3.4.2 Design Spare Capacity of Sandpocket Ciponyo I & II

It is necessary to secure the spare capacity of sandpocket corresponding to the annual accumulated volume, by excavation or dike raising for the purpose of disaster prevention by accumulated sediment in the sandpocket Ciponyo and Ciponyo II shown in Table - 3.4.

(1) Design Runoff Sediment Volume by Flood

Generally, the design runoff sediment volume in the sediment control plan should be established in consideration of the design yield sediment volume that flowed from the sediment yield area of the upper basin and control volume by river channel.

The survey materials concerning the sediment runoff around S. Ciloseh, S. Cisaruni, S. Cimerah and other basins are not sufficient. Accordingly, in this study, the design runoff sediment volume of each basin is determined on the basis of the sediment runoff materials concerning the debris flow area at the volcanic product zone in "Technical Standard of Rivers and Sabo Engineering Ministry of Construction in Japan".*)

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*) "Technical Standard of Rivers and Sabo Engineering Ministry of Construction in Japan"

Chapter 4, 2.4.2 Design Runoff Sediment Volume (D.R.S.V)

If there is no debris flow data of the objective area, and no expectation of the occurrence of the land slide type - large scale breaking, DRSV will be decided consulting the following figures.

Debris flow zone, standard area = 1 km^2

1) Granite zone ; 50,000 - 150,000 m^3/km^2/flood
2) Volcanic product zone ; 80,000 - 200,000 m^3/km^2/flood
3) Tertiary zone ; 40,000 - 100,000 m^3/km^2/flood
4) Shuttered zone ; 100,000 - 200,000 m^3/km^2/flood
5) Other zone ; 30,000 - 80,000 m^3/km^2/flood

If the catchment area is 10 times the standard area, 0.5 times the above figures will be used, and if the catchment area is 0.1 times the standard area, 3 times the above figures will be used. (From Department of Sabo, River Bureau, Ministry of Construction)

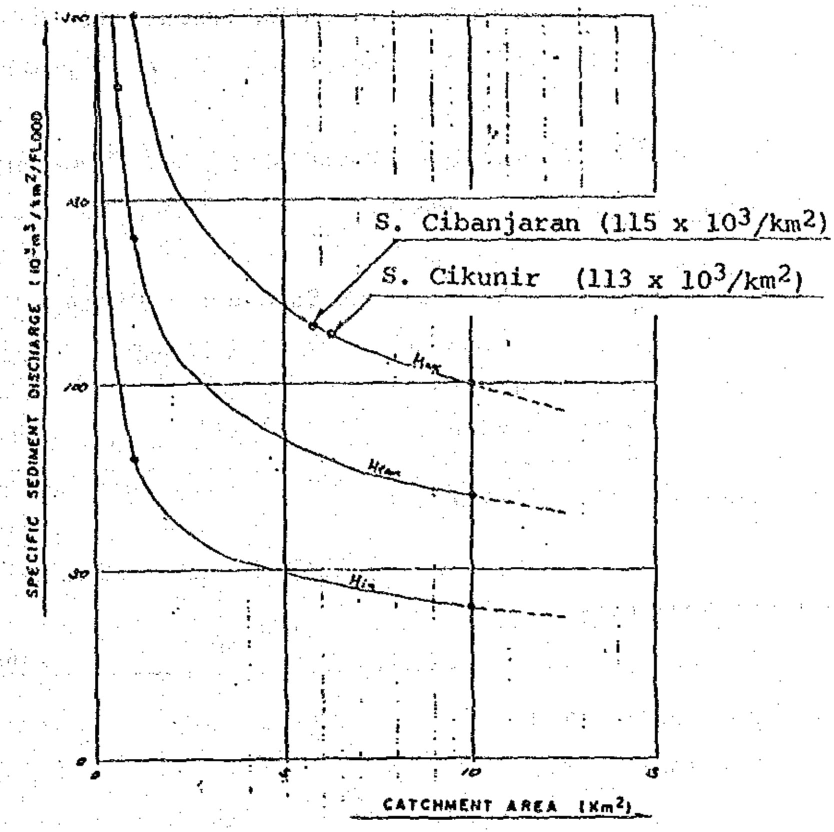
The V shaped valley area of the river is regarded as the debris flow source area (hereinafter referred to as "the sediment yield area") in this study.

The design runoff sediment volume by flood (DRSV) for S. Cibanjaran is calculated by using the maximum value of specific runoff sediment shown in Fig. - 3.5.

The results are shown in Table - 3.5.

Table - 3.5 Design Runoff Sediment Volume of by Flood in S. Cikunir S. Cibanjaran Area

	Debris Flow Source Area (km^2)	Specific Runoff Sediment Volume (10^3 m^3/km^2)	Runoff Sediment Volume by Flood (10^3 m^3)
S. Cibanjaran	5.76	115	662
S. Cikupang	6.35	113	718
Total	12.11		1,380



Source: "Technical Standard of Rivers and Sabo Engineering
Ministry of Construction in Japan"

Fig. - 3.5 Specific Sediment Runoff of Debris Flow

(2) Design Spare Capacity for Sandpocket Ciponyo I and Ciponyo II

From a viewpoint of the disaster prevention, the design spare capacity (DSC) is basically defined as the capacity which is able to control the following year's annual accumulated sediment volume decreases every year in a long period. (refer to Fig. - 3.3, Table - 3.4).

The actual accumulated sediment volume is considered to fluctuate irregularly around the volume shown in Fig. - 3.3, because of influences of rainfall which occurred irregularly.

DSC for sandpockets is established by taking into account the 10% surplus of the mean annual accumulated sediment volume (1,236 10^3 m^3) from August, 1985 to August, 1987.

Furthermore, the volume mentioned above is able to regulate the runoff sediment volume (1,380 10^3 m^3) by flood in a return period of 50 years.

The design spare capacity for sandpocket Ciponyo I and Ciponyo II is shown as follows:

Table - 3.6 Design Spare Capacity of Sandpocket Ciponyo I & II

Annual Accumulated Sediment Volume from August 1985 to August 1987 (10^3 m^3/year) (1)	1,236
Design Spare Capacity (2) = (1) x 1.1 (10^3 m^3)	1,400
Runoff Sediment Volume by flood (3) (10^3 m^3/flood)	1,380

Notes: (1) See Table - 3.3

(3) See Table - 3.5

3.4.3 Design Management Sediment Volume in Sandpocket Ciponyo I and Ciponyo II

To maintain the spare capacity of the sandpocket, the total volume of design annual accumulated sediment and design spare capacity will be excavated for 10 years.

The total volume is called "Design management sediment volume."

The design management sediment volume (DMSV) for the excavation of the disaster prevention plan is formularized as follows;

$$V_{te}\ (T) = C_{ds} + V_d\ (T) \quad \cdots\cdots\cdots\cdots \quad (3.2)$$

$$V_{ae}\ (T) = V_{de}\ (T)/T \quad \cdots\cdots\cdots\cdots \quad (3.3)$$

where;

T	:	Proposed excavation period (year)
$V_{te}\ (T)$	:	Total design excavation volume during T (m^3)
C_{ds}	:	Design spare capacity (m^3)
$V_d\ (T)$	:	Total design accumulated volume during T (m^3)
$V_{ae}\ (T)$	:	Design average annual excavation volume (m^3)

The design management sediment volume for the management period of 10 years, 15 years form 1988 is calculated as Table - 3.7.

The relationship between design accumulated sediment volume and the average annual management sediment volume is described as Fig. - 3.6, if the annual management volume is to be supposed as the constant in the excavation period.

From Fig. - 3.6 the accumulated volume in the sandpocket Ciponyo I Dalam is larger than design management sediment volume in the period of 2 - 3 years from starting of excavation. Therefore, it is necessary that the excess sediment for the design excavation sediment is transferred temporarily to a dead water area of the sandpocket.

In the excavation plan for maintenance of sandpockets, the design average annual excavation sediment including the excess sediment for design excavation sediment in the sandpocket Ciponyo I Dalam are excavated.

Table - 3.7 Design Management Sediment Volume of Sandpocket Ciponyo I & II

Proposed Management Period	From 1988 till 1997	From 1988 till 2002	From 1988 till 2007
Number of Management Years (Years)	10	15	20
Design Spare Capacity (10^3 m^3)	1,400	1,400	1,400
Design Accumulated Sediment Volume (10^3 m^3)	4,741	5,601	6,194
Management Sediment Volume (10^3 m^3)	6,141	7,001	7,594
Annual Management Sediment Volume (10^3 m^3/year)	600	470	380
Excess Sediment Volume for Annual Management Sediment Volume (10^3 m^3)	345	706	1,094

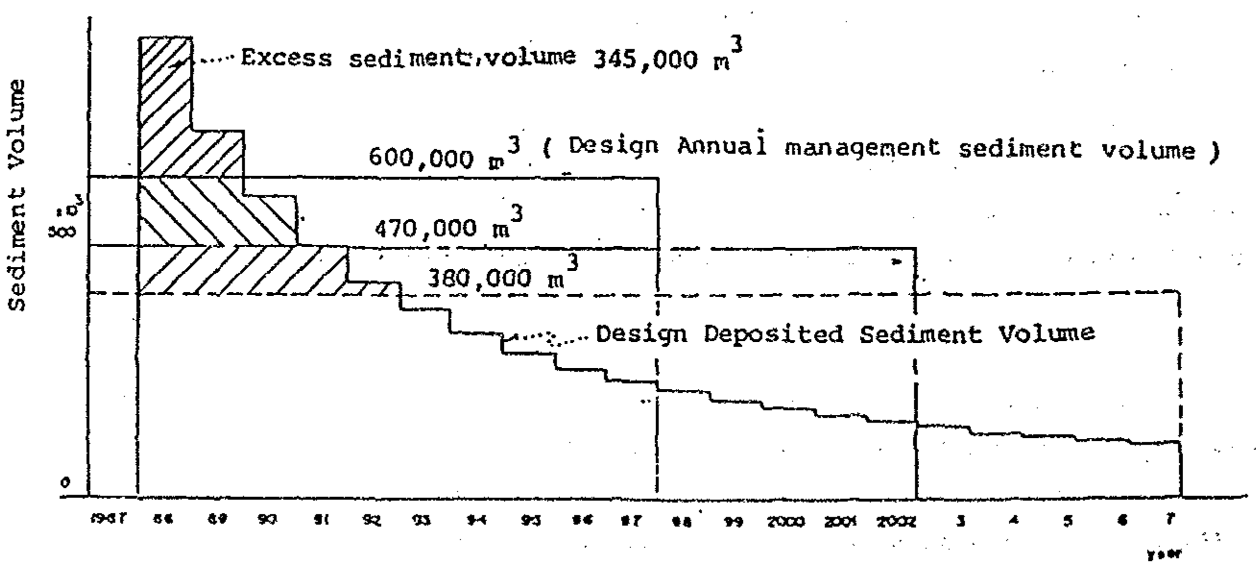


Fig. - 3.6 Annual Management Sediment Volume of Sandpocket Ciponyo I & II

According to the Table - 3.7, the longer the project period (proposed management period), the larger excess sediment volume. The project period was set for ten (10) years and design annual management sediment volume was set for 614,000 m^3 by following reason.

i) In consideration of the size of sandpocket, the design annual management sediment volume of 614,000 m^3 is the maximum volume for the execution of work.

ii) The longer the management period of sediment, the smaller the economic benefits from the view point of disaster prevention.

iii) It is necessary to assure the spare capacity of the sandpocket for the large scale runoff of the sediment accumulated in the S. Cikunir area due to the eruption.

The design management sediment volume of sandpocket Ciponyo I and Ciponyo II area is shown as follows;

a.	Design management sediment volume for ten (10) years;	6,141 m^3 (a = b + c)
b.	Design accumulated sediment volume	; 4,741,000 m^3
c.	Design spare capacity	; 1,400,000 m^3

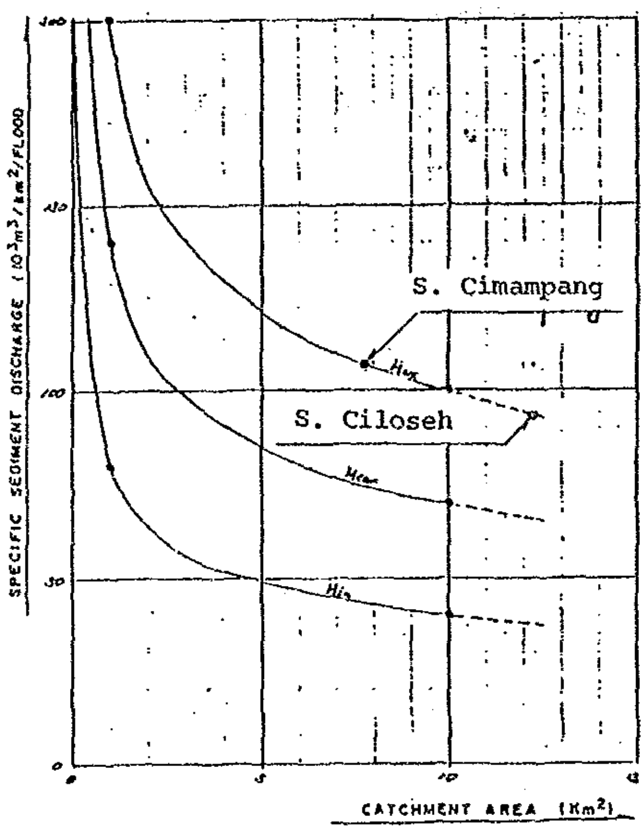
3.5 Design Management Sediment Volume in S. Ciloseh - S. Cimampang Area

The sediment control plan in S. Cilosh - S. Cimampang Basin has decided to decrease design runoff sediment volume to less than the design allowable runoff sediment volume (DARSV) at the reference point.

3.5.1 Design Runoff Sediment Volume by Flood

The V shaped valley section of the river is regarded as the debris flow source area. DRSV for S. Ciloseh - S. Cimampang areas is calculated by using the maximum value of specific runoff sediment as shown in Fig. - 3.7.

The results are shown in Table - 3.8.



Source: "Technical Standard of Rivers and Sabo Ministry of Construction in Japan"

Fig. - 3.7 Specific Sediment Runoff of Debris Flow

Table - 3.8 Design Runoff Sediment Volume by Flood in S. Ciloseh - S. Cimampang Area

	Debris Flow Source Area (km^3)	Specific Runoff Sediment Volume (10^3 m^3/km^2)	Design Runoff Sediment Volume by Flood (10^3 m^3)
Ciloseh	12.35	93	1,149
Cimampang	7.79	105	820
Total (Negla)	20.14		1,969

3.5.2 Design Allowable Sediment Volume by Flood

The allowable sediment volume of S. Ciloseh - S. Cimampang area is quoted from the result of calculations of runoff sediment (50 year return period) at the reference point decribed in "SUPPORTING REPORT (I)", and summarized in Table - 3.9.

The allowable sediment volume of S. Ciloseh - S. Cimampang area is relatively small compared with DRSV. Therefore, the design allowable sediment volume of S. Ciloseh - S. Cimampang area is neglected in this study and the design excess sediment volume (DESV) is assumed to be same volume as DRSV.

Table - 3.9 Allowable Sediment Volume

	Name of Reference Point	Catchment Area (km^2)	Allowable Sediment Volume (10^3 m^3)	Remarks
(1)	Cimampang	14.56	55	Sub Base Point
(2)	Negla	32.07	78	Sub Base Point
I	Ciloseh Bridge	38.16	84	
II	Tasikmalaya	63.64	79	

3.5.3 Design Management Sediment Volume of S. Ciloseh - S. Cimampang Area

The total volume of the runoff sediment by flood shown in Table - 3.8 is called as "Design control sediment volume (DCSV)".

To secure the storage capacity of sandpockets for DCSV, the same volume of accumulated sediment in sandpocket (Negla and Cimampang) as DCSV shall be excavated.

The management period of sandpocket Negla and Cimampang is established 10 years as well as sandpocket Ciponyo I.

DMSV for 10 years is calculated as 394 x 10^3 m^3 by using formula shown below. The design annual management sediment volume (DAMSV) is set up as 40 10^3 m^3/year. (see Table - 3.10)

$$V_d\ (T) = V_c \times W \times T$$

where;

V_d (T) ; Design management sediment volume during T years (m^3)
T ; Management Period = 10 years
V_c ; *Design control sediment volume = 1,969,000 m^3*
W ; Probability of sediment runoff = 1/50

Table - 3.10 Design Management Sediment Volume for the Sandpocket Cimampang & Negla

Design Control Sediment Volume (10^3 m^3)	(1)	1,969
Design Management Period (Years)	(2)	10
Design Management Sediment Volume (10^3 m^3/10 years)	(3)	394
Design Annual Management Sediment Volume (10^3 m^3/year)	(4)	40

3.6 Design Control Sediment Volume of the Southern Slope Area

The sediment control plan in the Southern Slope Basin has decided to decrease design runoff sediment volume (DRSV) to less than design allowable sediment volume (DASV) at the reference point.

3.6.1 Target Rivers of Sediment Control Plan

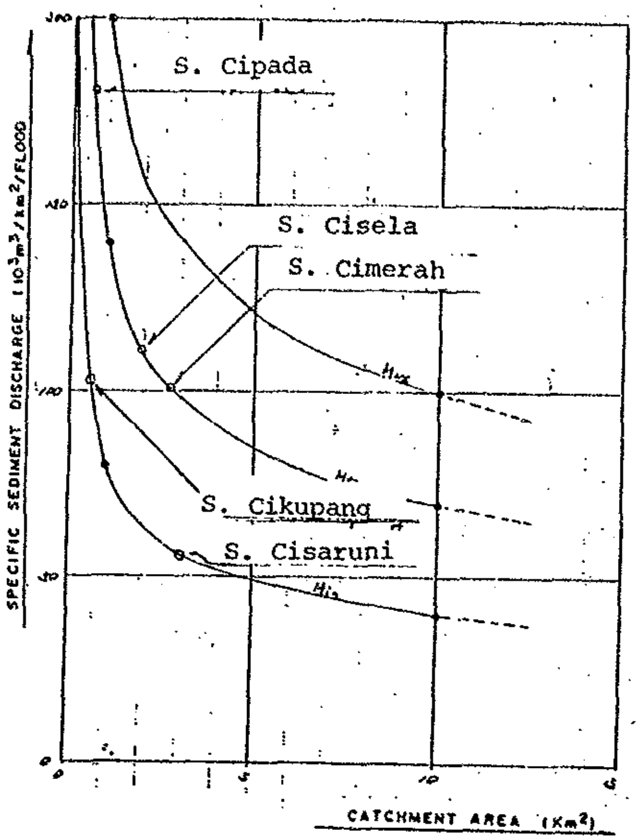
A. Cisaruni, S. Cikupang and S. Cimerah are adopted as the target rivers of the sediment control plan in Disaster Prevention Plan.

Because, in accordance with the results of the field investigation, the rivers which have unstable sediment on the riverbed or the sediment runoff by the bank erosion is large, are the three (3) rivers, the S. Cisaruni, S. Cikupang and S. Cimerah.

3.6.2 Design Runoff Sediment Volume by Flood

The V shaped valley area of river is regarded as the bebris flow source area. Considering the present sediment condition of the river, DRSV for the rivers in the Southern Slope Basin is calculated using the mean value or minimum value of specific runoff sediment shown in Fig. - 3.8.

The results are shown in Table - 3.11.



Source: "Technical Standard of Rivers and Sabo Ministry of Construction in Japan"

Fig. - 3.8 Specific Sediment Runoff of Debris Flow

Table - 3.11 Design Runoff Sediment Volume by Flood Southern Slope Basin

Name of Rivers	Name of Point	Debris Flow Source Area (km^2)	Specific Run off Sediment Volume (10^3 m^3/km^2)	Design Runoff Sediment Volume (10^3 m^3)
S. Cisaruni	Nagrag	3.01	56	169
S. Cikupang	Kondang	0.61	104	63
S. Cimerah	Cimerah (Meeting Point of Cikunten I)	2.69	101	272
	Cipada (Meeting Point of S. Cimerah)	0.56	181	101
	Cisela (Meeting Point of S. Cimerah)	1.98	111	220
	Total (Bojongpal)	-	-	593

3.6.3 Design Allowable Sediment Volume by Flood

The sediment transportation capability at the reference point was calculated by using Mayer-Peter-Müller formula. The purpose of this calculation is to set design allowable sediment volume (DASV) (50 years return period) to be used in the sediment control plan.

The specification for calculation of the sediment transportation capability by flood are shown in Table - 3.12. The results of calculation are shown in Table - 3.13.

Table - 3.12 Specification for calculation of the sediment transportation capability

Name of River		S. Cisaruni	S. Cikupang	S. Cimerah
Name of Reference Point		Nagrag	Kondang	Bojongpel
Catchment Area (km^3)		6.26	3.40	10.95
Gradient of Riverbed		0.0211	0.0206	0.0203
Width of River (m)		30	25	20
Riverbed	Specific Gravity	2.70	2.70	2.70
Materials	Dry Density	1.71	1.71	1.71
	Porosity	0.38	0.38	0.38
	Mean Diameter	12 mm	15 mm	15 mm

Note: See "SUPPORTING REPORT (I) Chapter 6."

Table - 3.13 Sediment Transportation Capability by Flood (Design Allowable Sediment Volume)

Name of River	Name of Base Point	Catchment Area (km^2)	Design Allowable Sediment Volume (10^3 m^3)
S. Cisaruni	Nagrag	6.25	35
S. Cikupang	Kondang	3.40	17
S. Cimerah	Bojongampel	10.95	59

3.6.4 Design Excess Sediment Volume by Flood

The sediment control plan has decided to decrease DRSV to less than DASV at the reference point.

Design excess sediment volume (DESV) is volume to be an object of the sediment control plan, and to be sought at each reference point by subtracting DARSV from DRSV.

DESV of the rivers flowed in the southern slope of Mt. *Galunggung* is shown in Table - 3.14.

Table - 3.14 Design Excess Sediment Volume by Flood

Name of River	Name of Reference Point	Catchment Area (km^2)	Design Runoff Sediment Volume (10^3 m^3) (1)	Design Allowable Sediment Volume (10^3 m^3) (2)	Design Excess Sediment Volume (10^3 m^3) (3)=(1)-(2)
S. Cisaruni	Nagrag	6.26	169	35	134
S. Cikupang	Kondang	3.40	63	17	46
S. Cimerah	Bojongpel	10.95	593	59	534

3.7 Sabo Facilities Plan

3.7.1 Basic Principles

The Sabo facilities plan was decided after consideration of the design excess sediment volume determined in the sediment control analysis and the actual conditions of the existing Sabo facilities such as the sandpockets, the check dams, etc. to have been obtained in the 1st work in Indonesia from July to November, 1987. The Sabo facilities plan includes the construction of the new facilities, improvement of the existing facilities and its rehabilitation.

The establishment method of the design flood discharge, the design excess sediment volume and the sediment control function of the Sabo facilities which are the fundamentals for the facility plan are shown as follows.

(1) Fundamental Items for the Determination of the Facility Plan

The fundamental items for the determination of the facility plan are shown in Table - 3.15 and Table - 3.16 according to the result of the hydrological analysis as well as the sediment control analysis.

Table - 3.15 Design Management Sediment Volume of Sandpockets

Area	S. Cikunir Area	S. Ciloseh Area
Kind of Sediment Runoff for Sediment Control Plan	Annual Sediment Runoff	Sediment Runoff by Flood
Name of Sandpocket	Ciponyo I & Ciponyo II	Cimampang & Negla
Design Management Sediment Volume	6,141,000 m /10 years (600 m^3/Years)	394,000 m /10 Years (40,000 m^3/Years)

Table - 3.16 Fundamental Items for Disaster Prevention Plan

Name of Area	Kind of Sediment Runoff for Sediment Control Plan	Name of River	Name of Reference Point (refer to Fig. - 3.2)	Catchment Area A (km^2) (1)	Design Runoff Sediment Volume by Flood (10^3 m^3) (2)	Design Runoff Allowable Volume by Floor (10^3 m^3) (3)	Design Excess Sediment Volume (10^3 m^3) (4)=(2)-(3)	Design *1 Flood Discharge (m^3/s) (5)	Remarks
S. Cikunir-S. Cibanjaran Area	Annual Sediment Runoff	S. Cikunir	3 Kokoncong	7.11	662	-	662	175	
		S. Cibanjaran	4 Sinagar	6.77	718	-	718	169	
		S. Cikunir	III Cikunir Bri.	24.66	1,380	-	1,380	419	
		S. Cikunir	IV Bojongparang	84.22	1,380	-	1,380	1,036	
S. Ciloseh - S. Cimampang Area	Sediment Runoff by Flood	S. Ciloseh	Ciloseh	16.93	1,149	-	-	324	
		S. Cimampang	1 Cimampang	14.56	820	-	-	277	
		S. Ciloseh	2 Negla	32.07	1,969	-	1,969	558	
		S. Ciloseh	1 Ciloseh Bri	38.16	1,969	-	1,969	558	
		S. Ciloseh	II Tasikmalayaya	63.64	1,969	-	1,969	717	
Southern Slope Basin	Sediment Runoff by Flood	S. Cisaruni	VI Nagrag	6.26	169	35	134	176	
		S. Cikupang	VIII Kondang	3.40	63	17	46	81	
		S. Cimerah	Cimerah	4.71	272	-	-	124	
		S. Cipada	Cipada	2.49	101	-	-	81	
		S. Cisela	Cisela	3.21	220	-	-	90	
		S. Cimerah	X Bojongpel	10.95	593	59	534	225	

*) See "SUPPORTING REPORT (I) Chapter 5"
Design Flood Discharge including runoff sediment (sediment concentration Cs = 5%)

(2) Sediment Control Function by Sabo Facilities

The effect of the Sabo facilities is sought as the sum of the volume of the sediment control function. The sediment control function consists of the suppression of sediment yield, the regulation of sediment runoff and the sediment transportation by flow.

The design sedimentation gradient and the design riverbed gradient in flood at the check dam and the consolidation dam are decided as follows using the longitudinal profile of river.

$$Id = (1/2) \times Io$$
$$If = (2/3) \times Io \quad \cdots\cdots (3.4)$$

Where:

Id ; Design sedimentation gradient
If ; Design riverbed gradient in flood
Io ; Original riverbed gradient

The design sediment storage volume (Vs), the design runoff sediment regulation volume (Vrr) and the design yield sediment suppression volume (Vys) are calculated by the average section formula method using the lateral profile of river.

The design yield sediment suppression volume is to be the unstable materials volume under the design sedimentation line, and it is mentioned below.

$$V_{ys} = t * A \quad \cdots\cdots (3.5)$$

Where,

V_{ys} ; Design yield sediment suppression volume (m^3)

t ; Thickness of unstable materials of banks and riverbed (m)

S. Ciloseh - S. Cimampang Area t = 2 m

S. Cikunir - S. Cibanjaran Area t = 3 m

Southern Slope Area t = 1 m

A ; Design sedimentation area (m^2)

Among the sediment control function calculated as above, effective sediment volume for the design control sediment volume in the disaster prevention plan are shown as follows.

In case of check dam ;

$$Vc = Vrr + Vys \quad \text{.......................} \quad (3.6)$$

In case of consolidation dam ;

$$Vc = Vys \quad \text{.............................} \quad (3.7)$$

Where,

Vc ; Design sediment control volume

Vrr ; Design runoff sediment regulation volume

Vys ; Design yield sediment suppression volume

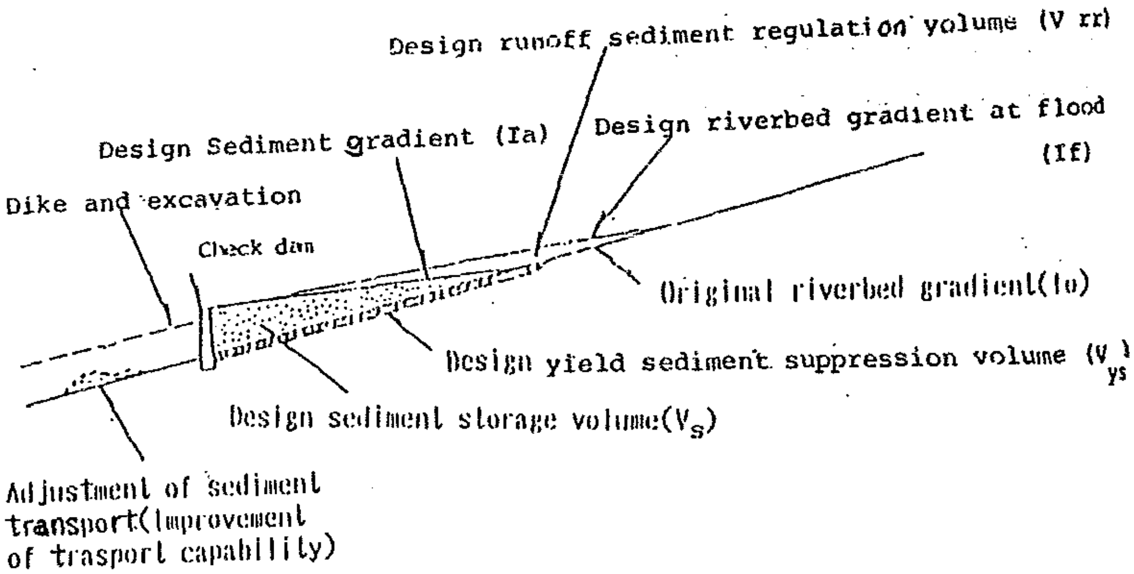


Fig. - 3.9 Sediment Control Function by Sabo Facilities

(3) Design Sediment Storage Volume in Sandpockets

The design sediment storage volume in sandpockets is decided in consideration of the actual conditions of the lateral and longitudinal form of the accumulated sediment.

3.7.2 Facility Plan in S. Cikunir - S. Cibanjaran Area

About 9,500 thousand m^3 of the ejected materials by the 1982 volcanic activities remain on the hillside and in the river channel at S. Cikunir - S. Cibanjaran area. They become the source of the sediment yield and a large quantity of sediment is still running off now. A part of this sediment runoff is accumulated in the sandpocket. The total sediment volume that will be accumulated in the sandpocket during the 10 year period from September, 1987 to December, 1997 is estimated at 4,741 thousand m^3 (see to Table - 3.7).

Though the appearance spare capacity of existing Sandpocket Ciponyo I and II is estimated as 2,369 thousand m^3, the actual spare capacity is 631 thousand m^3 by taking into consideration the excess accumulated sediment volume (1,738 thousand m^3). (refer to Table - 3.17)

Table - 3.17 Spare Capacity

Name of Sandpocket		Spare Capacity (appearance) (1)	Excess Sediment volume (2)	Spare Capacity (actual) (3)=(1)-(2)
Ciponyo I	Dalam	1,508	1,079	429
	Luar	94	644	-550
	Total	1,602	1,723	-121
Ciponyo II		767	15	752
Total		2,369	1,738	631

Now, the some section of dike in Sandpocket Ciponyo I Dalam is under the dangerous condition from the viewpoint of disaster prevention.

The actual spare capacity of Ciponyo I Dalam to be located at the fan head of S. Cikunir and S. Cibanjaran has only 429 thousand m^3 of spare capacity for the design spare capacity of 1,400 thousand m^3.

At the existing dike itself, the degree of security of the disaster prevention decreases because of the scouring at toe of dike and the collapse of slope.

The Sabo facility plan at S. Cikunir - S. Cibanjaran area was decided as follows after the consideration of the above mentioned facts.

(1) Sand pocket Ciponyo I and its Upper Reaches

The Sabo facilities in Ciponyo I and its upper reaches will be planned by following three (3) countermeasures.

-; Assurance of the design management sediment volume in the sandpocket
-; Construction of check dam and consolidation dams
-; Improvement and rehabilitation of existing dikes

1) Assurance of the design management sediment volume in the sandpocket

As shown in Table - 3.7, the design management sediment volume in sandpocket Ciponyo I and Ciponyo II is 6,141,000 m^3 for ten years.

The greater parts of the runoff sediment from the upper area of the sandpocket area is assumed to be accumulated in the Ciponyo I Dalam area by considering the topographical location.

The target area for the assurance of the design management sediment volume was decided on the Ciponyo I Dalam sandpocket area.

The countermeasures are shown as follows;

a) Excavation and conveyance of sediment deposit in sandpocket
b) Raising of existing dikes in sandpocket

2) Construction of check dams and consolidation dams

When the large-scale sediment to the sandpocket occurs it is presumed that there will be an occurrence of the large scale aggradation and the breaking of dikes. The check dams and consolidation dams are arranged in order to the following objectives.

a. To decrease the runoff force of the large-scale sediment at the upper reaches of the sandpocket.
b. To regulate and stabilize the course of the debris flow at the top of fan in the sandpocket.
c. To decrease the sudden aggradation by the large-scale sediment runoff at the top of fan in the sandpocket.

The sediment control volume of the check dams and the consolidation dams shown in Table - 3.18 are not evaluated as the control effect for the annual sediment runoff volume. Because those sediment control volumes, fundamentaly, are only the temporary effect for the regulation of the annual sediment volume.

Table - 3.18 Check Dams and Consolidation Dams in Upper Reaches of Ciponyo I

Name of River	Name of Facility	Altitude of Construction Site (EL.m)	Control Sediment Volume (10^3 m^3)
	CKN-3	605	13.0
S. Cikunir	CKN-4	615	15.4
	CKN-5	630	17.7
	CBJ-3	605	36.1
S. Cibanjaran	CBJ-4	635	9.1
	CBJ-5	655	83.4
Total			174.7

3) Improvement and rehabilitation of existing dikes

The top of the dike in the sand partially is around 1.0 high from the accumulated line of sediment. Therefore, some sections are in danger of the overflow of the runoff sediment, and there are some sections where the toe scouring and the collapse of slope are arising.

Particularly, since the runoff sediment has accumulated so thickly on the cross dike on upper stream and the right side of Ciponyo I Dalam, there is less than 0.5 m left to the top of dike is some sections. This is dangerous from the viewpoint of disaster prevention.

The degree of a dike's security is heightened by the improvement of the dike as well as the arrangement of the groine and the slope protection works for such existing dike.

(2) Sandpocket Ciponyo II

The Sabo facilities in sand Pocket Ciponyo II are composed of following three (3) countermeasures.

-; Construction of consolidation dams
-; Improvement and rehabilitation of existing dikes
-; Construction of revetment works nearby the confluence of S. Cikunir and S. Cibanjaran

1) Construction of consolidation

The greater part of the runoff sediment from the upper reaches are accumulated in Sandpocket Ciponyo I, and a part of the fine materials flow down and are accumulated in sand Pocket Ciponyo II as the bed load or the suspension - load.

The latest accumulated sediment, Ciponyo II, is mainly found on S. Cikunir side and scarcely found on S. Cibanjaran side. The sediment deposit are on S. Cikunir side in the area of about 3.8 km from the place nearly 800 m up stream of the S. Cibanjaran confluence to the spillway point in Ciponyo I Luar. The width of accumulated sediment is 100-300 m in the lower reaches and 300-700 m in the upper reaches.

Thousands of people live in Ciponyo II and their number tends to increase. In particular, on S. Cibanjaran side, the restoration of farmland is proceeding as the sediment deposit is hardly found.

The water course on S. Cikunir side in the sandpocket changes every flood. This unstable change of the water course causes, not only the flood or the sediment runoff to the communities on the left bank side of S. Cikunir, but also the decreasing the security of dike by scouring the toe of right bank of S. Cikunir.

The following consolidation dams will be constructed in Ciponyo I so as to stabilize the watercourse (See Table - 3.19).

Table - 3.19 Consolidation Dam in Ciponyo II

Name of River	Name of Facility	Location	Objective of Construction Work
S. Cikunir	CKN-1 CKN-2	11k300 13k100	Stabilization of River Course
S. Cibanjaran	CBJ-1 CBJ-2	1k200 3k200	Stabilization of River Course

2) Improvement and rehabilitation of existing dikes

Some section of dikes are in a dangerous state because of the occurrence of the scouring of toe and the collapse of slope. Therefore the factor of security on dike will be heightened by the improvement of dike, the arrangement of the groine and the slope protection works.

3) Construction of revetment works nearby the confluence of S. Cikunir

In order to prevent the collapse of a riverbank near the confluence of S. Cikunir and S. Cibanjaran and to improve the sediment transport capability, the channel works which combines the revetment works will be executed.

3.7.3 Facility Plan in S. Ciloseh - S. Cimampang Area

The design excess sediment volume by flood of 1,969 thousand m^3 (see Table - 3.16) in S. Ciloseh - S. Cimampang Basin will be controlled not only by the existing sandpockets (Cimampang and Negla) but also by the series of check dams at the upper stream of the sandpocket.

The Sabo facilities are composed of the following three (3) countermeasures.

-; Construction of check dams
-; Assurance of design management sediment volume in sandpocket
-; Improvement and rehabilitation of existing dike

1) Construction of check dams

So as to control the sediment yield of unstable materials accumulated on the upper river channel and to decrease the sediment runoff force at the same time, the following check dams will be arranged in the upper reaches of S. Ciloseh and S. Cibanjaran.

Table - 3.20 Check Dam in S. Ciloseh and S. Cimampang

Name of River	Name of Facility	Altitude of Construction Site (EL.m)	Design Control Sediment Volume Volume (10^3 m^3)
S. Ciloseh	CLS-1	535	14.5
	CLS-2	555	23.4
	CLS-3	585	24.5
S. Cimampang	CMP-1	540	63.3
	CMP-2	590	22.5
Total			148.2

The sediment control volume of the check dams shown in Table - 3.20 are not evaluated as the control effect for the annual sediment runoff volume. Because the objective of those check dams is fundamentaly to decrease the sediment runoff force.

2) Assurance of design management sediment volume in sandpocket

The design excess sediment volume by flood of 1,969 thousand m^3 will be regulated in the existing sandpocket, Cimampang and Negla.

The design management sediment volume of the sandpocket will be ensured by either countermeasure mentioned below.

a) Excavation and conveyance of the accumulated sediment in the sandpocket

b) Raising of the existing dikes of the sandpocket.

Table - 3.21 Design Excavation Volume in Sandpocket Cimampang and Negla

Name of River	S. Cimampang	S. Ciloseh	Total
Amount Volume (10^3 m^3) (1)	820	1,149	1,969
Annual Excavation Volume (Excavation Period = 10 years). (10^3/m^3/years) (2) = (1) x 0.020	17	23	40

Note * Annual Excavation Volume = V x W/T

Where, V ; Design Excavation Volume = 1,969,000 m^3

W ; Provability of Sediment Runoff = 1/50 years

T ; Excavation Period = 10 years

3) Improvement and rehabilitation of existing dikes

At the right bank dike in the sandpocket, the factor of security on dike will be heightened by the improvement of the dikes section form and the arrangement of the groine and the place where the degree of security is low from the viewpoint of the disaster prevention because of the occurrence of the scouring of toe of dike, the collapse of the slope.

3.7.4 Facility Plan in Southern Slope Area

The design excess sediment volume of a 50 years return period in three (3) rivers of S. Cisaruni, S. Cikupang and S. Cimerah on the southern slope of Mt. Galunggung should be controlled by the series of check dams.

(1) S. Cisaruni Area

Five (5) check dams will be constructed in order to control the design excess sediment volume of 134 thousand m^3.

Table - 3.22 Check Dams in S. Cisaruni

Name of River	Name of Facility	Altitude of Construction Site (EL.m)	Design Control Sediment Volume Volume (10^3 m^3)
	CSR-1	535	11.5
	CSR-2	550	19.6
	CSR-3	590	48.8
	CSR-4	650	35.1
	CSR-5	710	19.0
Total			134.0

(2) S. Cikupang Area

Three (3) check dams will be constructed in order to control the design excess sediment volume of 46 thousand m^3.

Table - 3.23 Check Dams in S. Cikupang

Name of River	Name of Facility	Altitude of Construction Site (EL.m)	Design Control Sediment Volume Volume (10^3 m^3)
	CKP-1	545	6.0
	CKP-2	590	16.0
	CKP-3	630	24.0
Total			46.0

(3) S. Cimerah Area

In the S. Cimerah area, a check dam to control the sediment runoff volume from the upper stream devastated basin will be constructed.

Thirteen (13) check dams including existing one (1) check dam at S. Cimerah upper stream will be arranged in order to control the design excess volume of 534 thousand m^3.

Table - 3.24 Check Dams in S. Cikupang

Name of River	Name of Facility	Altitude of Construction Site (EL.m)	Design Control Sediment Volume Volume (10^3 m^3)
S. Cimerah	CMR-1	555	5.2
	CMR-2	585	10.8
	CMR-3*1	660	8.6
	CMR-4	680	165.7
	CMR-5	740	76.8
	CPD-1	680	40.3
	CPD-2	760	40.4
S. Cisela	CSL-1	555	5.0
	CSL-2	575	4.0
	CSL-3	610	9.4
	CSL-4	635	45.8
	CSL-5	780	81.3
	CSL-6	880	40.3
Total			534.4

Note; *1 Existing Facility

The sediment control effect by disaster prevention facilities for design excess sediment volume is summarized as shown in Table - 3.25.

Table - 3.25 Sediment Control Effects by Disaster Prevention Facilities in Southern Basin of Mt. Galunggung (Design Return Period = 50 Years)

River Basin	River Name & Reference Point	Catchment Area (km^2) (1)	Design Runoff Sediment Volume (10^3 m^3) (2)	Allowable Runoff Sediment Volume (10^3 m^3) (3)	Design Excess Sediment Volume (10^3 m^3) (4)=(2)-(3)	Sediment Control Effects by Facilities: Number of Sediment Control Facilities (5)	Sediment Control Effects by Facilities: Sediment Regulation Volume (10^3 m^3) (6)	Sediment Control Effects by Facilities: Sediment Suppresion Volume (10^3 m^3) (7)	Sediment Control Effects by Facilities: Total (10^3 m^3) (8)=(6)+(7)	Remarks
S.Cisaruni	VI Nagrang	6.26	169	35	134	5	107.1	26.9	134.0	
S. Cikupang	VII Kondang	3.40	63	17	46	3	29.5	17.5	46.0	
S. Cimerah	Cimerah	4.71	272	-	-	5	202.0	65.1	267.1*	
	Cipada	2.49	101	-	-	2	61.7	19.0	80.7	
	Cisela	3.21	220	-	-	6	140.6	45.6	186.2	
	X Bojongampel	10.95	593	59	534	13	-	-	534.0	

Note: Include the sediment control effects of existing check dam (8,600 m^3)

3.7.5 Design Control Sediment Volume by Check Dam

The control sediment volume by check dams and consolidation dams are shown in Table - 3.26.

The sediment control volume by check dams and consolidation dams in S. Coloseh, S. Cimampang, and S. Cikunir are not evaluated in this disaster prevention plan because the purpose of the construction of these check dams and consolidation dams are mainly to decrease the runoff force of the sediment and to stabilize the course of the debris flow at the top of fan in the sandpocket.

Table - 3.26 Design Control Sediment Volume of Check Dam and Consolidation Dam

Name of River	Name of Facility	Location	Sediment Storage F (m^3) (1)	Sediment Regulat. G (m^3) (2)	Sediment Reduct. J (m^3) (3)	Sediment *2 Control Volume (m^3) (2) + (3)
S. Ciloseh	CLS-1	20/000	7,400	6,000	8,500	-
	CLS-2	20/500	19,100	6,800	16,600	-
	CLS-3	21/400	15,500	8,900	15,600	-
Sub Total			42,000	21,700	40,700	-
S. Cimampang	CMP-1	2/800	61,600	34,900	28,400	-
	CMP-2	3/800	25,000	12,500	10,000	-
Sub Total			86,600	47,400	38,400	-
S. Cibanjaran	CBJ-3	7/860	25,000	-	36,100	-
	CBJ-4	8/160	4,300	1,700	7,400	-
	CBJ-5	8/660	46,700	43,800	39,600	-
Sub Total			75,700	54,800	83,100	-
S. Cikunir	CKN-3	17/510	5,000	-	13,000	-
	CKN-4	17/810	3,500	300	15,100	-
	CKN-5	18/010	7,000	5,000	12,700	-
Sub Total			15,500	7,200	40,800	-
S. Cisaruni	CSR-1	2/100	12,500	6,800	4,700	11,500
	CSR-2	2/600	24,500	12,800	6,800	19,600
	CSR-3	3/100	83,600	41,800	7,000	48,800
	CSR-4	3/500	60,400	30,200	4,900	35,100
	CSR-5	3/900	31,000	15,500	3,500	19,000
Sub Total			212,000	107,100	26,900	134,900
S. Cikupang	CKP-1	2/200	7,400	2,600	3,400	6,000
	CKP-2	3/200	31,600	9,100	6,900	16,000
	CKP-3	3/800	27,300	17,800	7,200	24,000
Sub Total			66,300	29,500	17,500	46,000
S. Cimerah	CMR-1	2/095	5,100	2,700	2,500	5,200
	CMR-2	3/410	16,400	6,300	4,500	10,800
	CMR-3*1	4/378	10,600	4,500	4,100	8,600
	CMR-4	5/000	349,100	127,300	38,400	165,700
	CMR-5	6/300	122,300	61,200	15,600	76,800
Sub Total			503,500	202,000	65,100	267,100
S.Cipada	CPD-1	2/100	61,600	30,800	9,500	40,300
	CPD-2	2/800	61,700	30,900	9,500	40,400
Sub Total			123,300	61,700	19,700	80,700
S. Cisela	CSL-1	2/000	4,700	2,500	2,500	5,000
	CSL-2	2/400	5,800	1,700	2,300	4,000
	CSL-3	3/000	13,300	5,100	4,300	9,400
	CSL-4	3/400	136,000	33,200	12,600	45,800
	CSL-5	4/000	134,700	67,300	14,400	81,700
	CSL-6	4/600	61,600	30,800	9,500	40,300
Sub Total			356,100	140,600	45,600	186,200

Note) *1 CMR-3 is the existing check dam
*2 Sediment Control Volume in S. Ciloseh, S. Cimampang, S. Cibanjaran and S. Cikunir have not been evaluated in this sediment control plan.

3.7.6 Design Peak Flood Discharge for Design of Sabo Facilities

(1) Magnitude of Plan

The magnitude for disaster prevention facilities is decided as the 50 year return period.

(2) Design Daily Rainfall

The design daily rainfall is decided as 250 mm/day (see SUPPORTING REPORT (I)).

(3) Design Peak Flood Discharge

The design peak flood discharge included sediment runoff volume was calculation by using Rational Formula and results are shown in Table - 3.27.

The method for calculation of rainfall intensity and peak discharge are as follows;

a) Rainfall Intensity

$$r = \frac{R_{24}}{24} \left(\frac{24}{T}\right)^{2/3} \quad \text{.......................... .... (3.8)}$$

Where;

r = Rainfall intensity (mm/hr)
R_{24} = Daily rainfall (mm)
T = Concentration time (hr)
(by Kraven method)

b) Peak Water Flood Discharge

$$Qw = \frac{1}{3.6} \cdot f \cdot r \cdot A \quad \text{................} \quad (3.9)$$

Qw = Peak water flood discharge (m^3/s)

f = Runoff coefficient ($f=0.7$)

r = Rainfall intensity (mm/hr)

A = Catchment area (km^2)

c) Design Peak Flood Discharge

$$Q_d = \frac{1}{1 - C} \times Qw \quad \text{......................} \quad (3.10)$$

Where;

Q_d : Design peak flood discharge included runoff sediment volume (m^3/s)

Qw : Peak water flood discharge (m^3/s)

C : Sediment concentration
Lower stream of Sandpocket ; C = 5%
Upper stream of Sandpocket and site of check dam ; C = 30%

Table - 3.27 Design Peak Flood Discharge for Design of Sabo Facilities

Name of River	Name of Facility	Location	Catchment Area (m^2/s)	Peak Water Flood Discharge (m^3/s)	Design Peak Flood Discharge (m^3/s)	Remarks
S. Ciloseh	Consideration Dam of Negla		30.33	531	558	
	CLS-1	20/000	14.83	309	442	
	CLS-2	20/500	14.68	309	442	
	CLS-3	21/400	12.66	272	399	
S. Cimampang	Consideration Dam of Cimampang		14.56	264	277	
	CMP-1	2/800	7.05	158	226	
	CMP-2	3/800	6.25	158	226	
	Ciponyo I Luar		7.62	163	171	
	Ciponyo I Dalam		6.77	161	169	
	CBJ-1	1/200	10.25	183	192	
	CBJ-2	3/200	9.39	178	187	
	CBJ-3	7/860	4.71	146	209	
	CBJ-4	8/160	4.40	137	196	
	CBJ-5	8/660	4.21	131	187	
S. Cikunir	Confluence of CBJ		23.62	399	420	
	Ciponyo I Luar		7.40	169	177	
	Ciponyo I Dalam		7.11	169	177	
	CKN-1	11/300	10.03	186	195	
	CKN-2	13/100	9.10	184	193	
	CKN-3	17/510	3.20	100	143	
	CKN-4	17/810	3.00	93	133	
	CKN-5	18/010	2.75	86	123	
S. Cisaruni	CSR-1	2/100	2.47	77	110	
	CSR-2	2/600	2.35	73	104	
	CSR-3	3/100	2.22	69	99	
	CSR-4	3/500	1.70	53	76	
	CSR-5	3/900	1.16	36	51	
S. Cikupang	CKP-1	2/200	1.83	57	82	
	CKP-2	3/200	1.50	47	67	
	CKP-3	3/800	1.16	36	51	
S. Cimerah	CMR-1	2/095	4.24	105	150	
	CMR-2	3/110	3.97	105	150	
	CMR-3	4/378	3.78			Existing
	CMR-4	5/000	3.21	100	143	
	CMR-5	6/300	1.30	40	57	
S. Cisela	CSL-1	2/000	2.37	74	106	
	CSL-2	2/400	2.10	66	94	
	CSL-3	3/000	1.84	57	82	
	CSL-4	3/400	1.67	52	74	
	CLS-5	4/000	1.24	38	54	
	CSL-7	4/600	0.60	19	27	
S. Cipada	CPD-1	2/100	0.99	31	44	
	CPD-2	2/800	0.72	22	31	

3.8 Alternative Plan for Sandpocket Ciponyo I Dalam

3.8.1 Design Management Sediment Volume

The design management sediment volume for Sandpocket Ciponyo I & II mentioned in "3.3.2" is shown as follows;

Table - 3.28 Design Management Sediment Volume of Sandpocket Ciponyo I

Proposed Management Period	From 1988 till 1977
Number of Management Years (Years)	10
Design Spare Capacity (10^3 m^3)	1,400
Design Accumulated Sediment Volume (10^3 m^3)	4,741
Management Sediment Volume (10^3 m^3)	6,141
Annual Management Sediment Volume (10^3 m^3)	614

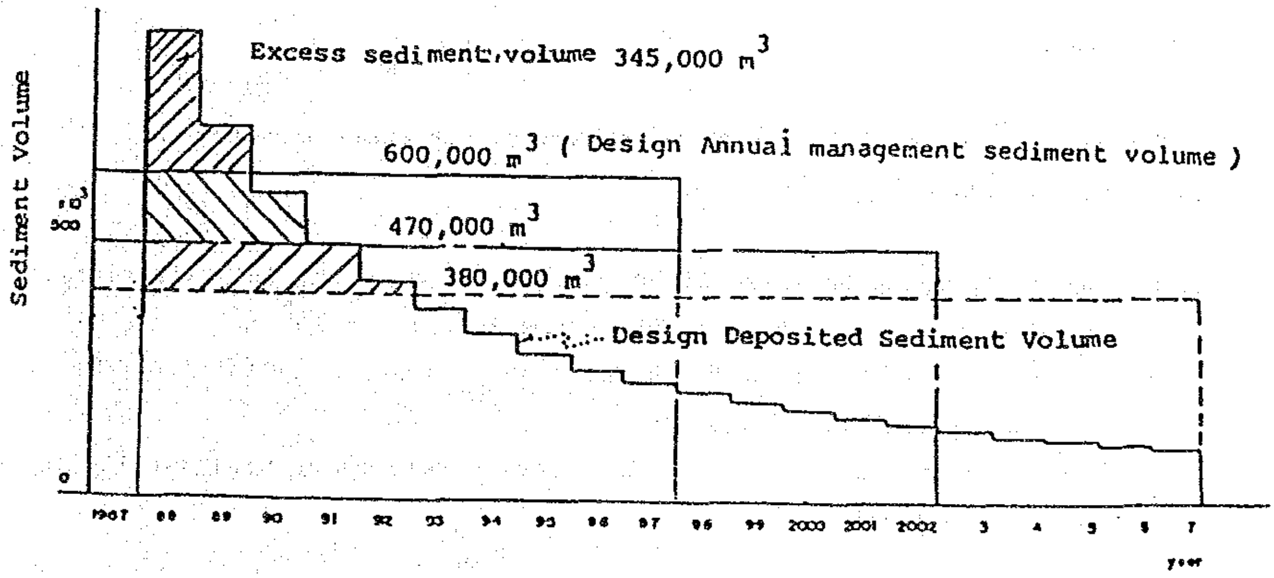


Fig. - 3.10 Annual Management Sediment Volume of Sandpocket Ciponyo I & II

3.8.2 Alternative Plan

Based on the design criteria and the specifications mentioned in 3.7.1, three alternative plans on the sandpocket Ciponyo I Dalam are basically proposed as follows:

<u>Alternative I - A</u>

By raising the existing dike, the design management sediment volume is stored in the sandpocket Ciponyo I Dalam.

<u>Alternative I - B</u>

The design management Sediment Volume is transported from Ciponyo I Dalam by truck, part being disposed into S. Ciwulan near Sakaraja and the rest being disposed in the Indian Ocean.

<u>Alternative I - C</u>

As the sediment in the sandpocket is presently being used as an aggregate, the sediment in the sandpocket could also be used as an aggregate.

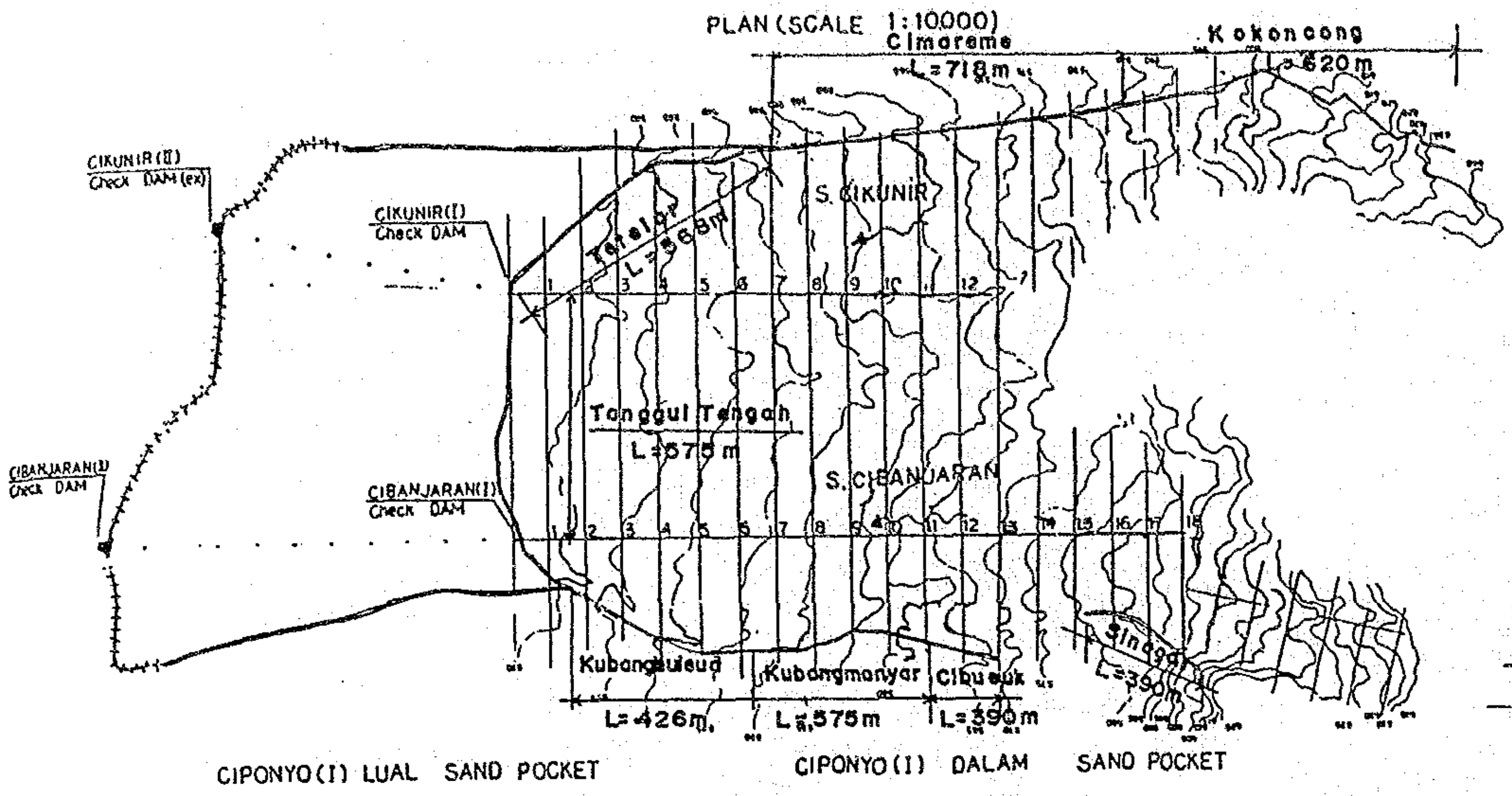
(1) Alternative I - A

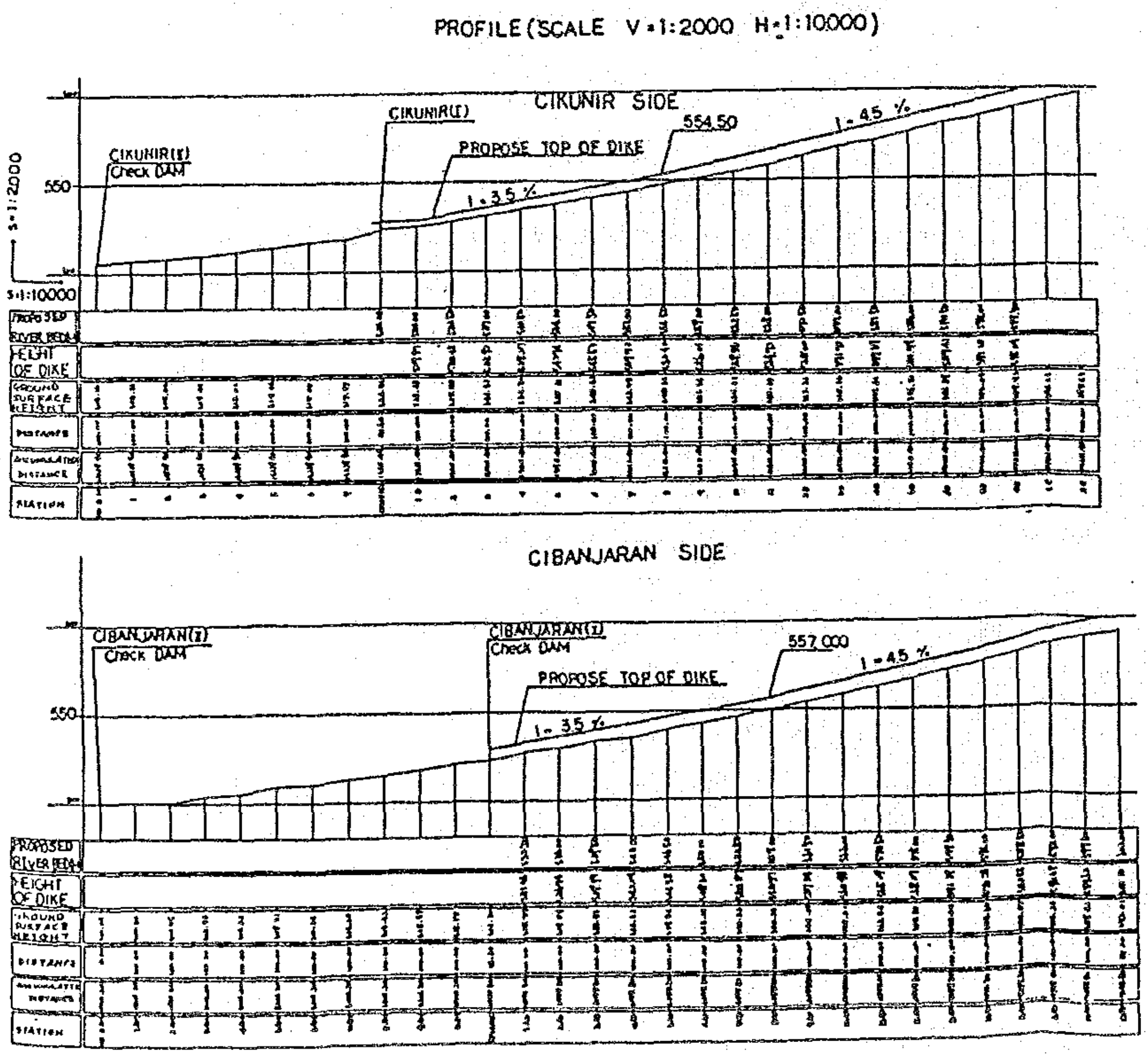
The major purpose of this plan is to secure the spare capacity of sandpocket by raising of existing dike.

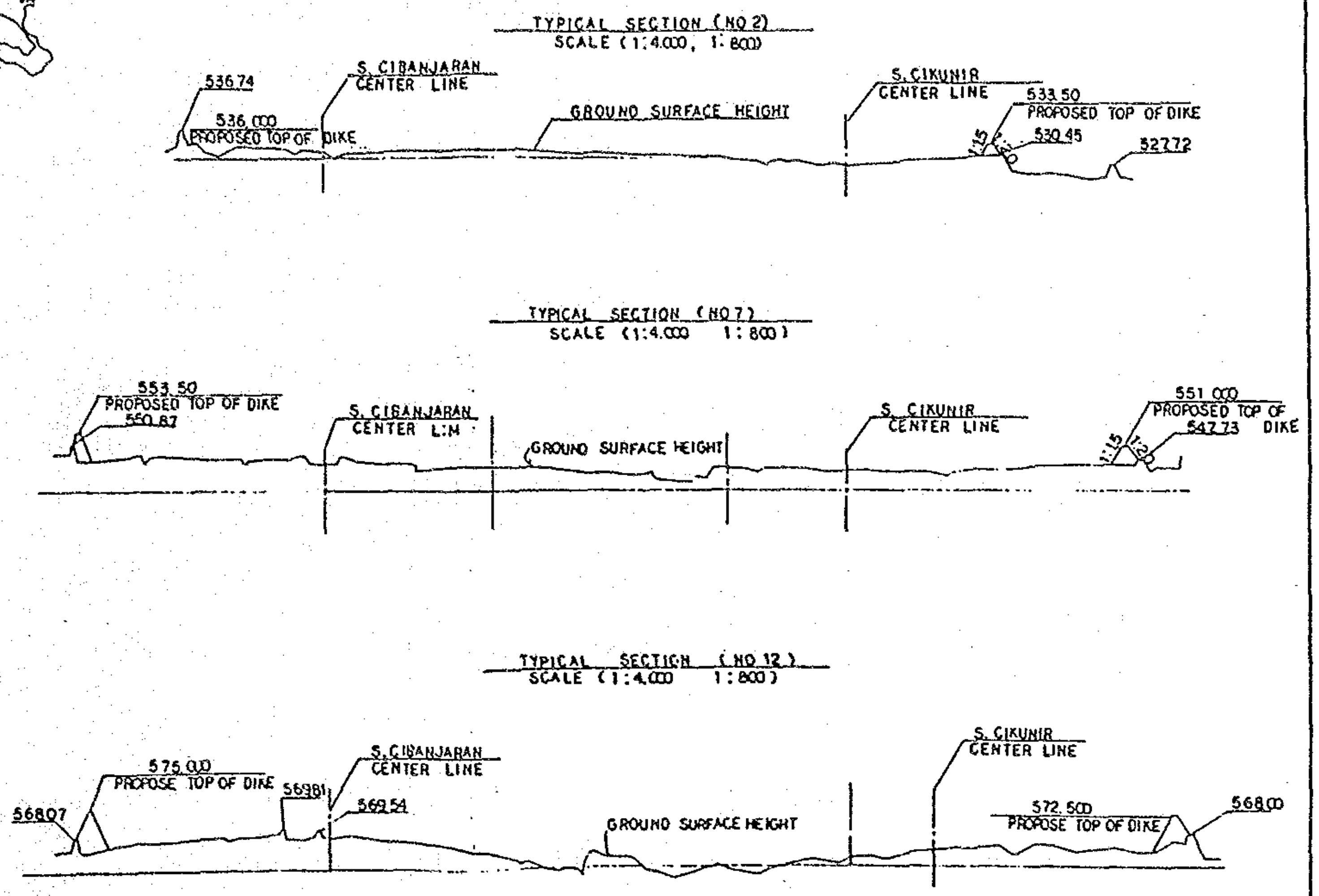
The height by which to raise dikes was estimated by the following items:

a) The design management sediment volume is $6,141 \times 10^3$ m^3
b) The average accumulated depth for each dike was calculated by the two dimensional flood simulation
c) Under the supposition that sedimentation will occur horizontally on each cross section.

Detail concerning the proposed height of raising dike were shown in Supporting Report (III). The typical section of rasing dike and length of dike are as shown in Fig. - 3.11.







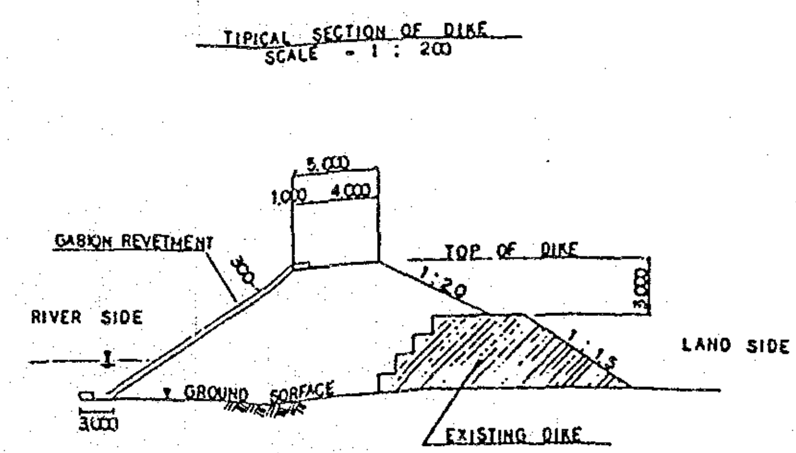


Fig. - 3.11 Alternative I-B, I-C (Excavation of Sandpocket)

Brief description for Alternative I - A are shown as follows:

1) Raising dikes

a) Cikunir side

	Length	Average Raising Height of Dike
Kokoncong dike	620 m	3.0 m
Cimareme dike	718 m	3.0 m
Tetelar dike	568 m	3.0 m
Total	1,906 m	

b) Cibanjaran side

	Length	Average Raising Height of Dike
Kubang Buleud dike	426 m	3.0 m
Kubang manyar dike	575 m	3.0 m
Cibueuk dike	200 m	3.0 m
Sinagar dike	390 m	3.0 m
Total	1,591 m	

2) Excavation riverbed 2,000,000 m^3

For lahar smoothly flows down along the sandpocket without overtopping bank.

(3) Alternative I - B

The major purpose of this plan is to secure the spare capacity of sandpocket by excavating riverbed in sandpocket. The material will be transported to and disposed of in the S. Ciwulan and Indian Ocean. At river mouth of the S. Ciwulan (Indian Sea), 4,140,000 m^3 will be disposed of, at Sukaraja in S. Ciwulan 2,000,000 m^3 will be disposed of.

1) Excavation plan

The excavation in the river channel is planned to prevent lahar from overtopping the dike, having a distance of 50 m from the existing dikes. The proposed height of riverbed was estimated by the following items:

a) The design management sediment volume is 6,141 x 10^3 m^3.
b) The average accumulated depth for each dike was calculated by two dimensional flood simulation.
c) Under the supposition that sedimentation will occur horizontally on each cross section.

The typical section of riverbed and the area of excavation area as shown in Fig. - 3.12.

2) Long distance transportation plan

The material of excavated riverbed is to be shipped at the sandpocket to dump trucks. Part of the material will be transported to S. Ciwulan near Sukaraja and disposed of in S. Ciwulan, the rest will be transported to dump site in the vicinity of Cipatujah on S. Ciwulan and disposed of in the sea.

The amount to be transported to S. Ciwulan or the sea are shown in Table - 3.29.

Table - 3.29 Long Distance Transportation Volume

Dumping Site	Distance from Job Site (km)	Transportation volume
Sukaraja (S. Ciwulan)	27.0 km	2,000 x 10^3
Cipatujah (Indian sea)	80.5 km	4,140 x 10^3

Note: (1) The maximum volume of disposed material of allowable sediment discharge of the 4 BMD sites in S. Ciwulan.

(2) The ratio of S. Ciwulan basin to S. Cikunir basin.

$$\frac{\text{S. Ciwulan basin}}{\text{S. Cikunir basin}} = 0.081$$

(3) Average grain diameter of downstream in the sandpocket is 10 mm.

(4) Allowable sediment discharge of average grain diameter of 10 mm is $2,568 \times 10^3\ m^3$/year.

(5) The volume of disposed material is calculated shown as follows:

$$V = 2,568 \times 10^3 \times 0.081 \times 10 \text{ years} = 2,080 \times 10^3$$
$$= 2,000 \times 10^3\ m^3$$

Table - 3.10 Sediment Balance for Each River Basin after the Eruption in 1982

Name of River Basin	Period from	Period until	Number of Month	Volume of Ejected Materials (10^3 m^3) Ash Deposits	Ladu Deposits	Total	Eroded Volume from Sep.1982 until Aug.1987 (10^3 m^3) Ash Deposits	Ladu Deposits	Riverbed Mate-rials	Others	Total	Volume of Deposited Sediment in Sand Pocket (10^3 m^3)	Volume of Present Unstable Materials (10^3 m^3) Ash De-posits	Ladu De-posits	Riverbed Mate-rials	Others	Total
Ciloseh Cimampang	Apr.1982	Aug.1982	5	7,200	0	7,200	-	0	-	-	-	-					
	Sep.1982	Apr.1984	18	-	0	-	5,400	0	-	-	5,400	2,400 *1					
	May 1984	Jul.1985	15	0	0	0	1,800	0	-	-	1,800	1,450 *1					
	Aug.1985	Aug.1987	25	0	0	0		0	-	-		-					
		Total	63	7,200	0	7,200	7,200	0	-	-	7,200	3,850	0	0	548	-	548
Cikunir Cibanjaran	Apr.1982	Aug.1982	5	14,200	26,240	40,400	-		-	-	-	22,270 *2					
	Sep.1982	Apr.1984	18	-	0	-	7,600		-	-		7,900					
	May 1984	Jul.1985	15	0	0	0	6,600	18,630	-	-	32,830	3,450					
	Aug.1985	Aug.1987	25	0	0	0		0	-	-		2,576					
		Total	63	14,200	26,240	40,400	14,200	18,630	-	-	32,830	36,196	0	7,610	1,862	-	9,472
Southern Slope	Apr.1982	Aug.1982	5	18,500	0	18,500	-	0	-	-	-	-					
	Sep.1982	Apr.1984	18	-	0	-	11,700	0	-	-	11,700	-					
	May 1984	Jul.1985	15	0	0	0	6,800	0	-	-	6,800	-					
	Aug.1985	Aug.1987	25	0	0	0		0	-	-		-					
		Total	63	18,500	0	18,500	18,500	0	-	-	18,500	-	0	0	-	-	-
Total	Apr.1982	Aug.1982	5	39,900	26,240	63,140	-		-	-	-	22,270					
	Sep.1982	Apr.1984	18	-	0	-	24,700		-	-		10,300					
	May 1984	Jul.1985	15	0	0	0	15,200	18,630	-	-	58,560	4,900					
	Aug.1985	Aug.1987	25	0	0	0		0	-	-		2,576					
		Total	63	39,900	26,240	63,140	39,900	18,630	-	-	58,560	40,046	0	7,610	2,410	-	10,020
Remarks				Table -3.4	Table -3.5 &-3.6		Table -3.4	Table -3.5 &-3.6						Table -3.11	Table -3.11		

Note: " - " means no data

*1 Overflowed sediment volume from S. Cibanjaran

*2 Including overflowed sediment volume at Sinagar ~~of~~ or S. Cibanjaran (=1,740^3 x 10 m^3)

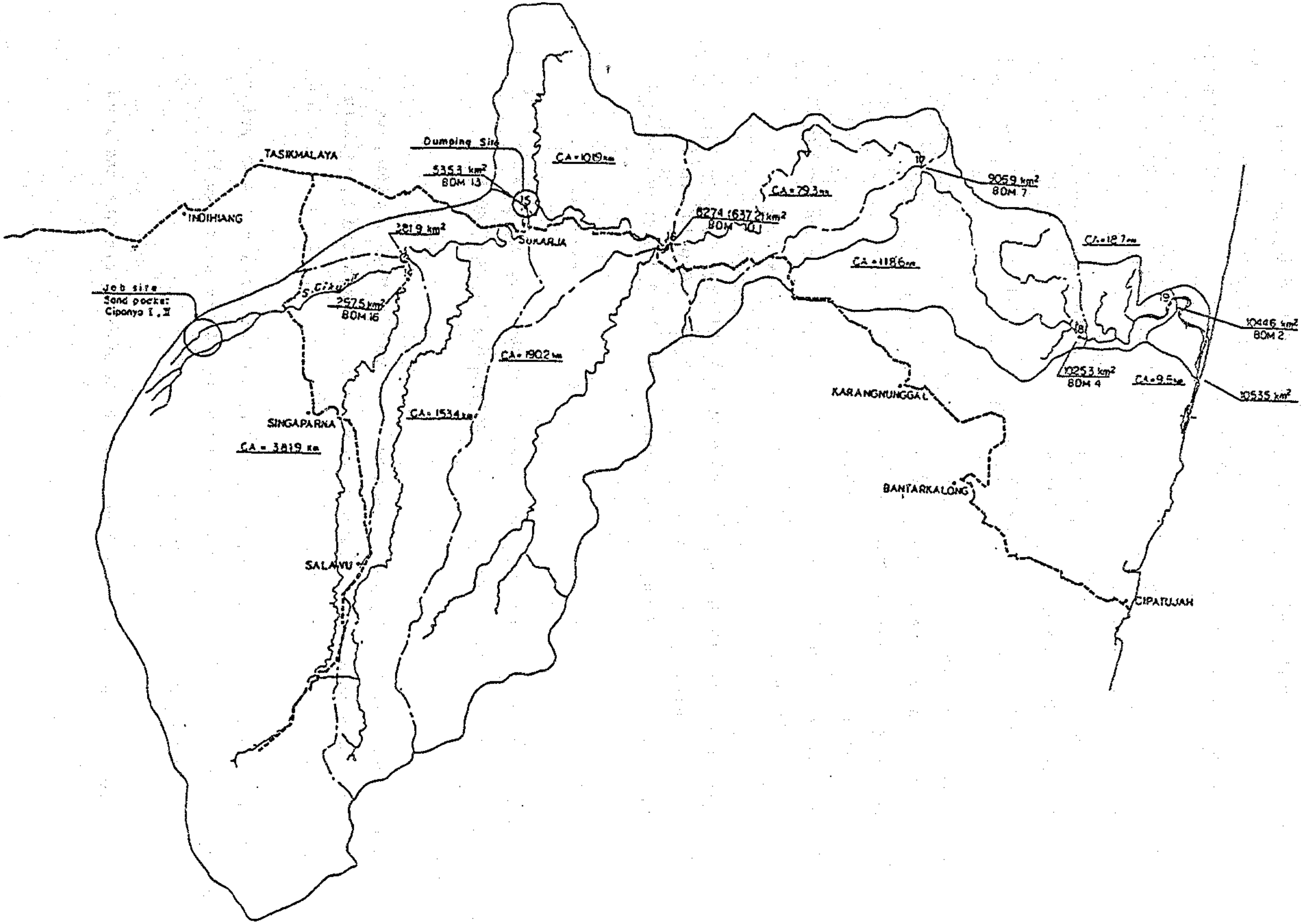


Fig. - 3.13 Dumping Site for Long Distance Transportation

Brief description for Alternative I - B are as follows:

1) Improvement of Dike (Width = 5.00)

a) Cikunir side

Kokoncong Dike Length	620 m
Cimareme Dike Length	718 m
Tetelar Dike Length	568 m
Total	1,906 m

b) Cibanjaran side

Kubang Buleud Dike Length	426 m
Kubang Manyar Dike Length	575 m
Cibueuk Dike Length	200 m
Sinagar Dike Length	390 m
Total	1,591 m

2) Long distance transportation and disposal volume

From job site to Sukaraja	27 km	2,000 10^3 (m^3)
From job site to Cuwulan river mouth	80.5 km	4,141 x 10^3 (m^3)

(4) Alternative I - C

In this alternative, as in Alternative I - B the Ciponyo I Dalam sandpocket will be excavated. The material excavated will be used as aggregate.

The sediment in the Ciponyo I Luar and Ciponyo II, Negla, Cimampang sandpockets is excavated. After being washed, it is transported by railway from nearby Tasikmalaya to Jakarta.

The same excavation plans will be used as in Alternative I - C, and the sediment will be transported by dump truck to an aggregate plant to be processed into sand and coarse aggregates.

The processed aggregates will be sent to Jakarta by freight car from Tasikmalaya.

The 6,141,000 m^3 of sediment could be excavated from the sandpocket, haul to the aggregate plant installed in Pirusa station, and transported to Jakarta.

Brief description for alternative I - C are as follows:

1) Improvement of existing dike (Width = 5.00)

a) Cikunir side

Kokoncong Dike Length	620 m
Cimareme Dike Length	718 m
Tetelar Dike Length	568 m
Total	1,906 m

b) Cibanjaran side

Kubang Buleud Dike Length	426 m
Kubang Manyar Dike Length	575 m
Cibueuk Dike Length	200 m
Sinagar Dike Length	390 m
Total	1,591 m

2) Aggregate plan Railway 300 t/hour 1 unit

3) Long distance transportation volume by
From Job site to Jakarta $V = 6,141,000\ m^3$

3.8.3 Selection of Alternatives

The preliminary cost estimate were made for major works such as excavation, embankment, gabion works, transportation of materials. The estimated cost include costs for construction works and procurement of materials and equipment. For the sake of comparative study of alternative, the expenses needed for preconstruction works are not included in these cost estimates; they are cost for land acquisition, government administration, engineering service, physical contingency, price escalation and so on.

The selective comparison of three alternatives are shown in Table - 3.30.

As a result of comparison of the construction cost, the alternative 1 - C shows the lowest cost in these three Alternatives (refer to Table - 3.30) and next one is alternative A.

Comments for each alternative is explained as follows;

Alternative A;
(1) The height of some section of dike is higher than 10 m from the original ground level.
(2) If the riverbed becomes higher, to maintain the dike is very difficult.
(3) From the view point of construction, it is easy for construction because of little land acquisition.

Alternative B; This alternative have many of the following problems mentioned below.
(1) It is presumed that the riverbed condition will be worse because of changing of sediment balance from the river mouth to the upperstream in the S. Ciwulan, if the sediment is dumped.
(2) Environmental measures for are necessary the prevention of the pollution of water quality of river.

Alternative C; (1) It is the best alternative in terms of budgets.

(2) It will be necessary to strengthen transportation capacities.

An effective countermeasures for the management of sandpocket is to excavate and carry out the sediment in the sandpocket for the restoration and the continuous maintenance of the sediment control in it.

For this reason, alternative C is most desirable of the three as it involves both excavation and use as aggregate.

However, it will be necessary for alternative C to strengthen transportation capacities.

Alternative A shows the minimum construction cost.

Alternative A and alternative C were selected for the management of the sandpocket in this comparison.

One alternative was selected by taking into account the economic condition as well as financial condition described in the Supporting Report V.

Table - 3.30 Alternative to Countermeasures for Sand Pocket Ciponyo I Dalam

Alternatives	Raising of Existing Dike (I -A)	Excavation in Sand Pocket and Spoil - Bank (I - B)	Excavation in Sand Pocket and Utilization (I - C)
Specification (Description)	Average raised height of dike H = 3.0 m Total Length of raised dike L = 3,497 m	Excavation of sand pocket 6,141 x 10^6 m^3 Long distance transportation by truck from Job site to dumping site SUKARAJA 27 km 2.00 x 10^6 m^3 GIPATUJAH 80.5 km 4,141 x 10^6 m^3	Excavation of sand pocket 6,141 x 10^6 m^3 Aggregate plan (300 t/h) 1 unit Long distance transportation by railway from Job site to Jakarta JAKARTA 6,141 x 10^6 m^3 Sale of aggregate 6,141 x 10^6 m^3
Cost of Construction (Rp x 10^6)	Raising of dike 3,128 Maintenance of sand pocket 3,822 6,950	Excavation 11,435 Long distance by truck 72,441 83,876	Excavation Fee ; 11,434 Sieving & Washing Fee ; 29,485 Long Fee Transportation Fee from Site to Jakarta ; 36,078 Unloading & Stocking Fee ; 8,290 Selling & Marketing Fee Total Fee ; 85,287 Total Income ; 82,904 ; 2,383 2,383
	Height of raised dike is 10 m from ground surface To deposite the sediment of 5.0 x 10^6 m^3 in Ciponyo I Dalam To become a social problem	very expensive	Augment transportation capacity by railway Possible to transport and sell aggregate at 300 x 10^3 m^3 in present condition

4. Countermeasures for Crater Lake of Mt. Galunggung

4.1 General

Mt. Galunggung's volcanic activities had terminated by January 1983, but they had created a crater lake. The rise of the water level in this crater lake has resulted in faults in the lake wall and the danger of disasters occurring during re-eruptions because of hot water overflowing and hot mud flows (lahar). This has become a major social problem not only for the local area (Tasikmalaya), but also for Indonesia as a whole.

This has caused the Directorate of Volcanology to conduct concrete surveys, which were begun in 1986. In this connection, the Mt. Galunggung Project Office also installed staff gauges in April 1987 to measure water levels.

The JICA Study Team installed its own automatic water level recorders and rain gauges in September 1987 in order to understand the water balance in the crater lake. Drilling (3 holes, total length 200 m), and seismic surveys were also performed to study the geological conditions of the crater lake wall. This work was performed as the preliminary study for drainage work in the crater lake.

Countermeasures were determined based on the results of the studies described above by comparing outlines.

4.2 Geology

4.2.1 Geological Features

(1) Geomorphology

Crater lake is situated at the top of the horse-shoe shaped valley in the southeastern slope of Mt. Galunggung. The water surface is approximately 1,090 meters high in elevation and the lake is about 600 meters in diameter. (as of November, 1987)

The slope of the inner wall is very steep, with an angle of 50 to 70 degrees and the outer wall is very gentle, with an angle of 20 to 30 degrees.

A small cinder cone, the summit meters high in elevation, is located in the lake.

(2) Geology

The geology around the crater lake is composed of Quarternary pyroclastic rocks and deposits.

The stratigraphy is divided into five (5) units namely i) order volcanic breccia (Ob) ii) Andesite dome (Ad), iii) Younger volcanic breccia (Yb), iv) Pyroclastic flow deposit (Py) and Tephra (Tp) in ascending order.

Every unit except andesite dome is roughly parallel to each of order, dipping with an angle of 20 to 30 degrees.

Andesite dome is a portion of Mt. Jadi, which had been formed in 1918 and was destroyed in 1982 - 1983.

There are some fumarole zone in the inner crater wall. Chemical composition analysis for fumarole from drilling holes was executed by JICA Study Team. The results of this is shown in Table - 4.2.

Table - 4.1 Stratigraphy around the Crater Lake

Bed	Rock or Sediments faces	Year of Eruption
Tephra (Tp)	Scoria, pumice and ash, accompanied with volcanic bomb	1982 - 1983
Pyroclastic flow deposits (Py)	Coarse sand and gravel	1982 - 1983
Younger volcanic breccia (Yb)	Matrix soft, loose, not consolidated, breccia small - big	1894
Andesite dome (Ad)	Hard, cracky, every joint opened partially auto-breccia	1918
Older volcanic breccia (Ob)	Matrix soft a little consolidated breccia small - big	1822

Table - 4.2 Chemical Composition of Fumaroles

Location	Height (msl)	Temperature	Gas Composition
B_1	1,161.70 m	92°C	CO_2 : 1.32% H_2O : 50.1% H_2 : - SO_2 : 0.09% N_2 : 42.5%
B_2	1,155.90 m	94.6°C	CO_2 : 1.97% H_2O : 41.20% H_2 : - SO_2 : 0.09% N_2 : 46.73%
Fumarole at the crater rim	1,100 m	86°C	CO_2 : 1.32% H_2O : 38.96% H_2 : 7.2% SO_2 : 0.088% N_2 : 46.32%

Poisonous gases : CO_2 (threshold estimate value 0.05%)
SO_2 (threshold estimate value 0.001%)

Non-poisonous gases : H_2O, H_2 and N_2

(3) Instability of excavated slopes:

Andesite near the proposed shaft is very cracked and every joint is open. Therefore, creep occurs on steep slopes excavated. Near the outlet of proposed drainage tunnel, the foundation consists of pyroclastic flow deposits and it is very soft, loose and not consolidated.

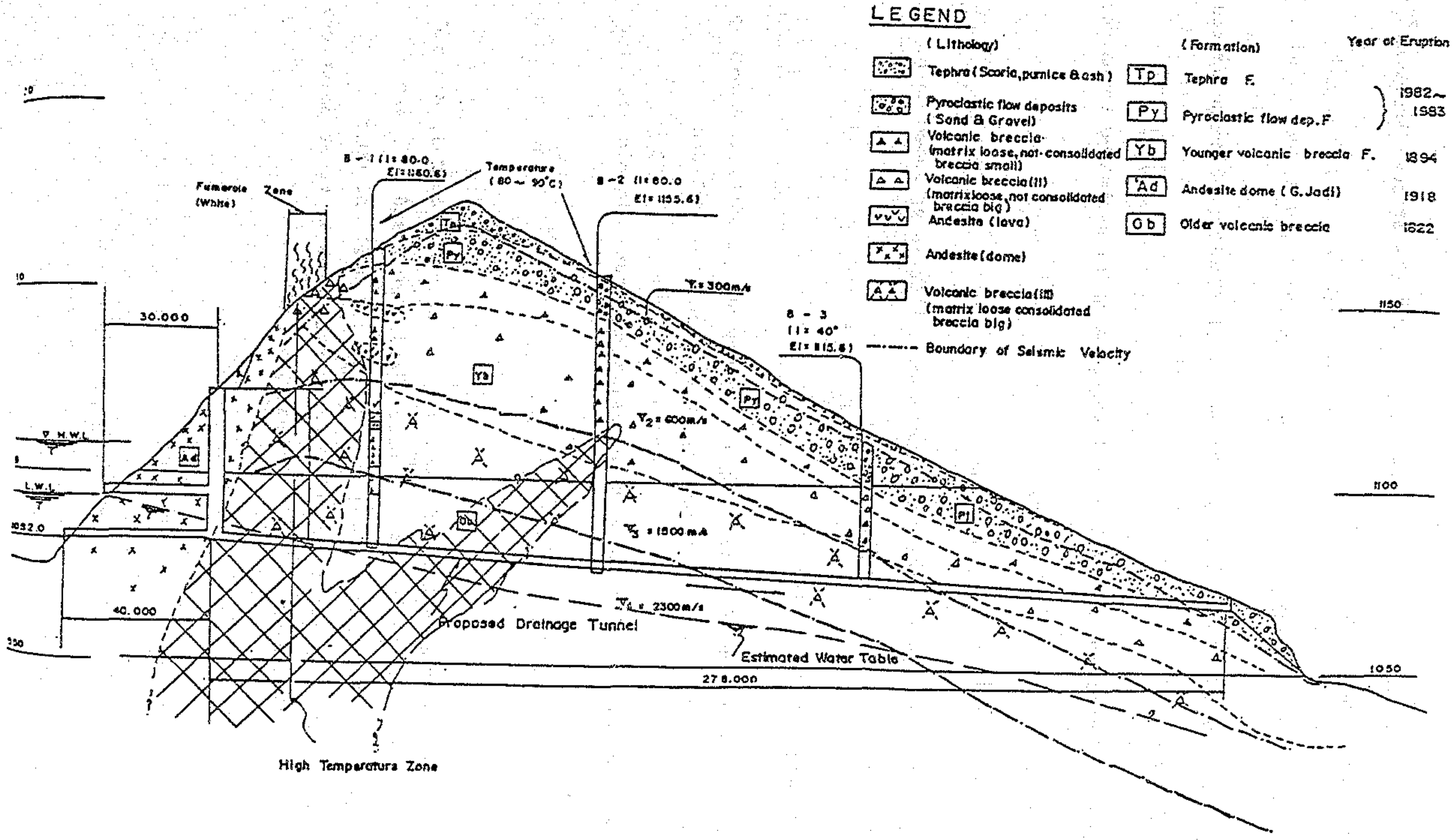


Fig. - 4.1 Geological Profile (A-A)

4.2.2 *Recommendation for Countermeasures of Crater Lake*

Geological survey around the crater lake have revealed some problems for the foundation rocks, as follows:

(a) Weakness of the foundations;

Every foundation except andesite is very soft, loose, not consolidated and heterigeneous.

Judging from drilling core and seismic velocity (max. - V_4 = 2.30 km/sec), the strength of the four (4) foundations is estimated to be very weak.

(b) High permeability;

Foundation is very pervious and the permeability is presumed to be approximately $k = 10^{-3}$ in order.

(c) High temperature fumarole;

Fumarole whose temperature is approximately 80° to 90°C, is blown up from B-1 and B-2 drilling hole, including small amounts of solfatara.

High temperature is believed to be caused by post volcanic activity around the crater.

(d) Volcanic gas;

Main chemical composition of fumaroles, collected from B-1, B-2 and crater rim, is shown in Table - 4.2. Poison gases, SO_2, and CO_2, are contained more than threshold estimate value (SO_2: 0.001% and CO_2: 0.05%). It is necessary for planning of countermeasures to treat poisonous gases, especially in closed areas (i.e. tunnels).

4.3 Tendency of Water Level Fluctuation

4.3.1 Results of Observation

The results of observation of the crater lake's water level fluctuation and rainfall are shown in Fig. - 4.2.

The storage capacity of the crater lake shall be obtained from existing drawing, and its H - V curve shall be as shown in Fig. - 4.3, Table - 4.3.

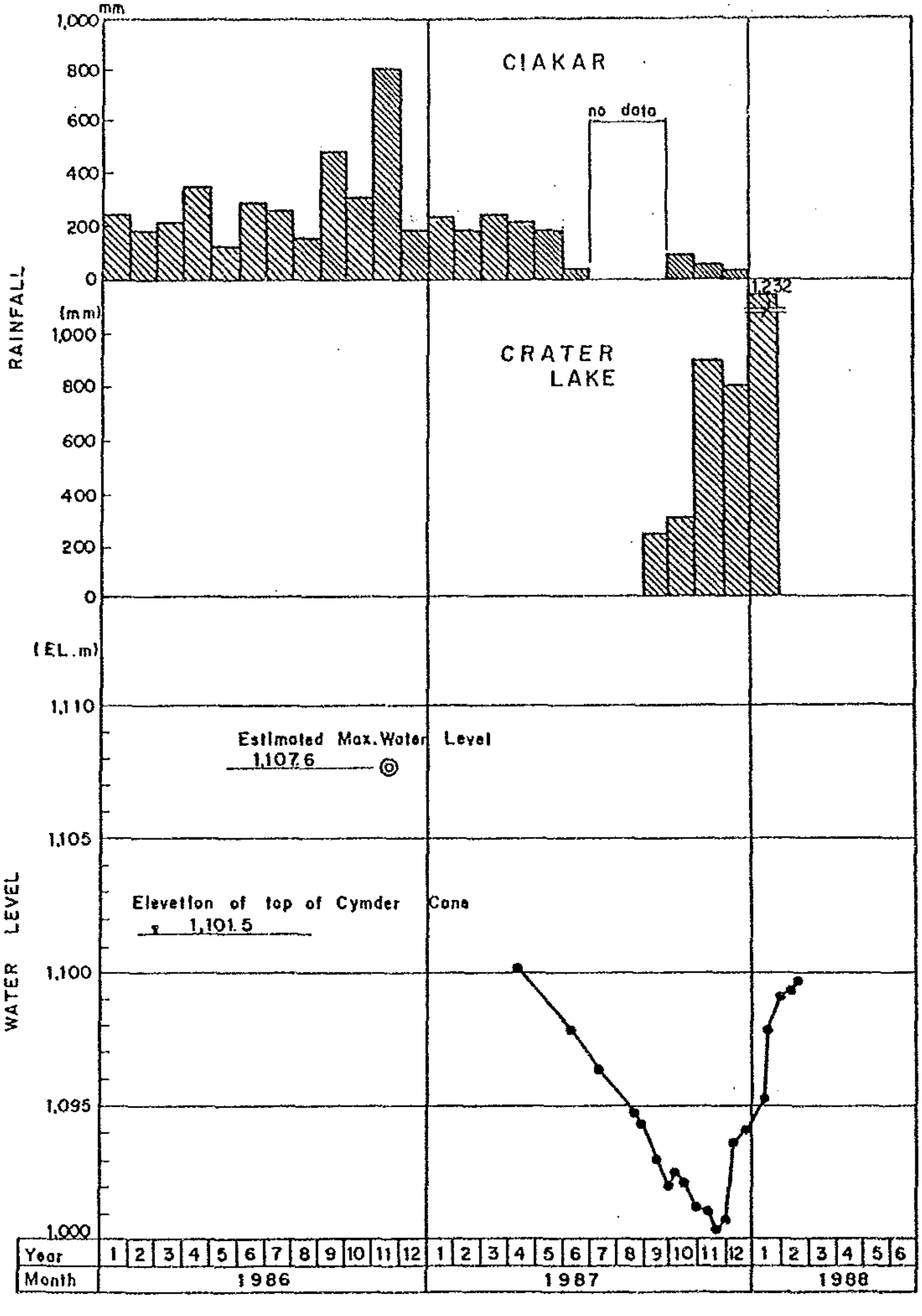


Fig. - 4.2 Water Level Fluctuation in the Crater Lake

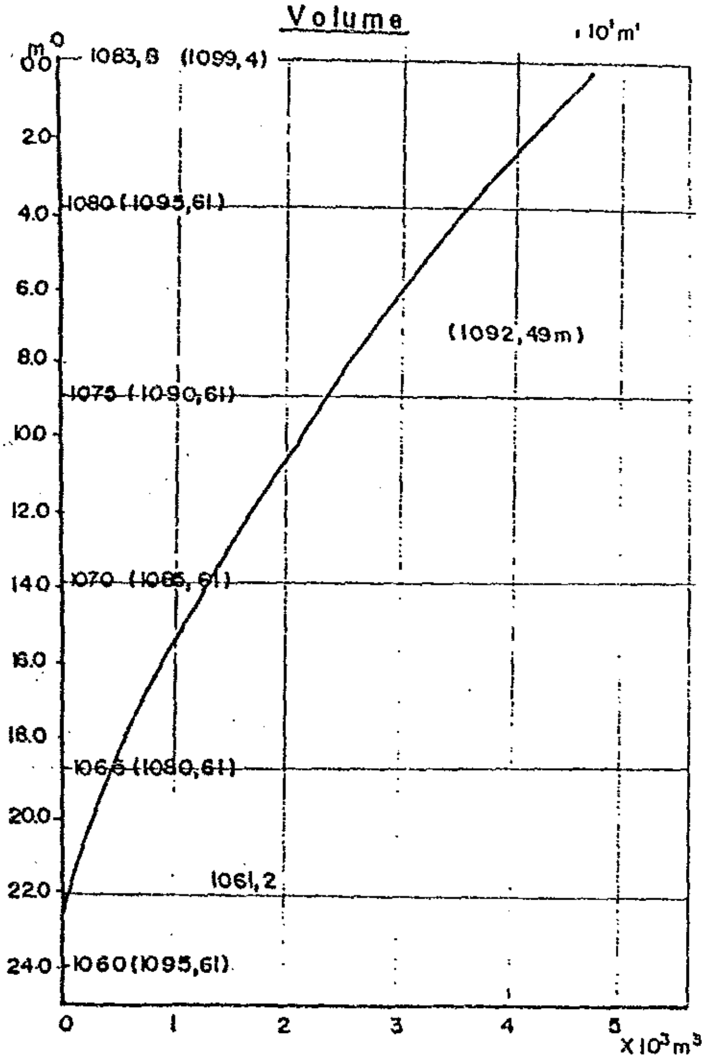


Fig. - 4.3 Water Level - Water Volume Curve of Crater Lake

Table - 4.3 Storage Curve (H - V Curve) of Crater Lake

Elevation m	Dept m	Area m^2	Volume m^3	Sum of Vol m^3
1,076.01	0.0	0		
1,076.41	0.4	39,970	7,994	7,994
1,077.41	1.4	83,030	61,500	69,494
1,079.41	3.4	126,280	209,310	278,804
1,081.41	5.4	154,570	280,850	559,654
1,083.41	7.4	182,810	337,380	897,034
1,085.41	9.4	197,150	379,960	1,276,994
1,087.41	11.4	209,610	406,760	1,683,754
1,089.41	13.4	223,190	432,800	2,116,554
1,091.41	15.4	244,430	467,620	2,504,174
1,091.41	15.4	244,430	467,620	2,504,174
1,093.41	17.4	264,980	509,410	3,093,584
1,095.41	19.4	280,090	548,070	3,641,654
1,097.41	21.4	303,270	586,810	4,228,464
1,099.41	23.4	336,100	639,820	4,868,284
1,105.61	29.6	388,500	2,246,263	7,114,544
1,107.0	30.9	401,000	552,	7,667,194
1,115.61	39.6	477,780	4,331,400	11,445,944
1,125.61	49.6	571,500	5,246,400	16,692,344
1,135.61	59.6	650,500	6,1110,000	12,802,344
1,145.61	69.6	716,000	6,832,000	29,634,844
1,155.61	79.6	766,000	7,410,000	37,044,844
1,165.61	89.6	822,000	7,940,000	44,984,844

4.3.2 Simulation for Water Level Fluctuation

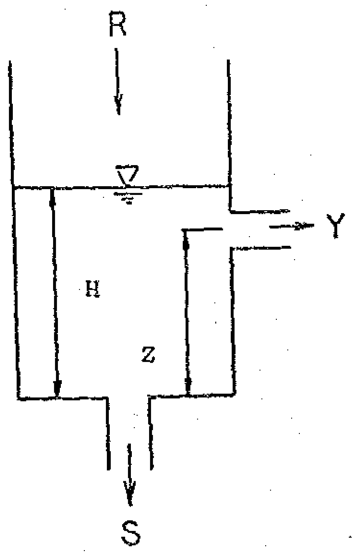
(1) Simulation Model

On the assumption that CRATER LAKE can be simplified as the figured tank, the water balance is calculated by the following equation.

$H = R(Y+S) < R = r.f.A/a$

$Y = C(H-Z)$

$S = KH$



where; H : Storage depth

R : Inflow depth (R=r.f.A/a)

Y,S: Infiltration depth [Y=C(H-Z)m S=KH]

r: Rainfall of CRATER LAKE

f: Coefficient of discharge

A: Catchment area ($A=3.59\ Km^2$)

a: Mean surface area of CRATER LAKE ($a=0.34\ Km^2$)

The coefficient of "C" and "K" was "K" identified by verification between observed water level and calculated water level.

(2) Conditions for Simulation

Under the following conditions, the water level simulation of the crater lake was carried out.

1) Inflow discharge no inflow sediment to the crater lake
2) Outflow combined evaporation
3) Water level data used;
   June, 1986 - December, 1987

(3) Rainfall

Owing to the rainfall data of the crater lake station was not enough, the rainfall was estimated from the TASIKMALAYA station data. (See Table - 4.4.).

Table - 4.4 Available Rainfall Data

Year St.	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Remarks
Gisayong					Δ	o	o				
Tejakelapa						o	o				
Gigaleuh						o	o				
Angkrek						o	o				
Gigadog							o				
Gibasuki	o	o	o	o	o	o	o	o	o	o	
Gisolak						o	o	o	o	o	
Gikasasah					o	o	o	o	o	o	
Gigangsa								o	o	o	
Tanjungsari	o	o	o	o	o	o	o	o	o	o	
Indihiang	o	o	o	o	o	o	o	o	o	o	
Pangkalan							o	o	o	o	
Pasir Malang					o		o	o	o	Δ	
Sinagar						o	o	o	o		
Giakar								o	o	Δ	
Gintawana					o	o	o	o	o	o	
Grater Lake										Δ	From Sep. '87
Tasikmalaya	o	o	o	o	o	o	o	o	o	o	From 1942
Singaparna	o	o	o	o	o	o	o		o		From 1942

To grasp the relationship of rainfall between Crater Lake and Tasikmalaya, the correlation analysis was carried out by following two steps.

1) Crater Lake and Pangkalan

The relation between the monthly rainfall of CRATER LAKE station and that of PANGKALAN station is as follows; (see Fig. - 4.4.)

$$RL = 1.7PR$$

where; RL: The monthly rainfall of CRATER LAKE station
RP: The monthly rainfall of PANGKALAN station

2) Pangkalan and Tasikmalaya

The relation between the rainfall of PANGKALAN station and that of TASIKMALAYA station is as follows; (see Fig. - 4.5).

$$RP = 1.3RT$$

where; RP: The annual rainfall of PANGKALAN station
RT: The annual rainfall of TASIKMALAYA station

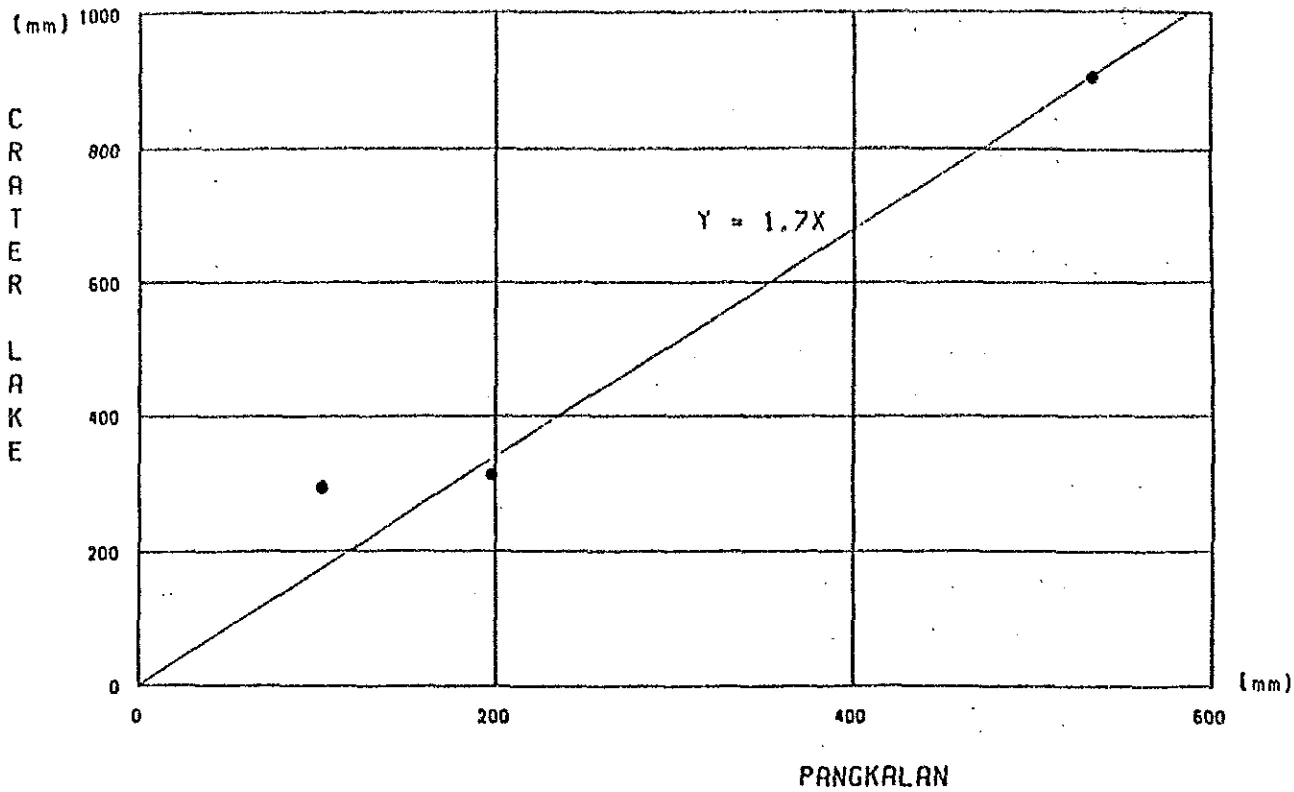


Fig. - 4.4 Relationship between CRATER LAKE and PANGKALAN

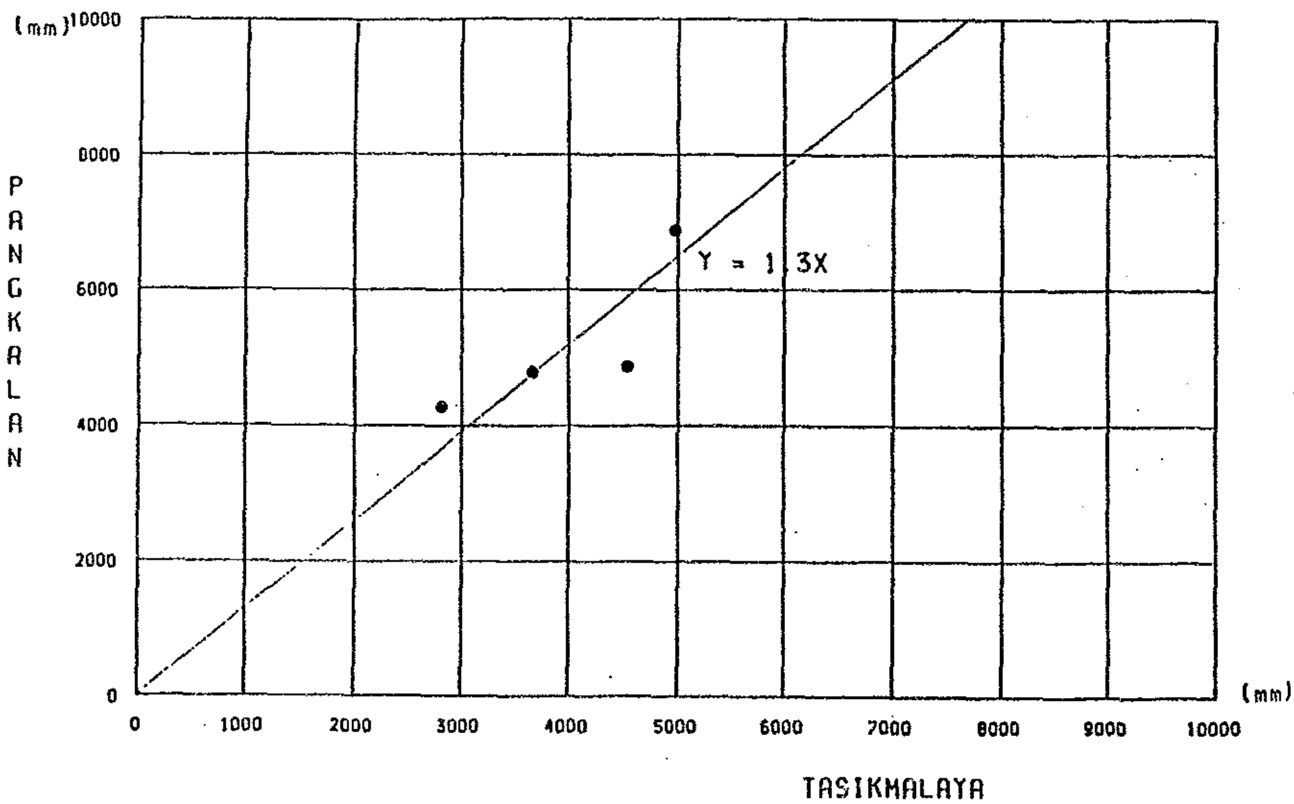


Fig. - 4.5 Relationship between PANGKALAN and TASIKMALAYA

3) Crater Lake and Tasikmalaya

The relationship of both stations, CRATER LAKE and TASIKMALAYA, can be estimated as follows;

$$RL = 2.2RT$$

where; RL: The rainfall of CRATER LAKE station
RT: The rainfall of TASIKMALAYA station

(3) Identification of Coefficient "C" and "K"

As a result of verification, the coefficient "C:" and "K" was identified as C= 2.4 and K=0.06. (refer to Fig. - 4.6)

Initial parameters are shown in Table - 4.5.

Table - 4.5 Initial Parameters

Parameter	Remarks
H1 = 1,099.7 m - 1,076.0 m = 23,700 mm	Initial Storage Depth
Z = 1,100.0 m - 1,076.0 m = 24,000 mm	Infiltration Depth
f = 0.5	Coefficient of Discharge

Fig. - 4.6

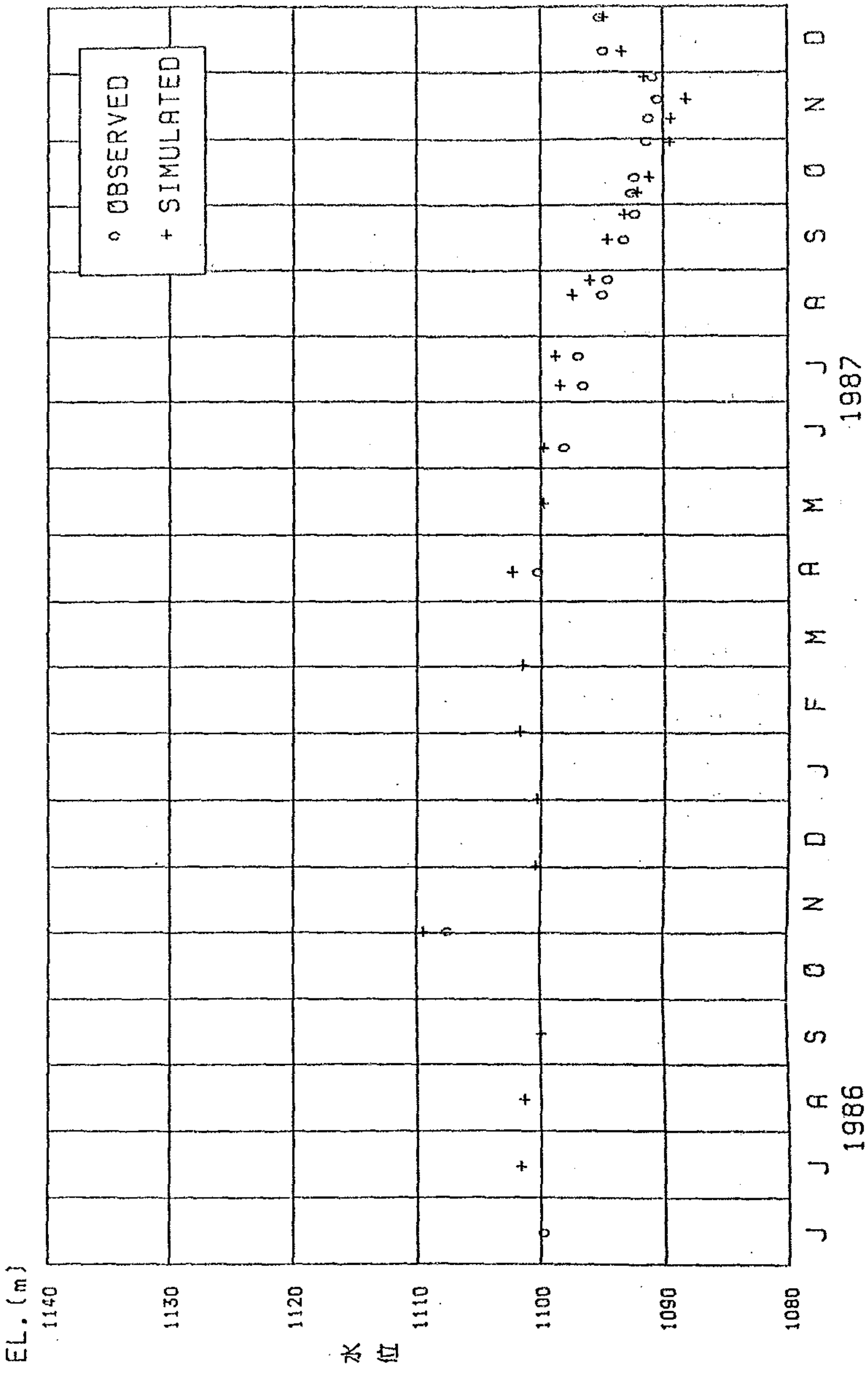


Fig. - 4.6 Simulated Water Level Compared with the Observed Data

4.3.3 Estimation of Water Level Fluctuation

According to the simulation results, the estimation of water level fluctuation for CRATER LAKE was carried out by using monthly rainfall of Tasikmalaya from 1963 to 1987. The results are shown in the following figures and tables respectively. The water level fluctuations between EL. 1,098 m and EL. 1,105 m. (refer to Fig. - 4.7)

According to Fig. - 4.7, the highest water level in the crater lake was 1,105 m (total storage capacity 7,100 10^3 m^3).

4.3.4 Design Water Level for the Disaster Prevention Plan

The disaster prevention plan for the crater lake, is only the so-called Drainage Plan for the draining of the water stored in the crater lake.

The water level (hereafter called the design water level) of the drainage plan was set for a level of EL 1,082.5 m by taking into account the inflow sediment volume of 750,000 m^3 into the crater into the crater lake in 50 years.

As was done for the crater lake at Mt. Kerut in the province of East Jave, a combination of inlet siphon tunnels (constructed in three different stages according to altitude) and a drainage tunnel shall be used.

These drainage facilities were planned for S. Cibanjaran side because of the thickness of the crater wall.

Fig. - 4.7

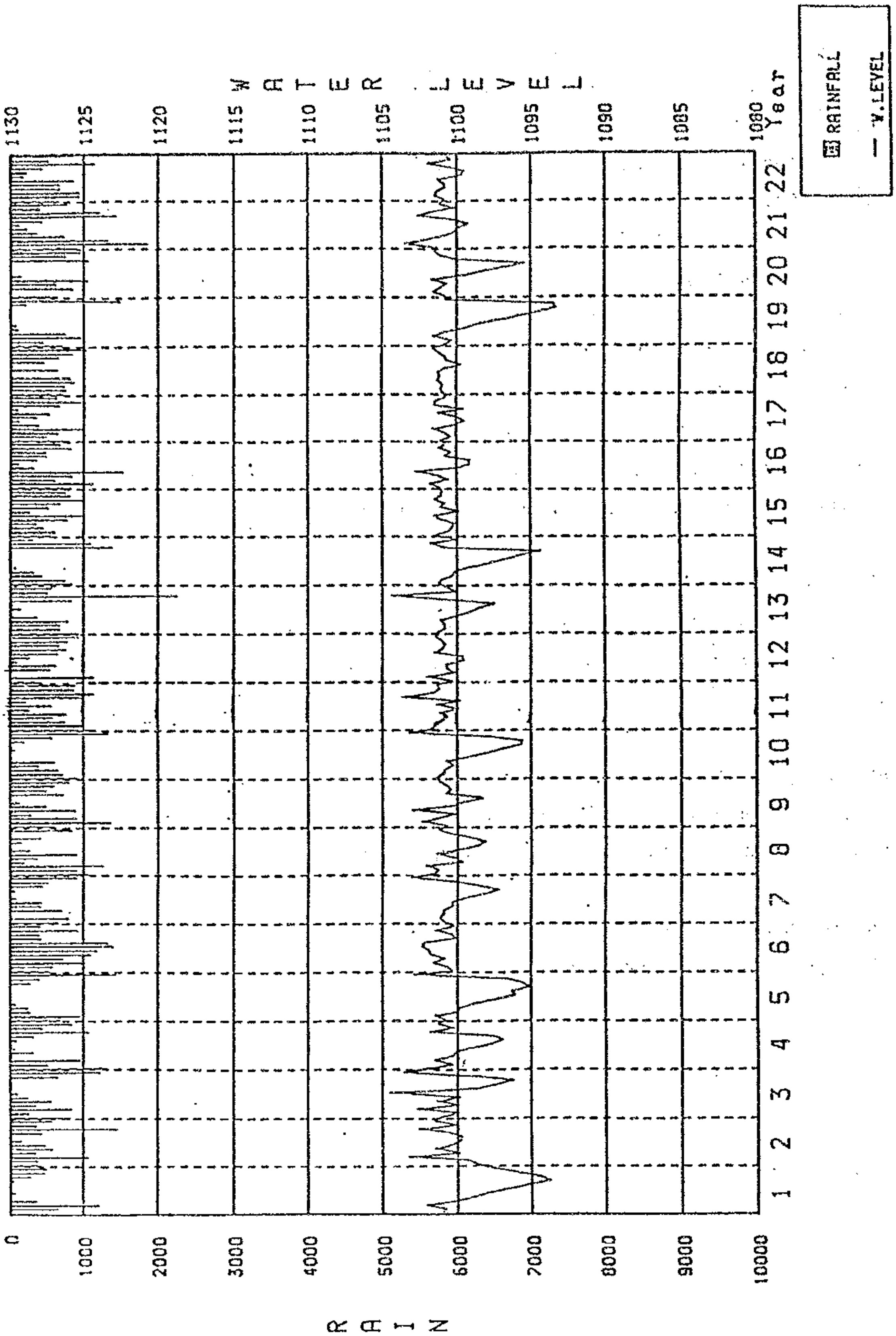


Fig. - 4.7 Simulation of Water Level in Crater Lake

4.4 Preliminary Design for Drainage Facilities

4.4.1 Design Criteria

The preliminary design criteria for drainage facilities on the crater lake are as follows:

1) The storage capacity of the lake shall be obtained from existing drawings, and its H - V curve shall be as shown in Fig. - 4.3.

2) The A line of the boring implementation lines shall be the center line of the countermeasure facilities. Crater lake water will be drained into S. Cibanjaran side.

3) All of the water stored in the crater lake will be drained, or the amount stored will be decreased so that there will be no damage should the Mt. Galunggung volcano eruption.

4) The design water level for the drainage of water shall be 1,082.5 m.

Design runoff sediment volume is 750,000 m^3/50 years. If sedimentation is considered to occur from the bottom of the lake, this elevation corresponds to EL 1,082.5 m on the H - V curve.

4.4.2 Alternative Plan

It is necessary that the water level of the crater lake be lowered at all times if the destruction of its walls and direct damage from volcanic eruptions are to be reduced.

The following points should be considered when planning facilities to drain water from the crater lake.

(i) There is a high temperature zone (Approx. 150 m sector).

(ii) The outer wall of the crater lake is loose.

(iii) There are cracks and traces of damage in the lock of the inner wall of the crater lake.

(iv) A generation of poisonous gas is expected.

(v) Transportation of Construction Materials

The conditions described above were taken into account and an alternative for the facilities to drain the crater lake was selected.

(1) Alternative I - A

By constructing a tunnel in the wall of the crater, the water in the crater lake can be drained. This method has been used before at Kelud volcano. The execution procedures for the drainage tunnel are as follows:

(i) A vertical shaft of 4.00 m is constructed in the inner wall of the crater lake. Several horizontal tunnels will be necessary to drain the lake water with syphons, and the vertical tunnel is to facilitate this work.

(ii) The main tunnel is constructed from the outer wall of the crater lake. The extension of this tunnel is approximately 300 m. The high temperature zone is distributed from the center to the crater lake side.

(iii) It is thought that it will be possible for the normal temperature zone to be executed using conventional methods. The execution in the high temperature zone will be performed using both the freezing method and the fan method (in which cold air is sent in).

(iv) When the execution of the tunnel is completed the water level of the crater lake will be lowered using syphons. The drain capabilities of various bores of syphon are shown in Table - 4.6.

(v) Because the drain capability of the syphon is the 8 m of the water pillar, several horizontal tunnels will be constructed and the water drained to the design level.

The typical section of drainage tunnel are as shown in Fig. - 4.4. Brief descriptions for Alternative II - A area as follows;

Tables - 4.6 Outline of Crater Lake Drainage Tunnel Work (Alternative II - A)

Facilities			Specification
Horizontal tunnels	No. 1	2,000	: Corrugate pipe - 25.0 m
	No. 2		Corrugate pipe - 35.0 m
	No. 3		Corrugate pipe - 45.0 m
	No. 4		Corrugate pipe - 378.0 m
Vertical shaft		4,000	: Corrugate pipe - 43.0 m
Boring operator	100 m	4.70 m	: Corrugate pipe - 5 m
Cooling plant *1)			1 unit

Note *) Capacity of refrigerating plant is 192,000 kcal/unit.

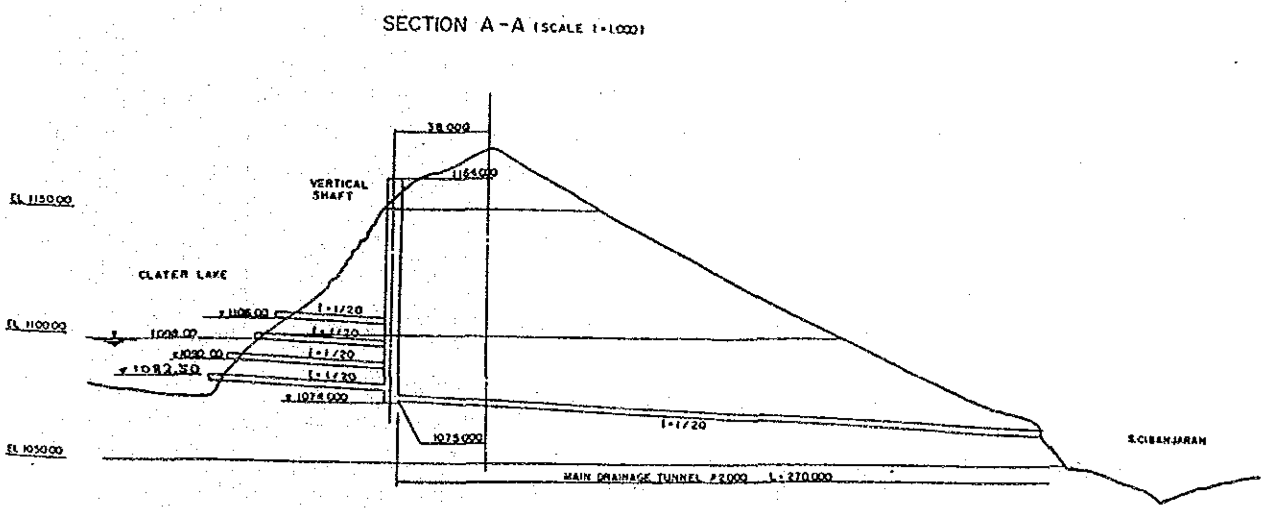


Fig. - 4.8 Drainage Tunnel (Alternative II-A)

(2) Alternative II - B

Excavating is performed to the elevation of the drain channel. Execution will be performed by machines or using cooling. Thus excavation may be easily executed in the high temperature zone.

The typical section of open cut is as shown in Fig. - 4.9. Brief description for Alternative II - B is shown in Table - 4.7.

Table - 4.7 Outline of Open Channel Work
(Alternative II - B)

Item	Quantity (m^3)
Excavation of sand and gravel by manpower	336,800
Excavation of sand and gravel by machine	505,000
Excavation of rock by machine	144,300
Excavation of rock by machine	216,400
Total	1,202,400
Transportation	1,442,900

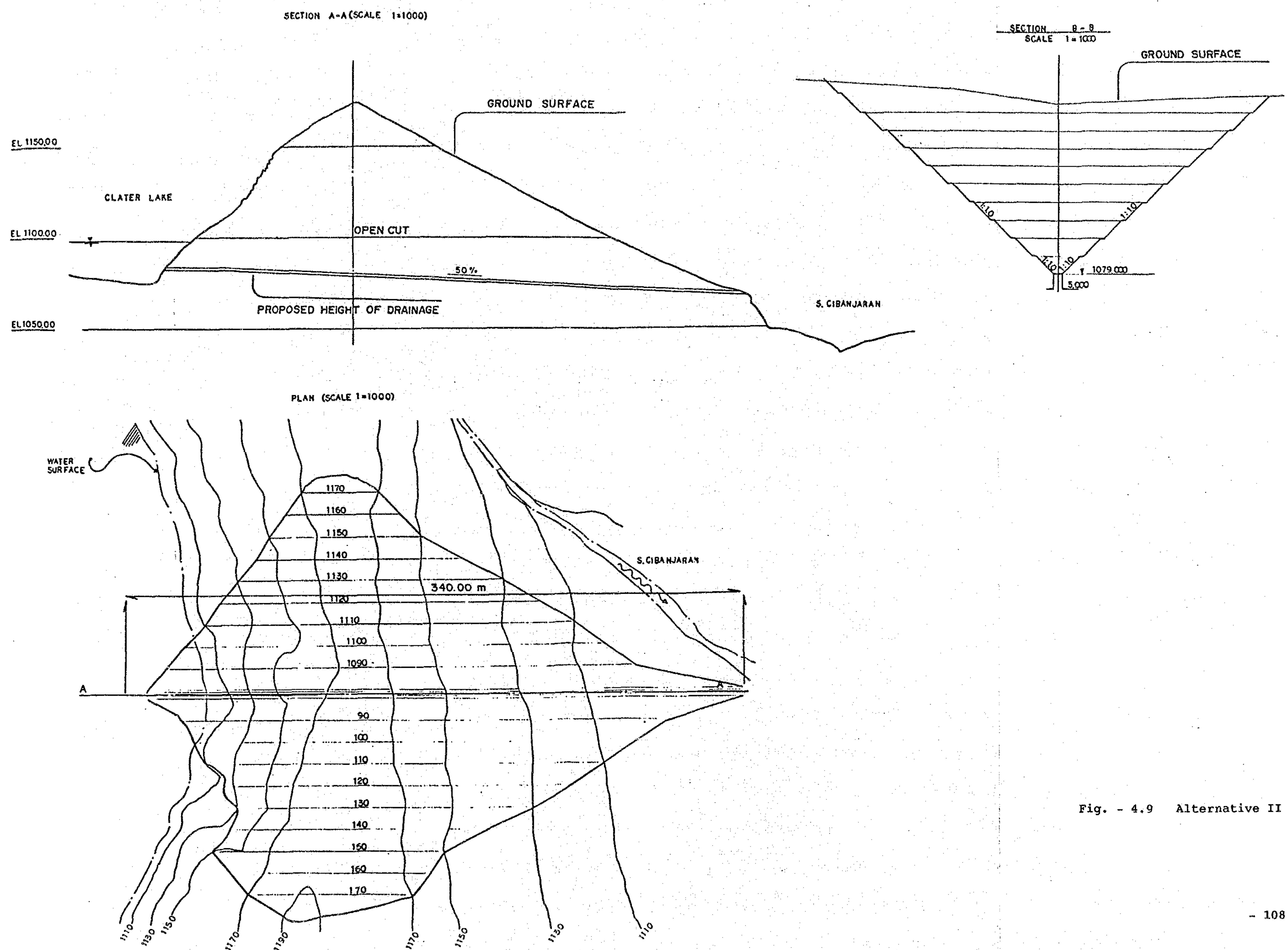


Fig. - 4.9 Alternative II - B (Open Cut)

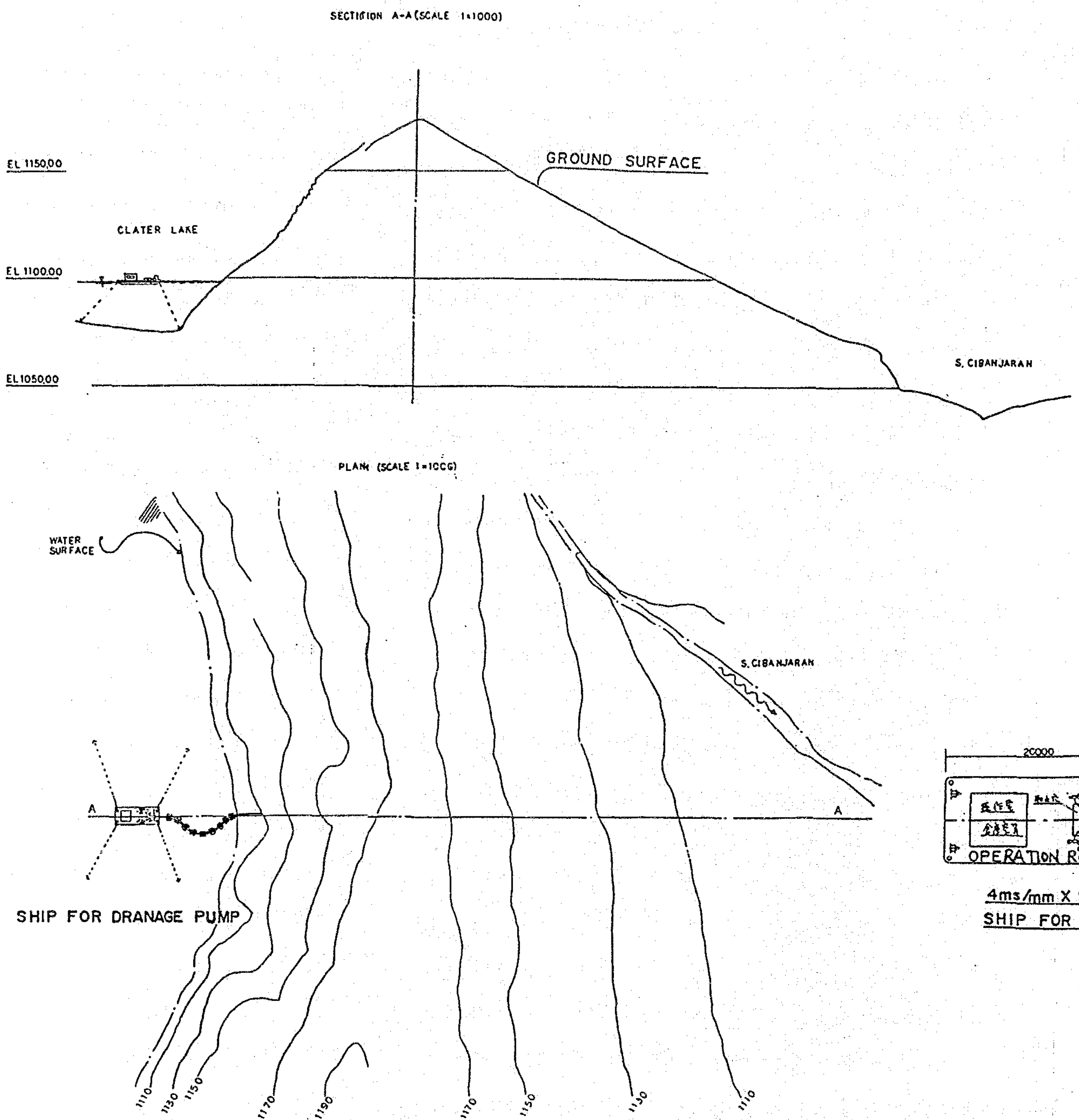
(3) Alternative II - C

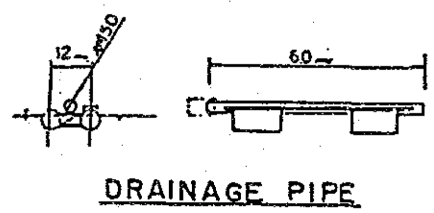
Drainage is performed using a pump, necessitating no excavation of the high temperature zone crater lake wall. If the discharge is to be the same as in syphoning, 6 pumps will be needed. Adding 3 reserves, this makes a total of 9 pumps. In this alternative it will be possible to drain 0.23 m^3/s.

The typical section of pump up is as shown in Fig. - 4.10. Brief description for Alternative II - C is shown in Table - 4.8.

Table - 4.8 Outline of Pumping Works (Alternative II - C)

Item	Specification	Quantity
Pump	Head 100 m Capacity 132 kw Diagram 20 mm	9 units
Control board	3.6 V 132 kw	9 units
Uncoming panel	7.2 kv	1 unit
Transpower board	1,000 kvA	1 unit
Piping material	600 mm	1 unit
Distributing material		





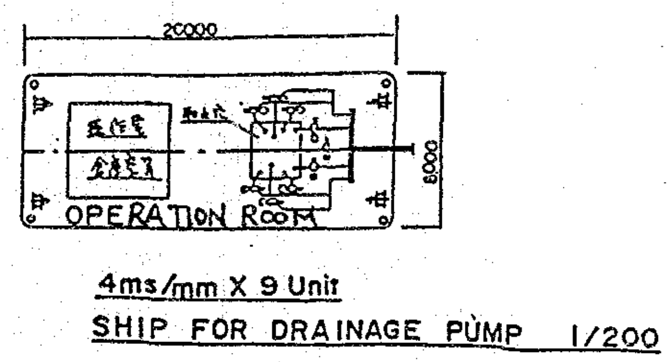


Fig. - 4.10 Drainage Pump (Alternative II - C)

4.4.3 Preliminary Cost Estimate

The preliminary cost estimate were made for major works such as excavation of tunnel, tunnel materials, open cut, transportation of material. The estimate costs included costs for construction work and procurement of materials and equipment. For the sake of comparative study of alternatives, the expenses needed for preconstruction work are to be included in the cost estimate; they are costs for land acquisition, government administration, engineering service, physical contingency, rice escalation and so on.

Cost summary of alternative are shown in Table - 4.9.
Breakdown cost of construction are indicated in Annex.

Table - 4.9 Comparison with Construction Cost for Alternatives

(Rp x 10^6)

	Alternative II - A	Alternative II - B	Alternative II - C
Construction Cost	2,640.6	7,370.6	4,630.5

4.5 Selection of Alternatives

The selection comparison of three alternatives are shown in Table - 4.10.

The countermeasure for crater lake is alternative II - A, to be adopted for drainage of crater lake by taking account the construction cost and maintenance.

Table - 4.10 Alternatives for Countermeasure for Crater Lake

Specification	Alternative II - A			Alternative II - B		Alternative II - C	
Specification	Tunnel (I) = 2.0 m		L = 383.0 m	Open channel	W = 1.5 m	Drainage pump	4 m^3/min 132 kw
	Vertical tunnel (II) = 4.0 m		L = 43.0 m			Pipe line	30 cm - 500 m
	Cooling Plant		2 units			Electric equipment	
Quantity	Excavation		2,483.0 m^3	Excavation	1,202,000 m^3	Excavation	800 m^3
	Corrugate pipe	2.0 m	383.0 m	Slope protection	40,700 m^3	Drainage pump	9 units
	Corrugate pipe	4.0 m	43.0 m	Transportation of sand & Gravel	1,443,000 m^3	Electric control board	9 units
	Cooling time		4,600 hour			Pipe line	500 mm
						Electric work	
Cost of Construction (Rp x 10^6)	2,640.6			7,370.7		4,630.5	
Selective Comparison of Alternative							

5. Disaster Prevention Project

The sediment control plans for the south-eastern slope basin of Mt. Galunggung were described in Chapter 3, drainage plans for the water stored in the crater lake were described in Chapter 4. Disaster prevention plans consist of these "hardware" plans, and also of "software" plans like the evacuation warning system.

Facility plans were investigated for each different basin and area to be conserved in the sediment control plans described in Chapter 3, though the details and processes were the same for some basins. Project units have been devised, taking into account the common nature of the disaster prevention countermeasures and their locations.

The measures called for in the disaster prevention project and the project units were as shown in Fig. - 5.1.

Project units were divided into sub units according to work schedules, areas, river basins etc.

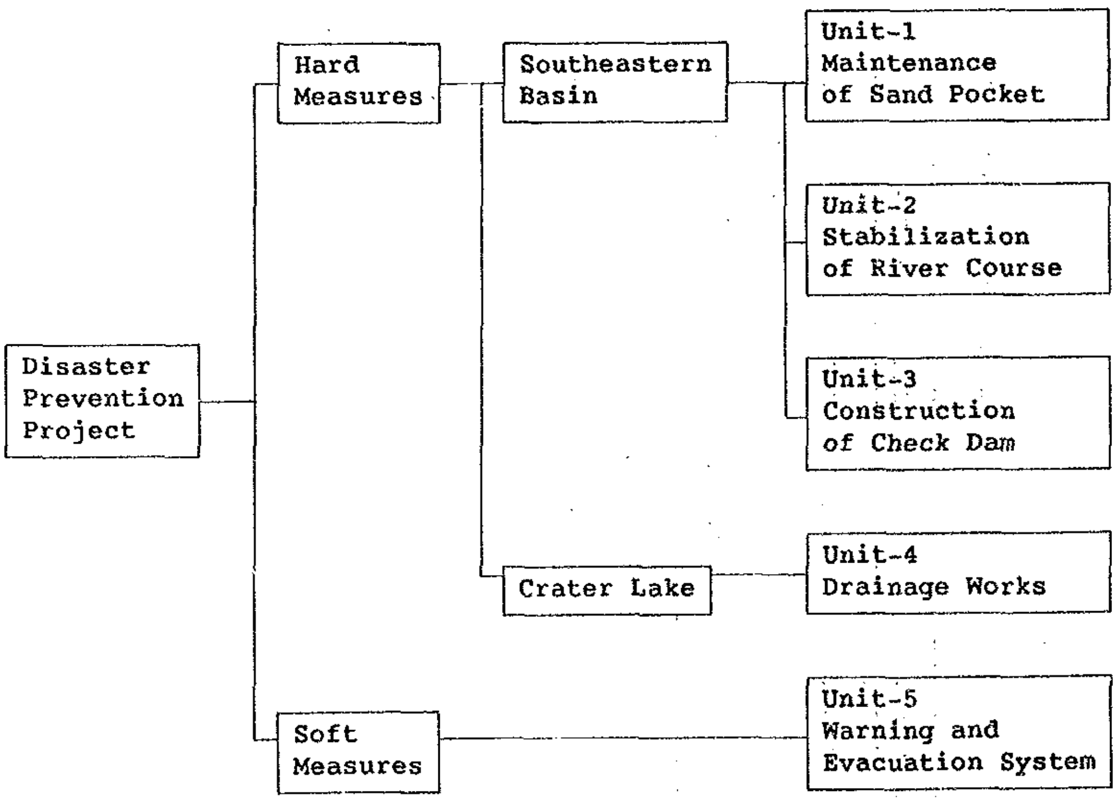


Fig. - 5.1 Classification of the Disaster Prevention Project into Project Units

Of the measures shown above, Unit 5 has already been introduced and is functioning in certain areas. However, data storage is not sufficient and the system is not yet up to its ultimate purposes: the issuance of alarms and warnings to evacuate. It was decided in the study to consider the system as being in the data accumulation stages, and we offer the following suggestions concerning its operation in the future.

The sub-units making up the project units have been compiled in Fig. - 5.2 by area and facilities involved.

There are two alternatives for project sub-unit 1-2. These alternatives was decided through the economic evaluation described in Supporting Report V.

The preliminary evaluation results for the disaster prevention project as of the meeting concerning the submission of the interim report is shown in Annex - 2.

The construction of check dam of S. Ciloseh (project sub-unit 1-3) in the S. Ciloseh basin area was excluded from the project unit because of no emergency by comparison of the sediment runoff characteristics in S. Ciloseh with its in S. Cimampang.

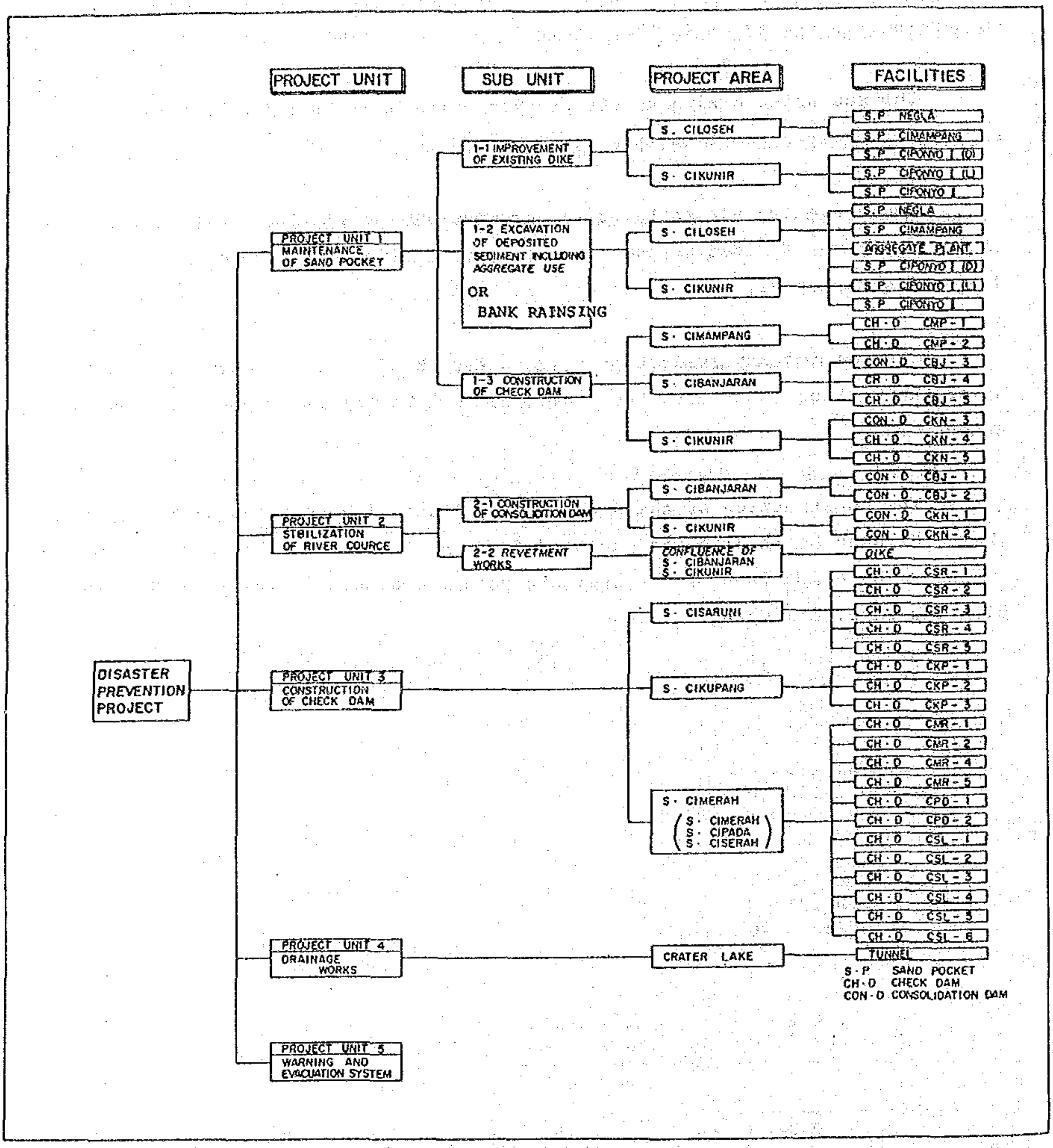


Fig. - 5.2 Project Unit on the Disaster Prevention Project and Its Area and Facilities

ANNEX - 1

CALCULATION RESULTS OF WATER LEVEL FLUCTUATION

IN CRATER LAKE OF MT. GALUNGGUNG

Table- Water Balance in CRATER LAKE

YEAR	MONTH	① Rainfall TASIKMALAYA	②* Rainfall CRATER LAKE	③ ② × 0.5 × 10.56	④ Infilt. a (mm)	⑤ Infilt. b (mm)	⑥ Storage Dep. (mm)	⑦ VOLUME OF CRATER LAKE	ELEVATION EL. (m)
								4,973,351	1,099.70
	JAN	241	530	2,799	0	1,482	25,037	5,427,931	1,100.95
	FEB	299	658	3,473	2,210	1,495	24,805	5,349,051	1,100.74
	MAR	558	1,228	6,482	3,579	1,529	26,178	5,815,871	1,102.02
	APR	170	374	1,975	2,632	1,506	24,015	5,080,451	1,100.00
	MAY	22	48	256	0	1,408	22,865	4,689,451	1,098.85
	JUN	40	88	465	0	1,345	21,984	4,389,911	1,097.91
1983	JUL	1	2	12	0	1,281	20,715	3,958,451	1,096.49
	AUG	0	0	0	0	1,207	19,509	3,548,411	1,095.07
	SEP	5	11	58	0	1,138	18,429	3,181,211	1,093.73
	OCT	136	299	1,580	0	1,120	18,889	3,337,611	1,094.30
	NOV	216	475	2,509	0	1,173	20,225	3,791,851	1,095.92
	DEC	232	510	2,695	0	1,257	21,663	4,260,771	1,097.57
	JAN	195	429	2,265	0	1,328	22,600	4,599,351	1,098.57
	FEB	178	392	2,068	0	1,377	23,291	4,834,291	1,099.30
	MAR	491	1,080	5,703	0	1,523	27,471	6,255,401	1,103.24
	APR	164	361	1,905	3,986	1,540	23,850	5,024,351	1,098.84
	MAY	273	601	3,171	0	1,482	25,540	5,598,951	1,101.42
	JUN	224	493	2,602	2,282	1,497	24,362	5,198,431	1,100.32
1984	JUL	78	172	906	103	1,443	23,723	4,981,171	1,099.72
	AUG	118	260	1,371	0	1,422	23,672	4,963,831	1,099.67
	SEP	198	436	2,300	0	1,446	24,526	5,254,191	1,100.49
	OCT	666	1,465	7,736	3,954	1,539	26,769	6,018,811	1,102.58
	NOV	171	376	1,986	3,274	1,522	23,959	5,061,411	1,099.94
	DEC	271	596	3,148	0	1,487	25,620	5,626,151	1,101.50
	JAN	385	847	4,472	3,375	1,524	25,193	5,480,971	1,101.10
	FEB	127	279	1,475	1,302	1,473	23,893	5,038,971	1,099.88
	MAR	389	856	4,519	0	1,523	26,888	6,057,271	1,102.69
	APR	169	372	1,963	3,390	1,525	23,937	5,053,931	1,099.92
	MAY	258	568	2,997	0	1,482	25,452	5,569,031	1,101.34
	JUN	122	268	1,417	1,550	1,479	23,840	5,020,951	1,099.83
1985	JUL	56	123	650	0	1,578	28,767	6,696,131	1,104.46
	AUG	0	0	0	4,355	1,549	22,863	4,688,771	1,098.85
	SEP	3	7	35	0	1,333	21,565	4,247,451	1,097.47
	OCT	16	35	186	0	1,262	20,499	3,881,611	1,096.23
	NOV	305	671	3,543	0	1,297	22,735	4,645,251	1,098.71
	DEC	563	1,239	6,540	0	1,515	27,761	6,354,091	1,103.51
	JAN	594	1,307	6,900	6,985	1,615	28,061	5,776,091	1,101.92
	FEB	239	526	2,776	2,937	1,513	24,367	5,206,931	1,100.34
	MAR	441	970	5,123	2,398	1,500	25,612	5,623,431	1,101.49
	APR	222	488	2,579	2,347	1,499	24,345	5,192,651	1,100.30
	MAY	149	328	1,731	527	1,453	24,095	5,107,651	1,100.07
	JUN	37	81	430	0	1,416	23,109	4,772,411	1,099.11
1986	JUL	5	11	58	0	1,348	21,819	4,333,811	1,097.74
	AUG	49	108	569	0	1,288	21,100	4,089,351	1,096.94
	SEP	154	339	1,789	0	1,281	21,608	4,262,071	1,097.52
	OCT	492	1,082	5,715	0	1,425	25,898	5,720,671	1,101.78
	NOV	206	453	2,393	2,555	1,504	24,232	5,154,231	1,100.20
	DEC	390	858	4,530	1,912	1,488	25,382	5,538,431	1,101.26
	JAN	316	695	3,671	2,866	1,507	24,860	5,367,751	1,100.79
	FEB	439	966	5,099	2,895	1,512	25,552	5,603,031	1,101.44
	MAR	134	295	1,557	1,733	1,483	23,892	5,038,631	1,099.88
	APR	116	255	1,347	0	1,431	23,808	5,010,071	1,099.80
	MAY	41	90	476	0	1,401	22,884	4,695,911	1,098.87
	JUN	2	4	23	0	1,334	21,573	4,250,171	1,097.47
1987	JUL	3	7	35	0	1,258	20,350	3,834,351	1,096.07
	AUG	12	26	139	0	1,226	20,520	3,892,151	1,096.26
	SEP	16	35	186	0	1,201	19,505	3,547,051	1,095.07
	OCT	134	295	1,557	0	1,182	19,881	3,674,891	1,095.52
	NOV	188	414	2,184	0	1,222	20,843	4,001,971	1,096.63
	DEC	661	1,454	7,678	0	1,438	27,083	6,123,571	1,102.87
	JAN	245	539	2,846	4,075	1,542	24,312	5,181,431	1,100.27
	FEB	269	592	3,125	1,243	1,471	24,723	5,321,171	1,100.66
	MAR	463	1,019	5,378	2,898	1,512	25,691	5,650,291	1,101.57
	APR	333	733	3,868	3,127	1,516	24,914	5,386,111	1,100.84
	MAY	506	1,113	5,878	3,372	1,524	25,996	5,719,991	1,101.76
	JUN	544	1,197	6,319	4,865	1,557	25,992	5,752,631	1,101.85
1988	JUL	646	1,421	7,504	5,407	1,575	26,514	5,930,111	1,102.34
	AUG	614	1,351	7,132	5,768	1,584	26,293	5,854,971	1,102.13
	SEP	201	442	2,335	2,950	1,514	24,165	5,131,451	1,100.14
	OCT	188	414	2,184	578	1,454	24,317	5,183,131	1,100.28
	NOV	427	939	4,960	2,235	1,498	25,546	5,600,991	1,101.43
	DEC	194	427	2,254	2,102	1,493	24,206	5,145,391	1,100.17

Table- Water Balance in CRATER LAKE

YEAR	MONTH	① Rainfall TASIKMALAYA	②* Rainfall CRATER LAKE	③ =② X 0.5 x 10.56	④ Infilt. a (mm)	⑤ Infilt. b (mm)	⑥ Storage Dep. (mm)	⑦ VOLUME OF CRATER LAKE	ELEVATION EL.(m)
	JAN	305	671	3,543	1,353	1,474	24,922	5,386,831	1,100.85
	FEB	369	812	4,286	2,524	1,503	25,181	5,476,891	1,101.09
	MAR	330	726	3,833	2,559	1,504	24,951	5,398,691	1,100.87
	APR	326	717	3,787	2,287	1,497	24,954	5,399,711	1,100.88
	MAY	198	436	2,300	1,490	1,477	24,287	5,172,931	1,100.25
	JUN	199	438	2,312	778	1,459	24,361	5,198,091	1,100.32
1969	JUL	47	103	546	0	1,435	23,472	4,895,831	1,099.48
	AUG	10	22	116	0	1,371	22,218	4,469,471	1,098.16
	SEP	39	86	453	0	1,307	21,363	4,178,771	1,097.24
	OCT	210	462	2,439	0	1,316	22,487	4,560,931	1,098.45
	NOV	244	537	2,834	0	1,392	23,928	5,050,871	1,099.91
	DEC	424	933	4,925	0	1,537	27,316	6,202,791	1,103.09
	JAN	487	1,071	5,657	5,838	1,586	25,549	5,602,011	1,101.44
	FEB	421	926	4,890	3,524	1,528	25,387	5,546,931	1,101.28
	MAR	580	1,276	6,737	4,543	1,549	26,232	5,834,231	1,102.08
	APR	98	216	1,138	2,240	1,496	23,634	4,950,911	1,099.64
	MAY	176	387	2,044	0	1,438	24,242	5,157,831	1,100.21
	JUN	416	915	4,832	2,086	1,492	25,498	5,583,991	1,101.38
1970	JUL	130	286	1,510	1,645	1,481	23,877	5,033,531	1,099.87
	AUG	7	15	81	0	1,393	22,565	4,587,451	1,098.53
	SEP	80	176	929	0	1,342	22,152	4,447,031	1,098.09
	OCT	194	427	2,254	0	1,356	23,050	4,752,351	1,099.05
	NOV	245	539	2,846	0	1,426	24,471	5,235,491	1,100.42
	DEC	384	845	4,461	2,131	1,493	25,305	5,519,051	1,101.21
	JAN	288	634	3,345	2,429	1,503	24,720	5,320,151	1,100.66
	FEB	625	1,375	7,260	3,806	1,538	26,536	5,937,591	1,102.36
	MAR	416	915	4,832	4,554	1,554	25,260	5,503,751	1,101.16
	APR	140	308	1,626	1,456	1,476	23,953	5,059,371	1,099.94
	MAY	409	900	4,751	0	1,534	27,171	6,153,491	1,102.96
	JUN	231	508	2,683	4,081	1,542	24,230	5,153,551	1,100.20
1971	JUL	58	128	674	0	1,431	23,473	4,896,171	1,099.49
	AUG	20	44	232	0	1,374	22,331	4,507,891	1,098.28
	SEP	332	730	3,857	0	1,413	24,775	5,338,851	1,100.71
	OCT	230	506	2,672	1,497	1,477	24,473	5,236,171	1,100.43
	NOV	278	612	3,229	1,471	1,477	24,754	5,331,711	1,100.69
	DEC	372	818	4,321	2,361	1,499	25,214	5,488,111	1,101.12
	JAN	422	928	4,902	3,170	1,519	25,427	5,560,531	1,101.32
	FEB	333	733	3,868	2,843	1,511	24,842	5,395,631	1,100.86
	MAR	305	671	3,543	2,145	1,494	24,846	5,362,991	1,100.77
	APR	185	407	2,149	1,292	1,472	24,231	5,153,891	1,100.20
	MAY	274	603	3,183	1,186	1,470	24,759	5,333,071	1,100.69
	JUN	4	9	46	65	1,442	23,297	4,836,331	1,099.31
1972	JUL	12	26	139	0	1,361	22,075	4,420,851	1,098.01
	AUG	36	79	418	0	1,298	21,195	4,121,651	1,097.05
	SEP	2	4	23	0	1,235	19,982	3,709,231	1,095.64
	OCT	97	213	1,127	0	1,197	19,912	3,685,431	1,095.56
	NOV	267	587	3,101	0	1,250	21,763	4,314,771	1,097.68
	DEC	613	1,349	7,121	0	1,475	27,409	6,234,411	1,103.18
	JAN	534	1,175	6,209	6,232	1,596	25,784	5,681,911	1,101.66
	FEB	446	981	5,181	3,933	1,538	25,494	5,583,311	1,101.38
	MAR	347	763	4,031	3,002	1,515	25,008	5,418,071	1,100.93
	APR	274	603	3,183	2,023	1,491	24,678	5,305,871	1,100.62
	MAY	352	774	4,089	2,155	1,494	25,118	5,455,471	1,101.03
	JUN	126	277	1,464	1,216	1,470	23,895	5,039,651	1,099.88
1973	JUL	260	572	3,020	0	1,480	25,436	5,563,251	1,101.33
	AUG	109	240	1,266	1,451	1,476	23,774	4,998,511	1,099.77
	SEP	459	1,010	5,332	0	1,540	27,568	6,287,791	1,103.33
	OCT	521	1,146	6,052	6,319	1,598	25,700	5,653,351	1,101.58
	NOV	399	878	4,635	3,549	1,529	25,257	5,502,731	1,101.16
	DEC	411	904	4,774	3,147	1,519	25,365	5,539,451	1,101.26
	JAN	200	440	2,323	1,945	1,489	24,255	5,162,051	1,100.22
	FEB	521	1,146	6,052	2,756	1,509	26,042	5,769,631	1,101.90
	MAR	200	440	2,323	2,873	1,507	24,185	5,138,251	1,100.15
	APR	256	563	2,974	1,025	1,468	24,669	5,302,811	1,100.61
	MAY	288	634	3,345	1,745	1,484	24,785	5,342,251	1,100.72
	JUN	50	110	581	383	1,450	23,534	4,916,911	1,099.54
1974	JUL	126	277	1,464	0	1,414	23,584	4,933,911	1,099.59
	AUG	301	662	3,496	0	1,476	25,605	5,621,051	1,101.49
	SEP	350	770	4,066	3,140	1,519	25,012	5,419,431	1,100.93
	OCT	310	682	3,601	2,252	1,496	24,865	5,369,451	1,100.79
	NOV	360	792	4,182	2,406	1,500	25,140	5,462,951	1,101.05
	DEC	431	949	5,008	3,119	1,519	25,508	5,588,071	1,101.40

Table- Water Balance in CRATER LAKE

YEAR	MONTH	① Rainfall TASIKMALAYA	②* Rainfall CRATER LAKE	③ *② X 0.5 x 10.56	④ Infilt. a (mm)	⑤ Infilt. b (mm)	⑥ Storage Dep. (mm)	⑦ VOLUME OF CRATER LAKE	ELEVATION EL.(m)
	JAN	418	920	4,855	3,461	1,527	25,376	5,543,191	1,101.27
	FEB	312	686	3,624	2,656	1,506	24,837	5,359,931	1,100.76
	MAR	312	686	3,624	2,077	1,492	24,893	5,378,971	1,100.82
	APR	363	799	4,217	2,455	1,501	25,153	5,467,371	1,101.06
	MAY	169	372	1,963	1,523	1,478	24,116	5,114,791	1,100.09
	JUN	34	75	395	0	1,416	23,094	4,767,311	1,099.09
1975	JUL	71	156	825	0	1,369	22,550	4,582,351	1,099.52
	AUG	28	62	325	0	1,323	21,552	4,243,031	1,097.46
	SEP	385	847	4,472	0	1,386	24,638	5,292,271	1,100.56
	OCT	1032	2,270	11,988	6,363	1,599	28,664	6,661,111	1,104.36
	NOV	234	515	2,718	5,706	1,563	24,092	5,106,631	1,100.07
	DEC	264	581	3,067	975	1,464	24,720	5,320,151	1,100.66
	JAN	388	854	4,507	2,425	1,501	25,301	5,517,691	1,101.20
	FEB	345	759	4,008	2,782	1,510	25,017	5,421,131	1,100.94
	MAR	201	442	2,335	1,577	1,479	24,296	5,175,991	1,100.26
	APR	151	332	1,754	488	1,452	24,110	5,112,751	1,100.08
	MAY	39	86	453	0	1,418	23,146	4,784,991	1,099.15
	JUN	13	29	151	0	1,353	21,944	4,376,311	1,097.87
1976	JUL	16	35	186	0	1,294	20,846	4,002,991	1,096.64
	AUG	32	70	372	0	1,225	19,893	3,712,971	1,095.65
	SEP	4	9	46	0	1,166	18,873	3,332,171	1,094.28
	OCT	636	1,404	7,411	0	1,315	24,969	5,404,811	1,100.89
	NOV	506	1,113	5,878	3,431	1,526	25,890	5,717,951	1,101.75
	DEC	147	323	1,708	2,179	1,494	23,925	5,049,851	1,099.91
	JAN	278	612	3,229	0	1,488	25,665	5,641,791	1,101.54
	FEB	281	618	3,264	2,775	1,509	24,646	5,294,991	1,100.59
	MAR	206	453	2,393	1,208	1,470	24,361	5,198,091	1,100.32
	APR	166	365	1,928	651	1,456	24,182	5,137,231	1,100.15
	MAY	358	788	4,159	1,659	1,481	25,201	5,483,691	1,101.11
	JUN	458	1,008	5,320	3,380	1,524	25,616	5,624,791	1,101.50
1978	JUL	128	282	1,487	1,765	1,484	23,854	5,025,711	1,099.84
	AUG	239	526	2,776	0	1,470	25,160	5,469,751	1,101.07
	SEP	317	697	3,682	2,455	1,501	24,886	5,376,591	1,100.81
	OCT	447	983	5,192	2,972	1,514	25,591	5,616,291	1,101.47
	NOV	374	823	4,344	3,275	1,522	25,138	5,462,271	1,101.05
	DEC	346	761	4,019	2,613	1,505	25,039	5,428,611	1,100.96
	JAN	382	840	4,437	2,731	1,508	25,237	5,495,931	1,101.14
	FEB	518	1,140	6,017	3,794	1,535	25,925	5,729,851	1,101.79
	MAR	283	623	3,287	3,067	1,517	24,630	5,289,551	1,100.57
	APR	384	845	4,461	2,303	1,496	25,290	5,513,951	1,101.19
	MAY	703	1,547	8,166	5,007	1,565	26,883	6,055,571	1,102.69
	JUN	152	334	1,766	3,278	1,522	23,849	5,024,011	1,029.84
1979	JUL	58	128	674	0	1,409	23,114	4,774,111	1,099.12
	AUG	168	370	1,951	0	1,403	23,662	4,760,431	1,099.07
	SEP	228	502	2,649	0	1,455	24,654	5,365,711	1,100.78
	OCT	223	491	2,590	1,538	1,478	24,428	5,220,871	1,100.38
	NOV	379	834	4,402	2,054	1,491	25,284	5,511,911	1,101.18
	DEC	314	691	3,647	2,570	1,504	24,857	5,366,731	1,100.78
	JAN	356	783	4,135	2,373	1,499	25,120	5,456,151	1,101.03
	FEB	227	499	2,637	1,850	1,486	24,421	5,218,491	1,100.38
	MAR	300	660	3,485	1,554	1,479	24,874	5,372,511	1,100.80
	APR	464	1,021	5,390	3,066	1,517	25,681	5,648,891	1,101.56
	MAY	180	396	2,091	2,160	1,494	24,119	5,115,811	1,100.09
	JUN	64	141	743	0	1,426	23,435	4,883,251	1,099.45
1980	JUL	164	361	1,905	0	1,421	23,919	5,047,811	1,099.90
	AUG	242	532	2,811	0	1,475	25,255	5,502,051	1,101.16
	SEP	52	114	604	901	1,463	23,496	4,903,991	1,099.51
	OCT	306	673	3,554	0	1,472	25,577	5,611,531	1,101.46
	NOV	440	968	5,111	3,873	1,532	25,483	5,579,571	1,101.37
	DEC	293	645	3,403	2,653	1,506	24,727	5,322,531	1,100.66
	JAN	330	726	3,833	2,070	1,492	24,998	5,414,671	1,100.92
	FEB	350	770	4,066	2,487	1,502	25,075	5,440,851	1,100.99
	MAR	338	744	3,926	2,494	1,502	25,004	5,416,711	1,100.92
	APR	399	878	4,635	2,800	1,510	25,329	5,527,211	1,101.23
	MAY	374	823	4,344	2,993	1,515	25,165	5,471,451	1,101.07
	JUN	403	887	4,681	2,998	1,515	25,333	5,528,571	1,101.23
1981	JUL	295	649	3,427	2,504	1,503	24,754	5,331,711	1,100.69
	AUG	86	189	999	574	1,454	23,725	4,981,851	1,099.72
	SEP	209	460	2,428	0	1,453	24,700	5,313,351	1,100.64
	OCT	305	671	3,543	1,885	1,487	24,871	5,371,491	1,100.80
	NOV	387	851	4,495	2,581	1,505	25,280	5,510,551	1,101.18
	DEC	477	1,049	5,541	3,567	1,529	25,693	5,650,971	1,101.57

Table- Water Balance in CRATER LAKE

YEAR	MONTH	① Rainfall TASIKMALAYA	②* Rainfall CRATER LAKE	③ =② X 0.5 x 10.56	④ Infilt. a (mm)	⑤ Infilt. b (mm)	⑥ Storage Dep. (mm)	⑦ VOLUME OF CRATER LAKE	ELEVATION EL.(m)
	JAN	326	717	3,787	3,085	1,517	24,678	5,373,871	1,100.80
	FEB	209	460	2,426	1,476	1,477	24,353	5,195,371	1,100.31
	MAR	442	972	5,134	2,367	1,499	25,620	5,626,151	1,101.50
	APR	347	763	4,031	3,138	1,518	24,995	5,413,651	1,100.91
	MAY	53	117	616	627	1,456	23,528	4,914,871	1,099.54
	JUN	41	90	476	0	1,384	22,619	4,605,811	1,098.59
1982	JUL	4	9	46	0	1,319	21,348	4,172,991	1,097.22
	AUG	0	0	0	0	1,243	20,103	3,750,371	1,095.78
	SEP	4	9	46	0	1,172	18,977	3,367,531	1,094.41
	OCT	12	26	139	0	1,109	18,006	3,037,391	1,093.22
	NOV	105	231	1,220	0	1,084	18,142	3,083,631	1,093.38
	DEC	685	1,507	7,957	0	1,289	24,810	5,350,751	1,100.74
	JAN	297	653	3,450	1,954	1,489	24,818	5,353,471	1,100.75
	FEB	453	997	5,262	2,937	1,513	25,830	5,829,551	1,101.51
	MAR	391	860	4,542	3,423	1,526	25,223	5,491,171	1,101.13
	APR	285	627	3,311	2,323	1,498	24,713	5,317,771	1,100.65
	MAY	485	1,067	5,834	3,024	1,518	25,807	5,689,731	1,101.68
	JUN	72	158	836	1,620	1,480	23,543	4,919,931	1,099.55
1983	JUL	10	22	116	0	1,375	22,284	4,491,911	1,098.23
	AUG	0	0	0	0	1,298	20,986	4,050,591	1,096.80
	SEP	0	0	0	0	1,222	19,763	3,634,771	1,095.38
	OCT	486	1,069	5,645	0	1,316	24,093	5,106,971	1,100.07
	NOV	348	766	4,042	1,900	1,477	25,157	5,468,731	1,101.07
	DEC	440	968	5,111	3,221	1,521	25,527	5,594,531	1,101.41
	JAN	425	935	4,937	3,525	1,528	25,411	5,555,091	1,101.31
	FEB	857	1,885	9,955	6,100	1,593	27,673	6,324,171	1,103.43
	MAR	612	1,346	7,109	7,009	1,615	26,183	5,810,771	1,102.01
	APR	338	744	3,926	3,666	1,532	24,892	5,378,631	1,100.82
	MAY	170	374	1,975	1,248	1,471	24,148	5,125,671	1,100.12
	JUN	112	246	1,301	84	1,442	23,922	5,048,831	1,099.91
1984	JUL	64	141	743	0	1,415	23,250	4,820,351	1,099.26
	AUG	200	440	2,323	0	1,422	24,151	5,126,891	1,100.12
	SEP	661	1,454	7,678	3,519	1,528	26,782	6,021,231	1,102.59
	OCT	562	1,236	6,528	5,732	1,583	25,995	5,753,651	1,101.85
	NOV	187	411	2,172	2,541	1,504	24,123	5,117,171	1,100.10
	DEC	360	792	4,182	1,807	1,480	25,217	5,489,131	1,101.12
	JAN	310	682	3,601	2,473	1,502	24,844	5,361,971	1,100.77
	FEB	432	950	5,018	2,833	1,511	25,517	5,591,131	1,101.41
	MAR	433	953	5,030	3,565	1,529	25,453	5,569,371	1,101.34
	APR	309	680	3,589	2,721	1,508	24,814	5,352,111	1,100.75
	MAY	309	680	3,589	2,032	1,491	24,880	5,374,551	1,100.81
	JUN	395	869	4,588	2,641	1,506	25,321	5,524,491	1,101.22
1985	JUL	87	191	1,011	1,191	1,470	23,671	4,963,491	1,099.67
	AUG	110	242	1,278	0	1,416	23,533	4,916,571	1,099.54
	SEP	201	442	2,335	0	1,439	24,429	5,221,211	1,100.38
	OCT	525	1,155	6,098	2,969	1,514	26,045	5,770,651	1,101.90
	NOV	241	530	2,799	2,932	1,513	24,399	5,211,011	1,100.36
	DEC	317	697	3,682	1,635	1,481	24,964	5,403,111	1,100.89

* ② = ① x 2.2

⑥ = ③ - ④ - ⑤

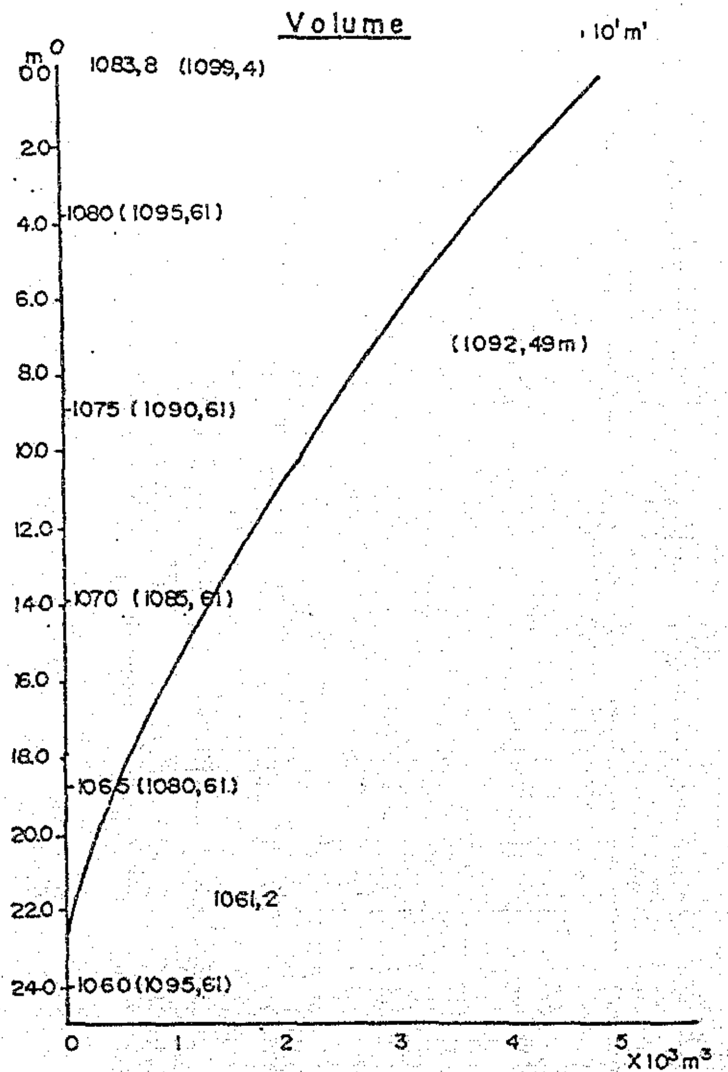


Fig. Waterlevel - water Volume Curve of Crater lake

Table- Water level - Water volume Curve of CRATER LAKE

ELEVATION (m)	DEPTH (m)	AREA (m²)	VOLUME (m3)	SUM OF VOL. (m3)
1.076.01	0	0		
1.076.41	0.4	39.970	7.994	7.994
1.077.41	1.4	83.030	61.500	69.494
1.079.41	3.4	126.260	209.310	278.804
1.081.41	5.4	154.570	280.850	559.654
1.083.41	7.4	182.810	337.380	897.034
1.085.41	9.4	197.150	379.960	1.276.994
1.087.41	11.4	209.610	406.760	1.683.754
1.089.41	13.4	223.190	432.800	2.116.554
1.091.41	15.4	244.430	467.620	2.504.174
1.093.41	17.4	264.980	509.410	3.093.584
1.095.41	19.4	280.090	548.070	3.641.654
1.097.41	21.4	303.270	586.810	4.228.464
1.099.41	23.4	336.100	639.820	4.868.284
1.105.61	29.6	388.500	2.246.260	7.114.544
1.115.61	39.6	477.780	4.331.400	11.445.944
1.125.61	49.6	571.500	5.246.400	16.692.344
1.135.61	59.6	650.500	6.110.000	22.802.344
1.145.61	69.6	716.000	6.832.000	29.634.844
1.155.61	79.6	766.000	7.410.000	37.044.844
1.165.61	89.6	822.000	7.940.000	44.984.844
1.175.61	99.6	918.300	8.701.500	53.686.344

Table-　　Water Balance in CRATER LAKE

YEAR	MONTH	① Rainfall (TASIKMALAYA)	②* Rainfall (CRATER LAKE)	③ = ② X 0.5 x 10.56	④ Infilt. a (mm)	⑤ Infilt. b (mm)	⑥ Storage Dep. (mm)	⑦ VOLUME OF CRATER LAKE	ELEVATION EL.(m)
1986	15/Jun							4,973,351	1,099.70
	15/Jul	308	678	3,578	0	1,485	25,795	5,685,651	1,101.66
	15/Aug	439	966	5,099	3,902	1,538	25,456	5,570,391	1,101.35
	15/Sep	145	319	1,684	1,098	1,482	23,959	5,061,411	1,099.94
	01/Nov	1091	2,400	12,673	0	1,765	34,867	8,770,131	1,109.43
	01/Dec	421	926	4,890	13,552	1,779	24,426	5,220,191	1,100.38
1987	01/Jan	196	431	2,277	908	1,463	24,331	5,187,891	1,100.29
	01/Feb	498	1,096	5,785	2,695	1,507	25,916	5,726,451	1,101.78
	01/Mar	480	1,056	5,576	4,287	1,547	25,657	5,638,791	1,101.54
	14/Apr	637	1,401	7,399	4,989	1,565	26,500	5,925,351	1,102.33
	15/May	126	277	1,464	2,703	1,508	23,752	4,991,031	1,099.75
	10/Jun	122	268	1,417	0	1,425	23,743	4,987,971	1,099.74
	08/Jul	0	0	0	0	1,383	22,360	4,517,751	1,098.31
	22/Jul	148	326	1,719	0	1,353	22,728	4,642,871	1,098.70
	20/Aug	0	0	0	0	1,324	21,404	4,192,711	1,097.29
	27/Aug	0	0	0	0	1,247	20,157	3,768,731	1,095.94
	15/Sep	0	0	0	0	1,174	18,983	3,369,571	1,094.42
	27/Sep	0	0	0	0	1,106	17,877	2,993,531	1,093.07
	06/Oct	10	22	116	0	1,045	16,948	2,677,671	1,092.00
	13/Oct	27	59	314	0	996	16,264	2,445,111	1,091.10
	30/Oct	0	0	0	0	947	15,317	2,123,131	1,089.44
	10/Nov	74	163	860	0	917	15,260	2,103,751	1,089.35
	19/Nov	10	22	116	0	892	14,484	1,839,911	1,088.13
	29/Nov	253	557	2,939	0	929	16,496	2,523,991	1,091.48
	10/Dec	222	488	2,579	0	1,038	18,037	3,047,931	1,093.25
	28/Dec	195	429	2,265	0	1,117	19,185	3,438,251	1,094.67

* ② = ① x 2.2

⑥ = ③ - ④ - ⑤

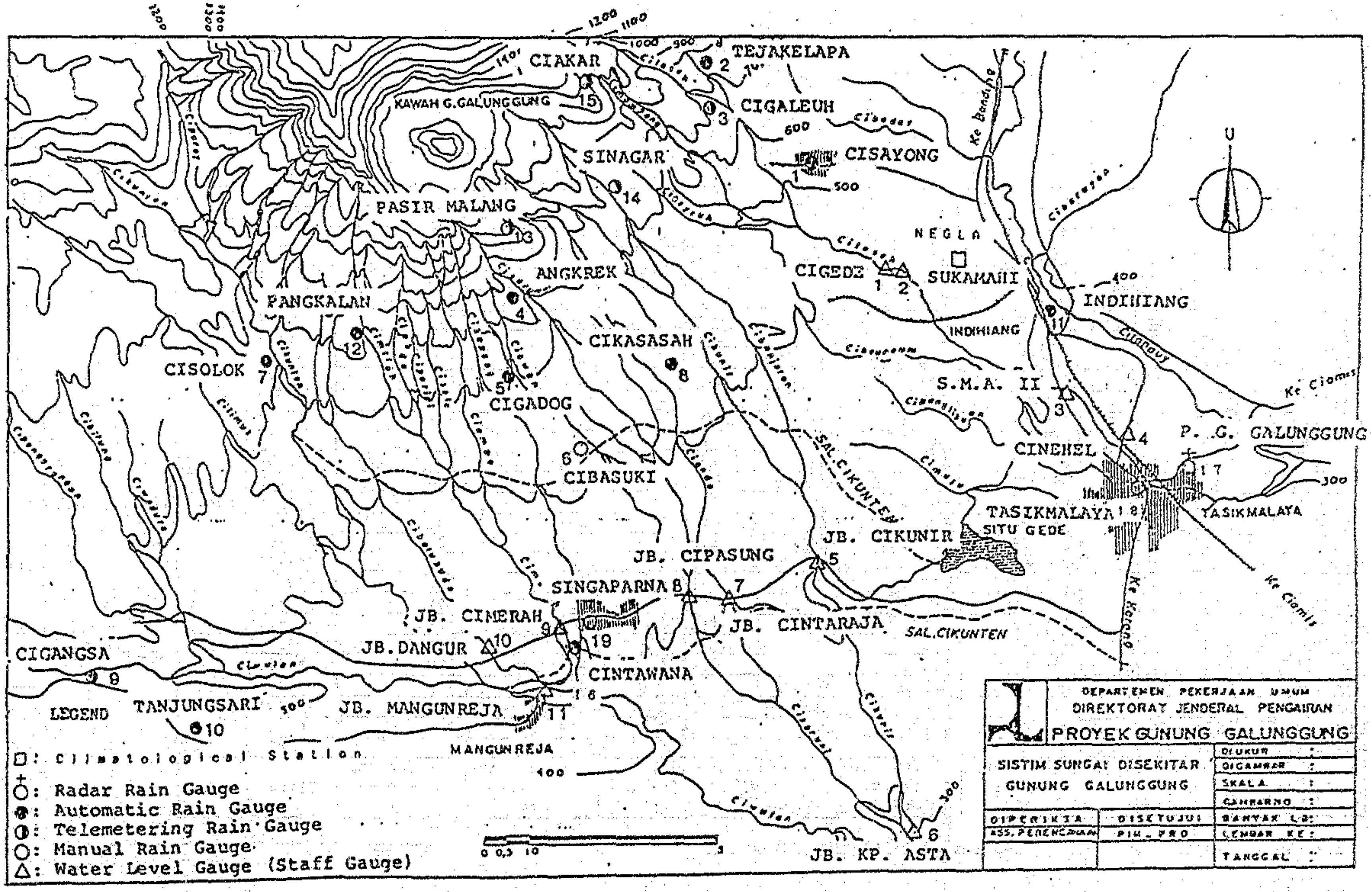
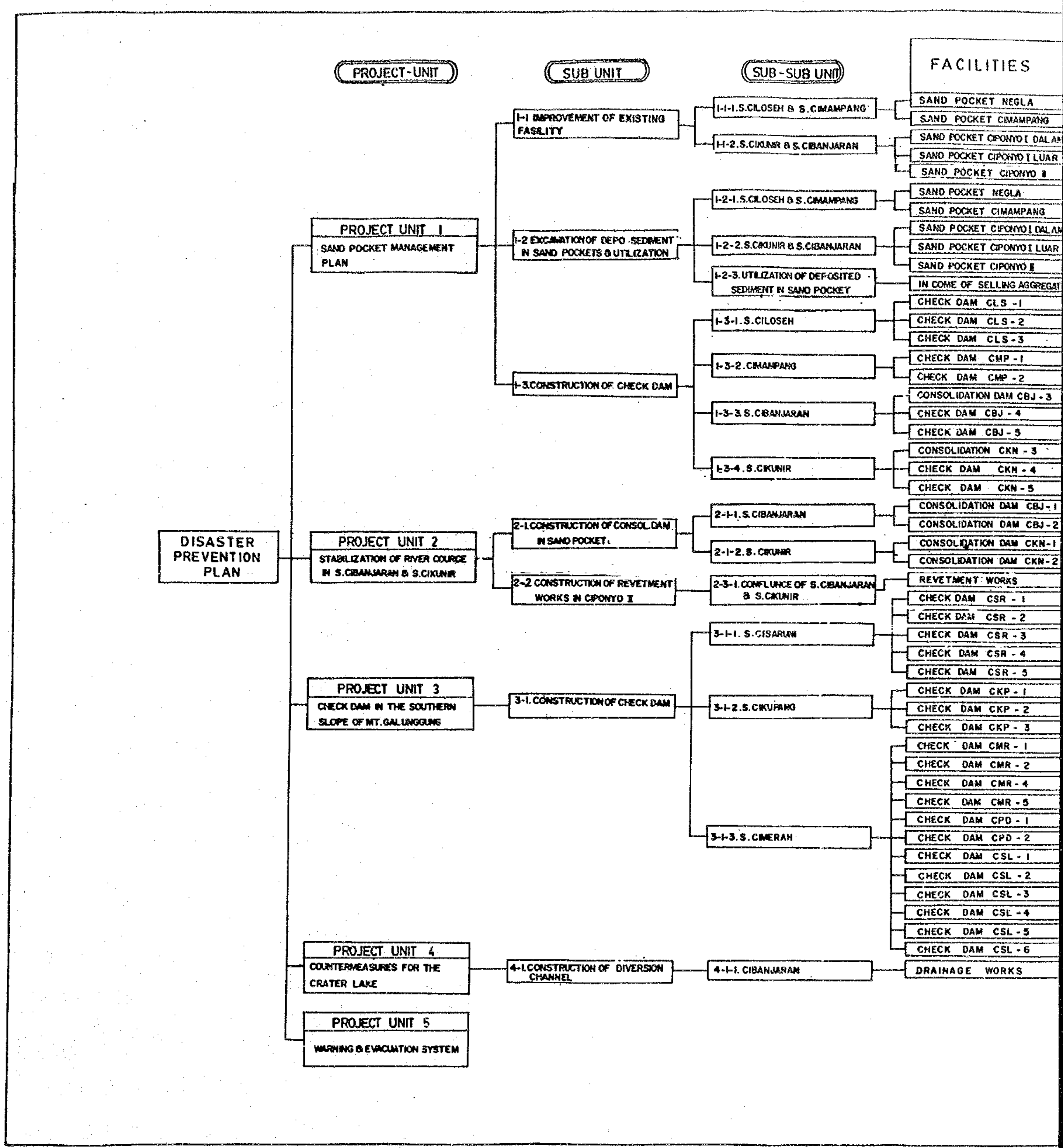


Fig.- Location of Hydrological and Climatological Stations



PROJECT-UNIT
SUB UNIT
SUB-SUB UNIT
FACILITIES
DISASTER PREVENTION PLAN
PROJECT UNIT 1
SAND POCKET MANAGEMENT PLAN
1-1 IMPROVEMENT OF EXISTING FASILITY
1-1-1. S.CILOSEH & S.CIMAMPANG
SAND POCKET NEGLA
SAND POCKET CIMAMPANG
1-1-2. S.CIKUNIR & S.CIBANJARAN
SAND POCKET CIPONYO I DALAM
SAND POCKET CIPONYO I LUAR
SAND POCKET CIPONYO II
1-2 EXCAVATION OF DEPO SEDIMENT IN SAND POCKETS & UTILIZATION
1-2-1. S.CILOSEH & S.CIMAMPANG
SAND POCKET NEGLA
SAND POCKET CIMAMPANG
1-2-2. S.CIKUNIR & S.CIBANJARAN
SAND POCKET CIPONYO I DALAM
SAND POCKET CIPONYO I LUAR
SAND POCKET CIPONYO II
1-2-3. UTILIZATION OF DEPOSITED SEDIMENT IN SAND POCKET
IN COME OF SELLING AGGREGAT
1-3 CONSTRUCTION OF CHECK DAM
1-3-1. S.CILOSEH
CHECK DAM CLS-1
CHECK DAM CLS-2
CHECK DAM CLS-3
1-3-2. CIMAMPANG
CHECK DAM CMP-1
CHECK DAM CMP-2
1-3-3. S.CIBANJARAN
CONSOLIDATION DAM CBJ-3
CHECK DAM CBJ-4
CHECK DAM CBJ-5
1-3-4. S.CIKUNIR
CONSOLIDATION CKN-3
CHECK DAM CKN-4
CHECK DAM CKN-5
PROJECT UNIT 2
STABILIZATION OF RIVER COURCE IN S.CIBANJARAN & S.CIKUNIR
2-1. CONSTRUCTION OF CONSOL. DAM IN SAND POCKET
2-1-1. S.CIBANJARAN
CONSOLIDATION DAM CBJ-1
CONSOLIDATION DAM CBJ-2
2-1-2. S.CIKUNIR
CONSOLIDATION DAM CKN-1
CONSOLIDATION DAM CKN-2
2-2 CONSTRUCTION OF REVETMENT WORKS IN CIPONYO II
2-3-1. CONFLUNCE OF S.CIBANJARAN & S.CIKUNIR
REVETMENT WORKS
PROJECT UNIT 3
CHECK DAM IN THE SOUTHERN SLOPE OF MT. GALUNGGUNG
3-1. CONSTRUCTION OF CHECK DAM
3-1-1. S.CISARUNI
CHECK DAM CSR-1
CHECK DAM CSR-2
CHECK DAM CSR-3
CHECK DAM CSR-4
CHECK DAM CSR-5
3-1-2. S.CIKUPANG
CHECK DAM CKP-1
CHECK DAM CKP-2
CHECK DAM CKP-3
3-1-3. S.CIMERAH
CHECK DAM CMR-1
CHECK DAM CMR-2
CHECK DAM CMR-4
CHECK DAM CMR-5
CHECK DAM CPD-1
CHECK DAM CPD-2
CHECK DAM CSL-1
CHECK DAM CSL-2
CHECK DAM CSL-3
CHECK DAM CSL-4
CHECK DAM CSL-5
CHECK DAM CSL-6
PROJECT UNIT 4
COUNTERMEASURES FOR THE CRATER LAKE
4-1. CONSTRUCTION OF DIVERSION CHANNEL
4-1-1. CIBANJARAN
DRAINAGE WORKS
PROJECT UNIT 5
WARNING & EVACUATION SYSTEM

SUB UNIT	FACILITIES	SPECIFICATION	DESIGN CONTROL SEDIMENT (m^3)	D.S.C.V OF FACILITY (m^3)	CONSTRUCTION COST ($\times 10^6$ Rp) FASILITY	SUB-SUB UNIT	SUB UNIT	PROJECT UNIT	TOTAL	COST OF UNIT (Rp/m^3)
S. CIMAMPANG	SAND POCKET NEGLA	H=3.00m L=2.651m	3,850×10³	3,850×10³ (100)	839.9	1,203.7	10,763			313
	SAND POCKET CIMAMPANG	H=3.00m L=1.150m			363.8					
S.CIBANJARAN	SAND POCKET CIPONYO I DALAM	H=3.00m L=3.497m EXCAVATION=11,271×10³m³	13,930×10³	13,930×10³ (100)	7,199	9,559.3				686
	SAND POCKET CIPONYO I LUAR	H=3.00m L=1.177m			4,991					
	SAND POCKET CIPONYO II	H=3.00m L=4.522m			1,831.2					
S.CIMAMPANG	SAND POCKET NEGLA	EXCAVATION=394×10³m³	1,969×10³	394×10³ (20)	153 (5,319)	153 (5,319)	2,536 (88,223)			388
	SAND POCKET CIMAMPANG									
S.CIBANJARAN	SAND POCKET CIPONYO I DALAM	EXCAVATION=6,141×10³m³	6,141×10³	6,141×10³ (100)	2,383 (82,904)	2,383 (82,904)				388
	SAND POCKET CIPONYO I LUAR									
	SAND POCKET CIPONYO II									
...OF DEPOSITED SAND POCKET	IN COME OF SELLING AGGREGATE	6,141×10³+394×10³=6,535×10³	6,141×10³ / 394×10³	82,904 / 5,319	=88,223					(13,500)
	CHECK DAM CLS-1	H=8.00m L=41.00m V=1,900m³	1,058×10³	14,500 (1.4)	80.1	278.2	1,614.9	14,913 (88,223)	24,044 (88,223) (78.8%)	5,524
	CHECK DAM CLS-2	H=8.00m L=62.00m V=2,600m³		23,400 (2.3)	109.6					4,684
	CHECK DAM CLS-3	H=8.00m L=42.00m V=2,100m³		24,500 (2.4)	88.5					3,612
	CHECK DAM CMP-1	H=12.00m L=41.00m V=3,400m³	98×10³	63,300 (7.2)	143.3	286.6				3,264
	CHECK DAM CMP-2	H=12.00m L=42.00m V=3,500m³		22,500 (2.6)	143.3					6,369
	CONSOLIDATION DAM CBJ-3	H=5.00m L=204.0m V=5,500m³	673×10³	0	230.4	700.2				–
	CHECK DAM CBJ-4	H=8.00m L=52.00m V=2,100m³		9,100 (1.5)	88.5					9,725
	CHECK DAM CBJ-5	H=13.00m L=104.00m V=9,100m³		83,400 (13.8)	381.3					4,572
	CONSOLIDATION CKN-3	H=5.00m L=94.00m V=2,700m³	707×10³	0	113.8	349.9				–
	CHECK DAM CKN-4	H=5.00m L=122.00m V=3,000m³		15,400 (2.4)	126.5					8,214
	CHECK DAM CKN-5	H=5.00m L=105.00m V=2,600m³		17,700 (2.8)	109.0					6,192
	CONSOLIDATION DAM CBJ-1	H=4.00m L=70.00m V=1,267m³		–	117.6	317.7	635.4	760.9		–
	CONSOLIDATION DAM CBJ-2	H=4.00m L=70.00m V=1,267m³		–	200.1					–
	CONSOLIDATION DAM CKN-1	H=4.00m L=70.00m V=1,267m³			117.6	317.7				–
	CONSOLIDATION DAM CKN-2	H=4.00m L=70.00m V=1,267m³			200.1					–
...OF S.CIBANJARAN	REVETMENT WORKS	H=4.00m B=25m L=400m I=1/75		–	125.5	125.5	125.5			–
	CHECK DAM CSR-1	H=7.00m L=29.00m V=1,200m³	134×10³	11,500 (8.5)	50.6	1,777.1	5,728.6	5,728.6		4,900
	CHECK DAM CSR-2	H=11.00m L=31.00m V=2,300m³		19,600 (14.5)	47.0					4,949
	CHECK DAM CSR-3	H=22.00m L=56.00m V=14,400m³		48,800 (36.2)	603.2					12,361
	CHECK DAM CSR-4	H=22.00m L=56.00m V=14,400m³		35,100 (26.0)	603.2					19,185
	CHECK DAM CSR-5	H=18.00m L=46.00m V=10,100m³		19,000 (14.1)	423.1					22,268
	CHECK DAM CKP-1	H=7.00m L=24.00m V=1,000m³	46×10³	6,000 (13.0)	42.2	312.0				7,033
	CHECK DAM CKP-2	H=12.00m L=34.00m V=2,800m³		16,000 (34.0)	118.0					7,375
	CHECK DAM CKP-3	H=14.00m L=32.00m V=3,600m³		24,000 (52.2)	151.8					6,325
	CHECK DAM CMR-1	H=7.00m L=24.00m V=1,000m³	534×10³	5,200 (1.0)	42.2	3,639.5				8,115
	CHECK DAM CMR-2	H=10.00m L=29.00m V=2,200m³		10,800 (2.0)	92.7					8,583
	CHECK DAM CMR-4	H=22.00m L=56.00m V=14,400m³		165,700 (31.0)	603.2					3,640
	CHECK DAM CMR-5	H=17.00m L=43.00m V=9,200m³		76,800 (14.4)	385.4					5,018
	CHECK DAM CPD-1	H=15.00m L=40.00m V=3,400m³		40,300 (7.5)	362.8					9,002
	CHECK DAM CPD-2	H=15.00m L=40.00m V=3,500m³		40,400 (7.6)	362.8					8,980
	CHECK DAM CSL-1	H=7.00m L=30.00m V=1,300m³		5,000 (2.7)	54.8					10,960
	CHECK DAM CSL-2	H=7.00m L=27.00m V=1,200m³		4,000 (0.7)	50.6					12,650
	CHECK DAM CSL-3	H=12.00m L=34.00m V=2,500m³		9,400 (1.8)	105.4					11,123
	CHECK DAM CSL-4	H=22.00m L=51.00m V=9,800m³		45,800 (8.6)	410.7					8,969
	CHECK DAM CSL-5	H=22.00m L=67.00m V=13,700m³		81,700 (15.3)	783.5					9,590
	CHECK DAM CSL-6	H=17.00m L=43.00m V=9,200m³		40,300 (7.5)	385.4					9,563
	DRAINAGE WORKS	Ø=2.00m L=383.0m Ø=4.00m L=43.0m	3,000×10³m³ (Water)		2,640.6	2,640.6	2,640.6	2,640.6		880

Facility group	ECONOMIC CONDITION: PROPERTY OF DPA (B) ($\times 10^6$ Rp)	PROJECT COST ($\times 10^6$ Rp) (C)	RATIO (B)/(C)	SOCIAL CONDITION: DISASTER PREVENTION AREA (Km²)	POPULATION (PERSON)
Sand pocket Negla, Cimampang	80,647	3,407.4 (3,848.0)	21.0	20.65	53,765
Sand pocket Ciponyo I Dalam, I Luar, II	196,221	10,518.6 (27,506.4)	9.1	50.29	132,765
Sand pocket Negla, Cimampang (excavation)	80,647	306 (3,848.0)	21.0	20.65	53,566
Sand pocket Ciponyo I Dalam, I Luar, II (excavation)	196,221	4,766 (27,506.4)	9.1	50.29	132,765
Check dams CLS-1 – CMP-2	80,647	1,129.6 (3,848.0)	21.0	20.65	53,566
CBJ-3 – Revetment works	196,221	3,622 (27,506.4)	9.1	50.29	132,765
CSR-1 – CSR-5	9,365	3,554.2	2.6	5.95	6,771
CKP-1 – CKP-3	8,412	624.0	13.5	2.06	4,464
CMR-1 – CSL-6	4,598	7,279	0.6	3.30	3,954
Total	255,087	5,231.2	48.8	50.29	132,765

EVALUATION: TECHNICAL CONDITION 1 2 3 4; ECONOMIC CONDITION 5 6; SOCIAL CONDITION 7 8; OTHERS; PROPOSED SUB-SUB UNIT

Total row of evaluation: 0 0 0 0 0 0 0 0

H : HEIGHT OF DAM OR REVETMENT
L : CREST LENGTH OF DAM
V : VOLUME OF DAM CONCREAT
Ø : DIAMETER OF DRAINAGE TUNNEL
L : LENGTH OF DRAINAGE TUNNEL OR REVETMENT WORKS
B : WIDTH OF CHANNEL

DSCV Design Sediment Control Volume

( ) : RATIO OF DSCV (%)

INCLUDE INCOME OF SELLING AGGRIGATE

Implemented Priod 10 years

( ): INCOME OF SELLING AGGREGATE.

TOTAL CONSTRUCTION COST OF EXCLUDE SELLING AGGREGATE 112,274×10⁶ Rp

COST OF UNIT CONSTRUCTION COST OF FACILITY / D.S.C.V. OF FACILITY

Total Project Cost 48,088×10⁶ Rp.
Project cost = Construction cost × 2.0
2.0 : Ratio of construction cost and Project cost in Seneru Project

EVALUATION
1: RATIO OF DSCV IS OVER 20%
2: DSCV IS OVER 40,000m³
3: CONSTRUCTION COST IS UNDER 500×10⁶ Rp
4: RATIO OF CONSTRUCTION COST IS UNDER 5,000 Rp/m³
5: (B): IS OVER 80,000×10⁶ Rp
6: (B)/(C) IS OVER 5.0
7: DP AREA IS OVER 20 Km²
8: POPULATION IS OVER 50,000 PERSONS

Annex - 2 Preliminary Evaluation Results for the Disaster Prevention Project as of Meeting concerning the Submission of Interim Report

JICA