GOVERNMENT OF PUERTO RICO
PUBLIC SERVICE REGULATORY BOARD
PUERTO RICO ENERGY BUREAU

IN RE: REVIEW OF THE PUERTO RICO ELECTRIC POWER AUTHORITY'S HYDROELECTRIC STUDY	**CASE NO.:** NEPR-MI-2021-0012 **SUBJECT**: Presentation to be offered during the August 23, 2021 Virtual Technical Conference

MOTION TO SUBMIT PRESENTATION IN COMPLIANCE WITH THE JULY 23, 2021 ORDER

TO THE HONORABLE PUERTO RICO ENERGY BUREAU:

COMES NOW, the Puerto Rico Electric Power Authority (the "Authority"), through its counsel of record and respectfully sets forth and prays:

On July 23, 2021, the Puerto Rico Energy Bureau of the Public Service Regulatory Board (the "Energy Bureau") entered a *Resolution and Order* (the "Order") directing the Authority, to among other things, file on or before today, August 19, 2021, a PDF copy of the presentation to be offered during the August 23, 2021, Virtual Technical Conference. In compliance with the Order, PREPA submits the presentation titled *Feasibility Study for Improvements to Hydroelectric System*. Exhibit A.

WHEREFORE, the Authority herein requests the Energy Bureau to find the Authority in compliance with the Order.

RESPECTFULLY SUBMITTED.

In San Juan, Puerto Rico, this 19th day of August 2021.

s/Katiuska Bolaños-Lugo
Katiuska Bolaños-Lugo
TSPR 18,888
kbolanos@diazvaz.law

s/ Joannely Marrero Cruz
Joannely Marrero Cruz
TSPR 20,014
jmarrero@diazvaz.law

DÍAZ & VÁZQUEZ LAW FIRM, P.S.C.
290 Jesús T. Piñero Ave.
Oriental Tower, Suite 803
San Juan, PR 00918
Tel. (787) 395-7133
Fax. (787) 497-9664

Exhibit A

FEASIBILITY STUDY FOR IMPROVEMENTS TO HYDROELECTRIC SYSTEM

Increased Hydro Generation
Improved Capacity Factor
Added Value

Presented by Black & Veatch:

Randy Boyce – Project Manager
Aaron Lemke – Civil/Mechanical Engineer
Dianys Arocho – Water Resources Engineer
Bruce Benson – Electrical Engineer
Robert Chambers – Economic Consultant
Jorge Villalobos – Economic Consultant

August 23, 2021
B&V Project 407635

Today's Agenda

- Introductions
- Feasibility Study Objectives
- Feasibility Study Deliverables
- Facility Evaluations
  - Recommendations
  - Economic Analysis
- Summary
  - Generation Potential
  - Capital Costs
  - Implementation/Next Steps

Feasibility Study Objectives

OBJECTIVE	EXISTING CONDITION	GOAL FOR OBJECTIVE	VALUE IN RECOMMENDED PORTFOLIO
IRP capacity factor goal	0.06	0.28	0.28
IRP Goal - increase in hydroelectric capacity	38.8 MW Active	70 MW Active	91.7 MW Active
Evaluate units for responsiveness to frequency variations	Most Units Responsive	All Units Responsive	All Units Responsive
Evaluate potential for remote operation from PREPA Energy Control Center	Limited Remote Operation at a few Plants	Remote Operation for each Unit	Remote Operation included for Controls Upgrades

All Objectives Completed with the Recommended Portfolio

Increases in Capacity and Capacity Factor

FACILITY	2021 CAPACITY (MW)	RECOMMENDED PORTFOLIO CAPACITY (MW)	HISTORICAL CAPACITY FACTOR (2017-2020)	RECOMMENDED PORTFOLIO CAPACITY FACTOR
Yauco 1	0	20	0	0.25
Yauco 2	8	8	0.10	0.31
Toro Negro 1	8.6	8.6	0.07	0.35
Toro Negro 2	0	1.9	0.07	0.19
Garzas 1	7.2	7.2	0.05	0.20
Garzas 2	0	5	0	0.20
Rio Blanco	0	5	0	0.66
Dos Bocas	15	15	0.18	0.23
Caonillas 1	0	20	0	0 .35
Caonillas 2	0	1	0	0.59
Total	**38.8**	**91.7**	**0.06**	**0.28**

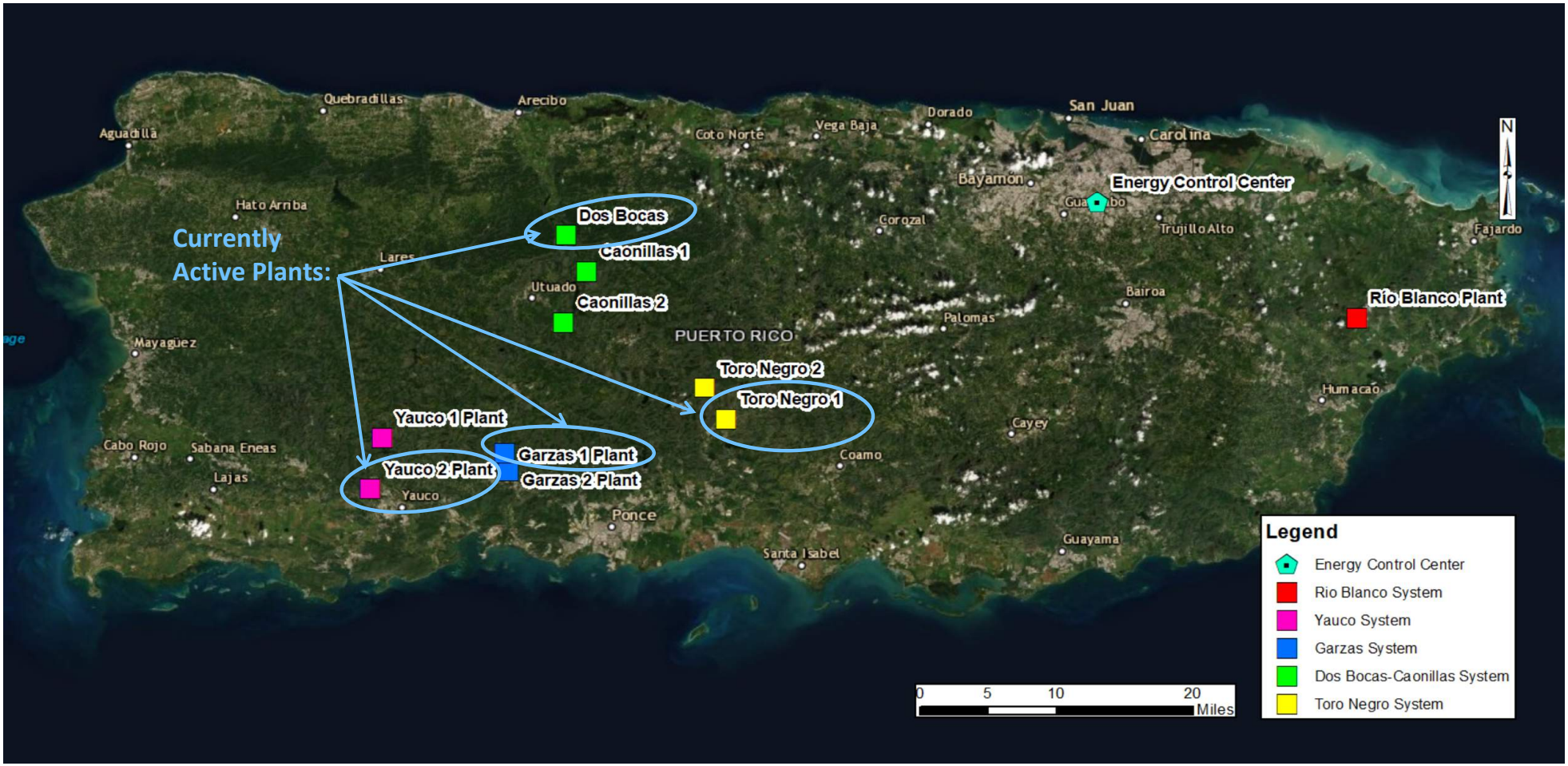
- Active generating capacity increases by 52.9 MW and capacity factor increases from 0.06 to 0.28.
- Caonillas 1 is currently under project execution for its repair.
- Toro Negro 2 repairs have been completed, and startup/synchronization test is currently being coordinated with LUMA.

Feasibility Study Deliverables

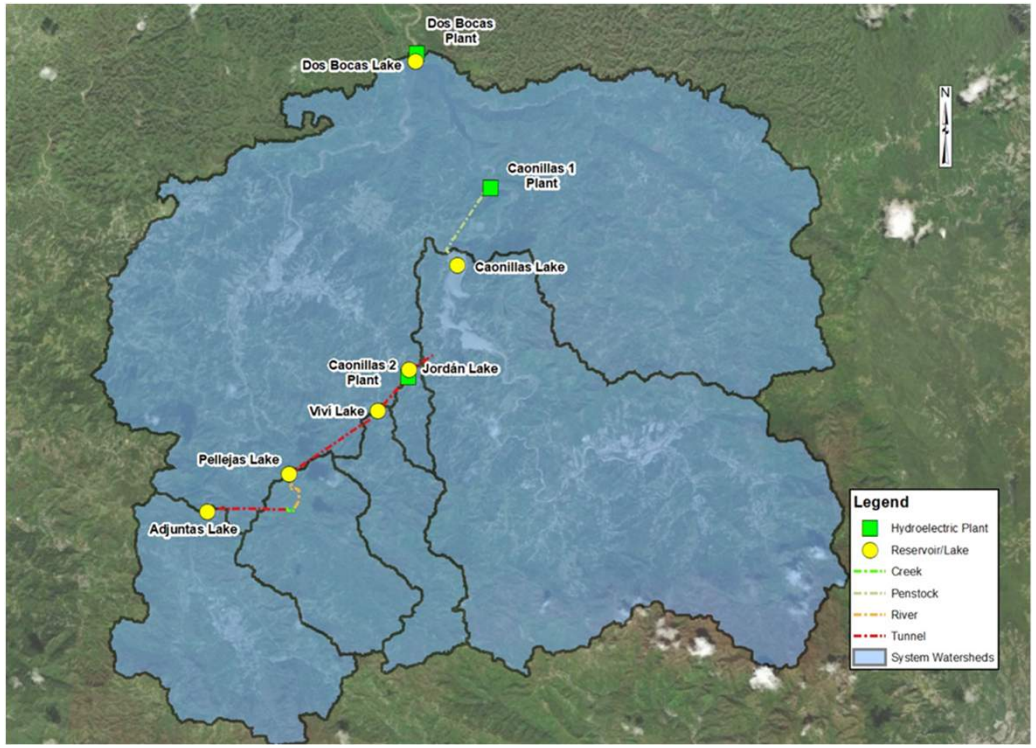
- Task 200 - Site Visit / Condition Assessment Report
- Task 201 - Installed Capacity & Average Annual Generation Report
- Task 300 – Review Water Availability Models Report
- Task 400 – Reservoir Operations Optimization Report
- Task 500 – Evaluation for Frequency Response & Remote Control Report
- Task 600 - Economic Feasibility Evaluation Report
- Task 700 – Final Summary Report

Refer to individual Task reports for detailed evaluations.

Hydroelectric Generation Facilities Included in Study



Dos Bocas – Caonillas Hydroelectric System



Cascading system from Caonillas 2 to Caonillas 1 to Dos Bocas

Reservoirs – Dos Bocas, Caonillas

Four Small Diversions

Generating Plants:

- Dos Bocas – 15.0 MW (Active)
- Caonillas 1 – 20.0 MW (Inactive)
- Caonillas 2 – 3.6 MW (Inactive)

Caonillas 2 Hydroelectric Facility (Inactive – Damaged by Hurricane Georges in 1998)

- Built 1950 – one vertical Francis unit, 3.6 MW
- Potential Net Generation with Improvements 5,200 MWh with new 1 MW Unit
- Major Recommendations:
  - Dredge Adjuntas, Pellejas, Vivi, Jordan Diversions
  - Clean out Tunnels and Tailrace
  - Replace Balance-of-Plant Mechanical and Electrical Equipment
  - Install Fixed Cone Bypass Valve Around Turbine
  - Replace Step-Up Transformer and 38KV Breaker
  - New Electrical Protection and Control Systems (including Governor Function with Frequency Response)
  - Restore Remote Communication to Facility
  - Add Remote Control from Dos Bocas or ECC

- High Sedimentation Rate - Estimate $750K to $1M per year for Dredging.
- Replace with Smaller 1 MW Unit Operating Run-of-River and new Sediment Passage System

Caonillas 2 – Economic Feasibility Analysis

LINE	CAONILLAS 2 IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST ($)	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Return to service 3.6 MW	(8,139,000)	1,486,000	NA	12,660,000	34.2%	3.6
2	New 1 MW full auto, no bypass	(7,071,000)	1,833,000	NA	36,360,000	59.4%	1.0
3	New 1 MW full auto, with bypass, sediment passage gates	(9,843,000)	2,203,000	NA	20,300,000	59.4%	1.0
4	New 2 MW full auto, no bypass	(16,667,000)	1,907,000	NA	37,150,000	30.3%	2.0
5	New 2 MW full auto, with bypass, sediment passage gates	(20,288,000)	2,350,000	NA	21,870,000	30.3%	2.0

Restoration of Caonillas 2 has a negative NPV but increases the NPV of Caonillas 1 by $58,000,000.

Caonillas 1 Hydroelectric Facility (Inactive – Hurricane Maria in 2017 Flooded Powerhouse, Tailrace Blocked with Sediment)

- Built 1948 – two vertical Francis units, 10 MW each
- Calculated Average Annual Net Generation 5,711 MWh Potential with Improvements 54,400 MWh
- Major Recommendations:
  - Finish Refurbishing Electrical / Mechanical Equipment
  - Replace Flooded Digital Governor Panel – will provide frequency response
  - Return Adjuntas, Pellejas, Vivi, Jordan Diversions to Service
  - Dredge Small Diversions
  - Dredge Caonillas Reservoir- Restore Lost Storage Volume
- Remote Start / Stop / Load Control Available from Dos Bocas via Microwave

Caonillas 1 – Economic Feasibility Analysis

LINE	CAONILLAS 1 IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST ($)	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Refurbished plant	130,297,000	1,192,000	0.4	2,795,000	25.2%	20
2	Refurb with 3.6 MW Caonillas 2	148,486,000	1,192,000	0.4	2,795,000	28.3%	20
3	Refurb with 1 MW Caonillas 2 no bypass	174,099,000	1,192,000	0.3	2,795,000	32.8%	20
4	Refurb with 1 MW Caonillas 2 with bypass	188,204,000	1,192,000	0.3	2,795,000	35.3%	20
5	Refurb with 2 MW Caonillas 2 no bypass	172,985,000	1,192,000	0.3	2,795,000	32.6%	20
6	Refurb with 2 MW Caonillas 2 with bypass	188,204,000	1,192,000	0.3	2,795,000	35.3%	20
7	Refurb with 1 MW Caonillas 2 with bypass with Rule Curve 1	186,348,000	1,192,000	0.3	2,795,000	35.0%	20
8	Refurb with 1 MW Caonillas 2 with bypass with Rule Curve 2	186,719,000	1,192,000	0.3	2,795,000	35.0%	20

Restoration of Caonillas 2 increases the NPV of Caonillas 1 by $58,000,000.

Dos Bocas Hydroelectric Facility (Active)

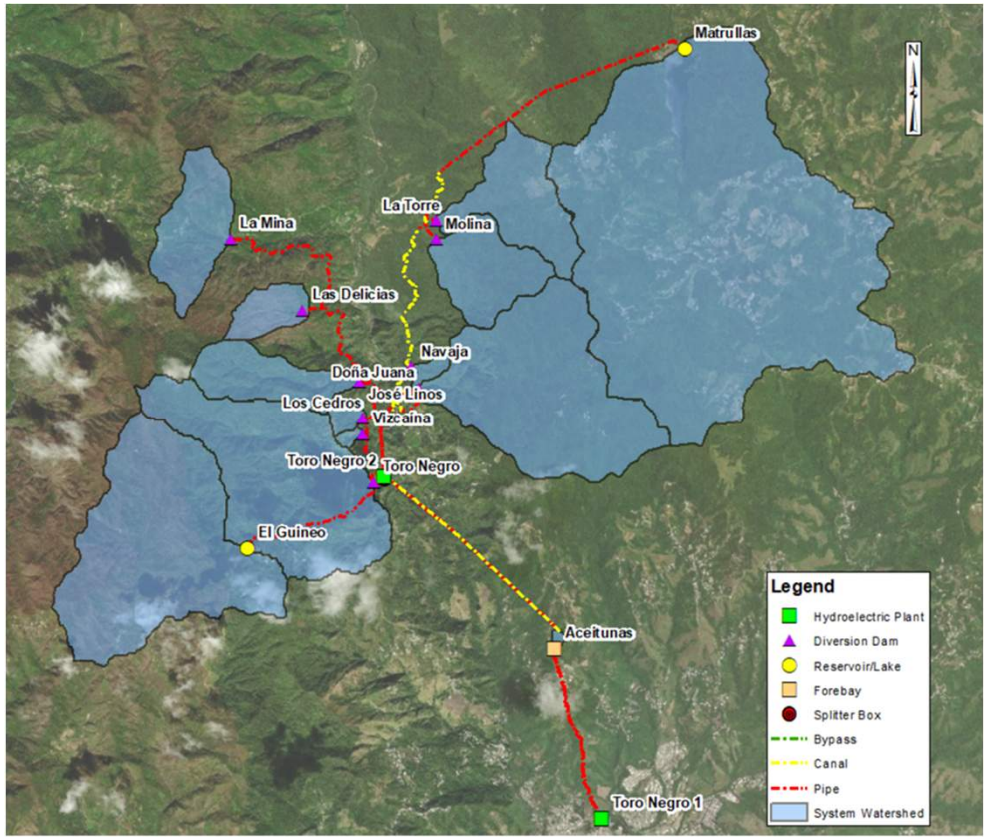
- Built 1942 – three vertical Francis units, 5 MW each
- Calculated Average Annual Net Generation 28,838 MWh
  Potential with Improvements 30,650 MWh
- Generator 1 is being rewound. Expect to be finished by October 2021
- Major Recommendations:
  - Inspect Unit 2, Repair Runner
  - Mechanical Governor Provides Frequency Response – Modernize, Convert to Digital Governor
  - Rewind Generator 3
  - Replace Generator Step-up Transformers
  - Replace Station Service Switchgear
  - Upgrade Electrical Protection and Control Systems
  - Replace Neutral Breaker with Resistance Grounding System
  - Upgrade Plant Communication System to Support Remote Operation of Caonillas 1
- Remote Monitoring Only by ECC via Fiber
- Dredging of the reservoir will occur as part of a separate project using FEMA funds

Dos Bocas – Economic Feasibility Analysis

LINE	DOS BOCAS IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST ($)	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Refurbished plant	95,479,000	1,567,000	1.3	5,946,000	23.4%	15.00
2	Refurb with 3.6 MW Caonillas 2	92,881,000	1,567,000	1.3	5,946,000	22.8%	15.00
3	Refurb with 1 MW Caonillas 2 no bypass	95,293,000	1,567,000	1.3	5,946,000	23.3%	15.00
4	Refurb with 1 MW Caonillas 2 with bypass	95,293,000	1,567,000	1.3	5,946,000	23.3%	15.00
5	Refurb with 2 MW Caonillas 2 no bypass	94,737,000	1,567,000	1.3	5,946,000	23.2%	15.00
6	Refurb with 2 MW Caonillas 2 with bypass	94,737,000	1,567,000	1.3	5,946,000	23.2%	15.00
7	Refurb with 1 MW Caonillas 2 with bypass with Rule Curve 1	91,025,000	1,567,000	1.3	5,946,000	22.5%	15.00
8	Refurb with 1 MW Caonillas 2 with bypass with Rule Curve 2	91,025,000	1,567,000	1.3	5,946,000	22.5%	15.00

Minimal opportunities to increase Capacity Factor at Dos Bocas.

Toro Negro Hydroelectric System



Conveyance system (canals, small diversion pipes, tunnels, and penstocks) needs repair

Reservoirs – El Guineo, Matrullas

Ten Diversion Structures

Generating Plants:

- Toro Negro 1 – 8.6 MW (Active)
- Toro Negro 2 – 1.9 MW (Inactive)

Toro Negro 1 Hydroelectric Facility (Active)

- Built 1927 – three horizontal Pelton units 1.44MW each, added 4th Unit in 1937, 4.48 MW
- Calculated Average Annual Net Generation 5,123 MWh Potential with Improvements 26,700 MWh
- Major Recommendations:
  - Replace Penstocks
  - Original Three Units Manual Needle Control Only – No Frequency Response, Upgrade to Digital Governor
  - 4th Unit Mechanical Governor with Frequency Response – Upgrade with Digital Governor
  - Rewind Generators 1-2 and 1-3
  - Replace Voltage Regulators / Rheostats with Static Excitation System
  - Replace Generator Step-up Transformers, Generator Circuit Breakers and AC Station Service
  - Upgrade Electrical Protection and Control Systems
  - Restore Communication to Aceitunas Forebay, Toro Negro 2, El Guineo and Matrullas Reservoirs
- Remote Monitoring Only by ECC via Microwave, Establish Remote Control - Extend Operating Hours

Toro Negro 1 – Economic Feasibility Analysis

LINE	TORO NEGRO 1 IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST ($)	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Refurbish Powerhouse	2,378,000	5,203,000	490.3	38,863,000	22.9%	8.6
2	Restored Small Diversions	4,898,000	5,321,000	167.0	40,908,000	24.5%	8.6
3	Small Diversions with full Auto	31,241,000	5,433,000	27.0	42,133,000	34.6%	8.6
4	Small Diversions with Tyrolean weirs and full Auto	28,672,000	5,520,000	30.1	43,073,000	34.1%	8.6
5	Small Diversions with Tyrolean weirs and full Auto Rule Curve 1	20,213,000	5,520,000	42.6	43,073,000	31.0%	8.6
6	Small Diversions with Tyrolean weirs and full Auto Rule Curve 2	20,461,000	5,520,000	42.1	43,073,000	31.1%	8.6

- High capital costs due to penstock replacements in 10 and 15 years.

Toro Negro 2 Hydroelectric Facility (Inactive – Penstock Issues)

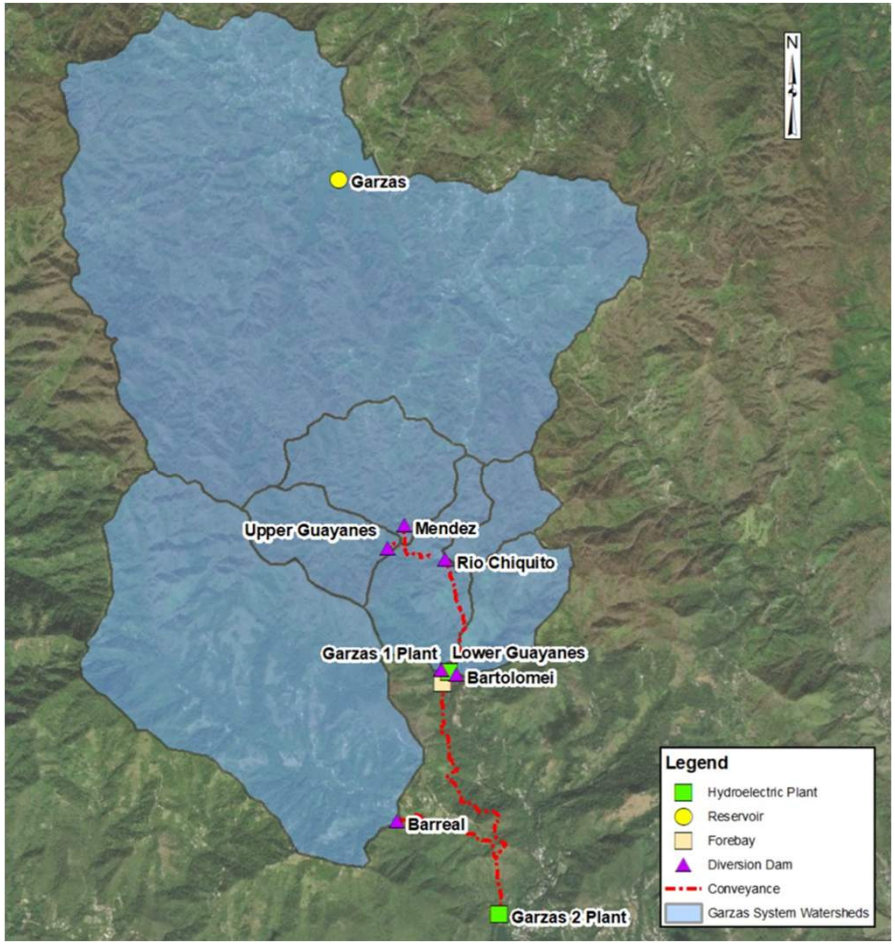
- Built 1937 – one horizontal Pelton unit, 1.9 MW
- Potential Net Generation with Improvements 3,300 MWh
- Major Recommendations:
  - Replace the Leaking Roof
  - Mechanical Governor Provides Frequency Response – Modernize, Convert to Digital Governor
  - Replace Rheostat and Field Breaker with Modern Static Excitation System
  - Replace Oil-Filled Generator Circuit Breaker inside Powerhouse
  - Replace Generator Step-Up Transformer
  - New Electrical Protection and Control Systems
- Remote Monitoring Only at ECC via Microwave

Toro Negro 2 – Economic Feasibility Analysis

LINE	TORO NEGRO 2 IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Refurbished plant	(8,212,000)	1,560,000	NA	21,827,000	10.9%	1.9
2	Fully Automated	(3,605,000)	1,509,000	NA	22,077,000	17.2%	1.9
3	Fully Automated Rule Curve 1	(2,582,000)	1,509,000	NA	22,077,000	18.8%	1.9
4	Fully Automated Rule Curve 2	(2,510,000)	1,509,000	NA	22,077,000	18.9%	1.9

High total capital cost due to future penstock replacement expected within the next 15 years.

Garzas Hydroelectric System



Reservoir – Garzas

Six Diversion Structures

Generating Plants:

- Garzas 1 – 7.2 MW (Active)
- Garzas 2 – 5.0 MW (Inactive)

Garzas 1 Hydroelectric Facility (Active)

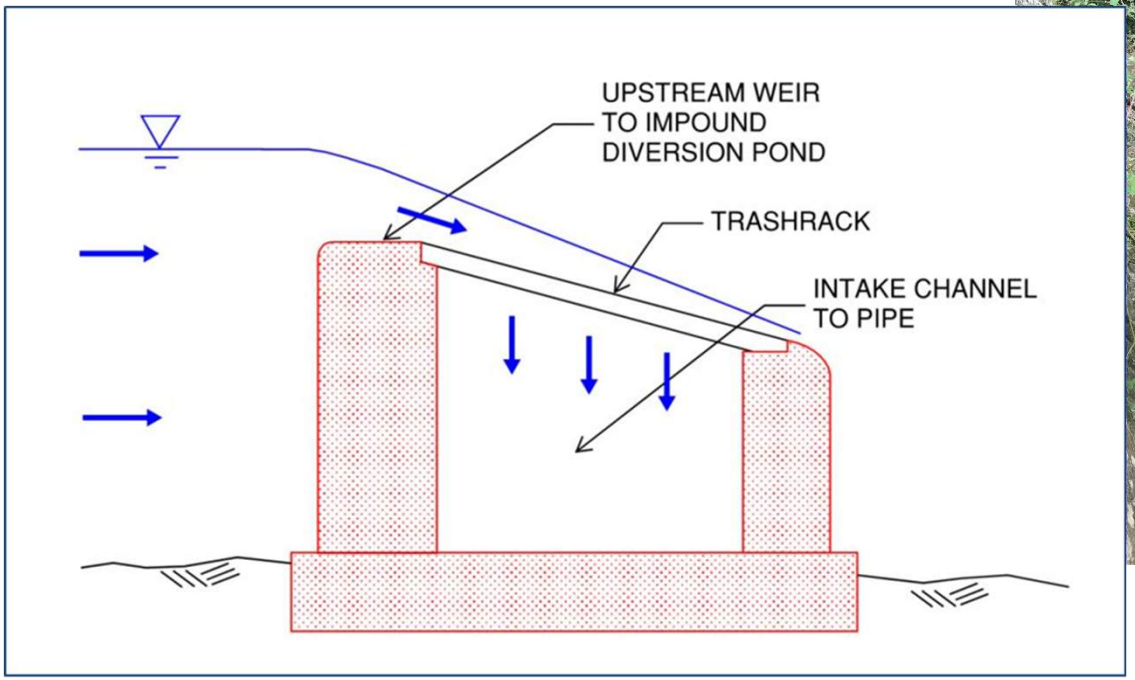
- Built 1941 – two horizontal Pelton units 3.6 MW each
- Calculated Average Annual Net Generation 2,829 MWh
  Potential with Improvements 12,500 MWh
- Major Recommendations:
  - Inspect Penstock
  - Mechanical Governor with Frequency Response – Upgrade with Digital Governor
  - Rewind Generator 1-2
  - Replace Voltage Regulators / Rheostats with Static Excitation System
  - Replace Generator Step-up Transformers and Generator Circuit Breakers
  - Upgrade Electrical Protection and Control Systems
  - Return Small Diversions to Service
  - Add Automation, Measure Inflows at three diversions, Install Tyrolean Weirs to reduce maintenance
  - Restore Communication Link with Garzas 2 – Coordinate Operation
  - Restore Communication to ECC, Establish Remote Control – Extend Operating Hours
  - Future replacement of penstock

Garzas 1 – Economic Feasibility Analysis

LINE	GARZAS 1 IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST ($)	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Electrical Refurbishment	11,969,000	2,722,000	40.5	24,247,000	14.3%	7.2
2	Small Diversions	12,464,000	2,766,000	39.7	24,717,000	14.7%	7.2
3	Tyrolean Weirs on small diversions	12,035,000	2,799,000	41.7	25,067,000	14.7%	7.2
4	Tyrolean Weirs on small diversions, full Auto	16,785,000	2,762,000	31.4	26,347,000	16.8%	7.2
5	Tyrolean Weirs on small diversions, full Auto Rule Curve 1	23,638,000	2,762,000	22.3	26,347,000	19.8%	7.2
6	Tyrolean Weirs on small diversions, full Auto Rule Curve 2	23,638,000	2,762,000	22.3	26,347,000	19.8%	7.2

- High total capital cost due to future penstock replacement in the next 11 years.
- Alternative 5 selected over 6. NPV the same but Rule Curve 1 has less level change.

Tyrolean Weirs



Benefits:

- Reduces Clogging by Sediment and Cobbles at Intake
- Reduces Maintenance Required to Clean Intakes – Valuable Due to Remote Locations

Garzas 2 Hydroelectric Facility (Inactive – Transmission Line Down since Hurricane Maria in 2017)

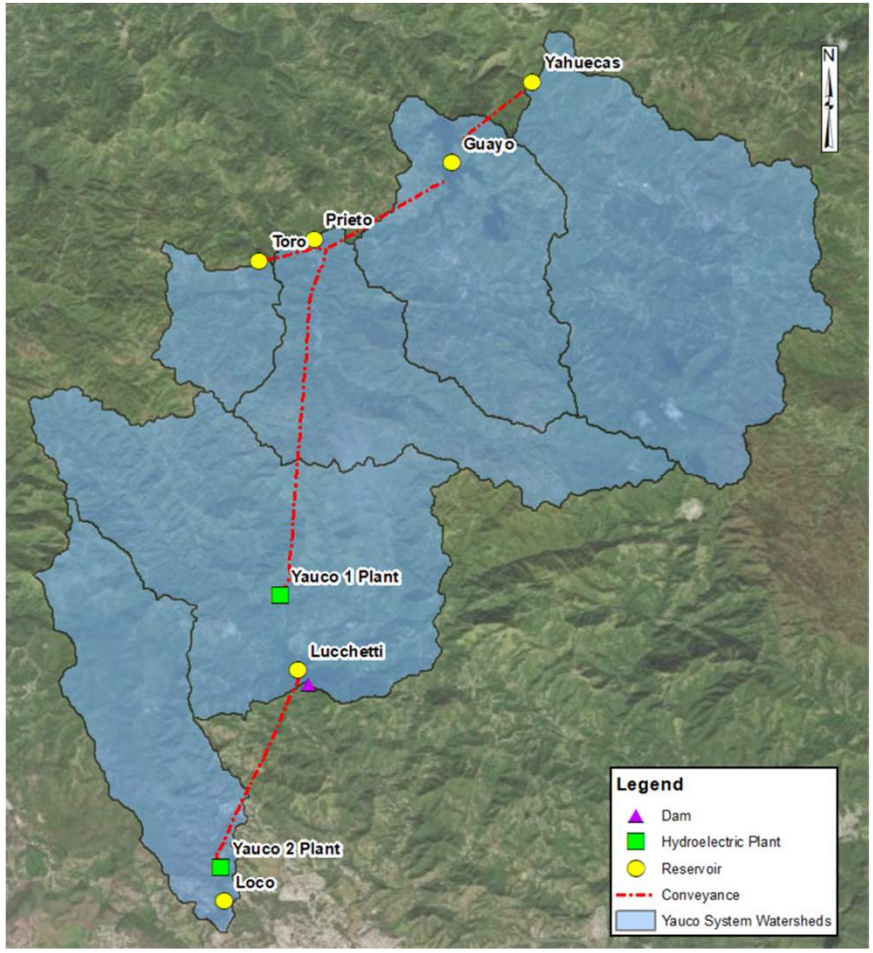
- Built 1941 – one horizontal Pelton unit, 5.0 MW
- Potential Net Generation with Improvements 8,800 MWh
- Major Recommendations:
  - Inspect Penstock
  - Return Small Diversions to Service, Add Tyrolean Weir to Reduce Maintenance
  - Mechanical Governor Provides Frequency Response – Modernize, Convert to Digital Governor
  - Rewind Generator
  - Replace Rheostat and Resistor Bank with Modern Static Excitation System
  - Replace Switchgear with Generator Circuit Breaker
  - Replace Generator Step-Up Transformer
  - New Electrical Protection and Control Systems
  - Repair Microwave for ECC Remote Control – Extend Operating Hours
  - Restore Communication Link with Garzas 1 – Coordinate Operation
  - Future replacement of penstock
  - Restore transmission line to re-connect Garzas 2 to the grid (being completed under a separate contract)

Garzas 2 – Economic Feasibility Analysis

LINE	GARZAS 2 IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST ($)	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Return to service	9,803,000	2,562,000	49.0	23,996,000	13.8%	5.0
2	Return Small Diversions to service	10,858,000	2,567,000	44.3	24,046,000	14.5%	5.0
3	Tyrolean Weirs at Small Diversions	10,491,000	2,595,000	46.4	24,346,000	14.5%	5.0
4	Tyrolean Weirs on small diversions, full Auto	17,068,000	2,522,000	29.6	25,246,000	18.4%	5.0
5	Tyrolean Weirs on small diversions, full Auto, increase Barreal Pipe	15,632,000	2,691,000	34.6	27,046,000	18.9%	5.0
6	Tyrolean Weirs on small diversions, full Auto Rule Curve 1	19,615,000	2,522,000	25.7	25,246,000	20.1%	5.0
7	Tyrolean Weirs on small diversions, full Auto Rule Curve 2	19,824,000	2,522,000	25.5	25,246,000	20.2%	5.0

- High total capital cost due to future penstock replacement in the next 20 years.
- Alternative 6 selected over 7. NPV similar but Rule Curve 1 has less level change.

Yauco Hydroelectric System



Yauco 1 turbine runner needs replacement, reservoirs require dredging.

Reservoirs – Yahuecas, Guayo, Prieto, Lucchetti, Toro, Loco

Diversion Tunnels

Generating Plants:

- Yauco 1 – 20.0 MW (Inactive)
- Yauco 2 – 8.0 MW (Active)

Yauco 1 Hydroelectric Facility (Inactive –Turbine Vibration and Contract Issues – Inactive since at Least 2012)

- Built 1956 –one vertical six jet Pelton unit 20.0 MW
- Potential Net Generation with Improvements 55,300 MWh
- Major Recommendations:
  - Dredge Yahuecas and Prieto Reservoirs or Implement Sediment Passing Gate System
  - Mechanical Governor with Frequency Response – Upgrade to Digital and 2-4-6 Needle Operation to Improve Efficiency
  - Rewind Generator
  - Replace Voltage Regulator / Field Breaker with Modern Static Excitation System
  - Replace Neutral Breaker with Resistance Grounding System
  - Replace 46KV Generator Oil-Type Breaker on Roof
  - Replace Generator Step-up Transformer
  - Upgrade Electrical Protection and Control Systems
  - Restore Microwave Communication with ECC
  - Restore Remote Load and Voltage Control from ECC
  - Guayo Reservoir will be dredged under a separate project using FEMA funding

Yauco 1 – Economic Feasibility Analysis

LINE	YAUCO 1 IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST ($)	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Refurbished	90,159,000	1,606,000	8.1	36,600,000	15.1%	20
2	Dredging	166,491,000	1,527,000	4.4	36,600,000	25.3%	20
3	Dredging & modify Yahuecas & Prieto to pass sediment (full Auto)	161,590,000	2,080,000	2.2	17,500,000	25.3%	20
4	Dredging & modify Yahuecas & Prieto (full Auto) to pass sediment Rule Curve 1	154,823,000	2,080,000	2.3	17,500,000	24.3%	20
5	Dredging & modify Yahuecas & Prieto (full Auto) to pass sediment Rule Curve 2	157,192,000	2,080,000	2.2	17,500,000	24.7%	20

- 20 MW hydro facility has been out of service for over 10 years.
- Significant cost savings to include sedimentation passage in the design.
- Payback less than 3 years for recommended improvements.

Yauco 2 Hydroelectric Facility (Active)

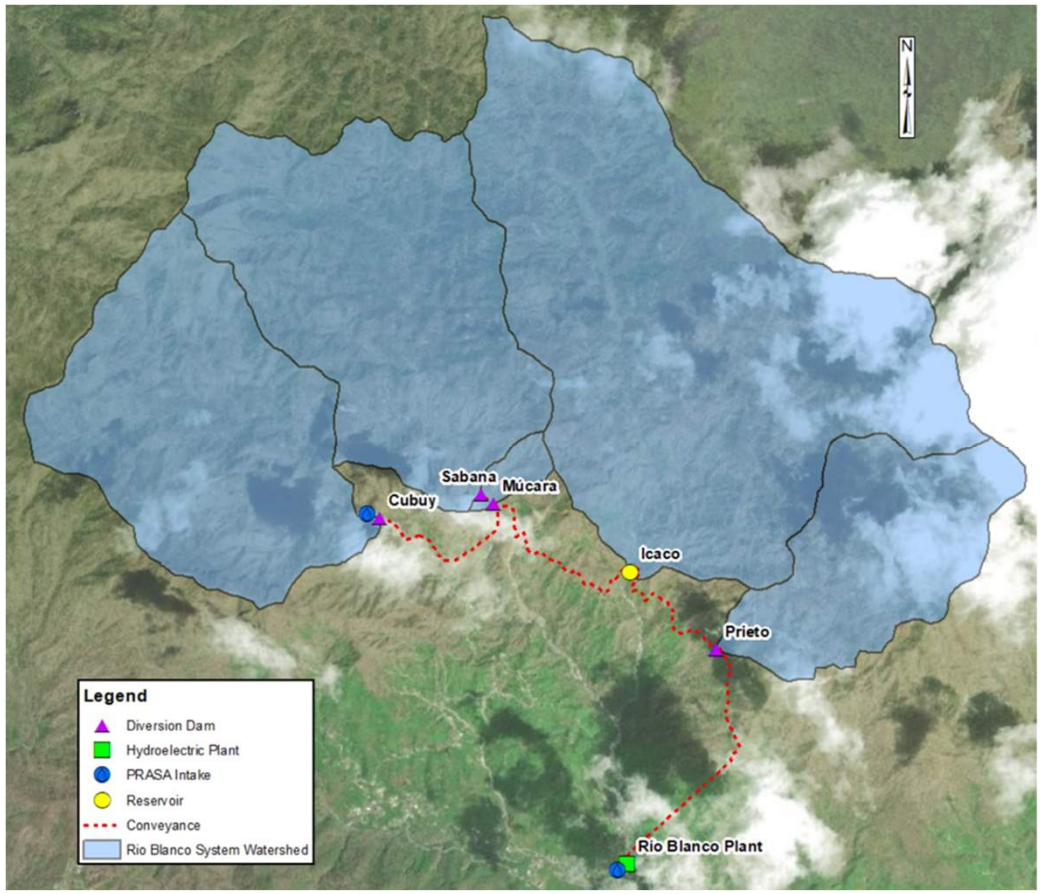
- Built 1953 – two vertical reaction units 4 MW each
- Calculated Annual Average Net Generation 7,523 MWh
  Potential Net Generation with Improvements 27,300 MWh
- Major Recommendations:
  - Dredge Yahuecas and Prieto Reservoirs or Implement Sediment Passing Gate System
  - Dredge Lago Lucchetti near Yauco 2 Intake
  - Mechanical Governor with Frequency Response – Modernize, Convert to Digital Governor
  - Refurbish or Replace Voltage Regulator / Field Breaker with Modern Static Excitation System
  - Upgrade Electrical Protection and Control Systems
  - Luchetti reservoir will be dredged under a separate project using FEMA funding
- ECC has Remote Load and Voltage Control After Manual Start-up

Yauco 2 – Economic Feasibility Analysis

LINE	IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST ($)	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Refurbished	67,481,000	666,000	0.8	2,700,000	23.2%	8
2	Dredging	92,591,000	744,000	0.6	2,700,000	31.2%	8
3	Dredging and modify Yahuecas and Prieto to pass sediment (full Auto)	92,008,000	789,000	0.7	3,176,000	31.2%	8
4	Dredging and modify Yahuecas and Prieto (full Auto) to pass sediment Rule Curve 1	63,426,000	789,000	1.0	3,176,000	22.4%	8
5	Dredging and modify Yahuecas and Prieto (full Auto) to pass sediment Rule Curve 2	73,820,000	789,000	0.9	3,176,000	25.6%	8

- Payback less than 1 year for recommended improvements.
- Dredging of the reservoirs are from FEMA funding.

Rio Blanco Hydroelectric System



Penstock and conveyance from small diversions needs replacement or repair

With no storage, Automation is necessary to fully utilize available water

Diversion Dams

Generating Plant:

- Rio Blanco – 5.0 MW (Inactive)

Rio Blanco Hydroelectric Facility (Inactive since 2011 due to penstock issues. Penstock failure during Hurricane Maria in 2017)

- Built 1930 – two horizontal Pelton units 2.5 MW each
- Potential Net Generation with Improvements 28,890 MWh
- Major Recommendations:
  - Dredge Diversions
  - Inspect Penstock, Address Stability Issues
  - Mechanical Governor with Frequency Response – Modernize, Convert to Digital Governor, Eliminate Leather Belts
  - Replace Manual Rheostats / Field Breakers with Modern Static Excitation System
  - Replace Manually Operated Oil-Type Generator Circuit Breakers in Powerhouse
  - Upgrade Electrical Protection and Control Systems
  - Restore Inlet Valve Control from Powerhouse
  - Replace penstock and restore small diversions to operation is being completed under a separate project using FEMA funds
- Remote Monitoring Only by ECC via Fiber

Rio Blanco – Economic Feasibility Analysis

LINE	RÍO BLANCO IMPROVEMENT	NET PRESENT VALUE ($)	ANNUAL AVERAGE COST ($)	ADJUSTED PAYBACK PERIOD (YEARS)	TOTAL CAPITAL COST ($)	CAPACITY FACTOR (%)	FACILITY CAPACITY (MW)
1	Refurbished	2,317,000	1,598,000	6.0	700,000	12.8%	5.0
2	Restore all diversions (FEMA Grant)	9,127,000	1,327,000	1.5	700,000	15.3%	5.0
3	All Diversions, Full Auto	88,214,000	1,374,000	0.3	1,200,000	66.0%	5.0
4	Tyrolean weirs all diversions, full Auto	87,761,000	1,409,000	0.4	1,570,000	66.0%	5.0

- Penstock replacement is being covered by FEMA funding.
- Activating all diversions and automating recommended.
- Payback period is less than one year for recommended improvement.

Summary Generation Potential with Recommended Improvements

Facility	Existing Capacity (MW)	Average Annual Generation w/o Recommended Improvements [b] (MWh)	Potential Capacity with Recommended Improvements (MW)	Average Annual Generation with Recommended Improvements (MWh)	Percent Increase in Annual Generation
Dos Bocas	15.0 (Active)	28,838	15.0	30,650	6%
Caonillas 1	20.0	5,711	20.0	54,400	852%
Caonillas 2	3.6	0	1.0	5,200	-
Toro Negro 1	8.6 (Active)	5,123	8.6	26,700	420%
Toro Negro 2	1.9	85	1.9	3,300	3782%
Garzas 1	7.2 (Active)	2,829	7.2	12,500	341%
Garzas 2	5.0	0	5.0	8,800	-
Yauco 1	20.0	45	20.0	55,300	122,789%
Yauco 2	8.0 (Active)	7,523	8.0	27,300	263%
Río Blanco [a]	5.0[a]	0	5.0	28,890	-
Total	**94.3 (38.8 Active)**	**50,154**	**91.7**	**253,040**	**504%**

a. Inactive since May 2011
b. Average annual generation from the past 3 years

- The system has the potential to more than double capacity and improve annual generation by over 500%.

Summary Average Annual Costs, Capital Costs and Net Present Value

Facility	Improvements	Average Annual Cost ($)	Total Capital Cost ($)	Net Present Value ($)
Dos Bocas	Reliability Improvements	$1,567,000	$5,946,000	$95,293,000
Caonillas 1	Reliability Improvements, and 1MW Caonillas 2 Plant with Bypass	$1,192,000	$2,795,000	$188,204,000
Caonillas 2	New 1 MW full Automation, with Bypass and Sediment Passage Gates	$2,203,000	$20,300,000	($9,843,000)
Toro Negro 1	Rehabilitate Small Diversions with full Automation, New Penstocks in Future	$5,433,000	$42,133,000	$31,241,000
Toro Negro 2	Full Automation, and Rule Curve 2, New Penstocks in Future	$1,509,000	$22,077,000	($2,510,000)
Garzas 1	Tyrolean Weirs on Small Diversions, Full Automation, and Rule Curve 1, New Penstock in Future	$2,762,000	$26,347,000	$23,638,000
Garzas 2	Tyrolean Weirs on Small Diversions, Full Automation, and Rule Curve 1, New Penstock in Future	$2,522,000	$25,246,000	$19,615,000
Yauco 1	Modify Yahuecas and Prieto to Pass Sediment, Refurbish Electrical and Mechanical, Full Automation	$2,080,000	$17,500,000	$161,590,000
Yauco 2	Modify Yahuecas and Prieto to Pass Sediment, Reliability Improvements, Full Automation	$789,000	$3,176,000	$92,008,000
Río Blanco	Restore All Small Diversions to Service, Full Automation	$1,374,000	$1,200,000	$88,214,000
Total		**$21,431,000**	**$166,700,000**	**$687,500,000**

- This portfolio produces positive and increasing cash flow over a 30-year study period.

Engineering and Construction Schedule*

SCHEDULE			
YEAR	**ENGINEERING (cost in $1,000)**	**CONSTRUCTION/ REFURBISH (cost in $1,000)**	**PENSTOCK REPLACEMENT (cost in $1,000)**
1	Dos Bocas ($425) Caonillas 1 ($195) Caonillas 2 ($1,420) Toro Negro 1 ($635) Toro Negro 2 ($120) Garzas 1 ($330) Garzas 2 ($220) Yauco 1 ($1,750) Yauco 2 ($320) Río Blanco ($120)	Dos Bocas ($5,630) Caonillas 1 ($2,600) Caonillas 2 ($10,875) Toro Negro 1 ($5,715) Toro Negro 2 ($1,080) Garzas 1 ($2,970) Garzas 2 ($1,980) Yauco 1 ($7,000) Yauco 2 ($2,856) Río Blanco ($1,080)	
2		Caonillas 2 ($8,000) Yauco 1 ($8,750)	
5	Toro Negro 1 ($1,650)		Toro Negro 1 ($14,920)
10	Toro Negro 1 ($1,900)		Toro Negro 1 ($17,300)
11	Garzas 1 ($2,300)		Garzas 1 ($20,750)
15	Toro Negro 2 ($2,100)		Toro Negro 2 ($18,775)
20	Garzas 2 ($2,300)		Garzas 2 ($20,745)

***Recommended Portfolio 2 - Best Implementable Projects for each Hydroelectric Plant (Portfolio 1 is Highest NPV) from Task 600 Report**

Recommended Engineering and Construction Schedule:

- Year 1: Goal is to begin engineering and construction to return projects to service and increase generation.
- Year 2: Goal is to increase automation and capacity factor.
- Years 5 and beyond: Goal is to replace aging infrastructure as it approaches its end of useful life to extend service life of facilities

Next Steps

- Budget Allocations – Select Alternatives
- Develop Implementation Plan – Capital Cost, Schedule
- Scope Specific Projects – Preliminary Design
- Detailed Design – Procurement Specifications, Construction Package

Discussion

Thank You

Contact Us

Randy Boyce
BoyceRD@bv.com

Dianys Arocho
ArochoSalgadoD@bv.com

Bruce Benson
BensonBA1@bv.com

Aaron Lemke
LemkeAW@bv.com