



Autoridad Del Canal De Panama  
Division de Proyectos de Capacidad del Canal

PARA USO OFICIAL

Work Order No.5  
Feasibility Design For  
The Ríos Coclé Del  
Norte And Caño Sucio  
Water Supply Projects

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VOLUME 5:  
APPENDICES



In association with





AUTORIDAD DEL CANAL DE PANAMA  
Division de Proyectos de Capacidad del Canal

## THE PANAMA CANAL

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### ENGINEERING SERVICES

Work Order No. 5  
The Ríos Coclé del Norte and Caño Sucio  
Water Supply Projects

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*Feasibility Study*

**Volume 5 APPENDICES F-G**

**DECEMBER 2003**



In association with  
**TAMS Consultants, Inc.**  
Ingeniería Avanzada, S.A.  
Tecnilab, S.A.

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**FEASIBILITY DESIGN  
FOR  
THE RÍOS COCLÉ DEL NORTE AND CAÑO SUCIO  
WATER SUPPLY PROJECTS**

**APPENDIX F**

**AGRICULTURE AND IRRIGATION POTENTIAL**

Prepared by



In association with



**PARA USO OFICIAL**

**FEASIBILITY DESIGN  
FOR  
THE RÍOS COCLE DEL NORTE AND CAÑO SUCIO  
WATER SUPPLY PROJECTS**

**APPENDIX F – AGRICULTURE AND IRRIGATION POTENTIAL**

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## 1 BACKGROUND AND SCOPE

The Panama Canal Authority (ACP) is evaluating several sources of additional water supply to meet future demand for the Canal operation and for municipal and industrial use in the Gatun Lake watershed. A Reconnaissance Study performed by the US Army Corps of Engineers, Mobil District, in 1999 has identified a number of options in the "Western Watershed" as a promising source of water for the Canal. These options include the Río Indio Water Supply Project in combination with other reservoirs such as Caño Sucio, Río Toabré and Coclé del Norte. The Río Coclé del Norte is a river located west of the Panama Canal; it flows northward from the Continental Divide to the Caribbean Sea. The proposed dam is located approximately 15 km inland. At the dam location, the Río Coclé del Norte watershed has an area of 1,600 km<sup>2</sup>, and the average annual flow is approximately 110 m<sup>3</sup>/sec. The water stored in the Coclé del Norte reservoir is to be transferred into the Río Indio reservoir through an 18-km long tunnel. An 8-km long tunnel is used to transfer the regulated flows from the Río Indio watershed into the Gatun Lake.

Based on the outcome of the Reconnaissance Study, the ACP has selected the Río Coclé del Norte project to be evaluated at the feasibility level. As part of the Feasibility Study, the ACP has decided to assess the agricultural and irrigation potential of the basin. This report presents the analysis performed to evaluate this potential. The study was divided in eight tasks as follows:

- Data Collection and Site Reconnaissance;
- Review of Present Land Use;
- Mapping of Land Capability for Irrigation;
- Identification of Potential Irrigable Areas;
- Crop Pattern Definition;
- Water Requirement Estimate;
- Agriculture Net Benefit Estimate;
- Preliminary Definition of Irrigation Developments (Engineering and Cost).

The study of the agricultural and irrigation potential in the Río Coclé del Norte basin was performed by TAMS Consultants, Inc., an Earth Tech company, under the Sub-consultant Services Agreement No.15593 S-1 for MWH.

## 2 PROJECT LOCATION AND INITIAL RECONNAISSANCE

The study area is located in the Río Coclé del Norte and Río Caño Sucio basins and intermediate coastal areas, approximately 100 kilometers northwest of Panama City, in the Provinces of Colón (District of Donoso, Corregimientos of Coclé del Norte, Miguel de la Borda and El Guásimo) and Coclé (District of Penonomé, Corregimientos of Toabré, Tulú and Chiriguí). These basins are adjacent to and West of the Río Indio basin, which, in turn is adjacent to and lies West of the Panama Canal basin. Most of the Río Coclé del Norte, Río Caño Sucio and Río Indio form the Western Watershed to be managed by the ACP. Its total population is approximately 35,000. The northern portion of the study area is accessible by helicopter and by boat from the City of Colón, and the southern portion is accessible by helicopter and by dry weather roads, from the City of Penonomé.

Studies being carried out in the Río Coclé del Norte and Río Caño Sucio envisage the creation of new reservoirs in the region. The highest normal operating pool level of the reservoirs being considered in the study area would be at El. 100 meters above sea level. The total drainage area in the study area, including the Río Coclé del Norte basin, the Río Caño Sucio basin and the small coastal streams between these two river basins at their mouths in the Caribbean Sea is approximately 2,500 square kilometers. The population in the vicinity of the reservoirs has been estimated at approximately 6,500.

The Río Coclé del Norte, Río Caño Sucio basins and the intermediate coastal areas are largely undeveloped rural areas. Climate is humid and tropical with mean temperatures ranging from 25°C in the coast to 26.5°C inland and mean annual rainfall varying from 2200 mm at Toabré, inland, to 4900 mm at Coclé del Norte, on the coast. Rainfall occurs most of the year; however, there is a drier season from January through April. The apparently more promising areas for agriculture and irrigation development, in the coastal and interior valleys, excluding the existing forest areas West of the Coclé del Norte river and the proposed reservoir in the same river basin, were initially identified on available 1:50,000 scale maps. Subsequently, a site reconnaissance of several of these areas was conducted on January 23, 2002 by ACP and TAMS personnel by helicopter, as described in Attachment 1. The population of the main villages according to the latest Census in year 2000 is presented in Attachment 2. The Location Map of the study area is presented in Exhibit 1.

### 3 LAND RESOURCES

#### 3.1 Methodology

The evaluation of the land resources includes a review of the present land use and an estimate of the land capability for agriculture and irrigation. Initially, existing documentation, including previous soils map, topographic maps, aerial photographs and other relevant information were collected and reviewed.

The existing soils map is the map prepared by the Joint Venture of Resources and Geotechnics, Inc and J. L. Jacobs for the National Rural Cadastre Project (CATAPAN). This work was performed in the 1960's and financed by USAID.

The topographic maps from the Instituto Geográfico Nacional "Tommy Guardia" included the 1:250,000 scale maps (Donoso and Santiago sheets) and the following 1:50,000 scale maps: 4042 – I (Petaquilla), 4042 – II (Coclecito), 4043 – II (Coclé del Norte), 4142 – I (Boca de Uracillo), 4142 – II (San Pedro), 4142 – III (Tulú), 4143 – III (Miguel de la Borda).

The aerial photos used, from the Instituto Nacional "Tommy Guardia", at 1:20,000 scale, and dated June 1983, were the following:

**Table 1 – Aerial Photograph Coverage**

Layer	Photograph Numbers
R-61-L-3B	0013 to 0027
R-61-L-5B	0084 to 0088
R-61-L-2B	0189 to 0195
R-61-L-5B	0102 to 0104
R-61-L-6B	0137 to 0141
R-61-L-4B	0042 to 0048
R-61-L-4B	0058 to 0063
R-61-L-3B	0006 to 0008

In addition, existing aerial photographs from Layer FL – 240 – 263, were reviewed. The ACP's Remote Sensing Unit, Canal Basin Monitoring and Institutional Coordination Section, Environmental Management Division, had provided these photographs. The Remote Sensing Unit also made available a map concerning Present Land Use, a Road Map and a Slope Map, all prepared by this unit.

Before initiating the field trips, interpretation of the aerial photographs indicated above was carried out and the information provided by the Remote Sensing Unit and the existing soils map and topographic maps were reviewed.

The next step consisted in carrying out a field investigation. The purpose of this investigation was to check the available land use data and information and to estimate the land capability for agriculture and irrigation.

The field investigation included the execution of 25 soils auger holes at potential irrigable areas, logging the soils profiles at these sites, taking soils samples (see Attachment 5) from the various soils layers (horizons) and taking water samples (see Attachment 6) at the location of potential surface water sources for irrigation purposes. The augers were made at a local shop in Panama City, following the indications of TAMS agronomist. The soils samples were analyzed at the Laboratorio de Análisis Especializado (LABAE), an independent privately owned laboratory, and the water samples were analyzed at an ACP owned laboratory.

Existing land uses, crops and cropping patterns, agricultural practices and various other agro-economic data were also obtained from the local farmers, from the Ministerio de Desarrollo Agropecuario (Ministry of Agricultural Development) and from the Censo Nacional Agropecuario de 2001 (2001 Agricultural Census) data obtained at the Controloría General del Estado, Dirección de Estadística y Censos, and other government and private sources.

The site investigation was conducted by TAMS agronomist, ACP counterpart agronomist and local farmers hired by TAMS. The ACP provided transportation by helicopter and all-terrain vehicle. The TAMS and ACP agronomists were lodged at local house rented by TAMS.

### 3.2 Present Land Use

The main uses found are as follows:

- **Forestlands** – Include some mature forests but mainly secondary forest
- **Slash and burn lands** – Include previous forest areas that have been recently burnt in order to open up new land for agriculture and pastures.
- **Bush/thicket lands** –Include lands that have been deforested and cleared by slash and burn methods some time ago and that are presently covered by bush/thicket.
- **Pasturelands** – Include natural and man-made pasturelands. These are probably areas that were formerly open by slash and burn methods and that have been transformed into pasturelands by either natural or man intervention. The predominant pastures are known as “ratana”.
- **Miscellaneous use** – stubble, small sparse cultivated areas, villages, marshlands, and wetlands.

The main crops grown (see Attachment 3) are the following:

- **Annual Crops** – Rice, maize, beans, cassava, vegetables (peppers, tomatoes, melon, water melon, cucumber), nance, otoe, squash, sugar cane.
- **Perennial Crops** – Coffee, cocoa, fruit trees (avocado, guava, mango, maracuya, marañón, papayas, oranges, grape fruit, lime, anona, plantains, bananas, pineapple, coconut)

The various land uses in hectares for the 7 main areas within the study area are presented in Table 2, below.

**Table 2 – Present Land Use**

Area	Forest Lands	Slash & Burn	Bush/ Thicket	Pasture Lands	Misc. (1)	Totals
1. Valle Bajo Río Coclé del Norte	9,000	110	1,540	110	570	<b>11,330</b>
2. Costa Platanal – Punta Diego	7,220	240	2,110	260	830	<b>10,660</b>
3. Valle Bajo Río Miguel de la Borda	13,450	310	2,100	1,660	3,720	<b>21,240</b>
4. Valle Río Caño Sucio	6,810	500	5,660	1,730	840	<b>15,540</b>
5. Valles Ríos Tulú & Curiá	1,360	160	1,720	1,900	700	<b>5,840</b>
6. Valles Ríos San Miguel & Chiguirí	5,310	860	9,320	6,680	460	<b>22,630</b>
7. Valles Ríos Lura, Tucué, Toabré	1,470	220	2,400	2,560		<b>7,810</b>
<b>Totals (hectares)</b>	<b>44,620</b>	<b>2,400</b>	<b>24,850</b>	<b>14,900</b>	<b>8,280</b>	<b>95,050</b>
<b>Totals, (%)</b>	<b>46.9%</b>	<b>2.5%</b>	<b>26.1%</b>	<b>15.7%</b>	<b>8.8%</b>	<b>100%</b>

(1) Includes stubble, small sparse farm land, villages, marshlands, wetlands.

The land use map of the above indicated 7 valley areas, at scale 1:50,000, is presented in Exhibit 2.

According to the 2001 Agricultural Census, almost 100% of the existing farms exceed 1 hectare in size. Our estimate, based on conversations with farmers in the field, is that the average size farm is in the order of 4 to 5 hectares.

### 3.3 Land Capability for Irrigation

The study area is located in Recent Quaternary formations. Small plains with slopes of less than 5% located in alluvial valleys and colluvial hillside slopes form the landscape. The soils are mainly clayey loams, mild to slightly undulating topography, light erosion, slow surface drainage, poor internal drainage, medium fertility that can be improved.

The assessment of the Land Capability for Irrigation was based on the aforementioned semi-detailed soils study by the National Rural Cadastre Project (CATAPAN), supplemented by aerial photo interpretation and the field investigation by TAMS

agronomist accompanied by an ACP counterpart agronomist and assisted by local farmers.

Assessments of the conditions that define arable and non-arable land, and land classifications were made in accordance with the US Bureau of Reclamation Standards. The Land Classification Specifications, the symbols used, class and sub class definitions, are given in Attachment 4. The physical factors used as criteria in the classification of land for irrigation purposes are: climate, soils, topography and drainage.

Land classes for irrigation and symbols were selected among classes :

**Land Class and Sub-Class**

Arable:

Class 1

Class 2 Sub-classes 2s, 2t, 2d, 2st, 2sd, 2dt, and 2sdt.

Class 3 Sub-classes 3s, 3t, 3d, 3st, 3sd, 3dt, and 3std.

Sub-classes indicate deficiencies in soils (s), topography (t) and drainage (d).

Limited arable:

Class 4

Tentatively Non - Arable:

Class 5

Non - Arable:

Class 6

The symbols in the land classification indicate: class, sub-class (deficiencies), land use, productivity, development cost, water demand level, drainability, leveling requirement, susceptibility to flooding. A complete description of the symbols used in the land classification is given in Attachment 4.

Based on the above, the mapping units were delineated and their capabilities for irrigation were assessed. Random field observations and auger holes were carried out, 25 soils profiles were logged, 55 soils samples were taken and fertility tests were done in a soils laboratory. The mapping was finalized after verification of the results of the laboratory tests. The locations of the 25 soils profiles are shown on Exhibits 3 through 10.

The eight 1/50,000 scale Land Capability for Irrigation Maps showing the land classification in the study areas are given in Exhibits 3 through 10. These maps concern the following areas:

- 1) Valle Bajo del Río Coclé del Norte;
- 2) Costa Platanal – Punta Diego;
- 3) Valle Bajo del Río Miguel de la Borda;
- 4) Valle del Río Caño Sucio;
- 5) Valles de los Ríos Tulú y Curiá;
- 6) Valles de los Ríos Lurá y Tucué;
- 7) Valles de los Ríos San Miguel y Chiguirí; and,
- 8) Valles de los Ríos San Miguel y Chiguirí.

The general location (key) of these eight maps is shown in Exhibit 1.

The results of the Soils Laboratory Analyses (soils fertility) of the 55 soils samples are given in Table E-3, Attachment 5. The soils are clayey, clayey loams, acid (low pH), medium in organic matter, medium to low in nitrogen, low in phosphorus, aluminum, copper and zinc, medium in potassium and iron, high in calcium and magnesium.

Table 3, below, indicates the approximate gross irrigable surface areas. Values given indicate the areas in classes 2 and 3 arable lands and the combined total areas, in hectares, regardless of the water requirements and water availability. Class 1 lands were not found.

**Table 3 – Gross Irrigable Areas in Hectares**

Area Location	Class 2 Lands	Class 3 Lands	Total
<b>Coastal Areas</b>			
1. Valle Bajo del Río Coclé del Norte	6,600	1,700	8,300
2. Costa Platanal – Punta Diego	200	2,300	2,500
3. Valle Bajo del Río Miguel de la Borda	3,000	3,000	6,000
<b>Subtotal</b>	<b>9,800</b>	<b>7,000</b>	<b>16,800</b>
<b>Inland Areas</b>			
4. Valle del Río Miguelito	-	500	500
5. Valle del Río Caño Sucio at El Cedro	1,200	-	1,200
6. Valle del Río Caño Sucio at Las Maravillas	2,000	2,000	4,000
7. Valle del Río Curiá	200	-	200
8. Valle del Río Tulú	400	700	1,100
9. Valle del Río San Miguel	1,400	1,500	2,900
10. Valle del Río Lurá	400	150	550
11. Valle del Río Tucué	300	-	300
12. Valle del Río Chiguirí	1,000	1,200	2,200
13. Valle del Río Toabré	250	200	450
<b>Subtotal</b>	<b>7,150</b>	<b>6,250</b>	<b>13,400</b>
<b>Total Gross Area (hectares)</b>	<b>16,950</b>	<b>13,250</b>	<b>30,200</b>

The results of the laboratory analyses of the 14 surface water samples are presented in Attachment 6. These results suggest that all surface waters can be used for irrigation purposes with little risk of salt accumulation that cannot be overcome with normal infiltration of water through the soil profile. The only restriction for use is for poorly drained soils. Similarly, risk of alkalinization is low.

The location of the sites where the water samples were taken is shown in Exhibits 3 through 10.

## 4 WATER RESOURCES

### 4.1 Precipitation

A listing of the rainfall gauging stations in the vicinity of the project was collected from the ACP. The eleven stations listed in Table 4 characterize the rainfall pattern in the Río Coclé del Norte basin. Daily and monthly data for these stations were collected from the ACP.

**Table 4 – Rainfall Stations**

Name of the Station	Location and Altitude			Station No.	Period of Record	Mean Annual Rainfall
	Latitude	Longitude	Elevation			
Icacal	9°12'	80°09'	11	113-001	1959-1998	3,919
Miguel de la Borda	9°09'	80°19'	2	109-001	1975-1998	3,752
Boca de Uracillo	8°58'	80°11'	20	111-001	1975-1998	2,967
Boca de Toabré	8°55'	80°33'	20	105-001	1958-1998	4,364
Coclé del Norte	9°04'	80°34'	2	105-003	1969-1998	4,903
Coclesito	8°49'	80°33'	60	105-009	1980-1997	3,155
San Lucas	9°00'	80°34'	20	105-007	1974-1997	4,685
Santa Ana	8°49'	80°16'	200	105-010	1981-1999	2,247
Chiguirí Arriba	8°40'	80°11'	180	105-002	1959-1999	3,465
Tambo	8°39'	80°17'	200	105-004	1970-1998	1,904
Toabré	8°38'	80°21'	200	105-005	1970-1998	1,847

Monthly rainfall series for these stations are presented in Attachment 7. Statistical analysis of the monthly precipitation at these stations were performed to evaluate the degree of reliability with which rainfall can be expected. For that purpose, the monthly precipitation exceeded 50% and 80% of the time were estimated and are presented on Table 5 and Table 6.

Monthly rainfall series for these stations are presented in Attachment 7. Statistical analysis of the monthly precipitation at these stations were performed to evaluate the degree of reliability with which rainfall can be expected. For that purpose, the monthly precipitation exceeded 50% and 80% of the time were estimated and are presented on Table 5 and Table 6.

**Table 5 – Monthly Precipitation at 80% Reliability**

Name of the Station	Monthly Precipitation (mm) Exceeded 80% of the Time											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Icacal	50	30	20	50	305	280	380	330	260	300	400	180
Miguel de la Borda	55	30	20	50	270	240	300	310	220	290	355	180
Boca de Uracillo	55	30	20	65	235	235	195	195	200	300	280	115
Boca de Toabré	190	100	75	165	300	260	285	310	230	320	360	270
Coclé del Norte	130	90	55	115	335	325	420	340	205	315	515	260
Coclesito	120	65	40	85	240	190	195	210	195	250	230	215
San Lucas	160	115	80	125	290	260	330	320	235	305	390	290
Santa Ana	50	20	20	55	150	170	125	145	180	210	175	75
Chiguirí Arriba	30	20	14	45	255	300	290	360	315	380	270	90
Tambo	7	4	1	11	110	160	165	165	190	205	110	30
Toabré	10	6	3	12	125	130	135	135	180	200	105	30

**Table 6 – Monthly Precipitation at 50% Reliability**

Name of the Station	Monthly Precipitation (mm) Exceeded 50% of the Time											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Icacal	90	55	65	150	420	390	430	370	320	430	520	370
Miguel de la Borda	120	80	65	190	360	380	390	420	300	400	480	380
Boca de Uracillo	95	55	60	125	325	310	250	295	315	390	340	205
Boca de Toabré	280	180	145	315	475	335	365	410	320	375	450	490
Coclé del Norte	200	140	90	240	520	470	635	445	315	470	590	440
Coclesito	200	125	110	165	370	265	220	310	255	340	280	280
San Lucas	265	175	195	310	460	390	450	440	330	420	525	500
Santa Ana	75	40	50	90	225	230	220	200	215	295	255	135
Chiguirí Arriba	75	40	25	110	370	410	370	420	400	440	380	190
Tambo	25	13	15	35	215	220	225	230	260	300	200	90
Toabré	23	13	13	45	190	215	180	220	280	290	200	95

#### 4.2 River Flows

There are four river gauging stations with daily flow records in the Río Coclé del Norte basin and none in the Río Caño Sucio and in the adjacent coastal areas. The existing stations, their location and record periods are given in Table 7.

**Table 7 – Existing River Gauging Stations**

River	Station Name	Station Number	Drainage Area km <sup>2</sup>	Location and Elevation			Period of Records
				Lat.	Long.	Elev.	
Coclé del Norte	Canoas	105-01 -02	571	08° 55'	80° 30'	20 masl	1983-1999
Coclé del Norte	El Torno	105-01 -01	672	08° 56'	80° 33'	15 masl	1958-1986
Toabré	Batatilla	105-02 -01	786	08° 55'	80 30'	20 masl	1958-1999
San Juan	Los Higuerones	105-03-01	264	08° 48'	80° 36'	99 masl	1981-2000

Daily flow duration curves were prepared for the Canoas and El Torno Stations and are presented in Attachment 8.

The flow rates at the Canoas and El Torno river gauging stations, for several time durations (percentage of time exceedence), based on the flow duration curves, are given in Table 8.

**Table 8 – Flow duration Curve**

Exceedence (% of time)	Flow rates			
	Las Canoas Station		El Torno Station	
	m <sup>3</sup> /s	l/s/km <sup>2</sup>	m <sup>3</sup> /s	l/s/km <sup>2</sup>
75	17.5	30.6	25	37.2
80	15.5	27.1	22	32.7
85	12.5	21.9	19.5	29.0
90	7.5	13.1	16	23.8
95	0	0	11	16.4

The minimum flows recorded during the low – flow season, in m<sup>3</sup>/s and in l/s/sq. km, are as follows:

**Table 9 – Minimum recorded flows**

River Gauging Station	January		February		March		April	
	m <sup>3</sup> /s	l/s/km <sup>2</sup>	m^{3}/s	l/s/km^{2}	m^{3}/s	l/s/km^{2}	m^{3}/s	l/s/km^{2}
Coclé del Norte at Canoas	7.46	13.06	6.42	11.24	3.13	5.48	3.07	5.38
Coclé del Norte at El Torno	8.66	12.88	8.13	12.10	4.82	7.17	4.72	7.02
Toabré at Batatilla	7.70	9.80	5.76	7.32	3.11	3.96	2.01	2.56
San Juan at Los Higuerones	2.93	11.10	2.70	10.22	2.95	11.17	2.08	7.88

## 5 CROPPING PATTERNS AND ON-FARM WATER DEMANDS

### 5.1 Climate

The climatic data in the study area were analyzed to determine the factors that influence the choice of crops, the cropping patterns. Monthly rainfall distribution, potential evapo-transpiration (PET), solar radiation and mean monthly temperatures were collected at three meteorological stations: Icacal, Santa Ana, and Boca de Uracillo. These data are presented in Attachment 9. These parameters were used to determine the duration of the growing season, the planting and crop timing and the water requirements. Also as discussed in the preceding Section, monthly rainfall records at 13 rainfall stations were collected and analyzed. This information was used to determine the crop and the supplementary (irrigation) water requirements.

In addition, information on monthly crop coefficients was obtained from the FAO, Ministry of Agricultural Development (MIDA) and existing reports. These coefficients were used to determine the crop and irrigation water requirements.

For the purpose of the cropping pattern design, onset is assumed to be the period at which the monthly precipitation (P) exceeds half of the evapo-transpiration (PET/2). Offset of rains is considered the period when monthly precipitation (P), decreases below half of the evapo-transpiration (PET/2) plus the period required to extract the evapo-transpiration of up to 100 mm of water stored in the soil, if available. Since the radiation and temperature are relatively uniform during the year, rainfall is the most important parameter affecting the cropping cycle. For all the stations, the onset of rains is about the second half of April, and extends approximately eight months, to about mid – December.

### 5.2 Potential Agricultural Development Areas

Based on the land classification, several potential development areas were identified, both, on the coast and inland. They were generally located in the existing river valley areas.

The areas located on the coast are:

1. The Valle Bajo del Río Coclé del Norte. This includes areas downstream of the proposed Río Coclé del Norte dam site, and is located on both the left and right banks.
2. The Costa Platanal – Punta Diego. This area includes the valleys of the Rivers Platanal, Majagual, Aguacate, Ciri and Diego, located along the coast line between the village of Platanal and the Punta Diego.
3. The Valle del Río Miguel de la Borda, is the lower portion of the Caño Sucio River Valley.

The areas located inland are:

4. The Valle del Río Miguelito. This is a small valley formed by a left tributary of the Miguel de la Borda River.
5. Valle del Río Caño Sucio at El Cedro. This is the part of the Caño Sucio River Valley, located just downstream of the Dam site of the same name.
6. Valle del Río Caño Sucio at Las Maravillas. This is the upper portion of the Caño Sucio River Valley occupying the reservoir area of the potential dam of the same name.
7. Valle del Río Curiá. This is a small valley formed by the Curiá River, a left tributary of the Toabré River.
8. Valle del Río Tulú. This valley is upstream of the Curiá. The Tulú River, a left tributary of the Toabré River, forms the valley, which runs approximately south–north.
9. Valle del Río San Miguel. This valley runs approximately east–west and is formed by the San Miguel River, a right tributary of the Toabré.
10. Valle del Río Lurá. The Lurá is a small valley formed by the river of the same name, a left tributary of the Toabré.
11. Valle del Río Tucué. This is a small valley running approximately south–north and formed by the river of the same name, a left tributary of the Toabré.
12. Valle del río Chiguirí. The Chiguirí River, a right tributary of the Toabré, forms this valley also running east west, south of the San Miguel.
13. Valle del Río Toabré. This is a small valley in the upper Toabré River Basin, adjacent to the Tucué.

The approximate location of the above-described Potential Development Areas, including coordinates and altitude, is given in Table 10.

**Table 10 – Approximate Location of Potential Areas**

Area	Lat	Long	Elev.
1. Valle Bajo del RioCoclé del Norte	9° 03'	80° 34'	0 to 40
2. Costa Platanal – Punta Diego	9° 08'	80° 25'	0 to 40
3. Valle Bajo del Río Miguel de la Borda	9° 05'	80° 19'	0 to 40
4. Valle del Río Miguelito	8° 57'	80° 22'	70 to 100
5. Valle del Río Caño Sucio at El Cedro	8° 58'	80° 19'	80 to 120
6. Valle del Río Caño Sucio at Las Maravillas	8° 55'	80° 18'	90 to 100
7. Valle del Río Curiá	8° 49'	80° 23'	40 to 100
8. Valle del Río Tulú	8° 45'	80° 24'	100 to 200
9. Valle de Río San Miguel	8° 47'	80° 18'	100 to 300
10. Valle del Río Lurá	8° 45'	80° 22'	120 to 160
11. & 13. Valles de los Ríos Tucué & Toabré	8° 44'	80° 20'	110 to 160
12. Valle del Río Chiguirí	8° 41'	80° 12'	160 to 200

### 5.3 Existing Crops

The 2001 Agricultural Census data on existing cultivated areas and crops are presented in Attachment 3. There are approximately 5,550 hectares and 14,300 plots cultivated with annual crops. The annual cultivated area is about 5,970 hectares; the resulting cropping intensity ( $5,970/5,550$ ) is approximately 108%. The main annual crops grown are rice and maize, with part of the land getting 2 crops per year. Other annual crops grown are beans, cassava, and vegetables.

There are also approximately 2,630 hectares cultivated with perennial crops, including coffee, cocoa, and fruit trees in approximately 17,000 very small farm units. Thus, the total cultivated surface area, according to the 2001 Agricultural Census data, including annual and perennial crops, excluding pasturelands, is in the order of 8,200 hectares. As previously mentioned in the description of present land use, there are some 14,900 hectares in pasturelands in the study area.

In addition, according to the 2001 Agricultural Census data, there are approximately 170,000 bovine livestock in the Coclé and Colon Provinces, combined. A part of that is in the project area.

The present yields recorded by the 2001 Agricultural Census are also indicated in Attachment 3.

According to the farmers interviewed during the site investigation, the agricultural development is hampered by lack of all weather access roads, technical assistance and the generally insufficient basic infrastructure in the project area.

### 5.4 Proposed Crops and Cropping Pattern

The proposed crops are based on the presently cultivated crops, and include the following:

**Annual crops:** Rice (*oryza sativa*) (2 crops per year), maize (*Zea mays*) (2 crops per year), beans (*Phaseolus vulgaris*), bejuco beans (*Phaseolus spp*), squash (*Cucurbita pepo*), table tomatoes (*Lycopersicum esculentum*), industrial tomatoes (*Lycopersicum spp.*), melon (*Cucumis melo*), watermelon (*Citrullus vulgaris*), cassava (*Manihot esculenta*), name (*Dioscorea spp*), otoe (*Xanthosoma sagittifolium*).

**Perennial crops:** coffee (*Coffea arabica*), pineapple (*Anonas comosus*), plantains (*Musa spp*), bananas (*Musa paradisiaca*), citrus (*Citrus sinensis*) (oranges), pasture grasses (*Ischaelum ciliare*), teca trees (*Tectona grandis*), pine trees (*Pinus caribaea*), marañon (*Anacardium occidentale*).

The proposed cropping patterns for annual and perennial crops and for the coastal and inland areas are presented in Table 11 and Table 12. The main differences in the cropping patterns between the coastal and the interior projects are the percentages of certain crops, based on the higher precipitation in the coastal areas than inland. For instance, more rice would be planted in the more humid coastal areas than inland.

**Table 11 – Proposed Cropping Pattern for Coastal Areas**

Crops	Total Net Area (ha)	Surface Areas				Total Annual Cropped Area (ha)	
		First Crop		Second Crop			
		%	ha	%	ha		
<b>Annual Crops</b>							
Rice	1,064.0	20	1,064.0	25	1,330.0	2,394.0	
Maize	532.0	10	532.0	5	266.0	798.0	
Beans	159.6	3	159.6			159.6	
Bejuco beans	159.6	3	159.6			159.6	
Squash	106.4	2	106.4			106.4	
Table tomatoes	53.2	1	53.2			53.2	
Industrial tomatoes	53.2	1	53.2			53.2	
Watermelons	53.2	1	53.2			53.2	
Melons	53.2	1	53.2			53.2	
Cassava	266.0	5	266.0			266.0	
Ñame	266.0	5	266.0			266.0	
Otoe	266.0	5	266.0			266.0	
<b>Subtotal</b>	<b>3,032.4</b>	<b>57</b>	<b>3,032.4</b>	<b>30</b>	<b>1,596.0</b>	<b>4628.4</b>	
<b>Perennial Crops</b>							
Pineapple	53.2	1	53.2			53.2	
Coffee	319.2	6	319.2			319.2	
Bananas	159.6	3	159.6			159.6	
Plantains	159.6	3	159.6			159.6	
Citrus (oranges)	212.8	4	212.8			212.8	
Pasture grasses	744.8	14	744.8			744.8	
Teca trees	212.8	4	212.8			212.8	
Pine trees	212.8	4	212.8			212.8	
Marañon	212.8	4	212.8			212.8	
<b>Subtotal</b>	<b>2,287.6</b>	<b>43</b>	<b>2,287.6</b>			<b>2,287.6</b>	
<b>Total</b>	<b>5,320.0</b>	<b>100</b>	<b>5,320.0</b>	<b>30</b>	<b>1,596.0</b>	<b>6,916.0</b>	

*Total irrigable surface area = 5,320 ha (100%)*

*Total annual cropped area = 6,916 ha*

*Cropping intensity = 6,916/5,320 = 1.30 (130%)*

**Table 12 – Proposed Cropping Pattern for Inland Areas**

Crops	Total Net Area Ha	Surface Areas				Total Annual Cropped Area ha	
		First Crop		Second Crop			
		%	ha	%	Ha		
<b>Annual Crops</b>							
Rice	316.8	10	316.8	25	792.0	1,108.8	
Maize	380.2	12	380.2	5	158.4	538.6	
Beans	126.7	4	126.7			126.7	
Bejuco beans	126.7	4	126.7			126.7	
Squash	95.0	3	95.0			95.0	
Table tomatoes	63.4	2	63.4			63.4	
Industrial tomatoes	63.4	2	63.4			63.4	
Watermelons	63.4	2	63.4			63.4	
Melons	63.4	2	63.4			63.4	
Cassava	126.7	4	126.7			126.7	
Ñame	126.7	4	126.7			126.7	
Otoe	126.7	4	126.7			126.7	
<b>Subtotal</b>	<b>1,679.0</b>	<b>53</b>	<b>1,679.0</b>	<b>30</b>	<b>950.4</b>	<b>2,629.4</b>	
<b>Perennial Crops</b>							
Pineapple	63.4	2	63.4			63.4	
Coffee	126.7	4	126.7			126.7	
Bananas	95.0	3	95.0			95.0	
Plantains	126.7	4	126.7			126.7	
Citrus (oranges)	158.4	5	158.4			158.4	
Pasture grasses	475.2	15	475.2			475.2	
Teca trees	158.4	5	158.4			158.4	
Pine trees	158.4	5	158.4			158.4	
Marañón	126.7	4	126.7			126.7	
<b>Subtotal</b>	<b>1,489.0</b>	<b>47</b>	<b>1,489.0</b>			<b>1,489.0</b>	
<b>Total</b>	<b>3,168.0</b>	<b>100</b>	<b>3,168.0</b>	<b>30</b>	<b>950.4</b>	<b>4,118.4</b>	

*Total irrigable surface area = 3,168 ha (100 %)*

*Total annual cropped area = 4,118.4 ha*

*Cropping intensity = 4,118.4/3,168 = 1.3 (130%)*

The proposed cropping schedules/cropping patterns for the coastal and inland agricultural development areas are presented in Table 13 and Table 14, respectively.

**Table 13 – Cropping Schedule for Coastal Areas**

Crops	Months												Cropped Area (%)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Rice, 1 <sup>st</sup> crop													20.0
Rice, 2 <sup>nd</sup> crop													25.0
Maize, 1 <sup>st</sup> crop													10.0
Maize, 2 <sup>nd</sup> crop													5.0
Beans													3.0
Bejuco beans													3.0
Squash													2.0
Table tomatoes													1.0
Ind. Tomatoes													1.0
Watermelons													1.0
Melons													1.0
Cassava													5.0
Ñame													5.0
Otoe													5.0
Pineapple													1.0
Coffee													6.0
Bananas													3.0
Plantains													3.0
Citrus(orange)													4.0
Pasture grasses													14.0
Teca trees													4.0
Pine trees													4.0
Marañón *													4.0
* Anacardium		.											
Cropping Intensity - %													130.0

**Table 14 – Cropping Schedule for Inland Areas**

Crops	Months												Cropped Area in %
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Rice, 1 <sup>st</sup> crop													10.0
Rice, 2 <sup>nd</sup> crop													25.0
Maize, 1 <sup>st</sup> crop													12.0
Maize, 2 <sup>nd</sup> crop													5.0
Beans													4.0
Bejuco beans													4.0
Squash													3.0
Table Tomatoes													2.0
Ind. Tomatoes													2.0
Watermelons													2.0
Melons													2.0
Cassava													4.0
Ñame													4.0
Otoe													4.0
Pineapple													2.0
Coffee													4.0
Bananas													3.0
Plantains													4.0
Citrus(orange)													5.0
Pasture grasses													15.0
Teca trees													5.0
Pine trees													5.0
Marañón *													4.0
* Anacardium													
Cropping Intensity - %													130.0

## 5.5 On Farm Water Requirements

The monthly net (on farm) crop water demands/requirements were estimated for the proposed crops at each of the potential agricultural development areas for two rainfall conditions: 1) average year and 2) dry year. This information is presented in Attachment 10.

The crop water demand is defined as the crop evapo-transpiration ( $E_t_c$ ) minus water supply by rainfall. In turn, the crop evapo-transpiration is defined as the potential evapo-transpiration ( $E_t_p$ ) of a standard grass crop times a crop coefficient ( $K_c$ ). An average year rainfall is defined as the rainfall that is exceeded 50% of time and a dry year is the one for which rainfall is exceeded more than 50% of time. For the purpose of this report the rainfall exceeded 80% of time has been taken as the rainfall in a dry year. This is considered the design condition.

For each specific area, a climatic station was adopted for determining the  $E_t_p$  and a rainfall station was taken for determining the rainfall values. The climatic station and the rainfall station adopted for each potential development areas are indicated in Table 15.

**Table 15 – Climatic and Rainfall Stations**

Area	Climatic Station	Rainfall Station
1. Valle Bajo del Río Coclé del Norte	Icacal	San Lucas
2. Costa Platanal - Punta Diego	Icacal	Miguel de la Borda
3. Valle Bajo del Río Miguel de la Borda	Icacal	Miguel de la Borda
4. Valle de Río Miguelito	Boca de Uracillo	Boca de Uracillo
5. Valle de Río Caño Sucio at El Cedro	Boca de Uracillo	Boca de Uracillo
6. Valle del Río Caño Sucio at Las Maravillas	Boca de Uracillo	Boca de Uracillo
7. Valle del Río Curiá	Santa Ana	Santa Ana
8. Valle del Río Tulú	Santa Ana	Santa Ana
9. Valle del Río San Miguel	Santa Ana	Santa Ana
10. Valle del Río Luriá	Santa Ana	Santa Ana
11. Valle del Río Tucué	Santa Ana	Tambo (1)
12. Valle del Río Chiguirí	Santa Ana	Chiguirí Arriba
13. Valle del Río Toabré	Santa Ana	Santa Ana

(1) The Santa Ana Station was adopted for the area in the vicinity of the Toabré River Valley near the villages of Boca del Tucué and Paso Real. Tambo would be more appropriate further South.

The monthly crop coefficients ( $K_c$ ) used are given in Table 16.

**Table 16 – Monthly Crop Coefficients ( $K_c$ )**

Crops	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rice, 1 <sup>st</sup> crop				1.10	1.09	1.06	1.05					
Rice, 2 <sup>nd</sup> crop	1.05									1.10	1.09	1.06
Maize, 1 <sup>st</sup> crop				0.45	0.84	1.05	0.84					
Maize, 2 <sup>nd</sup> crop	0.84									0.45	0.84	1.05
Beans	0.58	1.04	0.77									
Bejuco beans	0.34	0.64	0.08	0.64								
Squash	0.34	0.73	1.01	0.82								
Table Tomatoes	0.34	0.73	1.01	0.82								
Ind. Tomatoes	0.34	0.73	1.01	0.82								
Watermelons	0.40	0.75	0.93	0.75								
Melons	0.40	0.75	0.93	0.75								
Cassava	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70
Ñame	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70
Otoe	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70
Pineapple	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61
Coffee	0.5	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90
Bananas	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69
Plantains	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69
Citrus (oranges)	0.75	0.76	0.78	0.81	0.84	0.80	0.84	0.84	0.84	0.82	0.79	0.76
Pasture grasses	0.55	0.70	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75
Teca trees	0.50	0.64	0.78	0.92	1.06	1.20	0.50	0.64	0.78	0.92	1.06	1.20
Pine trees	0.50	0.64	0.78	0.92	1.06	1.20	0.50	0.64	0.78	0.92	1.06	1.20
Marañón (1)	0.50	0.64	0.78	0.92	1.06	1.20	0.50	0.64	0.78	0.92	1.06	1.20

(1) *Anacardium*

The total net supplementary water requirements (on farm supplementary /irrigation water demands) were calculated for the proposed crops, cropping patterns and the potential agricultural development areas.

The determinations of these total net (on farm) crop water requirements in millimeters, including the mean monthly values, based on the mean monthly precipitation, and the dry year monthly values, based on the 5- year return period drought are found in tables J-1 through J –12, Attachment 10. The supplementary net (on farm) water requirements and gross water requirements for the cropping patterns and the potential agricultural development areas are found in tables K – 1 through K – 12, Attachment 11. The mean values are based on the rainfall values corresponding to the 50% of time exceedence and the 5- year return period drought conditions correspond to the 80% of time exceedence rainfall, which demands are the peak on farm demands. The mean monthly net (on farm) supplementary irrigation water requirements and the dry year monthly net (on farm) supplementary irrigation water requirements for the proposed cropping patterns at the potential development areas, in millimeters, are presented in Table 17 and Table 18, respectively.

**Table 17 – Mean Monthly Net Supplementary Irrigation Water Requirements**

Valley Area	Monthly Water Requirements (mm)								Annual (mm)
	Jan	Feb	Mar	Apr	May	Jun-Oct	Nov	Dec	
1 Coclé del Norte	0	0	0	0	0	0	0	0	0
2 Costa Platanal	0	2.07	22.90	0	0	0	0	0	24.97
3 Miguel de laBorda	0	2.07	22.90	0	0	0	0	0	24.97
4 Miguelito	0.84	20.66	34.30	2.66	0	0	0	0	57.96
5C.Sucio/El Cedro	0.84	20.66	34.30	2.66	0	0	0	0	57.96
6C.Sucio/Maravillas	0.84	20.66	34.30	2.66	0	0	0	0	57.96
7 Cuiríá	19.53	32.44	39.88	19.68	0	0	0	0	111.53
8 Tulú	19.53	32.44	39.88	19.68	0	0	0	0	111.53
9 San Miguel	19.53	32.44	39.88	19.68	0	0	0	0	111.53
10 Lurá	19.53	32.44	39.88	19.68	0	0	0	0	111.53
11 Tocué*	61.06	50.25	61.61	57.08	0	0	0	0	230.00
12 Chiguirí	19.52	32.33	55.38	8.81	0	0	0	0	116.04
13 Toabré	19.53	32.44	39.88	19.68	0	0	0	0	111.53

**Table 18 – Dry Year Monthly Net Supplementary Irrigation Water Requirements**

Valley Area	Monthly Water Requirements (mm)								Annual (mm)
	Jan	Feb	Mar	Apr	May	Jun-Oct	Nov	Dec	
1 Coclé del Norte	0	0.11	16.91	4.16	0	0	0	0	21.18
2 Costa Platanal	22.87	27.42	48.11	50.13	0	0	0	0	148.53
3 Miguel de laBorda	22.87	27.42	48.11	50.13	0	0	0	0	148.53
4 Miguelito	35.21	37.18	58.99	45.90	0	0	0	0	177.28
5 C.Sucio/El Cedro	35.21	37.18	58.99	45.90	0	0	0	0	177.28
6C.Sucio/Maravillas	35.21	37.18	58.99	45.90	0	0	0	0	177.28
7 Cuiríá	35.22	39.05	58.48	48.87	0	0	0	0	181.62
8 Tulú	35.22	39.05	58.48	48.87	0	0	0	0	181.62
9 San Miguel	35.22	39.05	58.48	48.87	0	0	0	0	181.62
10 Lurá	35.22	39.05	58.48	48.87	0	0	0	0	181.62
11 Tocué*	83.43	56.21	70.66	83.74	0.01	0	0	68.84	362.89
12 Chiguirí	60.32	44.20	62.20	53.06	0	0	0	17.82	237.60
13 Toabré	35.22	39.05	58.48	48.87	0	0	0	0	181.62

\*The water requirements for the lower part of the Tocué River Valley, near Boca del Tocué and Paso Real, are the same as for the Toabré River Valley.

## 6 AGRICULTURE BENEFITS

Crop budgets for annual and perennial crops, were estimated for the "With Project" and "Without Project" conditions and are given in Attachment 12. The "With Project" condition is the estimated future condition if the project is implemented including improved technology and inputs as well as the irrigation and related rural infrastructure. The "Without Project" condition is the estimated future condition including the normal technological evolution by the local farmers. In this case it is assumed that the project as such will not be implemented.

The crop budgets include the estimated production costs, yields, market prices, gross returns and net returns. The estimated production costs included seeds, fertilizers (N, P, K), labor, tractor, agro-chemicals (insecticides, herbicides, fungicides), transportation and other miscellaneous costs.

The analyses were done for all the proposed annual crops and perennial crops. The annual crops were analyzed on an annual basis. The perennial crops were analyzed for a number of years long enough to be able to assess the average long term returns or benefits. The period of analysis, for the perennial crops was three years for pineapple, fifteen years for coffee, plantains, bananas, and oranges, twenty years for marañón, and twenty-five years for teca and pine trees.

In the case of pasture grasses a special analysis was done which evaluated the development of livestock for the dual-purpose of milk and meat productions. The objective is to develop 50 farms with a combined area of 1000 hectares. Initially a total of 1000 cows and 50 breeder bulls would be purchased. Each farm would receive 1 bull and 20 cows. The analysis, over a 12-year period is also included in Attachment 12.

The information presented includes: 1) The evolution of the heard (Table L-11), the technical parameters (Table L-12), the financial analysis of the dual purpose bovine herd (Table L-13), and the pasture grasses crop budgets (Table L-14).

The average annual net crop benefits per hectare, resulting from subtracting the average net return per hectare "Without Project" from the average net return per hectare "With Project" is given in Table 19.

**Table 19 – Average Annual Net Crop Benefits**

Crops	Avg Net Return With Project US\$/yr/ha	Avg Net Return Without Project US\$/yr/ha	Avg Net Crop Benefit US\$/yr/ha
<b>Annuals</b>			
Rice, 1st crop	\$269.93	\$55.00	\$214.93
Rice, 2nd crop	\$208.99	\$35.20	\$173.79
Maize, 1st crop	\$183.94	\$14.30	\$169.64
Maize, 2nd crop	\$156.44	\$16.50	\$139.94
Beans	\$110.37	\$26.95	\$83.42
Bejuco beans	\$137.54	\$56.21	\$81.33
Table Tomatoes	\$3,312.41	\$1,699.17	\$1,613.25
Ind. Tomatoes	\$1,261.95	\$165.35	\$1,096.60
Watermelons	\$2,543.64	\$1,715.71	\$831.93
Melons	\$1,650.81	\$687.20	\$963.61
Squash	\$690.56	\$229.90	\$460.66
Cassava	\$378.03	\$54.91	\$323.12
Otoe	\$1,350.77	\$358.21	\$992.56
Name	\$1,858.22	\$282.37	\$1,575.85
<b>Perennials</b>			
Pineapple (1)	\$1,364.73	\$744.39	\$620.34
Coffee (2)	\$248.29	\$30.37	\$217.92
Plantains (2)	\$1,458.37	\$245.59	\$1,212.78
Oranges (2)	\$818.90	\$148.10	\$670.80
Bananas (2)	\$3,083.36	\$511.19	\$2,571.77
Pasture/livestock	\$76.24	Nil	\$76.24
Teca trees (3)(5)	\$8,906.52	\$1,530.23	\$7,376.29
Pine trees (3)	\$2,217.74	\$1,665.85	\$551.89
Marañón (4)(5)	\$4,511.63	\$1,133.95	\$3,377.68

**Notes:**

(1) Over 3 years; (2) Over 15 years; (3) Over 25 years (4) Over 20 years

(5) These crops, under "With project" conditions, would be exported.

(6) All crops, except those indicated, would be sold in the Panama national markets.

The average annual net benefits per hectare for the proposed cropping patterns are determined by multiplying the net benefits of each crop by the surface area cropped. The net annual benefits for the cropping pattern in the coastal areas and the net benefits for the cropping pattern in the inland areas, in US\$ per hectare, are presented in Table 20 and Table 21, respectively.

**Table 20 – Average Annual Benefit for Coastal Areas**

Crop	Average Annual Benefit per ha	Cultivated Area in Hectares	Net Annual Benefit
<b>Annuals</b>			
Rice, 1 <sup>st</sup> crop	\$214.93	0.20	\$42.99
Rice, 2 <sup>nd</sup> crop	\$173.79	0.25	\$43.45
Maize, 1 <sup>st</sup> crop	\$169.64	0.10	\$16.96
Maize, 2 <sup>nd</sup> crop	\$139.94	0.05	\$7.00
Beans	\$83.42	0.03	\$2.50
Bejuco beans	\$81.33	0.03	\$2.44
Table tomatoes	\$1,613.25	0.01	\$16.13
Indust. tomatoes	\$1,096.60	0.01	\$10.97
Watermelons	\$831.93	0.01	\$8.32
Melons	\$963.61	0.01	\$9.64
Squash	\$460.66	0.02	\$9.21
Cassava	\$323.12	0.05	\$16.15
Otoe	\$992.56	0.05	\$49.63
Ñame	\$1,575.85	0.05	\$78.79
<b>Sub-total</b>			<b>\$314.18</b>
<b>Perennials</b>			
Pineapple	\$620.34	0.01	\$6.20
Coffee	\$217.92	0.06	\$13.07
Plantains	\$1,212.78	0.03	\$36.38
Oranges	\$670.80	0.04	\$26.83
Bananas	\$2,571.77	0.03	\$77.15
Pasture/livestock	\$76.24	0.14	\$10.67
Teca trees	\$7,376.29	0.04	\$295.05
Pine trees	\$551.89	0.04	\$22.75
Marañón	\$3,377.78	0.04	\$135.10
<b>Sub – total</b>			<b>\$523.20</b>
<b>TOTAL</b>			<b>\$837.38</b>

**Table 21 - Average Annual Benefits for Inland Areas**

Crop	Average Annual Benefit per ha	Cultivated Area in Hectares	Net Annual Benefit
<b>Annuals</b>			
Rice, 1 <sup>st</sup> crop	\$214.93	0.10	\$21.49
Rice, 2 <sup>nd</sup> crop	\$173.79	0.25	\$43.45
Maize, 1 <sup>st</sup> crop	\$169.64	0.12	\$20.35
Maize, 2 <sup>nd</sup> crop	\$139.94	0.05	\$7.00
Beans	\$83.42	0.04	\$3.34
Bejuco Beans	\$81.33	0.04	\$3.25
Table Tomatoes	\$1,613.25	0.02	\$32.26
Indust. Tomatoes	\$1,096.60	0.02	\$21.93
Watermelons	\$831.93	0.02	\$16.64
Melons	\$963.61	0.02	\$19.27
Squash	\$460.66	0.03	\$13.82
Cassava	\$323.12	0.04	\$12.92
Otoe	\$992.56	0.04	\$39.70
Ñame	\$1,575.85	0.04	\$63.03
<b>Sub-total</b>			<b>\$318.45</b>
<b>Perennials</b>			
Pineapple	\$620.34	0.02	\$12.40
Coffee	\$217.92	0.04	\$8.72
Plantains	\$1,212.78	0.04	\$48.51
Oranges	\$670.80	0.05	\$33.54
Bananas	\$2,571.77	0.03	\$77.15
Pasture/livestock	\$76.24	0.15	\$11.44
Teca trees	\$7,376.29	0.05	\$368.81
Pine trees	\$551.89	0.05	\$27.59
Marañón	\$3,377.68	0.04	\$135.11
<b>Sub-total</b>			<b>\$723.27</b>
<b>TOTAL</b>			<b>\$1,041.72</b>

The average annual net benefits for the entire project is made of the sum of benefits for all the irrigable areas, which respective benefits are found by multiplying the net benefits per hectare by the net irrigated area in hectares, as shown in Table 22.

**Table 22 – Average Annual Net Project Benefits**

Irrigable Area/River Valleys	Net Irrigable Area (ha)	Annual Net Benefit per ha	Total Annual Net Benefit
<b>Coast</b>			
1 Bajo Coclé del Norte	2,200	\$837.38	\$1,842,236
2 Costa Platanal –Punta Diego	900	\$837.38	\$753,642
3 Bajo Miguel de la Borda	2,220	\$837.38	\$1,858,984
<b>Sub-total</b>	<b>5,320</b>		<b>\$4,454,862</b>
<b>Inland</b>			
6 Caño Sucio at Las Maravillas	500	\$1,041.72	\$520,860
8 Tulú	580	\$1,041.72	\$604,198
9 San Miguel	830	\$1,041.72	\$864,628
10 Lurá	160	\$1,041.72	\$166,675
11 & 13 Tocué & Toabré	600	\$1,041.72	\$625,032
12 Chiguirí	500	\$1,041.72	\$520,860
<b>Sub-total</b>	<b>3,170</b>		<b>\$3,302,253</b>
<b>Total</b>	<b>8,490</b>		<b>\$7,757,115</b>

## 7 POTENTIAL DEVELOPMENTS

### 7.1 Potential Development Areas

The potential development areas are indicated in section 5.2. Based on the land classification, their position with respect to potential water sources, and possibilities of tapping, conveying and distributing the available water supplies, possible boundaries of the arable lands that could be developed were delineated at scale 1:25,000 on blown up 1:50,000 scale maps. The resulting project areas including the total gross areas and the estimated net surface areas resulting from subtracting at least 20% of the gross area to account for the irrigation and other needed infrastructure, and unusable land, in hectares, are given in Table 23.

**Table 23 - Potential Development Areas**

Irrigable Area/River Valley	Gross Area (ha)	Net Area (ha)
<b>Coast</b>		
1 Bajo Coclé del Norte	2,760 <sup>(2)</sup>	2,200 <sup>(1)</sup>
2 Costa Platanal – Punta Diego	1,400	900
3 Bajo Miguel de la Borda	3,595	2,220
<b>Sub-total</b>	<b>7,755</b>	<b>5,320</b>
<b>Inland</b>		
4 Miguelito	-	-
5 Caño Sucio at El Cedro	-	-
6 Caño Sucio at Las Maravillas	800	500
7 Curiá	-	-
8 Tulú	740 <sup>(4)</sup>	580 <sup>(3)</sup>
9 San Miguel	1,035 <sup>(6)</sup>	830 <sup>(5)</sup>
10 Lurá	200	160
11 & 13 Tocué and Toabré	750	600
12 Chiguirí	635 <sup>(8)</sup>	500 <sup>(7)</sup>
<b>Sub-total</b>	<b>4,160</b>	<b>3,170</b>
<b>Totals</b>	<b>11,915</b>	<b>8,490</b>

Notes: <sup>(1)</sup> 670 ha in the left bank and 1,530 ha on the right bank; <sup>(2)</sup> 900 ha in the left bank and 1,860 ha on the right bank; <sup>(3)</sup> 260 in the upper area, Tulú Arriba, and 320 ha in the lower area, Tulú Abajo; <sup>(4)</sup> 330 ha in the upper area, Tulú Arriba, and 410 ha in the lower area, Tulú Abajo; <sup>(5)</sup> 380 ha in the upper area, San Miguel Abajo, 210 ha in the middle area, San Miguel, and 240 ha in the lower part, near Santa Ana; <sup>(6)</sup> 475 ha in the upper area, San Miguel Abajo, 260 ha in the middle area, San Miguel, and 300 ha in the lower area, near Santa Ana; <sup>(7)</sup> 280 ha in the upper part, Chiguirí Abajo, and 220 ha in the lower part, Boca de Chiguirí; <sup>(8)</sup> 352 ha in the upper part, Chiguirí Abajo, and 283 ha in the lower part, Boca de Chiguirí.

A general description of the above areas is given in section 5.2

Area 4, in the Río San Miguelito valley, was discarded because of the insufficient available water resources. Area 5, in the Río Caño Sucio valley at El Cedro, was eliminated because of the difficult terrain for conveying and distributing water. Area 7, in the Curiá valley was disregarded in view of its small area and difficult terrain.

## 7.2 Available Flows

Based on available flow records discussed in section 4, the flows available during the low flow season with a reliability of at 80 % of the time, at the streams other than those which flows would be controlled by the proposed storage dam(s), after deducting the minimum flow required for environmental purposes, were estimated to vary from 7 to 8 liters per second per square kilometer.

The estimated low flows available, which could be used for supplying water to the potential irrigated agriculture development areas , are as shown in Table 24.

## 7.3 Water Requirements

The supplemental irrigation water requirements vary according to crops grown, the growing season, the precipitation (rainfall) occurrence, the method of irrigation used and the irrigation efficiencies achieved. Estimated overall irrigation efficiencies overall irrigation efficiencies vary from 50% in the case of surface and flood irrigation to 60 % to 65 % for pressure (sprinkler, drip) systems. Surface irrigation methods require on-farm open channels whereas sprinkler, micro – sprinkler and drip systems or combinations thereof require on farm pressure pipe. All crops can be irrigated by surface methods but not all crops can be irrigated by pressure systems. Water losses are usually lower in the case of pressure systems thus resulting in higher irrigation efficiencies.

Monthly and annual supplemental irrigation water requirements were estimated for 80% rainfall exceedence for the purpose of establishing design flows and for sizing the irrigation facilities and for 50% exceedence to estimate the mean water and energy requirements.

The estimated monthly and annual gross supplemental mean water requirements and the estimated monthly and annual gross supplemental dry year (peak design condition) water requirements for the proposed cropping patterns and the potential development areas are given in tables K-1 through K-12, Attachment 12. These estimates assume a global irrigation efficiency of 50%.

**Table 24 – Estimated Available Flows**

Area	Source of Water	Drainage area km <sup>2</sup>	Approx. Low flow (l/sec)
1 Bajo Coclé del Norte	Coclé del Norte River at El.0	1,600	12,800
2 Costa Platanal–Punta Diego	Platanal, Majagual, Aguacate and Diego Rivers at El.40	60	450
3 Bajo Miguel de la Borda	Miguel de la Borda River at El0 to 10	520	4,200
4 Miguelito <sup>(1)</sup>	-	6	40
5 Caño Sucio at El Cedro <sup>(1)</sup>	-	111	890
6 Caño Sucio at Las Maravillas	Riequito River at El.100	42	300
7 Cuirá <sup>(1)(2)</sup>		4	30
8 Tulú - Upper area	Tulú River at El.140	23	160
8 Tulú - Lower area	Tulú River & Proposed Reservoir at El.100	75	600
9 San Miguel - Upper area	San Miguel River at El.300	32	250
9 San Miguel - Middle area	San Miguel at El.110	40	320
9 San Miguel - Lower area	San Miguel River & Proposed Reservoir at El.100	92	700
10 Lurá	Lurá River at El.120	20	150
11 Tocué	Toabré River at El.110	26	200
12 Chiguirí - Upper area	Chiguirí River at El. 160	50	350
12 Chiguirí - Lower area	Chiguirí River at El.160	54	380
13 Toabré at Paso Real	Toabré River at El.110	174	1,200

*Notes:*

<sup>(1)</sup> Discarded

<sup>(2)</sup> Lower areas would be flooded by proposed reservoir with pool level at El. 100

The total gross annual irrigation supplemental irrigation water demands for the proposed cropping patterns and the potential development areas, in cubic meters per hectare, for an average year (mean) and for a dry year (peak year), are given in Table 25.

**Table 25 – Total Gross Annual Supplemental Irrigation Water Demands**

Valley Area	Supplemental Water Demands (m <sup>3</sup> /ha/yr)	
	Mean Year <sup>(1)</sup>	Design Dry Year <sup>(2)</sup>
1 Bajo Coclé del Norte	nil	424
2 Costa Platanal – Punta Diego	499	2,513
3 Bajo Miguel de la Borda	499	2,513
4 Miguelito <sup>(4)</sup>	1,142	2,841
5 Caño Sucio at El Cedro <sup>(4)</sup>	1,142	2,841
6 Caño Sucio at Las Maravillas	1,142	2,841
7 Curiá <sup>(4)</sup>	1,840	2,928
8 Tulú	1,840	2,928
9 San Miguel	1,840	2,928
10 Lurá	1,840	2,928
11 Tocué <sup>(3)</sup>	3,379	4,212
12 Chiguirí	1,930	3,189
13 Toabré	1,840	2,928

### *Notes:*

<sup>(1)</sup> For 50% exceedence rainfall

<sup>(2)</sup> For 80% exceedence rainfall

<sup>(3)</sup> The water demands for the lower part of the Tocué River valley, near Boca del Tocué and Paso Real, are the same as for the Toaibré River valley.

<sup>(4)</sup> These areas have been discarded.

The peak monthly water demand for the dry year in cubic meters per hectare per month (for the peak month), the corresponding flow rate for the peak month during 24 hours in liters per second per hectare, the peak demand flow rate during an 18 hour irrigation in liters per second per hectare, and the adopted design flow rate in liters per second per hectare, are given in Table 26. The design flow rate shown assumes delivery of water during 18 hours per day. The adopted flow rates were used to size the irrigation systems.

**Table 26 – Peak Monthly Water Demands and Design Flow Rates**

Valley Area	Peak Monthly Water Demands	Design Flow Rates		
	m <sup>3</sup> /month (month) <sup>(3)</sup>	l/s/ha in 24 hrs	l/s/ha in 18 hrs	l/s/ha Adopted
1 Bajo Coclé del Norte	338 (March)	0.13	0.17	0.20
2 Costa Platanal – Punta Diego	1,003 (April)	0.39	0.52	0.50
3.Bajo Miguel de la Borda	1,003 (April)	0.39	0.52	0.50
4 Miguelito <sup>(1)</sup>	1,180 (March)	0.44	0.59	0.60
5 Caño Sucio at El Cedro <sup>(1)</sup>	1,180(March)	0.44	0.59	0.60
6 Caño Sucio at Las Maravillas	1,180 (March)	0.44	0.59	0.60
7 Curiá <sup>(1)</sup>	1,170 (March)	0.44	0.59	0.60
8 Tulú	1,170 (March)	0.44	0.50	0.60
9 San Miguel	1,170 (March)	0.44	0.59	0.60
10 Lurá	1,170 (March)	0.44	0.59	0.60
11 Tucué <sup>(2)</sup>	1,675 (April)	0.65	0.87	0.90
12 Chiguirí	1,244 (March)	0.46	0.61	0.60
13 Toabré	1,170 (March)	0.44	0.59	0.60

Notes:

<sup>(1)</sup> These areas have been discarded

<sup>(2)</sup> The water demands for the lower part of the Tocué river valley near Boca del Tocué and Paso Real, are the same as for the Toabré river valley

<sup>(3)</sup> See Attachment 11

#### 7.4 Irrigation Schemes

For most cases, except Areas 2, 6 and the upper part of Area 9, the water has to be lifted at the main intake by means of a pumping station because of the land position with respect to the probable water source. If pumping was not provided, a gravity intake on the same water source would have to be located further upstream, at a site with considerably smaller available minimum flow, thus rendering such system largely insufficient to meet the peak water demands. Areas 2, 6, and the upper part of Area 9, are the only areas that lend themselves to taking the water from the source by gravity.

For all areas, by assuming an irrigation system operating during 18 hours per day, the hydraulic system would have the capability of pumping water at the intake area during the off-peak hours of the day only, assuming the pumps are driven by electric motors. Each irrigation scheme would consist of one or more main hydraulic systems including a main water intake, a pumping station if required, a main canal, one or more branch canals, canal structures, a water distribution system, between the canals and the farm gates, off-farm drainage and roads, and on-farm irrigation and drainage systems. The principal canal structures include turnouts/off-takes to supply the distribution system, check structures to control water levels and flows along the canals, flow division

structures to distribute the flows between the main canals and a branch or between two branch canals, drop or chute structures in case of a sudden drop in canal water levels, inverted siphon crossings, safety spillways along the canals, waste ways at the lower end of the canals and bridge structures. In some cases, relift pump stations to supply higher areas are also required.

A layout of the main irrigation systems for the 9 retained study areas (1, 2, 3, 6, 8, 9, 10, 11 combined with 13, and 12) was done on 1: 25,000 scale maps, enlargements from the existing 1: 50,000 scale maps. The main system layouts are presented on Exhibits 11 through 28. The typical structures are shown on Exhibits 28 through 38. A brief description of the main systems follows.

**Area 1.** The proposed main irrigation systems for Area 1, the Valle Bajo del Río Coclé del Norte, are shown on Exhibits 11, 12, and 13. The layout consists of three separate irrigation systems, two on the left bank and one on the right bank. The total net irrigable area is 2,200 ha.

The downstream system on the left bank includes one river pumping station (No.1), two branch canals A and B, and one siphon on Branch Canal B. The upstream system on the left bank is a small pumping system consisting of one river pumping station (No.2) and a main canal. This system would be located just downstream of the proposed Coclé del Norte Dam and Reservoir. The system on the right bank consists of one river pumping station (No.3), one main canal, 7 branch canals C, D, E, F, G, H, and I, and 7 siphons. The main characteristics of the system are outlined in Table 27.

**Table 27- Irrigation System Characteristics of Potential Area 1**

Area	Sectors	Net Area (ha)	Max. Flow (l/s)	Pumping Stations		Canal Length (m)	Siphon Length (m)
				Units	Total (kW)		
Area 1.Bajo Coclé del Norte	Main Left Bank Canal No.1	570	120	3	72	250	-----
	Branch Canal A	370	80			5,000	-----
	Branch Canal B	200	40			8,000	250
	Main Left Bank Canal No.2	100	20	3	12	5,000	-----
	Main Right Bank No.1	1,530	340	3	204	6,500	280
	Branch Canal C	180	40			5,670	
	Branch Canal D	780	150			350	1,300
	Branch Canal E	470	100			8,000	350
	Branch Canal F	330	60			4,170	2,900
	Branch Canal G	60	20			2,220	
	Branch Canal H	110	25			830	
	Branch Canal I	210	45			4,160	200

**Area 2.** The proposed main irrigation systems for Area 2, the Costa Platanal – Punta Diego are shown on Exhibits 14 and 15. The layout consists of two separate gravity systems: 1) the Platanal – Majagual – Aguacate System and 2) the Diego – Ciénaga- Cirí System. These systems are formed by diversion weirs and river intakes, main and branch canals and siphons. The total net irrigable area is estimated at 600 ha. The main characteristics of these systems are given in Table 28.

**Table 28 – Irrigation System Characteristics of Potential Area 2**

Systems	Sectors	Net Area ha	Max. Flow (l/s)	Pumping Stations		Canal Length (m)	Siphon Length (m)
				Units	Total (kW)		
Platanal - Majagual - Aguacate System	Main Canal No.1	350	200	----	----	3,500	475
	Branch Canal A	90	100			4,500	
	Branch Canal B	130	120			6,000	
	Branch Canal C	130	120			4,000	
	Main Canal No.2	200	200	----	----	2,000	150
	Branch Canal D	150	150			6,000	
	Main Canal No.3	50	200	----	---	3,000	75
Diego - Ciénaga - Ciri System	Main Canal No.4	120	100	----	----	5,000	
	Branch Canal E	100	100			2,000	
	Main Canal No.5	80	50	----	----	4,000	

**Area 3.** The proposed main irrigation systems for Area 3, the Valle Bajo del Río Miguel de la Borda are shown on Exhibits 16, 17, and 18. The layout consists of 7 separate pumped systems each comprising a pumping station, a main canal, branch canals, and siphons. The total net irrigable area is estimated at 2,220 ha. The main characteristics of these systems are outlined in Table 29.

**Table 29 – Irrigation System Characteristics of Potential Area 3**

Area	Sectors	Net Area (ha)	Max. Flow (l/s)	Pumping Stations		Canal Length (m)	Siphon Length (m)
				Units	Total (kW)		
Área 3. Bajo Miguel de la Borda	Main Canal No.1	120	60	3	18	5,000	250
	Main Canal No.2	480	240	3	144	-	-
	Branch Canal A	280	140			6,000	500
	Branch Canal B	200	100			3,000	1,000
	Branch Canal C	100	50			1,500	-
	Main Canal No.3	280	140	3	82	4,000	250
	Branch Canal D	160	80			3,500	600
	Main Canal No.4	800	400	3	210	10,500	390
	Pump Station No.5	280	140	3	63	-	-
	Main Canal No.5	200	100			4,000	-
	Branch Canal E	80	40			2,500	
	Pump Station No.6	200	100	3	45	-	-
	Main Canal No.6	120	60			3,000	-
	Branch Canal F	80	40			2,000	-
	Branch Canal G	60	30			1,200	80
	Main Canal No.7	60	30	3	13.5	2,000	-

**Area 6.** The proposed main irrigation system for area 6, the Valle del Río Caño Sucio at Las Maravilla, is shown on Exhibit 19. It is a gravity system. The layout consists of two diversion weirs and river intakes, a gravity canal and a siphon. The total net irrigable area is estimated at 500 ha. The main characteristics of the system are outlined in Table 30.

**Table 30 – Irrigation System Characteristics of Potential Area 6**

Irrigable Area/ River Valley	Sectors	Net Area (ha)	Max. Flow (l/s)	Pumping Stations		Canal Length (m)	Siphon Length (m)
				Units	Total (kW)		
Area 6. Caño Sucio at Las Maravillas	Main Canal	500	300	-	-	8,000	100
	Diversion Canal	-	50	-	-	1,000	-

**Area 8.** The proposed main irrigation system for Area 8, the Valle del Río Tulú, is shown on Exhibits 20 and 21. The development comprises an upper area with a pumped system on the right bank of the Tulú river, in the vicinity of Tulú Arriba, and a lower area with two pumped systems, one on the left bank and one on the right bank of the Tulú river in

the vicinity of Tulú Abajo and just upstream of the propose reservoir at El. 100. The upper system includes a pumping station, a second pumping (relift) station, and canals. Both of the lower systems include a pumping station and canals; in addition, the left bank system has two siphons.

The total net irrigable area is estimated at 580 hectares: 260 hectares in the upper area and 320 hectares in the lower area. The main characteristics of the systems are outlined in Table 31.

**Table 31 – Irrigation System Characteristics of Potential Area 8**

Area	Sectors	Net Area (ha)	Max. Flow (l/s)	Pumping Stations		Canal Length (m)	Siphon Length (m)
				Units	Total (kW)		
<b>Area 8 - Tulú – Upper Area</b>	Main Canal	260	160	3	50	2,000	-
	Branch Canal No1	180	110	3	100	6,500	-
<b>Area 8 - Tulú – Lower Area</b>	Main Canal No1	320	140	3	84	4,500	-
	Branch Canal No1	90	40			3,500	-
	Branch Canal No2	60	40			2,000	-
	Main Canal No.2	80	50	3	30	4,000	-

**Area 9.** The proposed main irrigation system for area 9, the Valle del Río San Miguel, is shown on Exhibits 22, 23 and 24. The proposed development includes 3 areas: 1) an upper area, in the vicinity of San Miguel Abajo, 2) a middle area in the neighborhood of San Miguel, and 3) a lower area at Santa Ana. The total net irrigable area is estimated at 830 ha.

The upper area (Exhibit 24) is a gravity system consisting of a weir on the San Miguel river with a double intake (one on each bank), main canal on the left and right banks, siphons on the left bank canal and a chute on the right bank canal. The total net irrigable area is estimated at 380 ha.

The middle area (Exhibit 23) is a pumped system on the left bank of the San Miguel river and consists of a pumping station and 2 branch canals originating from a flow division structure at the upper end of the penstock. One of the canals has a short siphon. The total net irrigable area is estimated at 210 ha.

The lower area (Exhibit 22) comprises two pumped systems, the first one on the right bank of the Obré river, a right tributary of the San Miguel and the second one on the right bank of the San Miguel river. Both systems consist of a pumping station and two branch canals stemming from a flow division struture located at the upper end of the penstock. These systems are located immediately upstream of the proposed reservoir situated at El. 100. The total net irrigable area is estimated at 240 ha.

The main characteristics of the proposed systems are given in Table 32.

**Table 32 – Irrigation Systems Characteristics of Potential Area 9**

Area	Sectors	Net Area (ha)	Max. Flow (l/s)	Pumping Stations		Canal Length (m)	Siphon Length (m)
				Units	Total (kW)		
<b>Area 9 San Miguel – Upper Area</b>	Main Left Bank Canal	230	150	-	-	7,000	600
	Main Right Bank Canal	150	100	-	-	6,500	-
<b>Area 9 San Miguel – Middle Area</b>	Main Canal	210	120	3	90	-	-
	Branch Canal A	105	60	-	-	7,200	150
	Branch Canal B	105	60	-	-	4,600	-
<b>Area 9 San Miguel – Lower Area</b>	Main Right Bank Canal	90	70	3	42	-	-
	Branch Canal No.1	34	30			1,500	-
	Branch Canal No.2	56	40			3,000	-
	Main Left Bank Canal	150	90	3	54	-	-
	Branch Canal N.3	50	30			1,500	-
	Branch Canal No.4	100	60			2,000	-

**Area 10.** The proposed main irrigation system for area 10, the Valle del Río Lurá, is shown on Exhibit 25. The layout consists of a pumping station and a main canal on the right bank of the Río Lurá shortly upstream of Boca de Lurá. The net irrigable area is estimated at 160 ha.

The main characteristics of the proposed system are given in Table 33.

**Table 33 – Irrigation System Characteristics of Potential Area 10**

Irrigable Area/ River Valley	Sectors	Net Area (ha)	Max. Flow (l/s)	Pumping Stations		Canal Length (m)	Siphon Length (m)
				Units	Total (kW)		
Area 10. Lurá	Main Canal	160	100	3	60	4,000	-

**Areas 11 and 13.** The proposed main irrigation system for areas 11 and 13, the Valles de los Ríos Tucué and Toabré is shown on Exhibit 26. The layout consists of two pumped systems on both banks of the Toabré river. Both systems comprise a pumping station and main canals. The system on the right bank also has a branch canal with the main and the branch originating at a flow division structure located at the upper end of the penstock. Both main canals on the left bank system also start at a similarly situated flow division structure. In addition, the left bank system includes a siphon. The net irrigable area is estimated at 600 hectares. The main characteristics of the proposed systems are summarized in Table 34.

**Table 34 – Irrigation System Characteristics of Potential Areas 11 and 13**

Area	Sectors	Net Area (ha)	Max. Flow (l/s)	Pumping Stations		Canal Length (m)	Siphon Length (m)
				Units	Total (kW)		
Areas 11 & 13 Tucué & Toabré	Main Left Bank Canal	520	310	3	232.5	-	-
	Main Canal No.1	420	250			8,500	-
	Main Canal No.3	100	60			2,300	300
	Main Right Bank Canal	80	60	3	45	-	-
	Main Canal No.2	40	30			1,700	-
	Branch Canal	40	30			1500	-

**Area 12.** The proposed main irrigation system for Area 12, the Valle del Río Chiguirí, is shown on Exhibits 27 and 28. The proposed development comprises two areas: 1) an upper area in the vicinity of Chiriguí Abajo; and, 2) a lower area in the neighborhood of Boca de Chiguirí. The total irrigable area is estimated at 500 ha.

The upper area development (see Exhibit 28) would comprise 2 pumped water systems, located in the left and right banks of the Chiguirí river. The layout of the left bank system includes a pumping station, a main canal and a siphon. The right bank scheme consists of a pumping station, a main canal and a branch canal. The canals originate at a flow division structure situated at the top of the penstock. The net irrigable area is estimated at 280 hectares.

The lower area development (Exhibit 27) would consist of a pumping scheme on the left bank of the Larguillo (Chiguirí ) river . The layout would consist of a pumping station, a main canal and a branch canal. These canals would originate at a flow division structure at the top of the penstock. The net irrigable area is estimated at 220 hectares. The main characteristics of the proposed systems are given on Table 35.

**Table 35 – Irrigation System Characteristics of Potential Area 12**

Area	Sectors	Net Area (ha)	Max Flow (l/s)	Pumping Stations		Canal Length (m)	Siphon Length (m)
				Units	Total (kW)		
Area 12 Chiguirí – Upper Area	Main Canal No1	160	100	3	60	6,550	450
	Pumping Sta. No2	120	80	3	48	-	-
	Main Canal No.2	70	50			2,000	-
	Branch Canal	50	30			2,500	-
Area 12 Chiguirí – Lower Area	Pumping Sta. No1	220	150	3	90	-	-
	Main Canal	180	120	-	-	6,300	-
		40	30	-	-	1,500	-

### 7.5 Construction Cost Estimates

Based on the proposed developments and the water requirements for irrigation the primary conveyance systems including pumping stations, primary canals, siphons and hydraulic structures were sized. For each irrigation sector, a cost estimate was developed for the primary conveyance system. Typical canal sections, pumping stations, and structures, as shown on Exhibits 29 through 38 were used to estimate quantities. Details of the cost estimates are presented in Attachment 13. Table 36 below shows a summary of the development cost for each potential area.

**Table 36 – Construction Cost Estimate (\$,000)**

Potential Area/ River Valley	Net Area (ha)	Primary Conveyance Cost	Off-Farm System Cost	On-Farm System Cost	Cont. (25%)	Eng. & Adm. (10%)	Total Constr. Cost
1.Bajo Coclé del Norte	2,200	6,373	4,043	3,465	3,470	1,735	19,086
2. Costa Platanal – Punta Diego	900	5,397	1,654	1,418	2,117	1,059	11,644
3.Bajo Miguel de La Borda	2,220	7,390	4,079	3,497	3,742	1,871	20,579
6. Caño Sucio at Las Maravillas	500	1,244	919	788	738	369	4,057
8. Tulú	580	3,273	1,066	914	1,313	657	7,222
9. SanMiguel	830	4,227	1,522	1,304	1,763	882	9,698
10. Lurá	160	603	294	252	287	144	1,580
11 & 13 Tucué & Toabré	600	2,196	1,103	945	1,061	531	5,835
12. Chiguirí	500	2,547	919	788	1,063	532	5,849

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## 7.6 Operation and Maintenance Cost Estimates

The operation and maintenance (O&M) cost have been estimated on an annual basis as a percentage of the construction cost as follows:

- Primary Conveyance System:
  - Civil Works: 0.5%
  - Mechanical and Electrical: 4.0%
  - Energy Cost: \$0.07/KWh
- Distribution (Secondary and Tertiary), Drainage and Roads:
  - Total Cost: 1.5%
- On-Farm Irrigation:
  - Total Cost: 2.0%

For each of the potential area, the annual energy requirements for the off-farm system (main pump station) have been calculated on the basis of the water demand in an average year in terms of precipitation. These energy requirements are shown on Table 37 below. The on-farm energy requirements were not included as it is assumed for the purpose of this report that the on-farm irrigation systems will be designed as gravity systems. This does not exclude the possibility of switching to pressure irrigation in the future.

**Table 37 – Average Annual Energy Requirements**

Potential Area	Primary Conveyance Energy Requirement (KWh/yr)	Annual Cost (\$)
Area 1 – Bajo Coclé del Norte	Nil	Nil
Area 2 – Costa Patanal – Punta Diego	Nil	Nil
Area 3 – Bajo Miguel de la Borda	160,500	\$11,200
Area 6 – Caño Sucio at Las Maravillas	Nil	Nil
Area 8 – Tulu	209,300	\$14,700
Area 9 – San Miguel	152,400	\$10,700
Area 10 – Lurá	48,800	\$3,400
Area 11 & 13 – Tucué & Toabré	222,500	\$15,600
Area 12 – Chiguirí	160,300	\$11,200

The total annual O&M cost are presented in Table 38 below.

Category	Area	Construction Cost (\$)	Annual Energy Requirement (KWh/yr)	Annual Cost (\$)
1	Area 1 – Bajo Coclé del Norte	Nil	Nil	Nil
2	Area 2 – Costa Patanal – Punta Diego	Nil	Nil	Nil
3	Area 3 – Bajo Miguel de la Borda	160,500	160,500	\$11,200
4	Area 6 – Caño Sucio at Las Maravillas	Nil	Nil	Nil
5	Area 8 – Tulu	209,300	209,300	\$14,700
6	Area 9 – San Miguel	152,400	152,400	\$10,700
7	Area 10 – Lurá	48,800	48,800	\$3,400
8	Area 11 & 13 – Tucué & Toabré	222,500	222,500	\$15,600
9	Area 12 – Chiguirí	160,300	160,300	\$11,200

**Table 38 – Annual Operation and Maintenance Cost Estimates (US\$)**

Potential Area	Primary Conveyance	Off-Farm Distribution	On-Farm System	Total
Area 1 – Bajo Coclé del Norte	72,500	83,400	95,300	251,200
Area 2 – Costa Patanal – Punta Diego	37,100	34,100	39,000	110,200
Area 3 – Bajo Miguel de la Borda	131,000	84,100	96,200	311,300
Area 6 – Caño Sucio at Las Maravillas	8,600	19,000	21,700	49,300
Area 8 – Tulu	69,700	22,000	25,100	116,800
Area 9 – San Miguel	65,400	31,400	35,900	132,700
Area 10 – Lurá	15,700	6,100	6,900	28,700
Area 11 & 13 – Tucué & Toabré	54,700	22,700	26,000	103,400
Area 12 – Chiguirí	53,900	19,000	21,600	94,500

### 7.7 Estimated Agricultural Net Benefits

Based on the cropping pattern options for each area and the estimated net benefits per hectare (Attachment 12), the average net benefits for each potential area were calculated and are presented in Table 39 below. For each area, the construction cost, annual O&M costs and annual net benefits are summarized in Table 40.

**Table 39 – Estimated Net Benefits**

Potential Area	Net Area	Net Benefit (US\$/yr)
Area 1 – Bajo Coclé del Norte	2,200	1,842,200
Area 2 – Costa Patanal – Punta Diego	900	753,600
Area 3 – Bajo Miguel de la Borda	2,220	1,859,000
Area 6 – Caño Sucio at Las Maravillas	500	520,900
Area 8 – Tulu	580	604,200
Area 9 – San Miguel	830	864,600
Area 10 – Lurá	160	166,700
Area 11 & 13 – Tucué & Toabré	600	625,000
Area 12 – Chiguirí	500	520,900

For the purpose of comparing the potential areas, an internal rate of return has also been calculated for each area. In general, the construction period of the developments has been estimated on the basis of approximately 500 hectares per year. The net benefits have been assumed to grow progressively from 50% for the first year of production to 75% the second year and 100% thereafter. It should be noted that the costs of development

exclude the construction cost of any major dams (Coclé del Norte and Caño Sucio) and auxiliary structures as well as the cost of land acquisition for the potential irrigated areas.

**Table 40 – Internal Rate of Return for Potential Areas**

Potential Area	Construction Cost	O&M Cost	Net Benefit	Internal Rate of Return
Area 1 – Bajo Coclé del Norte	19,086,000	251,200	1,842,200	7.6%
Area 2 – Costa Patanal – Punta Diego	11,644,000	110,200	753,600	4.8%
Area 3 – Bajo Miguel de la Borda	20,579,000	311,300	1,859,000	6.8%
Area 6 – Caño Sucio at Las Maravillas	4,057,000	49,300	520,900	10.7%
Area 8 – Tulu	7,222,000	116,800	604,200	6.0%
Area 9 – San Miguel	9,698,000	132,700	864,600	6.8%
Area 10 – Lurá	1,580,000	28,700	166,700	8.0%
Area 11 & 13 – Tucué & Toabré	5,835,000	103,400	625,000	8.2%
Area 12 – Chiguirí	5,849,000	94,500	520,900	6.6%

The population that will benefit from the productive activities in the project area is currently, the 7,300 people that inhabit the districts (Corregimientos) located within the project area. The planned agricultural activity will require approximately 617,200 man-days per year which means that the implementation of the project will generate approximately 2,200 jobs for the people that will be directly involved in the farming activities. In addition, many more people that will be part of the agricultural and food activities such as agro-commercialization, transportation, etc., will benefit indirectly from the project.

need only and makes it easy to maintain its water infrastructure. It is being considered to use the existing irrigation system to serve the new areas and agricultural plots. The total irrigation system will have a capacity of 1,000 ha and will be able to irrigate 600 ha directly, 300 ha in the Coclé River basin and 100 ha in the Caño Sucio River basin. The irrigation system will be implemented in two phases and follow the following schedule:

## 8 TECHNICAL ASSISTANCE AND TECHNOLOGY TRANSFER

A program of technical assistance, training and technology transfer to the farmers would benefit the human resources available and increase the chance of success in accomplishing the productive activities planned for the development of the agricultural and irrigation potential in the study area.

The program objectives would be to promote the farm management, increase productivity levels, reduce production costs, adopt new and improved technologies and modernize the existing agriculture, agro-forestry and livestock activities, which are the principal economic activities in the project area. The present model used in research and technology transfer is based on improving the offer of technical know-how to the farmers by means of technical assistance and training.

A great responsibility will be imposed on the technical personnel that will implement such program, considering the limitations of the farmers in the project area. The implementation of the technical assistance should consider the adoption of valid technologies by the farmers considering their needs and possibilities, the site conditions and the farmers' organization. The extensionists should establish priorities and give recommendations for the solutions of the main technological issues/problems regarding the farming, agro-forestry and livestock activities. The results of the various methods and actions should be evaluated in order to improve learning based on actual experience. The training and technology transfer should be designed and implemented as part of and to supplement the overall strategy.

The farmers that will benefit from the program should be selected carefully, so as to accept those who appear to be the most likely to benefit from the program. An executing agency could be established in a major nearby town such as Penonomé. The ACP activities related to agricultural and irrigation development should be coordinated with related activities by other government agencies such as the Ministry of Agricultural Development (MIDA), Ministry of Public Health, Ministry of Education, Ministry of Public Works, Autoridad Nacional del Ambiente, Instituto de Investigaciones Agropecuarias.

The estimated requirements of technical and administrative personnel are given in Table 41. A 10 - year budget estimate is given in Table 42.

**Table 41 – Estimated Personnel Requirements**

Description	Quantity	Monthly Salary US\$	Annual Cost <sup>(1)</sup> US\$
Chief Engineer	1	\$1,000	\$15,000
Eng. Agronomist	6	\$800	\$72,000
Forestry Engineer	2	\$800	\$24,000
Livestock Veterinarian	3	\$800	\$36,000
Sociologist	4	\$600	\$36,000
Secretary	1	\$450	\$6,750
Accountant	1	\$450	\$6,750
Book keeper	1	\$400	\$6,000
Store keeper	1	\$500	\$7,500
Clerk	1	\$350	\$5,250
Watchman	2	\$350	\$10,500
<b>Totals</b>			<b>\$225,750</b>

<sup>(1)</sup> The annual costs include a 25% allowance for social benefits.

**Table 42 – Ten-year budget estimate for Technical Assistance (US\$ ,000)**

Description	Years									
	1	2	3	4	5	6	7	8	9	10
Personnel	226	226	226	226	226	226	226	226	226	226
Office Supplies and Materials	100	100	100	100	100	100	100	100	100	100
Mobilization Expenses (Per diem, subsistence, etc)	88	88	88	88	88	88	88	88	88	88
Vehicles (16) (all-terrain, 4wd)	480	0	0	0	0	0	0	0	0	0
Fuel and lubricants	17	17	17	17	17	17	17	17	17	17
Vehicle maintenance and Repairs	20	20	30	50	50	50	50	50	50	50
Utilities (electricity, water, Telecommunications)	2	2	2	2	2	2	2	2	2	2
Miscellaneous (10%)	93	45	46	48	48	48	48	48	48	48
<b>Totals</b>	<b>1,026</b>	<b>498</b>	<b>509</b>	<b>531</b>	531	531	531	531	531	531

## 9 PROPOSED ROAD DEVELOPMENT PROGRAM

The study area lacks a suitable system of roads that would allow commercialization of the agriculture products. Only part of the southern part of the Río Coclé del Norte basin, in the headwaters of the Toabré River, and part of the nearby Chiguirí, San Miguel, Tulú, Lurá and Tocué Rivers have roads; these are mostly dry weather roads. Access along the coastal areas and inland along navigable rivers is by boat.

In order to provide an improved access to the potential irrigable areas, a scheme of new, rehabilitated and improved roads is proposed. The existing and proposed roads are shown on Exhibit 1. The existing and proposed roads in the Río Indio basin are shown on the same exhibit. It is assumed that the development in the Río Indio valley, including road construction, will precede work in the Río Coclé del Norte study area.

In order to estimate the order of magnitude of the cost involved in road improvement, rehabilitation and new construction, three levels of costs were assumed:

1. New all weather road, with gravel roadway, base and side berms, similar to the service roads proposed along the irrigation canals (Exhibits 29 and 30), including drainage and related structures (culverts, short bridge crossings, side drains). Estimated cost per kilometer of road: \$100,000.
2. Upgrading existing dry weather earth roads, including base, gravel surfacing, side berms, drainage and related structures (culverts, short bridge crossings, side drains). Estimated cost per kilometer: \$60,000.
3. Rehabilitation of existing gravel surface roads, including rehabilitation of base, gravel surface, berms, drainage. It assumes no rehabilitation of existing structures or construction of new structures is necessary. Estimated cost per kilometer: \$40,000.

The proposed overhaul scope is presented in Table 43; it would consist of the construction of 76 kilometers of new all weather road, the upgrading of 42 kilometers of dry weather road, and the rehabilitation of 33 kilometers of existing gravel roads.

**Table 43 – Proposed Road Development Program**

Description	Unit Price (US\$/km)	Approx. Quantity (km)	Cost (US\$)
<b>Inland Areas:</b>			
Upgrade existing dry weather earth road from 2 km West of Las Minas to Tulú Centro	\$60,000	15	\$900,000
Upgrade existing dry weather earth road from Boca de Chiguirí to Valle de San Miguel	\$60,000	12	\$720,000
Rehabilitate existing grave surface roads:			
• From Caimito to Chiguirí Arriba: 8 km			
• From Tambo to Boca de Tocué: 12 km	\$40,000	33	\$1,320,000
• From Sabana Larga to Boca de Chiguirí: 3 km			
• From Sabana Larga to San Pedro: 10 km			
Construct new roads:			
• From Tulú Centro to Boca de Cuirá: 8 km	\$100,000	26	\$2,600,000
• From Boca de Tocué to Lurá Centro: 6 km			
• From San Pedro to San Miguel Centro: 10 km			
• From Alto San Miguel to Santa Ana: 2 km			
<b>Coastal Areas:</b>			
Upgrade existing dry weather earth road from Mouth of Río Indio to Miguel de la Borda	60,000	15	\$900,000
Construct new coastal road from Miguel de la Borda to Coclé del Norte	100,000	35	\$3,500,000
Construct new inland roads:			
• From Las Marias to Alto Rieci: 12 km			
• Left Bank Río Coclé del Norte: 5 km			
• Inland, along right bank of Miguel de la Borda river: 18 km	100,000	50	\$5,000,000
• Several spur roads inland along Platanal – Punta Diego costal plain: 15 km			
<b>Subtotal</b>			<b>\$14,940,000</b>
Contingencies (25%)			\$3,735,000
<b>Subtotal</b>			<b>\$18,675,000</b>
Engineering and Administration (10%)			\$1,867,500
<b>TOTAL</b>			<b>\$20,542,500</b>

## 10 DEVELOPMENT POWER SUPPLY

Area 1 This area, located near the Río Coclé del Norte, between the dam and the mouth of the river, will require three pumping stations with installed capacity of 12 kW, 72 kW and 204 kW respectively. Power will be supplied from the anticipated power plant located at the toe of the dam. Approximately 12 km of transmission line will be required for that purpose. An estimated cost for the power supply of this area is shown in Table 44 below.

Area 2 The water supply for this irrigation project will consist of small diversion dams and a system of gravity fed canals; no electrical power is necessary for this area.

Area 3 This coastal area may be too remote from the dam site to be connected via transmission lines, if only a small power plant is built at the toe of the dam, as the area is located approximately 30 kilometers from the mouth of the Río Coclé del Norte. If a larger power plant were to be built at the toe of the dam, with a 115-kV transmission line connecting to the La Chorrera substation, it is likely that populated areas such as Miguel de la Borda would be connected to the National Grid, through a local substation, and so would the proposed irrigation system.

The area will require seven pumping stations, ranging in size from 15 kW to 210 kW. Approximately 13 kilometers of transmission line will be required to connect the pumps to a central location in Miguel de la Borda. This location could be either a connection to a larger electrical system, such as the National Grid or a diesel power plant with a capacity of approximately 0.75 MW. The estimated cost for the power supply of this area shown in Table 44 below includes the cost of a diesel generator.

Area 6 The water supply for this irrigation project will consist of small diversion dams and a system of gravity fed canals; no electrical power is necessary for this area.

Area 8 The area will require four pumping stations, ranging in size from 30 kW to 100 kW. Approximately 7 kilometers of transmission line will be required to connect the pumps to a centrally located 300-kW diesel generator in the village of Tulú Centro. An estimated cost for the power supply of this area is shown in Table 44 below.

Area 9 Each of the two lower areas will be provided with a diesel generator. The irrigation area near the Río Obré will require two pumping stations, 42 kW and 54 kW respectively; the 120-kW generator will be located in the village of Santa Ana and a one kilometer long transmission line will connect the two pumps. The irrigation area on the left bank of the Río San Miguel will be provided with a 90-kW pumping station and a 120-kW diesel generator. An estimated cost for the power supply of this area is shown in Table 44 below.

The water supply for the irrigation area in the upper Río San Miguel valley will consist of a small diversion dam and a system of gravity fed canals; no electrical power is necessary for that area.

Area 10 A single 60-kW pumping station that will be provided with a diesel generator will feed the area. An estimated cost for the power supply of this area is shown in Table 44 below.

Areas 11 and 13 These areas will require two pumping stations, 45 kW and 233 kW respectively; they will be connected to a centrally located 320-kW diesel generator in the village of El Valencio. An estimated cost for the power supply of this area is shown in Table 44 below.

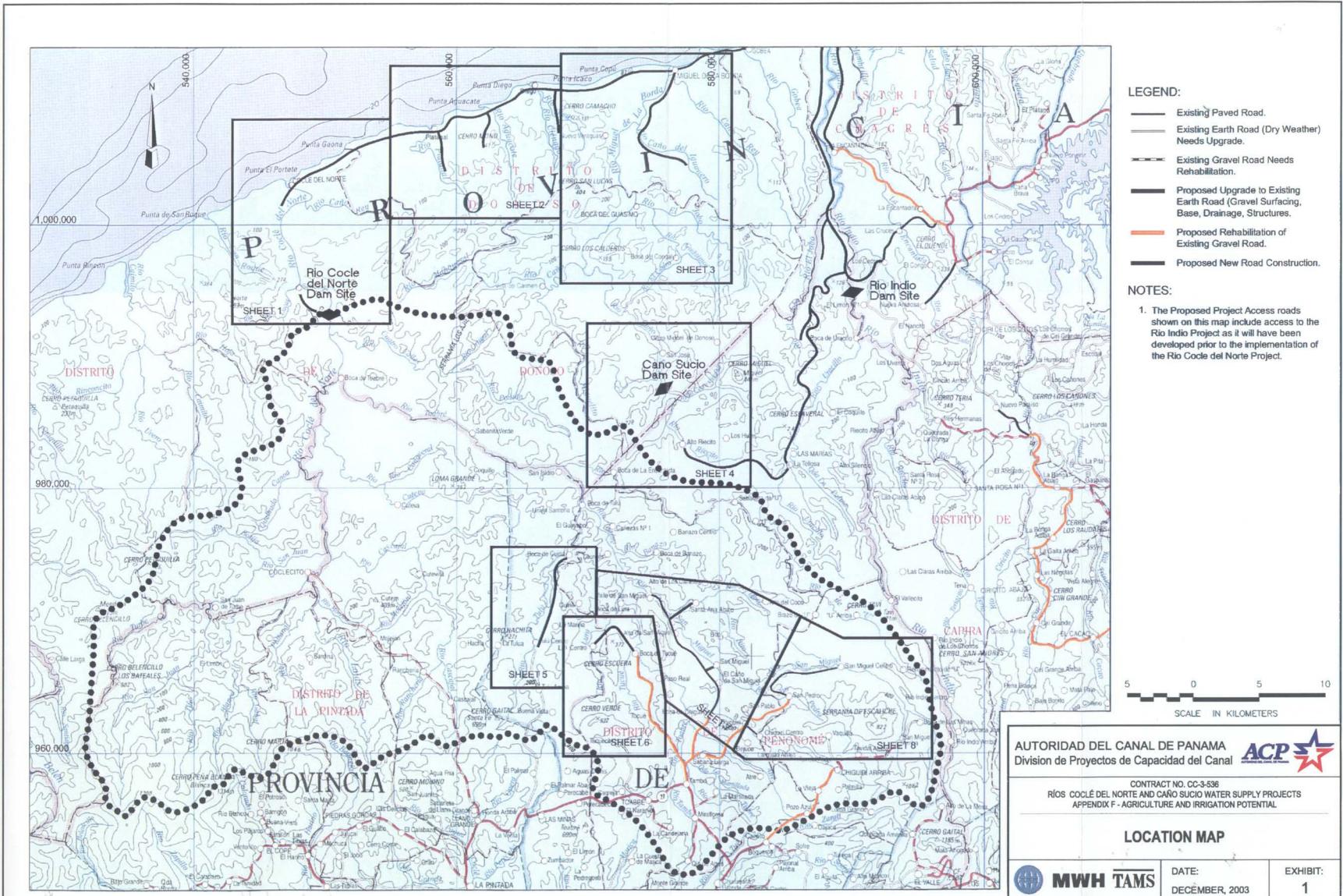
Area 12 The area will require three pumping stations, ranging in size from 48 kW to 90 kW. Approximately 3.5 kilometers of transmission line will be required to connect the pumps to a centrally located 250-kW diesel generator in the village of Chiquirí Abajo. An estimated cost for the power supply of this area is shown in Table 44 below.

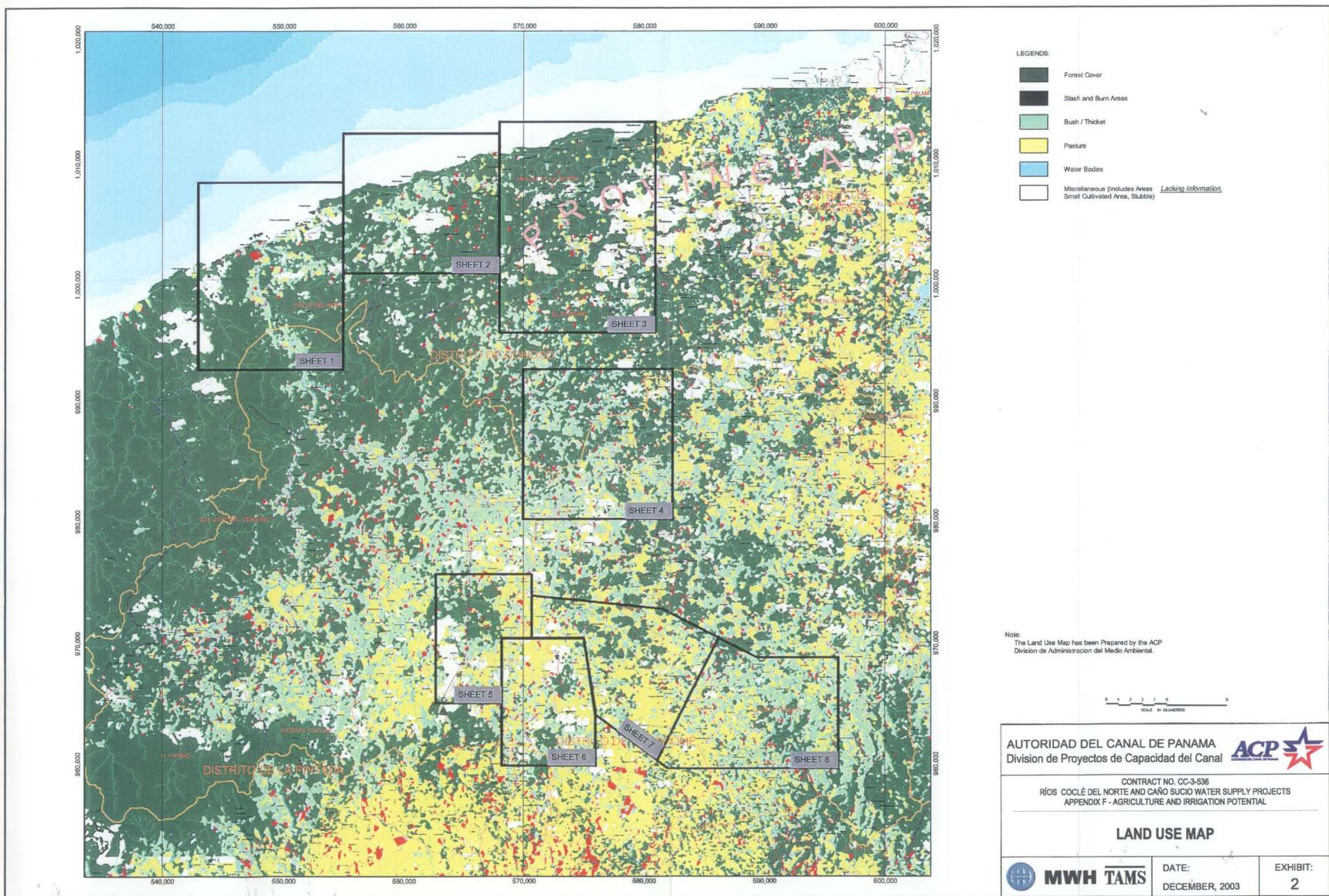
The total cost associated with power supply for irrigation development is estimated to be \$1,030,000. Table 44 below provides a breakdown of the cost allocation for each area if all the areas are developed.

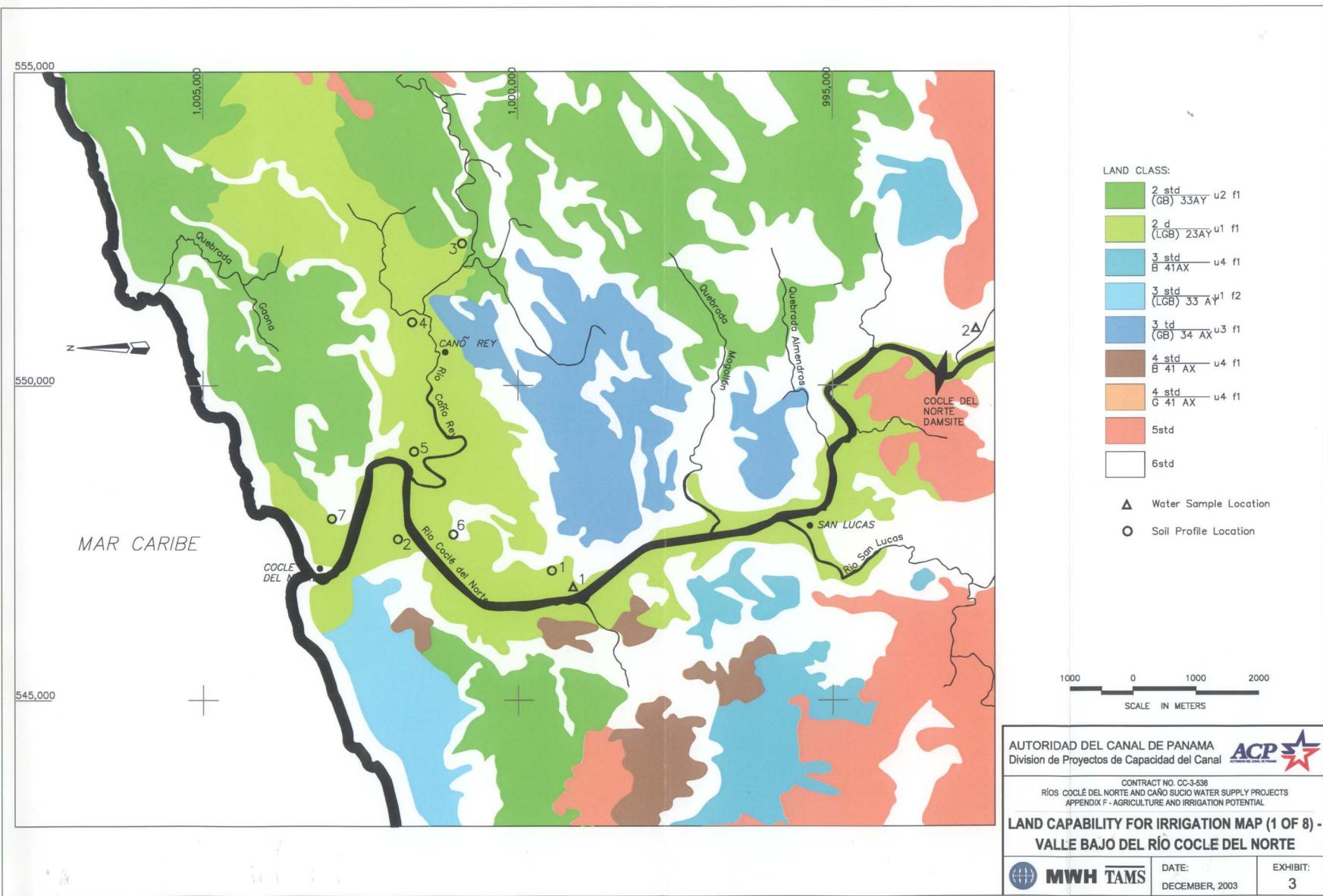
**Table 44 – Power Supply Costs**

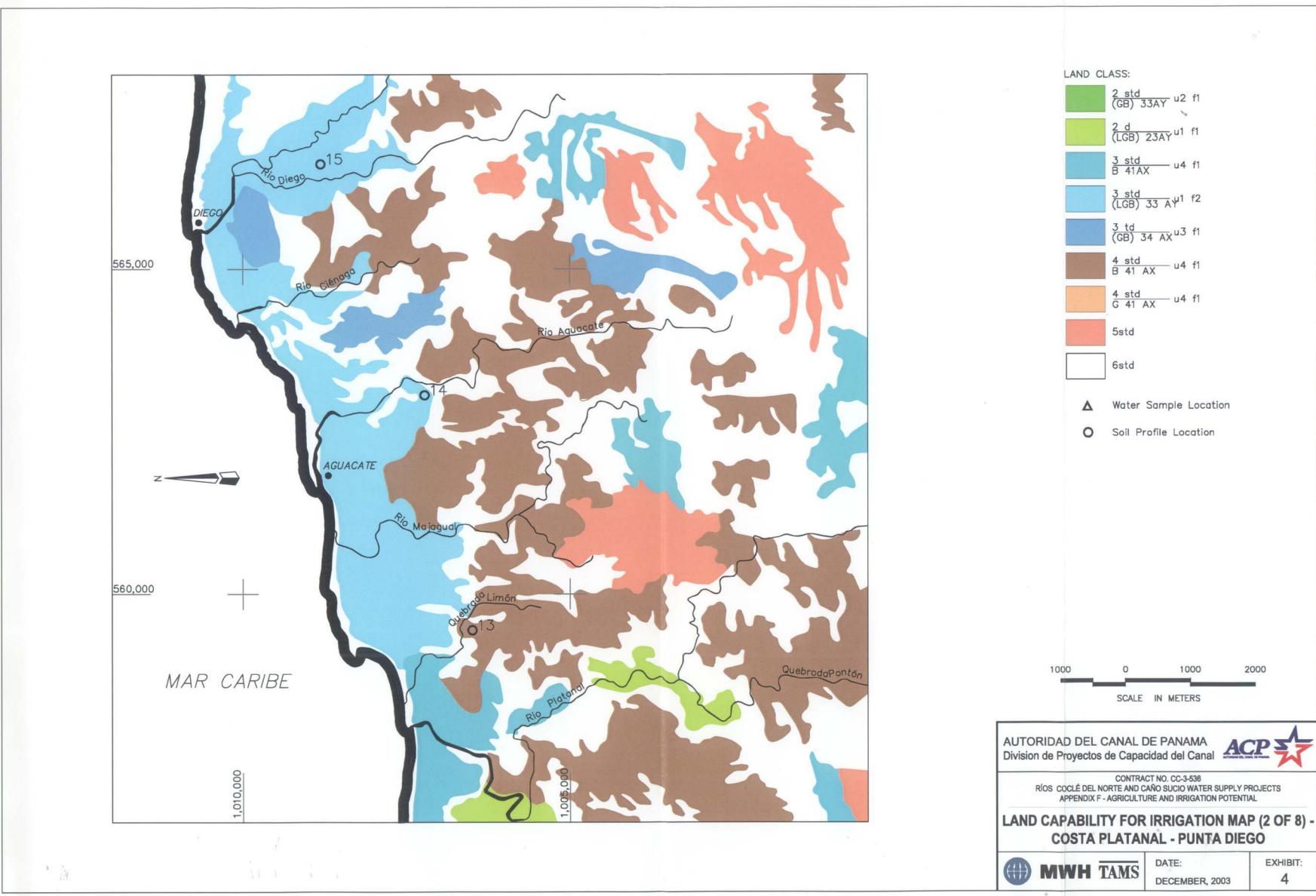
Potential Area	Estimated Electrical Power Supply Cost	Observation
Area 1	\$60,000	Transmission Line
Area 2	-	No power required
Area 3	\$310,000	750-kW Generator and Transmission Line
Area 6	-	No power required
Area 8	\$180,000	300-kW Generator and Transmission Line
Area 9	\$145,000	2 120-kW Generators and Transmission Line
Area 10	\$45,000	80-kW Generator
Areas 11 & 13	\$150,000	320-kW Generator
Area 12	\$140,000	250-kW Generator and Transmission Line

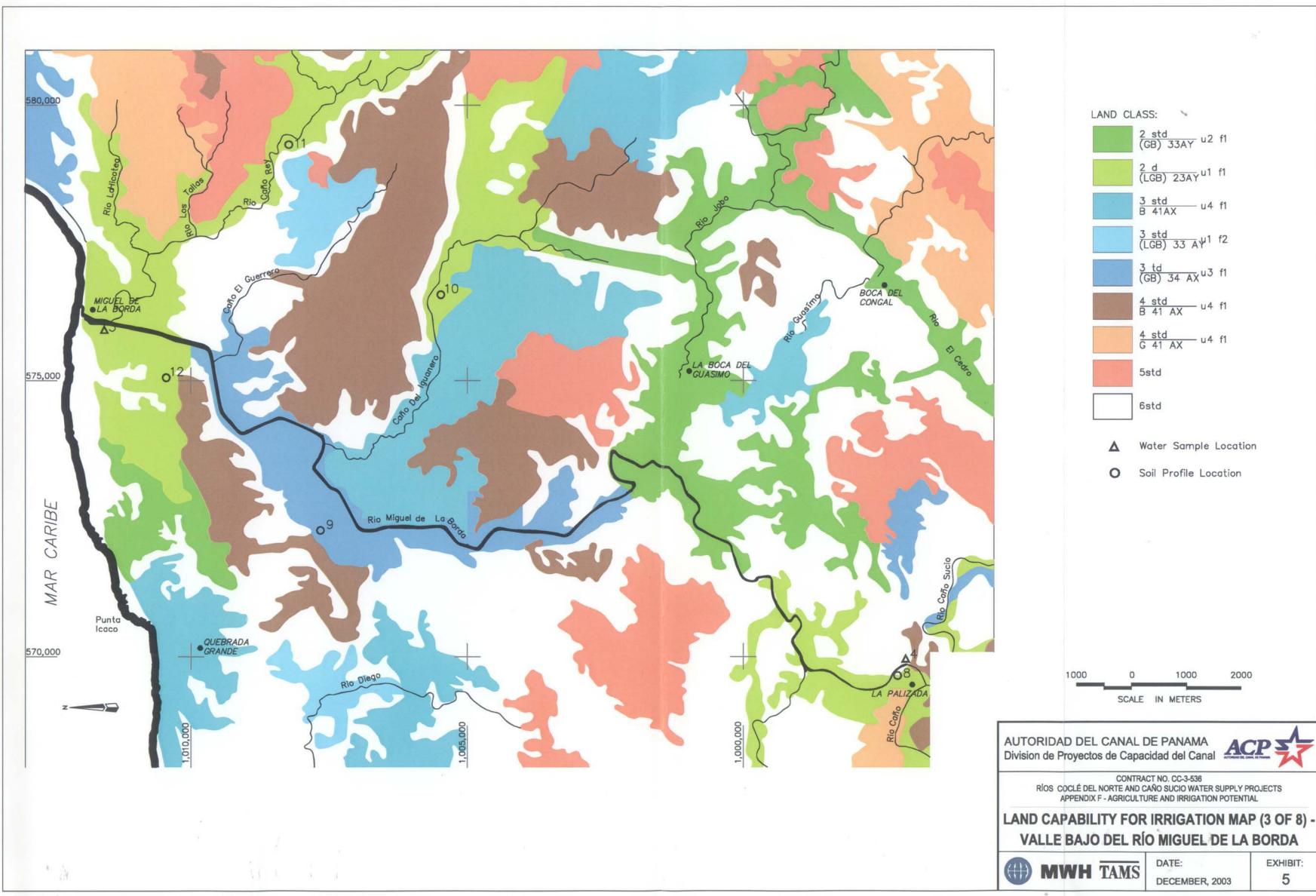
## **EXHIBITS**

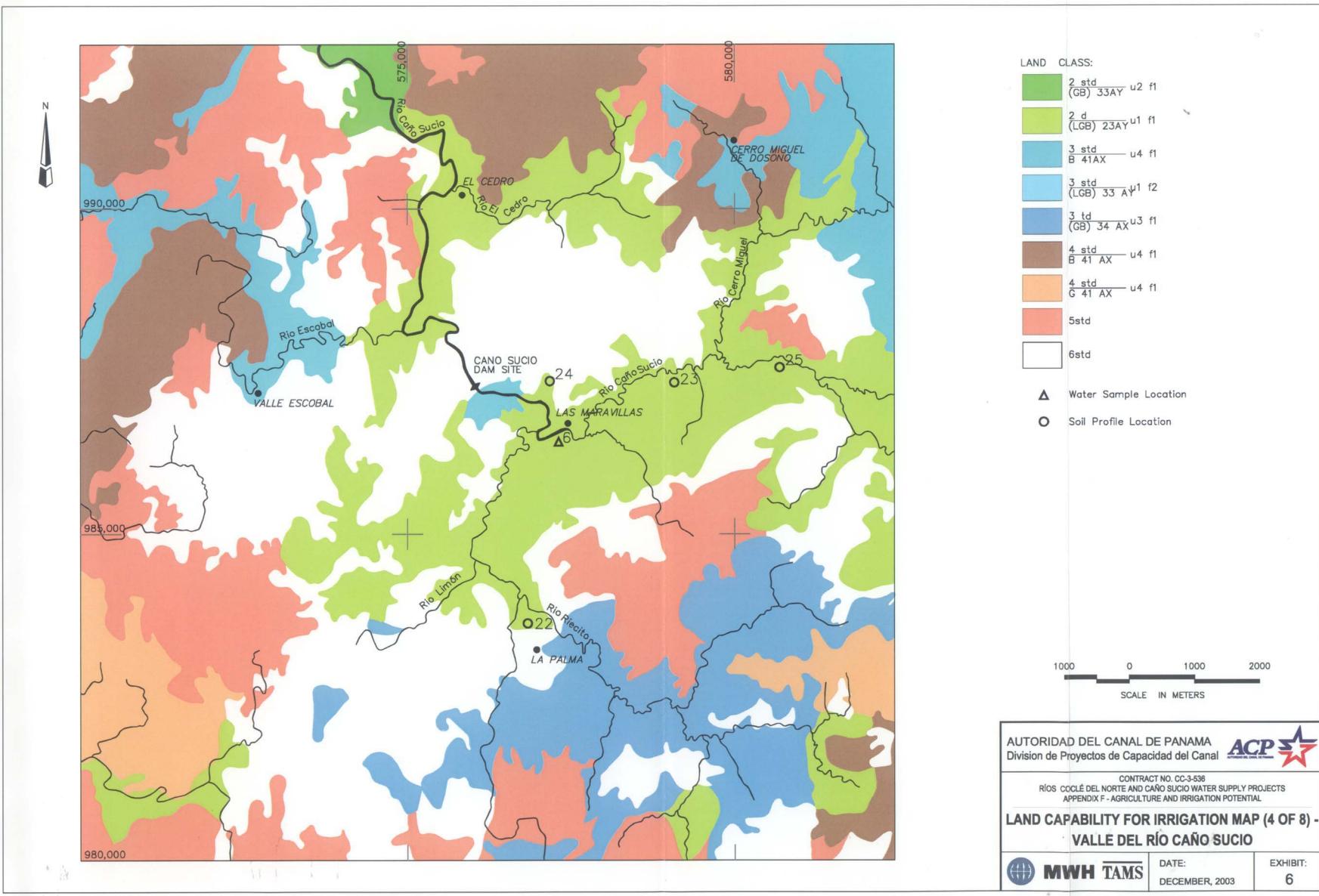


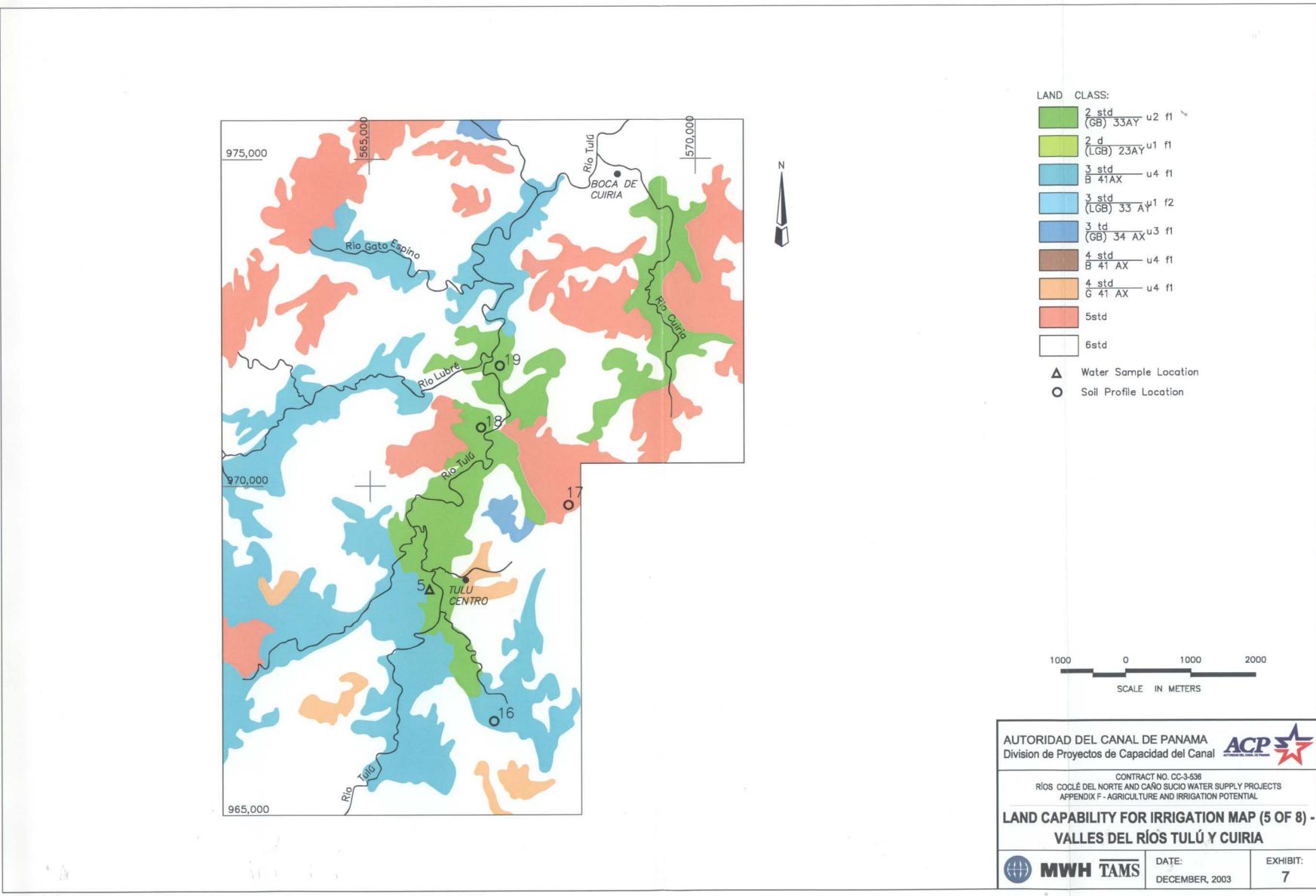


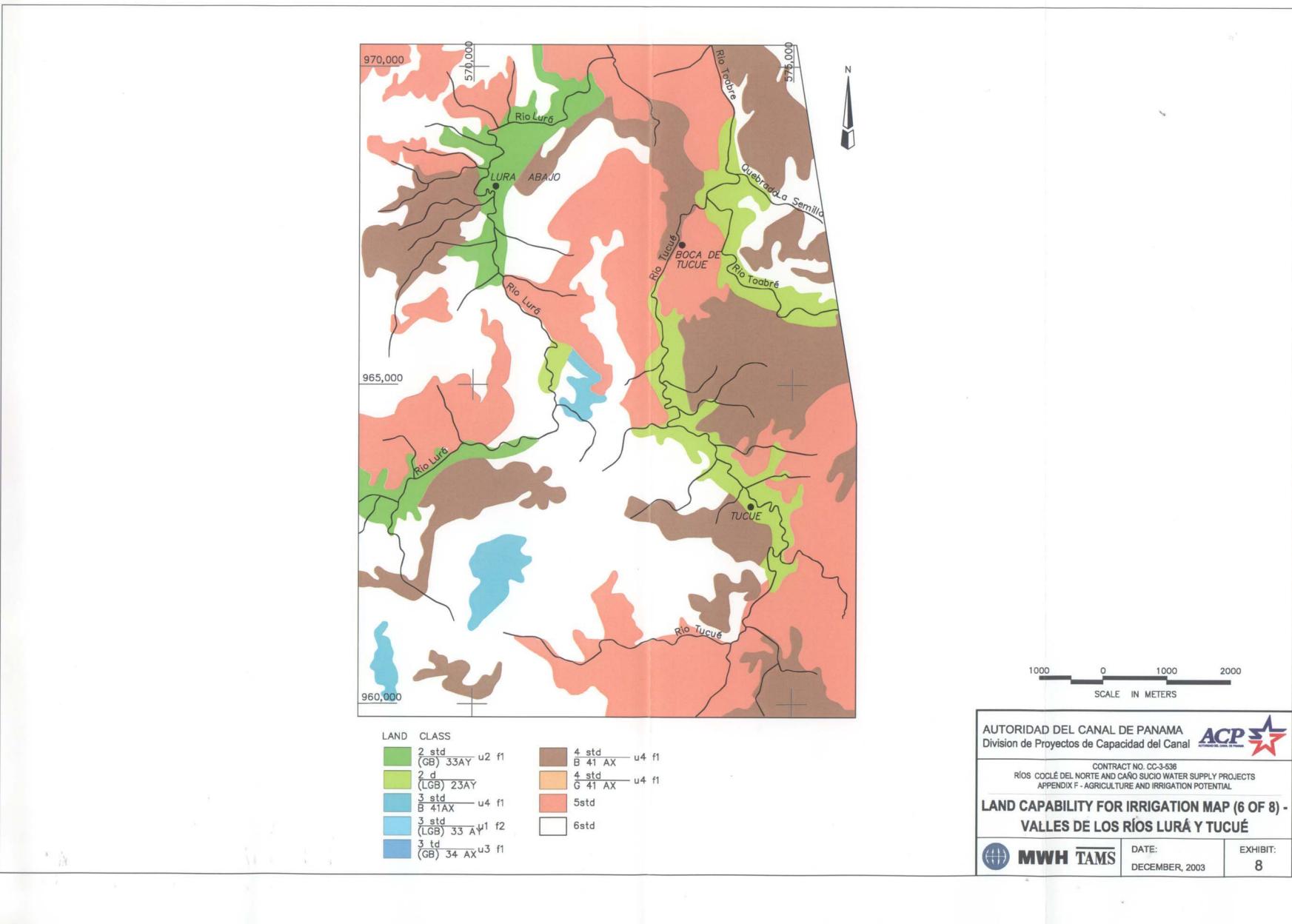


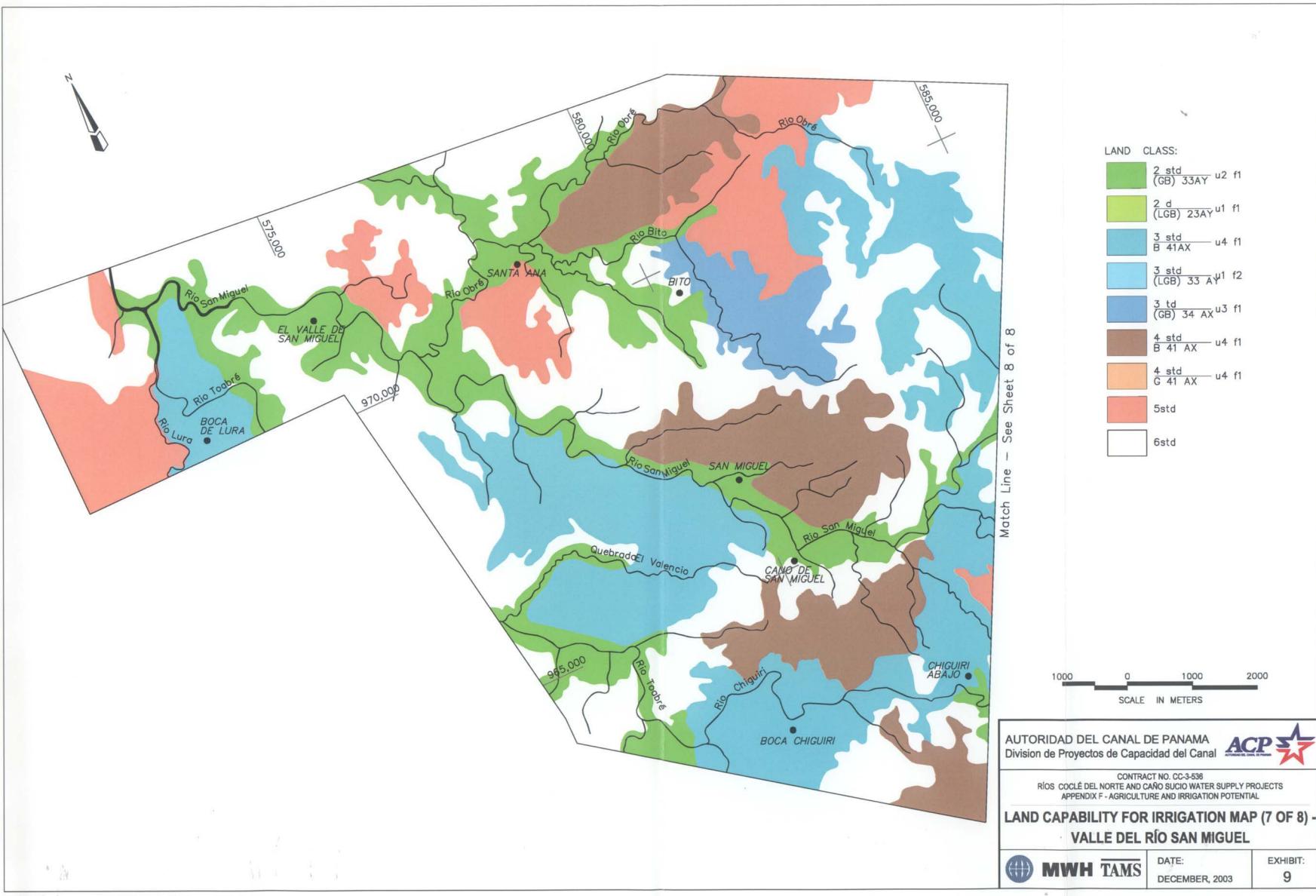


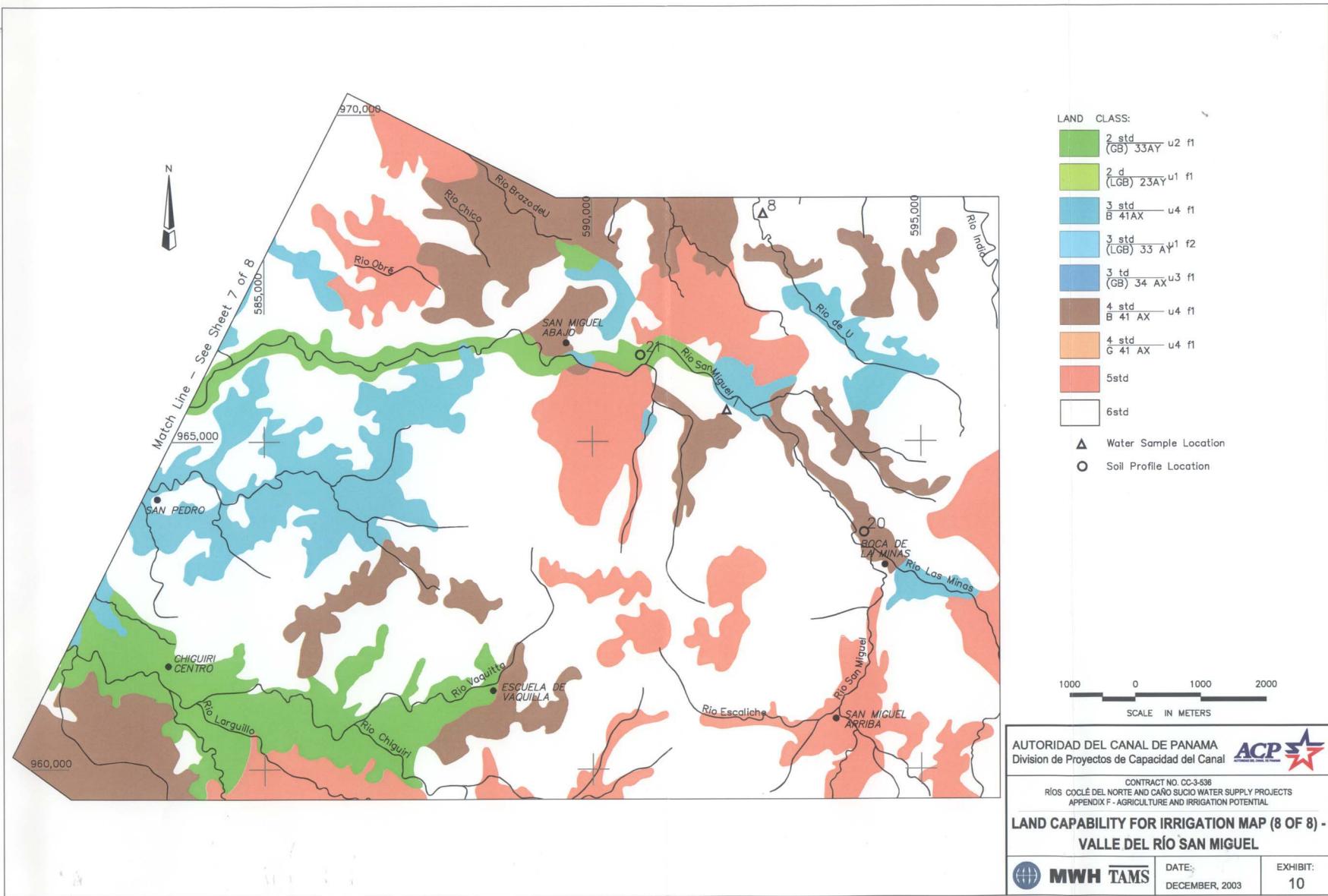


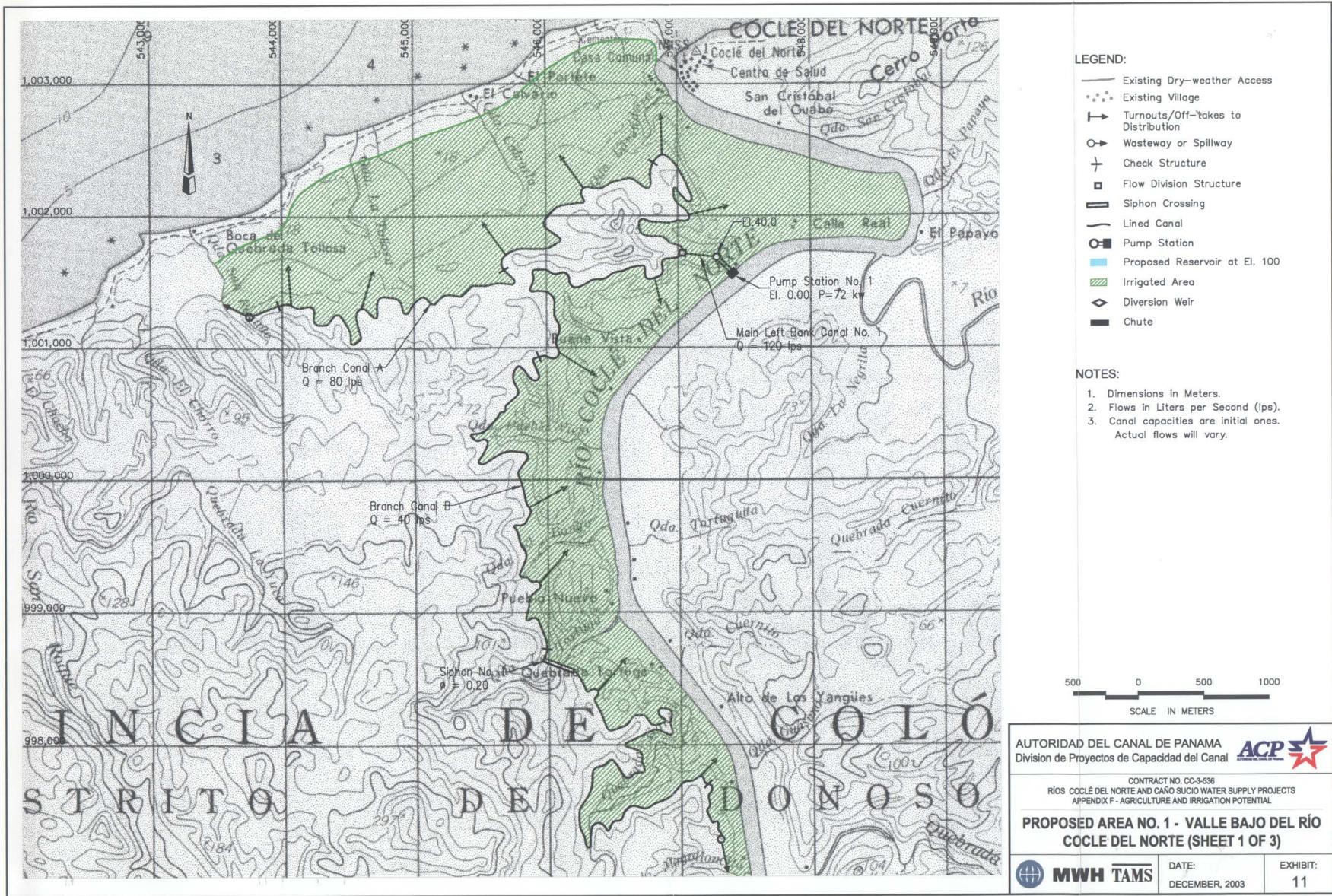


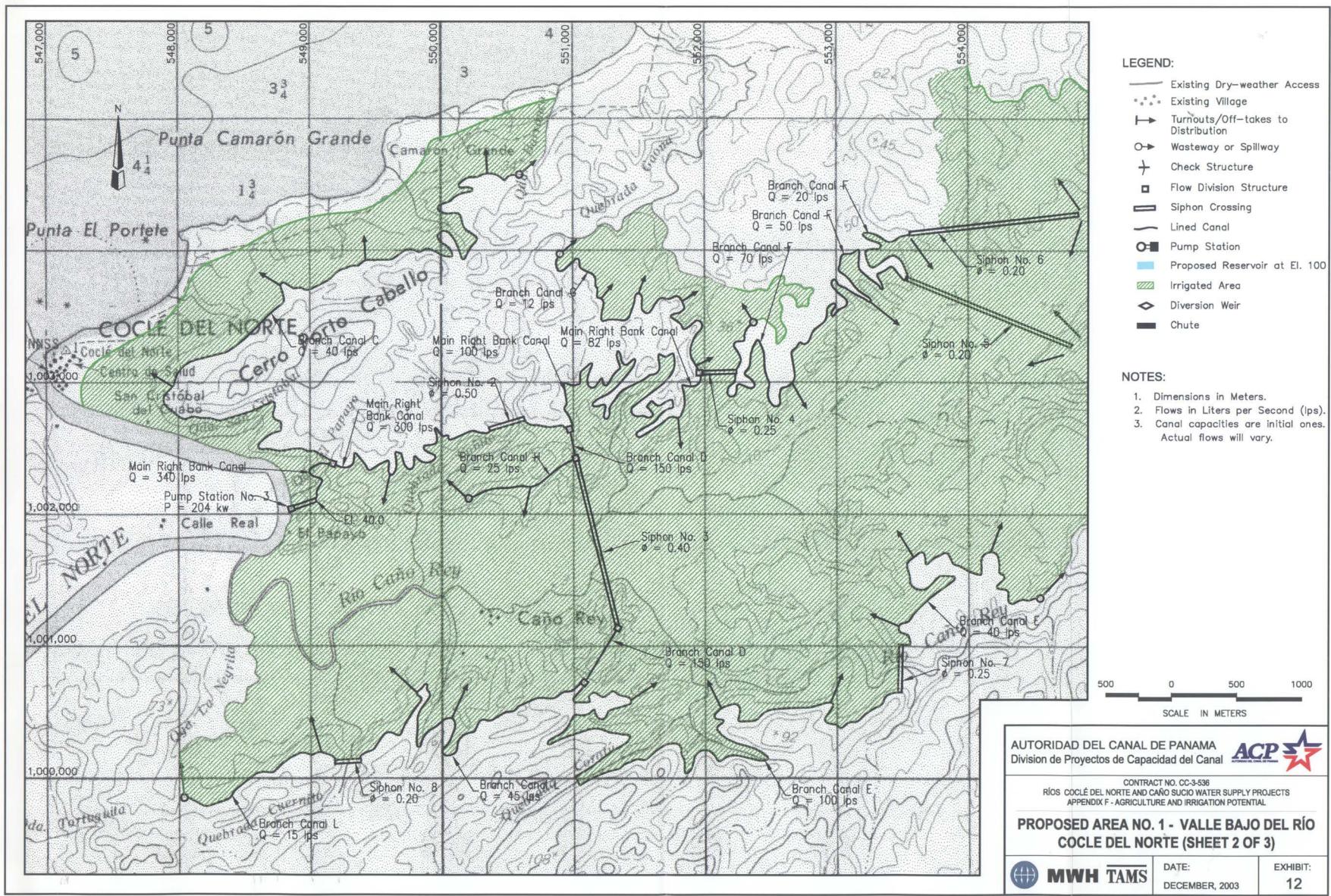


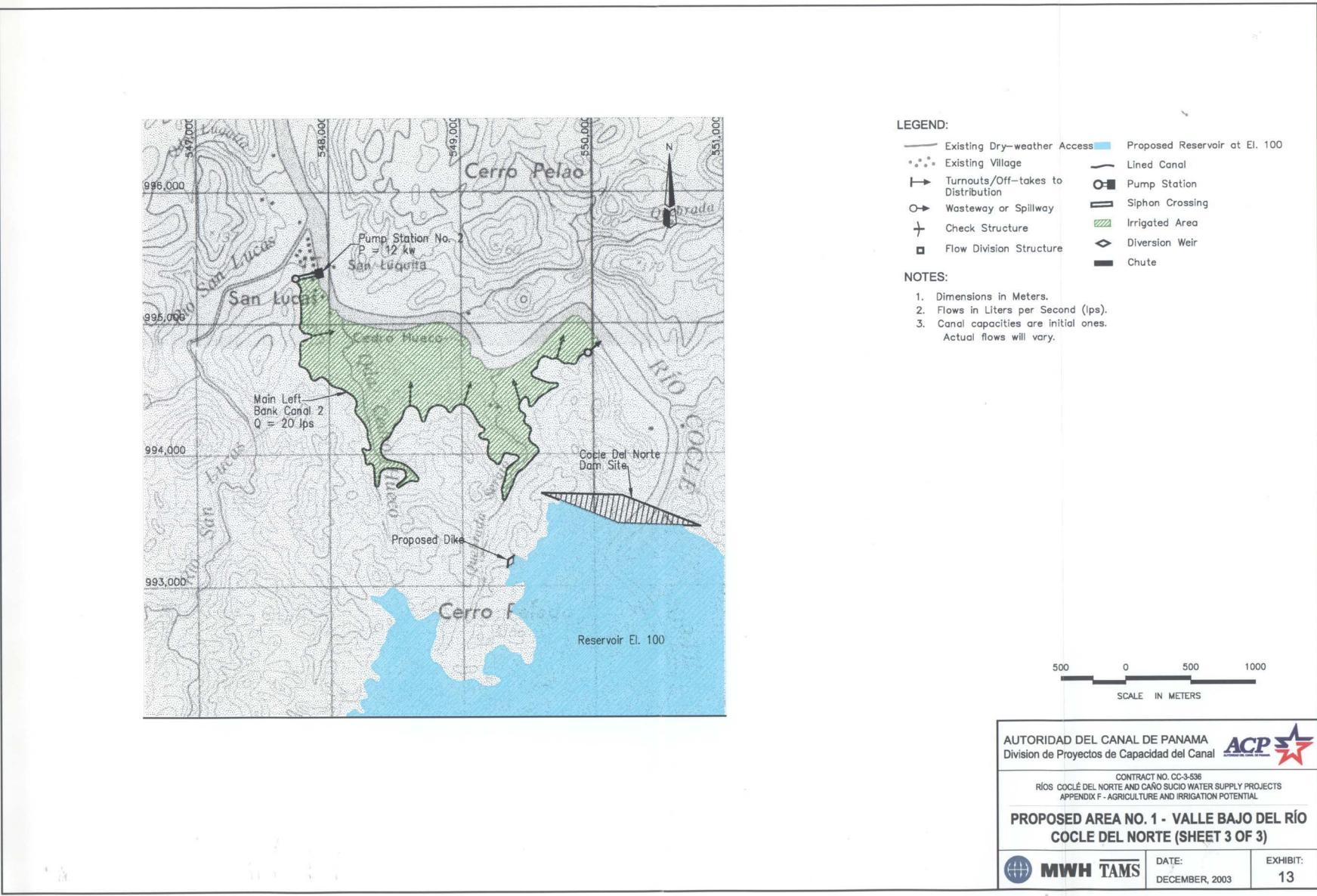


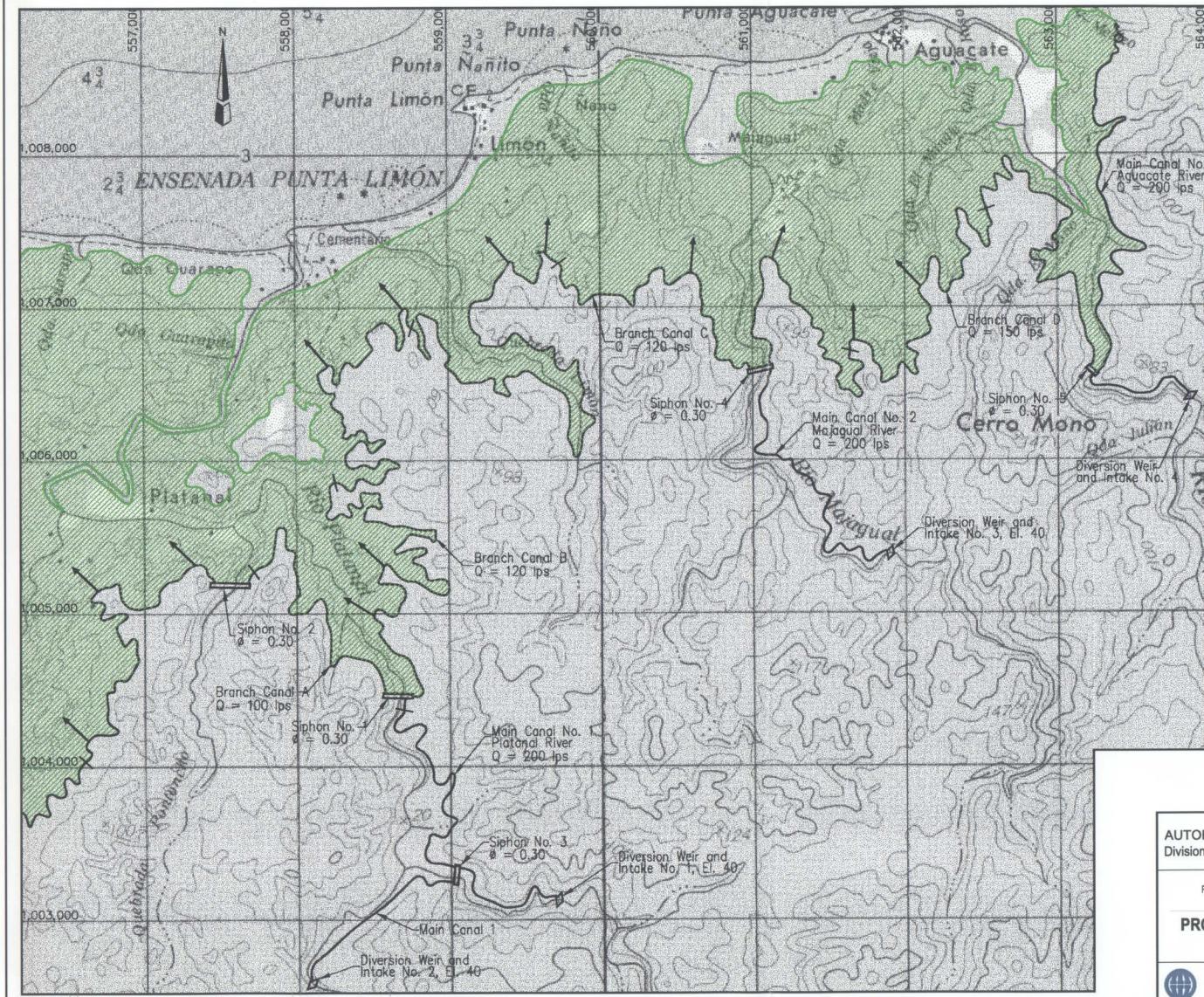












#### LEGEND:

- Existing Dry-weather Access
- • • Existing Village
- Turnouts/Off-takes to Distribution
- Wasteway or Spillway
- ✚ Check Structure
- Flow Division Structure
- Siphon Crossing
- Lined Canal
- Pump Station
- Proposed Reservoir at El. 100
- Irrigated Area
- ◆ Diversion Weir
- Chute

#### NOTES:

1. Dimensions in Meters.
2. Flows in Liters per Second (lps).
3. Canal capacities are initial ones. Actual flows will vary.

500 0 500 1000  
SCALE IN METERS

AUTORIDAD DEL CANAL DE PANAMA  
Division de Proyectos de Capacidad del Canal



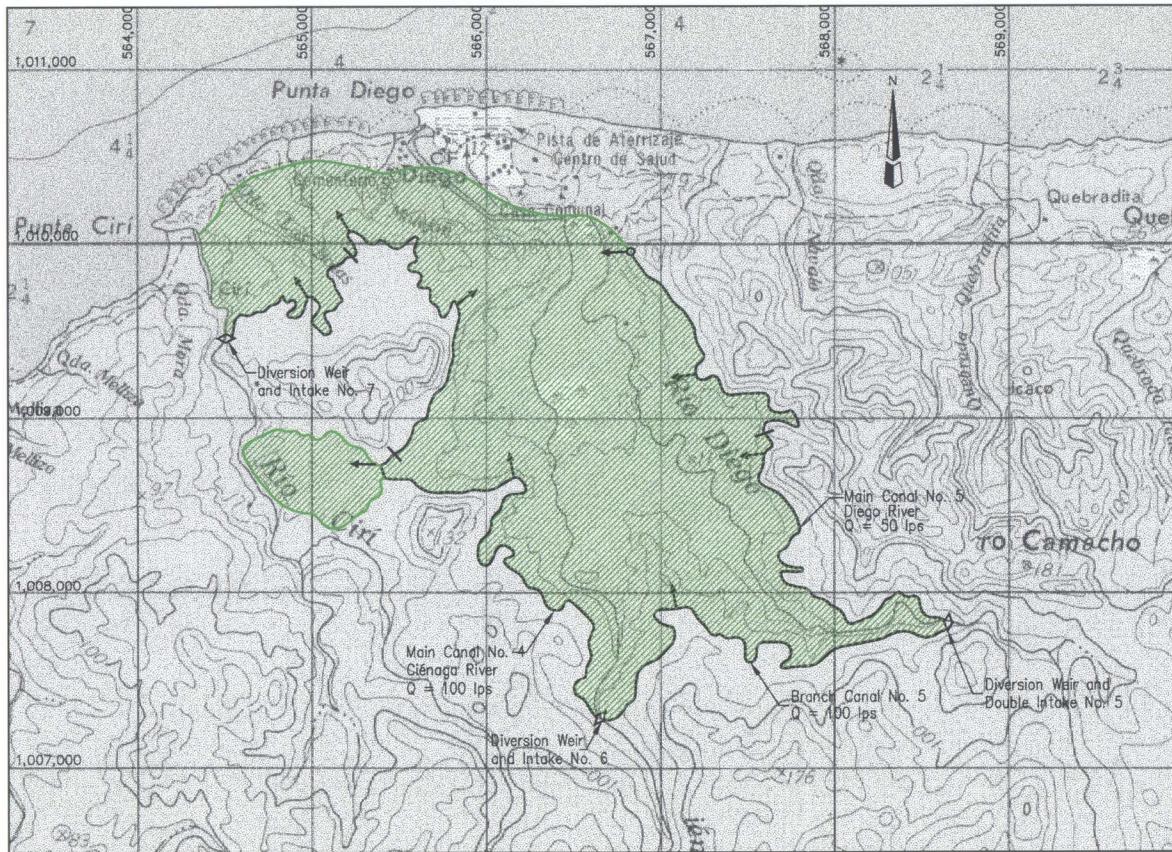
CONTRACT NO. CC-3-538  
RÍOS COCLE DEL NORTE AND CAÑO SUCIO WATER SUPPLY PROJECTS  
APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL

**PROPOSED AREA NO. 2 - COSTA PLATANAL -  
PUNTA DIEGO (SHEET 1 OF 2)**



DATE:  
DECEMBER, 2003

EXHIBIT:  
14



#### LEGEND:

- Existing Dry-weather Access
- Existing Village
- Turnouts/Off-takes to Distribution
- Wasteway or Spillway
- ✚ Check Structure
- Flow Division Structure
- Siphon Crossing
- Lined Canal
- Pump Station
- Proposed Reservoir at El. 100
- Irrigated Area
- ◇ Diversion Weir
- Chute

#### NOTES:

1. Dimensions in Meters.
2. Flows in Liters per Second (lps).
3. Canal capacities are initial ones. Actual flows will vary.

500 0 500 1000  
SCALE IN METERS

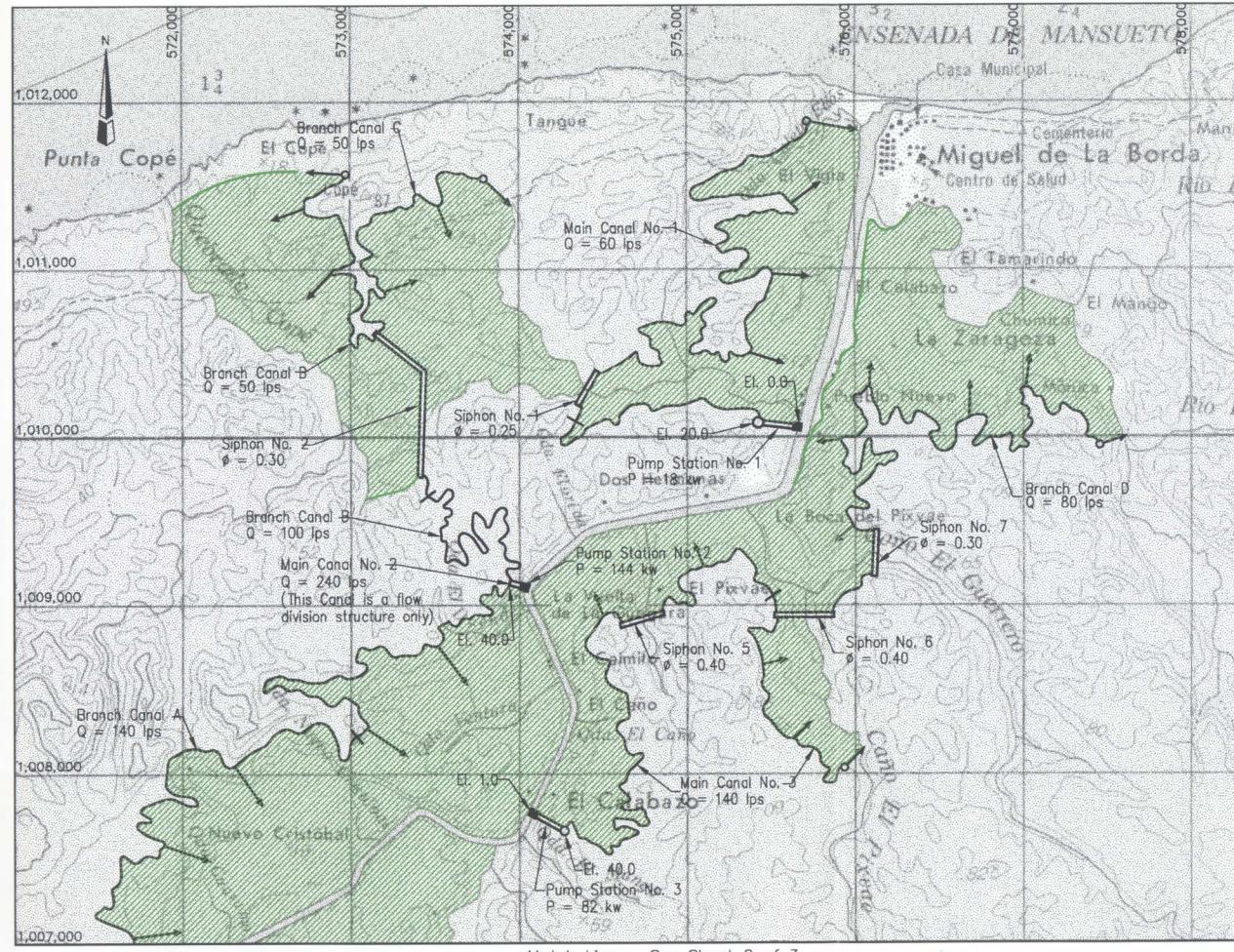
AUTORIDAD DEL CANAL DE PANAMA  
División de Proyectos de Capacidad del Canal



CONTRACT NO. CC-3-538  
RÍOS COCLE DEL NORTE AND CAÑO SUICIO WATER SUPPLY PROJECTS  
APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL

#### PROPOSED AREA NO. 2 - COSTA PLATANAL - PUNTA DIEGO (SHEET 2 OF 2)

MWH TAMS DATE: DECEMBER, 2003 EXHIBIT: 15



LEGEND:

- Existing Dry-weather Access
- Existing Village
- Turnouts/Off-takes to Distribution
- Wasteway or Spillway
- ⊕ Check Structure
- Flow Division Structure
- Siphon Crossing
- Lined Canal
- Pump Station
- Proposed Reservoir at El. 100
- Irrigated Area
- ◇ Diversion Weir
- Chute

NOTES:

1. Dimensions in Meters.
2. Flows in Liters per Second (lps).
3. Canal capacities are initial ones.  
Actual flows will vary.

500 0 500 1000  
SCALE IN METERS

AUTORIDAD DEL CANAL DE PANAMA  
División de Proyectos de Capacidad del Canal



CONTRACT NO. CC-3-535  
RÍOS COCLÉ DEL NORTE AND CAÑO SUCIO WATER SUPPLY PROJECTS  
APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL

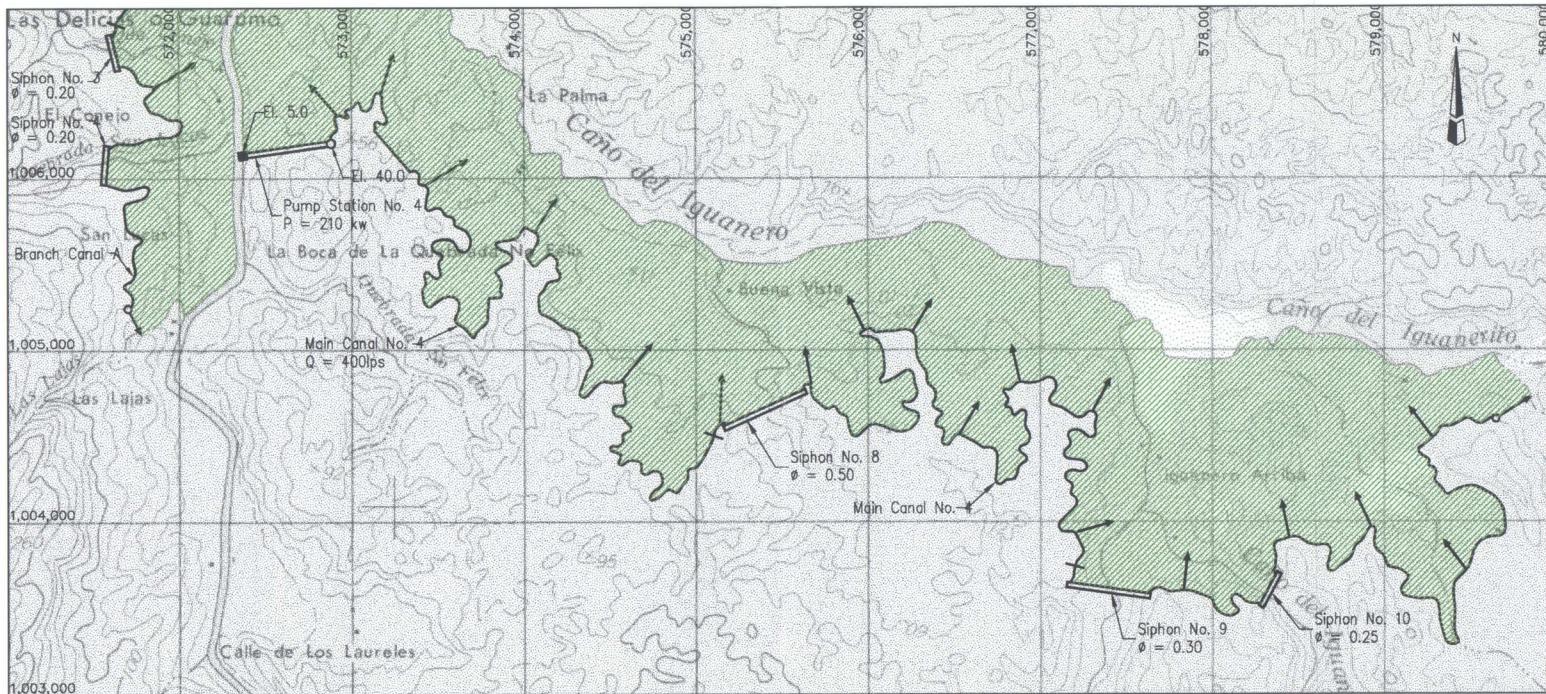
PROPOSED AREA NO. 3 - VALLE BAJO DEL RÍO  
MIGUEL DE LA BORDA (SHEET 1 OF 3)



DATE:  
DECEMBER, 2003

EXHIBIT:  
16

Match Line - See Sheet 1 of 3



LEGEND:

- Existing Dry-weather Access
- Existing Village
- Turnouts/Off-takes to Distribution
- Wasteway or Spillway
- ✚ Check Structure
- Flow Division Structure
- Siphon Crossing

- Lined Canal
- Pump Station
- Proposed Reservoir at El. 100
- Irrigated Area
- ◆ Diversion Weir
- Chute

NOTES:

1. Dimensions in Meters.
2. Flows in Liters per Second (lps).
3. Canal capacities are initial ones. Actual flows will vary.

500 0 500 1000

SCALE IN METERS

AUTORIDAD DEL CANAL DE PANAMA  
División de Proyectos de Capacidad del Canal



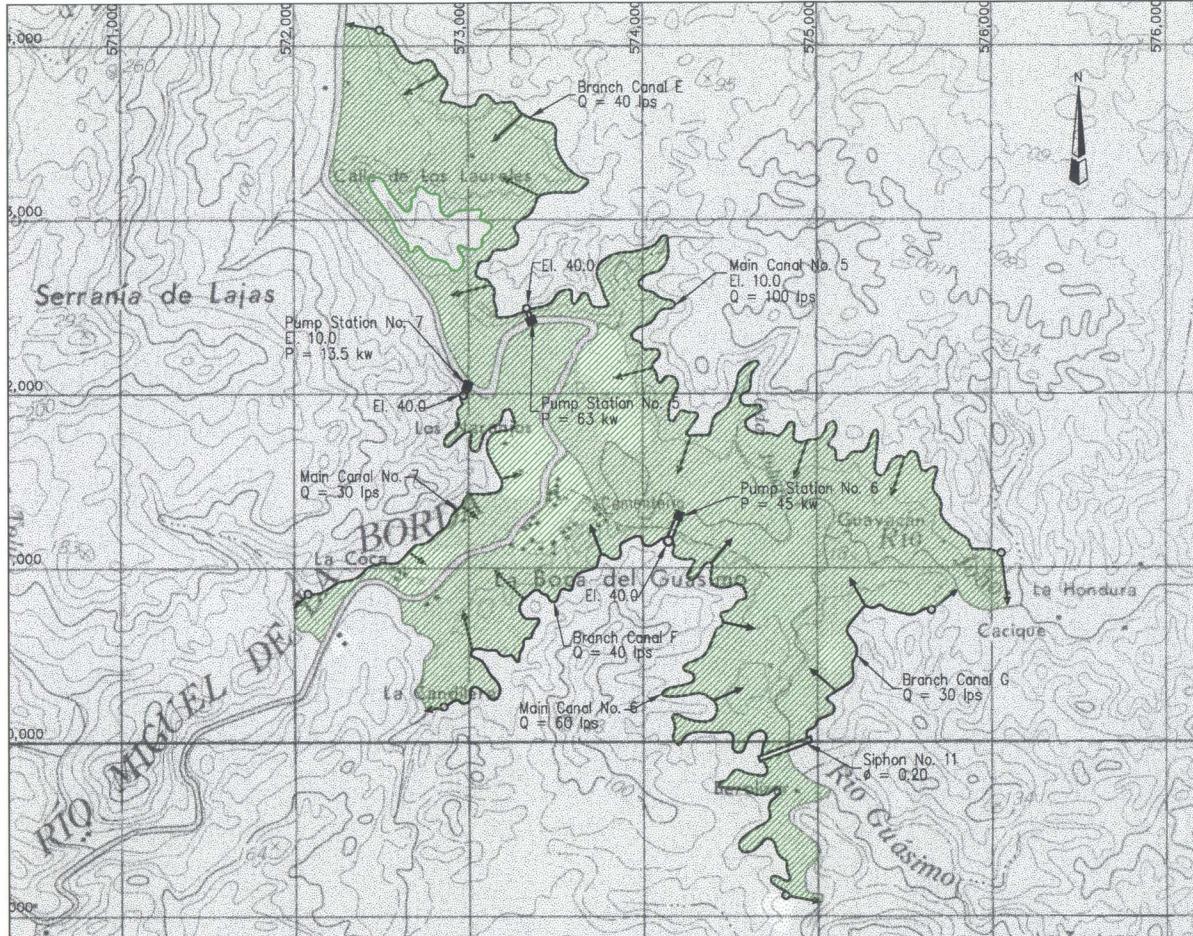
CONTRACT NO. CC-3-538  
RÍOS COCLES DEL NORTE AND CAÑO SUJO WATER SUPPLY PROJECTS  
APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL

PROPOSED AREA NO. 3 - VALLE BAJO DEL RÍO  
MIGUEL DE LA BORDA (SHEET 2 OF 3)



MWH TAMS  
DATE:  
DECEMBER, 2003

EXHIBIT:  
17



#### LEGEND:

- Existing Dry-weather Access
- Existing Village
- Turnouts/Off-takes to Distribution
- Wasteway or Spillway
- ✚ Check Structure
- Flow Division Structure
- Siphon Crossing
- Lined Canal
- Pump Station
- Proposed Reservoir at El. 100
- Irrigated Area
- ◇ Diversion Weir
- Chute

#### NOTES:

1. Dimensions in Meters.
2. Flows in Liters per Second (lps).
3. Canal capacities are initial ones. Actual flows will vary.

500 0 500 1000  
SCALE IN METERS

AUTORIDAD DEL CANAL DE PANAMA  
División de Proyectos de Capacidad del Canal



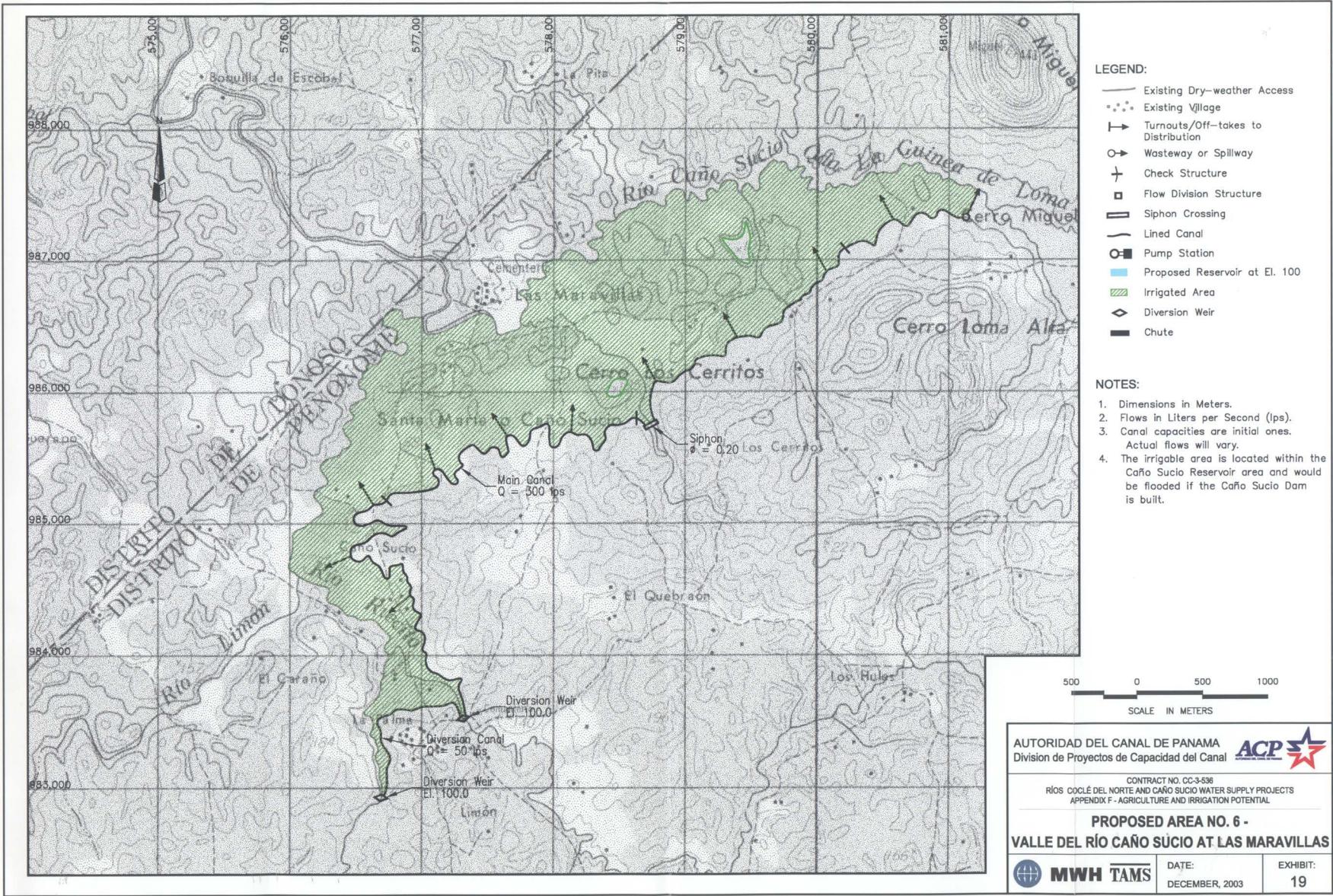
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RÍOS COCLÉ DEL NORTE AND CAÑO SUICU WATER SUPPLY PROJECTS  
APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL

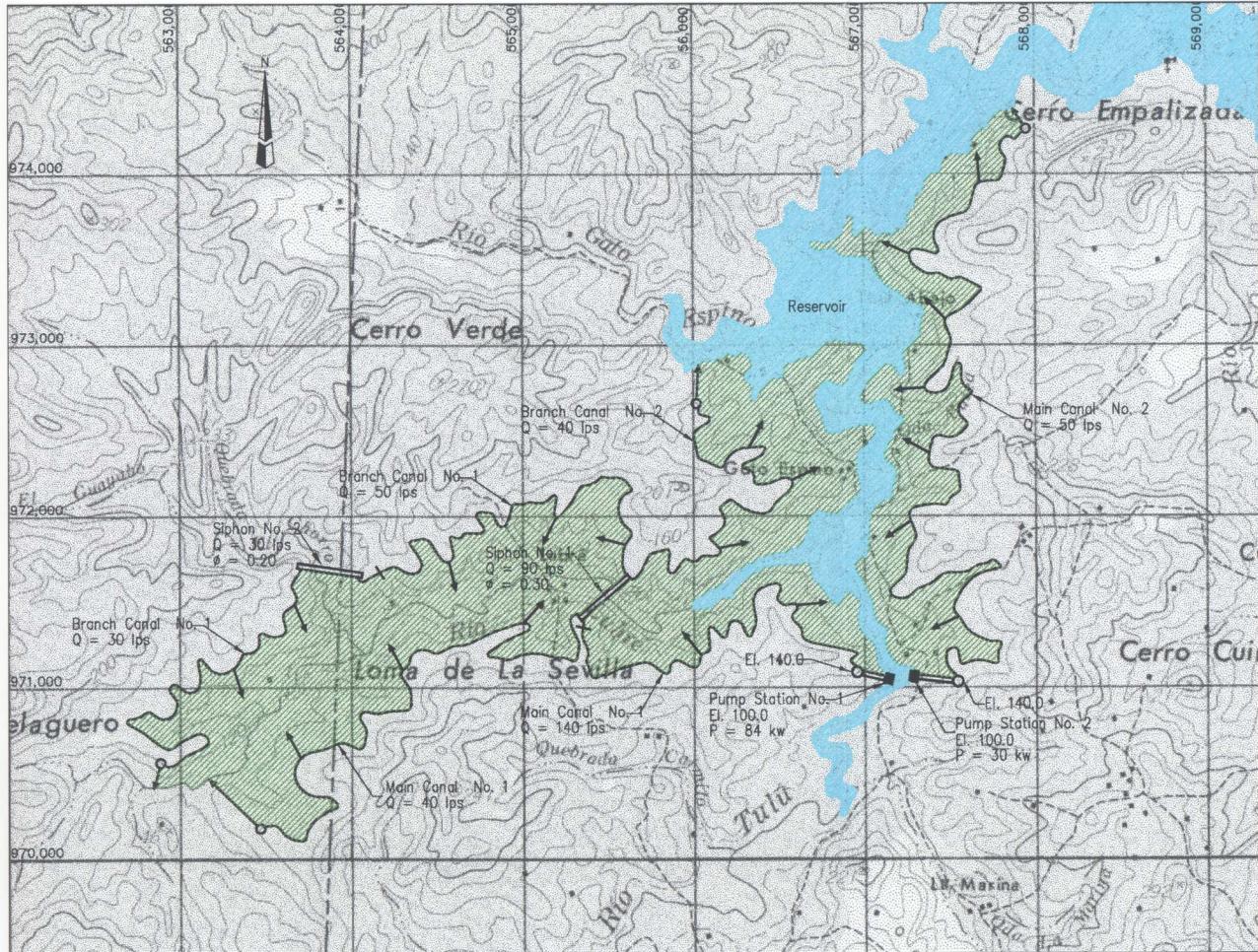
PROPOSED AREA NO. 3 - VALLE BAJO DEL RÍO  
MIGUEL DE LA BORDA (SHEET 3 OF 3)



DATE:  
DECEMBER, 2003

EXHIBIT:  
18





#### LEGEND:

- Existing Dry-weather Access
- Existing Village
- Turnouts/Off-takes to Distribution
- Wasteway or Spillway
- ✚ Check Structure
- Flow Division Structure
- Siphon Crossing
- Lined Canal
- Pump Station
- Proposed Reservoir at El. 100
- Irrigated Area
- ◇ Diversion Weir
- Chute

#### NOTES:

1. Dimensions in Meters.
2. Flows in Liters per Second (lps).
3. Canal capacities are initial ones. Actual flows will vary.

500 0 500 1000  
SCALE IN METERS

AUTORIDAD DEL CANAL DE PANAMA  
División de Proyectos de Capacidad del Canal



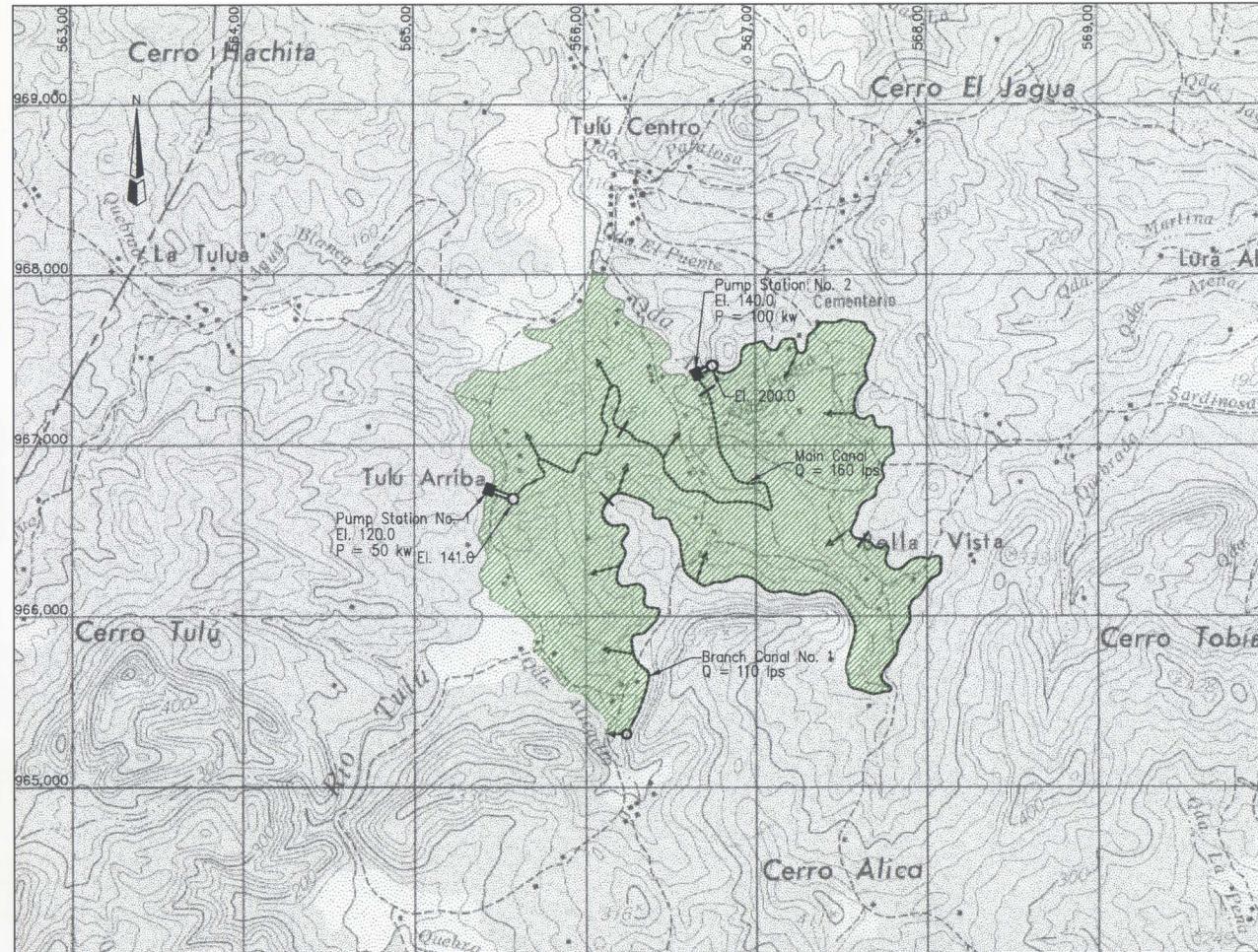
CONTRACT NO. CC-3-536  
RÍOS COCLE DEL NORTE AND CAÑO SUICIO WATER SUPPLY PROJECTS  
APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL

PROPOSED AREA NO. 8 -  
VALLE DEL RÍO TULÚ (SHEET 1 OF 2)



DATE:  
DECEMBER, 2003

EXHIBIT:  
20



#### LEGEND:

- Existing Dry-weather Access
- Existing Village
- Turnouts/Off-takes to Distribution
- Wasteway or Spillway
- ⊕ Check Structure
- Flow Division Structure
- Siphon Crossing
- Lined Canal
- Pump Station
- Proposed Reservoir at El. 100
- Irrigated Area
- ◆ Diversion Weir
- Chute

#### NOTES:

1. Dimensions in Meters.
2. Flows in Liters per Second (lps).
3. Canal capacities are initial ones.  
Actual flows will vary.

500      0      500      1000  
SCALE IN METERS

AUTORIDAD DEL CANAL DE PANAMA  
División de Proyectos de Capacidad del Canal



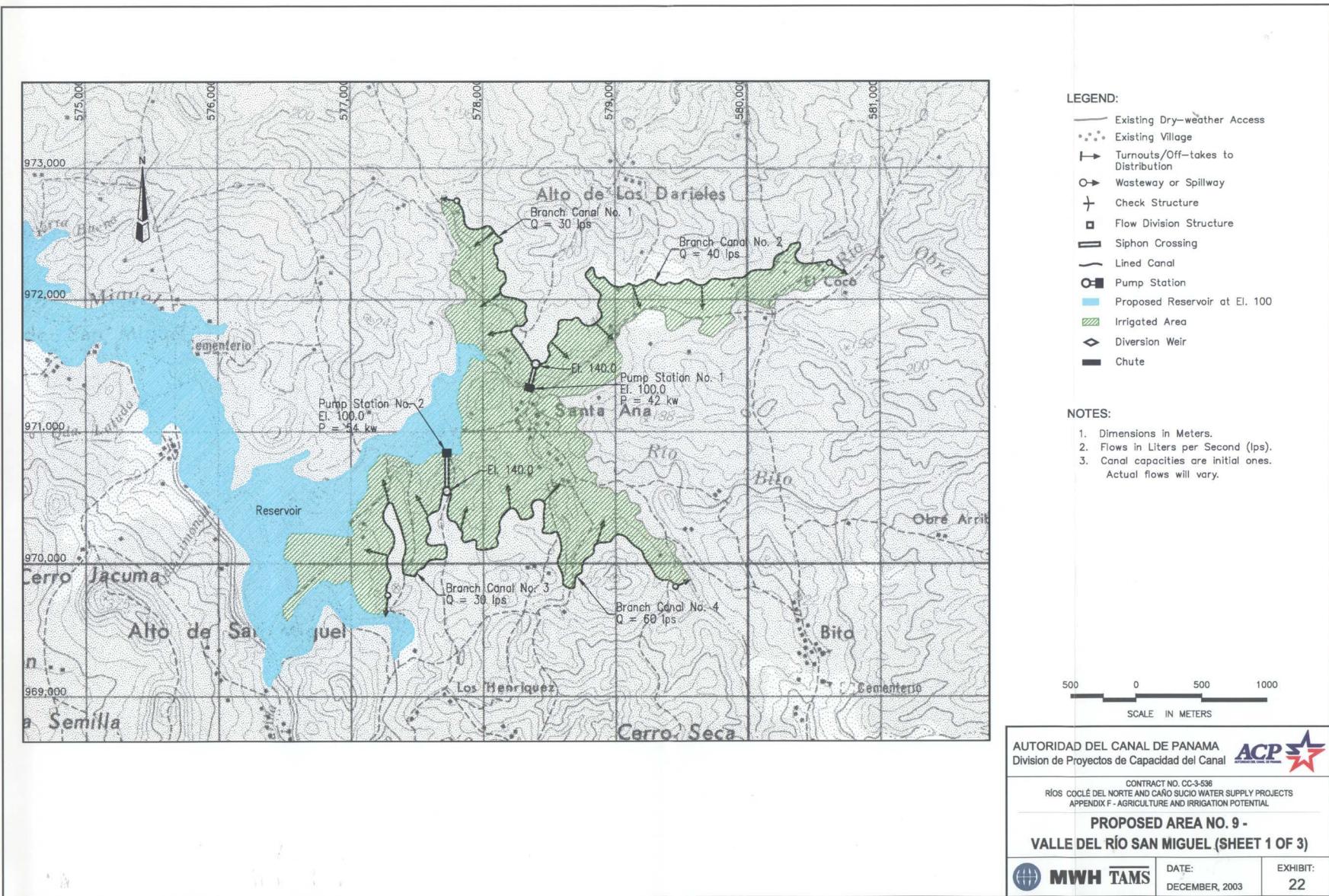
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RÍOS COCLES DEL NORTE AND CAÑO SUICO WATER SUPPLY PROJECTS  
APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL

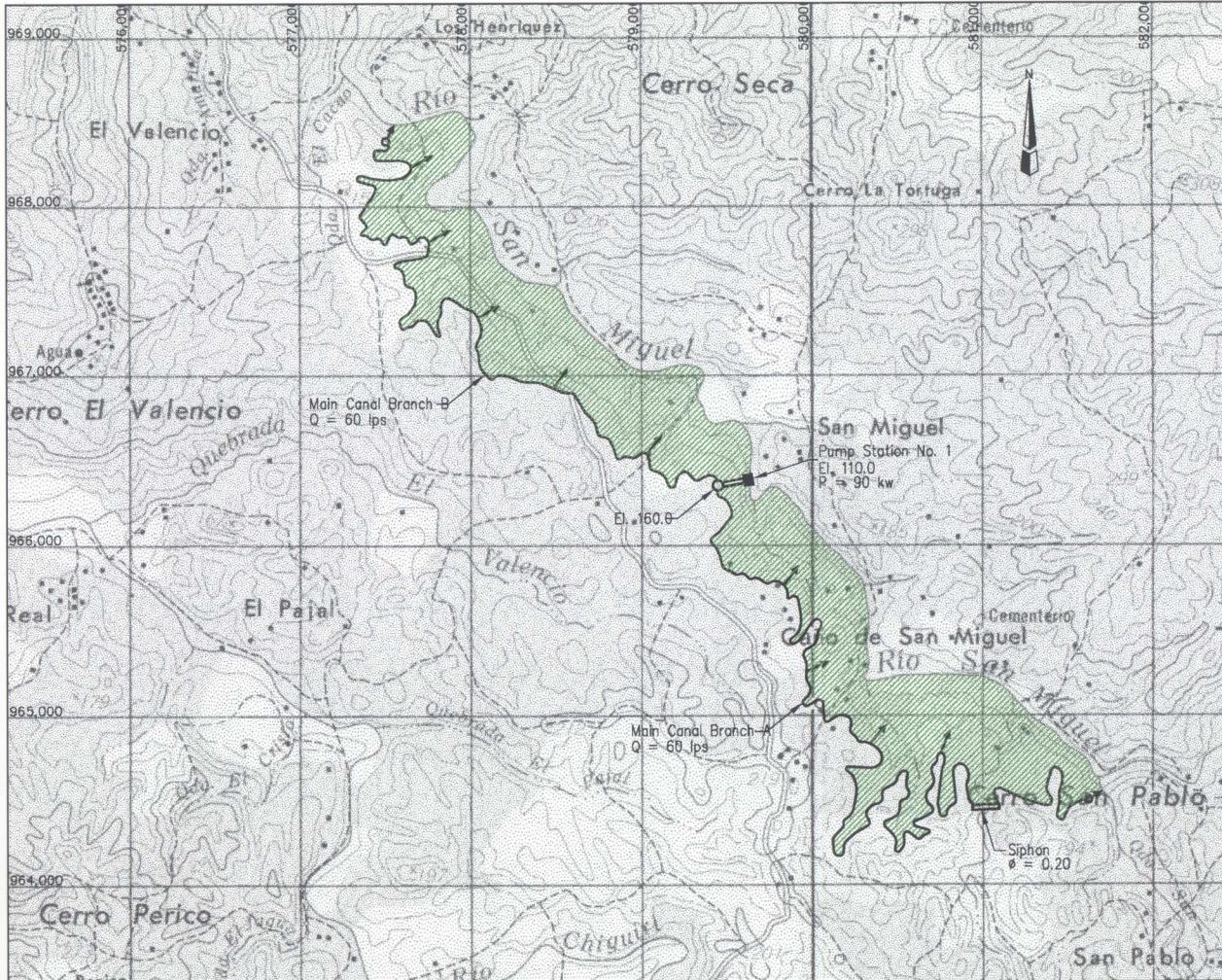
#### PROPOSED AREA NO. 8 - VALLE DEL RÍO TULÚ (SHEET 2 OF 2)



DATE:  
DECEMBER, 2003

EXHIBIT:  
21





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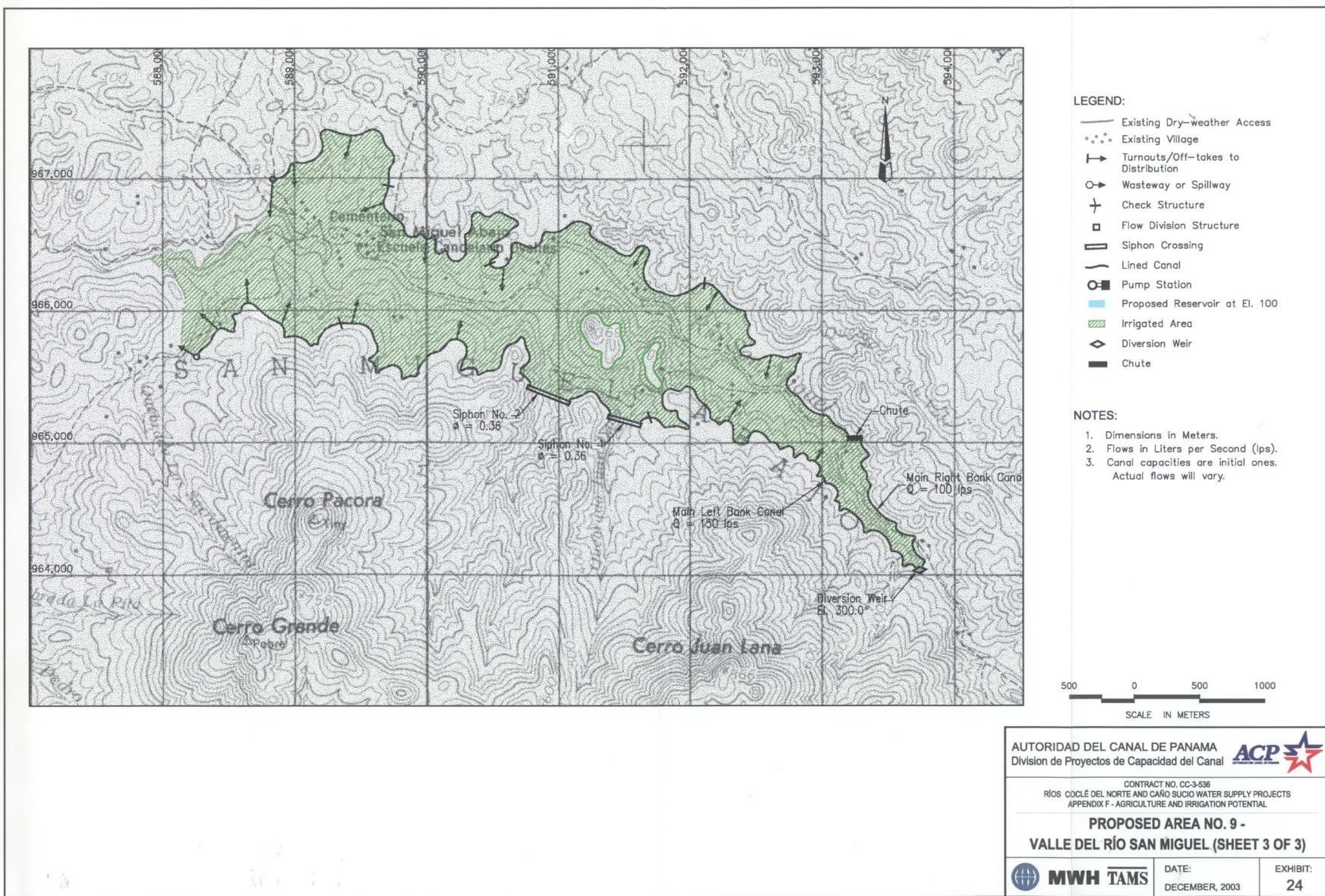
- Existing Dry-weather Access
- Existing Village
- Turnouts/Off-takes to Distribution
- Wasteway or Spillway
- ✚ Check Structure
- Flow Division Structure
- Siphon Crossing
- Lined Canal
- Pump Station
- Proposed Reservoir at El. 100
- Irrigated Area
- ◇ Diversion Weir
- Shute

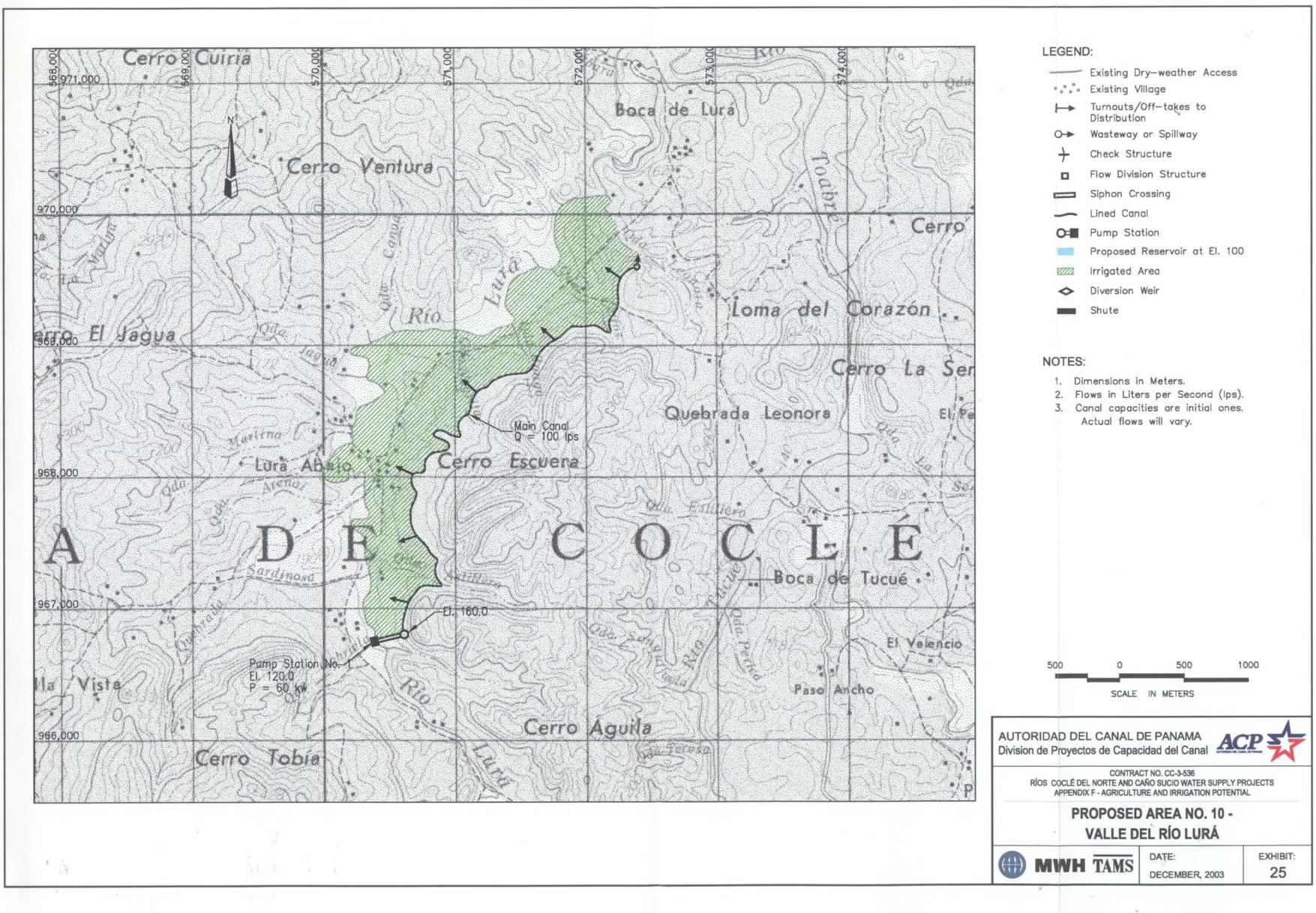
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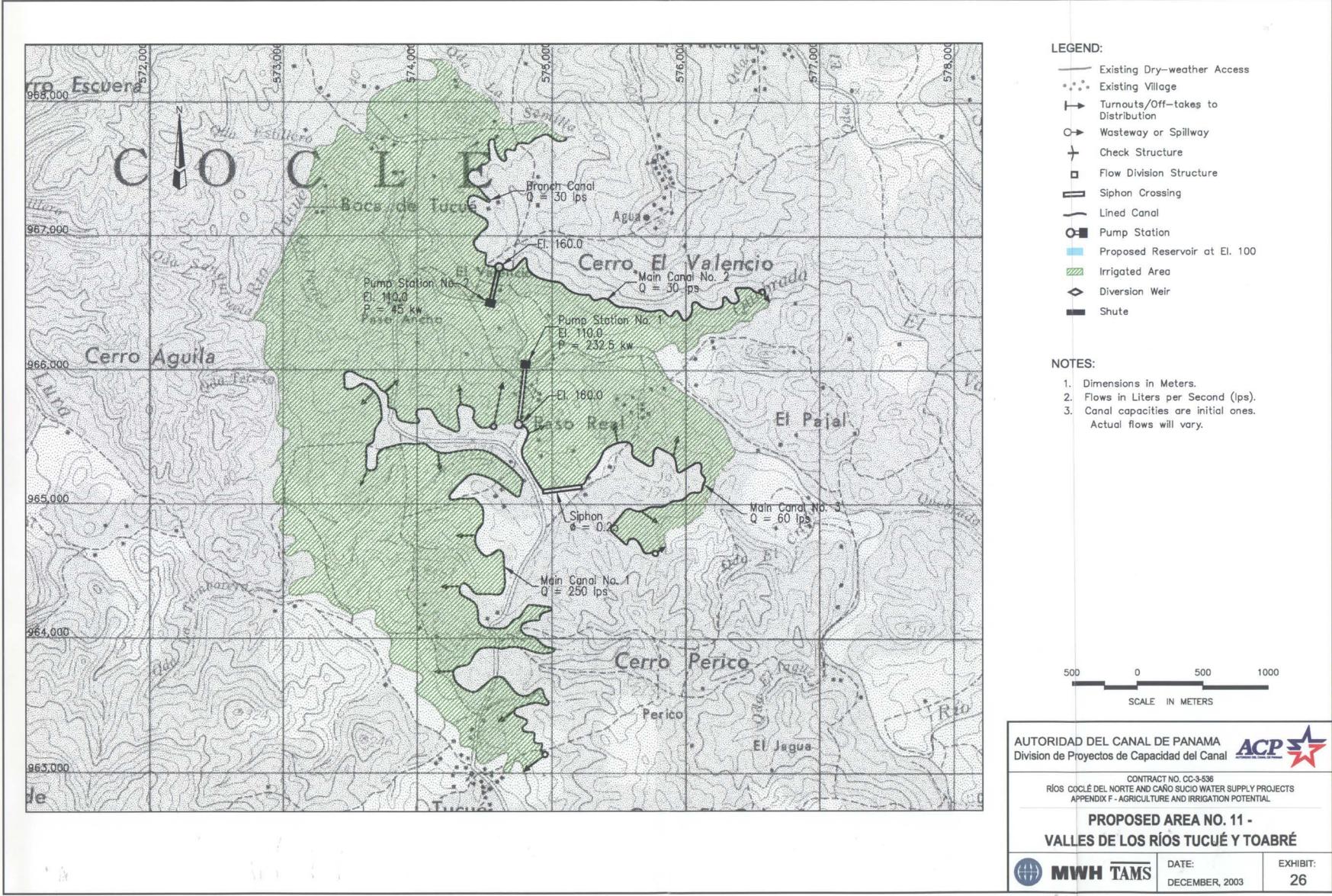
1. Dimensions in Meters.
2. Flows in Liters per Second (lps).
3. Canal capacities are initial ones. Actual flows will vary.

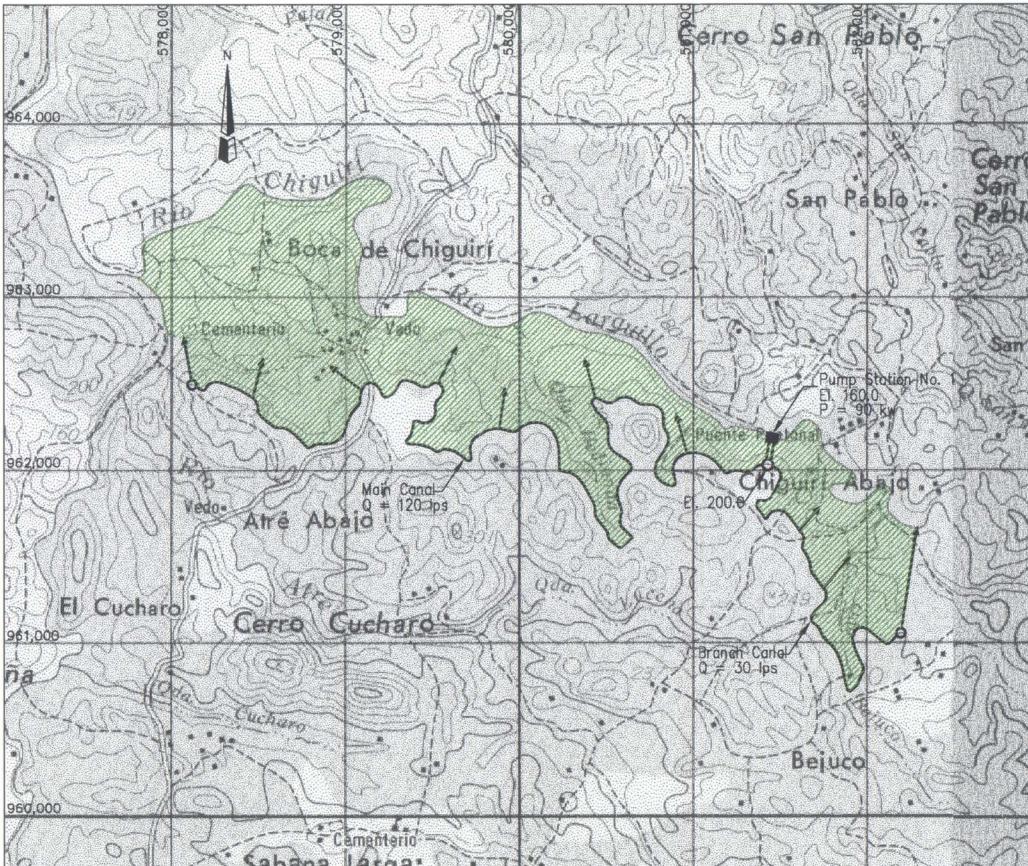
500 0 500 1000  
SCALE IN METERS

AUTORIDAD DEL CANAL DE PANAMA División de Proyectos de Capacidad del Canal	<b>ACP</b>
CONTRACT NO. CC-3-536 RIOS COCLE DEL NORTE AND CANO SUICO WATER SUPPLY PROJECTS APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL	
<b>PROPOSED AREA NO. 9 -</b>	
<b>VALLE DEL RÍO SAN MIGUEL (SHEET 2 OF 3)</b>	
<b>MWH TAMS</b>	DATE: DECEMBER, 2003
	EXHIBIT: 23









#### LEGEND:

- Existing Dry-weather Access
- Existing Village
- Turnouts/Off-takes to Distribution
- Wasteway or Spillway
- ✚ Check Structure
- Flow Division Structure
- Siphon Crossing
- Lined Canal
- Pump Station
- Proposed Reservoir at El. 100
- Irrigated Area
- ◇ Diversion Weir
- Chute

#### NOTES:

1. Dimensions in Meters.
2. Flows in Liters per Second (lps).
3. Canal capacities are initial ones.  
Actual flows will vary.

500 0 500 1000  
SCALE IN METERS

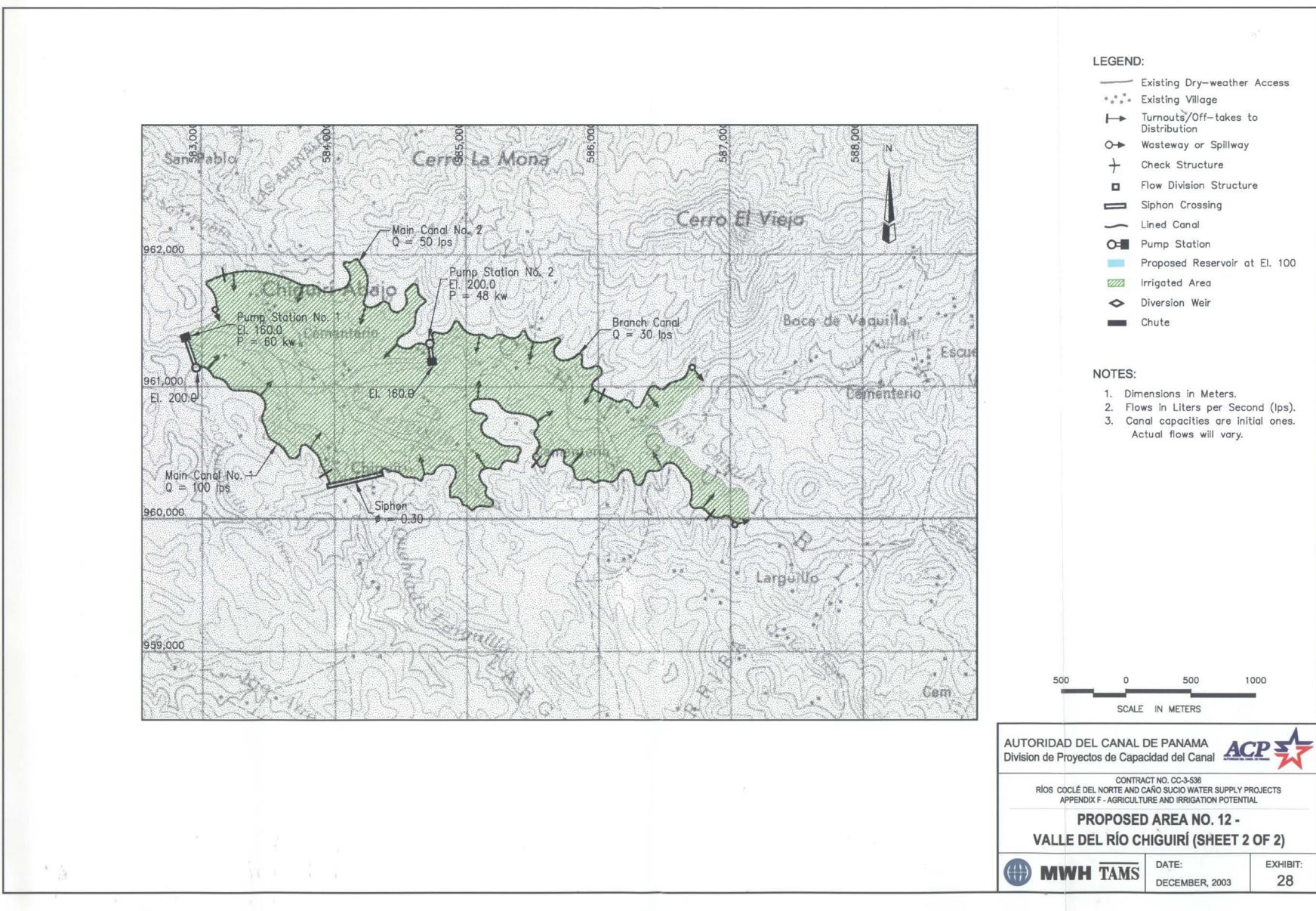
AUTORIDAD DEL CANAL DE PANAMA  
Division de Proyectos de Capacidad del Canal

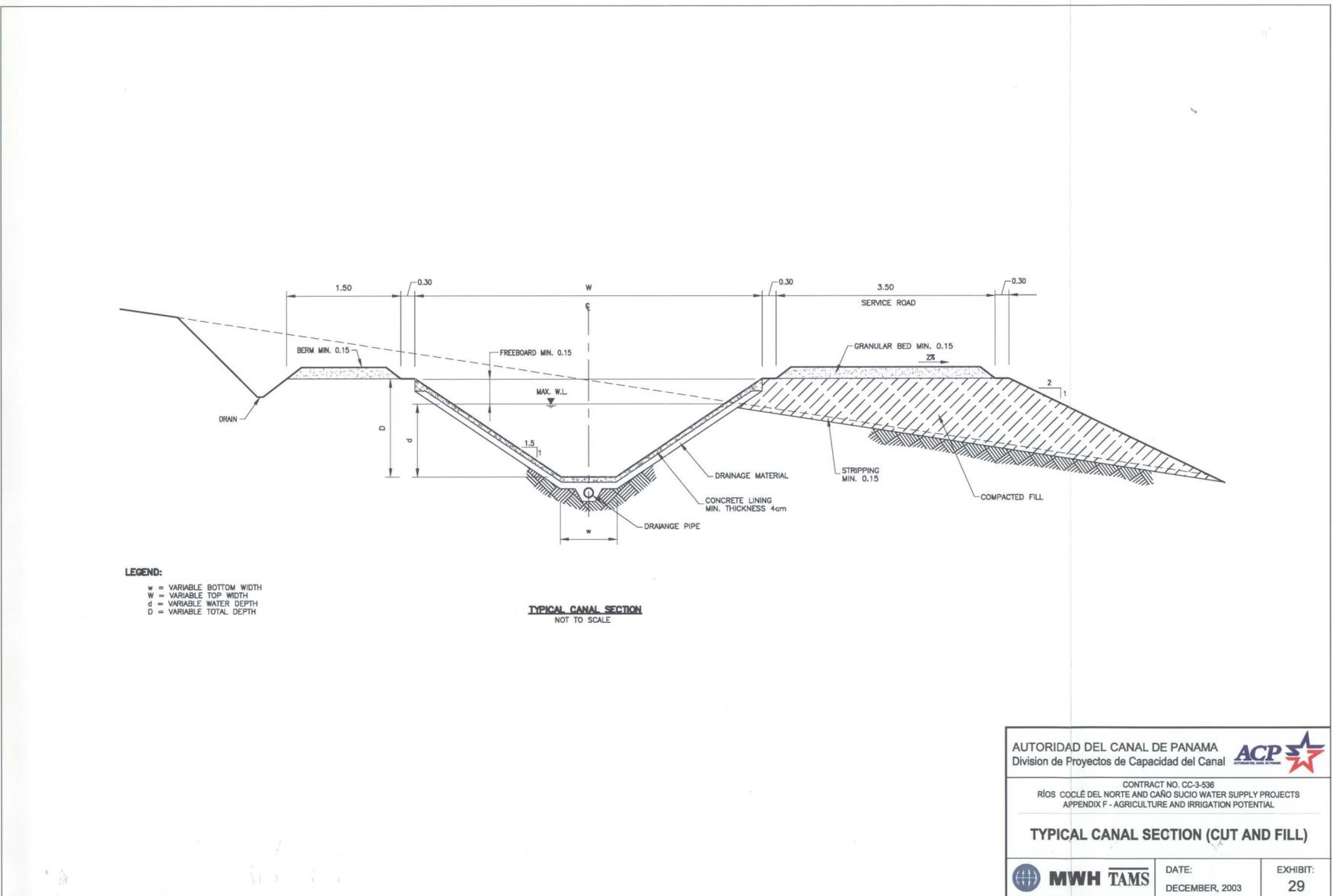


CONTRACT NO. CC-3-536  
RÍOS COCLÉ DEL NORTE AND CAÑO SUICIO WATER SUPPLY PROJECTS  
APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL

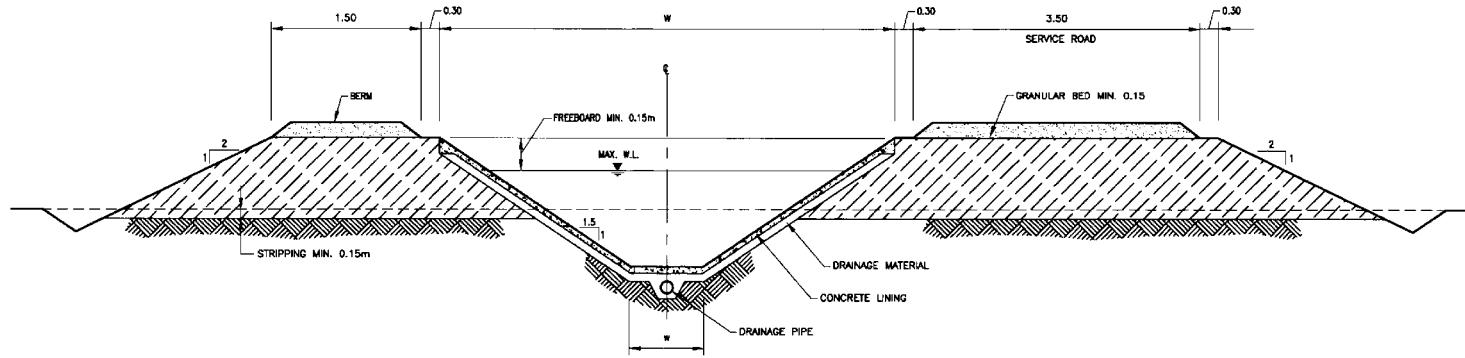
**PROPOSED AREA NO. 12 -  
VALLE DEL RÍO CHIGUIRÍ (SHEET 1 OF 2)**

	<b>MWH TAMS</b>	DATE: DECEMBER, 2003	EXHIBIT: 27
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AUTORIDAD DEL CANAL DE PANAMA Division de Proyectos de Capacidad del Canal		<b>ACP</b>
CONTRACT NO. CC-3-536 RÍOS COCLE DEL NORTE AND CAÑO SUCIO WATER SUPPLY PROJECTS APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL		
<b>TYPICAL CANAL SECTION (CUT AND FILL)</b>		
	DATE: DECEMBER, 2003	EXHIBIT: 29



**LEGEND:**

- w = VARIABLE BOTTOM WIDTH
- W = VARIABLE TOP WIDTH
- d = VARIABLE WATER DEPTH
- D = VARIABLE TOTAL DEPTH

**TYPICAL CANAL SECTION**  
NOT TO SCALE

AUTORIDAD DEL CANAL DE PANAMA  
Division de Proyectos de Capacidad del Canal



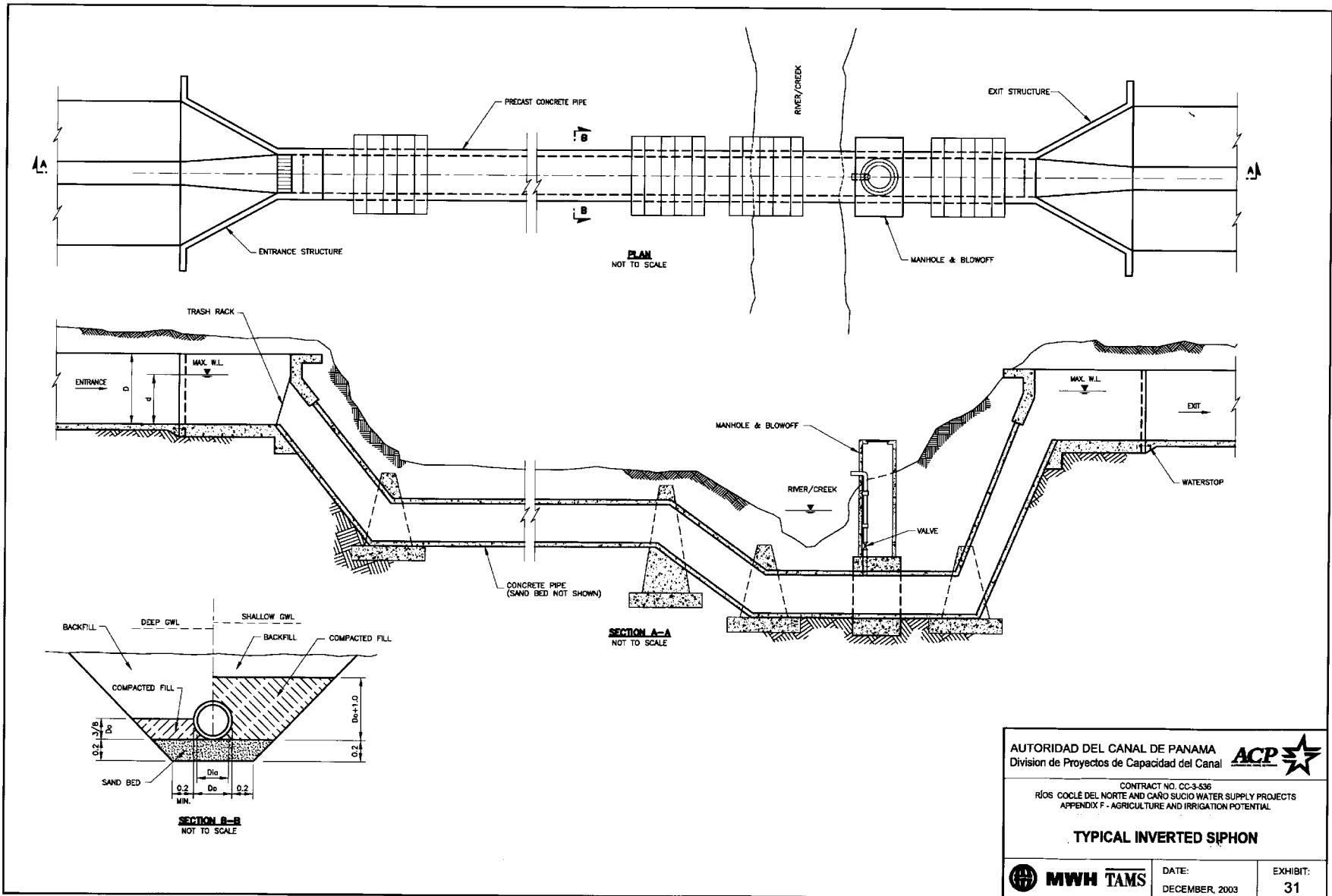
CONTRACT NO. CC-3-536  
RÍOS COCLE DEL NORTE AND CAÑO SUCIO WATER SUPPLY PROJECTS  
APPENDIX F - AGRICULTURE AND IRRIGATION POTENTIAL

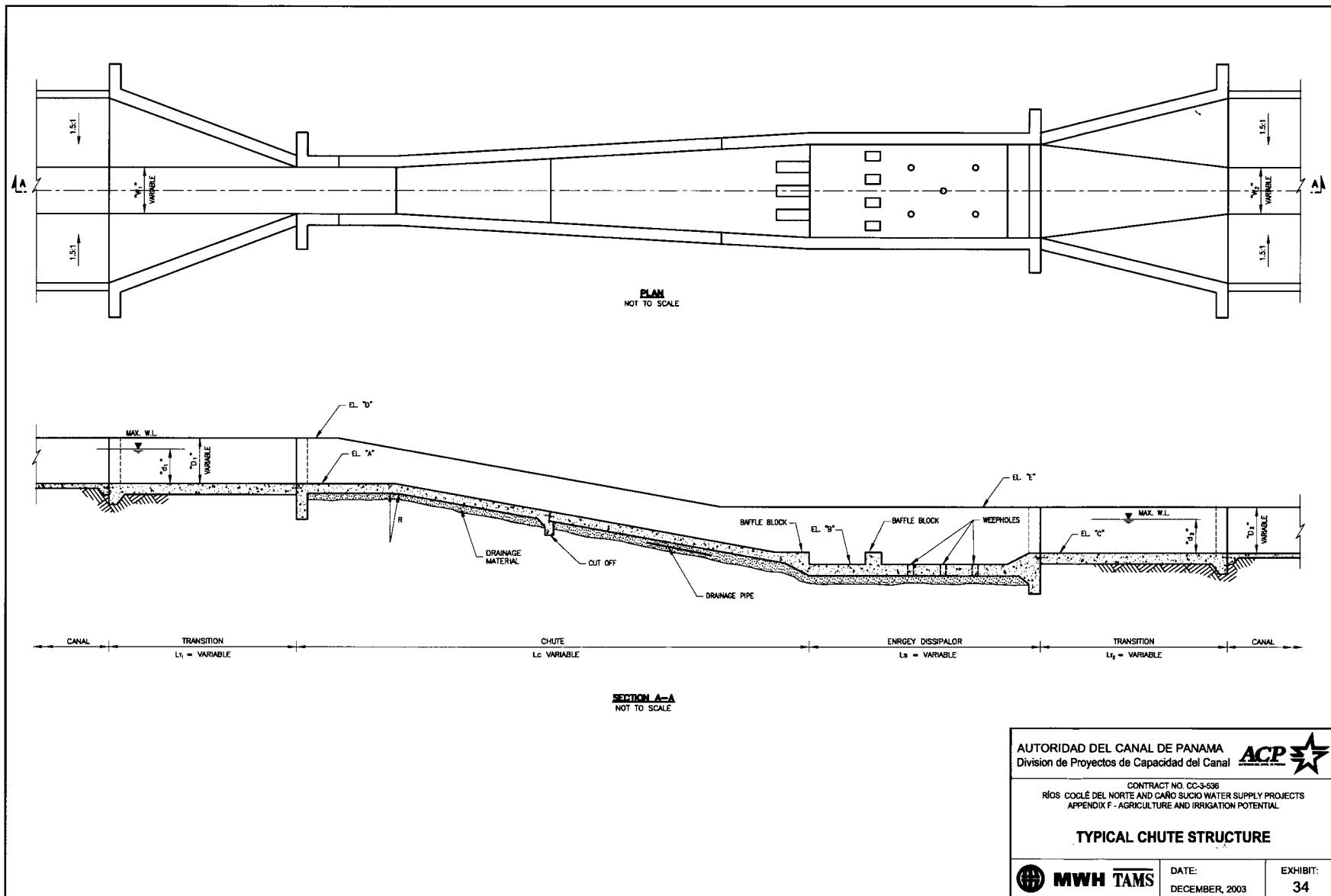
**TYPICAL CANAL SECTION (FILL)**

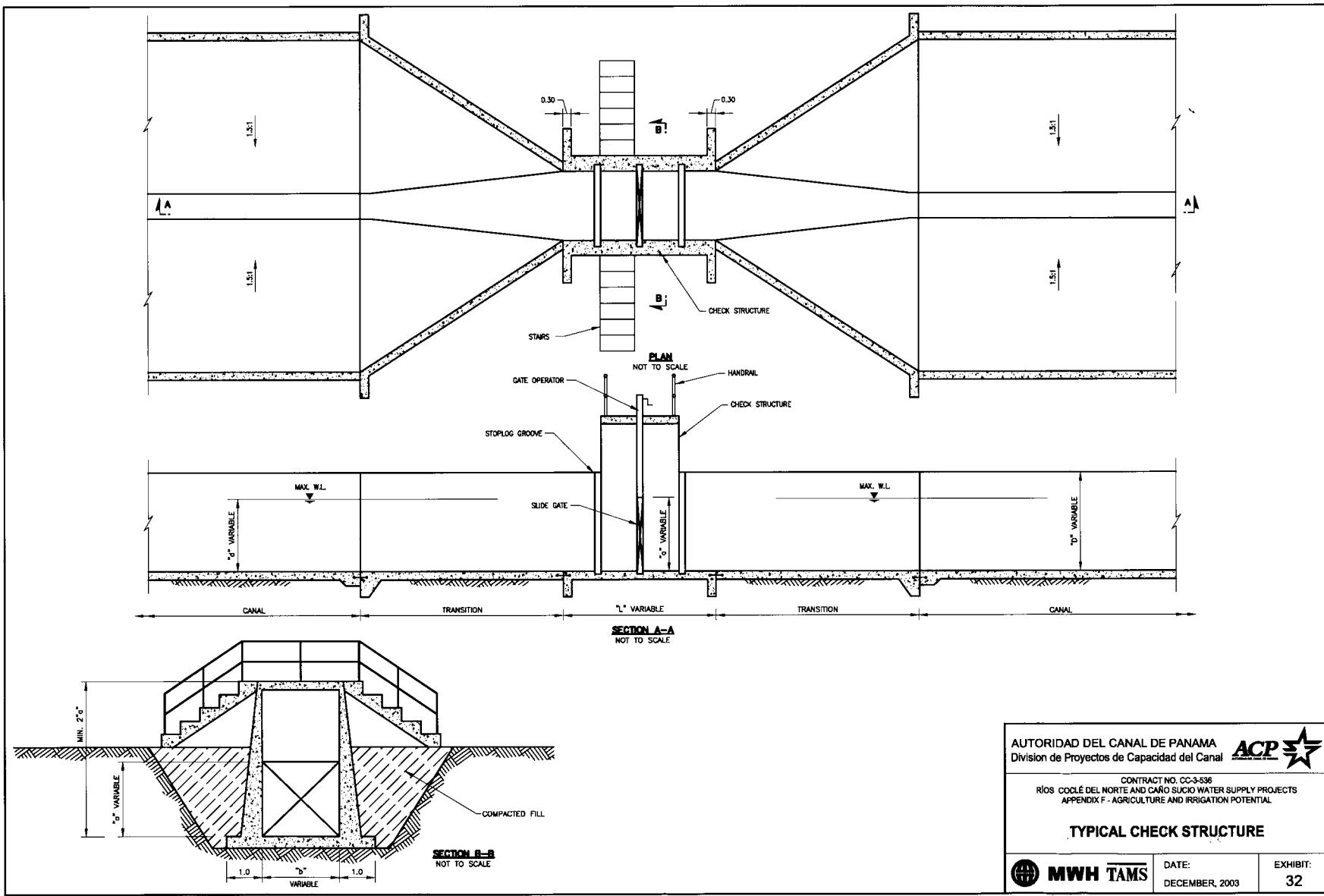


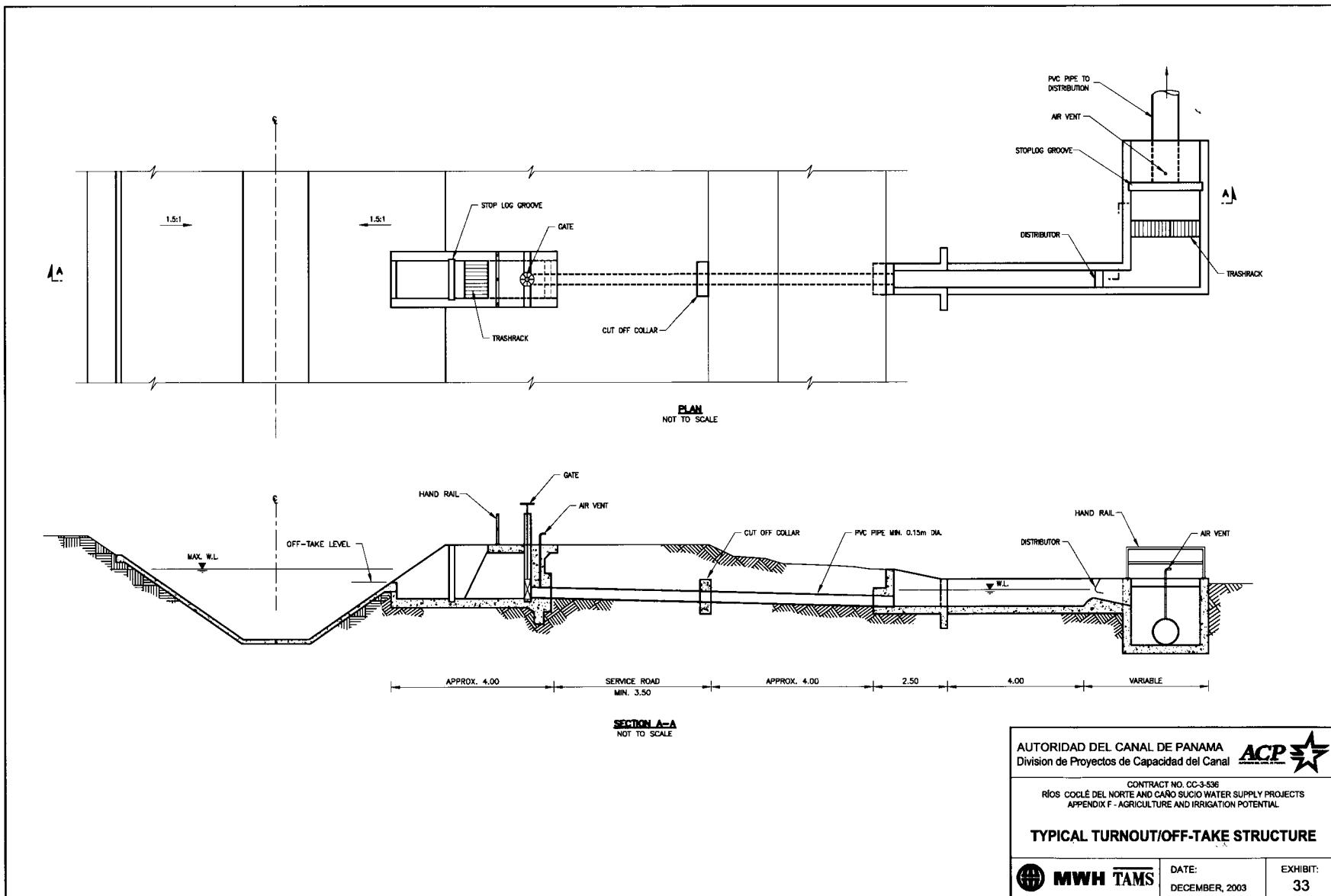
DATE:  
DECEMBER, 2003

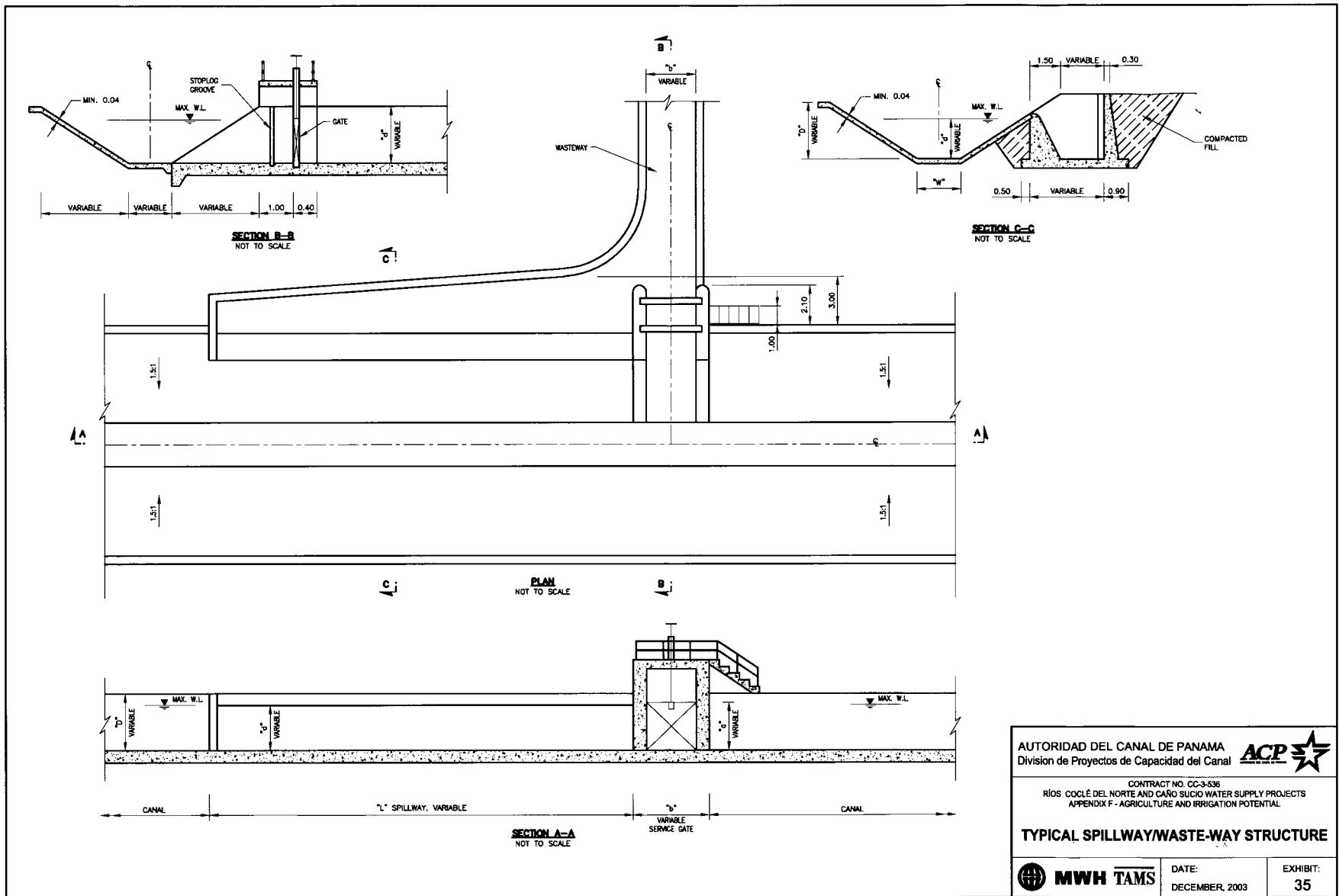
EXHIBIT:  
30

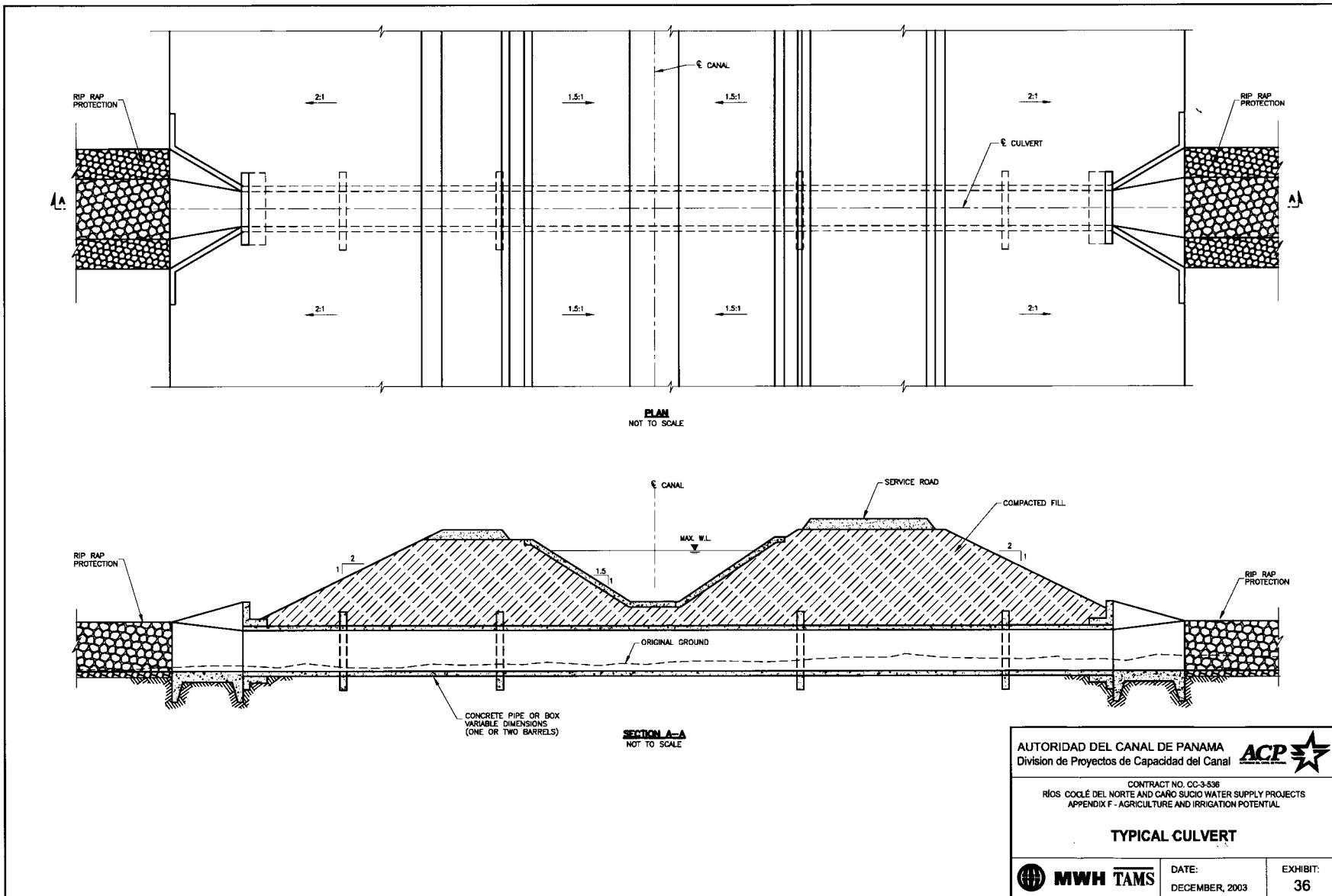


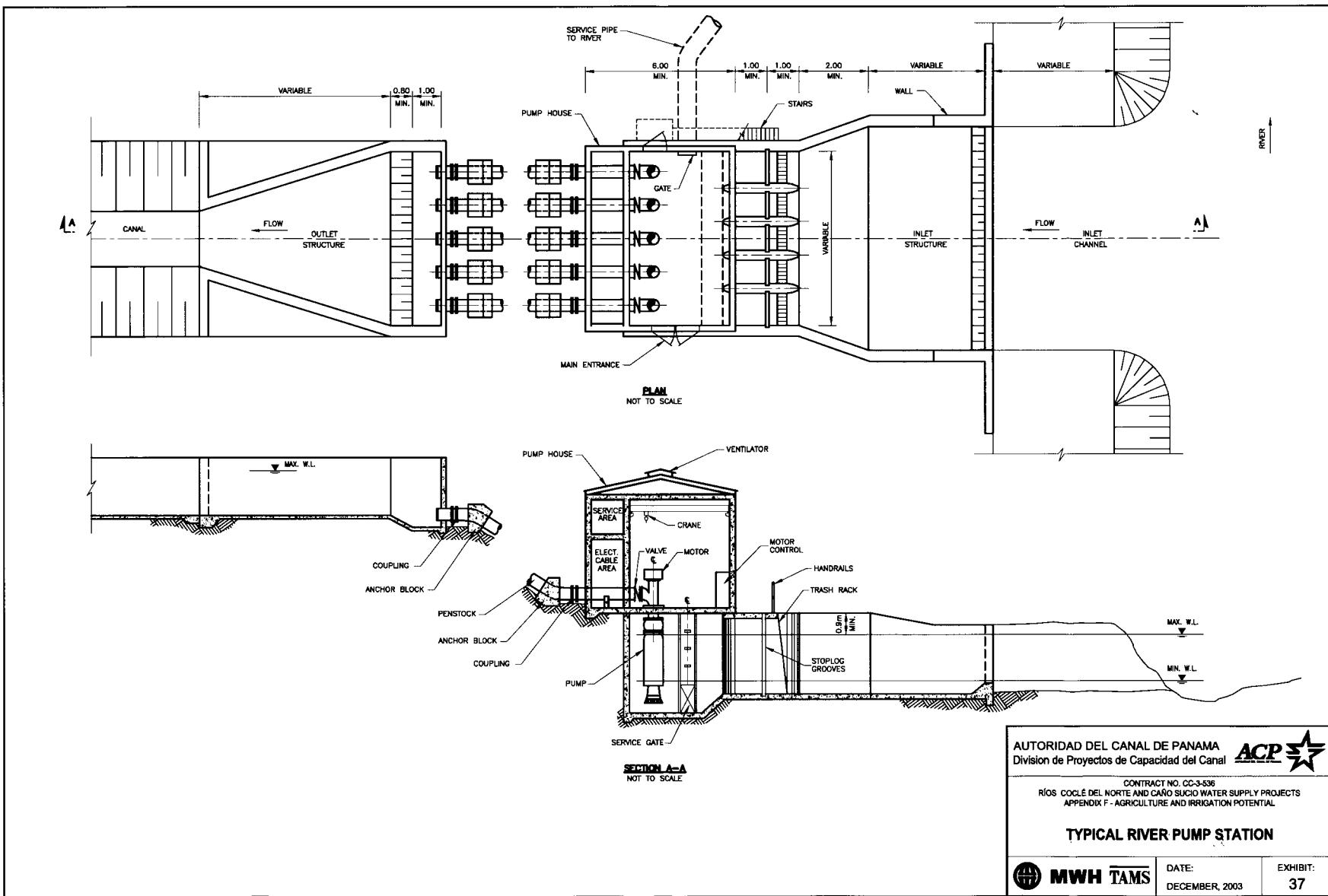


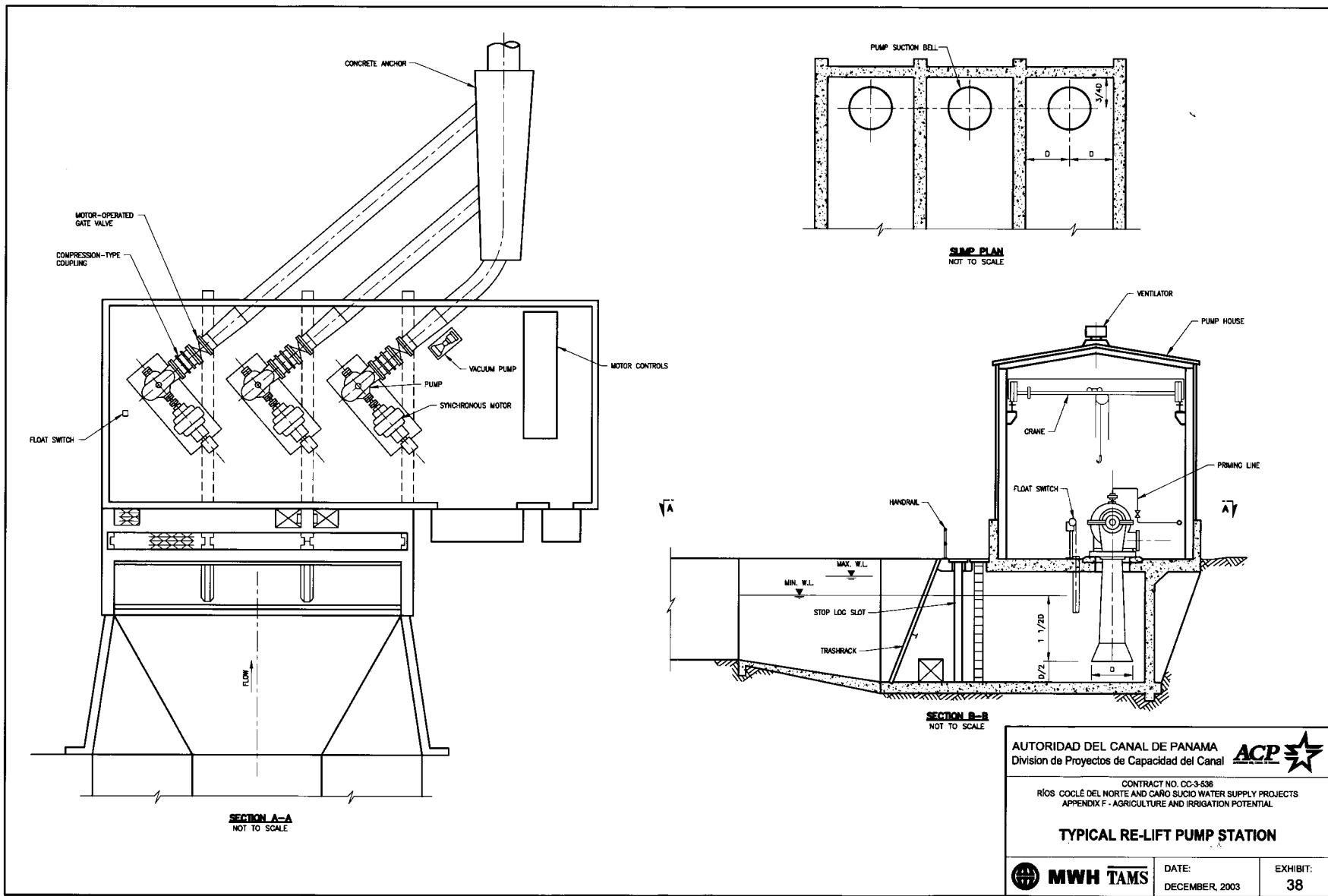












**ATTACHMENTS**

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Coclé del Norte and Caño Sucio Water Supply Projects



**ATTACHMENT 1**

**INITIAL SITE RECONNAISSANCE REPORT**

## **Initial Site Reconnaissance Report**

The initial Site Reconnaissance of the Coclé del Norte Project Area was carried out on Wednesday January 23, 2002. The party included Ing. Agr. José F Abrego of the ACP Environmental Management Division, Ing. Agr Hugo Sanchez Castelo, sub-consultant to TAMS, and Gustavo R. Sobrino, Irrigation Engineer for TAMS. A helicopter provided by ACP was used for this visit.

The party departed at about 9 a.m. from the Marcos A Gelabert (formerly Albrook) Airport in Balboa. About 40 minutes later the flight reached the Southeast corner of the the Coclé del Norte watershed in the headwaters of the Toabré River, a major right tributary of the Coclé del Norte. The flight also went over the San Miguel and Tulú River Valleys, two upper tributaries of the Toabré. It then continued over the Caño Sucio River Valley and then went west and landed at the Coclecito airstrip. A water sample from the Coclé del Norte River (Photo No.1) was taken.

Around 11 a.m. the helicopter took off from Coclecito and flew along the lower course of the Coclé del Norte River, over the villages of Boca del Toabré, San Lucas and Coclé del Norte and then landed at the village bearing this name on the right bank of the river near its mouth on the Caribbean Sea (Photos No.2 and No.3). The spent almost one hour at this village to meet with village leaders in preparation for the field investigations and then took off about 12: 30 p.m.

We flew in an East-West direction along the coastal areas (Photo No.4) including Punta Platanal, Rio Platanal, Punta Limón, Rio Majagual, Rio Aguacate, Rio Cirí and Punta/Rio Diego and finally landed in the village of Miguel de la Borda on the right bank near the mouth of the river bearing the same name .

At Miguel de la Borda, we met with several village leaders in preparation for the field investigations; we departed Miguel de la Borda near 2 p.m. and flew back to Balboa. We flew over the Miguel de la Borda/Caño Sucio (Photo No.5), Coclé del Norte/Toabré and Rio Indio River basins, the Panama Canal basin and landed at the Marcos A Gelabert airport near 3 p.m.



**Photo No.1 – Water Sampling – Río Coclé del Norte Near Coclecito**



**Photo No.2 – Río Coclé del Norte from its mouth in the Caribbean Sea**



Photo No.3 – Village of Coclé del Norte at the mouth of the River



Photo No. 4 – Coastal Areas between Coclé del Norte and Miguel de la Borda



**Photo No. 5 – Inland Areas between Miguel de la Borda and Caño Sucio**

**ATTACHMENT 2**

**POPULATION CENTERS**

## POPULATION CENTERS

Potential irrigable area/rural population center	Corregimiento	Population
<b>AREA 1 - VALLE BAJO DEL RIO COCLE DEL NORTE</b>		
Coclé del Norte	Coclé del Norte	376
San Lucas	Coclé del Norte	185
Coclesito *	San José del General	683
<b>AREA 2 - VALLE DE LOS RIOS PLATANAL, LIMON, AGUACATE Y DIEGO</b>		
Platanal	Miguel de la Borda	172
Limón	Miguel de la Borda	59
Aguacate	Miguel de la Borda	67
Diego	Miguel de la Borda	198
<b>AREA 3 - VALLE BAJO DEL RIO MIGUEL DE LA BORDA</b>		
Miguel de la Borda	Miguel de la Borda	475
<b>AREA 4 - VALLE DEL RIO MIGUELITO</b>		
<b>AREA 5 - VALLE DEL CANO SUCIO: EL CEDRO</b>		
San José del Cedro	Guásimo	115
<b>AREA 6 - VALLE DEL RIO CANO SUCIO: LAS MARAVILLAS</b>		
Las Maravillas	Río Indio	3
Los Chorrillos de Santa María	Guásimo	10
Cerro Miguel de Donoso	Guásimo	55
<b>AREA 7 - VALLE DEL CUIRIA</b>		
Curiá o San Francisco	Toabré	95
Boca del Curiá	Tulú	142
<b>AREA 8 - VALLE DEL RIO TULU</b>		
Tulú Arriba	Tulú	174
Tulú Centro	Tulú	276
<b>AREA 9 - VALLE DEL RIO SAN MIGUEL</b>		
San Miguel Centro	Chiguirí Arriba	710
San Pedro	Chiguirí Arriba	593
Valle del San Miguel	Toabré	256
Larguillo de Abajo	Chiguirí Arriba	68
San Pablo Abajo	Toabré	79
San Miguel	Toabré	26
<b>AREA 10 - VALLE DEL RIO LURA</b>		
Lura Centro	Tulú	328
Boca del Lura	Toabré	220
Lura Arriba	Tulú	116
<b>AREA 11 - VALLE DEL RIO TOCUE</b>		
Tocué	Toabré	259
Boca del Tucué	Toabré	208
<b>AREA 12 - VALLE DEL RIO CHIGUIRI</b>		
Chiguirí Abajo	Toabré	197
Boca del Chiguirí	Toabré	164
Chiguirí Centro	Chiguirí Arriba	226
<b>AREA 13 - VALLE DEL RIO TOABRE</b>		
Tambo	Toabré	570
Paso Real	Toabré	204
<b>TOTAL</b>		<b>7309</b>

Source: Censo de Población y Vivienda Año 2000.- Contraloría General de la República de Panamá.- Dirección de Censos y Estadísticas de Censos y Estadísticas

\* Coclesito is upstream of the study area in the lower valley of the Coclé del Norte River

**ATTACHMENT 3**

**EXISTING AGRICULTURE**

## NET CROP WATER DEMANDS

Table AT10-1 Area No 1 Valle Bajo del Rio Coclé del Norte

Potential evapotranspiration at Icacaí Meteorological Station  
 Monthly rainfall, exceedance 80% of time, at San Lucas Station

DESCRIPTION	Months												Year (mm)	
	J	F	M	A	M	J	J	A	S	O	N	D		
Precipitation	160	115	80	125	290	260	330	320	235	305	390	290	2900	
Potential evapotranspiration	112	114	137	123	106	87	95	99	99	94	78	99	1243	
<b>Annual crops</b>														
Rice, first crop														
Kc					1.1	1.09	1.06	1.05						
Etc					135.3	115.54	92.22	99.75						
Net crop water demand					10.3	0	0	0					10.3	
Rice, second crop														
Kc	1.05											1.1	1.09	1.06
Etc	117.6											103.4	85.02	104.94
Net crop water demand	0											0	0	0
Maize, first crop														0
Kc					0.45	0.84	1.05	0.84						
Etc					55.35	89.04	91.35	79.8						
Net crop water demand					0	0	0	0						
Maize, second crop														
Kc	0.84											0.45	0.84	1.05
Etc	94.08											42.3	65.52	103.95
Net crop water demand	0											0	0	0
Beans														
Kc	0.58	1.04	0.77											
Etc	64.96	116.56	105.49											
Net crop water demand	0	3.56	25.49											29.05
Bejuco beans														
Kc	0.34	0.64	0.08	0.64										
Etc	38.08	72.96	10.96	78.72										
Net crop water demand	0	0	0	0										0
Squash														
Kc	0.34	0.73	1.01	0.82										
Etc	38.08	83.22	138.37	100.86										
Net crop water demand	0	0	58.37	0										58.37
Table tomatoes														
Kc	0.34	0.73	1.01	0.82										
Etc	38.08	83.22	138.37	100.86										
Net crop water demand	0	0	58.37	0										58.37
Industrial tomatoes														
Kc	0.34	0.73	1.01	0.82										
Etc	38.08	83.22	138.37	100.86										
Net crop water demand	0	0	58.37	0										58.37
Watermelons														
Kc	0.40	0.75	0.93	0.75										
Etc	44.8	85.5	127.41	92.25										
Net crop water demand	0	0	47.41	0										47.41
Melons														
Kc	0.40	0.75	0.93	0.75										
Etc	44.8	85.5	127.41	92.25										
Net crop water demand	0	0	47.41	0										47.41
Cassava														
Kc	0.56				0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	62.72				28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Name														
Kc	0.56				0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	62.72				28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Otöe														
Kc	0.56				0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	62.72				28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0	0

## NET CROP WATER DEMANDS

**Table AT10-1 Area No 1 Valle Bajo del Rio Coclé del Norte**

*Potential evapotranspiration at Icacos Meteorological Station  
Monthly rainfall, exceedance 80% of time, at San Lucas Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	160	115	80	125	290	260	330	320	235	305	390	290	2900
Potential evapotranspiration	112	114	137	123	106	87	95	99	99	94	78	99	1243
<b>Perennial crops</b>													
<b>Pineapple</b>													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	50.4	55.86	78.09	88.56	86.92	69.6	76.95	77.22	73.26	65.8	50.7	60.39	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Coffee</b>													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.80	
Etc	56	66.12	90.42	91.02	86.92	78.3	47.5	57.42	65.34	69.56	63.96	89.1	
Net crop water demand	0	0	10.42	0	0	0	0	0	0	0	0	0	10.42
<b>Bananas</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	80.64	86.64	124.67	159.9	110.24	87	98.8	100.98	93.06	79.9	60.84	68.31	
Net crop water demand	0	0	44.67	34.9	0	0	0	0	0	0	0	0	79.57
<b>Plantains</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	80.64	86.64	124.67	159.9	110.24	87	98.8	100.98	93.06	79.9	60.84	68.31	
Net crop water demand	0	0	44.67	34.9	0	0	0	0	0	0	0	0	79.57
<b>Citrus (oranges)</b>													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	84	86.64	106.86	99.63	89.04	69.6	79.8	83.16	83.16	77.08	61.62	75.24	
Net crop water demand	0	0	26.86	0	0	0	0	0	0	0	0	0	26.86
<b>Pasture grasses</b>													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	61.6	79.8	117.82	119.31	107.06	87	96.9	100.98	97.02	87.42	67.08	74.25	
Net crop water demand	0	0	37.82	0	0	0	0	0	0	0	0	0	37.82
<b>Teca trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	0	0	26.86	0	0	0	0	0	0	0	0	0	26.86
<b>Pine trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	0	0	26.86	0	0	0	0	0	0	0	0	0	26.86
<b>Anacardium</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	0	0	26.86	0	0	0	0	0	0	0	0	0	26.86

## NET CROP WATER DEMANDS

Table AT10-2 Area No 1 Valle Bajo del Rio Coclé del Norte

Potential evapotranspiration at Icatal Meteorological Station  
 Monthly rainfall, exceedance 50% of time, at San Lucas Station

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	265	175	195	310	460	390	450	440	330	420	525	600	4460
Potential evapotranspiration	112	114	137	123	106	87	95	99	99	94	78	99	1243
<b>Annual crops</b>													
Rice, first crop													
Kc				1.1	1.09	1.06	1.05						
Etc				135.3	115.54	92.22	99.75						
Net crop water demand				0	0	0	0						0
Rice, second crop													
Kc		1.05									1.1	1.09	1.06
Etc		117.6									103.4	85.02	104.94
Net crop water demand	0										0	0	0
Maize, first crop													
Kc				0.45	0.84	1.05	0.84						
Etc				55.35	89.04	91.35	79.8						
Net crop water demand				0	0	0	0						0
Malze, second crop													
Kc		0.84									0.45	0.84	1.05
Etc		94.08									42.3	65.52	103.95
Net crop water demand	0										0	0	0
Beans													
Kc		0.58	1.04	0.77									
Etc		64.96	118.56	105.49									
Net crop water demand	0	0	0										0
Bejuco beans													
Kc		0.34	0.64	0.08	0.64								
Etc		38.08	72.96	10.96	78.72								
Net crop water demand	0	0	0	0									0
Squash													
Kc		0.34	0.73	1.01	0.82								
Etc		38.08	83.22	138.37	100.86								
Net crop water demand	0	0	0	0									0
Table tomatoes													
Kc		0.34	0.73	1.01	0.82								
Etc		38.08	83.22	138.37	100.86								
Net crop water demand	0	0	0	0									0
Industrial tomatoes													
Kc		0.34	0.73	1.01	0.82								
Etc		38.08	83.22	138.37	100.86								
Net crop water demand	0	0	0	0									0
Watermelons													
Kc		0.40	0.75	0.93	0.75								
Etc		44.8	85.5	127.41	92.25								
Net crop water demand	0	0	0	0									0
Melons													
Kc		0.40	0.75	0.93	0.75								
Etc		44.8	85.5	127.41	92.25								
Net crop water demand	0	0	0	0									0
Cassava													
Kc		0.56		0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc		62.72		28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
Name													
Kc		0.56		0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc		62.72		28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
Otoe													
Kc		0.56		0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc		62.72		28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0

## NET CROP WATER DEMANDS

**Table AT10-2 Area No 1 Valle Bajo del Rio Coclé del Norte**

*Potential evapotranspiration at Icacos Meteorological Station  
Monthly rainfall, exceedance 50% of time, at San Lucas Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	265	176	196	310	460	390	450	440	330	420	525	500	4460
Potential evapotranspiration	112	114	137	123	106	87	95	99	99	94	78	99	1243
<b>Perennial crops</b>													
<b>Pineapple</b>													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	50.4	55.86	78.09	88.56	86.92	69.6	76.95	77.22	73.26	65.8	50.7	60.39	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Coffee</b>													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	56	66.12	90.42	91.02	86.92	78.3	47.5	57.42	65.34	69.56	63.96	89.1	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Bananas</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	80.64	86.64	124.67	159.9	110.24	87	98.8	100.98	93.06	79.9	60.84	68.31	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Plantains</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	80.64	86.64	124.67	159.9	110.24	87	98.8	100.98	93.06	79.9	60.84	68.31	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Citrus (oranges)</b>													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	84	86.64	106.86	99.63	89.04	69.6	79.8	83.16	83.16	77.08	61.62	75.24	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Pasture grasses</b>													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	61.6	79.8	117.82	119.31	107.06	87	96.9	100.98	97.02	87.42	67.08	74.25	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Teca trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Pine trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Anacardium</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0

## NET CROP WATER DEMANDS

**Table AT10-3 Area No 2: Platanal, Limon, Aguacate y Diego**  
**Area No.3: Valle Bajo del Rio Miguel de la Borda**  
*Potential evapotranspiration at Icatal Meteorological Station*  
*Monthly rainfall,exceedance 80% of time,at Miguel de la Borda Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	F	O	N	D	
Precipitation	55	30	20	50	270	240	300	210	220	290	355	180	2220
Potential evapotranspiration	112	114	137	123	106	87	95	99	99	94	78	99	1243
<b>Annual crops</b>													
Rice,first crop													
Kc				1.1	1.09	1.06	1.05						
Etc				135.3	115.54	92.22	99.75						
Net crop water demand				85.3	0	0	0						85.3
Rice,second crop													
Kc	1.05										1.1	1.09	1.06
Etc	117.6										103.4	85.02	104.94
Net crop water demand	62.6										0	0	0
Maize,first crop													
Kc				0.45	0.84	1.05	0.84						
Etc				55.35	89.04	91.35	79.8						
Net crop water demand				5.35	0	0	0						5.35
Malza,second crop													
Kc	0.84										0.45	0.84	1.05
Etc	94.08										42.3	65.52	103.95
Net crop water demand	39.08										0	0	0
Beans													
Kc	0.58	1.04	0.77										
Etc	64.96	118.56	105.49										
Net crop water demand	9.96	88.56	85.49										184.01
Bejuco beans													
Kc	0.34	0.64	0.08	0.64									
Etc	38.08	72.96	10.96	78.72									
Net crop water demand	0	42.96	0	28.72									71.88
Squash													
Kc	0.34	0.73	1.01	0.82									
Etc	38.08	83.22	138.37	100.86									
Net crop water demand	0	53.22	118.37	50.86									222.45
Table tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	38.08	83.22	138.37	100.86									
Net crop water demand	0	53.22	118.37	50.86									222.45
Industrial tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	38.08	83.22	138.37	100.86									
Net crop water demand	0	53.22	118.37	50.86									222.45
Watermelons													
Kc	0.40	0.75	0.93	0.75									
Etc	44.8	85.5	127.41	92.25									
Net crop water demand	0	55.5	107.41	42.25									205.16
Melons													
Kc	0.40	0.75	0.93	0.75									
Etc	44.8	85.5	127.41	92.25									
Net crop water demand	0	55.5	107.41	42.25									205.16
Cassava													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	62.72			28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3	
Net crop water demand	7.72	0	0	0	0	0	0	0	0	0	0	0	7.72
Name													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	62.72			28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3	
Net crop water demand	7.72	0	0	0	0	0	0	0	0	0	0	0	7.72
Otoe													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	62.72			28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3	
Net crop water demand	7.72	0	0	0	0	0	0	0	0	0	0	0	7.72

## NET CROP WATER DEMANDS

**Table AT10-3 Area No 2: Platanal, Limon, Aguacate y Diego**  
**Area No.3: Valle Bajo del Rio Miguel de la Borda**  
*Potential evapotranspiration at Icacaí Meteorological Station*  
*Monthly rainfall,exceedance 80% of time,at Miguel de la Borda Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	F	O	N	D	
Precipitation	55	30	20	50	270	240	300	210	220	290	355	180	2220
Potential evapotranspiration	112	114	137	123	106	87	95	99	99	94	78	99	1243
<b>Perennial crops</b>													
Pineapple													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	50.40	55.86	78.09	88.56	86.92	69.60	76.95	77.22	73.26	65.80	50.70	60.39	
Net crop water demand	0	25.86	58.09	38.56	0	0	0	0	0	0	0	0	122.5
Coffee													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	56.00	66.12	90.42	91.02	86.92	78.3	47.5	57.42	65.34	69.56	63.96	89.1	
Net crop water demand	1	36.12	70.42	41.02	0	0	0	0	0	0	0	0	148.56
Bananas													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	80.64	86.64	124.67	159.9	110.24	87	98.8	100.98	93.06	79.9	60.84	68.31	
Net crop water demand	25.64	56.64	104.67	109.9	0	0	0	0	0	0	0	0	296.85
Plantains													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	80.64	86.64	124.67	159.9	110.24	87	98.8	100.98	93.06	79.9	60.84	68.31	
Net crop water demand	25.64	56.64	104.67	109.9	0	0	0	0	0	0	0	0	296.85
Citrus (oranges)													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	84	86.64	106.86	99.63	89.04	69.6	79.8	83.16	83.16	77.08	61.62	75.24	
Net crop water demand	29	56.64	86.86	49.63	0	0	0	0	0	0	0	0	222.13
Pasture grasses													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	61.6	79.8	117.82	119.31	107.06	87	96.9	100.98	97.02	87.42	67.08	74.25	
Net crop water demand	6.6	49.8	97.82	69.31	0	0	0	0	0	0	0	0	223.53
Teca trees													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	1	42.96	86.86	63.16	0	0	0	0	0	0	0	0	193.98
Pine trees													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	1	42.96	86.86	63.16	0	0	0	0	0	0	0	0	193.98
Anacardium													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	1	42.96	86.86	63.16	0	0	0	0	0	0	0	0	193.98

## NET CROP WATER DEMANDS

**Table AT10-4 Area No 2: Platanal, Limon, Aguacate y Diego  
Area No.3: Valle Bajo del Rio Miguel de la Borda**  
*Potential evapotranspiration at Icaca Meteorological Station  
Monthly rainfall, exceedance 50% of time, at Miguel de la Borda Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	F	O	N	D	
Precipitation	120	80	65	190	360	380	390	420	300	400	480	380	3565
Potential evapotranspiration	112	114	137	123	106	87	95	99	99	94	78	99	1243
<b>Annual crops</b>													
Rice,first crop													
Kc				1.1	1.09	1.06	1.05						
Etc				135.3	115.54	92.22	99.75						
Net crop water demand				0	0	0	0						0
Rice,second crop													
Kc	1.05											1.1	1.09
Etc	117.6											103.4	85.02
Net crop water demand	0											0	104.94
Maize,first crop													
Kc				0.45	0.84	1.05	0.84						
Etc				55.35	89.04	91.35	79.8						
Net crop water demand				0	0	0	0						0
Maize,second crop													
Kc	0.84											0.45	0.84
Etc	94.08											42.3	65.52
Net crop water demand	0											0	103.95
Beans													
Kc	0.58	1.04	0.77										
Etc	64.96	118.56	105.49										
Net crop water demand	0	38.56	40.49										79.05
Bejuco beans													
Kc	0.34	0.64	0.08	0.64									
Etc	38.08	72.96	10.96	78.72									
Net crop water demand	0	0	0	0									0
Squash													
Kc	0.34	0.73	1.01	0.82									
Etc	38.08	83.22	138.37	100.86									
Net crop water demand	0	3.22	73.37	0									76.59
Table tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	38.08	83.22	138.37	100.86									
Net crop water demand	0	3.22	73.37	0									76.59
Industrial tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	38.08	83.22	138.37	100.86									
Net crop water demand	0	3.22	73.37	0									76.59
Watermelons													
Kc	0.40	0.75	0.93	0.75									
Etc	44.8	85.5	127.41	92.25									
Net crop water demand	0	5.5	62.41	0									67.91
Melons													
Kc	0.40	0.75	0.93	0.75									
Etc	44.8	85.5	127.41	92.25									
Net crop water demand	0	5.5	62.41	0									67.91
Cassava													
Kc	0.56		0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70		
Etc	62.72		28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3		
Net crop water demand	0		0	0	0	0	0	0	0	0	0		0
Name													
Kc	0.56		0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70		
Etc	62.72		28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3		
Net crop water demand	0		0	0	0	0	0	0	0	0	0		0
Otoe													
Kc	0.56		0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70		
Etc	62.72		28.29	34.98	40.02	58.9	74.25	80.19	78.02	61.62	69.3		
Net crop water demand	0		0	0	0	0	0	0	0	0	0		0

## NET CROP WATER DEMANDS

**Table AT10-4 Area No 2: Platanal, Limon, Aguacate y Diego**  
**Area No.3: Valle Bajo del Rio Miguel de la Borda**  
*Potential evapotranspiration at Icacaí Meteorological Station*  
*Monthly rainfall,exceedance 50% of time,at Miguel de la Borda Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	F	O	N	D	
Precipitation	120	80	65	190	360	380	390	420	300	400	480	380	3565
Potential evapotranspiration	112	114	137	123	106	87	95	99	99	94	78	99	1243
<b>Perennial crops</b>													
<b>Pineapple</b>													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	50.40	55.86	78.09	88.56	86.92	69.60	76.95	77.22	73.26	65.80	50.70	60.39	
Net crop water demand	0	0	13.09	0	0	0	0	0	0	0	0	0	13.1
<b>Coffee</b>													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	56.00	66.12	90.42	91.02	86.92	78.3	47.5	57.42	65.34	69.56	63.96	69.1	
Net crop water demand	0	0	25.42	0	0	0	0	0	0	0	0	0	25.42
<b>Bananas</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	80.64	86.64	124.67	159.9	110.24	87	98.8	100.98	93.06	79.9	60.84	68.31	
Net crop water demand	0	6.64	59.67	0	0	0	0	0	0	0	0	0	66.31
<b>Plantains</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	80.64	86.64	124.67	159.9	110.24	87	98.8	100.98	93.06	79.9	60.84	68.31	
Net crop water demand	0	6.64	59.67	0	0	0	0	0	0	0	0	0	66.31
<b>Citrus (oranges)</b>													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	84	86.64	106.86	99.63	89.04	69.6	79.8	83.16	83.16	77.08	61.62	75.24	
Net crop water demand	0	6.64	41.86	0	0	0	0	0	0	0	0	0	48.5
<b>Pasture grasses</b>													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	61.6	79.8	117.82	119.31	107.06	87	96.9	100.98	97.02	87.42	67.08	74.25	
Net crop water demand	0	0	52.82	0	0	0	0	0	0	0	0	0	52.82
<b>Teca trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	0	0	41.86	0	0	0	0	0	0	0	0	0	41.86
<b>Pine trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	0	0	41.86	0	0	0	0	0	0	0	0	0	41.86
<b>Anacardium</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	56	72.96	106.86	113.16	112.36	104.4	47.5	63.36	77.22	86.48	82.68	118.8	
Net crop water demand	0	0	41.86	0	0	0	0	0	0	0	0	0	41.86

**NET CROP WATER DEMANDS**

**Table AT10-5 Area No 4 Valle del Rio Miguelito**  
**Area No. 5 Area del Rio Cano Sucio, Sector El Cedro**  
**Area No. 6 Valle del Rio Cano Sucio, Sector las Maravillas**  
*Potential evapotranspiration in mm at Boca de Uracillo Meteorological Station*  
*Monthly rainfall exceeded 80% of time at Boca de Uracillo Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	55	30	20	65	235	235	195	195	200	300	280	115	1925
Potential evapotranspiration	130	122	138	121	101	104	110	105	103	93	96	115	1338
<b>Annual crops</b>													
Rice, first crop													
Kc				1.1	1.09	1.06	1.05						
Etc				133.1	110.09	110.24	115.5						
Net crop water demand				68.1	0	0	0						68.1
Rice, second crop													
Kc	1.05									1.1	1.09	1.06	
Etc	136.5									102.3	104.64	121.9	
Net crop water demand	81.5									0	0	6.9	88.4
Maize, first crop													
Kc				0.45	0.84	1.05	0.84						
Etc				54.45	84.84	109.2	92.4						
Net crop water demand				0	0	0	0						0
Maize, second crop													
Kc	0.84									0.45	0.84	1.05	
Etc	109.2									41.85	80.64	120.75	
Net crop water demand	54.2									0	0	5.75	59.95
Beans													
Kc	0.58	1.04	0.77										
Etc	75.4	126.88	106.26										
Net crop water demand	20.4	96.88	86.26										203.64
Bejuco beans													
Kc	0.34	0.64	0.08	0.64									
Etc	44.2	78.08	11.04	77.44									
Net crop water demand	0	48.08	0	12.44									60.52
Squash													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	89.06	139.38	99.22									
Net crop water demand	0	59.06	119.38	34.22									212.66
Table tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	89.06	139.38	99.22									
Net crop water demand	0	59.06	119.38	34.22									212.66
Industrial tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	89.06	139.38	99.22									
Net crop water demand	0	59.06	119.38	34.22									212.66
Watermelons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	91.5	128.34	90.75									
Net crop water demand	0	61.5	108.34	25.75									195.59
Melons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	91.5	128.34	90.75									
Net crop water demand	0	61.5	108.34	25.75									195.59
Cassava													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			27.83	33.33	47.84	68.2	78.75	83.43	77.19	75.84	80.5	
Net crop water demand	17.8			0	0	0	0	0	0	0	0	0	17.8
Name													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			27.83	33.33	47.84	68.2	78.75	83.43	77.19	75.84	80.5	
Net crop water demand	17.8			0	0	0	0	0	0	0	0	0	17.8
Otoe													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			27.83	33.33	47.84	68.2	78.75	83.43	77.19	75.84	80.5	
Net crop water demand	17.8			0	0	0	0	0	0	0	0	0	17.8

## NET CROP WATER DEMANDS

**Table AT10-5 Area No 4 Valle del Rio Miguelito  
Area No. 5 Area del Rio Cano Sucio, Sector El Cedro  
Area No. 6 Valle del Rio Cano Sucio, Sector las Maravillas**  
*Potential evapotranspiration in mm at Boca de Uracillo Meteorological Station  
Monthly rainfall exceeded 80% of time at Boca de Uracillo Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	55	30	20	65	235	235	195	195	200	300	280	116	1925
Potential evapotranspiration	130	122	138	121	101	104	110	105	103	93	96	115	1338
<b>Perennial crops</b>													
<b>Pineapple</b>													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	58.50	59.78	78.66	87.12	82.82	83.20	89.10	81.90	76.22	65.10	62.40	70.15	
Net crop water demand	3.5	29.78	58.66	22.12	0	0	0	0	0	0	0	0	114.1
<b>Coffee</b>													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	65.00	70.76	91.08	89.54	82.82	93.6	55	60.9	67.98	68.82	78.72	103.5	
Net crop water demand	10	40.76	71.08	24.54	0	0	0	0	0	0	0	0	146.38
<b>Bananas</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	92.72	125.58	157.3	105.04	104	114.4	107.1	96.82	79.05	74.88	79.35	
Net crop water demand	38.6	62.72	105.58	92.3	0	0	0	0	0	0	0	0	299.2
<b>Plantains</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	92.72	125.58	157.3	105.04	104	114.4	107.1	96.82	79.05	74.88	79.35	
Net crop water demand	38.6	62.72	105.58	92.3	0	0	0	0	0	0	0	0	299.2
<b>Citrus (oranges)</b>													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	97.5	92.72	107.64	98.01	84.84	83.2	92.4	88.2	86.52	76.26	75.84	87.4	
Net crop water demand	42.5	62.72	87.64	33.01	0	0	0	0	0	0	0	0	225.87
<b>Pasture grasses</b>													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	71.5	85.4	118.68	117.37	102.01	104	112.2	107.1	100.94	86.49	82.56	86.25	
Net crop water demand	16.5	55.4	98.68	52.37	0	0	0	0	0	0	0	0	222.95
<b>Teca trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	78.08	107.64	111.32	107.06	124.8	55	67.2	80.34	85.56	101.76	138	
Net crop water demand	10	48.08	87.64	46.32	0	0	0	0	0	0	0	23	215.04
<b>Pine trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	78.08	107.64	111.32	107.06	124.8	55	67.2	80.34	85.56	101.76	138	
Net crop water demand	10	48.08	87.64	46.32	0	0	0	0	0	0	0	23	215.04
<b>Anacardium</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	78.08	107.64	111.32	107.06	124.8	55	67.2	80.34	85.56	101.76	138	
Net crop water demand	10	48.08	87.64	46.32	0	0	0	0	0	0	0	23	215.04

## NET CROP WATER DEMANDS

**Table AT10-5 Area No 4 Valle del Rio Miguelito**  
**Area No. 5 Area del Rio Cano Sucio, Sector El Cedro**  
**Area No. 6 Valle del Rio Cano Sucio, Sector las Maravillas**

*Potential evapotranspiration in mm at Boca de Uracillo Meteorological Station  
Monthly rainfall exceeded 50% of time at Boca de Uracillo Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	95	65	60	125	325	310	260	295	315	390	340	206	2765
Potential evapotranspiration	130	122	138	121	101	104	110	105	103	93	96	115	1338
<b>Annual crops</b>													
Rice,first crop													
Kc				1.1	1.09	1.06	1.05						
Etc				133.1	110.09	110.24	115.5						
Net crop water demand				8.1	0	0	0						8.1
Rice,second crop													
Kc	1.05											1.1	1.09
Etc	136.5											102.3	104.64
Net crop water demand	41.5											0	121.9
Maize,first crop													
Kc				0.45	0.64	1.05	0.84						
Etc				54.45	84.84	109.2	92.4						
Net crop water demand				0	0	0	0						0
Maize,second crop													
Kc	0.84											0.45	0.84
Etc	109.2											41.85	80.64
Net crop water demand	14.2											0	120.75
Beans													
Kc	0.58	1.04	0.77										
Etc	75.4	126.88	106.26										
Net crop water demand	0	71.88	46.26										118.14
Bejuco beans													
Kc	0.34	0.64	0.08	0.64									
Etc	44.2	78.08	11.04	77.44									
Net crop water demand	0	23.08	0	0									23.08
Squash													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	89.06	139.38	99.22									
Net crop water demand	0	34.06	79.38	0									113.44
Table tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	89.06	139.38	99.22									
Net crop water demand	0	34.06	79.38	0									113.44
Industrial tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	89.06	139.38	99.22									
Net crop water demand	0	34.06	79.38	0									113.44
Watermelons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	91.5	128.34	90.75									
Net crop water demand	0	36.5	68.34	0									104.84
Melons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	91.5	128.34	90.75									
Net crop water demand	0	36.5	68.34	0									104.84
Cassava													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			27.83	33.33	47.84	68.2	78.75	83.43	77.19	75.84	80.5	
Net crop water demand	0			0	0	0	0	0	0	0	0	0	0
Name													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			27.83	33.33	47.84	68.2	78.75	83.43	77.19	75.84	80.5	
Net crop water demand	0			0	0	0	0	0	0	0	0	0	0
Otote													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			27.83	33.33	47.84	68.2	78.75	83.43	77.19	75.84	80.5	
Net crop water demand	0			0	0	0	0	0	0	0	0	0	0

## NET CROP WATER DEMANDS

**Table AT10-5 Area No 4 Valle del Rio Miguelito**  
**Area No. 5 Area del Rio Cano Sucio, Sector El Cedro**  
**Area No. 6 Valle del Rio Cano Sucio, Sector las Maravillas**

*Potential evapotranspiration in mm at Boca de Uracillo Meteorological Station*  
*Monthly rainfall exceeded 50% of time at Boca de Uracillo Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	95	55	60	125	325	310	250	295	315	390	340	205	2765
Potential evapotranspiration	130	122	138	121	101	104	110	105	103	93	96	115	1338
<b>Perennial crops</b>													
Pineapple													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	58.50	59.78	78.66	87.12	82.82	83.20	89.10	81.90	78.22	65.10	62.40	70.15	
Net crop water demand	0	4.78	18.66	0	0	0	0	0	0	0	0	0	23.4
Coffee													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	65.00	70.76	91.08	89.54	82.82	93.6	55	60.9	67.98	68.82	78.72	103.5	
Net crop water demand	0	15.76	31.08	0	0	0	0	0	0	0	0	0	46.84
Bananas													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	92.72	125.58	157.3	105.04	104	114.4	107.1	96.82	79.05	74.88	79.35	
Net crop water demand	0	37.72	65.58	32.3	0	0	0	0	0	0	0	0	135.6
Plantains													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	92.72	125.58	157.3	105.04	104	114.4	107.1	96.82	79.05	74.88	79.35	
Net crop water demand	0	37.72	65.58	32.3	0	0	0	0	0	0	0	0	135.6
Citrus (oranges)													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	97.5	92.72	107.64	98.01	84.84	83.2	92.4	88.2	86.52	76.26	75.84	87.4	
Net crop water demand	2.5	37.72	47.64	0	0	0	0	0	0	0	0	0	87.88
Pasture grasses													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	71.5	85.4	118.68	117.37	102.01	104	112.2	107.1	100.94	86.49	82.56	86.25	
Net crop water demand	0	30.4	58.68	0	0	0	0	0	0	0	0	0	89.08
Teca trees													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	78.08	107.64	111.32	107.06	124.8	55	67.2	80.34	85.56	101.76	138	
Net crop water demand	0	23.08	47.64	0	0	0	0	0	0	0	0	0	70.72
Pine trees													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	78.08	107.64	111.32	107.06	124.8	55	67.2	80.34	85.56	101.76	138	
Net crop water demand	0	23.08	47.64	0	0	0	0	0	0	0	0	0	70.72
Anacardium													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	78.08	107.64	111.32	107.06	124.8	55	67.2	80.34	85.56	101.76	138	
Net crop water demand	0	23.08	47.64	0	0	0	0	0	0	0	0	0	70.72

## NET CROP WATER DEMANDS

**Table AT10-7 Area No7 Valle del Rio Cuiria, Area No8 Valle del Rio Tulu  
Area No 9 Valle del Rio San Miguel  
Area No 10 Valle del Rio Luria, Area No 13 Valle del Rio Toab**  
*Potential evapotranspiration in mm at Santa Ana Meteorological Station.  
Monthly rainfall exceeded 80 % of time at Santa Ana Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	50	20	20	65	150	170	125	145	180	210	175	75	1375
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312
<b>Annual crops</b>													
Rice,first crop													
Kc				1.1	1.09	1.06	1.05						
Etc				137.5	110.09	104.94	110.25						
Net crop water demand				82.5	0	0	0						82.5
Rice,second crop													
Kc	1.05										1.1	1.09	1.06
Etc	136.5										89.1	99.19	124.02
Net crop water demand	86.5										0	0	49.02
Maize,first crop													
Kc				0.45	0.84	1.05	0.84						
Etc				56.25	84.84	103.95	88.2						
Net crop water demand				1.25	0	0	0						1.25
Maize,second crop													
Kc	0.84										0.45	0.84	1.05
Etc	109.2										36.45	76.44	122.85
Net crop water demand	59.2										0	0	47.85
Beans													
Kc	0.58	1.04	0.77										
Etc	75.4	131.04	105.49										
Net crop water demand	25.4	111.04	85.49										221.93
Bejuco beans													
Kc	0.34	0.64	0.08	0.64									
Etc	44.2	80.64	10.96	80									
Net crop water demand	0	60.64	0	25									85.64
Squash													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	0	71.98	118.37	47.5									237.85
Table tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	0	71.98	118.37	47.5									237.85
Industrial tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	0	71.98	118.37	47.5									237.85
Watermelons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	94.5	127.41	93.75									
Net crop water demand	2	74.5	107.41	38.75									222.66
Melons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	94.5	127.41	93.75									
Net crop water demand	2	74.5	107.41	38.75									222.66
Cassava													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand	22.8			0	0	0	0	0	0	0	0	6.9	29.7
Name													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand	22.8			0	0	0	0	0	0	0	0	6.9	29.7
Otoe													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand	22.8			0	0	0	0	0	0	0	0	6.9	29.7

## NET CROP WATER DEMANDS

**Table AT10-7 Area No7 Valle del Rio Cuiria, Area No8 Valle del Rio Tulu  
Area No 9 Valle del Rio San Miguel  
Area No 10 Valle del Rio Luria, Area No 13 Valle del Rio Toab**

*Potential evapotranspiration in mm at Santa Ana Meteorological Station.*

*Monthly rainfall exceeded 80 % of time at Santa Ana Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	50	20	20	55	150	170	125	145	180	210	175	75	1375
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312

<b>Perennial crops</b>													
<b>Pineapple</b>													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	58.5	61.74	78.09	90	82.82	79.2	85.05	79.56	72.52	56.7	59.15	71.37	
Net crop water demand	8.5	41.74	58.09	35	0	0	0	0	0	0	0	0	143.33
<b>Coffee</b>													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	65	73.08	90.42	92.5	82.82	89.1	52.5	59.16	64.68	59.94	74.62	105.3	
Net crop water demand	15	53.08	70.42	37.5	0	0	0	0	0	0	0	30.3	206.3
<b>Bananas</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	43.6	75.76	104.67	107.5	0	0	0	0	0	0	0	5.73	337.26
<b>Plantains</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	43.6	75.76	104.67	107.5	0	0	0	0	0	0	0	5.73	337.26
<b>Citrus (oranges)</b>													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	97.5	95.76	106.86	101.25	84.84	79.2	88.2	85.68	82.32	66.42	71.89	88.92	
Net crop water demand	47.5	75.76	86.86	46.25	0	0	0	0	0	0	0	13.92	270.29
<b>Pasture grasses</b>													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	71.5	86.2	117.82	121.25	102.01	99	107.1	104.04	96.04	75.33	78.26	87.75	
Net crop water demand	21.5	68.2	97.82	66.25	0	0	0	0	0	0	0	12.75	266.52
<b>Teca trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	15	60.64	86.86	60	0	0	0	0	0	0	0	65.4	287.9
<b>Pine trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	15	60.64	86.86	60	0	0	0	0	0	0	0	65.4	287.9
<b>Anacardium</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	15	60.64	86.86	60	0	0	0	0	0	0	0	65.4	287.9

## NET CROP WATER DEMANDS

**Table AT10-8 Area No7 Valle del Rio Cuiria, Area No8 Valle del Rio Tulu  
Area No 9 Valle del Rio San Miguel  
Area No 10 Valle del Rio Luria, Area No 13 Valle del Rio Toab**  
*Potential evapotranspiration in mm at Santa Ana Meteorological Station.  
Monthly rainfall exceeded 50 % of time at Santa Ana Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	75	40	50	90	225	230	220	200	215	295	255	135	2030
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312
<b>Annual crops</b>													
Rice, first crop													
Kc				1.1	1.09	1.06	1.05						
Etc				137.5	110.09	104.94	110.25						
Net crop water demand				47.5	0	0	0						47.5
Rice, second crop													
Kc	1.05										1.1	1.09	1.06
Etc	136.5										89.1	99.19	124.02
Net crop water demand	61.5										0	0	0
Maize, first crop													
Kc				0.45	0.84	1.05	0.84						
Etc				56.25	84.84	103.95	88.2						
Net crop water demand				0	0	0	0						0
Maize, second crop													
Kc	0.84										0.45	0.84	1.05
Etc	109.2										36.45	76.44	122.85
Net crop water demand	34.2										0	0	34.2
Beans													
Kc	0.58	1.04	0.77										
Etc	75.4	131.04	105.49										
Net crop water demand	0.4	91.04	55.49										146.93
Bejucos beans													
Kc	0.34	0.64	0.08	0.64									
Etc	44.2	80.64	10.96	80									
Net crop water demand	0	40.64	0	0									40.64
Squash													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	0	51.98	88.37	12.5									152.85
Table tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	0	51.98	88.37	12.5									152.85
Industrial tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	0	51.98	88.37	12.5									152.85
Watermelons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	94.5	127.41	93.75									
Net crop water demand	0	54.5	77.41	3.75									135.66
Melons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	94.5	127.41	93.75									
Net crop water demand	0	54.5	77.41	3.75									135.66
Cassava													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand	0			0	0	0	0	0	0	0	0	0	0
Name													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand	0			0	0	0	0	0	0	0	0	0	0
Otoe													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand	0			0	0	0	0	0	0	0	0	0	0

## NET CROP WATER DEMANDS

**Table AT10-8 Area No7 Valle del Rio Cuiria, Area No8 Valle del Rio Tulu  
Area No 9 Valle del Rio San Miguel  
Area No 10 Valle del Rio Luria, Area No 13 Valle del Rio Toab**

*Potential evapotranspiration in mm at Santa Ana Meteorological Station.*

*Monthly rainfall exceeded 50 % of time at Santa Ana Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	75	40	50	90	225	230	220	200	215	295	255	135	2030
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312
<b>Perennial crops</b>													
Pineapple													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	58.5	61.74	78.09	90	82.82	79.2	85.05	79.56	72.52	56.7	59.15	71.37	
Net crop water demand	0	21.74	28.09	0	0	0	0	0	0	0	0	0	49.83
Coffee													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	65	73.08	90.42	92.5	82.82	89.1	52.5	59.16	64.68	59.94	74.62	105.3	
Net crop water demand	0	33.08	40.42	2.5	0	0	0	0	0	0	0	0	76
Bananas													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	18.6	55.76	74.67	72.5	0	0	0	0	0	0	0	0	221.53
Plantains													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	18.6	55.76	74.67	72.5	0	0	0	0	0	0	0	0	221.53
Citrus (oranges)													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	97.5	95.76	106.86	101.25	84.84	79.2	88.2	85.68	82.32	66.42	71.89	88.92	
Net crop water demand	22.5	55.76	56.86	11.25	0	0	0	0	0	0	0	0	146.37
Pasture grasses													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	71.5	88.2	117.82	121.25	102.01	99	107.1	104.04	96.04	75.33	78.26	87.75	
Net crop water demand	0	48.2	67.82	31.25	0	0	0	0	0	0	0	0	147.27
Teca trees													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	0	40.64	56.86	25	0	0	0	0	0	0	0	5.4	127.9
Pine trees													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	0	40.64	56.86	25	0	0	0	0	0	0	0	5.4	127.9
Anacardium													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	0	40.64	56.86	25	0	0	0	0	0	0	0	5.4	127.9

## NET CROP WATER DEMANDS

**Table AT10-9 Area No 11 Valle del Rio Tucue**  
*Potential evapotranspiration in mm at Santa Ana Meteorological Station*  
*Monthly rainfall exceeded 80% of time at Tambo Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	7	4	1	11	110	160	165	165	190	205	110	30	1168
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312
<b>Annual crops</b>													
Rice, first crop													
Kc				1.1	1.09	1.06	1.05						
Etc				137.5	110.09	104.94	110.25						
Net crop water demand				126.5	0.09	0	0						126.59
Rice, second crop													
Kc	1.05											1.1	1.09
Etc	136.5											89.1	99.19
Net crop water demand	129.5											0	94.02
Maize, first crop													
Kc				0.45	0.84	1.05	0.84						
Etc				56.25	84.84	103.95	88.2						
Net crop water demand				45.25	0	0	0						45.25
Maize, second crop													
Kc	0.84											0.45	0.84
Etc	109.2											36.45	76.44
Net crop water demand	102.2											0	92.85
Beans													
Kc	0.58	1.04	0.77										
Etc	75.4	131.04	105.49										
Net crop water demand	68.4	127.04	104.49										299.93
Bejucos beans													
Kc	0.34	0.64	0.08	0.64									
Etc	44.2	80.64	10.96	80									
Net crop water demand	37.2	76.64	9.96	69									192.8
Squash													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	37.2	87.98	137.37	91.5									364.05
Table tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	37.2	87.98	137.37	91.5									354.05
Industrial tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	37.2	87.98	137.37	91.5									364.05
Watermelons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	94.5	127.41	93.75									
Net crop water demand	45	90.5	126.41	82.75									344.66
Melons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	94.5	127.41	93.75									
Net crop water demand	45	90.5	126.41	82.75									344.66
Cassava													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand	65.8			17.75	0	0	0	0	0	0	0	51.9	135.45
Name													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand	65.8			17.75	0	0	0	0	0	0	0	51.9	135.45
Otote													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand	65.8			17.75	0	0	0	0	0	0	0	51.9	135.45

## NET CROP WATER DEMANDS

**Table AT10-9 Area No 11 Valle del Rio Tucue**  
*Potential evapotranspiration in mm at Santa Ana Meteorological Station*  
*Monthly rainfall exceeded 80% of time at Tambo Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	7	4	1	11	110	160	165	165	190	205	110	30	1158
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312
<b>Perennial crops</b>													
<b>Pineapple</b>													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	58.5	61.74	78.09	90	82.82	79.2	85.05	79.56	72.52	56.7	59.15	71.37	
Net crop water demand	51.5	57.74	77.09	79	0	0	0	0	0	0	0	41.37	306.7
<b>Coffee</b>													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	65	73.08	90.42	92.5	82.82	89.1	52.5	59.16	64.68	59.94	74.62	105.3	
Net crop water demand	58	69.08	89.42	81.5	0	0	0	0	0	0	0	75.3	373.3
<b>Bananas</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	86.6	91.76	123.67	151.5	0	0	0	0	0	0	0	50.73	504.26
<b>Plantains</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	86.6	91.76	123.67	151.5	0	0	0	0	0	0	0	50.73	504.26
<b>Citrus (oranges)</b>													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	97.5	95.76	106.86	101.25	84.84	79.2	88.2	85.68	82.32	66.42	71.89	88.92	
Net crop water demand	90.5	91.76	105.86	90.25	0	0	0	0	0	0	0	58.92	437.29
<b>Pasture grasses</b>													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.04	1.02	0.98	0.93	0.86	0.75	
Etc	71.5	88.2	117.82	121.25	102.01	99	107.1	104.04	96.04	75.33	78.26	87.75	
Net crop water demand	64.5	84.2	116.82	110.25	0	0	0	0	0	0	0	57.75	433.52
<b>Teca trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	58	76.64	105.86	104	0	0	0	0	0	0	0	110.4	454.9
<b>Pine trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	58	76.64	105.86	104	0	0	0	0	0	0	0	110.4	454.9
<b>Anacardium</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	58	76.64	105.86	104	0	0	0	0	0	0	0	110.4	454.9

## NET CROP WATER DEMANDS

**Table AT10-10 Area No 11 Valle del Rio Tucue**  
*Potential evapotranspiration in mm at Santa Ana Meteorological Station  
Monthly rainfall exceeded 50% of time at Tambo Station*

DESCRIPTION	Months												Year (mm)		
	J	F	M	A	M	J	J	A	S	O	N	D			
Precipitation	25	13	15	35	215	220	225	230	260	300	200	90	1828		
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312		
<b>Annual crops</b>															
Rice, first crop															
Kc				1.1	1.09	1.06	1.05								
Etc				137.5	110.09	104.94	110.25								
Net crop water demand				102.5	0	0	0						102.5		
Rice, second crop															
Kc	1.05											1.1	1.09	1.06	
Etc	136.5											89.1	99.19	124.02	
Net crop water demand	111.5											0	0	34.02	145.52
Maize, first crop															
Kc				0.45	0.84	1.05	0.84								
Etc				56.25	84.84	103.95	88.2								
Net crop water demand				21.25	0	0	0							21.25	
Maize, second crop															
Kc	0.84											0.45	0.84	1.05	
Etc	109.2											36.45	76.44	122.85	
Net crop water demand	84.2											0	0	32.85	117.05
Beans															
Kc	0.58	1.04	0.77												
Etc	75.4	131.04	105.49												
Net crop water demand	50.4	118.04	90.49											258.93	
Bejuco beans															
Kc	0.34	0.64	0.08	0.64											
Etc	44.2	80.64	10.96	80											
Net crop water demand	19.2	67.64	0	45										131.84	
Squash															
Kc	0.34	0.73	1.01	0.82											
Etc	44.2	91.98	138.37	102.5											
Net crop water demand	19.2	78.98	123.37	67.5										289.05	
Table tomatoes															
Kc	0.34	0.73	1.01	0.82											
Etc	44.2	91.98	138.37	102.5											
Net crop water demand	19.2	78.98	123.37	67.5										289.05	
Industrial tomatoes															
Kc	0.34	0.73	1.01	0.82											
Etc	44.2	91.98	138.37	102.5											
Net crop water demand	19.2	78.98	123.37	67.5										289.05	
Watermelons															
Kc	0.40	0.75	0.93	0.75											
Etc	52	94.5	127.41	93.75											
Net crop water demand	27	81.5	112.41	58.75										279.66	
Melons															
Kc	0.40	0.75	0.93	0.75											
Etc	52	94.5	127.41	93.75											
Net crop water demand	27	81.5	112.41	58.75										279.66	
Cassava															
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70			
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9			
Net crop water demand	47.8	0	0	0	0	0	0	0	0	0	0	0		47.8	
Name															
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70			
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9			
Net crop water demand	47.8	0	0	0	0	0	0	0	0	0	0	0		47.8	
Otoe															
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70			
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9			
Net crop water demand	47.8	0	0	0	0	0	0	0	0	0	0	0		47.8	

## NET CROP WATER DEMANDS

**Table AT10-10 Area No 11 Valle del Rio Tucue**

*Potential evapotranspiration in mm at Santa Ana Meteorological Station*

*Monthly rainfall exceeded 50% of time at Tambo Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
<b>Precipitation</b>	26	13	15	35	215	220	225	230	260	300	200	90	1828
<b>Potential evapotranspiration</b>	130	126	137	125	101	99	105	102	98	81	91	117	1312
<b>Perennial crops</b>													
<b>Pineapple</b>													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	58.5	61.74	78.09	90	82.82	79.2	85.05	79.56	72.52	56.7	59.15	71.37	
Net crop water demand	33.5	48.74	63.09	55	0	0	0	0	0	0	0	0	200.33
<b>Coffee</b>													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	65	73.08	90.42	92.5	82.82	89.1	52.5	59.16	64.68	59.94	74.62	105.3	
Net crop water demand	40	60.08	75.42	57.5	0	0	0	0	0	0	0	15.3	248.3
<b>Bananas</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	68.6	82.76	109.67	127.5	0	0	0	0	0	0	0	0	388.53
<b>Plantains</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	68.6	82.76	109.67	127.5	0	0	0	0	0	0	0	0	388.53
<b>Citrus (oranges)</b>													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	97.5	95.76	106.86	101.25	84.84	79.2	88.2	85.68	82.32	66.42	71.89	88.92	
Net crop water demand	72.5	82.76	91.86	66.25	0	0	0	0	0	0	0	0	313.37
<b>Pasture grasses</b>													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.96	0.93	0.86	0.75	
Etc	71.5	88.2	117.82	121.25	102.01	99	107.1	104.04	96.04	75.33	78.26	87.75	
Net crop water demand	46.5	75.2	102.82	86.25	0	0	0	0	0	0	0	0	310.77
<b>Teca trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	40	67.64	91.86	80	0	0	0	0	0	0	0	50.4	329.9
<b>Pine trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	40	67.64	91.86	80	0	0	0	0	0	0	0	50.4	329.9
<b>Anacardium</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	40	67.64	91.86	80	0	0	0	0	0	0	0	50.4	329.9

## NET CROP WATER DEMANDS

**Table AT10-11 Area No 12 Valle del Rio Chiguirí**  
*Potential evapotranspiration in mm at Santa Ana Meteorological Station  
Monthly rainfall exceeded 80% at Chiguirí Arriba Station*

DESCRIPTION	Months												Year (mm)	
	J	F	M	A	M	J	J	A	S	O	N	D		
Precipitation	30	20	14	45	255	300	290	360	315	380	270	90	2369	
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312	
<b>Annual crops</b>														
Rice,first crop														
Kc					1.1	1.09	1.06	1.05						
Etc					137.5	110.09	104.94	110.25						
Net crop water demand					92.5	0	0	0					<b>92.50</b>	
Rice,second crop														
Kc		1.05										1.1	1.09	1.06
Etc		136.5										89.1	99.19	124.02
Net crop water demand		106.5										0	0	34.02
<b>Malze,first crop</b>														
Kc					0.45	0.84	1.05	0.84						
Etc					56.25	84.84	103.95	88.2						
Net crop water demand					11.25	0	0	0						<b>11.25</b>
<b>Maize,second crop</b>														
Kc		0.84										0.45	0.84	1.05
Etc		109.2										36.45	76.44	122.85
Net crop water demand		79.2										0	0	32.85
<b>Beans</b>														
Kc		0.58	1.04	0.77										
Etc		75.4	131.04	105.49										
Net crop water demand		45.4	111.04	91.49										<b>247.93</b>
<b>Bejucos beans</b>														
Kc		0.34	0.64	0.06	0.64									
Etc		44.2	80.64	10.96	80									
Net crop water demand		14.2	60.64	0	35									<b>109.84</b>
<b>Squash</b>														
Kc		0.34	0.73	1.01	0.82									
Etc		44.2	91.98	138.37	102.5									
Net crop water demand		14.2	71.98	124.37	57.5									<b>268.05</b>
<b>Table tomatoes</b>														
Kc		0.34	0.73	1.01	0.82									
Etc		44.2	91.98	138.37	102.5									
Net crop water demand		14.2	71.98	124.37	57.5									<b>268.05</b>
<b>Industrial tomatoes</b>														
Kc		0.34	0.73	1.01	0.82									
Etc		44.2	91.98	138.37	102.5									
Net crop water demand		14.2	71.98	124.37	57.5									<b>268.05</b>
<b>Watermelons</b>														
Kc		0.40	0.75	0.93	0.75									
Etc		52	94.5	127.41	93.75									
Net crop water demand		22	74.5	113.41	48.75									<b>258.66</b>
<b>Melons</b>														
Kc		0.40	0.75	0.93	0.75									
Etc		52	94.5	127.41	93.75									
Net crop water demand		22	74.5	113.41	48.75									<b>258.66</b>
<b>Cassava</b>														
Kc		0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc		72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand		42.8			0	0	0	0	0	0	0	0	0	<b>42.80</b>
<b>Name</b>														
Kc		0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc		72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand		42.8			0	0	0	0	0	0	0	0	0	<b>42.80</b>
<b>Otote</b>														
Kc		0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc		72.8			28.75	33.33	45.54	65.1	76.5	79.38	67.23	71.89	81.9	
Net crop water demand		42.8			0	0	0	0	0	0	0	0	0	<b>42.80</b>

## NET CROP WATER DEMANDS

**Table AT10-11 Area No 12 Valle del Rio Chiguirí**

*Potential evapotranspiration in mm at Santa Ana Meteorological Station*

*Monthly rainfall exceeded 80% at Chiguirí Arriba Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	30	20	14	45	255	300	290	360	315	380	270	90	2369
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312
<b>Perennial crops</b>													
<b>Pineapple</b>													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	58.5	61.74	78.09	90	82.82	79.2	85.05	79.56	72.52	56.7	59.15	71.37	
Net crop water demand	28.5	41.74	64.09	45	0	0	0	0	0	0	0	0	179.33
<b>Coffee</b>													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	65	73.08	90.42	92.5	82.82	89.1	52.5	59.16	64.68	59.94	74.62	105.3	
Net crop water demand	35	53.08	76.42	47.5	0	0	0	0	0	0	0	15.3	227.3
<b>Bananas</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	63.6	75.76	110.67	117.5	0	0	0	0	0	0	0	0	367.53
<b>Plantains</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	63.6	75.76	110.67	117.5	0	0	0	0	0	0	0	0	367.53
<b>Citrus (oranges)</b>													
Kc	0.75	0.76	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	97.5	95.76	106.86	101.25	84.84	79.2	88.2	85.68	82.32	66.42	71.89	88.92	
Net crop water demand	67.5	75.76	92.86	56.25	0	0	0	0	0	0	0	0	292.37
<b>Pasture grasses</b>													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	71.5	88.2	117.82	121.25	102.01	99	107.1	104.04	96.04	75.33	78.26	87.75	
Net crop water demand	41.5	68.2	103.82	76.25	0	0	0	0	0	0	0	0	289.77
<b>Teca trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	35	60.64	92.86	70	0	0	0	0	0	0	0	50.4	308.90
<b>Pine trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	35	60.64	92.86	70	0	0	0	0	0	0	0	50.4	308.90
<b>Anacardium</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	35	60.64	92.86	70	0	0	0	0	0	0	0	50.4	308.90

## NET CROP WATER DEMANDS

**Table AT10-12 Area No 12 Valle del Rio Chiguirí**  
*Potential evapotranspiration in mm at Santa Ana Meteorological Station*  
*Monthly rainfall exceeded 50% at Chiguirí Arriba Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
<b>Precipitation</b>	75	40	25	110	370	410	370	420	400	440	380	190	3230
<b>Potential evapotranspiration</b>	130	126	137	125	101	99	105	102	98	81	91	117	1312
<b>Annual crops</b>													
Rice, first crop													
Kc				1.1	1.09	1.06	1.05						
Etc				137.5	110.09	104.94	110.25						
Net crop water demand				27.5	0	0	0						27.50
Rice, second crop													
Kc	1.05											1.1	1.09
Etc	136.5											89.1	99.19
Net crop water demand	61.5											0	124.02
Maize, first crop													
Kc				0.45	0.84	1.05	0.84						
Etc				56.25	84.84	103.95	88.2						
Net crop water demand				0	0	0	0						0
Maize, second crop													
Kc	0.84											0.45	0.84
Etc	109.2											36.45	76.44
Net crop water demand	34.2											0	122.85
Beans													
Kc	0.58	1.04	0.77										
Etc	75.4	131.04	105.49										
Net crop water demand	0.4	91.04	80.49										171.83
Bejuco beans													
Kc	0.34	0.64	0.08	0.64									
Etc	44.2	80.64	10.96	80									
Net crop water demand	0	40.64	0	0									40.64
Squash													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	0	51.98	113.37	0									165.35
Table tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	0	51.98	113.37	0									165.35
Industrial tomatoes													
Kc	0.34	0.73	1.01	0.82									
Etc	44.2	91.98	138.37	102.5									
Net crop water demand	0	51.98	113.37	0									165.35
Watermelons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	94.5	127.41	93.75									
Net crop water demand	0	54.5	102.41	0									156.91
Melons													
Kc	0.40	0.75	0.93	0.75									
Etc	52	94.5	127.41	93.75									
Net crop water demand	0	54.5	102.41	0									156.91
Cassava													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	87.23	71.89	81.9	
Net crop water demand	0			0	0	0	0	0	0	0	0	0	0.00
Name													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	87.23	71.89	81.9	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Otoe													
Kc	0.56			0.23	0.33	0.46	0.62	0.75	0.81	0.83	0.79	0.70	
Etc	72.8			28.75	33.33	45.54	65.1	76.5	79.38	87.23	71.89	81.9	
Net crop water demand	0	0	0	0	0	0	0	0	0	0	0	0	0.00

## NET CROP WATER DEMANDS

**Table AT10-12 Area No 12 Valle del Rio Chiguirí**  
*Potential evapotranspiration in mm at Santa Ana Meteorological Station*  
*Monthly rainfall exceeded 50% at Chiguirí Arriba Station*

DESCRIPTION	Months												Year (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
Precipitation	75	40	25	110	370	410	370	420	400	440	380	190	3230
Potential evapotranspiration	130	126	137	125	101	99	105	102	98	81	91	117	1312
<b>Perennial crops</b>													
<b>Pineapple</b>													
Kc	0.45	0.49	0.57	0.72	0.82	0.80	0.81	0.78	0.74	0.70	0.65	0.61	
Etc	58.5	61.74	78.09	90	82.82	79.2	85.05	79.56	72.52	56.7	59.15	71.37	
Net crop water demand	0	21.74	53.09	0	0	0	0	0	0	0	0	0	<b>74.83</b>
<b>Coffee</b>													
Kc	0.50	0.58	0.66	0.74	0.82	0.90	0.50	0.58	0.66	0.74	0.82	0.90	
Etc	65	73.08	90.42	92.5	82.82	89.1	52.5	59.16	64.68	59.94	74.62	105.3	
Net crop water demand	0	33.08	65.42	0	0	0	0	0	0	0	0	0	<b>98.5</b>
<b>Bananas</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	18.6	55.76	99.67	52.5	0	0	0	0	0	0	0	0	<b>226.53</b>
<b>Plantains</b>													
Kc	0.72	0.76	0.91	1.30	1.04	1.00	1.04	1.02	0.94	0.85	0.78	0.69	
Etc	93.6	95.76	124.67	162.5	105.04	99	109.2	104.04	92.12	68.85	70.98	80.73	
Net crop water demand	18.6	55.76	99.67	52.5	0	0	0	0	0	0	0	0	<b>226.53</b>
<b>Citrus (oranges)</b>													
Kc	0.75	0.78	0.78	0.81	0.84	0.8	0.84	0.84	0.84	0.82	0.79	0.76	
Etc	97.5	95.76	106.86	101.25	84.84	79.2	88.2	85.68	82.32	66.42	71.89	88.92	
Net crop water demand	22.5	55.76	81.86	0	0	0	0	0	0	0	0	0	<b>160.12</b>
<b>Pasture grasses</b>													
Kc	0.55	0.7	0.86	0.97	1.01	1.00	1.02	1.02	0.98	0.93	0.86	0.75	
Etc	71.5	88.2	117.82	121.25	102.01	99	107.1	104.04	96.04	75.33	78.26	87.75	
Net crop water demand	0	48.2	92.82	11.25	0	0	0	0	0	0	0	0	<b>152.27</b>
<b>Teca trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	0	40.64	81.86	5	0	0	0	0	0	0	0	0	<b>127.50</b>
<b>Pine trees</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	0	40.64	81.86	5	0	0	0	0	0	0	0	0	<b>127.50</b>
<b>Anacardium</b>													
Kc	0.5	0.64	0.78	0.92	1.06	1.2	0.5	0.64	0.78	0.92	1.06	1.2	
Etc	65	80.64	106.86	115	107.06	118.8	52.5	65.28	76.44	74.52	96.46	140.4	
Net crop water demand	0	40.64	81.86	5	0	0	0	0	0	0	0	0	<b>127.50</b>

## **ATTACHMENT 11**

### **IRRIGATION WATER REQUIREMENTS**

## IRRIGATION WATER REQUIREMENTS

**Table AT11-1 Area No. 1 - Valle Bajo del Rio Coclé del Norte**

*Based on 5-year return period drought*

Crops	ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice, first crop	0.20				2.06	0.00	0.00	0.00						0.41
Rice, second crop	0.25	0.00									0.00	0.00	0.00	0.00
Maize, first crop	0.10				0.00	0.00	0.00	0.00						0.00
Maize, second crop	0.05	0.00									0.00	0.00	0.00	0.00
Beans	0.03	0.00	0.11	0.76										0.87
Bejuco beans	0.03	0.00	0.00	0.00	0.00									0.00
Squash	0.02	0.00	0.00	1.17	0.00									1.17
Table tomatoes	0.01	0.00	0.00	0.58	0.00									0.58
Industrial tomatoes	0.01	0.00	0.00	0.58	0.00									0.58
Watermelons	0.01	0.00	0.00	0.47	0.00									0.47
Melons	0.01	0.00	0.00	0.47	0.00									0.47
Cassava	0.05	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ñame	0.05	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Otoe	0.05	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pineapple	0.01	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coffee	0.06	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bananas	0.03	0.00	0.00	1.34	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63
Plantains	0.03	0.00	0.00	1.34	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.39
Citrus (oranges)	0.04	0.00	0.00	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
Pasture grasses	0.14	0.00	0.00	5.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.29
Teca trees	0.04	0.00	0.00	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
Pine trees	0.04	0.00	0.00	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
Anacardium	0.04	0.00	0.00	1.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
<b>Total Net (mm)</b>	0.00	0.11	16.91	4.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.18
<b>Total Gross (mm)</b>	0.00	0.22	33.82	8.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.36
<b>Total Net (m<sup>3</sup>/ha)</b>	0.0	1.1	169.1	41.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	211.8
<b>Total Gross (m<sup>3</sup>/ha)</b>	0.0	2.2	338.2	83.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	423.6

Note: The gross values assume an overall irrigation efficiency of 50%

## IRRIGATION WATER REQUIREMENTS

**Table AT11-2 Area No. 1 - Valle Bajo del Rio Coclé del Norte**

*Based on mean monthly precipitation*

Crops	ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice,first crop	0.20	0.00			0.00	0.00	0.00	0.00						0.00
Rice second crop	0.25	0.00								0.00	0.00	0.00		0.00
Maize,first crop	0.10				0.00	0.00	0.00	0.00						0.00
Maize,second crop	0.05	0.00								0.00	0.00	0.00		0.00
Beans	0.03	0.00	0.00	0.00										0.00
Bejuco beans	0.03	0.00	0.00	0.00	0.00									0.00
Squash	0.02	0.00	0.00	0.00	0.00									0.00
Table tomatoes	0.01	0.00	0.00	0.00	0.00									0.00
Industrial tomatoes	0.01	0.00	0.00	0.00	0.00									0.00
Watermelons	0.01	0.00	0.00	0.00	0.00									0.00
Melons	0.01	0.00	0.00	0.00	0.00									0.00
Cassava	0.05	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name	0.05	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Otoe	0.05	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pineapple	0.01	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coffee	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bananas	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plantains	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Citrus (oranges)	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pasture grasses	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Teca trees	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pine trees	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anacardium	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total Net (mm)</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total Gross (mm)</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total Net (m<sup>3</sup>/ha)</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total Gross (m<sup>3</sup>/ha)</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: The gross values assume an overall irrigation efficiency of 50%

## IRRIGATION WATER REQUIREMENTS

**Table AT11-3 Area No. 2 Valle de los Ríos Platanal, Limón, Aguacate y Diego  
Area No 3 Valle Bajo del Río Miguel de la Borda**

*Based on 5-year return period drought*

Crops	ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice, first crop	0.20				17.06	0.00	0.00	0.00						17.06
Rice, second crop	0.25	15.65									0.00	0.00	0.00	15.65
Maize, first crop	0.10				0.54	0.00	0.00	0.00						0.54
Maize, second crop	0.05	1.95									0.00	0.00	0.00	1.95
Beans	0.03	0.30	2.66	2.56										5.52
Bejuco beans	0.03	0.00	1.29	0.00	0.86									2.15
Squash	0.02	0.00	1.06	2.37	1.02									4.45
Table tomatoes	0.01	0.00	0.53	1.19	0.51									2.23
Industrial tomatoes	0.01	0.00	0.53	1.19	0.51									2.23
Watermelons	0.01	0.00	0.56	1.07	0.42									2.05
Melons	0.01	0.00	0.56	1.07	0.42									2.05
Cassava	0.05	0.39			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
Ñame	0.05	0.39			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
Otoe	0.05	0.39			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
Pineapple	0.01	0.00	0.26	0.58	0.39		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.23
Coffee	0.06	0.06	2.17	4.23	2.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.92
Bananas	0.03	0.77	1.70	3.14	3.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.91
Plantains	0.03	0.77	1.70	3.14	3.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.91
Citrus (oranges)	0.04	1.16	2.27	3.47	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.89
Pasture grasses	0.14	0.92	6.97	13.69	9.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.28
Teca trees	0.04	0.04	1.72	3.47	2.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.78
Pine trees	0.04	0.04	1.72	3.47	2.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.78
Anacardium	0.04	0.04	1.72	3.47	2.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.78
<b>Total Net (mm)</b>	<b>22.87</b>	<b>27.42</b>	<b>48.11</b>	<b>50.13</b>	<b>0.00</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>148.53</b>
<b>Total Gross (mm)</b>	<b>45.74</b>	<b>54.84</b>	<b>96.22</b>	<b>100.26</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>	<b>297.06</b>
<b>Total Net (m<sup>3</sup>/ha)</b>	<b>228.7</b>	<b>274.2</b>	<b>481.1</b>	<b>501.3</b>	<b>0.0</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>1485.3</b>
<b>Total Gross (m<sup>3</sup>/ha)</b>	<b>457.4</b>	<b>548.4</b>	<b>962.2</b>	<b>1002.6</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</b>	<b>2970.6</b>

*Note: The gross values assume an overall irrigation efficiency of 50%*

## IRRIGATION WATER REQUIREMENTS

**Table AT11-4 Area No. 2 Valle de los Ríos Platanal, Limón, Aguacate y Diego  
Area No 3 Valle Bajo del Río Miguel de la Borda**

*Based on mean monthly precipitation*

Crops	Ha	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rice,first crop	0.20				0.00	0.00	0.00	0.00						0.00
Rice second crop	0.25	0.00								0.00	0.00	0.00	0.00	0.00
Maize,first crop	0.10				0.00	0.00	0.00	0.00						0.00
Maize,second crop	0.05	0.00								0.00	0.00	0.00	0.00	0.00
Beans	0.03	0.00	1.16	1.21										2.37
Bejuco beans	0.03	0.00	0.00	0.00	0.00									0.00
Squash	0.02	0.00	0.06	1.47	0.00									1.53
Table tomatoes	0.01	0.00	0.03	0.73	0.00									0.76
Industrial tomatoes	0.01	0.00	0.03	0.73	0.00									0.76
Watermelons	0.01	0.00	0.06	0.62	0.00									0.68
Melons	0.01	0.00	0.06	0.62	0.00									0.68
Cassava	0.05	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ñame	0.05	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Otoe	0.05	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pineapple	0.01	0.00	0.00	0.13	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
Coffee	0.06	0.00	0.00	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53
Bananas	0.03	0.00	0.20	1.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.99
Plantains	0.03	0.00	0.20	1.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.99
Citrus (oranges)	0.04	0.00	0.27	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.94
Pasture grasses	0.14	0.00	0.00	7.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.39
Teca trees	0.04	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67
Pine trees	0.04	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67
Anacardium	0.04	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67
<b>Total Net (mm)</b>	0.00	2.07	22.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.97
<b>Total Gross (mm)</b>	0.00	4.14	45.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	49.94
<b>Total Net (m<sup>3</sup>/ha)</b>	0.0	20.7	229.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	249.7
<b>Total Gross (m<sup>3</sup>/ha)</b>	0.0	41.4	458.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	499.4

Note: The gross values assume an overall irrigation efficiency of 50%

## IRRIGATION WATER REQUIREMENTS

**Table AT11-5 Area No.4 Valle del Rio San Miguelito; Area No5 Valle del Rio Caño Sucio, Sector El Cedro  
Area No 6 Valle del Rio Caño Sucio Sector Las Maravillas**

*Based on 5-year return period drought*

Crops	ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice, first crop	0.10				8.31	0.00	0.00	0.00						8.31
Rice, second crop	0.25	20.38									0.00	0.00	0.00	20.38
Maize, first crop	0.12				0.53	0.00	0.00	0.00						0.53
Maize, second crop	0.05	2.71									0.00	0.00	0.00	2.71
Beans	0.04	0.82	3.88	3.45										8.15
Bejuco beans	0.04	0.00	1.92	0.00	1.10									3.02
Squash	0.03	0.00	1.77	3.58	1.48									6.83
Table tomatoes	0.02	0.00	1.18	2.39	0.98									4.55
Industrial tomatoes	0.02	0.00	1.18	2.39	0.98									4.55
Watermelons	0.02	0.00	1.23	2.17	0.81									4.21
Melons	0.02	0.00	1.23	2.17	0.81									4.21
Cassava	0.04	0.71			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
Name	0.04	0.71			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
Otoe	0.04	0.71			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
Pineapple	0.02	0.07	0.60	1.17	0.74		0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58
Coffee	0.04	0.40	1.63	2.84	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.45
Bananas	0.03	1.16	1.88	3.17	3.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.43
Blantains	0.04	1.54	2.51	4.22	4.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.56
Citrus (oranges)	0.05	2.12	3.14	4.38	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.04
Pasture grasses	0.15	2.48	8.31	14.80	10.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.69
Teca trees	0.05	0.50	2.40	4.38	3.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.34
Pine trees	0.05	0.50	2.40	4.38	3.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.34
Anacardium	0.04	0.40	1.92	3.50	2.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.27
<b>Total Net (mm)</b>	<b>35.21</b>	<b>37.18</b>	<b>58.99</b>	<b>45.90</b>	<b>0.00</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>177.28</b>
<b>Total Gross (mm)</b>	<b>70.42</b>	<b>74.36</b>	<b>117.98</b>	<b>91.80</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>	<b>354.56</b>
<b>Total Net (m<sup>3</sup>/ha)</b>	<b>352.1</b>	<b>371.8</b>	<b>589.9</b>	<b>459.0</b>	<b>0.0</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>1772.8</b>
<b>Total Gross (m<sup>3</sup>/ha)</b>	<b>704.2</b>	<b>743.6</b>	<b>1179.8</b>	<b>918.0</b>	<b>0.0</b>	<b>3545.6</b>								

*Note: The gross values assume an overall irrigation efficiency of 50%*

## IRRIGATION WATER REQUIREMENTS

**Table AT11-6 Area No.4 Valle del Rio San Miguelito; Area No5 Valle del Rio Cano Sucio, Sector El Cedro  
Area No 6 Valle del Rio Cano Sucio Sector Las Maravillas**

*Based on mean monthly precipitation*

Crops	Ha	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rice,first crop	0.10				0.00	0.00	0.00	0.00						0.00
Rice,second crop	0.25	0.00									0.00	0.00	0.00	0.00
Maize,first crop	0.12				0.00	0.00	0.00	0.00						0.00
Maize,second crop	0.05	0.71									0.00	0.00	0.00	0.71
Beans	0.04	0.00	2.88	1.85										4.73
Bejuco beans	0.04	0.00	0.92	0.00	0.00									0.92
Squash	0.03	0.00	1.02	2.38	0.00									3.40
Table tomatoes	0.02	0.00	0.68	1.59	0.00									2.27
Industrial tomatoes	0.02	0.00	0.68	1.59	0.00									2.27
Watermelons	0.02	0.00	0.73	1.37	0.00									2.10
Melons	0.02	0.00	0.73	1.37	0.00									2.10
Cassava	0.04	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name	0.04	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Otoe	0.04	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pineapple	0.02	0.00	0.10	0.37	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47
Coffee	0.04	0.00	0.63	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.87
Bananas	0.03	0.00	1.13	1.97	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.07
Plantains	0.04	0.00	1.51	2.62	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.42
Citrus (oranges)	0.05	0.13	1.87	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.38
Pasture grasses	0.15	0.00	4.56	8.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.36
Teca trees	0.05	0.00	1.15	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.53
Pine trees	0.05	0.00	1.15	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.53
Anacardium	0.04	0.00	0.92	1.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83
<b>Total Net (mm)</b>	<b>0.84</b>	<b>20.66</b>	<b>34.20</b>	<b>2.26</b>	<b>0.00</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>57.96</b>
<b>Total Gross (mm)</b>	<b>1.68</b>	<b>41.32</b>	<b>68.40</b>	<b>4.52</b>	<b>0.00</b>	<b>115.92</b>								
<b>Total Net (m<sup>3</sup>/ha)</b>	<b>8.4</b>	<b>206.6</b>	<b>342.0</b>	<b>22.6</b>	<b>0.0</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>579.6</b>
<b>Total Gross (m<sup>3</sup>/ha)</b>	<b>16.8</b>	<b>413.2</b>	<b>684.0</b>	<b>45.2</b>	<b>0.0</b>	<b>1159.2</b>								

Note: The gross values assume an overall irrigation efficiency of 50%

## IRRIGATION WATER REQUIREMENTS

**Table AT11-7 Areas Nos 7-Valle del Rio Cuiria, 8-Valle del Rio Tulu, 9-Valle del Rio San Miguel  
10-Valle del Rio Lura and 13-Valle del Rio Toabre**

*Based on 5-year return period drought*

Crops	ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice, first crop	0.10				8.75	0.00	0.00	0.00						8.75
Rice, second crop	0.25	20.38									0.00	0.00	0.00	20.38
Maize, first crop	0.12				0.75	0.00	0.00	0.00						0.75
Maize, second crop	0.05	2.71									0.00	0.00	0.00	2.71
Beans	0.04	0.82	4.04	3.42										8.28
Bejuco beans	0.04	0.00	2.03	0.00	1.20									3.23
Squash	0.03	0.00	1.86	3.55	1.58									6.99
Table tomatoes	0.02	0.00	1.24	2.37	1.05									4.66
Industrial tomatoes	0.02	0.00	1.24	2.37	1.05									4.66
Watermelons	0.02	0.00	1.29	2.15	0.88									4.32
Melons	0.02	0.00	1.29	2.15	0.88									4.32
Cassava	0.04	0.71			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
Ñame	0.04	0.71			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
Otoe	0.04	0.71			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
Pineapple	0.02	0.07	0.63	1.16	0.80		0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.66
Coffee	0.04	0.40	1.72	2.82	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.64
Bananas	0.03	1.16	1.97	3.14	3.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.65
Plantains	0.04	1.54	2.63	4.19	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.86
Citrus (oranges)	0.05	2.13	3.29	4.34	2.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.32
Pasture grasses	0.15	2.48	8.73	14.67	10.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.57
Teca trees	0.05	0.50	2.53	4.34	3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.62
Pine trees	0.05	0.50	2.53	4.34	3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.62
Anacardium	0.04	0.40	2.03	3.47	2.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.50
<b>Total Net (mm)</b>	35.22	39.05	58.48	48.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	181.62
<b>Total Gross (mm)</b>	70.44	78.10	116.96	97.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	363.24
<b>Total Net (m<sup>3</sup>/ha)</b>	352.2	390.5	584.8	488.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1816.2
<b>Total Gross (m<sup>3</sup>/ha)</b>	704.4	781.0	1169.6	977.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3632.4

Note: The gross values assume an overall irrigation efficiency of 50%

## IRRIGATION WATER REQUIREMENTS

**Table AT11-8 Areas Nos 7-Valle del Rio Cuiria, 8-Valle del Rio Tulu, 9-Valle del Rio San Miguel  
10-Valle del Rio Lura and 13-Valle del Rio Toabre**

*Based on mean monthly precipitation*

Crops	Ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice, first crop	0.10				4.75	0.00	0.00	0.00						4.75
Rice, second crop	0.25	15.38									0.00	0.00	0.00	15.38
Maize, first crop	0.12				0.00	0.00	0.00	0.00						0.00
Maize, second crop	0.05	1.71									0.00	0.00	0.00	1.71
Beans	0.04	0.02	3.64	2.22										5.88
Bejuco beans	0.04	0.00	1.63	0.00	0.00									1.63
Squash	0.03	0.00	1.56	2.65	0.38									4.59
Table tomatoes	0.02	0.00	1.04	1.77	0.25									3.06
Industrial tomatoes	0.02	0.00	1.04	1.77	0.25									3.06
Watermelons	0.02	0.00	1.09	1.55	0.07									2.71
Melons	0.02	0.00	1.09	1.55	0.07									2.71
Cassava	0.04	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ñame	0.04	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Otoe	0.04	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pineapple	0.02	0.00	0.43	0.56	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99
Coffee	0.04	0.00	1.32	1.62	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.04
Bananas	0.03	0.56	1.67	2.24	2.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.64
Plantains	0.04	0.74	2.23	2.99	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.86
Citrus (oranges)	0.05	1.12	2.79	2.84	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.31
Pasture grasses	0.15	0.00	7.23	10.17	4.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.08
Teca trees	0.05	0.00	2.03	2.84	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.12
Pine trees	0.05	0.00	2.03	2.84	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.12
Anacardium	0.04	0.00	1.62	2.27	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.89
<b>Total Net (mm)</b>		19.53	32.44	39.88	19.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	111.53
<b>Total Gross (mm)</b>		39.06	64.88	79.76	39.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	223.06
<b>Total Net (m<sup>3</sup>/ha)</b>		195.3	324.4	398.8	196.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1115.3
<b>Total Gross (m<sup>3</sup>/ha)</b>		390.6	648.8	797.6	393.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2230.6

Note: The gross values assume an overall irrigation efficiency of 50%

## IRRIGATION WATER REQUIREMENTS

**Table AT11-9 Area No 11 Valle del Rio Tocue**

*Based on 5-year return period drought*

Crops	ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice, first crop	0.10				12.65	0.01	0.00	0.00						12.66
Rice, second crop	0.25	32.38									0.00	0.00	23.50	55.88
Maize, first crop	0.12				5.43	0.00	0.00	0.00						5.43
Maize, second crop	0.05	5.11									0.00	0.00	4.64	9.75
Beans	0.04	2.74	5.08	4.18										12.00
Bejuco beans	0.04	1.49	3.07	0.40	2.76									7.72
Squash	0.03	1.12	2.64	4.12	2.75									10.63
Table tomatoes	0.02	0.74	1.76	2.75	1.83									7.08
Industrial tomatoes	0.02	0.74	1.76	2.75	1.83									7.08
Watermelons	0.02	0.90	1.81	2.53	1.65									6.89
Melons	0.02	0.90	1.81	2.53	1.65									6.89
Cassava	0.04	2.63			0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	5.42
Name	0.04	2.63			0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	5.42
Otoe	0.04	2.63			0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	5.42
Pineapple	0.02	1.03	1.15	1.54	1.58		0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.13
Coffee	0.04	2.32	2.76	3.58	3.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.01	14.93
Bananas	0.03	2.60	2.75	3.71	4.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	15.13
Plantains	0.04	3.46	3.67	4.95	6.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.03	20.17
Citrus (oranges )	0.05	4.53	4.59	5.29	4.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.95	21.87
Pasture grasses	0.15	9.68	12.63	17.52	16.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.66	65.03
Teca trees	0.05	2.90	3.83	5.29	5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.52	22.74
Pine trees	0.05	2.90	3.83	5.29	5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.52	22.74
Anacardium	0.04	2.32	3.07	4.23	4.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.42	18.20
<b>Total Net (mm)</b>	<b>83.43</b>	<b>56.21</b>	<b>70.66</b>	<b>83.74</b>	<b>0.01</b>	<b>0.00</b>	0.00	0.00	0.00	0.00	0.00	0.00	<b>68.84</b>	<b>362.89</b>
<b>Total Gross (mm)</b>	<b>166.86</b>	<b>112.42</b>	<b>141.32</b>	<b>167.48</b>	<b>0.02</b>	<b>0.00</b>	0.00	0.00	0.00	0.00	0.00	0.00	<b>137.68</b>	<b>725.78</b>
<b>Total Net (m<sup>3</sup>/ha)</b>	<b>834.3</b>	<b>562.1</b>	<b>706.6</b>	<b>837.4</b>	<b>0.1</b>	<b>0.0</b>	0.0	0.0	0.0	0.0	0.0	0.0	<b>688.4</b>	<b>3628.9</b>
<b>Total Gross (m<sup>3</sup>/ha)</b>	<b>1668.6</b>	<b>1124.2</b>	<b>1413.2</b>	<b>1674.8</b>	<b>0.2</b>	<b>0.0</b>	0.0	0.0	0.0	0.0	0.0	0.0	<b>1376.8</b>	<b>7257.8</b>

*Note: The gross values assume an overall irrigation efficiency of 50%*

## IRRIGATION WATER REQUIREMENTS

**Table AT11-10 Area No 11 Valle del Rio Tocue**

*Based on mean monthly precipitation*

Crops	Ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice, first crop	0.10				10.25	0.00	0.00	0.00						10.25
Rice, second crop	0.25	27.86									0.00	0.00		27.86
Maize, first crop	0.12				0.00	0.00	0.00	0.00						0.00
Maize, second crop	0.05	4.21									0.00	0.00	0.00	4.21
Beans	0.04	0.00	4.72	3.62										8.34
Bejuco beans	0.04	0.00	2.70	0.00	0.00									2.70
Squash	0.03	0.00	2.37	3.70	2.02									8.09
Table tomatoes	0.02	0.00	1.58	2.47	1.35									5.40
Industrial tomatoes	0.02	0.00	1.58	2.47	1.35									5.40
Watermelons	0.02	0.00	1.63	2.25	1.17									5.05
Melons	0.02	0.00	1.63	2.25	1.17									5.05
Cassava	0.04	1.91			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.91
Ñame	0.04	1.91			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.91
Otoe	0.04	1.91			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.91
Pineapple	0.02	0.67	0.97	1.26	1.10		0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Coffee	0.04	1.60	2.40	3.02	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.32
Bananas	0.03	2.06	2.48	3.29	3.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.65
Plantains	0.04	2.74	3.31	4.39	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.54
Citrus (oranges)	0.05	3.62	4.14	4.59	3.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.66
Pasture grasses	0.15	6.97	11.28	15.42	12.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.61
Teca trees	0.05	2.00	3.38	4.59	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.97
Pine trees	0.05	2.00	3.38	4.59	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.97
Anacardium	0.04	1.60	2.70	3.70	3.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.20
<b>Total Net (mm)</b>		61.06	50.25	61.61	57.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	230.00
<b>Total Gross (mm)</b>		122.12	100.50	123.22	114.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	460.00
<b>Total Net (m<sup>3</sup>/ha)</b>		610.6	502.5	616.1	570.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2300
<b>Total Gross (m<sup>3</sup>/ha)</b>		1221.2	1005.0	1232.2	1141.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4600

*Note: The gross values assume an overall irrigation efficiency of 50%*

## IRRIGATION WATER REQUIREMENTS

**Table AT11-11 Area No 12 Valle del Rio Chiguirí**

*Based on 5-year return period drought*

Crops	ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice, first crop	0.10				9.25	0.00	0.00	0.00						9.25
Rice, second crop	0.25	26.62									0.00	0.00	8.51	35.13
Maize, first crop	0.12				1.35	0.00	0.00	0.00						1.35
Maize, second crop	0.05	3.96									0.00	0.00	1.64	5.60
Beans	0.04	1.82	4.44	3.66										9.92
Bejuco beans	0.04	.57	2.43	0.00	1.40									4.40
Squash	0.03	0.43	2.16	3.73	1.73									8.05
Table tomatoes	0.02	0.28	1.44	2.49	1.15									5.36
Industrial tomatoes	0.02	0.28	1.44	2.49	1.15									5.36
Watermelons	0.02	0.44	1.49	2.27	0.98									5.18
Melons	0.02	0.44	1.49	2.27	0.98									5.18
Cassava	0.04	1.71			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.71
Ñame	0.04	1.71			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.71
Otoe	0.04	1.71			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.71
Pineapple	0.02	0.57	0.83	1.28	0.90		0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.58
Coffee	0.04	1.40	2.12	3.06	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.09
Bananas	0.03	1.91	2.27	3.32	3.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.02
Plantains	0.04	2.54	3.03	4.43	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.70
Citrus (oranges )	0.05	3.38	3.79	4.64	2.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.62
Pasture grasses	0.15	6.22	10.23	15.57	11.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.46
Teca trees	0.05	1.75	3.03	4.64	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.44
Pine trees	0.05	1.75	3.03	4.64	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.44
Anacardium	0.04	1.40	2.42	3.71	2.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.35
<b>Total Net (mm)</b>	<b>60.32</b>	<b>44.20</b>	<b>62.20</b>	<b>53.06</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>	<b>17.82</b>	<b>237.60</b>
<b>Total Gross (mm)</b>	<b>120.64</b>	<b>88.40</b>	<b>124.40</b>	<b>106.12</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>	<b>35.64</b>	<b>475.20</b>
<b>Total Net (m<sup>3</sup>/ha)</b>	<b>603.2</b>	<b>442.0</b>	<b>622.0</b>	<b>530.6</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</b>	<b>178.2</b>	<b>2376</b>
<b>Total Gross (m<sup>3</sup>/ha)</b>	<b>1206.4</b>	<b>884.0</b>	<b>1244.0</b>	<b>1061.2</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</b>	<b>356.4</b>	<b>4752</b>

*Note: The gross values assume an overall irrigation efficiency of 50%*

## IRRIGATION WATER REQUIREMENTS

**Table AT11-12 Area No 12 Valle del Rio Chiguirí**

*Based on mean monthly precipitation*

Crops	Ha	J	F	M	A	M	J	J	A	S	O	N	D	Total annual
Rice, first crop	0.10				2.75	0.00	0.00	0.00						2.75
Rice, second crop	0.25	15.37									0.00	0.00	0.00	15.37
Maize, first crop	0.12				0.00	0.00	0.00	0.00						0.00
Maize, second crop	0.05	1.71									0.00	0.00	0.00	1.71
Beans	0.04	0.02	3.64	3.22										6.88
Bejuco beans	0.04	0.00	1.52	0.00	0.00									1.62
Squash	0.03	0.00	1.56	3.40	0.00									4.96
Table tomatoes	0.02	0.00	1.04	2.27	0.00									3.31
Industrial tomatoes	0.02	0.00	1.04	2.27	0.00									3.31
Watermelons	0.02	0.00	1.09	2.05	0.00									3.14
Melons	0.02	0.00	1.09	2.05	0.00									3.14
Cassava	0.04	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Name	0.04	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Otoe	0.04	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pineapple	0.02	0.00	0.43	1.06	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.49
Coffee	0.04	0.00	1.32	2.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.94
Bananas	0.03	0.56	1.67	2.99	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.79
Plantains	0.04	0.74	2.23	3.99	2.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.06
Citrus (oranges)	0.05	1.12	2.79	4.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00
Pasture grasses	0.15	0.00	7.23	13.92	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.84
Teca trees	0.05	0.00	2.03	4.09	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.37
Pine trees	0.05	0.00	2.03	4.09	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.37
Anacardium	0.04	0.00	1.62	3.27	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.09
<b>Total Net (mm)</b>	<b>19.52</b>	<b>32.33</b>	<b>55.38</b>	<b>8.81</b>	<b>0.00</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>116.04</b>
<b>Total Gross (mm)</b>	<b>39.04</b>	<b>64.66</b>	<b>110.76</b>	<b>17.62</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>	<b>232.08</b>
<b>Total Net (m<sup>3</sup>/ha)</b>	<b>195.2</b>	<b>323.3</b>	<b>553.8</b>	<b>88.1</b>	<b>0.0</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>1160.4</b>
<b>Total Gross (m<sup>3</sup>/ha)</b>	<b>390.4</b>	<b>646.6</b>	<b>1107.6</b>	<b>176.2</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</b>	<b>2320.8</b>

*Note: The gross values assume an overall irrigation efficiency of 50%*

## **ATTACHMENT 12**

### **AGRICULTURE NET BENEFITS**

## AGRICULTURE NET BENEFITS

**Table AT12-1 Annual Crop Budgets with Project**

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Crops	Seeds (Kg/ha) or plants	Fertilizers			Labor man- days	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Harvest	Transportatio- n	Yield MT/ha	Market Price US\$/MT
		N kg/ha	P kg/ha	K kg/ha									
Rice, 1st crop	68.18	116	48	24	50	3	1	10	1	mechanical	vehicle	4.8	220
Rice, 2nd crop	90.9	116	48	24	45	3	1	10	1	mechanical	vehicle	4.4	220
Maize, 1st crop	16	104	24	12	45	3	0.5	3	0	mechanical	vehicle	4.1	198
Maize, 2nd crop	16	104	24	12	45	3	0.5	3	0	mechanical	vehicle	3.9	198
Beans	28	24	48	24	20	2.5	0.5	2.5	1	mechanical	vehicle	1.36	396
Bejuco beans	28	24	48	24	20	2.5	0.5	2.5	1	mechanical	vehicle	1.59	352
Table tomatoes	0.17	232	96	48	110	4	4	6	6	manual	vehicle	10.2	588
Industrial tomatoes	0.17	304	240	64	90	4	4	6	6	manual	vehicle	26.5	154
Watermelons	0.45	232	96	48	50	4	4	6	8	manual	vehicle	13.6	275
Melons	0.68	232	96	48	60	4	4	4	6	manual	vehicle	7.0	400
Squash	1	91	90	24	60	3	2	4	0.5	manual	vehicle	13.6	110
Cassava	2700	116	48	24	51	3	3	4	0.5	manual	vehicle	15.9	77
Otoe	2300	150	24	12	110	4	2	3	1	manual	vehicle	9.1	308
Name	1575	140	96	48	110	4	2	2.5	2	manual	vehicle	13.6	264

*Estimated Production Costs, Gross and Net Returns per Hectare*

Crops	Seeds or plants US\$	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Harvest US\$	Transp. US\$	Misc. 10% US\$	Total Cost US\$	Gross Return US\$	Net Return US\$
		N US\$	P US\$	K US\$											
Rice, 1st crop	48.00	35.04	14.88	7.44	300.00	75.00	7.00	75.00	15.75	73.50	63.00	71.46	786.07	1056.00	269.93
Rice, 2nd crop	64.00	35.04	14.88	7.44	270.00	75.00	7.00	75.00	15.75	67.90	58.00	69.00	759.01	968.00	208.99
Maize. 1st crop	45.50	31.32	7.44	3.72	270.00	75.00	23.50	15.30	0.00	45.00	54.00	57.08	627.86	811.80	183.94
Maize, 2nd crop	45.50	31.32	7.44	3.72	270.00	75.00	23.50	15.30	0.00	40.00	48.00	55.98	615.76	772.20	156.44
Beans	27.00	7.44	14.88	7.44	120.00	62.50	13.00	75.00	29.00	15.00	18.00	38.93	428.19	538.56	110.37
Bejuco beans	27.00	7.44	14.88	7.44	120.00	62.50	13.00	75.00	29.00	12.50	15.00	38.38	422.14	559.68	137.54
Table tomatoes	21.00	70.08	29.76	14.88	660.00	100.00	148.00	91.00	196.35	360.00	750.00	244.11	2685.18	5997.60	3312.42
Industrial tomatoes	13.50	88.80	67.20	17.92	540.00	100.00	148.00	91.00	196.35	300.00	1000.00	256.28	2819.05	4081.00	1261.95
Watermelons	14.00	70.08	29.76	14.88	300.00	100.00	124.16	34.92	156.16	120.00	120.00	108.40	1192.36	3740.00	2547.64
Melons	45.00	70.08	29.76	14.88	360.00	100.00	92.50	28.00	64.50	120.00	120.00	104.47	1149.19	2800.00	1650.81
Squash	25.00	26.40	25.20	6.72	360.00	75.00	19.40	28.00	16.50	0.00	150.00	73.22	805.44	1496.00	690.56
Cassava	108.00	35.04	14.88	7.44	306.00	75.00	12.40	33.08	2.50	0.00	175.00	76.93	846.27	1224.30	378.03
Otoe	345.00	45.12	7.44	3.72	660.00	100.00	12.00	15.75	31.00	0.00	100.00	132.00	1452.03	2802.80	1350.77
Name	560.00	42.48	29.76	14.88	660.00	100.00	12.00	26.50	70.00	0.00	150.00	166.56	1832.18	3690.40	1858.22

Sources: 1) Ministerio de Desarrollo Agropecuario

## AGRICULTURE NET BENEFITS

**Table AT12-2 Annual Crop Budgets without Project**

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Crops	Seeds (Kg/ha) or plants	Fertilizers			Labor man-days	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Other materials	Harvest	Transportation	Yield MT/ha	Market Price US\$/MT
		N kg/ha	P kg/ha	K kg/ha										
Rice, 1st crop	45	0	0	0	25	0	0	6	0	bags - misc.	Manual	Vehicle	1.50	220
Rice, 2nd crop	45	0	0	0	25	0	0	6	0	bags - misc.	Manual	Vehicle	1.40	220
Maize, 1st crop	20	0	0	0	20	0	0	4	0	bags - misc.	Manual	Vehicle	1.00	198
Maize, 2nd crop	20	0	0	0	20	0	0	4	0	bags - misc.	Manual	Vehicle	1.00	198
Beans	28	0	0	0	30	0	0	2	0	bags - misc.	Manual	Vehicle	0.82	330
Bejucos beans	25	0	0	0	30	0	0	2	0	bags - misc.	Manual	Vehicle	0.77	374
Table tomatoes	0.17	58	24	12	70	0	2	3	3	boxes - misc.	Manual	Vehicle	5.11	587
Industrial tomatoes	0.17	58	24	12	50	0	2	3	3	boxes - misc.	Manual	Vehicle	9.50	154
Watermelons	0.45	58	24	12	30	0	2	3	2	misc.	Manual	Vehicle	8.18	275
Melons	0.68	58	24	12	25	0	2	2	3	misc.	Manual	Vehicle	3.00	400
Squash	1	0	0	0	20	0	0	4	0	bags - misc.	Manual	Vehicle	5.00	110
Cassava	1200	0	0	0	35	0	0	4	0	bags - misc.	Manual	Vehicle	6.50	77
Otote	900	0	0	0	50	0	0	3	0	bags - misc.	Manual	Vehicle	3.18	308
Name	675	0	0	0	40	0	0	2.5	0	bags - misc.	Manual	Vehicle	3.63	264

*Estimated Production Costs, Gross and Net Returns per Hectare*

Crops	Seeds or Plants US\$	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Harvest US\$	Transp. US\$	Misc.10% US\$	Total Cost US\$	Gross Return US\$	Net Return US\$
		N US\$	P US\$	K US\$											
Rice, 1st crop	12.00	0.00	0.00	0.00	150.00	0.00	0.00	45.00	0.00	23.00	20.00	25.00	275.00	330.00	55.00
Rice, 2nd crop	12.00	0.00	0.00	0.00	150.00	0.00	0.00	45.00	0.00	22.00	19.00	24.80	272.80	308.00	35.20
Maize, 1st crop	3.00	0.00	0.00	0.00	120.00	0.00	0.00	20.00	0.00	11.00	13.00	16.70	183.70	198.00	14.30
Maize, 2nd crop	3.00	0.00	0.00	0.00	120.00	0.00	0.00	20.00	0.00	10.00	12.00	16.50	181.50	198.00	16.50
Beans	15.00	0.00	0.00	0.00	180.00	0.00	0.00	10.00	0.00	7.50	9.00	22.15	243.65	270.60	26.95
Bejucos beans	12.00	0.00	0.00	0.00	180.00	0.00	0.00	0.00	0.00	8.50	10.20	21.07	231.77	287.98	56.21
Table tomatoes	21.00	17.52	7.44	3.72	420.00	0.00	74.00	45.50	98.00	120.00	375.00	118.22	1300.40	2999.57	1699.17
Industrial tomatoes	13.50	17.52	7.44	3.72	300.00	0.00	74.00	45.50	98.00	120.00	500.00	117.97	1297.65	1463.00	165.35
Watermelons	14.00	17.52	7.44	3.72	180.00	0.00	62.08	17.46	39.04	72.00	72.00	48.53	533.79	2249.50	1715.71
Melons	45.00	17.52	7.44	3.72	150.00	0.00	46.25	14.00	32.25	90.00	60.00	46.62	512.80	1200.00	687.20
Squash	25.00	0.00	0.00	0.00	120.00	0.00	0.00	20.00	0.00	60.00	66.00	29.10	320.10	550.00	229.90
Cassava	24.00	0.00	0.00	0.00	210.00	0.00	0.00	33.08	0.00	90.00	48.00	40.51	445.59	500.50	54.91
Otote	135.00	0.00	0.00	0.00	300.00	0.00	0.00	15.75	0.00	72.00	42.00	56.48	621.23	979.44	358.21
Name	180.00	0.00	0.00	0.00	240.00	0.00	0.00	26.50	0.00	120.00	48.00	61.45	675.95	958.32	282.37

Sources: 1- Ministerio de Desarrollo Agropecuario

2- Censo Nacional Agropecuario, 2001

3-Field investigation

### AGRICULTURE NET BENEFITS

**Table AT12-3 Perennial Crop Budgets - Pineapple**

**With Project**

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Seeds	Fertilizers			Labor man-days/ha	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Transportation	Other	Yield MT/ha	Market Price US\$
		N kg/ha	P kg/ha	K kg/ha									
1	40000	280	192	96	50	5	12	5	6	-	Misc.	0	0
2		280	192	96	80	-	12	5	6	Vehicle	Misc.	20.36	220
3		280	192	96	80	-	12	5	6	Vehicle	Misc.	30.55	220

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Plants US\$	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation	Misc. US\$ 10%	Total Cost US\$	Gross Return US\$	Net Return US\$
		N US\$	P US\$	K US\$										
1	2,400.00	84.96	59.52	29.76	300.00	125.00	183.60	49.50	111.00	0.00	334.33	3,677.67	0.00	-3,677.67
2		84.96	59.52	29.76	480.00	0.00	183.60	49.50	111.00	448.00	144.63	1,590.97	4479.20	2,888.23
3		84.96	59.52	29.76	480.00	0.00	183.60	49.50	111.00	672.00	167.03	1,837.37	6721.00	4,883.63

**Without Project**

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Plants	Fertilizers			Labor man-days/ha	Tractor Hours/ha	Insecticide l/ha	Herbicide l/ha	Fungicide l/ha	Transportation	Other	Yield MT/ha	Market Price US\$
		N Kg/Ha.	P Kg/Ha.	K Kg/Ha.									
1	20000	58	24	12	40	-	4	2	2	-	Misc.	0	0
2		58	24	12	50	-	4	3	2	Vehicle	Misc.	10.18	220
3		58	24	12	50	-	4	3	2	Vehicle	Misc.	15.27	220

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Years	Plants US\$	Fertilizers			Labor US\$	Tractor US\$/ha	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation	Misc. US\$ 10%	Total Cost US\$	Gross Return US\$	Net Return US\$
		N US\$	P US\$	K US\$										
1	1,200.00	17.52	7.44	3.72	240.00	-	61.20	19.80	37.00	0.00	158.67	1,745.35	0.00	-1,745.35
2		17.52	7.44	3.72	300.00	-	61.20	29.70	37.00	224.00	68.06	748.64	2,239.60	1,490.96
3		17.52	7.44	3.72	300.00	-	61.20	29.70	37.00	336.00	79.26	871.84	3,359.40	2,487.56

Note: This crop is replanted every three years

Sources: 1- Ministerio de Desarrollo Agropecuario  
 2- Censo Nacional Agropecuario,2001  
 3- Field Investigation

### AGRICULTURE NET BENEFITS

**Table AT12-4 Perennial Crop Budgets - Coffee**

#### With Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Plants	Fertilizer			Labor man-days/ha	Tractor Hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Transportation	Other	Yield MT/ha	Market Prices US\$
		N kg/ha	P kg/ha	K kg/ha									
1	1111	140	96	48	60	0	2	2	2	-	Misc.	0	0
2		140	96	48	50	0	2	2	2	-	Misc.	0	0
3		140	96	48	58	0	3	3	4	-	Misc.	0	0
4		140	96	48	120	0	3	3	4	Vehicle	Misc.	0.68	1650
5		140	96	48	150	0	3	3	4	Vehicle	Misc.	0.91	1650
6 to 15		140	96	48	180	0	3	3	4	Vehicle	Misc.	1.14	1650

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Plants	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation	Misc. US\$ 10%	Total Cost US\$	Gross Return US\$	Net Return US\$
		N US\$	P US\$	K US\$										
1	199.98	42.48	29.76	14.88	360.00	0.00	13.00	10.00	10.00	0.00	68.01	748.11	0.00	-748.11
2		42.48	29.76	14.88	300.00	0.00	13.00	10.00	10.00	0.00	42.01	462.13	0.00	-462.13
3		42.48	29.76	14.88	348.00	0.00	27.57	15.00	20.00	0.00	49.77	547.46	0.00	-547.46
4		42.48	29.76	14.88	720.00	0.00	27.57	15.00	20.00	15.00	88.47	973.16	1,122.00	148.84
5		42.48	29.76	14.88	900.00	0.00	27.57	15.00	20.00	20.00	106.97	1,176.66	1,501.50	324.84
6 to 15		42.48	29.76	14.88	1,080.00	0.00	27.57	15.00	20.00	25.00	125.47	1,380.16	1,881.00	500.84

Note: Production stabilizes in the sixth year

#### Without Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Plants	Fertilizers			Labor man-days/ha	Tractor Hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Transportation	Other	Yield MT/ha	Market Price US\$/MT
		N kg/ha	P kg/ha	K kg/ha									
1	816	0	0	0	60	-	0	0	0	-	Misc.	0	0
2		0	0	0	40	-	0	0	0	-	Misc.	0	0
3		0	0	0	40	-	0	0	0	-	Misc.	0	0
4		0	0	0	60	-	0	0	0	Vehicle	Misc.	0.27	1650
5		0	0	0	70	-	0	0	0	Vehicle	Misc.	0.36	1650
6 to 15		0	0	0	90	-	0	0	0	Vehicle	Misc.	0.45	1650

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Plants	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation	Misc. US\$ 10%	Total Cost US\$	Gross Return US\$	Net Return US\$
		N US\$	P US\$	K US\$										
1	146.88	0.00	0.00	0.00	360.00	-	0.00	0.00	0.00	0.00	50.69	557.57	0.00	-557.57
2		0.00	0.00	0.00	240.00	-	0.00	0.00	0.00	0.00	24.00	264.00	0.00	-264.00
3		0.00	0.00	0.00	240.00	-	0.00	0.00	0.00	0.00	24.00	264.00	0.00	-264.00
4		0.00	0.00	0.00	360.00	-	0.00	0.00	0.00	6.00	36.60	402.60	445.50	42.90
5		0.00	0.00	0.00	420.00	-	0.00	0.00	0.00	8.00	42.80	470.80	594.00	123.20
6 to 15		0.00	0.00	0.00	540.00	-	0.00	0.00	0.00	10.00	55.00	605.00	742.50	137.50

Note: 1 Production stabilizes in the sixth year

Sources: 1- Ministerio de Desarrollo Agropecuario

2- Censo Nacional Agropecuario, 2001

3- Field Investigation

**AGRICULTURE NET BENEFITS**  
**Table AT12-5 Perennial Crop Budgets - Plantain**

**With Project**

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Cornel trees	Fertilizers			Labor man-days/ha	Tractor hours/ha	Insecticide l/ha	Herbicides l/ha	Fungicides l/ha	Transportation	Other	Yield MT/ha	Market Price US\$/MT
		N kg/ha	P kg/ha	K kg/ha									
1	1111	87	36	18	85	-	50	4	2	Vehicle	Misc.	18.9	90
2		174	72	36	85	-	3	4	4	Vehicle	Misc.	29.7	90
3		174	72	36	85	-	3	4	4	Vehicle	Misc.	29.7	90
4		174	72	36	85	-	3	4	4	Vehicle	Misc.	29.7	90
5 to 15		174	72	36	85	-	3	4	4	Vehicle	Misc.	29.7	90

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Cornel trees US\$	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation	Misc. US\$ 10%	Total Cost US\$	Gross Return US\$	Net Return US\$
		N US\$	P US\$	K US\$										
1	277.75	26.28	11.16	5.58	510.00	0.00	220.50	20.00	31.50	225.00	132.77	1,460.54	1701.00	240.46
2		52.56	22.32	11.16	510.00	0.00	21.00	20.00	63.00	325.00	102.60	1,127.64	2673.00	1,545.36
3		52.56	22.32	11.16	510.00	0.00	21.00	20.00	63.00	325.00	102.60	1,127.64	2673.00	1,545.36
4		52.56	22.32	11.16	510.00	0.00	21.00	20.00	63.00	325.00	102.60	1,127.64	2673.00	1,545.36
5 to 15		52.56	22.32	11.16	510.00	0.00	21.00	20.00	63.00	325.00	102.60	1,127.64	2673.00	1,545.36

Note: Production stabilizes in the sixth year

**Without Project**

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Cornel trees	Fertilizers			Labor man-days/ha	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Transportation	Other	Yield MT/ha	Market Price US\$/MT
		N kg/ha	P kg/ha	K kg/ha									
1	816	46	0	0	60	-	1	4	0	Vehicle	Misc.	6.8	90.00
2		46	0	0	50	-	1	4	0	Vehicle	Misc.	9.1	90.00
3		46	0	0	60	-	1	4	0	Vehicle	Misc.	9.1	90.00
4		46	0	0	60	-	1	4	0	Vehicle	Misc.	9.1	90.00
5 to 15		46	0	0	60	-	1	4	0	Vehicle	Misc.	9.1	90.00

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Cornel trees US\$	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation	Misc. US\$ 10%	Total Cost US\$	Gross Return US\$	Net Return US\$
		N US\$	P US\$	K US\$										
1	204.00	13.80	0.00	0.00	360.00	0.00	7.00	20.00	0.00	75.00	67.98	747.78	612.00	-135.78
2		13.80	0.00	0.00	300.00	0.00	7.00	20.00	0.00	100.00	44.08	484.88	819.00	334.12
3		13.80	0.00	0.00	360.00	0.00	7.00	20.00	0.00	100.00	50.08	550.88	819.00	268.12
4		13.80	0.00	0.00	360.00	0.00	7.00	20.00	0.00	100.00	50.08	550.88	819.00	268.12
5 to 15		13.80	0.00	0.00	360.00	0.00	7.00	20.00	0.00	100.00	50.08	550.88	819.00	268.12

Note: Production stabilizes in the second year

Sources: 1- Ministerio de Desarrollo Agropecuario

2- Censo Nacional Agropecuario, 2001

3- Field Investigation

## AGRICULTURE NET BENEFITS

**Table AT12-6 Perennial Crop Budgets - Citrus (Oranges)**

### With Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Plants	Fertilizers			Labor man-days/ha	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Transportation	Other	Yields MT/ha	Market Price US\$
		N kg/ha	P kg/ha	K kg/ha									
1	278	116	48	24	90	3	2	4	1	0	Misc.	0	0
2		128	72	36	50	-	3	4	1	0	Misc.	0	0
3		128	72	36	50	-	3	4	2	0	Misc.	0	0
4		232	96	48	70	-	4	4	2	Vehicle	Misc.	10	120
5		232	96	48	80	-	4	4	3	Vehicle	Misc.	15	120
6		232	96	48	80	-	4	4	3	Vehicle	Misc.	18	120
7 to 15		232	96	48	80	-	4	4	3	Vehicle	Misc.	20	120

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Plants US\$	FERTILIZANTES			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation US\$	Misc. US\$ 10%	Total Cost US\$	Gross Returns US\$	Net Returns US\$
		N US\$	P US\$	K US\$										
1	417.00	35.04	14.88	7.44	540.00	75	20.34	20.00	29.50	0.00	115.92	1,275.12	0.00	-1,275.12
2		38.76	22.32	11.16	300.00	0	30.51	20.00	29.50	0.00	45.22	497.47	0.00	-497.47
3		38.76	22.32	11.16	300.00	0	30.51	20.00	59.00	0.00	48.18	529.93	0.00	-529.93
4		70.08	29.76	14.88	420.00	0	40.68	20.00	59.00	100.00	75.44	829.84	1,200.00	370.16
5		70.08	29.76	14.88	480.00	0	40.68	20.00	88.50	150.00	89.39	983.29	1,800.00	816.71
6		70.08	29.76	14.88	480.00	0	40.68	20.00	88.50	180.00	92.39	1,016.29	2,160.00	1,143.71
7 to 15		70.08	29.76	14.88	480.00	0	40.68	20.00	88.50	200.00	94.39	1,038.29	2,400.00	1,361.71

Note: Production stabilizes in the seventh year

### Without Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Plants	Fertilizers			Labor man-days/ha	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Transportation	Other	Yields MT/ha	Market Price US\$
		N kg/ha	P kg/ha	K kg/ha									
1	278	12	24	12	50	3	2	4	1	-	Misc.	0	0
2		12	24	12	40	-	2	4	1	-	Misc.	0	0
3		12	24	12	40	-	2	4	2	-	Misc.	0	0
4		0	0	0	50	-	2	0	2	Vehicle	Misc.	5	120
5		0	0	0	50	-	2	0	2	Vehicle	Misc.	6	120
6		0	0	0	60	-	2	0	2	Vehicle	Misc.	8	120
7 to 15		0	0	0	60	-	2	0	2	Vehicle	Misc.	8	120

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Plants US\$	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation US\$	Misc. US\$ 10%	Total Cost US\$	Gross Returns US\$	Net Returns US\$
		N US\$	P US\$	K US\$										
1	417.00	3.72	7.44	3.72	300.00	75.00	20.34	20.00	29.50	0.00	87.67	964.39	0.00	-964.39
2		3.72	7.44	3.72	240.00	0.00	20.34	20.00	29.50	0.00	32.47	357.19	0.00	-357.19
3		3.72	7.44	3.72	240.00	0.00	20.34	20.00	59.00	0.00	35.42	389.64	0.00	-389.64
4		0.00	0.00	0.00	300.00	0.00	20.34	0.00	59.00	100.00	47.93	527.27	600.00	72.73
5		0.00	0.00	0.00	300.00	0.00	20.34	0.00	59.00	100.00	47.93	527.27	720.00	192.73
6		0.00	0.00	0.00	360.00	0.00	20.34	0.00	59.00	100.00	53.93	593.27	960.00	366.73
7 to 15		0.00	0.00	0.00	360.00	0.00	20.34	0.00	59.00	100.00	53.93	593.27	960.00	366.73

Note: Production stabilizes in the sixth year

Sources: 1- Ministerio de Desarrollo Agropecuario

2- Censo Nacional Agropecuario, 2001

3- Field Investigation

## AGRICULTURE NET BENEFITS

**Table AT12-7 Perennial Crop Budgets - Bananas**

### With Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Cornel Trees	Fertilizer			Labor man-days/ha	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Transportation	Other	Yields MT/ha	Market Price US\$/MT
		N kg/ha	P kg/ha	K kg/ha									
1	816	116	48	24	80	-	50	4	2	Vehicle	Misc.	14	222
2		174	72	36	70	-	3	4	4	Vehicle	Misc.	16	222
3		174	72	36	70	-	3	4	4	Vehicle	Misc.	18	222
4		174	72	36	70	-	3	4	4	Vehicle	Misc.	20	222
5 to 15		174	72	36	70	-	3	4	4	Vehicle	Misc.	20	222

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Cornel Trees US\$	FERTILIZANTES			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation US\$	Misc. US\$ 20%	Total Cost US\$	Gross Returns US\$	Net Returns US\$
		N US\$	P US\$	K US\$										
1	204.00	35.04	14.88	7.44	480.00	-	220.50	20.00	31.50	252.00	253.07	1,518.43	3,108.00	1,589.57
2		52.56	22.32	11.16	420.00	-	21.00	20.00	63.00	288.00	179.61	1,077.65	3,552.00	2,474.35
3		52.56	22.32	11.16	420.00	-	21.00	20.00	63.00	324.00	186.81	1,120.85	3,996.00	2,875.15
4		52.56	22.32	11.16	420.00	-	21.00	20.00	63.00	360.00	194.01	1,164.05	4,440.00	3,275.95
5 to 15		52.56	22.32	11.16	420.00	-	21.00	20.00	63.00	360.00	194.01	1,164.05	4,440.00	3,275.95

Note: Production stabilizes in the fourth year

### Without Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Cornel Trees	Fertilizers			Labor man-days/ha	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Transportation	Other	Yields bunches/ha	Market Price US\$/bunch
		N kg/ha	P kg/ha	K kg/ha									
1	625	46	0	0	50	-	1	0	0	Vehicle	Misc.	300	2.00
2		46	0	0	40	-	1	0	0	Vehicle	Misc.	400	2.00
3		46	0	0	40	-	1	0	0	Vehicle	Misc.	600	2.00
4		46	0	0	40	-	1	0	0	Vehicle	Misc.	600	2.00
5 to 15		46	0	0	40	-	1	0	0	Vehicle	Misc.	600	2.00

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Cornel Trees US\$	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportation US\$	Misc. US\$ 10%	Total Cost US\$	Gross Returns US\$	Net Returns US\$
		N US\$	P US\$	K US\$										
1	156.25	13.80	0.00	0.00	300.00	0.00	7.00	0.00	0.00	150.00	62.71	689.76	600.00	-89.76
2		13.80	0.00	0.00	240.00	0.00	7.00	0.00	0.00	300.00	56.08	616.88	800.00	183.12
3		13.80	0.00	0.00	240.00	0.00	7.00	0.00	0.00	300.00	56.08	616.88	1,200.00	583.12
4		13.80	0.00	0.00	240.00	0.00	7.00	0.00	0.00	300.00	56.08	616.88	1,200.00	583.12
5 to 15		13.80	0.00	0.00	240.00	0.00	7.00	0.00	0.00	300.00	56.08	616.88	1,200.00	583.12

Note: Production stabilizes in the third year

Sources: 1- Ministerio de Desarrollo Agropecuario

2- Censo Nacional Agropecuario, 2001

3- Field Investigation

## AGRICULTURE NET BENEFITS

**Table AT12-8 Perennial Crop Budgets - Teca Trees ( *Tectona grandis* ) 1 of 4**

### With Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Plants	Fertilizers			Labor man-days/ha	Tractor/equipment	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Misc. and Contingencies %	Yields m3/ha	International Market Price US\$/m3
		N kg/ha	P kg/ha	K kg/ha								
1	1111	70	48	24	80	As estimated	2	4	0	20	0	
2		24	48	24	58	0	2	4	0	20	0	
3		24	48	24	46	0	4	4	0	20	0	
4		24	48	24	46	0	4	4	0	20	0	
5		24	48	24	46	0	4	4	0	20	0	
6		24	48	24	64	As estimated	4	4	0	20	0	
7		24	48	24	46	0	4	4	0	20	0	
8		24	48	24	64	As estimated	4	4	0	20	0	
9		24	48	24	46	0	4	4	0	20	0	
10		24	48	24	64	As estimated	4	4	0	20	8.7	260
11		24	48	24	46	0	4	4	0	20	0	
12		24	48	24	46	0	4	4	0	20	0	
13		24	48	24	46	0	4	4	0	20	0	
14		24	48	24	46	0	4	4	0	20	0	
15		24	48	24	70	As estimated	4	4	0	20	26.4	919
16		24	48	24	46		4	4	0	20	0	
17		24	48	24	46	0	4	4	0	20	0	
18		24	48	24	46	0	4	4	0	20	0	
19		24	48	24	46	0	4	4	0	20	0	
20		24	48	24	70	As estimated	4	4	0	20	29.1	1131
21		24	48	24	46	0	4	4	0	20	0	
22		24	48	24	46	0	4	4	0	20	0	
23		24	48	24	46	0	4	4	0	20	0	
24		24	48	24	46	0	4	4	0	20	0	
25		24	48	24	80	As estimated	4	4	0	20	129	1403
<b>* TOTAL</b>											<b>193.2</b>	

\* Yield during the useful life of the plantation (25 years)

Sources:  
 1- International Tropical Timber Organization (ITTO)  
 2- Propuesta de Inversión y Ganancias de la Inversión (Producción y Precios), United Nature, Panama

## AGRICULTURE NET BENEFITS

**Table AT12-8 Perennial Crop Budgets - Teca Trees ( *Tectona grandis* ) 2 of 4**

### With Project

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Plants US\$	Fertilizers			Labor US\$	Tractor/equipment US\$	Insecticides US\$	Herbicides US\$	Sub-total Costs US\$	Misc. and Contingencies US\$	Total Cost US\$	Gross Returns US\$	Net Returns US\$
		N	P	K									
		US\$	US\$	US\$									
1	277.75	21.24	14.88	7.44	480.00	200.00	14.00	20.00	1,035.31	207.06	1,242.37	0.00	-1,242.37
2		7.44	14.88	7.44	348.00	0.00	14.00	20.00	411.76	82.35	494.11	0.00	-494.11
3		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
4		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
5		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
6		7.44	14.88	7.44	384.00	200.00	28.00	20.00	661.76	132.35	794.11	0.00	-794.11
7		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
8		7.44	14.88	7.44	384.00	200.00	28.00	20.00	661.76	132.35	794.11	0.00	-794.11
9		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
10		7.44	14.88	7.44	384.00	500.00	28.00	20.00	961.76	192.35	1,154.11	2,262.00	1,107.89
11		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
12		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
13		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
14		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
15		7.44	14.88	7.44	420.00	800.00	28.00	20.00	1,297.76	259.55	1,557.31	24,261.60	22,704.29
16		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
17		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
18		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
19		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
20		7.44	14.88	7.44	420.00	1,200.00	28.00	20.00	1,697.76	339.55	2,037.31	32,912.10	30,874.79
21		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
22		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
23		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
24		7.44	14.88	7.44	276.00	0.00	28.00	20.00	353.76	70.75	424.51	0.00	-424.51
25		7.44	14.88	7.44	480.00	1,500.00	28.00	20.00	2,057.76	411.55	2,469.31	180,987.00	178,517.69
<b>TOTALS</b>	<b>277.75</b>	<b>199.80</b>	<b>372.00</b>	<b>186.00</b>	<b>7,992.00</b>	<b>4600.00</b>	<b>630.00</b>	<b>460.00</b>	<b>14,439.80</b>	<b>2,752.85</b>	<b>17759.46</b>	<b>240,422.70</b>	<b>222,663.24</b>

Notes: 1- The anticipated net return over the 25 year useful life of the plantation is US\$ 222,663.24 per hectare

2- Cost recovery begins approximately in year 15

## AGRICULTURE NET BENEFITS

**Table AT12-8 Perennial Crop Budgets - Teca Trees ( *Tectona grandis* ) 3 of 4**

### Without Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Year	Plants	Fertilizers			Labor man-days/ha	Tractor /equipment	Insecticide l/ha	Herbicides l/ha	Fungicides l/ha	Misc. and Contingencies %	Yields m3/ha	Local Market Price US\$/m3
		N kg/ha	P kg/ha	K kg/ha								
1	952	12	24	12	70	As estimated	2	4	0	10	0	
2		12	24	12	40	0	2	4	0	10	0	
3		12	24	12	30	0	2	4	0	10	0	
4		0	0	0	30	0	2	4	0	10	0	
5		0	0	0	30	0	2	4	0	10	0	
6		0	0	0	50	As estimated	2	4	0	10	0	
7		0	0	0	30	0	0	0	0	10	0	
8		0	0	0	40	0	0	0	0	10	0	
9		0	0	0	30	0	0	0	0	10	0	
10		0	0	0	50	As estimated	0	0	0	10	4	150
11		0	0	0	30	0	0	0	0	10	0	
12		0	0	0	30	0	0	0	0	10	0	
13		0	0	0	30	0	0	0	0	10	0	
14		0	0	0	30	0	0	0	0	10	0	
15		0	0	0	60	As estimated	0	0	0	10	16	200
16		0	0	0	30	0	0	0	0	10	0	
17		0	0	0	30	0	0	0	0	10	0	
18		0	0	0	30	0	0	0	0	10	0	
19		0	0	0	30	0	0	0	0	10	0	
20		0	0	0	60	As estimated	0	0	0	10	22	260
21		0	0	0	30	0	0	0	0	10	0	
22		0	0	0	30	0	0	0	0	10	0	
23		0	0	0	30	0	0	0	0	10	0	
24		0	0	0	30	0	0	0	0	10	0	
25		0	0	0	60	As estimated	0	0	0	10	110	350
<b>* TOTAL</b>											<b>152</b>	

\* Yield during the useful life of the plantation (25 years)

Sources:  
 1- International Tropical Timber Organization (ITTO)  
 2- Propuesta de Inversión y Ganancias de la Inversión (Producción y Precios), United Nature, Panama

## AGRICULTURE NET BENEFITS

**Table AT12-8 Perennial Crop Budgets - Teca Trees ( *Tectona grandis* ) 4 of 4**

### Without Project

*Estimated Production Costs, Gross and Net Returns per Hectare*

Year	Plants US\$	Fertilizers			Labor US\$	Tractor/equipment US\$	Insecticides US\$	Herbicides US\$	Sub-total Costs US\$	Misc. and Contingencies US\$	Total Cost US\$	Gross Returns US\$	Net Returns US\$
		N US\$	P US\$	K US\$									
1	238.00	3.72	7.44	3.72	420.00	150.00	14.00	20.00	857	85.69	942.57	0.00	-942.57
2		3.72	7.44	3.72	240.00	0.00	14.00	20.00	289	28.89	317.77	0.00	-317.77
3		3.72	7.44	3.72	180.00	0.00	14.00	20.00	229	22.89	251.77	0.00	-251.77
4		0.00	0.00	0.00	180.00	0.00	14.00	20.00	214	21.40	235.40	0.00	-235.40
5		0.00	0.00	0.00	180.00	0.00	14.00	20.00	214	21.40	235.40	0.00	-235.40
6		0.00	0.00	0.00	300.00	200.00	14.00	20.00	534	53.40	587.40	0.00	-587.40
7		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
8		0.00	0.00	0.00	240.00	0.00	0.00	0.00	240	24.00	264.00	0.00	-264.00
9		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
10		0.00	0.00	0.00	300.00	400.00	0.00	0.00	700	70.00	770.00	600.00	-170.00
11		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
12		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
13		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
14		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
15		0.00	0.00	0.00	360.00	600.00	0.00	0.00	960	96.00	1,056.00	3,200.00	2,144.00
16		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
17		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
18		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
19		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
20		0.00	0.00	0.00	360.00	600.00	0.00	0.00	960	96.00	1,056.00	5,720.00	4,664.00
21		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
22		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
23		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
24		0.00	0.00	0.00	180.00	0.00	0.00	0.00	180	18.00	198.00	0.00	-198.00
25		0.00	0.00	0.00	360.00	800.00	0.00	0.00	1,160	116.00	1,276.00	38,500.00	37,224.00
<b>TOTALS</b>	<b>238.00</b>	<b>11.16</b>	<b>22.32</b>	<b>11.16</b>	<b>5,640.00</b>	<b>2750.00</b>	<b>84.00</b>	<b>120.00</b>	<b>8,877</b>	<b>887.66</b>	<b>9,764.30</b>	<b>48,020.00</b>	<b>38,255.70</b>

Notes: 1- The anticipated net return over the 25 year useful life of the plantation is US\$ 38,255.70 per hectare

2- Cost recovery begins approximately in year 15

## AGRICULTURE NET BENEFITS

**Table AT12-9 Perennial Crop Budgets - Pine Trees ( Pinus Caribaea) 1 of 4**

### With Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	PLANTS	Fertilizers			Labor man-days/ha	Tractor/equipment	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Misc. and Contingencies %	Yields m <sup>3</sup> /ha	Local Market Price US\$/m <sup>3</sup>
		N	P	K								
		kg/ha	kg/ha	kg/ha								
1	1111	24	48	24	75	As estimated	2	4	0	20	0	0
2		24	48	24	50	0	2	4	0	20	0	0
3		24	48	24	40	0	4	4	0	20	0	0
4		24	48	24	40	0	4	4	0	20	0	0
5		24	48	24	40	0	4	4	0	20	0	0
6		24	48	24	60	0	4	4	0	20	0	0
7		24	48	24	45	0	4	4	0	20	0	0
8		24	48	24	60	As estimated	4	4	0	20	0	0
9		24	48	24	45	0	4	4	0	20	0	0
10		24	48	24	65	As estimated	4	4	0	20	8	162
11		24	48	24	45	0	4	4	0	20	0	0
12		24	48	24	45	0	4	4	0	20	0	0
13		24	48	24	45	0	4	4	0	20	0	0
14		24	48	24	45	0	4	4	0	20	0	0
15		24	48	24	65	As estimated	4	4	0	20	30	240
16		24	48	24	45	0	4	4	0	20	0	0
17		24	48	24	45	0	4	4	0	20	0	0
18		24	48	24	45	0	4	4	0	20	0	0
19		24	48	24	45	0	4	4	0	20	0	0
20		24	48	24	70	As estimated	4	4	0	20	40	320
21		24	48	24	45	0	4	4	0	20	0	0
22		24	48	24	45	0	4	4	0	20	0	0
23		24	48	24	45	0	4	4	0	20	0	0
24		24	48	24	45	0	4	4	0	20	0	0
25		24	48	24	80	As estimated	4	4	0	20	132	380
<b>Total*</b>											<b>210</b>	

\* Yield during the useful life of the plantation (25 years)

Sources: 1- International Tropical Timber Organization (ITTO)  
 2- Propuesta de Inversión y Ganancias de la Inversión (Producción y Precios), United Nature, Panama

## AGRICULTURE NET BENEFITS

**Table AT12-9 Perennial Crop Budgets - Pine Trees ( Pinus Caribaea) 2 of 4**

**With Project**

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Plants	Fertilizer			Labor US\$	Tractor/equipment US\$	Insecticides US\$	Herbicides US\$	Sub-total Costs US\$	Misc. and Contingencies US\$	Total Cost US\$	Gross Returns US\$	Net Returns US\$
		N	P	K									
		US\$	US\$	US\$									
1	277.75	7.44	14.88	7.44	450.00	200.00	14.00	20.00	991.51	198.30	1,189.81	0.00	-1,189.81
2		7.44	14.88	7.44	300.00	0	14.00	20.00	363.76	72.75	436.51	0.00	-436.51
3		7.44	14.88	7.44	240.00	0	28.00	20.00	317.76	63.55	381.31	0.00	-381.31
4		7.44	14.88	7.44	240.00	0	28.00	20.00	317.76	63.55	381.31	0.00	-381.31
5		7.44	14.88	7.44	240.00	0	28.00	20.00	317.76	63.55	381.31	0.00	-381.31
6		7.44	14.88	7.44	360.00	0	28.00	20.00	437.76	87.55	525.31	0.00	-525.31
7		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
8		7.44	14.88	7.44	360.00	200.00	28.00	20.00	637.76	127.55	765.31	0.00	-765.31
9		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
10		7.44	14.88	7.44	390.00	300.00	28.00	20.00	767.76	153.55	921.31	1,296.00	374.69
11		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
12		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
13		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
14		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
15		7.44	14.88	7.44	390.00	500.00	28.00	20.00	967.76	193.55	1,161.31	7,200.00	6,038.69
16		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
17		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
18		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
19		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
20		7.44	14.88	7.44	420.00	800.00	28.00	20.00	1297.76	259.55	1,557.31	12,800.00	11,242.69
21		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
22		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
23		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
24		7.44	14.88	7.44	270.00	0	28.00	20.00	347.76	69.55	417.31	0.00	-417.31
25		7.44	14.88	7.44	480.00	1500.00	28.00	20.00	2057.76	411.55	2,469.31	50,160.00	47,690.69
<b>TOTALS</b>	<b>277.75</b>	<b>186.00</b>	<b>372.00</b>	<b>186.00</b>	<b>7,650.00</b>	<b>3,500.00</b>	<b>672.00</b>	<b>500.00</b>	<b>13,343.75</b>	<b>2,668.75</b>	<b>16,012.5</b>	<b>71,456.00</b>	<b>55,443.50</b>

Notes: 1- The anticipated net return over the 25 year useful life of the plantation is US\$ 55,443.50 per hectare

2- Cost recovery begins approximately in year 15

## AGRICULTURE NET BENEFITS

**Table AT12-9 Perennial Crop Budgets - Pine Trees ( Pinus Caribaea) 3 of 4**

### Without Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Year	PLANTS	Fertilizers			Labor man-days/hs	Tractor/equipment	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Misc. and contingencies %	Yields m3/ha	Local Market Prices US\$/m3
		N kg/ha	P kg/ha	K kg/ha								
1	833	24	48	24	65	As estimated	2	4	0	10	0	0
2		24	48	24	40	0	2	4	0	10	0	0
3		24	48	24	40	0	2	4	0	10	0	0
4		24	48	24	40	0	2	4	0	10	0	0
5		24	48	24	40	0	2	4	0	10	0	0
6		24	48	24	50	As estimated	2	4	0	10	0	0
7	0	0	0	0	40	0	0	0	0	10	0	0
8	0	0	0	0	40	0	0	0	0	10	0	0
9	0	0	0	0	40	0	0	0	0	10	0	0
10	0	0	0	0	60	As estimated	0	0	0	10	6	162
11	0	0	0	0	40	0	0	0	0	10	0	0
12	0	0	0	0	40	0	0	0	0	10	0	0
13	0	0	0	0	40	0	0	0	0	10	0	0
14	0	0	0	0	40	0	0	0	0	10	0	0
15	0	0	0	0	60	As estimated	0	0	0	10	25	240
16	0	0	0	0	40	0	0	0	0	10	0	0
17	0	0	0	0	40	0	0	0	0	10	0	0
18	0	0	0	0	40	0	0	0	0	10	0	0
19	0	0	0	0	40	0	0	0	0	10	0	0
20	0	0	0	0	70	As estimated	0	0	0	10	35	320
21	0	0	0	0	40	0	0	0	0	10	0	0
22	0	0	0	0	40	0	0	0	0	10	0	0
23	0	0	0	0	40	0	0	0	0	10	0	0
24	0	0	0	0	40	0	0	0	0	10	0	0
25	0	0	0	0	70	As estimated	0	0	0	10	90	380
<b>* TOTAL</b>											<b>156</b>	

\* Yield during the useful life of the plantation (25 years)

Sources: 1- International Tropical Timber Organization (ITTO)  
2- Propuesta de Inversión y Ganancias de la Inversión (Producción y Precios), United Nature, Panama

## AGRICULTURE NET BENEFITS

**Table AT12-9 Perennial Crop Budgets - Pine Trees ( Pinus Caribaea) 4 of 4**

### Without Project

*Estimated Production Costs, Gross and Net Returns per Hectare*

Year	Plants US\$	Fertilizers			Labor US\$	Tractor/equipment US\$	Insecticides US\$	Herbicides US\$	Sub-total Costs US\$	Misc. and Contingencies US\$	Total Costs US\$	Gross Returns US\$	Net Returns US\$
		N	P	K									
		US\$	US\$	US\$									
1	208.00	7.44	14.88	7.44	390.00	150	14.00	20.00	811.76	81.18	892.94	0.00	-892.94
2		7.44	14.88	7.44	240.00	0	14.00	20.00	303.76	30.38	334.14	0.00	-334.14
3		7.44	14.88	7.44	240.00	0	14.00	20.00	303.76	30.38	334.14	0.00	-334.14
4		7.44	14.88	7.44	240.00	0	14.00	20.00	303.76	30.38	334.14	0.00	-334.14
5		7.44	14.88	7.44	240.00	0	14.00	20.00	303.76	30.38	334.14	0.00	-334.14
6		7.44	14.88	7.44	240.00	0	14.00	20.00	303.76	30.38	334.14	0.00	-334.14
7		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
8		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
9		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
10		0.00	0.00	0.00	360.00	300	0.00	0.00	660.00	66.00	726.00	972.00	246.00
11		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
12		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
13		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
14		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
15		0.00	0.00	0.00	360.00	400	0.00	0.00	760.00	76.00	836.00	6,000.00	5,164.00
16		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
17		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
18		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
19		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
20		0.00	0.00	0.00	420.00	600	0.00	0.00	1,020.00	102.00	1,122.00	11,200.00	10,078.00
21		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
22		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
23		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
24		0.00	0.00	0.00	240.00	0	0.00	0.00	240.00	24.00	264.00	0.00	-264.00
25		0.00	0.00	0.00	420.00	700	0.00	0.00	1,120.00	112.00	1,232.00	34,200.00	32,968.00
<b>TOTALS</b>	<b>208.00</b>	<b>44.64</b>	<b>89.28</b>	<b>44.64</b>	<b>6,810.00</b>	<b>2,350</b>	<b>84.00</b>	<b>120.00</b>	<b>9,750.56</b>	<b>975.06</b>	<b>10,725.6</b>	<b>52,372.00</b>	<b>41,646.38</b>

Notes: 1- The anticipated net return over the 25 year useful life of the plantation is US\$ 41,646.38 per hectare

2- Cost recovery begins approximately in year 15

## AGRICULTURE NET BENEFITS

**Table AT12-10 Perennial Crop Budgets - Maranon (*Anacardium Occidentale L*) 1 of 4**

### With Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Project Year	Plants	Fertilizers			Labor man-day/ha	Tractor /equipment	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Misc.and Contingencies %	Yields kg/ha	International Market Price US\$/kg
		N kg/ha	P kg/ha	K kg/ha								
1	204	70	48	24	60	As estimated	2	4	1	20	0.00	0.00
2	24	48	24	24	56	0	2	4	1	20	0.00	0.00
3	24	48	24	24	56	0	3	4	1	20	0.00	0.00
4	24	48	24	24	60	0	3	4	2	20	450	3.75
5	24	48	24	24	60	0	4	4	2	20	640	3.75
6	24	48	24	24	80	As estimated	4	4	2	20	800	3.75
7	24	48	24	24	100	0	4	4	2	20	1200	3.75
8	24	48	24	24	120	As estimated	4	4	2	20	2000	3.75
9	24	48	24	24	120	0	4	4	2	20	2000	3.75
10	24	48	24	24	120	0	4	4	2	20	2000	3.75
11	24	48	24	24	120	0	4	4	2	20	2000	3.75
12	24	48	24	24	120	0	4	4	2	20	2000	3.75
13	24	48	24	24	120	0	4	4	2	20	2000	3.75
14	24	48	24	24	120	0	4	4	2	20	2000	3.75
15	24	48	24	24	120	0	4	4	2	20	2000	3.75
16	24	48	24	24	120	0	4	4	2	20	2000	3.75
17	24	48	24	24	120	0	4	4	2	20	2000	3.75
18	24	48	24	24	120	0	4	4	2	20	2000	3.75
19	24	48	24	24	120	0	4	4	2	20	2000	3.75
20	24	48	24	24	120	0	4	4	2	20	2000	3.75
<b>TOTAL YIELD OVER THE 20 YEAR LIFE OF THE PLANTATION - kg/ha</b>											<b>20,090</b>	

*Note: The estimated international market price of the Maranon nut is US\$ 3.75 per kg*

Sources 1-GUA-AG-09

2- INFOAGRO.COM

## AGRICULTURE NET BENEFITS

**Table AT12-10 Perennial Crop Budgets - Maranon (Anacardium Occidentale L) 2 of 4**

**With Project**

*Estimated Production Costs, Gross and Net Returns per Hectare*

Project Year	Plants US\$	Fertilizers			Labor US\$	Tractor/equipment US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Sub-Total Costs US\$	Misc.and Contingencies US\$	Total Costs US\$	Gross Returns US\$	Net Returns US\$
		N US\$	P US\$	K US\$										
1	102.00	21.24	14.88	7.44	360	200	14.00	20.00	29.50	769.06	153.81	922.87	0.00	-922.87
2		7.44	14.88	7.44	336	0	14.00	20.00	29.50	429.26	85.85	515.11	0.00	-515.11
3		7.44	14.88	7.44	336	0	21.00	20.00	29.50	436.26	87.25	523.51	0.00	-523.51
4		7.44	14.88	7.44	360	0	21.00	20.00	59.00	489.76	97.95	587.71	1687.50	1099.79
5		7.44	14.88	7.44	360	0	28.00	20.00	59.00	496.76	99.35	596.11	2400.00	1803.89
6		7.44	14.88	7.44	480	300	28.00	20.00	59.00	916.76	183.35	1,100.11	3000.00	1899.89
7		7.44	14.88	7.44	600	0	28.00	20.00	59.00	736.76	147.35	884.11	4500.00	3615.89
8		7.44	14.88	7.44	720	300	28.00	20.00	59.00	1,156.76	231.35	1,388.11	7500.00	6111.89
9		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
10		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
11		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
12		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
13		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
14		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
15		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
16		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
17		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
18		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
19		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
20		7.44	14.88	7.44	720	0	28.00	20.00	59.00	856.76	171.35	1,028.11	7500.00	6471.89
*Totals	102.00	162.6	297.6	148.8	12,192	800	518.00	400.00	1,091.5	15,610.5	3,142.50	18,855.00	109,087.50	90,232.50

\* Costs and gross and net returns during the 20 year life of the plantation considering the production of nuts only. Does not include the production of fresh fruit which has an economic value in both the international and local markets.

The cost recovery/net returns begin in the fourth year.

## AGRICULTURE NET BENEFITS

**Table AT12-10 Perennial Crop Budgets - Maranon (Anacardium Occidentale L) 3 of 4**

### Without Project

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices*

Year	Plants	Fertilizers			Labor man-days/ha	Tractor/equipment	Insecticides l/ha	herbicides l/ha	Fungicides l/ha	Misc.and Contingencies %	Yield 50kg boxes	Local Market Price US\$/box
		N kg/ha	P kg/ha	K kg/ha								
1	204	12	24	12	40	As estimated	1	2	0	15	0	0
2		12	24	12	30	0	1	2	0	15	0	0
3		12	24	12	30	0	1	0	0	15	0	0
4		12	24	12	40	As estimated	1	0	0	15	750	2
5		0	0	0	60	0	0	0	0	15	1000	2
6		0	0	0	70	0	0	0	0	15	1000	2
7		0	0	0	70	0	0	0	0	15	1000	2
8		0	0	0	70	0	0	0	0	15	1000	2
9		0	0	0	70	0	0	0	0	15	1000	2
10		0	0	0	80	0	0	0	0	15	1000	2
11		0	0	0	80	0	0	0	0	15	1000	2
12		0	0	0	80	0	0	0	0	15	1000	2
13		0	0	0	80	0	0	0	0	15	1000	2
14		0	0	0	100	0	0	0	0	15	1000	2
15		0	0	0	100	0	0	0	0	15	1000	2
16		0	0	0	100	0	0	0	0	15	1000	2
17		0	0	0	100	0	0	0	0	15	1000	2
18		0	0	0	100	0	0	0	0	15	1000	2
19		0	0	0	100	0	0	0	0	15	1000	2
20		0	0	0	100	0	0	0	0	15	1000	2
<b>Total yield over the 20 year life of the plantation (50 kg fruit boxes only; does not include nut production)</b>											<b>16,750</b>	

*Note: At present trees are dispersed, strongly developed, but only partially utilized. Fresh fruit is sold in the local market (nationwide) only. The nuts are highly valued in the international market (US, UK, Europe, Singapore, Japan) but are presently not sold, either locally or outside Panama. The local market price of fresh fruit is US\$ 2 per box containing 50 kg.*

Sources 1-GUA-AG-09  
 2- INFOAGRO.COM

## AGRICULTURE NET BENEFITS

**Table AT12-10 Perennial Crop Budgets - Maranon (*Anacardium Occidentale L*) 4 of 4**

### Without Project

*Estimated Production Costs, Gross and Net Returns per Hectare*

Year	Plants US\$	Fertilizers			Labor US\$	Tractor/equipment US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Sub-Total Costs US\$	Misc. and Contingencies US\$	Total Costs US\$	Gross Returns US\$	Net Returns US\$
		N US\$	P US\$	K US\$										
1	102.00	3.72	7.44	3.72	240.00	100	7.00	10	0	473.88	71.08	544.96	0.00	-544.96
2		3.72	7.44	3.72	180.00	0	7.00	10	0	211.88	31.78	243.66	0.00	-243.66
3		3.72	7.44	3.72	180.00	0	7.00	0	0	201.88	30.28	232.16	0.00	-232.16
4		3.72	7.44	3.72	240.00	100	7.00	0	0	361.88	54.28	416.16	1500.00	1083.84
5		0.00	0.00	0.00	360.00	0	0.00	0	0	380.00	54.00	414.00	2000.00	1586.00
6		0.00	0.00	0.00	420.00	0	0.00	0	0	420.00	63.00	483.00	2000.00	1517.00
7		0.00	0.00	0.00	420.00	0	0.00	0	0	420.00	63.00	483.00	2000.00	1517.00
8		0.00	0.00	0.00	420.00	0	0.00	0	0	420.00	63.00	483.00	2000.00	1517.00
9		0.00	0.00	0.00	420.00	0	0.00	0	0	420.00	63.00	483.00	2000.00	1517.00
10		0.00	0.00	0.00	480.00	0	0.00	0	0	480.00	72.00	552.00	2000.00	1448.00
11		0.00	0.00	0.00	480.00	0	0.00	0	0	480.00	72.00	552.00	2000.00	1448.00
12		0.00	0.00	0.00	480.00	0	0.00	0	0	480.00	72.00	552.00	2000.00	1448.00
13		0.00	0.00	0.00	480.00	0	0.00	0	0	480.00	72.00	552.00	2000.00	1448.00
14		0.00	0.00	0.00	600.00	0	0.00	0	0	600.00	90.00	690.00	2000.00	1310.00
15		0.00	0.00	0.00	600.00	0	0.00	0	0	600.00	90.00	690.00	2000.00	1310.00
16		0.00	0.00	0.00	600.00	0	0.00	0	0	600.00	90.00	690.00	2000.00	1310.00
17		0.00	0.00	0.00	600.00	0	0.00	0	0	600.00	90.00	690.00	2000.00	1310.00
18		0.00	0.00	0.00	600.00	0	0.00	0	0	600.00	90.00	690.00	2000.00	1310.00
19		0.00	0.00	0.00	600.00	0	0.00	0	0	600.00	90.00	690.00	2000.00	1310.00
20		0.00	0.00	0.00	600.00	0	0.00	0	0	600.00	90.00	690.00	2000.00	1310.00
<b>*Totals</b>	<b>102.00</b>	<b>14.88</b>	<b>29.76</b>	<b>14.88</b>	<b>9,000.0</b>	<b>200</b>	<b>28.00</b>	<b>20</b>	<b>0</b>	<b>9,409.52</b>	<b>1,411.43</b>	<b>10,820.95</b>	<b>33,500.00</b>	<b>22679.05</b>

\* Costs and gross and net returns during the 20 year life of the plantation, under the present conditions, considering the production of fresh fruit only, intended for the local market, although not fully utilized at present.

## AGRICULTURE NET BENEFITS

**Table AT12-11- Evolution of a Dual Purpose Bovine Herd (50 bulls and 1,000 cows)**

Item		Start development: 50 bulls and 1000 cows	Years				
			1	2	3	4	5 to 12
<b>CATEGORY</b>							
H	1	Breeder bulls	50	50	50	50	50
E	2	Nursing cows	611	536	522	614	687
R	3	Dry (non-nursing) cows	281	242	208	211	236
D	4	Young breeding cows (18 to 24 months old)	77	259	281	288	
C	5	Young breeding cows (12 to 18 months old)		155	181	176	199
M	6	Young cows (6 to 12 months old)	159	225	216	241	274
P	7	Female calves (less than 6 months old)	160	148	146	171	191
O	<b>SUB-TOTAL</b>						
S	8	Male calves (less than 6 months old)					
I	9	Young bulls (6 to 12 months old)					
T	10	Young bulls (12 to 18 months old)					
I	11	Young bulls (18 to 24 months old)					
O	12	Young bulls (over 24 months old)					
N	<b>SUB-TOTAL</b>						
	<b>TOTAL HEAD</b>		1261	1433	1582	1744	1925
	<b>TOTAL BOVINE UNITS (B.U.'s)</b>		942	1060	1220	1332	1460
<b>A.- INPUTS</b>							
H	1.- Purchases :						
E	Breeder Bulls		50				50(1)
A	Young cows/heifers		1000				
M	Female calves						
I	Male calves						
C	2.- Births :						
S	Males		340	312	307	360	403
	Females		339	311	306	359	402
	<b>TOTAL INPUTS</b>		1729	623	613	719	805
<b>B.- OUTPUTS</b>							
H	1.- Sales :						
E	Old breeder bulls						50(2)
A	Rejected cows		78	87	99	134	150
M	Nursing cows						
I	Young breeding cows (18 to 24 months old)						
C	Young cows (12 to 18 months old)						
S	Male calves (less than 6 months old)		340	312	307	360	403
	Young bulls (6 to 12 months old)						
	Young bulls (12 to 18 months old)						
	Young bulls (18 to 24 months old)						
	Young bulls (over 24 months old)						
	2.- Deaths :						
	Adults		30	27	26	30	33
	Nursing calves		20	15	15	18	20
	Young cows			10	17	15	17
	<b>TOTAL OUTPUTS</b>		468	451	464	557	623

**Notes:**

- 1- In year 7 only (not included in total inputs for years 5 to 12)
- 2- 50 bulls in year 6 and in year 12, each (not included in total outputs for years 5 to 12)

## AGRICULTURE NET BENEFITS

**Table AT12-12 - Technical Parameters used in Projecting the Bovine Herd**  
*(System for small and medium size producers)*

ITEM	Start development: 50 bulls and 1000 cows	YEARS				
		1	2	3	4	5 to 12
Pasturelands surface area, hectares		1,000	1,000	1,000	1,000	1,000
Total carrying capacity , B. U.'s		1,500	1,500	1,500	1,500	1,500
Carrying capacity per hectare , B. U.'s		1.50	1.50	1.50	1.50	1.50
Total animal load , B. U.'s		942	1,060	1,220	1,332	1,460
Animal load per hectare , B. U.'s		0.94	1.06	1.22	1.33	1.46
Birth rate , %		70	72	74	75	75
Adult mortality rate , %		3	3	3	3	3
Rejects , %		8	10	12	14	14
Effective weaning , %		94	95	95	95	95
Nursing cows , %		63	62	63	64	64
Nursing time , days		320	315	312	312	312
Milk production per cow , liters/day		5	6	6	8	8
Milk production per cow , liters/year		1,825	2,190	2,190	2,920	2,920
Total milk production , liters/year		1,115,075	1,173,840	1,143,180	1,792,880	2,006,040
Milk production per hectare, liters/year		1,115	1,174	1,143	1,793	2,006

*Source: Metodologia para la elaboracion de la evolucion se un hato bovino carne - leche , Banco Nacional de Fomento, Republica del Ecuador*

*Note: The first breeder bulls are substituted by new bulls with similar or superior characteristics during the sixth year. Also, the total animal load during the fifth year (1460 B. U. 's) approaches the total carrying capacity (1500 B. U. 's) and thus , it is assumed that the size of the herd remains stable.*

## AGRICULTURE NET BENEFITS

**Table AT12-13 Financial Analysis of a Dual Purpose (Meat-Milk) Bovine Herd**

ITEMS	YEARS												TOTAL U.S.\$
	1	2	3	4	5	6	7	8	9	10	11	12	
<b>GROSS RETURNS</b>													
Milk sales	334,523	352,152	342,954	537,864	601,812	601,812	601,812	601,812	601,812	601,812	601,812	601,812	6,381,989
Male Calves sales	51,000	46,800	46,050	54,000	60,450	60,450	60,450	60,450	60,450	60,450	60,450	60,450	681,450
Rejected cows sales	27,300	30,450	34,650	46,900	52,500	52,500	52,500	52,500	52,500	52,500	52,500	52,500	559,300
Old breeder bull sales					30,000							30,000	60,000
<b>Total gross returns</b>	<b>412,823</b>	<b>429,402</b>	<b>423,654</b>	<b>638,764</b>	<b>714,762</b>	<b>744,762</b>	<b>714,762</b>	<b>714,762</b>	<b>714,762</b>	<b>714,762</b>	<b>714,762</b>	<b>744,762</b>	<b>7,682,739</b>
<b>COSTS</b>													
Breeder bulls purchase	72,500	-	-	-	-	-	72,500	-	-	-	-	-	145,000
Young cows purchase	492,000	-	-	-	-	-	-	-	-	-	-	-	492,000
Small infrastructure, installations	75,000	37,500	18,750	18,750	18,750	18,750	18,750	18,750	18,750	18,750	18,750	18,750	300,000
Tools and materials	60,000	30,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	240,000
Seeding of pastures	400,000	-	-	-	-	-	-	-	-	-	-	-	400,000
Maintenance of pasturelands	-	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	2,200,000
Animal feed (4)	100,000	110,000	120,000	130,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	1,580,000
Animal health care (5)	125,000	140,000	160,000	180,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	2,205,000
<b>Total costs</b>	<b>1,324,500</b>	<b>517,500</b>	<b>513,750</b>	<b>543,750</b>	<b>573,750</b>	<b>573,750</b>	<b>646,250</b>	<b>573,750</b>	<b>573,750</b>	<b>573,750</b>	<b>573,750</b>	<b>573,750</b>	<b>7,562,000</b>
<b>Net returns</b>	<b>-911,677</b>	<b>-88,098</b>	<b>-90,096</b>	<b>95,014</b>	<b>141,012</b>	<b>171,012</b>	<b>68,512</b>	<b>141,012</b>	<b>141,012</b>	<b>141,012</b>	<b>141,012</b>	<b>171,012</b>	<b>120,739</b>
<b>NET RETURNS</b>													

- Note: 1- The breakeven occurs in year 4. The producer assets include the entire herd.  
 2- This analysis includes the cost of acquiring 50 herds made of 20 young cows and 1 breeder bull, each.  
 3- The sale value of the herd(s) at the end of year 12 is in the order of \$ 800,000  
 4- Includes minerals, molasses, salt.  
 5- Includes vitamins, medications, vaccinations

ITEM	Unit Price US\$	ITEM	Unit Price US \$ /herd	Quantity	Total Cost US\$
Breeder bull (Cebu)	\$1,450.00	Small infrastructure, installations	\$1,500.00	50	\$75,000.00
Young cows (double purpose)	\$492.00	Tools and materials	\$1,200.00	50	\$60,000.00
Rejected old breeder bull	\$600.00	Seeding of pasturelands ,cost per hectare	\$400.00	1000	\$400,000.00
Rejected cow	\$350.00	Maintenance of pasturelands,cost per ha	\$200.00	1000	\$200,000.00
Male Calves	\$150.00	Animal feed	\$2,000.00	50	\$100,000.00
Milk, in farm , liter	\$0.30	Animal health care	\$2,500.00	50	\$125,000.00

## AGRICULTURE NET BENEFITS

**Table AT12-14 Perennial Crop Budgets - Rotana Pasture Grasses**

*Estimated Input and Labor Requirements per Hectares with Project*

Project Year	Seeds qq	Fertilizers			Labor man- days/ha	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Other materials	Transportatio n
		N kg/ha	P kg/ha	K kg/ha							
		US\$	US\$	US\$							
1	1.5	122	30	30	40	0	1	4	0	Misc.	Vehicle
2		76	30	30	15	0	1	4	0	Misc.	Vehicle
3		198	60	60	15	0	1	4	0	Misc.	Vehicle
4		198	60	60	15	0	1	4	0	Misc.	Vehicle
5 to 12		198	60	50	15	0	1	4	0	Misc.	Vehicle

*Production Costs per Hectare with Project*

Project Year	Seeds US\$	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportatio n US\$	Misc. 10% US\$	Total Cost US\$
		N US\$	P US\$	K US\$								
		US\$	US\$	US\$								
1	30.00	32.60	5.00	5.00	240.00	0	7.00	20.00	0	16.44	43.96	400.00
2		32.60	5.00	5.00	90.00	0	7.00	20.00	0	11.44	28.96	200.00
3		32.60	5.00	5.00	90.00	0	7.00	20.00	0	11.44	28.96	200.00
4		32.60	5.00	5.00	90.00	0	7.00	20.00	0	11.44	28.96	200.00
5 to 12		32.60	5.00	5.00	90.00	0	7.00	20.00	0	11.44	28.96	200.00

*Estimated Input and Labor Requirements, Yields per Hectare and Market Prices for Meat and Milk without Project*

Year	Seeds qq	Fertilizers			Labor man - days/ha	Tractor hours/ha	Insecticides l/ha	Herbicides l/ha	Fungicides l/ha	Other	Transportatio n	Yield live animals lb/ha	Price Live animal US\$/Lb	Yield Milk l/ha	Price Milk US\$/l
		N kg/ha	P kg/ha	K kg/ha											
		US\$	US\$	US\$											
1	1	0	0	0	20	0	0	0	0	Misc.	0	200	0.48	0	0.30
2		0	0	0	15	0	0	0	0	Misc.	0	200	0.48	0	0.30
3		0	0	0	15	0	0	0	0	Misc.	0	200	0.48	0	0.30
4		0	0	0	15	0	0	0	0	Misc.	0	200	0.48	0	0.30
5 to 12		0	0	0	15	0	0	0	0	Misc.	0	200	0.48	0	0.30

*Production Costs, Gross and Net Returns per Hectare without Project*

Year	Seeds US\$	Fertilizers			Labor US\$	Tractor US\$	Insecticides US\$	Herbicides US\$	Fungicides US\$	Transportatio n US\$	Misc. 5% US\$	Total Cost US\$	Gross Returns		Net Returns US\$
		N US\$	P US\$	K US\$									Meat	Milk	
		US\$	US\$	US\$									US\$	US\$	
1	20.00	0.00	0.00	0.00	120.00	0.00	0.00	0.00	0.00	0.00	7.00	147.00	96	0	-51.00
2		0.00	0.00	0.00	90.00	0.00	0.00	0.00	0.00	0.00	4.50	94.50	96	0	1.50
3		0.00	0.00	0.00	90.00	0.00	0.00	0.00	0.00	0.00	4.50	94.50	96	0	1.50
4		0.00	0.00	0.00	90.00	0.00	0.00	0.00	0.00	0.00	4.50	94.50	96	0	1.50
5 to 12		0.00	0.00	0.00	90.00	0.00	0.00	0.00	0.00	0.00	4.50	94.50	96	0	1.50

- Notes:
- 1- Annual maintenance costs for 1 hectare of pasturelands are those shown for year 2 and thereafter
  - 2- See financial analysis of a dual purpose (meat - milk) bovine herd
  - 3- The livestock activity by small and medium farmers in the project area, mainly in bovine meat production, is carried out under a traditional subsistence type activity.

## **ATTACHMENT 13**

### **COST ESTIMATES**

**Table AT13 - 1 - Cost Estimate****Area No.1 - Valle Bajo Rio Coclé del Norte**

Net Irrigable Area (hectares): 2200

**Construction Cost (2002 US\$)*****Primary Conveyance***

Diversion Weirs (including Intakes)	\$	-
Pumping Stations (including Penstocks)	\$	553,000
Canals and Siphons	\$	5,255,500
Structures	\$	564,500
	<i>Subtotal</i>	<b>\$ 6,373,000</b>

***Off-farm System***

Distribution System (Off-farm)	\$	2,956,800
Drainage (Off-farm)	\$	508,200
Roads (Off-farm)	\$	577,500
	<i>Subtotal</i>	<b>\$ 4,042,500</b>

***On-farm Irrigation System*****\$ 3,465,000**

Contingencies (25%)	\$	3,470,100
	<i>Subtotal</i>	<b>\$ 17,350,600</b>

Engineering and Administration (10%)	\$	1,735,100
	<b>Total Construction Cost</b>	<b>\$ 19,085,700</b>

**Table AT13 - 2 - Cost Estimate****Area No.2 - Costa Platanal -Punta Diego**

Net Irrigable Area (hectares): 900

**Construction Cost (2002 US\$)*****Primary Conveyance***

Diversion Weirs (including Intakes)	\$	420,000.00
Pumping Stations (including Penstocks)	\$	-
Canals and Siphons	\$	4,452,100
Structures	\$	525,100
	<i>Subtotal</i>	<b>\$ 5,397,200</b>

***Off-farm System***

Distribution System (Off-farm)	\$	1,209,600
Drainage (Off-farm)	\$	207,900
Roads (Off-farm)	\$	236,300
	<i>Subtotal</i>	<b>\$ 1,653,800</b>

***On-farm Irrigation System***

\$ 1,417,500

Contingencies (25%)	\$	2,117,100
	<i>Subtotal</i>	<b>\$ 10,585,600</b>

***Engineering and Administration (10%)***

\$ 1,058,600

**Total Construction Cost****\$ 11,644,200**

**Table AT13 - 3 - Cost Estimate**

**Area No.3 - Valle Bajo del Rio Miguel de la  
Borda**

Net Irrigable Area (hectares): 2220

**Construction Cost (2002 US\$)**

***Primary Conveyance***

Diversion Weirs (including Intakes)	\$	-
Pumping Stations (including Penstocks)	\$	1,432,700
Canals and Siphons	\$	5,367,500
Structures	\$	590,200
	<i>Subtotal</i>	<b>\$ 7,390,400</b>

***Off-farm System***

Distribution System (Off-farm)	\$	2,983,700
Drainage (Off-farm)	\$	512,800
Roads (Off-farm)	\$	582,800
	<i>Subtotal</i>	<b>\$ 4,079,300</b>

***On-farm Irrigation System***

**\$ 3,496,500**

Contingencies (25%)

**\$ 3,741,600**

***Direct Construction Cost***

**\$ 18,707,800**

Engineering and Administration (10%)

**\$ 1,870,800**

**Total Construction Cost**

**\$ 20,578,600**

**Table AT13 - 4 - Cost Estimate**

**Area No.6 - Valle del Caño Sucio at Las Maravillas**

**Net Irrigable Area (hectares): 500**

**Construction Cost (2002 US\$)**

***Primary Conveyance***

Diversion Weirs (including Intakes)	\$	150,000.00
Pumping Stations (including Penstocks)	\$	-
Canals and Siphons	\$	978,000
Structures	\$	116,400
	<i>Subtotal</i>	<b>\$ 1,244,400</b>

***Off-farm System***

Distribution System (Off-farm)	\$	672,000
Drainage (Off-farm)	\$	115,500
Roads (Off-farm)	\$	131,300
	<i>Subtotal</i>	<b>\$ 918,800</b>

***On-farm Irrigation System***

Contingencies (25%)	\$	737,700
	<i>Subtotal</i>	<b>\$ 3,688,400</b>

**Engineering and Administration (10%)**

<b>Total Construction Cost</b>	<b>\$ 4,057,200</b>
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**Table AT13 - 5 - Cost Estimate****Area No.8 - Valle del Rio Tulu**

Net Irrigable Area (hectares): 580

**Construction Cost (2002 US\$)*****Primary Conveyance***

Diversion Weirs (including Intakes)	\$	-
Pumping Stations (including Penstocks)	\$	674,300
Canals and Siphons	\$	2,327,800
Structures	\$	<u>270,800</u>
	<i>Subtotal</i>	\$ 3,272,900

***Off-farm System***

Distribution System (Off-farm)	\$	779,520
Drainage (Off-farm)	\$	133,980
Roads (Off-farm)	\$	<u>152,300</u>
	<i>Subtotal</i>	\$ 1,065,800

***On-farm Irrigation System***

\$ 913,500

Contingencies (25%) \$ 1,313,100

***Direct Construction Cost*** \$ 6,565,300

Engineering and Administration (10%) \$ 656,500

**Total Construction Cost** \$ 7,221,800

**Table AT13 - 6 - Cost Estimate****Area No.9 - Valle del Rio San Miguel**

Net Irrigable Area (hectares): 828

**Construction Cost (2002 US\$)*****Primary Conveyance***

Diversion Weirs (including Intakes)	\$ 100,000.00
Pumping Stations (including Penstocks)	\$ 532,100
Canals and Siphons	\$ 3,219,500
Structures	\$ 375,700
	<b>Subtotal</b> \$ 4,227,300

***Off-farm System***

Distribution System (Off-farm)	\$ 1,112,800
Drainage (Off-farm)	\$ 191,300
Roads (Off-farm)	\$ 217,400
	<b>Subtotal</b> \$ 1,521,500

***On-farm Irrigation System***

\$ 1,304,100

Contingencies (25%)	\$ 1,763,200
	<b>Subtotal</b> \$ 8,816,100

***Direct Construction Cost***

Engineering and Administration (10%)	\$ 881,600
	<b>Total Construction Cost</b> \$ 9,697,700

**Table AT13 - 7 - Cost Estimate****Area No.10 - Valle del Rio Lura**

Net Irrigable Area (hectares): 160

**Construction Cost (2002 US\$)*****Primary Conveyance***

Diversion Weirs (including Intakes)	\$	-
Pumping Stations (including Penstocks)	\$	168,700
Canals and Siphons	\$	388,000
Structures	\$	46,600
	<i>Subtotal</i>	<b>\$ 603,300</b>

***Off-farm System***

Distribution System (Off-farm)	\$	215,000
Drainage (Off-farm)	\$	37,000
Roads (Off-farm)	\$	42,000
	<i>Subtotal</i>	<b>\$ 294,000</b>

***On-farm Irrigation System***

\$ 252,000

Contingencies (25%)

\$ 287,300

***Direct Construction Cost***

\$ 1,436,600

Engineering and Administration (10%)

\$ 143,700

**Total Construction Cost****\$ 1,580,300**

**Table AT13 - 8 - Cost Estimate**

**Area Nos.11 & 13 - Valles de los Ríos Tocue y  
Toabre**

Net Irrigable Area (hectares): 600

**Construction Cost (2002 US\$)**

***Primary Conveyance***

Diversion Weirs (including Intakes)	\$	-
Pumping Stations (including Penstocks)	\$	499,000
Canals and Siphons	\$	1,518,700
Structures	\$	<u>178,600</u>
	<b><i>Subtotal</i></b>	<b>\$ 2,196,300</b>

***Off-farm System***

Distribution System (Off-farm)	\$	806,400
Drainage (Off-farm)	\$	138,600
Roads (Off-farm)	\$	<u>157,500</u>
	<b><i>Subtotal</i></b>	<b>\$ 1,102,500</b>

***On-farm Irrigation System***

\$ 945,000

Contingencies (25%)

\$ 1,061,000

***Direct Construction Cost***

\$ 5,304,800

Engineering and Administration (10%)

\$ 530,500

**Total Construction Cost**

**\$ 5,835,300**

**Table AT13 - 9 - Cost Estimate****Area No.12 - Valle del Rio Chiguiri**

Net Irrigable Area (hectares): 500

**Construction Cost (2002 US\$)*****Primary Conveyance***

Diversion Weirs (including Intakes)	\$	-
Pumping Stations (including Penstocks)	\$	523,900
Canals and Siphons	\$	1,812,000
Structures	\$	211,400
	<i><b>Subtotal</b></i>	<i><b>\$ 2,547,300</b></i>

***Off-farm System***

Distribution System (Off-farm)	\$	672,000
Drainage (Off-farm)	\$	115,500
Roads (Off-farm)	\$	131,300
	<i><b>Subtotal</b></i>	<i><b>\$ 918,800</b></i>

***On-farm Irrigation System***

\$ 787,500

Contingencies (25%)

\$ 1,063,400

***Direct Construction Cost***

\$ 5,317,000

Engineering and Administration (10%)

\$ 531,700

**Total Construction Cost****\$ 5,848,700**

## COST ESTIMATES

**Table AT13 - 10 - Conveyance Construction Cost**

Potential Area	Sectors	Cost of Canals	Cost of Siphons	Cost of Structures	Cost of Diversion Weirs	Cost of Pump Stations	Cost of Penstocks	Total Conveyance Cost
Area No.1 - Valle Bajo Rio Coclé del Norte	Main Left Bank Canal No.1	\$ 27,500	\$ -	\$ 3,300	\$ -	\$ 149,900	\$ 15,600	\$ 196,300
	Branch Canal A	\$ 500,000	\$ -	\$ 60,000	\$ -	\$ -	\$ -	\$ 560,000
	Branch Canal B	\$ 720,000	\$ 20,000	\$ 86,400	\$ -	\$ -	\$ -	\$ 826,400
	Main Left Bank Canal No.2	\$ 400,000	\$ -	\$ 48,000	\$ -	\$ 102,300	\$ 7,500	\$ 557,800
	Main Right Bank Canal	\$ 46,200	\$ 50,400	\$ 5,500	\$ -	\$ 232,500	\$ 45,200	\$ 379,800
	Main Right Bank Canal	\$ 290,800	\$ -	\$ 34,900	\$ -	\$ -	\$ -	\$ 325,700
	Main Right Bank Canal	\$ 416,000	\$ 25,000	\$ 49,900	\$ -	\$ -	\$ -	\$ 490,900
	Branch Canal C	\$ 499,000	\$ -	\$ 59,900	\$ -	\$ -	\$ -	\$ 558,900
	Branch Canal D	\$ 40,300	\$ 192,400	\$ 4,800	\$ -	\$ -	\$ -	\$ 237,500
	Branch Canal E	\$ 589,700	\$ -	\$ 70,800	\$ -	\$ -	\$ -	\$ 660,500
	Branch Canal E	\$ 205,000	\$ 35,000	\$ 24,600	\$ -	\$ -	\$ -	\$ 264,600
	Branch Canal F	\$ 285,300	\$ 108,000	\$ 34,200	\$ -	\$ -	\$ -	\$ 427,500
	Branch Canal F	\$ 80,000	\$ 104,000	\$ 9,600	\$ -	\$ -	\$ -	\$ 193,600
	Branch Canal G	\$ 177,600	\$ -	\$ 21,300	\$ -	\$ -	\$ -	\$ 198,900
	Branch Canal H	\$ 68,900	\$ -	\$ 8,300	\$ -	\$ -	\$ -	\$ 77,200
	Branch Canal I	\$ 254,700	\$ -	\$ 30,600	\$ -	\$ -	\$ -	\$ 285,300
	Branch Canal J	\$ 103,700	\$ 16,000	\$ 12,400	\$ -	\$ -	\$ -	\$ 132,100
Area No.2 - Costa Platanal -Punta Diego	Main Canal No.1	\$ 441,000	\$ 11,000	\$ 52,900	\$ 120,000	\$ -	\$ -	\$ 624,900
	Branch Canal A	\$ 468,000	\$ 41,300	\$ 56,200	\$ -	\$ -	\$ -	\$ 565,500
	Branch Canal B	\$ 660,000	\$ -	\$ 79,200	\$ -	\$ -	\$ -	\$ 739,200
	Branch Canal C	\$ 440,000	\$ 16,500	\$ 52,800	\$ -	\$ -	\$ -	\$ 509,300
	Main Canal No.2	\$ 252,000	\$ -	\$ 30,200	\$ 60,000	\$ -	\$ -	\$ 342,200
	Branch Canal D	\$ 648,000	\$ 8,300	\$ 77,800	\$ -	\$ -	\$ -	\$ 734,100
	Main Canal No.3	\$ 378,000	\$ -	\$ 45,400	\$ 60,000	\$ -	\$ -	\$ 483,400
	Main Canal No.4	\$ 520,000	\$ -	\$ 62,400	\$ 120,000	\$ -	\$ -	\$ 702,400
	Branch Canal E	\$ 208,000	\$ -	\$ 25,000	\$ -	\$ -	\$ -	\$ 233,000
	Main Canal No.5	\$ 360,000	\$ -	\$ 43,200	\$ 60,000	\$ -	\$ -	\$ 463,200
Area No.3 - Valle Bajo del Rio Miguel de la Borda	Main Canal No. 1	\$ 450,000	\$ 25,000	\$ 54,000	\$ -	\$ 102,300	\$ 19,200	\$ 650,500
	Main Canal No. 2	\$ -	\$ -	\$ -	\$ -	\$ 191,800	\$ 11,500	\$ 203,300
	Branch Canal A	\$ 600,000	\$ 40,000	\$ 72,000	\$ -	\$ -	\$ -	\$ 712,000
	Branch Canal B	\$ 285,000	\$ 110,000	\$ 34,200	\$ -	\$ -	\$ -	\$ 429,200
	Branch Canal C	\$ 135,000	\$ -	\$ 16,200	\$ -	\$ -	\$ -	\$ 151,200
	Main Canal No. 3	\$ 400,000	\$ 75,500	\$ 48,000	\$ -	\$ 149,900	\$ 30,000	\$ 703,400
	Branch Canal D	\$ 315,000	\$ 27,500	\$ 37,800	\$ -	\$ -	\$ -	\$ 380,300
	Main Canal No. 4	\$ 1,407,000	\$ 148,500	\$ 168,800	\$ -	\$ 232,500	\$ 281,700	\$ 2,238,500
	Main Canal No. 5	\$ 380,000	\$ -	\$ 45,600	\$ -	\$ 149,900	\$ 7,500	\$ 583,000
	Branch Canal E	\$ 225,000	\$ -	\$ 27,000	\$ -	\$ -	\$ -	\$ 252,000
	Main Canal No. 6	\$ 270,000	\$ 22,000	\$ 32,400	\$ -	\$ 138,700	\$ 12,500	\$ 475,600
	Branch Canal F	\$ 180,000	\$ -	\$ 21,600	\$ -	\$ -	\$ -	\$ 201,600
	Branch Canal G	\$ 102,000	\$ -	\$ 12,200	\$ -	\$ -	\$ -	\$ 114,200
	Main Canal No. 7	\$ 170,000	\$ -	\$ 20,400	\$ -	\$ 102,300	\$ 2,900	\$ 295,600

## COST ESTIMATES

**Table AT13 - 10 - Conveyance Construction Cost**

Potential Area	Sectors	Cost of Canals	Cost of Siphons	Cost of Structures	Cost of Diversion Weirs	Cost of Pump Stations	Cost of Penstocks	Total Conveyance Cost
Area No.6 - Valle del Caño Sucio at Las Maravillas	Main Canal	\$ 880,000	\$ 8,000	\$ 105,600	\$ 100,000	\$ -	\$ -	\$ 1,093,600
	Diversion Canal	\$ 90,000	\$ -	\$ 10,800	\$ 50,000	\$ -	\$ -	\$ 150,800
Area No.8 - Valle del Rio Tulu	Upper Main Canal	\$ 264,000	\$ -	\$ 31,700	\$ -	\$ 143,400	\$ 15,000	\$ 454,100
	Upper Branch Canal	\$ 682,500	\$ -	\$ 81,900	\$ -	\$ 191,800	\$ 6,300	\$ 962,500
	Lower Main Canal No.1	\$ 230,000	\$ 41,300	\$ 27,600	\$ -	\$ 149,900	\$ 22,500	\$ 471,300
	Lower Main Canal No.1	\$ 225,000	\$ -	\$ 27,000	\$ -	\$ -	\$ -	\$ 252,000
	Lower Branch Canal No.1	\$ 315,000	\$ 30,000	\$ 37,800	\$ -	\$ -	\$ -	\$ 382,800
	Lower Branch Canal No.2	\$ 180,000	\$ -	\$ 21,600	\$ -	\$ -	\$ -	\$ 201,600
	Lower Main Canal No.2	\$ 360,000	\$ -	\$ 43,200	\$ -	\$ 126,200	\$ 19,200	\$ 548,600
Area No.9 - Valle del Rio San Miguel	Upper Main Left Bank Canal	\$ 728,000	\$ 78,000	\$ 87,400	\$ 150,000	\$ -	\$ -	\$ 1,043,400
	Upper Main Right Bank Canal	\$ 630,500	\$ -	\$ 75,700	\$ -	\$ -	\$ -	\$ 706,200
	Middle Main Canal	\$ -	\$ -	\$ -	\$ -	\$ 191,800	\$ 12,500	\$ 204,300
	Middle Branch Canal A	\$ 648,000	\$ 12,000	\$ 77,800	\$ -	\$ -	\$ -	\$ 737,800
	Middle Branch Canal B	\$ 414,000	\$ -	\$ 49,700	\$ -	\$ -	\$ -	\$ 463,700
	Lower Main Canal	\$ -	\$ -	\$ -	\$ -	\$ 282,100	\$ 45,700	\$ 327,800
	Lower Branch Canal No.1	\$ 127,500	\$ -	\$ 15,300	\$ -	\$ -	\$ -	\$ 142,800
	Lower Branch Canal No.2	\$ 264,000	\$ -	\$ 31,700	\$ -	\$ -	\$ -	\$ 295,700
	Lower Branch Canal No.3	\$ 127,500	\$ -	\$ 15,300	\$ -	\$ -	\$ -	\$ 142,800
	Lower Branch Canal No.4	\$ 190,000	\$ -	\$ 22,800	\$ -	\$ -	\$ -	\$ 212,800
Area No.10 - Valle del Rio Lura	Main Canal	\$ 388,000	\$ -	\$ 46,600	\$ -	\$ 149,900	\$ 18,800	\$ 603,300
Area Nos.11 & 13 - Valles de los Rios Tocue y Toabre	Main Canal No.1	\$ 977,500	\$ -	\$ 117,300	\$ -	\$ 237,900	\$ 103,200	\$ 1,435,900
	Main Canal No.2	\$ 144,500	\$ -	\$ 17,300	\$ -	\$ 138,700	\$ 19,200	\$ 319,700
	Main Canal No.3	\$ 239,200	\$ 30,000	\$ 28,700	\$ -	\$ -	\$ -	\$ 297,900
	Branch Canal	\$ 127,500	\$ -	\$ 15,300	\$ -	\$ -	\$ -	\$ 142,800
Area No.12 - Valle del Rio Chiguirí	Upper Main Canal - No.1	\$ 635,400	\$ 49,500	\$ 76,200	\$ -	\$ 149,900	\$ 25,000	\$ 936,000
	Upper Main Canal - No.2	\$ 176,000	\$ -	\$ 21,100	\$ -	\$ 138,700	\$ 9,600	\$ 345,400
	Upper Branch Canal	\$ 212,500	\$ -	\$ 25,500	\$ -	\$ -	\$ -	\$ 238,000
	Lower Main Canal	\$ 611,100	\$ -	\$ 73,300	\$ -	\$ 185,700	\$ 15,000	\$ 885,100
	Lower Branch Canal	\$ 127,500	\$ -	\$ 15,300	\$ -	\$ -	\$ -	\$ 142,800

## COST ESTIMATE

**Table AT13 - 11 - Pumping Station Cost**

Irrigable Area	Pump Station	Pump Cap. (m³/s)	Total Head (m)	Inst. Cap. (kW)	No. of Pumps	Pumping Station Cost				Pipe Dia. (m)	Pipe Length (m)	Pipe Cost (US\$/m)	Pipe Cost	Total Cost
						Civil	Mech.	Elect.	Total					
Area No.1 - Valle Bajo Rio Coclé del Norte	Main Left Bank Canal - PS No.1	0.120	40.0	72	3	\$ 35,000	\$ 54,500	\$ 60,400	\$ 149,900	0.25	125	\$ 125	\$ 15,600	\$ 165,500
	Main Left Bank Canal - PS No.2	0.020	40.0	12	3	\$ 35,000	\$ 25,800	\$ 41,500	\$ 102,300	0.10	125	\$ 60	\$ 7,500	\$ 109,800
	Main Right Bank Canal - PS No.3	0.340	40.0	204	3	\$ 35,000	\$ 84,600	\$ 112,900	\$ 232,500	0.40	175	\$ 258	\$ 45,200	\$ 277,700
Area No.3 - Valle Bajo del Rio Miguel de la Borda	Main Canal No.1 - PS No.1	0.060	20.0	18	3	\$ 35,000	\$ 25,800	\$ 41,500	\$ 102,300	0.20	200	\$ 96	\$ 19,200	\$ 121,500
	Main Canal No.2 - PS No.2	0.240	40.0	144	3	\$ 35,000	\$ 80,700	\$ 76,100	\$ 191,800	0.35	50	\$ 229	\$ 11,500	\$ 203,300
	Main Canal No.3 - PS No.3	0.140	39.0	82	3	\$ 35,000	\$ 54,500	\$ 60,400	\$ 149,900	0.30	200	\$ 150	\$ 30,000	\$ 179,900
	Main Canal No.4 - PS No.4	0.400	35.0	210	3	\$ 35,000	\$ 84,600	\$ 112,900	\$ 232,500	0.45	900	\$ 313	\$ 281,700	\$ 514,200
	Main Canal No.5 - PS No.5	0.140	30.0	63	3	\$ 35,000	\$ 54,500	\$ 60,400	\$ 149,900	0.30	50	\$ 150	\$ 7,500	\$ 157,400
	Main Canal No.6 - PS No.6	0.100	30.0	45	3	\$ 35,000	\$ 43,300	\$ 60,400	\$ 138,700	0.25	100	\$ 125	\$ 12,500	\$ 151,200
	Main Canal No.7 - PS No.7	0.030	30.0	13.5	3	\$ 35,000	\$ 25,800	\$ 41,500	\$ 102,300	0.20	30	\$ 96	\$ 2,900	\$ 105,200
Area No.8 - Valle del Rio Tulu	Upper Main Canal No.1 - PS No.1	0.160	21.0	50	3	\$ 35,000	\$ 48,000	\$ 60,400	\$ 143,400	0.30	100	\$ 150	\$ 15,000	\$ 158,400
	Upper Branch Canal No.1 - PS No.2	0.110	60.0	100	3	\$ 35,000	\$ 80,700	\$ 76,100	\$ 191,800	0.25	50	\$ 125	\$ 6,300	\$ 198,100
	Lower Main Canal - PS No.1	0.140	40.0	84	3	\$ 35,000	\$ 54,500	\$ 60,400	\$ 149,900	0.30	150	\$ 150	\$ 22,500	\$ 172,400
	Lower Main Canal No.2 - PS No.2	0.050	40.0	30	3	\$ 35,000	\$ 41,200	\$ 50,000	\$ 126,200	0.20	200	\$ 96	\$ 19,200	\$ 145,400
Area No.9 - Valle del Rio San Miguel	Middle Main Canal PS	0.120	50.0	90	3	\$ 35,000	\$ 80,700	\$ 76,100	\$ 191,800	0.25	100	\$ 125	\$ 12,500	\$ 204,300
	Lower Branch Canals Nos.1&2 - PS No.1	0.070	40.0	42	3	\$ 35,000	\$ 43,300	\$ 60,400	\$ 138,700	0.20	150	\$ 96	\$ 14,400	\$ 153,100
	Lower Branch Canals Nos.1&2 - PS No.2	0.090	40.0	54	3	\$ 35,000	\$ 48,000	\$ 60,400	\$ 143,400	0.25	250	\$ 125	\$ 31,300	\$ 174,700
Area No.10 - Valle del Rio Lura	Main Canal - PS	0.100	40.0	60	3	\$ 35,000	\$ 54,500	\$ 60,400	\$ 149,900	0.25	150	\$ 125	\$ 18,800	\$ 168,700
Area Nos.11 & 13 - Valles de los Ríos Tocue y Toabre	Main Canal No.1 - PS No.1	0.310	50.0	233	3	\$ 35,000	\$ 90,000	\$ 112,900	\$ 237,900	0.40	400	\$ 258	\$ 103,200	\$ 341,100
	Main Canal No.2 - PS No.2	0.060	50.0	45	3	\$ 35,000	\$ 43,300	\$ 60,400	\$ 138,700	0.20	200	\$ 96	\$ 19,200	\$ 157,900
Area No.12 - Valle del Rio Chiguirí	Upper Main Canal No.1 - PS No.1	0.100	40.0	60	3	\$ 35,000	\$ 54,500	\$ 60,400	\$ 149,900	0.25	200	\$ 125	\$ 25,000	\$ 174,900
	Upper Main Canal No.2 - PS No.2	0.080	40.0	48	3	\$ 35,000	\$ 43,300	\$ 60,400	\$ 138,700	0.20	100	\$ 96	\$ 9,600	\$ 148,300
	Lower Main Canal - PS No.1	0.150	40.0	90	3	\$ 35,000	\$ 80,700	\$ 70,000	\$ 185,700	0.30	100	\$ 150	\$ 15,000	\$ 200,700

## COST ESTIMATE

**Table AT13 - 12 - Construction Cost of Primary Canals**

Irrigable Area	Canal	Canal Capacity (m <sup>3</sup> /sec)	Canal Length (km)	Canal Cost per meter	Canal Cost
Area No.1 - Valle Bajo Rio Coclé del Norte	Main Left Bank Canal No.1	0.120	0.25	\$ 110	\$ 27,500
	Branch Canal A	0.080	5.00	\$ 100	\$ 500,000
	Branch Canal B	0.040	8.00	\$ 90	\$ 720,000
	Main Left Bank Canal No.2	0.020	5.00	\$ 80	\$ 400,000
	Main Right Bank Canal	0.340	0.33	\$ 140	\$ 46,200
	Main Right Bank Canal	0.300	2.17	\$ 134	\$ 290,800
	Main Right Bank Canal	0.100	4.00	\$ 104	\$ 416,000
	Branch Canal C	0.040	5.67	\$ 88	\$ 499,000
	Branch Canal D	0.150	0.35	\$ 115	\$ 40,300
	Branch Canal E	0.100	5.67	\$ 104	\$ 589,700
	Branch Canal E	0.040	2.33	\$ 88	\$ 205,000
	Branch Canal F	0.060	3.17	\$ 90	\$ 285,300
	Branch Canal F	0.020	1.00	\$ 80	\$ 80,000
	Branch Canal G	0.020	2.22	\$ 80	\$ 177,600
	Branch Canal H	0.025	0.83	\$ 83	\$ 68,900
	Branch Canal I	0.045	2.83	\$ 90	\$ 254,700
	Branch Canal J	0.015	1.33	\$ 78	\$ 103,700
Area No.2 - Costa Platanal -Punta Diego	Main Canal No.1	0.200	3.50	\$ 126	\$ 441,000
	Branch Canal A	0.100	4.50	\$ 104	\$ 468,000
	Branch Canal B	0.120	6.00	\$ 110	\$ 660,000
	Branch Canal C	0.120	4.00	\$ 110	\$ 440,000
	Main Canal No.2	0.200	2.00	\$ 126	\$ 252,000
	Branch Canal D	0.150	6.00	\$ 108	\$ 648,000
	Main Canal No.3	0.200	3.00	\$ 126	\$ 378,000
	Main Canal No.4	0.100	5.00	\$ 104	\$ 520,000
	Branch Canal E	0.100	2.00	\$ 104	\$ 208,000
	Main Canal No.5	0.050	4.00	\$ 90	\$ 360,000
Area No.3 - Valle Bajo del Rio Miguel de la Borda	Main Canal No. 1	0.050	5.00	\$ 90	\$ 450,000
	Main Canal No. 2	-	-	\$ -	\$ -
	Branch Canal A	0.090	6.00	\$ 100	\$ 600,000
	Branch Canal B	0.070	3.00	\$ 95	\$ 285,000
	Branch Canal C	0.050	1.50	\$ 90	\$ 135,000
	Main Canal No. 3	0.090	4.00	\$ 100	\$ 400,000
	Branch Canal D	0.050	3.50	\$ 90	\$ 315,000
	Main Canal No. 4	0.250	10.50	\$ 134	\$ 1,407,000
	Main Canal No. 5	0.070	4.00	\$ 95	\$ 380,000
	Branch Canal E	0.040	2.50	\$ 90	\$ 225,000
	Main Canal No. 6	0.050	3.00	\$ 90	\$ 270,000
	Branch Canal F	0.040	2.00	\$ 90	\$ 180,000
	Branch Canal G	0.030	1.20	\$ 85	\$ 102,000
	Main Canal No. 7	0.030	2.00	\$ 85	\$ 170,000

## COST ESTIMATE

**Table AT13 - 12 - Construction Cost of Primary Canals**

Irrigable Area	Canal	Canal Capacity (m <sup>3</sup> /sec)	Canal Length (km)	Canal Cost per meter	Canal Cost
Area No.6 - Valle del Caño Sucio at Las Maravillas	Main Canal	0.125	8.00	\$ 110	\$ 880,000
	Diversion Canal	0.050	1.00	\$ 90	\$ 90,000
Area No.8 - Valle del Rio Tulu	Upper Main Canal	0.160	2.20	\$ 120	\$ 264,000
	Upper Branch Canal	0.110	6.50	\$ 105	\$ 682,500
	Lower Main Canal No.1	0.140	2.00	\$ 115	\$ 230,000
	Lower Main Canal No.1	0.040	2.50	\$ 90	\$ 225,000
	Lower Branch Canal No.1	0.040	3.50	\$ 90	\$ 315,000
	Lower Branch Canal No.2	0.040	2.00	\$ 90	\$ 180,000
	Lower Main Canal No.2	0.050	4.00	\$ 90	\$ 360,000
Area No.9 - Valle del Rio San Miguel	Upper Main Left Bank Canal	0.100	7.00	\$ 104	\$ 728,000
	Upper Main Right Bank Canal	0.070	6.50	\$ 97	\$ 630,500
	Middle Main Canal	-	-	\$ -	\$ -
	Middle Branch Canal A	0.045	7.20	\$ 90	\$ 648,000
	Middle Branch Canal B	0.045	4.60	\$ 90	\$ 414,000
	Lower Main Canal	-	-	\$ -	\$ -
	Lower Branch Canal No.1	0.030	1.50	\$ 85	\$ 127,500
	Lower Branch Canal No.2	0.040	3.00	\$ 88	\$ 264,000
	Lower Branch Canal No.3	0.030	1.50	\$ 85	\$ 127,500
	Lower Branch Canal No.4	0.060	2.00	\$ 95	\$ 190,000
Area No.10 - Valle del Rio Lura	Main Canal	0.070	4.00	\$ 97	\$ 388,000
Area Nos.11 & 13 - Valles de los Ríos Tocue y Toabre	Main Canal No.1	0.150	8.50	\$ 115	\$ 977,500
	Main Canal No.2	0.030	1.70	\$ 85	\$ 144,500
	Main Canal No.3	0.050	2.30	\$ 104	\$ 239,200
	Branch Canal	0.030	1.50	\$ 85	\$ 127,500
Area No.12 - Valle del Rio Chiguirí	Upper Main Canal - No.1	0.070	6.55	\$ 97	\$ 635,400
	Upper Main Canal - No.2	0.040	2.00	\$ 88	\$ 176,000
	Upper Branch Canal	0.030	2.50	\$ 85	\$ 212,500
	Lower Main Canal	0.075	6.30	\$ 97	\$ 611,100
	Lower Branch Canal	0.030	1.50	\$ 85	\$ 127,500

## COST ESTIMATE

**Table AT13 -13 - Siphon Construction Cost**

Irrigable Area	Siphon	Pipe Diameter (m)	Pipe Length (meter)	Pipe Cost per meter	Siphon Cost
Area No.1 - Valle Bajo del Rio Cocle del Norte	Branch Canal B - Siphon No.1	0.20	250	\$ 80	\$ 20,000
	Main Right Bank Canal - Siphon No.2	0.50	280	\$ 180	\$ 50,400
	Branch Canal D - Siphon No.3	0.40	1300	\$ 148	\$ 192,400
	Main Right Bank Canal - Siphon No.4	0.25	250	\$ 100	\$ 25,000
	Branch Canal F - Siphon No.5	0.20	1350	\$ 80	\$ 108,000
	Branch Canal F - Siphon No.6	0.20	1300	\$ 80	\$ 104,000
	Branch Canal E - Siphon No.7	0.25	350	\$ 100	\$ 35,000
	Branch Canal J - Siphon No.8	0.20	200	\$ 80	\$ 16,000
Area No.2 - Costa Platanal - Punta Diego	Branch Canal A - Siphon No.1	0.30	150	\$ 110	\$ 16,500
	Branch Canal A - Siphon No.2	0.30	225	\$ 110	\$ 24,800
	Main Canal No.1 - Siphon No.3	0.30	100	\$ 110	\$ 11,000
	Branch Canal C - Siphon No.4	0.30	150	\$ 110	\$ 16,500
	Branch Canal D - Siphon No.5	0.30	75	\$ 110	\$ 8,300
Area No.3 - Valle Bajo del Rio Miguel de la Borda	Main Canal No.1 - Siphon No.1	0.25	250	\$ 100	\$ 25,000
	Branch Canal B - Siphon No.2	0.30	1000	\$ 110	\$ 110,000
	Branch Canal A - Siphon No.3	0.20	250	\$ 80	\$ 20,000
	Branch Canal A - Siphon No.4	0.20	250	\$ 80	\$ 20,000
	Main Canal No.3 - Siphon No.5	0.40	250	\$ 148	\$ 37,000
	Main Canal No.3 - Siphon No.6	0.30	350	\$ 110	\$ 38,500
	Branch Canal D - Siphon No.7	0.30	250	\$ 110	\$ 27,500
	Main Canal No.4 - Siphon No.8	0.50	500	\$ 180	\$ 90,000
	Main Canal No.4 - Siphon No.9	0.30	350	\$ 110	\$ 38,500
	Main Canal No.4 - Siphon No.10	0.25	200	\$ 100	\$ 20,000
	Main Canal No.6 - Siphon No.11	0.20	275	\$ 80	\$ 22,000
Area No.6 - Valle del Cano Sucio at Maravillas	Main Canal	0.20	100	\$ 80	\$ 8,000
Area No.8 - Valle del Rio Tulu	Lower Main Canal No.1 - Siphon No.1	0.30	375	\$ 110	\$ 41,300
	Lower Branch Canal No.1 - Siphon No.2	0.20	375	\$ 80	\$ 30,000
Area No.9 - Valle del Rio San Miguel	Upper Main Left Bank Canal - Siphon No.1	0.36	250	\$ 130	\$ 32,500
	Upper Main Left Bank Canal - Siphon No.2	0.36	350	\$ 130	\$ 45,500
	Middle Branch Canal A	0.20	150	\$ 80	\$ 12,000
Area Nos 11 & 13 - Valles de los Rios Tucue y Toabre	Main Canal No.3	0.25	300	\$ 100	\$ 30,000
Area No.12 - Valle del Rio Chiguirí	Upper Main Canal No.1	0.30	450	\$ 110	\$ 49,500

## EXISTING AGRICULTURE

**Table AT3 - 1 - Annual Crops**

**Provincia : Coclé, Distrito: Pemonome, Corregimiento: Toabre**

Crops	Number of farms	Surface area (ha)		Total ha	Crop size		Yield unit/ha
		1st crop	2nd crop		Quantity	Unit	
Rice	1273	1264.67	31.04	1295.71	19744.00	qq, not polished	15.24
Maize *	586	397.20	77.26	474.46	5835.60	qq, dry	12.3
Bejuco beans	306	64.04	0.00	64.04	313.00	qq, dry	4.89
Poroto beans	58	14.40	0.00	14.40	40.00	qq, dry	2.78
Guandu beans	249	5.05	0.00	5.05	51.00	qq, dry	10
Cassava	1282	115.47	0.00	115.47	13586.00	qq	117.66
Ñame	488	16.37	0.00	16.37	1996.00	qq	121.93
Otoe	207	6.41	0.00	6.41	474.00	qq	73.95
Sugar cane	313	25.31	0.00	25.31	531.00	MT	20.98
Cucumber	25	0.40	0.00	0.40	25.00	qq	62.5
Sweet pepper	33	0.12	0.00	0.12	33.00	qq	275
Table tomatoes	23	0.20	0.00	0.20	24.00	qq	120
Industrial tomatoes	32	0.18	0.00	0.18	13.00	qq	72
Watermelons	1	0.02	0.00	0.02	Not available	Units	Not available
Melons	4	0.02	0.00	0.02	18.00	Units	900
Squash	25	1.16	0.00	1.16	510.00	Units	440
<b>Total</b>	<b>4905</b>	<b>1911.02</b>	<b>108.30</b>	<b>2019.32</b>			

\*Includes dry maize and tender maize. For conversion 500 ears of tender maize would equal 1 qq of dry maize

**Provincia : Coclé, Distrito: Pemonome, Corregimiento: Tulu**

Crops	Number of farms	Surface area - ha		Total ha	Crop size		Yield unit/ha
		1st crop	2nd crop		Quantity	Unit	
Rice	637	613.63	17.56	631.19	8277	qq, not polished	13.11
Maize *	553	202.71	53.88	256.59	3253	qq, dry	12.68
Bejuco beans	127	30.38	0.00	30.38	211	qq, dry	6.95
Poroto beans	27	4.62	0.00	4.62	1.38	qq, dry	0.3
Guandu beans	85	1.03	0.00	1.03	19	qq	18.45
Cassava	570	43.76	0.00	43.76	6343	qq	144.95
Ñame	212	5.55	0.00	5.55	867	qq	156.22
Otoe	78	2.24	0.00	2.24	222	qq	99.11
Sugar cane	132	10.52	0.00	10.52	265	MT	25.19
Cucumber	8	0.03	0.00	0.03	45	qq	1500
Sweet pepper	0	0.00	0.00	0.00	0.00	qq	Not Available
Table tomatoes	20	0.10	0.00	0.1	12	qq	120
Industrial tomatoes	23	0.11	0.00	0.11	8	qq	72.72
Watermelons	0	0.00	0.00	0.00	0.00	Units	Not Available
Melons	1	0.00	0.00	0.00	10	Units	Not Available
Squash	16	0.7	0.00	0.7	123	Units	123
<b>Total</b>	<b>2489</b>	<b>915.38</b>	<b>71.44</b>	<b>986.82</b>			

\*Includes dry maize and tender maize. For conversion 500 ears of tender maize would equal 1 qq of dry maize

## EXISTING AGRICULTURE

**Table AT3 - 1 - Annual Crops**

**Provincia : Coclé, Distrito: Pemonome, Corregimiento: Rio Indio (30% of the area)**

Crops	Number of farms	Surface area - ha		Total ha	Crop size		Yield unit/ha
		1st crop	2nd crop		Quantity	Unit	
Rice	246	422.55	3.32	425.87	5954.40	qq, not polished	13.98
Maize *	201	86.69	25.08	111.77	1367.76	qq, dry	12.24
Bejuco beans	41	7.23	0.00	7.23	62.70	qq, dry	8.67
Poroto beans	3	0.32	0.00	0.32	1.20	qq, dry	3.75
Guandu beans	31	1.34	0.00	1.34	6.90	qq, dry	5.15
Cassava	212	20.39	0.00	20.39	3257.10	qq	159.74
Name	114	2.54	0.00	2.54	359.70	qq	141.61
Otoe	44	0.84	0.00	0.84	118.80	qq	141.43
Sugar cane	48	11.89	0.00	11.89	153.60	MT	12.92
Cucumber	3	0.00	0.00	0.00	2.40	qq	800.00
Sweet pepper	2	0.00	0.00	0.00	0.30	qq	100.00
Table tomatoes	2	0.00	0.00	0.00	0.60	qq	200.00
Industrial tomatoes	8	0.39	0.00	0.39	6.90	qq	17.56
Watermelons	0.3	0.00	0.00	0.00	0.30	qq	100.00
Melons	0.00	0.00	0.00	0.00	0.00	Units	Not available
Squash	8	0.06	0.00	0.06	281.70	Units	4895.00
<b>Total</b>	<b>962</b>	<b>554.26</b>	<b>28.40</b>	<b>582.66</b>			

\*Includes dry maize and tender maize. For conversion 500 ears of tender maize would equal 1 qq of dry maize

**Provincia : Coclé, Distrito: Pemonome, Corregimiento: Chiguirí Arriba**

Crops	Number of farms	Surface area - ha		Total ha	Crop size		Yield unit/ha
		1st crop	2nd crop		Quantity	Unit	
Rice	676	495.93	12.70	508.63	5445.00	qq, not polished	10.71
Maize *	807	238.58	89.78	328.36	3070.20	qq, dry	9.35
Bejuco beans	230	43.14	0.00	43.14	169.00	qq, dry	3.92
Poroto beans	31	4.59	0.00	4.59	10.00	qq, dry	2.18
Guandu beans	137	3.70	0.00	3.70	30.00	qq, dry	8.11
Cassava	1039	107.89	0.00	107.89	11974.00	qq	110.98
Name	354	4.96	0.00	4.96	999.00	qq	201.41
Otoe	104	7.08	0.00	7.08	202.00	qq	28.53
Sugar cane	120	19.51	0.00	19.51	4.29	MT	0.22
Cucumber	11	8.51	0.00	8.51	196.00	qq	23.03
Sweet pepper	14	0.13	0.00	0.13	78.00	qq	600.00
Table tomatoes	24	1.46	0.00	1.46	3.94	qq	2.70
Industrial tomatoes	19	0.76	0.00	0.76	19.00	qq	25.00
Watermelons	3	0.11	0.00	0.11	56.00	Units	509.09
Melons	0	0.00	0.00	0.00	0.00	Units	Not Available
Squash	19	0.21	0.00	0.21	296.00	Units	1409.52
<b>Total</b>	<b>3588</b>	<b>936.56</b>	<b>102.48</b>	<b>1039.04</b>			

\*Includes dry maize and tender maize. For conversion 500 ears of tender maize would equal 1 qq of dry maize

## EXISTING AGRICULTURE

**Table AT3 - 1 - Annual Crops**

**Provincia : Coclé, Distrito: Donoso, Corregimiento: Coclé del Norte**

Crops	Number of farms	Surface area - ha		Total ha	Crop size		Yield unit/ha
		1st crop	2nd crop		Quantity	Unit	
Rice	201	256.56	85.76	342.32	4589.00	qq, not polished	13.41
Maize *	130	85.76	1.44	87.20	938.80	qq, dry	10.77
Bejuco beans	17	3.15	0.00	3.15	12.00	qq, dry	3.81
Poroto beans	2	0.27	0.00	0.27	Not available	qq, dry	Not available
Cassava	143	13.45	0.00	13.45		qq, dry	
Name	71	0.97	0.00	0.97	1529.00	qq	113.68
Otoe	28	0.75	0.00	0.75	229.00	qq	236
Sugar cane	60	7.43	0.00	7.43	66.00	qq	88
Table tomatoes	5	0.05	0.00	0.05	Not available	MT	15.21
Industrial tomatoes	3	0.01	0.00	0.01		qq	Not available
Cucumber	4	0.01	0.00	0.01	1.00	qq	100
Squash	9	0.10	0.00	0.10	Not available	qq	Not available
Total	673	368.51	87.20	455.71		Units	

\*Includes dry maize and tender maize. For conversion 500 ears of tender maize would equal 1 qq of dry maize

**Provincia : Coclé, Distrito: Donoso, Corregimiento: Miguel de la Borda**

Crops	Number of farms	Surface area - ha		Total ha	Crop size		Yield unit/ha
		1st crop	2nd crop		Quantity	Unit	
Rice	268.00	308.67	6.27	314.94	4010.00	qq, not polished	12.73
Maize *	160	95.05	13.00	108.05	1028.00	qq, dry	9.51
Bejuco beans	52	9.22	0.00	9.22	48.00	qq, dry	5.2
Poroto beans	2	0.24	0.00	0.24	1.00	qq, dry	4.17
Guandú beans	36	3.75	0.00	3.75	7.00	qq	1.87
Cassava	243	23.02	0.00	23.02	3462.00	qq	150.39
Name	110	3.58	0.00	3.58	456.00	qq	127.37
Otoe	102	6.96	0.00	6.96	427.00	qq	61.35
Sugar cane	69	1.72	0.00	1.72	10.00	MT	5.81
Table tomatoes	9	0.03	0.00	0.03	23.00	qq	767
Watermelons	1	0.01	0.00	0.01	60.00	Units	6000
Total	1052	452.25	19.27	471.52			

\*Includes dry maize and tender maize. For conversion 500 ears of tender maize would equal 1 qq of dry maize

**Provincia : Coclé, Distrito: Donoso, Corregimiento: Guasimo (50% of the area)**

Crops	Number of farms	Surface area - ha		Total ha	Crop size		Yield unit/ha
		1st crop	2nd crop		Quantity	Unit	
Rice	151	295.83	0.23	296.06	5204.00	qq, not polished	17.58
Maize*	130	74.82	7.67	82.49	892.30	qq, dry	10.82
Bejuco beans	24	3.20	0.00	3.20	22.00	qq, dry	6.89
Poroto beans	1	0.03	0.00	0.03	Not Available	qq, dry	Not Available
Guandú beans	6	0.14	0.00	0.14		qq	
Cassava	156	25.64	0.00	25.64	2501.00	qq	17.86
Name	54	1.07	0.00	1.07	149.50	qq	97.54
Otoe	30	0.54	0.00	0.54	96.00	qq	140.38
Sugar cane	60	12.10	0.00	12.10	186.50	MT	177.78
Table tomatoes	1.0	0.01	0.00	0.01	1.00	qq	15.41
Industrial tomatoes	7	0.05	0.00	0.05	8.00	qq	100.00
Cucumber	1	0.05	0.00	0.05	Not Available	Units	Not Available
Squash	9	0.10	0.00	0.10		Units	
Total	626	413.56	7.90	421.46			

\*Includes dry maize and tender maize. For conversion 500 ears of tender maize would equal 1 qq of dry maize

## EXISTING AGRICULTURE

**Table AT3 - 2 - Perennial Crops**

**Provincia : Coclé, Distrito: Pemonome, Corregimiento: Toabre**

Crops	Number of farms	Number of plants	Total ha	Crop size	
				Quantity	Unit
Coffee	1285	583270	525.00	4001	qq, polished
Bananas	1012	38806	46.60	24688	bunch
Plantains	637	21279	25.60	3482	a hundred
Papayas	139	645	0.60	6664	unit
Oranges	1296	58617	94.00	23856	a hundred
Cocoa	104	961	1.54	1964	pound
Pineapple	219	159463	5.30	81636	unit
Coconut	1014	12062	30.00	73726	Unit
Achiote or bixa	359	1276	2.00	26	quintal
Avocado	351	1809	4.50	397	a hundred
Lime	546	1848	2.96	3137	a hundred
Grapefruit	177	551	1.00	408	a hundred
Mango	1131	9840	20.00	4863	a hundred
Anona	297	939	1.00	1046	a hundred
Maracuya	52	804	10.00	147	pound
Pixbae	787	8826	0.00	24772	bunch
Guava	144	1675	3.40	Not available	Not available
Maranon	599	8712	17.42	Not available	Not available
<b>TOTAL</b>	<b>10149</b>		<b>790.92</b>		

**Provincia : Coclé, Distrito: Pemonome, Corregimiento: Tulu**

Crops	Number of farms	Number of plants	Total ha	Crop size	
				Quantity	Unit
Coffee	419	75299	67.78	559	qq, polished
Bananas	440	18138	21.77	11025	bunch
Plantains	293	7587	9.00	1091	a hundred
Papayas	56	274	0.30	1179	unit
Oranges	539	16328	26.00	8956	a hundred
Cocoa	49	437	0.70	817	pound
Pineapple	96	6499	0.22	1543	unit
Coconut	394	5413	1.30	39505	Unit
Achiote or bixa	144	513	0.70	10	quintal
Avocado	149	625	1.30	168	a hundred
Lime	204	690	1.10	738	a hundred
Grapefruit	42	111	0.20	61	a hundred
Mango	451	3881	11.70	2587	a hundred
Anona	128	706	1.40	647	a hundred
Maracuya	8	31	0.04	110	pound
Pixbae	319	3219	0.00	8614	bunch
Guava	91	1435	2.90	Not available	Not available
Maranon	195	2372	4.70	Not available	Not available
<b>TOTAL</b>	<b>4017</b>		<b>151.11</b>		

## EXISTING AGRICULTURE

**Table AT3 - 2 - Perennial Crops**

**Provincia : Coclé, Distrito: Pemonome, Corregimiento: Rio Indio (30% of the area)**

Crops	Number of farms	Number of plants	Total ha	Crop size	
				Quantity	Unit
Coffee	197.4	106445	95.81	877.5	qq, polished
Bananas	192.9	9395	11.28	6086.4	bunch
Plantains	139.2	4552	5.46	1029	a hundred
Papayas	22.2	80	0.10	437.4	unit
Oranges	159	5759	9.21	2487.9	a hundred
Cocoa	172.5	603	0.96	11357.4	pound
Pineapple	72.6	5230	0.26	1708.2	unit
Coconut	172.5	3703	9.26	25822.5	Unit
Achiote or bixa	62.4	250	0.40	5.4	quintal
Avocado	73.5	429	0.69	192.4	a hundred
Lime	73.5	256	0.41	243	a hundred
Grapefruit	15.9	46	0.07	26.7	a hundred
Mango	106.2	735	2.21	116.1	a hundred
Anona	43.8	130	0.39	237.9	a hundred
Maracuya	1.8	14	0.00	6.3	pound
Pixbae	178.8	3853	0.00	10812.6	bunch
Guava	62.1	2116	4.23	Not available	Not available
Maranon	115.8	3566	7.13	Not available	Not available
<b>TOTAL</b>	<b>1862.1</b>		<b>147.87</b>		

**Provincia : Coclé, Distrito: Pemonome, Corregimiento: Chiguirí Arriba**

Crops	Number of farms	Number of plants	Total ha	Crop size	
				Quantity	Unit
Coffee	1133	442519	398.31	3015	qq, polished
Bananas	1071	88400	106.12	60698	bunch
Plantains	303	8143	9.78	1406	a hundred
Papayas	61	286	0.34	574	unit
Oranges	1108	74221	118.75	45381	a hundred
Cocoa	127	1199	1.92	1600	pound
Pineapple	121	18651	0.93	2242	unit
Coconut	612	6200	15.50	34208	Unit
Achiote or bixa	188	1183	1.89	12	quintal
Avocado	252	1285	2.06	521	a hundred
Lime	147	524	0.84	438	a hundred
Grapefruit	114	684	1.09	303	a hundred
Mango	652	4456	13.38	2989	a hundred
Anona	159	622	1.87	953	a hundred
Maracuya	22	76	0.00	32	pound
Pixbae	675	10483	0.00	20984	bunch
Guava	77	1079	2.16	Not available	Not available
Maranon	233	1820	3.64	Not available	Not available
<b>TOTAL</b>	<b>7055</b>		<b>678.58</b>		

## EXISTING AGRICULTURE

**Table AT3 - 2 - Perennial Crops**

**Provincia : Coclé, Distrito: Donoso, Corregimiento: Coclé del Norte**

Crops	Number of farms	Number of plants	Total ha	Crop size	
				Quantity	Unit
Coffee	196	167627	150.88	894	qq, polished
Bananas	200	20445	24.54	9733	bunch
Plantains	157	13027	15.64	1913	a hundred
Papayas	16	75	0.09	226	unit
Oranges	101	2593	4.15	1813	a hundred
Cocoa	14	12417	19.86	245	pound
Pineapple	97	12611	0.42	4198	unit
Coconut	157	10735	26.84	83699	Unit
Achiote or bixa	24	92	0.15	2	quintal
Avocado	44	223	0.36	316	a hundred
Lime	47	119	0.19	180	a hundred
Grapefruit	1	3	0.00	Not available	a hundred
Mango	36	108	0.32	21	a hundred
Anona	45	220	0.66	416	a hundred
Maracuya	3	6	0.00	4	pound
Pixbae	160	4141	0.00	8534	bunch
Guava	32	453	0.91	Not available	Not available
Maranon	58	648	1.05	Not available	Not available
<b>TOTAL</b>	<b>1388</b>		<b>246.06</b>		

**Provincia : Coclé, Distrito: Donoso, Corregimiento: Miguel de la Borda**

Crops	Number of farms	Number of plants	Total ha	Crop size	
				Quantity	Unit
Coffee	270	227221	264.52	1733	qq, polished
Bananas	182	10773	12.90	4750	bunch
Plantains	227	18428	21.12	2340	a hundred
Papayas	24	66	0.08	386	unit
Oranges	76	1253	2.00	644	a hundred
Cocoa	26	7830	12.53	613	pound
Pineapple	104	13791	0.46	4357	unit
Coconut	237	91329	228.32	531430	Unit
Achiote or bixa	29	110	0.18	4	quintal
Avocado	120	1622	0.31	474	a hundred
Lime	68	245	0.19	246	a hundred
Grapefruit	8	117	0.00	12	a hundred
Mango	152	2094	6.29	890	a hundred
Anona	42	163	0.49	471	a hundred
Maracuya	1	4	0.00	2	pound
Pixbae	148	2187	0.00	5447	bunch
Guava	59	611	1.22	Not available	Not available
Maranon	75	3752	6.11	Not available	Not available
<b>TOTAL</b>	<b>1848</b>		<b>556.72</b>		

## EXISTING AGRICULTURE

**Table AT3 - 2 - Perennial Crops**

**Provincia : Coclé, Distrito: Donoso, Corregimiento: Guasimo (50% of the area)**

Crops	Number of farms	Number of plants	Total ha	Crop size	
				Quantity	Unit
Coffee	151	6399	5.76	272	qq, polished
Bananas	180.5	13795	16.56	6632	bunch
Plantains	113.5	9214	11.06	1170	a hundred
Papayas	12	33	0.04	193	unit
Oranges	38	626.5	1.00	322	a hundred
Cocoa	7	6208.5	9.93	122.5	pound
Pineapple	48.5	6305.5	0.32	2099	unit
Coconut	78.5	5367.5	13.42	41849.5	Unit
Achiote or bixa	12	46	0.07	1	quintal
Avocado	17.5	146.5	0.23	21.5	a hundred
Lime	12	45.5	0.07	32.5	a hundred
Grapefruit	2	3	0.00	0.5	a hundred
Mango	30	277	0.83	112.5	a hundred
Anona	5.5	11.5	0.03	30.5	a hundred
Maracuya	1	1.5	0.00	2.5	pound
Pixbae	18.5	208.5	0.00	183	bunch
Guava	2	10	0.02	Not available	Not available
Maranon	10.5	47	0.09	Not available	Not available
<b>TOTAL</b>	<b>740</b>		<b>59.46</b>		

Source: Contraloría de la República de Panamá; Dirección de Estadística y Censos - Censo Nacional Agropecuario Año 2001

Coclé del Norte and Caño Sucio Water Supply Projects

## **ATTACHMENT 4**

### **LAND CLASSIFICATION SPECIFICATIONS**

<b>Land Classification Specifications</b>			
<b>Land Characteristics</b>	<b>Class 1 - Arable</b>	<b>Class 2 - Arable</b>	<b>Class 3 . Arable</b>
<b>Soils</b>			
Texture	Sand loam to friable clay loam.	Loamy sand, to very permeable clay.	Loamy sand, to permeable clay.
Depth: To sand, gravel, or cobble.	36° plus - good free working soil of fine sandy loam or finer; or 42° of sandy loam.	24° plus - good free working of fine sandy loam or finer; or 30 - 36° of sandy loam to loamy sand.	18° plus - good free working soil of fine sandy loam or finer; or 24 - 30° of coarser textured soil.
To shale, raw soil from shale, or similar material (6" less in each instance to rock and similar material).	60" plus; or 54" with minimum of 6" of gravel overlying impervious material or sandy loam throughout.	48" plus; or 42" with minimum of 6" of gravel overlying impervious material or loamy sand throughout.	42" plus or 36" with minimum of 6" of gravel overlying impervious material or loamy sand throughout.
To penetrable lime zone.	18" with 60" penetrable.	14" with 48" penetrable.	10" to 36" penetrable-
Alkalinity	pH 9.0 or less, unless soil is calcareous, total salts are low and evidence of black alkali is absent.	pH 9.0 or less, unless soil is calcareous, total salts are low and evidence of black alkali is absent.	pH 9.0 or less, unless soil is calcareous, total salts are low and evidence of black alkali is absent.
Salinity	Total salts not to exceed 0.2%. May be higher in open permeable soil and under good drainage conditions.	Total salts not to exceed 0.5%. May be higher in open permeable soil and under good drainage conditions.	Total salts not to exceed 0.5%. May be higher in open permeable soil and under good drainage conditions.
<b>Topography</b>			
Slopes	Smooth slopes up to 4% in general gradient in reasonably large sized bodies sloping in the same plane.	Smooth slopes up to 8% in general gradient in reasonably large sized bodies sloping in the same plane; or rougher slopes which are less than 4% in general gradient.	Smooth slopes up to 12% in general gradient in reasonably large sized bodies sloping in the same plane; or rougher slopes which are less than 8% in general gradient.
Surface	Even enough to require only small amount of leveling and no heavy grading.	Moderate grading required but in amounts found feasible at reasonable cost in comparable irrigated areas.	Heavy and expensive grading required in spots but in amounts found feasible in comparable irrigated areas.
Cover (loose rocks and vegetation).	Insufficient to modify productivity or cultural practices, or clearing cost small.	Sufficient to reduce productivity and interfere with cultural practices. Clearing required but at moderate cost.	Present in sufficient amounts to require expensive but feasible clearing.
<b>Drainage</b>			
Soil and topography	Soil and topographic conditions such that no specific farm drainage requirement is anticipated.	Soil and topographic conditions such that some farm drainage will probably be required but with reclamation by artificial means appearing feasible at reasonable cost..	Soil and topographic conditions such that significant farm drainage will probably be required but with reclamation by artificial means appearing expensive but feasible.
<b>Class 4 - Limited Arable</b>			
Includes lands having excessive deficiencies and restricted utility but with special economic and engineering studies have shown to be irrigable.			
<b>Class 5 - Nonarable</b>			
Includes lands which will require additional economic and engineering studies to determine their irrigability and lands classified as temporarily nonproductive pending construction of corrective works and reclamation.			
<b>Class 6 - Nonarable</b>			
Includes lands, which do not meet the minimum requirements of the next higher class mapped in a particular survey and small areas of arable land lying within larger bodies of nonarable land.			

## LAND CLASSIFICATION SPECIFICATIONS

### SYMBOLS USED FOR THE LAND CLASSIFICATIONS

#### LAND CLASSES AND SUBCLASSES

##### **ARABLE LANDS**

CLASS	SUBCLASS	GENERAL CHARACTERISTICS
<b>CLASS 1</b>	1	Lands with best capability for irrigated agriculture, including a broad range of crops and not requiring special methods of irrigation or drainage. Lands capable of producing relatively high yields at reasonable cost and have relatively high payment capacity. Soils are loams and clayey loams, friable, with pH less than 9, smooth, well drained, less than 4% slope, with minimum erosion.
<b>CLASS 2</b>	2s-2t-2d-2st-2sd-2dt-2std	Arable lands suitable for permanent cultivation with simple agricultural methods. Lands suitable for irrigated agriculture, with production and development costs somewhat higher and with more limitations than for class 1 lands. Soils texture ranges from loams to high permeability clays. Lands topography is somewhat irregular with smooth slopes of less than 8% and suitable for leveling. Due to soils and topography, lands require moderate drainage at reasonable cost, in order to minimize erosion. pH is less than 9.
<b>CLASS 3</b>	3s-3t-3d-3st-3sd-3dt-3std	Arable lands less suitable for irrigation than class 1 and 2 lands due to deficiencies in soils, topography and drainage. These lands can have good topography but the soils quality restrict the crops and result in higher production and irrigation and drainage infrastructure costs. Its development, however, is economically justified if appropriate agricultural practices are followed. Its topography can be more irregular with slopes of up to 12%. pH less than 9.

##### **LIMITED ARABLE LANDS**

<b>CLASS 4</b>	Arable lands restricted to special use. Lands with excessive deficiencies in soils, topography and drainage that require engineering and economic studies to be considered arable. Its high development cost could be justified for export crops such as fruits and vegetables. If managed properly, could be used for permanent pasturelands for livestock. The drainage deficiencies in flat lands could result in salt build up and increased costs. Another limitation is the irregular topography or excessive stoniness in the arable layer.
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##### **TENTATIVELY NON ARABLE LANDS**

<b>CLASS 5</b>	Pending investigation Pending reclamation Drainage-Flooding
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##### **NON ARABLE LANDS**

<b>CLASS 6</b>	Lands that do not meet the minimum requirements to be included in the previous classes, or cannot be supplied with sufficient water or drainage. These lands generally consist of irregular topography, steep eroded lands. Also they can be made of very fine or very heavy textured, imperfectly drained or saline soils.
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## LAND CLASSIFICATION SPECIFICATIONS

### SYMBOLS USED FOR THE LAND CLASSIFICATIONS

#### EVALUATION PARAMETERS

##### **LAND USE**

- C - Cultivated, irrigated land
- L - Cultivated, non-irrigated land
- P - Permanent irrigated grassland
- G - Permanent non-irrigated grassland
- B - Brush or timber (forest)
- H - Suburban or homestead
- W - Waste or miscellaneous

##### **SUPPLEMENTARY SPECIFICATIONS**

The description of the soils profiles throughout the study areas include data on soils texture, color, structure, plasticity, consistency, internal drainage, permeability, root presence, HCl reaction, mottling, and coarse fragments. Also described are vegetation or crop, parent material, physiography, relief, topography, slope, surface drainage, humidity, stoniness, in support of the parameters indicated in the present formulae.

##### **PRODUCTIVITY AND LAND DEVELOPMENT**

(preliminary estimates according to arable land class)

##### **PRODUCTIVITY**

- (Production capability and production costs)
- 1 - Highly productive
  - 2 - Productive
  - 3 - Medium productive
  - 4 - Poorly productive

##### **LAND DEVELOPMENT**

(Leveling, irrigation and drainage canals, irrigation equipment, etc.)

- 1. Requires major infrastructure
- 2. Requires average infrastructure
- 3. Requires minor infrastructure
- 4. Requires very minor infrastructure

##### **WATER DEMAND**

- A - Low
- B - Medium
- C - High

##### **DRAINABILITY**

- X - Good
- Y - Restricted
- Z - Poor

##### **LEVELING**

- u1 - Small
- u2 - Medium
- u3 - Large
- u4 - Impossible

##### **FLOODING**

- f1 - Absent
- f2 - Occasional
- f3 - Frequent

##### **SOILS PROFILE SYMBOLS**

##### **PARENT MATERIAL**

- A - Residual
- B - Transported by water: 1. Alluvial; 2 lacustrine; 3 marine
- C - Transported by gravity: 1 Colluvial

##### **PHYSIOGRAPHY**

- A - Alluvial deposits: a- Flood plains b-River deltas; c-Alluvial terraces

##### **TOPOGRAPHY**

- a - Almost plane 0 to 0.5%; b-Slightly undulating 0.5 to 2%; c-Ondulating 2 to 5%;  
d - slightly broken 5 to 9%; e-moderately broken 9 to 15%; f - highly broken 15 to 30%;  
g - hilly, mountain, over 30%

##### **RELIEF**

- A - Normal : B - Subnormal y C - Plano o cóncavo

##### **EROSION**      **Subnormal ;and Plane or Concave**

- E1 - Light; E2 - Moderate; and E3 - Severe

##### **SURFACE DRAINAGE**

- 0 - Stagnant ; 1-Very slow; 2-Slow ; 3- Medium ; 4- Rapid ; and 5-Very rapid

##### **HUMIDITY**

- a - Wet ; b - Humid ; and c - Dry

##### **TEXTURE**

- S-Sands; LS-Loamy Sands; SL-Sandy Loam; L-Loam; Si-Silt; SIL-Silty Loams; C-Clayey  
CL-Clayey Loams; SCL-Sandy, Clayey Loams; VPC-Very Permeable Clays; PC-Permeable Clays;  
SPC-Slowly Permeable Clays; Gr- Gravel; Cb-Cobble; SR- Solid Rock

##### **STRUCTURE**

- P - prismatic; C - columnar; B - blocky; G- granular; M - massive

##### **MOTTLING**

- f - few: up to 2% ; c - Common: 2 to 20% ; m - many : over 20 %

##### **ROOT PRESENCE**

- vf- very few; f- few; ab- abundant

##### **HCL REACTION**

- n - None; + Slight: ++ Moderate; +++ Strong

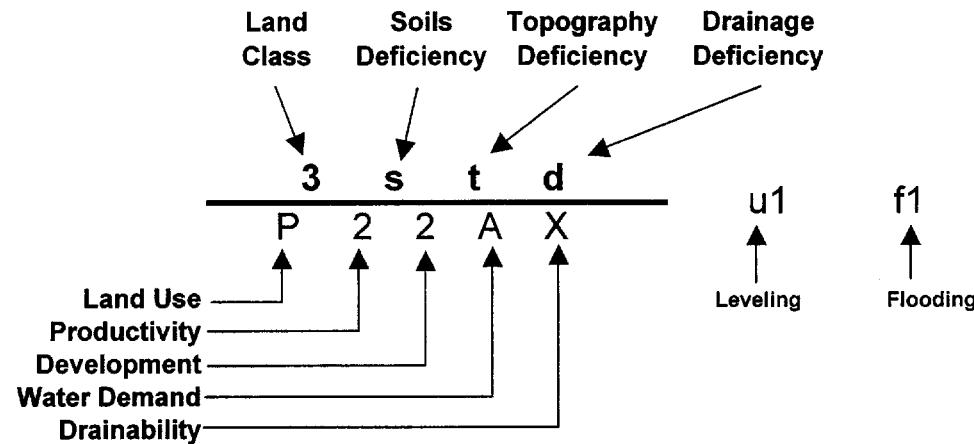
##### **INTERNAL DRAINAGE**

- Di0 - None; Di1- Very poor; Di2- Poor;

- Di3 - Medium; Di4 - Good; Di5 - Very good

## LAND CLASSIFICATION SPECIFICATIONS

### SYMBOLS USED FOR THE LAND CLASSIFICATIONS



*In accordance with the methodology used by the US Bureau of Reclamation*

Coclé -al Norte and Caño Sucio Water Supply Projects

**ATTACHMENT 5**

**SOIL INVESTIGATIONS**

## SOIL INVESTIGATIONS

**Table AT5-1 Surface Characteristics of the Soils Profiles**

Areas	Sector	Soil profile No	Vegetation of crop	Parent material	Physiography	Relief	Topography	Slope %	Erosion	Surface drainage	Permeability
<b>1 - COCLE DEL NORTE</b>											
	Cazuela	1	Natural vegetation	Alluvial	Floodplain	Subnormal	Slightly undulating	0.5 - 2	Light	Slow	
	Calle Real	2	Natural pasture grasses	Alluvial	Floodplain	Subnormal	Slightly undulating	0.5 - 2	Light	Slow	Medium low
	Coruto	3	Cultivated pasture grass	Alluvial	Floodplain	Normal	Slightly undulating	2 - 5 %	Moderate	Slow	Low
	Caño Rey	4	Thicket	Alluvial	Floodplain	Plain	Almost plane	0 - 0.5	Light	Very slow	Low
	Cuernito	5	Cultivated pasture grass	Alluvial	Floodplain	Plain	Almost plane	0 - 0.5	Light	Stagnant	Very low
	Boca del Caño Rey	6	Natural pasture grasses	Alluvial	Floodplain	Plain or concave	Almost plane	0 - 0.5	Light	Stagnant	Very low
	Guarapito	7	Natural vegetation	Alluvial	Floodplain	Subnormal	Very mild slope	0.5 - 2	Light	Very slow	Low
<b>2 - MIGUEL DE LA BORDA</b>											
	Concepción	8	Cultivated pasture grasses	Alluvial	Floodplain	Subnormal	Ondulating	2 to 5 %	Light	Slow	Medium low
	El Guarumo	9	Natural pasture grasses	Alluvial	Floodplain	Subnormal	Almost plane	0.5 - 2	Light	Slow	Low
	Iguanero de Arriba	10	Cultivated pasture grasses	Alluvial	Floodplain	Subnormal	Mild slope	2 - 5 %	Light	Slow	Low
	Maqueunque	11	Cultivated pasture grasses	Alluvial	Floodplain	Subnormal	Mild slope	2 - 5 %	Light	Slow	Very low
	Primer Corriente	12	Natural pasture grasses	Alluvial	Floodplain	Subnormal	Mild slope	2 - 5 %	Light	Slow	Very low
<b>3 - LIMÓN, AGUACATE, DIEGO</b>											
	Quebrada de Bejuco-Limón	13	Natural vegetation	Alluvial	Floodplain	Subnormal	Ondulating	2 - 5 %	Light	Slow	Low
	S/N.- Aguacate	14	Coconut palms	Alluvial	Floodplain	Subnormal	Ondulada	2 - 5 %	Light	Slow	Medium
	S/N.- Diego	15	Cultivated pasture grasses	Alluvial	Floodplain	Subnormal	Ondulating	2 - 5 %	Light	Slow	Low
<b>4.- TULU</b>											
	Tulu de Arriba	16	Maize-rice crops	Alluvial	Floodplain	Subnormal	Ondulating	2 - 5 %	Light	Slow	Medium
	Tulu Centro	17	Cultivated pasture grasses	Alluvial	Floodplain	Normal	Ondulating	2 - 5 %	Light	Slow	Medium
	San Antonio 1	18	Cultivated pasture grasses	Alluvial	Floodplain	Normal	Mild slope	2 - 5 %	Moderate	Slow	Low
	San Antonio 2	19	Cultivated pasture grasses	Alluvial	Floodplain	Normal	Mild slope	2 - 5 %	Moderate	Slow	Low
<b>5.- SAN MIGUEL</b>											
	San Miguel Centro 1	20	Beans-rice crops	Alluvial	Floodplain	Normal	Mild slope	2 - 5 %	Moderate	Slow	Medium low
	San Miguel Centro 2	21	Pastures-thicket	Alluvial	Floodplain	Subnormal	Slightly undulating	0.5 - 2	Light	Slow	Medium
<b>6.- CAÑO SUCIO</b>											
	Ricito	22	Cultivated pasture grasses	Alluvial	Floodplain	Normal	Mild slope	2 - 5 %	Light	Slow	Medium low
	Lapita	23	Cultivated pasture grasses	Alluvial	Floodplain	Subnormal	Mild slope	2 - 5 %	Light	Slow	Medium low
	Santa María	24	Cultivated pasture grasses	Alluvial	Floodplain	Normal	Moderate slope	5 - 10 %	Moderate	Moderately rapid	Medium low
	Las Cruces	25	Cultivated pasture grasses	Alluvial	Floodplain	Normal	Moderate slope	5 - 10 %	Moderate	Moderately rapid	Medium low

Notes: 1.All profiles were humid  
 2.Stoniness was not present at any of the profiles  
 3.Salinity or alcalinity were not present at any of the profiles

## SOIL INVESTIGATIONS

**Table AT5-2 Physical Characteristics of the Soils Profiles**

Areas	Sector	Soil profile No	Horizon	Depth in meters	Texture	Color	Structure	Plasticity	Consistency	Internal drainage	Permeability	Root presence	Motility	HCl Reaction	Care fragments
1 - COCLE DEL NORTE	Cazuela	1	A	0 - 0.08	Clayey loam	7.5 YR 4/6	Granular	Low	Loose	Poor	Low	Abundant	None	No	Not present
			B1	0.08 - 0.40	Clayey	10 YR 4/6	Massive	Medium	Firm	Very poor	Very low	Abundant	Some-fine	No	Not present
			B2	0.40 - 0.95	Clayey	2.5 YR 4/6	Massive	High	Firm	Very poor	Very low	Medium	Some-fine	No	Not present
			B3	0.95 - 1.50	Clayey	10 YR 3/1	Massive	High	Firm	Very poor	Very low	Medium	Common medium	No	Not present
	Calle Real	2	A	0 - 0.25	Clayey	2.5 Y 4/2	Massive	Medium	Firm	Poor	Very low	Scarce	None	No	Not present
			B1	0.25 - 0.35	Transition horizon	..	..	..	..	..	..	..	..	..	..
			B2	0.35 - 0.48	Clayey loam	2.5 Y 5/4	Massive	High	Firm	Poor	Very low	None	Some fine	No	Not present
			B3	0.48 - 1.60	Clayey	2.5 Y 6/4	Massive	High	Firm	Poor	Very low	None	Some fine	No	Not present
	Coruto	3	A	0 - 0.10	Loam	10 YR 4/3	Massive	Low	Highly friable	Poor	Medium	Abundant	None	No	Not present
			B1	0.10 - 0.20	Clayey	5 Y 4/3	Massive	Medium	Firm	Very poor	Low	Scarce	Some fine	No	Not present
			B2	0.20 - 1.50	Clayey loam	10 YR 4/4	Massive	Low	Firm	Poor	Medium	Very scarce	None	No	Not present
	Caño Rey	4	A	0 - 0.25	Loam	10 YR 4/4	Granular	Low	Loose	Poor	Low	Abundant	Some fine	No	Not present
			B1	0.25 - 0.45	Clayey loam	10 YR 2/5	Massive	Medium	Highly friable	Very poor	Very low	Scarce	Common medium	No	Not present
			B2	0.45 - 1.60	Clayey	5 Y 4/3	Massive	Medium	Firm	Very poor	Very low	None	Common medium	No	Not present
	Cuernito	5	A	0 - 0.20	Clayey	2.5 Y 4/2	Massive	Medium	Firm	None	Very low	Abundant	None	No	Not present
			B1	0.20 - 0.55	Clayey	10 YR 3/2	Massive	Medium	Firm	None	Very low	Abundant	None	No	Not present
			B2	0.55 - 1.50	Clayey	10 YR 3/2	Massive	High	Firm	None	Very low	Scarce	Some medium	No	Not present
	Boca del Caño Rey	6	A	0 - 0.20	Clayey loam	10 YR 3/2	Massive	High	Firm	None	Very low	Abundant	Common medium	No	Not present
			B1	0.20 - 1.50	Clayey	10 YR 4/2	Massive	High	Firm	None	Very low	Abundant	Common medium	No	Not present
	Guarapito	7	A	0 - 0.10	Loam	10 YR 4/2	Massive	Medium	Firm	Very poor	Low	Scarce	None	No	Not present
			B1	0.10 - 0.25	Clayey	2.5 Y 4/2	Massive	High	Firm	Very poor	Low	Scarce	None	No	Not present
			B2	0.25 - 1.40	Clayey	10 IR 3/2	Massive	High	Firm	Very poor	Low	None	Some fine	No	Not present
2 - MIGUEL DE LA BORDA	Concepción	8	A	0 - 0.20	Clayey loam	10 YR 3/4	Granular	Low	Friable	Moderate	Medium	Medium	None	No	Not present
			B1	0.20 - 1.50	Clayey loam	10 YR 4/4	Massive	Low	Friable	Moderate	Medium	Scarce	None	No	Not present
	El Guarumo	9	A	0 - 0.25	Clayey loam	10 YR 4/3	Massive	Low	Highly friable	Poor	Low	Abundance	None	No	Not present
			B1	0.25 - 0.40	Clayey	2.5 Y 4/4	Massive	Medium	Firm	Very poor	Low	Scarce	None	No	Not present
			B2	0.40 - 1.50	Clayey	10 YR 5/6	Massive	High	Firm	Very poor	Low	None	Some fine	No	Not present
	Iguanero de Arriba	10	A	0 - 0.15	Clayey	10 YR 3/4	Massive	High	Firm	Very poor	Low	Abundant	Lots medium	No	Not present
			B1	0.15 - 1.50	Clayey	10 YR 4/4	Massive	High	Firm	Very poor	Low	Medium	Lots medium	No	Not present
	Maquenque	11	A	0 - 0.15	Loam	10 YR 2/3	Granular	None	Highly friable	Moderate	Low	Abundant	Lots fine	No	Not present
			B1	0.15 - 0.55	Clayey	2.5 Y 3/3	Massive	Medium	Firm	Very poor	Medium low	Medium	Lots fine	No	Not present
			B2	0.55 - 1.50	Clayey loam	10 YR 3/1	Massive	Low	Firm	Poor	Low	Scarce	Few fine	No	Not present
	Primer Corriente	12	A	0 - 0.10	Clayey loam	i) 10 YR 4/3	Massive	Low	Firm	Poor	Very low	Abundant	None	No	Not present
			B1	0.10 - 1.40	Clayey	10 YR 4/4	Massive	High	Firm	Very poor	Very low	Medium	None	No	Not present
3 - LIMÓN, AGUACATE, DIEGO	Quebrada de Bejuco-Limón	13	A	0 - 0.15	Clayey loam	10 YR 4/4	Granular	Low	Highly friable	Poor	Medium low	Medium	None	No	Not present
			B1	0.15 - 0.40	Clayey	10 YR 3/6	Massive	Medium	Firm	Very poor	Very low	Medium	None	No	Not present
			B2	0.40 - 1.50	Clayey loam	10 YR 4/6	Massive	Low	Highly friable	Poor	Low	Scarce	Few fine	No	Not present
	S/N.- Aguacate	14	B1	0 - 0.60	Clayey loam	10 YR 3/4	Granular	None	Highly friable	Moderate	Low	Medium	None	No	Not present
			B2	0.60 - 1.45	Sandy	2.5 Y 4/4	Loose	None	Loose	Moderate	Low	Scarce	Common medium	No	Not present
	S/N.- Diego	15	A	0 - 0.10	Loam	10 YR 3/4	Granular	None	Loose	Very poor	Low	Abundant	None	No	Not present
			B1	0.10 - 0.70	Clayey	10 YR 4/3	Massive	Medium	Firm	Very poor	Very low	Medium	Common medium	No	Not present
			B2	0.70 - 1.50	Clayey	10 YR 3/2	Massive	Medium	Firm	Very poor	Very low	Scarce	Common medium	No	Not present

## SOIL INVESTIGATIONS

**Table AT5-2 Physical Characteristics of the Soils Profiles**

Areas	Sector	Soil profile No	Horizon	Depth in meters	Texture	Color	Structure	Plasticity	Consistency	Internal drainage*	Permeability	Root presence	Motleyness	HCl Reaction	CaCO <sub>3</sub> fragments
4 - TULU	Tulú de Arriba	16	A	0 - 0.20	Clayey loam	10 YR 3/4	Massive	Low	Highly friable	Poor	Low	Medium	None	No	Not present
			B1	0.20 - 1.45	Clayey	10 YR 4/4	Massive	Medium	Firm	Very poor	Very low	Scarce	Common medium	No	Not present
	Tulú Centro	17	A	0 - 0.20	Clayey loam	10 YR 4/4	Massive	Low	Highly friable	Poor	Low	Abundant	None	No	Not present
			B1	0.20 - 1.50	Clayey loam	10 YR 4/4	Massive	Low	Highly friable	Poor	Low	Medium	Common medium	No	Not present
	San Antonio 1	18	A	0 - 0.15	Clayey loam	10 YR 4/2	Granular	Low	Friable	Poor	Low	Abundant	None	No	Not present
			B1	0.15 - 0.70	Clayey	10 YR 4/3	Massive	Medium	Firm	Very poor	Very low	Scarce	None	No	Not present
			C1	Más 0.70	Stoney										at 0.7 m depth
	San Antonio 2	19	A	0 - 0.15	Clayey loam	10 YR 4/3	Granular	None	Friable	Poor	Low	Medium	None	No	Not present
			B1	0.15 - 0.50	Clayey loam	10 YR 4/4	Massive	Low	Medium friable	Poor	Low	Scarce	None	No	Not present
			C1	Más 0.50	Stoney										at 0.5 m depth
5 - SAN MIGUEL	San Miguel - Centro 1	20	A	0 - 0.15	Clayey loam	10 YR 4/3	Granular	Low	Friable	Poor	Low	Very scarce	Lots fine	No	Not present
			B1	0.15 - 1.40	Clayey	10 YR 4/3	Massive	Medium	Medium friable	Poor	Low	Scarce	None	No	Not present
	San Miguel - Centro 2	21	A	0 - 0.15	Clayey loam	10 YR 4/4	Granular	Low	Friable	Poor	Low	Abundant	Lots fine	No	Not present
			B1	0.15 - 1.40	Clayey loam	10 YR 4/4	Massive	Low	Friable	Poor	Low	Medium	Few fine	No	Not present
6 - CAÑO SUCIO	Riecto	22	A	0 - 0.15	Clayey	10 YR 3/8	Massive	Medium	Firm	Very poor	Very low	Abundant	None	No	Not present
			B1	0.15 - 1.50	Clayey	10 YR 4/6	Massive	Medium	Firm	Very poor	Very low	Medium	None	No	Not present
	Lapita	23	A	0 - 0.15	Clayey loam	10 YR 3/4	Granular	Low	Friable	Poor	Low	Abundant	Common medium	No	Not present
			B1	0.15 - 0.70	Clayey	10YR 3/4	Massive	Medium	Firm	Very poor	Very low	Medium	Common medium	No	Not present
			B2	0.70 - 1.50	Clayey	10 YR 4/4	Massive	Medium	Firm	Very poor	Very low	Scarce	Common thick	No	Not present
	Santa María	24	A	0 - 0.10	Clayey loam	10 YR 3/4	Granular	Low	Friable	Poor	Low	Abundant	Common fine	No	Not present
			B1	0.10 - 0.30	Clayey	2.5 Y 6/4	Massive	Medium	Firm	Very poor	Very low	Medium	Common medium	No	Not present
			B2	0.30 - 1.45	Clayey	2.5 Y 6/2	Mesiva	Plástico	Firm	Very poor	Very low	Scarce	Abundant	No	Not present
	Las Cruces	25	A	0 - 0.15	Clayey loam	10 YR 3/4	Granular	Low	Friable	Poor	Low	Abundant	Common fine	No	Not present
			B1	0.15 - 1.50	Clayey	10 YR 5/8	Massive	Medium	Firm	Very poor	Very low	Scarce	Abundant	No	Not present

## SOIL INVESTIGATIONS

**Table AT5-3 Soils Laboratory Analyses**

Profile No	Soil Horizons/Samples	Total Nitrogen %	Texture %	pH	P	K	Ca	Mg	Acidity	Al	Organic matter	Fe	Cu	Mn	Zn
			C-Si-S	1:2.5 solution	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%	ppm	ppm	ppm	
1	A	0.13	22 - 24 - 54	6.09	8.40	155	16.80	3.14	0.20	0.00	5.01	52	1.20	32	2
	B1	0.11	20 - 24 - 56	5.70	6.20	140	15.40	3.04	0.40	0.20	4.74	72	1.40	40	2
	B2	0.09	21 - 20 - 59	5.64	5.40	120	13.70	2.92	0.30	0.10	4.50	78	1.60	44	4
	B3	0.06	18 - 22 - 60	5.81	5.00	115	12.10	2.89	0.30	0.10	4.28	84	1.70	47	4
2	B1	0.10	22 - 26 - 52	5.58	7.40	130	10.80	3.03	0.30	0.10	4.10	69	1.80	39	3
	B3	0.08	17 - 28 - 55	5.69	7.00	110	10.10	2.94	0.30	0.10	4.03	72	2.00	42	4
	B4	0.10	24 - 26 - 50	5.70	7.20	120	10.30	2.96	0.30	0.10	4.00	71	1.90	40	4
3	A	0.10	23 - 25 - 52	5.87	5.00	160	15.20	3.04	0.20	0.10	4.01	58	1.20	38	3
	B1	0.08	21 - 25 - 54	5.80	6.80	150	14.40	2.88	0.30	0.20	3.90	62	1.50	44	4
	B2	0.04	17 - 27 - 56	5.78	6.00	130	13.80	2.74	0.40	0.30	3.74	68	1.70	48	5
5	A	0.11	18 - 24 - 58	5.82	5.80	130	11.90	2.54	0.30	0.20	4.40	64	2.00	38	3
	B1	0.09	12 - 26 - 62	5.74	5.00	100	10.10	2.39	0.20	0.10	4.09	70	2.40	46	4
	B2	0.07	19-28-61	5.79	5.20	120	10.90	2.43	0.30	0.20	4.22	69	2.20	44	4
6	B1	0.09	40 - 21 - 39	5.69	7.00	110	13.90	3.14	0.30	0.20	3.99	60	1.20	34	5
7	A	0.13	38 - 22 - 38	5.96	5.40	155	13.90	2.29	0.20	0.10	4.97	59	1.30	34	2
	B1	0.11	38 - 22 - 40	5.84	4.80	135	12.10	2.01	0.30	0.20	4.41	67	1.70	40	4
	B2	0.09	36 - 22 - 40	5.59	3.80	110	11.50	1.97	0.30	0.20	4.18	72	1.90	44	4
8	A	0.11	38 - 22 - 40	6.02	8.20	140	14.80	3.22	0.20	0.00	4.64	56	1.00	28	3
9	A	0.08	38 - 22 - 40	5.84	8.20	130	10.60	2.79	0.20	0.10	3.88	69	1.60	40	2
	B1	0.06	34 - 20 - 46	5.59	7.80	110	10.10	2.64	0.30	0.20	3.79	75	1.90	43	4
	B2	0.04	36 - 15 - 49	5.12	7.20	100	9.90	2.58	0.50	0.30	3.72	80	2.00	46	6
10	A	0.11	32 - 26 - 42	5.84	5.40	160	16.20	2.99	0.10	0.00	3.89	62	2.00	39	2
	B1	0.10	34 - 16 - 50	5.72	5.00	155	15.10	2.80	0.20	0.00	3.74	58	2.00	36	2
11	B1	0.13	30 - 22 - 48	6.04	7.80	155	15.10	2.99	0.10	0.00	4.87	56	1.40	30	2
	B2	0.11	28 - 20 - 52	6.00	7.20	150	14.50	2.81	0.10	0.00	4.62	60	1.70	36	2
12	A	0.07	20-26-54	5.71	5.40	130	14.10	3.11	0.40	0.30	3.97	84	2.00	48	5
	B1	0.05	18 - 24 - 58	5.66	4.80	100	13.70	3.04	0.30	0.20	3.89	79	3.00	52	5
13	A	0.12	52 - 14 - 34	5.90	6.90	130	12.70	2.74	0.20	0.10	4.21	58	1.20	40	2
	B1	0.08	38 - 22 - 40	5.74	5.80	110	11.90	2.32	0.40	0.30	3.67	64	1.30	50	4
	B2	0.06	36 - 24 - 42	5.67	5.20	98	11.20	2.27	0.40	0.30	3.54	67	1.70	58	4
14	B1	1.13	69 - 12 - 19	6.14	3.80	180	16.20	1.90	0.20	0.00	3.88	42	1.00	29	2
	B2	0.11	89 - 6 - 5	6.00	3.00	174	14.40	1.78	0.10	0.00	3.64	44	1.30	26	2
15	A	0.09	18 - 22 - 50	5.81	4.50	115	11.80	2.47	0.50	0.30	4.01	57	2.00	43	3
	B1	0.10	21-30-49	5.73	4.80	110	13.10	2.54	0.30	0.20	4.10	58	1.60	45	3
	B2	0.08	16 - 32 - 52	5.68	4.30	100	12.80	2.49	0.40	0.10	4.02	63	1.90	49	3
16	A	0.09	38 - 22 - 40	5.82	6.20	140	14.90	2.41	0.20	0.10	4.01	54	1.80	48	4
	B1	0.07	24 - 22 - 54	5.58	5.80	130	13.60	1.90	0.40	0.20	3.44	50	3.00	42	5
17	A	0.11	39 - 21 - 40	5.89	6.40	140	12.90	3.04	0.30	0.20	4.11	49	1.80	37	3

## SOIL INVESTIGATIONS

**Table AT5-3 Soils Laboratory Analyses**

Profile No	Soil Horizons/Samples	Total Nitrogen %	Texture %	pH	P	K	Ca	Mg	Acidity	Al	Organic matter	Fe	Cu	Mn	Zn
			C-Si-S	1:2.5 solution	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	%	ppm	ppm	ppm	ppm
	B1	0.10	37 - 19 - 44	5.84	5.90	110	11.70	2.90	0.30	0.20	3.99	45	1.60	34	4
18	A	0.12	36 - 26 - 38	5.95	4.80	120	15.40	2.54	0.20	0.00	4.79	38	1.40	30	2
	B1	0.11	36 - 26 - 40	5.91	4.20	99	14.30	2.39	0.30	0.10	4.67	34	1.10	26	3
20	A	0.10	36 - 21 - 43	5.89	4.00	100	12.10	2.48	0.20	0.10	4.21	43	1.80	30	4
	B1	0.09	34 - 18 - 48	5.78	3.80	97	11.00	2.29	0.30	0.20	4.03	40	1.70	44	4
21	A	0.13	58 - 16 - 26	5.94	5.40	160	16.20	3.04	0.20	0.00	5.01	48	1.40	32	2
	B1	0.11	36 - 24 - 40	5.87	5.00	158	15.80	2.89	0.20	0.10	4.90	44	1.90	29	3
22	A	0.08	39 - 21 - 38	5.84	6.80	140	13.10	2.54	0.30	0.20	4.22	62	1.80	34	3
	B1	0.06	36 - 22 - 42	5.28	5.40	115	12.40	2.41	0.40	0.30	3.89	70	2.00	40	4
23	A	0.11	38 - 22 - 38	5.97	6.90	158	11.70	2.78	0.20	0.10	4.01	56	1.60	28	2
	B1	0.08	39 - 21 - 40	5.59	5.20	145	10.20	2.59	0.40	0.20	3.84	64	1.70	37	3
	B2	0.07	38 - 21 - 41	5.31	4.80	130	9.10	2.40	0.40	0.30	3.70	70	1.90	40	3
24	A	0.11	36 - 24 - 38	5.77	5.80	151	10.70	2.39	0.30	0.20	3.58	62	1.40	38	3
	B1	0.09	35 - 27 - 38	5.66	5.00	120	9.20	2.11	0.40	0.20	3.40	68	1.70	42	4
	B2	0.07	36 - 24 - 40	5.59	4.50	110	9.00	2.01	0.40	0.20	3.29	72	1.80	46	4
25	A	0.07	30 - 18 - 52	5.47	4.00	110	9.40	1.70	0.80	0.50	3.01	68	1.80	44	4
	B1	0.05	32 - 13 - 55	5.11	3.20	98	8.80	1.40	1.10	0.60	2.94	76	2.40	48	4

Note: The interpretation of the analyses of the soils samples is given in the LABAE laboratory reports

## **ATTACHMENT 6**

### **WATER SAMPLES**

**WATER SAMPLES****LABORATORY ANALYSES OF WATER SAMPLES**

Sample		Date	E.C. micromho/cm	Water Temperatur e oC	pH	C03 <sup>(1)</sup>	HCO3 <sup>(1)</sup>	SO4	Cl	Na	K	Ca	Mg	Hardness <sup>(1)</sup>	TDS
No	Location					mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1/1C	Rio Coclé del Norte at Solis	8-Feb-02	ND	nd	ND	ND	ND	ND	7.89	0.91	6.98	2.69	29	ND	
1/2C	Rio Coclé del Norte at Solis	8-Feb-02	ND	nd	ND	ND	ND	ND	14.8	0.89	5.31	2.00	21	ND	
1/3C	Rio Coclé del Norte at Solis	8-Feb-02	ND	nd	ND	ND	ND	ND	7.92	0.86	7.67	2.63	30	ND	
2	Rio Coclé del N. at Boca Cuatro Call	23-Feb-02	92.5	26	7.29	0	38	<10	ND	8.35	0.88	4.12	3.31	24	80
3/1A	Rio M. de la Borda at Boca Cano Re	8-Feb-02	ND	nd	ND	ND	ND	ND	ND	7.64	0.84	6.99	2.56	28	ND
3/1B	Rio M. de la Borda at Boca Cano Re	8-Feb-02	ND	nd	ND	ND	ND	ND	ND	13.64	0.84	6.72	2.81	28	ND
3/1C	Rio M. de la Borda at Boca Cano Re	8-Feb-02	ND	nd	ND	ND	ND	ND	ND	7.31	0.85	7.04	2.63	28	ND
4	Rio M. de la Borda at Concepcion (Boca de Cano Sucio)	23-Feb-02	86.2	25.5	7.25	0	34	<10	ND	5.95	0.94	13.42	3.00	46	66
5	Rio Tulu at Tulu Centro	15-Feb-02	73.5	25	7.38	0	26	ND	ND	6.40	1.53	6.00	2.44	25	ND
6	Rio Cano Sucio at Santa Maria	23-Feb-02	83.1	25.5	7.07	0	33	<10	ND	6.66	0.81	7.34	2.88	30	67
7	Rio San Miguel at San Miguel Centr	16-Feb-02	102	26	7.21	0	41	ND	ND	8.66	0.51	7.60	2.63	30	ND
8	Rio de la U at Quebrada Grande	23-Feb-02	66.1	24	7.46	0	25	<10	ND	6.7	0.76	5.48	2.25	23	67
9	Rio Toabre at Vista Alegre (Boca del Rio San Miguel)	23-Feb-02	91.3	26	7.57	0	35	<10	ND	6.47	1.38	7.71	2.5	30	76
10	Rio Coclesito at Coclesito	16-Feb-02	91.9	25	7.44	0	33	ND	ND	7.67	0.83	8.17	3.31	34	ND

**Notes:** 1. Expressed in Ca Co3 equivalent

2. ND = Not determined in the laboratory

3. nd = Not determined in the field

## **ATTACHMENT 7**

### **MONTHLY RAINFALL RECORDS**

## MONTHLY RAINFALL RECORDS

### 50%-Reliable Monthly Rainfall

Name of the Station	Location and Altitude	Station No.	Period of Record	Mean Annual Precipitation	Monthly Precipitation (mm) Exceeded 50% of the Time											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Icacal	Lat: 9°12' Long: 80°09' Elev: 11msnm	113-001	1959-1998	3,919	90	55	65	150	420	390	430	370	320	430	520	370
Miguel de la Borda	Lat: 9°09' Long: 80°19' Elev: 2msnm	109-001	1975-1998	3,752	120	80	65	190	360	380	390	420	300	400	480	380
Boca de Uracillo	Lat: 8°58' Long: 80°11' Elev: 20msnm	111-001	1975-1998	2,967	95	55	60	125	325	310	250	295	315	390	340	205
Santa Ana	Lat: 8°49' Long: 80°16' Elev: 200msnm	105-010	1981-1999	2,247	75	40	50	90	225	230	220	200	215	295	255	135
Chiguiri Arriba	Lat: 8°40' Long: 80°11' Elev: 180msnm	105-002	1959-1999	3,465	75	40	25	110	370	410	370	420	400	440	380	190
El Cacao	Lat: 8°46' Long: 80°01' Elev: 180msnm	115-081	1974-1998	2,209	40	20	18	60	260	225	190	225	300	350	275	100
Ciri Grande	Lat: 8°46' Long: 80°03' Elev: 200msnm	115-083	1974-1999	2,476	45	25	18	90	310	250	205	210	315	370	270	120
Boca de Toabre	Lat: 8°55' Long: 80°33' Elev:	105-001	1958-1998	4,364	280	180	145	315	475	335	365	410	320	375	450	490
Cocle del Norte	Lat: 9°04' Long: 80°34' Elev: 2msnm	105-003	1969-1998	4,903	200	140	90	240	520	470	635	445	315	470	590	440
Tambo	Lat: 8°39' Long: 80°17' Elev: 200msnm	105-004	1970-1998	1,904	25	13	15	35	215	220	225	230	260	300	200	90
Toabre	Lat: 8°38' Long: 80°21' Elev: 200msnm	105-005	1970-1998	1,847	23	13	13	45	190	215	180	220	280	290	200	95
San Lucas	Lat: 9°00' Long: 80°34' Elev: 200msnm	105-007	1974-1997	4,685	265	175	195	310	460	390	450	440	330	420	525	500
Coclecito	Lat: 8°49' Long: 80°33' Elev: 60msnm	105-009	1980-1997	3,155	200	125	110	165	370	265	220	310	255	340	280	280

**MONTHLY RAINFALL RECORDS****80%-Reliable Monthly Rainfall**

Name of the Station	Location and Altitude	Station No.	Period of Record	Mean Annual Precipitation	Monthly Precipitation (mm) Exceeded 80% of the Time											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Icacal	Lat: 9°12' Long: 80°09' Elev: 11msnm	113-001	1959-1998	3,919	50	30	20	50	305	280	380	330	260	300	400	180
Miguel de la Borda	Lat: 9°09' Long: 80°19' Elev: 2msnm	109-001	1975-1998	3,752	55	30	20	50	270	240	300	310	220	290	355	180
Boca de Uracillo	Lat: 8°58' Long: 80°11' Elev: 20msnm	111-001	1975-1998	2,967	55	30	20	65	235	235	195	195	200	300	280	115
Santa Ana	Lat: 8°49' Long: 80°16' Elev: 200msnm	105-010	1981-1999	2,247	50	20	20	55	150	170	125	145	180	210	175	75
Chiguirí Arriba	Lat: 8°40' Long: 80°11' Elev: 180msnm	105-002	1959-1999	3,465	30	20	14	45	255	300	290	360	315	380	270	90
El Cacao	Lat: 8°46' Long: 80°01' Elev: 180msnm	115-081	1974-1998	2,209	12	7	4	20	195	160	125	185	230	250	175	45
Ciri Grande	Lat: 8°46' Long: 80°03' Elev: 200msnm	115-083	1974-1999	2,476	18	9	3	35	205	205	150	170	220	260	210	50
Boca de Toabre	Lat: 8°55' Long: 80°33' Elev:	105-001	1958-1998	4,364	190	100	75	165	300	260	285	310	230	320	360	270
Cocle del Norte	Lat: 9°04' Long: 80°34' Elev: 2msnm	105-003	1969-1998	4,903	130	90	55	115	335	325	420	340	205	315	515	260
Tambo	Lat: 8°39' Long: 80°17' Elev: 200msnm	105-004	1970-1998	1,904	7	4	1	11	110	160	165	165	190	205	110	30
Toabre	Lat: 8°38' Long: 80°21' Elev: 200msnm	105-005	1970-1998	1,847	10	6	3	12	125	130	135	135	180	200	105	30
San Lucas	Lat: 9°00' Long: 80°34' Elev: 200msnm	105-007	1974-1997	4,685	160	115	80	125	290	260	330	320	235	305	390	290
Coclecito	Lat: 8°49' Long: 80°33' Elev: 60msnm	105-009	1980-1997	3,155	120	65	40	85	240	190	195	210	195	250	230	215

## MONTHLY RAINFALL RECORDS

### Boca de Toabre

Monthly Precipitation in mm

Lat: 8°55' Long: 80°33' Elev: 20 msnm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1958					337	172	322	386					
1959	219	79	74	368	487	299	555	434	315	278	377	794	4,276
1960	410	215	177	396	259	341	220	302	230	375	506	796	4,224
1961	241	49	57	337	465	473	325	567	209	425	405	731	4,281
1962	295	122	94	190	473	281	265	300	301	336	534	386	3,575
1963	265	259	225	661	355	339	417	402	172	348	490	300	4,231
1964	228	79	118	670	462	578	255	304	407	350	381	242	4,071
1965	515	122	43	103	659	375	413	273	376	419	463	515	4,273
1966	293	66	147	286	383	465	435	253	236	403	950	723	4,635
1967	326	136	163	454	722	425	315	510	221	450	363	513	4,594
1968	147	206	483	147	383	381	408	396	329	259	348	434	3,919
1969	185	191	98	265	268	176	237	457	365	296	424	609	3,567
1970	491	245	166	668	970	407	400	496	297	371	914	817	6,239
1971	433	270	430	115	595	530	360	499	260	316	299	236	4,341
1972	680	264	197	600	419	294	503	231	480	364	359	367	4,756
1973	273	131	61	185	538	257	299	366	234	382	920	504	4,148
1974	431	242	212	215	417	296	414	451	343	515	639	321	4,493
1975	338	109	109	73	777	260	362	419	387	468	622	598	4,518
1976	285	227	55	284	206	269	280	454	328	320	345	211	3,260
1977	113	117	130	317	245	233	437	651	322	447	340	251	3,600
1978	190	123	264	650	568	323	280	295	364	249	532	231	4,067
1979	77	202	102	518	429	495	382	431	327	417	433	548	4,360
1980	369	245	78	303	274	366	429	365	307	354	450	628	4,166
1981	379	372	174	889	526	338	526	484	211	394	862	955	6,108
1982	355	213	158	303	252	238	536	526	362	325	368	257	3,891
1983	221	59	89	236	720	254	330	444	395	219	485	574	4,026
1984	393	649	128	90	526	428	292	403	315	345	373	303	4,244
1985	350	118	193	109	319	383	357	281	180	412	348	476	3,525
1986	517	150	274	707	485	397	451	636	389	467	713	237	5,420
1987	184	130	73	868	295	241	364	345	298	361			
1988	193	233	105	150	602	345	282	452	409	348	453	428	3,998
1989	246	225	217	171	516	344	473	606	327	395	588	361	4,467
1990	295	137	250	357	506	242	306	553	397	636	486	567	4,840
1991	219	206	316	242	550	433	434	360	701	400	584	661	5,075
1992	154	215	66	633	657	283	439	574	400	417	375	305	4,517
1993	314	129	200	411	281	271	327	267	462	353	816	710	4,540
1994	199	168	201	382	526	475	383	451	244	396	511	373	4,307
1995	213	102	186	297	304	353	371	308	264	309	422	872	4,001
1996	678	472	379	333	556	331	300	465	230	414	734	938	5,831
1997	260	399	50	153	527	275	395	375	266	508	155	103	3,464
1998	193	97	79	500	324	435	263	367					
1999													
2000													
2001													
2002													
Avg	304	194	165	366	467	344	369	418	324	380	509	497	4,364
Std	137	118	104	219	166	95	84	107	98	79	190	227	671
Max	680	649	483	889	970	578	555	651	701	636	950	955	6,239
Min	77	49	43	73	206	172	220	231	172	219	155	103	3,260
50% exc	280	179	152	310	473	339	364	419	322	375	458	490	4,275
80% exc	190	115	77	167	304	260	292	304	235	323	365	274	3,951
90% exc	155	49	43	73	206	172	220	231	172	219	155	103	3,260

# MONTHLY RAINFALL RECORDS

## Chiguirí Arriba

Monthly Precipitation in mm

Lat: 8°40' Long: 80°11' Elev: 180msnm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1959	51	15	20	112	220	463	367	403	347	542	224	369	3,131
1960	150	50	68	189	414	424	511	513	341	371	619	434	4,083
1961	79	28	6	60	179	421	366	449	307	445	364	364	3,065
1962	86	27	39	204	353	412	239	673	289	425	492	216	3,453
1963	81	99	21	262	308	405	484	371	261	381	353	162	3,186
1964	46	191	61	293	364	398	527	493	392	608	319	93	3,783
1965	140	42	15	3	188	288	374	448	239	297	404	310	2,746
1966	123	34	32	196	489	507	614	412	519	430	545	516	4,414
1967	96	48	25	193	298	623	417	430	536	554	475	308	4,001
1968	13	105	102	85	350	489	454	255	399	540	418	241	3,448
1969	85	41	23	84	310	370	351	364	503	290	506	196	3,120
1970	215	85	137	198	551	271	619	353	493	475	343	577	4,315
1971	145	160	264	72	492	520	600	668	412	485	453	94	4,363
1972	193	49	34	348	287	377	290	261	370	370	185	87	2,847
1973	30	38	14	79	390	635	380	469	400	526	689	176	3,824
1974	116	32	30	48	264	285	342	334	432	613	365	54	2,912
1975	40	20	22	25	336	436	290	591	343	491	807	384	3,782
1976	82	35	12	81	318	247	172	382	348	426	189	66	2,355
1977	28	29	19	78	408	394	356	409	344	504	211	102	2,878
1978	68	61	215	203	486	349	317	422	293	458	624	68	3,562
1979	16	32	15	289	311	303	324	442	390	338	263	405	3,125
1980	119	51	12	52	415	362	373	482	315	517	319	171	3,186
1981	131	99	82	303	557	328	462	510	459	407	536	462	4,335
1982	113	18	25	270	372	363	321	361	207	426	306	69	2,848
1983	41	10	15	148	744	566	278	509	670	402	242	350	3,975
1984	78	229	32	2	302	382	405	424	497	487	238	66	3,142
1985	69	22	18	14	142	487	194	412	353	488	353	203	2,754
1986	30	4	15	158	124	525	345	386	318	427	393	59	2,784
1987	56	48	6	159	168	237	215	241	556	479	145	96	2,407
1988	31	64	13	113	409	421	434	396	430	485	354	226	3,376
1989	72	57	40	24	424	328	428	574	314	374	447	176	3,259
1990	120	93	55	37	398	261	354	395	468	467	308	241	3,196
1991	82	35	125	58	382	311	326	464	412	442	208	144	2,938
1992	40	33	11	191	379	423	293	324	482	349	306	153	2,978
1993	125	31	126	101	164	517	350	359	413	435	716	244	3,580
1994	32	23	26	182	636	520	612	433	605	685	378	172	4,304
1995	60	15	87	218	750	700	488	724		606	693	414	
1996	544	244	83	97	784	817	616	485	609	327	518	579	5,703
1997	87	176	5	45	255	319	317	292	508	434	375	67	2,880
1998	9	17	35	187	465	637	557	740	413	629	712	696	5,097
1999	123	58	47	255	938	648							
2000													
2001													
2002													
Avg	94	62	49	139	393	433	394	441	410	461	410	245	3,465
Std	86	58	55	92	178	132	118	116	104	90	165	166	713
Max	544	244	264	348	938	817	619	740	670	685	807	696	5,703
Min	9	4	5	2	124	237	172	241	207	290	145	54	2,355
50% exc	81	41	26	113	372	412	367	423	400	451	370	199	3,196
80% exc	40	23	15	52	264	319	312	361	317	379	259	92	2,879
90% exc	9	4	5	2	124	237	172	241	207	290	145	54	2,355

# MONTHLY RAINFALL RECORDS

## Coclé del Norte

Monthly Precipitation in mm

Lat: 9°04' Long: 80°34' Elev: 2 msnm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1969					437	721	746	549	330	637	675	669	
1970	340	426	935	895	1098	642	791	536	463	511	1288	911	8,836
1971	472	253	467	134	558	745	632	518	175	252	299	241	4,746
1972	496	133	100	286	357	351	453	398	718	462	520	396	4,670
1973	814	139	38	104	754	468	668	303	217	362	1065	777	5,709
1974	423	131	144	171	583	674	937	404	17	370	563	273	4,688
1975	320	146	190	78	762	620	656	353	109	410	440	811	4,894
1976	283	160	39	226	512	325	535	421	578	485	598	456	4,617
1977	86	114	65	232	328	450	804	501	193	563	558	318	4,211
1978	114	103	393	808	576	304	567	372	276	182	603	213	4,510
1979	90	204	77	252	198	267	420	400	217	274	290	475	3,164
1980	200	226	60	104	223	391	390	287	305	380	556	625	3,745
1981	226	234	135	775	372	395	519	322	173	473	973	880	5,476
1982	526	171	191	298	334	465	836	615	286	486	488	260	4,955
1983	176	49	50	245			744	464	736	616	506	1004	
1984	361	624	72	113	609	576	371	476	323	495	654	262	4,935
1985	173		95	18	561	551	660	520	434	465	772	396	
1986	390	245	130	518	308	554	511	458	408	625	1101	227	5,473
1987	127		52	422	438	331	771	517	370	820	517	336	
1988	91	88	59	162	427	248	306	324	244	413	560	544	3,465
1989	150	142	291	214	589	558	518	503	219	596	519	256	4,553
1990	307	28	66	146	552	380	567	528	393	504	535	491	4,496
1991	157	90	68	226	731	460	672	340	528	484	717	402	4,875
1992	184	239	60	335	646	284	862	499	436	602	539	316	5,001
1993	153	44	259	391	331	549	638	434	425	398	1313	887	5,822
1994	167	95	290	433	567	709	897	796	413	240	799	538	5,944
1995	312	91	218	434	492	507	647	302	305	211	638	891	5,049
1996	815	411	419	519	477	475	400		278	330	927	1350	
1997	184	321	49	30	562	145	402	444	347	644	596	103	3,827
1998	70	32	39	396	348	626	569	439					
1999													
2000													
2001													
2002													
Avg	283	183	174	309	508	475	616	449	342	458	676	528	4,903
Std	196	136	191	226	187	157	170	109	163	149	260	300	1,093
Max	815	624	935	895	1,098	745	937	796	736	820	1,313	1,350	8,836
Min	70	28	38	18	198	145	306	287	17	182	290	103	3,164
50% exc	200	142	95	245	512	468	635	444	323	473	596	456	4,811
80% exc	141	90	56	126	342	329	447	348	217	349	518	261	4,382
90% exc	91	47	47	99	324	281	399	318	175	249	479	238	3,770

## MONTHLY RAINFALL RECORDS

### Tambo

Monthly Precipitation in mm

Lat: 8°39' Long: 80°17' Elev: 200msnm

	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Annual</b>
<b>1970</b>		197	258	380	765	478	230	141	244	545	261	224	
<b>1971</b>	90	26	34	13	65	218	224	228	299	192	217	79	<b>1,682</b>
<b>1972</b>	58	25	32	98	81	78	141	201	227	164	77	45	<b>1,227</b>
<b>1973</b>	8	11	2	29	191	272	329	261	351	403	292	85	<b>2,233</b>
<b>1974</b>	15	32	21	31	125	211	254	222	299	359	164	22	<b>1,755</b>
<b>1975</b>	8	5	1	3	221	160	244	373	382	445	513	267	<b>2,621</b>
<b>1976</b>	24	9	0	66	95	145	152	230	261	266	24	29	<b>1,302</b>
<b>1977</b>	3	6	0	8	185	209	168	354	181	161	160	49	<b>1,484</b>
<b>1978</b>	27	10	102	122	313	238	292	265	396	303	300	124	<b>2,493</b>
<b>1979</b>	22	15	6	142	211	261	186	333	280	287	190	84	<b>2,017</b>
<b>1980</b>	42	18	4	17	323	279	116	229	169	384	358	124	<b>2,063</b>
<b>1981</b>	78	34	51	125	252	116	224	287	169	222	254	189	<b>1,999</b>
<b>1982</b>	69	4	13	100	252	208	361	207	204	376	40	19	<b>1,850</b>
<b>1983</b>	11	1	14	66	299	172	145	102	248	283	124	151	<b>1,616</b>
<b>1984</b>	24	66	30	33	242	356	387	454	201	322	210	51	<b>2,376</b>
<b>1985</b>	64	12	24	4	161	445	194	365	252	249	326	118	<b>2,213</b>
<b>1986</b>	49	5	16	128	86	316	279	191	234	332	309	24	<b>1,969</b>
<b>1987</b>	16	14	2	62	104	173	212	184	285	386	146	46	<b>1,628</b>
<b>1988</b>	5	18	0	71	322	280	255	350	449	406	304	110	<b>2,571</b>
<b>1989</b>	43	32	23	11	266	272	238	172	117	166	263	138	<b>1,740</b>
<b>1990</b>	53	0	41	18	159	98	212	353	366	317	158	160	<b>1,935</b>
<b>1991</b>	7	20	87	0	206	173	199	148	363	214	95	138	<b>1,649</b>
<b>1992</b>	5	16	1	53	229	334	233	130	208	350	84	35	<b>1,677</b>
<b>1993</b>	82	4	64	38	117	254	81	169	232	232	321	101	<b>1,695</b>
<b>1994</b>	0	0	72		357	160	230	227		396	117	24	
<b>1995</b>	16	6	10	86	269	180	180	343	426	205	157	151	<b>2,028</b>
<b>1996</b>	149	114	43	27	386	237	288	263	314	202	293	294	<b>2,610</b>
<b>1997</b>	31	11	2	6	93	98	165	78	184	282	113	14	<b>1,076</b>
<b>1998</b>	9	21	0	32	241	227	229	218	310	329			
<b>1999</b>													
<b>2000</b>													
<b>2001</b>													
<b>2002</b>													
<b>Avg</b>	36	25	33	63	228	229	222	244	273	303	209	103	<b>1,904</b>
<b>Std</b>	35	40	51	75	136	95	69	91	85	94	112	76	<b>420</b>
<b>Max</b>	149	197	258	380	765	478	387	454	449	545	513	294	<b>2,621</b>
<b>Min</b>	0	0	0	0	65	78	81	78	117	161	24	14	<b>1,076</b>
<b>50% exc</b>	24	14	16	36	221	218	224	228	256	303	200	93	<b>1,892</b>
<b>80% exc</b>	8	5	1	11	112	160	166	171	202	210	114	32	<b>1,628</b>
<b>90% exc</b>	5	3	0	5	92	112	144	139	177	187	82	23	<b>1,393</b>

# MONTHLY RAINFALL RECORDS

## Toabre

Monthly Precipitation in mm

Lat: 8°38' Long: 80°21' Elev: 200msnm

	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Annual</b>
<b>1970</b>						215	224	179	395	439	213	289	
<b>1971</b>	166	11	56	14	188	245	187	252	325	290	288	36	<b>2,060</b>
<b>1972</b>	105	27	63	176	113	76	133	195	203	135	107	74	<b>1,408</b>
<b>1973</b>	6	33	1	46	181	266	370	299	399	501	338	100	<b>2,540</b>
<b>1974</b>	22	28	14	36	100	269	231	190	356	266	170	30	<b>1,711</b>
<b>1975</b>	10	6	7	10	203	186	178	413	246	454	551	164	<b>2,426</b>
<b>1976</b>	42	15	12	73	86	94	139	222	266	246	46	34	<b>1,273</b>
<b>1977</b>	17	13	3	11	331	219	174	371	146	256	194	106	<b>1,839</b>
<b>1978</b>	30	15	100	171	243	190	181	247	296	408	339	72	<b>2,292</b>
<b>1979</b>	10	17	4	247	303	253	361	338	186	257	137	168	<b>2,281</b>
<b>1980</b>	59	29	3	24	264	306	158	302	214	416	307	119	<b>2,201</b>
<b>1981</b>	76	26	44	173	391	213	271	419	252	335	310	234	<b>2,744</b>
<b>1982</b>	78	6	14	125	307	164	215	173	148	330	38	10	<b>1,607</b>
<b>1983</b>	19	0	8	41	146	132	153	91	267	267	140	174	<b>1,439</b>
<b>1984</b>	22	48	42	34	210	315	436	398	316	304			
<b>1985</b>	70	10	18	12	170	376	145	373	282	250	233	81	<b>2,021</b>
<b>1986</b>	52	6	28	103	130	335	210	210	291	381	305	12	<b>2,062</b>
<b>1987</b>	19	11	2	91	54	129	260	124	224	364	110	47	<b>1,435</b>
<b>1988</b>	11	20	4	52	285	235	294	438	368	384	303	96	<b>2,490</b>
<b>1989</b>	28	29	9	8	259	243	226	156	143	160	309	150	<b>1,719</b>
<b>1990</b>	32	11	44	17	213	133	179	228	361	276	197	149	<b>1,840</b>
<b>1991</b>	7	12	81	2	216	165	173	134	338	140	73	64	<b>1,407</b>
<b>1992</b>	10	3	0	72	153	346	126	218	187	230	92	61	<b>1,497</b>
<b>1993</b>	133	14	65	31	160	263	63	155	295	289	240	90	<b>1,799</b>
<b>1994</b>	11	10	37	63	358	185	116	134	141	251	111	15	<b>1,431</b>
<b>1995</b>	7	5	6	76	186	161	136	126	348	153	133	128	<b>1,465</b>
<b>1996</b>	115	55	14	72	359	154	208	287	352	124	198	177	<b>2,113</b>
<b>1997</b>	24	13	0	17	65	74	95	34	89	295	201	28	<b>936</b>
<b>1998</b>	13	18	21	40	174	253	276	228	382				
<b>1999</b>													
<b>2000</b>													
<b>2001</b>	25												
<b>2002</b>	10												
<b>Avg</b>	41	18	25	66	209	214	204	239	270	293	210	100	<b>1,847</b>
<b>Std</b>	42	13	27	62	91	80	85	107	88	100	115	70	<b>454</b>
<b>Max</b>	166	55	100	247	391	376	436	438	399	501	551	289	<b>2,744</b>
<b>Min</b>	6	0	0	2	54	74	63	34	89	124	38	10	<b>936</b>
<b>50% exc</b>	23	14	14	44	195	215	181	222	282	283	198	90	<b>1,819</b>
<b>80% exc</b>	10	8	3	15	136	145	138	147	186	236	110	34	<b>1,435</b>
<b>90% exc</b>	9	6	2	10	96	122	124	126	145	149	84	23	<b>1,407</b>

## MONTHLY RAINFALL RECORDS

### San Lucas

Monthly Precipitation in mm  
Lat: 9°00' Long: 80°34' Elev: 20msnm

	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Annual</b>
<b>1974</b>		59	239	250	439	425	549	576	265	401	845	408	
<b>1975</b>	510	172	139	65	854	466	450	448	208	453	590	758	<b>5,111</b>
<b>1976</b>	311	217	45	376	398	255	429	564	347	354	476	413	<b>4,184</b>
<b>1977</b>	122	161	96	387	295	467	610	615	392	585	501	274	<b>4,504</b>
<b>1978</b>	139	179	286	756	610	372	350	367	387	235	632	299	<b>4,610</b>
<b>1979</b>	143	206	199	380	397	505	346	556	192	439	517	724	<b>4,605</b>
<b>1980</b>	394	264	78	213	292	487	449	396	211	365	529	853	<b>4,532</b>
<b>1981</b>	340	383	201	1117	415	327	537	427	131	516	841	824	<b>6,058</b>
<b>1982</b>	437	211	237	262	356	322	717	406	321	323	349	347	<b>4,288</b>
<b>1983</b>	209	72	119	104	599	220	427	477	433	264	382	774	<b>4,080</b>
<b>1984</b>	400	678	135	126	549	490	291	429	335	395	402	270	<b>4,500</b>
<b>1985</b>	283	106	196	84	466	449	273	272	309	323	352	324	<b>3,434</b>
<b>1986</b>	394	202	211	284	175	373	683	495	287	554	912	257	<b>4,826</b>
<b>1987</b>	232	117	48	313	205	225	575	209	257	1013	505	578	<b>4,278</b>
<b>1988</b>	174	262	124	250	284	280	263	281	247	373	387	496	<b>3,420</b>
<b>1989</b>	273	158	271	175	873	608	511	621	283	501	597	294	<b>5,165</b>
<b>1990</b>	385	117	214	378	593	373	392	579	393	543	451	622	<b>5,040</b>
<b>1991</b>	241	213	341	268	613	509	605	508	624	434	601	588	<b>5,544</b>
<b>1992</b>	194	117	81	472	546	256	691	326	372	441	480	434	<b>4,408</b>
<b>1993</b>	229	165	223	381	277	349	493	420	416	278	691	544	<b>4,466</b>
<b>1994</b>	80	137	329	416	518	647	973	629	341	223	625	501	<b>5,418</b>
<b>1995</b>	297	127	174	334	420	413	298	246	268	309	567	877	<b>4,329</b>
<b>1996</b>	833	529	524	364	572	451	346	418	369	493	778	1030	<b>6,708</b>
<b>1997</b>	233	607	38	68	548	239	441	455	348	735	360	172	<b>4,242</b>
<b>1998</b>													
<b>1999</b>													
<b>2000</b>													
<b>2001</b>													
<b>2002</b>													
<b>Avg</b>	298	227	190	326	471	396	487	447	322	440	557	528	<b>4,685</b>
<b>Std</b>	161	162	112	228	179	118	170	122	100	173	163	236	<b>753</b>
<b>Max</b>	273	678	524	1,117	873	647	973	629	624	1,013	912	1,030	<b>6,708</b>
<b>Min</b>	182	59	38	65	175	220	263	209	131	223	349	172	<b>3,420</b>
<b>50% exc</b>	273	175	197	298	452	393	449	439	328	418	523	499	<b>4,504</b>
<b>80% exc</b>	182	117	90	155	294	270	346	350	253	317	396	297	<b>4,257</b>
<b>90% exc</b>	140	109	57	90	279	243	293	275	209	268	367	271	<b>4,101</b>

# MONTHLY RAINFALL RECORDS

## Sabanita Verde

Monthly Precipitation in mm

Lat: \_\_\_\_\_ ° Long: \_\_\_\_\_ ° Elev: \_\_\_\_\_ msnm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1979	44	127	111	303	337	558	263	442	174	377	330	448	3,512
1980	211	120	12	143	397	447	342	293	294	429	351	548	3,586
1981	336	183	148	650	364	296	387	452	152	361	458	620	4,406
1982	262	97	87	245	359	245	504	329	278	392	289	176	3,264
1983	209	36	22	184	597	240	275	320	319	211	394	398	3,204
1984	229	339	101	49	370	268	228	471	274	291	402	171	3,192
1985	219	70	135	52	222	413	293	160	271	479	374	220	2,909
1986	248	48	144	452	335	318	251	421	267	361	489	145	3,479
1987	105	198	65	399		194	250	292	260	175			
1988	88	108	45	97	430	302	328	286	318	482	567	250	3,301
1989	165	138	134	94	366	294	308	372	258	293	373	291	3,084
1990	175	83	153	182	347	209	294	314	208	526	353	286	3,129
1991	110	93	75	154	294	253	237	282	406	310	352	581	3,146
1992	107	182	69	263	325	244	261	300	331	233	335	227	2,876
1993	305	78	134	225	263	330	274	275	499	349	440	274	3,446
1994	139	93	229	292	367	419	256	274	286				171
1995	143	109	163	256	240	244	246	290	331	319	411	336	3,088
1996	407	211	257	127	363	301	267	396	289	348	353	410	3,729
1997	177	307	35	110	342	147	177	205	349	400	198	70	2,518
1998	136	31	63	368	364	416	427	241					
1999													
2000													
2001													
2002													
Avg	191	132	109	232	352	307	293	321	293	352	380	312	3,286
Std	90	83	65	150	79	99	75	82	78	94	82	158	410
Max	407	339	257	650	597	558	504	471	499	526	567	620	4,406
Min	44	31	12	49	222	147	177	160	152	175	198	70	2,518
50% exc	176	108	106	204	359	295	270	297	286	355	373	280	3,204
80% exc	110	77	59	107	313	243	250	275	259	292	338	173	3,085
90% exc	103	46	34	90	258	207	236	238	201	226	313	163	2,895

## MONTHLY RAINFALL RECORDS

### Coclesito

Monthly Precipitation in mm

Lat: 8°49' Long: 80°33' Elev: 60msnm

	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Annual</b>
<b>1980</b>	197	188	44	131	259	166	205	292	325	404	387	406	<b>3,002</b>
<b>1981</b>	346	253	143	653	378	296	233	308	194	332	456	503	<b>4,095</b>
<b>1982</b>	193	147	106	261	266	334	439	240	167	293	224	194	<b>2,862</b>
<b>1983</b>	176	36	61	166	527	163	152	371	177	353	224	344	<b>2,747</b>
<b>1984</b>	301	395	87	78	396	280	190	437	296	303	370	202	<b>3,336</b>
<b>1985</b>	262	98	111	62	265	411	205	198	250	286	239	232	<b>2,619</b>
<b>1986</b>													
<b>1987</b>	122	47	35	573	223	201	311	166	391	625	247	238	<b>3,179</b>
<b>1988</b>	105	160	50	74	323	262	207	454	347	379	235	275	<b>2,871</b>
<b>1989</b>	208	69	120	137	400	396	425	370	243	153	325	262	<b>3,108</b>
<b>1990</b>	254	101	248	150	354	185	302	446	227	436	326	371	<b>3,399</b>
<b>1991</b>	93	134	252	144	380	295	246	327	380	341	310	495	<b>3,396</b>
<b>1992</b>	143	127	37	399	374	263	211	272	269	217	238	275	<b>2,823</b>
<b>1993</b>	253	123	188	163	308	244	192	221	437	354	360	559	<b>3,402</b>
<b>1994</b>	122	71	178	388	381	392	191	307	197	529	291	245	<b>3,292</b>
<b>1995</b>	131	102	152	216	209	217	221	320	240	207	256	332	<b>2,604</b>
<b>1996</b>	469	339	211	199	483	323	211	416	364	341	388	658	<b>4,401</b>
<b>1997</b>	226	219	30	94	404	250	339	119	248	295	202	66	<b>2,491</b>
<b>1998</b>													
<b>1999</b>													
<b>2000</b>													
<b>2001</b>													
<b>2002</b>													
<b>Avg</b>	212	153	121	229	349	275	252	310	280	344	299	333	<b>3,155</b>
<b>Std</b>	98	99	75	174	87	78	83	100	82	114	74	151	<b>510</b>
<b>Max</b>	469	395	252	653	527	411	439	454	437	625	456	658	<b>4,401</b>
<b>Min</b>	93	36	30	62	209	163	152	119	167	153	202	66	<b>2,491</b>
<b>50% exc</b>	197	127	111	163	374	263	211	308	250	341	291	275	<b>3,108</b>
<b>80% exc</b>	124	76	45	101	265	204	195	225	203	287	235	233	<b>2,763</b>
<b>90% exc</b>	115	60	36	77	244	177	191	185	187	213	224	199	<b>2,613</b>

**MONTHLY RAINFALL RECORDS****Santa Ana**

Monthly Precipitation in mm

Lat: 8°49' Long: 80°16' Elev: 200msnm

	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Annual</b>
<b>1980</b>													
<b>1981</b>	188	115	95	261	457	245	402	412	119	414	438	404	<b>3,549</b>
<b>1982</b>	174	35	38	153	161	258	249	203	208	424	107	95	<b>2,103</b>
<b>1983</b>	60	12	28	87	381	178	104	255	311	316	250	251	<b>2,233</b>
<b>1984</b>	70	149	47	21	305	345	359	349	358	339	238	77	<b>2,655</b>
<b>1985</b>	142	32	72	41	215	308	192	348	199	228	287	98	<b>2,162</b>
<b>1986</b>	103	15	70	301	132	415	277	273	207	489	403	50	<b>2,733</b>
<b>1987</b>	49	37	12	187	189	147	249	137	233	418	184	120	<b>1,961</b>
<b>1988</b>	46	62	12	89	319	180	292	303	188	356	309	109	<b>2,265</b>
<b>1989</b>	67	51	79	51	248	350	296	248	220	280	349	139	<b>2,376</b>
<b>1990</b>	67	23	84	71	207	192	133	158	387	442	408	225	<b>2,397</b>
<b>1991</b>	56	47	332	62	309	227	234	209	369	424	266	133	<b>2,668</b>
<b>1992</b>	43	51	16	123	308	238	157	200	313	225	229	117	<b>2,021</b>
<b>1993</b>	162	36	88	91	80	151	108	163	200	321	274	168	<b>1,843</b>
<b>1994</b>	62	29	133	133	266	205	210	236	345	291	185	71	<b>2,165</b>
<b>1995</b>	71	23	95	111	256	275	243	214	258	264	224	136	<b>2,170</b>
<b>1996</b>	163	191	30	69	194	226	221	138	225	216	374	216	<b>2,262</b>
<b>1997</b>	81	116	27	57	233	105	125	58	136	205	151	65	<b>1,358</b>
<b>1998</b>	20	25	20	64	153	501	90	142	36	90	89	294	<b>1,524</b>
<b>1999</b>	124		91	159	138								
<b>2000</b>													
<b>2001</b>													
<b>2002</b>													
<b>Avg</b>	92	58	72	112	239	253	219	225	240	319	271	165	<b>2,247</b>
<b>Std</b>	49	49	70	72	91	98	86	87	91	101	100	100	<b>469</b>
<b>Max</b>	188	191	332	301	457	501	402	412	387	489	438	404	<b>3,549</b>
<b>Min</b>	20	12	12	21	80	105	90	58	36	90	89	50	<b>1,358</b>
<b>50% exc</b>	70	36	70	89	233	232	227	212	223	319	266	133	<b>2,202</b>
<b>80% exc</b>	53	24	24	60	157	179	128	148	192	227	185	88	<b>1,985</b>
<b>90% exc</b>	46	21	15	49	137	149	107	137	131	213	142	70	<b>1,747</b>

**MONTHLY RAINFALL RECORDS****Miguel de la Borda**

Monthly Precipitation in mm

Lat: 9°09' Long: 80°19' Elev: 2msnm

	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Annual</b>
1975			148	28	398	576	402	481	194	316	461	643	
1976	126	91	11	299	351	128	325	542	743	561	555	491	4,223
1977	52	95	47	44	484	490	356	562	357	737	733	442	4,400
1978	118	39	218	415	200	393	698	532	395	472	473	125	4,077
1979	47	162	45	174	478	467	235	314	286	309	492	462	3,471
1980	188	143	19	37	335	388	336	423	430	425	290	524	3,536
1981	261	244	118	750	415	237	377	397	272	456	746	747	5,019
1982	171	100	114	184	168	432	496	537	423	536	421	201	3,782
1983	93	24	17	215	433	311	477	350	588	341	362	711	3,921
1984	314	219	79	79	444	459	366	380	255	310	432	176	3,513
1985	145	67	96	39	420			309	537	491	556	408	
1986	102		81	491	337	317	487	401	229	327	321	80	
1987	44	31	27	226	279	242	298	261	256	501	407	334	2,906
1988	46	25	19	116	236	304	360				478	381	
1989	54	60	82	115	340	463	373	504	246	658	439	184	3,519
1990	126	55	48	185	430	255	327	500	297	422	338	462	3,444
1991	158	52	183	99	474	511	456	341	559	391	867	196	4,285
1992	134	112	20	460	324	119	572	436	283	310	504	168	3,442
1993	104	68	138	475	122	405	260	516	259	334	536	438	3,653
1994	165	65	113	203	496	418	358	647	145	269	421	142	3,441
1995	129	6	111	308	330	328	322	264	328	265	523	588	3,503
1996	422	192		229	408	528	421	384	258	493	688	297	
1997	169	299	4	87	324	318	248	309	309	449	268	26	2,810
1998	104	53	90	405	454	640	525	556	133	210	488	691	4,347
1999													
2000													
2001													
2002													
<b>Avg</b>	142	100	79	236	362	379	394	432	338	417	492	372	3,752
<b>Std</b>	88	77	57	179	101	130	108	105	147	127	144	209	524
<b>Max</b>	422	299	218	750	496	640	698	647	743	737	867	747	5,019
<b>Min</b>	44	6	4	28	122	119	235	261	133	210	268	26	2,810
<b>50% exc</b>	126	67	81	194	375	393	366	423	286	422	476	394	3,536
<b>80% exc</b>	69	42	19	84	306	275	323	325	250	310	389	173	3,443
<b>90% exc</b>	48	6	4	28	122	119	235	261	133	210	268	26	2,810

# MONTHLY RAINFALL RECORDS

## Boca de Uracillo

Monthly Precipitation in mm

Lat: 8°58' Long: 80°11' Elev: 20msnm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1975	65	35	60	27	418	247	241	451	364	567	610	616	3,700
1976	101	74	32	126	310	243	142	198	431	365	303	166	2,490
1977	59	64	25	77	309	229	337			477	337	222	
1978	196	110	185	388	404	222	374	287	306	380	363	97	3,309
1979	36	134	31	216	416	433	471	533	327	323	258	219	3,396
1980	195	125	19	68	438	371	391	246	170	291	329	310	2,954
1981	222	122	169	396	352	386	407	378	190	330	520	466	3,939
1982	163	41	56	139	183	216	347	366	244	514	197	74	2,540
1983	58	23	10	105	413	313	251	248	395	411	314	320	2,860
1984	144	126	73	63	608	358	263	431	323	406	358	111	3,263
1985	201	44	79	37	306	435	315	311	286	411	349	248	3,021
1986	105	21	54	517	257	297	196	249	288	462	405	77	2,928
1987	74	61	14	234	319	253	353	287	338	473	307	187	2,900
1988	38	87	20	126	325	250	313	495	390	472	446	154	3,114
1989	55	103	40	77	232	258	236	438	193	475	391	168	2,665
1990	160	22	115	116	561	235	235	305	566	586	282	408	3,590
1991	60	60	140	106	295	225	180	131	440	355	288	268	2,547
1992	70	56	22	200	396	328	301	303	254	315	327	164	2,734
1993	109	59	122	323	212	332	181	173	343	432	397	282	2,964
1994	78	39	161	148	526	389	212	186	394	366	368	128	2,995
1995	151	28	79	257	319	509	345	257	320	312	344	260	3,181
1996	305	217	141	118	373	355	235	186	225	427	366	280	3,229
1997	67	37	10	54	168	232	134	137	193	206	178	36	1,452
1998	36	22	56	195	224	333	239	344	100	223	246	442	2,461
1999													
2000													
2001													
2002													
Avg	114	71	71	171	350	314	274	303	308	399	345	238	2,967
Std	70	47	54	124	113	78	85	109	103	95	91	137	498
Max	305	217	185	517	608	509	471	533	566	586	610	616	3,939
Min	36	21	10	27	168	216	134	131	100	206	178	36	1,452
50% exc	90	59	56	126	325	311	246	295	320	409	341	220	2,964
80% exc	58	32	21	73	242	240	205	193	206	320	286	122	2,594
90% exc	43	23	16	56	214	227	180	177	191	297	250	83	2,500

## MONTHLY RAINFALL RECORDS

### Icacal

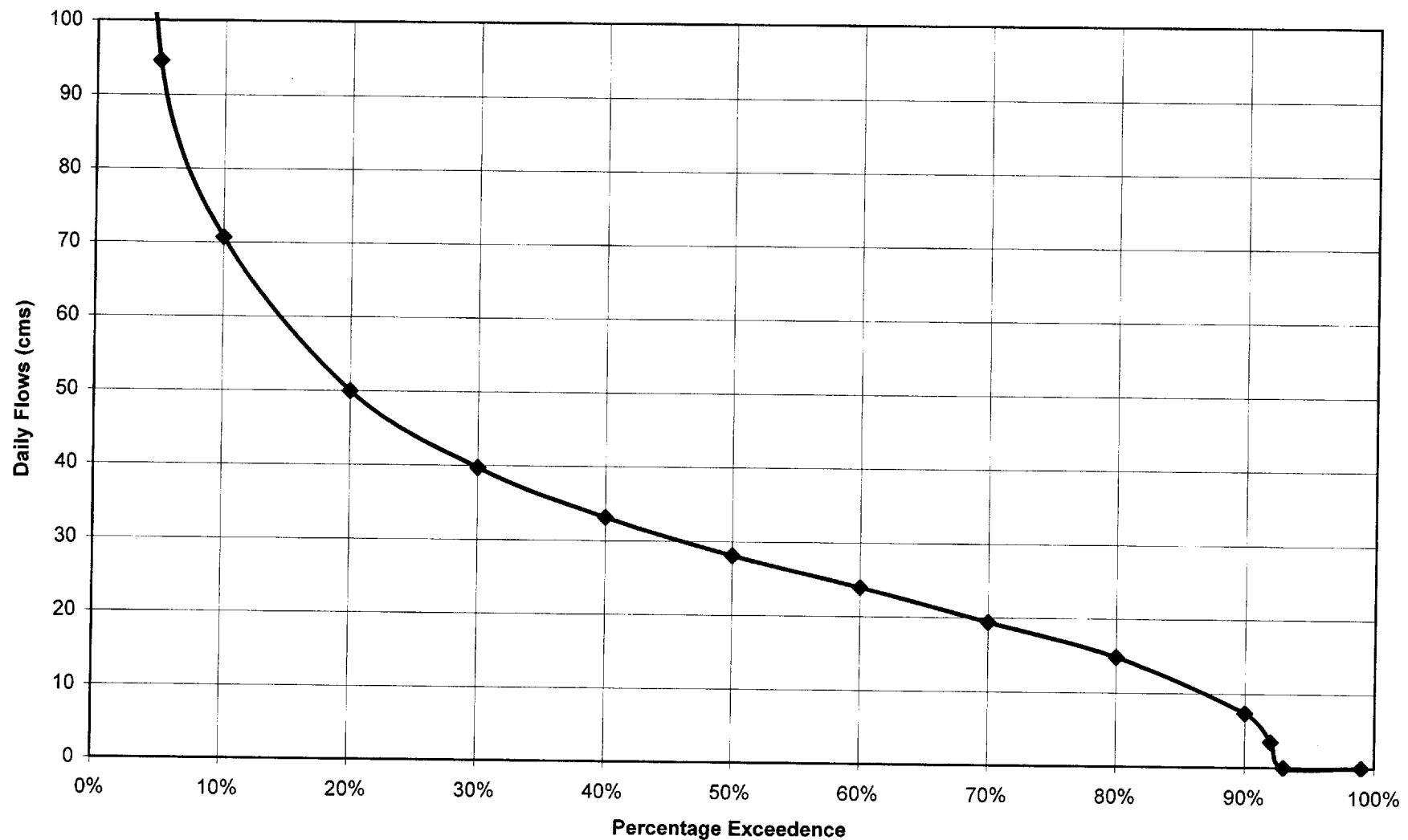
Monthly Precipitation in mm

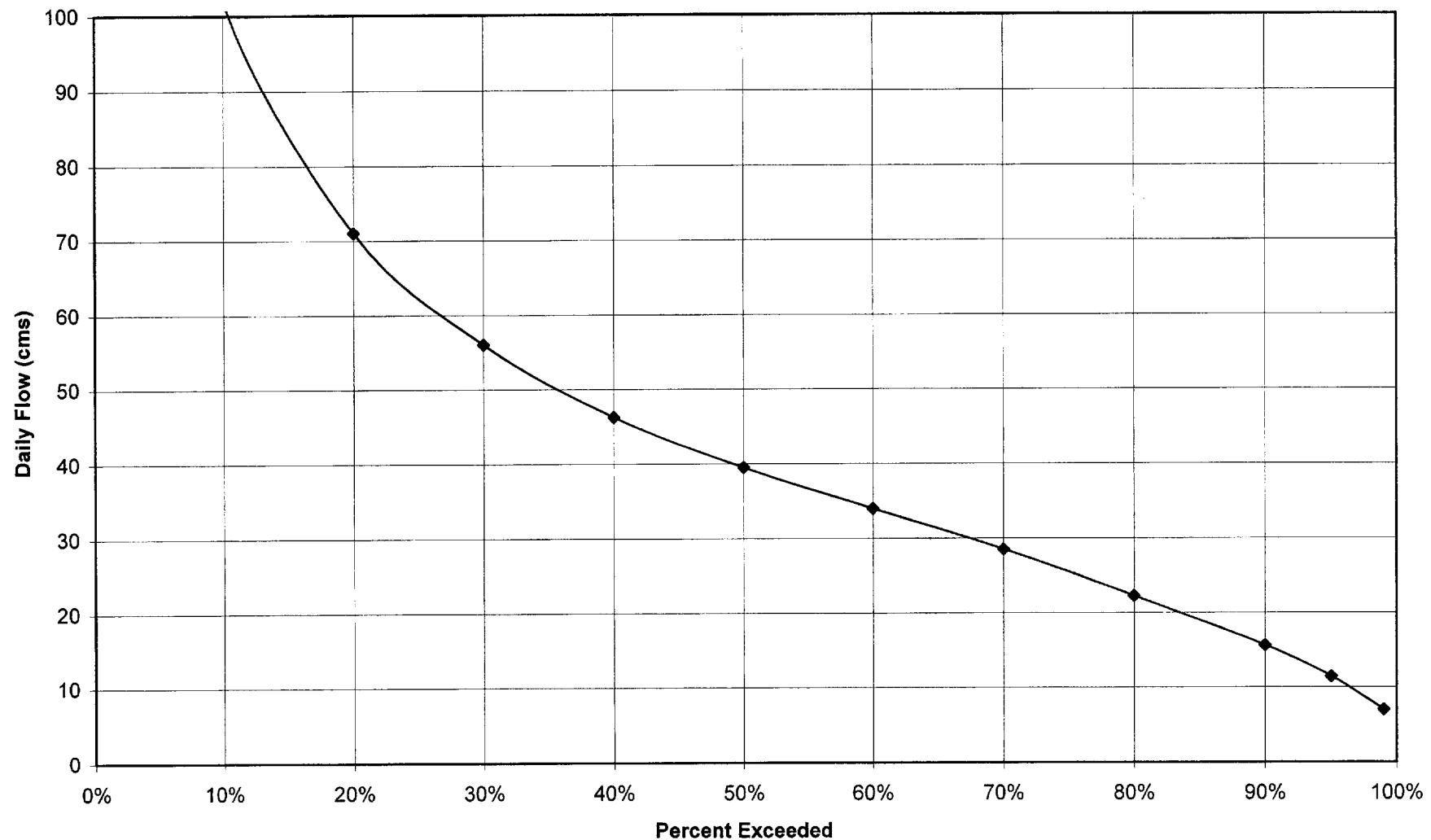
Lat: 9°12' Long: 80°09' Elev: 11msnm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1959	50	11		82	484	424	427	308	586	243	685	463	
1960	134	65	395	531	489	359	495	271	296	627	597	1016	<b>5,274</b>
1961	68				303	543	339	950	317	575	691	388	
1962	155	73	48	142	625	345	791				736		
1963	185	176	39	139	715		476	361	362	450	526	176	
1964	193	36	48	115	538	492	453	378	294	518	564	196	<b>3,823</b>
1965	222	35	8	136	451	457	370	538	291	689	1166	415	<b>4,778</b>
1966	75	7	70	225	665	286	461	652	290	615	1081	468	<b>4,896</b>
1967	167	35	71	160	338	527	497	671	257	272	620	304	<b>3,919</b>
1968	10	205	115	48	409	266	580	510	308	668	515		
1969		107	36	156	516	222	493	327	313	421	384	612	
1970	284	51	134	509	572	278	380	252	311	423	1005	757	<b>4,956</b>
1971	156	112	146	9	457	602	587	367	227	315	398	167	<b>3,543</b>
1972	408	73	112	627	454	196	341	393	325	673	273	236	<b>4,112</b>
1973	46	29	20	104	424	412	376	466	292	343	516	417	<b>3,445</b>
1974	63	67	72	40	461	348	699	484	117	284	955	130	<b>3,719</b>
1975	43	37	137	34	418	770	669	342	353	438	451	668	<b>4,359</b>
1976	64	60	9	155	355	290	343	393	502	502	329	207	<b>3,210</b>
1977	23	31	8	40	339	426	313	568	416	728	601	480	<b>3,972</b>
1978	102	72	147	369	250	556	464	375	269	401	473	109	<b>3,586</b>
1979	22	137	7	214	565	512	364	358	354	359	550	399	<b>3,839</b>
1980	206	79	18	14	431	144	374	323	457	548	283	449	<b>3,324</b>
1981	158	96	81	677	553	334	534	389	352	416	926	656	<b>5,171</b>
1982	271	52	220	114	106	291	565	373	418			167	
1983	63	30	74	240	551	299	410	473	346	199	237	547	<b>3,468</b>
1984			78	71	423	386	405	339	229	346	547	142	
1985	183	56	52	25	439	393	444		367	407			
1986			89	413	403	478	783	546	455	575	505	185	
1987	73	47	33	522	608	324	510	373	572	840	366	423	<b>4,689</b>
1988	48	67	32	77	411	295	446	356	218	373	590	314	<b>3,227</b>
1989	28	55	70	18	207	425	288	740	481	677	484	220	<b>3,693</b>
1990	79	10	59	170	412	246	432	425	496	587	433	467	<b>3,816</b>
1991	134	60	126	190	816	442	395	309	435	552	755	196	<b>4,394</b>
1992	49				249			472	366	343	524	278	
1993	94	32	203	278	290	30	86	226	236	354	582	373	<b>2,785</b>
1994	72	46	62	78	322	565	439	364	405	288	597	149	<b>3,386</b>
1995	178	34		193	498	528	490	137	152	227	707	645	
1996		168	121	159	345	437	476	369	257	223	542	361	
1997	178	59	5	67	215	223	339	354	411	316	333	23	<b>2,522</b>
1998	70	26	34	454	379	462	439		172		514	609	
1999													
2000													
2001													
2002													
<b>Avg</b>	120	65	83	200	437	385	456	420	341	454	580	373	<b>3,919</b>
<b>Std</b>	86	45	75	180	142	141	131	150	106	161	215	212	<b>704</b>
<b>Max</b>	408	205	395	677	816	770	791	950	586	840	1,166	1,016	<b>5,274</b>
<b>Min</b>	10	7	5	9	106	30	86	137	117	199	237	23	<b>2,522</b>
<b>50% exc</b>	86	55	70	148	428	389	444	373	325	421	544	373	<b>3,820</b>
<b>80% exc</b>	49	32	32	55	335	281	368	329	257	315	412	178	<b>3,386</b>
<b>90% exc</b>	10	7	5	9	106	30	86	137	117	199	237	23	<b>2,522</b>

**ATTACHMENT 8**

**MONTHLY FLOW RECORDS**

**Rio Coclé del Norte at Canoas****Daily Flow Duration Curve**

**Rio Coclé del Norte at El Torno****Daily Flow Duration Curve**

## **ATTACHMENT 9**

### **MONTHLY CLIMATIC DATA**

## Table AT9-1 – Monthly Climatic Data at the Icacal Meteorological Station

Month	P	PET	PET / 2	R	T
	mm			Cal / cm <sup>2</sup>	°C
1	50 <sup>b</sup>	90 <sup>c</sup>	112	56	386
2	30	55	114	57	428
3	20	65	137	68	457
4	50	150	123	61	424
5	305	420	106	53	362
6	280	390	87	43	315
7	380	430	95	47	329
8	330	370	99	49	343
9	260	320	99	49	354
10	300	430	94	47	328
11	400	520	78	39	288
12	180	370	99	49	344
Total	2585	3610	1243		26.6

<sup>a/</sup> Record period: 1959–1998 for P; 1959–1993 for the estimate of PET, R & T.

<sup>b/</sup> Dependable rainfall. Exceeded 80 % of the time.

<sup>c/</sup> P exceeded 50 % of the time.

**Table AT9-2 – Monthly Climatic Data at the Santa Ana Meteorological Station**

Table AT9-1 – Monthly Climatic Data at the Santa Ana Meteorological Station

Month	P	PET	PET / 2	R Cal / cm <sup>2</sup>	T °C
	mm	mm	mm		
1	50 <sup>b</sup>	75 <sup>c</sup>	130	451	25.3
2	20	40	126	477	25.8
3	20	50	137	465	26.3
4	55	90	125	438	26.6
5	150	225	101	356	25.7
6	170	230	99	359	25.7
7	125	220	105	368	25.6
8	145	200	102	358	25.6
9	180	215	98	356	25.4
10	210	295	81	294	25.3
11	175	255	91	334	25.2
12	75	135	117	407	25.3
Total	1375	2030	1312		

<sup>a/</sup> Record period: 1981–1999 for P; 1980–1993 for the estimate of PET, R & T.<sup>b/</sup> Dependable rainfall. Exceeded 80 % of the time.<sup>c/</sup> P exceeded 50 % of the time.

**Table AT9-3 – Monthly Climatic Data at the Boca de Uracillo Meteorological Station**

Month	P		PET	PET / 2	R	T
		mm			Cal / cm <sup>2</sup>	°C
1	55 <sup>b</sup>	95 <sup>c</sup>	130	65	442	26.3
2	30	55	122	61	457	26.9
3	20	60	138	69	459	27.4
4	65	125	121	60	418	27.6
5	235	325	101	50	348	27.1
6	235	310	104	52	370	26.7
7	195	250	110	55	376	26.8
8	195	295	105	52	360	26.8
9	200	315	103	51	366	26.5
10	300	390	93	46	324	26.4
11	280	340	96	48	345	26.4
12	115	205	115	57	395	26.5
Total	1925	2765	1338			

<sup>a/</sup> Record period: 1975–1998 for P; 1974–1993 for the estimate of PET, R & T.

<sup>b/</sup> Dependable rainfall. Exceeded 80 % of the time.

<sup>c/</sup> P exceeded 50 % of the time.

**ATTACHMENT 10**

**NET CROP WATER DEMANDS**

**Appendix G**  
**Cost Estimates**



**FEASIBILITY DESIGN  
FOR THE RÍOS COCLÉ DEL NORTE AND CAÑO SUCIO  
WATER SUPPLY PROJECTS**

**APPENDIX G**

**COST ESTIMATES**

Prepared by



In association with



**FEASIBILITY DESIGN  
FOR THE RÍOS COCLÉ DEL NORTE AND CAÑO SUCIO  
WATER SUPPLY PROJECTS**

**APPENDIX G – COST ESTIMATES**

**LIST OF TABLES**

1. Project Management and Support – Coclé 50 – 71
2. Common Equipment – Coclé 50 – 71
3. Other Costs – Coclé 50 – 71
4. Project Management and Support – Coclé 90 – 100
5. Common Equipment – Coclé 90 – 100
6. Other Costs – Coclé 90 – 100
7. Local Labor Hourly Rates
8. Equipment Hourly Rates
9. Common Excavation
10. Structural Rock Excavation
11. Bulk Rock Excavation
12. Rock Transport
13. Quarry Operation
14. Rockfill – Coclé 50 – 71
15. Rockfill – Coclé 90 – 100
16. Mass Concrete Mix and Transport
17. Mass Concrete Placement
18. Structural Concrete Mix and Transport
19. Structural Concrete Placement
20. Steel Reinforcement
21. Formwork
22. RCC Mix, Transport and Place – Caño Sucio Dam
23. Coclé del Norte Diversion Tunnel
24. Indio – Gatun Second Transfer Tunnel
25. TBM Operation
26. Caño – Indio Transfer Tunnel

## Project Management and Support - Coclé 50 - 71

<b>Description</b>	<b>Monthly Salary (\$)</b>	<b>Cost of Salary</b>	<b>Number</b>	<b>Duration (month)</b>			<b>Total</b>
				<b>Pre</b>	<b>Const.</b>	<b>Post</b>	
Project Manager	\$8,500	\$12,750	1	6	42	3	\$650,250
Superintendent	\$7,500	\$11,250	1	6	42	3	\$573,750
Staff Engineers	\$5,500	\$8,250	3	2	42		\$1,089,000
Purchasing Agent	\$6,500	\$9,750	1	6	42		\$468,000
Coordinator (subs)	\$6,000	\$9,000	1	6	42		\$432,000
Accountant	\$6,500	\$9,750	1	2	42	3	\$458,250
Administrative Assistant	\$2,000	\$3,000	3	3	42	2	\$423,000
Secretary	\$1,000	\$1,500	2	3	42	2	\$141,000
							<b>\$4,235,250</b>
<b>Airfare for Expatriate and Family</b>							
	\$1,500			180 RT			<b>\$270,000</b>
<b>Office Equipment</b>							
Computers	\$2,500			14 each			<b>\$35,000</b>
Copiers, printers, video, etc.	\$20,000			1 LS			<b>\$20,000</b>
Supplies	\$1,000			50 mth			<b>\$50,000</b>
Telephone (satellite, other)	\$1,500			50 mth			<b>\$75,000</b>
<b>Vehicles</b>							
Compact Pickup	\$415			5 each		42 mth	<b>\$87,150</b>
3/4 ton pickup	\$615			3 each		42 mth	<b>\$77,490</b>
							<b>\$4,849,890</b>

## Common Equipment - Coclé 50 - 71

<b>Equipment Description</b>	<b>Hourly Operating Rate</b>	<b>Standby Hourly Rate</b>
50 ton Crawler Mounted Crane	\$51.06	\$19.43
Forklift truck	\$25.60	\$6.96
50 ton Lowboy	\$8.32	\$2.96
Flatbed trailer	\$3.07	\$1.06
Fuel Bowser	\$6.79	\$2.36
Tractor trailer	\$33.51	\$5.57
Utility Trailer	\$1.15	\$0.42
75 mm submersible pump	\$1.09	\$0.27
100 mm diaphragm pump	\$2.00	\$0.50
150 mm submersible pump	\$8.04	\$1.23
3/4 Pickup Truck	\$7.63	\$1.28
Welding set	\$5.61	\$0.68
	<b>\$153.87</b>	<b>\$42.72</b>

*Assume 70% standby and 30% operating on the basis  
of 40 hr per week*

<b>Cost of Commun Equipment</b>	<b>\$13,185</b>	<b>42 mth</b>	<b>\$553,755</b>
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**Operating Crew**

Crew Leader	\$10.00	1	\$10.00
Drivers	\$6.30	3	\$18.90
Mechanics	\$6.70	3	\$20.10
Electrician	\$6.70	1	\$6.70
Welder	\$8.00	1	\$8.00
Equipment Operator	\$8.00	1	\$8.00
			<b>\$71.70</b>

*Assume 40 hr per week*

<b>Cost of Operating Crew</b>	<b>\$12,428</b>	<b>42 mth</b>	<b>\$521,976</b>
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**Total \$1,075,731**

## Other Costs - Coclé 50 - 71

**Mobilization of Equipment**
**Cocle Dam Contract**

40-ft container from US port including

 Shipping, US port handling, Panama Port  
 Handling

**\$10,000**

Trucking Container to construction Site

Loading	4 hr
Travel 65 km to site	2 hr
Unload	4 hr
Return	2 hr

Transportation Cost	\$ 27.94	14 hr	\$391.16
Loading/Unloading	\$ 70.25	8 hr	\$562.00

**Estimated cost per container      \$11,000**
*Assume same cost for demobilization*

Estimated Number of containers	70		<b>\$1,540,000</b>
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**Power**

Generators 275kW	\$40,000	4 each	\$160,000 ( <i>one standby</i> )
Generators 545 kW	\$86,000	1 each	\$86,000
Housing	\$8,000	4 each	\$32,000
Transmission	\$4,500	7 km	\$31,500
Operating Cost at \$0.08/kWh	\$0.08	32,000,000 kWh	\$2,560,000 (50% load) <b>\$2,869,500</b>

## Project Management and Support - Coclé 90-100

<b>Description</b>	<b>Monthly Salary (\$)</b>	<b>Cost of Salary</b>	<b>Number</b>	<b>Duration (month)</b>			<b>Total</b>
				<b>Pre</b>	<b>Const.</b>	<b>Post</b>	
Project Manager	\$8,500	\$12,750	1	6	54	3	\$803,250
Superintendent	\$7,500	\$11,250	1	6	54	3	\$708,750
Staff Engineers	\$5,500	\$8,250	3	2	54		\$1,386,000
Purchasing Agent	\$6,500	\$9,750	1	6	54		\$585,000
Coordinator (subs)	\$6,000	\$9,000	1	6	54		\$540,000
Accountant	\$6,500	\$9,750	1	2	54	3	\$575,250
Administrative Assistant	\$2,000	\$3,000	3	3	54	2	\$531,000
Secretary	\$1,000	\$1,500	2	3	54	2	\$177,000
							<b>\$5,306,250</b>
<b>Airfare for Expatriate and Family</b>							<b>\$300,000</b>
	\$1,500			200 RT			
<b>Office Equipment</b>							
Computers	\$2,500			14 each			\$35,000
Copiers, printers, video, etc.	\$20,000			1 LS			\$20,000
Supplies	\$1,000			57 mth			\$57,000
Telephone (satellite, other)	\$1,500			57 mth			\$85,500
<b>Vehicles</b>							
Compact Pickup	\$415			5 each		54 mth	\$112,050
3/4 ton pickup	\$615			3 each		54 mth	\$99,630
							<b>\$6,015,430</b>

## Common Equipment - Coclé 90 - 100

<b>Equipment Description</b>	<b>Hourly Operating</b>	<b>Standby Hourly</b>
	<b>Rate</b>	<b>Rate</b>
50 ton Crawler Mounted Crane	\$51.06	\$19.43
Forklift truck	\$25.60	\$6.96
50 ton Lowboy	\$8.32	\$2.96
Flatbed trailer	\$3.07	\$1.06
Fuel Bowser	\$6.79	\$2.36
Tractor trailer	\$33.51	\$5.57
Utility Trailer	\$1.15	\$0.42
75 mm submersible pump	\$1.09	\$0.27
100 mm diaphragm pump	\$2.00	\$0.50
150 mm submersible pump	\$8.04	\$1.23
3/4 Pickup Truck	\$7.63	\$1.28
Welding set	\$5.61	\$0.68
	<b>\$153.87</b>	<b>\$42.72</b>

*Assume 70% standby and 30% operating on the basis  
of 40 hr per week*

<b>Cost of Commun Equipment</b>	<b>\$13,185</b>	<b>54 mth</b>	<b>\$711,971</b>
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**Operating Crew**

Crew Leader	\$10.00	1	\$10.00
Drivers	\$6.30	3	\$18.90
Mechanics	\$6.70	3	\$20.10
Electrician	\$6.70	1	\$6.70
Welder	\$8.00	1	\$8.00
Equipment Operator	\$8.00	1	\$8.00
			<b>\$71.70</b>

*Assume 40 hr per week*

<b>Cost of Operating Crew</b>	<b>\$12,428</b>	<b>54 mth</b>	<b>\$671,112</b>
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**Total \$1,383,083**

## Other Costs - Coclé 90 - 100

**Mobilization of Equipment**
**Cocle Dam Contract**

40-ft container from US port including  
Shipping, US port handling, Panama Port  
Handling **\$10,000**

**Trucking Container to construction Site**

Loading	4 hr
Travel 65 km to site	2 hr
Unload	4 hr
Return	2 hr

Transportation Cost	\$ 27.94	14 hr	<b>\$391.16</b>
Loading/Unloading	\$ 70.25	8 hr	<b>\$562.00</b>
<b>Estimated cost per container</b> <span style="float: right;"><b>\$11,000</b></span>			

*Assume same cost for demobilization*

Estimated Number of containers	70	<b>\$1,540,000</b>
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**Power**

Generators 275kW	\$40,000	4 each	<b>\$160,000 (one standby)</b>
Generators 545 kW	\$86,000	1 each	<b>\$86,000</b>
Housing	\$8,000	4 each	<b>\$32,000</b>
Transmission	\$4,500	7 km	<b>\$31,500</b>
Operating Cost at \$0.08/kWh	\$0.08	36,000,000 kWh	<b>\$2,880,000 (50% load)</b>
			<b>\$3,189,500</b>

## Local Labor Hourly Rates

Description	Rate (\$/hr)	Standby Rate	Comments
Crew Leader	\$ 10.00		Estimate
Equipment Operator	\$ 8.00		Estimate
Truck Driver	\$ 6.30		Estimate
Skilled Labor	\$ 6.70		Guidance from the COE for Estimates in Panama: \$3.50/hr (Apr 98) escalated at 2%p.a. plus 50% for social cost and adjusted for overtime (60-hr work week)
Unskilled Labor	\$ 5.60		Guidance from the COE for Estimates in Panama: \$2.90/hr (Apr 98) escalated at 2%p.a. plus 50% for social cost and adjusted for overtime (60-hr work week)

## Equipment Hourly Rates

Equipment Description	Ownership Cost		Operating Cost			Repair Cost		Total Hourly
	Depr.	FCCM	Fuel	FOG	Tire	Tire	General	
Compressor 375cfm	\$ 3.25	\$ 0.91	\$ 5.88	\$ 1.45	\$ 0.16	\$ 0.02	\$ 2.59	\$ 14.26
Batching Plant 45 cm/hr	\$ 9.53	\$ 2.34	\$ 18.74	\$ 9.34	\$ 1.94	\$ 0.24	\$ 10.76	\$ 52.89
Cement Silo & loading	\$ 2.55	\$ 0.57	\$ 1.89	\$ 1.83	\$ -	\$ -	\$ 2.81	\$ 9.64
Pugmill, 10cm feederhopper, twin shaft, etc	\$ 21.88	\$ 4.99	\$ 9.15	\$ 3.62	\$ 0.44	\$ 0.05	\$ 24.32	\$ 64.45
Concrete Pump	\$ 5.77	\$ 1.09	\$ 3.78	\$ 0.93	\$ 0.03	\$ -	\$ 5.62	\$ 17.21
15-ton Yard Crane	\$ 7.08	\$ 2.47	\$ 5.61	\$ 1.48	\$ 0.54	\$ 0.07	\$ 5.83	\$ 23.08
50-ton Crane (Crawler)	\$ 20.21	\$ 9.61	\$ 4.04	\$ 0.71	\$ -	\$ -	\$ 16.49	\$ 51.06
80-ton Crane (Crawler)	\$ 31.33	\$ 13.33	\$ 9.64	\$ 2.88	\$ -	\$ -	\$ 28.98	\$ 86.16
Tower Crane	\$ 19.81	\$ 7.69	\$ 5.20	\$ 5.33	\$ -	\$ -	\$ 17.69	\$ 55.72
Drill Rig with Compressor	\$ 8.56	\$ 3.54	\$ 13.96	\$ 3.44	\$ -	\$ -	\$ 10.06	\$ 39.55
Generator 275kW	\$ 3.51	\$ 0.80	\$ 17.50	\$ 3.69	\$ -	\$ -	\$ 2.34	\$ 27.85
Generator 455kW	\$ 6.32	\$ 1.45	\$ 29.69	\$ 6.27	\$ -	\$ -	\$ 4.22	\$ 47.96
Hydraulic Excavator 6cy bucket CAT 375-L	\$ 27.11	\$ 18.77	\$ 18.49	\$ 3.91	\$ -	\$ -	\$ 37.78	\$ 106.06
Front End Loader CAT 953 Crawler - 1.7cm	\$ 16.68	\$ 3.77	\$ 5.70	\$ 1.91	\$ -	\$ -	\$ 25.12	\$ 53.18
Front End Loader CAT 939-C Crawler - 1.15cm	\$ 10.77	\$ 2.43	\$ 4.24	\$ 1.42	\$ -	\$ -	\$ 16.22	\$ 35.08
Front End Loader CAT 980-G Wheel - 4.6cm	\$ 24.92	\$ 8.44	\$ 12.96	\$ 3.42	\$ 7.84	\$ 0.97	\$ 19.38	\$ 77.93
Front End Loader CAT 990-SeriesII Wheel - 9.2cm	\$ 60.17	\$ 20.65	\$ 27.01	\$ 7.13	\$ 9.88	\$ 1.23	\$ 46.90	\$ 172.96
Roller, Double-drum, self Propelled	\$ 13.44	\$ 3.03	\$ 6.81	\$ 1.92	\$ -	\$ -	\$ 15.96	\$ 41.16
Staking Conveyor	\$ 2.46	\$ 0.58	\$ 0.62	\$ 0.24	\$ 0.20	\$ 0.02	\$ 1.68	\$ 5.81
Conveyor	\$ 3.60	\$ 0.86	\$ 1.66	\$ 0.66	\$ 0.38	\$ 0.05	\$ 2.47	\$ 9.68
Crushing Plant (Secondary)	\$ 12.28	\$ 6.63	\$ 13.09	\$ 5.19	\$ 0.62	\$ 0.08	\$ 14.38	\$ 52.27
Screening Plant	\$ 11.89	\$ 2.76	\$ 3.33	\$ 1.32	\$ 0.41	\$ 0.05	\$ 9.29	\$ 29.04
Crushing Plant (Primary)	\$ 10.26	\$ 5.49	\$ 7.77	\$ 1.92	\$ 0.57	\$ 0.07	\$ 6.44	\$ 32.52
Dozer/Ripper D8	\$ 14.79	\$ 8.60	\$ 14.37	\$ 3.54	\$ -	\$ -	\$ 17.59	\$ 58.89
Dozer/Ripper D6	\$ 11.70	\$ 4.65	\$ 7.77	\$ 2.47	\$ -	\$ -	\$ 17.90	\$ 44.50
Water Truck	\$ 9.25	\$ 2.91	\$ 13.33	\$ 3.28	\$ 1.08	\$ 0.13	\$ 6.47	\$ 36.44
Flatbed Trailer, 48 ft long	\$ 1.41	\$ 0.37	\$ -	\$ -	\$ 0.53	\$ 0.06	\$ 0.70	\$ 3.07
Bottom Dum Truck	\$ 19.20	\$ 5.47	\$ 12.11	\$ 3.39	\$ 7.60	\$ 0.94	\$ 13.31	\$ 62.03
Lowboy 50 ton	\$ 4.52	\$ 0.51	\$ 1.65	\$ 0.09	\$ 0.49	\$ 0.06	\$ 1.00	\$ 8.32
3/4 Ton Pickup F250 4X4	\$ 1.76	\$ 0.42	\$ 2.96	\$ 0.73	\$ 0.39	\$ 0.05	\$ 1.33	\$ 7.63
Transit Mixer	\$ 4.81	\$ 1.15	\$ 5.96	\$ 1.87	\$ 0.36	\$ 0.04	\$ 3.44	\$ 17.62
Tractor trailer	\$ 6.70	\$ 2.30	\$ 14.13	\$ 3.48	\$ 1.94	\$ 0.24	\$ 4.71	\$ 33.51
Truck, off-highway; rear dump 58 ton	\$ 19.77	\$ 14.56	\$ 15.32	\$ 4.58	\$ 11.73	\$ 1.46	\$ 12.42	\$ 79.84
Truck, off-highway; rear dump 25 ton	\$ 8.68	\$ 6.32	\$ 6.13	\$ 1.83	\$ 6.58	\$ 0.82	\$ 5.44	\$ 35.80
Compressor & Vibrators	\$ 4.67	\$ 3.40	\$ 3.30	\$ 0.98	\$ 3.53	\$ 0.44	\$ 2.91	\$ 19.23

## Common Excavation

<b>Description</b>	<b>Hourly Rates</b>			<b>Quantity</b>	<b>Amount</b>
	<b>Labor</b>	<b>Equip.</b>			
Dozer/Ripper D8	\$ 8.00	\$ 58.89		1	\$ 66.89
Hyd Excavator 4.6 cm bucket	\$ 8.00	\$ 106.06		1	\$ 114.06
Dozer D6	\$ 8.00	\$ 44.50		1	\$ 52.50
Loader 9.2 cm bucket	\$ 8.00	\$ 172.96		1	\$ 180.96
58-ton Rear Dump Truck	\$ 6.30	\$ 79.84		4	\$ 344.56
Crew Leader	\$ 10.00			1	\$ 10.00
Unskilled Labor	\$ 5.60			4	\$ 22.40
				<b>Total</b>	<b>\$ 791.36</b>
Production Rate	320 cm/hr	Rate			\$ 2.47
		Indirect Cost 30%			\$ 0.74
		Total Rate			\$ 3.21

## Structural Rock Excavation

<b>Description</b>	<b>Hourly Rates</b>			<b>Amount</b>
	<b>Labor</b>	<b>Equip.</b>	<b>Quantity</b>	
Dozer/Ripper D6	\$ 8.00	\$ 44.50	1	\$ 52.50
Drill Rig	\$ 8.00	\$ 39.55	1	\$ 47.55
Compressor & 4 hand drills	\$ 22.40	\$ 17.78	2	\$ 80.36
Loader 1.7 cm bucket	\$ 8.00	\$ 53.18	1	\$ 61.18
25-ton Rear Dump Truck	\$ 6.30	\$ 35.80	2	\$ 84.20
Crew Leader	\$ 10.00		1	\$ 10.00
Unskilled Labor	\$ 5.60		4	\$ 22.40
			<b>Subtotal</b>	<b>\$ 358.19</b>
Production Rate	40 cm/hr	Rate		\$ 8.95
Explosives	1.00 kg/cm @	\$ 1.50		\$ 1.50
Misc consummable (10%)				\$ 0.90
			<b>Subtotal</b>	<b>\$ 11.35</b>
<b>Indirect Cost 30%</b>				\$ 3.41
			<b>Total Rate</b>	<b>\$ 14.76</b>

## Bulk Rock Excavation

<b>Description</b>	<b>Hourly Rates</b>			
	<b>Labor</b>	<b>Equip.</b>	<b>Quantity</b>	<b>Amount</b>
Dozer/Ripper D8	\$ 8.00	\$ 58.89	1	\$ 66.89
Drill Rig	\$ 8.00	\$ 39.55	2	\$ 95.11
Compressor & 4 hand drills	\$ 22.40	\$ 17.78	2	\$ 80.36
Loader 4.6 cm bucket	\$ 8.00	\$ 77.93	1	\$ 85.93
25-ton Rear Dump Truck	\$ 6.30	\$ 35.80	4	\$ 168.40
Crew Leader	\$ 10.00		1	\$ 10.00
Unskilled Labor	\$ 5.60		4	\$ 22.40
			<b>Subtotal</b>	<b>\$ 529.09</b>
Production Rate	100 cm/hr	Rate		\$ 5.29
Explosives	0.65 kg/cm @	\$ 1.50		\$ 0.98
Misc consummable (10%)				\$ 0.53
			<b>Subtotal</b>	<b>\$ 6.79</b>
			<b>Indirect Cost 30%</b>	<b>\$ 2.04</b>
			<b>Total Rate</b>	<b>\$ 8.83</b>

**Rock Transport**

<b>Description</b>	<b>Hourly Rates</b>			
	<b>Labor</b>	<b>Equip.</b>	<b>Quantity</b>	<b>Amount</b>
Front End Loader - 9.2cm	\$ 8.00	\$ 172.96	1	\$ 180.96
Truck, off-highway; rear dump 58 ton	\$ 6.30	\$ 79.84	7	\$ 602.98
Crew Leader	\$ 10.00		2	\$ 20.00
Unskilled Labor	\$ 5.60		2	\$ 11.20
			<b>Subtotal</b>	<b>\$ 815.14</b>
<b>Production Rate</b>	840 cm/hr		<b>Rate</b>	\$ 0.97
			<b>Subtotal</b>	\$ 0.97
			<b>Indirect Cost 30%</b>	\$ 0.29
			<b>Total Rate</b>	<b>\$ 1.26</b>

## Quarry Operation

<b>Description</b>	<b>Hourly Rates</b>			
	<b>Labor</b>	<b>Equip.</b>	<b>Quantity</b>	<b>Amount</b>
Dozer/Ripper D6	\$ 8.00	\$ 44.50	1	\$ 52.50
Drill Rig incl. Compressor	\$ 8.00	\$ 39.55	2	\$ 95.11
Compressor & 4 hand drills	\$ 22.40	\$ 17.78	2	\$ 80.36
Crushing and Screening Plant	\$ 8.00	\$ 61.45	1	\$ 69.45
Secondary Crushing Plant		\$ 52.27	1	\$ 52.27
Conveyor		\$ 5.81	2	\$ 11.62
Front End Loader CAT 939-C Crawler - 1.15cm	\$ 8.00	\$ 35.08	1	\$ 43.08
25-ton Rear Dump Truck	\$ 6.30	\$ 35.80	2	\$ 84.20
Crew Leader	\$ 10.00		1	\$ 10.00
Unskilled Labor	\$ 5.60		10	\$ 56.00
			<b>Subtotal</b>	<b>\$ 554.59</b>
Production Rate	80 cm/hr	Rate		\$ 6.93
Explosives	0.80 kg/cm @	\$ 1.50		\$ 1.20
Misc consummable (10%)				\$ 0.69
			<b>Subtotal</b>	<b>\$ 8.83</b>
			<b>Indirect Cost 30%</b>	<b>\$ 2.65</b>
			<b>Total Rate</b>	<b>\$ 11.47</b>

**Rockfill - Coclé 50-71**

Total Required Rockfill	2,730,000 cm	(compacted)	
Total Rock Excavation	490,000 cm	(bank)	
Usable Rock from Excavation	416,500 cm	(bank)	
Usable Rock from Excavation	541,500	(compacted)	
Rockfill from Quarry	2,188,500 cm	(compacted)	
Quarry Excavation	1,980,500	(bank)	
	<b>Quant</b>	<b>Unit Rate</b>	<b>Amount</b>
Cost of Excavation	1,980,500	\$ 8.83 per cm	\$ 17,494,600
Transportation (3km)	2,970,800	\$ 1.26 per cm	\$ 3,747,700
Placement	2,730,000	\$ 3.50 per cm	\$ 9,555,000
			\$ 30,797,300
	<b>Unit Rate</b>		\$ 11.28
	say	\$	11.30

**Note:**

Shrinkage Factor	1.30
Load Factor	0.67
Waste Factor	0.85

**Rockfill - Coclé 90 - 100**

Total Required Rockfill	5,760,000 cm	(compacted)	
Total Rock Excavation	397,300 cm	(bank)	
Usable Rock from Excavation	337,700 cm	(bank)	
Usable Rock from Excavation	439,000	(compacted)	
Rockfill from Quarry	5,321,000 cm	(compacted)	
Quarry Excavation	4,815,400	(bank)	
	Quant	Unit Rate	Amount
Cost of Excavation	4,815,400	\$ 8.83 per cm	\$ 42,536,600
Transportation (3km)	7,223,100	\$ 1.26 per cm	\$ 9,112,100
Placement	5,760,000	\$ 3.50 per cm	\$ 20,160,000
			\$ 71,808,700
	Unit Rate	\$ 12.47	
	say \$	<b>12.50</b>	

**Note:**

Shrinkage Factor	1.30
Load Factor	0.67
Waste Factor	0.85

## Mass Concrete Mix & Transport

<b>Description</b>	<b>Hourly Rates</b>			<b>Amount</b>
	<b>Labor</b>	<b>Equip.</b>	<b>Quantity</b>	
Batching Plant 75 cm/hr	\$ 8.00	\$ 52.89	1	\$ 60.89
Cement Silo & loading		\$ 9.65	1	\$ 9.65
Standby Generator		\$ 5.00	1	\$ 5.00
Transit Mixer	\$ 6.30	\$ 17.62	8	\$ 191.36
Dumper 2cm		\$ 5.00	4	\$ 20.00
Water Storage & Cooling Plant	\$ 8.00	\$ 47.00	1	\$ 55.00
25-ton Rear Dump Truck	\$ 6.30	\$ 35.80	2	\$ 84.20
Expatriate	\$ 60.00		1	\$ 60.00
Crew Leader	\$ 10.00		3	\$ 30.00
Unskilled Labor	\$ 5.60		10	\$ 56.00
			<b>Subtotal</b>	<b>\$ 572.10</b>
Production Rate	40 cm/hr	Rate		\$ 14.30
Cement	0.36 T/cm @	\$ 122.00		\$ 43.92
Additive	0.5 gal/cm	\$ 15.00		\$ 7.50
Aggregates	1 cm/cm @	\$ 8.83		\$ 8.83
		<b>Subtotal</b>		<b>\$ 74.55</b>
		<b>Indirect Cost 30%</b>		<b>\$ 22.36</b>
			<b>Total Rate</b>	<b>\$ 96.91</b>

## Mass Concrete Placement

<b>Description</b>	<b>Hourly Rates</b>			<b>Amount</b>
	<b>Labor</b>	<b>Equip.</b>	<b>Quantity</b>	
50-ton Crane	\$ 8.00	\$ 51.06	1	\$ 59.06
80-ton Crane	\$ 8.00	\$ 86.16	1	\$ 94.16
Tower Crane	\$ 8.00	\$ 55.72	1	\$ 63.72
Concrete Pump	\$ 8.00	\$ 17.21	2	\$ 50.43
Compressor & Vibrators	\$ 6.30	\$ 19.25	2	\$ 88.90
Expatriate	\$ 60.00		1	\$ 60.00
Crew Leader	\$ 10.00		3	\$ 30.00
Unskilled Labor	\$ 5.60		10	\$ 56.00
Miscellaneous			15%	\$ 75.34
			<b>Subtotal</b>	<b>\$ 577.62</b>
Production Rate Concrete	40 cm/hr	Rate	\$ 14.44	
			\$ 74.55	
			<b>Subtotal</b>	<b>\$ 88.99</b>
		<b>Indirect Cost 30%</b>	\$ 26.70	
			<b>Total Rate</b>	<b>\$ 115.69</b>

## Struct Concrete Mix & Transport

<b>Description</b>	<b>Hourly Rates</b>			<b>Amount</b>
	<b>Labor</b>	<b>Equip.</b>	<b>Quantity</b>	
Batching Plant 75 cm/hr	\$ 8.00	\$ 52.89	1	\$ 60.89
Cement Silo & loading		\$ 9.65	1	\$ 9.65
Standby Generator		\$ 5.00	1	\$ 5.00
Transit Mixer	\$ 6.30	\$ 17.62	8	\$ 191.36
Dumper 2cm		\$ 5.00	4	\$ 20.00
Water Storage & Cooling Plant	\$ 8.00	\$ 47.00	1	\$ 55.00
25-ton Rear Dump Truck	\$ 6.30	\$ 35.80	2	\$ 84.20
Expatriate	\$ 60.00		1	\$ 60.00
Crew Leader	\$ 10.00		3	\$ 30.00
Unskilled Labor	\$ 5.60		10	\$ 56.00
			<b>Subtotal</b>	<b>\$ 572.10</b>
Production Rate	25 cm/hr	Rate		\$ 22.88
Cement	0.4 T/cm @	\$ 122.00		\$ 48.80
Additive	0.5 gal/cm	\$ 15.00		\$ 7.50
Aggregates	1 cm/cm @	\$ 8.83		\$ 8.83
		<b>Subtotal</b>		<b>\$ 88.01</b>
		<b>Indirect Cost 30%</b>		<b>\$ 26.40</b>
			<b>Total Rate</b>	<b>\$ 114.41</b>

## Structural Concrete Placement

<b>Description</b>	<b>Hourly Rates</b>			
	<b>Labor</b>	<b>Equip.</b>	<b>Quantity</b>	<b>Amount</b>
50-ton Crane	\$ 8.00	\$ 51.06	1	\$ 59.06
80-ton Crane	\$ 8.00	\$ 86.16	1	\$ 94.16
Tower Crane	\$ 8.00	\$ 55.72	1	\$ 63.72
Concrete Pump	\$ 8.00	\$ 17.21	2	\$ 50.43
Compressor & Vibrators	\$ 6.30	\$ 19.25	2	\$ 88.90
Expatriate	\$ 60.00		1	\$ 60.00
Crew Leader	\$ 10.00		3	\$ 30.00
Unskilled Labor	\$ 5.60		10	\$ 56.00
Miscellaneous			15%	\$ 75.34
			<b>Subtotal</b>	<b>\$ 577.62</b>
Production Rate Concrete	25 cm/hr	Rate		\$ 23.10
				\$ 88.01
			<b>Subtotal</b>	<b>\$ 111.11</b>
			<b>Indirect Cost 30%</b>	<b>\$ 33.33</b>
			<b>Total Rate</b>	<b>\$ 144.45</b>

## Steel Reinforcement

<b>Description</b>	<b>Hourly Rates</b>			<b>Quantity</b>	<b>Amount</b>
	<b>Labor</b>	<b>Equip.</b>			
<i>Unload, Sort and Pile</i>					
Crew Leader	\$ 10.00			1	\$ 10.00
15-ton Yard Crane	\$ 8.00	\$ 23.08		1	\$ 31.08
Unskilled Labor	\$ 5.60			4	\$ 22.40
				<b>Subtotal</b>	\$ 63.48
Production Rate		9 T/hr		Rate	\$ 7.05
<i>Cut, Bend and Place</i>					
Crew Leader	\$ 10.00			1	\$ 10.00
15-ton Yard Crane	\$ 8.00	\$ 23.08		1	\$ 31.08
Unskilled Labor	\$ 6.70			30	\$ 201.00
				<b>Subtotal</b>	\$ 242.08
Production Rate		1 T/hr		Rate	\$ 242.08
Reinforcement Steel		1 T/T @	\$ 725.00	\$	725.00
Miscellaneous			5%	\$	36.25
				<b>Subtotal</b>	\$ 1,010.38
Indirect Cost 30%				\$	303.12
				<b>Subtotal</b>	\$ 1,313.50

## Formwork

<b>Description</b>	<b>Hourly Rates</b>		<b>Quantity</b>	<b>Amount</b>
	<b>Labor</b>	<b>Equip.</b>		
<i>Fabrication</i>				
Crew Leader	\$ 10.00		1	\$ 10.00
Skilled Labor	\$ 6.70		3	\$ 20.10
Unskilled Labor	\$ 5.60		2	\$ 11.20
			<b>Subtotal</b>	\$ 41.30
<i>Material</i>				
Production Rate	2 sm/hr	Rate		\$ 20.15
Wood & Plywood	1.1 sm/sm @	\$ 20.50		\$ 22.55
Miscellaneous		10%	\$ 2.26	
			<b>Subtotal</b>	\$ 44.95
Reuse	5			\$ 8.99
<i>Cleanup &amp; Erection</i>				
Crew Leader	\$ 10.00		1	\$ 10.00
Unskilled Labor	\$ 5.60		3	\$ 16.80
			<b>Subtotal</b>	\$ 26.80
			<b>Indirect Cost 30%</b>	\$ 10.74
			<b>Total Rate</b>	\$ 46.53

## RCC Mix, Transport and Place - Caño Sucio Dam

<b>Description</b>	<b>Hourly Rates</b>				
	<b>Labor</b>	<b>Equip.</b>	<b>Quantity</b>	<b>Amount</b>	<b>Labor</b>
Pugmill	\$ 8.00	\$ 64.45	1	\$ 72.45	\$ 8.00
Conveyors		\$ 31.80	8	\$ 254.40	\$ -
Cement Silo & loading		\$ 9.50	3	\$ 28.50	\$ -
Bottom Dump Truck	\$ 6.30	\$ 62.03	4	\$ 273.31	\$ 25.20
Dozer D8	\$ 8.00	\$ 58.89	4	\$ 267.56	\$ 32.00
Roller, Double-drum, self Propelled	\$ 8.00	\$ 41.16	4	\$ 196.63	\$ 32.00
Loader 1.7 cm bucket	\$ 8.00	\$ 53.18	4	\$ 244.70	\$ 32.00
Transit Mixer	\$ 6.30	\$ 17.62	2	\$ 47.84	\$ 12.60
Water Storage & Cooling Plant	\$ 8.00	\$ 54.70	2	\$ 125.40	\$ 16.00
25-ton Rear Dump Truck	\$ 6.30	\$ 35.80	2	\$ 84.20	\$ 60.00
Mobile lighting Set 4 x 1000 W		\$ 6.00	4	\$ 24.00	
Water Truck	\$ 6.30	\$ 36.44	3	\$ 128.22	\$ 30.00
Expatriate	\$ 60.00		1	\$ 60.00	\$ 84.00
Crew Leader	\$ 10.00		3	\$ 30.00	\$ 49.77
Unskilled Labor	\$ 5.60		15	\$ 84.00	\$ 381.57
Miscellaneous			15%	\$ 288.18	
			<b>Subtotal</b>	<b>\$ 2,209.39</b>	
Production Rate	70 cm/hr	Rate		\$ 31.56	
Cement	0.08 T/cm @	\$ 122.00		\$ 9.76	
Fly Ash/Pozzolan	0.05 T/cm @	\$ 25.00		\$ 1.25	
Miscellaneous		10%		\$ 0.98	
Aggregates	1 cm/cm @	\$ 12.00		\$ 12.00	
		<b>Subtotal</b>		<b>\$ 55.55</b>	
		<b>Indirect Cost 30%</b>		<b>\$ 16.66</b>	
		<b>Total Rate</b>		<b>\$ 72.21</b>	
				<b>Say \$72</b>	

### COCLE DEL NORTE DIVERSION TUNNEL

Panama

Feature:	Feasibility Level Cost for Tunneling		
Length	Diversion Tunnel		
Diameter	530 meters		
Method	8.00 meters (D-shaped Section)		
Basic Drill/Blast			

#### SUMMARY

The following summary is prepared from the detailed analysis that follows

	Total
Total Tunnel Excavation Price	\$5,807,600
Total Tunnel Concrete Lining Price	\$1,132,400
Total at January 2003 Level	\$6,940,000

Method of Excavation	Analysis				Totals
	Drill and Blast Method				
Type of Support Requirements	Type I	Type II	Type III	Type IV	
Finished Diameter (m)	8.00	8.00	8.00	8.00	
Finished Area (sq.m.)	57.13	57.13	57.13	57.13	
Excavated tunnel diameter	9.00	9.00	9.00	9.00	
Tunnel Length (m)	106	212	159	53	530
Excavation Volume (Pay cu.m/m)	72.31	72.31	72.31	72.31	
Excavation Volume (Pay cu.m)	7,660	15,330	11,500	3,830	38,320
Concrete Lining Thickness (m)	0.50	0.50	0.50	0.50	
Overbreak assumed (m)	0.10	0.10	0.15	0.15	
Shotcrete Lining Thickness (m)	0.00	0.05	0.05	0.05	
Shotcrete Area (sq.m.)	0	3,000	3,680	1,230	7,910
Excavated Volume (Actual cu.m/m)	75.6	75.6	77.2	77.2	
Excavated Volume (Actual cu.m)	8,010	16,020	12,280	4,090	40,400
Loose Volume Mucking (cu.m)	12,816	25,632	19,648	6,544	64,640
Concrete Lining Volume (cu.m)	1,953	3,906	3,192	1,064	10,116
3-meter long (#8) Rockbolts	40	530	740	50	1,360
Steel Sets (kg)				57,000	57,000
Excavation Production (days)	71	142	114	45	372
Labor Cost - Excavation	281,200	562,400	451,500	178,200	1,473,300
Equipment Cost	409,000	818,000	656,700	259,200	2,142,900
Material Cost	109,400	281,100	257,100	203,500	851,100
Tunnel Excavation Cost	799,600	1,661,500	1,365,300	640,900	4,467,300
Concrete Lining Cost, Total	169,100	335,000	273,600	93,400	871,100
Contractors OH&P	30%	30%	30%	30%	
Tunnel Excavation Price	\$1,039,500	\$2,160,000	\$1,774,900	\$833,200	\$5,807,600
Tunnel Lining Price	\$219,800	\$435,500	\$355,700	\$121,400	\$1,132,400
Tunnel Price	\$1,259,300	\$2,595,500	\$2,130,600	\$954,600	\$6,940,000

#### Excavation Unit Price

	Excavation	Shotcrete Lining	Rockbolts	Steel Sets	Miscellaneous
Labor Cost	\$1,074,808	\$48,473	\$45,166	\$51,642	\$253,211
Equipment Cost	\$994,441	\$59,593	\$4,241	\$12,426	\$1,072,199
Material Cost	\$403,159	\$78,309	\$91,800	\$114,000	\$163,832
Subtotal	\$2,472,407	\$186,375	\$141,207	\$178,068	\$1,489,243
Miscellaneous	\$1,236,381	\$93,201	\$70,614	\$89,047	
Contractors OH&P	\$3,708,788	\$279,577	\$211,820	\$267,115	\$4,467,300
	\$1,112,637	\$83,873	\$63,546	\$80,134	\$1,340,190
	\$4,821,425	\$363,450	\$275,366	\$347,249	\$5,807,490
Quantities	38,320	7,910	4,080	57,000	
Unit Price	\$125.82	\$45.95	\$67.49	\$6.09	
	\$/cu.m	\$/sq.m	\$/l.m	\$/kg	

#### Concrete Lining Unit Price

	Avg. Price
Unit Price (\$/cu.m) Concrete Lining	\$111.95

### COCLE DEL NORTE DIVERSION TUNNEL

Panama

#### Feasibility Level Cost for Tunneling

<i>Feature:</i>	Diversion Tunnel
<i>Length</i>	530 meters
<i>Diameter</i>	8.00 meters (D-shaped Section)
<i>Method</i>	Basic Drill/Blast

#### **GEOLOGY**

Rock type as interpreted from site visits and geol mapping suggests four types of supports for the following lengths

Tunneling Condition	Segment 1
Roca Buena - Designation Type I	20%
Roca Regular - Designation Type II	40%
Roca Mala - Designation Type III	30%
Roca Muy Mala - Designation Type IV	10%
	100%

Type I - Roca Buena best rock conditions, minimal overbreak, generally self-supporting or requiring minimal support with shotcrete and spot bolting; full face excavation with normal advance

Type II - Roca Regular, good to fair rock conditions, moderate overbreak with rockbolt support and shotcrete; normal advance possible with proper bolting and shotcreting

Type III - Roca Mala, poor rock conditions, weathered or weak rock, loosely jointed, possible water inflows; Full face excavation with slower short advance and large overbreaks. Requires prompt support with pattern rockbolting and shotcrete

Type IV - Roca Muy Mala/Pesima, very poor rock conditions, full of fault and shear zones, mod to highly weathered, potential squeezing conditions in gouge; water inflows; possibly top heading and benching; prompt support within the open face with steel ribs and lagging, backpacking and shotcrete with fabric; grouting may be necessary to control water; spiling possible in worst conditions.

Type V - Not mentioned above but worse than type IV and with high waterflows. Specific areas are not identified for above tunnels at this time

Condition/Rock Type	Q Values	Rock Mass Rating (RMR)
I	> 7	>60
II	7 > Q >1	60>RMR>40
III	1 > Q >.4	40>RMR>35
IV	.4 > Q	35 > RMR
<b>Blastability</b>	<b>Good</b>	<b>Medium</b>
SPR =	0.38	0.47
Basalt/Sandstones		

**COCLE DEL NORTE DIVERSION TUNNEL**

Panama

**Feasibility Level Cost for Tunneling****Diversion Tunnel**

530 meters

**Diameter** 8.00 meters (D-shaped Section)**Method** Basic Drill/Blast**SUPPORT**

Shotcrete Thickness	5 cm Layers	Fiber or wire reinf
Rockbolts	25 mm X 3 meter long w/epoxy	
Steel Ribs	6" X 12" I section @ .5 to 1.5 spacing	
Lagging	5 cm corrugated	
Dry Pack	0.5 in. from Tunnel Muck	

All tunnel analysis is based on geological interpretation presented on the Geology Studies

Length of Segment 530 Meters

Finished Diameter 8.00 Meters

Concrete Lining Thickness 0.50 Meters

Length of tunnel for each type	Type I	106 Meters
	Type II	212 Meters
	Type III	159 Meters
	Type IV	53 Meters

Shotcrete with wire(or fibrous), 5 cm layers	0 Sqm, Type I 3,000 Sqm, Type II 3,680 Sqm, Type III 1,230 Sqm, Type IV 7,910 Sqm	None Crown only Crown and Ribs Crown and Ribs
Total Shotcrete		
Rockbolts, 25 mm X 3 m Long	40 EA, Type I 530 EA, Type II 740 EA, Type III 50 EA, Type IV 1,360 EA	3 Bolts/@ 7.5 m Spacing 5 Bolts/@ 2 m Spacing 7 Bolts/@ 1.5 m Spacing 5 Bolts/@ 5 m Spacing

Total Rockbolts	57,000 KG, Type IV
Steel ribs, 6" X 12" X 45 kg/m	

**COCLE DEL NORTE DIVERSION TUNNEL**

Panama

**Feasibility Level Cost for Tunneling****Diversion Tunnel****530 meters****8.00 meters (D-shaped Section)****Basic Drill/Blast**

**Feature:**  
**Length**  
**Diameter**  
**Method**

**TUNNEL EXCAVATION**

	<b>\$\$/hr</b>	<b>\$\$/hr</b>
1.0 Walker	\$12.50	\$12.50
1.0 Foreman	\$10.00	\$10.00
1.0 Jumbo Drill Foreman	\$10.00	\$10.00
8.0 Miners	\$6.70	\$53.60
1.0 Blaster	\$6.70	\$6.70
1.0 Compressor Operator	\$6.30	\$6.30
4.0 Mucker Operator	\$8.00	\$32.00
2.0 Truck Drivers	\$6.30	\$12.60
1.0 Dozer Operator	\$8.00	\$8.00
0.5 HVAC Electrician/Mechanics	\$6.70	\$3.35
0.5 Oilers	\$6.30	\$3.15
2.0 Rockbolters	\$6.70	\$13.40
2.0 Shotcreters	\$6.70	\$13.40
1.0 Pump Operators	\$6.30	\$6.30
0.5 Mechanics	\$6.70	\$3.35
0.5 Electricians	\$6.70	\$3.35

27 Total Crew, \$\$/Hr

198

<b>ROUNDS</b>	<b>Type I</b>	<b>Type II</b>	<b>Type III</b>	<b>Type IV</b>
Meters/Round	3.0	2.5	2.0	1.0
Vol/Round	226.7	188.9	154.4	77.2
Holes/SqM	3	3	2	2
No. of Holes	210	210	188	173
Length of Holes (total, cum.)	630	525	376	173
Drill Holes, Meters/Hr	10	10	10	10
No. of drills	6	6	6	6
Total Drilling/Hr	60.0	60.0	60.0	60.0
Drilling Time	10.5	8.8	6.3	2.9
Move in	0.3	0.3	0.3	0.3
Total drilling Time	10.8	9.1	6.6	3.2
<hr/>				
Blasting				
Kg/CuM	2	2	2	2
Kg/Round	453.3	340.0	262.5	115.8
Load Time @ 80 Kg/Hr	5.7	4.3	3.3	1.5
Add for blasting & Ventilating	1.0	1.0	1.0	1.0
Total Blast time	7	5	4	3
<hr/>				
Excavation Supports				
Scaling	0.3	0.3	0.3	0.5
Place supports	0.2	1.0	1.5	3.0
Total Support Time	1	1	2	4
<hr/>				
Muck				
Move in	0.5	0.5	0.5	0.5
Mucking at 20 CM/hr	20.2	16.8	13.7	6.9
Total Muck Cycle	21	17	14	7
<hr/>				
Total Cycle Hours	38.7	33.0	26.9	16.6
No of Rds with 2 X 10 Hr Shifts	0.5	0.6	0.7	1.2
Advance/Day	2	2	1	1
Total number of Days for one Crew	71	142	114	45
<hr/>				
Total explosives required	16,100	28,900	20,900	6,200
Detonators	5,635	13,005	15,675	4,960
Drill Bits & Steel	22,300	44,600	29,900	9,200
				372

**COCLE DEL NORTE DIVERSION TUNNEL**

Panama

**Feasibility Level Cost for Tunneling**  
**Diversion Tunnel**  
**Length** 530 meters  
**Diameter** 8.00 meters (D-shaped Section)  
**Method** Basic Drill/Blast

Plant & Equipment	Unit Operating Cos	Standby Cost			
1 6 Drill Jumbo	\$67.40	\$16.85	\$52.24		
4 4 CuM Mucker	\$31.25	\$7.81	\$96.88		
2 Trucks, 25 CuM	\$24.46	\$6.12	\$37.91		
1 Shotcrete Pump	\$23.56	\$5.89	\$18.26		
1 Dozer	\$44.50	\$11.13	\$34.49		
2 Compressors, Electrical	\$14.26	\$3.57	\$22.10		
1 Dewatering Equipment	\$7.53	\$1.88	\$5.84		
2 100 HP Fans	\$6.04	\$1.51	\$9.36		
1 Drifters	\$0.75	\$0.19	\$0.58		
1 Flatbeds	\$13.35	\$3.34	\$10.35		
Equipment Cost per hour	\$233.10	\$58.28	\$288.00		
Utilization Factor	70%				
Actual Cost/Hr	\$288.00				
Equipment & Plant, Local	\$408,957	\$817,914	\$656,635	\$259,198	
<b>Materials</b>					
Explosives	\$1.50	\$\$/KG			
Detonators	\$2.50	\$\$/EA			
Bits & Steel	\$2.50	\$\$/LM			
Spiling	\$150.00	\$\$/EA			
Shotcrete Cement	\$120.00	\$\$/TON			
Shotcrete Aggregate	\$4.00	\$\$/TON			
Steel Fibers	\$1.20	\$\$/KG			
Wiremesh	\$1.00	\$\$/KG			
Timber	\$0.35	\$\$/BF			
Rockbolts	\$67.50	\$\$/EA			
Steel Sets	\$2.00	\$\$/KG			
Vent air line	\$40.00	\$\$/LM			
Utility lines	\$30.00	\$\$/LM			
ST&S	5.00%				
	Type I	Type II	Type III	Type IV	
Explosives	\$24,150	\$43,350	\$31,350	\$9,300	\$108,150
Detonators	\$14,088	\$32,513	\$39,188	\$12,400	\$98,188
Bits & Steel	\$55,750	\$111,500	\$74,750	\$23,000	\$265,000
Spiling	\$0	\$0	\$0	\$15,000	\$15,000
Shotcrete Cement	\$0	\$10,800	\$13,248	\$4,428	\$28,476
Shotcrete Aggregate	\$0	\$1,980	\$2,429	\$812	\$5,221
Steel Fibers	\$0	\$9,720	\$11,923	\$3,985	\$25,628
Wiremesh	\$0	\$7,200	\$8,832	\$2,952	\$18,984
Timber	\$0	\$0	\$1,995	\$788	\$2,783
Rockbolts	\$2,700	\$35,775	\$49,950	\$3,375	\$91,800
Steel Sets	\$0	\$0	\$0	\$114,000	\$114,000
Vent air line	\$4,240	\$8,480	\$6,360	\$2,120	\$21,200
Utility lines	\$3,180	\$6,360	\$4,770	\$1,590	\$15,900
ST&S	\$5,205	\$13,384	\$12,240	\$9,687	\$40,516
Total Materials for tunnel work	\$109,313	\$281,061	\$257,034	\$203,437	\$850,845

**COCLE DEL NORTE DIVERSION TUNNEL**

Panama

**Feasibility Level Cost for Tunneling****Diversion Tunnel****530 meters****8.00 meters (D-shaped Section)****Basic Drill/Blast**

**Feature:**  
**Length**  
**Diameter**  
**Method**

TUNNEL CONCRETE LINING					Total
Length	106	212	159	53	530
Quantity	1,953	3,906	3,192	1,064	10,116
Use Fabricated Steel Forms on Dolly					
Each set 20 M Long and a 24 hour concrete placing will be used with 8 hours for placing forms and reinforcing (if any), 8 hours of concrete placing and 8 hours to cure, clean and move					
Average placing Rate (cu. M / day)	150	150	150	150	
No. of Steel Sets	0	0	0	0	0
Number of 10 hour work days	14	27	22	8	71
<b>Concrete Lining Crew</b>	<b>\$/hr</b>	<b>\$/hr</b>			
1 Walker	\$12.50	\$12.50			0
1 Foreman	\$10.00	\$10.00			
1 Form Foreman	\$10.00	\$10.00			
8 Miners	\$6.70	\$53.60			
2 Carpenters	\$6.70	\$13.40			
1 Compressor Operator	\$6.30	\$6.30			
2 Mucker Operator	\$8.00	\$16.00			
2 Flat Bed Operators	\$6.30	\$12.60			
1 HVAC Electrician/Mechanics	\$6.70	\$6.70			
1 Pump Operators	\$6.30	\$6.30			
1 Mechanics	\$6.70	\$6.70			
1 Electricians	\$6.70	\$6.70			
<b>22 Total Crew, \$\$/Hr</b>	<b>\$160.80</b>				
		<b>\$114,168</b>			
<b>Plant &amp; Equipment</b>	<b>Unit Oper</b>	<b>Unit Standby</b>	<b>Average</b>		
1 Johnson Type Low Profile + Ice Plant	\$52.00	\$13.00	\$42.25		
1 Batching Plant	\$52.89	\$13.22	\$42.97		
1 Cement Silos	\$9.65	\$2.41	\$7.84		
1 Standby Generators	\$5.00	\$1.25	\$4.06		
2 Concrete Haulers	\$17.62	\$4.41	\$28.63		
2 Lot Pumping Equipment	\$17.21	\$4.30	\$27.97		
1 Lot fans	\$5.25	\$1.31	\$4.27		
			<b>\$157.99</b>		
Utility Factor	75.00%				
Actual Cost/Hr	\$157.99				
Equipment Cost/Day	\$1,579.91				
<b>MATERIALS</b>					
Cement	4,249 Tons @		\$122.00	518,320	
Aggregate & Sand	22,254 Tons @		\$4.00	89,017	
Admixtures	5,058 Gals @		\$15.00	75,866	
Timber for Bulkheads	1,415 SqM @		\$25.00	35,382	111,249
				718,585	
<b>Concrete Costs by Sections</b>	<b>Type I</b>	<b>Type II</b>	<b>Type III</b>	<b>Type IV</b>	
Labor Cost - Concrete	22,500	43,400	35,400	12,900	114,200
Equipment Cost	22,119	42,657	34,758	12,639	112,173
Material Cost	124,446	248,892	203,401	67,800	644,539
<b>TOTAL CONCRETE COST</b>	<b>\$169,065</b>	<b>\$334,950</b>	<b>\$273,559</b>	<b>\$93,339</b>	<b>\$870,913</b>

## TBM Operation

<b>Description</b>	<b>Hourly Rates</b>					
	<b>Labor</b>	<b>Operating</b>	<b>Standby</b>	<b>Quantity</b>	<b>Amount</b>	<b>Labor</b>
TBM 9.80 m dia - 925 tonnes	\$ -	\$ 3,100.00	\$ 1,180.00	1	\$ 2,044.00	\$ -
Trailing Gear - 575 tonnes	\$ -	\$ 400.00	\$ 150.00	1	\$ 262.50	\$ -
Conveying System (250 T/hr)	\$ -	\$ 800.00	\$ 180.00	1	\$ 459.00	\$ -
Flatbed	\$ 6.30	\$ 36.57	\$ 15.53	3	\$ 74.99	
Engineer/Geologist	\$ 45.00			1	\$ 45.00	\$ 45.00
Crew Leader	\$ 10.00			3	\$ 30.00	\$ 30.00
Equipment Operator	\$ 8.00			6	\$ 48.00	\$ 48.00
Mechanics	\$ 6.70			2	\$ 13.40	\$ 13.40
Electricians	\$ 6.70			2	\$ 13.40	\$ 13.40
Drivers	\$ 6.30			3	\$ 18.90	\$ 18.90
Unskilled Labor	\$ 5.60			15	\$ 84.00	\$ 84.00
					<b>Subtotal</b>	\$ 3,093.19
						\$ 252.70
Utilization Rate	45%					
Daily Operation		20 hr per day				\$ 61,863.89
Advance Rate		13 m per day				\$ 4,758.76
Shotcrete (material)		20% of length @ \$ 116.41 per m				\$ 23.28
					<b>Subtotal per linear meter</b>	\$ 4,782.04
					<b>Indirect Cost 30%</b>	\$ 1,434.61
					<b>Total Rate</b>	\$ 6,193.37
						<b>Say \$6,200</b>

### Shotcrete Material Cost per linear meter

Area (Crown)	15.39 m <sup>2</sup>
Thickness	0.05 m
Cement	0.4 T/m <sup>3</sup> @ \$ 122.00 per ton
Aggregate	1 m <sup>3</sup> /m <sup>3</sup> @ \$ 8.83 per m <sup>3</sup>
Steel Fibers	36 kg/m <sup>3</sup> @ \$ 1.20 per kg
	<b>Subtotal</b> \$ 116.41

### Precast Lining per linear meter of Tunnel

Lining thickness	0.40 m
Tunnel Finished Diameter	9.00 m
Lining Volume per liner meter	11.81 m <sup>3</sup> @ \$ 88.99 per m <sup>3</sup>
Miscellaneous	3% \$ 31.54
Reinforcement	50 kg/m <sup>3</sup> @ \$ 1.01 per kg
	<b>Subtotal</b> \$ 1,679.46
	<b>Indirect Cost 30%</b> \$ 503.84
	<b>Total Rate</b> \$ 2,183.29
	<b>Say \$2,180</b>

### Muck Disposal (5 km from portal)

Front End Loader - 4.6 cm	\$ 8.00	\$ 77.93	1	\$ 85.93
Truck, off-highway; rear dump 25 ton	\$ 6.30	\$ 35.80	4	\$ 168.40
Crew Leader	\$ 10.00		1	\$ 10.00
Unskilled Labor	\$ 5.60		2	\$ 11.20
			<b>Subtotal</b>	\$ 275.53
Production Rate	170	cm/hr	Rate	\$ 1.62
			<b>Subtotal</b>	\$ 1.62
			<b>Indirect Cost 30%</b>	\$ 0.49
			<b>Total Rate</b>	\$ 2.11
				<b>Say \$2.10</b>

Ríos Coclé del Norte and Caño Sucio Water Supply Projects

**INDIO - GATUN TRANSFER TUNNEL**

Panama

**Feasibility Level Cost for Tunneling**

<b>Feature:</b>	<b>Transfer Tunnel</b>
<b>Length</b>	<b>8,250 meters</b>
<b>Diameter</b>	<b>6.50 meters (D-shaped Section)</b>
<b>Method</b>	<b>Basic Drill/Blast</b>

**SUMMARY**

The following summary is prepared from the detailed analysis that follows

	Total
Total Tunnel Excavation Price	\$45,304,500
Total Tunnel Concrete Lining Price	\$10,578,400
Total at January 2003 Level	\$55,882,900

Method of Excavation	Analysis				Totals
	Drill and Blast Method				
Type of Support Requirements	Type I	Type II	Type III	Type IV	
Finished Diameter (m)	6.50	6.50	6.50	6.50	
Finished Area (sq.m.)	37.72	37.72	37.72	37.72	
Excavated tunnel diameter	7.20	7.20	7.20	7.20	
Tunnel Length (m)	2,063	3,300	2,475	413	8,250
Excavation Volume (Pay cu.m/m)	46.28	46.28	46.28	46.28	
Excavation Volume (Pay cu.m)	95,450	152,720	114,540	19,090	381,800
Concrete Lining Thickness (m)	0.35	0.35	0.35	0.35	
Overbreak assumed (m)	0.10	0.10	0.15	0.15	
Shotcrete Lining Thickness (m)	0.00	0.05	0.05	0.05	
Shotcrete Area (sq.m)	0	37,320	45,810	7,640	90,770
Excavated Volume (Actual cu.m/m)	48.9	48.9	50.2	50.2	
Excavated Volume (Actual cu.m)	100,820	161,320	124,280	20,710	407,130
Loose Volume Mucking (cu.m)	161,312	258,112	198,848	33,136	651,408
Concrete Lining Volume (cu.m)	23,033	36,853	30,932	5,155	95,974
2-meter long (#8) Rockbolts	830	8,250	11,550	410	21,040
Steel Sets (kg)				357,900	357,900
Excavation Production (days)	625	1,065	825	207	2,722
Labor Cost - Excavation	2,475,000	4,217,400	3,267,000	819,800	10,779,200
Equipment Cost	3,600,000	6,134,400	4,752,000	1,192,400	15,678,800
Material Cost	1,446,400	3,024,900	2,780,000	1,140,300	8,391,600
Tunnel Excavation Cost	7,521,400	13,376,700	10,799,000	3,152,500	34,849,600
Concrete Lining Cost, Total	1,952,600	3,122,900	2,622,900	438,800	8,137,200
Contractors OH&P	30%	30%	30%	30%	
Tunnel Excavation Price	\$9,777,800	\$17,389,700	\$14,038,700	\$4,098,300	\$45,304,500
Tunnel Lining Price	\$2,538,400	\$4,059,800	\$3,409,800	\$570,400	\$10,578,400
Tunnel Price	\$12,316,200	\$21,449,500	\$17,448,500	\$4,668,700	\$55,882,900
<b><u>Excavation Unit Price</u></b>					
	Excavation	Shotcrete Lining	Rockbolts	Steel Sets	Miscellaneous
Labor Cost	\$7,457,593	\$556,248	\$465,826	\$324,257	\$1,975,276
Equipment Cost	\$6,509,067	\$683,852	\$43,742	\$78,022	\$8,364,117
Material Cost	\$4,552,337	\$898,623	\$946,800	\$715,800	\$1,278,040
Subtotal	\$18,518,997	\$2,138,723	\$1,456,368	\$1,118,080	\$11,617,433
Miscellaneous	\$9,260,574	\$1,069,486	\$728,268	\$559,105	
Contractors OH&P	\$27,779,571	\$3,208,208	\$2,184,636	\$1,677,184	\$34,849,600
	\$8,333,871	\$962,463	\$655,391	\$503,155	\$10,454,880
	\$36,113,442	\$4,170,671	\$2,840,027	\$2,180,340	\$45,304,480
Quantities	381,800	90,770	42,080	357,900	
Unit Price	\$94.59	\$45.95	\$67.49	\$6.09	
	\$/cu.m	\$/sq.m	\$/l.m	\$/kg	
<b><u>Concrete Lining Unit Price</u></b>					
	Type I	Type II	Type III	Type IV	Avg. Price
Unit Price (\$/cu.m) Concrete Lining	\$110.21	\$110.16	\$110.24	\$110.64	\$110.22

**INDIO - GATUN TRANSFER TUNNEL**

Panama

<i>Feature:</i>	<b>Feasibility Level Cost for Tunneling</b>
<i>Length</i>	<b>Transfer Tunnel</b>
<i>Diameter</i>	<b>8,250 meters</b>
<i>Method</i>	<b>6.50 meters (D-shaped Section)</b>
	<b>Basic Drill/Blast</b>

**GEOLOGY**

Rock type as interpreted from site visits and geol mapping suggests four types of supports for the following lengths

Tunneling Condition	Segment 1
Roca Buena - Designation Type I	25%
Roca Regular - Designation Type II	40%
Roca Mala - Designation Type III	30%
Roca Muy Mala - Designation Type IV	5%
	100%

Type I - Roca Buena best rock conditions, minimal overbreak, generally self-supporting or requiring minimal support with shotcrete and spot bolting; full face excavation with normal advance

Type II - Roca Regular, good to fair rock conditions, moderate overbreak with rockbolt support and shotcrete; normal advance possible with proper bolting and shotcreting

Type III - Roca Mala, poor rock conditions, weathered or weak rock, loosely jointed, possible water inflows; Full face excavation with slower short advance and large overbreaks. Requires prompt support with pattern rockbolting and shotcrete

Type IV - Roca Muy Mala/Pesima, very poor rock conditions, full of fault and shear zones, mod to highly weathered, potential squeezing conditions in gouge; water inflows; possibly top heading and benching; prompt support within the open face with steel ribs and lagging, backpacking and shotcrete with fabric; grouting may be necessary to control water; spiling possible in worst conditions.

Type V - Not mentioned above but worse than type IV and with high waterflows. Specific areas are not identified for above tunnels at this time

Condition/Rock Type	Q Values	Rock Mass Rating (RMR)
I	> 7	>60
II	7 > Q >1	60>RMR>40
III	1 > Q >.4	40>RMR>35
IV	.4> Q	35 > RMR
<b>Blastability</b>	<b>Good</b>	<b>Medium</b>
SPR =	0.38	0.47
	Basalt/Sandstones	

**INDIO - GATUN TRANSFER TUNNEL****Panama****Feasibility Level Cost for Tunneling****Transfer Tunnel****8,250 meters****6.50 meters (D-shaped Section)****Basic Drill/Blast****SUPPORT**

<b>Shotcrete Thickness</b>	<b>5 cm Layers</b>	<b>Fiber or wire reinf</b>
<b>Rockbolts</b>	<b>25 mm X 2 meter long w/epoxy</b>	
<b>Steel Ribs</b>	<b>6" X 12" I section @ .5 to 1.5 spacing</b>	
<b>Lagging</b>	<b>5 cm corrugated</b>	
<b>Dry Pack</b>	<b>0.5 in. from Tunnel Muck</b>	

All tunnel analysis is based on geological interpretation presented on the Geology Studies

<b>Length of Segment</b>	<b>8,250 Meters</b>	
<b>Finished Diameter</b>	<b>6.50 Meters</b>	
<b>Concrete Lining Thickness</b>	<b>0.35 Meters</b>	
<b>Length of tunnel for each type</b>		
Type I	2,063 Meters	
Type II	3,300 Meters	
Type III	2,475 Meters	
Type IV	413 Meters	
<b>Shotcrete with wire(or fibrous), 5 cm lay</b>	<b>0 SqM, Type I 37,320 SqM, Type II 45,810 SqM, Type III 7,640 SqM, Type IV</b>	<b>None Crown only Crown and Ribs Crown and Ribs</b>
<b>Total Shotcrete</b>	<b>90,770 SqM</b>	
<b>Rockbolts, 25 mm X 2 M Long</b>	<b>830 EA, Type I 8,250 EA, Type II 11,550 EA, Type III 410 EA, Type IV</b>	<b>3 Bolts/@ 7.5 M Spacing 5 Bolts/@ 2 M Spacing 7 Bolts/@ 1.5 M Spacing 5 Bolts/@ 5 M Spacing</b>
<b>Total Rockbolts</b>	<b>21,040 EA</b>	
<b>Steel ribs, 6" X 12" X 45 KG/M</b>	<b>357,900 KG, Type IV</b>	

**INDIO - GATUN TRANSFER TUNNEL**

Panama

**Feature:**  
**Length:**  
**Diameter:**  
**Method:**

**Feasibility Level Cost for Tunneling**  
**Transfer Tunnel**  
**8,250 meters**  
**6.50 meters (D-shaped Section)**  
**Basic Drill/Blast**

**TUNNEL EXCAVATION**

<b>Tunnel Crew</b>	<b>Unit \$\$/HR</b>	<b>\$\$/HR</b>
1.0 Walker	\$12.50	\$12.50
1.0 Foreman	\$10.00	\$10.00
1.0 Jumbo Drill Foreman	\$10.00	\$10.00
8.0 Miners	\$6.70	\$53.60
1.0 Blaster	\$6.70	\$6.70
1.0 Compressor Operator	\$6.30	\$6.30
4.0 Mucker Operator	\$8.00	\$32.00
2.0 Truck Drivers	\$6.30	\$12.60
1.0 Dozer Operator	\$8.00	\$8.00
0.5 HVAC Electrician/Mechanics	\$6.70	\$3.35
0.5 Oilers	\$6.30	\$3.15
2.0 Rockbolters	\$6.70	\$13.40
2.0 Shotcreters	\$6.70	\$13.40
1.0 Pump Operators	\$6.30	\$6.30
0.5 Mechanics	\$6.70	\$3.35
0.5 Electricians	\$6.70	\$3.35
27 Total Crew, \$\$/Hr		\$198.00

<b>ROUNDS</b>	<b>Type I</b>	<b>Type II</b>	<b>Type III</b>	<b>Type IV</b>
Meters/Round	3.0	2.5	2.0	1.0
Vol/Round	146.7	122.2	100.4	50.2
Holes/SqM	2.5	2.5	2.2	2.0
No. of Holes	139	139	125	116
Length of Holes (total, cum.)	417	348	250	116
Drill Holes, Meters/Hr	10	10	10	10
No. of drills	6	6	6	6
Total Drilling/Hr	60	60	60	60
Drilling Time	7.0	5.8	4.2	2.0
Move in	0.3	0.3	0.3	0.3
Total drilling Time	7.3	6.1	4.5	2.3
<b>Blasting</b>				
Kg/CuM	2.0	1.8	1.7	1.5
Kg/Round	293	220	171	75
Load Time @ 80 Kg/Hr	3.7	2.8	2.2	1.0
Add for blasting & Ventilating	1.0	1.0	1.0	1.0
Total Blast time	4.7	3.8	3.2	2.0
<b>Excavation Supports</b>				
Scaling	0.3	0.3	0.3	0.5
Place supports	0.2	1.0	1.5	3.0
Total Support Time	0.5	1.3	1.8	3.5
<b>Muck</b>				
Move in	0.5	0.5	0.5	0.5
Mucking at 50 CM/hr	4.7	4.0	3.3	1.7
Total Muck Cycle	5.2	4.5	3.8	2.2
<b>Total Cycle Hours</b>				
No of Rds with 2 X 10 Hr Shifts	1.1	1.3	1.5	2.0
Advance/Day	3.3	3.1	3.0	2.0
Total number of Days for one Crew	625	1,065	825	207
Total explosives required	201,700	290,400	211,300	31,100
Detonators	70,595	130,680	158,475	24,880
Drill Bits & Steel	286,700	458,700	309,400	47,900

**INDIO - GATUN TRANSFER TUNNEL**

Panama

**Feasibility Level Cost for Tunneling**

**Feature:**  
**Length**  
**Diameter**  
**Method**

**Transfer Tunnel**  
**8,250 meters**  
**6.50 meters (D-shaped Section)**  
**Basic Drill/Blast**

Plant & Equipment	Unit Operating Cos	Standby Cost		
1 6 Drill Jumbo	\$67.40	\$16.85	\$52.24	
4 4 CuM Mucker	\$31.25	\$7.81	\$96.88	
2 Trucks, 25 CuM	\$24.46	\$6.12	\$37.91	
1 Shotcrete Pump	\$23.56	\$5.89	\$18.26	
1 Dozer	\$44.50	\$11.13	\$34.49	
2 Compressors, Electrical	\$14.26	\$3.57	\$22.10	
1 Dewatering Equipment	\$7.53	\$1.88	\$5.84	
2 100 HP Fans	\$6.04	\$1.51	\$9.36	
1 Drifters	\$0.75	\$0.19	\$0.58	
1 Flatbeds	\$13.35	\$3.34	\$10.35	
Equipment Cost per hour	\$233.10	\$58.28	\$288.00	
Utilization Factor	70%			
Actual Cost/Hr	\$288.00			
	Type I	Type II	Type III	
Equipment & Plant	\$3,599,972	\$6,134,352	\$4,751,963	Type IV \$1,192,311

**Materials**

Materials	Type I	Type II	Type III	Type IV	Total
Explosives	\$1.50	\$\$/KG			
Detonators	\$2.50	\$\$/EA			
Bits & Steel	\$2.50	\$\$/LM			
Spiling	\$150.00	\$\$/EA			
Shotcrete Cement	\$120.00	\$\$/TON			
Shotcrete Aggregate	\$4.00	\$\$/TON			
Steel Fibers	\$1.20	\$\$/KG			
Wiremesh	\$1.00	\$\$/KG			
Timber	\$0.35	\$\$/BF			
Rockbolts	\$45.00	\$\$/EA			
Steel Sets	\$2.00	\$\$/KG			
Vent air line	\$40.00	\$\$/LM			
Utility lines	\$30.00	\$\$/LM			
ST&S	5.00%				
Explosives	\$302,550	\$435,600	\$316,950	\$46,650	\$1,101,750
Detonators	\$176,488	\$326,700	\$396,188	\$62,200	\$961,575
Bits & Steel	\$716,750	\$1,146,750	\$773,500	\$119,750	\$2,756,750
Spiling	\$0	\$0	\$0	\$15,000	\$15,000
Shotcrete Cement	\$0	\$134,352	\$164,916	\$27,504	\$326,772
Shotcrete Aggregate	\$0	\$24,631	\$30,235	\$5,042	\$59,908
Steel Fibers	\$0	\$120,917	\$148,424	\$24,754	\$294,095
Wiremesh	\$0	\$89,568	\$109,944	\$18,336	\$217,848
Timber	\$0	\$0	\$14,438	\$3,623	\$18,060
Rockbolts	\$37,350	\$371,250	\$519,750	\$18,450	\$946,800
Steel Sets	\$0	\$0	\$0	\$715,800	\$715,800
Vent air line	\$82,500	\$132,000	\$99,000	\$16,500	\$330,000
Utility lines	\$61,875	\$99,000	\$74,250	\$12,375	\$247,500
ST&S	\$68,876	\$144,038	\$132,380	\$54,299	\$399,593
Total Materials for tunnel work	\$1,446,388	\$3,024,806	\$2,779,974	\$1,140,283	\$8,391,451

## **INDIO - GATUN TRANSFER TUNNEL**

## Panama

Feasibility Level Cost for Tunneling					
Feature:	Transfer Tunnel				
Length	8,250 meters				
Diameter	6.50 meters (D-shaped Section)				
Method	Basic Drill/Blast				
<b>TUNNEL CONCRETE LINING</b>					
Length	2063	3300	2475	413	Total
Quantity	23,033	36,853	30,932	5,155	95,974
Use Prefabricated Steel Forms on Dolly					
Each set 20 M Long and a 24 hour concrete placing will be used with 8 hours for placing forms and reinforcing (if any), 8 hours of concrete placing and 8 hours to cure, clean and move					
Average placing Rate (cu. M / day)	150	150	150	150	
No. of Steel Sets	0	0	0	0	0
Number of 10 hour work days	154	246	207	35	642
<b>Concrete Lining Crew</b>					
	Unit \$\$/HR	\$\$/HR			
1 Walker	\$12.50	\$12.50			0
1 Foreman	\$10.00	\$10.00			
1 Form Foreman	\$10.00	\$10.00			
8 Miners	\$6.70	\$53.60			
2 Carpenters	\$6.70	\$13.40			
1 Compressor Operator	\$6.30	\$6.30			
2 Mucker Operator	\$8.00	\$16.00			
2 Flat Bed Operators	\$6.30	\$12.60			
1 HVAC Electrician/Mechanics	\$6.70	\$6.70			
1 Pump Operators	\$6.30	\$6.30			
1 Mechanics	\$6.70	\$6.70			
1 Electricians	\$6.70	\$6.70			
2 Total Crew, \$\$/Hr	\$160.80				
<b>Total Labor Cost</b>	\$1,032,336				
<b>Plant &amp; Equipment</b>					
	Unit Oper	Unit Standby		Average	
1 Johnson Type Low Profile + Ice Plant	\$52.00	\$13.00		\$42.25	
1 Batching Plant	\$52.89	\$13.22		\$42.97	
1 Cement Silos	\$9.65	\$2.41		\$7.84	
1 Standby Generators	\$5.00	\$1.25		\$4.06	
2 Concrete Haulers	\$17.62	\$4.41		\$28.63	
2 Lot Pumping Equipment	\$17.21	\$4.30		\$27.97	
Lot fans	\$5.25	\$1.31		\$4.27	
				\$157.99	
<b>Utility Factor</b>	75.00%				
<b>Actual Cost/Hr</b>	\$157.99				
<b>Equipment Cost/Day</b>	\$1,579.91				
<b>MATERIALS</b>					
Cement	34,551 Tons @		\$122.00	4,215,177	
Aggregate & Sand	211,143 Tons @		\$4.00	844,571	
Admixtures	47,987 Gals @		\$15.00	719,805	
Timber for Bulkheads	12,428 SqM @		\$25.00	310,694	1,030,498
				6,090,246	
<b>Concrete Costs by Sections</b>	Type I	Type II	Type III	Type IV	
Labor Cost - Concrete	247,600	395,600	332,900	56,300	1,032,400
Equipment Cost	243,306	388,657	327,041	55,297	1,014,300
Material Cost	1,461,631	2,338,610	1,962,862	327,144	6,090,246
					8,136,900
<b>TOTAL CONCRETE COST</b>	\$1,952,500	\$3,122,900	\$2,622,800	\$438,700	\$8,136,946
<b>Tunnel concrete Lining Cost</b>	\$1,952,537	\$3,122,867	\$2,622,802	\$438,740	\$8,136,946

**CANO-INDIO TRANSFER TUNNEL**

Panama

**Feasibility Level Cost for Tunneling****Transfer Tunnel**

2,550 meters (Outlet portal to Shaft)

5.50 meters (D-shaped Section)

Basic Drill/Blast

**SUMMARY**

The following summary is prepared from the detailed analysis that follows

Method of Excavation	Analysis				Totals
	Drill and Blast Method				
Type of Support Requirements	Type I	Type II	Type III	Type IV	
Finished Diameter (m)	5.50	5.50	5.50	5.50	
Finished Area (sq.m.)	27.00	27.00	27.00	27.00	
Excavated tunnel diameter	6.00	6.00	6.00	6.00	
Tunnel Length (m)	510	893	893	255	2,550
Excavation Volume (Pay cu.m/m)	32.14	32.14	32.14	32.14	
Excavation Volume (Pay cu.m)	16,390	28,680	28,680	8,190	81,940
Concrete Lining Thickness (m)	0.25	0.25	0.25	0.25	
Overbreak assumed (m)	0.10	0.10	0.15	0.15	
Shotcrete Lining Thickness (m)	0.00	0.05	0.05	0.05	
Shotcrete Area (sq.m)	0	8,410	13,770	3,930	26,110
Excavated Volume (Actual cu.m/m)	34.3	34.3	35.4	35.4	
Excavated Volume (Actual cu.m)	17,500	30,630	31,620	9,030	88,780
Loose Volume Mucking (cu.m)	28,000	49,008	50,592	14,448	142,048
Concrete Lining Volume (cu.m)	3,729	6,525	7,521	2,149	19,924
2-meter long (#8) Rockbolts	200	2,230	4,170	260	6,860
Steel Sets (kg)				185,800	185,800
Excavation Production (days)	114	218	235	111	678
Labor Cost - Excavation	451,500	863,300	930,600	439,600	2,685,000
Equipment Cost	656,700	1,255,700	1,353,600	639,400	3,905,400
Material Cost	268,400	645,000	811,800	586,300	2,311,500
Tunnel Excavation Cost	1,376,600	2,764,000	3,096,000	1,665,300	8,901,900
Concrete Lining Cost, Total	315,100	552,200	637,300	183,500	1,688,100
Contractors OH&P	30%	30%	30%	30%	
Tunnel Excavation Price	\$1,789,600	\$3,593,200	\$4,024,800	\$2,164,900	\$11,572,500
Tunnel Lining Price	\$409,600	\$717,900	\$828,500	\$238,600	\$2,194,600
Tunnel Price	\$2,199,200	\$4,311,100	\$4,853,300	\$2,403,500	\$13,767,100
<b><u>Excavation Unit Price</u></b>					
	Excavation	Shotcrete Lining	Rockbolts	Steel Sets	Miscellaneous
Labor Cost	\$1,700,219	\$160,005	\$151,880	\$168,335	\$504,561
Equipment Cost	\$1,517,409	\$196,710	\$14,262	\$40,504	\$2,136,515
Material Cost	\$1,046,251	\$258,489	\$308,700	\$371,600	\$326,460
Subtotal	\$4,263,878	\$615,204	\$474,842	\$580,439	\$2,967,536
Miscellaneous	\$2,132,194	\$307,639	\$237,450	\$290,254	
	\$6,396,072	\$922,842	\$712,292	\$870,693	\$8,901,900
Contractors OH&P	\$1,918,822	\$276,853	\$213,688	\$261,208	\$2,670,570
	\$8,314,894	\$1,199,695	\$925,979	\$1,131,901	\$11,572,470
Quantities	81,940	26,110	13,720	185,800	
Unit Price	\$101.48	\$45.95	\$67.49	\$6.09	
	\$/cu.m	\$/sq.m	\$/l.m	\$/kg	
<b><u>Concrete Lining Unit Price</u></b>					
	Type I	Type II	Type III	Type IV	Avg. Price
Unit Price (\$/cu.m) Concrete Lining	\$109.85	\$110.02	\$110.16	\$111.03	\$110.15

**CANO-INDIO TRANSFER TUNNEL**

Panama

Feature:	Feasibility Level Cost for Tunneling
Length	Transfer Tunnel
Diameter	5.50 meters (D-shaped Section)
Method	Basic Drill/Blast

**GEOLOGY**

Rock type as interpreted from site visits and geol mapping suggests four types of supports for the following lengths

Tunneling Condition	Segment 1
Roca Buena - Designation Type I	20%
Roca Regular - Designation Type II	35%
Roca Mala - Designation Type III	35%
Roca Muy Mala - Designation Type IV	10%
	100%

Type I - Roca Buena best rock conditions, minimal overbreak, generally self-supporting or requiring minimal support with shotcrete and spot bolting; full face excavation with normal advance

Type II - Roca Regular, good to fair rock conditions, moderate overbreak with rockbolt support and shotcrete; normal advance possible with proper bolting and shotcreting

Type III - Roca Mala, poor rock conditions, weathered or weak rock, loosely jointed, possible water inflows; Full face excavation with slower short advance and large overbreaks. Requires prompt support with pattern rockbolting and shotcrete

Type IV - Roca Muy Mala/Pesima, very poor rock conditions, full of fault and shear zones, mod to highly weathered, potential squeezing conditions in gouge; water inflows; possibly top heading and benching; prompt support within the open face with steel ribs and lagging, backpacking and shotcrete with fabric; grouting may be necessary to control water; spiling possible in worst conditions.

Type V - Not mentioned above but worse than type IV and with high waterflows. Specific areas are not identified for above tunnels at this time

Condition/Rock Type	Q Values	Rock Mass Rating (RMR)
I	> 7	>60
II	7 > Q >1	60>RMR>40
III	1 > Q >.4	40>RMR>35
IV	.4> Q	35 > RMR
<b>Blastability</b>	<b>Good</b>	<b>Medium</b>
SPR =	0.38	0.47
	Basalt/Sandstones	

**CANO-INDIO TRANSFER TUNNEL**

Panama

**Feasibility Level Cost for Tunneling****Transfer Tunnel**

2,550 meters (Outlet portal to Shaft)

5.50 meters (D-shaped Section)

Basic Drill/Blast

**SUPPORT**

Shotcrete Thickness	5 cm Layers	Fiber or wire reinf
Rockbolts	25 mm X 2 meter long w/epoxy	
Steel Ribs	6" X 12" 1 section @ .5 to 1.5 spacing	
Lagging	5 cm corrugated	
Dry Pack	0.5 in. from Tunnel Muck	

All tunnel analysis is based on geological interpretation presented on the Geology Studies

Length of Segment	2,550 Meters	
Finished Diameter	5.50 Meters	
Concrete Lining Thickness	0.25 Meters	
Length of tunnel for each type		
Type I	510 Meters	
Type II	893 Meters	
Type III	893 Meters	
Type IV	255 Meters	
Shotcrete with wire(or fibrous), 5 cm la	0 SqM, Type I 8,410 SqM, Type II 13,770 SqM, Type III 3,930 SqM, Type IV	None Crown only Crown and Ribs Crown and Ribs
Total Shotcrete	26,110 SqM	
Rockbolts, 25 mm X 2 M Long	200 EA, Type I 2,230 EA, Type II 4,170 EA, Type III 260 EA, Type IV	3 Bolts/@ 7.5 M Spacing 5 Bolts/@ 2 M Spacing 7 Bolts/@ 1.5 M Spacing 5 Bolts/@ 5 M Spacing
Total Rockbolts	6,860 EA	
Steel ribs, 6" X 12" X 45 KG/M	185,800 KG, Type IV	

**CANO-INDIO TRANSFER TUNNEL**

Panama

**Feasibility Level Cost for Tunneling  
Transfer Tunnel**  
**2,550 meters (Outlet portal to Shaft)**  
**5.50 meters (D-shaped Section)**  
**Basic Drill/Blast**

**TUNNEL EXCAVATION**

<i>Tunnel Crew</i>	Unit \$\$/HR	\$\$/HR	
1.0 Walker	\$12.50	\$12.50	
1.0 Foreman	\$10.00	\$10.00	
1.0 Jumbo Drill Foreman	\$10.00	\$10.00	
8.0 Miners	\$6.70	\$53.60	
1.0 Blaster	\$6.70	\$6.70	
1.0 Compressor Operator	\$6.30	\$6.30	
4.0 Mucker Operator	\$8.00	\$32.00	
2.0 Truck Drivers	\$6.30	\$12.60	
1.0 Dozer Operator	\$8.00	\$8.00	
0.5 HVAC Electrician/Mechanics	\$6.70	\$3.35	
0.5 Oilers	\$6.30	\$3.15	
2.0 Rockbolters	\$6.70	\$13.40	
2.0 Shotcreters	\$6.70	\$13.40	
1.0 Pump Operators	\$6.30	\$6.30	
0.5 Mechanics	\$6.70	\$3.35	
0.5 Electricians	\$6.70	\$3.35	
27 Total Crew, \$\$/Hr		\$198.00	

<b>ROUNDS</b>	Type I	Type II	Type III	Type IV
Meters/Round	3.0	2.5	2.0	1.0
Vol/Round	102.9	85.8	70.9	35.4
Holes/SqM	2.5	2.5	2.2	2.0
No. of Holes	100	100	90	84
Length of Holes (total, cum.)	300	250	180	84
Drill Holes, Meters/Hr	10	10	10	10
No. of drills	6	6	6	6
Total Drilling/Hr	60	60	60	60
Drilling Time	5.0	4.2	3.0	1.4
Move in	0.3	0.3	0.3	0.3
Total drilling Time	5.3	4.5	3.3	1.7
<b>Blasting</b>				
Kg/CuM	2.0	1.8	1.7	1.5
Kg/Round	206	154	120	53
Load Time @ 80 Kg/Hr	2.6	2.0	1.6	0.7
Add for blasting & Ventilating	1.0	1.0	1.0	1.0
Total Blast time	3.6	3.0	2.6	1.7
<b>Excavation Supports</b>				
Scaling	0.3	0.3	0.3	0.5
Place supports	0.2	1.0	1.5	3.0
Total Support Time	0.5	1.3	1.8	3.5
<b>Muck</b>				
Move in	0.5	0.5	0.5	0.5
Mucking at 50 CM/hr	3.3	2.8	2.3	1.2
Total Muck Cycle	3.8	3.3	2.8	1.7
<b>Total Cycle Hours</b>				
No of Rds with 2 X 10 Hr Shifts	1.5	1.7	1.9	2.3
Advance/Day	4.5	4.1	3.8	2.3
Total number of Days for one Crew	114	218	235	111
Total explosives required	35,100	55,200	53,800	13,600
Detonators	12,285	24,840	40,350	10,880
Drill Bits & Steel	51,000	89,300	80,400	21,500

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**CANO-INDIO TRANSFER TUNNEL**

Panama

**Feasibility Level Cost for Tunneling****Transfer Tunnel****2,550 meters (Outlet portal to Shaft)****5.50 meters (D-shaped Section)****Basic Drill/Blast**

<b>Plant &amp; Equipment</b>	<b>Unit Operating Cos</b>	<b>Standby Cost</b>	
1 6 Drill Jumbo	\$67.40	\$16.85	\$52.24
4 4 CuM Mucker	\$31.25	\$7.81	\$96.88
2 Trucks, 25 CuM	\$24.46	\$6.12	\$37.91
1 Shotcrete Pump	\$23.56	\$5.89	\$18.26
1 Dozer	\$44.50	\$11.13	\$34.49
2 Compressors, Electrical	\$14.26	\$3.57	\$22.10
1 Dewatering Equipment	\$7.53	\$1.88	\$5.84
2 100 HP Fans	\$6.04	\$1.51	\$9.36
1 Drifters	\$0.75	\$0.19	\$0.58
1 Flatbeds	\$13.35	\$3.34	\$10.35
Equipment Cost per hour	\$233.10	\$58.28	\$288.00
Utilization Factor	70%		
Actual Cost/Hr	\$288.00		
	Type I	Type II	Type III
Equipment & Plant	\$656,635	\$1,255,670	\$1,353,589
	Type IV		
			\$639,355

**Materials**

Explosives	\$1.50	\$/KG
Detonators	\$2.50	\$/EA
Bits & Steel	\$2.50	\$/LM
Spiling	\$150.00	\$/EA
Shotcrete Cement	\$120.00	\$\$/TON
Shotcrete Aggregate	\$4.00	\$\$/TON
Steel Fibers	\$1.20	\$/KG
Wiremesh	\$1.00	\$/KG
Timber	\$0.35	\$/BF
Rockbolts	\$45.00	\$/EA
Steel Sets	\$2.00	\$/KG
Vent air line	\$40.00	\$/LM
Utility lines	\$30.00	\$/LM
ST&S	5.00%	

	Type I	Type II	Type III	Type IV	Total
Explosives	\$52,650	\$82,800	\$80,700	\$20,400	\$236,550
Detonators	\$30,713	\$62,100	\$100,875	\$27,200	\$220,888
Bits & Steel	\$127,500	\$223,250	\$201,000	\$53,750	\$605,500
Spiling	\$0	\$0	\$0	\$15,000	\$15,000
Shotcrete Cement	\$0	\$30,276	\$49,572	\$14,148	\$93,996
Shotcrete Aggregate	\$0	\$5,551	\$9,088	\$2,594	\$17,233
Steel Fibers	\$0	\$27,248	\$44,615	\$12,733	\$84,596
Wiremesh	\$0	\$20,184	\$33,048	\$9,432	\$62,664
Timber	\$0	\$0	\$4,113	\$1,943	\$6,055
Rockbolts	\$9,000	\$100,350	\$187,650	\$11,700	\$308,700
Steel Sets	\$0	\$0	\$0	\$371,600	\$371,600
Vent air line	\$20,400	\$35,700	\$35,700	\$10,200	\$102,000
Utility lines	\$15,300	\$26,775	\$26,775	\$7,650	\$76,500
ST&S	\$12,778	\$30,712	\$38,657	\$27,917	\$110,064
Total Materials for tunnel work	\$268,341	\$644,946	\$811,792	\$586,267	\$2,311,346

**CANO-INDIO TRANSFER TUNNEL**

Panama

**Feasibility Level Cost for Tunneling****Transfer Tunnel****2,550 meters (Outlet portal to Shaft)****5.50 meters (D-shaped Section)****Basic Drill/Blast**

**Feature:**  
**Length**  
**Diameter**  
**Method**

<b>TUNNEL CONCRETE LINING</b>					<b>Total</b>
Length	510	893	893	255	2,550
Quantity	3,729	6,525	7,521	2,149	19,924
Use Prefabricated Steel Forms on Dolly					
Each set 20 M Long and a 24 hour concrete placing will be used with 8 hours for placing forms and reinforcing (if any), 8 hours of concrete placing and 8 hours to cure, clean and move					
Average placing Rate (cu. M / day)	150	150	150	150	
No. of Steel Sets	0	0	0	0	0
Number of 10 hour work days	25	44	51	15	135
<b>Concrete Lining Crew</b>					
1.0 Walker	\$12.50	\$12.50			0
1.0 Foreman	\$10.00	\$10.00			
1.0 Form Foreman	\$10.00	\$10.00			
8.0 Miners	\$6.70	\$53.60			
2.0 Carpenters	\$6.70	\$13.40			
1.0 Compressor Operator	\$6.30	\$6.30			
2.0 Mucker Operator	\$8.00	\$16.00			
2.0 Flat Bed Operators	\$6.30	\$12.60			
1.0 HVAC Electrician/Mechanics	\$6.70	\$6.70			
1.0 Pump Operators	\$6.30	\$6.30			
1.0 Mechanics	\$6.70	\$6.70			
1.0 Electricians	\$6.70	\$6.70			
<b>22 Total Crew, \$\$/Hr</b>	\$160.80				
<b>Total Labor Cost</b>	\$217,080				
<b>Plant &amp; Equipment</b>					
1 Johnson Type Low Profile + Ice Plant	\$52.00	\$13.00	\$42.25		
1 Batching Plant	\$52.89	\$13.22	\$42.97		
1 Cement Silos	\$9.65	\$2.41	\$7.84		
1 Standby Generators	\$5.00	\$1.25	\$4.06		
2 Concrete Haulers	\$17.62	\$4.41	\$28.63		
2 Lot Pumping Equipment	\$17.21	\$4.30	\$27.97		
1 Lot fans	\$5.25	\$1.31	\$4.27		
			\$157.99		
Utility Factor	75.00%				
Actual Cost/Hr	\$157.99				
Equipment Cost/Day	\$1,579.91				
<b>MATERIALS</b>					
Cement	7,173 Tons @		\$122.00	875,064	
Aggregate & Sand	43,833 Tons @		\$4.00	175,332	
Admixtures	9,962 Gals @		\$15.00	149,430	
Timber for Bulkheads	2,303 SqM @		\$25.00	57,580	207,010
				1,257,405	
<b>Concrete Costs by Sections</b>	<b>Type I</b>	<b>Type II</b>	<b>Type III</b>	<b>Type IV</b>	
Labor Cost - Concrete	40,200	70,800	82,000	24,100	217,100
Equipment Cost	39,498	69,516	80,575	23,699	213,287
Material Cost	235,319	411,808	474,661	135,617	1,257,405
<b>TOTAL CONCRETE COST</b>	<b>\$315,000</b>	<b>\$552,100</b>	<b>\$637,200</b>	<b>\$183,400</b>	<b>1,687,800</b>
<b>Tunnel concrete Lining Cost</b>	<b>\$315,017</b>	<b>\$552,124</b>	<b>\$637,236</b>	<b>\$183,416</b>	<b>\$1,687,792</b>