1. INTRODUCTION

The field activity was done as to be able to fully understand the application of each analytical methods in solving for the discharge measurement in the specific river area. The site was selected due to the recent flooding event occurred in the area by Typhoon Santi which flood water exceeded its maximum bank limits.

Its headwaters are located at the Sierra Madre and runs a south and southwesterly course for about 260 kilometers until it drains into Manila Bay.

The river's basin covers an area of 10,540 km², including the allied basin of Guagua River. The basin is drained through the Pampanga River and via the Labangan Channel into the Manila Bay.

Its main tributaries are Peñaranda and the Coronel-Santor Rivers on the eastern side of the basin and the Rio Chico River from the northwest side. The Angat River joins the Pampanga River at Calumpit, Bulacan via the Bagbag River. Mount Arayat (elevation: 1,026) stands in the middle of the basin. Southeast of Mount Arayat and the Pampanga River is the Candaba Swamp, covering an area of some 250 km². Absorbing most of the flood flows from the western slopes of a portion of the Sierra Madre and the overflowing of the Pampanga River via the Cabiao Floodway. This area is submerged during the rainy season but is relatively dry during summer.

1.1 OBJECTIVE

- To determine the discharge "Q" from the different methods in solving the discharge measurement.
- To know how flood water react during high water flows.
- To be able to fully understand each different method used in the actual application.

2. SITE DESCRIPTION:

Site Name:San Agustin Norte - Camba Bridge, Arayat, PampangaBridge length:260 metersCoordinates:Latitude: 15°09'57"N Longitude: 120°47'05"ESoil Type:Loam Clay & Sand



3. LIST OF METHODS USED:

- 1. Acoustic Doppler Current Profiler Method (ADCP)
- 2. Current Meter Method
- 3. Float Method
- 4. Slope-Area Method

4. METHODOLOGY OF STREAM GAUGING

Different types of method were used in getting the discharge measurement over the specific studied area. The first method used is by the Acoustic Doppler Current Meter Profiler, second is by the Current Meter method, third is by Float method and the fourth is by Slope-Area method.

4.1 Acoustic Doppler Current Meter Profiler (ADCP)

For the first method, using the Acoustic Doppler Current Meter Profiler, taking all parts to assemble from its antenna, cable connection, batteries, and data logger were installed and checked to set the instrument for calibration.

The calibration was done to set the instrument from the motions that would happen when the instrument is traversing the river. The instrument has three motions for its calibration such as yaw, roll and pitch. After completing the said three calibration motions, the system will verify if the calibration is passed. After the said procedure, the instrument will be set to the river prior to its traverse. To set the instrument at the river, we have to consider a safe distance as not to aground the instrument from the river bed surface, there is no specific required distance as long as the instrument is protected from said surface to the traducer. Also, we have to input some required data to the system such as measured safe distance from water edge to the transducer, vertical distance measurement from water surface to the submerged transducer, water gauge height, date and time of the activity performed.

After completing the said details, it is now ready to set the instrument to Travers the river. When the instrument reached at the opposite site of the bank, it is also required to measure the safe distance from the water edge to the transducer and input the data to the system as to have a final distance measurement from the both banks. The system will have now the complete picture of its river profile that includes the computed total discharge, the maximum depth of the river and the velocity of the instrument when traversing the river width.



ILLUSTRATION 1: Traversing the river with ADCP Method.

4.2 Current Meter Method

The second method used is by the application of current meter using Price AA instrument. There are many ways that are classified in terms of the method used to cross the river or stream during the measurement, such as wading, cableways, bridge and boat. In measuring from bridge or from other means, the procedure is quite similar. First, established several points that are taken from the total width of the river and divided on how many observations vertical are required. The closer the station or vertical observations, the better results obtained. In assembling of its parts, it is needed to familiarize some of the important parts that are to be connected from each other such as connector for attaching sounding cable to sounding-weight hanger, hanger bar, sounding weight, reel, computing depth indicator and the current meter timer which counts every revolution of the rotor made during a specified time interval.

To start with, level the equipment to any known point as your reference point and set the computing depth indicator to zero. Lowering the equipment until it reached the water level surface will give a distance from point of reference to water level surface and from water level to the bottom of the river bed which gives the total depth of the river. Since the depth is already known, it is now by choice to select which method of computing the velocities are applicable. There are many methods to select but there are two types of methods which are commonly used, and these are the two-point method and the three-point method. The instrument is to be leveled at 0.2, 0.6 and 0.8 of the depth of river below water surface at each vertical observation to get the velocities at each point. Taking at point 2, counting the revolution made by the instrument versus the time counts for a minimum of 60 seconds will give the velocity at its vertical point. Adding up the results of 0.2 and 0.8 measurements will give an average value and will be used as the mean velocity of the particular vertical observation and these is the two-point method. For the three point method, the average result value of 0.2 and 0.8 will be added to the result value taken at 0.6 and again, average the value of this will give the average velocity at the observation vertical but, this method is used when the velocities in the vertical observation are abnormally distributed due to turbulence or friction from any obstruction produced from the riverbed and the depths must be greater than 0.75 meter before this method can be used.

The process is repeatedly done at each vertical observation from the left water edge to right water edge or vice versa. The result of this observation will be tabulated and computed to give us a better understanding, and a true value of the total discharge, velocities and area of the studied river site.



ILLUSTRATION 2. Current meter application at bridge.

4.3 Float Method

The third method is by float, which the procedure is done by throwing floatation by means of bamboo. It has been said that this method is advisable when used during heavy discharge or at high flow events when flood waters is confined to its river bank compared to the other measuring instrument that is costly enough if sweep by high water discharge. First is by establishing several points at the bridge as observation verticals where the bamboo will be thrown. The measurement starts at the left water edge to the opposite bank or vice versa. Dividing the total river width by the needed vertical observation points and this serves as the drop points of the floatation device. Second is by measuring a distance from the bridge to the first point along the river length as approach section of not less than 30 meters from the bridge and this serves as the first cross-section of the river. From the first cross-section the minimum distance is not less than 50 meter to the second cross-section of the river.

The activity is manned by a minimum of three observer persons. The first person is located at the bridge which gave information to the second observer located at the first cross-section point that the float was drop and heading to the first cross-section point. When the float reaches at the imaginary line along the first cross-section, second observer will raise a flag to notify that the float is already parallel to the imaginary line at first cross-section and the third observer will start the counting thru stopwatch the time travelled by the float until it reach the imaginary line at the second cross-section and thus, ending the counted time in seconds. To compute the velocity at the particular observation vertical, distance from both cross-sections will be divided to the observed time travelled by the float.

The value is not valid or accurate if the float diverted to the left or right banks. Studied river must be straight in length to give accurate value of its velocity. The process is repeatedly done at all observation

verticals as to compute the velocity at each vertical section. There are many methods in getting the area at each cross-section, neither by using the values derived from different methods applied such as slope area method and current meter method or by doing water sounding to measure the depth of the river from the water surface, and a range finder to measure the distance from water edge to the point of observation verticals along the cross-section. It is very important also to note and monitor the water gauge height when the activity is carried out in order to know the exact water level for solving for the correct area and velocity during the time the float measurement. The results will be tabulated and computed such as the average time and area, the velocity multiplied by the coefficient factor to get the corrected velocity and the total discharge for the river site.



ILLUSTRATION 3. Float method application.

4.4 Slope-Area Method

The slope-area method is also an indirect method application in determining discharge measurement which is the same in the above mentioned methods except for the Acoustic Doppler Current Profiler (ADCP). The required data for computation of discharge using slope-area can be obtained thru surveying the reach of the channel that includes the elevation of high-water marks correspond to the peak water discharge.

There are many different types of instrument to use in finding the elevation of specific point. The totalstation is the recommended instrument to use due to its simple and easy application. The instrument measures electronically the vertical distance, horizontal distance and the horizontal angle.

The first step is to set up the instrument at the point where the known Benchmark (BM) is visible by taking as back sight. Turning the instrument toward the opposite point of the BM and sighting the rod or prism and mark the point as turning point 1, it gives the value of its elevation at TP1. The second step is to transfer the instrument and take the TP1 as back sight and by turning again to opposite side of TP1, taking the point as Foresight 1 (FS1/Point 1) as the first rod reading of the flood water mark. By continuing the succeeding FS points until it reached the water edges of both right and left banks and extending the points to the opposite side of the bank to identify the maximum flood water marks at the other side.

The result at each FS point readings will give the profile elevation of the particular cross-section of the river. The process is repeatedly done until the required numbers of cross-section are obtained.

The rod reading of each points will be plot to give a full perspective of the profiled cross-sections and tabulated to the given formulated excel suites provided by Pampanga River Flood Forecasting and Warning Center (PRFFWC) for automatic computation of discharge.



ILLUSTRATION 4. Profiling for slope area method

4.5 Rating Curve

One of the goals of discharge measurement is to establish a rating curve defined by measured discharges at various water surface elevations. Based on actual discharge data, an equation can be formulated that would best describe the observations in such a way that if the equation would be plotted out in a graph, the curve that forms "best-fit" the distribution of the data. With a rating equation, a hydrologist can estimate discharges at various water levels, even those water elevations not present in the actual data. The discharge for every water level, based on the rating equation, is then presented in a rating table. This would then serve as a guide for the hydrologist.

5. TABLES AND RESULTS:

5.1 Acoustic Doppler Current Profiler (ADCP) Method:



Figure 1. Results from traversed made by ADCP method.

Discha	rge Mea	asureme	ent (Cu	irrent Mete	r) for :		1	traya	t		River:		Pampang	ga 👘	PRFFC
DM #:		2	Date:	00	ot. 18,	2013		Team				Group 4			FFB
Gage	Height:	Start:	4.68	End:	4.57	Inst. #	ŧ:	F	Price A	A	Ws:		fair		PAGASA
Observal	tion Time:	Start	10:55	End:	3:00	Calibra	tion Eq	tn.: V =	0.702	N+	0.013	note: jus	input negati	ve value	0075
		Vertic	al dist	. to water s	urface	e (m) =	11.	00				for latter	if eqtn. is mi	nus.	
Total	Area í	m²]=		405.42		Ave	Gao	e Hei	aht =	4	63	Secti	ional Vidi	th (m) =	120.0
Total	0(m3	9-1-		225 70		A	V-I	(-1	- 1 -	0	002	0000		(mj -	120.0
Dist	G (III	15] -		329.70		Ave	. vei	. Umrs	5] -	υ.	003				D 1
from		Depth	Vert.	Angle		0	bservat	ion Dep	th		Velo	ocity			Remarks
Initial	Width	(ep for	Angle	Corrected	0.	.2	0	.6	0.	8	at point	Mean (0.0.0.6	Area	Q	Excellent, Good
	(Dieri	4"-	Dunk	Due	Time	Due	T:	Dur	Time	for 0.6	(0.2 %	. 2	(6666
point	(mcs.)	(mcs.j	261	Depth	Rev.	TIME	Rev.	TIME	Rev.	TIME	onlu	0.81	(m ⁻)	(cumecs)	Fair, Poor
0	_			0	00				0.0	07		0.077			LWE
5	5	2.3	-	2.300	60	62			60	65	×	0.677	11.50	7.78	
10	5	4.11	8	3.989	90	64			75	62	×	0.931	19.95	18.57	
15	5	4.56	10	4.368	95	65			80	65	×	0.358	21.84	20.92	
20	5	8,18	5	8.129	95	63			30	64	8	0.707	40.65	28.73	ripples
25	5			X							X	X	X	8	turbulent
30	5			8							8	8	×	X	pier
35	5			8							×	8	X	×	too deep
40	5	9.72	19	X Q Q01	QE	62			75	60	×	N 933	× 44.40	× 41.42	too deep
45	5	9.63	13	9 5 9 7	90	60			50	62	N U	0.333	44.40	39.47	
55	5	8.1	4	8.049	85	64			60	65	0 U	0.023	40.25	32.32	
03	5	6.72	5	6.671	85	65			60	63	n V	0.808	33.35	26.89	
65	5	52		5 200	85	62			70	62	 x	0.891	26.00	23.15	
70	5	5.25		5.250	85	64			65	62	8	0.847	26.25	22.24	
75	5	5.05		5.050	80	61			60	64	8	0.802	25.25	20.26	
80	5	4,45		4,450	80	61			60	62	8	0.813	22.25	18.09	
85	5	4		4.000	60	63			65	64	X	0.704	20.00	14.08	
90	5			х							×	×	х	х	waterlily
95	5			×							×	х	x	x	pier
100	5			X							×	х	х	8	turbulent
105	5			X							×	х	×	×	pier
110	5	2.55		2.550	55	63			50	61	×	0.607	12.75	7.74	
115	5	2.6		2.600	30	66			25	64	×	0.310	13.00	4.03	
120	×			X							×	х	х	x	RWE
	#REF!			X							×	8	х	х	shallow
	At distar	nce 25 - 40	08.90-	105, no veloc	ity meas	urement	was ma	de due	to obstr	action	Total	Area =	405.42		
Rem:	from the	pier that r	nay alter	r the true mea	suremen	it from r	ipples e	r turbul	ent. Also	o, at	Tota	al Discl	arge =	325.70	
	stn 35-41	U the eleva	ition fro	m surface wa	ter to ri	ver bed	is too d	eep.			Av	e. Yelo	city =	0.803	

TABLE 5.2.1: Result of Discharge Measurement by Current Meter Method

Cross-Section





5.3 Float Method:

Table No. 3. - Result of Discharge Measurement by Float Method Date: Ocotober 21, 2003

	Time	Staff gage (m)	As of	Distance (m)
Start	11:30	3.16	11:00 AM	100
End	12:05	3.12	12:00 NN	100
Average	6:05			100

								Divided Area			
Measuring Line		Time of Drop	Traveling Time (secs)	Average traveling time (1st trial + 2nd trial)/2	Velocity of Float (m/s)	Corr. Coef.	Corr. Velo. (m/s)	Section 1	Section 2	Average Area (\$q.=.)	Divided Q (cu.m/s)
No.1	1st trial	11:30	186	186	0.5376	0.85	0.45699	27.75	27.33	27.54	12.5855
NO. 1	2nd trial	failed	0								
No.2	1st trial	failed	0	123	0.8130	0.85	0.69106	105.9	62.025	83.9625	58.0229
110.2	2nd trial	11:44	123								
No.2	1st trial	11:47	118	127	0.7874	0.85	0.66929	229.65	113.5	171.575	114.834
NO. 5	2nd trial	11:51	136								
No.4	1st trial	11:55	120	128	0.7813	0.85	0.66406	338.7	144.7	241.7	160.504
NO. 4	2nd trial	11:58	136								
No.E	1st trial	12:02	140	140	0.7143	0.85	0.60714	338.05	146.9	242.475	147.217
NO. 5	2nd trial	failed	0								
									Tota	al Q	493.163

5.4 Slope-Area (S-A) Method:

	TABLE 4.1 CROSS-SECTION 1									
Slope-Area	Cross-Sect	ion Comput	tation							
Station:		Arayat		S	urvey Date:	Oct. 22	2, 2013			
River:		Pamp	anga		Gage Ht.=	8.78	meters			
		Cross-Se	ction numb	per ONE(1)	-		heh/			
			Water		Mean		Wetted			
Station	Distance	Elevation	Sfc alow	Depth	Denth	Area	Dorimoto			
0		8.129	8.129	0	Depth		rennete			
25.509	25,509	6.825	8.129	1.304	0.652	16.63187	25.54230			
42.67	17.161	6.709	8.129	1.42	1.362	23.37328	17.16139			
75.27	32.6	6.31	8.129	1.819	1.6195	52.7957	32.60244			
104.001	28.731	7.073	8.129	1.056	1.4375	41.30081	28.7411			
116.728	12.727	6.352	8.129	1.777	1.4165	18.0278	12.74740			
141.631	24.903	5.969	8.129	2.16	1.9685	49.02156	24.90594			
175.413	33.782	5.12	8.129	3.009	2.5845	87.30958	33.79266			
191.773	16.36	4.991	8.129	3.138	3.0735	50.28246	16.36050			
196.461	4.688	4.343	8.129	3.786	3.462	16.22986	4.732573			
200.129	3.668	3.569	8.129	4.56	4.173	15.30656	3.748773			
217.429	17.3	0.0745	8.129	8.0545	6.30725	109.1154	17.64940			
222.429	5	-0.4755	8.129	8.6045	8.3295	41.6475	5.03019			
227.429	5	-1.3755	8.129	9.5045	9.0545	45.2725	5.080354			
232.429	5	-2.3255	8.129	10.4545	9.9795	49.8975	5.089449			
237.429	5	-3.1955	8.129	11.3245	10.8895	54.4475	5.075125			
242.429	5	-4.9955	8.129	13.1245	12.2245	61.1225	5.314132			
247.429	5	-6.0755	8.129	14.2045	13.6645	68.3225	5.115310			
252.429	5	-6.9755	8.129	15.1045	14.6545	73.2725	5.080354			
257.429	5	-7.6255	8.129	15.7545	15.4295	77.1475	5.04207			
262.429	5	-7.6855	8.129	15.8145	15.7845	78.9225	5.0003			
267.429	5	-8.1755	8.129	16.3045	16.0595	80.2975	5.023952			
272.429	5	-7.6755	8.129	15.8045	16.0545	80.2725	5.024937			
277.429	5	-6.3755	8.129	14.5045	15.1545	75.7725	5.166236			
282.429	5	-5.5755	8.129	13.7045	14.1045	70.5225	5.063595			
286.429	4	-4.2755	8.129	12.4045	13.0545	52.218	4.205948			
289.429	3	-2.7455	8.129	10.8745	11.6395	34.9185	3.367625			
292.429	3	-1.6755	8.129	9.8045	10.3395	31.0185	3.18510			
300.429	8	-0.5755	8.129	8.7045	9.2545	74.036	8.075270			
301.429	1	0.88	8.129	7.249	249 7.97675 7.97675		1.765921			
314.571	13.142	3.877	8.129	4.252	5.7505	75.57307	13.47939			
318.913	4.342	6.808	8.129	1.321	2.7865	12.09898	5.238675			
321.651	2.738	6.713	8.129	1.416	1.3685	3.746953	2.739647			
	x			x	x	x	x			
Total W	/idth =	321.65	meters	Hydraulic R	adius(r) =	4.99	meters			
Total /	Area =	1627.90	meters ²	Mean Secti	on Depth =	5.061073	meters			
Netted Per	meter(P) = 326.148 meters									

	TABLE 4.2 CROSS-SECTION 2										
Slope-Area C	ross-Section Co	mputation									
Station:		Arayat			Survey Date:	Oct. 22	2, 2013				
River:		Pamp	anga		Gage ht.=	8.78	meters				
		Cross-Se	ction number	TWO(2)			hth/97				
Station	Distance	Elevation	Water Sfc. elev.	Depth	Mean Depth	Area	Wetted Perimeter				
0		8.001	8.001	0							
18.2	18.2	7.99	8.001	0.011	0.0055	0.1001	18.200003				
58.972	40.772	7.701	8.001	0.3	0.1555	6.340046	40.773024				
67.263	8.291	7.612	8.001	0.389	0.3445	2.8562495	8.2914777				
74.655	7.392	7.365	8.001	0.636	0.5125	3.7884	7.3961255				
85.681	11.026	7.243	8.001	0.758	0.697	7.685122	11.026675				
98.611	12.93	7.168	8.001	0.833	0.7955	10.285815	12.930218				
120.597	21.986	7.151	8.001	0.85	0.8415	18.501219	21.986007				
147.577	26.98	7.141	8.001	0.86	0.855	23.0679	26.980002				
158.263	10.686	7.063	8.001	0.938	0.899	9.606714	10.686285				
163.171	4.908	7.014	8.001	0.987	0.9625	4.72395	4.9082446				
260.233	97.062	7.093	8.001	0.908	0.9475	91.966245	97.062032				
266.634	6.401	6.909	8.001	1.092	1	6.401	6.403644				
269.411	2.777	4.979	8.001	3.022	2.057	5.712289	3.3818085				
276.167	6.756	3.533	8.001	4.468	3.745	25.30122	6.9090124				
302.942	26.775	2.566	8.001	5.435	4.9515	132.57641	26.792456				
325.942	23	1.949	8.001	6.052	5.7435	132.1005	23.008274				
334.942	9	1.649	8.001	6.352	6.202	55.818	9.0049986				
345.942	11	0.849	8.001	7.152	6.752	74.272	11.029053				
356.942	11	0.449	8.001	7.552	7.352	80.872	11.00727				
362.942	6	0.049	8.001	7.952	7.752	46.512	6.0133186				
384.942	22	-0.551	8.001	8.552	8.252	181.544	22.00818				
395.942	11	-1.251	8.001	9.252	8.902	97.922	11.02225				
399.942	4	1.749	8.001	6.252	7.752	31.008	5				
402.442	2.5	2.932	8.001	5.069	5.6605	14.15125	2.765771				
411.878	9.436	6.056	8.001	1.945	3.507	33.092052	9.9396917				
418.479	6.601	7.127	8.001	0.874	1.4095	9.3041095	6.6873195				
420.497	2.018	7.086	8.001	0.915	0.8945	1.805101	2.0184165				
	x			x	x	x	x				
Total V	Vidth =	420.50	meters	Hydraulic Rad	lius(r) =	2.62	meters				
Total	Area =	1107.31	meters ²	Mean Section	n Depth =	2.6333451	meters				
Wetted Per	rimeter(P) =	423.232	meters								

TABLE 4.3 CROSS-SECTION 3								
lope-Area Cr	oss-Section Co	omputation						
Station:		Arayat			Survey Date:	Oct. 22	2, 2013	
River:		Pamp	anga		Gage ht.=	8.78	meters	
		Cross-Sec	tion number 1	THREE (3)			heh/97	
Station	Distance	Elevation	Water Sfc. elev.	Depth	Mean Depth	Area	Wetted Perimeter	
0		7.979	7.979	0				
21.521	21.521	7.976	7.979	0.003	0.0015	0.0322815	21.521	
66.242	44.721	7.283	7.979	0.696	0.3495	15.62999	44.726369	
146.794	80.552	6.674	7.979	1.305	1.0005	80.592276	80.554302	
166.819	20.025	6.482	7.979	1.497	1.401	28.055025	20.02592	
182.931	16.112	2.722	7.979	5.257	3.377	54.410224	16.544913	
186.095	3.164	1.393	7.979	6.586	5.9215	18.735626	3.4317834	
199.628	13.533	1.016	7.979	6.963	6.7745	91.679308	13.53825	
216.628	17	0.4335	7.979	7.5455	7.25425	123.32225	17.009977	
226.628	10	0.216	7.979	7.763	7.65425	76.5425	10.002365	
234.628	8	0.016	7.979	7.963	7.863	62.904	8.0024996	
248.628	14	-0.584	7.979	8.563	8.263	115.682	14.012851	
259.628	11	-0.884	7.979	8.863	8.713	95.843	11.00409	
281.628	22	-1.284	7.979	9.263	9.063	199.386	22.003636	
287.628	6	-1.384	7.979	9.363	9.313	55.878	6.0008333	
295.628	8	-1.884	7.979	9.863	9.613	76.904	8.0156098	
308.628	13	-2.084	7.979	10.063	9.963	129.519	13.001538	
314.628	6	-0.484	7.979	8.463	9.263	55.578	6.2096699	
317.318	2.69	0.711	7.979	7.268	7.8655	21.158195	2.9434886	
324.345	7.027	3.269	7.979	4.71	5.989	42.084703	7.4781076	
329.542	5.197	5.446	7.979	2.533	3.6215	18.820936	5.6345486	
335.94	6.398	5.667	7.979	2.312	2.4225	15.499155	6.4018158	
	x			x	x	x	x	
Total W	/idth =	335.94	meters	Hydraulic Rad	lius(r) =	4.08	meters	
Total A	Area =	1378.26	meters ²	Mean Section	n Depth =	4.1026864	meters	
Wetted Per	imeter(P) =	338.064	meters		-			



Graph 5.4.1: Cross-section profile of the river derived from the slope-area method.

					PHII ASTRON Pampan	ogy CAL AND N (PAGASA) nter (PRFFC)							
FFB, PA	AGASA		L		Slope-A	rea Summar	y Sheet (3-Se	ection)		1			
	Station:		Ara	yat			River:			Pampanga	1		
	Flood Date:		22-0	ct-13		Dra	inage Area:			6,487			
Ga	uge Height:		8. 2	78			Meas.#:						
<u>ຫຫຫຫ</u>	ຉຉຉຉຉຉຉຉ	ຓຓຓຓຓຓຓຓ	ຠຉຉຉຉຉຉຉຉ	ຑຉຉຉຉຉຉຉຉ	ຉຉຉຉຉຉຉຉ	ຉຉຉຉຉຉຉຉ	ຓຓຓຓຓຓຓຓ	ຉຉຉຉຉຉຉຉ	ຉຉຉຉຉຉຉຉ	ຉຉຉຉຉຉຉ	աաա	ເວດອອ	ເດດດອ
X - Sec	tion Propertie	s:											hth/97
			Highwat	er Marks									
X- Sect.	Width	Area	Left Bank	Right Bank	Average Water Sfc.	d _{m (mean}	n	r	к	K ³ /A ²	а	F	State of Flow
1	321.65	1627.90	6.713	8.129	7.421	5.061	0.035	4.99	136572.06	961237162	1	0.312	tranquil
2	420.50	1107.31	6.086	8.001	7.0435	2.633	0.035	2.62	60263.824	178496095	1	0.636	tranquil
3	335.94	1378.26	5.667	7.979	6.823	4.103	0.035	4.08	100968.11	541866820	1	0.410	tranquil
note:	Assume no	sub-divided	sections, he	ence a is alw	vays 1!!					n - roug	hness	s coefficie	nt
Reach	Properties:									K - conv K _w - w to	/eyan d. con	ice vevance (Geometric
Reac h	Length	Dh Fall	k	reach condition	K _U /K _D	K _U /K _D Condition	Ave. A	Q by formula	Ave V	.("mea F - Frou .(of flow	an of de no /	K of 2 sec .(indicate	tions s the state
1-2	150	0.3775	0	contracting	2.2662361	poor	1367.606	3049.9017	2.230	α - veloc r - hvdra	city he aulic r	ead coeffi adius	cient
2-3	150	0.2205	0.5	expanding	0.59686	poor	1242.785	3572.5882	2.875	k - coeff	ficient	t for differe	ences in
1-2-3	300	0.598	0	contracting	1.3526257	good	1371.156	3579.188	2.610	h _v - velo	city h	ead	
										n _f - ener	gy los in the	reach	soundary
Discha	rge Computat	ion:(comparis	son)							S - fricti	on slo	pe	
		h	v										
Reac h	Assumed Q	U/S	D/S	Dh_v	h _f	S=h _f /L	S ^{1/2}	Kw	Computed Q				
1-2	3049.90172	0.24663685	0.5330545	-0.2864177	0.0910823	0.0006072	0.0246417	90721.301	2235.5312				
2-3	3572.5882	0.53305451	0.3440748	0.1889797	0.3149898	0.0020999	0.045825	78004.642	3574.5642	Q ₁₋₂₋₃	= '	3!	579.19
Rem:												7	cumecs
										Discharge	1		

Table 5.4.2: Slope-Area Summary Sheet.

5.5 H-Q Table and Rating Curve:

Table 5.5.1 Rating Table

Rating Tab	le for:			Arayat			Date:	October	22, 2013	
River:		Pampanga		Location:		San Agust	in, Arayat, P	ampanga		
Elevation o	of S.G. "0" rea	iding:	()						
Rating Curv	e Equation (Coefficients:	a =	0.026	Ho=	-10.100	b^=	3.851		
Range of G	.H.:	Min.	G.H. =	0.082	Max	k. possible G	.H.=	11.08		
Remarks:	readings ba	ised on staff g	age and not	in MSL						
G.H.(m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.1	197.76	198.51	199.26	200.01	200.77	201.53	202.29	203.05	203.81	204.58
0.2	205.35	206.12	206.89	207.66	208.44	209.22	210.00	210.78	211.57	212.35
0.3	213.14	213.93	214.73	215.52	216.32	217.12	217.93	218.73	219.54	220.35
0.4	221.16	221.97	222.79	223.61	224.43	225.25	226.07	226.90	227.73	228.56
0.5	229.39	230.23	231.07	231.91	232.75	233.60	234.44	235.29	236.15	237.00
0.6	237.86	238.71	239.58	240.44	241.30	242.17	243.04	243.91	244.79	245.67
0.7	246.55	247.43	248.31	249.20	250.09	250.98	251.87	252.77	253.67	254.57
0.8	255.47	256.37	257.28	258.19	259.10	260.02	260.94	261.86	262.78	263.70
0.9	264.63	265.56	266.49	267.42	268.36	269.30	270.24	271.18	272.13	273.08
1.0	274.03	274.98	275.94	276.90	277.86	278.82	279.79	280.76	281.73	282.70
1.1	283.68	284.65	285.63	286.62	287.60	288.59	289.58	290.58	291.57	292.57
1.2	293.57	294.57	295.58	296.59	297.60	298.61	299.63	300.65	301.67	302.69
1.3	303.72	304.75	305.78	306.81	307.85	308.89	309.93	310.97	312.02	313.07
1.4	314.12	315.18	316.24	317.30	318.36	319.42	320.49	321.56	322.64	323.71
1.5	324.79	325.87	326.96	328.04	329.13	330.22	331.32	332.42	333.52	334.62
1.6	335.72	336.83	337.94	339.06	340.17	341.29	342.41	343.54	344.66	345.79
1.7	346.93	348.06	349.20	350.34	351.48	352.63	353.78	354.93	356.09	357.24
1.8	358.40	359.57	360.73	361.90	363.07	364.25	365.42	366.60	367.79	368.97
1.9	370.16	371.35	372.55	373.74	374.94	376.14	377.35	378.56	379.77	380.98
2.0	382.20	383.42	384.64	385.87	387.10	388.33	389.56	390.80	392.04	393.28
2.1	394.53	395.77	397.03	398.28	399.54	400.80	402.06	403.33	404.60	405.87
2.2	407.14	408.42	409.70	410.99	412.27	413.56	414.86	416.15	417.45	418.75
2.3	420.06	421.37	422.68	423.99	425.31	426.63	427.95	429.28	430.61	431.94
2.4	433.28	434.61	435.95	437.30	438.65	440.00	441.35	442.71	444.07	445.43
2.5	446.80	448.17	449.54	450.91	452.29	453.67	455.06	456.44	457.84	459.23
2.6	460.63	462.03	463.43	464.84	466.25	467.66	469.08	470.50	471.92	473.34
2.7	474.77	476.20	477.64	479.08	480.52	481.96	483.41	484.86	486.32	487.78
2.8	489.24	490.70	492.17	493.64	495.11	496.59	498.07	499.55	501.04	502.53
2.9	504.02	505.52	507.02	508.52	510.03	511.54	513.05	514.57	516.09	517.61
3.0	519.14	520.67	522.20	523.74	525.28	526.82	528.37	529.92	531.47	533.03
3.1	534.59	536.15	537.72	539.29	540.86	542.44	544.02	545.61	547.19	548.78
3.2	550.38	551.98	553.58	555.18	556.79	558.40	560.01	561.63	563.25	564.88
3.3	566.51	568.14	569.78	571.41	573.06	574.70	576.35	578.00	579.66	581.32
3.4	582.98	584.65	586.32	588.00	589.67	591.36	593.04	594.73	596.42	598.12
3.5	599.81	601.52	603.22	604.93	606.65	608.36	610.08	611.81	613.53	615.27
3.6	617.00	618.74	620.48	622.23	623.98	625.73	627.49	629.25	631.01	632.78
3.7	634.55	636.32	638.10	639.88	641.67	643.46	645.25	647.05	648.85	650.66
3.8	652.46	654.28	656.09	657.91	659.73	661.56	663.39	665.22	667.06	668.90
3.9	670.75	672.60	674.45	676.31	678.17	680.03	681.90	683.77	685.65	687.53
4.0	689.41	691.30	693.19	695.09	696.99	698.89	700.79	702.70	704.62	706.54
4.1	708.46	710.38	712.31	714.25	716.18	718.13	720.07	722.02	723.97	725.93

4.2 727.89 729.85 731.80 735.75 737.75 739.74 741.73 743.72 745.74 4.3 747.71 749.92 751.73 755.75 757.77 759.80 761.83 763.83 764.88 768.89 4.4 757.95 759.71 777.19 798.02 761.83 763.83 784.40 786.43 4.5 789.59 811.71 813.84 815.98 818.11 822.40 824.62 844.44 850.68 4.6 890.59 815.11 857.31 859.53 861.75 863.98 866.21 866.48 870.68 872.92 5.0 897.88 900.18 902.74 904.78 907.09 909.40 911.71 914.40 915.65 912.93 933.68 912.29 933.6 913.29 916.21 5.1 921.02 933.8 951.7 937.43 980.82 983.27 985.12 937.44 939.86 912.9 912.9 912.9 912.9											
4.4 747.71 749.72 751.74 752.75 757.77 759.80 761.83 763.84 766.48 4.4 767.97 769.84 772.03 774.82 796.22 790.22 801.13 803.23 805.45 806.44 4.6 800.59 811.71 813.84 815.98 818.11 820.26 822.40 824.45 826.67 828.49 850.68 870.42 873.57 837.54 839.72 841.91 844.09 846.42 846.44 870.68 877.29 841.91 840.02 889.30 893.30 895.59 5.0 897.88 900.18 902.47 907.09 909.40 917.11 914.40 916.83 946.23 5.2 944.61 946.99 949.38 917.79 951.16 958.07 901.38 966.21 5.3 968.63 971.06 973.49 975.33 976.37 980.82 983.27 985.72 988.18 990.64 5.4 1943.49 1043.31 </td <td>4.2</td> <td>727.89</td> <td>729.85</td> <td>731.82</td> <td>733.80</td> <td>735.77</td> <td>737.75</td> <td>739.74</td> <td>741.73</td> <td>743.72</td> <td>745.71</td>	4.2	727.89	729.85	731.82	733.80	735.77	737.75	739.74	741.73	743.72	745.71
4.4 767.93 776.98 774.08 776.13 778.13 778.19 780.26 782.33 784.40 786.44 4.5 788.56 790.64 792.73 794.82 796.92 799.02 801.13 803.23 805.35 807.47 4.6 809.59 811.11 813.84 833.78 835.53 861.75 863.84 886.21 884.44 870.64 872.92 4.9 875.17 877.42 879.68 881.94 884.20 886.47 888.74 891.02 893.30 895.59 5.0 897.88 900.18 925.71 928.20 930.40 932.71 934.44 891.62 983.27 985.72 988.18 990.64 5.1 921.06 971.06 973.49 975.39 978.37 980.82 983.27 985.72 988.18 990.64 5.4 993.11 920.58 993.06 1002.51 1003.31 1005.22 1008.1 1010.51 1013.02 105.53 1088.	4.3	747.71	749.72	751.73	753.74	755.75	757.77	759.80	761.83	763.86	765.89
4.5 788.56 790.64 790.52 790.92 801.13 803.23 805.33 807.47 4.6 809.59 811.11 813.84 815.98 815.11 822.40 824.55 826.57 828.87 4.7 831.03 833.20 835.31 855.53 861.75 861.98 866.21 886.47 800.68 872.92 4.9 875.17 877.42 879.68 881.44 884.04 886.47 890.02 893.99 943.83 911.71 914.04 916.36 918.69 5.1 921.02 923.36 927.71 928.05 930.40 931.71 951.83 963.79 965.21 966.21 5.2 944.61 966.99 943.83 917.79 951.61 958.97 961.33 966.21 5.3 1086.83 971.06 973.49 975.33 976.37 980.82 983.27 988.18 190.64 5.4 1043.43 1046.00 1046.87 1051.14 1030.32	4.4	767.93	769.98	772.03	774.08	776.13	778.19	780.26	782.33	784.40	786.48
4.6 809.59 811.71 813.84 815.88 811.11 820.26 824.09 826.71 828.87 4.7 831.00 833.20 835.37 837.54 839.72 841.91 844.09 846.29 886.44 870.68 872.92 4.9 875.17 877.42 879.68 881.44 884.00 886.47 888.44 891.02 893.06 895.59 5.0 897.88 900.41 902.47 907.09 909.40 911.71 914.04 916.36 942.23 5.1 921.02 923.36 925.71 928.05 903.04 932.76 983.17 938.86 942.23 5.3 968.63 971.06 975.39 975.37 980.82 1003.52 1003.71 1013.62 1013.52 1013.52 1013.52 1013.52 1003.53 1004.87 1048.75 103.52 1035.72 981.13 1010.51 1013.62 1010.55 1013.54 1040.54 1040.87 1010.55 1035.74 1014.47	4.5	788.56	790.64	792.73	794.82	796.92	799.02	801.13	803.23	805.35	807.47
4.7 831.03 833.20 833.27 841.91 844.09 846.23 846.24 870.68 877.29 4.8 852.80 855.10 857.31 859.53 861.75 863.98 866.21 868.44 870.68 877.292 5.0 897.88 900.18 902.47 904.78 907.09 909.40 911.71 914.04 963.39 963.39 963.39 963.39 963.39 963.39 963.39 963.39 963.39 963.39 963.39 963.39 963.42 937.49 939.86 993.64 966.31 993.64 993.65 983.67 101.51 101.51 101.53 51 51.018.04 1020.56 1023.08 1025.61 1028.14 103.068 1033.22 1005.77 1083.32 1004.82 1064.08 1066.48 1066.48 1066.48 1066.48 1066.48 1066.48 1066.48 1066.48 1066.48 1066.48 1067.71 1092.31 1174.42 114.97 1154.24 114.47 114.22 11	4.6	809.59	811.71	813.84	815.98	818.11	820.26	822.40	824.55	826.71	828.87
4.8 852.89 855.10 857.31 857.31 863.98 866.21 868.44 870.68 872.92 4.9 875.17 877.42 879.68 881.94 884.07 888.47 888.74 891.02 893.08 995.59 5.1 921.02 923.36 922.71 928.05 930.40 932.76 935.12 937.49 939.86 942.23 5.2 944.61 946.99 949.38 951.77 954.16 956.56 958.97 968.13 906.621 103.03 1005.52 1008.01 101.01 101.03.02 1015.53 5.5 1018.04 1020.56 1023.64 1003.03 1005.52 1008.01 101.01.1 101.82 5.6 1043.43 1046.00 1048.57 1055.30 1058.89 1087.67 1090.31 1092.95 5.7 1069.29 1071.90 1074.52 1077.40 1108.29 1111.64 111.47 114.42 114.42 114.42 114.42 114.42 114.4	4.7	831.03	833.20	835.37	837.54	839.72	841.91	844.09	846.29	848.48	850.68
4.9 875.17 877.42 877.68 881.44 886.47 886.47 887.4 891.02 893.30 895.59 5.0 897.88 900.18 902.47 904.78 907.09 909.40 911.71 914.04 916.36 918.69 5.1 921.02 923.36 925.71 928.05 930.40 923.72 985.72 988.81 990.64 5.3 968.63 971.06 973.49 975.93 978.37 980.82 983.27 985.72 988.18 990.64 5.5 1018.04 1020.56 1023.08 1025.61 1038.12 1005.61 1038.22 1040.81 1046.08 1066.68 5.7 1069.29 1071.90 1074.52 1077.14 1079.76 1082.38 1085.01 1087.67 1090.31 1092.96 5.8 1095.62 1098.28 1100.94 1103.66 1138.74 114.74 114.72 1117.02 1117.02 1117.02 1117.02 1113.74 114.74 1146.	4.8	852.89	855.10	857.31	859.53	861.75	863.98	866.21	868.44	870.68	872.92
5.0 897.88 900.18 902.47 907.09 993.40 917.71 914.04 916.36 918.69 5.1 921.02 923.36 925.71 928.05 930.40 932.76 935.12 937.40 933.86 942.33 5.3 968.63 971.06 973.49 975.33 978.37 980.82 983.37 985.72 988.13 990.64 5.4 1993.11 995.58 980.60 1005.41 1003.06 103.32 1013.52 103.81 103.22 1015.53 5.6 1043.43 1046.00 1048.57 1051.14 1052.71 1058.39 1085.03 1058.89 1061.48 1064.08 1065.68 5.7 1069.29 1071.90 1074.52 1077.14 1079.76 1082.39 1085.03 1085.03 1085.03 1085.03 1085.03 103.41 1144.22 1146.96 6.1 1127.74 1180.24 1103.61 1132.88 1130.01 113.84 1141.47 1144.92 <t< td=""><td>4.9</td><td>875.17</td><td>877.42</td><td>879.68</td><td>881.94</td><td>884.20</td><td>886.47</td><td>888.74</td><td>891.02</td><td>893.30</td><td>895.59</td></t<>	4.9	875.17	877.42	879.68	881.94	884.20	886.47	888.74	891.02	893.30	895.59
5.1 921.02 923.32 925.71 928.05 930.40 935.12 937.49 938.86 942.23 5.2 944.61 946.99 943.8 951.77 954.16 956.56 958.97 961.38 966.21 5.3 968.63 971.06 973.81 975.31 978.37 980.82 983.27 983.71 983.81 906.61 5.4 193.11 195.58 998.06 1000.54 1003.31 1005.52 1008.01 1010.51 1010.32 1015.53 5.5 1018.04 1020.56 1023.08 1025.71 1055.30 1058.63 1067.7 1090.31 1092.96 5.8 1095.62 1098.28 1100.94 1132.81 1136.01 1138.74 1141.22 1145.92 1183.24 1136.32 1166.32 1169.10 1171.89 1174.69 6.1 1177.74 1185.27 1188.74 1194.39 1197.22 1200.06 1202.91 6.2 1226.76 1226.74 1227.	5.0	897.88	900.18	902.47	904.78	907.09	909.40	911.71	914.04	916.36	918.69
5.2 944.61 946.39 949.38 951.77 954.16 958.97 961.38 963.79 966.21 5.3 993.11 995.58 998.06 1000.54 1000.30 1005.52 1008.10 1010.51 1013.02 1015.53 5.5 1018.04 1020.56 1023.08 1025.61 1023.14 1030.66 1033.22 1035.77 1038.32 1040.87 5.6 1063.29 0170.10 1077.52 1077.41 1079.76 1082.39 1087.07 1000.31 1092.96 5.8 1095.62 1098.28 1100.94 1103.61 1106.28 1108.96 111.64 1114.33 1117.92 1119.72 5.9 1122.42 1127.44 1135.29 1188.74 1191.56 1163.21 1161.00 1171.84 1144.96 6 111.67 1163.24 1127.96 1227.96 1227.96 1227.96 1227.96 1202.91 123.163 6 123.143 123.43 123.43 123.43 123.43 123.43<	5.1	921.02	923.36	925.71	928.05	930.40	932.76	935.12	937.49	939.86	942.23
5.3 968.63 971.46 973.49 978.37 980.82 983.72 985.72 988.18 990.64 5.4 993.11 995.58 998.06 1000.54 1003.03 1005.52 1008.01 1015.15 1013.02 1015.55 5.5 1018.44 1026.56 1023.08 1028.14 1008.61 1033.22 1036.80 1035.77 1038.32 1040.87 5.6 1043.43 1046.00 1048.57 1051.14 1052.77 1056.30 1058.89 1061.48 1066.68 5.7 1069.29 1071.90 1074.52 1077.14 1076.76 1082.39 1085.63 1085.77 1093.11 1197.22 1147.02 1147.91 6.0 1149.71 1152.47 1155.23 1157.99 1160.76 1163.54 1169.10 1171.89 1172.69 6.1 1205.76 1208.61 1217.00 1222.06 1224.96 1227.90 1220.81 6.2 1205.61 1206.61 1302.42 1305.64 </td <td>5.2</td> <td>944.61</td> <td>946.99</td> <td>949.38</td> <td>951.77</td> <td>954.16</td> <td>956.56</td> <td>958.97</td> <td>961.38</td> <td>963.79</td> <td>966.21</td>	5.2	944.61	946.99	949.38	951.77	954.16	956.56	958.97	961.38	963.79	966.21
5.4 993.11 995.58 998.06 1000.54 1003.03 1005.52 1008.01 1010.51 1013.02 1013.03 5.5 1018.04 1023.06 1023.08 1023.01 1023.02 1037.7 1038.32 1040.87 5.6 1064.33 1046.00 1048.57 1051.41 1057.2 1055.00 1058.89 1061.48 1060.08 1066.68 5.7 1069.29 1071.90 1074.52 1077.14 1079.76 1082.39 1085.03 1087.67 1090.31 1092.96 5.8 1095.62 1098.28 1100.94 1103.61 1108.78 1114.44 1141.22 1144.22 1147.69 6.0 1149.71 1152.47 1155.23 1157.99 1160.76 1194.39 1197.22 1200.06 1222.96 1228.49 1227.90 1200.85 6.1 1233.43 1234.74 1243.91 1222.03 1254.96 1227.90 1200.85 6.5 1233.59 1236.09 1302.62 13	5.3	968.63	971.06	973.49	975.93	978.37	980.82	983.27	985.72	988.18	990.64
5.5 1018.04 1023.05 1023.04 1023.04 1030.68 1033.22 1035.77 1038.32 1040.87 5.6 1063.29 1071.40 1079.76 1028.39 1085.00 1087.67 1009.31 1092.96 5.8 1095.62 1098.28 1100.94 1103.61 1106.28 1108.96 1111.64 1114.33 1117.02 1117.72 5.9 1122.42 1125.13 1127.84 1130.56 1133.82 1136.01 1138.74 1141.47 1144.42 1147.69 6.0 1149.71 1155.23 1157.99 1160.76 1163.54 1166.32 1169.10 1171.89 1174.69 6.1 1124.43 1211.47 124.34 1227.00 1220.96 1225.84 1228.73 1230.83 6.2 1205.76 1208.67 1200.61 1211.47 124.24 1247.63 1281.41 1244.50 128.40 1287.59 1290.58 6.3 1234.53 1236.59 1330.01 1333.08	5.4	993.11	995.58	998.06	1000.54	1003.03	1005.52	1008.01	1010.51	1013.02	1015.53
5.6 1043.43 1046.00 1048.57 1051.14 1053.72 1056.30 1058.89 1061.48 1066.08 5.7 1069.29 1071.90 1074.52 1077.14 1077.76 1082.39 1085.03 1087.67 1090.31 1092.96 5.8 11025.21 1125.13 1127.84 1130.56 1133.28 1136.01 1138.74 1141.47 1144.22 1146.96 6.0 1149.71 1152.47 1155.23 1157.99 1160.76 1163.54 1166.32 1197.22 1202.91 6.1 1177.49 1180.29 1188.74 1122.08 1222.96 1228.44 1228.73 1228.73 1228.73 1228.73 1228.73 1228.61 1211.78 1320.83 6.4 1263.80 1266.76 1269.72 1272.68 1278.63 1281.61 1214.74 1317.78 1320.83 6.5 1323.89 1326.05 1330.01 1333.08 1336.15 1336.23 1344.32 1444.74 1444.74	5.5	1018.04	1020.56	1023.08	1025.61	1028.14	1030.68	1033.22	1035.77	1038.32	1040.87
5.7 1069.29 1071.90 1074.52 1077.14 1079.76 1082.39 1085.03 1087.67 1090.31 1092.96 5.8 1095.62 1098.28 1100.94 1103.61 1106.28 1111.64 1114.33 1117.22 1119.72 5.9 1122.42 1155.13 1127.84 1130.55 1133.28 1136.01 1138.74 1144.27 1144.22 1146.96 6.1 1177.49 1180.29 1183.10 1185.92 1188.74 1191.56 1194.39 1197.22 1200.06 1202.91 6.2 1205.76 1208.61 1211.47 1214.34 1217.20 1220.03 1225.94 1227.90 1260.85 6.3 1234.53 1266.76 1269.72 127.68 1276.63 1311.70 1314.74 1317.78 1320.83 6.4 1233.80 1360.64 1337.02 1370.32 1373.41 1445.41 1345.05 1381.40 6.7 1354.71 1357.82 1360.94 1364.06 <t< td=""><td>5.6</td><td>1043.43</td><td>1046.00</td><td>1048.57</td><td>1051.14</td><td>1053.72</td><td>1056.30</td><td>1058.89</td><td>1061.48</td><td>1064.08</td><td>1066.68</td></t<>	5.6	1043.43	1046.00	1048.57	1051.14	1053.72	1056.30	1058.89	1061.48	1064.08	1066.68
5.8 1095.62 1098.28 1100.94 1103.61 1106.28 1108.96 1111.64 1114.33 1117.02 1119.72 5.9 1122.42 1125.13 1127.84 1130.56 1133.28 1136.01 1138.74 1141.47 1144.22 1146.96 6.0 1149.71 1152.47 1155.23 1157.99 1160.76 1163.54 1164.39 1197.22 1200.06 1202.91 6.2 1205.76 1208.61 1211.47 1244.34 1217.20 1220.08 1222.96 1254.96 1287.99 1260.85 6.4 1263.80 1265.76 1269.72 1272.68 1275.63 1381.61 1384.60 1367.60 1377.81 1320.88 6.6 1323.89 1326.95 1330.01 1333.08 1336.15 1339.23 1342.32 1345.41 1348.50 1311.70 1347.41 1347.80 1341.73 1328.89 136.6 1338.23 1324.01 1352.57 130.93 1400.513 1408.51 1414.73 <td>5.7</td> <td>1069.29</td> <td>1071.90</td> <td>1074.52</td> <td>1077.14</td> <td>1079.76</td> <td>1082.39</td> <td>1085.03</td> <td>1087.67</td> <td>1090.31</td> <td>1092.96</td>	5.7	1069.29	1071.90	1074.52	1077.14	1079.76	1082.39	1085.03	1087.67	1090.31	1092.96
5.9 1122.42 1125.13 1127.84 1130.56 1133.28 1136.01 1138.74 1141.47 1144.22 1144.96 6.0 1149.71 1152.47 1155.23 1157.99 1160.76 1163.54 1165.23 1101.00 1171.89 1171.49 1120.08 1222.05 1252.03 1254.96 1257.90 1260.85 1265.59 1290.58 1300.11 1303.08 1365.15 1311.70 1311.70 1317.78 1302.83 1332.89 1342.32 1342.43 1347.53 1342.33 1317.70 1328.93 1365.64 1366.66 1367.91 1373.46 1376.60 1379.75 1382.90 6.8 1386.06 1389.23 1392.40 <	5.8	1095.62	1098.28	1100.94	1103.61	1106.28	1108.96	1111.64	1114.33	1117.02	1119.72
6.0 1149.71 1152.47 1155.23 1157.99 1160.76 1163.54 1166.32 1169.10 1171.49 1171.49 6.1 1177.49 1180.29 1183.10 1185.92 1188.74 1191.56 1194.39 1197.22 1200.06 1202.91 6.2 1205.76 1208.61 1211.47 1214.34 1272.06 1222.93 1225.44 1228.73 1231.63 6.4 1263.80 1266.76 1269.72 1272.68 1275.65 1281.61 1284.60 1287.59 1290.58 6.5 1293.59 1296.59 1290.60 1302.62 1305.64 1308.67 1311.70 1314.74 1317.78 1320.83 6.6 1323.89 1326.95 1330.01 1333.08 1335.15 1339.23 1342.32 1345.14 1348.50 1351.60 6.7 1354.71 1355.82 1360.04 1367.33 1405.33 1411.53 1441.71 7.0 1450.37 1451.17 1424.39 1427.62 <	5.9	1122.42	1125.13	1127.84	1130.56	1133.28	1136.01	1138.74	1141.47	1144.22	1146.96
6.1 1177.49 1180.29 1183.10 1185.92 1188.74 1191.56 1194.39 1197.22 1200.06 1202.91 6.2 1205.76 1208.61 1211.47 1214.34 1217.20 1220.08 1222.96 1225.84 1228.73 1231.63 6.3 1234.53 1237.43 1240.34 1243.26 1246.18 1249.10 1252.03 1254.96 1257.59 1200.58 6.4 1263.80 1266.76 1267.68 1275.65 1278.63 1281.61 1311.70 1314.74 1317.78 1320.83 6.6 1323.89 1326.95 1330.01 1333.08 1336.15 1339.23 1345.41 1348.50 1351.60 6.7 1354.71 1357.82 1360.06 1392.37 1343.09 1437.34 1440.51 1443.83 1441.71 7.0 1450.37 1453.65 1456.92 1460.21 1463.50 1466.79 1470.09 1473.40 1476.71 1480.02 7.1 1483.35 <	6.0	1149.71	1152.47	1155.23	1157.99	1160.76	1163.54	1166.32	1169.10	1171.89	1174.69
6.2 1205.76 1208.61 1211.47 1214.34 1217.20 1220.08 1222.96 1225.84 1228.73 1231.63 6.3 1234.53 1237.43 1240.34 1243.26 1246.18 1249.10 1252.03 1254.96 1257.90 1260.85 6.4 1265.76 1269.72 1272.68 1275.65 1278.63 1281.61 1284.60 1287.59 1290.58 6.5 1232.89 1320.65 1330.08 1331.61 1389.23 1342.32 1345.41 1348.50 1351.60 6.7 1354.71 1357.82 1360.94 1364.06 1367.19 1370.32 1373.46 1376.60 1379.75 1382.90 6.8 1380.06 1389.23 1392.40 1395.57 1398.75 1401.94 1405.13 1408.33 1411.51 1441.74 6.9 1471.95 1421.17 1424.39 1476.2 1430.85 1434.09 1437.34 1440.59 1531.40 7.0 1450.37 1421.71 <t< td=""><td>6.1</td><td>1177.49</td><td>1180.29</td><td>1183.10</td><td>1185.92</td><td>1188.74</td><td>1191.56</td><td>1194.39</td><td>1197.22</td><td>1200.06</td><td>1202.91</td></t<>	6.1	1177.49	1180.29	1183.10	1185.92	1188.74	1191.56	1194.39	1197.22	1200.06	1202.91
6.3 1234.53 1237.43 1240.34 1243.26 1246.18 1249.10 1252.03 1254.96 1257.90 1260.85 6.4 1263.80 1266.76 1269.72 1272.68 1275.65 1286.63 1281.61 1284.60 1287.59 1290.60 1302.62 1305.64 1308.67 1311.70 1314.74 1317.78 1320.83 6.6 1323.89 1326.95 1300.01 1333.08 1336.15 1337.32 1345.41 1348.50 1351.71 1348.50 1357.50 1382.90 6.8 1386.06 1389.23 1392.40 1395.57 1398.75 1401.94 1405.13 1408.33 1411.53 1414.74 6.9 1417.95 1421.17 1424.39 1427.62 1430.85 1440.09 1437.34 1440.59 1443.85 1447.11 7.0 1453.37 1455.69 1520.25 1523.64 1527.03 1530.43 1533.84 1537.25 1540.69 1504.71 1478.62 1582.10 7.4	6.2	1205.76	1208.61	1211.47	1214.34	1217.20	1220.08	1222.96	1225.84	1228.73	1231.63
6.4 1263.80 1266.76 1269.72 1272.68 1275.65 1286.61 1284.60 1287.59 1290.58 6.5 1293.59 1296.59 1299.60 1302.62 1305.64 1308.67 1311.70 1314.74 1317.78 1320.83 6.6 1323.89 1326.95 1330.01 1333.08 1336.15 1339.23 1342.32 1345.41 1348.50 1351.60 6.7 1354.71 1357.82 1360.94 1395.57 1398.75 1401.94 1405.33 1414.74 6.9 1417.95 1421.17 1424.39 1427.62 1430.85 1444.09 1437.34 1440.59 1447.11 7.0 1450.37 1453.65 1450.22 1520.4 1527.03 150.04 1503.39 1506.75 1510.12 151.349 7.2 1516.87 1520.25 1523.64 1527.03 1530.43 1533.84 1537.25 1540.67 1544.09 1547.52 7.3 1550.59 1554.39 1592.59 <td< td=""><td>6.3</td><td>1234.53</td><td>1237.43</td><td>1240.34</td><td>1243.26</td><td>1246.18</td><td>1249.10</td><td>1252.03</td><td>1254.96</td><td>1257.90</td><td>1260.85</td></td<>	6.3	1234.53	1237.43	1240.34	1243.26	1246.18	1249.10	1252.03	1254.96	1257.90	1260.85
6.5 1293.59 1296.59 1299.60 1302.62 1305.64 1308.67 1311.70 1314.74 1317.78 1320.83 6.6 1323.89 1326.95 1330.01 1333.08 1336.15 1339.23 1342.32 1345.41 1348.50 1351.60 6.7 1354.71 1357.82 1360.94 1364.06 1367.19 1370.32 1373.46 1376.60 1379.75 1382.90 6.8 1386.06 1389.23 1392.40 1395.57 1398.75 1401.94 1405.13 1440.59 1447.41 6.9 1417.95 1421.17 1424.39 1427.62 1430.85 1434.09 147.34 1440.59 1447.61 7.0 1450.37 1453.65 1456.92 140.21 1463.50 1460.79 1470.09 1473.40 1447.51 148.02 7.1 1483.35 1486.67 1490.01 1493.34 1496.69 1500.04 1503.39 1506.75 1510.12 1513.49 7.2 1516.87	6.4	1263.80	1266.76	1269.72	1272.68	1275.65	1278.63	1281.61	1284.60	1287.59	1290.58
6.6 1323.89 1326.95 1330.01 1333.08 1336.15 1339.23 1342.32 1345.41 1348.50 1351.60 6.7 1354.71 1357.82 1360.94 1364.06 1367.19 1370.32 1373.46 1376.60 1379.75 1382.90 6.8 1386.06 1389.23 1392.40 1395.57 1398.75 1401.94 1405.13 1408.33 1411.53 1414.74 6.9 1417.95 1421.17 1424.39 1427.62 1430.85 1434.09 1437.34 1440.59 1448.02 7.0 1450.37 1453.65 1456.92 1460.50 1500.04 1503.39 1506.75 1510.12 1513.49 7.2 1516.87 1520.25 1523.64 1527.03 1530.43 1568.20 1571.67 154.09 1547.52 7.3 1550.95 1554.39 1557.83 1561.28 1564.74 1568.20 1571.67 1575.14 1578.62 1582.10 7.4 1585.9 1580.90 <td< td=""><td>6.5</td><td>1293.59</td><td>1296.59</td><td>1299.60</td><td>1302.62</td><td>1305.64</td><td>1308.67</td><td>1311.70</td><td>1314.74</td><td>1317.78</td><td>1320.83</td></td<>	6.5	1293.59	1296.59	1299.60	1302.62	1305.64	1308.67	1311.70	1314.74	1317.78	1320.83
6.7 1354.71 1357.82 1360.94 1364.06 1367.19 1370.32 1373.46 1376.60 1379.75 1382.90 6.8 1386.06 1389.23 1392.40 1395.57 1398.75 1401.94 1405.13 1408.33 1411.53 1414.74 6.9 1417.95 1421.17 1424.39 1427.62 1430.85 1434.09 1437.34 1440.59 1443.85 1447.11 7.0 1450.37 1453.65 1456.92 1460.21 1463.50 1466.79 1470.09 1473.40 1476.71 1480.02 7.1 1483.35 1486.67 1490.01 1493.34 1496.69 1500.04 1503.39 1506.75 1510.12 1513.49 7.2 1516.87 1520.25 1523.64 1527.03 1530.43 1537.25 1540.67 1544.09 1547.52 7.3 1550.95 1554.39 1595.10 1599.61 1691.31 1606.65 1610.18 1613.72 1617.26 7.5 1620.81 <	6.6	1323.89	1326.95	1330.01	1333.08	1336.15	1339.23	1342.32	1345.41	1348.50	1351.60
6.8 1386.06 1389.23 1392.40 1395.57 1398.75 1401.94 1405.13 1408.33 1411.53 1414.74 6.9 1417.95 1421.17 1424.39 1427.62 1430.85 1434.09 1437.34 1440.59 1443.85 1447.11 7.0 1450.37 1453.65 1456.92 1460.21 1463.50 1466.79 1470.09 1473.40 1476.71 1480.02 7.1 1483.35 1486.67 1490.01 1493.34 1496.69 1500.04 1503.39 1506.75 1510.12 1513.49 7.2 1516.87 1520.25 1523.64 1527.03 1530.43 1538.24 1567.74 1568.20 1540.67 1540.07 1541.40 1571.67 1575.4 1578.62 1582.10 7.4 1555.9 1589.09 1592.59 1596.10 1599.61 1603.13 1606.65 1610.18 1613.72 1677.63 1620.81 1662.21 1663.82 1667.45 1671.07 1674.71 1678.35 <td>6.7</td> <td>1354.71</td> <td>1357.82</td> <td>1360.94</td> <td>1364.06</td> <td>1367.19</td> <td>1370.32</td> <td>1373.46</td> <td>1376.60</td> <td>1379.75</td> <td>1382.90</td>	6.7	1354.71	1357.82	1360.94	1364.06	1367.19	1370.32	1373.46	1376.60	1379.75	1382.90
6.91417.951421.171424.391427.621430.851434.091437.341440.591443.851447.117.01450.371453.651456.921460.211463.501466.791470.091473.401476.711480.027.11483.351486.671490.011493.341496.691500.041503.391506.751510.121513.497.21516.871520.251523.641527.031530.431533.841537.251540.671544.091547.527.31550.951554.391557.831561.281564.741568.201571.671575.141578.621582.107.41585.591589.091592.591596.101599.611603.131606.651610.181613.721617.267.51620.811624.361627.921631.481635.051638.631642.211645.801649.391652.997.61656.601660.211663.821667.451671.071674.711678.351681.991685.651689.307.71692.971696.641700.311703.991707.681711.371715.071718.781722.491726.207.81729.931733.661737.391741.131748.631752.391756.151759.921763.707.91767.481771.271775.061778.861782.491828.821832.701836.591840.498.01805.631809.481813.341817.20 <td>6.8</td> <td>1386.06</td> <td>1389.23</td> <td>1392.40</td> <td>1395.57</td> <td>1398.75</td> <td>1401.94</td> <td>1405.13</td> <td>1408.33</td> <td>1411.53</td> <td>1414.74</td>	6.8	1386.06	1389.23	1392.40	1395.57	1398.75	1401.94	1405.13	1408.33	1411.53	1414.74
7.01450.371453.651456.921460.211463.501466.791470.091473.401476.711480.027.11483.351486.671490.011493.341496.691500.041503.391506.751510.121513.497.21516.871520.251523.641527.031530.431533.841537.251540.671544.091547.527.31550.951554.391557.831561.281564.741568.201571.671575.141578.621582.107.41585.591589.091592.591596.101599.611603.131606.651610.181613.721617.267.51620.811624.361627.921631.481635.051638.631642.211645.801649.391652.997.61656.601660.211663.821667.451671.071674.711678.351681.991685.651689.307.71692.971696.641700.311703.991707.681711.371715.071718.781722.491726.207.81729.931733.661737.391741.131744.881748.631752.391756.151759.921763.707.91767.481771.71775.061778.861782.671786.481790.301794.121797.951801.798.01805.631889.741891.711895.70189.691903.681907.681911.691915.711919.738.11844.391848.30<	6.9	1417.95	1421.17	1424.39	1427.62	1430.85	1434.09	1437.34	1440.59	1443.85	1447.11
7.11483.351486.671490.011493.341496.691500.041503.391506.751510.121513.497.21516.871520.251523.641527.031530.431533.841537.251540.671544.091547.527.31550.951554.391557.831561.281564.741568.201571.671575.141578.621582.107.41585.591589.091592.591596.101599.611603.131606.651610.181613.721617.267.51620.811624.361627.921631.481635.051638.631642.211645.801649.391652.997.61656.601660.211663.821667.451671.071674.711678.351681.991685.651689.307.71692.971696.641700.311703.991707.681711.371715.071718.781722.491726.207.81729.931733.661737.391741.131744.881748.631752.391756.151759.921763.707.91767.481771.271775.061778.861782.671786.481790.301794.121797.951801.798.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.89197.51191.738.31923.761927.79<	7.0	1450.37	1453.65	1456.92	1460.21	1463.50	1466.79	1470.09	1473.40	1476.71	1480.02
7.21516.871520.251523.641527.031530.431533.841537.251540.671544.091547.527.31550.951554.391557.831561.281564.741568.201571.671575.141578.621582.107.41585.591589.091592.591596.101599.611603.131606.651610.181613.721617.267.51620.811624.361627.921631.481635.051638.631642.211645.801649.391652.997.61656.601660.211663.821667.451671.071674.711678.351681.991685.651689.307.71692.971696.641700.311703.991707.681711.371715.071718.781722.491726.207.81729.931733.661737.391741.131744.881748.631752.391756.151759.921763.707.91767.481771.271775.061778.861782.671786.481790.301794.121797.951801.798.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761887.741891.711895.701899.691903.681907.681911.691915.711919.738.31923.761927.79 <td>7.1</td> <td>1483.35</td> <td>1486.67</td> <td>1490.01</td> <td>1493.34</td> <td>1496.69</td> <td>1500.04</td> <td>1503.39</td> <td>1506.75</td> <td>1510.12</td> <td>1513.49</td>	7.1	1483.35	1486.67	1490.01	1493.34	1496.69	1500.04	1503.39	1506.75	1510.12	1513.49
7.31550.951554.391557.831561.281564.741568.201571.671575.141578.621582.107.41585.591589.091592.591596.101599.611603.131606.651610.181613.721617.267.51620.811624.361627.921631.481635.051638.631642.211645.801649.391652.997.61656.601660.211663.821667.451671.071674.711678.351681.991685.651689.307.71692.971696.641700.311703.991707.681711.371715.071718.781722.491726.207.81729.931733.661737.391741.131744.881748.631752.391756.151759.921763.707.91767.481771.271775.061778.861782.671786.481790.301794.121797.951801.798.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761937.741891.711895.70189.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.87193.931943.981948.051952.121956.201960.288.41964.371968.47<	7.2	1516.87	1520.25	1523.64	1527.03	1530.43	1533.84	1537.25	1540.67	1544.09	1547.52
7.41585.591589.091592.591596.101599.611603.131606.651610.181613.721617.267.51620.811624.361627.921631.481635.051638.631642.211645.801649.391652.997.61656.601660.211663.821667.451671.071674.711678.351681.991685.651689.307.71692.971696.641700.311703.991707.681711.371715.071718.781722.491726.207.81729.931733.661737.391741.131744.881748.631752.391756.151759.921763.707.91767.481771.271775.061778.861782.671786.481790.301794.121797.951801.798.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761887.741891.711895.70189.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.471972.571976.681980.791984.921989.041993.181997.322001.478.52005.622009.78	7.3	1550.95	1554.39	1557.83	1561.28	1564.74	1568.20	1571.67	1575.14	1578.62	1582.10
7.51620.811624.361627.921631.481635.051638.631642.211645.801649.391652.997.61656.601660.211663.821667.451671.071674.711678.351681.991685.651689.307.71692.971696.641700.311703.991707.681711.371715.071718.781722.491726.207.81729.931733.661737.391741.131744.881748.631752.391756.151759.921763.707.91767.481771.271775.061778.861782.671786.481790.301794.121797.951801.798.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761887.741891.711895.701899.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.471972.571976.681980.791984.92198.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.73	7.4	1585.59	1589.09	1592.59	1596.10	1599.61	1603.13	1606.65	1610.18	1613.72	1617.26
7.61656.601660.211663.821667.451671.071674.711678.351681.991685.651689.307.71692.971696.641700.311703.991707.681711.371715.071718.781722.491726.207.81729.931733.661737.391741.131744.881748.631752.391756.151759.921763.707.91767.481771.271775.061778.861782.671786.481790.301794.121797.951801.798.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761887.741891.711895.701899.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.471972.571976.681980.791984.921989.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.32 <td>7.5</td> <td>1620.81</td> <td>1624.36</td> <td>1627.92</td> <td>1631.48</td> <td>1635.05</td> <td>1638.63</td> <td>1642.21</td> <td>1645.80</td> <td>1649.39</td> <td>1652.99</td>	7.5	1620.81	1624.36	1627.92	1631.48	1635.05	1638.63	1642.21	1645.80	1649.39	1652.99
7.71692.971696.641700.311703.991707.681711.371715.071718.781722.491726.207.81729.931733.661737.391741.131744.881748.631752.391756.151759.921763.707.91767.481771.271775.061778.861782.671786.481790.301794.121797.951801.798.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761887.741891.711895.701899.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.47197.571976.681980.791984.92198.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.57<	7.6	1656.60	1660.21	1663.82	1667.45	1671.07	1674.71	1678.35	1681.99	1685.65	1689.30
7.81729.931733.661737.391741.131744.881748.631752.391756.151759.921763.707.91767.481771.271775.061778.861782.671786.481790.301794.121797.951801.798.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761887.741891.711895.701899.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.471972.571976.681980.791984.921989.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.47 <td>7.7</td> <td>1692.97</td> <td>1696.64</td> <td>1700.31</td> <td>1703.99</td> <td>1707.68</td> <td>1711.37</td> <td>1715.07</td> <td>1718.78</td> <td>1722.49</td> <td>1726.20</td>	7.7	1692.97	1696.64	1700.31	1703.99	1707.68	1711.37	1715.07	1718.78	1722.49	1726.20
7.91767.481771.271775.061778.861782.671786.481790.301794.121797.951801.798.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761887.741891.711895.701899.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.471972.571976.681980.791984.921989.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.472185.902190.332194.77219.222203.672208.132212.602217.079.02221.552226.04	7.8	1729.93	1733.66	1737.39	1741.13	1744.88	1748.63	1752.39	1756.15	1759.92	1763.70
8.01805.631809.481813.341817.201821.061824.941828.821832.701836.591840.498.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761887.741891.711895.701899.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.471972.571976.681980.791984.921989.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.472185.902190.332194.772199.222203.672208.132212.602217.079.02221.552226.042230.532235.032239.542244.052248.572253.102257.632262.179.12266.722271.27 <td>7.9</td> <td>1767.48</td> <td>1771.27</td> <td>1775.06</td> <td>1778.86</td> <td>1782.67</td> <td>1786.48</td> <td>1790.30</td> <td>1794.12</td> <td>1797.95</td> <td>1801.79</td>	7.9	1767.48	1771.27	1775.06	1778.86	1782.67	1786.48	1790.30	1794.12	1797.95	1801.79
8.11844.391848.301852.221856.141860.071864.001867.941871.891875.841879.808.21883.761887.741891.711895.701899.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.471972.571976.681980.791984.921989.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.472185.902190.332194.772199.222203.672208.132212.602217.079.02221.552226.042230.532235.032239.542244.052248.572253.102257.632262.179.12266.722271.272275.832280.402284.982289.562294.152298.742303.342307.95	8.0	1805.63	1809.48	1813.34	1817.20	1821.06	1824.94	1828.82	1832.70	1836.59	1840.49
8.21883.761887.741891.711895.701899.691903.681907.681911.691915.711919.738.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.471972.571976.681980.791984.921989.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.472185.902190.332194.772199.222203.672208.132212.602217.079.02221.552226.042230.532235.032239.542244.052248.572253.102257.632262.179.12266.722271.272275.832280.402284.982289.562294.152298.742303.342307.95	8.1	1844.39	1848.30	1852.22	1856.14	1860.07	1864.00	1867.94	1871.89	1875.84	1879.80
8.31923.761927.791931.831935.871939.931943.981948.051952.121956.201960.288.41964.371968.471972.571976.681980.791984.921989.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.54215.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.472185.902190.332194.772199.222203.672208.13221.602217.079.02221.552226.042230.532235.032239.542244.052248.572253.102257.632262.179.12266.722271.272275.832280.402284.982289.562294.152298.742303.342307.95	8.2	1883.76	1887.74	1891.71	1895.70	1899.69	1903.68	1907.68	1911.69	1915.71	1919.73
8.41964.371968.471972.571976.681980.791984.921989.041993.181997.322001.478.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.472185.902190.332194.772199.222203.672208.132212.602217.079.02221.552226.042230.532235.032239.542244.052248.572253.102257.632262.179.12266.722271.272275.832280.402284.982289.562294.152298.742303.342307.95	8.3	1923.76	1927.79	1931.83	1935.87	1939.93	1943.98	1948.05	1952.12	1956.20	1960.28
8.52005.622009.782013.942018.122022.302026.482030.672034.872039.082043.298.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.472185.902190.332194.772199.222203.672208.132212.602217.079.02221.552226.042230.532235.032239.542244.052248.572253.102257.632262.179.12266.722271.272275.832280.402284.982289.562294.152298.742303.342307.95	8.4	1964.37	1968.47	1972.57	1976.68	1980.79	1984.92	1989.04	1993.18	1997.32	2001.47
8.62047.502051.732055.962060.192064.442068.692072.942077.212081.482085.758.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.472185.902190.332194.772199.222203.672208.132212.602217.079.02221.552226.042230.532235.032239.542244.052248.572253.102257.632262.179.12266.722271.272275.832280.402284.982289.562294.152298.742303.342307.95	8.5	2005.62	2009.78	2013.94	2018.12	2022.30	2026.48	2030.67	2034.87	2039.08	2043.29
8.72090.032094.322098.622102.922107.232111.542115.862120.192124.522128.878.82133.212137.572141.932146.292150.672155.052159.442163.832168.232172.648.92177.052181.472185.902190.332194.772199.222203.672208.132212.602217.079.02221.552226.042230.532235.032239.542244.052248.572253.102257.632262.179.12266.722271.272275.832280.402284.982289.562294.152298.742303.342307.95	8.6	2047.50	2051.73	2055.96	2060.19	2064.44	2068.69	2072.94	2077.21	2081.48	2085.75
8.8 2133.21 2137.57 2141.93 2146.29 2150.67 2155.05 2159.44 2163.83 2168.23 2172.64 8.9 2177.05 2181.47 2185.90 2190.33 2194.77 2199.22 2203.67 2208.13 2212.60 2217.07 9.0 2221.55 2226.04 2230.53 2235.03 2239.54 2244.05 2248.57 2253.10 2257.63 2262.17 9.1 2266.72 2271.27 2275.83 2280.40 2284.98 2289.56 2294.15 2298.74 2303.34 2307.95	8.7	2090.03	2094.32	2098.62	2102.92	2107.23	2111.54	2115.86	2120.19	2124.52	2128.87
8.92177.052181.472185.902190.332194.772199.222203.672208.132212.602217.079.02221.552226.042230.532235.032239.542244.052248.572253.102257.632262.179.12266.722271.272275.832280.402284.982289.562294.152298.74230.342307.95	8.8	2133.21	2137.57	2141.93	2146.29	2150.67	2155.05	2159.44	2163.83	2168.23	2172.64
9.0 2221.55 2226.04 2230.53 2235.03 2239.54 2244.05 2248.57 2253.10 2257.63 2262.17 9.1 2266.72 2271.27 2275.83 2280.40 2284.98 2289.56 2294.15 2298.74 2303.34 2307.95	8.9	2177.05	2181.47	2185.90	2190.33	2194.77	2199.22	2203.67	2208.13	2212.60	2217.07
9.1 2266.72 2271.27 2275.83 2280.40 2284.98 2289.56 2294.15 2298.74 2303.34 2307.95	9.0	2221.55	2226.04	2230.53	2235.03	2239.54	2244.05	2248.57	2253.10	2257.63	2262.17
	9.1	2266.72	2271.27	2275.83	2280.40	2284.98	2289.56	2294.15	2298.74	2303.34	2307.95

9.2	2312.57	2317.19	2321.82	2326.45	2331.09	2335.74	2340.40	2345.06	2349.73	2354.41
9.3	2359.09	2363.79	2368.48	2373.19	2377.90	2382.62	2387.34	2392.07	2396.81	2401.56
9.4	2406.31	2411.07	2415.84	2420.61	2425.39	2430.18	2434.98	2439.78	2444.59	2449.40
9.5	2454.23	2459.06	2463.89	2468.74	2473.59	2478.45	2483.31	2488.19	2493.06	2497.95
9.6	2502.84	2507.75	2512.65	2517.57	2522.49	2527.42	2532.36	2537.30	2542.25	2547.21
9.7	2552.17	2557.14	2562.12	2567.11	2572.10	2577.10	2582.11	2587.13	2592.15	2597.18
9.8	2602.21	2607.26	2612.31	2617.37	2622.43	2627.51	2632.59	2637.67	2642.77	2647.87
9.9	2652.98	2658.10	2663.22	2668.35	2673.49	2678.64	2683.79	2688.95	2694.12	2699.29
10.0	2704.47	2709.66	2714.86	2720.07	2725.28	2730.50	2735.72	2740.96	2746.20	2751.45
10.1	2756.71	2761.97	2767.24	2772.52	2777.81	2783.10	2788.40	2793.71	2799.03	2804.35

Table 5.5.2 Data Table for H, A and Q

			rayat				
		(based o	on cross-section	n undertaken o	n October 22, 2	2013)	
Elevation of "O	" of S.G.=	0.082	m.(AMSL)				
n=	0.030	=	0.00015				
Elevation	Equivalent	Area	Width	W.P.	hyd radius	Discharge	Remarks
MSL (m)	G.H.(m)	a (m²)	w (m)	s	r	Q (cumecs)	
							bank full/level with
15.40	15.320	3363.89	292.34	302.21	11.13	6846.29	bridge road
15.00	14.918	3247.38	291.50	300.97	10.79	6473.36	
14.00	13.918	2956.91	288.60	297.38	9.94	5581.85	
13.00	12.918	2670.61	286.30	294.09	9.08	4745.56	
12.00	11.918	2385.26	283.15	290.25	8.22	3965.54	
11.00	10.918	2104.14	281.00	287.13	7.33	3240.86	
10.00	9.918	1824.65	278.00	283.48	6.44	2577.59	
9.00	8.918	1548.21	275.30	279.97	5.53	1976.52	
8.00	7.918	1291.18	236.10	240.54	5.37	1616.03	
7.00	6.918	1053.37	162.40	166.46	6.33	1471.25	
6.00	5.918	902.84	137.90	141.81	6.37	1266.12	
5.00	4.918	769.53	128.20	131.89	5.83	1018.18	
4.00	3.918	643.90	122.10	125.45	5.13	782.18	
3.00	2.918	525.10	116.30	119.21	4.40	576.02	
2.00	1.918	412.62	108.00	110.58	3.73	405.26	
1.00	0.918	310.25	98.00	100.34	3.09	268.82	
0.50	0.418	262.09	93.50	95.73	2.74	209.40	
-1.00	-1.082	163.04	56.40	57.80	2.82	132.88	
-2.00	-2.082	110.61	40.90	42.35	2.61	85.63	
-3.00	-3.082	72.23	36.90	37.84	1.91	45.37	
-4.00	-4.082	39.10	30.70	31.30	1.25	18.51	
							1.168m from thalweg
							(thalweg @ 6.168 below
-5.00	-5.082	11.85	25.00	25.27	0.47	2.92	MSL)
	-0.082					0.00	
	-0.082					0.00	
	-0.082					0.00	
	-0.082					0.00	
	-0.082					0.00	







Graph 5.5.2 – Rating Curve (H vs. A)

Rating Curve	ting Curve Development for			Pampanga River							
	Measuring St	ation:			Arayat						
	Drainage Are	a:									
	River:				Pampanga						
	Location:				Arayat Statio	n					
	Elev. S.G."0"	rdg.=	0.082	meters							
Meas.#	Day	Month	Year	S.G.(m)	Q(m ³ /sec)	Remarks					
	22	10	2013	15.320	6846.291						
				14.918	6473.362						
				13.918	5581.845						
				12.918	4745.562						
				11.918	3965.539						
				10.918	3240.859						
				9.918	2577.586						
				8.918	1976.518						
				7.918	1616.029						
				6.918	1471.252						
				5.918	1266.117						
				4.918	1018.181						
				3.918	782.183						
				2.918	576.024						
				1.918	405.261						
				0.918	268.817						
				0.418	209.401						
				-1.082	132.877						
				-2.082	85.635						
				-3.082	45.374						
			Q =	0.026	[H-(-10.10)]	3.851			
					7						
		Th	e Rating	Curve							
Range of An	nlication:		Equation	n !!! 🔰							
Remarks:											
incinarity.											

Table 5.5.3 – Rating Curve Equation

6. SUMMARY AND CONCLUSIONS

The four methods were used during the entire field work, both direct and indirect applications. The first method applied was the Acoustic Doppler Current Profiler (ADCP) on the first day, current meter method on the second day, float method on the third day and slope-area method on the fourth day.

The four methods gave different value of discharge measurement for they have their own advantages and disadvantages or limitations. During floods, it is advisable to use the float method since it is the most practical and effective application at peak discharge measurement and the rest can be used during medium flows. The slope-area method gives good information of maximum level of water reach during the flood events by identifying flood marks which is visible in the area and using advance instrument for surveying. The current meter is commonly and widely use instrument in measuring discharge by observing and computing its velocity and area. And lastly the ADCP which is the revolutionary and sophisticated instrument over all other measuring instrument in identifying discharge measurement due to its one time application and improves the accuracy of discharge measurement. The ADCP gives full detailed information of the river profile such as depth, velocity, discharge and reduces the time for discharge measurement application compared to other mechanical instrument.

7. FIELD VISITS

7.1 La Mesa Watershed and Eco-Park



The La Mesa Watershed and Eco-Park consists of the La Mesa Dam and an ecological nature reserve site in Quezon City commissioned in 1929 in the Philippines. It is part of the Angat-Ipo-La Mesa water system, which supplies most of the water supply of Metro Manila. The La Mesa Dam is an earth dam whose reservoir can hold up to 50.5 million cubic meters and occupying an area of 27 square kilometers.

The water collected in the reservoir is treated on-site by the Maynilad Water Services, and at the Balara Treatment Plant further south by the Manila Water. Both water companies are private concessionaires awarded by the Metropolitan Waterworks and Sewage System, the government agency in charge of water supply. It is a vital link to the water requirements of 12 million residents of Metro Manila considering that 1.5 million liters of water pass through this reservoir everyday. It is also the last forest of its size in the metropolis.

7.2 Calumpit – Bulacan Flood Preparedness and monitoring system



It all started many years ago when the Province of Bulacan experienced flooding almost every year. Local Provincial Executives particularly the Provincial Disaster Risk Reduction Management Council (PDRRMC) initiated the idea that every Municipality that are under their jurisdictions must be knowledgeable on flood awareness from the Municipal Mayors down to the Barangay leaders.

Municipality of Calumbit replied to the urgency call and installed one (1) rain gauge as required by the local government. Due to the apprehension that floods can affect their livelihood and even lives of their constituents, the Mayor encouraged his MDRRMC staff to make a simple monitoring system which enables them to obtain the capacity as to how much rainfall at a certain time and able to analyze how this rainfall affects their Municipality and other Municipalities of Bulacan.

Through Microsoft-excel data were encoded. They have 10 and 90 days monitoring period which data's are taken from different government and private weather agencies both local and international website. The data recordings of all weather conditions/disturbances was their own way to determine where typical typhoons come into the region and how it can affect Calumpit thru correlation of other data bases. Also, they included some traffic monitoring data so that people from Manila or from other areas will be aware of Calumpit's weather condition.

The system was quite good enough as far as determining the weather condition is concerned. However, they need to orient and educate their people about their system and proper procedures on safety to minimize casualties in time of disaster.

7.3 The Pantabangan Dam

Pantabangan Dam is an earth-fill embankment dam on the Pampanga River located in Pantabangan in Nueva Ecija province of the Philippines. The multi-purpose dam provides water for irrigation and hydroelectric power generation while its reservoir, Pantabangan Lake, affords flood control. The Construction of the dam began in 1971 and it was complete in 1977.

Coordinates 15°48′52″N 121°06′29″E

Owner(s) National Power Corporation, National Irrigation Administration



Specification of Dam:

Type of dam:	Embankment, earth-fill

- Length: 1,615 m (5,299 ft)
- Crest width: 12 m (39 ft)
- Base width: 535 m (1,755 ft)
- Volume: 12,000,000 cu yd (9,174,658 m3)
- Crest elevation: 232 m (761 ft)
- Impounds: Pampanga River
- Spillways: 3 x radial gates, 1 x overflow
- Spillway capacity: 4,200 m3/s (148,322 cu ft/s)

The Reservoir

- Creates: Pantabangan Lake
- Capacity: 2,996,000,000 m3 (2,428,897 acre·ft)
- Active capacity: 2,083,000,000 m3 (1,688,716 acre·ft)
- Catchment Area: 853 km2 (329 sq mi)
- Surface area: 69.62 km2 (27 sq mi) (max)
- Normal elevation: 230 m (755 ft) (max)

Power station

Turbines:2 x 50 MW Francis-typeInstalled capacity:100 MWCapacity factor90%Annual generation232,000,000 kWh

The Design:

The dam is a 107 m (351 ft) tall and 1,615 m (5,299 ft) long embankment-type with 12,000,000 cu yd (9,174,658 m3) of homogeneous earth-fill and an impervious core. The crest of the dam is 12 m (39 ft) wide while the widest part of its base is 535 m (1,755 ft). The dam's crest sits at an elevation of 232 m (761 ft) and is composed of three sections: the main dam, a saddle dam, and an auxiliary dam located with the spillway. The spillway is a chute-type controlled by three radial gates but equipped with an overflow section as well. The design discharge of the spillway is 4,200 m3/s (148,322 cu ft/s). The dam's reservoir has a gross capacity of 2,996,000,000 m3 (2,428,897 acre·ft) and 2,083,000,000 m3 (1,688,716 acre·ft) of that volume is active (or useful) for irrigation and power. The dam sits at the head of a 853 km2 (329 sq mi) catchment area and its reservoir has a surface area of 69.62 km2 (27 sq mi) and elevation of 230 m (755 ft) when at its maximum level. The reservoir's life is estimated at 107 years due to silt from denudation. The dam was design to withstand an intensity 10 earthquake.

The power house is located at the base of the main dam and contains two 50 MW Francis turbine-generators for an installed capacity of 100 MW. Each turbine receives water via a 6 m (20 ft) diameter penstock. When the water is discharged, it is released into a 250 m (820 ft) long tailrace channel where it re-enters the river.

7.4 The Angat Dam



SPILLWAY

The spillway consists of three (3) gates, 12.5 meter by 15.0 meter in size. The chute-type spillway with motor driven radial tainter regulates the flow of water. The structure consists of an approach channel, crest ogee and piers, chute, flip-bucket deflector, spillway bridge and side training walls.

The water surface level is expected to rise and fall between elevation 219 and 180 meters masl., depending on the volume of inflow. The drainage area is about 568 sq. kms. With level is at elevation 212.00 masl. Its discharging capacity is 5800 cms.

ANGAT HYDRO-ELECTRIC POWER PLANT

Construction work in the Angat River Hydro-electric Power Plant started on November 16, 1961 when the National Power Corporation awarded the contract to GROGUN, Inc. for diversion tunnels, dam foundation excavation and grouting. Construction of the dam, dike, spillway, tunnels, powerhouse and power facilities was done by Paul Hardeman – Philippines Inc. and the Filipino Engineers Syndicate Inc. took over the job for its completion.

Construction actually started with the initial spade work on the access road leading to the project site at San Mateo, Norzagaray, Bulacan. Preliminary investigation and surveys had been undertaken which finally laid the groundwork for the implementation of engineering design and construction.

Initial power plant operation started when auxiliary unit's no. 1 and 2 both rated at 6MW capacity was officially commissioned on July 1967. On October on the same year main unit's no. 1 and 2 were commissioned for commercial operation, followed by main unit's no. 3 and 4 on August 1968.

In 1978, the construction of the 6MW auxiliary unit no. 3 was completed and put on commercial operation on October of the same year. Five years later, construction of auxiliary unit no. 4 was completed with a rated capacity of 10MW. It was commissioned on June 1986 for commercial operation. The last to be constructed was the 18MW auxiliary no. 5 which started in 1991 and completed in 1993 and synchronized to the grid on January 1993.

7.5 The Cong Da Dong Dam



The P3.4-billion Cong Dadong Dam here, designed to irrigate 10,270 hectares of farms in seven eastern towns, feeds only some 3,500 ha despite a slight surplus amid the long dry spell in Luzon.

The dam is also servicing a fraction of its service area because some canals had been damaged, a number of farms had been converted to commercial uses and the maps used to estimate the farmlands were old and did not reflect actual land use by the time the project resumed in 1996.

Its critical level is 7 meters but the water level has never fallen to that point. The dam operates year round, dispersing water through a network of canals supposed to be 31.8-km long.

8. Site visit insights:

As a hydrologist trainee, it is important to know some basic operation for dams such as releasing of water when it reaches its critical level. We all know that rivers are subjected to change its flow anytime during heavy rains and this could be resulted to in danger the communities downstream. Water that is stored in dam particularly controls the flow of this huge water for future uses such as for irrigation, electric power and for domestic use. This water should be monitored and controlled the inflow and outflow to manage its use for the said purposes. Also, by monitoring its water levels, we can give information as to give warning to the people or community by any danger that may arise during discharge of this water to low lands.