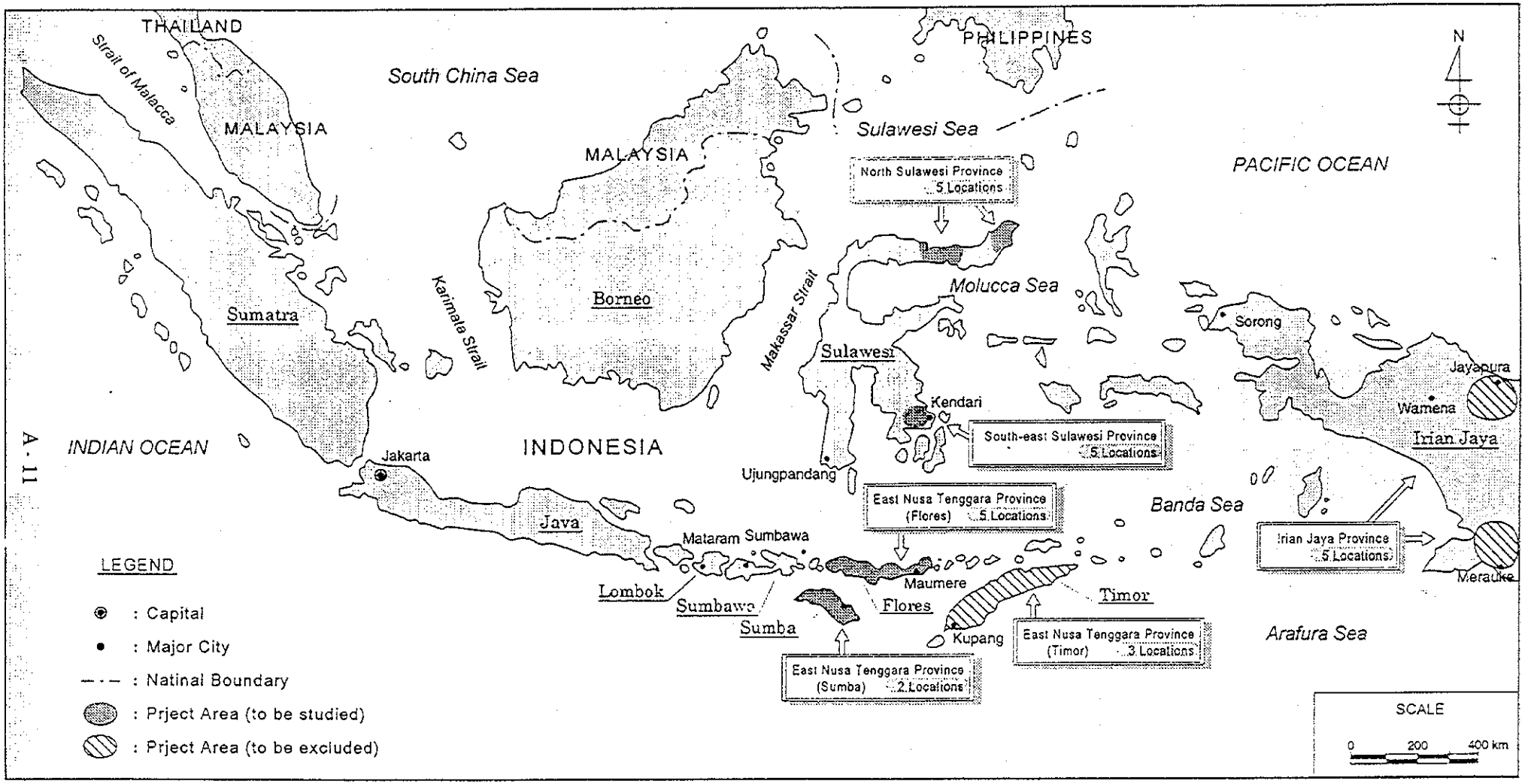


A-11

Location Map

Annex-1

Annex-2

List of 17 Proposed Sites

	Driling			Area
	Daia (inch)	Depth (m)	Well Number	(ha)
1. North Sulawesi				
(1) -Desa Bongo I	10 - 6	100	1	25
(2) -Desa Bongo II	10 - 6	100	1	25
(3) -Desa Bongo III	10 - 6	100	1	25
(4) -Desa Tempok	10 - 6	100	1	25
(5) -Desa Parepe	10 - 6	100	1	25
Sub-total		500	5	125
2. South East Sulawesi				
(6) -Desa Pamandati	12 - 8	110	1	20
(7) -Desa Ranometo	12 - 8	110	1	20
(8) -Desa Lapulu	12 - 8	110	1	20
(9) -Desa Moolo Inda	12 - 8	110	1	20
(10) -Desa UPT Lapoa Indah	12 - 8	110	1	20
Sub-total		550	5	100
3. East Nusa Tenggara (Sumba)				
(11) -Desa Kalembukaka	14 - 8	70	1	20
(12) -Ds Palakahembi	14 - 8	70	1	20
Sub-total		140	2	40
4. East Nusa Tenggara (Flores)				
(13) -Ds Namangkewa	12 - 8	75	1	10
(14) -Desa Magepanda	12 - 8	75	1	12
(15) -Desa Ranakolo	12 - 8	75	1	10
(16) -Desa Dawa	12 - 8	75	1	10
(17) -Desa Toto Mala	12 - 8	75	1	10
Sub-total		375	5	52
Total		1,565	17	317

Remarks: The figures described in the Table are tentatively proposed by DGERD, and they may be altered after the Study.

Annex 3

Japan's Grant Aid Scheme

1. *Grant Aid Procedures*

1) Japan's Grant Aid Program is executed through the following procedures.

Application	(Request made by a recipient country)
Study	(Basic Design Study conducted by JICA)
Appraisal & Approval	(Appraisal by the Government of Japan and Approval by Cabinet)
Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)

2) Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using (a) Japanese consulting firm(s).

Thirdly, the Government of Japan appraises the Project to see whether or not it is suitable for Japan's Grant Aid Program, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the Project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. *Basic Design Study*

1) Contents of the Study

The aim of the Basic Design Study (hereafter referred to as "the Study"), conducted by JICA on a requested project (hereinafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Japanese Government. The contents of the Study are as follows:

a) Confirmation of the background, objectives, and benefits of the requested Project and also institutional capacity of agencies concerned of the recipient country necessary for Project's implementation.

b) Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.

c) Confirmation of items agreed on by both parties concerning the basic concept of the Project.

d) Preparation of a basic design of the Project.

e) Estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consultant firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms. The firm(s)

selected carry(ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA.

The consultant firm(s) used for the Study is(are) recommended by JICA to the recipient country to also work on the Project's implementation after the Exchanges of Notes, in order to maintain technical consistency and also to avoid any undue delay in implementation should the selection process be repeated.

3. *Japan's Grant Aid Scheme*

1) What is Grant Aid?

The Grant Aid Program provides a recipient country with non-reimbursable funds to procure facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. Grant Aid is not supplied through the donation of materials as such.

2) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc. are confirmed.

3) "The period of the Grant Aid" means the one fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consultant firm(s) and (a) contractor(s) and a final payment to them must be completed.

However in case of delays in delivery, installation or construction due to unforeseen factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

4) Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However the prime contractors, namely, consulting, contracting and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

5) Necessity of the "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

6) Undertakings required of the Government of the Recipient Country

In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the following:

(1) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction.

(2) To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities in and around the sites.

(3) To secure buildings prior to the procurement in case the installation of the equipment.

(4) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid.

(5) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts.

(6) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

(7) Proper Use

The recipient country is required to maintain and use facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

(8) Re-export

The products purchased under the Grand Aid should not be re-exported from the recipient country.

(9) Banking Arrangement (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the verified contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an authorization to pay issued by the Government of the recipient country or its designated authority.

Annex - 4

Necessary measures to be taken by the Government of the Republic of Indonesia in case Japan's Grant Aid is extended

1. To provide data and information necessary for the Project.

2. To secure the land necessary for the execution of the Project.

3. To clear the sites prior to the commencement of the construction, if required.

4. To make passable all roads and bridges leading to the Projects sites before the commencement of inland transportation of materials and equipment, if required.

5. To bear commissions to the Japanese foreign exchange bank for its banking services based upon the Banking Arrangement, namely the advising commission of the "Authorization to Pay" and payment commission.

6. To ensure prompt unloading, tax exemption, customs clearance at the port of disembarkation in the Republic of Indonesia and prompt internal transportation of the materials and equipment for the Project purchased under the Grant Aid.

7. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the verified contracts.

8. To accord Japanese nationals whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into the Republic of Indonesia and stay therein for the performance of their work.

9. To provide necessary permissions, licenses and other authorizations for implementing the Project, if necessary.

10. To maintain and use properly and effectively the facilities constructed under the Project.

11. To coordinate and solve any issues related to the Project which may be raised from third parties or inhabitants in the Project area during implementation of the Project.

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY ON THE PROJECT
FOR
THE CONSTRUCTION OF FACILITY FOR IRRIGATION IN EASTERN AREA
IN
THE REPUBLIC OF INDONESIA
(EXPLANATION ON THE DRAFT BASIC DESIGN)

In April 1999, the Japan International Cooperation Agency (JICA) dispatched the Basic Design Study Team on the Project for the construction of facility for Irrigation in the East Area (hereinafter referred to as "the Project") to the Republic of Indonesia. After the assessment of the data and information obtained through the study, JICA has prepared the Draft Basic Design on the Project.

In order to explain and consult with the officials concerned of the Government of Indonesia on the components of the Draft Basic Design, JICA sent to the Republic of Indonesia a Study Team (hereinafter referred to as "the Team") headed by Mr. Akira INAMOTO, Geologist, Resources Division, Planning Department, Kwanto Regional Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries, which is scheduled to stay in the country from August 19 to 24, 1999.

As a result of the discussions held between the Team and the officials concerned of the Government of Indonesia, both parties have confirmed the main items described on the attached sheets.

Jakarta, August 24, 1999

Mr. Akira Inamoto

Team Leader,
Draft Report Explanation Team,
JICA

Mr. M. Napitupulu

Director
Directorate of Technical Guidance
Directorate General of Water Resources Development
Ministry of Public Works
The Republic of Indonesia

ATTACHMENT

1. Components of the Draft Report

The Government of Indonesia has agreed and accepted in principle the components of the Draft Report proposed by the Team.

2. Japan's Grant Aid System

(1) The Government of Indonesia has understood the system of Japanese Grant Aid on Annex II as explained by the team.

(2) The Government of Indonesia will take the necessary measures, described in Annex III, for smooth implementation of the Project, on condition that the Grant Aid assistance by the Government of Japan is extended to the Project.

3. Schedule of the Study

JICA will complete the final report and send it to the Government of Indonesia by the end of December 1999.

4. Other Relevant Issues

(1) The Team explained the Indonesian side the results of the Basic Design Study and confirmed the following.

a) The sites No. 10, 15 and 16, which are considered to be inappropriate as Japan's Grant Aid Scheme due to the results of the hydro-geological survey, shall be excluded from the Projects.

b) Design areas of the sites No. 8, 11, 12 and 14 shall be decreased from the requested areas in accordance with the proper groundwater yields derived from the results of the hydro-geological survey.

Therefore, the team explained the Indonesian side that among 17sites, 14 sites were selected and the groundwater irrigation development project were planned for these sites, and the Indonesian side understood it.

(2) The Indonesian side requested as follows.

a) The drilling diameter of wells shall be 17- ½" for the whole length of the bore hole in accordance with the Indonesian standard.

b) The brief report concerning the PCM workshop held at North Sulawesi shall be attached to the Final Report with photos.

The Team understood it.

(3) The Team requested the Indonesian side again the proper maintenance of the drilling rigs with necessary equipment, which had been provided under the past two Japan's Grant Aid Schemes, namely "The Project for Supply of Equipment for Irrigation in Eastern Area (1/2) and (2/2)", in order to keep them good conditions for their smooth use. The Indonesian side assured to fully maintain them.

(4) The Team reconfirmed the items confirmed in the Minutes of Discussions signed between the Indonesian side and the Team dated on the 20th April 1999, and the reconfirmed items are as follows.

"7. Other Relevant Issues (3) number and usability of the existing drilling rigs;

7. (4) establishment of WUA and O/M of the irrigation facilities by WUA and overall water management including collection of irrigation service fees;

7. (5) responsibility of DGWRD;

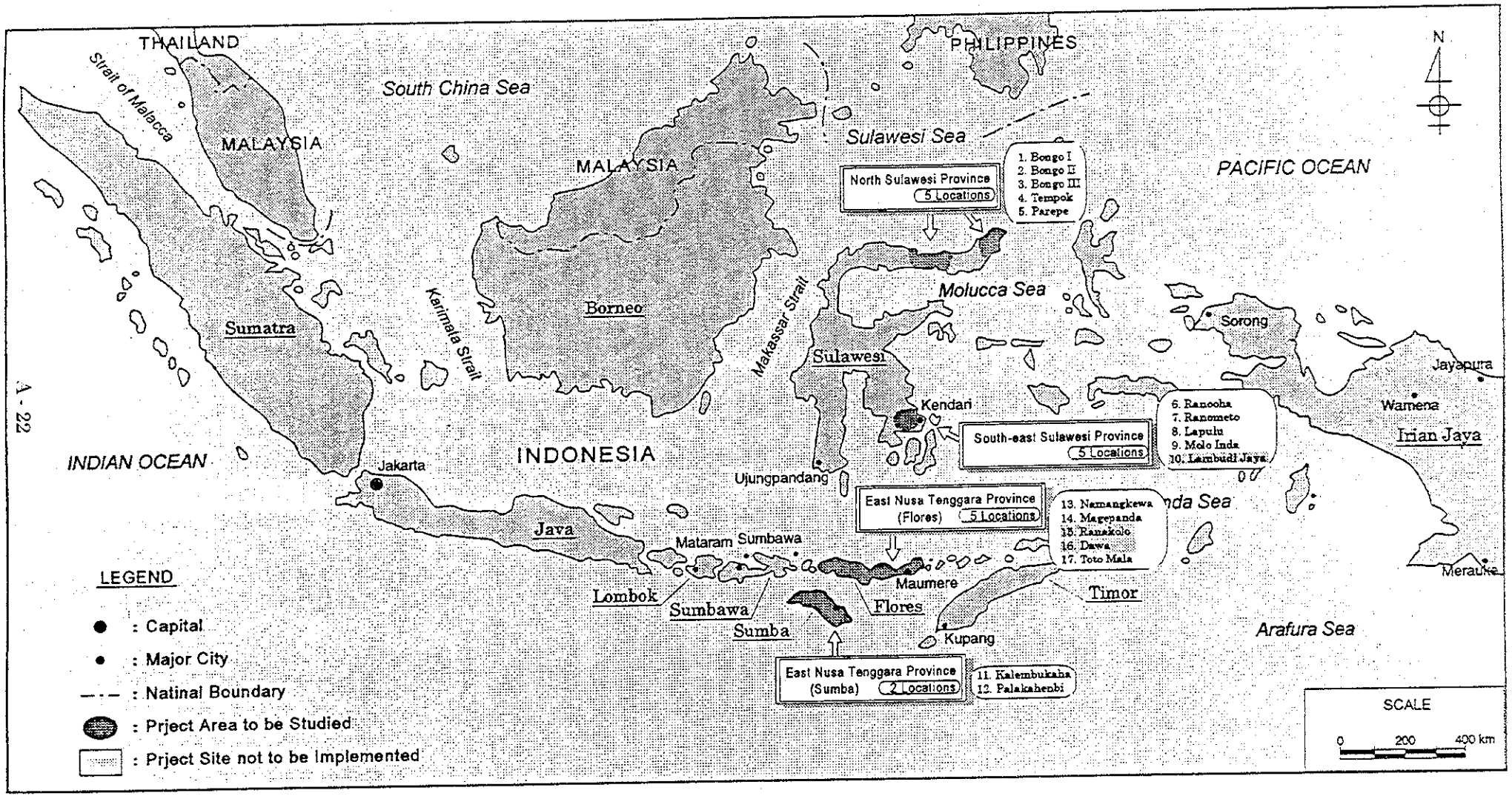
7. (6) responsibility of the Indonesian side for the organization, staff, etc. for the Project;

7. (7) responsibility of the Indonesian side for the land preparation needed for construction"

in the Minutes of Discussions.

The Indonesian side assured them again.

The Indonesian side assured that he would fully understand the contents of the Draft Report, and he especially assured establishment of WUA by the completion of facilities construction in order to realize effective and smooth water management soon after commencement of their operation.



A - 22

Location Map

Annex- I-2

Summary of Consideration on 17 Sites

No.	Site	Hydro-geological Conditions	Access Conditions	Operation & Maintenance Conditions	Overall Evaluation	Remarks
1	Bongo I	A	A	A	A	
2	Bongo II	A	A	A	A	
3	Bongo III	A	A	A	A	
4	Tempok	A	A	A	A	
5	Parepe	A	A	A	A	
6	Ranooha	B	A	A	A	
7	Ranometo	B	A	A	A	
8	Lapulu	C／B	A	B	B	decrease of area
9	Molo Inda	B	A	A	A	
10	Lambodi Jaya	D	C	A	D	inappropriate
11	Kalenbukaha	C／B	A	B	B	decrease of area
12	Palakahembi	C／B	A	B	B	decrease of area
13	Nawangkewa	A	A	B	B	
14	Magepanda	C／B	A	B	B	decrease of area
15	Ranakolo	D	A	B	D	inappropriate
16	Dawa	D	B	B	D	inappropriate
17	Toto Mala	A	B	B	B	

* A: Appropriate
B: Small problems
C: Some problems/counter measure or design modification
D: Serious problems/impossible to judge

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Necessary measures to be taken by the Government of the Republic of Indonesia in case Japan's Grant Aid is extended

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9. To provide necessary permissions, licenses and other authorizations for implementing the Project, if necessary.

10. To maintain and use properly and effectively the facilities constructed under the Project.

11. To coordinate and solve any issues related to the Project which may be raised from third parties or inhabitants in the Project area during implementation of the Project.

5. Deep Tube Well

Extent of Hydrogeological Survey: Table A-1
Existing Wells around the Proposed Sites: Table A-2
Hydrogeological Conditions of Each Site: Table A-3
Pumping Test Results: Table A-4
Geo-electrical Survey Data : Figure A-1-1 - Figure A-1-17
Pumping Test Data : Figure A-2-1 - Figure A-2-14
Calculation Sheet for Well Design
Groundwater Balance Study

Table A-1 Extent of Hydrogeological Survey

Region	No.	Site	Existing Data			Vicinal Existing Production Well	Local Contract		Remarks
			G. Sounding	Well	Pumping Test		G. Sounding	P. Test	
North Surawesi	1	Bongo I	abundant	abundant	slightly poor	yes	3 points	1	
	2	Bongo II				yes (not complete)	3 points	1	
	3	Bongo III				yes	3 points	1	
	4	Parepe				yes	0 points	1	
	5	Tempok				yes (not complete)	3 points	1	
Southeast Surawesi	6	Ranooha	not available	abundant	slightly poor	yes	3 points	1	
	7	Ranometo					3 points	1	
	8	Lapulu	not available	available	available	yes	3 points	1	
	9	Moolo Indah					3 points	1	
	10	Lambedi Jaya	not available	available	slightly poor	no	3 points	1 * (11 km)	
NTT (Sumba)	11	Kalembukaha	not available	available	slightly poor	yes (not complete)	3 points	1	
	12	Palakahembi				no	3 points	1 * (8 km)	
NTT (Flores)	13	Namangkewa	not available	poor	not available	yes	3 points	1	
	14	Magepanda		available		yes	3 points	1	
	15	Ranakolo		not available		no	3 points	0	
	16	Dawa	poor			no	3 points	0	
	17	Toto Mala		poor	poor	no(test well)	3 points	1	
						Total	48 points	15	

Note 1. *: distant place & distance between the proposed well and the test well.

2. yes (not complete): pump will be installed as a production well in '99.

3. no (test well): no production well but there is a well available to pumping test.

Table A-2 Existing Wells around the Proposed Sites

No.	Area	Well No.	Elevation (m)	Depth (m)	Pump Housing		Well (Casing & Screen)			Constant Rate Test							Remarks
					D (m)	d (in)	D (m)	d (in)	TSL (m)	SWL (m)	DWL (m)	s (m)	Q (lit/sec)	Q/s (l/s/m)	t (hr)	T (m^2/day)	
1	Bongo I BongoII	TWG14	-	95.96	34.56	12	61.40	6	30	2.95	9.37	6.42	6.00	0.93	72	-	
2		TWG15	-	95.56	34.56	12	61.00	6	40	10.20	29.89	19.69	8.00	0.15	72	-	
3		TWG16	-	93.10	38.40	12	54.70	6	39	11.00	22.38	11.38	4.00	0.35	72	-	
4		TWG30	-	102.00	29.00	10	73.00	6	30	2.50	11.47	8.97	21.87	2.41	72	-	
5		TWG31	-	82.80	23.50	10	59.30	6	42	3.50	11.66	8.36	19.11	2.29	72	-	
6		TWG32	47	96.00	41.70	10	54.30	6	21	-	-	-	-	-	-	-	
7		TWG33	48	99.00	41.70	10	57.30	6	21	-	-	-	-	-	-	-	
8		TWG34	67	102.00	41.70	10	60.30	6	21	-	-	-	-	-	-	-	
9		TWG35	48	99.00	40.70	10	58.30	6	21	-	-	-	-	-	-	-	
10		TWG36	-	99.00	36.00	10	63.00	6	21	-	-	-	-	-	-	-	
11		TWG37	-	96.00	41.70	10	54.30	6	21	-	-	-	-	-	-	-	
12		TWG39	-	90.00	29.00	10	61.00	6	18	-	-	-	-	-	-	-	
13	Parepe Tempok	TWM03	687	98.99	36.06	12	62.93	6	33	2.55	13.59	11.04	7.03	0.64	72	-	
14		TWM06	730	85.12	35.11	12	50.01	6	36	8.86	20.32	11.46	6.93	0.67	72	-	
15		TWM08	710	96.00	35.50	10	60.50	6	21	9.00	19.47	10.47	12.11	1.16	72	-	
16		TWM09	710	90.00	36.00	10	54.00	6	21	20.20	26.98	6.78	8.47	1.25	72	-	
17		TWM12		93.00	42.00	10	51.00	6	18	3.30	-	-	-	-	-	-	
18	Ranooha Ranometo	P27KDI	-	116.00	37.00	8	79.00	6	36	+2.10	6.04	8.14	5.58	0.69	80	-	
19		P28KDI	-	120.00	37.00	8	83.00	6	36	+2.24	6.05	8.29	5.58	0.67	80	-	
20		P37KDI	-	104.00	38.00	8	66.00	6	33	4.20	7.16	2.96	2.80	0.95	80	-	
21		P38KDI	-	115.00	38.00	8	77.00	6	39	+1.24	6.05	7.29	5.53	0.76	80	-	
22		P39KDI	-	115.00	42.00	8	73.00	6	39	+2.70	6.04	8.74	5.58	0.64	80	-	
23		P42KDI	-	106.00	38.00	8	68.00	6	36	+1.67	6.04	7.71	5.90	0.77	80	-	
24	Lapulu	P48KDI	-	72.00	30.00	8	42.00	6	21	0	8.11	8.11	4.00	0.49	72	-	
25	Moolo Indaha	P60KDI	-	78.00	36.00	8	42.00	6	24	0	5.31	5.31	12.11	2.28	48	342.04	
26		P61KDI	-	78.00	36.00	8	42.00	6	24	1.50	10.60	9.10	6.10	0.67	48	144.59	
27		P62KDI	-	100.00	30.00	8	70.00	6	30	0	7.67	7.67	12.11	1.58	48	544.87	
28	Lambedi Java	(SB.02)	-	71.25	22.25	6	49.00	3	30	-	0.45		1.00	-	-	39.01	
29	Kalembu-kaha	WKKI-29	-	78.50	45.00	10	33.50	8	12	23.65	23.77	0.12	5.60	46.67	72	5316.00	
30		WKKI-30	-	75.00	64.00	10	11.00	6	9	51.76	52.10	0.34	5.20	15.29	72		
31		WKKI-31	-	43.00	34.00	10	9.00	6	6	19.73	19.74	0.01	5.60	560.00	72	5316.00	
32	Palaka-hembi	EPI-15	-	34.50	-	-	34.50	10	8	14.75	19.31	4.56	9.55	2.09	-	-	
33	Namang-kewa	KKI-11	-	50.00	27.00	8	23.00	6	6	-	-	0.92	5.80	6.30		183.17	
34		KKI-19	-	57.00	39.00	8	18.00	6	9	12.77	13.73	0.96	8.00	8.33	72	907.20	
35	Mage-panda	KMI-27	-	61.00	33.00	8	28.00	6	9	0.86	6.00	5.14	10.00	1.95	72	423.36	
36		KMI-45	-	58.00	40.00	8	18.00	6	6	0.73	3.05	2.32	11.40	4.91	72	600.48	
37		KMI-59	-	56.00	24.00	8	24.00	6	9	0.00	-	-	-	-	-	-	
38	Toto Mala	NMI-06	-	55.00	30.00	8	26.00	6	9	20.90	27.90	7.00	5.50	0.79	73	459.62	

Table A-3 Hydrogeological Conditions of Each Site

Region	No.	Site	Hydrogeological Conditions	Groundwater Development Conditions in the Vicinity of the Site.
North Surawesi	1	Bongo I	Basin (15 x 30 km) surrounded by the mountains with elevation of about 500 m and composed of igneous rocks from Tertiary to Quaternary time. Elevation of the basin 50 to 70 m. It is composed of the lake deposits of Quaternary age. Coarse grain layers of the deposits form good aquifers. Thickness of the deposits is estimated to be more than 150m.	Developing area. There are many complete and incomplete production wells.
	2	Bongo II		
	3	Bongo III		
	4	Parepe	Basin surrounded by the volcanic mountains from Tertiary to Quaternary time. Lake Tondano is in the center of the basin. Elevation of the basin ranges 700 to 750 m. It is composed of the lake deposits of Quaternary age. Coarse grain layers of the deposits form good aquifers. Thickness of the deposits is estimated to be more than 150 m.	Developed area. There are many complete and incomplete production wells.
	5	Tempok		
Southeast Surawesi	6	Ranooha	Plain composed of the Quaternary deposits (diluvium - alluvium). Coarse grain layers of the deposits form good aquifers. Elevation of the plain ranges 20 to 30 m. Artesian area.	Developed area. There are many production wells.
	7	Ranometo		
	8	Lapulu	Alluvial plain faces on the seashore. Elevation of the plain is less than 10 m. Artesian area. It is about 1.3 km to the seashore.	Developed area. There are several production wells.
	9	Moolo Indaha	Boundary area between alluvial plain faces on the seashore and hill composed of Tertiary sediments. Artesian area. Elevation ranges 15 to 20 m. It is about 1.3 km to the seashore.	Alluvial plain is developed area. There are several production wells.
	10	Lambedi Jaya	Large basin in the mountains extends more than 15 km east and west and 50 km south and north. Swamp-land are formed locally on the basin. The basin is composed of alluvium with elevation of more or less 30 m. Hills composed of the diluvium with elevation of less than 100 m extends widely around the basin.	Undeveloped area.There is no production well except for a test well.
NTT (Sumba)	11	Kalembukaha	Coastal plain composed of coral limestone. Elevation of the plain is more or less 50 m. It is less than 3 km to the coast.	Preparation area. There are several incomplete production wells.
	12	Palakahembi	Coastal plain composed of coral limestone. Elevation of the plain ranges 10 to 15 m. It is less than 2 km to the coast.	Preparation area. There is no production well.
NTT (Flores)	13	Namangkewa	Narrow alluvial plain faces on the seashore with elevation of more or less 50 m. It is about 1 km to the sea. Gentle mountain slopes extend behind the plain.	It is one km to the developed area. Upland field.
	14	Magepanda	Small alluvial plain formed near the river mouth. Elevation of the plain ranges 10 to 20 m. It is 1.5 to 3.5 km to the sea.	Developed area. There are many complete and incomplete production wells.
	15	Ranakolo		Undeveloped area. There is no existing well.
	16	Dawa		
	17	Toto Mala		Undeveloped area. There is a existing well (not yet used).

Table A-4 Pumping Test Results

Region	No.	Site	Test Well	Step Drawdown Test						Constant Rate Test					Remarks
				Max.Q (m)	Max.DWL (m)	Max.D.Down (m)	Well Coefficient EFE (%)	Well Coefficient B (m/l/s)	Well Coefficient C m/(l/s)^2	SWL (m)	Q (l/s)	Drawdown (m)	Specific Capacity (l/s/m)	Trans-missivity (m^2/d)	
North Surawesi	1	Bongo I	TWG-14	20.19	17.46	10.17	67.40	0.3381	0.0081	7.52	20.46	12.73	1.61	419.65	
	2	Bongo II	TWG-31	20.46	15.72	6.31	58.71	0.1772	0.0061	10.78	21.02	6.36	3.31	431.09	
	3	Bongo III	TWG-30	20.19	9.29	3.98	96.13	0.1638	0.0003	6.50	20.46	6.24	3.28	392.06	
	4	Tempok	TWG-12	20.19	7.18	3.88	83.28	0.1631	0.0016	3.30	21.90	4.40	4.98	866.24	
	5	Parepe	TWM-03	20.46	9.72	8.73	68.18	0.2883	0.0066	0.96	19.11	9.98	1.91	440.86	
Southeast Surawesi	6	Ranooha	P.39.KDI	6.90	3.41	7.71	79.87	0.8937	0.0326	+4.30	6.04	8.16	0.74	139.27	
	7	Ranometo	P.28.KDI	12.11	10.30	12.92	82.46	0.8772	0.0154	+2.62	8.47	11.11	0.76	234.52	
	8	Lapulu	P.48.KDI	8.23	7.90	8.40	90.03	0.8996	0.0121	+0.50	5.58	8.99	0.62	61.80	
	9	Moolo Indah	P.60.KDI	11.12	6.43	7.10	52.18	0.3416	0.0282	+0.67	8.17	5.70	1.49	166.34	
	10	Lambedi Jaya	P.33.KDI *1	12.11	2.50	5.01	56.05	0.2321	0.0150	+2.51	12.11	5.03	2.41	1,117.67	
NTT (Sumba)	11	Kalembukaha	WKKI-30	No step test data						51.00	0.44	0.17	2.59	609.13	
	12	Palakahembi	EPI-15 *2	12.01	20.31	5.68	74.37	0.3363	0.0097	14.74	12.01	6.06	1.98	201.53	
NTT (Flores)	13	Namangkewa	KKI-11	7.28	10.26	2.16	73.07	0.217	0.0110	8.09	7.53	2.21	3.41	1,225.76	
	14	Magepanda	KMI-59	8.90	9.66	9.66	58.48	0.6404	0.0511	0.00	7.68	8.02	0.96	146.61	
	15	Ranakolo	-	No vicinal available well for test											
	16	Dawa	-												
	17	Toto Maia	NMI-06	7.50	23.09	4.86	83.58	0.5349	0.0140	18.24	7.50	4.88	1.54	692.20	

Note *1:The distance between the proposed well and the test well is about 11 km, therefore, another vicinal existing well data were used for well design.
*2:The distance between the proposed well and the test well is about 8 km, the hydrogeological conditions of the both sites, however, were estimated almost the same.

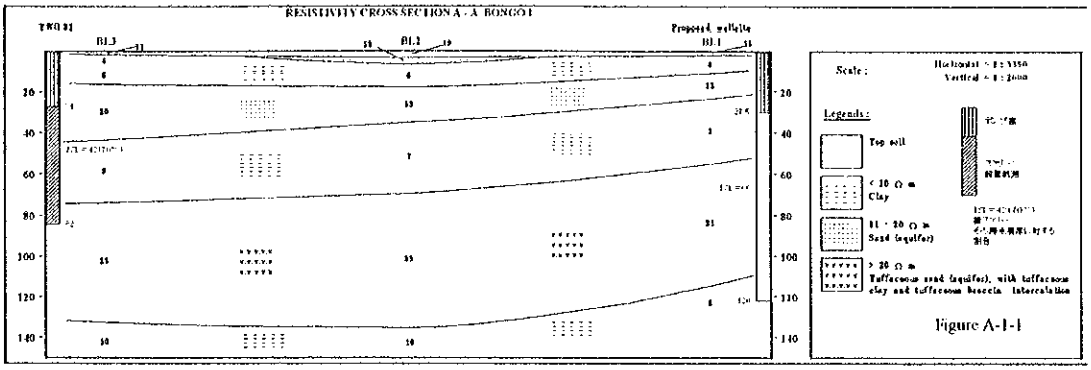


Figure A-1-1

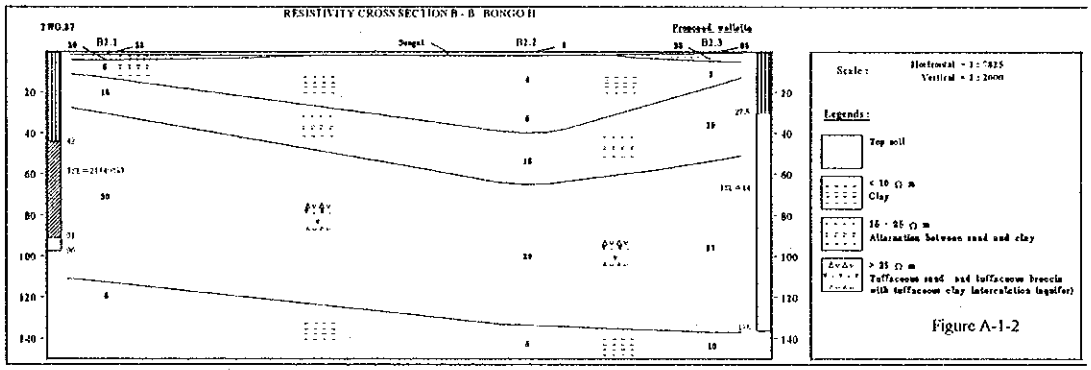


Figure A-1-2

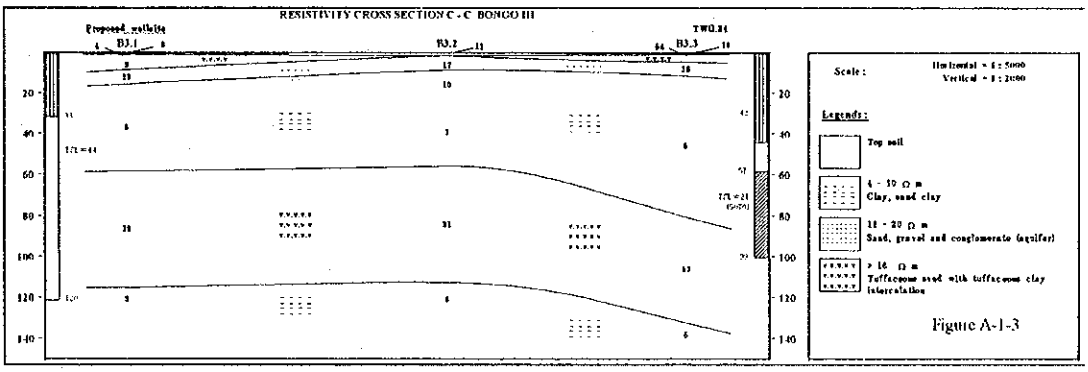


Figure A-1-3

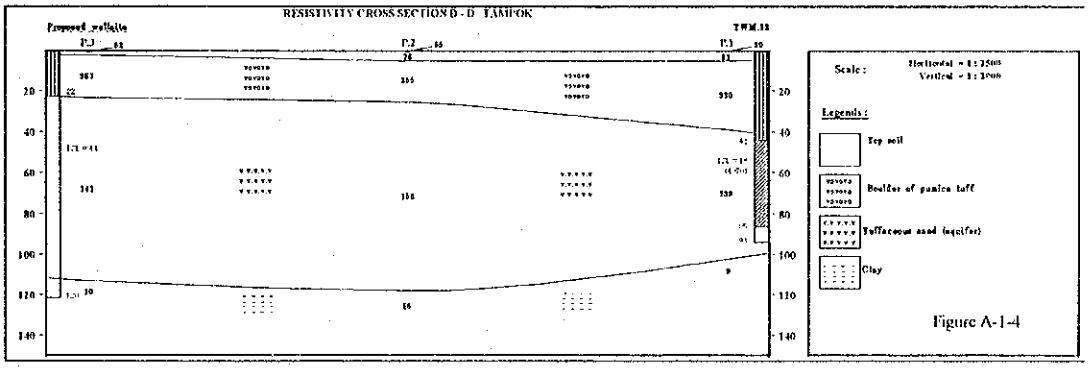


Figure A-1-4

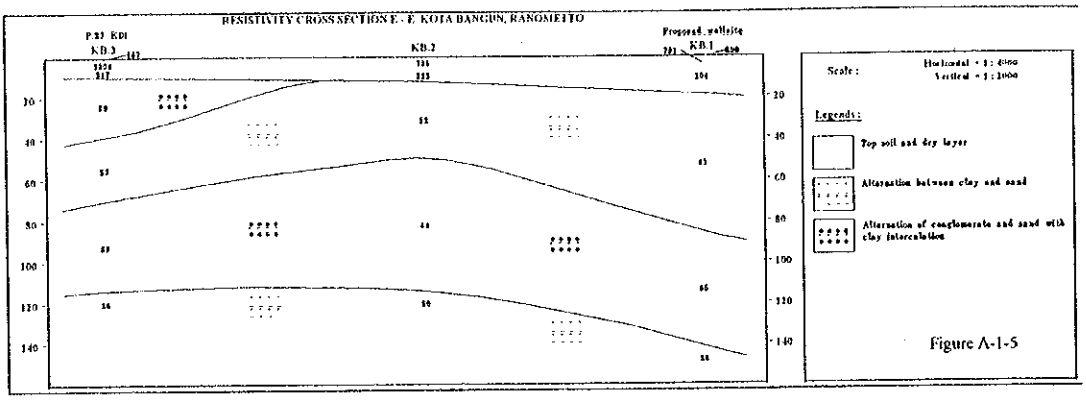


Figure A-1-5

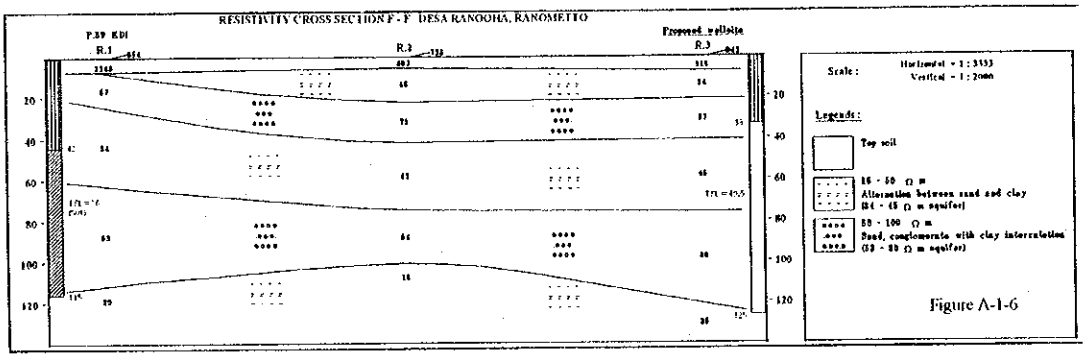


Figure A-1-6

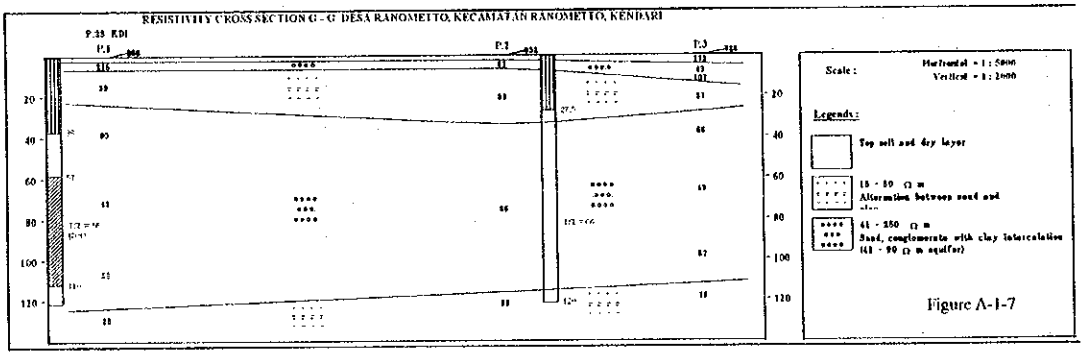
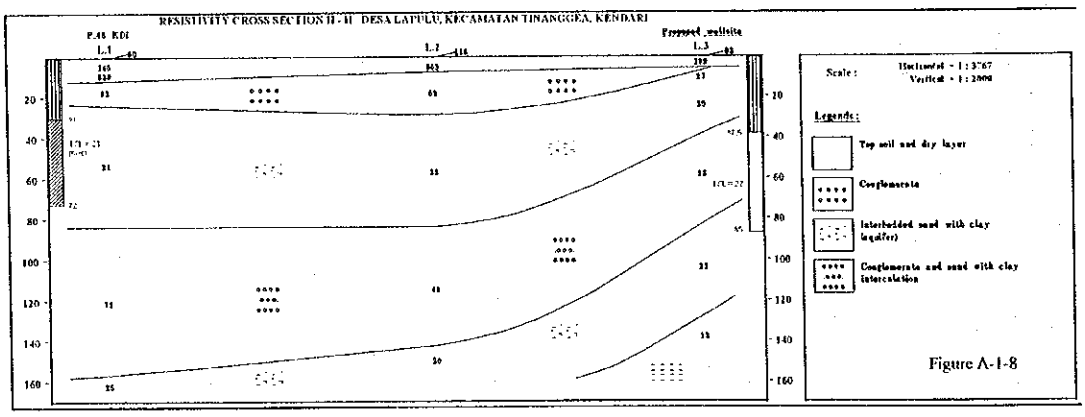


Figure A-1-7



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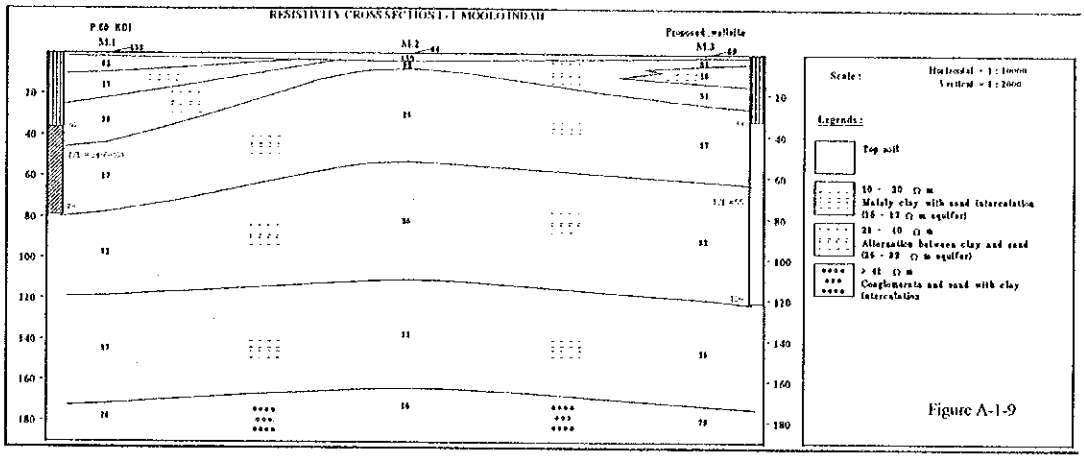


Figure A-1-9

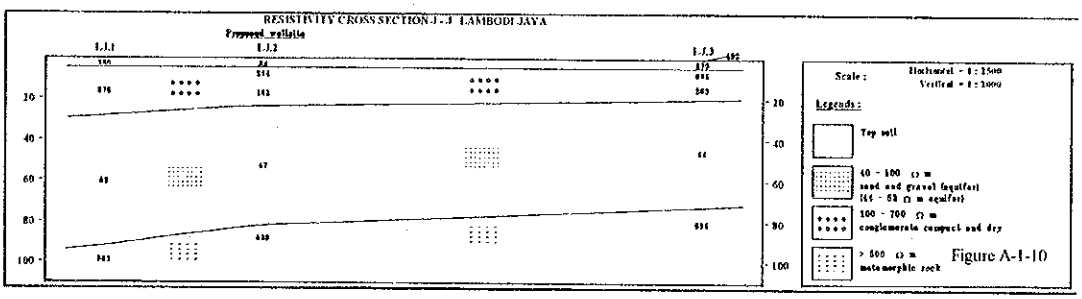


Figure A-1-10

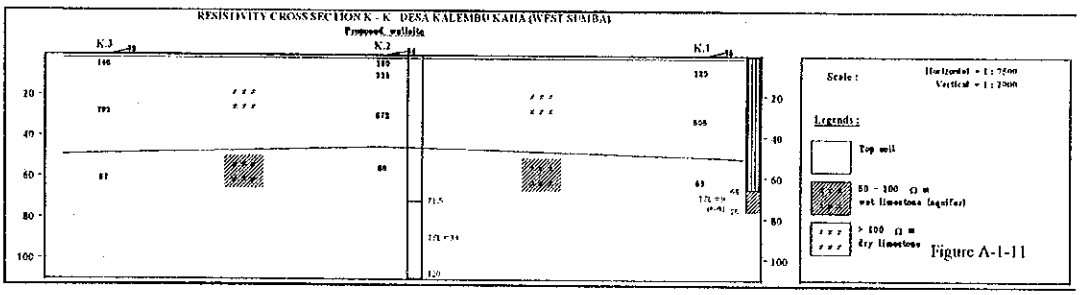


Figure A-1-11

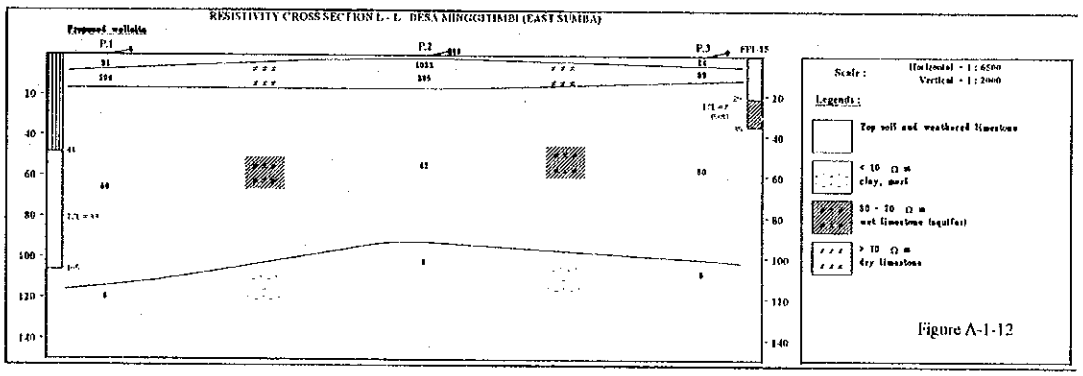


Figure A-1-12

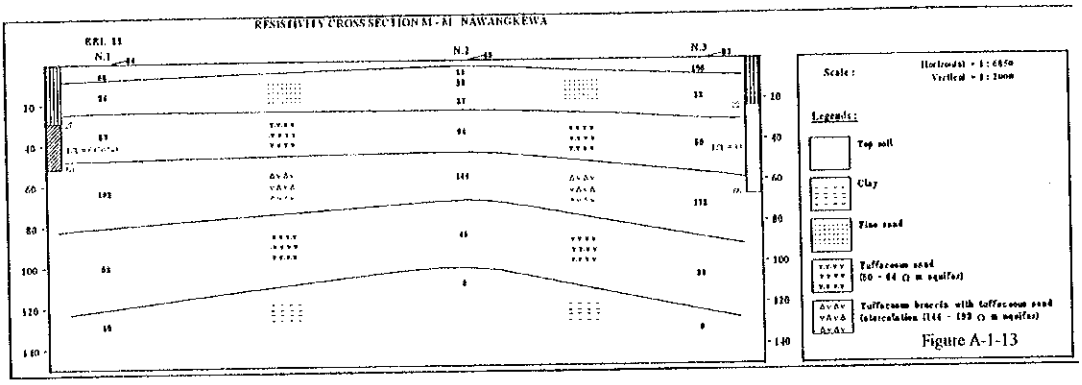


Figure A-1-13

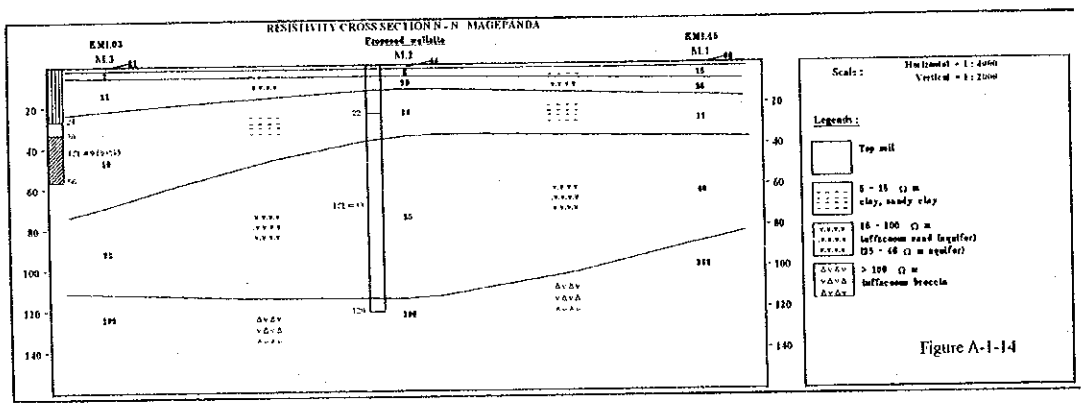


Figure A-1-14

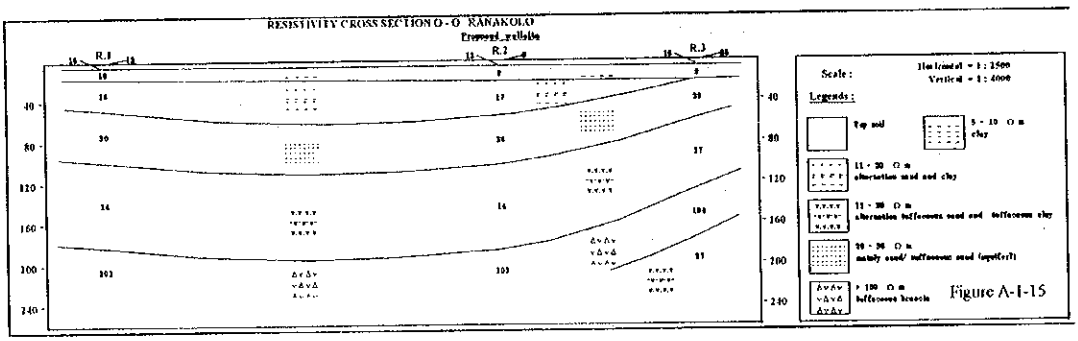


Figure A-1-15

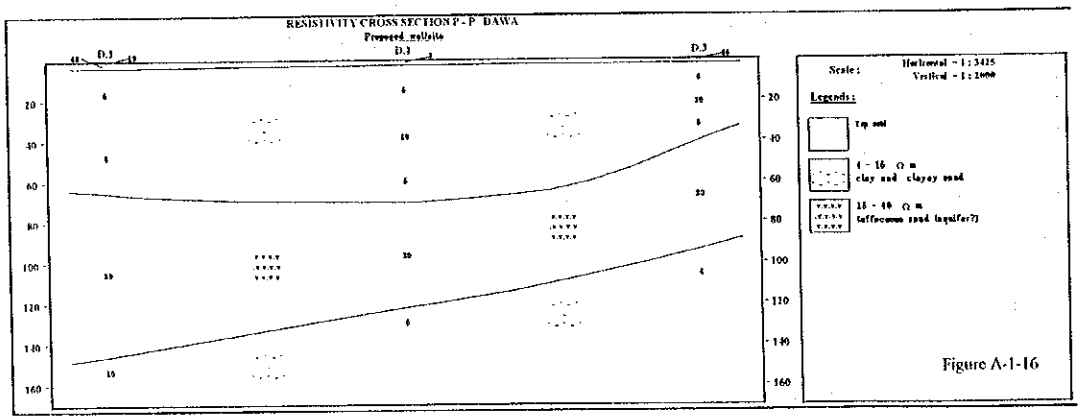


Figure A-1-16

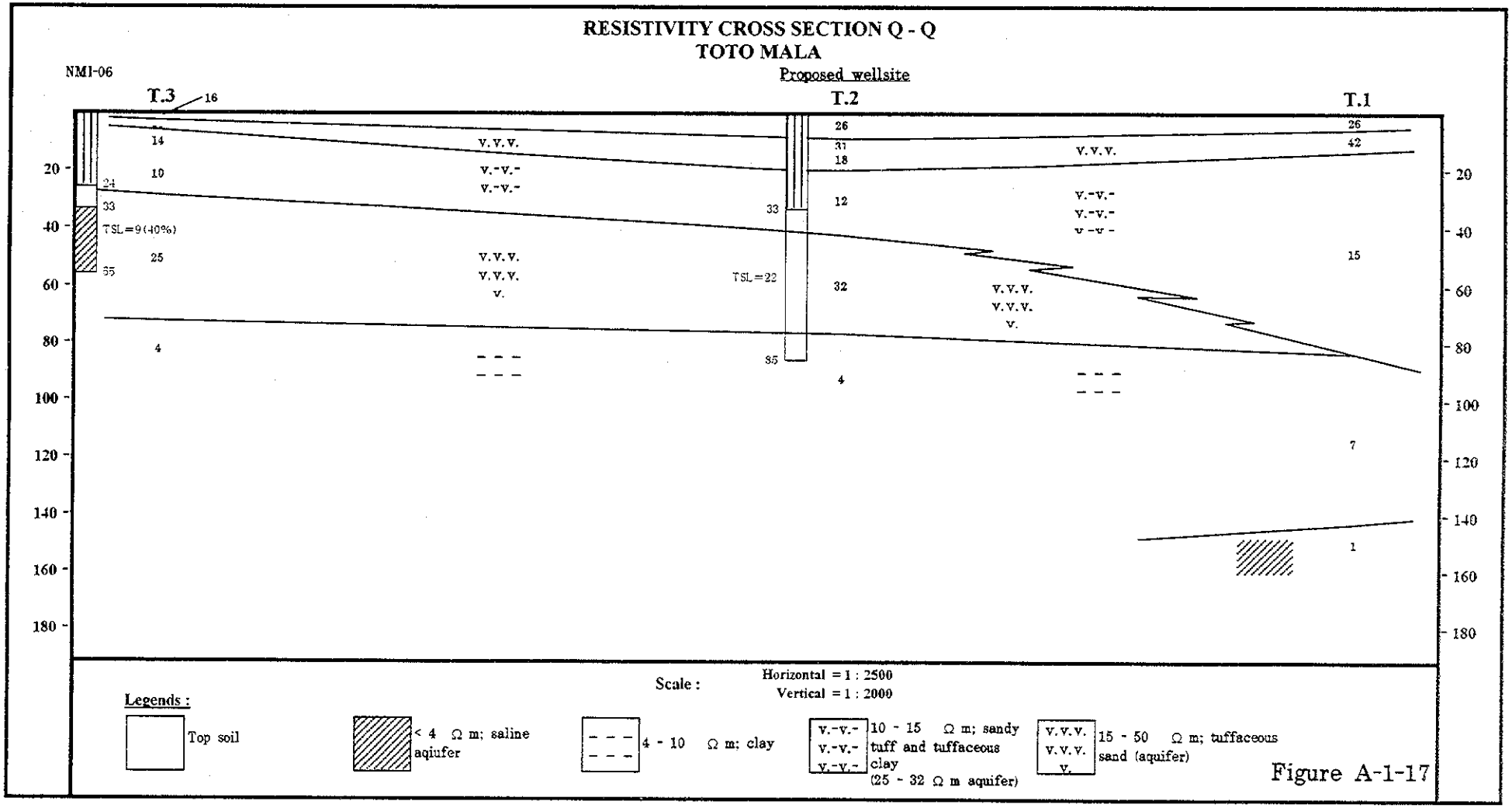

RESISTIVITY CROSS SECTION Q - Q
TOTO MALA
NM1-06
Proposed wellsite
T.3
T.2
T.1
16
14
10
24
33
TSL=9(40%)
25
55
4
V.V.V.
V.-V.-
V.-V.-
V.V.V.
V.V.V.
V.
33
TSL=22
85
26
31
18
12
32
4
V.V.V.
V.-V.-
V.-V.-
V.V.V.
V.V.V.
V.
26
42
15
7
1
20
40
60
80
100
120
140
160
180
Legends :
Top soil
< 4 Ω m; saline aqiufer
4 - 10 Ω m; clay
10 - 15 Ω m; sandy tuff and tuffaceous clay (25 - 32 Ω m aquifer)
15 - 50 Ω m; tuffaceous sand (aquifer)
Scale :
Horizontal = 1 : 2500
Vertical = 1 : 2000

Figure A-1-17

Figure A-2-1 Bongo I s. Q-Q Graph (TWG-14)

■ : Test Well

Q	11.13	14.91	20.19
Sw. Q	0.431	0.453	0.504

○ : Constant Rate Test

Q	20.46
Sw./ Q	0.624

● : Proposed Well

Q	30.00
Sw./ Q	0.333

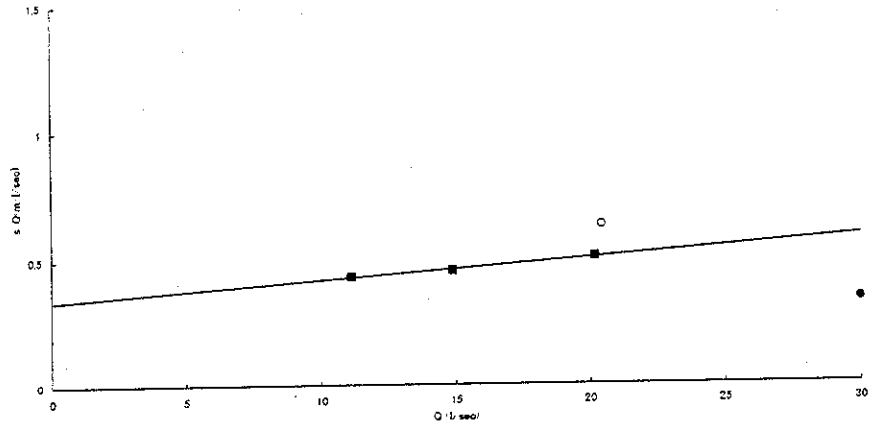


Figure A-2-2 Bongo II s/Q-Q Graph (TWG-31)

■ : Test Well

Q	10.19	15.37	20.46
Sw./Q	0.246	0.258	0.308

○ : Constant Rate Test

Q	21.02
Sw./ Q	0.303

● : Proposed Well

Q	30.00
Sw./ Q	0.333

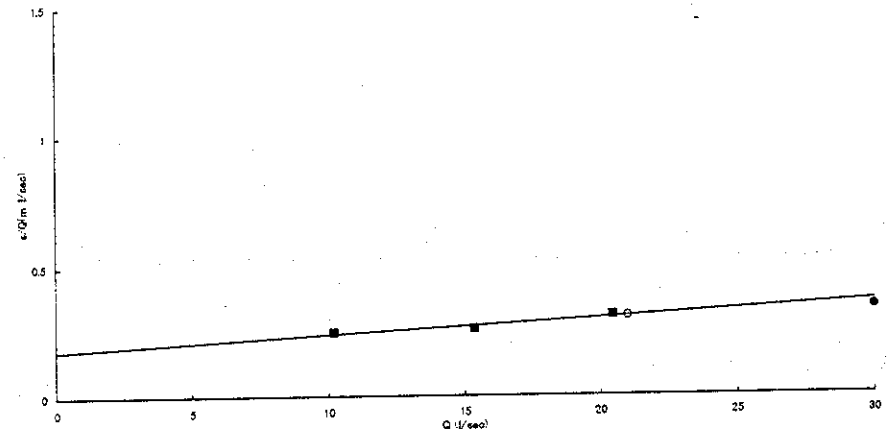


Figure A-2-3 Bongo III s. Q-Q Graph (TWG-30)

■ : Test Well

Q	11.13	15.14	20.19
Sw./ Q	0.161	0.15	0.197

○ : Constant Rate Test

Q	20.46
Sw./ Q	0.305

● : Proposed Well

Q	30.00
Sw./ Q	0.333

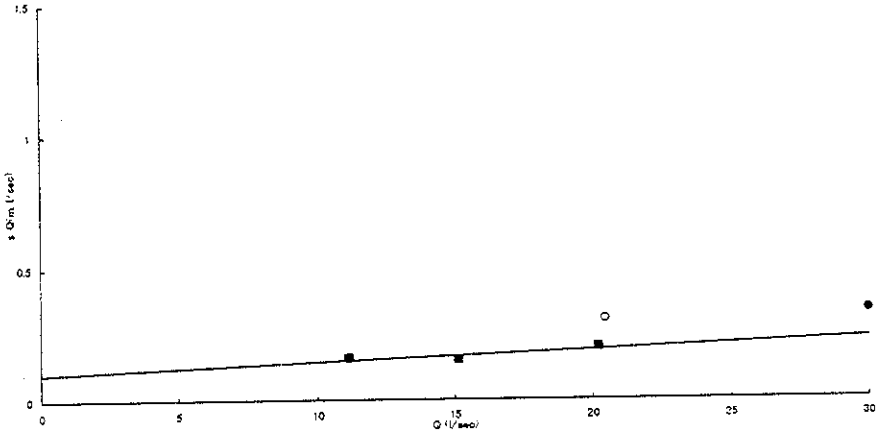


Figure A-2-4 Tempok s/Q-Q Graph (TWG-12)

■ : Test Well

Q	11.13	15.37	20.19
Sw./Q	0.177	0.189	0.192

Q	21.5
Sw./ Q	0.201

● : Proposed Well

Q	30.00
Sw./ Q	0.167

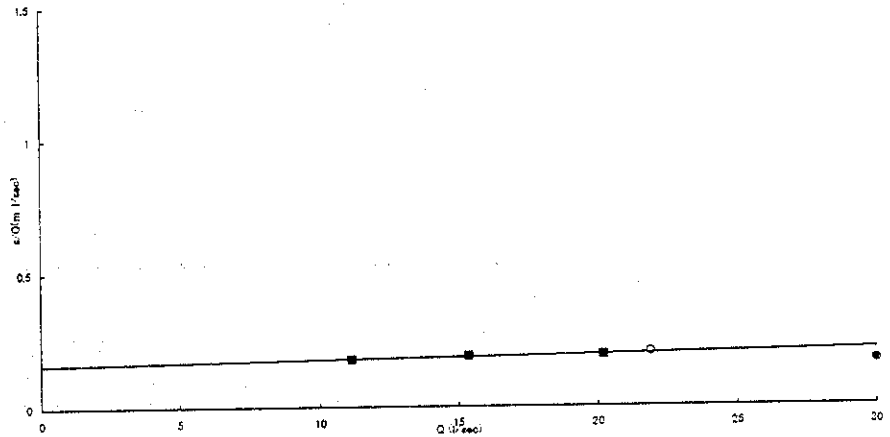


Figure A-2-5 Parepe s/Q-Q Graph (TWM-03)

■ : Test Well

Q	10.19	15.37	20.46
Sw/Q	0.359	0.382	0.427

○ : Constant Rate Test

Q	19.11
Sw/Q	0.522

● : Proposed Well

Q	30.00
Sw/Q	0.3

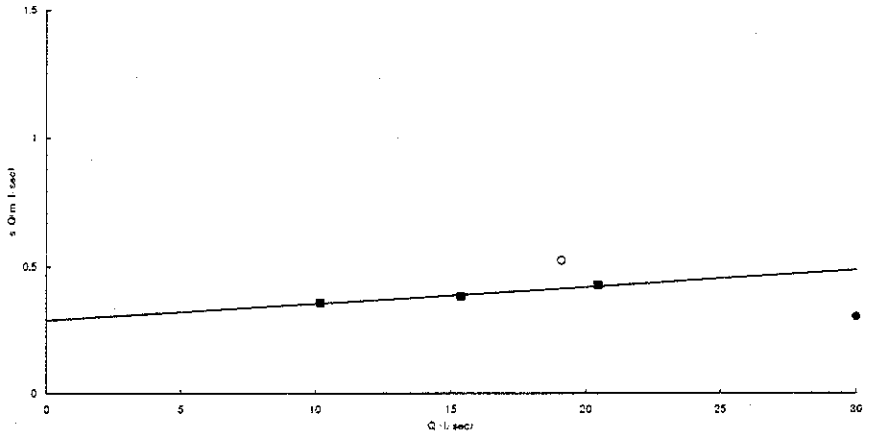


Figure A-2-6 Rangoha s/Q-Q Graph (P.39.KDI)

■ : Test Well

Q	5	6.2	8.9
Sw/Q	1.056	1.098	1.117

○ : Constant Rate Test

Q	6.04
Sw/Q	1.351

● : Proposed Well

Q	24.00
Sw/Q	0.958

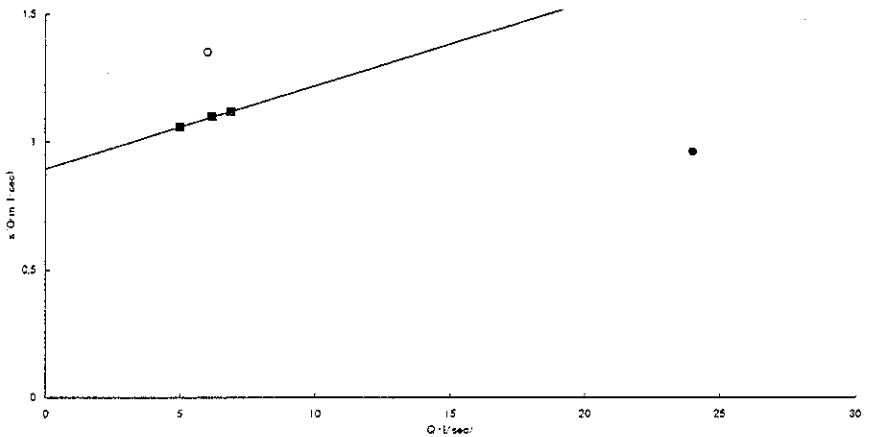


Figure A-2-7 Ranometo s/Q-Q Graph (P.28.KDI)

■ : Test Well

Q	4.4	8.5	12.11
Sw/Q	0.948	1.002	1.067

○ : Constant Rate Test

Q	8.47
Sw/Q	1.312

● : Proposed Well

Q	24.00
Sw/Q	0.583

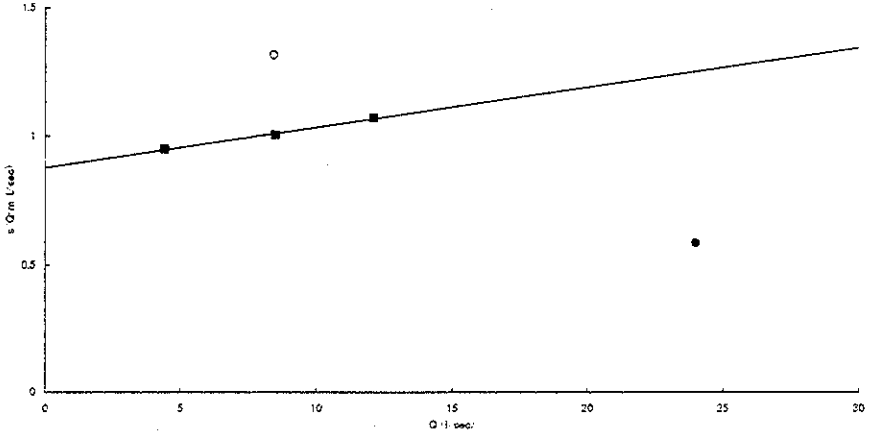


Figure A-2-8 Lapulu s/Q-Q Graph (P.48.KDI)

■ : Test Well

Q	3.52	6.51	8.23
Sw/Q	0.955	0.945	1.021

○ : Constant Rate Test

Q	5.58
Sw/Q	1.611

● : Proposed Well

Q	12.00
Sw/Q	2.083

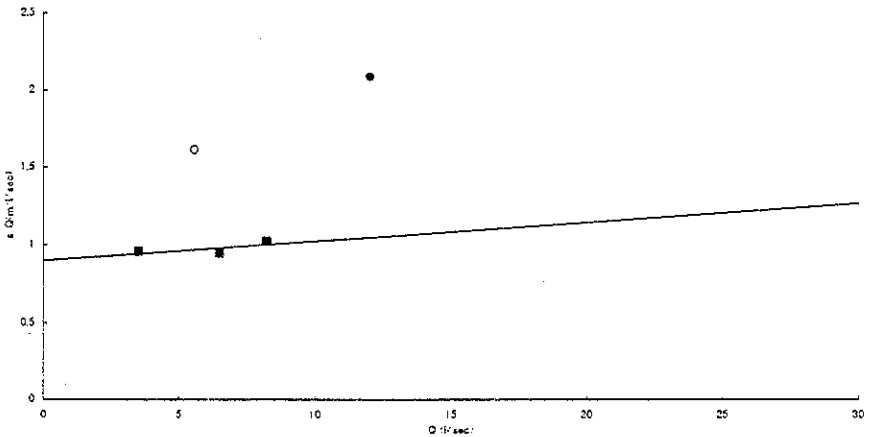


Figure A-2-9 Moolo Indaha s/Q-Q Graph (P.60,KDI)

■ : Test Well

Q	6.93	8.96	11.12
Sw/Q	0.519	0.627	0.638

○ : Constant Rate Test

Q	8.47
Sw/Q	0.673

● : Proposed Well

Q	24.00
Sw/Q	0.833

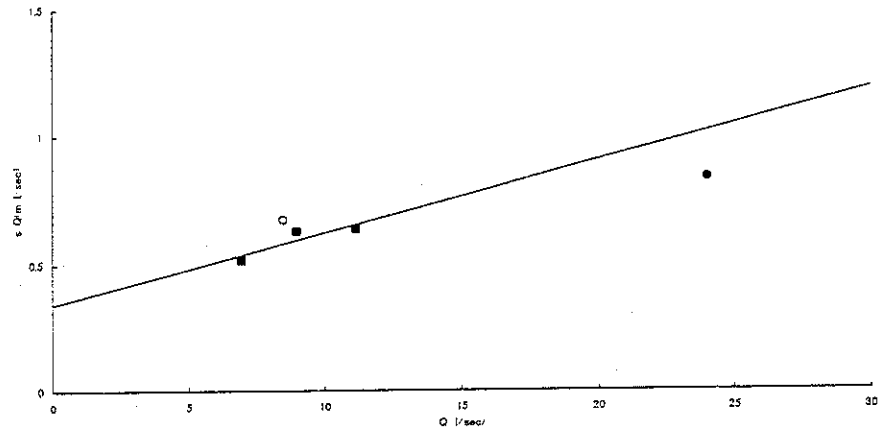


Figure A-2-10 Kalembukaha s/Q-Q Graph (WKKI-30)

■ : Test Well

Q			
Sw/Q			

○ : Constant Rate Test

Q	0.44
Sw/Q	0.368

● : Proposed Well

Q	24.00
Sw/Q	0.25

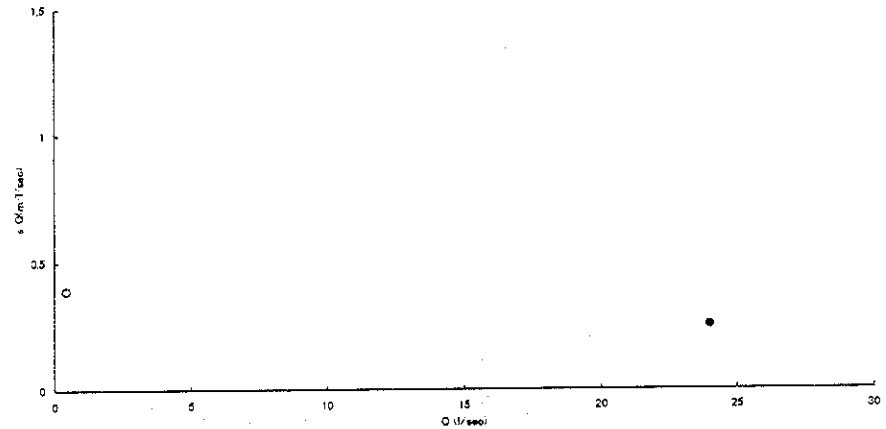


Figure A-2-11 Palakahembi s/Q-Q Graph (EPI-15)

■ : Test Well

Q	4.2	8.1	12.01
Sw/Q	0.398	0.373	0.473

○ : Constant Rate Test

Q	12.01
Sw/Q	0.505

● : Proposed Well

Q	24.00
Sw/Q	0.667

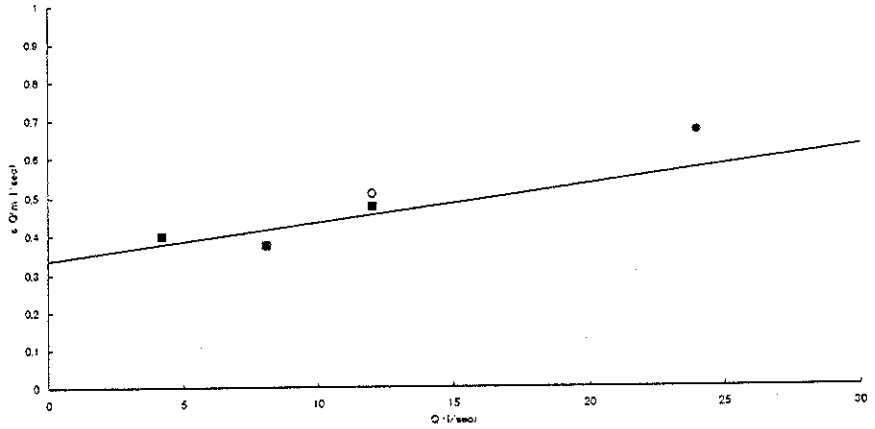


Figure A-2-12 Namangkowa s/Q-Q Graph (KKI-11)

■ : Test Well

Q	2.58	5.58	7.28
Sw/Q	0.246	0.279	0.297

○ : Constant Rate Test

Q	7.53
Sw/Q	0.294

● : Proposed Well

Q	11.00
Sw/Q	0.182

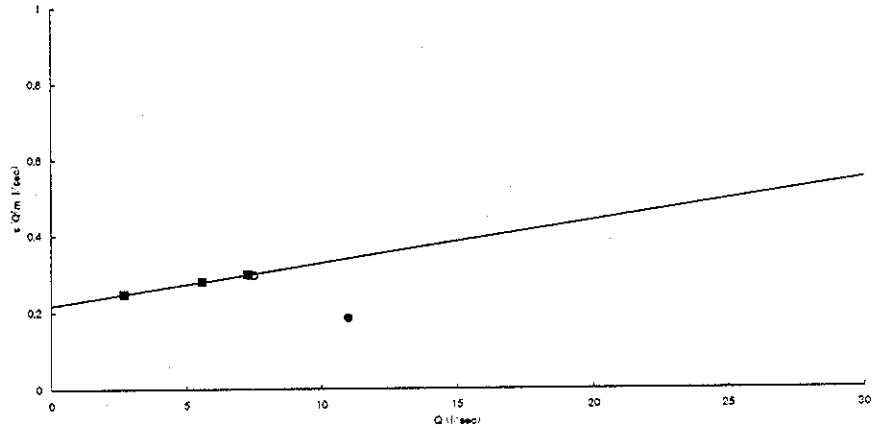


Figure A-2-13 Magepanda s/Q-Q Graph (KMI-59)

■ : Test Well

Q	3.91	6.7	8.9
Sw/Q	0.832	1	1.085

○ : Constant Rate Test

Q	7.68
Sw/Q	1.044

● : Proposed Well

Q	15.00
Sw/Q	0.933

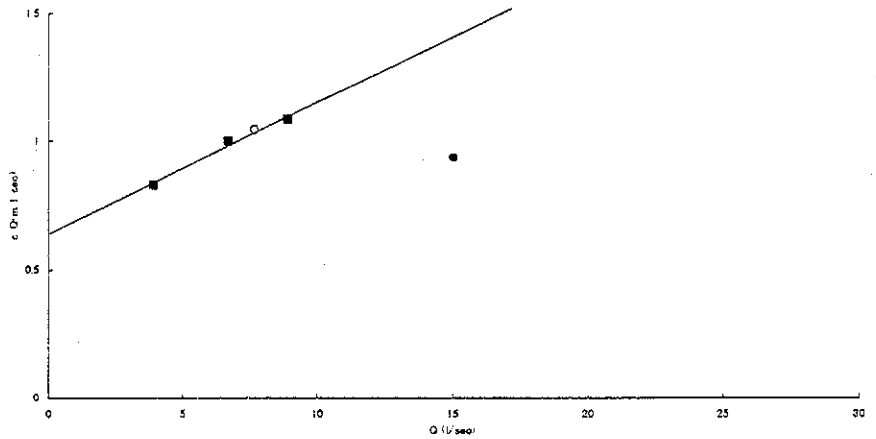


Figure A-2-14 Toto Mala s/Q-Q Graph(NMI-06)

■ : Test Well

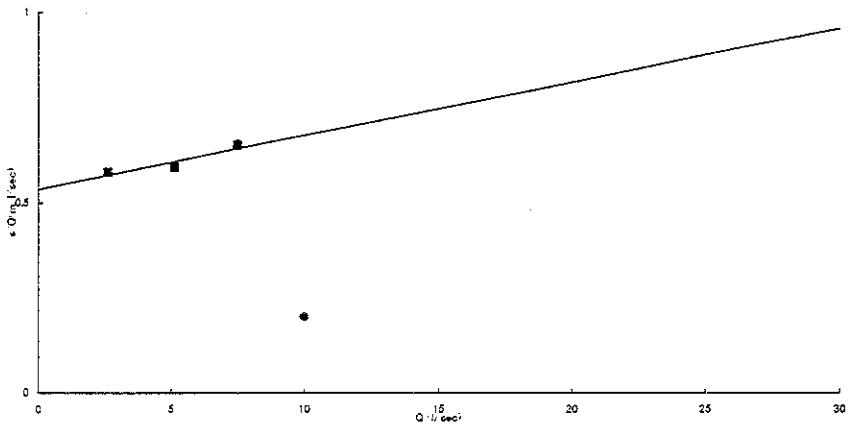
Q	2.8	5.13	7.5
Sw/Q	0.579	0.591	0.648

○ : Constant Rate Test

Q	7.5
Sw/Q	0.651

● : Proposed Well

Q	10.00
Sw/Q	0.2



Calculation sheet for well design

1. Formulations and Terms

The study on well design is carried out by the study on the drawdown with the Theis' non-equilibrium equation. The Theis' non-equilibrium equation is the most general equation used to study on drawdow.

1) Proposed discharge (Q:m^3/sec)

2) Operation hour of pump (t:sec)

3) Drawdown (s:m) = $(Q \cdot W(u)) / (4\pi \cdot T)$ .....(Theis' non-equilibrium equation)

4) Well function $(W(u)) = \int ((e^{-u})/u) \cdot du$, $u = r^2 \cdot S / 4 \cdot T \cdot t$

Theis' type curve shows W(u) against u

5) Transmissivity (T:m^2/sec)

6) Radius of the proposed well (r:m)

7) Strativity (S)

Strativity was assumed empirically to be one order smaller than the transmissivity with the unit of m2/sec.

While, the drawdown (x: m) at the (R: m) distance place from the pumping well is given by the following formulation。

$(s - x) = (Q \cdot \ln (R/r)) / 2\pi \cdot T$

2. Calculation

1) Bongo I

$T = 4.80 \times 10^{-3}$ (average of the three wells in Bongo area)、 $S = 5.00 \times 10^{-4}$、 $Q = 30 \times 10^{-3}$ 、 $t = 5.76 \times 10^{4}$、 $r = 10 \times 10^{-2}$

$s = (30 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (4.80 \times 10^{-3}) = (4.97 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-4}) / 4 \cdot (4.80 \times 10^{-3}) \cdot (5.76 \times 10^{4})$

$= 4.52 \times 10^{-9}$ then, W(u) = 18.5 (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (4.97 \times 10^{-1}) \cdot 18.5 = 9.19$ (about 10 m)

Depth of DWL (PWL) = SWL + DWL = 7.52 + 9.19 = 16.71

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 16.71+ 1 = 17.71

(about 18 m).

Interference to the 500 m distance place,

$(9.19 - x) = (30 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (4.80 \times 10^{-3}) = 8.46$

$x = 0.73$ (m)

2) Bongo II

$T = 4.80 \times 10^{-3}$ (average of the three wells in Bongo area), $S = 5.00 \times 10^{-4}$, $Q = 30 \times 10^{-3}$, $t = 5.76 \times 10^{4}$, $r = 10 \times 10^{-2}$

$s = (30 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (4.80 \times 10^{-3}) = (4.97 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-4}) / 4 \cdot (4.80 \times 10^{-3}) \cdot (5.76 \times 10^{4})$

$= 4.52 \times 10^{-9}$ then, $W(u) = 18.5$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (4.97 \times 10^{-1}) \cdot 18.5 = 9.19$ (about 10 m)

Depth of DWL (PWL) = SWL + DWL = 6.50+ 9.19 = 15.69

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 15.69 + 1 = 16.69 (about 17m)

Interference to the 500 m distance place,

$(9.19 - x) = (30 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (4.80 \times 10^{-3}) = 8.46$

$x = 0.73$ (m)

3) Bongo III

$T = 4.80 \times 10^{-3}$ (average of the three wells in Bongo area), $S = 5.00 \times 10^{-4}$, $Q = 30 \times 10^{-3}$, $t = 5.76 \times 10^{4}$, $r = 10 \times 10^{-2}$

$s = (30 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (4.80 \times 10^{-3}) = (4.97 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-4}) / 4 \cdot (4.80 \times 10^{-3}) \cdot (5.76 \times 10^{4})$

$= 4.52 \times 10^{-9}$ then, $W(u) = 18.5$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (4.97 \times 10^{-1}) \cdot 18.5 = 9.19$ (about 10 m)

Depth of DWL (PWL) = SWL + DWL = 10.78 + 9.19 = 19.9 7

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 19.97 + 1 = 20.97 (about 21m)

Interference to the 500 m distance place,

$(9.19 - x) = (30 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (4.80 \times 10^{-3}) = 8.46$

$x = 0.73$ (m)

4) Tempok

$T = 1.00 \times 10^{-2}$、 $S = 1.00 \times 10^{-3}$、 $Q = 30 \times 10^{-3}$ 、 $t = 5.04 \times 10^{4}$、 $r = 10 \times 10^{-2}$

$s = (30 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (1.00 \times 10^{-2}) = (2.39 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (1.00 \times 10^{-3}) / 4 \cdot (1.00 \times 10^{-2}) \cdot (5.04 \times 10^{4})$

$= 4.96 \times 10^{-9}$ then, $W(u) = 18.5$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (2.39 \times 10^{-1}) \cdot 18.5 = 4.42$ (約 5 m)

Depth of DWL (PWL) = SWL + DWL = 3.30 + 4.42 = 7.70

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 7.70 + 1 =8.70 (about 9 m)

Interference to the 500 m distance place,

$(4.42 - x) = (30 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (1.00 \times 10^{-3}) = 4.06$

$x = 0.36$ (m)

5) Parepe

$T = 5.10 \times 10^{-3}$、 $S = 5.00 \times 10^{-4}$、 $Q = 30 \times 10^{-3}$ 、 $t = 5.04 \times 10^{4}$、 $r = 10 \times 10^{-2}$

$s = (30 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (5.10 \times 10^{-3}) = (4.68 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-4}) / 4 \cdot (5.10 \times 10^{-3}) \cdot (5.04 \times 10^{4})$

$= 4.86 \times 10^{-9}$ then, therefore, $W(u) = 18.5$ (from Theis' type curve) ..... (2)

Therefore, from formulation (1) and (2),

$s = (4.68 \times 10^{-1}) \cdot 18.5 = 8.66$ (about 9 m)

Depth of DWL (PWL) = SWL + DWL = 0.96 + 8.66 = 9.62

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 9.62 + 1 = 10.62 (about 11 m)

Interference to the 500 m distance place,

$(8.66 - x) = (30 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (5.10 \times 10^{-3}) = 7.97$

$x = 0.69$ (m)

6)Ranooha

$T = 1.61 \times 10^{-3}$、$S = 1.00 \times 10^{-4}$、$Q = 24 \times 10^{-3}$ 、$t = 5.04 \times 10^{4}$、$r = 10 \times 10^{-2}$

$s = (24 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (1.61 \times 10^{-3}) = (1.19 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (1.00 \times 10^{-4}) / 4 \cdot (1.61 \times 10^{-3}) \cdot (5.04 \times 10^{4})$

$= 3.08 \times 10^{-9}$ then, $W(u) = 18.5$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = 1.19 \times 18.5 = 22.02$ (約 23 m)

Depth of DWL (PWL) = SWL + DWL = 0 + 22.02 = 22.02

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 22.02 + 1 = 23.02 (about 24 m)

Interference to the 500 m distance place,

$(22.02 - x) = (24 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (1.61 \times 10^{-3}) = 20.19$

$x = 1.83$ (m)

7) Ranometo

$T = 2.71 \times 10^{-3}$、$S = 1.00 \times 10^{-4}$、$Q = 24 \times 10^{-3}$ 、$t = 5.04 \times 10^{4}$、$r = 10 \times 10^{-2}$

$s = (24 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (2.71 \times 10^{-3}) = (7.05 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (1.00 \times 10^{-4}) / 4 \cdot (2.71 \times 10^{-3}) \cdot (5.04 \times 10^{4})$

$= 1.83 \times 10^{-9}$ then, $W(u) = 19$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (7.05 \times 10^{-1}) \cdot 19 = 13.40$ (about 14 m)

Depth of DWL (PWL) = SWL + DWL = 0 + 13.40 = 13.40

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 13.40 + 1 = 14.40 (about 15 m)

Interference to the 500 m distance place,

$(13.40 - x) = (24 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (2.71 \times 10^{-3}) = 11.99$

$x = 1.41$ (m)

8) Lapuru

$T = 7.15 \times 10^{-4}$、 $S = 5.00 \times 10^{-5}$、 $Q = 12 \times 10^{-3}$ 、 $t = 5.04 \times 10^{4}$、 $r = 10 \times 10^{-2}$

$s = (12 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (7.15 \times 10^{-4}) = 1.34 \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-5}) / 4 \cdot (7.15 \times 10^{-4}) \cdot (5.04 \times 10^{-4})$

$= 3.47 \times 10^{-9}$ then, $W(u) = 18.5$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = 1.34 \times 18.5 = 24.79$ (about 25 m)

Depth of DWL (PWL) = SWL + DWL = 0 + 24.79 = 24.79

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 24.79 + 1 =25.79 (about 26 m)

Interference to the 500 m distance place,

$(24.79 - x) = (12 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (7.15 \times 10^{-4}) = 22.73$

$x = 2.06$ greater than 2.0 (m)

Therefore, if $Q = 10 \times 10^{-3}$ is proposed,

$s = 1.11 \times 18.5 = 20.53$ (about 21m)

Depth of DWL (PWL) = SWL + DWL = 0 + 20.53 =20.53 (about 21 m)

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 20.53 + 1 = 21.53 (about 22 m)

Interference to the 500 m distance place (again)

$(20.53 - x) = (10 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (7.15 \times 10^{-4}) = 18.94$

$x = 1.59$ (m)

Interference to the coast (1,200 m)

$(20.53 - x) = (10 \times 10^{-3}) \times 2.3 \times 4.08 / 2\pi \times (7.15 \times 10^{-4}) = 20.09$

$x = 0.44$ (m)

9) Moolo Indaha

$T = 1.81 \times 10^{-3}$、$S = 1.00 \times 10^{-4}$、$Q = 24 \times 10^{-3}$ 、$t = 5.04 \times 10^{4}$、$r = 10 \times 10^{-2}$

$s = (24 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (1.81 \times 10^{-3}) = 1.06 \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (1.00 \times 10^{-4}) / 4 \cdot (1.81 \times 10^{-3}) \cdot (5.04 \times 10^{4})$

$= 2.74 \times 10^{-9}$ then, $W(u) = 18.5$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = 1.06 \times 18.5 = 19.61$ (about 20 m)

Depth of DWL (PWL) = SWL + DWL = 0 +19.61 = 19.61

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 19.61 + 1 = 20.61 (about 21 m)

Interference to the 500 m distance place,

$(19.61 - x) = (24 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (1.81 \times 10^{-3}) = 17.95$

$x = 1.66$ (m)

Interference to the coast (1,200 m)

$(19.61 - x) = (24 \times 10^{-3}) \times 2.3 \times 4.08 / 2\pi \cdot (1.81 \times 10^{-3}) = 19.80$

$x = -0.19$ (m)

10) Lambedi Jaya

$T = 4.52 \times 10^{-4}$ (m^2/sec = 39.01 m^2/day)、 $S = 5.00 \times 10^{-5}$、$Q = 24 \times 10^{-3}$、 $t = 4.32 \times 10^{4}$、$r = 10 \times 10^{-2}$

$s = (24 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (4.52 \times 10^{-4}) = 4.23 \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-5}) / 4 \cdot (4.52 \times 10^{-4}) \cdot (4.32 \times 10^{4})$

$= 6.40 \times 10^{-9}$ これに対する $W(u) = 18.5$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = 4.23 \times 18.5 = 78.26$ (about 78 m)

Depth of DWL (PWL) = SWL + DWL = 1.50 + 78.26 =79.76

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 79.76+ 1 =80.76 (about 81 m)

Interference to the 500 m distance place,

$(19.61 - x) = (24 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (1.81 \times 10^{-3}) = 17.95$

$x = 1.66$ (m)

Q = 12×10^{-3}

$s = (12 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (4.52 \times 10^{-4}) = 2.11 \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-5}) / 4 \cdot (4.52 \times 10^{-4}) \cdot (4.32 \times 10^{4})$

$= 6.40 \times 10^{-9}$ これに対する W(u) = 18.5 (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = 2.11 \times 18.5 = 39.04$ (about 39 m)

Depth of DWL (PWL) = SWL + DWL = 1.50 + 39.04 =40.54

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 40.54+ 1 =41.54 (about 42 m)

Interference to the 500 m distance place,

$(39.04 - x) = (12 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (4.52 \times 10^{-4}) = 35.96$

$x = 1.66$ (m)

Q = 10×10^{-3}

$s = (10 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (4.52 \times 10^{-4}) = 1.76 \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-5}) / 4 \cdot (4.52 \times 10^{-4}) \cdot (4.32 \times 10^{4})$

$= 6.40 \times 10^{-9}$ これに対する W(u) = 18.5 (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = 1.76 \times 18.5 = 32.56$ (about 33 m)

Depth of DWL (PWL) = SWL + DWL = 1.50 + 33.00 =34.50

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 34.50+ 1 =35.50 (about 36 m)

Interference to the 500 m distance place,

$(32.56 - x) = (6 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (4.52 \times 10^{-4}) = 29..96$

$x = 2.60$ (m)

11) Kalembukaha

$T = 7.05 \times 10^{-3}$、 $S = 5.00 \times 10^{-4}$、 $Q = 12 \times 10^{-3}$ 、 $t = 5.76 \times 10^{4}$、 $r = 10 \times 10^{-2}$

$s = (12 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (7.05 \times 10^{-3}) = (1.35 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-4}) / 4 \cdot (7.05 \times 10^{-3}) \cdot (5.76 \times 10^{4})$

$= 3.08 \times 10^{-9}$ then, $W(u) = 18.5$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (1.35 \times 10^{-1}) \cdot 18.5 = 2.50$ (about 3 m)

Depth of DWL (PWL) = SWL + DWL = 51.00 +2.50 = 53.50

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 53.50 + 1 = 54.50 (about 55 m)

Interference to the 500 m distance place,

$(5.01 - x) = (24 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (7.05 \times 10^{-3}) = 4.61$

$x = 0.40$ (m)

Interference to the coast (2,800 m)

$(2.50 - x) = (12 \times 10^{-3}) \times 2.3 \times 4.45 / 2\pi \cdot (7.05 \times 10^{-3}) = 2.77$

$x = -0.27$ (m)

12) Palakahembi

$T = 2.33 \times 10^{-3}$、 $S = 1.00 \times 10^{-4}$、 $Q = 12 \times 10^{-3}$ 、 $t = 4.32 \times 10^{4}$、 $r = 10 \times 10^{-2}$

$s = (12 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (2.33 \times 10^{-3}) = (4.10 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (1.00 \times 10^{-4}) / 4 \cdot (2.33 \times 10^{-3}) \cdot (4.32 \times 10^{4})$

$= 2.48 \times 10^{-9}$ then, $W(u) = 19$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (4.10 \times 10^{-1}) \cdot 19 = 7.79$ (about 8 m)

Depth of DWL (PWL) = SWL + DWL = 14.74 +7.79 =22.53

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 22.53 + 1 = 23.53 (about 24 m)

Interference to the 500 m distance place,

$(7.79 - x) = (12 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (2.33 \times 10^{-3}) = 6.98$

$x = 0.81$ (m)

Interference to the coast (1,750 m)

$(7.79 - x) = (12 \times 10^{-3}) \cdot 2.3 \cdot 4.24 / 2\pi \cdot (2.33 \times 10^{-3}) = 7.99$

$x = -0.20$ (m)

13) Namangkewa

$T = 1.42 \times 10^{-2}$、$S = 1.00 \times 10^{-3}$、$Q = 11 \times 10^{-3}$ 、$t = 4.32 \times 10^{-4}$、$r = 10 \times 10^{-2}$

$s = (11 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (1.42 \times 10^{-2}) = (6.16 \times 10^{-2}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (1.00 \times 10^{-3}) / 4 \cdot (1.42 \times 10^{-2}) \cdot (4.32 \times 10^{-4})$

$= 4.08 \times 10^{-9}$ then, $W(u) = 18$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (6.16 \times 10^{-1}) \cdot 18 = 1.11$ (約 2 m)

Depth of DWL (PWL) = SWL + DWL = 8.09 +1.11 = 9.20

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 9.20 + 1 = 10.20 (about 11 m)

Interference to the 500 m distance place,

$(1.11 - x) = (11 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (1.42 \times 10^{-2}) = 1.05$

$x = 0.06$ (m)

Interference to the coast (850 m)

$(1.11 - x) = (11 \times 10^{-3}) \cdot 2.3 \cdot 3.93 / 2\pi \cdot (1.42 \times 10^{-2}) = 1.14$

$x = -0.03$ (m)

14) Magepanda

$T = 1.70 \times 10^{-3}$、$S = 1.00 \times 10^{-4}$、$Q = 15 \times 10^{-3}$ 、$t = 4.32 \times 10^{4}$、$r = 10 \times 10^{-2}$

$s = (15 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (1.70 \times 10^{-3}) = (7.02 \times 10^{-1}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (1.00 \times 10^{-4}) / 4 \cdot (1.70 \times 10^{-3}) \cdot (4.32 \times 10^{4})$

$= 4.08 \times 10^{-9}$ then, $W(u) = 19$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (7.02 \times 10^{-1}) \cdot 19 = 13.33$ (約 14 m)

Depth of DWL (PWL) = SWL + DWL = 0.00 +13.33 =13.33

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 13.33 + 1 =14.33 (about 15 m)

Interference to the nearest well (300 m)

$(13.33 - x) = (15 \times 10^{-3}) \cdot 2.3 \cdot 3.48 / 2\pi \cdot (1.70 \times 10^{-3}) = 11.24$

$x = 2.09$ greater than 2.0 (m)

Therefore, if $Q = 10 \times 10^{-3}$ is proposed,

$s = (4.68 \times 10^{-1}) \cdot 19 = 8.89$ (about 9 m)

Depth of DWL (PWL) = SWL + DWL = 0 + 8.89 =8.89 (約 9 m)

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 8.89 + 1 = 9.89 (about 10 m)

Interference to the nearest well (300 m) (again)

$(8.89 - x) = (10 \times 10^{-3}) \cdot 2.3 \cdot 3.48 / 2\pi \cdot (1.70 \times 10^{-3}) = 7.49$

$x = 1.40$ (m)

Interference to the coast (1,350 m)

$(8.89 - x) = (10 \times 10^{-3}) \cdot 2.3 \cdot 4.13 / 2\pi \cdot (1.70 \times 10^{-3}) = 8.89$

$x = 0.00$ (m)

15) 、16)

Omission

17) Toto Mala

$T = 8.01 \times 10^{-3}$、 $S = 5.00 \times 10^{-4}$、 $Q = 10 \times 10^{-3}$ 、 $t = 4.32 \times 10^{4}$、 $r = 10 \times 10^{-2}$

$s = (10 \times 10^{-3}) \cdot W(u) / 4\pi \cdot (8.01 \times 10^{-3} = (9.93 \times 10^{-2}) \cdot W(u)$.....(1)

$u = (10 \times 10^{-2})^2 \cdot (5.00 \times 10^{-4}) / 4 \cdot (8.01 \times 10^{-3}) \cdot (4.32 \times 10^{-4})$

$= 3.61 \times 10^{-9}$ then, $W(u) = 18.5$ (from Theis' type curve) .....(2)

Therefore, from formulation (1) and (2),

$s = (9.93 \times 10^{-2}) \cdot 18.5 = 1.84$ (about 2 m)

Depth of DWL (PWL) = SWL + DWL = 18.42 +1.84 = 20.26

If the depth of DWL (PWL) in dry season is assumed 1 m below the present one, 20.26 + 1 = 21.26 (about 22 m)

Interference to the 500 m distance place,

$(1.84 - x) = (10 \times 10^{-3}) \cdot 2.3 \cdot 3.70 / 2\pi \cdot (8.01 \times 10^{-3}) = 1.69$

$x = 0.15$ (m)

Interference to the coast (1,200 m)

$(1.84 - x) = (10 \times 10^{-3}) \cdot 2.3 \cdot 4.08 / 2\pi \cdot (8.01 \times 10^{-3}) = 1.86$

$x = -0.02$ (m)

Groundwater balance study

The groundwater balance around the project area was studied as follows. Three study areas, (1)Bongo area in North Surawesi, (2)Tempok- Parepe area in North Surawesi and (3)Ranometo-Ranooha area in South-east Surawesi were selected. These are rather developed areas.

(1) Bongo area in North Surawesi

The annual rainfall in this area is 1,200 mm (see "Climate"). One-third of this is assumed to recharge the groundwater through the year (basic water balance calculations are used in Indonesia), then the annual recharge is 400 mm or 1.10 mm /day. Recharge per unit area is 1,100 m^3/day/ km^2.

The average discharge of one well (including proposed wells) was assumed to be 20 lit/sec or 1,730 m^3/day. If the average operation hours of a pump are 12 hours/day, the average discharge is 870 m^3/day.

Well density of the most developed part in this area is 14 wells/40 km^2, or one well/2.86 km^2. The rechargeable groundwater available for one well in this area is 1,100 m^3/day/ km^2 x 2.86 km^2 = 3,140 m^3/day, greater than 870 m^3/day.

(2)Tempok- Parepe area in North Surawesi

The annual rainfall in this area is 1,900 mm (see "Climate"). One-third of this is assumed to recharge the groundwater through a year, for an annual recharge of 630 mm or 1.73 mm /day. Recharge per unit area is 1,730 m^3/day/ km^2.

The average discharge per well (including proposed wells) was assumed to be 20 lit/sec or 1,730 m^3/day. If the average operation hours of a pump are 12 hours/day, the average discharge will be 870 m^3/day.

The well density of the most developed part in this area is 7 wells/40 km^2, or one well/5.71 km^2. The rechargeable groundwater available for one well in this area is 1,730 m^3/day/ km^2 x 5.71 km^2 = 9,800 m^3/day greater than 870 m^3/day.

(3)Ranometo-Ranooha area in the Southeast Surawesi

The annual rainfall in this area is 1,650 mm (see "Climate"). One-third of this is assumed to recharge the groundwater through a year, for an annual recharge of 550 mm or 1.51 mm /day.

Recharge per unit area is 1,510 m^3/day/ km^2.

The average discharge of one well (including proposed wells) was assumed to be 20 lit/sec, or 1,730 m^3/day. If the average operation hours of a pump are 12 hours/day, the average discharge will be 870 m^3/day.

The well density of the most developed part in this area is 8 wells/25 km^2, or one well/3.13 km^2. The rechargeable groundwater available for one well in this area is 1,510 m^3/day/ km^2 x 3.13 km^2 = 4,700 m^3/day greater than 870 m^3/day.

If the catchment area of groundwater is used for the calculation of the well density, it will be smaller. Furthermore, the actual average pump operation hours through a year are less than 12 hours/day. Therefore, the actual groundwater balance will be more satisfactory.

6. Irrigation

Water Requirements : Table A-5 - Table A-14

Table A-5 Water Requirement for Bongo I, II, III

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	4.7	4.7	5.3	5.3	5.4	5.4	5.3	5.3	5.0	5.0	4.6	4.6	4.9	4.9	5.5	5.5	5.7	5.7	5.4	5.4	4.8	4.8	4.9	4.9	
	mm	71	75	74	74	81	86	80	80	75	80	69	69	74	78	83	88	86	86	81	86	72	72	74	78	1,872
2. Cropping Pattern		Rainy Season Paddy				Semi-Rainy Season Paddy								Dry Season Upland Crops (Green Beans, Maize, Soybeans)										Rainy Season Paddy		
3. Crop Coefficient (k)																										
(1) P-1 + P-2 + UC		1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95				0.50	0.64	0.89	0.95	0.88		LP	1.10	1.10	1.10	1.10	
(2) P-1 + P-2 + UC		1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.59	0.96	1.05	1.02	0.95		LP	1.10	1.10	1.10	
(3) P-1 + P-2 + UC		1.10	1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.75	1.00	1.00	0.82	0.45		LP	1.10	1.10	
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm	75	71			89	95	88	88	79	76				39	53	78	82	76			79	79	81	86	1,314
(2) P-1 + P-2 + UC	mm	78	79	70			95	88	88	83	84	66			39	49	84	90	88	77			79	81	86	1,404
(3) P-1 + P-2 + UC	mm	78	83	78	70			88	88	83	88	72	66			42	66	86	86	66	39			81	86	1,346
5. Land Preparation (Puddling: 200 mm)																										
(1) P-1 + P-2	mm				200																200					400
(2) P-1 + P-2	mm					200																200				400
(3) P-1 + P-2	mm						200																			400
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm	23	24			23	24	23	23	23	24											23	23	23	24	
(2) P-1 + P-2	mm	23	24	21			24	23	23	23	24	30											23	23	24	
(3) P-1 + P-2	mm	23	24	21	21			23	23	23	24	23	23											23	24	
7. Effective Rainfall (ER)																										
Paddy (P)	mm	30	34	32	15	35	42	42	34	62	25	32	35	31	25	19	15	5	10	18	36	56	39	41	29	742
Upland Crops (UC)	mm	36	41	38	18	42	50	50	41	74	29	37	42	37	29	22	18	6	12	22	42	66	46	49	34	881
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm	68	61		185	77	77	69	77	40	75				10	31	60	76	64		164	46	63	63	81	1,387
(2) P-1 + P-2 + UC	mm	71	69	59		165	77	69	77	44	83	64			10	27	66	84	76	55		144	63	63	81	1,447
(3) P-1 + P-2 + UC	mm	71	73	67	76		158	69	77	44	87	63	54			20	48	80	74	44	0		161	63	81	1,410
Average	mm	70	68	42	87	81	104	69	77	43	82	42	18		7	26	58	80	71	33	55	63	96	63	81	1,416
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	74	72	44	92	85	109	73	81	45	86	44	19	0	7	27	61	84	75	35	58	66	101	66	85	1,489
	m3/ha	740	720	440	920	850	1,090	730	810	450	860	440	190	0	70	270	610	840	750	350	580	660	1,010	660	850	14,890
	l/sec/ha	0.57	0.52	0.36	0.76	0.66	0.79	0.56	0.63	0.35	0.62	0.34	0.15	0.00	0.05	0.21	0.44	0.65	0.58	0.27	0.42	0.51	0.78	0.51	0.61	
11. GWR with 16 hours Pump Operation	l/sec/ha	0.9	0.8	0.6	1.2	1.0	1.2	0.9	1.0	0.6	1.0	0.6	0.3	0.0	0.1	0.4	0.7	1.0	0.9	0.5	0.7	0.8	1.2	0.8	1.0	
12. Irrigation Area	ha	25	25	17	17	17	25	25	25	25	25	17	9	0	16	23	23	23	23	16	16	17	25	25	25	
13. Design Discharge	l/sec	23	20	10	20	17	30	23	25	15	25	10	3	0	2	9	16	23	21	8	11	14	30	20	25	

Table A-6 Water Requirement for Tempok, Parepe

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	4.1	4.1	4.6	4.6	4.6	4.6	4.4	4.4	3.8	3.8	3.9	3.9	4.1	4.1	4.8	4.8	5.0	5.0	4.5	4.5	3.9	3.9	3.9	3.9	
	mm	62	66	64	64	69	74	66	66	57	61	59	59	62	66	72	77	75	75	68	72	59	59	59	62	1,573
2. Cropping Pattern		Rainy Season Paddy				Semi-Rainy Season Paddy								Dry Season Upland Crops (Green Beans, Maize, Soybeans)										Rainy Season Paddy		
3. Crop Coefficient (k)																										
(1) P-1 + P-2 + UC		1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95				0.50	0.64	0.89	0.95	0.88		LP	1.10	1.10	1.10	1.10	
(2) P-1 + P-2 + UC		1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.59	0.96	1.05	1.02	0.95		LP	1.10	1.10	1.10	
(3) P-1 + P-2 + UC		1.10	1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.75	1.00	1.00	0.82	0.45		LP	1.10	1.10	
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm	65	63			76	81	73	73	60	58				33	46	69	71	66			65	65	65	68	1,097
(2) P-1 + P-2 + UC	mm	68	69	61			81	73	73	63	64	56			33	42	74	79	77	65			65	65	68	1,176
(3) P-1 + P-2 + UC	mm	68	73	67	61			73	73	63	67	62	56			36	58	75	75	56	32			65	68	1,128
5. Land Preparation (Puddling: 200 mm)																										
(1) P-1 + P-2	mm				200																200					400
(2) P-1 + P-2	mm					200																200				400
(3) P-1 + P-2	mm						200																200			400
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm	30	32			30	32	30	30	30	32											30	30	30	32	
(2) P-1 + P-2	mm	30	32	28			32	30	30	30	32	30											30	30	32	
(3) P-1 + P-2	mm	30	32	28	28			30	30	30	32	30	30											30	32	
7. Effective Rainfall (ER)																										
Paddy (P)	mm	43	50	36	36	43	56	44	42	56	42	44	38	37	29	31	15	10	20	33	34	60	47	36	42	924
Upland Crops (UC)	mm	55	63	47	47	55	72	56	53	72	53	56	49	48	37	40	20	13	25	43	44	76	61	46	54	1,185
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm	52	45		164	63	57	59	61	34	48				0	6	49	58	41		166	35	48	59	58	1,103
(2) P-1 + P-2 + UC	mm	55	51	53		157	57	59	61	37	54	42			0	2	54	66	52	22		140	48	59	58	1,127
(3) P-1 + P-2 + UC	mm	55	55	59	53		144	59	61	37	57	48	48			0	38	62	50	13	0		153	59	58	1,109
Average	mm	54	50	37	72	73	86	59	61	36	53	30	16		0	3	47	62	48	12	55	58	83	59	58	1,112
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	57	53	39	76	77	91	62	64	38	56	32	17	0	0	3	49	65	51	13	58	61	87	62	61	1,172
	m^3/ha	570	530	390	760	770	910	620	640	380	560	320	170	0	0	30	490	650	510	130	580	610	870	620	610	11,720
	l/sec/ha	0.44	0.38	0.32	0.63	0.59	0.66	0.48	0.49	0.29	0.41	0.25	0.13	0.00	0.00	0.02	0.35	0.50	0.39	0.10	0.42	0.47	0.67	0.48	0.44	
11. GWR with 14 hours Pump Operation	l/sec/ha	0.8	0.7	0.6	1.1	1.1	1.2	0.9	0.9	0.5	0.8	0.5	0.3	0.0	0.0	0.1	0.6	0.9	0.7	0.2	0.8	0.9	1.2	0.9	0.8	
12. Irrigation Area	ha	25	25	17	17	17	25	25	25	25	25	17	9	0	17	25	25	25	25	17	17	17	25	25	25	
13. Design Discharge	l/sec	20	18	10	19	19	30	23	23	13	20	9	3	0	0	3	15	23	18	3	14	15	30	25	20	

Table A-7 Water Requirement for Ranooha, Ranometo

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	4.0	4.0	4.1	4.1	4.4	4.4	4.0	4.0	4.2	4.2	3.9	3.9	4.2	4.2	4.7	4.7	5.4	5.4	5.3	5.3	4.8	4.8	3.9	3.9	
	mm	60	64	57	57	66	70	60	60	63	67	59	59	63	67	71	75	81	81	80	85	72	72	59	62	1,610
2. Cropping Pattern				Rainy Season Paddy						Semi-Rainy Season Paddy								Dry Season Upland Crops (Groundnuts, Maize, Soybeans)								
3. Crop Coefficient (k)																										
(1) P-1 + P-2 + UC		LP	1.10	1.10	1.10	1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.51	0.66	0.85	0.95	0.75		
(2) P-1 + P-2 + UC			LP	1.10	1.10	1.10	1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.59	0.96	1.05	1.02	0.95	
(3) P-1 + P-2 + UC		0.45		LP	1.10	1.10	1.10	1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.75	1.00	1.00	0.82	
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm		70	63	63	73	74	57			74	65	65	69	70	67			41	41	56	61	68	44		1,121
(2) P-1 + P-2 + UC	mm			63	63	73	77	63	57			65	65	69	74	75	71			40	50	69	76	60	59	1,169
(3) P-1 + P-2 + UC	mm	27			63	73	77	66	63	60			65	69	74	78	79	77			43	54	72	59	51	1,150
5. Land Preparation (Puddling: 200 mm)																										
(1) P-1 + P-2	mm	200								200																400
(2) P-1 + P-2	mm		200								200															400
(3) P-1 + P-2	mm			200								200														400
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm		32	28	28	30	32	30			32	30	30	30	32	30										
(2) P-1 + P-2	mm			28	28	30	32	30	30			30	30	30	32	30	32									
(3) P-1 + P-2	mm				28	30	32	30	30	30			30	30	32	30	32	30								
7. Effective Rainfall (ER)																										
Paddy (P)	mm	42	53	51	39	52	66	65	53	54	67	64	42	61	46	33	37	21	15	16	33	23	42	37	37	1,049
Upland Crops (UC)	mm	52	66	63	48	64	81	81	65	67	83	78	51	75	56	41	45	26	19	20	40	28	51	46	46	1,292
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm	158	49	40	52	51	40	22		146	39	31	53	38	56	64			22	21	16	33	17	0		948
(2) P-1 + P-2 + UC	mm		147	40	52	51	43	28	34		133	31	53	38	60	72	66			20	10	41	25	14	13	971
(3) P-1 + P-2 + UC	mm	0		149	52	51	43	31	40	36		136	53	38	60	75	74	86			3	26	21	13	5	992
Average	mm	53	65	76	52	51	42	27	25	61	57	66	53	38	59	70	47	29	7	14	10	33	21	9	6	971
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	56	68	80	55	54	44	28	26	64	60	69	56	40	62	74	49	31	7	15	11	35	22	9	6	1,021
	m^3/ha	560	680	800	550	540	440	280	260	640	600	690	560	400	620	740	490	310	70	150	110	350	220	90	60	10,210
	l/sec/ha	0.43	0.49	0.66	0.45	0.42	0.32	0.22	0.20	0.49	0.43	0.53	0.43	0.31	0.45	0.57	0.35	0.24	0.05	0.12	0.08	0.27	0.17	0.07	0.04	
11. GWR with 14 hours Pump Operation	l/sec/ha	0.8	0.9	1.2	0.8	0.8	0.6	0.4	0.4	0.9	0.8	1.0	0.8	0.6	0.8	1.0	0.6	0.5	0.1	0.3	0.2	0.5	0.3	0.2	0.1	
12. Irrigation Area	ha	14	14	20	20	20	20	20	14	14	14	20	20	20	20	20	14	7	7	14	20	20	20	20	14	
13. Design Discharge	l/sec	11	13	24	16	16	12	8	6	13	11	20	16	12	16	20	8	4	1	4	4	10	6	4	1	

Table A-8 Water Requirement for Lapulu

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	4.0	4.0	4.1	4.1	4.4	4.4	4.0	4.0	4.2	4.2	3.9	3.9	4.2	4.2	4.7	4.7	5.4	5.4	5.3	5.3	4.8	4.8	3.9	3.9	
	mm	60	64	57	57	66	70	60	60	63	67	59	59	63	67	71	75	81	81	80	85	72	72	59	62	1,610
2. Cropping Pattern		Rainy Season Paddy					Semi-Rainy Season Paddy							Dry Season Upland Crops (Green Beans, Maize, Groundnuts)									Rainy Season Paddy			
3. Crop Coefficient (k)																										
(1) P-1 + P-2 + UC		1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95				0.50	0.64	0.89	0.95	0.88		LP	1.10	1.10	1.10	
(2) P-1 + P-2 + UC		1.10	1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.59	0.96	1.05	1.02	0.95		LP	1.10	1.10	
(3) P-1 + P-2 + UC		1.10	1.10	1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.51	0.66	0.85	0.95	0.75		LP	1.10	
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm	66	67	54			77	66	66	69	70	56				36	48	72	77	70			79	65	68	1,106
(2) P-1 + P-2 + UC	mm	66	70	60	54			66	66	69	74	62	56			36	44	78	85	82	81			65	68	1,182
(3) P-1 + P-2 + UC	mm	66	70	63	60	63			66	69	74	65	62	60			38	41	53	68	81	54			68	1,121
5. Land Preparation (Puddling: 200 mm)																										
(1) P-1 + P-2	mm					200																200				400
(2) P-1 + P-2	mm						200																200			400
(3) P-1 + P-2	mm							200																200		400
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm	30	32	28			32	30	30	30	32	30											30	30	32	
(2) P-1 + P-2	mm	30	32	28	28			30	30	30	32	30	30											30	32	
(3) P-1 + P-2	mm	30	32	28	28	30			30	30	32	30	30	30											32	
7. Effective Rainfall (ER)																										
Paddy (P)	mm	57	41	54	45	51	53	57	58	50	48	53	33	38	27	23	20	11	17	17	23	20	28	50	42	916
Upland Crops (UC)	mm	72	51	69	57	64	67	71	73	62	60	66	41	47	34	29	25	14	22	22	29	25	35	64	53	1,152
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm	39	58	28		149	56	39	38	49	54	33				7	23	58	55	48		180	74	45	58	1,091
(2) P-1 + P-2 + UC	mm	39	61	34	37		147	39	38	49	58	39	53			7	19	64	63	60	52		165	45	58	1,127
(3) P-1 + P-2 + UC	mm	39	61	37	43	42		143	38	49	58	42	59	52			13	27	31	46	52	29		150	58	1,069
Average	mm	39	60	33	27	64	68	74	38	49	57	38	37	17		5	18	50	50	51	35	70	80	80	58	1,098
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	41	63	35	28	67	72	78	40	52	60	40	39	18	0	5	19	53	53	54	37	74	84	84	61	1,157
	m^3/ha	410	630	350	280	670	720	780	400	520	600	400	390	180	0	50	190	530	530	540	370	740	840	840	610	11,570
	l/sec/ha	0.32	0.46	0.29	0.23	0.52	0.52	0.60	0.31	0.40	0.43	0.31	0.30	0.14	0.00	0.04	0.14	0.41	0.41	0.42	0.27	0.57	0.65	0.65	0.44	
11. GWR with 14 hours Pump Operation	l/sec/ha	0.6	0.8	0.5	0.4	0.9	0.9	1.1	0.6	0.7	0.8	0.6	0.6	0.3	0.0	0.1	0.3	0.8	0.8	0.8	0.5	1.0	1.2	1.2	0.8	
12. Irrigation Area	ha	10	10	10	7	7	7	10	10	10	10	10	7	4	0	7	10	10	10	10	7	7	7	10	10	
13. Design Discharge	l/sec	6	8	5	3	6	6	11	6	7	8	6	4	1	0	1	3	8	8	8	4	7	8	12	8	

Table A-9 Water Requirement for Moolo Inda

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	4.0	4.0	4.1	4.1	4.4	4.4	4.0	4.0	4.2	4.2	3.9	3.9	4.2	4.2	4.7	4.7	5.4	5.4	5.3	5.3	4.8	4.8	3.9	3.9	
	mm	60	64	57	57	66	70	60	60	63	67	59	59	63	67	71	75	81	81	80	85	72	72	59	62	1,610
2. Cropping Pattern		Rainy Season Paddy					Semi-Rainy Season Paddy							Dry Season Upland Crops (Green Beans, Maize, Groundnuts)									Rainy Season Paddy				
3. Crop Coefficient (k)																										
(1) P-1 + P-2 + UC		1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95				0.50	0.64	0.89	0.95	0.88		LP	1.10	1.10	1.10	
(2) P-1 + P-2 + UC		1.10	1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.59	0.96	1.05	1.02	0.95		LP	1.10	1.10	
(3) P-1 + P-2 + UC		1.10	1.10	1.10	1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.51	0.66	0.85	0.95	0.75		LP	1.10	
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm	66	67	54			77	66	66	69	70	56				36	48	72	77	70			79	65	68	1,106
(2) P-1 + P-2 + UC	mm	66	70	60	54			66	66	69	74	62	56			36	44	78	85	82	81			65	68	1,182
(3) P-1 + P-2 + UC	mm	66	70	63	60	63			66	69	74	65	62	60			38	41	53	68	81	54			68	1,121
5. Land Preparation (Puddling: 200 mm)																										
(1) P-1 + P-2	mm					200																200				400
(2) P-1 + P-2	mm						200																200			400
(3) P-1 + P-2	mm							200																200		400
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm	30	32	28			32	30	30	30	32	30											30	30	32	
(2) P-1 + P-2	mm	30	32	28	28			30	30	30	32	30	30											30	32	
(3) P-1 + P-2	mm	30	32	28	28	30			30	30	32	30	30	30											32	
7. Effective Rainfall (ER)																										
Paddy (P)	mm	57	41	54	45	51	53	57	58	50	48	53	33	38	27	23	20	11	17	17	23	20	28	50	42	916
Upland Crops (UC)	mm	72	51	69	57	64	67	71	73	62	60	66	41	47	34	29	25	14	22	22	29	25	35	64	53	1,152
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm	39	58	28		149	56	39	38	49	54	33				7	23	58	55	48		180	74	45	58	1,091
(2) P-1 + P-2 + UC	mm	39	61	34	37		147	39	38	49	58	39	53			7	19	64	63	60	52		165	45	58	1,127
(3) P-1 + P-2 + UC	mm	39	61	37	43	42		143	38	49	58	42	59	52			13	27	31	46	52	29		150	58	1,069
Average	mm	39	60	33	27	64	68	74	38	49	57	38	37	17		5	18	50	50	51	35	70	80	80	58	1,098
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	41	63	35	28	67	72	78	40	52	60	40	39	18	0	5	19	53	53	54	37	74	84	84	61	1,157
	m^3/ha	410	630	350	280	670	720	780	400	520	600	400	390	180	0	50	190	530	530	540	370	740	840	840	610	11,570
	l/sec/ha	0.32	0.46	0.29	0.23	0.52	0.52	0.60	0.31	0.40	0.43	0.31	0.30	0.14	0.00	0.04	0.14	0.41	0.41	0.42	0.27	0.57	0.65	0.65	0.44	
11. GWR with 14 hours Pump Operation	l/sec/ha	0.6	0.8	0.5	0.4	0.9	0.9	1.1	0.6	0.7	0.8	0.6	0.6	0.3	0.0	0.1	0.3	0.8	0.8	0.8	0.5	1.0	1.2	1.2	0.8	
12. Irrigation Area	ha	20	20	20	14	14	14	20	20	20	20	20	14	7	0	14	20	20	20	20	14	14	14	20	20	
13. Design Discharge	l/sec	12	16	10	6	13	13	22	12	14	16	12	8	2	0	1	6	16	16	16	7	14	17	24	16	

Table A-10 Water Requirement for Kalembukaha

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	4.2	4.2	4.6	4.6	5.6	5.6	6.3	6.3	6.7	6.7	6.3	6.3	6.1	6.1	6.7	6.7	6.8	6.8	6.8	6.8	5.8	5.8	4.6	4.6	
	mm	63	67	64	64	84	90	95	95	101	107	95	95	92	98	101	107	102	102	102	109	87	87	69	74	2,150
2. Cropping Pattern				Semi-Rainy Season Paddy								Dry Season Upland Crops (Green Beans, Maize, Groundnuts)									Rainy Season Paddy						
3. Crop Coefficient (k)																										
(1) P-1 + P-2 + UC			LP	1.10	1.10	1.10	1.10	1.05	0.95				0.50	0.64	0.89	0.95	0.88		LP	1.10	1.10	1.10	1.10	1.05	0.95	
(2) P-1 + P-2 + UC		0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.59	0.96	1.05	1.02	0.95		LP	1.10	1.10	1.10	1.10	1.05	
(3) P-1 + P-2 + UC		1.05	0.95		LP	1.10	1.10	1.10	1.10	1.05	0.95			0.50	0.51	0.66	0.85	0.95	0.75		LP	1.10	1.10	1.10	1.10	
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm			70	70	92	99	100	90				48	59	87	96	94			112	120	96	96	72	70	1,471
(2) P-1 + P-2 + UC	mm	60			70	92	99	105	100	96			48	54	94	106	109	97			120	96	96	76	78	1,596
(3) P-1 + P-2 + UC	mm	66	64			92	99	105	105	106	102			46	50	67	91	97	77			96	96	76	81	1,516
5. Land Preparation (Puddling: 200 mm)																										
(1) P-1 + P-2	mm		200																200							400
(2) P-1 + P-2	mm			200																200						400
(3) P-1 + P-2	mm				200																200					400
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm			21	21	23	24	23	23											22.5	24	23	23	23	24	
(2) P-1 + P-2	mm	23			21	23	24	23	23	30											24	23	23	23	24	
(3) P-1 + P-2	mm	23	24			23	24	23	23	23	24											23	23	23	24	
7. Effective Rainfall (ER)																										
Paddy (P)	mm	90	171	112	124	155	99	105	69	24	15	9	10	16	22	5	20	5	27	18	61	82	93	128	99	1,559
Upland Crops (UC)	mm	103	196	129	142	178	114	120	80	28	17	10	12	18	25	6	23	6	30	21	70	94	107	147	113	1,789
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm		29	0	0	0	24	18	44				36	41	62	90	71		173	114	83	37	26	0	0	848
(2) P-1 + P-2 + UC	mm	0		88	0	0	24	23	54	102			36	36	69	100	86	91		179	83	37	26	0	3	1,037
(3) P-1 + P-2 + UC	mm	0	0		76	0	24	23	59	105	111			28	25	61	68	91	47		139	37	26	0	6	926
Average	mm	0	10	29	25	0	24	21	52	69	37		24	35	52	84	75	61	73	98	102	37	26	0	3	937
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	0	11	31	26	0	25	22	55	73	39	0	25	37	55	88	79	64	77	103	107	39	27	0	3	986
	m^3/ha	0	110	310	260	0	250	220	550	730	390	0	250	370	550	880	790	640	770	1,030	1,070	390	270	0	30	9,860
	l/sec/ha	0.00	0.08	0.26	0.21	0.00	0.18	0.17	0.42	0.56	0.28	0.00	0.19	0.29	0.40	0.68	0.57	0.49	0.59	0.79	0.77	0.30	0.21	0.00	0.02	
11. GWR with 16 hours Pump Operation	l/sec/ha	0.0	0.2	0.4	0.4	0.0	0.3	0.3	0.7	0.9	0.5	0.0	0.3	0.5	0.6	1.1	0.9	0.8	0.9	1.2	1.2	0.5	0.4	0.0	0.1	
12. Irrigation Area	ha	14	14	14	20	20	20	20	20	14	7	0	12	18	18	18	18	12	13	14	20	20	20	20	20	
13. Design Discharge	l/sec	0	3	6	8	0	6	6	14	13	4	0	4	9	11	20	16	10	12	17	24	10	8	0	2	

Table A-11 Water Requirement for Palakahembi

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	4.2	4.2	4.6	4.6	5.6	5.6	6.3	6.3	6.7	6.7	6.3	6.3	6.1	6.1	6.7	6.7	6.8	6.8	6.8	6.8	5.8	5.8	4.6	4.6	
	mm	63	67	64	64	84	90	95	95	101	107	95	95	92	98	101	107	102	102	102	109	87	87	69	74	2,150
2. Cropping Pattern		Wet Season Upland Crops								Dry Season Upland Crops										Dry Season Upland Crops						
3. Crop Coefficient (k)		(Green Beans, Maize, Sorghum)								(Green Beans, Maize, Sorghum)										(Green Beans, Maize, Sorghum)						
(1) P-1 + P-2 + UC		0.64	0.89	0.95	0.88				0.50	0.64	0.89	0.95	0.88				0.50	0.64	0.89	0.95	0.88				0.50	
(2) P-1 + P-2 + UC		0.59	0.96	1.05	1.02	0.95			0.50	0.59	0.96	1.05	1.02	0.95			0.50	0.59	0.96	1.05	1.02	0.95			0.50	
(3) P-1 + P-2 + UC		0.50	0.75	1.00	1.00	0.82	0.45			0.50	0.75	1.00	1.00	0.82	0.45			0.50	0.75	1.00	1.00	0.82	0.45			
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm	40	60	61	56				48	65	95	90	84				54	65	91	97	96				37	1,039
(2) P-1 + P-2 + UC	mm	37	64	67	65	80			48	60	103	100	97	87			54	60	98	107	111	83			37	1,358
(3) P-1 + P-2 + UC	mm	32	50	64	64	69	41			51	80	95	95	75	44			51	77	102	109	71	39			1,209
5. Land Preparation (Puddling: 200 mm)																										0
(1) P-1 + P-2	mm																									0
(2) P-1 + P-2	mm																									0
(3) P-1 + P-2	mm																									
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm																									
(2) P-1 + P-2	mm																									
(3) P-1 + P-2	mm																									
7. Effective Rainfall (ER)																										
Paddy (P)	mm	49	62	53	51	51	37	34	10	4	5	2	4	1	2	0	0	1	1	1	1	5	20	43	44	481
Upland Crops (UC)	mm	56	69	59	57	57	41	38	12	5	6	2	4	1	3	0	0	1	1	1	1	5	22	49	49	539
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm	0	0	2	0				36	60	89	88	80				54	64	90	96	95				0	754
(2) P-1 + P-2 + UC	mm	0	0	8	8	23			36	55	97	98	93	86			54	59	97	106	110	78			0	1,008
(3) P-1 + P-2 + UC	mm	0	0	5	7	12	0			46	74	93	91	74	41			50	76	101	108	66	17			861
Average	mm	0	0	5	5	12	0		24	54	87	93	88	53	14		36	58	88	101	104	48	6		0	876
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	0	0	7	7	18	0	0	36	81	130	139	131	79	21	0	54	87	131	151	155	72	9	0	0	1,308
	m^3/ha	0	0	70	70	180	0	0	360	810	1,300	1,390	1,310	790	210	0	540	870	1,310	1,510	1,550	720	90	0	0	13,080
	l/sec/ha	0.00	0.00	0.06	0.06	0.14	0.00	0.00	0.28	0.63	0.94	1.07	1.01	0.61	0.15	0.00	0.39	0.67	1.01	1.17	1.12	0.56	0.07	0.00	0.00	
11. GWR with 12 hours Pump Operation	l/sec/ha	0.0	0.0	0.2	0.2	0.3	0.0	0.0	0.6	1.3	1.9	2.2	2.1	1.3	0.3	0.0	0.8	1.4	2.1	2.4	2.3	1.2	0.2	0.0	0.0	
12. Irrigation Area	ha	20	20	20	20	14	7	0	7	10	10	10	10	7	4	0	7	10	10	10	10	7	4	0	14	
13. Design Discharge	l/sec	0	0	4	4	4	0	0	4	13	19	22	21	9	1	0	6	14	21	24	23	8	1	0	0	

Table A-12 Water Requirement for Namangkewa

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	6.0	6.0	6.4	6.4	6.9	6.9	6.9	6.9	6.9	6.9	6.8	6.8	6.7	6.7	6.9	6.9	6.9	6.9	6.8	6.8	6.5	6.5	5.8	5.8	
	mm	90	96	90	90	104	110	104	104	104	110	102	102	101	107	104	110	104	104	102	109	98	98	87	93	2,423
2. Cropping Pattern		Wet Season Upland Crops							Dry Season Upland Crops							Dry Season Upland Crops										
3. Crop Coefficient (k)		(Green Beans, Maize, Groundnuts)							(Green Beans, Maize, Groundnuts)							(Green Beans, Maize, Groundnuts)										
(1) P-1 + P-2 + UC		0.64	0.89	0.95	0.88				0.50	0.64	0.89	0.95	0.88				0.50	0.64	0.89	0.95	0.88				0.50	
(2) P-1 + P-2 + UC		0.59	0.96	1.05	1.02	0.95			0.50	0.59	0.96	1.05	1.02	0.95			0.50	0.59	0.96	1.05	1.02	0.95			0.50	
(3) P-1 + P-2 + UC		0.50	0.51	0.66	0.85	0.95	0.75			0.50	0.51	0.66	0.85	0.95	0.75			0.50	0.51	0.66	0.85	0.95	0.75			
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm	58	85	86	79				52	67	98	97	90				55	67	93	97	96				47	1,167
(2) P-1 + P-2 + UC	mm	53	92	95	92	99			52	61	106	107	104	96			55	61	100	107	111	93			47	1,531
(3) P-1 + P-2 + UC	mm	45	49	59	77	99	83			52	56	67	87	96	80			52	53	67	93	93	74			1,282
5. Land Preparation (Puddling: 200 mm)																										
(1) P-1 + P-2	mm																									0
(2) P-1 + P-2	mm																									0
(3) P-1 + P-2	mm																									0
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm																									
(2) P-1 + P-2	mm																									
(3) P-1 + P-2	mm																									
7. Effective Rainfall (ER)																										
Paddy (P)	mm	38	44	56	58	36	34	21	24	8	6	4	8	5	4	0	1	1	2	2	4	21	37	33	49	496
Upland Crops (UC)	mm	49	57	72	75	46	44	27	31	10	8	5	11	6	5	0	1	1	3	2	5	27	48	43	64	640
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm	9	28	14	4				21	57	90	92	79				54	66	90	95	91				0	790
(2) P-1 + P-2 + UC	mm	4	35	23	17	53			21	51	98	102	93	90			54	60	97	105	106	66			0	1,075
(3) P-1 + P-2 + UC	mm	0	0	0	2	53	39			42	48	62	76	90	75			51	50	65	88	66	26			833
Average	mm	4	21	12	8	35	13		14	50	79	85	83	60	25		36	59	79	88	95	44	9		0	899
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	6	31	18	12	52	19	0	21	75	118	127	124	90	37	0	54	88	118	131	142	66	13	0	0	1,342
	m^3/ha	60	310	180	120	520	190	0	210	750	1,180	1,270	1,240	900	370	0	540	880	1,180	1,310	1,420	660	130	0	0	13,420
	l/sec/ha	0.05	0.22	0.15	0.10	0.40	0.14	0.00	0.16	0.58	0.85	0.98	0.96	0.69	0.27	0.00	0.39	0.68	0.91	1.01	1.03	0.51	0.10	0.00	0.00	
11. GWR with 12 hours Pump Operation	l/sec/ha	0.1	0.5	0.3	0.2	0.8	0.3	0.0	0.4	1.2	1.7	2.0	2.0	1.4	0.6	0.0	0.8	1.4	1.9	2.1	2.1	1.1	0.2	0.0	0.0	
12. Irrigation Area	ha	10	10	10	10	4	7	0	4	5	5	5	5	4	2	0	4	5	5	5	5	4	2	0	5	
13. Design Discharge	l/sec	1	5	3	2	3	2	0	2	6	9	10	10	6	1	0	3	7	10	11	13	4	0	0	0	

Table A-13 Water Requirement for Magepanda

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	6.0	6.0	6.4	6.4	6.9	6.9	6.9	6.9	6.9	6.9	6.8	6.8	6.7	6.7	6.9	6.9	6.9	6.9	6.8	6.8	6.5	6.5	5.8	5.8	
	mm	90	96	90	90	104	110	104	104	104	110	102	102	101	107	104	110	104	104	102	109	98	98	87	93	2,423
2. Cropping Pattern		Wet Season Upland Crops							Dry Season Upland Crops								Dry Season Upland Crops									
3. Crop Coefficient (k)		(Green Beans, Maize, Rice)							(Green Beans, Maize, Rice)								(Green Beans, Maize, Rice)									
(1) P-1 + P-2 + UC		0.64	0.89	0.95	0.88				0.50	0.64	0.89	0.95	0.88				0.50	0.64	0.89	0.95	0.88				0.50	
(2) P-1 + P-2 + UC		0.59	0.96	1.05	1.02	0.95			0.50	0.59	0.96	1.05	1.02	0.95			0.50	0.59	0.96	1.05	1.02	0.95			0.50	
(3) P-1 + P-2 + UC		1.10	1.10	1.10	1.10	1.05	0.95			1.10	1.10	1.10	1.10	1.05	0.95			1.10	1.10	1.10	1.10	1.05	0.95			
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm	58	85	86	79				52	67	98	97	90				55	67	93	97	96				47	1,167
(2) P-1 + P-2 + UC	mm	53	92	95	92	99			52	61	106	107	104	96			55	61	100	107	111	93			47	1,531
(3) P-1 + P-2 + UC	mm	99	106	99	99	109	105			114	121	112	112	106	102			114	114	112	120	103	93			1,940
5. Land Preparation (Puddling: 200 mm)																										
(1) P-1 + P-2	mm																									0
(2) P-1 + P-2	mm																									0
(3) P-1 + P-2	mm																									0
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm																									
(2) P-1 + P-2	mm																									
(3) P-1 + P-2	mm																									
7. Effective Rainfall (ER)																										
Paddy (P)	mm	42	54	75	72	30	23	19	15	9	2	5	8	4	6	2	3	3	4	1	12	7	17	39	40	492
Upland Crops (UC)	mm	53	67	94	89	38	28	24	19	11	2	6	10	5	7	3	4	3	5	1	15	9	21	49	49	612
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm	5	18	0	0				33	56	96	91	80				51	64	88	96	81				0	759
(2) P-1 + P-2 + UC	mm	0	25	1	3	61			33	50	104	101	94	91			51	58	95	106	96	84			0	1,053
(3) P-1 + P-2 + UC	mm	46	39	5	10	71	77			103	119	106	102	101	95			111	109	111	105	94	72			1,476
Average	mm	17	27	2	4	44	26		22	70	106	99	92	64	32		34	78	97	104	94	59	24		0	1,095
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	25	40	3	6	66	39	0	33	104	158	148	137	96	48	0	51	116	145	155	140	88	36	0	0	1,634
	m^3/ha	250	400	30	60	660	390	0	330	1,040	1,580	1,480	1,370	960	480	0	510	1,160	1,450	1,550	1,400	880	360	0	0	16,340
	l/sec/ha	0.19	0.29	0.02	0.05	0.51	0.28	0.00	0.25	0.80	1.14	1.14	1.06	0.74	0.35	0.00	0.37	0.90	1.12	1.20	1.01	0.68	0.28	0.00	0.00	
11. GWR with 12 hours Pump Operation	l/sec/ha	0.4	0.6	0.1	0.1	1.1	0.6	0.0	0.5	1.6	2.3	2.3	2.2	1.5	0.7	0.0	0.8	1.8	2.3	2.4	2.1	1.4	0.6	0.0	0.0	
12. Irrigation Area	ha	12	12	12	12	8	4	0	4	6	6	6	6	4	2	0	4	6	6	6	6	4	2	0	8	
13. Design Discharge	l/sec	5	7	1	1	9	2	0	2	10	14	14	13	6	1	0	3	11	14	15	13	6	1	0	0	

Table A-14 Water Requirement for Ranakolo, Dawa, Toto Mala

Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
days		15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16	365
1. Evapotranspiration (Eto)	mm/day	6.0	6.0	6.4	6.4	6.9	6.9	6.9	6.9	6.9	6.9	6.8	6.8	6.7	6.7	6.9	6.9	6.9	6.9	6.8	6.8	6.5	6.5	5.8	5.8	
	mm	90	96	90	90	104	110	104	104	104	110	102	102	101	107	104	110	104	104	102	109	98	98	87	93	2,423
2. Cropping Pattern			Wet Season Upland Crops								Dry Season Upland Crops								Dry Season Upland Crops							
3. Crop Coefficient (k)			(Green Beans, Maize, Groundnuts)								(Green Beans, Maize, Groundnuts)								(Green Beans, Maize, Groundnuts)							
(1) P-1 + P-2 + UC			0.50	0.64	0.89	0.95	0.88				0.50	0.64	0.89	0.95	0.88				0.50	0.64	0.89	0.95	0.88			
(2) P-1 + P-2 + UC			0.50	0.59	0.96	1.05	1.02	0.95			0.50	0.59	0.96	1.05	1.02	0.95			0.50	0.59	0.96	1.05	1.02	0.95		
(3) P-1 + P-2 + UC				0.50	0.51	0.66	0.85	0.95	0.75			0.50	0.51	0.66	0.85	0.95	0.75			0.50	0.51	0.66	0.85	0.95	0.75	
4. Crop Evapotranspiration (ETc)																										
(1) P-1 + P-2 + UC	mm		48	58	80	99	97				55	65	91	96	94				52	65	97	93	86			1,176
(2) P-1 + P-2 + UC	mm		48	53	86	109	112	99			55	60	98	106	109	99			52	60	105	103	100	83		1,537
(3) P-1 + P-2 + UC	mm			45	46	69	94	99	78			51	52	67	91	99	83			51	56	65	83	83	70	1,282
5. Land Preparation (Puddling: 200 mm)																										
(1) P-1 + P-2	mm																									0
(2) P-1 + P-2	mm																									0
(3) P-1 + P-2	mm																									0
6. Percolation (2 mm)																										
(1) P-1 + P-2	mm																									
(2) P-1 + P-2	mm																									
(3) P-1 + P-2	mm																									
7. Effective Rainfall (ER)																										
Paddy (P)	mm	123	115	96	86	73	75	58	48	17	20	11	6	8	11	1	4	9	19	9	11	47	70	83	78	1,078
Upland Crops (UC)	mm	136	126	105	95	81	83	63	53	19	22	13	7	8	12	1	4	10	21	10	12	51	77	91	85	1,185
8. Net Water Requirements (NWR)																										
(1) P-1 + P-2 + UC	mm		0	0	0	18	14				33	52	84	88	82				31	55	85	42	9			593
(2) P-1 + P-2 + UC	mm		0	0	0	28	29	36			33	47	91	98	97	98			31	50	93	52	23	0		806
(3) P-1 + P-2 + UC	mm			0	0	0	11	36	25			38	45	59	79	98	79			41	44	14	6	0	0	575
Average	mm		0	0	0	15	18	24	8		22	46	73	82	86	65	26		21	49	74	36	13	0	0	658
9. Irrigation Efficiency (IE)																										
Paddy (P)		0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	
Upland Crops (UC)		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	
10. Gross Water Requirements (GWR)																										
	mm	0	0	0	0	22	27	36	12	0	33	69	109	122	128	97	39	0	31	73	110	54	19	0	0	981
	m^3/ha	0	0	0	0	220	270	360	120	0	330	690	1,090	1,220	1,280	970	390	0	310	730	1,100	540	190	0	0	9,810
	l/sec/ha	0.00	0.00	0.00	0.00	0.17	0.20	0.28	0.09	0.00	0.24	0.53	0.84	0.94	0.93	0.75	0.28	0.00	0.24	0.56	0.80	0.42	0.15	0.00	0.00	
11. GWR with 12 hours Pump Operation	l/sec/ha	0.0	0.0	0.0	0.0	0.4	0.4	0.6	0.2	0.0	0.5	1.1	1.7	1.9	1.9	1.5	0.6	0.0	0.5	1.2	1.6	0.9	0.3	0.0	0.0	
12. Irrigation Area	ha	0	10	10	10	10	10	7	4	0	4	5	5	5	5	4	2	0	4	5	5	5	5	4	2	
13. Design Discharge	l/sec	0	0	0	0	4	4	4	1	0	2	6	9	10	10	6	1	0	2	6	8	5	2	0	0	