

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF AGRICULTURE
ROYAL GOVERNMENT OF BHUTAN

**THE STUDY
ON
GROUNDWATER DEVELOPMENT
IN
WANGDUEPHODRANG DISTRICT**

**FINAL REPORT
VOLUME V: DATA BOOK**

March 1996

PACIFIC CONSULTANTS INTERNATIONAL
CHUO KAIHATSU CORPORATION

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VOLUME V: DATA BOOK**

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March 1996

PACIFIC CONSULTANTS INTERNATIONAL
CHUO KAIHATSU CORPORATION

In this report, project costs are estimated based on July 1995 prices with an exchange rate of
US\$1.00=Nu.30.85=J.Yen100.00

I. TOPOGRAPHIC DATA

THE STUDY
ON
GROUNDWATER DEVELOPMENT
IN
WANGDUEPHODRANG DISTRICT OF BHUTAN

FINAL REPORT

VOLUME V: DATA BOOK

TABLE OF CONTENTS

- I. TOPOGRAPHIC DATA
- II. METEO-HYDROLOGICAL DATA
- III. GEOPHYSICAL SURVEY DATA
- IV. MONITORING DATA
- V. DATA FOR IRRIGATION IMPROVEMENT PLAN
- VI. DATA FOR DOMESTIC WATER SUPPLY PLAN
- VII. DATA ON WATER QUALITY ANALYSES

| | |
|------------|-------------------|
| Volume I | Executive Summary |
| Volume II | Main Report |
| Volume III | Supporting Report |
| Volume IV | Drawings |
| Volume V | Data Book |

I. TOPOGRAPHIC DATA

List of Topographic Survey Drawings (1/2)

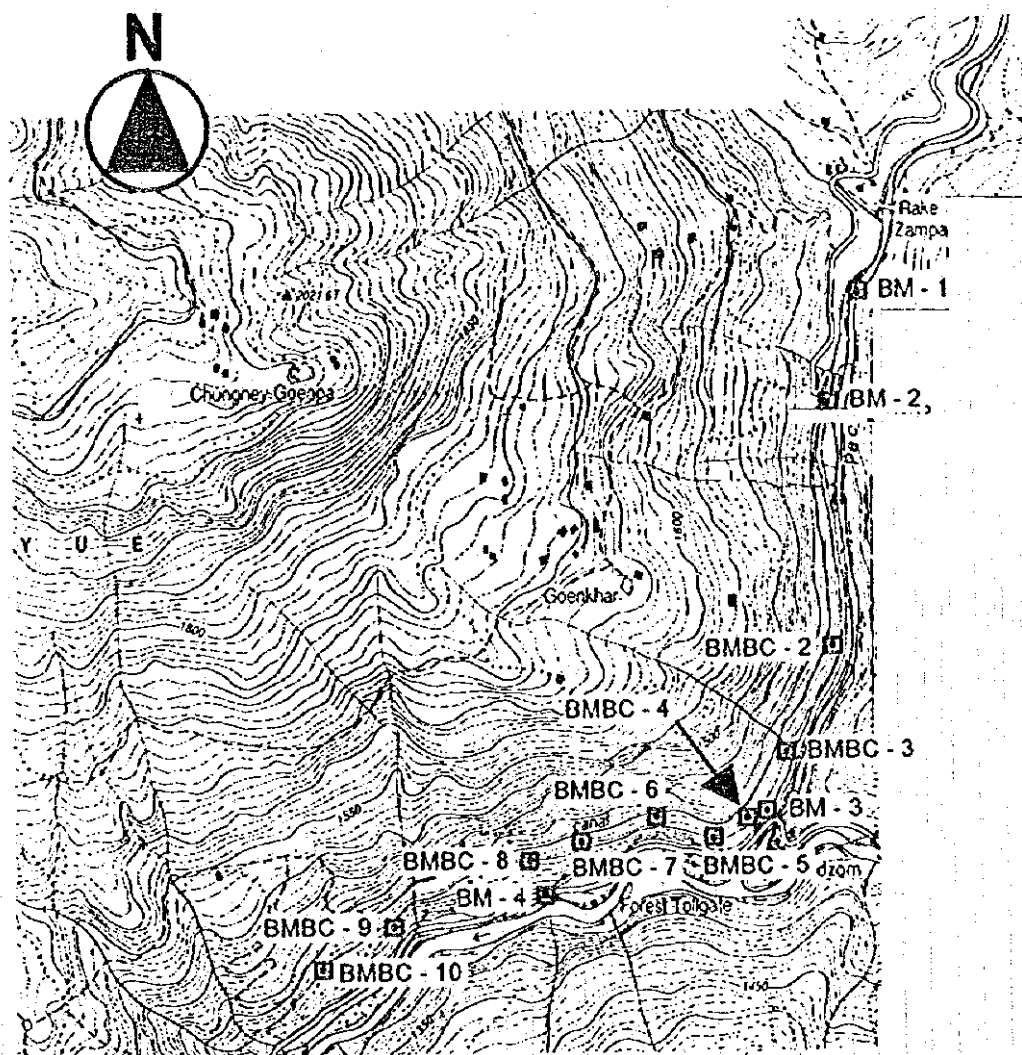
| <u>Titles of Drawings</u> | <u>No. of Drawings</u> |
|--|------------------------|
| 1. Location Map of Bench Marks | 1 sheet |
| 2. River Cross Section Survey | |
| (1) Stream Gauging Stations | |
| 1) Location Map | 1 sheets |
| 2) Cross Section SR 1 (Pe Chhu) | 3 sheets |
| Cross Section SR 2 (Dang Chhu) | 1 sheet |
| 3) Cross Section SR 3 (Dang Chhu) | 3 sheets |
| 4) Cross Section SR 4 (Limti Chhu) | 3 sheets |
| 5) Cross Section SR 5 (Tabe Rongchhu) | 3 sheets |
| 6) Cross Section SR 6 (Tabe Rongchhu) | 3 sheets |
| (2) Chang Chhu | |
| 1) Location Map of River Cross-sections | 1 sheet |
| 2) River Cross sections (Chang Chhu) | 5 sheets |
| 3. Topographic Survey for Experimental Facilities | |
| (1) Groundwater Scheme | |
| 1) Plan for General Layout (1:1,000) | 1 sheet |
| 2) Plan for Solar System Layout (1:200) | 1 sheet |
| 3) Longitudinal Profiles of Pipeline | 4 sheets |
| (2) Spring Water Scheme | |
| 1) General Plan of the site | 1 sheet |
| 2) Plan of the Proposed Command Area (1:500) | 2 sheets |
| (3) Sub-surface Water Scheme | |
| 1) Plan of the Proposed Well Site (1:500) and Longitudinal Profile of Delivery Pipeline | 1 sheet |
| (4) River Water Scheme | |
| 1) Plan of Pumping Station Site (1:500) | 1 sheet |
| 2) Cross-section of River Bank | 11 sheets |
| 3) Depth of the Chang Chhu in front of the Site | 1 sheet |
| 4) Cross section of the Chang Chhu | 2 sheets |

List of Topographic Survey Drawings (2/2)

| <u>Titles of Drawings</u> | <u>No. of Drawings</u> |
|---|------------------------|
| 5) Plan of the Route for Delivery Pipeline (1:500) and Longitudinal Profile of the Delivery Pipeline Route | 1 sheet |
| 4. Irrigation Canals | |
| (1) Location Map of the Irrigation Canals Surveyed (1:25,000) ... | 1 sheet |
| (2) Plan of the Existing Irrigation Canals (1:1,000) | 19 sheets |
| (3) Longitudinal Profile of the Existing Irrigation Canals | 1 sheet |
| 5. Urban Water Supply System in Wangduephodrang Town | |
| (1) Existing Conveyance Pipeline and Canal | |
| 1) Index Map for Plans | 2 sheets |
| 2) Plan of Conveyance Pipeline and Canal Route (1:1,000) ... | 6 sheets |
| 3) Longitudinal Profile of Water Supply in Wangduephodrang .. | 1 sheet |
| 4) Cross-sections of Conveyance Pipeline and Canal Routes ... | 3 sheets |
| (2) Distribution Pipelines | |
| 1) Guide Map for Plan | 1 sheet |
| 2) Plan of the Water Supply Service Area (1:1,000) | 7 sheets |
| 3) Routes of the Existing Distribution Pipelines (1:1,000) ... | 7 sheets |
| 4) Longitudinal Profiles of the Major Distribution Pipelines ... | 7 sheets |
| (3) Water Distribution Station | |
| 1) Existing Distribution Station (Plan) | 1 sheet |

LOCATION MAP OF BENCH MARKS

RECEIVED 10/10/1964



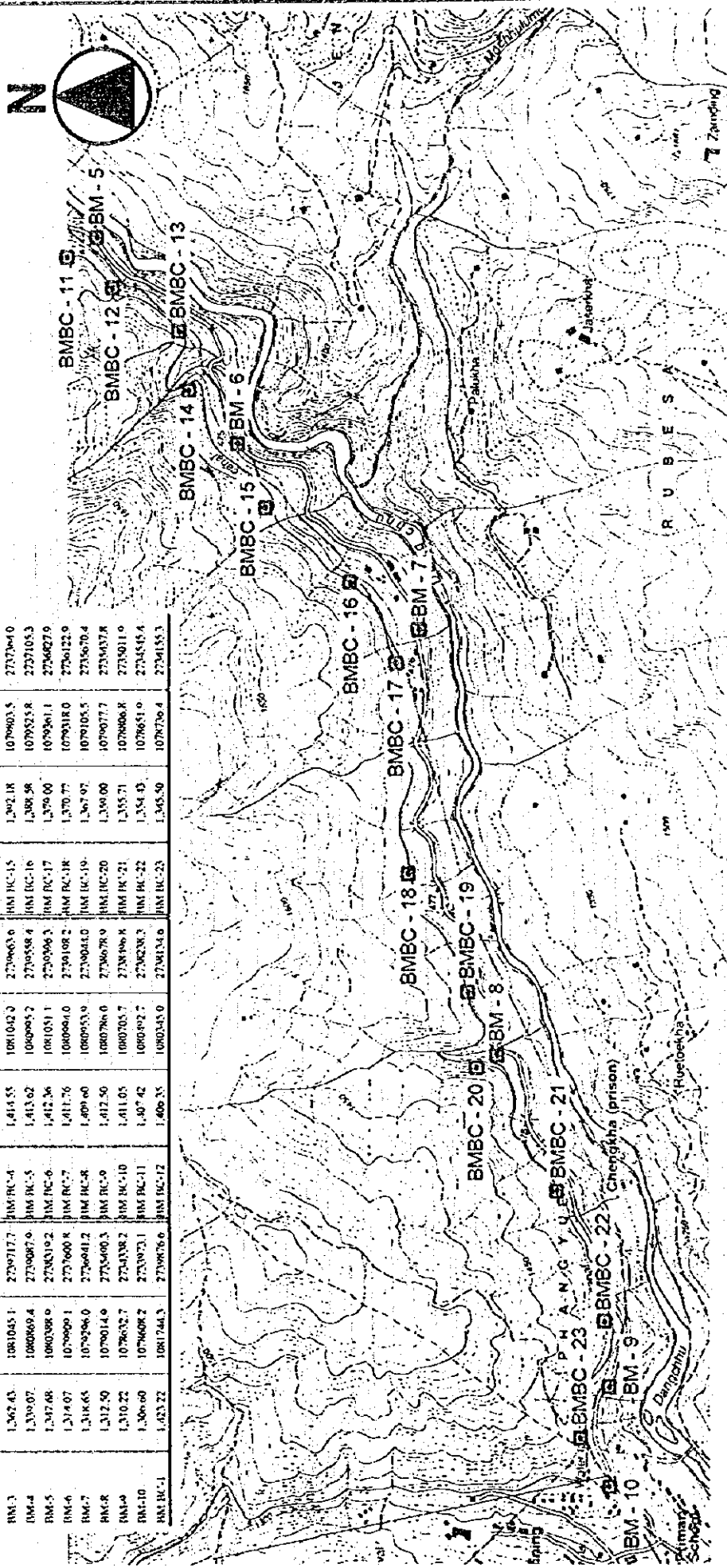
List of Established Bench Marks

| Name of BM | Elevation (m) | Longitude | Latitude | Name of BM | Elevation (m) | Longitude | Latitude | Name of BM | Elevation (m) | Longitude | Latitude |
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| BM-2 | 1,416.78 | 1082012.0 | 2739881.8 | BMBC-2 | 1,416.48 | 1081208.6 | 2739765.4 | BMBC-14 | 1,394.27 | 1080082.9 | 2737792.1 |
| BM-3 | 1,362.43 | 1081045.1 | 2739717.7 | BMBC-3 | 1,414.55 | 1081042.0 | 2739663.6 | BMBC-15 | 1,392.18 | 1079803.5 | 2737364.0 |
| BM-4 | 1,339.07 | 1080869.4 | 2739087.9 | BMBC-4 | 1,413.62 | 1080995.2 | 2739558.4 | BMBC-16 | 1,388.58 | 1079542.8 | 2737105.3 |
| BM-5 | 1,347.68 | 1080388.9 | 2738319.2 | BMBC-5 | 1,412.36 | 1081051.1 | 2739396.3 | BMBC-17 | 1,379.00 | 1079301.1 | 2736827.9 |
| BM-6 | 1,314.07 | 1079909.1 | 2737600.8 | BMBC-6 | 1,411.76 | 1080994.0 | 2739198.2 | BMBC-18 | 1,370.77 | 1079318.0 | 2736122.9 |
| BM-7 | 1,318.65 | 1079296.0 | 2736941.2 | BMBC-7 | 1,409.60 | 1080953.9 | 2739044.0 | BMBC-19 | 1,367.97 | 1079105.5 | 2735670.4 |
| BM-8 | 1,312.56 | 1079014.9 | 2735490.3 | BMBC-8 | 1,412.50 | 1080786.0 | 2738678.9 | BMBC-20 | 1,359.00 | 1079077.7 | 2735437.8 |
| BM-9 | 1,310.22 | 1078632.7 | 2734338.2 | BMBC-9 | 1,411.05 | 1080705.7 | 2738456.8 | BMBC-21 | 1,355.71 | 1078896.8 | 2735011.9 |
| BM-10 | 1,306.60 | 1078608.2 | 2733973.1 | BMBC-10 | 1,407.42 | 1080492.7 | 2738238.3 | BMBC-22 | 1,354.43 | 1078651.9 | 2734545.4 |
| BMBC-1 | 1,423.22 | 1081744.3 | 2739876.6 | BMBC-11 | 1,406.35 | 1080345.0 | 2738134.6 | BMBC-23 | 1,345.50 | 1078736.4 | 2734155.3 |

LOCATION OF BENCH MARKS (1/2)

List of Established Bench Marks

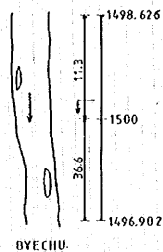
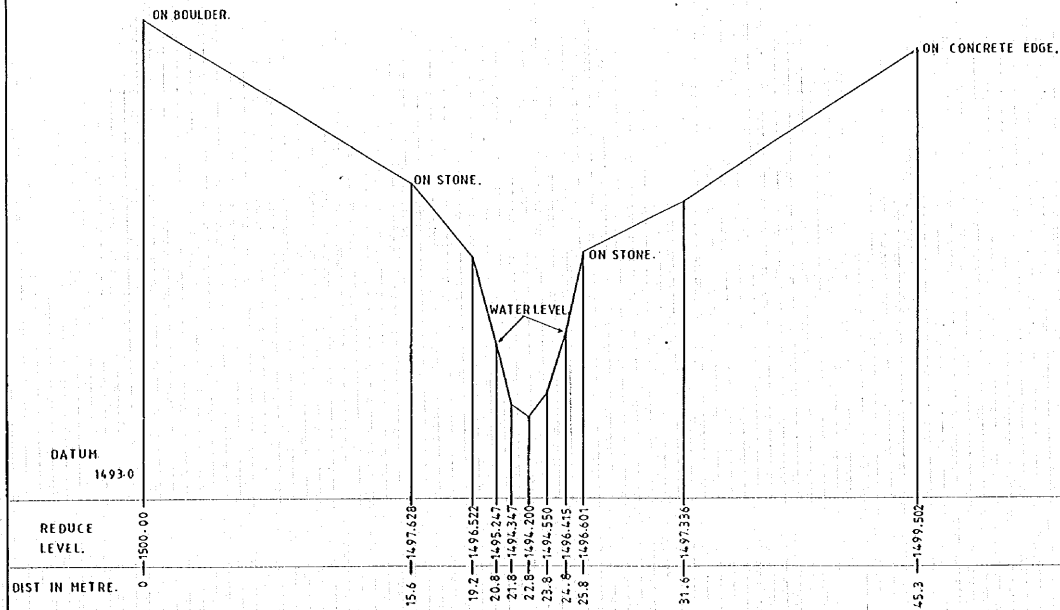
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LOCATION OF BENCH MARKS (2/2)

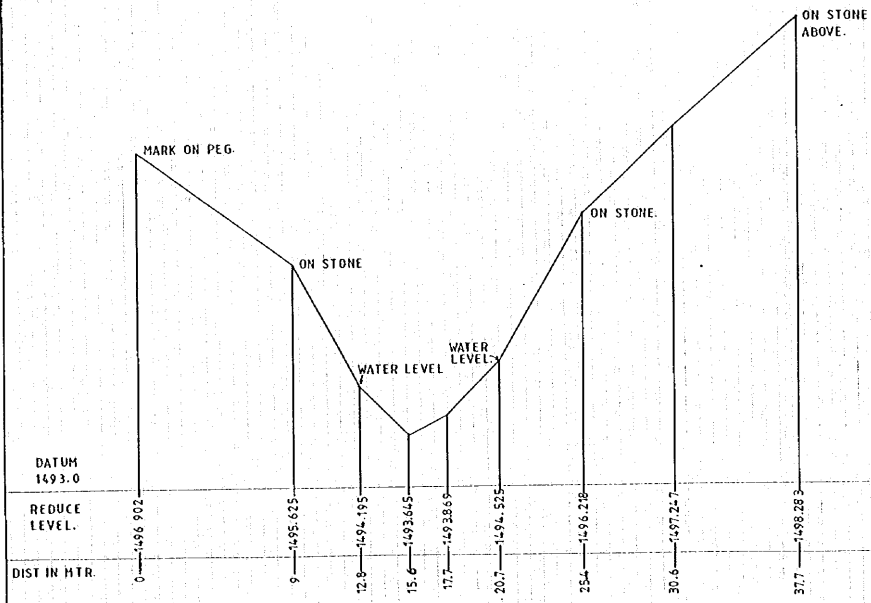
RIVER CROSS SECTION SURVEY

X-SEC OF SR1 MIDDLE SIDE.



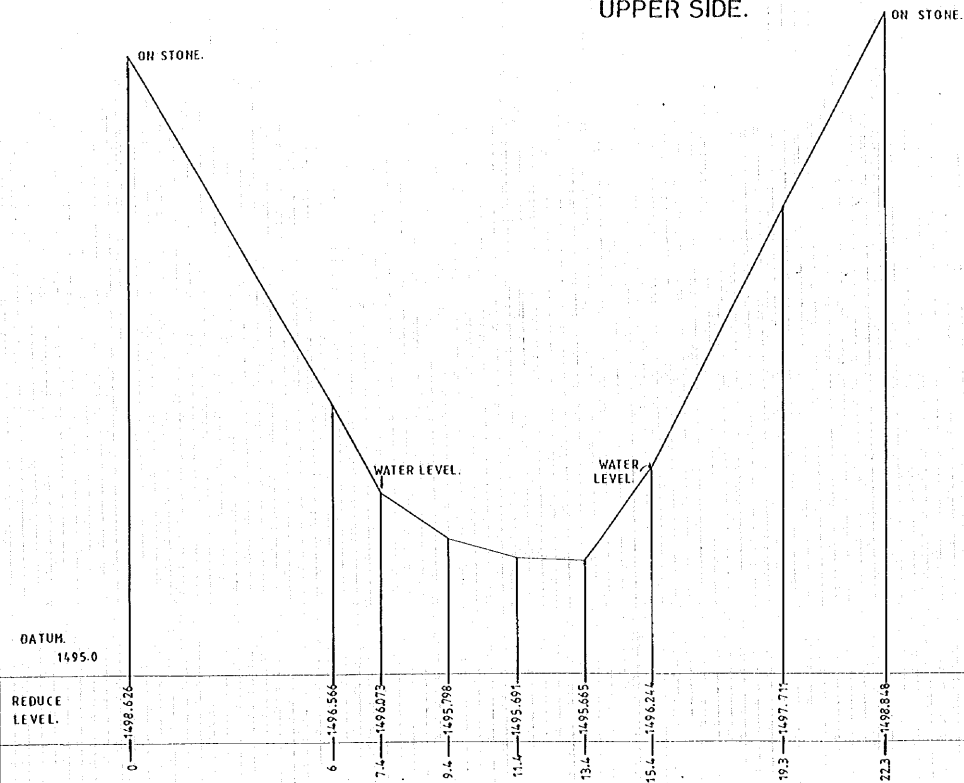
SCALE. V-1:50
H-1:200

X-SEC OF SRI LOWER.



SCALE. V - 1:40
H - 1:200

X-SEC OF SR1 UPPER SIDE.

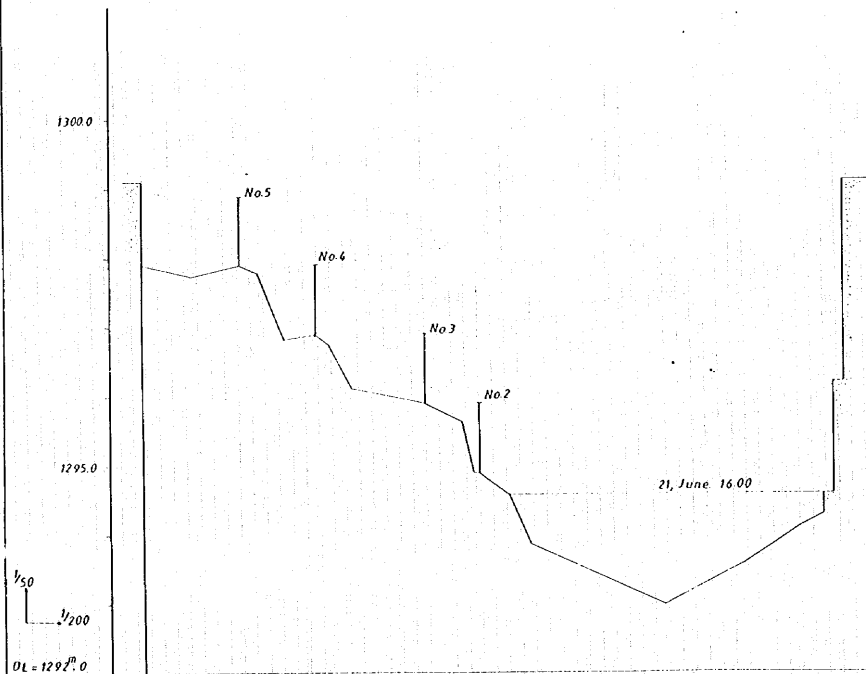


DATUM.
1495.0

REDUCE
LEVEL.

SCALE. V-1:20
H-1:100

X-SEC OF SR2.



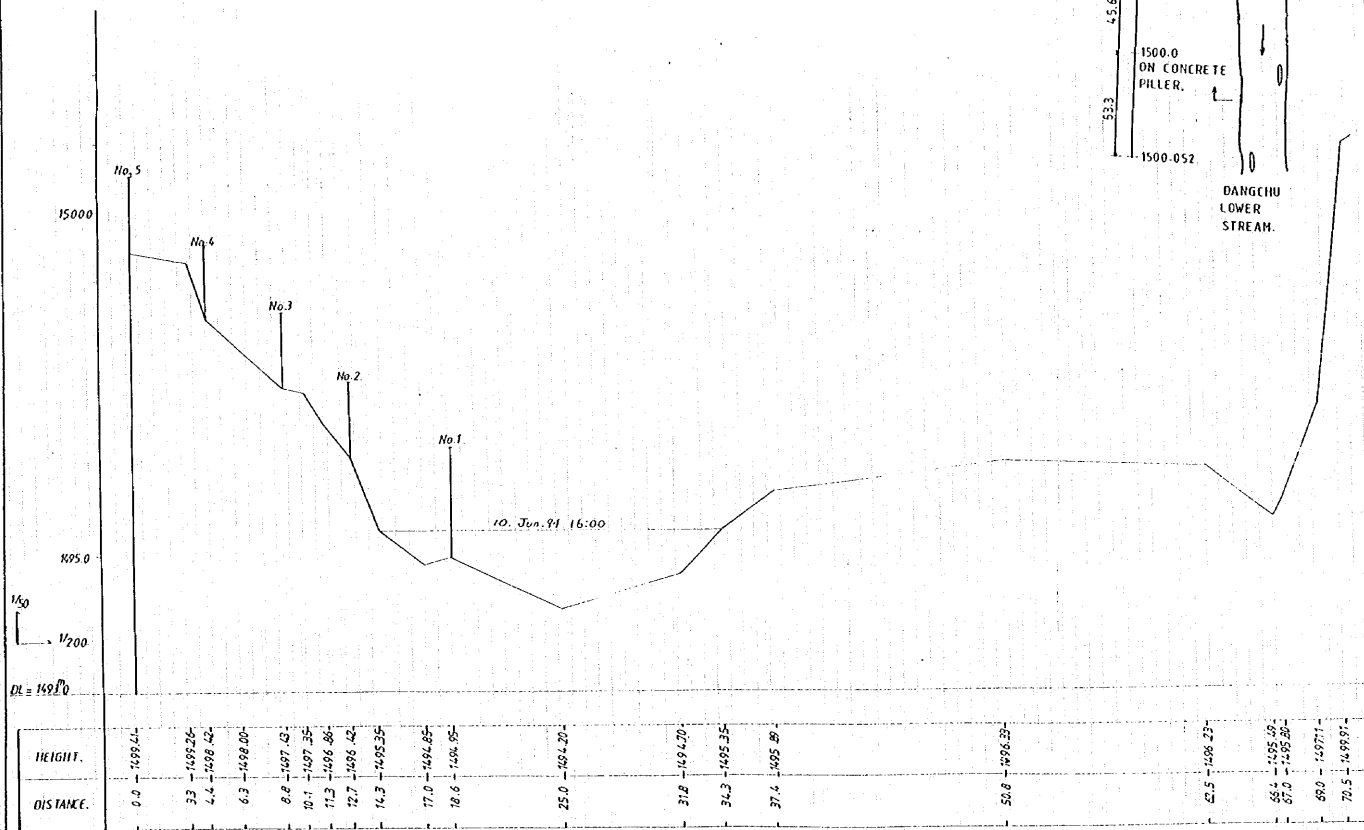
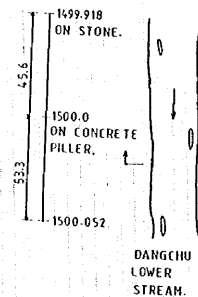
0L = 12927.0

HEIGHT

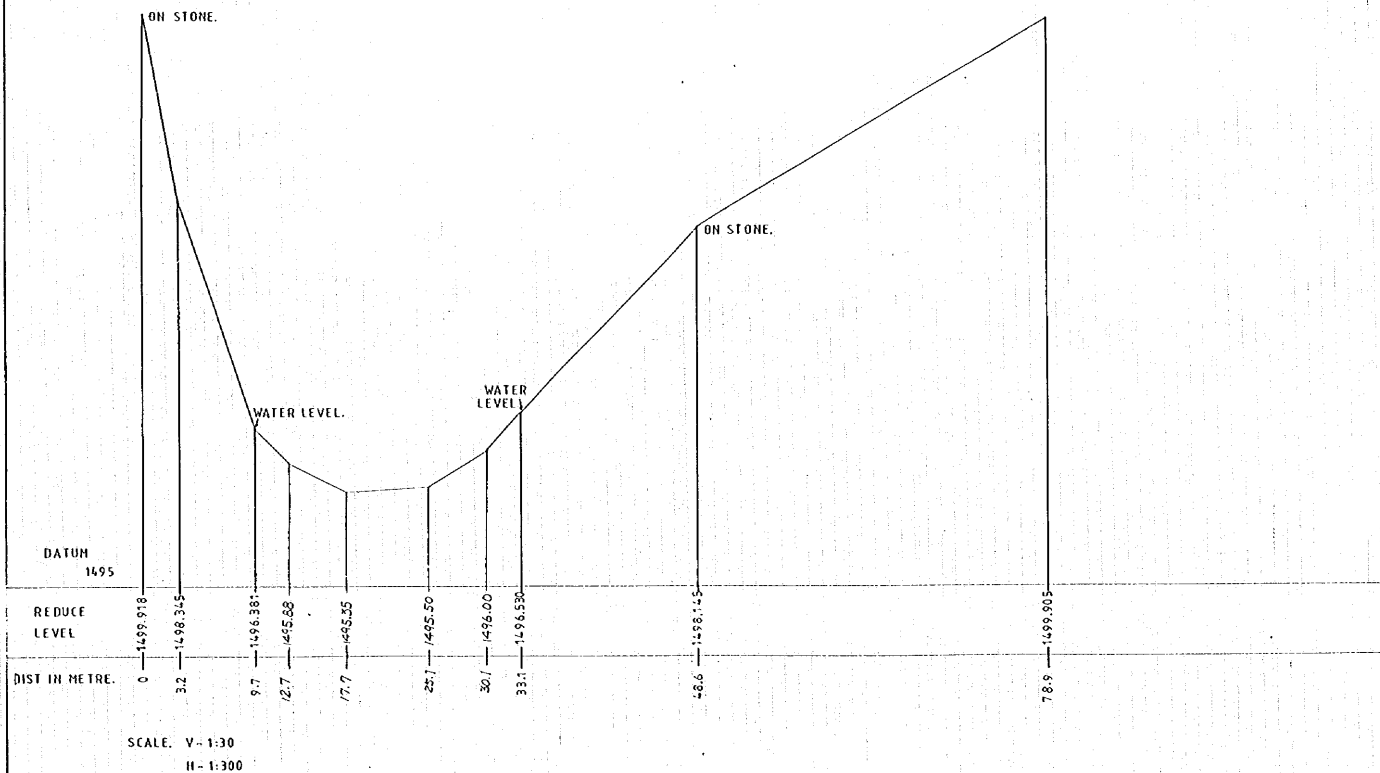
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| 6.7 | 1297.79 |
| 8.2 | 1296.82 |
| 10.0 | 1296.91 |
| 10.7 | 1296.76 |
| 12.0 | 1296.12 |
| 16.3 | 1295.62 |
| 18.5 | 1295.65 |
| 19.2 | 1295.57 |
| 19.5 | 1294.97 |
| 21.2 | 1294.58 |
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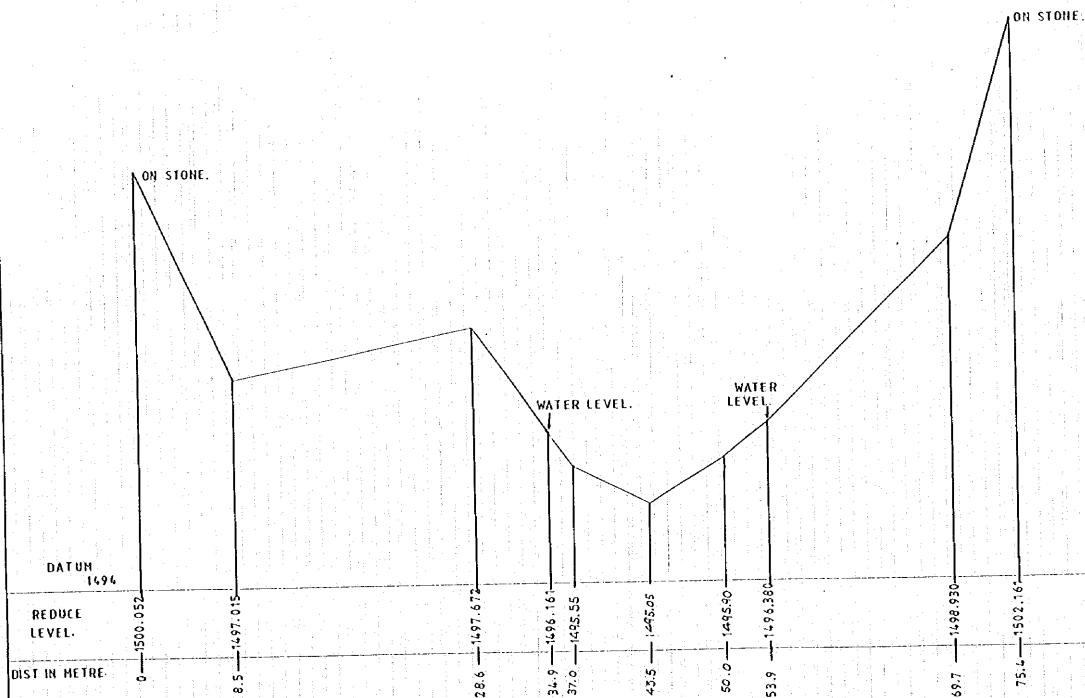
X-SEC OF SR3 MIDDLE.



X-SEC OF SR3 UPPER SIDE.

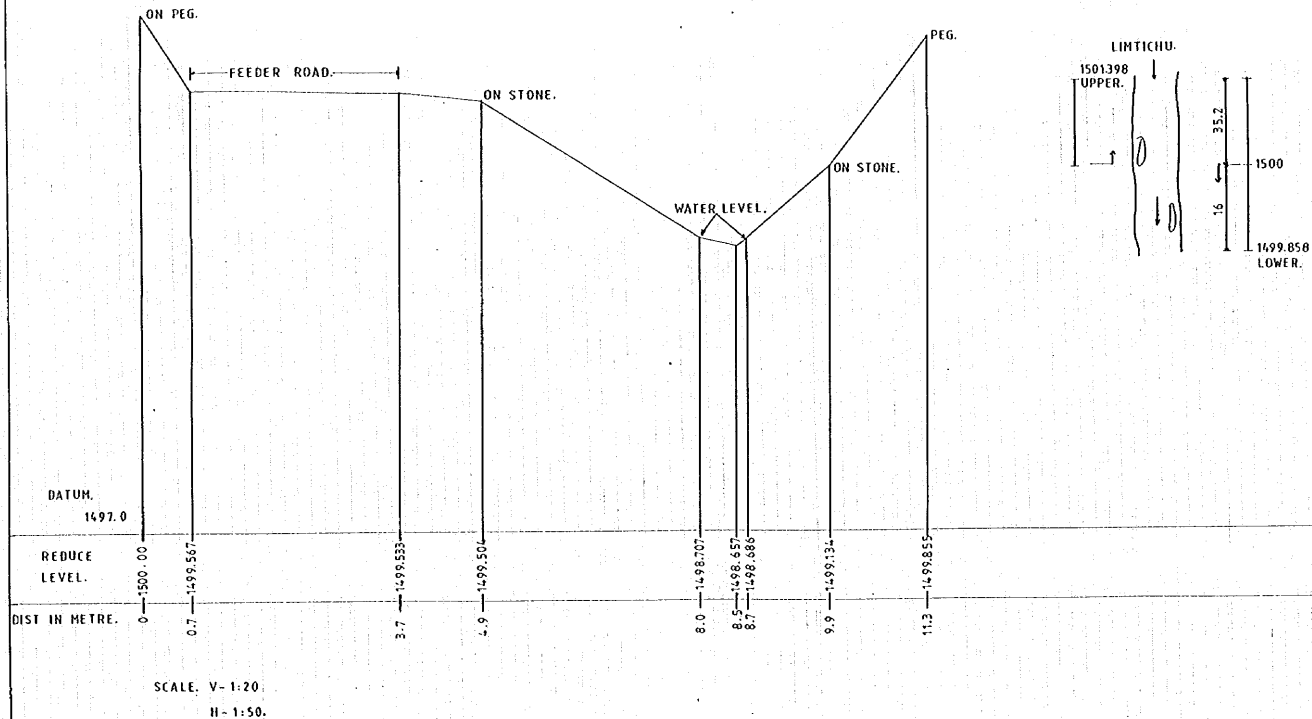


X-SEC OF SR3 LOWER.

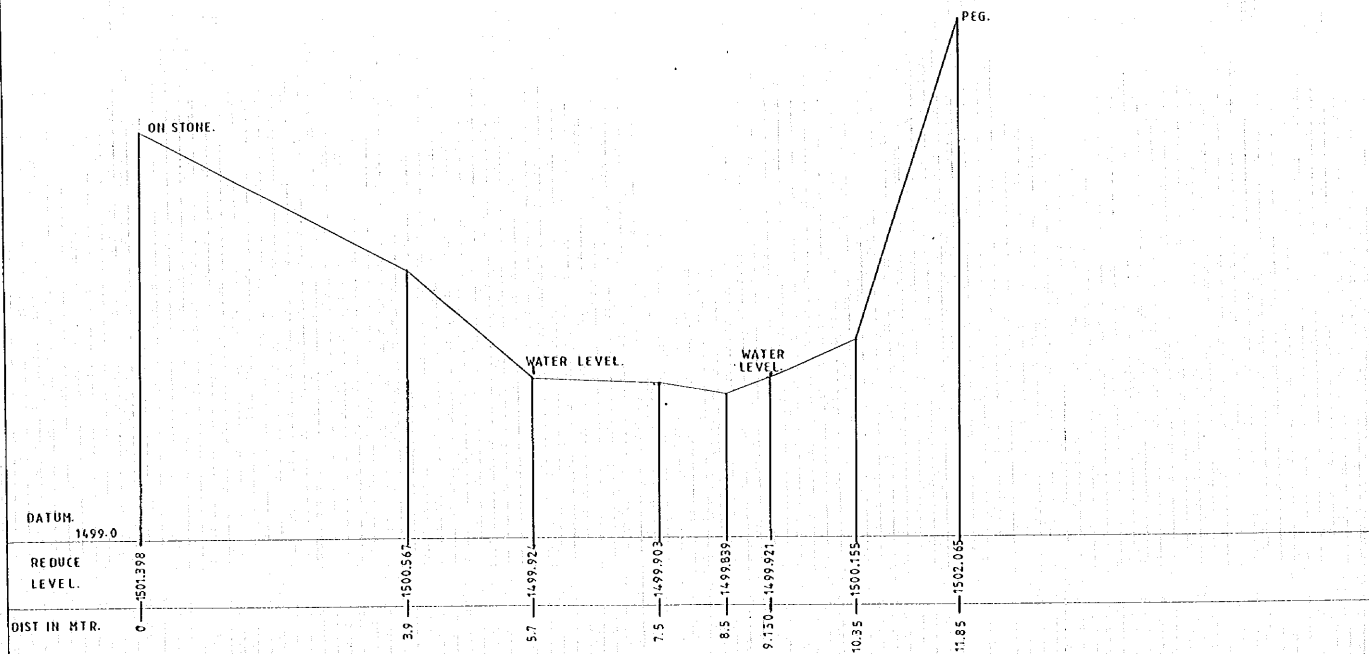


SCALE. V - 1:50
H - 1:300

X-SEC OF SR4 MIDDLE.

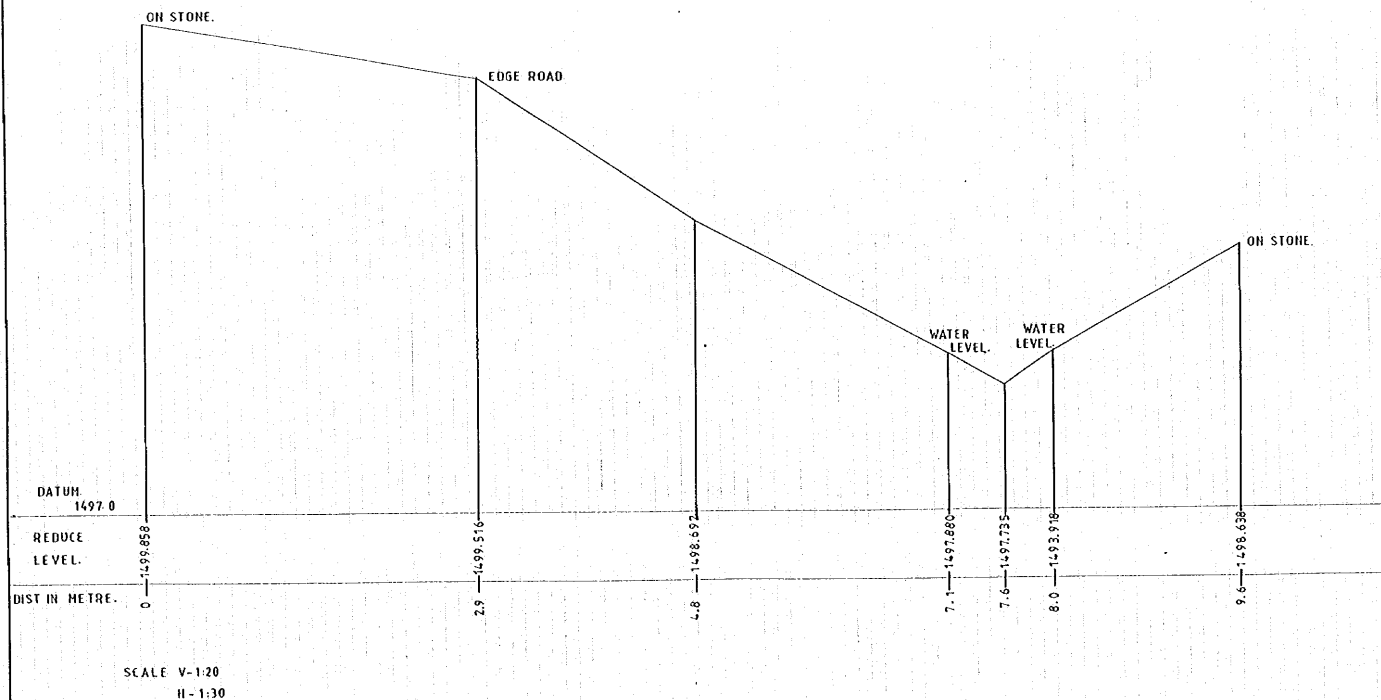


X-SEC OF SR4. UPPER SIDE.

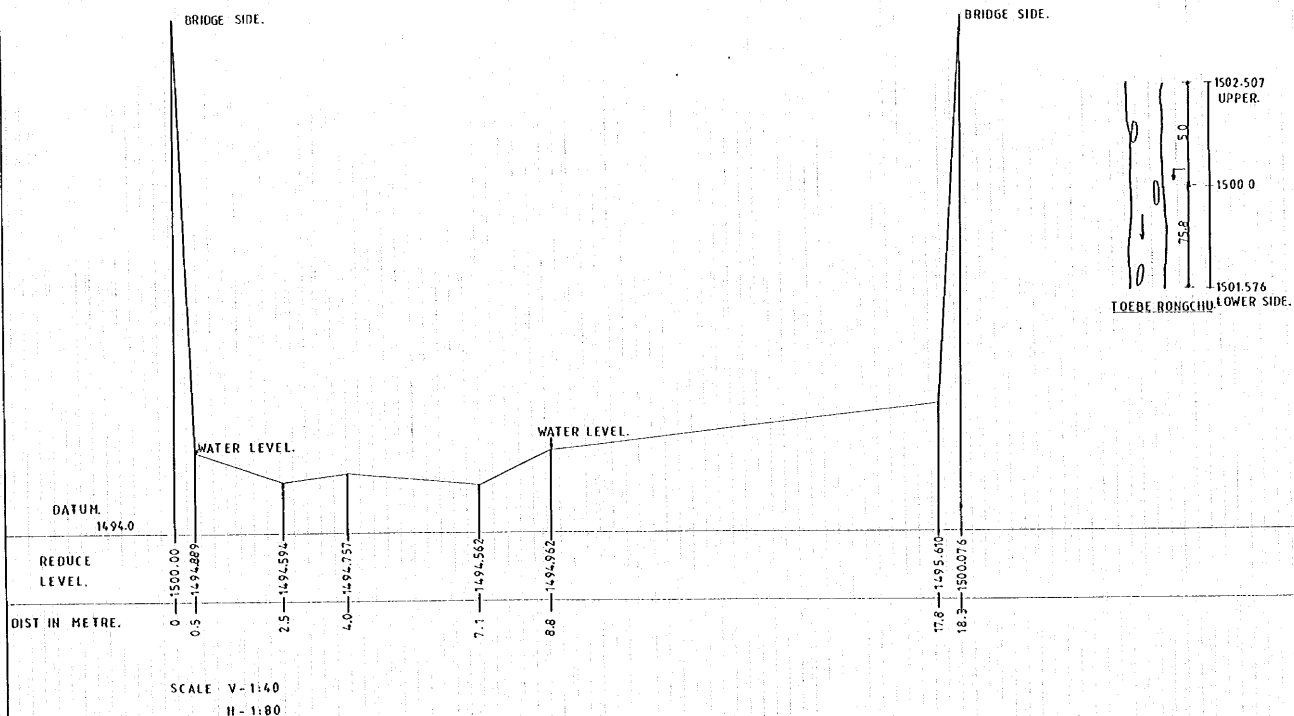


SCALE. V- 1:20
H- 1:50

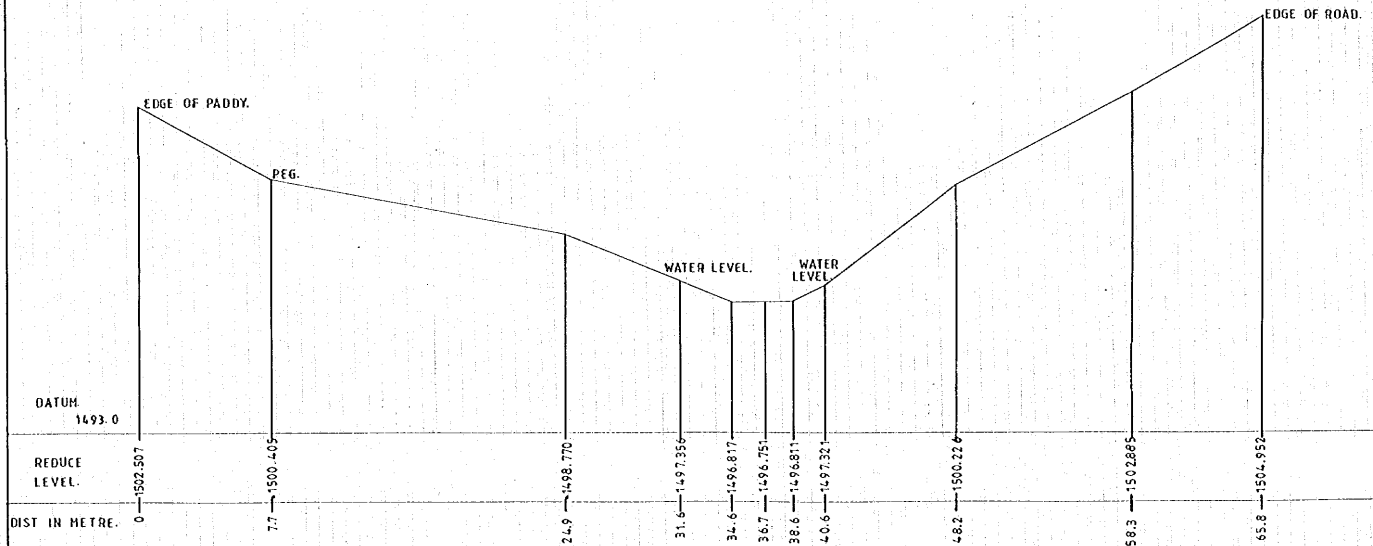
X-SEC OF SR4 LOWER SIDE.



X-SECTION OF SR5.

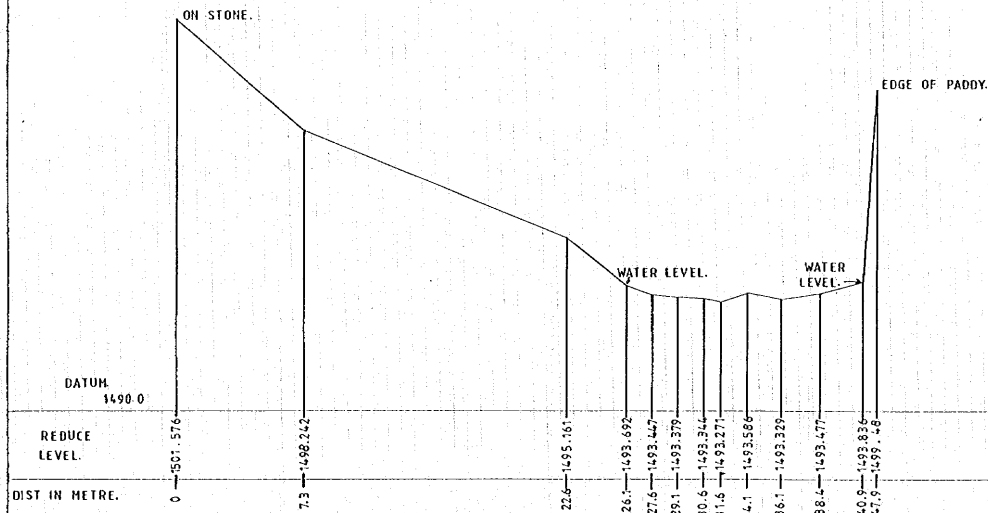


X-SEC OF SR5 UPPER SIDE.



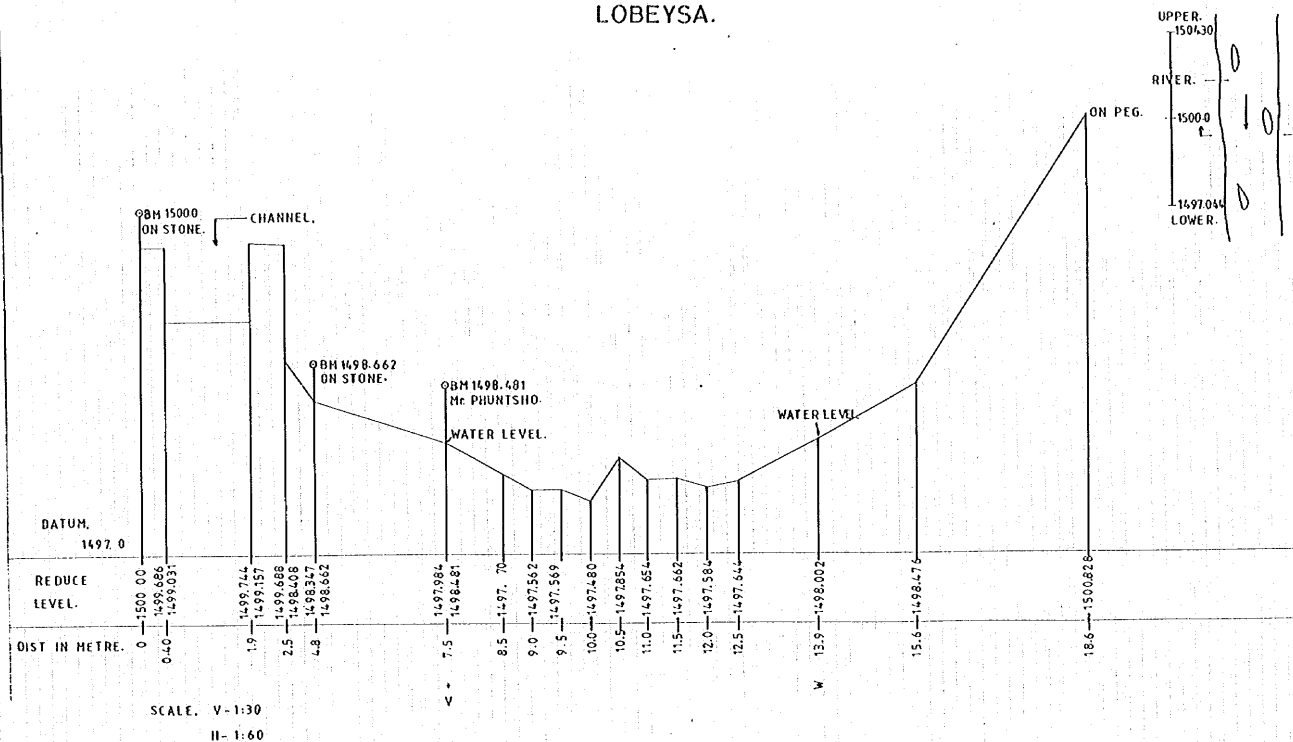
SCALE: V - 1:100
H - 1:200

X-SEC OF SR5 LOWER SIDE,

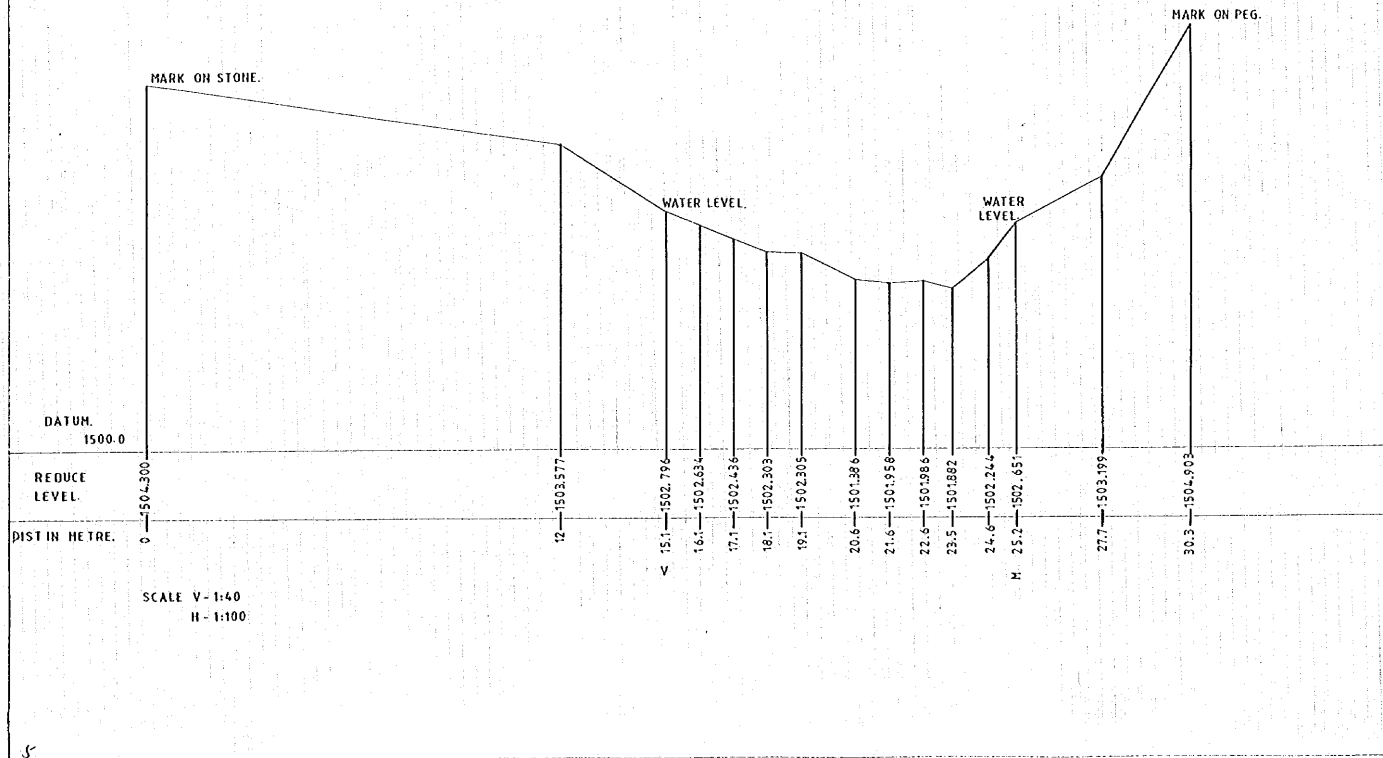


SCALE V - 1:100
II - 1:200

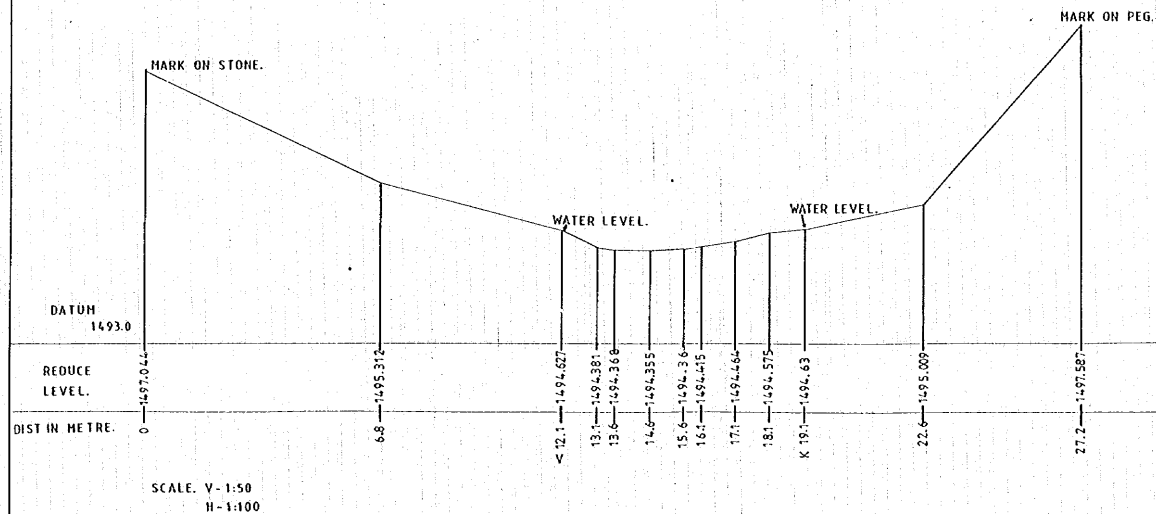
X-SEC OF SR6 MIDDLE LOWER CHANNEL LOBEYSA.

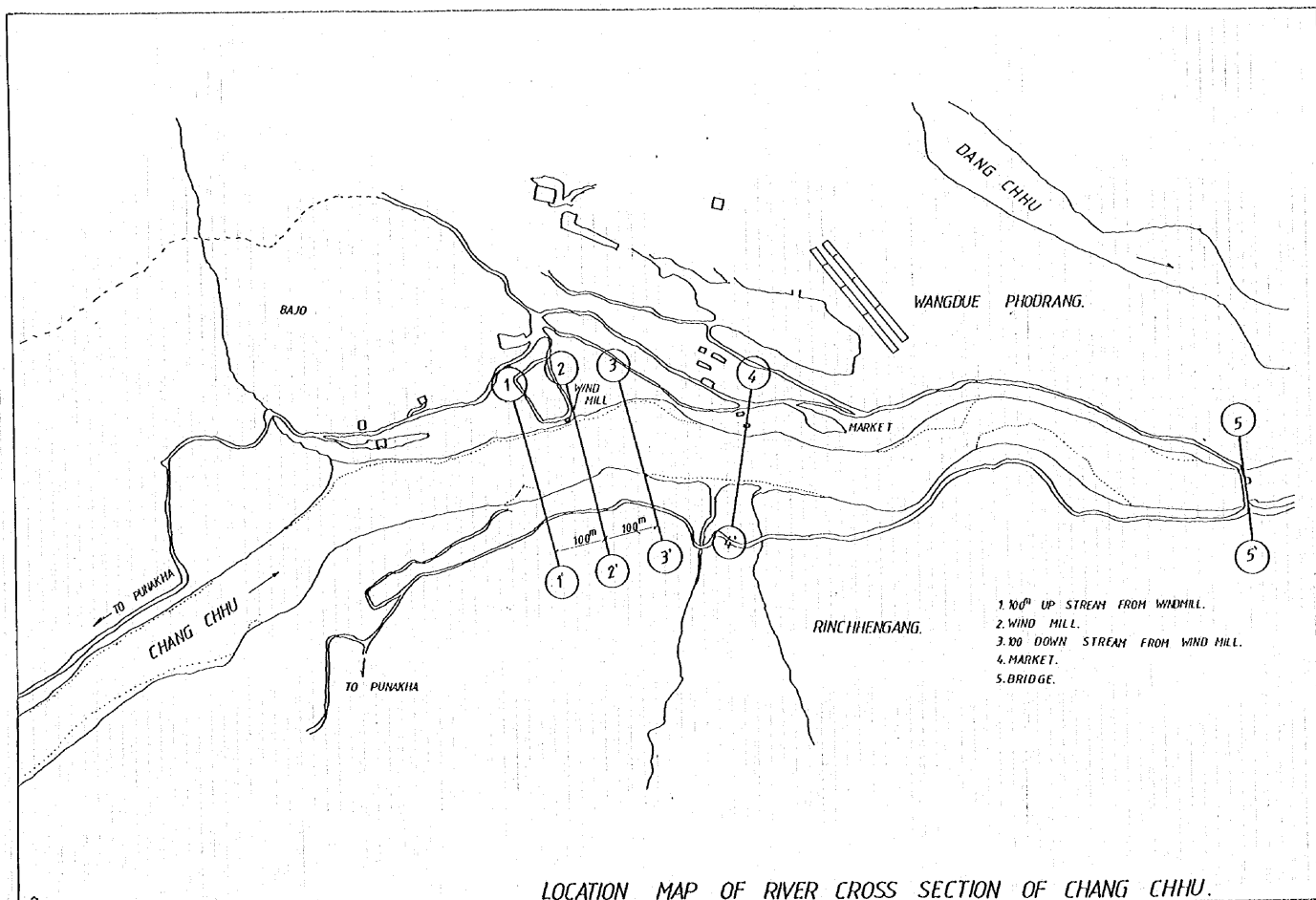


X-SEC OF SR6 UPPER SIDE.

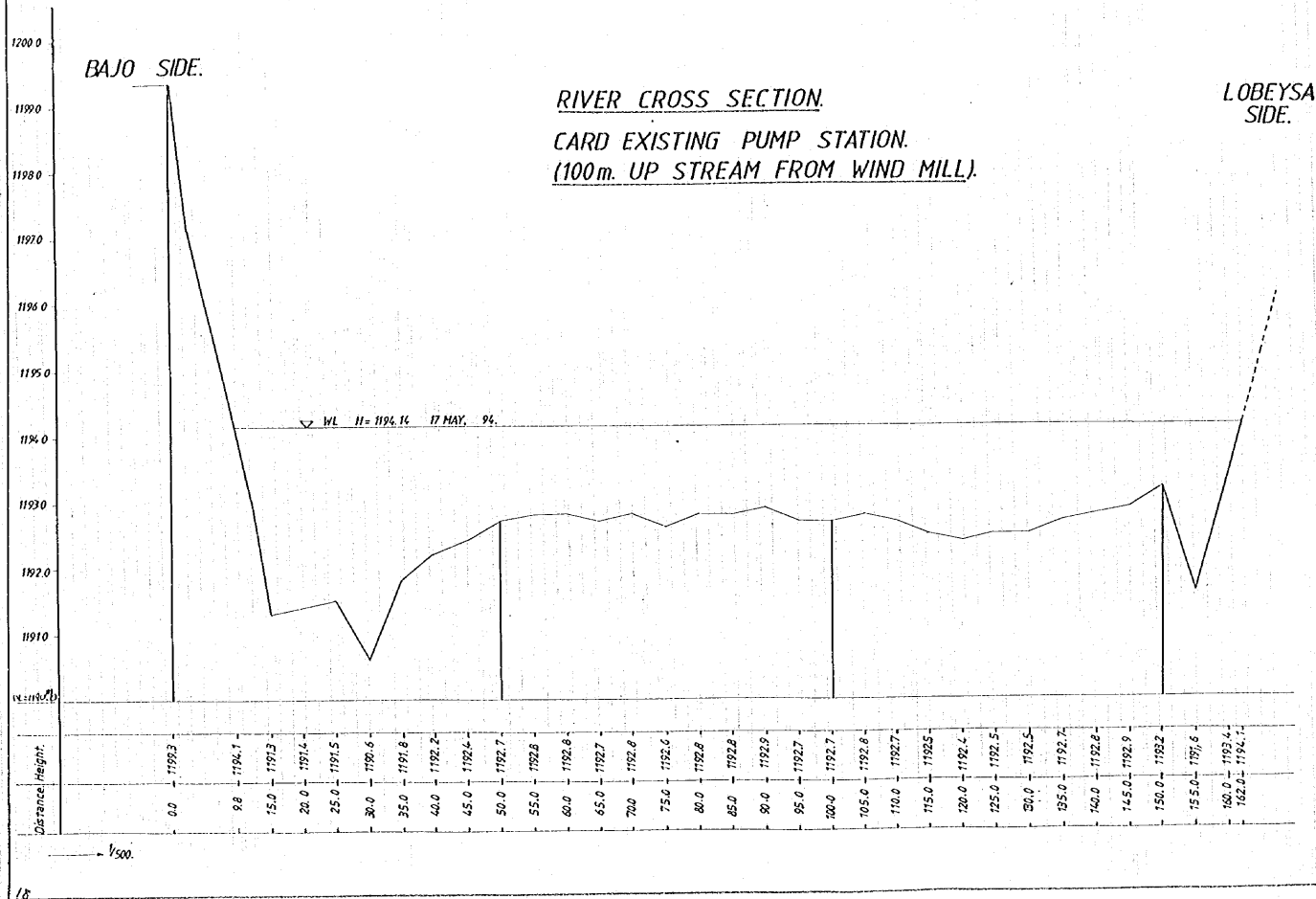


X-SEC OF SR6 LOWER SIDE.





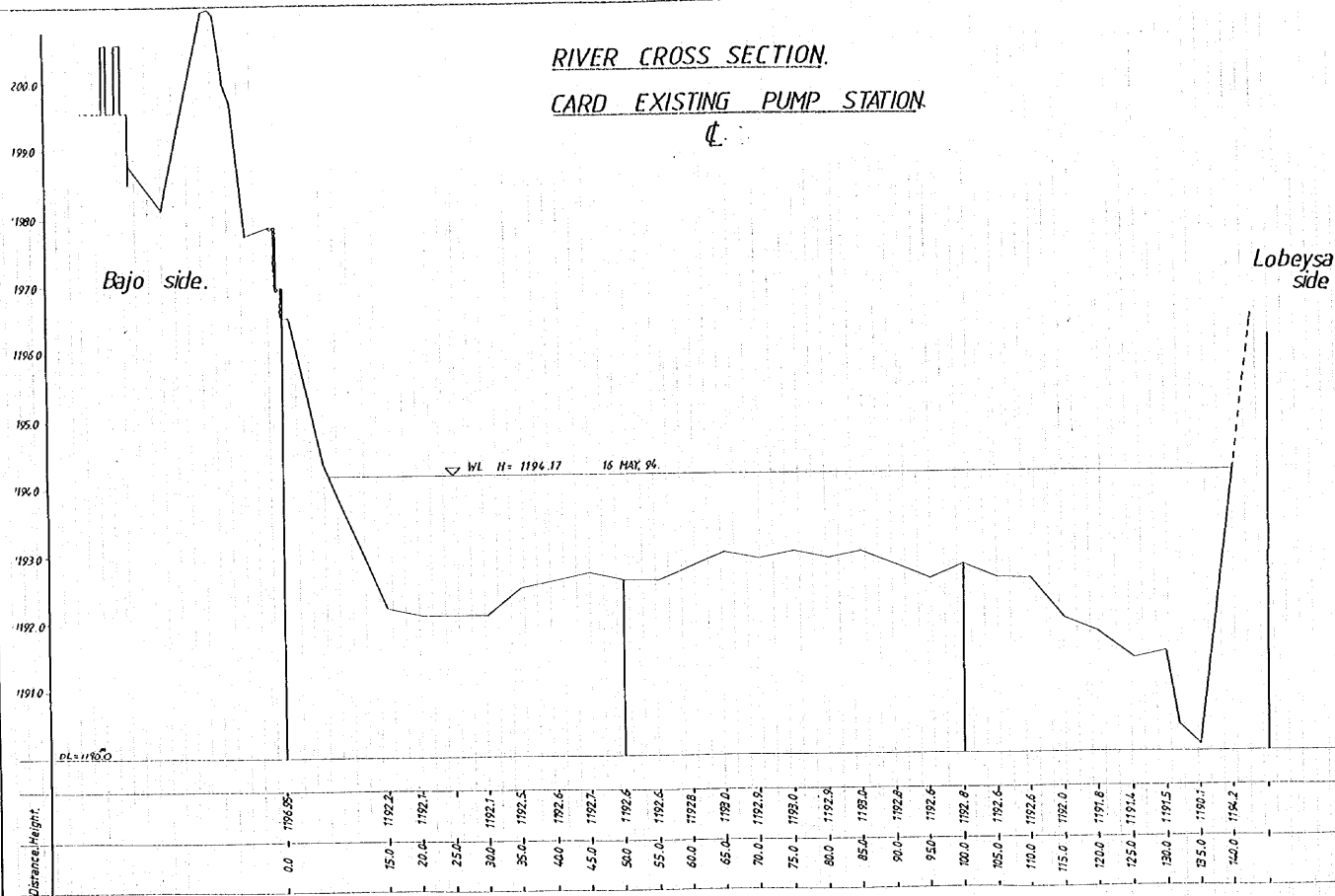
LOCATION MAP OF RIVER CROSS SECTION OF CHANG CHHU.



RIVER CROSS SECTION.

CARD EXISTING PUMP STATION

CL

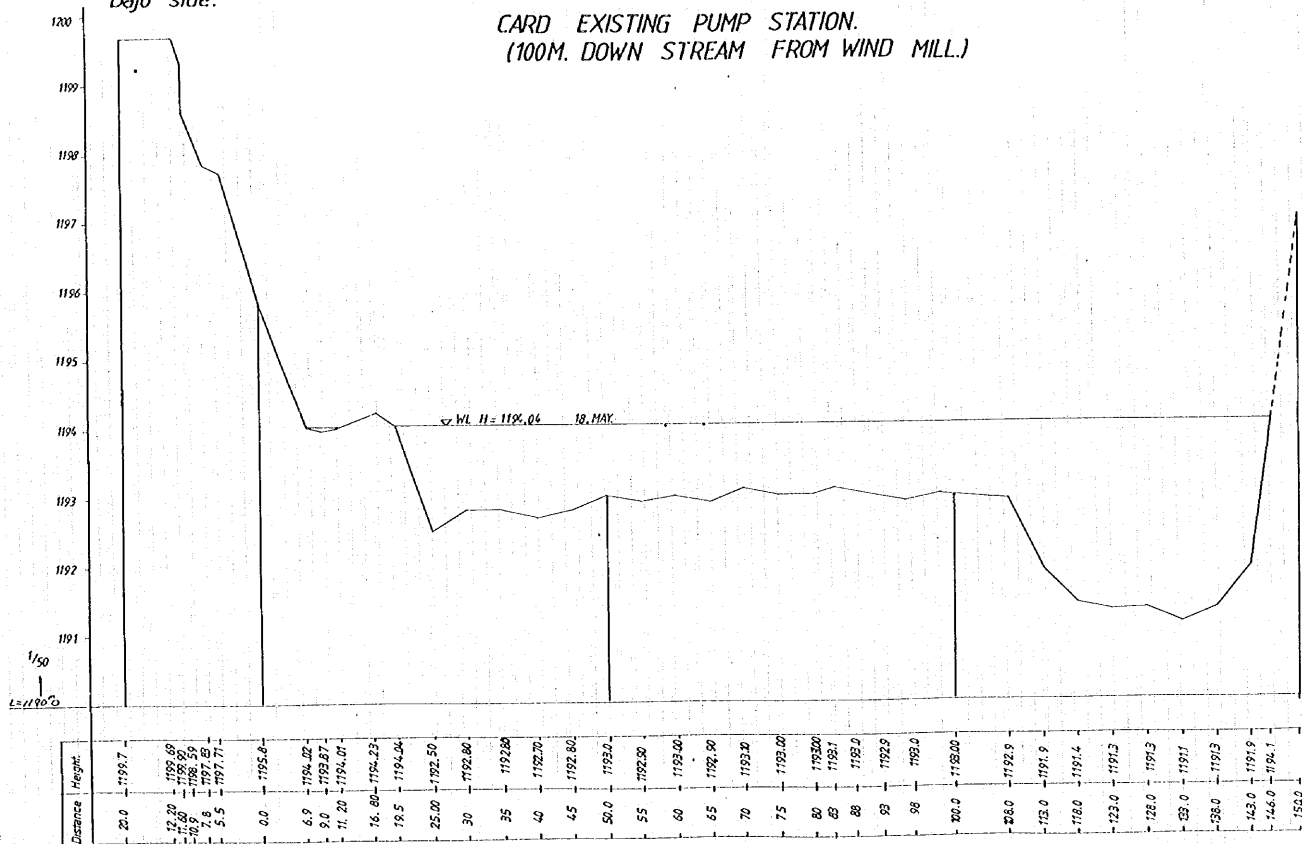


Bajo side.

RIVER CROSS SECTION.

Lobeysa side.

CARD EXISTING PUMP STATION.
(100M. DOWN STREAM FROM WIND MILL.)



1/500

RIVER CROSS SECTION. MARKET.

BAJO SIDE.

LOBEYSA
SIDE.

h_{50}
 h_{500}

DL = 1190M.

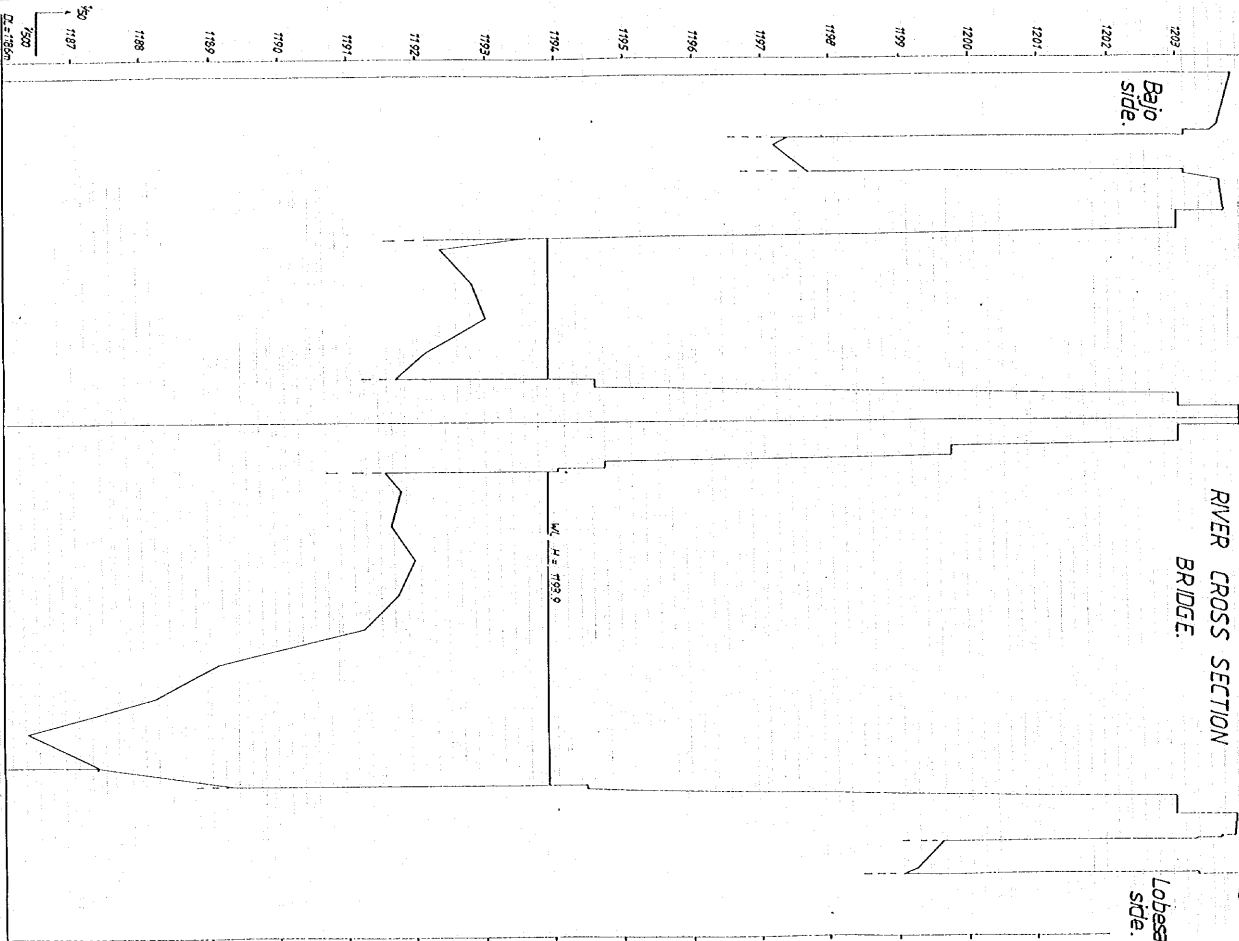
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RIVER CROSS SECTION BRIDGE.

Bajo
side.

Lobos
side.

M.L. H. = 1183.9

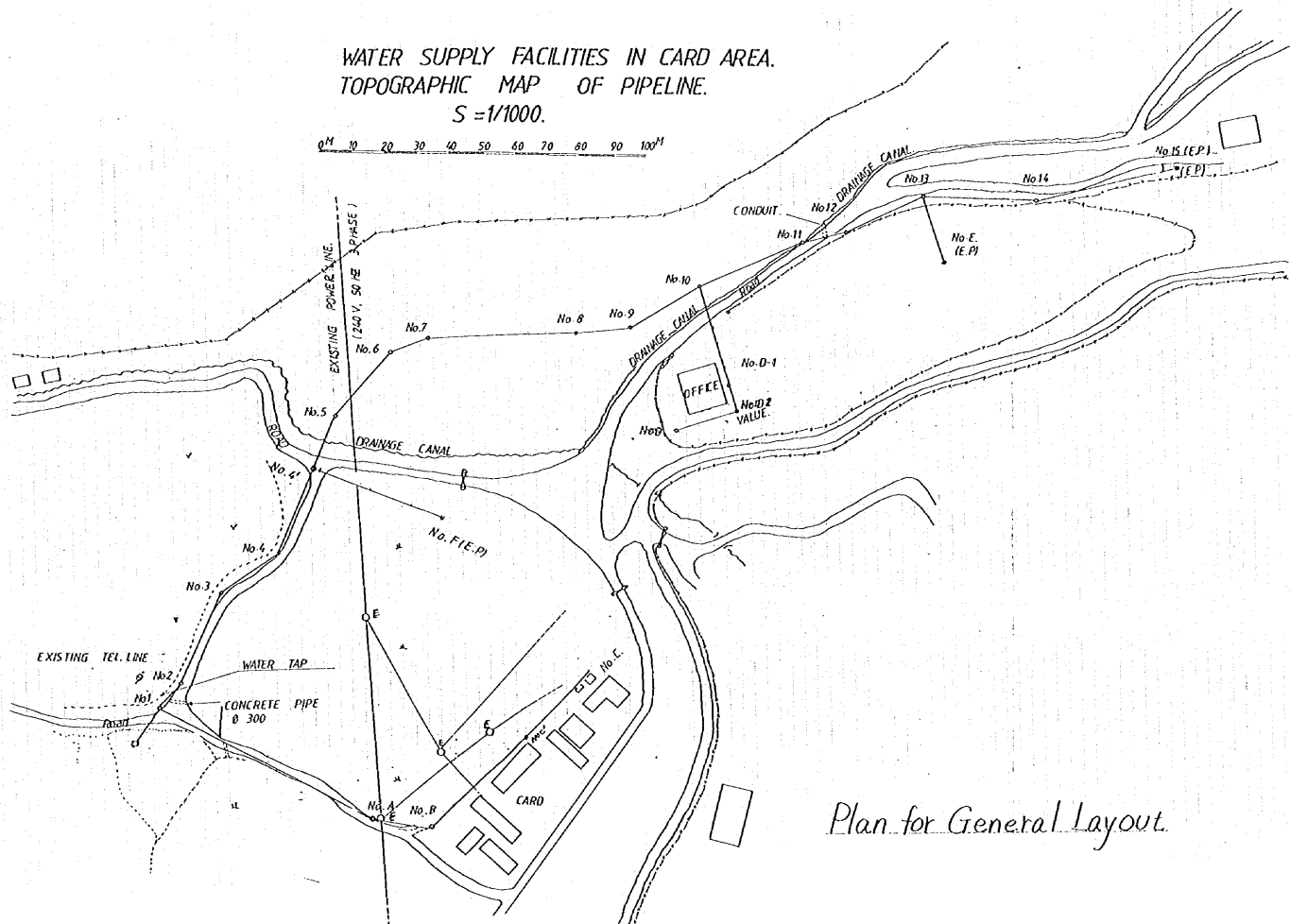


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| 20.0 | 1203.0 |
| 25.0 | 1192.3 |
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| 35.0 | 1193.0 |
| 40.0 | 1192.1 |
| 45.0 | 1194.6 |
| 50.0 | 1202.9 |
| 55.0 | 1199.7 |
| 60.0 | 1191.8 |
| 65.0 | 1191.6 |
| 70.0 | 1192.0 |
| 75.0 | 1191.7 |
| 80.0 | 1191.2 |
| 85.0 | 1189.1 |
| 90.0 | 1188.2 |
| 95.0 | 1186.3 |
| 100.0 | 1187.4 |
| 105.0 | 1203.0 |
| 110.0 | 1203.8 |
| 115.0 | 1189.2 |
| 120.0 | 1202.9 |

TOPOGRAPHIC SURVEY FOR EXPERIMENTAL FACILITIES

WATER SUPPLY FACILITIES IN CARD AREA.
TOPOGRAPHIC MAP OF PIPELINE.

$S = 1/1000.$

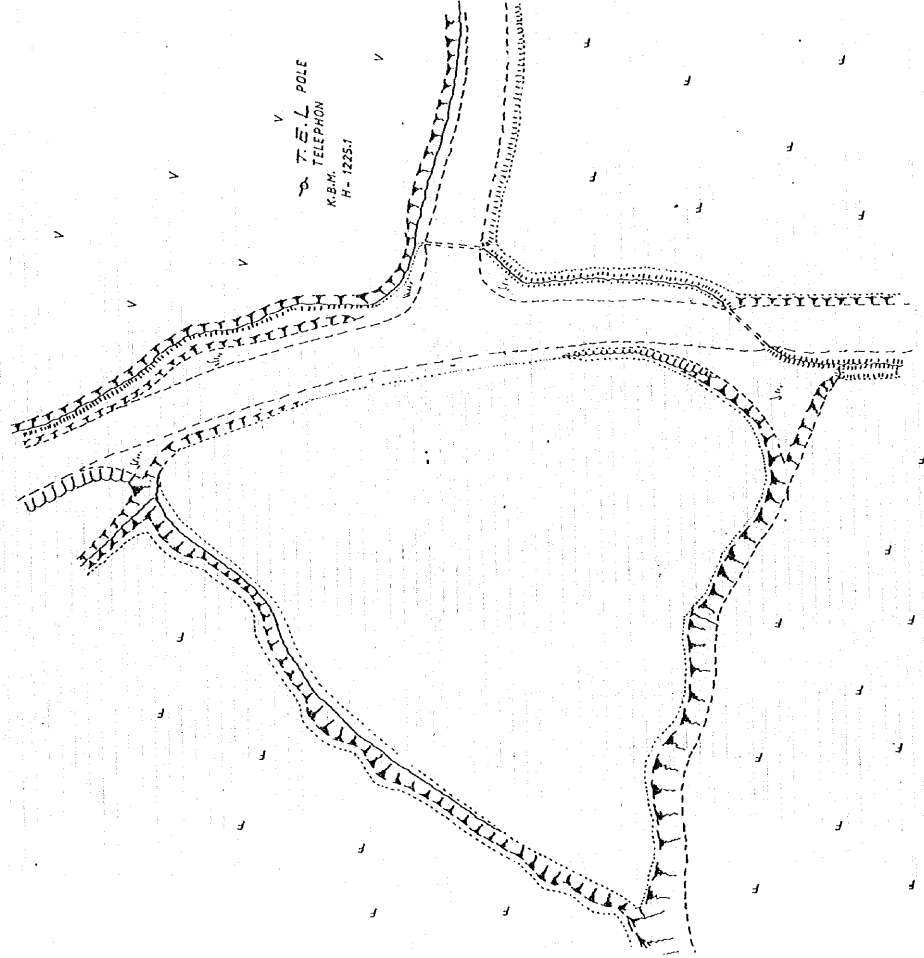


Plan for General Layout.

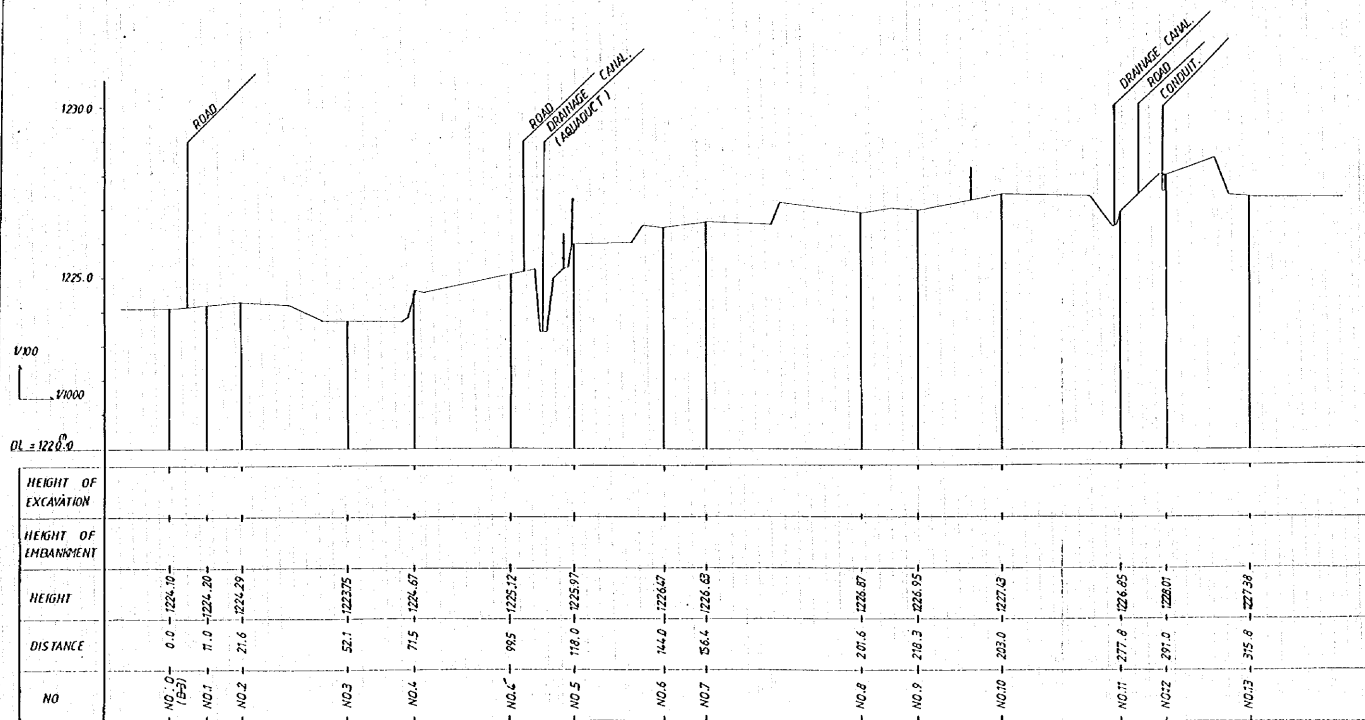
Plan for Solar System Layout

WATER SUPPLY FACILITIES IN CARD AREA.
TOPOGRAPHIC MAP OF SOLAR PUMPING FACILITY.

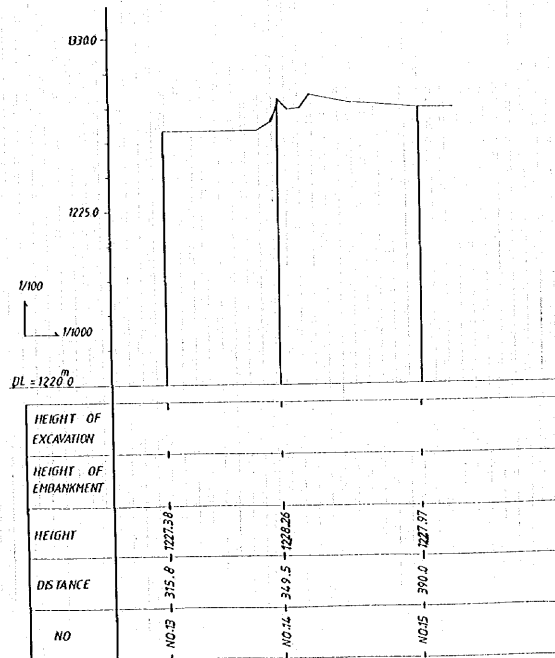
$S = 1/200$
0 50' 100'



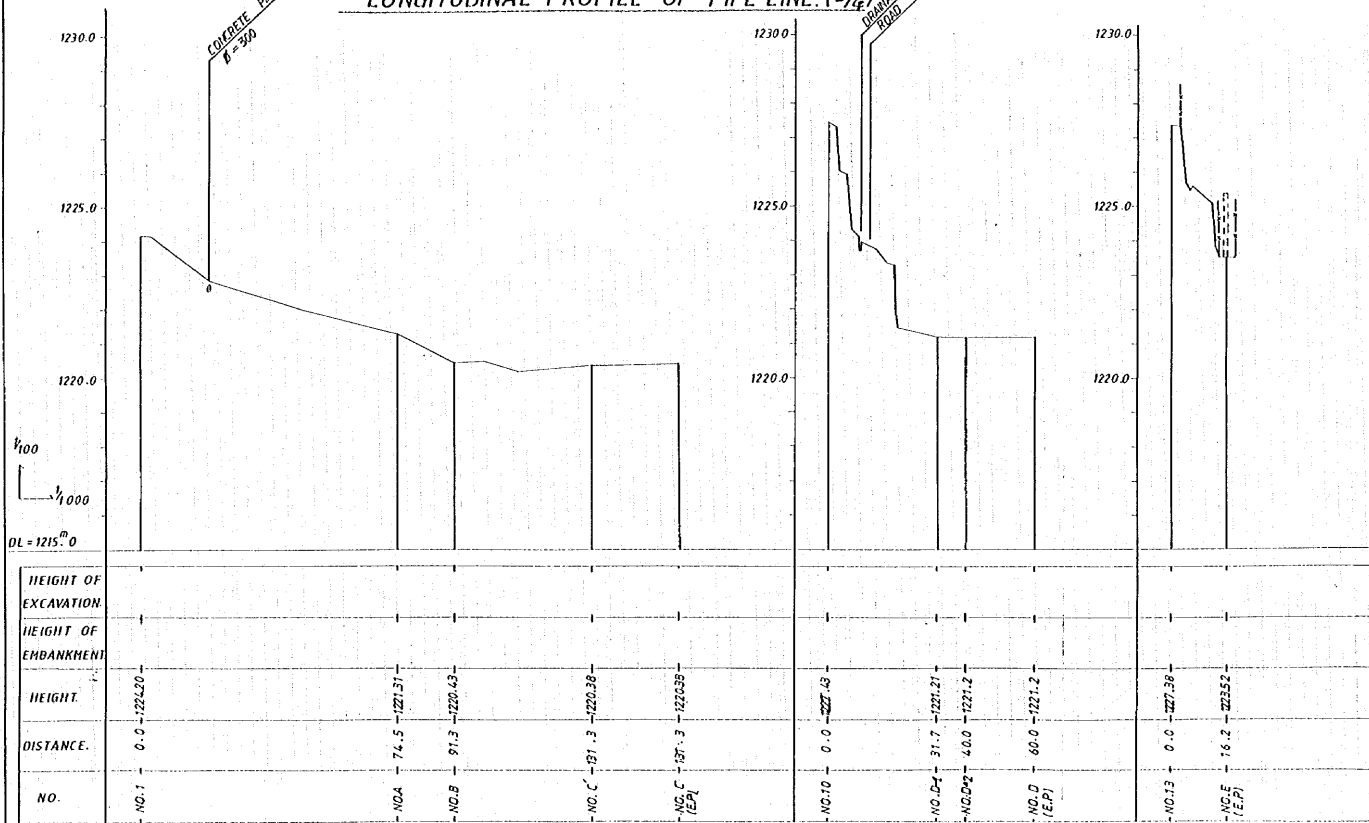
WATER SUPPLY FACILITIES IN CARD AREA.
LONGITUDINAL PROFILE OF PIPELINE (1/4")



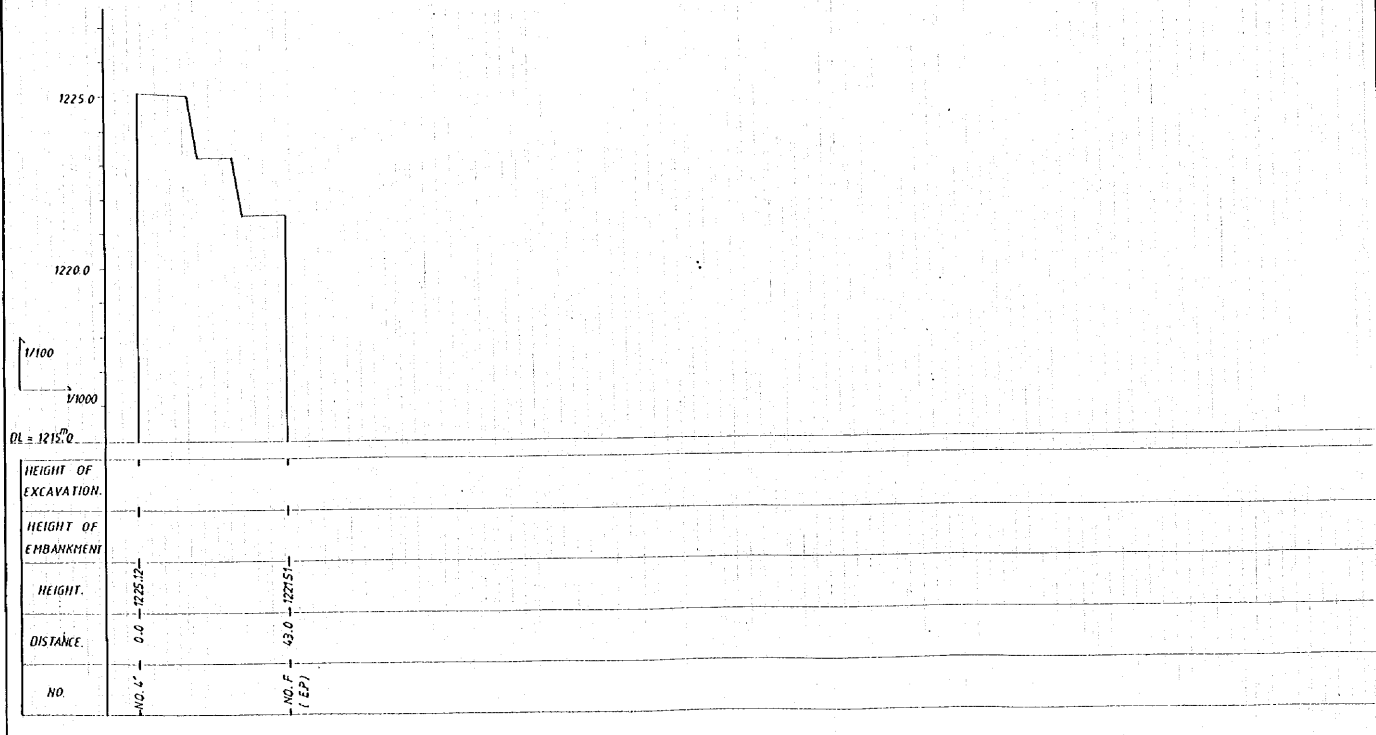
WATER SUPPLY FACILITIES IN CARD AREA.
LONGITUDINAL PROFILE OF PIPELINE 2 1/4



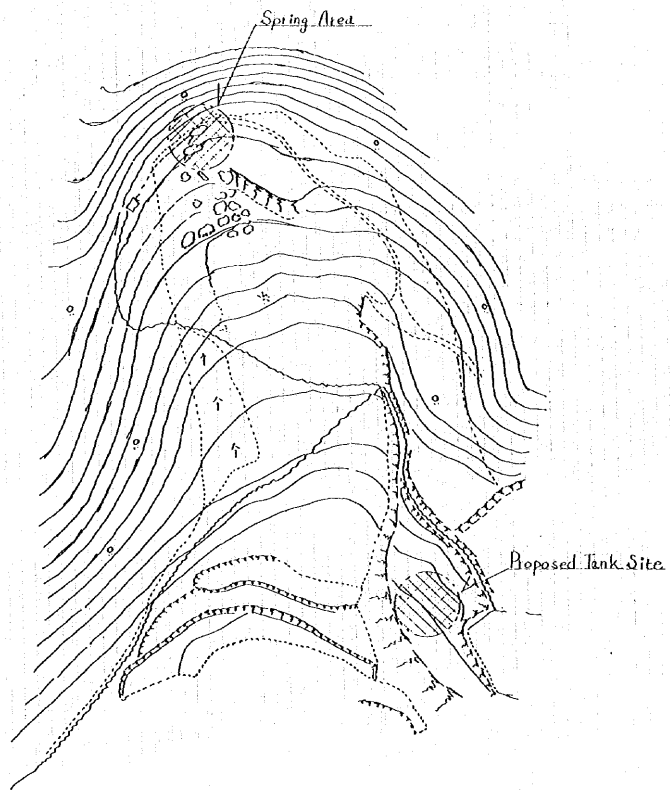
WATER SUPPLY FACILITIES OF CARD AREA LONGITUDINAL PROFILE OF PIPE LINE. (3/4)



WATER SUPPLY FACILITIES IN CARD AREA
LONGITUDINAL PROFILE OF PIPELINE (4/4)



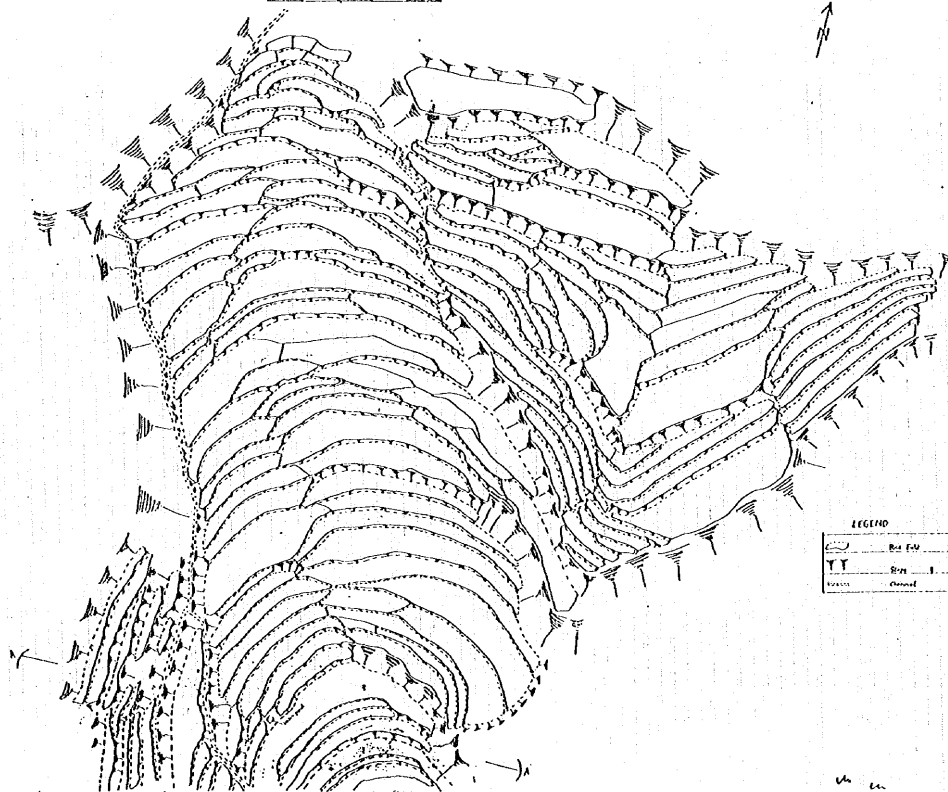
General Plan of the Site



| |
|--|
| |
| |
| |
| |
| |

Plan of the Proposed Command Area 14

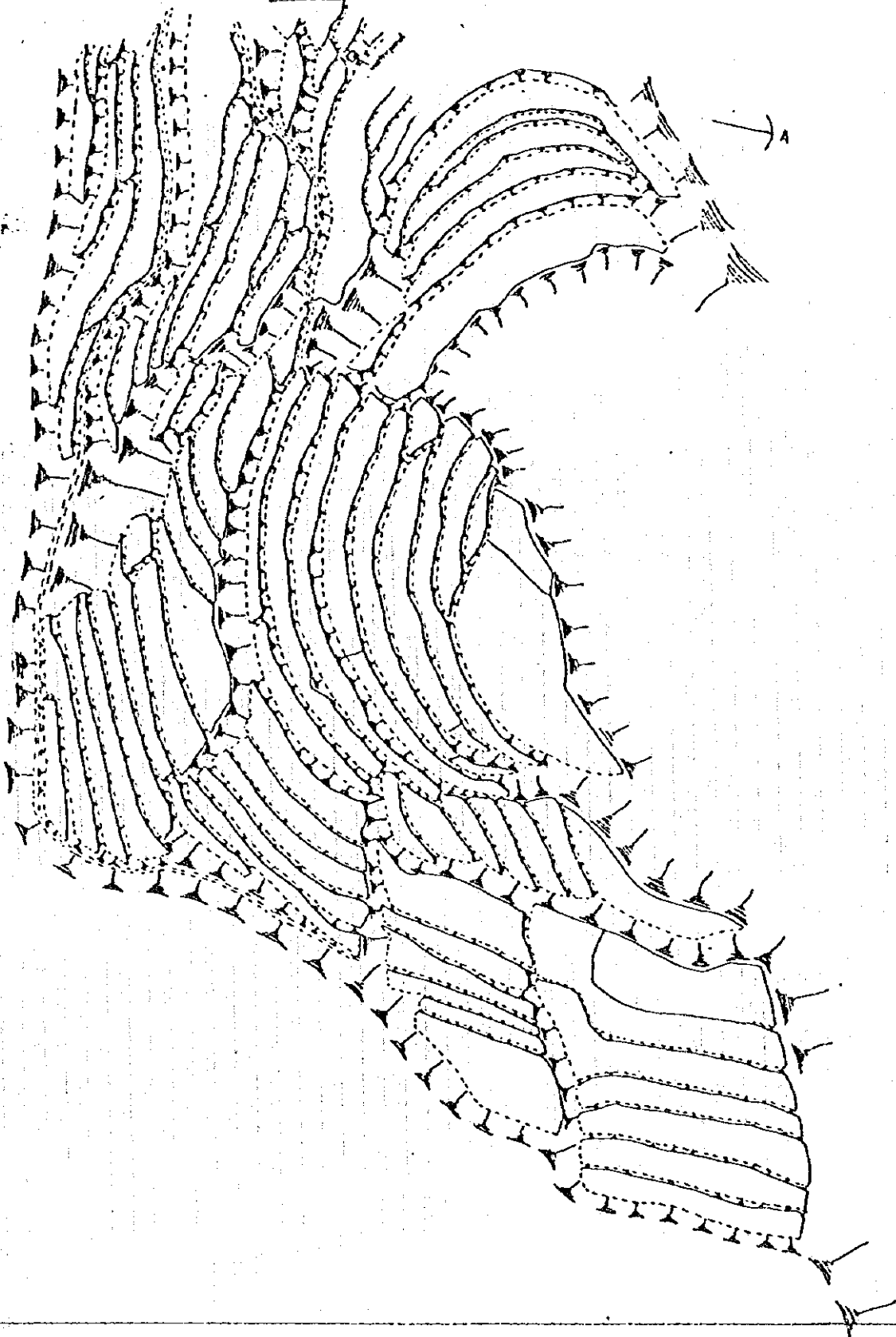
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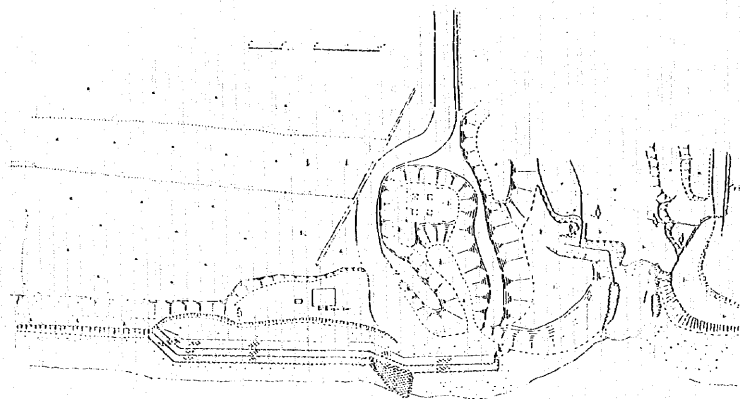
Plan of the Proposed Command Area 3/2

SCALE 1:500

Proposed Command Area

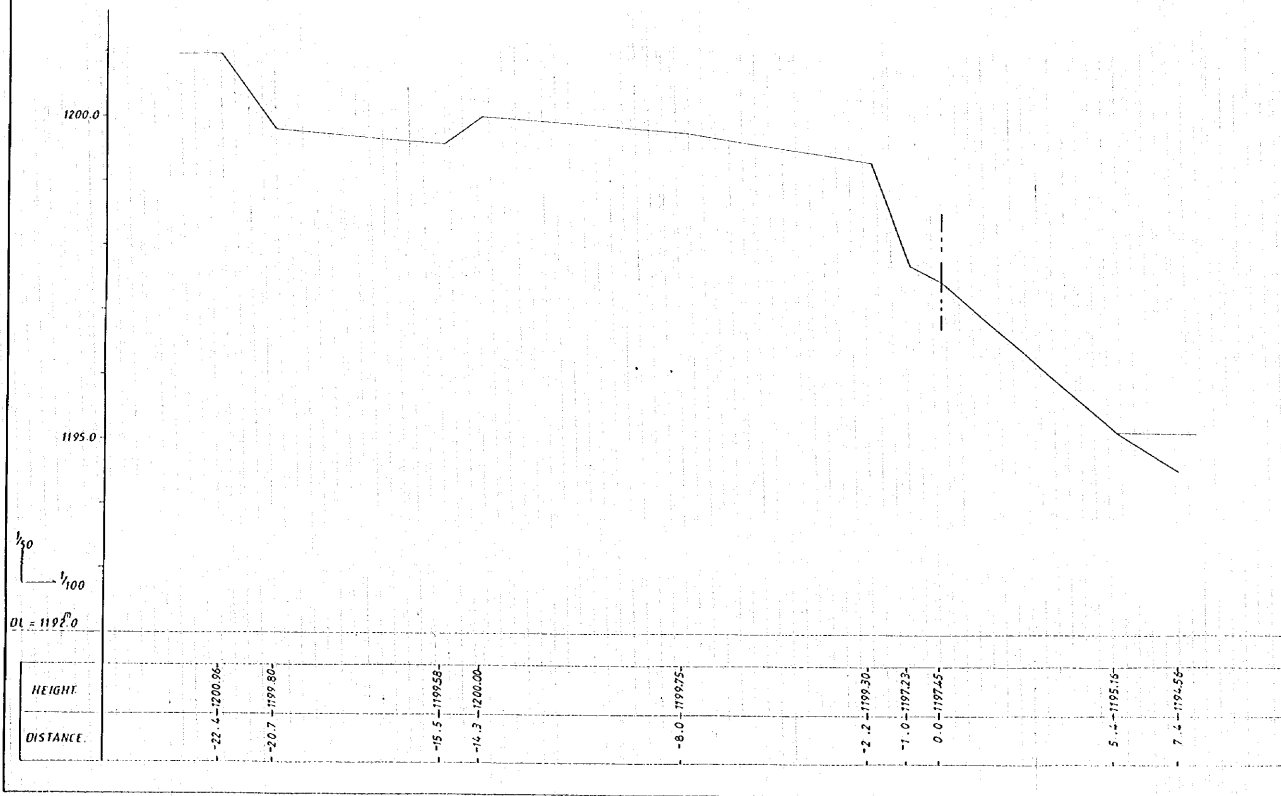


Plan of the Fort of St. Louis
1/500



CARD PUMP STATION
NO-5 (E - 50M)
GH=1197.45

Cross-section of River Bank 3/11

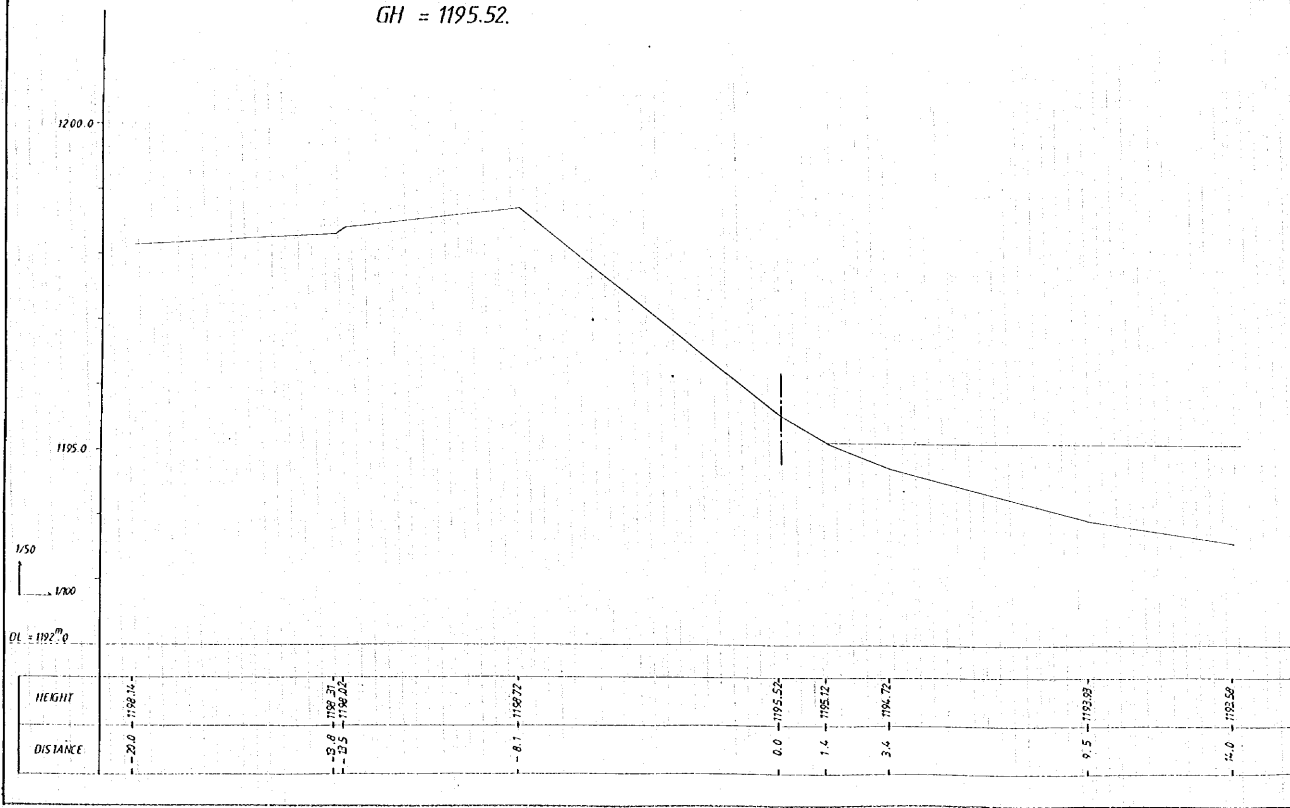


CARD PUMP STATION.

NO-4 (L - 40M)

GH = 1195.52.

Cross-section of River Bank 2/11

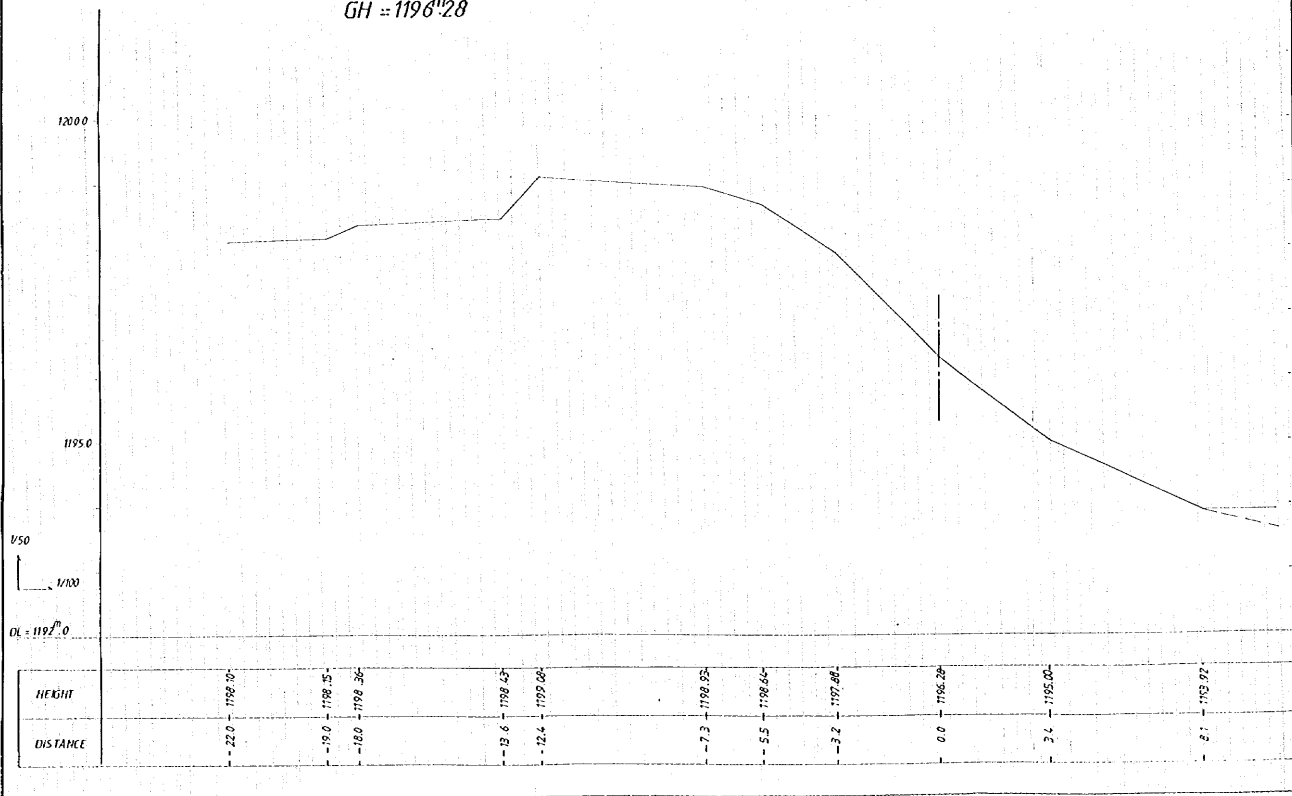


CARD PUMP STATION.

NO -3 (t. -30M)

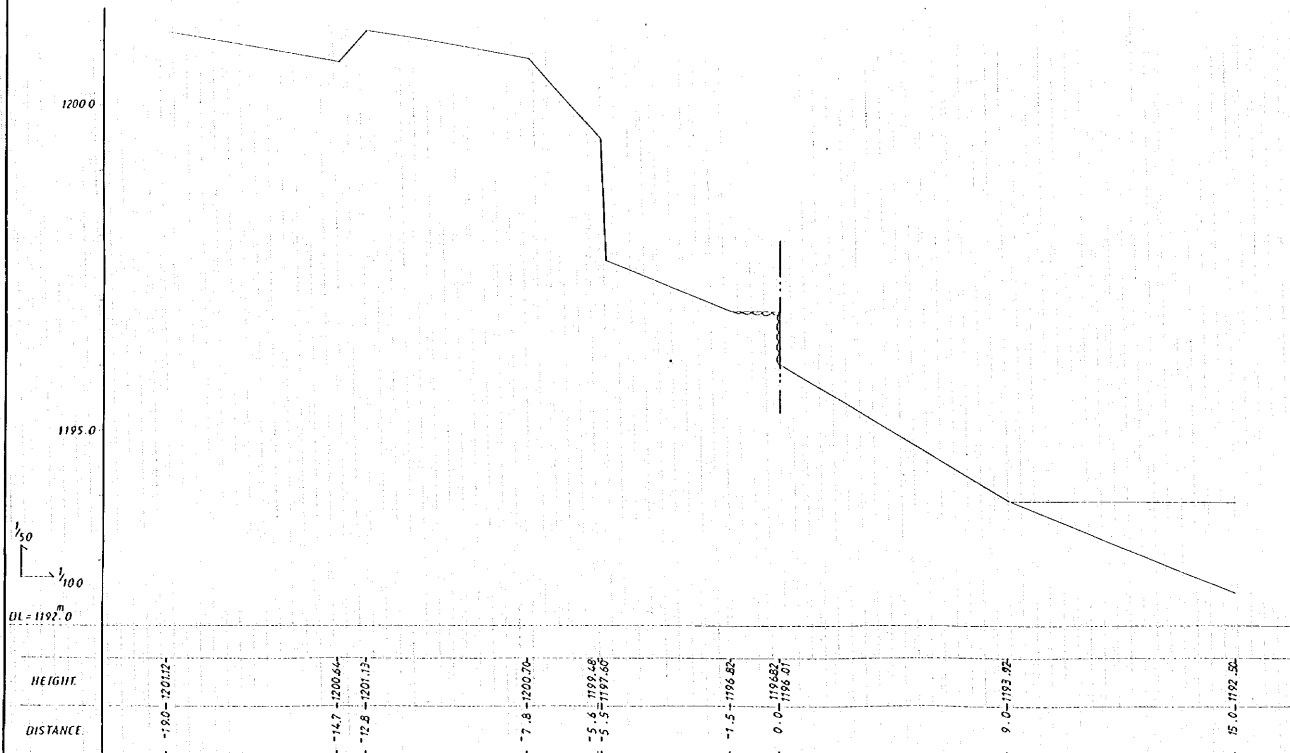
GH = 1196^m28

Cross-section of River Bank 3/1



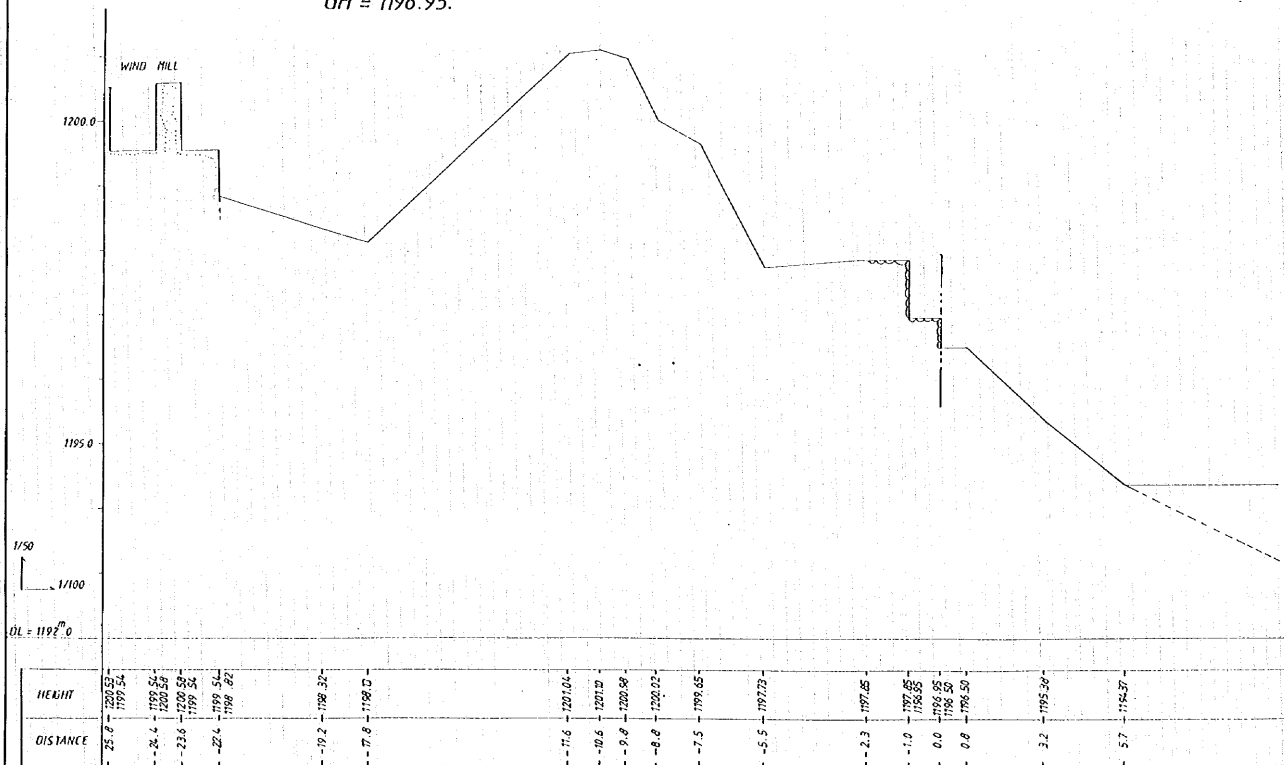
CARD PUMP STATION
 NO-2 (4 - 20M)
 GH=1196.82

Cross-section of River Bank 1/11



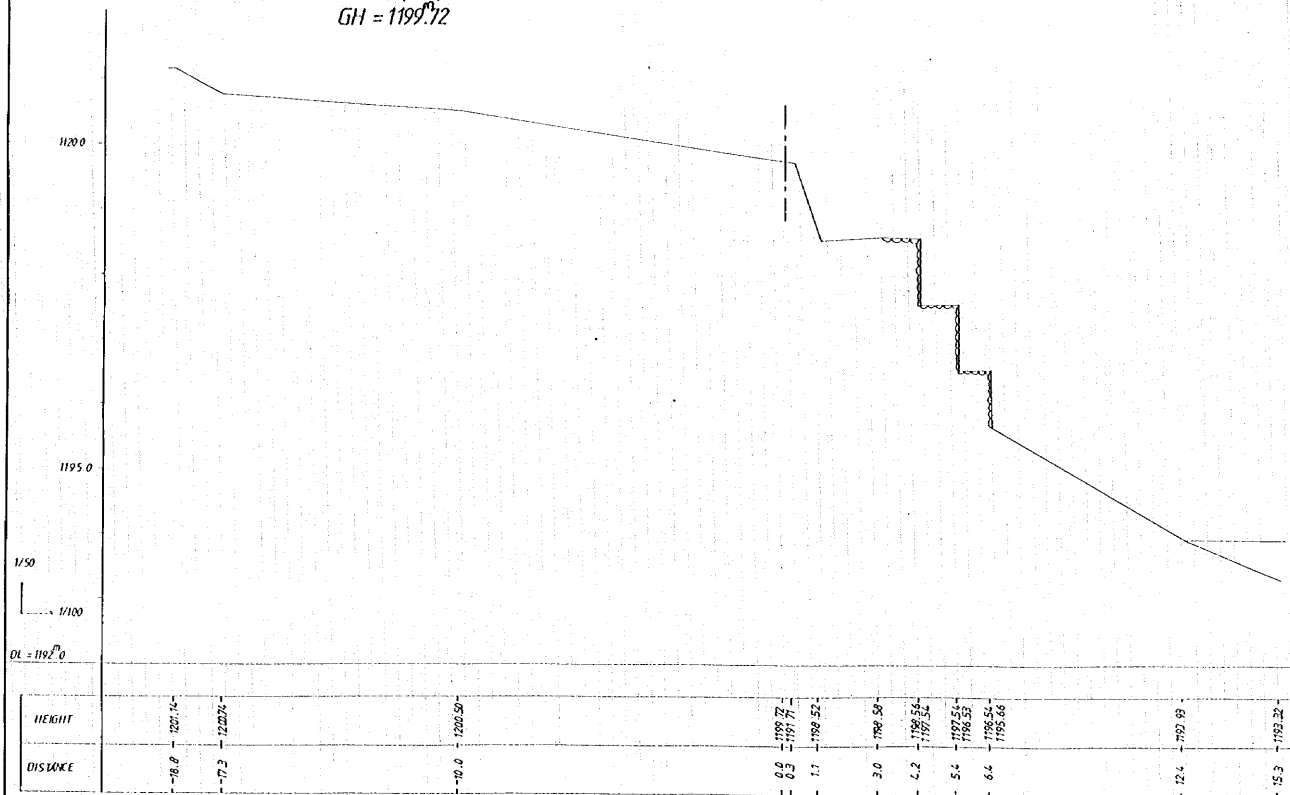
$$GH = 1196.95.$$

Cross-section of River Bank 5/11



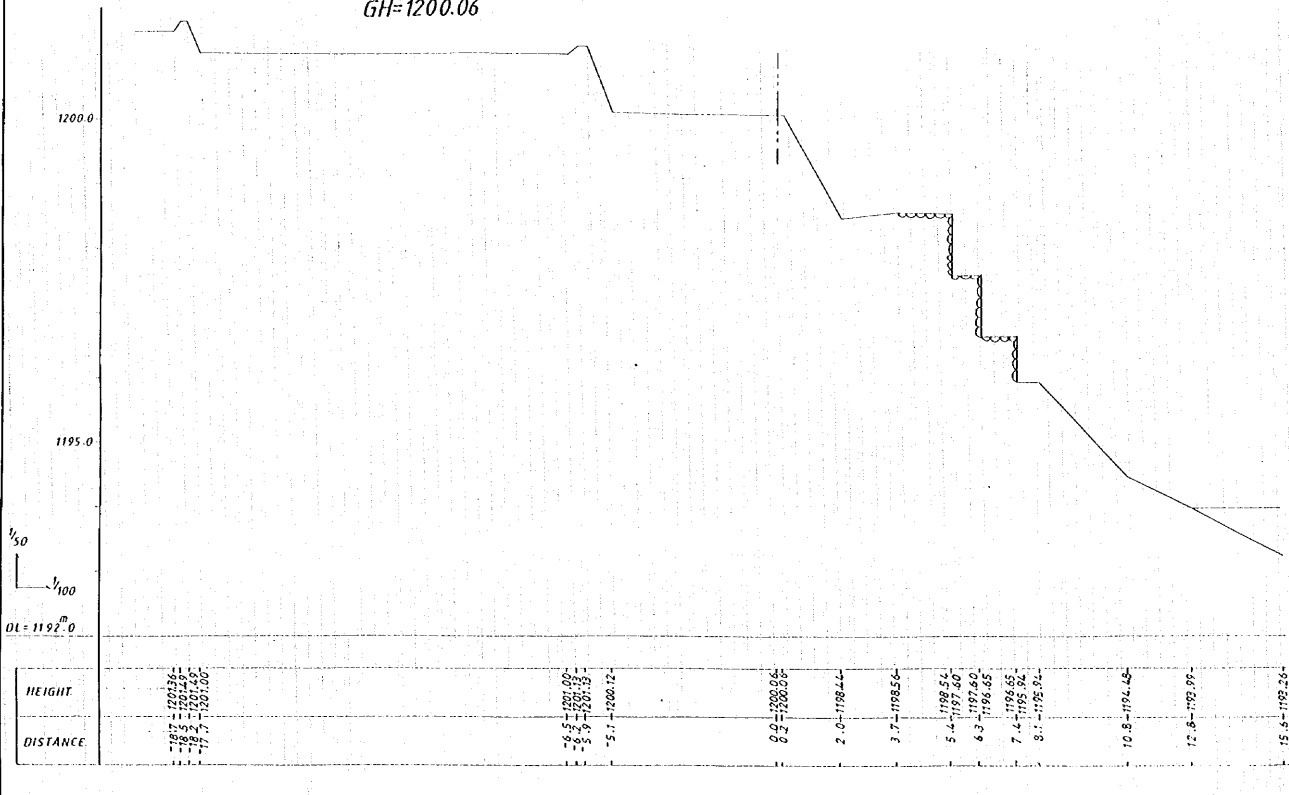
CARD PUMP STATION
NO. 0 (E.)
GH = 1199.72

Cross-section of River Bank 6/11



$$GH = 1200.06$$

Cross-section of River Bank 7/11

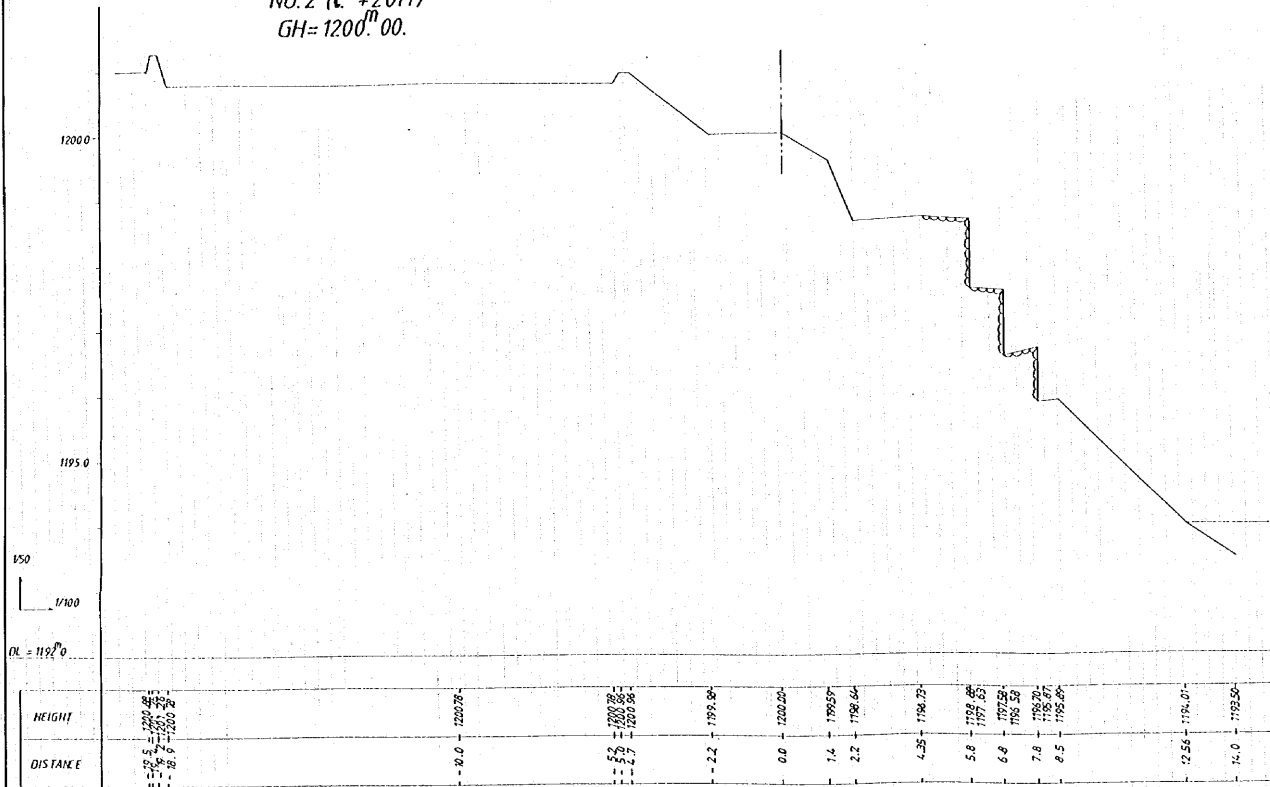


CARD PUMP STATION.

NO. 2 (L + 20M)

GH = 1200^m. 00.

Cross-section of River Bank 2/1

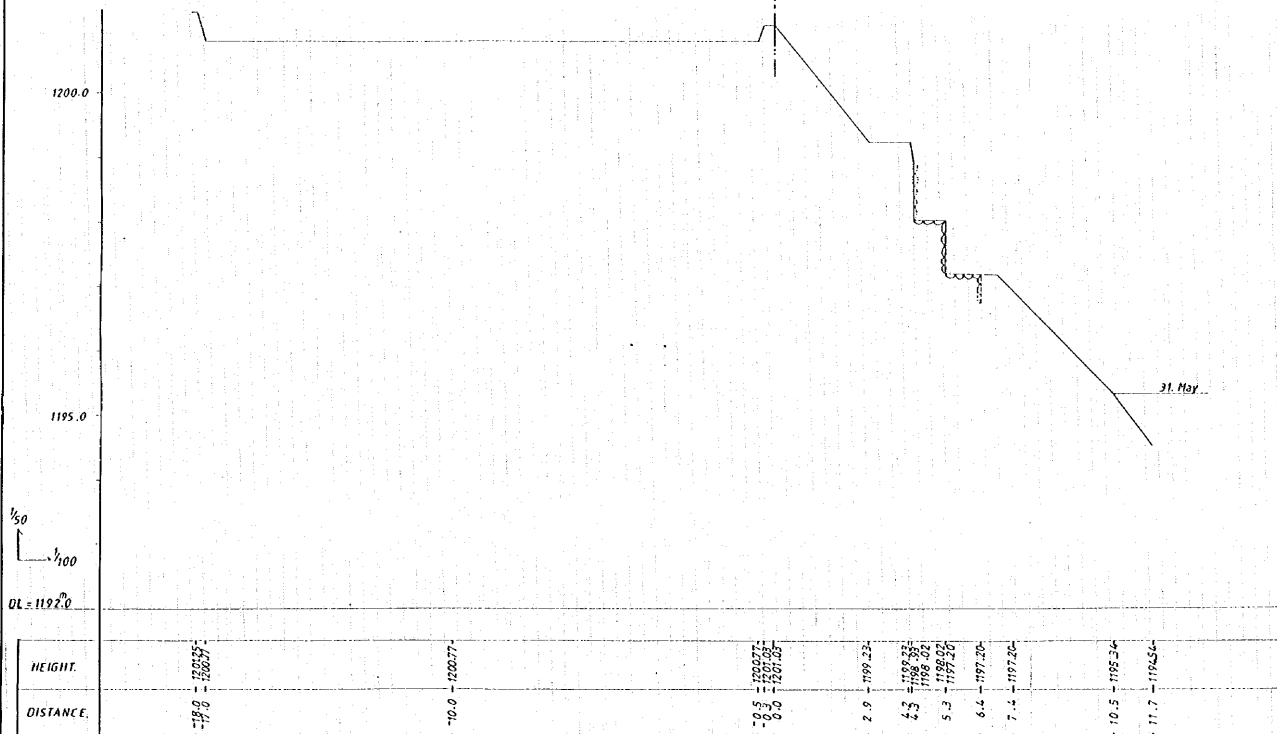


CARD PUMP STATION

NO. 3 (E + 32.5M)

GH=1201.03

Cross-section of River Bank 9/11

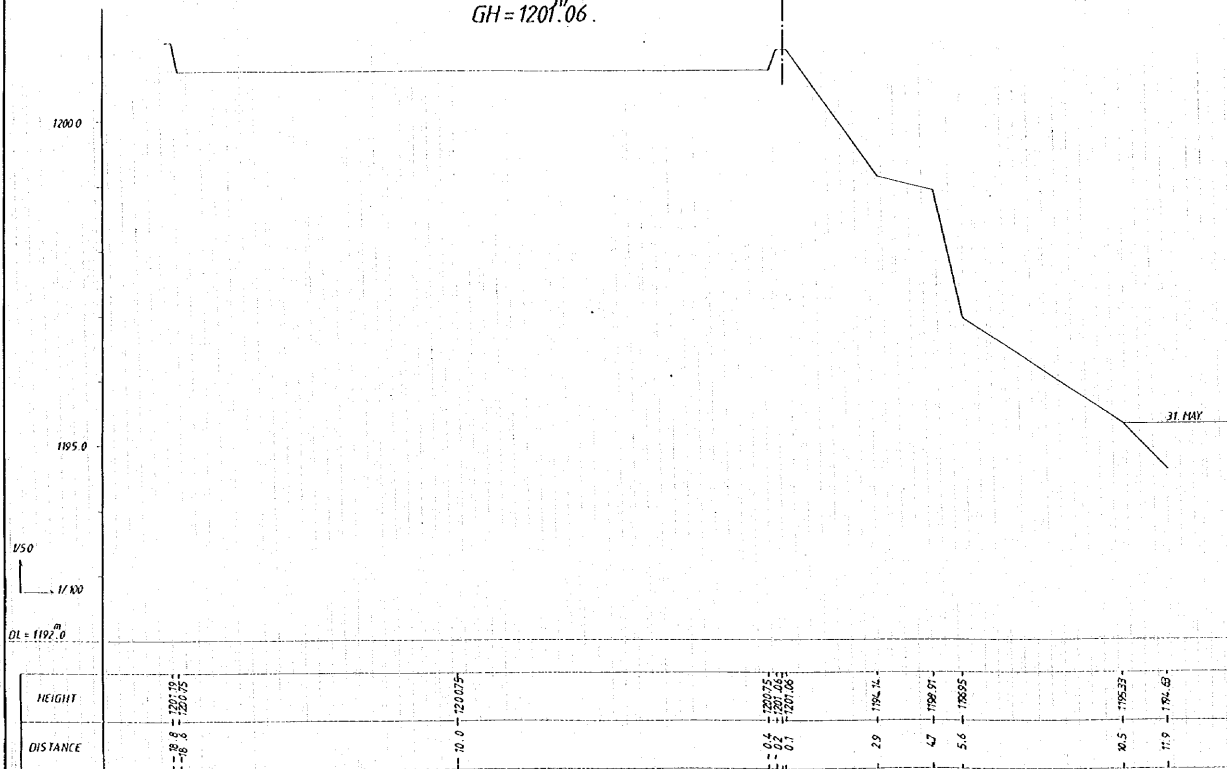


CARD PUMP STATION..

NO. 4 (4. + 40M)

GH = 1201.06 m.

Cross-section of River Bank 10/11

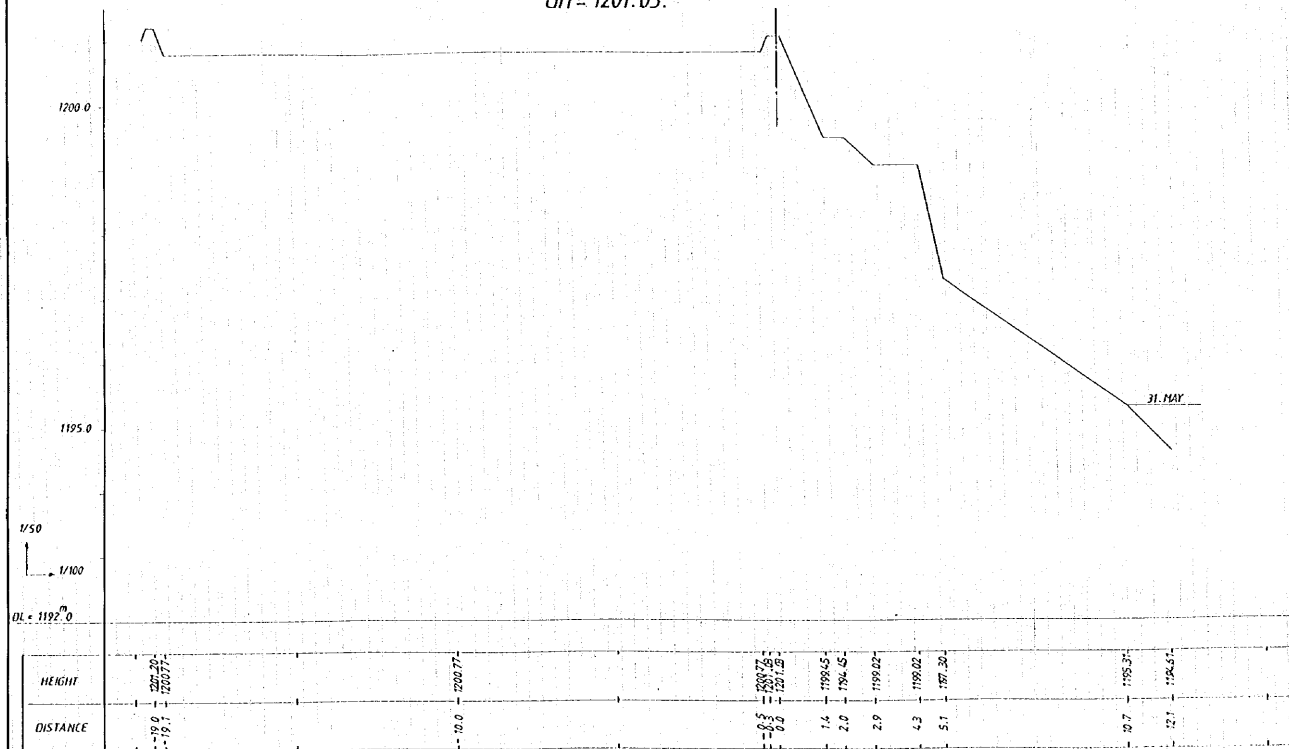


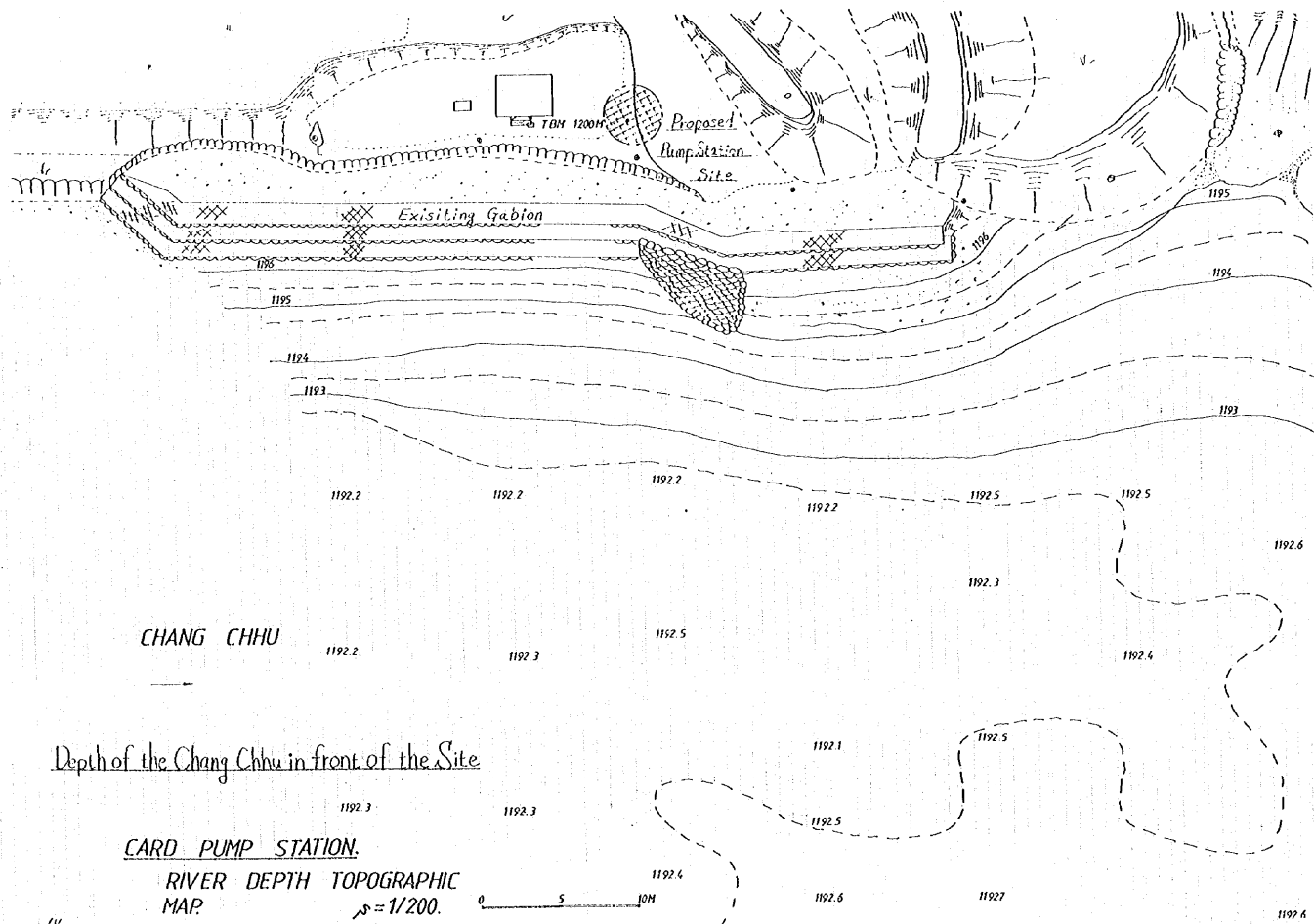
CARD PUMP STATION.

NO. 5 (L_m + 50M)

GH = 1201.03.

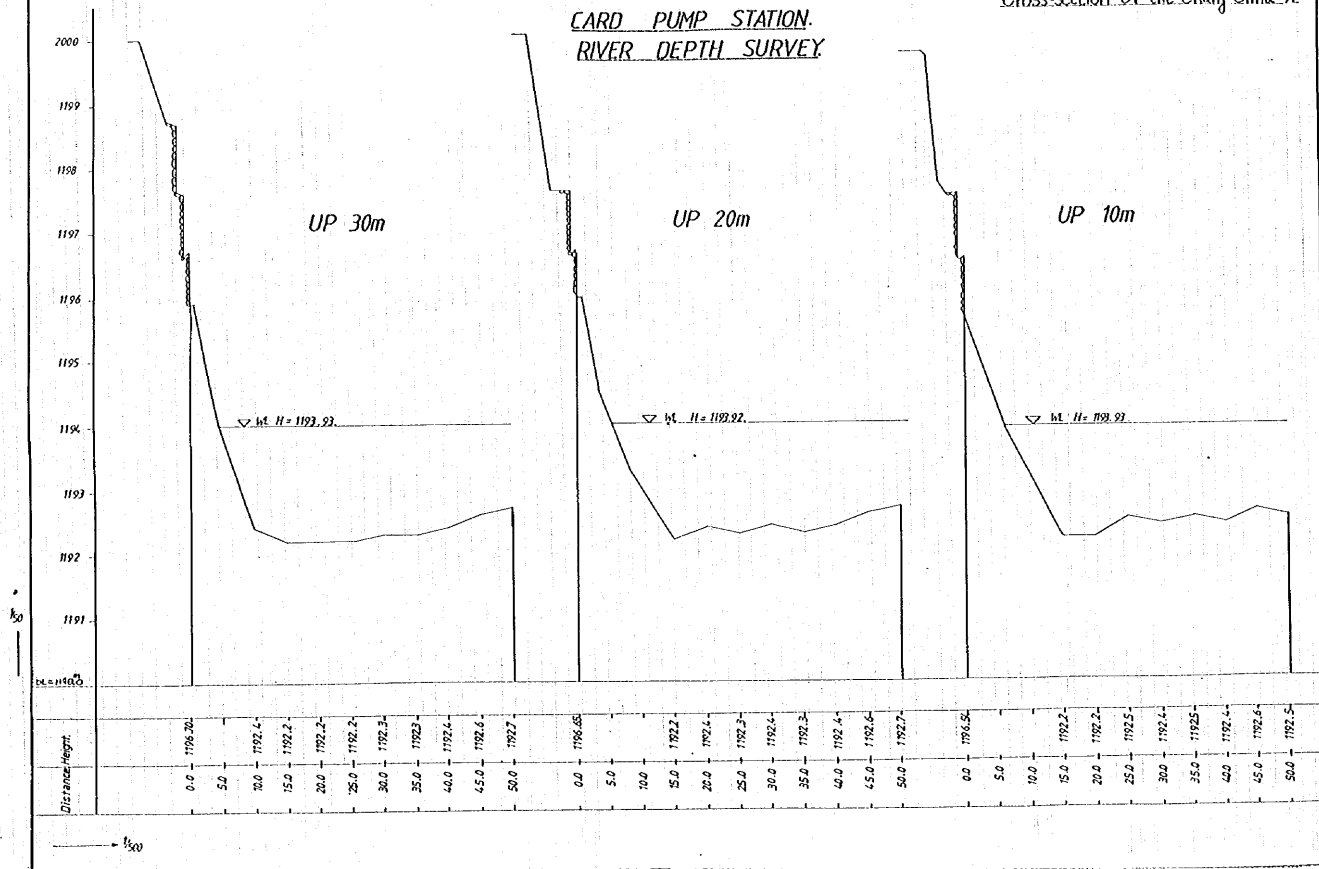
Cross-section of River Bank 11/1





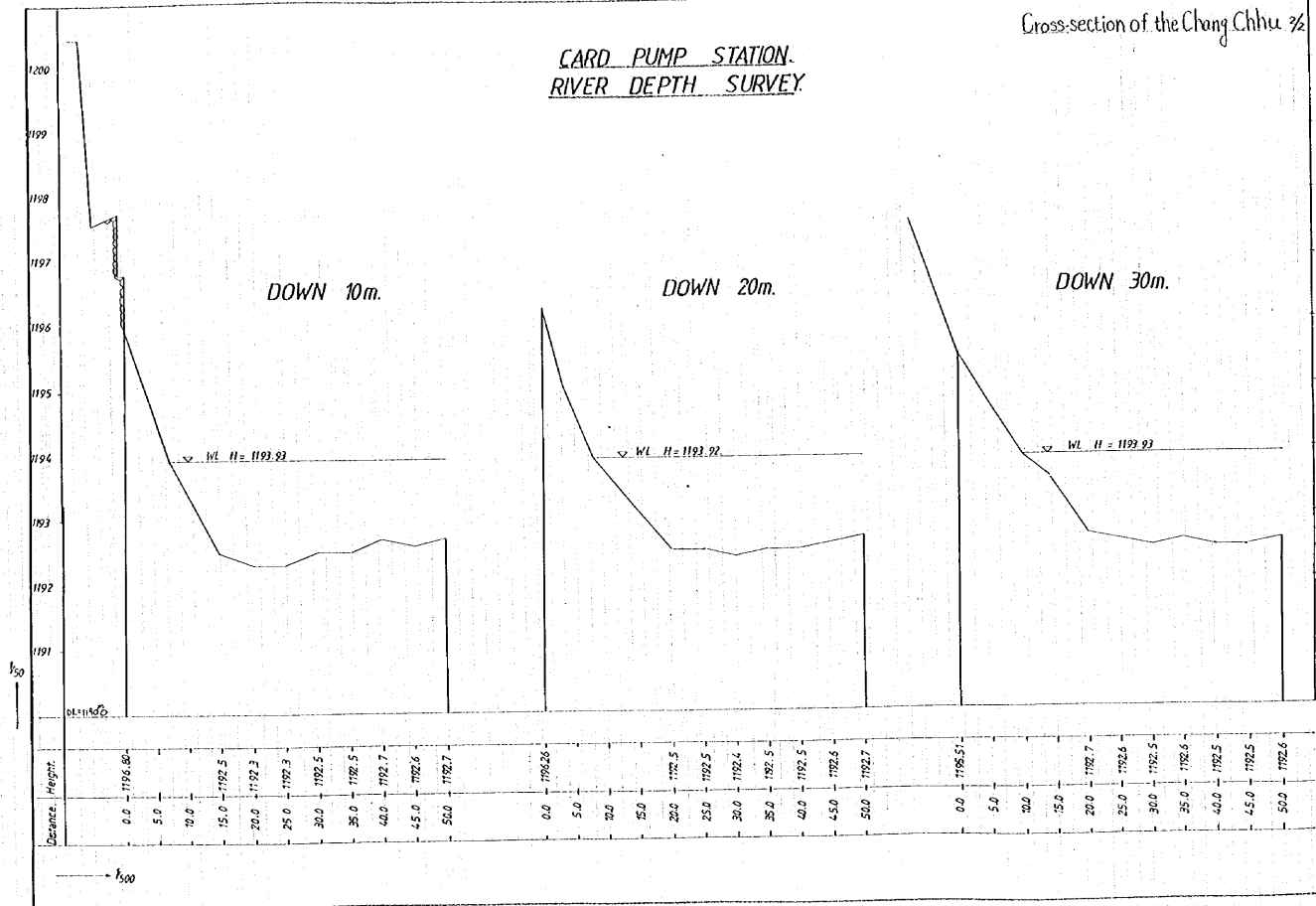
CARD PUMP STATION. RIVER DEPTH SURVEY

Cross-section of the Chang Chhu ½

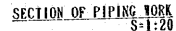


Cross-section of the Chang Chhu ¾

CARD PUMP STATION
RIVER DEPTH SURVEY



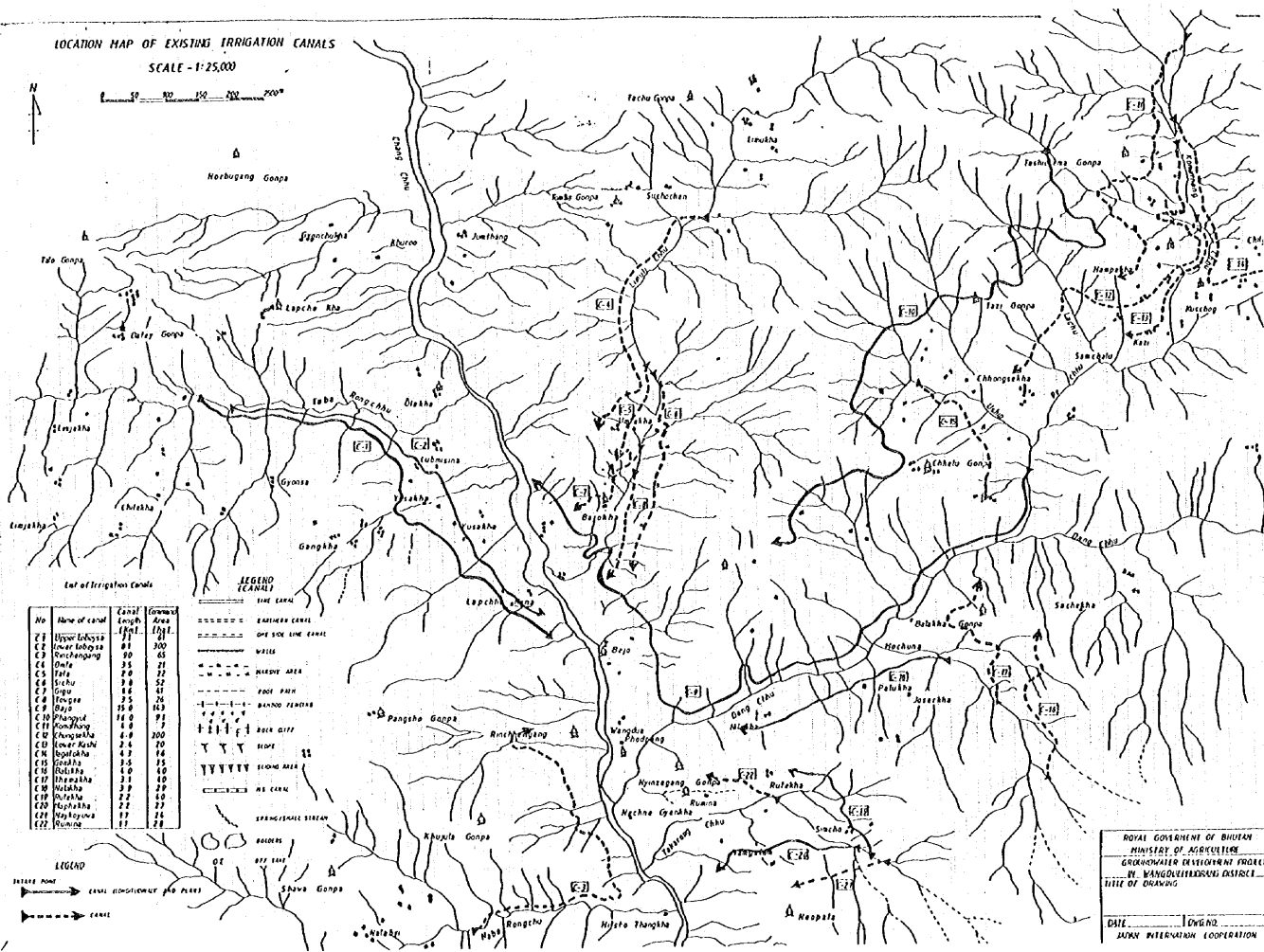
SCALE H=1:1000 , V=1:200

[illegible]

IRRIGATION CANALS

SCALE - 1:25,000

1 50 100 150 200 250



ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF AGRICULTURE
GROUNDWATER DIVISION
IN WANGDUEIDRANG DISTRICT
TITLE OF DRAWING

DATE 10/26/62 10/26/62
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