

THE STUDY ON RURAL ELECTRIFICATION
IMPLEMENTATION PLAN BY RENEWABLE ENERGY
IN THE REPUBLIC OF BOLIVIA
JAPAN INTERNATIONAL COOPERATION AGENCY

Figura 2.8
Ubicacion de la Estacion W.L. del Rio Tequeje
(Ixamas/ Iturrealde/ La Paz)

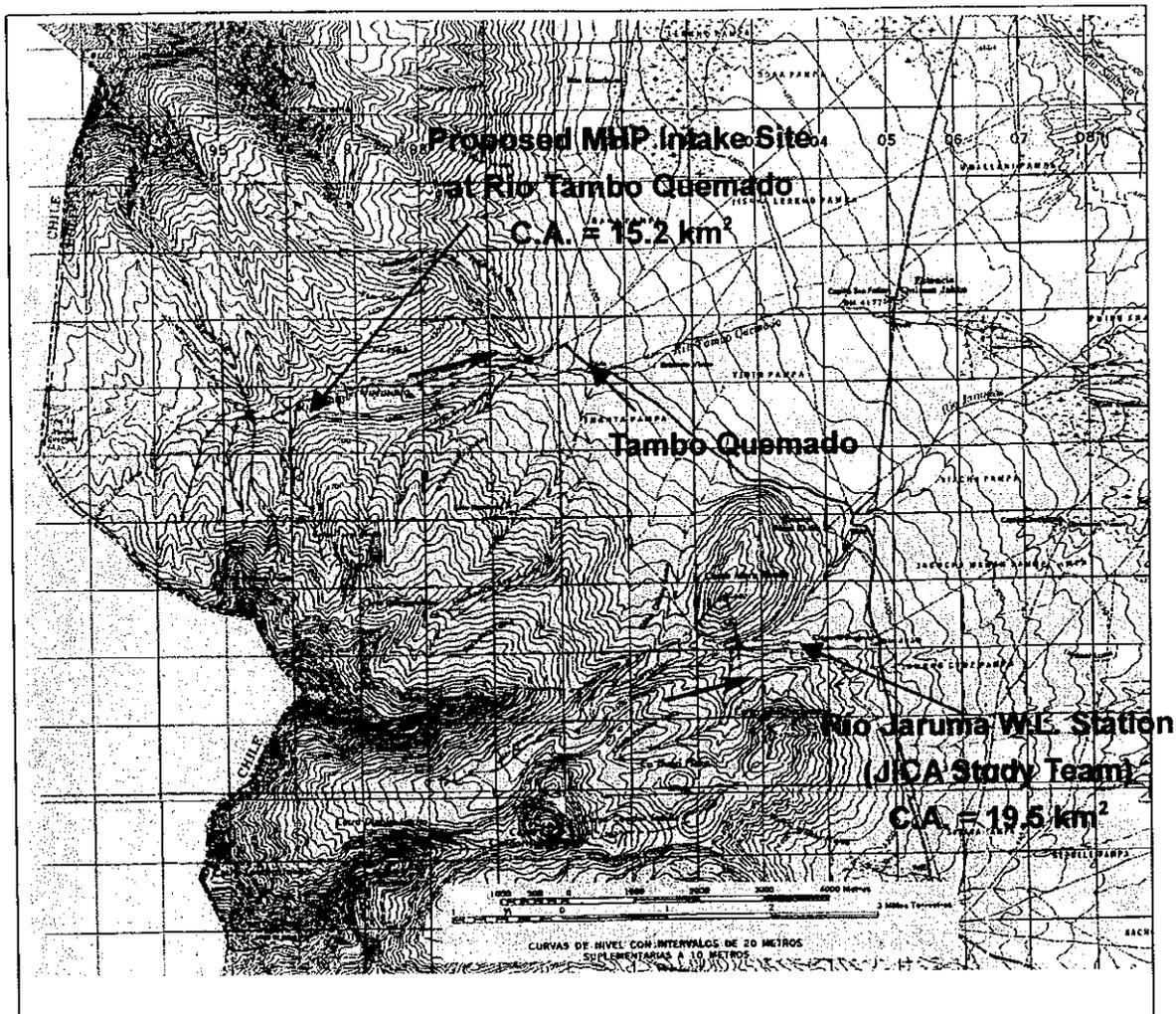
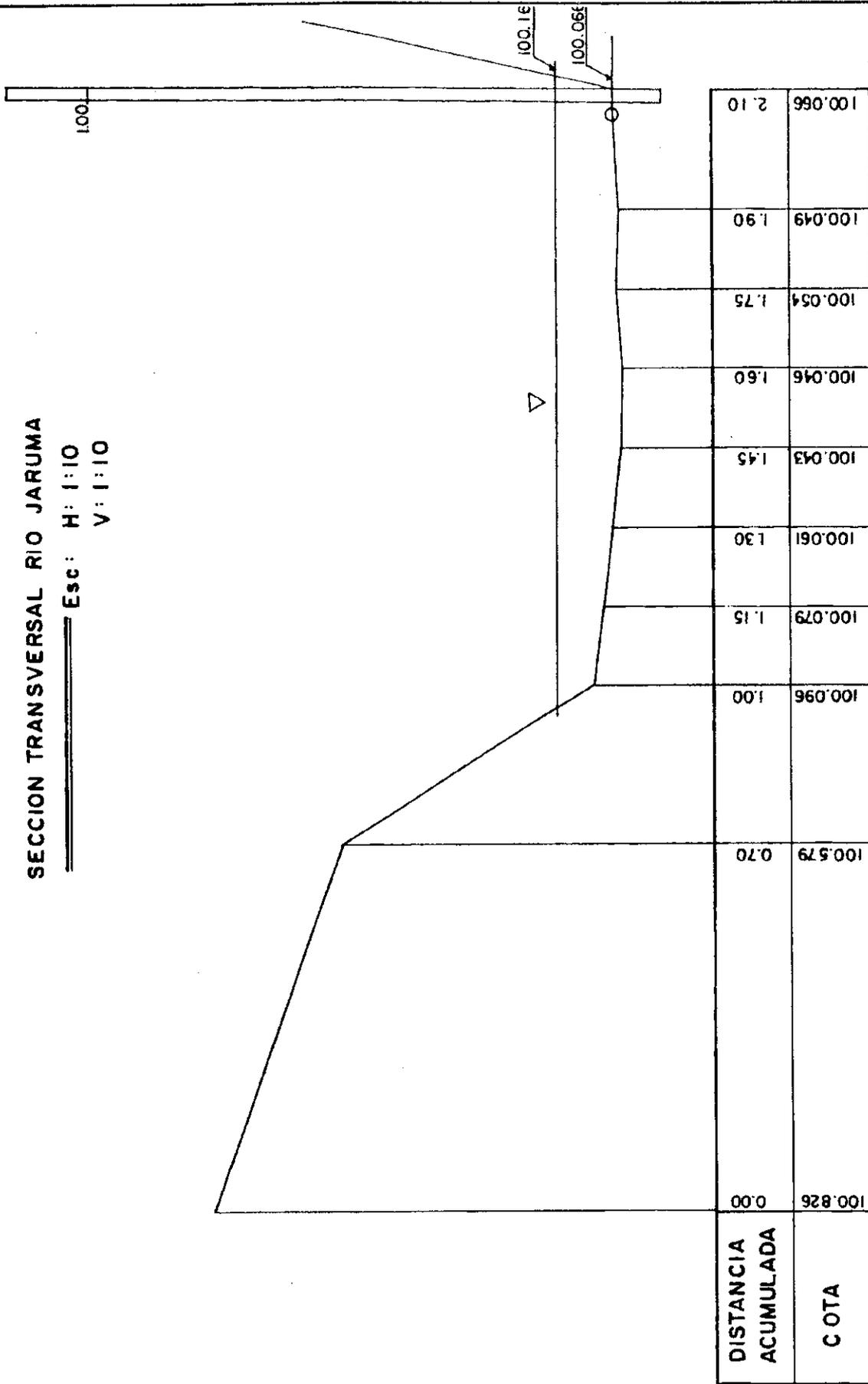


Figura 2.10 **Ubicación de la Estación W.L. del Río Jaruma**
(Chachacomani/ Turco/ Sajama /Oruro)

SECCION TRANSVERSAL RIO JARUMA

Esc: H: 1:10
V: 1:10



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Figura 2.11

Corte Transversal de la Estacion W.L. del Rio Jaruma
(Chachacomani/ Turco/ Sajama /Oruro) [6 Nov. 1999]

DEPARTAMENTO DE ORURO



LEGENDA	
.....	Distrito
-----	Municipio
-----	Municipio
-----	Ciudad
-----	Centro de Cultura
-----	Centro de Cultura
-----	Proyecto de Energía
-----	Comunidad

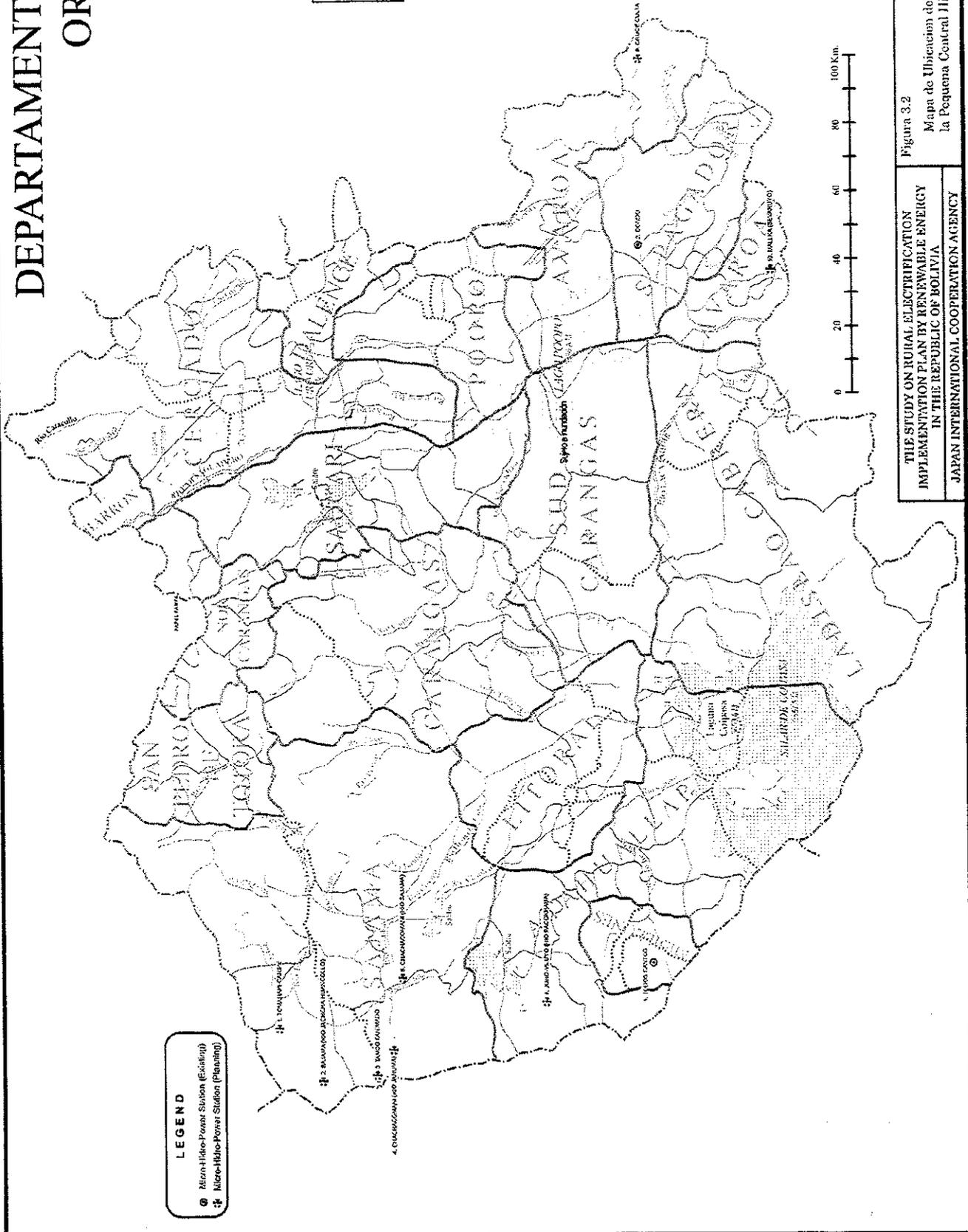


Figura 3.2

Mapa de Ubicación del Proyecto de la Pequeña Central Hidroeléctrica (Oruro)

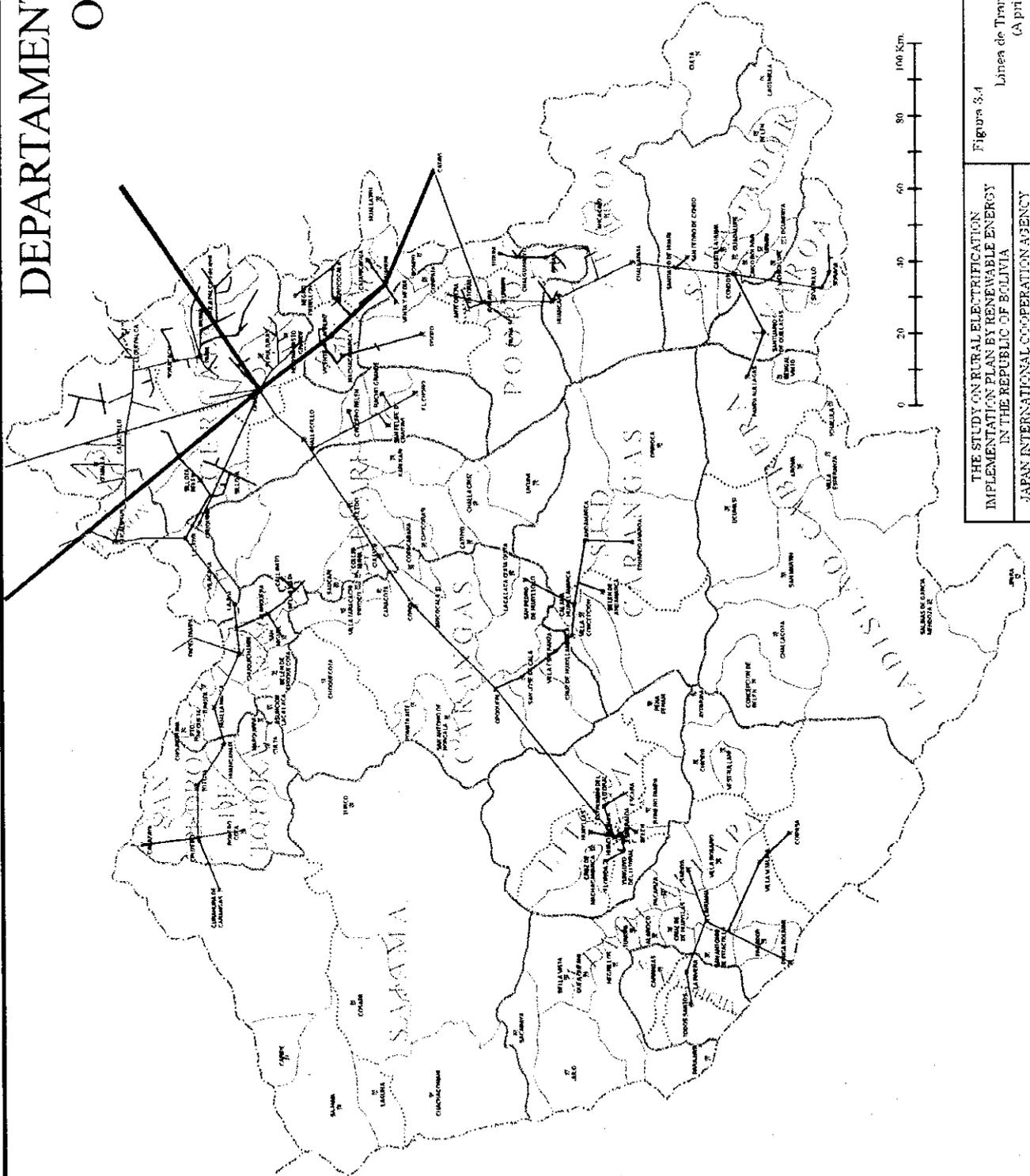
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DEPARTAMENTO DE ORURO



LEGENDA	
-----	Departamento
-----	Municipio
-----	Cantón
⊙	Capital de Cantón

LEGENDA de Transmisión Lineal	
-----	10, 20 and 30 KV (Emit. 2000)
-----	35, 40 and 50 KV (Emit. 2000)
-----	75, 80 and 100 KV (Emit. 2000)
-----	135, 140 and 150 KV (Emit. 2000)
-----	150, 160 and 170 KV (Emit. 2000)
-----	220 KV (Emit. 2000)

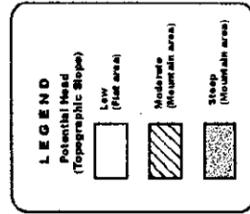
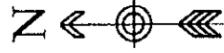


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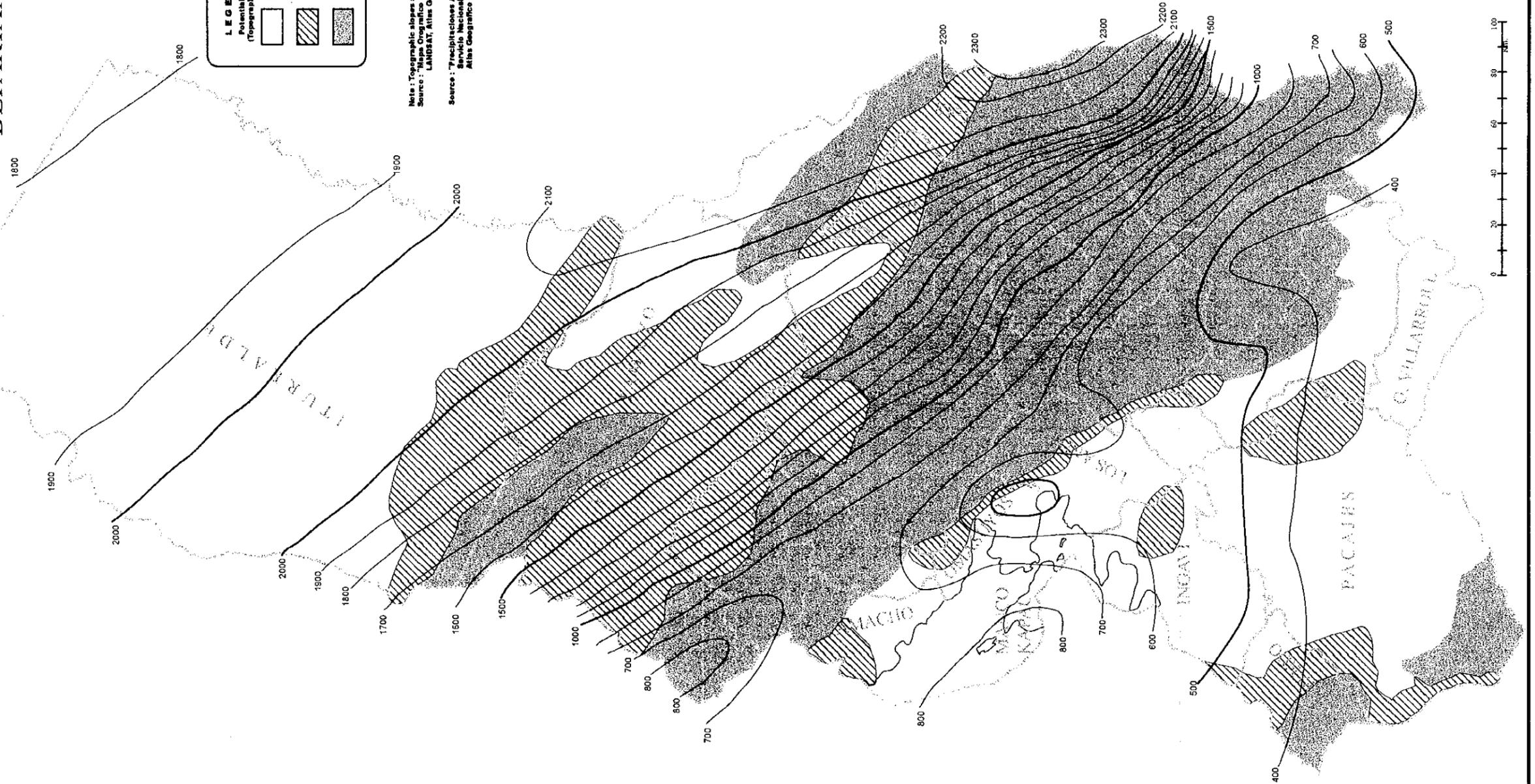
Figura 3-4
Línea de Transmisión Existente (Oruro)
(A principios de 2001)



DEPARTAMENTO DE LA PAZ



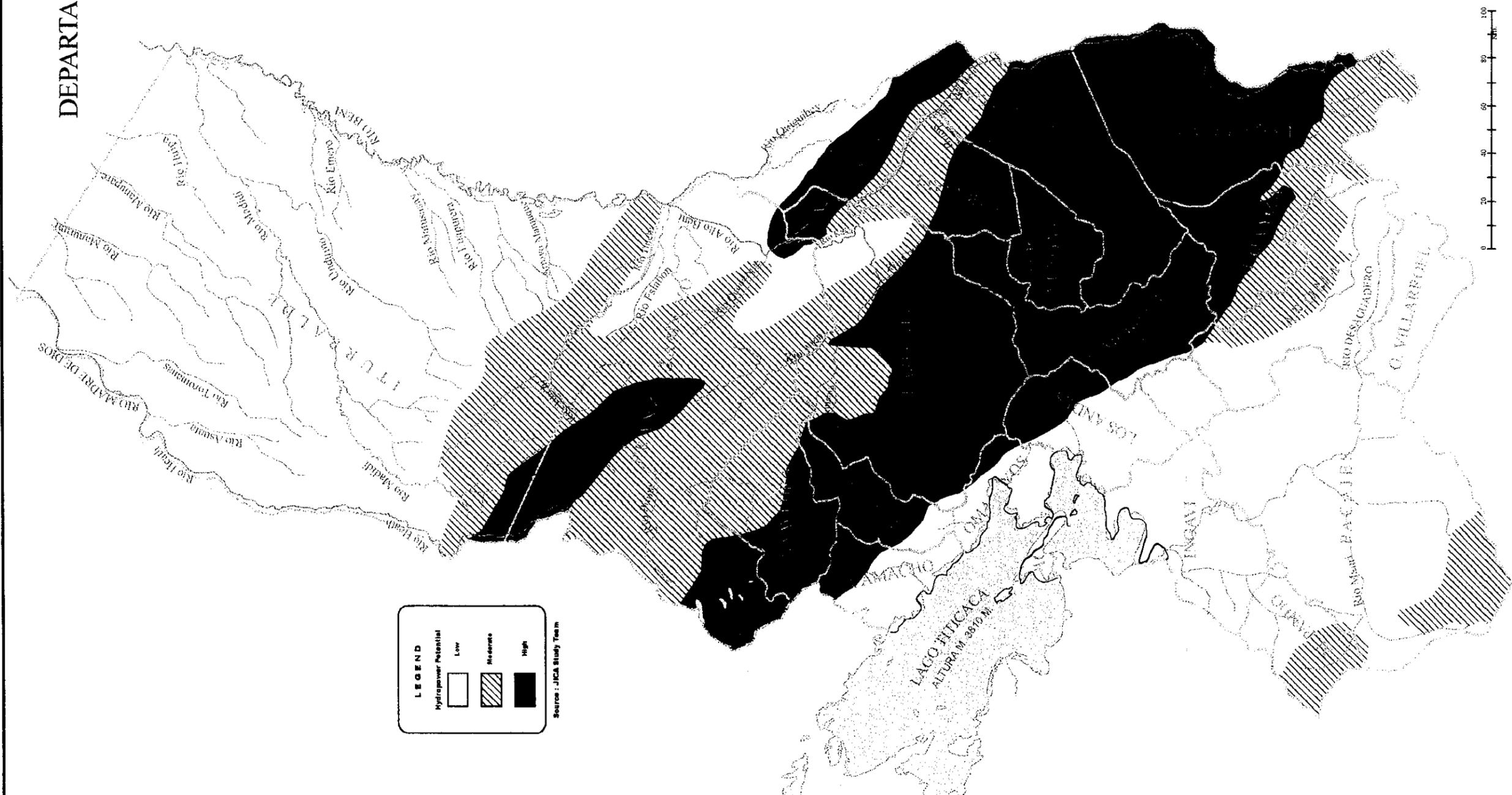
Nota: Topographic slopes are decided based on the LANDSAT image.
 Source: "Mapa Orografico de Bolivia", Mapa Base, Con Mensajes de Imagenes LANDSAT, Atlas Geografico de la Republica Boliviana, I.C.N.
 Source: "Precipitaciones Anuales Período 1951 - 1997", Servicio Nacional de Meteorología e Hidrología, Atlas Geografico de la Republica Boliviana, I.C.N.



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Figura 4.1
 Mapa Isohyetal de la Precipitacion Pluvial
 con Potencial de Cabecera (La Paz)

DEPARTAMENTO DE
LA PAZ



LEGEND

Hydropower Potential

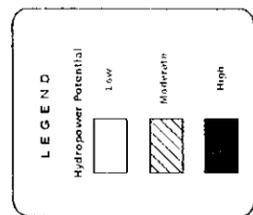
Low	Medium	High

Source : JICA Study Team

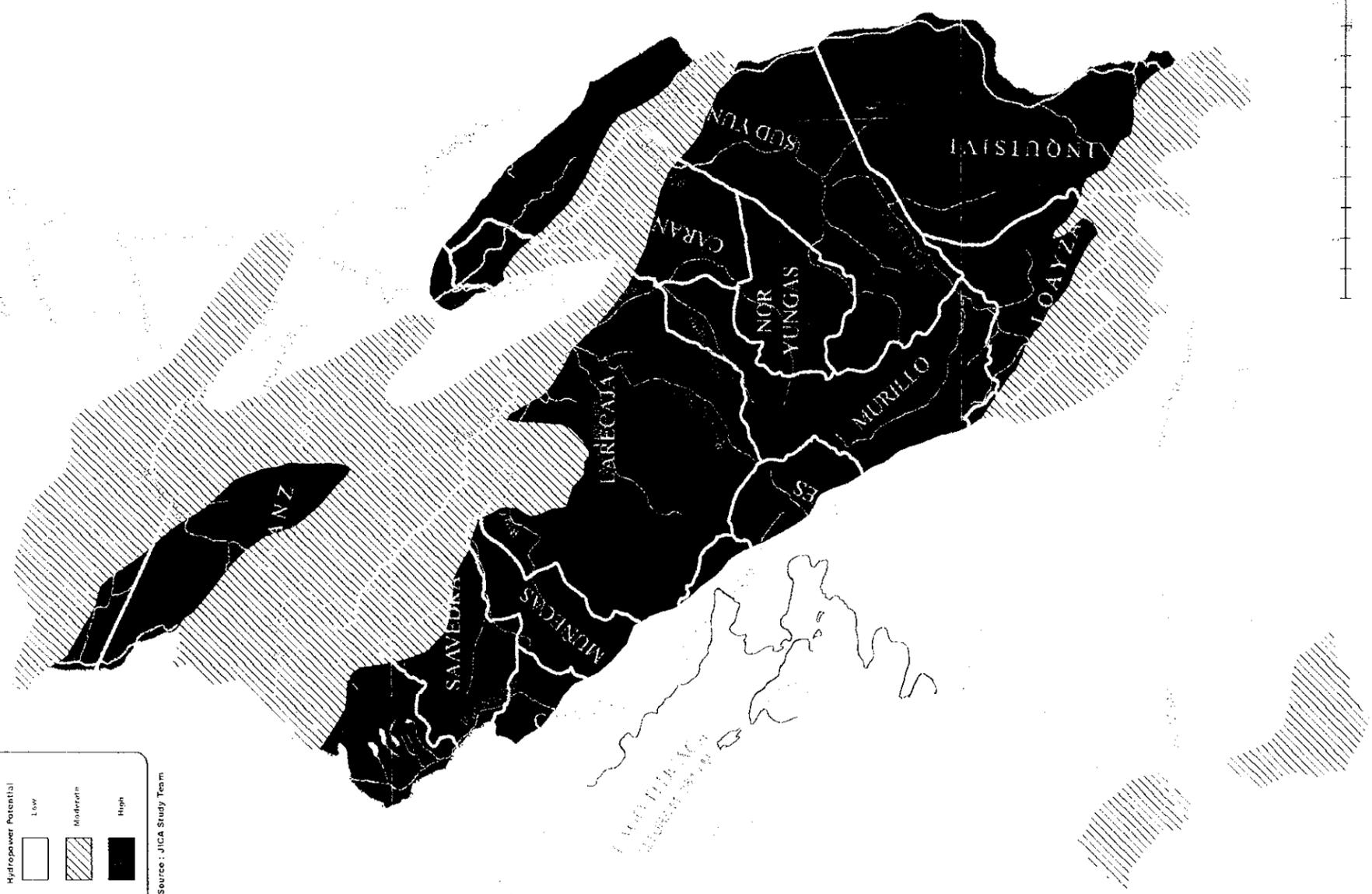
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Figura 4.3
Mapa Potencial de Centrales Hidroelectricas
(La Paz)

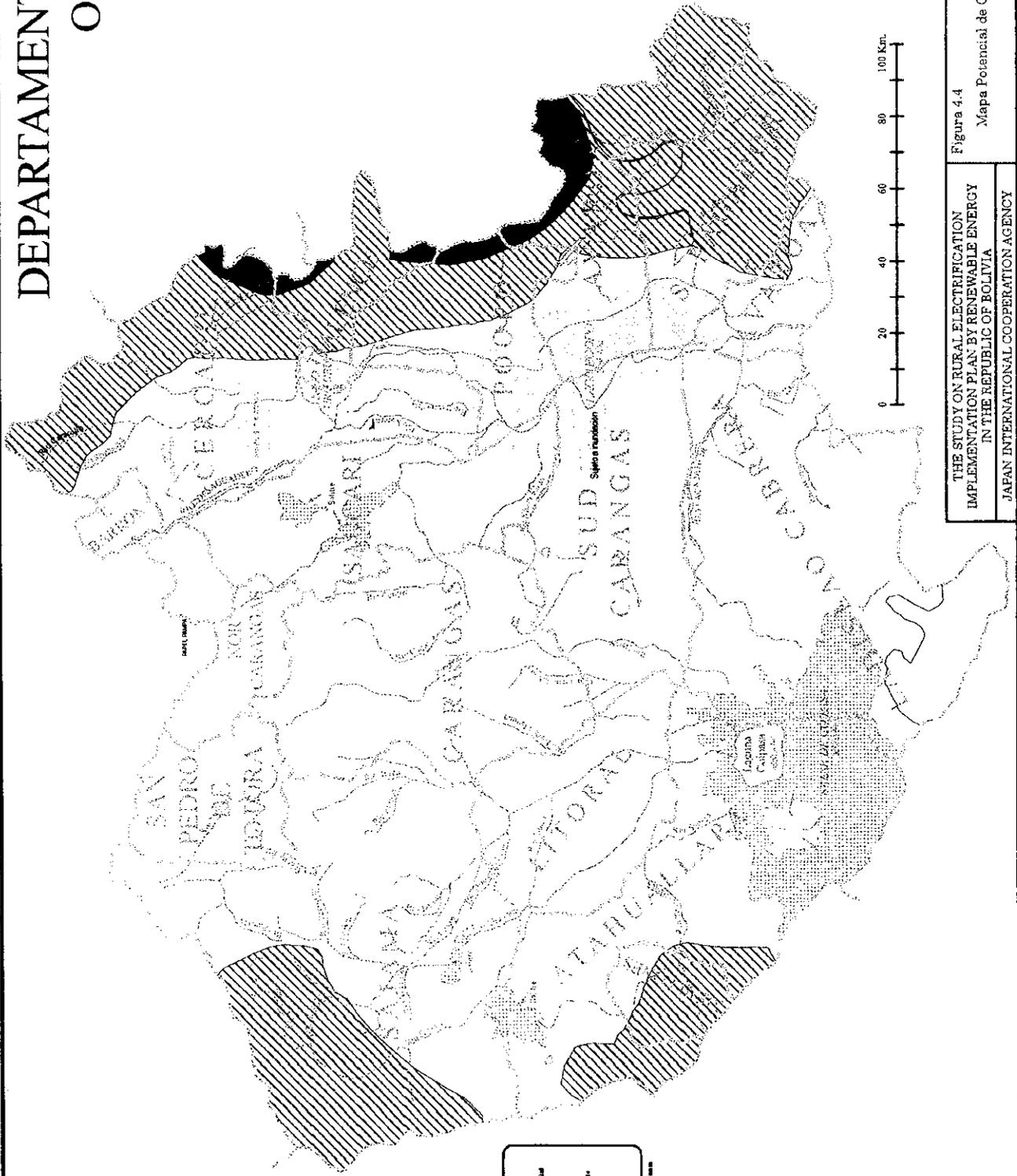
DEPARTAMENTO DE
LA PAZ



Source : JICA Study Team



DEPARTAMENTO DE ORURO



LEGEND

	Hydroelectric Potential
	Low
	Medium
	High

Source: JICA Study Team

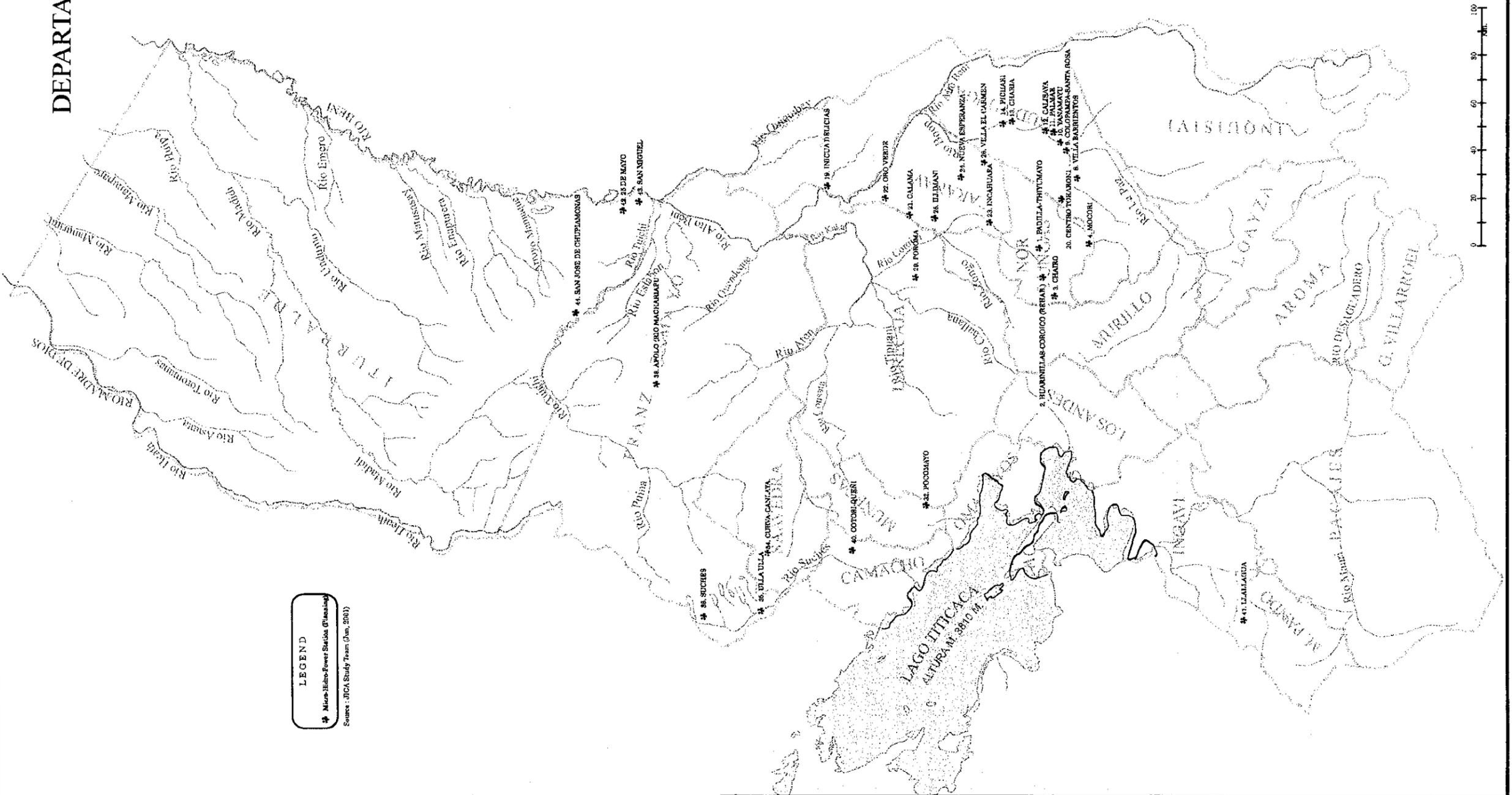


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Figura 4.4
Mapa Potencial de Centrales Hidroeléctricas
(Oruro)



DEPARTAMENTO DE LA PAZ



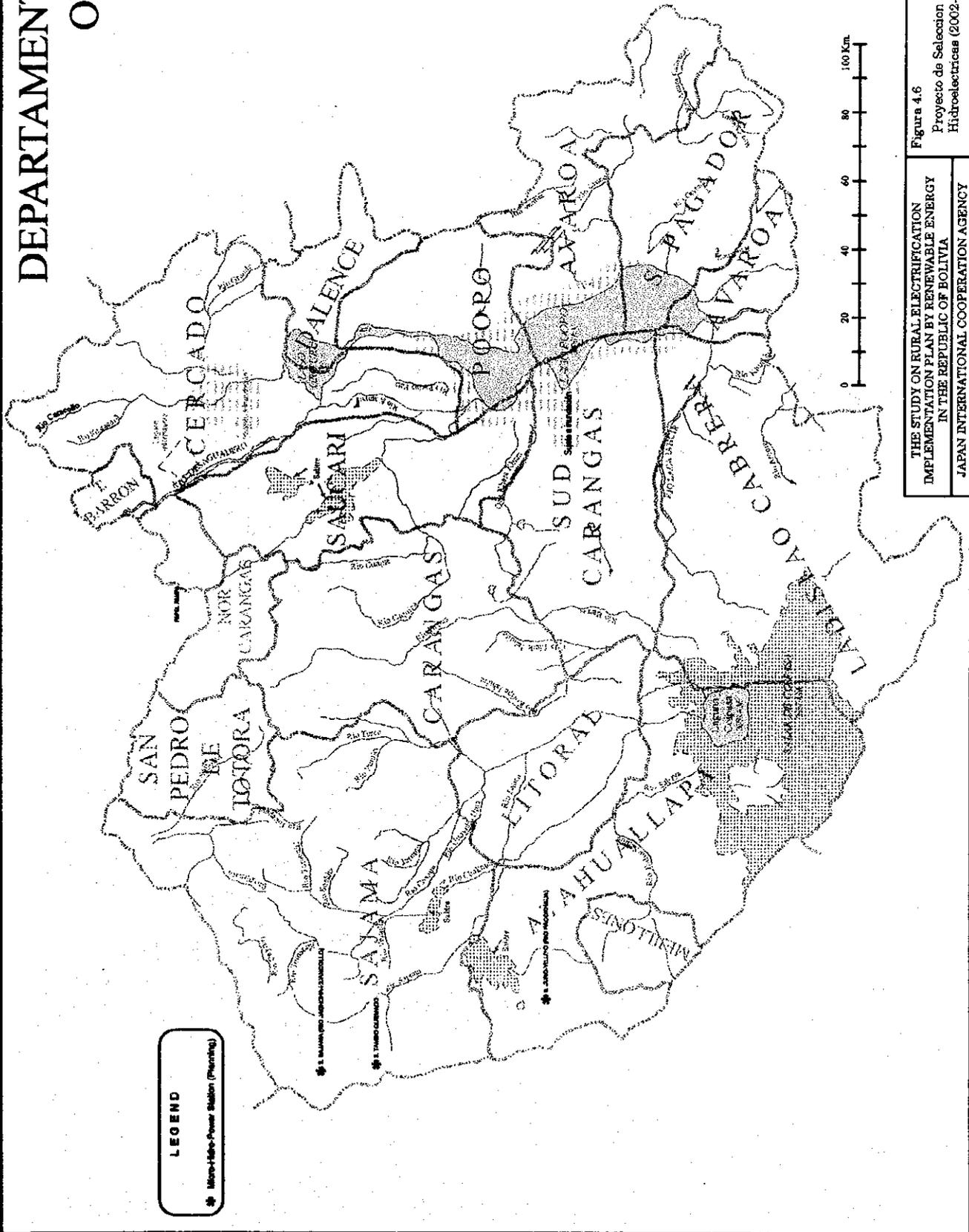
LEGEND
 * Micro-Hidro-Power Station (Macahidro)
 Source: JICA Study Team (Jan. 2003)

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Figura 4.5
 Proyecto de Selección Prioritaria de Micro Centrales
 Hidroeléctricas (2002-2006, 2007-2011) (La Paz)



DEPARTAMENTO DE ORURO

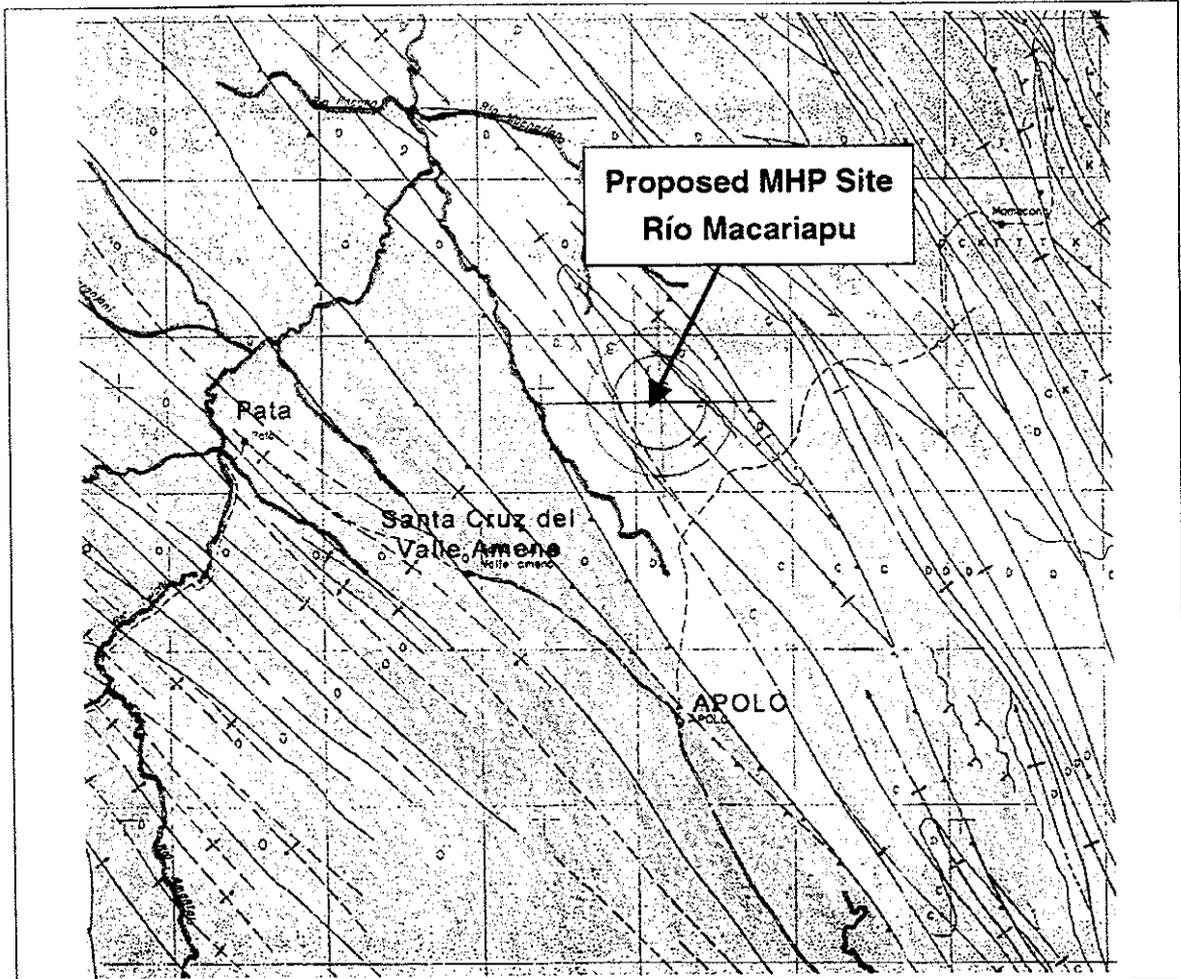


LEGEND
 Micro-Hidro-Power Station (Proposed)



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Figure 4.6
 Proyecto de Selección Prioritaria de Micro Centrales
 Hidroeléctricas (2002-2006, 2007-2011) (Oruro)



Source: Centro de Investigacion y Aplicacion de Sensores Remitos Ciaser - Geobol", Estudio Integrado de Los Recursos Naturales del Departamento de La Paz. Geologia, Interpretado y Compilado por: Ing. Raul Ballon Ayllon, Apolo, (1985)

LEGEND

- C** **Carboniferous [Carbonifero]** (3.5 ~ 2.7 hundreds million years ago)
 - a) Gritty, limelight with thin diamictitas intercalations. (Altiplano and Oriental Mountain range)
[Areniscas, limolitas con delgadas intercalaciones de diamictitas. (Altiplano y Cordillera Oriental)]
 - b) Diamictitas, limelight, gritty, gritty conglome resides and diamictitas with intercalations of gritty and conglomerates in the superior part. (Subandino North)
[Diamictitas, limolitas, areniscas, areniscas conglome ráticas y diamictitas con intercalaciones de areniscas y conglomerados en la parte superior. (Subandino Norte)]
- D** **Devonian [Devonico]** (4.0 ~ 3.5 hundreds million years ago)
Shale, gritty and limelight [Lutitas, areniscas y limolitas]
- **Ordovician [Ordovico]** (4.9 ~ 4.3 hundreds million years ago)
Shale, gritty and limelight [Lutitas, areniscas y limolitas]

Figura 5.1 Mapa Geológico de Apolo

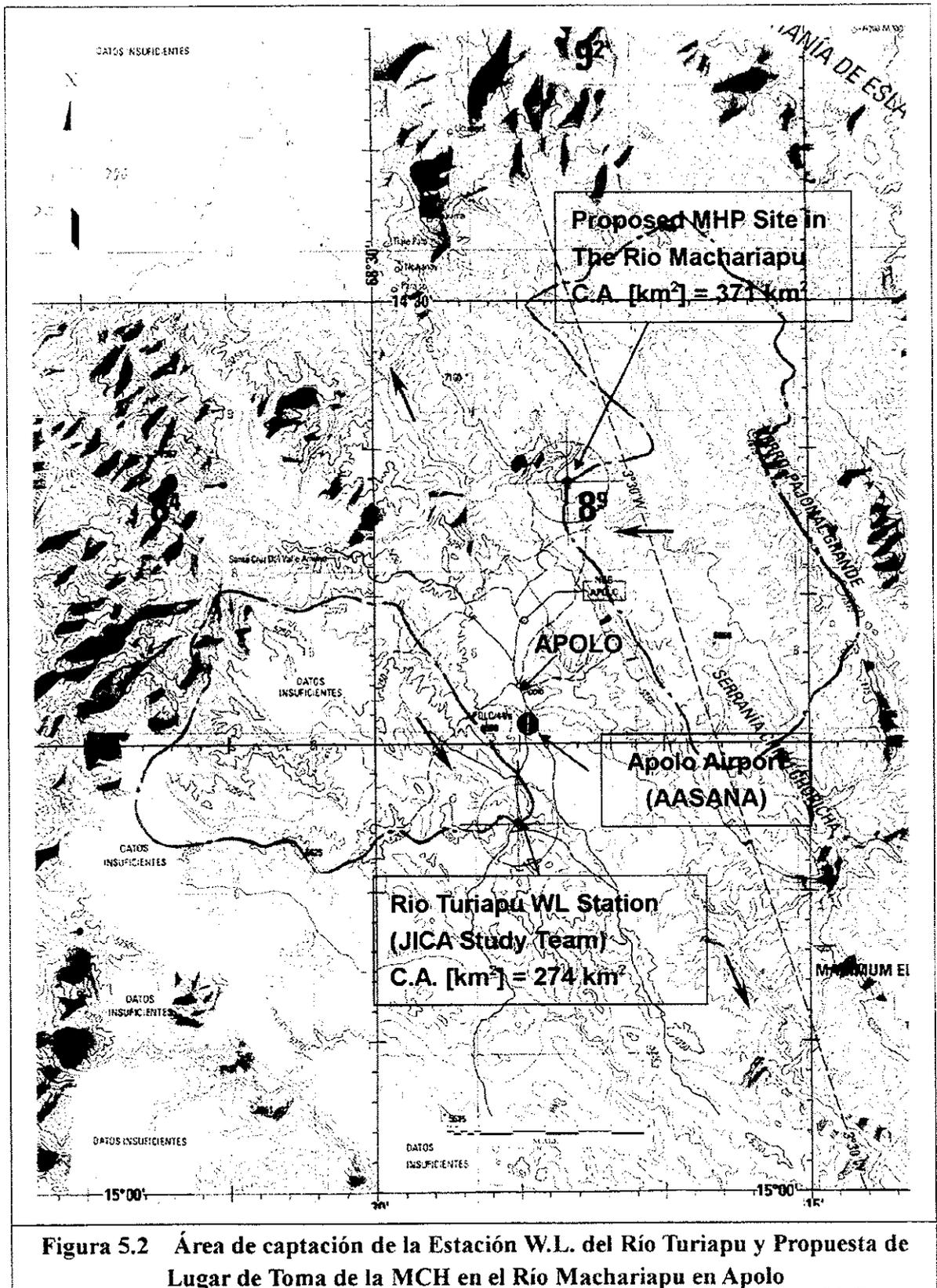


Figura 5.2 Área de captación de la Estación W.L. del Río Turiapu y Propuesta de Lugar de Toma de la MCH en el Río Machariapu en Apolo

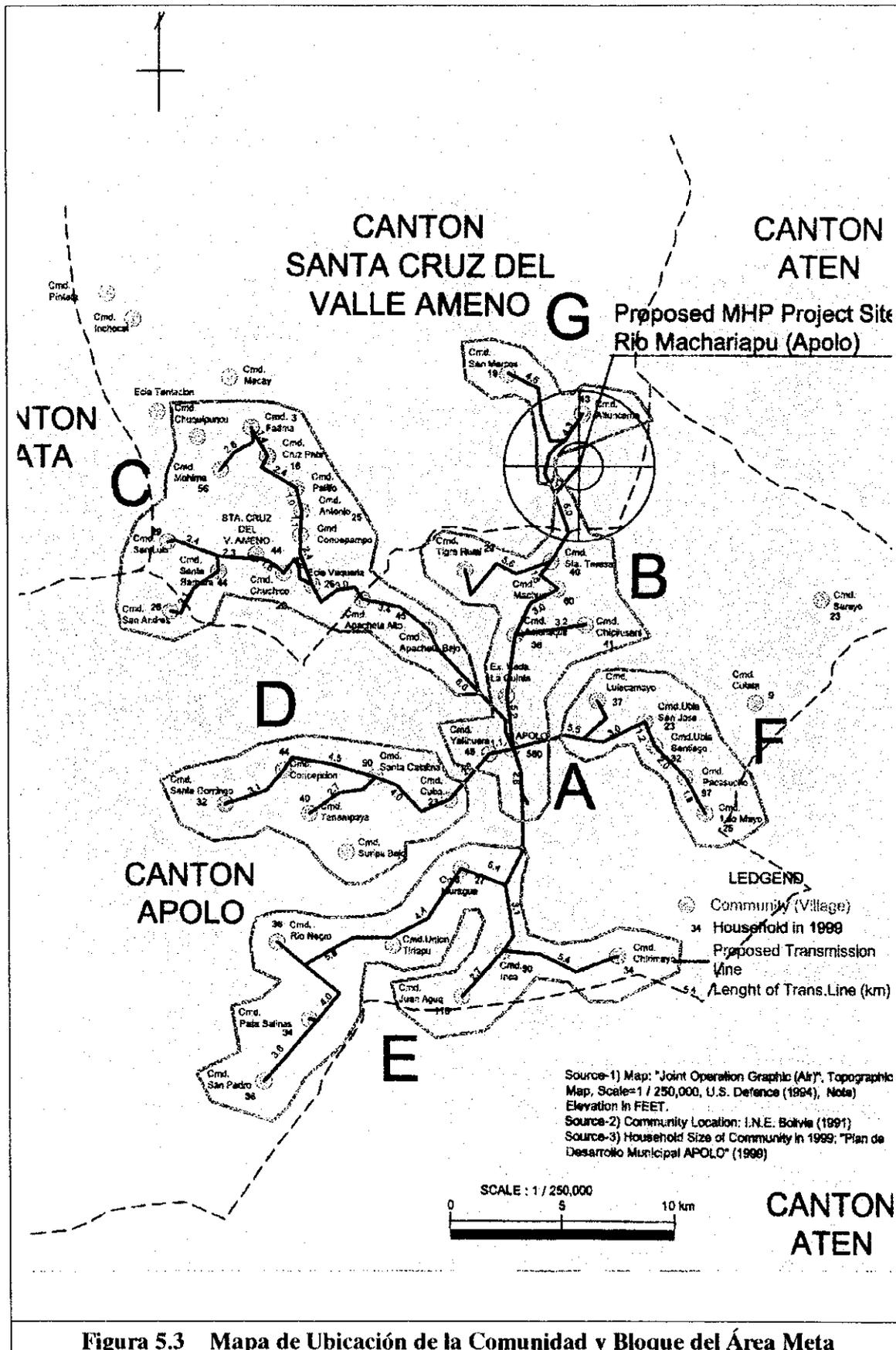


Figura 5.3 Mapa de Ubicación de la Comunidad y Bloque del Área Meta

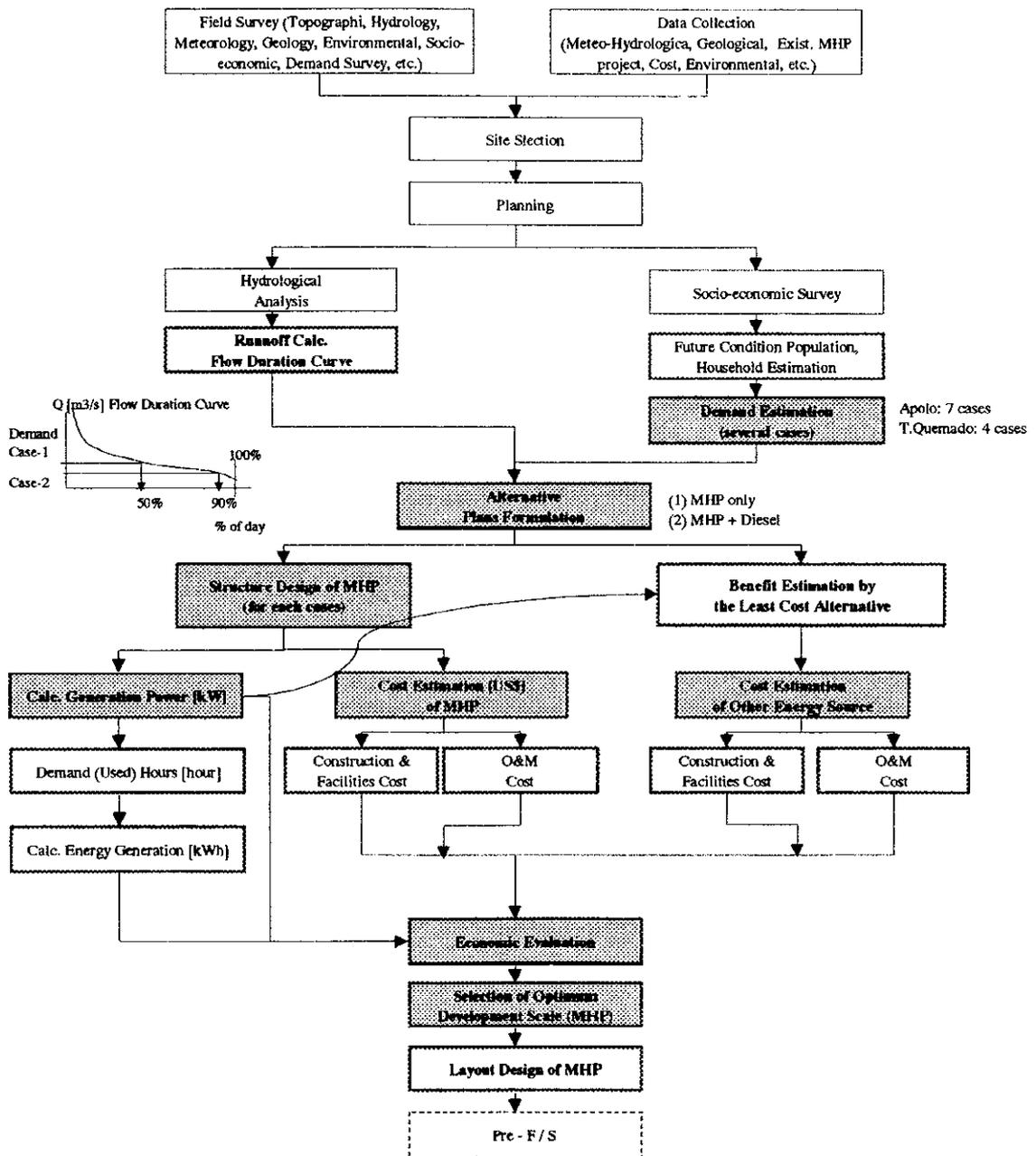
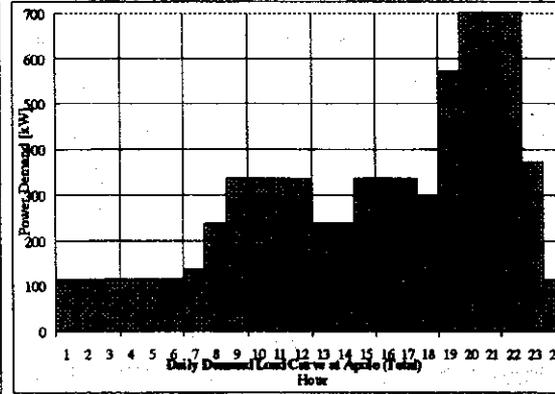
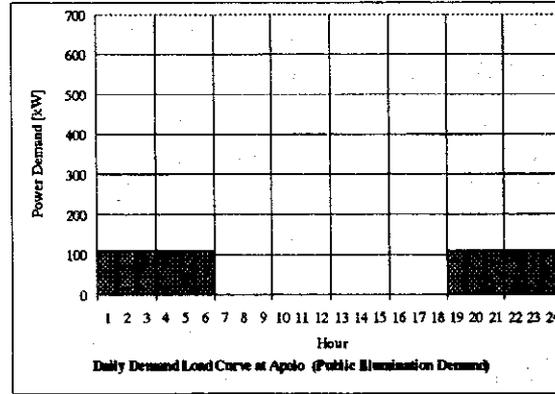
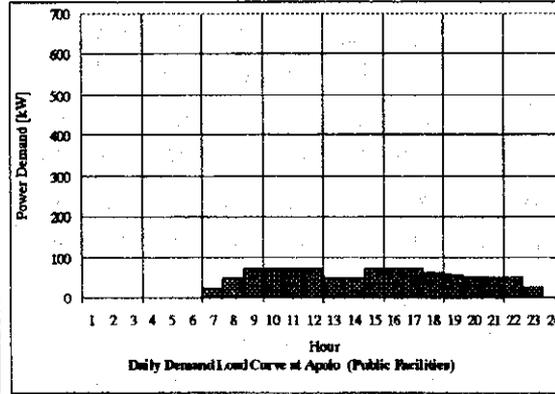
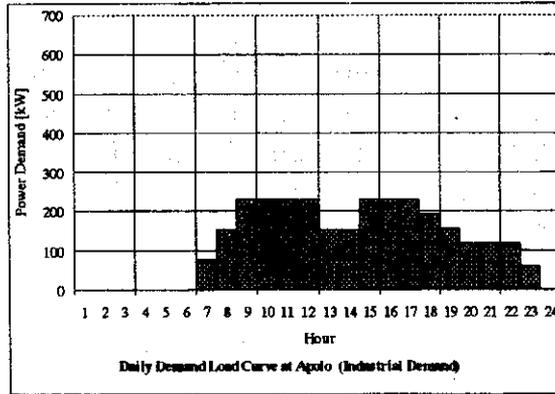
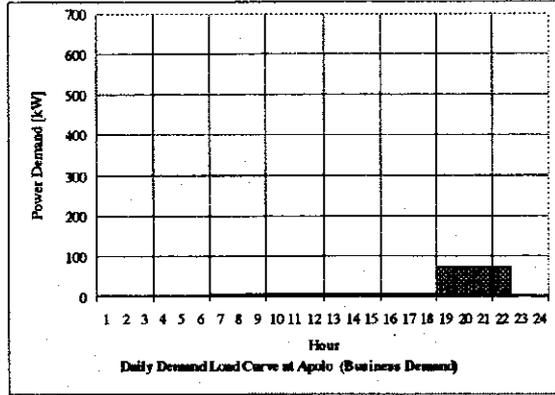
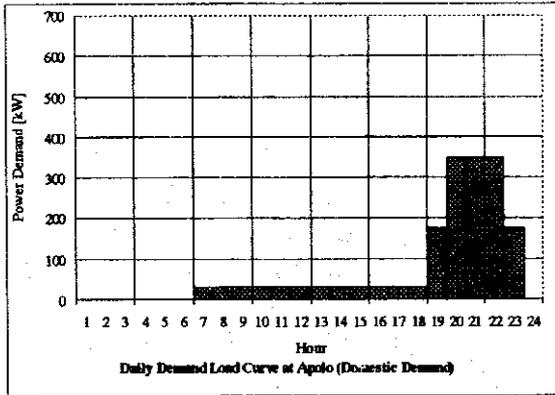


Figura 5.4 Flujo de Trabajo de la Formulación del Esquema Optimo de Desarrollo de la Pequeña Central Hidroeléctrica

Estimated Demand for Apolo MHP (2005)
[Case-7, Peak 700kW]

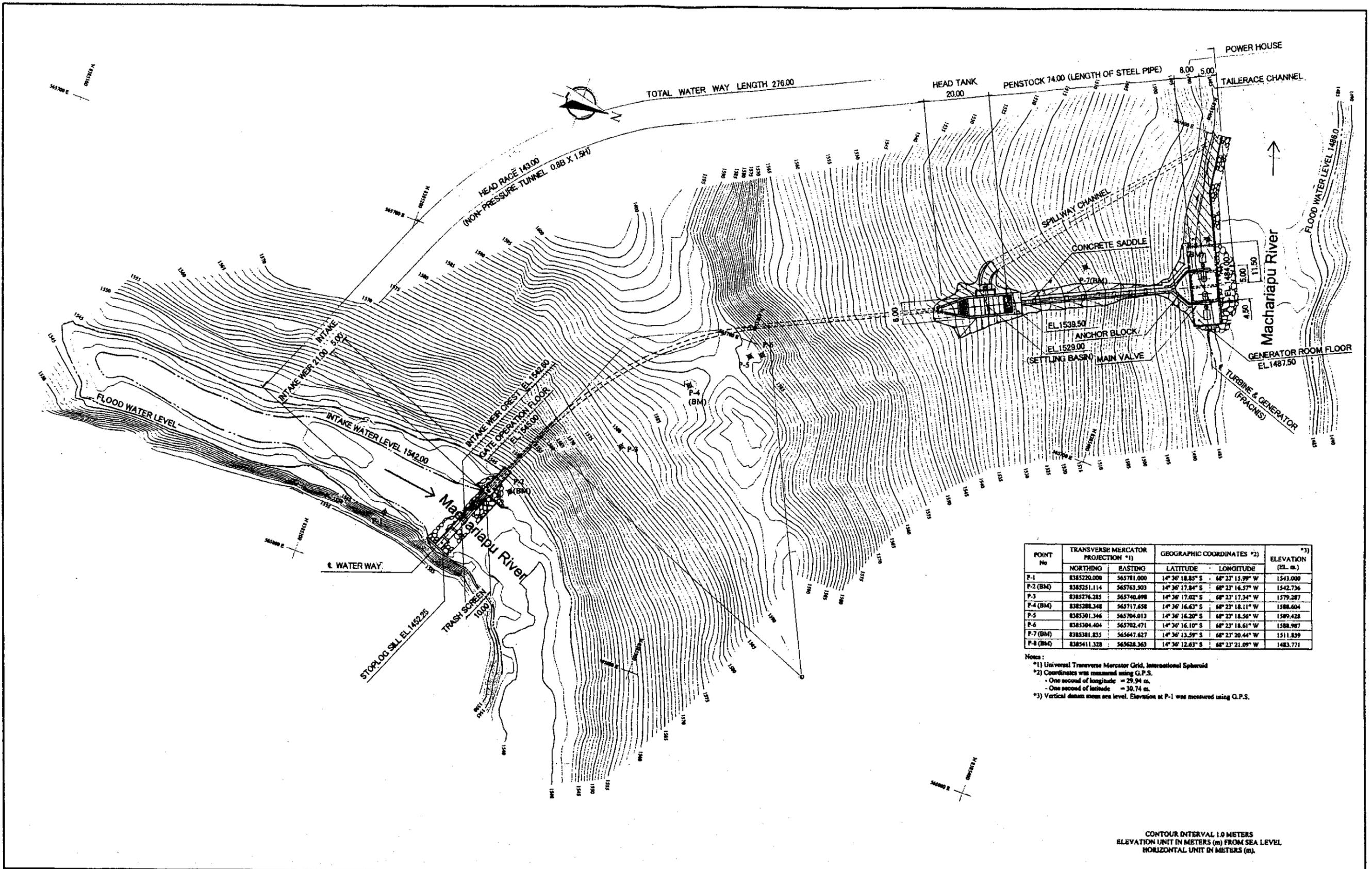
	Midnight					Day time												Evening				Midnight		Daily Total Energy Demand (kWh/D)	Monthly Total Energy Demand (kWh/M)	Annual Total Energy Demand (kWh/Y)			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23				24		
	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00				23:00	24:00	
1) Domestic	0	0	0	0	0	0	30	30	30	30	30	30	30	30	30	30	30	30	30	30	175	150	150	150	175	0	1,760	51,860	642,400
2) Business	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3) Industry	0	0	0	0	0	0	77	153	200	230	230	230	153	153	230	230	153	153	153	157	120	120	120	157	0	2,917	87,500	1,064,593	
4) Public (Public Facilities)	110	110	110	110	110	110	23	47	70	70	70	70	47	47	70	70	70	70	70	167	160	160	160	167	110	2,260	68,090	827,943	
(Public Illumination)	110	110	110	110	110	110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	110	110	110	110	110	110	137	237	337	337	337	337	237	237	337	337	337	337	294	571	703	703	703	571	113	7,343	220,330	2,680,925	



(Case-7, Peak Demand = 700kW)

Figura 5.5 Estimación de la Curva Diaria de Carga para el Proyecto de la MCH de Apolo



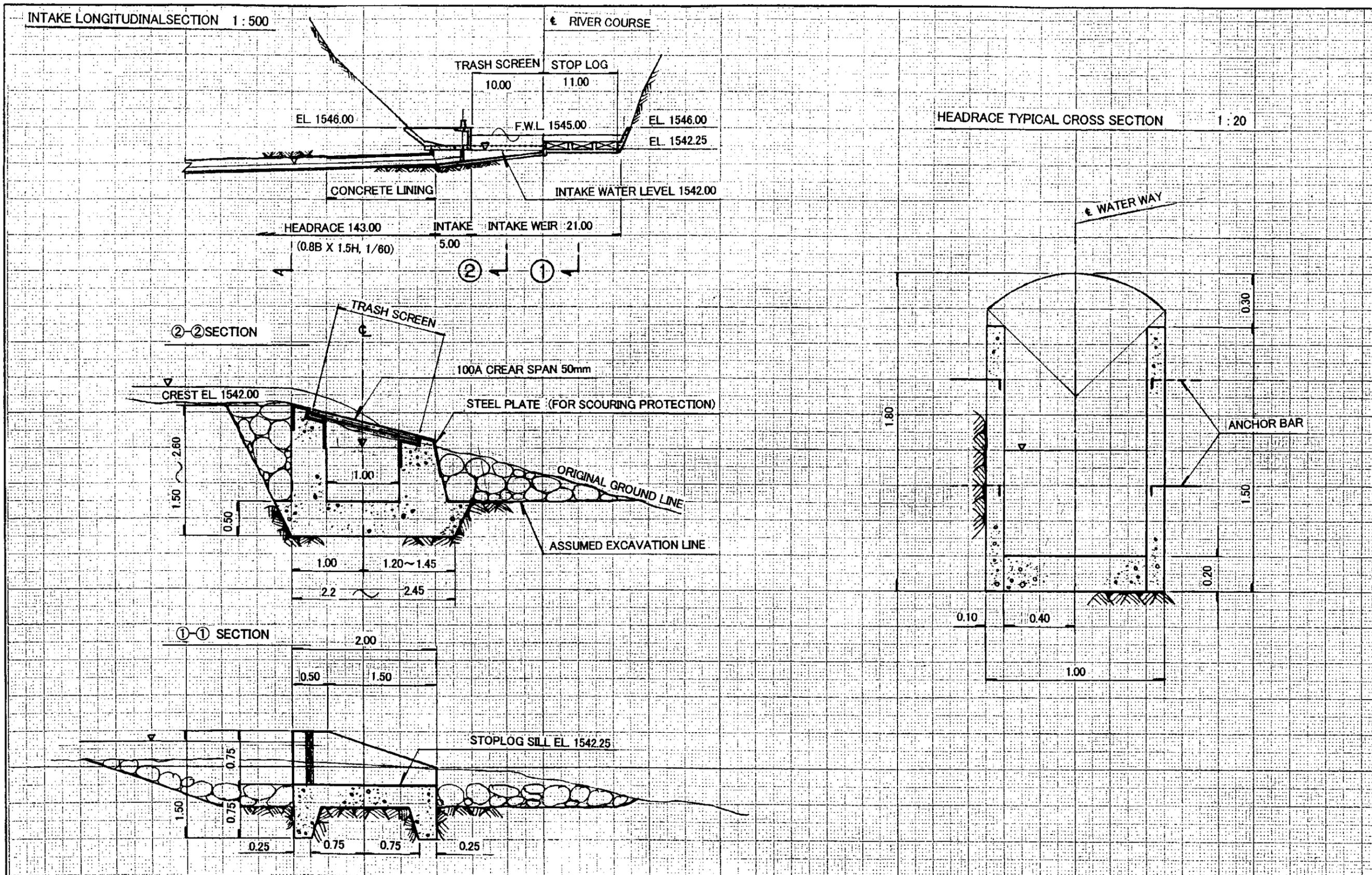


POINT No	TRANSVERSE MERCATOR PROJECTION *1)		GEOGRAPHIC COORDINATES *2)		ELEVATION (EL. m.)
	NORTHING	EASTING	LATITUDE	LONGITUDE	
P-1	8385220.000	565781.000	14° 36' 18.85" S	68° 23' 15.99" W	1543.000
P-2 (BM)	8385251.114	565763.503	14° 36' 17.84" S	68° 23' 16.57" W	1542.736
P-3	8385276.285	565740.498	14° 36' 17.02" S	68° 23' 17.34" W	1579.287
P-4 (BM)	8385288.348	565717.458	14° 36' 16.63" S	68° 23' 18.11" W	1588.604
P-5	8385301.346	565704.013	14° 36' 16.20" S	68° 23' 18.50" W	1589.428
P-6	8385304.404	565702.471	14° 36' 16.10" S	68° 23' 18.61" W	1588.987
P-7 (BM)	8385381.835	565647.627	14° 36' 13.59" S	68° 23' 20.44" W	1511.859
P-8 (BM)	8385411.328	565628.363	14° 36' 12.63" S	68° 23' 21.09" W	1483.771

Notes:
 *1) Universal Transverse Mercator Grid, International Spheroid
 *2) Coordinates was measured using G.P.S.
 - One second of longitude = 29.94 m.
 - One second of latitude = 30.74 m.
 *3) Vertical datum mean sea level. Elevation at P-1 was measured using G.P.S.

CONTOUR INTERVAL 1.0 METERS
 ELEVATION UNIT IN METERS (m) FROM SEA LEVEL
 HORIZONTAL UNIT IN METERS (m)

THE STUDY ON RURAL ELECTRIFICATION IMPLEMENTATION PLAN BY RENEWABLE ENERGY IN THE REPUBLIC OF BOLIVIA	JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION: APOLO / FRANZ TAMAYO PROVINCE LA PAZ DEPARTAMENT MACHARIAPU RIVER	Figura 5.6 Plano de la MCH de Apolo (1/3) (Río Machariapu)	SCALE: 1: 1000	DATE: JULY - 2001	SHEET: 1 / 1
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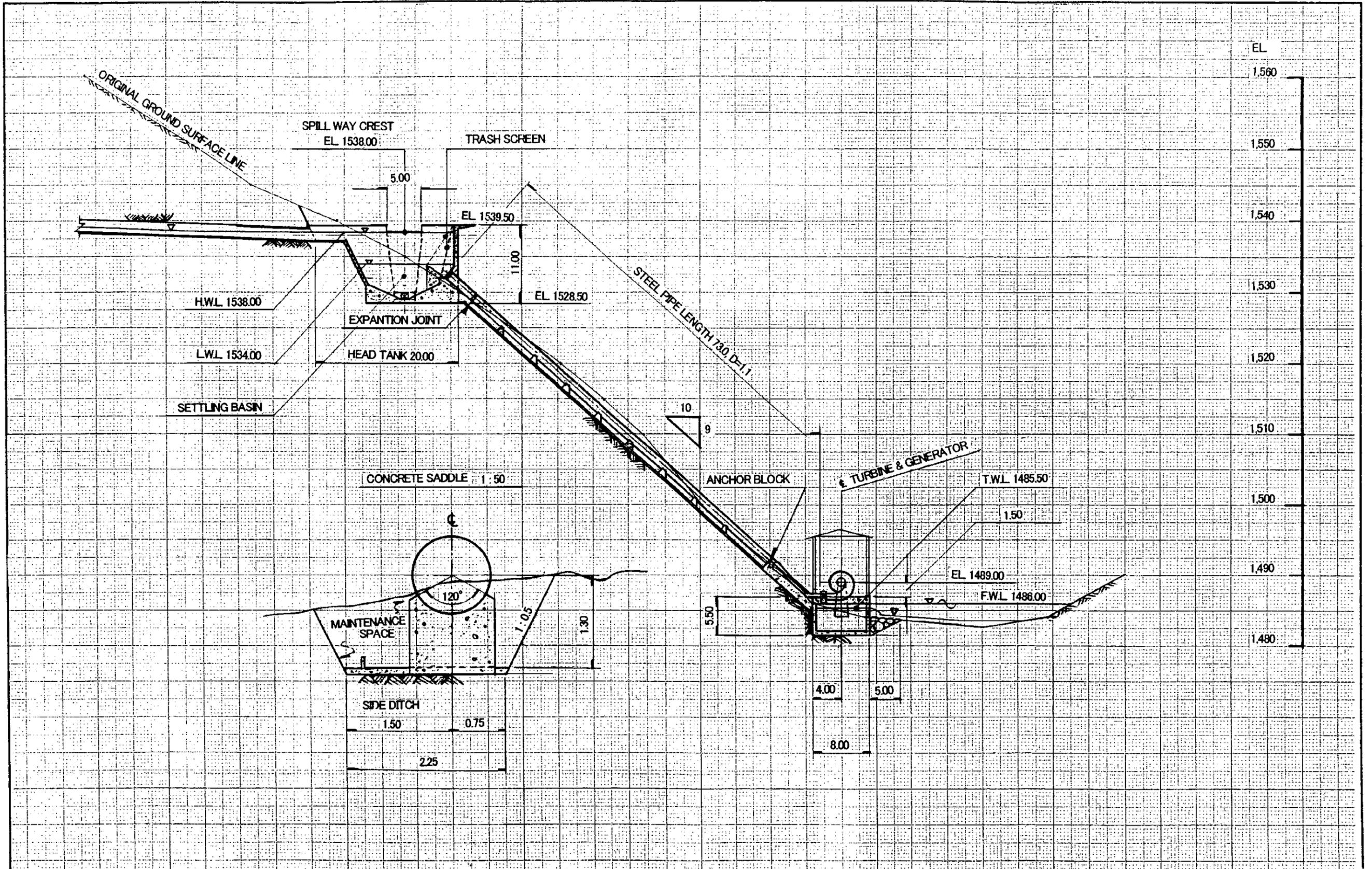
LOCATION :
APOLO / FRANZ TAMAYO PROVINCE
LA PAZ DEPARTAMENT
MACHARIAPU RIVER

Figura 5.6 Plano de la MCH de Apolo (2/3)
(Río Machariapu)

SCALE :
Intake 1 : 500
Headrace 1 : 20

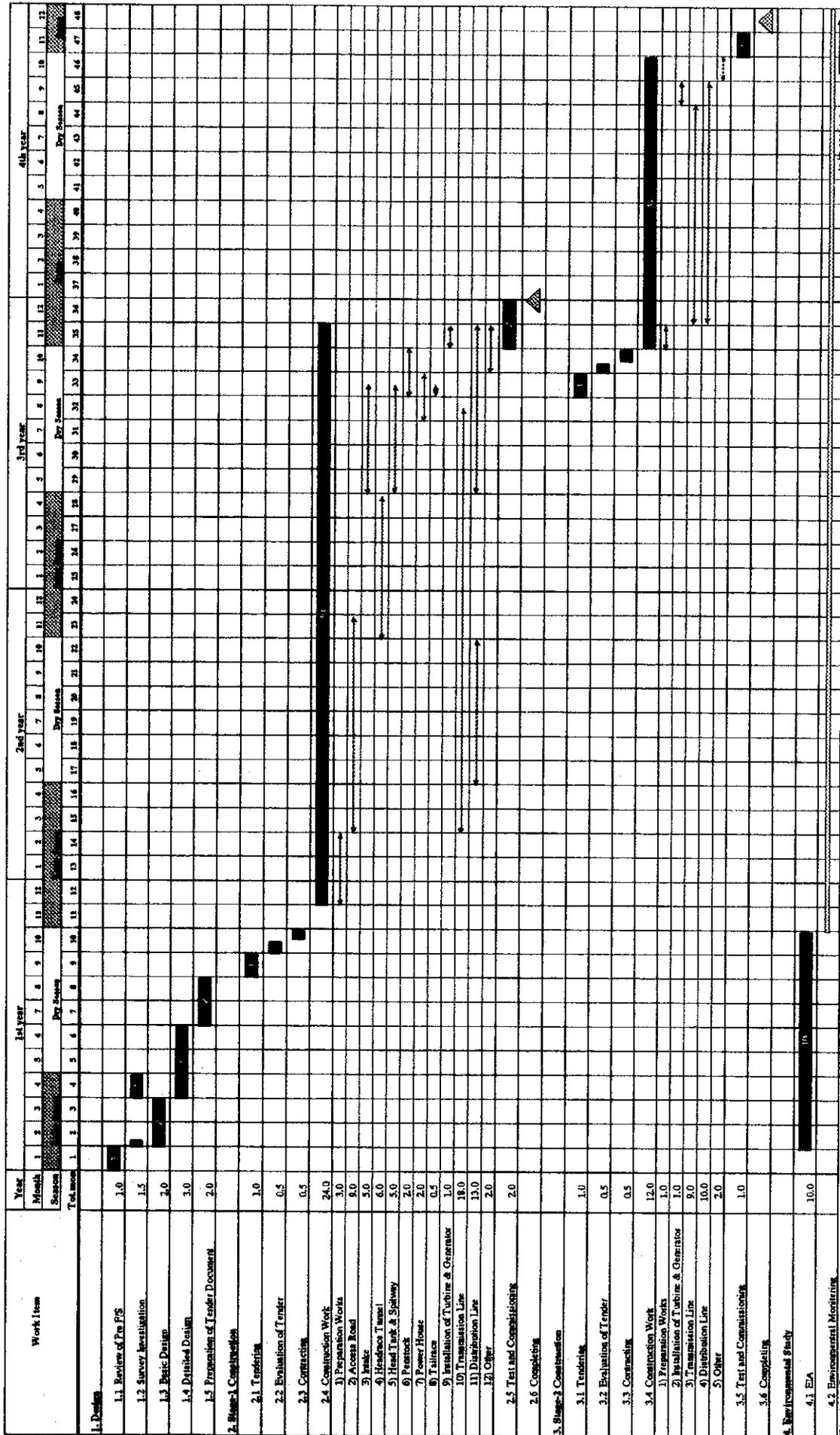
DATE :
JULY - 2001

SHEET :
1 / 1



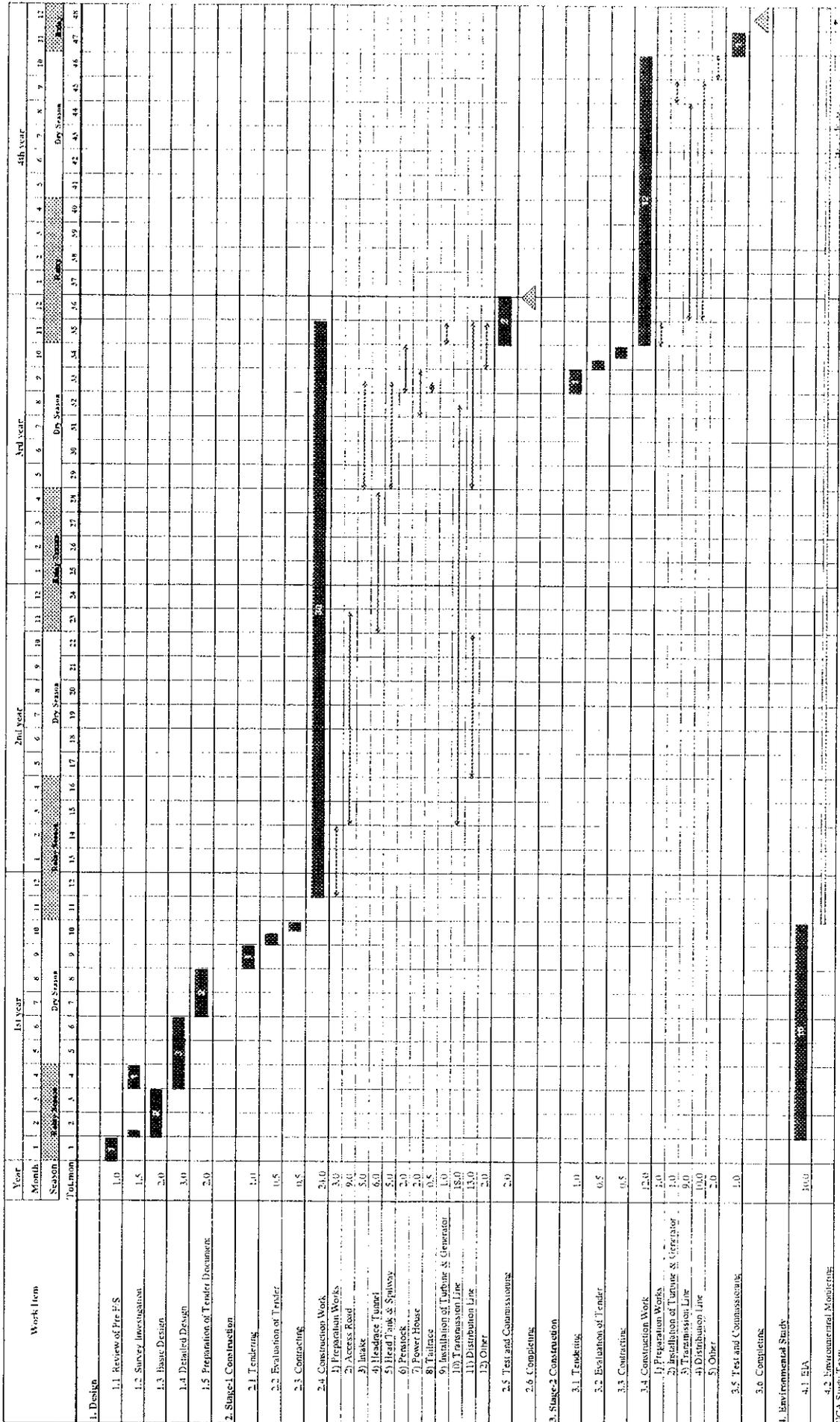
THE STUDY ON RURAL ELECTRIFICATION IMPLEMENTATION PLAN BY RENEWABLE ENERGY IN THE REPUBLIC OF BOLIVIA	 JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION: APOLO / FRANZ TAMAYO PROVINCE LA PAZ DEPARTMENT MACHARIAPU RIVER	Figura 5.6 Plano de la MCH de Apolo (3/3) (Río Machariapu)	SCALE: 1: 500	DATE: JULY - 2001	SHEET: 1 / 1
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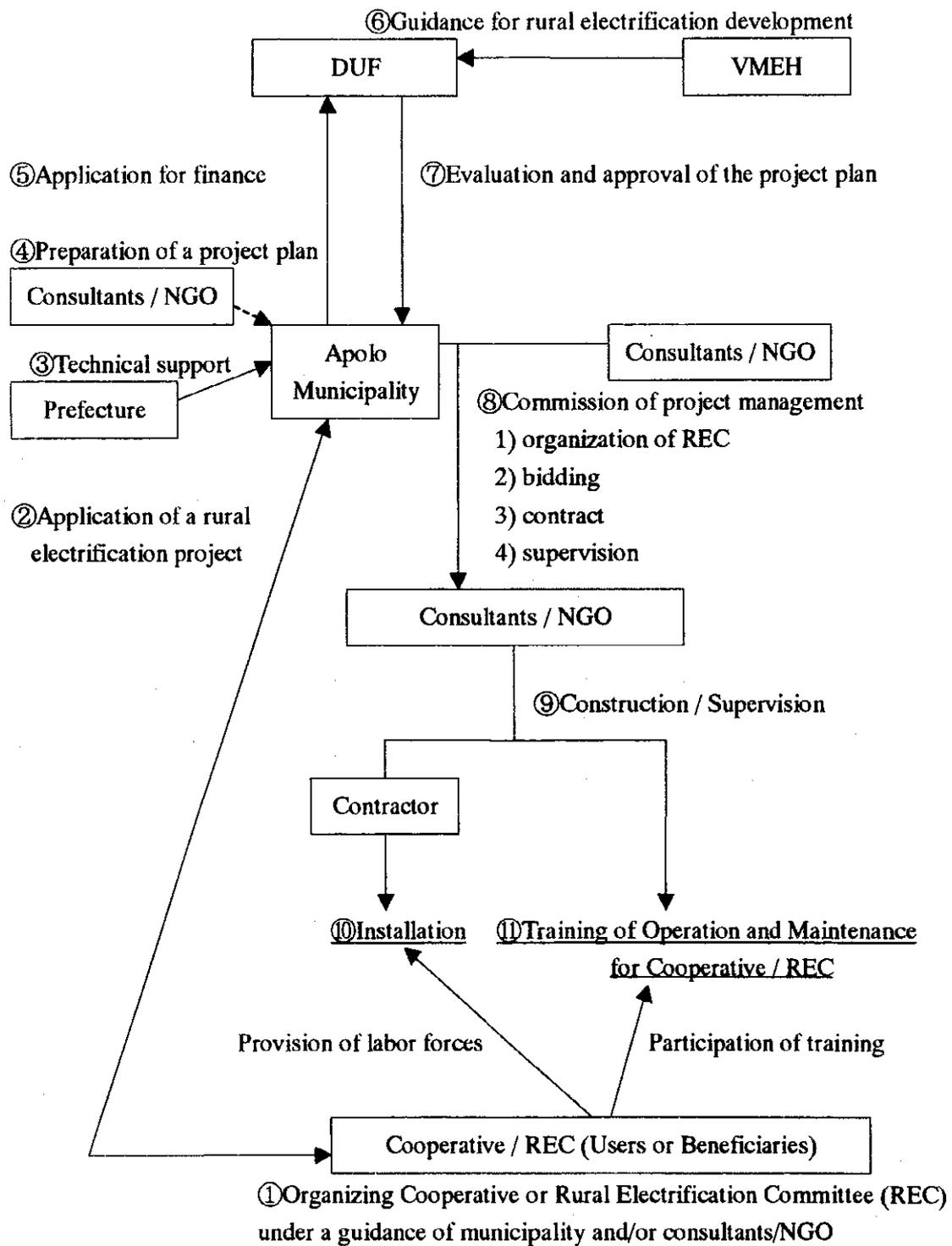
Note: Construction Stage-1 : Preparation works, Construction of Access road, Intake weir, Inake, Headrace Tunnel, Headrace Penstock, Spillway, Powerhouse, Tailrace, Maintenance Service Road, etc.
 Installation of Turbine & Generator (350kW x 1 set), Electric Facilities, Transmission & Distribution Line (Site see Block 'A' (Apolo town) and Block 'B')
 Construction Stage-2: Installation of additional Turbine & Generator (350kW x 1 set), Transmission & Distribution Line (Block 'C', 'D', 'E', 'F' & 'G')

Figura 5.7 Programa de Implementación Propuesto para el Proyecto de la MCH de Apolo



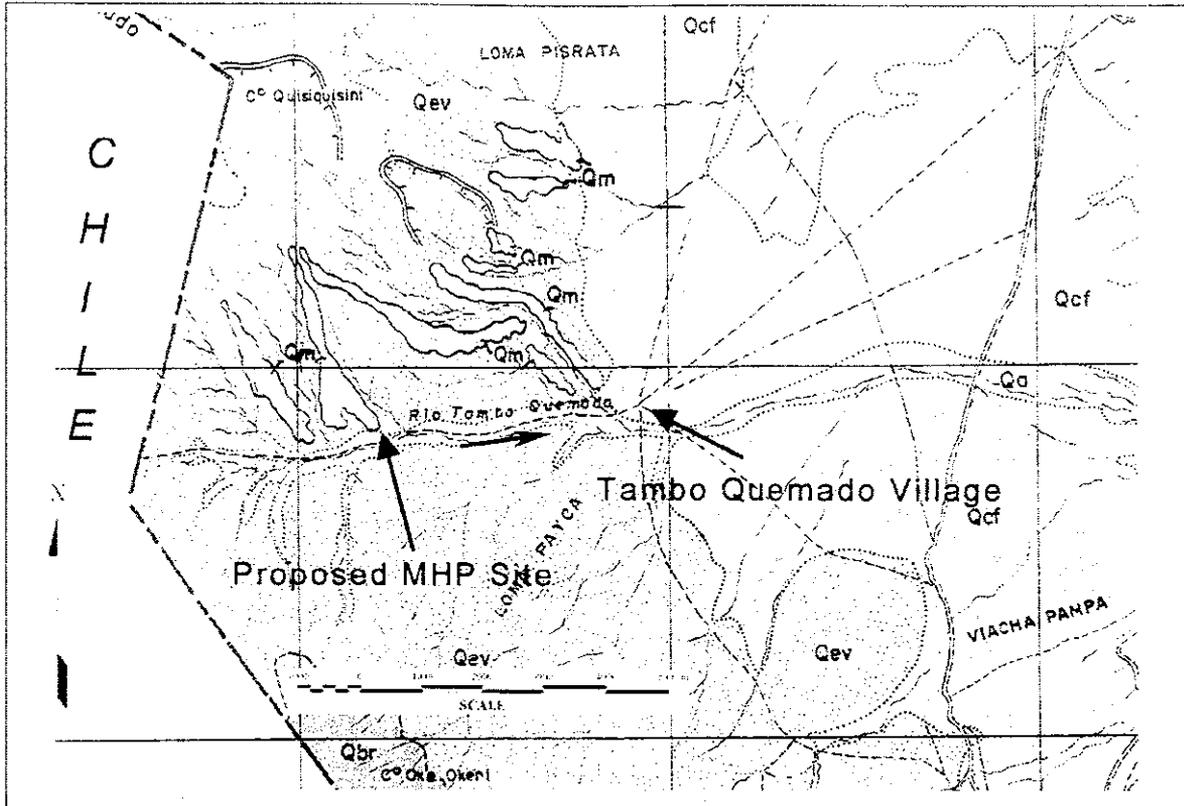
Note:
 Construction Stage 1 : Preparation works, Construction of Access road, Inake weir, Inake, Headrace Tunnel, Headbank, Francis Spillway, Powerhouse, Tailrace, Maintenance Service Road, etc.
 Installation of Turbine & Generator (W/G & T set), Electric facilities, Transmission & Distribution Line, Site as Block "A" (A) (to room and Block "B")
 Construction Stage 2 : Installation of additional Turbine & Generator (S/G & T set), Transmission & Distribution Line (Block "C", "D", "E", "F", "G", "H")

Figura 5.7 Programa de Implementación Propuesto para el Proyecto de la MCH de Apolo



Source: JICA Study Team

Figura 5.8 Propuesta de Implementación para el Proyecto de la MCH de Apolo



Source: Sajama, Republica de Bolivia
 Ministerio de Minas y Petroleo,
 Departamento Nacional de Geologia,
 Hoja No. 5839 (1963)

LEGEND

Qa	Depositos aluviales
Qa	Depositos coluvio-fluviales
Qaa	Abanicos aluviales
Qt	Terrazas
Qm	Morrenas
Qve	Volcanes en escudo
Qcl	Consos de lava
Qh	Hornitos volcanicos
Qbr	Brechas volcanicos
Qev	Estratovolcanes [Volcanic stratums] Andesite - daciticas associated with clastic rocks [Lavas andesitico - daciticas asociadas con rocas piroclasticas]
Qgp	Glaciales de piedras
Qlt	Form. Taracollo
QI	Intrusiones cuaternarias
Tpe	Form. Perez (Ignimbritas blancas y rosadas de compacion riodiacitica)
Tma	Form. Mauri (Sedimentos tobaceos con lavas intercaladas)

Figura 6.1 Mapa Geológico de Tambo Quemado

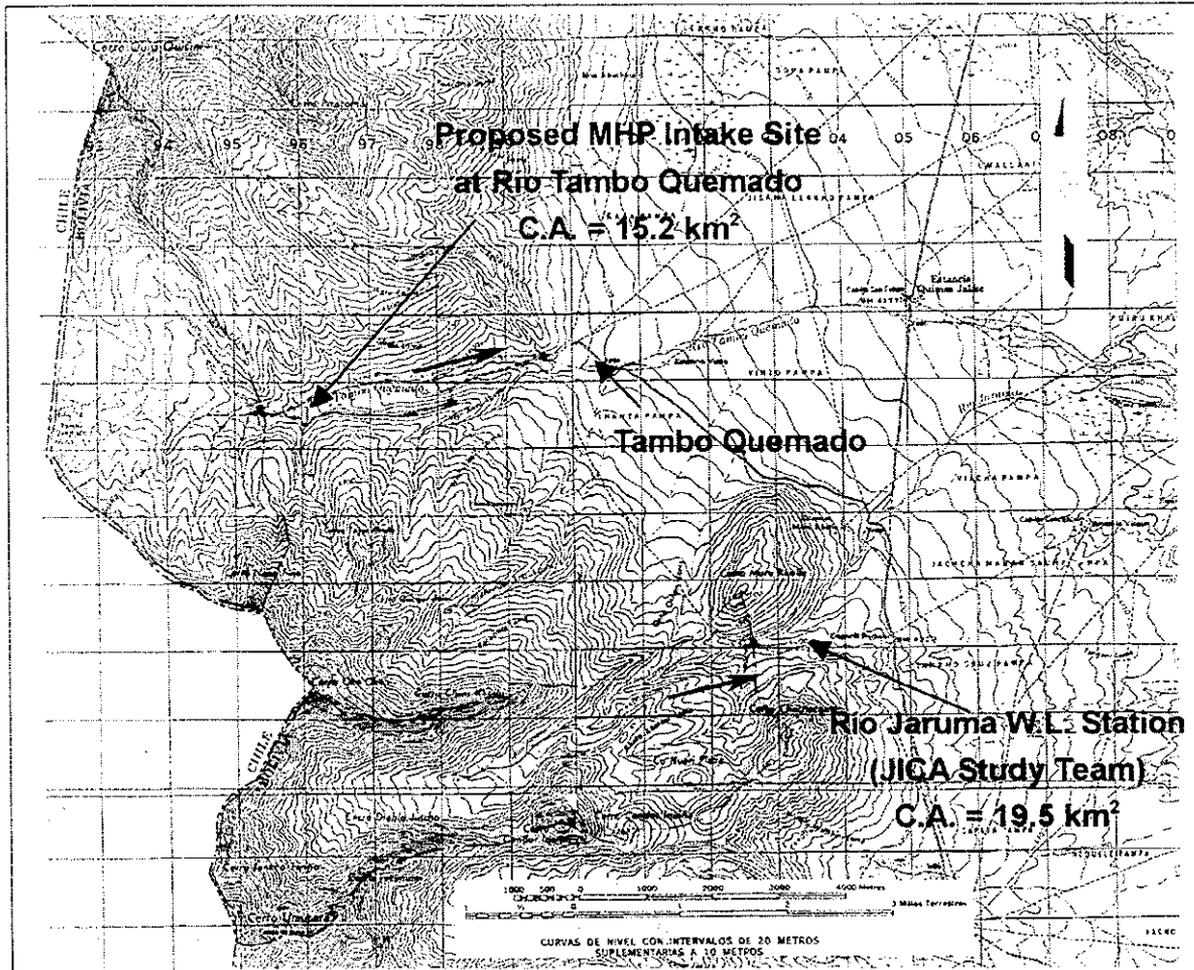


Figura 6.2 Área de Captación de la Estación W.L. del Río Jaruma y Propuesta del Lugar de Toma de la MCH en Tambo Quemado

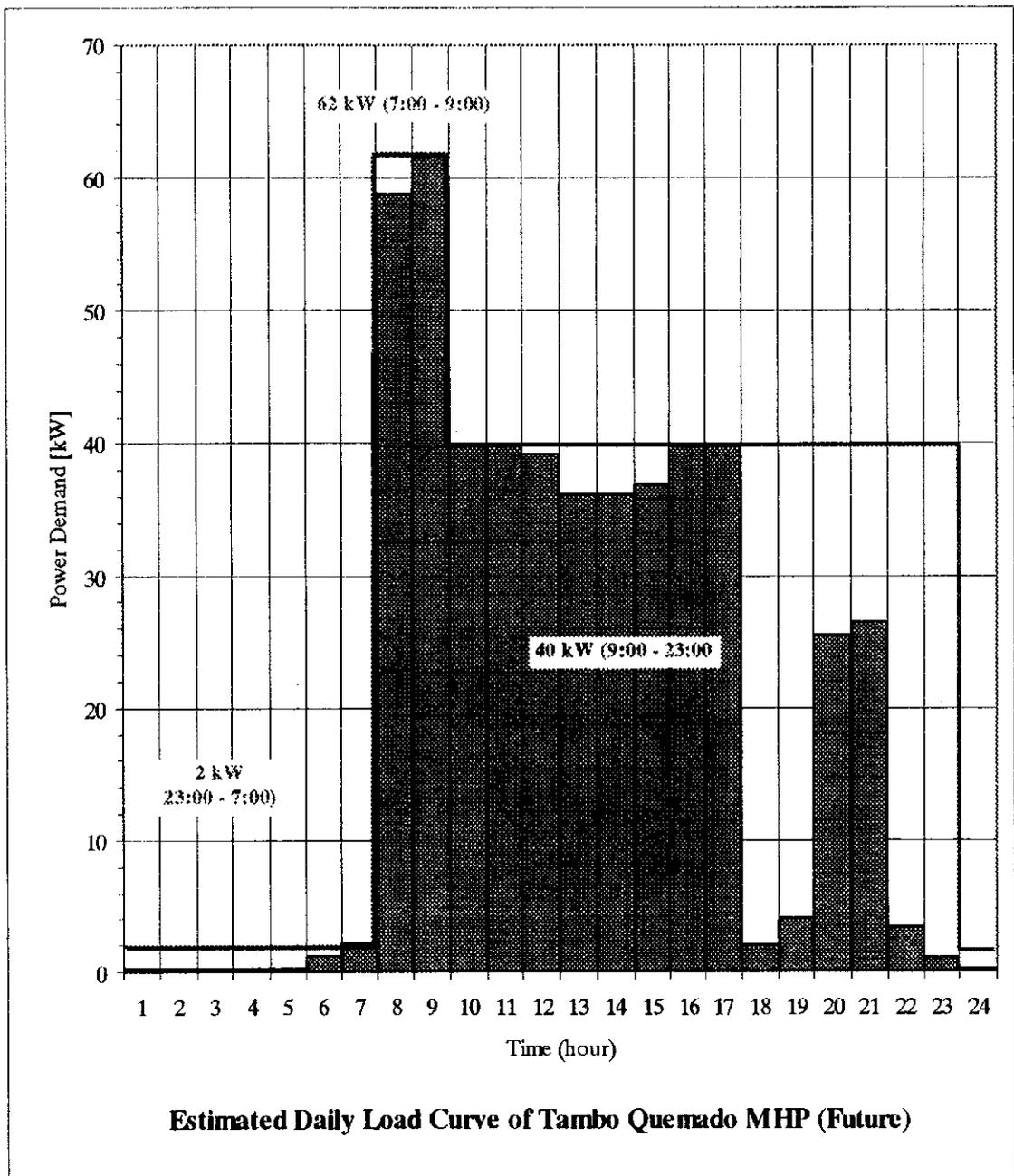
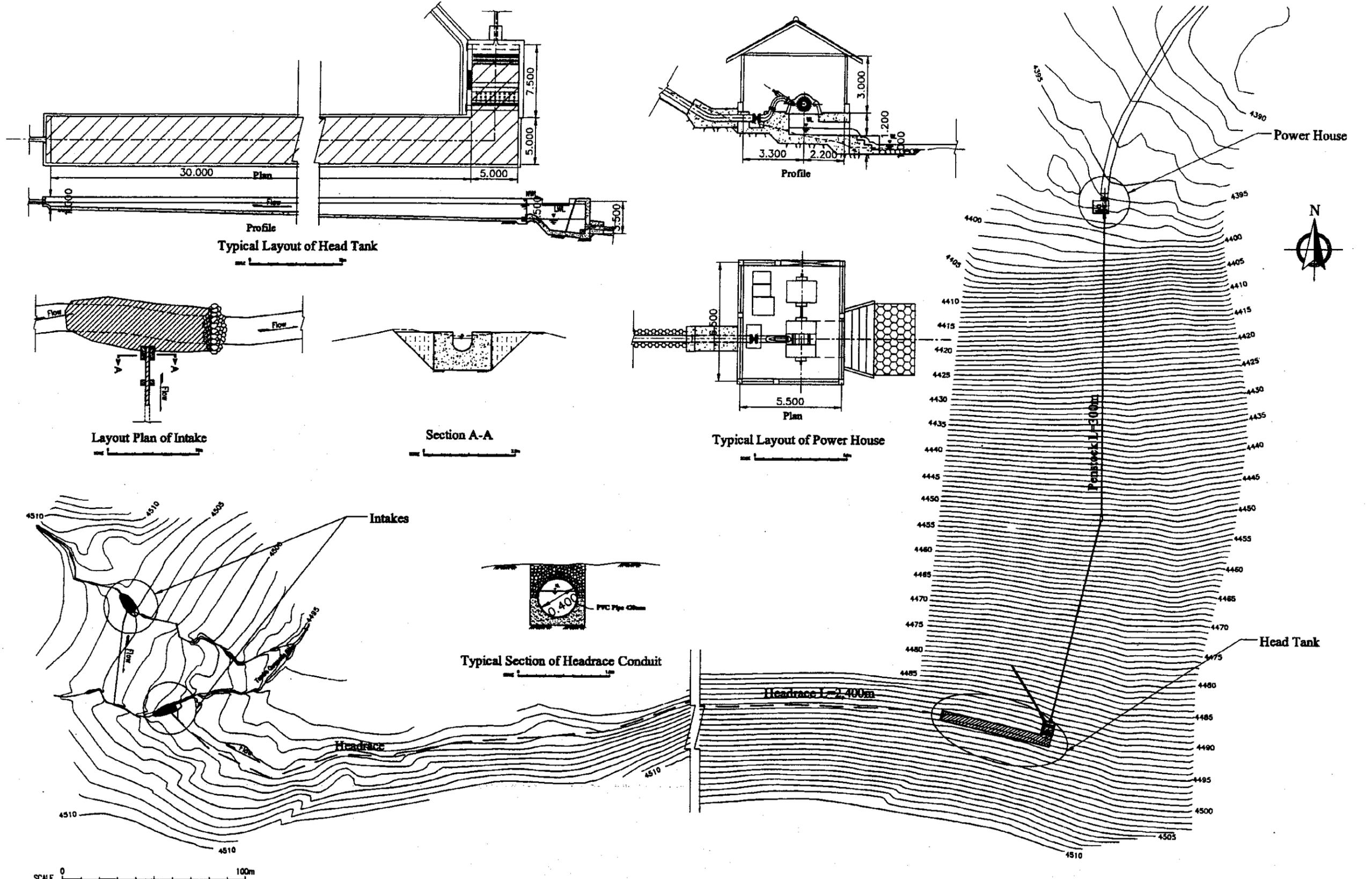


Figura 6.3 Estimación de la Curva Diaria de Carga para el Proyecto de la MCH de Tambo Quemado



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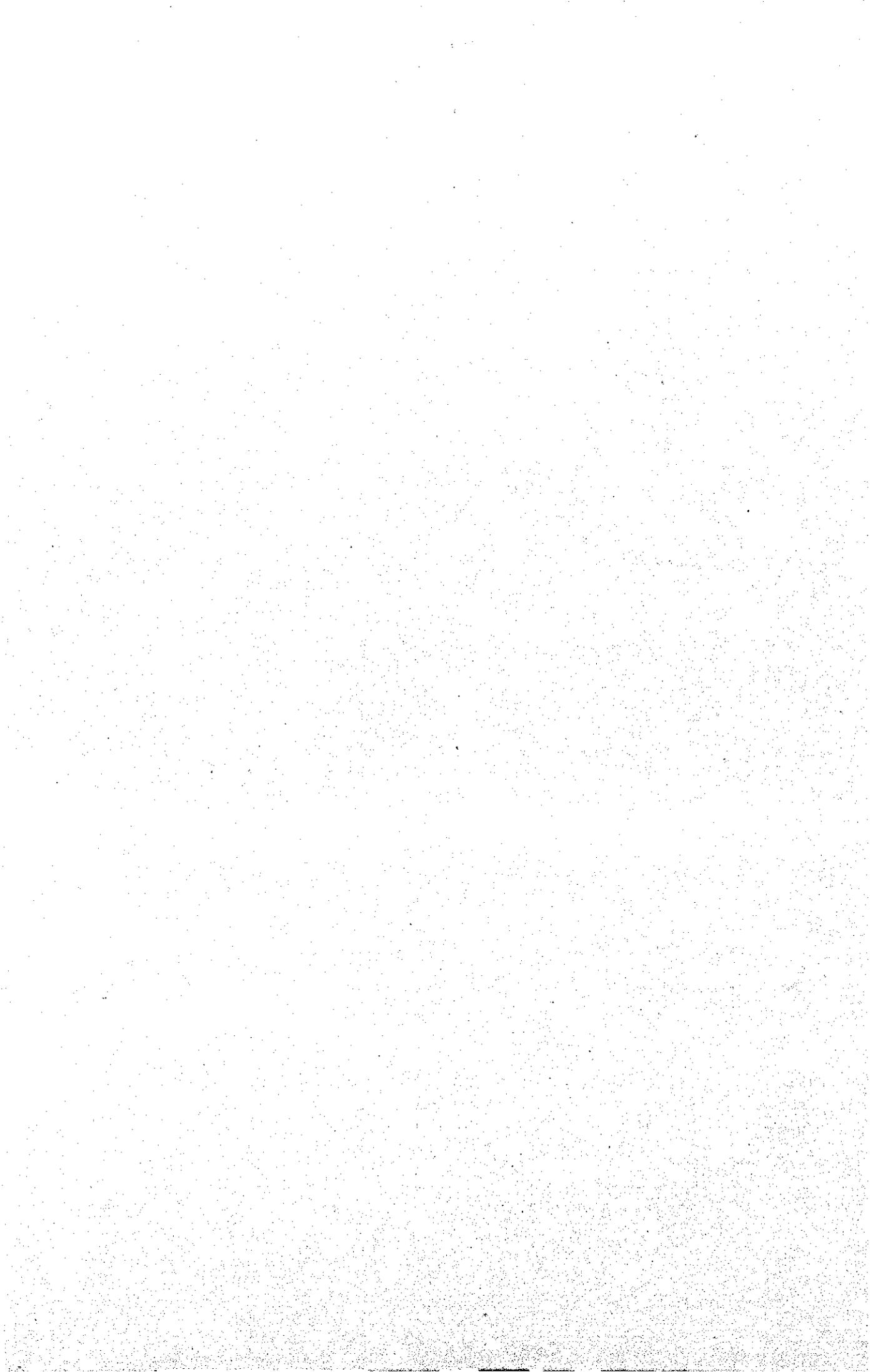
LOCATION:
TAMBO QUEMADO / SAJAMA PROVINCE
ORURO DEPARTAMENT

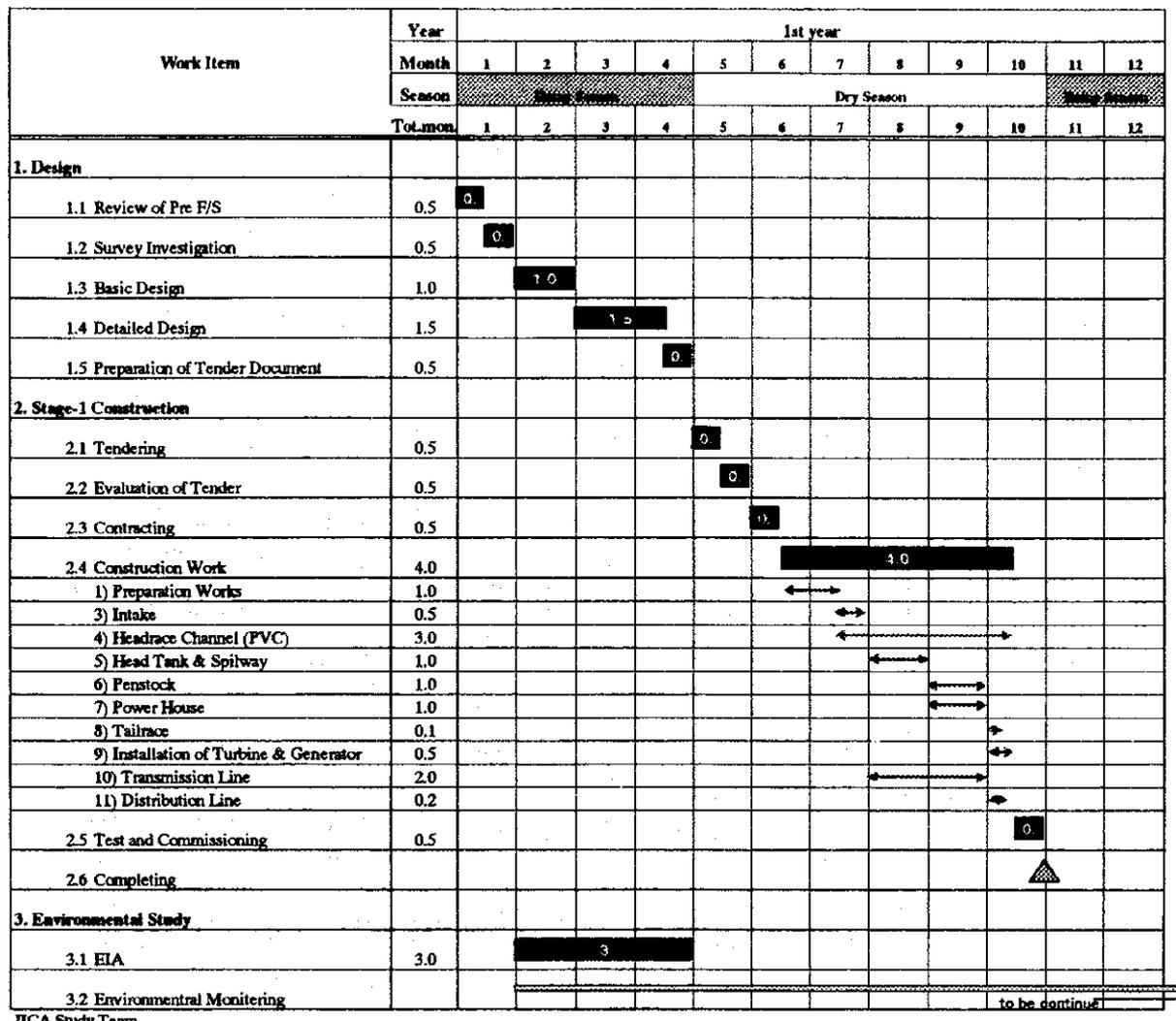
Figura 6.4
Plano de la MCH de Tambo Quemado

SCALE:
H = 1 : 2000

DATE:
February- 2001

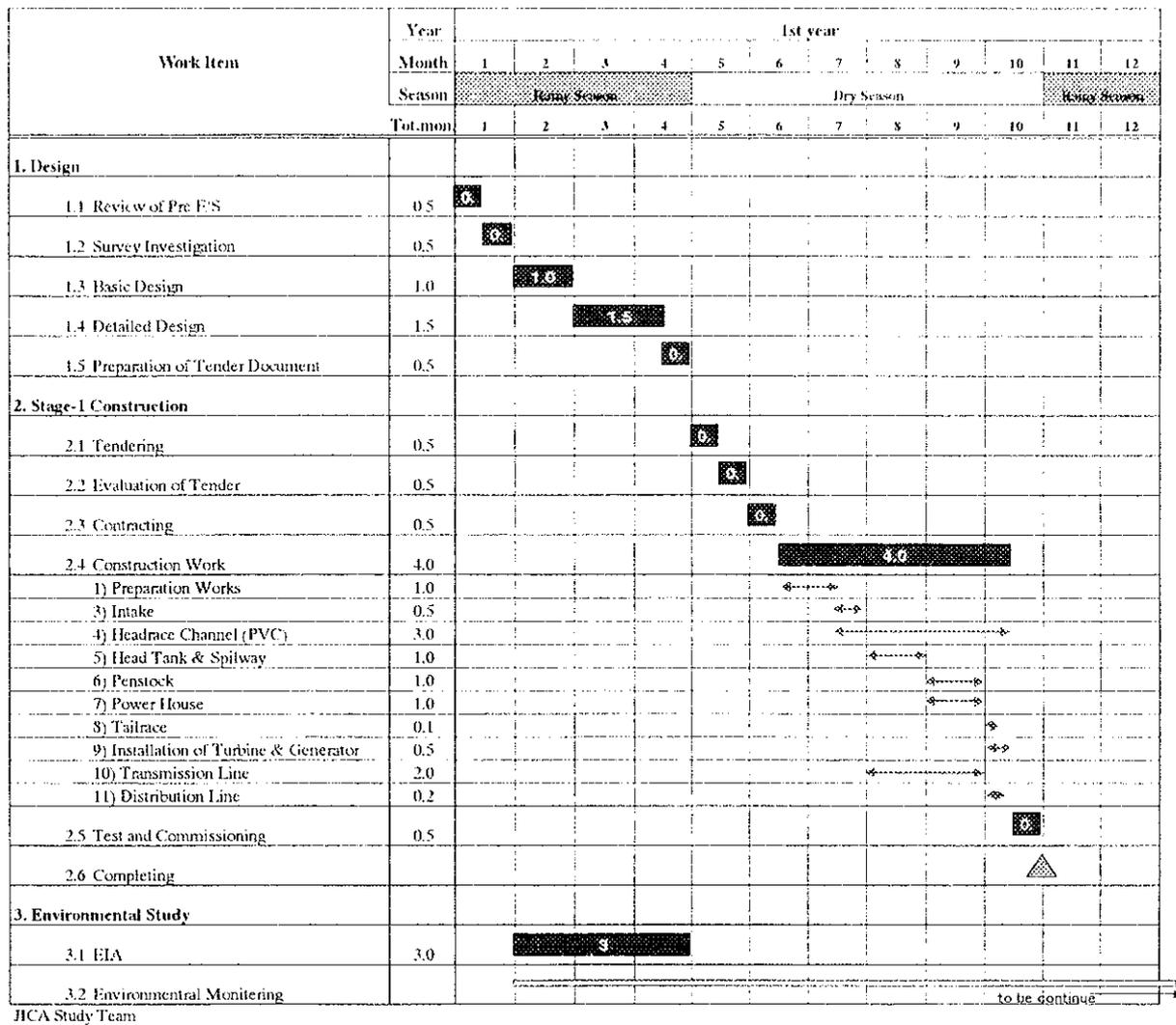
SHEET:





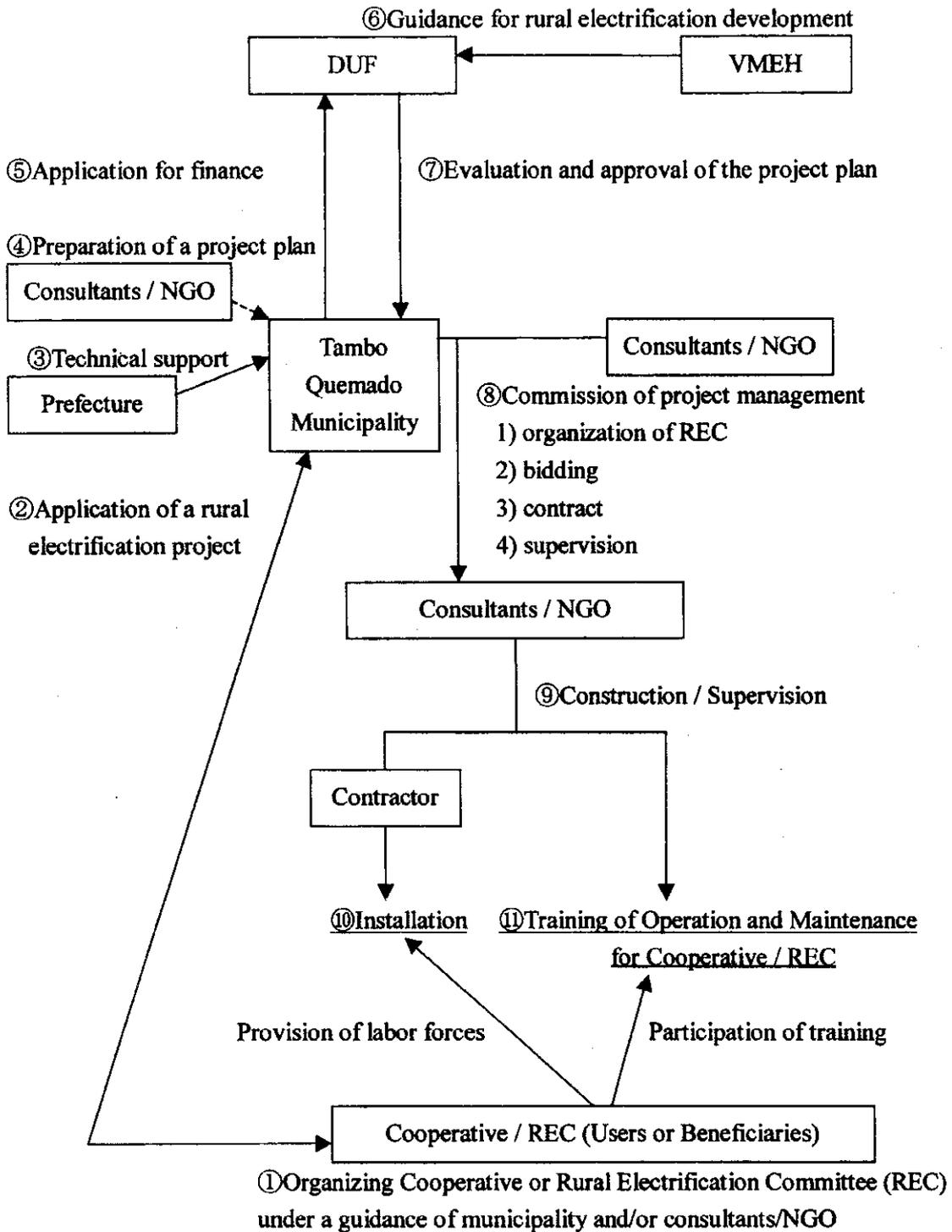
JICA Study Team

Figura 6.5 Programa de Implementación Propuesto para el Proyecto de la MCH de Tambo Quemado



JICA Study Team

Figura 6.5 Programa de Implementación Propuesto para el Proyecto de la MCH de Tambo Quemado



Fuente: JICA Study Team

Figura 6.6 Propuesta de Implementación del Proyecto de la MCH de Tambo Quemado

JICA