Preliminary Study of PDAM Tirtawening Water Treatment Plant, Bandung, Indonesia for Sustainable Production Capacity

MSc. Multidisciplinary Project Report

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November 2015 – February 2016

Acknowledgments

The authors would like to express their gratitude to persons and institutions that have contributed in succeeding this project and has provided valuable information in completing the report, including:

1. Sander De Vree & Frank Kalkman (TUDelft), for organizing the equipment to bring to Bandung, and providing us with the necessary software and learning environment
2. All staffs from PDAM Tirtawening, Bandung, especially Ibu Titi, Pak Tantan, Ibu Novera and more specifically by sections:
    a. Intake & Pipeline: Pak Edang, Pak Ma'mur, Pak Tatang, Pak Rohimat and the team
    b. Water quality: Pak Eko and Ibu Nia
    c. Pak Wendy for taking care of us
3. Jaap Boomsma, the Vitens Evides International project team leader, for his support, information and guidance, especially for presedimentation tanks and discussions for the treatment plant.
4. Prof. Suprihanto, from Environmental Engineering Department of ITB.
5. Prof. Iwan Kridasantausa, from Water Resources section, Civil Engineering Department of ITB.
6. Prof. Dhemi Harlan, from Water Resources section, Civil Engineering Department of ITB.
7. Pak Iwan Irawan, the head of PLTA Cikalong Hydropower Plant from Indonesian Power.
8. Hasfian Febrianto, civil engineering bachelor student from Bandung Institute of Technology, for his willingness to share plenty of data regarding rainfall intensity, climate, Cisangkuy River tributary area, previous design reports and water resources utilizations along Cilaki, Cisangkuy and Citarum River.
9. Ivo Pothof, for suggesting WANDA for the simulation of pipelines and helping us obtain the license
10. Mikkel Tukker and those in WANDA Deltares support, for the help and support throughout the simulation process
11. Environmental Engineering Department of ITB, especially Ibu Yuni and Ibu Marissa

Executive Summary

In this study, the raw water intake, transmission pipeline and the PDAM Badaksinga Treatment Plant in the city of Bandung in West Java, Indonesia was researched in order to evaluate the increase of capacity of Treatment Plant in order to satisfy the water demand of the citizens of Bandung.

For this purpose water quality and flow measurements from the raw water intake, flow measurements along the transportation to the treatment plant and the water quality at the treatment plant were done to obtain an integral view of the current situation.

The raw water intake from Cikalong area in the south of Bandung was observed in this project. It comes mainly from the outlet discharge of PLTA Cikalong, the hydropower plant (3000L/s – 8000L/s with better water quality), and alternatively from Cisangkuy River (500L/s). The contribution of these two sources, along with their water quality and the efficiency of presedimentation tanks, were investigated through field measurements and historical data observation. This study gives the indication that the quantity of water is generally sufficient but it needs some mechanisms to have a daily constant flow. A seasonal cycle storage mechanism and presedimentation tanks behaviour are recommended as an alternative solution and a consideration.

The new transmission pipeline, Pipa Baru, was focused for research in this project. This pipeline had 3 main problems which included the occurrence of bursts, never functioning at full capacity, and lacking accurate flow measurements. These problems were tackled through field measurements and simulations. For the first two problems, the results showed that air stagnation may be the cause of the problem. The accuracy of flow measurements can be overcome by more training and calibration of the SCADA, the online measurement device of the plant.

Concerning the water quality, even when most of the times the effluent of PDAM Badaksinga Treatment Plant meet the environment and legal standards, the system is not robust and vulnerable to any change in the influent due to the lack of monitoring, therefore the frequency of monitoring should be increased, moreover online devices should be installed. Furthermore, the removal of certain parameters should be studied in the future and special attention should be given to the PAC dose to know the exact amount of aluminum that is dose in order to enhance the performance of the following units (sedimentation and filtration) and consequently to produce a better and safer water quality.

It should be noted that the expertise of the operators is an advantage, so that training should be given to the operators in order to update the knowledge. Furthermore, in relation to the operation and equipment more improvements, investments and preventive maintenance need to be done to enhance the performance of the complete water supply system of PDAM.

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Introduction

Based on a Grant Decision RVO/FDW Bandung Water Supply Upgrading from 2015-2019, there is a cooperation among Delft University of Technology (TU Delft), Bandung Water Company, and Major City of Bandung, where TU Delft acts as the leader of Result 2 - FDW Bandung Water Supply. Bandung is third largest city in Indonesia, located in West Java – this can be seen in Figure 1. With the growing population of Bandung, the demand of water is increasing rapidly, and the production of the drinking water treatment plants is not able to meet the current or future demand. Furthermore, there are many unknowns within the water treatment plant, which requires further study and improvement.

Figure 0. 1 Location of Bandung on Java island

This study was done in the PDAM Badaksinga Tirtawening Drinking Water Treatment Plant which has a design capacity of 1800 lps. The focus of this multi-disciplinary project is to (1) analyze the current situation of raw water intake, (2) analyse the raw water transmission pipeline, (3) quick scan of water treatment plant, and (4) investigation of the water quality of Degremont part. Each member of the team focused on each of the parts mentioned in order to formulate an suggestions to approach a more sustainable system. The team often split up for field work – the intake and transmission team to Cikalong, and the water quality analysis conducted in cooperation with Bandung Institute of Technology.

The report consists of the overview of each section of the project study scope, and follows in more detail about field work and results in the order from the intake, transmission pipeline, and water quality.

Chapter 1 Intake

1.1 General Background

In Bandung, the capital city of West Java province, Indonesia, the drinking water treatment plants, which is called PDAM (*Perusahaan Daerah Air Minum*), are built in several parts of the city, but the largest one is located in Badaksinga street, in Northern side from the centre of the city. This plant was constructed in 1950s and firstly operated in 1955.

The plant extracts the raw water intake from three areas, as follows:

1. From the upstream part of Cikapundung River, located in the Northern part of the city called Dago Bengkok area. The raw water comes as the discharge from PLTA Dago, a hydropower plant for the Nothern area of Bandung. The water is taken to the plant by one transmission pipe.
2. From Cisangkuy River, located in the Southern part of the city called Cikalong village. The raw water comes primarily from PLTA Cikalong, a hydropower plant for the Southern area of Bandung, and if the flow is not sufficient, the water from Cisangkuy River can be extracted directly. The water is taken to the plant by two transmission pipes; the old one, called *Pipa Lama* from 1955 and the new one, called *Pipa Baru* from 1993.
3. From the more downstream part of Cikapundung River, located in Sabuga area. The raw water is pumped up to be delivered to the plant with one transmission pipe. This extraction point is only operated only in emergency situation when the flow is insufficient for the treatment plant.

The hydropower plants or PLTAs (*Pembangkit Listrik Tenaga Air*), owned by the national electrical company, called PLN (*Perusahaan Listrik Negara*), play an important role for the intake operation, both from the Northern and Southern parts of the intake. These PLTAs operate based on the demand from the client companies to produce electricity, so that they do not have exact schedule for operation. However, they are normally operated approximately 18 hours a day and their discharge is always higher than $3m^3/s$. They also have a frequent flushing schedule, which sometimes influences the water quality in the intake.

The focus of this study is the second intake from Cisangkuy River in the southern part of the city.

Figure 1. 1 Distance between the City of Bandung and the Raw Water Intake in Cikalong, Banjaran

The southern intake is located in Cikalong, Banjaran area, near Pangalengan, a district from the province of West Java. It gives the largest contribution to the whole raw water requirement for the water treatment plant. The raw water availability is dependent on several conditions from the hydropower plant (PLTA Cikalong) and also from Cisangkuy River itself.

In line with the objective of the Municipality of Bandung to increase 25% of potable water production for the whole city, especially in poor areas, there is a need to not only increase the capacity of the treatment plant, but also to increase the amount of raw water which can be delivered to the plant.

1.2 Sources

From the Southern part of Bandung, the water treatment plant abstracts the intake from Cisangkuy River. There are two points of abstraction, the old intake point and the new one. The location of those intake points can be seen below:

Figure 1. 2 Location of Southern Raw Water Intake

The difference between these two points and the methods of daily operation is described as follows:

1.2.1 Old Intake

The old intake was built at the same time with the Degremont plant during 1950s. This intake point comes directly from Cisangkuy River in the downstream of PLTA Cikalong. That means in the beginning of the desain, the intake source for the treatment plant does not depend on the hydropower discharge.

During normal condition, the old intake is not operated anymore, since the hydropower plant gives raw water with lower turbidity in a sufficient flow rate. Therefore, this intake is only operated when the hydropower plant stops the operation or during its frequent flushing. In this situation, the discharge from the turbine is flushed to Cisangkuy River from the point before the intake gate so that although in the beginning of the flushing period the turbidity usually reaches 15,000 NTU, it is then mixed with the river water and the turbidity decreases.

1.2.2 New Intake

The new intake comes from the discharge of the third hydropower plant in the series, PLTA Cikalong. It was built due to the decrease of Cisangkuy River flow quantity and quality, while at the same time the treatment plant wanted to upgrade its production capacity.

The raw water source of PLTA Cikalong comes from the upper rearch of Cibutarua River. From this river, an interbasin tunnel for transferring water was built and it gives the flow for Cilaki River.

A dam called Cilaki-Wanasuka was built by the hydropower company as storage for Cilaki River flow required for the hydropower plants in the downstream areas. From this dam, there is a headrace tunnel that connects the intake to the power house and it goes to Cipanunjang Lake, an artificial storage which was also built by the hydropower company. This lake goes in series with Cileunca lake

in the downstream part before the water flows to the three hydropower plants in series; PLTA Plengan, PLTA Lamajan and PLTA Cikalong.

PLTA Cikalong is the last hydropower plant in the series and it gives its discharge after moving the turbine into an open channel for the intake of the water treatment plant. From this open channel, the water goes to a series of intake structure, which consists of a pipe bridge, a collecting pond which divides the estimated amount of the intake water. This intake structure section is called *Bak* 1, or the first pond. After that, the water is delivered via a pipe tunnel into two presedimentation basins, which is called *Bak* 2. After going through these basins, the water is ready to be delivered via two transmission pipes, Pipa Lama and Pipa Baru.

During the rainy season or when the discharge from PLTA Cikalong is relatively high, the excess of raw water is discharged into the downstream part of the Cisangkuy River through the collecting pond. In this part of the river, there are two small dams for irrigation; Ciherang and Kiangroke. The excess of these two facilities is discharged downstream into Citarum River, one of the biggest rivers in West Java province.

The source path can be described as below:

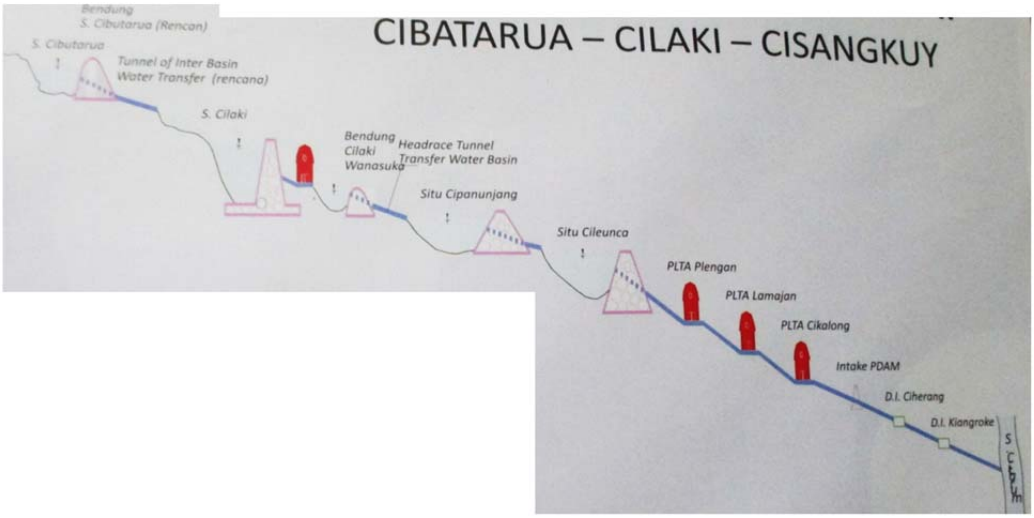


Figure 1. 3 Source Path of Southern Raw Water Intake

Therefore, the raw water intake for the treatment plant is abstracted from two parts; Cisangkuy River (downstream area) and the discharge of PLTA Cikalong. The quantity of these two sources shall be reviewed in section **6. Water Quantity in the Intake** while the quality shall be elaborated in section 7**. Water Quality in the Intake**.

1.3 Steps and Flow Paths

The intake water goes through several facilities before coming to the transmission pipes to be delivered into the plant. The facilities can be seen as below:

1.3.1 From the Hydropower Plant (PLN)

1.3.1.1 Cipanunjang Lake

Cipanunjang is the first artificial lake which was built to store the water from Cilaki River. It has a tributary of 8.0 km^2 and a design capacity of 18.86 x 10^6 m^3 (PT. Kwarsa Hexagon, 1996, p.V-4).

During the first site visit period (first week of November), Cipanunjang Lake was in a critical condition due to a severe dry season. The rainy season usually starts in November and normally takes up until May to fill the lake until its full condition. During the next visits in the end of November, it could be seen that the water level slightly increased according to the frequency of rainfalls.

Figure 1. 4 Cipanunjang Lake in Critical Condition

When dry season comes and there is no water surface above the soil, the land is transformed to agricultural fields. According to Pak Ma'mur, the pipeline operator, the farmers of these seasonal fields use natural fertilizers from animals in the beginning of the farming activities. After the plants start to grow, they start to use chemical fertilizers and pesticides, which are usually carried out by the runoff in the beginning of rainy seasons into the hydropower plant and Cisangkuy River itself.

The residue of natural fertilizers, usually comes from animals as manure, also covers the soil and creates sedimentation, which is resulted to flattened bed. The volume of the lake decreases due to the raise and the flattening of the soil bed.

The agricultural activities increase the organic content in the water, which is very difficult to be neutralized and creates greenish water. PDAM Bandung normally gives the treatment for this problem by pouring a large amount of PAC (poly-aluminum chloride).

1.3.1.2 Cileunca Lake

Cileunca is the second artificial lake after Cipanunjang. In Cileunca, the water is stored before going to the three hydropower units. Each hydropower units has their own detention pond called *Kolam Tando*. The situation of Cileunca Lake is pretty much the same as its predecessor, Cipanunjang. It has a tributary of 21.7 km^2 and a design capacity of 11 x 10^6 m^3 (PT. Kwarsa Hexagon, 1996, p.V-4). seasonal agricultural field also appears during dry seasons, similar to the one in Cipanunjang Lake.

Figure 1. 5 Cileunca Lake in Critical Condition (26-10-2015)) and Filling-up Again (11-11-2015)
(Source: Tantan Setiawan, Production Manager I of PDAM Bandung)

1.3.1.3 Kolam Tando

Kolam Tando is the collection or detention pond which stores the water before going to the turbine for electricity (PLTA Cikalong). It is the collection point which receives the water from Cileunca Lake and divides it to all hydropower units in the plant. Each plant has its own pond before delivering the water to move the turbine.

Figure 1. 6 The Dry Condition of *Kolam Tando*

1.3.1.4 PLTA Cikalong (Hydropower Plant)

Cikalong is the third hydropower plant in a row which receives the energy from the water of *Kolam Tando*. It is the third hydropower plant. After the water moves the turbine, it goes to a series of open channel, to a trash screen, and flows to a pipe, and then flows gravitationally to the other side of a river mouth, where the flow from Cisangkuy River also goes here. There are 2 scenarios for the water intake:

1. During high water flow from the turbine, and there is a discharge from Cisangkuy River, the water inflow will be too high for the intake. Therefore, the river flow will be discharged directly to the downstream without being extracted into the intake gate.
2. During low water flow from the turbine but there is a discharge from Cisangkuy River, the river flow will also be collected to the intake gate to meet the raw water demand.

1.3.2 From Badaksinga Treatment Plant (PDAM)

The integrated raw water intake structure from the drinking water treatment plant of Bandung can be seen below:

Figure 1. 7 Southern Raw Water Intake Structure

It consists of one open channel to transfer the water from hydropower plant, a pipe bridge, collecting pond, intake gate and a tunnel to transport water from the gate into the sedimentation tanks. The structures are elaborated in these following subsections.

1.3.2.1 PLTA Cikalong Open Channel

This open channel receives the flow from the outlet of hydropower plant and transport the water to the inlet of the pipe bridge. It is made from reinforced concrete, has one overflow in the middle of the route, and goes in the same direction with Cisangkuy River. The dimensions of this channel can be found in section **1.4 Field Measurement in the Intake** page 23.

Figure 1. 8 Open Channel from PLTA Cikalong Discharge

1.3.2.2 Pipe Bridge

This pipe bridge transfers the water from the open channel to the collecting pond. It crosses the width of Cisangkuy River directly to the pond where there is an intake gate. If the amount of water going through this pipe bridge is more than what can be transferred into the presedimentation tanks, the extra volume will be discharge outside the intake gate and the collecting pond and together with the water from Cisangkuy River flows downstream from beneath the pipe bridge.

Figure 1. 9 Pipe Bridge

1.3.2.3 Collecting Pond

This pond is constructed to provide a space for discharged water from the pipe bridge and control the amount of water coming to the intake gate. If the discharge is higher than the maximum capacity of the intake gate, the water will be divided by the large screen on the side of the pond and run downstream with the flow of Cisangkuy River. On the other hand, if the discharge is lower than the demand, the flow from Cisangkuy River will also be collected by the pond through the same screen and combined with the flow from the pipe bridge before being discharged to the intake gate.

Figure 1. 10 Pipe Bridge Connection and Collecting Pond

1. 3.2.4 Cisangkuy River

The river flows with the normal capacity between 500 and 600 L/s. It is a constant and reliable flow but the water quality is worse than the one from the turbine. This condition occurs due to the process in the pond and turbine which behaves like presedimentation and aeration units.

The river is influenced by the seasonal rainfall period. The wet season begins in November and the precipitation gradually decreases from early March. During heavy rainfalls, severe floods usually come and carry a lot of solid wastes, such as plastics, bottles, cans, etc. Having no screen or bars, these wastes directly block the intake gate, so that the operators have to go down and remove them manually.

Figure 1. 11 Cisangkuy River

1.3.2.5 Intake Gate

The location of the intake gate is approximately 120m downstream of the confluence of the Cisangkuy River. It was used to control the inflow before going to the presedimentation tanks, but nowadays it is fully opened by default.

Figure 1. 12 Intake Gate/Penstock

1.3.2.6 Tunnel

The intake tunnel transports the water from the intake gate to the presedimentation tanks. The distance between these two structures is 600m. The diameter of the pipe tunnel is 700mm and the elevation difference between the intake and the presedimentation tanks is approximately 15m.

Figure 1. 13 Tunnel Outlet

1.3.2.7 Presedimentation Tanks/Desilting Basins

There are two presedimentation tanks before the water going to the intake transmission line. The total inflow is 1800 L/s but during dry season the intake only comes from Cisangkuy River, approximately 500L/s. The dimension of each tank is 32m length x 6m width x 4m depth.

The water from the intake gate goes in via the tunnel from PLTA Cikalong and it is discharge to the tanks after being combined into one channel. After being pre-settled for a while, the water goes to the transmission line by three gates; the first one from the right-side is the gate for the old pipe (Pipa Lama), the second one in the middle is for the new pipe (Pipa Baru) and the last one is the overflow for balancing the movement of the water in the other two gates. The water from the overflow is discharged to 4 hoses that run to the Cikalong district and its surroundings which use it as their intake source for their treatment plant. The complete review and analysis of the presedimentation tanks can be found in section **1.6 Presedimentation Tanks**.

1.3.2.8 Sluice Gates

These integrated gates are built to control the water from the presedimentation tanks to enter the pipeline system. There two sluice gates which are operated manually; one for *Pipa Lama*,one for *Pipa Baru*, and one overflow to balance the pressure of water to the gates.

When one gate is opened, the overflow functions as stabilizer so that the amount of water going to the pipe will be proportional to the one going to the overflow. The water from the overflow is sent to the local water treatment plant in Cikalong and also for the neighbourhood, while the water going through the pipelines goes directly to the central drinking water treatment plant in Bandung.

Figure 1. 14 Sluice Gates

According to Pak Rohimat, the intake operator, it is difficult to measure the flow that runs from the intake point through the tunnel and leaves the presedimentation tanks because there is no flowmeter in the intake system. To identify the amount of flow being transported to the plant, the operators in the intake can only depend on the plant operators to inform them via handy-talkies to mention how much water has been arrived in the plant.

Similar procedure is also undertaken when the flow from PLTA Cikalong is suddenly stopped and the intake operators have to close the sluice gates. They only trust their visual observation of the depth of the tanks. If the water level suddenly decreases, the operators will know that the hydropower plant discharge is stopped and they will rapidly close the sluice gates. The duration of opening the sluice gate from its closed condition until fully opened is about 15 minutes, but the closing time is only about 2 minutes. This mechanism may cause some problems, such as backwater from the outlet of presedimentation tanks, but even more dangerous is the effects on the pipeline system, which will be elaborated in the next chapter.

1.3.3 Flow Paths

Using the facilities mentioned above, there are four different paths that the raw water can be extracted, due to the variety of the condition from the hydropower plant and the seasonal changes of the weather. In general, it can be divided as below:

1. **Path 1**

   This path is operated when the discharge from the hydropower is more than the intake need, the excess water will be discharged to the downstream of Cisangkuy River, as the steps below:

a. For the intake water:
   PLTA Cikalong Outlet → Open Channel → Pipe Bridge → Collecting Pond (cut excess water) → Gate
b. For the excess water:
   PLTA Cikalong Outlet → Open Channel → Pipe Bridge → Collecting Pond (cut excess water) → Cisangkuy River

2. **Path 2**
   This path is undertaken during normal condition from the hydropower, which means that the flow is perfectly sufficient to be taken as the intake. This is the default condition in the intake. The water goes to the tunnel through the steps below:
   PLTA Cikalong Outlet → Open Channel → Pipe Bridge → Collecting Pond → Gate
3. **Path 3**
   This path is operated when the discharge from the hydropower is insufficient, so that the water from Cisangkuy River will also be extracted at the same time directly when it passes the gate. The intake is extracted from two parts below:
   a. From PLTA Cikalong:
      PLTA Cikalong Outlet → Open Channel → Pipe Bridge → Gate
   b. From Cisangkuy River:
      Cisangkuy River → (Collecting Pond) → Gate
4. **Path 4**
   This last part is undertaken when there is no flow from the hydropower. It is usually performed only under emergency conditions. The water is collected through the steps below:
   Cisangkuy River → (Collecting Pond) → Gate

1.4 Field Measurement in the Intake

The field measurement is conducted using flowmeter on top of the open channel, with the dimensions as below:

Width (B) = 1500mm
Depth (H) = 2000mm (starting point of measurement)
= 2300mm (endpoint of measurement)
Thickness (b) = 250mm

The measurement with flowmeter is also compared to the most conventional way of velocity measurement, by knowing the distance and the time of a particle movement.

The measurement result can be seen as below:

Table 1. 1 Flow Velocity Measurement in the Open Channel of PLTA Cikalong

A. Manual

Date	Distance [m]	Time [s]	Velocity (1D) [m/s]
23/11/2015	3	2.13	1.4085
	3	2.07	1.4493
30/11/2015	3	1.81	1.6575
	3	2.34	1.2821
	3	1.75	1.7143
	3	2.13	1.4085
Average			1.4867

B. EMS

X-direction = not working (higher than 1.0 m/s)

Y-direction = 0.34 - 0.40 m/s

Therefore, based on the field measurement, the velocity of the discharge of hydropower plant via the open channel is approximately 1.50m/s.

On the other hand, based on Manning's equation, the flow velocity of the open channel from PLTA Cikalong can be calculated as below:

Dimension:				
Length	(L)	=	92.5 m	
Width	(W)	=	1.5 m	
Depth	(H)	=	2.5 m	(average)
Water Depth	(h)	=	1.35 m	(average)
Thickness	(t)	=	0.25 m	
Cross-Section Area	(A)	=	2.025 m2	
Wetted Perimeter	(P)	=	4.2 m	
Hydraulic Radius	(R)	=	0.482	
Slope	(I)	=	0.004	(average)
Manning coeff.	(n)	=	0.015	(concrete)
Velocity (field)	(v)	=	1.4867 m/s	
Velocity (formula)	(v)	=	2.59252266 m/s	
Flow (field)	(Q)	=	3.010 m3/s	
Flow (formula)	(Q)	=	5.250 m3/s	

From the Manning's equation, as below:

$$v = \frac{1}{n} \cdot R^{2/3} \cdot S^{1/2}$$

Where R = A/P

Thus:

$$v = \frac{1}{0.015} \cdot (0.482)^{\frac{2}{3}} \cdot (0.004)^{\frac{1}{2}} = 2.59252 \ldots m/s$$

The flow velocity based on the Manning's formula is approximately 2.60m/s.

The difference between those two values is probably generated by the flow (Q) that was running through the channel during the field measurement. The actual discharge (Q-field) may be lower than the design discharge (Q-formula) because the design should be more conservative. Moreover, during the calculation using Manning's formula, the freeboard of the open channel was not taken into consideration, while in reality there is always a freeboard as an allowance of higher water level. It also indicates that there is a high fluctuation in water discharge from this open channel. This variation is proven by the data of daily outlet discharge from PLTA Cikalong.

Nevertheless, the field measurement sessions were conducted while the hydropower excess was in its maximum amount of discharge, which means that the intake operations were in Path 1 or Path 2. It indicates that even the actual flow velocity is lower than the value in the design, the water supply for the water treatment plant can still be provided in optimum condition.

1.5 Presedimentation Tanks

The presedimentation tanks, or desilting basins, were built to retain sands and silts (mostly suspended solids) to help decreasing the raw water turbidity before going through the pipelines. These tanks are located in the downstream of Cikalong intake point and the water enters the tanks after passing through a grit removal screen in the intake gate and a half-cirle baffle to decrease the flow velocity.

The specifications of these tanks were retrieved from the final design report of Bandung Water Supply Augmentation and Improvement – Detailed Engineering Study (DHV, et al, 1988, p.A-1), as below:

- Number of basins : 2
- Length : 35m
- Width : 6m
- Depth : 4.04m
- Surface area per tank : 210m^2
- Volume per tank : 840m^3
- Rated capacity per tank : 500 L/s = 0.5m^3/s
- Surface load per tank : 8.6 m/h = 0.002 m/s
- Retention time : 28 min.
- Horizontal velocity : 75 m/h = 0.021m/s
- Elevation difference with PDAM Badaksinga : 100m (gravitational method)

The type of the flow in the tank is static, with a flat rectangular bottom slab. The presedimentation method is only physical, mainly as grit removers. Each tank is equipped by a scraper held onto a holding bridge to gather the sludge and take it into sludge hoppers.

The sludge hoppers are located in the upstream, middle point and downstream of the tank, and each location has 2 hoppers. Thus, there are 6 hoppers in total. At this moment the removal of the sludge is operated manually by opening the valve in the bottom slab of the tank.

According to the analysis from Degremont (1985), the maximum suspended solids reduction of the tanks is 20% and if the suspended solids content is more than 10 g/L, the accelators at the treatment plant will be considerably overloaded (DHV, et al, 1988, p. A-1).

1.5.1 Ideal Settling and Flow Velocities

Due to the uniformity of sediment sizes and the nonexistence of chemical substances, the settling velocity can be determined only by the balance between settling force and upward force of the particles.

In laminar flows, the settling velocity can be determined by Stoke's Law. It is based on the balance between gravitational force and the sum of buoyancy force with viscous drag force that appear when a particle falls down through a medium with certain viscosity. Hence, the value of the viscous drag force is the result of subtracting gravitational force with buoyancy force. Since in laminar flow the Reynolds number (Re) is lower than 1 and the temperature is constant at 30°C, the velocity of the settling particles can be determined by the kinematic viscosity of the medium (see **Table A.1** in **Appendix A**).

$$v_s = \frac{1}{18} \cdot \frac{g}{\vartheta} \cdot \frac{\rho_s - \rho_w}{\rho_w} \cdot d^2$$

where:

v_s = settling velocity (m/s)
g = gravitational acceleration (m/s^2)
ϑ = kinematic viscosity (m^2/s)
ρ_s = particle density (kg/m^3)
ρw = water density (kg/m^3)
d = particle diameter (m) = 100 µm (the minimum settleable suspended solids)

The kinematic viscosity varies according to the temperature, as follows:

$$\vartheta = \frac{497 \cdot 10^{-6}}{(T + 42.5)^{1.5}}$$

Thus, when T = 30°C according to the field investigation:

$$\vartheta = \frac{497 \cdot 10^{-6}}{(30 + 42.5)^{1.5}} = 0.805 \cdot 10^{-6}\ m^2/s$$

Hence;

$$v_s = \frac{1}{18} \cdot \frac{9.81}{0.805 \cdot 10^{-6}} \cdot \frac{(2650 - 1000)}{1000} \cdot (100 * 10^{-6})^2$$

$$v_s = 0.0111708 \ldots m/s = 40.21488 \ldots m/h$$

The settling velocity (v_s) is 0.01 m/s = 40.21 m/h.

To check whether the settling velocity (v_s) is sufficient for the particles to reach the bottom of the tanks, it should be compared to the surface loading or the critical settling velocity (v_{s0}), which will be calculated in section **1.5.2 Horizontal Flow Velocity, Surface Loading and Efficiency**. However, the ideal setting time can only occur when the flow is laminar.

To check whether the flow is truly laminar, the Reynolds number is calculated, as follows:

$$Re = \frac{v_s \cdot d}{\vartheta}$$

where:

v_s = settling velocity (m/s)
d = diameter of spherical particle (m)
ϑ = kinematic viscosity of fluid (m^2/s) when T = 30°C

Thus:

$$Re = \frac{0.01 \cdot (100 * 10^{-6})}{0.805 \cdot 10^{-6}} = 1.2422 \ldots$$

The Reynolds number of the flow is 1.24. It is usually recognized that the flow is laminar when Re is lower than 1, in a transient mode between laminar and turbulent when it is between 1 and 1600, and turbulent when higher than 1600. Hence, the flow is considered transient, which means that the settling velocity may be higher and the ideal settling mechanism using Stoke's Law cannot be reached. It also indicates the occurrence of external effect(s) to tanks, such as turbulence, bottom scour or short-circuit phenomenon from the entry to the outlet, which forces the flow to move faster horizontally towards the outlet and carries out sediments before it can move downwards to be settled. This condition may lead to the inefficiency of the presedimentation tanks, as will be elaborated in subsection **1.5.3.2 Effects of Disturbances in Practice**.

1.5.2 Horizontal Flow Velocity, Surface Loading and Efficiency

Based on the actual dimensions, the horizontal velocity and the surface loading can be calculated. These parameters are important to identify whether the particles can be settled completely, partially or cannot be settled at all.

The horizontal velocity is determined by the width and height of the tanks, as follows:

$$v_0 = \frac{Q}{B \cdot H}$$

where:

Q = flow = rated capacity per tank (m3/s)
B = width of the tank (m)
H = height of the tank (m)

Thus;

$$v_0 = \frac{0.5}{(6) \cdot (4.04)} = 0.020627 \ldots m/s \approx 74.2572 \ldots m/h$$

The horizontal flow velocity is 0.02 m/s ≈ 74.26 m/h.

The surface loading is determined by the width and length of the tanks, as follows:

$$v_{s0} = \frac{Q}{B \cdot L}$$

where:

Q = flow = rated capacity per tank (m3/s)
B = width of the tank (m)
L = length of the tank (m)

Thus;

$$v_{s0} = \frac{0.5}{(6) \cdot (35)} = 0.00238 \dots m/s \approx 8.57142 \dots m/h$$

The surface loading is 0.002 m/s ≈ 8.57 m/h.

In order to have settled materials, the time that a particle can be settled (T_s) should be the same or lower than the residence time of water in the tank (T_r). Therefore, the following rule should be applied:

$$T_s \leq T_r$$

$$\frac{v_0}{L} \leq \frac{v_{s0}}{H}$$

From the calculation results:

$$T_s = \frac{v_0}{L} = \frac{74.26}{35} = 2.12171428 \dots h$$

and

$$T_r = \frac{v_{s0}}{H} = \frac{8.57}{4.04} = 2.121287129 \dots h$$

Therefore, T_s = 2.1217 hours and T_r = 2.1213 hours.

It can be seen that T_s is slightly higher than T_r. As the rule shows that T_s should be the same or lower than T_r to have a proper sedimentation, it can be argued that the particles have difficulties to be settled in the tanks within the actual dimensions.

During the design period, the residence time (T_r) is set to be 28 minutes, which is still insufficient for the sediments to be settled completely. The residence time (T_r) for these two tanks with current dimensions should be at least 2.12123 hours = 127.27 minutes.

To optimize the horizontal sedimentation process, it is theoretically recommended to increase the length or decrease the depth of the tanks. Longer residence time can also become another alternative, as long as the supply to the plant is not delayed.

However, it should fit the condition in the field and keep the discharge of the inflow to the pipeline systems with the same value as what is needed by the water treatment plant. In order to evaluate the field condition, a simple measurement has been undertaken in section **1.5.3.1 Field Measurement**.

From the previous calculation, the settling velocity (v_s = 0.01m/s) is higher than the design surface loading (v_{s0} = 0.002m/s), which means that all particles settle completely and the design has a good efficiency. However, according to the detailed engineering study final design report (DHV, *et al*, 1988, p.A-1), it is stated that the removal efficiency is 80% ($r = \frac{v_s}{v_{s0}} = 0.8$). Therefore, there has been a consideration in the design to handle some disturbances in practice, which will be elaborated more on 1.5.3.2 Effects of Disturbances in Practice.

1.5.3. Field Investigation and Analysis

1.5.3.1 Field Measurement

A simple measurement has been performed in the presedimentation tank to identify the velocity of the water in one dimensional horizontal direction. By throwing the visual object and measuring the time until it came into the edge of the tank, the horizontal velocity can be obtained.

Figure 1. 15 Flowing Visual Object for Measuring 1-D Flow Velocity in Presedimentation Tanks

The complete result can be seen below:

Table 1. 2 1-D Velocity Measurement in Presedimentation Tank

Date	Distance [m]	Time [min.]	Velocity (1D) [m/s]
1/12/2015	35	5.46	0.106837607
	35	6.31	0.092445853
	35	9.24	0.063131313
	35	8.71	0.066972828
Average			0.0823469

The distance is measured from the outlet of the tunnel until the flow suddenly decreases drastically, which always came into the same position approximately 30cm before the outlet of the tank, as the figure below:

Figure 1. 16 Approximation of Finishing Point of 1-D Flow Velocity in Presedimentation Tanks

The average flow velocity (v_0) based on the measurement is approximately 0.08m/s. This is far above the design horizontal flow velocity of the tank (0.02m/s). The possible reasons behind this difference will be described in the next subsection.

1.5.3.2 Discussions of Disturbances in Practice

Some findings are recognized during site investigations, which may lead to the difference between the formula-calculated values and the measured/empirical ones. Some indications can be seen as follows:

1. Looking at the flow rate and condition of the tanks, sometimes the actual rated capacity of the inflow (Q) may be higher than during design period (0.5m^3/s per tank), so that the balance between each dimension changes.
2. The temperature (T) in the field is more likely to be higher than during design period. In that case, it decreases the value of kinematic viscosity (ϑ) as can be seen in the previous equation:

$$\vartheta = \frac{497 \cdot 10^{-6}}{(T + 42.5)^{1.5}}$$

This condition increases settling velocity (v_s) from the Stoke's Law:

$$v_s = \frac{1}{18} \cdot \frac{g}{\vartheta} \cdot \frac{\rho_s - \rho_w}{\rho_w} \cdot d^2$$

It can be inferred that the particles is faster to be settled under high temperature conditions, which in the end will accelerate the sedimentation process within the same tank dimensions. The particles will have short time to reach the bottom of the tank and the critical settling velocity can be reached more rapidly.

3. The effect of turbulence

Turbulence affects the hydraulic radius of the flow (R), which in turn will influence the efficiency of the tanks;

$$R = \frac{B \cdot H}{B + 2 \cdot H} = \frac{(6) \cdot (4.04)}{6 + 2 \cdot (4.04)} = 1.72159 \dots m$$

The hydraulic radius is 1.72m.

Hence, with the same horizontal flow velocity (v_0), the Reynolds number is changed to be;

$$Re = \frac{v_0 \cdot R}{\vartheta} = \frac{(0.02) \cdot (1.72)}{(0.805 \cdot 10^{-6})} = 42732.92$$

The Reynolds number (Re) is higher than 1600, which means that the flow in the direction from the inlet to outlet is in a turbulent mode. Therefore, the effect of turbulence exists in practice and it decreases the efficiency.

The new efficiency can be calculated after identifying the ratio between settling velocity (v_s) and horizontal flow velocity (v_0) from the design efficiency (in this case, r = 80%).

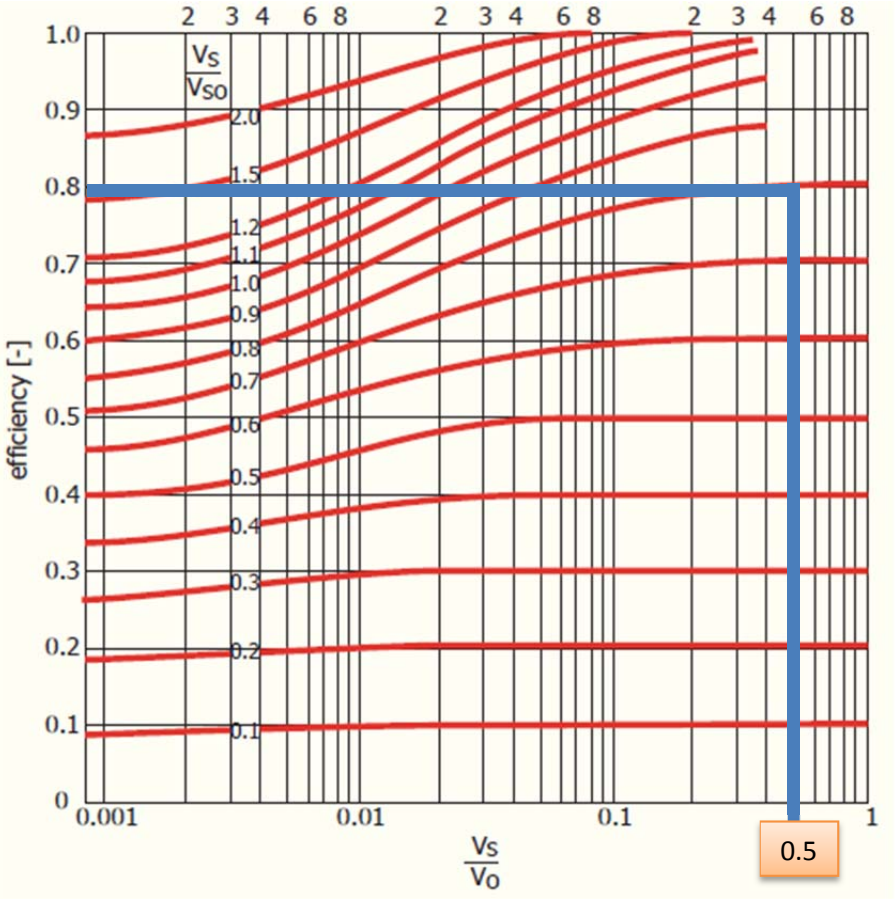


Figure 1. 17 Influence Graph of Turbulence on the Efficiency of Settling (Ideal State)
(Source: Sanitary Engineering – Water Management Department, 2007, p.58)

where:

r	= design efficiency	= 0.8
v_s	= settling velocity (m/s)	= 0.01 m/s (calculated)
v_{s0}	= surface loading (m/s)	= 0.002 m/s (calculated)
v_0	= horizontal flow velocity (m/s)	= 0.02 m/s (ideal), 0.08 m/s (measured)

From the graph:

$$r = \frac{v_s}{v_{s0}} = 0.8$$

Thus;

$$\frac{v_s}{v_0} = 0.5$$

For ideal short, wide and deep basin:

$$\frac{L}{H} = \frac{v_0}{v_{s0}} = \frac{\frac{v_s}{v_{s0}}}{\frac{v_s}{v_0}} = \frac{0.8}{0.5} = 1.6$$

With the real dimensions:

$$\frac{L}{H} = \frac{35}{4.04} = 8.663366 \ldots \approx 8.66$$

With L/H = 8.66 and keep the $\frac{v_s}{v_{s0}} = 0.8$;

$$\frac{L}{H} = \frac{\frac{v_s}{v_{s0}}}{\frac{v_s}{v_0}}$$

$$8.66 = \frac{0.8}{\frac{v_s}{v_0}}$$

$$\frac{v_s}{v_0} = \frac{0.8}{8.66} = 0.092378 \ldots \approx 0.09$$

The new efficiency shall be:

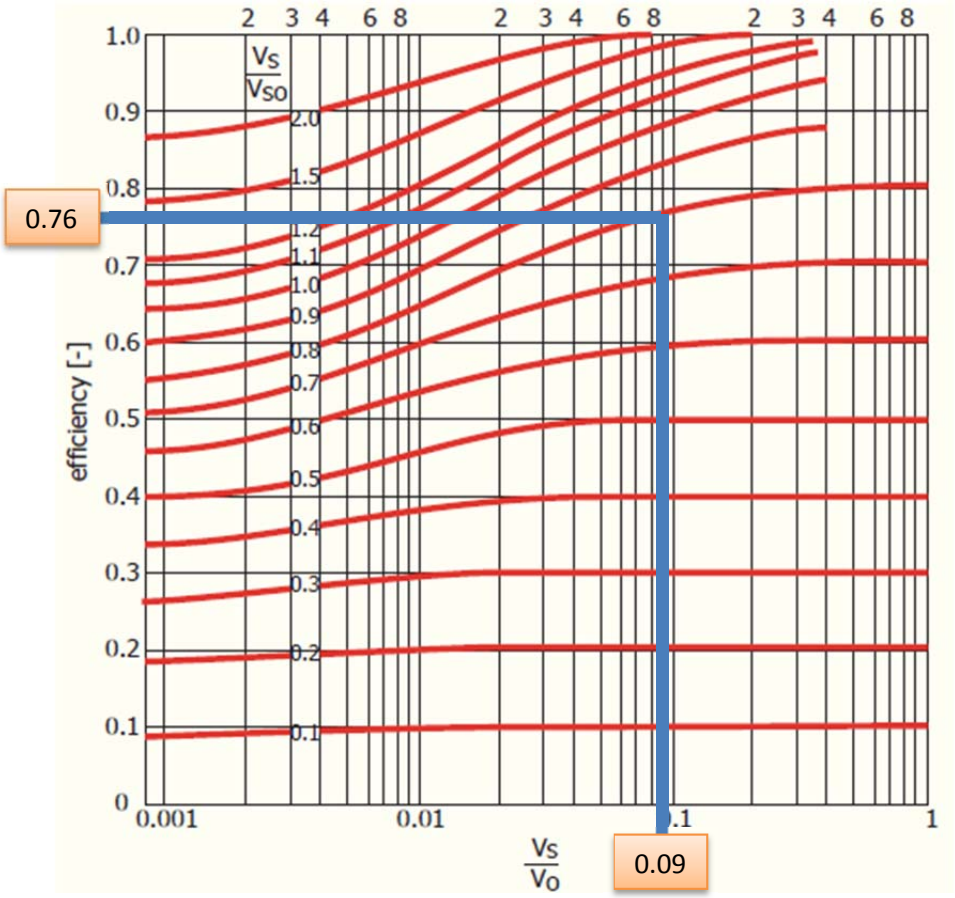


Figure 1. 18 Influence Graph of Turbulence on the Efficiency of Settling (Actual Dimensions State)
(Source: Sanitary Engineering – Water Management Department, 2007, p.58)

The new efficiency, r' = 0.76 or 76%. It has 4% difference from the ideal design case.

4. The effect of shear stress or scouring

   The sediments which have been settled down can experience resuspension, or being moved upwards back, or, due to bottom scour. To prevent this situation, the displacement velocity (v_0) should be lower than the maximum flow velocity that will not cause the occurrence of bottom scour (v_{sc}). If the flow runs above this limitation, the bottom scour will occur. It can be calculated as follows:

$$v_{sc} = \sqrt{\frac{40}{3} \cdot \frac{\rho_s - \rho_w}{\rho_w} \cdot g \cdot d}$$

$$v_{sc} = \sqrt{\frac{40}{3} \cdot \frac{(2650 - 1000)}{1000} \cdot 9.81 \cdot (100 \cdot 10^{-6})} = 0.14690 \ldots m/s$$

   The maximum flow velocity that is still safe from creating bottom scour is 0.14m/s.

   Both the calculation (v_0 = 0.02m/s) and field measurement (v_0 = 0.08m/s) does not reach above the bottom scour velocity limit. It can be seen that the bottom scour may not appear. This argument has been proven during frequent cleaning period; the sediments are fully trapped in the bottom of the tanks (section **1.5.4 Frequent Cleaning**).

5. The effect of short-circuit flow

   The wind can change the flow line and disturb the stability of the flow. It creates a dead zone in the corner of the tank and urges the water to move in the opposite direction. The stability of the flow is expressed by the Camp number (C_p). It shows that the calculated flow will be stable if C_p> 1 x 10^{-5} and instable if C_p < 1 x 10^{-5}.

   The calculation can be seen as follows:

$$C_p = \frac{Q^2}{g} \cdot \frac{B + 2 \cdot H}{B^3 \cdot H^3}$$

$$C_p = \frac{(0.5)^2}{(9.81)} \cdot \frac{(6) + 2 \cdot (4.04)}{(6)^3 \cdot (4.04)^3} = 2.51927 \ldots \cdot 10^{-5}$$

   The Camp number (C_p) is 2.52 x 10^{-5}. It is higher than 1 x 10^{-5}, which means that the flow is still stable if the rated capacity (Q) is always 500L/s. In this case, there is no influence from the short-circuit phenomenon into the sedimentation tank.

Based on the result, further research is recommended to identify the cause(s) of the huge difference between the displacement velocity (v_0) from the calculations of dimensions and from the field measurements.

1.5.4 Frequent Cleaning Mechanism

The presedimentation tanks are cleaned manually, approximately once every three months. During this operation, the inflow from the tunnel and the outflow to pipeline system are stopped for a while to empty the basins.

The cleaning procedure uses clean water to remove sediments on the bottom and sides of the tanks. It is transferred via flexible hoses into the tanks, so that it can dilute the sediments to be easily removed. The workers rake and sweep the sediments into the disposal part at the end of the tanks.

Some of the cleaning activities can be seen in the figures below:

Figure 1. 19 Presedimentation Tank Cleaning Activity

Figure 1. 20 Sludge Disposal

Figure 1. 21 Plan View of Sludge Box
(Source: Jaap Boomsma, Team Leader of Vitens-Evides for PDAM Bandung Project)

From the site investigation, it can be proven that the presedimentation tanks works properly, since during the cleaning process, the settled materials could be clearly seen and the layer of sediments reached approximately 3-5cm near the outlet of the tanks. However, referring to the calculation in the previous sections (1.5.2 and 1.5.3), it can also be argued that the settled particles were the ones with much larger diameter than 100µm.

1.5.5 Performance under Frequent Flushing of Hydropower Plant

These cleaning processes influence the raw water quality from the entry of presedimentation tanks. Based on the turbidity test in the beginning of the presedimentation tank operation (13 July 1986), the highest turbidity after 6 hours of flushing of hydropower structures is 1650 NTU. However, when PLTA Cikalong had its frequent flushing period in early December 2016 (week 48), the turbidity in the inlet point of the treatment plant could reach 19900 NTU.

This finding can be an indication that the presedimentation tanks were overloaded. Although the the electrical company of PLTA Cikalong has sent official letters as early warning information, sometimes the flushing excess is discharged into the presedimentation tanks. As the basins cannot retain the sludge anymore, it runs out in the pipelines and ends up in the inlet of the water treatment plant.

To cope with this issue, a prevention-based action is recommended, since the presedimentation tanks has limitation design capacity. Therefore, it would be advantageous to recognize the flushing schedule of the three PLTAs in the upstream of the intake and close the gates to prevent more sludge coming through the pipelines into the plant. The two important reasons are:

1. It is possible for the sludge to retain in the pipelines and decrease the flow rate that these pipelines can deliver. The pipelines system will be elaborated in the next chapter.
2. The sludge may end up in the treatment plant and overload the facilities, which can lead to more backwashing for the filters and less production of clean water. The treatment facilities will be elaborated in another next chapter.

Based on the first final design (DHV, *et al*, 1988, p.A-7), the flushing schedule of reservoirs from hydropower plants (PLTAs) from Cisangkuy intake can be seen as below:

Table 1. 3 Flushing Schedule of Reservoirs from Hydropower Plants in Cisangkuy River

No.	PLTA	Pond and Dam	Flushing Requency	Impact on PDAM Intake	Remark
I.	Plengan	1. Cisarua Pond I and II	once every 3 months	Does not increase turbidity	Week 12, 25, 40, 51
		2. Cisangkuy Pond	monthly	Does not increase turbidity	monthly
		3. Cilaki-Wanasuka Pond	once every 3 months	Does not increase turbidity	Week 5, 18, 30, 43
		4. Cisarua Dam I and II	once every 3 months	Increase turbidity	Week 5, 18, 30, 44
		5. Cisangkuy Dam	once every 3 months	Increase turbidity	Week 4, 17, 30, 44
		6. Cilaki-Wanasuka Dam	once every 6 months	Does not increase turbidity	Week 10 and 40
II.	Lamajan	1. Daily Retention Pond	once every 3 months	Increase turbidity	Week 11, 25, 39, 51
		2. Pond in front of the Filter/Screen	once every 6 months	Increase turbidity	Week 20 and 48
		3. Cisangkuy Dam	monthly	Increase turbidity from PLTA Cikalong	monthly
III.	Cikalong	1. Daily Retention Pond	once every 3 months	Increase turbidity	Week 7, 20, 34, 48
		2. Pond in front of the Filter/Screen	once every 6 months	Increase turbidity	Week 4, 5, 30, 31

(Source: DHV, et al, 1988, p.A-7)

PLTA Cikalong, the hydropower plant, performs a cleaning schedule for its daily detention pond every 3 months (week 7, 20, 34 and 48) and the settling pond in front of the screen every 6 months (4, 5, 30 and 31). Furthermore, PLTA Lamajan, the previous hydropower plant in the upstream of PLTA Cikalong, also performs its cleaning process in Cisangkuy Dam every month, and it affects the operation in PLTA Cikalong.

1.6 Water Quantity in the Intake

The raw water intake from the Southern part comes primarily from the hydropower discharge of PLTA Cikalong and from Cisangkuy River in emergency cases. However, the water treatment plant should also give part of the supply flow to the irrigation system downstream.

As the initial investigation, the volume of water which the Tirtawening drinking water treatment plant in Bandung normally extracts is:

Common daily intake time = 18hrs/day
Common daily intake flow rate = 1.80m^3/s
Total Volume per Year for PDAM = Common daily intake flow rate * time
= 56,764,800.00m^3/year
(1800L/s, 24 hours, 12 months or 365 days)
Thus, to increase the capacity until 25% of the initial raw water extraction:
Common daily intake flow rate = 1.25% * 1.80m^3/s = 2.25m^3/s

And, the total volume will be:
Total Volume per Year for PDAM = Common daily intake flow rate * time
= 70,956,000.00m^3/year
(1800L/s, 24 hours, 12 months or 365 days)

The raw water resources will be elaborated in these following sections.

6.1. PLTA Cikalong Discharge

The first and foremost source for the intake of the water treatment plant from the Southern part is from the excess of the third hydropower plant, PLTA Cikalong.

Figure 1. 22 PLTA Cikalong

The following table describes the specifications of the maximum discharge and the ponds in this hydroelectric system:

Table 1. 4 Specifications of Hydropower Facilities in PLTA Cikalong

Parameter	Value	Unit
Max. Output	19.30	m3/s
Max. Discharge	19.20	m3/s
Head	140.00	m
Daily Detention Pond		
Max. Flood Position	5.00	m
Highest Level	4.80	m
Lowest Level	1.80	m
Area	616,900.00	m2
Gross Capacity	70,000.00	m3
Effective Capacity	60,000.00	m3
Dam/ Settling Pond		
Height	7.50	m
Area	1,226.50	m2
Volume	8,670,375.00	m3
Turbine		
Type	Neyrpic-Alsthom (Francis)	
Water Use	5.54	m3/6MW/s
Total Jump Head	140.00	m
Year of Constuction	1957	
Year of Operation	1961	
Generator		
Number	3	units
Type	Neyrpic-Belfort (RV 220-85)	
Installed Power	8000	KW
Electric Current	740	A
Electric Voltage	6.3	KV
Year of Construction	1958	
Average Production (data from 2012 - 2015)	4,520,116.92	KWh

According to the final report of Study on Possibility of Increasing Energy of Water from Cisangkuy/Citarum Tributary (PT. Kwarsa Hexagon, 1996, p.II-2 – p.II-7), the engineering consultant of the national electrical company (PLN), the water from Cisangkuy tributary is utilized for:

1. Three hydropower plants (PLTA Plengan, PLTA Lamajan, PLTA Cikalong). Basically, the flow from Cipanunjang and Cileunca Lake runs to PLTA Plengan. After being used by this hydropower plant, the discharge is reused by PLTA Lamajan and Cikalong. After that, the last discharge from PLTA Cikalong is returned to Cisangkuy River.
2. Technical irrigation systems (Cikalong area: 160ha, 192L/s, Ciherang area: 2676 ha, 4328L/s, Kiangroke area: 65ha, 93.6L/s). They are provided by the Ministry of Public Works.
3. Local/seasonal irrigation systems (Cikadu Gondang: 85ha, 102L/s, Cibatu Beureum: 50ha, 60L/s, Cimedal: 252ha, 302L/s). These irrigation systems are only operated occasionally and it is provided by the villagers themselves.

   In the near future, the seasonal village irrigation systems are going to be transformed into technical irrigation systems. That means the irrigation areas of Cikalong, Ciherang and Kiangroke will increase. According to the plan from the Ministry of Public Works, Cikalong irrigation area is going to be 462ha, Ciherang will be 2771ha and Kiangroke will be 468ha. In total, the water demand for irrigation will reach 4441 L/s ≈ 4.5m^3/s.
4. Raw water source for drinking water treatment plants (PDAM Tirtawening in Badaksinga, Bandung and PDAM from the district of Bandung suburbs in Banjaran area). PDAM Tirtawening from Badaksinga, the city of Bandung extracts 2 x 800L/s (800L/s for Pipa Lama and 800L/s for Pipa Baru) and PDAM from Banjaran area takes only 20L/s.

The mechanism of extraction and discharge is presented as below:

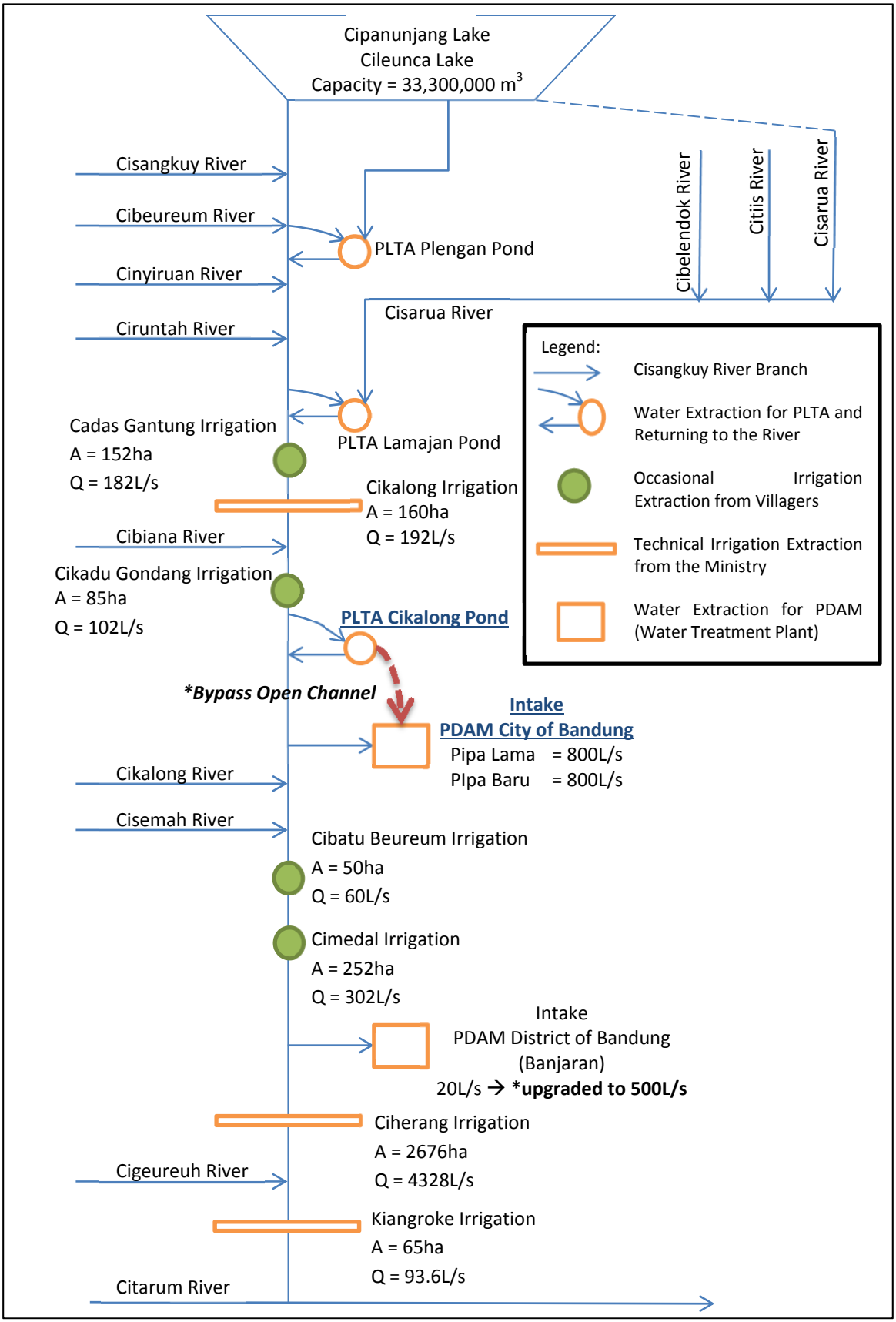


Figure 1. 23 Schematization of Water Utilization for Hydropower, Irrigation and Drinking Water Source
(Source: PT. Kwarsa Hexagon, 1996, p.II-7)

*With an update of: Bypassing Channel from PLTA Cikalong to PDAM City of Bandung and PDAM District Intake

The monthly data for water discharge and electricity production during the last 2 years (2014 – 2015) were obtained from PLTA Cikalong office. The data consists of the inlet discharge to the hydropower plant, the outlet discharge from the turbine, the electricity production, the total water use to produce electricity, the price of water paid by PLTA Cikalong to the regional municipality, and the total volume of the outlet per day. The data can be found in **Appendix A**.

Based on these data, it can be seen that actually the volume of the hydropower discharge is more than sufficient to be taken by the treatment plant as their intake. However, the discontinuity of the discharge creates a problem for the treatment plant. From this condition, there is a need to save water during higher discharge period from the hydropower plant as a saving source during dry seasons. At the same time, the irrigation facilities in the downstream of Cisangkuy River should still have continuous supply of water, which means that the water cannot be stored in its full percentage, but there should be part of it that flows downstream to the irrigation facilities in Ciherang and Kiangroke.

Thus, a storage pond is considered one of the alternatives to save some parts of hydropower discharge while at the same time can still give it to the downstream area continuously. There will be 4 scenarios for the filling system of the storage pond. The first two scenarios are only based on the estimation of 18 hours extraction from the hydropower discharge to Cikalong intake point, while the last ones also consider the influences of Cisangkuy River flow (elaborated in section 1.6.2) and downstream irrigation from Cikalong, Ciherang and Kiangroke (elaborated in section 1.6.3).

1.6.2 Cisangkuy River

Being the old intake point of the treatment plant, Cisangkuy River is still believed to provide adequate amount of water although nowadays the flow is getting lower and the quality of the water decreases. To review the capacity and availability of Cisangkuy River as the intake point, some hydrological data has been obtained to estimate the flow that is visible to be taken for the treatment plant. The data were obtained from the Indonesian Meteorological and Geophysical Centre and the Water Resources Centre from the Ministry of Public Works.

The calculation of flow estimation with hydrological data can be found in **Appendix C**, **Table 14** and **15**.

The calculation also includes evapotranspiration estimation using Penman equation, since there is a high indication in the field that evaporation plays an important role in determining the runoff discharge. The Penman equation is a semi-empirical equation which calculates the mass transfer (Ea) and energy budget (H) from incoming and outgoing radiation. It requires some field data, such as the latitude, average temperature, air humidity, wind speed, sunshine hours and actual vapour pressure.

The potential evapotranspiration (Eo) is estimated using the following equation:

$$E_o = \frac{\left(\frac{\Delta}{\gamma} H + E_a\right)}{\frac{\Delta}{\gamma} + 1}$$

Figure 1. 24 Penman Equation for Evapotranspiration

where Δ/γ is an empirical parameter depending on temperature (Magnus, 2009, p.01).

For the runoff flow calculation, the NRECA (National Rural Electric Cooperative Association) method, which was developed by Norman H. Crawford from the US Agency for International Development to be used for facilitating the huge catchment area. This method is suitable for Cisangkuy River which has 25,700 ha of catchment area. NRECA method is based on the water balance in the watershed, which gives the basic equation as:

Precipitation – Actual Evapotranspiration + Storage = Runoff

This principle is the basis for determining some storage locations that may occur in reality and retain some percentage of rainfall, which includes moist storage (from the remaining rainfall after being decreased by evapotranspiration), delta storage (which causes direct runoff) and groundwater storage (from the excess of soil moisture and goes out as groundwater flow). After identifying each storage, the actual runoff can be calculated.

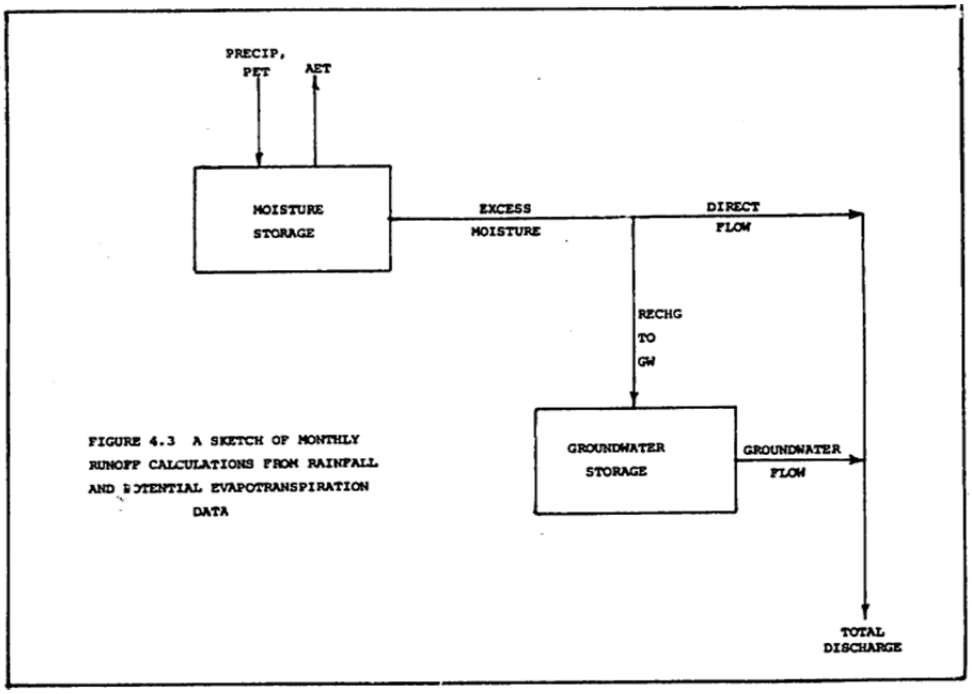


FIGURE 4.3 A SKETCH OF MONTHLY RUNOFF CALCULATIONS FROM RAINFALL AND POTENTIAL EVAPOTRANSPIRATION DATA

Figure 1. 25 NRECA Model for Monthly Runoff Discharge Calculation

The average discharge based on NRECA calculation can be seen below:

Table 1. 5 Average Discharge of Cisangkuy River

1. Total Discharge per Month (m3/s)												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	11.35	5.03	13.88	16.62	3.61	1.86	0.90	0.45	0.23	0.11	0.06	0.03
2002	6.19	3.91	14.05	8.43	2.24	1.16	0.56	0.28	0.14	0.07	0.04	1.08
2003	0.71	3.16	6.16	1.25	0.60	0.31	0.15	0.08	0.04	0.62	3.00	8.53
2004	9.89	11.60	14.01	3.29	1.68	0.84	0.41	0.20	0.10	0.05	0.67	4.76
2005	5.81	15.39	15.29	5.09	1.97	1.02	0.49	0.25	0.13	0.06	0.03	0.02
2006	1.42	5.51	0.91	7.06	1.29	0.67	0.32	0.16	0.08	0.04	0.02	1.08
2007	0.18	7.80	7.54	1.71	0.83	0.43	0.21	0.10	0.05	1.51	5.72	2.80
2008	1.84	0.73	9.40	7.51	1.77	0.91	0.44	0.22	0.11	0.55	4.68	11.24
2009	10.38	20.54	9.59	8.43	3.92	1.48	0.71	0.36	0.18	0.94	4.25	0.75
2010	13.65	34.29	24.86	8.50	7.60	9.08	2.27	4.97	15.70	8.78	17.73	26.59
2011	12.07	6.20	4.43	11.52	16.31	4.85	2.24	1.02	0.53	4.77	6.73	10.33
2012	6.82	18.89	9.84	8.81	2.36	1.22	0.59	0.30	0.15	0.43	4.25	8.72
Average	6.69	11.09	10.83	7.35	3.68	1.99	0.77	0.70	1.46	1.49	3.93	6.33
Std. Dev.	4.80	9.68	6.20	4.26	4.40	2.53	0.72	1.37	4.49	2.65	4.99	7.64
Variance	23.04	93.77	38.45	18.16	19.33	6.41	0.52	1.87	20.13	7.01	24.94	58.37
Skewness	-0.07	1.37	0.71	0.55	2.54	2.46	1.70	3.28	3.46	2.38	2.09	1.84

From the calculation, it can be seen that the reliable discharge, with the statistic percentage of being equal or more than calculated values is 80%, can be found during the first quarter of each year, normally between January and April, as can be seen below:

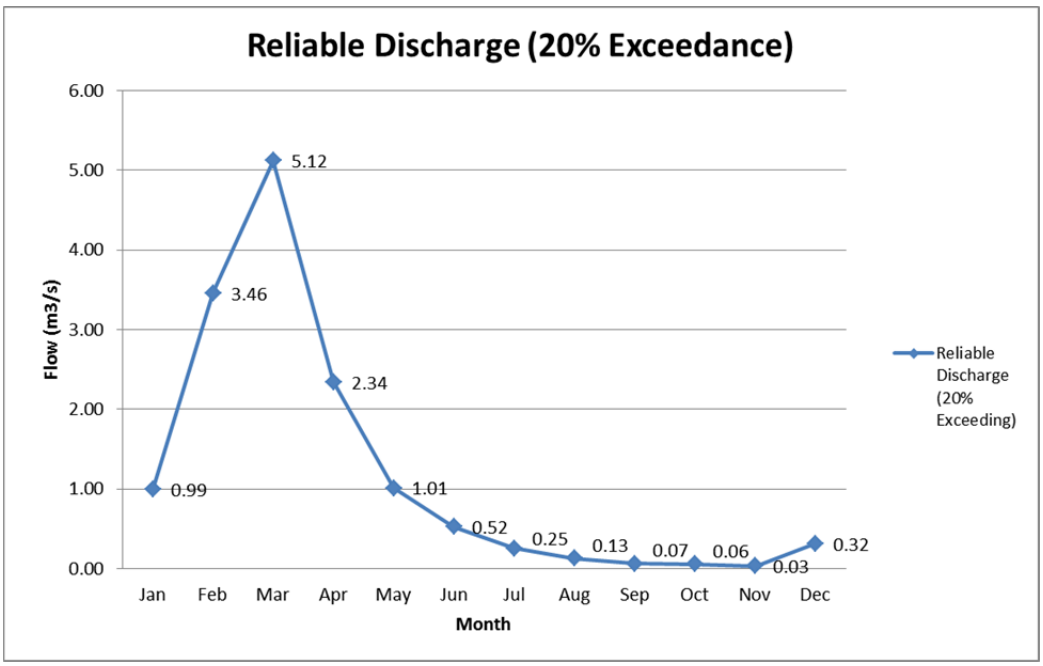


Figure 1. 26 Flow Pattern of Cisangkuy River

Unfortunately, the moment when the flow is in the lowest period (September – November) is the same as the lowest period of the hydropower production, which means that if the water from the hydropower plant is totally collected in the storage pond, there will be no excess water for the irrigation system downstream.

One of the alternatives to handle this condition is by giving some amount of water from the storage pond to the irrigation system, as long as it will not decrease the supply to the treatment plant. In contrast, between February and April there will be more water from Cisangkuy River which can be stored in the storage pond. Therefore, if the storage calculation is combined with the discharge from Cisangkuy River, the storage pond scenario and dimensions can be upgraded to store more raw water. However, the lower quality of Cisangkuy River water should also be taken into consideration. If the amount of more turbid water from the river is mixed with the water from hydropower discharge, the total water quality will decrease compared to the hydropower discharge itself.

1.6.3 Downstream Irrigation System

Another extra saving for the irrigation system in the downstream of Cisangkuy River should be taken into account. Even though it is important, there is no sufficient data regarding the volume of extraction or the time when the irrigation takes place. Therefore, some assumptions are made for the irrigation system using the standard approximate method for water need from Food and Agriculture Organization from United Nations (FAO), as follows:

The approximate method of determining water need for irrigation (SINgross) uses a constant estimated average irrigation need (INnet). The most simplified standard value for INnet is 1 L/s/ha, which is equivalent to a daily water requirement of 8.6mm, based on the FAO's conversion table

from mm/day to L/s/ha. The value of INnet in hot and dry climates can be three times higher than in humid climates.

To identify the gross water need for irrigation, the approximate value of irrigation need for an entire area (SINnet), should be calculated previously by multiplying INnet with the area (ha), as follows:

***SINnet** (L/s) = **Area** (ha) * **INnet** (L/s/ha)*

The estimated values of INnet based on the climates can be seen in the table below:

Table 1. 6 INnet Values Based on the Climates

Climate Type	INnet (L/s/ha)
Humid tropical climate	0.5
Monsoon climate in wet season	0.5
Monsoon climate in dry season	1.0
Semi-arid climate in wet season	1.0
Semi-arid climate in dry season	1.5
Arid climate	1.5
Agriculture field with rice only	1.5

Based on the data from the Central River Region Institution under the Indonesian Ministry of Public Works, the areas of irrigation in Ciherang and Kiangroke, the downstream parts of Cisangkuy River from Cikalong, are 2434.67 ha and 63 ha, respectively. Furthermore, in the Cikalong area, there are also some parts of agricultural fields of 503.54 ha. All of the fields are varied between rice and other crops.

Thus, in total, the irrigation area shall be:
Area = 2434.67 ha + 63 ha + 503.54 ha = 3001.21 ha.

The chosen climate type for Cisangkuy River area can be separated into two seasons; the monsoon climate in wet season (INnet = 0.5 L/s/ha) and dry season (INnet = 1.0 L/s/ha).

The net irrigation water need shall be:
SINnet = 3001.21 ha * 0.5 L/s/ha = 1500.61 L/s (wet season)
SINnet = 3001.21 ha * 1.0 L/s/ha = 3001.21 L/s (dry season)

Considering that there are some losses during delivery and application, there is another parameter for irrigation efficiency, as follows:

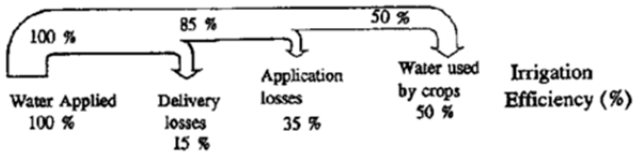


Figure 1. 27 Irrigation Efficiency Pattern

Total irrigation efficiency (e) = 50%
Thus, the total water need shall be:
SINgross = 100/e * 1500.61 L/s = 100/50 * 1500.61 L/s = 730.31 L/s (wet season)
SINgross = 100/e * 3001.21 L/s = 100/50 * 3001.21 L/s = 1500.61 L/s (dry season)

With the assumption that the wet season starts from October until March and the dry season starts from April until September, the total water need for irrigation will be extracted from the total storage pond volume, which means that the water treatment plant always has to discharge some parts of the water to the downstream agricultural fields for irrigation purpose.

On the other hand, the Ministry of Public Works from Indonesia also has estimated values of irrigation water, as follows:

Table 1. 7 Estimated Irrigation Water Need for the Downstream of Cisangkuy River from the Ministry of Public Works

No.	Dam/Catchment Name	Catchment Area [km2]	Irrigation Area [ha]	Water Need [L/s]	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	Ciherang	182.404	2434.67	Rice	2715.4	2715.4	2169.2	3215.4	2429.2	2429.2	1508.5	2160.0	2160.0	1630.8	1630.8	1630.8
	(Dam)			Crops	0.0	0.0	0.0	266.2	266.2	266.2	380.0	547.7	547.7	547.7	547.7	547.7
				Total	2715.4	2715.4	2169.2	3481.6	2695.4	2695.4	1888.5	2707.7	2707.7	2178.5	2178.5	2178.5
2	Kiangroke	183.836	63	Rice	70.3	70.3	56.1	83.2	62.9	62.9	39.0	55.9	55.9	42.2	42.2	42.2
	(Dam)			Crops	0.0	0.0	0.0	6.9	6.9	6.9	9.8	14.2	14.2	14.2	14.2	14.2
				Total	70.3	70.3	56.1	90.1	69.8	69.8	48.8	70.1	70.1	56.4	56.4	56.4
3	Cikalong	12.97	503.54	Rice	561.6	561.6	448.6	665.0	502.4	502.4	312.0	446.7	446.7	337.3	337.3	337.3
	(Sub-catchment)			Crops	0.0	0.0	0.0	55.0	55.0	55.0	78.6	113.3	113.3	113.3	113.3	113.3
				Total	561.6	561.6	448.6	720.0	557.4	557.4	390.6	560.0	560.0	450.6	450.6	450.6
Total Water Need for Irrigation					3347.3	3347.3	2673.9	4291.7	3322.6	3322.6	2327.9	3337.8	3337.8	2685.5	2685.5	2685.5

It can be seen that according to the table above, the highest water need comes in October, November, January, February, March, May and June. The pattern is not exactly the same as the values from FAO calculation. Considering this condition, there is an indication of the El Nino effect throughout the latest years, so that the pattern of dry and wet seasons has been changed.

Furthermore, the values from FAO estimation are far more conservative than the prediction from the Ministry of Public Works. It may lead to an interpretation that the Ministry of Public Works has more sufficient and reliable field measurement data which will produce more optimistic results.

Therefore, to approach a safer or conservative analysis, the final values for irrigation water need shall be the average values from the FAO estimation and the Ministry of Public Works data. By combining these two inputs, the pattern of the seasons will be more likely the usual pattern as FAO estimation, but the number will be more optimistic as from the Ministry of Public Works data.

The final values for irrigation water need per month can be seen below:

Table 1. 8 Final Estimation for Irrigation Water Need for the Downstream of Cisangkuy River

No.	Dam/Catchment Name	Catchment Area [km2]	Irrigation Area [ha]	Water Need [L/s]	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	Ciherang	182.404	2434.67	Rice	2715.4	2715.4	2169.2	3215.4	2429.2	2429.2	1508.5	2160.0	2160.0	1630.8	1630.8	1630.8
	(Dam)			Crops	0.0	0.0	0.0	266.2	266.2	266.2	380.0	547.7	547.7	547.7	547.7	547.7
				Total	2715.4	2715.4	2169.2	3481.6	2695.4	2695.4	1888.5	2707.7	2707.7	2178.5	2178.5	2178.5
2	Kiangroke	183.836	63	Rice	70.3	70.3	56.1	83.2	62.9	62.9	39.0	55.9	55.9	42.2	42.2	42.2
	(Dam)			Crops	0.0	0.0	0.0	6.9	6.9	6.9	9.8	14.2	14.2	14.2	14.2	14.2
				Total	70.3	70.3	56.1	90.1	69.8	69.8	48.8	70.1	70.1	56.4	56.4	56.4
3	Cikalong	12.97	503.54	Rice	561.6	561.6	448.6	665.0	502.4	502.4	312.0	446.7	446.7	337.3	337.3	337.3
	(Sub-catchment)			Crops	0.0	0.0	0.0	55.0	55.0	55.0	78.6	113.3	113.3	113.3	113.3	113.3
				Total	561.6	561.6	448.6	720.0	557.4	557.4	390.6	560.0	560.0	450.6	450.6	450.6
Total Water Need for Irrigation (Ministry of Public Works) = $\sum_{Total(1,2,3)}$					3347.3	3347.3	2673.9	4291.7	3322.6	3322.6	2327.9	3337.8	3337.8	2685.5	2685.5	2685.5
Water Need for Irrigation (FAO Estimation)					3001.21	3001.21	3001.21	3001.21	3001.21	3001.21	1500.61	1500.61	1500.61	1500.61	1500.61	1500.61
Average Irrigation Water Need					3174.3	3174.3	2837.6	3646.5	3161.9	3161.9	1914.3	2419.2	2419.2	2093.1	2093.1	2093.1

The average values are going to be added as a limitation for water storage pond mechanism to still discharge water for irrigation in the downstream parts of the river. The calculation can be seen in **Appendix C**.

The result shows the two conditions that can be done for irrigation system in the downstream of Cikalong intake point, as follows:

1. An Intermittent Flow from Cikalong intake point
   During this condition, there are several times that the intake point cannot supply flow to the downstream. However, in some other times, it can discharge more than the irrigation system needs. Therefore, the farmers downstream are suggested to create their own storage pond before discharging the whole water from the intake point directly to the irrigation channels.
2. A Continuous Flow from Cikalong intake point
   During this condition, the intake point from the water treatment plant is expected to have a larger storage pond to facilitate the downstream in dry conditions, so that the water can keep flowing downstream anytime.

The main difference of these two conditions is the dimension of storage pond that should be provided by the water treatment plant before the intake point. If the irrigation system is not part of the responsibility of the water company, the amount of water discharged downstream can be retained by another pond made by the responsible actors of these irrigation fields. However, if the previous agreement stated that the water company should provide water for irrigation, a larger pond in the upstream part of the intake point should be built to retain more water from the electrical company and Cisangkuy River. These considerations will be considered in the scenarios of the storage pond.

1.6.4 Discussions for Alternative Solution: Storage Pond

A simple-but-effective solution for having sufficient supply for all parties in Cisangkuy River tributary area has been a never-ending discussion since more than 20 years ago. According to Pak Ma'mur, the pipeline operator, several alternatives have been planned by the local government, regional government of Bandung, provincial government of West Java, and even the national government of Indonesia with the help of national and international engineering consultants. The proposed solutions are creating dam/storage, having another resource from Cilaki River which is more dependable, and massive rainwater harvesting. Nevertheless, all of them are still in conceptual design phase.

A storage pond can be considered as an alternative to have a constant supply and increase the capacity of raw water from the Southern part of Bandung. This consideration is based on the preliminary calculation of the flow condition from the hydropower plant (PLTA Cikalong) within the last two years:

Total Volume/Year from Hydropower (2014) = 153,331,056.00m^3 (12 months)
Total Volume/Year from Hydropower (2015) = 118,062,360.00m^3 (12 months, assumed Nov=Dec)
Total Volume/Year for PDAM = 56,764,800.00m^3
(1800L/s, 24 hours, 12 months or 365 days)
Percentage of Untaken Water (2014) = 62.98% (12 months)
Percentage of Untaken Water (2015) = 51.92% (12 months, assumed Nov=Dec)

The storage pond is designed in such way that the volume starts to decline in the beginning of September and fills up again in the beginning of December, as the water supply decreases during this period. The supply comes mainly from the discharge of electrical plant, PLTA Cikalong. When this supply point is not sufficient, the flow from Cisangkuy River will be the other accompaniment. The water treatment plant is also responsible not to take all water at the same time, so that the farmers in the downstream of the river can still extract water for irrigation purpose.

1.6.4.1 Scenario 1

The first scenario only considers the discharge from electrical plant as the only source and the Cikalong intake point as the only extraction point. The farmers in the downstream who need the water for their irrigation system are suggested to construct their own dam or storage pond based on the discharge from the Cikalong intake point, which does not flow constantly in a year, but is possibly sufficient if being managed by small dams or storage ponds.

The result from storage pond calculation based on Scenario 1 can be seen below:

Minimum Volume of Storage	=	20.00m^3
Maximum Storage Usage	=	-90,720.00m^3 (negative value of storage input)
Estimated Volume of Storage	=	223,580.00m^3
Estimated average depth	=	20m
Estimated area	=	11,179.00m^2 = 1.12ha

1.6.4.2 Scenario 2

The second scenario considers the same supply and extraction points as Scenario 1, while increasing the extraction capacity approximately 25% from the current volume. This intention is in line with the objective of the improvement project of Badaksinga water treatment plant to increase 25% from the total production capacity. The irrigation system is still not considered in this scenario, so that the flow downstream should be managed separately if the irrigation demand needs to be fulfilled constantly.

The result from storage pond calculation based on Scenario 2 can be seen below:

Minimum Volume of Storage	=	8.00m^3
Maximum Storage Usage	=	-129,600.00m^3 (negative value of storage input)
Estimated Volume of Storage	=	415,700.00m^3
Estimated average depth	=	20m
Estimated area	=	20,785.00m^2 = 2.08ha

1.6.4.3 Scenario 3

The third scenario considers the supply points from the hydropower plant (PLTA Cikalong) and from Cisangkuy River. Because the amount of water going to the Cikalong intake point is higher than only from the hydropower plant, the irrigation demand can be also put into consideration. Apart from the main extraction for the water treatment plant, the excess of the water can be eliminated for the irrigation purpose, too. However, it increases the dimension of the storage pond that should be provided by the water treatment plant.

The result from storage pond calculation based on Scenario 3 can be seen below:

Minimum Volume of Storage	=	4.94m^3
Maximum Storage Usage	=	-261,943.63m^3 (negative value of storage input)

Estimated Volume of Storage = 5,706,440.00m^3
Estimated average depth = 20m
Estimated area = 285,322.00m^2 = 28.53ha

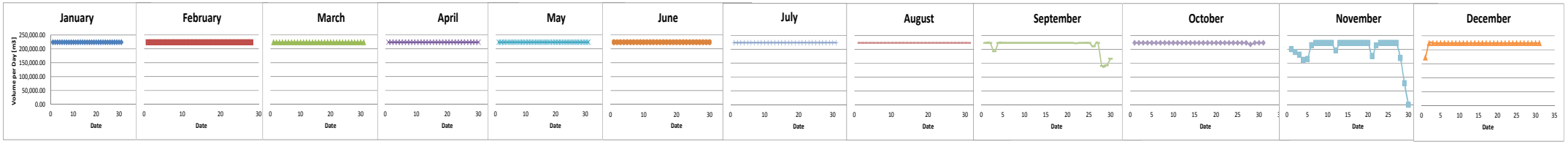
1.6.4.4 Scenario 4

The last scenario combines all considerations into one; two supply points from the hydropower plant and from the river, two demand points from the intake point of water treatment plant and from the downstream irrigation systems, and the 25% increase of the extraction point. These considerations create the largest dimension of the storage pond, but guarantee the sufficiency of water during the whole year, in the condition that the hydropower plant releases the discharge in a similar flow rate and pattern as within the last two years (2014 and 2015).

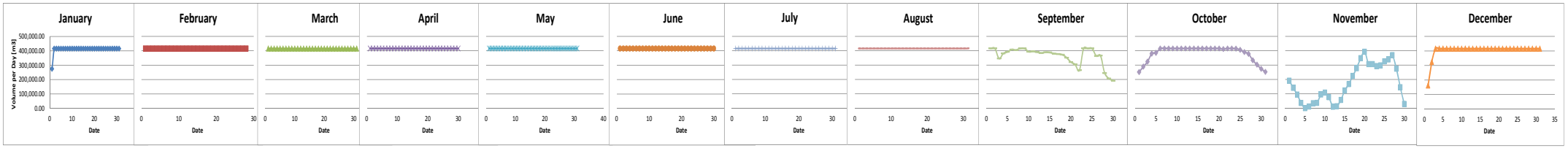
The result from storage pond calculation based on Scenario 4 can be seen below:
Minimum Volume of Storage = 4.90m^3
Maximum Storage Usage = -300,823.63m^3 (negative value of storage input)
Estimated Volume of Storage = 8,632,687.00m^3
Estimated average depth = 20m
Estimated area = 431,634.35m^2 = 43.16ha

The complete calculation of the dimension of the storage pond, including the filling and discharging mechanism from all scenarios can be seen in **Appendix C** and the results can be seen in the graphs below.

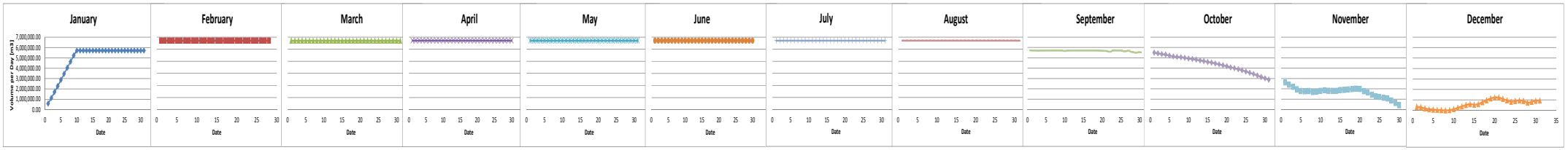
Scenario 1



Scenario 2



Scenario 3



Scenario 4

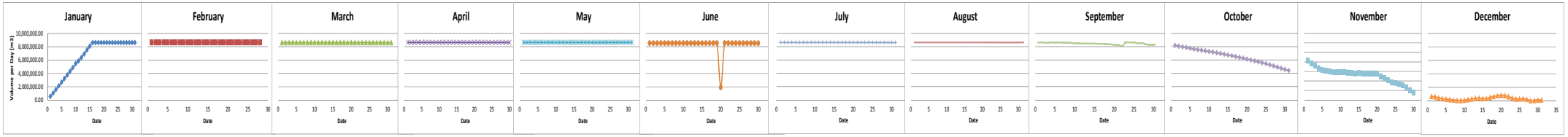
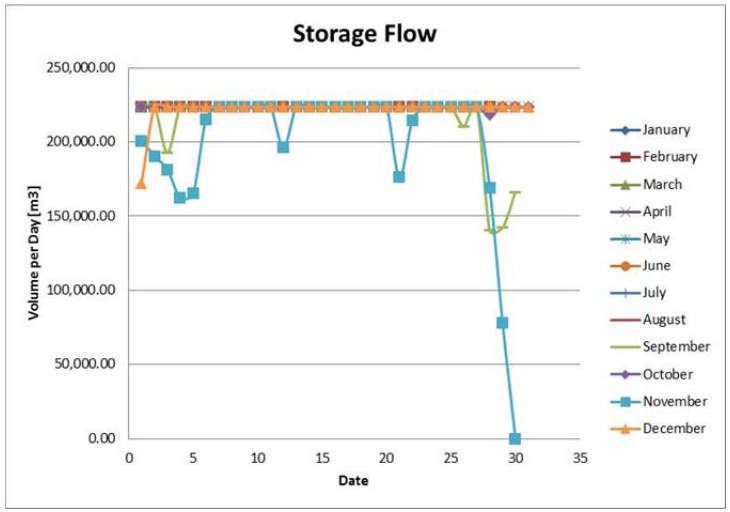
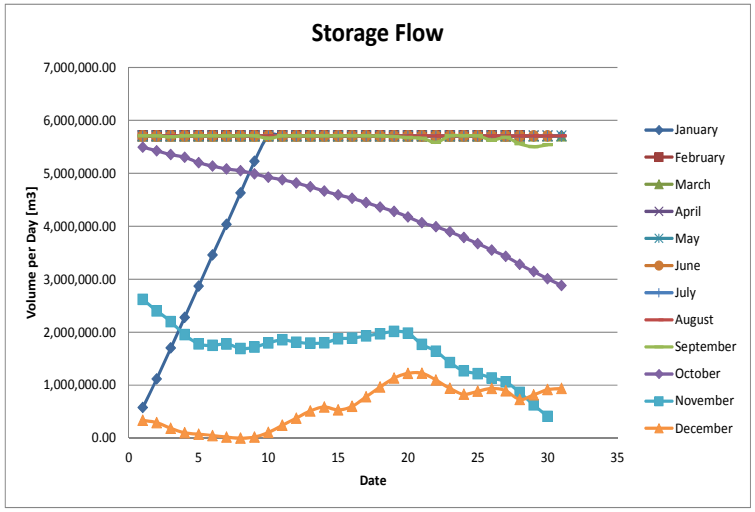


Figure 1. 28 Storage Pond Estimated Occupancy

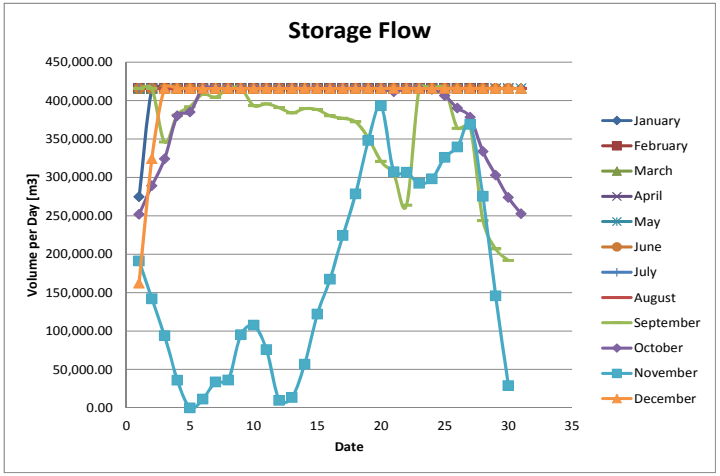
Scenario 1



Scenario 3



Scenario 2



Scenario 4

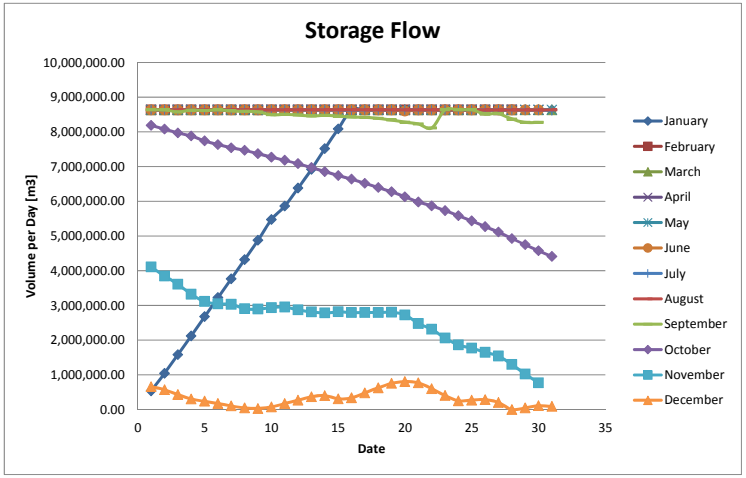


Figure 1. 29 Storage Pond Estimated Volume per Day

As can be seen from the graphs above, the storage is in full-filled condition by default. The water level starts to decrease in September and begins to rise again in the late December. Based on those 4 scenarios, the most recommended one depends on the area which can be occupied to create the storage pond and the agreement with the farmers for irrigation systems. Furthermore, due to the evaporation effect, it would be better to design a deep storage pond with a proportional surface area than a large one with shallow depth because the amount of water which can be evaporated is directly proportional to the surface area.

To evaluate the advantage of constructing a storage pond, a simple comparison between the intake volume with storage pond (constant and stable flow rate for 24 hours) and without using it (constant flow is only for 18 hours) is calculated as can be found in Appendix D. Assuming that the extraction of water for any other purpose is the same between both conditions, the saving of raw water until 33% can be taken by constructing the storage pond.

1.7 Water Quality in the Intake

There is an important issue that should be considered further before mixing the two supply points; the raw water quality. The sample for water quality analysis was taken from the open channel in the intake area because this is the default raw water source for the water treatment plant. The flow from Cisangkuy River is only taken in emergency condition where the flow is insufficient.

During the normal flow condition from the hydropower plant, the turbidity of the intake is between 10 and 50 NTU. The turbidity is considered sufficient for the intake. Meanwhile, the turbidity of Cisangkuy River is usually higher than the hydropower plant discharge because the water from the turbine has been stored beforehand, so that the sand has been pre-settled and it gives a result of lower turbidity from the discharged water via the open channel to the treatment plant intake.

However, during the flushing periods of the hydropower plant, the turbidity of the turbine discharge can reach more than 15,000 NTU. When this turbid water occurs, the operators will close the transmission pipelines. The flushing schedule is regulated by the hydropower plant, as has been elaborated in section **1.5.5. Performance under Frequent Flushing of Hydropower Plant** page 25.

At this moment, there is no turbidity measurement in the intake point at Cikalong. The operators estimate the turbidity from the raw water only by visual experiences and after the water reaches the treatment plant, and then the water can be examined. Usually the turbidity in the intake from the river varies from 20 until 5000 NTU and the operators identify it with certain local codes ("*bajigur*" if the turbidity is in the highest value, "*kopi susu*/café latte" for a medium one, and "tea" for a good quality of the intake). If the quality is too inadequate for the treatment plant, the plant operators will inform the intake operators to immediately stop the supply. Therefore, to check the quality of the raw water source, water quality analysis is conducted by a third-party laboratory.

1.7.1 Laboratory Analysis

Laboratory analysis is performed by LPKL, a daughter company of PDAM Bandung, the water treatment plant itself. It also conducts regular inspection for the plant. The sample was taken in the beginning of the rainy season.

Table 1. 9 Raw Water Quality Analysis Result

NO	PARAMETER	UNIT	STANDARD	ANALYSIS	METHOD OF REFERENCE
	Physical				
1	Total Suspended Solids (TSS)	mg/L	-	44.00	SNI 06-6989.3-2004
	Chemical				
1	Arsenic (As)	mg/L	0.01	< 0.05797	USEPA Method No. 200.7
2	Total Chromium (Cr-T)	mg/L	0.05	< 0.00269	USEPA Method No. 200.7
3	Cadmium *(Cd)	mg/L	0.003	< 0.00618	USEPA Method No. 200.7
4	Aluminium (Al)	mg/L	0.2	< 0.01090	USEPA Method No. 200.7
5	pH		6.5-8.5	6.948	SNI 06-6989.11-2004
6	Copper (Cu)	mg/L	2	< 0.00527	USEPA Method No. 200.7
7	Ammonia (NH3-N)	mg/L	1.5	< 0.0005	SNI 06-6989.30-2005
8	Mercury (Hg)	mg/L	0.001	< 0.01320	USEPA Method No. 200.7
9	Lead (Pb)	mg/L	0.01	< 0.0307	SNI 6989.8-2009
10	Oil and Grease	mg/L	-	< 2.21	SNI 06-6989.10-2004
11	Total Organic Carbon (TOC)	mg/L	-	< 0.3000	SM 5310 B (21 Ed./2005)

Date of Sampling : 30 November 2015 *Date of Analysis : 30 November – 08 December 2015*

= analysis result is considered too low

= analysis result is higher than the standard

1.7.1.1 Result Discussions

As can be seen from the water quality assessment, it can be inferred that:

1. The TSS concentration is acceptable based on visual experience. In general, water with a TSS concentration less than 20 mg/L is considered clear, with concentrations between 40 and 80 mg/L tends to be cloudy, and over 150 mg/L is usually dirty. If functioning well, the presedimentation tanks can help lowering the TSS concentration (Durgan, 2002, p.01).
2. Some chemical compounds exist in the raw water sample (Cd, Al, Hg and Pb), which are possibly harmful. Their appearance in the raw water is possibly from the waste dumping in the upstream parts (solid wastes or grey water from the bathroom or kitchen sinks), pesticides, insecticides and/or fertilizers for the plants in the seasonal agricultural fields in Cipanunjang and Cileunca Lake, zeolite mining in Cikalong side areas (Eddy, 2015), the functional shift of Cileunca Lake from a water storage to a casual motorcycle racing circuit, and roof tiles industries in the village of Cikalong (Juanita, 2015).
3. The amount of oil and grease is acceptable based on several standards which are normally state the maximum amount of oil and grease should be 5.0mg/L.
4. The amount of ammonia (NH_3-N) is considered too low for common raw water quality. Ammonia concentration in groundwater is normally 0.1 – 0.2mg/L and in surface water can vary between 0.2 and 12mg/L. Thus, the analysis result is closer to the quality of effluent, instead of raw water. Considering the existence of agricultural fields and animal farms upstream, it is recommended to retest the ammonia concentration in raw water.
5. The amount of total organic carbon (TOC) is considered too low for common raw water quality, which is normally starts from 2.0mg/L and can reach more than 8.0mg/L.

Hence, in general, the water from the hydropower plant discharge is qualified to be supplied as raw water for the drinking water treatment plant. However, this source is not continuously

available for 24 hours. Since the discharge is generally higher than the demand from the plant, the storage scenarios elaborated in section **1.6 Water Quantity in the Intake** can be used as a basic consideration for improvement in the future.

1.7.2 Visual Interpretation in the Field

From the visual interpretation in the field, it can be observed that during rainy seasons, the turbidity from the discharge of the hydropower plant is much lower than the quality of Cisangkuy River flow, as below:

Figure 1. 30 Visual Appearance of Raw Water Sources during Rainy Seasons

However, during dry seasons, the turbidities of both raw water sources are more similar to each other, as below:

Figure 1. 31 Visual Appearance of Raw Water Sources during Dry Seasons

1.7.2.1 Visual Appearance Discussions

During rainy seasons, the idea of mixing these two sources will dilute the undesired substances and they will end up together in the presedimentation tanks, which leads to a higher load for the presedimentation tanks. However, it is a good advantage during dry seasons because both sources can be combined together to meet the demand from the plant.

There is also an indication that suspended solids may be carried through the pipelines and arrive as the influent of water treatment plant, due to the inefficiency of presedimentation tanks (section **5. Presedimentation Tanks** on page 13). Thus, the decision of taking raw water source should be handled with extra attention. It is recommended to prioritize the discharge from hydropower plant as the first and only supply point, and use the water from Cisangkuy River for emergency purpose only. In the future, further research and solution for improving settling efficiency in presedimentation tanks will be highly beneficial.

1.8 Conclusion

The main problems of the southern raw water intake were:

1. Inadequacy of the water quantity due to the intermittent flow from the discharge of PLTA Cikalong, the hydropower plant, which is the main source from the south
2. Fluctuation of water quantity and quality between rainy and dry seasons
3. Indication of inefficiency in the presedimentation tanks

Through the investigation within the historical data from the hydropower plant and hydrological data for Cikalong catchment area, it can be concluded that the quantity of water is sufficient when it is calculated daily and monthly, but the discontinuous flow from the hydropower plant discharge decrease the provision of raw water to the plant. The flow also fluctuates between rainy and dry seasons, both from the hydropower plant and from Cisangkuy River. A storage mechanism is proposed to become an alternative solution for this matter.

When both sources from the hydropower plant and from the river are combined to meet the demand, the water quality may decrease. The presedimentation tanks are also indicated to be inefficient with actual dimensions and retention time. Lower horizontal flow or longer retention time can be some recommendations to increase the efficiency.

Chapter 2 Transmission Pipeline

This section of the report is about the transmission pipelines for the PDAM Drinking Water Treatment Plant (DWTP). There are 4 transmission pipelines for this DWTP: Pipa Lama (old pipeline) and Pipa Baru (new pipeline) from Cisangkuy River, a pipeline from Dago Bengkok, and another from Cikapundung River. Due to the limited time, the research is focused on Pipa Baru, the new transmission pipeline from Cisangkuy River.

Pipa Baru currently faces 3 main problems: burst along the pipeline, not being able to transport water at full capacity and the accuracy of flow meters. The possible solutions for these problems will be explained in the Discussions section. This section will follow in order from a quick scan of the transmission pipelines, conducted field measurements, a numerical simulation, finally the evaluation of these results.

2.1 Background

The new pipeline, Pipa Baru, was built in 1993 and has a length of 31.135 km, from Cikalong to Badaksinga, with a diameter of 850 mm. The design capacity of this pipeline is 800 L/s, but unfortunately, the capacity which it transports is on average 600 – 650 L/s, and has never been able to operate with its full capacity in its lifetime. The profile of Pipa Baru is illustrated in Figure 2.1. The points are taken from air valve and washout locations.

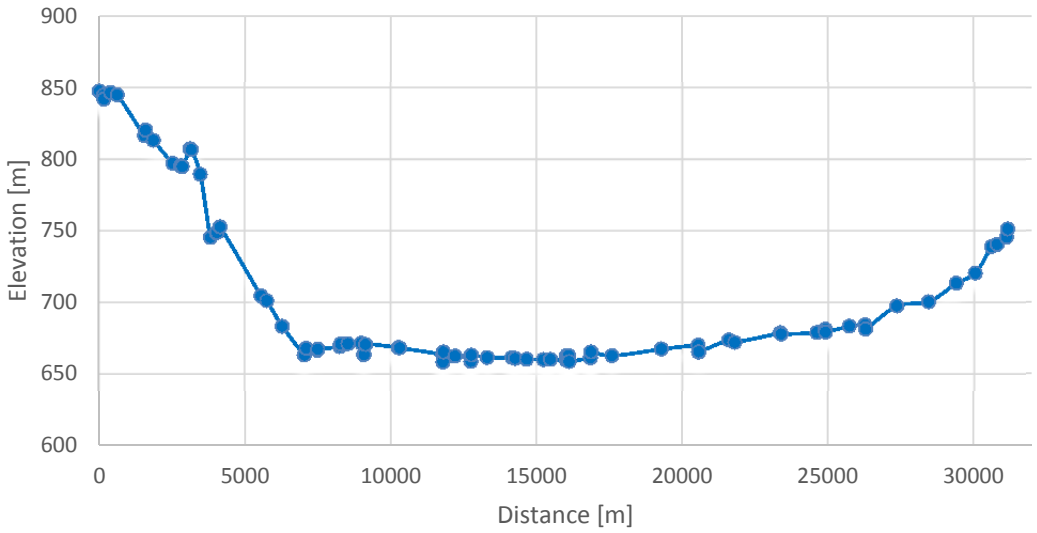


Figure 2. 1 Profile of Pipa Baru, new transmission pipeline

This pipeline is made of steel with a concrete lining, however, in five sections of the pipeline, it is only made of reinforced concrete. These sections are given in Table 2.1.

Table 2. 1 Locations and Length of Concrete Sections

	Section locations	length [M]
1	Jagabaya – Tarigu	957
2	Kulalei – Bale Endan	553
3	Perum Bali – De Leng Kong	1048
4	Sekajati – Kejaksaan Kiaracondong	941
5	Jl. Melania – Geologi Museum	250

The reason for having these reinforced concrete sections in the transmission pipeline is unknown, but having a change in the type of material can cause the existence of weak spots along the pipeline. One of these five sections have all the historical records of bursts along Pipa Baru, the section from Jagabaya to Tarigu. The reasons for these bursts are not known, and experts have not been called to search for the possible causes of the pipe bursts. The details of the bursts are illustrated in Table 2.2.

Table 2. 2 Historical Records of Bursts

	Date	Location	Average pressure [BAR]
1	September 2006	500 m after OVS1	9
2	June 2011	1000 m after OVS1	13
3	June 18th,2015	1100 m after OVS1	13

*OVS1 is an air valve location approximately 4000 m from the intake

During the dry season, there is often not enough water supply from the intake, in some days the discharge to the DWTP was as low as 1000 L/s. In these situations, only Pipa Lama, the old pipeline, is used for the transmission of water. The operators stated that the reasons for this is because firstly, the old cast iron pipe is difficult to fill up once made empty. The accessories have deteriorated, and there are possible leakages along the pipe, which are difficult to fix due to its cast iron material. Secondly, the operators want to keep the pressure in Pipa Lama constant to avoid the deformation of the old cast iron pipe. For these reason, Pipa Baru is often filled and emptied repeatedly during the dry season.

2.2 Measurements and data from PDAM

Under these different seasonal conditions, the pressure is measured along Pipa Baru and all the other pipelines every month by the operators in Cikalong using a manometer. The values measured from 2013 till now are shown in Figure 2.2.

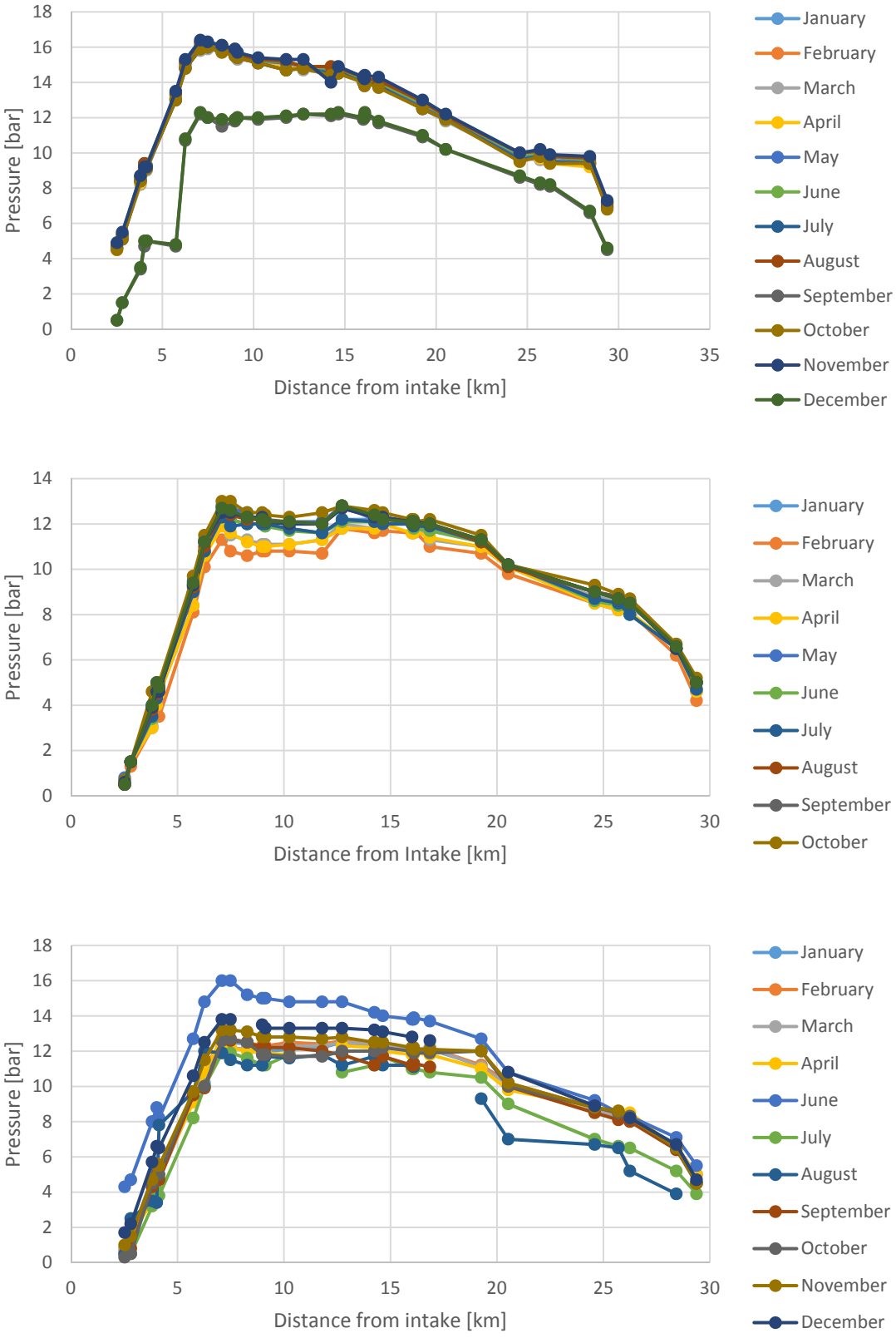


Figure 2. 2 Pressure Measurements conducted by PDAM from 2013 (top) to 2015 (bottom)

These pressure measurements are not conducted at the same time of the day, and are just point measurements; not taken for a continuous time, only for a particular time. The operators whom conduct the measurements start at the intake, and measure each point one at a time moving down the pipeline till the DWTP. Thus, these measurements do not consider the possible variations during the day. Furthermore, the manometer does not have a digital display, so the accuracy also relies on eyes of the operators.

Figure 2. 3 Monthly pressure measurements conducted with a manometer

The flow velocity of the pipeline is only measured at Badaksinga, the location of the DWTP, with a fixed strapped on flow meter from Endress+Hauser. This flow meter has been said to have been installed when Pipa Baru was built, thus it must be at least 20 years old. This Endress+Hauser flow meter is shown in **Figure 2.4**.

Figure 2. 4 Endress+Hauser Clamp-on flow meter in Badaksinga

In other locations of the pipeline, flow measurements are not made, although they have a clamp-on ultrasonic flow meter readily available. This ultrasonic flow meter was later used to check the flow in Pipa Baru.

At the hydroelectric plant upstream of the transmission pipelines in Cikalong, there are discharge measurements made, however, it is manually measured relying just on the eyes of the operators, and the accuracy is unknown and have never been checked. In **Figure 2.5**, this discharge measurement is shown: the openings from largest to smallest measure 600 L/s, 400 L/s, 200 L/s, 200 L/s and 100 L/s.

Figure 2. 5 Discharge measurement in Hydroelectric power plant upstream of PDAM Cikalong

Furthermore, since there is no flow meter upstream in the PDAM facilities, the opening and closing of the sluice gates controlling the flow in the transmission pipelines are conducted while communicating with the operators the Badaksinga DWTP. Once the operators in Badaksinga state that there is enough water supply reaching the DWTP, the operators upstream in Cikalong will stop altering the sluice gate. This results in inaccuracies of the amount of discharge, and the pipelines almost never operates at full capacity.

Moreover, the duration of the opening and closing of the sluice gates are stated to be approximately 30 minutes, however, from observing the operators, some closures were conducted in as fast as 2 minutes. Closing the gate in a very short time, without being able to monitor the discharge, could be one of the main causes of the problems which occur in the pipeline. Emptying and filling the pipe must be done over a certain time to have minimal impact to the pipeline, but again, this will require further research. And in the later sections, there are other mechanisms having a larger impact on the pipe.

According to the Dutch design of Pipa Baru in 1988, there were check valves, butterfly valves and speed reducer valves along the pipeline. Although the details for the check valves and speed reducer valves were not found, the operators stated that the original butterfly valve was removed in 2003.

Figure 2. 6 Valves removed from pipeline stored in PDAM Cikalong

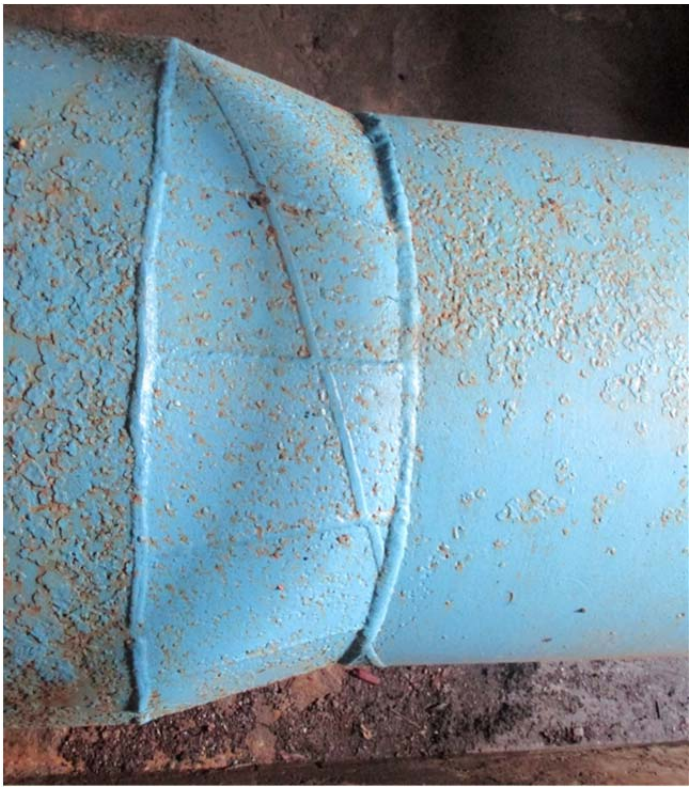


Figure 2. 7 Location at OVS1 Pipa Baru where the butterfly valve was removed and pipeline was welded back together

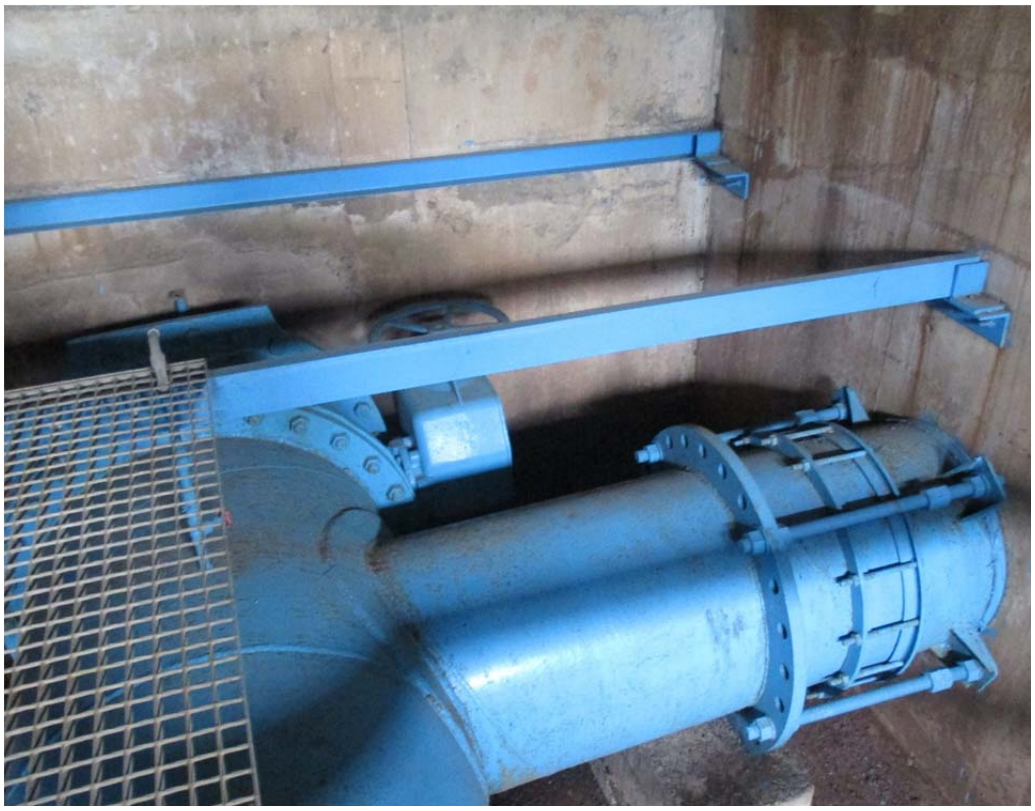


Figure 2. 8 Interconnection between Pipa Baru and Pipa Lama at OVS1, and butterfly valve after the interconnection

The butterfly valves were still functioning when it was removed, however, the operators were not explained properly the main functions of the valve. They thought the valve was restricting the flow too much, but the final condition of this butterfly valve is not known. This could have resulted from a maintenance issue as well. To overcome this problem, the operators decided to fixate the plate in the valve to stop restricting the flow. Furthermore, due to the heavy traffic load on the roads next to the pipeline, the valve seemed to have also blocked the flow in the past. For all these reasons, the butterfly valves was removed, and were replaced by larger butterfly valves with a diameter of 1000 mm. These butterfly valves are located after the interconnections in air valves OVS1 and NRVS.

The transmission pipeline from Cikalong to Badaksinga runs through the areas of Cikalong, Banjaran and Bandung city. Through Banjaran and the suburban areas of Bandung, peoples' houses, schools and shops are located above the pipelines. People inhabited the area before, but as the Bandung area became more developed, more people inhabited the areas above the pipeline. In these rural areas, people have more power than the company so it is very difficult to move the people away and there is no law which would protect PDAM. So the safety of the people are constantly at risk if there are any bursts or problems along the pipeline.

2.3 Accessories, Air valves & Maintenance

2.3.1 Accessories

Along Pipa Baru, there are 5 different types of accessories: air valves (AV) or air valves on pipe bridges (AVPB), air valve from TM manufacturer (AVTM), over-valve speed (OVS), check valve (NRVS), and washout (WO). The details of the accessories are shown in Table 2.3.

Table 2. 3 Information of Air Valves and Accessories

	Type of Accessory	Diameter of valve	Amount
1	AV/AVPB	Ø150	35
2	AVTM	Ø125	24
3	OVS	Ø1000	3
		Ø700	1
4	NRVS	Ø1000	2
		Ø700	1
5	WO	Ø600	4
		Ø400	1
		Ø200	25

From observing Pipa Baru during the 5 weeks, it is unclear if all of these accessories are functioning as it should. It seems that there is a lot of air in the pipeline, possibly the reason behind why Pipa Baru has never been able to transport water at its full capacity. Furthermore, during one of the final meetings at PDAM, a question was raised whether the over-speed valve which is supposed to control the pressure in the pipe to be less than 15 bars is working. This over-speed valve (OVS) is supposed to control the peak of the highest pressure, however, from viewing Figure 2.2 illustrating the pressure measurements of 2015, it is clear that for the month of June the peak exceeds 15 bars. This OVS which the managers of PDAM are referring to is most probably the butterfly valve. This is said because in the location of where this OVS should be, there was only an AVTM and a butterfly valve.

Moreover, other operators stated that although the pipe is recorded to be full in the lowest point of Pipa Baru, there is no flow near Badaksinga. This raises the question of whether the NRVS check valves located near Badaksinga DWTP which is supposed to restrict the flow to go in the opposite direction is working. These will be discussed further in Section 2.8.2.

2.3.2 Air valves & Maintenance

There are 51 air valves along Pipa Baru, and the size of the valves along the pipe are 1/2”. The valve size were originally 5/8” because the pipeline was designed to be used for distribution. However, after its construction, the use of the pipeline was changed to transmission. With this change, the 5/8” sized valves which have thinner walls were easily broken, and thus increased the size to strengthen the valves, and also to simplify the pressure measurements.

On December 8th, the monthly pressure measurements and air valve maintenances were conducted along Pipa Baru. The pressure measurements were conducted in the method as explained before. To understand the air valve maintenance, first the air valve itself will be explained briefly. This new type of air valve has a small ball, approximately 2 cm, located in the

Figure 2. 9 New type of air valves along Pipa Baru

middle which moves up and down as necessary to release the air from the pipes. This small ball is stabilized by the three layers of piston like pvc materials illustrated in **Figure 2.9**. During the maintenance, the operators tested whether the ball would push itself back into its normal position. To check this, the operators closed the valve, pushed the ball out of its position with a stick of bamboo, and opened the valve causing the water to flow out of the valve. Next, they removed the stick to check if the water flow would stop and the air bubbles would come out of the valve. Although this is not the conventional way of conducting maintenance in other more developed countries, the theory behind what needs to be checked an maintained is correct. Thus, as long as the air valve is not damaged from the process, it can be said to be an acceptable method. A part of the process if shown in **Figure 2.10**.

Figure 2. 10 Air valve maintenance

These maintenances are important in order to prevent air valve malfunctions. On November 30th, there was an air valve malfunction along Pipa Baru. This air valve problem occurred at a valve located inside an elementary school. Fortunately, the flooding from the air valve occurred after the children were sent home so it did not cause any problems within the school.

Figure 2. 11 Elementary school where the flood cause by the air valve malfunction occurred

The engine for the pump is as old as the pipe, over 20 years old, thus, it took 2 hours for it to start working. Once the pump started working, the water was taken out of the valve hole, and the operators were able to fix the air valve. This air valve problem was caused due to solids in the pipe getting stuck inside the pipe, resulting in the ball of the valve not being able to move back into its right position. The solids which were retrieved from the valve are shown in **Figure 2.13**. The solid on the left is a piece from an aluminum can, and on the right is sediment solidified after a long period. These kinds of air valve malfunctions can most probably be prevented by improving the processes upstream – this is explained in more detail in the previous section of the water quality and quantity in the intake.

Figure 2. 12 Flooding caused by the air valve malfunction

Figure 2. 13 Solids removed from the air valve causing the flooding

2.4 Equipment

2.4.1 Ultrasonic flow meter

The ultrasonic flow meter (UDM-300) which is used for the flow measurements in this project is provided from the supplier sebaKMT. This portable flow meter is easy to use, and the requirements for measurement are that the pipe is more than 70% full, there are minimal material deposits in the pipe, minimal bubble accumulation, and to have an undisturbed flow profile for accuracy. At PDAM, the company is at close contact with the supplier company branch based in Jakarta, Indonesia. Therefore, if there are any problems with this flow meter, they can easily reach the supplier and also contact them for any inquiries. During the 5 week stay for field research, the supplier visited PDAM in order to teach the operators how to use the flow meter correctly.

Figure 2. 14 Ultrasonic Flowmeter Measurement

2.3.2 Pressure Gauges

The LOGiT LPT Pressure and Temperature data logger allows the measurement and recording of temperature and pressure with external sensors. The measurement range is 0 to 500 PSI for the pressure, which was more than sufficient to measure the pressure changes in the pipeline. Furthermore, the data logger allows a total of 21500 readings, which, for example, is capable of recording the measurements every 2 seconds for 6 hours. Unfortunately, the time interval of 1 second is the shortest possible interval, and that is too large in order to measure a water hammer.

2.4.3 WANDA

WANDA is a software developed by Deltares for the hydraulic design, control and optimization of pipeline systems. This program is used to assess the steady state characteristics of the system and the dynamic behavior of different media transported through the system. In this project, WANDA was used to analyse the current situation of the pipeline, specifically Pipa Baru, and determine the weak points and possible improvements which could be suggested under the ideal pipeline conditions simulated in the program.

2.5 Pressure Measurements

The first measurement for pressure was conducted on November 26th. To get an overview of Pipa Baru as a whole, 3 locations along the pipeline are chosen for measurements: one near the intake, one around the lowest point of the pipeline profile, and another near the DWTP.

The first location of measurement is OVS (Over-valve speed) 1. In this location, there is an interconnection between Pipa Baru and Pipa Lama which is used when there is a burst downstream as illustrated before in **Figure 2.8**. Further, there is a butterfly valve after the interconnection and a TM air valve before the interconnection. The second location is Kukje, in the Banjaran area. This valve is located inside a small village, and this location was chosen as this location has the highest pressure in the pipeline. The third location is DKK (Dinas Kesehatan Kota) 1. This location is very close to the DWTP, and is already inside Bandung city. The pressure and temperature data was logged for 6 hours, every 2 seconds, to see the variation during the day. The results are illustrated in **Figure 2.16**.

Figure 2. 15 Air valve in Kukje, located inside a village

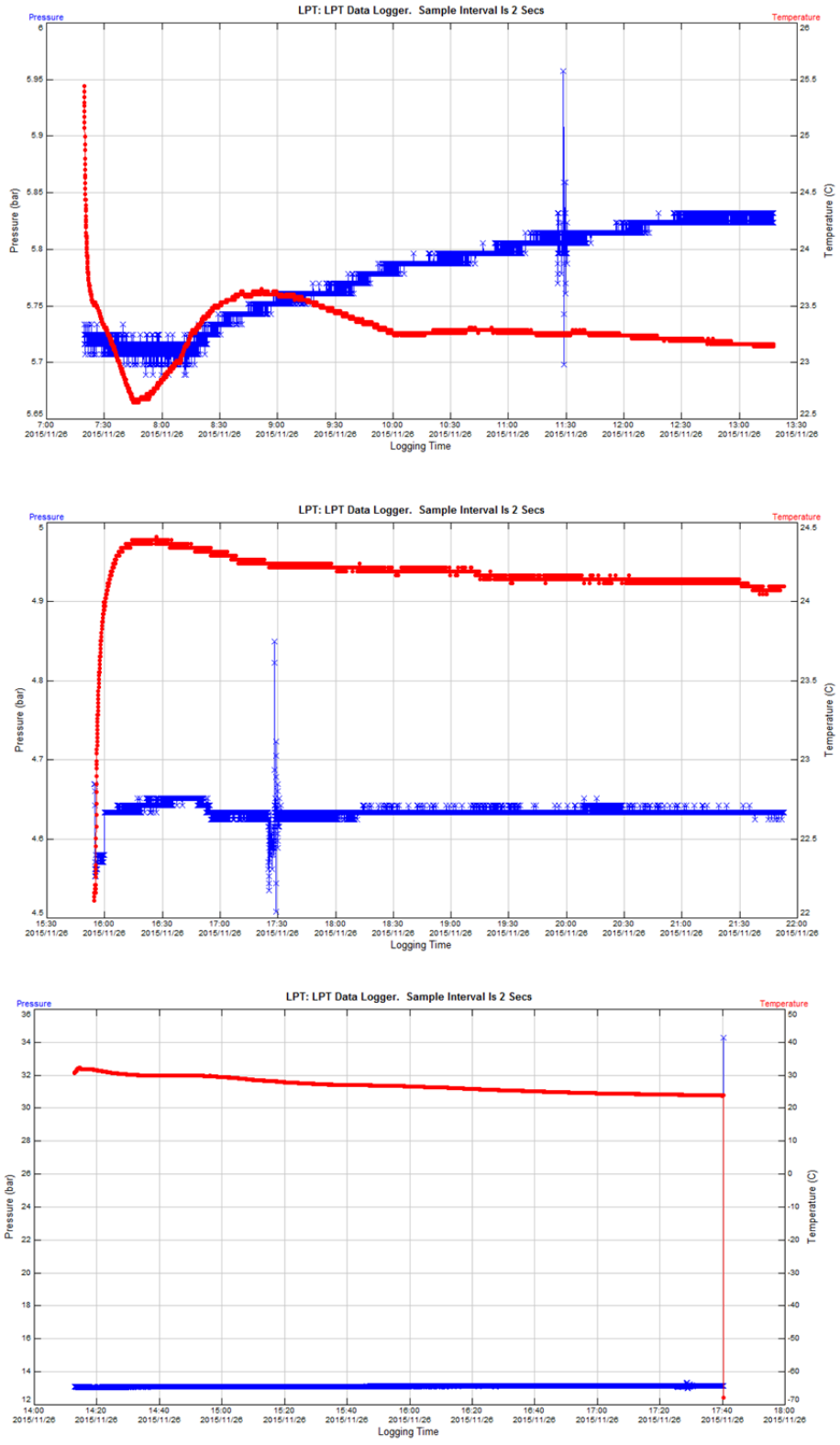


Figure 2. 16 Pressure and Temperature at (a) OVS1, (b) Kukje[1], and (c) DKK

During this first measurement, Pipa Baru was closed at 15:40 due to the insufficient water supply at the intake, and was continuously closed for the following 7 hours. This can also be

[1] Time axis in (b) is incorrect due to error in the program, and it should start at 12:00.

seen in the Figure 2.16. It is clear that there is a slight peak at around 16:30, which could be assumed to have been caused by the closure of the gate. Although it is visible in the graph, the change in pressure is very slight, approximately 0.4 bars, thus its influence on the pipe is negligible. For the case of Kukje, there was a sudden jump in the pressure which caused an automatic stop in the measurements. The operators stated that this may have resulted from the closure of the gate as well, however, the reason for such a large jump to have occurred is unknown. In all three of these graphs, the influence of the gate closure can be recognized, and these closures may be causing water hammers to occur in this pipeline. This calculation is made in the Section 2.8.3.

All the historically recorded bursts of Pipa Baru are located near OVS1, 4000 m downstream of the intake. For this reason, the pressure measurements and flow measurements are focused in that section in the pipeline. Moreover, the first measurements of pressure left some questions, so a second pressure measurement was taken on November 30th. The chosen location was air valve at Tarigu (Jl. Kiangroke), in the section with historical bursts.

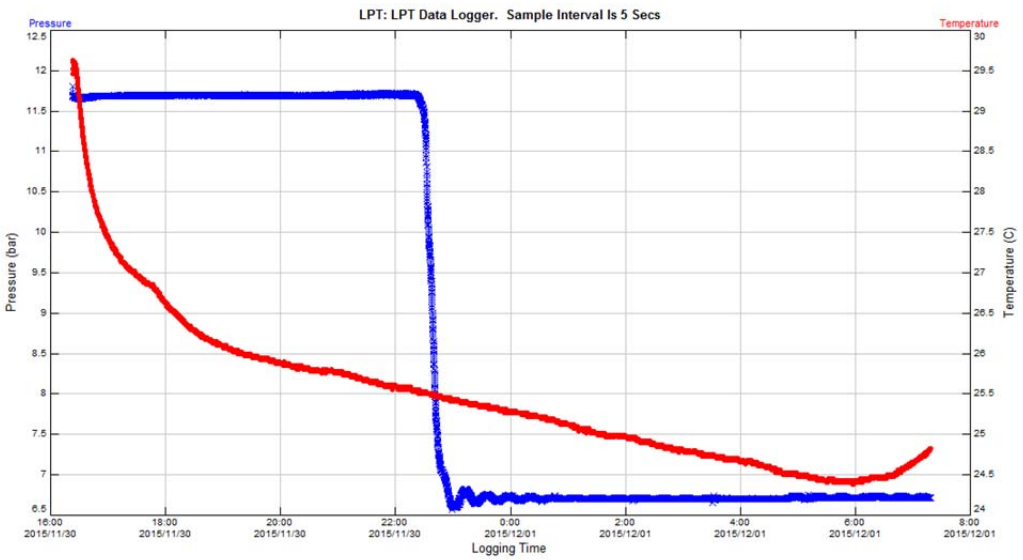


Figure 2. 17 Pressure and Temperature at Tarigu

Again due to the insufficient water supply at the intake, Pipa Baru was closed at 22:00, and was continuously closed for 10 hours. The change in the pressure from 11.7 bars to 6.5 bars occurred in a duration of approximately 30 minutes. From the elevation effect, the allowable pressure at Tarigu should be around 13.5 bars, and from the usual data, the average pressure measured at the location is also around 13 bars. This is sufficient, and should not affect the pipeline. Furthermore, a change of 5 bars in the pipeline is large but as it is over a time span of 30 minutes it would not cause immediate damage to the pipes. In the dry season, however, this process of emptying the pipe and filling the pipe is repeated quite frequently, in times twice a day, and this repetition may be a large factor impacting the strength of the pipeline and affecting the transport capacity. This impact is further discussion in Section 2.7, looking at it from different points of views such as water hammer causes and air stagnation.

2.6 Flow Velocity Measurements

The measurements for flow velocity were conducted on a pipe bridge to enhance the accuracy of the flow meter - the flow meter requires causes of distrurbances to be a certain distance away for accuracy. The first location chosen was a pipe bridge in Cisela, however, due to the rain protection and the severe rusting of the pipeline, the flow meter could not read the flow in the pipeline. Furthermore, the transducers for the flow meter were placed on top of the pipeline, and without having a full pipe, the meter cannot read the flow.

To overcome the problem in the first location, the second location chosen was on the pipe bridge at OVS1 shown in Figure 2.18. This time, the transducers were placed on the side of the pipe, and were also placed 10 m away from the butterfly valve and 6 m away from a bend. With this condition, it is possible to measure the flow in an undisturbed profile as it is far from causes of disturbances.

Figure 2. 18 Location of Flow measurement

The values for wall thickness and lining thickness were taken from a new auxiliary pipe located on the side of the road near OVS1. The measured lining thickness was 8 mm, thus for the parameters for the ultrasonic meter, this value was used assuming there was no corrosion of concrete from the pH of the intake water. Although the operators stated that the auxiliary pipe on the side of the road was new and unused, the pipe was not sheltered and just placed on the side of the road, hence, the condition of this new pipe was very bad. The sides were rusting, and garbage was overflowing in and around the pipe.

The flow velocity was measured from 11:15, for 10 minutes, and the velocity measurements were taken every 30 seconds. These measurements were taken once the numbers seemed to stabilize. The plot of the flow is illustrated in Figure 2.19. In a normal condition, the operators stated that the flow at this location is approximately 600 L/s. The pressure read from the manometer at the time of the measurement was 5 bars, which is relatively low compared to its normal condition.

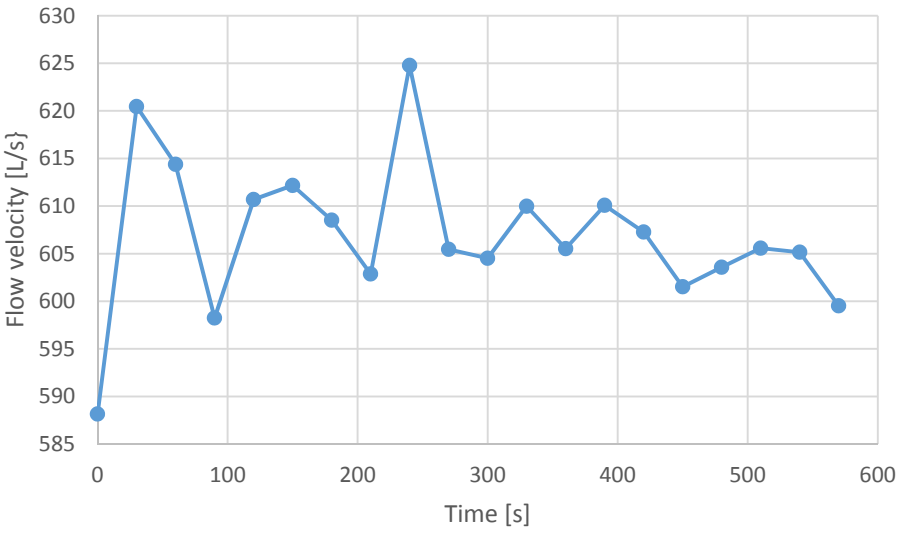


Figure 2. 19 Flow velocity measurements at OVS1 Pipe Bridge

Although the operators stated that the pipeline was not full and much lower compared to its normal conditions, the ultrasonic flow meter read the flow measurements to be around 600 L/s. This correlated with the amount which was recorded in Badaksinga, but of couse this does not justify the discharge as these locations are kilometers away, and the accuracy of the SCADA is also unclear. This amount of flow is what is seen during the normal conditions, thus, regular checks of the flow with this portable flow meter may be useful to check whether the flow is in its normal condition or not.

2.7 WANDA results

There are two modes in the Wanda software in order to simulate the water behavior: Engineering mode and Transient mode. The necessary parameters in the engineering mode are the wall roughness, pipe diameter, and length and elevation of the pipeline system. In the transient mode, the necessary parameters are the Young's modulus and wall thickness. The steady-state is calculated to determine the flow velocity and pressure distributions along the pipeline. These parameters needed for the calculation were not measureable in the site, thus the values were taken from reliable literature and adjusted to conservative values (explanation given in **Appendix E**). Furthermore, multiple simulations were run but only the most important one is introduced in this report. The rest of the simulations are shown in **Appendix E** as well.

To determine the flow velocities and pressure along the pipeline, the free surface conduit component was used. This component allows the modeling of a pipeline with both atmospheric flow and pressurized flow, however, the limit is that it cannot include water hammer calculations. Using this node, the free flow condition without any accessories was computed. The free flow condition should be ideal as there accessories only cause more disturbances in the flow. Moreover, from discussions with the Deltares support team, it became clear that the problem with transport capacity is most probably caused from the air trapped in the pipeline. And flow velocities are an important indicator of whether the pipe will

be able to transport the air or if it will stagnate into large air pockets of high points in the pipeline.

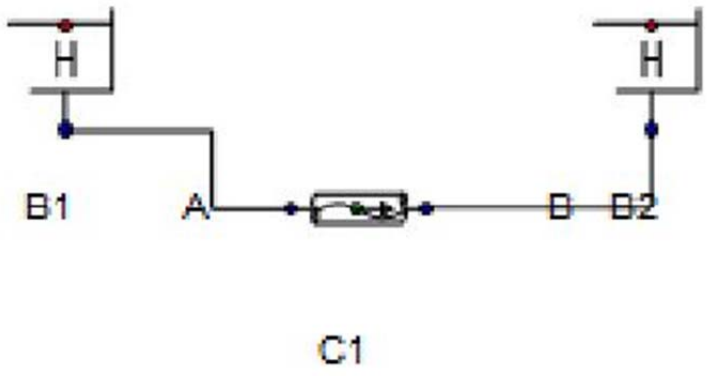


Figure 2. 20 Diagram for Free surface flow conduit Pipa Baru

The diagram for this simulation is shown in **Figure 2.20**. The mathematical model of this free surface flow conduit is described by the continuity and momentum equation. The friction model used is the Darcy-Weibach model with a friction factor of $f = 1$. Furthermore, the maximum element length is chosen to be 100 m, as it requires a length which is less than 200 times the diameter for sufficient accuracy. From these input parameters, the flow velocity and pressure profiles obtained are illustrated in **Figures 2.21** and **2.22**.

An ideal velocity profile should show a straight line with a constant flow velocity. However, from **Figure 2.22**, it is clear that the flow velocity is not constant at all. The flow velocity has a range of 0 and 0.2, and in the middle of the pipeline there are 2 points where the flow velocity reaches 0. These are due to the unique pipeline profile of Pipa Baru, firstly where the elevation increases at Cadas ngampar around 3000m from the intake, and the second point where there is another slight elevation increase at Jagabaya. Having zero points in the velocity profile is clearly not good, and can enhance stagnation of air. Overall, this velocity profile is very strange and seems very unrealistic, although the pressure profile retrieved from the same simulation looks acceptable. Thus, it is clear that the flow velocity in the pipeline may be the hidden problem.

Again, this is discussed along with the all the other problems of the pipeline in **Section 2.8**.

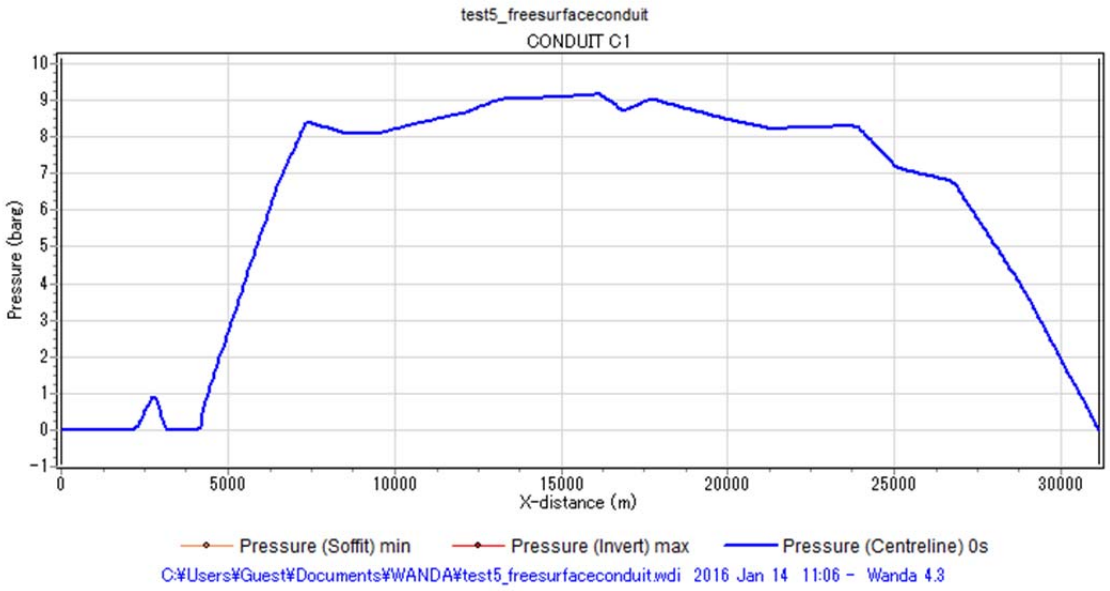


Figure 2. 21 Pressure profile for Pipa Baru from WANDA

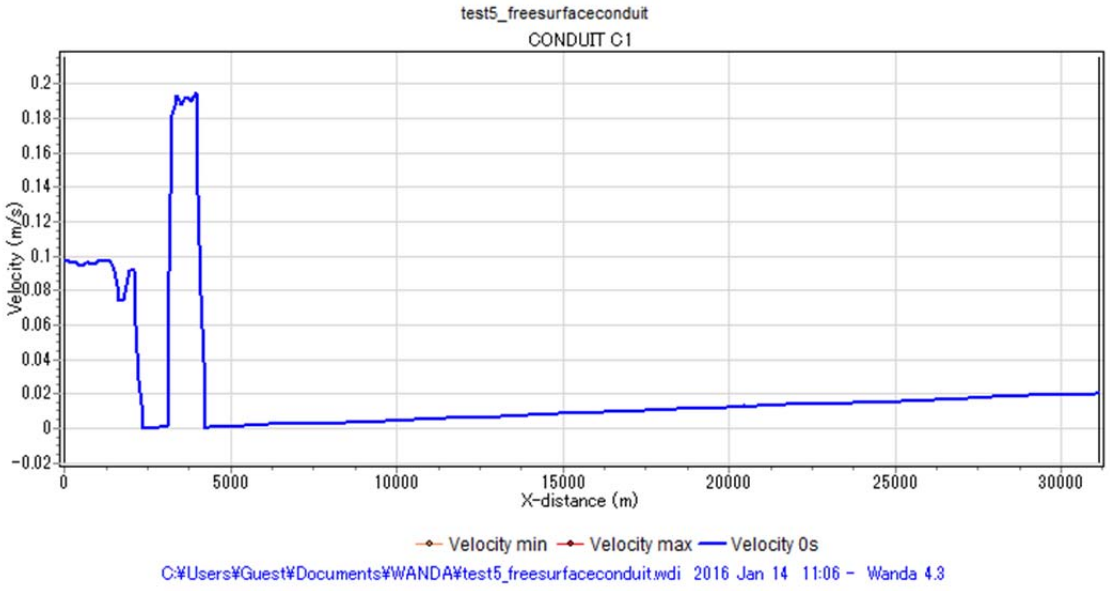


Figure 2. 22 Flow velocity profile for Pipa Baru from WANDA

2.8 Discussions

2.8.1 SCADA

From obtaining the manual of the clamp-on flow meter from Endress-Hauser Pulsmag Vl from the supplier company, information which was worth noting was found. In PDAM, the flow in and out of the DWTP is monitored with the SCADA system. Unfortunately, none of the operators know how the values from the SCADA were calculated or obtained, or the significance of having accurate values. They only know what the values represent. In the manual, it is stated that the flow rate is expressed in %, and depends on the percentage of the measuring range of the equipment. The clamp on flow meter at PDAM has a measuring range of 1.2 m^3/s, which results to be 1200 L/s. This can be seen from **Figure 2.23**, which was taken by Mr. Tantan, the operating manager at PDAM, and is on the bottom left corner of the picture.

Knowing that the flow rate is the percentage of the measurement range, when the flow is 100%, the flow rate is 1200 L/s. At the moment when the picture was taken, the flow is stated to be 61%. Thus, the flow rate can be calibrated to be 732 L/s. Knowing the ways of calibration will be important for the operators to understand whether the flow meter is working, and whether the SCADA is making any sense or not. Furthermore, this could also be the reason why the pipe is thought to not have been functioning at full capacity. It may be due to the inaccuracies of measurements, and in actuality, it has been functioning as it should. This should be explained to the managers and operators as soon as possible.

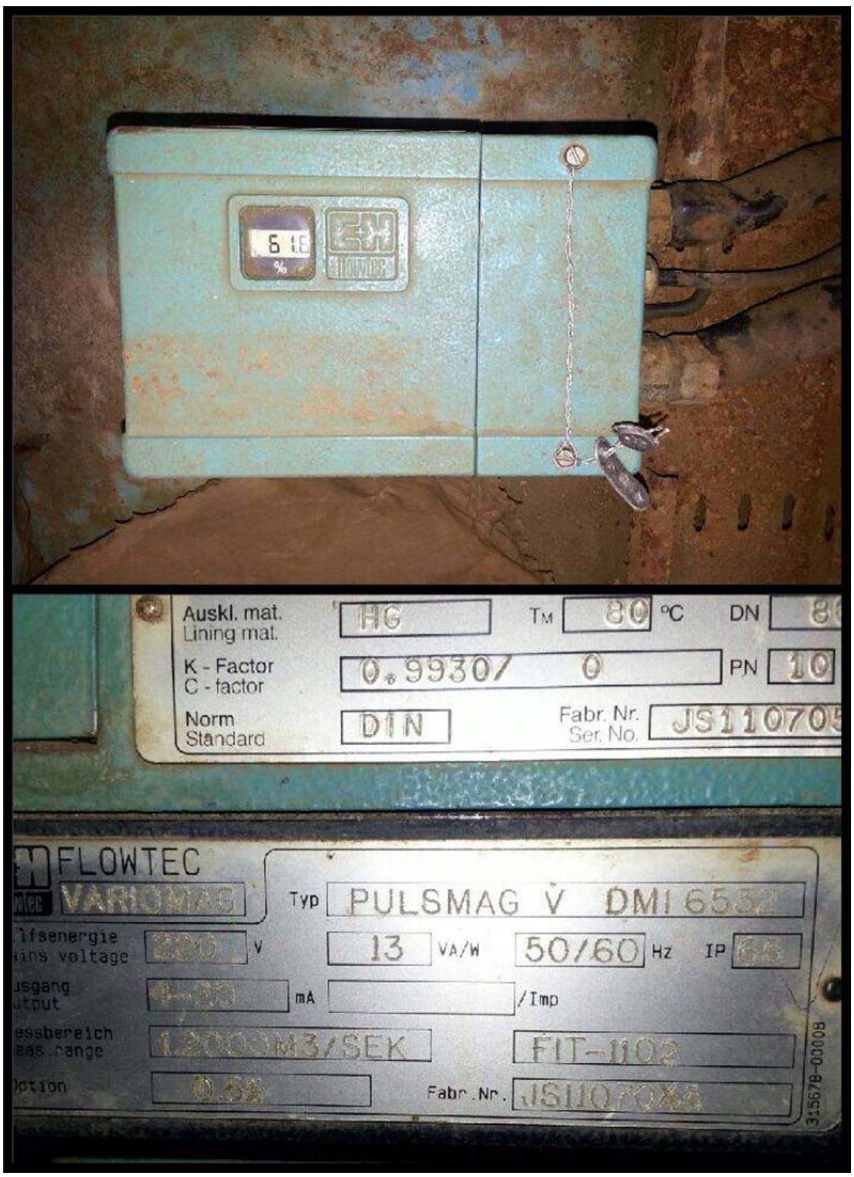


Figure 2. 23 Pulsmag V Clamp-on Flow meter at Badaksinga and its details

2.8.2 Profile of Pressure, Flow velocity and Pipeline

In this study, 3 different sets of data was collected for flow velocity and pressure: field measurements, PDAM data, and simulation data. It would be complete to be able to compare these 3 sets of data, however, there are some limits. The field measurements, were only taken at 4 points, and due to the dry season and its lack of water supply, the flow conditions were rarely normal. Thus, it is difficult to compare these results with the PDAM measurements and simulation results. Moreover, the flow velocity was also only measured at 1 point, and the SCADA measurements were manually done in the Badaksinga DWTP, which most likely results in inaccuracies – these will also not be compared.

The PDAM measurements and simulation results show a similar shape in its profile for pressure. However, the maximum value in the simulation only reaches approximately 9 bar, while the in some years, the maximum value in the pressure measurements conducted by PDAM exceeds 16 bar. First, it must be noted that the simulation is only looking at a case with no accessories, but even with all the disturbances combined, the maximum pressure should

not differ by approximately 7 bar. In Appendix B, the example with the accessories included is given, and the values seem reasonably close to those measured by PDAM.

With these results of flow velocity and pressure, some explanations for probable reasons to why there are bursts between Jagabaya and Tarigu can be given. Firstly, this pipe section is located where the change in pressure along the pipeline is very large. From viewing both the pressure measurements from PDAM and the simulation results, it is clear that the slope illustrating the pressure is relatively steep. This results from the unique pipeline profile of Pipa Baru – a long downward profile, followed by a mild slope and back up again at the end. On top of this large pressure change, due to the ups and downs of the hydraulic gradient of the pipeline, the flow velocity has some drastic changes in the first 4000 m, but after that, the flow is very low. This low velocity may result in air stagnation in the pipeline. Therefore, these 2 phenomena may be causing OVS1 the pipe segment after OVS1 to be a 'weak' point.

In an ideal situation, the pressure profile should be symmetric, or in other words a mirror image, of the hydraulic gradient of the pipeline. Furthermore, when the actual pressure profile exceeds this ideal pressure profile, it can be said that the limit of the pipeline is exceeded.

When including the flow velocity into consideration with these two parameters, it becomes more complex. As mentioned before, for an ideal pipeline the flow velocity should be constant. Furthermore, the flow velocity should be high enough to be able to transport air, instead of releasing them and causing stagnant air to exist in the pipeline. The flow velocity also has a limit to how high it could be, in order to prevent material corrosion, and large disturbances will result at bends and other accessories. There is a certain flow velocity which meets both requirements found in Pothof et al. 2010, but this is beyond the scope of the project, but it is important to note that further research could be done here.

Furthermore, keeping in mind the research of flow velocity and its relationship with air stagnation, it is important to know that the water must have enough pressure and flow speed to be transported to the water treatment plant. As mentioned in Section 2.3, there are times where the flow was recorded at the lowest point of the pipe profile but there was no flow towards the treatment plant. This is most probably due to the 'U' shaped profile of the pipe, and either checking the functions of the NRVS check valves or placing a pump to make sure the water is pumped up to the treatment plant would be very important. Having water stagnate at the bottom of the profile also causes air to enter the pipeline from the exit, and these causes need to be interrupted.

2.8.3 Calculations for water hammer

The wave speed of pressure waves in pipelines can be calculated with this simple equation:

$$\frac{1}{c^2} = \frac{\rho}{K} + \frac{\rho D}{E\delta}$$

Where, c: wave speed [m/s], ρ: density of water [kg/m^3], K: bulk modulus (=2.2x10^9) [N/m^2], D: diameter [m], δ: wall thickness [m], E: Young's modulus [N/m^2].

If c/g is large, pressure variations in the pipeline are also large. Furthermore, when there is high pressure larger than 10 bars, it can be said that water hammer occurs. This is a simplified

equation, and is only used as a check criterion to determine whether water hammer could exist in Pipa Baru or not.

$$\frac{1}{c^2} = \frac{1000}{2.2 \cdot 10^9} + \frac{1000 \cdot 0.85}{(2 \cdot 10^{11}) \cdot 0.01031} \quad \rightarrow \quad c = 1074.11\, m/s$$

From knowing the wave speed c, the change in pressure p relative to the change in flow velocity U can be found through this characteristic equation.

$$\partial p = \rho c \partial U$$

The usual capacity of Pipa Baru is Q = 650 L/s, which can be computed to be,

$$U_n = \frac{Q_n}{A} = \frac{650}{\pi \cdot 0.425^2} = 1.1455 m/s$$

Since Pipa Baru is often filled and emptied continuously throughout the dry season, the most extreme condition is computed. The change in flow velocity U is assumed to be empty to its normal condition, so ∂U = 1.1455 m/s.

$$\partial p = 1000 \cdot 1074.11 \cdot (1.1455 - 0) = 12.304\, bars$$

This is a very large pressure change, and this size of pressure variation can cause water hammer. Although this does not justify immediately whether water hammer occurs in Pipa Baru or not, the emptying and filling of the pipeline clearly causes high pressure waves to occur within the pipeline, which could eventually result in damage. This can be justified by having more precise measurements of the pressure changes along the pipeline with equipment which can measure with time intervals of less than 1 second.

2.9 Conclusion

The main problems of the new pipeline, Pipa Baru, were:

4. Occurrence of bursts
5. Never functioning at full capacity
6. Accuracy of flow meters

The occurrence of bursts and the problem with the pipe not functioning at full capacity are most probably due to the air stagnation in the pipeline. This air stagnation needs further research as most of the theoretical approaches to mitigate air stagnation by regulating flow velocity are still empirical, and in this project, the field measurements were more focused on pressure than flow velocity. Once the flow velocity to mitigate air stagnation is determine, the Pipa Baru should be regulated and controlled downstream instead of upstream. This keeps the pipe full at all times, and can have the advantages of opening and closing the pipe as the DWTP requires more easily.

For the case of the accuracy of flow meters, now that the calibration of the Endress+Hauser (EH) flow meter is clear, the calibration for the SCADA can be confirmed. This can be done by conducting flow measurements next to the EH flow meter and comparing the values of what is read in percentages on the EH flow meter, the SCADA and the clamp on flow meter.

Chapter 3 Water Quality

During the 5 weeks of the research programme the quality of water of the Degrémont or old part in PDAM Badaksinga was investigated. The influent of the drinking water treatment plant of PDAM is followed by a mixing chamber where the pre-chlorination takes place. After this step the Poly Aluminium Chloride is added and mixed with the help of small waterfalls. All these steps are shared by the new and old part, after this step the flow is divided and 1000L/s are send to the old (Degrémont) part. The Figure 3.1 shows the lay-out of the Degrémont part, which includes 4 accelators, 20 rapid sand filter RSF and the effluent of this part that combines the outlet of the 20 RSF.

In order to analyze de quality of the water three aspects were considered: direct conversations with the staff of PDAM, data mining of water quality from the last year and a monitoring plan with sampling and analysis of the samples.

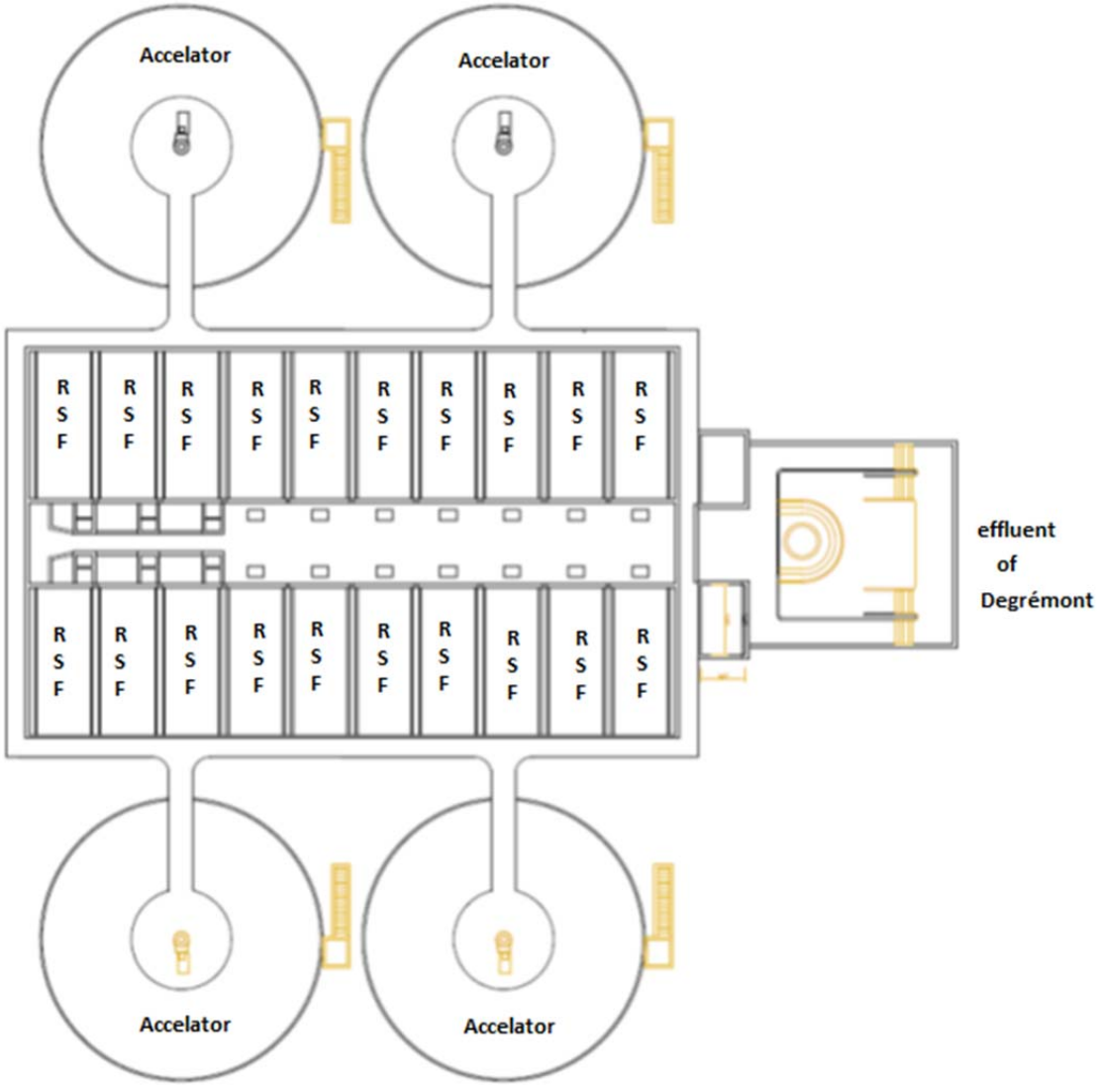


Figure 3. 1 Lay out of Degrémont part of the Drinking water treatment plant PDAM-Badaksinga

3.1 Current Situation

After a visual inspection and conversations with the staff of the Drinking water treatment plant of PDAM-Badaksinga, information regarding to the operation of the Degrémont part was collected.

3.1.1 Screens and Pre-chlorination

The first step of the treatment is the screening. This step is very important due to the high amount of plastics and coarse material that come in the water. However the coarse screens do not retain all the plastics, as it has been observed in the other units of the treatment. The Figure 3.2 shows the mixing chamber with the screens in both sides. The objective of the screens is to remove the big solids and plastics from the raw water in order to not pass through the following treatment steps (as it could be seen in the treatment plant). Another important aspect is the cleaning frequency of screens, because the plastics, solids, branches, tree roots among others are accumulated on screens and this situation could be seen during the morning and afternoon.

Figure 3. 2 Mixing chamber with the screens in both sides.

On the other hand, if the big solids contain organic matter might consume more chlorine in the pre-chlorination step.

During the inspection, it was observed algae growth in the accelators and the rapid sand filters(RSF), which might indicate that the pre-chlorine dose is not enough because is not able to inhibit the growth of algae in the accelators and filters

3.1.2 Poly Aluminium Chloride (PAC)

The coagulant used at the installation of the Old and New Badaksinga is Poly Aluminum Chloride (PAC).

PAC solution has a degree of basicity due to the hydroxide groups that contains, therefore depresses the PH less than other aluminum coagulants, requiring less alkali dose for pH

correction. Moreover PAC has a broader optimum pH range (6-9) (Twort, Ratnayaka, & Brandt, 2000). The PAC is stored in two tanks, from there the PAC is transferred to other open tank and diluted with water in the relation of 1:10 according to the operators and the previous bachelors group. The preparation is done manually by stirring solution of PAC and water. PAC solution is pumped to the PAC dosing tanks (**Figure 3.3**) and it is added to the raw water opening a valve using a measuring tube which has the same water level that the tank. After opening the valve the tube is emptied in certain time giving the dose that is needed. However this manual dose is not accurate because there is no flow or level control equipment.

Figure 3. 3 PAC dosing tank

It should be noted that currently there is no analysis of the concentration of Aluminium present in the commercial PAC. In fact when it was mentioned that this study wanted to analyse the staff were discontented saying that we did not trust in the PAC supplier company. However, according to the laboratory results from the previous Bachelor group the amount of Al_2O_3 contained in the PAC is 10.58%, which is the most commonly available PAC (Twort, Ratnayaka, & Brandt, 2000). Therefore the amount of Al_2O_3 in the diluted solution is 1%.

The PAC dose is only controlled once per day during the first measurement of the day. After reading the record book of PAC and asking the Chief of the Laboratory it can be seen that the operators add PAC following their instincts. Besides they take into account the turbidity shown in SCADA and add a PAC dose that they feel is needed and they fill the registers of the jar test column with these values. Some of the register can be found in the Table 1. As it can be observed the PAC is dosed between 3 and 7 times per day based on the turbidity, however sometimes the turbidity is not checked (no values of turbidity in the records). Therefore the only value that could be reliable is the PAC dose from the morning after the first measurement. Besides it seems that there is no correlation between the turbidity and the PAC dose. For example the first value at 10hrs of turbidity is 44 NTU and the PAC added was 39ppm of PAC, at 13hrs the turbidity was 45.9 but the PAC dose that the operators estimated was 33ppm, which is a lower dose than the previous dose used for a lower turbidity. The table

shows only the records of the days when the monitoring plan took place. It can be seen that the doses fluctuates between 26 and almost 50ppm.

Table 3. 1 PAC dose records. Source: Daily operational records from Badaksinga

		Turbidity NTU		PAC dose ppm	
Date	Time	Raw water	Clean water	Jar test	Field
26-11-2015	10	44	0.25	39	39.4
	13	45.9	0.36	33	33.16
	16	40	0.3	33	33.16
	22	46	0.59	33	33.34
	1	50	0.57	33	33.7
	4	40	0.27	36	36.87
	6	45	0.28	37	37.75
27-11-2015	10	43	0.36	45	45.57
	13	45	0.26	45	45.57
	16	44	0.28	28	28.7
	22	40	0.3	33	33.86
	1	44	0.33	33	33.71
	4	42	0.38	33	33.7
30-11-2015	10	23	0.2	37	37.21
	13	28	0.31	26	26.5
	22	53.6	0.13	48	48.52
	1	45	0.15	37	37.75
	4	38	0.33	37	37.75
01-12-2015	16	45	0.28	49	49.55
	18	40	0.26	33	33.9
	22	47	0.39	40	40.87
	1	52	0.31	40	40.21
	4	48	0.33	40	40.54
02-12-2015	13	24.9	0.21	35	35.25
	16	23.4	0.25	35	35.15
	22			39	39.3
	1	56	0.34	44	44.36
	4	36	0.3	39	39.2
	6	38	0.33	38	38.95
03-12-2015	10	68.6	0.45	47	47.82
	13	67		46	
	16	68		46	
	22	78.8	0.23	44	44.53
	1	68	0.21	44	44.21
	4	56	0.43	44	44.32
	6	52	0.52	44	44.24
08-12-2015	16	60	0.47	38	38.21
	19	65.2	0.35	66	46.43
	22	59	0.63	45	45.9
	24			45	45.8
	2			45	45.82
	4			46	46.27

3.1.3 Accelator

The accelator combines flocculation and clarification/sedimentation in the same unit. The coagulation occurs in the middle of the tank, while the process of clarification occurs at the edge of the tank, this can be seen in the **Figure 3.4** and **3.5.** This unit has a diameter of 19m and a volume of 390m^3 according the original lay-out of the old plant.

Figure 3. 4 Front view of accelators

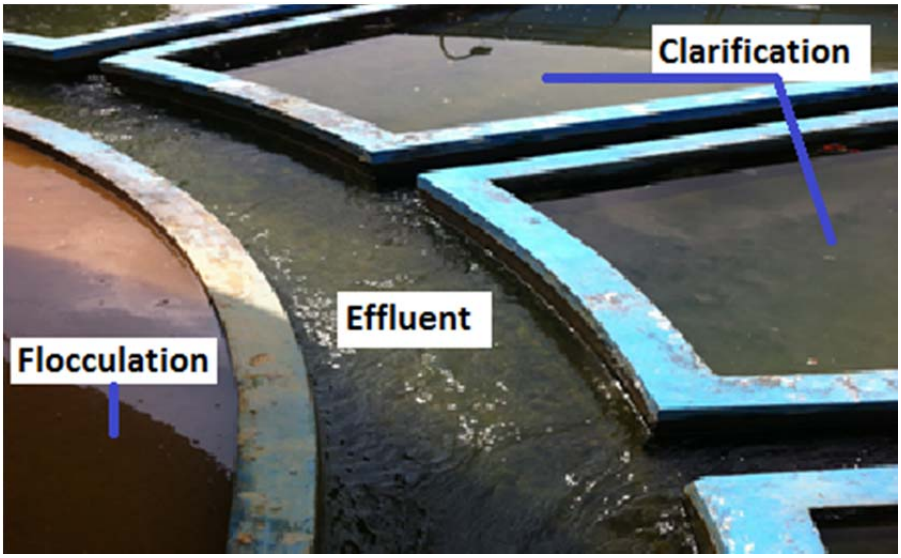


Figure 3. 5 Parts of accelator where coagulation and clarification take place

In the surface of the accelators, there was small floating garbage. It can also be observed that the structure of concrete submerged in water was covered with algae. The operator (opening the valve) sets the duration and frequency of sludge drain/discharge manually.

3.1.3.1 Cleaning procedure

The cleaning process was observed and according to the operators its duration is 1:30 hrs approximately and its frequency is monthly. The cleaning process is manual and is performed by the operators from the drinking water treatment.

The accelator is emptied and cleaned with water coming from a hose as it can be seen in the Figure 3.6. The plates inside the accelator are cleaned until remove all the sludge accumulated there. The sludge is drained and discharged to the river. At the time of the cleaning, sludge was accumulated in all parts of the tank. Besides there were small plastics stuck in different parts of the tank accelator. Besides it could be seen that the installed settling plates contain asbestos. Nowadays the asbestos is classified as a hazardous material because it is carcinogenic.

Figure 3. 6 Manual cleaning of accelator

3.1.4 Rapid sand filter (RSF)

The rapid sand filters installed in Badaksinga are filter types Aquazur T. This type is the first generation of open sand filter developed by Degremont.
The rapid sand filter uses silica sand as a porous media. The particle size of the silica sand is between 0.9 to 1.0 mm.

3.1.4.1 Backwashing

Currently the RSF does not have pressure control, however there are pressure gauges in every RSF that show the pressure in meters of water column. Due to the lack of pressure control the backwashing is based on:

1. Visual condition (when the filter stops working due to the clogging).
2. According to the schedule. The frequency of the backwashing is daily.

The duration of the backwashing is not fixed, depends on every operator. The duration was asked to the staff and they gave 3 different values, 7 min, 10 min and 15 min. However, when the backwashing was observed it could be noticed that the operators do not control the time that this procedure takes.

During the backwashing, the water level in the filter will rise to overflow into the wash water canal and subsequently discharged to the river. This can be seen in the **Figure 3.7.**

Figure 3. 7 Backwashing of the filters.

There are no register regarding the amount of water that is discharged during the backwashing. Therefore an unknown and high amount of water is used for backwashing, adding the fact that there are 20 RSF in the old part of the treatment plant and the frequency is daily during approx. 15 min. All these facts result in high volumes of water that is wasted to the river.

Other important aspect that was also mentioned in the accelators is the algae growth. This was observed in all the filters as it can be seen in the **Figure 3.8** and **3.9**.

Figure 3. 8 RSF 3 with algae growth

Figure 3. 9 RSF 5 with algae growth

3.2 Data mining

Information of the water quality analysed during the last year were collected and evaluated from the inlet south Cikalong, inlet north Cikapundung and Dago Bengkok and the effluent (from old and new part). It should be noted that there are two pipes from the north inlet.

Nowadays PDAM Badaksinga is monitoring daily in the influent, effluent and in every unit the pH, temperature, turbidity, free chlorine are measured twice per day and the selection of the PAC dose is done once per day.

Moreover once per month the odour, taste, turbidity, temperature, pH, chlorine, coliforms and E.coli is monitored in the effluent. And every 3 months a complete analysis including physical, chemical and biological parameters is done to the effluent with an external laboratory.

The quality of raw water received in Badaksinga installations were compared to the Government Regulation N°82 of 2001. The Regulation N°492 controls the treated effluent of the Drinking water treatment plant. The minimum requirements stablished by the norm are shown in the **Table 3.2.**

Table 3. 2 Minimum requirements stablished by regulation N°82/2001 and N°492/2010.

Parameter	Unit	Regulation N°82/2001	Regulation N°492/2010
E. Coli	CFU/100ml	2000	0
Coliforms	CFU/100ml	10000	0
Arsenic	mg/l	0.05	0,01
Fluoride	mg/l	0.5	1.5
Total Chromium	mg/l	0.05	0.05
Cadmium	mg/l	0.01	0.003
Nitrite (NO_2^-)	mg/l	1	3
Nitrate (NO_3^-)	mg/l	10	50
Cyanide	mg/l	0.02	0.07
Selenium	mg/l	0.01	0.01
Odor	-	-	Odourless
Color	PCU	-	15
TDS	mg/l	1000	500
Turbidity	NTU	-	5
Taste	-	-	Tasteless
Temperature	°C	Air temperature ± 3	Air temperature ± 3
Aluminium	mg/l	-	0.2
Iron	mg/l	5	0.3
Hardness	mg/l	-	500
Chloride	mg/l	600	250
Manganese	mg/l	0.1	0.4
pH	-	6 - 9	6.5 - 8.5
Zinc	mg/l	0.05	3
Sulphate	mg/l	400	250
Copper	mg/l	1	2
Ammonia	mg/l	0.5	1.5
TSS	mg/l	5000	-
Organic substances	mg/l $KMnO_4$	-	10
Detergent	mg/l	0.2	0.05
BOD	mg/l	2	-
COD	mg/l	10	-

Source: (PT DEGREMONT, 2015)

Table 3. 3 Water quality from the three inlets during September 2014 to September 2015

			12-09-2014			11-12-2014			13-03-2015			10-06-2015			08-09-2015		
Max. Limit N°82/2001	Parameter	Units	Cikapundung	Dago Bengkok	Cikalong	Cikapundung	Dago Bengkok	Cikalong	Cikapundung	Dago Bengkok	Cikalong	Cikapundung	Dago Bengkok	Cikapundung	Dago Bengkok	Cikalong	Cisangkuy
1000	TDS	mg/L	78.4	110.4	47.2	114.9	143	57.1	91.8	107.1	45.5	101.7	114.5	52.9	127.5	185.7	53.6
50	TSS	mg/L	8	31	13	2	4	<1.06	19	50	91	15	26	15	32	141	28
	T	°C	21.6	22.3	23.8	21.9	222.8	21.9	21.1	21.6	21.4	21.9	22.7	21.9	20	20	20
0.5	NH3-N	mg/L	0.02	0.98	0.05	0.04	0.67	0.05	0.28	<0.01	<0.01	0.1208	0.5569	0.2029	0.3748	0.4964	0.4745
0.05	As	mg/L	<0.005	<0.005	<0.005	<0.0005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05797	<0.05797	<0.05797
1	Ba	mg/L	<0.46	<0.46	<0.46	<0.46	<0.46	<0.46	<0.4656	<0.4656	<0.4656	<0.4656	<0.4656	<0.4656	<0.2602	<0.2602	<0.2602
0.3	Fe	mg/L	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.059	<0.0461	<0.0461	0.2424	0.2007	<0.0461	0.078	0.0621	0.0785
1	B	mg/L	<0.1	0.1	<0.1	0.2	<0.1	<0.1	0.2	0.3	0.2	0.3	0.3	0.2	<0.07232	<0.07232	<0.07232
2	BOD	mg/L	9.8	6.5	3.5	6.6	3.8	2.8	14.2	12.6	15.5	12.6	7.8	4.8	2.6	180	6.8
10	COD	mg/L	28.4	18.9	10.9	19.2	10.2	7.1	24.4	36.4	26.8	34.8	22.6	14.4	7.5	433.0	20.9
6,0-9,0	pH	mg/L	7.61	7.73	7.36	7.3	7.67	6.59	7.2	7.59	6.69	6.59	7.2	6.34	7.53	7.41	6.73
0.2	Detergens	mg/L	0.06	0.07	0.04	0.06	0.08	0.08	0.15	0.16	0.14	0.03	0.12	0.15	0.64	0.51	0.57
0.001	Phenol	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	0.005	0.005
0.2	PO4	mg/L	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	0.028	<0.01	<0.01	0.0114	0.1708	0.0888	0.0802
0.01	Cd	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.0232	0.0458	0.0263	<0.022	<0.022	<0.022	<0.0205	<0.0205	<0.0205
600	Cl	mg/L	<1.4	7.44	<1.4	2.07	11.39	3.1	6.59	8.56	1.51	26.52	23.78	20.58	46.81	55.12	1719
0.2	Co	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.0313	0.018	0.0658	<0.01	<0.01	<0.01	0.0322	<0.0277	<0.0277
0.05	Cr VI	mg/L	<0.02	0.02	<0.02	0.16	<0.02	0.09	<0.0201	<0.0201	<0.0201	<0.0201	<0.0201	<0.0201	<0.0154	<0.0154	0.0916
0.1	Mn	mg/L	<0.05	<0.05	<0.05	<0.05	0.22	<0.05	0.05	<0.05	<0.05	0.01985	0.0449	0.0213	0.0265	0.0285	0.0314
1	Oil& Fats	mg/L	1	2	2	2	2	2	2	2	2	1	1	1	<2.21	<2.21	<2.21
10	NO3	mg/L	1.68	1.97	1.46	3.1	3.76	2.81	1.978	2.318	2.182	1.5602	2.0095	0.8612	6.0608	6.2583	5.603
0.06	NO2	mg/L	0.31	2.96	0.46	0.75	0.25	0.03	0.57	1.18	0.026	<0.0053	0.1622	<0.0053	0.4092	0.2885	0.1201
>6	DO	mg/L	6.61	5.34	5.96	3.59	3.18	4.44	4.51	4.42	5.05	4	4.01	5.72	3.96	2.16	2.34
0.001	Hg	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01320	<0.01320	<0.01320
0.01	Se	mg/L	<0.01	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01797	<0.01797	<0.01797
0.05	Zn	mg/L	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.0086	<0.0086	<0.0086	<0.0086	0.0184	<0.0086	<0.0052	<0.0052	<0.0052
0.02	CN	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.014	0.01	0.01	<0.024	<0.0240	0.026
400	SO4-2	mg/L	0.26	0.44	0.31	25.00	29.54	20.72	1.98	2.16	4.11	17.67	9.94	12.45	20.24	19.66	18.63
0.002	S2	mg/L	0.005	0.01	0.008	0.01	<0.005	<0.005	0.008	0.011	0.0083	<0.005	<0.005	<0.005	0.0871	0.0841	0.1033
0.02	Cu	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.019	0.034	<0.0282	<0.0282	<0.0282	<0.0282	<0.0295	<0.0295	<0.0295
0.03	Pb	mg/L	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.069	<0.069	<0.069	0.141	<0.069	0.091	0.083	0.087	0.115
1000	Coliform	CFU/100mL	9.3E+03	1.5E+04	3.5E+03	1.5E+04	5.3E+03	2.1E+04	1.1E+03	2.1E+04	1.2E+04	2.1E+04	2.9E+04	2.1E+04	2.9E+03	4.4E+03	2.7E+03
100	E.coli	CFU/100mL	4.3E+03	4.3E+03	2.8E+03	7.5E+03	2.1E+03	9.3E+03	1.2E+02	9.3E+03	4.3E+03	9.3E+03	9.3E+03	7.5E+03	1.3E+03	2.0E+03	1.1E+03

Source: Water quality analysis from Badaksinga

The water quality information of the three sources that supply raw water to the drinking treatment plant from the inlent south Cikalong, inlet north Cikapundung and Dago Bengkok can be seen in the **Table 3.3.**

As it could be seen on the field the main pollution is rubbish especially plastic waste which can carry organic matter. Moreover the **Table 3.3** shown in red parameters that exceed the maximum limit of the regulation N°82/2001 such as organic matter, coliforms and E. coli, sulphur and heavy metals specifically lead and copper. The incoming concentrations of organic matter are always high and fluctuated from 7.1 to 433 for COD, 2.6 to 180 for BOD. For coliforms and E.coli their values are above 1100CFU/100mL and 120CFU/100mL respectively.

From these water quality information, it can be seen in the **Figure 3.10** that the TSS in the influent have fluctuated in a wide range from 2 to 141mg/L from September to 2014 to September 2015. For instance, this variation could be related to the wet and dry season, where at the beginning of the rainy season the rain flush out all the sediments, carrying all the solids to the treatment plant, increasing the amount of TSS. Moreover after the first rains the concentrations of TSS can be diluted.

Therefore is challenging to operate the drinking water treatment plant and especially to determine the PAC dose for every hour due to the concentration of TSS does not remain constant.

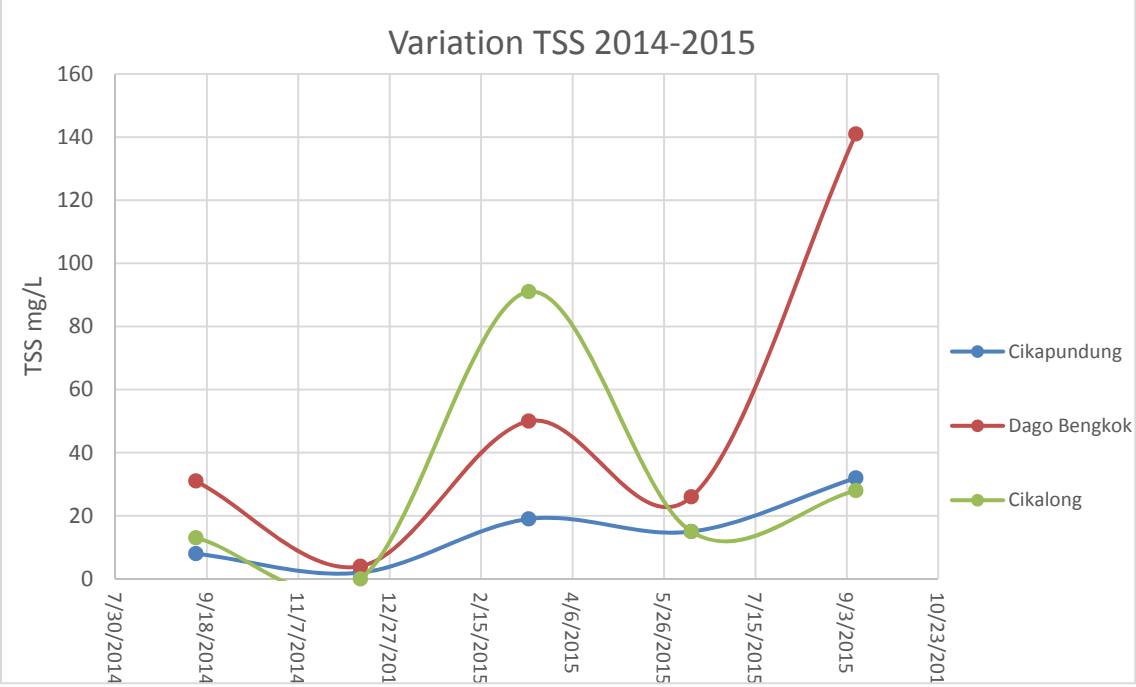


Figure 3. 10 Variation of TSS from September 2014 to September to 2015

The **Table 3.4** shows the variation of the effluent during September of 2014 to October of 2015.

According to this data the quality of treated water compared with standard N°492/2010 generally meets the requirements of the standard N°492/2010 for almost all the parameters except (the values in red) coliform that were above 0 CFU/100mL and free chlorine was lower than the minimum requirement between 0,2 to 1mg/L and coliforms.

This might be due to inadequate doses of chlorine, in fact low values of free chlorine do not guarantee a safety distribution of drinking water, because the chlorine will be reduced due to the

reaction between chlorine and the organic matter or coliforms present in the treated water or in the pipes from the distribution network and reservoirs.

Actually it should be noted that some water quality results from the distribution network were seen. In some of the different sampling locations there was no residual chlorine left and the proliferation of E.coli and coliforms was observed in the analysis. However this was out of the scope of this study.

Regarding to copper even when its concentration in the influent were above the maximum limits, the table 4 shows low concentration of copper in the effluent that meet the requirements regulated by the law. According to a brochure of PAC, it is mentioned that PAC reacts with heavy metals and can remove arsenic, lead, chromium among others. (Orica-watercare, 2015)

Table 3. 4 Water quality from the effluent during September 2014 to September 2015

		2014					2015								
Parameters	Units	12-09	01-10	10-10	18-11	11-12	15-01	13-03	09-04	15-05	10-06	10-07	10-08	03-09	07-10
Turbidity	NTU	1,02	0,3	0,84	2,41	0,52	0,28	0,28	3,34	0,32	0,28	0,45	0,47	0,67	1,46
TDS	mg/L	59,8	88,3	74,9	86,7	81,6	72,5	64,9	56,65	61,8	63,4	75,2	84	78,1	74,3
T	℃	22,3	24,4	23,1	23,1	22,5	21,6	22,8	23	21,6	22,7	21,6	21,4	23,3	23,3
Al	mg/L	<0,02	<0,02			<0,02		<0,0004			0,0267			<0,0109	
NH3-N	mg/L	<0,01	0,04			<0,01		0,2016			<0,01			<0,0005	
As	mg/L	<0,005	<0,005			<0,005		<0,005			<0,005			<0,05797	
Fe	mg/L	<0,05	<0,05			<0,05		0,0099			0,128			<0,08832	
pH		6,99	7,61	6,78	6,97	6,72		6,69	6,876	6,57	6,18	6,41	6,75	6,67	7,14
Cd	mg/L	<0,003	<0,003			<0,008		<0,0008			0,0029			<0,00618	
CaCO3	mg/L	63	96			76		82,32			184			193,8	
Cl	mg/L	1,98	<1,4			9,06		2,52			25,61			43,92	
Total Cr	mg/L	<0,02	<0,02			0,004		0,0036			0,0189			<0,00269	
Mn	mg/L	<0,05	<0,05			0,0032		0,0002			0,0037			<0,00912	
Nitrate	mg/L	3,25	<0,1			0,34		<0,1			2,8066			0,4428	
Nitrite	mg/L	<0,005	<0,0005			0,011		<0,0053			<0,0053			<0,0005	
Se	mg/L	<0,01	<0,01			<0,01		<0,01			<0,01			<0,01797	
Zn	mg/L	<0,009	<0,009			<0,0007		0,0007			0,0038			<0,01852	
CN	mg/L	<0,01	<0,01			<0,01		<0,01			<0,01			<0,0240	
Free Chlorine	mg/L	0,5	<0,01	0,5	0,27	0,55	0,44	0,55	0,69	0,27	0,62	0,46	1,14	0,49	0,29
Total Chlorine	mg/L			0,54	0,45		0,6		0,83	0,58		0,48	1,28		0,58
SO4-2	mg/L	0,67	<0,18			10,58		2,0776			19,4019			9,7732	
Cu	mg/L	<0,03	<0,03			<0,001		<0,00126			0,0481			<0,00527	
Coliform	CFU/100mL	0	4	0	0	0	0	0	0	0	0	0	0	0	0
E.coli	CFU/100mL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3.3 Monitoring plan

The monitoring plan involved two types of sampling that are shown in the Figure 3.11. The first type is identified with red numbers while the green numbers belong to the second type.

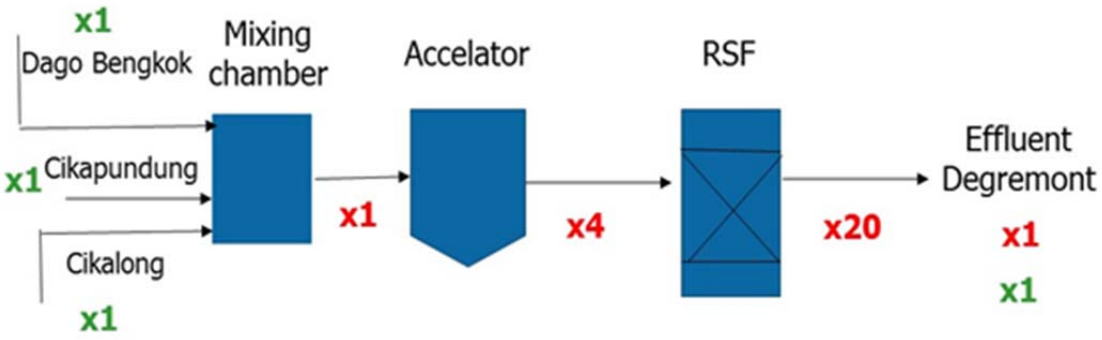


Figure 3. 11 Monitoring points: Type 1 - physical parameter (red colour), Type 2-Complete analysis (green colour)

3.3.1 Physical parameters

The first type includes the sampling and analysis of physical parameters. During every set of sampling for the first type 26 samples were taking Figure 3.12. One sample was taken from the mixing chamber (considered as an influent), one sample at the effluent of each accelator (4 in total), one sample at the effluent of every rapid sand filter (20 in total) and the combined effluent of the Degrémont part.

Figure 3. 12 26 samples taken in every set of sampling

At the beginning the schedule of the sampling was 4 times per day for the samples with the physical parameters.

The sampling schedule was modified and adapted to the current situation taking into account the sampling time, transportation time from PDAM to ITB laboratory and the opening hours of the laboratory from ITB (08- 16hrs). Consequently the 26 samples corresponding to the physical parameters were taken twice per day due to logistic issues, availability of equipment and laboratory.

The physical parameters analysed were pH, T°, turbidity, TDS, and TSS as the Figures 13, 14 and 15.

Figure 3. 13 Turbidity-meter used for turbidity measurments

Figure 3. 14 pH measurements

Figure 3. 15 Filters used for TSS analysis

In these samples free chlorine was not measured due to the high price of the reagent, according to PDAM Badaksinga and ITB. These parameters could be measured in the facilities of PDAM laboratory. Unfortunately, the laboratory at PDAM Badaksinga was not fully equipped to measure all the physical parameters as it was informed, besides the opening hours of the laboratory together with the use of the laboratory for the PDAM staff and bachelor students did not suit with our planned schedule. Therefore, the facilities of the Environmental Engineering Department from ITB were used to analyse the physical parameters. However arrange the use of the laboratory from ITB took more time than it was expected.

3.3.2 Complete analysis

For the second type of sampling, two samples were taken from the two north inlets, one sample was taken from the south and one sample was taken from the effluent of the Degrémont. The following parameters were analysed by an external laboratory: Turbidity, TDS, TSS, NH_3, As, Ba, Cd. Cu, Pb, Al, TOC, NO_3, NO_2, free chlorine, oils& fats, coliforms and E.coli.

The initial schedule for the complete analysis was modified as well, due to the logistic issues, availability of sterilized bottles and transportation time. Finally these more specific parameters were measured once or twice per week.

3.4 Results and Discussions

The results of the physical parameters can be seen in the Appendix I (Results of physical parameters from the monitoring plan). As it can be seen the pH along the treatment units slightly decreases. This might be due to the addition of chlorine during the pre-chlorination that cause a drop in the pH but on the other hand the PAC (known for their basicity) contains hydroxide group increasing the pH of the water when it is added, as a result the decrease of pH is not too drastic.

It should be noted that on December 1st during the second set of sampling the accelator number 2 was emptied, hence there are no results from that unit.

3.4.1 TDS

The conductivity was measured as an indirect form of TDS. The TDS values in the Appendix I remain constant, due to the treatment steps are not designed to remove TDS. This was measured the first three days, after that the lent pHmeter was not available, and for pH measurements was necessary to use other installations, therefore due to the fix schedule of the laboratory the TDS measurements were discarded.

3.4.2 Turbidity

In relation to the turbidity it can be observed that most of the time it is high in the influent. However, the range of turbidity that entered to the treatment plant during the monitoring days fluctuated from 16 to 247 NTU. Even though, after the accelators the turbidity drops considerably, and in some RSF was lower than the minimum limit of detection of the turbidity meter. According to the Brochure of the modern accelators from Degremont (with better performance than the accelators installed in the 60's in Badaksinga) the turbidity of treated water is normally between 1 - 3 NTU (Degremont, 2016) and in most of the samples at the exit of the accelators the turbidity was higher than this range. Turbidity must be controlled more often, especially when the PAC dosing is based on this parameter.

3.4.3 TSS

As it can be seen in the Appendix 5 that there are negative values of TSS the first day and in two accelators the second day due to some problems with the preparation of the filters for the TSS analysis. Moreover on December 1st there is no value for TSS and there is a yellow space showing the day when the accelator 2 was emptied for cleaning.

3.4.3.1 Increase of TSS with PAC dose

The addition of PAC contribute to the increase of the TSS. Due to the measurement of TSS were taken from the mixing chamber (considered as an influent) and from the effluent of the accelerators, an estimation of the contribution of PAC in the increase of TSS after the influent was taken into account in order to calculate the removal efficiency of the accelators.

The amount of Aluminium contained in the PAC is expressed as Al_2O_3 (10%). However it need to be considered that the oxide form is no present in aqueous solution. In fact the following reaction occurs when PAC is added into the water:

$$Al_2(OH)_3Cl_3 \rightarrow Al_2(OH)_3^{3+} + 3Cl^- + 3H_2O \rightarrow 2Al(OH)_3 + 3H^+ + 3Cl^-$$

As the reaction above shows when the as $Al_2(OH)_3Cl_3$ is added into the water, the compound dissociates and the Chloride ions Cl^- remains in the aqueous solution. Then $Al(OH)_3^{+3}$ is positively charged and will destabilize/neutralize the negatively charged particles (solids and colloids), forming flocs and making them settle. The molar weight of as Al_2O_3 and $Al(OH)_3$ was calculated.

	Individual Molar Weight	Number	Total Molar Weight		
Al	27	2	54		
O	16	3	48		
H	1	3	3		
		Al_2O_3		102	g/mol
		$Al(OH)_3$		78	g/mol

Then using the information of content of Al_2O_3 in the PAC together with the dilution used to dose the PAC (1:10) it can be said that 100g of Al_2O_3 is contained in 1L. However it is necessary to know how many Aluminium is contained there. For that the following calculation is used:

$$\frac{10\frac{gAl_2O_3}{L} * 27\frac{gAl}{mol}}{102\frac{gAl_2O_3}{mol}} = 2.65\frac{gAl}{L}$$

Then the dilution is calculated using the dose of PAC that is added.

Finally the amount of TSS that the Al contributes need to be calculated using the molar weight of $Al(OH)_3$ (due to the hydroxide is in the solution and will form the flocs) the g of Aluminium calculated before and the dilution.

For example for a dose of 7.6ml/L of PAC the following contribution of TSS is calculated.

$$\frac{2.65\frac{gAl}{L} * \frac{1000ml}{7.6ml} * 78\frac{g\ Al(OH)_3}{mol}}{27\frac{gAl}{mol}} * \frac{1000mg}{1g} = 58.44mg/L$$

The **Table 3.5** shows the calculation of the TSS contributed by the PAC.

Table 3. 5 Contribution of Aluminium in the increase of TSS and molar concentration of Al.

Date	pH	PAC dose mg/L	ml/L	1% of Al_2O_3 in solution (g/L)	g Al/L	Dilution	g Al/L after dilution	mg TSS/L	mol Al/L	log [Al]
26-11-2015 11:00	7.00	37.75	7.6	10	2.65	130.86	0.02	58.44	7.49E-04	-3.13
27-11-2015 8:40	7.17	33.7	6.8	10	2.65	146.59	0.02	52.17	6.69E-04	-3.17
27-11-2015 12:00	7.07	45.57	9.2	10	2.65	108.40	0.02	70.54	9.04E-04	-3.04
30-11-2015 8:30	6.82	37.75	7.6	10	2.65	130.86	0.02	58.44	7.49E-04	-3.13
30-11-2015 13:00	6.97	26.5	5.4	10	2.65	186.42	0.01	41.02	5.26E-04	-3.28
01-12-2015 8:30	6.97	40.54	8.2	10	2.65	121.85	0.02	62.76	8.05E-04	-3.09
01-12-2015 12:00	7.02	49.55	10.0	10	2.65	99.70	0.03	76.70	9.83E-04	-3.01
02-12-2015 8:30	6.95	38.95	7.9	10	2.65	126.83	0.02	60.29	7.73E-04	-3.11
02-12-2015 11:30	6.91	35.25	7.1	10	2.65	140.14	0.02	54.57	7.00E-04	-3.16
03-12-2015 9:30	6.85	44.24	9.0	10	2.65	111.66	0.02	68.48	8.78E-04	-3.06
03-12-2015 13:15	6.95	47.82	9.7	10	2.65	103.30	0.03	74.02	9.49E-04	-3.02

On the other hand to see if the dose is adequate to perform an optimal coagulation, it is necessary to calculate the molar concentration of Aluminium in the dose and the logarithm of this molar concentration as it can be seen in the Table 3.5. The values obtained for the logarithms together with the pH are compared with the graph in the **Figure 3.16**

It can be seen in the graph that for pH close to 7 and log [Al] of close to -3 the sweep coagulation takes place, however the optimal is not reached. In fact, the dose is too high to perform optimal sweep coagulation.

It should be noted that this is an estimation, better results could be achieved if a sample is analysed by a laboratory and the real amount of Aluminium can be determined.

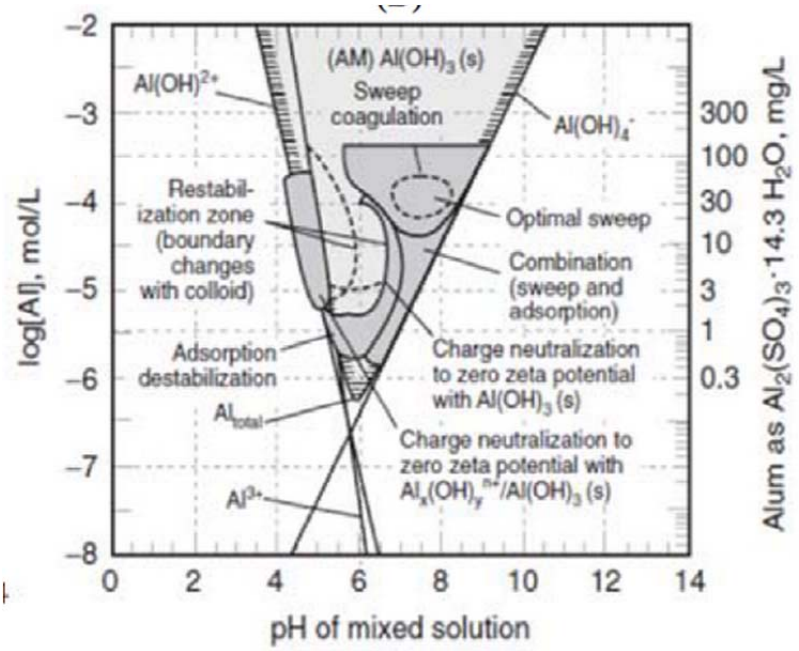


Figure 3. 16 Dose of Alum at different pH.

Table 3. 6 Removal Efficiency of Accelators

Influent	Influent		Acc1			Acc2		Acc3		Acc4	
Turbidity NTU	TSS measured mg/L	Total TSS mg/L	Turbidity NTU	TSS measured mg/L	Efficiency	TSS measured mg/L	Efficiency	TSS measured mg/L	Efficiency	TSS measured mg/L	Efficiency
247.00	227.00	285.44	5.17								
64.30	68.00	120.17	5.81			12.00	90%	9.00	93%		
26.50	24.00	94.54	4.43	16.00	83%	6.00	94%	4.00	96%		
25.20	95.00	153.44	0.82	30.00	80%	40.00	74%	28.00	82%	34.00	78%
37.50	49.00	90.02	5.70	41.00	54%	38.00	58%	32.00	64%	47.00	48%
16.00	82.00	144.76	12.70	50.00	65%	75.00	48%	75.00	48%	62.00	57%
32.00	88.00	164.70	4.32	57.00	65%			75.00	54%	86.00	48%
37.00	100.00	160.29	3.09	60.00	63%	61.00	62%	31.00	81%	41.99	74%
28.60	105.00	159.57	2.88	68.00	57%	82.00	49%	82.00	49%	76.00	52%
54.20	60.00	128.48	24.90	38.00	70%	43.00	67%	15.00	88%	17.00	87%
69.20	127.00	201.02	21.70	9.00	96%	17.00	92%	11.00	95%	67.00	67%

The Table 3.6 shows the removal efficiency of TSS of each accelator. The total TSS in the inffluent showed in the Table 3.6 is the sum of the TSS measured in the mixing chamber and the contribution of the PAC calculated in the **Table 3.5**.

The maximum removal efficiency is 96% reached by the accelator 1 and 3 followed by accelator 2 with 94% and accelator 4 with 86%. In general terms the removal efficiency is high for instance in the accelator 1 was above 90%. The minimum removals were 54% for the accelator 1 and 48% for accelator 2, 3 and 4.

Therefore the removal efficiency changes in every accelerator, even during the same day. For instance, on the same day for the Accelerator 3 in the morning the efficiency was 81% and in the afternoon is 49%. This might be related to the amount of TSS and characteristic of the solids that enter in to the system, the addition of PAC, the detention time and the temperature.

According to (Metcalf & Eddy, 2014) the effect of temperature can be significant in sedimentation, it has been shown that a 1°C temperature differential between the incoming water and the water in the sedimentation tank can cause a density current, however the impact of the temperature on performance will depend on the material that is being removed and its characteristics. The Appendix I shows that in some cases there are no difference or a difference of 2.1°C or lower between the influent and the water in the accelator. Perhaps a study of the effect of temperature in the sedimentation will be interesting to evaluate.

Furthermore, an appropriate dose of PAC will save PAC and money but the most important thing will enhance the sedimentation and reduce the TSS colloids and other particles, therefore a water with less solids will flow through the sand filter, reducing the clogging and backwashing (less water loss). For this a jar test should be done more often to give an accurate dose of PAC.

Assuming that the accelator works as a primary sedimentation tank or clarifier. The **Figure 3.17** shows the typical removal for TSS. It can be seen that for primary clarifiers with an inlet of TSS between 100 to 200mg/L or 200 to 300mg/L the maximum removal efficiency that can be achieved is between 60 and 70% depending on the detention time. The TSS in the influent of the accelators after the PAC addition is between 90mg/L and 285mg/L and the average removal during the monitoring plan was between 64 and 75%. Furthermore, Metcalf &Eddy mention that normally primary tanks are design to provide 1.5 to 2.5h of detention time. Lower detention times will provide lower removal as the Figure 16 shows. Consequently detention time is an important factor to consider.

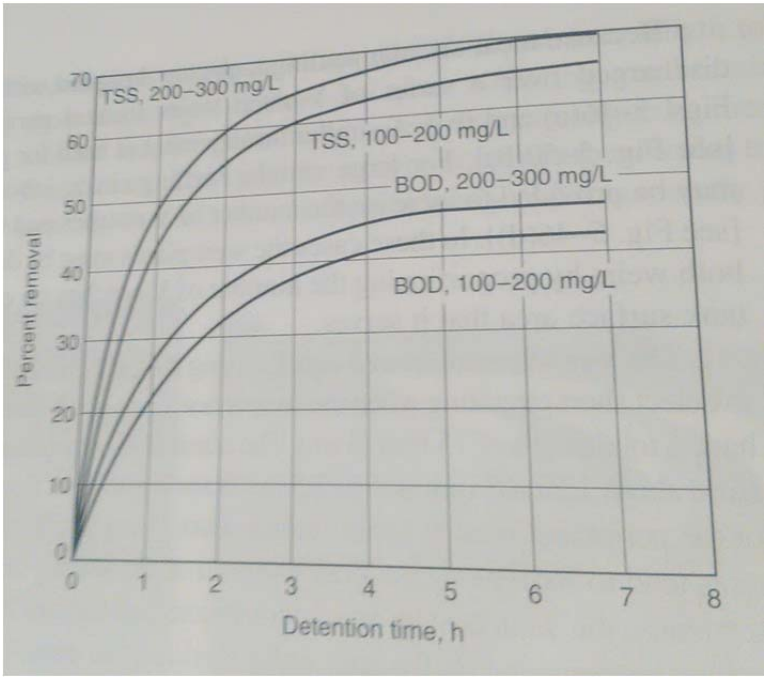


Figure 3. 177 Typical BOD and TSS removal in primary sedimentation tanks
Source: (Metcalf & Eddy, 2014)

3.4.3.2 Relation between PAC dose and TSS removal efficiency

In order to show that the fact to add more PAC does not guarantee a better or faster sedimentation, a relation between the PAC dose and the efficiency was evaluated. The **Figure 3.18** shows the low

coefficients of correlation for the tendency line of the four accelators which indicate that there is no linear relation between the addition of PAC and the removal efficiency of TSS on the contrary as the operators think, at least in this water treatment plant.

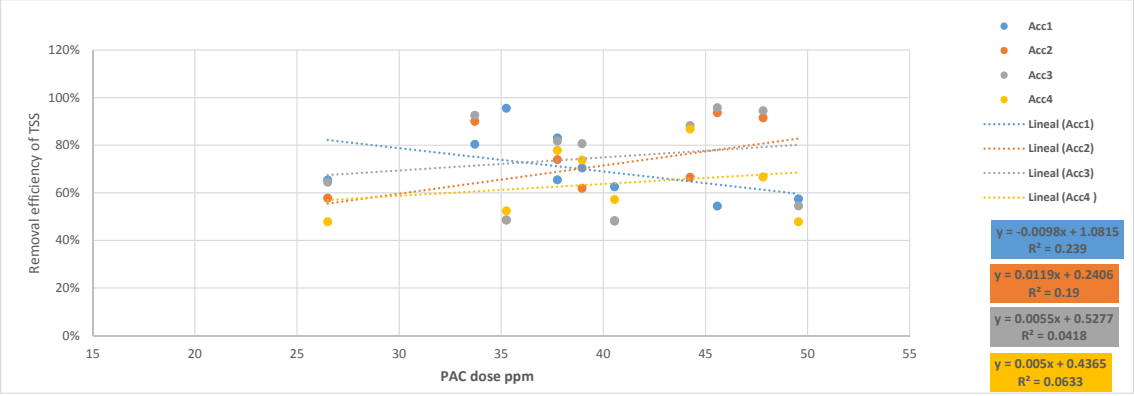


Figure 3. 188 Relation between PAC dose and removal efficiency of TSS in the four accelators

3.4.3.3 Relation between TSS and Turbidity

The Figure 3.19 shows the variation of turbidity and TSS both have a similar behaviour, except for two points, at the influent. In order to see if there is a relation between these two parameters in the influent a graph of relationship between the two parameters was done. In fact, the Figure 3.20 shows that a linear trend described the relation between the TSS and the Turbidity in the influent.

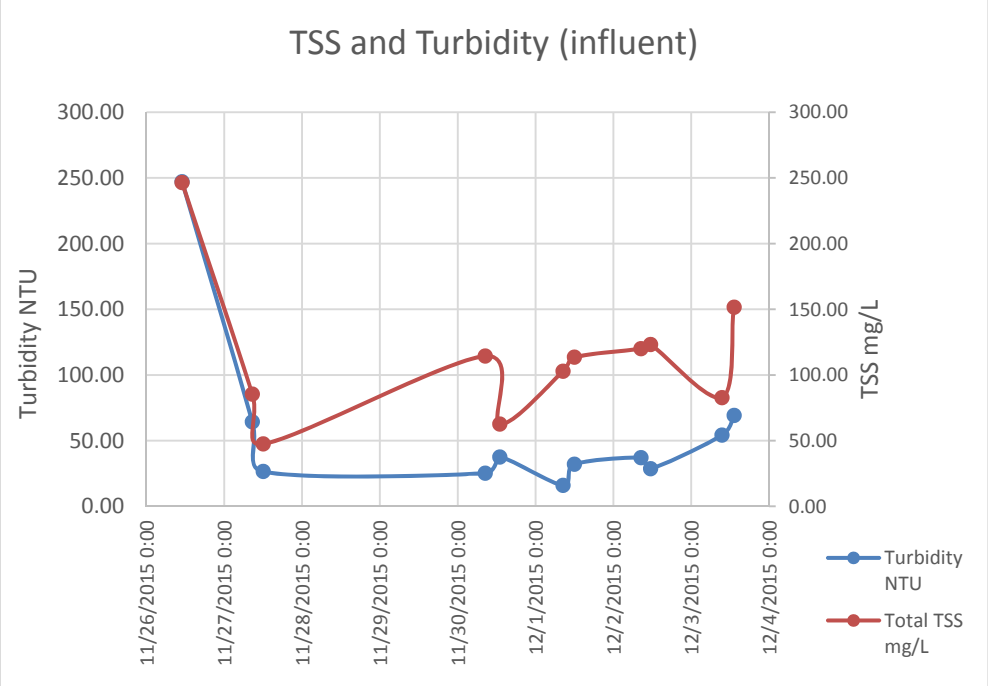


Figure 3. 19 Variation of TSS and Turbidity in the influent during the monitoring plan

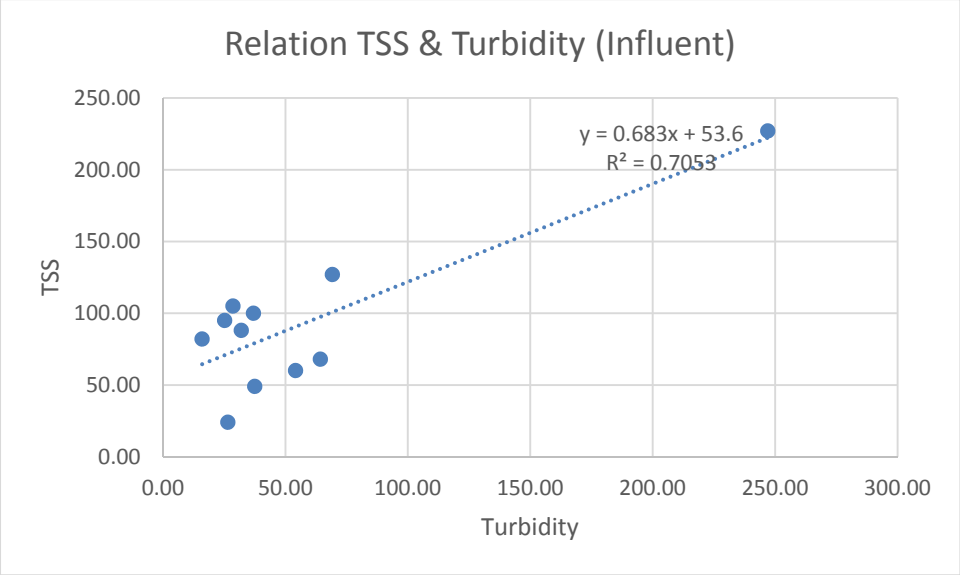


Figure 3. 20 Relation between TSS and Turbidity in the influent

On the contrary to the situation in the influent, the coefficients of determination from the **Figure 3.21, 3.22, 3.23** and **3.24** indicate that there is no relation between the two parameters in the accelators 1, 2, 3 and 4 respectively. The no relation in the accelators could be explained due to the PAC addition and the pre-chlorination that interact with the particles causing an impact in these parameters. For example, the PAC increase at the beginning the TSS, however after certain time makes that the particles settle reducing the turbidity and the TSS.

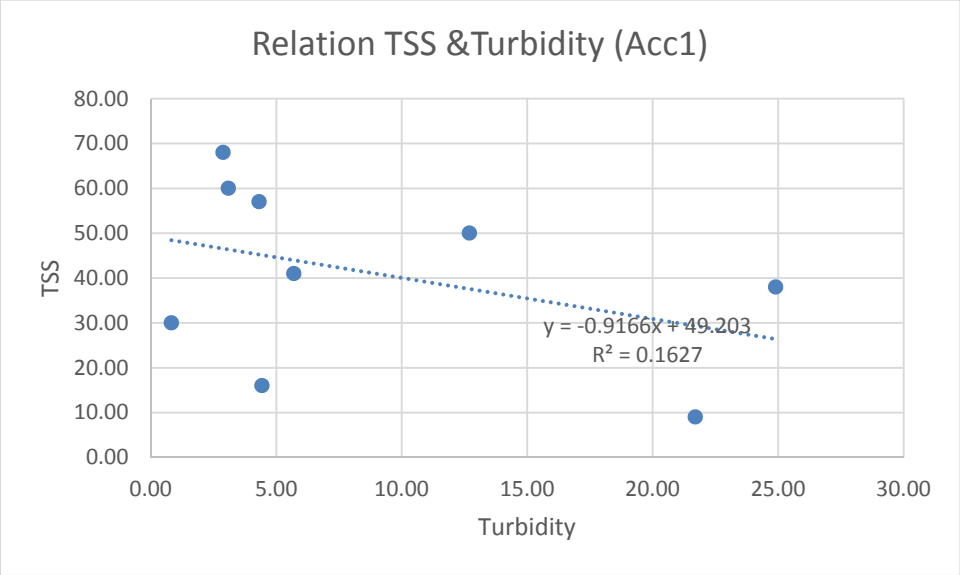


Figure 3. 19 Relation between TSS and Turbidity in the effluent of the Acc1

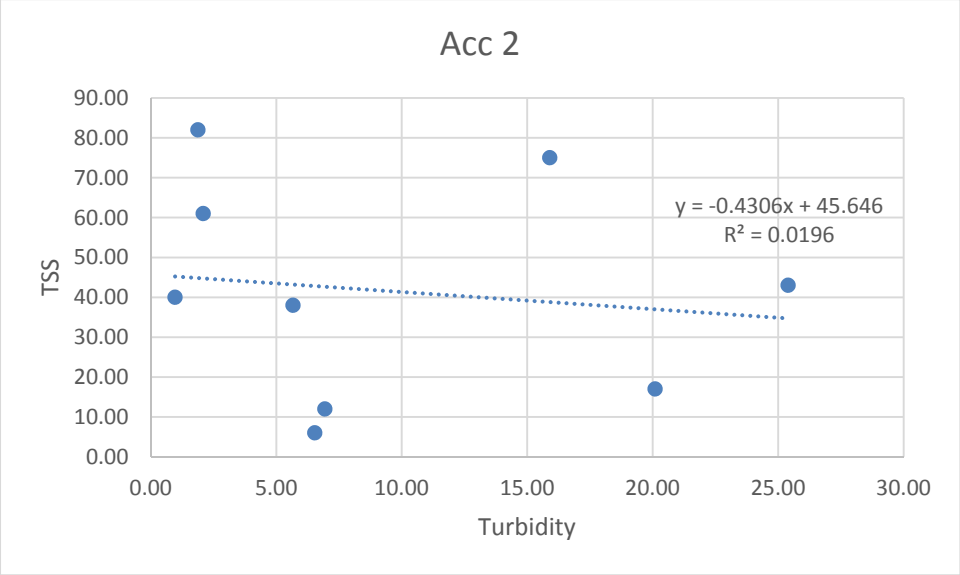


Figure 3. 20 Relation between TSS and Turbidity in the effluent of the Acc2

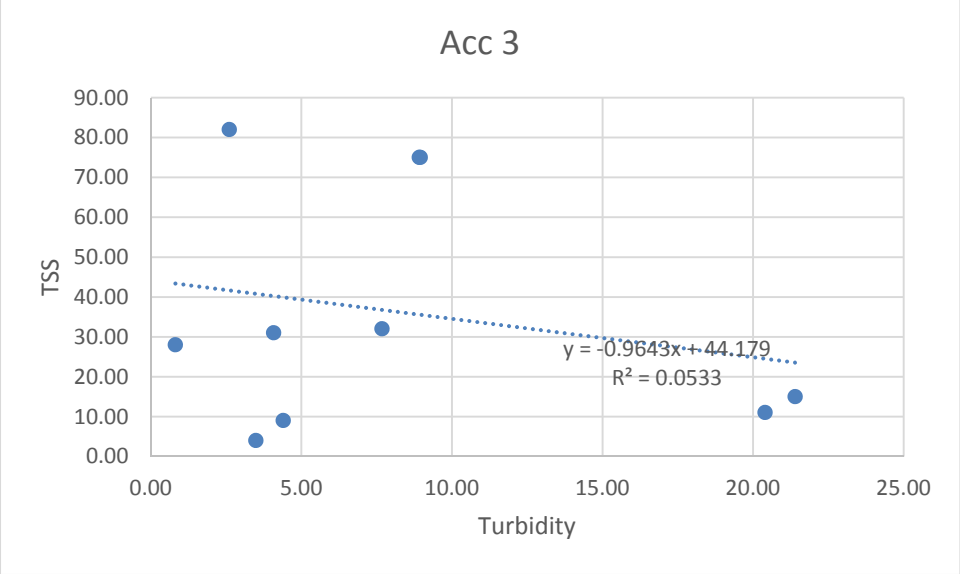


Figure 3. 213 Relation between TSS and Turbidity in the effluent of the Acc3

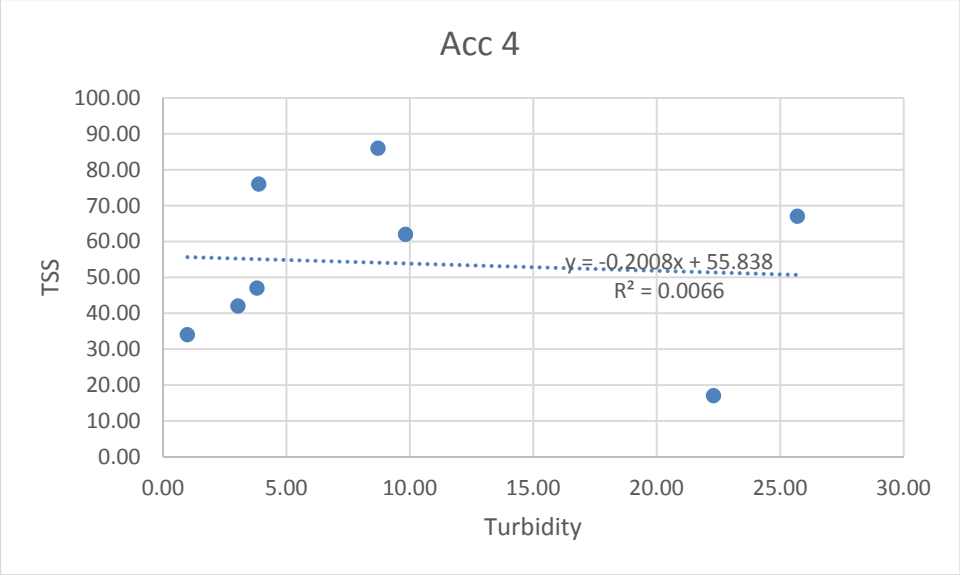


Figure 3. 224 Relation between TSS and Turbidity in the effluent of the Acc4

3.4.4 Analysis with external Laboratory

The first sample that was send it to the external laboratory contents a few parameters as it can be seen in the Table 3.7. After a meeting with the supervisors and the manager of the project more parameters were incorporated.

Table 3. 7 Result of the complete analysis from the external laboratory LPKL

	20-11-2015			01-12-2015			03-12-2015			08-12-2015			
Parameters	Influent north	Cikalong	Effluent	Influent north	Cikalong	Effluent	Influent north	Cikalong	Effluent	Cikapundung	Dago Bengkok	Cikalong	Effluent
TDS	105	160	112				27	21	19				
TSS	44	27	10	54	41	20	10,1	5,68	0,28	36	28	31	2
NTU				10,6	7,82	0,75	6,81			25,8	62,8	37	0,32
pH	7,506	7,06	7,277	6,58	6,16	7,132	2,2214	6,57	7,094	6,21	6,36	6,01	6,774
NO3				2,6667	3,6002	1,2093	0,0005	2,8031	0,9691	2,6523	3,9928	3,605	0,9091
NH3	0,524	0,2752	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	0,0013	<0,0005	<0,0005	<0,0005	<0,0005
As				<0,05797	<0,05797	<0,05797	<0,05797	<0,05797	<0,05797	<0,05797	<0,05797	<0,05797	<0,05797
Ba				<0,01090	<0,01090	<0,01090	<0,01090	<0,01090	<0,01090	<0,01090	<0,01090	<0,01090	<0,01090
Cd				<0,00618	<0,00618	<0,00618	<0,00618	<0,00618	<0,00618	<0,00618	<0,00618	<0,00618	<0,00618
Cu				<0,00527	<0,00527	<0,00527	<0,00527	<0,00527	<0,00527	<0,00527	<0,00527	<0,00527	<0,00527
Pb				<0,02495	<0,02495	<0,02495	<0,02495	<0,02495	<0,02495	<0,02495	<0,02495	<0,02495	<0,02495
NO2				0,6998	0,266	0,0066	0,7575	0,0122	0,0284	0,557	0,2852	0,2054	0,0067
Free chlorine				0,07	0,07	0,8	0,09	0,1	0,06	0,09	0,09	0,18	0,27
Oils&Fats				<2,22	<2,21	<2,21	<2,21	<2,21	<2,21	<2,21	<2,21	<2,21	<2,21
Al	0,02164	0,01677	<0,01090	<0,01091	<0,01090	<0,0109	<0,0109	<0,0109	<0,0109	<0,0109	0,02272	<0,0109	<0,0109
TOC	<0,3	<0,3	<0,4	4,62	4,45	<0,3	3,2	2,4	<0,3	5,2	10,2	1,2	<0,3
Coliforms		460	64	36	29	0	29	28	0	1,10E+03	2,40E+03	2,40E+03	0
E.coli				6	3	0	11	7	0	460	1,10E+03	1,10E+03	0

In general most of the parameters meet the requirements. Few parameters such as arsenic which was slightly above the limits from the influent and the effluent and cadmium that did not obey the effluent's requirements as well.

Table 3.7 also indicates that during one of the sampling days free chlorine was lower than the minimum required value in the effluent, the dose of chlorine was the same than the day before (December 2nd) however the turbidity was higher according with the records from Badaksinga. It might be possible that the organic matter present in the water could react with the chlorine, leaving less free chlorine free.

In relation to NO_2, its concentration was above the maximum limit in the influent but was removed, meeting the required values according the regulations for the treated water.

A critical review of the external laboratory will be done. It should be noted that there are values of TDS that are missing without explanation.

The delivery of the results was always delayed. Once that the results were delivered, errors in the identification of the samples and date of sampling were detected. Moreover for the samples of December 3rd, two samples from the north inlet were sent for analysis, but only one was delivered.

Furthermore. when the laboratory deliver the results (after 21 days from the first sampling) they returned the samples due to some samples from the influent gave lower values than the usual for some parameters in order to analyse by ourselves and get rid of the doubts. However, after so many days it is very likely that the quality of the water is not the same when it was taken, besides there are parameters that must be analysed in a certain period of time after the sampling.

On the other hand, when the laboratory was visited there is no place for reception of samples and they do not identify with name or date/time of reception, in order to not accept the samples if the time since the sample was taken exceed the maximum time to measure certain parameters. Moreover there was no cold chain required to store samples.

Finally, this careless control makes us wonder how reliable the results of these analysis are.

3.4.5 Special situation (Bulking sludge)

The morning of November 30th (Monday) the four accelators had a layer of sludge on the top as it can be seen in the **Figure 3.25**. It was informed that the PAC was changed before of this incident. When the accelator was looked with more attention it could be seen that the flocs were not settled, in fact they were coming upwards and forming the brown layer on the top. According to the staff this situation has never happened before. The staff faced this situation trying to get rid of the sludge mixing the sludge with the water as it can observed in the **Figure 3.26**. The **Figure 3.27** and **3.28** show the situation after the cleaning procedure when the clean water of the effluent was mixed/polluted with sludge and send it to the filters causing a faster clogging there.

In wastewater treatment plants sludge bulking is associated to filamentous bacteria. It should be noted that the characteristics of the influent of Badaksinga sometimes similar to the characteristics of wastewater. High growth of filamentous bacteria is caused by these environmental conditions (Richard, 2003):

- Low dissolved oxygen
- Low ratio between food and microorganisms
- Septicity
- Grease and oil
- Nitrogen or phosphorus deficiency.

In waste water treatment plant the bulking sludge is controlled in short terms by:

Changing the recirculation rates of activated sludge to increase the amount microorganism that can degrade the organic matter, however in drinking water treatment there is no recirculation of sludge.

Wasting the sludge from the clarifiers to stop the re-floating of the settled sludge, polymer and coagulant addition to aid sludge settling and chlorination. This last option might suit better for a drinking water treatment plant.

After this incident, more attention must be paid to:

- The analysis of the aluminium content in the PAC, especially when is a new purchase.
- Frequency of jar test.
- Flow meter/control for PAC dose preferably automatic.
- Increase frequency of sampling especially at night or weekend.

Unfortunately there are no registers of monitoring during the weekends that could be crucial to know if the influent has low levels of dissolved oxygen or high concentrations of grease and oils or other components that characterize the industrial wastewater.

Figure 3. 23 Sludge layer on the top of the accelators

Figure 3. 246 Cleaning procedure done by operators

Figure 3. 27 Condition after cleaning

Figure 3. 25 Effluent contaminated with sludge after the cleaning procedure

3.5 Conclusions

According to the records of the analysis the water quality meet the drinking water guideline N°492/2010. However the frequency of the monitoring is low therefore is necessary more analysis to evaluate the real compliance with the standards.

The quality of raw water fluctuated considerably, especially in terms of turbidity, TSS lead, copper, coliforms due to their fluctuation. On the other hand the monitoring plan shows that there is no variation of TDS. Therefore, water is challenging to treat by the existing installation.

The addition of chemicals (PAC and chlorination) should be done according to the needs (not too much or too little) and doses will always change depending on the quality of raw water received and the quality of the effluent of the accelator in order to see how PAC dose enhance the sedimentation.

Chapter 4 Suggestions & Recommendations

4.1 Intake

4.1.1 Raw Water Supply

Since it has been observed that the volume per day of supply from the excess discharge of PLTA Cikalong is sufficient for the daily demand of PDAM Tirtawening, Badaksinga, Bandung, the decision should be made by the water treatment plant itself. PDAM Tirtawening had once requested PLTA Cikalong to arrange a continuous discharge even if it causes lower flow rate (less than $3m^3/s$). However, after the PLTA tried to manage it, the turbines could not work well and those facilities were out of order in the end. Therefore, it would be advantageous if PDAM Tirtawening can find a solution that will be sustainable for all stakeholders who use Cisangkuy River as their supply, either creating a storage pond as one of the alternatives or other solutions which can will not disturb the balance among all stakeholders demands.

The graph of raw water flow below can be used as a background reference. However, it should be noted that these monthly flow rates are the average values from the hydropower plant data from 2014 until 2015. It does not mean that there is a daily or monthly constant flow. Meanwhile, the river flow values come from the statistically 20% exceeding, which means that there are 80% of data that are higher than those values. The graph gives the occurrence of dry and rainy seasons in 2 cycles, as follows:

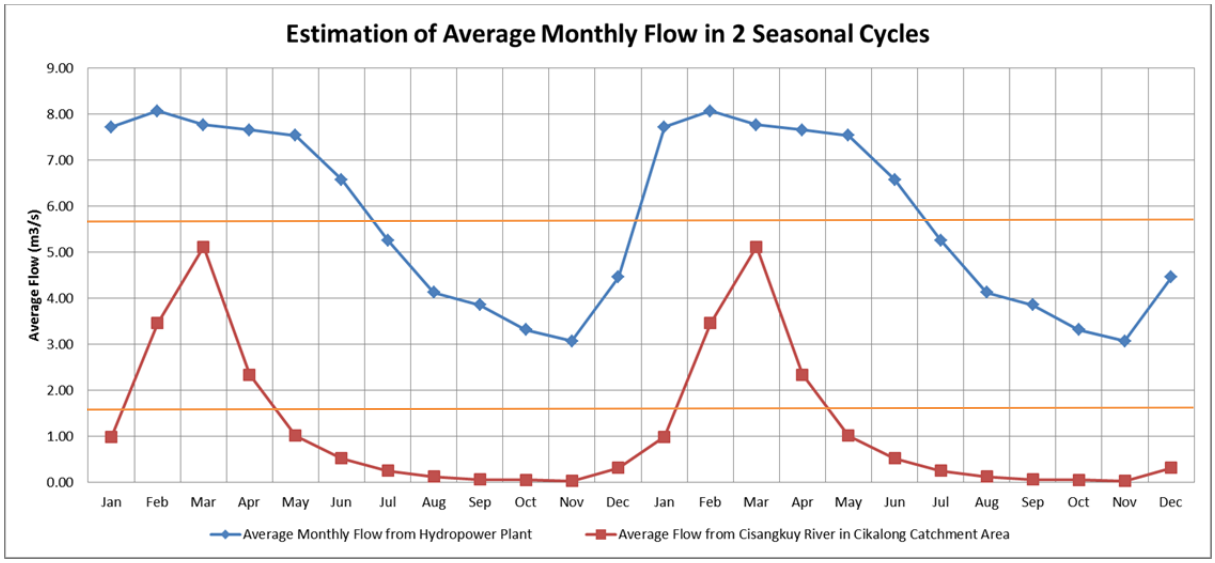


Figure 4. 1 Estimation of Average Monthly Flow in 2 Cycles

It can be inferred from the graph that there is a huge difference of flow during rainy seasons and dry seasons, which means that saving water in rainy seasons to be used in dry seasons is can be an alternative to have a possible constant flow along the year. The constant flow is roughly estimated by the two orange lines, both for the flows from hydropower plant and Cisangkuy River in Cikalong catchment area.

4.1.2 Presedimentation

Since it has been calculated that the presedimentation tanks are not in optimum condition, it would be better to:

1. Use the third tank (belongs to the central province government) at the same time so that the load can be divided into three tanks.
2. Install a flowmeter and begin to use again the sluice gate in the intake (before the flow goes to the tunnel) to save the presedimentation tanks for being overloaded with higher discharge.
3. Install a more efficient baffle to convert the flow into laminar condition.
4. Install a mechanical screen to remove the solid garbage before coming to the intake gate. The solid garbage, especially plastics, tends to degenerate the settling process.
5. If it is necessary, to increase the settling velocity, chemical additives can be given into the tanks, so that in the end the water coming through the pipeline will contain less sediment.

4.2 Transmission Pipeline

Firstly, from the intake to the air valve Bugel, approximately 8000m downstream of the intake, the pressure increase is seen to be very steep in both the measured data and simulation results. To overcome this problem, a butterfly valve could be placed within that section. A butterfly valve is used for isolating and regulating the flow, and always induces a pressure drop in the flow. This would relieve the pressure increase, and reduce the pressure acting along that pipe section.

Secondly, air stagnation is most probably causing the loss in the capacity of the transported water supply and has been a problem since its construction. One way to conquer this problem is by pumping water from the downstream end until entire pipeline is completely filled with water. This way, all the stagnated air will be taken out. This however, will only be a short term fixation, as if the operation is the same, the problem situation will come back. Therefore, study is required to determine the critical flow velocity to prevent air from being stagnant in the pipeline, and thus the pipeline will be able to transport air. Moreover, while air stagnation is also a problem, low flow velocities can also cause sedimentation in the pipeline. To make sure this is also not reducing the transport capacity of the pipeline, pigging of the pipeline to remove solids is also suggested.

4.3 Laboratory

It has been seen that to enhance the water quality, it is necessary to increase the frequency of monitoring and implement an equipped laboratory following safety regulations. Whether an external laboratory will do the analysis or a new lab is implemented, the results must be handled quickly, because with fast results there will be a better internal control to allow for quick action. This is especially for the parameters which are crucial for the good operation of a drinking water treatment plant.

Regarding the sampling it is necessary to keep the cold chain in sampling process and make the sampling traceable. At the same time is essential to be aware of sampling times and reception time in the external laboratory, thinking ahead about the transportation time and closing times.

4.4 People & Safety

4.4.1 Intake

During the rainy seasons, Cisangkuy River often floods at a sudden and with an extreme flow rates. The flow comes to the downstream while carrying plenty amount of solid garbage, which often clogs the intake gate. The intake operators have to go down into the tip of the gate to pick up the garbage manually by sticks or hands without proper body harness or safety belts. It would be better if in the future, the health and safety of the operators can be improved.

4.4.2 Transmission Pipeline

The pipeline operators conduct the maintenance in the middle of the pipeline without any proper safety belts. Sometimes they also perform the repair of air valves which have high pressure only with manual sticks. It would be better if they can use proper equipment and use safe procedures of maintenance.

4.4.3 Laboratory

During the sampling the people should wear gloves, especially at the influent where the raw water is full of microorganism or toxic compounds that can cause infections or diseases. The laboratory is a work place with some reagents that are toxic. In this place the use of lab coat and gloves must be mandatory for the security of the people who works there. Moreover it should be prohibited to eat or drink in this place due to the risk of contamination and to avoid that people get sick.

During the cleaning procedures of accelerator or RSF, operators should wear appropriate shoes, clothes, perhaps masks and helmets that protect them against falls, illness, infections, etc.

For the sampling process if students are taking samples. it should be recommended that at least two students go together especially at the influent where the floor is always wet ant slippery and the water arrives with high velocity that could push the person who is taking the sample, falling into the chamber.

Finally, there are many improvements which can be made in the social environment at PDAM. There is a high need for information to be shared among the whole company accordingly. This should also include the fact that the operators have an opportunity to speak up, and share what they notice within their daily work environment. This is very important because the operators are working at the forefront in all sections of the treatment plant. Further, there is a lot of data being collected by PDAM but there is no one in charge of analyzing or validating the data. Hence, they assume that all the data which is being given to them is correct.

4.4.4 Training

Training is one of the key factors which PDAM is lacking in their work environment. During the research, there was a workshop conducted in order to share the vision of PDAM, not just among the managers, but with the operators. This was the first time any workshop or an event to share information among different sectors in the company was held. It is important that these events are continued and have more parties involved.

Other training sessions, such as learning the use of equipments, its functions and why to use the equipments are also very important.

Training for the operators every time that a new equipment for the laboratory or for the treatment is installed or a new procedure is implemented in the operation or in the laboratory.

4.5 Operation and Equipment

4.5.1 Intake

Since there is no flowmeter in the intake, it would be better to have flowmeter in the intake point, so that the opening/closing gate mechanism can be performed more controllable. Another solution is to control the flow just before the inlet of PDAM Tirtawening itself, which means that there should always be a maximum flow from the intake. This condition will positively influence the opening/closing gate mechanism and save the pipelines from having disturbances but improving the condition of presedimentation tanks should be conducted at first.

4.5.2 Pipeline

Now with the underlying concept of the Endress+Hauser clamp-on flow meter monitor known, the calibration of the SCADA can be done. The SCADA and the percentage values on the flow meter should be monitored regularly to check that the SCADA calibration is accurate and correct. Furthermore, it is important to share this knowledge of the flow meter and SCADA with the other operators. This is important as during the research, most of the operators did not know the functions of many of the equipment existing in the water treatment plant, or why they had to conduct such procedures.

4.5.3 Water quality control

The installation of fine screens before the division of the flow is highly recommended.

The purpose of pre-chlorination needs to be clarified, so that the determination of the dose can be adjusted. It is recommended to apply a chlorination shock with high doses regularly, to get rid of the algae growth.

Regarding to the control and operation of the RSF this could be improve restoring the head-loss measurements then backwashing frequency would be reduced and consequently the amount of water wasted to the river will be reduced as well. Furthermore, the energy consumption would be reduced because the backwashing pump would be used less often.

An unknown and high amount of water is used for backwashing of the filters and discharged to the river. This water could be treated in a settle tank and the effluent of this unit send it back to the top of the treatment plant mixed with the influent and treated again therefore the waste of water would be avoided. One option to reduce the water losses could be the recirculation of sludge or the dewatering of the sludge in order to separate the water from the solids and send the liquid portion back to the top of the treatment plant mixed with the influent and treated again, recovering the water.

PAC facilities need to be equipped with measuring devices and dosing pumps in order to the PAC dosing can be measured accurately. Regarding to the open tanks, lids are necessary to avoid the contamination with dust, bird droppings, among others.

There should be a standard operating procedures, maintenance, and laboratory analysis to guide operators and analysts. Asbestos material should not be used anymore, due to its carcinogenic effect. Therefore asbestos material should be replaced from the accelerators. Finally, calibration and preventive maintenance schedule should be planned, especially for all the online sensors.

4.5.3 Easy measurements

Field parameters such as Temperature and pH can be tested with portable pH meter. Even when some analysis takes time, the help of well-trained students can be an advantage to reduce the time needed for some test such as TSS.

4.6 Future monitoring

4.6.1 Intake

A frequent control for water quantity and quality would improve the condition in the intake. For instance, a flowmeter can be placed in the intake gate (before entering the tunnel) and basic water quality measurement devices can be used in the intake, especially for TSS, turbidity, organic content and heavy metals. Moreover, it is recommended to take samples frequently from the intake, so that the raw water condition can be identified. If the water is too turbid or high in organic content, it would be better if the raw water flow is stopped from the intake than let it go through the pipelines and end up in the plant.

4.6.2 Pipeline

Placing a flow meter upstream of the pipeline would greatly allow the operational procedures of opening and closing of the pipeline to be easily done, and the amount of discharge can be controlled and monitored without constant connection with Badaksinga.

Regular SCADA monitoring, with the EH flow meter within the DWTP, and check with the upstream flow meter should allow a more clear idea of whether the pipeline is functioning at its full capacity.

4.6.3 Water Quality Control

Currently Badaksinga has some online measurements of free chlorine and turbidity at the effluent however there is no a calibration or maintenance schedule for these equipment. Unfortunately, if the measurements are no accurate or do not reflect the reality, wrong decisions can be made.

At least, turbidity, TSS, pH and jar test must be tested regularly to calculate the PAC dose and consumption. The aluminum content from the PAC should be checked, to avoid problems like the one caused for the change of PAC. Regarding to lead, copper, arsenic and cadmium levels in the raw water, these need to be verified and the levels in the treated water also needs to be checked, to determine whether these heavy metals can bound onto the flocs and be disposed in an appropriate place.

It will be desirable if the daily monitoring includes evenings, nights and weekends, because if something happens on weekends the situation cannot be detected or detected on Monday morning and it might be too late to fix it. It is also recommended to propose a monitoring plan upstream, to investigate the variation of the water quality, and to detect possible industrial discharges.

Conclusions & Future Research

In general, PDAM Tirtawening Water Treatment Plant is operated below the optimum condition in regards to its raw water intake, transmission pipelines, and treatment efficiency. There can be many improvements done in the PDAM Tirtawening Water Treatment Plant.

From the raw water intake, with the study area of the southern part in Cikalong, along Cisangkuy River, the water was taken primarily from PLTA Cikalong, the hydropower plant operated by Indonesian Power. The flow of Cisangkuy River is sometimes extracted to meet the demand if the discharge from the hydropower plant is not sufficient. However, after the observation and calculation have been performed, it can be concluded that the discharge volume per day from PLTA Cikalong is sufficient for PDAM daily demand, but since it does not continuously flow, PDAM is recommended to create an arrangement for water storage to provide stable flow for 24 hours.

Furthermore, after combining all water supply from PLTA Cikalong and Cisangkuy River and all water extraction from evaporation and irrigation, it can be concluded that it is possible to have 25% increase of the raw water intake. It can only be achieved if the storage pond is constructed. However, in regards to water quality, sometimes combining both sources is not a good idea since Cisangkuy River has lower water quality.

The presedimentation tanks are considered not in the optimum condition, and some suggestions have been elaborated for improving the efficiency. Some improvements on mechanism, equipment and safety standards are also recommended to obtain better quantity and quality of the raw water intake.

For the future research, some water quality test for the intake point is suggested from other sources, for example: Cisangkuy River and presedimentation tanks. It is also advisable to have an investigation of the impact of frequent flood from Cisangkuy River to the intake system. Lastly, as an interface with the transmission pipelines, it would be valuable to study the mechanism of opening and closing gates from the outlet of presedimentation tanks to the inlet of pipelines, especially the duration of opening and closing and the effect of both the presedimentation tanks and the pipelines.

The analysis for transmission pipelines were focused on Pipa Baru, and this 32 km long pipe has its problems of never having functioned at its full capacity, bursts and control of discharges and flow velociity. The observations and simulations showed that there were possible air stagnations within this long pipeline from when it was built, causing it to not carry its full capacity. Optimizing the flow velocity will prevent this air stagnation from continuing, and may allow the pipe to function as designed. Thus, it is necessary to have future research in the optimal flow velocity in the pipeline to mitigate the occurrence of air stagnation. Moreover, validating this with more field measurements for flow velocity in different locations of the pipeline should also clarify the flow behavior in the pipeline. This should also help validify the calibration of the SCADA, and the flow would be more monitored and easy to control. From a social point of view, it would be interesting to conduct workshop to explain the core of mechanisms within pipelines.

Most of the days when the water was monitored the quality of treated water from treatment plant-Badaksinga meets the requirements of drinking water standard N°492/2010. However the frequency

of the monitoring is low therefore is necessary more analysis to evaluate the real compliance with the standards.

The quality of raw water fluctuated considerably, especially in terms of turbidity and TSS. Therefore, the water is challenging to treat by the existing installation. The addition of chemicals (PAC and chlorination) should be done according to the needs (not too much or too little) and doses will always change depending on the quality of raw water received. Moreover PAC should be analyzed to determine the amount of alum and to calculate the dose that will allow the optimal coagulation.

Although it is true that the drinking water standards are met, the operation of the treatment has some deficiencies and needs to be improved, enhancing the control, monitoring and procedures to make more robust and reliable the treatment system.

References

Brouwer, C., Hoevenaars, J., van Bosch, B., Hatcho, N. & Heibloem, M. (1992). *Irrigation Water Management: Training Manual No. 6 - Scheme Irrigation Water Needs and Supply*. International Institute for Land Reclamation and Improvement (ILRI) & FAO Land and Water Development Division (Food and Agriculture Organization). Retrieved on 5 January, 2016 from http://www.fao.org/docrep/u5835e/u5835e04.htm.

Crawford, H. & Thurin, S. (1981). *Hydrologic Estimates for Small Hydroelectric Projects*. NRECA Small Decentralized Hydropower (SDH) Program. Retrieved on 28 December, 2015 from http://pdf.usaid.gov/pdf_docs/PNAAP521.pdf.

Degremont. (2016, January 10). *Degremont Technologies.* Retrieved from http://www.degremont-technologies.com/cms_medias/pdf/ACCELATOR_US_Infilco.pdf.

DHB Consulting Engineers, IWACO Consultants for Water & Environment, PT. Deserco Development Services & PT. Waseco Tirta. (1988). *Bandung Water Supply Augmentation and Improvement – Phase 2 Detailed Engineering Study. Final Design Report Volume 3B: Cisangkuy Water Works*. Government of Indonesia - Ministry of Public Works Directorate General Cipta Karya & Government of the Netherlands – Ministry of Foreign Affairs Directorate General of International Cooperation.

Durgan. M. (2002). *Total Suspended Solids*. Michigan Government Official Website. Retrieved on 03 Febrruary, 2016 from http://www.michigan.gov/documents/deq/wb-npdes-TotalSuspendedSolids_247238_7.pdf.

Ebeling, J. & Vince, B. (2006). *Solids Capture. Aquaculture Systems Technologies*. University of Arizona Lecture Note. Retrieved on 12 January, 2016 from https://ag.arizona.edu/azaqua/ista/ISTA7/RecircWorkshop/Workshop%20PP%20%20&%20Misc%20Papers%20Adobe%202006/5%20Solids%20Capture/Solids%20Control.pdf.

Eddy, H. (2012). *Potensi Dan Pemanfaatan Zeolit Di Provinsi Jawa Barat Dan Banten*. Badan Geologi – Pusat Sumber Daya Geologi. Official Website. Retrieved on 03 February, 2016 from http://psdg.bgl.esdm.go.id/index.php?option=com_content&view=article&id=493&Itemid=395.

Endress+Hauser. (1991). *Variomag (discomag DMI6531, pulsmag V DMI 6532, picomag II DMI 6533) Flow Measurement: Operating and Installation Manual.* Jakarta, Indonesia: Author.

Engineering page: *Typical Surface Roughness.* (7th Jan, 2016). Retrieved from http://www.engineeringpage.com/technology/pressure_drop/wall_roughness.html

Juanita, N. (2015). *Situ Cileunca Mengering, Kini Jadi Arena Balap Motor*. Bisnis.com Article. Official Website. Retrieved on 03 February, 2016 from

http://traveling.bisnis.com/read/20151028/224/486605/situ-cileunca-mengering-kini-jadi-arena-balap-motor-.

Larock, B., et al. (2000). *Hydraulics of Pipeline Systems.* Boca Raton: CRC Press.

Metcalf, & Eddy. (2014). *Wastewater Engineering Treatment and Resource Recovery.* New York: McGraw- Hill.

McAllister, E. W. (2009). *Pipeline Rules of Thumb Handbook: A manual of quick, accurate solutions to everyday pipeline engineering problems.* Seventh edition, p.401-403.

Orica-watercare. (2015, December 16). *Orica-watercare.* Retrieved from http://www.orica-watercare.com/files/PAC%2023.pdf.

Pipeflow, fluid thinking software solutions: Pipe Roughness. (1997 – 2016). Retrieved from http://www.pipeflow.com/pipe-pressure-drop-calculations/pipe-roughness

Pothof, I. (2015). *Capacity Losses in waste water transport: Hydraulic design and manage wastewater discharge pipes.* Retrieved from https://publicwiki.deltares.nl/display/CAPWAT/CAPaciteitsverliezen+in+afvalWATertransportsystemen;jsessionid=8E49A59C6BEB1FA9E522C048CFE90151

Pothof, I. & Clemens, F. (2010). *On elongated air pockets in downward sloping pipes, Journal of Hydraulic Research*, 48:4, 499-503.

PT DEGREMONT. (2015). *LAPORAN AKHIR AUDIT TEKNIS IPA BADAKSINGA LAMA.* Bandung.

PT. Kwarsa Hexagon, Consulting Engineers. (1996). *Studi Peningkatan Energi Tenaga Air DAS Cisangkuy/Citarum*. Laporan Utama. Bandung: PT. PLN (Persero). Direktorat Bina Program. DIvisi Perencanaan Sistem.

Richard, M. (2003). *ACTIVATED SLUDGE MICROBIOLOGY PROBLEMS AND THEIR CONTROL*. *20th Annual USEPA National Operator Trainers Conference*, (p. 21). Buffalo, New York.

Rietveld, L. (2014). *CTB3365x – Introduction to Water Treatment D5c – Sedimentation*. TU Delft Open Courseware Slide Text. Retrieved on 02 February, 2016 from https://courses.edx.org/c4x/DelftX/CTB3365DWx/asset/D5c_SlidesTekst.pdf.

Sanitary Engineering – Water Management Department. (2007). *Sedimentation – Water Treatment.* TU Delft Open Courseware Lecture Note. Retrieved on 12 January, 2016 from http://ocw.tudelft.nl/fileadmin/ocw/courses/DrinkingWaterTreatment1/res00063/embedded/!534420536564696d656e746174696f6e32303037.pdf.

Sealed Unit Parts Co., Inc. LPT. *Pressure and Temperature Data Logger LOGiT: Overview & Specifications.* Allenwood, NJ, USA: Author.

Sealed Unit Parts Co., Inc. *LOGiTpc Interface Software: User's Guide Version 2.5x*. January 12th, 2012. Allenwood, NJ, USA: Author.

SebaKMT. (03/2015). *Ultrasonic Flow Measurement Device UDM-300: User Manual.* Germany: Author.

Stoyko, D. K., Popplewell, N., and Shah, A. H. (2009). Estimating a Pipe's Equivalent Wall Thickness and Elastic Properties From Ultrasonic Measurements.

Tchobanoglous, G., Burton, F. & Stensel H. Metcalf & Eddy, Inc. (2004). *Wastewater Engineering Treatment & Reuse. Fourth Edition*. New York: McGraw Hill Companies, Inc.

The Engineering Toolbox: *Modulus of Elasticity or Young's modulus and Tensile modulus for some common Materials.* (2016). Retrieved from http://www.engineeringtoolbox.com/young-modulus-d_417.html

Twort, A., Ratnayaka, D., & Brandt, M. J. (2000). WATER SUPPLY. Butterworth-Heinemann.

Verberk, J. (2013). *Sedimentation*. Lecture Slide. TU Delft Sanitary Engineering, Water Management. Retrieved on Nov, 2014 from Blackboard.

APPENDIX

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APPENDIX A. WATER DISCHARGE AND ELECTRICITY PRODUCTION FROM PLTA CIKALONG

For estimated daily discharge time = 18 hours/day.

Outlet Total Volume = Outlet Discharge * Estimated daily discharge time

Water Discharge and Electricity Production
Sub Unit Cikalong Hydropower
January 2014

Date	Inlet Discharge [m3/s]	Outlet Discharge [m3/s]	Electricity Production [KWh]	Water Use [m3]	Water Price [m3/KWh]	Outlet Total Volume [m3]
1	8.25	8.25	196,020.00	712,800.00	3.64	534,600.00
2	7.33	7.10	168,795.00	613,800.00	3.64	460,080.00
3	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
4	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
5	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
6	7.83	7.81	185,625.00	675,000.00	3.64	506,088.00
7	7.50	7.50	178,200.00	648,000.00	3.64	486,000.00
8	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
9	7.30	7.38	175,230.00	637,200.00	3.64	478,224.00
10	8.25	8.25	196,020.00	712,800.00	3.64	534,600.00
11	2.10	2.33	55,440.00	201,600.00	3.64	150,984.00
12	6.29	6.06	144,045.00	523,800.00	3.64	392,688.00
13	6.60	6.54	155,430.00	565,200.00	3.64	423,792.00
14	8.25	8.25	196,020.00	712,800.00	3.64	534,600.00
15	7.37	7.40	175,725.00	639,000.00	3.64	479,520.00
16	8.54	8.54	202,950.00	738,000.00	3.64	553,392.00
17	9.00	8.94	212,355.00	772,200.00	3.64	579,312.00
18	9.08	9.17	217,800.00	792,000.00	3.64	594,216.00
19	6.87	6.90	163,845.00	595,800.00	3.64	447,120.00
20	9.00	8.83	209,880.00	763,200.00	3.64	572,184.00
21	8.50	8.52	202,455.00	736,200.00	3.64	552,096.00
22	8.17	8.02	190,575.00	693,000.00	3.64	519,696.00
23	8.20	8.21	195,030.00	709,200.00	3.64	532,008.00
24	9.00	9.02	214,335.00	779,400.00	3.64	584,496.00
25	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
26	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
27	9.00	8.92	211,860.00	770,400.00	3.64	578,016.00
28	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
29	8.21	8.21	195,030.00	709,200.00	3.64	532,008.00
30	8.12	8.13	193,050.00	702,000.00	3.64	526,824.00
31	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
Total	**245.76**	**245.28**	**5,827,635.00**	**21,191,400.00**		**15,894,144.00**
Average	**7.93**	**7.91**	**187,988.23**	**683,593.55**		**512,714.32**

Inlet Discharge

Maximum	9.08	m3/s
Minimum	2.10	m3/s
Average	7.93	m3/s

Outlet Discharge

Maximum	9.17	m3/s
Minimum	2.33	m3/s
Average	7.91	m3/s

Water Discharge and Electricity Production

Sub Unit Cikalong Hydropower

February 2014

Date	Inlet Discharge [m3/s]	Outlet Discharge [m3/s]	Electricity Production [KWh]	Water Use [m3]	Water Price [m3/KWh]	Outlet Total Volume [m3]
1	7.66	7.67	182,160.00	662,400.00	3.64	497,016.00
2	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
3	7.33	7.35	174,735.00	635,400.00	3.64	476,280.00
4	7.66	7.63	181,170.00	658,800.00	3.64	494,424.00
5	7.00	6.90	163,845.00	595,800.00	3.64	447,120.00
6	7.63	7.67	182,160.00	662,400.00	3.64	497,016.00
7	8.33	8.31	197,505.00	718,200.00	3.64	538,488.00
8	9.10	9.08	215,820.00	784,800.00	3.64	588,384.00
9	8.50	8.46	200,970.00	730,800.00	3.64	548,208.00
10	10.00	10.00	237,600.00	864,000.00	3.64	648,000.00
11	8.58	8.58	203,940.00	741,600.00	3.64	555,984.00
12	8.50	8.50	201,960.00	734,400.00	3.64	550,800.00
13	8.62	8.65	205,425.00	747,000.00	3.64	560,520.00
14	8.70	8.83	209,880.00	763,200.00	3.64	572,184.00
15	8.25	8.25	196,020.00	712,800.00	3.64	534,600.00
16	8.25	8.25	196,020.00	712,800.00	3.64	534,600.00
17	8.50	8.31	197,505.00	718,200.00	3.64	538,488.00
18	8.66	8.67	205,920.00	748,800.00	3.64	561,816.00
19	8.50	8.50	201,960.00	734,400.00	3.64	550,800.00
20	8.54	8.58	203,940.00	741,600.00	3.64	555,984.00
21	7.83	7.83	186,120.00	676,800.00	3.64	507,384.00
22	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
23	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
24	8.00	8.13	193,050.00	702,000.00	3.64	526,824.00
25	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
26	7.88	7.96	189,090.00	687,600.00	3.64	515,808.00
27	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
28	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
Total	**230.02**	**230.11**	**5,467,275.00**	**19,881,000.00**		**14,911,128.00**
Average	**8.22**	**8.22**	**195,259.82**	**710,035.71**		**532,540.29**

Inlet Discharge

Maximum	10.00	m3/s
Minimum	7.00	m3/s
Average	8.22	m3/s

Outlet Discharge

Maximum	10.00	m3/s
Minimum	6.90	m3/s
Average	8.22	m3/s

Water Discharge and Electricity Production

Sub Unit Cikalong Hydropower

March 2014

Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
2	7.33	7.02	166,815.00	606,600.00	3.64	454,896.00
3	5.37	5.02	119,815.00	4,343,800.00	3.64	325,296.00
4	6.60	6.15	146,025.00	531,000.00	3.64	398,520.00
5	7.37	7.50	178,200.00	648,000.00	3.64	486,000.00
6	8.33	8.25	196,020.00	712,800.00	3.64	534,600.00
7	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
8	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
9	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
10	8.12	8.13	193,050.00	702,000.00	3.64	526,824.00
11	5.20	1.23	29,205.00	106,200.00	3.64	79,704.00
12	-	-	-	-	-	-
13	4.42	4.40	104,445.00	379,800.00	3.64	285,120.00
14	6.13	5.98	142,065.00	516,600.00	3.64	387,504.00
15	5.00	4.81	114,345.00	415,800.00	3.64	311,688.00
16	5.66	5.38	127,710.00	464,400.00	3.64	348,624.00
17	1.45	1.33	31,680.00	115,200.00	3.64	86,184.00
18	3.60	1.31	31,185.00	113,400.00	3.64	84,888.00
19	5.16	5.13	121,770.00	442,800.00	3.64	332,424.00
20	8.00	8.06	191,565.00	696,600.00	3.64	522,288.00
21	7.08	7.63	181,170.00	658,800.00	3.64	494,424.00
22	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
23	7.17	7.23	171,765.00	624,600.00	3.64	468,504.00
24	7.50	7.48	177,705.00	646,200.00	3.64	484,704.00
25	6.12	6.10	145,035.00	527,400.00	3.64	395,280.00
26	8.25	8.58	203,940.00	741,600.00	3.64	555,984.00
27	9.00	9.13	216,810.00	788,400.00	3.64	591,624.00
28	8.00	7.75	184,140.00	669,600.00	3.64	502,200.00
29	10.00	9.38	222,750.00	810,000.00	3.64	607,824.00
30	10.00	9.88	234,630.00	853,200.00	3.64	640,224.00
31	10.25	10.06	239,085.00	869,400.00	3.64	651,888.00
Total	**211.11**	**202.92**	**4,821,325.00**	**21,440,200.00**		**13,149,216.00**
Average	**7.04**	**6.76**	**160,710.83**	**714,673.33**		**424,168.26**

Inlet Discharge

Maximum	10.00	m3/s
Minimum	7.00	m3/s
Average	8.22	m3/s

Outlet Discharge

Maximum	10.00	m3/s
Minimum	6.90	m3/s
Average	8.22	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
March 2014						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
2	7.33	7.02	166,815.00	606,600.00	3.64	454,896.00
3	5.37	5.02	119,815.00	4,343,800.00	3.64	325,296.00
4	6.60	6.15	146,025.00	531,000.00	3.64	398,520.00
5	7.37	7.50	178,200.00	648,000.00	3.64	486,000.00
6	8.33	8.25	196,020.00	712,800.00	3.64	534,600.00
7	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
8	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
9	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
10	8.12	8.13	193,050.00	702,000.00	3.64	526,824.00
11	5.20	1.23	29,205.00	106,200.00	3.64	79,704.00
12	-	-	-	-	-	-
13	4.42	4.40	104,445.00	379,800.00	3.64	285,120.00
14	6.13	5.98	142,065.00	516,600.00	3.64	387,504.00
15	5.00	4.81	114,345.00	415,800.00	3.64	311,688.00
16	5.66	5.38	127,710.00	464,400.00	3.64	348,624.00
17	1.45	1.33	31,680.00	115,200.00	3.64	86,184.00
18	3.60	1.31	31,185.00	113,400.00	3.64	84,888.00
19	5.16	5.13	121,770.00	442,800.00	3.64	332,424.00
20	8.00	8.06	191,565.00	696,600.00	3.64	522,288.00
21	7.08	7.63	181,170.00	658,800.00	3.64	494,424.00
22	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
23	7.17	7.23	171,765.00	624,600.00	3.64	468,504.00
24	7.50	7.48	177,705.00	646,200.00	3.64	484,704.00
25	6.12	6.10	145,035.00	527,400.00	3.64	395,280.00
26	8.25	8.58	203,940.00	741,600.00	3.64	555,984.00
27	9.00	9.13	216,810.00	788,400.00	3.64	591,624.00
28	8.00	7.75	184,140.00	669,600.00	3.64	502,200.00
29	10.00	9.38	222,750.00	810,000.00	3.64	607,824.00
30	10.00	9.88	234,630.00	853,200.00	3.64	640,224.00
31	10.25	10.06	239,085.00	869,400.00	3.64	651,888.00
Total	**211.11**	**202.92**	**4,821,325.00**	**21,440,200.00**		**13,149,216.00**
Average	**7.04**	**6.76**	**160,710.83**	**714,673.33**		**424,168.26**

Inlet Discharge

Maximum	10.25	m3/s
Minimum	0.00	m3/s
Average	6.81	m3/s

Outlet Discharge

Maximum	10.06	m3/s
Minimum	0.00	m3/s
Average	6.55	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
April 2014						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	10.50	10.25	243,540.00	885,600.00	3.64	664,200.00
2	10.00	9.50	225,720.00	820,800.00	3.64	615,600.00
3	10.00	9.19	218,295.00	793,800.00	3.64	595,512.00
4	10.00	9.00	213,840.00	777,600.00	3.64	583,200.00
5	10.00	9.21	218,790.00	795,600.00	3.64	596,808.00
6	10.00	9.50	225,720.00	820,800.00	3.64	615,600.00
7	10.00	9.21	218,790.00	795,600.00	3.64	596,808.00
8	10.00	9.19	218,295.00	793,800.00	3.64	595,512.00
9	9.20	8.67	205,920.00	748,800.00	3.64	561,816.00
10	7.12	6.83	162,360.00	590,400.00	3.64	442,584.00
11	10.00	9.15	217,305.00	790,200.00	3.64	592,920.00
12	8.54	7.85	186,615.00	678,600.00	3.64	508,680.00
13	9.25	8.54	202,950.00	738,000.00	3.64	553,392.00
14	9.25	8.69	206,415.00	750,600.00	3.64	563,112.00
15	7.04	7.33	174,240.00	633,600.00	3.64	474,984.00
16	6.58	6.50	154,440.00	561,600.00	3.64	421,200.00
17	7.25	7.04	167,310.00	608,400.00	3.64	456,192.00
18	10.00	9.00	213,840.00	777,600.00	3.64	583,200.00
19	10.00	9.13	216,810.00	788,400.00	3.64	591,624.00
20	10.00	9.19	218,295.00	793,800.00	3.64	595,512.00
21	7.29	7.23	171,765.00	624,600.00	3.64	468,504.00
22	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
23	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
24	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
25	9.25	9.19	218,295.00	793,800.00	3.64	595,512.00
26	7.00	6.92	164,340.00	597,600.00	3.64	448,416.00
27	6.80	6.63	157,410.00	572,400.00	3.64	429,624.00
28	6.83	6.54	155,430.00	565,200.00	3.64	423,792.00
29	6.65	6.60	156,915.00	570,600.00	3.64	427,680.00
30	8.50	7.52	178,695.00	649,800.00	3.64	487,296.00
Total	**264.05**	**250.60**	**5,953,860.00**	**21,650,400.00**		**16,238,880.00**
Average	**8.80**	**8.35**	**198,462.00**	**721,680.00**		**541,296.00**

Inlet Discharge

Maximum	10.50	m3/s
Minimum	6.58	m3/s
Average	8.80	m3/s

Outlet Discharge

Maximum	10.25	m3/s
Minimum	6.50	m3/s
Average	8.35	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
May 2014						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	9.00	8.85	210,375.00	765,000.00	3.64	573,480.00
2	9.00	8.83	209,880.00	763,200.00	3.64	572,184.00
3	9.30	9.15	217,305.00	790,200.00	3.64	592,920.00
4	10.00	9.06	215,325.00	783,000.00	3.64	587,088.00
5	10.00	9.00	213,840.00	777,600.00	3.64	583,200.00
6	10.00	9.42	223,740.00	813,600.00	3.64	610,416.00
7	10.00	9.44	224,235.00	815,400.00	3.64	611,712.00
8	10.00	9.15	217,305.00	790,200.00	3.64	592,920.00
9	10.00	9.71	230,670.00	838,800.00	3.64	629,208.00
10	10.00	9.63	228,690.00	831,600.00	3.64	624,024.00
11	10.00	9.33	221,760.00	806,400.00	3.64	604,584.00
12	9.75	9.21	218.00	795,600.00	3.64	596,808.00
13	10.00	9.48	225,225.00	819,000.00	3.64	614,304.00
14	10.00	9.25	219,780.00	799,200.00	3.64	599,400.00
15	10.00	9.31	221,265.00	804,600.00	3.64	603,288.00
16	10.00	9.04	214,830.00	781,200.00	3.64	585,792.00
17	8.13	7.52	178,695.00	649,800.00	3.64	487,296.00
18	6.42	6.40	151,965.00	552,600.00	3.64	414,720.00
19	6.85	6.73	159,885.00	581,400.00	3.64	436,104.00
20	10.00	9.00	213,840.00	777,600.00	3.64	583,200.00
21	10.40	9.69	230,175.00	837,000.00	3.64	627,912.00
22	11.16	9.90	235,125.00	855,000.00	3.64	641,520.00
23	10.00	9.56	227,205.00	826,200.00	3.64	619,488.00
24	10.80	9.50	225,720.00	820,800.00	3.64	615,600.00
25	10.25	9.92	235,620.00	856,800.00	3.64	642,816.00
26	9.70	9.25	219,780.00	799,200.00	3.64	599,400.00
27	10.00	9.79	232,650.00	846,000.00	3.64	634,392.00
28	9.66	9.50	225,720.00	820,800.00	3.64	615,600.00
29	10.30	9.92	235,620.00	856,800.00	3.64	642,816.00
30	10.00	9.54	226,710.00	824,400.00	3.64	618,192.00
31	8.75	8.10	192,555.00	700,200.00	3.64	524,880.00
Total	**299.47**	**282.18**	**6,485,708.00**	**24,379,200.00**		**18,285,264.00**
Average	**9.66**	**9.10**	**209,216.39**	**786,425.81**		**589,847.23**

Inlet Discharge

Maximum	11.16	m3/s
Minimum	6.42	m3/s
Average	9.66	m3/s

Outlet Discharge

Maximum	9.92	m3/s
Minimum	6.40	m3/s
Average	9.10	m3/s

Water Discharge and Electricity Production

Sub Unit Cikalong Hydropower

June 2014

Date	Inlet Discharge [m3/s]	Outlet Discharge [m3/s]	Electricity Production [KWh]	Water Use [m3]	Water Price [m3/KWh]	Outlet Total Volume [m3]
1	9.33	8.83	209,880.00	763,200.00	3.64	572,184.00
2	9.41	9.23	219,285.00	797,400.00	3.64	598,104.00
3	6.75	6.83	162,360.00	590,400.00	3.64	442,584.00
4	5.00	5.02	119,295.00	433,800.00	3.64	325,296.00
5	6.80	6.83	162,360.00	590,400.00	3.64	442,584.00
6	10.08	9.98	237,105.00	862,200.00	3.64	646,704.00
7	10.00	9.50	225,720.00	820,800.00	3.64	615,600.00
8	10.00	9.50	225,720.00	820,800.00	3.64	615,600.00
9	8.62	8.46	200,970.00	730,800.00	3.64	548,208.00
10	8.79	8.44	200,475.00	729,000.00	3.64	546,912.00
11	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
12	8.66	8.67	205,920.00	748,800.00	3.64	561,816.00
13	8.25	8.23	195,525.00	711,000.00	3.64	533,304.00
14	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
15	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
16	8.90	8.96	212,850.00	774,000.00	3.64	580,608.00
17	5.83	5.60	133,155.00	484,200.00	3.64	362,880.00
18	7.50	7.52	178,695.00	649,800.00	3.64	487,296.00
19	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
20	7.50	7.38	175,230.00	637,200.00	3.64	478,224.00
21	6.83	6.83	162,360.00	590,400.00	3.64	442,584.00
22	6.50	6.54	155,430.00	565,200.00	3.64	423,792.00
23	7.16	6.54	155,430.00	565,200.00	3.64	423,792.00
24	2.33	6.35	150,975.00	549,000.00	3.64	411,480.00
25	6.50	6.38	151,470.00	550,800.00	3.64	413,424.00
26	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
27	8.00	8.00	192,060.00	698,400.00	3.64	518,400.00
28	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
29	7.63	7.33	174,240.00	633,600.00	3.64	474,984.00
30	7.63	7.65	181,665.00	660,600.00	3.64	495,720.00
Total	**235.00**	**235.60**	**5,599,935.00**	**20,363,400.00**		**15,266,880.00**
Average	**7.83**	**7.85**	**186,664.50**	**678,780.00**		**508,896.00**

Inlet Discharge

Maximum	10.08	m3/s
Minimum	2.33	m3/s
Average	7.83	m3/s

Outlet Discharge

Maximum	9.98	m3/s
Minimum	5.02	m3/s
Average	7.88	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
July 2014						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	6.33	6.44	152,955.00	556,200.00	3.64	417,312.00
2	6.20	6.13	145,530.00	529,200.00	3.64	397,224.00
3	6.00	6.04	143,550.00	522,000.00	3.64	391,392.00
4	6.00	6.15	140,580.00	511,200.00	3.64	398,520.00
5	6.16	6.56	146,025.00	531,000.00	3.64	425,088.00
6	6.60	6.10	155,925.00	567,000.00	3.64	395,280.00
7	6.00	6.10	145,035.00	527,400.00	3.64	395,280.00
8	6.33	6.25	148,500.00	540,000.00	3.64	405,000.00
9	5.83	5.85	139,095.00	505,800.00	3.64	379,080.00
10	5.50	5.63	133,650.00	486,000.00	3.64	364,824.00
11	5.50	5.46	129,690.00	471,600.00	3.64	353,808.00
12	6.66	6.67	158,400.00	576,000.00	3.64	432,216.00
13	7.77	7.15	169,785.00	617,400.00	3.64	463,320.00
14	6.67	6.77	160,875.00	585,000.00	3.64	438,696.00
15	6.79	6.52	154,935.00	563,400.00	3.64	422,496.00
16	5.66	5.69	135,135.00	491,400.00	3.64	368,712.00
17	7.17	7.27	172,755.00	628,200.00	3.64	471,096.00
18	6.33	6.33	150,480.00	547,200.00	3.64	410,184.00
19	7.00	6.85	162,855.00	592,200.00	3.64	443,880.00
20	6.66	7.06	167,805.00	610,200.00	3.64	457,488.00
21	6.67	6.96	165,330.00	601,200.00	3.64	451,008.00
22	7.33	7.58	180,180.00	655,200.00	3.64	491,184.00
23	7.12	7.13	169,290.00	615,600.00	3.64	462,024.00
24	7.33	7.33	174,240.00	633,600.00	3.64	474,984.00
25	7.25	7.25	173,250.00	630,000.00	3.64	469,800.00
26	6.83	6.79	161,370.00	586,800.00	3.64	439,992.00
27	7.50	7.48	177,705.00	646,200.00	3.64	484,704.00
28	6.83	6.81	161,865.00	588,600.00	3.64	441,288.00
29	7.00	7.23	171,765.00	624,600.00	3.64	468,504.00
30	6.66	6.98	165,825.00	603,000.00	3.64	452,304.00
31	6.66	6.56	155,925.00	567,000.00	3.64	425,088.00
Total	**204.34**	**205.12**	**4,870,305.00**	**17,710,200.00**		**13,291,776.00**
Average	**6.59**	**6.62**	**157,106.61**	**571,296.77**		**428,766.97**

Inlet Discharge

Maximum	7.77	m3/s
Minimum	5.50	m3/s
Average	6.59	m3/s

Outlet Discharge

Maximum	7.58	m3/s
Minimum	5.46	m3/s
Average	6.62	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
August 2014						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	6.66	6.46	153,450.00	558,000.00	3.64	418,608.00
2	6.00	6.40	151,965.00	552,600.00	3.64	414,720.00
3	5.75	5.79	137,610.00	500,400.00	3.64	375,192.00
4	6.00	6.48	140,580.00	511,200.00	3.64	419,904.00
5	6.60	5.73	153,945.00	559,800.00	3.64	371,304.00
6	5.50	5.46	136,125.00	495,000.00	3.64	353,808.00
7	5.50	5.46	129,690.00	471,600.00	3.64	353,808.00
8	5.66	5.67	134,640.00	489,600.00	3.64	367,416.00
9	5.62	5.50	130,680.00	475,200.00	3.64	356,400.00
10	5.54	5.81	138,105.00	502,200.00	3.64	376,488.00
11	6.08	6.08	144,540.00	525,600.00	3.64	393,984.00
12	6.00	5.90	140,085.00	509,400.00	3.64	382,320.00
13	6.40	5.63	133,650.00	486,000.00	3.64	364,824.00
14	5.83	5.77	137,115.00	498,600.00	3.64	373,896.00
15	5.66	5.54	131,670.00	478,800.00	3.64	358,992.00
16	5.50	5.52	131,175.00	477,000.00	3.64	357,696.00
17	4.75	4.88	115,830.00	421,200.00	3.64	316,224.00
18	5.00	6.08	144,540.00	525,600.00	3.64	393,984.00
19	4.83	4.81	114,345.00	415,800.00	3.64	311,688.00
20	4.83	4.83	114,840.00	417,600.00	3.64	312,984.00
21	4.13	3.94	93,555.00	340,200.00	3.64	255,312.00
22	4.17	4.29	101,970.00	370,800.00	3.64	277,992.00
23	4.66	4.63	109,890.00	399,600.00	3.64	300,024.00
24	4.50	4.60	109,395.00	397,800.00	3.64	298,080.00
25	4.50	7.25	107,415.00	390,600.00	3.64	469,800.00
26	4.42	4.44	105,435.00	383,400.00	3.64	287,712.00
27	4.50	4.52	107,415.00	390,600.00	3.64	292,896.00
28	4.85	4.75	112,860.00	410,400.00	3.64	307,800.00
29	5.16	5.21	123,750.00	450,000.00	3.64	337,608.00
30	4.87	4.90	116,325.00	423,000.00	3.64	317,520.00
31	5.00	4.92	116,820.00	424,800.00	3.64	318,816.00
Total	**164.47**	**167.25**	**3,919,410.00**	**14,252,400.00**		**10,837,800.00**
Average	**5.31**	**5.40**	**126,432.58**	**459,754.84**		**349,606.45**

Inlet Discharge

Maximum	6.66	m3/s
Minimum	4.13	m3/s
Average	5.31	m3/s

Outlet Discharge

Maximum	7.25	m3/s
Minimum	3.94	m3/s
Average	5.40	m3/s

Water Discharge and Electricity Production

Sub Unit Cikalong Hydropower

September 2014

Date	Inlet Discharge [m3/s]	Outlet Discharge [m3/s]	Electricity Production [KWh]	Water Use [m3]	Water Price [m3/KWh]	Outlet Total Volume [m3]
1	6.66	4.58	108,900.00	396,000.00	3.64	296,784.00
2	6.00	4.67	110,880.00	403,200.00	3.64	302,616.00
3	5.75	0.85	20,295.00	73,800.00	3.64	55,080.00
4	6.00	4.08	81,180.00	295,200.00	3.64	264,384.00
5	6.60	3.90	97,020.00	352,800.00	3.64	252,720.00
6	5.50	3.50	92,565.00	336,600.00	3.64	226,800.00
7	5.50	3.50	83,160.00	302,400.00	3.64	226,800.00
8	5.66	3.96	94,050.00	342,000.00	3.64	256,608.00
9	5.62	3.75	89,100.00	324,000.00	3.64	243,000.00
10	5.54	3.46	82,170.00	298,800.00	3.64	224,208.00
11	6.08	3.17	75,240.00	273,600.00	3.64	205,416.00
12	6.00	3.25	77,220.00	280,800.00	3.64	210,600.00
13	6.40	3.33	79,200.00	288,000.00	3.64	215,784.00
14	5.83	3.17	75,240.00	273,600.00	3.64	205,416.00
15	5.66	3.48	82,665.00	300,600.00	3.64	225,504.00
16	5.50	3.25	77,220.00	280,800.00	3.64	210,600.00
17	4.75	3.23	76,725.00	279,000.00	3.64	209,304.00
18	5.00	3.42	81,180.00	295,200.00	3.64	221,616.00
19	4.83	3.00	71,280.00	259,200.00	3.64	194,400.00
20	4.83	2.73	64,845.00	235,800.00	3.64	176,904.00
21	4.13	3.23	76,725.00	279,000.00	3.64	209,304.00
22	4.17	3.13	74,250.00	270,000.00	3.64	202,824.00
23	4.66	29.98	712,280.00	2,590,109.09	3.64	1,942,704.00
24	4.50	29.98	712,280.00	2,590,109.09	3.64	1,942,704.00
25	4.50	7.25	59,400.00	216,000.00	3.64	469,800.00
26	4.42	2.65	62,865.00	228,600.00	3.64	171,720.00
27	4.50	3.10	73,755.00	268,200.00	3.64	200,880.00
28	4.85	-	-	-	3.64	-
29	5.16	2.96	70,290.00	255,600.00	3.64	191,808.00
30	4.87	2.54	60,390.00	219,600.00	3.64	164,592.00
Total	**159.47**	**153.10**	**3,522,370.00**	**12,808,618.18**		**9,920,880.00**
Average	**5.32**	**5.28**	**121,461.03**	**441,676.49**		**330,696.00**

Inlet Discharge

Maximum	6.66	m3/s
Minimum	4.13	m3/s
Average	5.32	m3/s

Outlet Discharge

Maximum	29.98	m3/s
Minimum	0.00	m3/s
Average	5.27	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
October 2014						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
2	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
3	2.42	2.52	59,895.00	217,800.00	3.64	163,296.00
4	2.80	3.00	64,350.00	234,000.00	3.64	194,400.00
5	3.00	1.00	71,280.00	259,200.00	3.64	64,800.00
6	0.83	3.00	23,760.00	86,400.00	3.64	194,400.00
7	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
8	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
9	3.00	2.77	65,835.00	239,400.00	3.64	179,496.00
10	3.04	3.00	71,280.00	259,200.00	3.64	194,400.00
11	3.12	3.15	74,745.00	271,800.00	3.64	204,120.00
12	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
13	2.91	2.38	56,430.00	205,200.00	3.64	154,224.00
14	3.25	3.25	77,220.00	280,800.00	3.64	210,600.00
15	3.20	3.21	76,230.00	277,200.00	3.64	208,008.00
16	3.25	3.23	76,725.00	279,000.00	3.64	209,304.00
17	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
18	3.25	3.25	77,220.00	280,800.00	3.64	210,600.00
19	3.25	3.25	77,220.00	280,800.00	3.64	210,600.00
20	3.25	3.07	72,963.00	265,320.00	3.64	198,936.00
21	3.25	3.33	79,002.00	287,280.00	3.64	215,784.00
22	3.75	3.73	88,605.00	322,200.00	3.64	241,704.00
23	3.29	3.25	77,220.00	280,800.00	3.64	210,600.00
24	2.29	3.29	78,210.00	284,400.00	3.64	213,192.00
25	3.25	3.25	77,220.00	280,800.00	3.64	210,600.00
26	3.25	3.25	77,220.00	280,800.00	3.64	210,600.00
27	3.25	3.25	77,220.00	280,800.00	3.64	210,600.00
28	3.00	2.98	70,785.00	257,400.00	3.64	193,104.00
29	3.25	3.42	81,180.00	295,200.00	3.64	221,616.00
30	3.75	3.75	89,100.00	324,000.00	3.64	243,000.00
31	3.87	3.85	91,575.00	333,000.00	3.64	249,480.00
Total	**94.77**	**95.43**	**2,260,170.00**	**8,218,800.00**		**6,183,864.00**
Average	**3.06**	**3.08**	**72,908.71**	**265,122.58**		**199,479.48**

Inlet Discharge

Maximum	3.87	m3/s
Minimum	0.83	m3/s
Average	3.06	m3/s

Outlet Discharge

Maximum	3.85	m3/s
Minimum	1.00	m3/s
Average	3.08	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
November 2014						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	3.62	3.56	84,645.00	307,800.00	3.64	230,688.00
2	3.24	3.48	82,665.00	300,600.00	3.64	225,504.00
3	3.25	3.25	77,220.00	280,800.00	3.64	210,600.00
4	3.45	3.48	82,665.00	300,600.00	3.64	225,504.00
5	3.20	3.35	74,745.00	271,800.00	3.64	217,080.00
6	3.37	3.35	79,695.00	289,800.00	3.64	217,080.00
7	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
8	3.00	3.83	91,080.00	331,200.00	3.64	248,184.00
9	4.75	4.67	110,880.00	403,200.00	3.64	302,616.00
10	6.00	1.71	40,590.00	147,600.00	3.64	110,808.00
11	-	-	-	-	3.64	-
12	-	-	-	-	3.64	-
13	2.87	2.83	67,320.00	244,800.00	3.64	183,384.00
14	4.25	4.25	100,980.00	367,200.00	3.64	275,400.00
15	4.29	4.27	101,475.00	369,000.00	3.64	276,696.00
16	4.25	4.23	100,485.00	365,400.00	3.64	274,104.00
17	4.29	4.35	103,455.00	376,200.00	3.64	281,880.00
18	4.25	4.27	101,475.00	369,000.00	3.64	276,696.00
19	5.00	4.90	116,325.00	423,000.00	3.64	317,520.00
20	5.00	5.00	118,800.00	432,000.00	3.64	324,000.00
21	1.45	1.63	38,610.00	140,400.00	3.64	105,624.00
22	5.20	4.31	102,465.00	372,600.00	3.64	279,288.00
23	5.00	5.00	118,800.00	432,000.00	3.64	324,000.00
24	5.08	5.10	121,275.00	441,000.00	3.64	330,480.00
25	4.63	4.46	105,930.00	385,200.00	3.64	289,008.00
26	4.25	4.25	100,980.00	367,200.00	3.64	275,400.00
27	5.00	4.83	114,840.00	417,600.00	3.64	312,984.00
28	5.00	1.15	27,225.00	99,000.00	3.64	74,520.00
29	-	-	-	-		-
30	5.00	0.31	7,425.00	27,000.00	3.64	20,088.00
Total	**111.69**	**98.82**	**2,343,330.00**	**8,521,200.00**		**6,403,536.00**
Average	**4.14**	**3.66**	**86,790.00**	**315,600.00**		**213,451.20**

Inlet Discharge

Maximum	6.00	m3/s
Minimum	0.00	m3/s
Average	3.72	m3/s

Outlet Discharge

Maximum	5.10	m3/s
Minimum	0.00	m3/s
Average	3.52	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
December 2014						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	5.45	5.06	120,245.00	437,254.55	3.64	327,888.00
2	4.70	5.50	128,205.00	466,200.00	3.64	356,400.00
3	4.92	4.54	107,910.00	392,400.00	3.64	294,192.00
4	4.92	4.88	115,830.00	421,200.00	3.64	316,224.00
5	4.92	5.77	128,205.00	466,200.00	3.64	373,896.00
6	5.87	5.77	137,115.00	498,600.00	3.64	373,896.00
7	5.70	5.75	136,620.00	496,800.00	3.64	372,600.00
8	5.87	5.88	139,590.00	507,600.00	3.64	381,024.00
9	5.87	6.50	154,440.00	561,600.00	3.64	421,200.00
10	7.58	7.52	178,695.00	649,800.00	3.64	487,296.00
11	8.29	8.29	197,010.00	716,400.00	3.64	537,192.00
12	8.25	8.25	196,020.00	712,800.00	3.64	534,600.00
13	8.25	8.29	197,010.00	716,400.00	3.64	537,192.00
14	7.41	7.33	174,240.00	633,600.00	3.64	474,984.00
15	5.29	5.33	126,720.00	460,800.00	3.64	345,384.00
16	7.25	7.21	171,270.00	622,800.00	3.64	467,208.00
17	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
18	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
19	8.66	8.79	208,890.00	759,600.00	3.64	569,592.00
20	7.50	7.56	179,685.00	653,400.00	3.64	489,888.00
21	6.25	6.23	148,005.00	538,200.00	3.64	403,704.00
22	4.08	4.19	99,495.00	361,800.00	3.64	271,512.00
23	3.87	3.77	89,595.00	325,800.00	3.64	244,296.00
24	4.45	4.44	105,435.00	383,400.00	3.64	287,712.00
25	7.12	7.08	168,300.00	612,000.00	3.64	458,784.00
26	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
27	5.87	5.50	130,720.00	475,345.45	3.64	356,400.00
28	4.80	3.63	86,130.00	313,200.00	3.64	235,224.00
29	7.67	7.56	179,685.00	653,400.00	3.64	489,888.00
30	7.66	7.69	182,655.00	664,200.00	3.64	498,312.00
31	6.50	6.50	154,440.00	561,600.00	3.64	421,200.00
Total	**199.97**	**199.81**	**4,736,160.00**	**17,222,400.00**		**12,947,688.00**
Average	**6.45**	**6.45**	**152,779.35**	**555,561.29**		**417,667.35**

Inlet Discharge

Maximum	9.00	m3/s
Minimum	3.87	m3/s
Average	6.45	m3/s

Outlet Discharge

Maximum	9.00	m3/s
Minimum	3.63	m3/s
Average	6.45	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
January 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	6.25	6.23	148,005.00	538,200.00	3.64	403,704.00
2	6.50	6.31	149,985.00	545,400.00	3.64	408,888.00
3	6.62	6.63	157,410.00	572,400.00	3.64	429,624.00
4	6.50	6.48	153,945.00	559,800.00	3.64	419,904.00
5	6.00	7.00	141,570.00	514,800.00	3.64	453,600.00
6	6.00	7.00	166,320.00	604,800.00	3.64	453,600.00
7	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
8	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
9	7.71	7.71	183,150.00	666,000.00	3.64	499,608.00
10	7.91	8.02	190,575.00	693,000.00	3.64	519,696.00
11	7.45	7.52	178,705.00	649,836.36	3.64	487,296.00
12	7.78	7.88	187,110.00	680,400.00	3.64	510,624.00
13	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
14	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
15	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
16	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
17	8.00	8.19	194,535.00	707,400.00	3.64	530,712.00
18	8.00	8.38	198,990.00	723,600.00	3.64	543,024.00
19	8.00	8.50	201,960.00	734,400.00	3.64	550,800.00
20	7.91	8.38	198,990.00	723,600.00	3.64	543,024.00
21	6.87	7.00	166,320.00	604,800.00	3.64	453,600.00
22	7.16	7.65	181,665.00	660,600.00	3.64	495,720.00
23	8.00	8.50	201,960.00	734,400.00	3.64	550,800.00
24	5.70	5.88	139,590.00	507,600.00	3.64	381,024.00
25	6.46	6.38	151,470.00	550,800.00	3.64	413,424.00
26	7.75	7.35	174,735.00	635,400.00	3.64	476,280.00
27	8.00	8.54	202,950.00	738,000.00	3.64	553,392.00
28	7.25	7.69	182,655.00	664,200.00	3.64	498,312.00
29	8.00	8.21	195,030.00	709,200.00	3.64	532,008.00
30	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
31	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
Total	**227.82**	**233.43**	**5,520,745.00**	**20,075,436.36**		**15,126,264.00**
Average	**7.35**	**7.53**	**178,088.55**	**647,594.72**		**487,944.00**

Inlet Discharge

Maximum	8.00	m3/s
Minimum	5.70	m3/s
Average	7.35	m3/s

Outlet Discharge

Maximum	8.54	m3/s
Minimum	5.88	m3/s
Average	7.53	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
February 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	6.25	8.23	195,525.00	711,000.00	3.64	533,304.00
2	6.50	8.19	194,535.00	707,400.00	3.64	530,712.00
3	6.62	8.00	190,080.00	691,200.00	3.64	518,400.00
4	6.50	8.00	190,080.00	691,200.00	3.64	518,400.00
5	6.00	8.00	190,080.00	691,200.00	3.64	518,400.00
6	6.00	8.00	190,080.00	691,200.00	3.64	518,400.00
7	7.00	8.00	190,080.00	691,200.00	3.64	518,400.00
8	7.00	8.00	190,080.00	691,200.00	3.64	518,400.00
9	7.71	8.13	193,050.00	702,000.00	3.64	526,824.00
10	7.91	8.00	190,080.00	691,200.00	3.64	518,400.00
11	7.45	7.02	166,815.00	606,600.00	3.64	454,896.00
12	7.78	6.17	146,520.00	532,800.00	3.64	399,816.00
13	8.00	4.92	116,820.00	424,800.00	3.64	318,816.00
14	8.00	6.21	147,510.00	536,400.00	3.64	402,408.00
15	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
16	8.00	8.25	196,020.00	712,800.00	3.64	534,600.00
17	8.00	9.00	213,840.00	777,600.00	3.64	583,200.00
18	8.00	8.25	196,020.00	712,800.00	3.64	534,600.00
19	8.00	8.25	196,020.00	712,800.00	3.64	534,600.00
20	7.91	9.00	213,840.00	777,600.00	3.64	583,200.00
21	6.87	9.00	213,840.00	777,600.00	3.64	583,200.00
22	7.16	9.00	213,840.00	777,600.00	3.64	583,200.00
23	8.00	8.29	197,010.00	716,400.00	3.64	537,192.00
24	5.70	8.04	191,090.00	694,872.73	3.64	520,992.00
25	6.46	8.00	190,080.00	691,200.00	3.64	518,400.00
26	7.75	8.00	190,080.00	691,200.00	3.64	518,400.00
27	8.00	7.46	177,210.00	644,400.00	3.64	483,408.00
28	7.25	8.58	203,880.00	741,381.82	3.64	555,984.00
Total	**203.82**	**221.99**	**5,274,185.00**	**19,178,854.55**		**14,384,952.00**
Average	**7.28**	**7.93**	**188,363.75**	**684,959.09**		**513,748.29**

Inlet Discharge

Maximum	8.00	m3/s
Minimum	5.70	m3/s
Average	7.28	m3/s

Outlet Discharge

Maximum	9.00	m3/s
Minimum	4.92	m3/s
Average	7.93	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
March 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	7.50	7.50	178,200.00	648,000.00	3.64	486,000.00
2	8.75	8.69	206,415.00	750,600.00	3.64	563,112.00
3	8.95	8.90	211,365.00	768,600.00	3.64	576,720.00
4	8.25	8.25	196,020.00	712,800.00	3.64	534,600.00
5	8.95	9.04	212,355.00	772,200.00	3.64	585,792.00
6	9.16	9.04	214,830.00	781,200.00	3.64	585,792.00
7	8.60	8.69	206,415.00	750,600.00	3.64	563,112.00
8	8.66	8.67	205,920.00	748,800.00	3.64	561,816.00
9	8.66	8.67	205,920.00	748,800.00	3.64	561,816.00
10	8.96	8.85	210,375.00	765,000.00	3.64	573,480.00
11	9.90	9.83	233,640.00	849,600.00	3.64	636,984.00
12	9.25	9.21	218,790.00	795,600.00	3.64	596,808.00
13	10.50	10.17	241,560.00	878,400.00	3.64	659,016.00
14	8.25	8.27	196,515.00	714,600.00	3.64	535,896.00
15	9.20	9.83	233,640.00	849,600.00	3.64	636,984.00
16	8.33	8.31	197,505.00	718,200.00	3.64	538,488.00
17	0.75	8.73	207,405.00	754,200.00	3.64	565,704.00
18	8.96	9.65	229,185.00	833,400.00	3.64	625,320.00
19	10.00	9.75	231,660.00	842,400.00	3.64	631,800.00
20	9.16	9.25	219,780.00	799,200.00	3.64	599,400.00
21	9.04	8.92	211,860.00	770,400.00	3.64	578,016.00
22	8.08	8.06	191,565.00	696,600.00	3.64	522,288.00
23	8.65	8.69	206,415.00	750,600.00	3.64	563,112.00
24	9.30	9.33	221,760.00	806,400.00	3.64	604,584.00
25	8.45	8.38	198,990.00	723,600.00	3.64	543,024.00
26	8.00	8.00	190,080.00	691,200.00	3.64	518,400.00
27	8.50	8.50	201,960.00	734,400.00	3.64	550,800.00
28	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
29	8.83	8.83	209,880.00	763,200.00	3.64	572,184.00
30	9.00	9.00	213,840.00	777,600.00	3.64	583,200.00
31	5.83	6.04	143,550.00	522,000.00	3.64	391,392.00
Total	**263.42**	**272.05**	**6,461,235.00**	**23,495,400.00**		**17,628,840.00**
Average	**8.50**	**8.78**	**208,426.94**	**757,916.13**		**568,672.26**

Inlet Discharge

Maximum	10.50	m3/s
Minimum	0.75	m3/s
Average	8.50	m3/s

Outlet Discharge

Maximum	10.17	m3/s
Minimum	6.04	m3/s
Average	8.78	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
April 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	6.45	6.19	534,600.00	534,600.00	3.64	401,112.00
2	7.16	7.17	619,200.00	619,200.00	3.64	464,616.00
3	7.16	7.10	613,800.00	613,800.00	3.64	460,080.00
4	8.00	8.00	691,200.00	691,200.00	3.64	518,400.00
5	7.62	7.13	649,800.00	649,800.00	3.64	462,024.00
6	7.60	7.13	615,600.00	615,600.00	3.64	462,024.00
7	8.00	8.00	691,200.00	691,200.00	3.64	518,400.00
8	8.65	8.73	754,200.00	754,200.00	3.64	565,704.00
9	9.16	9.19	793,800.00	793,800.00	3.64	595,512.00
10	8.50	8.54	738,000.00	738,000.00	3.64	553,392.00
11	6.67	6.60	570,600.00	570,600.00	3.64	427,680.00
12	9.30	9.27	801,000.00	801,000.00	3.64	600,696.00
13	8.50	8.48	732,600.00	732,600.00	3.64	549,504.00
14	7.17	6.98	603,000.00	603,000.00	3.64	452,304.00
15	7.17	4.81	415,800.00	415,800.00	3.64	311,688.00
16	7.17	6.85	592,200.00	592,200.00	3.64	443,880.00
17	7.75	7.83	676,800.00	676,800.00	3.64	507,384.00
18	7.16	7.17	619,200.00	619,200.00	3.64	464,616.00
19	6.79	7.08	612,000.00	612,000.00	3.64	458,784.00
20	6.79	7.42	640,800.00	640,800.00	3.64	480,816.00
21	7.00	7.06	610,054.55	610,054.55	3.64	457,488.00
22	7.00	5.92	511,200.00	511,200.00	3.64	383,616.00
23	5.29	5.27	455,400.00	455,400.00	3.64	341,496.00
24	5.29	6.02	520,200.00	520,200.00	3.64	390,096.00
25	7.00	7.00	604,800.00	604,800.00	3.64	453,600.00
26	7.00	5.65	487,800.00	487,800.00	3.64	366,120.00
27	5.96	7.00	604,800.00	604,800.00	3.64	453,600.00
28	2.45	5.83	504,000.00	504,000.00	3.64	377,784.00
29	2.45	2.60	225,000.00	225,000.00	3.64	168,480.00
30	2.45	6.83	590,400.00	590,400.00	3.64	442,584.00
Total	**204.66**	**208.85**	**18,079,054.55**	**18,079,054.55**		**13,533,480.00**
Average	**6.82**	**6.96**	**602,635.15**	**602,635.15**		**451,116.00**

Inlet Discharge

Maximum	9.30	m3/s
Minimum	2.45	m3/s
Average	6.82	m3/s

Outlet Discharge

Maximum	9.27	m3/s
Minimum	2.60	m3/s
Average	6.96	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
May 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
2	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
3	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
4	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
5	7.00	4.98	166,320.00	604,800.00	3.64	322,704.00
6	7.00	4.98	118,305.00	430,200.00	3.64	322,704.00
7	5.45	5.54	131,670.00	478,800.00	3.64	358,992.00
8	4.38	4.56	108,405.00	394,200.00	3.64	295,488.00
9	5.50	5.38	127,710.00	464,400.00	3.64	348,624.00
10	5.25	5.40	128,205.00	466,200.00	3.64	349,920.00
11	5.33	5.19	123,255.00	448,200.00	3.64	336,312.00
12	4.83	4.73	112,365.00	408,600.00	3.64	306,504.00
13	6.50	6.40	151,965.00	552,600.00	3.64	414,720.00
14	5.91	5.88	139,590.00	507,600.00	3.64	381,024.00
15	6.66	6.58	156,420.00	568,800.00	3.64	426,384.00
16	6.50	6.40	151,965.00	552,600.00	3.64	414,720.00
17	6.25	6.23	148,005.00	538,200.00	3.64	403,704.00
18	4.25	4.27	101,475.00	369,000.00	3.64	276,696.00
19	5.62	5.35	127,215.00	462,600.00	3.64	346,680.00
20	4.88	4.79	113,850.00	414,000.00	3.64	310,392.00
21	5.63	5.60	133,155.00	484,200.00	3.64	362,880.00
22	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
23	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
24	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
25	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
26	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
27	5.54	5.52	131,175.00	477,000.00	3.64	357,696.00
28	6.40	6.38	6.40	550,800.00	3.64	413,424.00
29	6.00	5.96	6.00	514,800.00	3.64	386,208.00
30	5.63	5.54	5.63	478,800.00	3.64	358,992.00
31	6.50	6.48	6.50	559,800.00	3.64	419,904.00
Total	**190.01**	**185.14**	**3,867,954.53**	**16,169,400.00**		**11,997,072.00**
Average	**6.13**	**5.97**	**124,772.73**	**521,593.55**		**387,002.32**

Inlet Discharge

Maximum	7.00	m3/s
Minimum	4.25	m3/s
Average	6.13	m3/s

Outlet Discharge

Maximum	7.00	m3/s
Minimum	4.27	m3/s
Average	5.97	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
June 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	6.63	6.60	156,915.00	570,600.00	3.64	427,680.00
2	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
3	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
4	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
5	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
6	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
7	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
8	7.00	7.00	166,320.00	604,800.00	3.64	453,600.00
9	5.83	5.81	138,105.00	502,200.00	3.64	376,488.00
10	4.00	3.98	94,545.00	343,800.00	3.64	257,904.00
11	6.16	6.02	143,055.00	520,200.00	3.64	390,096.00
12	6.45	6.38	151,470.00	550,800.00	3.64	413,424.00
13	2.29	2.23	52,965.00	192,600.00	3.64	144,504.00
14	4.87	4.85	115,335.00	419,400.00	3.64	314,280.00
15	5.91	5.83	138,600.00	504,000.00	3.64	377,784.00
16	6.00	6.00	142,560.00	518,400.00	3.64	388,800.00
17	5.75	5.79	137,610.00	500,400.00	3.64	375,192.00
18	4.75	4.67	110,880.00	403,200.00	3.64	302,616.00
19	4.75	4.65	110,385.00	401,400.00	3.64	301,320.00
20	1.25	1.35	32,175.00	117,000.00	3.64	87,480.00
21	3.71	3.65	86,625.00	315,000.00	3.64	236,520.00
22	4.50	4.46	105,930.00	385,200.00	3.64	289,008.00
23	1.50	5.38	127,710.00	464,400.00	3.64	348,624.00
24	5.50	5.48	130,185.00	473,400.00	3.64	355,104.00
25	4.75	4.79	113,850.00	414,000.00	3.64	310,392.00
26	5.63	5.52	131,175.00	477,000.00	3.64	357,696.00
27	5.37	5.31	126,225.00	459,000.00	3.64	344,088.00
28	1.83	1.92	45,540.00	165,600.00	3.64	124,416.00
29	3.00	4.25	100,980.00	367,200.00	3.64	275,400.00
30	5.12	5.00	118,800.00	432,000.00	3.64	324,000.00
Total	**154.55**	**158.92**	**3,775,860.00**	**13,730,400.00**		**10,298,016.00**
Average	**5.15**	**5.30**	**125,862.00**	**457,680.00**		**343,267.20**

Inlet Discharge

Maximum	7.00	m3/s
Minimum	1.25	m3/s
Average	5.15	m3/s

Outlet Discharge

Maximum	7.00	m3/s
Minimum	1.35	m3/s
Average	5.30	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
July 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	4.54	4.71	111,870.00	406,800.00	3.64	305,208.00
2	4.62	4.65	110,385.00	401,400.00	3.64	301,320.00
3	4.63	4.56	108,405.00	394,200.00	3.64	295,488.00
4	4.00	4.02	95,535.00	347,400.00	3.64	260,496.00
5	4.50	4.33	104,940.00	381,600.00	3.64	280,584.00
6	4.45	4.33	102,940.00	374,400.00	3.64	280,584.00
7	4.38	4.35	103,455.00	376,200.00	3.64	281,880.00
8	4.00	4.00	95,040.00	345,600.00	3.64	259,200.00
9	4.50	4.50	106,920.00	388,800.00	3.64	291,600.00
10	4.25	4.23	100,485.00	365,400.00	3.64	274,104.00
11	4.50	4.54	107,910.00	392,400.00	3.64	294,192.00
12	4.00	4.00	95,040.00	345,600.00	3.64	259,200.00
13	4.38	4.38	103,950.00	378,000.00	3.64	283,824.00
14	3.58	3.58	85,140.00	309,600.00	3.64	231,984.00
15	3.54	3.48	82,665.00	300,600.00	3.64	225,504.00
16	3.33	3.33	79,200.00	288,000.00	3.64	215,784.00
17	4.00	4.00	95,040.00	345,600.00	3.64	259,200.00
18	4.00	4.00	95,040.00	345,600.00	3.64	259,200.00
19	4.00	4.00	95,040.00	345,600.00	3.64	259,200.00
20	4.00	4.00	95,040.00	345,600.00	3.64	259,200.00
21	3.75	3.75	89,100.00	324,000.00	3.64	243,000.00
22	4.25	4.23	100,485.00	365,400.00	3.64	274,104.00
23	3.58	3.58	85,140.00	309,600.00	3.64	231,984.00
24	3.75	3.75	89,100.00	324,000.00	3.64	243,000.00
25	3.33	3.25	77,220.00	280,800.00	3.64	210,600.00
26	4.00	4.00	95,040.00	345,600.00	3.64	259,200.00
27	4.00	4.00	95,040.00	345,600.00	3.64	259,200.00
28	3.33	3.33	79,200.00	288,000.00	3.64	215,784.00
29	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
30	2.75	2.77	65,835.00	239,400.00	3.64	179,496.00
31	2.38	2.29	54,450.00	198,000.00	3.64	148,392.00
Total	**121.32**	**120.94**	**2,875,930.00**	**10,458,000.00**		**7,836,912.00**
Average	**3.91**	**3.90**	**92,771.94**	**337,354.84**		**252,803.61**

Inlet Discharge

Maximum	4.63	m3/s
Minimum	2.38	m3/s
Average	3.91	m3/s

Outlet Discharge

Maximum	4.71	m3/s
Minimum	2.29	m3/s
Average	3.90	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
August 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	3.00	2.96	70,290.00	255,600.00	3.64	191,808.00
2	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
3	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
4	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
5	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
6	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
7	3.00	2.38	56,430.00	205,200.00	3.64	154,224.00
8	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
9	2.50	2.52	59,895.00	217,800.00	3.64	163,296.00
10	2.50	2.52	59,895.00	217,800.00	3.64	163,296.00
11	3.36	3.04	72,270.00	262,800.00	3.64	196,992.00
12	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
13	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
14	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
15	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
16	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
17	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
18	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
19	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
20	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
21	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
22	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
23	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
24	2.63	2.60	61,875.00	225,000.00	3.64	168,480.00
25	3.08	2.48	58,905.00	214,200.00	3.64	160,704.00
26	3.00	3.02	71,775.00	261,000.00	3.64	195,696.00
27	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
28	2.63	2.60	61,875.00	225,000.00	3.64	168,480.00
29	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
30	2.25	2.17	51,480.00	187,200.00	3.64	140,616.00
31	2.37	2.40	56,925.00	207,000.00	3.64	155,520.00
Total	**90.32**	**88.69**	**2,107,215.00**	**7,662,600.00**		**5,747,112.00**
Average	**2.91**	**2.86**	**67,974.68**	**247,180.65**		**185,390.71**

Inlet Discharge

Maximum	3.36	m3/s
Minimum	2.25	m3/s
Average	2.91	m3/s

Outlet Discharge

Maximum	3.04	m3/s
Minimum	2.17	m3/s
Average	2.86	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
September 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	3.00	2.96	70,920.00	255,600.00	3.64	191,808.00
2	2.97	2.29	54,450.00	198,000.00	3.64	148,392.00
3	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
4	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
5	2.50	2.44	57,915.00	210,600.00	3.64	158,112.00
6	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
7	2.37	2.38	56,430.00	205,200.00	3.64	154,224.00
8	2.50	2.42	57,420.00	208,800.00	3.64	156,816.00
9	2.50	2.46	58,410.00	212,400.00	3.64	159,408.00
10	2.71	1.85	44,055.00	160,200.00	3.64	119,880.00
11	3.00	2.90	68,805.00	250,200.00	3.64	187,920.00
12	2.62	2.60	61,875.00	225,000.00	3.64	168,480.00
13	2.50	2.46	58,410.00	212,400.00	3.64	159,408.00
14	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
15	2.50	2.48	58,905.00	214,200.00	3.64	160,704.00
16	2.50	2.50	59,400.00	216,000.00	3.64	162,000.00
17	2.75	2.67	63,360.00	230,400.00	3.64	173,016.00
18	3.11	2.44	57,915.00	210,600.00	3.64	158,112.00
19	2.37	2.35	55,935.00	203,400.00	3.64	152,280.00
20	2.37	2.33	55,440.00	201,600.00	3.64	150,984.00
21	2.25	2.25	53,460.00	194,400.00	3.64	145,800.00
22	3.00	1.63	38,610.00	140,400.00	3.64	105,624.00
23	2.25	2.08	49,500.00	180,000.00	3.64	134,784.00
24	2.12	2.00	47,520.00	172,800.00	3.64	129,600.00
25	1.88	1.88	44,550.00	162,000.00	3.64	121,824.00
26	2.88	1.75	41,580.00	151,200.00	3.64	113,400.00
27	3.00	2.96	70,290.00	255,600.00	3.64	191,808.00
28	2.85	2.23	52,965.00	192,600.00	3.64	144,504.00
29	1.89	1.90	45,045.00	163,800.00	3.64	123,120.00
30	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
Total	**79.39**	**73.21**	**1,739,565.00**	**6,323,400.00**		**4,744,008.00**
Average	**2.65**	**2.44**	**57,985.50**	**210,780.00**		**158,133.60**

Inlet Discharge

Maximum	3.11	m3/s
Minimum	1.88	m3/s
Average	2.65	m3/s

Outlet Discharge

Maximum	3.00	m3/s
Minimum	1.63	m3/s
Average	2.44	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
October 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	4.87	4.85	115,335.00	419,400.00	3.64	314,280.00
2	4.12	4.15	98,505.00	358,200.00	3.64	268,920.00
3	4.63	4.56	1,087,405.00	394,200.00	3.64	295,488.00
4	4.63	4.73	112,365.00	408,600.00	3.64	306,504.00
5	5.25	5.15	122,265.00	444,600.00	3.64	333,720.00
6	4.25	4.25	100,980.00	367,200.00	3.64	275,400.00
7	4.75	4.63	109,890.00	399,600.00	3.64	300,024.00
8	5.25	5.23	124,245.00	451,800.00	3.64	338,904.00
9	4.63	4.65	110,385.00	401,400.00	3.64	301,320.00
10	4.33	4.33	102,960.00	374,400.00	3.64	280,584.00
11	4.63	4.69	111,375.00	405,000.00	3.64	303,912.00
12	4.38	4.38	103,950.00	378,000.00	3.64	283,824.00
13	4.70	4.69	111,375.00	405,000.00	3.64	303,912.00
14	3.62	3.54	84,150.00	306,000.00	3.64	229,392.00
15	3.92	3.83	91,080.00	331,200.00	3.64	248,184.00
16	4.08	4.06	96,525.00	351,000.00	3.64	263,088.00
17	3.79	3.77	89,595.00	325,800.00	3.64	244,296.00
18	3.42	3.42	81,180.00	295,200.00	3.64	221,616.00
19	3.46	3.48	82,665.00	300,600.00	3.64	225,504.00
20	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
21	2.63	2.54	60,390.00	219,600.00	3.64	164,592.00
22	3.37	3.29	78,210.00	284,400.00	3.64	213,192.00
23	3.04	3.04	72,270.00	262,800.00	3.64	196,992.00
24	2.75	2.67	63,360.00	230,400.00	3.64	173,016.00
25	2.50	2.50	59,400.00	216,000.00	3.64	162,000.00
26	2.25	2.25	53,460.00	194,400.00	3.64	145,800.00
27	2.25	2.38	56,430.00	205,200.00	3.64	154,224.00
28	1.75	1.65	39,105.00	142,200.00	3.64	106,920.00
29	1.66	1.63	38,610.00	140,400.00	3.64	105,624.00
30	1.25	1.35	32,175.00	117,000.00	3.64	87,480.00
31	1.50	1.50	35,640.00	129,600.00	3.64	97,200.00
Total	**110.66**	**110.19**	**3,596,560.00**	**9,518,400.00**		**7,140,312.00**
Average	**3.57**	**3.55**	**116,018.06**	**307,045.16**		**230,332.65**

Inlet Discharge

Maximum	5.25	m3/s
Minimum	1.25	m3/s
Average	3.57	m3/s

Outlet Discharge

Maximum	5.23	m3/s
Minimum	1.35	m3/s
Average	3.55	m3/s

Water Discharge and Electricity Production						
Sub Unit Cikalong Hydropower						
November 2015						
Date	Inlet Discharge	Outlet Discharge	Electricity Production	Water Use	Water Price	Outlet Total Volume
	[m3/s]	[m3/s]	[KWh]	[m3]	[m3/KWh]	[m3]
1	0.63	0.54	12,870.00	46,800.00	3.64	34,992.00
2	1.00	1.00	23,760.00	86,400.00	3.64	64,800.00
3	1.25	1.27	30,195.00	109,800.00	3.64	82,296.00
4	0.75	0.73	17,325.00	63,000.00	3.64	47,304.00
5	1.63	1.54	36,630.00	133,200.00	3.64	99,792.00
6	3.00	3.00	71,280.00	259,200.00	3.64	194,400.00
7	3.66	3.69	87,615.00	318,600.00	3.64	239,112.00
8	3.25	2.25	53,460.00	194,400.00	3.64	145,800.00
9	3.38	3.15	74,745.00	271,800.00	3.64	204,120.00
10	4.88	4.67	110,880.00	403,200.00	3.64	302,616.00
11	5.04	5.02	119,295.00	433,800.00	3.64	325,296.00
12	3.04	3.96	94,050.00	342,000.00	3.64	256,608.00
13	3.38	3.29	78,210.00	284,400.00	3.64	213,192.00
14	3.29	3.08	73,260.00	266,400.00	3.64	199,584.00
15	3.75	3.75	89,100.00	324,000.00	3.64	243,000.00
16	3.13	3.17	75,240.00	273,600.00	3.64	205,416.00
17	3.29	3.40	80,685.00	293,400.00	3.64	220,320.00
18	3.41	3.40	80,685.00	293,400.00	3.64	220,320.00
19	3.20	3.25	77,220.00	280,800.00	3.64	210,600.00
20	2.38	2.40	56,925.00	207,000.00	3.64	155,520.00
21	1.75	1.71	40,590.00	147,600.00	3.64	110,808.00
22	1.62	1.67	39,600.00	144,000.00	3.64	108,216.00
23	0.62	0.56	13,365.00	48,600.00	3.64	36,288.00
24	1.13	1.08	25,740.00	93,600.00	3.64	69,984.00
25	2.50	2.40	56,925.00	207,000.00	3.64	155,520.00
26	2.25	2.17	51,480.00	187,200.00	3.64	140,616.00
27	2.12	2.08	49,500.00	180,000.00	3.64	134,784.00
28	2.00	1.96	46,530.00	169,200.00	3.64	127,008.00
29	2.00	2.00	47,520.00	172,800.00	3.64	129,600.00
30	2.25	2.08	49,500.00	180,000.00	3.64	134,784.00
Total	**75.58**	**74.27**	**1,764,180.00**	**6,415,200.00**		**4,812,696.00**
Average	**2.52**	**2.48**	**58,806.00**	**213,840.00**		**160,423.20**

Inlet Discharge

Maximum	5.04	m3/s
Minimum	0.62	m3/s
Average	2.52	m3/s

Outlet Discharge

Maximum	5.02	m3/s
Minimum	0.54	m3/s
Average	2.48	m3/s

APPENDIX B. CLIMATE DATA

DAILY RAINFALL DATA (mm)

Station Name	**: Cipanas-Pangalengan**		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2001

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	0	4.5	7.5	0.5	0.5	0	0	0	0	0	1	0,5	
2	19.5	7	11.5	4	0	0	0	0	0	0	0	2	
3	30.5	0	21.5	0.5	0.5	0	0	29	29.5	2	5	0	
4	26	7.5	19.5	32	0.5	1.5	0	34	26.5	22	6	0	
5	32	15.5	12.5	29.5	23.5	0	0	0	3.5	0	3	0	
6	14	18.5	15.5	28	0	0	0	3.5	7.5	4	0	3	
7	19.5	16	18.5	18.5	0	2.5	0	0	4.5	0	0	3	
8	21	27.5	19	31	0	0	0	4.5	9,5	0	0	0	
9	23.5	32.5	19.5	26.5	0	0	0	0	4	0	0	0	
10	23.5	2.5	15	19.5	33	0.5	7	0	0	0	12	0	
11	2.5	1.5	2.5	22.5	0	25.5	0	0	0	0	0	0	
12	4	2.5	1.5	18.5	0	0	0	0	0	0	0	0	
13	2.5	0.5	3.5	7.5	0	0	0	2.5	0	7.8	0	0	
14	1.5	0.5	2.5	15.5	0	15.5	3.5	0	0	0	0	0	
15	0.5	2.5	3	33	0	0	0	21	0	19	0	0	
16	2	2	0.5	0	0	24	21	0	0	10	0	0	
17	1.5	2.5	3.5	4	1	0	0	0	0	0	2	0	
18	8	0	32	2.5	0.5	0	6.5	0	0	0	2	0	
19	10	3.5	23.5	0	0	0	3	0	0	0	0	0	
20	11.5	2	3.5	0	0	0	4.5	0	0	0	0	0	
21	12.5	6	6.5	0	0	0	1.5	0	0	0	0	0	
22	9.5	6.5	2	15.5	28.5	0	5	0	0	0	23	0	
23	12	7	21	0	9	0	0	0	0	0	7	0	
24	11	5.5	19.5	12	0	0	0	0	0	0	0	0	
25	14.5	2.5	17	2.5	0.5	23	0	0	0	0	1	23	
26	8	0.5	25.5	23	4	0	0	0	0	0	0	22	
27	9.5	1	17	25.5	17	0	0	0	0	0	0	7,5	
28	11.5	0.5	7.5	1.5	0.5	8	0	0	0	0	0	8	
29	17.5		11	0	0	0	0	1.5	32.5	2,2	0	0	
30	15.5		6.5	9.5	0	0	0	0	0	0	0	0	
31	3		1.5		0		0	0		0		0	
Maximum Rainfall	32	33	32	33	33	26	21	34	33	22	23	23	34
Total Rainfall	378	179	371	383	119	101	52	96	118	65	62	61	1983
Total Days of Rainfall	30	26	31	24	13	8	8	7	8	6	10	6	177
Average Rainfall	12	6	12	13	4	3	2	3	4	2	2	2	
First-Half Rainfall (1-15)	221	139	173	287	58	46	11	95	85	55	27	8	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	158	40	198	96	61	55	42	2	33	10	35	53	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

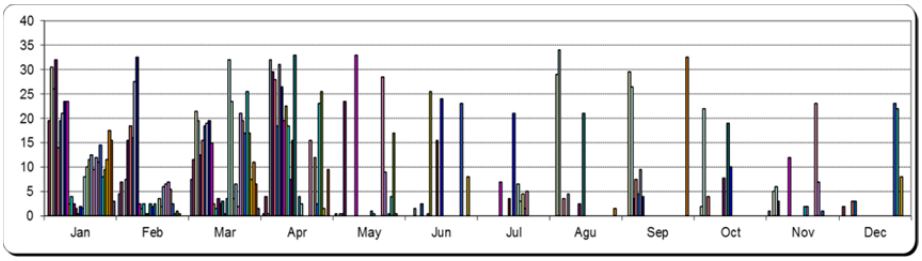


Figure B.1 Rainfall Fluctuation (2001)

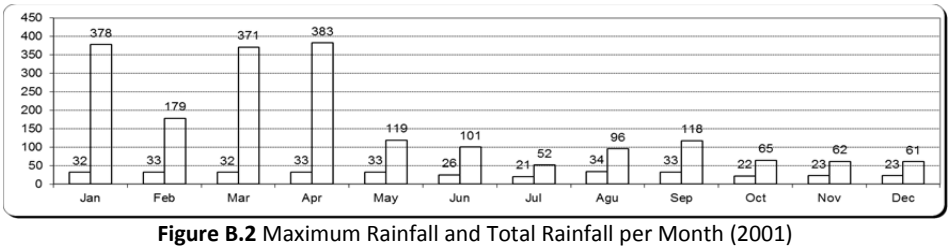


Figure B.2 Maximum Rainfall and Total Rainfall per Month (2001)

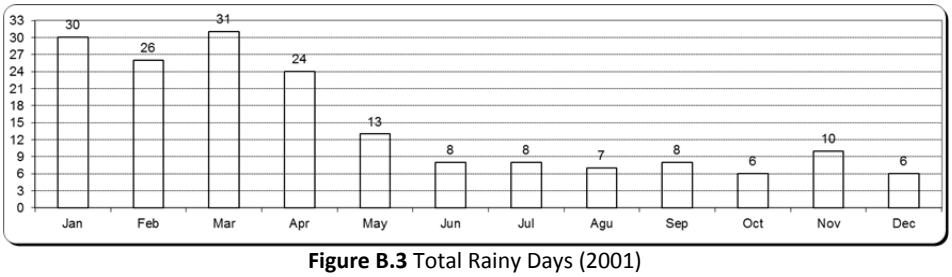


Figure B.3 Total Rainy Days (2001)

Table B.1 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2001)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	28.6	19.8	24.2	24.1	20.2	22.2	29.2	19.4	24.3	29.4	20.0	24.7	29.5	20.0	24.8	29.0	19.2	24.1	30.2	17.6	23.9	27.8	17.8	22.8	30.0	19.0	24.5	28.6	19.6	24.1	28.8	19.0	23.9	28.0	19.8	23.9
2	30.0	21.0	25.5	28.4	19.6	24.0	28.0	19.0	23.5	29.2	20.0	24.6	28.6	20.5	24.6	27.0	21.6	24.3	29.0	15.4	22.2	29.0	19.6	24.3	28.2	20.0	24.1	26.2	18.8	22.5	28.2	20.4	24.3	28.9	19.7	24.3
3	28.5	19.6	24.1	26.6	18.6	22.6	27.6	21.4	24.5	27.2	21.3	24.3	28.2	21.6	24.9	28.5	20.8	24.7	27.5	15.0	21.3	26.6	20.0	23.3	27.6	21.6	24.6	26.8	18.5	22.7	27.2	18.2	22.7	28.4	17.8	23.1
4	28.5	20.8	24.7	26.4	18.0	22.2	29.4	21.0	25.2	27.2	19.6	23.4	27.6	20.0	23.8	29.2	20.2	24.7	27.0	15.0	21.0	27.2	20.2	23.7	26.2	19.0	22.6	27.0	20.0	23.5	29.2	20.0	24.6	27.7	19.0	23.4
5	27.5	20.2	23.9	26.0	19.0	22.5	28.6	21.8	25.2	28.0	19.8	23.9	30.0	20.8	25.4	27.8	20.0	23.9	27.2	14.4	20.8	28.6	19.6	24.1	28.0	18.6	23.3	27.4	19.0	23.2	29.0	19.2	24.1	28.8	18.2	23.5
6	27.0	19.2	23.1	24.8	21.2	23.0	26.0	20.0	23.0	27.8	19.0	23.4	30.2	19.0	24.6	29.8	19.4	24.6	28.4	14.8	21.6	27.6	17.0	22.3	28.8	18.8	23.8	28.0	17.8	22.9	26.6	18.2	22.4	28.6	17.6	23.1
7	27.4	19.5	23.5	24.8	20.2	22.5	27.4	20.0	23.7	27.8	20.4	24.1	30.4	19.4	24.9	29.5	19.2	24.4	28.4	16.0	22.2	28.4	17.2	22.8	29.8	18.4	24.1	25.6	18.2	21.9	28.0	19.2	23.6	28.1	21.4	24.8
8	28.2	18.0	23.1	27.0	19.4	23.2	29.6	19.6	24.6	27.2	21.8	24.5	29.0	20.4	24.7	27.4	19.2	23.3	28.4	17.6	23.0	29.4	17.4	23.4	29.2	19.0	24.1	28.2	20.0	24.1	29.3	21.0	25.2	30.0	20.8	25.4
9	27.0	19.6	23.3	26.7	19.0	22.9	30.0	20.0	25.0	27.4	19.6	23.5	29.6	19.4	24.5	27.0	20.0	23.5	27.6	21.0	24.3	28.0	20.0	24.0	30.4	19.4	24.9	27.8	20.8	24.3	29.0	20.4	24.7	28.6	18.0	23.3
10	26.0	19.6	22.8	26.4	20.4	23.4	27.4	19.6	23.5	28.3	20.8	24.6	30.0	20.6	25.3	30.0	19.4	24.7	27.0	21.0	24.0	29.8	18.8	24.3	29.4	18.0	23.7	30.0	19.0	24.5	29.6	20.4	25.0	28.8	18.2	23.5
11	24.8	19.2	22.0	23.2	19.8	21.5	29.2	20.8	25.0	27.6	20.0	23.8	30.0	17.4	23.7	29.6	19.6	24.6	29.4	19.0	24.2	30.4	18.6	24.5	28.8	19.0	23.9	30.0	18.6	24.3	29.8	20.0	24.9	30.0	19.2	24.6
12	27.6	19.0	23.3	23.4	19.8	21.6	27.0	20.2	23.6	28.0	20.1	24.1	29.8	19.0	24.4	29.4	19.4	24.4	29.0	19.4	24.2	29.8	19.0	24.4	28.5	18.2	23.4	30.2	19.8	25.0	29.8	21.0	25.4	28.6	20.4	24.5
13	29.8	18.4	24.1	24.2	20.2	22.2	30.0	20.0	25.0	29.4	21.0	25.2	29.6	19.2	24.4	28.4	18.6	23.5	27.0	18.8	22.9	28.8	19.0	23.9	29.8	21.4	25.6	30.2	20.4	25.3	30.2	19.0	24.6	30.0	19.4	24.7
14	29.2	21.4	25.3	27.6	20.6	24.1	29.0	21.2	25.1	29.0	19.2	24.1	28.8	18.6	23.7	28.6	20.8	24.7	29.0	19.0	24.0	28.4	20.2	24.3	31.2	19.4	25.3	30.0	20.4	25.2	28.2	20.8	24.5	28.4	20.0	24.2
15	29.0	16.6	22.8	25.0	20.0	22.5	30.0	20.4	25.2	27.2	20.0	23.6	30.4	20.0	25.2	30.4	18.8	24.6	27.8	21.2	24.5	29.8	19.6	24.7	32.2	20.4	26.3	27.8	21.2	24.5	26.0	19.4	22.7	29.6	21.0	25.3
16	27.4	20.4	23.9	27.8	18.6	23.2	28.2	20.0	24.1	28.6	19.2	23.9	31.4	20.2	25.8	28.6	19.0	23.8	29.0	20.4	24.7	29.0	18.6	23.8	30.8	20.4	25.6	29.0	20.2	24.6	27.2	19.0	23.1	29.4	21.0	25.2
17	28.0	20.0	24.0	26.4	20.8	23.6	29.8	21.0	25.4	28.8	20.3	24.6	29.8	19.6	24.7	28.0	18.8	23.4	28.8	19.8	24.3	29.2	18.0	23.6	32.8	19.4	26.1	28.2	19.6	23.9	27.4	20.0	23.7	30.0	21.4	25.7
18	26.2	19.6	22.9	25.2	20.6	22.9	28.8	21.4	25.1	29.6	20.2	24.9	27.0	20.2	23.6	28.8	18.2	23.5	29.0	20.0	24.5	28.8	17.0	22.9	32.2	20.4	26.3	27.2	19.6	23.4	28.0	19.6	23.8	30.8	20.2	25.5
19	27.5	21.2	24.4	28.0	20.0	24.0	25.2	20.4	22.8	29.2	17.4	23.3	28.0	19.4	23.7	29.0	17.0	23.0	28.8	19.4	24.1	28.6	17.0	22.8	32.2	19.2	25.7	27.0	20.2	23.6	26.2	20.2	23.2	29.8	20.0	24.9
20	28.0	21.2	24.6	26.4	19.0	22.7	28.4	19.0	23.7	29.0	18.1	23.6	29.3	20.0	24.7	27.6	17.0	22.3	27.2	19.8	23.5	29.6	17.4	23.5	29.6	18.4	24.0	27.7	18.6	23.2	26.6	20.6	23.6	29.6	20.0	24.8
21	27.2	20.4	23.8	26.8	18.0	22.4	28.0	18.8	23.4	28.2	20.0	24.1	28.0	19.8	23.9	28.8	16.8	22.8	26.8	19.6	23.2	30.0	19.0	24.5	29.6	18.2	23.9	27.6	18.6	23.1	26.2	20.0	23.1	30.4	20.0	25.2
22	28.2	20.0	24.1	28.5	20.6	24.6	28.2	20.2	24.2	29.6	19.8	24.7	29.6	19.2	24.4	29.2	17.8	23.5	27.4	18.6	23.0	30.6	18.2	24.4	29.2	19.4	24.3	25.0	19.0	22.0	27.2	20.4	23.8	30.2	17.0	23.6
23	27.6	19.6	23.6	29.0	20.4	24.7	27.6	20.5	24.1	29.4	18.8	24.1	30.4	19.8	25.1	28.4	17.2	22.8	28.0	17.6	22.8	30.8	19.8	25.3	30.0	19.0	24.5	26.4	20.0	23.2	26.8	20.2	23.5	29.4	18.6	24.0
24	29.2	20.4	24.8	29.5	20.2	24.9	27.0	19.6	23.3	28.8	18.0	23.4	27.6	18.0	22.8	28.3	20.0	24.2	29.0	17.4	23.2	30.6	19.8	25.2	29.6	19.0	24.3	26.4	19.2	22.8	27.6	21.0	24.3	30.4	18.4	24.4
25	29.3	20.0	24.7	29.8	19.2	24.5	26.2	20.6	23.4	30.2	21.2	25.7	28.0	20.0	24.0	29.4	19.0	24.2	27.0	18.8	22.9	30.2	19.0	24.6	30.0	21.0	25.5	27.6	20.0	23.8	28.8	20.4	24.6	30.0	20.6	25.3
26	28.0	19.4	23.7	30.6	19.4	25.0	27.6	19.2	23.4	28.9	20.2	24.6	26.4	20.0	23.2	29.8	19.2	24.5	28.6	18.0	23.3	30.4	19.0	24.7	29.8	20.2	25.0	27.6	19.0	23.3	27.2	20.0	23.6	29.2	21.0	25.1
27	28.3	19.0	23.7	30.4	20.6	25.5	27.6	19.0	23.3	28.2	19.4	23.8	27.4	18.4	22.9	28.2	19.4	23.8	28.6	18.2	23.4	31.0	17.8	24.4	29.0	20.0	24.5	28.0	18.6	23.3	29.2	21.4	25.3	30.2	20.8	25.5
28	28.2	18.4	23.3	20.2	28.6	24.4	27.6	19.0	23.3	30.0	21.6	25.8	29.2	19.6	24.4	30.0	21.6	25.8	29.6	17.4	23.5	29.8	18.0	23.9	28.4	19.4	23.9	28.8	19.6	24.2	28.8	20.2	24.5	29.2	19.6	24.4
29	27.0	20.0	23.5				27.7	18.0	22.9	30.2	18.2	24.2	27.0	19.4	23.2	28.0	17.5	22.8	30.0	19.2	24.6	28.6	18.9	23.8	29.2	18.6	23.9	29.2	19.0	24.1	29.2	19.8	24.5	28.2	19.2	23.7
30	27.4	20.8	24.1				25.7	21.0	23.4	28.4	19.6	24.0	28.6	18.8	23.7	30.5	17.4	24.0	29.6	20.3	25.0	29.4	19.4	24.4	27.2	19.6	23.4	26.6	19.4	23.0	28.8	19.4	24.1	28.0	20.0	24.0
31	26.6	19.8	23.2				26.0	20.8	23.4				28.4	18.4	23.4				29.4	18.6	24.0	28.4	19.4	23.9				28.0	19.4	23.7				25.0	21.0	23.0

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	80	90	79	81	77	81	61	77	76	84	84	72
2	81	81	74	83	80	83	66	75	80	92	89	67
3	79	82	76	85	85	82	69	81	86	87	88	72
4	84	75	77	89	83	82	64	84	93	86	84	72
5	86	79	66	87	83	87	66	70	84	84	84	69
6	87	79	84	86	77	77	71	65	78	89	92	68
7	94	88	78	87	74	84	76	68	76	88	90	70
8	84	93	76	84	79	85	78	76	73	77	83	58
9	84	75	77	85	77	83	81	82	76	81	83	63
10	80	75	85	84	77	75	85	78	70	75	79	69
11	79	89	77	83	75	80	85	75	75	68	78	65
12	68	87	76	87	72	79	79	70	74	72	75	77
13	67	83	69	82	73	80	84	70	74	71	75	78
14	63	81	66	86	78	82	79	76	63	75	89	79
15	68	90	71	85	78	73	80	69	61	80	93	69
16	68	77	77	87	72	77	80	70	60	88	90	74
17	72	85	77	84	78	74	83	68	64	90	87	67
18	82	81	84	82	78	64	83	67	67	88	86	62
19	81	75	86	78	81	66	82	66	61	88	88	70
20	77	74	83	77	77	69	85	66	71	85	88	71
21	81	63	82	75	81	59	90	68	76	90	91	71
22	82	72	76	77	85	71	85	67	77	92	88	65
23	85	78	86	74	80	75	79	69	79	94	89	72
24	71	69	88	79	82	76	77	68	70	89	90	64
25	83	73	90	81	82	78	83	62	69	92	87	71
26	84	72	91	83	87	77	77	61	72	93	77	86
27	82	75	88	79	85	75	78	66	70	89	81	72
28	83	83	88	76	84	77	74	69	82	81	86	72
29	89		83	67	82	69	76	71	75	83	83	77
30	87		88	77	75	67	72	73	81	83	78	75
31	87		89		79		68	79		80		80

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.8		6.6	5.2	5.1	6.5	7.7	3.7	4.1	3.4	4.2	3.7
2	4.8	4.4	4.6	5.7	2.2	1.3	8.0	6.1	4.1	1.7	2.8	6.1
3	5.2	0.3	2.7	3.6	2.5	0.2	7.3	1.4	2.3	1.9	4.1	7.7
4	3.9	0.4	6.3	2.9	4.9	6.3	7.6	2.6	2.0	2.9	3.9	3.4
5	2.9	1.0	5.2	4.4	4.4	2.4	7.9	4.7	3.3	4.0	5.0	4.3
6	0.2	0.1	0.5	4.0	7.3	5.4	7.1	4.6	5.3	4.1	2.2	5.7
7	2.3	0.4	4.4	3.7	7.1	5.8	5.2	5.8	4.3	5.8	2.7	5.4
8	3.5	0.3	5.2	0.7	7.0	2.4	5.0	5.2	5.9	0.2	6.4	8.0
9	1.8	6.0	5.3	2.7	5.6	2.2	3.0	4.3	7.2	4.1	1.7	7.7
10	1.4	4.1	1.1	3.0	7.8	7.1	1.5	5.8	5.7	8.0	4.6	7.7
11		0.6	3.5	3.8	7.4	7.1	4.6	6.2	5.9	8.0	3.5	7.7
12	2.5	0.8		3.9	7.8	5.1	7.6	5.4	3.6	7.2	3.7	4.9
13	3.6	0.6	6.6	5.6	7.6	3.3	3.5	5.8	6.2	7.8	5.8	7.7
14	4.8	5.4	2.9	4.1	2.7	3.5	7.4	4.2	8.0	5.4	3.5	2.8
15	7.1	0.9	7.2	4.7	4.9	5.3	3.8	6.3	8.0		0.6	5.1
16	3.2	7.2	3.8	4.1	0.4	6.8	4.5	5.7	7.6	3.1	1.9	3.3
17	1.4	3.9	0.3	3.8	4.5	5.4	4.1	6.4	8.0	5.2	4.3	6.9
18	2.1	0.9	3.0	5.2		7.9	6.6	6.3	7.2	1.5	3.6	7.4
19	2.2	5.0	5.0	7.3	1.0	7.4	4.9	6.4	7.9	2.2	1.1	7.0
20	4.7	1.4	5.0	8.0	4.3	7.2	3.6	6.3	4.7	3.3	0.1	5.5
21	2.3	4.5	0.9	6.0	3.5	7.9	1.4	6.3	3.8	2.8	0.1	7.8
22	1.8	2.9	3.5	6.6	6.0	7.9	2.3	6.0	3.9	0.9	0.8	7.9
23	3.5	7.2	2.8	5.4	7.8	5.4	6.4	7.9	5.0	2.2		7.6
24	5.2	6.9	0.9	3.0	4.2	3.7	5.9	7.0	6.2	2.1	1.7	8.0
25	6.6	6.2	0.2	5.5	3.4	7.9	2.0	7.9	5.8	2.7	5.4	5.1
26	2.1	3.8	2.9	6.3	1.5	8.0	5.3	7.9	5.0	3.1	0.3	4.3
27	4.0	7.2	1.6	4.8	4.0	4.8	5.3	7.6	4.1	4.9	2.8	6.7
28	3.7	7.8	3.6	6.6	5.5	6.6	7.0	8.0	3.3	3.7	5.8	5.5
29	3.2		5.2	7.7	0.7	7.6	7.6	4.7	5.0	4.7	4.2	4.1
30	3.3		0.2	4.5	4.2	7.8	6.7	4.0	3.0	0.6	4.6	5.0
31	1.4		1.3		3.9			4.0		2.9		0.4

DAILY RAINFALL DATA (mm)

Station Name	**: Cipanas-Pangalengan**		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2002

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	0	17	0	12.5	0	0	0	0	0	0	0	0	
2	0	15.5	0	0	0	19.5	0	0	0	0	0	0	
3	25	19.5	0	40	0	15	0	0	0	0	0	34	
4	15	18.5	0	0	0	0	0	0	0	0	0	0	
5	3	17	19	2.5	0	0	0	0	0	0	2	0	
6	0	0.5	2.5	6	0	0	0.5	0	0	3	0	0	
7	2	2.5	0	27	0	0	0	0	0	0	0	25	
8	3	9.5	7.5	10	0.5	0	0	0	0	22	11	6.5	
9	2	7.5	35	0	0	0	0	0	0	0	1	0	
10	0	8.5	17.5	2.5	0	0	0	1.5	0	0	0.5	1	
11	18.5	3.5	29	7.5	0.5	0	5	0	0	0	0	10.5	
12	4	2.5	49.5	0	0	0	0	0	0	0	0	39.5	
13	10.5	5	14.5	10.5	0	0	2	0	0	0	0	36	
14	8.5	6.5	0	15	0	0	0	0	0	0	0	34.5	
15	16.5	4.5	41	2	0	0	0	0	0	0	0	7.5	
16	0	6.5	27	0	0	0	0.5	0	0	0	0	0	
17	27.5	0	25.5	21	0	0	0	0	0	0	0	0	
18	25.5	0	10.5	15	0	0	0	0	0	0	0	1.5	
19	49.5	0	0	5	0	0	24	0	0	0	15.0	0	
20	47.5	8.5	35	0	0	0	0	0	0	0	7.5	0	
21	43.5	7.5	0.5	12	0	0	0	0	0	0	5.5	8	
22	24	6	1.5	13.5	0	0	0	0	0	0	0	13	
23	31.5	5.5	2.5	10	0	0	0	0	0	0	14.5	28.5	
24	26.5	0	9	17	0	0	0	0	0	0	11.5	29.5	
25	23	4.5	6	0	0	0	0	0	0	6	10.5	27.5	
26	21.5	0	10.5	25	0	0	0	0	0	0	12.5	16.5	
27	22.5	1.5	24.5	8.5	0	0	0	0	0	0	0	0	
28	0	0	8.5	0	0	0	0	0	0	0	4	28.5	
29	0.5		9.5	0	0	0	0	0	0	0	0	11	
30	9.5		15.5	0	0	0	0	0	0	0	0	0	
31	15		24		15.5		0	0		0		0	
Maximum Rainfall	49.5	19.5	49.5	40	15.5	20	24	2	0	22	15	40	50
Total Rainfall	475.5	178	425.5	260	17	35	32	2	0	31	96	358	1908
Total Days of Rainfall	25	22	24	20	3	2	5	1	0	3	12	18	135
Average Rainfall	15.3	6.4	13.7	9	1	1	1	0	0	1	3	12	
First-Half Rainfall (1-15)	108	138	215.5	135	1	35	8	2	0	25	15	195	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	367.5	40	210	125	16	0	25	0	0	6	81	164	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

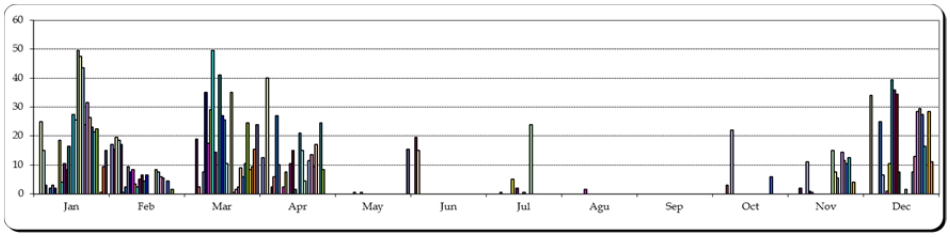


Figure B.4 Rainfall Fluctuation (2002)

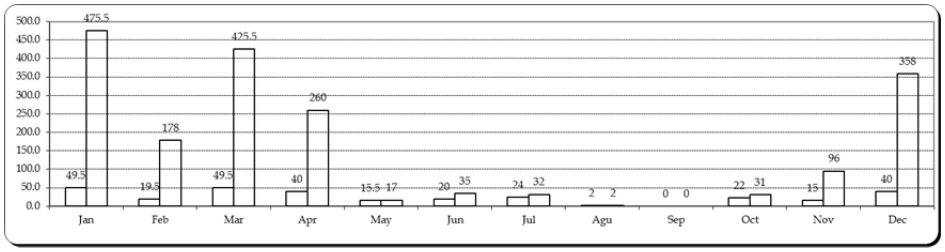


Figure B.5 Maximum Rainfall and Total Rainfall per Month (2002)

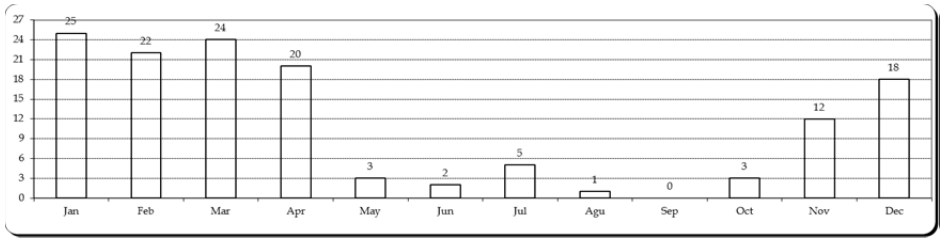


Figure B.6 Total Rainy Days (2002)

Table B.2 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2002)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	29.4	20.4	24.9	26.2	20.5	23.4	30	19.5	24.8	28	20.4	24.2	29.4	20	24.7	28.4	20.2	24.3	29.4	18.6	24.0	30	18.4	24.2	30.8	17.8	24.3	33.4	19.4	26.4	31.8	19.4	25.6	29.6	18.6	24.1
2	29.9	20.4	25.2	28.4	20	24.2	30.4	20.8	25.6	29.8	20.2	25.0	30.8	20	25.4	29.4	19.8	24.6	29.6	19.2	24.4	28.8	18.6	23.7	29	17.2	23.1	33	19	26.0	32.8	19.2	26.0	28.4	18.4	23.4
3	29.6	20	24.8	26.6	21.2	23.9	31	21	26.0	29.2	20	24.6	32	20.4	26.2	29.6	20.6	25.1	30	17.4	23.7	29.8	19.2	24.5	30	17.8	23.9	31.4	18.7	25.1	32.8	21.8	27.3	29.6	20.4	25.0
4	29.9	19.9	24.9	27	20.4	23.7	29.8	20.6	25.2	26.4	19.2	22.8	29	21.6	25.3	26.4	21.2	23.8	29.2	16	22.6	30.8	19	24.9	30.2	17.6	23.9	31.6	18.4	25.0	31.4	19.2	25.3	30	19.8	24.9
5	28	20	24.0	25	20.2	22.6	30.4	19.6	25.0	30	21.2	25.6	28.4	19	23.7	28.8	20	24.4	29	18.4	23.7	29.8	18.4	24.1	30	20.7	25.4	31	18.8	24.9	31	21.4	26.2	27.6	21	24.3
6	27.6	20.2	23.9	25.8	19.8	22.8	29.8	18	23.9	27.3	20.2	23.8	29	20.4	24.7	30	19.4	24.7	30	18.2	24.1	28.6	18	23.3	31	18.2	24.6	29.8	18.6	24.2	31.8	19.4	25.6	28.8	20.2	24.5
7	30.2	21	25.6	26.6	19.4	23.0	29.4	21	25.2	30.2	20.4	25.3	29.2	20.4	24.8	29	19.8	24.4	29.4	20.2	24.8	28.6	17.8	23.2	30	19.2	24.6	29.8	21.3	25.6	30.2	21	25.6	28.8	20.4	24.6
8	29.9	19.6	24.8	27.2	20	23.6	27.9	20.2	24.1	31	20	25.5	30	20.8	25.4	30.6	19.6	25.1	28.8	20	24.4	28.6	18.6	23.6	31.2	18.6	24.9	29.2	18.6	23.9	33	20.1	26.6	29.2	19.6	24.4
9	29.2	19.2	24.2	27	20	23.5	28.6	20.4	24.5	28.6	20.8	24.7	28.8	20	24.4	29.6	17.2	23.4	28.2	20.8	24.5	29	19.8	24.4	29.5	17.2	23.4	31.8	19	25.4	31.6	20.8	26.2	30	19	24.5
10	26.4	19.9	23.2	26.6	19.4	23.0	29.2	20.2	24.7	28.3	20.3	24.3	24	19.4	21.7	30	18	24.0	29	21	25.0	29.6	18.2	23.9	30.6	16.4	23.5	31.2	20	25.6	30.6	22	26.3	28.2	20	24.1
11	30	19	24.5	25.7	20	22.9	30.2	19.4	24.8	29.8	18.8	24.3	29.8	20	24.9	30.6	17.2	23.9	26	20	23.0	30	18.6	24.3	30.2	16.5	23.4	32.8	20	26.4	31.8	20.6	26.2	29.8	20.8	25.3
12	30.4	19.2	24.8	27	20.5	23.8	28.3	19.6	24.0	29.4	18.6	24.0	28.6	19.8	24.2	28.4	18.8	23.6	29	18.6	23.8	30.4	16.4	23.4	28.7	20	24.4	33.8	18.4	26.1	31.6	21	26.3	31	20.4	25.7
13	29	19.2	24.1	25	20.2	22.6	27.8	20	23.9	28	20.4	24.2	30.4	21	25.7	29.8	19.8	24.8	28.3	20.4	24.4	28.6	15.8	22.2	30.4	20	25.2	33.6	19	26.3	31.8	20.2	26.0	24.9	20.8	22.9
14	29	19.2	24.1	24	19.6	21.8	29.5	20.2	24.9	30.1	18.6	24.4	31.4	20.4	25.9	29.2	19.8	24.5	29.2	20.2	24.7	29.4	15	22.2	29.8	20	24.9	33.2	20	26.6	30.4	21	25.7	28.6	20.8	24.7
15	27	19.2	23.1	29	19.2	24.1	29.4	20.4	24.9	29.6	19.4	24.5	29.8	20	24.9	29.8	19	24.4	29	19.9	24.5	28.2	15	21.6	32.7	19	25.9	33	15	24.0	30	20.6	25.3	27.4	20.4	23.9
16	30	19.2	24.6	28.6	21	24.8	27.2	19.2	23.2	30.4	20.6	25.5	29.2	20.2	24.7	28.4	18.8	23.6	28.4	19	23.7	29	14.8	21.9	31	17.6	24.3	33.2	21	27.1	33	20.6	26.8	28.4	19.6	24.0
17	28.9	19	24.0	26	20.6	23.3	28.7	19.4	24.1	24.6	21	22.8	30.2	19	24.6	29.4	18.6	24.0	28	20.4	24.2	29.4	17.2	23.3	30.6	16.9	23.8	33.6	20.4	27.0	30.8	21	25.9	31.8	20.4	26.1
18	27.9	20.2	24.1	26.8	20.2	23.5	27.2	19	23.1	28.2	19.2	23.7	30.2	18	24.1	29.4	18	23.7	29	18.5	23.8	29.4	14.4	21.9	31.4	18	24.7	33.5	20.1	26.8	29	22	25.5	32.6	20	26.3
19	27	20.2	23.6	25.6	20.6	23.1	27.1	20.8	24.0	28.6	19.2	23.9	29.8	17.4	23.6	28.2	17	22.6	28.6	19	23.8	27	18.8	22.9	31	18.9	25.0	33.8	18	25.9	28.6	20.2	24.4	32	21.2	26.6
20	29.9	19.6	24.8	25	20.2	22.6	27.4	19.4	23.4	27.8	21	24.4	28.8	17.4	23.1	29.7	18.2	24.0	29.6	17.8	23.7	27.6	18.2	22.9	30.4	18	24.2	34.4	21	27.7	29.2	19.8	24.5	33.4	20	26.7
21	29.8	19.5	24.7	24.8	19.8	22.3	30	19	24.5	29.3	20	24.7	29.7	19.8	24.8	29.8	18.2	24.0	29.2	18.4	23.8	28.6	17.6	23.1	31	18.4	24.7	34.9	20	27.5	29.6	19.6	24.6	29.2	21.4	25.3
22	26.2	19	22.6	26	19.6	22.8	31.8	19.6	25.7	27.4	20	23.7	30	19.2	24.6	29	18.6	23.8	28.8	17	22.9	30.8	17.2	24.0	30.2	18.8	24.5	33.4	18.6	26.0	28.6	19	23.8	29.3	21	25.2
23	29.6	20.2	24.9	28.1	21	24.6	28.5	18.7	23.6	27.2	20	23.6	30.2	19.4	24.8	28.8	18	23.4	28.8	18	23.4	30.6	19.6	25.1	29	19.2	24.1	34.3	19.8	27.1	29	19	24.0	28.4	20	24.2
24	27.8	20	23.9	28.8	20.8	24.8	29	20.2	24.6	29.2	20	24.6	30	19	24.5	29.8	17.8	23.8	29.2	17.6	23.4	31.3	19.8	25.6	29	19	24.0	29.4	19	24.2	28.6	18.6	23.6	29	19.4	24.2
25	29	19.8	24.4	29.4	20.4	24.9	28.6	20.8	24.7	30.4	20	25.2	31.2	18.8	25.0	30	20	25.0	30	19.8	24.9	30.8	18.2	24.5	29	19	24.0	32.8	19	25.9	28.4	20.6	24.5	27.2	20.8	24.0
26	27.6	19.4	23.5	30.5	20	25.3	27.8	20	23.9	29.8	19.8	24.8	30.7	16.4	23.6	29.6	19.4	24.5	28.6	18	23.3	29	18.8	23.9	31.2	18.2	24.7	34.2	19	26.6	27.2	20	23.6	27.4	20.4	23.9
27	27.4	20.5	24.0	30.2	19.8	25.0	30	19	24.5	30.4	19.6	25.0	29	18.4	23.7	29	18.4	23.7	30.2	18	24.1	30.2	19.4	24.8	29.8	21	25.4	32.2	19.6	25.9	27.8	20	23.9	26.4	21	23.7
28	24.2	20.4	22.3	29.4	19.4	24.4	29.6	19.2	24.4	30.9	20.2	25.6	29.8	17.4	23.6	29.8	17.4	23.6	29.4	18.8	24.1	29.2	18	23.6	29	19	24.0	31	20	25.5	28.6	19.6	24.1	27	19.8	23.4
29	23.8	20.8	22.3				27.6	21	24.3	30.2	19.8	25.0	30	18.4	24.2	30	18.4	24.2	29.2	18.2	23.7	29.2	18	23.6	29.2	18.8	24.0	32.6	19.2	25.9	28	19.2	23.6	26.7	20.4	23.6
30	25	20.2	22.6				29.8	19.2	24.5	29.8	19	24.4	29.4	19.4	24.4	29	19	24.0	30	20.2	25.1	29.6	18.2	23.9	32.6	19.4	26.0	30.6	20.4	25.5	26.2	20	23.1	27.6	20.4	24.0
31	26.6	20	23.3				29.8	18.2	24.0				29	20.2	24.6				30	19	24.5	29.6	18	23.8				28.8	20	24.4				28.2	20.2	24.2

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	81	87	85	84	78	80	73	75	69		66	70
2	79	81	78	85	77	81	73	73	69	67	66	77
3	80	81	69	80	78	84	65	74	69	60	64	76
4	79	81	78	82	77	85	72	71	68	59	72	70
5	74	82	78	79	83	79	74	64	75	73	71	84
6	82	84	74	91	84	77	74	68	68	73	67	86
7	76	80	75	80	77	78	80	71	65	74	78	87
8	72	80	79	71	82	76	83	75	63	69	70	85
9	82	79	82	88	84	66	79	82	67	60	70	82
10	92	86	82	80	85	70	77	75	66	61	73	87
11	80	79	79	78	75	77	78	69	66		64	78
12	82	86	88	80	73	77	77	68	72		67	77
13	77	86	88	84	74	81	76	61	72		81	91
14	95	92	82	75	74	84	79	58	73	57	76	88
15	84	80	87	74	73	78	78	58			71	86
16	81	76	84	81	79	75	82	63	64		69	89
17	86	83	86	93	75	77	83	57	64		67	74
18	88	84	85	81	66	68	81	68	65		84	73
19	91	83	90	83	66	71	82	81	61		85	70
20	88	89	85	89	69	77	81	71	65		81	69
21	91	80	82	86	75	77	78	75	61		79	78
22	89	80	80	87	74	80	69	77	67		82	81
23	81	81	86	89	72	79	78	71	67	65	87	84
24	86	75	87	85	69	77	74	76	69	65	89	84
25	89	74	90	79	66	77	68	70	70		82	87
26	89	72	90	83	70	81	74	74	68		82	87
27	86	71	78	77	78	78	69	65	79	63	82	93
28	90	71	85	74	78	78	73	66	74	74	80	82
29	87		87	75	79	79	75	64	69	65	87	82
30	90		84	79	83	81	72	73		66	86	88
31	85		83		79		73	67		69		84

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	5.3	1.5	4.5	4.8	4.4	4	8	6.4	7.5	7.8	5.6	5.3
2	7.3	2.1	7.8	4.3	5.4	4.8	7.2	5.4	6.5	5.6	6.7	5.3
3	7.6	4.2	7.7	5.5	5	4.9	8	7.8	6.4	7.2	7.4	8
4	7.6	0.8	5.9	0.8	3	0.9	6.5	6.8	7.2	7	3.8	8
5	3.5	0.1	6.5	6.5	0.7	4.2	7.9	6.9	6.4	4.9	4.1	2.7
6	3.9	1.2	8	1.7	3.8	6.7	7.2	7.1	6.7	4.8	6.4	3
7	5.5	3.4	3.2	6.1	3.7	5	5.1	5.4	4.9	3.9	4.8	3.5
8	8	3	0.8	7	3.1	5.7	1.5	5.3	7.2	4	7.3	6
9	4.3	3.4	6.7	1.6	1.1	7	4.7	4.6	6.1	6.2	6	5.8
10	0.8	4.8	3.6	4		6	2.8	6.1	7.8	6.4	3.7	4.6
11	5.3	0.2	5.5	4.2	4.2	8	0.4	7.5	6.3	7.9	7.5	6.2
12	7.6	0.8	4.2	4.8	2.6	4.5	4.6	8	3.7	7.5	5	7.4
13	4.2	1.4	4.3	3.7	5.1	3.8	2.7	5.9	4.7	8	4.2	1.1
14	0.5		4.8	5.6	6	7.1	4.8	8	4.9	7.9	4.4	3.2
15	3.5	8	4.8	5.9	5.9	7.7	5.3	7.9	7.9	7.7	4.5	3.5
16	6.6	6.2	3.8	5.1	3	4.7	4.3	7.7	8	7.7	6.4	3.3
17	4.5	3.8	2.7	0.5	5.8	7	4.6	6.3	7.6	8	5.2	8
18	2.5	5.5	3.7	4.7	6.1	6.1	7.4	5.5	7.4	8	1.5	7
19	1.5	0.8	2	4.9	6.3	7.6	6.5	2.9	5.4	8	3.3	6.7
20	4.4	0.6	3.9	2.8	5.9	5	5.7	6.5	7.2	7.5	4.2	7.3
21	1.7	6.8	3.3	4.4	5.4	5.1	6.6	5.2	5.6	6.8	2.6	4.1
22	1.5	4.4	7.6	4.2	6.2	7.6	7.2	7.8	5.2	7.4	2.3	2.9
23	4.1	1.1	5.2	4.1	6.3	5.1	4.9	7.8	4.9	8	3.2	2.1
24	4.4	0.5	3.7	3.1	5.4	8	5.2	7.3	4.9	2.5	2.5	3.5
25	3.6	8	2.9	5.9	6.2	7.6	7.6	7.6	3.6	6.5	1.7	3
26	1.8	8	4.2	6.9	5.8	7.8	6.1	7.1	6.8	8	0.9	2.3
27	1.3	7.5	3.4	7.3	3.3	8	7.1	7.9	7.1	7.2	1.1	
28		5.6	5.7	6.5	5.2	4	6.4	7.6	4.1	4.1	2.4	0.5
29			3.5	6.5	3.5	7.2	7.9	7.3	4.1	8	2.4	
30	0.4		7.4	5.5	3.7	7.2	7.8	6.4	7.7	3.6	0.5	2.2
31	4		5.4		3.1		7.1	8		0.5		3

DAILY RAINFALL DATA (mm)

Station Name	: Cipanas-Pangalengan		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2003

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	5.5	12.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.5	8.0	
2	7.0	15.5	8.5	9.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	6.5	
3	16.5	0.0	3.5	6.5	0.0	0.0	0.0	0.0	0.0	11.5	3.5	10.5	
4	13.5	9.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	8.0	
5	8.5	14.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	2.0	27.0	15.0	
6	7.5	0.0	15.0	0.0	13.0	0.0	0.0	0.0	11.0	20.5	17.5	11.0	
7	0.0	6.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	35.0	0.0	9.5	
8	0.0	9.5	6.5	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	14.5	
9	0.0	4.0	15.0	0.0	13.5	0.0	0.0	5.5	0.0	5.5	0.0	13.5	
10	0.0	7.5	17.5	9.5	0.0	0.0	0.0	0.0	0.0	8.5	0.0	30.5	
11	0.0	0.0	0.0	24.5	0.0	0.0	0.0	0.0	0.0	2.5	0.0	7.5	
12	0.0	9.5	0.0	0.0	32.5	0.0	0.0	0.0	3.5	1.0	0.0	4.0	
13	0.0	18.5	15.0	0.0	11.5	0.5	0.0	0.0	17.5	0.0	0.0	8.0	
14	6.0	0.0	17.5	8.5	0.0	0.0	0.0	0.0	20.0	17.5	0.0	6.5	
15	7.5	17.5	25.5	4.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	
16	0.0	14.0	21.5	0.0	0.0	1.5	0.0	0.0	55.5	0.0	0.0	0.0	
17	3.5	29.5	19.5	0.0	0.0	1.0	0.0	0.0	11.0	18.0	13.0	0.0	
18	0.0	27.0	43.5	0.0	0.0	0.0	0.0	4.0	6.0	42.0	15.0	4.5	
19	0.0	9.5	37.5	0.0	0.0	0.5	0.0	0.0	0.0	16.5	24.5	2.5	
20	2.5	6.5	21.5	0.0	0.0	0.0	0.0	0.0	3.0	0.0	45.0	17.5	
21	3.0	7.0	11.5	12.5	0.0	0.0	0.0	21.0	0.0	0.0	32.5	23.5	
22	7.5	0.0	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.5	22.0	
23	6.0	0.0	1.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	12.5	12.0	
24	4.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.5	17.0	
25	0.0	2.5	1.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	42.5	12.0	
26	11.5	5.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0	0.0	30.0	0.0	
27	7.5	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	7.5	
28	15.5	6.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	5.0	9.5	
29	14.0		0.0	0.0	0.0	0.0	0.0	32.0	0.0	0.0	9.5	8.0	
30	16.5		0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	8.5	24.5	
31	24.5		0.0		0.0		0.0	0.0		27.0		26.5	
Maximum Rainfall	24.5	29.5	43.5	25	32.5	2	0	32	56	50	45	31	56
Total Rainfall	188.5	234	330.5	82	90	4	0	63	128	261	375	340	2094
Total Days of Rainfall	20	21	23	8	8	4	0	4	8	15	20	27	158
Average Rainfall	6.1	8.4	10.7	3	3	0	0	2	4	8	13	11	
First-Half Rainfall (1-15)	72	123	167.5	62	81	1	0	6	52	107	88	153	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	116.5	111	163	20	9	3	0	57	76	154	287	187	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

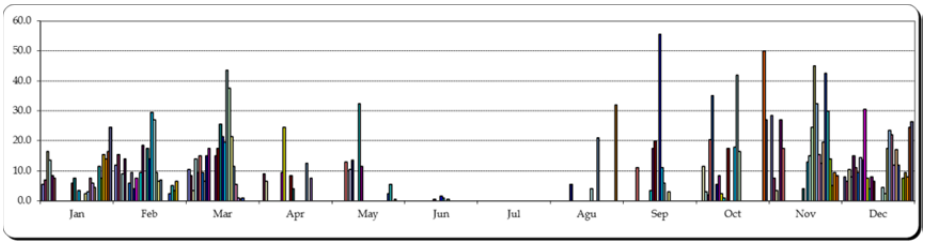


Figure B.7 Rainfall Fluctuation (2003)

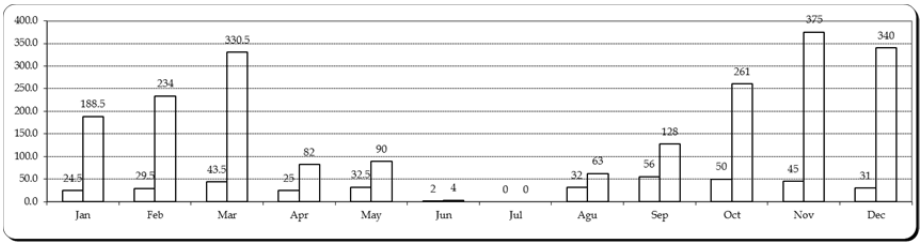


Figure B.8 Maximum Rainfall and Total Rainfall per Month (2003)

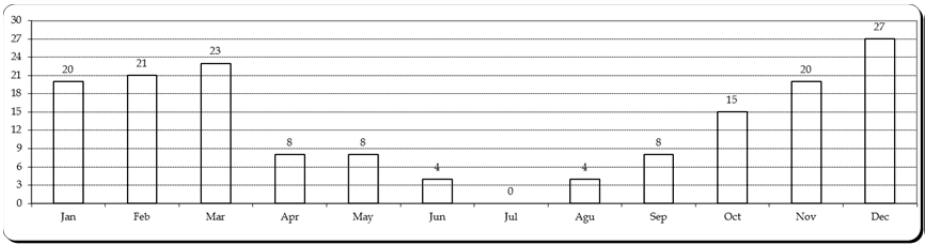


Figure B.9 Total Rainy Days (2003)

Table B.3 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2003)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	26.6	20.2	23.4	29.2	20.4	24.8	27.2	20.4	23.8	30	20	25.0	28	20.4	24.2	30	18	24.0	30	16.2	23.1	30.6	14.2	22.4	30	17	23.5	30.4	17.2	23.8	27.2	20	23.6	31	18.8	24.9
2	25.4	19.8	22.6	29	19.8	24.4	28.2	20.2	24.2	30.2	20.2	25.2	30.8	18	24.4	30	14.4	22.2	31.8	18	24.9	30.6	15.2	22.9	29.2	17.2	23.2	30	19.6	24.8	29	21.4	25.2	28.7	20.4	24.6
3	27.6	19.6	23.6	28.2	19.6	23.9	28.6	20	24.3	29.4	20.6	25.0	29.2	21	25.1	29.6	16.3	23.0	28.8	15.8	22.3	29.8	17.8	23.8	29	16.2	22.6	29.2	17.4	23.3	28.8	17.4	23.1	27	17.2	22.1
4	27.2	20	23.6	28.2	19.6	23.9	28.8	20.4	24.6	30.8	19.6	25.2	30	20	25.0	30.5	17.8	24.2	29.2	14.8	22.0	30.2	16.5	23.4	29.8	19	24.4	29.6	19.2	24.4	28.6	20.4	24.5	26	20	23.0
5	29.2	19.6	24.4	25.6	20	22.8	28.8	20	24.4	30.4	20.4	25.4	30.6	18.4	24.5	32	15.8	23.9	28.6	15.4	22.0	29.2	16.8	23.0	29.6	19.2	24.4	29.4	16.8	23.1	30	19.4	24.7	27	20	23.5
6	29.9	19	24.5	26	20.8	23.4	29.8	21.4	25.6	30.2	20	25.1	30.2	21.2	25.7	31	18	24.5	30.2	18.6	24.4	30.8	14.6	22.7	29.8	16.2	23.0	28.8	20.6	24.7	29.2	16.8	23.0	26.4	17.6	22.0
7	30.4	18.8	24.6	26.8	20.6	23.7	28.8	20.4	24.6	31	20	25.5	28.6	18	23.3	29.4	15.4	22.4	29.8	17	23.4	30	17.6	23.8	32	16.6	24.3	28.2	21.4	24.8	30.2	19.2	24.7	26.8	19.6	23.2
8	31	14.4	22.7	26.7	21	23.9	27	19.4	23.2	29.2	21	25.1	28.8	20	24.4	29.2	15.2	22.2	30.1	15	22.6	30	18.4	24.2	30.8	13	21.9	28.8	18.4	23.6	31.5	28	29.8	30	16.6	23.3
9	30.2	18.6	24.4	28.2	20.2	24.2	29.6	20.8	25.2	30.6	20.2	25.4	29.6	21	25.3	30	18.8	24.4	31	15	23.0	31.2	19	25.1	30	16.2	23.1	29.2	20.6	24.9	30.5	21	25.8	27.4	20	23.7
10	29.8	18.2	24.0	28.6	19.4	24.0	29.6	20	24.8	28.8	17.8	23.3	27.9	19.6	23.8	29.8	17.2	23.5	30.4	16	23.2	30	19	24.5	30.4	17	23.7	29.2	20.7	25.0	32.5	19.3	25.9	27.8	20	23.9
11	30	20	25.0	28.6	20	24.3	29.4	17.6	23.5	30	20	25.0	28.4	18.4	23.4	30	18	24.0	31.4	14.2	22.8	30.2	18.4	24.3	29	14.2	21.6	29.2	17.6	23.4	33	16.6	24.8	29.2	17.4	23.3
12	30.3	20.4	25.4	26.8	20	23.4	29.4	18.4	23.9	29.8	17.6	23.7	27.6	20	23.8	31	14.4	22.7	28.2	17.6	22.9	30	16.4	23.2	28.6	20	24.3	29.4	19.8	24.6	31	18.8	24.9	26.4	19.8	23.1
13	30.4	20.4	25.4	28.5	19.6	24.1	29.8	18.4	24.1	29.8	21	25.4	29.6	21.2	25.4	28.6	17	22.8	29	16.2	22.6	29.8	18.8	24.3	30.6	18.6	24.6	28.4	18	23.2	30.4	17.6	24.0	28.2	17	22.6
14	30	20	25.0	30	19.2	24.6	28.8	20.2	24.5	29.2	20.4	24.8	28.4	21.8	25.1	30	16.8	23.4	29.4	18.6	24.0	30.3	19	24.7	29	21	25.0	30.2	18	24.1	28.1	21.2	24.7	27.8	20	23.9
15	29.8	20.8	25.3	28.8	21	24.9	27.6	19	23.3	29.6	20.4	25.0	30	17.2	23.6	29.2	19.8	24.5	29	17	23.0	30.8	16.4	23.6	28	21	24.5	29	17.4	23.2	30.4	21	25.7	29.4	19	24.2
16	30.4	19.8	25.1	28.8	20.4	24.6	27.4	21	24.2	30.8	19.2	25.0	31.6	19.6	25.6	30.4	19	24.7	30	17	23.5	29.2	19.2	24.2	27	18.4	22.7	28.6	19.6	24.1	29.8	21	25.4	28.6	18.4	23.5
17	29.8	19.8	24.8	28.4	20.4	24.4	26.5	18.2	22.4	30.5	18.2	24.4	30.6	19.3	25.0	30.8	17.2	24.0	30.6	17	23.8	29	20	24.5	29	17.6	23.3	29.4	17.6	23.5	27	20.3	23.7	27.2	19.8	23.5
18	31	19.5	25.3	28	20	24.0	27.8	16.8	22.3	30	20.8	25.4	29.4	19.6	24.5	30	17.6	23.8	29	18	23.5	29.4	20.4	24.9	28.8	18.4	23.6	29	20	24.5	27	18.4	22.7	27.8	17.2	22.5
19	32.1	19.4	25.8	27.4	21.4	24.4	28.8	19	23.9	29.2	20	24.6	29.6	20	24.8	28.6	21	24.8	29.4	15	22.2	29.4	20.2	24.8	27.6	21.6	24.6	30	20.2	25.1	29.6	20.4	25.0	27.8	20	23.9
20	30.2	18.4	24.3	24.5	20.4	22.5	30	20	25.0	29	18.2	23.6	29.6	19	24.3	29	16	22.5	29.8	16.8	23.3	29.4	20	24.7	27	19	23.0	30.2	17.6	23.9	28	20.2	24.1	27.4	20.6	24.0
21	29.6	18	23.8	26	20.6	23.3	28	20	24.0	27.9	18.4	23.2	30.2	17.8	24.0	27	19	23.0	30	17.4	23.7	30	17.3	23.7	30	19.2	24.6	31.6	19.4	25.5	28	17.6	22.8	27	20.4	23.7
22	29	21.8	25.4	28	20	24.0	27.2	19.2	23.2	29.2	16.4	22.8	31.4	17.4	24.4	29.8	15.8	22.8	29.6	14.4	22.0	30.8	18.2	24.5	29.6	18.6	24.1	30.6	16.8	23.7	28	20	24.0	25.8	20.2	23.0
23	27.6	21	24.3	28.8	19.8	24.3	28.6	18.6	23.6	29	21.8	25.4	30.4	19	24.7	28.8	15.8	22.3	30.3	16.8	23.6	30	19	24.5	31	16	23.5	32.8	19.2	26.0	28.2	17	22.6	26.8	18	22.4
24	30.2	20.8	25.5	28	21.2	24.6	29.8	19.6	24.7	29.5	21	25.3	30	19	24.5	30.4	18.8	24.6	28	19	23.5	30	15.4	22.7	31.6	18	24.8	32	16	24.0	27.4	19.2	23.3	29	21	25.0
25	29.4	19.6	24.5	28.5	20	24.3	29	20.8	24.9	28.4	17.2	22.8	30.3	19.1	24.7	30.6	19.2	24.9	29.4	18.6	24.0	30	15.6	22.8	30	18	24.0	29	18.4	23.7	27.2	19	23.1	26	21	23.5
26	28.2	21	24.6	26.4	20.4	23.4	29	20.4	24.7	29.6	19.8	24.7	30.8	19	24.9	30.4	15.8	23.1	30.8	16	23.4	28.4	17.8	23.1	30.6	15.4	23.0	28.6	19.4	24.0	27.5	20	23.8	28.4	18.4	23.4
27	30	18.2	24.1	25	21.4	23.2	29.2	18.4	23.8	26.4	18.8	22.6	30.4	18.8	24.6	29.6	15.8	22.7	30.9	18.2	24.6	29	18	23.5	29	18.8	23.9	29	16	22.5	28.8	19.2	24.0	29.3	20.6	25.0
28	28.2	20.4	24.3	28.2	20.8	24.5	28.8	18.2	23.5	29.6	20	24.8	30	20	25.0	30	18.2	24.1	30	17.6	23.8	29.6	15.2	22.4	30.4	17	23.7	29.2	18.2	23.7	27.8	20	23.9	29.2	19	24.1
29	28.2	20.6	24.4				29	18	23.5	28.2	21	24.6	30.2	19.2	24.7	29.6	19.5	24.6	31.8	19.4	25.6	29.8	18.6	24.2	30.6	20	25.3	29.4	21	25.2	28.7	19	23.9	29.8	21	25.4
30	29	21.6	25.3				28.4	20.4	24.4	25	18	21.5	29.4	19	24.2	29.8	17.6	23.7	32.4	16	24.2	29.4	17.4	23.4	32	20	26.0	26.6	19.6	23.1	31.4	21.4	26.4	28.6	21	24.8
31	26.4	21	23.7				29.8	19.2	24.5				28.8	19.4	24.1				31.4	15.4	23.4	30.4	19	24.7				26	20	23.0				30	21	25.5

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	89	87	82	79	82	71	71	66	67	70	88	79
2	86	87	84	75	74	65	66	69	73	71	83	81
3	76	74	71	83	81	69	62	61	70	81	83	87
4	78	87	79	75	72	70	70	61	68	81	85	90
5	80	87	81	69	72	67	69	65	74	80	81	84
6	79	83	78	61	73	67	65	67	75	81	70	84
7	73	80	85	66	85	76	62	70	53	83	66	89
8	78	87	80	77	78	77	68	69	55	81	70	91
9	72	84	77	73	68	68	67	66	58	73	79	88
10	66	83	82	84	82	69	66	69	60	82		76
11	71	85	84	86	83	66	70	69	69	81	60	84
12	69	84	85	78	88	65	73	63	82	74	64	86
13	71	84	85	80	87	78	75	68	79	78	76	85
14	71	77	82	85	83	71	71	70	75	71	85	82
15	72	84	76	85	72	69	72	71	83	76	77	80
16	71	80	87	71	75	69	61	73	83	82	85	86
17	69	86	91	77	70	66	61	73	78	82	85	85
18	61	81	87	77	75	71	62	71	81	85	91	77
19	59	83	84	76	81	72	67	71	84	74	83	84
20	63	87	80	82	82	76	61	76	82	73	85	78
21	68	79	87	83	67	79	65	79	75	65	86	78
22	75	80	90	80	67	76	64	66	75	63	85	79
23	81	76	83	84	69	80	64	61	65	65	82	83
24	79	76	80	72	71	74	70	68	63	66	85	74
25	79	79	85	77	72	71	73	68	70	70	89	78
26	85	83	80	73	70	68	77	70	68	77	86	68
27	76	81	77	84	68	75	76	72	68	79	83	72
28	77	75	83	79	66	71	76	70	72	74	85	73
29	82		76	83	68	70	68	78	63	84	77	74
30	79		80	82	69	71		83	65	86	74	76
31	91		80		71		62	67		93		79

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1		3.8	0.3	6.1	0.6	6.5	7.5	6.5	7	6.8		1.3
2		2.3	0.1	5.6	5.6	8	8	7.9	4.7	5.5	4.6	7.6
3	0.6	3.8	0.3	5	5.8	5.7	8	6.7	5	3.1	3.4	0.4
4	1.6	6.4	0.3	7.8	4.6	7.8	5.1	7.6	4.7	4.3	2.8	0.8
5	3.5	6.4	0.5	7.8	7	7	5.2	8	5.1	4.4	4.3	1
6	2.7	2.3	0.4	7.7	4.3	7.9	7.4	0.8	5.9	2.4	6.4	0.1
7	4.6	0.2	0.2	8	1.2	6	7.5	5.9	7.9	1.8	6.2	2.3
8	7.3	1.3	0.2	4.2	5	6.3	7.8	6.2	8	4.3	6.8	4.8
9	7.7	3.2	0.3	1.6	1.6	7	7.9	6.3	8	4.9	4.5	0.3
10	6.1	4.2	0.3	3.7	0.3	7.9	7.6	6.9	5.3	3.1	3.9	0.4
11	7.7	3.9	0.4	3	3.4	7.7	2.6	6.1	3.9	4.6	7.3	3.3
12	8	2.3	0.3	5.1	3.9	7.2	1	7.3	3.6	5.1	7.3	0.2
13	5.9	3.2		5.9	4	4.2	4.2	6.8	4.6	2.6	7.1	2.8
14	7.9	6.3		4.4	3.8	6.3	4.7	7.2	3.8	4.5	3	0.3
15	6.4	5.1		3.3	7.2	5.8	7	7.8	3.1	1.9	5.2	5.9
16	8	3.1		3.5	8	6.8	8	4	1.5	3.5	2.3	0.8
17	4.8	3.7		5.3	6.8	8	6.6	3.8	5.6	4.3		0.7
18	8	3.5		5.2	7.6	7	6.7	3.4	2.9	4.3	1	
19	7.4	1.3		6.1	5.1	5.5	6.4	3.4	0.4	5.3	3	2.3
20	4.8	0.6		4.8	7.8	6.4	7	4.4	3.3	6.9	0.1	1.3
21	4.4	0.2		3.4	7	0.3	6.1	4.5	4.5	8	1.7	2.8
22	7	5.4		5.2	7.8	3.4	8	7.2	6.9	6.7	0.6	3.2
23	0.3	7.8		3.9	7.1	6.2	7.9	8	7.2	8	1.4	1.3
24	4.6	8	0.2	2.8	7.7	7.5	4.5	4.4	5.9	6.7	2.7	5.6
25	4.6	5	0.1	3.2	8	6.9	5.3	6	7	3.9	2	0.3
26	1.5	1.4	0.2	4.8	7.8	6	4.6	5.2	5.7	2.1	2	4.4
27	6.6	0.2	0.2	1.1	7.2	5.1	5	5.1	4.3	5.2	6.7	6.5
28	2.5	3.2	0.3	4.9	5.3	7.3	5.8	4.3	5.5	4.6	3	4.1
29	6.1		0.3	3.8	7.3	8	7.3	3.7	6.7	4.2	4.2	4.6
30	5.8		0.2	1.4	4.8	5.6	8	0.8	7.1	1.7	7.2	1.9
31	0.5		0.2		5.7		7.1	8		1.5		6.8

DAILY RAINFALL DATA (mm)

Station Name	: **Cipanas-Pangalengan**		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2004

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	0.0	0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	49.5	
2	0.0	0.0	13.5	0.0	2.5	0.5	0.0	0.0	51.0	0.0	0.0	11.5	
3	0.0	6.5	32.5	1.0	32.5	0.0	0.0	0.0	0.0	0.0	24.0	8.5	
4	0.0	22.5	37.5	0.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5	12.5	0.0	30.0	0.0	5.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	
6	12.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7	0.0	11.5	0.0	0.0	17.0	0.0	0.0	0.0	0.0	0.0	6.5	0.0	
8	2.5	13.0	17.5	7.5	3.5	0.0	0.0	0.0	0.0	0.0	1.5	0.0	
9	1.5	25.5	2.5	0.0	18.0	0.0	0.0	0.0	0.0	0.0	26.0	0.0	
10	0.0	0.0	13.0	8.5	17.5	1.0	0.0	0.0	0.0	0.5	1.5	4.5	
11	0.5	7.0	24.5	3.5	12.0	0.0	6.0	0.0	0.0	0.0	16.5	25.0	
12	0.0	4.5	16.5	48.5	0.0	0.0	5.5	0.0	0.0	0.0	0.0	17.5	
13	30.5	0.0	22.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	19.5	
14	21.0	8.5	23.5	0.0	0.0	9.0	10.5	0.0	0.0	0.0	0.0	18.5	
15	35.5	1.5	11.5	0.0	0.0	12.0	16.0	0.0	0.0	0.0	0.0	32.5	
16	24.0	5.0	10.5	0.0	7.5	0.0	2.5	0.0	0.0	0.0	0.0	4.5	
17	7.5	0.0	21.0	0.0	6.5	0.0	10.5	0.0	0.0	0.0	0.0	6.5	
18	15.5	0.0	14.5	0.0	2.0	0.0	0.0	0.0	2.0	0.0	0.5	8.0	
19	9.0	12.5	3.5	0.0	1.5	0.0	5.0	0.0	0.0	0.0	0.0	9.5	
20	0.0	14.5	0.0	5.5	5.0	0.0	0.0	0.0	0.0	0.0	13.5	0.0	
21	0.0	17.0	5.5	23.5	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22	29.5	25.5	0.0	13.5	4.5	0.0	0.0	0.0	0.0	11.5	0.0	15.5	
23	20.5	0.5	0.0	6.5	0.0	0.0	0.0	0.0	0.0	2.5	26.0	38.5	
24	23.0	7.5	0.0	0.0	4.5	0.0	0.0	0.0	0.0	5.0	37.5	35.5	
25	24.5	26.5	6.5	0.0	3.5	0.0	0.0	0.0	0.0	0.0	6.5	37.0	
26	17.5	32.5	9.5	0.0	6.5	0.0	0.0	0.0	24.5	0.0	13.5	28.5	
27	15.0	28.5	17.5	0.0	5.5	0.0	0.0	0.0	9.0	0.0	12.0	5.5	
28	19.0	3.5	0.0	0.0	1.5	0.0	0.0	0.0	12.5	0.0	0.0	0.5	
29	0.0	0.0	0.5	0.0	2.0	0.0	0.0	0.0	0.0	0.0	5.5	15.0	
30	0.0	-	25.0	0.0	0.5	0.0	0.0	0.0	0.0	6.5	14.5	14.5	
31	0.0	-	0.5	-	2.0	-	0.0	0.0	-	2.5	-	28.0	
Maximum Rainfall	35.5	32.5	37.5	49	32.5	12	16	0	51	12	38	50	51
Total Rainfall	321.0	274	367.5	133	178	23	62	0	99	29	207	434	2126
Total Days of Rainfall	19	20	24	10	24	4	9	0	5	6	16	23	160
Average Rainfall	10.4	9.8	11.9	4	6	1	2	0	3	1	7	14	
First-Half Rainfall (1-15)	116	101	253.0	84	122	23	44	0	51	1	77	187	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	205.0	174	115	49	57	0	18	0	48	28	130	247	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

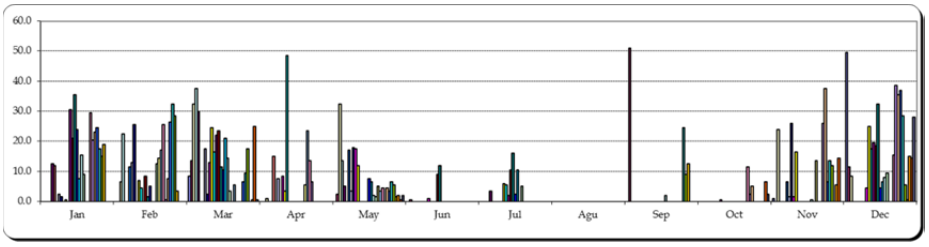


Figure B.10 Rainfall Fluctuation (2004)

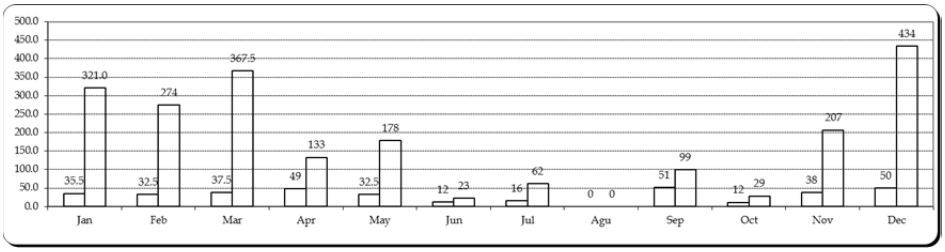


Figure B.11 Maximum Rainfall and Total Rainfall per Month (2004)

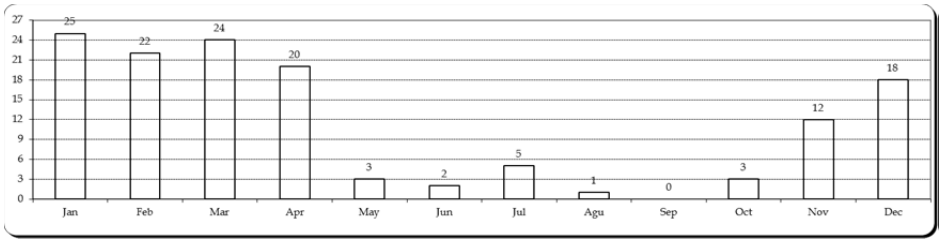


Figure B.12 Total Rainy Days (2004)

Table B.4 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2004)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	29.8	21.4	25.6	29.4	17.6	23.5	30	21	25.5	28.8	17.6	23.2	30.4	17.6	24.0	29	14.4	21.7	29.4	19	24.2	30	17	23.5	28.4	19	23.7	31.4	20	25.7	32.8	20	26.4	25.4	19.7	22.6
2	29.6	16.6	23.1	29	20	24.5	30	19.6	24.8	30.4	20.2	25.3	29.2	22.3	25.8	28.6	12.6	20.6	27.5	19.4	23.5	30	15	22.5	26.4	19.8	23.1	30	19.2	24.6	31.6	20.6	26.1	25.4	20.3	22.9
3	30	20.2	25.1	28.6	20.8	24.7	29.8	21.6	25.7	29.2	17.2	23.2	30	19.6	24.8	29.2	15	22.1	29.2	16.4	22.8	30.2	17	23.6	27.2	20.1	23.7	29.6	19.8	24.7	30.1	22	26.1	27.8	19.8	23.8
4	29.8	20.2	25.0	28	17.6	22.8	29.8	21	25.4	30	18	24.0	30.6	17.4	24.0	29.6	15	22.3	29.2	19	24.1	30.2	14.2	22.2	29.2	18	23.6	30.6	20.8	25.7	29.8	19.7	24.8	28.2	19.2	23.7
5	29.8	19.6	24.7	28.6	20	24.3	28.6	18	23.3	28.6	18.9	23.8	28.8	19.8	24.3	29.2	18.2	23.7	28.8	20	24.4	28.4	16	22.2	30	18.6	24.3	30.8	16.8	23.8	31.2	20	25.6	29	17.6	23.3
6	29.4	19.8	24.6	28.8	17.6	23.2	29.4	20.4	24.9	29.8	16.8	23.3	29.4	17	23.2	30.8	18.2	24.5	29	20	24.5	30.2	17.2	23.7	31.5	18.8	25.2	30.8	16.6	23.7	27.8	20.2	24.0	27.4	18.8	23.1
7	30.4	18.8	24.6	28	21.8	24.9	27.6	19.2	23.4	29	19.2	24.1	28.6	22	25.3	32	18.6	25.3	29.2	19	24.1	29.4	17.2	23.3	31	18.6	24.8	30	17	23.5	26.8	21.4	24.1	27.4	21	24.2
8	29.6	21.2	25.4	26.8	20	23.4	27.4	21.2	24.3	28.6	20.4	24.5	27.8	19	23.4	31.2	18.8	25.0	29.2	16.2	22.7	29.2	16.4	22.8	31.2	17.4	24.3	31.5	19	25.3	29.2	20.8	25.0	30.2	19.9	25.1
9	30.4	21	25.7	28.2	16.8	22.5	29.6	21	25.3	28.6	16.2	22.4	30	17.8	23.9	29	18.4	23.7	28.6	20.2	24.4	27.2	18.2	22.7	30	17.9	24.0	29.4	19.1	24.3	28.5	20.2	24.4	29.4	20.4	24.9
10	30.4	18.4	24.4	30.6	18.8	24.7	29.4	18.2	23.8	27.6	19.6	23.6	28.6	20.2	24.4	24.6	19	21.8	27	17	22.0	30.4	17.4	23.9	28.8	17.6	23.2	30.7	21.2	26.0	28.8	20	24.4	30	19.8	24.9
11	27.8	20.8	24.3	29.6	18.4	24.0	30.2	20	25.1	27	18.6	22.8	29.8	19.2	24.5	27.2	18	22.6	27.2	16.4	21.8	30.4	17	23.7	29.6	19.2	24.4	31.6	19	25.3	29	19.8	24.4	29	19.2	24.1
12	30.1	18.8	24.5	27.2	20.8	24.0	30	18.4	24.2	29	20.6	24.8	30.6	20.6	25.6	26	15.4	20.7	25.4	19.8	22.6	29.4	15.6	22.5	30.4	18.8	24.6	32.8	18.4	25.6	31	19	25.0	30	22	26.0
13	30	22	26.0	25.6	21	23.3	29.2	19.2	24.2	30.4	20.4	25.4	30.4	20.4	25.4	28.6	16	22.3	26.4	15.6	21.0	29	18	23.5	31.2	18.5	24.9	33	19	26.0	29.6	20	24.8	29.7	20.8	25.3
14	30	22	26.0	26.6	18.2	22.4	29	19	24.0	29.8	17.6	23.7	30.4	17.2	23.8	28.8	21	24.9	27.8	17.6	22.7	29.6	18.4	24.0	29.4	18	23.7	33.4	17	25.2	32	20.8	26.4	28.8	21.2	25.0
15	30	19	24.5	25.6	20.6	23.1	29.2	16.4	22.8	28.6	20	24.3	29.6	19.6	24.6	29.6	16.8	23.2	28	15.4	21.7	30.2	18.2	24.2	28	19	23.5	33	17.3	25.2	31.6	20	25.8	27.1	21.4	24.3
16	31	21.2	26.1	26.8	18.2	22.5	30	18.2	24.1	29.2	16.4	22.8	29	19.4	24.2	29.4	18.4	23.9	28.8	20	24.4	30	17.8	23.9	29.6	18.2	23.9	32.4	17	24.7	32.8	20.6	26.7	30.6	21	25.8
17	27.6	20	23.8	23.8	21	22.4	26.5	16.6	21.6	30	18.2	24.1	30	24.2	27.1	30	18.6	24.3	28	17.6	22.8	30.2	18.6	24.4	30	18.8	24.4	30.4	19	24.7	33	21	27.0	23.8	20.4	22.1
18	28.8	22.2	25.5	26	20.4	23.2	28.6	18.4	23.5	31	20.4	25.7	28.6	21	24.8	29.2	15.8	22.5	28	17	22.5	30.8	19.4	25.1	30	18.6	24.3	31.8	18.8	25.3	29.4	21.6	25.5	29	21.4	25.2
19	30.4	19	24.7	24.2	17.8	21.0	28.8	19.4	24.1	30	17.4	23.7	29.8	18.2	24.0	30	18	24.0	29.2	19.6	24.4	29.8	18	23.9	30	18.7	24.4	31.8	17	24.4	29.6	20.6	25.1	28.4	20	24.2
20	29.2	16	22.6	28.6	20	24.3	28.6	16.6	22.6	29.6	19.8	24.7	29.4	20.6	25.0	29.2	17.2	23.2	29.2	14.6	21.9	29.6	18.2	23.9	30.4	19.8	25.1	29.6	17	23.3	30	21.1	25.6	27.2	20	23.6
21	28.2	18	23.1	28.8	18.6	23.7	29	19.2	24.1	28	19.2	23.6	30.8	18.4	24.6	30	19.4	24.7	27.8	18.2	23.0	29.8	19	24.4	31.4	19.6	25.5	29.2	19.7	24.5	29.7	20.6	25.2	28.6	20.4	24.5
22	28.2	16.2	22.2	29	20.6	24.8	27.8	17.2	22.5	28	19	23.5	29	19	24.0	29.6	18	23.8	29.6	19	24.3	30.8	19	24.9	29.6	18.6	24.1	30.8	20.6	25.7	26.8	19.6	23.2	28	19.8	23.9
23	28.2	20	24.1	29	21	25.0	30	21.4	25.7	26.8	20	23.4	29	20	24.5	29	18	23.5	30	16.2	23.1	31.6	19	25.3	30.2	18.4	24.3	30.8	19.8	25.3	25.8	18.2	22.0	26.4	21.8	24.1
24	28.4	21	24.7	29.6	16.8	23.2	29.8	21.2	25.5	30.6	17.6	24.1	29	17	23.0	29.8	18	23.9	29.2	18.5	23.9	31.3	18.7	25.0	28.9	18.8	23.9	31.6	19.6	25.6	27	19.8	23.4	29.2	19	24.1
25	27.4	18.4	22.9	29.2	19	24.1	31	21	26.0	28.6	20	24.3	30.6	19.2	24.9	28.6	15.5	22.1	29.2	20.4	24.8	30.2	18.4	24.3	30	19.8	24.9	32	19	25.5	27.1	20	23.6	27.6	19	23.3
26	26.8	20.4	23.6	29.4	18	23.7	29	21	25.0	30	16	23.0	27.6	17	22.3	30.2	19	24.6	30.4	18	24.2	30.6	18.6	24.6	30	20.4	25.2	33.8	19	26.4	29.8	18.6	24.2	27.6	20.2	23.9
27	28.6	17.4	23.0	28.6	19.4	24.0	29.4	21	25.2	28.6	20.8	24.7	27.6	19.2	23.4	28.4	19.4	23.9	30.4	17.6	24.0	31	16.8	23.9	29.2	20.3	24.8	33.6	20.9	27.3	29.7	20.4	25.1	27	20.7	23.9
28	28.4	20	24.2	28.6	17	22.8	29.2	21	25.1	29.8	21	25.4	25.2	19	22.1	29.2	16.4	22.8	28.8	15	21.9	31	18.2	24.6	29.8	20	24.9	32.2	22.6	27.4	29.4	20.2	24.8	27.6	20.8	24.2
29	29	18	23.5	29.8	20.4	25.1	31	20	25.5	28.8	18.6	23.7	28.6	16.4	22.5	28.8	18.6	23.7	28.4	18.4	23.4	30.2	18.4	24.3	30	19.2	24.6	31.4	21.2	26.3	26.5	20.6	23.6	27.6	20.8	24.2
30	30	20.4	25.2				29.3	17.4	23.4	29.6	20.6	25.1	28.6	18.6	23.6	29.6	14.6	22.1	30	15.8	22.9	29.9	18.2	24.1	30	19.2	24.6	33.2	20.4	26.8	27.2	19.8	23.5	28.4	19.2	23.8
31	29.4	20.4	24.9				29.4	20	24.7				29	14.4	21.7				30.6		15.3	30	17.6	23.8				31.6	22	26.8				25	18.8	21.9

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	82	78	57	82	79	64	70	67	80	80	66	93
2	77	76	75	74	81		75	67	89	77	68	84
3	77	86	80	81	84	74	75	68	81	80	71	79
4	76	79	83	75	80	71	78	68	76	79	80	78
5	75	82	76	74	75	75	76	68	73	73	78	75
6	72	80	68	79	82	72	77	68	69	67	87	87
7	71	78	80	83	81	70	74	66	67	74	90	83
8	74	86	74	84	83	74	75	70	67	70	88	76
9	72	79	72	85	86	71	77	72	68	76	83	86
10	85	71	72	86	85	84	80	70	72	77	85	81
11	91	70	86	86	81	84	79	68	73	70	84	81
12	84	74	85	84	76	90	86	68	71	57	78	85
13	82	84	85	83	73	83	86	72	67	63	78	86
14	76	82	86	80	76	85	88	70	69	59	79	90
15	79	87	80	75	77	73	85	68	75	56	77	89
16	76	85	83	79	79	70	77	72	74	59	73	83
17	81	90	86	72	80	74	80	67	73	73	73	83
18	84	83	84	75	84	73	81	65	75	71	84	89
19	76	94	77	81	83	74	74	71	78	62	82	
20	84	84	74	79	82	70	75	74	76	73	80	89
21	87	84	76	87	79	73	75	73	73	75	87	86
22	86	84	81	86	77	71	75	70	70	80	90	85
23	84	87	77	84	80	62	71	64	72	78	82	88
24	89	86	68	81	82	72	73	63	76	73	90	91
25	88	84	68	84	83	75	74	73	81	73	89	87
26	85	84	75	78	86	61	67	67	83	67	84	84
27	85	84	79	79	86	73	71	65	84	73	79	86
28	83	76	80	78	86	68	73	64	80	63	84	85
29	85	73	71	83	75	67	77	67	75	72	89	83
30	78		82	80	79	67	72	68	81	74	88	80
31	83		85		65		66	73		73		87

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	6.4	3.3	5.9	4.1	6.9	8	7.7	8	4.1	4.7	7.6	0.2
2	6.3	4.5	5.4	4.7	6.3	7.1	2.1	8	1.2	6.3	6.5	
3	6.3	2.2	5.2	4.7	3.4	8	5	7.6	2.7	5.7	3.6	2
4	4.5	1.1	5.5	6	5.6	6.9	4.4	7	7.2	6.2	4.1	0.2
5	6.6	5.5	3.7	4.4	2.3	5.5	5.5	7.1	6.5	7.7	3.1	5.1
6	7	4	5.9	4.1	4.3	6.1	6.4	7.9	8	5.3	2.3	1.2
7	7.5	1.3	2.3	4.7	1.6	7.8	4.7	7.3	8	5.1	1.2	
8	4.6	4.7	0.8	3.7	1.4	7	5.7	8	6.8	8	5.3	7.5
9	8	5	5	5.1	6.3	2.4	5.2	4.3	5.4	5	4.5	5.4
10	1.9	7.9	2.4	2.3	4.3		3.3	8	4.4	6.5	4.2	4.9
11	2.4	6.9	6.4	1.2	7.4	4.1	4.1	8	6	7.9	4.8	4.2
12	5.2	5.4	6	4.3	8	0.6	0.3	6.7	6.3	8	5.5	3.6
13	5	0.6	3.7	5.9	8	4.6	1.9	7.8	8	8	3.7	3.8
14	4.7	0.7	2	5.1	8	3.3	3.3	7.2	3.9	8	4.9	2.8
15	5.9	0.3	5.8	4.3	6.8	7.2	5.7	7.5	1.6	8	4.9	0.5
16	7.9	1.8	5.8	5.3	8	7.3	5.3	7.4	5.5	6.2	6	6.5
17	1.5		3.8	5.4	4.8	7	4	8	5	5.3	7.6	
18		1.1	1.8	6	3.8	6.8	4.3	6.4	5.4	7.8	3	3.2
19	6.3		7.5	4.8	4.3	7.9	7.1	8	5.1	7.5	6.6	0.2
20		4.2	5.8	4.7	6.5	6.3	7	8	5.4	5.1	2.9	2.7
21		4	5.4	0.6	6.3	6	5.6	5.8	7.3	4.3	2.5	3.6
22	3.8	3	2.3	3.8	5.8	7.4	6.2	6.4	5.9	4.4	2	3.1
23	4.1	3.2	6.4	2	4.6	7.6	5.6	8	4.8	5.4	1	
24	2	4.6	5.5	5.6	5.8	6	5.5	8	3.9	5.5	1.3	4
25	3.2	1.3	6.7	5	3.9	4.5	5.5	7.5	4.4	8		3.7
26	2.8	3.8	4.1	5.7	3.8	6.3	7.8	8	5.1	7.1	6.4	5
27	2.9	3.4	4.7	4.1	3.1	6.6	7.6	6.8	4.7	7.5	4.5	4.1
28	3.3	2.6	4.4	4.8	0.4	5.8	6.7	5	4.9	7.6	3.3	3
29	4.2	3.7	7.9	2.4	4.7	7.9	5.9	7.5	5.4	4.8		4.1
30	2.7		3.1	1.8	5.4	7.7	5.8	5.1	4.1	7.2	0.7	5
31	6.4		4		8		7.4	5.9		6.1		0.5

DAILY RAINFALL DATA (mm)

Station Name	**: Cipanas-Pangalengan**		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2005

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	38.0	0.0	3.5	27.5	0.0	0.0	0.0	2.5	0.0	0.0	-	-	
2	3.5	16.5	0.0	28.0	0.0	0.0	0.0	0.5	0.0	0.0	-	-	
3	0.0	10.5	13.0	0.0	0.0	6.0	0.0	1.0	0.0	0.0	-	-	
4	0.0	12.0	7.5	25.5	18.5	0.0	0.0	0.0	0.0	0.0	-	-	
5	0.0	0.0	9.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	-	-	
6	0.5	5.5	11.0	0.0	23.0	0.0	0.0	0.0	0.0	0.0	-	-	
7	12.5	5.0	9.5	0.0	0.0	0.0	14.5	0.0	0.0	0.0	-	-	
8	11.5	2.0	32.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	
9	13.0	15.5	13.0	0.0	0.0	30.0	0.0	0.0	1.0	0.0	-	-	
10	16.5	19.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	
11	0.0	18.0	2.5	10.0	0.0	0.0	24.0	0.0	0.0	0.0	-	-	
12	0.0	27.5	1.5	8.0	0.0	0.0	20.5	0.0	0.0	0.0	-	-	
13	0.0	22.5	0.0	0.0	21.5	5.0	15.0	0.0	0.0	5.0	-	-	
14	15.5	17.5	35.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	-	-	
15	4.0	7.5	28.0	0.0	0.0	0.0	0.0	0.0	11.5	0.0	-	-	
16	0.0	2.5	3.5	0.0	17.0	3.0	0.0	0.0	0.0	0.0	-	-	
17	2.0	10.0	18.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	-	-	
18	21.5	2.0	17.5	0.0	0.0	0.0	9.0	0.0	0.0	0.0	-	-	
19	17.5	25.5	4.5	77.0	0.0	0.0	0.0	0.0	25.5	0.0	-	-	
20	15.0	21.5	7.5	4.5	0.0	0.0	0.0	0.0	0.0	0.0	-	-	
21	14.5	22.5	7.0	1.5	0.0	0.0	0.0	0.0	25.0	34.5	-	-	
22	16.5	20.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.5	-	-	
23	16.0	18.5	37.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0	-	-	
24	0.0	17.5	42.0	0.0	0.0	35.0	0.0	0.0	0.0	5.0	-	-	
25	0.0	20.5	6.5	0.0	0.0	0.0	0.0	0.0	0.0	6.5	-	-	
26	0.0	17.0	4.5	0.0	8.5	0.0	0.0	0.0	0.0	2.5	-	-	
27	7.5	2.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	3.0	-	-	
28	8.5	17.5	13.5	0.0	0.0	0.0	0.0	0.0	0.0	8.5	-	-	
29	4.5	-	11.5	0.0	0.0	0.0	0.0	0.0	18.0	5.5	-	-	
30	6.5	-	9.5	0.0	0.0	0.0	0.0	0.0	0.0	1.5	-	-	
31	0.0	-	24.0		0.0		0.0	0.0		0.0		-	
Maximum Rainfall	38.0	27.5	42.0	77	23.0	35	24	3	26	35	0	0	77
Total Rainfall	245.0	378	375.0	190	89	90	94	4	81	107	0	0	1651
Total Days of Rainfall	20	26	27	9	5	6	6	3	5	11	0	0	118
Average Rainfall	7.9	13.5	12.1	6	3	3	3	0	3	3	0	0	
First-Half Rainfall (1-15)	115	180	166.0	107	63	41	74	4	13	11	0	0	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	130.0	198	209	83	26	49	20	0	69	96	0	0	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

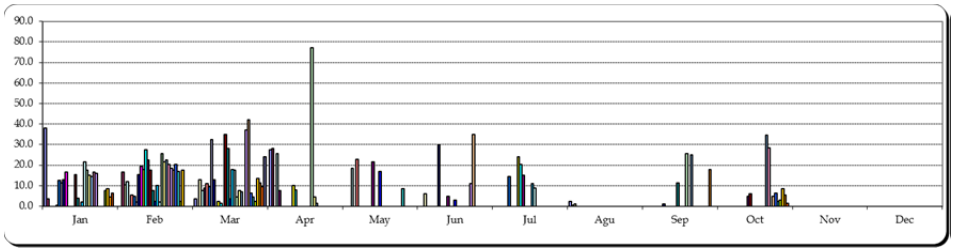


Figure B.13 Rainfall Fluctuation (2005)

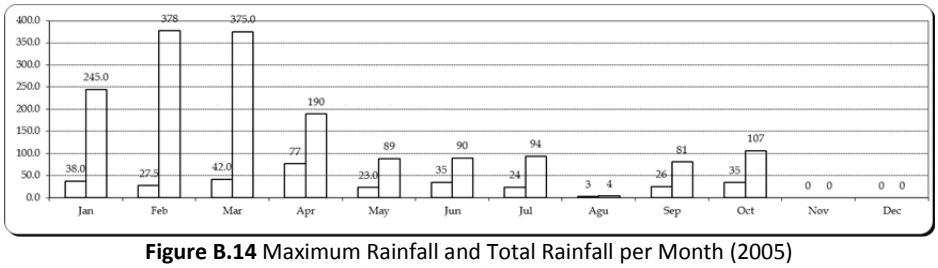


Figure B.14 Maximum Rainfall and Total Rainfall per Month (2005)

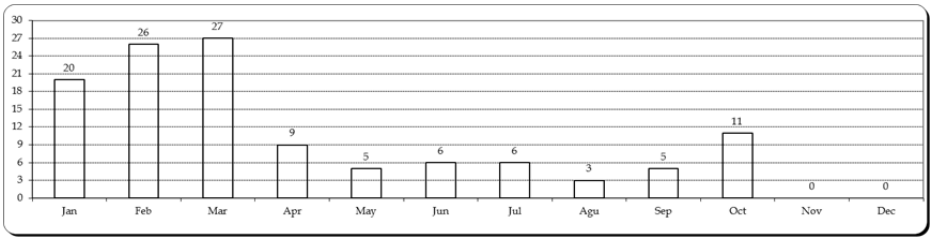


Figure B.15 Total Rainy Days (2005)

Table B.5 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2005)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	27.8	20.3	24.1	29.3	19.8	24.6	29.6	19.6	24.6	29.2	20	24.6	30.8	20.4	25.6	28	20.2	24.1	29.8	19.2	24.5	26.4	20	23.2	30.2	17.8	24.0	30.2	17.6	23.9	29.6	19.6	24.6	27.8	18.8	23.3
2	29.1	20.6	24.9	29.8	19.8	24.8	29	19.5	24.3	29.6	20.6	25.1	29.2	20	24.6	29.8	20.7	25.3	30.4	18	24.2	26.6	20	23.3	30.4	15.8	23.1	28.8	18	23.4	28.2	19.5	23.9	29.2	18.6	23.9
3	28.6	20.8	24.7	30.5	18.6	24.6	28.6	20	24.3	28	20.2	24.1	27.2	21.6	24.4	27.4	22.2	24.8	28.8	16	22.4	27	19	23.0	30.6	20	25.3	30.2	18.8	24.5	28	20	24.0	29.2	19.8	24.5
4	28.4	20.4	24.4	29.8	19.4	24.6	28.7	20.2	24.5	28.6	20	24.3	29.2	20.2	24.7	28.8	21.8	25.3	28.4	16.8	22.6	29.8	18.6	24.2	29.6	19.6	24.6	30	19	24.5	27	20.6	23.8	30	19.8	24.9
5	27.8	21.6	24.7	29.7	17.5	23.6	28.8	21	24.9	28.6	20.8	24.7	28.4	20.8	24.6	27.6	21.8	24.7	29	18	23.5	28.6	18.6	23.6	30.3	18.4	24.4	29.6	20.4	25.0	28.4	19.6	24.0	28.6	20	24.3
6	27.2	21.4	24.3	28.8	21.2	25.0	26.1	20.6	23.4	29.3	19.4	24.4	29.4	20.9	25.2	28.1	21.2	24.7	28.5	19	23.8	29.6	17	23.3	29.9	19.4	24.7	29.6	19.8	24.7	30	20.2	25.1	28	19.6	23.8
7	26.2	20.3	23.3	29.7	21	25.4	29.3	20	24.7	29.6	20	24.8	30.2	21.4	25.8	28.2	22	25.1	25.4	20	22.7	28.6	17.1	22.9	30.6	19.4	25.0	31.6	19	25.3	30.4	20.6	25.5	29.2	19.6	24.4
8	28.2	20.8	24.5	28.4	20.8	24.6	29.2	19.8	24.5	29.6	20.4	25.0	30.6	20.2	25.4	28.3	20.2	24.3	28.4	18.6	23.5	29	17.6	23.3	29.8	20.2	25.0	32	19.4	25.7	30.6	20.4	25.5	28.4	20.4	24.4
9	28	20.8	24.4	29.4	20.8	25.1	29.4	20.8	25.1	29.6	18	23.8	29.4	18	23.7	29	20.2	24.6	28.6	18.8	23.7	28	18	23.0	29	20.4	24.7	31.6	19.2	25.4	19.6	19	19.3	27.8	20.4	24.1
10	29.2	19	24.1	29.6	20.6	25.1	30	20.4	25.2	30	18	24.0	30.2	18	24.1	30	18.6	24.3	27	19.4	23.2	29	19	24.0	29.9	20.3	25.1	31.5	19	25.3	29.4	18.6	24.0	27.2	20	23.6
11	29.6	20	24.8	25.4	20.7	23.1	30.2	20	25.1	29.6	20.2	24.9	29.8	19.8	24.8	29.8	18.8	24.3	28.4	19.4	23.9	29.8	18.4	24.1	30	20.3	25.2	29.2	18.8	24.0	29.5	19	24.3	30.2	20.1	25.2
12	29.2	20	24.6	28	20.6	24.3	31	20	25.5	30	19.8	24.9	28.2	19.8	24.0	29.5	19.2	24.4	28	18.6	23.3	29	21	25.0	30	20.6	25.3	29.4	20	24.7	30.6	18.2	24.4	27.6	20.2	23.9
13	29.2	21.1	25.2	26.3	21	23.7	30.4	21.4	25.9	29.3	20.4	24.9	27.7	20.4	24.1	29.6	20	24.8	29.2	18.6	23.9	29.6	20.6	25.1	29.6	20.8	25.2	28.2	20.4	24.3	28.8	20	24.4	28.6	19.4	24.0
14	30.1	20.4	25.3	29.8	21	25.4	31	20.9	26.0	27.6	20.2	23.9	28.8	20	24.4	27.6	20.8	24.2	29.2	19.4	24.3	30.2	19.2	24.7	28.8	14.6	21.7	30.6	21	25.8	29.8	28	28.9	29.6	19.4	24.5
15	30	20.2	25.1	27.8	20	23.9	29.4	20.4	24.9	29.8	21.2	25.5	27.4	20	23.7	26.6	20.8	23.7	27.4	19.6	23.5	30.2	18.4	24.3	29	20.5	24.8	29.8	20.8	25.3	30.6	19	24.8	25.4	19.2	22.3
16	29.6	19.8	24.7	29	19.6	24.3	29.9	20.8	25.4	31.2	20	25.6	29.8	18.6	24.2	27.6	20	23.8	28.2	19.4	23.8	29	19.4	24.2	29.8	20.4	25.1	29.4	18.6	24.0	31.6	19.2	25.4	27.6	20	23.8
17	25.6	21	23.3	29.4	20.8	25.1	29.4	21	25.2	30.7	20.2	25.5	30.6	18.4	24.5	28.4	19.7	24.1	24.4	18.8	21.6	28.2	19.5	23.9	28.2	20.4	24.3	27.6	19	23.3	31	18.8	24.9	28.3	20.9	24.6
18	25.6	20.6	23.1	27.4	21	24.2	27.4	21	24.2	28.6	20.2	24.4	29.2	20.4	24.8	28.3	19.2	23.8	28.8	18.8	23.8	29.2	20	24.6	28.5	19.2	23.9	28	20.6	24.3	29.4	19.8	24.6	26.9	21.2	24.1
19	25.6	20.8	23.2	28	20	24.0	29	20.8	24.9	28.4	21	24.7	29.6	19	24.3	28.9	19.3	24.1	28.3	19	23.7	29	18.6	23.8	26.4	19.2	22.8	28.8	20.2	24.5	28.8	20.4	24.6	21.4	21.4	21.4
20	28	20	24.0	29.4	20.2	24.8	29.6	20	24.8	28.9	20.5	24.7	28.6	19.2	23.9	27.7	20.4	24.1	28.6	19.4	24.0	29	18.2	23.6	28.4	19.2	23.8	29.2	20	24.6	28.6	20.2	24.4	28.2	21	24.6
21	28	20	24.0	26.6	19.8	23.2	30.5	20.5	25.5	28.5	20.4	24.5	29.6	18.6	24.1	28.6	20.2	24.4	28.6	19	23.8	27.6	18	22.8	28.4	20.2	24.3	28.8	21	24.9	28.4	19.8	24.1	27.6	20	23.8
22	28.6	20.6	24.6	27.4	21	24.2	28.2	21	24.6	26.2	20.3	23.3	29	19.6	24.3	25.6	20	22.8	29	19	24.0	30.6	20	25.3	30.6	20.2	25.4	27	20.5	23.8	28.6	19.5	24.1	28	21.5	24.8
23	27.4	21	24.2	28.5	20.6	24.6	26	21.4	23.7	28.4	18	23.2	29	20	24.5	29.4	18.8	24.1	29	18.2	23.6	29.6	20	24.8	30.6	19.6	25.1	27.6	19.4	23.5	30.4	19	24.7	29	21.6	25.3
24	25.8	20.6	23.2	29.6	20.4	25.0	28.4	19.4	23.9	30.8	18	24.4	29.6	20.2	24.9	29	18.2	23.6	28.6	17.4	23.0	28.1	21	24.6	30.4	20	25.2	28.2	19.4	23.8	28.5	21.1	24.8	27.8	20.9	24.4
25	27.8	20	23.9	28	19.8	23.9	28.2	19.6	23.9	30.1	20.5	25.3	29.2	19.8	24.5	29	19.3	24.2	28.6	17	22.8	29.2	20.8	25.0	28	19	23.5	29	19	24.0	26.6	21	23.8	29.8	18.4	24.1
26	28.4	19.8	24.1	28.5	19.8	24.2	25.8	20.2	23.0	29.4	21	25.2	29.8	19.6	24.7	28.6	19.4	24.0	28.4	16.8	22.6	29	20.8	24.9	28.5	18.4	23.5	29.2	19.8	24.5	25	20	22.5	28.2	19.2	23.7
27	28	19.4	23.7	26.4	20	23.2	26.8	19	22.9	29	20.6	24.8	30.6	19.2	24.9	28.2	20	24.1	29.2	18.4	23.8	29	20	24.5	29.4	18	23.7	29.6	19.5	24.6	27.2	20.2	23.7	26.2	20.5	23.4
28	28.4	19	23.7	27.4	19.8	23.6	28	19.4	23.7	28.8	19.2	24.0	29.2	19	24.1	28.2	18.6	23.4	28.6	19	23.8	29.4	19.6	24.5	28.2	18.9	23.6	28.2	19.5	23.9	28.4	20.6	24.5	25.6	20.3	23.0
29	26.4	20.8	23.6				27.5	19.8	23.7	28.5	19.8	24.2	29	19.4	24.2	30	19	24.5	29.8	20.2	25.0	30.2	19.8	25.0	28	19	23.5	28	19.8	23.9	28.2	19.6	23.9	27.6	19.8	23.7
30	27.4	20.5	24.0				27.4	20.2	23.8	29.4	19.7	24.6	29	20	24.5	29.6	19.8	24.7	29.8	19	24.4	30.6	17	23.8	28.6	19	23.8	28.8	20.2	24.5	27	18.6	22.8	27.4	21	24.2
31	28.6	21.2	24.9				28.5	20.4	24.5				28.5	20.6	24.6				29.3	20.2	24.8	31	17	24.0				26	19.2	22.6				28.4	20.8	24.6

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	80	83	87	86	80	84	84	87	73	78	79	85
2	74	83	84	82	81	84	72	87	73	78	84	80
3	79	81	84	84	89	89	74	83	75	73	85	76
4	82	81	87	88	83	87	77	77	73	75	84	81
5	86	80	86	85	83	86	81	73	76	76	85	86
6	82	79	87	82	86	86	83	69	72	79	80	84
7	89	82	84	81	84	89	89	73	77	72	85	85
8	87	80	84	84	80	86	86	73	80	68	74	86
9	87	86	78	82	78	82	86	78	84	71	72	88
10	76	84	74	81	75	80	85	75	79	73	81	92
11	74	86	79	83	79	80	83	79	82	79	91	85
12	76	84	74	81	81	83	85	83	81	86	76	93
13	84	86	74	78	86	83	84	73	80	89	89	87
14	83	83	87	86	85	91	85	75	83	82	75	85
15	84	85	79	83	89	92	86	76	80	81	77	90
16	86	83	82	78	83	86	85	81	81	81	67	86
17	85	86	85	79	78	84	89	87	82	85	72	82
18	90	92	87	86	81	83	80	75	87	84	85	80
19	88	86	86	86	88	82	83	78	85	84	84	87
20	86	87	83	86	79	86	83	77	82	81	86	78
21	83	87	76	88	76	89	79	81	84	83	85	82
22	82	89	86	85	82	86	75	79	74	87	73	80
23	80	88	88	81	81	82	76	79	75	90	65	80
24	87	86	88	77	80	87	74	81	71	83	81	85
25	79	90	88	80	81	85	75	79	79	82	88	85
26	85	91	92	82	76	88	79	78	79	83	91	86
27	86	91	89	82	77	85	70	81	76	89	85	86
28	85	91	92	81	80	78	76	78	80	89	86	86
29	92		89	82	85	82	64	73	83	83	94	84
30	85		89	81	83	82	74	64	85	82	88	81
31	76		89		85		77	74		89		81

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.8	4.4	4.3	2.4	6.8	5.7	7.9	2.9	6	6.8	3.7	4.5
2	6.4	6.7	4.1	6.3	4.3	4.8	8	1.4	6.2	5.6	3.5	4.8
3	4.7	6.7	4.6	2.4	2.3	1.7	7.6	4.9	5.3	5.9	2.5	4.4
4	4.1	6.9	4	3.9	4.4	4.2	6.8	6.7	7.3	5.4	0.8	4.3
5	1.5	8	3.6	5	3.3	4.5	6.4	4.9	7.2	5.3	4.8	3.3
6	0.1	4.3	3.1	5.5	4	2.7	5.5	8	7.1	5.7	6.6	2.4
7	0.3	7.6	6.5	1.4	6	5.4		8	6.4	8	5.5	3.9
8	4.2	7.1	7.4	4.3	8	3.9	3.3	7.3	5	8	8	1.4
9	4.5	4.5	7.3	5.5	7.5	4.4	3.7	7.1	3.3	5.7	5.2	3.9
10	4.2	3.5	8	6.7	7.9	7.2	4.4	7.6	7.1	6	5	2.8
11	5.3	0.7	8	6.2	7.2	7.3	3	7.2	6.9	4	5.5	2.6
12	5.9	2.1	8		3.8	4.8	4.7	7.5	5.8	2.8	6.5	3.3
13	6.3	2.1	5.5		3.8	5.9	5	6.9	5.3	4	3.4	5.2
14	7	3.9	5.5	3.2	4.6	1.4	6.6	6.3	4.8	6.2	7.9	6.8
15	7.4	3	8	3.7	2.5	3.9	3.5	5.1	5.2	5.5	6	
16	6.5	3.4	4.3	7.7	7.4	5.7	4.7	6.5	6.6	4.8	7	0.6
17	2.1	5	4.1	6.3	6.8	5.4	7.3	3.4	4.2	3.1	6.6	2.3
18	0.8	3.6	1.1	3.7	6.5	6.2	0.2	5.4	2.2	1.9	4.8	0.3
19	1.4	3.5	5.2	4.9	7.7	3.4	6.4	6.1	0.1	4.6	4	2.5
20	3	5.7	7.1	4.6	6.4	3.2	6.9	5.5	3.8	6.7	3	2.5
21	6	3.6	5.6	3.7	6.7	1.5	5.2	5.3	5.2	3.9	2.8	2.2
22	5.3	2	2.4	0.7	4.6	0.7	7.6	6.2	2.7	0.9	2.6	1.5
23	5.5	5.6	0.2	4.7	3.1	7.7	8	7.3	6.1	1.9	6.3	5.2
24	0.3	5.2	4.1	7.3	5.4	5.4	6.9	2.7	7.7	3.2	1.2	1.3
25	4.8	1	4.5	5.6	2.5	6.7	7.9	6.6	3.1	5.7		4.3
26	4.8	5	0.9	5.4	6.3	6.8	7.5	6.6	5.3	5.6	1	2.6
27	5.1	2.1	0.3	5.8	8	5.6	6	6.8	4.4	4.5	1	
28	4.5	2.6	3.2	5.4	7.2	6.7	4.5	5.8	4.5	1.5	2.9	
29	1.7		4	4.7	4.5	6.3	7.6	6.8	3.9	4.6	3.8	2.1
30	2.2		3.4	6.2	5.9	5.9	6.1	5.9	4.5	1.6	4	2.4
31	0.6		3.3		3.3		7.3	6.1		0.7		3.4

DAILY RAINFALL DATA (mm)

Station Name	: **Cipanas-Pangalengan**		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2006

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	10.5	40.0	0.5	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	
2	8.0	0.5	7.5	4.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	48.5	
3	45.5	0.0	0.0	3.5	8.5	0.0	0.0	0.0	0.0	0.0	0.0	50.0	
4	5.5	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.0	
5	5.0	36.0	0.0	4.5	10.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	
6	19.0	40.0	25.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	9.0	-	
7	0.0	2.0	18.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	7.0	23.5	
8	9.0	8.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	7.0	3.0	
9	17.0	8.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
10	2.5	38.0	0.0	16.0	0.5	0.0	0.0	0.0	11.0	0.0	0.0	0.0	
11	15.5	3.0	0.0	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
12	9.0	5.5	0.0	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
13	5.0	2.5	39.0	23.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	
14	0.0	0.0	2.5	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
15	8.5	29.0	0.0	24.5	0.0	0.0	0.0	0.0	0.0	9.0	0.0	3.5	
16	10.0	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
17	46.5	0.5	0.0	18.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	10.5	
18	9.5	0.0	0.0	17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
19	0.0	15.0	0.5	23.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.5	
20	1.5	8.5	23.5	27.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	-	
21	0.0	9.5	15.5	20.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.0	
22	0.0	8.0	0.0	25.0	5.5	0.0	0.0	0.0	0.0	0.0	0.0	-	
23	11.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	63.0	
24	14.5	1.5	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	
25	12.0	7.0	3.5	21.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
26	2.0	43.5	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	23.0	
27	12.0	30.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	84.0	
28	5.0	0.5	0.5	0.0	7.5	0.0	0.0	0.0	0.0	40.0	15.0	47.0	
29	17.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0	-	
30	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	
31	6.0	-	0.0	-	0.0	-	0.0	0.0	-	0.0	-	30.0	
Maximum Rainfall	46.5	43.5	39.0	27	10.0	0	0	0	11	40	15	84	84
Total Rainfall	307.0	358	148.5	342	38	0	0	0	11	49	71	525	1849
Total Days of Rainfall	25	23	12	24	7	0	0	0	1	2	9	18	121
Average Rainfall	9.9	12.8	4.8	11	1	0	0	0	0	2	2	17	
First-Half Rainfall (1-15)	160	213	92.5	163	21	0	0	0	11	9	23	178	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	147.0	145	56	179	18	0	0	0	0	40	48	347	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

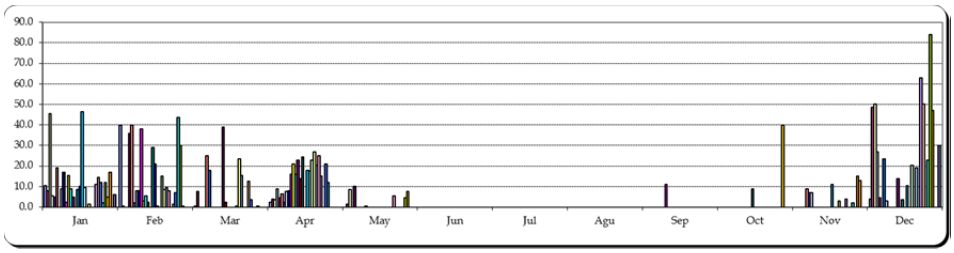


Figure B.16 Rainfall Fluctuation (2006)

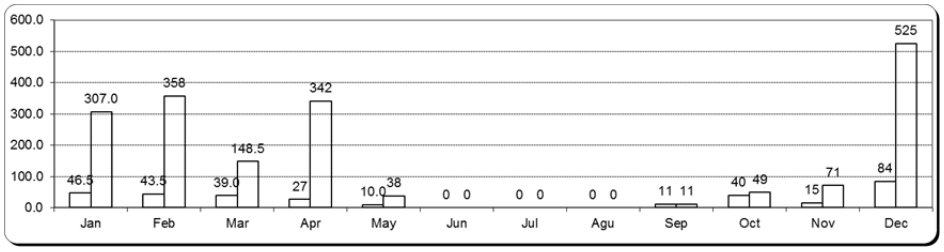


Figure B.17 Maximum Rainfall and Total Rainfall per Month (2006)

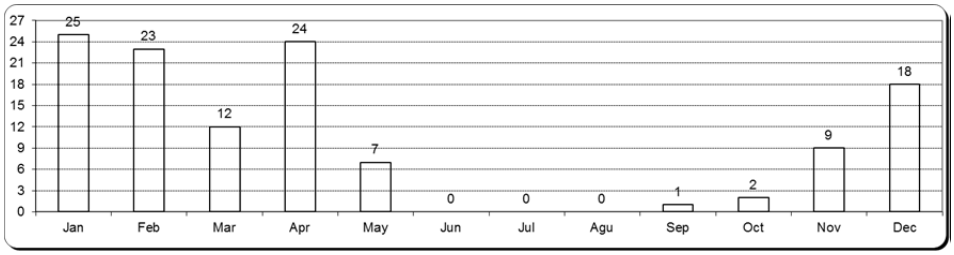


Figure B.18 Total Rainy Days (2006)

Table B.6 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2006)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	29.2	20.4	24.8	29.2	20.2	24.7	26.6	20.7	23.7	28.2	21.4	24.8	30.3	19.4	24.9	28	19.2	23.6	28.6	17.4	23.0	28.6	17.4	23.0	30	18.8	24.4	31.5	17	24.3	29.2	20.2	24.7	29.4	20.2	24.8
2	28	20.5	24.3	29	20	24.5	28	20.2	24.1	29.2	20.6	24.9	29.6	19.6	24.6	27	20	23.5	28.9	16.8	22.9	29.4	16.2	22.8	30.8	17	23.9	32.2	17.4	24.8	28.6	19.8	24.2	29.6	20	24.8
3	25.2	20.8	23.0	29.8	19.2	24.5	29.6	20.2	24.9	29.2	22	25.6	29.8	19	24.4	28.8	18.2	23.5	29.4	17.8	23.6	30	16	23.0	30.4	17	23.7	32	17.2	24.6	30	19.8	24.9	28.4	20.4	24.4
4	26.6	20.6	23.6	29.4	21.2	25.3	29.9	20.4	25.2	29.2	21.8	25.5	29.9	19.5	24.7	29.8	18.8	24.3	29.4	17.2	23.3	29.1	16.5	22.8	30.6	17.1	23.9	33.2	19	26.1	32.1	19.8	26.0	27.8	21.4	24.6
5	29.6	20	24.8	28.8	21.4	25.1	30.4	20	25.2	29.2	20	24.6	30.8	19.4	25.1	28.6	19	23.8	28.8	17	22.9	29.4	16.2	22.8	30.5	17	23.8	33.8	18	25.9	29.6	20	24.8	28	20	24.0
6	28.8	20	24.4	28.5	20.6	24.6	28	20	24.0	30.6	20.6	25.6	29.8	20.4	25.1	29.5	18.6	24.1	29.2	17.4	23.3	28.4	17.6	23.0	29.2	17.2	23.2	33.4	18.2	25.8	31.6	16.6	24.1	28.2	19.8	24.0
7	29.4	20.5	25.0	29.8	20	24.9	29.8	20.5	25.2	30	20.4	25.2	28.8	18.6	23.7	24.8	19.4	22.1	29.2	18.6	23.9	28.8	16.2	22.5	28.8	18	23.4	32.6	19.2	25.9	30.8	19.4	25.1	27.4	20	23.7
8	26.6	20.2	23.4	29	20	24.5	30.6	20.2	25.4	29.2	20	24.6	28.6	19	23.8	28.7	19.4	24.1	28.9	18.4	23.7	29	16.2	22.6	32	18	25.0	31	17.8	24.4	29.6	20.2	24.9	27	20	23.5
9	28.2	20.2	24.2	24.2	20.2	22.2	31.4	19	25.2	29.4	20	24.7	27	18	22.5	29.8	16.4	23.1	29	19	24.0	28	16.8	22.4	32.8	18.2	25.5	31.2	17.8	24.5	29	20.6	24.8	28.2	19.2	23.7
10	28.2	20.4	24.3	28.4	20.6	24.5	28.2	20.2	24.2	29.1	21	25.1	27.6	18.8	23.2	29	17.4	23.2	28.3	20.6	24.5	26.8	17	21.9	31.4	19	25.2	31.6	18.5	25.1	32.4	19.4	25.9	28.4	18.8	23.6
11	27.2	20	23.6	29	19.1	24.1	29.3	19.4	24.4	28.3	19.8	24.1	30.2	20.6	25.4	27.8	17.3	22.6	29.4	19.3	24.4	28.6	17.4	23.0	31.6	18.8	25.2	33.3	17	25.2	31	19.4	25.2	31.2	19.2	25.2
12	27	20.4	23.7	30.2	18.4	24.3	29.8	19.4	24.6	28.4	19	23.7	29.4	19.5	24.5	28.5	17.2	22.9	29.8	17.3	23.6	29	16.8	22.9	30.2	18	24.1	32.6	17	24.8	31.4	20.2	25.8	29.2	19.5	24.4
13	27.4	19.6	23.5	29.6	19	24.3	29.6	20.9	25.3	27.3	18.8	23.1	29.8	18.8	24.3	29.4	17.4	23.4	28	18.8	23.4	30.4	16	23.2	30.7	18.2	24.5	32	18	25.0	32.3	19.2	25.8	27.4	20	23.7
14	29.2	19	24.1	29	20	24.5	30.8	20.6	25.7	25.8	19.2	22.5	29.8	19	24.4	28.9	18.6	23.8	28	18.8	23.4	29	16.6	22.8	29.8	18.4	24.1	31.9	18	25.0	32.6	20.6	26.6	29.6	19.2	24.4
15	27.9	19.6	23.8	29.2	20.6	24.9	27.8	20.4	24.1	28.4	19.6	24.0	29.2	17.8	23.5	30	18.6	24.3	28.8	18.6	23.7	29.4	16.8	23.1	31.2	19.4	25.3	30	18.8	24.4	32.2	20.4	26.3	29.4	20.2	24.8
16	28.4	20	24.2	28.5	21.4	25.0	28.7	21.6	25.2	30	18.3	24.2	29.6	18.2	23.9	28.8	18.4	23.6	29.8	18.8	24.3	28.3	18.1	23.2	30.2	19.2	24.7	30.8	18.6	24.7	30.8	19.6	25.2	28.4	19.8	24.1
17	25.2	20.4	22.8	31	19.6	25.3	29.6	21.2	25.4	29	18.6	23.8	29	19.2	24.1	30.1	17.9	24.0	28	19	23.5	30.7	18	24.4	30	19.8	24.9	29.3	19.3	24.3	32.4	19.5	26.0	29.4	20	24.7
18	28	20.3	24.2	29.8	19.8	24.8	29.8	20	24.9	28.4	20.4	24.4	30.2	18.5	24.4	30.2	17	23.6	28.2	19	23.6	30.4	17.8	24.1	31.8	18	24.9	30.8	19.2	25.0	32	19.2	25.6	26.4	20.2	23.3
19	28.2	21	24.6	28.6	20	24.3	28.4	22	25.2	27.9	20	24.0	29.6	18.6	24.1	30.4	17	23.7	28.2	19.8	24.0	30.6	18	24.3	31.4	17	24.2	30	20.2	25.1	33.8	21.2	27.5	29.4	21.6	25.5
20	29.4	20.4	24.9	28.2	19.8	24.0	28.4	21.6	25.0	29.2	20.4	24.8	27.2	20.8	24.0	30.1	17	23.6	29.2	20.2	24.7	29.8	18.8	24.3	30.5	18.4	24.5	31.6	19.4	25.5	34.2	21	27.6	28.2	20	24.1
21	28.5	21.6	25.1	29	19.2	24.1	26.6	20	23.3	26.3	19.9	23.1	27.8	20	23.9	30.4	18.2	24.3	29	19	24.0	29.6	19	24.3	30	17.8	23.9	33	19.4	26.2	33.6	21.2	27.4	28.8	20.4	24.6
22	27.8	20.8	24.3	28.8	20.8	24.8	28.2	21	24.6	26.8	19.4	23.1	25.4	20	22.7	29.2	18.8	24.0	28.4	18.4	23.4	29.5	18.7	24.1	30.6	17.8	24.2	31.6	19.8	25.7	33.2	21.8	27.5	28.6	20.1	24.4
23	27	20.4	23.7	30	20.2	25.1	27.4	21	24.2	27.8	19	23.4	28.8	19	23.9	29.6	19	24.3	28.8	18.4	23.6	28.9	18.2	23.6	31.6	19	25.3	32.8	21.8	27.3	28.3	21.2	24.8	27.4	19.8	23.6
24	26.6	20	23.3	29.4	20.2	24.8	27	21	24.0	27.2	19	23.1	27.8	19	23.4	29	18.6	23.8	29.4	18	23.7	29	18.6	23.8	31	16	23.5	33.4	20	26.7	28.8	21.2	25.0	29.2	20.4	24.8
25	26.4	20	23.2	28.6	20.7	24.7	25.8	21.1	23.5	29.5	18.4	24.0	29.8	19.4	24.6	30.2	17.7	24.0	28	18	23.0	31.2	18.6	24.9	31.8	16.2	24.0	31.2	17.6	24.4	30.2	20	25.1	28.8	21.4	25.1
26	26	20.2	23.1	28.9	20.4	24.7	30.2	19.6	24.9	29.6	18.9	24.3	30	19.6	24.8	29.5	16.6	23.1	29	17.4	23.2	31.2	17.4	24.3	30.6	17.1	23.9	31.4	19	25.2	30.2	19.8	25.0	27.6	20.6	24.1
27	26.1	20	23.1	27	20	23.5	29	19.6	24.3	29.8	20.2	25.0	28.7	19.6	24.2	28	16	22.0	30.2	18	24.1	29.4	17.6	23.5	31.4	18	24.7	31.6	19.6	25.6	27	21.2	24.1	27.3	20.2	23.8
28	26	20	23.0	25.6	20	22.8	28.8	21.2	25.0	30.2	19	24.6	28	20.4	24.2	29.4	16	22.7	28	18.8	23.4	29.2	17.2	23.2	30.2	19.4	24.8	28.4	20	24.2	29.2	19.6	24.4	29.5	20.2	24.9
29	26	21.2	23.6				27.6	21	24.3	30.2	22	26.1	27.2	19.4	23.3	28.8	17.4	23.1	27.7	18.8	23.3	30.1	17	23.6	32.6	18.1	25.4	30.2	20	25.1	28.8	19.6	24.2	24.2	20.6	22.4
30	28	21.2	24.6				29	20	24.5	28.2	22	25.1	29.2	19	24.1	29	17.3	23.2	29	18.7	23.9	29.8	17.8	23.8	33	18	25.5	30.8	20.4	25.6	31.6	20	25.8	26	20.5	23.3
31	27.8	20.8	24.3				28.2	21.7	25.0				28.8	19.2	24.0				30.4	18.4	24.4	29	19	24.0				30	20.2	25.1				24.5	19.8	22.2

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	78	76	88	78	82	83	74	75	77	68	79	84
2	83	76	84	79	81	87	76	72	66	63	87	81
3	89	76	89	79	76	80	76	74	72	68	78	84
4	78	76	81	84	81	82	74	73	73	73	78	93
5	83	80	80	81	79	81	76	74	72	68	79	87
6	83	83	81	80	82	79	78	78	78	66	77	88
7	83	82	77	78	84	90	77	75	77	66	82	93
8	89	81	78	79	81	79	80	73	69	68	84	90
9	88	92	78	82	90	75	80	76	66	71	81	89
10	86	90	87	85	87	72	79	75	74	68	73	85
11	89	86	81	85	84	78	81	77	71	63	77	82
12	89	77	81	87	84	78	73	73	73	63	74	81
13	90	84	82	88	76	80	76	73	75	64	74	87
14	87	83	74	90	75	80	74	76	79	71	72	86
15	83	81	77	82	75	74	76	76	76	78	65	87
16	80	85	83	80	78	75	79	78	78	78	74	88
17	87	84	80	81	76	76	80	80	79	73	78	88
18	81	86	75	84	76	72	83	78	72	73	74	89
19	79	87	81	90	81	76	86	81	72	76	73	86
20	73	89	83	86	84	73	85	78	71	71	70	89
21	79	84	83	88	93	79	79	80	78	74	70	89
22	88	88	86	90	86	79	77	79	77	75	74	90
23	88	84	83	88	80	77	79	75	75	70	87	91
24	88	82	88	92	82	75	78	79	65	70	82	90
25	87	85	92	82	78	73	78	80	69	75	80	92
26	86	88	90	83	76	74	77	72	77	82	81	93
27	91	84	84	78	83	74	77	73	74	79	90	91
28	90	89	85	80	87	71	78	75	77	85	84	86
29	89		87	79	90	70	84	77	71	82	87	87
30	86		80	87	86	74	84	75	67	76	83	87
31	81		82		83		77	77		79		88

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	5.2	7.5		3.9	5.2	4.7	7.7	8	5.5	8	3	4.2
2	4.3	6.6	3.9	4.4	7.6	2	7.4	7.9	7.6	8	5.5	3.9
3		6.6	6.6	6.5	8	4.3	6.1	8	7.8	7.6	5.3	2.7
4	1.5	7.3	7.3	5.4	5.8	6.5	5.7	8	7.9	6	6.2	2.6
5	7.9	4.6	5.2	5	7.9	4.9	6.2	7.9	7.9	6.8	4.2	3.5
6	3.7	4.9	1.6	7	4.7	6.4	7.3	7.2	7.5	7.8	5.9	3.3
7	5	7.5	7.4	6.3	5.5		8	8	4.7	8	4.3	2.7
8	1.8	8	8	4.3	5.2	6.5	6	7.8	6.8	6.7	4.2	2.6
9	4.3		4.8	5.6	2.9	8	6.2	6.8	7.9	5.3	2.6	4.4
10	2.8	3.8	4.9	4.3	4	7.3	4.1	4.3	6.8	5.5	7.1	4.2
11	1.5	5.7	7.6	3.7	5.8	5.5	7.9	5.8	6.5	8	5.5	7.9
12	3.4	8	5.3	4.7	5.5	5.8	7.7	8	5	5.9	5.4	4.1
13	3.7	6.6	6.4	3.3	7.9	5.2	6.1	8	5.7	5.7	7.9	1.6
14	5.9	5.9	7	2.4	7.5	5.2	6	7.9	5	7.2	7.2	4.2
15	4.8	3.7	3.1	6.1	7.9	6.4	6.7	8	6.1	4.1	7.4	6.8
16	6	3.2	6.7	7.1	6.5	5.9	7.5	4.3	6.1	4.6	5	4.2
17	1.3	5.4	7	5	5.3	7.6	4.2	7.6	6.4	4.2	5.7	5.1
18	5.2	7.4	4	2.6	6.2	6.9	4.3	7.8	6.8	5.9	7.4	
19	2.5	4	4.2	3.8	5	6.9	3.6	6.5	7.4	5.2	8	4.8
20	8	4	2.2	4.7	0.9	7.1	5	6.3	5.5	7.2	8	3.5
21	5.4	5.5	1	0.2	1.2	6.2	5	6.6	4.8	6.6	7	3.4
22	5.9	4.9	4.5	3.6		5.5	5.4	6.8	6	5.8	7.5	4.6
23	2.3	5.5	1.7	3	7.4	6.2	6.1	5.8	7.9	7.6	2.3	2.7
24	5.1	6.5	0.4	2.4	4.3	5.9	7.1	5.4	7.9	8	3.1	3.5
25	1.9	5.4		8	7.7	7.5	5.4	6.9	8	4.9	2.2	3.9
26	3.7	6	6.7	4.5	6.6	8	6.8	8	7.2	5.9	3.8	1.7
27	2.2	5.9	7.1	7.9	6	6.8	7.6	7.8	7.7	5.7	1.2	1.2
28	0.2	0.1	5.8	8	3	8	4.4	8	4.9	3	4.7	6.4
29	1.1		2	7.8	1.4	7.5	4.6	7.9	8	5.2	2.2	
30	4.8		4.2	2.1	6.5	6.3	6.2	7.6	6.4	5.4	6.5	
31	4.5		4.3		5.9		7.7	6.3		4.1		

DAILY RAINFALL DATA (mm)

Station Name	: **Cipanas-Pangalengan**		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2007

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	2.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	
2	0.0	6.5	18.5	0.0	9.5	0.0	0.0	0.0	0.0	0.0	4.0	47.0	
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	
4	0.0	32.0	3.0	0.0	0.0	25.5	0.0	0.0	0.0	0.0	2.0	11.0	
5	0.0	10.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	14.5	23.0	
6	0.0	0.0	23.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	63.0	23.0	
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	
8	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	
9	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	14.0	79.0	10.0	
10	0.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	
11	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	
12	0.0	8.0	36.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	
13	0.0	9.0	3.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	67.5	
14	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	11.5	0.0	
15	0.0	13.0	7.5	0.0	0.0	0.0	0.0	4.0	0.0	0.0	7.5	4.0	
16	0.0	53.0	31.5	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	10.0	
17	0.0	22.0	25.0	0.0	16.5	0.0	0.0	0.0	0.0	0.0	0.0	9.0	
18	0.0	25.0	25.0	0.0	12.0	48.5	0.0	0.0	0.0	0.0	0.0	0.0	
19	0.0	14.5	35.0	0.0	0.0	0.0	0.0	6.0	0.0	17.5	0.0	5.0	
20	0.0	44.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0	0.0	3.0	
21	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	9.0	
22	12.0	24.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	9.0	
23	10.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.0	0.0	9.0	
24	10.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	49.0	
25	3.0	53.5	5.5	0.0	0.0	0.0	0.0	0.0	1.1	0.0	8.5	24.0	
26	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5	12.0	
27	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
28	0.0	0.0	7.0	0.0	0.0	4.0	0.0	0.0	0.0	2.0	30.0	6.0	
29	48.0	-	25.0	0.0	0.0	0.0	0.0	0.0	4.0	46.0	0.0	9.0	
30	0.0	-	0.0	0.0	17.5	0.0	0.0	0.0	0.0	28.5	7.5	0.0	
31	6.0	-	31.0		0.0		0.0	0.0		14.5		0.0	
Maximum Rainfall	48.0	53.5	36.5	0	17.5	49	2	6	4	50	79	68	79
Total Rainfall	97.0	335	307.5	0	89	93	2	10	5	231	262	372	1802
Total Days of Rainfall	8	17	18	0	8	5	1	2	2	10	13	24	108
Average Rainfall	3.1	11.9	9.9	0	3	3	0	0	0	7	9	12	
First-Half Rainfall (1-15)	2	86	111.5	0	40	29	2	4	0	14	194	218	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	95.0	249	196	0	49	65	0	6	5	217	69	154	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

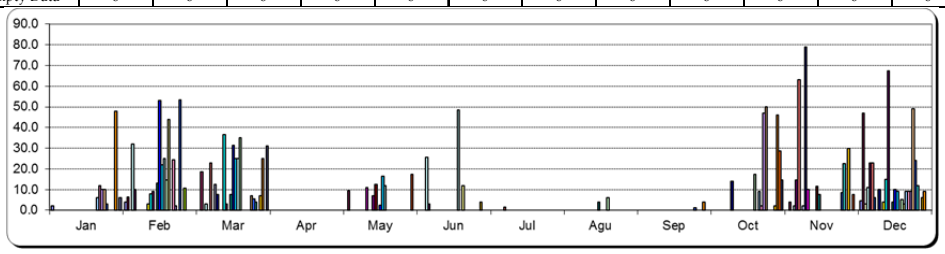


Figure B.19 Rainfall Fluctuation (2007)

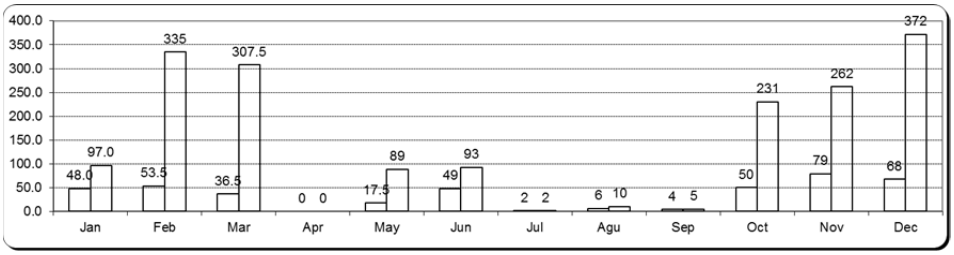


Figure B.20 Maximum Rainfall and Total Rainfall per Month (2007)

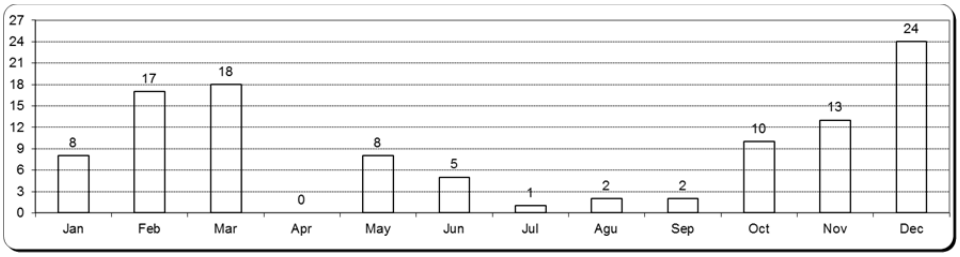


Figure B.21 Total Rainy Days (2007)

Table B.7 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2007)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1			0.0	26.8	19.8	23.3	27.8	19	23.4	28.8	20.4	24.6	25.8	19.2	22.5	28	21.4	24.7	29.6	19.6	24.6	29.6	16.8	23.2	31.6	17	24.3	33	16	24.5	27	18.7	22.9	28.8	20	24.4
2	29.4		14.7	27.6	20	23.8	27	20	23.5	29	20.5	24.8	27.2	19	23.1	28	21	24.5	29.4	19.1	24.3	29	16.4	22.7	32.6	17	24.8	31.8	16.8	24.3	26.4	19.6	23.0	28	19.8	23.9
3	27.6	21	24.3	26.2	20.3	23.3	25.6	20	22.8	27.2	20	23.6	28.2	18.6	23.4	28.8	18.2	23.5	30	19	24.5	30	16.2	23.1	30.6	18	24.3	31.2	18	24.6	26	20.4	23.2	29.1	19.5	24.3
4	28.3	19.6	24.0	23.2	20.4	21.8	27	20.4	23.7	29.2	19.6	24.4	29.2	18.6	23.9	29.1	18	23.6	28.9	18.2	23.6	29	15.8	22.4	31.4	20	25.7	31.6	18.8	25.2	26	20	23.0	28.2	19	23.6
5	30	19	24.5	26.8	19.8	23.3	29.5	21	25.3	28.8	19.8	24.3	28.4	18.6	23.5	26.6	19	22.8	28.4	17	22.7	29.4	18.2	23.8	30.6	17	23.8	30.9	19	25.0	26.6	20.5	23.6	28.7	20.2	24.5
6	29.8	20.2	25.0	28.6	19.8	24.2	26.2	20.2	23.2	27.6	19.8	23.7	29.6	20	24.8	28.6	19.2	23.9	29.4	17	23.2	28.8	18	23.4	32.8	17	24.9	31.6	19.2	25.4	25.2	19.4	22.3	27.2	20.8	24.0
7	30.4	20.2	25.3	29.6	20.4	25.0	24	20.4	22.2	26.4	19.6	23.0	31	20	25.5	28.8	18.9	23.9	30	19.4	24.7	29.2	17.8	23.5	29.4	18	23.7	31	19.2	25.1	27.4	18.4	22.9	28	20	24.0
8	30	17.8	23.9	27.6	19.8	23.7	25.4	20.6	23.0	28.8	19.2	24.0	30.2	19.4	24.8	29.2	19.4	24.3	29	19	24.0	30.8	17.4	24.1	30.2	19.4	24.8	30.2	21.3	25.8	27.8	18.2	23.0	28.3	17.4	22.9
9	30.7	17.4	24.1	29	21.2	25.1	27.4	21.2	24.3	29	19.6	24.3	30	20.6	25.3	30	20.4	25.2	28.3	17.4	22.9	30	17.8	23.9	29.7	19	24.4	29	21.2	25.1	27.8	20.3	24.1	28.4	19.7	24.1
10	30.8	20.4	25.6	29.8	20.8	25.3	27	20.2	23.6	27.4	21.4	24.4	30	19.6	24.8	30.2	19	24.6	29	15.8	22.4	28.6	19.2	23.9	29.8	17.8	23.8	32	18	25.0	26.6	20.2	23.4	27.8	19.2	23.5
11			0.0	28.6	21	24.8	28.2	20.2	24.2	24.8	19.6	22.2	29.4	19.6	24.5	29.2	17.8	23.5	28.7	16.4	22.6	29.6	17.6	23.6	31	19	25.0	30	18	24.0	29.6	18.6	24.1	27	20.2	23.6
12	29.8	19.8	24.8	28.4	21.2	24.8	29.2	18.8	24.0	28	19	23.5	28.8	20.2	24.5	29.2	16.9	23.1	27.4	16.4	21.9	29.2	18.1	23.7	30.4	19	24.7	30.6	20	25.3	30.1	18.6	24.4	26.5	19.8	23.2
13	31	20	25.5	26.9	20.6	23.8	28.2	20.4	24.3	28.4	19.2	23.8	27.6	20	23.8	29.6	17.1	23.4	27.2	16	21.6	28.2	18	23.1	30	18.8	24.4	30	20	25.0	29.2	19.9	24.6	29.1	21	25.1
14	30.4	20.2	25.3	28.6	19	23.8	29.8	20	24.9	27.8	19.2	23.5	26	19	22.5	28.8	17	22.9	28.6	18	23.3	30.4	18	24.2	31	19.6	25.3	30.2	19.3	24.8	27.4	20.4	23.9	27.4	19.6	23.5
15	30	19.6	24.8	27.2	19	23.1	29.2	20.7	25.0	29	19	24.0	27.8	19.8	23.8	29.4	19.2	24.3	28.3	18.4	23.4	30.2	18.4	24.3	30.5	18.8	24.7	33.2	20	26.6	29	19.8	24.4	27.5	19.8	23.7
16	30.6	19.5	25.1	27.4	19.9	23.7	28.8	20.6	24.7	27.6	18	22.8	26.5	20	23.3	30.2	19.4	24.8	29.3	18	23.7	30.2	17	23.6	31.1	19.6	25.4	31.6	20.6	26.1	28.2	19.9	24.1	26	21	23.5
17	31.6	20.2	25.9	27.4	18.8	23.1	28.8	20.6	24.7	28.6	20.6	24.6	30.4	21	25.7	29.3	19.3	24.3	29.6	18.8	24.2	29.2	16.8	23.0	30.4	19.8	25.1	31.5	21.8	26.7	29.2	20.1	24.7	27	20.2	23.6
18	30.8	21.2	26.0	29	18.4	23.7	28.3	18.8	23.6	29.6	20	24.8	28.2	20.4	24.3	29.4	19.8	24.6	29	19.8	24.4	29.7	16.8	23.3	31.4	20.5	26.0	32.6	17.9	25.3	31	19.4	25.2	27.5	19	23.3
19	30.6	21.6	26.1	27	19.2	23.1	30	18.8	24.4	28.8	20	24.4	28.2	19.3	23.8	26	19.8	22.9	30.4	19.2	24.8	30.8	17.2	24.0	31.5	18.4	25.0	31	18.6	24.8	29.8	18.8	24.3	27	19	23.0
20	30.2	21.3	25.8	25.2	19.5	22.4	29	19.2	24.1	29.2	19.6	24.4	29.6	19.4	24.5	25	21	23.0	29	18.8	23.9	30.4	18.2	24.3	32.6	18.4	25.5	30	20.6	25.3	29.8	18.8	24.3	26.8	19.4	23.1
21	29.4	21.2	25.3	27.8	19.4	23.6	29.2	20.5	24.9	28.5	19	23.8	30.4	19.5	25.0	27.6	19.4	23.5	30.6	20.2	25.4	27.8	19.6	23.7	32	17.4	24.7	28.8	20.6	24.7	30	22	26.0	28	20.2	24.1
22	27.4	20.6	24.0	25.6	19.2	22.4	27.6	20.6	24.1	29.2	21	25.1	31.5	19	25.3	29.4	19	24.2	29.6	19.6	24.6	30	19.6	24.8	30.8	17.2	24.0	27.6	19.8	23.7	30	21.5	25.8	27	19.4	23.2
23	28.4	21.6	25.0	26	19.8	22.9	28.2	20.8	24.5	29.8	19.3	24.6	31.2	21	26.1	29.8	19.1	24.5	29.2	18.6	23.9	29.2	20.4	24.8	30	20.4	25.2	27.8	19.8	23.8	29.6	20.1	24.9	26.2	20.5	23.4
24	27.2	20.6	23.9	25.2	19.4	22.3	30.4	20.6	25.5	28.4	19	23.7	30.6	20	25.3	29.2	19.2	24.2	30	17	23.5	30	19.6	24.8	29.4	20.8	25.1	29.4	19.4	24.4	30.8	19	24.9	28	20.3	24.2
25	29.6	20.3	25.0	28.8	20	24.4	28.4	20.6	24.5	26.8	20.7	23.8	30	20.2	25.1	29.3	19	24.2	29.2	16	22.6	30.2	19.2	24.7	30.4	19.6	25.0	26.6	19.6	23.1	31.4	19.8	25.6	28	20	24.0
26	27.8	20.8	24.3	29	20	24.5	27.4	21.6	24.5	26.2	20.6	23.4	30.4	18.8	24.6	29.2	18.7	24.0	29.3	15.3	22.3	29.4	17	23.2	32.1	19.4	25.8	31	20	25.5	28.4	20.8	24.6	25	20.6	22.8
27	27	20.6	23.8	27.6	19.6	23.6	28.4	21.4	24.9	27	20.4	23.7	29.8	18.6	24.2	28.4	18.7	23.6	28.6	14.6	21.6	29	18	23.5	31.6	20	25.8	29.8	19.8	24.8	29	20.8	24.9	26.8	20.1	23.5
28	28.6	20.4	24.5	28.4	21	24.7	28.6	21.2	24.9	27.8	19.6	23.7	31	19.2	25.1	22.2	19.6	20.9	28.4	16.8	22.6	30.4	16.8	23.6	32.8	17.3	25.1	28.6	19.6	24.1	29.9	20.7	25.3	24.8	20	22.4
29	27.8	20.4	24.1				28.4	20.6	24.5	28.8	19.6	24.2	28.8	18.6	23.7	27	18.8	22.9	29	17.2	23.1	31.8	16.5	24.2	32.7	17.8	25.3	29	20.2	24.6	28.8	20.2	24.5	27.8	20	23.9
30	27	20.6	23.8				29.4	20.4	24.9	26.4	20.2	23.3	28.8	19.6	24.2	29	18.5	23.8	29.3	18.2	23.8	31	18.4	24.7	33.6	18.2	25.9	27	20.2	23.6	28.2	20	24.1	26.4	20.4	23.4
31	28	20	24.0				28	20.7	24.4				27.6	19.2	23.4				31.5	17.9	24.7	31.6	17.4	24.5				26.6	20	23.3				25	20.9	23.0

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1		89	83	88	89	89	85	71	69			
2		87	88	90	92	85	84	70	69			
3	74	87	84	94	86	85	78	72	76			
4	68	94	81	85	82	85	79	77	73			
5	72	90	83	84	86	91	79	73	72			
6	63	86	84	91	82	86	88	76	72			
7	61	82	92	92	80	82	83	75	80			
8	71	85	83	86	79	82	81	74	72			
9	75	85	83	86	79	83	79	76	69			
10	67	78	89	91	81	74	76	75	75			
11		84	84	93	79	66	79	75	70			
12	71	87	81	90	81	77	80	76	71			
13	66	93	88	89	87	78	80	80	75			
14	76	82	88	90	89	79	81	75	71			
15	71	89	86	88	84	82	83	76	68			
16	76	93	90	86	87	79	82	72	74			
17	72	90	89	94	85	82	81	72	77			
18	74	86	86	85	84	79	82	75	74			
19	79	91	85	89	88	93	78	76	71			
20	82	94	86	83	84	94	83	73	67			
21	81	88	81	87	81	86	80	81	63			
22	88	91	81	87	80	81	77	75	74			
23	83	90	71	88	78	80	79	77	81			
24	84	93	70	89	80	81	72	78	84			
25	87	86	76	92	79	83	69	75	74			
26	88	81	78	90	72	80	64	77	60			
27	86	86	83	76	77	82	69	75	60			
28	86	82	85	87	78	95	75	69	62			
29	86		82	86	84	87	65	72	68			
30	85		85	86	81	86	77	66	47			
31	87		88		86		68	67				

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.5	2.7	4.8	4	0.2	3.1	5.6	7.3	0.4	6.5	3.6	4.5
2	4	5.7	1	4.4	2.6	3.2	8	7.7	0.3	7.1	1.9	4
3	5.4	2.1	3.2	2.1	5.9	5.2	7.5	6.4	0.5	5.8	1.4	7.1
4	5.8	2.9	3.3	5.3	7.3	6.2	7.9	5	0.3	8	2.3	5.3
5	5.7		6.2	5.7	4.7	0.4	5.1	5.8	0.3	5.8	1.4	5.4
6	5.2	4.4	0.7	3	5.1	4.8	2.5	4.9	0.2	6.5	0.5	5.2
7	8	7.6	0.3	3.2	7.1	6	5.1	6	0.3	5.4	0.6	5.1
8	8	0.8	2.6	5.5	7.1	4.5	7.1	8	0.5	4.3	3	3
9	8	6.8	3.9	5.1	6.9	6.7	7.1	7.1	0.4	2.6	3.5	3.6
10	8	6.3	2.2	2.1	4.9	7.5	8	5.2	0.6	7.8	2.5	3.4
11	7.1	2.8	7.3	1	5.1	7.5	7	6	0.3	5.5	6.3	2.7
12	7.4	3	6.7	4.2	3.4	6.4	6.4	5	0.6	4.7	5.3	1
13	7.4	2.1	4.8	3.6	3.4	8	4.8	3.3	0.5	4.1	4.2	3.6
14	3.6	6.9	7.3	0.6	1.2	4.8	4.8	7.2	0.4	6.4	1.4	1.6
15	6.4	1.7	5	4.7	4.1	7.2	4.4	5.5	0.4	8	3.5	3.9
16	7.5	2.4	3.8	3.2	0.6	6.9	5.4	7.8	0.4	6.3	3.8	0.4
17	7.9	3	5.5	2.9	7.2	7.8	7	4.9	0.3	6.1	6.2	1.3
18	6.5	3.9	5.7	6.8	4.4	5.5	5.6	5.7	0.5	8	7.9	0.7
19	5	4.1	6.8	3.5	5.3	0.4	7.5	5.8	0.4	6.1	8	3
20	4.4	0.2	6.7	6.7	5.4	0.2	6.9	5.8	0.4	4.5	7	2.9
21	3.5	1.9	2.5	3.8	7.1	2.9	7.5	2	0.5	3.7	6.8	2.2
22	2.5		0.4	3.8	6.7	8	8	2	0.4	1.4	7.7	2.5
23	3.1	2.3	1.7	4.4	6.5	7.3	6.4	5.2	0.6	2.4	7.8	0.3
24	0.3	0.6	7.6	6.7	5.7	8	8	6.3	0.3	3.9	8	4.8
25	4.2	3.5	4	2.8	5.8	7.1	5.7	8	0.2	1.4	7.8	5.5
26	2.6	3.5	3		5.7	5.2	8	7.7	0.6	7.1	4.2	0
27	1.8	2.3	0.6		6	3.7	7.9	5.6	0.6	5.4	5	4.9
28	4	4.6	4.6	6.2	6.2		6.1	7.2	0.6	3.3	5.3	0.1
29	4.6		4.3	5.5	3.4	4.5	5.5	7.5	0.5	2.9	3.8	4.5
30	3.8		4.9		3.3	3.3	5	8	0.5	1.1	4.9	0.9
31	6.2		2.8		2.3		8	7.3		0.4		0

DAILY RAINFALL DATA (mm)

Station Name	: **Cipanas-Pangalengan**		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2008

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	6.5	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	23.5	31.0	23.5	
2	11.0	7.0	5.0	19.0	14.5	0.0	0.0	0.0	0.0	0.0	24.0	0.0	
3	20.5	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	43.0	
4	17.0	0.0	6.5	6.5	0.0	0.0	0.0	0.0	0.0	7.5	12.0	46.5	
5	8.0	0.0	26.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	0.0	
6	4.5	0.0	10.5	17.0	0.0	0.0	0.0	0.0	0.0	0.0	21.0	0.0	
7	4.0	0.0	5.5	33.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8	0.0	8.5	35.5	0.0	0.0	0.0	0.0	0.0	0.0	21.5	0.0	0.0	
9	0.0	0.0	34.5	7.0	0.0	0.0	0.0	0.0	22.0	0.0	29.0	0.0	
10	0.0	20.0	20.5	0.0	0.0	14.5	0.0	0.0	0.0	22.0	44.0	11.0	
11	0.0	8.0	33.0	5.5	0.0	0.0	0.0	0.0	0.0	7.0	14.0	0.0	
12	0.0	0.0	13.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	
13	0.0	0.0	15.0	0.0	0.0	0.0	0.0	4.0	0.0	8.5	4.5	0.0	
14	8.0	0.0	38.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	80.0	
15	0.0	0.0	82.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.0	95.0	
16	0.0	0.0	11.0	23.5	0.0	0.0	0.0	0.0	0.0	0.0	50.0	5.0	
17	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	0.0	
18	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	
19	13.5	0.0	59.0	59.0	0.0	0.0	0.0	0.0	0.0	10.0	17.0	0.0	
20	0.0	9.0	22.5	8.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	
21	0.0	0.0	14.0	30.0	10.0	0.0	0.0	0.0	0.0	0.0	37.0	6.5	
22	0.0	8.0	4.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	5.5	
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5	41.0	46.0	
24	0.0	15.0	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	
25	14.0	11.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	0.0	
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.5	18.0	0.0	
27	28.0	11.0	0.0	0.0	35.0	0.0	0.0	0.0	0.0	22.0	0.0	7.5	
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0	0.0	5.5	
29	21.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	15.5	0.0	0.0	
30	24.5	-	0.0	0.0	0.0	0.0	0.0	21.5	0.0	0.0	47.0	0.0	
31	9.0	-	0.0		0.0		0.0	0.0		0.0		0.0	
Maximum Rainfall	28.0	20.0	82.0	59	35.0	15	0	22	22	75	50	95	95
Total Rainfall	189.5	111	460.5	253	60	15	0	30	22	266	505	375	2284
Total Days of Rainfall	14	10	21	15	3	1	0	3	1	12	25	12	117
Average Rainfall	6.1	4.0	14.9	8	2	0	0	1	1	9	17	12	
First-Half Rainfall (1-15)	80	57	325.0	124	15	15	0	4	22	90	251	299	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	110.0	54	136	129	45	0	0	26	0	176	254	76	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

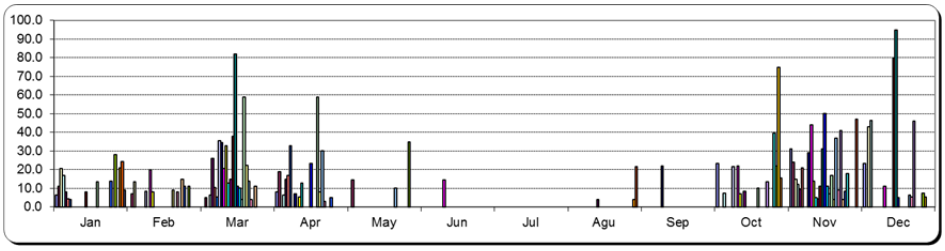


Figure B.22 Rainfall Fluctuation (2008)

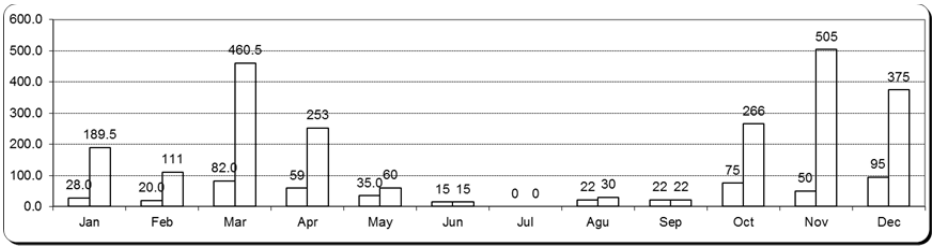


Figure B.23 Maximum Rainfall and Total Rainfall per Month (2008)

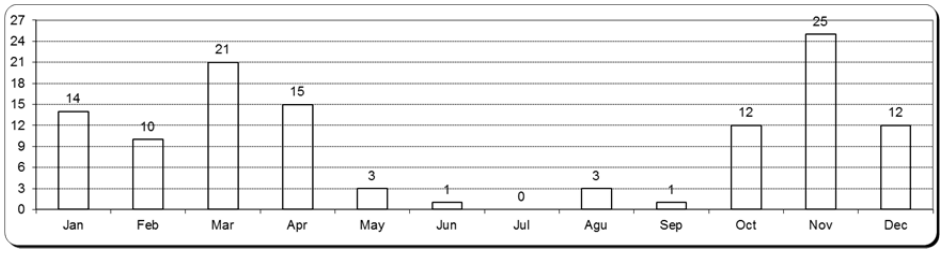


Figure B.24 Total Rainy Days (2008)

Table B.8 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2008)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	26.5	20.7	23.6	25.4	21.2	23.3	29	19	24.0	28	18	23.0	26.8	19.6	23.2	27.7	18.8	23.3	30	17.8	23.9	30.4	20	25.2	29.4	19.2	24.3	30.4	20.8	25.6	27.6	19.2	23.4	29.2	20	24.6
2	24.3	20.8	22.6	27.8	20.6	24.2	27.6	19.2	23.4	29	19.2	24.1	29	20	24.5	28.4	18.2	23.3	28.7	16.9	22.8	29.4	20	24.7	31.2	19.4	25.3	29.4	19	24.2	28	20.4	24.2	28.6	19	23.8
3	25.6	19.7	22.7	28.4	19.7	24.1	29	20	24.5	29	19.2	24.1	29.3	20.8	25.1	29.4	18	23.7	29	17.2	23.1	29.4	17.6	23.5	30.2	18.8	24.5	29.5	18.8	24.2	26.4	20.2	23.3	29.6	19.8	24.7
4	24.3	19.4	21.9	28.8	19	23.9	26	19.5	22.8	29.4	19.8	24.6	29	22	25.5	29	18	23.5	28.8	17.2	23.0	30.1	17.8	24.0	30.4	19	24.7	30.4	20	25.2	28.3	20.1	24.2	26.6	20.4	23.5
5	27.3	19.6	23.5	28.5	20.8	24.7	26.5	19.6	23.1	27.8	20.2	24.0	29	20.4	24.7	29.3	17.4	23.4	28.4	18.2	23.3	30.2	17.6	23.9	30.2	19.4	24.8	30.3	21	25.7	26.6	19.6	23.1	28.8	20.2	24.5
6	29.6	18	23.8	29.2	20.6	24.9	27	19.2	23.1	28.8	19.4	24.1	28.6	20.4	24.5	27.6	19.2	23.4	29	16.8	22.9	27.3	18	22.7	28.8	18	23.4	31.2	20.9	26.1	26.6	20	23.3	29.2	20	24.6
7	28.7	19	23.9	27	19.6	23.3	28.6	19.4	24.0	27.8	19.5	23.7	29	19.8	24.4	29.2	19.2	24.2	29.5	16.2	22.9	31.2	17.4	24.3	29.2	18.2	23.7	28.3	19.8	24.1	27.2	18.9	23.1	29	19.2	24.1
8	29.8	18.5	24.2	25.4	21	23.2	26.4	21.6	24.0	27.2	18.8	23.0	29	18.7	23.9	27.8	18.9	23.4	30.2	17.8	24.0	30	17.2	23.6	28.6	20.8	24.7	27.2	19.4	23.3	28	19.6	23.8	28.8	19.6	24.2
9	30.1	19	24.6	25.4	20	22.7	27.4	20	23.7	27.8	19.2	23.5	28.8	18.7	23.8	27.4	18.2	22.8	30.4	17.6	24.0	30.6	17.2	23.9	29.4	19.6	24.5	30.2	19	24.6	27.8	19.8	23.8	25.8	20.6	23.2
10	29.6	19	24.3	24	20.2	22.1	27.2	19.4	23.3	29.8	18.6	24.2	28.6	18	23.3	26.3	18	22.2	28.6	17.8	23.2	28	19.2	23.6	30.4	20	25.2	30.2	20	25.1	27.6	19.6	23.6	27.6	20.8	24.2
11	30.2	18.6	24.4	25.8	19.8	22.8	26.8	19	22.9	27.5	19.3	23.4	27.1	17.2	22.2	26.2	18.4	22.3	28	18.4	23.2	30.4	19.9	25.2	30	20.8	25.4	31.4	21.8	26.6	27.8	19	23.4	25	20.2	22.6
12	29.8	18.4	24.1	25.2	19.4	22.3	28.2	19	23.6	26.4	19.6	23.0	28.4	17	22.7	28.2	18.6	23.4	28.8	18	23.4	29	19.5	24.3	29.6	20.6	25.1	31	20.6	25.8	27.8	19	23.4	28.4	19.5	24.0
13	29.4	18	23.7	25.4	19.4	22.4	27.4	19	23.2	28.6	18.8	23.7	27.6	18	22.8	28	19	23.5	30.7	17.9	24.3	27.4	20	23.7	28.4	20.4	24.4	31.4	21.2	26.3	29	20	24.5	29.6	20	24.8
14	29.4	19	24.2	23.4	20	21.7	27	19.6	23.3	28	21	24.5	26.6	18.7	22.7	27.4	20.2	23.8	29.4	17.6	23.5	28.1	18.4	23.3	29	19.4	24.2	32	21.8	26.9	27.8	19.8	23.8	28.4	20.2	24.3
15	27.2	20	23.6	24.4	19	21.7	27.8	19.2	23.5	28.4	19.4	23.9	27.4	18	22.7	28.7	20.4	24.6	29	17.2	23.1	29.8	19	24.4	32.2	19	25.6	31.2	21.6	26.4	26.8	19.4	23.1	28	20.2	24.1
16	28.7	21	24.9	27	20.2	23.6	26.8	19	22.9	28.6	19.4	24.0	29.7	17.6	23.7	28.8	20.6	24.7	27.8	17.2	22.5	29.3	18.6	24.0	31	17.6	24.3	31	20.4	25.7	29.4	20	24.7	27.8	20.8	24.3
17	30	19.8	24.9	24.6	20.2	22.4	29.3	18.2	23.8	27.4	20.3	23.9	29	18	23.5	29.4	19.6	24.5	28.6	16.2	22.4	29.3	18.6	24.0	31.8	18.4	25.1	29.8	19.8	24.8	26.3	19.7	23.0	28.9	21	25.0
18	30.2	21.2	25.7	26.4	20	23.2	27.2	19.5	23.4	28	20	24.0	28.6	19.2	23.9	29.4	18.2	23.8	28.6	16.2	22.4	27	19	23.0	33.1	19.6	26.4	31.3	19.8	25.6	26.6	20.8	23.7	29.2	20.2	24.7
19	28	21.7	24.9	25.6	19.8	22.7	26.2	19.2	22.7	28	19.7	23.9	28.6	19.5	24.1	29.6	18.2	23.9	30.8	16.6	23.7	29	18	23.5	32	20.4	26.2	31	21	26.0	27.6	19.8	23.7	29.2	20.8	25.0
20	30	19.2	24.6	25.6	20	22.8	28.6	19.4	24.0	27	18.8	22.9	28.8	18.9	23.9	28.6	17	22.8	30.6	17	23.8	26.6	19	22.8	32	20.2	26.1	32	21.2	26.6	27.6	19.6	23.6	27.4	21.6	24.5
21	29.8	19.5	24.7	25.2	20.2	22.7	28.6	19.2	23.9	26.6	18.7	22.7	28.8	18.9	23.9	29	17.2	23.1	30.3	17.2	23.8	29.4	17.4	23.4	32.6	20	26.3	31.2	21.2	26.2	29.8	20	24.9	28	20.4	24.2
22	29.2	20.2	24.7	24	17.4	20.7	29	20.5	24.8	26.7	20.6	23.7	29.4	19.5	24.5	29.4	17.6	23.5	29.5	17.2	23.4	29.2	19	24.1	30.6	19	24.8	28.4	20.6	24.5	28.2	21.4	24.8	28.2	20.2	24.2
23	29.4	20.4	24.9	26.8	20.2	23.5	27.4	20	23.7	25	21.2	23.1	28.9	19.5	24.2	29.2	16.9	23.1	29.4	17.2	23.3	28.2	19	23.6	33.1	18.8	26.0	28.2	21.7	25.0	29.8	22	25.9	25.2	19.8	22.5
24	29.6	19.4	24.5	29.2	19	24.1	28.6	19.4	24.0	28.5	19.6	24.1	28.8	19.5	24.2	29.2	16.6	22.9	29.2	17	23.1	29.7	19.2	24.5	32.6	19.2	25.9	26.4	21	23.7	26.7	20.4	23.6	29	20	24.5
25	28.8	19	23.9	27.8	21	24.4	27.4	19.8	23.6	26	19.4	22.7	28.4	18	23.2	28.8	18.2	23.5	30.3	17	23.7	28.6	19.8	24.2	30.3	19.2	24.8	27.4	19.6	23.5	29	21	25.0	25.3	21	23.2
26	28.6	19.2	23.9	26	20.2	23.1	29	18.6	23.8	28.3	19.6	24.0	29.8	17.8	23.8	28.4	18.8	23.6	27.8	17.8	22.8	28	19.8	23.9	29.4	20.5	25.0	29.4	19.4	24.4	28.2	20.6	24.4	27.6	21.8	24.7
27	29	19.8	24.4	28	20.4	24.2	28.6	19.7	24.2	29.6	18.5	24.1	27.6	18.4	23.0	29.4	19	24.2	31	19.8	25.4	29.2	19	24.1	31.4	19	25.2	29.4	19.8	24.6	29.6	19.6	24.6	28.2	20	24.1
28	28.4	20.6	24.5	28.2	21	24.6	28.2	20.2	24.2	29.3	19.2	24.3	29.9	18	24.0	29.4	19	24.2	32.4	18.4	25.4	28.2	18.6	23.4	31.3	18.8	25.1	26.7	19.2	23.0	30	20.3	25.2	29.6	21.3	25.5
29	27.8	20.5	24.2	26.2	20.2	23.2	30.2	17	23.6	29.5	21.2	25.4	30	17.8	23.9	29	17.4	23.2	29	18.2	23.6	29.6	19.7	24.7	30.6	20.6	25.6	29	20	24.5	30.5	20.3	25.4	27.1	21.8	24.5
30	29.2	20	24.6				29.2	21.8	25.5	29.4	20.8	25.1	28	17.6	22.8	28.4	17.4	22.9	30.4	16.4	23.4	28	20	24.0	31	20.6	25.8	27.6	18.4	23.0	29.2	20.5	24.9	29.2	21.6	25.4
31	28.8	19.8	24.3				27.6	20	23.8				27.6	17.8	22.7				30.3	17	23.7	28.2	19.4	23.8				29	18.2	23.6				26.8	20	23.4

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	88	91	78	84	84	87	73	80	79	79	87	84
2	92	83	86	80	81	82	76	78	72	80	92	86
3	89	75	78	75	79	75	73	72	73	73	94	82
4	87	79	80	77	83	78	75	72	75	83	93	90
5	81	74	84	80	80	75	68	73	70	76	88	85
6	72	80	81	85	81	78	69	77	70	70	93	85
7	77	82	86	88	83	73	71	68	74	76	88	86
8	79	88	88	87	80	77	73	71	77	91	87	81
9	79	85	88	86	74	77	73	69	78	78	84	83
10	76	89	89	81	70	85	77	75	73	73	90	80
11	75	80	89	89	70	81	78	74	74	71	84	85
12	71	85	84	89	72	79	77	78	78	74	86	79
13	68	81	89	87	73	76	74	80	76	71	83	79
14	76	84	90	88	70	81	73	82	78	71	85	82
15	80	88	87	84	75	83	76	81	66	71	93	88
16	75	81	85	84	69	84	75	75	65	72	83	83
17	66	87	86	84	75	78	76	69	69	67	87	78
18	70	82	90	93	79	74	75	76	65	70	91	80
19	78	83	90	84	79	73	69	77	65	72	88	80
20	70	87	85	91	81	73	64	85	64	69	88	79
21	72	85	83	83	80	76	69	75	67	73	80	80
22	81	86	84	88	81	74	72	75	68	76	71	82
23	82	79	81	91	76	74	71	76	69	84	72	92
24	82	81	80	86	78	74	74	77	70	83	83	83
25	80	82	78	88	75	78	72	78	69	76	80	87
26	83	88	69	84	76	80	78	81	71	78	87	81
27	76	85	69	76	81	79	73	76	78	88	82	78
28	87	82	80	74	78	84	66	82	72	84	76	74
29	94	81	71	77	77	79	75	80	73	88	81	73
30	89		85	83	78	79	71	86	77	81	80	75
31	85				79		73	82		81		76

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.2	0.5	2.9	1.2	1.2	3.3	7.7	6.7	5.8	6	2.1	4.1
2	0	4.5	2.2	5.4	1	5.3	7.5	7.1	6.5	5.3	4.3	3.8
3	1.3	5.6	5.6	5	2	6	7.2	7.6	6.6	4.4	2.8	6.8
4	1.5	6.5	1.5	3.5	2	5.3	5.7	7.3	7.2	5.6	4.2	1.4
5	5.4	5.7	0.8		4	6.8	8	8	6	4.5	1.2	6.3
6	6.1	7.2	3.6	2.1	5	4.1	8	2.9	5.3	7.4	2.1	5.3
7	6.2	2	3.2		3.5	7.9	6.4	8	4	3.7	1.5	4.4
8	7.3	0.7	0.9	1.4	6.2	4.9	7.6	7.3	3	1.7	4.7	5.2
9	7	0.5	3.1	0.5	7	3.7	7.6	7.5	5.8	7.6	1.3	
10	6.7	0.3	3.7	0.6	7.4	2.4		0.7	5.8	4.9	2.1	3.4
11	7.8	0.3	4.4	2.5	7.7	1		6.3	4.8	7.2	4.3	
12	7.7		4.8	0.8	5.6	5.1	5.6	1.7	3.8	7.7	4.6	5.1
13	6.1	1.7	2.1	4.3	7	0.6	6.1	3.1	1	5.8	2.8	7.2
14	5.5		3.1	3.9	4.4	1.6	7.8	3.8	5.4	5.5	3.6	1.7
15	3.2		3.9	4.3	6.8	2	6.2	4.7	7.8	6.1	3	4.1
16	7.5	2.5	3.6	4.2	3.8	4.2	5.7	6.9	6.1	8	5.8	2
17	8		5.3	3.2	7.5	7	7.6	7	7.4	4.3	2.2	8
18	7.6	2.6	3.3	4.2	5.8	8	5.6	4.7	7.3	8	1.4	4.6
19	1.5	2.1	3.4		4	8	7.7	3.4	7.7	4.5	2.9	3
20	8	0.1	4	1.4	7	7.7	8	2.5	6.9	5.7		1.5
21	6.7	0.5	5.8	1	5.1	8	7.3	6.8	7.5	6.6	6.3	8
22	3.7		5.1	0.3	5.5	6.4	8	5.9	6.1	5.8	4.4	5
23	4.3		1.5	0.3	5	7.8	6.9	6	6.7	0.2	4.7	
24	6.7	0.3	5.5	5	4.5	7.4	7.1	4.3	7.1	0.2	2.1	5.2
25	4.8	0.3	4.4	2	6.4	7.4	6.9	2.9	4.8	1	4	0.1
26	4		5.9	6.8	5.6	3.4	3.8	4	4.2	4.3	3.4	3.3
27	5.7		5.4	8	4	5.3	6.7	4.9	5.3		6.2	2.8
28	4.1		3.5	4.7	4.9	2.1	7	3.5	7.7	3.7	8	3.2
29	0.6		5.1	3	6.6	5.7	6.6	3.7	7.2	0.1	7.5	0.4
30	4.2		1.5	4.9	4.9	3.1	6.6	3.7	7.2	3.9	5.2	4
31	2.9		3		3.8		6.5	5.8		3.7		0.6

DAILY RAINFALL DATA (mm)

Station Name	: Cipanas-Pangalengan		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2009

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	28.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2	0.0	8.5	0.0	10.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	9.5	
4	0.0	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5	0.0	7.0	19.5	38.0	15.0	0.0	0.0	0.0	0.0	13.0	0.0	0.0	
6	0.0	19.0	10.0	24.0	6.5	0.0	0.0	0.0	0.0	10.0	0.0	0.0	
7	0.0	0.0	53.0	8.0	8.0	0.0	0.0	0.0	0.0	44.0	0.0	0.0	
8	27.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	15.0	0.0	0.0	
9	13.5	3.0	0.0	10.0	23.0	0.0	0.0	0.0	0.0	0.0	10.0	27.0	
10	0.0	4.0	7.0	8.0	9.0	0.0	0.0	0.0	0.0	26.0	8.0	0.0	
11	12.5	12.0	0.0	0.0	23.0	0.0	0.0	0.0	0.0	0.0	41.0	0.0	
12	13.0	25.0	0.0	10.5	0.0	0.0	0.0	0.0	12.0	3.0	0.0	0.0	
13	5.5	12.0	0.0	4.5	5.0	0.0	0.0	0.0	0.0	13.0	6.0	0.0	
14	7.0	0.0	21.0	0.0	0.0	8.0	0.0	0.0	0.0	53.5	0.0	0.0	
15	0.0	0.0	22.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
16	37.0	20.5	0.0	0.0	0.0	0.0	0.0	0.0	16.0	0.0	0.0	0.0	
17	0.0	58.5	0.0	0.0	15.5	0.0	0.0	0.0	0.0	0.0	59.0	0.0	
18	8.0	0.0	0.0	0.0	22.0	0.0	0.0	0.0	0.0	0.0	56.0	0.0	
19	8.5	0.0	0.0	8.0	5.0	0.0	0.0	0.0	0.0	0.0	29.0	0.0	
20	4.0	22.0	0.0	0.0	16.5	0.0	0.0	0.0	0.0	0.0	43.0	0.0	
21	0.0	8.0	51.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0	
22	0.0	66.0	21.0	36.0	4.0	0.0	0.0	0.0	0.0	64.5	11.0	6.0	
23	0.0	15.0	17.0	39.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24	0.0	0.0	0.0	5.0	0.0	0.0	5.0	0.0	6.0	5.0	0.0	0.0	
25	13.0	25.0	31.0	0.0	0.0	0.0	0.0	0.0	41.0	0.0	0.0	18.0	
26	6.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	15.0	5.5	25.0	26.0	
27	20.0	15.5	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0	
28	0.0	0.0	0.0	0.0	20.5	0.0	0.0	0.0	0.0	0.0	13.0	0.0	
29	22.5	-	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	
30	38.0	-	12.5	17.5	0.0	0.0	0.0	0.0	0.0	0.0	16.0	48.0	
31	27.0	-	0.0	-	23.5	-	0.0	0.0	-	0.0	-	0.0	
Maximum Rainfall	38.0	66.0	53.0	39	23.5	24	5	0	41	65	59	48	66
Total Rainfall	290.5	400	280.0	234	217	38	5	0	90	253	339	164	2308
Total Days of Rainfall	17	19	12	15	16	3	1	0	5	11	15	7	121
Average Rainfall	9.4	14.3	9.0	8	7	1	0	0	3	8	11	5	
First-Half Rainfall (1-15)	107	169	132.5	118	90	38	0	0	12	178	75	37	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	184.0	231	148	116	127	0	5	0	78	75	264	127	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

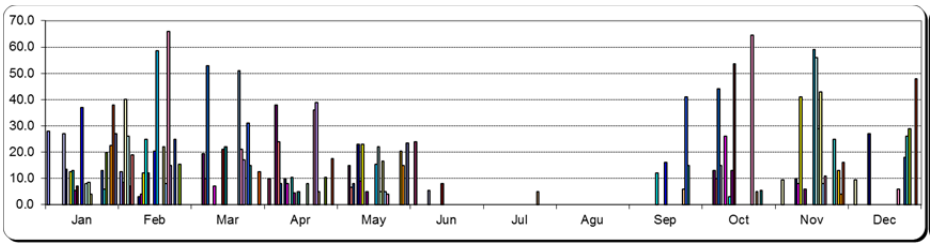


Figure B.25 Rainfall Fluctuation (2009)

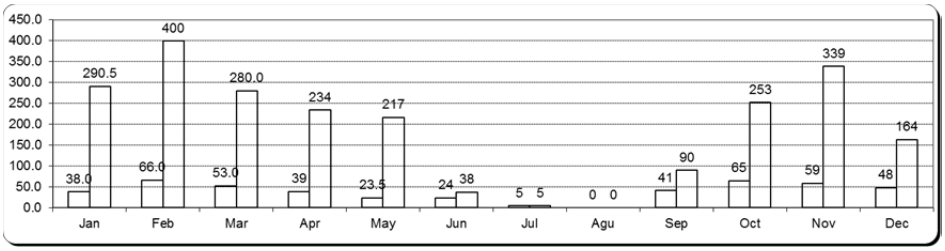


Figure B.26 Maximum Rainfall and Total Rainfall per Month (2009)

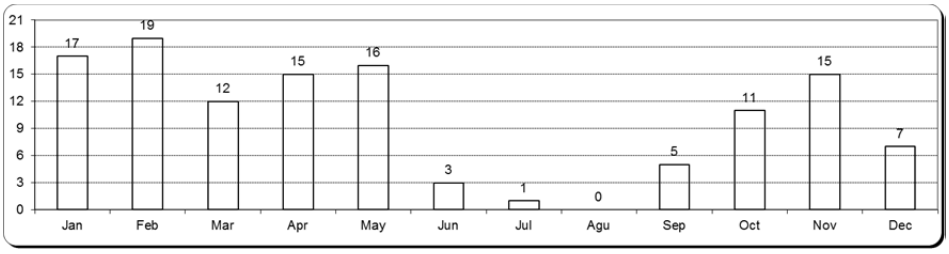


Figure B.27 Total Rainy Days (2009)

Table B.9 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2009)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	27.6	21.8	24.7	27.6	20.8	24.2	27.8	20.8	24.3	27.6	19.2	23.4	30.2	20.6	25.4	28.8	20	24.4	28.6	19.2	23.9	30	15.6	22.8	31.6	20.6	26.1	31.8	19.2	25.5	30.2	18.8	24.5	29.4	17.8	23.6
2	30	22	26.0	24.8	20	22.4	29.2	20	24.6	28.3	20	24.2	31	19.8	25.4	30.2	20	25.1	28.7	19	23.9	28	18	23.0	29.6	20.2	24.9	29.8	19	24.4	31.6	19.8	25.7	28.2	18.6	23.4
3	30	20.4	25.2	25.3	20	22.7	30.1	19.6	24.9	27.6	20	23.8	29.2	19.4	24.3	29.4	20.5	25.0	27.2	19.8	23.5	30	15.2	22.6	32	20	26.0	29.2	21	25.1	31.4	19.9	25.7	29.8	20.4	25.1
4	29.8	18.6	24.2	25.3	20	22.7	30.6	20.4	25.5	28	19.7	23.9	29.2	19.7	24.5	28.5	20.6	24.6	30.2	19.4	24.8	28.4	16	22.2	29.6	19.8	24.7	29.3	21	25.2	31.6	20.1	25.9	30.8	20.7	25.8
5	29.8	18.4	24.1	25.8	19.6	22.7	29.1	20	24.6	28	20.7	24.4	30.2	20.2	25.2	28.4	20.4	24.4	29	19.3	24.2	29.4	17.2	23.3	30.2	20	25.1	30.2	20.5	25.4	30.5	21	25.8	27.6	21.2	24.4
6	30	18.8	24.4	23.4	20	21.7	29.8	20.4	25.1	27.2	19.8	23.5	28.8	21	24.9	28.6	19.8	24.2	28.6	18.2	23.4	30.8	18.2	24.5	30.8	19.7	25.3	27.8	20.2	24.0	30.2	20.2	25.2	26.4	20.8	23.6
7	28	19.7	23.9	26.2	19.6	22.9	27	20.6	23.8	25.6	19.7	22.7	28.6	21	24.8	28.2	19.4	23.8	29.8	16.2	23.0	31.4	18.1	24.8	32.6	18	25.3	26.6	19	22.8	30	20	25.0	27	19.8	23.4
8	28	20.6	24.3	26.4	20.5	23.5	28.6	20.4	24.5	26.6	19.2	22.9	27.5	21	24.3	28.8	19.3	24.1	28.4	16.5	22.5	29.6	19.6	24.6	32	17.6	24.8	27.4	20.2	23.8	31.2	20.2	25.7	29.4	19.2	24.3
9	25.6	20.1	22.9	25.8	19.8	22.8	28	20	24.0	30.4	19.5	25.0	27.2	20.2	23.7	26.6	18.8	22.7	30.4	18.8	24.6	29.6	19.8	24.7	31.6	17.9	24.8	28.8	19	23.9	31.4	20.4	25.9	27	19.4	23.2
10	25.6	20.4	23.0	28.6	20.6	24.6	27.8	18.7	23.3	27.4	20	23.7	28.2	19.4	23.8	28.8	19.8	24.3	29.6	18.6	24.1	29.8	18.6	24.2	31.2	20.2	25.7	28.6	19	23.8	29.2	22	25.6	27.3	19	23.2
11	26.9	20.4	23.7	28.4	20	24.2	29	18.2	23.6	29	19.2	24.1	25.6	19.4	22.5	29.4	20	24.7	29.8	16.6	23.2	30.8	18.4	24.6	31	21.4	26.2	30.8	19.2	25.0	29.2	20.6	24.9	31.4	17.6	24.5
12	25.8	19.6	22.7	27.8	21.2	24.5	29.4	18.2	23.8	28.4	19.9	24.2	24.4	18.8	21.6	28.7	19.4	24.1	29.3	16.6	23.0	29.2	18.8	24.0	31.6	18.8	25.2	29.1	19.4	24.3	26.4	19.8	23.1	29.2	20	24.6
13	22.6	20	21.3	28.5	21.3	24.9	28.6	18.2	23.4	27.6	20	23.8	26.7	19.2	23.0	29.4	20	24.7	29	16.4	22.7	29	20.4	24.7	30.8	20	25.4	28.2	19.4	23.8	30	19.7	24.9	29.8	20	24.9
14	24	20	22.0	29.2	21.2	25.2	26.6	18.4	22.5	28.2	18.7	23.5	26	20	23.0	29.2	19.8	24.5	28	16.6	22.3	30.6	19	24.8	32.6	19.8	26.2	29	18.6	23.8	30.4	20.2	25.3	29.2	21.4	25.3
15	24.8	19.4	22.1	26.8	21	23.9	29.5	20.6	25.1	29.2	19.6	24.4	28.6	20.4	24.5	28.2	20.8	24.5	29.2	17.4	23.3	30.2	20	25.1	32	19.6	25.8	27.8	19	23.4	29.6	21	25.3	28.7	21.4	25.1
16	26	19.2	22.6	26.8	20	23.4	30.8	18.7	24.8	29.2	20.2	24.7	27.8	21	24.4	27.8	20.2	24.0	28.8	18.8	23.8	29.8	18	23.9	30	20.4	25.2	29.6	20.3	25.0	27.2	20.4	23.8	30.2	19.8	25.0
17	27.8	19.5	23.7	29	20	24.5	30.2	18	24.1	31.2	21	26.1	29.2	20.2	24.7	29	19.8	24.4	29	18.4	23.7	29.6	19.5	24.6	29	20.2	24.6	30.8	17.1	24.0	26.6	20.6	23.6	30	20	25.0
18	27.8	20	23.9	29.6	20.4	25.0	30	18.2	24.1	30.8	19.6	25.2	28.6	20.2	24.4	28.1	19.8	24.0	29.6	19.4	24.5	30.6	19.6	25.1	30.6	20	25.3	31.2	17	24.1	26.7	20.4	23.6	30.4	20	25.2
19	27.3	20.6	24.0	29	20.9	25.0	29.8	20	24.9	30	19.5	24.8	29.6	20.4	25.0	29.5	19.2	24.4	28.4	19.8	24.1	33	18	25.5	30	19.5	24.8	31.4	19.8	25.6	28.2	18.5	23.4	31	20.7	25.9
20	28.6	20.4	24.5	29.4	21.2	25.3	29.2	19.4	24.3	28.6	19	23.8	28.8	20.8	24.8	29.2	18.2	23.7	29.8	19.4	24.6	31.8	17.2	24.5	32.2	19.4	25.8	31.2	20.8	26.0	26	20.2	23.1	30.3	20.4	25.4
21	27.8	20.2	24.0	29.3	19.5	24.4	29.4	20.8	25.1	28.9	20	24.5	27.8	21.2	24.5	30	18	24.0	29.4	19.4	24.4	30.6	16.6	23.6	31.4	17.6	24.5	31.2	20	25.6	26.4	18.2	22.3	29.8	20	24.9
22	28.4	19.3	23.9	28.6	19.5	24.1	28.2	18.7	23.5	28.4	19	23.7	27.6	21.4	24.5	28.8	18.6	23.7	30.1	19.6	24.9	31.7	16.5	24.1	30	18	24.0	29.8	19.6	24.7	26	19.2	22.6	28.2	20.8	24.5
23	29.6	19.4	24.5	28.4	19.6	24.0	28	18.2	23.1	28.7	19.2	24.0	26.9	20.8	23.9	30	18.8	24.4	29.4	21.2	25.3	31.2	16.6	23.9	29.8	20	24.9	29	19.4	24.2	26.4	19.4	22.9	29.6	20.8	25.2
24	28	21	24.5	27.2	20.5	23.9	28.4	18.9	23.7	29	19.2	24.1	29.2	21.2	25.2	28.6	20.2	24.4	27.8	21	24.4	29.8	18.3	24.1	30	19	24.5	27	20.5	23.8	28.8	20.2	24.5	29	21.7	25.4
25	28.5	20.2	24.4	26.4	21	23.7	28.2	18	23.1	29.8	19.4	24.6	29.6	21.6	25.6	28.4	20	24.2	27.6	21	24.3	31.2	19.2	25.2	31	20.2	25.6	29.4	18.9	24.2	27.3	20	23.7	29.8	21.8	25.8
26	28.4	20.8	24.6	28	21	24.5	29.2	19.6	24.4	29.8	20	24.9	29	20.4	24.7	30.4	20	25.2	27.6	18.8	23.2	30	20	25.0	31.6	19	25.3	27.5	19	23.3	27.1	19.2	23.2	27	20.2	23.6
27	28.4	21	24.7	28.4	21.4	24.9	30.8	18.4	24.6	27	19.6	23.3	31	20.2	25.6	28.3	18.8	23.6	29.3	16.1	22.7	31	20	25.5	32	18.7	25.4	28.2	18.7	23.5	28	20	24.0	28	19.6	23.8
28	27.8	20.7	24.3	24.4	21	22.7	29	18.5	23.8	28.8	19.2	24.0	29.6	20.1	24.9	28.7	18	23.4	31.4	16.1	23.8	31.2	20	25.6	31.7	18	24.9	30	17.4	23.7	29	20.2	24.6	26.2	19.6	22.9
29	27.3	21	24.2				27.8	20.4	24.1	30.7	19.9	25.3	29.6	20.3	25.0	28.4	17.8	23.1	29.4	17	23.2	29.7	20.2	25.0	31	18.2	24.6	31.2	17.4	24.3	30	21.3	25.7	28	20.6	24.3
30	27.1	20	23.6				26.9	18.2	22.6	30.4	19.6	25.0	28.6	20.6	24.6	29.2	19	24.1	29.5	15.8	22.7	30.9	19.4	25.2	29	19.4	24.2	31.8	19	25.4	29	19.3	24.2	28	20.6	24.3
31	27	20.5	23.8				29	18.2	23.6				28.6	21.4	25.0				29.4	16	22.7	31.2	18.2	24.7				29.8	20.2	25.0				26.4	20	23.2

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	79	82	81	82	78	80	77	67	68	67	73	80
2	66	91	74	88	71	81	75	70	74	75	71	84
3	67	89	76	87	73	77	81	67	73	75	76	78
4	72	90	82	85	75	81	83	74	69	78	72	78
5	69	81	86	85	79	81	79	75	77	85	69	84
6	73	88	81	91	84	80	75	70	69	85	75	88
7	80	81	86	90	84	82	73	69	65	90	78	89
8	78	86	87	86	86	81	75	74	66	86	73	83
9	84	89	89	77	88	84	77	73	72	78	71	85
10	81	83	88	81	83	85	74	74	75	78	83	88
11	83	72	87	78	93	80	67	74	71	70	88	78
12	82	71	79	85	88	80	66	76	69	75	91	81
13	90	76	80	85	84	82	63	76	69	82	83	84
14	89	75	87	87	86	79	72	74	64	91	77	79
15	89	84	80	82	80	83	74	75	70	81	81	74
16	84	81	74	84	80	84	74	76	83	75	84	75
17	82	78	69	79	76	83	74	76	77	63	90	74
18	82	81	70	75	84	81	74	74	73	66	89	72
19	82	81	74	80	83	79	77	68	76	62	87	72
20	82	81	74	82	81	79	78	62	71	63	94	72
21	83	84	80	82	84	75	75	70	65	74	90	74
22	82	85	86	84	82	78	74	69	69	77	94	80
23	79	86	89	86	80	78	75	72	75	79	66	77
24	86	86	82	85	78	77	77	72	77	85	79	83
25	85	83	85	79	79	82	80		78	74	84	86
26	83	80	80	80	73	77	76	73	61	81	86	88
27	82	82	79	89	63	80	65	73	54	77	85	90
28	80	91	85	83	75	80	66	70	54	79	84	90
29	80		88	81	71	82	62	74	63	58	84	89
30	88		86	77	80	80	62	71	73	63	84	89
31	85		88		80		68	72		76		89

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.1	4.3	5.8	0.4	6.6	4.4	7.5	7.7	5.9	3.3	7	5.9
2	7.9		7.9	0.3	6.4	5.5	8	6.5	5.3	4.5	8	4
3	8	1.4	6.8	0.3	5.3	4.4	3.3	6.3	7.4	3.6	5.1	6.8
4	6	1.7	7.1	0.2	6.6	3.8	7.6	5.8	4.5	4.2	6.7	7.5
5	6.3	1.8	4.8	0.1	6.7	3.9	7.7	7.4	4.8	1.2	5.8	6.8
6	7.4	0.2	5.4	0.2	3	6.3	8	8	6.9	3.1	4.9	3.1
7	5.8	4.1	1.8	0.2		5.5	8	7.9	7.9	0.8	6.4	3
8	5.2	4	3.5	0.1	3.4	4.5	7.3	6.8	8	3.3	4.5	5.9
9	0.3		3.4	0.2	2.4	0.1	8	8	7.4	6.6	4.4	3.7
10	0.4	6.7	5.6	0.4	5	3.5	8	7.3	6.2	4.1	1.8	3.9
11	2.3	1.9	6.1	0.2	2.7	5.9	7.8	8	5.5	6.6	4.3	5
12	3.1	3.3	7.6	0.2	2.1	4.9	8	4	7	3.4	2.5	4.5
13		2.9	2.4	0.2	3.5	5.1	8	4.4	6.4	2.6	3.2	5.3
14	0.6	3	1.8		1.3	7.5	7.5	5.7	7.6	5.7	4.6	2.7
15	2.2	1.5	5.3	0.3	6.6	5	8	5.8	5.7	4.6	4	3.5
16	3.7	2.1	6.9	0.2	4.7	6.5	4.9	6.6	3.9	6.2	1.6	6.8
17	7.9	7.2	7.4	0.2	6.7	6.1	8	6.4	4.3	1.6	1	5.4
18	7.7	4.2	8	0.4	5.8	6.3	7.3	7.7	4.5	8	2.3	5.8
19	4.1	2.3	7.8	0.4	5.7	7.2	5.5	8	5	8	5.3	5.7
20	6.8	6.3	7.2	0.4	4.2	5.3	5.8	8	7.8	8	5.3	6.2
21	4.8	4.2	4.2	0.3	4.3	7.8	7	7.2	6.4	5.4	2.8	3.7
22	6.5	3.9	4	0.2	3.4	7.3	8	7.5	5.2	4.4	1.8	2.3
23	6.8	4.5	3.5	0.2	0.2	7.9	8	7.9	4.9	4.1	4.3	2.6
24	1.8	3.2	4.4	0.2	6.7	7.3	5.1	6.1	5.1	2.2	4.2	0
25	4.9	1.6	4.3	0.1	5.5	8	2.1	7.7	5.9	5.6	2.3	1.9
26	4.3	3.5	5.2	0.4	3.9	6.3	3.4	7.4	7.3	3.4	1.2	2.8
27	4.5	5.4	7.4	0.2	7.7	6.2	8	7.9	7.5	2.1	2	2.6
28	7		2.9	0.2	4.9	5.5	8	8	7.5	5.3	4.3	2.6
29			3.1	0.3	6.7	3.9	8	6.1	7.6	6.1	2.9	
30	4		4.1	0.6	5.1	7.5	8	7.8	3.7	6.3	2.7	1.3
31	2		2		5.7		7.5	7.3		4.5		4.5

DAILY RAINFALL DATA (mm)

Station Name	: Cipanas-Pangalengan		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2010

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	15.0	15.0	7.0	12.0	0.0	11.0	21.0	0.0	49.0	26.0	0.0	47.0	
2	10.0	10.0	0.0	2.0	0.0	3.0	0.0	0.0	19.0	0.0	8.0	0.0	
3	19.0	45.0	0.0	5.0	6.0	0.0	0.0	6.0	0.0	8.0	38.0	68.0	
4	10.0	30.0	16.0	14.0	5.0	23.0	0.0	22.0	0.0	0.0	9.5	5.0	
5	5.0	35.0	0.0	7.0	4.0	27.0	18.0	7.0	31.0	0.0	25.0	9.0	
6	55.0	27.0	0.0	0.0	2.0	43.0	8.0	0.0	19.0	0.0	0.0	31.5	
7	65.0	18.0	6.0	5.0	7.0	5.0	0.0	0.0	35.0	13.0	12.0	23.0	
8	9.0	26.0	25.0	11.0	8.0	18.0	0.0	0.0	22.0	0.0	12.0	45.0	
9	18.0	25.0	0.0	0.0	5.0	13.0	23.0	19.0	6.0	0.0	0.0	5.0	
10	12.0	55.0	15.0	0.0	6.0	7.0	0.0	0.0	12.0	0.0	0.0	47.0	
11	21.0	16.0	50.0	3.0	16.0	5.0	0.0	0.0	17.5	0.0	0.0	0.0	
12	12.0	37.0	0.0	38.0	11.0	12.0	21.0	0.0	24.0	17.0	0.0	0.0	
13	1.0	25.0	0.0	7.0	9.0	3.0	0.0	0.0	15.0	0.0	0.0	0.0	
14	11.0	50.0	0.0	5.0	13.0	7.0	0.0	0.0	0.0	4.0	19.5	9.0	
15	5.0	30.0	18.0	7.0	12.0	9.0	0.0	0.0	20.0	0.0	20.0	0.0	
16	4.0	13.0	20.5	3.0	39.0	15.0	0.0	0.0	11.5	15.0	37.0	0.0	
17	0.0	17.0	43.0	0.0	20.0	3.0	14.0	0.0	0.0	16.0	7.0	18.5	
18	0.0	85.0	0.0	0.0	17.0	20.0	0.0	0.0	0.0	10.0	0.0	9.0	
19	1.0	2.0	62.0	0.0	13.0	16.0	19.0	27.0	18.0	23.0	23.0	3.0	
20	1.0	0.0	47.0	8.0	9.0	2.0	0.0	41.0	24.0	0.0	0.0	19.0	
21	7.0	13.0	28.0	93.0	0.0	0.0	0.0	40.0	0.0	23.0	26.0	60.0	
22	15.0	7.0	22.0	7.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	32.5	
23	44.0	7.0	25.0	3.0	12.0	0.0	0.0	0.0	19.0	31.0	32.5	20.0	
24	28.0	5.0	0.0	0.0	5.0	3.0	0.0	0.0	0.0	4.0	22.0	7.0	
25	12.0	9.0	4.0	0.0	3.0	0.0	0.0	25.0	17.0	0.0	0.0	0.0	
26	17.0	7.0	0.0	1.0	1.0	0.0	0.0	69.0	0.0	0.0	12.0	24.5	
27	15.0	14.0	20.0	0.0	0.0	0.0	10.0	0.0	11.0	26.0	15.5	11.0	
28	30.0	6.0	15.0	0.0	1.0	5.0	0.0	0.0	0.0	14.0	6.0	0.0	
29	27.0	-	14.0	7.0	7.0	3.0	0.0	0.0	0.0	0.0	38.5	0.0	
30	25.0	-	15.5	0.0	9.0	0.0	0.0	0.0	0.0	12.0	9.0	0.0	
31	4.0	-	0.0	-	1.0	-	-	0.0	-	14.5	-	0.0	
	7											o	
Maximum Rainfall	65.0	85.0	62.0	93	39.0	43	23	69	49	31	39	68	93
Total Rainfall	498.0	629	453.0	238	248	253	134	256	370	257	373	494	4202
Total Days of Rainfall	29	27	19	19	27	22	8	9	18	16	19	20	233
Average Rainfall	16.1	22.5	14.6	8	8	8	4	8	12	8	12	16	
First-Half Rainfall (1-15)	268	444	137.0	116	104	186	91	54	270	68	144	290	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	230.0	185	316	122	144	67	43	202	101	189	229	205	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

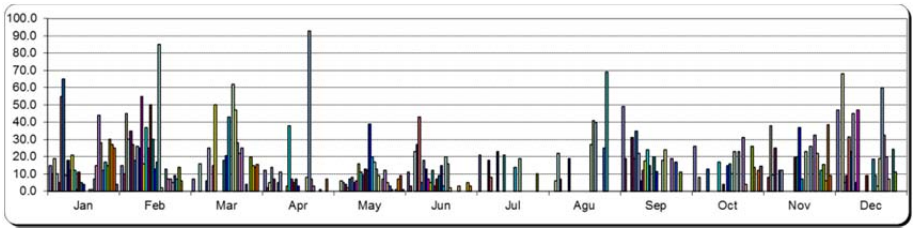


Figure B.28 Rainfall Fluctuation (2010)

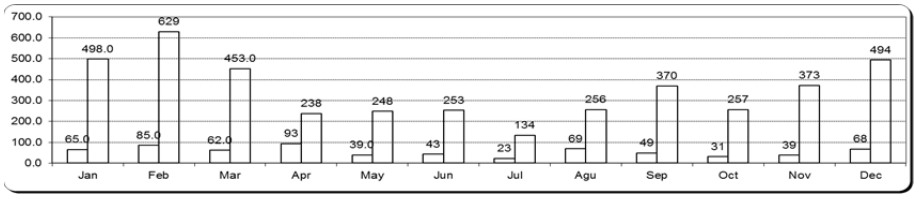


Figure B.29 Maximum Rainfall and Total Rainfall per Month (2010)

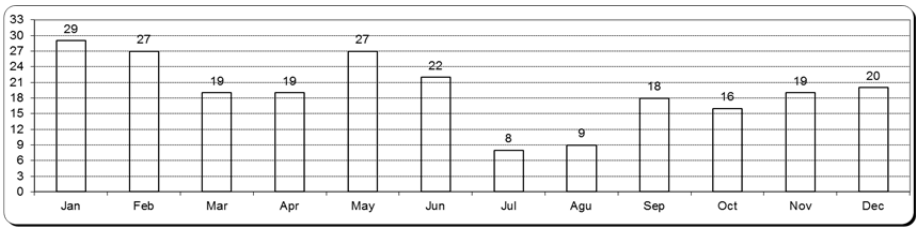


Figure B.30 Total Rainy Days (2010)

Table B.10 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2010)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	28	19.2	23.6	27	21.2	24.1	28.4	21	24.7	30.4	20	25.2	31.6	20.2	25.9	29.6	20	24.8	28.4	18.4	23.4	28.6	19.3	24.0	29.6	20.4	25.0	30	20.2	25.1	29.3	20	24.7	26.8	20	23.4
2	29	20	24.5	28	20.4	24.2	30.4	19.2	24.8	29.3	20.6	25.0	29.8	21.6	25.7	31	20.4	25.7	27	19.4	23.2	29.2	19.2	24.2	30.5	19.7	25.1	29	20	24.5	30	22	26.0	28	20	24.0
3	29	20	24.5	28.6	20.2	24.4	29.8	19	24.4	29.2	21	25.1	30	21.4	25.7	31.7	21	26.4	26.6	19	22.8	29	19	24.0	29.2	20	24.6	26.4	21	23.7	28.2	21	24.6	28	20.8	24.4
4	28.5	20	24.3	27.2	19	23.1	29	22	25.5	30.7	21	25.9	29	21.4	25.2	30	20.7	25.4	28	18.4	23.2	27.8	19	23.4	29	19.7	24.4	29.8	21	25.4	27.6	20.9	24.3	28.5	19.8	24.2
5	28.2	19.8	24.0	28.3	20	24.2	26.6	21.7	24.2	29.2	20.2	24.7	29.7	21.2	25.5	28	20	24.0	29	19.2	24.1	29.2	19.2	24.2	27.6	19.9	23.8	30.2	20.6	25.4	27	20.4	23.7	28.2	20	24.1
6	28	20	24.0	28.4	20.1	24.3	28.7	20	24.4	30.4	19.4	24.9	29.4	20.4	24.9	27	20	23.5	29.6	20	24.8	28.2	19.5	23.9	21.2	23.9	22.6	30.6	21.4	26.0	28.2	20	24.1	25.6	20	22.8
7	27.6	18.6	23.1	28.5	19.8	24.2	30.6	20	25.3	30	19.3	24.7	30	20	25.0	28.2	19.2	23.7	28.4	21	24.7	28.6	19.5	24.1	28.4	19.7	24.1	31	20	25.5	28.4	20.8	24.6	28.4	20.7	24.6
8	26	18.6	22.3	27.2	20	23.6	29	20.6	24.8	30.4	21.5	26.0	28	21.4	24.7	27.1	20.6	23.9	27	20.5	23.8	27.8	19.2	23.5	26.6	19.6	23.1	29	20	24.5	27.2	20.6	23.9	28	20	24.0
9	27.2	20	23.6	27.2	21	24.1	27	20.5	23.8	30.2	20	25.1	29.7	20	24.9	28	18.5	23.3	28.3	19.3	23.8	29.7	19	24.4	28.3	18.9	23.6	28.3	20	24.2	29.6	19.8	24.7	27.3	20	23.7
10	27.4	20	23.7	28.4	20	24.2	26.6	20.2	23.4	29.2	19.8	24.5	29.6	20	24.8	28.6	18.6	23.6	27.5	18.8	23.2	27.2	19.4	23.3	27.4	19.5	23.5	30	18.6	24.3	28.6	19.8	24.2	26.4	20.2	23.3
11	28	20	24.0	27.7	20.6	24.2	27.4	19.6	23.5	30.2	21.8	26.0	29	21	25.0	29	20.8	24.9	28.5	18.7	23.6	28	20.5	24.3	29.8	19.2	24.5	29.9	16.6	23.3	28.3	19.8	24.1	24.4	19.8	22.1
12	27	20.2	23.6	28.6	20.7	24.7	27	19.8	23.4	30.8	18.3	24.6	29.2	20.8	25.0	26.2	20.4	23.3	28.4	20.4	24.4	28.5	20.4	24.5	29.1	18.8	24.0	30	19	24.5	28.8	20.2	24.5	27.5	20	23.8
13	25.8	21	23.4	26.7	20.6	23.7	28	19	23.5	30.6	19	24.8	28.4	20.9	24.7	29.8	18	23.9	27.6	20.4	24.0	28.3	20.3	24.3	25.7	20	22.9	27.3	19.6	23.5	25.2	21.2	23.2	27.8	20.5	24.2
14	27.2	20	23.6	27	19.6	23.3	28	20.4	24.2	30.2	21.2	25.7	28.3	20.8	24.6	27.2	17.7	22.5	27.2	20.4	23.8	30.4	20.6	25.5	28	20.1	24.1	28.6	20.2	24.4	28.4	20.2	24.3	26.5	20.2	23.4
15	26.2	20	23.1	29.2	19.4	24.3	27.7	19.4	23.6	30.5	20.4	25.5	30.4	20	25.2	27	19.8	23.4	27.8	18	22.9	27.4	20.7	24.1	25.4	20.3	22.9	28.5	21.1	24.8	27.2	20.6	23.9	28	20.2	24.1
16	25.4	20	22.7	27.4	20.3	23.9	26.4	19.2	22.8	27.6	20.6	24.1	27.7	20.2	24.0	24.2	19.8	22.0	26.5	18	22.3	26.4	21.8	24.1	27	19	23.0	29.2	21.2	25.2	26.9	19.8	23.4	25.8	20	22.9
17	27	20	23.5	26.2	20	23.1	27.9	20	24.0	29.8	21	25.4	28.8	20.6	24.7	26.2	20.4	23.3	27.4	19.2	23.3	26.8	21.4	24.1	27.3	18.7	23.0	28.6	20.2	24.4	29.2	20	24.6	27	20.6	23.8
18	28.2	19.4	23.8	28.8	21	24.9	27.9	19.7	23.8	29	20.7	24.9	30	22.4	26.2	29.6	20.8	25.2	26.8	20.4	23.6	27.4	19.4	23.4	27.6	18.8	23.2	27.2	20.6	23.9	30	20	25.0	28.5	21	24.8
19	25.8	20.3	23.1	27	21	24.0	28.6	19.6	24.1	29.6	20.7	25.2	30.3	21.7	26.0	28	19.6	23.8	27	20	23.5	27.2	19.8	23.5	29	19.1	24.1	29.2	19.4	24.3	29	20.3	24.7	28	21.3	24.7
20	27.5	19.9	23.7	28.2	20.6	24.4	29	19.8	24.4	30.9	20.2	25.6	29	21.2	25.1	29	20	24.5	28	19	23.5	28.2	19.5	23.9	29.4	21.4	25.4	26.8	19.7	23.3	29	20.8	24.9	28	21	24.5
21	29	19.8	24.4	28.2	19.6	23.9	27.6	19	23.3	31.3	20.4	25.9	31	18.8	24.9	29.6	20	24.8	29.2	19	24.1	27.8	19.6	23.7	26.8	21.5	24.2	28.5	19.8	24.2	28.3	20.6	24.5	28.6	20	24.3
22	29	20.7	24.9	29	19.4	24.2	30.4	19.8	25.1	31.2	21.4	26.3	30.1	18.2	24.2	30	19.8	24.9	29.6	19	24.3	29.4	18.4	23.9	27.6	20	23.8	28	19.8	23.9	30.4	19.3	24.9	27.2	20.2	23.7
23	30	20	25.0	30.6	21.2	25.9	28.8	19.7	24.3	29	23	26.0	31	21.4	26.2	29	19	24.0	28	18.8	23.4	30.2	18.1	24.2	27.6	20	23.8	27.5	19.6	23.6	27.3	19.5	23.4	27.4	19.7	23.6
24	29.6	20	24.8	29.2	19	24.1	31	20	25.5	31.4	22	26.7	30.8	22	26.4	28.2	18.7	23.5	29	18.2	23.6	29.2	20	24.6	27.8	20	23.9	26.4	19.7	23.1	27.3	20.7	24.0	29.2	19.8	24.5
25	28.8	20	24.4	27.2	19.2	23.2	30.4	20.4	25.4	31.8	20.8	26.3	30	19.8	24.9	26.8	21	23.9	28	18.2	23.1	30.6	19	24.8	26.2	20	23.1	27.8	20.1	24.0	27.8	19.3	23.6	27.8	21.2	24.5
26	28.4	20.6	24.5	28.6	19.2	23.9	28	19.8	23.9	32	20.4	26.2	30	20.4	25.2	27.3	20.2	23.8	28.7	20	24.4	28.6	19.9	24.3	28.8	20	24.4	28.4	20.4	24.4	27.3	19.4	23.4	28.6	19.6	24.1
27	29.6	20.2	24.9	30.3	20	25.2	30.2	20	25.1	30	21.7	25.9	29.8	20.4	25.1	29.2	19	24.1	25.8	20.8	23.3	28.4	19.4	23.9	28.4	21	24.7	27	19.6	23.3	29.3	20.2	24.8	27	20.4	23.7
28	29.2	20.5	24.9	30.2	21	25.6	27.8	20	23.9	28.6	22.6	25.6	29.2	21.2	25.2	26.9	19.7	23.3	27.1	20.2	23.7	28.8	19.2	24.0	28.1	20	24.1	26.8	20.6	23.7	28.1	19.3	23.7	28.3	20.8	24.6
29	29.2	21	25.1				29.4	19.8	24.6	30.8	21	25.9	28.2	20.8	24.5	26.2	16.4	21.3	27	20	23.5	29	19	24.0	30.7	20	25.4	27.8	20.5	24.2	29.2	20	24.6	25.7	20.7	23.2
30	27.7	20.8	24.3				25	20	22.5	31.2	20	25.6	29.2	20.2	24.7	28	19.2	23.6	29.6	20	24.8	29.9	19.3	24.6	29	19.9	24.5	26.2	19.4	22.8	28.4	20.3	24.4	27.2	21	24.1
31	27.8	20.8	24.3				28.4	19	23.7				31	20.2	25.6				29.5	19.8	24.7	30	20	25.0				28.3	20	24.2				28	20.4	24.2

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	87	84	86	83	78	83	90	76	77	84	69	92
2	86	87	79	79	81	77	93	78	80	82	75	84
3	91	82	82	79	79	81	89	80	78	86	84	84
4	87	91	79	78	81	81	89	83	78	78	86	87
5	87	88	88	85	86	89	88	86	82	77	86	87
6	89	87	82	82	79	88	89	82	95	77	81	89
7	85	82	83	83	81	90	85	80	87	78	82	85
8	88	86	85	83	88	91	93	80	88	83	87	88
9	86	93	94	79	81	82	91	78	87	78	85	85
10	87	84	88	71	83	83	90	85	86	67	84	88
11	82	90	88	81	91	85	82	84	79	59	81	84
12	79	90	88	74	88	88	85	84	88	67	81	77
13	87	92	87	75	91	80	86	80	94	85	90	70
14	84	89	87	77	91	85	90	77	87	84	84	82
15	77	88	86	80	90	90	91	85	89	82	88	80
16	83	86	89	82	94	92	87	86	84	83	88	80
17	83	93	89	79	88	85	87	89	87	84	88	82
18	75	93	88	77	79	85	92	83	87	90	84	76
19	90	86	85	75	79	84	94	87	82	86	84	75
20	83	85	88	75	76	80	90	82	81	96	85	85
21	83	85	89	72	80	82	80	84	86	85	93	79
22	82	82	84	76	83	73	72	81	88	87	78	86
23	80	77	86	77	88	77	75	78	88	87	89	87
24	80	87	83	78	83	78	73	81	89	93	90	84
25	79	93	81	71	80	86	74	80	91	86	87	81
26	80	84	86	73	82	86	78	81	86	82	90	75
27	85	82	80	79	80	80	91	86	87	87	85	84
28	83	83	88	79	81	87	88	79	85	86	89	81
29	80		84	78	85	94	85	77	78	84	83	77
30	83		91	81	84	91	80	77	79	90	85	82
31	82		88		81		79	77		79		72

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.6	0.5	3.5	1.2	5.6	5.9	3.5	6	5.1	4.5	4.4	2.1
2	4.1	1	7.4	3.3	4.6	6.9	2.8	6.1	5.7	3.8	3.5	3.5
3	3.4	2.9	5	1.2	3.8	6.5	0.8	4.3	6.4	0.8	3.6	3
4	3.5	2.9	3.4	8	3.6	6.8	4.9	2.7	5.1	2.6	3.2	2.6
5	3	3.7	1.8	4.1	2.5	3.1	2.9	4.3	2.9	2.3	0.8	3.8
6	4.2	3.6	4.9	8	4.3	1.7	6	5.9	3.4	5.3	3.4	
7	3.9	5.1	6.3	5.4	5.9	2.1	3.6	6.1	5	5.9		2.8
8	2.7	1.5	2.4	5.9	1.6	1.9	3.6	4.2	2.5	6.1	0.4	2.8
9	1.3	3.4	2.2	7.7	6.8	1.3	4	6	4.7	3.3	4.5	0.4
10	2.4	4.8	0.4	3.8	1.7	4.5	3.9	3.2	2.8	8	4.8	0.4
11	3	2.2	2.7	4.6	5.2	4.1	5.1	3.7	7.7	8	4.3	
12	1.6	2.8	1.9	7.8	5.5	0.3	5	6.1	4.3	8	4.5	4.1
13	2	3.6	4.5	7.9	2.8	6.3	1.5	4.7	2.3	4.7		6.7
14	4.7	3.6	2.3	6	2.4	1.3	4.9	7	1.9	2.1	3.9	1.9
15	2.9	2.8	3	6.3	6.6	3.5	4.7	1.6	0.6	3.3	2.4	5.4
16	2.5	1.3	3.6	2.2	0.6			0.3	1.7	2.2	1.2	1.6
17	4	2.4	2.8	5	4.3	0.2	0.7	2.8	4.5	4.1	4.3	2.4
18	8	3.6	4	6.3	7.7	6.2	2.1	3.6	4.6	2.9	5.8	5.4
19	1.2	2.5	4.9	8	5.5	5.7	2.9	3.8	4.2	4.3	1.5	3
20	2.6	2.7	4.8	8	4	7.6	2.1	4.6	5.6	2.2	4.4	3.4
21	3.9	3.9	2	8	7.6	7.9	7	1.9	0.4	2.8	2.5	4
22	5.7	6.6	6	8	5.7	7.7	7.1	3.8	3.3		6.7	1.1
23	5	5.4	5	4.2	3.7	5.1	4.9	4	2.7	1.3	2.3	2.8
24	5.6	3	7.5	6	6.3	4	7.7	7.2	2.6	2.1	2.2	6.5
25	4.6	3.1	6.9	6.3	6.9	2.7	3.6	7	0.6	4.4	4.9	3.3
26	5.5	4	2	6.7	6.3	3.4	6.3	5	5	3.9	3.6	4.1
27	5.5	4.7	6.1	5	2.4	5.3	0.4	3.4	3.8	3.1	5.3	3.9
28	6.2	4.8	1	4.8	5.6	2.7	3.9	5.1	3.6	1.1	3.3	4.6
29	7.2		4.8	6.7	2.7	2.1	3.5	5.4	7.2	1.8	5	0.3
30	3.7			6.4	4.1	4.6	5.9	5.8	5.5	0.4	3.8	2.5
31	1		1.4		6.9		5.2	5		1.9		4.4

DAILY RAINFALL DATA (mm)

Station Name	: Cipanas-Pangalengan		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2011

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	0	3.0	0	3	28	26	0	0	11	0	0	3	
2	0.0	0.0	0.0	0	32	0	0	0	0	0	0.0	0	
3	8	12	7	12	0	2	0	0	0.0	0	5	12	
4	3	18.0	1.0	11	0	14	41	0	0	0	0	11	
5	49.0	14	2	2	12	0	26	0	0	9	0	2	
6	26	0.0	12.0	7	33.0	0	0	0	0	0	0	24.0	
7	0.0	21	0	24	24	14	0	0	16.0	0	0	14	
8	0	0	8.0	14	9	0	0	0	0	12	0	0	
9	27.0	0.0	29.0	0	0.0	0	0	0	0	0	0	0.0	
10	0	0	0	0	12	0	2	0.0	0	0	0	12	
11	9.0	0.0	0	0	2	6	0	0	0	12	47	2	
12	0	2	1.0	34	0	0	0	0	0	7	22	0	
13	58	31	19	0	1	0	24	0	0	0	13	1	
14	0.0	5	0	8	15	0	12	15	0	0	5	15	
15	0	0.0	0.0	0	5	0	0	0	10	0	28.0	5	
16	6.0	49.0	0	0	11	0	0	0	1	0	0	11	
17	3	0	35.0	0	0	0	60	0	17.0	3	62	0	
18	0	0.0	8.0	4	0.0	0	0	2	1	0	29	0.0	
19	0	0	2	0	0	0	29	0.0	21	0	2	0	
20	2.0	0	0.0	52	9	0	0	0	6	7	0	9	
21	1	0.0	0	4	0	0	0	0	0.0	2	1	0	
22	0.0	0	5.0	4	44	0	0	0	0	13	2	44	
23	0	0.0	0.0	9	19	5	38	0	0	23	0	19	
24	0.0	0	5	5	35	0	0	0	0	0	9	35	
25	0	2.0	11	7	0	0	0	0	24	46	6.0	0	
26	23.0	0.0	31.0	85	70	0	0	0	0	29	0	70	
27	0	9	0	25	0	9	0	0	0	86	4	0	
28	3.0	13	0.0	0	0	50	0	0	32	28	0.0	0	
29	8	-	5	0	0	78	0	0	0	5	4	0	
30	0.0	-	12.0	8	7	16	0	0	0	13	8	7	
31	0	-	9	-	23	-	0	0	-	10	-	23	
	7											o	
Maximum Rainfall	58.0	49.0	35.0	85	70.0	78	60	15	32	86	62	70	86
Total Rainfall	226.0	179	202.0	318	391	220	232	17	139	305	247	319	2795
Total Days of Rainfall	14	12	18	19	19	10	8	2	10	16	16	19	163
Average Rainfall	7.3	6.4	6.5	11	13	7	7	1	5	10	8	10	
First-Half Rainfall (1-15)	180	106	79.0	115	173	62	105	15	37	40	120	101	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	46.0	73	123	203	218	158	127	2	102	265	127	218	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

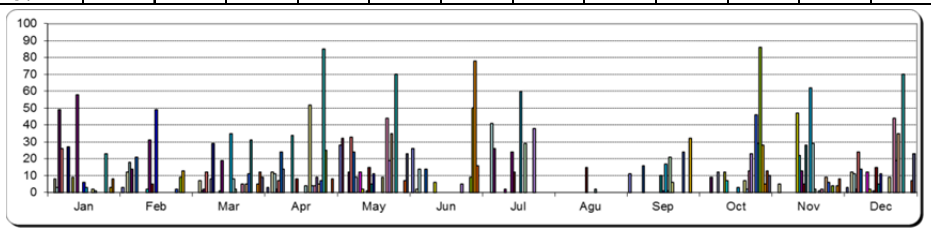


Figure B.31 Rainfall Fluctuation (2011)

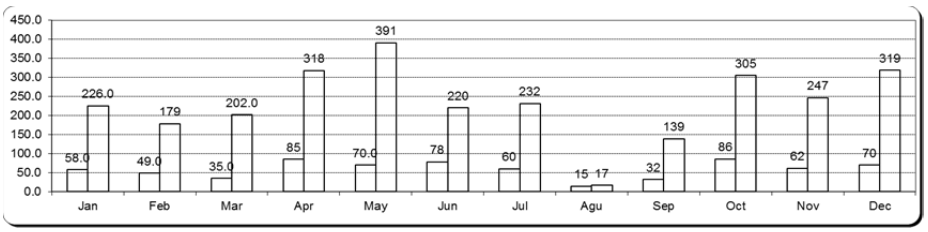


Figure B.32 Maximum Rainfall and Total Rainfall per Month (2011)

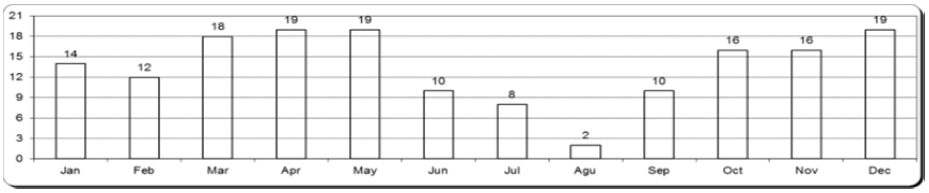


Figure B.33 Total Rainy Days (2011)

Table B.11 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2011)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	28	21	24.5	28.7	20.2	24.5	27.8	20.8	24.3	28	21.5	24.8	28.8	20.5	24.7	28.8	20	24.4	25.8	19	22.4	29.8	16.8	23.3	29.8	19.6	24.7	31	20.5	25.8	28	22.2	25.1	28.8	21.8	25.3
2	27.2	21.1	24.2	28.2	20.8	24.5	30.8	20.6	25.7	35	21	28.0	30	19.7	24.9	29.6	20	24.8	29.4	17.6	23.5	31.2	18.8	25.0	30.6	18.9	24.8	30.2	21	25.6	26.9	21.2	24.1	27.8	20.8	24.3
3	27.1	21.4	24.3	27.2	21	24.1	27.1	20.6	23.9	28.9	21.8	25.4	30	20.4	25.2	30.4	19.5	25.0	28.2	19.4	23.8	30.8	18.7	24.8	29.8	18.8	24.3	30.6	20.4	25.5	26.6	21	23.8	27	20.6	23.8
4	27.7	21	24.4	27.6	21.1	24.4	28	20.7	24.4	29.8	21.2	25.5	30.2	19.7	25.0	29.4	20	24.7	31	19.4	25.2	29.4	18.6	24.0	30.8	18	24.4	30.8	18.8	24.8	23.4	21.6	22.5	30	21.8	25.9
5	26.4	20.8	23.6	25.9	20	23.0	28.6	20.8	24.7	29.2	21.2	25.2	25	20	22.5	29.2	19	24.1	29.2	20.6	24.9	29	18.4	23.7	30.4	18.6	24.5	30.6	20.8	25.7	27.4	19.7	23.6	29.4	20.3	24.9
6	29	20.8	24.9	26.2	20.4	23.3	29.8	20.8	25.3	30.3	21.3	25.8	29	20.2	24.6	29.6	18	23.8	29.6	19	24.3	29.4	18.6	24.0	30.3	18.6	24.5	29.2	21	25.1	26.6	20.2	23.4	30	20.6	25.3
7	27.8	20.8	24.3	27.7	20.6	24.2	29.7	20.4	25.1	36	21.2	28.6	27.2	20.2	23.7	29.4	20.2	24.8	29.6	17.4	23.5	28.4	17.5	23.0	31	17.7	24.4	31	20.8	25.9	27.4	19.2	23.3	29.6	19.7	24.7
8	27.8	21	24.4	29	20.4	24.7	29.2	21.4	25.3	34	22	28.0	28.4	19.5	24.0	29.2	20	24.6	28.1	17.2	22.7	29.4	19	24.2	31.8	18	24.9	25.8	21.2	23.5	28	19	23.5	31.4	20.6	26.0
9	28.2	21	24.6	29.2	20.8	25.0	27.9	20.2	24.1	27.4	20.8	24.1	31	19.4	25.2	30	20	25.0	28	17.1	22.6	30.8	19	24.9	30.8	17.2	24.0	27.4	20.4	23.9	27.4	19.8	23.6	30.4	21	25.7
10	27.8	20	23.9	29.5	20	24.8	28.8	20	24.4	29.8	20.6	25.2	28.8	19.4	24.1	29.6	19.8	24.7	29	18	23.5	29.6	19	24.3	30.3	17.4	23.9	29.2	20.2	24.7	26.4	19.6	23.0	28.6	21.8	25.2
11	27	20.6	23.8	29	20	24.5	29.6	20	24.8	29	22.1	25.6	30	20.2	25.1	29.4	19.2	24.3	28.4	19	23.7	29	19.4	24.2	31.6	18.4	25.0	30.1	20.4	25.3	29.1	20.6	24.9	29	19.2	24.1
12	26	20.5	23.3	29.2	20	24.6	29.6	20.3	25.0	30	19.8	24.9	28.4	20.6	24.5	29.3	18.6	24.0	29	19	24.0	28.8	19	23.9	30.8	17.8	24.3	30.8	18.8	24.8	31.7	20.2	26.0	29.6	19.8	24.7
13	26.5	20.6	23.6	30.2	20.2	25.2	28.7	20.4	24.6	29.5	20	24.8	30	20.4	25.2	29.4	19.2	24.3	29.6	19	24.3	30	19.8	24.9	31	18.2	24.6	31.4	18.5	25.0	27	18.8	22.9	29.4	18.8	24.1
14	26.6	20.2	23.4	28.8	20.4	24.6	31.2	20	25.6	28.6	20.4	24.5	28.6	21.2	24.9	29.8	19	24.4	28.8	18.4	23.6	30.8	19.2	25.0	28.5	20.4	24.5	30.8	18.2	24.5	30	20.2	25.1	29.8	21.4	25.6
15	25.5	20.7	23.1	25.8	20.2	23.0	28.6	21	24.8	28.5	20	24.3	27.2	20.6	23.9	30	17.6	23.8	30.5	18	24.3	30.2	17	23.6	31.2	18.4	24.8	31.4	18.4	24.9	28.2	19.8	24.0	29.2	20	24.6
16	25.6	20.4	23.0	28.5	20	24.3	31.4	18.8	25.1	29.2	20	24.6	30	18.5	24.3	30.2	17	23.6	29.5	18	23.8	29	18.2	23.6	30.8	18.4	24.6	32.4	19	25.7	28.4	21.4	24.9	29.4	21.2	25.3
17	27	20.6	23.8	29	20	24.5	27.3	20.6	24.0	32	19.8	25.9	29.8	18.8	24.3	30.2	17.4	23.8	28.4	18.5	23.5	28.8	17.8	23.3	29	20	24.5	32.2	20	26.1	29.4	20.4	24.9	30	21.8	25.9
18	26.2	20.8	23.5	29.2	20.2	24.7	32	20	26.0	29.4	18.8	24.1	25.8	20	22.9	29.2	16.2	22.7	28.6	18	23.3	28.8	18	23.4	29	20	24.5	32	20	26.0	29	19.6	24.3	29	21.8	25.4
19	28.8	19.8	24.3	29	20.2	24.6	27.6	20.8	24.2	28	18.8	23.4	28	19	23.5	28	16.2	22.1	27.4	18.2	22.8	29.2	18.4	23.8	29	18.4	23.7	32.6	20	26.3	30	18.4	24.2	28	18.4	23.2
20	27.2	20.4	23.8	29.2	20.1	24.7	29.4	20.5	25.0	28	20.2	24.1	29	18.7	23.9	27.6	17.4	22.5	29	19	24.0	30	18.6	24.3	27.6	18	22.8	29.8	20.2	25.0	30	21.2	25.6	29	21.2	25.1
21	26	20.2	23.1	30.3	20.2	25.3	28.2	20.4	24.3	28	20.6	24.3	27.4	18.4	22.9	29.4	17.8	23.6	27.2	19	23.1	29.2	19	24.1	29.4	18	23.7	30	19	24.5	27.7	20.6	24.2			0.0
22	27.4	20.4	23.9	27.8	20	23.9	27.4	19.3	23.4	30	20.2	25.1	29	19.4	24.2	29.6	18	23.8	28.5	18.8	23.7	30.4	17.6	24.0	29.3	17.6	23.5	29.6	20	24.8	27.6	17.6	22.6	30.4	17.6	24.0
23	28.2	20.1	24.2	29.6	20.6	25.1	27.4	19.2	23.3	28.8	20.6	24.7	29.5	19.8	24.7	29.8	18.4	24.1	29.1	19	24.1	29.8	18	23.9	30.6	17.2	23.9	29.4	20	24.7	29.2	19.2	24.2	30	20	25.0
24	28.2	20.4	24.3	29.2	21	25.1	28	20.6	24.3	27	19.8	23.4	29.8	19	24.4	29	18.6	23.8	29.6	19	24.3	30.8	18	24.4	30.8	17.2	24.0	31	19.4	25.2	29.8	20.8	25.3	31	22.4	26.7
25	27.5	21.3	24.4	29.2	21	25.1	27.4	19.8	23.6	27.6	19.4	23.5	29.4	20.2	24.8	31	18	24.5	29.7	19.4	24.6	30	16.7	23.4	31	17	24.0	27	20.8	23.9	30.2	20.8	25.5	28	22	25.0
26	29.6	20.8	25.2	28.8	21.2	25.0	27.5	21.2	24.4	27.2	20	23.6	29	20	24.5	29.4	15.8	22.6	29	17.9	23.5	29.2	16	22.6	32.8	19	25.9	31	20.2	25.6	30.4	21	25.7	28.6	20.8	24.7
27	30.6	20.5	25.6	27.8	21.3	24.6	29.4	20.8	25.1	26.4	19	22.7	29.4	21	25.2	28.4	19.8	24.1	29.8	18.2	24.0	30.6	16.2	23.4	31.2	19	25.1	31.2	21.8	26.5	31.3	20.4	25.9	29.3	20.8	25.1
28	28.2	20.6	24.4	27.6	21	24.3	27	20.2	23.6	29	19.6	24.3	30.2	20.6	25.4	28.2	20.8	24.5	29.8	18.7	24.3	30.8	16.6	23.7	30.6	17	23.8	31.2	22	26.6	31	21	26.0	29	20.8	24.9
29	29.4	20.8	25.1				29.7	21.4	25.6	29.4	17.7	23.6	30	19.4	24.7	27.6	20.3	24.0	29.6	18.6	24.1	30.6	17.7	24.2	30.4	17	23.7	31	20	25.5	28.4	21.2	24.8	29.8	21.6	25.7
30	30.6	20.9	25.8				26.4	21.2	23.8	27.8	20.4	24.1	29.2	19.2	24.2	27	20.6	23.8	29.6	17.4	23.5	30.2	19.6	24.9	31.4	19.4	25.4	29.4	20.8	25.1	29	20.8	24.9	30	21.8	25.9
31	27.4	21.8	24.6				27.4	21.2	24.3				29.4	19.4	24.4				29.8	16.8	23.3	30.8	18	24.4				30.8	20	25.4				29.8	22.4	26.1

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	75	84	73	76	83	84	85	70	72	70	85	85
2	74	81	70	71	80	83	78	70	67	71	86	85
3	78	80	78	69	79	77	78	68	69	69	87	73
4	80	84	78	76	75	87	75	69	65	70	90	76
5	81	82	80	74	80	80	78	69	64	70	86	85
6	80	81	81	73	77	76	63	72	67	68	87	86
7	82	84	76	65	80	78	69	69	68	73	80	78
8	83	79	81	70	81	76	71	70	57	87	88	67
9	80	71	80	76	80	76	75	69	63	78	89	76
10	79	69	75	73	79	67	73	69	63	78	86	82
11	75	77	76	79	79	69	70	75	63	79	77	79
12	81	80	71	78	77	74	77	74	69	72	77	82
13	82	76	70	79	83	74	78	72	71	66	86	79
14	75	82	64	84	83	74	79	69	73	64	82	85
15	79	83	76	81	86	71	74	66	76	64	85	84
16	85	83	70	82	82	66	75	69	70	64	82	80
17	78	80	77	78	75	69	75	72	75	68	80	76
18	84	73	81	83	83	70	75	73	81	67	82	74
19	81	75	81	80	81	72	79	75	81	60	79	80
20	80	71	83	83	83	73	79	67	72	73	85	78
21	81	72	88	82	85	71	79	68	77	72	88	
22	84	79	82	85	80	74	75	67	70	75	91	79
23	81	73	75	85	83	70	75	66	67	82	83	80
24	79	74	81	89	81	72	72	66	62	75	82	78
25	81	76	83	84	76	71	70	54	63	85	80	86
26	77	79	85	85	78	72	69	63	69	75	77	82
27	81	80	80	91	81	78	69	65	66	75	74	76
28	79	85	72	90	80	80	67	64	66	79	81	80
29	82		74	84	76	80	68	65	66	82	81	80
30	77		77	81	70	86	66	74	69	82	86	74
31	74		74		76		67	71		75		69

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.7	2.2		2.4	3.9	3.6	2.9	7.9	5.8	7.7	2	1.4
2	2.3	3.5	2.1	6.6	3.5	3	7.8	7.3	7.3	5	1.4	6.3
3	2	3	7.6	2.4	6.3	5.5	6.7	7.8	8	6.9	0	2
4	4.9	2	0.5	6.6	7.9	2.9	7.4	6.2	6.8	7.6	1.4	4.3
5	0.9	0.3	8	6.5	0	5.1	7.3	7.6	6.5	7.4	1.9	4.6
6	4.2	3.4	4.1	7.4	6.2	7.9	7.7	7.9	5.1	1.7	0	0
7	2.3	4	6.3	6.6	2.6	6.5	6.6	7.7	6.9	5.2	1.3	6.3
8	1	6.6	6.6	3.9	2.8	7.7	7.5	7.6	7.8	0.2	3	7.6
9	6	3.5	0.8	2.9	2.4	7.8	5.2	7.3	6.5	0.5	1.4	4.2
10	2.6	7.5	8	5.2	4.6	8	7.5	7.2	5.9	4.6	4.2	2.6
11	3.9	4.5	4	1.2	6.1	5.3	4.8	5.7	7	4.7	5.7	3.5
12	1.2	5.3	7		5.2	5.5	6.2	5.7	5	6.1	5.6	2.6
13	2.4	7.3	8	3.9	5.7	7.9	5.3	6.8	4.9	7.4	1.9	3.7
14	0.6	4.5	1.2	2.4	2.7	7.3	5.1	7.5	5.8	6.5	5	1.8
15	0.9	0.4	4	3.7	4.4	8	6	7.6	5	6.2	1.6	4.8
16	2.5	5.7	3.7	4.5	7.1	7.2	5.6	4.5	7	7.3	5.2	6.2
17	2.8	8	5	5.7	7.5	8	5.8	4.8	4.2	6.5	4.8	4.6
18	2.3	7.7	3.9	5.1	1.3	7.7	4.8	4.3	3.9	7.1	7.1	4.1
19	4.4	7.8	5.5	3.7	3.7	6	5.5	6.1	2.8	7.8	4.9	1.8
20	1.5	8	4	3.9	4.3	4.5	4.3	8	4.7	3.2	2	3.2
21	0.3	7.3	0.4	1.4	4.3	5.5	4.9	7.7	5	1.9	2.2	
22	1.8	3.4	2	4.3	4.3	7.5	5.2	8	7.2	4.9	1.9	4.5
23	4.7	6	1.2	4.3	4.9	8	7.9	7.9	6.9	3.6	4.4	4.9
24	5.6	6.6	0.5	2	3.6	7.6	8	7.3	6.7	6.6	4.2	6.4
25	1.8	2	3	3	7.5	7.5	6.7	7.5	5.8	3.3	4	2.3
26	7	7.1	2.6	3.1	6.8	6.9	7.8	6.8	7.5	0.3	6.6	5.3
27	7.4	3.6	4.4	2.4	5.7	1.9	6.4	7.9	7.1	5.2	5.4	4.4
28	5.9	0.4	1	4.7	5.9	2.7	7	7.3	7.5	4.7	4.4	3.5
29	6.2		7.2	5.4	6.8	3.6	7.8	6.6	7.2	4.5	2.1	5.6
30	7.1		1.5	4.5	6.2	2	7.3	4.7	7.4	5.6	2.6	2.6
31	4.4		2.9		3.4		7.3	4.7		7.2		2.6

DAILY RAINFALL DATA (mm)

Station Name	: Cipanas-Pangalengan		
District	: Pangalengan	South Latitude	: 07^0 11' 05"
Regency	: Bandung	East Longitude	: 107^0 35' 15"
Water Basin	: Citarum	Equipment Type	: Automatic
Province	: West Java	Owner	: Water Resources Service Department - Ministry of Public Works

Year of Data: 2012

Date	Month												Yearly
	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec	
1	17.5	0.0	0.0	6.5	12.0	4.5	0.0	0.0	0.0	14.0	0.0	0.0	
2	0.0	14.0	46.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.0	
3	24.0	20.0	20.0	19.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	
4	0.0	0.0	30.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5	13.0	14.5	0.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.0	
6	23.0	0.0	2.0	0.0	5.5	5.5	0.0	0.0	0.0	0.0	6.0	49.0	
7	19.0	9.0	66.0	0.0	0.0	5.5	0.0	0.0	5.0	0.0	13.0	0.0	
8	0.0	22.5	16.0	30.0	0.0	0.0	0.0	0.0	0.0	74.0	0.0	29.0	
9	0.0	1.5	11.0	19.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	
10	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	27.0	0.0	
11	0.0	18.0	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
12	19.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0	
13	8.0	34.0	3.0	10.0	16.0	0.0	0.0	0.0	0.0	0.0	13.0	0.0	
14	16.5	0.0	0.0	18.0	21.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	
15	14.0	3.0	0.0	4.0	9.5	0.0	0.0	0.0	0.0	10.0	26.0	0.0	
16	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	20.0	
17	6.0	25.5	0.0	21.5	2.5	0.0	0.0	0.0	0.0	0.0	29.0	0.0	
18	6.5	0.0	0.0	11.0	11.0	0.0	0.0	0.0	0.0	24.0	87.0	21.0	
19	8.0	6.5	10.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	35.0	0.0	
20	0.0	44.0	5.0	20.0	7.0	0.0	0.0	0.0	0.0	0.0	7.0	8.0	
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
22	0.0	68.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	61.0	14.0	
23	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	14.0	
24	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.0	5.0	
25	0.0	16.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	
26	0.0	49.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.0	14.0	0.0	
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	5.0	0.0	
28	0.0	31.0	25.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
29	5.0	2.0	7.0	0.0	12.0	0.0	0.0	0.0	16.0	45.0	15.0	25.0	
30	24.0		4.0	41.0	0.0	0.0	0.0	0.0	0.0	5.0	56.0	19.0	
31	0.0		34.0		22.5		0.0	0.0		9.0		18.0	
												o	
Maximum Rainfall	24	68	66	41	23	6	5	0	16	74	87	49	87
Total Rainfall	204	398	285	268	119	16	5	0	31	245	467	334	2371
Total Days of Rainfall	14	21	16	17	10	3	1	0	3	10	18	16	129
Average Rainfall	7	14	9	9	4	1	0	0	1	8	16	11	
First-Half Rainfall (1-15)	154	143	198	166	64	16	5	0	15	98	90	160	
Total Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	
Second-Half Rainfall (16-31)	50	255	87	103	55	0	0	0	16	147	377	174	
Total Days of Empty Data	0	0	0	0	0	0	0	0	0	0	0	0	

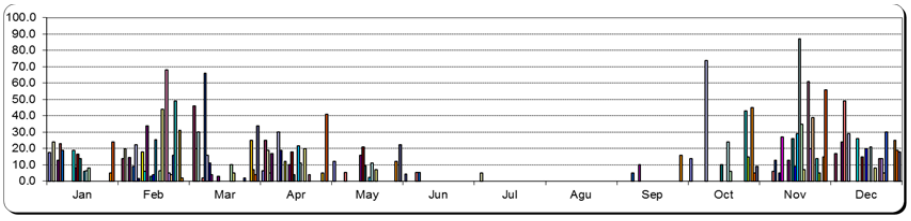


Figure B.34 Rainfall Fluctuation (2012)

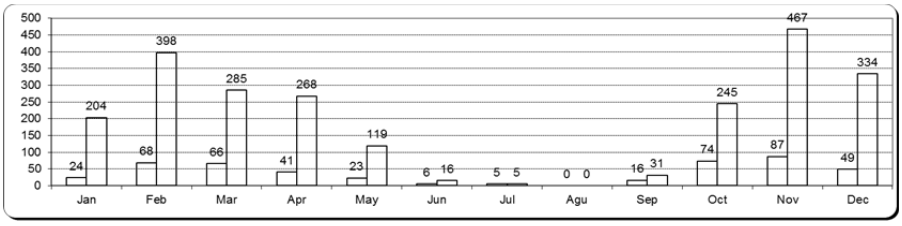


Figure B.35 Maximum Rainfall and Total Rainfall per Month (2012)

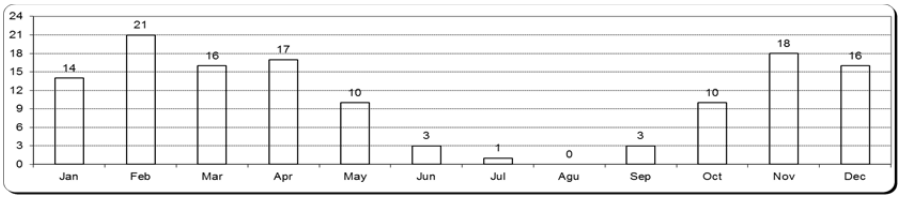


Figure B.36 Total Rainy Days (2012)

Table B.12 Temperature, Humidity and Sunshine in Cikalong – Pangalengan – West Java Area (2012)

Temperature (°C)

Date	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
1	27.2	22.2	24.7	29.8	20	24.9	27.6	19.5	23.6	27.8	20.6	24.2	29	19.6	24.3	28.4	19.2	23.8	29.2	16.4	22.8	29.2	16.6	22.9	31	17.5	24.3	31	20.5	25.8	32.7	19.8	26.3	30	20.6	25.3
2	28.6	20.8	24.7	27.8	20.6	24.2	30	19.2	24.6	29.4	20.5	25.0	31.3	20.2	25.8	29	19	24.0	30.2	15.8	23.0	29.8	18.6	24.2	31	17.2	24.1	31.3	21	26.2	32	20.7	26.4	28	19.6	23.8
3	31.2	21.8	26.5	28.4	21	24.7	29.4	21	25.2	28	20.7	24.4	30.2	20.8	25.5	29.2	19.6	24.4	30	15.8	22.9	29	16.3	22.7	29.4	17.2	23.3	32	20.7	26.4	29	22	25.5	28.8	19.4	24.1
4	30.4	20.5	25.5	27	20.2	23.6	29	21.8	25.4	28.4	20	24.2	29.7	18.6	24.2	29.2	20.8	25.0	28.6	15.8	22.2	29	16.1	22.6	30.7	17	23.9	31	19.8	25.4	30.2	21.4	25.8	29	19.8	24.4
5	30.1	20.6	25.4	29.8	20.5	25.2	28.4	20.4	24.4	28.2	18.5	23.4	28.9	18.6	23.8	26.2	20.8	23.5	29.4	17.4	23.4	31	17.2	24.1	30.8	17.6	24.2	30.4	19.8	25.1	30.8	21	25.9	29.2	20	24.6
6	28.8	20	24.4	29.2	20.8	25.0	30	19.6	24.8	28	18.5	23.3	27.8	19.2	23.5	26.4	21.2	23.8	29	17.6	23.3	31	17.4	24.2	29.6	18	23.8	27.2	19.8	23.5	30.4	20	25.2	26.2	21.2	23.7
7	27	20.3	23.7	30.6	20.6	25.6	30.4	20	25.2	29	21.2	25.1	25.4	20.8	23.1	28.6	19.6	24.1	29.4	18.2	23.8	31	19.5	25.3	30.4	20	25.2	28.9	20	24.5	32.4	20.5	26.5	28.2	19.8	24.0
8	27	21.4	24.2	30.4	21.2	25.8	25.8	20	22.9	27.6	21	24.3	27.4	19.6	23.5	30.5	21	25.8	30	18	24.0	31	17.1	24.1	30.4	19.2	24.8	28.4	19.2	23.8	29.4	19.6	24.5	27	20.2	23.6
9	27.4	21.6	24.5	29.6	21.6	25.6	27.6	20	23.8	29	19	24.0	28.8	19.2	24.0	27.8	21.5	24.7	28.5	18.2	23.4	29.8	15.4	22.6	31	19.2	25.1	28.8	19.6	24.2	28.4	21.4	24.9	31.2	19.1	25.2
10	25.4	21.1	23.3	28.6	20	24.3	26.8	20.8	23.8	27.8	19.6	23.7	30.8	19.8	25.3	28.4	21.5	25.0	29.2	19.5	24.4	30	16	23.0	31.2	20.5	25.9	31.4	20.2	25.8	29.6	19.8	24.7	30.2	21.1	25.7
11	25.4	20.6	23.0	29	19.8	24.4	27.2	20.7	24.0	28.6	18	23.3	29.6	19.7	24.7	28	21.4	24.7	29.2	19.8	24.5	30	16.8	23.4	32.2	19.2	25.7	33.8	19.6	26.7	29.2	20	24.6	28.9	20.4	24.7
12	28	20.4	24.2	28	20.6	24.3	28.6	20.2	24.4	29.4	20.4	24.9	30.2	19.4	24.8	28	21.4	24.7	27.8	18.8	23.3	29.6	18.5	24.1	31.2	17	24.1	30.8	18.8	24.8	29	19.6	24.3	28.7	20.6	24.7
13	25.6	21.4	23.5	29.8	20.5	25.2	27.6	20.8	24.2	29	19.5	24.3	30.6	18.5	24.6	29	20.8	24.9	28.8	18	23.4	32.6	18.7	25.7	31.8	17.8	24.8	31.4	18.5	25.0	28.8	21.5	25.2	30.4	20.4	25.4
14	27.4	20	23.7	31.2	20.4	25.8	27.8	21.5	24.7	28.4	19.6	24.0	28.8	21.2	25.0	29.7	18.7	24.2	29.4	18	23.7	30	18.5	24.3	31.6	18	24.8	31.4	18.2	24.8	30.1	21.1	25.6	28.6	20.6	24.6
15	28	20.4	24.2	29.8	19.3	24.6	28.4	20.8	24.6	27.5	20.6	24.1	26.6	20.4	23.5	30	18.2	24.1	30	18.2	24.1	30.5	17	23.8	30.4	19	24.7	31.4	18.4	24.9	29.5	20.1	24.8	31.2	19.3	25.3
16	30.6	20.6	25.6	27.2	19.4	23.3	28.7	20	24.4	28.8	18.6	23.7	28	20.6	24.3	31.4	17.2	24.3	29.4	17.2	23.3	30.2	17.4	23.8	33.4	19	26.2	32.3	20	26.2	29	19.9	24.5	29.8	21.4	25.6
17	27.4	21	24.2	28	19	23.5	27	20.4	23.7	29	19.2	24.1	29.8	18.8	24.3	30.4	16.8	23.6	29.2	18.4	23.8	30.1	17.5	23.8	31.8	19.6	25.7	30	20	25.0	29.2	20.4	24.8	29.4	21.2	25.3
18	27.6	20.8	24.2	31	19.2	25.1	28	20	24.0	29.4	19.2	24.3	28.4	18.4	23.4	29.6	18.4	24.0	28.2	18	23.1	30	17.2	23.6	31.8	19.6	25.7	29.8	20	24.9	27	21.3	24.2	29	20.6	24.8
19	30.4	20.6	25.5	25.2	20.2	22.7	29	20.7	24.9	29.6	21	25.3	30.7	19	24.9	29.8	19.4	24.6	28.3	18	23.2	30.6	17.4	24.0	31.2	18.4	24.8	28.2	20.5	24.4	28	18.4	23.2	30.4	18.4	24.4
20	29	21	25.0	27.4	20.3	23.9	27.4	20.8	24.1	28.4	20.5	24.5	28.2	19	23.6	29.8	18	23.9	28.4	19	23.7	30.4	18.4	24.4	30.6	21.2	25.9	31.2	20.4	25.8	30	21.2	25.6	29.1	20	24.6
21	28.5	21	24.8	29	19.8	24.4	29.3	20.6	25.0	29.2	21.3	25.3	30.6	19.1	24.9	31	17.6	24.3	30	18.4	24.2	30	16.4	23.2	30.6	20	25.3	30.8	19	24.9	29.2	19.4	24.3	28.2	20.7	24.5
22	28	21.2	24.6	30.4	20	25.2	30.4	20.8	25.6	28.7	20.5	24.6	30.4	19.2	24.8	28.2	18.4	23.3	31.8	17.4	24.6	30.7	16.6	23.7	31.5	17.6	24.6	31.6	20.5	26.1	26.6	17.6	22.1	28.4	17.6	23.0
23	26.6	21	23.8	28.4	21	24.7	31	21.2	26.1	29.6	19.2	24.4	29.8	17.5	23.7	28.9	18.8	23.9	31	17.7	24.4	30.3	19.4	24.9	31.6	19.6	25.6	33.7	18	25.9	26	19.8	22.9	29	20.6	24.8
24	29.2	20.6	24.9	28.4	21	24.7	31.2	20.5	25.9	30.6	19.6	25.1	30.2	19.6	24.9	30.3	19.2	24.8	29.4	16	22.7	30.6	19	24.8	30.8	20	25.4	34	18	26.0	28.4	20.1	24.3	28	20.6	24.3
25	25.8	20.6	23.2	29.2	21	25.1	30.8	20.8	25.8	30.4	20	25.2	29.8	17.6	23.7	29.2	17	23.1	29.4	16	22.7	31	18	24.5	30.8	20.2	25.5	30.4	20.6	25.5	28.7	20	24.4	29.6	21	25.3
26	27.6	21.2	24.4	29	20.4	24.7	29.2	21.2	25.2	29.8	20	24.9	29	17.6	23.3	28.6	17.4	23.0	28.5	16.2	22.4	30.8	17.7	24.3	30.8	18.4	24.6	31	20.2	25.6	28.5	19.8	24.2	28.5	20.4	24.5
27	28.6	21.2	24.9	27.4	20	23.7	29.2	20.2	24.7	29.6	20.8	25.2	29.5	18	23.8	28.2	18.1	23.2	29.5	15	22.3	30.6	17.8	24.2	30.9	19.8	25.4	31.2	21	26.1	27.2	19.6	23.4	30	20	25.0
28	27.8	20.8	24.3		21.6	10.8	30.3	18.4	24.4	30	21.2	25.6	28.2	18.8	23.5	29.8	17.4	23.6	30.4	15	22.7	30.7	21	25.9	29.2	19.2	24.2	31.2	19.8	25.5	28.6	19.7	24.2	28.4	20.6	24.5
29	27	21	24.0	27.4	19.4	23.4	29	19.2	24.1	28	20.6	24.3	29.8	19.2	24.5	29.7	18	23.9	30.2	17.7	24.0	30.6	19	24.8	30.3	21	25.7	29.8	19.4	24.6	30.8	20	25.4	29	21.4	25.2
30	29.4	21	25.2				29	18.4	23.7	27.8	20.9	24.4	27.2	19.8	23.5	30	17	23.5	29.4	17.5	23.5	30.8	18.4	24.6	30.2	20.5	25.4	29.4	20.8	25.1	27.2	20.4	23.8	30.2	21.4	25.8
31	25.8	20.8	23.3				28.3	19	23.7				31.3	17.5	24.4				29	16.4	22.7	31	18.7	24.9				29.6	21	25.3				29.8	21.4	25.6

Humidity (%)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	83	74	84	89	81	81	64	66	64	74	67	78
2	77	78	81	80	77	76	66	57	60	71	72	90
3	82	75	71	86	83	74	75	68	62	79	80	84
4	84	74	77	83	76	76	72	68	62	71	77	86
5	82	67	80	88	78	82	64	68	63	76	75	82
6	83	69	76	81	82	84	70	72	67	81	74	92
7	81	69	77	83	85	81	72	66	70	79	71	88
8	79	73	83	84	80	75	71	63	68	83	73	88
9	74	77	80	83	80	84	71	63	72	81	86	76
10	85	84	79	81	77	83	71	70	74	71	85	80
11	84	78	74	76	78	81	76	72	62		84	80
12	81	82	70	80	70	80	80	74	57	73	79	80
13	85	81	72	80	71	76	76	64	61	67	80	83
14	76	81	71	83	81	76	71	62	65	68	78	82
15	82	74	67	86	89	71	77	63	72	74	83	79
16	71	81	66	80	91	65	73	68	67	63	89	80
17	82	89	65	83	77	69	76	68	68	72	89	89
18	81	74	67	82	85	70	74	70	67	80	90	82
19	77	84	73	83	77	70	78	69	70	76	90	79
20	72	84	71	83	83	70	80	69	74	72	86	80
21	69	81	69	81	72	70	80	65	64	74	87	92
22	70	72	68	79	69	77	66	69	66	64	92	86
23	78	78	71	78	72	79	66	64	68		90	84
24	68	78	69	74	68	69	67	69	66		94	82
25	76	80	73	70	69	71	68	60	65	66	85	91
26	75	91	84	76	73	72	71	71	63	72	88	92
27	74	85	81	78	72	72	67	64	68	82	85	82
28	71	88	86	82	73	69	68	65	73	79	87	83
29	75	87	77	78	75	69	63	66	73	77	87	83
30	76		74	84	77	67	65	65	73	77	88	78
31	73		78		81		68	70		80		77

Sunshine (hr)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.5	7	4.7	3.3	5.2	4.6	8	7.4	7.6	4.2	7.3	6.5
2	3.2	2.5	6.2	4.8	7.5	7	6.9	7.4	7.5	4.9	6.2	3.2
3	2.9	2.6	2.5	2.7	6.6	7.8	3.6	7.2	8	7	1	2.7
4	3.7	2.1	5	3.2	7.2	7.1	5.6	6.7	6.5	5.6	2.8	2.4
5	3.8	7	5.3	2	4.8	0	8	7.1	6.6	6.6	4.2	4.6
6	1.6	7.3	6.1	5.1	1.5	2.2	5	6.8	5.8	2.8	4.3	1.6
7	0.5	8	6.3	4.1	2.3	3.9	5.7	7.5	6	4.1	5.1	3.1
8	1.4	5.9	0.2	2.5	5.8	7.8	8	7.7	5.1	3.8	3.5	1.3
9	1.7	4.5	1.6	5.8	2.4	3.6	5.9	6.7	5.7	4.6	2.1	7.1
10	1	3.4	1.1	2.5	2.4	4.3	6.8	6.6	6	5.8	6.4	6
11	0.9	5.7	1.9	3.3	8	0.4	4	5.3	7.8	8	3.4	3.1
12	2.8	4.3	6.6	4.9	8	3.1	4.9	6.3	7.7	3.8	1.4	3.2
13	3	5.3	2.7	4.5	7.6	6.2	5.3	8	7.7	5.3	1.7	3
14	3.1	4.2	3.7	1.8	3.5	7.7	7.6	8	6.2	6.4	6	1.4
15	3.8	8	0.6	1.9	1.8	8	6	8	3.8	3.6	1.4	6.6
16	7.6	7.2	6.2	4.7	4.5	8	7	8	7.8	7.8	4.3	6.5
17	3.9	1.2	3.3	3.7	7.2	7	5.8	6.1	5.2	2.8	2.1	1.8
18	2.7	4.2	2.8	5.5	4.1	7.7	6.1	6.5	6.8	5.7	1.7	3.3
19	5.8	9.1	4	5.8	7.7	6.3	5.5	7.3	5.8	3.4	0.9	5.2
20	4.4	1.5	3.2	4.2	3	7.4	2.2	7	4.4	4	2.6	3.9
21	5.2	5.8	6.6	5.1	8	6.3	4.9	7.6	5.5	5.1	3.9	2.9
22	1.9	5.2	6.7	4	7.3	4.4	5.2	7.4	5.2	7.4	1.5	2.2
23	2	4	7.6	7.8	6.7	7.9	7.8	6.9	6.4	8	0.6	4.6
24	7.6	4	7	7.8	7.6	8	7.9	8	5	7.5	3	3.1
25	2.6	5.6	6.3	7.7	7.8	6.8	6.2	7.9	4.4	6.5	2.9	2.4
26	0.2	3.1	2.8	5.4	5.8	8	5.4	6	7	0.3	2.3	2.1
27	8	2.6	4.4	5.3	6.2	7.3	7.6	5.1	6.6	3.1	3.1	6
28	4.3	1.9	6.1	6.3	5.3	7.9	8	4.3	3.9	2.6	0.9	1.3
29	2.9	0.4	6.2	4.7	4.7	7.6	8	6.2	4.5	4.2	5.1	3.2
30	4.9		6.3	3.4	2.8	7.4	7.9	7.6	4.1	2.9	2.6	2.6
31	0		3.7		0.9		6	7.5		5.4		2.6

Table B.13 Monthly Rainfall Average from 2001 until 2012

1. Total Daily Rainfall per Month (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	378	179	371	383	119	101	52	96	118	65	62	61
2002	476	178	426	260	17	35	32	2	0	31	96	358
2003	189	234	331	82	90	4	0	63	128	261	375	340
2004	321	274	368	133	178	23	62	0	99	29	207	434
2005	245	378	375	190	89	90	94	4	81	107	0	0
2006	307	358	149	342	38	0	0	0	11	49	71	525
2007	97	335	308	0	89	93	2	10	5	231	262	372
2008	190	111	461	253	60	15	0	30	22	266	505	375
2009	291	400	280	234	217	38	5	0	90	253	339	164
2010	498	629	453	238	248	253	134	256	370	257	373	494
2011	226	179	202	318	391	220	232	17	139	305	247	319
2012	204	398	285	268	119	16	5	0	31	245	467	334
Average	284.96	304.17	333.83	224.96	137.67	73.71	51.43	39.71	91.09	174.61	250.13	314.63
Std. Dev.	119.70	142.38	95.62	109.57	105.64	84.01	71.63	74.48	101.25	107.85	166.82	161.44
Variance	14328.93	20271.11	9143.02	12005.79	11160.83	7057.16	5131.31	5546.79	10251.38	11630.72	27829.37	26063.05
Skewness	0.52	0.87	-0.54	-0.72	1.35	1.39	1.72	2.62	2.04	-0.40	-0.02	-0.87

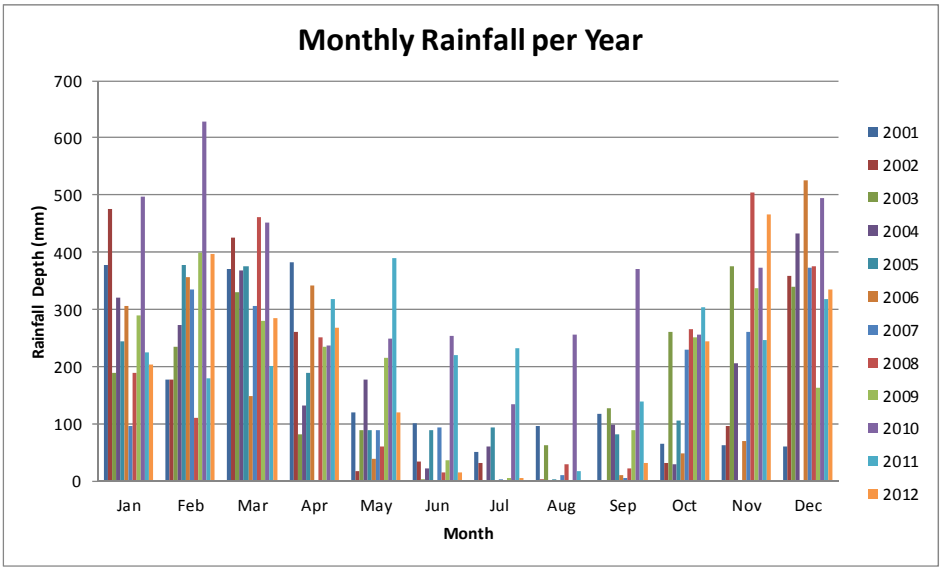


Figure B.37 Monthly Rainfall per Year

Table B.13 Monthly Evaporation from 2001 until 2012

2001

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	°C	26.5	23.3	24.0	24.2	24.3	23.9	23.4	24.0	24.5	23.6	24.0	24.4
3	Average Air Humidity	RH = ed/ea	%	79.9	79.4	80.2	81.7	79.2	76.2	77.3	71.2	73.8	84.3	85.2	70.9
4	Wind Speed	u2	km/day	68.5	74	67.8	56.8	61.9	65.2	81.7	110.2	81.1	88	58.9	46.5
5	Average Sunshine Hours	n	hr	3.32	3.34	3.41	4.76	4.64	5.54	5.36	5.63	5.21	3.68	3.15	5.82
6	Average Temperature	Tk = 273 + T	Kelvin	299.5	296.3	297.0	297.2	297.3	296.9	296.4	297.0	297.5	296.6	297.0	297.4
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
8	Max. Possible Sunshine Hours	N	hr	7.1	7.8	7.2	8.0	7.8	8.0	8.0	8.0	8.0	8.0	6.4	8.0
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	46.71	42.83	47.36	59.5	59.49	69.25	67	70.36	65.17	46	49.25	72.74
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	5.855	5.929	6.578	7.625	7.421	8.039	7.934	8.372	7.987	6.264	6.132	7.6
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.647	0.52	0.469	0.607	0.567	0.728	0.672	0.673	0.595	0.206	0.423	0.513
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	4.916	5.112	5.78	6.637	6.484	6.908	6.866	7.281	6.992	5.745	5.402	6.707
17	Saturation Vapour Pressure	ea = ed/RH		33.65	35.5	36.9	35.63	37.36	37.65	37.65	41.31	40.4	39.85	35.81	44.16
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	2.8	3.17	3.008	2.442	3.04	3.608	3.941	6.681	4.863	3.017	2.025	4.345
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	4.311	4.557	4.988	5.438	5.5	5.965	6.03	7.109	6.384	4.966	4.437	6.032
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	133.7	127.6	154.6	163.1	170.5	179	186.9	220.4	191.5	153.9	133.1	187

2002

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	°C	27.0	20.1	23.6	29.1	19.8	24.5	29.0	19.9	24.5	29.6	19.4	24.5
3	Average Air Humidity	RH = ed/ea	%	84.3	80.8	82.8	81.7	75.9	77.6	75.8	69.7	68.0	65.9	75.9	81.6
4	Wind Speed	u2	km/day	68.5	74	67.8	56.8	61.9	65.2	81.7	110.2	81.1	88	58.9	46.5
5	Average Sunshine Hours	n	hr	4.04	3.47	4.73	4.63	4.51	5.94	5.78	6.71	6.13	6.41	4.05	4.47
6	Average Temperature	Tk = 273 + T	Kelvin	300.0	293.1	296.6	302.1	292.8	297.5	302.0	292.9	297.5	302.6	292.4	297.5
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
8	Max. Possible Sunshine Hours	N	hr	8.0	8.0	8.0	7.3	6.3	8.0	8.0	8.0	8.0	8.0	7.5	8.0
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	50.52	43.38	59.15	63.42	71.53	74.29	72.22	83.87	76.58	80.08	54.04	55.82
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	6.136	5.972	7.547	7.95	8.391	8.436	8.35	9.469	8.918	8.976	6.491	6.38
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.689	0.526	0.564	0.641	0.663	0.774	0.717	0.784	0.684	0.329	0.457	0.409
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	5.14	5.148	6.605	6.911	7.308	7.24	7.215	8.212	7.788	8.198	5.71	5.652
17	Saturation Vapour Pressure	ea = ed/RH		31.93	34.89	35.76	35.6	39.01	36.98	38.39	42.19	43.8	51	40.17	38.37
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	2.084	2.904	2.54	2.431	3.687	3.34	4.281	7.174	6.424	8.404	3.685	2.387
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	4.267	4.507	5.444	5.631	6.273	6.126	6.377	7.915	7.398	8.257	5.131	4.719
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	132.3	126.2	168.8	168.9	194.5	183.8	197.7	245.4	222	256	153.9	146.3

2003

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	°C	27.7	20.3	24.0	28.6	19.5	24.1	29.4	19.6	24.5	29.7	19.4	24.5
3	Average Air Humidity	RH = ed/ea	%	75.0	82.1	82.0	77.9	74.9	71.2	67.8	69.4	71.1	76.8	80.3	81.0
4	Wind Speed	u2	km/day	68.5	74	67.8	56.8	61.9	65.2	81.7	110.2	81.1	88	58.9	46.5
5	Average Sunshine Hours	n	hr	5.07	3.50	0.27	4.62	5.46	6.38	6.32	5.62	5.17	4.39	3.95	2.60
6	Average Temperature	Tk = 273 + T	Kelvin	300.7	293.3	297.0	301.6	292.5	297.1	302.4	292.6	297.5	302.7	292.4	297.5
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
8	Max. Possible Sunshine Hours	N	hr	8.0	8.0	0.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.3	7.6
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	63.32	43.79	53	57.75	68.27	79.71	78.95	70.24	64.63	54.92	54.16	34.25
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	7.079	6.005	7.041	7.481	8.128	8.863	8.885	8.363	7.942	6.974	6.5	4.826
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.832	0.53	0.515	0.592	0.637	0.823	0.775	0.672	0.591	0.238	0.457	0.277
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	5.893	5.175	6.174	6.514	7.084	7.597	7.666	7.273	6.954	6.387	5.717	4.308
17	Saturation Vapour Pressure	ea = ed/RH		35.85	34.35	36.11	37.37	39.53	40.29	42.92	42.39	41.91	43.75	37.99	38.66
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	3.713	2.667	2.685	3.092	3.891	4.673	6.37	7.284	5.558	4.901	2.856	2.485
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	5.27	4.458	5.177	5.537	6.172	6.761	7.296	7.276	6.555	5.962	4.9	3.787
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	163.4	124.8	160.5	166.1	191.3	202.8	226.2	225.6	196.7	184.8	147	117.4

2004

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	°C	28.0	19.2	23.6	29.2	19.5	24.4	29.1	18.9	24.0	29.2	19.2	24.2
3	Average Air Humidity	RH = ed/ea	%	80.9	81.7	77.6	80.6	80.2	73.1	76.2	68.6	74.9	70.9	81.5	84.6
4	Wind Speed	u2	km/day	68.5	74	67.8	56.8	61.9	65.2	81.7	110.2	81.1	88	58.9	46.5
5	Average Sunshine Hours	n	hr	4.76	3.34	4.68	4.22	5.15	6.20	5.25	7.17	5.23	6.46	4.07	3.34
6	Average Temperature	Tk = 273 + T	Kelvin	301.0	292.2	296.6	302.2	292.5	297.4	302.1	291.9	297.0	302.2	292.2	297.2
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
8	Max. Possible Sunshine Hours	N	hr	8.0	7.9	7.9	6.0	8.0	8.0	7.8	8.0	8.0	8.0	7.6	7.5
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	59.55	42.24	59.29	70.33	64.44	77.46	67.25	89.6	65.42	80.73	53.57	44.49
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	6.802	5.883	7.558	8.521	7.82	8.686	7.954	9.934	8.007	9.027	6.456	5.564
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.79	0.515	0.565	0.701	0.606	0.803	0.674	0.832	0.597	0.331	0.453	0.34
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	5.671	5.074	6.615	7.395	6.822	7.449	6.882	8.606	7.01	8.245	5.68	4.946
17	Saturation Vapour Pressure	ea = ed/RH		33.26	34.51	38.15	36.12	36.93	39.26	38.19	42.87	39.77	47.41	37.41	36.98
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	2.639	2.737	3.527	2.624	2.869	4.258	4.191	7.552	4.574	6.67	2.633	1.919
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	4.805	4.406	5.732	6.032	5.693	6.537	6.113	8.305	6.314	7.795	4.809	4.081
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	149	123.4	177.7	180.9	176.5	196.1	189.5	257.5	189.4	241.6	144.3	126.5

2005

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	°C	28.5	20.2	24.3	28.8	20.3	24.5	29.2	20.0	24.6	29.3	19.8	24.5
3	Average Air Humidity	RH = ed/ea	%	83.2	85.4	84.4	82.7	81.7	84.9	80.0	77.6	79.0	81.1	81.6	84.3
4	Wind Speed	u2	km/day	68.5	69.5	70.5	71.5	72.5	73.5	74.5	75.5	76.5	77.5	78.5	79.5
5	Average Sunshine Hours	n	hr	3.91	4.28	4.57	4.76	5.44	4.83	5.88	5.96	5.11	4.52	4.34	3.10
6	Average Temperature	Tk = 273 + T	Kelvin	301.5	293.2	297.3	301.8	293.3	297.5	302.2	293.0	297.6	302.3	292.8	297.5
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5
8	Max. Possible Sunshine Hours	N	hr	7.4	8.0	8.0	7.7	8.0	7.7	8.0	8.0	7.7	8.0	8.0	6.8
9	Actual Vapour Pressure	ed	mmHg	26.9	27.9	28.9	29.9	30.9	31.9	32.9	33.9	34.9	35.9	36.9	37.9
10	Percentage of Sunshine	n/N	%	52.88	53.48	57.1	61.78	68.02	62.77	73.54	74.52	66.32	56.49	54.27	45.59
11	Solar Radiation	Ra	mm/day	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
12	Albedo for Water	r = 0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	6.31	6.354	6.621	6.966	7.426	7.039	7.833	7.905	7.3	6.576	6.412	5.772
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.716	0.646	0.602	0.56	0.519	0.403	0.369	0.281	0.172	0.08	0.01	-0.05
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	5.279	5.391	5.687	6.057	6.536	6.284	7.072	7.228	6.763	6.167	6.081	5.533
17	Saturation Vapour Pressure	ea = ed/RH		32.35	32.69	34.23	36.17	37.8	37.57	41.14	43.68	44.16	44.25	45.24	44.98
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	2.259	2.002	2.25	2.666	2.959	2.452	3.591	4.295	4.099	3.726	3.75	3.209
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	4.416	4.638	5.062	5.536	6.059	5.833	6.706	6.949	6.531	5.972	5.909	5.372
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	136.9	129.9	156.9	166.1	187.8	175	207.9	215.4	195.9	185.1	177.3	166.5

2006

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	°C	28.8	20.1	24.4	28.8	20.5	24.6	28.7	20.0	24.4	29.0	19.3	24.1
3	Average Air Humidity	RH = ed/ea	%	84.9	83.5	82.6	83.5	81.8	77.2	78.4	76.0	73.3	72.1	78.2	87.8
4	Wind Speed	u2	km/day	68.5	69.5	70.5	71.5	72.5	73.5	74.5	75.5	76.5	77.5	78.5	79.5
5	Average Sunshine Hours	n	hr	3.86	5.57	4.86	4.79	5.51	6.24	6.13	7.14	6.66	6.13	5.21	3.84
6	Average Temperature	Tk = 273 + T	Kelvin	301.8	293.1	297.4	301.8	293.5	297.6	301.7	293.0	297.4	302.0	292.3	297.1
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5
8	Max. Possible Sunshine Hours	N	hr	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.9
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	48.29	69.68	60.73	59.83	68.88	78.02	76.61	89.19	83.21	76.57	65.13	48.62
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	5.972	8.036	7.676	7.653	8.177	8.73	8.699	9.902	9.458	8.697	7.32	5.861
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.664	0.779	0.577	0.61	0.642	0.808	0.755	0.828	0.736	0.316	0.534	0.365
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	5.009	6.855	6.716	6.66	7.126	7.486	7.51	8.578	8.25	7.946	6.42	5.203
17	Saturation Vapour Pressure	ea = ed/RH		31.7	33.77	35.84	34.85	36.18	37.18	37.11	38.67	40.64	46.58	38.99	35.66
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	1.989	2.331	2.633	2.445	2.822	3.664	3.49	4.071	4.798	5.794	3.817	1.976
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	4.146	5.849	5.973	6.012	6.552	7.036	7.087	8.149	7.95	7.774	6.227	4.981
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	128.5	163.8	185.2	180.4	203.1	211.1	219.7	252.6	238.5	241	186.8	154.4

2007

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	°C	27.5	19.9	23.7	28.1	20.3	24.2	28.1	19.8	23.9	29.1	19.6	24.3
3	Average Air Humidity	RH = ed/ea	%	77.1	87.5	83.6	88.1	82.6	83.1	77.9	74.2	70.6	80.5	80.5	80.5
4	Wind Speed	u2	km/day	68.5	69.5	70.5	71.5	72.5	73.5	74.5	75.5	76.5	77.5	78.5	79.5
5	Average Sunshine Hours	n	hr	5.21	3.39	4.01	4.10	4.86	5.25	6.45	6.04	0.43	4.92	4.52	3.01
6	Average Temperature	Tk = 273 + T	Kelvin	300.5	292.9	296.7	301.1	293.3	297.2	301.1	292.8	296.9	302.1	292.6	297.3
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5
8	Max. Possible Sunshine Hours	N	hr	8.0	7.6	7.6	6.8	7.3	8.0	8.0	8.0	0.6	8.0	8.0	7.1
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	65.08	44.59	52.72	60.35	66.55	65.65	80.56	75.48	71.11	61.49	56.5	42.44
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	1.05	2.05	3.05	4.05	5.05	6.05	7.05	8.05	9.05	10.05	11.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	7.209	-115	-6.35	-3.57	-2.49	-1.82	-1.7	-1.38	-1.14	-0.88	-0.7	-0.51
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.852	0.537	0.512	0.615	0.623	0.696	0.789	0.715	0.641	0.262	0.474	0.327
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	5.997	5.226	6.155	6.696	6.967	6.671	7.775	7.634	7.407	6.86	5.867	4.818
17	Saturation Vapour Pressure	ea = ed/RH		34.89	32.24	35.39	33.04	35.84	34.55	37.34	39.61	42.21	41.73	37.88	38.87
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	3.312	1.69	2.441	1.677	2.677	2.529	3.59	4.484	5.494	3.627	3.318	3.432
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	5.23	4.44	5.479	5.924	6.395	6.184	7.334	7.334	7.24	6.602	5.678	4.722
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	162.1	124.3	169.9	177.7	198.2	185.5	227.4	227.4	217.2	204.7	170.3	146.4

2008

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	°C	26.4	20.0	23.2	27.9	19.5	23.7	28.0	19.6	23.8	28.6	18.9	23.7
3	Average Air Humidity	RH = ed/ea	%	79.4	83.2	83.1	84.2	77.3	78.2	72.9	76.8	71.8	76.7	85.2	81.8
4	Wind Speed	u2	km/day	68.5	69.5	70.5	71.5	72.5	71.5	74.5	75.5	71.5	77.5	71.5	79.5
5	Average Sunshine Hours	n	hr	5.01	2.31	3.62	3.13	5.01	5.05	6.88	5.12	5.93	4.78	3.75	3.95
6	Average Temperature	Tk = 273 + T	Kelvin	299.4	293.0	296.2	300.9	292.5	296.7	301.0	292.6	296.8	301.6	291.9	296.7
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	3.5	4.5	5.5	6.5	5.5	8.5	9.5	5.5	11.5	5.5	13.5
8	Max. Possible Sunshine Hours	N	hr	8.0	7.2	5.9	8.0	7.7	8.0	8.0	8.0	7.8	8.0	8.0	8.0
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	62.62	32.09	61.29	39.12	65.02	63.13	85.95	63.99	76.07	59.75	46.85	49.33
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	1.05	2.05	3.05	4.05	3.05	6.05	7.05	3.05	9.05	3.05	11.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	7.028	-96.6	-6.99	-2.75	-2.45	-3.5	-1.78	-1.23	-4.11	-0.87	-2.76	-0.56
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.825	0.417	0.581	0.432	0.611	0.673	0.835	0.62	0.68	0.256	0.406	0.37
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	5.852	4.415	6.755	5.211	6.862	6.505	8.135	6.842	7.752	6.735	5.249	5.248
17	Saturation Vapour Pressure	ea = ed/RH		33.9	33.89	35.62	34.56	38.28	36.7	39.93	38.29	41.48	43.78	35.8	38.26
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	2.903	2.38	2.539	2.322	3.722	3.402	4.721	3.907	4.969	4.544	2.253	3.155
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	5.009	3.963	5.988	4.767	6.443	6.028	7.776	6.563	7.324	6.56	4.788	5.103
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	155.3	111	185.6	143	199.7	180.8	241	203.4	219.7	203.3	143.6	158.2

2009

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	°C	27.3	20.4	23.9	28.9	19.2	24.1	28.7	19.7	24.2	28.5	20.4	24.4
3	Average Air Humidity	RH = ed/ea	%	80.9	82.8	81.7	83.2	80.0	80.4	73.2	72.0	70.0	75.7	81.4	81.7
4	Wind Speed	u2	km/day	68.5	69.5	70.5	71.5	72.5	71.5	74.5	75.5	71.5	77.5	71.5	79.5
5	Average Sunshine Hours	n	hr	4.67	3.41	5.09	0.26	4.76	5.65	7.01	7.01	6.10	4.48	3.91	4.19
6	Average Temperature	Tk = 273 + T	Kelvin	300.3	293.4	296.9	301.9	292.2	297.1	301.7	292.7	297.2	301.5	293.4	297.4
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	3.5	4.5	5.5	6.5	5.5	8.5	9.5	5.5	11.5	5.5	13.5
8	Max. Possible Sunshine Hours	N	hr	8.0	7.2	8.0	0.6	7.7	8.0	8.0	8.0	8.0	8.0	8.0	7.5
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	58.36	47.33	63.59	43.68	61.82	70.58	87.62	87.58	76.29	55.97	48.83	55.91
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	6.714	6.282	7.911	6.317	7.609	8.144	9.575	9.771	8.894	7.057	6.101	6.387
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.777	0.564	0.6	0.471	0.585	0.74	0.849	0.815	0.682	0.242	0.42	0.41
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	5.601	5.405	6.916	5.53	6.643	6.996	8.247	8.467	7.768	6.463	5.376	5.658
17	Saturation Vapour Pressure	ea = ed/RH		33.26	34.08	36.24	34.99	36.99	35.71	39.78	40.83	42.57	44.36	37.48	38.31
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	2.639	2.459	2.8	2.505	3.166	2.982	4.652	5.022	5.431	4.802	2.97	3.176
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	4.755	4.75	6.167	5.065	6.179	6.379	7.869	8.139	7.408	6.33	5.006	5.487
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	147.4	133	191.2	151.9	191.6	191.4	243.9	252.3	222.2	196.2	150.2	170.1

2010

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	^{o}C	28.2	20.1	24.2	28.4	19.9	24.2	30.2	20.7	25.4	29.6	20.7	25.1
3	Average Air Humidity	RH = ed/ea	%	83.6	86.8	85.8	78.0	83.6	84.4	85.7	81.5	85.1	82.3	84.7	82.2
4	Wind Speed	u2	km/day	68.5	69.5	70.5	71.5	72.5	71.5	74.5	75.5	71.5	77.5	71.5	79.5
5	Average Sunshine Hours	n	hr	3.79	3.30	3.82	5.76	4.62	4.19	4.02	4.54	3.86	3.57	3.59	3.20
6	Average Temperature	Tk = 273 + T	Kelvin	301.2	293.1	297.2	301.4	292.9	297.2	303.2	293.7	298.4	302.6	293.7	298.1
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	3.5	4.5	5.5	6.5	5.5	8.5	9.5	5.5	11.5	5.5	13.5
8	Max. Possible Sunshine Hours	N	hr	8.0	6.6	7.5	8.0	7.7	7.9	7.7	7.2	7.7	8.0	6.7	6.7
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	47.38	50	50.89	72	59.99	52.99	52.16	62.99	50.09	44.67	53.57	47.76
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	5.904	6.492	6.868	8.659	7.462	6.757	6.754	7.774	6.756	6.158	6.456	5.8
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.654	0.589	0.498	0.715	0.571	0.581	0.544	0.612	0.477	0.201	0.453	0.36
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	4.955	5.578	6.027	7.511	6.518	5.838	5.872	6.773	5.941	5.649	5.68	5.15
17	Saturation Vapour Pressure	ea = ed/RH		32.16	32.51	34.48	37.29	35.41	33.99	33.96	36.08	35.02	40.82	36.01	38.08
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	2.181	1.801	2.06	3.484	2.493	2.25	2.12	2.935	2.219	3.22	2.343	3.073
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	4.163	4.739	5.305	6.892	5.981	5.286	5.477	6.408	5.368	5.455	5.166	5.007
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	129	132.7	164.5	206.7	185.4	158.6	169.8	198.6	161.1	169.1	155	155.2

2011

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	^{o}C	28.5	20.5	24.5	28.7	20.5	24.6	29.4	20.3	24.9	29.0	19.8	24.4
3	Average Air Humidity	RH = ed/ea	%	79.6	78.3	77.2	79.5	79.7	75.0	73.6	68.7	68.7	73.2	83.4	79.1
4	Wind Speed	u2	km/day	68.5	69.5	70.5	71.5	72.5	71.5	74.5	75.5	71.5	77.5	71.5	79.5
5	Average Sunshine Hours	n	hr	3.34	4.70	3.90	4.13	4.76	5.95	6.33	6.84	6.17	5.08	3.27	3.92
6	Average Temperature	Tk = 273 + T	Kelvin	301.5	293.5	297.5	301.7	293.5	297.6	302.4	293.3	297.9	302.0	292.8	297.4
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	3.5	4.5	5.5	6.5	5.5	8.5	9.5	5.5	11.5	5.5	13.5
8	Max. Possible Sunshine Hours	N	hr	7.4	8.0	8.0	7.4	7.9	8.0	8.0	8.0	8.0	7.8	7.1	7.6
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	45.16	58.75	48.75	55.78	60.27	74.42	79.15	85.44	77.17	65.1	46.1	51.62
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	5.741	7.178	6.692	7.318	7.484	8.446	8.901	9.597	8.966	7.784	5.897	6.078
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.629	0.674	0.481	0.575	0.573	0.775	0.776	0.797	0.689	0.275	0.401	0.384
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	4.825	6.146	5.877	6.377	6.537	7.249	7.68	8.32	7.829	7.12	5.201	5.39
17	Saturation Vapour Pressure	ea = ed/RH		33.79	36.01	38.36	36.59	37.12	38.27	39.51	42.79	43.38	45.93	36.57	39.55
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	2.857	3.265	3.695	3.184	3.224	4.068	4.538	5.881	5.774	5.5	2.582	3.741
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	4.262	5.505	5.48	5.885	6.095	6.759	7.349	8.088	7.513	6.99	4.798	5.277
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	132.1	154.1	169.9	176.6	189	202.8	227.8	250.7	225.4	216.7	143.9	163.6

2012

No.	Parameter	Equation	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Latitude	6.66 (North Lat.), 6.94 (South Lat.)													
2	Average Temperature	T	^{o}C	28.8	20.4	24.1	28.8	20.3	24.6	28.8	20.0	24.4	29.2	19.3	24.2
3	Average Air Humidity	RH = ed/ea	%	79.6	78.3	77.2	79.5	79.7	75.0	73.6	68.7	68.7	73.2	83.4	79.1
4	Wind Speed	u2	km/day	68.5	69.5	70.5	71.5	72.5	71.5	74.5	75.5	71.5	77.5	71.5	79.5
5	Average Sunshine Hours	n	hr	3.29	4.76	4.44	4.46	5.30	6.06	6.22	6.97	6.02	4.94	3.14	3.53
6	Average Temperature	Tk = 273 + T	Kelvin	301.8	293.4	297.1	301.8	293.3	297.6	301.8	293.0	297.4	302.2	292.3	297.2
7	Weighing Factor Depending on Temperature	Δ/γ		2.5	3.5	4.5	5.5	6.5	5.5	8.5	9.5	5.5	11.5	5.5	13.5
8	Max. Possible Sunshine Hours	N	hr	8.0	9.1	7.6	7.8	8.0	8.0	8.0	8.0	8.0	8.0	7.3	7.1
9	Actual Vapour Pressure	ed	mmHg	26.9	28.2	29.6	29.1	29.6	28.7	29.1	29.4	29.8	33.6	30.5	31.3
10	Percentage of Sunshine	n/N	%	41.09	52.28	58.45	57.18	66.21	75.71	77.74	87.14	75.25	61.77	43.06	49.75
11	Solar Radiation	Ra	mm/day	13.4	14.3	14.9	15.0	14.6	14.3	14.5	14.8	14.8	14.5	13.6	13.1
12	Albedo for Water	r = 0.05		0.05	1.05	2.05	3.05	4.05	5.05	6.05	7.05	8.05	9.05	10.05	11.05
13	Incoming Radiation	Rin = 0.95Ra (0.18+0.55n/N) / (1-r)	mm/day	5.441	-127	-6.78	-3.44	-2.48	-2.01	-1.65	-1.53	-1.19	-0.89	-0.6	-0.56
14	Theoretical Black Body Radiation	σT^4	mm	15	15	15	15	15	15	15	15	15	15	15	15
15	Outgoing Radiation	Ro = σT^4 (0.56-0.092 √ed) (0.1+0.90 n/N)	mm/day	0.584	0.611	0.558	0.587	0.621	0.787	0.764	0.811	0.674	0.263	0.38	0.372
16	Energy Budget	H = (1-r)Rin - Ro	mm/day	4.585	5.725	6.556	6.475	6.944	7.334	7.585	8.437	7.695	6.881	5.006	5.274
17	Saturation Vapour Pressure	ea = ed/RH		33.79	36.01	38.36	36.59	37.12	38.27	39.51	42.79	43.38	45.93	36.57	39.55
18	Mass Transfer	Ea = 0.35 (0.5 + u2/100) (ea-ed)	mm/day	2.857	3.265	3.695	3.184	3.224	4.068	4.538	5.881	5.774	5.5	2.582	3.741
19	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/day	4.091	5.179	6.036	5.968	6.448	6.831	7.265	8.193	7.399	6.77	4.633	5.168
20	Evaporation	Eo = (Δ/γ * H + Ea)/(Δ/γ + 1)	mm/mth.	126.8	145	187.1	179.1	199.9	204.9	225.2	254	222	209.9	139	160.2

Table B.13 Monthly Extraction from Evaporation to the Total Rainfall from 2001 until 2012

1. Total Daily Rainfall per Month (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	378	179	371	383	119	101	52	96	118	65	62	61
2002	476	178	426	260	17	35	32	2	0	31	96	358
2003	189	234	331	82	90	4	0	63	128	261	375	340
2004	321	274	368	133	178	23	62	0	99	29	207	434
2005	245	378	375	190	89	90	94	4	81	107	0	0
2006	307	358	149	342	38	0	0	0	11	49	71	525
2007	97	335	308	0	89	93	2	10	5	231	262	372
2008	190	111	461	253	60	15	0	30	22	266	505	375
2009	291	400	280	234	217	38	5	0	90	253	339	164
2010	498	629	453	238	248	253	134	256	370	257	373	494
2011	226	179	202	318	391	220	232	17	139	305	247	319
2012	204	398	285	268	119	16	5	0	31	245	467	334
Average	284.96	304.17	333.83	224.96	137.67	73.71	51.43	39.71	91.09	174.61	250.13	314.63
Std. Dev.	119.70	142.38	95.62	109.57	105.64	84.01	71.63	74.48	101.25	107.85	166.82	161.44
Variance	14328.93	20271.11	9143.02	12005.79	11160.83	7057.16	5131.31	5546.79	10251.38	11630.72	27829.37	26063.05
Skewness	0.52	0.87	-0.54	-0.72	1.35	1.39	1.72	2.62	2.04	-0.40	-0.02	-0.87

2. Evaporation per Month (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	134	128	155	163	170	179	187	220	192	154	133	187
2002	132	126	169	169	194	184	198	245	222	256	154	146
2003	163	125	160	166	191	203	226	226	197	185	147	117
2004	149	123	178	181	176	196	190	257	189	242	144	127
2005	137	130	157	166	188	175	208	215	196	185	177	167
2006	129	164	185	180	203	211	220	253	238	241	187	154
2007	162	124	170	178	198	186	227	227	217	205	170	146
2008	155	111	186	143	200	181	241	203	220	203	144	158
2009	147	133	191	152	192	191	244	252	222	196	150	170
2010	129	133	164	207	185	159	170	199	161	169	155	155
2011	132	154	170	177	189	203	228	251	225	217	144	164
2012	127	145	187	179	200	205	225	254	222	210	139	160
Average	141.37	132.98	172.65	171.72	190.63	189.31	213.59	233.61	208.46	205.20	153.71	154.32
Std. Dev.	13.41	14.60	12.51	16.12	9.73	15.09	23.14	21.04	21.62	30.41	16.27	18.75
Variance	179.84	213.09	156.47	260.01	94.76	227.79	535.52	442.73	467.22	924.86	264.74	351.42
Skewness	0.62	0.95	0.08	0.33	-0.85	-0.46	-0.56	-0.44	-0.87	0.11	0.98	-0.52

3. (Rainfall - Evaporation) per Month (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	244	51	216	220	-51	-78	-135	-124	-74	-89	-71	-126
2002	343	52	257	91	-178	-149	-166	-244	-222	-225	-58	212
2003	25	109	170	-84	-102	-199	-226	-163	-69	76	228	223
2004	172	151	190	-48	2	-174	-128	-257	-90	-213	62	307
2005	108	248	218	23	-99	-85	-114	-211	-115	-79	-177	-167
2006	178	194	-37	161	-165	-211	-220	-253	-227	-192	-116	371
2007	-65	210	138	-178	-110	-93	-226	-217	-212	26	92	226
2008	34	0	275	109	-140	-166	-241	-174	-198	62	361	217
2009	143	267	89	82	25	-154	-239	-252	-132	56	188	-7
2010	369	496	289	31	63	94	-36	57	209	87	218	339
2011	94	25	32	141	202	17	4	-234	-86	88	103	155
2012	77	253	98	89	-81	-189	-220	-254	-191	35	328	174
Average	143.59	171.19	161.18	53.24	-52.96	-115.61	-162.16	-193.90	-117.37	-30.59	96.42	160.31
Std. Dev.	128.13	139.15	100.48	111.88	109.45	92.79	82.48	89.83	119.28	122.81	175.09	172.83
Variance	16417.35	19361.98	10096.27	12517.91	11980.10	8610.45	6802.25	8069.48	14228.62	15081.20	30655.31	29871.08
Skewness	0.41	0.99	-0.62	-0.71	1.19	1.29	0.96	2.28	1.98	-0.68	-0.06	-0.93

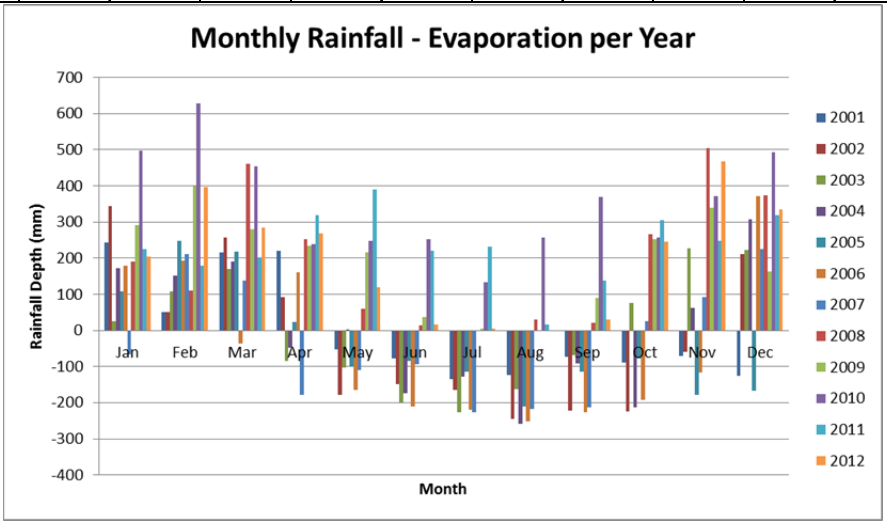


Table B.14 NRECA Calculation for Cisangkuy Discharge River Discharge

where:

Note:

P	=	monthly rainfall (mm)
PET	=	potential evaporation (from Penman formula)
NOMINAL	=	soil moisture storage capacity index =
	=	100 + C * Ra
AET	=	actual evaporation
C	=	watershed coefficient
	=	0.2 (steady seasonal rainfall)
Ra	=	annual rainfall (mm)
PSUB	=	runoff fraction that moves out of the watershed as baseflow or GF
	=	0.5 (normal catchment permeability)
GWF	=	rate of discharge index from GF storage to the stream
	=	0.5 (normal catchment reliability)
Total Streamflow	=	Groundwater Flow (FW) + Direct Flow
Total Discharge	=	Total Streamflow * Catchment Area

Year	Month	P	PET	Moist Storage	Storage Ratio	P/PET	AET/PET	AET	Water Balance	Excess Moist Ratio	Excess Moist	Delta Storage	Recharge to GW	Begin Storage GW	End Storage GW	GW Flow	Direct Flow	Total Streamflow	Total Discharge	
		[mm]	[mm]	[mm]	NOMINAL =			[mm]	[mm]			[mm]	PSUB =			GWF =	[mm]	[mm]	[m3/mth.]	[m3/s]
					497								0.5			0.5				
2001	Jan	378	134	575.00	1.16	2.83	1.00	134	244	0.64	156	88	78.19	2.00	80.19	40.10	78.19	118.29	30399339.53	11.35
	Feb	179	128	662.96	1.33	1.40	1.00	128	51	0.76	39	12	19.34	40.10	59.44	29.72	19.34	49.06	12607947.13	5.03
	Mar	371	155	675.18	1.36	2.40	1.00	155	216	0.80	173	43	86.55	29.72	116.27	58.13	86.55	144.69	37184095.82	13.88
	Apr	383	163	718.45	1.45	2.35	1.00	163	220	0.84	185	35	92.34	58.13	150.47	75.24	92.34	167.57	43066236.94	16.62
	May	119	170	753.63	1.52	0.70	0.91	155	-36	0.00	0	-36	0.00	75.24	75.24	37.62	0.00	37.62	9667792.844	3.61
	Jun	101	179	717.49	1.44	0.56	0.85	152	-52	0.00	0	-52	0.00	37.62	37.62	18.81	0.00	18.81	4833896.422	1.86
	Jul	52	187	665.87	1.34	0.28	0.74	138	-86	0.00	0	-86	0.00	18.81	18.81	9.40	0.00	9.40	2416948.211	0.90
	Aug	96	220	579.53	1.17	0.44	0.74	163	-67	0.00	0	-67	0.00	9.40	9.40	4.70	0.00	4.70	1208474.106	0.45
	Sep	118	192	512.44	1.03	0.61	0.81	155	-38	0.00	0	-38	0.00	4.70	4.70	2.35	0.00	2.35	604237.0528	0.23
	Oct	65	154	474.82	0.96	0.42	0.69	106	-41	0.00	0	-41	0.00	2.35	2.35	1.18	0.00	1.18	302118.5264	0.11
	Nov	62	133	433.40	0.87	0.47	0.67	89	-27	0.00	0	-27	0.00	1.18	1.18	0.59	0.00	0.59	151059.2632	0.06
	Dec	61	187	406.21	0.82	0.33	0.58	108	-47	0.00	0	-47	0.00	0.59	0.59	0.29	0.00	0.29	75529.6316	0.03
Jan - Dec Storage				168.79																
2002	Jan	476	132	358.75	0.72	3.59	1.00	132	343	0.25	86	257	42.90	0.29	43.20	21.60	42.90	64.50	16577207.59	6.19
	Feb	178	126	616.17	1.24	1.41	1.00	126	52	0.67	35	17	17.36	21.60	38.95	19.48	17.36	36.83	9465907.964	3.91
	Mar	426	169	633.27	1.28	2.52	1.00	169	257	0.71	182	74	91.15	19.48	110.62	55.31	91.15	146.46	37639344.76	14.05
	Apr	260	169	707.73	1.42	1.54	1.00	169	91	0.84	76	15	38.25	55.31	93.56	46.78	38.25	85.02	21851184.16	8.43

Year	Month	P	PET	Moist Storage	Storage Ratio	P/PET	AET/PET	AET	Water Balance	Excess Moist Ratio	Excess Moist	Delta Storage	Recharge to GW	Begin Storage GW	End Storage GW	GW Flow	Direct Flow	Total Streamflow	Total Discharge	
		[mm]	[mm]	[mm]	NOMINAL =			[mm]	[mm]			[mm]	PSUB =			GWF =	[mm]	[mm]	[m3/mth.]	[m3/s]
					497								0.5			0.5				
	May	17	194	722.30	1.45	0.08	0.72	140	-124	0.00	0	-124	0.00	46.78	46.78	23.39	0.00	23.39	6011028.002	2.24
	Jun	35	184	598.78	1.21	0.19	0.67	123	-89	0.00	0	-89	0.00	23.39	23.39	11.69	0.00	11.69	3005514.001	1.16
	Jul	32	198	510.14	1.03	0.16	0.58	115	-83	0.00	0	-83	0.00	11.69	11.69	5.85	0.00	5.85	1502757	0.56
	Aug	2	245	427.48	0.86	0.01	0.40	98	-97	0.00	0	-97	0.00	5.85	5.85	2.92	0.00	2.92	751378.5002	0.28
	Sep	0	222	330.84	0.67	0.00	0.30	67	-67	0.00	0	-67	0.00	2.92	2.92	1.46	0.00	1.46	375689.2501	0.14
	Oct	31	256	264.25	0.53	0.12	0.33	84	-53	0.00	0	-53	0.00	1.46	1.46	0.73	0.00	0.73	187844.6251	0.07
	Nov	96	154	210.78	0.42	0.62	0.69	106	-11	0.00	0	-11	0.00	0.73	0.73	0.37	0.00	0.37	93922.31253	0.04
	Dec	358	146	200.06	0.40	2.45	1.00	146	212	0.07	15	197	7.41	0.37	7.78	3.89	7.41	11.30	2903406.272	1.08
	Jan - Dec Storage			158.69																
2003	Jan	189	163	396.95	0.80	1.15	1.00	163	25	0.29	7	18	3.64	3.89	7.53	3.77	3.64	7.41	1904371.064	0.71
	Feb	234	125	414.80	0.84	1.87	1.00	125	109	0.34	37	72	18.56	3.77	22.32	11.16	18.56	29.72	7638043.612	3.16
	Mar	331	160	486.84	0.98	2.06	1.00	160	170	0.46	78	92	39.10	11.16	50.26	25.13	39.10	64.23	16507383.22	6.16
	Apr	82	166	578.64	1.17	0.49	0.76	126	-44	0.00	0	-44	0.00	25.13	25.13	12.57	0.00	12.57	3229334.452	1.25
	May	90	191	534.41	1.08	0.47	0.74	142	-52	0.00	0	-52	0.00	12.57	12.57	6.28	0.00	6.28	1614667.226	0.60
	Jun	4	203	482.33	0.97	0.02	0.45	91	-88	0.00	0	-88	0.00	6.28	6.28	3.14	0.00	3.14	807333.6129	0.31
	Jul	0	226	394.55	0.79	0.00	0.35	79	-79	0.00	0	-79	0.00	3.14	3.14	1.57	0.00	1.57	403666.8065	0.15
	Aug	63	226	315.38	0.64	0.28	0.48	108	-46	0.00	0	-46	0.00	1.57	1.57	0.79	0.00	0.79	201833.4032	0.08
	Sep	128	197	269.62	0.54	0.65	0.74	146	-18	0.00	0	-18	0.00	0.79	0.79	0.39	0.00	0.39	100916.7016	0.04
	Oct	261	185	251.59	0.51	1.41	1.00	185	76	0.11	8	67	4.16	0.39	4.55	2.28	4.16	6.44	1654732.226	0.62
	Nov	375	147	318.93	0.64	2.55	1.00	147	228	0.17	39	189	19.38	2.28	21.66	10.83	19.38	30.21	7763835.903	3.00
	Dec	340	117	508.17	1.02	2.90	1.00	117	223	0.50	111	111	55.65	10.83	66.48	33.24	55.65	88.89	22845006.38	8.53
	Jan - Dec Storage			-111.22																
2004	Jan	321	149	619.48	1.25	2.16	1.00	149	172	0.67	115	57	57.64	33.24	90.88	45.44	57.64	103.07	26489804.63	9.89
	Feb	274	123	676.25	1.36	2.22	1.00	123	151	0.80	120	30	60.25	45.44	105.69	52.84	60.25	113.09	29064796.34	11.60
	Mar	368	178	706.37	1.42	2.07	1.00	178	190	0.84	159	30	79.71	52.84	132.56	66.28	79.71	145.99	37519963.79	14.01
	Apr	133	181	736.74	1.48	0.74	0.89	161	-28	0.00	0	-28	0.00	66.28	66.28	33.14	0.00	33.14	8516787.821	3.29
	May	178	176	708.70	1.43	1.01	1.00	176	2	0.84	1	0	0.64	33.14	33.78	16.89	0.64	17.53	4505616.836	1.68
	Jun	23	196	708.94	1.43	0.11	0.73	143	-121	0.00	0	-121	0.00	16.89	16.89	8.45	0.00	8.45	2170400.776	0.84
	Jul	62	190	588.29	1.18	0.32	0.69	131	-69	0.00	0	-69	0.00	8.45	8.45	4.22	0.00	4.22	1085200.388	0.41
	Aug	0	257	519.02	1.05	0.00	0.50	129	-129	0.00	0	-129	0.00	4.22	4.22	2.11	0.00	2.11	542600.194	0.20
	Sep	99	189	390.29	0.79	0.52	0.68	129	-30	0.00	0	-30	0.00	2.11	2.11	1.06	0.00	1.06	271300.097	0.10
	Oct	29	242	360.49	0.73	0.12	0.42	101	-73	0.00	0	-73	0.00	1.06	1.06	0.53	0.00	0.53	135650.0485	0.05

Year	Month	P	PET	Moist Storage	Storage Ratio	P/PET	AET/PET	AET	Water Balance	Excess Moist Ratio	Excess Moist	Delta Storage	Recharge to GW	Begin Storage GW	End Storage GW	GW Flow	Direct Flow	Total Streamflow	Total Discharge	
		[mm]	[mm]	[mm]	NOMINAL =			[mm]	[mm]			[mm]	PSUB =			GWF =	[mm]	[mm]	[m3/mth.]	[m3/s]
					497								0.5			0.5				
	Nov	207	144	287.50	0.58	1.43	1.00	144	62	0.14	9	54	4.36	0.53	4.88	2.44	4.36	6.80	1747033.842	0.67
	Dec	434	127	341.02	0.69	3.43	1.00	127	307	0.21	65	243	32.29	2.44	34.73	17.36	32.29	49.65	12759756.83	4.76
	Jan - Dec Storage			278.46																
2005	Jan	245	137	583.92	1.18	1.79	1.00	137	108	0.64	69	39	34.60	17.36	51.96	25.98	34.60	60.57	15567640.18	5.81
	Feb	378	130	622.84	1.25	2.91	1.00	130	248	0.71	176	72	87.91	25.98	113.89	56.95	87.91	144.86	37229260.28	15.39
	Mar	375	157	694.66	1.40	2.39	1.00	157	218	0.80	174	44	87.23	56.95	144.18	72.09	87.23	159.32	40944440.74	15.29
	Apr	190	166	738.27	1.49	1.14	1.00	166	23	0.87	20	3	10.19	72.09	82.28	41.14	10.19	51.33	13192734.08	5.09
	May	89	188	741.32	1.49	0.47	0.83	156	-67	0.00	0	-67	0.00	41.14	41.14	20.57	0.00	20.57	5286553.378	1.97
	Jun	90	175	673.93	1.36	0.51	0.83	145	-55	0.00	0	-55	0.00	20.57	20.57	10.29	0.00	10.29	2643276.689	1.02
	Jul	94	208	618.68	1.25	0.45	0.78	162	-68	0.00	0	-68	0.00	10.29	10.29	5.14	0.00	5.14	1321638.345	0.49
	Aug	4	215	550.54	1.11	0.02	0.55	118	-114	0.00	0	-114	0.00	5.14	5.14	2.57	0.00	2.57	660819.1723	0.25
	Sep	81	196	436.07	0.88	0.41	0.65	127	-46	0.00	0	-46	0.00	2.57	2.57	1.29	0.00	1.29	330409.5861	0.13
	Oct	107	185	389.70	0.78	0.58	0.71	131	-25	0.00	0	-25	0.00	1.29	1.29	0.64	0.00	0.64	165204.7931	0.06
	Nov	0	177	364.76	0.73	0.00	0.35	62	-62	0.00	0	-62	0.00	0.64	0.64	0.32	0.00	0.32	82602.39654	0.03
	Dec	0	167	302.72	0.61	0.00	0.30	50	-50	0.00	0	-50	0.00	0.32	0.32	0.16	0.00	0.16	41301.19827	0.02
	Jan - Dec Storage			281.20																
2006	Jan	307	129	252.76	0.51	2.39	1.00	129	178	0.11	20	159	9.82	0.16	9.98	4.99	9.82	14.80	3804819.46	1.42
	Feb	358	164	411.60	0.83	2.18	1.00	164	194	0.34	66	128	32.93	4.99	37.92	18.96	32.93	51.89	13336380.34	5.51
	Mar	149	185	539.46	1.09	0.80	0.88	163	-14	0.00	0	-14	0.00	18.96	18.96	9.48	0.00	9.48	2436403.426	0.91
	Apr	342	180	525.00	1.06	1.89	1.00	180	161	0.55	89	73	44.32	9.48	53.80	26.90	44.32	71.21	18301827.33	7.06
	May	38	203	597.52	1.20	0.19	0.67	136	-98	0.00	0	-98	0.00	26.90	26.90	13.45	0.00	13.45	3456371.793	1.29
	Jun	0	211	499.43	1.01	0.00	0.50	106	-106	0.00	0	-106	0.00	13.45	13.45	6.72	0.00	6.72	1728185.897	0.67
	Jul	0	220	393.89	0.79	0.00	0.35	77	-77	0.00	0	-77	0.00	6.72	6.72	3.36	0.00	3.36	864092.9484	0.32
	Aug	0	253	317.00	0.64	0.00	0.30	76	-76	0.00	0	-76	0.00	3.36	3.36	1.68	0.00	1.68	432046.4742	0.16
	Sep	11	238	241.21	0.49	0.05	0.24	57	-46	0.00	0	-46	0.00	1.68	1.68	0.84	0.00	0.84	216023.2371	0.08
	Oct	49	241	194.97	0.39	0.20	0.32	77	-28	0.00	0	-28	0.00	0.84	0.84	0.42	0.00	0.42	108011.6185	0.04
	Nov	71	187	166.86	0.34	0.38	0.45	84	-13	0.00	0	-13	0.00	0.42	0.42	0.21	0.00	0.21	54005.80927	0.02
	Dec	525	154	153.80	0.31	3.40	1.00	154	371	0.04	15	356	7.41	0.21	7.62	3.81	7.41	11.22	2884351.314	1.08
	Jan - Dec Storage			98.96																
2007	Jan	97	162	509.58	1.03	0.60	0.81	131	-34	0.00	0	-34	0.00	3.81	3.81	1.91	0.00	1.91	489726.1873	0.18
	Feb	335	124	475.26	0.96	2.69	1.00	124	210	0.46	97	113	48.34	1.91	50.24	25.12	48.34	73.46	18879265.54	7.80
	Mar	308	170	588.75	1.19	1.81	1.00	170	138	0.64	88	50	44.04	25.12	69.17	34.58	44.04	78.63	20207297.73	7.54

Year	Month	P	PET	Moist Storage	Storage Ratio	P/PET	AET/PET	AET	Water Balance	Excess Moist Ratio	Excess Moist	Delta Storage	Recharge to GW	Begin Storage GW	End Storage GW	GW Flow	Direct Flow	Total Streamflow	Total Discharge	
		[mm]	[mm]	[mm]	NOMINAL =			[mm]	[mm]			[mm]	PSUB =			GWF =	[mm]	[mm]	[m3/mth.]	[m3/s]
					497								0.5			0.5				
	Apr	0	178	638.30	1.29	0.00	0.60	107	-107	0.00	0	-107	0.00	34.58	34.58	17.29	0.00	17.29	4443938.051	1.71
	May	89	198	531.67	1.07	0.45	0.74	147	-58	0.00	0	-58	0.00	17.29	17.29	8.65	0.00	8.65	2221969.026	0.83
	Jun	93	186	473.47	0.95	0.50	0.74	137	-44	0.00	0	-44	0.00	8.65	8.65	4.32	0.00	4.32	1110984.513	0.43
	Jul	2	227	429.19	0.86	0.01	0.40	91	-89	0.00	0	-89	0.00	4.32	4.32	2.16	0.00	2.16	555492.2564	0.21
	Aug	10	227	339.85	0.68	0.04	0.30	68	-58	0.00	0	-58	0.00	2.16	2.16	1.08	0.00	1.08	277746.1282	0.10
	Sep	5	217	281.64	0.57	0.02	0.25	54	-49	0.00	0	-49	0.00	1.08	1.08	0.54	0.00	0.54	138873.0641	0.05
	Oct	231	205	232.44	0.47	1.13	1.00	205	26	0.80	21	5	10.34	0.54	10.88	5.44	10.34	15.78	4055477.814	1.51
	Nov	262	170	237.61	0.48	1.54	1.00	170	92	0.80	73	18	36.66	5.44	42.10	21.05	36.66	57.71	14831560.43	5.72
	Dec	372	146	255.94	0.52	2.54	1.00	146	226	0.11	25	201	12.41	21.05	33.46	16.73	12.41	29.14	7488501.452	2.80
Jan - Dec Storage				253.64																
2008	Jan	190	155	456.73	0.92	1.22	1.00	155	34	0.42	14	20	7.19	16.73	23.91	11.96	7.19	19.14	4919628.884	1.84
	Feb	111	111	476.58	0.96	1.00	0.97	108	3	0.46	2	2	0.77	11.96	12.73	6.37	0.77	7.14	1834604.415	0.73
	Mar	461	186	478.39	0.96	2.48	1.00	186	275	0.46	126	148	63.22	6.37	69.58	34.79	63.22	98.01	25188799.94	9.40
	Apr	253	143	626.82	1.26	1.77	1.00	143	109	0.71	78	32	38.87	34.79	73.66	36.83	38.87	75.70	19455181.44	7.51
	May	60	200	658.57	1.33	0.30	0.77	154	-94	0.00	0	-94	0.00	36.83	36.83	18.42	0.00	18.42	4732790.155	1.77
	Jun	15	181	564.27	1.14	0.08	0.57	103	-89	0.00	0	-89	0.00	18.42	18.42	9.21	0.00	9.21	2366395.077	0.91
	Jul	0	241	475.69	0.96	0.00	0.45	108	-108	0.00	0	-108	0.00	9.21	9.21	4.60	0.00	4.60	1183197.539	0.44
	Aug	30	203	367.22	0.74	0.15	0.42	85	-56	0.00	0	-56	0.00	4.60	4.60	2.30	0.00	2.30	591598.7694	0.22
	Sep	22	220	311.28	0.63	0.10	0.37	81	-59	0.00	0	-59	0.00	2.30	2.30	1.15	0.00	1.15	295799.3847	0.11
	Oct	266	203	251.98	0.51	1.31	1.00	203	62	0.11	7	55	3.42	1.15	4.57	2.28	3.42	5.70	1465671.111	0.55
	Nov	505	144	307.30	0.62	3.51	1.00	144	361	0.17	61	300	30.67	2.28	32.96	16.48	30.67	47.15	12117822.18	4.68
	Dec	375	158	606.80	1.22	2.37	1.00	158	217	0.67	145	72	72.63	16.48	89.11	44.55	72.63	117.18	30115409.15	11.24
Jan - Dec Storage				-150.07																
2009	Jan	291	147	678.35	1.37	1.97	1.00	147	143	0.80	114	29	57.24	44.55	101.79	50.90	57.24	108.14	27790850.33	10.38
	Feb	400	133	706.97	1.42	3.00	1.00	133	267	0.84	224	43	111.93	50.90	162.83	81.41	111.93	193.34	49689445.57	20.54
	Mar	280	191	749.61	1.51	1.46	1.00	191	89	0.89	79	10	39.52	81.41	120.93	60.47	39.52	99.99	25696599.77	9.59
	Apr	234	152	759.38	1.53	1.54	1.00	152	82	0.89	73	9	36.52	60.47	96.98	48.49	36.52	85.01	21846759.22	8.43
	May	217	192	768.40	1.55	1.13	1.00	192	25	0.89	22	3	11.10	48.49	59.59	29.79	11.10	40.89	10508856.08	3.92
	Jun	38	191	771.15	1.55	0.20	0.80	153	-116	0.00	0	-116	0.00	29.79	29.79	14.90	0.00	14.90	3828515.556	1.48
	Jul	5	244	655.56	1.32	0.02	0.65	159	-154	0.00	0	-154	0.00	14.90	14.90	7.45	0.00	7.45	1914257.778	0.71
	Aug	0	252	502.01	1.01	0.00	0.50	126	-126	0.00	0	-126	0.00	7.45	7.45	3.72	0.00	3.72	957128.889	0.36
	Sep	90	222	375.85	0.76	0.40	0.62	138	-48	0.00	0	-48	0.00	3.72	3.72	1.86	0.00	1.86	478564.4445	0.18

Year	Month	P	PET	Moist Storage	Storage Ratio	P/PET	AET/PET	AET	Water Balance	Excess Moist Ratio	Excess Moist	Delta Storage	Recharge to GW	Begin Storage GW	End Storage GW	GW Flow	Direct Flow	Total Streamflow	Total Discharge	
		[mm]	[mm]	[mm]	NOMINAL =			[mm]	[mm]			[mm]	PSUB =			GWF =	[mm]	[mm]	[m3/mth.]	[m3/s]
					497								0.5			0.5				
	Oct	253	196	328.06	0.66	1.29	1.00	196	56	0.21	12	44	5.91	1.86	7.77	3.89	5.91	9.79	2517230.82	0.94
	Nov	339	150	372.51	0.75	2.25	1.00	150	188	0.29	55	134	27.31	3.89	31.19	15.60	27.31	42.90	11026098.98	4.25
	Dec	164	170	506.22	1.02	0.96	0.97	165	-1	0.00	0	-1	0.00	15.60	15.60	7.80	0.00	7.80	2004116.233	0.75
	Jan - Dec Storage			172.12																
2010	Jan	498	129	504.74	1.02	3.86	1.00	129	369	0.50	184	184	92.24	7.80	100.04	50.02	92.24	142.26	36560597.77	13.65
	Feb	629	133	689.22	1.39	4.74	1.00	133	496	0.80	397	99	198.53	50.02	248.55	124.27	198.53	322.80	82960283.99	34.29
	Mar	453	164	788.49	1.59	2.75	1.00	164	289	0.91	263	26	131.28	124.27	255.56	127.78	131.28	259.06	66578665.58	24.86
	Apr	238	207	814.45	1.64	1.15	1.00	207	31	0.93	29	2	14.53	127.78	142.31	71.16	14.53	85.69	22021804.69	8.50
	May	248	185	816.64	1.64	1.34	1.00	185	63	0.93	58	4	29.10	71.16	100.25	50.13	29.10	79.23	20360829.07	7.60
	Jun	253	159	821.02	1.65	1.60	1.00	159	94	0.94	89	6	44.38	50.13	94.50	47.25	44.38	91.63	23548057.2	9.08
	Jul	134	170	826.69	1.66	0.79	0.95	161	-27	0.00	0	-27	0.00	47.25	47.25	23.63	0.00	23.63	6071774.58	2.27
	Aug	256	199	799.38	1.61	1.29	1.00	199	57	0.93	53	4	26.67	23.63	50.30	25.15	26.67	51.82	13318383.49	4.97
	Sep	370	161	803.40	1.62	2.30	1.00	161	209	0.93	194	15	97.16	25.15	122.31	61.15	97.16	158.32	40686959.4	15.70
	Oct	257	169	818.02	1.65	1.52	1.00	169	87	0.93	81	6	40.64	61.15	101.80	50.90	40.64	91.54	23525927.35	8.78
	Nov	373	155	824.14	1.66	2.40	1.00	155	218	0.94	204	13	102.23	50.90	153.13	76.57	102.23	178.80	45950759.44	17.73
	Dec	494	155	837.19	1.69	3.18	1.00	155	339	0.94	318	20	159.23	76.57	235.80	117.90	159.23	277.13	71223455.1	26.59
	Jan - Dec Storage			-332.45																
2011	Jan	226	132	857.52	1.73	1.71	1.00	132	94	0.95	89	5	44.59	117.90	162.49	81.24	44.59	125.83	32338159.45	12.07
	Feb	179	154	862.21	1.74	1.16	1.00	154	25	0.95	24	1	11.80	81.24	93.05	46.52	11.80	58.33	14990149.03	6.20
	Mar	202	170	863.46	1.74	1.19	1.00	170	32	0.95	31	2	15.25	46.52	61.78	30.89	15.25	46.14	11858464.54	4.43
	Apr	318	177	865.06	1.74	1.80	1.00	177	141	0.95	134	7	67.18	30.89	98.07	49.04	67.18	116.22	29867868.54	11.52
	May	391	189	872.13	1.76	2.07	1.00	189	202	0.96	194	8	96.98	49.04	146.02	73.01	96.98	169.99	43687378.79	16.31
	Jun	220	203	880.22	1.77	1.08	1.00	203	17	0.96	17	1	8.27	73.01	81.28	40.64	8.27	48.90	12568466.32	4.85
	Jul	232	228	880.91	1.77	1.02	1.00	228	4	0.96	4	0	2.00	40.64	42.64	21.32	2.00	23.32	5994258.513	2.24
	Aug	17	251	881.07	1.77	0.07	0.85	213	-196	0.00	0	-196	0.00	21.32	21.32	10.66	0.00	10.66	2739688.367	1.02
	Sep	139	225	684.96	1.38	0.62	0.86	194	-55	0.00	0	-55	0.00	10.66	10.66	5.33	0.00	5.33	1369844.183	0.53
	Oct	305	217	630.14	1.27	1.41	1.00	217	88	0.71	63	26	31.35	5.33	36.68	18.34	31.35	49.69	12769921.63	4.77
	Nov	247	144	655.74	1.32	1.72	1.00	144	103	0.76	78	25	39.16	18.34	57.50	28.75	39.16	67.91	17453327.38	6.73
	Dec	319	164	680.48	1.37	1.95	1.00	164	155	0.80	124	31	62.17	28.75	90.92	45.46	62.17	107.63	27660428.92	10.33
	Jan - Dec Storage			177.04																
2012	Jan	204	127	711.56	1.43	1.60	1.00	127	77	0.84	64	12	32.20	45.46	77.66	38.83	32.20	71.03	18255505.78	6.82
	Feb	398	145	723.83	1.46	2.74	1.00	145	253	0.87	220	33	109.84	38.83	148.67	74.33	109.84	184.17	47332200.22	18.89

Year	Month	P	PET	Moist Storage	Storage Ratio	P/PET	AET/PET	AET	Water Balance	Excess Moist Ratio	Excess Moist	Delta Storage	Recharge to GW	Begin Storage GW	End Storage GW	GW Flow	Direct Flow	Total Streamflow	Total Discharge	
		[mm]	[mm]	[mm]	NOMINAL =			[mm]	[mm]			[mm]	PSUB =			GWF =	[mm]	[mm]	[m3/mth.]	[m3/s]
					497								0.5			0.5				
	Mar	285	187	756.66	1.52	1.52	1.00	187	98	0.89	87	11	43.56	74.33	117.90	58.95	43.56	102.51	26345891.16	9.84
	Apr	268	179	767.42	1.55	1.50	1.00	179	89	0.89	79	10	39.58	58.95	98.53	49.27	39.58	88.85	22833761.2	8.81
	May	119	200	777.21	1.56	0.60	0.89	178	-59	0.00	0	-59	0.00	49.27	49.27	24.63	0.00	24.63	6330615.9	2.36
	Jun	16	205	718.32	1.45	0.08	0.72	148	-132	0.00	0	-132	0.00	24.63	24.63	12.32	0.00	12.32	3165307.95	1.22
	Jul	5	225	586.26	1.18	0.02	0.55	124	-119	0.00	0	-119	0.00	12.32	12.32	6.16	0.00	6.16	1582653.975	0.59
	Aug	0	254	467.40	0.94	0.00	0.45	114	-114	0.00	0	-114	0.00	6.16	6.16	3.08	0.00	3.08	791326.9875	0.30
	Sep	31	222	353.11	0.71	0.14	0.42	93	-62	0.00	0	-62	0.00	3.08	3.08	1.54	0.00	1.54	395663.4938	0.15
	Oct	245	210	290.87	0.59	1.17	1.00	210	35	0.14	5	30	2.46	1.54	4.00	2.00	2.46	4.46	1145668.658	0.43
	Nov	467	139	321.08	0.65	3.36	1.00	139	328	0.17	56	272	27.88	2.00	29.88	14.94	27.88	42.82	11004818.28	4.25
	Dec	334	160	593.32	1.19	2.08	1.00	160	174	0.64	111	63	55.61	14.94	70.55	35.28	55.61	90.89	23358616.61	8.72
Jan - Dec Storage				118.24																

SUMMARY OF CISANGKUY RIVER DISCHARGE USING NRECA METHOD

Table B.15 NRECA Calculation Summary

1. Total Discharge per Month (m3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	11.35	5.03	13.88	16.62	3.61	1.86	0.90	0.45	0.23	0.11	0.06	0.03
2002	6.19	3.91	14.05	8.43	2.24	1.16	0.56	0.28	0.14	0.07	0.04	1.08
2003	0.71	3.16	6.16	1.25	0.60	0.31	0.15	0.08	0.04	0.62	3.00	8.53
2004	9.89	11.60	14.01	3.29	1.68	0.84	0.41	0.20	0.10	0.05	0.67	4.76
2005	5.81	15.39	15.29	5.09	1.97	1.02	0.49	0.25	0.13	0.06	0.03	0.02
2006	1.42	5.51	0.91	7.06	1.29	0.67	0.32	0.16	0.08	0.04	0.02	1.08
2007	0.18	7.80	7.54	1.71	0.83	0.43	0.21	0.10	0.05	1.51	5.72	2.80
2008	1.84	0.73	9.40	7.51	1.77	0.91	0.44	0.22	0.11	0.55	4.68	11.24
2009	10.38	20.54	9.59	8.43	3.92	1.48	0.71	0.36	0.18	0.94	4.25	0.75
2010	13.65	34.29	24.86	8.50	7.60	9.08	2.27	4.97	15.70	8.78	17.73	26.59
2011	12.07	6.20	4.43	11.52	16.31	4.85	2.24	1.02	0.53	4.77	6.73	10.33
2012	6.82	18.89	9.84	8.81	2.36	1.22	0.59	0.30	0.15	0.43	4.25	8.72
Average	6.69	11.09	10.83	7.35	3.68	1.99	0.77	0.70	1.46	1.49	3.93	6.33
Std. Dev.	4.80	9.68	6.20	4.26	4.40	2.53	0.72	1.37	4.49	2.65	4.99	7.64
Variance	23.04	93.77	38.45	18.16	19.33	6.41	0.52	1.87	20.13	7.01	24.94	58.37
Skewness	-0.07	1.37	0.71	0.55	2.54	2.46	1.70	3.28	3.46	2.38	2.09	1.84

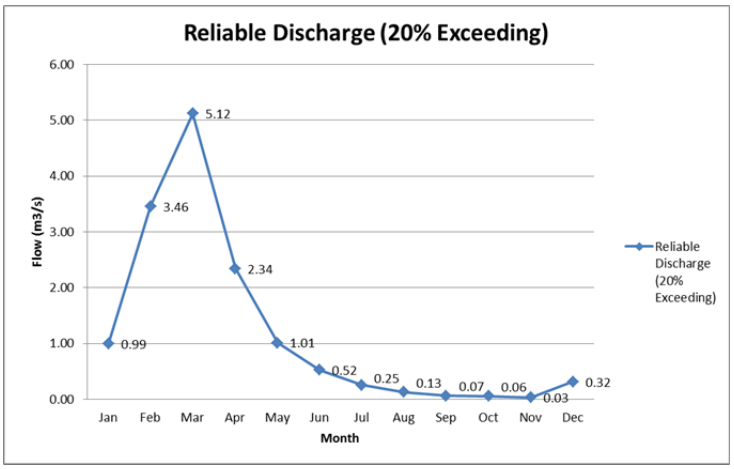
2. Rank of Discharge per Month

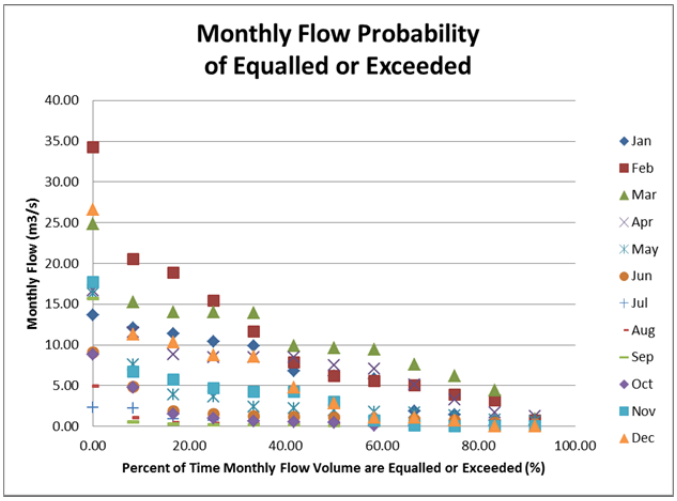
Rank	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Exceeding (%)	Exceeded (%)
1	0.18	0.73	0.91	1.25	0.60	0.31	0.15	0.08	0.04	0.04	0.02	0.02	8.33	91.67
2	0.71	3.16	4.43	1.71	0.83	0.43	0.21	0.10	0.05	0.05	0.03	0.03	16.67	83.33
3	1.42	3.91	6.16	3.29	1.29	0.67	0.32	0.16	0.08	0.06	0.04	0.75	25.00	75.00
4	1.84	5.03	7.54	5.09	1.68	0.84	0.41	0.20	0.10	0.07	0.06	1.08	33.33	66.67
5	5.81	5.51	9.40	7.06	1.77	0.91	0.44	0.22	0.11	0.11	0.67	1.08	41.67	58.33
6	6.19	6.20	9.59	7.51	1.97	1.02	0.49	0.25	0.13	0.43	3.00	2.80	50.00	50.00
7	6.82	7.80	9.84	8.43	2.24	1.16	0.56	0.28	0.14	0.55	4.25	4.76	58.33	41.67
8	9.89	11.60	13.88	8.43	2.36	1.22	0.59	0.30	0.15	0.62	4.25	8.53	66.67	33.33
9	10.38	15.39	14.01	8.50	3.61	1.48	0.71	0.36	0.18	0.94	4.68	8.72	75.00	25.00
10	11.35	18.89	14.05	8.81	3.92	1.86	0.90	0.45	0.23	1.51	5.72	10.33	83.33	16.67
11	12.07	20.54	15.29	11.52	7.60	4.85	2.24	1.02	0.53	4.77	6.73	11.24	91.67	8.33
12	13.65	34.29	24.86	16.62	16.31	9.08	2.27	4.97	15.70	8.78	17.73	26.59	100.00	0.00

Note: Probability = event of equalled or exceeded

3. Reliable Discharge (20% exceeding) Interpolation

Rank	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Probability (%)
2	0.71	3.16	4.43	1.71	0.83	0.43	0.21	0.10	0.05	0.05	0.03	0.03	16.67
3	1.42	3.91	6.16	3.29	1.29	0.67	0.32	0.16	0.08	0.06	0.04	0.75	25.00
Exceeding	0.99	3.46	5.12	2.34	1.01	0.52	0.25	0.13	0.07	0.06	0.03	0.32	20.00





APPENDIX C. WATER STORAGE MECHANISMS

1. Scenario 1 (Storage Only)

1. January

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

Month	Date	PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jan	1	534,600.00	403,704.00	469,152.00	155,520.00	313,632.00	223,580.00	-90,052.00
	2	460,080.00	408,888.00	434,484.00	155,520.00	278,964.00	223,580.00	278,964.00
	3	518,400.00	429,624.00	474,012.00	155,520.00	318,492.00	223,580.00	318,492.00
	4	518,400.00	419,904.00	469,152.00	155,520.00	313,632.00	223,580.00	313,632.00
	5	518,400.00	453,600.00	486,000.00	155,520.00	330,480.00	223,580.00	330,480.00
	6	506,088.00	453,600.00	479,844.00	155,520.00	324,324.00	223,580.00	324,324.00
	7	486,000.00	453,600.00	469,800.00	155,520.00	314,280.00	223,580.00	314,280.00
	8	518,400.00	453,600.00	486,000.00	155,520.00	330,480.00	223,580.00	330,480.00
	9	478,224.00	499,608.00	488,916.00	155,520.00	333,396.00	223,580.00	333,396.00
	10	534,600.00	519,696.00	527,148.00	155,520.00	371,628.00	223,580.00	371,628.00
	11	150,984.00	487,296.00	319,140.00	155,520.00	163,620.00	223,580.00	163,620.00
	12	392,688.00	510,624.00	451,656.00	155,520.00	296,136.00	223,580.00	296,136.00
	13	423,792.00	518,400.00	471,096.00	155,520.00	315,576.00	223,580.00	315,576.00
	14	534,600.00	518,400.00	526,500.00	155,520.00	370,980.00	223,580.00	370,980.00
	15	479,520.00	518,400.00	498,960.00	155,520.00	343,440.00	223,580.00	343,440.00
	16	553,392.00	518,400.00	535,896.00	155,520.00	380,376.00	223,580.00	380,376.00
	17	579,312.00	530,712.00	555,012.00	155,520.00	399,492.00	223,580.00	399,492.00
	18	594,216.00	543,024.00	568,620.00	155,520.00	413,100.00	223,580.00	413,100.00
	19	447,120.00	550,800.00	498,960.00	155,520.00	343,440.00	223,580.00	343,440.00
	20	572,184.00	543,024.00	557,604.00	155,520.00	402,084.00	223,580.00	402,084.00
	21	552,096.00	453,600.00	502,848.00	155,520.00	347,328.00	223,580.00	347,328.00
	22	519,696.00	495,720.00	507,708.00	155,520.00	352,188.00	223,580.00	352,188.00
	23	532,008.00	550,800.00	541,404.00	155,520.00	385,884.00	223,580.00	385,884.00
	24	584,496.00	381,024.00	482,760.00	155,520.00	327,240.00	223,580.00	327,240.00
	25	583,200.00	413,424.00	498,312.00	155,520.00	342,792.00	223,580.00	342,792.00
	26	583,200.00	476,280.00	529,740.00	155,520.00	374,220.00	223,580.00	374,220.00
	27	578,016.00	553,392.00	565,704.00	155,520.00	410,184.00	223,580.00	410,184.00
	28	583,200.00	498,312.00	540,756.00	155,520.00	385,236.00	223,580.00	385,236.00
	29	532,008.00	532,008.00	532,008.00	155,520.00	376,488.00	223,580.00	376,488.00
	30	526,824.00	518,400.00	522,612.00	155,520.00	367,092.00	223,580.00	367,092.00
	31	518,400.00	518,400.00	518,400.00	155,520.00	362,880.00	223,580.00	362,880.00

2. February

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

Month	Date	PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Feb	1	497,016.00	533,304.00	515,160.00	155,520.00	359,640.00	223,580.00	359,640.00
	2	518,400.00	530,712.00	524,556.00	155,520.00	369,036.00	223,580.00	369,036.00
	3	476,280.00	518,400.00	497,340.00	155,520.00	341,820.00	223,580.00	341,820.00
	4	494,424.00	518,400.00	506,412.00	155,520.00	350,892.00	223,580.00	350,892.00
	5	447,120.00	518,400.00	482,760.00	155,520.00	327,240.00	223,580.00	327,240.00
	6	497,016.00	518,400.00	507,708.00	155,520.00	352,188.00	223,580.00	352,188.00
	7	538,488.00	518,400.00	528,444.00	155,520.00	372,924.00	223,580.00	372,924.00
	8	588,384.00	518,400.00	553,392.00	155,520.00	397,872.00	223,580.00	397,872.00
	9	548,208.00	526,824.00	537,516.00	155,520.00	381,996.00	223,580.00	381,996.00
	10	648,000.00	518,400.00	583,200.00	155,520.00	427,680.00	223,580.00	427,680.00
	11	555,984.00	454,896.00	505,440.00	155,520.00	349,920.00	223,580.00	349,920.00
	12	550,800.00	399,816.00	475,308.00	155,520.00	319,788.00	223,580.00	319,788.00
	13	560,520.00	318,816.00	439,668.00	155,520.00	284,148.00	223,580.00	284,148.00
	14	572,184.00	402,408.00	487,296.00	155,520.00	331,776.00	223,580.00	331,776.00
	15	534,600.00	518,400.00	526,500.00	155,520.00	370,980.00	223,580.00	370,980.00
	16	534,600.00	534,600.00	534,600.00	155,520.00	379,080.00	223,580.00	379,080.00
	17	538,488.00	583,200.00	560,844.00	155,520.00	405,324.00	223,580.00	405,324.00
	18	561,816.00	534,600.00	548,208.00	155,520.00	392,688.00	223,580.00	392,688.00
	19	550,800.00	534,600.00	542,700.00	155,520.00	387,180.00	223,580.00	387,180.00
	20	555,984.00	583,200.00	569,592.00	155,520.00	414,072.00	223,580.00	414,072.00
	21	507,384.00	583,200.00	545,292.00	155,520.00	389,772.00	223,580.00	389,772.00
	22	518,400.00	583,200.00	550,800.00	155,520.00	395,280.00	223,580.00	395,280.00
	23	518,400.00	537,192.00	527,796.00	155,520.00	372,276.00	223,580.00	372,276.00
	24	526,824.00	520,992.00	523,908.00	155,520.00	368,388.00	223,580.00	368,388.00
	25	518,400.00	518,400.00	518,400.00	155,520.00	362,880.00	223,580.00	362,880.00
	26	515,808.00	518,400.00	517,104.00	155,520.00	361,584.00	223,580.00	361,584.00
	27	518,400.00	483,408.00	500,904.00	155,520.00	345,384.00	223,580.00	345,384.00
	28	518,400.00	555,984.00	537,192.00	155,520.00	381,672.00	223,580.00	381,672.00

3. March

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

Month	Date	PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
March	1	518,400.00	486,000.00	502,200.00	155,520.00	346,680.00	223,580.00	346,680.00
	2	454,896.00	563,112.00	509,004.00	155,520.00	353,484.00	223,580.00	353,484.00
	3	325,296.00	576,720.00	451,008.00	155,520.00	295,488.00	223,580.00	295,488.00
	4	398,520.00	534,600.00	466,560.00	155,520.00	311,040.00	223,580.00	311,040.00
	5	486,000.00	585,792.00	535,896.00	155,520.00	380,376.00	223,580.00	380,376.00
	6	534,600.00	585,792.00	560,196.00	155,520.00	404,676.00	223,580.00	404,676.00
	7	518,400.00	563,112.00	540,756.00	155,520.00	385,236.00	223,580.00	385,236.00
	8	518,400.00	561,816.00	540,108.00	155,520.00	384,588.00	223,580.00	384,588.00
	9	518,400.00	561,816.00	540,108.00	155,520.00	384,588.00	223,580.00	384,588.00
	10	526,824.00	573,480.00	550,152.00	155,520.00	394,632.00	223,580.00	394,632.00
	11	79,704.00	636,984.00	358,344.00	155,520.00	202,824.00	223,580.00	202,824.00
	12	-	596,808.00	298,404.00	155,520.00	142,884.00	223,580.00	142,884.00
	13	285,120.00	659,016.00	472,068.00	155,520.00	316,548.00	223,580.00	316,548.00
	14	387,504.00	535,896.00	461,700.00	155,520.00	306,180.00	223,580.00	306,180.00
	15	311,688.00	636,984.00	474,336.00	155,520.00	318,816.00	223,580.00	318,816.00
	16	348,624.00	538,488.00	443,556.00	155,520.00	288,036.00	223,580.00	288,036.00
	17	86,184.00	565,704.00	325,944.00	155,520.00	170,424.00	223,580.00	170,424.00
	18	84,888.00	625,320.00	355,104.00	155,520.00	199,584.00	223,580.00	199,584.00
	19	332,424.00	631,800.00	482,112.00	155,520.00	326,592.00	223,580.00	326,592.00
	20	522,288.00	599,400.00	560,844.00	155,520.00	405,324.00	223,580.00	405,324.00
	21	494,424.00	578,016.00	536,220.00	155,520.00	380,700.00	223,580.00	380,700.00
	22	518,400.00	522,288.00	520,344.00	155,520.00	364,824.00	223,580.00	364,824.00
	23	468,504.00	563,112.00	515,808.00	155,520.00	360,288.00	223,580.00	360,288.00
	24	484,704.00	604,584.00	544,644.00	155,520.00	389,124.00	223,580.00	389,124.00
	25	395,280.00	543,024.00	469,152.00	155,520.00	313,632.00	223,580.00	313,632.00
	26	555,984.00	518,400.00	537,192.00	155,520.00	381,672.00	223,580.00	381,672.00
	27	591,624.00	550,800.00	571,212.00	155,520.00	415,692.00	223,580.00	415,692.00
	28	502,200.00	583,200.00	542,700.00	155,520.00	387,180.00	223,580.00	387,180.00
	29	607,824.00	572,184.00	590,004.00	155,520.00	434,484.00	223,580.00	434,484.00
	30	640,224.00	583,200.00	611,712.00	155,520.00	456,192.00	223,580.00	456,192.00
	31	651,888.00	391,392.00	521,640.00	155,520.00	366,120.00	223,580.00	366,120.00

4. April

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Apr	1	664,200.00	401,112.00	532,656.00	155,520.00	377,136.00	223,580.00	377,136.00
	2	615,600.00	464,616.00	540,108.00	155,520.00	384,588.00	223,580.00	384,588.00
	3	595,512.00	460,080.00	527,796.00	155,520.00	372,276.00	223,580.00	372,276.00
	4	583,200.00	518,400.00	550,800.00	155,520.00	395,280.00	223,580.00	395,280.00
	5	596,808.00	462,024.00	529,416.00	155,520.00	373,896.00	223,580.00	373,896.00
	6	615,600.00	462,024.00	538,812.00	155,520.00	383,292.00	223,580.00	383,292.00
	7	596,808.00	518,400.00	557,604.00	155,520.00	402,084.00	223,580.00	402,084.00
	8	595,512.00	565,704.00	580,608.00	155,520.00	425,088.00	223,580.00	425,088.00
	9	561,816.00	595,512.00	578,664.00	155,520.00	423,144.00	223,580.00	423,144.00
	10	442,584.00	553,392.00	497,988.00	155,520.00	342,468.00	223,580.00	342,468.00
	11	592,920.00	427,680.00	510,300.00	155,520.00	354,780.00	223,580.00	354,780.00
	12	508,680.00	600,696.00	554,688.00	155,520.00	399,168.00	223,580.00	399,168.00
	13	553,392.00	549,504.00	551,448.00	155,520.00	395,928.00	223,580.00	395,928.00
	14	563,112.00	452,304.00	507,708.00	155,520.00	352,188.00	223,580.00	352,188.00
	15	474,984.00	311,688.00	393,336.00	155,520.00	237,816.00	223,580.00	237,816.00
	16	421,200.00	443,880.00	432,540.00	155,520.00	277,020.00	223,580.00	277,020.00
	17	456,192.00	507,384.00	481,788.00	155,520.00	326,268.00	223,580.00	326,268.00
	18	583,200.00	464,616.00	523,908.00	155,520.00	368,388.00	223,580.00	368,388.00
	19	591,624.00	458,784.00	525,204.00	155,520.00	369,684.00	223,580.00	369,684.00
	20	595,512.00	480,816.00	538,164.00	155,520.00	382,644.00	223,580.00	382,644.00
	21	468,504.00	457,488.00	462,996.00	155,520.00	307,476.00	223,580.00	307,476.00
	22	583,200.00	383,616.00	483,408.00	155,520.00	327,888.00	223,580.00	327,888.00
	23	583,200.00	341,496.00	462,348.00	155,520.00	306,828.00	223,580.00	306,828.00
	24	583,200.00	390,096.00	486,648.00	155,520.00	331,128.00	223,580.00	331,128.00
	25	595,512.00	453,600.00	524,556.00	155,520.00	369,036.00	223,580.00	369,036.00
	26	448,416.00	366,120.00	407,268.00	155,520.00	251,748.00	223,580.00	251,748.00
	27	429,624.00	453,600.00	441,612.00	155,520.00	286,092.00	223,580.00	286,092.00
	28	423,792.00	377,784.00	400,788.00	155,520.00	245,268.00	223,580.00	245,268.00
	29	427,680.00	168,480.00	298,080.00	155,520.00	142,560.00	223,580.00	142,560.00
	30	487,296.00	442,584.00	464,940.00	155,520.00	309,420.00	223,580.00	309,420.00

5. May

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
May	1	573,480.00	453,600.00	513,540.00	155,520.00	358,020.00	223,580.00	358,020.00
	2	572,184.00	453,600.00	512,892.00	155,520.00	357,372.00	223,580.00	357,372.00
	3	592,920.00	453,600.00	523,260.00	155,520.00	367,740.00	223,580.00	367,740.00
	4	587,088.00	453,600.00	520,344.00	155,520.00	364,824.00	223,580.00	364,824.00
	5	583,200.00	322,704.00	452,952.00	155,520.00	297,432.00	223,580.00	297,432.00
	6	610,416.00	322,704.00	466,560.00	155,520.00	311,040.00	223,580.00	311,040.00
	7	611,712.00	358,992.00	485,352.00	155,520.00	329,832.00	223,580.00	329,832.00
	8	592,920.00	295,488.00	444,204.00	155,520.00	288,684.00	223,580.00	288,684.00
	9	629,208.00	348,624.00	488,916.00	155,520.00	333,396.00	223,580.00	333,396.00
	10	624,024.00	349,920.00	486,972.00	155,520.00	331,452.00	223,580.00	331,452.00
	11	604,584.00	336,312.00	470,448.00	155,520.00	314,928.00	223,580.00	314,928.00
	12	596,808.00	306,504.00	451,656.00	155,520.00	296,136.00	223,580.00	296,136.00
	13	614,304.00	414,720.00	514,512.00	155,520.00	358,992.00	223,580.00	358,992.00
	14	599,400.00	381,024.00	490,212.00	155,520.00	334,692.00	223,580.00	334,692.00
	15	603,288.00	426,384.00	514,836.00	155,520.00	359,316.00	223,580.00	359,316.00
	16	585,792.00	414,720.00	500,256.00	155,520.00	344,736.00	223,580.00	344,736.00
	17	487,296.00	403,704.00	445,500.00	155,520.00	289,980.00	223,580.00	289,980.00
	18	414,720.00	276,696.00	345,708.00	155,520.00	190,188.00	223,580.00	190,188.00
	19	436,104.00	346,680.00	391,392.00	155,520.00	235,872.00	223,580.00	235,872.00
	20	583,200.00	310,392.00	446,796.00	155,520.00	291,276.00	223,580.00	291,276.00
	21	627,912.00	362,880.00	495,396.00	155,520.00	339,876.00	223,580.00	339,876.00
	22	641,520.00	453,600.00	547,560.00	155,520.00	392,040.00	223,580.00	392,040.00
	23	619,488.00	453,600.00	536,544.00	155,520.00	381,024.00	223,580.00	381,024.00
	24	615,600.00	453,600.00	534,600.00	155,520.00	379,080.00	223,580.00	379,080.00
	25	642,816.00	453,600.00	548,208.00	155,520.00	392,688.00	223,580.00	392,688.00
	26	599,400.00	453,600.00	526,500.00	155,520.00	370,980.00	223,580.00	370,980.00
	27	634,392.00	357,696.00	496,044.00	155,520.00	340,524.00	223,580.00	340,524.00
	28	615,600.00	413,424.00	514,512.00	155,520.00	358,992.00	223,580.00	358,992.00
	29	642,816.00	386,208.00	514,512.00	155,520.00	358,992.00	223,580.00	358,992.00
	30	618,192.00	358,992.00	488,592.00	155,520.00	333,072.00	223,580.00	333,072.00
	31	524,880.00	419,904.00	472,392.00	155,520.00	316,872.00	223,580.00	316,872.00

6. June

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jun	1	572,184.00	427,680.00	499,932.00	155,520.00	344,412.00	223,580.00	344,412.00
	2	598,104.00	453,600.00	525,852.00	155,520.00	370,332.00	223,580.00	370,332.00
	3	442,584.00	453,600.00	448,092.00	155,520.00	292,572.00	223,580.00	292,572.00
	4	325,296.00	453,600.00	389,448.00	155,520.00	233,928.00	223,580.00	233,928.00
	5	442,584.00	453,600.00	448,092.00	155,520.00	292,572.00	223,580.00	292,572.00
	6	646,704.00	453,600.00	550,152.00	155,520.00	394,632.00	223,580.00	394,632.00
	7	615,600.00	453,600.00	534,600.00	155,520.00	379,080.00	223,580.00	379,080.00
	8	615,600.00	453,600.00	534,600.00	155,520.00	379,080.00	223,580.00	379,080.00
	9	548,208.00	376,488.00	462,348.00	155,520.00	306,828.00	223,580.00	306,828.00
	10	546,912.00	257,904.00	402,408.00	155,520.00	246,888.00	223,580.00	246,888.00
	11	583,200.00	390,096.00	486,648.00	155,520.00	331,128.00	223,580.00	331,128.00
	12	561,816.00	413,424.00	487,620.00	155,520.00	332,100.00	223,580.00	332,100.00
	13	533,304.00	144,504.00	338,904.00	155,520.00	183,384.00	223,580.00	183,384.00
	14	583,200.00	314,280.00	448,740.00	155,520.00	293,220.00	223,580.00	293,220.00
	15	583,200.00	377,784.00	480,492.00	155,520.00	324,972.00	223,580.00	324,972.00
	16	580,608.00	388,800.00	484,704.00	155,520.00	329,184.00	223,580.00	329,184.00
	17	362,880.00	375,192.00	369,036.00	155,520.00	213,516.00	223,580.00	213,516.00
	18	487,296.00	302,616.00	394,956.00	155,520.00	239,436.00	223,580.00	239,436.00
	19	518,400.00	301,320.00	409,860.00	155,520.00	254,340.00	223,580.00	254,340.00
	20	478,224.00	87,480.00	282,852.00	155,520.00	127,332.00	223,580.00	127,332.00
	21	442,584.00	236,520.00	339,552.00	155,520.00	184,032.00	223,580.00	184,032.00
	22	423,792.00	289,008.00	356,400.00	155,520.00	200,880.00	223,580.00	200,880.00
	23	423,792.00	348,624.00	386,208.00	155,520.00	230,688.00	223,580.00	230,688.00
	24	411,480.00	355,104.00	383,292.00	155,520.00	227,772.00	223,580.00	227,772.00
	25	413,424.00	310,392.00	361,908.00	155,520.00	206,388.00	223,580.00	206,388.00
	26	518,400.00	357,696.00	438,048.00	155,520.00	282,528.00	223,580.00	282,528.00
	27	518,400.00	344,088.00	431,244.00	155,520.00	275,724.00	223,580.00	275,724.00
	28	518,400.00	124,416.00	321,408.00	155,520.00	165,888.00	223,580.00	165,888.00
	29	474,984.00	275,400.00	375,192.00	155,520.00	219,672.00	223,580.00	219,672.00
	30	495,720.00	324,000.00	409,860.00	155,520.00	254,340.00	223,580.00	254,340.00

7. July

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jul	1	417,312.00	305,208.00	361,260.00	155,520.00	205,740.00	223,580.00	205,740.00
	2	397,224.00	301,320.00	349,272.00	155,520.00	193,752.00	223,580.00	193,752.00
	3	391,392.00	295,488.00	343,440.00	155,520.00	187,920.00	223,580.00	187,920.00
	4	398,520.00	260,496.00	329,508.00	155,520.00	173,988.00	223,580.00	173,988.00
	5	425,088.00	280,584.00	352,836.00	155,520.00	197,316.00	223,580.00	197,316.00
	6	395,280.00	280,584.00	337,932.00	155,520.00	182,412.00	223,580.00	182,412.00
	7	395,280.00	281,880.00	338,580.00	155,520.00	183,060.00	223,580.00	183,060.00
	8	405,000.00	259,200.00	332,100.00	155,520.00	176,580.00	223,580.00	176,580.00
	9	379,080.00	291,600.00	335,340.00	155,520.00	179,820.00	223,580.00	179,820.00
	10	364,824.00	274,104.00	319,464.00	155,520.00	163,944.00	223,580.00	163,944.00
	11	353,808.00	294,192.00	324,000.00	155,520.00	168,480.00	223,580.00	168,480.00
	12	432,216.00	259,200.00	345,708.00	155,520.00	190,188.00	223,580.00	190,188.00
	13	463,320.00	283,824.00	373,572.00	155,520.00	218,052.00	223,580.00	218,052.00
	14	438,696.00	231,984.00	335,340.00	155,520.00	179,820.00	223,580.00	179,820.00
	15	422,496.00	225,504.00	324,000.00	155,520.00	168,480.00	223,580.00	168,480.00
	16	368,712.00	215,784.00	292,248.00	155,520.00	136,728.00	223,580.00	136,728.00
	17	471,096.00	259,200.00	365,148.00	155,520.00	209,628.00	223,580.00	209,628.00
	18	410,184.00	259,200.00	334,692.00	155,520.00	179,172.00	223,580.00	179,172.00
	19	443,880.00	259,200.00	351,540.00	155,520.00	196,020.00	223,580.00	196,020.00
	20	457,488.00	259,200.00	358,344.00	155,520.00	202,824.00	223,580.00	202,824.00
	21	451,008.00	243,000.00	347,004.00	155,520.00	191,484.00	223,580.00	191,484.00
	22	491,184.00	274,104.00	382,644.00	155,520.00	227,124.00	223,580.00	227,124.00
	23	462,024.00	231,984.00	347,004.00	155,520.00	191,484.00	223,580.00	191,484.00
	24	474,984.00	243,000.00	358,992.00	155,520.00	203,472.00	223,580.00	203,472.00
	25	469,800.00	210,600.00	340,200.00	155,520.00	184,680.00	223,580.00	184,680.00
	26	439,992.00	259,200.00	349,596.00	155,520.00	194,076.00	223,580.00	194,076.00
	27	484,704.00	259,200.00	371,952.00	155,520.00	216,432.00	223,580.00	216,432.00
	28	441,288.00	215,784.00	328,536.00	155,520.00	173,016.00	223,580.00	173,016.00
	29	468,504.00	194,400.00	331,452.00	155,520.00	175,932.00	223,580.00	175,932.00
	30	452,304.00	179,496.00	315,900.00	155,520.00	160,380.00	223,580.00	160,380.00
	31	425,088.00	148,392.00	286,740.00	155,520.00	131,220.00	223,580.00	131,220.00

8. August

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Aug	1	418,608.00	191,808.00	305,208.00	155,520.00	149,688.00	223,580.00	149,688.00
	2	414,720.00	194,400.00	304,560.00	155,520.00	149,040.00	223,580.00	149,040.00
	3	375,192.00	194,400.00	284,796.00	155,520.00	129,276.00	223,580.00	129,276.00
	4	419,904.00	194,400.00	307,152.00	155,520.00	151,632.00	223,580.00	151,632.00
	5	371,304.00	194,400.00	282,852.00	155,520.00	127,332.00	223,580.00	127,332.00
	6	353,808.00	194,400.00	274,104.00	155,520.00	118,584.00	223,580.00	118,584.00
	7	353,808.00	154,224.00	254,016.00	155,520.00	98,496.00	223,580.00	98,496.00
	8	367,416.00	194,400.00	280,908.00	155,520.00	125,388.00	223,580.00	125,388.00
	9	356,400.00	163,296.00	259,848.00	155,520.00	104,328.00	223,580.00	104,328.00
	10	376,488.00	163,296.00	269,892.00	155,520.00	114,372.00	223,580.00	114,372.00
	11	393,984.00	196,992.00	295,488.00	155,520.00	139,968.00	223,580.00	139,968.00
	12	382,320.00	194,400.00	288,360.00	155,520.00	132,840.00	223,580.00	132,840.00
	13	364,824.00	194,400.00	279,612.00	155,520.00	124,092.00	223,580.00	124,092.00
	14	373,896.00	194,400.00	284,148.00	155,520.00	128,628.00	223,580.00	128,628.00
	15	358,992.00	194,400.00	276,696.00	155,520.00	121,176.00	223,580.00	121,176.00
	16	357,696.00	194,400.00	276,048.00	155,520.00	120,528.00	223,580.00	120,528.00
	17	316,224.00	194,400.00	255,312.00	155,520.00	99,792.00	223,580.00	99,792.00
	18	393,984.00	194,400.00	294,192.00	155,520.00	138,672.00	223,580.00	138,672.00
	19	311,688.00	194,400.00	253,044.00	155,520.00	97,524.00	223,580.00	97,524.00
	20	312,984.00	194,400.00	253,692.00	155,520.00	98,172.00	223,580.00	98,172.00
	21	255,312.00	194,400.00	224,856.00	155,520.00	69,336.00	223,580.00	69,336.00
	22	277,992.00	194,400.00	236,196.00	155,520.00	80,676.00	223,580.00	80,676.00
	23	300,024.00	194,400.00	247,212.00	155,520.00	91,692.00	223,580.00	91,692.00
	24	298,080.00	168,480.00	233,280.00	155,520.00	77,760.00	223,580.00	77,760.00
	25	469,800.00	160,704.00	315,252.00	155,520.00	159,732.00	223,580.00	159,732.00
	26	287,712.00	195,696.00	241,704.00	155,520.00	86,184.00	223,580.00	86,184.00
	27	292,896.00	194,400.00	243,648.00	155,520.00	88,128.00	223,580.00	88,128.00
	28	307,800.00	168,480.00	238,140.00	155,520.00	82,620.00	223,580.00	82,620.00
	29	337,608.00	194,400.00	266,004.00	155,520.00	110,484.00	223,580.00	110,484.00
	30	317,520.00	140,616.00	229,068.00	155,520.00	73,548.00	223,580.00	73,548.00
	31	318,816.00	155,520.00	237,168.00	155,520.00	81,648.00	223,580.00	81,648.00

9. September

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Sep	1	296,784.00	191,808.00	244,296.00	155,520.00	88,776.00	223,580.00	88,776.00
	2	302,616.00	148,392.00	225,504.00	155,520.00	69,984.00	223,580.00	69,984.00
	3	55,080.00	194,400.00	124,740.00	155,520.00	-30,780.00	192,800.00	0.00
	4	264,384.00	194,400.00	229,392.00	155,520.00	73,872.00	223,580.00	73,872.00
	5	252,720.00	158,112.00	205,416.00	155,520.00	49,896.00	223,580.00	49,896.00
	6	226,800.00	194,400.00	210,600.00	155,520.00	55,080.00	223,580.00	55,080.00
	7	226,800.00	154,224.00	190,512.00	155,520.00	34,992.00	223,580.00	34,992.00
	8	256,608.00	156,816.00	206,712.00	155,520.00	51,192.00	223,580.00	51,192.00
	9	243,000.00	159,408.00	201,204.00	155,520.00	45,684.00	223,580.00	45,684.00
	10	224,208.00	119,880.00	172,044.00	155,520.00	16,524.00	223,580.00	16,524.00
	11	205,416.00	187,920.00	196,668.00	155,520.00	41,148.00	223,580.00	41,148.00
	12	210,600.00	168,480.00	189,540.00	155,520.00	34,020.00	223,580.00	34,020.00
	13	215,784.00	159,408.00	187,596.00	155,520.00	32,076.00	223,580.00	32,076.00
	14	205,416.00	194,400.00	199,908.00	155,520.00	44,388.00	223,580.00	44,388.00
	15	225,504.00	160,704.00	193,104.00	155,520.00	37,584.00	223,580.00	37,584.00
	16	210,600.00	162,000.00	186,300.00	155,520.00	30,780.00	223,580.00	30,780.00
	17	209,304.00	173,016.00	191,160.00	155,520.00	35,640.00	223,580.00	35,640.00
	18	221,616.00	158,112.00	189,864.00	155,520.00	34,344.00	223,580.00	34,344.00
	19	194,400.00	152,280.00	173,340.00	155,520.00	17,820.00	223,580.00	17,820.00
	20	176,904.00	150,984.00	163,944.00	155,520.00	8,424.00	223,580.00	8,424.00
	21	209,304.00	145,800.00	177,552.00	155,520.00	22,032.00	223,580.00	22,032.00
	22	202,824.00	105,624.00	154,224.00	155,520.00	-1,296.00	222,284.00	0.00
	23	1,942,704.00	134,784.00	1,038,744.00	155,520.00	883,224.00	223,580.00	883,224.00
	24	1,942,704.00	129,600.00	1,036,152.00	155,520.00	880,632.00	223,580.00	880,632.00
	25	469,800.00	121,824.00	295,812.00	155,520.00	140,292.00	223,580.00	140,292.00
	26	171,720.00	113,400.00	142,560.00	155,520.00	-12,960.00	210,620.00	0.00
	27	200,880.00	191,808.00	196,344.00	155,520.00	40,824.00	223,580.00	40,824.00
	28	-	144,504.00	72,252.00	155,520.00	-83,268.00	140,312.00	0.00
	29	191,808.00	123,120.00	157,464.00	155,520.00	1,944.00	142,256.00	0.00
	30	164,592.00	194,400.00	179,496.00	155,520.00	23,976.00	166,232.00	0.00
	31							

10. October

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
Month	Date	2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Oct	1	194,400.00	314,280.00	254,340.00	155,520.00	98,820.00	223,580.00	98,820.00
	2	194,400.00	268,920.00	231,660.00	155,520.00	76,140.00	223,580.00	76,140.00
	3	163,296.00	295,488.00	229,392.00	155,520.00	73,872.00	223,580.00	73,872.00
	4	194,400.00	306,504.00	250,452.00	155,520.00	94,932.00	223,580.00	94,932.00
	5	64,800.00	333,720.00	199,260.00	155,520.00	43,740.00	223,580.00	43,740.00
	6	194,400.00	275,400.00	234,900.00	155,520.00	79,380.00	223,580.00	79,380.00
	7	194,400.00	300,024.00	247,212.00	155,520.00	91,692.00	223,580.00	91,692.00
	8	194,400.00	338,904.00	266,652.00	155,520.00	111,132.00	223,580.00	111,132.00
	9	179,496.00	301,320.00	240,408.00	155,520.00	84,888.00	223,580.00	84,888.00
	10	194,400.00	280,584.00	237,492.00	155,520.00	81,972.00	223,580.00	81,972.00
	11	204,120.00	303,912.00	254,016.00	155,520.00	98,496.00	223,580.00	98,496.00
	12	194,400.00	283,824.00	239,112.00	155,520.00	83,592.00	223,580.00	83,592.00
	13	154,224.00	303,912.00	229,068.00	155,520.00	73,548.00	223,580.00	73,548.00
	14	210,600.00	229,392.00	219,996.00	155,520.00	64,476.00	223,580.00	64,476.00
	15	208,008.00	248,184.00	228,096.00	155,520.00	72,576.00	223,580.00	72,576.00
	16	209,304.00	263,088.00	236,196.00	155,520.00	80,676.00	223,580.00	80,676.00
	17	194,400.00	244,296.00	219,348.00	155,520.00	63,828.00	223,580.00	63,828.00
	18	210,600.00	221,616.00	216,108.00	155,520.00	60,588.00	223,580.00	60,588.00
	19	210,600.00	225,504.00	218,052.00	155,520.00	62,532.00	223,580.00	62,532.00
	20	198,936.00	194,400.00	196,668.00	155,520.00	41,148.00	223,580.00	41,148.00
	21	215,784.00	164,592.00	190,188.00	155,520.00	34,668.00	223,580.00	34,668.00
	22	241,704.00	213,192.00	227,448.00	155,520.00	71,928.00	223,580.00	71,928.00
	23	210,600.00	196,992.00	203,796.00	155,520.00	48,276.00	223,580.00	48,276.00
	24	213,192.00	173,016.00	193,104.00	155,520.00	37,584.00	223,580.00	37,584.00
	25	210,600.00	162,000.00	186,300.00	155,520.00	30,780.00	223,580.00	30,780.00
	26	210,600.00	145,800.00	178,200.00	155,520.00	22,680.00	223,580.00	22,680.00
	27	210,600.00	154,224.00	182,412.00	155,520.00	26,892.00	223,580.00	26,892.00
	28	193,104.00	106,920.00	150,012.00	155,520.00	-5,508.00	218,072.00	0.00
	29	221,616.00	105,624.00	163,620.00	155,520.00	8,100.00	223,580.00	8,100.00
	30	243,000.00	87,480.00	165,240.00	155,520.00	9,720.00	223,580.00	9,720.00
	31	249,480.00	97,200.00	173,340.00	155,520.00	17,820.00	223,580.00	17,820.00

11. November

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
Month	Date	2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Nov	1	230,688.00	34,992.00	132,840.00	155,520.00	-22,680.00	200,900.00	0.00
	2	225,504.00	64,800.00	145,152.00	155,520.00	-10,368.00	190,532.00	0.00
	3	210,600.00	82,296.00	146,448.00	155,520.00	-9,072.00	181,460.00	0.00
	4	225,504.00	47,304.00	136,404.00	155,520.00	-19,116.00	162,344.00	0.00
	5	217,080.00	99,792.00	158,436.00	155,520.00	2,916.00	165,260.00	0.00
	6	217,080.00	194,400.00	205,740.00	155,520.00	50,220.00	215,480.00	42,120.00
	7	194,400.00	239,112.00	216,756.00	155,520.00	61,236.00	223,580.00	61,236.00
	8	248,184.00	145,800.00	196,992.00	155,520.00	41,472.00	223,580.00	41,472.00
	9	302,616.00	204,120.00	253,368.00	155,520.00	97,848.00	223,580.00	97,848.00
	10	110,808.00	302,616.00	206,712.00	155,520.00	51,192.00	223,580.00	51,192.00
	11	-	325,296.00	162,648.00	155,520.00	7,128.00	223,580.00	7,128.00
	12	-	256,608.00	128,304.00	155,520.00	-27,216.00	196,364.00	0.00
	13	183,384.00	213,192.00	198,288.00	155,520.00	42,768.00	223,580.00	42,768.00
	14	275,400.00	199,584.00	237,492.00	155,520.00	81,972.00	223,580.00	81,972.00
	15	276,696.00	243,000.00	259,848.00	155,520.00	104,328.00	223,580.00	104,328.00
	16	274,104.00	205,416.00	239,760.00	155,520.00	84,240.00	223,580.00	84,240.00
	17	281,880.00	220,320.00	251,100.00	155,520.00	95,580.00	223,580.00	95,580.00
	18	276,696.00	220,320.00	248,508.00	155,520.00	92,988.00	223,580.00	92,988.00
	19	317,520.00	210,600.00	264,060.00	155,520.00	108,540.00	223,580.00	108,540.00
	20	324,000.00	155,520.00	239,760.00	155,520.00	84,240.00	223,580.00	84,240.00
	21	105,624.00	110,808.00	108,216.00	155,520.00	-47,304.00	176,276.00	0.00
	22	279,288.00	108,216.00	193,752.00	155,520.00	38,232.00	214,508.00	29,160.00
	23	324,000.00	36,288.00	180,144.00	155,520.00	24,624.00	223,580.00	24,624.00
	24	330,480.00	69,984.00	200,232.00	155,520.00	44,712.00	223,580.00	44,712.00
	25	289,008.00	155,520.00	222,264.00	155,520.00	66,744.00	223,580.00	66,744.00
	26	275,400.00	140,616.00	208,008.00	155,520.00	52,488.00	223,580.00	52,488.00
	27	312,984.00	134,784.00	223,884.00	155,520.00	68,364.00	223,580.00	68,364.00
	28	74,520.00	127,008.00	100,764.00	155,520.00	-54,756.00	168,824.00	0.00
	29	-	129,600.00	64,800.00	155,520.00	-90,720.00	78,104.00	0.00
	30	20,088.00	134,784.00	77,436.00	155,520.00	-78,084.00	20.00	0.00
	31							

12. December

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
Month	Date	2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Dec	1	327,888.00	-	327,888.00	155,520.00	172,368.00	172,388.00	121,176.00
	2	356,400.00	-	356,400.00	155,520.00	200,880.00	223,580.00	200,880.00
	3	294,192.00	-	294,192.00	155,520.00	138,672.00	223,580.00	138,672.00
	4	316,224.00	-	316,224.00	155,520.00	160,704.00	223,580.00	160,704.00
	5	373,896.00	-	373,896.00	155,520.00	218,376.00	223,580.00	218,376.00
	6	373,896.00	-	373,896.00	155,520.00	218,376.00	223,580.00	218,376.00
	7	372,600.00	-	372,600.00	155,520.00	217,080.00	223,580.00	217,080.00
	8	381,024.00	-	381,024.00	155,520.00	225,504.00	223,580.00	225,504.00
	9	421,200.00	-	421,200.00	155,520.00	265,680.00	223,580.00	265,680.00
	10	487,296.00	-	487,296.00	155,520.00	331,776.00	223,580.00	331,776.00
	11	537,192.00	-	537,192.00	155,520.00	381,672.00	223,580.00	381,672.00
	12	534,600.00	-	534,600.00	155,520.00	379,080.00	223,580.00	379,080.00
	13	537,192.00	-	537,192.00	155,520.00	381,672.00	223,580.00	381,672.00
	14	474,984.00	-	474,984.00	155,520.00	319,464.00	223,580.00	319,464.00
	15	345,384.00	-	345,384.00	155,520.00	189,864.00	223,580.00	189,864.00
	16	467,208.00	-	467,208.00	155,520.00	311,688.00	223,580.00	311,688.00
	17	583,200.00	-	583,200.00	155,520.00	427,680.00	223,580.00	427,680.00
	18	583,200.00	-	583,200.00	155,520.00	427,680.00	223,580.00	427,680.00
	19	569,592.00	-	569,592.00	155,520.00	414,072.00	223,580.00	414,072.00
	20	489,888.00	-	489,888.00	155,520.00	334,368.00	223,580.00	334,368.00
	21	403,704.00	-	403,704.00	155,520.00	248,184.00	223,580.00	248,184.00
	22	271,512.00	-	271,512.00	155,520.00	115,992.00	223,580.00	115,992.00
	23	244,296.00	-	244,296.00	155,520.00	88,776.00	223,580.00	88,776.00
	24	287,712.00	-	287,712.00	155,520.00	132,192.00	223,580.00	132,192.00
	25	458,784.00	-	458,784.00	155,520.00	303,264.00	223,580.00	303,264.00
	26	453,600.00	-	453,600.00	155,520.00	298,080.00	223,580.00	298,080.00
	27	356,400.00	-	356,400.00	155,520.00	200,880.00	223,580.00	200,880.00
	28	235,224.00	-	235,224.00	155,520.00	79,704.00	223,580.00	79,704.00
	29	489,888.00	-	489,888.00	155,520.00	334,368.00	223,580.00	334,368.00
	30	498,312.00	-	498,312.00	155,520.00	342,792.00	223,580.00	342,792.00
	31	421,200.00	-	421,200.00	155,520.00	265,680.00	223,580.00	265,680.00

2. Scenario 2 (Storage + 25% Increase)

1. January

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s

Month	Date	PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jan	1	534,600.00	403,704.00	469,152.00	194,400.00	274,752.00	274,752.00	0.00
	2	460,080.00	408,888.00	434,484.00	194,400.00	240,084.00	415,700.00	240,084.00
	3	518,400.00	429,624.00	474,012.00	194,400.00	279,612.00	415,700.00	279,612.00
	4	518,400.00	419,904.00	469,152.00	194,400.00	274,752.00	415,700.00	274,752.00
	5	518,400.00	453,600.00	486,000.00	194,400.00	291,600.00	415,700.00	291,600.00
	6	506,088.00	453,600.00	479,844.00	194,400.00	285,444.00	415,700.00	285,444.00
	7	486,000.00	453,600.00	469,800.00	194,400.00	275,400.00	415,700.00	275,400.00
	8	518,400.00	453,600.00	486,000.00	194,400.00	291,600.00	415,700.00	291,600.00
	9	478,224.00	499,608.00	488,916.00	194,400.00	294,516.00	415,700.00	294,516.00
	10	534,600.00	519,696.00	527,148.00	194,400.00	332,748.00	415,700.00	332,748.00
	11	150,984.00	487,296.00	319,140.00	194,400.00	124,740.00	415,700.00	124,740.00
	12	392,688.00	510,624.00	451,656.00	194,400.00	257,256.00	415,700.00	257,256.00
	13	423,792.00	518,400.00	471,096.00	194,400.00	276,696.00	415,700.00	276,696.00
	14	534,600.00	518,400.00	526,500.00	194,400.00	332,100.00	415,700.00	332,100.00
	15	479,520.00	518,400.00	498,960.00	194,400.00	304,560.00	415,700.00	304,560.00
	16	553,392.00	518,400.00	535,896.00	194,400.00	341,496.00	415,700.00	341,496.00
	17	579,312.00	530,712.00	555,012.00	194,400.00	360,612.00	415,700.00	360,612.00
	18	594,216.00	543,024.00	568,620.00	194,400.00	374,220.00	415,700.00	374,220.00
	19	447,120.00	550,800.00	498,960.00	194,400.00	304,560.00	415,700.00	304,560.00
	20	572,184.00	543,024.00	557,604.00	194,400.00	363,204.00	415,700.00	363,204.00
	21	552,096.00	453,600.00	502,848.00	194,400.00	308,448.00	415,700.00	308,448.00
	22	519,696.00	495,720.00	507,708.00	194,400.00	313,308.00	415,700.00	313,308.00
	23	532,008.00	550,800.00	541,404.00	194,400.00	347,004.00	415,700.00	347,004.00
	24	584,496.00	381,024.00	482,760.00	194,400.00	288,360.00	415,700.00	288,360.00
	25	583,200.00	413,424.00	498,312.00	194,400.00	303,912.00	415,700.00	303,912.00
	26	583,200.00	476,280.00	529,740.00	194,400.00	335,340.00	415,700.00	335,340.00
	27	578,016.00	553,392.00	565,704.00	194,400.00	371,304.00	415,700.00	371,304.00
	28	583,200.00	498,312.00	540,756.00	194,400.00	346,356.00	415,700.00	346,356.00
	29	532,008.00	532,008.00	532,008.00	194,400.00	337,608.00	415,700.00	337,608.00
	30	526,824.00	518,400.00	522,612.00	194,400.00	328,212.00	415,700.00	328,212.00
	31	518,400.00	518,400.00	518,400.00	194,400.00	324,000.00	415,700.00	324,000.00

2. February

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s

Month	Date	PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Feb	1	497,016.00	533,304.00	515,160.00	194,400.00	320,760.00	415,700.00	320,760.00
	2	518,400.00	530,712.00	524,556.00	194,400.00	330,156.00	415,700.00	330,156.00
	3	476,280.00	518,400.00	497,340.00	194,400.00	302,940.00	415,700.00	302,940.00
	4	494,424.00	518,400.00	506,412.00	194,400.00	312,012.00	415,700.00	312,012.00
	5	447,120.00	518,400.00	482,760.00	194,400.00	288,360.00	415,700.00	288,360.00
	6	497,016.00	518,400.00	507,708.00	194,400.00	313,308.00	415,700.00	313,308.00
	7	538,488.00	518,400.00	528,444.00	194,400.00	334,044.00	415,700.00	334,044.00
	8	588,384.00	518,400.00	553,392.00	194,400.00	358,992.00	415,700.00	358,992.00
	9	548,208.00	526,824.00	537,516.00	194,400.00	343,116.00	415,700.00	343,116.00
	10	648,000.00	518,400.00	583,200.00	194,400.00	388,800.00	415,700.00	388,800.00
	11	555,984.00	454,896.00	505,440.00	194,400.00	311,040.00	415,700.00	311,040.00
	12	550,800.00	399,816.00	475,308.00	194,400.00	280,908.00	415,700.00	280,908.00
	13	560,520.00	318,816.00	439,668.00	194,400.00	245,268.00	415,700.00	245,268.00
	14	572,184.00	402,408.00	487,296.00	194,400.00	292,896.00	415,700.00	292,896.00
	15	534,600.00	518,400.00	526,500.00	194,400.00	332,100.00	415,700.00	332,100.00
	16	534,600.00	534,600.00	534,600.00	194,400.00	340,200.00	415,700.00	340,200.00
	17	538,488.00	583,200.00	560,844.00	194,400.00	366,444.00	415,700.00	366,444.00
	18	561,816.00	534,600.00	548,208.00	194,400.00	353,808.00	415,700.00	353,808.00
	19	550,800.00	534,600.00	542,700.00	194,400.00	348,300.00	415,700.00	348,300.00
	20	555,984.00	583,200.00	569,592.00	194,400.00	375,192.00	415,700.00	375,192.00
	21	507,384.00	583,200.00	545,292.00	194,400.00	350,892.00	415,700.00	350,892.00
	22	518,400.00	583,200.00	550,800.00	194,400.00	356,400.00	415,700.00	356,400.00
	23	518,400.00	537,192.00	527,796.00	194,400.00	333,396.00	415,700.00	333,396.00
	24	526,824.00	520,992.00	523,908.00	194,400.00	329,508.00	415,700.00	329,508.00
	25	518,400.00	518,400.00	518,400.00	194,400.00	324,000.00	415,700.00	324,000.00
	26	515,808.00	518,400.00	517,104.00	194,400.00	322,704.00	415,700.00	322,704.00
	27	518,400.00	483,408.00	500,904.00	194,400.00	306,504.00	415,700.00	306,504.00
	28	518,400.00	555,984.00	537,192.00	194,400.00	342,792.00	415,700.00	342,792.00

3. March

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s

Month	Date	PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
March	1	518,400.00	486,000.00	502,200.00	194,400.00	307,800.00	415,700.00	307,800.00
	2	454,896.00	563,112.00	509,004.00	194,400.00	314,604.00	415,700.00	314,604.00
	3	325,296.00	576,720.00	451,008.00	194,400.00	256,608.00	415,700.00	256,608.00
	4	398,520.00	534,600.00	466,560.00	194,400.00	272,160.00	415,700.00	272,160.00
	5	486,000.00	585,792.00	535,896.00	194,400.00	341,496.00	415,700.00	341,496.00
	6	534,600.00	585,792.00	560,196.00	194,400.00	365,796.00	415,700.00	365,796.00
	7	518,400.00	563,112.00	540,756.00	194,400.00	346,356.00	415,700.00	346,356.00
	8	518,400.00	561,816.00	540,108.00	194,400.00	345,708.00	415,700.00	345,708.00
	9	518,400.00	561,816.00	540,108.00	194,400.00	345,708.00	415,700.00	345,708.00
	10	526,824.00	573,480.00	550,152.00	194,400.00	355,752.00	415,700.00	355,752.00
	11	79,704.00	636,984.00	358,344.00	194,400.00	163,944.00	415,700.00	163,944.00
	12	-	596,808.00	298,404.00	194,400.00	104,004.00	415,700.00	104,004.00
	13	285,120.00	659,016.00	472,068.00	194,400.00	277,668.00	415,700.00	277,668.00
	14	387,504.00	535,896.00	461,700.00	194,400.00	267,300.00	415,700.00	267,300.00
	15	311,688.00	636,984.00	474,336.00	194,400.00	279,936.00	415,700.00	279,936.00
	16	348,624.00	538,488.00	443,556.00	194,400.00	249,156.00	415,700.00	249,156.00
	17	86,184.00	565,704.00	325,944.00	194,400.00	131,544.00	415,700.00	131,544.00
	18	84,888.00	625,320.00	355,104.00	194,400.00	160,704.00	415,700.00	160,704.00
	19	332,424.00	631,800.00	482,112.00	194,400.00	287,712.00	415,700.00	287,712.00
	20	522,288.00	599,400.00	560,844.00	194,400.00	366,444.00	415,700.00	366,444.00
	21	494,424.00	578,016.00	536,220.00	194,400.00	341,820.00	415,700.00	341,820.00
	22	518,400.00	522,288.00	520,344.00	194,400.00	325,944.00	415,700.00	325,944.00
	23	468,504.00	563,112.00	515,808.00	194,400.00	321,408.00	415,700.00	321,408.00
	24	484,704.00	604,584.00	544,644.00	194,400.00	350,244.00	415,700.00	350,244.00
	25	395,280.00	543,024.00	469,152.00	194,400.00	274,752.00	415,700.00	274,752.00
	26	555,984.00	518,400.00	537,192.00	194,400.00	342,792.00	415,700.00	342,792.00
	27	591,624.00	550,800.00	571,212.00	194,400.00	376,812.00	415,700.00	376,812.00
	28	502,200.00	583,200.00	542,700.00	194,400.00	348,300.00	415,700.00	348,300.00
	29	607,824.00	572,184.00	590,004.00	194,400.00	395,604.00	415,700.00	395,604.00
	30	640,224.00	583,200.00	611,712.00	194,400.00	417,312.00	415,700.00	417,312.00
	31	651,888.00	391,392.00	521,640.00	194,400.00	327,240.00	415,700.00	327,240.00

4. April

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Apr	1	664,200.00	401,112.00	532,656.00	194,400.00	338,256.00	415,700.00	338,256.00
	2	615,600.00	464,616.00	540,108.00	194,400.00	345,708.00	415,700.00	345,708.00
	3	595,512.00	460,080.00	527,796.00	194,400.00	333,396.00	415,700.00	333,396.00
	4	583,200.00	518,400.00	550,800.00	194,400.00	356,400.00	415,700.00	356,400.00
	5	596,808.00	462,024.00	529,416.00	194,400.00	335,016.00	415,700.00	335,016.00
	6	615,600.00	462,024.00	538,812.00	194,400.00	344,412.00	415,700.00	344,412.00
	7	596,808.00	518,400.00	557,604.00	194,400.00	363,204.00	415,700.00	363,204.00
	8	595,512.00	565,704.00	580,608.00	194,400.00	386,208.00	415,700.00	386,208.00
	9	561,816.00	595,512.00	578,664.00	194,400.00	384,264.00	415,700.00	384,264.00
	10	442,584.00	553,392.00	497,988.00	194,400.00	303,588.00	415,700.00	303,588.00
	11	592,920.00	427,680.00	510,300.00	194,400.00	315,900.00	415,700.00	315,900.00
	12	508,680.00	600,696.00	554,688.00	194,400.00	360,288.00	415,700.00	360,288.00
	13	553,392.00	549,504.00	551,448.00	194,400.00	357,048.00	415,700.00	357,048.00
	14	563,112.00	452,304.00	507,708.00	194,400.00	313,308.00	415,700.00	313,308.00
	15	474,984.00	311,688.00	393,336.00	194,400.00	198,936.00	415,700.00	198,936.00
	16	421,200.00	443,880.00	432,540.00	194,400.00	238,140.00	415,700.00	238,140.00
	17	456,192.00	507,384.00	481,788.00	194,400.00	287,388.00	415,700.00	287,388.00
	18	583,200.00	464,616.00	523,908.00	194,400.00	329,508.00	415,700.00	329,508.00
	19	591,624.00	458,784.00	525,204.00	194,400.00	330,804.00	415,700.00	330,804.00
	20	595,512.00	480,816.00	538,164.00	194,400.00	343,764.00	415,700.00	343,764.00
	21	468,504.00	457,488.00	462,996.00	194,400.00	268,596.00	415,700.00	268,596.00
	22	583,200.00	383,616.00	483,408.00	194,400.00	289,008.00	415,700.00	289,008.00
	23	583,200.00	341,496.00	462,348.00	194,400.00	267,948.00	415,700.00	267,948.00
	24	583,200.00	390,096.00	486,648.00	194,400.00	292,248.00	415,700.00	292,248.00
	25	595,512.00	453,600.00	524,556.00	194,400.00	330,156.00	415,700.00	330,156.00
	26	448,416.00	366,120.00	407,268.00	194,400.00	212,868.00	415,700.00	212,868.00
	27	429,624.00	453,600.00	441,612.00	194,400.00	247,212.00	415,700.00	247,212.00
	28	423,792.00	377,784.00	400,788.00	194,400.00	206,388.00	415,700.00	206,388.00
	29	427,680.00	168,480.00	298,080.00	194,400.00	103,680.00	415,700.00	103,680.00
	30	487,296.00	442,584.00	464,940.00	194,400.00	270,540.00	415,700.00	270,540.00

5. May

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
May	1	573,480.00	453,600.00	513,540.00	194,400.00	319,140.00	415,700.00	319,140.00
	2	572,184.00	453,600.00	512,892.00	194,400.00	318,492.00	415,700.00	318,492.00
	3	592,920.00	453,600.00	523,260.00	194,400.00	328,860.00	415,700.00	328,860.00
	4	587,088.00	453,600.00	520,344.00	194,400.00	325,944.00	415,700.00	325,944.00
	5	583,200.00	322,704.00	452,952.00	194,400.00	258,552.00	415,700.00	258,552.00
	6	610,416.00	322,704.00	466,560.00	194,400.00	272,160.00	415,700.00	272,160.00
	7	611,712.00	358,992.00	485,352.00	194,400.00	290,952.00	415,700.00	290,952.00
	8	592,920.00	295,488.00	444,204.00	194,400.00	249,804.00	415,700.00	249,804.00
	9	629,208.00	348,624.00	488,916.00	194,400.00	294,516.00	415,700.00	294,516.00
	10	624,024.00	349,920.00	486,972.00	194,400.00	292,572.00	415,700.00	292,572.00
	11	604,584.00	336,312.00	470,448.00	194,400.00	276,048.00	415,700.00	276,048.00
	12	596,808.00	306,504.00	451,656.00	194,400.00	257,256.00	415,700.00	257,256.00
	13	614,304.00	414,720.00	514,512.00	194,400.00	320,112.00	415,700.00	320,112.00
	14	599,400.00	381,024.00	490,212.00	194,400.00	295,812.00	415,700.00	295,812.00
	15	603,288.00	426,384.00	514,836.00	194,400.00	320,436.00	415,700.00	320,436.00
	16	585,792.00	414,720.00	500,256.00	194,400.00	305,856.00	415,700.00	305,856.00
	17	487,296.00	403,704.00	445,500.00	194,400.00	251,100.00	415,700.00	251,100.00
	18	414,720.00	276,696.00	345,708.00	194,400.00	151,308.00	415,700.00	151,308.00
	19	436,104.00	346,680.00	391,392.00	194,400.00	196,992.00	415,700.00	196,992.00
	20	583,200.00	310,392.00	446,796.00	194,400.00	252,396.00	415,700.00	252,396.00
	21	627,912.00	362,880.00	495,396.00	194,400.00	300,996.00	415,700.00	300,996.00
	22	641,520.00	453,600.00	547,560.00	194,400.00	353,160.00	415,700.00	353,160.00
	23	619,488.00	453,600.00	536,544.00	194,400.00	342,144.00	415,700.00	342,144.00
	24	615,600.00	453,600.00	534,600.00	194,400.00	340,200.00	415,700.00	340,200.00
	25	642,816.00	453,600.00	548,208.00	194,400.00	353,808.00	415,700.00	353,808.00
	26	599,400.00	453,600.00	526,500.00	194,400.00	332,100.00	415,700.00	332,100.00
	27	634,392.00	357,696.00	496,044.00	194,400.00	301,644.00	415,700.00	301,644.00
	28	615,600.00	413,424.00	514,512.00	194,400.00	320,112.00	415,700.00	320,112.00
	29	642,816.00	386,208.00	514,512.00	194,400.00	320,112.00	415,700.00	320,112.00
	30	618,192.00	358,992.00	488,592.00	194,400.00	294,192.00	415,700.00	294,192.00
	31	524,880.00	419,904.00	472,392.00	194,400.00	277,992.00	415,700.00	277,992.00

6. June

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jun	1	572,184.00	427,680.00	499,932.00	194,400.00	305,532.00	415,700.00	305,532.00
	2	598,104.00	453,600.00	525,852.00	194,400.00	331,452.00	415,700.00	331,452.00
	3	442,584.00	453,600.00	448,092.00	194,400.00	253,692.00	415,700.00	253,692.00
	4	325,296.00	453,600.00	389,448.00	194,400.00	195,048.00	415,700.00	195,048.00
	5	442,584.00	453,600.00	448,092.00	194,400.00	253,692.00	415,700.00	253,692.00
	6	646,704.00	453,600.00	550,152.00	194,400.00	355,752.00	415,700.00	355,752.00
	7	615,600.00	453,600.00	534,600.00	194,400.00	340,200.00	415,700.00	340,200.00
	8	615,600.00	453,600.00	534,600.00	194,400.00	340,200.00	415,700.00	340,200.00
	9	548,208.00	376,488.00	462,348.00	194,400.00	267,948.00	415,700.00	267,948.00
	10	546,912.00	257,904.00	402,408.00	194,400.00	208,008.00	415,700.00	208,008.00
	11	583,200.00	390,096.00	486,648.00	194,400.00	292,248.00	415,700.00	292,248.00
	12	561,816.00	413,424.00	487,620.00	194,400.00	293,220.00	415,700.00	293,220.00
	13	533,304.00	144,504.00	338,904.00	194,400.00	144,504.00	415,700.00	144,504.00
	14	583,200.00	314,280.00	448,740.00	194,400.00	254,340.00	415,700.00	254,340.00
	15	583,200.00	377,784.00	480,492.00	194,400.00	286,092.00	415,700.00	286,092.00
	16	580,608.00	388,800.00	484,704.00	194,400.00	290,304.00	415,700.00	290,304.00
	17	362,880.00	375,192.00	369,036.00	194,400.00	174,636.00	415,700.00	174,636.00
	18	487,296.00	302,616.00	394,956.00	194,400.00	200,556.00	415,700.00	200,556.00
	19	518,400.00	301,320.00	409,860.00	194,400.00	215,460.00	415,700.00	215,460.00
	20	478,224.00	87,480.00	282,852.00	194,400.00	88,452.00	415,700.00	88,452.00
	21	442,584.00	236,520.00	339,552.00	194,400.00	145,152.00	415,700.00	145,152.00
	22	423,792.00	289,008.00	356,400.00	194,400.00	162,000.00	415,700.00	162,000.00
	23	423,792.00	348,624.00	386,208.00	194,400.00	191,808.00	415,700.00	191,808.00
	24	411,480.00	355,104.00	383,292.00	194,400.00	188,892.00	415,700.00	188,892.00
	25	413,424.00	310,392.00	361,908.00	194,400.00	167,508.00	415,700.00	167,508.00
	26	518,400.00	357,696.00	438,048.00	194,400.00	243,648.00	415,700.00	243,648.00
	27	518,400.00	344,088.00	431,244.00	194,400.00	236,844.00	415,700.00	236,844.00
	28	518,400.00	124,416.00	321,408.00	194,400.00	127,008.00	415,700.00	127,008.00
	29	474,984.00	275,400.00	375,192.00	194,400.00	180,792.00	415,700.00	180,792.00
	30	495,720.00	324,000.00	409,860.00	194,400.00	215,460.00	415,700.00	215,460.00

7. July

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jul	1	417,312.00	305,208.00	361,260.00	194,400.00	166,860.00	415,700.00	166,860.00
	2	397,224.00	301,320.00	349,272.00	194,400.00	154,872.00	415,700.00	154,872.00
	3	391,392.00	295,488.00	343,440.00	194,400.00	149,040.00	415,700.00	149,040.00
	4	398,520.00	260,496.00	329,508.00	194,400.00	135,108.00	415,700.00	135,108.00
	5	425,088.00	280,584.00	352,836.00	194,400.00	158,436.00	415,700.00	158,436.00
	6	395,280.00	280,584.00	337,932.00	194,400.00	143,532.00	415,700.00	143,532.00
	7	395,280.00	281,880.00	338,580.00	194,400.00	144,180.00	415,700.00	144,180.00
	8	405,000.00	259,200.00	332,100.00	194,400.00	137,700.00	415,700.00	137,700.00
	9	379,080.00	291,600.00	335,340.00	194,400.00	140,940.00	415,700.00	140,940.00
	10	364,824.00	274,104.00	319,464.00	194,400.00	125,064.00	415,700.00	125,064.00
	11	353,808.00	294,192.00	324,000.00	194,400.00	129,600.00	415,700.00	129,600.00
	12	432,216.00	259,200.00	345,708.00	194,400.00	151,308.00	415,700.00	151,308.00
	13	463,320.00	283,824.00	373,572.00	194,400.00	179,172.00	415,700.00	179,172.00
	14	438,696.00	231,984.00	335,340.00	194,400.00	140,940.00	415,700.00	140,940.00
	15	422,496.00	225,504.00	324,000.00	194,400.00	129,600.00	415,700.00	129,600.00
	16	368,712.00	215,784.00	292,248.00	194,400.00	97,848.00	415,700.00	97,848.00
	17	471,096.00	259,200.00	365,148.00	194,400.00	170,748.00	415,700.00	170,748.00
	18	410,184.00	259,200.00	334,692.00	194,400.00	140,292.00	415,700.00	140,292.00
	19	443,880.00	259,200.00	351,540.00	194,400.00	157,140.00	415,700.00	157,140.00
	20	457,488.00	259,200.00	358,344.00	194,400.00	163,944.00	415,700.00	163,944.00
	21	451,008.00	243,000.00	347,004.00	194,400.00	152,604.00	415,700.00	152,604.00
	22	491,184.00	274,104.00	382,644.00	194,400.00	188,244.00	415,700.00	188,244.00
	23	462,024.00	231,984.00	347,004.00	194,400.00	152,604.00	415,700.00	152,604.00
	24	474,984.00	243,000.00	358,992.00	194,400.00	164,592.00	415,700.00	164,592.00
	25	469,800.00	210,600.00	340,200.00	194,400.00	145,800.00	415,700.00	145,800.00
	26	439,992.00	259,200.00	349,596.00	194,400.00	155,196.00	415,700.00	155,196.00
	27	484,704.00	259,200.00	371,952.00	194,400.00	177,552.00	415,700.00	177,552.00
	28	441,288.00	215,784.00	328,536.00	194,400.00	134,136.00	415,700.00	134,136.00
	29	468,504.00	194,400.00	331,452.00	194,400.00	137,052.00	415,700.00	137,052.00
	30	452,304.00	179,496.00	315,900.00	194,400.00	121,500.00	415,700.00	121,500.00
	31	425,088.00	148,392.00	286,740.00	194,400.00	92,340.00	415,700.00	92,340.00

8. August

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Aug	1	418,608.00	191,808.00	305,208.00	194,400.00	110,808.00	415,700.00	110,808.00
	2	414,720.00	194,400.00	304,560.00	194,400.00	110,160.00	415,700.00	110,160.00
	3	375,192.00	194,400.00	284,796.00	194,400.00	90,396.00	415,700.00	90,396.00
	4	419,904.00	194,400.00	307,152.00	194,400.00	112,752.00	415,700.00	112,752.00
	5	371,304.00	194,400.00	282,852.00	194,400.00	88,452.00	415,700.00	88,452.00
	6	353,808.00	194,400.00	274,104.00	194,400.00	79,704.00	415,700.00	79,704.00
	7	353,808.00	154,224.00	254,016.00	194,400.00	59,616.00	415,700.00	59,616.00
	8	367,416.00	194,400.00	280,908.00	194,400.00	86,508.00	415,700.00	86,508.00
	9	356,400.00	163,296.00	259,848.00	194,400.00	65,448.00	415,700.00	65,448.00
	10	376,488.00	163,296.00	269,892.00	194,400.00	75,492.00	415,700.00	75,492.00
	11	393,984.00	196,992.00	295,488.00	194,400.00	101,088.00	415,700.00	101,088.00
	12	382,320.00	194,400.00	288,360.00	194,400.00	93,960.00	415,700.00	93,960.00
	13	364,824.00	194,400.00	279,612.00	194,400.00	85,212.00	415,700.00	85,212.00
	14	373,896.00	194,400.00	284,148.00	194,400.00	89,748.00	415,700.00	89,748.00
	15	358,992.00	194,400.00	276,696.00	194,400.00	82,296.00	415,700.00	82,296.00
	16	357,696.00	194,400.00	276,048.00	194,400.00	81,648.00	415,700.00	81,648.00
	17	316,224.00	194,400.00	255,312.00	194,400.00	60,912.00	415,700.00	60,912.00
	18	393,984.00	194,400.00	294,192.00	194,400.00	99,792.00	415,700.00	99,792.00
	19	311,688.00	194,400.00	253,044.00	194,400.00	58,644.00	415,700.00	58,644.00
	20	312,984.00	194,400.00	253,692.00	194,400.00	59,292.00	415,700.00	59,292.00
	21	255,312.00	194,400.00	224,856.00	194,400.00	30,456.00	415,700.00	30,456.00
	22	277,992.00	194,400.00	236,196.00	194,400.00	41,796.00	415,700.00	41,796.00
	23	300,024.00	194,400.00	247,212.00	194,400.00	52,812.00	415,700.00	52,812.00
	24	298,080.00	168,480.00	233,280.00	194,400.00	38,880.00	415,700.00	38,880.00
	25	469,800.00	160,704.00	315,252.00	194,400.00	120,852.00	415,700.00	120,852.00
	26	287,712.00	195,696.00	241,704.00	194,400.00	47,304.00	415,700.00	47,304.00
	27	292,896.00	194,400.00	243,648.00	194,400.00	49,248.00	415,700.00	49,248.00
	28	307,800.00	168,480.00	238,140.00	194,400.00	43,740.00	415,700.00	43,740.00
	29	337,608.00	194,400.00	266,004.00	194,400.00	71,604.00	415,700.00	71,604.00
	30	317,520.00	140,616.00	229,068.00	194,400.00	34,668.00	415,700.00	34,668.00
	31	318,816.00	155,520.00	237,168.00	194,400.00	42,768.00	415,700.00	42,768.00

9. September

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average				
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Sep	1	296,784.00	191,808.00	244,296.00	194,400.00	49,896.00	415,700.00	49,896.00
	2	302,616.00	148,392.00	225,504.00	194,400.00	31,104.00	415,700.00	31,104.00
	3	55,080.00	194,400.00	124,740.00	194,400.00	-69,660.00	346,040.00	0.00
	4	264,384.00	194,400.00	229,392.00	194,400.00	34,992.00	381,032.00	324.00
	5	252,720.00	158,112.00	205,416.00	194,400.00	11,016.00	392,048.00	0.00
	6	226,800.00	194,400.00	210,600.00	194,400.00	16,200.00	408,248.00	8,748.00
	7	226,800.00	154,224.00	190,512.00	194,400.00	-3,888.00	404,360.00	0.00
	8	256,608.00	156,816.00	206,712.00	194,400.00	12,312.00	415,700.00	12,312.00
	9	243,000.00	159,408.00	201,204.00	194,400.00	6,804.00	415,700.00	6,804.00
	10	224,208.00	119,880.00	172,044.00	194,400.00	-22,356.00	393,344.00	0.00
	11	205,416.00	187,920.00	196,668.00	194,400.00	2,268.00	395,612.00	0.00
	12	210,600.00	168,480.00	189,540.00	194,400.00	-4,860.00	390,752.00	0.00
	13	215,784.00	159,408.00	187,596.00	194,400.00	-6,804.00	383,948.00	0.00
	14	205,416.00	194,400.00	199,908.00	194,400.00	5,508.00	389,456.00	0.00
	15	225,504.00	160,704.00	193,104.00	194,400.00	-1,296.00	388,160.00	0.00
	16	210,600.00	162,000.00	186,300.00	194,400.00	-8,100.00	380,060.00	0.00
	17	209,304.00	173,016.00	191,160.00	194,400.00	-3,240.00	376,820.00	0.00
	18	221,616.00	158,112.00	189,864.00	194,400.00	-4,536.00	372,284.00	0.00
	19	194,400.00	152,280.00	173,340.00	194,400.00	-21,060.00	351,224.00	0.00
	20	176,904.00	150,984.00	163,944.00	194,400.00	-30,456.00	320,768.00	0.00
	21	209,304.00	145,800.00	177,552.00	194,400.00	-16,848.00	303,920.00	0.00
	22	202,824.00	105,624.00	154,224.00	194,400.00	-40,176.00	263,744.00	0.00
	23	1,942,704.00	134,784.00	1,038,744.00	194,400.00	844,344.00	415,700.00	844,344.00
	24	1,942,704.00	129,600.00	1,036,152.00	194,400.00	841,752.00	415,700.00	841,752.00
	25	469,800.00	121,824.00	295,812.00	194,400.00	101,412.00	415,700.00	101,412.00
	26	171,720.00	113,400.00	142,560.00	194,400.00	-51,840.00	363,860.00	0.00
	27	200,880.00	191,808.00	196,344.00	194,400.00	1,944.00	365,804.00	0.00
	28	-	144,504.00	72,252.00	194,400.00	-122,148.00	243,656.00	0.00
	29	191,808.00	123,120.00	157,464.00	194,400.00	-36,936.00	206,720.00	0.00
	30	164,592.00	194,400.00	179,496.00	194,400.00	-14,904.00	191,816.00	0.00
	31							

10. October

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year						
Month	Date	2014	2015	Average	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Oct	1	194,400.00	314,280.00	254,340.00	194,400.00	59,940.00	251,756.00	0.00
	2	194,400.00	268,920.00	231,660.00	194,400.00	37,260.00	289,016.00	0.00
	3	163,296.00	295,488.00	229,392.00	194,400.00	34,992.00	324,008.00	0.00
	4	194,400.00	306,504.00	250,452.00	194,400.00	56,052.00	380,060.00	20,412.00
	5	64,800.00	333,720.00	199,260.00	194,400.00	4,860.00	384,920.00	0.00
	6	194,400.00	275,400.00	234,900.00	194,400.00	40,500.00	415,700.00	40,500.00
	7	194,400.00	300,024.00	247,212.00	194,400.00	52,812.00	415,700.00	52,812.00
	8	194,400.00	338,904.00	266,652.00	194,400.00	72,252.00	415,700.00	72,252.00
	9	179,496.00	301,320.00	240,408.00	194,400.00	46,008.00	415,700.00	46,008.00
	10	194,400.00	280,584.00	237,492.00	194,400.00	43,092.00	415,700.00	43,092.00
	11	204,120.00	303,912.00	254,016.00	194,400.00	59,616.00	415,700.00	59,616.00
	12	194,400.00	283,824.00	239,112.00	194,400.00	44,712.00	415,700.00	44,712.00
	13	154,224.00	303,912.00	229,068.00	194,400.00	34,668.00	415,700.00	34,668.00
	14	210,600.00	229,392.00	219,996.00	194,400.00	25,596.00	415,700.00	25,596.00
	15	208,008.00	248,184.00	228,096.00	194,400.00	33,696.00	415,700.00	33,696.00
	16	209,304.00	263,088.00	236,196.00	194,400.00	41,796.00	415,700.00	41,796.00
	17	194,400.00	244,296.00	219,348.00	194,400.00	24,948.00	415,700.00	24,948.00
	18	210,600.00	221,616.00	216,108.00	194,400.00	21,708.00	415,700.00	21,708.00
	19	210,600.00	225,504.00	218,052.00	194,400.00	23,652.00	415,700.00	23,652.00
	20	198,936.00	194,400.00	196,668.00	194,400.00	2,268.00	415,700.00	2,268.00
	21	215,784.00	164,592.00	190,188.00	194,400.00	-4,212.00	411,488.00	0.00
	22	241,704.00	213,192.00	227,448.00	194,400.00	33,048.00	415,700.00	33,048.00
	23	210,600.00	196,992.00	203,796.00	194,400.00	9,396.00	415,700.00	9,396.00
	24	213,192.00	173,016.00	193,104.00	194,400.00	-1,296.00	414,404.00	0.00
	25	210,600.00	162,000.00	186,300.00	194,400.00	-8,100.00	406,304.00	0.00
	26	210,600.00	145,800.00	178,200.00	194,400.00	-16,200.00	390,104.00	0.00
	27	210,600.00	154,224.00	182,412.00	194,400.00	-11,988.00	378,116.00	0.00
	28	193,104.00	106,920.00	150,012.00	194,400.00	-44,388.00	333,728.00	0.00
	29	221,616.00	105,624.00	163,620.00	194,400.00	-30,780.00	302,948.00	0.00
	30	243,000.00	87,480.00	165,240.00	194,400.00	-29,160.00	273,788.00	0.00
	31	249,480.00	97,200.00	173,340.00	194,400.00	-21,060.00	252,728.00	0.00

11. November

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year						
Month	Date	2014	2015	Average	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Nov	1	230,688.00	34,992.00	132,840.00	194,400.00	-61,560.00	191,168.00	0.00
	2	225,504.00	64,800.00	145,152.00	194,400.00	-49,248.00	141,920.00	0.00
	3	210,600.00	82,296.00	146,448.00	194,400.00	-47,952.00	93,968.00	0.00
	4	225,504.00	47,304.00	136,404.00	194,400.00	-57,996.00	35,972.00	0.00
	5	217,080.00	99,792.00	158,436.00	194,400.00	-35,964.00	8.00	0.00
	6	217,080.00	194,400.00	205,740.00	194,400.00	11,340.00	11,348.00	0.00
	7	194,400.00	239,112.00	216,756.00	194,400.00	22,356.00	33,704.00	0.00
	8	248,184.00	145,800.00	196,992.00	194,400.00	2,592.00	36,296.00	0.00
	9	302,616.00	204,120.00	253,368.00	194,400.00	58,968.00	95,264.00	0.00
	10	110,808.00	302,616.00	206,712.00	194,400.00	12,312.00	107,576.00	0.00
	11	-	325,296.00	162,648.00	194,400.00	-31,752.00	75,824.00	0.00
	12	-	256,608.00	128,304.00	194,400.00	-66,096.00	9,728.00	0.00
	13	183,384.00	213,192.00	198,288.00	194,400.00	3,888.00	13,616.00	0.00
	14	275,400.00	199,584.00	237,492.00	194,400.00	43,092.00	56,708.00	0.00
	15	276,696.00	243,000.00	259,848.00	194,400.00	65,448.00	122,156.00	0.00
	16	274,104.00	205,416.00	239,760.00	194,400.00	45,360.00	167,516.00	0.00
	17	281,880.00	220,320.00	251,100.00	194,400.00	56,700.00	224,216.00	0.00
	18	276,696.00	220,320.00	248,508.00	194,400.00	54,108.00	278,324.00	0.00
	19	317,520.00	210,600.00	264,060.00	194,400.00	69,660.00	347,984.00	1,944.00
	20	324,000.00	155,520.00	239,760.00	194,400.00	45,360.00	393,344.00	23,004.00
	21	105,624.00	110,808.00	108,216.00	194,400.00	-86,184.00	307,160.00	0.00
	22	279,288.00	108,216.00	193,752.00	194,400.00	-648.00	306,512.00	0.00
	23	324,000.00	36,288.00	180,144.00	194,400.00	-14,256.00	292,256.00	0.00
	24	330,480.00	69,984.00	200,232.00	194,400.00	5,832.00	298,088.00	0.00
	25	289,008.00	155,520.00	222,264.00	194,400.00	27,864.00	325,952.00	0.00
	26	275,400.00	140,616.00	208,008.00	194,400.00	13,608.00	339,560.00	0.00
	27	312,984.00	134,784.00	223,884.00	194,400.00	29,484.00	369,044.00	0.00
	28	74,520.00	127,008.00	100,764.00	194,400.00	-93,636.00	275,408.00	0.00
	29	-	129,600.00	64,800.00	194,400.00	-129,600.00	145,808.00	0.00
	30	20,088.00	134,784.00	77,436.00	194,400.00	-116,964.00	28,844.00	0.00
	31							

12. December

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s

		PLTA Cikalong Overflow			PDAM Intake	Storage		
		Daily Volume Each Year						
Month	Date	2014	2015	Average	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Dec	1	327,888.00	-	327,888.00	194,400.00	133,488.00	162,332.00	0.00
	2	356,400.00	-	356,400.00	194,400.00	162,000.00	324,332.00	70,632.00
	3	294,192.00	-	294,192.00	194,400.00	99,792.00	415,700.00	99,792.00
	4	316,224.00	-	316,224.00	194,400.00	121,824.00	415,700.00	121,824.00
	5	373,896.00	-	373,896.00	194,400.00	179,496.00	415,700.00	179,496.00
	6	373,896.00	-	373,896.00	194,400.00	179,496.00	415,700.00	179,496.00
	7	372,600.00	-	372,600.00	194,400.00	178,200.00	415,700.00	178,200.00
	8	381,024.00	-	381,024.00	194,400.00	186,624.00	415,700.00	186,624.00
	9	421,200.00	-	421,200.00	194,400.00	226,800.00	415,700.00	226,800.00
	10	487,296.00	-	487,296.00	194,400.00	292,896.00	415,700.00	292,896.00
	11	537,192.00	-	537,192.00	194,400.00	342,792.00	415,700.00	342,792.00
	12	534,600.00	-	534,600.00	194,400.00	340,200.00	415,700.00	340,200.00
	13	537,192.00	-	537,192.00	194,400.00	342,792.00	415,700.00	342,792.00
	14	474,984.00	-	474,984.00	194,400.00	280,584.00	415,700.00	280,584.00
	15	345,384.00	-	345,384.00	194,400.00	150,984.00	415,700.00	150,984.00
	16	467,208.00	-	467,208.00	194,400.00	272,808.00	415,700.00	272,808.00
	17	583,200.00	-	583,200.00	194,400.00	388,800.00	415,700.00	388,800.00
	18	583,200.00	-	583,200.00	194,400.00	388,800.00	415,700.00	388,800.00
	19	569,592.00	-	569,592.00	194,400.00	375,192.00	415,700.00	375,192.00
	20	489,888.00	-	489,888.00	194,400.00	295,488.00	415,700.00	295,488.00
	21	403,704.00	-	403,704.00	194,400.00	209,304.00	415,700.00	209,304.00
	22	271,512.00	-	271,512.00	194,400.00	77,112.00	415,700.00	77,112.00
	23	244,296.00	-	244,296.00	194,400.00	49,896.00	415,700.00	49,896.00
	24	287,712.00	-	287,712.00	194,400.00	93,312.00	415,700.00	93,312.00
	25	458,784.00	-	458,784.00	194,400.00	264,384.00	415,700.00	264,384.00
	26	453,600.00	-	453,600.00	194,400.00	259,200.00	415,700.00	259,200.00
	27	356,400.00	-	356,400.00	194,400.00	162,000.00	415,700.00	162,000.00
	28	235,224.00	-	235,224.00	194,400.00	40,824.00	415,700.00	40,824.00
	29	489,888.00	-	489,888.00	194,400.00	295,488.00	415,700.00	295,488.00
	30	498,312.00	-	498,312.00	194,400.00	303,912.00	415,700.00	303,912.00
	31	421,200.00	-	421,200.00	194,400.00	226,800.00	415,700.00	226,800.00

3. Scenario 3 (Storage + Irrigation)

1. January

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	1.8	m3/s
Common Cisangkuy River flow	=	6.69	m3/s
Common irrigation demand	=	3646.455	L/s

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jan	1	534,600.00	403,704.00	469,152.00	578,219.49	155,520.00	315,053.71	576,797.78	576,797.78	0.00
	2	460,080.00	408,888.00	434,484.00	578,219.49	155,520.00	315,053.71	542,129.78	1,118,927.56	0.00
	3	518,400.00	429,624.00	474,012.00	578,219.49	155,520.00	315,053.71	581,657.78	1,700,585.34	0.00
	4	518,400.00	419,904.00	469,152.00	578,219.49	155,520.00	315,053.71	576,797.78	2,277,383.12	0.00
	5	518,400.00	453,600.00	486,000.00	578,219.49	155,520.00	315,053.71	593,645.78	2,871,028.90	0.00
	6	506,088.00	453,600.00	479,844.00	578,219.49	155,520.00	315,053.71	587,489.78	3,458,518.68	0.00
	7	486,000.00	453,600.00	469,800.00	578,219.49	155,520.00	315,053.71	577,445.78	4,035,964.46	0.00
	8	518,400.00	453,600.00	486,000.00	578,219.49	155,520.00	315,053.71	593,645.78	4,629,610.24	0.00
	9	478,224.00	499,608.00	488,916.00	578,219.49	155,520.00	315,053.71	596,561.78	5,226,172.02	116,293.80
	10	534,600.00	519,696.00	527,148.00	578,219.49	155,520.00	315,053.71	634,793.78	5,706,440.00	634,793.78
	11	150,984.00	487,296.00	319,140.00	578,219.49	155,520.00	315,053.71	426,785.78	5,706,440.00	426,785.78
	12	392,688.00	510,624.00	451,656.00	578,219.49	155,520.00	315,053.71	559,301.78	5,706,440.00	559,301.78
	13	423,792.00	518,400.00	471,096.00	578,219.49	155,520.00	315,053.71	578,741.78	5,706,440.00	578,741.78
	14	534,600.00	518,400.00	526,500.00	578,219.49	155,520.00	315,053.71	634,145.78	5,706,440.00	634,145.78
	15	479,520.00	518,400.00	498,960.00	578,219.49	155,520.00	315,053.71	606,605.78	5,706,440.00	606,605.78
	16	553,392.00	518,400.00	535,896.00	578,219.49	155,520.00	315,053.71	643,541.78	5,706,440.00	643,541.78
	17	579,312.00	530,712.00	555,012.00	578,219.49	155,520.00	315,053.71	662,657.78	5,706,440.00	662,657.78
	18	594,216.00	543,024.00	568,620.00	578,219.49	155,520.00	315,053.71	676,265.78	5,706,440.00	676,265.78
	19	447,120.00	550,800.00	498,960.00	578,219.49	155,520.00	315,053.71	606,605.78	5,706,440.00	606,605.78
	20	572,184.00	543,024.00	557,604.00	578,219.49	155,520.00	315,053.71	665,249.78	5,706,440.00	665,249.78
	21	552,096.00	453,600.00	502,848.00	578,219.49	155,520.00	315,053.71	610,493.78	5,706,440.00	610,493.78
	22	519,696.00	495,720.00	507,708.00	578,219.49	155,520.00	315,053.71	615,353.78	5,706,440.00	615,353.78
	23	532,008.00	550,800.00	541,404.00	578,219.49	155,520.00	315,053.71	649,049.78	5,706,440.00	649,049.78
	24	584,496.00	381,024.00	482,760.00	578,219.49	155,520.00	315,053.71	590,405.78	5,706,440.00	590,405.78
	25	583,200.00	413,424.00	498,312.00	578,219.49	155,520.00	315,053.71	605,957.78	5,706,440.00	605,957.78
	26	583,200.00	476,280.00	529,740.00	578,219.49	155,520.00	315,053.71	637,385.78	5,706,440.00	637,385.78
	27	578,016.00	553,392.00	565,704.00	578,219.49	155,520.00	315,053.71	673,349.78	5,706,440.00	673,349.78
	28	583,200.00	498,312.00	540,756.00	578,219.49	155,520.00	315,053.71	648,401.78	5,706,440.00	648,401.78
	29	532,008.00	532,008.00	532,008.00	578,219.49	155,520.00	315,053.71	639,653.78	5,706,440.00	639,653.78
	30	526,824.00	518,400.00	522,612.00	578,219.49	155,520.00	315,053.71	630,257.78	5,706,440.00	630,257.78
	31	518,400.00	518,400.00	518,400.00	578,219.49	155,520.00	315,053.71	626,045.78	5,706,440.00	626,045.78

2. February

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	1.8	m3/s
Common Cisangkuy River flow	=	11.09	m3/s
Common irrigation demand	=	3161.905	L/s

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Feb	1	497,016.00	533,304.00	515,160.00	958,023.47	155,520.00	273,188.59	619,755.41	5,706,440.00	619,755.41
	2	518,400.00	530,712.00	524,556.00	958,023.47	155,520.00	273,188.59	626,559.41	5,706,440.00	626,559.41
	3	476,280.00	518,400.00	497,340.00	958,023.47	155,520.00	273,188.59	587,031.41	5,706,440.00	587,031.41
	4	494,424.00	518,400.00	506,412.00	958,023.47	155,520.00	273,188.59	596,103.41	5,706,440.00	596,103.41
	5	447,120.00	518,400.00	482,760.00	958,023.47	155,520.00	273,188.59	572,451.41	5,706,440.00	572,451.41
	6	497,016.00	518,400.00	507,708.00	958,023.47	155,520.00	273,188.59	597,399.41	5,706,440.00	597,399.41
	7	538,488.00	518,400.00	528,444.00	958,023.47	155,520.00	273,188.59	618,135.41	5,706,440.00	618,135.41
	8	588,384.00	518,400.00	553,392.00	958,023.47	155,520.00	273,188.59	643,083.41	5,706,440.00	643,083.41
	9	548,208.00	526,824.00	537,516.00	958,023.47	155,520.00	273,188.59	635,631.41	5,706,440.00	635,631.41
	10	648,000.00	518,400.00	583,200.00	958,023.47	155,520.00	273,188.59	672,891.41	5,706,440.00	672,891.41
	11	555,984.00	454,896.00	505,440.00	958,023.47	155,520.00	273,188.59	531,627.41	5,706,440.00	531,627.41
	12	550,800.00	399,816.00	475,308.00	958,023.47	155,520.00	273,188.59	446,415.41	5,706,440.00	446,415.41
	13	560,520.00	318,816.00	439,668.00	958,023.47	155,520.00	273,188.59	329,775.41	5,706,440.00	329,775.41
	14	572,184.00	402,408.00	487,296.00	958,023.47	155,520.00	273,188.59	460,995.41	5,706,440.00	460,995.41
	15	534,600.00	518,400.00	526,500.00	958,023.47	155,520.00	273,188.59	616,191.41	5,706,440.00	616,191.41
	16	534,600.00	534,600.00	534,600.00	958,023.47	155,520.00	273,188.59	640,491.41	5,706,440.00	640,491.41
	17	538,488.00	583,200.00	560,844.00	958,023.47	155,520.00	273,188.59	715,335.41	5,706,440.00	715,335.41
	18	561,816.00	534,600.00	548,208.00	958,023.47	155,520.00	273,188.59	654,099.41	5,706,440.00	654,099.41
	19	550,800.00	534,600.00	542,700.00	958,023.47	155,520.00	273,188.59	648,591.41	5,706,440.00	648,591.41
	20	555,984.00	583,200.00	569,592.00	958,023.47	155,520.00	273,188.59	724,083.41	5,706,440.00	724,083.41
	21	507,384.00	583,200.00	545,292.00	958,023.47	155,520.00	273,188.59	699,783.41	5,706,440.00	699,783.41
	22	518,400.00	583,200.00	550,800.00	958,023.47	155,520.00	273,188.59	705,291.41	5,706,440.00	705,291.41
	23	518,400.00	537,192.00	527,796.00	958,023.47	155,520.00	273,188.59	636,279.41	5,706,440.00	636,279.41
	24	526,824.00	520,992.00	523,908.00	958,023.47	155,520.00	273,188.59	616,191.41	5,706,440.00	616,191.41
	25	518,400.00	518,400.00	518,400.00	958,023.47	155,520.00	273,188.59	608,091.41	5,706,440.00	608,091.41
	26	515,808.00	518,400.00	517,104.00	958,023.47	155,520.00	273,188.59	606,795.41	5,706,440.00	606,795.41
	27	518,400.00	483,408.00	500,904.00	958,023.47	155,520.00	273,188.59	555,603.41	5,706,440.00	555,603.41
	28	518,400.00	555,984.00	537,192.00	958,023.47	155,520.00	273,188.59	664,467.41	5,706,440.00	664,467.41

3. March

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s
Common Cisangkuy River flow = 10.83 m3/s
Common irrigation demand = 3161.905 L/s

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
March	1	518,400.00	486,000.00	502,200.00	935,772.45	155,520.00	273,188.59	559,491.41	5,706,440.00	559,491.41
	2	454,896.00	563,112.00	509,004.00	935,772.45	155,520.00	273,188.59	643,407.41	5,706,440.00	643,407.41
	3	325,296.00	576,720.00	451,008.00	935,772.45	155,520.00	273,188.59	599,019.41	5,706,440.00	599,019.41
	4	398,520.00	534,600.00	466,560.00	935,772.45	155,520.00	273,188.59	572,451.41	5,706,440.00	572,451.41
	5	486,000.00	585,792.00	535,896.00	935,772.45	155,520.00	273,188.59	692,979.41	5,706,440.00	692,979.41
	6	534,600.00	585,792.00	560,196.00	935,772.45	155,520.00	273,188.59	717,279.41	5,706,440.00	717,279.41
	7	518,400.00	563,112.00	540,756.00	935,772.45	155,520.00	273,188.59	675,159.41	5,706,440.00	675,159.41
	8	518,400.00	561,816.00	540,108.00	935,772.45	155,520.00	273,188.59	673,215.41	5,706,440.00	673,215.41
	9	518,400.00	561,816.00	540,108.00	935,772.45	155,520.00	273,188.59	673,215.41	5,706,440.00	673,215.41
	10	526,824.00	573,480.00	550,152.00	935,772.45	155,520.00	273,188.59	694,923.41	5,706,440.00	694,923.41
	11	79,704.00	636,984.00	358,344.00	935,772.45	155,520.00	273,188.59	566,619.41	5,706,440.00	566,619.41
	12	-	596,808.00	298,404.00	935,772.45	155,520.00	273,188.59	466,503.41	5,706,440.00	466,503.41
	13	285,120.00	659,016.00	472,068.00	935,772.45	155,520.00	273,188.59	702,375.41	5,706,440.00	702,375.41
	14	387,504.00	535,896.00	461,700.00	935,772.45	155,520.00	273,188.59	568,887.41	5,706,440.00	568,887.41
	15	311,688.00	636,984.00	474,336.00	935,772.45	155,520.00	273,188.59	682,611.41	5,706,440.00	682,611.41
	16	348,624.00	538,488.00	443,556.00	935,772.45	155,520.00	273,188.59	553,335.41	5,706,440.00	553,335.41
	17	86,184.00	565,704.00	325,944.00	935,772.45	155,520.00	273,188.59	462,939.41	5,706,440.00	462,939.41
	18	84,888.00	625,320.00	355,104.00	935,772.45	155,520.00	273,188.59	551,715.41	5,706,440.00	551,715.41
	19	332,424.00	631,800.00	482,112.00	935,772.45	155,520.00	273,188.59	685,203.41	5,706,440.00	685,203.41
	20	522,288.00	599,400.00	560,844.00	935,772.45	155,520.00	273,188.59	731,535.41	5,706,440.00	731,535.41
	21	494,424.00	578,016.00	536,220.00	935,772.45	155,520.00	273,188.59	685,527.41	5,706,440.00	685,527.41
	22	518,400.00	522,288.00	520,344.00	935,772.45	155,520.00	273,188.59	613,923.41	5,706,440.00	613,923.41
	23	468,504.00	563,112.00	515,808.00	935,772.45	155,520.00	273,188.59	650,211.41	5,706,440.00	650,211.41
	24	484,704.00	604,584.00	544,644.00	935,772.45	155,520.00	273,188.59	720,519.41	5,706,440.00	720,519.41
	25	395,280.00	543,024.00	469,152.00	935,772.45	155,520.00	273,188.59	583,467.41	5,706,440.00	583,467.41
	26	555,984.00	518,400.00	537,192.00	935,772.45	155,520.00	273,188.59	626,883.41	5,706,440.00	626,883.41
	27	591,624.00	550,800.00	571,212.00	935,772.45	155,520.00	273,188.59	693,303.41	5,706,440.00	693,303.41
	28	502,200.00	583,200.00	542,700.00	935,772.45	155,520.00	273,188.59	697,191.41	5,706,440.00	697,191.41
	29	607,824.00	572,184.00	590,004.00	935,772.45	155,520.00	273,188.59	733,479.41	5,706,440.00	733,479.41
	30	640,224.00	583,200.00	611,712.00	935,772.45	155,520.00	273,188.59	766,203.41	5,706,440.00	766,203.41
	31	651,888.00	391,392.00	521,640.00	935,772.45	155,520.00	273,188.59	484,323.41	5,706,440.00	484,323.41

4. April

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s
Common Cisangkuy River flow = 7.35 m3/s
Common irrigation demand = 1914.255 L/s

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Apr	1	664,200.00	401,112.00	532,656.00	635,076.16	155,520.00	165,391.63	846,820.53	5,706,440.00	846,820.53
	2	615,600.00	464,616.00	540,108.00	635,076.16	155,520.00	165,391.63	854,272.53	5,706,440.00	854,272.53
	3	595,512.00	460,080.00	527,796.00	635,076.16	155,520.00	165,391.63	841,960.53	5,706,440.00	841,960.53
	4	583,200.00	518,400.00	550,800.00	635,076.16	155,520.00	165,391.63	864,964.53	5,706,440.00	864,964.53
	5	596,808.00	462,024.00	529,416.00	635,076.16	155,520.00	165,391.63	843,580.53	5,706,440.00	843,580.53
	6	615,600.00	462,024.00	538,812.00	635,076.16	155,520.00	165,391.63	852,976.53	5,706,440.00	852,976.53
	7	596,808.00	518,400.00	557,604.00	635,076.16	155,520.00	165,391.63	871,768.53	5,706,440.00	871,768.53
	8	595,512.00	565,704.00	580,608.00	635,076.16	155,520.00	165,391.63	894,772.53	5,706,440.00	894,772.53
	9	561,816.00	595,512.00	578,664.00	635,076.16	155,520.00	165,391.63	892,828.53	5,706,440.00	892,828.53
	10	442,584.00	553,392.00	497,988.00	635,076.16	155,520.00	165,391.63	812,152.53	5,706,440.00	812,152.53
	11	592,920.00	427,680.00	510,300.00	635,076.16	155,520.00	165,391.63	824,464.53	5,706,440.00	824,464.53
	12	508,680.00	600,696.00	554,688.00	635,076.16	155,520.00	165,391.63	868,852.53	5,706,440.00	868,852.53
	13	553,392.00	549,504.00	551,448.00	635,076.16	155,520.00	165,391.63	865,612.53	5,706,440.00	865,612.53
	14	563,112.00	452,304.00	507,708.00	635,076.16	155,520.00	165,391.63	821,872.53	5,706,440.00	821,872.53
	15	474,984.00	311,688.00	393,336.00	635,076.16	155,520.00	165,391.63	707,500.53	5,706,440.00	707,500.53
	16	421,200.00	443,880.00	432,540.00	635,076.16	155,520.00	165,391.63	746,704.53	5,706,440.00	746,704.53
	17	456,192.00	507,384.00	481,788.00	635,076.16	155,520.00	165,391.63	795,952.53	5,706,440.00	795,952.53
	18	583,200.00	464,616.00	523,908.00	635,076.16	155,520.00	165,391.63	838,072.53	5,706,440.00	838,072.53
	19	591,624.00	458,784.00	525,204.00	635,076.16	155,520.00	165,391.63	839,368.53	5,706,440.00	839,368.53
	20	595,512.00	480,816.00	538,164.00	635,076.16	155,520.00	165,391.63	852,328.53	5,706,440.00	852,328.53
	21	468,504.00	457,488.00	462,996.00	635,076.16	155,520.00	165,391.63	777,160.53	5,706,440.00	777,160.53
	22	583,200.00	383,616.00	483,408.00	635,076.16	155,520.00	165,391.63	797,572.53	5,706,440.00	797,572.53
	23	583,200.00	341,496.00	462,348.00	635,076.16	155,520.00	165,391.63	776,512.53	5,706,440.00	776,512.53
	24	583,200.00	390,096.00	486,648.00	635,076.16	155,520.00	165,391.63	800,812.53	5,706,440.00	800,812.53
	25	595,512.00	453,600.00	524,556.00	635,076.16	155,520.00	165,391.63	838,720.53	5,706,440.00	838,720.53
	26	448,416.00	366,120.00	407,268.00	635,076.16	155,520.00	165,391.63	721,432.53	5,706,440.00	721,432.53
	27	429,624.00	453,600.00	441,612.00	635,076.16	155,520.00	165,391.63	755,776.53	5,706,440.00	755,776.53
	28	423,792.00	377,784.00	400,788.00	635,076.16	155,520.00	165,391.63	714,952.53	5,706,440.00	714,952.53
	29	427,680.00	168,480.00	298,080.00	635,076.16	155,520.00	165,391.63	612,244.53	5,706,440.00	612,244.53
	30	487,296.00	442,584.00	464,940.00	635,076.16	155,520.00	165,391.63	779,104.53	5,706,440.00	779,104.53

5. May

Common daily discharge time =	18	hrs/day	
Common daily intake time =	18	hrs/day	(= discharge time)
Expected daily intake time =	24	hrs/day	
Common daily intake flow rate =	1.8	m3/s	
Common Cisangkuy River flow =	3.68	m3/s	
Common irrigation demand =	2419.205	L/s	

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily	Storage	Storage	Storage
Month	Date	2014	2015	Average			Volume	Input	Volume	Outlet
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
May	1	573,480.00	453,600.00	513,540.00	318,237.82	155,520.00	209,019.31	602,600.69	5,706,440.00	602,600.69
	2	572,184.00	453,600.00	512,892.00	318,237.82	155,520.00	209,019.31	601,952.69	5,706,440.00	601,952.69
	3	592,920.00	453,600.00	523,260.00	318,237.82	155,520.00	209,019.31	612,320.69	5,706,440.00	612,320.69
	4	587,088.00	453,600.00	520,344.00	318,237.82	155,520.00	209,019.31	609,404.69	5,706,440.00	609,404.69
	5	583,200.00	322,704.00	452,952.00	318,237.82	155,520.00	209,019.31	411,116.69	5,706,440.00	411,116.69
	6	610,416.00	322,704.00	466,560.00	318,237.82	155,520.00	209,019.31	424,724.69	5,706,440.00	424,724.69
	7	611,712.00	358,992.00	485,352.00	318,237.82	155,520.00	209,019.31	479,804.69	5,706,440.00	479,804.69
	8	592,920.00	295,488.00	444,204.00	318,237.82	155,520.00	209,019.31	375,152.69	5,706,440.00	375,152.69
	9	629,208.00	348,624.00	488,916.00	318,237.82	155,520.00	209,019.31	473,000.69	5,706,440.00	473,000.69
	10	624,024.00	349,920.00	486,972.00	318,237.82	155,520.00	209,019.31	472,352.69	5,706,440.00	472,352.69
	11	604,584.00	336,312.00	470,448.00	318,237.82	155,520.00	209,019.31	442,220.69	5,706,440.00	442,220.69
	12	596,808.00	306,504.00	451,656.00	318,237.82	155,520.00	209,019.31	393,620.69	5,706,440.00	393,620.69
	13	614,304.00	414,720.00	514,512.00	318,237.82	155,520.00	209,019.31	564,692.69	5,706,440.00	564,692.69
	14	599,400.00	381,024.00	490,212.00	318,237.82	155,520.00	209,019.31	506,696.69	5,706,440.00	506,696.69
	15	603,288.00	426,384.00	514,836.00	318,237.82	155,520.00	209,019.31	576,680.69	5,706,440.00	576,680.69
	16	585,792.00	414,720.00	500,256.00	318,237.82	155,520.00	209,019.31	550,436.69	5,706,440.00	550,436.69
	17	487,296.00	403,704.00	445,500.00	318,237.82	155,520.00	209,019.31	484,664.69	5,706,440.00	484,664.69
	18	414,720.00	276,696.00	345,708.00	318,237.82	155,520.00	209,019.31	257,864.69	5,706,440.00	257,864.69
	19	436,104.00	346,680.00	391,392.00	318,237.82	155,520.00	209,019.31	373,532.69	5,706,440.00	373,532.69
	20	583,200.00	310,392.00	446,796.00	318,237.82	155,520.00	209,019.31	392,648.69	5,706,440.00	392,648.69
	21	627,912.00	362,880.00	495,396.00	318,237.82	155,520.00	209,019.31	493,736.69	5,706,440.00	493,736.69
	22	641,520.00	453,600.00	547,560.00	318,237.82	155,520.00	209,019.31	636,620.69	5,706,440.00	636,620.69
	23	619,488.00	453,600.00	536,544.00	318,237.82	155,520.00	209,019.31	625,604.69	5,706,440.00	625,604.69
	24	615,600.00	453,600.00	534,600.00	318,237.82	155,520.00	209,019.31	623,660.69	5,706,440.00	623,660.69
	25	642,816.00	453,600.00	548,208.00	318,237.82	155,520.00	209,019.31	637,268.69	5,706,440.00	637,268.69
	26	599,400.00	453,600.00	526,500.00	318,237.82	155,520.00	209,019.31	615,560.69	5,706,440.00	615,560.69
	27	634,392.00	357,696.00	496,044.00	318,237.82	155,520.00	209,019.31	489,200.69	5,706,440.00	489,200.69
	28	615,600.00	413,424.00	514,512.00	318,237.82	155,520.00	209,019.31	563,396.69	5,706,440.00	563,396.69
	29	642,816.00	386,208.00	514,512.00	318,237.82	155,520.00	209,019.31	536,180.69	5,706,440.00	536,180.69
	30	618,192.00	358,992.00	488,592.00	318,237.82	155,520.00	209,019.31	483,044.69	5,706,440.00	483,044.69
	31	524,880.00	419,904.00	472,392.00	318,237.82	155,520.00	209,019.31	527,756.69	5,706,440.00	527,756.69

6. June

Common daily discharge time =	18	hrs/day	
Common daily intake time =	18	hrs/day	(= discharge time)
Expected daily intake time =	24	hrs/day	
Common daily intake flow rate =	1.8	m3/s	
Common Cisangkuy River flow =	1.99	m3/s	
Common irrigation demand =	2419.205	L/s	

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily	Storage	Storage	Storage
Month	Date	2014	2015	Average			Volume	Input	Volume	Outlet
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jun	1	572,184.00	427,680.00	499,932.00	171,600.93	155,520.00	209,019.31	563,072.69	5,706,440.00	563,072.69
	2	598,104.00	453,600.00	525,852.00	171,600.93	155,520.00	209,019.31	614,912.69	5,706,440.00	614,912.69
	3	442,584.00	453,600.00	448,092.00	171,600.93	155,520.00	209,019.31	537,152.69	5,706,440.00	537,152.69
	4	325,296.00	453,600.00	389,448.00	171,600.93	155,520.00	209,019.31	478,508.69	5,706,440.00	478,508.69
	5	442,584.00	453,600.00	448,092.00	171,600.93	155,520.00	209,019.31	537,152.69	5,706,440.00	537,152.69
	6	646,704.00	453,600.00	550,152.00	171,600.93	155,520.00	209,019.31	639,212.69	5,706,440.00	639,212.69
	7	615,600.00	453,600.00	534,600.00	171,600.93	155,520.00	209,019.31	623,660.69	5,706,440.00	623,660.69
	8	615,600.00	453,600.00	534,600.00	171,600.93	155,520.00	209,019.31	623,660.69	5,706,440.00	623,660.69
	9	548,208.00	376,488.00	462,348.00	171,600.93	155,520.00	209,019.31	474,296.69	5,706,440.00	474,296.69
	10	546,912.00	257,904.00	402,408.00	171,600.93	155,520.00	209,019.31	295,772.69	5,706,440.00	295,772.69
	11	583,200.00	390,096.00	486,648.00	171,600.93	155,520.00	209,019.31	512,204.69	5,706,440.00	512,204.69
	12	561,816.00	413,424.00	487,620.00	171,600.93	155,520.00	209,019.31	536,504.69	5,706,440.00	536,504.69
	13	533,304.00	144,504.00	338,904.00	171,600.93	155,520.00	209,019.31	118,868.69	5,706,440.00	118,868.69
	14	583,200.00	314,280.00	448,740.00	171,600.93	155,520.00	209,019.31	398,480.69	5,706,440.00	398,480.69
	15	583,200.00	377,784.00	480,492.00	171,600.93	155,520.00	209,019.31	493,736.69	5,706,440.00	493,736.69
	16	580,608.00	388,800.00	484,704.00	171,600.93	155,520.00	209,019.31	508,964.69	5,706,440.00	508,964.69
	17	362,880.00	375,192.00	369,036.00	171,600.93	155,520.00	209,019.31	379,688.69	5,706,440.00	379,688.69
	18	487,296.00	302,616.00	394,956.00	171,600.93	155,520.00	209,019.31	333,032.69	5,706,440.00	333,032.69
	19	518,400.00	301,320.00	409,860.00	171,600.93	155,520.00	209,019.31	346,640.69	5,706,440.00	346,640.69
	20	478,224.00	87,480.00	282,852.00	171,600.93	155,520.00	209,019.31	5,792.69	5,706,440.00	5,792.69
	21	442,584.00	236,520.00	339,552.00	171,600.93	155,520.00	209,019.31	211,532.69	5,706,440.00	211,532.69
	22	423,792.00	289,008.00	356,400.00	171,600.93	155,520.00	209,019.31	280,868.69	5,706,440.00	280,868.69
	23	423,792.00	348,624.00	386,208.00	171,600.93	155,520.00	209,019.31	370,292.69	5,706,440.00	370,292.69
	24	411,480.00	355,104.00	383,292.00	171,600.93	155,520.00	209,019.31	373,856.69	5,706,440.00	373,856.69
	25	413,424.00	310,392.00	361,908.00	171,600.93	155,520.00	209,019.31	307,760.69	5,706,440.00	307,760.69
	26	518,400.00	357,696.00	438,048.00	171,600.93	155,520.00	209,019.31	431,204.69	5,706,440.00	431,204.69
	27	518,400.00	344,088.00	431,244.00	171,600.93	155,520.00	209,019.31	410,792.69	5,706,440.00	410,792.69
	28	518,400.00	124,416.00	321,408.00	171,600.93	155,520.00	209,019.31	81,284.69	5,706,440.00	81,284.69
	29	474,984.00	275,400.00	375,192.00	171,600.93	155,520.00	209,019.31	286,052.69	5,706,440.00	286,052.69
	30	495,720.00	324,000.00	409,860.00	171,600.93	155,520.00	209,019.31	369,320.69	5,706,440.00	369,320.69

7. July

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s
Common Cisangkuy River flow = 0.77 m3/s
Common irrigation demand = 2093.055 L/s

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jul	1	417,312.00	305,208.00	361,260.00	66,924.57	155,520.00	180,839.95	91,824.61	5,706,440.00	91,824.61
	2	397,224.00	301,320.00	349,272.00	66,924.57	155,520.00	180,839.95	79,836.61	5,706,440.00	79,836.61
	3	391,392.00	295,488.00	343,440.00	66,924.57	155,520.00	180,839.95	74,004.61	5,706,440.00	74,004.61
	4	398,520.00	260,496.00	329,508.00	66,924.57	155,520.00	180,839.95	60,072.61	5,706,440.00	60,072.61
	5	425,088.00	280,584.00	352,836.00	66,924.57	155,520.00	180,839.95	83,400.61	5,706,440.00	83,400.61
	6	395,280.00	280,584.00	337,932.00	66,924.57	155,520.00	180,839.95	68,496.61	5,706,440.00	68,496.61
	7	395,280.00	281,880.00	338,580.00	66,924.57	155,520.00	180,839.95	69,144.61	5,706,440.00	69,144.61
	8	405,000.00	259,200.00	332,100.00	66,924.57	155,520.00	180,839.95	62,664.61	5,706,440.00	62,664.61
	9	379,080.00	291,600.00	335,340.00	66,924.57	155,520.00	180,839.95	65,904.61	5,706,440.00	65,904.61
	10	364,824.00	274,104.00	319,464.00	66,924.57	155,520.00	180,839.95	50,028.61	5,706,440.00	50,028.61
	11	353,808.00	294,192.00	324,000.00	66,924.57	155,520.00	180,839.95	54,564.61	5,706,440.00	54,564.61
	12	432,216.00	259,200.00	345,708.00	66,924.57	155,520.00	180,839.95	76,272.61	5,706,440.00	76,272.61
	13	463,320.00	283,824.00	373,572.00	66,924.57	155,520.00	180,839.95	104,136.61	5,706,440.00	104,136.61
	14	438,696.00	231,984.00	335,340.00	66,924.57	155,520.00	180,839.95	65,904.61	5,706,440.00	65,904.61
	15	422,496.00	225,504.00	324,000.00	66,924.57	155,520.00	180,839.95	54,564.61	5,706,440.00	54,564.61
	16	368,712.00	215,784.00	292,248.00	66,924.57	155,520.00	180,839.95	22,812.61	5,706,440.00	22,812.61
	17	471,096.00	259,200.00	365,148.00	66,924.57	155,520.00	180,839.95	95,712.61	5,706,440.00	95,712.61
	18	410,184.00	259,200.00	334,692.00	66,924.57	155,520.00	180,839.95	65,256.61	5,706,440.00	65,256.61
	19	443,880.00	259,200.00	351,540.00	66,924.57	155,520.00	180,839.95	82,104.61	5,706,440.00	82,104.61
	20	457,488.00	259,200.00	358,344.00	66,924.57	155,520.00	180,839.95	88,908.61	5,706,440.00	88,908.61
	21	451,008.00	243,000.00	347,004.00	66,924.57	155,520.00	180,839.95	77,568.61	5,706,440.00	77,568.61
	22	491,184.00	274,104.00	382,644.00	66,924.57	155,520.00	180,839.95	113,208.61	5,706,440.00	113,208.61
	23	462,024.00	231,984.00	347,004.00	66,924.57	155,520.00	180,839.95	77,568.61	5,706,440.00	77,568.61
	24	474,984.00	243,000.00	358,992.00	66,924.57	155,520.00	180,839.95	89,556.61	5,706,440.00	89,556.61
	25	469,800.00	210,600.00	340,200.00	66,924.57	155,520.00	180,839.95	70,764.61	5,706,440.00	70,764.61
	26	439,992.00	259,200.00	349,596.00	66,924.57	155,520.00	180,839.95	80,160.61	5,706,440.00	80,160.61
	27	484,704.00	259,200.00	371,952.00	66,924.57	155,520.00	180,839.95	102,516.61	5,706,440.00	102,516.61
	28	441,288.00	215,784.00	328,536.00	66,924.57	155,520.00	180,839.95	59,100.61	5,706,440.00	59,100.61
	29	468,504.00	194,400.00	331,452.00	66,924.57	155,520.00	180,839.95	62,016.61	5,706,440.00	62,016.61
	30	452,304.00	179,496.00	315,900.00	66,924.57	155,520.00	180,839.95	46,464.61	5,706,440.00	46,464.61
	31	425,088.00	148,392.00	286,740.00	66,924.57	155,520.00	180,839.95	17,304.61	5,706,440.00	17,304.61

8. August

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s
Common Cisangkuy River flow = 0.70 m3/s
Common irrigation demand = 2093.055 L/s

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Aug	1	418,608.00	191,808.00	305,208.00	60,411.36	155,520.00	180,839.95	160,656.05	5,706,440.00	160,656.05
	2	414,720.00	194,400.00	304,560.00	60,411.36	155,520.00	180,839.95	162,600.05	5,706,440.00	162,600.05
	3	375,192.00	194,400.00	284,796.00	60,411.36	155,520.00	180,839.95	142,836.05	5,706,440.00	142,836.05
	4	419,904.00	194,400.00	307,152.00	60,411.36	155,520.00	180,839.95	165,192.05	5,706,440.00	165,192.05
	5	371,304.00	194,400.00	282,852.00	60,411.36	155,520.00	180,839.95	140,892.05	5,706,440.00	140,892.05
	6	353,808.00	194,400.00	274,104.00	60,411.36	155,520.00	180,839.95	132,144.05	5,706,440.00	132,144.05
	7	353,808.00	154,224.00	254,016.00	60,411.36	155,520.00	180,839.95	71,880.05	5,706,440.00	71,880.05
	8	367,416.00	194,400.00	280,908.00	60,411.36	155,520.00	180,839.95	138,948.05	5,706,440.00	138,948.05
	9	356,400.00	163,296.00	259,848.00	60,411.36	155,520.00	180,839.95	86,784.05	5,706,440.00	86,784.05
	10	376,488.00	163,296.00	269,892.00	60,411.36	155,520.00	180,839.95	96,828.05	5,706,440.00	96,828.05
	11	393,984.00	196,992.00	295,488.00	60,411.36	155,520.00	180,839.95	156,120.05	5,706,440.00	156,120.05
	12	382,320.00	194,400.00	288,360.00	60,411.36	155,520.00	180,839.95	146,400.05	5,706,440.00	146,400.05
	13	364,824.00	194,400.00	279,612.00	60,411.36	155,520.00	180,839.95	137,652.05	5,706,440.00	137,652.05
	14	373,896.00	194,400.00	284,148.00	60,411.36	155,520.00	180,839.95	142,188.05	5,706,440.00	142,188.05
	15	358,992.00	194,400.00	276,696.00	60,411.36	155,520.00	180,839.95	134,736.05	5,706,440.00	134,736.05
	16	357,696.00	194,400.00	276,048.00	60,411.36	155,520.00	180,839.95	134,088.05	5,706,440.00	134,088.05
	17	316,224.00	194,400.00	255,312.00	60,411.36	155,520.00	180,839.95	113,352.05	5,706,440.00	113,352.05
	18	393,984.00	194,400.00	294,192.00	60,411.36	155,520.00	180,839.95	152,232.05	5,706,440.00	152,232.05
	19	311,688.00	194,400.00	253,044.00	60,411.36	155,520.00	180,839.95	111,084.05	5,706,440.00	111,084.05
	20	312,984.00	194,400.00	253,692.00	60,411.36	155,520.00	180,839.95	111,732.05	5,706,440.00	111,732.05
	21	255,312.00	194,400.00	224,856.00	60,411.36	155,520.00	180,839.95	82,896.05	5,706,440.00	82,896.05
	22	277,992.00	194,400.00	236,196.00	60,411.36	155,520.00	180,839.95	94,236.05	5,706,440.00	94,236.05
	23	300,024.00	194,400.00	247,212.00	60,411.36	155,520.00	180,839.95	105,252.05	5,706,440.00	105,252.05
	24	298,080.00	168,480.00	233,280.00	60,411.36	155,520.00	180,839.95	65,400.05	5,706,440.00	65,400.05
	25	469,800.00	160,704.00	315,252.00	60,411.36	155,520.00	180,839.95	139,596.05	5,706,440.00	139,596.05
	26	287,712.00	195,696.00	241,704.00	60,411.36	155,520.00	180,839.95	101,040.05	5,706,440.00	101,040.05
	27	292,896.00	194,400.00	243,648.00	60,411.36	155,520.00	180,839.95	101,688.05	5,706,440.00	101,688.05
	28	307,800.00	168,480.00	238,140.00	60,411.36	155,520.00	180,839.95	70,260.05	5,706,440.00	70,260.05
	29	337,608.00	194,400.00	266,004.00	60,411.36	155,520.00	180,839.95	124,044.05	5,706,440.00	124,044.05
	30	317,520.00	140,616.00	229,068.00	60,411.36	155,520.00	180,839.95	33,324.05	5,706,440.00	33,324.05
	31	318,816.00	155,520.00	237,168.00	60,411.36	155,520.00	180,839.95	56,328.05	5,706,440.00	56,328.05

9. September

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s
Common Cisangkuy River flow = 1.46 m3/s
Common irrigation demand = 2093.055 L/s

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Sep	1	296,784.00	191,808.00	244,296.00	125,734.11	155,520.00	180,839.95	99,744.05	5,706,440.00	99,744.05
	2	302,616.00	148,392.00	225,504.00	125,734.11	155,520.00	180,839.95	37,536.05	5,706,440.00	37,536.05
	3	55,080.00	194,400.00	124,740.00	125,734.11	155,520.00	180,839.95	-17,219.95	5,689,220.05	0.00
	4	264,384.00	194,400.00	229,392.00	125,734.11	155,520.00	180,839.95	87,432.05	5,706,440.00	87,432.05
	5	252,720.00	158,112.00	205,416.00	125,734.11	155,520.00	180,839.95	27,168.05	5,706,440.00	27,168.05
	6	226,800.00	194,400.00	210,600.00	125,734.11	155,520.00	180,839.95	68,640.05	5,706,440.00	68,640.05
	7	226,800.00	154,224.00	190,512.00	125,734.11	155,520.00	180,839.95	8,376.05	5,706,440.00	8,376.05
	8	256,608.00	156,816.00	206,712.00	125,734.11	155,520.00	180,839.95	27,168.05	5,706,440.00	27,168.05
	9	243,000.00	159,408.00	201,204.00	125,734.11	155,520.00	180,839.95	24,252.05	5,706,440.00	24,252.05
	10	224,208.00	119,880.00	172,044.00	125,734.11	155,520.00	180,839.95	-44,435.95	5,662,004.05	0.00
	11	205,416.00	187,920.00	196,668.00	125,734.11	155,520.00	180,839.95	48,228.05	5,706,440.00	48,228.05
	12	210,600.00	168,480.00	189,540.00	125,734.11	155,520.00	180,839.95	21,660.05	5,706,440.00	21,660.05
	13	215,784.00	159,408.00	187,596.00	125,734.11	155,520.00	180,839.95	10,644.05	5,706,440.00	10,644.05
	14	205,416.00	194,400.00	199,908.00	125,734.11	155,520.00	180,839.95	57,948.05	5,706,440.00	57,948.05
	15	225,504.00	160,704.00	193,104.00	125,734.11	155,520.00	180,839.95	17,448.05	5,706,440.00	17,448.05
	16	210,600.00	162,000.00	186,300.00	125,734.11	155,520.00	180,839.95	11,940.05	5,706,440.00	11,940.05
	17	209,304.00	173,016.00	191,160.00	125,734.11	155,520.00	180,839.95	27,816.05	5,706,440.00	27,816.05
	18	221,616.00	158,112.00	189,864.00	125,734.11	155,520.00	180,839.95	11,616.05	5,706,440.00	11,616.05
	19	194,400.00	152,280.00	173,340.00	125,734.11	155,520.00	180,839.95	-10,739.95	5,695,700.05	0.00
	20	176,904.00	150,984.00	163,944.00	125,734.11	155,520.00	180,839.95	-21,431.95	5,674,268.10	0.00
	21	209,304.00	145,800.00	177,552.00	125,734.11	155,520.00	180,839.95	-13,007.95	5,661,260.14	0.00
	22	202,824.00	105,624.00	154,224.00	125,734.11	155,520.00	180,839.95	-76,511.95	5,584,748.19	0.00
	23	1,942,704.00	134,784.00	#########	125,734.11	155,520.00	180,839.95	837,168.05	5,706,440.00	837,168.05
	24	1,942,704.00	129,600.00	#########	125,734.11	155,520.00	180,839.95	829,392.05	5,706,440.00	829,392.05
	25	469,800.00	121,824.00	295,812.00	125,734.11	155,520.00	180,839.95	81,276.05	5,706,440.00	81,276.05
	26	171,720.00	113,400.00	142,560.00	125,734.11	155,520.00	180,839.95	-80,399.95	5,626,040.05	0.00
	27	200,880.00	191,808.00	196,344.00	125,734.11	155,520.00	180,839.95	51,792.05	5,677,832.10	23,184.14
	28	-	144,504.00	72,252.00	125,734.11	155,520.00	180,839.95	-119,603.95	5,558,228.14	0.00
	29	191,808.00	123,120.00	157,464.00	125,734.11	155,520.00	180,839.95	-55,775.95	5,502,452.19	0.00
	30	164,592.00	194,400.00	179,496.00	125,734.11	155,520.00	180,839.95	37,536.05	5,539,988.24	0.00

10. October

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 1.8 m3/s
Common Cisangkuy River flow = 1.49 m3/s
Common irrigation demand = 3174.255 L/s

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Oct	1	194,400.00	314,280.00	254,340.00	129,122.20	155,520.00	274,255.63	-46,313.43	5,493,674.81	0.00
	2	194,400.00	268,920.00	231,660.00	129,122.20	155,520.00	274,255.63	-68,993.43	5,424,681.38	0.00
	3	163,296.00	295,488.00	229,392.00	129,122.20	155,520.00	274,255.63	-71,261.43	5,353,419.95	0.00
	4	194,400.00	306,504.00	250,452.00	129,122.20	155,520.00	274,255.63	-50,201.43	5,303,218.52	0.00
	5	64,800.00	333,720.00	199,260.00	129,122.20	155,520.00	274,255.63	-101,393.43	5,201,825.09	0.00
	6	194,400.00	275,400.00	234,900.00	129,122.20	155,520.00	274,255.63	-65,753.43	5,136,071.66	0.00
	7	194,400.00	300,024.00	247,212.00	129,122.20	155,520.00	274,255.63	-53,441.43	5,082,630.23	0.00
	8	194,400.00	338,904.00	266,652.00	129,122.20	155,520.00	274,255.63	-34,001.43	5,048,628.80	0.00
	9	179,496.00	301,320.00	240,408.00	129,122.20	155,520.00	274,255.63	-60,245.43	4,988,383.37	0.00
	10	194,400.00	280,584.00	237,492.00	129,122.20	155,520.00	274,255.63	-63,161.43	4,925,221.94	0.00
	11	204,120.00	303,912.00	254,016.00	129,122.20	155,520.00	274,255.63	-46,637.43	4,878,584.51	0.00
	12	194,400.00	283,824.00	239,112.00	129,122.20	155,520.00	274,255.63	-61,541.43	4,817,043.08	0.00
	13	154,224.00	303,912.00	229,068.00	129,122.20	155,520.00	274,255.63	-71,585.43	4,745,457.65	0.00
	14	210,600.00	229,392.00	219,996.00	129,122.20	155,520.00	274,255.63	-80,657.43	4,664,800.22	0.00
	15	208,008.00	248,184.00	228,096.00	129,122.20	155,520.00	274,255.63	-72,557.43	4,592,242.79	0.00
	16	209,304.00	263,088.00	236,196.00	129,122.20	155,520.00	274,255.63	-64,457.43	4,527,785.36	0.00
	17	194,400.00	244,296.00	219,348.00	129,122.20	155,520.00	274,255.63	-81,305.43	4,446,479.93	0.00
	18	210,600.00	221,616.00	216,108.00	129,122.20	155,520.00	274,255.63	-84,545.43	4,361,934.50	0.00
	19	210,600.00	225,504.00	218,052.00	129,122.20	155,520.00	274,255.63	-82,601.43	4,279,333.07	0.00
	20	198,936.00	194,400.00	196,668.00	129,122.20	155,520.00	274,255.63	-103,985.43	4,175,347.64	0.00
	21	215,784.00	164,592.00	190,188.00	129,122.20	155,520.00	274,255.63	-110,465.43	4,064,882.21	0.00
	22	241,704.00	213,192.00	227,448.00	129,122.20	155,520.00	274,255.63	-73,205.43	3,991,676.79	0.00
	23	210,600.00	196,992.00	203,796.00	129,122.20	155,520.00	274,255.63	-96,857.43	3,894,819.36	0.00
	24	213,192.00	173,016.00	193,104.00	129,122.20	155,520.00	274,255.63	-107,549.43	3,787,269.93	0.00
	25	210,600.00	162,000.00	186,300.00	129,122.20	155,520.00	274,255.63	-114,353.43	3,672,916.50	0.00
	26	210,600.00	145,800.00	178,200.00	129,122.20	155,520.00	274,255.63	-122,453.43	3,550,463.07	0.00
	27	210,600.00	154,224.00	182,412.00	129,122.20	155,520.00	274,255.63	-118,241.43	3,432,221.64	0.00
	28	193,104.00	106,920.00	150,012.00	129,122.20	155,520.00	274,255.63	-150,641.43	3,281,580.21	0.00
	29	221,616.00	105,624.00	163,620.00	129,122.20	155,520.00	274,255.63	-137,033.43	3,144,546.78	0.00
	30	243,000.00	87,480.00	165,240.00	129,122.20	155,520.00	274,255.63	-135,413.43	3,009,133.35	0.00
	31	249,480.00	97,200.00	173,340.00	129,122.20	155,520.00	274,255.63	-127,313.43	2,881,819.92	0.00

11. November

Common daily discharge time =	18	hrs/day	
Common daily intake time =	18	hrs/day	(= discharge time)
Expected daily intake time =	24	hrs/day	
Common daily intake flow rate =	1.8	m3/s	
Common Cisangkuy River flow =	3.93	m3/s	
Common irrigation demand =	3174.255	L/s	

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Nov	1	230,688.00	34,992.00	132,840.00	339,657.91	155,520.00	274,255.63	-261,943.63	2,619,876.29	0.00
	2	225,504.00	64,800.00	145,152.00	339,657.91	155,520.00	274,255.63	-219,823.63	2,400,052.65	0.00
	3	210,600.00	82,296.00	146,448.00	339,657.91	155,520.00	274,255.63	-201,031.63	2,199,021.02	0.00
	4	225,504.00	47,304.00	136,404.00	339,657.91	155,520.00	274,255.63	-246,067.63	1,952,953.39	0.00
	5	217,080.00	99,792.00	158,436.00	339,657.91	155,520.00	274,255.63	-171,547.63	1,781,405.76	0.00
	6	217,080.00	194,400.00	205,740.00	339,657.91	155,520.00	274,255.63	-29,635.63	1,751,770.13	0.00
	7	194,400.00	239,112.00	216,756.00	339,657.91	155,520.00	274,255.63	26,092.37	1,777,862.49	0.00
	8	248,184.00	145,800.00	196,992.00	339,657.91	155,520.00	274,255.63	-86,983.63	1,690,878.86	0.00
	9	302,616.00	204,120.00	253,368.00	339,657.91	155,520.00	274,255.63	27,712.37	1,718,591.23	0.00
	10	110,808.00	302,616.00	206,712.00	339,657.91	155,520.00	274,255.63	79,552.37	1,798,143.60	0.00
	11	-	325,296.00	162,648.00	339,657.91	155,520.00	274,255.63	58,168.37	1,856,311.97	0.00
	12	-	256,608.00	128,304.00	339,657.91	155,520.00	274,255.63	-44,863.63	1,811,448.33	0.00
	13	183,384.00	213,192.00	198,288.00	339,657.91	155,520.00	274,255.63	-18,295.63	1,793,152.70	0.00
	14	275,400.00	199,584.00	237,492.00	339,657.91	155,520.00	274,255.63	7,300.37	1,800,453.07	0.00
	15	276,696.00	243,000.00	259,848.00	339,657.91	155,520.00	274,255.63	73,072.37	1,873,525.44	0.00
	16	274,104.00	205,416.00	239,760.00	339,657.91	155,520.00	274,255.63	15,400.37	1,888,925.81	0.00
	17	281,880.00	220,320.00	251,100.00	339,657.91	155,520.00	274,255.63	41,644.37	1,930,570.17	0.00
	18	276,696.00	220,320.00	248,508.00	339,657.91	155,520.00	274,255.63	39,052.37	1,969,622.54	0.00
	19	317,520.00	210,600.00	264,060.00	339,657.91	155,520.00	274,255.63	44,884.37	2,014,506.91	0.00
	20	324,000.00	155,520.00	239,760.00	339,657.91	155,520.00	274,255.63	-34,495.63	1,980,011.28	0.00
	21	105,624.00	110,808.00	108,216.00	339,657.91	155,520.00	274,255.63	-210,751.63	1,769,259.65	0.00
	22	279,288.00	108,216.00	193,752.00	339,657.91	155,520.00	274,255.63	-127,807.63	1,641,452.01	0.00
	23	324,000.00	36,288.00	180,144.00	339,657.91	155,520.00	274,255.63	-213,343.63	1,428,108.38	0.00
	24	330,480.00	69,984.00	200,232.00	339,657.91	155,520.00	274,255.63	-159,559.63	1,268,548.75	0.00
	25	289,008.00	155,520.00	222,264.00	339,657.91	155,520.00	274,255.63	-51,991.63	1,216,557.12	0.00
	26	275,400.00	140,616.00	208,008.00	339,657.91	155,520.00	274,255.63	-81,151.63	1,135,405.49	0.00
	27	312,984.00	134,784.00	223,884.00	339,657.91	155,520.00	274,255.63	-71,107.63	1,064,297.85	0.00
	28	74,520.00	127,008.00	100,764.00	339,657.91	155,520.00	274,255.63	-202,003.63	862,294.22	0.00
	29	-	129,600.00	64,800.00	339,657.91	155,520.00	274,255.63	-235,375.63	626,918.59	0.00
	30	20,088.00	134,784.00	77,436.00	339,657.91	155,520.00	274,255.63	-217,555.63	409,362.96	0.00

12. December

Common daily discharge time =	18	hrs/day	
Common daily intake time =	18	hrs/day	(= discharge time)
Expected daily intake time =	24	hrs/day	
Common daily intake flow rate =	1.8	m3/s	
Common Cisangkuy River flow =	6.33	m3/s	
Common irrigation demand =	2837.555	L/s	

		PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
Month	Date	Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Dec	1	327,888.00	-	327,888.00	546,666.34	155,520.00	245,164.75	-72,796.75	336,566.21	0.00
	2	356,400.00	-	356,400.00	546,666.34	155,520.00	245,164.75	-44,284.75	292,281.45	0.00
	3	294,192.00	-	294,192.00	546,666.34	155,520.00	245,164.75	-106,492.75	185,788.70	0.00
	4	316,224.00	-	316,224.00	546,666.34	155,520.00	245,164.75	-84,460.75	101,327.95	0.00
	5	373,896.00	-	373,896.00	546,666.34	155,520.00	245,164.75	-26,788.75	74,539.20	0.00
	6	373,896.00	-	373,896.00	546,666.34	155,520.00	245,164.75	-26,788.75	47,750.45	0.00
	7	372,600.00	-	372,600.00	546,666.34	155,520.00	245,164.75	-28,084.75	19,665.69	0.00
	8	381,024.00	-	381,024.00	546,666.34	155,520.00	245,164.75	-19,660.75	4.94	0.00
	9	421,200.00	-	421,200.00	546,666.34	155,520.00	245,164.75	20,515.25	20,520.19	0.00
	10	487,296.00	-	487,296.00	546,666.34	155,520.00	245,164.75	86,611.25	107,131.44	0.00
	11	537,192.00	-	537,192.00	546,666.34	155,520.00	245,164.75	136,507.25	243,638.69	0.00
	12	534,600.00	-	534,600.00	546,666.34	155,520.00	245,164.75	133,915.25	377,553.93	0.00
	13	537,192.00	-	537,192.00	546,666.34	155,520.00	245,164.75	136,507.25	514,061.18	0.00
	14	474,984.00	-	474,984.00	546,666.34	155,520.00	245,164.75	74,299.25	588,360.43	0.00
	15	345,384.00	-	345,384.00	546,666.34	155,520.00	245,164.75	-55,300.75	533,059.68	0.00
	16	467,208.00	-	467,208.00	546,666.34	155,520.00	245,164.75	66,523.25	599,582.93	0.00
	17	583,200.00	-	583,200.00	546,666.34	155,520.00	245,164.75	182,515.25	782,098.17	0.00
	18	583,200.00	-	583,200.00	546,666.34	155,520.00	245,164.75	182,515.25	964,613.42	0.00
	19	569,592.00	-	569,592.00	546,666.34	155,520.00	245,164.75	168,907.25	1,133,520.67	0.00
	20	489,888.00	-	489,888.00	546,666.34	155,520.00	245,164.75	89,203.25	1,222,723.92	0.00
	21	403,704.00	-	403,704.00	546,666.34	155,520.00	245,164.75	3,019.25	1,225,743.17	0.00
	22	271,512.00	-	271,512.00	546,666.34	155,520.00	245,164.75	-129,172.75	1,096,570.41	0.00
	23	244,296.00	-	244,296.00	546,666.34	155,520.00	245,164.75	-156,388.75	940,181.66	0.00
	24	287,712.00	-	287,712.00	546,666.34	155,520.00	245,164.75	-112,972.75	827,208.91	0.00
	25	458,784.00	-	458,784.00	546,666.34	155,520.00	245,164.75	58,099.25	885,308.16	0.00
	26	453,600.00	-	453,600.00	546,666.34	155,520.00	245,164.75	52,915.25	938,223.41	0.00
	27	356,400.00	-	356,400.00	546,666.34	155,520.00	245,164.75	-44,284.75	893,938.65	0.00
	28	235,224.00	-	235,224.00	546,666.34	155,520.00	245,164.75	-165,460.75	728,477.90	0.00
	29	489,888.00	-	489,888.00	546,666.34	155,520.00	245,164.75	89,203.25	817,681.15	0.00
	30	498,312.00	-	498,312.00	546,666.34	155,520.00	245,164.75	97,627.25	915,308.40	0.00
	31	421,200.00	-	421,200.00	546,666.34	155,520.00	245,164.75	20,515.25	935,823.65	0.00

4. Scenario 4 (Storage + 25% Increase + Irrigation)

1. January

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s
Common Cisangkuy River flow = 6.69 m3/s
Common irrigation demand = 3646.455 L/s

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jan	1	534,600.00	403,704.00	469,152.00	578,219.49	194,400.00	315,053.71	537,917.78	537,917.78	0.00
	2	460,080.00	408,888.00	434,484.00	578,219.49	194,400.00	315,053.71	503,249.78	1,041,167.56	0.00
	3	518,400.00	429,624.00	474,012.00	578,219.49	194,400.00	315,053.71	542,777.78	1,583,945.34	0.00
	4	518,400.00	419,904.00	469,152.00	578,219.49	194,400.00	315,053.71	537,917.78	2,121,863.12	0.00
	5	518,400.00	453,600.00	486,000.00	578,219.49	194,400.00	315,053.71	554,765.78	2,676,628.90	0.00
	6	506,088.00	453,600.00	479,844.00	578,219.49	194,400.00	315,053.71	548,609.78	3,225,238.68	0.00
	7	486,000.00	453,600.00	469,800.00	578,219.49	194,400.00	315,053.71	538,565.78	3,763,804.46	0.00
	8	518,400.00	453,600.00	486,000.00	578,219.49	194,400.00	315,053.71	554,765.78	4,318,570.24	0.00
	9	478,224.00	499,608.00	488,916.00	578,219.49	194,400.00	315,053.71	557,681.78	4,876,252.02	0.00
	10	534,600.00	519,696.00	527,148.00	578,219.49	194,400.00	315,053.71	595,913.78	5,472,165.80	0.00
	11	150,984.00	487,296.00	319,140.00	578,219.49	194,400.00	315,053.71	387,905.78	5,860,071.57	0.00
	12	392,688.00	510,624.00	451,656.00	578,219.49	194,400.00	315,053.71	520,421.78	6,380,493.35	0.00
	13	423,792.00	518,400.00	471,096.00	578,219.49	194,400.00	315,053.71	539,861.78	6,920,355.13	0.00
	14	534,600.00	518,400.00	526,500.00	578,219.49	194,400.00	315,053.71	595,265.78	7,515,620.91	0.00
	15	479,520.00	518,400.00	498,960.00	578,219.49	194,400.00	315,053.71	567,725.78	8,083,346.69	18,385.47
	16	553,392.00	518,400.00	535,896.00	578,219.49	194,400.00	315,053.71	604,661.78	8,632,687.00	604,661.78
	17	579,312.00	530,712.00	555,012.00	578,219.49	194,400.00	315,053.71	623,777.78	8,632,687.00	623,777.78
	18	594,216.00	543,024.00	568,620.00	578,219.49	194,400.00	315,053.71	637,385.78	8,632,687.00	637,385.78
	19	447,120.00	550,800.00	498,960.00	578,219.49	194,400.00	315,053.71	567,725.78	8,632,687.00	567,725.78
	20	572,184.00	543,024.00	557,604.00	578,219.49	194,400.00	315,053.71	626,369.78	8,632,687.00	626,369.78
	21	552,096.00	453,600.00	502,848.00	578,219.49	194,400.00	315,053.71	571,613.78	8,632,687.00	571,613.78
	22	519,696.00	495,720.00	507,708.00	578,219.49	194,400.00	315,053.71	576,473.78	8,632,687.00	576,473.78
	23	532,008.00	550,800.00	541,404.00	578,219.49	194,400.00	315,053.71	610,169.78	8,632,687.00	610,169.78
	24	584,496.00	381,024.00	482,760.00	578,219.49	194,400.00	315,053.71	551,525.78	8,632,687.00	551,525.78
	25	583,200.00	413,424.00	498,312.00	578,219.49	194,400.00	315,053.71	567,077.78	8,632,687.00	567,077.78
	26	583,200.00	476,280.00	529,740.00	578,219.49	194,400.00	315,053.71	598,505.78	8,632,687.00	598,505.78
	27	578,016.00	553,392.00	565,704.00	578,219.49	194,400.00	315,053.71	634,469.78	8,632,687.00	634,469.78
	28	583,200.00	498,312.00	540,756.00	578,219.49	194,400.00	315,053.71	609,521.78	8,632,687.00	609,521.78
	29	532,008.00	532,008.00	532,008.00	578,219.49	194,400.00	315,053.71	600,773.78	8,632,687.00	600,773.78
	30	526,824.00	518,400.00	522,612.00	578,219.49	194,400.00	315,053.71	591,377.78	8,632,687.00	591,377.78
	31	518,400.00	518,400.00	518,400.00	578,219.49	194,400.00	315,053.71	587,165.78	8,632,687.00	587,165.78

2. February

Common daily discharge time = 18 hrs/day
Common daily intake time = 18 hrs/day (= discharge time)
Expected daily intake time = 24 hrs/day
Common daily intake flow rate = 2.25 m3/s
Common Cisangkuy River flow = 11.09 m3/s
Common irrigation demand = 3161.905 L/s

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Feb	1	497,016.00	533,304.00	515,160.00	958,023.47	194,400.00	273,188.59	580,875.41	8,632,687.00	580,875.41
	2	518,400.00	530,712.00	524,556.00	958,023.47	194,400.00	273,188.59	587,679.41	8,632,687.00	587,679.41
	3	476,280.00	518,400.00	497,340.00	958,023.47	194,400.00	273,188.59	548,151.41	8,632,687.00	548,151.41
	4	494,424.00	518,400.00	506,412.00	958,023.47	194,400.00	273,188.59	557,223.41	8,632,687.00	557,223.41
	5	447,120.00	518,400.00	482,760.00	958,023.47	194,400.00	273,188.59	533,571.41	8,632,687.00	533,571.41
	6	497,016.00	518,400.00	507,708.00	958,023.47	194,400.00	273,188.59	558,519.41	8,632,687.00	558,519.41
	7	538,488.00	518,400.00	528,444.00	958,023.47	194,400.00	273,188.59	579,255.41	8,632,687.00	579,255.41
	8	588,384.00	518,400.00	553,392.00	958,023.47	194,400.00	273,188.59	604,203.41	8,632,687.00	604,203.41
	9	548,208.00	526,824.00	537,516.00	958,023.47	194,400.00	273,188.59	596,751.41	8,632,687.00	596,751.41
	10	648,000.00	518,400.00	583,200.00	958,023.47	194,400.00	273,188.59	634,011.41	8,632,687.00	634,011.41
	11	555,984.00	454,896.00	505,440.00	958,023.47	194,400.00	273,188.59	492,747.41	8,632,687.00	492,747.41
	12	550,800.00	399,816.00	475,308.00	958,023.47	194,400.00	273,188.59	407,535.41	8,632,687.00	407,535.41
	13	560,520.00	318,816.00	439,668.00	958,023.47	194,400.00	273,188.59	290,895.41	8,632,687.00	290,895.41
	14	572,184.00	402,408.00	487,296.00	958,023.47	194,400.00	273,188.59	422,115.41	8,632,687.00	422,115.41
	15	534,600.00	518,400.00	526,500.00	958,023.47	194,400.00	273,188.59	577,311.41	8,632,687.00	577,311.41
	16	534,600.00	534,600.00	534,600.00	958,023.47	194,400.00	273,188.59	601,611.41	8,632,687.00	601,611.41
	17	538,488.00	583,200.00	560,844.00	958,023.47	194,400.00	273,188.59	676,455.41	8,632,687.00	676,455.41
	18	561,816.00	534,600.00	548,208.00	958,023.47	194,400.00	273,188.59	615,219.41	8,632,687.00	615,219.41
	19	550,800.00	534,600.00	542,700.00	958,023.47	194,400.00	273,188.59	609,711.41	8,632,687.00	609,711.41
	20	555,984.00	583,200.00	569,592.00	958,023.47	194,400.00	273,188.59	685,203.41	8,632,687.00	685,203.41
	21	507,384.00	583,200.00	545,292.00	958,023.47	194,400.00	273,188.59	660,903.41	8,632,687.00	660,903.41
	22	518,400.00	583,200.00	550,800.00	958,023.47	194,400.00	273,188.59	666,411.41	8,632,687.00	666,411.41
	23	518,400.00	537,192.00	527,796.00	958,023.47	194,400.00	273,188.59	597,399.41	8,632,687.00	597,399.41
	24	526,824.00	520,992.00	523,908.00	958,023.47	194,400.00	273,188.59	577,311.41	8,632,687.00	577,311.41
	25	518,400.00	518,400.00	518,400.00	958,023.47	194,400.00	273,188.59	569,211.41	8,632,687.00	569,211.41
	26	515,808.00	518,400.00	517,104.00	958,023.47	194,400.00	273,188.59	567,915.41	8,632,687.00	567,915.41
	27	518,400.00	483,408.00	500,904.00	958,023.47	194,400.00	273,188.59	516,723.41	8,632,687.00	516,723.41
	28	518,400.00	555,984.00	537,192.00	958,023.47	194,400.00	273,188.59	625,587.41	8,632,687.00	625,587.41

3. March

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s
Common Cisangkuy River flow	=	10.83	m3/s
Common irrigation demand	=	3161.905	L/s

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
March	1	518,400.00	486,000.00	502,200.00	935,772.45	194,400.00	273,188.59	520,611.41	8,632,687.00	520,611.41
	2	454,896.00	563,112.00	509,004.00	935,772.45	194,400.00	273,188.59	604,527.41	8,632,687.00	604,527.41
	3	325,296.00	576,720.00	451,008.00	935,772.45	194,400.00	273,188.59	560,139.41	8,632,687.00	560,139.41
	4	398,520.00	534,600.00	466,560.00	935,772.45	194,400.00	273,188.59	533,571.41	8,632,687.00	533,571.41
	5	486,000.00	585,792.00	535,896.00	935,772.45	194,400.00	273,188.59	654,099.41	8,632,687.00	654,099.41
	6	534,600.00	585,792.00	560,196.00	935,772.45	194,400.00	273,188.59	678,399.41	8,632,687.00	678,399.41
	7	518,400.00	563,112.00	540,756.00	935,772.45	194,400.00	273,188.59	636,279.41	8,632,687.00	636,279.41
	8	518,400.00	561,816.00	540,108.00	935,772.45	194,400.00	273,188.59	634,335.41	8,632,687.00	634,335.41
	9	518,400.00	561,816.00	540,108.00	935,772.45	194,400.00	273,188.59	634,335.41	8,632,687.00	634,335.41
	10	526,824.00	573,480.00	550,152.00	935,772.45	194,400.00	273,188.59	656,043.41	8,632,687.00	656,043.41
	11	79,704.00	636,984.00	358,344.00	935,772.45	194,400.00	273,188.59	527,739.41	8,632,687.00	527,739.41
	12	-	596,808.00	298,404.00	935,772.45	194,400.00	273,188.59	427,623.41	8,632,687.00	427,623.41
	13	285,120.00	659,016.00	472,068.00	935,772.45	194,400.00	273,188.59	663,495.41	8,632,687.00	663,495.41
	14	387,504.00	535,896.00	461,700.00	935,772.45	194,400.00	273,188.59	530,007.41	8,632,687.00	530,007.41
	15	311,688.00	636,984.00	474,336.00	935,772.45	194,400.00	273,188.59	643,731.41	8,632,687.00	643,731.41
	16	348,624.00	538,488.00	443,556.00	935,772.45	194,400.00	273,188.59	514,455.41	8,632,687.00	514,455.41
	17	86,184.00	565,704.00	325,944.00	935,772.45	194,400.00	273,188.59	424,059.41	8,632,687.00	424,059.41
	18	84,888.00	625,320.00	355,104.00	935,772.45	194,400.00	273,188.59	512,835.41	8,632,687.00	512,835.41
	19	332,424.00	631,800.00	482,112.00	935,772.45	194,400.00	273,188.59	646,323.41	8,632,687.00	646,323.41
	20	522,288.00	599,400.00	560,844.00	935,772.45	194,400.00	273,188.59	692,655.41	8,632,687.00	692,655.41
	21	494,424.00	578,016.00	536,220.00	935,772.45	194,400.00	273,188.59	646,647.41	8,632,687.00	646,647.41
	22	518,400.00	522,288.00	520,344.00	935,772.45	194,400.00	273,188.59	575,043.41	8,632,687.00	575,043.41
	23	468,504.00	563,112.00	515,808.00	935,772.45	194,400.00	273,188.59	611,331.41	8,632,687.00	611,331.41
	24	484,704.00	604,584.00	544,644.00	935,772.45	194,400.00	273,188.59	681,639.41	8,632,687.00	681,639.41
	25	395,280.00	543,024.00	469,152.00	935,772.45	194,400.00	273,188.59	544,587.41	8,632,687.00	544,587.41
	26	555,984.00	518,400.00	537,192.00	935,772.45	194,400.00	273,188.59	588,003.41	8,632,687.00	588,003.41
	27	591,624.00	550,800.00	571,212.00	935,772.45	194,400.00	273,188.59	654,423.41	8,632,687.00	654,423.41
	28	502,200.00	583,200.00	542,700.00	935,772.45	194,400.00	273,188.59	658,311.41	8,632,687.00	658,311.41
	29	607,824.00	572,184.00	590,004.00	935,772.45	194,400.00	273,188.59	694,599.41	8,632,687.00	694,599.41
	30	640,224.00	583,200.00	611,712.00	935,772.45	194,400.00	273,188.59	727,323.41	8,632,687.00	727,323.41
	31	651,888.00	391,392.00	521,640.00	935,772.45	194,400.00	273,188.59	445,443.41	8,632,687.00	445,443.41

4. April

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s
Common Cisangkuy River flow	=	7.35	m3/s
Common irrigation demand	=	1914.255	L/s

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Apr	1	664,200.00	401,112.00	532,656.00	635,076.16	194,400.00	165,391.63	807,940.53	8,632,687.00	807,940.53
	2	615,600.00	464,616.00	540,108.00	635,076.16	194,400.00	165,391.63	815,392.53	8,632,687.00	815,392.53
	3	595,512.00	460,080.00	527,796.00	635,076.16	194,400.00	165,391.63	803,080.53	8,632,687.00	803,080.53
	4	583,200.00	518,400.00	550,800.00	635,076.16	194,400.00	165,391.63	826,084.53	8,632,687.00	826,084.53
	5	596,808.00	462,024.00	529,416.00	635,076.16	194,400.00	165,391.63	804,700.53	8,632,687.00	804,700.53
	6	615,600.00	462,024.00	538,812.00	635,076.16	194,400.00	165,391.63	814,096.53	8,632,687.00	814,096.53
	7	596,808.00	518,400.00	557,604.00	635,076.16	194,400.00	165,391.63	832,888.53	8,632,687.00	832,888.53
	8	595,512.00	565,704.00	580,608.00	635,076.16	194,400.00	165,391.63	855,892.53	8,632,687.00	855,892.53
	9	561,816.00	595,512.00	578,664.00	635,076.16	194,400.00	165,391.63	853,948.53	8,632,687.00	853,948.53
	10	442,584.00	553,392.00	497,988.00	635,076.16	194,400.00	165,391.63	773,272.53	8,632,687.00	773,272.53
	11	592,920.00	427,680.00	510,300.00	635,076.16	194,400.00	165,391.63	785,584.53	8,632,687.00	785,584.53
	12	508,680.00	600,696.00	554,688.00	635,076.16	194,400.00	165,391.63	829,972.53	8,632,687.00	829,972.53
	13	553,392.00	549,504.00	551,448.00	635,076.16	194,400.00	165,391.63	826,732.53	8,632,687.00	826,732.53
	14	563,112.00	452,304.00	507,708.00	635,076.16	194,400.00	165,391.63	782,992.53	8,632,687.00	782,992.53
	15	474,984.00	311,688.00	393,336.00	635,076.16	194,400.00	165,391.63	668,620.53	8,632,687.00	668,620.53
	16	421,200.00	443,880.00	432,540.00	635,076.16	194,400.00	165,391.63	707,824.53	8,632,687.00	707,824.53
	17	456,192.00	507,384.00	481,788.00	635,076.16	194,400.00	165,391.63	757,072.53	8,632,687.00	757,072.53
	18	583,200.00	464,616.00	523,908.00	635,076.16	194,400.00	165,391.63	799,192.53	8,632,687.00	799,192.53
	19	591,624.00	458,784.00	525,204.00	635,076.16	194,400.00	165,391.63	800,488.53	8,632,687.00	800,488.53
	20	595,512.00	480,816.00	538,164.00	635,076.16	194,400.00	165,391.63	813,448.53	8,632,687.00	813,448.53
	21	468,504.00	457,488.00	462,996.00	635,076.16	194,400.00	165,391.63	738,280.53	8,632,687.00	738,280.53
	22	583,200.00	383,616.00	483,408.00	635,076.16	194,400.00	165,391.63	758,692.53	8,632,687.00	758,692.53
	23	583,200.00	341,496.00	462,348.00	635,076.16	194,400.00	165,391.63	737,632.53	8,632,687.00	737,632.53
	24	583,200.00	390,096.00	486,648.00	635,076.16	194,400.00	165,391.63	761,932.53	8,632,687.00	761,932.53
	25	595,512.00	453,600.00	524,556.00	635,076.16	194,400.00	165,391.63	799,840.53	8,632,687.00	799,840.53
	26	448,416.00	366,120.00	407,268.00	635,076.16	194,400.00	165,391.63	682,552.53	8,632,687.00	682,552.53
	27	429,624.00	453,600.00	441,612.00	635,076.16	194,400.00	165,391.63	716,896.53	8,632,687.00	716,896.53
	28	423,792.00	377,784.00	400,788.00	635,076.16	194,400.00	165,391.63	676,072.53	8,632,687.00	676,072.53
	29	427,680.00	168,480.00	298,080.00	635,076.16	194,400.00	165,391.63	573,364.53	8,632,687.00	573,364.53
	30	487,296.00	442,584.00	464,940.00	635,076.16	194,400.00	165,391.63	740,224.53	8,632,687.00	740,224.53

5. May

Common daily discharge time =	18	hrs/day	
Common daily intake time =	18	hrs/day	(= discharge time)
Expected daily intake time =	24	hrs/day	
Common daily intake flow rate =	2.25	m3/s	
Common Cisangkuy River flow =	3.68	m3/s	
Common irrigation demand =	2419.205	L/s	

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
May	1	573,480.00	453,600.00	513,540.00	318,237.82	194,400.00	209,019.31	563,720.69	8,632,687.00	563,720.69
	2	572,184.00	453,600.00	512,892.00	318,237.82	194,400.00	209,019.31	563,072.69	8,632,687.00	563,072.69
	3	592,920.00	453,600.00	523,260.00	318,237.82	194,400.00	209,019.31	573,440.69	8,632,687.00	573,440.69
	4	587,088.00	453,600.00	520,344.00	318,237.82	194,400.00	209,019.31	570,524.69	8,632,687.00	570,524.69
	5	583,200.00	322,704.00	452,952.00	318,237.82	194,400.00	209,019.31	372,236.69	8,632,687.00	372,236.69
	6	610,416.00	322,704.00	466,560.00	318,237.82	194,400.00	209,019.31	385,844.69	8,632,687.00	385,844.69
	7	611,712.00	358,992.00	485,352.00	318,237.82	194,400.00	209,019.31	440,924.69	8,632,687.00	440,924.69
	8	592,920.00	295,488.00	444,204.00	318,237.82	194,400.00	209,019.31	336,272.69	8,632,687.00	336,272.69
	9	629,208.00	348,624.00	488,916.00	318,237.82	194,400.00	209,019.31	434,120.69	8,632,687.00	434,120.69
	10	624,024.00	349,920.00	486,972.00	318,237.82	194,400.00	209,019.31	433,472.69	8,632,687.00	433,472.69
	11	604,584.00	336,312.00	470,448.00	318,237.82	194,400.00	209,019.31	403,340.69	8,632,687.00	403,340.69
	12	596,808.00	306,504.00	451,656.00	318,237.82	194,400.00	209,019.31	354,740.69	8,632,687.00	354,740.69
	13	614,304.00	414,720.00	514,512.00	318,237.82	194,400.00	209,019.31	525,812.69	8,632,687.00	525,812.69
	14	599,400.00	381,024.00	490,212.00	318,237.82	194,400.00	209,019.31	467,816.69	8,632,687.00	467,816.69
	15	603,288.00	426,384.00	514,836.00	318,237.82	194,400.00	209,019.31	537,800.69	8,632,687.00	537,800.69
	16	585,792.00	414,720.00	500,256.00	318,237.82	194,400.00	209,019.31	511,556.69	8,632,687.00	511,556.69
	17	487,296.00	403,704.00	445,500.00	318,237.82	194,400.00	209,019.31	445,784.69	8,632,687.00	445,784.69
	18	414,720.00	276,696.00	345,708.00	318,237.82	194,400.00	209,019.31	218,984.69	8,632,687.00	218,984.69
	19	436,104.00	346,680.00	391,392.00	318,237.82	194,400.00	209,019.31	334,652.69	8,632,687.00	334,652.69
	20	583,200.00	310,392.00	446,796.00	318,237.82	194,400.00	209,019.31	353,768.69	8,632,687.00	353,768.69
	21	627,912.00	362,880.00	495,396.00	318,237.82	194,400.00	209,019.31	454,856.69	8,632,687.00	454,856.69
	22	641,520.00	453,600.00	547,560.00	318,237.82	194,400.00	209,019.31	597,740.69	8,632,687.00	597,740.69
	23	619,488.00	453,600.00	536,544.00	318,237.82	194,400.00	209,019.31	586,724.69	8,632,687.00	586,724.69
	24	615,600.00	453,600.00	534,600.00	318,237.82	194,400.00	209,019.31	584,780.69	8,632,687.00	584,780.69
	25	642,816.00	453,600.00	548,208.00	318,237.82	194,400.00	209,019.31	598,388.69	8,632,687.00	598,388.69
	26	599,400.00	453,600.00	526,500.00	318,237.82	194,400.00	209,019.31	576,680.69	8,632,687.00	576,680.69
	27	634,392.00	357,696.00	496,044.00	318,237.82	194,400.00	209,019.31	450,320.69	8,632,687.00	450,320.69
	28	615,600.00	413,424.00	514,512.00	318,237.82	194,400.00	209,019.31	524,516.69	8,632,687.00	524,516.69
	29	642,816.00	386,208.00	514,512.00	318,237.82	194,400.00	209,019.31	497,300.69	8,632,687.00	497,300.69
	30	618,192.00	358,992.00	488,592.00	318,237.82	194,400.00	209,019.31	444,164.69	8,632,687.00	444,164.69
	31	524,880.00	419,904.00	472,392.00	318,237.82	194,400.00	209,019.31	488,876.69	8,632,687.00	488,876.69

6. June

Common daily discharge time =	18	hrs/day	
Common daily intake time =	18	hrs/day	(= discharge time)
Expected daily intake time =	24	hrs/day	
Common daily intake flow rate =	2.25	m3/s	
Common Cisangkuy River flow =	1.99	m3/s	
Common irrigation demand =	2419.205	L/s	

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jun	1	572,184.00	427,680.00	499,932.00	171,600.93	194,400.00	209,019.31	524,192.69	8,632,687.00	524,192.69
	2	598,104.00	453,600.00	525,852.00	171,600.93	194,400.00	209,019.31	576,032.69	8,632,687.00	576,032.69
	3	442,584.00	453,600.00	448,092.00	171,600.93	194,400.00	209,019.31	498,272.69	8,632,687.00	498,272.69
	4	325,296.00	453,600.00	389,448.00	171,600.93	194,400.00	209,019.31	439,628.69	8,632,687.00	439,628.69
	5	442,584.00	453,600.00	448,092.00	171,600.93	194,400.00	209,019.31	498,272.69	8,632,687.00	498,272.69
	6	646,704.00	453,600.00	550,152.00	171,600.93	194,400.00	209,019.31	600,332.69	8,632,687.00	600,332.69
	7	615,600.00	453,600.00	534,600.00	171,600.93	194,400.00	209,019.31	584,780.69	8,632,687.00	584,780.69
	8	615,600.00	453,600.00	534,600.00	171,600.93	194,400.00	209,019.31	584,780.69	8,632,687.00	584,780.69
	9	548,208.00	376,488.00	462,348.00	171,600.93	194,400.00	209,019.31	435,416.69	8,632,687.00	435,416.69
	10	546,912.00	257,904.00	402,408.00	171,600.93	194,400.00	209,019.31	256,892.69	8,632,687.00	256,892.69
	11	583,200.00	390,096.00	486,648.00	171,600.93	194,400.00	209,019.31	473,324.69	8,632,687.00	473,324.69
	12	561,816.00	413,424.00	487,620.00	171,600.93	194,400.00	209,019.31	497,624.69	8,632,687.00	497,624.69
	13	533,304.00	144,504.00	338,904.00	171,600.93	194,400.00	209,019.31	79,988.69	8,632,687.00	79,988.69
	14	583,200.00	314,280.00	448,740.00	171,600.93	194,400.00	209,019.31	359,600.69	8,632,687.00	359,600.69
	15	583,200.00	377,784.00	480,492.00	171,600.93	194,400.00	209,019.31	454,856.69	8,632,687.00	454,856.69
	16	580,608.00	388,800.00	484,704.00	171,600.93	194,400.00	209,019.31	470,084.69	8,632,687.00	470,084.69
	17	362,880.00	375,192.00	369,036.00	171,600.93	194,400.00	209,019.31	340,808.69	8,632,687.00	340,808.69
	18	487,296.00	302,616.00	394,956.00	171,600.93	194,400.00	209,019.31	294,152.69	8,632,687.00	294,152.69
	19	518,400.00	301,320.00	409,860.00	171,600.93	194,400.00	209,019.31	307,760.69	8,632,687.00	307,760.69
	20	478,224.00	87,480.00	282,852.00	171,600.93	194,400.00	209,019.31	-33,087.31	8,599,599.69	0.00
	21	442,584.00	236,520.00	339,552.00	171,600.93	194,400.00	209,019.31	172,652.69	8,632,687.00	172,652.69
	22	423,792.00	289,008.00	356,400.00	171,600.93	194,400.00	209,019.31	241,988.69	8,632,687.00	241,988.69
	23	423,792.00	348,624.00	386,208.00	171,600.93	194,400.00	209,019.31	331,412.69	8,632,687.00	331,412.69
	24	411,480.00	355,104.00	383,292.00	171,600.93	194,400.00	209,019.31	334,976.69	8,632,687.00	334,976.69
	25	413,424.00	310,392.00	361,908.00	171,600.93	194,400.00	209,019.31	268,880.69	8,632,687.00	268,880.69
	26	518,400.00	357,696.00	438,048.00	171,600.93	194,400.00	209,019.31	392,324.69	8,632,687.00	392,324.69
	27	518,400.00	344,088.00	431,244.00	171,600.93	194,400.00	209,019.31	371,912.69	8,632,687.00	371,912.69
	28	518,400.00	124,416.00	321,408.00	171,600.93	194,400.00	209,019.31	42,404.69	8,632,687.00	42,404.69
	29	474,984.00	275,400.00	375,192.00	171,600.93	194,400.00	209,019.31	247,172.69	8,632,687.00	247,172.69
	30	495,720.00	324,000.00	409,860.00	171,600.93	194,400.00	209,019.31	330,440.69	8,632,687.00	330,440.69

7. July

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s
Common Cisangkuy River flow	=	0.77	m3/s
Common irrigation demand	=	2093.055	L/s

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Jul	1	417,312.00	305,208.00	361,260.00	66,924.57	194,400.00	180,839.95	52,944.61	8,632,687.00	52,944.61
	2	397,224.00	301,320.00	349,272.00	66,924.57	194,400.00	180,839.95	40,956.61	8,632,687.00	40,956.61
	3	391,392.00	295,488.00	343,440.00	66,924.57	194,400.00	180,839.95	35,124.61	8,632,687.00	35,124.61
	4	398,520.00	260,496.00	329,508.00	66,924.57	194,400.00	180,839.95	21,192.61	8,632,687.00	21,192.61
	5	425,088.00	280,584.00	352,836.00	66,924.57	194,400.00	180,839.95	44,520.61	8,632,687.00	44,520.61
	6	395,280.00	280,584.00	337,932.00	66,924.57	194,400.00	180,839.95	29,616.61	8,632,687.00	29,616.61
	7	395,280.00	281,880.00	338,580.00	66,924.57	194,400.00	180,839.95	30,264.61	8,632,687.00	30,264.61
	8	405,000.00	259,200.00	332,100.00	66,924.57	194,400.00	180,839.95	23,784.61	8,632,687.00	23,784.61
	9	379,080.00	291,600.00	335,340.00	66,924.57	194,400.00	180,839.95	27,024.61	8,632,687.00	27,024.61
	10	364,824.00	274,104.00	319,464.00	66,924.57	194,400.00	180,839.95	11,148.61	8,632,687.00	11,148.61
	11	353,808.00	294,192.00	324,000.00	66,924.57	194,400.00	180,839.95	15,684.61	8,632,687.00	15,684.61
	12	432,216.00	259,200.00	345,708.00	66,924.57	194,400.00	180,839.95	37,392.61	8,632,687.00	37,392.61
	13	463,320.00	283,824.00	373,572.00	66,924.57	194,400.00	180,839.95	65,256.61	8,632,687.00	65,256.61
	14	438,696.00	231,984.00	335,340.00	66,924.57	194,400.00	180,839.95	27,024.61	8,632,687.00	27,024.61
	15	422,496.00	225,504.00	324,000.00	66,924.57	194,400.00	180,839.95	15,684.61	8,632,687.00	15,684.61
	16	368,712.00	215,784.00	292,248.00	66,924.57	194,400.00	180,839.95	-16,067.39	8,616,619.61	0.00
	17	471,096.00	259,200.00	365,148.00	66,924.57	194,400.00	180,839.95	56,832.61	8,632,687.00	56,832.61
	18	410,184.00	259,200.00	334,692.00	66,924.57	194,400.00	180,839.95	26,376.61	8,632,687.00	26,376.61
	19	443,880.00	259,200.00	351,540.00	66,924.57	194,400.00	180,839.95	43,224.61	8,632,687.00	43,224.61
	20	457,488.00	259,200.00	358,344.00	66,924.57	194,400.00	180,839.95	50,028.61	8,632,687.00	50,028.61
	21	451,008.00	243,000.00	347,004.00	66,924.57	194,400.00	180,839.95	38,688.61	8,632,687.00	38,688.61
	22	491,184.00	274,104.00	382,644.00	66,924.57	194,400.00	180,839.95	74,328.61	8,632,687.00	74,328.61
	23	462,024.00	231,984.00	347,004.00	66,924.57	194,400.00	180,839.95	38,688.61	8,632,687.00	38,688.61
	24	474,984.00	243,000.00	358,992.00	66,924.57	194,400.00	180,839.95	50,676.61	8,632,687.00	50,676.61
	25	469,800.00	210,600.00	340,200.00	66,924.57	194,400.00	180,839.95	31,884.61	8,632,687.00	31,884.61
	26	439,992.00	259,200.00	349,596.00	66,924.57	194,400.00	180,839.95	41,280.61	8,632,687.00	41,280.61
	27	484,704.00	259,200.00	371,952.00	66,924.57	194,400.00	180,839.95	63,636.61	8,632,687.00	63,636.61
	28	441,288.00	215,784.00	328,536.00	66,924.57	194,400.00	180,839.95	20,220.61	8,632,687.00	20,220.61
	29	468,504.00	194,400.00	331,452.00	66,924.57	194,400.00	180,839.95	23,136.61	8,632,687.00	23,136.61
	30	452,304.00	179,496.00	315,900.00	66,924.57	194,400.00	180,839.95	7,584.61	8,632,687.00	7,584.61
	31	425,088.00	148,392.00	286,740.00	66,924.57	194,400.00	180,839.95	-21,575.39	8,611,111.61	0.00

8. August

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s
Common Cisangkuy River flow	=	0.70	m3/s
Common irrigation demand	=	2093.055	L/s

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Aug	1	418,608.00	191,808.00	305,208.00	60,411.36	194,400.00	180,839.95	121,776.05	8,632,687.00	121,776.05
	2	414,720.00	194,400.00	304,560.00	60,411.36	194,400.00	180,839.95	123,720.05	8,632,687.00	123,720.05
	3	375,192.00	194,400.00	284,796.00	60,411.36	194,400.00	180,839.95	103,956.05	8,632,687.00	103,956.05
	4	419,904.00	194,400.00	307,152.00	60,411.36	194,400.00	180,839.95	126,312.05	8,632,687.00	126,312.05
	5	371,304.00	194,400.00	282,852.00	60,411.36	194,400.00	180,839.95	102,012.05	8,632,687.00	102,012.05
	6	353,808.00	194,400.00	274,104.00	60,411.36	194,400.00	180,839.95	93,264.05	8,632,687.00	93,264.05
	7	353,808.00	154,224.00	254,016.00	60,411.36	194,400.00	180,839.95	33,000.05	8,632,687.00	33,000.05
	8	367,416.00	194,400.00	280,908.00	60,411.36	194,400.00	180,839.95	100,068.05	8,632,687.00	100,068.05
	9	356,400.00	163,296.00	259,848.00	60,411.36	194,400.00	180,839.95	47,904.05	8,632,687.00	47,904.05
	10	376,488.00	163,296.00	269,892.00	60,411.36	194,400.00	180,839.95	57,948.05	8,632,687.00	57,948.05
	11	393,984.00	196,992.00	295,488.00	60,411.36	194,400.00	180,839.95	117,240.05	8,632,687.00	117,240.05
	12	382,320.00	194,400.00	288,360.00	60,411.36	194,400.00	180,839.95	107,520.05	8,632,687.00	107,520.05
	13	364,824.00	194,400.00	279,612.00	60,411.36	194,400.00	180,839.95	98,772.05	8,632,687.00	98,772.05
	14	373,896.00	194,400.00	284,148.00	60,411.36	194,400.00	180,839.95	103,308.05	8,632,687.00	103,308.05
	15	358,992.00	194,400.00	276,696.00	60,411.36	194,400.00	180,839.95	95,856.05	8,632,687.00	95,856.05
	16	357,696.00	194,400.00	276,048.00	60,411.36	194,400.00	180,839.95	95,208.05	8,632,687.00	95,208.05
	17	316,224.00	194,400.00	255,312.00	60,411.36	194,400.00	180,839.95	74,472.05	8,632,687.00	74,472.05
	18	393,984.00	194,400.00	294,192.00	60,411.36	194,400.00	180,839.95	113,352.05	8,632,687.00	113,352.05
	19	311,688.00	194,400.00	253,044.00	60,411.36	194,400.00	180,839.95	72,204.05	8,632,687.00	72,204.05
	20	312,984.00	194,400.00	253,692.00	60,411.36	194,400.00	180,839.95	72,852.05	8,632,687.00	72,852.05
	21	255,312.00	194,400.00	224,856.00	60,411.36	194,400.00	180,839.95	44,016.05	8,632,687.00	44,016.05
	22	277,992.00	194,400.00	236,196.00	60,411.36	194,400.00	180,839.95	55,356.05	8,632,687.00	55,356.05
	23	300,024.00	194,400.00	247,212.00	60,411.36	194,400.00	180,839.95	66,372.05	8,632,687.00	66,372.05
	24	298,080.00	168,480.00	233,280.00	60,411.36	194,400.00	180,839.95	26,520.05	8,632,687.00	26,520.05
	25	469,800.00	160,704.00	315,252.00	60,411.36	194,400.00	180,839.95	100,716.05	8,632,687.00	100,716.05
	26	287,712.00	195,696.00	241,704.00	60,411.36	194,400.00	180,839.95	62,160.05	8,632,687.00	62,160.05
	27	292,896.00	194,400.00	243,648.00	60,411.36	194,400.00	180,839.95	62,808.05	8,632,687.00	62,808.05
	28	307,800.00	168,480.00	238,140.00	60,411.36	194,400.00	180,839.95	31,380.05	8,632,687.00	31,380.05
	29	337,608.00	194,400.00	266,004.00	60,411.36	194,400.00	180,839.95	85,164.05	8,632,687.00	85,164.05
	30	317,520.00	140,616.00	229,068.00	60,411.36	194,400.00	180,839.95	-5,555.95	8,627,131.05	0.00
	31	318,816.00	155,520.00	237,168.00	60,411.36	194,400.00	180,839.95	17,448.05	8,632,687.00	17,448.05

9. September

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s
Common Cisangkuy River flow	=	1.46	m3/s
Common irrigation demand	=	2093.055	L/s

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Sep	1	296,784.00	191,808.00	244,296.00	125,734.11	194,400.00	180,839.95	60,864.05	8,632,687.00	60,864.05
	2	302,616.00	148,392.00	225,504.00	125,734.11	194,400.00	180,839.95	-1,343.95	8,631,343.05	0.00
	3	55,080.00	194,400.00	124,740.00	125,734.11	194,400.00	180,839.95	-56,099.95	8,575,243.10	0.00
	4	264,384.00	194,400.00	229,392.00	125,734.11	194,400.00	180,839.95	48,552.05	8,623,795.14	39,660.19
	5	252,720.00	158,112.00	205,416.00	125,734.11	194,400.00	180,839.95	-11,711.95	8,612,083.19	0.00
	6	226,800.00	194,400.00	210,600.00	125,734.11	194,400.00	180,839.95	29,760.05	8,632,687.00	29,760.05
	7	226,800.00	154,224.00	190,512.00	125,734.11	194,400.00	180,839.95	-30,503.95	8,602,183.05	0.00
	8	256,608.00	156,816.00	206,712.00	125,734.11	194,400.00	180,839.95	-11,711.95	8,590,471.10	0.00
	9	243,000.00	159,408.00	201,204.00	125,734.11	194,400.00	180,839.95	-14,627.95	8,575,843.14	0.00
	10	224,208.00	119,880.00	172,044.00	125,734.11	194,400.00	180,839.95	-83,315.95	8,492,527.19	0.00
	11	205,416.00	187,920.00	196,668.00	125,734.11	194,400.00	180,839.95	9,348.05	8,501,875.24	0.00
	12	210,600.00	168,480.00	189,540.00	125,734.11	194,400.00	180,839.95	-17,219.95	8,484,655.29	0.00
	13	215,784.00	159,408.00	187,596.00	125,734.11	194,400.00	180,839.95	-28,235.95	8,456,419.34	0.00
	14	205,416.00	194,400.00	199,908.00	125,734.11	194,400.00	180,839.95	19,068.05	8,475,487.38	0.00
	15	225,504.00	160,704.00	193,104.00	125,734.11	194,400.00	180,839.95	-21,431.95	8,454,055.43	0.00
	16	210,600.00	162,000.00	186,300.00	125,734.11	194,400.00	180,839.95	-26,939.95	8,427,115.48	0.00
	17	209,304.00	173,016.00	191,160.00	125,734.11	194,400.00	180,839.95	-11,063.95	8,416,051.53	0.00
	18	221,616.00	158,112.00	189,864.00	125,734.11	194,400.00	180,839.95	-27,263.95	8,388,787.58	0.00
	19	194,400.00	152,280.00	173,340.00	125,734.11	194,400.00	180,839.95	-49,619.95	8,339,167.62	0.00
	20	176,904.00	150,984.00	163,944.00	125,734.11	194,400.00	180,839.95	-60,311.95	8,278,855.67	0.00
	21	209,304.00	145,800.00	177,552.00	125,734.11	194,400.00	180,839.95	-51,887.95	8,226,967.72	0.00
	22	202,824.00	105,624.00	154,224.00	125,734.11	194,400.00	180,839.95	-115,391.95	8,111,575.77	0.00
	23	1,942,704.00	134,784.00	1,038,744.00	125,734.11	194,400.00	180,839.95	798,288.05	8,632,687.00	798,288.05
	24	1,942,704.00	129,600.00	1,036,152.00	125,734.11	194,400.00	180,839.95	790,512.05	8,632,687.00	790,512.05
	25	469,800.00	121,824.00	295,812.00	125,734.11	194,400.00	180,839.95	42,396.05	8,632,687.00	42,396.05
	26	171,720.00	113,400.00	142,560.00	125,734.11	194,400.00	180,839.95	-119,279.95	8,513,407.05	0.00
	27	200,880.00	191,808.00	196,344.00	125,734.11	194,400.00	180,839.95	12,912.05	8,526,319.10	0.00
	28	-	144,504.00	72,252.00	125,734.11	194,400.00	180,839.95	-158,483.95	8,367,835.14	0.00
	29	191,808.00	123,120.00	157,464.00	125,734.11	194,400.00	180,839.95	-94,655.95	8,273,179.19	0.00
	30	164,592.00	194,400.00	179,496.00	125,734.11	194,400.00	180,839.95	-1,343.95	8,271,835.24	0.00

10. October

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day (= discharge time)
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s
Common Cisangkuy River flow	=	1.49	m3/s
Common irrigation demand	=	3174.255	L/s

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Oct	1	194,400.00	314,280.00	254,340.00	129,122.20	194,400.00	274,255.63	-85,193.43	8,186,641.81	0.00
	2	194,400.00	268,920.00	231,660.00	129,122.20	194,400.00	274,255.63	-107,873.43	8,078,768.38	0.00
	3	163,296.00	295,488.00	229,392.00	129,122.20	194,400.00	274,255.63	-110,141.43	7,968,626.95	0.00
	4	194,400.00	306,504.00	250,452.00	129,122.20	194,400.00	274,255.63	-89,081.43	7,879,545.52	0.00
	5	64,800.00	333,720.00	199,260.00	129,122.20	194,400.00	274,255.63	-140,273.43	7,739,272.09	0.00
	6	194,400.00	275,400.00	234,900.00	129,122.20	194,400.00	274,255.63	-104,633.43	7,634,638.66	0.00
	7	194,400.00	300,024.00	247,212.00	129,122.20	194,400.00	274,255.63	-92,321.43	7,542,317.23	0.00
	8	194,400.00	338,904.00	266,652.00	129,122.20	194,400.00	274,255.63	-72,881.43	7,469,435.80	0.00
	9	179,496.00	301,320.00	240,408.00	129,122.20	194,400.00	274,255.63	-99,125.43	7,370,310.37	0.00
	10	194,400.00	280,584.00	237,492.00	129,122.20	194,400.00	274,255.63	-102,041.43	7,268,268.94	0.00
	11	204,120.00	303,912.00	254,016.00	129,122.20	194,400.00	274,255.63	-85,517.43	7,182,751.51	0.00
	12	194,400.00	283,824.00	239,112.00	129,122.20	194,400.00	274,255.63	-100,421.43	7,082,330.08	0.00
	13	154,224.00	303,912.00	229,068.00	129,122.20	194,400.00	274,255.63	-110,465.43	6,971,864.65	0.00
	14	210,600.00	229,392.00	219,996.00	129,122.20	194,400.00	274,255.63	-119,537.43	6,852,327.22	0.00
	15	208,008.00	248,184.00	228,096.00	129,122.20	194,400.00	274,255.63	-111,437.43	6,740,889.79	0.00
	16	209,304.00	263,088.00	236,196.00	129,122.20	194,400.00	274,255.63	-103,337.43	6,637,552.36	0.00
	17	194,400.00	244,296.00	219,348.00	129,122.20	194,400.00	274,255.63	-120,185.43	6,517,366.93	0.00
	18	210,600.00	221,616.00	216,108.00	129,122.20	194,400.00	274,255.63	-123,425.43	6,393,941.50	0.00
	19	210,600.00	225,504.00	218,052.00	129,122.20	194,400.00	274,255.63	-121,481.43	6,272,460.07	0.00
	20	198,936.00	194,400.00	196,668.00	129,122.20	194,400.00	274,255.63	-142,865.43	6,129,594.64	0.00
	21	215,784.00	164,592.00	190,188.00	129,122.20	194,400.00	274,255.63	-149,345.43	5,980,249.21	0.00
	22	241,704.00	213,192.00	227,448.00	129,122.20	194,400.00	274,255.63	-112,085.43	5,868,163.79	0.00
	23	210,600.00	196,992.00	203,796.00	129,122.20	194,400.00	274,255.63	-135,737.43	5,732,426.36	0.00
	24	213,192.00	173,016.00	193,104.00	129,122.20	194,400.00	274,255.63	-146,429.43	5,585,996.93	0.00
	25	210,600.00	162,000.00	186,300.00	129,122.20	194,400.00	274,255.63	-153,233.43	5,432,763.50	0.00
	26	210,600.00	145,800.00	178,200.00	129,122.20	194,400.00	274,255.63	-161,333.43	5,271,430.07	0.00
	27	210,600.00	154,224.00	182,412.00	129,122.20	194,400.00	274,255.63	-157,121.43	5,114,308.64	0.00
	28	193,104.00	106,920.00	150,012.00	129,122.20	194,400.00	274,255.63	-189,521.43	4,924,787.21	0.00
	29	221,616.00	105,624.00	163,620.00	129,122.20	194,400.00	274,255.63	-175,913.43	4,748,873.78	0.00
	30	243,000.00	87,480.00	165,240.00	129,122.20	194,400.00	274,255.63	-174,293.43	4,574,580.35	0.00
	31	249,480.00	97,200.00	173,340.00	129,122.20	194,400.00	274,255.63	-166,193.43	4,408,386.92	0.00

11. November

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s
Common Cisangkuy River flow	=	3.93	m3/s
Common irrigation demand	=	3174.255	L/s

(= discharge time)

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Nov	1	230,688.00	34,992.00	132,840.00	339,657.91	194,400.00	274,255.63	-300,823.63	4,107,563.29	0.00
	2	225,504.00	64,800.00	145,152.00	339,657.91	194,400.00	274,255.63	-258,703.63	3,848,859.65	0.00
	3	210,600.00	82,296.00	146,448.00	339,657.91	194,400.00	274,255.63	-239,911.63	3,608,948.02	0.00
	4	225,504.00	47,304.00	136,404.00	339,657.91	194,400.00	274,255.63	-284,947.63	3,324,000.39	0.00
	5	217,080.00	99,792.00	158,436.00	339,657.91	194,400.00	274,255.63	-210,427.63	3,113,572.76	0.00
	6	217,080.00	194,400.00	205,740.00	339,657.91	194,400.00	274,255.63	-68,515.63	3,045,057.13	0.00
	7	194,400.00	239,112.00	216,756.00	339,657.91	194,400.00	274,255.63	-12,787.63	3,032,269.49	0.00
	8	248,184.00	145,800.00	196,992.00	339,657.91	194,400.00	274,255.63	-125,863.63	2,906,405.86	0.00
	9	302,616.00	204,120.00	253,368.00	339,657.91	194,400.00	274,255.63	-11,167.63	2,895,238.23	0.00
	10	110,808.00	302,616.00	206,712.00	339,657.91	194,400.00	274,255.63	40,672.37	2,935,910.60	0.00
	11	-	325,296.00	162,648.00	339,657.91	194,400.00	274,255.63	19,288.37	2,955,198.97	0.00
	12	-	256,608.00	128,304.00	339,657.91	194,400.00	274,255.63	-83,743.63	2,871,455.33	0.00
	13	183,384.00	213,192.00	198,288.00	339,657.91	194,400.00	274,255.63	-57,175.63	2,814,279.70	0.00
	14	275,400.00	199,584.00	237,492.00	339,657.91	194,400.00	274,255.63	-31,579.63	2,782,700.07	0.00
	15	276,696.00	243,000.00	259,848.00	339,657.91	194,400.00	274,255.63	34,192.37	2,816,892.44	0.00
	16	274,104.00	205,416.00	239,760.00	339,657.91	194,400.00	274,255.63	-23,479.63	2,793,412.81	0.00
	17	281,880.00	220,320.00	251,100.00	339,657.91	194,400.00	274,255.63	2,764.37	2,796,177.17	0.00
	18	276,696.00	220,320.00	248,508.00	339,657.91	194,400.00	274,255.63	172.37	2,796,349.54	0.00
	19	317,520.00	210,600.00	264,060.00	339,657.91	194,400.00	274,255.63	6,004.37	2,802,353.91	0.00
	20	324,000.00	155,520.00	239,760.00	339,657.91	194,400.00	274,255.63	-73,375.63	2,728,978.28	0.00
	21	105,624.00	110,808.00	108,216.00	339,657.91	194,400.00	274,255.63	-249,631.63	2,479,346.65	0.00
	22	279,288.00	108,216.00	193,752.00	339,657.91	194,400.00	274,255.63	-166,687.63	2,312,659.01	0.00
	23	324,000.00	36,288.00	180,144.00	339,657.91	194,400.00	274,255.63	-252,223.63	2,060,435.38	0.00
	24	330,480.00	69,984.00	200,232.00	339,657.91	194,400.00	274,255.63	-198,439.63	1,861,995.75	0.00
	25	289,008.00	155,520.00	222,264.00	339,657.91	194,400.00	274,255.63	-90,871.63	1,771,124.12	0.00
	26	275,400.00	140,616.00	208,008.00	339,657.91	194,400.00	274,255.63	-120,031.63	1,651,092.49	0.00
	27	312,984.00	134,784.00	223,884.00	339,657.91	194,400.00	274,255.63	-109,987.63	1,541,104.85	0.00
	28	74,520.00	127,008.00	100,764.00	339,657.91	194,400.00	274,255.63	-240,883.63	1,300,221.22	0.00
	29	-	129,600.00	64,800.00	339,657.91	194,400.00	274,255.63	-274,255.63	1,025,965.59	0.00
	30	20,088.00	134,784.00	77,436.00	339,657.91	194,400.00	274,255.63	-256,435.63	769,529.96	0.00

12. December

Common daily discharge time	=	18	hrs/day
Common daily intake time	=	18	hrs/day
Expected daily intake time	=	24	hrs/day
Common daily intake flow rate	=	2.25	m3/s
Common Cisangkuy River flow	=	6.33	m3/s
Common irrigation demand	=	2837.555	L/s

(= discharge time)

Month	Date	PLTA Cikalong Overflow			Cisangkuy River Flow	PDAM Intake	Irrigation	Storage		
		Daily Volume Each Year			Daily Volume	Daily Volume	Daily Volume	Storage Input	Storage Volume	Storage Outlet
		2014	2015	Average						
		[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]
Dec	1	327,888.00	-	327,888.00	546,666.34	194,400.00	245,164.75	-111,676.75	657,853.21	0.00
	2	356,400.00	-	356,400.00	546,666.34	194,400.00	245,164.75	-83,164.75	574,688.45	0.00
	3	294,192.00	-	294,192.00	546,666.34	194,400.00	245,164.75	-145,372.75	429,315.70	0.00
	4	316,224.00	-	316,224.00	546,666.34	194,400.00	245,164.75	-123,340.75	305,974.95	0.00
	5	373,896.00	-	373,896.00	546,666.34	194,400.00	245,164.75	-65,668.75	240,306.20	0.00
	6	373,896.00	-	373,896.00	546,666.34	194,400.00	245,164.75	-65,668.75	174,637.45	0.00
	7	372,600.00	-	372,600.00	546,666.34	194,400.00	245,164.75	-66,964.75	107,672.69	0.00
	8	381,024.00	-	381,024.00	546,666.34	194,400.00	245,164.75	-58,540.75	49,131.94	0.00
	9	421,200.00	-	421,200.00	546,666.34	194,400.00	245,164.75	-18,364.75	30,767.19	0.00
	10	487,296.00	-	487,296.00	546,666.34	194,400.00	245,164.75	47,731.25	78,498.44	0.00
	11	537,192.00	-	537,192.00	546,666.34	194,400.00	245,164.75	97,627.25	176,125.69	0.00
	12	534,600.00	-	534,600.00	546,666.34	194,400.00	245,164.75	95,035.25	271,160.93	0.00
	13	537,192.00	-	537,192.00	546,666.34	194,400.00	245,164.75	97,627.25	368,788.18	0.00
	14	474,984.00	-	474,984.00	546,666.34	194,400.00	245,164.75	35,419.25	404,207.43	0.00
	15	345,384.00	-	345,384.00	546,666.34	194,400.00	245,164.75	-94,180.75	310,026.68	0.00
	16	467,208.00	-	467,208.00	546,666.34	194,400.00	245,164.75	27,643.25	337,669.93	0.00
	17	583,200.00	-	583,200.00	546,666.34	194,400.00	245,164.75	143,635.25	481,305.17	0.00
	18	583,200.00	-	583,200.00	546,666.34	194,400.00	245,164.75	143,635.25	624,940.42	0.00
	19	569,592.00	-	569,592.00	546,666.34	194,400.00	245,164.75	130,027.25	754,967.67	0.00
	20	489,888.00	-	489,888.00	546,666.34	194,400.00	245,164.75	50,323.25	805,290.92	0.00
	21	403,704.00	-	403,704.00	546,666.34	194,400.00	245,164.75	-35,860.75	769,430.17	0.00
	22	271,512.00	-	271,512.00	546,666.34	194,400.00	245,164.75	-168,052.75	601,377.41	0.00
	23	244,296.00	-	244,296.00	546,666.34	194,400.00	245,164.75	-195,268.75	406,108.66	0.00
	24	287,712.00	-	287,712.00	546,666.34	194,400.00	245,164.75	-151,852.75	254,255.91	0.00
	25	458,784.00	-	458,784.00	546,666.34	194,400.00	245,164.75	19,219.25	273,475.16	0.00
	26	453,600.00	-	453,600.00	546,666.34	194,400.00	245,164.75	14,035.25	287,510.41	0.00
	27	356,400.00	-	356,400.00	546,666.34	194,400.00	245,164.75	-83,164.75	204,345.65	0.00
	28	235,224.00	-	235,224.00	546,666.34	194,400.00	245,164.75	-204,340.75	4.90	0.00
	29	489,888.00	-	489,888.00	546,666.34	194,400.00	245,164.75	50,323.25	50,328.15	0.00
	30	498,312.00	-	498,312.00	546,666.34	194,400.00	245,164.75	58,747.25	109,075.40	0.00
	31	421,200.00	-	421,200.00	546,666.34	194,400.00	245,164.75	-18,364.75	90,710.65	0.00

APPENDIX D. COMPARISON WITH/WITHOUT STORAGE

Common daily discharge time = 18hrs/day
Maximum daily intake time = 18hrs/day
Expected daily intake time = 24hrs/day
Common daily intake flow rate = 1.8m^3/s

Note:

1. Assumed that the discharge from hydropower plant is always constant above 3m^3/s, so it will always be sufficient each day.
2. Assumed that the maximum time that the hydropower can discharge water is 18 hours (6 hours of idle condition)
3. Assumed that the common daily intake flow rate is going to increase 25% from the current situation.

Table D.1 Table of Comparison With/Without Storage

Month	Date	Volume of Intake per Day	
		Without Storage (18 hrs/day) [m3]	With Storage (24 hrs/day) [m3]
Jan	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
	31	40.50	54.00
Feb	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
Mar	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
	31	40.50	54.00
Apr	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
May	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00

Month	Date	Volume of Intake per Day	
		Without Storage (18 hrs/day) [m3]	With Storage (24 hrs/day) [m3]
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
	31	40.50	54.00
Jun	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
Jul	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00

Month	Date	Volume of Intake per Day	
		Without Storage (18 hrs/day) [m3]	With Storage (24 hrs/day) [m3]
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
	31	40.50	54.00
Aug	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
Sep	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00

Month	Date	Volume of Intake per Day	
		Without Storage (18 hrs/day) [m3]	With Storage (24 hrs/day) [m3]
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
Oct	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
	31	40.50	54.00
Nov	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00

Month	Date	Volume of Intake per Day	
		Without Storage (18 hrs/day) [m3]	With Storage (24 hrs/day) [m3]
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
Dec	1	40.50	54.00
	2	40.50	54.00
	3	40.50	54.00
	4	40.50	54.00
	5	40.50	54.00

Month	Date	Volume of Intake per Day	
		Without Storage (18 hrs/day) [m3]	With Storage (24 hrs/day) [m3]
	6	40.50	54.00
	7	40.50	54.00
	8	40.50	54.00
	9	40.50	54.00
	10	40.50	54.00
	11	40.50	54.00
	12	40.50	54.00
	13	40.50	54.00
	14	40.50	54.00
	15	40.50	54.00
	16	40.50	54.00
	17	40.50	54.00
	18	40.50	54.00
	19	40.50	54.00
	20	40.50	54.00

Month	Date	Volume of Intake per Day	
		Without Storage (18 hrs/day) [m3]	With Storage (24 hrs/day) [m3]
	21	40.50	54.00
	22	40.50	54.00
	23	40.50	54.00
	24	40.50	54.00
	25	40.50	54.00
	26	40.50	54.00
	27	40.50	54.00
	28	40.50	54.00
	29	40.50	54.00
	30	40.50	54.00
	31	40.50	54.00
Total		14782.50	19710.00
Difference		4927.50	
Increase (%)		33.33	

APPENDIX E. WANDA PROCEDURE

Due to limitations and lack of knowledge on WANDA, many different simulations were run in order to obtain the final necessary results.

To have a good approximation of the pipe wall roughness to obtain the steady state condition, two sources were checked [which ones?]. Assuming the pipe is rough due to the corrosion of the concrete lining, or the reinforced concrete pipe itself, over the years, the wall roughness is taken to be 2.0 mm. Next, the Young's modulus was approximated with another 2 sources [which ones??]. Since the pipeline is made of steel with a concrete lining, the Young's modulus for steel was taken for the calculations – with the conservative approach, the value of 2.02×10^{11} N/m^2 is taken. However, in the calculations, the Young's modulus had to be adjusted in order for the ratio between the adapted wave speed and calculated wave speed to be less than 25 %. This could be adjusted by changing the size of the pipe segments, creating the segments so the each of them have approximately the same amount of spacing, however, due to the lack of time available with the license, the simulation was made.

Due to the long length of the Pipa Baru pipeline and the limit to the amount of time available for research, the diagram of the pipeline is simplified in the WANDA software. The assumptions are that the pipeline between components, such as pipe bridges, stand pipes, and are simplified into 1 long pipe with the same properties with the same slope. This means that the slight differences in elevation are neglected and linearized.

The first simulation made is a free-flow condition, where all the accessories in the pipeline are neglected, and the real water behavior in the pipeline is measured.

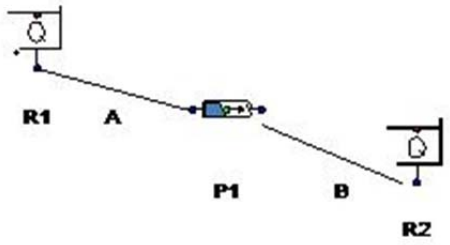


Figure 1. Diagram for free flow condition

The results of this, as expected is exactly the pipe elevation profile reversed, as the values illustrated in the figure are relative pressures. Therefore, the ideal pressure profile should be symmetrical to its pipeline profile.

The second simulation made is the flow condition with accessories.

Figure 2. Diagram for flow condition with accessories

To illustrate the air valves in the pipeline the most appropriately with the WANDA software, the air valve with a filling pipe section is used, and the level effect is automatically taken into account. The main reason for using this type of valve to simulate the pipeline was due to its mathematical model. The mathematical model simulates this air valve as a component through which air can be expelled from the hydraulic system, and is usually achieve by a floating-ball valve mechanism. This is exactly how it is should be working in Pipa Baru, thus this valve type was chosen.

To use this floating-ball type valve node, some variables must be specified and assumptions are made. Firstly, the Laplace coefficient is taken to be 1 to have a conservative approach. Secondly, the inlet and outlet discharge coefficients which describe the amount of contraction of the air flow is most commonly in the range of 0.5 to 1, thus again, the conservative value was chosen.

To include what PDAM refers to as 'Over Valve Speed (OVS)' in the simulation, it must be understood that the mechanisms for this valve is to reduce the pressure in the pipeline. In the locations of where these valves were located, the pipeline operators showed what we know as butterfly valves. Therefore, in the simulation the butterfly valves will be used to represent these OVSs. The set pressure for the butterfly valve is chosen to be 15 bars, and the speed of the butterfly valve is truncated to the full stroke when the pressure ranges ±1 bar. This mathematical mechanism is explained clearly in this equation: (p.258 of manual)

$$\theta_{valve} = \frac{p_2 - p_{set}}{p_{cutoff} \cdot T_c}$$

The full stroke closing time is taken longer as it is recommended in the manual to be conservative, and with Pipa Baru being a large pipeline, it is assumed to be the right approach because

instantaneous closure of a valve may cause secondary problems. Hence, the full closure is taken to be approximately 16 minutes.

There are check valves, which PDAM refers to as NRVS, downstream of the pipeline to prevent the backflow of the water as the pipeline has a 'U' shaped profile. To include this in the simulation, ideal check valves are used which is only open when the head on the upstream side is larger than the head on the downstream side. According to the data given from PDAM, there are 3 NRVSs, of which 2 are ϕ1000 and 1 is ϕ700. During the field work, only NRVS1 was possible to be viewed, and the size of NRVS1 was smaller compared to the pipeline itself. Thus, although it was not measured, in the simulation NRVS1 will have ϕ700 and the other 2 will have ϕ1000. This also correlates with the purpose of the check valves to prevent the back flow. Further, the valve loss coefficient ξ is taken to be 10, as the head difference is the largest when the valve is opened, thus results in a more conservative calculation. In other words, the valve will not open easily to slight head differences in the upstream and downstream.

APPENDIX F. DAFTAR ACCESSORIES PIPA TRANSMISI BARU SEKSI CIKALONG

NO	NO. OF ACCESSORIES	LOKASI	TIPE	GV. DIAMETER
1	AV – 01	CIPINANG	SINGLE-ACTING	150
2	AV – TM – 01	CIGEUREUH	SINGLE-ACTING	125
3	AV – PB – 02	CIGEUREUH	VENT-O MAT	150
4	AV – 03	BATUREOK	VENT-O MAT	150
5	AV – PB – 04	CIMAUNG	VENT-O MAT	150
6	AV – TM – 02	CIMAUNG HELERAN	SINGLE-ACTING	125
7	AV – PB – 05	CIMAUNG HELERAN	VENT-O MAT	150
8	AV – 06	CADAS NGAMPAR	VENT O MAT	SLIMMER
9	AV – TM – 03	CADAS NGAMPAR	DOUBLE-ACTING	125
10	AV – 07	CADAS NGAMPAR/ LONDOK	VENT-O MAT	SLIMMER
11	AV – 08	SP CIMENTENG	VENT-O MAT	150
12	AV – PB – 09	OVS 1 CIMENTENG	VENT-O MAT	150
13	AV – TM – 04	OVS 1 CIMENTENG	SINGLE-ACTING	125
14	AV – 10	JAGABAYA	VENT-O MAT	150
15	AV – 11	TARIGU	VENT-O MAT	150
16	AV – TM – 05	PLN BUGEL	SINGLE-ACTING	200
17	AV – TM – 06	RM.BUGEL	SINGLE-ACTING	125
18	AV – 12	RM. BUGEL	VENT-O MAT	150
19	AV – PB – 13	CISELA	VENT-O MAT	150
20	AV – TM – 07	BLK. PERKASA	VENT-O MAT	150
21	AV – 14	NAMBO RLL	VENT-O MAT	150
22	AV – 15 (OVS 2)	KORAMIL NAMBO	SINGLE-ACTING	150
23	AV – TM – 08	KORAMIL NAMBO	SINGLE-ACTING	125
24	AV – 16	PT KUKJE	VENT-O MAT	150
25	AV – TM – 09	PT KUKJE	SINGLE ACTING	125
26	AV – TM – 10	PT GANGA SUCI	SINGLE-ACTING	125-100
27	AV – PB – 17	PT GANGA SUCI	VENT-O MAT	150
28	AV – TM – 11	OVS 3 CIBIUK	SINGLE-ACTING	125-100
29	AV - 18	OVS 3 CIBIUK	VENT –O MAT	150
30	AV – TM – 12	OVS 3 CIBIUK	SINGLE -ACTING	125
31	AV – TM – 13	SUKASARI	SINGLE-ACTING	125-100
32	AV – TM – 14	HERICO	SINGLE-ACTING	125-100
33	AV – 19	HERICO	VENT-O MAT	150
34	AV – TM – 15	BALEENDAH	SINGLE-ACTING	125-100
35	AV – 20	BALEENDAH-SALON	SINGLE ACTING	125-100
36	AV – TM – 16	BALEENDAH-PASAR		
37	HP – PB – 21 ARAH CIKALONG	CITARUM	TABUNG/PELAMPUNG	150
38	AV – PB – 22 ARAH BANDUNG	CITARUM	VENT-O MAT	150
39	AV – 23 – NRVS 1	CITARUM	VENT-O MAT	150
40	AV – TM – 17	CITARUM	SINGLE-ACTING	150

41	AV – TM – 18	CIKAPUNDUNG KOLOT	SINGLE-ACTING	125-100
42	AV – PB – 24	CIKAPUNDUNG KOLOT	VENT-O MAT	150
43	AV – TM – 19	CIKONENG	SINGLE-ACTING	125-100
44	AV – 25	JL. TOL	VENT-O MAT	150
45	AV – PB – 26	CIWASTRA	VENT-O MAT	150
46	AV – TM – 20	CIWASTRA	SINGLE-ACTING	125-100
47	AV – 27	SAMSAT	VENT-O MAT	SLIMMER
48	AV – TM – 21/ NRVS 2	KIARA CONDONG	SINGLE-ACTING	125
49	AV – 28 – NRVS 3	SIEMENT	SINGLE-ACTING	150
50	AV – TM – 22	SIEMENT	VENT-O MAT	150
51	AV – 29	MBAH MALIM	VENT-O MAT	150
52	AV – 30	ANTAPANI	VENT-O MAT	SLIMMER
53	AV – 31	JL. JAKARTA	VENT-O MAT	SLIMMER
54	AV – TM – 23	SUPRATMAN	VENT-O MAT	150
55	AV – TM – 24	SUPRATMAN DKK	SINGLE-ACTING	125-100
57	AV – 32	P. CORNEL	SINGLE- ACTING	150
58	HIDRAN AV TAMAN	JL. CIKAPAYANG		
59	HIDRAN BDK SINGA	JL. CIUNG WANARA		

Keterangan :

DATA ACCESSOPIS JALUR PIPA TRANSMISI BARU

AV – AVTM : 58 Unit

Terdiri dari :

- AV / AVPB : 35 Unit
- AVTM : 24 Unit
- OVS : 3 Unit
- NRVS : 3 Unit
- WO (Wash Out) : 29 Unit

NO	Accessoris	Diameter Valve	Banyaknya	Keterangan
1	AV / AVPB	Ø 150	35 Buah	
2	AVTM	Ø 125	24 Buah	
3	OVS	Ø 1000 Ø 700	3 Buah 1 Buah	
4	NRVS	Ø 1000 Ø 700	2 Buah 1 Buah	
5	WO WO WO	Ø 200 Ø 600 Ø 400	25 Buah 4 Buah 1 Buah	

APPNEDIX G. FORMAT LOKASI, JARAK, ELEVASI DAN TEKANAN AV-AVTM

NO	AV-AVTM	Lokasi	Kilometer (km)	Elevasi	Tekanan	KET
1	Prassed	Bak II Cikalong	0	847,9	-	1.Prassed-Jagabaya (Pipa Steel 4473m)
2	AV-01	Kali Cikalong	0.134	846,50	-	
3	AVTM-1	Cigeureuh	1.550	816,68		2. Jagabaya- Tarigu (Pipa Beton 1007m)
4	AV-02	Cigeureuh	1.580	820,60	2,7	
5	AV-03	Batureok	1.863	813,41	3,2	3.Tarigu- Kulalet (Pipa Steel 9649m)
6	AV-04	Cimaung	2.541	797,28	4,7	
7	AVTM-2	Cimaung Heleran	2.811	795,39		
8	AV-05	Cadas ngampar	3.132	807,56	3,8	4.Kulalet- Baleendah (Pipa Beton 553m)
9	AVTM-3	Cadas ngampar	3.157	806,94	5,7	5. Baleendah- Perum Bali B.Soang(Pipa Steel 2899m)
10	AV-6 AVTM-4	Cimenteng	4.268	747,15	9,5	
11	AVTM-5	Cimenteng	4.289	744,75		6. Perum Bali-Lengkong(Pipa Beton 1155m)
12	AV-07	Jagabaya	4.373	751,13	9	
13	AV-08	Tarigu	5.780	703,04	13,2	7. Lengkong- Sekejati (Pipa Steel 2983m)
14	AVTM-6	Tarigu	5.980	699,53		
15	AVTM-7	Kiangroke PLN	6.506	683,39	15	8. Sekejati-Suzuki Kircon(Pipa Beton 941m)
16	AVTM 8	Bugel	7.267	664,5		
17	AV-09	Bugel	7.347	666,21	16,2	9. Suzuki Kircon-Jl.Melania (Pipa Steel 5336m)
18	AV-10	Cisela	7.752	667,85	16,1	
19	AVTM-9	Blk. Perkasa	8.543	669,27	15,8	10.Jl.Melania-GD.Geologi (Pipa Beton 250m)
20	AV-11	Nambo	9.282	669,82	15,6	
21	AVTM-10	Nambo/ OVS 2	9.435	669,44	15,5	11. GD.Geologi-Badak singa (Steel 2013m).
22	AV-12	Nambo/ OVS 2	9.440	669,44	15,5	
23	AVTM-11	Nambo/ OVS 2	9.443	669,44	15,4	
24	AV-13	PT.Kukje	10.572	666,83	15,2	
25	AVTM-12	PT.Kukje	10.622	666,61	15,2	
26	AVTM-13	Gangasuci	12.101	661,59	15,1	
27	AV-14	Gangasuci	12.131	663,45	15,2	
28	AVTM-14	Langonsari	12.783	660,87		
29	AVTM-15	Cibiuk/ OVS 3	13.091	659,86	15,1	
30	AV-15	Cibiuk/ OVS 3	13.096	659,86	15,1	
31	AVTM-16	Cibiuk/ OVS 3	13.101	659,86	15,1	
32	AVTM-17	Sukasari	14.485	659,84	15	
33	AVTM-18	Herico	14.981	659,17	15	
34	AV-17	Baleendah	15.958	658,52	14,7	
35	AVTM-19	Pasar BE	16.198	658.40		
36	AV-18	Citarum	16.872	662,94	14	
37	AVTM-20	Citarum/ NRVS 1	16.946	658,32	14,1	
38	AVTM-21	Cikapundung kolot	17.700	659,57	14	
39	AV-19	Cikapundung kolot	17.720	661,42	14	
40	AVTM-22	Cikoneng	18.262	661,15	13,9	
41	AVTM-23	Tol Buahbatu	19,959	665.30	13,3	
42	AV-20	Tol Buahbatu	19.964	665.30	13,3	
43	AV-21/AVTM24	NRVS 2 Kircon	21.243	668,11	12,1	
44	AVTM-25	NRVS 2 Kircon	21.268	667.90		
45	AV-22	Samsat	23.860	677,05	11,7	
46	AV-23/TM-26	Siement/NRVS 3	23.870	667,05	10	
47	AVTM-27	Mbah Malim	25.102	678,78		
48	AV- 24	Antapani	25.105	678,78	9,8	
49	AVTM-26	Jl.Jakarta	26.780	692,58	9,6	
50	AVTM-27	Jl.Supratman neutra	27.870	698,14	7,2	
51	AVTM-28	Jl.Supratman DKK	28.826	711,57	5,2	
52	AV-25	Prabu dimuntur	30.473	737,33		

APPENDIX H. FORMAT JARAK ANTARA PRASED &ACCESSORIES DAN ELEVASI JALUR TRANSMISI PIPA BARU AVPB-AVTM-OVS-NRVS-WO

NO	AVPB-AVTM-OVS-NRVS-WO	Jarak dari Prased (m)	Jarak Antar Accessories (m)	Elevasi	Beda Tinggi	KET
1	Prassed Bak II	0	0	847,9	0	
2	WO-01 Kali cikalong	140	140	845,58	-2,32	
3	AV-TM1/WO-02 Cigeureuh	1.550	1410	816,68	-28,9	
4	AV-PB 01 Cigeureuh	1.580	30	820,60	3,92	
5	AV- 02 Batureok	1.863	283	813,41	-7,19	
6	AV- 03 Cimaung	2.541	678	797,28	-16,13	
7	AV-TM 2 Heleran	2.811	270	795,39	-1,89	
8	WO-03 Heleran	2.822	11	795,09	-0,3	
9	AV- 04 Cadas ngampar	3.132	310	807,56	12,47	
10	AV-TM 3 Cadas ngampar	3.157	25	806,94	-0,62	
11	WO-04 Cimenteng	4.223	1066	745,50	-61,44	
12	AV-05 OVS 1 Cimenteng	4.268	45	747,15	1,65	
13	AV-TM OVS 1 Cimenteng	4.289	21	744,75	-2,4	
14	AV-06 Jagabaya	4.373	84	751,13	6,38	
15	AV-07 Tarigu	5.780	1407	703,04	-48,09	
16	AV-TM 5 Tarigu	5.980	200	699,53	-3,51	
17	AV-TM6 PLN Kiangroke	6.506	526	683,39	-16,13	
18	AV-TM 7 Bugel	7.267	761	664,50	-1,89	
19	WO-05 Bugel	7.282	15	665,42	-0,3	
20	AV-08 RM Bugel	7.347	65	666,21	12,47	
21	WO-06 Cisela	7.739	392	665,90	-0,62	
22	AV-09 Cisela	7.752	13	667,85	-61,44	
23	WO-07 Blk Perkasa	8.505	753	667,52	1,65	
24	AV-TM 8 Blk Perkasa	8.543	38	669,27	-2,4	
25	AV-10 Stasion Nambo	9.282	739	669,82	6,38	
26	WO-08 Citalutug	9.365	83	669,50	-48,09	
27	AV-TM 09 OVS 2 Kolumil	9.435	70	669,44	-3,51	
28	AV-11 Nambo	9.440	5	669,44	-16,14	
29	AV-TM 10 Nambo	9.443	3	669,44	-18,89	
30	AV-12 Kukje	10.572	1129	666,83	0,92	
31	WO-09 Kukje	10.582	10	666,83	0,79	
32	AV-TM 11 Kukje	10.622	40	666,61	-0,31	
33	AV-TM 12 Gangasuci	12.101	1479	661,59	1,95	
34	WO-10 Gangasuci	12.106	5	661,59	-0,33	
35	AV-13Gangasuci	12.131	25	663,45	1,75	
36	AV-TM 13 Langonsari	12.783	652	660,87	0,55	
37	AV-TM 14/ OVS 3 Cibiuk	13.091	308	659,86	-0,32	
38	AV-14 OVS 3 Cibiuk	13.096	5	659,86	-0,06	
39	AV-TM 15 Cibiuk	13.101	5	659,86	0	
40	WO-11 Cibiuk	13.123	22	660,73	0	
41	AV-TM 16 Sukasari	14.485	1362	659,84	-2,61	
42	AV-TM 17 Herico	14.981	496	659,17	0	
43	AV-15 Baleendah	15.958	977	658,52	-0,22	
44	AV-TM 18 Psr Dayeuhkolot	15.198	240	658,40	-5,02	tertimbun aspal
45	WO-12 Citarum	16.852	654	658,40	0	
46	AV-16 Citarum	16.872	20	657,97	1,86	
47	AV-17 Citarum	16.892	20	662,94	-2,58	
48	AV-TM 19 NRVS 1(Dlm gedung)	16.946	54	659,32	-1,01	
49	AV-18 NRVS 1	16.950	4	658,32	0	
50	AV-TM 20 NRVS 1(Luar gedung)	16.958	8	658,32	0	
51	AV-TM 21 Cikap kolot	17.700	742	661,15	2,83	
52	WO-13 Cikap kolot	17.720	20	661,42	0,27	
53	AV-19 Cikap kolot	17.730	10	659,57	-1,85	
54	AV-TM 22 Cikoneng	19.959	2229	665,30	5,73	
55	AV-20 Jembatan Tol	21.243	1284	668,11	2,81	
56	WO-14 Ciwastra	21.263	20	663,00	-5,11	
57	AV-21 Samsat	21.268	5	667,90	4,9	
58	WO-15 Samsat	22.498	1230	671,15	3,25	tertimbun aspal
59	AV-TM 23 Trs Kircon	23.870	1372	677,05	5,9	
60	WO-16 Salon kircon	23.880	10	677,05	0	
61	AV-TM 24 Siemens	25.102	1222	678,78	1,73	

62	AV-22 Mbah Malim	25.255	153	679,00	0,22	terimbun aspal
63	WO-17 Mbah Malim	25.392	137	679,42	0,42	tertimbun aspal
64	AV-23 Jl. Jakarta	26.780	1388	682,58	3,16	
65	WO-18 Jl. Jakarta	26.785	5	692,58	10	
66	AV-TM 25 Supratman	27.870	1085	698,14	5,56	
67	AV-TM 26 DKK	28.826	956	711,57	13,43	
68	WO-19 Cilaki TMN Lansia	29.510	684	724,19	12,62	
69	AV-24 P. Cornel	30.500	990	737,33	13,14	Tertimbun aspal
70	Hydrant Cikapayang	30.550	50	735,15	-2,18	
71	Hydrant ciungwanara	30.560	10	740,33	5,18	
72	Treatment BS	31.250	690	751,13	10,8	

APPENDIX I: RESULTS OF PHYSICAL PARAMETERS FROM THE MONITORING PLAN.

Date- Time	Location	pH	T °C	Conductivity (µS/cm)	TDS (mg/L)	Turbidity NTU	TSS (mg/L)	Clean and dry filter (g/100mL)	filter + sample (g/100mL)
26-11-2015 11:00	influent	7.00	22.90	126.90	81.22	247.00	227.00	0.3963	0.4190
26-11-2015 11:00	Acc1	6.85	23.00	138.70	88.77	5.17	-86.00	0.3878	0.3792
26-11-2015 11:00	Acc2	6.76	23.50	143.80	92.03	4.82	-80.00	0.3917	0.3837
26-11-2015 11:00	Acc3	6.73	23.70	141.50	90.56	1.90	-80.00	0.4023	0.3943
26-11-2015 11:00	Acc4	6.75	24.10	142.90	91.46	2.23	-70.00	0.3863	0.3793
26-11-2015 11:00	RSF1	6.72	21.60	131.80	84.35	1.43			
26-11-2015 11:00	RSF2	6.73	21.80	138.20	88.45	1.03			
26-11-2015 11:00	RSF3	6.70	21.40	138.90	88.90	0.39			
26-11-2015 11:00	RSF4	6.76	21.80	138.10	88.38	0.59			
26-11-2015 11:00	RSF5	6.73	22.20	139.60	89.34	0.42			
26-11-2015 11:00	RSF6	6.71	21.20	141.10	90.30	0.44			
26-11-2015 11:00	RSF7	6.81	21.80	145.20	92.93	0.37			
26-11-2015 11:00	RSF8	6.80	22.00	141.20	90.37	0.23			
26-11-2015 11:00	RSF9	6.86	22.40	144.10	92.22	0.60			
26-11-2015 11:00	RSF10	6.85	22.50	146.10	93.50	0.43			
26-11-2015 11:00	RSF11	6.89	23.10	143.90	92.10	0.24			
26-11-2015 11:00	RSF12	6.90	22.50	140.00	89.60	0.07			
26-11-2015 11:00	RSF13	6.93	22.90	140.90	90.18	0.11			
26-11-2015 11:00	RSF14	6.90	23.20	142.90	91.46	0.54			
26-11-2015 11:00	RSF15	6.88	23.40	143.80	92.03	0.63			
26-11-2015 11:00	RSF16	6.88	23.70	144.90	92.74	0.69			
26-11-2015 11:00	RSF17	6.90	23.50	145.50	93.12	0.47			
26-11-2015 11:00	RSF18	6.93	22.50	144.20	92.29	0.35			
26-11-2015 11:00	RSF19	6.90	23.70	139.10	89.02	0.64			
26-11-2015 11:00	RSF20	6.92	23.70	144.60	92.54	0.58			
26-11-2015 11:00	Effluent	6.87	23.50	143.90	92.10	0.30			
27-11-2015 8:40	influent	7.17	23.20	151.10	96.70	64.30	68.00	0.0971	0.1039
27-11-2015 8:40	Acc1	6.96	23.50	162.10	103.74	5.81	-8.00	0.0986	0.0978
27-11-2015 8:40	Acc2	6.89	23.40	161.60	103.42	6.94	12.00	0.0992	0.1004
27-11-2015 8:40	Acc3	6.90	22.80	155.90	99.78	4.40	9.00	0.0973	0.0982
27-11-2015 8:40	Acc4	6.89	23.40	161.60	103.42	4.89	-2.00	0.0982	0.0980
27-11-2015 8:40	RSF1	6.81	23.60	160.60	102.78	0.22			
27-11-2015 8:40	RSF2	6.78	23.50	160.20	102.53	0.15			
27-11-2015 8:40	RSF3	6.74	22.80	158.50	101.44	0.13			
27-11-2015 8:40	RSF4	6.69	22.80	161.20	103.17	0.38			
27-11-2015 8:40	RSF5	6.68	20.90	153.70	98.37	0.24			
27-11-2015 8:40	RSF6	6.72	22.90	159.40	102.02	0.19			
27-11-2015 8:40	RSF7	6.75	23.30	159.80	102.27	0.16			
27-11-2015 8:40	RSF8	6.79	21.80	157.30	100.67	0.41			
27-11-2015 8:40	RSF9	6.81	23.00	159.20	101.89	0.36			

27-11-2015 8:40	RSF10	6.86	22.10	154.10	98.62	0.28			
27-11-2015 8:40	RSF11	6.80	23.40	160.60	102.78	0.36			
27-11-2015 8:40	RSF12	6.82	23.40	161.60	103.42	0.48			
27-11-2015 8:40	RSF13	6.77	23.20	160.70	102.85	0.24			
27-11-2015 8:40	RSF14	6.80	22.90	157.80	100.99	0.10			
27-11-2015 8:40	RSF15	6.94	23.10	162.70	104.13	0.18			
27-11-2015 8:40	RSF16	6.86	23.30	161.60	103.42	0.22			
27-11-2015 8:40	RSF17	6.73	21.90	158.00	101.12	0.14			
27-11-2015 8:40	RSF18	6.83	22.10	159.30	101.95	0.16			
27-11-2015 8:40	RSF19	6.90	22.10	161.60	103.42	0.40			
27-11-2015 8:40	RSF20	6.85	23.00	162.40	103.94	0.05			
27-11-2015 8:40	Effluent	6.84	22.80	161.40	103.30	0.35			
27-11-2015 12:00	influent	7.07	24.10	147.80	103.50	26.50	24.00	0.0990	0.1014
27-11-2015 12:00	Acc1	6.82	22.00	148.10	103.70	4.43	16.00	0.0984	0.1000
27-11-2015 12:00	Acc2	6.85	23.40	155.80	109.00	6.54	6.00	0.0988	0.0994
27-11-2015 12:00	Acc3	6.78	23.50	156.70	109.70	3.49	4.00	0.0983	0.0987
27-11-2015 12:00	Acc4	6.74	22.40	150.30	105.20	3.40	-4.00	0.0994	0.0990
27-11-2015 12:00	RSF1	6.71	23.10	156.80	109.70	0.28			
27-11-2015 12:00	RSF2	6.73	21.80	153.70	106.90	0.20			
27-11-2015 12:00	RSF3	6.68	23.40	156.20	109.40	0.03			
27-11-2015 12:00	RSF4	6.71	23.60	158.40	110.90	0.05			
27-11-2015 12:00	RSF5	6.68	23.20	152.60	106.80	0.05			
27-11-2015 12:00	RSF6	6.85	23.50	158.00	110.60	0.15			
27-11-2015 12:00	RSF7	6.86	22.20	151.20	105.80	0.13			
27-11-2015 12:00	RSF8	6.86	23.60	157.70	110.40	0.12			
27-11-2015 12:00	RSF9	6.85	22.00	151.50	106.10	0.06			
27-11-2015 12:00	RSF10	6.79	22.90	153.90	107.70	0.16			
27-11-2015 12:00	RSF11	6.75	23.00	157.40	110.20	low			
27-11-2015 12:00	RSF12	6.72	22.50	151.50	106.10	0.05			
27-11-2015 12:00	RSF13	6.72	23.10	153.90	107.10	low			
27-11-2015 12:00	RSF14	6.74	23.80	157.00	109.90	0.10			
27-11-2015 12:00	RSF15	6.85	24.20	155.00	108.50	0.07			
27-11-2015 12:00	RSF16	6.80	23.90	154.80	108.40	0.04			
27-11-2015 12:00	RSF17	6.83	24.30	155.50	108.80	low			
27-11-2015 12:00	RSF18	6.85	24.50	156.70	109.70	low			
27-11-2015 12:00	RSF19	6.84	24.10	155.20	108.70	low			
27-11-2015 12:00	RSF20	6.89	24.20	156.30	109.40	0.25			
27-11-2015 12:00	Effluent	6.84	24.20	157.40	110.20	low			
30-11-2015 8:30	influent	6.82	20.40			25.20	95.00	0.3847	0.3942
30-11-2015 8:30	Acc1	6.72	21.90			0.82	30.00	0.3740	0.3770
30-11-2015 8:30	Acc2	6.69	21.60			0.97	40.00	0.3722	0.3762
30-11-2015 8:30	Acc3	6.75	22.10			0.82	28.00	0.3755	0.3783
30-11-2015 8:30	Acc4	6.76	21.80			0.99	34.00	0.3799	0.3833
30-11-2015 8:30	RSF1	6.63	21.40			0.02			
30-11-2015 8:30	RSF2	6.66	21.40			low			

30-11-2015 8:30	RSF3	6.64	22.00			low			
30-11-2015 8:30	RSF4	6.65	21.90			low			
30-11-2015 8:30	RSF5	6.64	21.70			0.07			
30-11-2015 8:30	RSF6	6.62	21.80			0.20			
30-11-2015 8:30	RSF7	6.63	21.90			0.56			
30-11-2015 8:30	RSF8	6.64	21.80			low			
30-11-2015 8:30	RSF9	6.68	21.70			low			
30-11-2015 8:30	RSF10	6.65	22.10			0.23			
30-11-2015 8:30	RSF11	6.65	22.30			0.04			
30-11-2015 8:30	RSF12	6.68	22.20			low			
30-11-2015 8:30	RSF13	6.64	21.90			0.18			
30-11-2015 8:30	RSF14	6.62	21.90			0.90			
30-11-2015 8:30	RSF15	6.66	22.50			0.30			
30-11-2015 8:30	RSF16	6.66	22.10			0.18			
30-11-2015 8:30	RSF17	6.64	22.40			0.08			
30-11-2015 8:30	RSF18	6.68	22.50			0.07			
30-11-2015 8:30	RSF19	6.66	22.20			0.03			
30-11-2015 8:30	RSF20	6.64	22.50			0.36			
30-11-2015 8:30	Effluent	6.67	22.40			0.47			
30-11-2015 13:00	influent	6.97	23.80			37.50	49.00	0.3819	0.3868
30-11-2015 13:00	Acc1	6.93	23.70			5.70	41.00	0.3842	0.3883
30-11-2015 13:00	Acc2	6.92	23.70			5.67	38.00	0.3847	0.3885
30-11-2015 13:00	Acc3	6.83	23.40			7.68	32.00	0.3860	0.3892
30-11-2015 13:00	Acc4	6.73	23.40			3.81	47.00	0.3862	0.3909
30-11-2015 13:00	RSF1	6.70	21.60			0.15			
30-11-2015 13:00	RSF2	6.70	21.40			0.69			
30-11-2015 13:00	RSF3	6.66	21.60			low			
30-11-2015 13:00	RSF4	6.67	21.70			0.39			
30-11-2015 13:00	RSF5	6.69	21.60			0.54			
30-11-2015 13:00	RSF6	6.66	21.90			0.09			
30-11-2015 13:00	RSF7	6.65	21.50			0.31			
30-11-2015 13:00	RSF8	6.66	21.60			0.17			
30-11-2015 13:00	RSF9	6.66	21.50			1.17			
30-11-2015 13:00	RSF10	6.64	22.10			0.27			
30-11-2015 13:00	RSF11	6.63	21.60			0.52			
30-11-2015 13:00	RSF12	6.61	22.20			0.47			
30-11-2015 13:00	RSF13	6.62	22.20			0.48			
30-11-2015 13:00	RSF14	6.64	21.90			0.62			
30-11-2015 13:00	RSF15	6.63	21.60			0.27			
30-11-2015 13:00	RSF16	6.64	21.80			low			
30-11-2015 13:00	RSF17	6.64	22.10			0.29			
30-11-2015 13:00	RSF18	6.67	22.40			0.55			
30-11-2015 13:00	RSF19	6.66	22.40			0.08			
30-11-2015 13:00	RSF20	6.72	22.20			low			
30-11-2015 13:00	Effluent	6.67	23.50			0.26			

01-12-2015 8:30	influent	6.97	23.10			16.00	82.00	0.3668	0.3750
01-12-2015 8:30	Acc1	6.99	23.30			12.70	50.00	0.3756	0.3806
01-12-2015 8:30	Acc2	6.69	22.90			15.90	75.00	0.3720	0.3795
01-12-2015 8:30	Acc3	7.00	22.50			8.92	75.00	0.3736	0.3811
01-12-2015 8:30	Acc4	6.62	23.00			9.83	62.00	0.3820	0.3882
01-12-2015 8:30	RSF1	6.71	22.50			0.46			
01-12-2015 8:30	RSF2	6.73	22.70			0.84			
01-12-2015 8:30	RSF3	6.77	22.50			2.18			
01-12-2015 8:30	RSF4	6.80	22.70			0.17			
01-12-2015 8:30	RSF5	6.81	22.80			1.30			
01-12-2015 8:30	RSF6	6.82	23.30			1.44			
01-12-2015 8:30	RSF7	6.81	22.80			1.19			
01-12-2015 8:30	RSF8	6.80	21.50			1.09			
01-12-2015 8:30	RSF9	6.73	22.00			0.20			
01-12-2015 8:30	RSF10	6.76	21.10			1.05			
01-12-2015 8:30	RSF11	6.78	21.80			1.27			
01-12-2015 8:30	RSF12	6.78	23.10			0.83			
01-12-2015 8:30	RSF13	6.84	22.90			0.66			
01-12-2015 8:30	RSF14	6.72	22.90			1.52			
01-12-2015 8:30	RSF15	6.69	23.10			1.05			
01-12-2015 8:30	RSF16	6.73	23.10			0.93			
01-12-2015 8:30	RSF17	6.75	22.90			0.24			
01-12-2015 8:30	RSF18	6.81	22.80			1.28			
01-12-2015 8:30	RSF19	6.77	22.70			0.86			
01-12-2015 8:30	RSF20	6.89	22.90			0.24			
01-12-2015 8:30	Effluent	6.73	23.40			1.38			
01-12-2015 12:00	influent	7.02	22.50			32.00	88.00	0.3747	0.3835
01-12-2015 12:00	Acc1	6.98	22.60			4.32	57.00	0.3773	0.3830
01-12-2015 12:00	Acc2								
01-12-2015 12:00	Acc3	6.96	21.90			8.95	75.00	0.3755	0.3830
01-12-2015 12:00	Acc4	6.94	22.30			8.71	86.00	0.3881	0.3967
01-12-2015 12:00	RSF1	6.85	23.50			1.10			
01-12-2015 12:00	RSF2	6.79	23.20			0.99			
01-12-2015 12:00	RSF3	6.76	23.60			0.05			
01-12-2015 12:00	RSF4	6.72	23.80			0.19			
01-12-2015 12:00	RSF5	6.78	23.50			0.07			
01-12-2015 12:00	RSF6	6.77	22.60			0.88			
01-12-2015 12:00	RSF7	6.74	22.70			1.10			
01-12-2015 12:00	RSF8	6.82	23.00			1.07			
01-12-2015 12:00	RSF9	6.80	23.20			0.44			
01-12-2015 12:00	RSF10	6.75	22.50			low			
01-12-2015 12:00	RSF11	6.75	23.30			0.65			
01-12-2015 12:00	RSF12	6.77	22.90			0.05			
01-12-2015 12:00	RSF13	6.75	23.60			0.09			
01-12-2015 12:00	RSF14	6.77	22.80			0.10			

01-12-2015 12:00	RSF15	6.81	22.30			0.06			
01-12-2015 12:00	RSF16	6.79	22.50			0.28			
01-12-2015 12:00	RSF17	6.78	23.60			0.33			
01-12-2015 12:00	RSF18	6.76	23.80			0.19			
01-12-2015 12:00	RSF19	6.79	23.50			0.47			
01-12-2015 12:00	RSF20	6.85	23.50			0.21			
01-12-2015 12:00	Effluent	6.83	23.40			0.31			
02-12-2015 8:30	influent	6.95	23.70			37.00	100.00	0.3717	0.3817
02-12-2015 8:30	Acc1	6.90	23.00			3.09	60.00	0.3760	0.3820
02-12-2015 8:30	Acc2	6.88	23.50			2.09	61.00	0.3780	0.3841
02-12-2015 8:30	Acc3	6.81	23.00			4.08	31.00	0.3857	0.3888
02-12-2015 8:30	Acc4	6.75	23.10			3.04	31.00	0.3844	0.3875
02-12-2015 8:30	RSF1	6.76	21.90			0.12			
02-12-2015 8:30	RSF2	6.75	22.60			0.39			
02-12-2015 8:30	RSF3	6.73	22.30			0.40			
02-12-2015 8:30	RSF4	6.77	23.00			1.60			
02-12-2015 8:30	RSF5	6.73	22.90			0.58			
02-12-2015 8:30	RSF6	6.74	22.90			0.36			
02-12-2015 8:30	RSF7	6.71	22.50			0.40			
02-12-2015 8:30	RSF8	6.72	22.20			0.29			
02-12-2015 8:30	RSF9	6.74	22.30			0.34			
02-12-2015 8:30	RSF10	6.74	21.00			low			
02-12-2015 8:30	RSF11	6.74	22.70			0.53			
02-12-2015 8:30	RSF12	6.76	22.10			0.43			
02-12-2015 8:30	RSF13	6.76	20.80			1.23			
02-12-2015 8:30	RSF14	6.74	21.40			0.62			
02-12-2015 8:30	RSF15	6.76	22.00			0.85			
02-12-2015 8:30	RSF16	6.72	21.60			low			
02-12-2015 8:30	RSF17	6.69	21.50			0.04			
02-12-2015 8:30	RSF18	6.65	21.90			0.32			
02-12-2015 8:30	RSF19	6.73	20.00			0.24			
02-12-2015 8:30	RSF20	6.70	21.90			0.75			
02-12-2015 8:30	Effluent	6.68	20.30			0.74			
02-12-2015 11:30	influent	6.91	23.20			28.60	105.00	0.3716	0.3821
02-12-2015 11:30	Acc1	6.92	23.10			2.88	68.00	0.3717	0.3785
02-12-2015 11:30	Acc2	6.92	23.30			1.88	82.00	0.3866	0.3948
02-12-2015 11:30	Acc3	6.75	22.80			2.61	82.00	0.3804	0.3886
02-12-2015 11:30	Acc4	6.70	23.20			3.88	76.00	0.3712	0.3788
02-12-2015 11:30	RSF1	6.63	21.80			low			
02-12-2015 11:30	RSF2	6.65	22.30			0.67			
02-12-2015 11:30	RSF3	6.68	22.30			0.48			
02-12-2015 11:30	RSF4	6.66	22.40			0.34			
02-12-2015 11:30	RSF5	6.63	22.20			0.05			
02-12-2015 11:30	RSF6	6.69	22.30			1.12			
02-12-2015 11:30	RSF7	6.73	22.40			0.34			

02-12-2015 11:30	RSF8	6.68	24.20			0.28			
02-12-2015 11:30	RSF9	6.69	22.50			0.07			
02-12-2015 11:30	RSF10	6.70	22.90			0.80			
02-12-2015 11:30	RSF11	6.64	22.10			0.06			
02-12-2015 11:30	RSF12	6.67	21.80			low			
02-12-2015 11:30	RSF13	6.67	22.20			0.18			
02-12-2015 11:30	RSF14	6.68	22.20			low			
02-12-2015 11:30	RSF15	6.68	21.90			low			
02-12-2015 11:30	RSF16	6.70	20.80			low			
02-12-2015 11:30	RSF17	6.69	22.10			low			
02-12-2015 11:30	RSF18	6.71	21.90			low			
02-12-2015 11:30	RSF19	6.72	22.10			0.36			
02-12-2015 11:30	RSF20	6.73	22.40			2.28			
02-12-2015 11:30	Effluent	6.73	21.80			low			
03-12-2015 9:30	influent	6.85	19.60			54.20	60.00	0.3809	0.3869
03-12-2015 9:30	Acc1	6.76	20.30			24.90	38.00	0.3729	0.3767
03-12-2015 9:30	Acc2	6.76	20.80			25.40	43.00	0.3702	0.3745
03-12-2015 9:30	Acc3	6.75	21.40			21.40	15.00	0.3796	0.3811
03-12-2015 9:30	Acc4	6.78	20.10			22.30	17.00	0.3724	0.3741
03-12-2015 9:30	RSF1	6.75	23.00			6.27			
03-12-2015 9:30	RSF2	6.74	22.90			3.79			
03-12-2015 9:30	RSF3	6.76	23.20			10.60			
03-12-2015 9:30	RSF4	6.75	22.90			13.20			
03-12-2015 9:30	RSF5	6.79	22.10			9.00			
03-12-2015 9:30	RSF6	6.79	22.00			20.10			
03-12-2015 9:30	RSF7	6.80	22.70			20.20			
03-12-2015 9:30	RSF8	6.76	22.70			16.60			
03-12-2015 9:30	RSF9	6.77	23.00			20.00			
03-12-2015 9:30	RSF10	6.75	22.70			11.80			
03-12-2015 9:30	RSF11	6.77	23.10			9.57			
03-12-2015 9:30	RSF12	6.76	22.70			11.00			
03-12-2015 9:30	RSF13	6.75	23.10			9.75			
03-12-2015 9:30	RSF14	6.74	23.00			8.05			
03-12-2015 9:30	RSF15	6.75	22.80			10.60			
03-12-2015 9:30	RSF16	6.74	22.80			3.63			
03-12-2015 9:30	RSF17	6.73	22.20			7.73			
03-12-2015 9:30	RSF18	6.76	22.30			5.33			
03-12-2015 9:30	RSF19	6.78	22.00			0.95			
03-12-2015 9:30	RSF20	6.75	22.90			4.49			
03-12-2015 9:30	Effluent	6.74	22.60			13.40			
03-12-2015 13:15	influent	6.95	23.40			69.20	127.00	0.3777	0.3904
03-12-2015 13:15	Acc1	6.85	23.00			21.70	9.00	0.3910	0.3919
03-12-2015 13:15	Acc2	6.83	23.30			20.10	17.00	0.4002	0.4019
03-12-2015 13:15	Acc3	6.79	23.00			20.40	11.00	0.3884	0.3895
03-12-2015 13:15	Acc4	6.75	22.90			25.70	67.00	0.3785	0.3852

03-12-2015 13:15	RSF1	6.72	22.60			19.50			
03-12-2015 13:15	RSF2	6.71	23.00			13.50			
03-12-2015 13:15	RSF3	6.72	23.30			9.47			
03-12-2015 13:15	RSF4	6.72	22.70			15.20			
03-12-2015 13:15	RSF5	6.72	22.80			16.40			
03-12-2015 13:15	RSF6	6.74	22.70			12.10			
03-12-2015 13:15	RSF7	6.74	22.60			6.02			
03-12-2015 13:15	RSF8	6.76	22.60			16.00			
03-12-2015 13:15	RSF9	6.74	22.70			8.53			
03-12-2015 13:15	RSF10	6.75	22.70			20.60			
03-12-2015 13:15	RSF11	6.70	22.50			14.30			
03-12-2015 13:15	RSF12	6.70	23.00			10.10			
03-12-2015 13:15	RSF13	6.67	22.80			19.70			
03-12-2015 13:15	RSF14	6.65	22.80			14.00			
03-12-2015 13:15	RSF15	6.64	22.40			18.30			
03-12-2015 13:15	RSF16	6.66	22.60			20.10			
03-12-2015 13:15	RSF17	6.65	22.70			16.40			
03-12-2015 13:15	RSF18	6.68	23.10			16.70			
03-12-2015 13:15	RSF19	6.71	23.00			9.65			
03-12-2015 13:15	RSF20	6.68	23.00			14.60			
03-12-2015 13:15	Effluent	6.75	22.30			18.40			