MINUTES OF MEETING
ON
THE PROGRESS REPORT FOR THE FEASIBILITY STUDY
ON
THE RAJKUDWA IRRIGATION PROJECT

The study team submitted 10 copies of the Progress Report on August 24, 1992 at Kathmandu.

The meeting on the report was held between the officials of the Department of Irrigation(DOI) and the Department of Agriculture(DOA) and the study team.

After explanation on the report by the study team, a series of discussions were held.

As a result of discussion, the following main items have been agreed upon by the Nepalese side and the study team.

1. Nepalese side agreed, in general, with the results of the study presented in the report.
2. Nepalese side also agreed with the programme for the succeeding study works presented in the report.

Kathmandu, August 24, 1992.

Mr. S. R. Pant
Director General,
Department of Irrigation,
His Majesty's Government
of Nepal

Mr. Kensaku TAKEDA
Leader,
Study Team for the
Rajkudwa Irrigation
Project

MINUTES OF MEETING
ON
THE START UP OF THE DRY SEASON STUDY
FOR
THE FEASIBILITY STUDY
ON
THE RAJKUDWA IRRIGATION PROJECT

The meeting was held between the officials of the Department of Irrigation(DOI) and the Department of Agriculture(DOA) and the study team.on January 10, 1993.

After explanation on the schedule and works of the dry season study by the study team, a series of discussions were held.

As a result of discussion, the following main items have been agreed upon by the Nepalese side and the study team.

1. Nepalese side agreed with the schedule and works of the dry season study presented by the study team
2. Nepalese side also agreed with the provision of the offices for the study team in Kathmandu and the site.

Kathmandu, January 10, 1993.

Mr. Y. L. Vaidya
Director General,
Department of Irrigation,
His Majesty's Government
of Nepal

Mr. Kensaku TAKEDA
Leader,
Study Team for the
Rajkudwa Irrigation
Project

List of Participants

Subject: Start up meeting on the F/S of Rajkudwa Irrigation Project
Date : January 10, 1993 ; 11.00 - 12.30 AM
Place : Meeting room, DOI, Kathmandu

No.	Name	Position
1.	Mr.Y.L.Vaidya	Director General,DOI
2.	Mr.C.P.Rauniyar	Deputy Director General, DOI (Planning Division)
3.	Mr.S.P.Sharma	Senior Division Engineer
4.	Mr.M.Poudel	Senior Division Engineer
5.	Mr.B.Rayamajhi	Irrigation Engineer(Project Manager)
6.	Mr.K.D.Adhikari	Irrigation Engineer
7.	Mr.N.Naito	JICA, Kathmandu Office
8.	Mr.K.Takeda	JICA Study team,(Team leader, O & M)
9.	Mr.Y.Mase	JICA Study team (Irrigation & Drainage)
10.	Mr.F.Nagao	JICA Study team (Agronomy)
11.	Mr.M.Ikeda	JICA Study team (Hydrogeology)
12.	Mr.N.Sanbe	JICA Study team (Meteo-Hydrology)
13.	Mr.H.Ishikawa	JICA Study team (Agro-Economy)
14.	Mr.Y.Mizukuchi	JICA Study team (Pedology)

MINUTES OF MEETING

ON

THE INTERIM REPORT

FOR

THE FEASIBILITY STUDY

ON

THE RAJKUDWA IRRIGATION PROJECT

AGREED UPON

BETWEEN

OFFICIALS OF THE DEPARTMENT OF IRRIGATION (DOI)

AND

THE STUDY TEAM OF JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

KATHMANDU, MARCH 23, 1993

MR. Y.L. VAIDYA
DIRECTOR GENERAL,
DEPARTMENT OF IRRIGATION,
HIS MAJESTY'S GOVERNMENT OF NEPAL
Director General

MR. KENSAKU TAKEDA
TEAM LEADER OF THE
STUDY TEAM

MR. HARUHIDE MIYOSHI
OBSERVER, JICA

In accordance with the Scope of Work for the Feasibility Study on the Rajkudwa Irrigation Project (hereinafter referred to as "the study") agreed upon between His Majesty's Government of Nepal and Japan International Cooperation Agency (JICA), the Study Team headed by Mr. Kensaku TAKEDA submitted officially twenty (20) copies of the Interim Report to His Majesty's Government of Nepal, through the Department of Irrigation (DOI) at the completion of the Field Work of the Study in Nepal.

On March 23, 1993, at the presence of representatives of DOI and DOAD, the Study Team explained the Interim Report, consisting of Five Chapters including objectives of the study, activities of the Study Team, present condition of the study area, basic development concept, formulation of basic development plan and programme for the future study works. Following the said explanation, the Nepalese side headed by Mr. Y.L.Vaidya, Director General of DOI, made comments on the Interim Report.

As a consequence of the explanation and presentation of comments in connection with the Interim Report, the following has been accorded upon by both sides.

1. The Nepalese side confirmed that the Interim Report has been prepared in compliance with the scope of the study, methodology and schedule set forth in the Inception Report.

2. The development concept and formulation of the development plan are based on both the development potential and the development constraints of the study area and are acceptable to the Nepalese side, accordingly.

3. Comments presented by the Nepalese side are as summarized in Annex 1.

4. In response to the pertaining comments, the Japanese side manifested that they would duly take them into account in formulating the irrigated agriculture development plan and preparing the feasibility report in Japan.

ANNEX 1

COMMENTS ON THE INTERIM REPORT

FOR THE FEASIBILITY STUDY

ON THE RAJKUDWA IRRIGATION PROJECT

GENERAL ASPECT

The Nepalese side accepts that the Interim Report submitted by the Study Team of Japan International Cooperation Agency (JICA), headed by Mr. Kensaku TAKEDA, satisfies requirements of technical quality and the basic development plan accords with the present irrigation and agriculture development policy of HMG/N.

SPECIFIC ASPECT

. DOI representatives inquired the Study Team about rather low value of irrigation duty adopted for paddy in the formulation of basic development plan. The concern of the DOI personnel was that it could be possible to formulate and design irrigation project theoretically, but it would be difficult to manage the project after implementation practically, and it was also low compared to the duties adopted in other projects in the country. The study team explained that the adopted irrigation duty of 0.4 l/sec/ha would be sufficient if the precipitation, concentrated during the growing season of paddy, were used effectively. The Study Team, however, agreed to review the irrigation duty during their office work in Japan.

ANNEX 2

LIST OF ATTENDANTS OF THE MEETING

NEPALESE SIDE

1. Mr. Y.L. Vaidya, Director General, DOI
2. Mr. C.P. Rauniyar, Deputy Director General, DOI
3. Mr. B.K. Aryal, Deputy Director General, DOI
4. Mr. S.P. Sharma, Senior Divisional Engineer, DOI
5. Mr. S.B. Regmee, Chief Counterpart Personnel, DOI
6. Mr. N.M. Joshi, Divisional Engineer, DOI
7. Mr. B. Rayamajhi, Project Manager, Rajkudwa Irrigation Project
8. Mr. K.D. Adhikari, Counterpart Irrigation Engineer
9. Mr. K.L. Shrestha, Counterpart Agronomist, DOAD

JAPANESE SIDE

Mr. Haruhide MIYOSHI	Member of Advisory Team, JICA Headquarters
Mr. Norio NAITO	Assistant Resident Representative, JICA-Nepal
Mr. Kensaku TAKEDA	Team Leader/O&M
Mr. Yoshimitsu MASE	Irrigation and Drainage/Water Management (Deputy Team Leader)
Mr. Mitsuyoshi IKEDA	Geology/Geohydrology
Mr. Nobuo SAMBE	Hydrology/Meteorology
Mr. Kozo YAMADA	Design/Cost Estimate for Civil Works
Mr. Fumihiro NAGAO	Agriculture/Farmers' Organization/Agricultural Support System
Mr. Hisashi ISHIKAWA	Agro-economy/Project Evaluation
Mr. Yoji MIZUGUCHI	Soil/Landuse

MINUTES OF THE MEETING

ON

THE DRAFT FINAL REPORT

FOR

THE FEASIBILITY STUDY

ON

THE RAJKUDWA IRRIGATION PROJECT

AGREED UPON

BETWEEN

OFFICIALS OF THE DEPARTMENT OF IRRIGATION (DOI)

AND

THE STUDY TEAM OF JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

KATHMANDU, JULY 25, 1993

MR C.P. RAUNIYAR
DEPUTY DIRECTOR GENERAL
DEPARTMENT OF IRRIGATION
HIS MAJESTY'S GOVERNMENT OF NEPAL

MR. KENSAKU TAKEDA
TEAM LEADER OF THE
STUDY TEAM

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MR. HIDEHIKO HIOKI
STAFF,
JICA HEADQUARTERS

In accordance with the Scope of Work for the Feasibility Study on the Rajkudwa Irrigation Project (hereinafter referred to as "the study"), the Study Team headed by Mr. kensaku TAKEDA submitted officially twenty (20) copies of the Draft Final Report to the Department of Irrigation (DOI) at the completion of the Home Work in Japan. The Draft Final Report consists of two volumes: Main Report and the Annexes containing eight and nine chapters respectively. On July 22, 1993, at the presence of the representatives of DOI, the Study Team explained the contents of the Draft Final Report.

In the next meeting held on July 25, 1993 the DOI representatives made general comments on the Draft Final Report and most of the comments were answered by the Study Team verbally. The main points of the discussion have been provided in Attachment - 1.

As a consequence of the explanation and presentation of comments in connection with the Draft Final Report, the followings have been accorded upon by both sides.

1. The Nepalese side confirmed that the Draft Final Report has been prepared in compliance with the scope of the study, methodology and schedule set forth in the Scope of work agreed upon between DOI and JICA on February 13, 1992.

2. The formulated irrigated agricultural development plan is based on both the development potential and the development constraints of the study area and are acceptable to the Nepalese side, accordingly.

3. Additional geo-technical investigation for the proposed irrigation pond and four existing ponds to be enlarged, has been planned to estimate the seepage/leakage loss in these ponds.

4. In response to the pertaining comments, the Japanese side manifested that they would duly take them into account in preparing the Final Feasibility Report in Japan.

5. Any further comments will be presented in written form, from the DOI side within coming one month and the Study Team agreed to incorporate them in the Final Report as far as possible.

ATTACHMENT - 1

COMMENTS ON THE DRAFT FINAL REPORT

FOR THE FEASIBILITY STUDY

ON THE RAJKUDWA IRRIGATION PROJECT

GENERAL ASPECT

The DRAFT FINAL REPORT submitted by the Study Team of Japan International Cooperation Agency (JICA), headed by Mr. Kensaku TAKEDA, satisfies requirements of technical quality and the development plans accords with the present irrigation and agriculture development policy of HMG/N.

SPECIFIC ASPECT

1. The DOAD representative expressed that the anticipated crop yield and the proposed cropping intensity were attainable.

2. The DOI side enquired about the possibility of silting up of the irrigation ponds while storing flood water. The Study Team explained that the three silt excluders proposed upstream from each of the ponds would solve the problem.

3. The DOI side made comments on the absence of fish ladder in the headworks for enviromental consideration. The Study Team explained that no fish ladder would be needed as the diversion weir in the river is only 1.5 metre high from the general river bed level.

4. Since the planned ponds are in the forest area the DOI enquired about the existing as well as proposed surface area of each pond and the Study Team agreed to provide one in the Final Report.

5. The DOI side requested to consider Alternative - 8 for increasing irrigation area and the Study Team explained that the alternative was not economically feasible though it was feasible technically.

ANNEX 2

LIST OF ATTENDANTS OF THE MEETING

NEPALESE SIDE

1. Mr. Y.L. Vaidya, Director General, DOI
2. Mr. C.P. Rauniyar, Deputy Director General, DOI
3. Mr. S.S. Shrestha, Division Chief, DOAD
4. Mr. S.P. Sharma, Senior Divisional Engineer, DOI
5. Mr. M.S. Paudel, Senior Divisional Engineer, DOI
6. Mr. S.B. Regmee, Chief Counterpart Personnel, DOI
7. Mr. S.M. Shrestha, Irrigation Engineer, DOI
8. Mr. K.D. Adhikari, Counterpart Irrigation Engineer, DOI
9. Mr. Nobuharu SASANO, JICA Expert

JAPANESE SIDE

1. Mr. Hisaki INDOU, Secretary of EOJ
2. Mr. Norio NAITO, Assistant Resident Representative, JICA-Nepal
3. Mr. Hidehiko HIOKI, Staff, JICA Headquarters
4. Mr. Kensaku TAKEDA, Team Leader/O & M
5. Mr. Yoshimitsu MASE, Irrigation and Drainage/ Water Management (Deputy Team Leader)

MINUTES OF MEETING
ON
THE FEASIBILITY STUDY
FOR
THE RAJKUDWA IRRIGATION PROJECT

1.	Date	:	November 18, 1993
2.	Place	:	Meeting Room at DOI
3.	Attending Personnel	:	As per attached Annex-2

Summary of Discussion

JICA study team submitted the technical paper for the captioned project, i.e. "Results of Additional Geotechnical and Soil Mechanical Surveys and Seepage Loss of the proposed Tikker Pond" to DOI. On behalf of the JICA Study Team, General Manager, Kathmandu Office, Nippon Koei Co.,Ltd., Mr. J. Saito explained it to the attending DOI personnel. On behalf of the DOI, S. DE, Mr. S. P. Sharma expressed DOI's acceptance on the technical paper on which discussions were made between DOI personnel and the JICA Study Team, and both sides confirmed the following:

1. According to the technical paper, the overall seepage loss of the Tikker pond, computed by the seepage analysis based on the results of the additional geotechnical and soil mechanical surveys is 1.5 mm/day on an average which is less than 3.0 mm/day as was estimated in the Draft Final Report on the feasibility study. Therefore, no protection work needs to be proposed for the Tikker pond so far as the seepage loss is concerned. The Tikker pond can storage 2.07 million tons of water against 2.00 million tons proposed in the Draft Final Report.

2. In addition to the above, the following matters were verbally explained by the Study Team and agreed by DOI.

   1) To avoid the expansion of Gorusinge pond to the army area, it is suggested that the area of Gorusinge pond be reduced to the storage capacity of 135 thousand tons from 200 thousand tons proposed in the Draft Final Report. The reduced effective water storage in the Gorusinge pond i.e. 65,000 tons will be covered in the Tikker pond as the seepage loss of Tikker pond is very low and the capacity would be 2.07 million tons.

   2) The Study Team proposed to construct an east side levee of the Gorusinge pond along the west boundary of the army camp area so that there would not be water intrusion to the army camp area. (refer to Annex-1). The construction cost remains almost the same as estimated in the Draft Final Report, because the south side levee was cancelled.

3. In view to the above, DOI and the JICA Study Team reconfirmed that the pond irrigation plan formulated in the Draft Final Report, which aims at irrigating about 1,800 ha of arable lands by the canal systems mostly branching from the proposed five irrigation ponds, is technically feasible.

For on behalf of
Department of Irrigation

S. P. Sharma
For: Deputy Director General
Department of Irrigation
Ministry of Water Resources

For and on behalf of
JICA Study Team for
Rajkudwa Irrigation Project

J. Saito
General Manager
Kathmandu Office
Nippon Koei Co.,Ltd.

Annex-1

添付資料 - 8

Annex-2

LIST OF ATTENDING PERSONNEL

HMG/N

1. Department of Irrigation

   Mr. S. P. Sharma, S. DE.

   Mr. M. S. Paudel, S. DE.

   Mr. K. D. Adhikari, Counterpart Irrigation Engineer

   Mr. M. Belbase, Irrigation Engineer

2. Nippon Koei Co.,Ltd.

   Mr. J. Saito, General Manager

   Mr. R. Sharma, Assistant Manager

Record of the 1st Meeting Between the JICA Study Team and the Beneficiary Farmers of Rajkudwa Irrigation Project

Date: July 26, 1992
Location: Gorusinghe

In connection with the feasibility study of Rajkudwa Irrigation Project, the first meeting between the JICA Study Team and the beneficiaries was held at the lower secondary school of Gorusinghe, Kapilvastu District at 11.30 AM on July 26, 1992. Fifty-two representative farmers from Mahendrakot, Jayanagar and Buddi Village Development Committees attended the meeting (the list is annexed). The details of the proceeding of the meeting and the itemwise discussions and conclusions of different issues were as follows:

First of all, DOI Engineer Mr. K. D. Adhikari introduced all JICA Study Team members, counterpart personnel and members of the local consultant to the farmers, and he briefly explained the context of the present study program.

Mr. Mase, the Irrigation Engineer and the Deputy Team Leader, on behalf of the study team, extended his sincere thanks to the farmers for attending the meeting and explained the findings of the project area and the tentative development plan conceived up to the time. Going on details, he mentioned that the headworks for the proposed irrigation scheme would be constructed somewhere downstream from the confluence of Rajkudwa and Kondre Rivers. Besides the headworks, the main canals, the branch canals, the major drains and the related structures would be constructed under the project. The size of the command area would depend on the availability of water in the source river.

Mr. Mase also explained about the plan to conserve the high rainy season discharge of the river(s). He explained that the excess rainy season discharge would be stored in the existing ponds of the project area with further rehabilitation of them, or new sites for constructing ponds would also be identified if they were available. In the course of explanation, he informed the farmers that the proposed Kondre Scheme could irrigate the area extending southward from 500 to 600 metres south of Basantapur Village, for topographical reason.

Explaining about the other possible alternate sources of irrigation for the project area (surrounded by Kondre River on the east, Belwagurdawa River on the west, Patharkot Village on the north and Banganga River on the south), Mr. Mase mentioned that a headwork site could be located downstream from the confluence of Sit Khola (Jabaiya Khola) and Gudrung River, but the source, being at low elevation, could irrigate only the area far south of the East-West Highway. He further mentioned that there could be one more alternative, offtaking canal from the existing intake site of Ranikudw Irrigation System (Gudrung river), but the study team was reluctant to intervene in the existing well managed farmers' irrigation scheme.

The meeting was then opened for general discussions for the both sides (study team and the farmers). The discussions and conclusions made on different issues were as follows:

Item No. 1: Request from the Farmers

Rehabilitation of the existing Ranikudwa Irrigation System was requested by the farmers of the system. In reply, Mr. Mase, on behalf of the study team, explained that there was no definite plan for rehabilitating the system, yet construction of a semi-permanent type of headworks and only a permanent conveyance system could be considered, but a definite plan could be formulated only after discussing the matter with HMG/N and the JICA. However, he promised to convey the request of the farmers to the concerned agencies.

Item No. 2: Tentative Schedule

Tentative schedule of the feasibility study as well as implementation of the irrigated agriculture development plan was discussed in the meeting. Mr. Mase, on behalf of the study team, explained that the feasibility study team would remain in the field till the end of the third week of August, 1992 for the investigation in the rainy season. The dry season study would commence from the second week of January, 1993 and would continue for about three months. The draft feasibility study report would be prepared by the end of June, 1993 and the final version of it would be made available by the end of August, 1993. If a Japanese Grant is provided for the project, the basic design of the project would be carried out in the following year, providing that the project is technically feasible and economically sound in the final report. Then the implementation of the scheme would take place in the next year of completion of the basic design and would be completed within one or two years of period.

Item No. 3: Farmers' Contribution

The study team explained about the existing Irrigation Policy of HMG, in which farmers' participation and contribution in the irrigation planning and implementation has been emphasized. The team also proposed that the headworks, main canal, secondary canals, main drains, secondary drains and all the related structures would be constructed under the Japanese Grant Aid, whereas the farmers should take the responsibility of constructing all tertiary and below tertiary canals and drains at their own expenses. The team also asked the farmers to take the responsibility of rehabilitating the existing pond. The farmers agreed with the proposal except the pond rehabilitation. Finally, it was concluded that the farmers would construct all the tertiary and below tertiary canals and drains at their own expenses.

Item No. 4: Turnover of the Completed Facilities

The study team proposed that all the constructed facilities would be turned over to the farmers for the effective operation and maintenance. They were informed that they should organize a Water Users' Association from the planning stage according to the existing HMG's Irrigation Policy and the same association would later take the responsibility of O & M. The farmers agreed on all the above proposal.

Item No. 5: Land Contribution

The study team informed the farmers that they should provide land free of cost for all canals, drains and related structures and they should not ask for any compensation for the loss of their land due to the construction of the irrigation system. In general, the proposal was accepted, but a few questions were raised what if some farmers lost all of their land in the canal. The team explained that it was the responsibility of the Water Users' Association to settle the issue by compensating the land from other beneficiaries who would not loose any land. Then the farmers agreed to settle the issue by themselves if any arisen later. The farmers were also informed in the meeting that the alignments of various canals, once finalized, would not alter on some farmers' request.

The meeting ended after informing the farmers that the next meeting would take place in the beginning of the dry season study.

List of Farmers Attending the First Meeting

S. No.	Name	VDC	Ward No.	Village	Lnad Holding	Unit
1.	Khadga Bahadur Bista	Mahendrakot	2	Basantapur	1.0	Bigha
2.	Tilak Bahadur Thapa	Mahendrakot	2	Basantapur	1.0	Bigha
3.	Bal Krishna Ghimire	Mahendrakot	2	Basantapur	6.5	Bigha
4.	Dhundi Raj Acharya	Mahendrakot	2	Basantapur	5.0	Bigha
5.	Yagya Bahadur Oli	Mahendrakot	6	Birpur	2.5	Bigha
6.	Bala Ram Bhusal	Mahendrakot	7	Patharkot	1.0	Bigha
7.	Narayan Prasad Bhusal	Jayanagar	7	Gorusinghe	7.5	Bigha
8.	Jhalak Bikram Shah	Jayanagar	8	Gorusinghe	9.0	Bigha
9.	Nathu Prasad Tharu	Jayanagar	9	Baragara	5.8	Bigha
10.	Dambar Ghimire	Jayanagar	6	Gorusinghe	7.0	Bigha
11.	Ganja Bahadur Rahu Magar (VDC Chairman)	Mahendrakot	7	Patharkot	Housing Only	
12.	Tilak Ram Bhusal	Mahendrakot	8	Patharkot	2.0	Katha
13.	Ram Prasad Bhusal	Mahendrakot	7	Patharkot	8.0	Katha
14.	Bhim Raj Pokhrel	Mahendrakot	7	Patharkot	2.0	Katha
15.	Kallu Tharu	Jayanagar	6	Gorusinghe	6.5	Bigha
16.	Ishwari Prasad Upadhaya	Jayanagar	1	Bakdriya	1.5	Bigha
17.	Toar Tharu	Jayanagar	2	Bakdriya	3.0	Bigha
18.	Bhawanishwor Bhattarai	Jayanagar	2	Bakdriya	3.0	Bigha
19.	Lochan Tharu	Jayanagar	9	Barahara	3.0	Bigha
20.	Dharma Raj Acharya	Mahendrakot	6	Birpur	1.5	Bigha
21.	Tek Lal Belbase	Mahendrakot	6	Birpur	1.3	Bigha
22.	Huta Kant Panthi	Mahendrakot	6	Birpur	17.0	Katha
23.	Meghe Tharu	Jayanagar	9	Barahara	5.0	Bigha
24.	Jageshwor Tharu	Jayanagar	9	Barahara	2.5	Katha
25.	Makhan Tharu	Jayanagar	4	Gorusinghe	5.5	Bigha
26.	Yhoraku Tharu	Jayanagar	5	Gorusinghe	4.0	Bigha
27.	Palar Tharu	Jayanagar	9	Barahara	3.0	Bigha
28.	Hallan Tharu	Jayanagar	9	Barahara	4.0	Bigha
29.	Top Pahadur Acharya	Buddi	7	Chauraha	3.0	Bigha
30.	Om Prasad Neoupane	Buddi	7	Chauraha	1.5	Bigha
31.	Budh Ram Tharu	Jayanagar	5	Gorusinghe	5.5	Bigha
32.	Ram Lakhan Tharu	Jayanagar	4	Gorusinghe	5.0	Bigha
33.	Yam Bahadur Malla	Buddi	9	Morma	12.0	Bigha
34.	Chudamani Panthi	Mahendrakot	7	Patharkot	1.0	Bigha
35.	Bhim Bahadur Magar	Mahendrakot	7	Patharkot	0.5	Bigha
36.	Gopal Prasad Tharu (VDC Chariman)	Buddi	1	Buddi	8.0	Bigha
37.	Til Bahadur Sen Oli	Buddi	4	Jodhpur	2.0	Katha
38.	Keshab Prasad Tharu	Buddi	3	Buddi	2.0	Bigha
39.	Khim Bahadur Sen Oli	Buddi	2	Kilauli	18.0	Katha
40.	R. L. Banjare	Buddi	5	Karnauliya	2.0	Katha
41.	N. P. Ghimire	Buddi	4	Jodhpur	12.0	Katha
42.	P. B. Sunuwar	Buddi	4	Jodhpur	18.0	Katha
43.	Dilli Raj Bhushal	Buddi	5	Karnauliya	18.0	Katha
44.	B. P. Biharya	Buddi	5	Chauraha	2.0	Katha
45.	Thage Prasad Tharu	Mahendrakot	1	Kapase	10.0	Bigha
46.	Mahato Tharu	Mahendrakot	1	Kapase	17.0	Katha
47.	N. P. Khanal	Mahendrakot	1	Kapase	2.0	Bigha
48.	Chirkuti Tharu	Mahendrakot	1	Kapase	5.0	Bigha
49.	H. R. Chaudhary	Mahendrakot	5	Tikker	4.5	Bigha
50.	Nirar Tharu	Jayanagar	9	Barahara	6.0	Bigha
51.	Bimal Khal	Jayanagar	9	Barahara	10.0	Bigha
52.	Ram Prasad Tharu	Mahendrakot	1	Kapase	5.0	Bigha

Record of the 2nd Meeting Between the JICA Study Team and Canal Chiefs/Secretaries/Farmers of the Ranikudwa Irrigation System

Date: August 4, 1992
Location: Patharkot Village
Time: 1300 hrs.

Context of the Meeting

In consideration of such factors as request from the farmers under the Ranikudwa Irrigation System for taking up their system for major rehabilitation, availability of relatively high discharge in the Gudrung River at existing intake site and the source being in the best command position for irrigating the entire project area by gravity, the study team concentrated its attention of the system after the first meeting with the farmers held on 26th July 1992. During the course of several field investigations made and informal meeting held with the farmers, it was learnt that twelve villages (moujas) were being supplied with water from the existing Ranikudwa Irrigation System and each village had one elected canal chief and one canal secretary together with one paid canal chaukidar. Finally, it was decided by the study team to call a meeting of all the canal chiefs and secretaries for obtaining detailed information of the system as well as the attitude of the farmers. The following is the record of the meeting in which not only the canal chiefs and the secretaries were present but also 114 farmers (34 from Patharkot, 39 from Birpur, 13 from Tikar, 20 from Basantapur, 6 from Bhelai and 2 from Changhat) attended the meeting.

After introducing all JICA Study Team members and the DOI counterpart personnel, the study team again explained the tentative schedule of the feasibility study as well as the implementation of the irrigated agriculture development plan [Re. Item No. 2 of 1st Meeting].

Following the introduction, Mr. Mase, the Irrigation Engineer and the Deputy Team Leader, on behalf of the study team, thanked all the farmers for participating in the meeting. The different items of issues, which were discussed and concluded in the meeting were as follows:-

Item No. 1: Findings of the Study

The study team explained that three water sources had been identified for the surface irrigation purpose and in order of abundance of water they were;-

1. Belwagurdawa river, downstream from the confluence of Gudrung River and Sit Khola,

2. Gudrung river at Ranikudwa and

3. Kondre River, downstream from the confluence with Rajkudwa River.

Similarly, they in order of the size of the command area based on the elevation of headwork sites were;-
(1) Gudrung River, at Ranikudwa
(2) Kondre River, downstream from the confluence of Rajkudwa River and
(3) Belwagurdawa River, downstream from the confluence of Gudrung River and Sit Khola.

Apart from the above, construction cost of the system would also be a basis for selecting the best alternative.

Item No. 2: Most Promising System

The farmers were informed that major rehabilitation of Ranikudwa Irrigation System with permanent headwork structures and conveyance system including the plan for extension of the command area and storage of excess rainy season river flow in the rehabilitated existing ponds seemed best solution for irrigating the cultivated field in the project area. They, however,were informed that final selection of the alternatives was yet to be carried out and definite plan was yet to be formulated. The farmers were also informed that finalization of plan would depend much on their demand and willingness to share the construction cost and take over the operation and maintenance work of the constructed system.

Item No. 3: Water Sharing

The farmers were informed in the meeting that water should be shared uniformly over the existing as well as extended command area regardless of one part being in the headreach or tailreach. The farmers agreed on the water sharing proposal.

Item No. 4: Farmers' Contribution

The study team reiterated HMG's cost sharing policy on irrigation and put forward the proposal as in the 1st meeting, at Gorusinghe on 26th July 1992. The farmers agreed on the proposal (Re: Item No. 3 of 1st meeting)

Item No. 5: Turnover of the Completed Facilities

The study team proposed that all the constructed facilities would be turned over to the farmers for the effective operation and maintenance. They were informed that they should organize a Water Users' Association from the planning stage according to the existing HMG's Irrigation Policy and the same association would later take the responsibility of O & M. The farmers agreed on all the above proposal

Item No. 6: Land Contribution

The study team informed the farmers that they should provide land free of cost for all canals, drains and related structures and they should not ask for any compensation for the loss of their land due to the construction of the irrigation system. In general, the proposal was accepted, but a few questions were raised what if some formers lost all of their land in the canal. The team explained that it was the responsibility of the Water Users' Association to settle the issue by compensating the land from other beneficiaries who would not lose any land. Then the farmers agreed to settle the issue by themselves if any arisen later. The farmers were also informed in the meeting that the alignments of various canals, once finalized, would not alter on some farmers' request.

The meeting ended after informing the farmers that the next meeting would take place in the begining of the dry season study.

Minutes of the 3rd Meeting Between the JICA Study Team and the Beneficiary Farmers of Rajkudwa Irrigation Project (Translated to English by K. D. Adhikari, DOI).

Date: January 22, 1993
Location: Gorusinghe School

Today on 22nd January 1993, the meeting, between the Rajkudwa Irrigation Project feasibility study team members and the beneficiary farmers, attended by the heads of line agencies, peoples representatives including the honorable Member of Parliament Mr. B.R. Acharya has made the following decisions in connection with the future development of the irrigation project.

Decisions

1. The farmers put forward their strong demands for the rehabilitation, and extension of the existing Ranikudwa Irrigation Project. The improvement works would include the construction of a permanent headworks together with a permanent canal system.

2. The farmers committed their full cooperation, on their behalf, for the irrigation development.

3. Regarding the land in the canal line, that would be lost by the farmers during the implementation, they were ready to contribute according to the prevailing rules and regulations of HMGN and the existing Irrigation policy of the government.

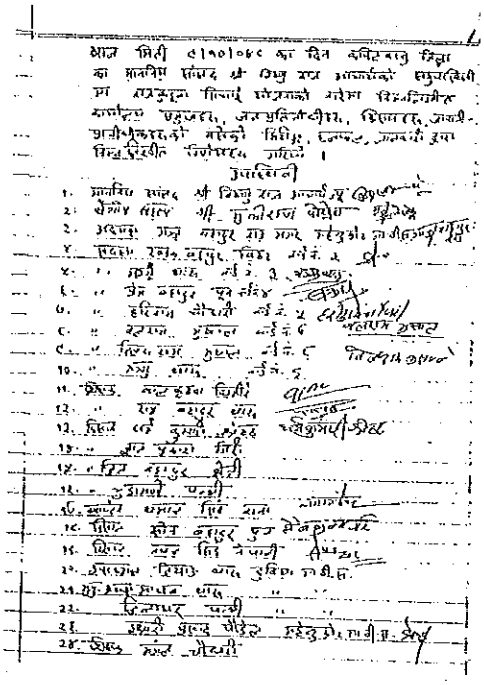
4. The farmers were ready to construct the irrigation canals as well as drainage canals below tertiary level, at their own expense according to the lines and grades shown by the concerned technical personnel of the system with their full participation.

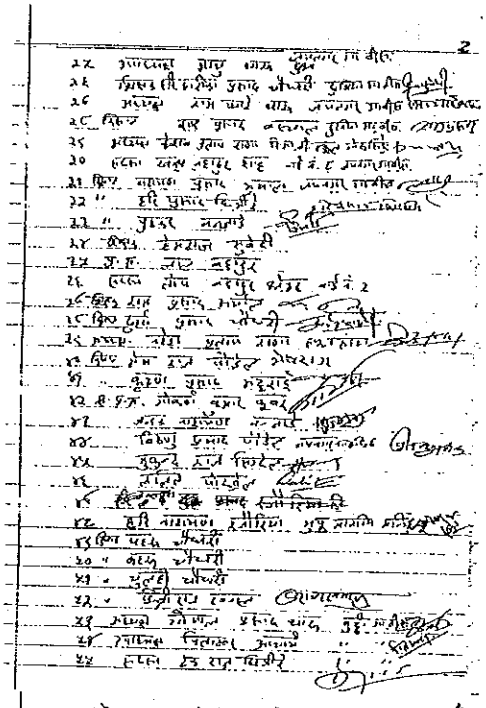
5. The operation and maintenance of the entire system after the completion of implementation would be taken over by the farmers themselves through an organized Water User's Association.

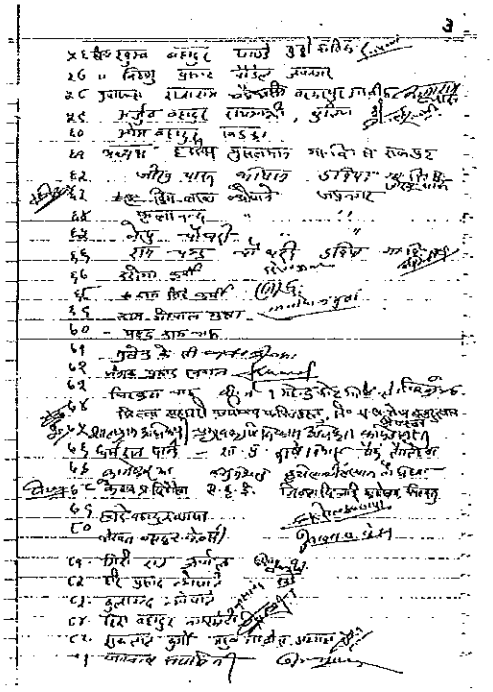
Attendance

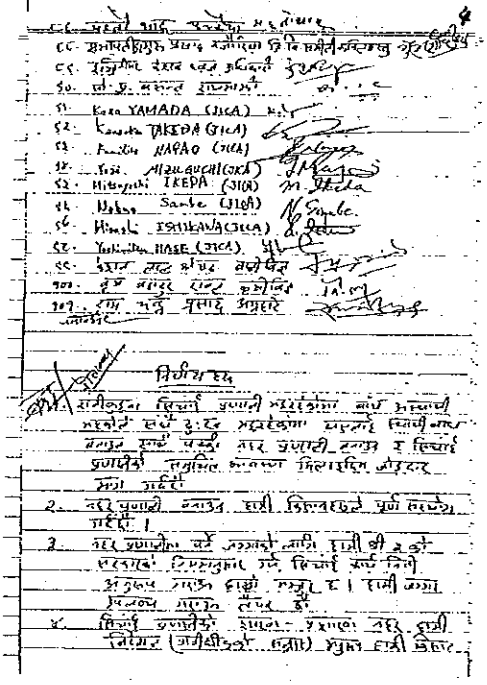
1. Mr. B. R. Acharya, Honorable Parliament Member.
2. Mr. M. R. Pokhrel, Regional Member
3. Mr. G. B. Rau Magar, Chairman, Mahendrakot VDC
4. Mr. K. B. Bist, Ward Member
5. Mr. M. Tharu, Ward Member
6. Mr P. B. Pun, Ward Member
7. Mr. H. R. Chaudhary, Ward Member
8. Mr. B. R. Bhusal, Ward Member
9. Mr. T. R. Bhusal, Ward Member
10. Mr. B. Tharu, Ward Member
11. Mr. B. K. Ghimire, School Teacher
12. Mr. R. B. Tharu, School Teacher
13. Mrs. D. K. Shrestha, Farmer
14. Mr. G. P. Giri, Farmer
15. Mr. J. B. Chhetri, Farmer
16. Mr. C. M. Panthi, Farmer
17. Capt T. S. Rana, Farmer
18. Mr. S. B. Pun, Farmer
19. Mr. N. S. Nepali, Farmer
20. Mr. J. Tharu, Vice Chairman, Dubiya VDC
21. Mr. M. Tharu, Exchairman, Dubiya VDC
22. Mr. L. Panthi, Farmer
23. Mr. I. P. Poudel, Farmer
24. Mr. M. Chaudhary, Teacher
25. Mr. N. Tharu, Vice Chairman, Jayanagar VDC
26. Mr. H. D. P. Chaudhary, Teacher
27. Mr. R. P. Tharu, Chairman, Jayanagar VDC
28. Mr. R. P. Basyal, Farmer
29. Mr. K. P. Rana, Farmer
30. Mr. K. B. Shah, Ward Member
31. Mr. N. P. Bhusal, Farmer
32. Mr. H. P. Ghimire, Farmer
33. Mr. P. Banjadi, Farmer
34. Mr. H. R. Subedi, Farmer
35. Mr. L. Bahadur, Head Master

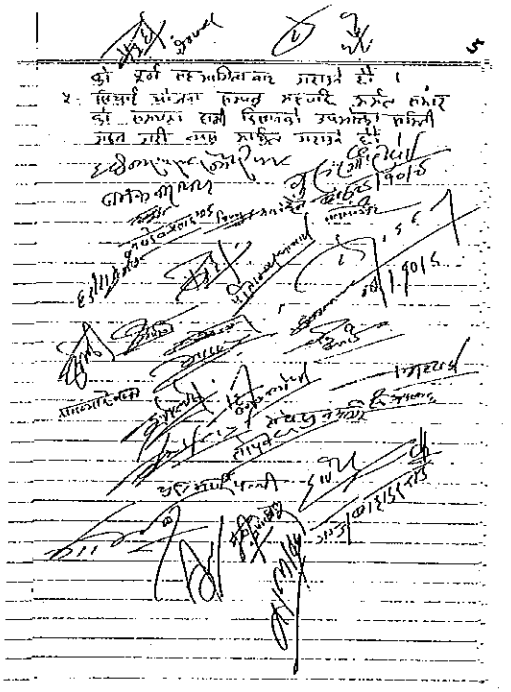
36. Mr. Top Bahadur Shrestha, Teacher
37. Mr. R. P. Aryal, Teacher
38. Mr. D. P. Chaudhary, Farmer
39. Mr. N. P. Rana, Head, Cooperative organization
40. Mr. B. R. Poudel, Farmer
41. Mr. K. P. Bhattari, Farmer
42. Mr. G. K. Kunwar, Farmer
43. Mr. J. N. Banjadi, Farmer
44. Mr. B. P. Poudel, Farmer
45. Mr. M. R. Sigdel, Farmer
46. Mr. L. Pokhrel, Farmer
47. Mr. H. N. Rajauriya, Ex Minister for Agriculture
48. Mr. P. Chaudhary, Farmer
49. Mr. K. Chaudhary, Farmer
50. Mr. C. Chaudhary, Farmer
51. Mr. D. R. Khanal, Farmer
52. Mr. G. P. Tharu, chairman, Buddi VDC
53. Mr. P Acharya, Vice chairman, Buddi VDC
54. Mr. T. R. Ghimire, Member, Buddi VDC
55. Mr. K. B. Pandey, Farmer
56. Mr. B. P. Poudel, Farmer
57. Mr. B. P. Poudel,Farmer
58. Mr. R. Chaudhary, Vice chairman, Baskarpur VDC
59. Mr. A. B. Rayamajhi, Farmer
60. Mr. H. Musalnan, Chairman, Rajpur VDC
61. Mr. R. Shresta, Farmer
62. Mr. J. Tharu, Farmer
63. Mr. H. L. Neupane, Farmer
64. Mr. K. Neupane, Farmer
65. Mr. Nepu Chaudhary, Farmer
66. Mr. R. C. Chaudhary, Farmer
67. Mr. D. Kurmi, Farmer
68. Mr. R. S. Kurmi, Farmer
69. Mr. R. G. Gupta, Farmer
70. Mr. P. R. Tharu, Farmer
71. Mr. Tulendra K. C, Farmer
72. Mr. J. P. Khanal, Farmer
73. Mr. C. Tharu, Farmer
74. Mr. T. B. L. Srivastav, Representative, District Cooperativers
75. Mr. S. Adhikary, Chief, District Agriculture Development Office
76. Mr. D. R. Pandey, Head, Agriculture Dev. Bank, Taulihawa
77. Mr. K. Jha, Acting Chief, Agriculture Input Corporation, Taulihawa
78. Mr. K. P. Sitaula, Agri-Engineer, DOI, Kapilvastu
79. Mr. H. B. Thapa, Farmer
80. Mr. L. B. KC, Farmer
81. Mr. G. R. Aryal, Farmer
82. Mr. H. P. Neupane, Farmer
83. Mr. K. Neupane, Farmer
84. Mr. H. B. Nagarkoti, Farmer
85. Mr. S. L. Kurmi, Chairman, Mahuwa VDC
86. Mr. J. Pudasaini, Farmer
87. Mr. Mahoto Tharu, Farmer
88. Dr. G. P. Rajauriya, Chairman, District Dev. Cmmittee
89. Mr. K. D. Adhikari, Counterpart Irrigation Engineer, DOI
90. Mr. B. Rayamajhi, Project-in-charge, DOI
91. Mr. K. Yamada, JICA
92. Mr. K. Takeda, JICA
93. Mr. F. Nagao, JICA
94. Mr. Y. Mizuguchi, JICA
95. Mr. M. Ikeda, JICA
96. Mr. N. Sambe, JICA
97. Mr. H. Ishikawa, JICA
98. Mr. Y. Mase, JICA
99. Mr. K. L. Shrestha, Counterpart Agronomist, DOAD
100. Mr. B. B Rawal, Counterpart, Agri-Economist, DOI
101. Mr. R. C. P. Agrahari, Counterpart, Agri-Economist, DOAD











Minutes of the 4th Meeting Between the JICA Study Team and the Beneficiary Farmers of Rajkudwa Irrigation Project

Date: February 14, 1993
Location: Gorusinge

A meeting on agricultural services was held at Gorusinge between the co-operative members, farmers representatives, officials from line agencies, and Rajkudwa study team members on February 14, 1993. The meeting was presided by village committee chairman Mr. R.P. Tharu and conducted by the Project Incharge. Prior to discussion a welcome speech covering the purpose of the meeting was given by Mr. B.Rayamajhi. District agriculture officer Mr. S.R. Adhikari and district co-operative officer Mr. L.N. Ghimire gave a briefing on their new approach in Rajkuduwa Irrigation Project area. The meeting was attended by about 300 farmers representatives. The attendance of the officials is as follows.

S.No.	Name	Designation	Office
1.	Mr. P. Poudel	Incharge	District Irrigation office
2.	Mr. S.R. Adhikari	Incharge	District Agriculture Dev.office
3.	Mr. L.N. Ghimire	Incharge	District co-operative office
4.	Mr. T.B.L. Shrivastav	Inspector	District co-operative office
5.	Mr. G.B. Rana	Officer	District co-operative office
6.	Mr. K.L. Shrestha	Agronomist	Dept. of Agriculture
7.	Mr. B. Rayamajhi	Project incharge	Rajkuduwa I. Project
8.	Mr. F. Nagao	Agronomist	F/S Team JICA
9.	Mr. K. Takeda	Team leader	F/S Team JICA

Minutes: **After hectic discussion, following requests were made by all the farmers representatives.**

1. There is much difficulty for purchasing fertilizers, insecticides etc on time by farmer without farmers co-operative in each VDC area. So it is requested by all of them to have 100 MT capacity godown with office room for farmers co-operative in each VDC area.

2. The farmers of Dhankauli, Mahuwa, Rajpur and Hariharpur are facing problem to transport their production to the market place viz. Taulihawa and Bahadurgunj The farmers representatives suggested to establish a Rice Mill in the project area.

3. Most of the farmers representatives complained their grievances of not having agro-technical services. Therefore, a decision was made for proposing one agricultural sub-centre with permanent technicians in North on highway. They were in the opinion that the sub-centre can be used for training the farmers on new technology.

4. The farmers representatives proposed for constructing one cold storage for storing seeds, food grains, and cash crops at Kodanliya or Buddi or Badaharra or Gorusinge under the management of farmers co-operative.

Lastly the chairman of the meeting Mr. R.P. Tharu gave vote of thanks and closed the meeting.

Rajkudwa Irrigation Project

Minutes of the 5th Meeting Between JICA Study Team & Farmers

Date: February 25, 1993
Location: Gorusinghe Lower Secondary School field

As a part of explaining the findings of field survey and tentative irrigation and drainage plan to the farmers and involving them in the planning process, the fifth meeting between the JICA F/S team members and the beneficiary farmers was held in Gorusinghe Lower Secondary School field at 14:00hrs on 25th February 1993. The meeting was chaired by Mr. Ram Pyare Tharu, the Chairman of Jayanagar VDC. The list of other attendants of the meeting has been annexed. The discussions and decisions made in the meeting were as follows:-

1. At first, Mr. R.P. Ghimire, the Ex-Chairman of Kapilvastu District Development Committee and a local farmer addressed the meeting welcoming all and the team members in particular. In his address, he, on behalf of all the beneficiary farmers, thanked the team members and the Government of Japan for showing interest in uplifting the standard of living of the local farmers. He also expressed his commitment that the farmers would extend all the necessary cooperation on their behalf.

2. After the welcome speech, Mr. Y. Mase, the Dy. Team Leader and Irrigation Engineer explained, with the help of maps, the findings of field work and the tentative irrigation and drainage plan conceived so far. In his explanation, he told the farmers that the existing Ranikudwa System, after improvement, would be utilized for irrigating most of the cultivated area north of East-West Highway and the system might also feed Badahara and Dewari or Buddi ponds. The main canal alignment of the Ranikudwa system was also explained to the farmers with the help of the map. Mr. Mase further explained about the location of proposed Kondre River Headwork and the canal system under it. He made it clear that the Kondreriver bed level, being at low elevation, could irrigate only southern part of the project area.

During his explanation, he informed the farmers that six or seven of the existing ponds in the project area would be rehabilitated and two to three new ponds would be constructed. The existing command area of the ponds and the cultivated area of higher elevation would come under the pond irrigation systems.

Mr. Mase explained to the farmers that the total command area of the irrigation project would be approximately 2000ha. He also informed them that the project would consist of 70 to 80 tertiary units each with average size of 30ha. He requested them to organize a water users' group in each tertiary unit from which they would elect two representatives (one Chair-person and one Secretary) for the respective water users' organization at secondary canal level. Similarly, two representatives elected from the secondary canal level would from a central Water Users' Association. He informed the farmers that pre-establishment of Water Users' Association was the prerequisite for Japanese grant aid. Mr. Mase reiterated, as in the previous meetings, the necessity of farmers' responsibility for constructing the canals, drains ad related structures at and beyond tertiary level at their own expense. He also explained that the Water Users Association would have to take over completely the completed project for operation and maintenance.

In his explanation, Mr. Mase informed the farmers that the existing village roads would be improved instead of constructing new survice roads. The reason for that kind of proposal was that the farmers would not have to loose much land in the road construction.

The farmers generally agreed on the irrigation and drainage development plan. The only request from the farmers' side was that the existing Gorusinghe pond be rehabilitated and included in the irrigation development plan.

3. In the meeting the other team members, Mr. Sambe, hydrologist; Mr. Ikeda, geophysicist; and Mr. Yamada, irrigation engineer were also introduced and they had briefly explained field findings on their parts.

4. At last, Mr. K.P. Rana, a leading farmer of the project area thanked the team members and reassured on behalf of the farmers that they would fulfill all the pre-requisites.

Attendance:

1.	R.P.Tharu	Chairman	Jainagar	2.	G.B.Run Magar	Chairman	Mahendrakot VDC
3.	D.Rana	Chairman	Dubiya VDC	4.	G.Chevdlaey	Chairman	Buddi VDC
5.	P.Khanal		Jainagar.-3	6.	K.B.Bista		Mahendrakot-2
7.	B.L.Khanal		Buddi-6	8.	B.Khanal		Dubiya-5
9.	D.B.Malla		Buddi-9	10.	K.P.Rana		Jainagar-4
11.	R.P.Chimire		Jainagar-6	12.	C.Khanal		Buddi-5
13.	B.Pondel		Jainagar-9	14.	U.M.Povdel		Dubiya-3
15.	G.B.Rama		Dubiya-3	16.	P.Acherya	Deputy Chairman	Dubiya VDC
17.	B.Yhimire		School Teacher	18.	B.P.Tharu		Mahendrakot-9
19.	B.Bhattarai		Mahendrakot-2	20.	T.B.Kunwar		Buddi-3
21.	Sita Reudel		Jainagar-7	22.	Kamala Yanlam		Mahendrakot-7
23.	Nimkala Bhet		Dubiya-3	24.	Sita D.Rau Magar		Dubiya-3
25.	R.M Rokhrat		Dubiya-5	26.	Shyam Yuruong		Dubiya-5
27.	Pyseri Darji		Dubiya-3	28.	Yamuna KL.		Buddi-7
29.	Savitri Belbase		Buddi-7	30.	Uuma Chhetri		Buddi-7
31.	Laxmi Belbose		Buddi-5	32.	D.K.Rayamajhi		Mahendrakot-8
33.	Bishnu Bhattari		Mahendrakot-8	34.	Kamala Thapa		Mahendrakot-7
35.	Ujcli Chhemi		Mahendrakot-8	36.	V.P Mishra		Mahendrakot-3
37.	J.B.Shah		Jayanager-8	38.	H.P.Yhimire		Jayanager-6
39.	I.P.Adhikari		Jayanager-6	40.	R.P.Yhimire		
41.	T.P.Khanal		Buddi-7	42.	M.Malla		Buddi-9
43.	Roshari Saugam		Buddi-9	44.	Thakur Prasad		Buddi-9
45.	S.R.Aryal		Buddi-7	46.	B.L.Chudali		Buddi-5
47.	Bahadur Sharma		Buddi-5	48.	Buddhi Bahadur		Buddi-5
49.	Shobhakar Pondel		Yhanchausa-5	50.	Top Lal Khanal		Dubiya-5
51.	Tek hal Pokhrel		Dubiya-5	52.	Dila Ram Khanal		Dubiya-5
53.	Shiva B.Kunwar		Dubiya-5	54.	Lok Halth Khanal		Dubiya-5
55.	Himanda pokhrel		Dubiya-5	56.	Ram Chandra Tharu		Dubiya-5
57.	Bahadur Tharu		Dubiya-5	58.	H.B Kunwar		Dubiya-3
59.	Prem Lal Tharu		Dubiya-4	60.	Ram Shanker Tharu		Dubiya-3
61.	Kanchha Tharu		Buddi-2	62.	L.M Subidi		Buddi-5
63.	H.P Bhusal		Buddi-7	64.	Bhikhari Tharu		Buddi-1
65.	C.M Banjade		Mahendrakot-7	66.	B.B Kunwar		Tikker
67.	Yam KL		Mahendrakot-7	68.	B.R.Pokhrel		Mahendrakot-7
69.	Kishori Kurmi		Mahendrakot-2	70.	Diwakar Yhimire		Jainagar-3
71.	B.P.Subedi		Jainagar-3	72.	N.P.Khanal		Mahendrakot
73.	Dipendra Poudel		Jainagar-3	74.	Jeer Harayan Belbek		Mahendrakot-5
75.	R.B.BC		Mahendrakot-4	76.	Sankata Prusad Chaudhar		Dhankanli-1
77.	R.Shresta		Dhankanli-1	78.	Yhanshyam		
79.	Shiv Bahadur			80.	B.P.Shrestta		
81.	Jeev Lal Kharal			82.	J.L.Poudel		
83.	H.K.Rana			84.	D.R.Bhaharai		
85.	Him Lal Heupane			86.	Tek Raj Yhimire		
87.	Khanba B.Shah			88.	Nareyan Prased Bhousal		
89.	Nareyan Prased Poudel			90.	Hum Kant Belban		
91.	Hut Kant Pantti			92.	Sop Bahadur Roon		
93.	Ishusari Prasad Roudel			94.	Krishna Presad		
95.	Durga Bahadur Adhikari			96.	Liladhar Panthi		
97.	Bhoj Bahadur			98.	Khadananda		
99.	S.B.Regmee	Project in charge	Kapilvastu Tubewell Project				
100.	Kumar Yautam	Section officer	Kapilvastu Tubewell Project				
101.	B.Rayamajhi	Project Manager	Counter part, DOI				
102.	K.D.Adhikari	Irrigation Enginear	Counter part, DOI				
103.	Yoshimitsu Mase	Co-Team Leader	JICA Study Team				
104.	Mitsuyoshi Ikeda	Geologist	JICA Study Team				
105.	Nobuo Sanbe	Hydrologist	JICA Study Team				
106.	Kozo Yamada	Design Enginear	JICA Study Team				

付　録

Summary of Farm Survey

1. Objectives of the Survey

The main objective of the farm survey was to assess the current socio-economic conditions of the rural people and their general attitude to the Rajkudwa Irrigation Project through the direct interview to the farmers in the study area. The survey also aimed at collecting and analysing the relevant data on general conditions of the study area.

2. Scope of the Survey Works

The JICA Study Team specified the scope of works and prepared the questionnaire for the farm survey. The questionnaire covers the following aspects :

- Household characteristics
- Land ownership
- Crop production and agricultural support services
- Animal husbandry, and
- General attitude

Initially, it was proposed by JICA Study Team that 100 farmers be selected as the samples for the direct interview and obtaining necessary information. Later it was suggested that ten (10) more farmers be interviewed in Patharkot and Birpur, as it was clarified that the headworks site of the project would be located at the Gudrung river lying north of the previously proposed headworks site at the Kondre river.

3. Methodology of the Study

The primary data were collected from 110 households by the local consultanting firm entrusted by the study team through the direct interview to the farmers, which was carried out in line with the questionnaire prepared by the study team. The following two-step random sampling method was employed to select the sample households for the interview:

- The survey area was firstly divided into three blocks: head, middle and tail. The area lying north of the East-West Highway (EWH) was defined as the head part, the area lying between EWH and the Gidahawa Village as the middle part and the area south of Gidahawa Village as the tail part of the study area.
- The following criteria were adopted for dividing the farmers into four different strata. Then, the numbers of sample farmer were proportional to the total numbers of farmer in each stratum, and selected randomly from each stratum to interview a total of 20 farmers at each site.

CRITERIA	LAND HOLDING
Landless	< 0.1 ha. (3 kattha)
Small Farmers	0.1 ha. to 2.37 ha. (3 kattha to 3.5 bigha)
Medium Farmers	2.37 ha. to 5.08 ha (3.5 bigha to 7.5 bigha)
Large Farmers	> 5.08 ha. (7.5 bigha)

- 100 farmers were selected as 40 farmers in the head block, 40 in the middle block and 20 in the tail block of the study area. These selected farmers were interviewed directly by the investigators and research officer of the local consulting firm visited to their houses or farms.

- Finally, 10 farmers were selected randomly from the Pattharkot and Birpur areas, and interviewed using the same method as mentioned above. Thus, the total number of the farmer's households interviewed was 110 as follows;

Farmer's Strata	No. of Sample FH
Small	67
Medium	33
Large	10
TOTAL	110

The data arrangement was carried out twice to check the quality of the collected data. The first arrengement was done by the research officer in the form of checking the questionnaires filled by investigators in the field every day. In the case of that there were inconsistency and/or error among the data, the investigator was requested to re-visit the farmers and correct the inconsistency or error. The second arrengement was made by an agro-economist of the local consultant before inputing the data into the computers to check the data.

The arrenged data were directly inputed into the IBM desk-top computers. The FOXBASE was used for inputing the data and also for further analysis. All the data inputed into the computers were printed and verified by the agro-economist, and the omissions and errors on outputs were corrected to re-input the correct ones into the computers. Then, the outputs were processed to the final forms for the report.

4. Implementation

The farm survey was carried out during the period of one month and a half. The finalization of the methodology and survey tools took about a week. The team of the professionals and investigators visited the field in the last week of July, 1992 and completed the field survey by the first week of August, 1992. The data analysis and report preparation were completed by the last week of August. The final report was prepared by the fourth week of September 1992.

5. Study on the Farm Survey

5.1 Household Characteristics

Of the total interviewee, 105 were male and the rest (five) female. More than 62 percent of them were aged between 21 to 45, about 31 percent more than 45 years and 6 percent between 16 to 20 years of age. The education level of the interviewee was not found very inspiring as about 32 percent of them were not educated at all. Some 16 percent of the interviewee were completed at least secondary level of education. Detaileds of interviewee is summalized as follows;

	FARM STRATA							
	SMALL		MEDIUM		LARGE		TOTAL	
	Male	Female	Male	Female	Male	Female	Male	Female
Age (Years)								
Less than 16	0	0	0	0	0	0	0	0
16 to 20	3	1	3	0	0	0	6	1
21 to 45	36	4	24	0	5	0	65	4
More than 45	23	0	6	0	5	0	34	0
Education Level								
None	18	2	13	0	2	0	33	2
Some Primary	19	2	8	0	2	0	29	2
Completed Primary	5	0	2	0	0	0	7	0
Some Secondary	14	0	4	0	1	0	19	0
Completed Secondary	1	0	5	0	2	0	8	0
College/University	2	0	0	0	2	0	4	0
Adult literacy class	3	1	11	0	1	0	5	1
TOTAL	65	5	33	0	10	0	105	5

There were 1,027 population in 110 sample households. The average family size was 9.34 which ranged from 8.03 among small farmers to 11.61 among medium farmers. The average family size among the large farmers was 10.60 persons. This figure is higher than the size of household reported by Central Bureau of Statistics (CBS) in its census survey result, 1991. The reason is that the local inhabitants (Terai people) have larger family size than those migrated from the hills.

Of the total population in sample households, about 41 percent were upto 15 years age, 9 percent were 16 to 20 years, 41 percent were 21 to 45 years and the rest (9 percent) more than 45 years of age. Female population out-numbered male population by 9 in total. Male : Female ration is estimated at 1 : 1.02. Details on population distribution by age, sex and farm strata are presented as below.

	FARM STRATA											
	SMALL			MEDIUM			LARGE			TOTAL		
	Male	Female	Both	Male	Female	Both	Male	Female	Both	Male	Female	Both
Less than 16 yrs.	116	107	223 (41)	79	81	160 (42)	21	14	35 (33)	216	202	418 (41)
16 to 20 years	32	19	51 (10)	20	8	28 (7)	9	6	15 (14)	61	33	94 (9)
21 to 45 years	103	114	217 (40)	72	90	162 (42)	19	23	42 (40)	194	227	421 (41)
More than 45 years	19	28	47 (9)	12	21	33 (9)	7	7	14 (13)	38	56	94 (9)
Total :	270	268	538 (100)	183	200	383 (100)	56	50	106 (100)	509	518	1027 (100)
Family Size :			8.03			11.61			10.6			9.34

One of the indicator of living standard is the percentage of total expenditure going for basic need commodities like food. The survey result shows that purchase of food items alone accounted for 32 percent in average. The other important item of expenses was social/religious ceremonies accounting for about 25 percent of total expenses. Cash expenditure in last one year is summarized as below.

	FARM STRATA							
	SMALL		MEDIUM		LARGE		ALL	
	Rs/HH	%	Rs/HH	%	Rs/HH	%	Rs/HH	%
Food Items	3,813	39	2,888	29	1,688	0	3,343	32
Hired Labour	489	5	776	8	4,900	28	976	9
Education	468	5	709	7	1,185	7	606	6
Fuel	378	4	492	5	628	4	35	4
Transport	914	9	608	6	900	5	821	8
Remittance	62	1	27	<1	62	<1	52	<1
Farm Input	575	6	1,031	10	852	5	736	7
Aid and Donation	83	1	53	<1	700	4	130	1
Ceremonies	2,172	22	2,811	28	4,790	28	2,601	25
Livestock Purchase	493	5	702	7	1,398	8	638	6
Others	250	3	0	0	250	1	175	2
TOTAL	9,697	100	10,097	100	17,353	100	10,513	100

Rice, wheat and maize are the staple food in the area, while the pulses are the next important crop. Households cultivate these crops for home consumption as well as for income generation through sales.

Use of major food grains in the household by the farm strate is summarized as below.

(kg/HH)

	FARM STRATA			
	SMALL	MEDIUM	LARGE	AVERAGE
Paddy				
(a) Production	2,600	6,627	14,057	4,851
(b) Purchase	29	0	0	18
(c) Sales	217	1,264	5,109	976
(d) Use in HH (a+b-c)	2,412	5,363	8,948	3,893
Rice				
(a) Purchase (Use in HH)	106	0	0	65
Maize				
(a) Production	33	29	28	32
(b) Purchase	17	3	0	11
(c) Sales	11	0	0	7
(d) Use in HH (a+b-c)	39	32	28	36
Wheat				
(a) Production	623	812	1,529	762
(b) Purchase	42	86	35	55
(c) Sales	4	44	260	39
(d) Use in HH (a+b-c)	661	854	1,304	778
Pulses				
(a) Production	176	390	590	277
(b) Purchase	8	7	8	7
(c) Sales	7	34	195	32
d) Use in HH (a+b-c)	177	363	403	252

Considering the average family size and food availability, about 423 kg food grains per capita, 570 kg food grain per capita and 1008 kg food grain per capita was available among the small medium and large farmers, respectively in gross form. These quatities are used for human consumption, livestock feed, hiring of labours and exchange of other commodities.

The study area as a whole is food sufficient and food grains, oil seeds, pulses and livestock products are sold out from the area forming a major source of income.

5.2 Land Ownership

The average size and composition of operated land by farm size and land type is presented as below. The average size of land holding among small, medium and large was 1.22, 3.34, and 7.16 ha, respectively. A greater proportion of the operated land in the area was found to be lowland (93.1 percent), of the total lowland area 62.1 percent was reported to be under rainfed condition and 31.0 percent under some form of irrigation. Proportion of irrigated land was found higher among larger households than smaller households. About 1.6 percent of the total operated land was upland (Pakho), 2.0 percent squatted land and another 3.3 percent was under homestead which included kitchen garden.

	FARM STRATA			
	SMALL	MEDIUM	LARGE	TOTAL
Total Operational Area (ha)	81.74	110.22	71.6	269.5
Percentage Operational Area				
Low Land	91.0	94.4	98.2	93.1
Irrigated	22.1	34.7	38.1	31.0
Rainfed	68.9	59.9	60.1	62.1
Upland	2.5	1.2	0.4	1.6
Homestead	4.9	3.3	1.4	3.3
Squatted	1.6	0.9	0.0	2.0
Average Size of Holding (ha)	1.22	3.34	7.16	2.45

A greater proportion of households in the area were found to be exclusive land owner (48.2 percent). Among exclusive land owners, 52.2 percent households were in the small farmer group, 36.4 percent medium farmer and 60 percent in the large farmer group. The average proportion of owner cum rented-in land was 35.5 percent, owner cum rented-out 2.7 percent and owner-cum- squatted 8.2 percent. The owner cum rented-in land was found highest in medium households (42.4 %) followed by large (40 %) and small (31.3 %). From the survey it is noticed that some of the larger farmers also rented-in some land. Land tenurial pattern of the households in the survey area is presented as below.

TENURIAL STATUS	FARM STRATA			
	SMALL	MEDIUM	LARGE	TOTAL
Tenurial Status (%)				
Exclusive Owner	52.2	36.4	60	48.2
Owner cum Rented-in	31.3	42.4	40	35.5
Owner cum Rented-out	3.0	3.0	0	2.7
Owner Squatted +Rented out	1.5	0	0	0.9
Owner + Rented + Squatted	1.5	12.1	0	4.5
Owner cum Squatted	10.5	6.1	0	8.2

5.3 Crop Production

Paddy was the main rainy season crop of the study area. Share of paddy area to total cropped area in small, medium and large farm household groups was 56.5, 69.0 and 74.7 percent, respectively and for the study area it was 65.9 percent. Wheat was the important crop in the winter season in the surveyed area. Wheat crop contributed 17.6 percent in small, 11.2 percent in medium, 9.2 percent in the large and 13 percent in average household. The pulses was the next principle winter crop of the area. Proportion of total cropped area under pulses in small, medium, large and average households was 10.4, 11.1, 8.9 and 10.3 percent, respectively. The average share of oil crops in total cropped area was 6.9 percent, while potato

and other crops collectively shared 2.3 percent. The sample households cultivated a total of 248 ha and their total cropped area accounted for about 368 ha.

(ha)

CROPS	FARM STRATA							
	SMALL		MEDIUM		LARGE		TOTAL	
		%	AREA	%	AREA	%	AREA	%
Summer Crops								
Paddy	75.0	56.5	101.1	69.0	66.3	74.7	242.3	65.9
Maize	1.4	1.1	0.5	0.4	0.3	0.3	2.2	0.6
Pulses	2.8	2.0	0.9	0.6	0.0	0.0	3.7	1.0
Total	79.2	59.6	102.5	70.0	66.5	75	248.2	67.5
Winter Crops								
Wheat	23.4	17.6	16.3	11.2	8.2	9.2	48.0	13
Oilcrops	12.6	9.5	8.1	5.6	4.5	5.1	25.2	6.9
Pulses	13.9	10.4	16.3	11.1	7.9	8.9	38.1	10.3
Potato	2.9	2.2	2.5	1.7	1.4	1.5	6.7	1.8
Others	0.8	0.6	0.7	0.5	0.2	0.3	1.7	0.5
Total	53.6	40.3	43.9	30.0	22.2	25.0	119.7	32.5
Total Cropped area	132.9	100	146.4	100	88.7	100	368.0	100

The ownership of farm equipments by farm size is summarized as below.

DESCRIPTIONS	FARM STRATA											
	SMALL			MEDIUM			LARGE			ALL		
	HH	%	Avg. No.	HH	%	Avg. No.	HH	%	Avg. No.	HH	%	Avg. No.
Tractor	0	0	0	0	0	0	0	0	0	0	0	0
Water pump	0	0	0	1	3	2	2	20	1	3	3	1
Local plough	64	96	1.8	33	100	2.7	10	100	3.4	107	97	2.2
Improved Plough	2	3	1	2	6	2	1	10	1	5	5	1.4
Hoe	0	0	0	1	3	2	0	0	0	1	1	2
Sprayer	0	0	0	0	0	0	0	0	0	0	0	0
Thresher	0	0	0	0	0	0	0	0	0	0	0	0

Out of the total households, 44 percent reported irrigation facility in the study area. In average 43 percent household reported community irrigation facilities in their farms among them 43 percent small households, 45 percent medium and 30 percent large households. Only 1 percent of total respondent reported having their own irrigation facility. The number of households reporting (irrigation sources) by farm household is presented as below.

DESCRIPTIONS	FARM STRATA							
	SMALL		MEDIUM		LARGE		TOTAL	
	No.	%	No.	%	No.	%	No.	%
Number of Household reporting Irrigation Sources	30	45	15	45	3	30	48	44
Own	1	2	0	0	0	0	1	1
Community	29	43	15	45	3	30	47	43
Government	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0

Irrigation charges paid for diesel, irrigation fee and maintenance cost by farm size is shown as below. On an average Rs. 1000/ha was spent for diesel, Rs. 871/ha for maintenance and Rs. 270/ha for irrigation. In total Rs. 2,141/ha was spent for irrigation by the respondent.

	IRRIGATION CHARGE (RS./HA.)			
	SMALL	MEDIUM	LARGE	AVERAGE
Electricity	0	0	0	-
Diesel	0	1,000	1,000	1,000
Maintenance	533	1,039	0	871
Irrigation fee	40	500	0	270

A number of problems for irrigation were listed by the farm households. 35 percent among total household reported no irrigation facility, 29 percent household reported shortage of water and 21 percent households expressed intake of irrigation system was not good. The major problems faced by farm households for irrigation is presented as below.

	FARM STRATA							
	SMALL		MEDIUM		LARGE		TOTAL	
	No.	%	No.	%	No.	%	No.	%
Intake not good	14	21	7	21	2	20	23	21
Shortage of water	18	27	12	36	2	20	32	29
No irrigation in winter	3	5	1	3	1	10	5	5
No Equal Distribution	5	8	3	9	1	10	9	8
No irrigation facility	22	33	14	42	3	30	39	35
Drainage Problem	-	-	2	6	-	-	2	2
No WUG	7	10	1	3	-	-	8	7
Depend on Rain	4	6	-	-	2	20	6	6
Living Standard Low	3	5	-	-	2	20	5	5
Up Land	1	2	1	3	-	-	2	2
No	1	2	-	-	-	-	1	1
No Technology	2	3	-	-	-	-	2	2
Timely No Crop	-	-	1	3	-	-	1	1

The main reasons reported by farm households were shortage of water, late planting and poor knowledge about crop husbandry. Out of total households, 25 percent households expressed lower yield due to shortage of irrigation water, 16 percent household reported lower yield due to poor knowledge of farming, 15 percent households reported lower yield due to late planting and 10 percent household reported low yield due to diseases and insects incidence.

Reason for lower yield (HH)	FARM STRATA							
	SMALL		MEDIUM		LARGE		TOTAL	
	No.	%	No.	%	No.	%	No.	%
Late planting	18	27	6	18	2	20	16	15
Shortage of water	17	25	7	21	3	30	27	25
Wind	1	2	0	0	0	0	1	1
Animal/bird damage	1	2	2	6	2	20	5	5
Soil fertility	1	2	0	0	1	10	2	2
Salinity	-	-	-	-	-	-	-	-
Pest, disease	7	10	3	9	1	10	11	10
Poor husbandry	2	3	0	0	-	-	2	2
Seed quality	2	3	0	0	-	-	2	2
Poor knowledge on cultivation	10	15	6	18	2	20	18	16

An Agriculture Service Center and a Livestock Service Centre is located in Deuri village, Buddi village development committee. All the VDC of the project area are under the service area of Deuri Agriculture sub-center. Assistant Production Officer is the officer in-charge of the Agriculture Service Center. There are two cooperative society (Sajha) in the

project area and they are located in Gorusinge and Dhankauli (now in Mahuwa). These societies are selling agricultural inputs in the project area. There is a sub-branch office of Nepal Bank Limited in Pattharkot, which deals with commercial as well as agricultural loan.

5.4 Animal Husbandry

The large farm households in the area were observed having a large number of livestock than the small households. The vital role of bullock for ploughing may be the reason why 83 percent of households owned bullock. 90 percent of large household had about 8.9 bullocks, 94 percent of medium households had 5.4 bullocks and 76 percent small households had 3 bullocks. Data on the total number of farm animals in the command area by VDC was also availed to the study team by livestock sector, is presented as below.

ANIMALS	FARM STRATA							
	SMALL		MEDIUM		LARGE		ALL	
	% of HH Keeping	Ave. no of Animal	% of HH Keeping	Ave. no of Animal	% of HH Keeping	Ave. no of Animal	% of HH Keeping	Ave. no of Animal
Buffalo	51	2.4	36	1.8	40	4.3	46	2.4
Buffalo Bull	16	2.1	12	2.5	60	2.5	19	2.3
Cow	64	2.7	82	4.3	80	6.6	71	3.6
Bull/Steers	76	3	94	5.4	90	8.9	83	4.4
Pig	12	1	27	2.3	20	1	17	1.6
Sheep	5	5	15	4.6	-	-	7	4.8
Horse/Mule	-	-	-	-	-	-	-	-
Goat	39	2.6	46	5.1	50	3.6	42	4.7
Donkey	-	-	-	-	30	11.6	-	-
Chicken	30	6.6	49	6.7	-	4	37	7.2
Ducks	2	3	6	10	-	-	6	5.8
Others	-	-	-	-	-	-	-	-

5.5 General Attitude

The most serious problem constraining the development of agricultural production was the shortage of irrigation water which was pointed out by 93 percent of the farmers. The next one was the pest/disease in crops as pointed by 74 percent of the farmers. Poor road condition, and shortage of fertilizer and HYV seeds were the other constraints.

(percent)

CONSTRAINTS	FARM STRATA			
	SMALL	MEDIUM	LARGE	ALL
Irrigation Water	91	94	100	93
Excess Water	1	0	0	
Pests and Diseases	72	76	80	74
Labour Shortage	10	6	10	9
Shortage of HYV	28	24	30	27
Shortage of Fertilizer	25	39	30	30
Poor Road Condition	40	52	30	45
Other	1	0	0	1

Note : Percentage figures add-up to more than 100 because farmers had stated more than one constraints.

About 86 percent of the households were aware about Rajkudwa Irrigation Project. They were willing to help the project mainly by providing voluntary labour. However, people were very enthusiastic with the irrigation project in general. About 79 percent of them expected that production/productivity of crops will increase. Similarly 27 percent expected that production of fruits and vegetables will increase once the irrigation water will be available.

	FARM STRATA							
	SMALL		MEDIUM		LARGE		ALL	
	No.	%	No.	%	No.	%	No.	%
Even heard of the Project:								
- Yes	57	85	28	85	10	100	95	86
- No	10	15	5	15	0	0	15	14
Willing to contribute by *								
- Providing some cash	9	13	4	12	2	20	15	14
- Providing s-ome grain	1	1	3	9	2	20	6	5
- Providing Land	6	9	3	9	1	10	10	9
- Providing Voluntary Labour	57	85	29	88	8	80	94	85
Foresee any Hardship:								
- Yes	3	4	7	0	0	0	10	9
- No	64	96	26	0	10	100	100	91
If Yes, How								
- Project may take my land to construct canal/pond	3	4	7	21	0	0	10	9
Benefits Expected From the Project *								
- Increase in crop production	50	75	27	82	10	100	87	79
- Increase in Fruit & vegetable production	22	33	7	21	1	10	30	27
- Increase in Income	8	12	7	21	1	10	16	15
- Multiple cropping	10	15	2	6	1	10	13	12
- Timely cultivation	1	1	1	3	1	10	3	3
- Assured water supply with ower maintenance cost	1	1	1	3	1	10	3	3

* The totals add-up to more than hundred as farmers answers were more than one.

The general thinking of the people was that the project should start as soon as possible. It was suggested that the project should be directly helpful to as many farmers as possible, specially, in winter. Some of the farmers suggested that the Ranikudwa Irrigation Project should be rehabilitated and water available from Ranikudwa and Rajkudwa Project should combine together to irrigate largest possible area.

	FARM STRATA							
	SMALL		MEDIUM		LARGE		ALL	
	No.	%	No.	%	No.	%	No.	%
- Project is beneficial, should start soon	36	54	15	45	4	40	55	50
- Canal should use water from both Rajkudwa and Ranikudwa	6	9	1	3	1	10	8	7
- Should be directly helpful to farmers	8	12	11	33	2	20	21	19
- Should provide water during winter	8	12	3	9	1	10	12	11
- Seek peoples' participation	3	4	1	3	0	0	4	4
- Use existing ponds to increase discharge during dry season	1	1	1	3	0	0	2	2
- Provide compensation for land used by project	2	3	1	3	2	20	5	4
- Give priority to northern belt in distributing water	3	4	0	0	0	0	3	3

List of Farm Survey

No. of Farmer	Location	Family Size	Living Expediture	Cultivated Area
		Persons	NRs/year	ha
1	Dubiya VDC	14	18,180	1.50
2	Dubiya VDC	7	33,605	22.46
3	Dubiya VDC	10	12,620	16.42
4	Dubiya VDC	7	5,230	11.05
5	Dubiya VDC	7	3,025	1.50
6	Dubiya VDC	6	8,605	10.02
7	Dubiya VDC	13	8,774	2.58
8	Dubiya VDC	8	5,838	1.50
9	Dubiya VDC	19	13,928	9.68
10	Dubiya VDC	10	8,248	6.24
11	Dubiya VDC	6	1,380	2.10
12	Dubiya VDC	10	7,625	4.67
13	Dubiya VDC	15	15,974	4.68
14	Dubiya VDC	13	13,515	2.44
15	Dubiya VDC	12	4,280	6.91
16	Dubiya VDC	23	4,685	2.37
17	Dubiya VDC	8	6,154	2.44
18	Dubiya VDC	11	6,660	4.34
19	Dubiya VDC	16	14,260	7.92
20	Dubiya VDC	14	6,975	8.19
21	Jayanagar VDC	6	12,140	0.92
22	Jayanagar VDC	5	9,180	0.72
23	Jayanagar VDC	5	22,108	4.21
24	Jayanagar VDC	16	3,815	10.97
25	Jayanagar VDC	8	18,900	1.15
26	Jayanagar VDC	4	6,600	1.62
27	Jayanagar VDC	6	8,400	0.06
28	Jayanagar VDC	2	8,475	2.27
29	Jayanagar VDC	8	5,334	3.79
30	Jayanagar VDC	1	1,620	0.10
31	Jayanagar VDC	4	1,710	1.44
32	Jayanagar VDC	12	15,872	2.26
33	Jayanagar VDC	4	2,780	0.34
34	Jayanagar VDC	17	8,662	3.54
35	Jayanagar VDC	5	0	0.07
36	Jayanagar VDC	6	13,030	1.58
37	Jayanagar VDC	5	7,095	2.10
38	Jayanagar VDC	13	7,940	2.72
39	Jayanagar VDC	5	4,270	0.54
40	Jayanagar VDC	11	17,960	2.17
41	Buddi VDC	9	8,170	10.30
42	Buddi VDC	6	9,300	1.90
43	Buddi VDC	7	6,347	3.52
44	Buddi VDC	8	9,103	0.68
45	Buddi VDC	13	9,570	2.50
46	Buddi VDC	9	8,403	2.92
47	Buddi VDC	13	4,300	1.50
48	Buddi VDC	11	6,440	2.03
49	Buddi VDC	5	3,300	2.02
50	Buddi VDC	10	11,940	2.37
51	Buddi VDC	3	980	1.43
52	Buddi VDC	9	10,972	0.74
53	Buddi VDC	5	2,020	3.52
54	Buddi VDC	8	2,155	2.77
55	Buddi VDC	15	31,800	4.68

No. of Farmer	Location	Family Size	Living Expenditure	Cultivated Area
		Persons	NRs/year	ha
56	Buddi VDC	14	9,632	0.58
57	Buddi VDC	17	4,335	4.29
58	Buddi VDC	14	6,110	4.26
59	Buddi VDC	5	8,860	2.17
60	Buddi VDC	6	2,850	4.40
61	Dhankauli VDC	13	20,475	13.74
62	Dhankauli VDC	14	9,528	6.02
63	Dhankauli VDC	12	3,152	8.33
64	Dhankauli VDC	7	11,811	6.58
65	Dhankauli VDC	12	11,945	4.60
66	Dhankauli VDC	10	20,550	6.77
67	Dhankauli VDC	17	9,920	2.72
68	Dhankauli VDC	4	1,740	5.20
69	Dhankauli VDC	4	13,200	5.69
70	Dhankauli VDC	7	8,420	4.42
71	Dhankauli VDC	6	13,207	6.91
72	Dhankauli VDC	2	920	2.10
73	Dhankauli VDC	7	1,027	3.52
74	Dhankauli VDC	5	6,225	0.82
75	Dhankauli VDC	9	4,375	1.96
76	Dhankauli VDC	7	5,580	3.80
77	Dhankauli VDC	14	9,770	3.18
78	Dhankauli VDC	11	3,960	2.81
79	Dhankauli VDC	7	5,540	2.54
80	Dhankauli VDC	7	3,200	1.62
81	Buddi VDC	18	4,212	15.10
82	Buddi VDC	6	24,078	11.86
83	Buddi VDC	5	7,032	0.00
84	Buddi VDC	6	20,570	0.06
85	Buddi VDC	9	5,450	4.20
86	Buddi VDC	6	4,168	7.76
87	Buddi VDC	17	12,700	6.56
88	Buddi VDC	21	6,130	6.24
89	Buddi VDC	17	5,088	6.88
90	Buddi VDC	17	1,340	2.84
91	Buddi VDC	10	7,665	3.46
92	Buddi VDC	6	8,560	0.83
93	Buddi VDC	8	5,122	2.10
94	Buddi VDC	16	5,400	2.34
95	Buddi VDC	10	7,193	6.24
96	Buddi VDC	4	4,220	2.38
97	Buddi VDC	9	2,300	2.10
98	Buddi VDC	10	5,700	0.40
99	Buddi VDC	11	1,398	2.10
100	Buddi VDC	4	3,530	0.02
101	Mahendrakot VDC	7	5,210	0.54
102	Mahendrakot VDC	4	10,000	1.77
103	Mahendrakot VDC	8	32,660	0.48
104	Mahendrakot VDC	2	20,254	2.54
105	Mahendrakot VDC	5	18,560	1.56
106	Mahendrakot VDC	8	15,816	2.24
107	Mahendrakot VDC	16	22,982	4.68
108	Mahendrakot VDC	8	12,530	1.43
109	Mahendrakot VDC	7	16,305	3.45
110	Mahendrakot VDC	16	12,570	3.32

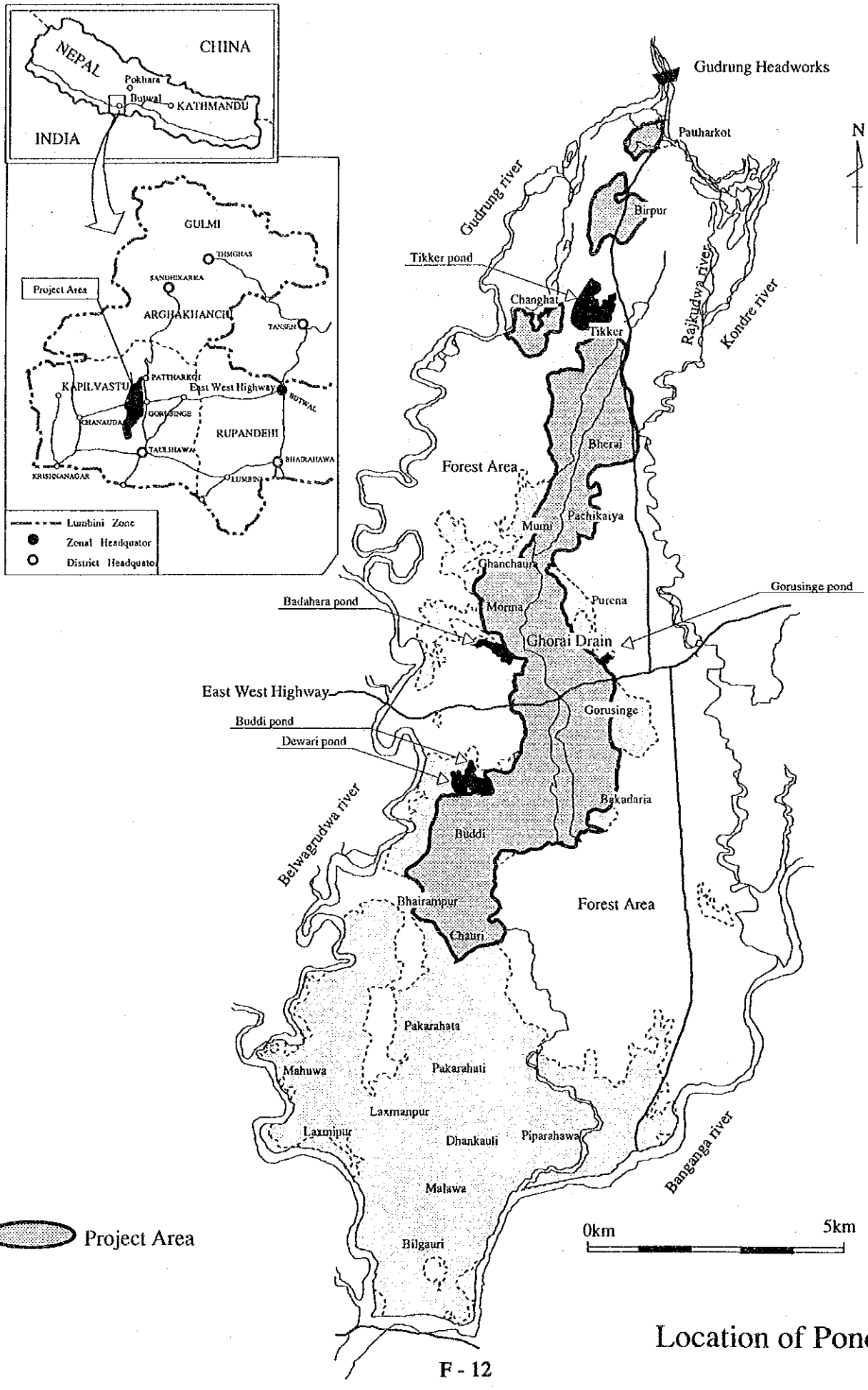
ネパール王国

ラジクドゥワ灌漑計画調査

ティカール溜池予定地に対する
追加地質／土質調査の結果と漏水量について

平成5年11月

国際協力事業団



Location of Ponds

ティカール溜池予定地に対する
追加地質／土質調査の結果と漏水量について

1. 経　緯

インテリム・レポートの灌漑計画案は、頭首工によって取水するグドゥルン川およびコンドレ川の自流灌漑を主とし、溜池による補給灌漑を従とした、表流水灌漑であり、溜池の規模および水深はさほど大きくなく、溜池予定地の表層地質（未固結堆積層）と土質（シルト層）から見て、浸透量調査を重視する必要はないとの認識であった。しかし、国内での水文解析の結果、両川とも、乾期のみならず雨期にも予想していたほど基底流量が大きくないことが判明したため、ドラフトファイナル・レポートにおける灌漑計画は、河川流量、特に洪水の有効利用を図る必要が生じたため、グドゥルン川の流量を先ず溜池に貯溜し、溜池からの配水で灌漑する溜池灌漑計画となった。（コンドレ川頭首工案は、自流灌漑面積が少なく、且つ取水位が低く溜池への貯溜も難しいため、廃案となった。）このため、溜池の規模および水深は必然的に大きくなり、溜池予定地（堤体を含む）からの浸透量等を推定するための追加地質／土質調査が必要となった。

上述の経緯を踏まえ、国際協力事業団（JICA）は、各省会議の同意を得て、調査団員（設計／積算担当）1名を9月17日から10月16日までの1ヵ月間現地に派遣し、追加地質／土質調査を実施した。

追加調査は、改修・拡大予定の既存溜池4ヵ所および新設溜池1ヵ所で実施されたが、この報告書は、漏水が危惧された新設予定のティカール溜池について調査結果と推定漏水量等を取り纏めたものである。

2. 追加地質／土質調査

2.1 調査内容

漏水量等の推定を目的とした、ティカール溜池予定地に対する追加地質／土質調査の内容は、以下の通りであった。

A. 現地調査

1)	コアボーリング	9本	計72 m	(6～10m／本)
2)	標準貫入試験		32 点	(孔内の2～3m間隔)

3)	孔内透水試験		21 点	(孔内の 3m 間隔)
4)	現場透水試験	5 ヵ所	10 点	
5)	試掘		12 ヵ所	(深度 1.5～4.0m)
6)	室内透水試験		7 点	
7)	土質試験（粒度、比重および含水試験）		39 点	(各39点)
8)	突き固め試験		7 点	
9)	直接剪断試験		7 点	

B. 国内作業

1) 試験結果の解析
2) 浸透流解析による漏水量の算定
3) 漏水量が大きい場合は、漏水防止工事の概略設計と概算工事費の算定
4) 上記の結果を含む簡単な報告書を作成するとともに、その内容を F/S ファイナル・レポートに反映させる。

2.2 調査結果

2.2.1 地形・地質概要

ティカール池予定地左岸には、比高 8 m 以内の残丘状地形が特徴的に存在する。これは、パタルコット扇状地で古期扇状地（更新世）とした面にほぼ相当するものか、または、古期扇状地よりも標高が数 m 高いことから、古期扇状地よりも若干古い可能性もある。ティカール池予定地の貯水池部分および右岸は、中位段丘面（更新世）に相当するおおむね平坦な地形上に位置する。この面は左岸の残丘状地形よりも新しい。

地質はティカール池予定地全体を完新統の表土が薄く覆い、その下の少なくとも深さ10 数 m までは更新統の未固結堆積物（礫、砂、シルト、粘土）で構成されている。地質は、新しい順に中位段丘面に相当する部分にⅠ層、左岸の残丘状地形を構成するⅡ層およびそれらの下位にⅢ層が存在する。

2.2.2 ボーリング結果

9 孔計 72 m のボーリングと 12 孔計 31.5 m のピット掘りを実施した。（図 2.1 参照）その結果は、表 2.1 と図 2.1 ～ 2.4 のように纏められる。地質は新しい順に、次の通りとなる。

・表土

・Ⅰ層　Ⅰ-1層（砂質シルト層）、Ⅰ-2'層（砂層）、Ⅰ-2層（砂礫層）の2～3層に区分される。このうち、Ⅰ-2'層の分布は、T-3, 4およびT-5付近に限定される。平均N値はそれぞれ22, 12, 16である。

・Ⅱ層　Ⅱ-1層（砂質シルト層）、Ⅱ-2層（砂層）、Ⅱ-2'層（砂礫層）、Ⅱ-3層（砂礫層）の3～4層に区分される。Ⅱ-2'層はQ-3および11のみに分布する。N値はⅡ-2層で15、Ⅱ-3層で38となっている。

・Ⅲ層　Ⅲ-1層（シルト質層）、Ⅲ-2層（シルト質層）とⅢ-3層（砂層）に区分される。Ⅲ-1とⅢ-2は2層に区分したが、その連続性から1層にまとめることも可能である。平均N値はそれぞれ22, 12, 16である。

なお、構造物の基礎として十分な値であるN値 ≧ 30となるのはⅠ-2'層の一部、Ⅰ-2層の多くおよびⅡ-3層である。また、N値 ≧ 20となるのは、Ⅰ-1層の一部、Ⅰ-2'層の多く、Ⅰ-2層の大部分およびⅡ-3層である。

2.2.3 水理地質

水理地質は、以下のごとく区分できる。

自由帯水層；　Ⅰ-1, Ⅰ-2', Ⅰ-2の各層とⅡ-2, Ⅱ-2', Ⅱ-3の各層で構成される。このうち、Ⅰ-2とⅡ-3層が主帯水層であり、ティカール池予定地に広範囲に分布する。平均透水係数は、Ⅰ-1層が 1×10^{-4} cm/s、Ⅰ-2'層が 3×10^{-4} cm/s、Ⅰ-2層が 5×10^{-4} cm/s（最大透水係数 1.2×10^{-3} cm/s）、Ⅱ-2層が 1.5×10^{-4} cm/sであり、Ⅱ-3層はⅠ-2層と同程度と思われる。Ⅰ-1とⅡ-1層がやや難透水性であるため、池からの漏水は少ないと考えられる。しかし、これらの層が欠如している沢部からの浸透流について、漏水量およびパイピング（限界動水勾配等に対する安全性）の観点から検討する必要がある。

難透水性基盤；　Ⅲ-1およびⅢ-2層が自由帯水層の難透水性基盤を形成する。平均透水係数は 1×10^{-4} cm/s程度である。

第2帯水層；　Ⅲ-3層で平均透水係数は 2×10^{-4} cm/sである。透水性が特に大きいというわけではないことと、この層までの深度が十分にあることから、漏水について考慮する必要性はほぼないと考えられる。

地下水位；　豊水位しか得られていないが、地表下4m以浅に分布する。沢では地下水位と河川水位が連続する。沢部は難透水性のⅠ-1層（砂質シルト層）が欠如していることから、漏水に対する検討

が必要と思われる。

なお、T-3, T-4 および T-9 の地下水位は周辺より低い。ボーリング孔が第 2 帯水層まで掘削されているため、もしも第 2 帯水層の地下水位が自由帯水層の地下水位より低いとすれば、第 2 帯水層の地下水位を示している可能性もある。

2.2.4 室内試験

堤体盛土材としての利用可能性を調べるため、7 ヵ所のテストピット（TP1～TP7）からピット別に採取した試料の透水係数は、最大乾燥密度の 95% の場合で $2.99 \times 10^{-7} \sim 6.30 \times 10^{-6}$ cm/s であった。また、同試料の剪断強度は0.78～1.63 kg/cm^2、剪断抵抗角は 13.5° ～28.5° であった。なお、ボーリング孔 T1～T8 とテストピットから採取した試料の真比重は、2.66～2.71 g/cm^3 であった。

これらの室内試験結果から、Ⅰ - 1 およびⅠ -2' 層は溜池の堤体材として利用可能であることが判明した。

3. 浸透流解析

3.1 解析方法

貯水池周辺の地下水分布および浸透による漏水問題を検討する浸透流解析には、鉛直二次元モデル、平面二次元モデルおよび三次元モデルがある。最も一般的な解析法は鉛直二次元モデルを使う方法であり、平面二次元モデルは、ダムアバットメントの地山内からの迂回流が懸念される場合などに、三次元モデルは、局所的な浸透流問題が懸念される場合に適用される。

ティカール溜池は、貯水池面積が約 52 ha、最大水深 約 9 mであることから、大部分の漏水は貯水池の周辺部（堤体近傍）で発生すると予測される。従って、最も一般的である鉛直二次元モデルを使って貯水池の周辺部を対象に解析し、全体の漏水量は周長を乗ずることにより算定できると考えられる。このため、解析断面は、動水勾配が最も大きくかつ透水性が高いと考えられる東西断面およびそれに直交する南北断面の 2 断面とした。

浸透流解析には、解析対象領域が飽和のみであるか、不飽和領域をも含むかによって、次の 2 種類の有限要素法がある。

・飽和解析法　　飽和領域を解析対象とし、地下水の変化に応じて解析領域を変形させる方法。

・飽和・不飽和解析法　飽和および不飽和領域双方を含む領域を解析領域とし、負のポテンシャルを解とする不飽和領域と、正のポテンシャルを解とする不飽和領域の双方を同時に求める解析法。

求める地下水面が複雑な場合、前者では限界があり、この点を克服でき、また不飽和領域の浸透を解析する方法として、後者が開発された経緯がある。従って、ティカール溜池の浸透流解析には、飽和・不飽和解析法を用いた。

3.2　推定漏水量

東西と南北の２断面の境界条件をそれぞれ図3.1のように設定し、各層の透水係数をボーリング調査の結果から設定して行なった計算結果は、下表-1および２の通りである。

表-1　東西断面の漏水量

境界地下水位 標高 (m)		各層の透水係数×10-4 (cm/sec)									漏水量 <単位周長(m)当たり> (m3/day)		
h1	h2	k1	k2	k3	k4	k5	k6	k7	k8	k9	東側	西側	計
127.0	125.0	1.5	13.0	5.0	3.9	0.88	0.57	3.4	1.2	0.5	0.267	0.317	0.584

表-2　南北断面の漏水量

境界地下水位 標高 (m)	各層の透水係数×10-4 (cm/sec)						漏水量 <単位周長(m)当たり> (m3/day)		
h0	k3	k4	k5	k6	k8	k9	北側	南側	計
133.0	5.0	3.9	0.88	0.57	1.2	0.5	0.0	0.238	0.238

表-1, 2の東西および南側の単位周長（m）当たり漏水量から、それぞれの周長（境界地下水位の変化も考慮した換算長）を乗じた全体の漏水量は、日当たり 770 m^3 となる。この日当たり漏水量を池底面積で割った日当たり漏水量の水深換算は、1.5 mm／日となる。

なお、漏水対策工の一つとして、現地盤を砕土し、転圧することで得られる透水係数が 5.0×10^{-5} cm/sec で厚さ１m のブランケットを検討した。堤体から池の中央に向かっ

て 50 m, 100 m, 150 m、および貯水池の底全面に設置した場合の漏水量について図 3.1 と表-1および-2 と同じ条件で漏水量を求めたところ、何れの場合も減少量は 3 % 台と極めて少なく、上記の仕様によるブランケットの有効性は認められなかった。

4. 結論

今回の追加地質／土質調査結果を使って行った浸透流解析で算定されたティカール溜池（有効貯水量 207 万トン、水面積 52 ha、堤長 2,100 m）からの平均漏水量は、1.5 mm／日であり、次に示した日本における溜池の整備・改修不要基準値をほぼ満足している。（括弧内はティカール池の算定値）

1) 1 日の漏水量が総貯水量の 0.05% 以下 (0.04 %)
2) 堤長 100 m あたりの漏水量が 1.0 l/s 以下 (0.4 l/s)
3) 漏水量が溜池への流入量の 1.0 % 以下 (1.4 %)

従って、ティカール溜池に対する特別な漏水対策は不要である。

ドラフト・ファイナル・レポートにおけるティカール溜池の推定漏水量 3 mm／日は、上記の算定漏水量 1.5 mm／日の2倍であるが、地層境界線、浸透流解析モデルの境界条件（不透水層の位置、地下水位、漏水出口までの距離等）、溜池の南北縦断面と東西横断面との 2 断面による浸透流解析等の不確定要因を考慮すれば、技術的に妥当な値である。

従って、ドラフト・ファイナル・レポートにおいて、漏水量を 3 mm／日に設定した溜池の水収支計算を基に策定した、ティカール溜池を主とした 5 ヵ所の溜池による 1,800 ha の灌漑計画は技術的に妥当である。

以 上

表 2.1　地 質 層 序 表

地質時代		地層名記号	構成物	層厚 m	透水係数 (cm/s) [ ]内は平均値*		水理地質	N値（回） [ ]内は平均値**	備考
第四紀	完新世	Aℓ	表土	0～1	——		—	—	
	更新世	Ⅰ－1	砂質シルト 粘土質シルト	0～4	8.7×10^{-5}～ 1.2×10^{-4} [1.0×10^{-4}]		自由帯水層 (やや難透水性)	11～25 [16]	バタルコット扇状地の中位段丘堆積層に相当。 ティカール池予定地点右岸及び中心部に分布。
		Ⅰ－2'	シルト混り砂 礫混りシルト質砂	0～2	$2.7\sim3.4\times10^{-4}$ [3.0×10^{-4}]		自由帯水層	8～42 [22]	
		Ⅰ－2	砂礫，礫混りシルト質砂，シルト混り砂（一部，粘土質シルト）	0～3.5+	1.7×10^{-4}～ 1.2×10^{-3} [5.0×10^{-4}]		自由帯水層 (主部)	15～50/20 [39]	
		Ⅱ－1	砂質シルト	0～2	——		—	—	バタルコット扇状地の古期扇状地堆積層に相当するか，またはそれよりもやや古い。 ティカール池予定地点右岸の丘陵部に分布。
		Ⅱ－2	シルト混り砂	0～2	1.5×10^{-4}		自由帯水層	15	
		Ⅱ－2'	砂礫（Q－3，Q－11にのみ分布）	—	——		自由帯水層	—	
		Ⅱ－3	砂礫	0～2	——		自由帯水層 (主部)	38	
		Ⅲ－1	シルト質粘土，粘土質シルト，シルト混り砂	1～3+	$1.1\sim3.9\times10^{-4}$ [2.1×10^{-4}]	[1.2×10^{-4}]	自由帯水層の難透水性基盤	13～32 [22]	ティカール池予定地点に広域的に分布するものと推定。
		Ⅲ－2	砂質シルト シルト混り粘土	1～4	$4.9\sim8.8\times10^{-5}$ [6.5×10^{-4}]			10～15 [12]	
		Ⅲ－3	礫混りシルト質砂 シルト質砂 砂質シルト	—	5.9×10^{-5}～ 5.7×10^{-4} [2.0×10^{-4}]		第 2 帯水層	11～24 [16]	

(注) * 相乗平均　　** 相加平均

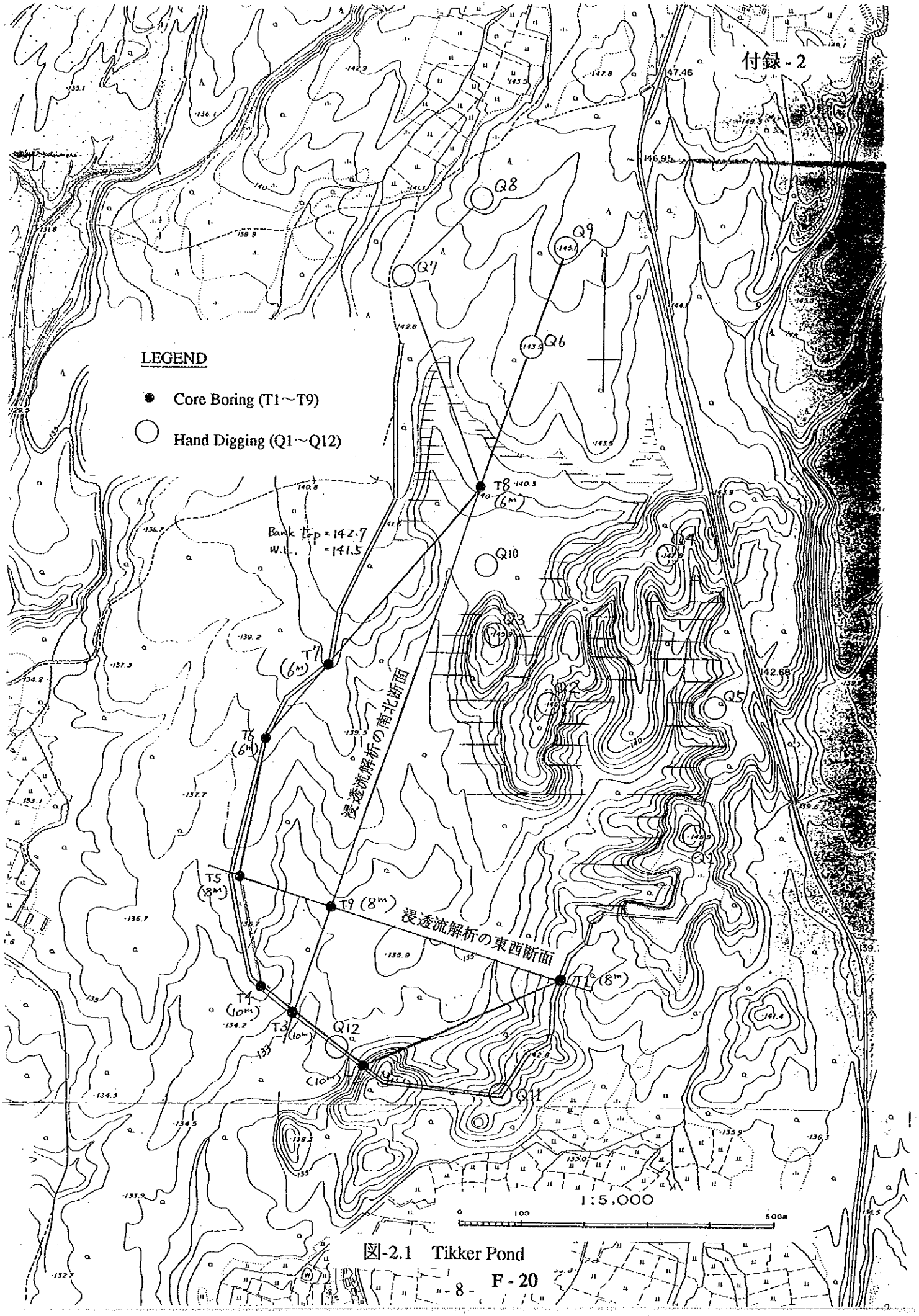
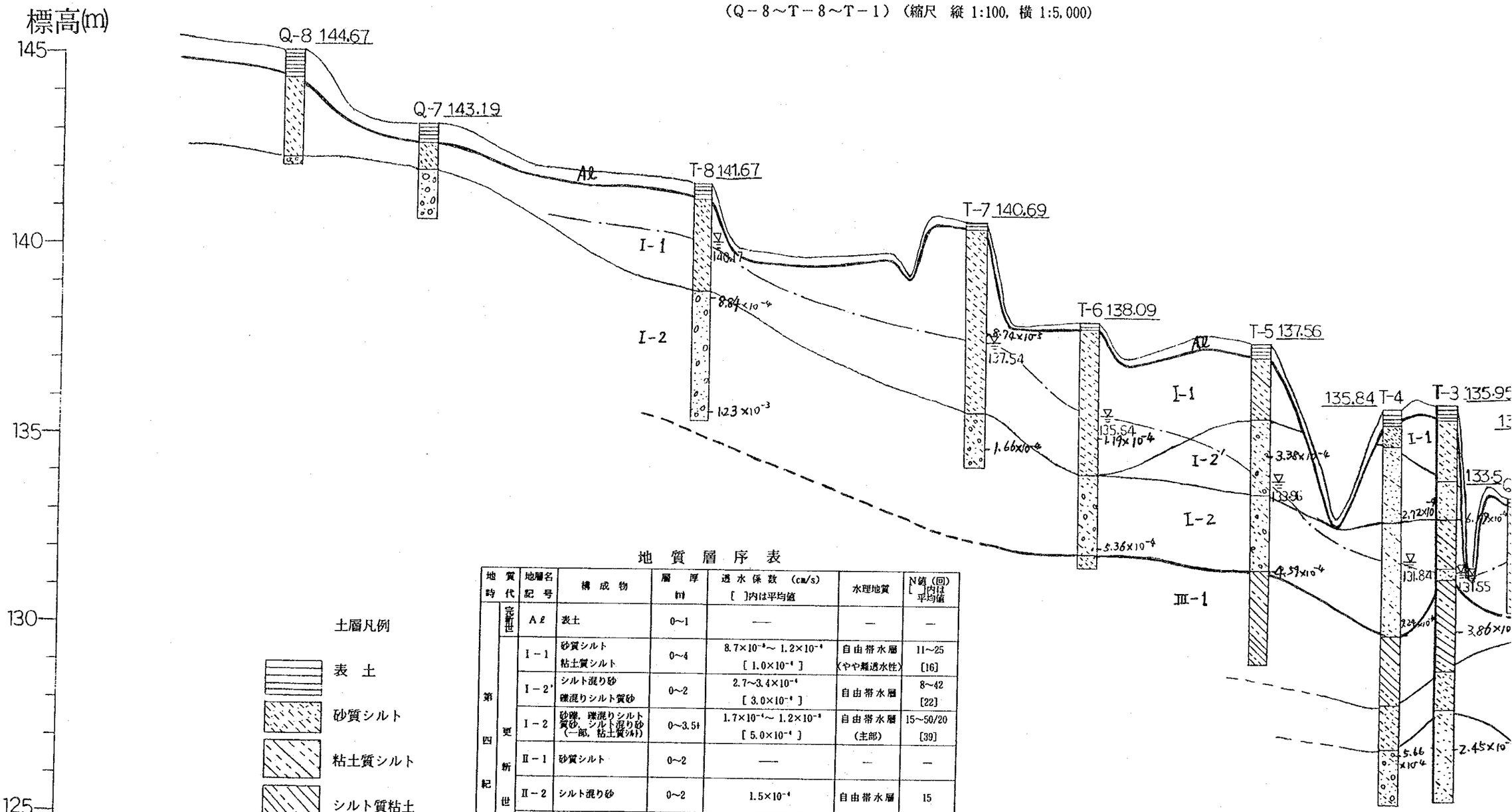


図-2.1 Tikker Pond

図 2.2.　　ティカール池予定地点地質断面図

（Q－8～T－8～T－1）（縮尺　縦 1:100，横 1:5,000）



土層凡例

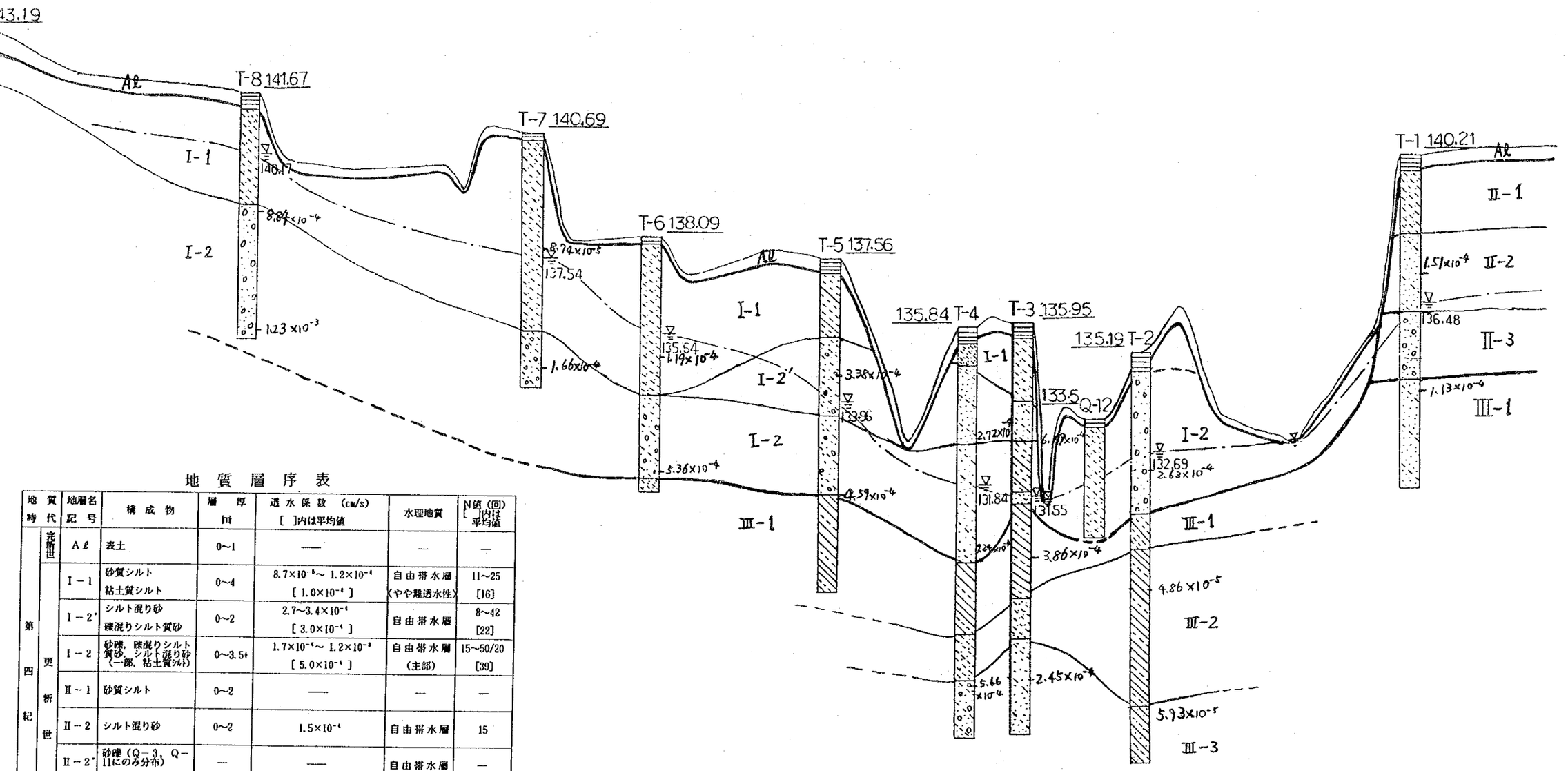
- 表　土
- 砂質シルト
- 粘土質シルト
- シルト質粘土
- シルト混り砂
- 礫混りシルト質砂
- 砂　礫

地　質　層　序　表

地質時代		地層名記号	構成物	層厚 m	透水係数 (cm/s) [ ]内は平均値		水理地質	N値（回）[ ]内は平均値
第四紀	完新世	Al	表土	0～1	——		—	—
	更新世	I－1	砂質シルト 粘土質シルト	0～4	8.7×10^{-5}～1.2×10^{-4} [1.0×10^{-4}]		自由帯水層 (やや難透水性)	11～25 [16]
		I－2'	シルト混り砂 礫混りシルト質砂	0～2	2.7～3.4×10^{-4} [3.0×10^{-4}]		自由帯水層	8～42 [22]
		I－2	砂礫，礫混りシルト質砂，シルト混り砂（一部，粘土質シルト）	0～3.5+	1.7×10^{-4}～1.2×10^{-3} [5.0×10^{-4}]		自由帯水層 (主部)	15～50/20 [39]
		II－1	砂質シルト	0～2	——		—	—
		II－2	シルト混り砂	0～2	1.5×10^{-4}		自由帯水層	15
		II－2'	砂礫（Q－3，Q－11にのみ分布）	—	——		自由帯水層	—
		II－3	砂礫	0～2	——		自由帯水層 (主部)	38
		III－1	シルト質粘土，粘土質シルト，シルト混り砂	1～3+	1.1～3.9×10^{-4} [2.1×10^{-4}]	[1.2×10^{-4}]	自由帯水層の難透水性基盤	13～32 [22]
		III－2	砂質シルト シルト混り粘土	1～4	4.9～8.8×10^{-5} [6.5×10^{-4}]			10～15 [12]
		III－3	礫混りシルト質砂 シルト質砂 砂質シルト	—	5.9×10^{-5}～5.7×10^{-4} [2.0×10^{-4}]		第2帯水層	11～24 [16]

図 2.2.　ティカール池予定地点地質断面図

（Q－8～T－8～T－1）（縮尺　縦 1:100, 横 1:5,000）

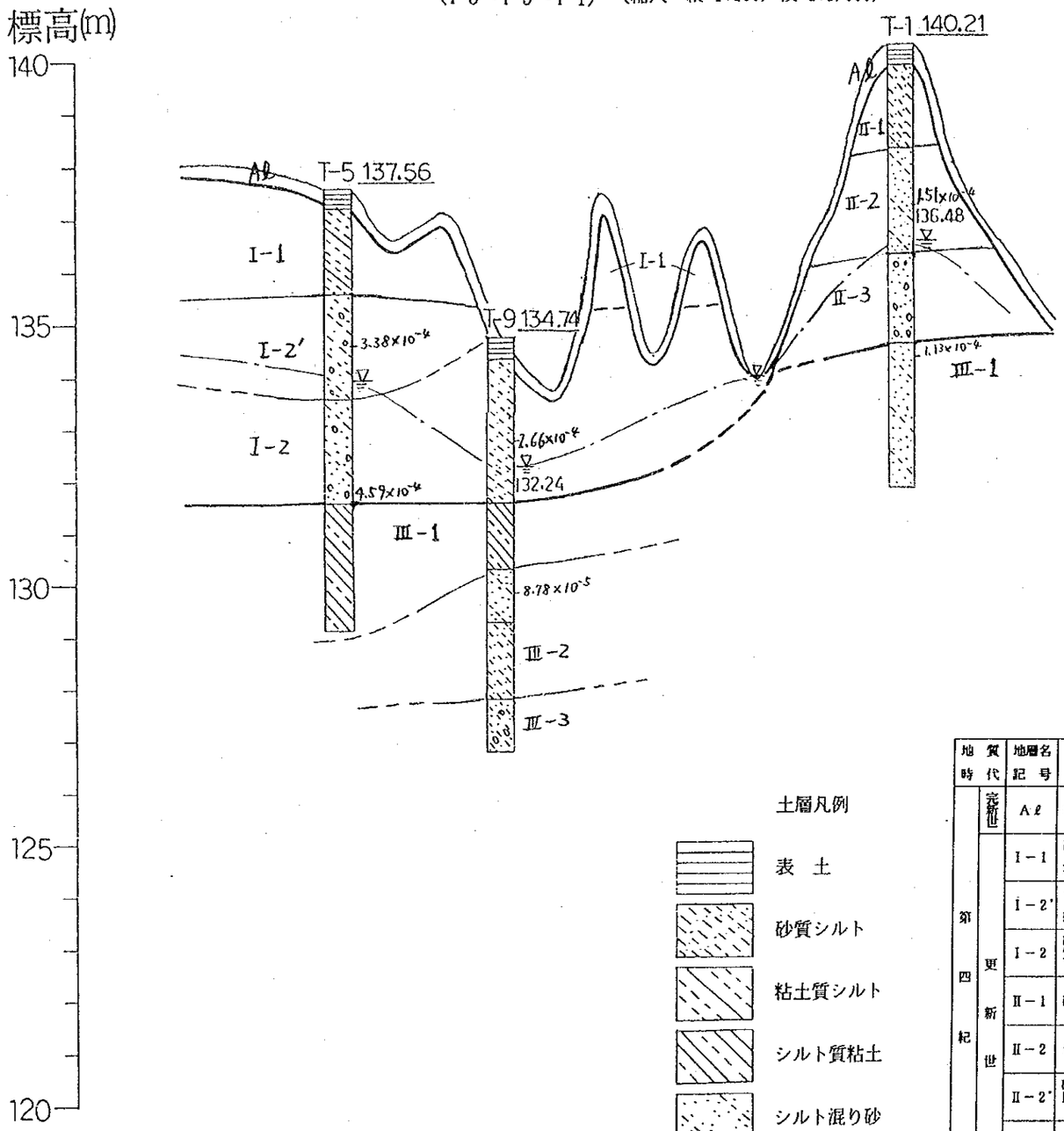


地　質　層　序　表

地質時代		地層名記号	構成物	層厚 m	透水係数 (cm/s) [ ]内は平均値		水理地質	N値 (回) [ ]内は平均値
第四紀	完新世	Aℓ	表土	0～1	——		—	—
	更新世	Ⅰ－1	砂質シルト 粘土質シルト	0～4	8.7×10^{-5}～1.2×10^{-4} [1.0×10^{-4}]		自由帯水層 (やや難透水性)	11～25 [16]
		Ⅰ－2'	シルト混り砂 礫混りシルト質砂	0～2	2.7～3.4×10^{-4} [3.0×10^{-4}]		自由帯水層	8～42 [22]
		Ⅰ－2	砂礫，礫混りシルト質砂，シルト混り砂（一部，粘土質シルト）	0～3.5+	1.7×10^{-4}～1.2×10^{-3} [5.0×10^{-4}]		自由帯水層 (主部)	15～50/20 [39]
		Ⅱ－1	砂質シルト	0～2	——		—	—
		Ⅱ－2	シルト混り砂	0～2	1.5×10^{-4}		自由帯水層	15
		Ⅱ－2'	砂礫（Q－3，Q－11にのみ分布）	—	——		自由帯水層	—
		Ⅱ－3	砂礫	0～2	——		自由帯水層 (主部)	38
		Ⅲ－1	シルト質粘土，粘土質シルト，シルト混り砂	1～3+	1.1～3.9×10^{-4} [2.1×10^{-4}]	[1.2×10^{-4}]	自由帯水層の難透水性基盤	13～32 [22]
		Ⅲ－2	砂質シルト シルト混り粘土	1～4	4.9～8.8×10^{-5} [6.5×10^{-4}]			10～15 [12]
		Ⅲ－3	礫混りシルト質砂 シルト質砂 砂質シルト	—	5.9×10^{-5}～5.7×10^{-4} [2.0×10^{-4}]		第2帯水層	11～24 [16]

図 2.3　ティカール池予定地点地質断面図

(T-5～T-9～T-1)　(縮尺　縦 1:100, 横 1:5,000)



土層凡例

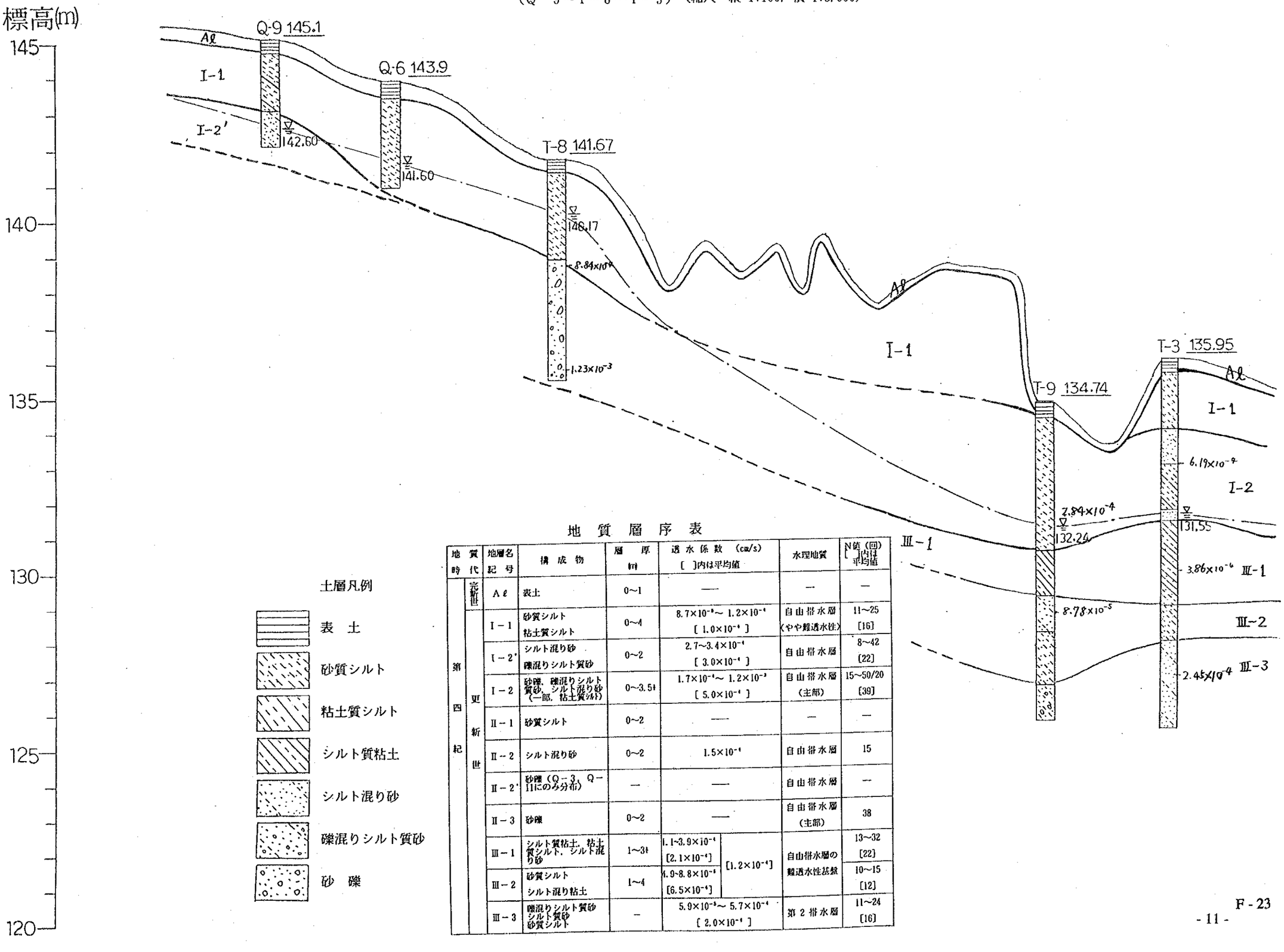
- 表　土
- 砂質シルト
- 粘土質シルト
- シルト質粘土
- シルト混り砂
- 礫混りシルト質砂
- 砂　礫

地　質　層　序　表

地質時代		地層名記号	構成物	層厚 (m)	透水係数 (cm/s) [ ]内は平均値		水理地質	N値 (回) [ ]内は平均値
第四紀	完新世	Aℓ	表土	0～1	——		—	—
	更新世	I－1	砂質シルト 粘土質シルト	0～4	8.7×10^{-5}～1.2×10^{-4} [1.0×10^{-4}]		自由帯水層 (やや難透水性)	11～25 [16]
		I－2'	シルト混り砂 礫混りシルト質砂	0～2	2.7～3.4×10^{-4} [3.0×10^{-4}]		自由帯水層	8～42 [22]
		I－2	砂礫，礫混りシルト質砂，シルト混り砂（一部，粘土質シルト）	0～3.5+	1.7×10^{-4}～1.2×10^{-3} [5.0×10^{-4}]		自由帯水層 (主部)	15～50/20 [39]
		II－1	砂質シルト	0～2	——		—	—
		II－2	シルト混り砂	0～2	1.5×10^{-4}		自由帯水層	15
		II－2'	砂礫（Q－3，Q－11にのみ分布）	—	——		自由帯水層	—
		II－3	砂礫	0～2	——		自由帯水層 (主部)	38
		III－1	シルト質粘土，粘土質シルト，シルト混り砂	1～3+	1.1～3.9×10^{-4} [2.1×10^{-4}]	[1.2×10^{-4}]	自由帯水層の難透水性基盤	13～32 [22]
		III－2	砂質シルト シルト混り粘土	1～4	4.9～8.8×10^{-5} [6.5×10^{-5}]			10～15 [12]
		III－3	礫混りシルト質砂 シルト質砂 砂質シルト	—	5.9×10^{-5}～5.7×10^{-4} [2.0×10^{-4}]		第2帯水層	11～24 [16]

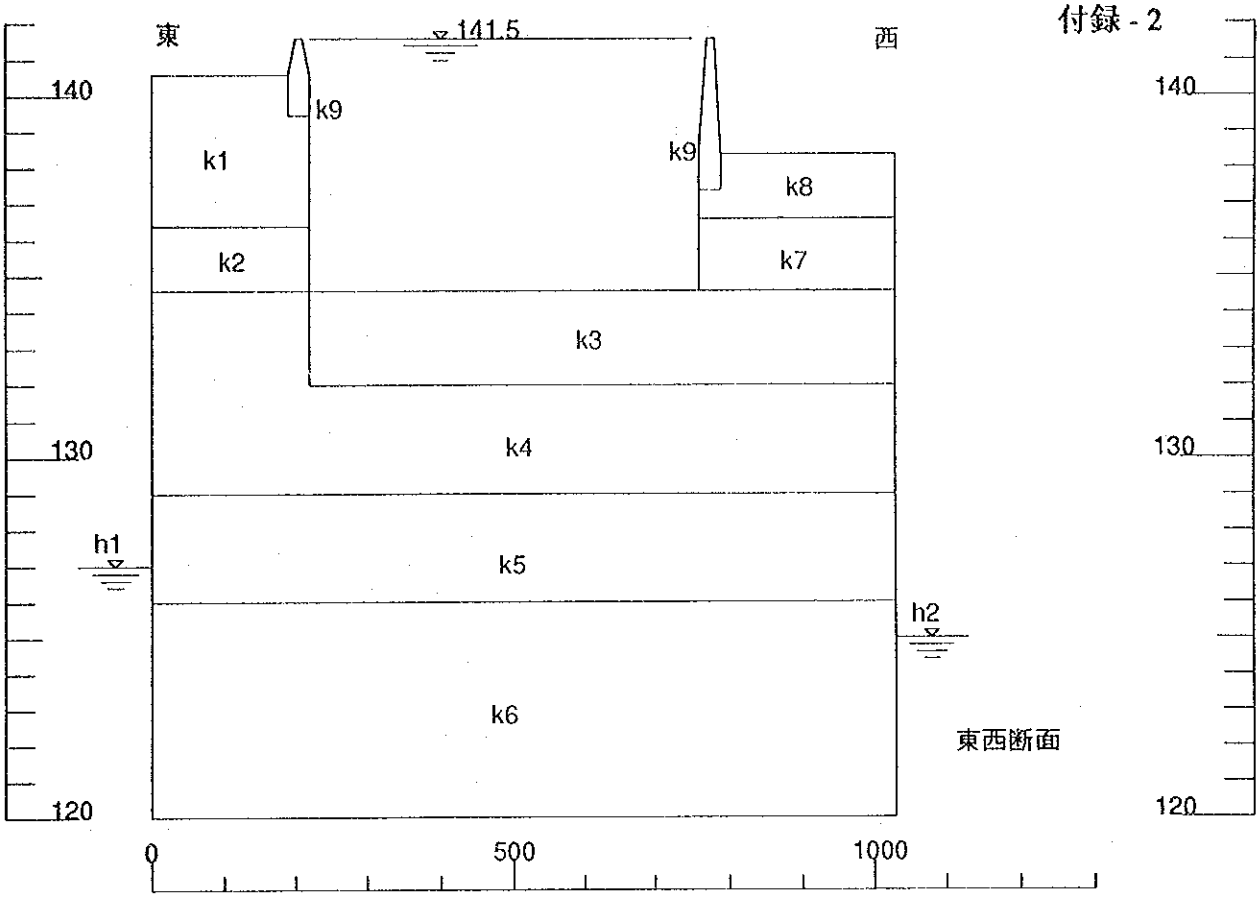
図 2.4　ティカール池予定地点地質断面図

（Q－9～T－8～T－3）（縮尺　縦 1:100，横 1:5,000）



地　質　層　序　表

地質時代		地層名記号	構成物	層厚 m	透水係数 (cm/s) [ ]内は平均値		水理地質	N値（回）[ ]内は平均値
第四紀	完新世	Al	表土	0～1	―		―	―
	更新世	I－1	砂質シルト 粘土質シルト	0～4	8.7×10^{-5}～1.2×10^{-4} [1.0×10^{-4}]		自由排水層 （やや難透水性）	11～25 [16]
		I－2'	シルト混り砂 礫混りシルト質砂	0～2	2.7～3.4×10^{-4} [3.0×10^{-4}]		自由排水層	8～42 [22]
		I－2	砂礫，礫混りシルト質砂，シルト混り砂（一部，粘土質シルト）	0～3.5+	1.7×10^{-4}～1.2×10^{-3} [5.0×10^{-4}]		自由排水層 （主部）	15～50/20 [39]
		Ⅱ－1	砂質シルト	0～2	―		―	―
		Ⅱ－2	シルト混り砂	0～2	1.5×10^{-4}		自由排水層	15
		Ⅱ－2'	砂礫（Q－3，Q－11にのみ分布）	―	―		自由排水層	―
		Ⅱ－3	砂礫	0～2	―		自由排水層 （主部）	38
		Ⅲ－1	シルト質粘土，粘土質シルト，シルト混り砂	1～3+	1.1～3.9×10^{-4} [2.1×10^{-4}]	[1.2×10^{-4}]	自由排水層の難透水性基盤	13～32 [22]
		Ⅲ－2	砂質シルト シルト混り粘土	1～4	4.9～8.8×10^{-4} [6.5×10^{-4}]			10～15 [12]
		Ⅲ－3	礫混りシルト質砂 シルト質砂 砂質シルト	―	5.9×10^{-5}～5.7×10^{-4} [2.0×10^{-4}]		第2帯水層	11～24 [16]


東
西
141.5
140
130
120
k1
k2
k3
k4
k5
k6
k7
k8
k9
h1
h2
0
500
1000
東西断面

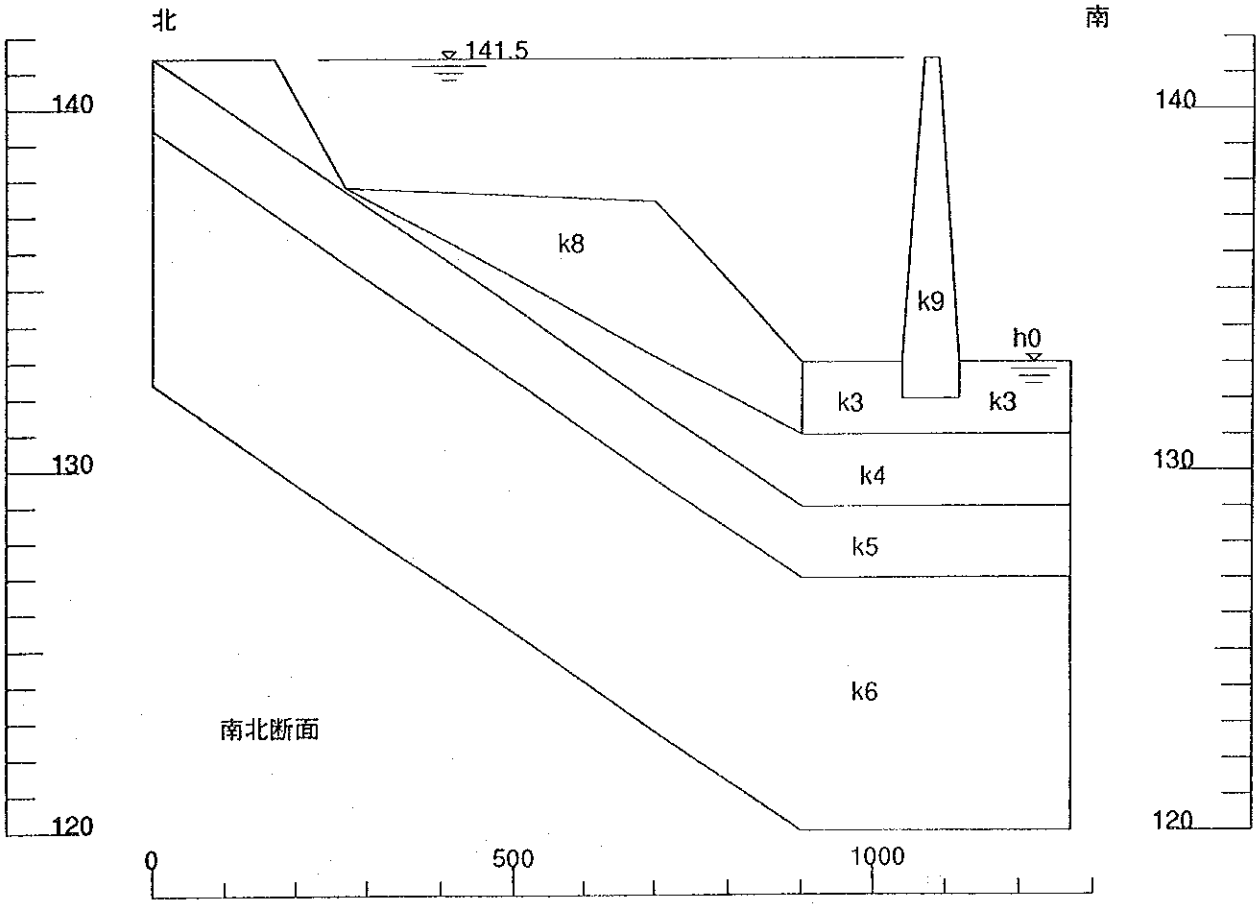

北
南
141.5
140
130
120
k3
k4
k5
k6
k8
k9
h0
0
500
1000
南北断面

図 3.1　解析モデル