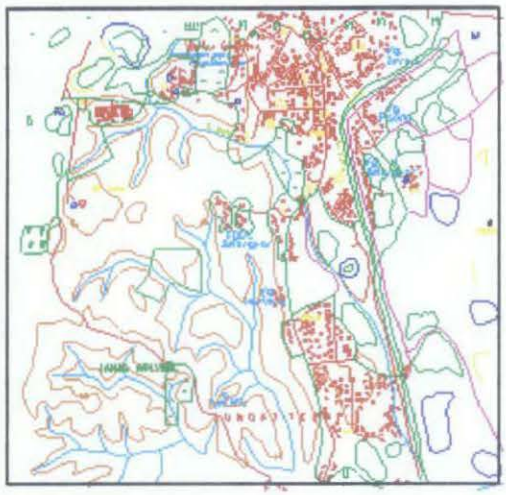


Figure 9 : Topo map for Batu Gajah area

Next, the map was worked on Watershed Modeling Software (WMS) ® 8.0 to come out with the basin delineation. Google Earth Pro V4 also used to obtain the specific point elevations and coordinates.

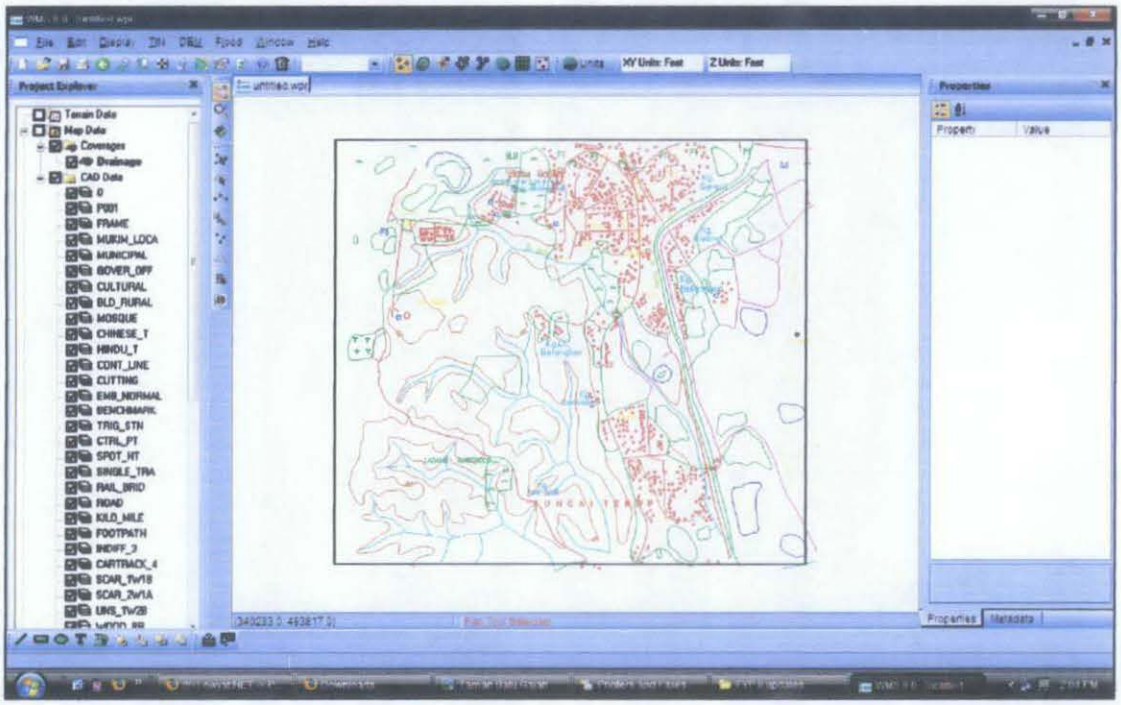


Figure 10 : Map of Batu Gajah on WMS

Figure 11 : map overlays by using AutoCAD

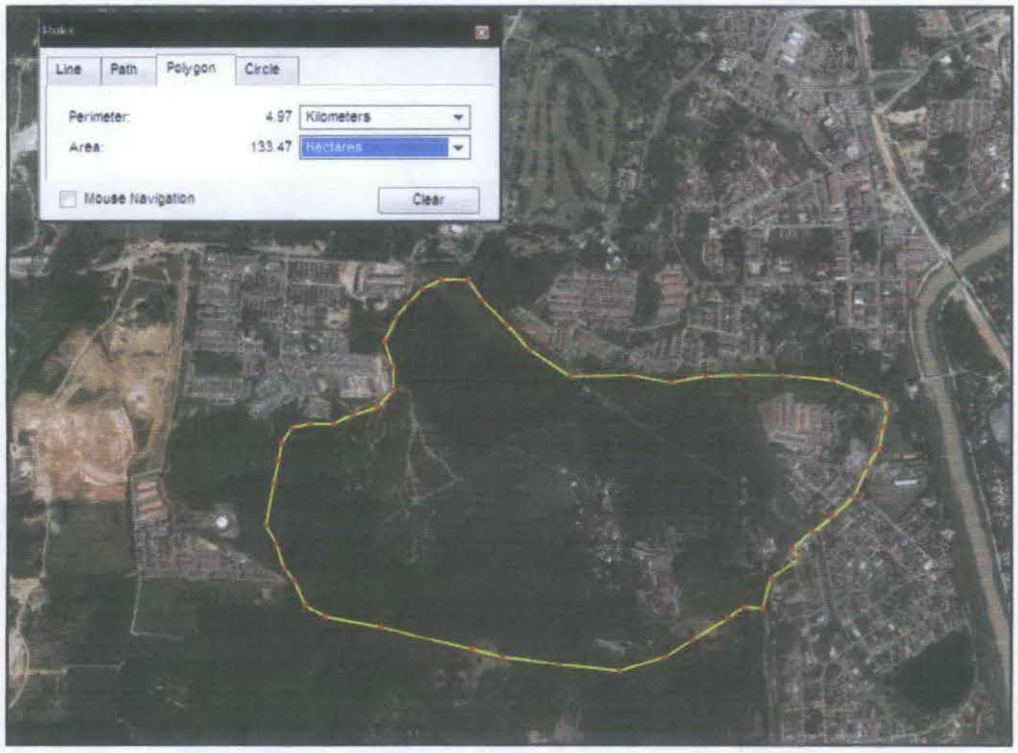


Figure 12 : Delineation of the overall drainage basin

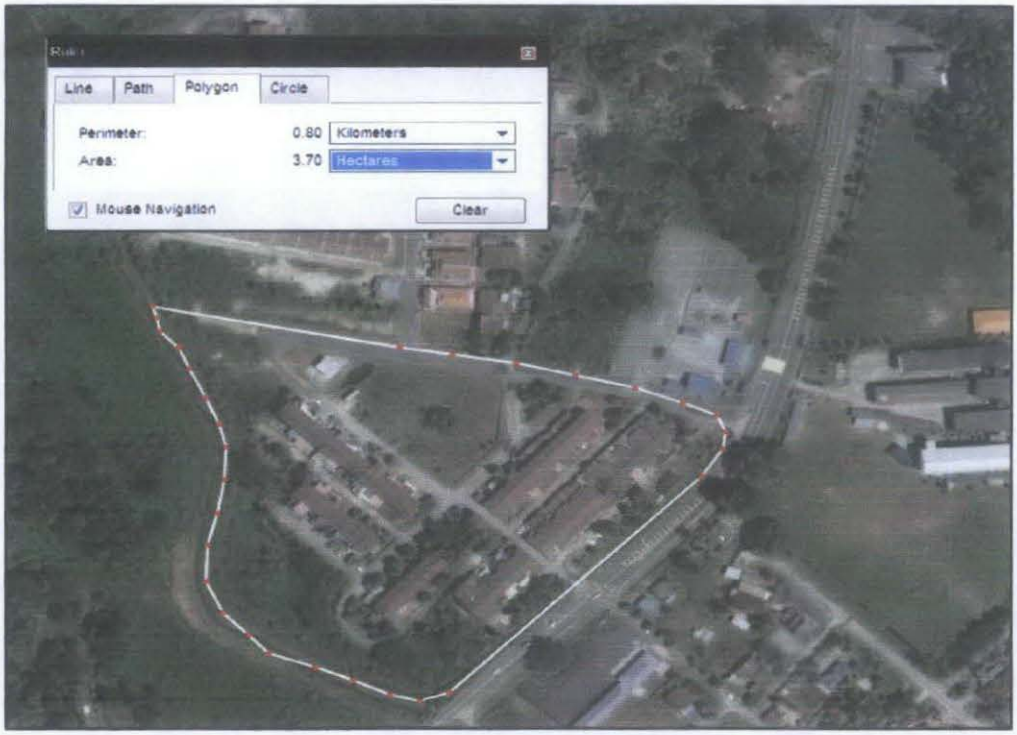


Figure 13 : Sub-catchment contributed to the flood area

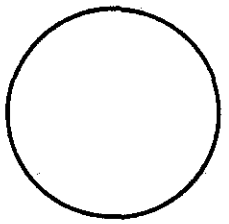
The area of sub-catchment to the point under study is 3.7 hectares.

The peak flow generated calculated to be = 1.14 m^3/s by the calculation below.

t_{cs} = 14 minute

Comparing the peak flow with the existing drain capacity on site :

CALCULATION FOR CULVERT



Diameter = 900 mm

Step (1) : Determine the general formula for hydraulic parameter

Area, A	=	$\pi d^2/4$
Wetted parameter,P	=	πd
Hydraulic Radius,R	=	A/P

Step (2) : Determine the value of hydraulic parameter

A	=	0.6363	m^2	
P	=	2.8278	m	
R	=	0.225	m	
S	=	1/200	=	0.0033

Step (3) : Determine the design capacity

From Manning's Equation;

$Q_{capacity}$	=	$(1/n) \times A_t \times R^{2/3} \times S^{1/2}$	
n	=	0.015	
$Q_{capacity}$	=	0.90140217	m^3/s

Step (4) : Determine the Average velocity

$$V = \frac{Q}{A}$$

$$= 1.41673098 \text{ m/s}$$

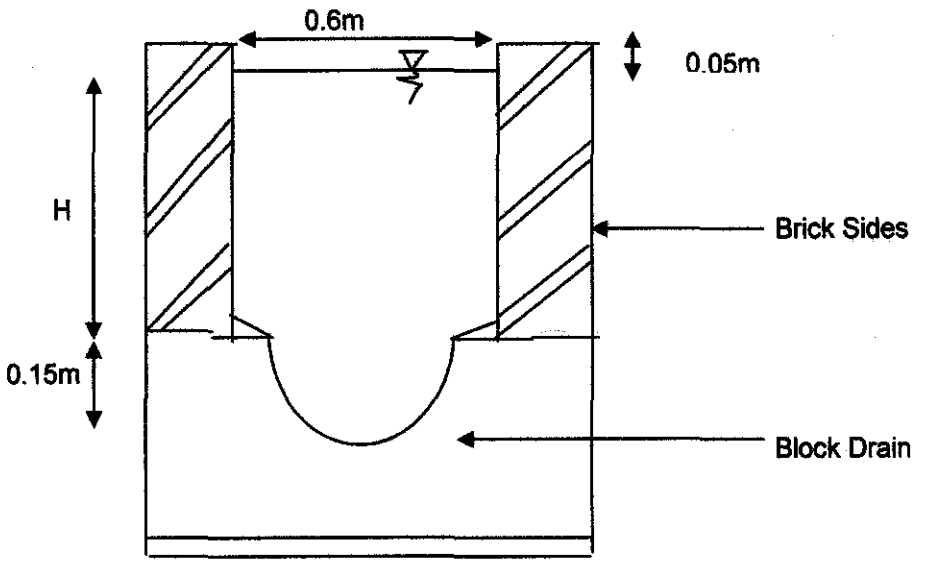
Hydraulic Analysis

Type of open drain : Half Round with Brick Sides

Size of drain : 300mm

Depth of drain, y : Road/Platform Level - Drain Invert Level = 1.00 m

Manning ,n : 0.015



Step (1) : Determine the general formula for hydraulic parameter

From analysis obtain the general formula for 300mm HR + BS.

$H = y - 0.15 - 0.05$ .....Eq.(1)

$Area, A = 0.6H + 0.035$ .....Eq.(2)

$Wetted\ parameter, P = 2H + 0.471$ .....Eq.(3)

$Hydraulic\ Radius, R = A/P$ .....Eq.(4)

Step (2) : Determine the value of hydraulic parameter

For ;

y	=	1.00	m
H	=	0.80	m
A	=	0.515	m^2
P	=	2.07	m
R	=	0.25	m
S	=	0.005	

Step (3) : Determine the Average velocity

$$V = \frac{1 \; X \; R^{2/3} \; X \; \frac{S^{1/2}}{n}}{}$$

V = 1.86 m/s

Step (4) : Determine the design capacity

From Manning's Equation;

$$Q = \frac{1 \; X \; A \; X \; R^{2/3} \; X \; S^{1/2}}{n}$$

Q = 0.96 m^3/s

Where the capacity of either could not even cater for runoff from Taman Batu Gajah **alone**. The excess discharge is creating flood problem, thus reduction in peak runoff is needed. The following engineering intervention were assessed and recommended:

On-site Detention Storage (Below Ground)

Providing a small proportion of the required storage volume underground can often enhance adevelopment by limiting the frequency of inundation of an above ground storage area.

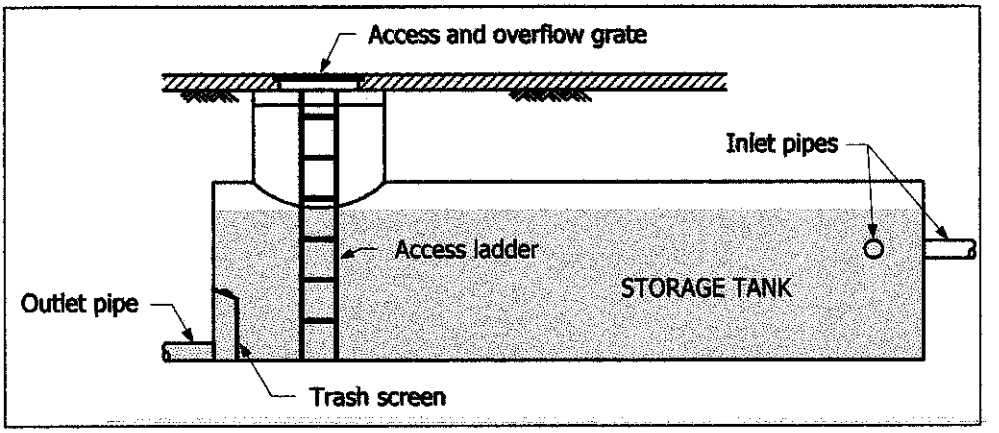


Figure 14 : Typical below ground on-site detention

CALCULATION ON OSD SYSTEM FOR TAMAN BATU GAJAH BARU

Designing Below - Ground OSR Storage System

Step (1) : Determine Storage Volume Required

1 Determine the area of the site that will be directed to the OSR storage system.

Catchment	:	Taman Batu Gajah
Catchment (m^2)	:	37000
Name of Block	:	1
Platform	:	Varies, majorly low lying

2 Determine the amount of impervious and pervious areas draining to the OSR Storage system.

Impervious area :

Building	=	13000.00	m^2
Parking	=	1000.00	m^2
Driveway	=	1000.00	m^2
Surface paving	=	2000.00	m^2
TOTAL	=	17000	m^2

Pervious area :

Landscape and Garden = 20000 m^2

The site condition before development was :
and the pervious area is = 37000 m^2

3 Times of concentration, t_c and t_{cs}

To determine the catchment times of concentration, an analysis of the catchment drainage system will need to be undertaken.
From calculation (Refer times of concentration analysis), the times of concentration is :

t_{cs} = 40 minutes

t_c = 14 minutes

4 Calculate the pre and post-development flows for the area draining to the OSR storage.

The minor drainage system that the OSR storage will discharge into the nearest drain has been designed for a **5-year ARI capacity**.
From the calculation, the rainfall intensity is :

$^5I_{14}$ = 130 mm/hr (Post Development)

$^5I_{40}$ = 101 mm/hr (Pre Development)

Using the Rational Method, the pre and post - development flows are calculated as follows :

Dev. Status	I (mm/hr)	Impervious Area		Pervious Area		C x A	Q (L/s)
		C	A (m2)	C	A (m2)		
Pre dev.	118			0.37	37000	13690.0	448.7
Post dev.	130	0.68	17000	0.58	20000	23160.0	836.3

5 Determine the required Permissible Site Discharge (PSD)

Using Equation 19.1 with Equation 19.1c and 19.1d for the *below ground storage* :

a = 20375

b = 3207945

PSD = 158.68 Liter/sec

6 Determine the required SSR

The site discharge to OSR has been designed for **10 year ARI** and the corresponding SSR is calculated for a range of storm durations to determine the maximum SSR for the total storage. Assumption has been make whereby storm duration is greater than 30 minutes.

t_d (min)	I (mm/hr)	Impervious Area		Pervious Area		C x A	Q_d (L/s)
		C	A (m2)	C	A (m2)		
5	250.68	0.68	17000	0.58	20000	23160.0	1612.7
10	195.48	0.68	17000	0.58	20000	23160.0	1257.6
15	158.37	0.68	17000	0.58	20000	23160.0	1018.8
20	133.25	0.68	17000	0.58	20000	23160.0	857.2
25	114.84	0.68	17000	0.58	20000	23160.0	738.8
30	102.57	0.68	17000	0.58	20000	23160.0	659.9
35	94	0.68	17000	0.58	20000	23160.0	604.7
40	86	0.68	17000	0.58	20000	23160.0	553.3
45	80	0.68	17000	0.58	20000	23160.0	514.7
50	75	0.68	17000	0.58	20000	23160.0	482.5
55	70	0.68	17000	0.58	20000	23160.0	450.3
60	66	0.68	17000	0.58	20000	23160.0	424.6
65	62	0.68	17000	0.58	20000	23160.0	398.9
70	59	0.68	17000	0.58	20000	23160.0	379.6
75	56	0.68	17000	0.58	20000	23160.0	360.3
80	54	0.68	17000	0.58	20000	23160.0	347.4

85	51	0.68	17000	0.58	20000	23160.0	328.1
90	49	0.68	17000	0.58	20000	23160.0	315.2
95	47	0.68	17000	0.58	20000	23160.0	302.4
100	45	0.68	17000	0.58	20000	23160.0	289.5

t_d (min)	Q_d (Liter/sec)	PSD (liter/sec)	c	d	SSR (m^3)
5	1612.7	158.68	102.98	1.83	452.37
10	1257.6	158.68	101.81	2.34	692.06
15	1018.8	158.68	100.57	2.89	823.85
20	857.2	158.68	99.34	3.44	905.36
25	738.8	158.68	98.09	3.99	955.09
30	659.9	158.68	97.01	4.46	1005.10
35	604.7	158.68	96.09	4.87	1057.92
40	553.3	158.68	95.07	5.32	1086.90
45	514.7	158.68	94.16	5.72	1119.90
50	482.5	158.68	93.30	6.11	1149.28
55	450.3	158.68	92.31	6.54	1159.88
60	424.6	158.68	91.42	6.94	1174.48
65	398.9	158.68	90.40	7.39	1174.20

70	379.6	158.68	89.56	7.76	1185.45
75	360.3	158.68	88.62	8.18	1185.63
80	**347.4**	**158.68**	**87.93**	**8.48**	**1204.75**
85	328.1	158.68	86.80	8.98	1184.83
90	315.2	158.68	85.97	9.35	1187.54
95	302.4	158.68	85.07	9.74	1183.03

From the above table, a maximum SSR of 1204.75 m^3 occurs at a duration of 80 minutes.

Step (2) Size Primary Outlet

The primary outlet flow-restricting pipe is to be sized to discharge the PSD flow.
The required pipe diameter is found by rearranging Equation 19.6 and using trial and error :

$$Ap = \frac{PSD}{(2g \times (y_s + S.L - Y_e)/K_L))^{0.5}}$$

and

$$Dp = \left(\frac{4A_p}{3.142} \right)^{0.5}$$

where ;

$$K_L = K_t + K_e + K_f + K_o$$

y_s = Height of from platform to invert outlet
= Depth of earth cover + height of OSD tank
= 0.3 + 1
= 1.3 metre

S = The outlet pipe slope = 1 %
L = Length outlet pipe = 4 m

(Refer schematic diagram in Appendix 1)

For the trash rack , $\frac{A_n}{A_g}$ = 0.75

From equation 19.8, trash loss factor, k_t
= 0.55

From equation 19.9, entrance loss factor, k_e = 2.78

From equation 19.10 & 19.11,friction loss factor, k_f = 0.071 D -4/3

Adopt outlet loss factor, k_o = 0.5

Hence ;

$$K_L = K_t + K_e + K_f + K_o$$

$$K_L = 3.83 + 0.071D^{-4/3}$$

PSD = 0.1587 m^3/sec

y_s = 1.3 meter

S x L = 0.04 meter

y_e = 0.3 meter

2g = 19.62 m/s

The trial and error calculation are summarized in the following table.

$Q_{outflow}$ = A_p x v

A_p = 0.0687472 m^2

K_L = 3.830052

Determine the velocity, v

$$\frac{K_L \times v^2}{2g} + Y_e = Y_s$$

v = 2.26 m/s

$Q_{outflow}$ = A_p x v

$Q_{outflow}$ = 0.15560 m^3/sec

$Q_{outflow}$ = 155.597 Litre/sec ..... Ok.

... Less than Q_{PSD}

Step (3) Determine Storage Dimension

a) Square type for OSD tank has been selected

Volume $_{required}$ = 1200 m^3

Adopt size tank = 40m (L) x 30m(W) x 1.0(D)

Volume $_{capacity}$ = 1200 m^3

Where the peak flow may be reduce up to 0.15560 m^3/sec.

The optimum dimension for OSD is 40 m × 30 m × 1 m.

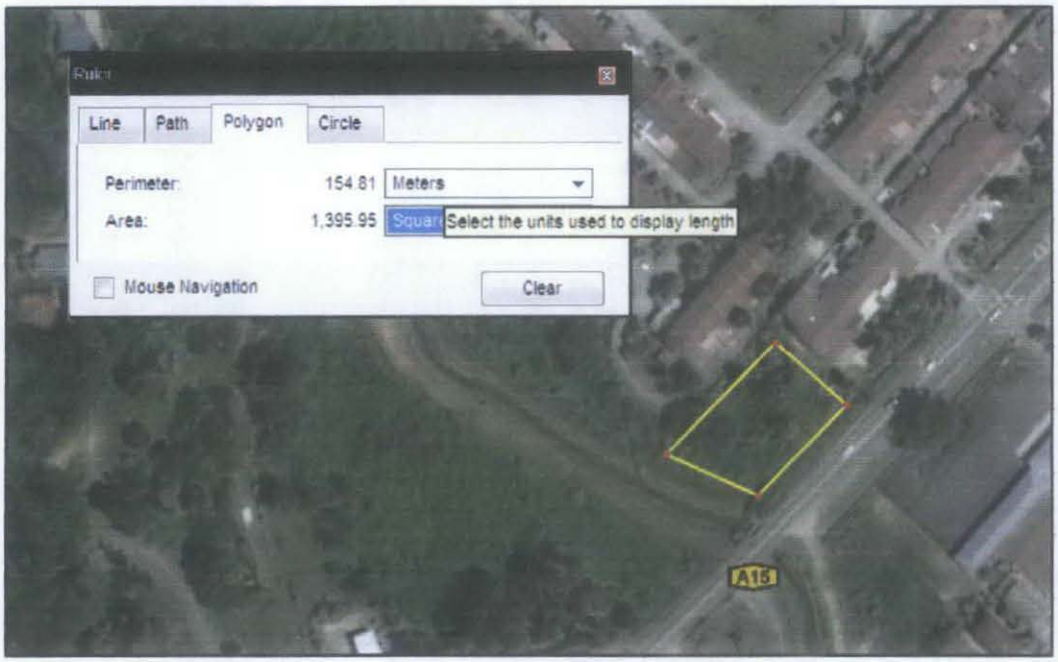


Figure 15 : Proposed area for OSD

Through analysis conducted upon study case area that includes survey and questionnaire the writer may come to conclude that:

- The existing drains are highly silted with significant amount of sedimentation visible. This may be cause by lack of maintenance, especially during rainy seasons.
- The existing drain and channel capacity could not cater the generated runoff from storm events
- Some drain structures are in need for maintenance. Some already collapsed and have improper lined surface.

Type of Drain/ Culvert	Size	Manning coefficient
Half Round + Brick Sides	300mm	0.015
RC culvert	900mm	0.015
RC culvert	600mm	0.015
V-drain	500mm	0.015

Table 1 : Existing drainage properties

The resultant of the current drain capacity with respect to the contemporarial weather condition had been numerically discussed in FYP I where comparatively hydrological analysis upon storm water runoff at Taman Batu Gajah found that the peak flow discharged by the residential area would be 1.14 m^3/s. While the discharge capacity of the existing main drain is 0.96 m^3/s, it is definitely could not adequate the surface runoff generated, let it be even from Taman Batu Gajah alone not to mention the Kg. Tersusun Sentang nearby. Suggested approach on OSD will provide reduction in the peak flow.

Discussion with DID personnel, Mr. Taquddin Azmi Bin Zawawi had outlined the issue of relation and synchronization in term of development plan, for instance, between the responsible government bodies.

In addition, he emphasized on the river bank reserve as outlined by DID prior to any development. The flood plain should be included for:

- Maintenance / upgrading the river
- Monsoon flood
- As a buffer zone for erosion, etc
- Aesthetic / recreation

Which as he said, sadly seldomly implemented and become an issue to concentrated areas, saturated developments, or occurrence of major storm events.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The existing drainage system in junction Kg. Sentang, Batu Gajah is experiencing a major drawback in its functionality due to an increase in runoff as a result of urban development.

The 5 year peak discharge (Q) 1.14 m^3/s from Taman Batu Gajah alone is higher than the capacity of the main drain which was designed at 0.901 m^3/s.

Proposal of Below Ground On-site Detention (OSD) facilities for the community was found to be able to reduce the peak flow. Consequently, it will reduce the peak flow to 0.155 m^3/s and alleviate the flooding problems.

Several workouts that may be exercise in order to improved the study about the case area:

- Conducting detailed study on siltation and sediment loading particularly at the study area
- Comprehensive analysis on the drainage flow system.
- Study on effects of drainage problem imposed on the residents (diseases outbreak, losses etc.)

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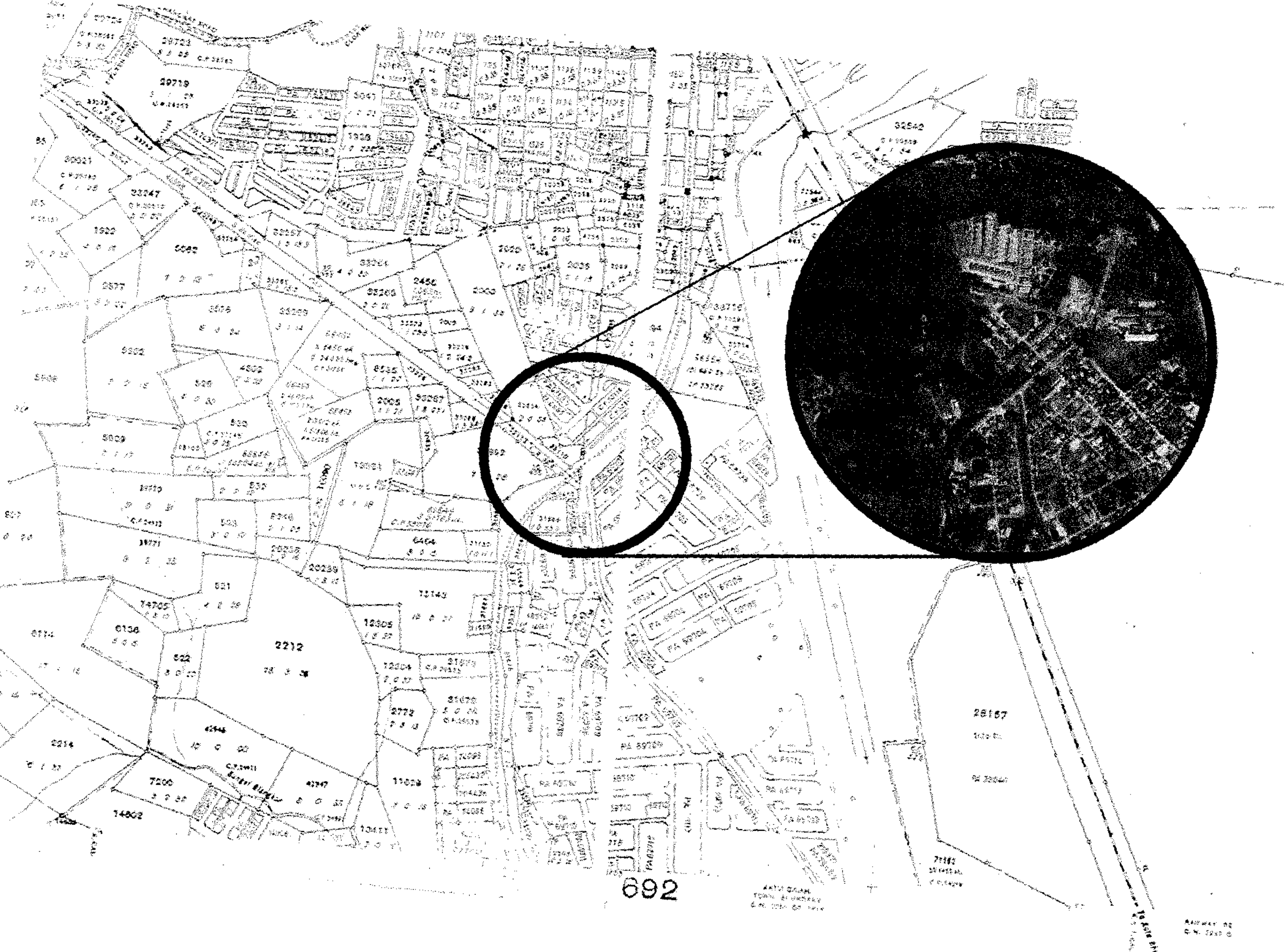
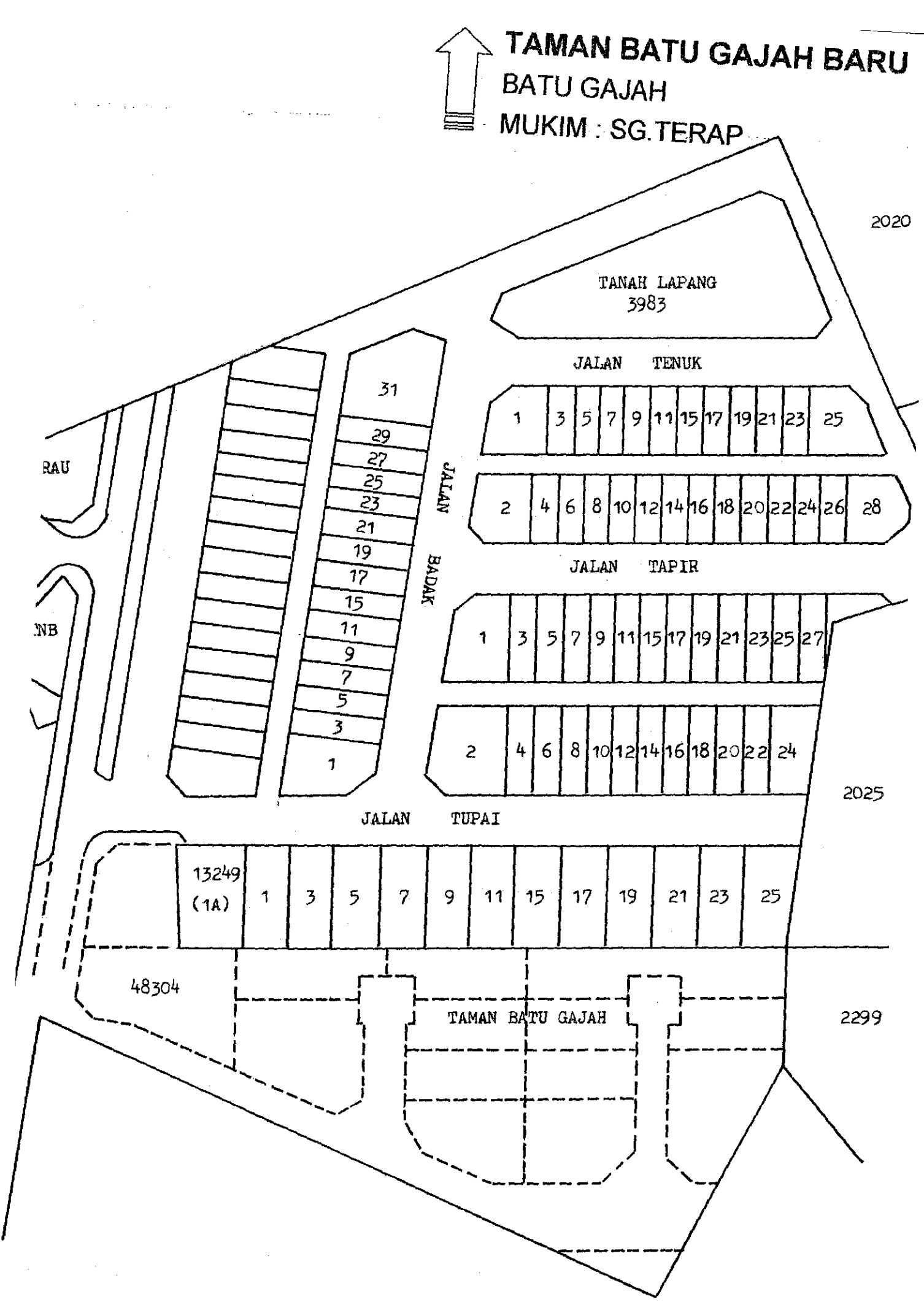
APPENDICES



RANCANGAN PERKAMPUNGAN TERSUSUN SENTANG


TAMAN BATU GAJAH BARU
BATU GAJAH
MUKIM : SG.TERAP
2020
TANAH LAPANG
3983
JALAN TENUK
1 3 5 7 9 11 15 17 19 21 23 25
2 4 6 8 10 12 14 16 18 20 22 24 26 28
JALAN TAPIR
1 3 5 7 9 11 15 17 19 21 23 25 27
2 4 6 8 10 12 14 16 18 20 22 24
2025
JALAN TUPAI
13249
(1A)
1 3 5 7 9 11 15 17 19 21 23 25
48304
TAMAN BATU GAJAH
2299
JALAN BADAK
31 29 27 25 23 21 19 17 15 11 9 7 5 3 1
RAU
NB

Mohd Arman B. Meohan @ Ashaari C 5553 017-5200400

Flood Problem in Kg. Sentang; it causes and Engineering Solutions

Detail/ Week	1	2	3	4	5	6	7	8	9	10		11	12	13	14	15
Project Work continue																
•Revision from results of FYP 1																
•Consultation with JPS Kg Temiang																
•Reference to HQ JPS																
•Survey on occurrence of flood conducted																
						●										
Submission of Progress Report																
Project work continue																
•Data from JPS Ampang obtained																
•Map of Catchment area prepared																
•Drainage Modelling for existing Catchment using FlowPro completed																
•Engineering solution and approach proposed and completed with required breakdown calculation with FlowPro																
Poster Presentation										●						
Project Work continue																
•Revision and ammendment																
•Discussion with Supervisor																
Submission of Dissertation Report													●			
Oral Presentation																●

FYP II : Flood Problem In Junction Kg. Sentang: It causes and the Engineering solutions

Introduction

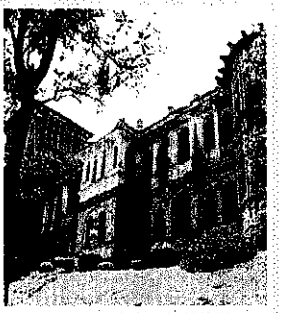
•Malaysia is experiencing rapid development in the past 10 years

•Establishment of large number of housing areas, business complexes, and infrastructures altered natural hydrological cycle

•Kg. Sentang in Batu Gajah, Perak is one of the affected areas covered in a catchment of approximately 100 hectares

Flooding problem occur frequently at Kg. Sentang Junction areas, where major development take place in the catchment area.

The previously designed drain can not cater the accumulated runoff



Kellie's Castle, Landmark of Batu Gajah

Objectives

•To assess the flood occurrences and peak flow at the Junction between the main road to Kg. Sentang and TamanBatu Gajah Baru.

•To determine the capacity of the existing drainage system in the area.

• To evaluate appropriate engineering solutions to solve the flooding problems namely via

-On site Detention Storage (OSD) and Roof runoff storage (Surface Tanks)

•To determine the predicted runoff reduction

Catchment area at Batu Gajah

Methodology

Data Collection (Rainfall, Land use, catchment's size)

Desktop Research

Survey and Questionnaire on site, consult with JPS

Data Analysis

Catchment's boundary determination

Data analysis process

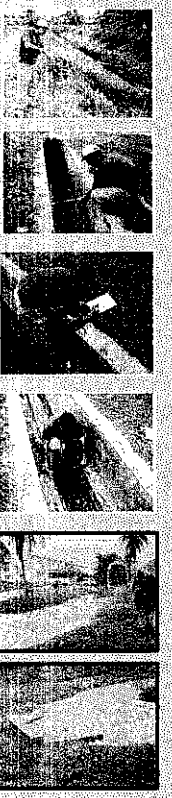
Obtain peak flow and existing drainage capacity

Design Approach

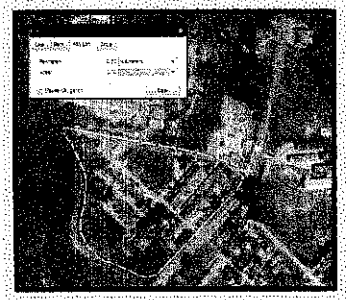
Proposed design OSD : calculate flow reduction

Suggest design Surface water tank

Determine possible peak flow reduction



Results & Discussions



Catchment for Taman Batu Gajah

t_o = 10 minutes

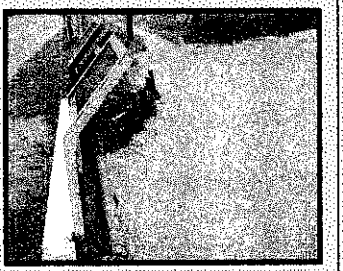
$t_d = L/V$ = 4 minutes

t_c = 14 minutes

$^5I_{14}$ = 130mm/hr

$$Q_{peak} = \frac{C \times I \times A}{360}$$

$$= 1.14 \text{ m}^3/\text{s}$$



Existing Road Side Drain at site

Using Manning formulation : $Q = \frac{A \times R^{2/3} \times S^{1/2}}{n}$

The capacity of the existing drain is Q = 0.901

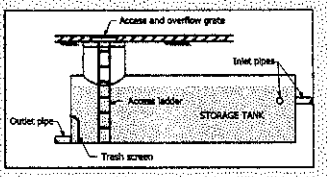
That is less than the total volume of runoff (Q_{peak}) ⇨ **Thus can not cater the amount generated runoff**

Engineering Solution

The excess in discharge is creating flood problem.

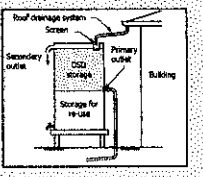
Reduction in peak discharge is needed.The following engineering interventions were assessed and recommended:

(a)



Below Ground OSD storage facilities

(b)



Surface water Tank

Combination of both can reduce the peak flow up to : 0.159 m³/s

Where the optimum dimension for OSD is 40m × 30m × 1m

Conclusion & Recommendation

The existing drainage system in junction Kg. Sentang, Batu Gajah is experiencing a major drawback in its functionality due to an increase in runoff as a result of urban development.

The 5 year peak discharge (Q) 1.14 m³/s is higher than the capacity of the main drain which was designed at 0.901 m³/s.

Proposal of Below Ground On-site Detention (OSD) facilities for the community and Water Surface Tank for individual houses was found to be able to reduce the the peak flow . Consequently it will reduce the peak flow to 0.155 m3/s and alleviate the flooding problems.

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2. Bart Schultz, Daniel Zimmer, Willem F. Vlotman, (2007) Drainage under increasing and changing requirements, Irrigation and Drainage Volume 56, Issue S1, Pages: S3-S22
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4. Liu, P.S. Chan, N. W. (2003) The Malaysian flood hazard management program, Volume 1, pages: 205-214

18th August 2008

To Whom it May Concerns,

Dear Sir,

FINAL YEAR PROJECT: Request for Data and Information regarding Batu Gajah, Perak Darul Ridzuan

Referring to the above subject, I am a registered Universiti Teknologi Petronas's final year student undergoing my Final Year Project II on the following topic : 'Studies on drainage system at Batu Gajah ; The issues and engineering solutions'. My personal ID is as below:

Mohd Arman B. Meohan @ Ashaari C 5553 (850726-08-5869)

2. In concern with this project, I would like to have your kind consideration and assistance to acquire and obtained the related information from your department. Your assistance will help and enable me to conduct the relevant analysis upon the subject interest. All the data given will be kept as the intended strict confidence and will be used only for this study purposes only.

3. For your information, this study is focusing on the issues related to the recurrence of flood events at Batu Gajah. The results of this study would be very useful in understanding and providing the necessary solutions and possible approach toward the problem.

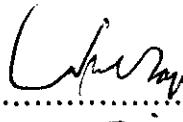
4. Hence, your kind consideration and assistance related to this project is very much appreciated and valued. Thank you very much.

Yours sincerely,

.....

(Mohd Arman B. Meohan)

Approved by,



.....

Assoc. Prof. Dr. Nasiman Sapari,
Associate Professor,
Civil Engineering Programme,
Universiti Teknologi Petronas.

BAHAGIAN HIDROLOGI DAN SUMBER AIR	DOKUMEN KUALITI	NO. KELUARAN : 1
		NO. PINDAAN : 0
	BORANG PEMBEKALAN DATA HIDROLOGI OLEH JABATAN PENGAIRAN DAN SALIRAN UNTUK PROJEK KERAJAAN / PENYELIDIKAN	TARIKH KUATKUASA : 01/ 07/06
BHSA-DK-DI.1		MUKA SURAT : 1 drpd. 1

FORM DI.1

1. NAMA PEMOHON (*Name of Applicant*) : MOHD ARMAN B. MEGHAN @ ASHARI
2. No. Kad Pengenalan (*I. C No.*) : 850726-08-5869
3. JAWATAN RASMI (*Official Designation*) : PELAJAR
4. ALAMAT RASMI (*Official Address*) : CIVIL DEPARTMENT, UNIVERSITI TEKNOLOGI PETRONAS 31750, BANDAR SERI ISKANDAR, TRONOH, PERAK.
5. NO. TELEFON DAN E-MEL (*Telephone No. and E-mail Address*) : 017-5200460 EMAIL : armontel32@yahoo.com
6. NAMA PROJEK (*Name of Project*) : Final Year Project II : Flood Problem at Junction Kg. Seintang
7. LOKASI PROJEK (*Location of Project*) : Batu Gajah, Perak Daru Ridzuan
8. BUTIRAN DATA YG .DI PERLUKAN (*Details of Data Required*) :

Jenis dan Unit Data yg. Diperlukan/*Type and Units of Data Required*	No. Stesen atau Nama Stesen/*Station No. or Name of Station*	Tempoh Data yang diperlukan/*Period of Data Required*	Kegunaan Data/ *Proposed Use Of Data*
Rainfall data, water level, drainage plan, discharge data flood history & records.	Sungai Kinta di Tg. Tualang, Ldg. Hillrise, Batu Gajah Ldg. Paint & Politeknik Ungku Omar (Stations at Batu Gajah and adjacent area)	50 - 100 years.	To study on the rainfall events that contributing to the recurrences of flood.

In the event of the above hydrological data being supplied by the Department of Irrigation and Drainage, I/we agree to comply with the following conditions:

(a) *that the data shall not be utilized for other project or study unless fresh application has been made to the D.I.D.*

(b) *that acknowledgement for the use of the data obtained from the D.I.D. will be suitably made in any report, paper or publication in which such data have been quoted or utilized and a copy of such report, paper on publication be extended to D.I.D. free of charge, on .....*

(c) *that all application and receipt of any data must be through the Data Information Unit, Hydrology and Water Resources Division.*

(d) *that the data shall be ready for collection within one week from the date of application. In the event that such an arrangement cannot be met, the applicant will be notified through telephone or E-mail for a new date of collection.*

(e) *that the applicant shall collect the data within three months from the date of application. The applicant shall then be requested to make a fresh application there after.*

9 OCTOBER 2008
(Date of Application)

(Signature of Applicant)

JABATAN PENGAIRAN DAN SALIRAN

MALAYSIA

Source is \\Svr-jpshis\datanegeri\Perak\Rfmanual.mtd
Monthly totals 1930 to 1995 site 4410122 LDG. HILL RISE at BATU GAJAH, PERAK

Days end at 8:00:00am
Rain mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1930	?	?	?	?	?	?	?	178.8	216.2	450.5	226.0	198.1	1269.6?
1931	443.4	54.9	179.4	308.1	111.0	89.8	177.5	73.3	222.1	174.0	157.8	471.2	2462.5
1932	258.7	295.4	462.5	334.1	253.1	146.9	41.6	236.6	98.5	375.9	282.3	279.8	3065.4
1933	379.9	94.7	149.2	317.2	302.1	49.4	167.0	270.3	124.8	126.5	290.1	193.1	2464.3
1934	259.6	143.8	444.7	437.1	124.1	285.1	129.2	247.8	177.4	355.8	585.0	194.7	3384.3
1935	315.5	210.0	282.7	268.3	149.3	135.1	75.8	391.6	92.0	479.0	289.9	429.7	3118.9
1936	325.3	115.8	415.6	321.5	421.3	154.2	102.2	149.8	156.9	324.8	280.5	450.8	3218.7
1937	349.5	286.6	265.9	305.9	105.5	33.9	74.1	66.2	196.7	542.1	263.4	198.2	2688.0
1938	166.8	165.2	306.4	308.3	140.7	85.6	78.7	194.8	281.2	238.5	300.7	225.5	2492.4
1939	420.1	202.2	210.8	249.6	303.5	82.5	93.4	66.4	245.5	217.6	84.3	322.9	2498.8
1940	275.1	173.8	123.3	165.8	156.8	200.9	114.6	108.4	266.1	196.4	487.2	256.5	2524.9
1941	186.6	193.0	183.1	305.2	326.5	96.3	113.0	104.1	324.8	244.0	376.5	?	2453.1?
1942	?	?	?	?	?	?	?	?	?	?	?	?	?
1943	?	?	?	?	?	?	?	?	?	?	?	?	?
1944	?	?	?	?	?	?	?	?	?	?	?	?	?
1945	?	?	?	?	?	?	?	?	?	?	?	?	?
1946	?	?	?	?	?	?	?	?	?	?	?	?	?
1947	?	?	?	?	?	?	109.8	433.2	305.9	262.8	256.3	694.9	2062.9?
1948	86.1	186.1	420.2	207.9	?	?	?	?	?	?	?	?	900.3?
1949	?	?	?	?	?	?	?	?	?	?	?	?	?
1950	?	?	?	?	?	?	?	?	?	?	?	?	?
1951	?	?	?	?	?	?	?	?	?	?	371.7	266.3	638.0?
1952	159.8	?	427.5	508.5	237.5	29.7	60.7	?	?	?	?	?	1423.7?
1953	?	?	277.5	383.2	204.2	106.3	190.5	101.9	70.9	142.6	121.9	109.0	1708.0?
1954	?	57.4	217.1	228.0	198.3	117.3	0.0	?	97.6	449.8	229.6	169.3	1764.4?
1955	104.3	175.5	145.9	316.4	160.5	48.2	2.5	162.1	247.2	438.9	260.4	326.6	2388.5
1956	197.5	99.9	436.1	206.6	205.7	351.8	211.2	94.5	117.9	481.1	450.7	158.0	

3011.0
1957 125.8 188.5 ? ? ? ? ? ? 189.8 320.8 629.9 342.2
1797.0?
1958 122.8 96.2 324.2 259.6 342.5 68.2 16.7 170.7 158.7 279.1 206.6 138.7
2184.0
1959 116.7 198.8 293.0 168.2 301.1 104.0 173.7 131.0 309.7 418.1 615.7 234.5
3064.5

1960 200.6 236.0 148.6 293.4 233.2 78.3 223.9 128.5 170.1 359.3 294.7 248.2
2614.8
1961 142.9 124.6 247.7 407.6 26.5 145.6 148.6 118.7 195.8 241.4 271.3 258.0
2328.7
1962 246.4 138.3 151.5 200.8 224.0 102.1 67.7 307.5 141.8 433.1 268.2 157.4
2438.8
1963 223.6 130.8 234.9 163.8 305.8 29.8 145.6 253.5 132.0 277.3 482.5 203.5
2583.1
1964 162.4 144.2 125.0 326.2 133.5 190.5 414.1 58.3 184.7 168.4 149.3 202.7
2259.3

1965 22.1 82.3 285.2 274.9 221.7 24.0 74.6 196.2 220.2 327.6 168.7 311.7
2209.2
1966 154.0 182.8 229.9 240.2 52.1 277.0 168.4 135.3 224.8 223.8 408.3 253.6
2550.2
1967 137.7 123.8 239.4 494.3 319.0 99.5 41.6 61.3 203.7 337.3 278.3 82.8
2418.7
1968 142.5 305.6 152.8 273.9 362.8 145.0 93.6 90.6 186.5 532.2 237.4 379.6
2902.5
1969 379.1 84.1 290.2 196.4 360.8 87.1 70.3 281.2 108.8 478.8 343.4 302.9
2983.1

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
1970	323.7	37.0	160.0	388.7	298.9	93.2	128.3	176.2	314.3	370.4	297.2	235.8	2823.7
1971	110.2	202.9	264.6	180.6	33.0	59.3	92.7	339.3	97.3	104.0	166.9	348.1	1998.9
1972	55.4	261.5	151.3	415.9	136.4	130.7	17.6	20.0	153.7	407.8	304.7	225.5	2280.5
1973	143.0	162.8	201.7	307.2	397.4	165.0	49.6	189.6	99.5	315.0	475.1	172.1	2678.0
1974	70.6	149.4	91.0	148.0	223.0	223.0	96.1	64.0	286.0	150.0	142.0	124.0	1767.1
1975	204.5	209.0	257.6	?	?	43.6	46.0	47.0	164.0	43.0	198.0	186.0	1398.7?
1976	193.0	125.0	174.0	355.0	49.0	106.0	244.0	121.0	122.0	350.0	201.0	202.0	2242.0
1977	154.0	229.0	111.0	181.0	92.0	144.0	76.0	107.0	153.0	?	?	196.0	1443.0?
1978	199.0	188.0	278.0	206.0	136.0	46.0	75.0	138.0	120.0	375.0	209.0	119.0	2089.0
1979	66.0	183.0	137.0	293.0	157.0	191.8	195.2	67.2	279.8	210.5	366.5	135.0	2282.0
1980	125.2	114.8	384.0	91.0	285.0	200.0	117.0	273.8	180.0	189.0	326.0	151.0	2436.8
1981	193.0	544.0	185.0	423.0	269.5	114.5	49.0	85.0	288.0	300.2	286.8	63.0	2801.0
1982	98.0	94.0	259.2	482.8	203.8	45.2	150.0	144.0	111.5	589.5	235.0	323.0	2736.0
1983	169.0	83.9	174.1	37.0	179.0	136.0	48.0	74.0	512.0	216.0	275.0	206.0	2110.0
1984	292.5	244.5	318.0	285.4	261.6	104.0	214.0	36.0	60.0	174.0	319.0	513.0	2822.0
1985	165.0	244.0	?	148.0	105.0	?	?	?	?	?	485.0	351.0	1498.0?
1986	85.0	164.0	257.0	464.0	176.0	39.0	68.0	13.0	216.0	345.0	468.0	205.0	2500.0
1987	297.0	202.0	500.0	333.0	184.0	96.0	46.0	637.0	500.0	670.0	234.0	?	3699.0?
1988	?	344.0	325.0	282.0	240.0	93.0	95.0	314.0	410.0	15.0	217.0	283.0	2618.0?
1989	150.0	208.0	105.0	197.0	91.0	137.0	163.0	141.5	155.0	307.0	45.0	132.0	1831.5
1990	85.0	85.0	128.0	265.0	361.0	135.0	324.0	69.0	295.0	458.0	66.0	376.0	2647.0
1991	271.0	129.0	130.0	640.0	636.0	90.0	158.0	55.0	218.0	367.0	212.0	191.0	3097.0
1992	35.0	50.0	33.0	100.0	175.0	15.0	122.0	110.0	174.0	120.0	308.0	361.0	1603.0
1993	226.0	30.0	355.0	169.0	367.0	78.0	328.0	73.0	355.0	263.0	335.0	338.0	2917.0
1994	134.0	210.0	357.0	294.0	187.0	18.0	30.0	284.0	188.0	209.0	244.0	128.0	2283.0
1995	157.0	58.0	109.0	226.0	188.0	205.0	88.0	220.0	148.0	168.0	233.0	85.0	1885.0
Min.	22.1	30.0	33.0	37.0	26.5	15.0	0.0	13.0	60.0	15.0	45.0	63.0	1603.0
Mean	190.7	167.5	242.9	284.9	221.0	114.6	118.5	162.5	204.9	307.7	291.4	249.3	2526.3
Max.	443.4	544.0	500.0	640.0	636.0	351.8	414.1	637.0	512.0	670.0	629.9	694.9	3384.3

The Min Mean and Max of Annual means are for complete years only.

End of process

Remarks:

1. The Min Mean and Max of Annual means are for complete years only.
2. '?' means incomplete data for the month.
3. 'xxxx?' means total amount with incomplete data.

JABATAN PENGAIRAN DAN SALIRAN

MALAYSIA

Source is \\SVR-JPSHIS\Datanegeri\Perak\Rfmanual.mtd
Monthly totals 1930 to 1995 site 4409121 LDG. NALLA at TRONOH, PERAK

Days end at 8:00:00am
Rain mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1930	?	?	?	?	?	?	?	216.2	86.2	590.8	227.9	207.3	1328.4?
1931	375.5	73.4	99.5	310.7	134.7	126.1	53.3	45.5	190.2	208.1	257.4	481.0	2355.4
1932	171.5	171.1	237.7	354.0	109.9	98.3	99.6	356.2	124.6	427.2	350.2	205.5	2705.8
1933	339.1	64.8	200.9	252.6	312.8	69.2	103.4	162.5	49.9	161.9	365.0	248.6	2330.7
1934	440.0	287.4	292.2	222.8	108.1	292.2	107.3	224.7	141.1	342.8	412.1	155.0	3025.7
1935	284.0	152.1	269.6	165.6	109.7	131.0	47.2	362.3	79.2	306.6	327.4	325.0	2559.7
1936	303.1	117.8	256.8	194.9	256.8	76.3	65.5	124.4	99.3	232.0	305.4	354.7	2387.0
1937	303.5	256.9	97.9	478.2	102.0	10.6	101.9	122.1	150.1	446.4	176.6	143.5	2389.7
1938	?	?	?	?	?	48.8	171.9	?	?	?	?	?	220.7?
1939	333.4	230.4	143.7	288.9	178.5	134.9	72.1	33.1	140.2	261.7	127.9	126.7	2071.5
1940	193.2	268.8	86.0	133.7	228.1	66.8	80.5	156.2	163.3	291.5	454.2	408.2	2530.5
1941	270.7	132.6	177.7	399.0	185.1	104.6	92.9	114.8	219.5	194.2	420.7	?	2311.8?
1942	?	?	?	?	?	?	?	?	?	?	?	?	?
1943	?	?	?	?	?	?	?	?	?	?	?	?	?
1944	?	?	?	?	?	?	?	?	?	?	?	?	?
1945	?	?	?	?	?	?	?	?	?	?	?	?	?
1946	?	?	?	?	?	?	?	?	?	?	?	?	?
1947	?	?	?	?	?	161.3	204.0	256.2	132.3	204.7	136.6	298.7	1393.8?
1948	176.5	202.9	194.0	151.8	113.3	39.6	?	?	?	?	?	?	878.1?
1949	?	?	?	211.6	207.8	65.3	350.1	212.4	197.6	358.6	300.8	280.0	2184.2?
1950	181.3	221.2	262.2	226.5	0.0	68.3	55.7	111.2	119.9	103.9	?	?	1350.2?
1951	?	172.2	115.7	199.4	198.9	52.3	169.6	93.0	168.4	159.2	294.2	228.5	1851.4?
1952	111.5	192.2	260.0	307.9	179.7	43.2	145.4	72.6	?	207.0	243.8	254.9	2018.2?
1953	187.7	317.1	247.4	255.5	52.4	215.1	244.5	43.6	251.0	?	?	220.7	2035.0?
1954	?	?	?	134.3	79.9	89.5	133.7	104.1	65.1	324.5	154.6	111.2	1196.9?
1955	63.3	150.0	125.0	110.5	79.6	67.1	123.2	43.3	244.6	305.4	262.3	164.6	1738.9
1956	261.2	64.3	300.1	106.2	159.2	113.8	148.4	113.6	152.8	412.5	264.2	144.7	2241.0

1957	141.4	42.5	175.0	217.2	327.8	31.6	122.8	90.9	101.4	202.2	434.5	234.1	2121.4
1958	152.1	98.8	104.6	100.6	147.2	88.1	11.4	77.0	99.9	232.3	252.5	104.8	1469.3
1959	195.0	145.8	282.1	188.1	391.2	112.1	209.3	110.2	178.6	282.7	373.0	110.0	2578.1
1960	182.1	317.0	175.3	128.9	103.9	135.0	262.6	157.2	128.1	324.5	265.8	348.1	2528.5
1961	94.6	240.6	290.3	352.2	5.0	146.8	162.3	124.1	138.0	238.7	441.0	226.4	2460.0
1962	201.9	78.2	183.8	104.2	142.3	48.8	82.0	323.8	170.9	466.5	268.7	195.1	2266.2
1963	172.4	177.3	74.0	93.2	229.4	22.0	99.5	160.3	42.1	374.5	530.8	146.0	2121.5
1964	179.1	98.7	94.9	363.2	134.7	66.8	358.3	39.7	187.1	126.5	150.2	72.8	1872.0
1965	47.7	77.3	164.7	298.1	134.3	0.0	59.1	144.3	78.7	251.1	236.7	200.3	1692.3
1966	83.0	126.0	128.6	275.7	46.3	180.2	124.6	181.8	272.1	279.7	271.6	234.0	2203.6
1967	186.6	68.4	245.5	344.1	334.5	115.4	51.9	136.5	163.7	354.0	275.3	200.9	2476.8
1968	162.4	107.0	191.4	207.3	332.3	133.0	147.0	162.0	181.9	380.4	349.9	506.0	2860.6
1969	259.8	101.6	400.0	167.9	240.4	61.3	117.2	335.3	65.3	451.0	328.9	347.3	2876.0
1970	166.7	40.0	85.1	192.4	256.9	65.7	183.6	118.4	173.9	369.1	207.3	158.0	2017.1
1971	95.3	230.2	260.6	131.7	64.0	37.8	74.6	159.0	137.4	54.9	174.4	482.2	1902.1
1972	68.6	244.9	98.5	332.1	42.2	192.7	48.5	12.6	205.3	255.6	241.5	237.3	1979.8
1973	216.1	71.4	230.9	262.1	270.5	63.0	92.3	147.3	99.4	377.4	277.4	237.7	2345.5
1974	109.5	?	?	336.5	258.5	152.5	72.0	86.0	257.0	155.5	67.5	95.0	1590.0?
1975	201.0	203.5	223.0	148.5	126.0	63.0	202.5	37.5	243.0	34.0	431.5	309.5	2223.0
1976	59.5	208.5	138.0	306.5	89.5	189.0	266.0	102.5	110.0	245.0	285.5	171.5	2171.5
1977	175.5	158.5	164.5	88.0	260.0	143.5	40.0	110.5	103.5	502.5	413.5	261.0	2421.0
1978	94.0	82.0	162.0	163.5	108.5	67.5	55.5	?	?	280.0	169.5	116.5	1299.0?
1979	85.0	249.0	90.0	374.0	56.5	215.0	175.5	115.5	253.0	295.5	292.0	22.0	2223.0
1980	171.0	54.5	322.0	208.0	300.5	153.5	37.5	242.5	175.5	213.0	238.0	279.0	2395.0
1981	67.0	274.0	75.0	216.0	485.5	45.0	16.5	75.0	267.0	261.0	166.0	36.5	1984.5
1982	40.0	77.5	126.0	365.0	193.0	74.5	114.0	188.2	178.3	318.3	179.7	239.0	2093.5
1983	112.0	80.2	148.8	78.5	202.5	159.5	49.5	67.0	314.0	127.0	193.5	293.0	1825.5
1984	394.0	?	268.5	231.5	203.0	49.5	146.5	91.5	82.0	119.5	386.5	309.0	2281.5?
1985	144.5	311.0	364.5	163.0	121.0	16.0	41.5	66.0	100.5	330.0	365.0	247.5	2270.5
1986	49.0	101.0	297.0	345.0	118.0	73.0	161.0	38.0	159.0	89.0	265.5	183.0	1878.5
1987	77.0	186.0	246.0	252.0	174.0	57.0	75.0	351.0	311.0	330.0	111.0	?	2170.0?
1988	?	139.0	206.5	233.0	115.0	57.0	192.0	188.0	247.5	57.4	266.6	217.5	1919.5?
1989	207.5	57.0	199.0	253.0	77.0	17.0	107.0	60.0	364.0	160.0	288.0	182.0	1971.5

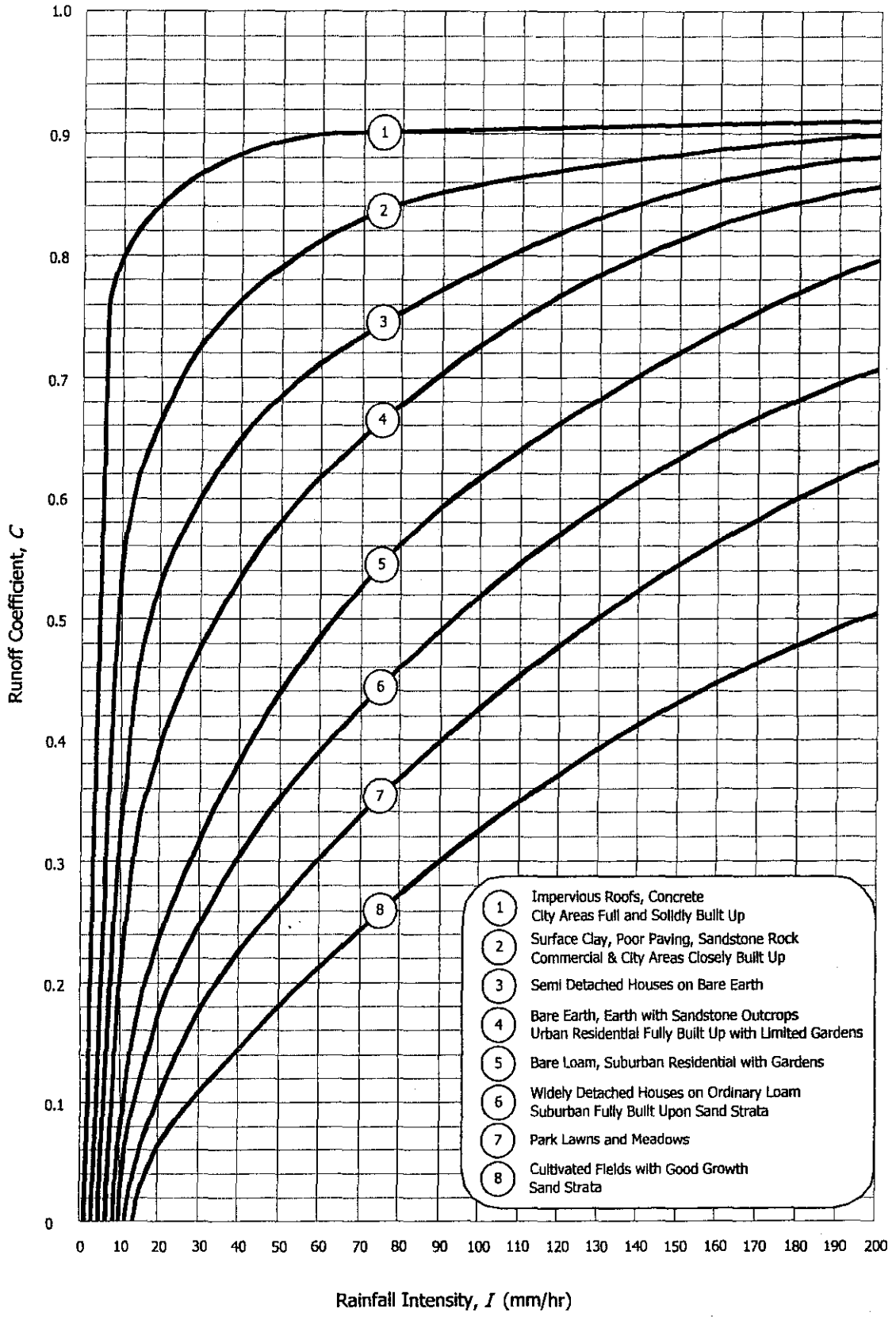
1990	123.0	109.0	80.0	219.5	232.5	1.5	142.5	25.0	118.5	469.5	145.5	116.0	1782.5
1991	133.0	22.0	106.0	176.0	351.0	60.0	144.0	60.0	55.0	128.0	198.0	80.0	1513.0
1992	78.0	39.0	51.0	57.0	205.0	59.0	182.0	93.0	0.0	54.0	156.5	195.0	1169.5
1993	71.0	107.5	195.0	9.6	9.9	9.6	9.9	9.9	9.6	9.9	428.3	500.0	1370.5
1994	287.0	277.0	261.0	163.0	87.0	10.5	17.0	266.5	164.3	199.4	311.5	151.2	2195.4
1995	196.0	156.0	185.0	275.0	259.0	175.0	143.0	324.0	164.0	79.0	289.5	274.0	2519.5
Min.	40.0	22.0	51.0	9.6	0.0	0.0	9.9	9.9	0.0	9.9	67.5	22.0	1169.5
Mean	175.5	152.5	190.2	222.8	173.0	90.4	121.5	138.7	155.7	258.9	277.4	226.4	2180.3
Max.	440.0	317.1	400.0	478.2	485.5	292.2	358.3	362.3	364.0	590.8	530.8	506.0	3025.7

The Min Mean and Max of Annual means are for complete years only.

End of process

Remarks:

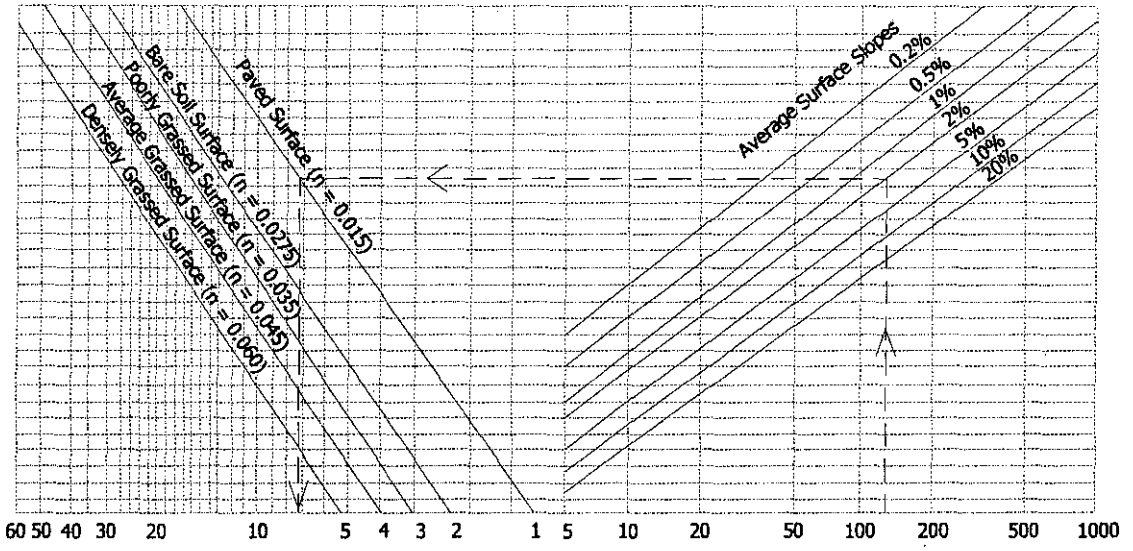
1. The Min Mean and Max of Annual means are for complete years only.
2. '?' means incomplete data for the month.
3. 'xxxx?' means total amount with incomplete data.



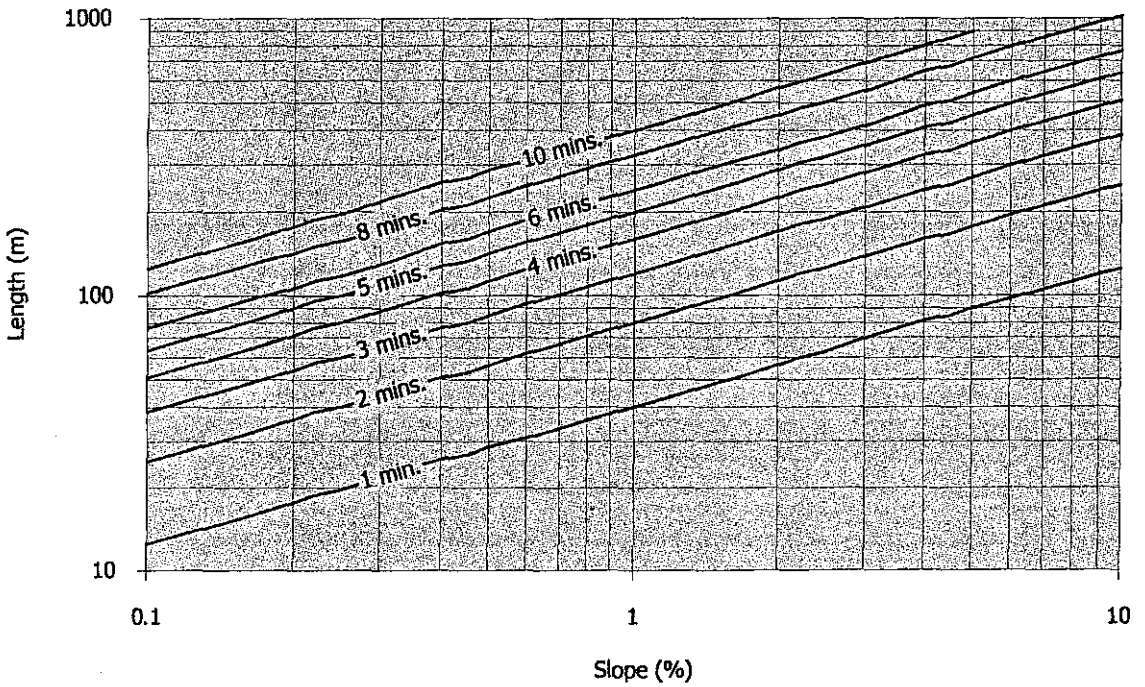
Design Chart 14.3 Runoff Coefficients for Urban Catchments
Source: AR&R, 1977

Note: For $I > 200$ mm/hr, interpolate linearly to $C = 0.9$ at $I = 400$ mm/hr

APPENDIX 14.A DESIGN CHARTS



Design Chart 14.1 Nomograph for Estimating Overland Sheet Flow Times (Source: AR&R, 1977)
(Overland Sheet Flow Times - Shallow Sheet Flow Only)



Design Chart 14.2 Kerb Gutter Flow Time

Mohd Arman B. Meohan
5553 Civil Engineering
Final Year Project II
Universiti Teknologi Petronas

Kaji Selidik Kejadian Banjir di Tempat Kediaman
Selaras dengan pra-syarat untuk Projek Tahun Akhir Universiti Teknologi PETRONAS (UTP))

Skop kajian : Batu Gajah, Perak Darul Ridzuan

Kaji selidik ini dijalankan untuk mendapatkan lebih maklumat berhubung kejadian banjir di tempat kediaman anda sepanjang tahun 2008. Oleh itu, kami ingin memohon kerjasama daripada pihak anda untuk melengkapkan borang kaji selidik ini.Kerjasama daripada pihak anda amat dihargai dan diucapkan terima kasih.

Umur : 43 Thn.
Jantina : Laki-laki
Pekerjaan : Sendiri (Berniaga)
Tempat tinggal : Beruban

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA	✓	TIDAK	

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000	✓	RM5001-RM10,000	
RM1000-RM5000		Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari	✓	1 minggu-2 minggu	
4-7 hari		Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari		5 hari	
2 hari		6 hari	
3 hari	✓	7 hari	
4 hari		Lebih dari seminggu	

Mohd Arman B. Meohan
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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	
Memindahkan barang-barang berharga ke tempat yang selamat	✓

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

---

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku? Jika Ya, apakah bentuk amaran yang diberikan?

---

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

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op kajian : Batu Gajah, Perak Darul Ridzuan

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Umur : 18 tahun
Jantina : Perempuan
Pekerjaan :
Tempat tinggal : Taman Bunga Mawar Batu Gajah.

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA		TIDAK	✓

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000	✓	RM5001-RM10,000	
RM1000-RM5000		Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari		1 minggu-2 minggu	
4-7 hari	✓	Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari		5 hari	
2 hari		6 hari	
3 hari	✓	7 hari	
4 hari		Lebih dari seminggu	

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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	
Memindahkan barang-barang berharga ke tempat yang selamat	✓

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

Ya

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku? Jika Ya, apakah bentuk amaran yang diberikan?

Tidak

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

Membesarkan sistem saliran.

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Umur : 39 thn
Jantina : P
Pekerjaan : Berniaga
Tempat tinggal : RPT Seriang

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA		TIDAK	✓

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000		RM5001-RM10,000	
RM1000-RM5000		Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari		1 minggu-2 minggu	
4-7 hari		Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari		5 hari	
2 hari		6 hari	
3 hari		7 hari	
4 hari		Lebih dari seminggu	

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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	✓
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	✓
Memindahkan barang-barang berharga ke tempat yang selamat	✓

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

_____

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku? Jika Ya, apakah bentuk amaran yang diberikan?

Tidak

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

Lebarkan sungai

* Tiada tindakan diambil berkenaan longkang tersumbat

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op kajian : Batu Gajah, Perak Darul Ridzuan

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Umur : 34
Jantina : LELAKI
Pekerjaan : MEKANIK
Tempat tinggal : LOT 130 KG ARA PAYONG BATU GAJAH

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA ✓		TIDAK	

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000		RM5001-RM10,000	✓
RM1000-RM5000		Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari		1 minggu-2 minggu	✓
4-7 hari		Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari		5 hari	
2 hari		6 hari	
3 hari		7 hari	
4 hari	✓	Lebih dari seminggu	

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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	✓
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	
Memindahkan barang-barang berharga ke tempat yang selamat	

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

_____

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku? Jika Ya, apakah bentuk amaran yang diberikan?

_____

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

_____

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Umur : 49 tahun
Jantina : Lelaki
Pekerjaan : Pemilik premis bengkel.
Tempat tinggal : Kg Sintang. Bt. Gajah. Pk.

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA	✓	TIDAK	

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000		RM5001-RM10,000	
RM1000-RM5000		Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari	✓	1 minggu-2 minggu	
4-7 hari		Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari	✓	5 hari	
2 hari		6 hari	
3 hari		7 hari	
4 hari		Lebih dari seminggu	

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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	✓
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	✓
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	✓
Memindahkan barang-barang berharga ke tempat yang selamat	✓

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

---

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku? Jika Ya, apakah bentuk amaran yang diberikan?

---

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

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Umur : 47
Jantina : LELAKI
Pekerjaan : PEKERJA RENDAH AWAM.
Tempat tinggal : MENGLEMBU : BANDAWAN.

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA		TIDAK	✓

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000		RM5001-RM10,000	✓
RM1000-RM5000		Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari		1 minggu-2 minggu	✓
4-7 hari		Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari		5 hari	
2 hari		6 hari	
3 hari		7 hari	✓
4 hari		Lebih dari seminggu	

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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	X
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	✓
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	✓
Memindahkan barang-barang berharga ke tempat yang selamat	✓

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

Tidak Semestinya.

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku? Jika Ya, apakah bentuk amaran yang diberikan?

tidak Juga Sekali.

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

tiada apa pun yg dia Orang buat.
Sekadar mengelak sje.

AM.

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Umur : 40 tahun
Jantina : Lelaki
Pekerjaan : PKP 429
Tempat tinggal : B.Gajah

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA	✓	TIDAK	

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000	✓	RM5001-RM10,000	
RM1000-RM5000		Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari	✓	1 minggu-2 minggu	
4-7 hari		Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari		5 hari	
2 hari	✓	6 hari	
3 hari		7 hari	
4 hari		Lebih dari seminggu	

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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	✓
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	✓
Memindahkan barang-barang berharga ke tempat yang selamat	✓

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

---

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku? Jika Ya, apakah bentuk amaran yang diberikan?

Tiada

---

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

Tiada - Selepas berlaku kejadian baru ada tinjauan dibuat tetapi tiada tindakan. Apabila ditanya jawapan mereka : dalam perbincangan.

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Umur : 33
Jantina : L
Pekerjaan : Penolong Pegawai Kesihatan Persekitaran
Tempat tinggal : Kg Sentay Batu Gajah

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA		TIDAK	✓

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000		RM5001-RM10,000	
RM1000-RM5000		Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari		1 minggu-2 minggu	
4-7 hari		Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari		5 hari	
2 hari		6 hari	
3 hari		7 hari	
4 hari		Lebih dari seminggu	

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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	✓
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	✓
Memindahkan barang-barang berharga ke tempat yang selamat	

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

X a.

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku?
   Jika Ya, apakah bentuk amaran yang diberikan?

Flyers amaran banjir, Hebahan melalui radio.

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

membersihkan kawasan longkang dan sungai.

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Umur :
Jantina : 18
Pekerjaan : Pemilik kedai
Tempat tinggal : K. Sentang

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA		TIDAK	✓

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000		RM5001-RM10,000	
RM1000-RM5000		Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari		1 minggu-2 minggu	
4-7 hari		Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari		5 hari	
2 hari		6 hari	
3 hari		7 hari	
4 hari		Lebih dari seminggu	

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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	✓
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	
Memindahkan barang-barang berharga ke tempat yang selamat	

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

Ya

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku? Jika Ya, apakah bentuk amaran yang diberikan?

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

membersihkan longkang 2

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op kajian : Batu Gajah, Perak Darul Ridzuan

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Umur : 61 -
Jantina : Jantan
Pekerjaan : Crane Surveyor
Tempat tinggal : Taman Batu Gajah

1. Pernahkah tempat kediaman / premis perniagaan anda dilanda banjir?

YA		TIDAK	✓

2. Jika ya, berapakah anggaran kos kerugian?

Kurang dari RM1000		RM5001-RM10,000	
RM1000-RM5000	✓	Lebih dari RM10,000	

3. Berapa lamakah untuk keadaan kembali pulih seperti sediakala?

1-3 hari		1 minggu-2 minggu	
4-7 hari	✓	Lebih dari 2 minggu	

4. Berapa lamakah jangka masa pembersihan selepas dilanda banjir?

1 hari		5 hari	
2 hari		6 hari	
3 hari	✓	7 hari	
4 hari		Lebih dari seminggu	

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5. Adakah anda mengambil sebarang tindakan persediaan berikut sebelum dilanda banjir?

Mendapatkan jaminan insurans	
Membersihkan longkang kecil di sekitar rumah / premis perniagaan	
Memastikan tiada barang-barang berharga berada di tempat yang berisiko untuk tenggelam	✓
Memindahkan barang-barang berharga ke tempat yang selamat	

6. Jika anda menjawab tidak untuk soalan (5), adakah anda akan mengambil tindakan-tindakan ini pada masa akan datang?

TIDAK

7. Adakah anda diberikan sebarang amaran/pemberitahuan sebelum kejadian banjir berlaku? Jika Ya, apakah bentuk amaran yang diberikan?

TIDAK

8. Apakah tindakan dari pihak berwajib yang anda dapat lihat bagi mengatasi masalah ini?

TIDAK

Flood Questionnaire

1. Did your home, contents and possession suffer from flood damage?

   YES 15 NO 5

2. If yes, how much is the estimated lost?

Below RM1000	18
RM1000-RM5000	0
RM5001-RM10000	2
more than RM10000	0

3. How long it takes to get back to daily routine?

1-3 days	18
4-7 days	1
1-2 weeks	1
more than 2 weeks	0

4. How much time spent for cleanups?

1 days	11
2 days	3
3 days	4
more	1

5. Have you taken any mitigation measures before the floods?

take insurance	2
keep drain around property clean	6
moved property, stock	5
Avoid keeping valuables on ground floor	12

6. If not, would you intend to take one after this?

   YES 19 NO 1

7. Have you been warned or noticed prior to the flood occurrence?
   If yes, by whom and how?

   YES 1 NO 19

8. Do you noticed any corrective, mitigative measure taken by authority in subsequent of the flood event?

   YES 4 NO 16