資料 7-2　水圧試験結果（コンセプシオン地点）

2011 年 11 月に行われた事前調査で、管路全長約 6km（管径 1,100mm、900mm）の導水路では、管路終点近く、発電所設置予定箇所で水圧が大きく減少することが指摘されている。今回の調査では、それを確認するため、既設導水路上の 4 箇所で同時に水圧測定を行った。

コンセプション　水圧テスト

1.実施日　　2012/8/23
2.測定位置 : 添付図参照

No.	Location	Point (km)	Remark
P1	Aerator	(+5+500)	φ900
P2	PI-69BN	(+4+400)	φ900
P3	PI-64AN	(+3+600)	φ900
-	Manhole 2	(+3+100)	Divert Option No.2
-	PI-58	(+2+950)	φ900 start point
-	PC	(+2+700)	Divert Option No.1
P4	PI-46	(+2+200)	φ1,100

3.実施者: SANAA
4. 実施結果　　2012/8/23

						2011/11/17
	Pressure (Bar)					Pressure (Bar)
	Aerator	PI-69BN	PI-64AN	PI-46		Aerator
Flow (lit./sec.)	Point 1	Point 2	Point 3	Point 4	Remark	Point 1
distance in m	6,243	4,306	3,592	2,172		5,525
diameter in mm	900	900	900	1,100		900
EL in m	1,117.78	1,117.00	1,116.35	1,081.25		1,117.78
0	3.55	3.40	3.10	6.50	バルブ隙間から漏れ有り。	3.60
200	3.50	3.40	3.10	6.40		
400	3.40	3.20	3.00	6.40		3.50
600	3.00	2.90	2.70	6.30		3.10
800	2.35	2.40	2.40	6.20		2.70
1,000	1.65	1.90	2.00	6.10		
1,200	1.20	1.70	1.80	6.10		0.95
1,300	1.10	1.60	1.80	6.10		
1,500	0.10	0.90	1.30	5.40		0.00

貫入試験の状況（コンセプション地点）

水圧 0（発電所計画地点。流量：1,500ℓ/sec.）（コンセプシオン地点）

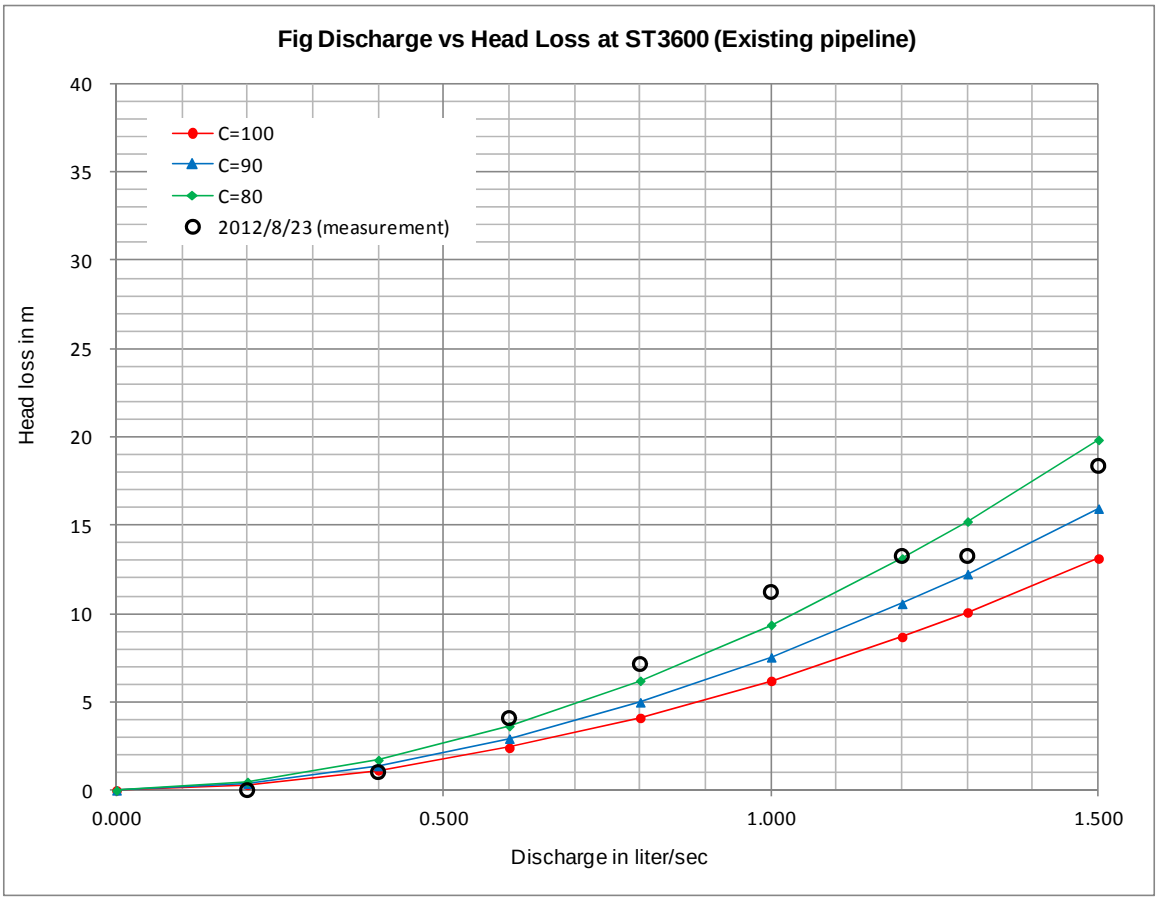


Fig Discharge vs Head Loss at ST3600 (Existing pipeline)
C=100
C=90
C=80
2012/8/23 (measurement)
Head loss in m
Discharge in liter/sec
0
5
10
15
20
25
30
35
40
0.000
0.500
1.000
1.500

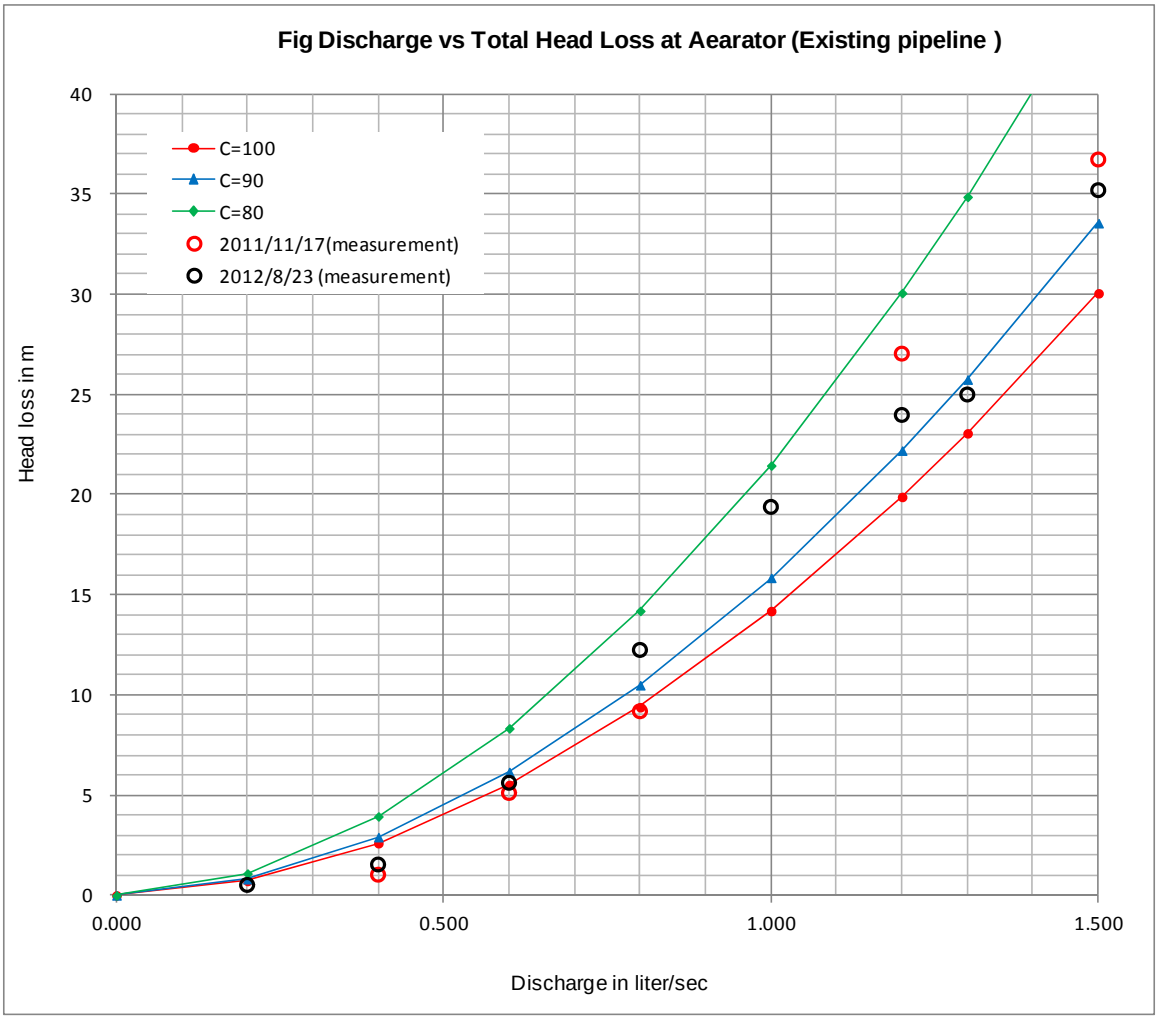


Fig Discharge vs Total Head Loss at Aearator (Existing pipeline)
C=100
C=90
C=80
2011/11/17(measurement)
2012/8/23 (measurement)
Head loss in m
Discharge in liter/sec
0
5
10
15
20
25
30
35
40
0.000
0.500
1.000
1.500

資料 7-3　流量及び圧力測定結果（ピカチョ地点）

ピカチョ浄水場から送水している配水管のうち L22 系統管路（管径φ400mm）を使って発電する計画である。2011 年 11 月に実施された事前調査では L22 系統管路で流量測定が行われていない。今回の調査で L22 系統管路の送水量を確認するため、流量測定を実施した。SANAA には、各配水系統毎の配水量のデータが残されていない。通常の送水量の調整は、浄水場のマニホールドのバルブを調整して行っている。また、浄水場流出部には、各配水系統に流量計が設置されているが、調査時にはキャリブレーションがされておらず測定不能であった。

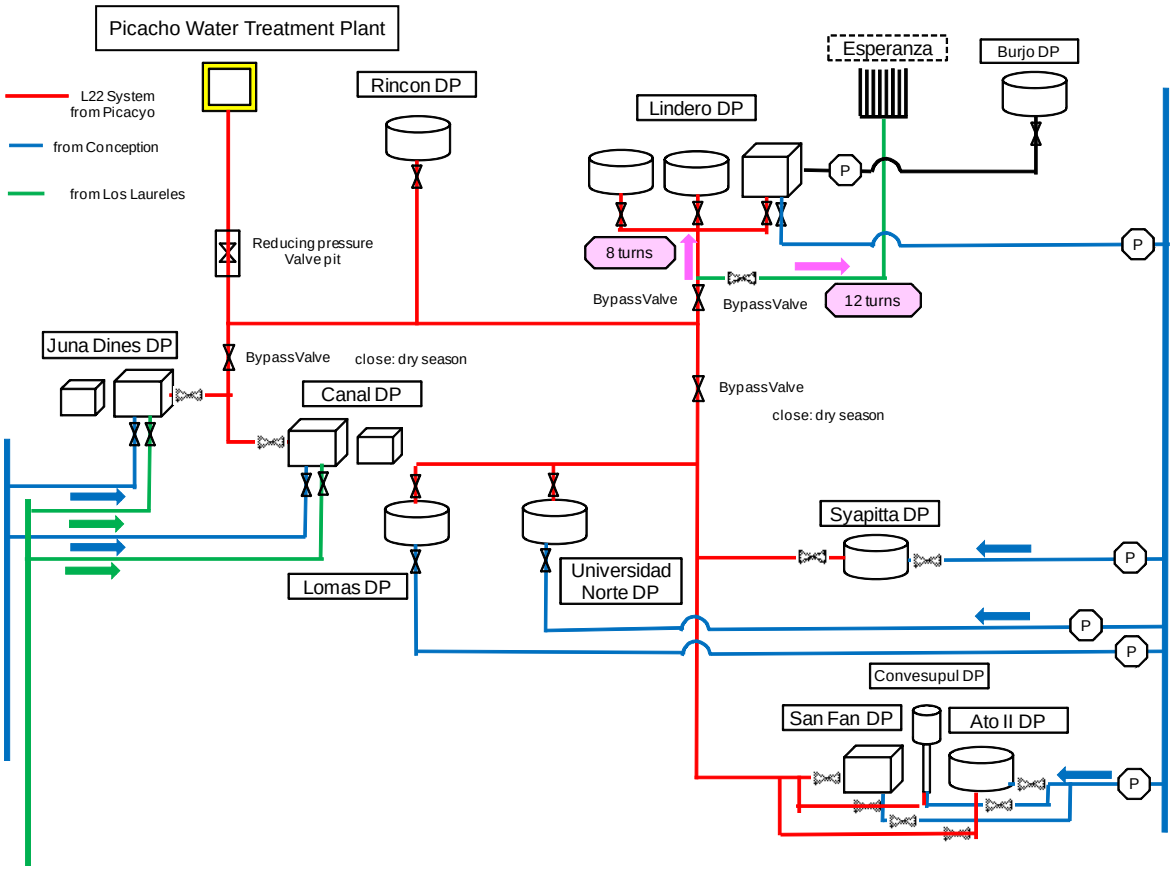
1.日時　　2012 年 8 月 24 日（金）16 時～17 時
2.場所　　リンデロ配水池入口
3.測定者　　SANAA（水量測定ラボ業者の立会い）
4.測定関連　器具：超音波流量計 PT878（メーカーGE）
　　測定管：ダクタイル鋳鉄管 φ300（12 インチ）
　　測定位置：配水池流入前の直線区間（管 1 本分（6m）以上）
5.測定結果

時間	流速 (m/s)	流量(m^3/hr)	流量(lit./sec)	ピカチョ浄水場バルブ回転数
16:07	1.85	472.81	131.34	12
16:08	1.83	466.75	129.65	12
16:09	1.83	466.30	129.53	12
16:10	1.87	474.41	131.78	12
16:11	1.92	487.93	135.54	12
16:12	1.94	494.13	137.26	12
16:13	2.00	508.45	141.24	12
16:15	2.16	549.84	152.73	12
		mean	136.13	
		max	152.73	
		min	129.53	
16:27	1.69	430.38	119.55	8
16:28	1.63	408.95	113.60	8
16:29	1.50	381.41	105.95	8
16:31	1.48	375.60	104.33	8
16:32	1.42	363.62	101.01	8
16:33	1.34	340.98	94.72	8
16:34	1.31	334.49	92.91	8
		mean	104.58	
		max	119.55	
		min	92.91	

ピカチョ取水量（800litter/sec。ｵﾍﾟﾚｰﾀｰによる）←全水量の 1/3 を 22 系統管路に流すとする事前報告書からすると少ない。浄水場水位は 1301.44m

	
超音波流量計の設置状況 （リンデロ配水池　ピカチョ地点）	超音波流量計の測定状況 （リンデロ配水池　ピカチョ地点）

ここで、配水バルブの回転数（8,12 回転）は、SANAA オペレーターの長年の経験により決められた回転数である。通常、SANAA では、L22 系統管路を使用し、下図に示す主に 2 つのエリアに配水している（8 回転時：リンデロ配水池、12 回転時：エスペランサ地区）。



L22 配水系統システム（SANAA 運転主任からの聞き取り）

L22 系統管路は、ピカチョ浄水場のメイン系統の一つであり、複数の配水池に送水している。但し、雨季と乾季によって、送水時間が異なり、雨季では、2 日間（48 時間）で、30~36 時間(60~75%)、乾季には、19~26 時間（41~54%）の配水となっている。

乾季		雨季	
年月	配水時間 / 1ｻｲｸﾙ時間	年月	配水時間 / 1ｻｲｸﾙ時間
2009. 3	-	2009. 10	34 / 48 hours
2010. 3	19 / 48 hours	2010. 10	30 / 48 hours
2011. 3	20 / 48 hours	2011. 10	30 / 48 hours
2012. 3	26 / 48 hours	2012. 8	34 / 48 hours
		2012. 9	36 / 48 hours

水頭については、8 月 29 日に減圧弁の前後での圧力測定を SANAA が実施した。SANAA が行っている現状の水運用（120～150 litter/sec）では、減圧弁の手前では圧力値が 60～70psi 程度=4～5bar（40～50m 程度）しかないとの測定結果となった。
事前調査では、ピカチョ浄水場と減圧弁ピットの静落差は 160m 以上あるので、下流に 90m残圧を確保しても 70m 近くは確保できるとの結果となっている。しかし、今回の調査結果では、流量が少ない場合は、配水池の弁を全開にして、浄水池のマニホールドの入口弁で各配水量を調整する SANAA の運用では満管にならず、圧力がなくなっているのではないかと想定される。この場合は、発電ができないことになる。ちなみに、20 回転で約 400 litter/sec を流した時は、圧力が 150psi まで上昇する結果となっている。おそらく、浄水場からの水の方が多い場合は満管となって想定の圧力が生じたのではないかと考えられる。

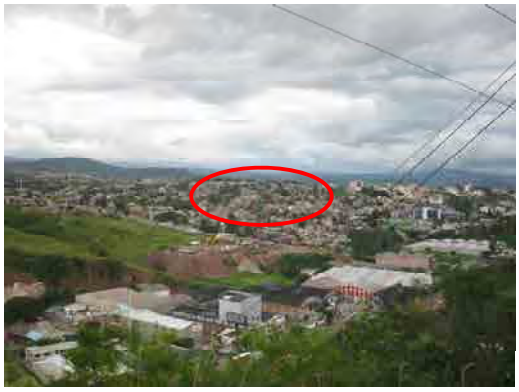
現在の SANAA の運用は、基本的に浄水場の入口バルブで調整し、配水池のバルブは全開とし調整は行っていない。管路の途中にあるバイパスバルブの開閉操作で、2 地域（リンデロ配水池とこれ以外の配水池）への流量の振分けを行っている。各配水池への配水量を管理しておらず、彼らの経験で配水池への送水が行われているのが実情である。

このように、配水池のバルブを調整して、浄水池からの送水量を管理していないため、流量が少ない場合は、管路が満管となっていないことが考えられる。送水が必要なバルブのみを開くのであれば、満管となり減圧弁の前後で圧力差が生じて発電ができるが、このように各配水池のバルブの開閉を調整するのは、SANAA がこれまで行ったことのない運用で担当者も、今の方法をかえるのは非常に困難であるとのことである。

L22 系統管路の配水池の状況調査

タンクの状況

リンデロから見たエルペランサWD

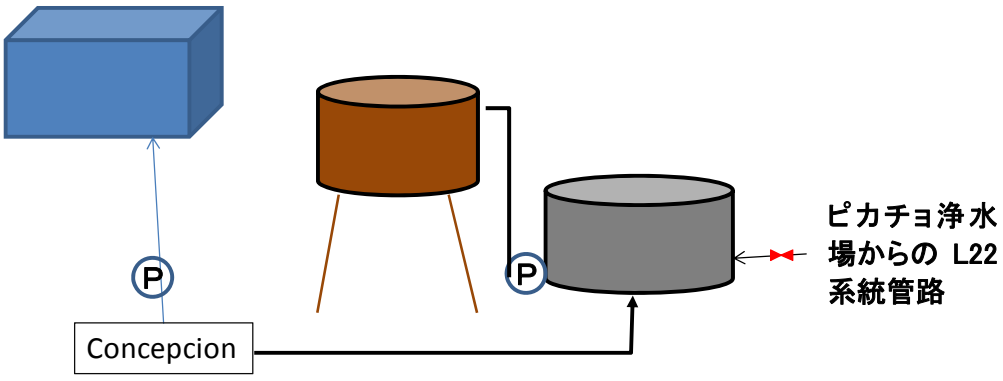


レベルスイッチ

スペイン納入の流量計（正しい表示をしていないと思われる）

HATO Ⅱ、Covesupl, San juan

運転管理員（24 時間勤務）によると、ピカチョ浄水場からの送水のバルブは閉じている。開にしても水はこない。



SAN MIGUEL　　乾季はCLOSE、雨季はOPEN

マンホール

周辺の状況

配管布設に伴い、整備。

SUYAPITTA

運転管理員（24時間）4人体制
8時間（昼）、16時間（夜）

ピカチョより22系統
現在CLOSE

コンセプシオン浄水場
から送水されている。

タンク内部
レベルスイッチなし

The Preparatory Survey for the Project of Micro-Hydroelectric Power Generation in Metropolitan Area of Tegucigalpa in the Republic of Honduras

Brief on First Field Survey

1. Schedule of the Study

Item \ Year	2012						2013		
	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Preparation of the survey in Japan	□								
First Field Survey in Honduras		■	■						
Analysis in Japan (Preparation of Draft report in Japan)				□	□	□			
Second Field Survey in Honduras						■			
Preparation and Submission of F/R						□	□	□	□
Submission of each report to JICA		▼Ic/R				▼Df/R			F/R▼

Remarks: □ work in Japan, ■ work in Honduras, ▼ Submission of Ic/R, Df/R, F/R to JICA
Ic/R: Inception Report, Df/R: Draft final Report, F/R: Final Report

2. Licenses / Permission / Approval for Required for Power Generation Business

Existing condition and forecasts/problems for Licenses / Permission / Approval for Required for Power Generation Business are summarized in the following tables.

3. Study Results

3 .1 Concepcion Site

The following essential data for power generation plan are collected

- Daily intake water data for 10 years
- Daily dam level data for 10 years
- Booster pump operation condition
- Pressure measurement for various discharge at several points
- Final drawings of existing pipe line, intake, dam etc.

The following study will be conducted according to flow chart of optimum study.

- Selection of new pipeline, steel pipe vs PVC pipe
- Optimum diameter of new pipeline
- Location of connecting point of existing and new pipe line s

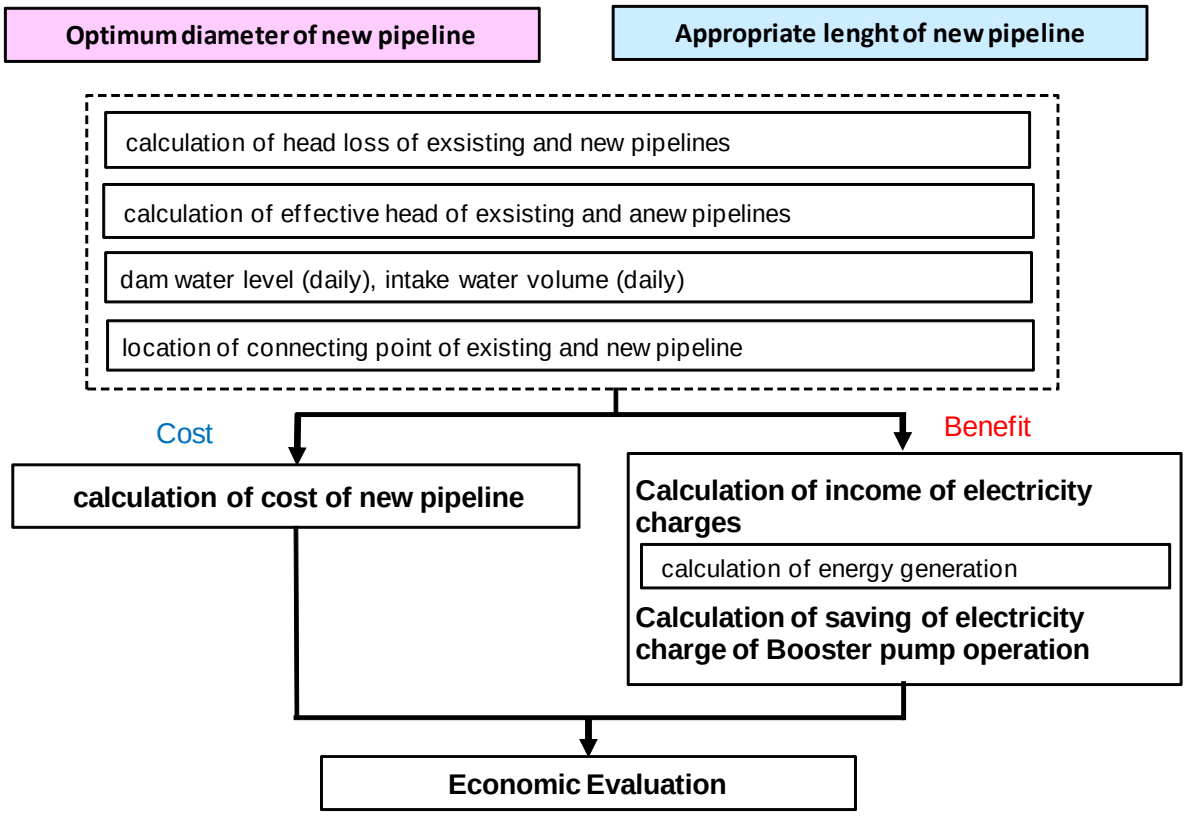
The Concepcion site has no difficulties for power generation plan and basic design.
The new pipeline route are basically located along the road and the connecting point of existing and new pipe lines are determined according to the topographic condition and around the boundary from 1100mm diameter to 900mm diameter pipes.

Licenses / Permission / Approval for Required for Power Generation Business

Required Licensing	Applicant	Acknowledge of licensing	Existing Conditions	Forecasts / Problems
Power Generation Operation License	SERNA (SANAA)	Cabinet	SANAA is confirming the procedures regarding the power generation operation license to CNE.	SERNA is to submit the documents for the cabinet approval with Environmental license and Water Right.
Water Contract	-	-	SANAA has water right utilized for water supply at Concepcion and Picacho sites. So SANAA understands it is not necessary to obtain further water right for power generation utilization.	SERNA shall confirm its water right.
Environmental License	SANAA	SERNA or Tegucigalpa city	Picacho site has high possibility to fall under Categoly 1 (low impact projects), which applies to Hydroelectric Power projects less than 3MW. Picacho powerhouse site is not inside national park areas and is properties of several private land owners. Concepcion site is not inside the protected area and is located in the public roads and private lands partly.	After submission of F01 for Category 1, the license will be issued within 15 days. F01 is to be fulfilled after the submission of Study report (Dec. 2012) and acquisition of necessary lands. The lands of Picacho powerhouse area are private ones not property of national park. The license will be obtained before E/N.
Renewable Resource Law Application	Contractor	SANAA	Not necessary	
Power Selling Agreement	SERNA (SANAA)	CNE	SANAA is confirming the procedures regarding the power selling agreement to CNE under guidance of ENEE. The electricity generated by the Hydroelectric Power plants is to be sold to ENEE.	SANAA is to submit the relevant document to SERNA. SERNA is to submit the documents for the approval of ENEE.
Construction License	Contractor	Tegucigalpa city	Construction license requires Environmental license and construction plan including environmental measures.	The Contractor will obtain the license before construction
Grid Connection / System Interconnection	SERNA (SANAA)	ENEE	SANAA and ENEE agreed that the powerhouse is to be connected directly to the nearby ENEE grid. E/M Equipment can be connected to ENEE system by review and approval by ENEE. SANAA is preparing draft documents regarding the grid connection.	SANAA is to submit the relevant document to SERNA, then SERNA will submit it for approval from ENEE
Tax Exemption	Contractor	SANAA	The procedures of tax exemption to such as import duties, VAT were obtained.	The Contractor shall apply to tax exemption according to the procedures.
Land Acquisition	SANAA	Land Owner	Picacho powerhouse site is the land of several land owners. Powerhouse and part of water pipeline are located in the lands of private owners in Concepcion site. Most of pipeline portion is under the existing roads.	The land actuation by SANAA shall be completed until construction of the Work.
Road Space Occupation Permission	Contractor	Tegucigalpa city	The road occupation approval during construction period is responsible for the Tegucigalpa city.	The Contractor shall submit the permission to the Tegucigalpa city before the construction

*CNE: Comisíon Nacional de Energia

Power Generation Plan of Concepcion Site

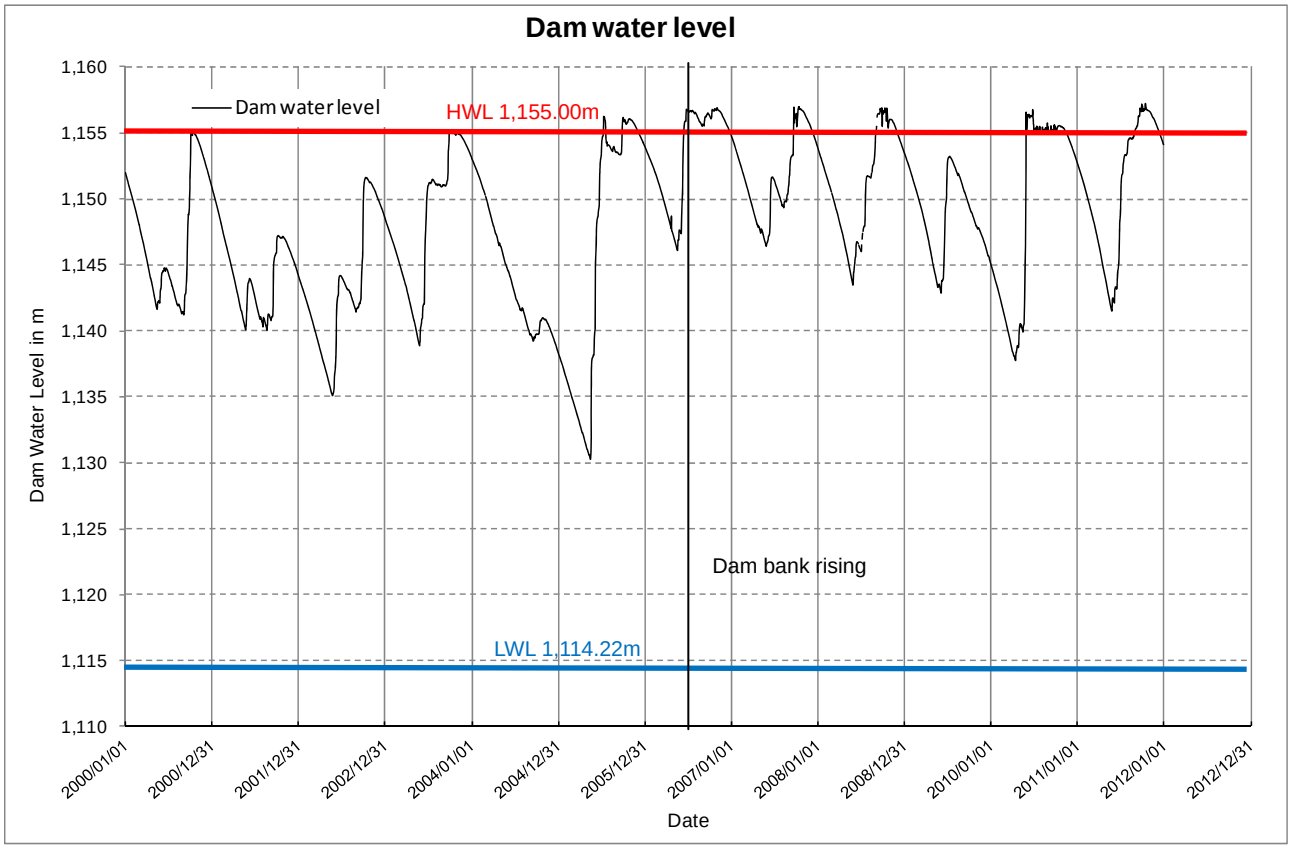


Flow Chart of Optimum Study

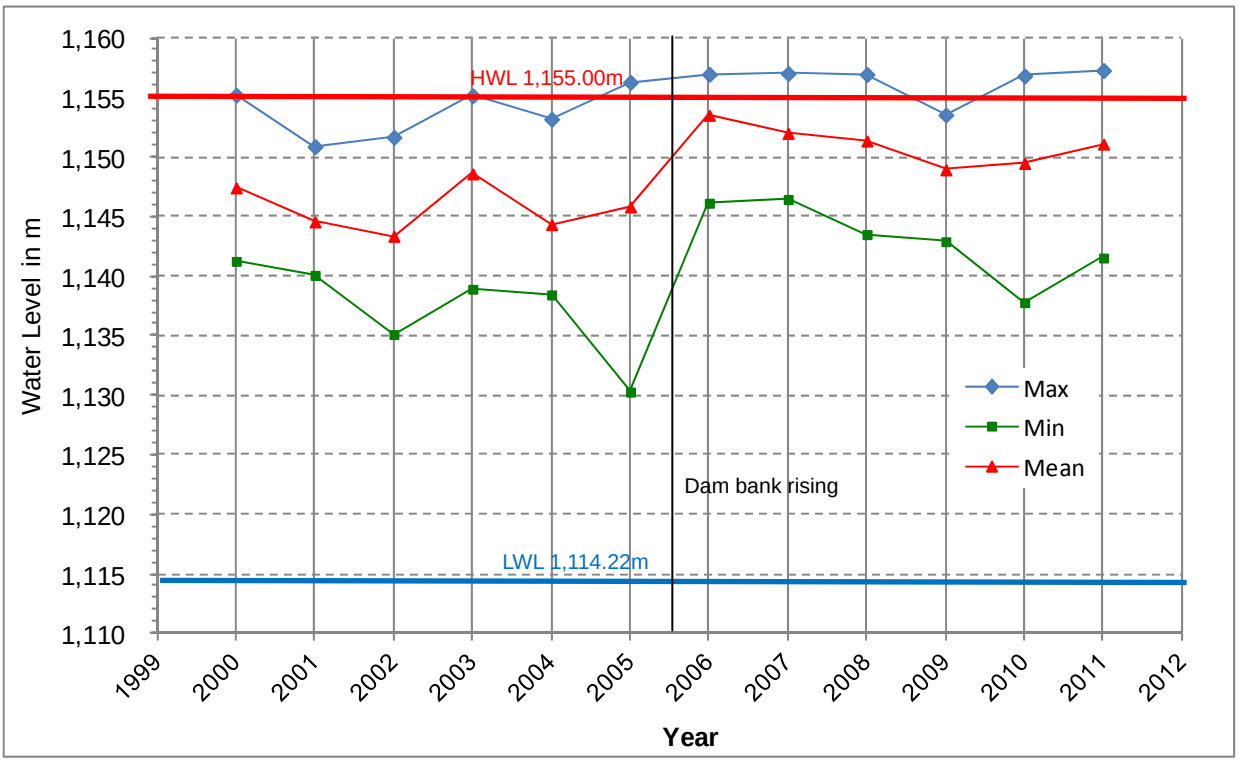
Pmax＝9.8 η Qpmax He
where, Pmax :Max Output（kW）
Qpmax :MaxPower discharge(m3/sec)
He :Effective head in case of Maxdischarge(m)
η :efficiency(=0.8, turbine-generator)
E=Σ 9.8 η(i) Q p(i) He(i) h
where, E:Energy Generation(kWh)
Qp(i) :power discharge (m3/sec)
h :hour

Calculation of Max. Power Output and Energy Generation

Fluctuation of Daily Dam Water Level

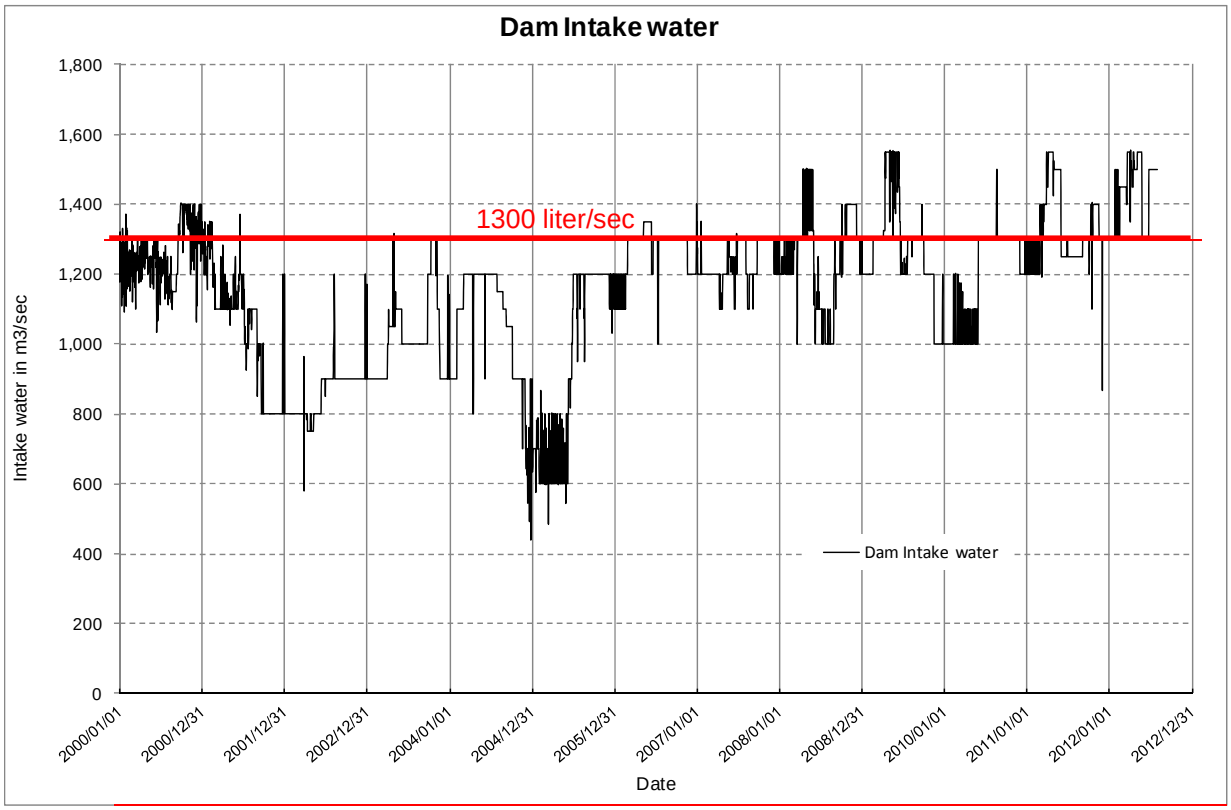


Annual Maximum/Minimum/Average Dam Water Level

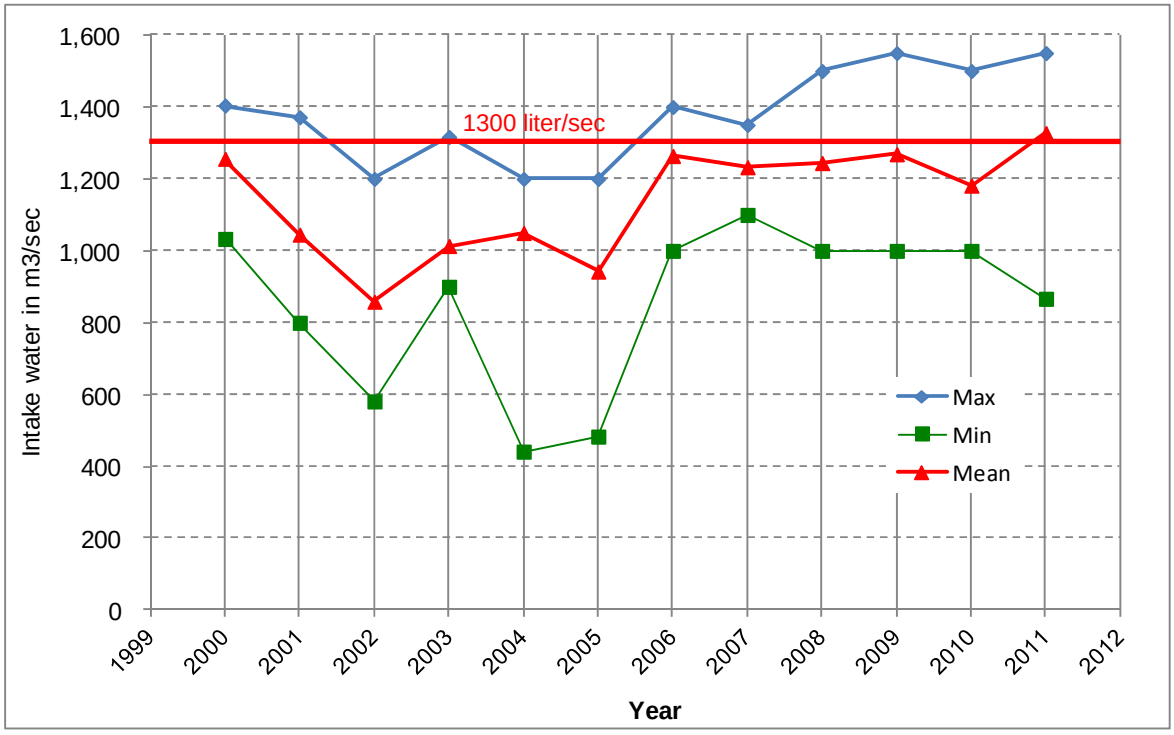


Fluctuation of Dam Water Level

Fluctuation of Daily Dam Intake Water

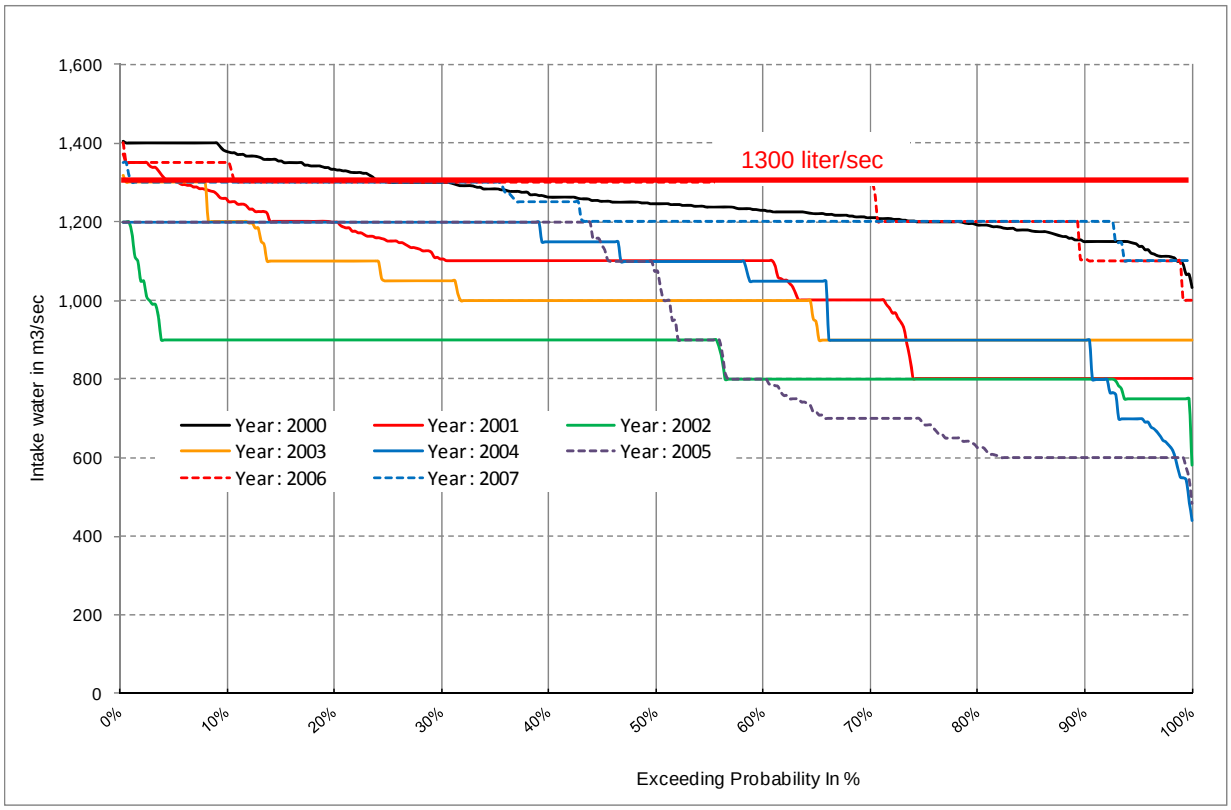


Annual Maximum/Minimum/Average Intake Water

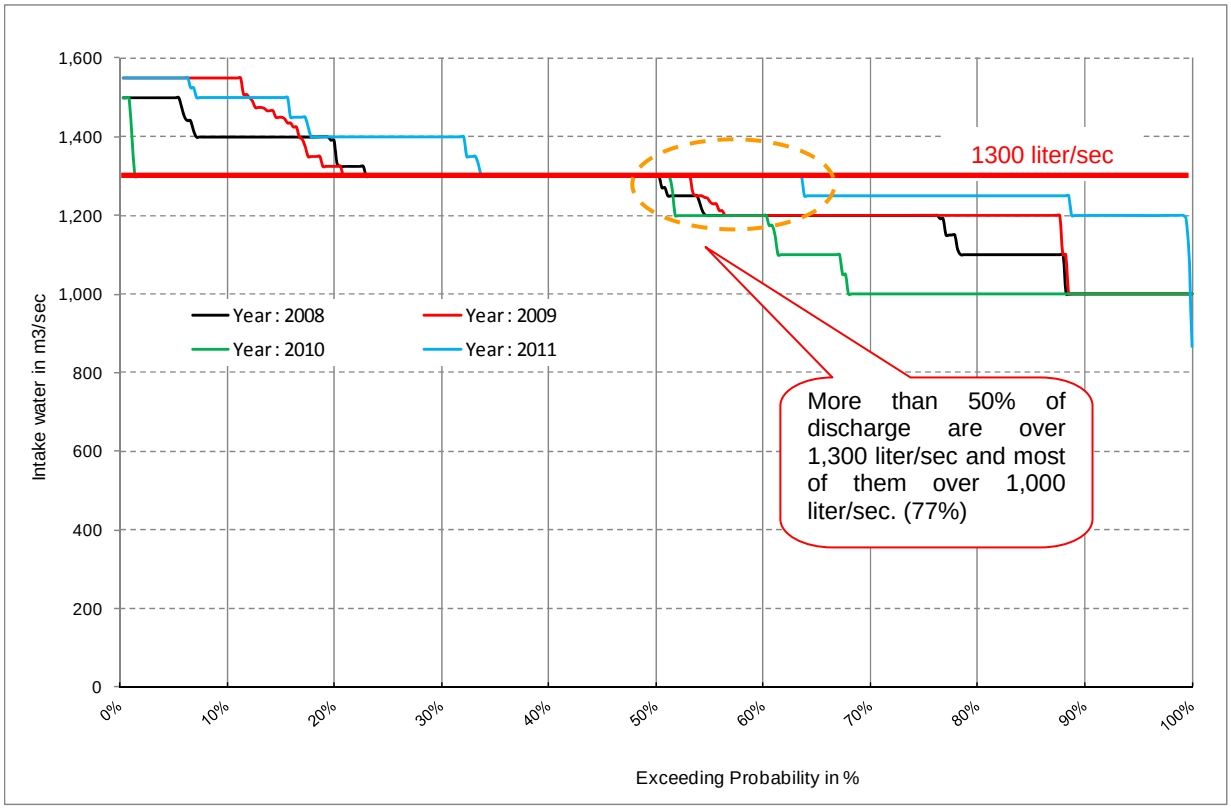


Fluctuation of Intake Water Volume

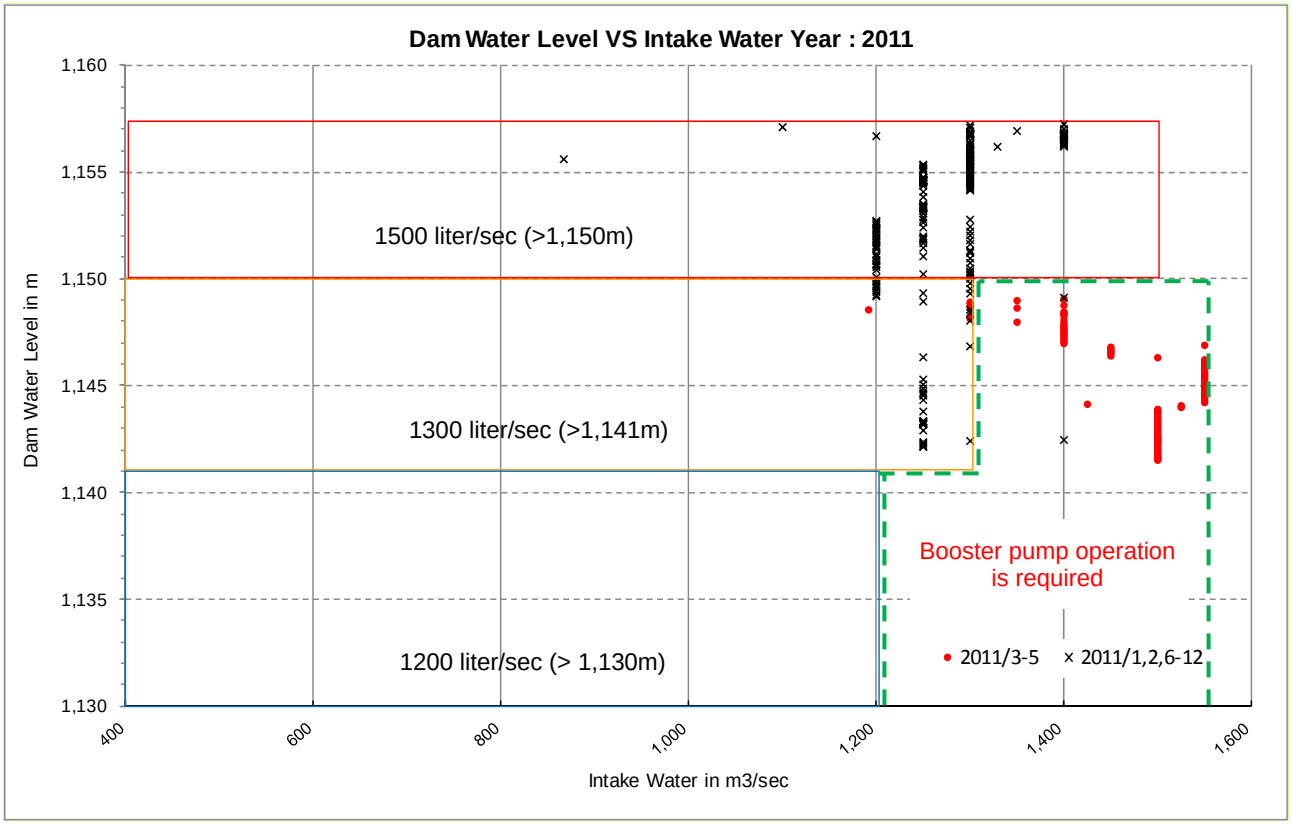
Duration Curve (2000-2007)

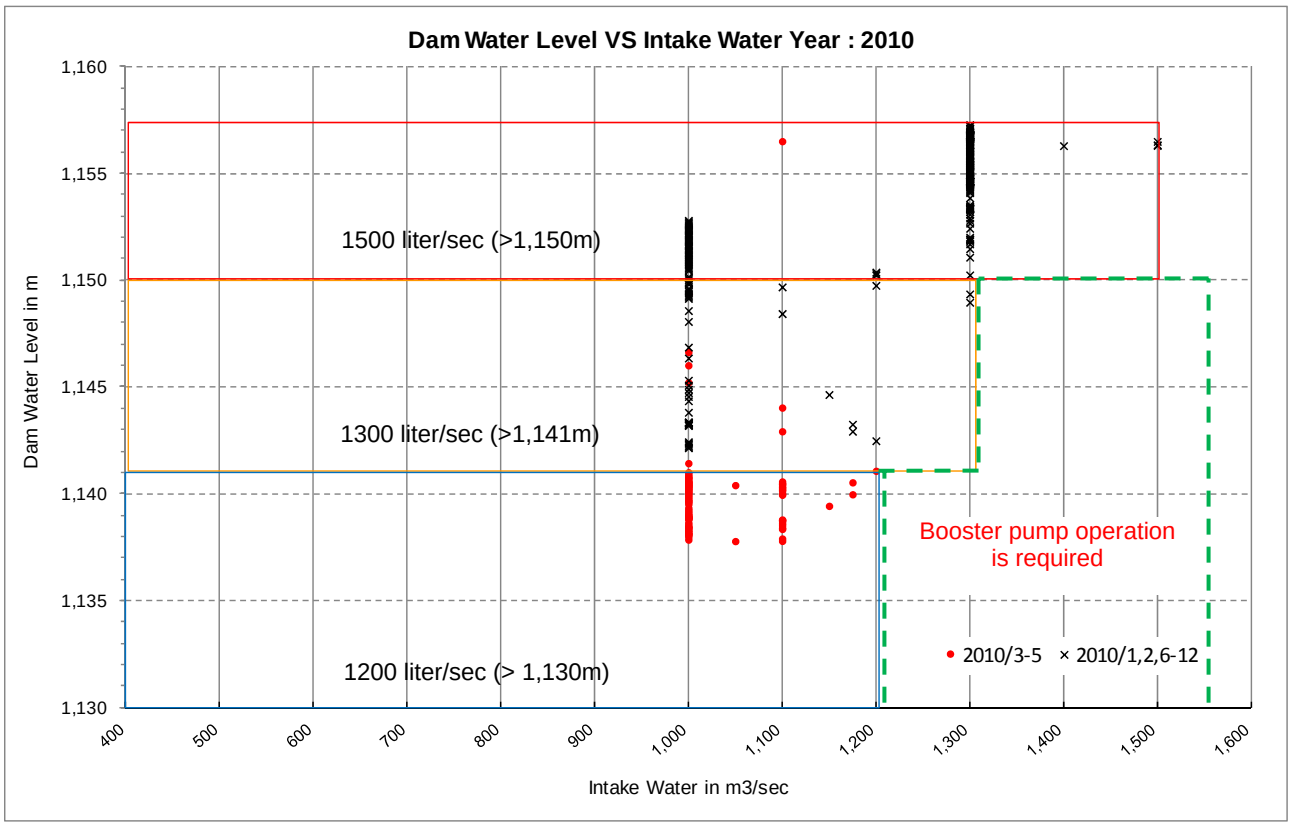


Duration Curve (2008-2011)



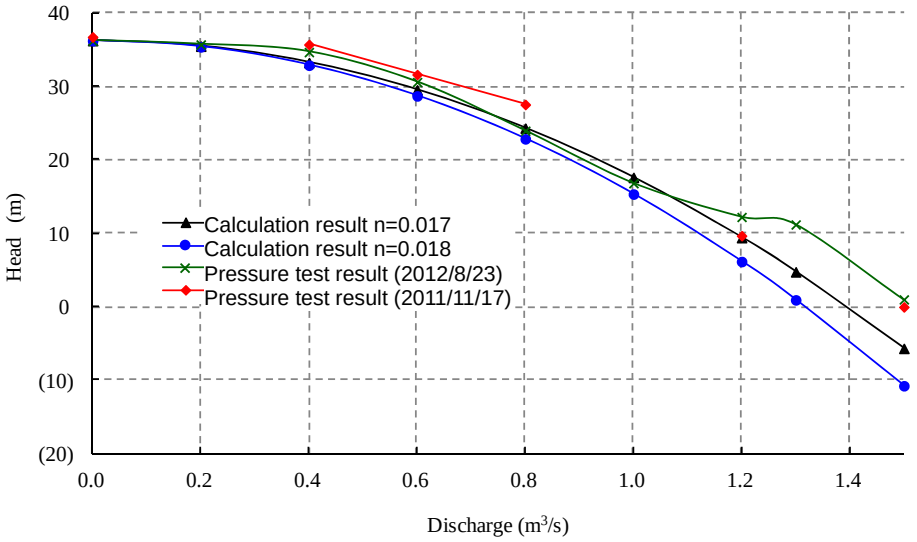
Fluctuation of Discharge Data



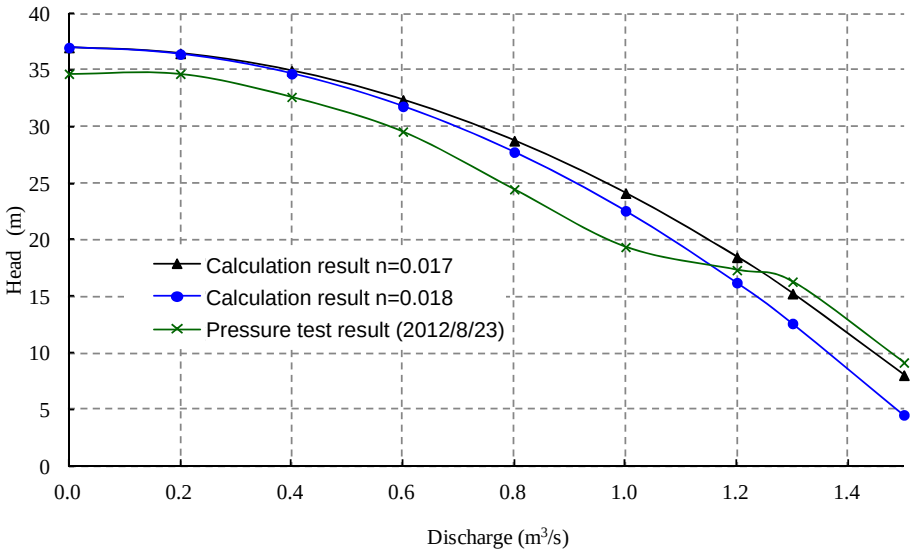


Booster Pump Operation Condition

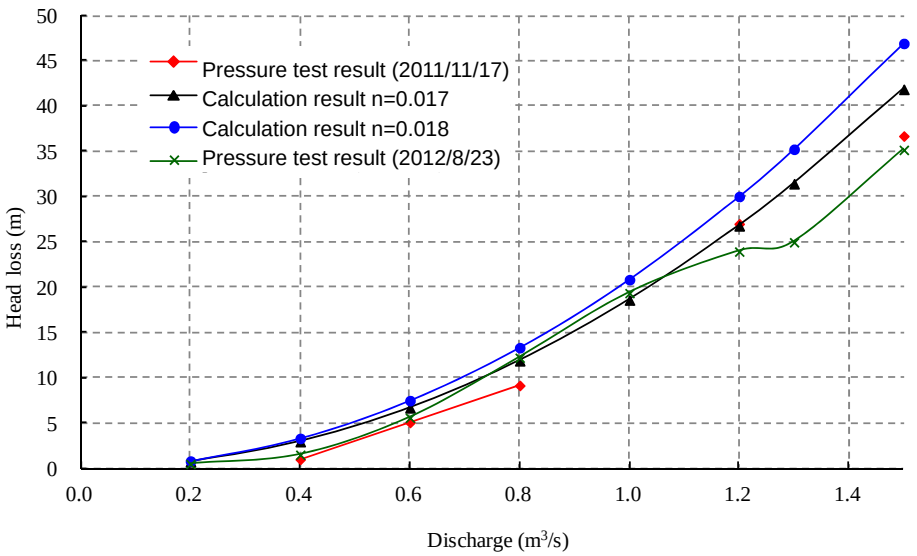
Head vs Discharge at Aerator （ST 5,500m）



Head vs Discharge at P-2 （ST 4,400m）



Head loss vs Discharge at Aerator （ST 5,500m）



Pressure Measurement Results along the Pipe line

Aerator

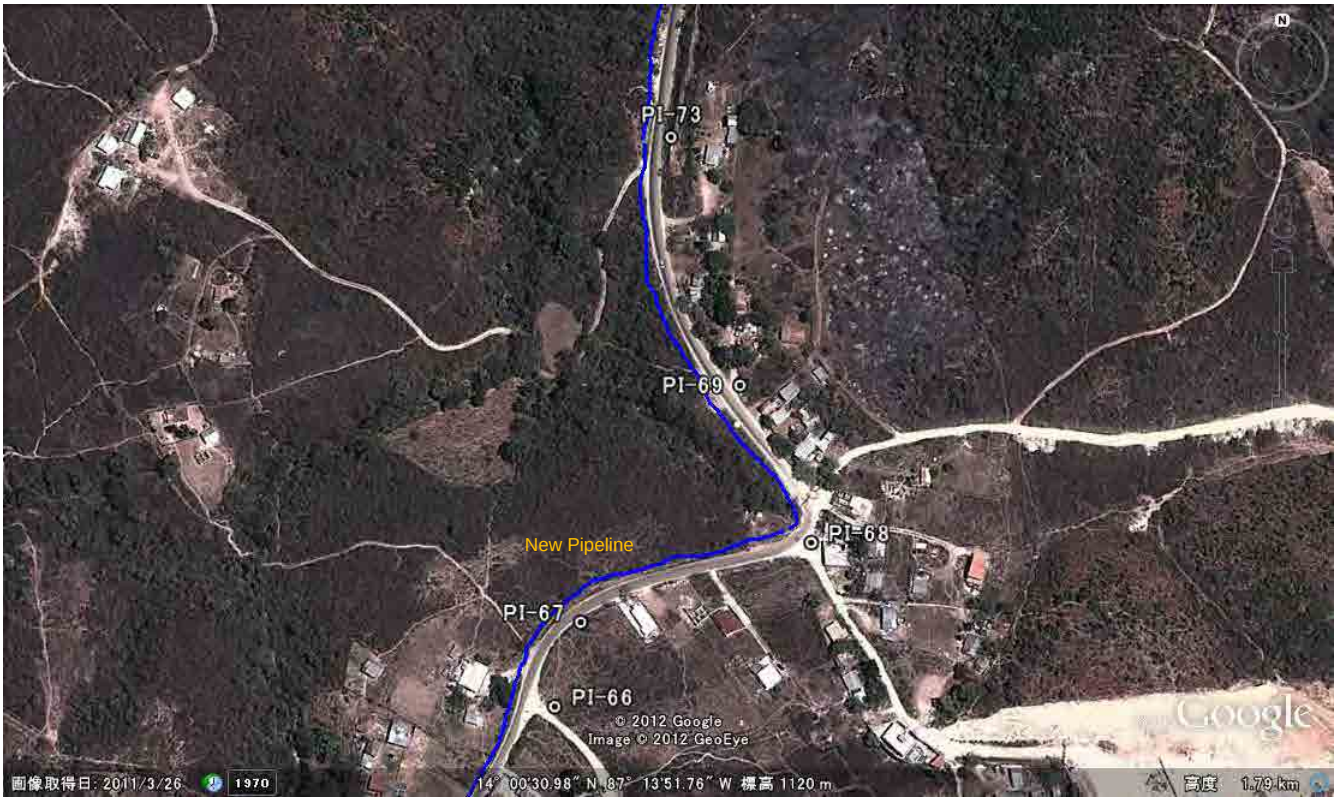
Concepcion Powerhouse Site

Conception Site：New Pipeline Route

Aerator-PI87

PI87 – P73

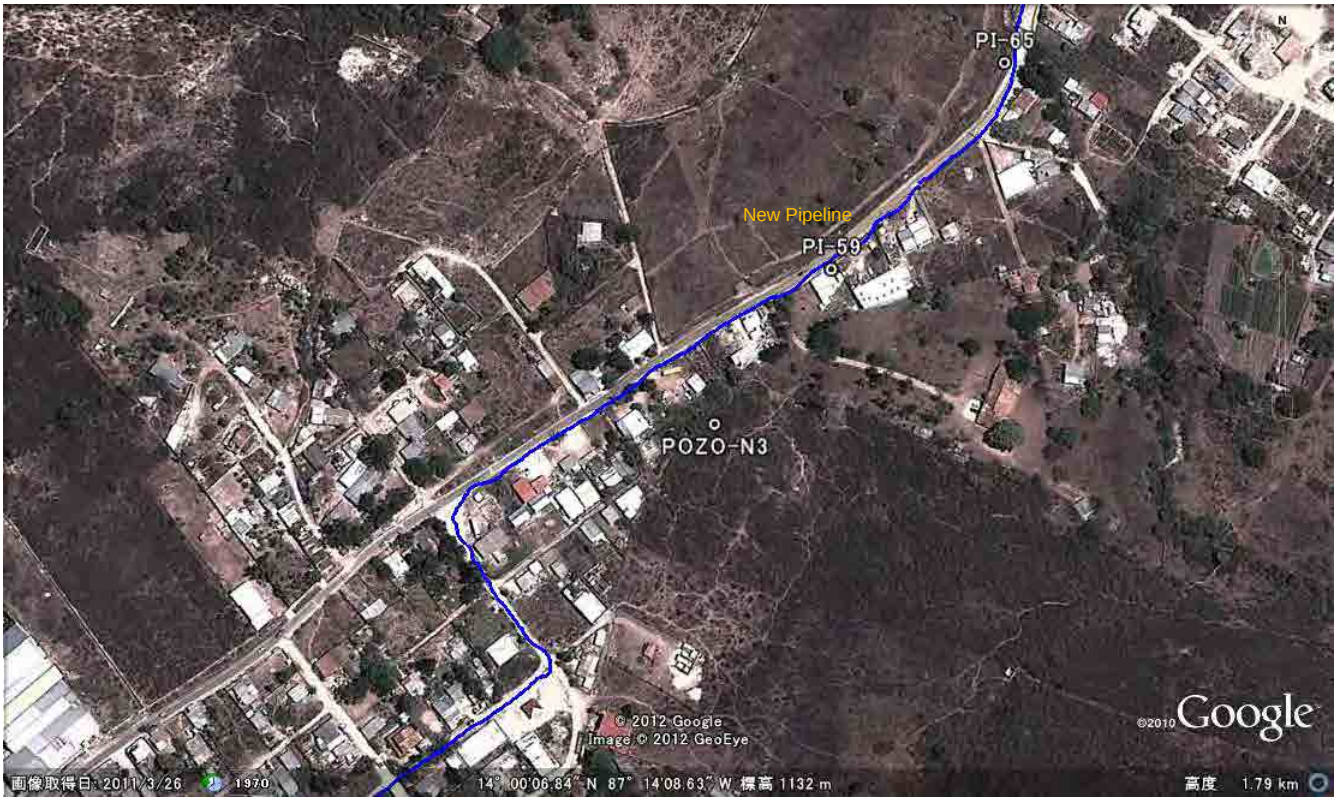
Conception Site：New Pipeline Route



PI73 - PI66

PI67 – PI65

Conception Site：New Pipeline Route



PI65 – Manhole No.3

Manhole No.2 – Manhole No.1

PI-89⇒PI－87

PI-89⇒PI－87⇒PI－86

PI-87⇒PI－86

PI-86⇒PI－75

PI-86⇒PI－75

PI-75⇒PI－73

PI-75⇒PI－73

PI-69⇒PI－68

Concepcion Site Pipeline Route

Concepcion 15/08/2012

PI-69⇒PI－68

PI-68⇒PI－67

PI-67⇒PI-66

PI-67⇒PI-66⇒PI－65

3

Concepcion 15/08/2012

PI-66⇒PI－65

PI-66⇒PI－65

PI-66⇒PI－65⇒PI－59

PI－65⇒PI－59

Concepcion Site Pipeline Route

3.2 Picacho Site

The essential data for power generation plan such as discharge data and effective head is not reliable.

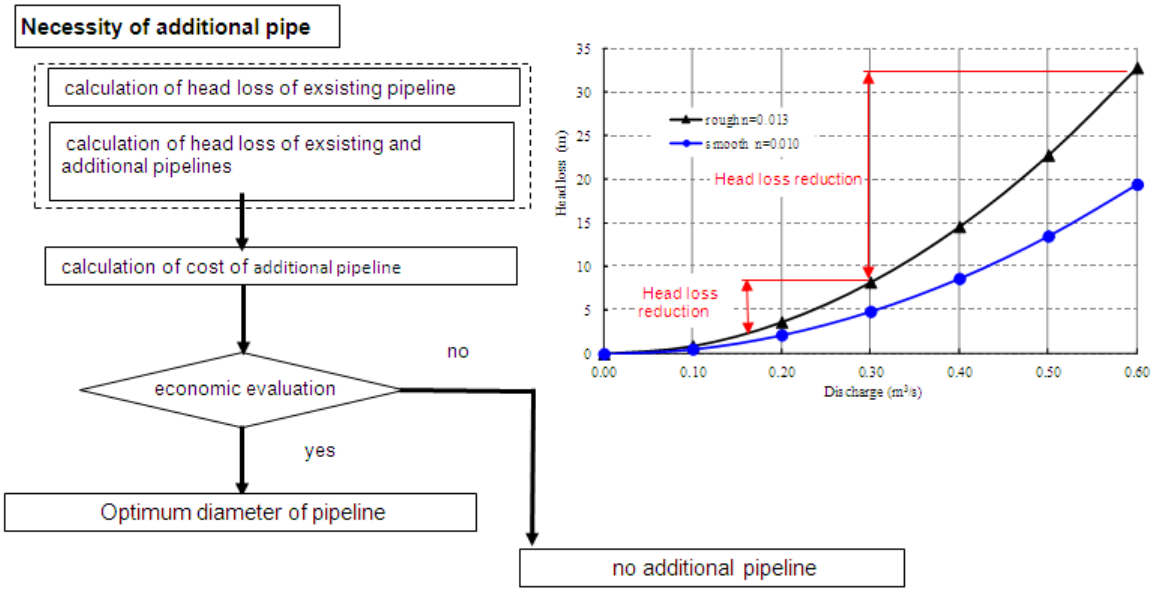
The following points shall be decided immediately for further study.

- Design and maximum distribution water volume of L22 system
- Future distribution water plan of L22 system and forecast
- Set pressure value of pressure reducing valve

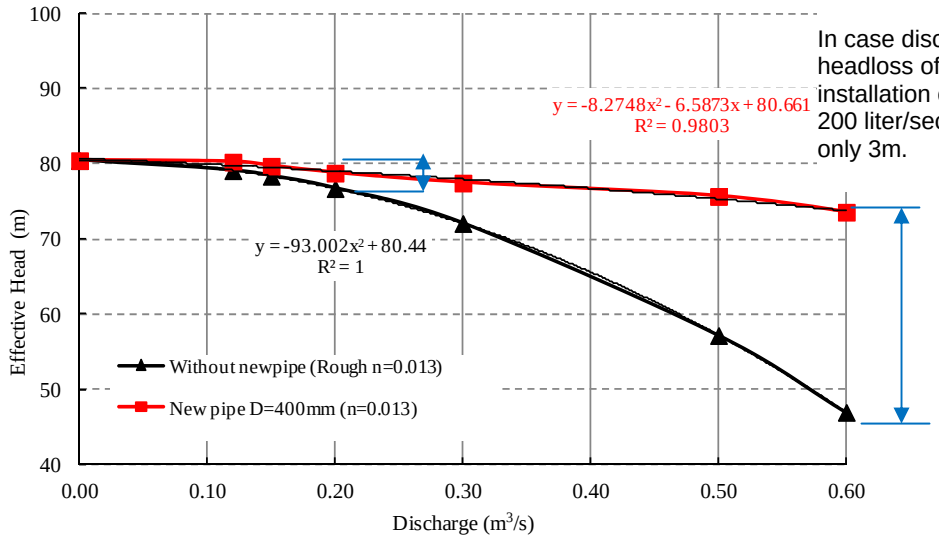
The Picacho site has difficulties for power generation plan due to very small amounts of water in addition to pressure degradation and aeration into the pipe.

The present valve operation for L22 pipeline at the treatment plant is to be changed and water regulating valve installed at the downstream of the turbine is to be operated for water distribution. Valve operation at each distribution pond is not changed. To avoid cavitation of the turbine, the minimum power discharge is required.

Power Generation Plan of Picacho Site



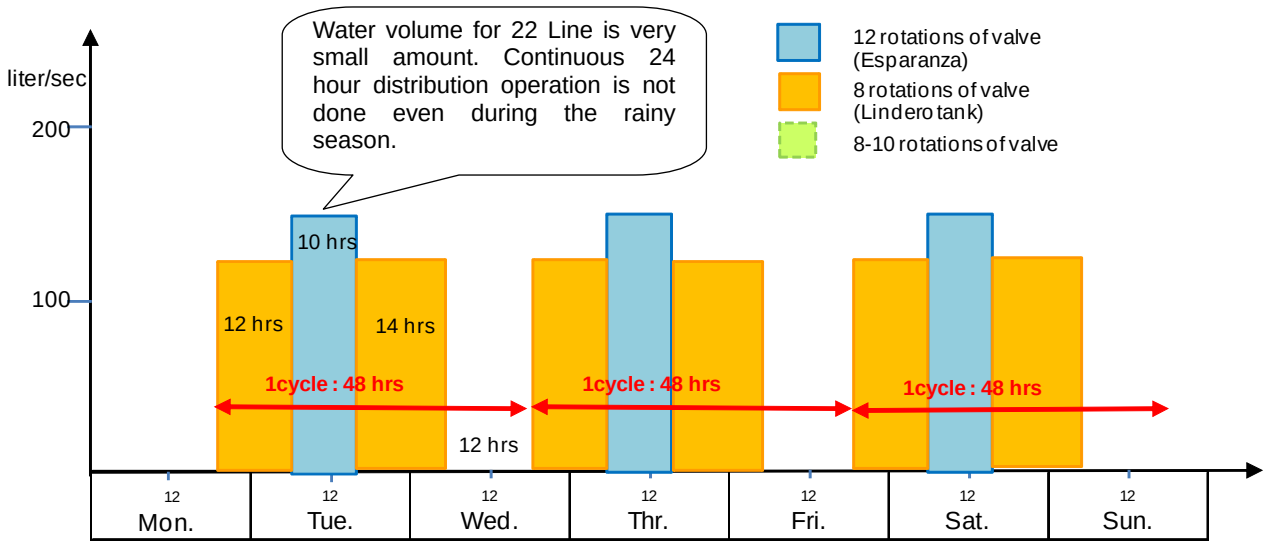
Study on Necessity of Additional Pipe



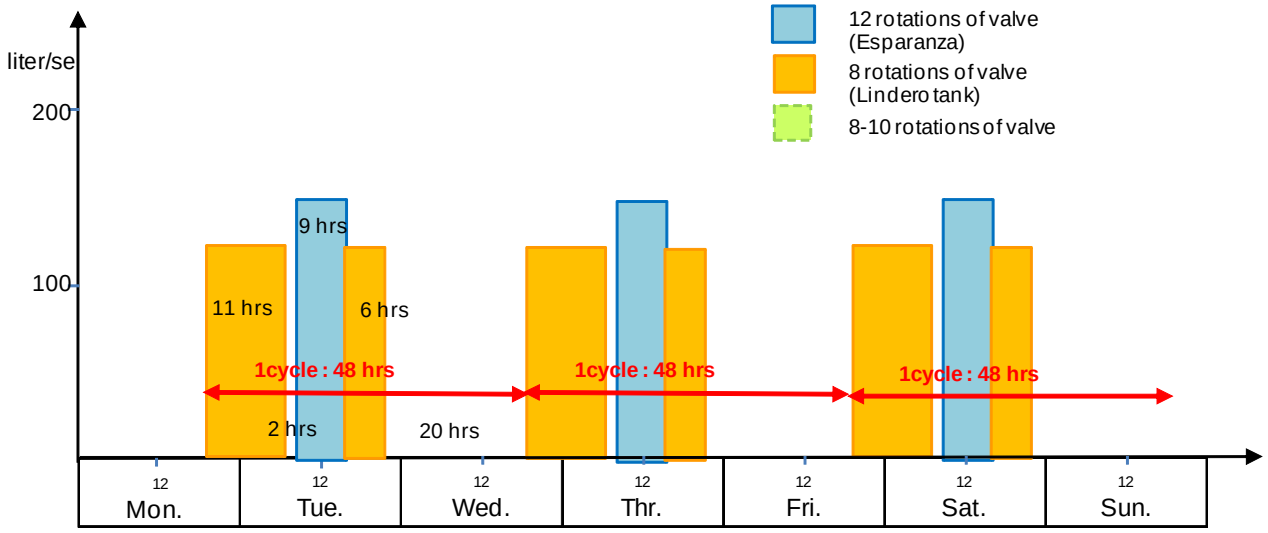
In case discharge is 600 liter/sec, headloss of 30m is reduced by new installation of 400mm pipe, but in case of 200 liter/sec, only reduced headloss is only 3m.

Calculated Effective Head of L22 Pipeline with new pipe for Various Discharges

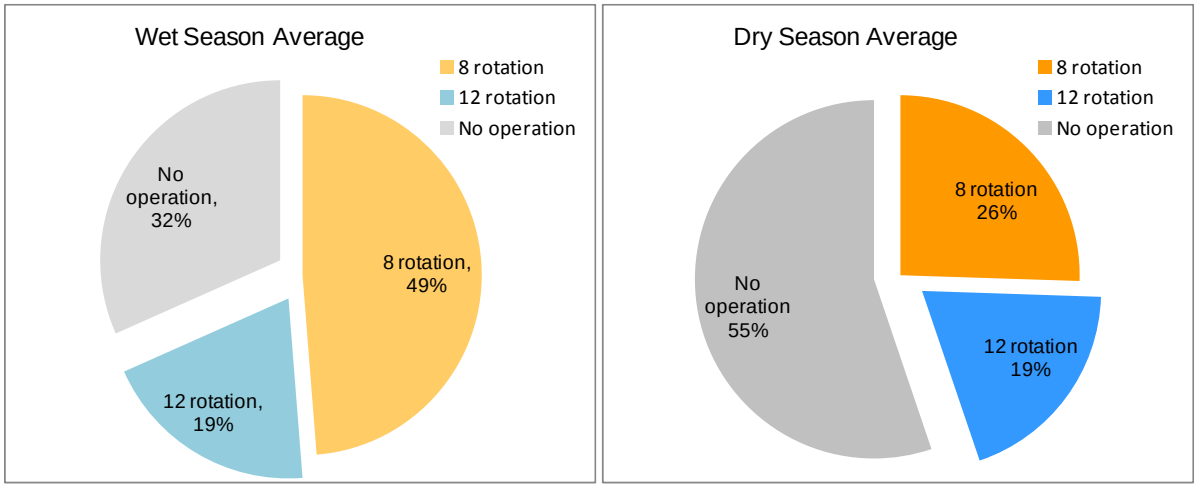
Water Distribution Pattern of L22 Pipeline in the rainy season (September 2012)



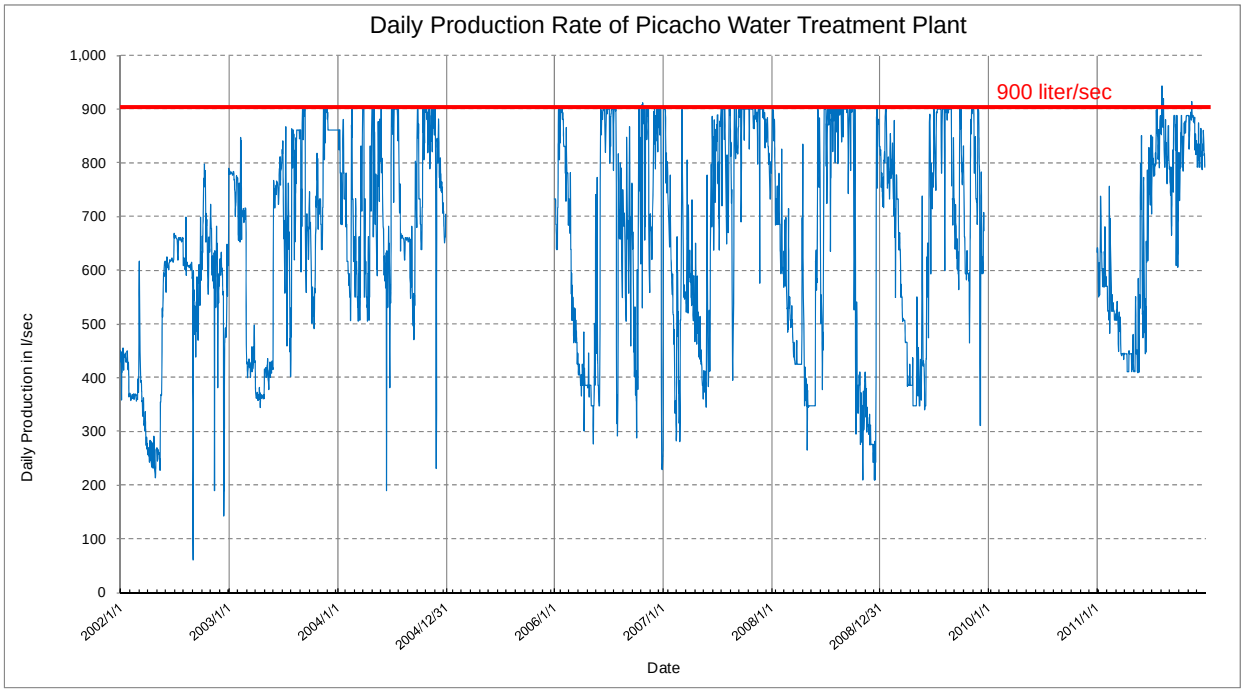
Water Distribution Pattern of L22 Pipeline in the dry season (March 2012)

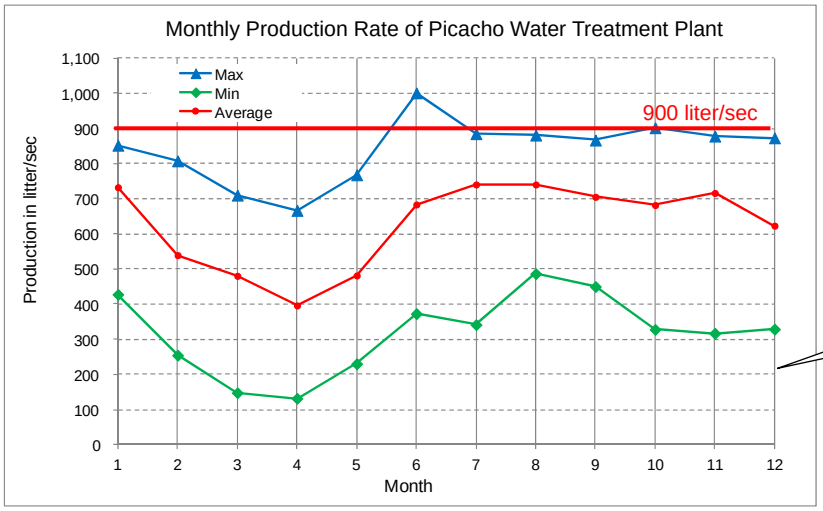


L22 System Water Distribution Typical Pattern in the rainy and dry seasons

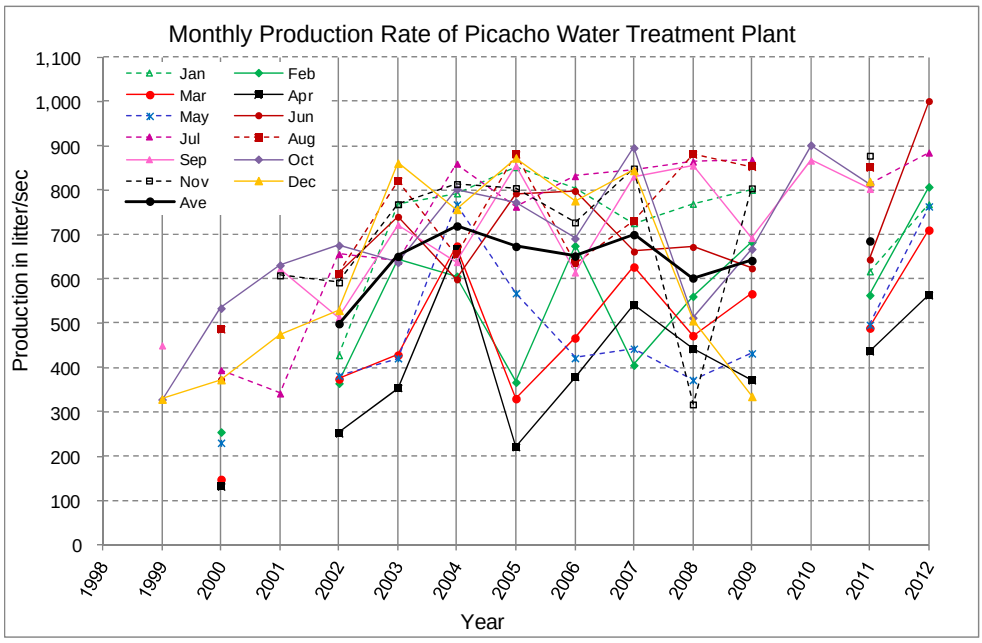


Water Distribution Pattern of L22 Distribution System

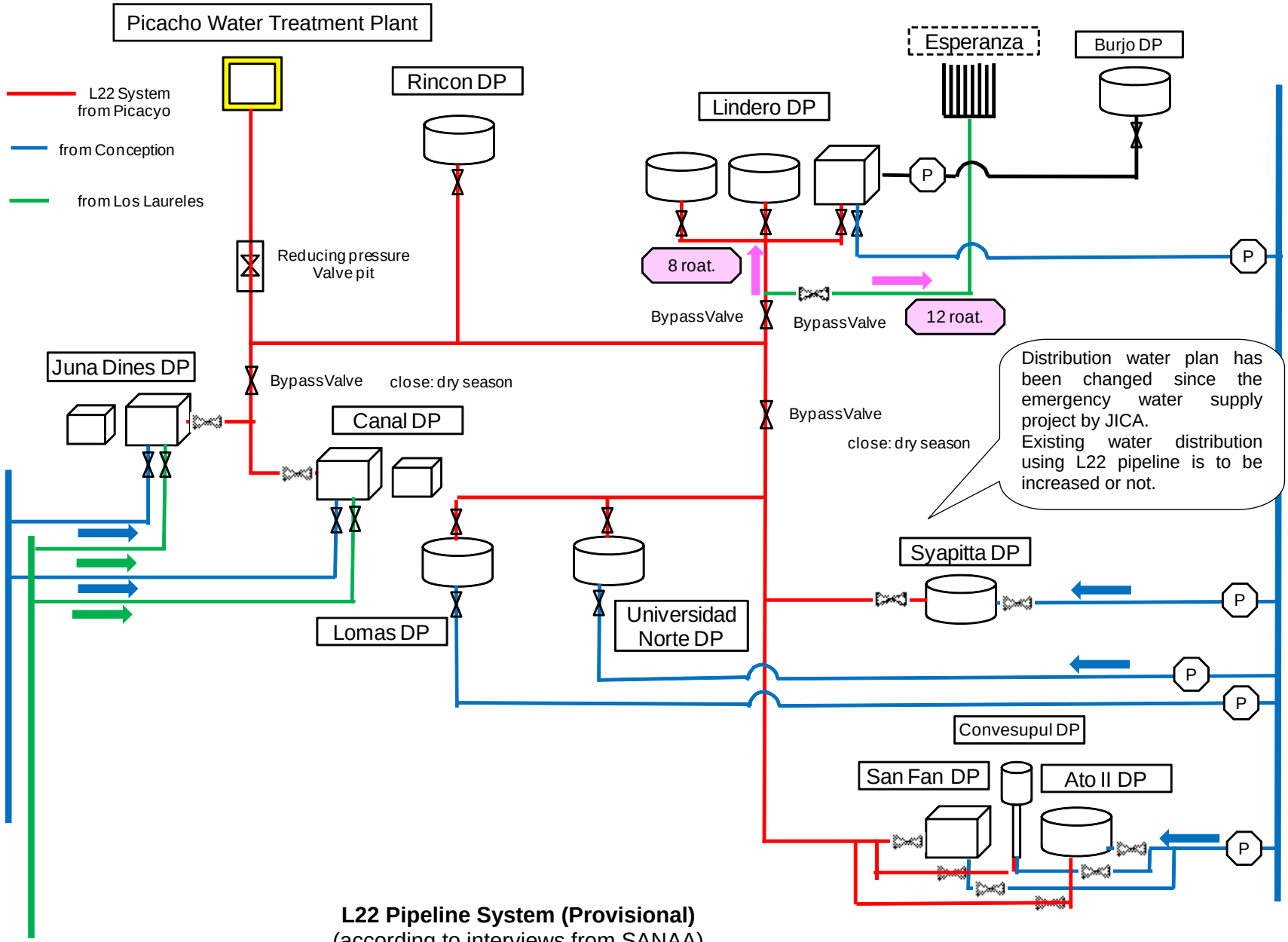




Large fluctuation between water in the rainy season and one in the dry season exists, max. 900 liter/sec and min. 300 liter/sec, it is 3 times.



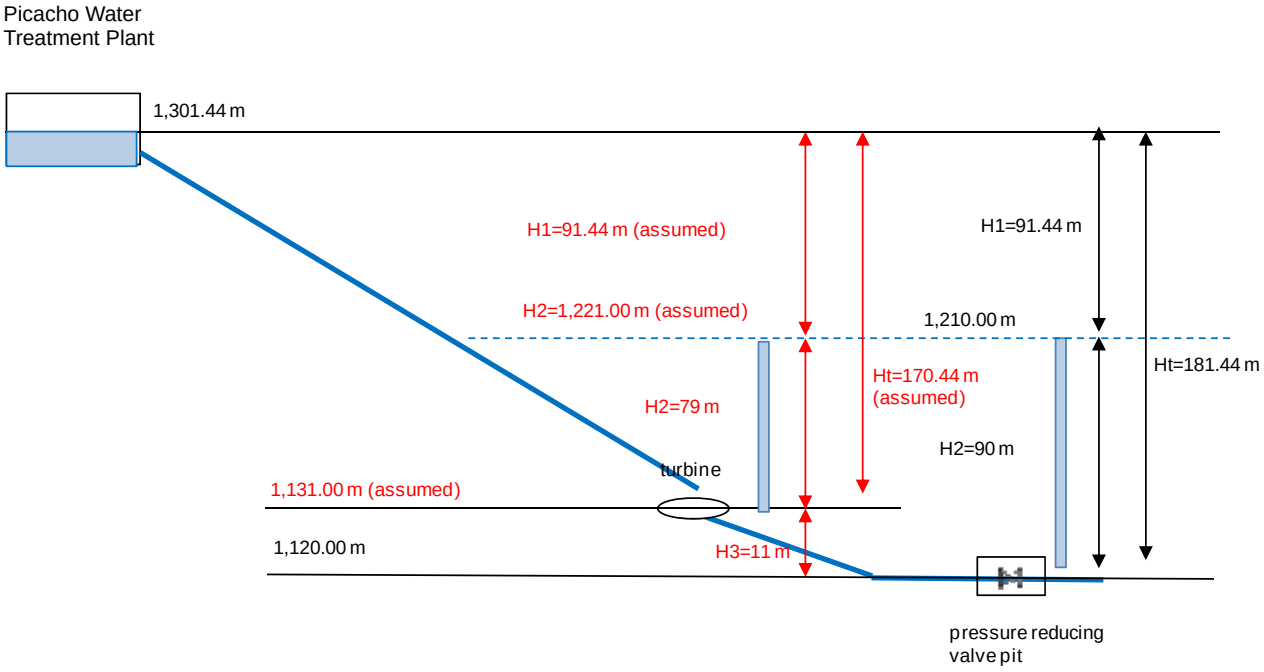
Water Production Rate of Picacho Treatment Plant



L22 Pipeline System (Provisional)
(according to interviews from SANAA)

Effective Head Calculation

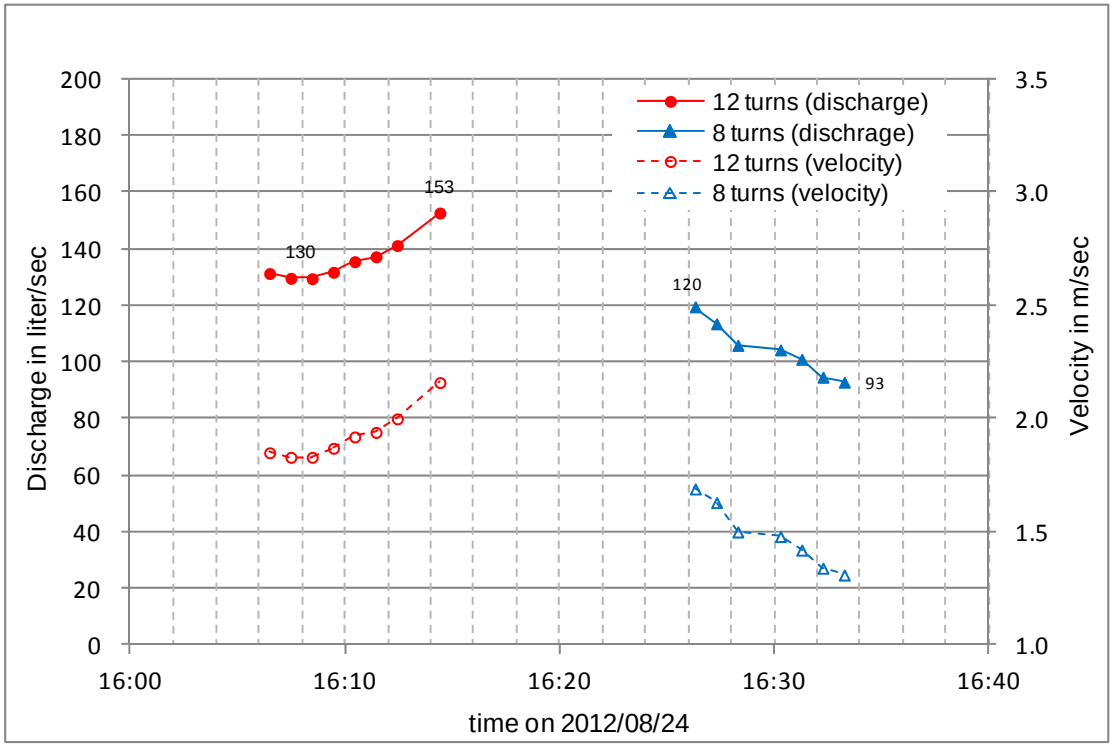
The pressure in the downstream of reducing valve is to be set to 90m according to JICA Study results. The high pressure will act on downstream pipes located in lower elevation. The location of powerhouse is around 10m higher than the existing pit.



Turbine Discharge (Qmax)	Gross Head (Hg)	Effective Head (He)
0.12 m3/s	91.44 m	90.29 m
0.15 m3/s	91.44 m	89.64 m
0.30 m3/s	91.44 m	84.22 m

* 10% increase of total friction loss, Manning roughness coefficient: n=0.014

Discharge Measurement at L22 System and Pressure Test at Pressure Reducing Valve



Discharge measurement results

Unit: liter/sec

Date		mean	max	min	remarks
2012/08/24	12 turns	136	153	130	Lindero distribution reservoir
	8 turns	105	120	93	
2012/08/29	8 turns	120			L22 pipeline upstream the valve pit
	20 turns		480	405	

Pressure measurement results

Unit: bar

Date		upstream	downstream	remarks
2012/08/29	8 turns	4.827 (70 psi)	4.068 (59 psi)	L22 pipeline upstream the valve pit
	15 turns	6.843	6.843	
	20 turns	15.393	15.393	

*: It is judged that pressure reducing valve must not be functioned properly.

Picacho Powerhouse Site

PREPARATORY SURVEY FOR THE PROJECT OF MICRO-HYDROELECTRIC POWER GENERATION IN METROPOLITAN AREA OF TEGUCIGALPA IN THE REPUBLIC OF HONDURAS

December, 2012

NEWJEC Inc.
JAPAN TECHNO Co., Ltd.

Location Map of Concepcion & Picacho Hydroelectric Power Plants

Picacho water resources

Picacho water treatment plant (Manifold)

Picacho Hydroelectric Power plant

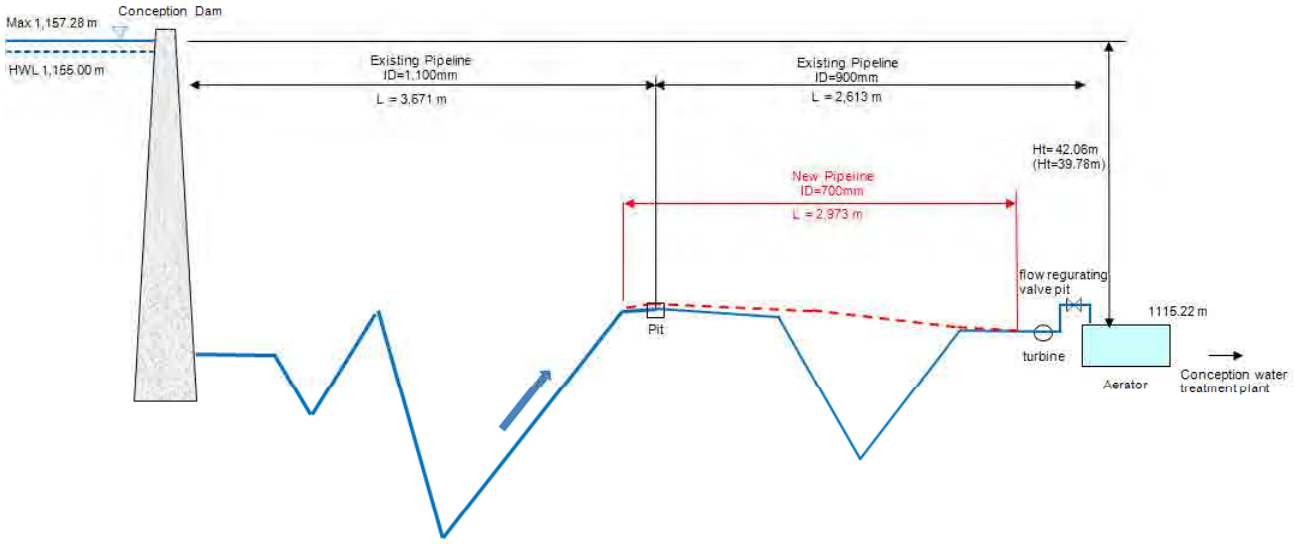
Concepcion Aerator

L22 pipeline (open penstock)

Concepcion reservoir dam

Pressure reduced valve pit

General Plan & Profile of Concepcion Hydroelectric Power Plant



item	value
Max. Power discharge	1.5 m^3/sec
Max. dam WL	1,157.28m
Tail water WL	1,115.22m
Max. gross head	42.06m
Power discharge at rated capacity	1.2m^3/sec

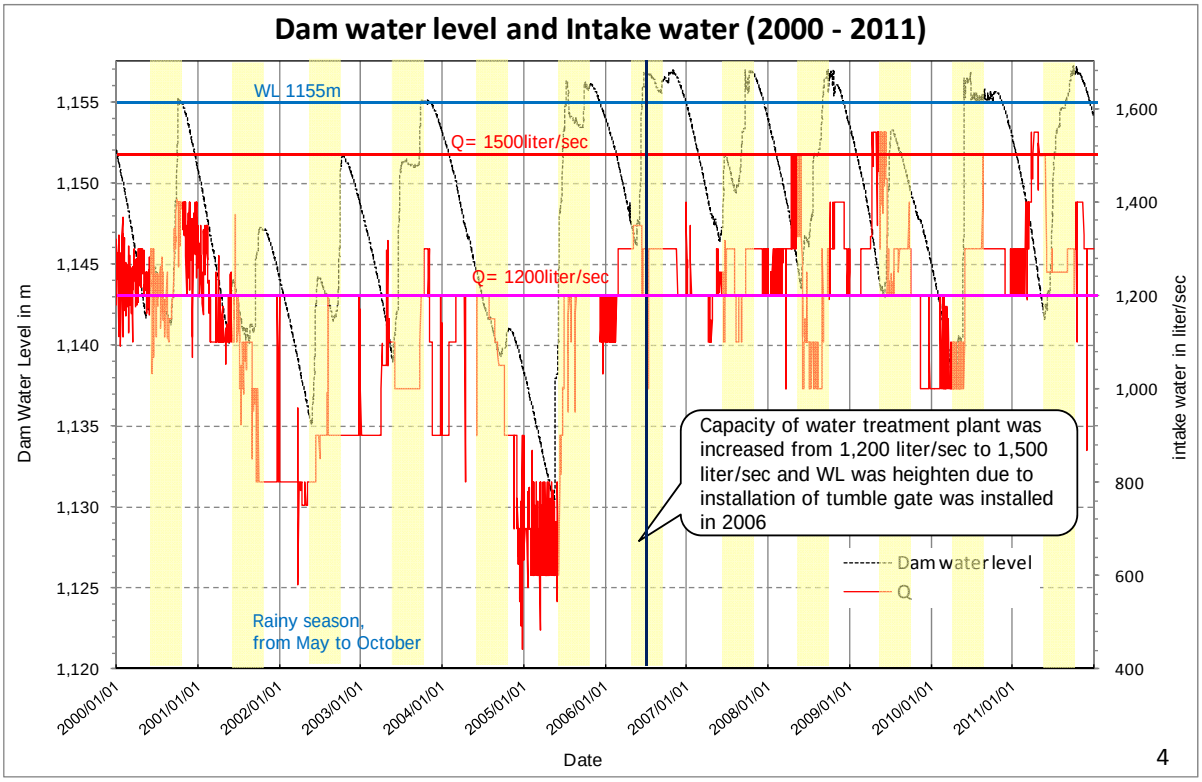
item	value
Effective head at rated capacity	26.52m
Rated capacity	273kW
Installed capacity	250kW

Daily Dam water level & Intake water of Concepcion Hydroelectric Power Plant

From 2006 to 2011

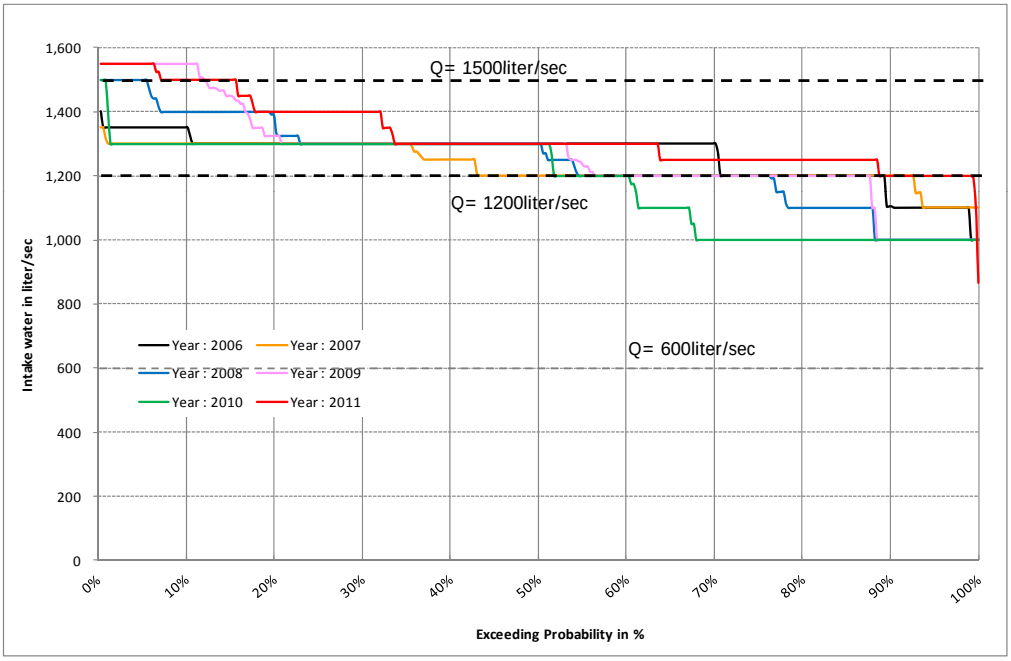
Dam Water Level: Max 1,157.3m – Min 1,137.8m Ave. 1,151.0m

Dam intake water : Max 1,550 – Min 866.7 liter/sec Ave 1,253.1 liter/sec



Duration Curve of Intake water of Concepcion Hydroelectric Power Plant

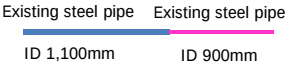
To utilize Intake water as much as possible for power generation
Max Intake water = Max Power discharge (Qpmax) = 1,500 liter/sec



Head loss and Effective head of Concepcion Hydroelectric Power Plant

Head loss of Existing steel pipe

Intake water m^3/sec	Friction Head loss (m)				Total head loss
	ID 1,100mm section L=3,671m		ID 900mm section L=2,613 m		
	Sub-total	Per 100m	Sub-total	Per 100m	
0.4	1.10	0.030	2.07	0.079	3.17
0.8	3.95	0.108	7.47	0.286	11.42
1.0	5.97	0.163	11.29	0.432	17.26
1.2	8.36	0.228	15.82	0.605	24.18
1.3	9.70	0.264	18.34	0.702	28.04
1.5	12.64	0.344	23.90	0.915	36.54



Large head loss occurs in ID900mm section, so new pipe shall be installed in ID 900mm section.

Total Head loss after installation of new ID 700mm ductile cast-iron pipe (L=2,973m)

Intake water m^3/sec	Total Head loss (m)	Decreasing head loss due to new pipe (m)	Effective Head at Max WL (m)
0.0	0.00	-	42.06
0.4	2.01	1.16	40.05
0.8	6.88	4.54	35.18
1.0	10.38	6.88	31.68
1.2	14.60	9.58	27.46
1.3	16.98	11.06	25.08
1.5	22.27	14.27	19.79

To increase electric energy due to installation of new ductile pipe.

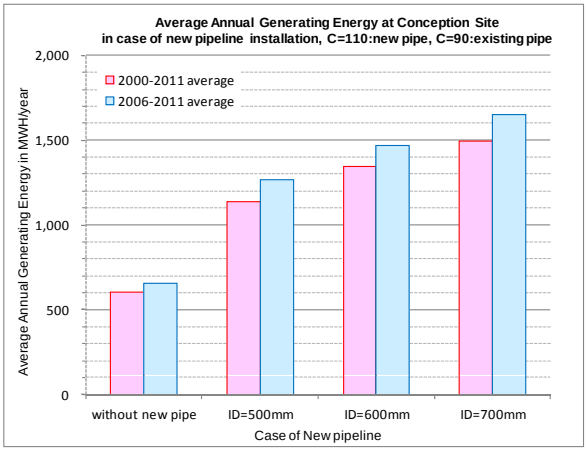
(Reference: Hazen-Williams formula existing steel pipe C=90, new ductile pipe C=110)

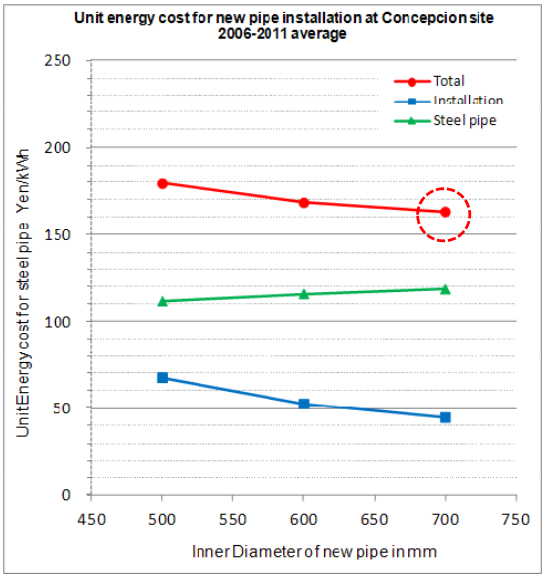
Economic Parameters for Optimization of Pipe Diameter at Concepcion Hydroelectric Power Plant

Optimum diameter of new ductile pipe is ID 700mm because of the lowest unit construction cost per kWh (material cost + installation cost)

Economic parameter	Period for calculation	500mm	600mm	700mm
Unit Pipe Construction Cost per kWh yen/kWh	2006－2011 Average	179	168	163
	2000－2011 Average	206	186	182
B-C a million yen/year	2006－2011 Average	3.98	5.52	6.85
	2000－2011 Average	3.10	4.66	5.71
B/C	2006－2011 Average	2.45	2.60	2.68
	2000－2011 Average	1.95	2.12	2.14

B: Annual income of electricity selling (0.13695 US$/kWh)
C: Annual capitation cost of ductile pipe installation in case of 40 year life time of the pipe (51,000US$/year)

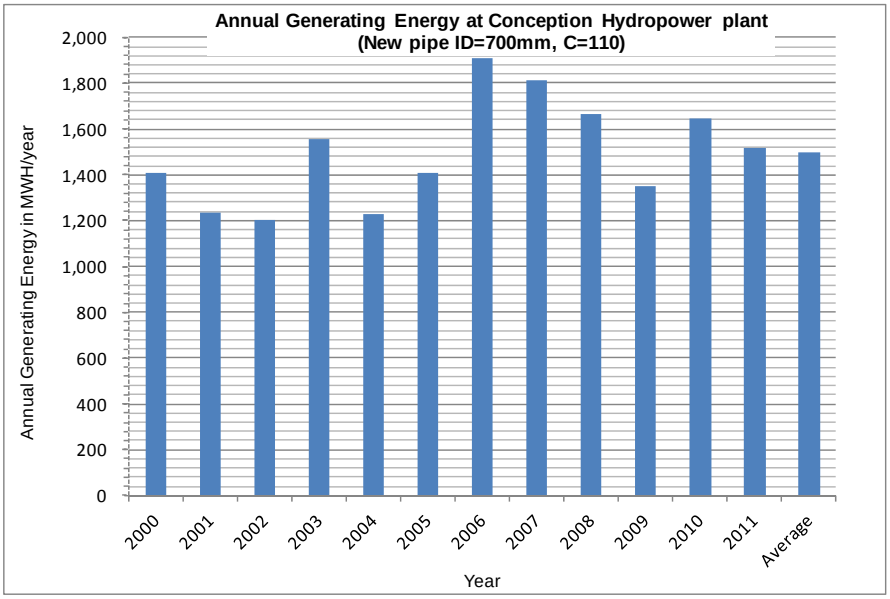




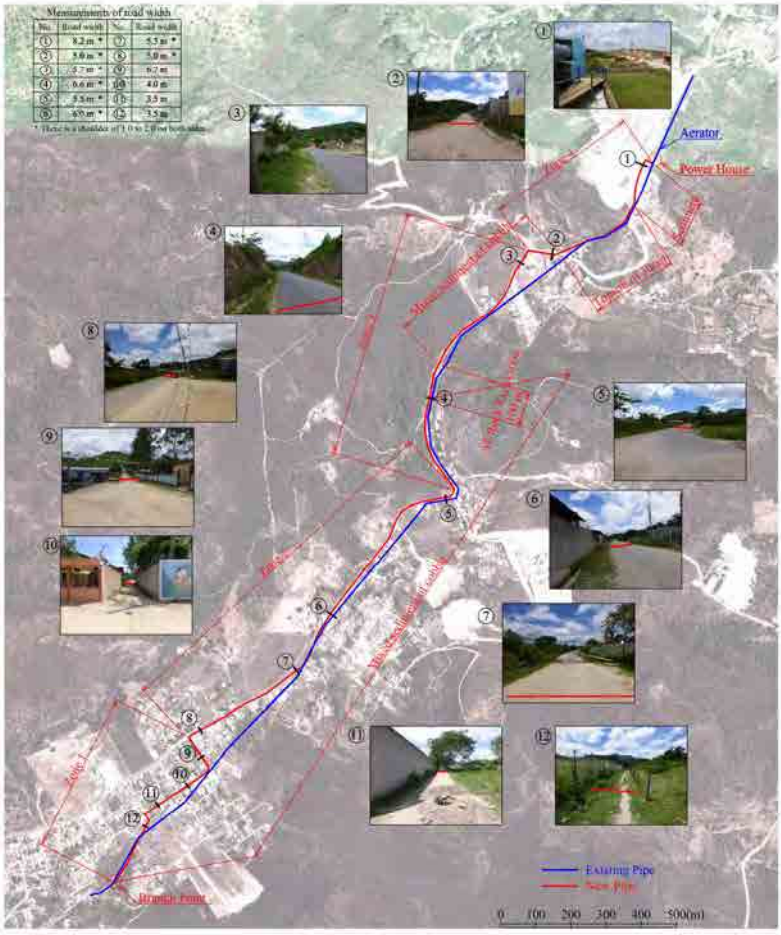
Annual Electric Energy of Concepcion Hydroelectric Power Plant

Mean annual electric energy with new installation of ID 700 mm ductile pipe is 1.650 GWh/year
(Assumed income of selling electricity : 230,000US$/year = 18 million yen/year (0.13695 US$/kWh))

Period For calculation		Mean Annual Electric Energy	Maximum Annual Electric Energy	Minimum Annual Electric Energy
2006 – 2011	GWh/year	1.650	1.910	1.349
	PF	75%	87%	62%
2000 - 2011	GWh/year	1.495	1.910	1.201
	PF	68%	87%	55%



Concepcion Hydroelectric Power Plant



New pipeline is to be installed under ground along the existing road.

Kind : Ductile cast-iron pipe

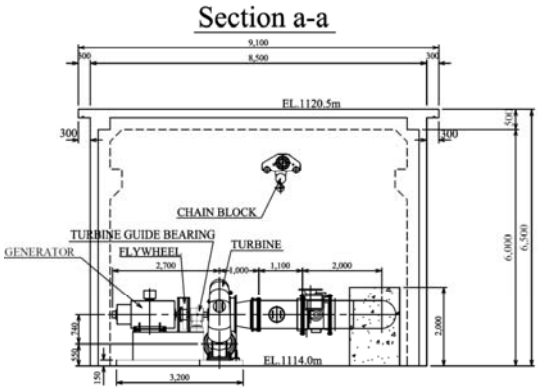
Diameter : 700 mm

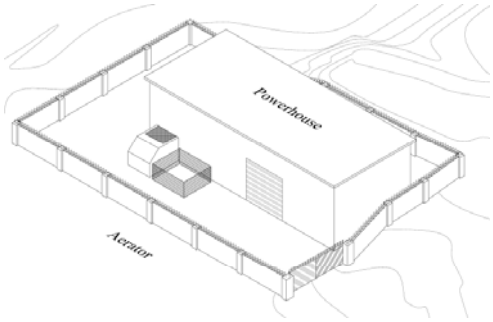
Total length : 2,973m

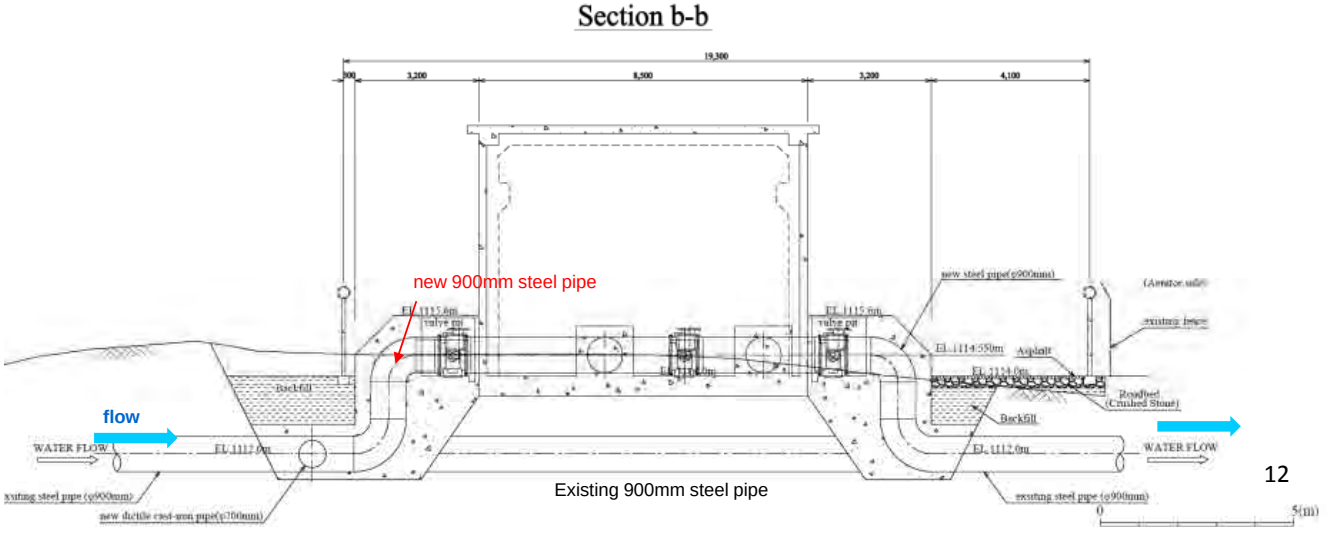
Concepcion Hydroelectric Power Plant

Concepcion Hydroelectric Power Plant

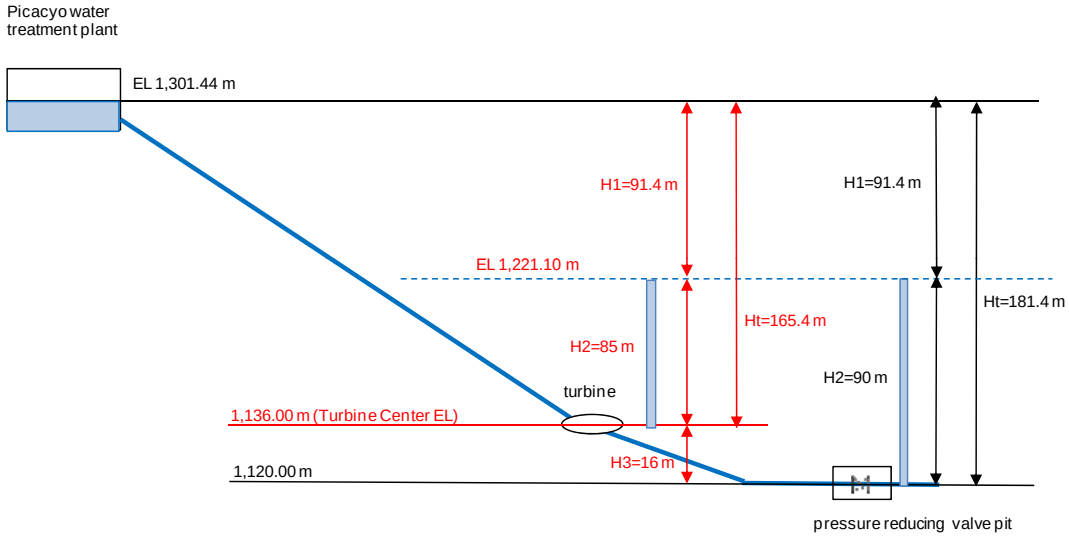
Concepcion Hydroelectric Power Plant







General Profile of Picacho Hydroelectric Power Plant

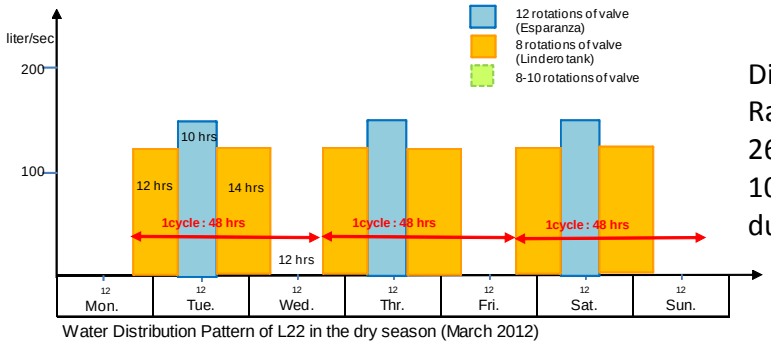


item	value
Max. Power discharge	0.3 m³/sec
Picacho water treatment plant WL	1,301.44m
Tail water WL	1,210.00m
Max. gross head	91.44m
Effective head at rated capacity	86.16m
Rated capacity	204kW
Installed capacity	180kW

to distribute 120liter/sec water to Lindero pond and distribute 150liter/sec to Esperanza community (actual measurement).
Max design distribution water 225 liter/sec

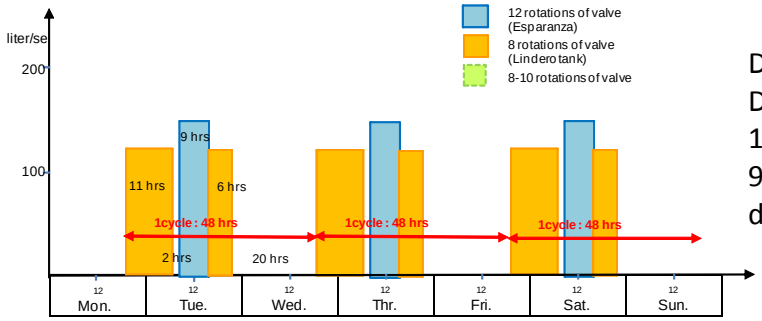
Water Distribution Operation Pattern of L22 pipeline of Picacho Water Treatment Pplant

Water Distribution Pattern of L22 in the wet season (September 2012)



Distribution operation pattern in the Rainy season :
26 hour-operation with 120liter/sec,
10 hour-operation with 150liter/sec
during 48 hours（total 75% operation)

Water Distribution Pattern of L22 in the dry season (March 2012)



Distribution operation pattern in the Dry season :
17 hour-operation with 120liter/sec,
9 hour-operation with 150liter/sec
during 48 hours（total 54% opration)

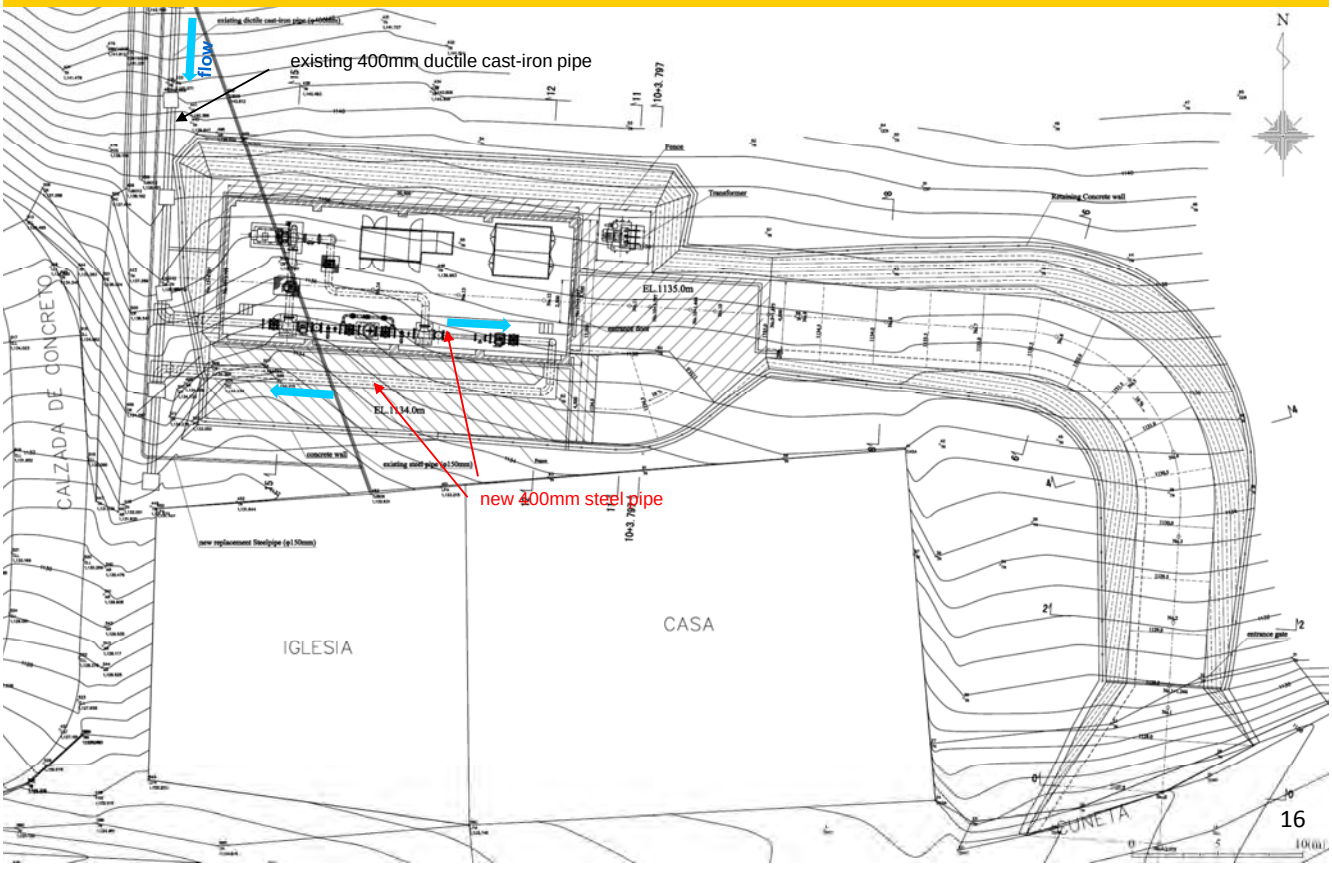
Annual Electric Energy of Picacho Hydroelectric Power Plant

Annual electric energy is 0.52GWh/year under existing water distribution condition, however, considering max design distribution water of 225 liter/sec for L22 pipeline , more energy can be generated under effective water distribution schedule.

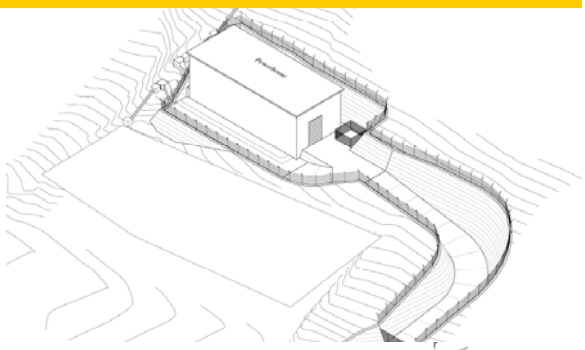
(Assumed income of selling electricity : 71,000US$/year = 5.6 million yen/year (0.13695 US$/kWh))

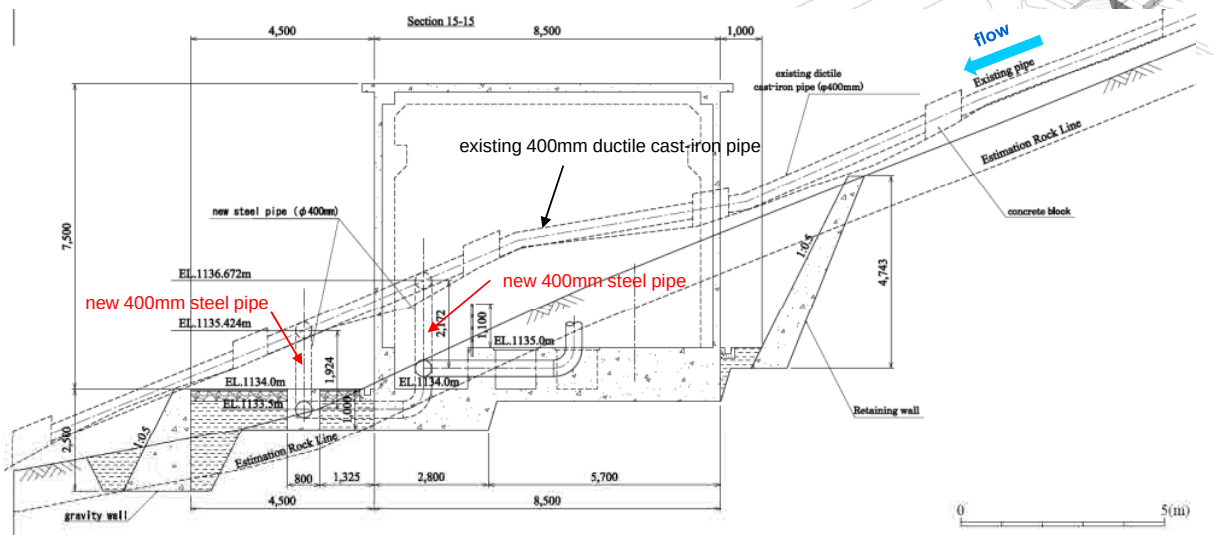
Picacho Hydroelectric Power Plant

Picacho Hydroelectric Power Plant

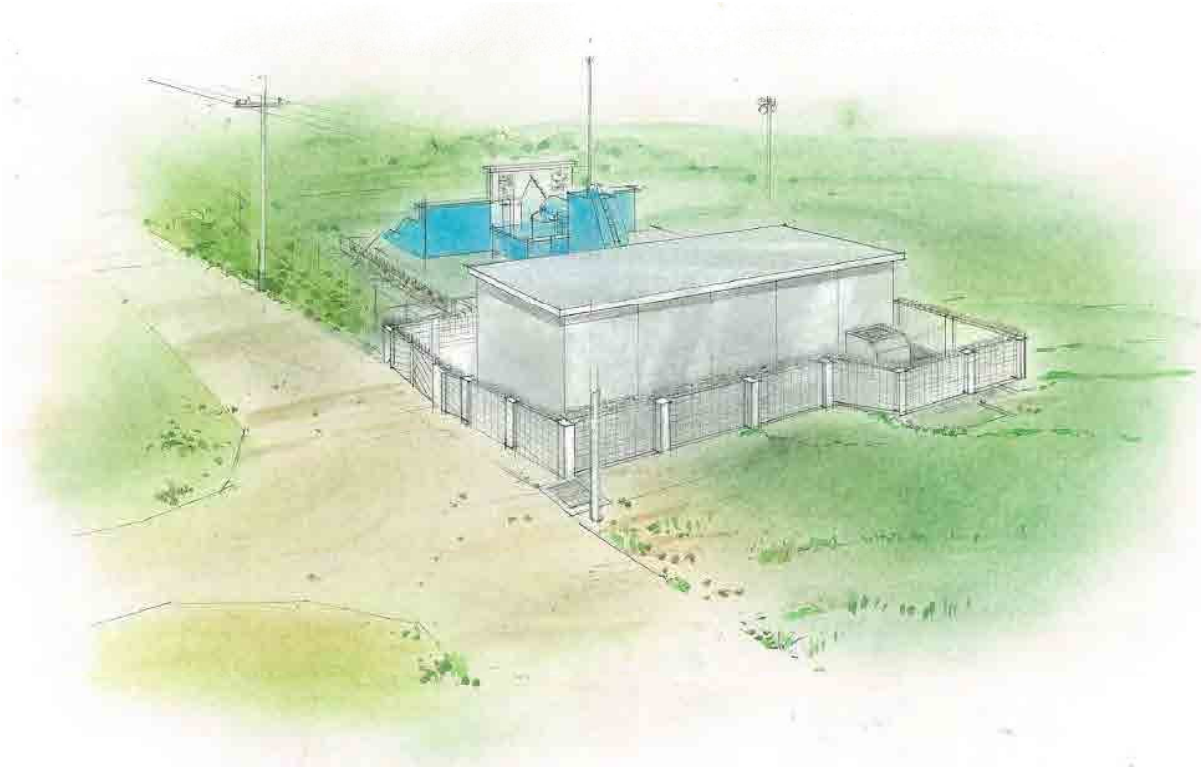


Picacho Hydroelectric Power Plant

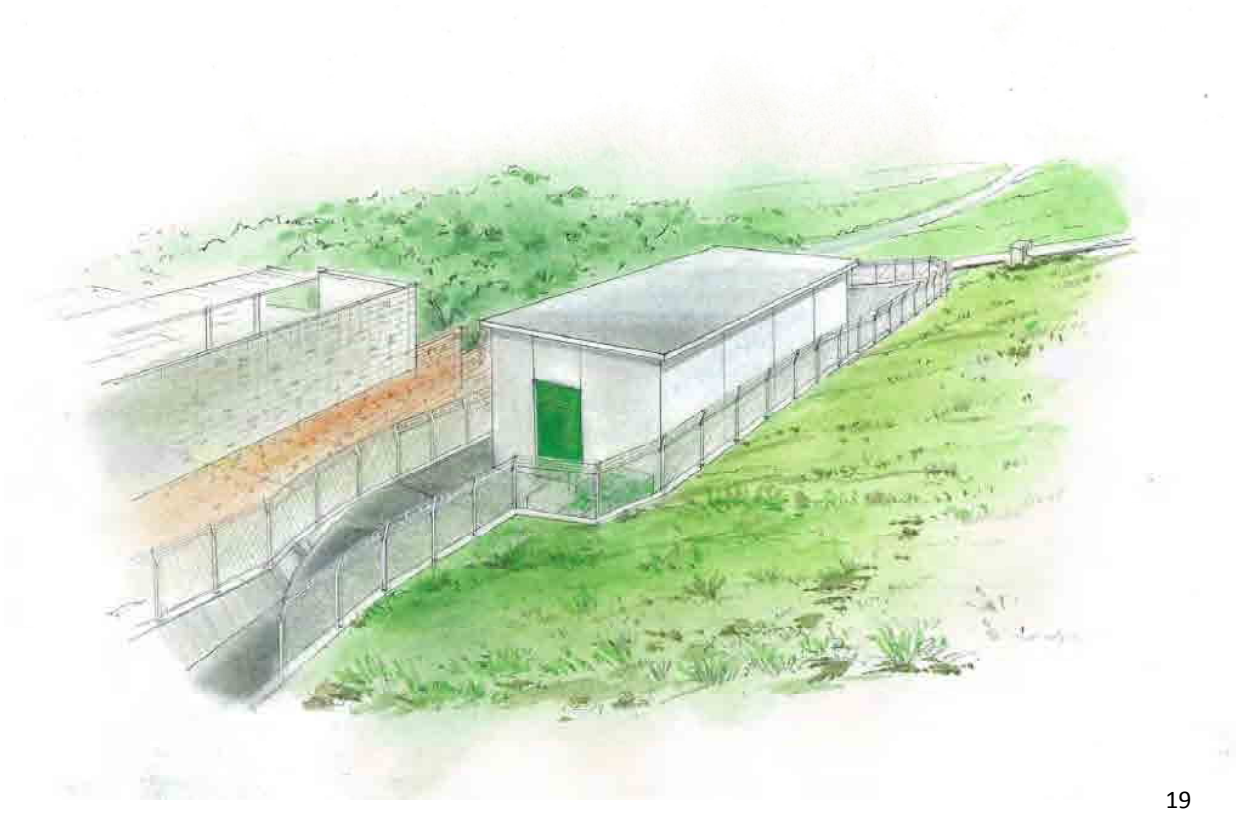




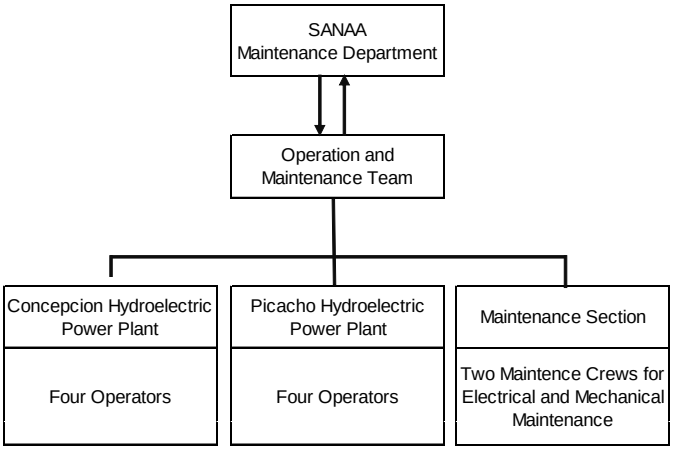
Concepcion Hydroelectric Power Plant (250kW)



Picacho Hydroelectric Power Plant (180 kW)



Operation & Maintenance of Concepcion & Picacho Hydroelectric Power Plants



Periodic Inspection and Deterioration Diagnosis

Daily Patrol Inspection		Periodic Inspection and Deterioration Diagnosis		
Facility	**Frequency**	**Facility**	**Item**	**Frequency**
Turbine, Generator and Electrical Equipment	one time/day	Turbine, Generator and Electrical Equipment	Periodic Inspection	one time/three years
			Deterioration Diagnosis	
			Detailed Inspection	an abnormality is observed

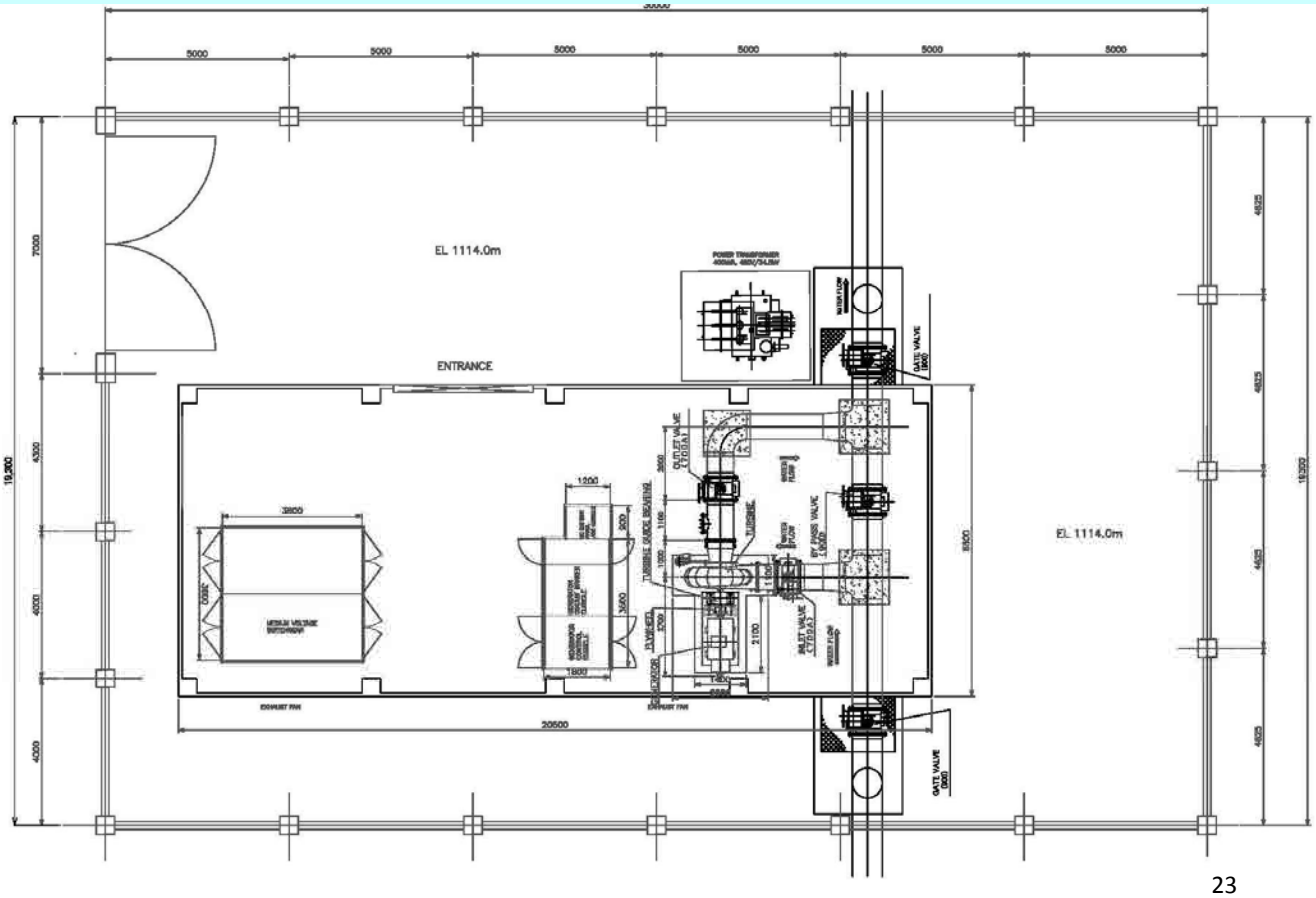
Overhaul of Turbine and Valves

Item	Frequency
Overhaul after Operation	One year after operation
Overhaul	a time/ten years

TURBINE, GENERATOR AND ELECTRICAL EQUIPMENT

Concepcion Hydroelectric Power Plant (250kW)

Concepcion Hydroelectric Power Plant



General Feature of Generating Equipment (Concepcion Site)

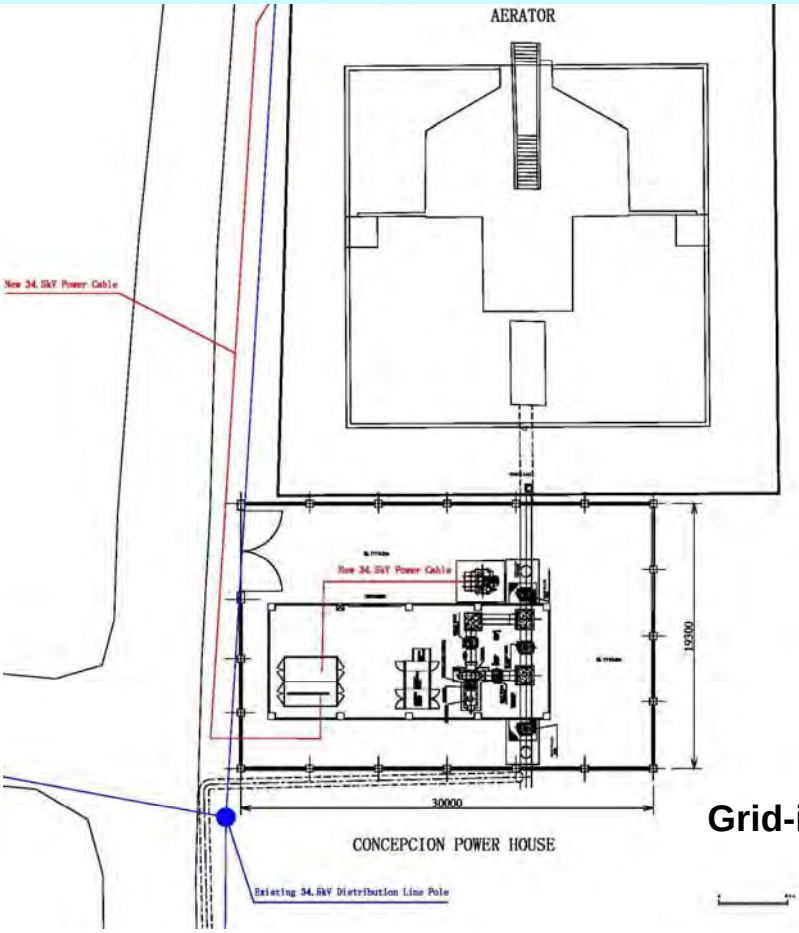
1. Hydraulic Turbine
   a. Quantity — 1
   b. Type — Horizontal-shaft, Francis
   c. Power — 273kW
   d. Speed — 900rpm
   e. Discharge — 1.50m3/s
   f. Rated head — 27.46m

2. Synchronous Generator
   a. Quantity — 1
   b. Type — Horizontal-shaft, synchronous
   c. Power — 314kVA
   d. Power factor — 80%
   e. Voltage — 480V, three (3) phases
   f. Speed — 900rpm
   g. Frequency — 60Hz

3. Power Transformer
   a. Quantity — 1
   b. Type — Oil immersed, outdoor
   c. Power — 400kVA
   d. Voltage — 0.48/34.5kV, three (3) phases

4. 34.5kV Medium Voltage Switchgear
   a. Quantity — 1

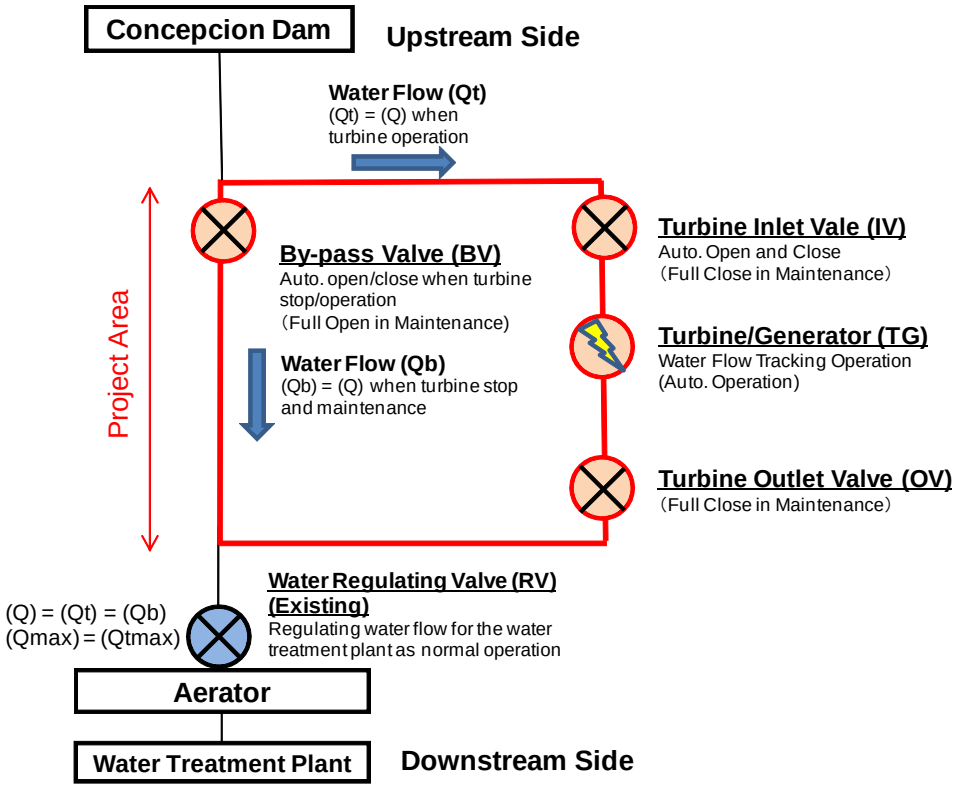
Concepcion Hydroelectric Power Plant



Grid-interconnection Scheme

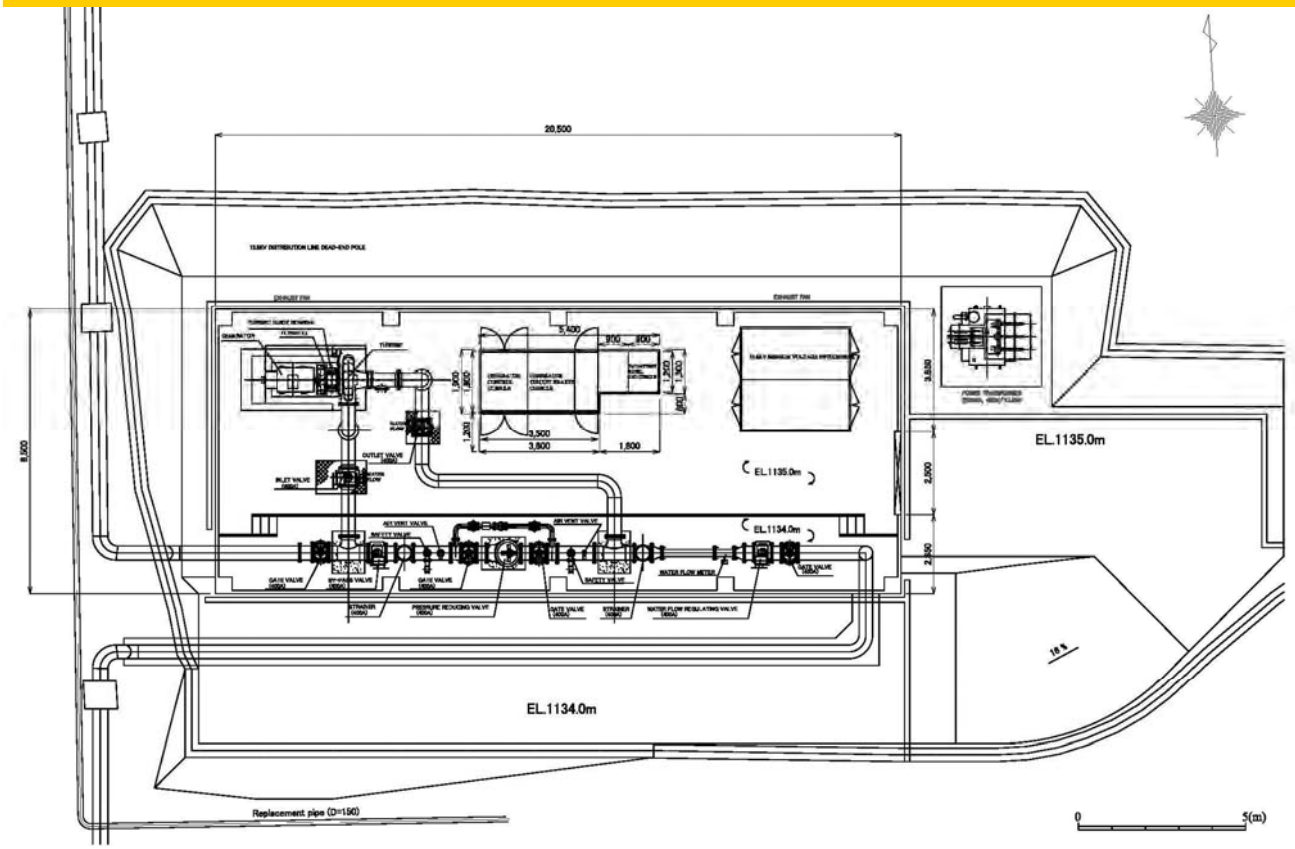
Concepcion Hydroelectric Power Plant

Operation Scheme (Concepcion Site)



Picacho Hydroelectric Power Plant (180kW)

Picacho Hydroelectric Power Plant



General Feature of Generating Equipment (Picacho Site)

1. Hydraulic Turbine
   - a. Quantity — 1
   - b. Type — Horizontal-shaft, Francis
   - c. Power — 204kW
   - d. Speed — 1,200rpm
   - e. Discharge — 0.30m3/s
   - f. Rated head — 88.16m

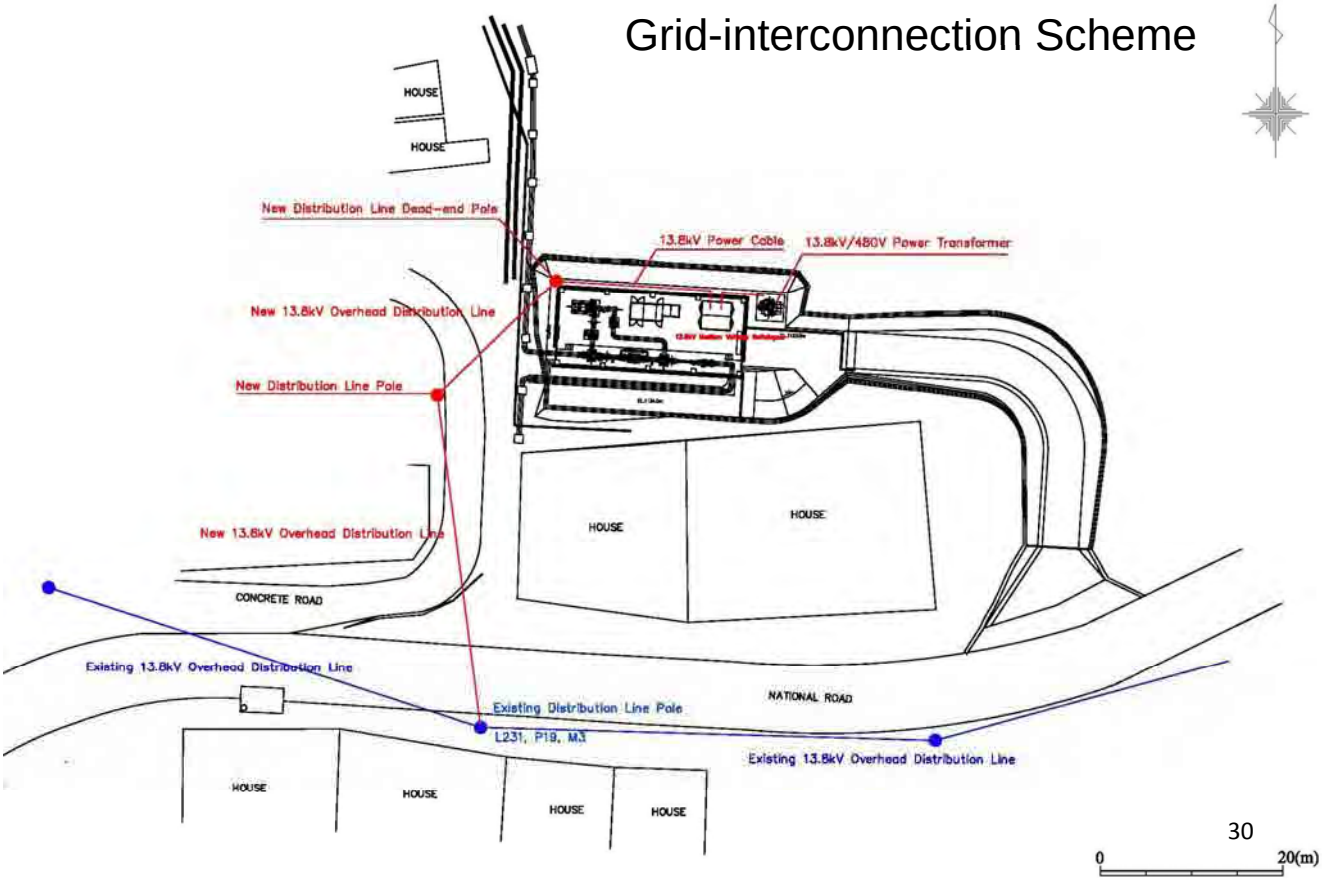
2. Synchronous Generator
   - a. Quantity — 1
   - b. Type — Horizontal-shaft, synchronous
   - c. Power — 235kVA
   - d. Power factor — 80%
   - e. Voltage — 480V, three (3) phases
   - f. Speed — 1,200rpm
   - g. Frequency — 60Hz

3. Power Transformer
   - a. Quantity — 1
   - b. Type — Oil immersed, outdoor
   - c. Power — 250kVA
   - d. Voltage — 0.48/13.8kV, three (3) phases

4. 13.8kV Medium Voltage Switchgear
   - a. Quantity — 1

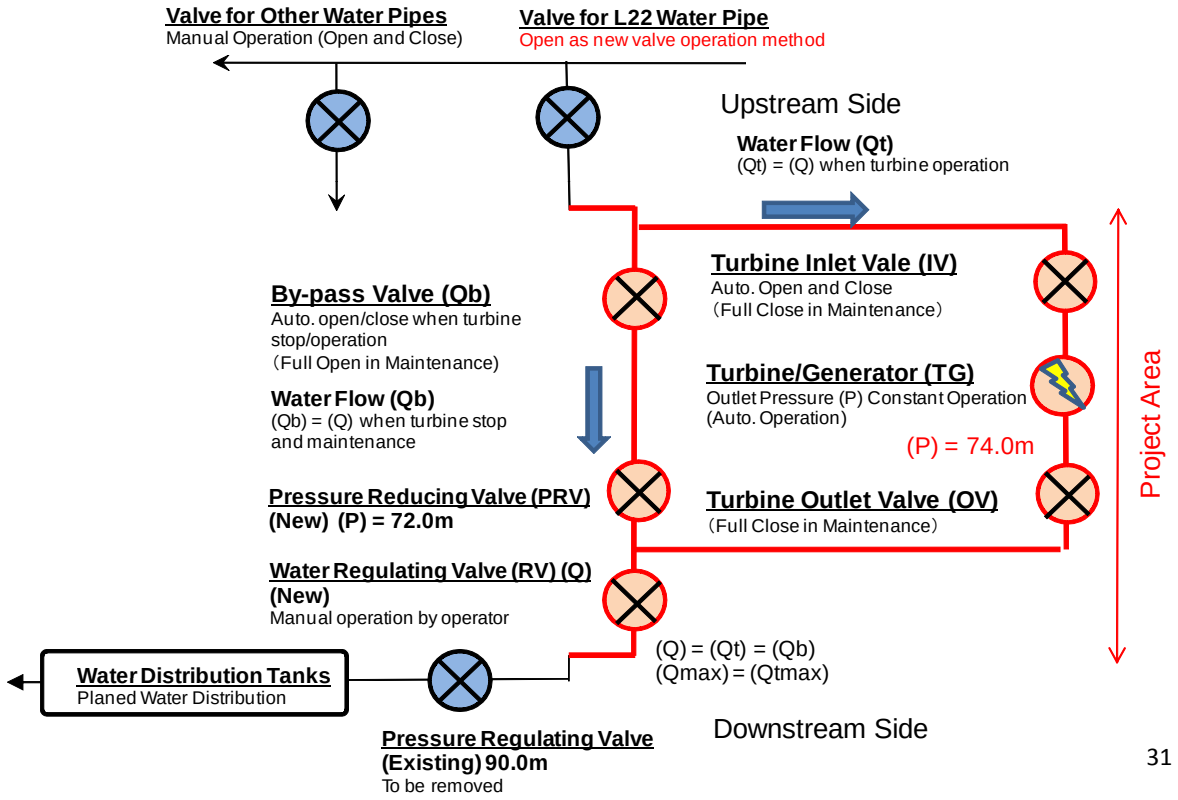
Picacho Hydroelectric Power Plant

Grid-interconnection Scheme



Picacho Hydroelectric Power Plant

Operation Scheme (Picacho Site)



Equipment & Material Procurement

The country of origin for the equipment being procured for the Project shall be fundamentally considered as shown in the following Table.

ITEM	Origin		
	Japan	Honduras	Other
Small-Scale Hydroelectric Power equipment			
Turbine	○		
Generator	○		
Turbine/generator Control System	○		
Low Voltage Distribution Cubicle	○		
Control System	○		
Medium Voltage Switchgear			○
Power Transformer			○
Construction Materials			
Ready-Mix-Concrete		○	
Cement		○	
Sand・Aggregate		○	
Deformed bar		○	
Wood		○	
Ductile Iron Pipe, Steel Pipe（more than φ200mm）			○
Valves			○
Electric line pole		○	
Construction Machines			
Crane		○	
Backhoe		○	
Dump Truck		○	
Bulldozer		○	

Main components of the small-scale Hydroelectric Power generation, such as a turbine, dynamos, and an operator control panel etc, are premised on Japanese-made supply.

Local Equipment & Material

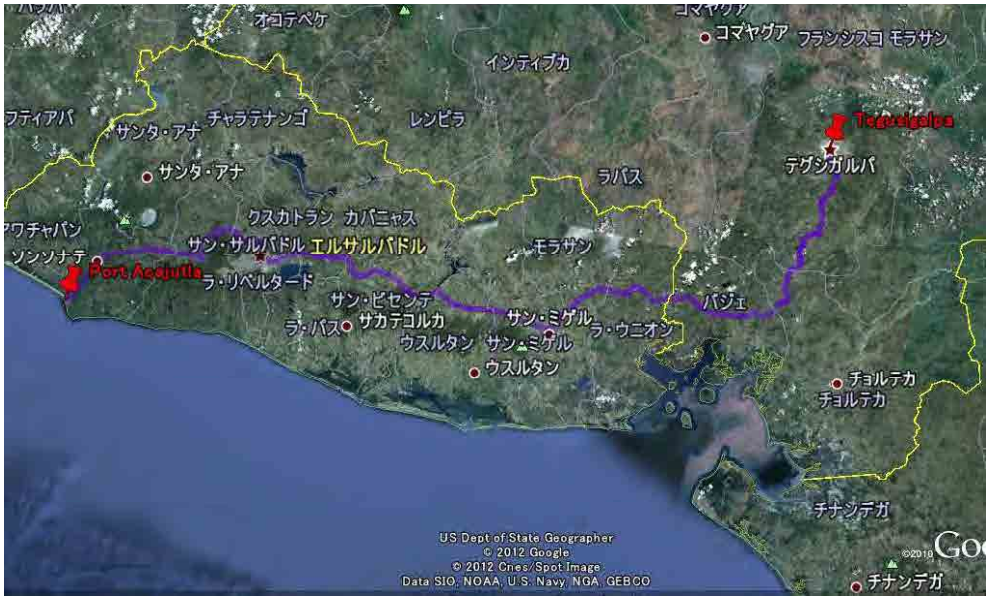
Construction material

Concrete plant

Construction machine

Transportation of Equipment from Japan

The small-scale-Hydroelectric Power related electrical items procured in Japan will arrive at the sole international port in El Salvador, Acajutla. The target sites are located in Tegucigalpa, which is located about 400km from the port. However, there are many experienced transport companies in Tegucigalpa and the access roads from the port to the sites are well maintained. Therefore, there is no concern related to the local transport of the materials from Japan.



Concepcion Construction Site

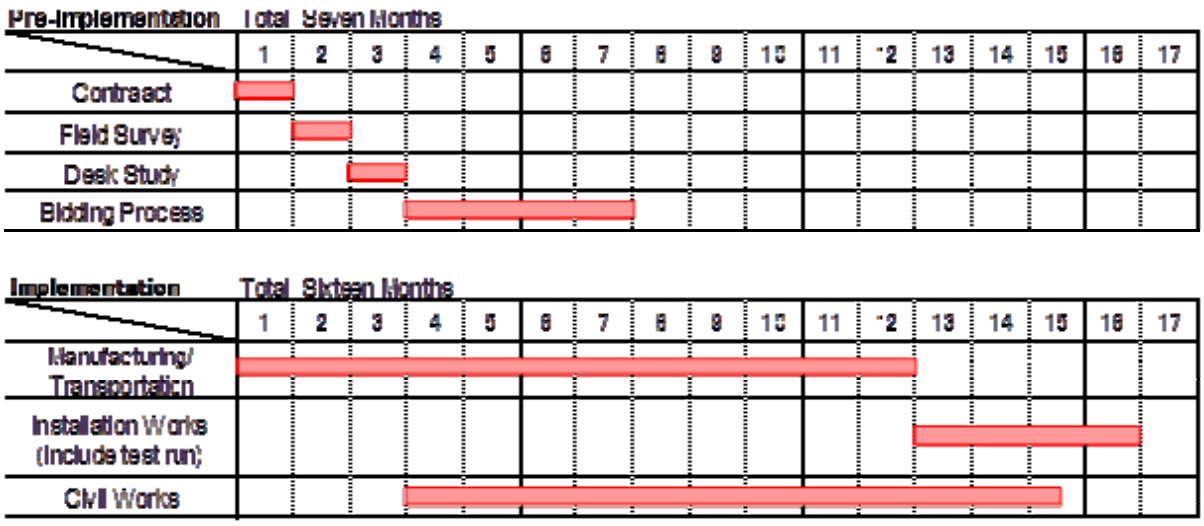
Powerhouse site

New pipeline route

Picacho Construction Site

Implementation Schedule

Based on the grant aide scheme of Japan, preliminary implementation schedule is drawn up as shown below.



In this project, the time necessary for completion is mainly determined by the process of manufacture and delivery of small-scale Hydroelectric Power equipment, installation, and adjustment works. The other construction works, such as pipeline works, proceed in parallel with the manufacture and delivery of the small-scale Hydroelectric Power equipment.

Allocation of Chief Responsibility

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	Acquisition and free provision of land necessary for the project		●
2	Acquisition and free provision of land necessary for the temporary works and the land clearance		●
3	Provision of waste disposal sites		●
4	To construct roads within the sites	●	
5	To maintain the roads outside of the sites		●
6	Procurement of Small-Scale Hydroelectric Power equipment	●	
7	Installation of Small-Scale Hydroelectric Power equipment	●	
8	New Bypass Pipeline Construction (Concepcion)	●	
9	To connect the new power line to the existing infrastructures	●	
10	Provision of free water for the construction works		●
11	To bear the following commissions applied by the bank in Japan for banking services based upon the Bank Arrangement (B/A):		
	1) Payment of bank commission		●
12	Application and acquisition of permits and licenses required for the construction works		●
13	To ensure all the expense and prompt execution of unloading and customs clearance at the port of disembarkation in the recipient country		
	1) Marine or air transportation of the products from Japan or third countries to the recipient	●	
	2) To ensure all the expense and prompt execution of unloading, tax exemption and customs clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
14	To accord Japanese nationals and/or nationals of third countries, including persons employed by the agent whose services may be required in connection with the Components such facilities as may be necessary for their entry into recipient country and stay therein for the performance of their work.		●
15	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the Components and to the employment of the Agent will be exempted by the Government of recipient country.		●
16	To maintain and use properly and effectively the facilities that are constructed and the equipment that is provided under the Grant.		●
17	To bear all the expenses, other than those covered by the Grant and its accrued interest, necessary for the purchase of the Components as well as for the agent's fees.		●
18	To ensure environmental and social consideration for the Programme.		● 1

Obligations of Honduras Side and the Allocation of Responsibilities

	Obligations	Allocation of responsibilities
1	**Acquisition and free provision of land** necessary for the **project**	The SANAA
2	**Acquisition and free provision of land** necessary for the **temporary works** and the land clearance	The SANAA
3	Provision of **waste disposal sites**	The SANAA with Tegucigalpa municipality
4	To **maintain the roads** outside of the sites	The SANAA with Tegucigalpa municipality
5	Provision of **free water for the construction works**	The SANAA
6	To **bear the commissions** applied by the bank in Japan for banking services based upon the Bank Arrangement (B/A) (ex; Payment of bank commission)	The SANAA
7	Application, acquisition of **permits and licenses** required for the **construction works**	The SANAA with relevant institutions and Tegucigalpa municipality
8	To **ensure all the expenses and prompt execution of unloading and customs clearance** at the port of disembarkation in the recipient country	The SANAA
9	To **accord Japanese nationals and/or nationals of third countries**, including persons employed by the agent whose services may be required in connection with the components such facilities as may be necessary for their entry into recipient country and stay therein for their works	The SANAA
10	To **ensure that customs duties, internal taxes and other fiscal levies** which may be imposed in the recipient country with respect to the purchase of the Components and to the employment of Agent will be exempted by the Government of recipient country	The SANAA with relevant institutions
11	To **maintain and use properly and effectively, the facilities** that are constructed and the equipment that are provided under the Grant	The SANAA
12	To **bear all the expenses, other than those covered by the Grant** and its accrued interest, necessary for the purchase of the components as well as the agent's fees.	The SANAA
13	To **ensure environmental and social consideration** for the Programme	The SANAA with relevant institutions

Operation and Maintenance Cost

(1) Labor Cost of Operation and Maintenance

	Name	Number of staff	Salary
1)	Operators	4 personnel × 2 Sites = 8 personnel	Lp.15,000/month × 8 personnel= Lp.120, 000
2)	Maintenance Crews	2 personnel	Lp.20, 000/month × 2 personnel= Lp.40, 000
			Lp.160,000/month

(2) Purchase Cost of Spare Parts

	item	amount
1)	a regular basis is a kind of valve seals and turbine shaft water seal packing.	Lps.24,000/year

(3) Other Direct Costs (Consumables)

	item	amount
1)	Consumables such as printer cartridges of the printers for the control system, grease for the generator and office supplies	Lps.12,000/year

(4) Overhaul Costs, etc.

	item	amount
1)	The overhaul of the turbine and the generator in every 10 years The replacement of turbine water seal packing and the valve seals	Lps.718,000/10years

Necessary spare parts are delivered in this Project. If spares are used in the repairing work, it is necessary to purchase and keep them for future maintenance.

Land Acquisition for the Project

	Location	Required area	Remarks
Concepcion site	Powerhouse site	Powerhouse site : 30m x 19.3m	Excluding space between the boundary and anterior road, neighboring aerator
	Buried pipeline route (garden of private house)	Pipe length :about 30m	
	Buried pipeline route (community land)	Pipe length :about 100m	
Picacho site	Powerhouse site （including Access road)	Powerhouse site: 600m^2 Access road: 430m^2	Excluding space between the boundary and private house below.

Others

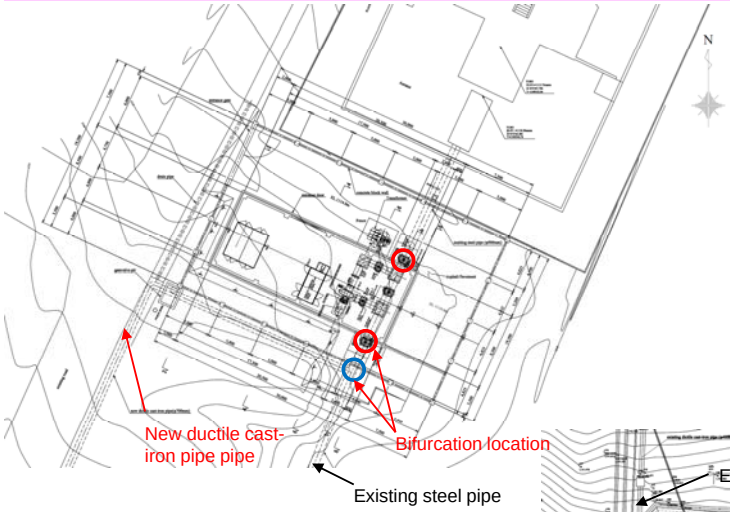
- Relocation of existing distribution water pipeline, which cross the powerhouse site to be constructed (steel pipe ID 150mm, length 48m) at Picacho site
- water stoppage to bifurcation of new pipe from existing pipeline
  Concepcion site: 4 locations, 2 along the existing pipeline, 2 in powerhouse
  Picacho site : 2 locations in powerhouse

Land Acquisition for the Project

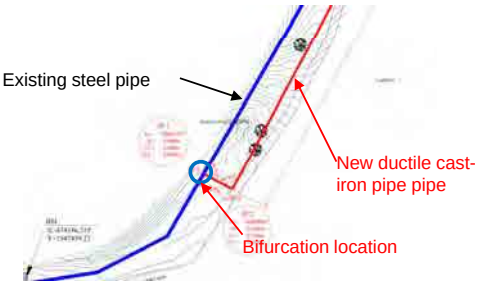
Picacho site

Concepcion site

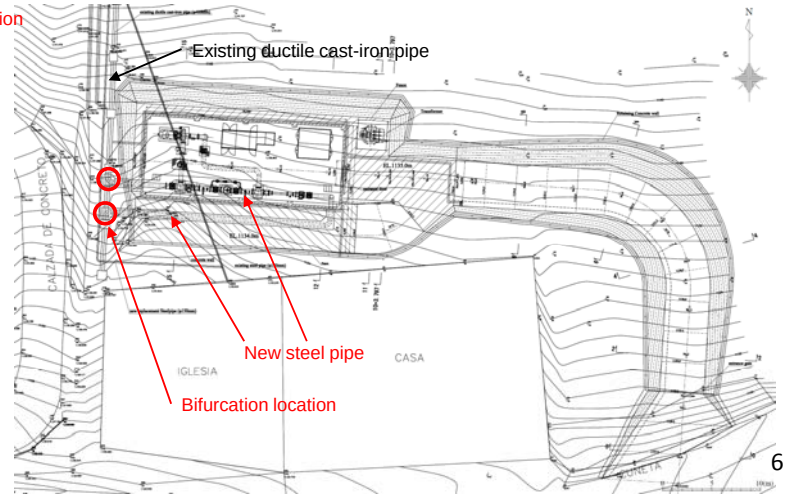
Construction required for Water Stoppage



Concepcion site



Picacho site

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