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Republic of the Philippines
PROVINCE OF BOHOL

BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN

(BHL - 01)

Water Supply Master Plan
Final Report

VOLUME II

coffey international development pty. ltd.

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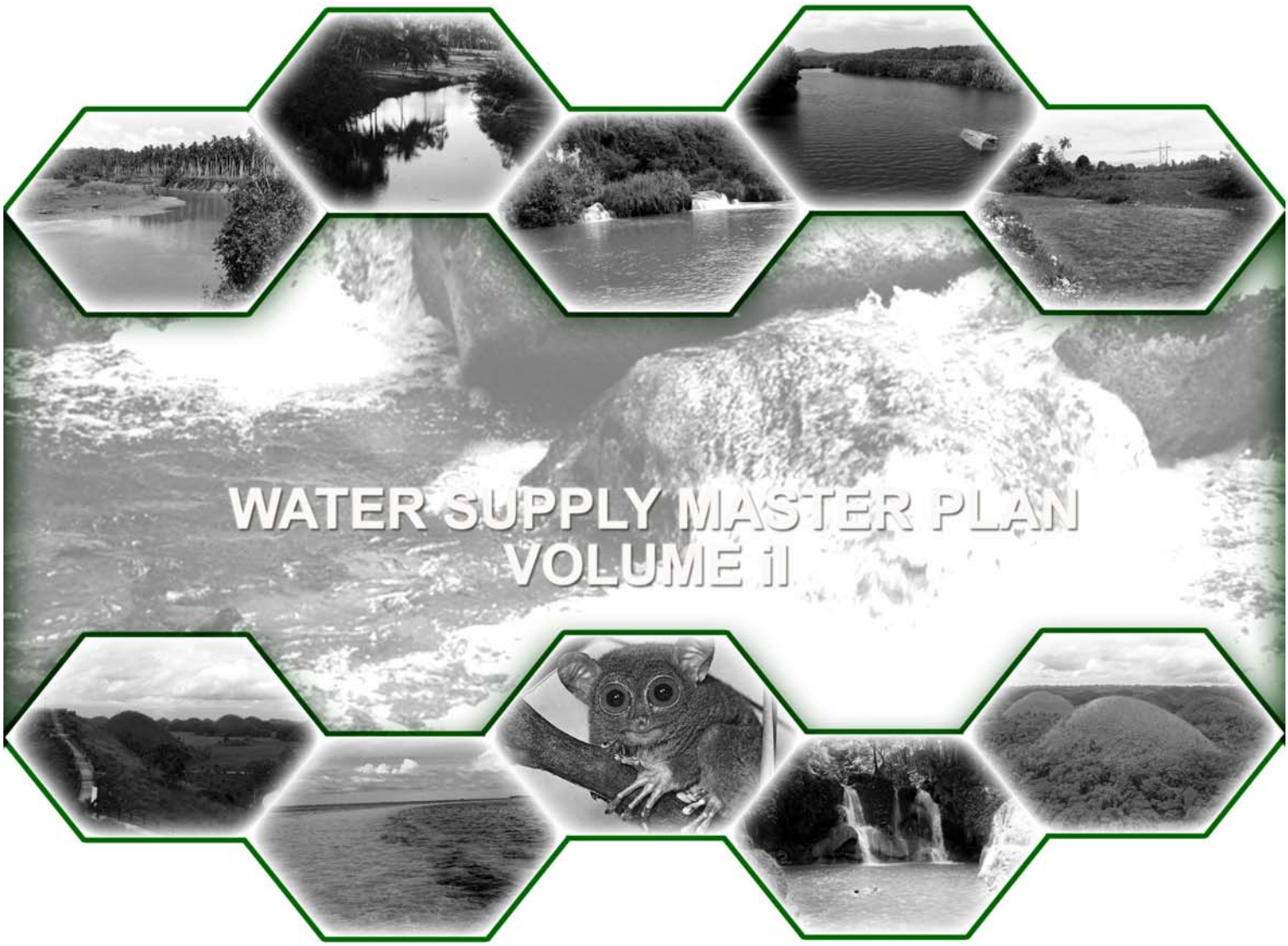
PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS



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WATER SUPPLY MASTER PLAN FINAL REPORT

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ACRONYMS and ABBREVIATIONS

ADD	Average Day Demand
BCCTV	Bohol Community Cable TV
BCRIP	Bohol Circumferential Road Improvement Project
BDPP	Bohol-Diesel Power Plant
BIAD	Bohol Integrated Area Development
BIMWC	Bohol Inter-Municipality Water Connection
BIPC	Bohol Investment Promotion Center
BIWRMB	Bohol Integrated Water Resources Management Board
BIWRMT	Bohol Integrated Water Resources Management Team
BIWSS	Bohol Integrated Water Supply System
BIWSSMP	Bohol Integrated Water Supply System Master Plan
BNS-BORDA	Basic Needs Sources – Bremen Overseas Research and Development Association
BOHECO	Bohol Electric Company
BPO	Business Processed Outsourcing
BPRMO	Bohol Poverty Reduction Management Office
BRS	Bureau of Research and Standards
BWUI	Bohol Water Utilities, Inc.
CBR	Crude Birth Rate
CDR	Crude Death Rate
CENRO	City Environment and Natural Resources Office
CLUP	Comprehensive Land Use Plan
CRNI	Crude Rate of Natural Increase
CRUZTELCO	Cruz Telephone Company
CVWRS	Central Visayas Water Supply Program
DAO	Department Administrative Order
DENR	Department of Environment and Natural Resources
DEWATS	Decentralized Waste Water Treatment System
DILG	Department of the Interior and Local Government
DOE	Department of Energy
DOH AO	Department of Health Administrative Order
DPWH	Department of Public Works and Highways
EC	Electrical Conductivity
ECA	Environmentally Critical Areas
ECC	Environmental Compliance Certificate
ECP	Environmentally Critical Projects
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMB	Environmental Management Bureau
FIES	Family Income and Expenditures Survey
GAD	Gender and Development
GTZ	German Technical Cooperation
HDI	Human Development Index
IDD	International Direct Dialing
IEC	Information, Education and Communication
IEE	Initial Environmental Examination
IRR	Implementing Rules and Regulations
ISLACOM	Isla Communications
ISP	Internet Service Providers
ITCZ	Intertropical Convergence Zone
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
KALAHI-CIDSS	Kapitbisig Laban sa Kahirapan – Comprehensive and Integrated Delivery of Social Services
KII	Key Informant Interview
LADP	Local Area Development Partnership
LGU	Local Government Unit
LWUA	Local Water Utilities Administration

M&E	Monitoring and Evaluation
MDD	Maximum Day Demand
MDGs	Millenium Development Goals
MGB	Mines and Geo-sciences
MPDC	Municipal Planning and Development Coordinator
MSIP	Municipal Solar Infrastructure Project
MTDP	Medium Term Development Plan
NAMRIA	National Mapping and Resource Inventory Authority
NCSO	National Census Statistics Office (NCSO)
NEDA	National Economic and Development Authority
NGOs	Non-Government Organizations
NIA	National Irrigation Authority
NIA-BPO	National Irrigation Authority-Bohol Province Office
NIA-GIS	National Irrigation Administration-Geographic Information Systems
NIPAS	National Integrated Protected Areas System
NPC	National Power Corporation
NRE	New and Renewable Energy
NRW	Non-Revenue Water
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
NWRB	National Water Resources Board
O&M	Operation and Maintenance
OPDS	Office of the Development Services
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PDMS	Poverty Database and Monitoring System
PENRO	Provincial Environment and Natural Resources Office
PEP	Poverty-Environment Partnership
PGR	Population Growth Rate
PHD	Peak Hour Demand
PHO	Provincial Health Office
PIWAS	Pilar Waterworks System
PLDT	Philippine Long Distance Telephone
PMTDP	Philippine Medium Term Development Plan
PNSDW	Philippine national Standards for Drinking Water
POs	People's Organizations
PPDO	Provincial Planning and Development Office
PSPT	Provincial Sector Planning Team
PUB	Public Utility Bus
PUV	Public Utility Vehicles
PW4SP	Provincial Water Supply, Sanitation and Sewerage Sector Plan
RA	Republic Act
ROW	Right-of-Way
SPUG	Small Power Utilities Group
TCWS	Tagbilaran City Waterworks System
TDS	Total Dissolved Solids
TelCos	Telephone Companies
TER	Tagbilaran East Road
TESDA	Technical Education and Skills Development Authority
TFR	Total Fertility Rate
TIN	Triangular Irregular Network
TNR	Tagbilaran North Road
UWASCO	Ubay Waterworks and Sanitation Cooperative
W4SMP	Water Supply, Sanitation, Sector Master Plan for Bohol Province
WD	Water District
WHO	World Health Organization
WTP	Water Treatment Plant

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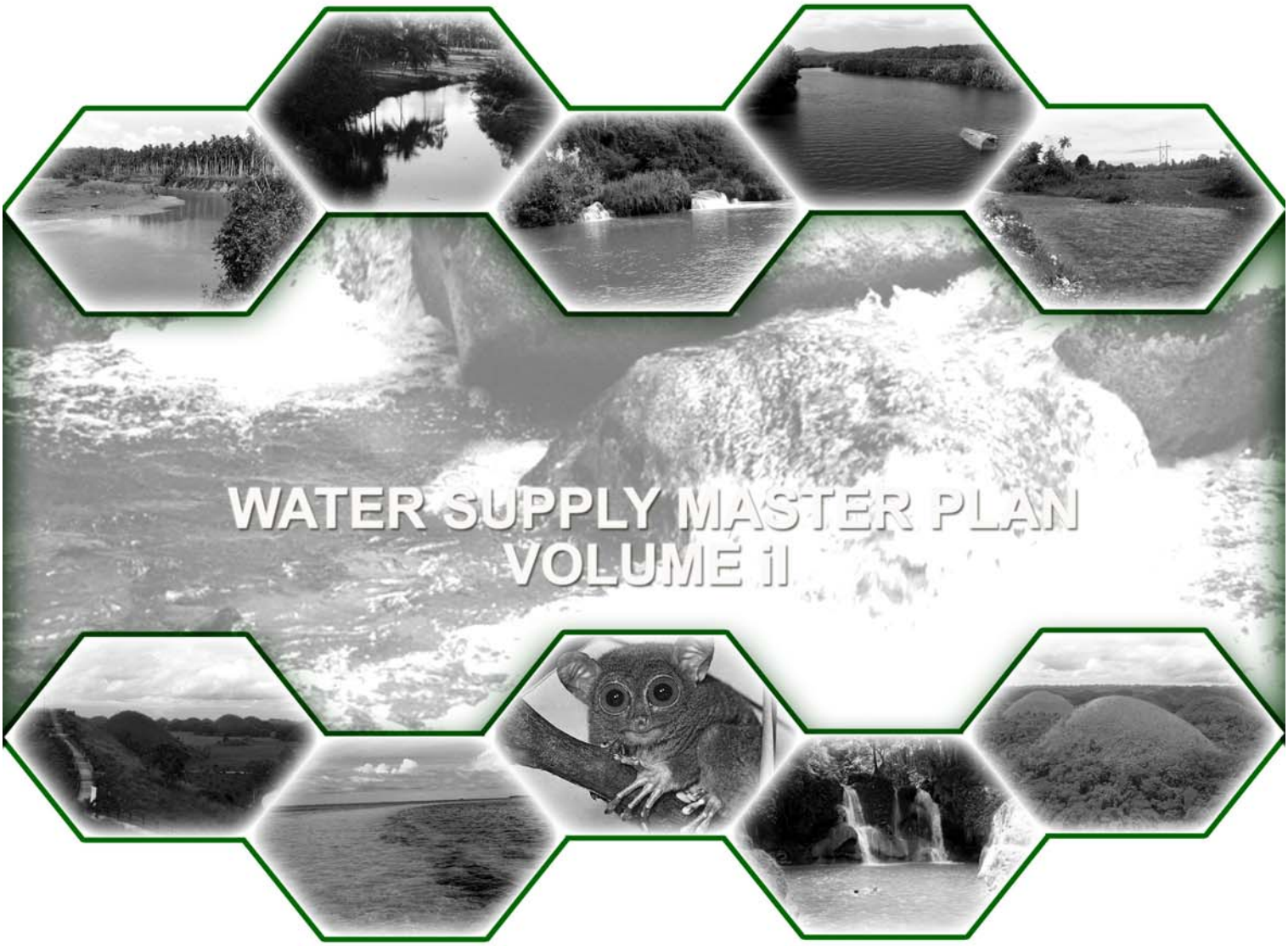

CHAPTER 1
THE STUDY AREA

CHAPTER 1 – THE STUDY AREA

1.1 LOCATION

One of four provinces in the Central Visayas Region (Region VII), the Province of Bohol is considered as the 10th largest island in the country possessing a land area of 411,726 hectares. It is located at bearing north latitude 9°30′ and 10˚15′ and east longitude 123˚40′ and 124˚40′, and is bounded by Cebu Island on the northwest, Leyte Island on the northeast and Mindanao Island on the south. The City of Tagbilaran, the island province's capital, is about 390 nautical miles or 700 kms south of Manila and can be easily reached in nearly an hour and 30 minutes plane ride. The province is about 1 hour and 30 minutes ride from Mactan Island, Cebu, which is about 70 kms away.

The province is geo-politically subdivided into 47 municipalities and one (1) city, and further into 1,109 barangays. Archipelagic in nature, it has 61 smaller islands and islets that involve 30 coastal municipalities covering 304 barangays and occupying 654 kilometers of coastline with nearly 6,245 sq-kms of municipal waters. The province takes pride in having the biggest mangrove area in Central Visayas at 14,502 hectares.

Further, Bohol is endowed with 2,224 springs, 59 rivers 11 of which are classified as major river systems, 200 creeks and river basins/watersheds thus suggesting an ample supply of fresh water and other environmental resources.

Three congressional district representatives ably represent the Province of Bohol in the Philippine Congress.

The Study Area is presented in **Figure 1-1.**

1.2 GEOGRAPHICAL FEATURES

1.2.1 Topography and Land Cover

The topography of Bohol Island varies from level to steeply sloping, with land elevation ranging from 0 to nearly 900 meters above sea level. **Figure 1-2** presents the summary of slopes distribution of the Bohol Island. The greater coverage of moderate and steep slopes promotes surface water runoff, while more level slopes allow for groundwater infiltration, depending on infiltration characteristics of soil and composition of outcropping rocks, vegetation cover and land use. The slope distribution on small islands is not known but is considered level to nearly level, because of small elevations prevailing in these islands.

Approximately 167,160 hectares or 40.6% of the total provincial land area have slope gradients of 0-8%, largely covering the central to northern areas which comprise the prime agricultural zone utilized for irrigated and rainfed palay and corn production. The areas with 8.18% slopes accounted for 29% (about 120,636 hectares), mostly coconut, corn and subsistence crops and openlidle or Imperata-dominated and eroded land areas. The rolling to mountain areas with slopes of 18% and above cover 123,930 hectares or 30% of Bohol land area. These areas generally cover the remaining timberlands and classified forests in the province. Due to increasing population and economic pressures, it is noted that the areas with slopes of 18% and above have been disturbed and exploited particularly for subsistence agricultural purposes.

The land cover as shown in **Figure 1-3** constitutes about 25.44% of the total land area of the Province mostly located in the southeastern mountain ranges, about 2% higher than area designated as forestland (23.5%). The existing land use pattern must be enhanced by rehabilitation of critical watersheds in which the remaining forest cover must be conserved to primarily serve as watershed rather than as source of timber and fuel. An efficiently managed watershed collects and regulates flow of water, controls soil erosion, and minimizes water pollution.

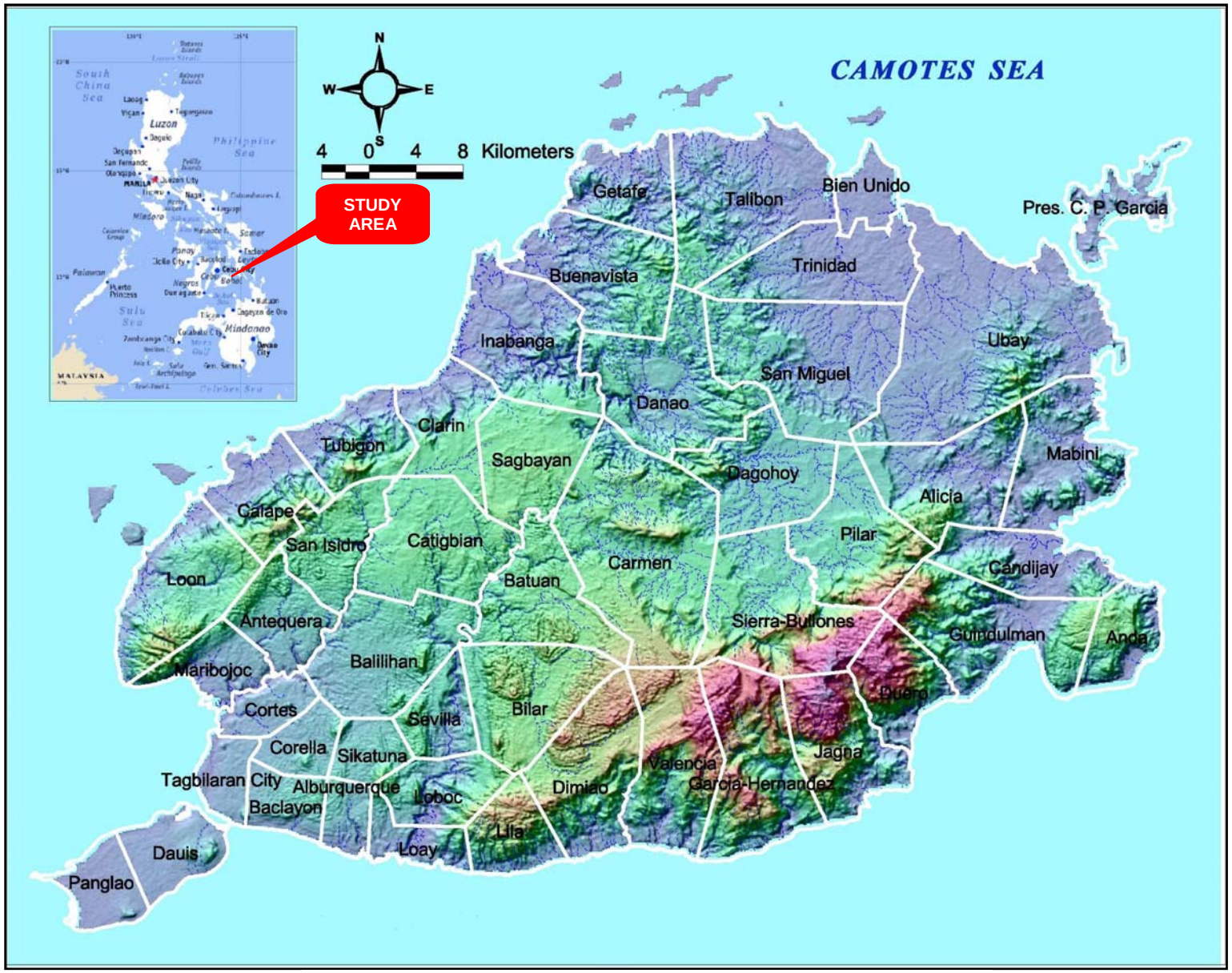

Figure 1-1 Study Area

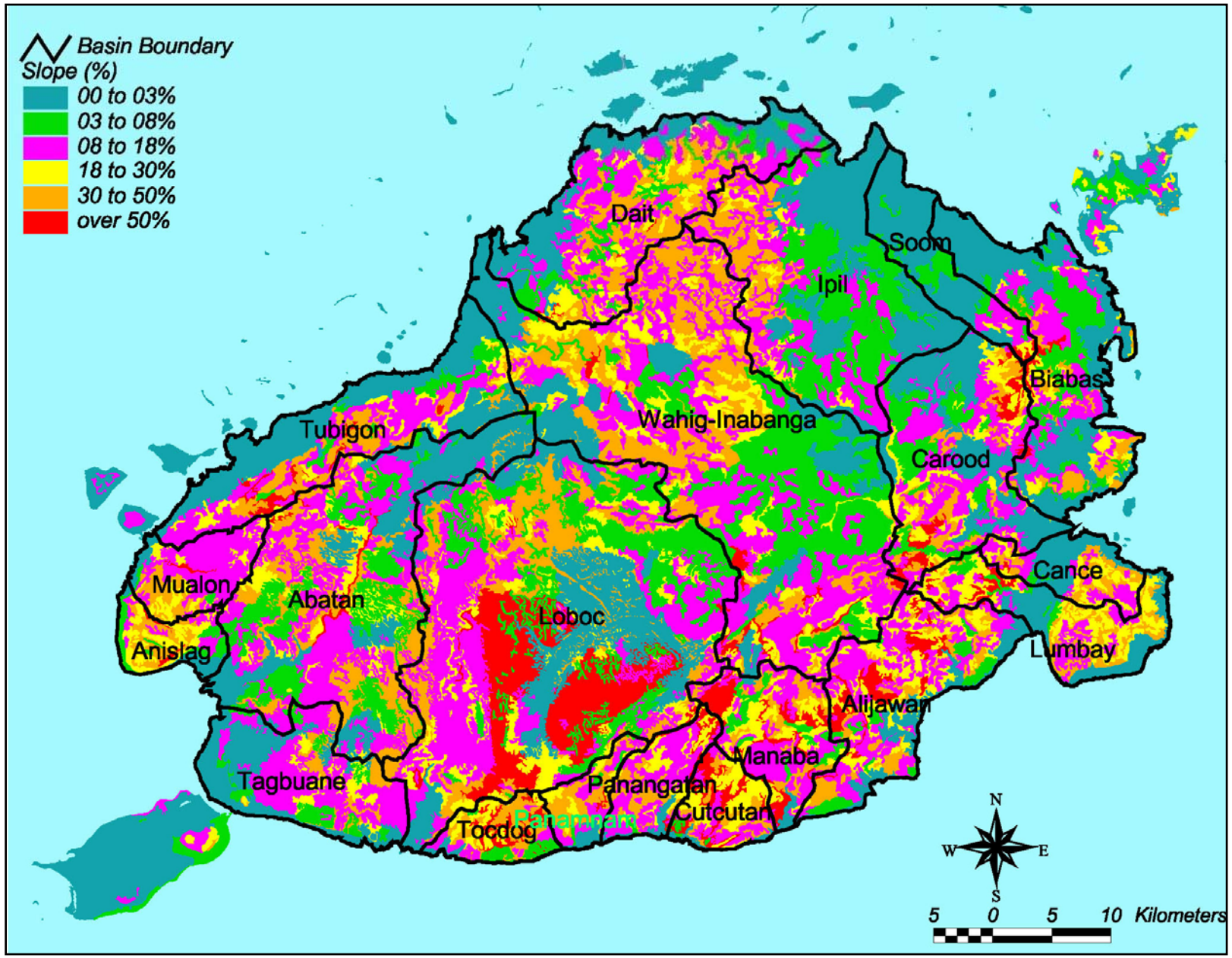

Figure 1-2 Slope Map

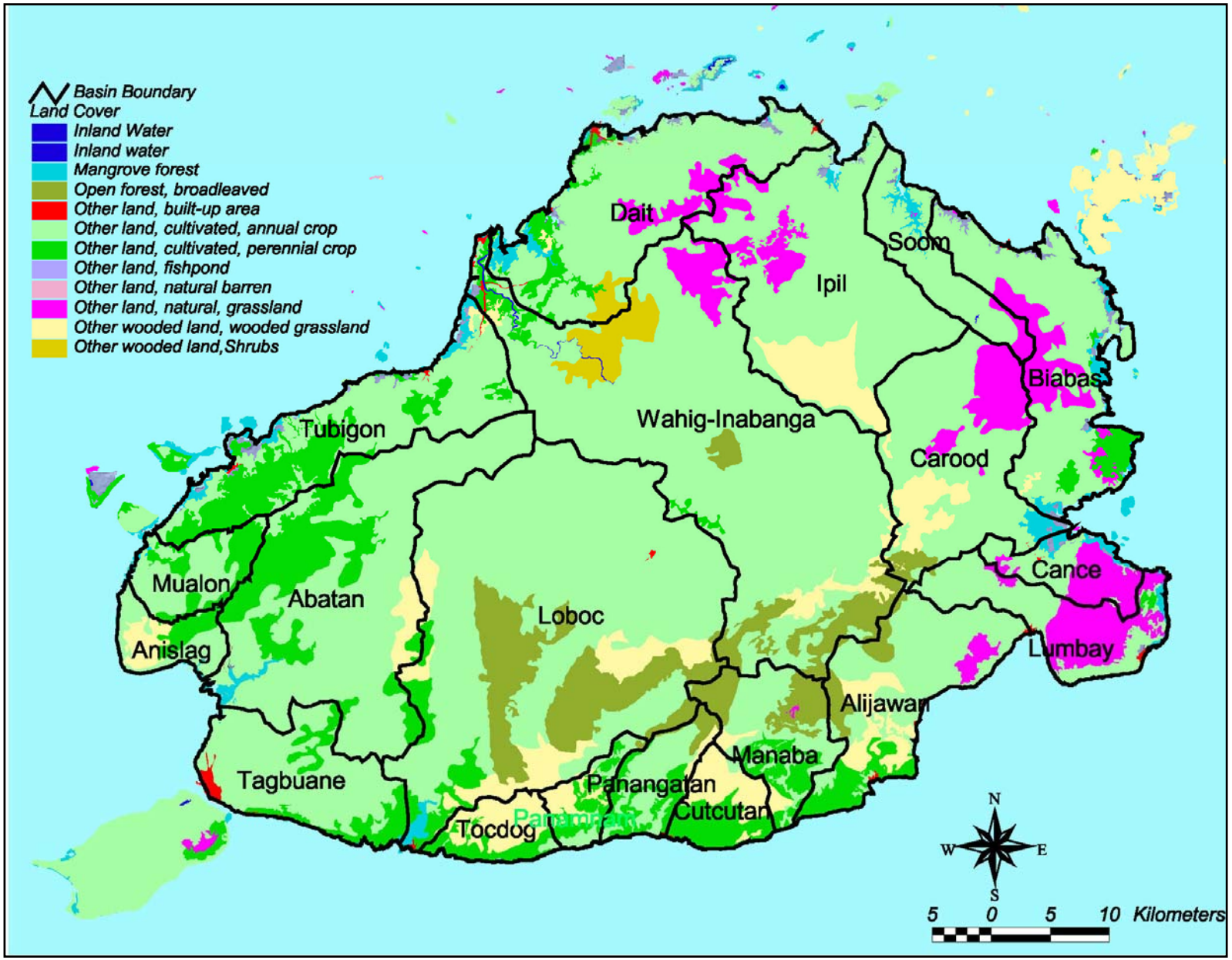

Figure 1-3 Land Cover Map

1.2.2 Drainage

There are about 81 river systems in Bohol including those located in small islands. The drainage area ranges from as low as 0.1km^2 to 9km^2 in Cabilao Island to 618 km^2 in Loboc.[1]

The existing drainage pattern in the province is generally radial.

Table 1-1 Drainage & Flow Rates of Principal Rivers

Principal River	Drainage Area (km2)	Flow Rate (m3/sec)			Water District (using river water)
		Peak	Maximum	Minimum	
Pamacsalan	71	99.00	69.80	0.050	none
Wahig-Inabanga	590	572.39	-	-	-do-
Cantimoc	74	-	221.03	0.003	-do-
Hibayog	41	-	86.05	0	-do-
Hinlayagan	41	-	91.75	0.022	-do-
Gabayan	28	-	95.8	0.100	-do-
Manaba	93	-	233.25	0.100	-do-
Abatan	140	-	205.48	0.120	-do-
Antequera	54	-	372.8	0.088	-do-
Bilar	92	159.77	72.02	0.010	-do-
Loboc	618	571.00	441.80	3.900	-do-

Sources: Philippine Water Resources Summary Data, NWRB; Streamflow Data, BRS-DPWH

Note: Peak- Peak discharge of Daily Maximum Discharge
Maximum- Maximum Daily Discharge of Weighted Daily Discharge
Minimum- Minimum Daily Discharge of Weighted Daily Discharge

1.2.3 Land Use

The province occupies a total land area of 411,726 hectares with nearly 310,455 hectares considered as alienable & disposal (74%) and the about 101,271 hectares as timberland/forest area (25%).

Of total alienable & disposable lands, 273,950 hectares (66%) are used for agriculture (rice, corn, coconut, vegetables & root-crops); 9,678 hectares are considered built-up areas; 1,888 hectares are used for tourism; 468 hectares considered for industrial zone; 21,721 hectares for infrastructure and utilities right-of-way; 1,421 hectares are open space and parks; and, the rest (roughly781 hectares) for mining and quarrying.

On the other hand, from the total timberland/forest area, some 23,940 hectares (24%) are categorized as natural forest/ second growth natural forest and mangrove, 75,766 hectares are classified as NIPAS (National Integrated Protected Areas System), meaning nearly 75% of the area is categorized as strictly natural reserve, natural park, natural monument, wildlife sanctuary, protected landscapes and seascapes.

1.2.4 Vegetation

Nearly half of the total land area of the province is covered by grassland/shrubland, about 11% by woodland, nearly 5% by wetland (i.e. mangrove, nipa, etc.), and the rest utilized for agriculture.

Efforts are being intensively made to re-forest the landscape notably the watershed areas as natural flora is fast becoming rare, *e.g. Dipterocarpaceae, Leguminosae and Verbanaceae.*

[1] Provincial Water Supply, Sewerage and Sanitation Sector Plan (PW4SP) Report

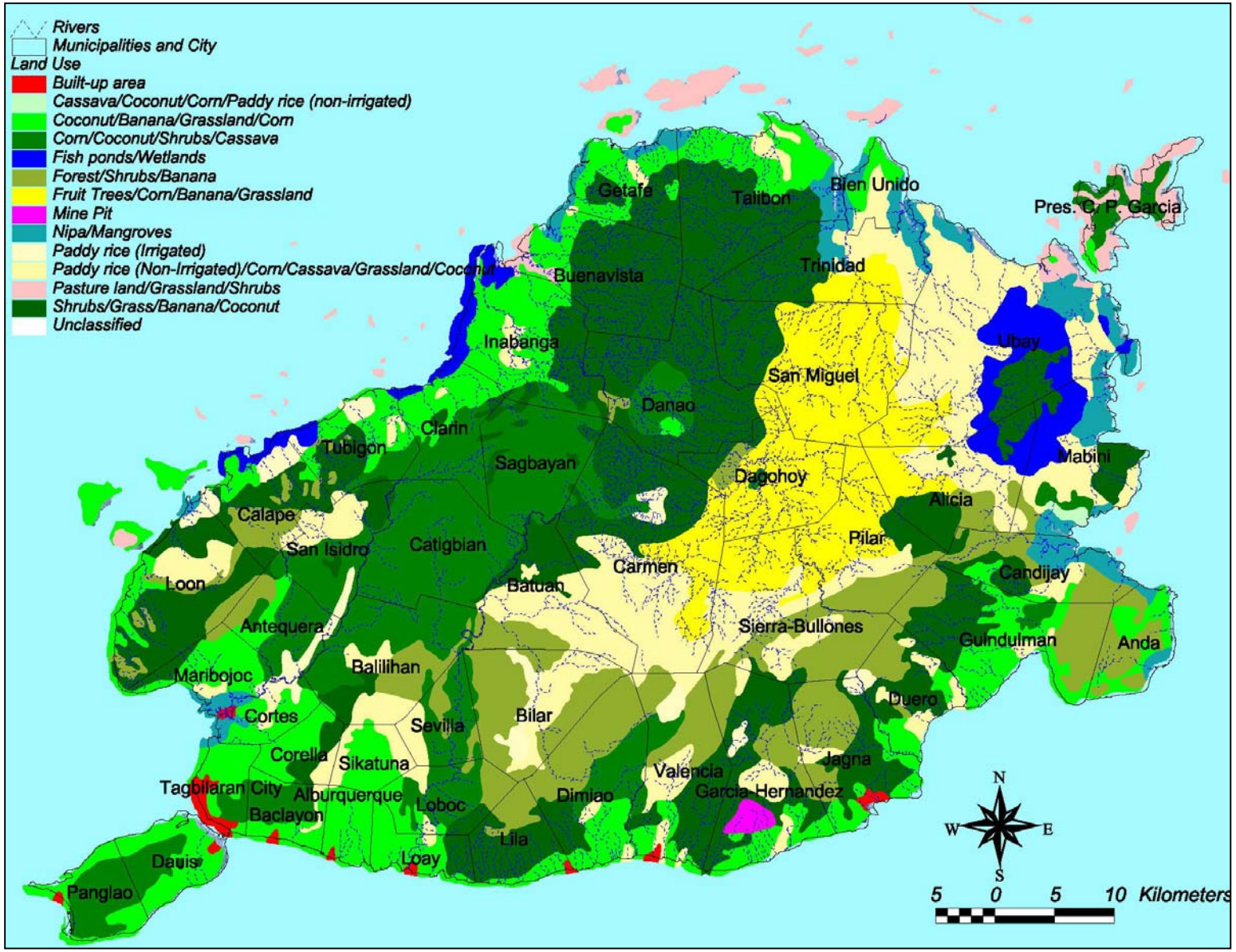

Figure 1-4 Land Use Map

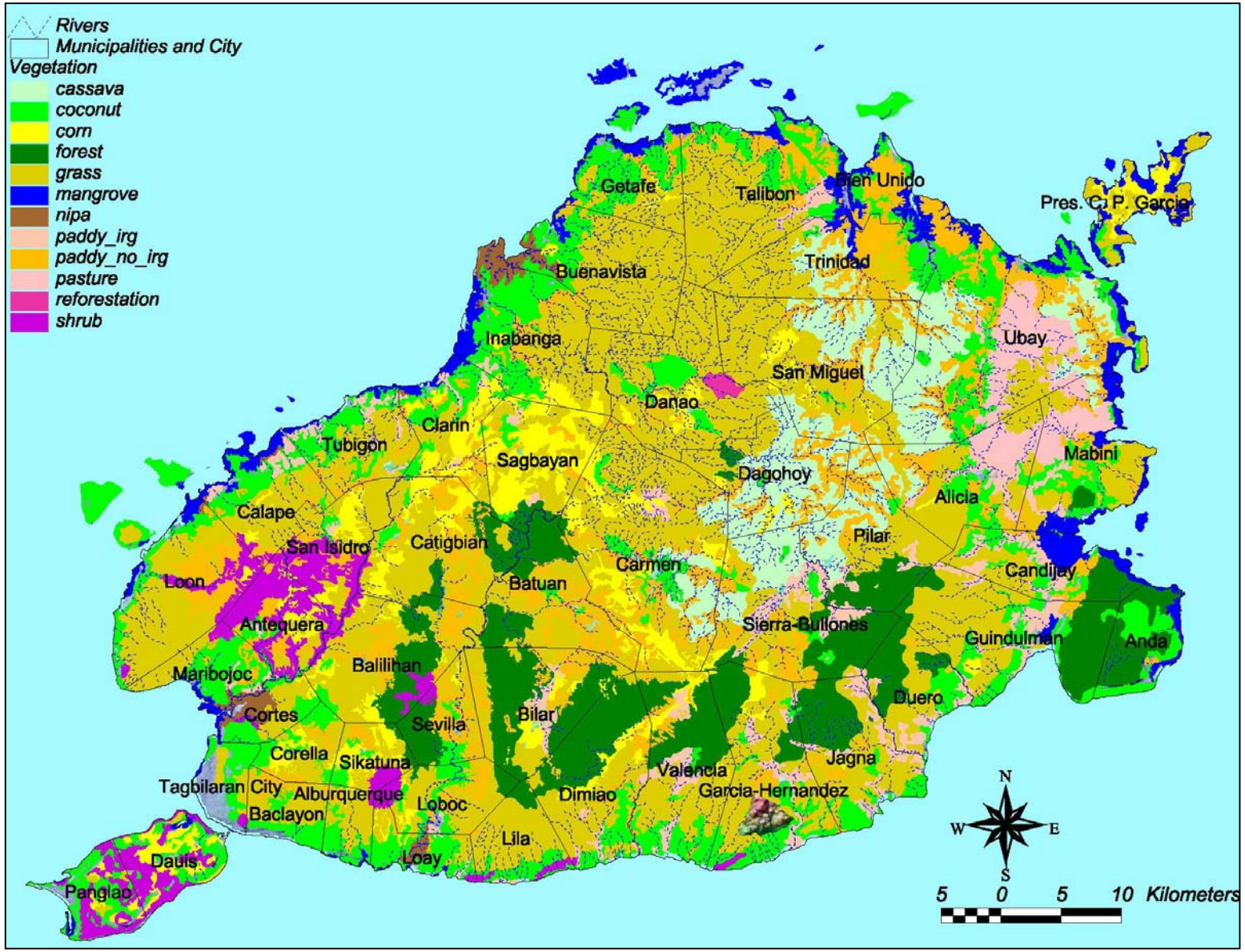

Figure 1-5 Vegetation Map

1.2.5 Climate

The archipelago of the Philippines is situated in what is considered as a typhoon-belt or cyclone-prone area of the world. Roughly 20 tropical cyclones of various intensities visit the country yearly. The Province of Bohol, lying outside the typhoon-belt zone and shielded by the outer islands in the Visayas, generally experience one cyclone per year.

Belonging to the 4th type of Corona's climatic classification, it receives rainfall rather evenly throughout the year. The climate is affected by southwest-originating monsoons, and is relatively dry from March to May. The wet season is from June to December with mean monthly rainfall averaging about 112mm to 182mm. The wettest months are October and November.

Meanwhile, the average annual rainfall in the watershed area is about 2,250mm, with a maximum and minimum annual rainfall of 3,500 and 1,000mm, respectively (based on historical records).

The mean temperature across the province is 27.7˚C.[2]

1.3 POPULATION

Ranked 17th most populous province in the country, Bohol's population reached 1,137,268 (2000) and is second only to Cebu in the Central Visayas Region. Household population is 209,588 with an average household size of five. Most of the population resides in the rural area, as agriculture is the main source of economic engagement.

Tagbilaran City, which account for almost 50% of the total population, together with 23 municipalities has an annual growth rate of equal to or more than two percentage point.

Consequently, Tagbilaran City, the capital and center of commerce and industry of the province, is the most densely populated with almost 3 thousand persons per sq-km, followed by the municipalities of Dauis, Tubigon, Bien Unido and Baclayon. The least populated municipality is Balilihan with only 119 persons per sq-km.

Table 1-2 Population, 2000

Province, City, Municipality and Barangay	Total Population	Household Population	Number of Households
BOHOL	1,137,268	1,134,733	209,588
ALBURQUERQUE	8,715	8,710	1,670
ALICIA	21,605	21,579	4,065
ANDA	17,863	17,859	3,072
ANTEQUERA	13,758	13,709	2,801
BACLAYON	14,996	14,996	2,978
BALILIHAN	16,837	16,829	3,101
BATUAN	11,835	11,828	2,287
BILAR	16,628	16,609	2,967
BUENAVISTA	25,960	25,954	4,550
CALAPE	27,921	27,906	5,588
CANDIJAY	30,389	30,096	5,420
CARMEN	40,713	40,601	7,379
CATIGBIAN	21,461	21,445	4,094
CLARIN	18,040	18,030	3,575
CORELLA	6,048	6,048	1,263
CORTES	12,702	12,699	2,547
DAGOHOY	16,845	16,845	3,095
DANAO	17,265	17,264	2,958
DAUIS	26,415	26,415	2,669

[2] Bohol Inter-Municipality Water Connection (BIMWC) Plan- Final Exec Summary Report

Province, City, Municipality and Barangay	Total Population	Household Population	Number of Households
DIMIAO	14,151	14,129	2,708
DUERO	16,485	16,484	3,245
GARCIA HERNANDEZ	21,428	21,392	3,989
GUINDULMAN	29,166	29,124	5,573
INABANGA	40,714	40,681	7,867
JAGNA	30,643	30,619	5,957
GETAFE	26,826	26,756	4,694
LILA	10,322	10,315	1,723
LOAY	14,433	14,430	2,615
LOBOC	15,734	15,622	2,738
LOON	45,215	45,171	7,915
MABINI	27,250	26,642	5,047
MARIBIJOC	16,786	16,786	2,630
PANGLAO	21,337	21,299	3,890
PILAR	25,095	25,087	4,489
PRES. C.P. GARCIA(PITOGO)	20,744	20,742	4,062
SAGBAYAN (BORJA)	18,346	18,309	3,688
SAN ISIDRO	9,106	9,094	1,848
SAN MIGUEL	20,828	20,816	3,738
SEVILLA	10,281	10,272	1,840
SIERRA BULLONES	25,499	25,488	4,473
SIKATUNA	6,602	6,602	1,177
TAGBILARAN CITY (CAPITAL)	77,700	77,181	15,585
TALIBON	54,147	53,992	9,712
TRINIDAD	25,683	25,679	4,707
TUBIGON	40,385	40,352	7,714
UBAY	59,827	59,751	11,511
VALENCIA	24,363	24,320	4,392
BIEN UNIDO	22,176	22,176	3,984

Source: NSO 2000 Census of Population and Housing

A consideration on how the population growth behaved in the past and how it is likely to behave in the future is important because of the issue of resource allocation including the water supply and sanitation sector requirements.

1.3.1 Population Disaggregation

1.3.1.1 Population Density

The degree of population density indicates the challenges posed not only on demands for water but on the challenges on sanitation and sewerage.

Table 1-3 Comparative Statistics Among Visayas Region on Total Population, Number of Households, Average Household Size, Population Growth Rate and Population Density (as of May 2000)

Region/Province/City	Total Population	Number of Households	Average HH Size	1990-1995	1995-2000	1990-2000	Population Density
VI (Western Visayas)	6,208,733	1,211,647	5.12	1.3	1.56	1.42	307
VIII (Eastern Visayas)	3,610,355	715,025	5.04	1.84	1.51	1.68	173
VII (Central Visayas)	5,701,064	1,129,317	5.03	1.65	2.79	2.18	381
Bohol	1,137,268	209,588	5.41	0.89	2.92	1.83	276
Cebu	2,377,588	473,559	5	2.01	3.07	2.51	496
Cebu City	718,821	147,600	4.84	1.54	1.77	1.65	2,562
Mandaue City	259,728	54,882	4.72	1.46	6.36	3.72	22,199
Negros Oriental	1,126,061	226,337	4.97	1.94	2.03	1.98	208
Siquijor	81,598	17,351	4.7	-0.04	2.19	0.99	238

Source: NSO 2000 Census

Overlayed with the province's strategic areas for development, it helps in forecasting and decision-making. Below is an enumeration of the ten most dense municipality in the province.

Table 1-4 Ten Most Dense Municipalities

MUNICIPALITY	POPULATION DENSITY/SQ.KM
Tagbilaran City	2,538
Dauis	616
Tubigon	534
Bien Unido	495
Baclayon	441
Mabini	422
Loay	415
Pilar	402
Panglao	385
Loon	378

Source: NSO, 2000 Census of Population & Housing, Manila.

1.3.1.2 Age-Sex Population Structure

Bohol's population is predominantly young with almost half of its population below 22 years old during the 2000 Census of Population. There were 62 young dependents per 100 working persons. Meanwhile, the number of elderly population (ages 65 and older) has increased significantly though constituting 7% of the population in Year 2000. They are concentrated in Loon (5.48%), Tagbilaran City (4.49%) and Ubay (3.7%). The municipality of Corella, however, had the most number of elderly person vis-à-vis their total population. About 26% of households head in Bohol is an elderly, mostly males.

There were more males than females in the age group 0 to 44 years. On the other hand, females dominated the rest of the age groups. The sex ratio of 101.6 males for every 100 females in 2000 was almost the same as that of 1995. Almost half of the female population during the 2000 Census are of childbearing ages (15-49 years old), concentrated mostly in the age group 15-19 years, while its estimated Total Fertility Rate (TFR) is 3.19 children per woman for the years 2005-2010. The province's net migration rate, as forecasted, is expected to exhibit a negative percent change or a decreasing trend with (-) 0.0032 and (-) 0.0066 for male and female, respectively, for the 5-year period (NSO-NSCB). This simply implies that the steady increase of Bohol's population is attributed mostly to the number of its live births.

1.3.1.3 Crude Birth Rate (CBR)/Crude Death Rate (CDR)

The Crude Birth Rate (CBR) and Crude Death Rate (CDR) in Bohol is estimated to decrease slowly in the ensuing years. An estimated CBR of 23.9 live births per 1,000 population and a CDR of 6.8 deaths per 1,000 population is projected in 2005-2010, which is slightly lower than that of the country and region. Per NSO projections, the average yearly growth rate of Bohol's population is expected to slow down in the coming years as a result of decreasing TFR/birth rates, declining migration and steady death rates. The Crude Rate of Natural Increase (CRNI) or the population increase per 1,000 persons is estimated at 17.1 for 2005-2010.

1.3.2 Previous Population Trend (Development)

In the span of 45 years (1903-1948), the provincial population was growing annually by roughly six thousand persons. Then, from 1960 to 1995 period, the population was doubling annually. In a dramatic surge for the following 4 years (1996-2000), the population was increasing by nearly 36,000 people annually. Hence, Bohol's population increased fivefold since 1903.

Table 1-5 Population Growth, 1903-2000

CENSAL YEAR	YEARLY INTERVAL	ANNUAL POPULATION DIFFERENCE	ANNUAL INCREASE
1903-1948	45	284,184	6,315
1960-1995	35	441,828	12,601
1996-2000	4	142,828	35,707

Sanger et al, United States Bureau of Census, 1905

1.3.3 Present Population Distribution

From the 2000 NSO census, the 2003 urban-rural population was estimated with rural population accounting for 66% of the provincial total, while 34% is urban. The average provincial household size is 5.43 persons/household.

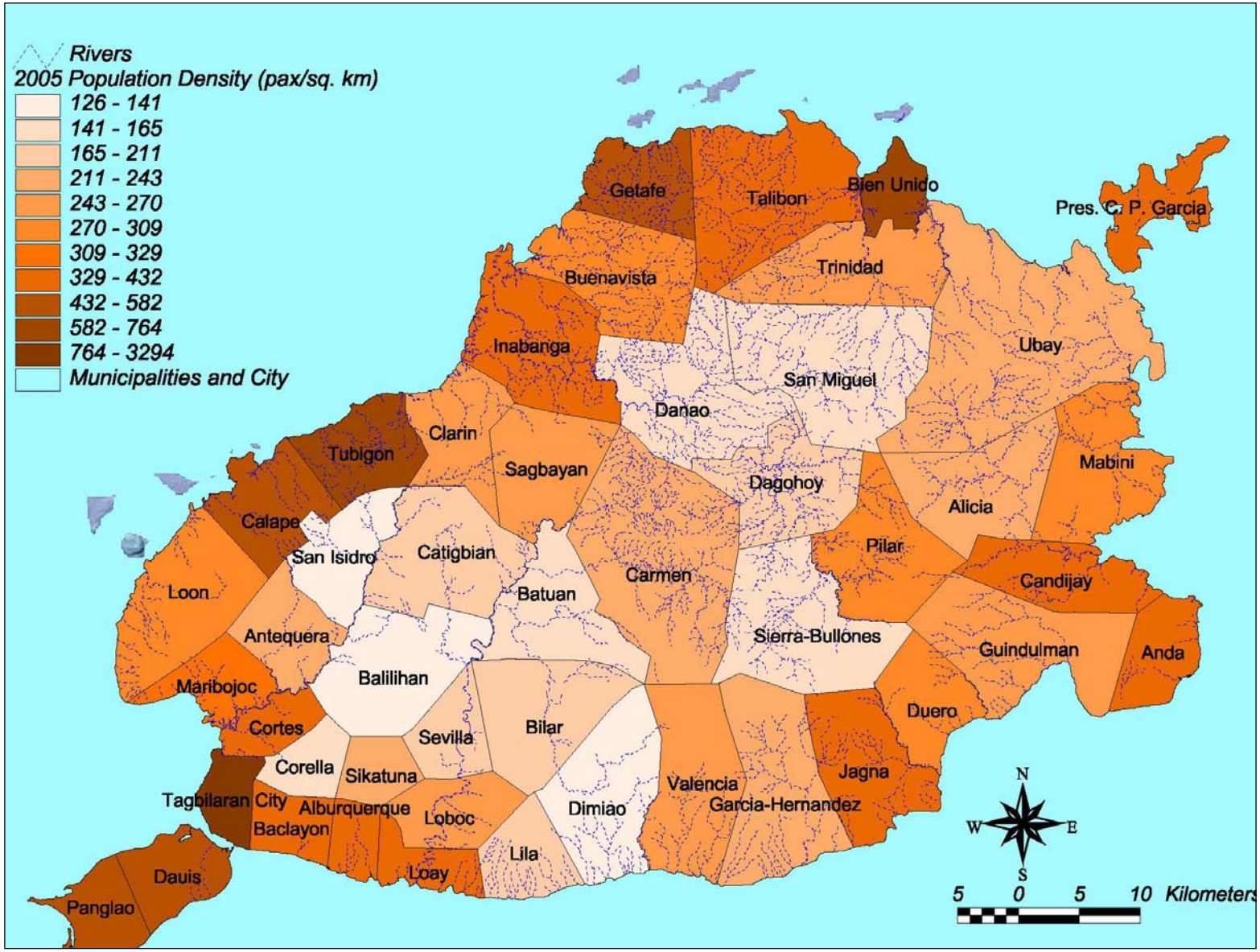

Figure 1-6 Population Density Map

1.4 SOCIO-ECONOMIC CONDITIONS

1.4.1 Economic Activities and Household Income

From the labor force survey conducted in 1999 by NSO in Bohol, the potential labor force increased to 691 thousand of which 66.4% were in the labor force. Employment rate, at the end of 1999 increased to 90.5% from 85.35% in 1998. However, an increase in under-employment was noted from 5% in 1998 to 11.7% in 1999. Employment was predominantly agriculture-led.

The NSO Family Income and Expenditures Survey (FIES) in 2000 showed that the average annual family income of the Province was P77,291 while the expenditure was at P66,907 or a net saving of P10,384. Percentages of families of lower income levels in the Province were greater than the average in the region. Based on the established poverty threshold level, about 29.2% of the total number of families in Bohol continue to live within and below the poverty threshold level.

As to the number of workers by major industry group, agriculture, services, fishery and trade have the dominant share followed by manufacturing[3].

1.4.2 Education

Providing a significant role in the development of its manpower base are the 1,156 schools (both public and privately owned) in Bohol. There are also five skills training centers operated by TESDA that offer formal and informal training programs. Most of the colleges and universities are located in Tagbilaran City. Likewise, Bohol has an agricultural school located in Bilar. A large part of the population had attained elementary or high school education.

1.4.3 Agriculture

Agriculture is the biggest sector in the province: biggest in terms of land utilization and biggest in terms of employment engagement. Nearly 50% of the land is devoted to agricultural use.

Rice production covers around 46,587 hectares involving nearly 57,780 households who depend on subsistence and income. The average yield per hectare at 1.40 cropping intensity is 2.36 metric tons.

Corn production covers about 15,293 hectares with an average yield per hectare per cropping of 2.19 metric tons (hybrid variety) and 0.92 metric tons (open pollinated variety).

Coconut farming, a major crop, occupies nearly 38,951 hectares involving nearly 5 million coconut trees (93% are bearing) with an average planting density of 129 trees per hectare. Production yield is 123,962 metric tons per harvesting season.

Oil Palm Trees cover an area of 4,285 hectares involving 1,414 growers located in 14 municipalities of the 2nd and 3rd Congressional District of the province.

Vegetables grown in the province are: pechay, cabbage, green onions, ampalaya, chayote, egg plant, okra, bell pepper, squash, tomato and water melons. Cabbage and chayote are grown in the highland areas of Duero, Jagna, Sierra Bullones, Candijay and Guindulman. The other vegetables are grown in the lowland areas covering nearly 1,823 hectares. Among

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the vegetables grown, ampalaya is the most extensive covering an area of 705 hectares and highest production yield of nearly 1,296 metric tons (2004).

Moreover, there are five major fruit varieties in the province: banana, mango, papaya, pineapple and calamansi.

Livestock include cattle, carabao, goat, hog, chicken and ducks.

1.4.4 Commerce

Commerce between the province and outlying areas are mostly confined to: Manila in Luzon; Cebu in the Visayas; and, Cagayan de Oro in Mindanao. The main trading goods going out are: limestone product, rice, salted fish, handicrafts, mangoes, banana, cattle, copra, carabao, salt, hog, raffia, cooked fish and nipa shingles. In turn, incoming goods are: cement, G.I. sheets, appliances, feeds, manufactured goods, fertilizers, corn grits, flour, cooking oil, rice, refined sugar, motorcycle, hardware/construction materials, plywood and medicines.

Furthermore, to boost commercial activities, the province had identified the establishment of Special Economic Zones/Industrial Estates through its landmark legislation − the Bohol Investment Code. The Code provides the policy environment that establishes fiscal and non-fiscal incentives as well as investment mechanism that are investor-friendly. The Northern Corridor within the proximity of Cebu had been identified as a zone for industrial development for light manufacturing and agro-industries.

The Code also identified “primary growth focus” that will receive incentives, assistance and public investment support from the province: tourism (with emphasis on eco-tourism) and agro-industrial development.

1.4.5 Industry

The manufacturing industries in Bohol are engaged in the manufacture of native crafts such as mats, baskets, furniture and shell crafts. According to the 1990 NCSO Census, there are about 600 cottage industries (small-scale activities done at home) scattered all over the island. Most of these activities are located in Tagbilaran City (56%) followed by Loon (6%) and Tubigon (6%). Minimal cottage industries exist in the other municipalities in the study area. The activities use minimal water in the production process[4.]

1.4.6 Tourism

Tourism in Bohol has grown consistently over the last decade and is at present a growing sector in the province's economy. The tourism industry is viewed as the engine for economic growth of the province. It is potentially a very important socioeconomic sector in Bohol, which generates substantial benefits to its people. A vast potential exists for further growth, which would lead to more job creation, and increase in foreign exchange earnings.

The island is endowed with the bounties of nature. What immediately captivates one in Bohol are its pristine beaches with white coral sands, abundant marine life, underground caves, coral reefs of diverse species, and a number of diving havens which are considered among the best in the world. Centuries-old churches and towers, historical landmarks and majestic falls and caves are some of its assets and untapped potentials. Bohol has numerous natural treasures like waterfalls and rivers. In the interior part are the world-famous Chocolate Hills, the man-made forest, and the Loboc River. The province is also blessed with a rich diversity

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of tourist attractions, like the presence of exotic wildlife in flora and fauna that includes the famous Philippine Tarsier, considered as the smallest primate in the world.

The Tourism Map is presented in **Figure 1-7**.

1.4.6.1 Major Tourism Attractions

Bohol anchors its tourism package, namely:

a. Chocolate Hills is the province's signature attraction, consists of 1,268 haycock hills spread over four municipalities. Each hill's height ranges from 40 to 120 meters. The hills are said to have been formed centuries ago by tidal movements.

b. Tarsier is one of the smallest living primates; this rare creature belongs to the primitive sub-order Prosimii dating around 45 million years. It is the oldest land species in continuous existence in the Philippines. It measures 4-5 inches long, with its tail longer than its body.

c. Dive Sites off the coast of Panglao, Balicasag, Cabilao in Loon, where one can marvel at one of the most colorful and exotic displays of marine life. The undersea terrain is predominantly limestone had creating overhangs, crevices and declivitous walls that contribute to the underwater beauty of the province's dive sites.

d. Beaches of Panglao and Anda municipalities, soft powdery and white sand, palm-fringed beaches and clear-blue seawaters. Heritage structures made of coralline stones dating back to the colonial era, erected at the instigation of the Spanish friars, include churches, convents, watchtowers, escuelas de nihos y nihas, cabildos and precidencias, and even today speak well of their adaptation and usefulness.

e. Bohol's History - doubtlessly rich in texture and topography, provided the fertile ground for the development of the people's dynamic arts, artistic traditions and cultural expressions evident in their music, painting, dance, literature, theater and sculpture.

1.4.6.2 Ecotourism

With the current focus of the Provincial Leadership in the alleviation of poverty in the province, ecotourism, also referred to as pro-poor tourism is seen as having the potential to provide economic benefits to more people which can, in turn, be channeled to improve nutrition and food security, housing, health and, on the whole - to an increase in the standard of living in the rural areas through the development of micro-enterprises or small-scale businesses which has the potential to close the gap between the employable labor force and actual jobs available.

Figure 1-7 Tourism Map

Enterprise development expands the opportunity base for the underutilized labor force to get involved in gainful employment and thus contribute to reducing overall poverty incidence in the province over time. Pro-poor tourism strategy can reduce poverty in the province, contribute to economic growth, increase employment, and promote conservation of natural and cultural heritage. It promotes sustainable development in the rural areas through environment-friendly infrastructure improvements, community and private sector cooperation. It can mitigate environmental degradation, develop human resources and promote cooperation between private and public sector by establishing tourism marketing and promotion, establish mechanism to increase LGU cooperation and facilitate the movements of tourists across the province.

Eco-cultural tourism can complement large-scale investments in tourism in the province. At present the bulk of tourists to Bohol are domestic tourists. In view of the great potential to expand Bohol's tourism industry, it is equally important to capture the short-haul markets (Asian) especially that of Japan, Korea, China and Taiwan, it is required to devise new strategies in order to attract tourists from these desired markets. However, growth in tourism is constrained by difficulties in access, the lack of investment in high-end tourist infrastructure and facilities, the insufficiency in the promotion of our new products to visitors and weaknesses in policy and institutional capacities. Ore investments in access - roads, airports, sewerage, solid waste management, and human resources development are badly needed. Also needed are investments in pro-poor, community-based tourism to put local communities at the heart of tourism growth in the province.

1.5 BASIC INFRASTRUCTURE

1.5.1 Water Supply

The existing water supply facilities and conditions are evaluated by municipality under the category of urban and rural areas. Facilities are classified into three (3) service levels, of which Level I facilities were further classified for drinking purposes into safe and unsafe. **Table 1-6** defines the classification of water supply by service level.

Table 1-6 Composition of Water Supply System / Facility by Service Level

Description	Level I (Point Source Facility)	Level II (Communal Faucet System)	Level III (Individual House Connection)
1. Water Source	Drilled / driven shallow well	Drilled shallow / deep well	Drilled deep well
	Drilled / driven deep well	Spring	Spring
	Dug well	Infiltration gallery	Infiltration gallery
	Spring, rain collector		Surface water intake
2. Water Treatment	Generally none. Disinfection of wells is conducted periodically by local health authorities.	Generally none	Disinfection is provided. Systems with surface water source have water treatment facilities.
3. Distribution	None	Piped system provided with reservoir/s	Piped system with reservoir/s and pumping facilities
4. Delivery and Service Level	At point	Communal faucet	Individual house connection / household tap
	(within 250m radius)	(within 250m radius)	

The population of 523 barangays out of 1,109 barangays all over the island is presently being served by Level III water supply and the location of these areas is shown in **Figure 1-8**.

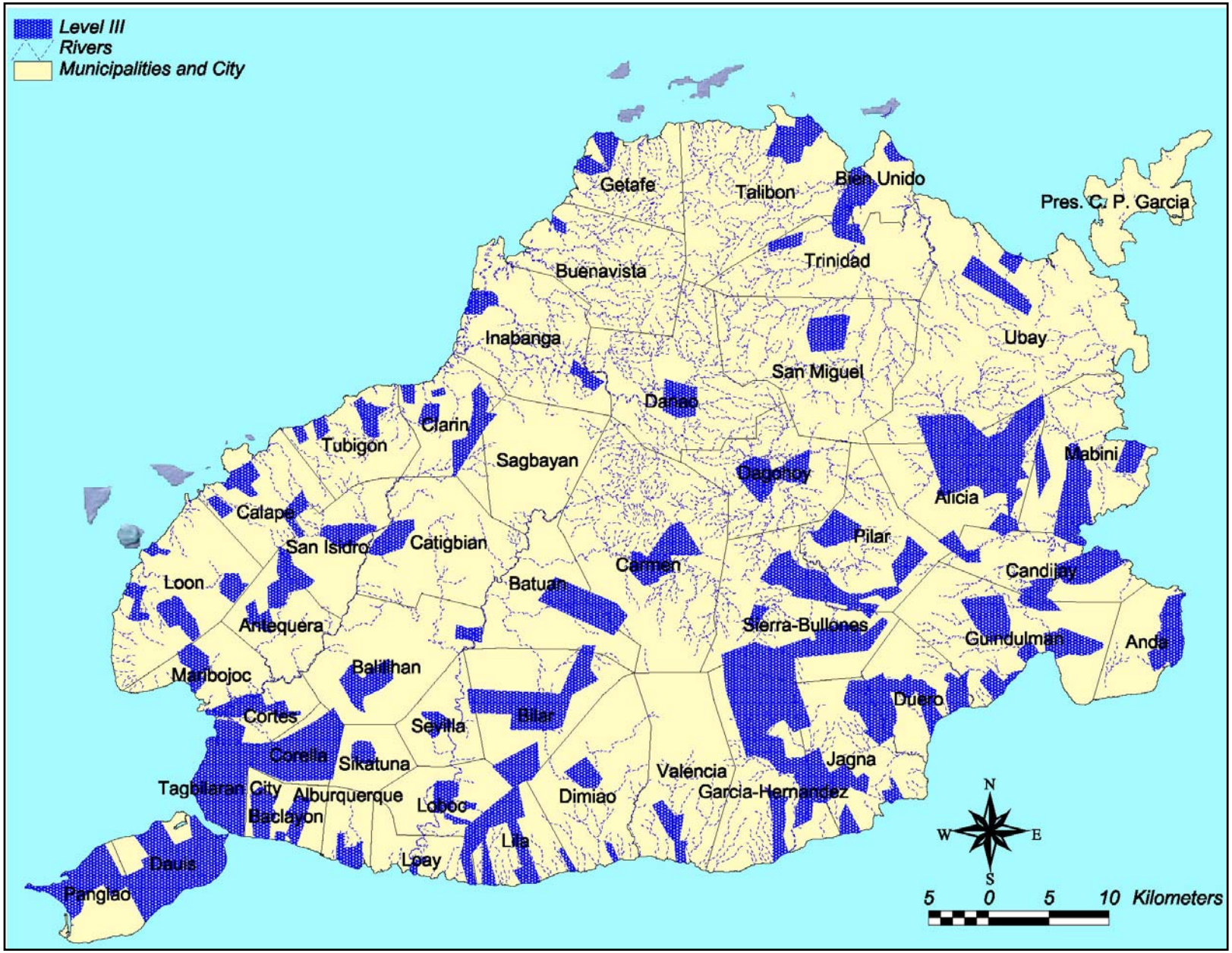


Figure 1-8 Existing Water Supply (Level III)

1.5.2 Irrigation

National Irrigation Authority-Bohol Provincial Office (NIA-BPO) has set for implementation ten (10) Communal Irrigation Systems for rehabilitation and/or improvement, three (3) small water impounding dams for construction, and installation of ten (10) projects under the Pump Irrigation category. Eleven (11) projects out of twenty-three (23) projects were completed. On the other hand, the Bohol Provincial Irrigation Office has accomplished 83% of their targets benefiting 458 hectares new service areas and at the same time, restored 187 hectares of service area.

The BHIP II is underway and will cover the irrigable areas of Ubay, San Miguel and Trinidad. Its target is 5,300 hectares when completed, and is expected to improve the province's yield per hectare of rice and other high value crops.

Potential irrigable area is about 40,800 hectares. There are two (2) National Irrigation System and about 215 Communal Irrigation Systems which are scattered and operating in the different municipalities. The present irrigation facilities cover a service area of 14,436 hectares for a rating on irrigation development status of 35.38% only. The NIA fell short of its target due to limited government financial resources and other pre-investment problems such as the difficulties encountered in social preparation, right-of-way (ROW) acquisition and sourcing of counterpart funds. The irrigation system for the island is shown in **Figure 1-9**.

1.5.3 Power and Transmission Lines

The combined installed capability of the power sources in Bohol is composed of the following: 17.5 MW from Diesel Power; 1.2MW from Loboc Hydroelectric; 5.0MW from Hanopol Hydroelectric; and 100MVA from the Leyte-Bohol Interconnection Project.

In its effort to further promote the development of new and renewable energy (NRE) systems, the government through the Department of Energy (DOE) spearheaded the continued active monitoring of available NRE systems in the province. Hydro and solar power systems are among the new and renewable energy sources that are prevalent in the province. Tapping nature as a source of energy, the DILG, thru the Office of the Project Development Services (OPDS) included Bohol Province in the Municipal Solar Infrastructure Project (MSIP). Selected remote barangays in six (6) municipalities (Danao, Buenavista, Dagohoy, Trinidad, Getafe and Bien-Unido) will be the beneficiaries of this project, which seeks to hasten development far-flung communities and uplift the living conditions of the inhabitants.

With the energization of the remaining ten (10) island barangays, BOHECO I has accomplished 100% within its area coverage, completing 602 potential barangays. These islands are Batasan in Ubay, Pangapasan, Bilangbilangan, Bag-ong Banwa and Mocaboc all in the town of Tubigon and Mantatao Island in Calape. Their source of power are from brand-new generator sets imported from the United Kingdom of England of different capacities, depending on the number of households the island.

Solar Power was launched at Inanuran Island, in Matabao Island of Tubigon assisting the Small Power Utilities Group (SPUG) of NPC giving service to 15 barangays. Another project that is being undertaken by BOHECO I is the construction of the 2.5 MW Hydroelectric Plant in Barangay Ewon, in Sevilla town. The completion of the project is targeted on the first quarter of 2008. The additional power supply will augment the power requirements of BOHECO I.

To support the delivery of health and other essential services, the provision of solar powered facilities and appropriate training are provided to communities. Municipal Solar Infrastructure Project had covered five (5) municipalities in the Second District of Bohol. A total of 16 barangays benefited from the project.

The power outlook of the island is shown in **Figure 1-10**.

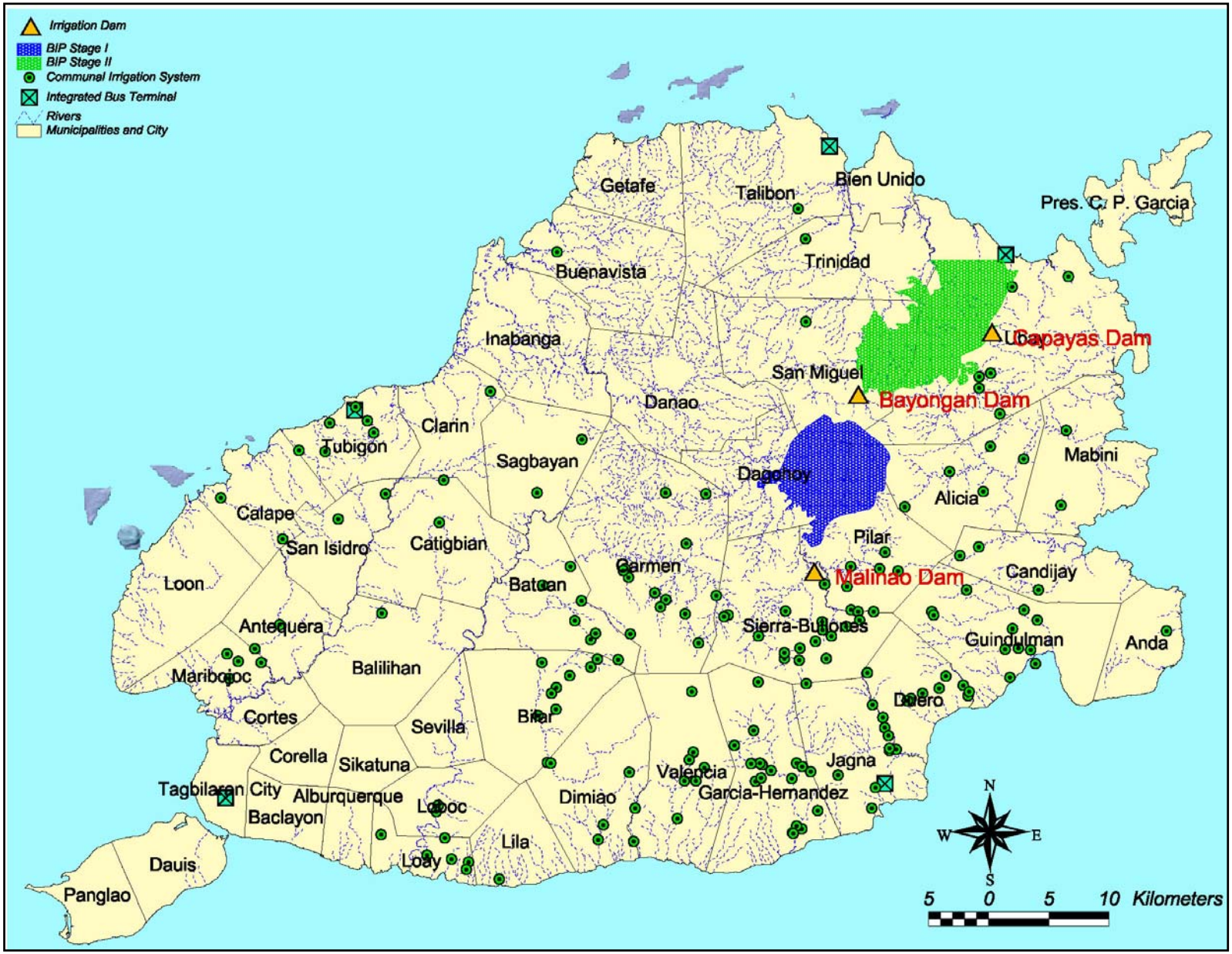


Figure 1-9 Irrigation System

Figure 1-10 Power System

1.5.4 Drainage System

The province, even its capital city of Tagbilaran, is challenged by the absence of a sewerage system. Open canals or ditches are used to drain all effluent directly to the rivers and streams. These practices pose grave risk to the integrity of the quality of the water, as well as endanger the health of people and all aquatic flora and fauna.

1.5.5 Communication

Three telephone companies (TelCos) are servicing the province and its municipalities and city: Philippine Long Distance Telephone Co. (PLDT); Cruz Telephone Co. (CRUZTELCO); and Isla Communications (ISLACOM). The latter covers 95% of the all municipalities of the province. Another three TelCos are providing cellular phone services: Globe, Smart, and Sun Cellular.

To ensure access to telecommunication services, PLDT & CRUZTELCO installed 43 pay phones capable of International Direct Dialing (IDD) across the province. Further, PLDT operates Public Calling Offices across the province.

In keeping with the demands of the Information Age, 6 Internet Service Providers (ISP's) provide internet access service: Bohol On-Line and BQ Link MosCom Tagbilaran. The latter covers the city of Tagbilaran and 19 other municipalities. However, this is just nearly 42% of actual demand.

In addition, there are five cable stations in the province: the Bohol Community Cable TV Systems Inc. (BCCTV) which covers Tagbilaran City, Corella, Cortes, part of Baclayon and Dauis; and, three others covering Maribojoc, Loay and Valencia.

In terms of broadcast and print media, there are 3 AM and 2 FM stations in operations and 4 weekly newspaper with nearly 15,000 copies in circulation.

1.5.6 Transportation

The primary mode of land transport in the island province is the Public Utility Bus (PUB) and the Public Utility Vehicles (PUJ), which are mostly Multi-Cabs. For short distance travel, the motorized tricycle is the preferred mode of transport. There are also taxicabs plying the route within the city proper up to anywhere within the province. There are also several "unregistered" Vehicles-for-Hire. These land transports traversed a road network of about 5,384 kilometers of varying road types: 6% Asphalt; 8% Concrete; 60% Gravel; and, 26% Earth. The latter road types are mostly barangay roads, which is the route of motorcycles-for-hire (habal-habal). Further, there is about 7,624 linear kilometers of bridges traversing the road network with nearly 58% being concrete bridges.

There are two flights daily from Manila to Tagbilaran and vice-versa serviced by the Philippine Airlines and Cebu Pacific. The airport at Tagbilaran City is classified as a secondary airport. Another airport, a feeder airport located in Ubay, is presently closed. Anticipating an increase in air traffic volume, the province is proposing for the development of another airport to be located at Panglao.

For sea-faring commuters and sea-based trading, the province has one (1) base port (the Tagbilaran City Port), four (4) terminal ports (Tubigon Port, Talibon Port, Ubay Port & Jagna Port), and two (2) sub-ports (Catagbacan Port & Getafe Port). There are also 16 municipal/fish landing areas catering to small vessels, motor bancas, pump boats and fishing boats, and three (3) private ports (Tantrade, Phil. Sinter Corp., and Bagacay Causeway).

1.6 OTHER INFRASTRUCTURE

The major road network of the province is expected to promote agricultural, eco-cultural tourism and agro-industrial development. These are classified as provincial roads and mostly linked by temporary provincial bridges. There are 5,383.584 kilometers of road in which, 10.94% are classified as national, 18.04% as provincial, 1.24% as city, 5.15% as municipal and 64.63% as barangay road.

Likewise, there are 7,623.692 linear meters of bridges within the road network, of which 58.21% are concrete, 9.09% are steel, 16.43% are bailey and 16.27% are timber bridges. Temporary bridges comprise 32.7%, mostly in bad condition and impassable to traffic due to poor maintenance. Bridges that were constructed several years ago are not designed for heavier traffic loads of more than 25 tons.

About half of the arterial/primary roads throughout the province had been upgraded as part of the Bohol Circumferential Road Improvement Project (BCRIP). The other half, the Tagbilaran North Road (TNR)-Tagbilaran City to Calape, and Tagbilaran East Road (TER)-Tagbilaran City to Candijay, being part of the BCRIP Phase II under the Arterial Road Links Development Project, has a total road length of about 136.03 kms and is due for completion this year. On the other hand, portions of the national secondary roads under the three (3) Highway Engineering Districts are dilapidated and require improvement and upgrading. In the meantime, regular maintenance, especially for asphalt and gravel sections, is necessary.

Figure 1-11 and **Figure 1-12** delineates the above infrastructure.

Figure 1-11 Roads, Bridges and Other Infrastructure

Figure 1-12 Flood Control Infrastructures

1.7 HEALTH STATUS

1.7.1 Morbidity and Mortality (10 leading causes)

The top ten leading causes of morbidity in the province for the past six years (2001-2006) were practically the same. Five (5) were respiratory illnesses that were infectious in nature. Hypertensive disease non-infectious in nature was consistently included among the top ten causes of morbidity during the same period. In 2006, nutritional deficiency ranked 10th. Diarrhea/acute gastroenteritis is consistently among the top two leading causes of morbidity in the area. This maybe an indicator of the poor water quality in the province. Skin disease which is watershed is also among the top ten leading causes for the same period. These two diseases also indicate poor environmental sanitation in Bohol community where about 21% of the household have no toilets or are underserved. This is compound by another reality where, except for Tagbilaran City, the potable water supply systems in the municipalities and barangays are untreated and generally prone to contamination.

Over 50% of deaths in Bohol were accounted for by the elderly of over 65 years old, meaning people are dying mostly due to old age. About 1/5th of deaths were accounted by people in the 50–64 years old bracket, while 5% of deaths occurred among the infant population. Compared to the previous years, deaths among the school-age children accounted for less than 1/5th of the entire population, hence children have now greater chances of reaching adulthood. This indicates a positive socio-economic development of the province.

The top 10 leading causes of death for the general population in year 2006 were practically the same as in the past five years. Seven (7) were due to degenerative causes, i.e., non-infectious in nature, while only three (3) were caused by infectious or biological agents. The top two leading causes of morbidity for the past six years (2001-2006) are diseases of the heart and pneumonia.

Although deaths predominantly occur among the old age group, illnesses or morbidity mostly affected the younger age group of 1–4 years old.

1.7.2 Water-Borne and Related Diseases

An indicator of health problems related to water supply and sanitation is the incidence of water-related diseases. The World Health Organization (WHO) has classified diseases related to water into four (4) categories: 1) water-borne diseases e.g., cholera, typhoid, hepatitis A, diarrhea and dysentery; 2) water-based diseases e.g., schistosomiasis; 3) water-washed diseases e.g., intestinal parasitism, scabies, conjunctivitis (sore eyes), and skin diseases; and 4) water-vector related diseases e.g., malaria, filariasis and dengue or H-fever. The reported cases in the Province were diarrhea, typhoid, hepatitis A, intestinal parasitism, skin disease and amoebiases. In 2006, water-related diseases in the ten leading causes of morbidity include diarrhea (rank 2nd) and skin diseases (rank 8th). Diarrhea (rank 2nd) is also among the ten leading causes of infant mortality.[5]

1.7.3 Health Facilities and Services

Present facilities serving the health care of the populace are 44 hospitals and 336 barangay health stations. The ratio of the population to these facilities is relatively lower as compared to the national average figures. On the other hand, in terms of the number of medical practitioners, the Province has more practitioners per population than the national.

[5] PW4SP Executive Summary

1.8 ENVIRONMENTAL CONDITION

Environmental problems related to wastewater discharge and unsanitary solid waste disposals are occurring in parts of the province. Major pollution sources in urban areas are domestic wastewater and dumped garbage. Only 14% of the total households in the Province relied on the municipal refuse collection services.

1.8.1 Sanitation Coverage

Based on PW4SP, Study, the overall percentage of households having approved types of toilet facilities in the whole province of Bohol is 79% in 2003. Twenty one percent (21%) of the households comprise the underserved or with unapproved toilet facilities) and unserved or those without toilet facilities. The absence of a safe water supply and approved toilet facilities in a household increases the risk of incidence of water-borne diseases such as diarrhea.

To help improve this situation, the German Technical Cooperation (GTZ), in collaboration with the local government units and NGOs, is currently implementing a program for sustainable sanitation in Bohol that included the introduction of Ecosan through Urine Diversion Dehydration Toilets (UDDT) as alternative to the conventional sanitation system. The UDDTs are recommended for waterless communities as this method eliminates use of water for flushing. Three pilot projects were already implemented in Panglao, Talibon and Sagbayan.

There are no centralized sewerage system to take care of the disposal of the sanitary wastes from septic tanks and other liquid wastes from industries and other sources in the province. Untreated sewage, domestic wastewater and industrial wastes therefore flows into the drainage system, canals or bodies of water or percolates into the ground. This practice is detrimental to the environment because it pollutes the bodies of water such as creeks, rivers and coastal waters, contaminates the groundwater aquifer, and poses risks to public health. Wastewater seeping underground might infiltrate pipelines with leaks when system pressures are low and may cause dirty water to reach the taps.

1.8.2 Wastewater Collection and Treatment

A major water pollution source in urban areas is domestic wastewater. Gray water generated by households is simply allowed to discharge into nearby water channels. Effluent from septic tanks or cesspools is also flowing into the streams. The other major pollutant is dumped refuse that finds its way to the river systems during rain or is thrown indiscriminately into the rivers. In rural areas, natural assimilation of the river may be expected to purify organic substances. However, pollution or contamination is anticipated caused by agricultural activities especially with reference to fertilizers and pesticides.

Domestic and agricultural activities are identified as potential pollution sources in the Province if control measures are not put in place.

At present, the provincial government is implementing the Decentralized Water Treatment System (DEWATS) with the technical assistance of the German Agency Technical Cooperation (GTZ). The project started in early 2007 and is scheduled for completion within the year. It has an estimated cost of about Php2 million funded by the provincial government. When completed, this facility will treat effluent from the septic tanks of the Provincial West Capitol Compound. The compound has about 600-700 occupants including those working at the commercial building within the compound. The Basic Needs Service-Bremen Overseas Research and Development Association (BNS-BORDA) provided the technical design and supervision of the facility.

1.8.3 Solid Waste Collection and Disposal

About 8% of households in Bohol have their garbage picked-up by garbage truck. Of the 48 municipalities/city, 44 have municipal refuse collection and disposal services (as of 2003). These municipalities/city have a total of 78 units of open dump truck or closed type trucks. Tagbilaran City has 8 closed type trucks.

Table 1-7 Households by Usual Manner of Garbage Disposal and Province/City, 2000

Province/City	Total Households	Usual Manner of Garbage Disposal						
		Picked-Up by Garbage Truck	Dumping in Individual Pit	Burning	Composting	Burying	Feeding to Animals	Others
Central Visayas	**1,133,767**	**252,241**	**126,249**	**609,406**	**62,251**	**32,544**	**45,655**	**5,421**
Bohol	213,215	17,556	28,059	110,756	22,850	7,633	25,887	474
Cebu	473,559	66,326	60,101	293,840	25,23	14,972	9,840	3.057
Negros Or	227,160	21,510	23,813	155,951	10,677	7,828	6,764	617
Siquijor	17,351	523	3,185	10,937	1,381	192	1,075	58
Cebu City	147,600	109,156	8,128	24,530	1,330	1,405	2.003	1,048
Mandaue City	54,882	37,170	2,963	13,392	590	514	86	167

Open dumping is practiced by all LGU's as disposal of solid wastes. The dumped refuse is usually burned or left unattended. Some significant negative effects associated with this unsanitary method are surface and groundwater pollution, air pollution, scattered solid waste, breeding grounds for insects, rodents and other disease vectors and fire hazard. At the household level, unserved households by the LGUs primarily depend on individual waste disposal such as dumping in vacant lots or body of water, burying and composting[6].

1.9 SITUATION OF GENDER AND DEVELOPMENT

Based on the existing population disaggregation, the ratio of male-female is 101.6:100, meaning there are more males than females among the population aged 0-44 years old. However, the migration pattern among the population indicates that there are more males emigrating than females[7].

With more females in the municipalities, local activities and development will impact most heavily on these half of the population.

A positive trend in the recognition of the relevant and significant roles played by women is the institutionalization, however weak at this time, of development agenda set forth by the local government. A GAD Code had been enacted in five (5) municipalities (Jagna, Batuan, Tubigon, Duero and Valencia) and in the city of Tagbilaran. Further, 85% of the 48 municipalities and city of the province had formulated respective GAD Plans. Moreover, nearly 14 non-government organizations and people's organizations (NGO's/PO's) are actively working to promote GAD issues and concerns through advocacy, IEC campaigns, and other developmental projects.

[6] PW4SP Chap 3

[7] Provincial Physical Framework Plan

Table 1-8 Municipalities with GAD Plans

Political District	BIAD	MUNICIPALITY	Complete Plan Collected	Collected Plan with Incomplete Budget	Collected Plan Without Budget	Budget only	Plan Not Collected	Existing Plan But Not Available For Collection	TOTAL
I	1	Alburquerque	1						1
I	1	Antequera	1						1
I	1	Baclayon	1						1
I	1	Balilihan					1	1	2
I	1	Corella	1						1
I	1	Cortes					1		1
I	1	Dauis	1						1
III	1	Lila	1						1
III	1	Loay	1						1
III	1	Loboc	1						1
I	1	Maribojoc	1						1
I	1	Panglao	1		1				2
III	1	Sevilla	1	1					2
I	1	Sikatuna	1		1				2
I	1	Tagbilaran City					1	1	2
		sub-total	**12**	**1**	**2**	**-**	**3**	**2**	**15**
II	2	Buenavista					1	1	2
I	2	Calape				1			1
I	2	Catigbian					1		1
II	2	Clarin					1		1
II	2	Getafe					1	1	2
II	2	Inabanga	1						1
I	2	Loon	1						1
II	2	San Isidro	1						1
I	2	Tubigon	1						1
		sub-total	**4**	**-**	**-**	**1**	**4**	**2**	**9**
III	3	Alicia	1						1
II	3	Bien Unido	1		1				2
III	3	Mabini	1	1					2
II	3	Pres.C.Garcia					1		1
II	3	San Miguel	1						1
II	3	Talibon	1						1
II	3	Trinidad				1			1
II	3	Ubay					1		1
		sub-total	**5**	**1**	**1**	**1**	**2**	**-**	**8**
III	4	Anda	1						1
III	4	Candijay	1						1
III	4	Dimiao	1						1
III	4	Duero	1		1				2
III	4	Garcia-Hernandez	1						1
III	4	Guindulman	1						1
III	4	Jagna	1						1
III	4	Valencia					1	1	2
		sub-total	**7**	**-**	**1**	**-**	**1**	**1**	**8**
III	5	Batuan					1		1
III	5	Bilar	1						1
III	5	Carmen	1						1
II	5	Dagohoy	1						1
II	5	Danao					1	1	2
III	5	Pilar				1			1
II	5	Sagbayan	1						1
III	5	Sierra Bullones					1		1
		sub-total	4	-	-	1	3	1	8
		TOTAL	**32**	**2**	**4**	**3**	**13**	**6**	**48**

1.10 POVERTY SITUATION

The poverty incidence in Bohol had dramatically improved to only 29.2% from a high of 50.2% of total households. Some of the factors cited for the continued high poverty incidence are: seasonal employment, particularly in agriculture; minimal opportunities for off-farm employment compared to the tremendous growth in labor force; decrease in the purchasing power of the peso vis-à-vis the increase in prices of basic commodities; and rapid population growth.

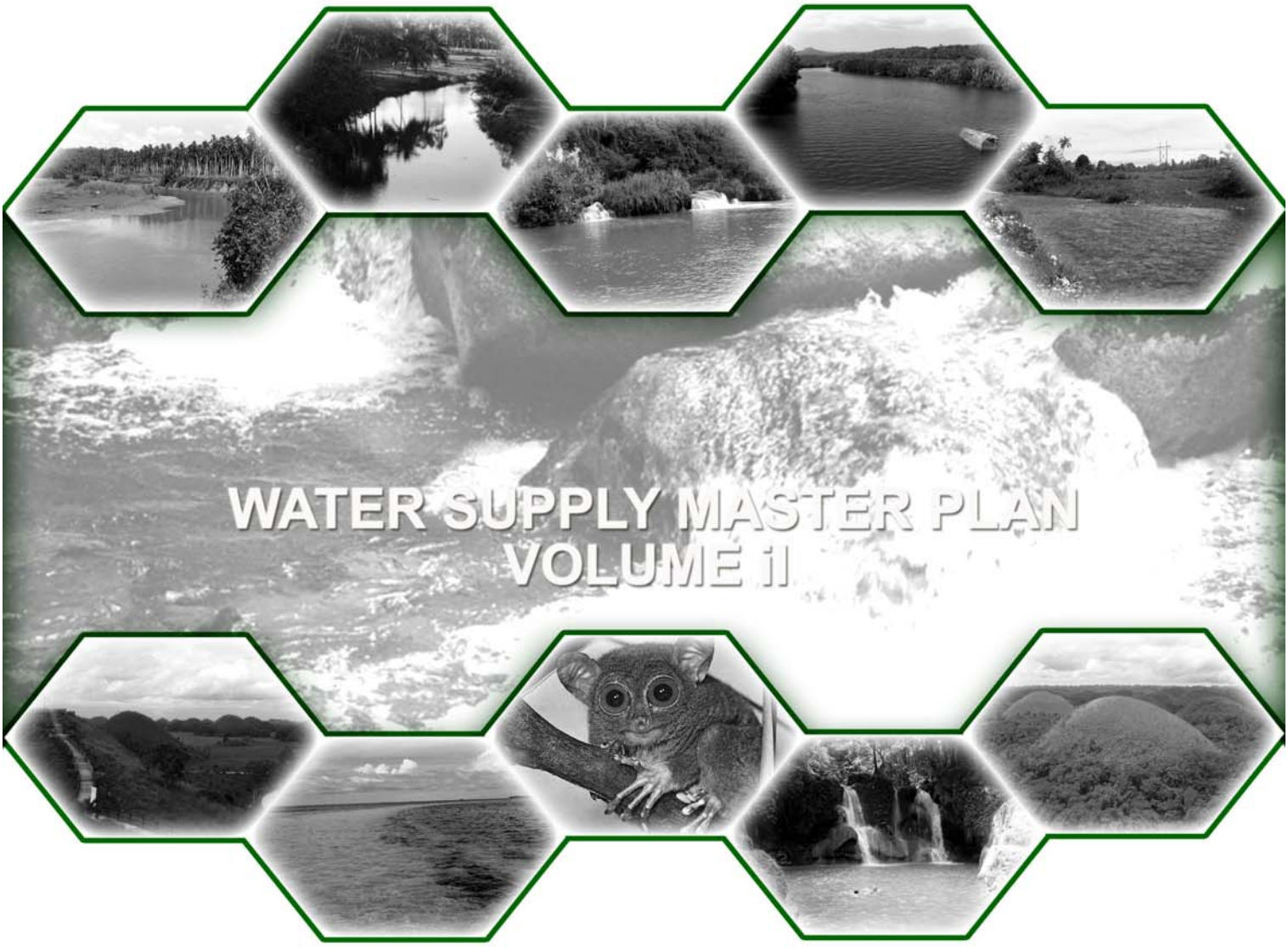
In a bid to map poverty, the province prepared a ranking system of determining degrees of deprivation. The indicators used were incidences of the following: households with unsanitary toilets; access to potable water; malnutrition among 0-6 years old; and, school drop-outs among school-aged group.

Based on such ranking, it was determined that nearly 16% of the household do not have sanitary toilets; nearly a fifth of the population lacks access to safe potable water; about one-third of 0-6 year olds suffer a certain degree of malnutrition; and, nearly 5.5% of school-aged population drop-out of school.

Further, nearly three percent (3%) of babies born in Bohol in 2004 weighed less than 2,500 grams, which indicate poor diet and/or low nutritional intake among mothers.

Despite the alarming increase in poverty incidence, however, the province has achieved improvement in the Human Development Index (HDI), a composite measure of education, income and life expectancy. This positive trend shows that despite limited cash income, Boholano families have managed their resources well to minimize the impact of low income on their quality of life.

The province currently seeks to reduce poverty incidence from 47.3% to 30% by 2012.



CHAPTER 2
THE EXISTING WATER SUPPLY SYSTEM AND SANITATION FACILITIES

CHAPTER 2 – THE EXISTING WATER SUPPLY SYSTEM AND SANITATION FACILITIES

2.1 SITUATIONAL ANALYSIS

The PW4SP[1] study conducted by the German Agency for Technical Cooperation (GTZ) presented that, in 2003 about 59% of the total population or about 732,220 persons in Bohol have access to safe water sources. Of this figure, 59% are served by Level III facilities, 6% by Level II facilities, and 35% by Level I facilities or point sources. The remaining portion of population (41%) relies on unsafe water sources. The unsafe sources are usually open dugwells, undeveloped springs, or rainwater collector and other sources which are open to contamination.

This finding may be supported by the health situation in Bohol. Based on records gathered from the Provincial Health Office (PHO), the top ranking cause of morbidity in the province for the past six years (2001 to 2006) was diarrhea, a water-borne disease which may be caused by ingesting water with poor quality , details of which will be discussed later in this chapter.

Dugwell at Barangay Nabuan, Inabanga

2.2 THE EXISTING WATER SYSTEM OF BOHOL

A rapid assessment of the condition of the existing waterworks system mostly serving the urban area of each municipality was undertaken by the Consultant through field surveys with municipal personnel in-charge of the supervision of the water systems. Field surveys and interviews were conducted by the Consultant on July 02-24, 2007 and August 06-20, 2007, to assess the situation of existing systems in each municipality. Some limiting factors were encountered during conduct of the survey such as, unavailability of records and inadequate knowledge of the system of the waterworks personnel and in few cases, reluctance of the personnel to share information about the water system. Emphasis was given to collection of the following data: consumption pattern, number of service connections, sources (existing and potential), water treatment method, existing water tariffs, on-going/proposed water supply improvement projects, if any, and common problems and deficiencies.

[1] Provincial Water Supply Sewerage and Sanitation Sector Plan for Bohol by German Agency for Technical Cooperation-Department of the Interior and Local Government in collaboration with the Provincial Government of Bohol

Information from previous studies such as the Provincial Water Supply, Sewerage and. Sanitation Sector Plan for Bohol (PW4SP), Water Supply, Sanitation, Sector Master Plan for Bohol,Province (W4SMP), Comprehensive Land Use Plan (CLUP) and the Municipal Socio-Eco Profile of the municipalities were also gathered.

The actual data gathered on the existing systems of Bohol municipalities and results and assumptions of previous studies will be used as bases in projecting requirements for the master plan.

The names of persons met during data gathering/interviews and field survey are listed in **Appendix II.2-A, Volume III, Databook**.

2.2.1 Existing Institutional Set-Up

The municipal water system operates as an economic enterprise usually under the office of the Municipal Planning and Development Coordinator or the Municipal Engineer which acts as the waterworks head responsible for the technical operation of the system including meter reading. The billing and collection functions are under the Municipal Treasurer's Office while the Municipal Health Office undertakes water quality monitoring including treatment of water from the sources and the reservoirs. Only a very few municipalities have a separate waterworks office (i.e. Talibon and Clarin Water Districts, Guinbuwasco and UWASCO) that is responsible for the overall operation (technical, financial and administrative functions) of the system. Some of the personnel utilized in municipal waterworks office do double jobs as some of them are also assigned in other units of the local governments.

Based on interviews maintenance and operations of the water systems, particularly for the pumping systems, are usually subsidized by the local government since the income from water sales is not sufficient to cover power cost for pumping. Loon is one of municipalities which earnings from water system can sustain its maintenance and operation.

2.2.2 Levels of Service and Service Coverage

The existing levels of service in the municipalities in Bohol are Levels I, II and III. By NEDA and DPWH definitions, Level I is a point source facility whether spring, well or rainwater collector which serves about 16 households located not more than 250m away from the farthest user. Level II service is a system where the source is either a spring, well or an infiltration gallery, and has a pipeline distribution for communal tappings and a reservoir. Level II system serves about 25 households per communal faucet where the farthest house is about 25 meters from the faucet. Level III, on the other hand is a system comprising of a source, reservoir, a distribution networks with individual house service connections. For clarificatory purposes, the definition of the types of services are established in the NEDA Board Resolution No. 12, **Appendix II.2-B, Volume III-Databook.**

Communal Faucet at Barangay Guinoban, Sevilla

Most urban barangays in Bohol have Level III water systems particularly those that are being served by the LGU water system. Some exceptions are the municipalities of Pres. C.P. Garcia and San Miguel. Pres. C.P. Garcia, a small island municipality, has no reported potential water source for Level III system while the newly constructed Level III system in San Miguel is still awaiting for source which may come from the municipality of Pilar or Bayongan Dam. The municipality of San Miguel has requested Pilar to extend water supply service to the municipality. Based also on interview with the MPDC, a pending request to source water from the newly constructed Bayongan Dam was already submitted to the National Irrigation Administration (NIA).

The number of barangays being served by the LGU managed waterworks system and other water service providers in the urban area is shown in **Table 2-1** while the reported number of service connections and estimated number of persons served computed based on the average number of persons per household (NSO 2000) is presented in **Table 2-2**.

Information on the service coverage for Levels I, II and III systems from the PW4SP study (**Table 2-3**) together with the information reflected in Tables 2-1 and 2-2 will be used as reference in projecting served population.

Table 2-1 Number of Barangays Served by the LGU Waterworks System

	Municipality	Total No. of Barangays	No of Barangays Served by LGU Water System, WDs and Cooperatives		Municipality	Total No. of Barangays	No of Barangays Served by LGU Water System, WDs and Cooperatives
1	Alburquerque	11	9	25	Guindulman	19	11
2	Alicia	15	2	26	Inabanga	50	15
3	Anda	16	6	27	Jagna	33	7
4	Antequera	21	20	28	Lila	18	8
5	Baclayon	17	11	29	Loay	24	11
6	Balilihan	31	31	30	Loboc	28	12
7	Batuan	15	3	31	Loon	67	35
8	Bien Unido	15	7	32	Mabini	22	4
9	Bilar	19	8	33	Maribojoc	22	19
10	Buenavista	35	9	34	Panglao	10	10
11	Calape	33	27	35	Pilar	21	15
12	Candijay	21	8	36	Pres. Carlos P. Garcia	23	0
13	Carmen	29	2	37	Sagbayan	24	14
14	Catigbian	22	13	38	San Isidro	12	4
15	Clarin	24	16	39	San Miguel	18	0
16	Corella	8	8	40	Sevilla	13	11
17	Cortes	14	14	41	Sierra Bullones	22	8
18	Dagohoy	15	10	42	Sikatuna	10	10
19	Danao	17	8	43	Tagbilaran City	15	15
20	Dauis	12	7	44	Talibon	25	9
21	Dimiao	35	16	45	Trinidad	20	3
22	Duero	21	15	46	Tubigon	34	12
23	Garcia Hernandez	30	12	47	Ubay	44	9
24	Getafe	24	2	48	Valencia	35	15
	Sub-total	500	264			609	257
Total Number of Barangays = 1,109							
Total Number of Served Barangays = 521							

The estimated number of persons presently being served by Level III systems managed by the LGUs, WDs and water cooperatives was derived by multiplying the reported number of service connections with the average number of persons per household. The number of persons per household was derived from the 2000 NSO data on population and number of household in a municipality. It is assumed that one service connection serves one household.

Table 2-2 Estimated Population Served by the LGU Waterworks Office, WDs and Cooperatives

	Municipality/City	2000 POP (NSO)	No. of Households	Persons Per Household	Existing Number of Service Connections	Estimated No. of Persons Presently Served by LGU Water System, WDs and Cooperatives
1	Alburquerque	8,715	1,670	5.22	1,218	6,356
2	Alicia	21,605	4,065	5.31	310	1,648
3	Anda	17,863	3,072	5.81	1,353	7,861
4	Antequera	13,758	2,801	4.91	1,620	7,957
5	Baclayon	14,996	2,978	5.04	2,006	10,101
6	Balilihan	16,837	3,101	5.43	2,034	11,044
7	Batuan	11,835	2,287	5.17	300	1,552
8	Bien Unido	22,176	3,984	5.57	552	3,073
9	Bilar	16,628	2,967	5.60	1,228	6,882
10	Buenavista	25,960	4,550	5.71	325	1,854
11	Calape	27,921	5,588	5.00	2,880	14,390
12	Candijay	30,389	5,420	5.61	1,474	8,264
13	Carmen	40,713	7,379	5.52	630	3,476
14	Catigbian	21,461	4,094	5.24	925	4,849
15	Clarin	18,040	3,575	5.05	1,138	5,743
16	Corella	6,048	1,263	4.79	999	4,784
17	Cortes	12,702	2,547	4.99	1,019	5,082
18	Dagohoy	16,845	3,095	5.44	548	2,983
19	Danao	17,265	2,958	5.84	800	4,669
20	Dauis	26,415	2,669	9.90	3,373	33,382
21	Dimiao [1/]	14,151	2,708	5.23	469	2,451
22	Duero	16,485	3,245	5.08	1,736	8,819
23	Garcia Hernandez	21,428	3,989	5.37	1,500	8,058
24	Getafe	26,826	4,694	5.71	88	503
25	Guindulman	29,166	5,573	5.23	1,726	9,033
26	Inabanga	40,714	7,867	5.18	1,574	8,146
27	Jagna	30,643	5,957	5.14	1,500	7,716
28	Lila	10,322	1,723	5.99	762	4,565
29	Loay	14,433	2,615	5.52	1,500	6,623
30	Loboc	15,734	2,738	5.75	891	5,120
31	Loon	45,215	7,915	5.71	3,639	20,788
32	Mabini	27,250	5,047	5.40	643	3,472
33	Maribojoc	16,786	2,630	6.38	2,482	15,841
34	Panglao	21,337	3,890	5.49	3,350	18,375
35	Pilar	25,095	4,489	5.59	1,684	9,414
36	Pres. Carlos P. Garcia	20,744	4,062	5.11	No existing Level III System	
37	Sagbayan	18,346	3,688	4.97	2,044	10,168
38	San Isidro	9,106	1,848	4.93	115	567
39	San Miguel [2/]	20,828	3,738	5.57	Awaiting for source	
40	Sevilla	10,281	1,840	5.59	800	4,470
41	Sierra Bullones	25,499	4,473	5.70	1,306	7,444
42	Sikatuna	6,602	1,177	5.61	1,085	6,086
43	Tagbilaran	77,700	15,585	4.99	15,126	75,412
44	Talibon	54,147	9,712	5.58	1,487	8,290
45	Trinidad	25,683	4,707	5.46	232	1,266
46	Tubigon	40,385	7,714	5.24	1,733	9,073
47	Ubay	59,827	11,511	5.20	1,735	9,017
48	Valencia	24,363	4,392	5.55	720	3,994
	Total	**1,137,268**	**209,590**		**74,659**	**412,318**

Source: Waterworks Office of each Municipality

[1/] No data was furnished, hence adopted from PW4SP

[2/] The newly constructed Level 3 system is not yet operational and still awaiting for supply which may come from NIA (Bayongan Dam) or the municipality of Pilar

Table 2-3 Percent Served Population/Service Coverage as of 2003

Barangay Class	Level of Service (Safe Sources)				Underserved/Unserved [1/]
	Level I	Level II	Level III	Total	
Urban	9	1	49	60	40
Rural	26	5	28	59	41
Total	20	4	45	50	41

[1/] Refers to percent of population not adequately served or with unsafe sources
Source: Provincial Water Supply, Sewerage and Sanitation Sector Plan for Bohol

2.2.3 Existing Water Sources

During field interviews, most of the identified sources are springs, deepwells, shallow wells, dugwells and rainwater through collectors. Two surface water sources were identified, one in Ubay which is the Calanggaman catchment area and another in Dagohoy, the Mas-ing Creek.

At the southern part of Bohol, the municipalities of Valencia, Jagna, Duero, Lila, Garcia Hernandez including the inland municipalities of Batuan, Bilar, Sierra Bullones and Pilar, there is abundance of groundwater reserve, however, the main problem is the lack of funds for source development such as for construction of intake boxes, laying of appropriate size of transmission lines, reservoirs and installation of proper treatment facilities. Existing sources also become lesser during summer months due to the lowering of the water table in cases of wells and/or drying up of the springs.

Hand Pump at Sitio Datan, Bgy. Katipunan, Carmen

Municipalities in the northern part to of Bohol such as Getafe, Trinidad, Buenavista, Dagohoy, San Miguel, Bien Unido and Ubay, have scarce water resource that is further aggravated by drying up of the sources during summer.

Tiguis Spring at Municipality of Lila

Barangays that are not yet covered by the water system rely on shallow wells, deep wells, improved springs and privately owned rain collectors for water sources. The PW4SP study accounted 3,414 and 11,015 safe and unsafe Level 1 sources, respectively, **Table 2-4**.

The study, however, did not mention unsafe sources for Level II and Level III services. As defined in the NEDA Guidelines, systems falling under these levels of service have reservoirs/storages, therefore, it is understood that treatment by chlorination may be applied to the reservoirs/storages to improve quality and eliminate harmful pathogens in the water prior to domestic use. The number of sources for Level 2 and Level 3 facilities (summarized from PWSP), is shown in **Table 2-4a**.

Due to the magnitude of data to be gathered and the limited time allotted for the study, the above sources were not visited and verified; hence an update of information on current status was not included. Future studies that will utilize the existing sources should undertake thorough review and verification on the water quality and quantity of flow from the said sources.

Table 2.4 Safe and Unsafe Sources for Level I Facilities

Name of Municipality/City	Number of Safe Water Sources					Number of Unsafe Water Sources					
	Deep Well	Shallow Well	Covered/ Improved Dug Well	Developed Spring	Total	Shallow Well	Covered/ Improved Dug Well	Open Dug Well	Undeveloped Spring	Rain Water Collector	Total
Alburquerque	26	3	0	2	31	31	5	2	3	0	41
Alicia	6	4	8	58	76	41	65	15	16	0	137
Anda	7	0	0	8	15	1	1	0	0	0	2
Antequera	46	3	2	34	85	31	26	24	7	0	88
Baclayon	41	0	1	5	47	2	8	9	11	0	30
Balilihan	32	4	1	45	82	37	11	16	0	0	64
Batuan	19	4	2	30	55	37	15	60	1	0	113
Bien Unido	1	0	22	0	23	5	201	234	21	0	461
Bilar	7	2	1	43	53	18	18	28	6	0	70
Buenavista	33	2	19	15	69	22	172	52	32	0	278
Calape	39	18	1	79	137	161	7	53	14	0	235
Candijay	39	18	1	79	137	161	7	53	14	0	235
Carmen	26	19	18	58	121	176	157	38	5	0	376
Catigbian	17	7	3	23	50	53	33	17	6	0	109
Clarin	19	4	3	2	28	42	34	32	9	0	117
Corella	30	1	1	1	33	12	5	0	8	0	25
Cortes	44	1	0	5	50	13	0	0	0	0	13
Dagohoy	26	13	20	2	61	110	175	187	20	0	492
Danao	22	5	7	28	62	46	59	4	2	0	111
Dauis	34	0	6	0	40	0	55	67	21	0	143
Dimiao	9	4	0	29	42	36	2	1	0	0	39
Duero	11	28	0	37	76	249	2	0	1	0	252
Garcia Hernandez	12	2	0	14	28	16	3	0	2	0	21
Getafe	13	12	12	3	40	99	101	105	9	0	314
Guindulman	37	8	1	32	78	79	8	7	3	0	97
Inabanga	89	13	27	26	155	108	252	272	29	0	661
Jagna	35	22	0	28	85	188	7	44	16	0	255
Lila	1	0	0	7	8	1	0	0	2	0	3
Loay	42	2	0	14	58	20	3	4	10	0	37
Loboc	36	5	0	16	57	44	8	4	8	0	64
Loon	33	3	0	75	111	34	1	16	10	0	61
Mabini	11	4	5	19	39	39	49	24	43	0	155
Maribojoc	33	2	0	13	48	17	2	6	4	0	29
Panglao	25	1	11	0	37	5	92	202	22	0	321
Pilar	19	11	5	44	79	99	42	0	27	0	168
Pres. Carlos P. Garcia	4	3	32	0	39	26	270	271	52	0	619
Sagbayan	130	15	10	16	171	131	88	49	6	0	274
San Isidro	41	2	2	69	114	23	14	7	11	0	55
San Miguel	12	16	28	4	60	152	259	109	18	0	538
Sevilla	17	8	1	24	50	72	6	13	2	0	93
Sierra Bullones	6	4	0	30	40	35	3	8	2	0	48
Sikatuna	13	2	1	4	20	14	5	0	16	0	35
Tagbilaran City (Capital)	65	4	1	5	75	35	9	69	7	0	120
Talibon	36	10	81	1	128	89	721	280	45	0	1,135
Trinidad	18	22	81	2	123	199	735	174	51	0	1,159
Tubigon	111	8	4	17	140	68	37	92	3	0	200
Ubay	11	22	61	2	96	200	553	263	33	0	1,049
Valencia	63	3	0	96	162	36	5	31	1	0	73
Provincial Total	1,447	344	479	1,144	3,414	3,113	4,331	2,942	629	0	11,015

Source: PW4SP

Table 2-4a: Water Sources for Level III and Level II Systems

Alburquerque	SP	1	-	-
Alicia	SP	9	-	-
Anda	SP	2	SP	12
Antequera	SP	2	DW	2
Baclayon	DW	6	DW	1
Balilihan	DW	3	SP	1
Batuan	SP	3	SP	17
Bien Unido	DW	3	-	-
Bilar	SP/DW/Surf	2/3/1	SP	1
Buenavista	DW	2	-	-
Calape	SP/DW	1/5	-	-
Candijay	SP	1	SP	34
Carmen	SP/DW	1/1	SP/DW	1/1
Catigbian	DW	1	DW	2
Clarin	SP/DW	6/1	SP/DW	3/2
Corella	DW	6	-	-
Cortes	SP/DW	4/3	-	-
Danao	SP/DW	4/1	SP	2
Dagohoy	Surf	1	-	-
Dauis	DW	6	DW	5
Dimiao	SP/DW	2/2	-	-
Duero	SP	10	SP	2
Garcia Hernandez	SP	6	-	-
Getafe	-	-	DW	2
Guindulman	DW	2	-	-
Inabanga	SP/DW	1/4	SP/DW	7
Jagna	SP	2	-	-
Lila	SP	2	-	-
Loay	SP/DW	5/5	DW	4
Loboc	SP/DW	10/3	SP/1	1/4
Loon	SP/DW	2/4	-	-
Mabini	SP/DW	10/5	SP	10
Maribojoc	SP	4	-	-
Panglao	SP/DW	1/3	-	-
Pilar	SP	1	-	-
	SP	1	-	-
Sagbayan	DW	1	SP	1
San Isidro	DW	1	SP	12
San Miguel	-	-	DW	3
Sevilla	SP/DW	1/2	-	-
Sierra Bullones	SP	26	SP	9
Sikatuna	DW	4	-	-
Tagbilaran City (Capital)	DW	21	-	-
	DW	19	-	-
Talibon	DW	3	-	-
Trinidad	SP/DW	1/1	SP	1
Tubigon	SP/DW	3/12	SP/DW	8/13
Ubay	Surf	1	DW	1
Valencia	SP	5	SP	1
Provincial Total		173		157

Source: PW4SP

Note: Type of Water Source are either ***DW*** - Deep Well, ***DgW*** - Dug Well, ***Surf*** - Surface Water (River), ***SP*** - Spring, and ***IG*** - Infiltration Gallery

2.2.4 Average Consumption

The average consumption information was derived based on interviews with the officials of the waterworks offices and other available records. The average consumption ranges from 10 cum to 30 cum meters per month. It was observed that municipalities which are largely rural have lesser unit consumption than other municipalities. The average unit consumption was derived by dividing the average daily consumption of a house service connection with the average number of persons per household per NSO data.

Municipalities which were found to have higher unit consumptions are tabulated below:

Table 2-5 Average Unit Consumption (High Bracket)

Municipality/City		Average Unit Consumption (lpcd)
1	Tagbilaran City	180-200
2	Garcia Hernandez	144
3	Loon	144
4	Ubay	142
5	Loboc	137
6	Danao	114
7	Talibon	109
8	Bilar	103
9	Alburquerque	102
9	Calape	100

The following municipalities have the lowest consumption usually falling within the bracket of minimum water rates:

Table 2-6 Average Unit Consumption (Low Bracket)

Municipality/City		Average Unit Consumption (lpcd)
1	Sagbayan	68
2	Sierra Bullones	68
3	San Isidro	68
4	Sevilla	68
5	Alicia	63
6	Dauis	62
7	Buenavista	60
8	Bien Unido	60

The derived average unit consumption of Talibon may be used as basis in projecting unit consumption for municipalities with estimated unit domestic consumption lower than 100 lpcd since it has a more established data recording system. The unit domestic consumption reflected in the table above was computed based on one year record from January to December 2006.

Water purifying stations are also sources of drinking water in the province, however, no data was compiled for this aspect. Considering the minimum requirement that a person should drink 6 to 8 glasses of water, 1.5 to 2.0 L may be added to a person's average daily consumption.

2.2.5 Treatment Facilities

Among the water service providers, only Bohol Water Utilities, Inc. (BWUI.) implements regular water treatment using pumped chlorinators and conducts monitoring of residual chlorine. Based on discussions with BWUI officials, the service area with an estimated served population of about 55,000 is divided into three clusters with two samplings points each, where samples are taken weekly for bacteriological testing and monitoring.

For a served population ranging from 5,000 to 100,000, the Philippine National Standard for Drinking Water (PNSDW) requires one (1) sample per 5,000 served population monthly for bacteriological testing and measurement of residual chlorine. The samples should be representative of the whole distribution system. Residual chlorine should be 0.2 to 0.5 mg/L in the distribution system to reduce the risk of microbial growth.

The Tagbilaran City Waterworks System's method of treatment is done by manually mixing the chlorine solution and pouring the solution into the reservoir. Chlorine dosing per reservoir is done on a weekly basis.

As a requirement of the NWRB, Talibon WD conducts physico-chemical testing of the sources once a year and a monthly bacteriological test as regulatory requirement of the LWUA. Prior to distribution, water from deepwell in Talibon pass thru silver anode since the treatment process which involves aeration, sedimentation, sand filtration and chlorination is not enough to remove iron.

The existing treatment facility/process in Dagohoy is not adequate in treating murkiness/turbidity of water. Water from Mas-ing Creek directly goes to the rapid sand filtration tanks then to the sump and pumped into a ground reservoir located at high elevation. The design for this filtration system should have included an equalization tank and a sedimentation tank prior to filtration.

Ubay Waterworks and Sanitation Cooperative (UWASCO) shared the same problem with Dagohoy. The existing filtration plant cannot remove turbidity from surface water source because it also does not have a sedimentation basin prior to filtration.

In Loon, all sources have chlorinators for continuous water treatment, while in other municipalities frequency of chlorination application at the reservoir ranges from once every two days to once a month. A few municipalities undertake water treatment and cleaning of the reservoir "as the need arises" when there are incidence of waterborne diseases such as diarrhea.

In Loay, people buy drinking water from water stations as they are aware that water being served by the LGU, particularly the water coming from a spring in Loboc is not intended for drinking purposes but for other domestic uses only.

Water that is not properly treated may cause waterborne diseases, the most common of which are diarrhea and acute gastroenteritis. **Tables 2-7 and 2-8** show a comparative ranking of the top ten causes of mortality and morbidity for five year period (2001-2006) for the whole province of Bohol. It was observed that Diarrhea/Acute Gastroenteritis has been the number one cause of morbidity for years 2001, and 2003 to 2005, and ranked 2nd in year 2001 and 2006. This is an indication that there might be some problems in the water quality in the area. No waterborne disease however, was included in the top ten leading cause of mortality for the same period which means that, in most cases diarrhea can be easily treated.

Table 2-7 Ten Leading Causes of Morbidity, Number of Cases and Rank

2001			2002			2003		
Rank	**Causes**	**No. of Cases**	**Rank**		**No. of Cases**	**Rank**		**No. of Cases**
1	Diarrhea/Acute Gastroenteritis	29,255	1	Acute Respiratory Infection/ No Pneumonia	21,434	1	Diarrhea/Acute Gastroenteritis	21,862
2	Acute Respiratory Infection/ No Pneumonia	16,692	2	Diarrhea/Acute Gastroenteritis	20,287	2	Acute Respiratory Infection/ No Pneumonia	21,880
3	Bronchitis/ Brochiolitis	12,278	3	Influenza	14,348	3	Bronchitis/ Brochiolitis	15,248
4	Pneumonia	12,174	4	Bronchitis/ Brochiolitis	13,398	4	Influenza	13,934
5	Influenza	9,327	5	Hypertensive Disease	9,750	5	Pneumonia	9,758
6	Hypertensive Disease	5,083	6	Pneumonia	9,164	6	Hypertensive Disease	9,667
7	Skin Disease	1,832	7	Skin Disease	2,677	7	Skin Disease	3,000
8	TB (all forms)	1,398	8	TB Respiratory	994	8	Parasitism (Intestinal)	1,315
9	Measles	1,047	9	Diseases of the Heart	853	9	Wounds (all types)	1,052
10	Wounds (all types)	611	10	Chicken Pox	658	10	TB Respiratory	926
2004			**2005**			**2006**		
Rank	**Causes**	**No. of Cases**	**Rank**		**No. of Cases**	**Rank**		**No. of Cases**
1	Diarrhea/Acute Gastroenteritis	25,310	1	Diarrhea/Acute Gastroenteritis	19,332	1	Acute Respiratory Infection/ No Pneumonia	3,011
2	Acute Respiratory Infection/ No Pneumonia	19,582	2	Upper Respiratory Tract Infection	17,194	2	Diarrhea/Acute Gastroenteritis	23,223
3	Influenza	15,402	3	Pneumonia	13,400	3	Bronchitis/ Brochiolitis	13,181
4	Bronchitis/ Brochiolitis	14,028	4	Influenza	12,424	4	Lower Respiratory Tract Infection	11,489
5	Pneumonia	13,257	5	Lower Respiratory Tract Infection	11,403	5	Pneumonia	10,057
6	Hypertensive Disease	7,540	6	Hypertensive Disease	8,225	6	Fibrile Fever	7,692
7	Skin Disease	3,133	7	Fibrile Fever	4,548	7	Hypertensive Disease	6,555
8	Fibrile Fever	2,949	8	Urinary Tract Infection	17,194	8	Skin Disease	5,612
9	TB Respiratory	981	9	Skin Disease	2,431	9	Influenza	4,966
10	Systemic Viral Infection	893	10	Wounds (all type)	1,371	10	Nutritional Deficiency	2,179

Source: Provincial Health Office

Table 2-8 Ten Leading Causes of Mortality, Number of Cases and Rank

2001			2002			2003		
Rank	Causes	No. of Cases	Rank		No. of Cases	Rank		No. of Cases
1	Disease of the heart	998	1	Pneumonia	979	1	Disease of the heart	1,147
2	Pneumonia	946	2	Disease of the heart	929	2	Pneumonia	798
3	Cancer (all kinds)	453	3	Cardio Vascular Diseases	616	3	Hypertensive Disease	472
4	Hypertensive Disease	348	4	Cancer (all kinds)	422	4	Cancer (all kinds)	324
5	Cardio Vascular Accident	321	5	Hypertensive Disease	348	5	Kidney Disease (all types)	269
6	TB (all forms)	281	6	TB Respiratory	285	6	TB (all forms)	259
7	Accident/Injuries	184	7	Kidney Disease (all types)	202	7	Accident/Injuries	216
8	Genito-urinary disease	164	8	Accident/Injuries	170	8	Bleeding Peptic Ulcer	172
9	Bleeding Peptic Ulcer	153	9	Liver Disease (all forms)	166	9	Septicemia	153
10	Septicemia	134	10	Septicemia	161	10	Stillbirths	106
2004				**2005**		**2006**		
Rank	Causes	No. of Cases	Rank		No. of Cases	Rank		No. of Cases
1	Disease of the heart	940	1	Pneumonia	870	1	Disease of the heart	1,152
2	Pneumonia	687	2	Disease of the heart	862	2	Pneumonia	806
3	Cancer (all kinds)	454	3	Cardio Vascular Diseases	603	3	Cancer (all kinds)	486
4	Cardio Vascular Diseases	332	4	Cancer (all kinds)	521	4	Hypertensive Disease	447
5	Kidney Disease (all types)	243	5	Hypertensive Disease	402	5	Kidney Disease (all types)	301
6	Hypertensive Disease	198	6	TB Respiratory	295	6	Cardio Vascular Diseases	220
7	TB Respiratory	170	7	Senility	250	7	Lower Respiratory Tract Infection	210
8	Accident/Injuries	153	8	Kidney Disease (all types)	247	8	Accident/Injuries	184
9	Septicemia	125	9	Lower Respiratory Tract Infection	211	9	TB Respiratory	172
10	Diabetes (all types)	118	10	Stomach Disease	187	10	Stomach Disease	171

Source: Provincial Health Office

2.2.6 Water Rates

The review of the water rates of the 47 municipalities and 1 city showed that Buenavista and Getafe have the highest cost of water at Php70 for the first 3 cum and Php 275 for the first 15 cum, respectively. In Buenavista also, water consumption in excess of 3 cum is priced at Php 50 per cum while in Getafe excess consumption is priced at Php 25 per cum. The sources of these two waterworks are both deepwells which require high pumping costs.

The municipalities in the southern part of Bohol with springs as sources have the lowest rates as follows:

Table 2-9 Municipalities with Lowest Water Rates

Municipality	Minimum Water Rate (Php)	Consumption Bracket
Garcia Hernandez	15.00	First 10 cum
Mabini	15.00	First 10 cum
Pilar (PIWAS)	20.00	First 10 cum
Sevilla	20.00	First 10 cum
Jagna	25.00	First 10 cum
Bilar	25.00	First 10 cum
Batuan	25.00	First 10 cum
Duero	30.00	First 10 cum

Source: Municipal Waterworks Office

2.2.7 Non-Revenue Water (NRW)

The municipal waterworks head of Tubigon estimated NRW at 48% due to leakages and other unbilled uses. Clarin Water District has 25% NRW while Talibon Water District has 28% NRW. Antequera has the lowest reported NRW at less than 5% of the total production. Other waterworks offices do not have a record of the unaccounted-for-water because there are no flowmetering devices to record the flow from sources. Amount of NRW is computed by subtracting the total billed consumption from the estimated production.

2.2.8 Institutional Capacity

Only the BWUI, Talibon WD, Clarin WD, Loon Waterworks System, and some cooperatives operate independently as water service providers. Funding for system operation, maintenance and improvements comes from internally generated cash and/or loans.

Most of the waterworks offices lacks adequate capacity in the administrative (to include records-keeping of waterworks data), financial (to include metering, billing and collection) and technical (to include thorough knowledge of the existing facilities and their operation and maintenance) aspects of the management and operation of the system. Delinquency of bills payment, however, may not be solely blamed on the waterworks office since payments are made to the Treasurer's Office.

Of the municipal waterworks system visited, Loon has a more systematic record of billed water consumption. Loon waterworks office sustains its own operation and does not depend on municipal subsidy for its expenses such as for repairs and maintenance works and pumping costs. Collections from water operations are submitted to the municipal treasury; hence waterworks' office requests for funding will have to undergo the LGU's standard procedures for budget requisition.

On the technical aspects, it was learned that in most cases no proper design was undertaken when implementing system improvements such as pipeline extensions. This may be the cause of insufficient system pressure, if pipe size and hydraulics design are not properly carried out. Proper treatment of water is also not practiced on a regular basis. In most LGUs, the Municipal Health Office is in-charged of this function.

The waterworks offices also lack the capacity in educating the consumers that potable water, like any other economic good is produced and delivered to household at a certain cost and is exhaustible. Based on interviews, however, some municipal waterworks offices cannot impose collection improvement measures because of inefficient water service.

These aspects need attention in the proposed integrated water supply master planning.

2.2.9 Details of Existing Water Supply System/Facilities

The highlights of data gathered for the 47 municipalities and one city are summarized in **Table 2-10**

Information on the existing water systems' sources, facilities, service connections, treatment method, system operation and maintenance and problems and deficiencies of some selected municipalities are briefly described in the following discussions.

2.2.9.1 Tagbilaran City

The Tagbilaran City being the biggest in terms of urban development in the province, is serviced by two waterworks systems, namely, the Bohol Water Utilities, Inc. (BWUI) and the Tagbilaran City Waterworks System (TCWS).

Bohol Water Utilities, Inc. and the Tagbilaran City Waterworks System share in providing water service to the city. The barangays in BWUI service area are Bool, Cogon, Dampas, Mansasa, Poblacion 1, Poblacion 2, and Poblacion 3. Barangays Cabawan, Manga and Ubujan are under TCWS' service area. Five barangays, namely, Booy, Dao, San Isidro, Taloto and Tiptip are jointly served by the two service providers.

A. Bohol Water Utilities, Inc. (BWUI)

The service area of BWUI includes 12 barangays in Tagbilaran City, municipality of Dauis (bulk supply), 2 barangays in Baclayon and Corella. BWUI is a joint venture ownership between Salcon Group of Companies, a Singaporean/Filipino Consortium (70%) and the Provincial Government of Bohol (30%).

The sources are groundwater through deepwells, totaling 22 as of July 2007. Of these 22 wells, only 20 are operational, one has right-of-way problem and one has water quality (turbidity) problem. Four of the 20 operational wells are with saline water intrusion. The average production from these sources is 18,000 cumd.

Six of the operational wells are located in the municipality of Corella. As form of royalty, BWUI is supplying Corella with about 15,000 cum per month of water free of charge, plus P0.20/cum of extraction for five of the wells and P0.50/cum in one well. The municipality will, however, pay P8.00 per cum in excess of 15,000 cum per month free allotment. In addition, the BWUI is supplying 50 cum per month of free water to the owner of the land where the wells are located.

The BWUI service area is divided into three pressure zones as follows: 1) areas with elevations 25 meters above mean seal level (mamsl) and below, 2) areas with 25mamsl and above which are provided with booster pumps, and 3) separate systems for subdivisions. Water service is available 24 hours a day.

There are eight reservoirs with a total storage capacity of about 3600 cum. In some sources, water undergoes the Amiad Filtration System before it is treated with chlorine.

As of July 2007, BWUI has a total of 11,040 connections broken down into 10,135 residential/domestic connections, 711 commercial connections, 60 institutional/ government connections and one bulk supply for the municipality of Dauis.

The total consumption for year 2006 was 4,919,380 cum or about 13,477 cumd. As discussed by BWUI officials during a meeting held on July 3, 2007, the unit domestic consumption is about 180 to 200 lpcd. The reported system's losses is about 42% broken down into 23% accounted but non-revenue-water and 19% unaccounted –for-water.

Table 2-10 Summary of Information Gathered from LGU Waterworks System

	Municipality/City	2000 POP (NSO)	No. of HH	Average No. of Persons Per Household	Existing Number of Service Connections	Estimated No. of Persons Presently Served by LGU Water System	Average Domestic Consumption per HSC (cum/mo)	Average per Capita Consumption (lpcd)	Minimum Domestic Water Rates (PhP)
1	Alburquerque	8,715	1,670	5.22	1218	6,356	16	102	40
2	Alicia	21,605	4,065	5.31	310	1,648	10	63	50
3	Anda	17,863	3,072	5.81	1353	7,861	1/	1/	25
4	Antequera	13,758	2,801	4.91	1620	7,957	16	109	37
5	Baclayon	14,996	2,978	5.04	2006	10,101	17	115	7
6	Balilihan	16,837	3,101	5.43	2034	11,044	17.5	107	8
7	Batuan	11,835	2,287	5.17	300	1,552	15	97	25
8	Bien Unido	22,176	3,984	5.57	552	3,073	10	60	100
9	Bilar	16,628	2,967	5.60	1,228	6,882	15	103	25
10	Buenavista	25,960	4,550	5.71	325	1,854	10	60	70
11	Calape	27,921	5,588	5.00	2880	14,390	15	100	90
12	Candijay	30,389	5,420	5.61	1,474	8,264			
13	Carmen	40,713	7,379	5.52	630	3,476	15	90	45
14	Catigbian	21,461	4,094	5.24	925	4,849	13	85	10
15	Clarin	18,040	3,575	5.05	1,138	5,743	13	83	9.8
16	Corella	6,048	1,263	4.79	999	4,784	10	70	25
17	Cortes	12,702	2,547	4.99	1,019	5,082	10	67	45
18	Dagohoy	16,845	3,095	5.44	548	2,983	12	73	80
19	Danao	17,265	2,958	5.84	800	4,669	20	114	90
20	Dauis	26,415	2,669	9.90	3,373	33,382	18.32	62	14/cum
21	Dimiao 1/	14,151	2,708	5.23	469	2,451			
22	Duero	16,485	3,245	5.08	1,736	8,819	13	80	30
23	Garcia Hernandez	21,428	3,989	5.37	1,500	8,058	26	144	15
24	Getafe	26,826	4,694	5.71	88	503			275
25	Guindulman (GUINBUWASCO)	29,166	5,573	5.23	1,726	9,033	22.5	143	90
26	Inabanga	40,714	7,867	5.18	1,574	8,146	14	88	35
27	Jagna	30,643	5,957	5.14	1500	7,716	10	65	25
28	Lila	10,322	1,723	5.99	762	4,565	10	56	40
29	Loay	14,433	2,615	5.52	1500	8,279	10	60	10
30	Loboc	15,734	2,738	5.75	891	5,120	24	137	40
31	Loon	45,215	7,915	5.71	3639	20,788	24	144	60
32	Mabini	27,250	5,047	5.40	643	3,472	12	75	15
33	Maribojoc	16,786	2,630	6.38	2482	15,841	14	73	55
34	Panglao	21,337	3,890	5.49	3,350	18,375	12	73	22.5
35	Pilar	25,095	4,489	5.59	1684	9,414	16	96	
	Picowasco				866		16	96	60
	Piwas				818		15	88	20
36	Pres. Carlos P. Garcia	20,744	4,062	5.11	2/				
37	Sagbayan	18,346	3,688	4.97	2044	10,168	10	67	45
38	San Isidro	9,106	1,848	4.93	115	567	10	68	60
39	San Miguel	20,828	3,738	5.57	3/				
40	Sevilla	10,281	1,840	5.59	800	4,470	10	60	20
41	Sierra Bullones	25,499	4,473	5.70	1306	7,445	10	58	30
42	Sikatuna	6,602	1,177	5.61	1085	6,086	10	67	12.5
43	Tagbilaran	77,700	15,585	4.99	15,126	75,412			
	Bohol Water, Inc.				11,040		30	180	65.00
	Tagbilaran City Water System				4,086		25	150.45	56.00
44	Talibon	54,147	9,712	5.58	1,487	8,290	18	105	150
45	Trinidad (Trinidad Multidevelopment Coop.)	25,683	4,707	5.46	232	1,266	13	80	150
46	Tubigon	40,385	7,714	5.24	1,733	9,073	18	115	120
47	Ubay (UWASCO)	59,827	11,511	5.20	1,735	9,017	22	142	70
48	Valencia	24,363	4,392	5.55	720	3,994	15	91	50
					74,659	412,318			

1/ Average consumption cannot be determined because 75% of meters installed are defective.
2/ No existing Level III water system
3/ Awaiting for source which may come from Pilar or from Bayongan Dam (NIA)

Water rate schedule in BWUI is as follows:

First 9 cum	:	Php 65.00
10th cum	:	Php 6.88
11-20 cum	:	Php 7.60/cum
21-30 cum	:	Php 8.78/cum
Above 30 cum	:	Php 17.87 cum

The average tariff for year 2006 was Php 10.70 per cum while the average bill was Php 323.70.

At present BWUI is supplying between 1,200 and 1,600cumd at an average of 42,000 cum/mo of treated water to Dauis at the following tariff:

First 6,250 cum	:	Php 5/cum
6,251 – 18,000 cum	:	Php 9/cum
Excess of 18,000	:	Php 11/cum

Dauis Municipal Waterworks System is distributing water to eight barangays at Php 14.00 per cum.

For water quantity and quality monitoring purposes, BWUI is undertaking the following measures:

1) submission of semi-annual physico-chemical characteristics to the National Water Resources Board (NWRB);
2) quarterly submission of production data to NWRB
3) weekly bacteriological quality monitoring of water at 2 sampling points for clusters.

There are 52 regular employees in BWUI manning the operation and maintenance of about 10, 135 connections which means that the employee to service connection ratio is about 1:195. This ratio is higher than the ideal ratio of 1:120 per LWUA standard.

Based on the interview with the BWUI officials, the common problem and deficiencies in the system include:

1) Intrusion of saline water into the groundwater aquifer. As mentioned in the Tagbilaran Water Supply Master Plan, saline water has already advanced inland to about 1.2 to 3 km.
2) Presence of iron bacteria along pipelines causing brownish water
3) Low to no pressure at some points especially during peak hour.
4) Inadequate supply for future requirements
5) Currently improvement works are hold due to financial problems

A more recent study on the Underground Water Quality in Tagbilaran City conducted by the Australian Youth Ambassadors in 2006 revealed that the groundwater quality in some areas in Tagbilaran City has degraded due to fecal contamination and salt water intrusion. Based also on the study some wells have reached their maximum yield.

The BWUI has a joint venture agreement with the provincial government to expand its service area to 10 adjoining municipalities; however, the proposed source and implementation plan is not yet identified. The adjoining municipalities included in the proposed service area expansion are: Loboc, Loay, Alburquerque, Baclayon, Dauis, Panglao, Cortes, Corella, Maribojoc and Loon.

B. Tagbilaran City Waterworks System

The Tagbilaran City Waterworks System (TCWS) presently serves 4,086 service connections broken down into 4,035 domestic connections, 9 public taps, 24 commercial connections and 18 institutional connections. The estimated served population is about 22,602.

There are 20 existing well and pumping stations with a total estimated production capacity of 4,754 cumd (55 L/s). The annual production for year 2006 was 1,605,308 or an average daily production of 4,398 cumd. Not all pumping stations are metered; however, the production is estimated using volumetric method pump capacity. The unaccounted-for-water is estimated at 21.73%.

Based on data furnished by TCWS, the unit domestic consumption is 150.45 liters/capita/day or a monthly consumption of 25.14cum/month.

There are seven reservoirs with a total volume of 1,793 cum. The system operates for 24 hours, however, due to frequent power service interruptions pumping operation is reduced to an average of two hours daily thus was unable to fill the required storage volume.

The existing distribution pipelines with sizes ranging from 50 to 200 mm diameter G.I., PVC and HDPE pipes are 3-25 years old.

The following water tariff structure was implemented since November 1, 1999 up to the present. However, there is a pending average increase in tariff of about 38% that is already approved by the NWRB which will be implemented upon approval of the revised City Revenue Code.

Metered Consumption (cum)	Residential	Commercial
1st 10 cum or less	Php 56.00	Php 20/cum
11-20 cum	Php 6.20/cum	Php 20/cum
21-30 cum	Php 7.00/cum	Php 20/cum
31-40 cum	Php 8.00/cum	Php 20/cum
41-50 cum	Php 9.00/cum	Php 20/cum
51-60 cum	Php 10.00/cum	Php 20/cum
61-70 cum	Php 12.00/cum	Php 20/cum
71-100 cum	Php 14.00/cum	Php 20/cum
101 and up	Php 20.00/cum	Php 20/cum

Source: Tagbilaran City Water System

The bulk of the operational expenses for year 2006 are allotted for the pumping cost representing about 57% of the total operation and maintenance expense. Based on the Utility Profile for 2006, TCWS is fully dependent on city government grant for capital development.

Water treatment by chlorination is applied to the reservoir three times a week where dosage is determined depending on the volume of water in the storage. Based on records furnished by TCWS, 27 out of 214 water samples failed the bacteriological tests in year 2006.

The problems and deficiencies in the system include the following:

1) There are no standby power generating sets; therefore there is no supply during power failures.
2) Inadequate pipe sizes thus big friction losses resulting in low pressure
3) Inadequate chlorination in the sources/reservoir resulting in high incidence of water borne diseases such as diarrhea.
4) Delinquent payment of water bills
5) Saline intrusion into the groundwater aquifer
6) Inadequate technical and institutional capacity for the operation and maintenance of the water system

There are 29 regular employees in TCWS manning the operation and maintenance of about 4,086 connections which means that the employee to service connection ratio is about 1:141.

The Tagbilaran Waterworks System is one of the waterworks system that was chosen for capacity building assistance to access financing under the Small Water Improvement and Financing under the Water and Sanitation Program of the World Bank Program of the World Bank.

2.2.9.2 Alburquerque

All 11 barangays in the municipality have Level III water service. Alburquerque Waterworks System serves five coastal barangays namely, Bahi, East Poblacion, San Agustin, Santa Filomena and a separate system for Tagbuane.

Five interior barangays, Basacdacu, Cantiguib, Dangay, Toril, West Poblacion have interconnected water system also under the municipal water system. Barangay Ponong has a separate Level III system constructed under the KALAHI-CIDSS.

There are 6 deepwells with submersible pumps (4-1.5 Hp, 1-3Hp, and 1-5Hp) and 5 reservoirs with a total storage volume of 302 cum. The system is a combination of direct pumping and fill-and-draw method. The pumps operate 24 hours alternately except during brown-outs.

All 1,218 metered connections are classified as domestic. Based on interview with the meter reader, the maximum bill is between the range of Php 70 to 80/month or about 15-16 cum billed water consumption. From these figures, per capita consumption may be estimated at 100 liters/capita/day. The existing water tariff is as follows:

1st 8 cum	:	Php 40.00
9-15 cum	:	Php 5.25/cum
16-25	:	Php 5.50/cum
26-35	:	Php 5.75/cum
36 and up	:	Php 6.00/cum

There 10 employees under the office of the MPDC manning the operation and maintenance of the system. Manual billing is implemented while collection is under the Treasurer's Office.

Water treatment is done by manual chlorination with a dosage determined by the municipal health officer.

The sources are not metered; hence, waterworks has no production record of the sources, hence no record of unaccounted-for-water.

The problems and deficiencies of the system include:

1) Inadequate supply, particularly during peak hour
2) Inadequate pipe sizes
3) No standby power generating set for continuous supply during power outages
4) Supply from the sources is decreased during summer
5) Inadequate technical and institutional capacity of the office handling the operation and maintenance the waterworks system

2.2.9.3 Alicia

As of date of survey, only Barangay Poblacion has operational Level 3 system being served by Alicia Waterworks System. Barangay La Hacienda has a separate Level III system. The rest of the barangays have either Level II (10 barangays) or Level I (3 barangays) service.

The sources of the municipal waterworks system are two springs in Bgys. Putlongcam and Progreso, and one shallow well at the Poblacion. Water supply system is operated at 8-10 AM and 3-5 PM only due to inadequate source.

There are 320 metered service connections. Water rates schedule is as follows:

Metered Consumption	Domestic	Commercial	Industrial
1st 5 cum	Php50.00	Php70.00	Php100
In excess of 5cum	Php6.50/cum	Php 10/cum	Php 20/cum

The spring in Putlongcam has a 1.5 x 4m intake box, then stored in a 80cum reservoir. Water treatment using powder chlorine is applied at the reservoir once month.

An average of 10 cum monthly or about 63 lpcd domestic consumption was derived from the CLUP data.

The problems and deficiencies of Alicia Waterworks System include:

1) Inadequate supply
2) Old pipes and inadequate pipe size
3) No funds for improvement works
4) Inadequate technical and institutional capacity for management and operation of the system

2.2.9.4 Antequera

Antequera has 20 barangays of which 19 are being served by the Antequera Waterworks System. The remaining barangay (Bgy. Quinaponan) has Level II and III systems constructed with the assistance of KALAHI –CIDSS.

The sources are 2 springs and 7 wells with depths varying from 150 to 180ft. The pump capacities range from 1 to 5 Hp. Each deepwell has its own reservoir where water is pumped prior to distribution. These sources serve about 1,664 service connections broken down into 1,620 house service connections, 14 public faucets, 1 commercial, 1 industrial and 28 institutional connections.

In the urban area, water service is available for 10 to 15 hours while in rural areas, service is only three hours.

The water tariff and surcharge schedule are as follows:

Domestic	Water Rate Schedule
8 cum or less	Php 37.00
9-20 cum	Php 37.00 + Php5.00/cum excess
21-30 cum	₱ 37.00 + ₱ 6.00/cum excess
31-40 cum	₱ 37.00 + ₱ 7.00/cum excess
41cum and above	₱ 37.00 + ₱ 8.00/cum excess
Commercial/Industrial	₱ 10.00/cum
Water Meter Rental /Month	₱ 5.00 (LGU Owned)
Surcharge for late/non-payment of Water Bill	10% per month

The average unit domestic consumption is 15.37 cum per month per connection equivalent to 104 L/c/d.

Based on the records, the average production is 34,004 cum/mo while the average billed volume is 33,494 cum/mo. The non-revenue-water is about 1.49% of the total production.

Water is treated by chlorination manually using perforated gallon container submerged in water. During summer or dry seasons, chlorination is applied every three months and once a month during rainy season.

The waterworks office is under the office of the Municipal Planning and Development Coordinator. There are 12 person including a plumber, utility worker and casual employees who do metering and operation and maintenance works. The employee to service connection ratio is computed at 1:139.

Antequera is also one of the municipalities that was chosen for capacity building assistance to access financing under the Small Water Improvement and Financing under the Water and Sanitation Program of the World Bank Program of the World Bank.

2.2.9.5 Clarin

The municipality of Clarin is also one of the municipalities in the northeastern corridor. Clarin has 24 barangays with either Level III or Level II systems. The Level III system covering 16 barangays, namely, Bacani, Bonbon, Buacao, Buangan,Caboy, Caluwasan, Candajec, Catoyoc, Comaang, Lahug, Nahawan, Poblacion Centro, Poblacion Norte, Poblacion Sur, Tangaran and Villaflor, is managed and operated by the Clarin Water District. The rest of the barangays are served by Level II system.

As of month of December 2006, there are 1,138 service connections and an estimated served population of 5,560. The total billed consumption for the month of December was 14,183 cum against a production of 18,910 cum. The average consumption was 12 cum or 82 lpcd computed based on the average 5.05 persons per household. The unaccounted-for-water was estimated at 25%.

The source facilities comprise of eight springs and two deepwells. There are three ground concrete reservoirs and the operation is a combined pumping and gravity system. Treatment by chlorination is done on a schedule basis.

The approved water rates for domestic service connections follow:

1st 10 cum	:	Php 98.00
11-20 cum	:	Php 11.00/cum
21-30 cum	:	Php 12.00/cum
31-40 cum	:	Php 13.00/cum
41 cum and up	:	Php 14.00/cum

The WD has 18 employees manning the operation and maintenance of 1,138 service connections, hence an employee to service connection ratio of 1:63. This ratio is quite low considering that the industry average is about 1:120 for small water districts.

As mentioned by the WD officials, the problems and deficiencies of the system include inadequate supply particularly during peak hour and summer months. The WD lacks funds for expansion and improvement works and is waiting for the municipal government's plan to give subsidy to the WD.

2.2.9.6 Dauis

Dauis has 12 barangays of which seven are being served by the municipal waterworks system. As of June 2007, there are 3,373 connections broken down into 3355 domestic and 18 commercial connections. The average daily domestic demand for the month of June was 1,865 cumd or a per capita consumption of about 101 L/d.

The supply comes from wells in the municipality and bulk supply from BWUI. The local wells have a daily production of 1,045 cum while average supply from BWUI is 1,295 cumd or a total daily supply of 2,340cumd. The wells pumped water into the reservoirs prior to distribution in the system. There are 12 reservoirs with a total volume of 1,076 cum.

The water rates schedule is as follows:

Residential and Institutional	
1-5 cum	₱ 14.00/cum
6-10 cum	₱ 16.00/cum
11-20 cum	₱ 17.00/cum
21-30 cum	₱ 18.00/cum
31 and up cum	₱ 20.00/cum
Commercial and Industrial	
1-25 cum	₱ 25.00/cum
26-50 cum	₱ 30.00/cum
51 and up cum	₱ 35.00/cum

Water availability varies from 18 to 24 hours. Chlorine is applied 4 to 5 times a week and reservoirs are disinfected once a month.

There are 15 personnel assigned to the waterworks office.

2.2.9.7 Maribojoc

All barangays in Maribojoc have existing potable water source. Of the 22 barangays, 20 are served by the Maribojoc Waterworks System. Water systems Barangays Busao and San Isidro have Level III facilities while Bgy. Candaba has Level II system, all run by BAWASA. Low areas in Bgy. Punta Cruz are served by the municipal water system while the higher areas are served by the municipality of Loon.

As of July 2007, there are 2,482 service connections broken down into 2,471 domestic and 11 commercial. The water rate schedule is as follows:

Consumption Bracket	Domestic	Commercial/Industrial
1st 10 cum	Php55.00	Php82.50
11-30 cum	Php5.00/cum	Php7.50
31-50 cum	Php6.00/cum	Php9.00
51 and up	Php7.00/cum	Php10.50

Source: Maribojoc Waterworks Office

At public taps, water users are charged ₱0.50 for every 5 gal container and ₱20.00 for every cum of water while fetching from fire hydrants is priced at ₱ 30.00/cum.

There are 5 springs and 6 deepwells and pumps. Due to low elevations at the sources, water is pumped into the reservoirs. There are no flowmeters to record production, hence also no accurate record of non-revenue water.

Water is treated using calcium hypochlorite liquid. Five gallons are consumed within two days. Chlorine application is done only during rainy days.

Water service is available 24 hours a day with alternate operations of the pumping stations.
In September 2006, the consumption was recorded at 33,961 cumd. Assuming that the number of connections is the same as above, the average domestic consumption is estimated at 67L/c/d.

The problems and deficiencies include inadequate water supply and pressure particularly during summer.

2.2.9.8 Panglao

All 10 barangays in Panglao are being served by the municipal waterworks system, however, some sitios that are very far from the water system are served by Level II and I systems. These sitios may also be served by the municipal waterworks systems if the supply and pressure are enough.

There are 11 wells of which nine are operational but there are no flowmeters to measure the production from the wells. The average monthly consumption of the 3,350 connection is 40,000 cum. The unit domestic consumption is 73 lpcd. The average consumption in the tourist area which is composed of four barangays, namely, Libaon, Bolod, Tawala and Danao, is 34,000 cum/mo.

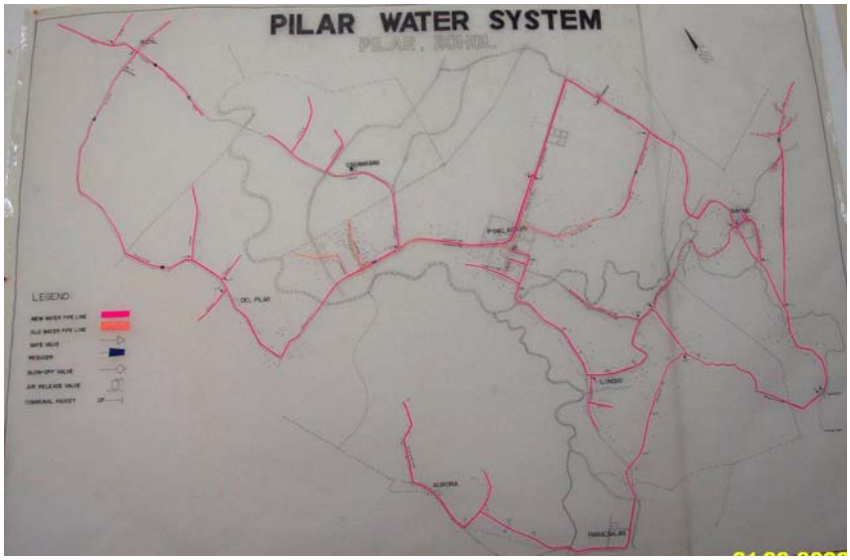
Domestic water is priced at ₱22.50 for the first 5cum and ₱5.00/cum in excess while commercial is priced at ₱10.00/cum.

The waterworks office has 18 personnel (3 regular and 15 casual employees) which translate to a ratio of about 1:186.

The problems identified during the field visit include lack of supply and pressure; inadequate treatment facilities; and no standby power generating set during power failure. Water being supplied from the wells is salty hence people have to buy purified/bottled water for drinking. The waterworks personnel need institutional and technical training to effectively manage the system.

2.2.9.9 Pilar

Pilar is an inland municipality with abundance of spring sources, particularly the Sagnap Spring in Barangay San Vicente. It has a total of 21 barangays, all of which has either Level II or III water systems. There are two water service providers in the municipality, the Pilar Waterworks System (PIWAS) and the Pilar Community on Water and Sanitation Services Cooperative.



Pilar Water System

A. PIWAS

The Pilar Waterworks System (PIWAS) serves seven barangays, namely, Aurora, Bayong, Cagawasan, Del Pilar, Lumbay, Rizal, and San Isidro. The water system was constructed in 1935 and was rehabilitated in 2005.

The source of PIWAS is the Bantayan Spring with a capacity of 21 lps, of which the municipality has applied for water rights.

PIWAS has 818 house service connections. The average total monthly consumption is 12,046 cum/mo while the average consumption per connection per month is 14.72 cum. With an average of 5.59 persons per household, the unit domestic consumption was estimated at 88 lpcd.

Domestic water rates are at Php20.00 for the first 10 cum.

Water treatment is by drip-type chlorination using 70 % powder chlorine.

The problems and deficiencies of the system include low collection efficiency. Collection from water billing is not enough for the system's expenses; hence operation is subsidized by the municipal government. At present, the municipality is paying a Php7M loan at Land Bank for the improvement works undertaken in 2005.

B. PICOWASSCO

PICOWASSCO serves 9 barangays as follows: Bagumbayan, Buenasuerte, Cagawasan (portion), Cansungay, Catagda-an, Estaca, Inaghuban, Poblacion and San Carlos

Sagnap Spring with a reported yield capacity of about 210 lps, is the source of PICOWASSCO. The irrigators association in the area has rights over 170 lps while remaining 40 lps is for domestic use. At present, PICOWASSCO is getting only 3 lps

but has water rights application for 20 lps to include expansion for the municipalities of San Miguel and Dagohoy.

PICOWASSCO has 866 services for the month of June 2007 with a total 13,901 cum or 16 cum/o/connection. The average domestic consumption for the month of June was 96 lpcd.

The water rates are as follows:

Metered Consumption	Domestic	Commercial	Industrial	Communal Faucets
First 10 cum	Php 60.00	Php 80.00	Php 100.00	Php 35.00
11-20 cum	Php 7.00/cum	Php 9.00/cum	Php 10.00/cum	Php 5.00
21-30 cum	Php 8.00/cum	Php 10.00/cum	Php 11.00/cum	Php 6.00
30 cum and up	Php 9.00/cum	Php 11.00/cum	Php 12.00/cum	Php 7.00

Water treatment is by gas chlorination.

There is no record of UFW because the sources are not metered.

Collection efficiency is 95%. There are six employees in the water cooperative which means that the employee to service connection ratio is 1:145.

The problems and deficiencies in PICOWASSCO include:
1) Lack of funds for the development of source.
2) Inadequate technical and institutional capacity in the management and operation of the waterworks system.

2.2.9.10 Talibon

Talibon is one of the municipalities in the cluster of northern industrial corridor. Of the 25 barangays in Talibon, 9 are being served by the Talibon Water District, namely, Bagacay, Balintawak, Poblacion, San Francisco, San Isidro, San Jose, San Pedro, Sto. Niño, and Tanghaligue. Three barangays are beneficiaries of the Level II program by KALAHI-CIDSS. Level I facilities is the source of water of the eight are island barangays and five inland barangays far from the service area of the water district

The construction of a Level II system in Barangay Zamora thru the LGU-Kalahi-CIDSS is included in the proposed programs of the municipal government for year 2007.

As of December 2006, there 1,487 metered connections, broken down into 1,367 domestic connections, 112 commercial connections and 2 industrial connections, and a served population of about 8,290. The total billed water consumption for year 2006 was 313,395 cum, which translates to an average consumption of 18 cum/mo/connection or 105 lpcd.

The existing water rates which were approved on January 1998 and took effect on February 2005 are as follows:

Metered Consumption	Domestic	Commercial	Industrial
1st 10 cum	Php 150.00	Php 300.00	Php 450.00
11-20 cum	Php 17.35/cum	Php 34.70/cum	Php 52.05/cum
21-30 cum	Php 19.85/cum	Php 39.70/cum	Php 59.55/cum
31-40 cum	Php 23.30/cum	Php 46.60/cum	Php 69.90/cum
41 and up	Php 26.80/cum	Php 53.60/cum	Php 80.40/cum

There are five deepwells and pumping stations with a total rated capacity of 15.95 lps. The measured production for year 2006 was 437,775 cum. The accounted-for-water was 72% placing the unaccounted-for-water at 28%. The system operates on a fill-and-draw scheme. The ground concrete reservoir has a capacity of 275 cum. Water service is available 24 hours a day.

Deepwell water undergoes the process of aeration, sedimentation, filtration and chlorination before going to the reservoir. From the reservoir, water will pass through silver anode to kill iron bacteria. According to the WD official, prior to the introduction of silver anode in the treatment process, water turns yellowish to brownish due to iron bacteria.

There are 13 employees of the water district, hence an employee to service connection ratio of 1:114.

The main problem and deficiencies of the system include the following:

1) WD cannot expand service area due to inadequate supply
2) Presence of iron bacteria in the water

2.2.9.11 Tubigon

Tubigon is another municipality in the cluster of northeastern corridor. Tubigon has 34 barangays of which six are island barangays. Eleven barangays are being served by the municipal waterworks system, these are: Bunacan, Bosongon, Buenos Aires, Centro (Poblacion), Macaas, Pinayagan Norte, Pooc Occidental, Pooc Oriental, Tinangnan and Ubojan.

Based on interview with the municipal engineer, there are 1,733 service connections, as of July 2007, the average consumption is about 18 cum/mo or 115 lpcd computed based on an average of 5.24 persons per household. The average service connection growth is 100 connections/year.

The sources comprise of one spring and nine deepwells with a total production capacity of 55,000 cum/mo. There are five reservoirs with a total capacity of 469 cum.

The municipality of Tubigon is implementing improvement works costing about Php 68 million, based on feasibility study conducted by DCCD Engineering Corporation/Sinclair Knights in year 2000. Source of funds for this undertaking is from the Congressional Initiative Fund and from municipal funding.

The system loss is estimated at 48% due to extensive leakages on the old pipes ad other unbilled uses.

The municipal water system has 15 personnel, therefore the employee to service connection ratio is 1:115.

The problems and deficiencies of the water system include:

1) Inadequate supply and pressure, hence water service is only for 12 hours a day
2) Huge unaccounted-for-water due to leaks
3) Inadequate technical and institutional capacity in the management and operation of the water system

2.2.9.12 Ubay

Ubay is one of the more progressive towns of Bohol and is also included in the northeastern corridor. It has 44 barangays of which eight is being served by the Ubay Water & Sanitation Cooperative (UWASCO). These Barangays are: Achila, Bood., Fatima, Calanggaman (portion), Katarungan, Poblacion Tapon, and Tipolo.

Another small water cooperative, the Metro San Pascual Waterworks serves Bgys. San Pascual, portions of Bongbong, Ilihan, Lomangog, San Francisco and California. Barangays Buenavista, Cagting, Juagdan, Los Angeles, and San Vicente have Level 2 water systems.

UWASCO's supply is surface water which is impounded in a reservoir in Bgy. Calanggaman, and is about 5.5 kilometers away from the town proper. The catchment has an area of about 119 has. From the catchment, raw water undergoes the treatment process consisting of filtration and chlorination by gas chlorine. Problems with water quality, particularly due to turbidity, often occur because the existing treatment plant does not include coagulation and sedimentation process to remove particles causing turbidity. This treatment facility was constructed in 1995 under the Central Visayas Water Supply Program (CVWSP).

According to the official of the UWASCO, water supply is not sufficient particularly during summer months. Sometime in year 2005, UWASCO got its supply from the Capayas Dam; however, there were many complaints from the irrigators and the mayor issued an executive order so that UWASCO can get water from said dam.

UWASCO has plans to upgrade its treatment plant and construct transmission lines to increase its service area however the cooperative has no funds for this purpose.

At the moment, the meter at the source is defective hence no record of production while average monthly consumption is 38,000 cum. With a connection of 1,735 (as of June 2007) and an average of 5.2 persons per household, the average unit domestic consumption is about 140 lpcd.

No record of UFW was secured from UWASCO.

There are 16 employees in UWASCO which means a connection to employee density ratio of 1:108.

The problems and deficiencies include inadequate supply since it is rain dependent; water quality due to turbidity; lack of funds for upgrading of the treatment facility and the distribution system.

2.3 EXISTING SANITATION FACILITIES

2.3.1 Existing Household Sanitation Facilities

As of 2003, the overall percentage of households having approved types of toilet facilities in the whole province of Bohol is 79%, breakdown of which is shown in **Table 2-11**.

Table 2-11 Percentage of Households with Approved Types of Toilet Facilities

City/Municipality	Urban	Rural	City/Municipality	Urban	Rural
Alburquerque	39	77	Guindulman	90	87
Alicia	94	86	Inabanga	71	43
Anda	90	58	Jagna	99	93
Antequera	88	90	Lila	97	22
Baclayon	96	89	Loay	92	88
Balilihan	92	91	Loboc	22	65
Batuan	91	78	Loon	91	75
Bien Unido	58	27	Mabini	91	75
Bilar	66	67	Maribojoc	68	79
Buenavista	44	39	Panglao	89	87
Calape	59	57	Pilar	84	86
Candijay	94	96	Pres. Carlos P. Garcia	47	60
Carmen	44	89	Sagbayan	85	83
Catigbian	91	69	San Isidro		92
Clarin	84	86	San Miguel	96	93
Corella	97	95	Sevilla	89	82
Cortes	96	93	Sierra Bullones	77	84
Dagohoy	95	90	Sikatuna	98	87
Danao	95	74	Tagbilaran City (Capital)	98	
Dauis	64	90	Talibon	88	52
Dimiao	100	100	Trinidad	82	57
Duero	95	91	Tubigon	68	78
Garcia-Hernandez	87	96	Ubay	70	78
Getafe	71	73	Valencia	98	92
Provincial Total				83	77

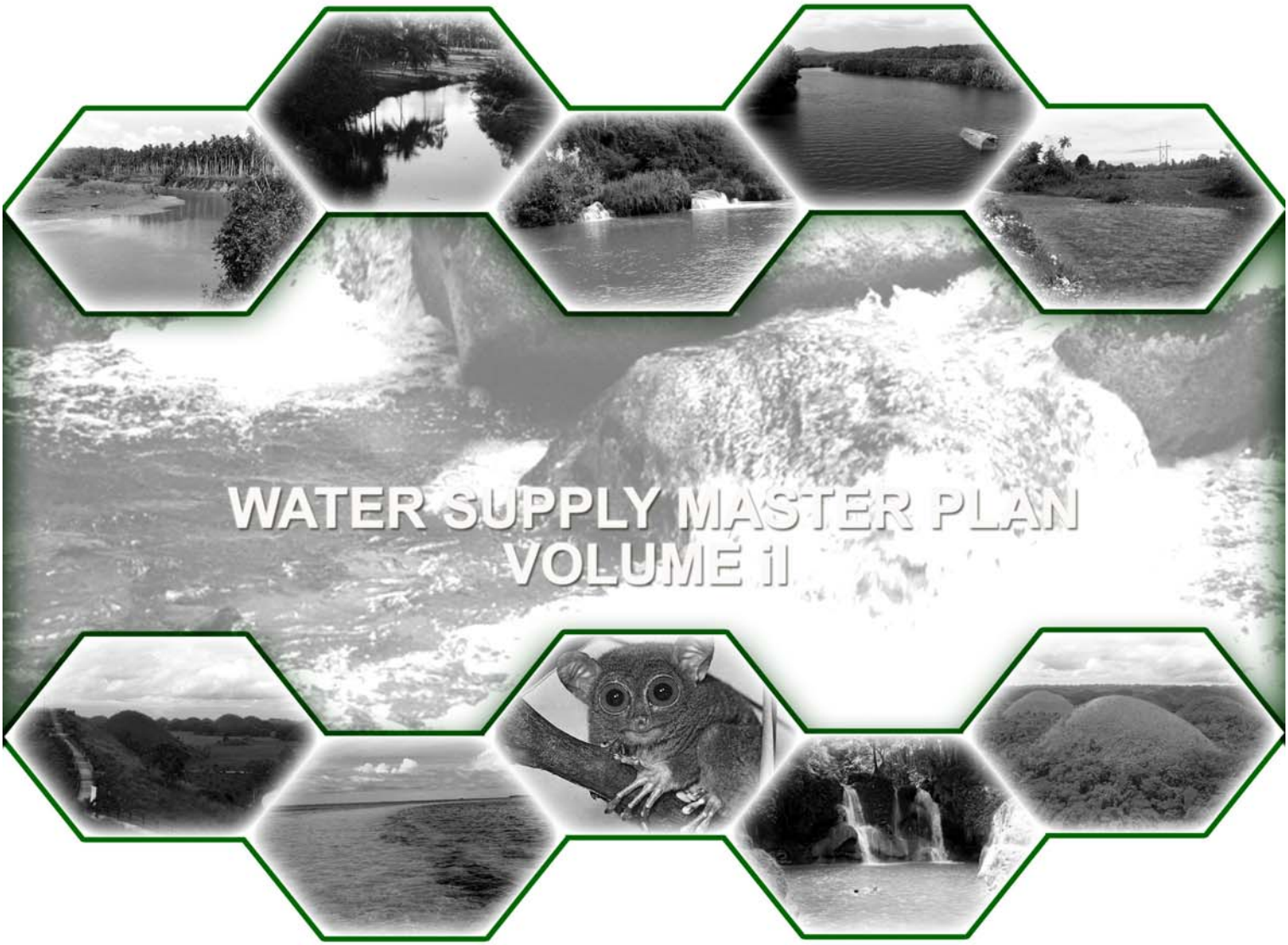
Source: PW4SP,2003

Twenty one percent (21%) of the households comprise the underserved or with unapproved toilet facilities) and unserved or those without toilet facilities.

To help improve this situation, the GTZ, in collaboration with the local government units and NGOs, is currently implementing a program for sustainable sanitation in Bohol that included the introduction of Ecosan through Urine Diversion Dehydration Toilets (UDDT) as alternative to the conventional sanitation system. The UDDTs are recommended for waterless communities as this method eliminates use of water for flushing. Three pilot projects were already implemented in Panglao, Talibon and Sagbayan.

There are no centralized sewerage systems to take care of the disposal of the sanitary wastes from septic tanks and other liquid wastes from industries and other sources in the province. Untreated sewage, domestic wastewater and industrial wastes therefore flows into the drainage system, canal or bodies of water or percolates into the ground. This practice is detrimental to the environment because it pollutes the bodies of water such as creeks, rivers and coastal waters, contaminates the groundwater aquifer and coastal waters, and poses risks to public health. Wastewater seeping underground might infiltrate pipelines with leaks when system pressures are low and may cause dirty water to reach the taps.

At present, the provincial government is implementing the Decentralized Water Treatment System (DEWATS) with the technical assistance from the German Agency Technical Cooperation (GTZ). The project started in early 2007 and is scheduled for completion within the year. It has an estimated cost of about Php2 million funded by the provincial government. When completed this facility will treat effluent from the septic tanks of the Provincial West Capitol Compound. The compound has about 600-700 occupants including those working at the commercial building within the compound. The Basic Needs Service-Bremen Overseas Research and Development Association (BNS-BORDA) provided the technical design and supervision of the facility.



CHAPTER 3
POPULATION AND WATER DEMAND PROJECTION

CHAPTER 3 – POPULATION AND WATER DEMAND PROJECTIONS

3.1 GENERAL

The demand for water will further increase in the coming years due to population growth, rapid urbanization, and commercial and industrial development in the province. As stated in the Medium Term Development Plan for Bohol province, various development works in the social, economic, agricultural and infrastructure sectors are equitably envisioned for each of the municipalities towards the reduction of poverty incidence. Two of the most promising economic drivers that are expected to create more jobs and provide additional source of income and eventually uplift living conditions of the populace are eco-tourism activities and agri-industrialization. These two areas are the "primary growth focus" which the province has prioritized in terms of incentives, assistance and public investment support.

Hand Pump at Sierra Bullones

Reliable and adequate supply of water supply is a very important factor in proposed developments works for both areas. For tourism, availability of reliable, adequate and safe water must be assured for establishments providing accommodations for tourists. Other expected investment in eco-tourism industries such golf course, restaurants, and food outlets will likewise require adequate water supply.

This chapter will present projections for potable water demand of the population of Bohol for years 2010 to 2035 including provisions for water that may be required by the proposed eco-tourism and industrial developments.

According to Medium Term Development Plan of Bohol Province (MTDP) 2004-2009, thirty two percent (32%) of the 184,874 hectares of agricultural land is devoted to rice production. It is the thrust of the province to provide facilities to 85% of all irrigable lands to improve rice production. Water supply for irrigation purposes do not need further treatment and do not require pressurized piping system. Open canals with high flow rates are the usual mode of conveyance of irrigation waters. Irrigation demand is presented in the water balance analysis under Chapter 4, Water Resources.

Population projection is undertaken to determine the population growth in the province and to estimate the number of persons which may be provided with access to safe and adequate water.

3.2 PROVINCIAL SECTOR TARGET

The goal of the province with regard to provision of safe water to the population of Bohol, as stated in the MTDP (2004-2009) Bohol Province is to reduce the number of households with unsafe sources of water and to expand existing service coverage for water supply. The percentage for existing service coverage was taken from the PW4SP while the target coverage was based on the MTDP 2004-2009 and the National Sector Master Plan.

Population Classification	Existing Coverage (%)	Target Coverage (%)
Urban	60	95
Rural	59	93

As outlined in the PW4SP, the type of water service that maybe provided for the target population may either be Level I, Level II or Level III facilities.

3.3 SERVICE AREA

By NEDA definition (NEDA Board Resolution No. 12, S. 1995), service area is the geographic jurisdiction of water utilities while service coverage refer to the number of people a facility can serve. For this study, the service area and service coverage were projected based on the extent of coverage of the existing Level III water systems being managed and operated by the LGUs, Water Districts and cooperatives. It is envisioned that barangays under the above service coverage may be served through interconnected piping system from a single source or a combination of sources.

Based on the results of field investigations, the number of barangays presently being served by the LGU waterworks system, water districts and cooperatives is about 523 while estimated served population is about 413,664, details of which were presented in Tables 2-1 and 2-2 of Chapter 2 (Existing Water Supply System and Sanitation Facilities) of this report.

Service Area Coverage by Level III Systems
(served by LGUs, Water Districts and Cooperatives)

Total Number of Barangays for 47 Municipalities and 1 City	1,109
Number of Barangays with Level III Systems Managed by LGUs, Water Districts and Cooperatives)	523
Reported No. of Service Connections (as of August 2007)	74,659
Estimated Number of Served Population	412,318
Projected Provincial Population (Year 2007)	1,293,400
% Service Coverage (August 2007)	32%

The service coverage for Bohol will be projected using the above figures.

3.4 POPULATION PROJECTIONS

The most basic information that needs to be determined in any water supply project is the target population that will be served by the system. The magnitude of the proposed service coverage will determine the extent of the needed facilities that will be constructed to meet the projected demand. For this reason, population projections were made for the planning period, years 2010 to 2035.

3.4.1 Past Growth Rates

The historical record of population growth in Bohol as presented below showed that the highest growth rates were attained during three recorded intercensal periods in 1903-1918, 1970-1975, and 1995-2000 at annual growth rates of 1.92%, 2.13%, and 2.72%, respectively. The following table shows the historical population record and past growth rates.

Table 3-1 Past Population Figures and Growth Rates

Censal Year	Historical Population Record [1/]	Annual Growth Rate	Censal Year	Historical Population Record [1/]	Annual Growth Rate
1903	269,223		1970	683,297	1.44
1918	358,387	1.92	1975	759,370	2.13
1939	491,608	1.52	1980	806,013	1.20
1948	533,407	0.91	1990	948403	1.64
1960	592,194	0.88	1995	994440	0.95
			2000	1,137,268	2.72

[1/] *Source: National Statistics Office*

As shown on the above table, Bohol's population increased four-fold from 1903 (when the first count was taken) to the latest census in May 2000.

Table 3-2 shows the population for each municipality for censal years 1980, 1990, 1995 and 2000. It was noted that some municipalities registered high growth of above 3% for the period 1995 to 2000. These municipalities are: Baclayon (3.20%), Balilihan (3.18%), Catigbian (4.05%), Dagohoy (3.85%), Danao (4.22%), Loay (3.00%), Loboc (3.36%), Loon (6.69%), Panglao (3.35%), Pilar (3.49%), San Isidro (3.82%), Sevilla (3.46%), Sierra Bullones (4.17%), Tagbilaran City (3.11%), Talibon (3.84%), Trinidad (4.21%), Tubigon (3.15%) and Ubay (3.35%).

During the censal period of 1980-1990,Talibon registered a negative annual growth rate of 0.96% due to creation of the Municipality of Bien Unido in December 1980 wherein eighteen barangays from Talibon and one from Trinidad were taken from said municipalities to compose the new municipality of Bien Unido.

Figure 3-1 below shows the past growth rate trends of the population.

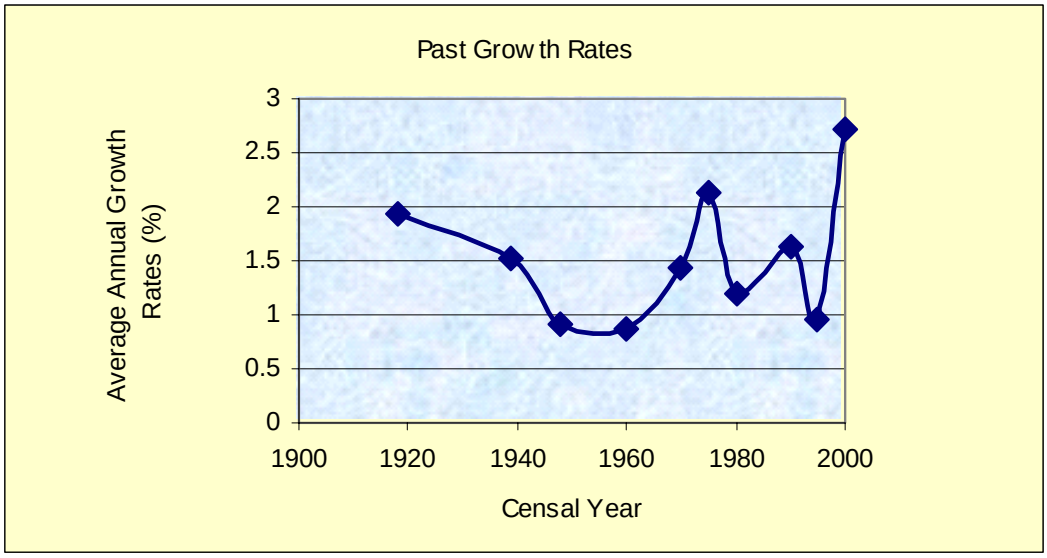


Figure 3-1 Population Growth Rates

Table 3-2 Historical Population and Growth Rates by Municipality

MUNICIPALITY/ BARANGAY	POPULATION (CENSUS)				AVE. ANNUAL GROWTH RATE (%)			
	1980	1990	1995	2000	1980-1990	1990-1995	1995-2000	1980-2000
Bohol Province	**806,013**	**948,403**	**994,440**	**1,137,268**	**1.64**	**0.95**	**2.72**	**1.74**
1 Alburquerque	7,062	6,881	7,709	8,715	-0.26	2.30	2.48	1.06
2 Alicia	15,766	18,653	19,402	21,605	1.70	0.79	2.17	1.59
3 Anda	12,625	13,497	16,108	17,863	0.67	3.60	2.09	1.75
4 Antequera	11,641	12,348	12,072	13,758	0.59	-0.45	2.65	0.84
5 Baclayon	10,776	11,986	12,808	14,996	1.07	1.34	3.20	1.67
6 Balilihan	13,925	14,850	14,400	16,837	0.65	-0.61	3.18	0.95
7 Batuan	9,833	11,438	11,898	11,835	1.52	0.79	-0.11	0.93
8 Bien Unido	-	19,047	19,185	22,176	0.00	0.14	2.94	1.53
9 Bilar	12,715	14,926	16,029	16,628	1.62	1.44	0.74	1.35
10 Buenavista	18,088	21,665	24,215	25,960	1.82	2.25	1.40	1.82
11 Calape	22,488	24,608	26,051	27,921	0.90	1.15	1.40	1.09
12 Candijay	21,342	26,102	25,729	30,389	2.03	-0.29	3.39	1.78
13 Carmen	26,359	34,573	36,797	40,713	2.75	1.25	2.04	2.20
14 Catigbian	15,620	17,362	17,596	21,461	1.06	0.27	4.05	1.60
15 Clarin	13,721	16,021	15,961	18,040	1.56	-0.08	2.48	1.38
16 Corella	5,197	6,150	5,526	6,048	1.70	-2.12	1.82	0.76
17 Cortes	9,350	10,527	11,133	12,702	1.19	1.13	2.67	1.54
18 Dagohoy	9,451	13,121	13,943	16,845	3.34	1.22	3.85	2.93
19 Danao	10,298	12,671	14,042	17,265	2.10	2.08	4.22	2.62
20 Dauis	18,260	23,601	24,041	26,415	2.60	0.37	1.90	1.86
21 Dimiao	10,845	11,697	12,372	14,151	0.76	1.13	2.72	1.34
22 Duero	11,619	14,242	14,299	16,485	2.06	0.08	2.89	1.76
23 Garcia Hernandez	16,715	18,956	21,323	21,428	1.27	2.38	0.10	1.25
24 Getafe	16,769	21,135	23,927	26,826	2.34	2.51	2.31	2.38
25 Guindulman	24,376	26,225	26,945	29,166	0.73	0.54	1.60	0.90
26 Inabanga	32,918	37,400	40,015	40,714	1.28	1.36	0.35	1.07
27 Jagna	23,494	26,163	29,354	30,643	1.08	2.33	0.86	1.34
28 Lila	8,278	8,556	9,014	10,322	0.33	1.05	2.75	1.11
29 Loay	10,842	12,677	12,450	14,433	1.58	-0.36	3.00	1.44
30 Loboc	11,778	13,716	13,335	15,734	1.53	-0.56	3.36	1.46
31 Loon	35,643	34,400	32,716	45,215	-0.35	-1.00	6.69	1.20
32 Mabini	20,876	21,854	23,370	27,250	0.46	1.35	3.12	1.34
33 Maribojoc	14,008	15,214	14,664	16,786	0.83	-0.73	2.74	0.91
34 Panglao	14,547	17,004	18,095	21,337	1.57	1.25	3.35	1.93
35 Pilar	14,902	19,930	21,141	25,095	2.95	1.19	3.49	2.64
36 Pres. Carlos P. Garcia	18,142	21,173	19,096	20,744	1.56	-2.04	1.67	0.67
37 Sagbayan	12,703	15,364	16,488	18,346	1.92	1.42	2.16	1.85
38 San Isidro	7,369	7,840	7,548	9,106	0.62	-0.76	3.82	1.06
39 San Miguel	12,220	16,775	17,979	20,828	3.22	1.40	2.99	2.70
40 Sevilla	9,073	9,165	8,671	10,281	0.10	-1.10	3.46	0.63
41 Sierra Bullones	17,904	21,101	20,787	25,499	1.66	-0.30	4.17	1.78
42 Sikatuna	5,244	5,525	6,030	6,602	0.52	1.76	1.83	1.16
43 Tagbilaran City (Capital)	42,683	56,363	66,683	77,700	2.82	3.42	3.11	3.04
44 Talibon	46,110	41,873	44,854	54,147	-0.96	1.38	3.84	0.81
45 Trinidad	15,501	19,945	20,893	25,683	2.55	0.93	4.21	2.56
46 Tubigon	29,993	34,302	34,578	40,385	1.35	0.16	3.15	1.50
47 Ubay	38,289	48,902	50,745	59,827	2.48	0.74	3.35	2.26
48 Valencia	18,655	20,879	22,423	24,363	1.13	1.44	1.67	1.34
Total for Bohol Province	**806,013**	**948,403**	**994,440**	**1,137,268**	**1.64**	**0.95**	**2.72**	**1.74**

3.4.2 Future Growth Rates

Bohol exhibited an average annual growth rate of 2.72% from 1995 to 2000 based on May 2000 Census of the NSO. The NSO 2000 Census based projections saw a slowing down in population growth in the coming years. This master plan adopts NSO 2000 Census based Population Projections as approved by the National Statistics Coordination Board (NSCB).

Future growth rates for the province were computed based on the projected population figures derived from the NSO 2000 Census based Population Projections by Five-Year Age Group and Sex, by Region and Province, and by Five-Calendar Years: 2000-2040 (Medium Series).

The preparation of population projections is a designated statistical activity of the NSO done after every census year in order to generate critical data for decision-making of the government and the private sector.

The projected population figures taken from the NSO 2000 census based projections is shown in **Table 3-3** while the graph showing population figures is shown in **Figure 3-2**. Although, the projected growth rates demonstrate a declining rate of increase (**Figure 3-3**),still an average of 22,000 persons are being added yearly to the provincial population from year 2001 to 2035.

Table 3-3 Projected Population and Annual Growth Rates 2000-2005

Year	Projected Population[1/]	Projected Annual Growth rate
2000	1,137,268 [2/]	
2005	1,249,200	1.90
2010	1,362,900	1.76
2015	1,480,700	1.67
2020	1,597,100	1.53
2025	1,707,600	1.35
2030	1,811,100	1.18
2035	1,908,200	1.05

[1/] Source: NSO 2000 Census-Based Population Projections
[2/] Actual Population Figure for Year 2000, based on NSO Census of Population and Housing

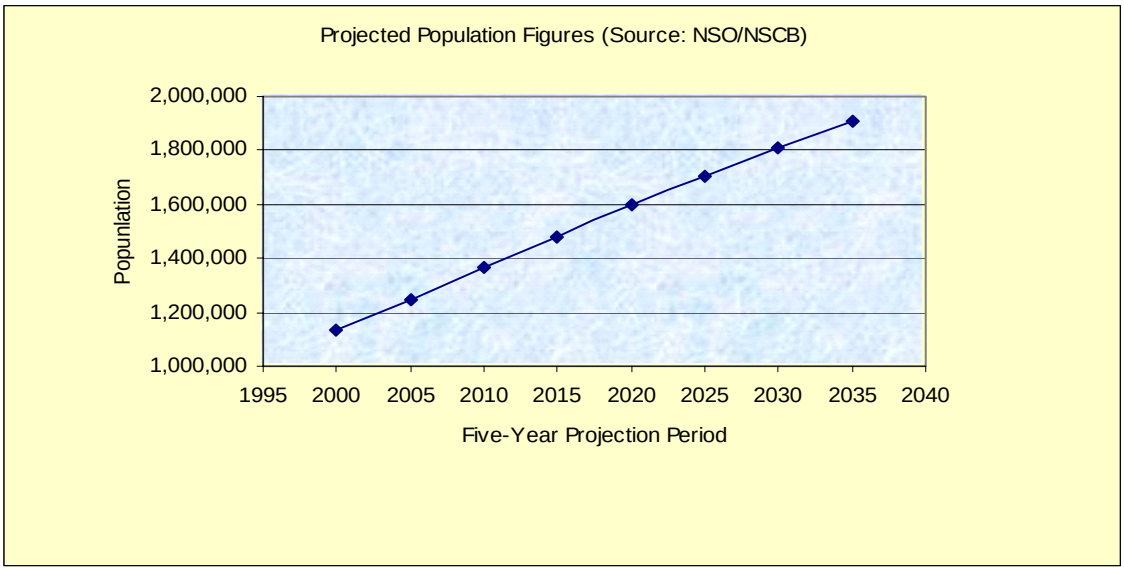


Figure 3-2 Projected Population Figures (2005-2035)

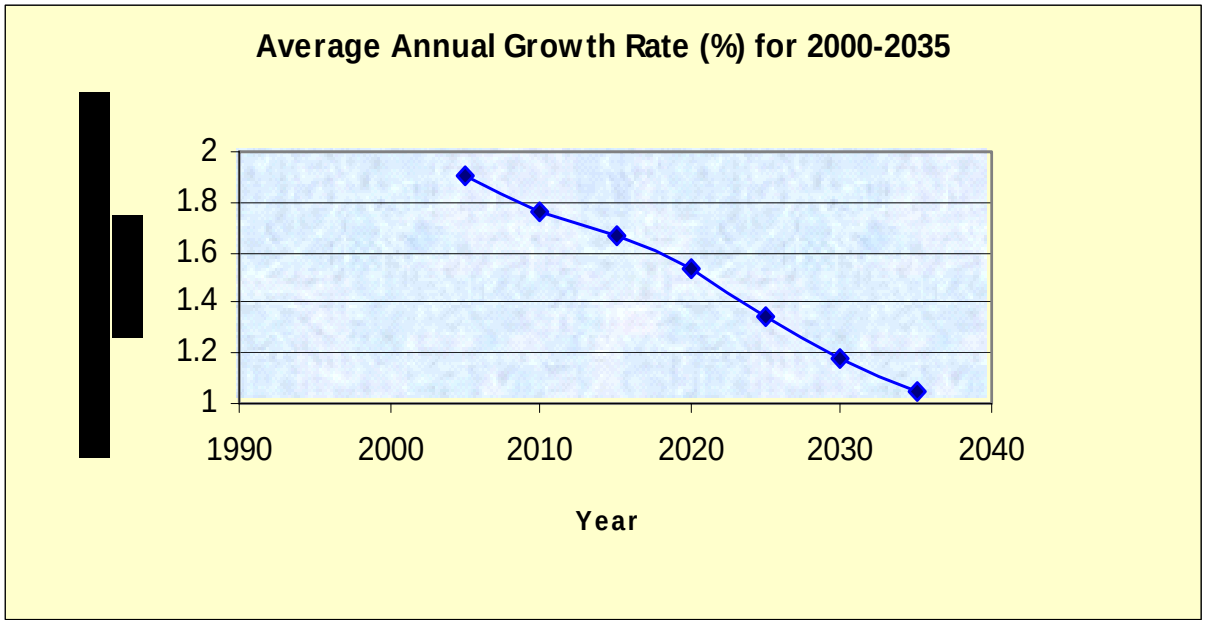


Figure 3-3 Projected Growth Rates (2000-2035)

3.4.3 Population Projections

The ratio method of population projection was used in this study. The ratio method of estimating future population of cities and municipalities makes use of levels and trends in the ratios of population of cities and municipalities to the population of the province as observed in previous censuses. These ratios are then projected on the assumption that after some time stability in the trend will be attained.

In the present application, all cities and municipalities comprising a province were classified according to trend of their ratios as observed in the 1980, 1990, 1995 and 2000 censuses. The trends may be classified as follows:

1. Type I - cities/municipalities that shows unidirectional trend in their ratios either increasing or decreasing) throughout the observation period.
2. Type II - cities/municipalities that had unidirectional trend only during the last two intercensal periods.
3. Type III - cities/municipalities that had unidirectional trend only during the first two intercensal period
4. Type IV - cities/municipalities with erratic trend

For each city/municipality, the initial rates of change of the ratios will be computed as follows:

1. For Type I city/municipality, the initial rate of change is equal to the lowest observed annual rate of change.
2. For Type II city/municipality, the initial rate of change is equal to the lower rate observed between the last two intercensal years.
3. For Type III city/municipality, the initial rate of change is equal to the one-half the annual rate of change in the last intercensal year.

4. For Type IV city/municipality, it is assumed that the ratio observed in 2000 would remain the same throughout the projection period.

It was assumed that for all cities and municipalities, R would gradually reduce so that they would all become zero in 70 years. Based on this assumption, a schedule of ratios were derived using the following formula:

$R_1 = R_0 (1+ r - r/70)$
$R_2 = R_1 (1+r – 2r/70)$
$R_k = R_n (1 + r – r/70) (1+r – 2r/70) \ldots\ldots (1 + r – kr/70)$
$Rk = R^k_0 (1+r – kr/70)$

The computed ratios of the population of cities and municipalities to the population of the province for year 1980,1990, 1995 and 2000 and the rates of change of the ratios between the censal years 1980-1990, 1990-1995, and 1995-2000 are presented in **Table 3-4**.

The projected ratios of each city and municipality for years 2005, 2010, 2015, 2020, 2025, 2030, and 2035 are shown in **Table 3-5** while the projected population is shown in **Table 3-6**. Some adjustments, however, were made to cope with actual population growth in some municipalities.

3.4.4 Projected Urban And Rural Population

The projected population of each city and municipality is further classified into urban and rural adopting the percent share as determined by the NSO and modified by the Provincial Sector Planning Team (PSPT) to meet actual conditions in the areas (*Chapter 8, PW4SP*). The guidelines in the classification of urban and rural barangays is defined in the NEDA Resolution No. 12 as shown in **Appendix II.3-A, Volume III-Databook.**

In this report, a conservative assumption of a two percent (2%) increase in the urbanization is applied in each projection period as shown in **Tables 3-7A and 3-7B.**

Table 3-4 Ratio of City/Municipality Population to Provincial Population (1980-2000)
Province of Bohol

City/Municipality	Historical Population				Ratios (City/Municipality to Province)			
	1980	1990	1995	2000	1980	1990	1995	2000
1 Alburquerque	7,062	6,881	7,709	8,715	0.0088	0.0073	0.0078	0.0077
2 Alicia	15,766	18,653	19,402	21,605	0.0196	0.0197	0.0195	0.0190
3 Anda	12,625	13,497	16,108	17,863	0.0157	0.0142	0.0162	0.0157
4 Antequera	11,641	12,348	12,072	13,758	0.0144	0.0130	0.0121	0.0121
5 Baclayon	10,776	11,986	12,808	14,996	0.0134	0.0126	0.0129	0.0132
6 Balilihan	13,925	14,850	14,400	16,837	0.0173	0.0157	0.0145	0.0148
7 Batuan	9,833	11,438	11,898	11,835	0.0122	0.0121	0.0120	0.0104
8 Bien Unido	-	19,047	19,185	22,176	0.0000	0.0201	0.0193	0.0195
9 Bilar	12,715	14,926	16,029	16,628	0.0158	0.0157	0.0161	0.0146
10 Buenavista	18,088	21,665	24,215	25,960	0.0224	0.0228	0.0244	0.0228
11 Calape	22,488	24,608	26,051	27,921	0.0279	0.0259	0.0262	0.0246
12 Candijay	21,342	26,102	25,729	30,389	0.0265	0.0275	0.0259	0.0267
13 Carmen	26,359	34,573	36,797	40,713	0.0327	0.0365	0.0370	0.0358
14 Catigbian	15,620	17,362	17,596	21,461	0.0194	0.0183	0.0177	0.0189
15 Clarin	13,721	16,021	15,961	18,040	0.0170	0.0169	0.0161	0.0159
16 Corella	5,197	6,150	5,526	6,048	0.0064	0.0065	0.0056	0.0053
17 Cortes	9,350	10,527	11,133	12,702	0.0116	0.0111	0.0112	0.0112
18 Dagohoy	9,451	13,121	13,943	16,845	0.0117	0.0138	0.0140	0.0148
19 Danao	10,298	12,671	14,042	17,265	0.0128	0.0134	0.0141	0.0152
20 Dauis	18,260	23,601	24,041	26,415	0.0227	0.0249	0.0242	0.0232
21 Dimiao	10,845	11,697	12,372	14,151	0.0135	0.0123	0.0124	0.0124
22 Duero	11,619	14,242	14,299	16,485	0.0144	0.0150	0.0144	0.0145
23 Garcia Hernandez	16,715	18,956	21,323	21,428	0.0207	0.0200	0.0214	0.0188
24 Getafe	16,769	21,135	23,927	26,826	0.0208	0.0223	0.0241	0.0236
25 Guindulman	24,376	26,225	26,945	29,166	0.0302	0.0277	0.0271	0.0256
26 Inabanga	32,918	37,400	40,015	40,714	0.0408	0.0394	0.0402	0.0358
27 Jagna	23,494	26,163	29,354	30,643	0.0291	0.0276	0.0295	0.0269
28 Lila	8,278	8,556	9,014	10,322	0.0103	0.0090	0.0091	0.0091
29 Loay	10,842	12,677	12,450	14,433	0.0135	0.0134	0.0125	0.0127
30 Loboc	11,778	13,716	13,335	15,734	0.0146	0.0145	0.0134	0.0138
31 Loon	35,643	34,400	32,716	45,215	0.0442	0.0363	0.0329	0.0398
32 Mabini	20,876	21,854	23,370	27,250	0.0259	0.0230	0.0235	0.0240
33 Maribojoc	14,008	15,214	14,664	16,786	0.0174	0.0160	0.0147	0.0148
34 Panglao	14,547	17,004	18,095	21,337	0.0180	0.0179	0.0182	0.0188
35 Pilar	14,902	19,930	21,141	25,095	0.0185	0.0210	0.0213	0.0221
36 Pres. C. P. Garcia	18,142	21,173	19,096	20,744	0.0225	0.0223	0.0192	0.0182
37 Sagbayan	12,703	15,364	16,488	18,346	0.0158	0.0162	0.0166	0.0161
38 San Isidro	7,369	7,840	7,548	9,106	0.0091	0.0083	0.0076	0.0080
39 San Miguel	12,220	16,775	17,979	20,828	0.0152	0.0177	0.0181	0.0183
40 Sevilla	9,073	9,165	8,671	10,281	0.0113	0.0097	0.0087	0.0090
41 Sierra Bullones	17,904	21,101	20,787	25,499	0.0222	0.0222	0.0209	0.0224
42 Sikatuna	5,244	5,525	6,030	6,602	0.0065	0.0058	0.0061	0.0058
43 Tagbilaran City (Capital)	42,683	56,363	66,683	77,700	0.0530	0.0594	0.0671	0.0683
44 Talibon	46,110	41,873	44,854	54,147	0.0572	0.0442	0.0451	0.0476
45 Trinidad	15,501	19,945	20,893	25,683	0.0192	0.0210	0.0210	0.0226
46 Tubigon	29,993	34,302	34,578	40,385	0.0372	0.0362	0.0348	0.0355
47 Ubay	38,289	48,902	50,745	59,827	0.0475	0.0516	0.0510	0.0526
48 Valencia	18,655	20,879	22,423	24,363	0.0231	0.0220	0.0225	0.0214
Total	**806,013**	**948,403**	**994,440**	**1,137,268**				

Table 3-5 Future Ratios (City/Municipality to Province)
Province of Bohol

City/Municipality	Year						
	2005	2010	2015	2020	2025	2030	2035
1 Alburquerque	0.008	0.008	0.008	0.007	0.007	0.007	0.007
2 Alicia	0.018	0.018	0.017	0.017	0.017	0.016	0.016
3 Anda	0.016	0.015	0.015	0.015	0.014	0.014	0.013
4 Antequera	0.012	0.012	0.012	0.012	0.012	0.012	0.011
5 Baclayon	0.013	0.013	0.014	0.014	0.014	0.014	0.014
6 Balilihan	0.015	0.015	0.015	0.015	0.015	0.015	0.015
7 Batuan	0.010	0.010	0.010	0.010	0.010	0.010	0.010
8 Bien Unido	0.020	0.020	0.020	0.020	0.020	0.020	0.020
9 Bilar	0.015	0.014	0.014	0.014	0.014	0.014	0.014
10 Buenavista	0.022	0.021	0.021	0.020	0.019	0.019	0.019
11 Calape	0.024	0.024	0.024	0.024	0.024	0.024	0.024
12 Candijay	0.027	0.026	0.026	0.026	0.026	0.026	0.026
13 Carmen	0.035	0.034	0.034	0.033	0.033	0.032	0.032
14 Catigbian	0.019	0.020	0.020	0.021	0.021	0.021	0.022
15 Clarin	0.016	0.016	0.015	0.015	0.015	0.015	0.015
16 Corella	0.005	0.005	0.005	0.005	0.005	0.005	0.005
17 Cortes	0.011	0.011	0.011	0.011	0.011	0.011	0.011
18 Dagohoy	0.015	0.015	0.015	0.015	0.015	0.015	0.015
19 Danao	0.015	0.016	0.016	0.016	0.016	0.016	0.016
20 Dauis	0.024	0.025	0.026	0.027	0.027	0.028	0.029
21 Dimiao	0.012	0.012	0.012	0.012	0.012	0.012	0.012
22 Duero	0.014	0.014	0.014	0.014	0.014	0.014	0.014
23 Garcia Hernandez	0.019	0.019	0.018	0.018	0.018	0.018	0.018
24 Getafe	0.023	0.023	0.023	0.022	0.022	0.022	0.022
25 Guindulman	0.024	0.023	0.022	0.022	0.021	0.020	0.020
26 Inabanga	0.036	0.035	0.034	0.034	0.033	0.032	0.030
27 Jagna	0.027	0.027	0.026	0.026	0.026	0.026	0.026
28 Lila	0.009	0.009	0.009	0.009	0.009	0.009	0.009
29 Loay	0.013	0.013	0.013	0.013	0.013	0.013	0.013
30 Loboc	0.014	0.014	0.014	0.014	0.014	0.014	0.014
31 Loon	0.043	0.047	0.050	0.054	0.057	0.060	0.063
32 Mabini	0.024	0.025	0.025	0.025	0.025	0.025	0.026
33 Maribojoc	0.015	0.015	0.015	0.014	0.014	0.014	0.014
34 Panglao	0.019	0.019	0.019	0.019	0.019	0.019	0.020
35 Pilar	0.022	0.022	0.022	0.022	0.022	0.023	0.023
36 Pres. C. P. Garcia	0.017	0.016	0.016	0.015	0.014	0.014	0.013
37 Sagbayan	0.016	0.016	0.015	0.015	0.015	0.015	0.014
38 San Isidro	0.008	0.008	0.008	0.008	0.008	0.008	0.008
39 San Miguel	0.018	0.019	0.019	0.019	0.019	0.019	0.019
40 Sevilla	0.009	0.009	0.009	0.009	0.009	0.010	0.010
41 Sierra Bullones	0.022	0.022	0.022	0.022	0.022	0.022	0.022
42 Sikatuna	0.006	0.006	0.006	0.006	0.006	0.006	0.006
43 Tagbilaran City (Capital)	0.069	0.070	0.070	0.071	0.072	0.072	0.073
44 Talibon	0.048	0.049	0.049	0.050	0.050	0.051	0.051
45 Trinidad	0.022	0.022	0.022	0.022	0.022	0.022	0.022
46 Tubigon	0.036	0.036	0.036	0.036	0.036	0.036	0.036
47 Ubay	0.052	0.052	0.052	0.051	0.051	0.051	0.051
48 Valencia	0.021	0.021	0.021	0.021	0.021	0.021	0.021
Total	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**

Table 3-6 Population Projection (2005-2035)
Province of Bohol

City/Municipality	2005	2010	2015	2020	2025	2030	2035
1 Alburquerque	9,511	10,312	11,137	11,947	12,711	13,422	14,087
2 Alicia	22,983	24,338	25,722	27,053	28,271	29,379	30,406
3 Anda	19,494	20,998	22,391	23,576	24,485	25,114	25,492
4 Antequera	14,964	16,175	17,420	18,639	19,784	20,847	21,841
5 Baclayon	16,664	18,373	20,152	21,925	23,624	25,231	26,749
6 Balilihan	18,570	20,333	22,160	23,968	25,690	27,309	28,832
7 Batuan	12,845	13,856	14,895	15,911	16,862	17,744	18,568
8 Bien Unido	24,449	26,760	29,155	31,525	33,780	35,900	37,894
9 Bilar	18,146	19,674	21,249	22,795	24,251	25,608	26,879
10 Buenavista	27,470	28,946	30,455	31,899	33,212	34,399	35,497
11 Calape	30,470	33,036	35,681	38,276	40,722	43,000	45,133
12 Candijay	33,163	35,956	38,835	41,660	44,322	46,801	49,123
13 Carmen	43,733	46,728	49,795	52,767	55,520	58,048	60,399
14 Catigbian	24,155	26,950	29,883	32,835	35,700	38,435	41,037
15 Clarin	19,614	21,194	22,819	24,409	25,901	27,287	28,582
16 Corella	6,618	7,194	7,788	8,372	8,924	9,439	9,922
17 Cortes	13,830	14,964	16,131	17,274	18,348	19,348	20,282
18 Dagohoy	18,619	20,428	22,305	24,166	25,942	27,614	29,189
19 Danao	19,248	21,287	23,413	25,537	27,580	29,516	31,348
20 Dauis	30,151	34,080	38,244	42,483	46,648	50,667	54,520
21 Dimiao	15,445	16,748	18,091	19,409	20,651	21,808	22,892
22 Duero	17,990	19,505	21,066	22,599	24,043	25,388	26,647
23 Garcia Hernandez	23,384	25,354	27,383	29,375	31,252	33,001	34,638
24 Getafe	28,998	31,166	33,391	35,557	37,578	39,445	41,186
25 Guindulman	30,493	31,776	33,092	34,339	35,453	36,446	37,360
26 Inabanga	44,430	47,860	51,035	53,736	55,808	57,241	58,103
27 Jagna	33,440	36,257	39,159	42,008	44,692	47,192	49,533
28 Lila	11,278	12,242	13,236	14,213	15,134	15,993	16,798
29 Loay	15,853	17,292	18,781	20,249	21,641	22,945	24,170
30 Loboc	17,429	19,161	20,960	22,748	24,457	26,068	27,589
31 Loon	54,071	63,810	74,507	85,822	97,377	108,918	120,271
32 Mabini	30,295	33,416	36,665	39,904	43,010	45,949	48,725
33 Maribojoc	18,327	19,878	21,478	23,049	24,529	25,909	27,201
34 Panglao	23,617	25,943	28,360	30,759	33,051	35,211	37,248
35 Pilar	27,691	30,333	33,072	35,785	38,369	40,798	43,085
36 Pres. C. P. Garcia	21,551	22,326	23,125	23,879	24,544	25,131	25,672
37 Sagbayan	19,760	21,166	22,607	24,006	25,306	26,504	27,618
38 San Isidro	9,937	10,774	11,637	12,483	13,281	14,024	14,719
39 San Miguel	23,011	25,236	27,544	29,832	32,014	34,068	36,002
40 Sevilla	11,415	12,577	13,785	14,988	16,141	17,230	18,258
41 Sierra Bullones	27,827	30,170	32,586	34,956	37,190	39,270	41,218
42 Sikatuna	7,205	7,811	8,437	9,051	9,629	10,168	10,672
43 Tagbilaran City (Capital)	86,324	95,158	104,354	113,512	122,292	130,591	138,432
44 Talibon	60,311	66,640	73,239	79,825	86,154	92,149	97,820
45 Trinidad	28,027	30,388	32,821	35,208	37,458	39,554	41,516
46 Tubigon	44,518	48,720	53,073	57,381	61,481	65,332	68,956
47 Ubay	65,288	70,787	76,454	82,015	87,256	92,138	96,708
48 Valencia	26,587	28,826	31,134	33,399	35,533	37,521	39,382
Total	**1,249,200**	**1,362,900**	**1,480,700**	**1,597,100**	**1,707,600**	**1,811,100**	**1,908,200**

Table 3-7A Projected Population Distribution by Urban and Rural Classification (2010-2020)

City/ Municipality	Projected Population (Year 2010)	% Share		Population Distribution by Classification		Projected Population (Year 2015)	% Share		Population Distribution by Classification		Projected Population (Year 2020)	% Share		Population Distribution by Classification	
		Urban (%)	Rural (%)	Urban	Rural		Urban (%)	Rural (%)	Urban	Rural		Urban (%)	Rural (%)	Urban	Rural
Alburquerque	10,307	38.21	61.79	3,938	6,368	11,137	38.97	61.03	4,340	6,796	11,952	39.75	60.25	4,751	7,200
Alicia	24,253	9.79	90.21	2,374	21,879	25,610	9.99	90.01	2,557	23,053	26,913	10.18	89.82	2,741	24,172
Anda	21,001	14.00	86.00	2,940	18,060	22,430	14.28	85.72	3,203	19,227	23,665	14.57	85.43	3,447	20,217
Antequera	16,118	18.05	81.95	2,910	13,208	17,344	18.42	81.58	3,194	14,150	18,543	18.78	81.22	3,483	15,060
Baclayon	18,364	27.54	72.46	5,058	13,307	20,152	28.09	71.91	5,661	14,491	21,933	28.65	71.35	6,284	15,648
Balilihan	20,292	15.66	84.34	3,178	17,114	22,111	15.98	84.02	3,532	18,579	23,910	16.29	83.71	3,896	20,014
Batuan	13,849	25.28	74.72	3,501	10,348	14,895	25.79	74.21	3,841	11,054	15,917	26.30	73.70	4,186	11,730
Bien Unido	26,666	79.61	20.39	21,229	5,438	29,027	81.20	18.80	23,571	5,457	31,361	82.82	17.18	25,975	5,386
Bilar	19,665	20.51	79.49	4,034	15,631	21,249	20.92	79.08	4,446	16,803	22,803	21.34	78.66	4,867	17,937
Buenavista	28,889	13.40	86.60	3,872	25,017	30,388	13.67	86.33	4,154	26,234	31,822	13.94	86.06	4,437	27,385
Calape	33,020	27.75	72.25	9,162	23,858	35,680	28.30	71.70	10,098	25,582	38,290	28.87	71.13	11,053	27,237
Candijay	35,939	39.51	60.49	14,198	21,740	38,834	40.30	59.70	15,649	23,184	41,675	41.10	58.90	17,130	24,545
Carmen	46,635	22.66	77.34	10,566	36,069	49,686	23.11	76.89	11,482	38,204	52,640	23.57	76.43	12,408	40,232
Catigbian	26,896	14.48	85.52	3,894	23,002	29,817	14.77	85.23	4,403	25,414	32,756	15.06	84.94	4,934	27,822
Clarin	21,183	23.31	76.69	4,938	16,246	22,818	23.78	76.22	5,425	17,393	24,418	24.25	75.75	5,922	18,496
Corella	7,190	13.51	86.49	971	6,219	7,787	13.78	86.22	1,073	6,714	8,375	14.05	85.95	1,177	7,198
Cortes	14,911	24.35	75.65	3,631	11,280	16,060	24.84	75.16	3,989	12,071	17,184	25.33	74.67	4,354	12,831
Dagohoy	20,418	14.64	85.36	2,989	17,429	22,304	14.93	85.07	3,330	18,974	24,175	15.23	84.77	3,682	20,493
Danao	21,276	17.56	82.44	3,735	17,541	23,413	17.91	82.09	4,192	19,220	25,546	18.27	81.73	4,666	20,880
Dauis	34,063	44.56	55.44	15,179	18,884	38,243	45.45	54.55	17,382	20,860	42,499	46.36	53.64	19,704	22,796
Dimiao	16,689	9.09	90.91	1,518	15,171	18,012	9.28	90.72	1,671	16,341	19,308	9.46	90.54	1,827	17,481
Duero	19,495	21.77	78.23	4,244	15,251	21,066	22.21	77.79	4,678	16,388	22,607	22.65	77.35	5,121	17,487
Garcia Hernandez	25,341	23.95	76.05	6,069	19,272	27,382	24.43	75.57	6,689	20,693	29,386	24.92	75.08	7,322	22,064
Getafe	31,104	45.84	54.16	14,257	16,847	33,317	46.75	53.25	15,577	17,741	35,471	47.69	52.31	16,916	18,556
Guindulman	33,788	18.30	81.70	6,184	27,604	35,204	18.67	81.33	6,572	28,632	36,545	19.04	80.96	6,959	29,586
Inabanga	47,865	26.95	73.05	12,900	34,965	51,124	27.49	72.51	14,054	37,070	53,937	28.04	71.96	15,124	38,813
Jagna	36,239	35.20	64.80	12,755	23,484	39,158	35.90	64.10	14,058	25,101	42,023	36.62	63.38	15,388	26,635
Lila	12,199	19.42	80.58	2,370	9,830	13,178	19.81	80.19	2,611	10,567	14,139	20.21	79.79	2,857	11,282
Loay	17,258	34.35	65.65	5,928	11,330	18,739	35.04	64.96	6,566	12,173	20,200	35.74	64.26	7,219	12,981
Loboc	19,122	17.35	82.65	3,318	15,805	20,914	17.70	82.30	3,701	17,212	22,693	18.05	81.95	4,096	18,596
Loon	63,681	32.40	67.60	20,633	43,048	74,339	33.05	66.95	24,568	49,771	85,611	33.71	66.29	28,859	56,751
Mabini	33,299	27.28	72.72	9,085	24,213	36,505	27.83	72.17	10,159	26,346	39,697	28.39	71.61	11,269	28,428
Maribojoc	19,839	49.29	50.71	9,779	10,060	21,431	50.28	49.72	10,775	10,656	22,993	51.28	48.72	11,791	11,202
Panglao	25,931	61.16	38.84	15,858	10,072	28,359	62.38	37.62	17,690	10,669	30,770	63.63	36.37	19,578	11,192
Pilar	30,318	14.59	85.41	4,423	25,895	33,071	14.88	85.12	4,921	28,150	35,798	15.18	84.82	5,433	30,365
Pres. C. P. Garcia	22,248	35.04	64.96	7,795	14,453	23,024	35.74	64.26	8,228	14,796	23,755	36.45	63.55	8,659	15,096
Sagbayan	21,124	19.39	80.61	4,096	17,028	22,558	19.78	80.22	4,461	18,097	23,949	20.17	79.83	4,831	19,118
San Isidro	10,769	0.00	100.00	0	10,769	11,636	0.00	100.00	0	11,636	12,488	0.00	100.00	0	12,488
San Miguel	25,148	10.26	89.74	2,580	22,568	27,424	10.47	89.53	2,870	24,554	29,677	10.67	89.33	3,168	26,509
Sevilla	12,552	14.27	85.73	1,791	10,761	13,755	14.55	85.45	2,002	11,753	14,952	14.85	85.15	2,220	12,732
Sierra Bullones	30,156	34.55	65.45	10,420	19,736	32,585	35.25	64.75	11,485	21,100	34,969	35.95	64.05	12,571	22,398
Sikatuna	7,808	14.10	85.90	1,101	6,707	8,437	14.38	85.62	1,214	7,223	9,054	14.67	85.33	1,328	7,726
Tagbilaran City	94,825	100.00	0.00	94,825	0	103,898	100.00	0.00	103,898	0	112,924	100.00	0.00	112,924	0
Talibon	66,608	56.86	43.14	37,872	28,736	73,237	58.00	42.00	42,474	30,763	79,855	59.16	40.84	47,238	32,616
Trinidad	30,373	11.30	88.70	3,431	26,942	32,820	11.52	88.48	3,781	29,039	35,221	11.75	88.25	4,139	31,082
Tubigon	48,622	49.33	50.67	23,984	24,638	52,956	50.31	49.69	26,645	26,312	57,243	51.32	48.68	29,377	27,865
Ubay	70,752	21.07	78.93	14,907	55,846	76,452	21.49	78.51	16,430	60,022	82,046	21.92	78.08	17,985	64,061
Valencia	28,812	8.97	91.03	2,584	26,228	31,133	9.15	90.85	2,848	28,285	33,411	9.33	90.67	3,118	30,294
Provincial Total	**1,362,900**			**457,005**	**905,895**	**1,480,700**			**506,151**	**974,549**	**1,597,100**			**556,416**	**1,040,684**

Note: % of urban and rural population in each municipality is projected to attain a minimal increase of 2% per year from 2015-2035

Table 3-7B Projected Population Distribution by Urban and Rural Classification (2025-2035)

City/Municipality	Projected Population (Year 2025)	% Share		Population Distribution by Classification		Projected Population (Year 2030)	% Share		Population Distribution by Classification		Projected Population (Year 2035)	% Share		Population Distribution by Classification	
		Urban (%)	Rural (%)	Urban	Rural		Urban (%)	Rural (%)	Urban	Rural		Urban (%)	Rural (%)	Urban	Rural
Alburquerque	12,720	40.55	59.45	5,158	7,562	13,435	41.36	58.64	5,557	7,878	14,105	42.19	57.81	5,950	8,154
Alicia	28,103	10.39	89.61	2,920	25,184	29,185	10.60	89.40	3,093	26,093	30,186	10.81	89.19	3,263	26,923
Anda	24,635	14.86	85.14	3,660	20,974	25,334	15.16	84.84	3,839	21,495	25,789	15.46	84.54	3,987	21,803
Antequera	19,667	19.16	80.84	3,768	15,898	20,709	19.54	80.46	4,047	16,662	21,683	19.93	80.07	4,322	17,361
Baclayon	23,641	29.23	70.77	6,909	16,732	25,256	29.81	70.19	7,529	17,727	26,782	30.41	69.59	8,144	18,638
Balilihan	25,623	16.62	83.38	4,259	21,364	27,231	16.95	83.05	4,617	22,615	28,744	17.29	82.71	4,970	23,774
Batuan	16,874	26.83	73.17	4,527	12,347	17,762	27.36	72.64	4,861	12,901	18,591	27.91	72.09	5,189	13,402
Bien Unido	33,580	84.48	15.52	28,369	5,211	35,662	86.17	13.83	30,730	4,932	37,619	87.89	12.11	33,065	4,554
Bilar	24,269	21.77	78.23	5,283	18,986	25,634	22.20	77.80	5,692	19,942	26,912	22.65	77.35	6,095	20,817
Buenavista	33,125	14.22	85.78	4,711	28,414	34,303	14.51	85.49	4,976	29,327	35,391	14.80	85.20	5,237	30,155
Calape	40,751	29.44	70.56	11,999	28,752	43,043	30.03	69.97	12,927	30,116	45,189	30.63	69.37	13,843	31,346
Candijay	44,353	41.93	58.07	18,595	25,758	46,848	42.76	57.24	20,034	26,814	49,183	43.62	56.38	21,454	27,730
Carmen	55,375	24.04	75.96	13,314	42,061	57,885	24.52	75.48	14,196	43,690	60,218	25.01	74.99	15,063	45,155
Catigbian	35,605	15.36	84.64	5,470	30,135	38,326	15.67	84.33	6,006	32,320	40,912	15.98	84.02	6,539	34,373
Clarin	25,920	24.74	75.26	6,412	19,508	27,314	25.23	74.77	6,892	20,423	28,618	25.74	74.26	7,365	21,253
Corella	8,930	14.34	85.66	1,280	7,650	9,448	14.62	85.38	1,382	8,067	9,934	14.91	85.09	1,482	8,453
Cortes	18,240	25.84	74.16	4,713	13,526	19,219	26.36	73.64	5,066	14,154	20,135	26.88	73.12	5,413	14,722
Dagohoy	25,960	15.54	84.46	4,033	21,927	27,641	15.85	84.15	4,380	23,261	29,225	16.16	83.84	4,724	24,502
Danao	27,599	18.63	81.37	5,142	22,457	29,545	19.00	81.00	5,614	23,931	31,387	19.38	80.62	6,084	25,303
Dauis	46,681	47.29	52.71	22,075	24,606	50,718	48.24	51.76	24,464	26,254	54,587	49.20	50.80	26,857	27,730
Dimiao	20,529	9.65	90.35	1,981	18,547	21,664	9.84	90.16	2,133	19,531	22,726	10.04	89.96	2,282	20,444
Duero	24,060	23.10	76.90	5,559	18,501	25,413	23.57	76.43	5,989	19,424	26,680	24.04	75.96	6,413	20,267
Garcia Hernandez	31,274	25.42	74.58	7,949	23,326	33,033	25.92	74.08	8,564	24,470	34,680	26.44	73.56	9,170	25,510
Getafe	37,480	48.64	51.36	18,231	19,249	39,334	49.61	50.39	19,515	19,819	41,062	50.61	49.39	20,780	20,282
Guindulman	37,743	19.42	80.58	7,331	30,412	38,811	19.81	80.19	7,689	31,122	39,795	20.21	79.79	8,041	31,753
Inabanga	56,148	28.60	71.40	16,059	40,089	57,742	29.17	70.83	16,845	40,897	58,780	29.76	70.24	17,491	41,289
Jagna	44,724	37.35	62.65	16,704	28,019	47,239	38.10	61.90	17,997	29,243	49,594	38.86	61.14	19,272	30,322
Lila	15,044	20.61	79.39	3,101	11,943	15,887	21.03	78.97	3,340	12,547	16,676	21.45	78.55	3,576	13,100
Loay	21,584	36.45	63.55	7,868	13,716	22,880	37.18	62.82	8,508	14,373	24,097	37.93	62.07	9,139	14,958
Loboc	24,392	18.41	81.59	4,491	19,901	25,995	18.78	81.22	4,882	21,112	27,505	19.16	80.84	5,269	22,236
Loon	97,115	34.38	65.62	33,392	63,723	108,601	35.07	64.93	38,088	70,513	119,897	35.77	64.23	42,891	77,006
Mabini	42,755	28.95	71.05	12,379	30,375	45,644	29.53	70.47	13,480	32,164	48,372	30.12	69.88	14,572	33,800
Maribojoc	24,465	52.31	47.69	12,797	11,668	25,836	53.35	46.65	13,784	12,051	27,119	54.42	45.58	14,758	12,360
Panglao	33,074	64.90	35.10	21,465	11,609	35,246	66.20	33.80	23,332	11,914	37,294	67.52	32.48	25,182	12,112
Pilar	38,396	15.48	84.52	5,944	32,452	40,839	15.79	84.21	6,449	34,390	43,138	16.11	83.89	6,948	36,190
Pres. Carlos P. Garcia	24,398	37.18	62.82	9,072	15,327	24,965	37.92	62.08	9,468	15,497	25,486	38.68	61.32	9,859	15,627
Sagbayan	25,241	20.58	79.42	5,193	20,047	26,429	20.99	79.01	5,547	20,883	27,535	21.41	78.59	5,894	21,641
San Isidro	13,290	0.00	100.00	0	13,290	14,038	0.00	100.00	0	14,038	14,738	0.00	100.00	0	14,738
San Miguel	31,824	10.89	89.11	3,465	28,359	33,842	11.11	88.89	3,758	30,083	35,741	11.33	88.67	4,049	31,692
Sevilla	16,098	15.14	84.86	2,438	13,661	17,181	15.45	84.55	2,654	14,527	18,203	15.75	84.25	2,868	15,335
Sierra Bullones	37,216	36.67	63.33	13,647	23,569	39,309	37.40	62.60	14,703	24,607	41,269	38.15	61.85	15,744	25,525
Sikatuna	9,636	14.96	85.04	1,442	8,194	10,178	15.26	84.74	1,554	8,624	10,685	15.57	84.43	1,664	9,021
Tagbilaran City (Capital)	121,566	100.00	0.00	121,566	0	129,726	100.00	0.00	129,726	0	137,428	100.00	0.00	137,428	0
Talibon	86,215	60.34	39.66	52,021	34,194	92,241	61.55	38.45	56,770	35,471	97,940	62.78	37.22	61,483	36,457
Trinidad	37,485	11.99	88.01	4,493	32,991	39,593	12.23	87.77	4,841	34,752	41,567	12.47	87.53	5,184	36,383
Tubigon	61,319	52.35	47.65	32,099	29,221	65,147	53.39	46.61	34,785	30,362	68,747	54.46	45.54	37,441	31,306
Ubay	87,318	22.36	77.64	19,523	67,795	92,229	22.81	77.19	21,034	71,196	96,827	23.26	76.74	22,524	74,303
Valencia	35,558	9.52	90.48	3,384	32,174	37,558	9.71	90.29	3,646	33,912	39,430	9.90	90.10	3,904	35,526
Provincial Total	**1,707,600**			**606,192**	**1,101,408**	**1,811,100**			**654,979**	**1,156,121**	**1,908,200**			**702,871**	**1,205,329**

Note: % of urban and rural population in each municipality is projected to attain a minimal increase of 2% per year from 2015-2035

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3.4.5 Provincial Water Supply Sector Target

The target in the MTDP (2004-2009) for Bohol for the planned water supply improvements were set vis-à-vis the NSMP. In consonance with the MTDP and the NSMP, the PW4SP study defined the targets years and service coverage as follows:

Table 3-8 Provincial Sector Targets

Sub-sector	Existing Service Coverage	Phase I (2005-2010)	Phase II (2011-2015)
Water Supply	Population Coverage (%)	Population Coverage (%)	Population Coverage (%)
Urban Water Supply	60	89	95
Rural Water Supply	59	90	93

Source: PW4SP

This study considers years 2010 to 2035 as projection period.

3.4.6 Service Coverage/Target Served Population Projections

In LWUA assisted studies, the service coverage or the number of population that may be served by the water supply system is determined through a willingness-to-connect survey which is usually conducted at the start of the feasibility study. However, since willingness-to-connect survey was not part of this study, the basis used in the estimation of the service coverage is the target of the provincial government as shown in **Table 3-8**. In addition, the information gathered from field surveys mentioned in Section 3.4.3, and the PW4SP report on existing served population were also used as guide in determining the projected service coverage.

It is envisaged that the target served population will be served by a combination of available sources, either from surface water or groundwater. Households in the urban and adjoining rural areas in the existing and proposed service area expansion may be served by an interconnected piped system through bulk supply, in addition to the current sources while those in outlying areas may be served by Level I, Level II or Level III facilities with springs and groundwater through deepwells as sources.

The projected service coverage for urban and rural population at five year interval projection period is presented in **Table 3-9**.

Table 3-9 Target Service Coverage (2010-2035)

Year	Population Class	Projected Population	Target Service Coverage		Source of Supply			
					Bulk Supply and Current Level III Sources		Other Sources	
			(%)	Population	(%)	Population	(%)	Population
2010	Urban	457,005	65	297,053	62	285,477	3	11,576
	Rural	905,895	60	543,537	26	234,013	34	309,524
	Total	1,362,900	62	840,590	38	519,490	24	321,100
2015	Urban	506,151	89	450,474	79	399,015	10	51,459
	Rural	974,549	90	877,094	48	465,623	42	411,471
	Total	1,480,700	90	1,327,568	59	864,638	31	462,930
2020	Urban	556,416	95	528,595	84	470,114	11	58,481
	Rural	1,040,684	93	967,836	53	546,898	40	420,938
	Total	1,597,100	94	1,496,431	64	1,017,012	30	479,419
2025	Urban	606,192	95	575,882	90	547,478	5	28,404
	Rural	1,101,408	93	1,024,310	53	578,821	40	445,489
	Total	1,707,600	94	1,600,192	66	1,126,300	28	473,892
2030	Urban	654,979	95	622,230	95	619,792	0	2,438
	Rural	1,156,121	93	1,075,193	53	607,577	40	467,616
	Total	1,811,100	94	1,697,423	68	1,227,369	26	470,054
2035	Urban	702,871	95	667,727	95	665,131	0	2,596
	Rural	1,205,329	93	1,120,956	53	633,428	40	487,528
	Total	1,908,200	94	1,788,683	68	1,298,559	26	490,124

The year-by-year municipal population and service coverage projection for proposed bulk supply and current sources for Level III water systems to be managed and operated by the LGU water systems, WDs and cooperatives is presented in **Table 3-10**. In 2007, it is estimated that about 32% of the projected municipal population is currently enjoying Level III water systems managed and operated by LGUs, WDs and cooperatives.

Table 3-10 Year-by-Year Municipal Population and Service Coverage

Year	Total Municipal Population	Service Coverage for Bulk Supply and Current Sources	%Served Population
2010	**1,362,900**	**519,490**	**38**
2011	1,386,460	526,855	38
2012	1,410,020	549,908	39
2013	1,433,580	573,432	40
2014	1,457,140	713,999	49
2015	**1,480,700**	**864,638**	**58**
2016	1,503,980	895,113	60
2017	1,527,260	925,588	61
2018	1,550,540	956,063	62
2019	1,573,820	986,537	63
2020	**1,597,100**	**1,017,012**	**64**
2021	1,619,200	1,038,870	64
2022	1,641,300	1,060,727	65
2023	1,663,400	1,082,585	65
2024	1,685,500	1,104,442	66
2025	**1,707,600**	**1,126,300**	**66**
2026	1,728,300	1,146,514	66
2027	1,749,000	1,166,728	67
2028	1,769,700	1,186,942	67
2029	1,790,400	1,207,155	67
2030	**1,811,100**	**1,227,369**	**68**
2031	1,830,520	1,241,607	68
2032	1,849,940	1,255,845	68
2033	1,869,360	1,270,083	68
2034	1,888,780	1,284,321	68
2035	**1,908,200**	**1,298,559**	**68**

Figure 3-4 is the graph showing growth in municipal and service coverage population

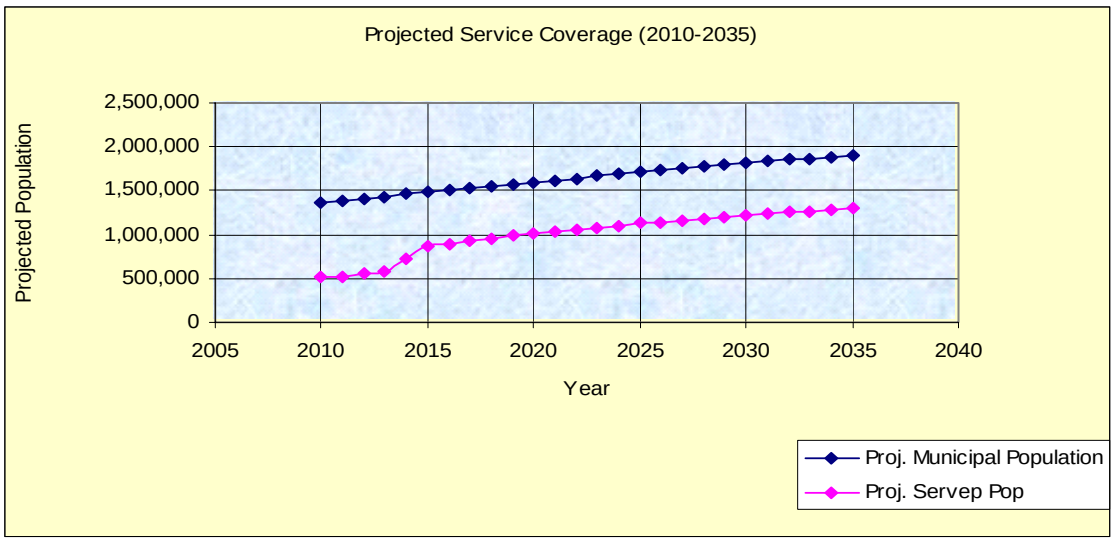


Figure 3-4 Projected Service Coverage (2010-2035)

3.5 WATER DEMAND PROJECTIONS

Water demand projection which is an estimate of the amount of water to be used by the population in the target service coverage during the projection years is considered as the main factor in designing a water system and its components. The source development and waterworks facilities consisting of transmission mains, reservoirs, treatment plants, etc., are usually planned and designed to meet the projected demand requirements of a defined service area.

The projections undertaken considered results of the field survey conducted on the water systems managed by the LGUs. Data were also gathered from two water systems managed by Water Districts and three systems managed by cooperatives.

Reference were also made to projection results from previous studies such as the

a) Tagbilaran System Water Supply System Master Plan (for Tagbilaran City only), 1992

Particulars	2000	2010	2015
Unit Domestic Water Comsumption (lpcd)	160	170	170

b) Bohol-Cebu Water Supply Project, 1996

The projected unit domestic water demand for 12 municipalities within the Wahig/Inabanga Watershed namely Alicia, Buenavista, Carmen, Dagohoy, Danao, Inabanga, Pilar, Sagbayan, San Miguel, Talibon, Trinidad and Sierra Bullones were projected as follows:

Population Classification	Projected Unit Domestic Water Demand (L/c/d)		
	2010	2015	2020
Urban	126	133	140
Rural	52	54	57

c) Water Supply, Sanitation and Sewerage Sector Master Plan for Bohol Province (W4SMP), 2000

The assumed equivalent consumptions that included domestic, commercial, industrial, institutional and an allowance for losses were as follows;

User Classification	Projected Consumption (L/c/d)	
	2010	2030
Urban	247.5	333.4
Rural	100.1	122.2

d) Bohol Integrated Waterworks and Irrigation Project, 1996

The water demand requirements of the following municipalities throughout the projection period as presented in the study were as follows:

Municipality/City	Projected Unit Demand in L/c/d (inclusive of domestic, commercial, industrial + losses)
Tagbilaran City	229
Dauis	103
Panglao	109
Corella	95
Baclayon	101
Alburquerque	97
Loay	97
Cortes	88
Maribojoc	103

The LWUA Methodology Manual was also used as reference in projecting water demands for the city of Tagbilaran and the 47 municipalities in Bohol. Water Demand projections were made for domestic, commercial/industrial demand, institutional, tourism and proposed industrial sites usage.

3.5.1 Domestic Water Demand

The unit domestic consumption derived from field surveys varied for each municipality as presented in Chapter 3 of this report. These unit domestic consumption were projected to increase as shown in the table below.

Table 3-11 Existing and Projected Demand for Selected Municipalities

City/ Municipality	Existing and Projected Unit Domestic Consumptions (L/c/d)						
	2007 [3/]	2010	2015	2020	2025	2030	2035
Tagbilaran City	200	200	200	200	200	200	200
Garcia Hernandez	144	150	155	160	165	165	165
Loboc	137	140	145	150	155	155	155
Loon	144	150	155	160	165	165	165
Ubay	142	150	155	160	165	165	165
Talibon	109	110	115	120	125	125	125

[3/] *results of field survey conducted on July 2 to August 20, 2007*

The consumption of Talibon Water District which was derived from a cumulative record of consumption for one year (January to December 2006) was used as the basis of projecting water demands for municipalities with average unit consumption of 100 L/c/d or less.

The rural domestic consumption is assumed to be 85% of the urban domestic consumption. It is assumed that activities involving use of water are more diverse in urban areas than in rural areas, hence urban areas have higher demand requirement.

Communal faucets will be provided for residents who can not afford to pay for individual service connections. The allotted per capita consumption is 60 L/c/d. Each communal faucet can cater to 25 households with an average 5.5 persons/household.

3.5.2 Commercial/Industrial Water Demand

The unit commercial/industrial demand was estimated for the following projection years as follows:

Year	Projected Commercial/Industrial Demand Per Connection (cumd)
2010	1.0
2015	1.2
2020	1.4
2025	1.6
2030	1.6
2035	1.6

The projected number of commercial service connections was estimated using a commercial connection density ratio of 0.3 to 0.60 connections for every 100 population in the service area.

The municipalities identified as the northeastern corridor are expected to have light industrial activities such as light manufacturing and ecotourism and agri-tourism businesses in the future. These municipalities include Clarin, Inabanga, Buenavista, Getafe, Talibon, Trinidad, and Ubay. For these municipalities, industrial connections with higher unit consumptions of

2.4 to 2.8 cumd per connection was assumed. Loon, Calape and Tubigon have proposed industrial sites that were also considered in the water demand projections.

According to provincial plans, the Panglao Island Tourism Estate (created under Executive Order No. 14, S. 1996) which is approximately 120 hectares will include construction of hotels, beach resort, a marina, golf course with a clubhouse, sports center, an entertainment and shopping district, a handicraft village, botanical garden, a retirement village, picnic grove and medical center. It is also the site of the proposed Panglao International Airport. The estimated consumption for all proposed industrial area is 86 cumd/ha.

Loon, Calape and Tubigon have proposed industrial sites that were also considered in the water demand projections. The estimated allotted consumption for all proposed industrial area is 86cumd/ha.

3.5 3 Institutional Water Demand

Institutional demand is the demand allotted for institutional establishments such as schools, churches, hospitals and public offices. The unit demand for institutional connection is projected to increase as follows:

Year	Demand (cumd)
2010	3.2
2015	4.0
2020	4.5
2025	6.0
2030	6.0
2035	6.0

One institutional connection is allotted for every 2,000 population in the study area.

3.5.4 Tourism Demand

Tourism activities in Bohol are very dominant in Panglao due to its pristine beach and world class diving locations. An alternative site identified as tourism haven is the municipality of Anda on the southeastern part of Bohol. Other areas which are mostly frequented by tourists are the municipalities of Carmen, Loboc and Bilar. The provision for tourist demand is 300 liters per tourist per day.

Provision for tourism demand was also considered in all other municipalities because of the proposed homestay program. The homestay program will enable households with enough facilities to accommodate tourists to augment deficiency in accommodation establishments due to projected increase of incoming tourists in years to come. Based on data from Bohol Tourism Office, about 1,373,689, 1,753,214, and 2,504,590 tourist are expected to visit Bohol in years 2015, 2020,and 2025, respectively.

Tourism in Loboc River (Floating Restaurant)

3.5.5 Non-Revenue-Water

An allowance of 20% for Non-Revenue-Water (NRW)/Unaccounted-for-Water (UFW)/ Unbilled Water from year 2015 onwards was provided in the demand projection. The sources of NRW are leaks, pilferages, use of unmetered fire hydrants, technical losses, and unmetered services/fixed rate and other authorized unmetered uses such as for flushing and disinfection of pipelines and reservoirs. The NRW is computed as a percentage of the average daily production. For purposes of estimates, a NRW of about 35% was included in Year 2010 demand.

The NRW is assumed to include a minimal loss of about 3% along the transmission mains.

3.5.6 Total Water Demand

The total water demand is the sum of domestic, commercial, industrial, institutional and tourism demands plus provision for non-revenue-water. This is also referred to as the average-day demand (ADD).

3.5.7 Demand Variations

The demand variation is due to the hourly fluctuations in water usage. The ratio of the maximum-day demand (MDD) to ADD is dependent upon population density and is estimated as follows:

Population	Ratio of MDD to ADD
≤ 30,000	1.30:1
30,000 – 200,000	1.25:1
Over 200,000	1.20:1

The peak hour demand (PHD) is usually twice the ADD.

Sources and transmission mains are usually designed based on the MDD requirement of the system. Distribution pipelines are designed based on the PHD requirement.

3.5.8 Water Demand Projection Results

The projection results showed that the Tagbilaran City has the highest demand requirement followed by Panglao, Loon, Talibon, Tubigon and Ubay. These municipalities are expected to have more industrial developments than other municipalities. Water demand requirement for these municipalities constitute 45% of the total projected demand for year 2035.

The summary of water demand projections for the whole province of Bohol is as follows:

Demand Category	Demand (cumd)					
	2010	2015	2020	2025	2030	2035
Domestic	59,985	94,789	112,526	131,073	143,411	152,195
Commercial/Industrial	4,007	6,000	13,158	15,480	16,543	17,273
Institutional	2,996	3,272	3,965	5,490	5,790	6,024
Tourism	1,954	3,387	3,675	5,249	5,249	5,249
Industrial Estate	-	11,985	21,420	21,420	21,420	22,270
Total Water Demand	68,942	119,433	154,744	178,712	192,413	203,011
Non-Revenue Water	37,122	29,858	38,686	44,678	48,103	50,753
Average Daily Demand	106,064	149,291	193,430	223,390	240,516	253,764
Maximum Day Demand	134,499	188,924	244,840	281,637	303,223	319,906
Yearly Demand (mcm/yr)	38.71	54.49	70.60	81.54	87.79	92.62

The details of the served population and water demand projections for years 2010 to 2035 are shown in **Tables 3-12 to 3-17**. The year-by-year water demand projections are shown in **Table 3-18**.

Table 3-12A Target Served Population Projection for Year 2010

	City/Municipality	Projected Population	% Share		Population Distribution by Classification		Projected Served Population												
							Total Served Population					Urban				Rural			
			Urban (%)	Rural (%)	Urban	Rural	Urban (%)	Rural (%)	Urban Pop.	Rural Pop.	Total	Level 2 (%)	Level 2	Level 3 (%)	Level 3	Level 2 (%)	Level 2	Level 3 (%)	Level 3
1	Alburquerque	10,307	38.21	61.79	3,938	6,368	80	62	3,150	3,948	7,099	5	158	95	2,993	10	395	90	3,554
2	Alicia	24,253	9.79	90.21	2,374	21,879	30	25	712	5,470	6,182	5	36	95	677	10	547	90	4,923
3	Anda	21,001	14.00	86.00	2,940	18,060	90	40	2,646	7,224	9,870	5	132	95	2,514	10	722	90	6,502
4	Antequera	16,118	18.05	81.95	2,910	13,208	97	40	2,823	5,283	8,106	5	141	95	2,682	10	528	90	4,755
5	Baclayon	18,364	27.54	72.46	5,058	13,307	90	85	4,552	11,311	15,862	5	228	95	4,324	10	1,131	90	10,180
6	Balilihan	20,292	15.66	84.34	3,178	17,114	90	60	2,860	10,268	13,129	5	143	95	2,717	10	1,027	90	9,242
7	Batuan	13,849	25.28	74.72	3,501	10,348	88	15	3,081	1,552	4,633	5	154	95	2,927	10	155	90	1,397
8	Bien Unido	26,666	79.61	20.39	21,229	5,438	25	10	5,307	544	5,851	5	265	95	5,042	10	54	90	489
9	Bilar	19,665	20.51	79.49	4,034	15,631	75	40	3,025	6,252	9,278	5	151	95	2,874	10	625	90	5,627
10	Buenavista	28,889	13.40	86.60	3,872	25,017	30	10	1,161	2,502	3,663	5	58	95	1,103	10	250	90	2,252
11	Calape	33,020	27.75	72.25	9,162	23,858	73	40	6,688	9,543	16,231	5	334	95	6,354	10	954	90	8,589
12	Candijay	35,939	39.51	60.49	14,198	21,740	40	20	5,679	4,348	10,027	5	284	95	5,395	10	435	90	3,913
13	Carmen	46,635	22.66	77.34	10,566	36,069	20	15	2,113	5,410	7,524	5	106	95	2,007	10	541	90	4,869
14	Catigbian	26,896	14.48	85.52	3,894	23,002	60	17	2,336	3,910	6,247	5	117	95	2,219	10	391	90	3,519
15	Clarin	21,183	23.31	76.69	4,938	16,246	75	25	3,703	4,061	7,765	5	185	95	3,518	10	406	90	3,655
16	Corella	7,190	13.51	86.49	971	6,219	95	90	923	5,597	6,520	5	46	95	877	10	560	90	5,037
17	Cortes	14,911	24.35	75.65	3,631	11,280	75	35	2,723	3,948	6,671	5	136	95	2,587	10	395	90	3,553
18	Dagohoy	20,418	14.64	85.36	2,989	17,429	50	10	1,495	1,743	3,237	5	75	95	1,420	10	174	90	1,569
19	Danao	21,276	17.56	82.44	3,735	17,541	70	20	2,615	3,508	6,123	5	131	95	2,484	10	351	90	3,157
20	Dauis	34,063	44.56	55.44	15,179	18,884	100	60	15,179	11,330	26,509	5	759	95	14,420	10	1,133	90	10,197
21	Dimiao	16,689	9.09	90.91	1,518	15,171	90	15	1,366	2,276	3,642	5	68	95	1,298	10	228	90	2,048
22	Duero	19,495	21.77	78.23	4,244	15,251	93	50	3,947	7,626	11,573	5	197	95	3,750	10	763	90	6,863
23	Garcia Hernandez	25,341	23.95	76.05	6,069	19,272	72	30	4,370	5,782	10,151	5	218	95	4,151	10	578	90	5,203
24	Getafe	31,104	45.84	54.16	14,257	16,847	15	5	2,139	842	2,981	5	107	95	2,032	10	84	90	758
25	Guindulman	33,788	18.30	81.70	6,184	27,604	45	33	2,783	9,109	11,892	5	139	95	2,644	10	911	90	8,199
26	Inabanga	47,865	26.95	73.05	12,900	34,965	40	15	5,160	5,245	10,405	5	258	95	4,902	10	524	90	4,720
27	Jagna	36,239	35.20	64.80	12,755	23,484	75	10	9,566	2,348	11,914	5	478	95	9,088	10	235	90	2,114
28	Lila	12,199	19.42	80.58	2,370	9,830	95	40	2,251	3,932	6,183	5	113	95	2,139	10	393	90	3,539
29	Loay	17,258	34.35	65.65	5,928	11,330	40	67	2,371	7,591	9,962	5	119	95	2,253	10	759	90	6,832
30	Loboc	19,122	17.35	82.65	3,318	15,805	70	35	2,323	5,532	7,854	5	116	95	2,206	10	553	90	4,978
31	Loon	63,681	32.40	67.60	20,633	43,048	85	15	17,538	6,457	23,995	5	877	95	16,661	10	646	90	5,811
32	Mabini	33,299	27.28	72.72	9,085	24,213	60	10	5,451	2,421	7,873	5	273	95	5,179	10	242	90	2,179
33	Maribojoc	19,839	49.29	50.71	9,779	10,060	90	85	8,801	8,551	17,352	5	440	95	8,361	10	855	90	7,696
34	Panglao	25,931	61.16	38.84	15,858	10,072	85	75	13,480	7,554	21,034	5	674	95	12,806	10	755	90	6,799
35	Pilar	30,318	14.59	85.41	4,423	25,895	85	30	3,760	7,769	11,528	5	188	95	3,572	10	777	90	6,992
36	Pres. C. P. Garcia	22,248	35.04	64.96	7,795	14,453	20	10	1,559	1,445	3,004	5	78	95	1,481	10	145	90	1,301
37	Sagbayan	21,124	19.39	80.61	4,096	17,028	90	55	3,686	9,366	13,052	5	184	95	3,502	10	937	90	8,429
38	San Isidro	10,769	0.00	100.00	0	10,769	-	20	-	2,154	2,154	5	0	95	0	10	215	90	1,938
39	San Miguel	25,148	10.26	89.74	2,580	22,568	20	-	516	-	516	5	26	95	490	10	-	90	-
40	Sevilla	12,552	14.27	85.73	1,791	10,761	55	50	985	5,380	6,365	5	49	95	936	10	538	90	4,842
41	Sierra Bullones	30,156	34.55	65.45	10,420	19,736	60	15	6,252	2,960	9,212	5	313	95	5,939	10	296	90	2,664
42	Sikatuna	7,808	14.10	85.90	1,101	6,707	93	90	1,024	6,036	7,060	5	51	95	973	10	604	90	5,432
43	Tagbilaran City	94,825	100.00	0.00	94,825	0	85	-	80,602	-	80,602	5	4,030	95	76,572	10	-	90	-
44	Talibon	66,608	56.86	43.14	37,872	28,736	30	5	11,362	1,437	12,798	5	568	95	10,794	10	144	90	1,293
45	Trinidad	30,373	11.30	88.70	3,431	26,942	50	5	1,715	1,347	3,063	5	86	95	1,630	10	135	90	1,212
46	Tubigon	48,622	49.33	50.67	23,984	24,638	45	10	10,793	2,464	13,257	5	540	95	10,253	10	246	90	2,217
47	Ubay	70,752	21.07	78.93	14,907	55,846	45	12	6,708	6,701	13,410	5	335	95	6,373	10	670	90	6,031
48	Valencia	28,812	8.97	91.03	2,584	26,228	85	15	2,196	3,934	6,131	5	110	95	2,087	10	393	90	3,541
	Provincial Total	**1,362,900**	**33.29**	**66.71**	**457,005**	**905,895**			**285,477**	**234,013**	**519,490**		**14,274**		**271,203**		**23,401**		**210,612**

Note: %of urban and rural population in municipality is projected to increase at a minimal rate of 2% for 2010-2015, 2015-2020, 2020-2025, 2025-2030 and 2030-2035

Table 3-12B Water Demand Projections for Year 2010

	City/Municipality	Domestic Water Demand	Comm'l/ Industrial Demand (cumd)		Institutional Demand (cumd)		Tourism Demand	Total Demand	Non-Revenue Water (20%)	Average-Day Demand (cumd)	Maximum-Day Demand (cumd)
1	Alburquerque	695	33	40	5	20	10	764.25	191	1,176	1,528
2	Alicia	570	35	42	12	48	10	669.67	167	1,030	1,339
3	Anda	936	51	61	11	44	195	688.00	309	1,058	1,375
4	Antequera	780	40	48	8	32	10	869.75	217	1,338	1,739
5	Baclayon	1,509	82	98	9	36	10	1,653.40	413	2,544	3,307
6	Balilihan	1,233	70	84	10	40	10	1,367.19	342	2,103	2,734
7	Batuan	471	19	23	7	28	10	531.96	133	818	1,064
8	Bien Unido	620	19	38	13	52	10	719.56	180	1,107	1,384
9	Bilar	889	47	56	10	40	10	995.29	249	1,531	1,991
10	Buenavista	350	18	36	14	56	10	452.41	113	696	870
11	Calape	1,579	77	92	17	68	10	1,749.71	437	2,692	3,365
12	Candijay	1,003	43	52	18	72	10	1,136.13	284	1,748	2,185
13	Carmen	715	39	47	23	92	98	951.40	238	1,464	1,830
14	Catigbian	604	30	36	13	52	10	701.68	175	1,080	1,349
15	Clarin	764	35	70	11	44	10	888.26	222	1,367	1,777
16	Corella	604	36	43	4	16	10	672.97	168	1,035	1,346
17	Cortes	649	32	38	7	28	10	725.09	181	1,116	1,450
18	Dagohoy	318	15	18	10	40	10	385.80	96	594	772
19	Danao	597	29	35	11	44	10	686.16	172	1,056	1,372
20	Dauis	2,653	114	137	17	68	98	2,955.67	739	4,547	5,684
21	Dimiao	352	18	22	8	32	10	415.63	104	639	831
22	Duero	1,112	58	70	10	40	10	1,231.39	308	1,894	2,463
23	Garcia Hernandez	1,309	48	58	13	52	10	1,428.65	357	2,198	2,857
24	Getafe	306	11	22	16	64	10	401.85	100	618	773
25	Guindulman	1,120	63	76	17	68	10	1,273.99	318	1,960	2,450
26	Inabanga	1,028	47	56	24	96	10	1,189.95	297	1,831	2,288
27	Jagna	1,240	43	52	18	72	10	1,373.66	343	2,113	2,642
28	Lila	596	30	36	6	24	10	666.48	167	1,025	1,333
29	Loay	939	53	64	9	36	10	1,048.85	262	1,614	2,098
30	Loboc	963	40	48	10	40	98	1,148.34	287	1,767	2,297
31	Loon	3,331	91	109	32	128	10	3,578.71	895	5,506	6,882
32	Mabini	804	31	37	17	68	10	919.51	230	1,415	1,768
33	Maribojoc	1,717	78	94	10	40	10	1,860.59	465	2,862	3,721
34	Panglao	2,130	86	103	13	52	586	2,871.40	718	4,418	5,743
35	Pilar	1,104	58	70	15	60	10	1,244.11	311	1,914	2,393
36	Pres. C. P. Garcia	298	13	16	11	44	10	367.50	92	565	735
37	Sagbayan	1,241	67	80	11	44	10	1,374.97	344	2,115	2,750
38	San Isidro	194	13	16	5	20	10	239.78	60	369	480
39	San Miguel	55	2	2	13	52	10	119.89	30	184	231
40	Sevilla	591	35	42	6	24	10	666.95	167	1,026	1,334
41	Sierra Bullones	939	37	44	15	60	10	1,053.39	263	1,621	2,026
42	Sikatuna	654	39	47	4	16	10	727.04	182	1,119	1,454
43	Tagbilaran City	15,556	440	1,388	115	460	195	17599.92	4,400	27,077	33,846
44	Talibon	1,351	43	86	33	132	98	1,666.59	417	2,564	3,205
45	Trinidad	306	13	26	15	60	10	401.87	100	618	773
46	Tubigon	1,382	47	94	24	96	98	1,670.04	418	2,569	3,212
47	Ubay	1,785	60	120	35	140	98	2,142.92	536	3,297	4,121
48	Valencia	591	30	36	14	56	10	692.80	173	1,066	1,332
	Provincial Total	**60,533**	**2,458**	**4,007**	**749**	**2,996**	**1,954**	**68,942**	**17,372**	**106,064**	**134,499**

Table 3-13A Target Served Population Projection for Year 2015

City/Municipality	Projected Population	% Share		Population Distribution by Classification		Projected Served Population												
						Total Served Population					Urban				Rural			
		Urban (%)	Rural (%)	Urban	Rural	Urban (%)	Rural (%)	Urban Pop.	Rural Pop.	Total	Level 2 (%)	Level 2	Level 3 (%)	Level 3	Level 2 (%)	Level 2	Level 3 (%)	Level 3
1 Alburquerque	11,137	38.97	61.03	4,340	6,796	90	60	3,906	4,078	7,984	10	391	90	3,516	15	612	85	3,466
2 Alicia	25,610	9.99	90.01	2,557	23,053	70	46	1,790	10,489	12,279	10	179	90	1,611	15	1,573	85	8,916
3 Anda	22,430	14.28	85.72	3,203	19,227	75	46	2,402	8,748	11,151	10	240	90	2,162	15	1,312	85	7,436
4 Antequera	17,344	18.42	81.58	3,194	14,150	75	46	2,396	6,438	8,834	10	240	90	2,156	15	966	85	5,473
5 Baclayon	20,152	28.09	71.91	5,661	14,491	75	49	4,246	7,101	11,346	10	425	90	3,821	15	1,065	85	6,035
6 Balilihan	22,111	15.98	84.02	3,532	18,579	75	49	2,649	9,103	11,753	10	265	90	2,384	15	1,366	85	7,738
7 Batuan	14,895	25.79	74.21	3,841	11,054	75	46	2,881	5,030	7,910	10	288	90	2,593	15	754	85	4,275
8 Bien Unido	29,027	81.20	18.80	23,571	5,457	75	46	17,678	2,483	20,161	10	1,768	90	15,910	15	372	85	2,110
9 Bilar	21,249	20.92	79.08	4,446	16,803	70	46	3,112	7,645	10,757	10	311	90	2,801	15	1,147	85	6,498
10 Buenavista	30,388	13.67	86.33	4,154	26,234	70	46	2,908	11,937	14,844	10	291	90	2,617	15	1,791	85	10,146
11 Calape	35,680	28.30	71.70	10,098	25,582	75	46	7,573	11,640	19,213	10	757	90	6,816	15	1,746	85	9,894
12 Candijay	38,834	40.30	59.70	15,649	23,184	75	46	11,737	10,549	22,286	10	1,174	90	10,563	15	1,582	85	8,967
13 Carmen	49,686	23.11	76.89	11,482	38,204	70	46	8,037	17,383	25,420	10	804	90	7,234	15	2,607	85	14,775
14 Catigbian	29,817	14.77	85.23	4,403	25,414	70	46	3,082	11,563	14,645	10	308	90	2,774	15	1,734	85	9,829
15 Clarin	22,818	23.78	76.22	5,425	17,393	75	49	4,069	8,523	12,591	10	407	90	3,662	15	1,278	85	7,244
16 Corella	7,787	13.78	86.22	1,073	6,714	75	49	805	3,290	4,095	10	80	90	724	15	494	85	2,797
17 Cortes	16,060	24.84	75.16	3,989	12,071	75	50	2,992	6,036	9,027	10	299	90	2,693	15	905	85	5,130
18 Dagohoy	22,304	14.93	85.07	3,330	18,974	70	46	2,331	8,633	10,964	10	233	90	2,098	15	1,295	85	7,338
19 Danao	23,413	17.91	82.09	4,192	19,220	70	46	2,935	8,745	11,680	10	293	90	2,641	15	1,312	85	7,433
20 Dauis	38,243	45.45	54.55	17,382	20,860	80	53	13,906	10,952	24,858	10	1,391	90	12,515	15	1,643	85	9,309
21 Dimiao	18,012	9.28	90.72	1,671	16,341	70	46	1,170	7,435	8,605	10	117	90	1,053	15	1,115	85	6,320
22 Duero	21,066	22.21	77.79	4,678	16,388	75	50	3,509	8,194	11,702	10	351	90	3,158	15	1,229	85	6,965
23 Garcia Hernandez	27,382	24.43	75.57	6,689	20,693	70	46	4,682	9,415	14,098	10	468	90	4,214	15	1,412	85	8,003
24 Getafe	33,317	46.75	53.25	15,577	17,741	70	49	10,904	8,693	19,597	10	1,090	90	9,813	15	1,304	85	7,389
25 Guindulman	35,204	18.67	81.33	6,572	28,632	70	49	4,600	14,030	18,630	10	460	90	4,140	15	2,104	85	11,925
26 Inabanga	51,124	27.49	72.51	14,054	37,070	70	46	9,838	16,867	26,705	10	984	90	8,854	15	2,530	85	14,337
27 Jagna	39,158	35.90	64.10	14,058	25,101	70	49	9,840	12,299	22,140	10	984	90	8,856	15	1,845	85	10,454
28 Lila	13,178	19.81	80.19	2,611	10,567	75	49	1,958	5,178	7,136	10	196	90	1,762	15	777	85	4,401
29 Loay	18,739	35.04	64.96	6,566	12,173	75	49	4,925	5,965	10,889	10	492	90	4,432	15	895	85	5,070
30 Loboc	20,914	17.70	82.30	3,701	17,212	75	49	2,776	8,434	11,210	10	278	90	2,498	15	1,265	85	7,169
31 Loon	74,339	33.05	66.95	24,568	49,771	75	49	18,426	24,388	42,814	10	1,843	90	16,584	15	3,658	85	20,730
32 Mabini	36,505	27.83	72.17	10,159	26,346	70	46	7,112	11,987	19,099	10	711	90	6,400	15	1,798	85	10,189
33 Maribojoc	21,431	50.28	49.72	10,775	10,656	90	80	9,697	8,525	18,222	10	970	90	8,728	15	1,279	85	7,246
34 Panglao	28,359	62.38	37.62	17,690	10,669	90	60	15,921	6,401	22,322	10	1,592	90	14,329	15	960	85	5,441
35 Pilar	33,071	14.88	85.12	4,921	28,150	70	46	3,445	12,808	16,253	10	344	90	3,100	15	1,921	85	10,887
36 Pres. C.P. Garcia	23,024	35.74	64.26	8,228	14,796	70	46	5,760	6,732	12,492	10	576	90	5,184	15	1,010	85	5,722
37 Sagbayan	22,558	19.78	80.22	4,461	18,097	85	50	3,792	9,048	12,840	10	379	90	3,413	15	1,357	85	7,691
38 San Isidro	11,636	0.00	100.00	0	11,636	-	55	0	6,400	6,400	10	0	90	0	15	960	85	5,440
39 San Miguel	27,424	10.47	89.53	2,870	24,554	70	46	2,009	11,172	13,181	10	201	90	1,808	15	1,676	85	9,496
40 Sevilla	13,755	14.55	85.45	2,002	11,753	70	46	1,401	5,348	6,749	10	140	90	1,261	15	802	85	4,545
41 Sierra Bullones	32,585	35.25	64.75	11,485	21,100	70	40	8,039	8,440	16,479	10	804	90	7,235	15	1,266	85	7,174
42 Sikatuna	8,437	14.38	85.62	1,214	7,223	90	85	1,092	6,140	7,232	10	109	90	983	15	921	85	5,219
43 Tagbilaran City	103,898	100.00	0.00	103,898	0	95	-	98,703	0	98,703	10	9,870	90	88,833	-	-	100	-
44 Talibon	73,237	58.00	42.00	42,474	30,763	75	49	31,856	15,074	46,930	10	3,186	90	28,670	15	2,261	85	12,813
45 Trinidad	32,820	11.52	88.48	3,781	29,039	70	46	2,647	13,213	15,859	10	265	90	2,382	15	1,982	85	11,231
46 Tubigon	52,956	50.31	49.69	26,645	26,312	75	49	19,983	12,893	32,876	10	1,998	90	17,985	15	1,934	85	10,959
47 Ubay	76,452	21.49	78.51	16,430	60,022	70	46	11,501	27,310	38,811	10	1,150	90	10,351	15	4,097	85	23,214
48 Valencia	31,133	9.15	90.85	2,848	28,285	70	46	1,994	12,870	14,863	10	199	90	1,794	15	1,930	85	10,939
Provincial Total	**1,480,700**	**34.18**	**65.82**	**506,151**	**974,549**			**399,015.28**	**465,623**	**864,638**		**39,902**		**359,114**		**69,843**		**395,779**

Assumption:
%of urban and rural population in municipality is projected to increase at a minimal rate of 2% for 2010-2015, 2015-2020, 2020-2025, 2025-2030 and 2030-2035

Table 3-13B Water Demand Projections for Year 2015

City/Municipality	Domestic Demand					Comm'l/ Industrial Demand (cumd)	Institutional Demand (cumd)	Tourism Demand	Demand for Prop. Ind'l Estate	Total Demand	Non-Revenue Water (20%)	Average-Day Demand (cumd)	Maximum-Day Demand (cumd)
	Urban		Rural		Total								
	Level 2	Level 3	Level 2	Level 3									
1 Alburquerque	23	404	37	339	803	29	24	17.37		873	218	1,092	1,419
2 Alicia	11	185	94	872	1,162	44	52	17.37		1,276	319	1,595	2,073
3 Anda	14	249	79	727	1,069	40	44	338.72		1,491	373	1,864	2,423
4 Antequera	14	248	58	535	855	32	36	17.37		941	235	1,176	1,529
5 Baclayon	25	439	64	590	1,119	41	40	17.37		1,217	304	1,521	1,978
6 Balilihan	16	274	82	756	1,128	42	44	17.37		1,232	308	1,540	2,002
7 Batuan	17	298	45	418	779	29	28	17.37		853	213	1,066	1,386
8 Bien Unido	106	1,830	22	206	2,164	72	60	17.37		2,314	578	2,892	3,615
9 Bilar	19	322	69	635	1,045	38	44	17.37		1,145	286	1,431	1,860
10 Buenavista	17	301	107	992	1,418	54	60	17.37		1,549	387	1,936	2,420
11 Calape	45	784	105	967	1,901	70	72	17.37	1,147.50	3,208	802	4,010	5,012
12 Candijay	70	1,215	95	876	2,257	80	76	17.37		2,430	608	3,038	3,797
13 Carmen	48	832	156	1,444	2,481	91	100	169.36	850.00	3,691	923	4,614	5,768
14 Catigbian	18	319	104	961	1,402	53	60	17.37		1,532	383	1,916	2,395
15 Clarin	24	421	77	708	1,230	46	44	17.37		1,337	334	1,672	2,173
16 Corella	5	83	30	273	391	14	16	17.37		439	110	549	713
17 Cortes	18	310	54	501	883	32	32	17.37		965	241	1,206	1,568
18 Dagohoy	14	241	78	717	1,050	40	44	17.37		1,151	288	1,439	1,871
19 Danao	18	304	79	727	1,127	42	48	17.37		1,234	309	1,543	2,005
20 Dauis	83	1,439	99	910	2,531	90	76	169.36		2,867	717	3,583	4,479
21 Dimiao	7	121	67	618	813	31	36	17.37		897	224	1,122	1,458
22 Duero	21	363	74	681	1,139	42	44	17.37		1,242	311	1,553	2,018
23 Garcia Hernandez	28	653	85	1,054	1,820	50	56	17.37		1,944	486	2,430	3,159
24 Getafe	65	1,129	78	722	1,994	71	68	17.37		2,151	538	2,688	3,360
25 Guindulman	28	476	126	1,166	1,796	67	72	17.37		1,952	488	2,440	3,050
26 Inabanga	59	1,018	152	1,401	2,630	96	104	17.37		2,848	712	3,560	4,450
27 Jagna	59	1,018	111	1,022	2,210	79	80	17.37		2,387	597	2,983	3,729
28 Lila	12	203	47	430	691	25	28	17.37		762	190	952	1,238
29 Loay	30	510	54	496	1,089	40	36	17.37		1,181	295	1,477	1,920
30 Loboc	17	145	76	914	1,152	41	40	169.36		1,402	350	1,752	2,278
31 Loon	111	155	219	2,731	3,216	154	148	17.37	1,062.50	4,598	1,149	5,747	7,184
32 Mabini	43	736	108	996	1,883	68	72	17.37		2,040	510	2,550	3,188
33 Maribojoc	58	1,004	77	708	1,847	66	44	17.37		1,974	494	2,468	3,208
34 Panglao	96	1,648	58	532	2,333	80	56	1016.15	5,100.00	8,585	2,146	10,732	13,951
35 Pilar	21	357	115	1,064	1,557	59	68	17.37		1,701	425	2,126	2,658
36 Pres. C.P. Garcia	35	596	61	559	1,251	44	48	17.37		1,360	340	1,701	2,211
37 Sagbayan	23	392	81	752	1,248	47	44	17.37		1,357	339	1,696	2,204
38 San Isidro	-	-	58	532	589	23	24	17.37		654	163	817	1,062
39 San Miguel	12	208	101	928	1,249	48	56	17.37		1,370	343	1,713	2,141
40 Sevilla	8	145	48	444	646	24	28	17.37		715	179	894	1,162
41 Sierra Bullones	48	832	76	701	1,658	59	64	17.37		1,798	449	2,247	2,809
42 Sikatuna	7	113	55	510	685	26	16	17.37		745	186	931	1,210
43 Tagbilaran City	592	17,767	-	-	18,359	3,110	508	338.72	1,700.00	24,015	6,004	30,019	37,524
44 Talibon	191	3,297	136	1,252	4,876	169	148	169.36		5,363	1,341	6,704	8,380
45 Trinidad	16	274	119	1,098	1,507	96	64	17.37		1,684	421	2,105	2,631
46 Tubigon	120	2,068	116	1,071	3,375	119	104	169.36	2,125.00	5,893	1,473	7,366	9,207
47 Ubay	69	1,604	246	3,058	4,978	232	152	169.36		5,531	1,383	6,914	8,642
48 Valencia	12	206	116	1,069	1,403	54	64	17.37		1,539	385	1,924	2,404
Provincial Total	**2,394**	**47,537.07**	**4,190.60**	**40,667**	**94,789**	**6,000**	**3,271.88**	**3,387.18**	**11,985.00**	**119,433**	**29,858**	**149,291**	**188,924**

Assumptions:

1) for Level II, number of communal faucets = projected number of beneficiaries/average no. of persons per hh/25 households
2) commercial connections = commercial connection density ratio of 0.30 connection for every 100 persons in the service coverage
3) instutional connections = 1 connection for every 2,000 population
4) Unit Consumption:

Domestic	115 lpcd
Commercial	1.4cumd/conn
Institutional	4.5 cumd/conn
Tourism	300 liters per tourist per day
Industrial	86 cumd/ha
UFW	20% of ADD

Table 3-14A Target Served Population Projection for Year 2020

City/Municipality	Projected Population (Year 2020)	% Share		Population Distribution by Classification		Projected Served Population												
						Total Served Population					Urban				Rural			
		Urban (%)	Rural (%)	Urban	Rural	Urban (%)	Rural (%)	Urban Pop.	Rural Pop.	Total	Level 2 (%)	Level 2	Level 3 (%)	Level 3	Level 2 (%)	Level 2	Level 3 (%)	Level 3
1 Alburquerque	11,952	39.75	60.25	4,751	7,200	95	66	4,514	4,752	9,266	15	677	85	3,837	33	1,584	67	3,168
2 Alicia	26,913	10.18	89.82	2,741	24,172	77	50	2,111	12,098	14,208	15	317	85	1,794	33	4,033	67	8,065
3 Anda	23,665	14.57	85.43	3,447	20,217	83	50	2,844	10,119	12,963	15	427	85	2,417	33	3,373	67	6,746
4 Antequera	18,543	18.78	81.22	3,483	15,060	83	50	2,874	7,537	10,411	15	431	85	2,443	33	2,512	67	5,025
5 Baclayon	21,933	28.65	71.35	6,284	15,648	83	54	5,185	8,434	13,619	15	778	85	4,407	11	888	89	7,547
6 Balilihan	23,910	16.29	83.71	3,896	20,014	83	54	3,214	10,788	14,002	15	482	85	2,732	33	3,596	67	7,192
7 Batuan	15,917	26.30	73.70	4,186	11,730	83	50	3,454	5,871	9,325	15	518	85	2,936	33	1,957	67	3,914
8 Bien Unido	31,361	82.82	17.18	25,975	5,386	83	50	21,429	2,696	24,125	15	3,214	85	18,215	33	899	67	1,797
9 Bilar	22,803	21.34	78.66	4,867	17,937	77	50	3,747	8,977	12,725	15	562	85	3,185	33	2,992	67	5,985
10 Buenavista	31,822	13.94	86.06	4,437	27,385	77	50	3,416	13,706	17,123	15	512	85	2,904	33	4,569	67	9,138
11 Calape	38,290	28.87	71.13	11,053	27,237	83	50	9,119	13,632	22,751	15	1,368	85	7,751	33	4,544	67	9,088
12 Candijay	41,675	41.10	58.90	17,130	24,545	83	50	14,132	12,285	26,417	15	2,120	85	12,012	33	4,095	67	8,190
13 Carmen	52,640	23.57	76.43	12,408	40,232	77	50	9,554	20,136	29,690	15	1,433	85	8,121	33	6,712	67	13,424
14 Catigbian	32,756	15.06	84.94	4,934	27,822	77	50	3,799	13,925	17,724	15	570	85	3,229	33	4,642	67	9,283
15 Clarin	24,418	24.25	75.75	5,922	18,496	83	54	4,885	9,969	14,855	15	733	85	4,152	11	1,108	89	8,862
16 Corella	8,375	14.05	85.95	1,177	7,198	83	54	971	3,880	4,851	15	146	85	825	5	204	95	3,675
17 Cortes	17,184	25.33	74.67	4,354	12,831	83	55	3,592	7,057	10,649	15	539	85	3,053	33	2,352	67	4,705
18 Dagohoy	24,175	15.23	84.77	3,682	20,493	77	50	2,835	10,257	13,092	15	425	85	2,410	33	3,419	67	6,838
19 Danao	25,546	18.27	81.73	4,666	20,880	77	50	3,593	10,451	14,043	15	539	85	3,054	33	3,484	67	6,967
20 Dauis	42,499	46.36	53.64	19,704	22,796	88	58	17,339	13,164	30,504	15	2,601	85	14,738	11	1,463	89	11,702
21 Dimiao	19,308	9.46	90.54	1,827	17,481	77	50	1,407	8,749	10,156	15	211	85	1,196	33	2,916	67	5,833
22 Duero	22,607	22.65	77.35	5,121	17,487	83	55	4,225	9,618	13,842	15	634	85	3,591	33	3,206	67	6,412
23 Garcia Hernandez	29,386	24.92	75.08	7,322	22,064	77	50	5,638	11,043	16,681	15	846	85	4,792	33	3,681	67	7,362
24 Getafe	35,471	47.69	52.31	16,916	18,556	77	54	13,025	10,002	23,027	15	1,954	85	11,071	33	3,334	67	6,668
25 Guindulman	36,545	19.04	80.96	6,959	29,586	77	54	5,358	15,947	21,305	15	804	85	4,555	33	5,316	67	10,631
26 Inabanga	53,937	28.04	71.96	15,124	38,813	77	50	11,646	19,426	31,072	15	1,747	85	9,899	33	6,475	67	12,951
27 Jagna	42,023	36.62	63.38	15,388	26,635	77	54	11,849	14,357	26,205	15	1,777	85	10,071	33	4,786	67	9,571
28 Lila	14,139	20.21	79.79	2,857	11,282	83	54	2,357	6,081	8,438	15	354	85	2,004	33	2,027	67	4,054
29 Loay	20,200	35.74	64.26	7,219	12,981	83	54	5,956	6,997	12,953	15	893	85	5,063	33	2,332	67	4,664
30 Loboc	22,693	18.05	81.95	4,096	18,596	83	54	3,380	10,023	13,403	15	507	85	2,873	33	3,341	67	6,682
31 Loon	85,611	33.71	66.29	28,859	56,751	83	54	23,809	30,589	54,398	15	3,571	85	20,237	33	10,196	67	20,393
32 Mabini	39,697	28.39	71.61	11,269	28,428	77	50	8,677	14,228	22,905	15	1,302	85	7,375	11	1,581	89	12,647
33 Maribojoc	22,993	51.28	48.72	11,791	11,202	95	88	11,202	9,857	21,059	15	1,680	85	9,522	11	1,095	89	8,762
34 Panglao	30,770	63.63	36.37	19,578	11,192	95	66	18,599	7,387	25,986	15	2,790	85	15,810	11	821	89	6,566
35 Pilar	35,798	15.18	84.82	5,433	30,365	77	50	4,184	15,198	19,381	15	628	85	3,556	33	5,066	67	10,132
36 Pres. C. P. Garcia	23,755	36.45	63.55	8,659	15,096	77	50	6,668	7,556	14,223	15	1,000	85	5,668	33	2,519	67	5,037
37 Sagbayan	23,949	20.17	79.83	4,831	19,118	94	55	4,517	10,515	15,032	15	678	85	3,839	33	3,505	67	7,010
38 San Isidro	12,488	0.00	100.00	0	12,488	-	60	0	7,493	7,493	15	0	85	0	33	2,498	67	4,995
39 San Miguel	29,677	10.67	89.33	3,168	26,509	77	50	2,439	13,268	15,707	15	366	85	2,073	33	4,423	67	8,845
40 Sevilla	14,952	14.85	85.15	2,220	12,732	77	50	1,709	6,372	8,082	15	256	85	1,453	33	2,124	67	4,248
41 Sierra Bullones	34,969	35.95	64.05	12,571	22,398	77	44	9,680	9,855	19,535	15	1,452	85	8,228	33	3,285	67	6,570
42 Sikatuna	9,054	14.67	85.33	1,328	7,726	95	94	1,262	7,223	8,485	15	189	85	1,073	33	2,408	67	4,816
43 Tagbilaran City	112,924	100.00	0.00	112,924	0	95	-	107,277	0	107,277	10	10,728	90	96,550	-	-		-
44 Talibon	79,855	59.16	40.84	47,238	32,616	83	54	38,972	17,580	56,552	15	5,846	85	33,126	33	5,860	67	11,720
45 Trinidad	35,221	11.75	88.25	4,139	31,082	77	50	3,187	15,557	18,744	15	478	85	2,709	33	5,186	67	10,371
46 Tubigon	57,243	51.32	48.68	29,377	27,865	83	54	24,236	15,019	39,256	15	3,635	85	20,601	33	5,006	67	10,013
47 Ubay	82,046	21.92	78.08	17,985	64,061	77	50	13,848	32,063	45,911	15	2,077	85	11,771	33	10,688	67	21,375
48 Valencia	33,411	9.33	90.67	3,118	30,294	77	50	2,401	15,162	17,562	15	360	85	2,040	33	5,054	67	10,108
Provincial Total	**1,597,100**			**556,416**	**1,040,684**			**470,114**	**546,898**	**1,017,012**		**65,153**		**404,961**		**167,152**		**379,746**

Assumption:
%of urban and rural population in municipality is projected to increase at a minimal rate of 2% for 2010-2015, 2015-2020, 2020-2025, 2025-2030 and 2030-2035

Table 3-14B Water Demand Projections for Year 2020

City/Municipality	Domestic Demand					Commercial/Industrial Demand (cumd)	Institutional Demand (cumd)	Tourism Demand	Demand for Prop. Ind'l Estate	Total Demand	Non-Revenue Water (20%)	Average-Day Demand (cumd)	Maximum-Day Demand (cumd)
	Urban		Rural		Total								
	Level 2	Level 3	Level 2	Level 3									
1 Alburquerque	41	460	95	323	919	78	27	22.17		1,047	262	1,308	1,701
2 Alicia	19	215	242	823	1,299	119	58.5	22.17		1,499	375	1,873	2,435
3 Anda	26	290	202	688	1,206	109	54	432.30		1,802	450	2,252	2,928
4 Antequera	26	293	151	513	982	87	40.5	22.17		1,132	283	1,415	1,839
5 Baclayon	47	529	53	770	1,399	115	49.5	22.17		1,585	396	1,981	2,576
6 Balilihan	29	328	216	734	1,306	118	54	22.17		1,500	375	1,875	2,437
7 Batuan	31	352	117	399	900	78	36	22.17		1,037	259	1,296	1,684
8 Bien Unido	193	2,186	54	183	2,616	319	72	22.17		3,029	757	3,786	4,733
9 Bilar	34	382	180	610	1,206	106	49.5	22.17		1,384	346	1,730	2,249
10 Buenavista	31	348	274	932	1,585	227	72	22.17		1,906	477	2,383	2,978
11 Calape	82	930	273	927	2,212	192	85.5	22.17	2,295.00	4,806	1,202	6,008	7,510
12 Candijay	127	1,441	246	835	2,650	223	94.5	22.17		2,989	747	3,736	4,670
13 Carmen	86	975	403	1,369	2,833	249	117	216.15	850.00	4,265	1,066	5,331	6,664
14 Catigbian	34	387	278	947	1,647	148	72	22.17		1,890	472	2,362	2,953
15 Clarin	44	498	66	904	1,513	196	54	22.17		1,785	446	2,231	2,900
16 Corella	9	99	12	375	495	41	18	22.17		576	144	720	936
17 Cortes	32	366	141	480	1,020	90	40.5	22.17		1,172	293	1,465	1,904
18 Dagohoy	26	289	205	697	1,217	111	54	22.17		1,404	351	1,755	2,282
19 Danao	32	366	209	711	1,318	118	58.5	22.17		1,517	379	1,896	2,465
20 Dauis	156	1,769	88	1,194	3,206	256	94.5	216.15		3,773	943	4,716	5,895
21 Dimiao	13	143	175	595	926	85	45	22.17		1,079	270	1,348	1,753
22 Duero	38	431	192	654	1,315	116	49.5	22.17		1,503	376	1,879	2,443
23 Garcia Hernandez	51	767	221	1,001	2,040	140	67.5	22.17		2,269	567	2,837	3,688
24 Getafe	117	1,329	200	680	2,326	304	81	22.17		2,733	683	3,416	4,270
25 Guindulman	48	547	319	1,084	1,998	179	81	22.17		2,280	570	2,851	3,563
26 Inabanga	105	1,188	389	1,321	3,002	409	121.5	22.17		3,555	889	4,444	5,555
27 Jagna	107	1,209	287	976	2,579	294	94.5	22.17		2,989	747	3,737	4,671
28 Lila	21	240	122	413	797	71	31.5	22.17		922	230	1,152	1,498
29 Loay	54	608	140	476	1,277	109	45	22.17		1,453	363	1,816	2,361
30 Loboc	30	445	200	880	1,557	112	49.5	216.15		1,934	484	2,418	3,143
31 Loon	214	3,238	612	2,773	6,837	609	193.5	22.17	2,125.00	9,787	2,447	12,234	15,292
32 Mabini	78	885	95	1,290	2,348	192	90	22.17		2,652	663	3,315	4,144
33 Maribojoc	101	1,143	66	894	2,203	176	49.5	22.17		2,451	613	3,064	3,983
34 Panglao	167	1,897	49	670	2,784	330	67.5	648.45	10,200.00	14,029	3,507	17,536	22,797
35 Pilar	38	427	304	1,033	1,802	162	81	22.17		2,067	517	2,584	3,230
36 Pres. C.P. Garcia	60	680	151	514	1,405	119	54	22.17		1,600	400	2,000	2,600
37 Sagbayan	41	461	210	715	1,427	126	54	22.17		1,629	407	2,036	2,647
38 San Isidro	-	-	150	510	659	63	27	22.17		772	193	964	1,254
39 San Miguel	22	249	265	902	1,438	132	67.5	22.17		1,660	415	2,075	2,593
40 Sevilla	15	174	127	433	750	67	31.5	22.17		871	218	1,089	1,416
41 Sierra Bullones	87	987	197	670	1,942	164	76.5	22.17		2,204	551	2,755	3,444
42 Sikatuna	11	129	144	491	776	71	22.5	22.17		892	223	1,115	1,449
43 Tagbilaran City	644	19,310	-	-	19,954	3,434	631	432.30	1700.00	26,150	6,538	32,688	40,860
44 Talibon	351	3,975	352	1,245	5,923	994	180	216.15		7,313	1,828	9,142	11,427
45 Trinidad	29	325	311	1,058	1,723	246	81	22.17		2,072	518	2,590	3,238
46 Tubigon	218	2,472	300	1,064	4,054	519	130.5	216.15	4,250.00	9,170	2,293	11,463	14,329
47 Ubay	125	1,883	641	2,907	5,556	807	184.5	216.15		6,764	1,691	8,455	10,569
48 Valencia	22	245	303	1,031	1,601	147	76.5	22.17		1,846	462	2,308	2,885
Provincial Total	**3,909**	**57,892**	**10,029.12**	**40,696**	**112,526**	**13,158**	**3965**	**3,674.54**	**21,420.00**	**154,743.92**	**38,685.98**	**193,430**	**244,840**

Assumptions:

1) for Level II, number of communal faucets = projected number of beneficiaries/average no. of persons per hh/25 households
2) commercial connections = commercial connection density ratio of 0.60 connection for every 100 persons in the service coverage
3) instutional connections = 1 connection for every 2,000 population
4) Unit Consumption:

Domestic	120 lpcd
Commercial	1.6cumd/conn
Institutional	5 cumd/conn
Tourism	300 liters per tourist per day
Industrial	86 cumd/ha
UFW	20% of ADD

Table 3-15A Target Served Population Projection for Year 2025

City/Municipality	Projected Population (Year 2025)	% Share		Population Distribution by Classification		Projected Served Population												
						Total Served Population					Urban				Rural			
		Urban (%)	Rural (%)	Urban	Rural	Urban (%)	Rural (%)	Urban Pop.	Rural Pop.	Total	Level 2 (%)	Level 2	Level 3 (%)	Level 3	Level 2 (%)	Level 2	Level 3 (%)	Level 3
1 Alburquerque	12,720	40.55	59.45	5,158	7,562	95	66	4,900	4,991	9,891	10	490	90	4,410	30	1,497	70	3,494
2 Alicia	28,103	10.39	89.61	2,920	25,184	85	50	2,473	12,605	15,077	10	247	90	2,226	30	3,781	70	8,823
3 Anda	24,635	14.86	85.14	3,660	20,974	91	50	3,322	10,498	13,819	10	332	90	2,989	30	3,149	70	7,348
4 Antequera	19,667	19.16	80.84	3,768	15,898	91	50	3,420	7,957	11,377	10	342	90	3,078	30	2,387	70	5,570
5 Baclayon	23,641	29.23	70.77	6,909	16,732	91	54	6,270	9,018	15,289	10	627	90	5,643	10	902	90	8,116
6 Balilihan	25,623	16.62	83.38	4,259	21,364	91	54	3,865	11,515	15,380	10	386	90	3,478	30	3,455	70	8,061
7 Batuan	16,874	26.83	73.17	4,527	12,347	91	50	4,108	6,180	10,288	10	411	90	3,697	30	1,854	70	4,326
8 Bien Unido	33,580	84.48	15.52	28,369	5,211	91	50	25,745	2,608	28,353	10	2,574	90	23,170	30	782	70	1,826
9 Bilar	24,269	21.77	78.23	5,283	18,986	85	50	4,475	9,502	13,977	10	447	90	4,027	30	2,851	70	6,652
10 Buenavista	33,125	14.22	85.78	4,711	28,414	85	50	3,990	14,221	18,212	10	399	90	3,591	30	4,266	70	9,955
11 Calape	40,751	29.44	70.56	11,999	28,752	91	50	10,889	14,390	25,279	10	1,089	90	9,800	30	4,317	70	10,073
12 Candijay	44,353	41.93	58.07	18,595	25,758	91	50	16,875	12,892	29,767	10	1,688	90	15,188	30	3,868	70	9,024
13 Carmen	55,375	24.04	75.96	13,314	42,061	85	50	11,277	21,052	32,329	10	1,128	90	10,149	30	6,316	70	14,736
14 Catigbian	35,605	15.36	84.64	5,470	30,135	85	50	4,633	15,083	19,716	10	463	90	4,170	30	4,525	70	10,558
15 Clarin	25,920	24.74	75.26	6,412	19,508	91	54	5,818	10,515	16,333	10	582	90	5,237	10	1,051	90	9,463
16 Corella	8,930	14.34	85.66	1,280	7,650	91	54	1,162	4,123	5,285	10	116	90	1,046	5	206	95	3,917
17 Cortes	18,240	25.84	74.16	4,713	13,526	91	55	4,277	7,439	11,717	10	428	90	3,850	30	2,232	70	5,208
18 Dagohoy	25,960	15.54	84.46	4,033	21,927	85	50	3,416	10,975	14,391	10	342	90	3,074	30	3,292	70	7,682
19 Danao	27,599	18.63	81.37	5,142	22,457	85	50	4,355	11,240	15,595	10	436	90	3,920	30	3,372	70	7,868
20 Dauis	46,681	47.29	52.71	22,075	24,606	97	58	21,369	14,210	35,578	10	2,137	90	19,232	10	1,421	90	12,789
21 Dimiao	20,529	9.65	90.35	1,981	18,547	85	50	1,678	9,283	10,961	10	168	90	1,510	30	2,785	70	6,498
22 Duero	24,060	23.10	76.90	5,559	18,501	91	55	5,045	10,176	15,220	10	504	90	4,540	30	3,053	70	7,123
23 Garcia Hernandez	31,274	25.42	74.58	7,949	23,326	85	50	6,733	11,675	18,407	10	673	90	6,059	30	3,502	70	8,172
24 Getafe	37,480	48.64	51.36	18,231	19,249	85	54	15,442	10,375	25,817	10	1,544	90	13,897	30	3,113	70	7,263
25 Guindulman	37,743	19.42	80.58	7,331	30,412	85	54	6,209	16,392	22,601	10	621	90	5,588	30	4,918	70	11,475
26 Inabanga	56,148	28.60	71.40	16,059	40,089	85	50	13,602	20,065	33,667	10	1,360	90	12,242	30	6,019	70	14,045
27 Jagna	44,724	37.35	62.65	16,704	28,019	85	54	14,149	15,102	29,251	10	1,415	90	12,734	30	4,531	70	10,572
28 Lila	15,044	20.61	79.39	3,101	11,943	91	54	2,814	6,437	9,252	10	281	90	2,533	30	1,931	70	4,506
29 Loay	21,584	36.45	63.55	7,868	13,716	91	54	7,141	7,393	14,534	10	714	90	6,427	30	2,218	70	5,175
30 Loboc	24,392	18.41	81.59	4,491	19,901	91	54	4,076	10,727	14,803	10	408	90	3,668	30	3,218	70	7,509
31 Loon	97,115	34.38	65.62	33,392	63,723	91	54	30,303	34,347	64,650	10	3,030	90	27,273	30	10,304	70	24,043
32 Mabini	42,755	28.95	71.05	12,379	30,375	85	50	10,485	15,203	25,688	10	1,049	90	9,437	10	1,520	90	13,683
33 Maribojoc	24,465	52.31	47.69	12,797	11,668	95	88	12,157	10,268	22,425	10	1,216	90	10,942	10	1,027	90	9,241
34 Panglao	33,074	64.90	35.10	21,465	11,609	95	66	20,392	7,662	28,054	10	2,039	90	18,353	10	766	90	6,896
35 Pilar	38,396	15.48	84.52	5,944	32,452	85	50	5,035	16,242	21,277	10	503	90	4,531	30	4,873	70	11,370
36 Pres. C. P. Garcia	24,398	37.18	62.82	9,072	15,327	85	50	7,684	7,671	15,355	10	768	90	6,915	30	2,301	70	5,370
37 Sagbayan	25,241	20.58	79.42	5,193	20,047	95	55	4,934	11,026	15,960	10	493	90	4,440	30	3,308	70	7,718
38 San Isidro	13,290	0.00	100.00	0	13,290	-	60	0	7,974	7,974	10	0	90	0	30	2,392	70	5,582
39 San Miguel	31,824	10.89	89.11	3,465	28,359	85	50	2,935	14,194	17,129	10	293	90	2,641	30	4,258	70	9,936
40 Sevilla	16,098	15.14	84.86	2,438	13,661	85	50	2,065	6,837	8,902	10	206	90	1,858	30	2,051	70	4,786
41 Sierra Bullones	37,216	36.67	63.33	13,647	23,569	85	44	11,559	10,370	21,929	10	1,156	90	10,403	30	3,111	70	7,259
42 Sikatuna	9,636	14.96	85.04	1,442	8,194	95	94	1,370	7,661	9,031	10	137	90	1,233	30	2,298	70	5,363
43 Tagbilaran City	121,566	100.00	0.00	121,566	0	95	-	115,487	0	115,487	10	11,549	90	103,939		-	-	-
44 Talibon	86,215	60.34	39.66	52,021	34,194	91	54	47,209	18,431	65,640	10	4,721	90	42,488	30	5,529	70	12,902
45 Trinidad	37,485	11.99	88.01	4,493	32,991	85	50	3,806	16,512	20,318	10	381	90	3,425	30	4,954	70	11,559
46 Tubigon	61,319	52.35	47.65	32,099	29,221	91	54	29,130	15,750	44,880	10	2,913	90	26,217	30	4,725	70	11,025
47 Ubay	87,318	22.36	77.64	19,523	67,795	85	50	16,536	33,931	50,467	10	1,654	90	14,883	30	10,179	70	23,752
48 Valencia	35,558	9.52	90.48	3,384	32,174	85	50	2,866	16,103	18,969	10	287	90	2,580	30	4,831	70	11,272
Provincial Total	**1,707,600**			**606,192**	**1,101,408**			**547,478**	**578,821**	**1,126,300**		**54,748**		**492,731**		**159,240**		**419,581**

Assumption:
%of urban and rural population in municipality is projected to increase at a minimal rate of 2% for 2010-2015, 2015-2020, 2020-2025, 2025-2030 and 2030-2035

Table 3-15B Water Demand Projections for Year 2025

City/Municipality	Domestic Demand					Commercial/Industrial Demand (cumd)	Institutional Demand (cumd)	Tourism Demand (cumd)	Demand for Prop. Ind'l Estate (cumd)	Total Demand (cumd)	Non-Revenue Water (20%)	Average-Day Demand	Maximum-Day Demand
	Urban		Rural		Total							(cumd)	(cumd)
	Level 2	Level 3	Level 2	Level 3									
1 Alburquerque	29	551	90	371	1,042	94	36	31.67		1,204	301	1,505	1,956
2 Alicia	15	278	227	937	1,457	144	84	31.67		1,717	429	2,146	2,790
3 Anda	20	374	189	781	1,363	133	72	617.55		2,186	546	2,732	3,552
4 Antequera	21	385	143	592	1,140	109	60	31.67		1,341	335	1,676	2,179
5 Baclayon	38	705	54	862	1,660	147	72	31.67		1,910	478	2,388	3,104
6 Balilihan	23	435	207	856	1,522	147	78	31.67		1,779	445	2,223	2,890
7 Batuan	25	462	111	460	1,058	99	48	31.67		1,237	309	1,546	2,009
8 Bien Unido	154	2,896	47	194	3,292	408	102	31.67		3,833	958	4,792	5,990
9 Bilar	27	503	171	707	1,408	134	72	31.67		1,646	412	2,058	2,675
10 Buenavista	24	449	256	1,058	1,787	262	102	31.67		2,182	545	2,727	3,409
11 Calape	65	1,225	259	1,070	2,620	243	120	31.67	2,295.00	5,310	1,327	6,637	8,296
12 Candijay	101	1,898	232	959	3,191	286	132	31.67		3,641	910	4,551	5,689
13 Carmen	68	1,269	379	1,566	3,281	349	168	308.77	850.00	4,957	1,239	6,196	7,745
14 Catigbian	28	521	271	1,122	1,942	189	108	31.67		2,271	568	2,838	3,548
15 Clarin	35	655	63	1,005	1,758	235	78	31.67		2,103	526	2,629	3,417
16 Corella	7	131	12	416	566	51	24	31.67		673	168	841	1,094
17 Cortes	26	481	134	553	1,194	112	54	31.67		1,392	348	1,740	2,262
18 Dagohoy	20	384	198	816	1,419	138	78	31.67		1,666	416	2,082	2,707
19 Danao	26	490	202	836	1,554	150	84	31.67		1,820	455	2,276	2,958
20 Dauis	128	2,404	85	1,359	3,976	341	138	308.77		4,764	1,191	5,955	7,443
21 Dimiao	10	189	167	690	1,056	106	60	31.67		1,254	313	1,567	2,037
22 Duero	30	568	183	757	1,538	146	72	31.67		1,787	447	2,234	2,904
23 Garcia Hernandez	40	1,000	210	1,146	2,396	176	96	31.67		2,700	675	3,375	4,219
24 Getafe	93	1,737	187	772	2,788	372	114	31.67		3,306	826	4,132	5,165
25 Guindulman	37	699	295	1,219	2,250	218	114	31.67		2,613	653	3,267	4,083
26 Inabanga	82	1,530	361	1,492	3,465	485	168	31.67		4,150	1,037	5,187	6,484
27 Jagna	85	1,592	272	1,123	3,072	317	132	31.67		3,552	888	4,440	5,550
28 Lila	17	317	116	479	928	90	48	31.67		1,097	274	1,372	1,783
29 Loay	43	803	133	550	1,529	139	66	31.67		1,766	441	2,207	2,870
30 Loboc	24	569	193	1,021	1,807	142	72	308.77		2,330	583	2,913	3,787
31 Loon	182	4,500	618	3,372	8,672	698	294	31.67	2,125.00	11,821	2,955	14,776	18,471
32 Mabini	63	1,180	91	1,454	2,788	246	126	31.67		3,192	798	3,989	4,987
33 Maribojoc	73	1,368	62	982	2,484	216	72	31.67		2,804	701	3,505	4,556
34 Panglao	122	2,294	46	733	3,195	269	102	926.32	10,200.00	14,692	3,673	18,365	22,957
35 Pilar	30	566	292	1,208	2,097	205	114	31.67		2,447	612	3,059	3,824
36 Pres. C. P. Garcia	46	864	138	571	1,619	147	72	31.67		1,870	467	2,337	3,039
37 Sagbayan	30	555	198	820	1,603	154	78	31.67		1,866	467	2,333	3,033
38 San Isidro	-	-	144	593	737	77	42	31.67		887	222	1,109	1,442
39 San Miguel	18	330	255	1,056	1,659	165	96	31.67		1,951	488	2,439	3,049
40 Sevilla	12	232	123	509	876	85	48	31.67		1,041	260	1,301	1,691
41 Sierra Bullones	69	1,300	187	771	2,328	211	114	31.67		2,685	671	3,356	4,195
42 Sikatuna	8	154	138	570	870	86	30	31.67		1,018	255	1,273	1,654
43 Tagbilaran City	693	20,788	-	-	21,481	4,044	720	617.55	1700.00	28,562	7,141	35,703	44,628
44 Talibon	283	5,311	332	1,426	7,352	946	258	308.77		8,864	2,216	11,080	13,850
45 Trinidad	23	428	297	1,228	1,976	293	114	31.67		2,415	604	3,018	3,773
46 Tubigon	175	3,277	283	1,218	4,954	646	186	308.77	4,250.00	10,344	2,586	12,930	16,162
47 Ubay	99	2,456	611	3,331	6,497	848	264	308.77		7,918	1,979	9,897	12,372
48 Valencia	17	322	290	1,198	1,827	182	108	31.67		2,149	537	2,687	3,358
Provincial Total	**3,285**	**71,425**	**9,554**	**46,808**	**131,073**	**15,480**	**5,490**	**5,249**	**21,420.00**	**178,712**	**44,678**	**223,390**	**281,637**

1) for Level II, number of communal faucets = projected number of beneficiaries/average no. of persons per hh/25 households
2) commercial connections = commercial connection density ratio of 0.60 connection for every 100 persons in the service coverage
3) instutional connections = 1 connection for every 2,000 population
4) Unit Consumption:

Domestic	125 lpcd
Commercial	1.8cumd/conn
Institutional	6 cumd/conn
Tourism	300 liters per tourist per day
Industrial	86 cumd/ha
UFW	20% of ADD

Table 3-16A Target Served Population Projection for Year 2030

City/Municipality	Projected Population (Year 2030)	% Share		Population Distribution by Classification		Projected Served Population												
						Total Served Population					Urban				Rural			
		Urban (%)	Rural (%)	Urban	Rural	Urban (%)	Rural (%)	Urban Pop.	Rural Pop.	Total	Level 2 (%)	Level 2	Level 3 (%)	Level 3	Level 2 (%)	Level 2	Level 3 (%)	Level 3
1 Alburquerque	13,435	41.36	58.64	5,557	7,878	95	66	5,279	5,200	10,479	10	528	90	4,751	30	1,560	70	3,640
2 Alicia	29,185	10.60	89.40	3,093	26,093	93	50	2,881	13,059	15,941	10	288	90	2,593	30	3,918	70	9,142
3 Anda	25,334	15.16	84.84	3,839	21,495	95	50	3,647	10,758	14,406	10	365	90	3,283	30	3,227	70	7,531
4 Antequera	20,709	19.54	80.46	4,047	16,662	95	50	3,845	8,339	12,184	10	384	90	3,460	30	2,502	70	5,838
5 Baclayon	25,256	29.81	70.19	7,529	17,727	95	54	7,153	9,555	16,708	10	715	90	6,437	10	955	90	8,599
6 Balilihan	27,231	16.95	83.05	4,617	22,615	95	54	4,386	12,189	16,575	10	439	90	3,947	30	3,657	70	8,533
7 Batuan	17,762	27.36	72.64	4,861	12,901	95	50	4,618	6,457	11,075	10	462	90	4,156	30	1,937	70	4,520
8 Bien Unido	35,662	86.17	13.83	30,730	4,932	95	50	29,193	2,468	31,662	10	2,919	90	26,274	30	740	70	1,728
9 Bilar	25,634	22.20	77.80	5,692	19,942	93	50	5,303	9,981	15,284	10	530	90	4,773	30	2,994	70	6,987
10 Buenavista	34,303	14.51	85.49	4,976	29,327	95	50	4,727	14,678	19,405	10	473	90	4,255	30	4,403	70	10,275
11 Calape	43,043	30.03	69.97	12,927	30,116	95	50	12,281	15,073	27,354	10	1,228	90	11,053	30	4,522	70	10,551
12 Candijay	46,848	42.76	57.24	20,034	26,814	95	50	19,032	13,420	32,453	10	1,903	90	17,129	30	4,026	70	9,394
13 Carmen	57,885	24.52	75.48	14,196	43,690	93	50	13,226	21,867	35,093	10	1,323	90	11,904	30	6,560	70	15,307
14 Catigbian	38,326	15.67	84.33	6,006	32,320	93	50	5,596	16,176	21,772	10	560	90	5,036	30	4,853	70	11,323
15 Clarin	27,314	25.23	74.77	6,892	20,423	95	54	6,547	11,008	17,555	10	655	90	5,892	10	1,101	90	9,907
16 Corella	9,448	14.62	85.38	1,382	8,067	95	54	1,312	4,348	5,660	10	131	90	1,181	5	217	95	4,131
17 Cortes	19,219	26.36	73.64	5,066	14,154	95	55	4,813	7,784	12,597	10	481	90	4,331	30	2,335	70	5,449
18 Dagohoy	27,641	15.85	84.15	4,380	23,261	93	50	4,081	11,642	15,723	10	408	90	3,673	30	3,493	70	8,150
19 Danao	29,545	19.00	81.00	5,614	23,931	93	50	5,231	11,977	17,208	10	523	90	4,708	30	3,593	70	8,384
20 Dauis	50,718	48.24	51.76	24,464	26,254	95	58	23,241	15,162	38,402	10	2,324	90	20,917	10	1,516	90	13,646
21 Dimiao	21,664	9.84	90.16	2,133	19,531	93	50	1,987	9,775	11,762	10	199	90	1,788	30	2,933	70	6,843
22 Duero	25,413	23.57	76.43	5,989	19,424	95	55	5,689	10,683	16,373	10	569	90	5,120	30	3,205	70	7,478
23 Garcia Hernandez	33,033	25.92	74.08	8,564	24,470	93	50	7,979	12,247	20,226	10	798	90	7,181	30	3,674	70	8,573
24 Getafe	39,334	49.61	50.39	19,515	19,819	95	54	18,540	10,682	29,222	10	1,854	90	16,686	30	3,205	70	7,478
25 Guindulman	38,811	19.81	80.19	7,689	31,122	93	54	7,164	16,775	23,938	10	716	90	6,447	30	5,032	70	11,742
26 Inabanga	57,742	29.17	70.83	16,845	40,897	93	50	15,695	20,469	36,164	10	1,569	90	14,125	30	6,141	70	14,328
27 Jagna	47,239	38.10	61.90	17,997	29,243	95	54	17,097	15,762	32,859	10	1,710	90	15,387	30	4,729	70	11,033
28 Lila	15,887	21.03	78.97	3,340	12,547	95	54	3,173	6,763	9,936	10	317	90	2,856	30	2,029	70	4,734
29 Loay	22,880	37.18	62.82	8,508	14,373	95	54	8,082	7,747	15,829	10	808	90	7,274	30	2,324	70	5,423
30 Loboc	25,995	18.78	81.22	4,882	21,112	95	54	4,638	11,380	16,018	10	464	90	4,174	30	3,414	70	7,966
31 Loon	108,601	35.07	64.93	38,088	70,513	95	54	36,184	38,006	74,190	10	3,618	90	32,565	30	11,402	70	26,604
32 Mabini	45,644	29.53	70.47	13,480	32,164	93	50	12,560	16,098	28,657	10	1,256	90	11,304	10	1,610	90	14,488
33 Maribojoc	25,836	53.35	46.65	13,784	12,051	95	88	13,095	10,605	23,700	10	1,310	90	11,786	10	1,061	90	9,545
34 Panglao	35,246	66.20	33.80	23,332	11,914	95	66	22,166	7,863	30,029	10	2,217	90	19,949	10	786	90	7,077
35 Pilar	40,839	15.79	84.21	6,449	34,390	93	50	6,008	17,212	23,221	10	601	90	5,408	30	5,164	70	12,049
36 Pres. Carlos P. Garcia	24,965	37.92	62.08	9,468	15,497	93	50	8,821	7,756	16,577	10	882	90	7,939	30	2,327	70	5,429
37 Sagbayan	26,429	20.99	79.01	5,547	20,883	95	55	5,269	11,485	16,755	10	527	90	4,742	30	3,446	70	8,040
38 San Isidro	14,038	0.00	100.00	0	14,038	-	60	0	8,423	8,423	10	0	90	0	30	2,527	70	5,896
39 San Miguel	33,842	11.11	88.89	3,758	30,083	93	50	3,502	15,057	18,559	10	350	90	3,152	30	4,517	70	10,540
40 Sevilla	17,181	15.45	84.55	2,654	14,527	93	50	2,472	7,271	9,743	10	247	90	2,225	30	2,181	70	5,090
41 Sierra Bullones	39,309	37.40	62.60	14,703	24,607	93	44	13,699	10,827	24,525	10	1,370	90	12,329	30	3,248	70	7,579
42 Sikatuna	10,178	15.26	84.74	1,554	8,624	95	94	1,476	8,064	9,539	10	148	90	1,328	30	2,419	70	5,644
43 Tagbilaran City (Capital)	129,726	100.00	0.00	129,726	0	95	-	123,239	0	123,239	10	12,324	90	110,915		-	-	-
44 Talibon	92,241	61.55	38.45	56,770	35,471	95	54	53,931	19,119	73,050	10	5,393	90	48,538	30	5,736	70	13,383
45 Trinidad	39,593	12.23	87.77	4,841	34,752	93	50	4,510	17,393	21,904	10	451	90	4,059	30	5,218	70	12,175
46 Tubigon	65,147	53.39	46.61	34,785	30,362	95	54	33,045	16,365	49,411	10	3,305	90	29,741	30	4,910	70	11,456
47 Ubay	92,229	22.81	77.19	21,034	71,196	95	50	19,982	35,633	55,615	10	1,998	90	17,984	30	10,690	70	24,943
48 Valencia	37,558	9.71	90.29	3,646	33,912	93	50	3,397	16,973	20,370	10	340	90	3,057	30	5,092	70	11,881
Provincial Total	**1,811,100**			**654,979**	**1,156,121**			**619,792**	**607,577**	**1,227,369**		**61,979**		**557,813**		**167,128**		**440,449**

Assumption:
%of urban and rural population in municipality is projected to increase at a minimal rate of 2% for 2010-2015, 2015-2020, 2020-2025, 2025-2030 and 2030-2035

Table 3-16B Water Demand Projections for Year 2030

City/Municipality	Domestic Demand					Commercial/ Industrial Demand	Institutional Demand (cumd)	Tourism Demand (cumd)	Demand for Prop. Ind'l Estate	Total Demand	Non-Revenue Water (20%)	Average-Day Demand	Maximum-Day Demand
	Urban		Rural		Total								
	Level 2	Level 3	Level 2	Level 3								(cumd)	(cumd)
1 Alburquerque	32	594	94	387	1,106	101	42	31.67		1,280	320	1,600	2,081
2 Alicia	17	324	235	971	1,548	154	90	31.67		1,823	456	2,279	2,962
3 Anda	22	410	194	800	1,426	138	78	617.55		2,259	565	2,824	3,671
4 Antequera	23	433	150	620	1,226	117	60	31.67		1,434	359	1,793	2,331
5 Baclayon	43	805	57	914	1,819	160	78	31.67		2,088	522	2,610	3,393
6 Balilihan	26	493	219	907	1,646	158	84	31.67		1,920	480	2,400	3,120
7 Batuan	28	519	116	480	1,144	106	54	31.67		1,335	334	1,669	2,169
8 Bien Unido	175	3,284	44	184	3,687	456	108	31.67		4,283	1,071	5,354	6,692
9 Bilar	32	597	180	742	1,550	147	78	31.67		1,807	452	2,259	2,937
10 Buenavista	28	532	264	1,092	1,916	278	102	31.67		2,328	582	2,910	3,638
11 Calape	74	1,382	271	1,121	2,848	262	132	31.67	2,295.00	5,569	1,392	6,961	8,701
12 Candijay	114	2,141	242	998	3,495	312	138	31.67		3,977	994	4,971	6,214
13 Carmen	79	1,488	394	1,626	3,587	380	174	308.77	850.00	5,300	1,325	6,625	8,281
14 Catigbian	34	630	291	1,203	2,157	210	114	31.67		2,513	628	3,141	3,926
15 Clarin	39	737	66	1,053	1,894	252	84	31.67		2,262	566	2,828	3,676
16 Corella	8	148	13	439	607	54	30	31.67		724	181	904	1,176
17 Cortes	29	541	140	579	1,289	122	60	31.67		1,503	376	1,878	2,442
18 Dagohoy	24	459	210	866	1,559	150	84	31.67		1,825	456	2,281	2,966
19 Danao	31	588	216	891	1,726	165	90	31.67		2,013	503	2,516	3,271
20 Dauis	139	2,615	91	1,450	4,295	368	150	308.77		5,122	1,280	6,402	8,002
21 Dimiao	12	224	176	727	1,138	114	66	31.67		1,350	337	1,687	2,193
22 Duero	34	640	192	795	1,661	157	78	31.67		1,928	482	2,409	3,132
23 Garcia Hernandez	48	1,185	220	1,202	2,656	194	102	31.67		2,983	746	3,728	4,661
24 Getafe	111	2,086	192	794	3,184	420	120	31.67		3,755	939	4,694	5,868
25 Guindulman	43	806	302	1,248	2,398	230	114	31.67		2,775	694	3,468	4,335
26 Inabanga	94	1,766	368	1,522	3,751	521	174	31.67		4,477	1,119	5,596	6,996
27 Jagna	103	1,923	284	1,172	3,482	355	144	31.67		4,012	1,003	5,015	6,269
28 Lila	19	357	122	503	1,001	96	48	31.67		1,176	294	1,471	1,912
29 Loay	48	909	139	576	1,673	152	66	31.67		1,923	481	2,404	3,125
30 Loboc	28	647	205	1,083	1,963	154	78	308.77		2,503	626	3,129	4,068
31 Loon	217	5,373	684	3,731	10,006	801	324	31.67	2,125.00	13,287	3,322	16,609	20,762
32 Mabini	75	1,413	97	1,539	3,124	275	138	31.67		3,569	892	4,461	5,577
33 Maribojoc	79	1,473	64	1,014	2,630	227	78	31.67		2,966	742	3,708	4,820
34 Panglao	133	2,494	47	752	3,426	288	108	926.32	10,200.00	14,948	3,737	18,685	23,356
35 Pilar	36	676	310	1,280	2,302	222	120	31.67		2,676	669	3,345	4,181
36 Pres. C. P. Garcia	53	992	140	577	1,762	158	72	31.67		2,024	506	2,530	3,289
37 Sagbayan	32	593	207	854	1,685	162	78	31.67		1,957	489	2,446	3,180
38 San Isidro	-	-	152	626	778	82	42	31.67		933	233	1,167	1,517
39 San Miguel	21	394	271	1,120	1,806	178	102	31.67		2,117	529	2,646	3,308
40 Sevilla	15	278	131	541	965	93	54	31.67		1,143	286	1,429	1,858
41 Sierra Bullones	82	1,541	195	805	2,623	235	120	31.67		3,010	753	3,763	4,704
42 Sikatuna	9	166	145	600	920	91	30	31.67		1,073	268	1,341	1,743
43 Tagbilaran City	739	22,183	-	-	22,923	4,044	720	617.55	1700.00	30,004	7,501	37,505	46,881
44 Talibon	324	6,067	344	1,479	8,214	1,051	276	308.77		9,850	2,462	12,312	15,390
45 Trinidad	27	507	313	1,294	2,141	314	120	31.67		2,607	652	3,259	4,074
46 Tubigon	198	3,718	295	1,266	5,476	710	198	308.77	4,250.00	10,943	2,736	13,679	17,099
47 Ubay	120	2,967	641	3,498	7,227	935	276	308.77		8,747	2,187	10,934	13,667
48 Valencia	20	382	306	1,262	1,970	195	114	31.67		2,311	578	2,889	3,611
Provincial Total	**3,719**	**80,480**	**10,028**	**49,184**	**143,411**	**16,543**	**5,790**	**5,249**	**21,420.00**	**192,413**	**48,103**	**240,516**	**303,223**

1) for Level II, number of communal faucets = projected number of beneficiaries/average no. of persons per hh/25 households
2) commercial connections = commercial connection density ratio of 0.60 connection for every 100 persons in the service coverage
3) instutional connections = 1 connection for every 2,000 population
4) Unit Consumption:

Domestic	125 lpcd
Commercial	1.8cumd/conn
Institutional	6 cumd/conn
Tourism	300 liters per tourist per day
Industrial	86 cumd/ha
UFW	20% of ADD

Table 3-17A Target Served Population for Year 2035

City/Municipality	Projected Population (Year 2035)	% Share		Population Distribution by Classification		Projected Served Population												
						Total Served Population					Urban				Rural			
		Urban (%)	Rural (%)	Urban	Rural	Urban (%)	Rural (%)	Urban Pop.	Rural Pop.	Total	Level 2 (%)	Level 2	Level 3 (%)	Level 3	Level 2 (%)	Level 2	Level 3 (%)	Level 3
1 Alburquerque	14,105	42.19	57.81	5,950	8,154	95	66	5,653	5,382	11,035	10	565	90	5,088	30	1,615	70	3,767
2 Alicia	30,186	10.81	89.19	3,263	26,923	93	50	3,040	13,475	16,515	10	304	90	2,736	30	4,043	70	9,433
3 Anda	25,789	15.46	84.54	3,987	21,803	95	50	3,787	10,912	14,699	10	379	90	3,408	30	3,274	70	7,639
4 Antequera	21,683	19.93	80.07	4,322	17,361	95	50	4,106	8,689	12,795	10	411	90	3,696	30	2,607	70	6,082
5 Baclayon	26,782	30.41	69.59	8,144	18,638	95	54	7,736	10,046	17,783	10	774	90	6,963	10	1,005	90	9,042
6 Balilihan	28,744	17.29	82.71	4,970	23,774	95	54	4,722	12,814	17,536	10	472	90	4,250	30	3,844	70	8,970
7 Batuan	18,591	27.91	72.09	5,189	13,402	95	50	4,930	6,708	11,637	10	493	90	4,437	30	2,012	70	4,695
8 Bien Unido	37,619	87.89	12.11	33,065	4,554	95	50	31,412	2,279	33,691	10	3,141	90	28,270	30	684	70	1,596
9 Bilar	26,912	22.65	77.35	6,095	20,817	93	50	5,679	10,419	16,097	10	568	90	5,111	30	3,126	70	7,293
10 Buenavista	35,391	14.80	85.20	5,237	30,155	95	50	4,975	15,092	20,067	10	497	90	4,477	30	4,528	70	10,565
11 Calape	45,189	30.63	69.37	13,843	31,346	95	50	13,151	15,689	28,839	10	1,315	90	11,836	30	4,707	70	10,982
12 Candijay	49,183	43.62	56.38	21,454	27,730	95	50	20,381	13,879	34,260	10	2,038	90	18,343	30	4,164	70	9,715
13 Carmen	60,218	25.01	74.99	15,063	45,155	93	50	14,034	22,600	36,634	10	1,403	90	12,631	30	6,780	70	15,820
14 Catigbian	40,912	15.98	84.02	6,539	34,373	93	50	6,093	17,203	23,296	10	609	90	5,484	30	5,161	70	12,042
15 Clarin	28,618	25.74	74.26	7,365	21,253	95	54	6,997	11,455	18,452	10	700	90	6,297	10	1,146	90	10,310
16 Corella	9,934	14.91	85.09	1,482	8,453	95	54	1,408	4,556	5,964	10	141	90	1,267	5	228	95	4,328
17 Cortes	20,135	26.88	73.12	5,413	14,722	95	55	5,143	8,097	13,240	10	514	90	4,628	30	2,429	70	5,668
18 Dagohoy	29,225	16.16	83.84	4,724	24,502	93	50	4,401	12,263	16,664	10	440	90	3,961	30	3,679	70	8,584
19 Danao	31,387	19.38	80.62	6,084	25,303	93	50	5,668	12,664	18,333	10	567	90	5,101	30	3,799	70	8,865
20 Dauis	54,587	49.20	50.80	26,857	27,730	95	58	25,514	16,014	41,528	10	2,551	90	22,962	10	1,601	90	14,413
21 Dimiao	22,726	10.04	89.96	2,282	20,444	93	50	2,126	10,232	12,358	10	213	90	1,914	30	3,070	70	7,163
22 Duero	26,680	24.04	75.96	6,413	20,267	95	55	6,093	11,147	17,239	10	609	90	5,483	30	3,344	70	7,803
23 Garcia Hernandez	34,680	26.44	73.56	9,170	25,510	93	50	8,544	12,768	21,312	10	854	90	7,690	30	3,830	70	8,937
24 Getafe	41,062	50.61	49.39	20,780	20,282	95	54	19,741	10,932	30,673	10	1,974	90	17,767	30	3,280	70	7,652
25 Guindulman	39,795	20.21	79.79	8,041	31,753	93	54	7,492	17,115	24,607	10	749	90	6,743	30	5,134	70	11,980
26 Inabanga	58,780	29.76	70.24	17,491	41,289	93	50	16,296	20,665	36,961	10	1,630	90	14,667	30	6,200	70	14,466
27 Jagna	49,594	38.86	61.14	19,272	30,322	95	54	18,308	16,344	34,652	10	1,831	90	16,477	30	4,903	70	11,441
28 Lila	16,676	21.45	78.55	3,576	13,100	95	54	3,398	7,061	10,458	10	340	90	3,058	30	2,118	70	4,942
29 Loay	24,097	37.93	62.07	9,139	14,958	95	54	8,682	8,062	16,745	10	868	90	7,814	30	2,419	70	5,644
30 Loboc	27,505	19.16	80.84	5,269	22,236	95	54	5,006	11,985	16,991	10	501	90	4,505	30	3,596	70	8,390
31 Loon	119,897	35.77	64.23	42,891	77,006	95	54	40,746	41,506	82,252	10	4,075	90	36,672	30	12,452	70	29,054
32 Mabini	48,372	30.12	69.88	14,572	33,800	93	50	13,576	16,917	30,493	10	1,358	90	12,219	10	1,692	90	15,225
33 Maribojoc	27,119	54.42	45.58	14,758	12,360	95	88	14,020	10,877	24,897	10	1,402	90	12,618	10	1,088	90	9,789
34 Panglao	37,294	67.52	32.48	25,182	12,112	95	66	23,922	7,994	31,917	10	2,392	90	21,530	10	799	90	7,195
35 Pilar	43,138	16.11	83.89	6,948	36,190	93	50	6,474	18,113	24,587	10	647	90	5,826	30	5,434	70	12,679
36 Pres. C. P. Garcia	25,486	38.68	61.32	9,859	15,627	93	50	9,186	7,821	17,007	10	919	90	8,267	30	2,346	70	5,475
37 Sagbayan	27,535	21.41	78.59	5,894	21,641	95	55	5,600	11,902	17,502	10	560	90	5,040	30	3,571	70	8,332
38 San Isidro	14,738	0.00	100.00	0	14,738	-	60	0	8,843	8,843	10	0	90	0	30	2,653	70	6,190
39 San Miguel	35,741	11.33	88.67	4,049	31,692	93	50	3,772	15,862	19,634	10	377	90	3,395	30	4,759	70	11,103
40 Sevilla	18,203	15.75	84.25	2,868	15,335	93	50	2,672	7,675	10,347	10	267	90	2,405	30	2,303	70	5,373
41 Sierra Bullones	41,269	38.15	61.85	15,744	25,525	93	44	14,669	11,231	25,900	10	1,467	90	13,202	30	3,369	70	7,862
42 Sikatuna	10,685	15.57	84.43	1,664	9,021	95	94	1,580	8,435	10,015	10	158	90	1,422	30	2,531	70	5,905
43 Tagbilaran City	137,428	100.00	0.00	137,428	0	95	-	130,556	0	130,556	10	13,056	90	117,501	-	-	-	-
44 Talibon	97,940	62.78	37.22	61,483	36,457	95	54	58,409	19,650	78,059	10	5,841	90	52,568	30	5,895	70	13,755
45 Trinidad	41,567	12.47	87.53	5,184	36,383	93	50	4,830	18,210	23,039	10	483	90	4,347	30	5,463	70	12,747
46 Tubigon	68,747	54.46	45.54	37,441	31,306	95	54	35,569	16,874	52,443	10	3,557	90	32,012	30	5,062	70	11,812
47 Ubay	96,827	23.26	76.74	22,524	74,303	95	50	21,398	37,189	58,586	10	2,140	90	19,258	30	11,157	70	26,032
48 Valencia	39,430	9.90	90.10	3,904	35,526	93	50	3,638	17,781	21,418	10	364	90	3,274	30	5,334	70	12,447
Provincial Total	**1,908,200**			**702,871**	**1,205,329**			**665,131**	**633,428**	**1,298,559**		**66,513**	**0**	**598,618**		**174,229**		**459,199**

Assumption:

%of urban and rural population in municipality is projected to increase at a minimal rate of 2% for 2010-2015, 2015-2020, 2020-2025, 2025-2030 and 2030-2035

Table 3-17B Water Demand Projections for Year 2035

City/Municipality	Domestic Demand					Commercial/Industrial Demand	Institutional Demand (cumd)	Tourism Demand (cumd)	Demand for Prop. Ind'l Estate (cumd)	Total Demand	Non-Revenue Water (20%)	Average-Day Demand	Maximum-Day Demand
	Urban		Rural		Total								
	Level 2	Level 3	Level 2	Level 3								(cumd)	(cumd)
1 Alburquerque	34	636	97	400	1,167	106	35	31.67		1,339	334.82	1,674	2,176
2 Alicia	18	342	243	1,002	1,605	158	90	31.67		1,885	471.26	2,356	3,063
3 Anda	23	426	196	812	1,457	141	78	617.55		2,293	573.29	2,866	3,726
4 Antequera	25	462	156	646	1,289	123	66	31.67		1,510	377.53	1,888	2,454
5 Baclayon	46	870	60	961	1,938	171	78	31.67		2,219	554.65	2,773	3,605
6 Balilihan	28	531	231	953	1,743	168	84	31.67		2,027	506.73	2,534	3,294
7 Batuan	30	555	121	499	1,204	112	54	31.67		1,401	350.36	1,752	2,277
8 Bien Unido	188	3,534	41	170	3,933	485	114	31.67		4,563	1,140.82	5,704	7,130
9 Bilar	34	639	188	775	1,635	155	78	31.67		1,900	475.06	2,375	3,088
10 Buenavista	30	560	272	1,122	1,984	288	108	31.67		2,411	602.83	3,014	3,768
11 Calape	79	1,479	282	1,167	3,008	277	138	31.67	2,295	5,749	1,437.27	7,186	8,983
12 Candijay	122	2,293	250	1,032	3,697	330	150	31.67		4,208	1,052.11	5,261	6,576
13 Carmen	84	1,579	407	1,681	3,751	396	180	308.77	850	5,485	1,371.37	6,857	8,571
14 Catigbian	37	685	310	1,280	2,311	224	120	31.67		2,687	671.71	3,359	4,198
15 Clarin	42	787	69	1,095	1,993	266	84	31.67		2,375	593.83	2,969	3,860
16 Corella	8	158	14	460	640	58	30	31.67		760	189.90	950	1,234
17 Cortes	31	579	146	602	1,357	126	60	31.67		1,575	393.86	1,969	2,560
18 Dagohoy	26	495	221	912	1,654	160	90	31.67		1,936	484.00	2,420	3,146
19 Danao	34	638	228	942	1,842	176	96	31.67		2,145	536.31	2,682	3,486
20 Dauis	153	2,870	96	1,531	4,651	398	162	308.77		5,520	1,380.00	6,900	8,625
21 Dimiao	13	239	184	761	1,197	118	66	31.67		1,413	353.30	1,767	2,296
22 Duero	37	685	201	829	1,752	165	78	31.67		2,026	506.53	2,533	3,292
23 Garcia Hernandez	51	1,410	230	1,253	2,944	205	102	31.67		3,283	820.70	4,103	5,129
24 Getafe	118	2,221	197	813	3,349	442	126	31.67		3,948	987.10	4,936	6,169
25 Guindulman	45	843	308	1,273	2,469	237	120	31.67		2,857	714.32	3,572	4,464
26 Inabanga	98	1,833	372	1,537	3,840	533	174	31.67		4,578	1,144.62	5,723	7,154
27 Jagna	110	2,060	294	1,216	3,679	374	150	31.67		4,235	1,058.84	5,294	6,618
28 Lila	20	382	127	525	1,055	101	48	31.67		1,235	308.83	1,544	2,007
29 Loay	52	977	145	600	1,774	160	72	31.67		2,037	509.32	2,547	3,311
30 Loboc	30	698	216	1,105	2,049	163	84	308.77		2,605	651.34	3,257	4,234
31 Loon	244	6,051	747	4,075	11,117	889	360	31.67	2,125	14,523	3,630.78	18,154	22,692
32 Mabini	81	1,527	102	1,618	3,328	293	144	31.67		3,796	949.11	4,746	5,932
33 Maribojoc	84	1,577	65	1,040	2,767	238	84	31.67		3,121	780.22	3,901	5,071
34 Panglao	144	2,691	48	764	3,647	306	114	926.32	10,200	15,193	3,798.28	18,991	23,739
35 Pilar	39	728	326	1,347	2,440	237	132	31.67		2,841	710.20	3,551	4,439
36 Pres. Carlos P. Garcia	55	1,033	141	582	1,811	163	78	31.67		2,084	520.97	2,605	3,386
37 Sagbayan	34	630	214	885	1,763	168	84	31.67		2,047	511.67	2,558	3,326
38 San Isidro	-	-	159	658	817	85	42	31.67		975	243.83	1,219	1,585
39 San Miguel	23	424	286	1,180	1,912	189	108	31.67		2,241	560.18	2,801	3,501
40 Sevilla	16	301	138	571	1,026	99	54	31.67		1,210	302.62	1,513	1,967
41 Sierra Bullones	88	1,650	202	835	2,776	248	126	31.67		3,181	795.35	3,977	4,971
42 Sikatuna	9	178	152	627	966	96	30	31.67		1,124	281.03	1,405	1,827
43 Tagbilaran City (Capital)	783	23,500	-	-	24,283	4,044	720	617.55	1700	31,365	7,841.23	39,206	49,008
44 Talibon	350	6,571	354	1,520	8,795	1,123	294	308.77	850	11,371	2,842.77	14,214	17,767
45 Trinidad	29	543	328	1,354	2,254	331	126	31.67		2,743	685.83	3,429	4,286
46 Tubigon	213	4,001	304	1,305	5,824	756	204	308.77	4250	11,343	2,835.65	14,178	17,723
47 Ubay	128	3,178	669	3,651	7,626	986	288	308.77		9,209	2,302.18	11,511	14,389
48 Valencia	22	409	320	1,322	2,074	206	120	31.67		2,432	607.91	3,040	3,799
Provincial Total	**3,991**	**86,461**	**10,454**	**51,289**	**152,195**	**17,273**	**6,023**	**5,249**	**22,270**	**203,010**	**50,752**	**253,762**	**319,906**

1) for Level II, number of communal faucets = projected number of beneficiaries/average no. of persons per hh/25 households
2) commercial connections = commercial connection density ratio of 0.60 connection for every 100 persons in the service coverage
3) instutional connections = 1 connection for every 2,000 population
4) Unit Consumption:

Domestic	125 lpcd
Commercial	1.8cumd/conn
Institutional	6 cumd/conn
Tourism	300 liters per tourist per day
Industrial	86 cumd/ha
UFW	20% of ADD

Table 3-18 Year-by-Year Annual Demand

Year	Total Demand	Average Day Demand (cumd)	Maximum Day Demand (cumd)
2010	**69,489**	**106,064**	**110,171**
2011	79,040	116,235	126,007
2012	89,138	125,547	141,843
2013	99,236	134,103	157,680
2014	109,335	141,993	173,516
2015	**119,433**	**149,291**	**188,924**
2016	126,495	158,119	200,108
2017	133,557	166,947	211,291
2018	140,619	175,774	222,474
2019	147,682	184,602	233,657
2020	**154,744**	**193,430**	**244,840**
2021	159,538	199,422	252,199
2022	164,331	205,414	259,559
2023	169,125	211,406	266,918
2024	173,918	217,398	274,278
2025	**178,712**	**223,390**	**281,637**
2026	181,452	226,815	285,954
2027	184,192	230,241	290,272
2028	186,933	233,666	294,589
2029	189,673	237,091	298,906
2030	**192,413**	**240,516**	**303,223**
2031	194,532	243,165	306,560
2032	196,652	245,815	309,896
2033	198,771	248,464	313,233
2034	200,890	251,113	316,569
2035	**203,010**	**253,762**	**319,906**

Figure 3-5 shows the water demand curve from 2010 to 2035 showing gradual increment in the projected water demands.

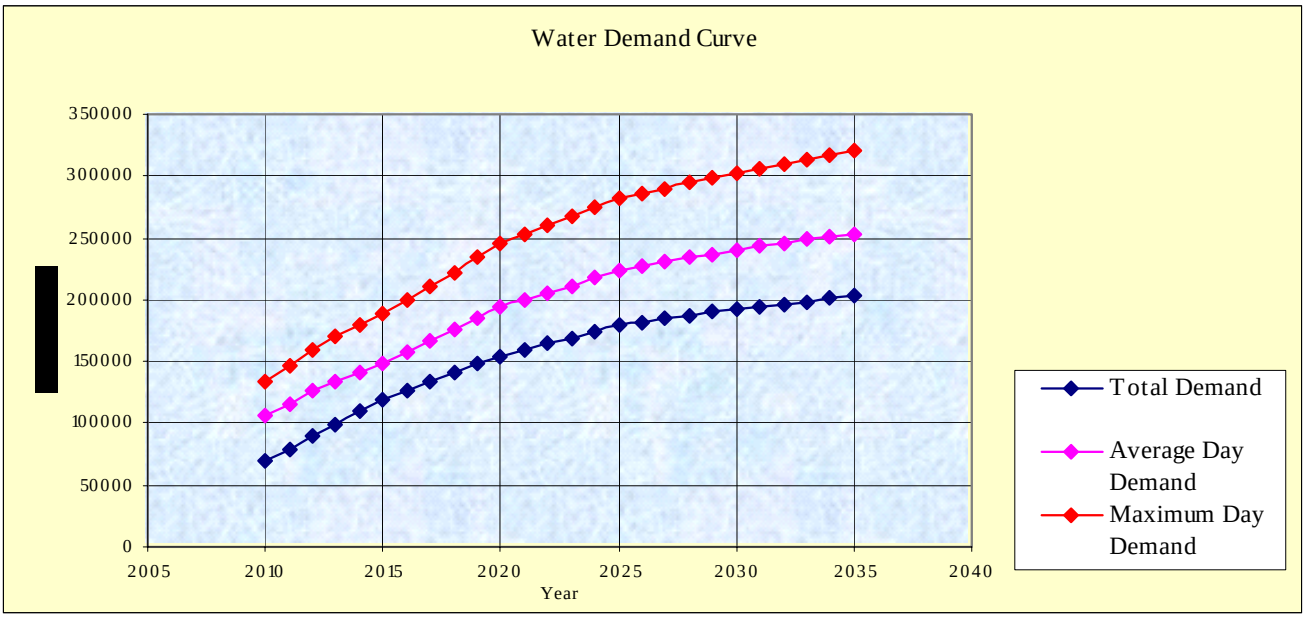


Figure 3-5 Water Demand Curve

3.5.9 Water Demand Requirements by BIAD System

The projected population and water demand were summarized considering the grouping of municipalities by BIAD system since it is the policy of the provincial government to implement programs and projects through the BIAD system. **Table 3-19 to 3-24** show the details of population and water demand projection by BIAD system for years 2010 to 2035.

Table 3-19 Bohol Integrated Water Supply System Master Plan Water Demand Projections Year 2010

City/Municipality	Projected Population	Total Served Population	Average-Day Demand	
			(cumd)	(L/s)
BIAD I				
Alburquerque	10,307	7,099	1,176	13.61
Antequera	16,118	8,106	1,338	15.49
Baclayon	18,364	15,862	2,544	29.44
Balilihan	20,292	13,129	2,103	24.34
Corella	7,190	6,520	1,035	11.98
Cortes	14,911	6,671	1,116	12.91
Dauis	34,063	26,509	4,547	52.63
Lila	12,199	6,183	1,025	11.87
Loay	17,258	9,962	1,614	18.68
Loboc	19,122	7,854	1,767	20.45
Maribojoc	19,839	17,352	2,862	33.13
Panglao	25,931	21,034	4,418	51.13
Sevilla	12,552	6,365	1,026	11.88
Sikatuna	7,808	7,060	1,119	12.95
Tagbilaran City (Capital)	94,825	80,602	27,077	313.39
Sub-total	**330,779**	**240,308**	**54,766**	**634**
BIAD II				
Buenavista	28,889	3,663	696	8.06
Calape	33,020	16,231	2,692	31.16
Catigbian	26,896	6,247	1,080	12.49
Clarin	21,183	7,765	1,367	15.82
Getafe	31,104	2,981	618	7.16
Inabanga	47,865	10,405	1,831	21.19
Loon	63,681	23,995	5,506	63.72
San Isidro	10,769	2,154	369	4.27
Tubigon	48,622	13,257	2,569	29.74
Sub-total	**312,029**	**86,697**	**16,727**	**194**
BIAD III				
Alicia	24,253	6,182	1,030	11.92
Bien Unido	26,666	5,851	1,107	12.81
Mabini	33,299	7,873	1,415	16.37
Pres. Carlos P. Garcia	22,248	3,004	565	6.54
San Miguel	25,148	516	184	2.13
Talibon	66,608	12,798	2,564	29.68
Trinidad	30,373	3,063	618	7.16
Ubay	70,752	13,410	3,297	38.16
Sub-total	**299,347**	**52,696**	**10,781**	**125**
BIAD IV				
Anda	21,001	9,870	1,059	12.26
Candijay	35,939	10,027	1,748	20.23
Dimiao	16,689	3,642	639	7.40
Duero	19,495	11,573	1,894	21.93
Garcia Hernandez	25,341	10,151	2,198	25.44
Guindulman	33,788	11,892	1,960	22.69
Jagna	36,239	11,914	2,113	24.46
Valencia	28,812	6,131	1,066	12.34
Sub-total	**217,305**	**75,201**	**12,678**	**147**
BIAD V				
Batuan	13,849	4,633	818	9.47
Bilar	19,665	9,278	1,531	17.72
Carmen	46,635	7,524	1,464	16.94
Dagohoy	20,418	3,237	594	6.87
Danao	21,276	6,123	1,056	12.22
Pilar	30,318	11,528	1,914	22.15
Sagbayan	21,124	13,052	2,115	24.48
Sierra Bullones	30,156	9,212	1,621	18.76
Sub-total	**203,441**	**64,587**	**11,112**	**129**
Provincial Total	**1,362,900**	**519,490**	**106,064**	**1,228**

Table 3-20 Bohol Integrated Water Supply System Master Plan
Water Demand Projections Year 2015

City/Municipality	Projected Population	Total Served Population	Average-Day Demand (cumd)	Average-Day Demand (L/s)
BIAD I				
Alburquerque	11,137	7,984	1,092	12.64
Antequera	17,344	8,834	1,176	13.61
Baclayon	20,152	11,346	1,521	17.61
Balilihan	22,111	11,753	1,540	17.82
Corella	7,787	4,095	549	6.35
Cortes	16,060	9,027	1,206	13.96
Dauis	38,243	24,858	3,583	41.47
Lila	13,178	7,136	952	11.02
Loay	18,739	10,889	1,477	17.09
Loboc	20,914	11,210	1,752	20.28
Maribojoc	21,431	18,222	2,468	28.56
Panglao	28,359	22,322	10,732	124.21
Sevilla	13,755	6,749	894	10.35
Sikatuna	8,437	7,232	931	10.77
Tagbilaran City (Capital)	103,898	98,703	30,019	347.45
Sub-total	**361,545**	**260,361**	**59,892**	**693**
BIAD II				
Buenavista	30,388	14,844	1,936	22.41
Calape	35,680	19,213	4,010	46.41
Catigbian	29,817	14,645	1,916	22.17
Clarin	22,818	12,591	1,672	19.35
Getafe	33,317	19,597	2,688	31.11
Inabanga	51,124	26,705	3,560	41.20
Loon	74,339	42,814	5,747	66.52
San Isidro	11,636	6,400	817	9.46
Tubigon	52,956	32,876	7,366	85.25
Sub-total	**342,076**	**189,686**	**29,711**	**344**
BIAD III				
Alicia	25,610	12,279	1,595	18.46
Bien Unido	29,027	20,161	2,892	33.47
Mabini	36,505	19,099	2,550	29.52
Pres. Carlos P. Garcia	23,024	12,492	1,701	19.68
San Miguel	27,424	13,181	1,713	19.82
Talibon	73,237	46,930	6,704	77.59
Trinidad	32,820	15,859	2,105	24.36
Ubay	76,452	38,811	6,914	80.02
Sub-total	**324,100**	**178,812**	**26,173**	**303**
BIAD IV				
Anda	22,430	11,151	1,864	21.57
Candijay	38,834	22,286	3,038	35.16
Dimiao	18,012	8,605	1,122	12.98
Duero	21,066	11,702	1,553	17.97
Garcia Hernandez	27,382	14,098	2,430	28.13
Guindulman	35,204	18,630	2,440	28.24
Jagna	39,158	22,140	2,983	34.53
Valencia	31,133	14,863	1,924	22.26
Sub-total	**233,219**	**123,475**	**17,354**	**201**
BIAD V				
Batuan	14,895	7,910	1,066	12.34
Bilar	21,249	10,757	1,431	16.56
Carmen	49,686	25,420	4,614	53.41
Dagohoy	22,304	10,964	1,439	16.66
Danao	23,413	11,680	1,543	17.85
Pilar	33,071	16,253	2,126	24.61
Sagbayan	22,558	12,840	1,696	19.63
Sierra Bullones	32,585	16,479	2,247	26.01
Sub-total	**219,760**	**112,305**	**16,161**	**187**
Provincial Total	**1,480,700**	**864,638**	**149,291**	**1,728**

Table 3-21 Bohol Integrated Water Supply System Master Plan
Water Demand Projections Year 2020

City/Municipality	Projected Population	Total Served Population	Average-Day Demand	
			(cumd)	(L/s)
BIAD I				
Alburquerque	11,952	9,266	1,308	15.14
Antequera	18,543	10,411	1,415	16.37
Baclayon	21,933	13,619	1,981	22.93
Balilihan	23,910	14,002	1,875	21.70
Corella	8,375	4,851	720	8.33
Cortes	17,184	10,649	1,465	16.96
Dauis	42,499	30,504	4,716	54.58
Lila	14,139	8,438	1,152	13.34
Loay	20,200	12,953	1,816	21.02
Loboc	22,693	13,403	2,418	27.98
Maribojoc	22,993	21,059	3,064	35.46
Panglao	30,770	25,986	17,536	202.97
Sevilla	14,952	8,082	1,089	12.61
Sikatuna	9,054	8,485	1,115	12.90
Tagbilaran City (Capital)	112,924	107,277	32,688	378.33
Sub-total	**392,120**	**298,984**	**74,358**	**861**
BIAD II				
Buenavista	31,822	17,123	2,383	27.58
Calape	38,290	22,751	6,008	69.54
Catigbian	32,756	17,724	2,362	27.34
Clarin	24,418	14,855	2,231	25.82
Getafe	35,471	23,027	3,416	39.54
Inabanga	53,937	31,072	4,444	51.43
Loon	85,611	54,398	12,234	141.60
San Isidro	12,488	7,493	964	11.16
Tubigon	57,243	39,256	11,463	132.67
Sub-total	**372,036**	**227,697**	**45,504**	**527**
BIAD III				
Alicia	26,913	14,208	1,873	21.68
Bien Unido	31,361	24,125	3,786	43.82
Mabini	39,697	22,905	3,315	38.37
Pres. Carlos P. Garcia	23,755	14,223	2,000	23.15
San Miguel	29,677	15,707	2,075	24.01
Talibon	79,855	56,552	9,142	105.81
Trinidad	35,221	18,744	2,590	29.98
Ubay	82,046	45,911	8,455	97.86
Sub-total	**348,526**	**212,376**	**33,237**	**385**
BIAD IV				
Anda	23,665	12,963	2,252	26.07
Candijay	41,675	26,417	3,736	43.24
Dimiao	19,308	10,156	1,348	15.61
Duero	22,607	13,842	1,879	21.75
Garcia Hernandez	29,386	16,681	2,837	32.83
Guindulman	36,545	21,305	2,851	32.99
Jagna	42,023	26,205	3,737	43.25
Valencia	33,411	17,562	2,308	26.71
Sub-total	**248,621**	**145,132**	**20,947**	**242**
BIAD V				
Batuan	15,917	9,325	1,296	15.00
Bilar	22,803	12,725	1,730	20.02
Carmen	52,640	29,690	5,331	61.70
Dagohoy	24,175	13,092	1,755	20.31
Danao	25,546	14,043	1,896	21.94
Pilar	35,798	19,381	2,584	29.91
Sagbayan	23,949	15,032	2,036	23.57
Sierra Bullones	34,969	19,535	2,755	31.89
Sub-total	**235,797**	**132,823**	**19,383**	**224**
Provincial Total	**1,597,100**	**1,017,012**	**193,430**	**2,239**

Table 3-22 Bohol Integrated Water Supply System Master Plan
Water Demand Projections Year 2025

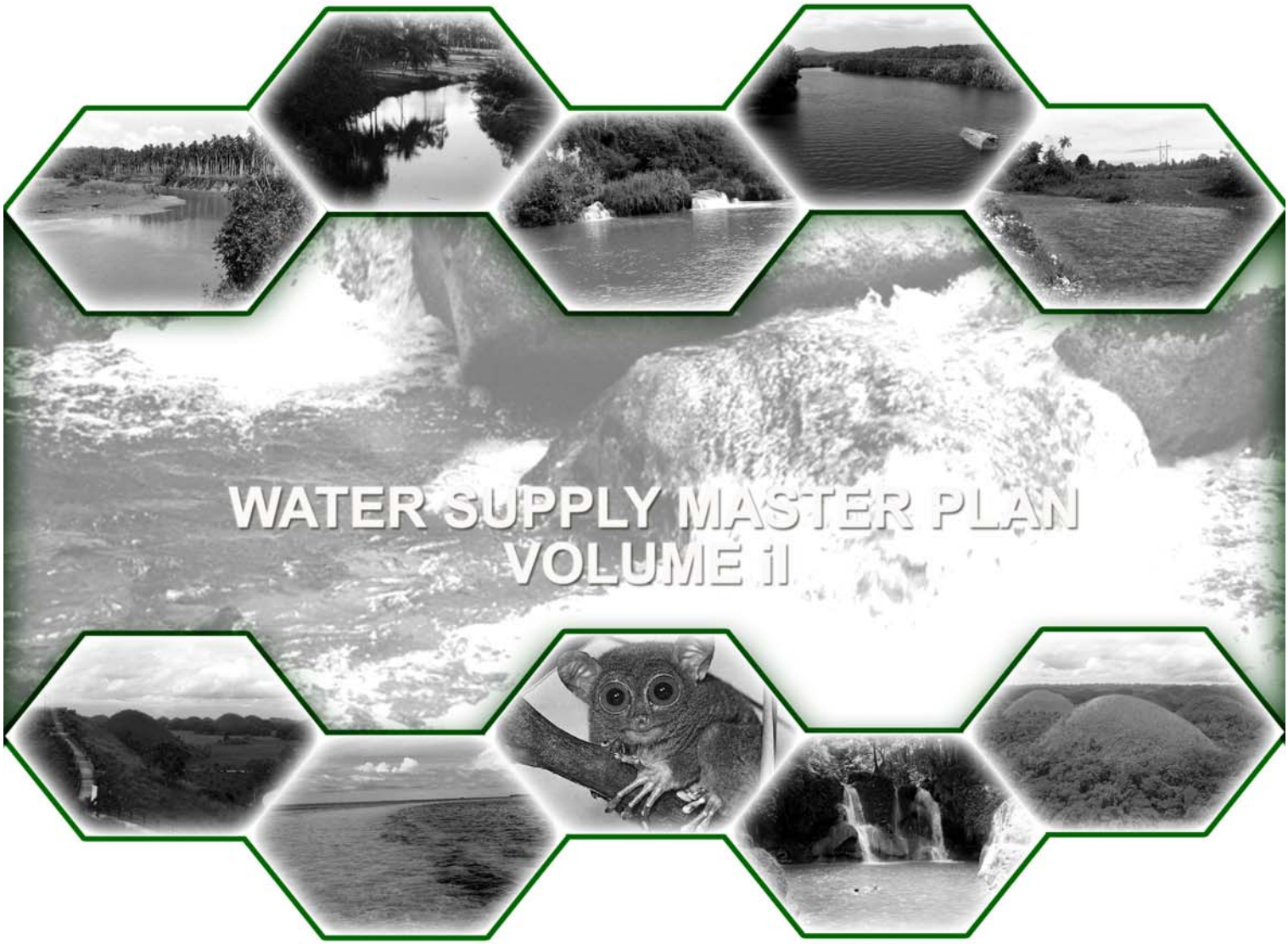
City/Municipality	Projected Population (Year 2025)	Total Served Population	Average-Day Demand	
			(cumd)	(L/s)
BIAD I				
Antequera	19,667	11,377	1,676	19.40
Balilihan	25,623	15,380	2,223	25.73
Corella	8,930	5,285	841	9.74
Sikatuna	9,636	9,031	1,273	14.73
Alburquerque	12,720	9,891	1,505	17.42
Baclayon	23,641	15,289	2,388	27.64
Cortes	18,240	11,717	1,740	20.14
Dauis	46,681	35,578	5,955	68.92
Lila	15,044	9,252	1,372	15.88
Loay	21,584	14,534	2,207	25.55
Loboc	24,392	14,803	2,913	33.72
Maribojoc	24,465	22,425	3,505	40.56
Panglao	33,074	28,054	18,365	212.56
Tagbilaran City (Capital)	121,566	115,487	35,703	413.22
Sevilla	16,098	8,902	1,301	15.06
Sub-total	**421,360**	**327,003**	**82,966**	**960**
BIAD II				
Catigbian	35,605	19,716	2,838	32.85
San Isidro	13,290	7,974	1,109	12.83
Calape	40,751	25,279	6,637	76.82
Clarin	25,920	16,333	2,629	30.42
Loon	97,115	64,650	14,776	171.02
Tubigon	61,319	44,880	12,930	149.65
Buenavista	33,125	18,212	2,727	31.57
Getafe	37,480	25,817	4,132	47.83
Inabanga	56,148	33,667	5,187	60.04
Sub-total	**400,755**	**256,528**	**52,966**	**613**
BIAD III				
Alicia	28,103	15,077	2,146	24.84
Mabini	42,755	25,688	3,989	46.17
Pres. Carlos P. Garcia	24,398	15,355	2,337	27.05
San Miguel	31,824	17,129	2,439	28.23
Ubay	87,318	50,467	9,897	114.55
Bien Unido	33,580	28,353	4,792	55.46
Talibon	86,215	65,640	11,080	128.24
Trinidad	37,485	20,318	3,018	34.94
Sub-total	**371,679**	**238,027**	**39,700**	**459**
BIAD IV				
Dimiao	20,529	10,961	1,567	18.14
Valencia	35,558	18,969	2,687	31.09
Anda	24,635	13,819	2,732	31.62
Candijay	44,353	29,767	4,551	52.67
Duero	24,060	15,220	2,234	25.85
Garcia Hernandez	31,274	18,407	3,375	39.06
Guindulman	37,743	22,601	3,267	37.81
Jagna	44,724	29,251	4,440	51.39
Sub-total	**262,875**	**158,997**	**24,852**	**288**
BIAD V				
Sagbayan	25,241	15,960	2,333	27.00
Batuan	16,874	10,288	1,546	17.89
Bilar	24,269	13,977	2,058	23.82
Carmen	55,375	32,329	6,196	71.71
Dagohoy	25,960	14,391	2,082	24.10
Pilar	38,396	21,277	3,059	35.41
Sierra Bullones	37,216	21,929	3,356	38.84
Danao	27,599	15,595	2,276	26.34
Sub-total	**250,931**	**145,745**	**22,905**	**265**
Provincial Total	**1,707,600**	**1,126,300**	**223,390**	**2,586**

Table 3-23 Bohol Integrated Water Supply System Master Plan Water Demand Projections Year 2030

City/Municipality	Projected Population (Year 2030)	Total Served Population	Average-Day Demand	
			(cumd)	(L/s)
BIAD I				
Alburquerque	13,435	10,479	1,600	18.52
Antequera	20,709	12,184	1,793	20.75
Baclayon	25,256	16,708	2,610	30.21
Balilihan	27,231	16,575	2,400	27.77
Corella	9,448	5,660	904	10.47
Cortes	19,219	12,597	1,878	21.74
Dauis	50,718	38,402	6,402	74.10
Lila	15,887	9,936	1,471	17.02
Loay	22,880	15,829	2,404	27.82
Loboc	25,995	16,018	3,129	36.22
Maribojoc	25,836	23,700	3,708	42.92
Panglao	35,246	30,029	18,685	216.26
Sevilla	17,181	9,743	1,429	16.54
Sikatuna	10,178	9,539	1,341	15.52
Tagbilaran City (Capital)	129,726	123,239	37,505	434.08
Sub-total	**448,945**	**350,639**	**87,259**	**1,010**
BIAD II				
Buenavista	34,303	19,405	2,910	33.68
Calape	43,043	27,354	6,961	80.57
Catigbian	38,326	21,772	3,141	36.35
Clarin	27,314	17,555	2,828	32.73
Getafe	39,334	29,222	4,694	54.33
Inabanga	57,742	36,164	5,596	64.77
Loon	108,601	74,190	16,609	192.24
San Isidro	14,038	8,423	1,167	13.50
Tubigon	65,147	49,411	13,679	158.33
Sub-total	**427,849**	**283,495**	**57,586**	**666**
BIAD III				
Alicia	29,185	15,941	2,279	26.38
Bien Unido	35,662	31,662	5,354	61.97
Mabini	45,644	28,657	4,461	51.64
Pres. Carlos P. Garcia	24,965	16,577	2,530	29.28
San Miguel	33,842	18,559	2,646	30.63
Talibon	92,241	73,050	12,312	142.50
Trinidad	39,593	21,904	3,259	37.72
Ubay	92,229	55,615	10,934	126.55
Sub-total	**393,360**	**261,965**	**43,775**	**507**
BIAD IV				
Anda	25,334	14,406	2,824	32.68
Candijay	46,848	32,453	4,971	57.53
Dimiao	21,664	11,762	1,687	19.53
Duero	25,413	16,373	2,409	27.89
Garcia Hernandez	33,033	20,226	3,728	43.15
Guindulman	38,811	23,938	3,468	40.14
Jagna	47,239	32,859	5,015	58.05
Valencia	37,558	20,370	2,889	33.44
Sub-total	**275,900**	**172,386**	**26,992**	**312**
BIAD V				
Batuan	17,762	11,075	1,669	19.31
Bilar	25,634	15,284	2,259	26.15
Carmen	57,885	35,093	6,625	76.68
Dagohoy	27,641	15,723	2,281	26.41
Danao	29,545	17,208	2,516	29.12
Pilar	40,839	23,221	3,345	38.72
Sagbayan	26,429	16,755	2,446	28.31
Sierra Bullones	39,309	24,525	3,763	43.55
Sub-total	**265,045**	**158,884**	**24,904**	**288**
Provincial Total	**1,811,100**	**1,227,369**	**240,516**	**2,784**

Table 3-24 Bohol Integrated Water Supply System Master Plan Water Demand Projections Year 2035

City/Municipality	Projected Population (Year 2035)	Total Served Population	Average-Day Demand	
			(cumd)	(L/s)
BIAD I				
Alburquerque	14,105	11,035	1,674	19.38
Antequera	21,683	12,795	1,888	21.85
Baclayon	26,782	17,783	2,773	32.10
Balilihan	28,744	17,536	2,534	29.32
Corella	9,934	5,964	950	10.99
Cortes	20,135	13,240	1,969	22.79
Dauis	54,587	41,528	6,900	79.86
Lila	16,676	10,458	1,544	17.87
Loay	24,097	16,745	2,547	29.47
Loboc	27,505	16,991	3,257	37.69
Maribojoc	27,119	24,897	3,901	45.15
Panglao	37,294	31,917	18,991	219.81
Sevilla	18,203	10,347	1,513	17.51
Sikatuna	10,685	10,015	1,405	16.26
Tagbilaran City (Capital)	137,428	130,556	39,206	453.77
Sub-total	**474,977**	**371,807**	**91,052**	**1,054**
BIAD II				
Buenavista	35,391	20,067	3,014	34.89
Calape	45,189	28,839	7,186	83.18
Catigbian	40,912	23,296	3,359	38.87
Clarin	28,618	18,452	2,969	34.37
Getafe	41,062	30,673	4,936	57.12
Inabanga	58,780	36,961	5,723	66.24
Loon	119,897	82,252	18,154	210.11
San Isidro	14,738	8,843	1,219	14.11
Tubigon	68,747	52,443	14,178	164.10
Sub-total	**453,332**	**301,826**	**60,738**	**703**
BIAD III				
Alicia	30,186	16,515	2,356	27.27
Bien Unido	37,619	33,691	5,704	66.02
Mabini	48,372	30,493	4,746	54.93
Pres. Carlos P. Garcia	25,486	17,007	2,605	30.15
San Miguel	35,741	19,634	2,801	32.42
Talibon	97,940	78,059	14,214	164.51
Trinidad	41,567	23,039	3,429	39.69
Ubay	96,827	58,586	11,511	133.23
Sub-total	**413,738**	**277,026**	**47,366**	**548**
BIAD IV				
Anda	25,789	14,699	2,866	33.18
Candijay	49,183	34,260	5,261	60.89
Dimiao	22,726	12,358	1,767	20.45
Duero	26,680	17,239	2,533	29.31
Garcia Hernandez	34,680	21,312	4,103	47.49
Guindulman	39,795	24,607	3,572	41.34
Jagna	49,594	34,652	5,294	61.28
Valencia	39,430	21,418	3,040	35.18
Sub-total	**287,878**	**180,546**	**28,435**	**329**
BIAD V				
Batuan	18,591	11,637	1,752	20.28
Bilar	26,912	16,097	2,375	27.49
Carmen	60,218	36,634	6,857	79.36
Dagohoy	29,225	16,664	2,420	28.01
Danao	31,387	18,333	2,682	31.04
Pilar	43,138	24,587	3,551	41.10
Sagbayan	27,535	17,502	2,558	29.61
Sierra Bullones	41,269	25,900	3,977	46.03
Sub-total	**278,275**	**167,354**	**26,172**	**303**
Provincial Total	**1,908,200**	**1,298,559**	**253,762**	**2,937**



CHAPTER 4
WATER RESOURCES

CHAPTER 4 – WATER RESOURCES

4.1 GENERAL

An understanding of the physical system and its interaction with the environment is a prerequisite for an effective planning and management of water resources. In line with this, an appraisal of the physiography which includes the topographical, geological and hydrometeorological aspects of the province is presented in this report. Contained herein are information on the source, extent, quantity of water and its availability and dependability for future exploitation.

Appraisal of the future use of the available surface runoff for future water supply for the province of Bohol is presented in this report. Also, contained herein are information on the existing water related infrastructures and a map study on the hydropower potential in the province.

Likewise, associated elaborations and analysis are also included in this context.

4.2 PHYSIOGRAPHY

4.2.1 Geological Profile

General Geology

Geologically, majority of the Province of Bohol is largely characterized with the prevalence of limestone rock units covering almost the entire western and southern Bohol, which creates one of the longest limestone chains in the Philippines. The large deposit is generally formed from several marine sedimentations under continuous recession of the sea and is generally composed of limestone formation consisting of layers with various porosity and permeability. The upper layer is chiefly composed of coralline materials and/or contained shells of sea creatures, which is generally brittle but massive in occurrence. The coralline limestone layer generally exhibits dirty white to buff in colours.

Topography of the entire island under limestone deposition is generally karstic and is highlighted and indicated with the occurrence of numerous sinkholes, caverns and solution channels. This rock unit of the limestone formation may represent the older layer, which have been subjected to persistent chemical weathering. Fractures, which have already developed have been invaded consistently with water to form solution cavities and other crevices.

Soil cover within the study area is relatively thin and generally contains gravely to cobbly fragments of limestone with considerable amount of clay and other fine-grained derivatives. A karstic terrain is basically made up of limestone from a former coral reef. After the uplift of the limestone formation and/or sea level decline, the contact surface has been exposed to agents of weathering such as rain water. The infiltration of rain water then caused the parts of the limestone to be dissolved creating solution channels which we now know as caves.

The portion of Bohol where the so-called Chocolate Hills are found is said to be at the late (advanced) stage of karst development. Other portions of the province underlain by the same limestone formation but not showing prominent hills are either at the early stage or mid-stage of karst development (chemical weathering).

The oldest rock formations in the province may be aged to Cretaceous and may include igneous and/or metamorphic rocks. These are the Alicia Schist and Bohol Ophiolite.

Tertiary rock formations include Ubay Volcanics, Talibon Diorite, Jagna Andesite, Ilihan Plug, Kabulao Conglomerate, Wahig Limestone, Carmen Formation, Sierra Bullones Limestone and Maribojoc Limestone.

The youngest deposits of the limestone formation where numerous haycock mounds around the Carmen area are prevalent formed part of the Pleistocene deposition.

Quaternary alluvial deposits consisting mainly of admixtures of clay, silt, sand and gravel can be found along the northwest and northeast coast of the province and along major drainage lines of the island.

The geologic map of the entire island of Bohol is shown in **Figure 4-1.**

Stratigraphic Sequence

A stratigraphic correlation of the entire island of Bohol is discussed below arranged in their order of decreasing geologic age:

Alicia Schist (Cretaceous)

Previously grouped with the Basement Complex that constitute the oldest formation in the island, this north-south trending elongated mass of foliated rocks are best exposed in the town of Alicia. This formation expands to an area of about 15 km by 5 km and restricts its occurrence in the eastern region of the island.

The schists are light green to light grey, sheared along lines of foliation and vary in composition into amphibolite made up of banded plagioclase and hornblende. Lithologic composition of this formation correlates roughly to the Tunlob Schist of Cebu.

Bohol Ophiolite (Cretaceous to Paleocene)

An ophiolite complex consisting mainly of dunites, massive layered gabbro, diabase dike complex, pillow basalt flows and the associated sediments, the formational sequence occurs in the south-eastern Bohol. The highly tectonized ultramafic to mafic sequences were also observed along roadcuts in Tabunok, Guindulman. Further observation of the entire sequence reveals that sedimentary rocks were found sitting on pillowed lava flows of basalt. In another cases, two (2) major thrusts were observedwithin the pillow lava and tuffaceous mudstone. Basalt and diabase dikes are also common to cut each other rock units.

A probable Cretaceous to Paleocene age is assigned to the Ophiolite Complex.

Ubay Formation/Volcanics (Eocene)

Consists mainly of heterogenous mass of volcanic flows of dacite, andesite, basalts and agglomerates and minor gabbro and diabase, the entire formation is uncomformably overlain by the Jetafe Andesite, Wahig Formation and Carrmen Formation.

The volcanic rock sequence covers the wide area of Northern Bohol from Jetafe, Talibon, Trinidad and Northern islets of the main Bohol over 600 km2 in area. Andesites predominate the Jetape and Talibon areas whereas basaltic rock units become prevalent in Talibon.

Getafe Andesite (Eocene-Oligocene)

The rock unit generally varies in composition, which ranges from fine-grained hornblende andesite to porphyritic andesite. It is closely associated with the Talibon Diorite.

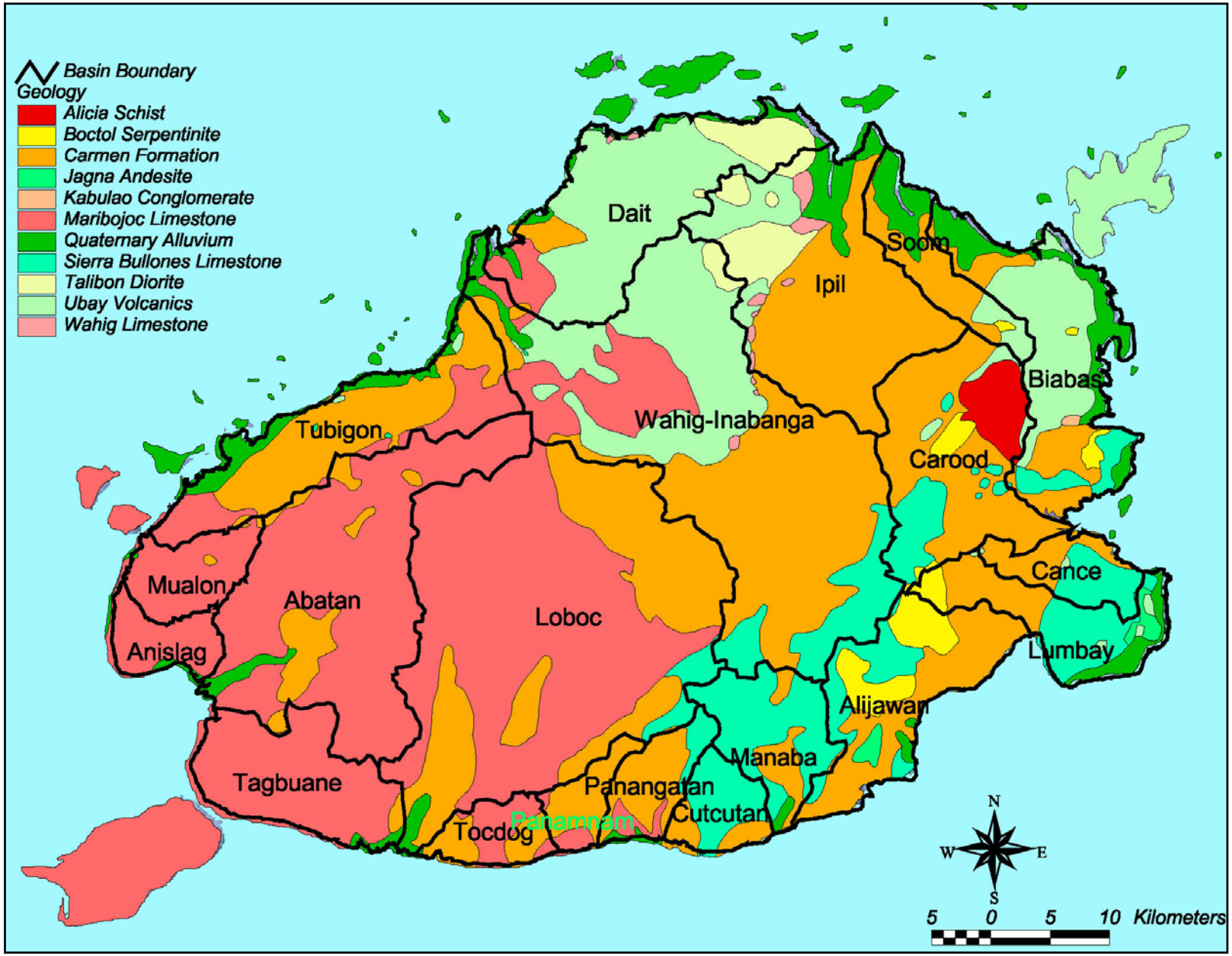


Figure 4-1 Geologic Map

Exposed in southeast Getafe, the andesite is described as coarse-grained hornblende andesite and andesite porphyry and it conformably overlies the basaltic wackes of the Ubay Formation. It is however, intruded by the Talibon Diorite. An Eocene to Oligocene age may be inferred for this rock unit

Talibon Diorite (Eocene-Oligocene)

The main Diorite body is sparsely distributed in northern Bohol and intrudes the Ubay Volcanics and Jetafe Andesite. Best exposed in Baboy and Bagacay, Talibon, the diorite exposures occupy a total area of 27 km^2 as it follows the northeast trend.

The main diorite exposure is probably correlative to the diorite intrusives at Talisay-Miglanilla area in central Cebu and age may be considered within the Eocene-Oligocene.

Ilihan Shale (Ealy Oligocene)

The Ilihan Shale was named after its exposure was first known in Ilihan Sur, south of Tubigon. The rock unit is uncomformably overlain by the Carmen Formation and may be considered in close association with the shale members.

The Ilihan Shale consists of interbeds of sandy tuff and hard calcareous volcanic rubble beds. The predominant shale is cream to buff and is fractured and indurated.
Jagna Andesite (Late Oligocene)

Earlier designated as Andesite Breccia, the Jagna Andesite consists mainly of massive phenocryst of plagioclase set in a glassy matrix. The notable exposure can be found 2 km north of Jagna proper, Ilihan Sur in Tubigon and around the Anda Peninsula.

The towering plug-like structure observed and exposed about 5 km south of Tubigon is considered a member of the entire formation. Reaching to an elevation of 249 meters above mean sea level, the rock is essentially composed of hornblende, biotite and opaque ores.

Stratigraphic correlation may be referred to the Bulalacao Andesite breccia of central Cebu and K-Ar dating indicates late Oligocene age of emplacement.

Wahig Formation (Early-Middle Miocene)

The entire formation consists mainly of limestone from its typical occurrence along gorges of the Wahig River, and it includes the basal conglomerate.

The limestone is well-bedded, massive, cream to buff with interbeds of conglomerate. The lower part of the formation consists of pebbles to boulders of volcanic clasts cemented by silty to sandy matrix. On the other hand, the upper member is apparently capped by agglomerates.

Carmen Formation (Middle Miocene)

The formation was originally referred to the rock units of Carmen Sandstones and Shales in relation to its first discovery in the town of Carmen. The Carmen Formation was found uncomformably overlying the Ilihan Shale and Ubay Formation. Most of the rock units are however, covered apparently by the Maribojoc Formation consisting mainly of limestone unit. Along the Mahayag-Danao road, the rock unit rests over the limestone bed of the Wahig Formation.

The Carmen Formation is divided into three (3) members, namely, Anda Limestone Member, Lumbog Volcaniclastic Member and Pansol Clastic Member. The Anda Limestone used to

interfinger with the Pansol Member, which is generally characterized by thinly bedded calcareous sandstone, siltstone, shal and conglomerate with basalt to andesite clasts set in andesitix matrix.

A Middle Miocene age was apparently assigned to the Carmen Sandstones and Shales.

Sierra-Bullones Limestone (Late Miocene)

The rock unit consists mainly of rubbly limestone, rubble breccia, medium to thick biocalcarenite beds and reefal limestone beds is notably exposed in the mountain range east of Sierra-Bullones. It is generally porous, cream to buff in colour with lenses of calcarenite.

The limestone member is correlative to the Lower Limestone Member of the Barili Formation of Cebu.

Maribojoc Formation (Pliocene)

The Maribojoc Formation was designated by most of the geologists as the youngest limestone unit that blankets the western part of Bohol and all the other islets fringing the mainland. It consists mainly of three (3) members, namely: Tubigon Conglomerate, Sevilla Marl and Cortes Limestone.

Tubigon Conglomerate

Originally mapped as part of the Carmen Formation, this member is composed of Tuffaceous conglomerate, sandstone, tuff beds and flow breccia and is typically observed along road cuts in the town of Tubigon.

Sevilla Marl

This middle member is best described as tuffaceous dirty white and fossiliferous layer of marl, which can be found in Sevilla, Loay, Corella, Lila, Balilihan, Loboc and Sikatuna. Pliocene in age, its stratigraphic contact with the overlying Cortes Limestone Member is gradational to comformable where the limestone overlaps with the marl. The marly facies are often inserted with occasional limestone interbeds and shale layers.

Cortes Limestone

Widely exposed in the area of Batuan and the rest of the southwestern Bohol around the Tagbilaran and Cortes, the limestone unit under this member occurs as cappings to the older formations in the entire Bohol. It represents the upper or younger member of the Maribojoc Formation thus, may be considered as the youngest limestone body in Bohol. The Haycock mounds of the famous Chocolate Hills are also believed part of the Cortes Limestone.

In general though, the limestone is chalky, non-compact, marly and coralline with varying hues from cream to brownies yellow or sometimes buff. It is characterized by the occurrence of numerous caverns and sinkholes and is poorly bedded. Late Plioce to Pleistocene age was postulated for this rock formation.

Geologic Structures

Mines and Geo-sciences (MGB) have identified several faults in the south-western, south-eastern, and central portions of the island of Bohol. In the south-eastern section, covering the municipalities of Anda, Guindulman and Duero thrust faulting and strike slip faults (right lateral) are apparently observed.

Within the vicinity of Mt. Malibalibad (eastern part of Bohol), thrust faulting also occurs in several exposures. Block faulting with a probable extensional origin can be observed in the municipalities of Danao (central Bohol); Balilihan, Cortes, Loboc (southwestern) and the western portion of Bohol (near Cabulao island).

Vertical joints are common features in the eastern rolling portions portion of Bohol (Mabini, Alicia and Ubay) having a NW-SE strike. Other joints in the area have dip directions of NW, SE and SW. In the northwest portion of Bohol (Clarin and Inabanga) vetical joints have a NE-SW strike and joints with a SE dip direction.

Many anticline and syncline structures can be delineated across the whole province.

Geotechnical Features of River Basins

The geotechnical investigation of the study area covered the surface geologic field verification of all the major river systems of the island province. The rock exposures along every river system were closely examined and were correlated with the available lithologic logs of wells and few borehole data in order to establish the stratigraphy of the entire Bohol Province.

The prevailing geotechnical features and other related geologic environments of the major river systems in the study area are presented in **Table 4-1**.

Groundwater Framework

Groundwater Utilization

Wells drilled within the combined deposits of the recent alluvium and younger limestone beds of the Maribojoc Formation are formed within the Tagbilaran City area and immediate municipalities. Depths of these wells have hardly reached more than 90 meters as depicted in the Bohol Water Utilities, Inc. (BWUI) wells and other water supply wells in the area. While other subdivisions draw their water from wells shallower than 60 meters in depth, the rest of the residents relies their water supply from the individual household shallow tube wells tapping the alluvium of the water table aquifer and from the numerous springs. Water from shallow depth of about 18 meters is already available from wells close or adjacent to the coastal banks and immediate flood plains of the study area.

The more than twenty (20) wells operated by BWUI for the City of Tagbilaran and nearby municipalities have a combined groundwater abstraction of about 13,000 m^3/d (13 MLD). For the Tagbilaran City Water Works, about 30% (4,400 m^3/d) of what BWUI is producing accounts for the other serviceable area of the city. Old records of the performance of most of these wells revealed that the highest discharge registered in one well was about 37 L/s to pumping (2005). For the other wells, the increase in the production can probably be attributed to the apparent increase in the pump capacity of each well as can be noted from the corresponding increase in the setting of each pump unit.

Elsewhere around the entire province, the yield of deep wells does not correspond with the depths they were represented so that its depth is not a direct function of the discharge. In other relatively shallower wells, the discharges are even much higher than the deeper ones. In general though, the depth of shallow groundwater utilization does not exceed 20 meters. For deepwells, the ranging depth of 40 to 80 meters accounts for most of the medium-scale groundwater extraction.

Table 4-1 Geotechnical Features of Surface Water Sources in Bohol Province

Name of River	River Geology	Watershed Geology	River Geotechnical Features
Abatan River	Limestone bed; coralline and brecciated.	Inambakan Falls - semi-consolidated limestone; coralline and brecciated - thin weathering (soil cover) of limestone unit envelops the karstic slopes of the area.	With numerous solution channels. Thin mantle of soil generally makes the river channel free from heavy sitation.
		Mag-Aso Falls - semi-consolidated limestone; coralline and breccated. - weathered limestone makes up the rolling topograhy of the area.	River channel is devoid from unconsolidated materials except for intermittent pockets of clay from the weathering of limestone unit. Moderatly thick soil cover is relatively stable even on high-angle slopes.
		Niluksuhan Falls - semi-consolidated limestone; sinkholes and solution channels are exposed to continuous chemical attack of water. - thin weathering (soil cover) of limestone unit envelops the karstic slopes of the area but thicker clayey soil dominates the plain area.	Small quantity of clayey materials often occupies the river channel. Lagoons and pools are often formed along river channel. Weathered limestone appears stable even on high-angle cuts.
Loboc River	Interbedded shale and conglomerate with limestone intercallations along moderately low slopes. Upstream is dominated with bouldery limestone floats while the downstream sections are covered with gravelly to sandy fragments of shale and conglomerate.	Ewok Area - Interbedded limestone and conglomerate units. Thick weathering of limestone is exposed to steep slopes. - The conglomerate/shale series are relatively consolidated with slight to moderate weathering.	Weathered limestone is relatively stable even on steeper slopes. River channel is often covered with sand and gravel materials. Continuous weathering of shale makes the river channel silted during heavy rains.
		Hanapol Area - Fractured and brecciated limestone unit with interbeds of siltstone and shale.	Numerous deposits of limestone boulders along the river channel as a result of mechanical weathering of fractured limestone upstream. Small amount of shale makes the river channel slightly silted during heavy rains.

Name of River	River Geology	Watershed Geology	River Geotechnical Features
Wahig-Inabanga River	Moderately weathered limestone unit at downslope sections of the river. Upstream sections are dominated with volcanics (basalt and agglomerates). Small amount of sand and gravel materials occupy the mid-stream section.	Hard and massive basalt and agglomerate rocks with minor intercallations of andesites. Thin weathering mantle (soil) on higher elevations and becomes thicker within the rolling and plain areas.	Moderately heavy siltation during heavy rains. Highly weathered volcanics are relatively stable on open cuts.
Ipil River	Shale/sandstone/conglomerate series. Silty sand dominates the river channel of considerable amount.	Interbeds of sandstone, shale and conglomerates of the Carmen Formation. Lenses and interlacallation of tuff is noticeable along road cuts.	Excessive weathering of shale beds makes the river channel silted during rainy season. Highly weathered rock units of this formation are relatively stable even on steep angle cuts.
Carood River	Cyclic layers of shale, siltstone and lenses of conglomerate. Intercallation of limestone beds are often noticeable upstream of the river system.	Shale/siltstone/conglomerate series of the Carmen Formation. Thick weathering mantle from the sedimentary units occupies the lower elevations.	Minor amount of silt/sand and gravels reveals that slight siltation occurs during periods of high flow.
Manaba River	Interbedded shale and conglomerate with major limestone intercallations.	Upstream sections are underlain with massive limestone beds. Lower sections of the stream are civered with sedimentary series of shale, siltstone and conglomerate.	The moderate amount of sand-gravel materials along river bed indicates slight siltation during heavy flow of water. Limestone floats of gravelly sizes are often noticeable. The sedimentary series are stable even on steep angle cuts.
Alijawan River	Marly limestone and brecciated beds.	Highly weathered limestone prevails on higher elevations while shale/siltstone/conglomerate interbeds dominate the downstream stretch of the river system.	Highly weathered limestone units often result to slumping and minor soil erosion during heavy rains. Considerable amount of silt/sand and gravel occupies the river channel.

Groundwater Occurrence and Movement

Under natural condition, the topography exerts considerable influence on the flow of surface water in a basin. Where the slopes are steep, the flow is rapid. Water also moves away from the ridges to valleys, gullies and plain areas. Soil and vegetation equally exercise some control on the surface flow and infiltration of water into the ground and subsurface.

The recharge to the groundwater system in the whole Island of Bohol originates mainly from the direct infiltration into the porous limestone surface and from the surface flow in the central highlands. Intermittent recharge also occurs as seepages from few networks of intermittent streams that occupy the whole island during periods of high flow.

Groundwater within the identified basins and river systems of the study area are mainly stored within the permeable layers of the limestone formation and other coarse-grained sedimentary rock units. Cyclic thin layers of clay beds form part of the aquifer system. However, sufficient thickness of these impermeable layers to act as confining beds to the more porous and permeable units of the limestone formation will apparently put the groundwater occurrence under artesian condition or semi-confine state. In general though, the groundwater would necessary occur under the water table condition so that available groundwater reservoirs can be found close to the surface under saturation from the direct infiltration and replenishment.

The relatively higher discharge in wells in most of the western and south-western parts of Tagbilaran City is generally compensated by the greater amount of recharge it receives from the eastern highlands. For the southern coastal areas, the groundwater potential is directly expressed by the presence and occurrence of numerous springs, which serve as conduits for the migration of groundwater from the central highlands to the lower elevations. The same nomenclature may be observed in some parts of the highlands and western slopes of the province.

Groundwater Levels

The true static water levels in wells around Tagbilaran City and the remaining municipalities in mainland Bohol are extremely difficult to obtain as most of the relatively high-capacity wells have not given sufficient time to recover to their original levels because they are utilized continuously. In other instances, most of the wells are not provided with access holes for water level measurements.

Judging from the records of some BWUI and Tagbilaran City Water Works wells, the depth to water levels within the city area and immediate municipalities seemed moderate in occurrence and is in the high range from 11 meters to 45 meters below ground surface during measurement in summer of 2006. On the other hand, the recently recorded levels of summer of 2007 have produced a deeper range starting from 35 to 61 meters below the ground level. The groundwater condition under the range of water level corresponds to the occurrence of groundwater under water table condition or semi-confined state. Elsewhere, the groundwater around the area with deep water levels and in large scale, the entire Tagbilaran City, would necessary occur under the artesian condition because of the apparent presence of clays, which act as confining layers in the restriction of the upward movement of groundwater.

A review of the recent water level records (2006) of some wells in the entire Tagbilaran have revealed a general trend of declination from eastern highlands to western coast and it generally conforms to the topography of the area. Where the water levels of the wells (west coast) considerably dropped below mean sea level (-2.00m), water abstraction have already tended to invite saline and corresponding inferior quality of water to pumping.

A picture of the water levels in wells around Tagbilaran City reveals that the shallow water levels in the north-eastern section of the city is reflected by a local recharge in-place whereas, the deeper water levels at the central section conforms with the relatively greater discharge from wells. In general though, the general configuration of the trend of water levels conforms essentially to the partial replenishment from the eastern highlands of Tagbilaran City. The apparent steep gradient towards the center of the city and probably steeper further west to the outflow areas indicates the considerable heavy abstraction of groundwater is being experienced by most of the wells surrounding the area.

The water levels in wells surrounding the western coastal areas of the province may be patterned from the apparent groundwater movement around the Tagbilaran City and Corella. In this case, the movement of water in the area of study may become distinct towards the western lowlands – that is the groundwater is apparently discharging on an east to west trend/fashion. The hydraulic trend for the rest of the area under groundwater utilization is a direct function of the elevation. The groundwater apparently moves towards the lowlands and plain areas.

Aquifers

The available aquifers or water-bearing formations in the entire Bohol Island are the moderately thick layers of permeable limestone rock units and the unconsolidated Alluvium. The existence of these limestone layers as described in some of the lithology of some wells may correspond to the relatively soft limestone layers, which are porous and permeable. The aquifer system of the limestone rock units as a whole may indicate lesser degree of permeability in some sections because of the occurrence of clay and silt interbeds in the entire sequence.

Evaluation of the available lithologic logs of wells in Tagbilaran City and nearby municipalities revealed that the cumulative thickness of the supposed permeable layers of the limestone aquifers comprised roughly 40% of every sectional deepwell at a depth of nearly 30 meters or more.

Under natural condition, the groundwater reservoirs in the southern coastal area of Bohol, including Tagbilaran City and Panglao Island, are usually recharged perennially by direct infiltration into the porous and permeable beds of the limestone formation. Precipitation on the outcropped slopes around the foothills and highlands from the identified water divide, on the other hand, will benefit the northern and southern plain areas where notable drainage area may be considered. The supposed permeable beds of the limestone unit due to inherent presence of sinkholes and other crevices/fractures serve as recharging points for the water to infiltrate into the deeper aquifer of the northern and southern lowlands. Intermittent recharge also occurs as seepages from several networks of streams that occupy the relatively moderate catchment basins during periods of high flow.

In general though, the only available aquifers or the water-bearing formation in the area of Tagbilaran-Panglao area are the porous and permeable beds and/or lenses of the limestone rock formation. Where notable perennial creeks and rivers are present within the surface drainage system, the expected aquifers would be saturated with water under water table condition. Under certain restrictions in the topography and drainage system of the area, the populated center of Tagbilaran will rely on the limited available groundwater deposit in the limestone unit and/or within the relatively thin mantle of the Alluvium.

In the northern parts of the province where relatively impermeable rock units predominate, the available groundwater is formed from the relatively thick accumulation of the recent alluvium and other unconsolidated materials. In other parts of the mainland island, the groundwater occurrence is expressed in the presence of numerous springs.

Springs

There are several spring sources that have long time been identified and developed in the entire area of Bohol Province. Most of these springs are being utilized for irrigation purposes. In other manner, some of the high-yielding springs served as the reliable source of water supply to residents close to the corresponding source. Some of the springs with notable discharges are investigated and verified in the field and the origin of deposition and geologic environments attached to their occurrence are summarized in **Table 4-2**.

Continuous flows of water from majority of the springs identified are generally fed by seepages from the apparent fractures and of the rock layers of the limestone bed and/or lines of weaknesses of the sedimentary rock units. In another manner, the limestone layer because of the inherent presence of solution channels and other crevices, considerable volume of water is also retained in the instertices and between openings of the rock mass and thus, contributes to the continuous flow into the surface to form springs. In other cliff-forming and wall-like elevated areas of the city, prospective spring sources may still be tapped but the discharge of the captured water may not be sufficient for reliable water source development.

Water Quality

In the entire coastal aquifer of Bohol Province, groundwater quality in wells often becomes an issue in terms of salinity scale. It is the amount of inorganic salts found in solution of water and is expressed as the Total Dissolved Solids content (TDS) in mg/L. In another way, it can be expressed indirectly as a measurement of electrical conductivity (EC) in micro-Siemens/cm.

The limestone aquifers of the Maribojoc Formation and other younger limestone beds under natural chemistry environment exhibit high calcium and bicarbonate ion contents so that the general quality of pumped groundwater in the coastal aquifer of the whole Bohol Island is extremely high in hardness. On the other hand, the quality of groundwater for the alluvium does not differ much from that of the limestone aquifers because the alluvium aquifer immediately overlies the limestone and apparently serves as collector of water for the deeper limestone aquifer.

The increased nitrate contents of pumped water in the study area may apparently indicate the widespread contamination and pollution from agricultural activities, septic tanks and sewers. The contamination in the groundwater is enhanced by the prevalence of fissures and porous strata of the limestone as observed in northern and southern areas where reported increased in the concentration of nitrates is being derived.

A review of the water quality records of some wells around Tagbilaran City and the nearby municipalities would reveal that the general character traits of groundwater are almost within the National Standards for Drinking Water except for few wells which bear certain increase in the TDS due to the apparent increase of concentration of the carbonate contents in water.

Two (2) major springs, Badiang and Sagnap, were tested for water quality. The results of the laboratory analysis of water conducted on the two (2) sites are presented in **Table 4-3**.

Table 4-3 indicates that Badiang and Sagnap Springs has water quality within acceptable range, which would require no special treatment except disinfection. Constituents such as total dissolved solids, total suspended solids, chlorides, iron and manganese are within normal limits. The high COD value of 25 mg/L and 20 mg/L of Badiang and Sagnap springs, respectively, maybe attributed to dissolved minerals present in the rock formation. A series of tests of the water have to be conducted to determine the suitability of the two (2) springs as water supply sources.

Table 4-2 Spring Sources Geology and Occurrence in Bohol Province

Name of Spring	Location	Coordinates		Estimated Discharge (L/s)	Occurrence and Geology	Remarks
		Latitude	Longitude			
Badiang Spring	Valencia	09-35-56	124-14-07.6	120	Sub-terranean water ways within the marly limestone bed that emanate from the outlets that intersect the land surface close to the sea shore at elev. 14.80 m amsl.	Main source of supply of resort/ swimming pool. Two (2) outlets are with intake structures for water supply of the residence in the immediate vicinity.
Tiguis Spring	Tiguis, Lila	09-35-28.1	124-04-44.8	500	The spring emanates from a series of outlets within the marly limestone that intersect the land surface near the shore. Tapping points are concentrated within the toes of the limestone slopes at elevation close to 30 m amsl.	Used for irrigation and Barangay Water Supply.
Logarita Spring	Bilar	09-42-14.8	124-06-59	120	The main outlet emanates from a cavernous fractured limestone bed at an elevation of 32 m amsl. It occurs as subterranean water way that cut across the vertical wall of the fractured and brecciated limestone.	Used for irrigation and water supply source of Logarita Resort. Irrigation structures are being used since 1954.
Sagnap Spring	Sn. Vicente, Pilar	09-49-15.51	124-22-52.1	400	Occurs as subterranean river that cut across the land surface from the vertical wall of the fractured limestone bed. Two (2) main outlets are formed with solution channels of more than a meter in diameter at an average elevation of 340 m amsl.	Mainly used for irrigation (450 has) by Sagnap-Catagdaan-San Carlos CIP of NIA. About 40 L/s of water is also taken for water supply source of nine (9) barangays in the lowlands of Pilar.
Wadang Spring	Celing, Antequera	09-47-30.9	123-53-35.2	50	Occurs as seepage from the fractured but massive limestone bed at an elevation of 270 m amsl. The outlet is formed by a main solution channel that intersects the ground surface.	Mainly used for irrigation.
Celing Spring	Celing, Antequera	09-47-06.8	123-53-27.4	60	The spring mainly occurs as ground emanation with few arms from the cavernous limestone that intersect the land surface. It is generally formed as subterranean pool water from a large solution channel across the vertical wall of the fractured limestone.	Mainly used for irrigation and minor amount goes to local residents of the area for water supply consumption.

Name of Spring	Location	Coordinates		Estimated Discharge (L/s)	Occurrence and Geology	Remarks
		Latitude	Longitude			
Ubojan Spring	Antequera	09-46-53.5	123-52-24.4	75	Occurs as seepage from the fractured and bedded limestone. The outlet is formed by a deep pool of water, which serves as impoundment for the domestic water supply source and irrigation. Elevation of free-flow water is within 124 m amsl.	The captured water is impounded within the cemented reservoir by NIA.
Loktob Spring	Loboc	09-38-51.1	124-01-27.5	80-100	Occurs mainly as surface water from a tributary creek of Loboc River. Discharge is probably enhanced from the supplementary supply of spring water that emanates from the gullies across the creek. Emanation is visible within the fractured limestone bed.	Mainly used for water supply source of Loay and Loboc municipalities.

Table 4-3 Water Quality Data of Badiang Spring and Sagnap Spring

Constituents	Unit	Badiang Spring	Sagnap Spring
Date of Sampling		10-Sep-07	10-Sep-07
pH		7.36	7.1
Color	PCU	5	10
Turbidity	NTU	0.8	3
Chemical Oxygen Demand	mg/L	**25**	**20**
Total Suspended Solids	mg/L	13	16
Total Dissolved Solids	mg/L	283	250
Chlorides	mg/L	4.4	2.4
Nitrate Nitrogen	mg/L	0.37	0.29
Phosphate P	mg/L	0.005	0.005
Total Hardness	mg/L	262	222
Total Alkalinity	mg/L	228	202
Total Acidity	mg/L	5.9	7.9
Sulfate	mg/L	1.8	7.7
Iron	mg/L	0.09	0.17
Manganese	mg/L	0.06	0.06

Saline Intrusion

The water levels in wells around the western Tagbilaran and other coastal municipalities of Bohol roughly correlate to the existence of saline water contamination. Where the levels are deep and almost lower than the level of the sea, apparent increase in the salinity scale of pumping water is being experienced.

Groundwater Availability

The groundwater potential in the entire study area is directly reflected from the geology of the island of Bohol Province. Only four (4) geologic units and environments of the study can be attached to the groundwater availability of Bohol Island, and these are:

a) North-western and North-eastern Coastal Alluvium

The alluvial areas in the north-western part covering the municipalities of Calape, Tubigon, Clarin, Inabanga and Buenavista are mostly formed by the younger relatively soft limestone, which are porous. Shallow wells formed in the Alluvium of this type do not exceed 20 meters in depth.

The relatively thinner mantle of the Alluvium from the weathering of the volcanics is available in the north-eastern plains of the Trinidad and Ubay municipalities. Extended depth (80 meters) to deeper aquifer was noted in one (1) deepwell in Ubay but utilization of the well appears relatively poor in its discharge potential. The depth to shallow tubewells is commonly limited to 18 meters and produces water to pumping intended for individual household consumption only.

b) Limestone Formation

The younger Cortes Limestone appears heavily used in the western Tagbilaran and around the areas of Cortes, Baclayon and Corella. Moderately high transmissivity values have been registered in some wells in the city with depths not exceeding 80 meters. Solution and cavernous features are common which may be subjected to saline intrusion/invasion and pollution.

c) Central Limestone Formation

Occurs as cappings to the older limestone beds in the central highlands of the Province, the formation is generally porous and indicates the presence of sinkholes, caverns and solution channels along the lines of sinks of the area. Fractures, which have already been developed in the rock formation have been invaded consistently with water to form solution cavities and other crevices which have often resulted to the occurrence of numerous springs in the area.

The areas where springs have notable discharges cover the municipalities of Pilar, Bilar, Antequera, Valencia, Lila and Loboc.

d) South-western Limestone (Saline Intruded Area)

Saline contamination of groundwater has long been felt in the coastal areas of eastern and south-western parts of Bohol, particularly in Tagbilaran-Panglao area way back in the early 1900s, where urbanization proliferated to meet the then increasing demands of water.

The contamination and sea intrusion of salt water into the coastal fresh aquifer of the area was initially caused by the continuous decline in water levels of wells in heavily pumped areas. Having already affected the upper aquifers (desaturation), it was further aggravated by the drilling of new wells by private users around the area with poor well construction techniques attached to it. The well itself serves as a conduit for the salty water to move downwards and allow the still fresh water aquifer to be contaminated. In another manner, the abandoned wells due to salty water contamination were not plugged properly so that they serve as pathways for the inland migration of salty water and downward percolation to the deeper aquifer.

In another manner, the groundwater occurrence along the coastal areas of the South-western Bohol (Tagbilaran City and Panglao) is subjected to tidal inundation in the Alluvium and may cause to infiltrate into the deeper younger limestone aquifer under the influence of gravity whereby the denser saline water tends to move downward. The absence of artesian pressure from the Cortes Limestone aquifer and in the absence of sufficient thickness of the alluvium further enhances the chance of saline invasion by density flow.

The availability of groundwater in the entire Bohol Province may be expressed according to the geology of the area with their corresponding hydrogeologic significance as indicated and summarized in **Table 4-4**.

4.2.2 River Basin and Networks

Bohol is the tenth largest island in the Philippine archipelago located in the Region VII-Central Visayas. The Province has an area of 4,117 km² with a population of over one million people It is bounded on the north by the Camotes Sea, on the west by Bohol Strait and on the south by the Mindanao Sea.

There are several rivers, creeks and waterways in Bohol including those located in small islands. These river systems are either group as river basins or coastal basins and among them are shown in **Figure 4-2** and the descriptive features are listed in **Table 4-5.**

Table 4-4 Geological Units and their Hydrogeological Significance in Bohol Province

Age		Formation	Lithology	Hydrogeological Significance
QUATERNARY	Holocene	Quaternary All	Admixtures of clay, silt, sand and gravel in the plains of Volcanics. Rubble and talus deposits are associated around the limestone areas. Thickness may reach 20 m.	Contains permeable layers not exceeding 15 m to act as shallow aquifer system in the northern plains of Tubigon and Ubay municipalities.
QUATERNARY	Pleistocene	Maribojoc Formation Cortes Limestone	Widely exposed around the southwestern part of Bohol and in Batuan area, the limestone occurs as cappings to the older formations.	Main aquifer system used in the region and in most parts of Cortes, Baclayon and Tagbilaran with relative low to medium transmissivity value of aquifer. The thickness may reach down to 500m but exploitable aquifer do not exceeds 80 meters in depth.
TERTIARY	Pliocene	Sevilla Marl	Tuffaceous marl in close stratigraphic contact with the younger limestone	When inserted with limestone layers, the unit may become responsive to small-scale pumping of groundwater
TERTIARY	Pliocene	Tubigon Conglomerate	Essential clastic members are sandstone, tuff beds, tuffaceous conglomerate, and flow breccia. Typically exposed along road cuts in the area of Tubigon. Entire thickness may reach to 1000m.	Relatively poor aquifer system due to its elevation and consolidate structures.
TERTIARY	Late Miocene	Sierra Bullones	Essential bedded to massive limestone with thin associations of rubble breccia and other reefal limestone layers. Occurs as capping to most ranges in the eastern parts of Bohol.	The elevations of occurrence do not warrant good exploitable groundwater.
TERTIARY	Middle Miocene	Carmen Formation	Consists mainly of shale, sandstone, conglomerate and limestone interbeds. The entire thickness of the formation ranges from 400 to 800 meters.	The limestone layers are similar to Cortes but not as productive. The porous limestone appears channel ways for the presence of numerous springs in the area of central highlands of Bohol.
TERTIARY	Early Miocene	Wahig Formation	Consists mainly of shale, sandstone, conglomerate and limestone interbeds. The entire thickness of the formation ranges from 400 to 800 meters.	Porous limestone beds may become the depository structure for the occurrence of small-scale groundwater in the form of springs.
TERTIARY	Late Oligocene	Jagna Andesite	Consists mainly of andesite breccia, the rock unit is significantly exposed in northern Jagna, LLihan Sur, Tubigon and Anda Peninsula.	Poor water-bearing unit.
TERTIARY	Early Oligocene	LLihan Shale	Essentially fractured shale unit with minor interbeds of sandy tuff and volcanic rubble beds.	Poor water-bearing unit
TERTIARY	Eocene	Talibon Diorite	Hard, massive diorite with notable occurrence in the northern parts of Bohol.	Impermeable rock unit
TERTIARY	Eocene	Getafe Andesite	The composition varies from hornblende andesite to porphyritic andesite and is associated with the Talibon Diorite	Of negligible importance for direct exploitation of groundwater even on weathered mantle.
TERTIARY	Eocene	Ubay Formation	Covering the wide area of Northern Bohol, the rock unit consists essentially of volcanic flows, basalts, dacite, agglomerates and minor gabbro.	Of negligible significance for exploitation
TERTIARY	Paleocene	Bohol Ophiolite	This mafic to ultramafic complex composed mainly of dunites, gabbro, gabbro and pillow basalts. The main body is best exposed in Southeast Bohol.	Of negligible significance for exploitation
TERTIARY	Cretaceous	Alicia Schist	Basement Complex and the oldest formation that occurs as north-south trending foliated rocks in Alicia.	Of negligible significance for exploitation

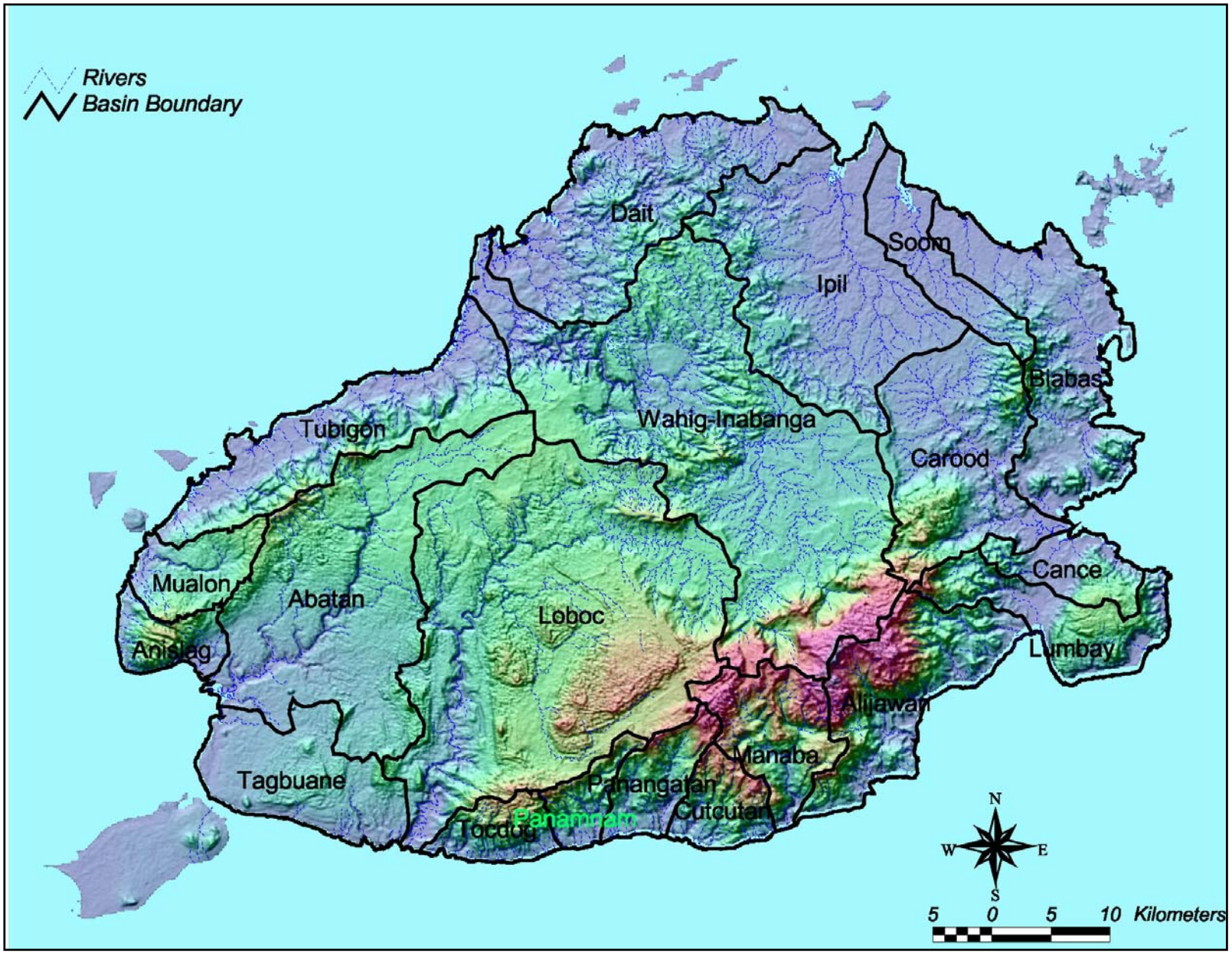


Figure 4-2 River Basins

Table 4-5 List of River Systems

No.	Sub basin
1	Biabas
2	Soom
3	Dait
4	Mualon
5	Tagbuane
6	Anislag
7	Cance
8	Lumbay
9	Tocdog
10	Panamnam
11	Cutcutan
12	Panangatan
13	Manaba
14	Alejawan
15	Tubigon
16	Carood
17	Ipil
18	Wahig-Inabanga
19	Loboc
20	Abatan

4.2.3 Climatological Profile

4.2.3.1 Climate

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) utilizes three climatic classification systems, namely: Corona, Hernandez, and Koppen. The Corona classification gives emphasis on season type, the Hernandez on the number of wet and dry months, and the Koppen on the temperature range and the amount of rainfall in the driest month.

Based on Corona Climatological Classification, the climate of the province of Bohol is generally classified as Type 4, it receives rainfall rather evenly throughout the year. The climate is affected by southwest-originating monsoons, and is relatively dry from March to May. The wet season is from June to December with mean monthly rainfall averaging about 112mm to 182mm. The wettest months are October and November.

Similarly, under the Hernandez classification, the basin belongs to Type A or rainy throughout the year and under Koppen, Type A for tropical wet climate. A map of the basin with the areas classified under the different types of climatic conditions is shown in **Figure 4-3.**

4.2.3.2 Temperature and Humidity

Atmospheric temperature observations for the province are obtained from PAGASA's synoptic station in Tagbilaran City. The monthly mean air temperature recorded at the station ranges from 26.5°C to 28.7°C with the annual average being 27.7°C. The values indicated show that temperature is fairly uniform throughout the year. The air temperature in the watershed can be considered low. This can be contributed to the mountains, alignment of the basin and the prevailing winds that tend to reduce the movement of warm air from the sea and promote outflow from the basin. As a result of these lower temperatures, the capacity of air to absorb water vapor (evaporation) is low. However, ground and water surface temperatures have a significant effect in the evaporation process.

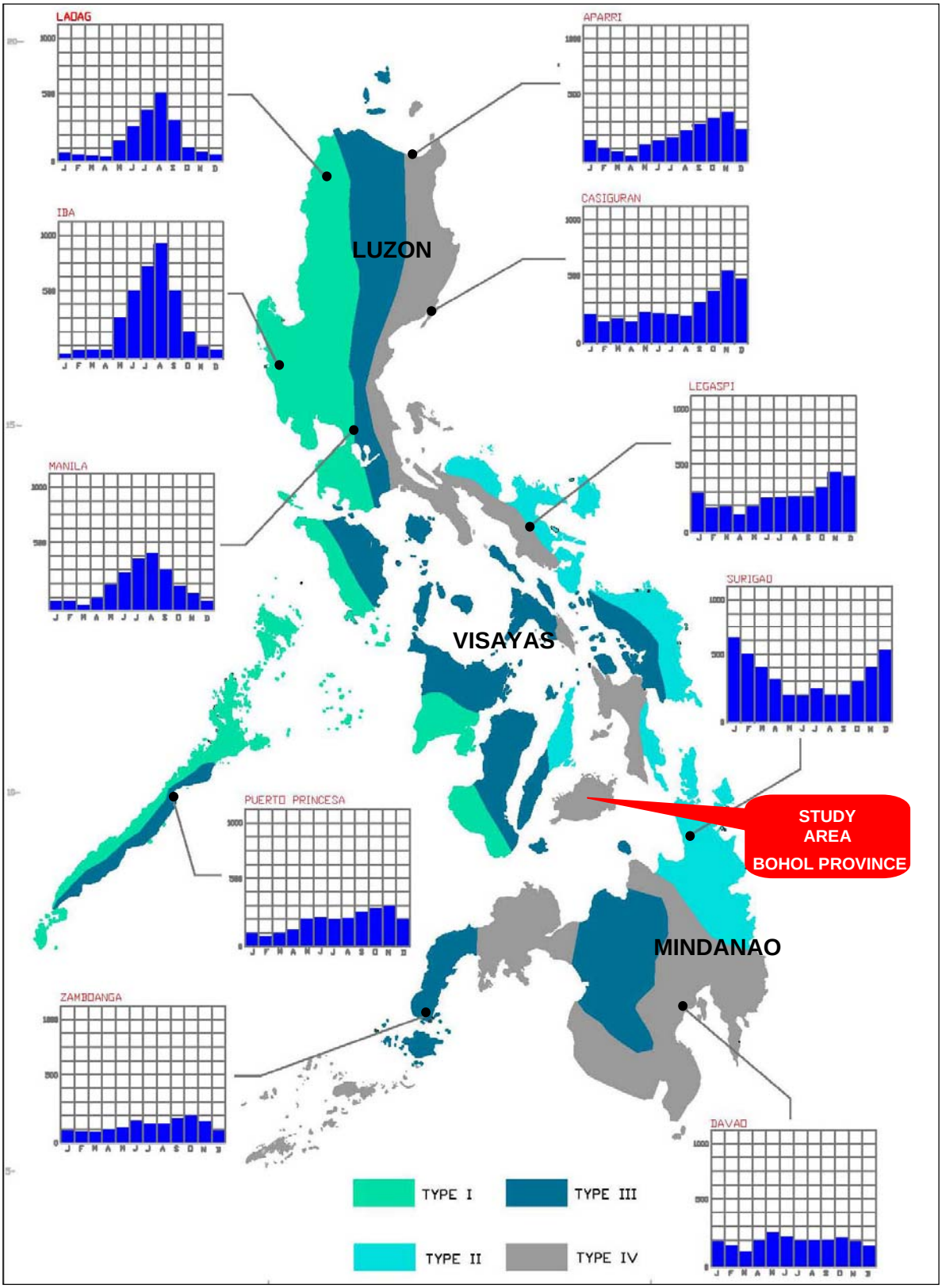


Figure 4-3 Climatological Map

The mean annual relative humidity recorded is 81.3% with monthly averages varying between 78 and 85%. Higher humidity is experienced from December to March. **Table 4-6** shows the climatological data.

Table 4-6 Climatological Data

Month	Rainfall		Temperature (ºC)			Relative Humidity (%)	Wind	
	Mean (mm)	No. of Rainy days	Maximum	Minimum	Mean		Speed (mps)	Direction
JAN	103.1	14	30.8	22.1	26.5	83	2	NE
FEB	78.7	11	31.3	22.0	26.6	81	2	NE
MAR	68.2	10	32.1	22.2	27.1	79	2	NE
APR	69.6	8	33.0	23.1	28.0	78	1	NE
MAY	75.1	10	33.3	24.1	28.7	79	1	S
JUN	112.3	15	32.6	24.1	28.4	81	1	S
JUL	118.8	14	32.3	24.1	28.2	81	2	S
AUG	111.8	13	32.7	24.3	28.5	80	2	S
SEP	135.5	15	32.5	24.1	28.3	81	1	SW
OCT	178.7	18	32.1	23.8	27.9	84	1	S
NOV	182.0	18	31.7	23.3	27.5	85	1	NE
DEC	126.3	16	31.2	22.7	27.0	84	2	NE
Annual	**1360.1**	**162**	**33.3**	**22.0**	**27.7**	**81.3**	**1.5**	

4.2.3.3 Precipitation

Also from **Table 4-6**, rainfall distribution is influenced by the prevailing air streams, the intertropical convergence zone (ITCZ) and the island's topography. Using the rainfall normal values of the Tagbilaran Synoptic Station tended by Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the mean annual rainfall is about 1,360 mm and the minimum monthly rainfall normally occurs in March at 62.8 mm with about 10 rainy days while the maximum monthly rainfall occurs in November at 182 mm with 18 rainy days.

The southwest monsoon usually starts from the month of July until October which is considered as the wettest months. Based on the observation of local residents, rainfall distribution and intensity is affected by the orographic effect of the topography thus, the distribution varies with the interior mountainous landscapes receiving greater rainfall as compared to the coastal and offshore islands. These values indicate that there is a very large variation in rainfall, not only between different locations but from year to year.

4.2.3.4 Atmospheric Pressure

The atmospheric pressure, derived from published mean annual isobars, ranges from 1,008.2 to 1,009.5 millibars with an average being approximately 1,008.9 millibars. Barometric pressure recorded at the synoptic station in Tagbilaran City averages 1,011.7 millibars and vary between 1,022.4 and 998.2 millibars. At these pressures, relative humidity can become quite high, which in turn may reduce the evaporation rate.

4.2.3.5 Winds

The prevailing wind direction from November to April is towards northeast with an average speed of 2 miles per hour . The months of May to October experience gentler winds oriented southward. Bohol is outside of the "typhoon belt" zone of the country, as typhoon rarely passes the province. However, typhoons passing below or above the island bring about greater volume of precipitation.

The typhoon comes in the country in a periodic cycle beginning as early as December to April but relatively few in number of occurrences which is about two (2) to three (3) events per year.

4.3 HYDROMETEOROLOGICAL DATA

4.3.1 Rainfall

Within the province, PAGASA maintains 13 rainfall recording stations, in which one of them is a synoptic station and the rest are climatic stations. The synoptic station is located at the Airport, Tagbilaran City. The data from these stations is almost continuous over the last 20 years.

Rainfall information from the synoptic stations are logged by an automatic rainfall recorder that has the rainfall data read every minute and recorded in a strip chart. Climatic station meanwhile does manual observation of rainfall. Rainfall data generated by this type of station are therefore daily average rainfall.

A summary of the rainfall stations is given in **Table 4-7**.

Table 4-7 List of Rainfall Stations

Sta. ID	Station Name	Latitude	Longitude	Period		Annual, mm
Climatic						
0701	**Central Carmen**	09˚ 50	124˚ 12	1-Jan-75	31-Dec-05	2,189.33
0702	**Dagohoy**	09˚ 54	124˚ 16	1-Jan-63	31-Dec-05	1,998.06
0703	**Guindulman**	09˚ 46	124˚ 29	1-Jan-75	31-Dec-00	1,715.73
0704	**Las Salinas Loay**	09˚ 36	124˚ 01	1-Jan-75	31-Dec-95	1,006.49
0705	**Bes Ubay**	10˚ 03	124˚ 28	1-Jan-78	31-Dec-05	1,763.69
0706	**Pob.Bilar**	09˚ 43	124˚ 07	1-Jan-75	31-Dec-05	2,895.20
0707	**Pob.Ilaud Inabanga**	10˚ 02	124˚ 04	1-Jan-75	31-Dec-05	1,509.24
0708	**Pob.Loon**	09˚ 48	123˚ 48	1-Jan-75	31-Dec-00	1,409.35
0710	**Pob.Trinidad**	10˚ 05	124˚ 19	1-Jan-75	31-Dec-00	2,434.57
0711	**Pob. Ubay**	10˚ 04	124˚ 28	1-Jan-75	31-Dec-05	1,403.22
0712	**Pres.Carlos P. Garcia Pitogo**	10˚ 08	124˚ 33	1-Jan-75	31-Dec-00	1,426.20
0713	**Tinangnan Tubigon**	09˚ 57	123˚ 58	1-Jan-66	31-Dec-05	1,814.68
Synoptic						
644	**Tagbilaran**	09˚ 38	123˚ 52	1-Jan-61	31-Dec-05	1,358.42

The locations of the rainfall recording stations are indicated in **Figure 4-4**.

4.3.2 Streamflow

Discharge data is available from Bureau of Research and Standards (BRS-DPWH) and NWRB. The officially released BRS data consists of daily mean and in some instances daily maximum values up to 1992. A 2004 publication is available from BRS but there are no river systems within the basin included. The discharge values are determined through gauge readings conducted three times a day and in the case of high flows, at a smaller interval.

A total of seven (7) NWRB or BRS gauging stations have been installed and operated in the basin at one time or another. Presently, data is only being collected for five (5) stations. The quality of the available data is poor because the location of the gauging station is affected by the backwater effect during high tides except for Abatan Stations. **Table 4-8** contains a summary of the available data and other information about these stations with their approximate point locations are shown in **Figure 4-5**.

Table 4-8 List of Streamflow Gauging Stations

No	River	Basin	Longitude	Latitude	Dr Area, km^2	Qm, m^3/s	Records
1	Loboc	Loboc	124º 02' 04"	09º 39' 57"	618	4.87	1957-1990
2	Abatan	Abatan	123º 57' 25"	09º 47' 22"	140	3.45	1984-2000
3	Zamora	Ipil	124º 17' 49"	10º 05' 56"	20	1.32	1985-1999
4	Hinlayagan	Ipil	124º 20' 52"	10º 02' 05"	41	3.24	1984-1988
5	Pamacsalan	Wahig-Inabanga	124º 21' 09"	09º 50' 58"	141	8.97	1966-1997

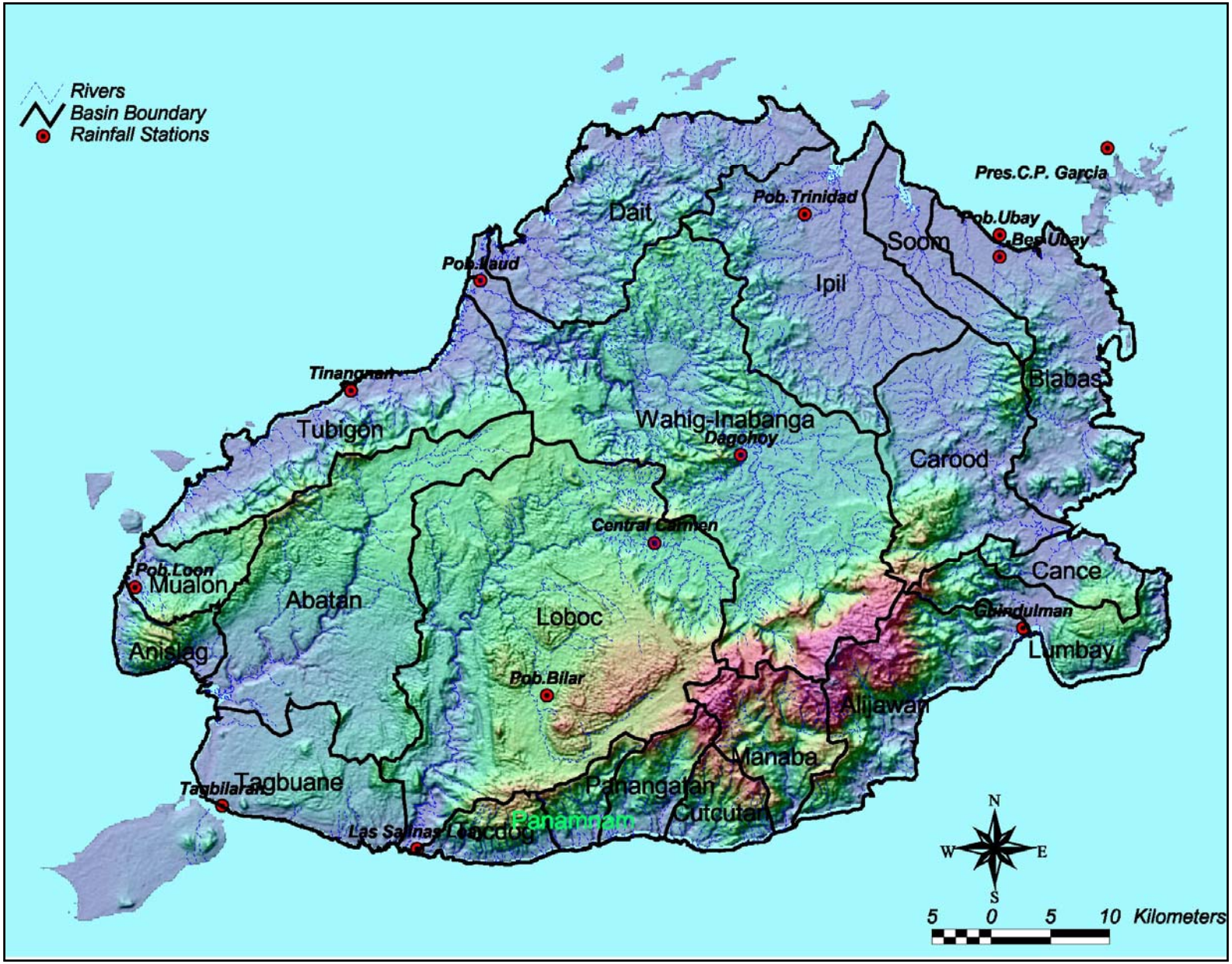


Figure 4-4 Location of the Rainfall Stations

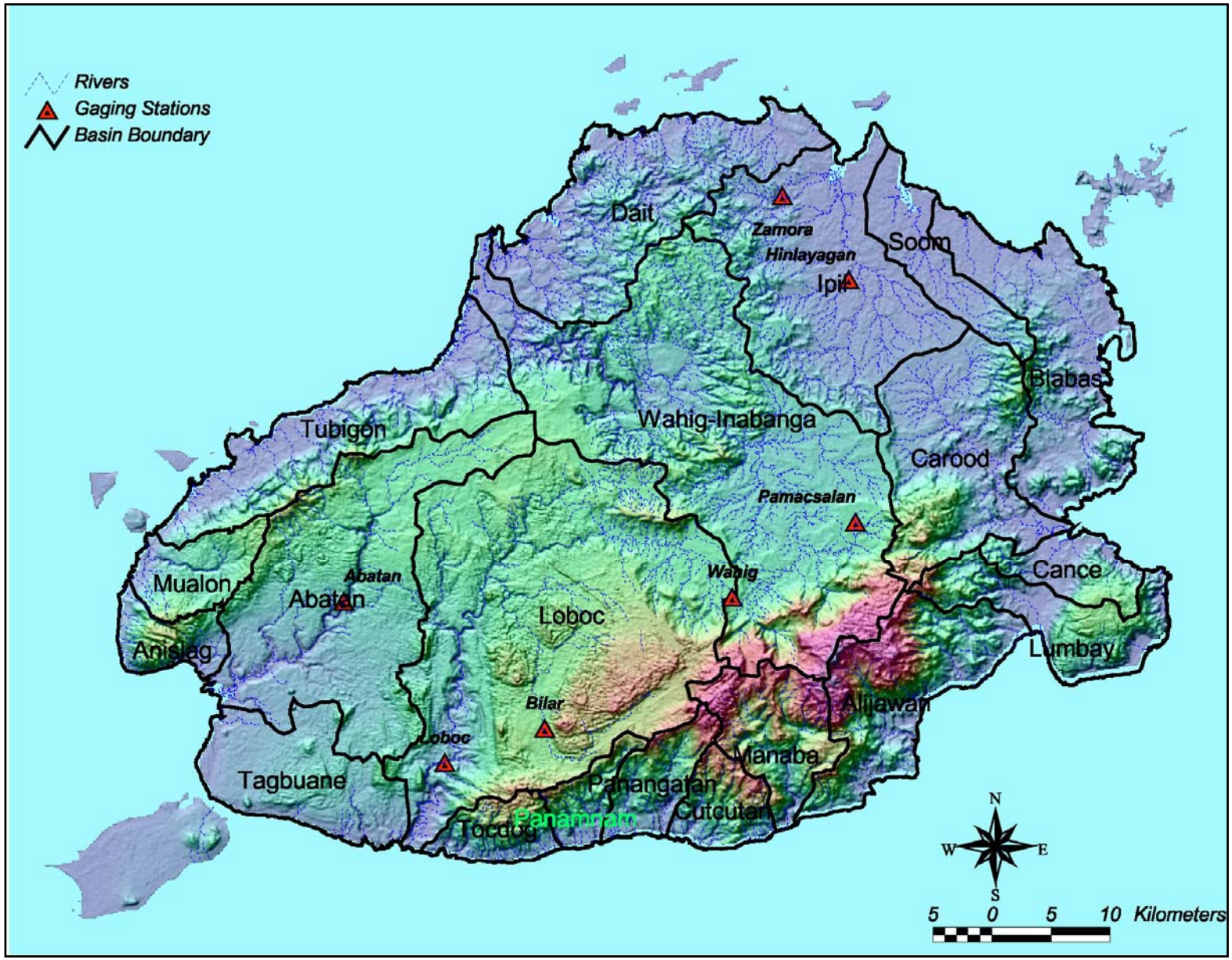


Figure 4-5 Location of Streamflow Gauging Stations

4.4 HYDROMETEOROLOGICAL DATA EVALUATION

4.4.1 Rainfall Analysis

An isohyetal map of average annual rainfall in the basin is also delineated in **Figure 4-6**. As shown in this map, the average annual rainfall is not uniform throughout the basin.

It varies from 1,000 mm to over 3,500 mm. The lowest accumulations occur in the coastal area of the island particularly the Talibon, Dait, Ipil and Soom River Basins. This part of the island is shielded from the path of the rain-bearing southwest monsoon while the rest of the island particularly the central basins received the highest rainfall distribution. The highest rainfall occurs in the mountains that bound the basin on south-east in the vicinity of the municipality of Bilar.

4.4.2 Streamflow Duration Curves Analysis

Water availability for water supply source, irrigation diversion, hydropower and other similar projects is undertaken using the flow duration curve analysis. This is done by graphically representing the flow data with percent of time of its occurrence.

For each of the five (5) streamflow data sets containing daily flow record of rivers, daily records are arranged from highest to lowest while its ranked is reduced as percentage of the total number of the daily values. Consequently, the flow data further reduced as a ratio of its average daily flow is plotted against its reduced ranking which become as percent of time of occurrence.

The resulting flow duration curves for each of the datasets is shown in **Figure 4-7.**

For water supply and irrigation purposes, the dependable flow as defined in the Water Code flow is the flow magnitude with at least 80% of time of occurrence.

4.4.3 Rainfall-Runoff Analysis

Since only five (5) among the many rivers in the island are considered as measured, a mathematical procedure to estimate the flow pattern for the other ungaged rivers is necessary. One way of undertaking the process is by identifying the relationship between rainfall and runoff.

From the previous discussion concerning rainfall analysis, rainfall information over the catchment of the gaged rivers can be determined. **Table 4-9** shows the comparison between rainfall and runoff for each of the gaged rivers.

Table 4-9 Comparison of Rainfall and Runoff

No	River	Basin	Dr Area, km²	Qm, m³/s	Runoff, mm	Rainfall, mm	Runoff Coefficient C
1	Loboc	Loboc	618	4.87	248.51	2,488	0.0999
2	Abatan	Abatan	140	3.45	777.14	2,220	0.3501
3	Zamora	Ipil	20	1.32	2081.38	2,364	0.8806
4	Hinlayagan	Ipil	41	3.24	2492.11	2,364	1.0543
5	Pamacsalan	Inabanga	141	8.97	2006.23	2,101	0.9547

Considering the basin retention losses, land cover and existing diversion of water in the catchments, the ratio between rainfall and runoff commonly called as runoff coefficient shows that the values for Abatan is more acceptable than that of the other rivers. Observation during the field visits listed that the gaging stations in Loboc, Zamora, and Hinlayagan are affected by tidal backwater, thus the daily readings are found higher than the reality.

With this observation, the rainfall-runoff relationship for Abatan catchment is concluded to be used as the basis in the estimation of flow regime for the other river basins in the island.

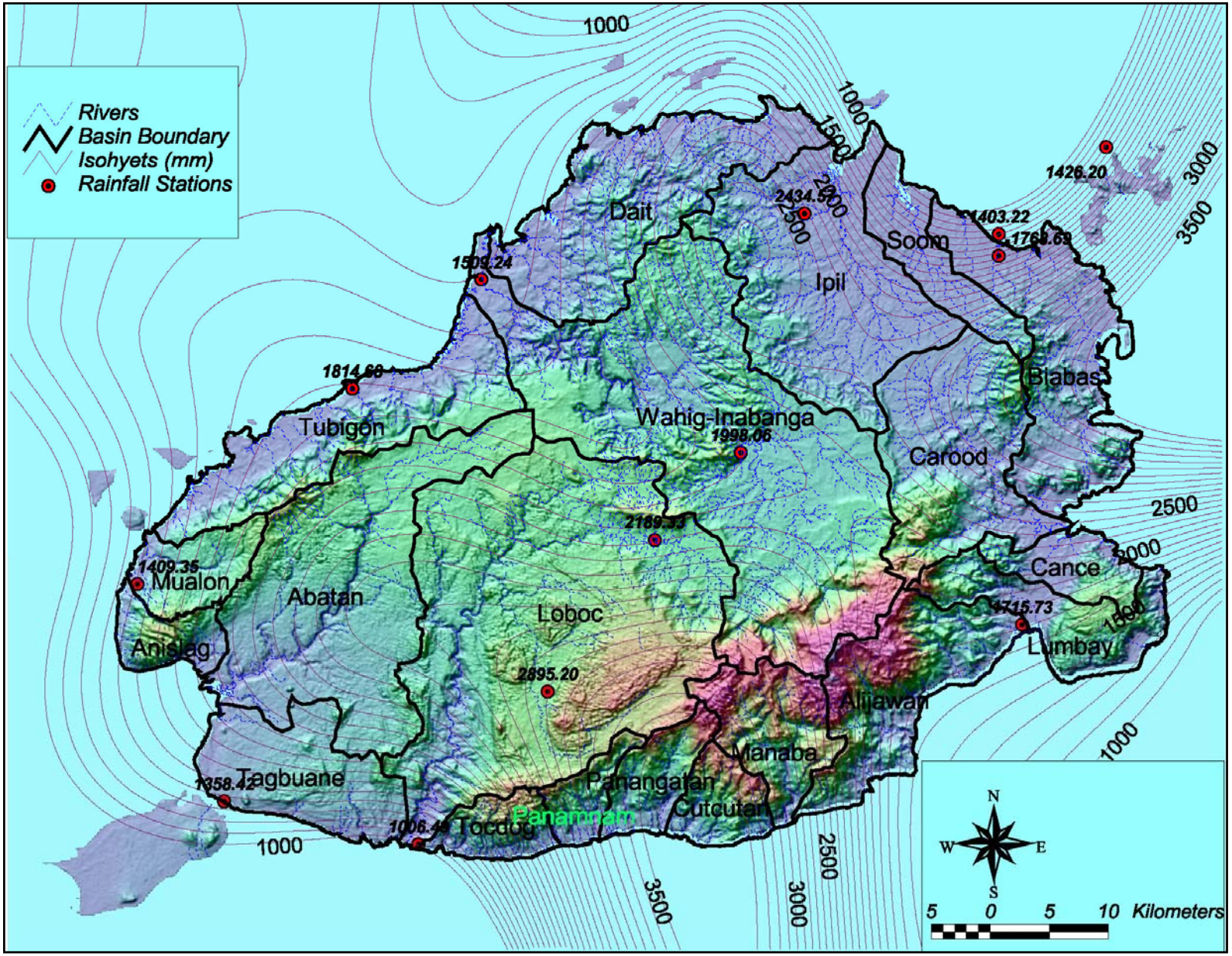


Figure 4-6 Isohyetal Map

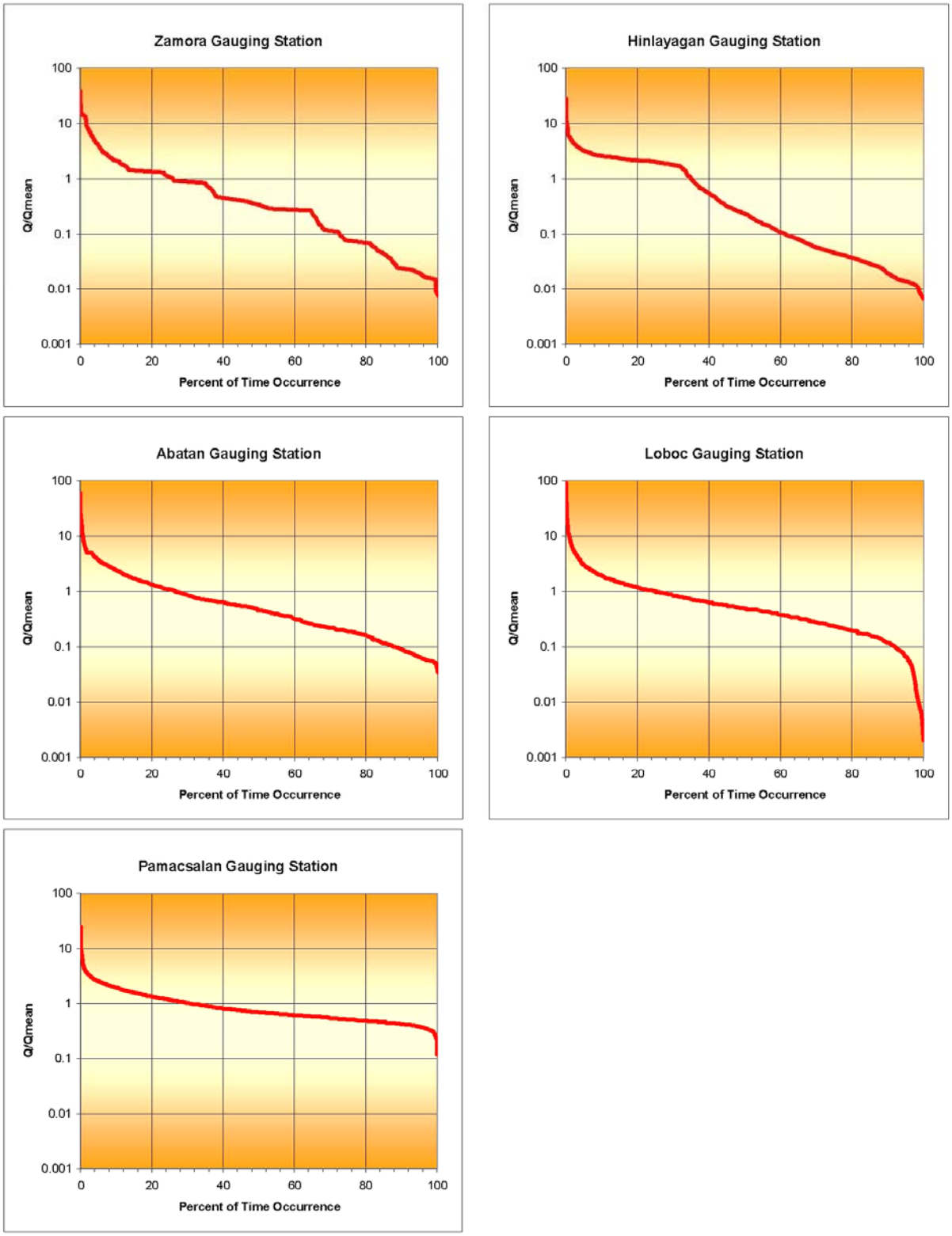


Figure 4-7 Flow Duration Curves

4.5 BASIN WATER AVAILABILITY EVALUATION

4.5.1 Basin Catchment Delineation

The contour polylines with a 20m interval digitized from 1:50,000 m NAMRIA maps undertaken by JICA for NIA-GIS project is used as the basis to delineate the boundaries of the various river basins in the Island. The digitized map objects are shown in **Figure 4-8**.

The following are the steps undertaken in the catchment boundary delineation:

In the GIS environment using ArcView GIS software with 3D Analyst and Spatial Analyst Extension, the digitized contour polylines are used to create a triangular irregular network (TIN) thematic map. This is done to interpolate elevations between the contour lines using bilinear interpolation. The created thematic theme is shown in **Figure 4-9**.

The TIN thematic theme is converted into grid theme as shown in **Figure 4-10**. The grid theme has cell grid size of 90m meaning there will be elevation data for every point measured 90m both ways in the island.

Using Hydro Model (ArcView extension), flow accumulation, ridges and valleys are determined and consequently, basin boundaries are delineated. Also in **Figure 10**, the delineated boundaries are also reflected. Likewise, areas for each of the boundaries are computed using Xtools extension and the result is listed in **Table 4-10.**

Table 4-10 Catchment Areas

No.	Subbasin	Area, km²
1	Biabas	208.49
2	Soom	77.76
3	Dait	241.08
4	Mualon	63.72
5	Tagbuane	139.53
6	Anislag	45.69
7	Cance	57.38
8	Lumbay	104.34
9	Tocdog	46.92
10	Panamnam	36.46
11	Cutcutan	52.87
12	Panangatan	58.00
13	Manaba	99.70
14	Alijawan	166.57
15	Tubigon	198.03
16	Carood	214.85
17	Ipil	299.58
18	Wahig-Inabanga	620.32
19	Loboc	659.68
20	Abatan	368.33

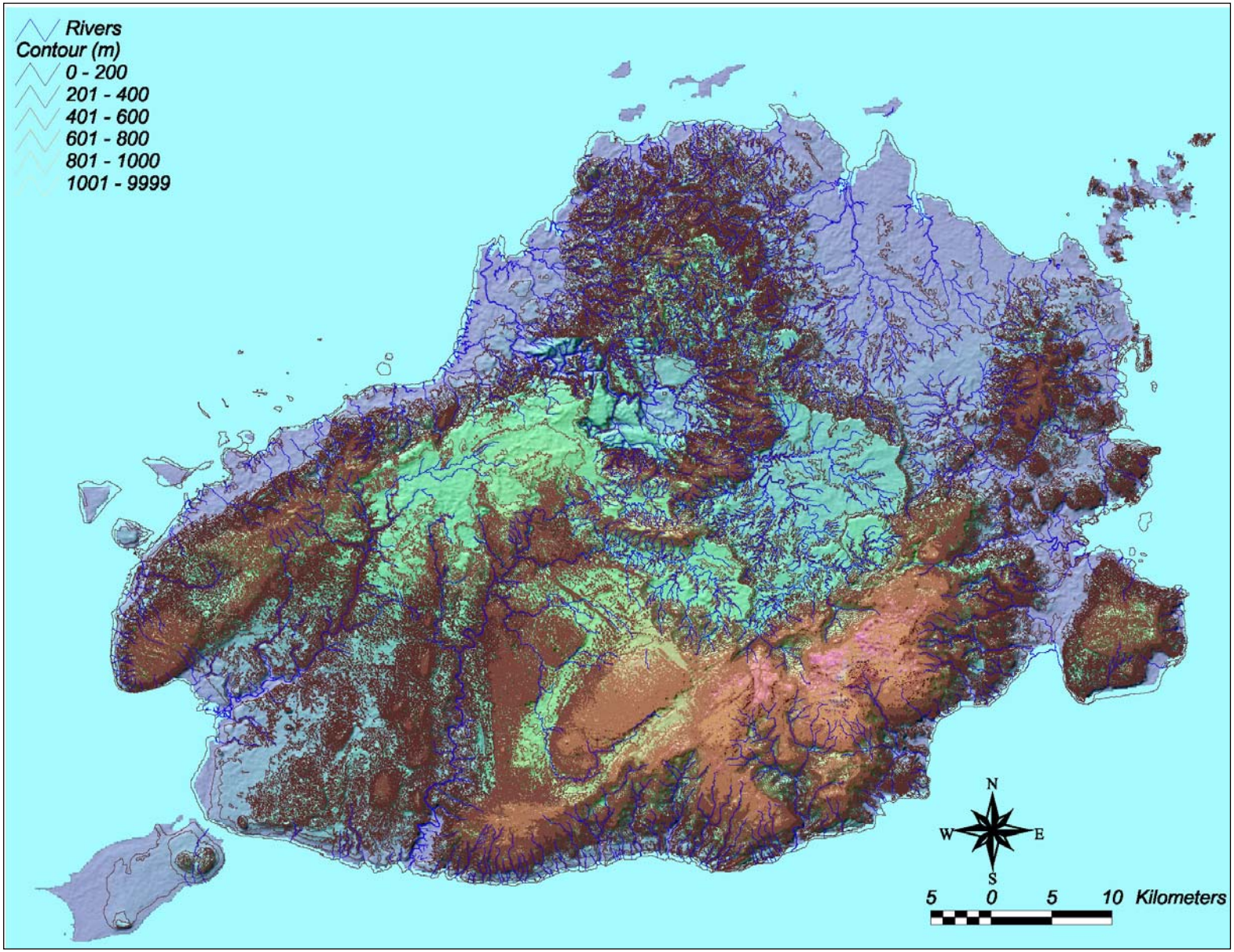


Figure 4-8 Digitized Contour from 1:50,000 NAMRIA Maps

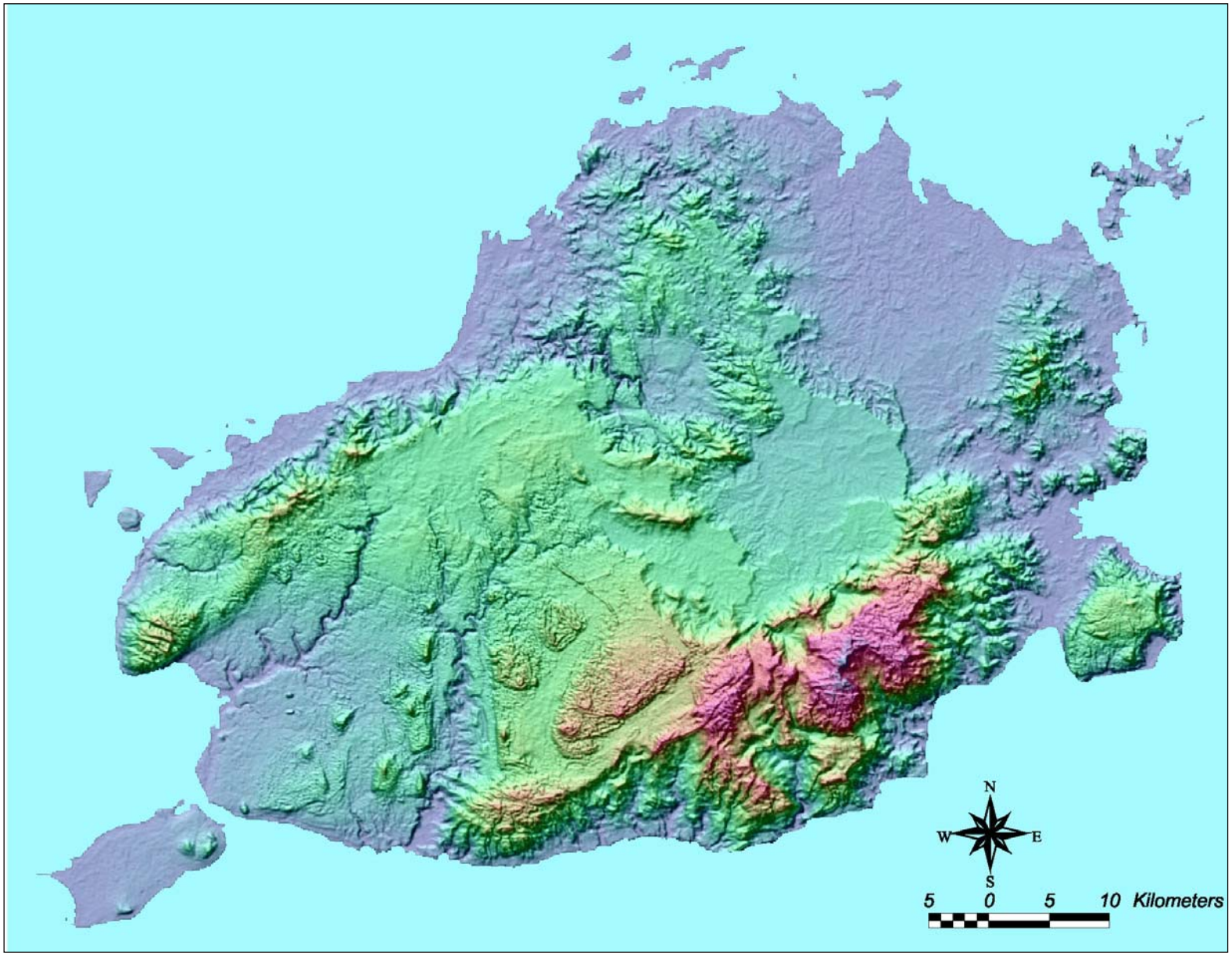


Figure 4-9 Triangular Irregular Network (TIN) Thematic Map

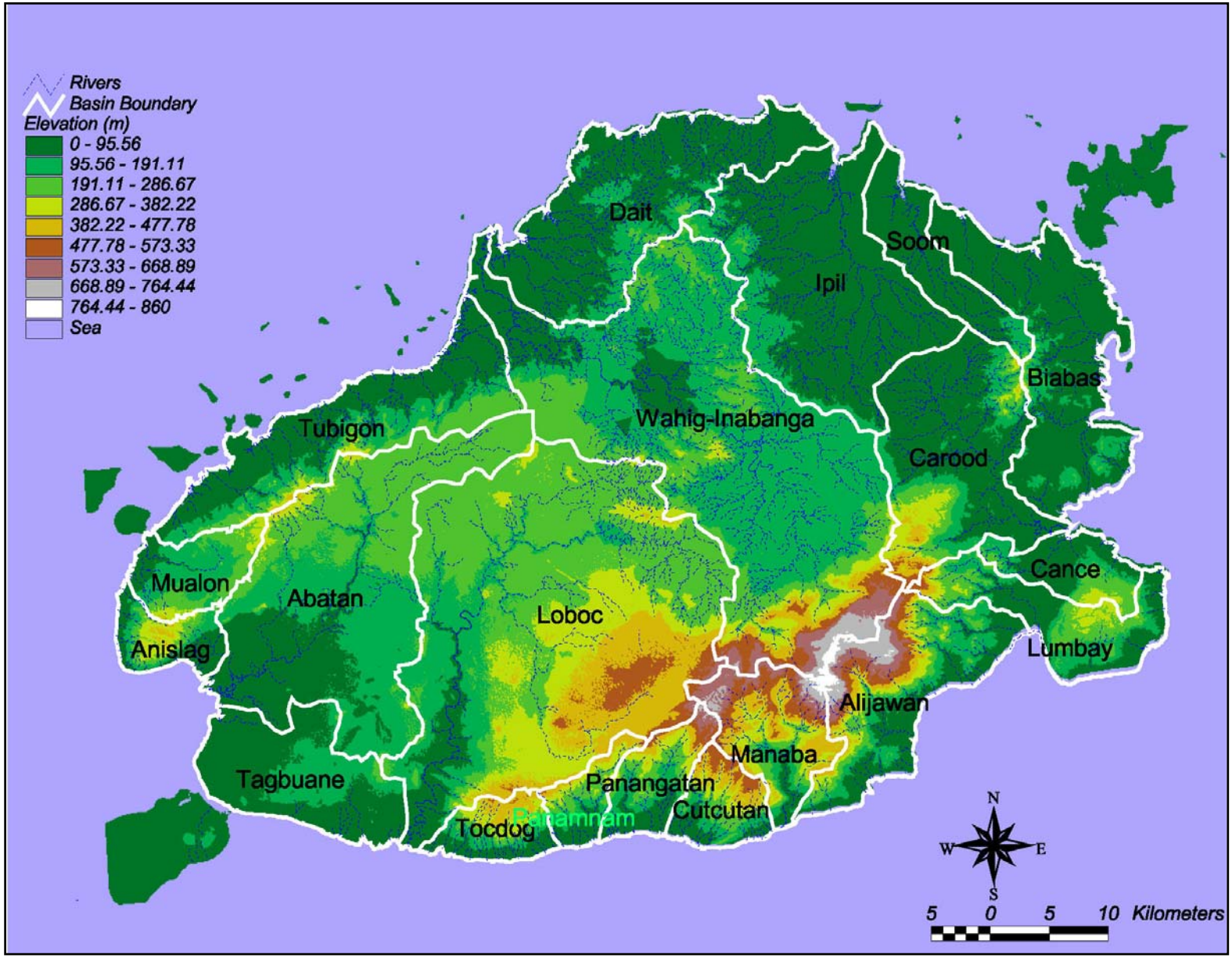


Figure 4-10 90 m Elevation Grid Map

4.5.2 Basin Rainfall

The objective of this exercise is to determine the average rainfall for each of the river basins earlier discussed. The steps undertaken are the following:

The isohyets shown in **Figure 4-6** are transposed into rainfall grid theme using similar fashion undertaken for the contour polylines. The result is shown in **Figure 4-11**.

The delineated catchment boundaries are converted into polygon theme with tabular attributes similar to the content of **Table 4-10.**

With the rainfall grid theme and the catchment boundary polygon theme, average rainfall for each of the river basins are computed using Surface Tools extension. **Table 4-11** shows the result of the analysis.

Table 4-11 Basin Rainfall

No.	Subbasin	Area, km²	mean Rainfall, mm
1	Tocdog	46.92	1,908
2	Panamnam	36.46	3,038
3	Soom	77.76	1,860
4	Cutcutan	52.87	3,474
5	Panangatan	58.00	3,452
6	Tagbuane	139.53	1,596
7	Anislag	45.69	1,644
8	Mualon	63.72	1,706
9	Cance	57.38	1,978
10	Manaba	99.70	2,979
11	Loboc	659.68	2,488
12	Abatan	368.33	2,220
13	Tubigon	198.03	1,803
14	Dait	241.08	1,968
15	Ipil	299.58	2,364
16	Carood	214.85	2,511
17	Alijawan	166.57	1,907
18	Inabanga	620.32	2,101
19	Biabas	208.49	2,757
20	Lumbay	104.34	1,644

4.5.3 Basin Water Availability

The availability of water for each of the basins is estimated based on the mean rainfall and the rainfall-runoff coefficient. **Table 4-12** shows the computation.

Table 4-12 Water Availability per Basin

No.	Subbasin	Area, km^2	mean Rainfall, mm	Residual Runoff, mm	mean Q, m^3/s	dep Q, m^3/s	env Q, m^3/s	net Q, m^3/s
1	Tocdog	46.92	1,908	668	0.99	0.15	0.01	0.13
2	Panamnam	36.46	3,038	1,064	1.23	0.18	0.02	0.17
3	Soom	77.76	1,860	651	1.61	0.24	0.02	0.22
4	Cutcutan	52.87	3,474	1,216	2.04	0.30	0.03	0.27
5	Panangatan	58.00	3,452	1,208	2.22	0.33	0.03	0.30
6	Tagbuane	139.53	1,596	559	2.47	0.37	0.04	0.33
7	Anislag	45.69	1,644	576	0.83	0.12	0.01	0.11
8	Mualon	63.72	1,706	597	1.21	0.18	0.02	0.16
9	Cance	57.38	1,978	692	1.26	0.19	0.02	0.17
10	Manaba	99.70	2,979	1,043	3.30	0.49	0.05	0.44
11	Loboc	659.68	2,488	871	18.22	2..72	0.27	2.45
12	Abatan	368.33	2,220	777	9.08	1.35	0.14	1.22
13	Tubigon	198.03	1,803	631	3.96	0.59	0.06	0.53
14	Dait	241.08	1,968	689	5.27	0.79	0.08	0.71
15	Ipil	299.58	2,364	827	7.86	1.17	0.12	1.06
16	Carood	214.85	2,511	879	5.99	0.89	0.09	0.80
17	Alijawan	166.57	1,907	668	3.53	0.53	0.05	0.47
18	Wahig-Inabanga	620.32	2,101	736	14.47	2.16	0.22	1.94
19	Biabas	208.49	2,757	965	6.38	0.95	0.10	0.86
20	Lumbay	104.34	1,644	576	1.90	0.28	0.03	0.26

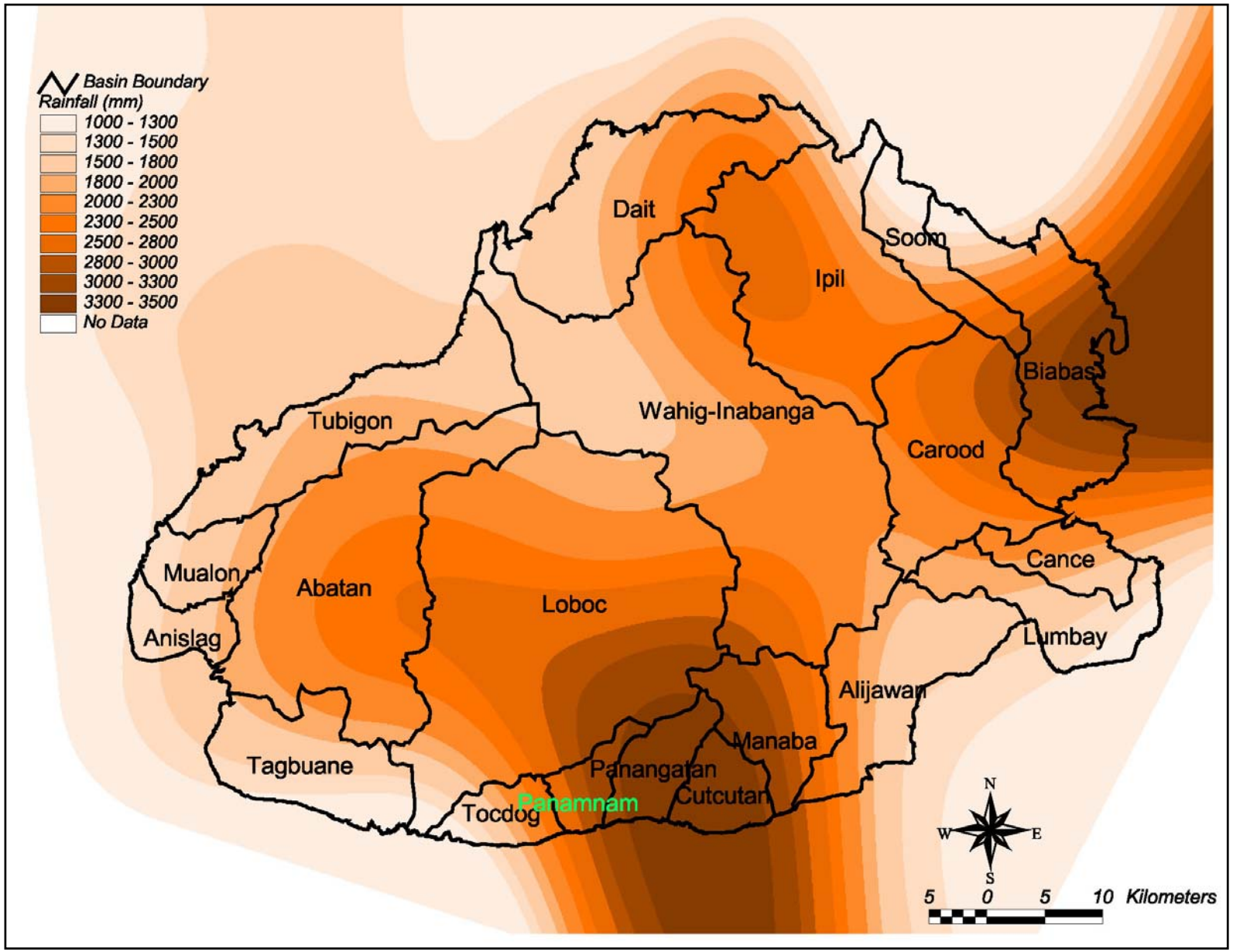


Figure 4-11 90 m Rainfall Grid Map

The residual runoff, about 35% of the mean rainfall, is converted into mean discharge. Using the characteristics of the Abatan flow duration curve, the estimated dependable for each of the basin is about 14.02% of the mean discharge. The net dependable flow is computed by reducing the dependable flow by 10% to account for riparian release for environmental consideration.

4.5.4 Hypsometric Curves

Hypsometric curve is an aid for planning of water sources for water supply site, hydropower potential and irrigation site. It is a combined graphical representation of both the hydrology and river profile of a certain river basin. In the graph, the abscissa (x-axis) contains the river station starting from mouth up to the headwater along the centerline of the river. The ordinate (y-axis) contains the elevation data in the primary axis and the mean discharge data in the secondary axis.

In this exercise, hypsometric curves for the seven (7) river basins namely; (a) Abatan, (b) Loboc, (c) Manaba, (d) Alijawan, (e) Carood, (f) Wahig-Inabanga, and (g) Ipil are presented in **Figure 4-12**.

4.5.5 Water Quality Reassessment of Major Rivers

There are two (2) studies conducted previously on the water quality of some major rivers in Bohol. The two (2) studies are funded by the GTZ and namely: Water Quality in Negros Oriental and Bohol (Sept 2004) and the Bohol Integrated Water Resources Management Team (BIWRMT) (Sept 2006). In the two (2) GTZ studies, several samplings were made on major rivers, such as Loboc, Wahig-Inabanga, Manaba, Carood and Ipil. The said studies indicate that pollution level have risen over the past years in this island. The coliform has exceeded set standards for Class A water in the DAO 34. The coliform counts obtained would classify these rivers under the Class C water, with coliform not more than 5,000 MPN/100 ml.

Water sampling and analysis of the major rivers and springs of Bohol were also conducted during the duration of this study. These rivers are identified as possible water supply sources to serve the various catchment areas of the island. Water samples were taken from the lower reaches of the different principal rivers, while the analyses were conducted for the following parameters, namely: pH, color, turbidity, Chemical Oxygen Demand (COD), Total Dissolved Solids, Chloride, Nitrate Nitrogen, Phosphate, Total Hardness, Total Alkalinity, Total Acidity, Sulfate, Iron and Manganese. Another water sampling for Biochemical Oxygen Demand (BOD) was taken at a later date to complete the parameters required for DAO 34. The results of laboratory analysis are shown in **Appendix II.4-A (Volume III- Databook),** while the summarized results of the water quality tests are presented in **Table 4-13**

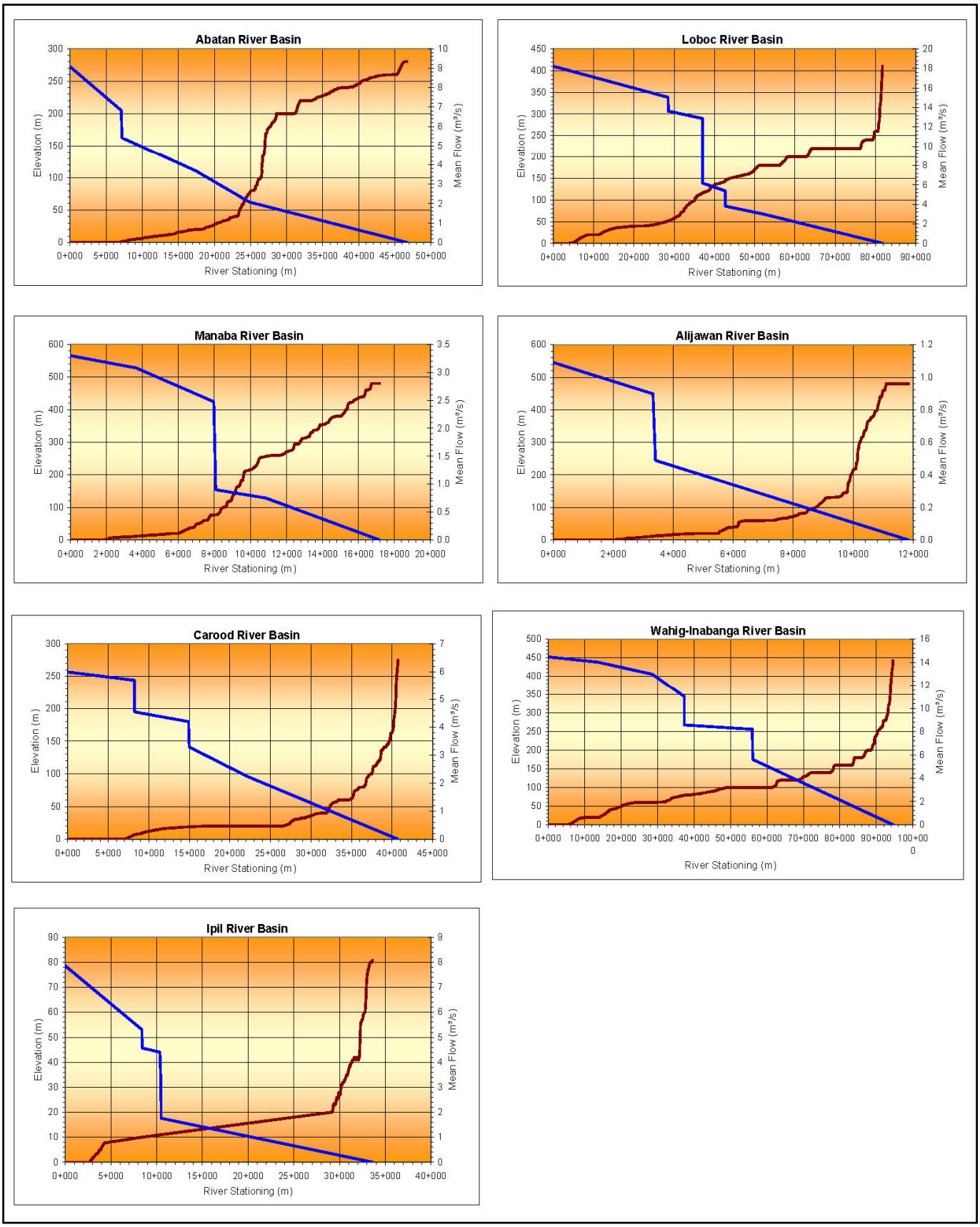


Figure 4-12 Hypsometric Curves for Selected Basins

Table 4-13 Water Quality Data of Various Rivers in Bohol

RIVER	DAO 34 CLASSIFI-CATION*	DATE OF SAMPLING	CONSTITUENTS								DATE OF SAMPLING	CONSTITUENTS	
			pH	*Color* PCU	*Total Suspended Solids* mg/L	*Total Dissolved Solids* mg/L	*Chlorides* mg/L	*Nitrate Nitrogen* mg/L	*Phosphate P* mg/L	*Chemical Oxygen Demand* mg/L		*Biochemical Oxygen Demand* Mg O_2/L	*Coliform* MPN/100ml
Abatan River	**C**	14-Aug-07	7.85	5	6	652	8.4	0.01	<0.005	10	6-Dec-07	<1.0	>200
			6.5-8.5	(c)	(g)	__	350	10 [(j)]	0.4[(k)]			7(10)	5,000[(m)]
Loboc River	**B**	13-Aug-07	7.85	10	12	238	3	0.23	<0.005	9.9	7-Dec-07	1.3	>200
			6.5-8.5	(c)	(f)	__	__	nr	0.2 [(k)]			5	1,000[(m)]
Carood River	**Not Classified by EMB**	14-Aug-07	7.68	50	41	138	5	0.2	0.25	25	6-Dec-07	1.3	>200
Manaba River	**C**	14-Aug-07	8.1	5	6	212	4	0.1	0.17	5	6-Dec-07	<1.0	>200
			6.5-8.5	(c)	(g)	__	350	10 [(j)]	0.4[(k)]			7(10)	5,000[(m)]
Upper Wahig-Inabanga River	**A**	14-Aug-07	7.63	25	16	214	7.9	0.16	<0.005	10	7-Dec-07	1	>200
			6.5-8.5	50	50	1,000[(i)]	250	10	0.1[(k)]			5	1,000[(m)]
Ipil River	**A**	10-Sep-07	7.56	100	**162**	194	2.4	0.2	0.95	**55**	7-Dec-07	1.4	>200
			6.5-8.5	50	50	1,000[(i)]	250	10	0.1[(k)]			5	1,000[(m)]
Alijawan River	**Not Classified by EMB**	10-Sep-07	7.73	20	16	262	4.4	0.02	<0.005	30	6-Dec-07	<1.0	>200
Lower Wahig-Inabanga River	**C**	14-Aug-07	7.44	10	15	230	18	0.03	<0.005	10	7-Dec-07		
			6.5-8.5	(c)	(g)	__	350	10 [(j)]	0.4[(k)]			7(10)	5,000[(m)]

**EMB-DENR Classified 2006*
For further details refer to Appendix II.4-B - Water Quality Criteria, DAO 34, S. 1990
Standard Water Quality Criteria, DAO 34, S. 1990

The results of laboratory analysis of the seven (7) identified rivers showed as follows:

Ipil River

Based on the EMB list (as of 2006), the whole stretch of Ipil River has been classified under Class A, which it is intended for public water supply sources as its primary beneficial use. However, the chemical quality results of water for Ipil River have turbidity level reaching 200 NTU and Chemical Oxygen Demand (COD) of 55 mg/L. The high COD value indicates that the water pollution is very evident. This has been further validated by taking water sampling at a later date for BOD. More testing is recommended to determine the source of the high COD value in water. Total suspended solids and turbidity are also high.

The iron and manganese contents of water for Ipil River are also high. Although iron and manganese are not likely to have significant toxicological effect, because the quantity consumed in the daily diet far exceeds the quantity that causes objectionable tastes and stains. The excessive iron imparts yellowish color and manganese leaves blackish color in water. However, raw water from Ipil River with appropriate purification methods (i.e. iron and manganese removal) will render it fit for human consumption.

Abatan River and Manaba River

The water quality of Abatan and Manaba Rivers were classified by EMB as Class C, which, based on beneficial use, is intended primarily for recreational, fishery and industrial uses. The water quality results are found to be within the values set by EMB.

Upper and Lower Wahig-Inabanga Rivers

The Upper and Lower Wahig-Inabanga Rivers are classified as Class A and Class C, respectively by EMB. During the preparation of the study, results of water analysis were validated to be within the set classifications.

Loboc River

Classified as Class B, Loboc River provides power generation through mini-hydro power and ecotourism industry (such as, river cruise/floating restaurants) contributing to economic development to the province. The result of the water quality analysis is within the limits set according to DAO 34. Loboc River is being used consistent to its intended purpose.

Alijawan River and Carood River

These rivers are not yet classified by EMB based on their 2006 list. Based on the results of the water analysis, Alijawan River may be compared to Class A, which could be used for primary source of small-scale water supply while Carood River may be compared to Class C which could be used for recreational, fishery and industrial purposes. The comparison of classification, however, could not be considered as conclusive because only one sampling was conducted. The official classification should be undertaken by EMB.

4.5.5.1 Standards for Drinking Water

A comparison of selected water quality parameters against the Philippine National Standards for Drinking Water (PNSDW) for the 7 major rivers is presented in **Table 4-14.** To identify the critical constituents that may affect the mode of water treatment process required, regular water sampling should be conducted and monitored at least on a one-year duration.

Table 4-14 Water Quality Analysis of Various Rivers for Drinking Water

	DATE OF SAMPLING	*pH*	*Color* PCU	*Turbidity* NTU	*Total Dissolved Solids* mg/L	*Chlorides* mg/L	*Nitrate Nitrogen* mg/L	*Total Hardness* mg/L	*Sulfate* mg/L	*Iron* mg/L	*Manganese* mg/L	*Total Alkalinity** mg/L	*Total Acidity** mg/L
Philippine National Standards for Drinking		6.5-8.5	5	5	500	250	50	300 as CaCO3	250	1	0.4	—	—
Abatan River	14-Aug-07	7.85	5	3	652	8.4	0.01	259	82	0.2	0.06	43	7
Loboc River	13-Aug-07	7.85	10	8	238	3	0.23	181	12	0.38	0.06	167	3.7
Carood River	14-Aug-07	7.68	50	24	138	5	0.2	*57*	23	**2.9**	0.09	62	5.2
Manaba River	14-Aug-07	8.1	5	1	212	4	0.1	169	22	0.16	0.06	156	1.7
Upper Wahig-Inabanga River	14-Aug-07	7.63	25	5	214	7.9	0.16	136	61	0.48	0.06	28	3.5
Ipil River	10-Sep-07	7.56	100	**200**	194	2.4	0.2	115	**48**	5.7	0.14	79	2
Alijawan River	10-Sep-07	7.73	20	8	262	4.4	0.02	192	28	0.44	0.06	181	2
Lower Wahig-Inabanga River	14-Aug-07	7.44	10	8	230	18	0.03	138	56	0.9	0.06	68	3.5

**No prescribed values set*
For further details refer to Appendix II.4-C - PNSWD

4.6 WATER BALANCE ANALYSIS

The assessment of the availability and dependability of water resources for development is anchored on the extent of available information of the Basin under scrutiny. The information available is not enough to be directly used at hand to forecast water balance analysis for planning purposes.

Nevertheless, water balance analysis is required; thus, the methodology applied herein requires mathematical modeling of the basin focused on the low flow or dependable flow analysis.

4.6.1 Water Requirement

On the other side of the water balance analysis was the estimation of water demand for relevant water resource development such as water supply and irrigation. It consists of domestic and municipal water demand, industrial water demand and agricultural water demand. Likewise, riparian releases for environmental consideration, which is about 10% of the dependable flow is included in the computation of the water demand.

Water users can be classified as those that consumed water and those that can be reused. Domestic, municipal, industrial, and agricultural water demands are normally consumed whereas those for hydropower are re-used. Target levels are set for each water usage as shown below.

Table 4-15 Water Demand Projection

Demand Scenario, lps	Present Day	Year 2015	Year 2020	Year 2025	Year 2030	Year 2035
Riparian for Selected Basin	931.49	931.49	931.49	931.49	931.49	931.49
Irrigation	2,400.00	2,580.00	2,760.00	2,760.00	2,760.00	2,760.00
Water Supply Demand		1,661	2,308	2,734	2,984	3,177

4.6.2 Available Supply

The availability of water for each of the basins is estimated based on the mean rainfall and the rainfall-runoff coefficient. **Table 4-16** shows the computation.

Table 4-16 Water Availability

No.	Subbasin	Area, km^2	mean Rainfall, mm	Residual Runoff, mm	mean Q, m^3/s	dep Q, m^3/s	env Q, m^3/s	net Q, m^3/s
1	Tocdog	46.92	1,908	668	0.99	0.15	0.01	0.13
2	Panamnam	36.46	3,038	1,064	1.23	0.18	0.02	0.17
3	Soom	77.76	1,860	651	1.61	0.24	0.02	0.22
4	Cutcutan	52.87	3,474	1,216	2.04	0.30	0.03	0.27
5	Panangatan	58.00	3,452	1,208	2.22	0.33	0.03	0.30
6	Tagbuane	139.53	1,596	559	2.47	0.37	0.04	0.33
7	Anislag	45.69	1,644	576	0.83	0.12	0.01	0.11
8	Mualon	63.72	1,706	597	1.21	0.18	0.02	0.16
9	Cance	57.38	1,978	692	1.26	0.19	0.02	0.17
10	Manaba	99.70	2,979	1,043	3.30	0.49	0.05	0.44
11	Loboc	659.68	2,488	871	18.22	2..72	0.27	2.45
12	Abatan	368.33	2,220	777	9.08	1.35	0.14	1.22
13	Tubigon	198.03	1,803	631	3.96	0.59	0.06	0.53
14	Dait	241.08	1,968	689	5.27	0.79	0.08	0.71
15	Ipil	299.58	2,364	827	7.86	1.17	0.12	1.06

No.	Subbasin	Area, km^2	mean Rainfall, mm	Residual Runoff, mm	mean Q, m^3/s	dep Q, m^3/s	env Q, m^3/s	net Q, m^3/s
16	Carood	214.85	2,511	879	5.99	0.89	0.09	0.80
17	Alijawan	166.57	1,907	668	3.53	0.53	0.05	0.47
18	Wahig-Inabanga	620.32	2,101	736	14.47	2.16	0.22	1.94
19	Biabas	208.49	2,757	965	6.38	0.95	0.10	0.86
20	Lumbay	104.34	1,644	576	1.90	0.28	0.03	0.26

Note: Selected River Basin

Total for the Island	**93.82**	**14.00**	**1.40**
Total for the Selected Basin	**62.44**	**9.31**	**0.93**

The following are the selected river basins for water availability analysis:

1. Manaba River
2. Loboc River
3. Abatan River
4. Ipil River
5. Carood River
6. Wahig-Inabanga River

4.6.3 Water Balance

By equating water available from the selected river basin with water demand with respect to the targeted planning horizon, surplus or deficits on water availability can be estimated. **Figure 4-13** shows the result of the analysis in graphical form.

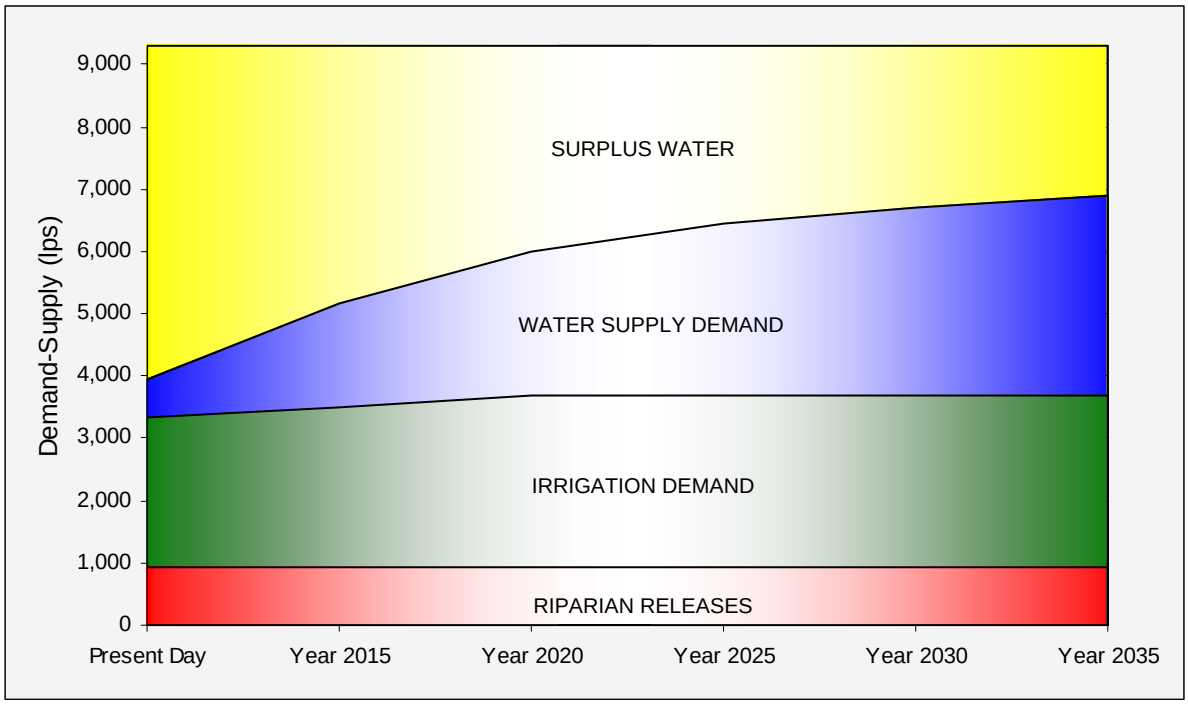


Figure 4-13 Water Balance

4.7 HYDROPOWER POTENTIAL

4.7.1 General

With the existing development in the island, assessment of the hydropower potential to augment the growing needs of the province especially for pumping requirements of the water supply is limited to steeper and larger river systems. The site selection for hydropower sites oftentimes compete with that of the irrigation, water supply, tourism and others, however, harmonization of the various purposes by applying a multipurpose project objective or by locating the hydropower sites upstream of them would then eliminate the said competition.

In this context, assessment of the hydropower potential is undertaken as a single purpose project and therefore the location to be investigated are limited to those areas upstream of existing or proposed systems (irrigation, water supply and etc.)

4.7.2 Potential Location

The hypsometric curves earlier discussed for the selected basin provide excellent initial data for the assessment of the hydropower potential sites. In general, the best location of hydropower sources and powerhouse sites are in the middle third of the river profile in which the head (elevation difference between the source and the powerhouse site) and the available discharge both factored as product (energy) is in optimum scenario. The hypsometric curves of the six (6) selected river basins, which are among the larger basins in terms of catchment size together with the existing/proposed system are analyze. The analysis revealed the following observations and possible hydropower sites.

4.7.2.1 Abatan River

There are two (2) independent potential sites found in Abatan River which can be developed into hydropower projects and these are Abatan-1 and Abatan-2.

Abatan-1

The proposed concrete weir with height of 10m will be located in the upper reaches of Abatan in the vicinity of the Barangay Poblacion in Catigbian which will stabilize the water level at elevation 200masl prior to its diversion, The diverted water will then be conveyed by a concrete pipe about 2,380m long to the surge tank located in Barangay Poblacion West in Catigbian, then through a steel pipe (penstock) and finally to the proposed powerhouse at elevation 80masl located in Barangay Cambang in the Municipality of San Isidro. The schematic diagram is shown in **Figure 4-14**.

Abatan-2

The tapping location for its source will be located in the upper reaches of Abatan in the vicinity of the Barangay Cambang in the Municipality of San Isidro which is done by a concrete weir with height of 15m that stabilized the water level at elevation 60masl prior to its diversion, The diverted water will then be conveyed by a concrete pipe about 3,700m long to the surge tank located in Barangay Sinkayanan in Catigbian, then through a steel pipe (penstock) and finally to the proposed powerhouse at elevation 20masl located in Barangay Sinkayanan in the Municipality of Catigbian. The schematic diagram is shown in **Figure 4-15**.

4.7.2.2 Loboc River

There are two (2) independent potential sites found in Loboc River which can be developed into hydropower projects and these are Loboc-1 and Loboc-2.

Loboc-1

Proposed concrete weir with height of 5m will be located in the upper reaches of Loboc in the vicinity of the Barangay Rosariohan in the Municipality of Batuan which will stabilize the water level at elevation 120masl prior to its diversion, The diverted water will then be conveyed by a concrete pipe about 3,700m long to the surge tank located in barangay Rizal in Batuan, then through a steel pipe (penstock) and finally to the proposed powerhouse at elevation 100masl located in Barangay Hanopol Este in the Municipality of Balilihan.

Loboc-2

The tapping location for its source using concrete weir with height of 10m will be located in the right confluence just upstream of existing Janopol Mini Hydropower System in the upper reaches of Loboc which will stabilized the water level at elevation 140masl prior to its diversion. The diverted water will then be conveyed by a concrete pipe about 5,220m long to the surge tank, then through a steel pipe (penstock) and finally to the proposed powerhouse at elevation 100masl. All the structures will be located in Barangay Rizal in the Municipality of Batuan.

The schematic diagrams for the two (2) are shown in **Figure 4-16.**

4.7.2.3 Manaba River, Alijawan River, Carood River

In terms of hydropower potential, the three (3) rivers namely; (i) Manaba, (ii) Alijawan and (iii) Carood have common characteristics. The catchment areas are quite small to yield acceptable firm flow (dry season runoff about 95% time of occurrence). Likewise, there are existing water supply systems upstreams of the basins while in the middle third of the basins, the proposed diversion location for water supply project are located.

4.7.2.4 Ipil River

The presence of Bayongan Dam of BIP stage II in the middle third of the basin which, catches all the water upstream of the dam to a large reservoir and diverts for irrigation purposes eliminates the basin for hydropower potential analysis.

4.7.2.5 Wahig-Inabanga River

Similar to Ipil River, the presence of Malinao Dam of BIP stage I in the middle third of the basin which, catches all the water upstream of the dam to a large reservoir and diverts for irrigation purposes eliminates the basin for hydropower potential analysis.

4.7.3 Initial Capacity and Energy Evaluation

Initial estimates of the power and energy output of the hydropower schemes earlier discussed are shown in **Table 4-17**.

Table 4-17 Capacity and Energy

Scheme Title	Abatan-1	Abatan-2	Loboc-1	Loboc-2
River Basin	Abatan	Abatan	Loboc	Loboc
Diversion Type	Weir	Weir	Weir	Weir
Height, m	10	15	5	10
Full Supply Level FSL, masl	200	70	120	140
Mean Discharge, m^3/s	1.68	2.12	5.89	6.7
Intake Capacity, m^3/s	3.36	4.24	11.78	13.4
Headrace Type	Pipe	Pipe	Pipe	Pipe
Headrace Length, m	2380	3700	3640	5220
Penstock Length, m	125	55	27	40
Tailwater TL, masl	80	20	100	100
Available Head, m	120	50	20	40
Net Head, m	117.50	46.245	16.333	34.74
Firm Flow, m^3/s	0.10	0.13	0.36	0.41
Secondary Flow, m^3/s	1.09	1.37	3.82	4.34
Installed Capacity. MW	3.40	1.69	1.66	4.01
Annual Firm Energy, GWh	9.11	4.52	4.44	10.74
Annual Secondary Energy, GWh	95.31	47.34	46.45	112.39
Annual Energy, GWh	104.42	51.86	50.89	123.13

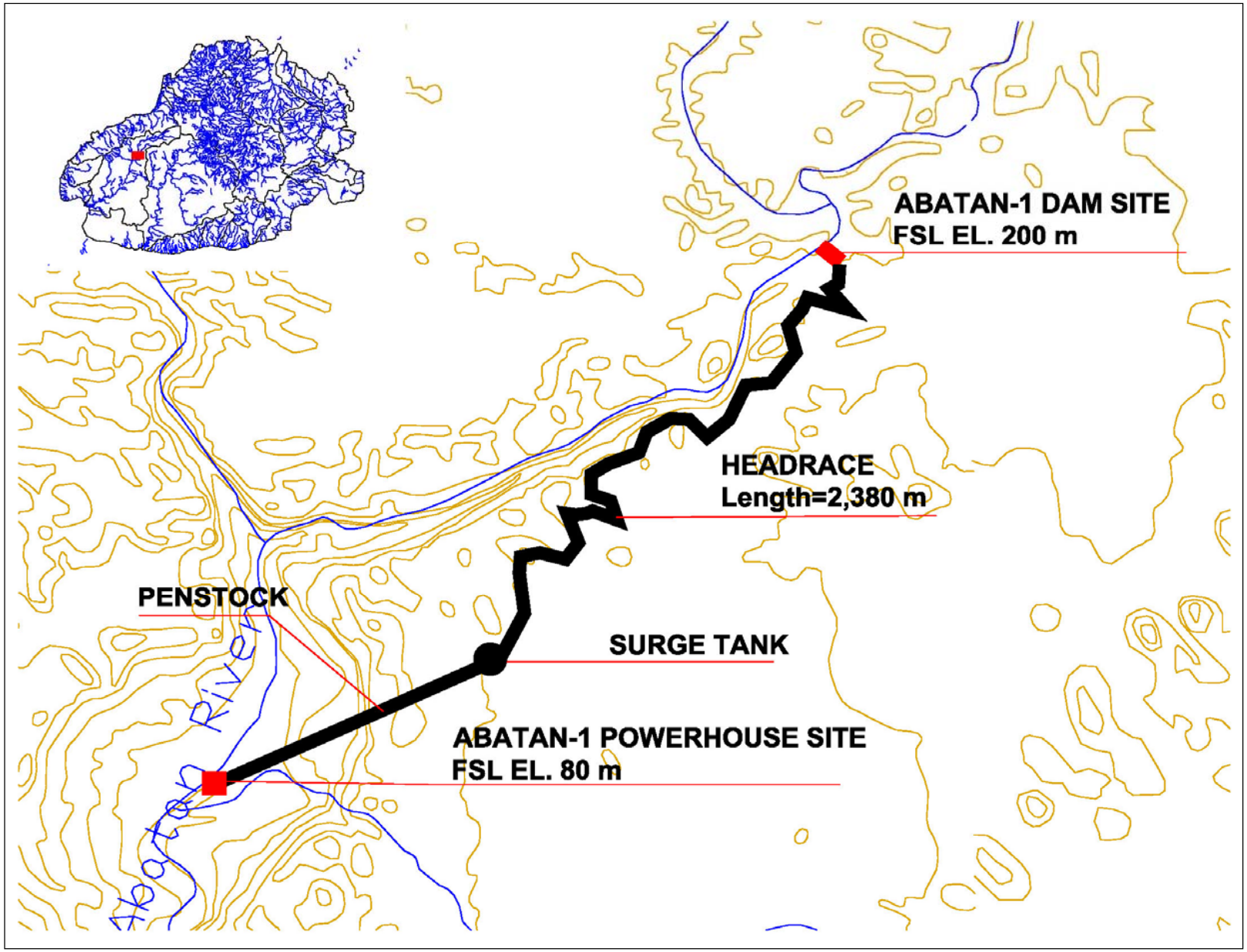


Figure 4-14 Schematic Diagram of Abatan-1 Hydropower Project

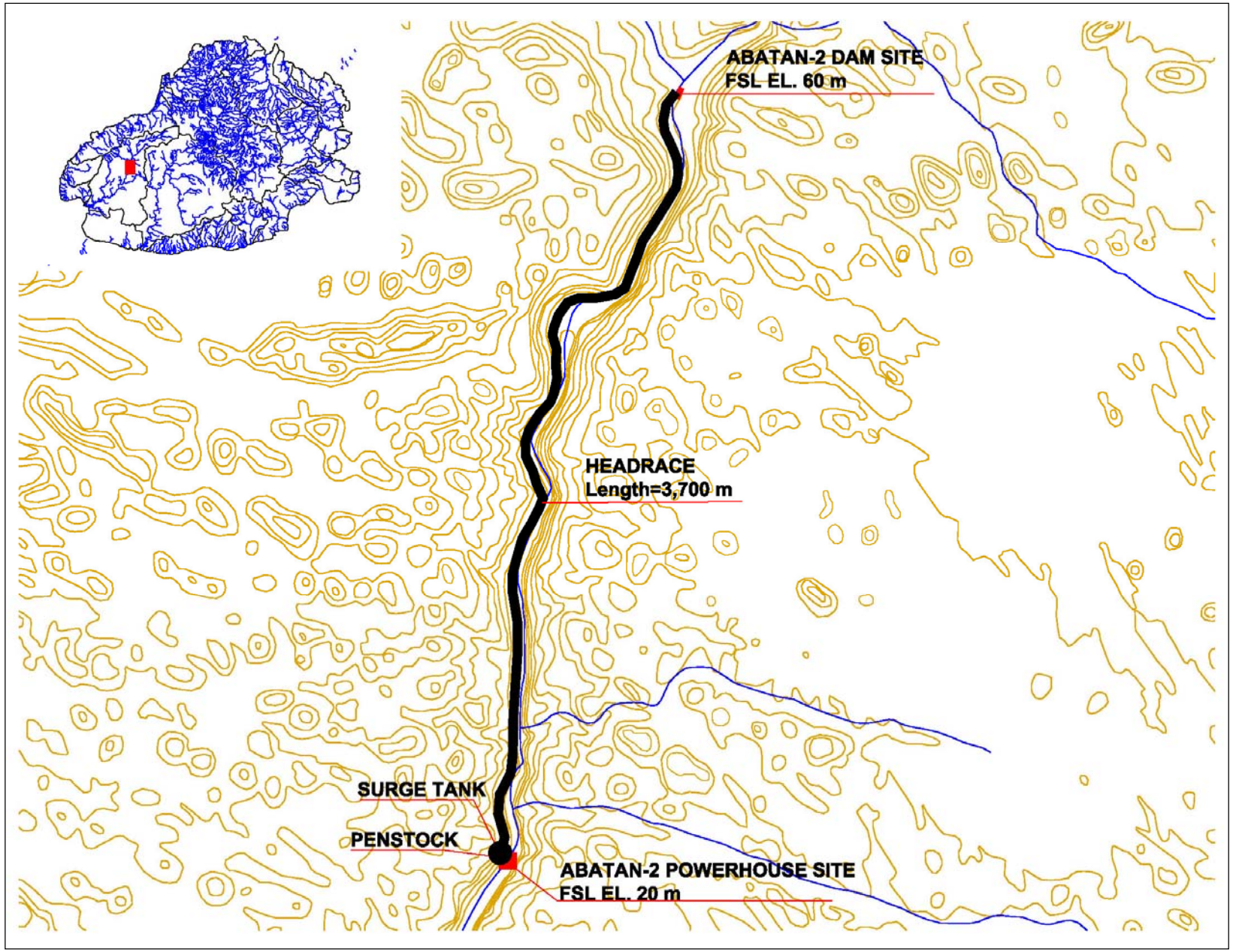


Figure 4-15 Schematic Diagram of Abatan-2 Hydropower Project

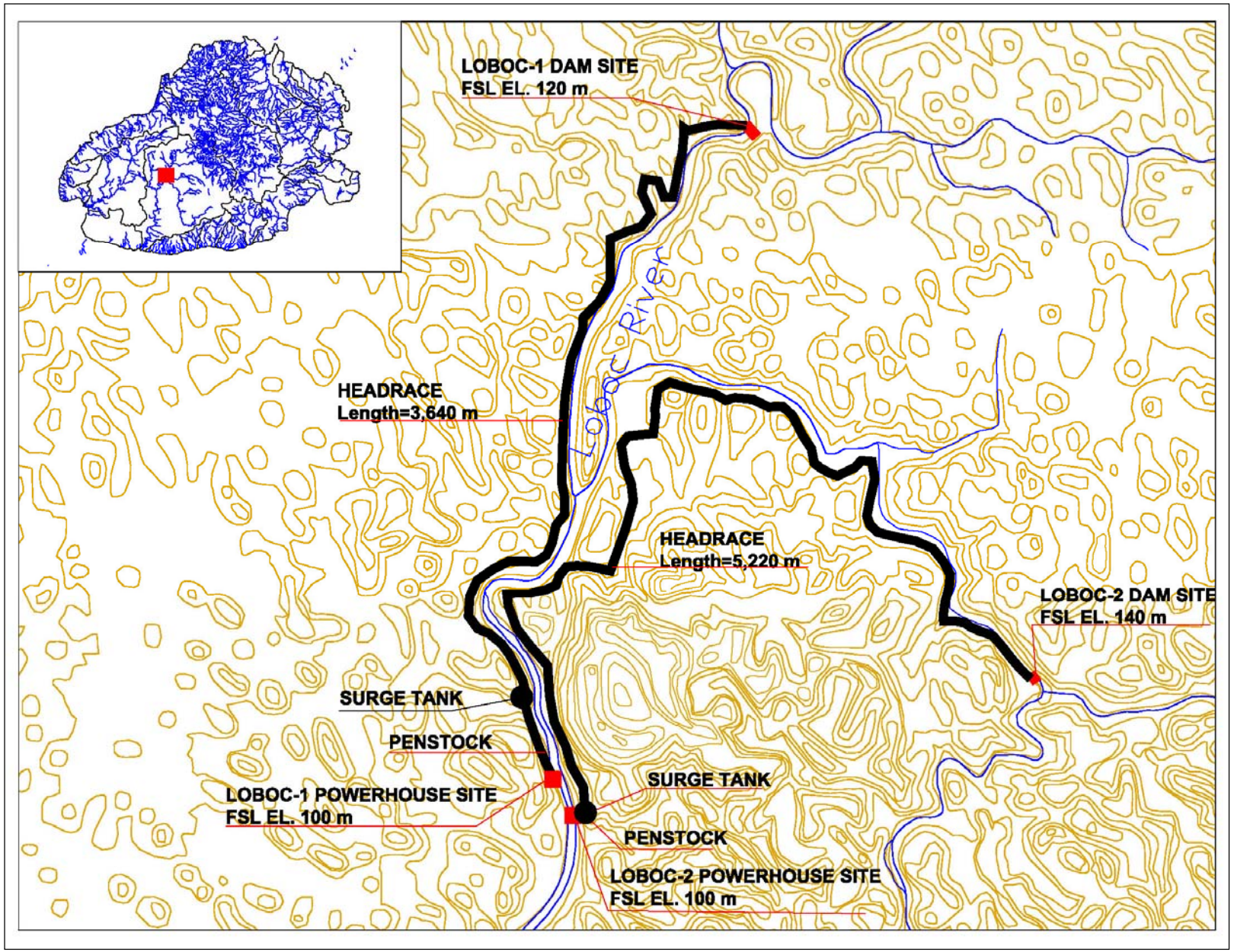
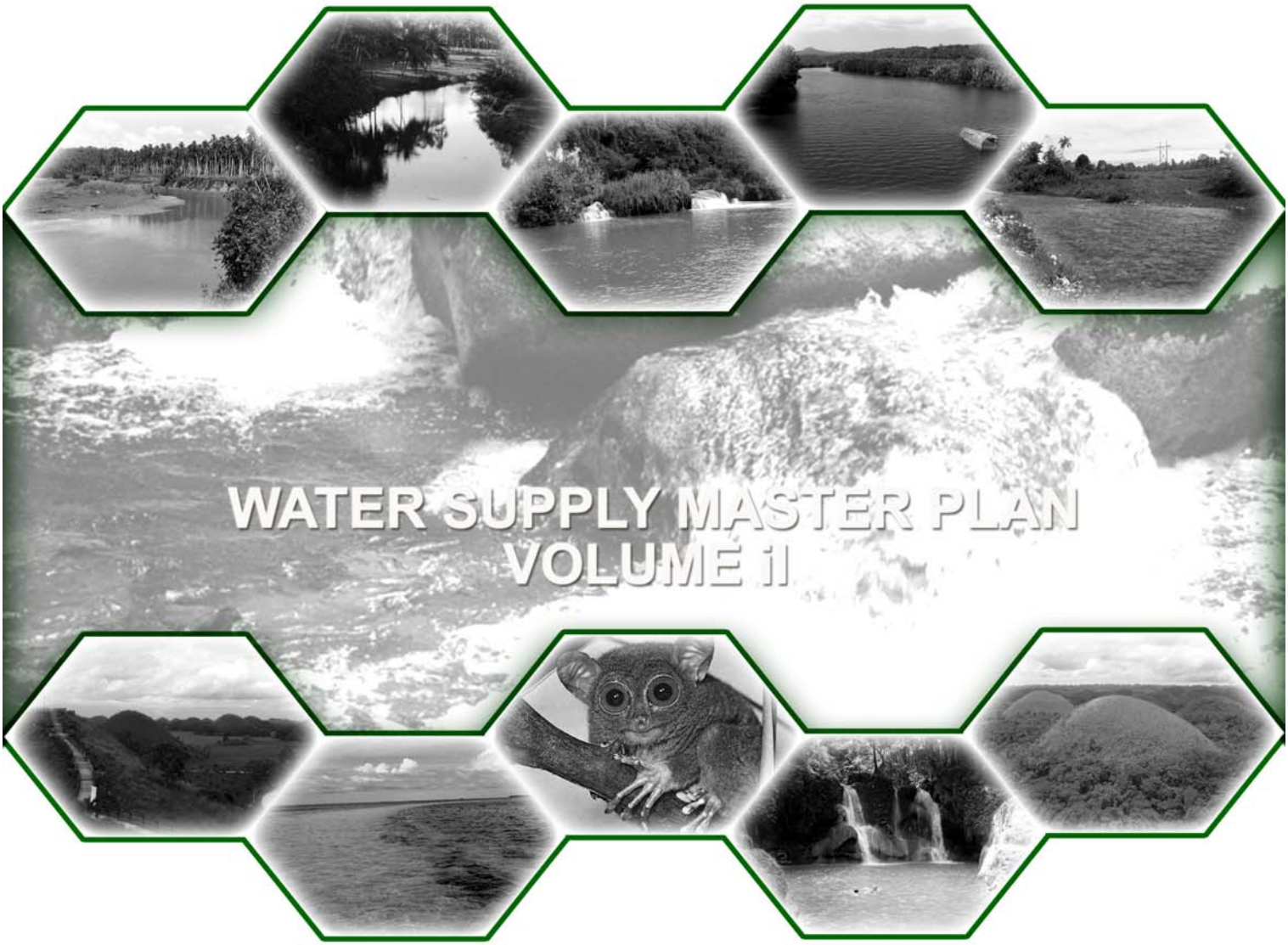


Figure 4-16 Schematic Diagram of Loboc-1 and Loboc-2 Hydropower Project



CHAPTER 5
ALTERNATIVE ANALYSES

CHAPTER 5 – ALTERNATIVE ANALYSES

5.1 GENERAL

This chapter presents and evaluates the different alternatives considered in developing the most viable water supply scheme for the province of Bohol. The alternatives considered in the study were mainly focused on the development of the surface water source to augment the existing groundwater source. As stated in the Scope of Services, the purpose of this study is to develop an Integrated Water Supply Master Plan that will guide the province of Bohol in the development of its water resources for safe domestic, commercial and industrial use in order to improve the health of the community, while increasing opportunities for local economic development and at the same time protect the depleting groundwater systems. This integrated water supply master plan where bulk supply may be recommended, aims to provide water for the entire province of Bohol comprising of 47 municipalities and one city. It also aims to address the problem on extreme and uncoordinated fragmented usage of water, inadequate water management planning, and institutional restrictions on water related issues.

The province visualizes the development of an integrated water system through laying of interconnected pipelines along the coastal and main roads, where possible, to serve clusters of municipalities according to location, proximity to the source, and topography or physical considerations.

As projected, the province will have an average day demand of about 2,585 L/s and 2,940 L/s or about 81.5 mcm/yr and 93 mcm/yr by year 2025 and 2035, respectively. Water supply for the projected demands will come from the existing developed and safe water sources in each municipality that are comprised either of springs and wells, and from the potential surface water sources identified and recommended under Chapter 4 of Volume II, Water Resources, of this report.

Water availability from each of the selected river basins, namely, Abatan, Loboc, Manaba, Carood, Ipil and Inabanga, was checked if it can meet the projected water demands of the 47 municipalities and the city of the Tagbilaran for years 2025 and 2035.

At least two schemes for each **river cluster (comprising of the river basin and the group of municipalities to be served)** were developed to include source development, pumping systems, treatment methods and facilities, reservoir and transmission lines. Preliminary design such as reservoir sizing and pipe sizing were undertaken. Potential sites for river diversion and its corresponding transmission pipeline to the prospective municipality were investigated. Basic concept design of the river diversion works, appurtenant structures and pipeline was also prepared. Depending on the water source site, system operation whether by a gravity-fed transmission system or pump system was evaluated. The basic cost estimate of each scheme was also prepared.

The basic construction cost (at October 2007 price levels), operation and maintenance costs and the non-economic aspects of the alternatives were compared to determine the most advantageous scheme that will be recommended for each river cluster.

The engineering and economic criteria used in evaluating the alternatives were based on the criteria contained in the LWUA Methodology Manual and other generally accepted evaluation procedures**.**

5.2 CONSIDERATIONS

Factors such as water supply requirement for the design year 2035, potential water supply sources, water quality, storage requirements and locations, and other parameters relating to the existing system were considered in the analysis and evaluation of alternatives.

5.2.1 Planning Stages

The analyses of the alternatives include staging of facilities relative to the projected yearly demand of the service area. Staging primarily considered the equipment/facility to be installed at the river intakes to extract water supply and to deliver projected demands at years 2025 and 2035.

Phase I facilities are proposed to be constructed in year 2010 and expected to be operational at year 2013. Facilities for Phase II requirement are considered for construction in 2025. Generally, the various facilities in the alternatives considered are designed for maximum serviceability.

5.2.2 Existing Facilities

The capacities of the existing sources were estimated based on the reported number of persons served and the average unit consumption. Since there are no reliable production and consumption records in most of the municipalities, only a percentage of the estimated production were adopted in the evaluation. Based also on the information gathered, discharges from wells and springs drop during summer months hence estimated production were not fully utilized. It also worth mentioning that previous studies found that there are in some areas, particularly in Tagbilaran, groundwater is already affected by saline intrusion.

5.2.3 Potential Water Sources

Six river basins were selected as potential water sources (*Section 4.6.2, Chapter 4, Water Resources*). Criteria for the selection of the river basins included the availability of water which may be diverted for water supply net of environmental flows and other uses, and water quality. Other consideration included proximity of the river basin to a number of municipalities that may be served.

Table 5-1 Selected River Basins

River Basin	Area (km^2)	Dependable Q (m^3/s)	Net Q (m^3/s)
Abatan	368.33	1.35	1.22
Loboc	659.68	2.72	2.45
Manaba	99.70	0.49	0.44
Carood	214.85	0.89	0.80
Ipil	299.58	1.17	1.06
Inabanga	620.32	2.16	1.94
Total		8.78	7.91

Based on the results of a one time sampling for raw water quality testing for the selected river basins conducted by the Consultant in August 2007 , only Ipil River demonstrated high values for turbidity, chemical oxygen demand, total suspended solids and iron which means that a more extensive treatment may be required to make it fit for human consumption. More sampling tests should be conducted to confirm water quality of all selected sources.

The above total flow (dependable or net flow) from the six potential sources is sufficient to supply the additional water demand requirement of Bohol for the master planning period at year 2035.

Intake Location

About forty eight (48) possible intake points (**Figure 5-1**) within the identified river basins were evaluated in the selection of location of intake structure/diversion weir. The criteria for the selection process were the following:

1) accessibility possibly with right-of-way and support facilities such as power and communication lines;
2) transmission lines should run along existing roadway either barangay, provincial or national to eliminate right-of-way acquisition costs and resettlement costs for settlements that may be affected;
3) mode or degree of difficulty of transporting water to cluster of municipalities that may be served. A gravity system is preferred over a pumping system, or if possible should require minimum energy for pumping; and
4) geological stability of the area

Confirmatory ocular site investigations were also undertaken to verify actual conditions of the proposed sites. **Table 5-2** tabulates brief location description and estimated available flow for diversion.

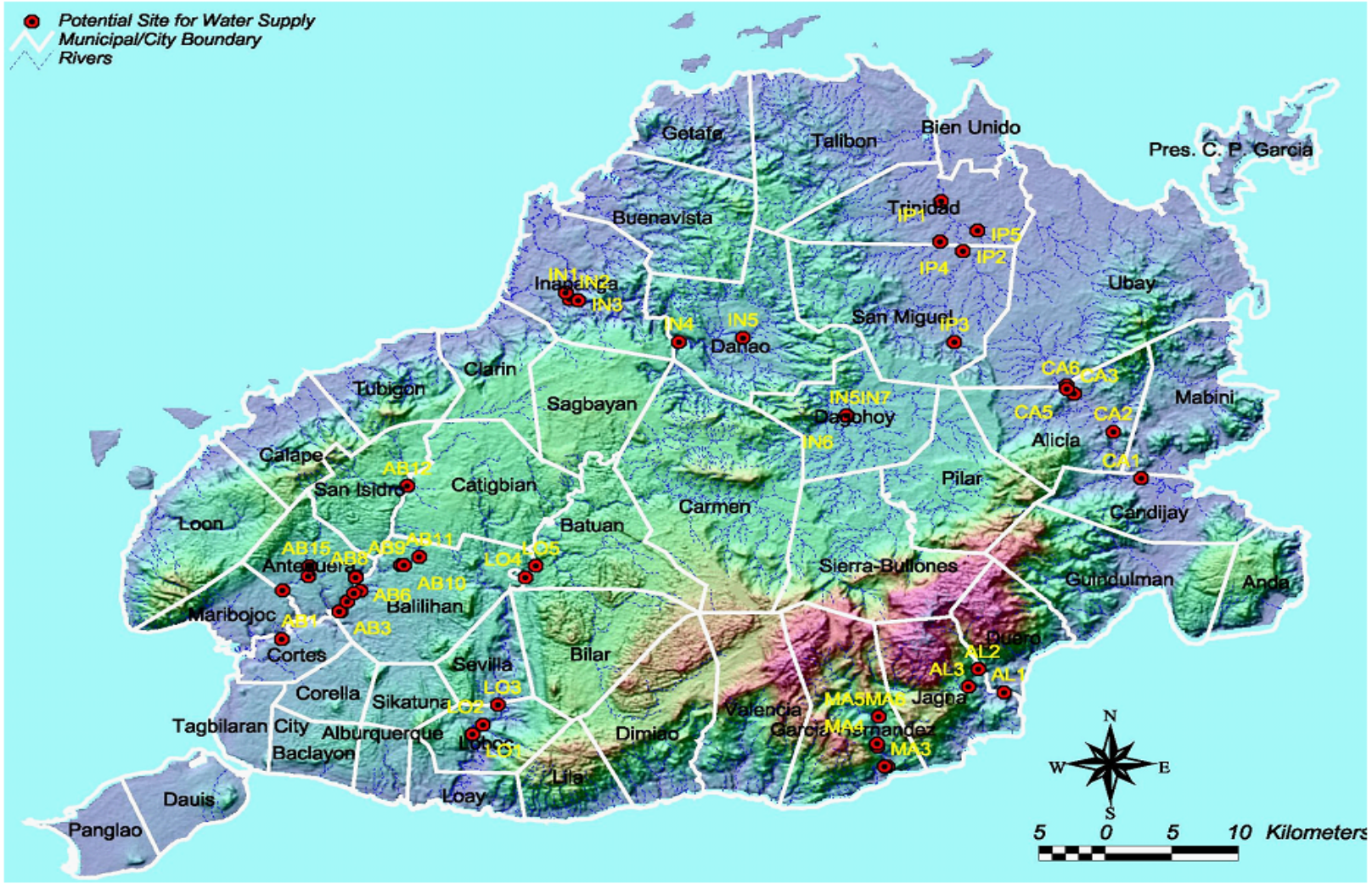
Table 5-2 Selected Intake Sites

River Intake Point	Barangay	Municipality	Longitude	Latitude	Available Q for Diversion (L/s)
Abatan (AB6)	Bgy. Viga	Antequera	123.9459	9.7658	532
Loboc (LO2)	Bgy. Gotozon	Loboc	124.0294	9.6633	1,780
Manaba (MA4)	Bgy. Victoria	Garcia-Hernandez	124.2993	9.6477	354
Carood (CA2)	Bgy. Mahayag	Alicia	124.4621	9.8855	529
Ipil (IP1)	Bgy. Hinlayagan Ilaud	Trinidad	124.3447	10.0622	623
Inabanga (IN1)	Bgy. Uog	Inabanga	124.0873	9.9934	1,454

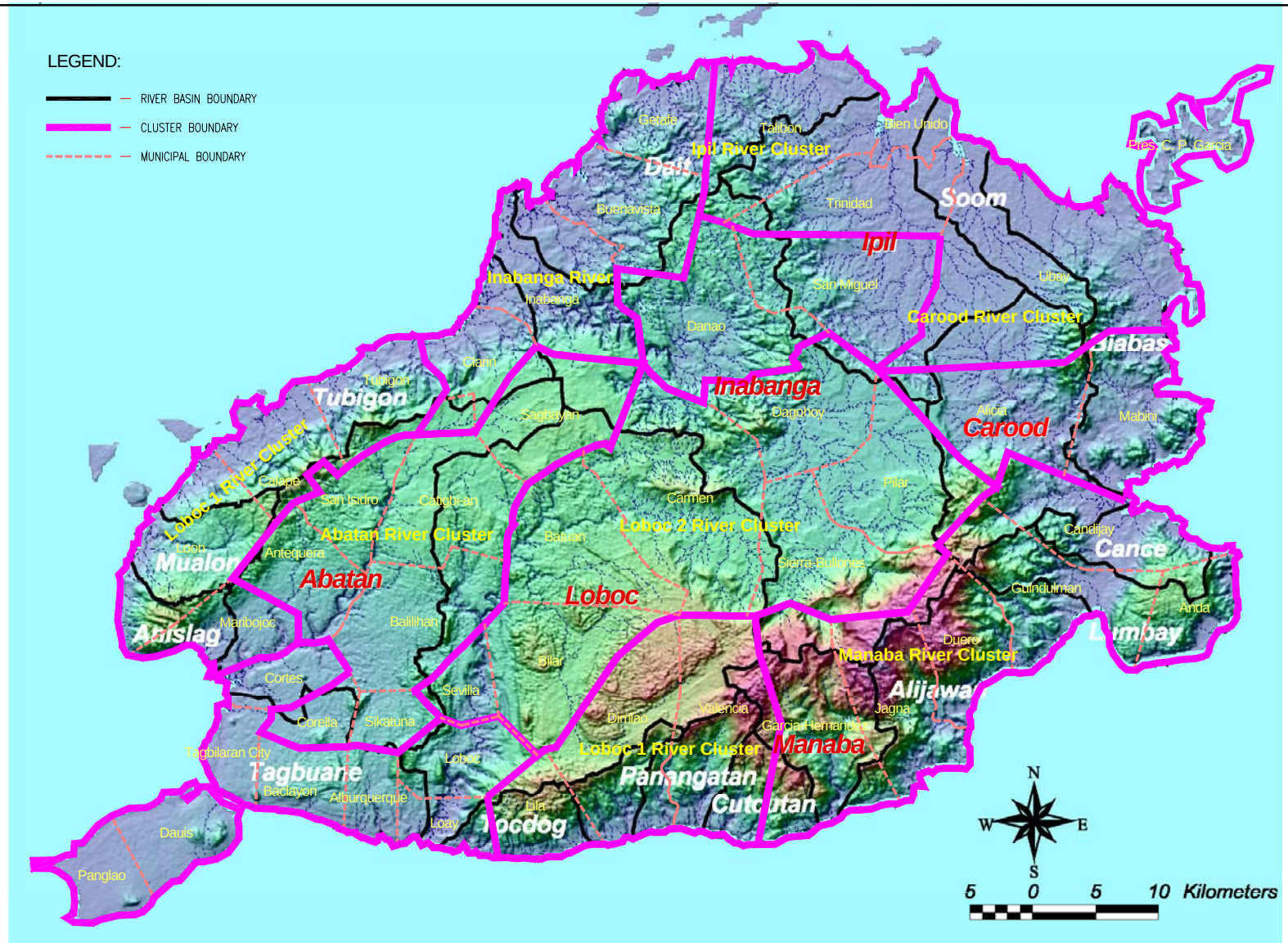
5.2.4 Projected Water Demand Requirements and Clustering of Municipalities

Based on the available flow that may be diverted for domestic supply, projected demands for years 2025 and 2035, the 47 municipalities and the city of Tagbilaran were grouped under each river basin. The major considerations in the clustering are the proximity of municipalities with respect to the river basin, hydraulic consideration and geomorphology of the area. **Figure 5-2** shows the proposed clustering of the municipalities superimposed on the six identified river basins. This figure also illustrates the area of influence of each basin.

Loboc River Basin may serve two clusters of municipalities because of the magnitude of flow which may be utilized for water supply.



CONSULTANTS		OWNER	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd.	WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	POSSIBLE INTAKE POINTS	FIGURE NO. 5-1



CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	RIVER BASINS & CLUSTERING OF MUNICIPALITIES	FIGURE NO. 5-2

As mentioned, in *Chapter 3, Population and Water Demand Projections*, the capacity of the source is designed to meet the maximum-day demand requirement of the system. Following is the table showing water demand by cluster and the corresponding supply that will come from the proposed and existing sources.

Table 5-3 Projected Water Demand By Cluster

River Cluster	Municipalities	Projected Average Day Demand at Year 2035 (cumd)	Projected Maximum Day Demand at Year 2035 (cumd)	Estimated Supply Quantity from Existing Sources (cumd)	Supply from River Basin (cumd)
Abatan	Antequera Catigbian San Isidro Sagbayan Balilihan Sikatuna Corella	13,912	17,918	3,733	14,185
Loboc 1	Loboc Loay Lila Dimiao Valencia Alburquerque Baclayon Tagbilaran Dauis Panglao Cortes	83,668	105,361	22,359	83,002
Loboc2	Sevilla Bilar Batuan Carmen Dagohoy Sierra Bullones Pilar	22,445	28,459	2,833	25,626
Manaba	Garcia-Hernandez Jagna Duero Guindulman Anda Candijay	23,629	29,806	5,211	24,595
Carood	Mabini Alicia San Miguel Danao Ubay Pres. C. P. Garcia	26,700	33,757	2,166	31,591
Ipil	Bien Unido Trinidad Talibon Getafe Buenavista	31,297	39121	1,329	37,792
Inabanga	Inabanga Calape Clarin Loon Maribojoc Tubigon	52,112	65,483	7,777	57,706
TOTAL		**253,763**	**319,906**	**45,408**	**274,498**

5.2.5 Storage Facilities

Generally, the required storage facility is taken as a percentage of the maximum day demand (MDD) usually sufficient to supplement and balance the constant supply rate against hourly demand fluctuations. During peak-hour conditions and whenever the production of the sources is less than the demand of the system, additional water supply will be provided by storage facilities.

For each river cluster, the volume of storage considered is equivalent to two hours operation of the system. This volume includes treated water reservoir to be located near the water treatment plant and the reservoirs/sumps along the transmission lines that will serve as emergency storage during actual operation of the whole system. **Table 5-4** presents the emergency storage volume requirements for each river cluster.

Table 5-4 Total Storage Volume for Each River Cluster

River Cluster	Storage Volume (cum)
Abatan	1,184
Loboc 1	6,917
Loboc 2	3,918
Manaba	2,054
Carood	2,633
Ipil	3,149
Inabanga	4,809

Operational storage requirement will be provided by each municipal waterworks to cope with the demand variation of the individual municipal system, hence, it will not be considered in proposed river cluster system.

5.2.6 Intake Facilities and Water Treatment Plant (WTP)

The intake facilities will consist of an intake structure/weir and pumping system to divert water to the proposed WTP. The intake structure will also prevent intrusion of seawater into the fresh water supply. The dimensions of the intake structure depend on the characteristics of the river at the selected diversion point.

Table 5-5 River Intake Dimensions

Intake Location	Length (m)	Height (m)
Abatan	45	4
Loboc	30	3
Manaba	34	2
Carood	45	3
Ipil	50	2
Inabanga	75	2

Due to the physical and chemical characteristics of raw water from the sources, treatment process involving coagulation, flocculation, sedimentation, filtration and chlorination will be undertaken. Water treatment process is the same for all schemes for the river clusters. The capacities of the WTP are listed in **Table 5-6**.

Table 5-6 WTP Capacity

River Cluster	WTP Capacity	
	MLD	L/s
Abatan	14.18	164.18
Loboc 1	83.00	960.67
Loboc 2	25.63	296.59
Manaba	24.60	284.67
Carood	31.59	365.13
Ipil	37.79	437.36
Inabanga	57.70	667.89

5.2.7 Transmission Lines

The transmission mains for raw water and treated water will be constructed to transport water from the source to the treatment plant and from treated water reservoir to the offtake at each municipality. The sizes of the transmission lines were determined through hydraulic simulations of flows and pressures in the system using the EPANET 2.0 computer programme.

The following design criteria were considered in the hydraulic analysis:

(i) System Pressure

The minimum pressure heads to be adopted along the transmission lines is 7 meters (10 psi) while the maximum pressure will be limited to 70 meters (100 psi). For bulk supply purposes, a minimum pressure of 14 meters (20 psi) is required at each municipal offtake. In cases, where pressure is less than 14 meters, or where it is more economical, a booster pump will be installed to satisfy a pressure of 14 meters at offtakes.

(ii) Flow Velocity in the Distribution System

The flow velocity in the transmission system will be limited to a maximum of 3 m/s at all times and a minimum of 0.3 m/s.

(iii) Computer Analyses

The results of the computer simulations using EPANET 2.0 water supply network analysis program and the schematic nodal diagram are shown in **Appendices II.5-1A, B, C and D to 5-7A and B , Vol. III, Databook.**

The Hazen-Williams empirical formula was used in the hydraulics analysis and the flow coefficients ("C" value) used is 120 for all pipes.

5.3 DEVELOPMENT AND EVALUATION OF SCHEMES

Two schemes were developed and evaluated for each of the six river clusters while only one scheme was developed for Wahig-Inabanga River. The development of schemes were simulated and analyzed based on two basic considerations: (a) minimum use of sumps; and (b) maximum use of sumps. The minimum use of sumps considers the use of bigger diameter pipes in order to provide the required pressures at the offtakes while minimizing the extensive utilization of booster pumps. The maximum use of sumps considers the use of smaller diameter pipes but uses booster pumps to provide adequate pressures at the offtakes. These basic considerations (schemes) have their own advantages and disadvantages depending on the topography, and relative distances and elevations of offtakes with reservoir.

Each scheme included source development, pumping system, treatment system, reservoir and sumps, transmission lines for the purpose of delivering required bulk water supply at the offtake of each municipality at a pressure of not less than 14 meters.

The net present worth costs of the schemes at a discount rate of 12% were compared with respect to the investment costs, maintenance and pumping costs at October 2007 price levels. The least cost schemes together with non-economic considerations were selected and recommended for the proposed integrated water supply system.

To simplify the analysis and evaluation of proposed schemes, the cost of facilities that are common were not included in the evaluation. The common items include power source development, site development and provision for right-of-way. However, common items that are major components of the schemes such as intakes, reservoirs and water treatment plants were included in the evaluation.

5.3.1 Abatan River Cluster

The Abatan River Cluster will serve seven inland municipalities shown in **Table 5-3** with a projected bulk demand of 14,185 cumd (164 L/s). For both schemes 1 and 2, the diversion weir and intake is located at Bgy. Viga, Municipality of Antequera while the WTP is located at Bgy.Del Carmen, Municipality of Balilihan. The capacity of the WTP is shown in **Table 5-6**, the intake and weir dimensions shown in **Table 5-5**, and the total reservoir volume for two-hour storage is shown in **Table 5-4**.

Both schemes will require the installation of 209 Hp pump at the intake to transport water to the WTP.

Scheme 1

Three booster pumps will be separately installed at the WTP, to pump water to Antequera (1Hp); 121 Hp for the combined demand of Catigbian, Sagbayan and San Isidro; and 17 Hp for the demands of Balilihan, Sikatuna and Corella. The elevations from the WTP to Sagbayan vary from 118 mamsl to 243 mamsl, hence a series of booster pumps with reservoirs/sumps are installed along the transmission mains and with heads sufficient to meet supply and pressure requirements for Catigbian and Sagbayan offtakes. San Isidro will be provided with its own sump and booster pump to deliver water supply requirement at pressure of 14 meters at the offtake. The total capacity of the pumps for this scheme is 534 Hp including those at the intake and WTP.

Figure 5-3A shows the schematic diagram of Scheme 1 for Abatan River Cluster with information on pipe sizes and lengths, and pump capacities.

Scheme 2

Similarly with Scheme 1, three booster pumps will be separately installed at the WTP to pump water to Antequera (1Hp); 121 Hp for the combined demand of Catigbian, Sagbayan and San Isidro; and 17 Hp for the demands of Balilihan, Sikatuna and Corella. Boosters pumps with sumps will also installed along the main transmission lines going to Catigbian and Sagbayan with heads sufficient to meet pressure requirements. Bigger pipes (250mmm diameter) going to San Isidro will be laid to minimize headlosses to be able to deliver about 17.95 L/s of water at a pressure of 14 meters. The total capacity of the pumps for this scheme is 561 Hp including those at the intake and WTP.

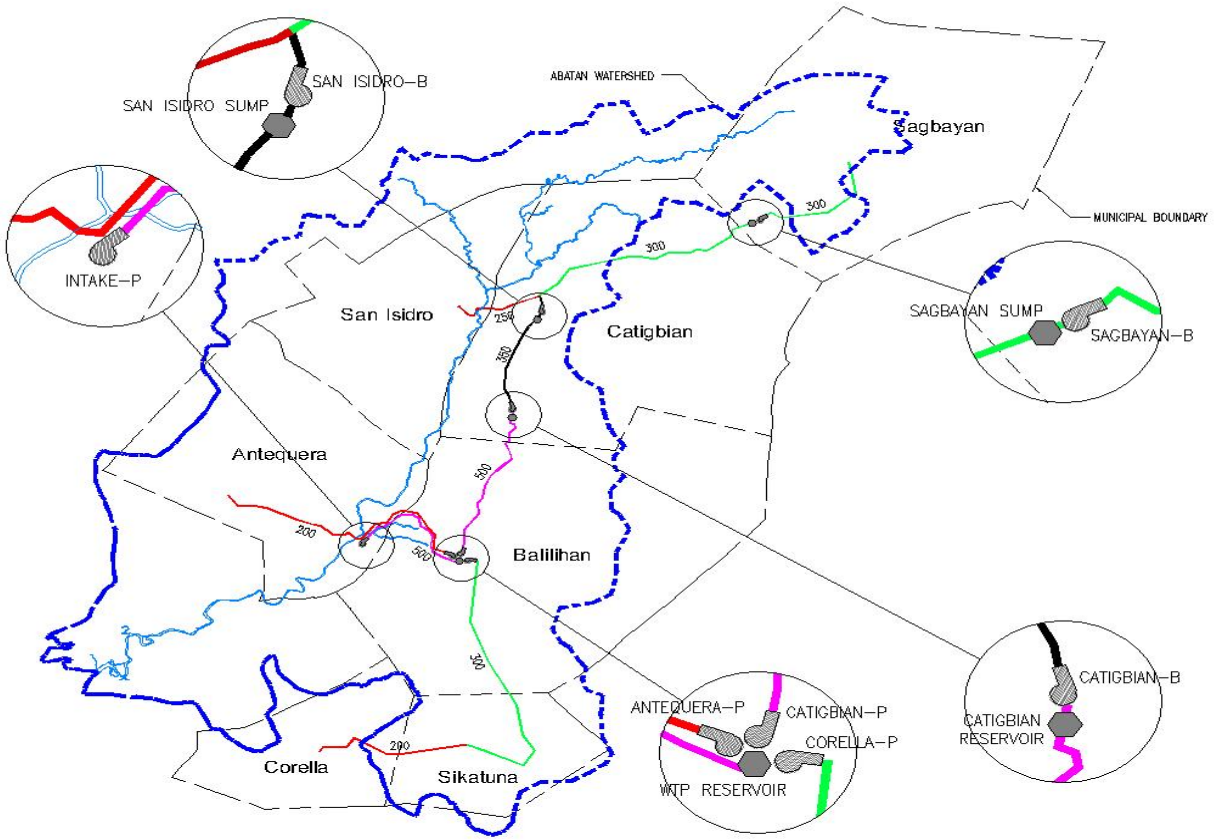
Figure 5-3B shows the schematic diagram of Abatan River Cluster Scheme 2 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

PIPES	
DIAMETER (mm)	LENGTH (m)
200	15161
250	3529
300	23896
350	5653
500	11266
TOTAL	59505

PUMPS	
NAME	Hp
INTAKE–P	209
ANTEQUERA–P	1
CATIGBIAN–P	121
CORELLA–P	17
CATIGBIAN–B	121
SAN ISIDRO–B	64
SAGBAYAN–B	28

RESERVOIRS/SUMPS	
NAME	VOLUME (m^2)
WTP RESERVOIR	976
CATIGBIAN RESERVOIR	111
SAN ISIDRO SUMP	58
SAGBAYAN SUMP	37

NOTE: 250 = PIPE DIAMETER IN MM



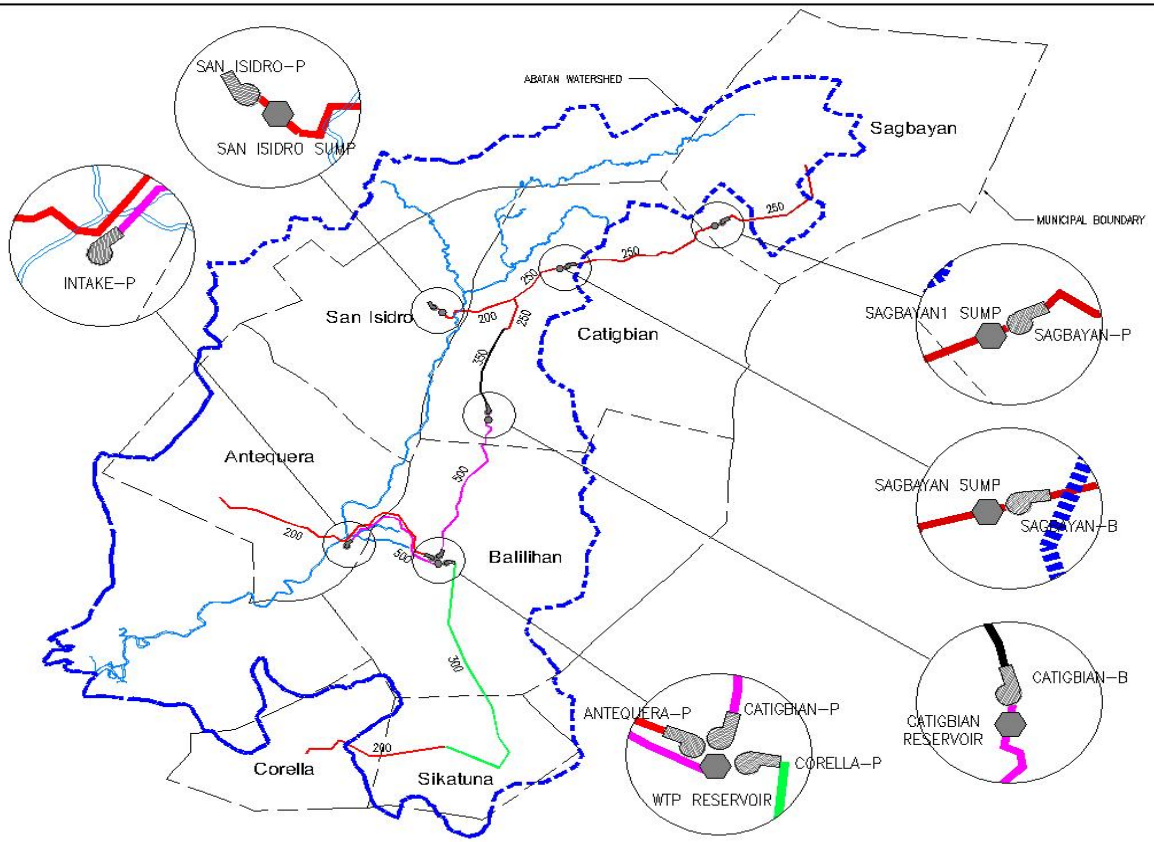
CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Abatan River Cluster Area Scheme 1	5-3A

PIPES	
DIAMETER (mm)	LENGTH (m)
200	18690
250	13110
300	10786
350	5653
500	11266
TOTAL	59505

PUMPS	
NAME	Hp
INTAKE–P	209
ANTEQUERA–P	1
CATIGBIAN–P	121
CORELLA–P	17
CATIGBIAN–B	121
SAN ISIDRO–P	11
SAGBAYAN–B	16
SAGBAYAN–P	38

RESERVOIRS/SUMPS	
NAME	VOLUME (m^3)
WTP RESERVOIR	976
CATIGBIAN RESERVOIR	111
SAN ISIDRO SUMP	22
SAGBAYAN SUMP	37
SAGBAYAN1 SUMP	37

NOTE: 250 = PIPE DIAMETER IN MM



CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Abatan River Cluster Area Scheme 2	5-3B

The result of the comparison of costs is presented as follows:

Costs	Scheme 1		Scheme2	
	Total Cost @ October 2007 Prices (PhP)	NPW @12% Discount Rate (PhP)	Total Cost @ October 2007 Prices (PhP)	NPW @12% Discount Rate (PhP)
Construction Cost	666,880,545	459,027,147	682,592,156	469,805,734
Maintenance Cost	51,298,053	11,426,469	52,577,745	11,711,003
Pumping Cost	345,971,885	67,443,153	366,524,775	71,800,264
Total		537,896,768		553,317,001

The above comparison shows that Scheme 1 is 2.79% lower than Scheme 2.

Tables 5-7A and B show the breakdown of costs of major project components and the details of the net present worth costs for Schemes 1 and 2.

5.3.2 Loboc 1 River Cluster

The Loboc River Cluster will serve eleven municipalities shown in **Table 5-3** with a projected bulk demand of 83,002 cumd (1,555 L/s). For both Schemes 1 and 2, the diversion weir and intake is located at Bgy. Gotozon, Municipality of Loboc. The WTP is located about 250 meters away from the intake. The capacity of the WTP is shown in **Table 5-6,** the intake and weir dimensions shown in **Table 5-5**, and the total reservoir volume for two-hour storage is shown in **Table 5-4**.

Scheme 1

Loboc is identified as the source for the water demands of the clustered southern coastal towns, the northern western coastal towns and the central interior towns. The water supply is divided into two (2) water sub-systems namely: Loboc (Bulk) Water Sub-system 1 and Loboc (Bulk) Water Sub-System 2. This scheme deals with the Loboc (Bulk) Water Sub-System 1.

The transmission main consists pipe toward the south to Loay and then splits into an eastern branch – serving the coastal towns of Lila, Dimiao, and Valencia, a western branch – serving the coastal town of Alburquerque, Baclayon, Tagbilaran City, Dauis, Panglao, and Cortes,. The total transmission length along is about 77 km.

A booster pump is installed downstream the treatment plant at full head which will produce a minimum head of 14 meters at its remotest point/municipality. Hence, a ground reservoir or sump downstream the water treatment plant is provided to satisfy the water demands for the downstream municipalities.

This scheme will require pumps with a total capacity of 2,492 Hp including those at the intake and WTP.

Table 5-7A
Net Present Worth Costs (PhP)
Abatan River Cluster Scheme 1
(October 2007 Price Level)

Const. Year	Facilities	Quantity	Unit	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**Source Facility**	1	unit	50	**7,780,000**	**5,374,779**
	Intake Structure with weir at Abatan River					
	Water Treatment Plant	1	unit	50	**141,900,000**	**98,030,993**
	Rapid Sand Filtration Plant					
	Transmission Pipelines				**500,112,805**	**345,500,738**
	Valves, Fittings, Appurtenances and River Crossings		LS	50	65,232,105	45,065,314
	200mm	18,690	lm.	50	74,760,000	51,647,618
	250mm	13,110	lm.	50	87,837,000	60,681,806
	300mm	10,786	lm.	50	75,502,000	52,160,226
	350mm	5,653	lm.	50	53,703,500	37,100,827
	500mm	11,266	lm.	50	143,078,200	98,844,947
		59,505	lm.			
	Storage Facilities				**12,517,692**	**8,647,793**
	Concrete Ground Reservoir at WTP	976	cum	50	9,762,360	6,744,284
	AB1 between Balilihan & Catigbian	111	cum	50	1,330,272	919,013
	AB2 at San Isidro	22	cum	50	323,100	223,212
	AB3 between Catigbian & Sagbayan	37	cum	50	550,980	380,642
	AB4 between Catigbian & Sagbayan	37	cum	50	550,980	380,642
	Pump Stations				**1,967,168**	**1,400,191**
	200 Hp Pump at Intake	1	unit	15	789,264.00	561,783
	1 Hp Pump WTP Antequera	1	unit	15	18,984.00	13,512
	100 Hp Pump WTP Catigbian (Cat, Snlsid, Sag)	1	unit	15	392,224.00	279,177
	15 Hp Pump WTP Bal (Bal, Sik, Cor)	1	unit	15	72,632.00	51,698
	100 Hp Pump AB1 (Cat, Snlsid, Sag)	1	unit	15	392,224.00	279,177
	10 Hp Pump AB2 (San Isidro)	1	unit	15	51,072.00	36,352
	15 Hp Pump AB3 (Sagbayan)	1	unit	15	72,632.00	51,698
	40 Hp Pump AB4 (Sagbayan)	1	unit	15	178,136.00	126,794
2025	**Pump Stations**				**2,602,880**	**72,654**
	250 Hp Pump at Intake	1	unit	15	1,014,216.00	28,310
	1 Hp Pump WTP Antequera	1	unit	15	18,984.00	530
	125 Hp Pump WTP Catigbian (Cat, Snlsid, Sag)	1	unit	15	580,104.00	16,192
	20 Hp Pump WTP Balilihan (Bal, Sik, Cor)	1	unit	15	79,352.00	2,215
	125 Hp Pump AB1 (Cat, Snlsid, Sag)	1	unit	15	580,104.00	16,192
	15 Hp Pump AB2 (San Isidro)	1	unit	15	72,632.00	2,027
	20 Hp Pump AB3 (Sagbayan)	1	unit	15	79,352.00	2,215
	40 Hp Pump AB4 (Sagbayan)	1	unit	15	178,136.00	4,972
	TOTAL CONSTRUCTION COST				**666,880,545**	**459,027,147**
	Total Annual Maintenance Cost				51,298,053	**11,426,469**
	Total Annual Pumping Cost (Y2010 - Y2025)				345,971,885	67,443,153
	TOTAL NET PRESENT WORTH COSTS					**537,896,768**

Table 5-7B
Net Present Worth Costs (PhP)
Abatan River System Scheme 2
(October 2007 Price Level)

Const. Year	Facilities	Quantity	Units	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**Source Facility**	1	unit	50	**7,780,000**	**5,374,779**
	Intake Structure with weir at Abatan River					
	Water Treatment Plant	1	unit	50	**141,900,000.00**	**98,030,993**
	Rapid Sand Filtration Plant					
	Transmission Pipelines				**515,593,300**	**356,195,370**
	Valves, Fittings, Appurtenances and River Crossings		LS	50	67,251,300	46,460,266
	200mm	15,161	lm.	50	60,644,000	41,895,641
	250mm	3,529	lm.	50	23,644,300	16,334,561
	300mm	23,896	lm.	50	167,272,000	115,559,128
	350mm	5,653	lm.	50	53,703,500	37,100,827
	500mm	11,266	lm.	50	143,078,200	98,844,947
		59,505				
	Storage Facilities				**12,542,000**	**8,664,586**
	Concrete Ground Reservoir at WTP	977	cum	50	9,770,000	6,749,562
	BP1	111	cum	50	1,332,000	920,206
	BP2	59	cum	50	885,000	611,398
	BP3	37	cum	50	555,000	383,419
	Pump Stations				**2,056,936**	**1,464,086**
	200 Hp Pump Intake	1	unit	15	789,264.00	561,783
	1 Hp Pump WTP Antequera	1	unit	15	18,984.00	13,512
	10 Hp Pump WTP Catigbian (Cat, SnIsid, Sag)	1	unit	15	392,224.00	279,177
	15 Hp Pump WTP Balilihan (Bal, Sik, Cor)	1	unit	15	72,632.00	51,698
	100 Hp Pump AB1 (Cat, SnIsid, Sag)	1	unit	15	392,224.00	279,177
	60 HP Pump AB2 (SnIsid, Sag)	1	unit	15	279,272.00	198,780
	25 Hp Pump AB3 (Sagbayan)	1	unit	15	112,336.00	79,959
2025	**Pump Stations**				**2,719,920**	**75,921**
	250 Hp Pump Intake	1	unit	15	1,014,216.00	28,310
	1 Hp Pump WTP Antequera	1	unit	15	18,984.00	530
	125 Hp Pump WTP Catigbian (Cat, SnIsid, Sag)	1	unit	15	580,104.00	16,192
	20 Hp Pump WTP Balilihan (Bal, Sik, Cor)	1	unit	15	79,352.00	2,215
	125 Hp Pump AB1 (Cat, SnIsid, Sag)	1	unit	15	580,104.00	16,192
	75 HP Pump AB2 (SnIsid, Sag)	1	unit	15	319,928.00	8,930
	30 Hp Pump AB3 (Sagbayan)	1	unit	15	127,232.00	3,551
	TOTAL CONSTRUCTION COST				**682,592,156**	**469,805,734**
	Annual Maintenance Cost				52,577,745	**11,711,003**
	Annual Pumping Cost (Y2010 - Y2025)				366,524,775	71,800,264
	TOTAL NET PRESENT WORTH COSTS					**553,317,001**

Figure 5-4A shows the schematic diagram of Loboc 1 River Cluster Scheme 1 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

Scheme 2

For Scheme 2, operation from the WTP to Loay is similar to Scheme 1. Booster pumps will be installed along the main transmission mains with head just enough to boost water to the next municipality. Each municipality will also be provided with booster pump and sump to deliver the required minimum pressure of 14 meters at each offtake.

Scheme 2 will require pumps with a total capacity of 2,911 Hp (including those at intake and WTP).

Figure 5-4A shows the schematic diagram of Loboc 1 River Cluster Scheme 1 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

5.3.3 Loboc 2 River Cluster

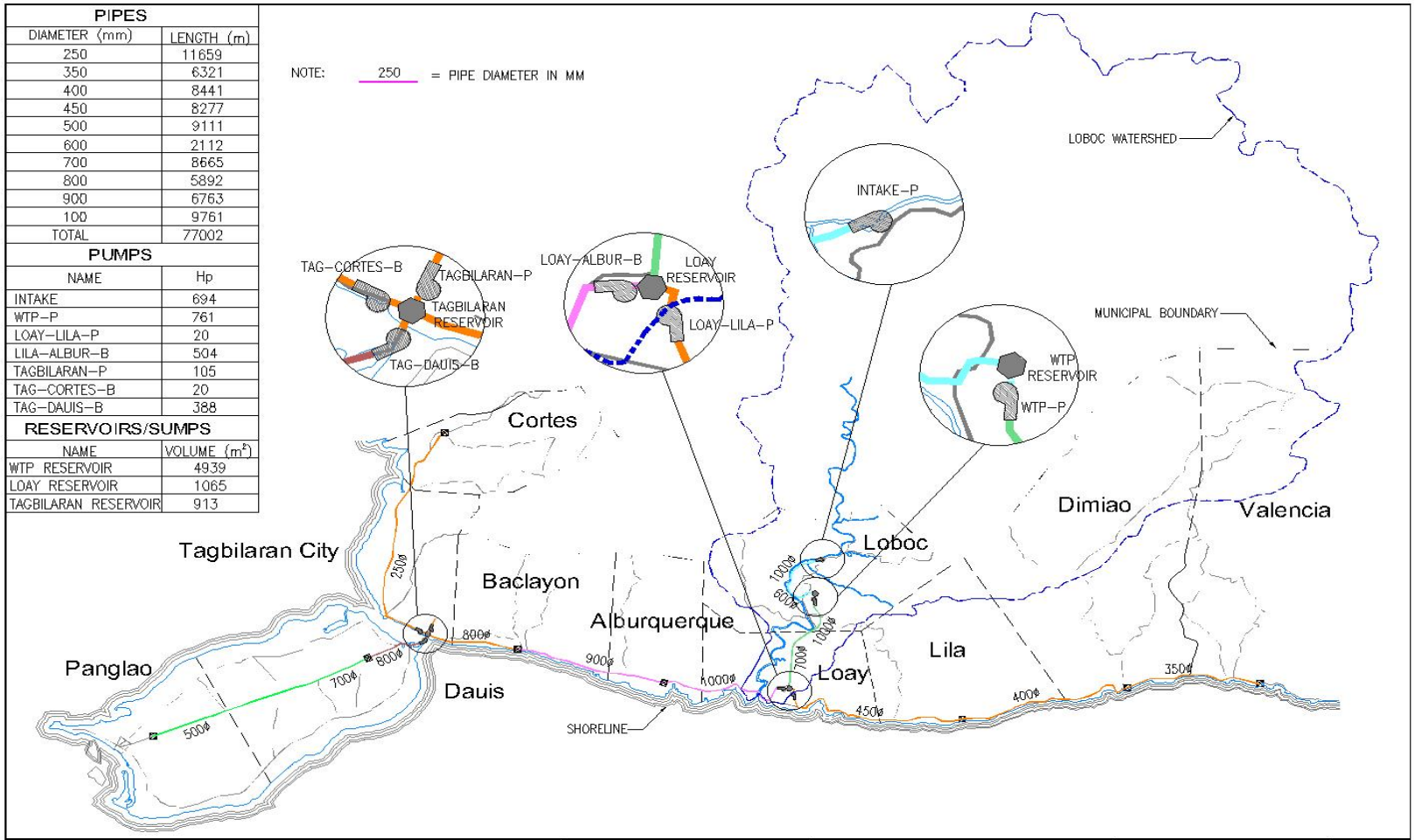
The Loboc River Cluster will serve six inland municipalities shown in **Table 5-3** with a projected bulk demand of 25,626 cumd (297 L/s). As mentioned in 5.3.2, this cluster will have the same intake point as Loboc 1 River Cluster. The WTP is distinct from that of Loboc 1. The WTP and is located in the Municipality of Bilar, about 8,694 meters away from the intake. The capacity of the WTP is shown in **Table 5-6**, the intake and weir dimensions is shown in **Table 5-5**, and the total reservoir volume for two-hour storage is shown in **Table 5-4.**

Both schemes will require a series of five pumps and reservoirs from the intake to transport water to the WTP. The total pump capacity from the intake to WTP is 1,764Hp.

Scheme 1

From the WTP, booster pumps will be provided along the transmission operating at full head which will produce a minimum head of 14 meters at its remotest point/municipality. Hence, a ground reservoir or sump downstream of the water treatment plant is provided to satisfy the water demands for the upstream municipalities of Bilar, Batuan, Carmen, Dagohoy and Sierra Bullones.

PIPES	
DIAMETER (mm)	LENGTH (m)
250	11659
350	6321
400	8441
450	8277
500	9111
600	2112
700	8665
800	5892
900	6763
100	9761
TOTAL	77002
PUMPS	
NAME	Hp
INTAKE	694
WTP-P	761
LOAY-LILA-P	20
LILA-ALBUR-B	504
TAGBILARAN-P	105
TAG-CORTES-B	20
TAG-DAUIS-B	388
RESERVOIRS/SUMPS	
NAME	VOLUME (m^3)
WTP RESERVOIR	4939
LOAY RESERVOIR	1065
TAGBILARAN RESERVOIR	913

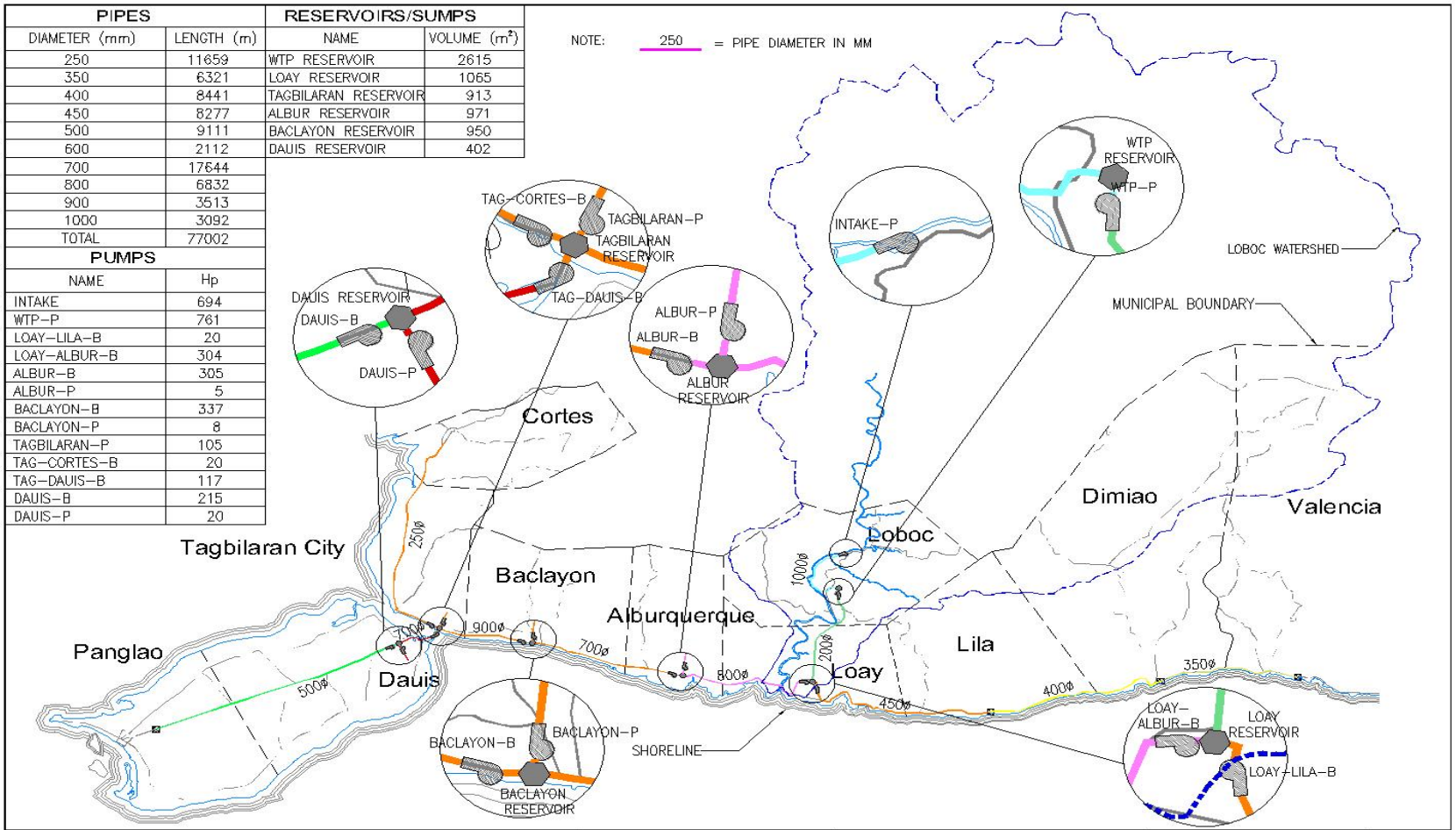


CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Loboc 1 River Cluster Area Scheme 1	5-4A

PIPES	
DIAMETER (mm)	LENGTH (m)
250	11659
350	6321
400	8441
450	8277
500	9111
600	2112
700	17644
800	6832
900	3513
1000	3092
TOTAL	77002

RESERVOIRS/SUMPS	
NAME	VOLUME (m^3)
WTP RESERVOIR	2615
LOAY RESERVOIR	1065
TAGBILARAN RESERVOIR	913
ALBUR RESERVOIR	971
BACLAYON RESERVOIR	950
DAUIS RESERVOIR	402

PUMPS	
NAME	Hp
INTAKE	694
WTP-P	761
LOAY-LILA-B	20
LOAY-ALBUR-B	304
ALBUR-B	305
ALBUR-P	5
BACLAYON-B	337
BACLAYON-P	8
TAGBILARAN-P	105
TAG-CORTES-B	20
TAG-DAUIS-B	117
DAUIS-B	215
DAUIS-P	20



CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Loboc 1 River Cluster Area Scheme 2	5-4B

This scheme will require two booster pumps with a total capacity of 284Hp from the WTP to offtakes at each municipality.

Figure 5-5A shows the schematic diagram of Loboc 2 River Cluster Scheme 1 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

Scheme 2

For Scheme 2, booster pumps will be installed along the main transmission mains with head just enough to boost water to the next municipality. Each municipality will also be provided with booster pump and sump to deliver the required minimum pressure of 14 meters at each offtake.

Scheme 2 will require three booster pumps with a total capacity of 655 Hp from WTP to offtakes at each municipality.

Figure 5-5B shows the schematic diagram of Loboc 2 River Cluster Scheme 2 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

The result of the comparison of costs is presented as follows:

Costs	Scheme 1		Scheme2	
	Total Cost @ October 2007 Prices (Php)	NPW @12% Discount Rate (PhP)	Total Cost @ October 2007 Prices (PhP)	NPW @12% Discount Rate (PhP)
Construction Cost	1,058,879,645	726,258,787	1,088,924,080	743,364,362
Maintenance Cost	83,523,583	18,595,161	85,101,328	18,912,636
Pumping Cost	1,398,880,473	262,214,369	1,456,435,114	273,412,619
Total		1,007,068,317		1,038,689,617

The above comparison shows that Scheme 1 is 3% lower than Scheme 2.

Tables 5-9A and B show the breakdown of costs of major project components and the details of the net present worth costs for Schemes 1 and 2.

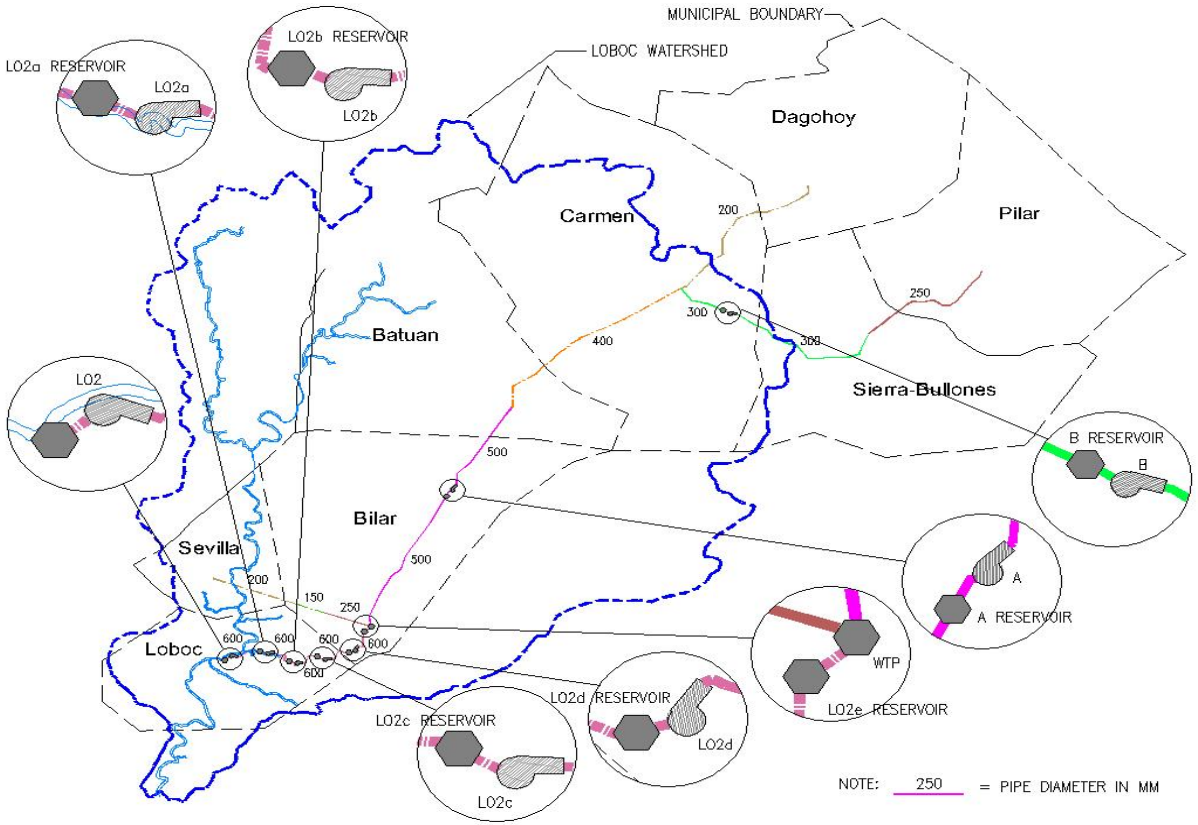
5.3.4 Manaba River Cluster

The Manaba Cluster will serve six municipalities shown in **Table 5-3** with a projected bulk demand of 24,595 cumd (285 L/s). For both schemes 1 and 2, the diversion weir and intake is located at Bgy. Victoria, Municipality of Garcia Hernandez while the WTP is located at Bgy. Canayaon West about 2086 meters away from the intake. The capacity of the WTP is shown in **Table 5-6**, the weir dimensions shown in **Table 5-5**, and the total reservoir volume for two-hour storage is shown in **Table 5-4**.

Both schemes will require the installation of 370Hp pump at the intake to lift water to the WTP.

Scheme 1

The treated water from the WTP is conveyed along transmission mains. The east branch - 2086 meters long of 250 mm pipe serves the municipality Garcia Hernandez, the west branch transmission pipe with 51,460 meters long of diameters ranging from 300 to 500 mm diameter provides water to the municipalities of Jagna, Duero, Guidulman, Candijay & Anda.

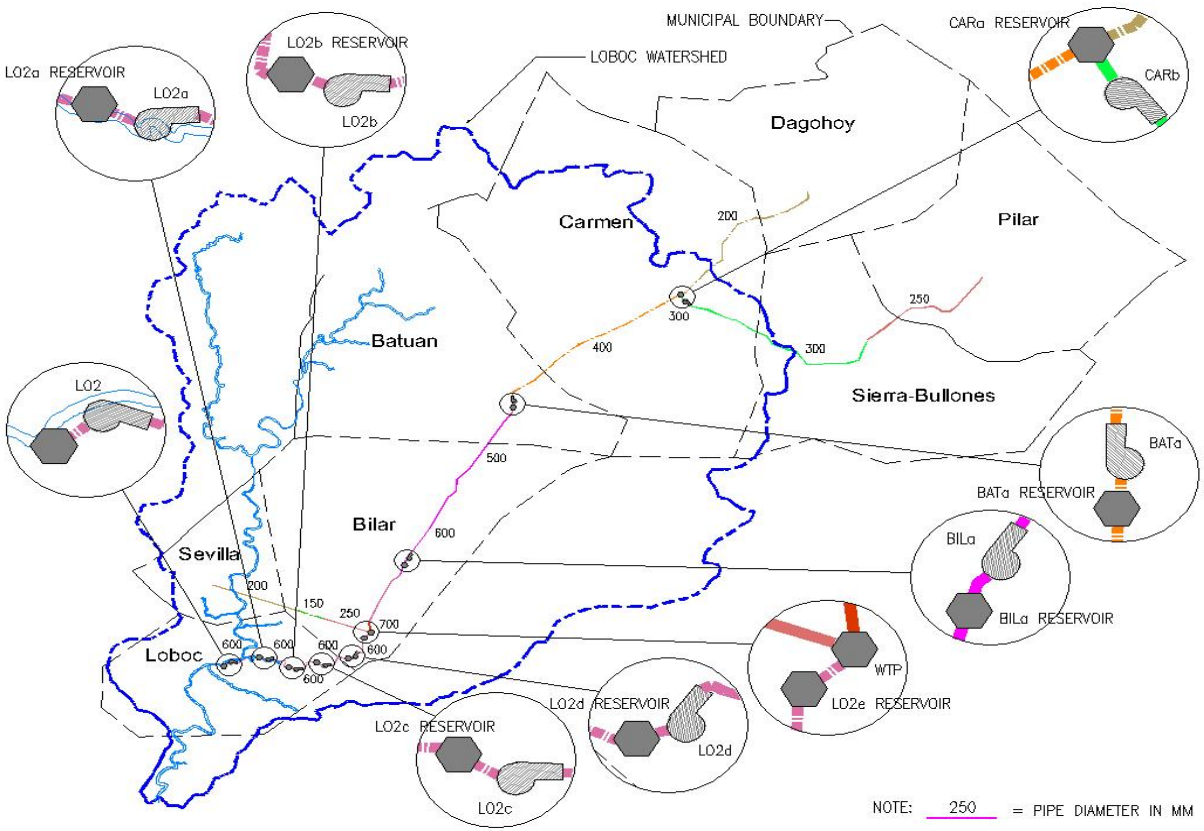


PIPES	
DIAMETER (mm)	LENGTH (m)
150	1416
200	12320
250	8853
300	10348
400	10073
500	13333
600	8694
TOTAL	65037

PUMPS	
NAME	Hp
LO2	223
LO2a	391
LO2b	391
LO2c	391
LO2d	368
A	224
B	60

RESERVOIRS/SUMPS	
NAME	VOLUME (m^2)
LO2a RESERVOIR	356
LO2b RESERVOIR	356
LO2c RESERVOIR	356
LO2d RESERVOIR	356
LO2e RESERVOIR	356
WTP–RESERVOIR	1727
A RESERVOIR	298
B RESERVOIR	113

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Loboc 2 River Cluster Area Scheme 1	5-5A



PIPES	
DIAMETER (mm)	LENGTH (m)
150	1416
200	10893
250	8853
300	11775
400	10073
500	9924
600	11539
700	564
TOTAL	65037
PUMPS	
NAME	Hp
LO2	223
LO2a	391
LO2b	391
LO2c	391
LO2d	368
BATa	329
BILa	234
CARb	92
RESERVOIRS/SUMPS	
NAME	VOLUME (m^2)
LO2a RESERVOIR	356
LO2b RESERVOIR	356
LO2c RESERVOIR	356
LO2d RESERVOIR	356
LO2e RESERVOIR	356
WTP-RESERVOIR	1727
BILa RESERVOIR	298
BATa RESERVOIR	113
CARa RESERVOIR	113

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Loboc 2 River Cluster Area Scheme 2	5-5B

Table 5-9A
Net Present Worth
Loboc 2 River Cluster Area Scheme 1
(October 2007 Price Level)

Const. Year	Facilities	Quantity	Units	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**1 Source Facility**	1	unit	50	**4,860,000**	**3,357,510**
	1.1 Intake Structure with weir at Loboc River River					
	2 **Water Treatment Plant**	1	unit	50	**291,500,000**	**201,381,496**
	2.1 Rapid Sand Filtration Plant					
	3 Transmission Pipelines				**703,886,365**	**486,276,808**
	3.1 Valves, Fittings, Appurtenances and River Crossings		LS	50	91,811,265	63,427,410
	3.2 150mm	1,416	lm.	50	4,672,800	3,228,183
	3.3 200mm	12,320	lm.	50	49,280,000	34,044,872
	3.4 250mm	8,853	lm.	50	59,315,100	40,977,577
	3.5 300mm	10,348	lm.	50	72,436,000	50,042,093
	3.6 400mm	10,073	lm.	50	105,766,500	73,068,323
	3.7 500mm	13,333	lm.	50	169,329,100	116,980,266
	3.8 600mm	8,694	lm.	50	151,275,600	104,508,085
		65,037	lm.			
	4 Storage Facilities				**43,562,000**	**30,094,617**
	4.1 Clear Water Reservoir at WTP	1,727	cum	50	17,270,000	11,930,904
	4.2 Reservoir A	298	cum	50	3,576,000	2,470,464
	4.3 Sump B	113	cum	50	1,356,000	936,787
	4.4 Raw Sump A	356	cum	50	4,272,000	2,951,292
	4.5 Raw Sump B	356	cum	50	4,272,000	2,951,292
	4.6 Raw Sump C	356	cum	50	4,272,000	2,951,292
	4.7 Raw Sump D	356	cum	50	4,272,000	2,951,292
	4.8 Raw Sump E	356	cum	50	4,272,000	2,951,292
	5 Pump Stations				**6,913,144**	**4,920,639**
	5.1 200 Hp LO2 (all)	1	unit	15	789,264.00	561,783
	5.2 350 Hp LO2a (all)	1	unit	15	1,289,120.00	917,570
	5.3 350 Hp LO2b (all)	1	unit	15	1,289,120.00	917,570
	5.4 350 Hp LO2c (all)	1	unit	15	1,289,120.00	917,570
	5.5 350 Hp LO2d (all)	1	unit	15	1,289,120.00	917,570
	5.6 200 Hp A (Batuan, Carmen, Dagohoy, Sierra Bullones, Pi	1	unit	15	789,264.00	561,783
	5.7 40 Hp B (Sierra Bullones, Pilar)	1	unit	15	178,136.00	126,794
2025	**6 Pump Stations**				**8,158,136**	**227,717**
	6.1 250 Hp LO2 (all)	1	unit	15	1,014,216.00	28,310
	6.2 400 Hp LO2a (all)	1	unit	15	1,462,608.00	40,826
	6.3 400 Hp LO2b (all)	1	unit	15	1,462,608.00	40,826
	6.4 400 Hp LO2c (all)	1	unit	15	1,462,608.00	40,826
	6.5 400 Hp LO2d (all)	1	unit	15	1,462,608.00	40,826
	6.6 250 Hp A (Batuan, Carmen, Dagohoy, Sierra Bullones, Pi	1	unit	15	1,014,216.00	28,310
	6.7 60 Hp B (Sierra Bullones, Pilar)	1	unit	15	279,272.00	7,795
	TOTAL CONSTRUCTION COST				**1,058,879,645**	**726,258,787**
	Total Annual Maintenance Cost				83,523,583	**18,595,161**
	Total Annual Pumping Cost (Y2010 - Y2025)				1,398,880,473	**262,214,369**
	TOTAL NET PRESENT WORTH COSTS					**1,007,068,317**

Table 5-9B
Net Present Worth
Loboc 2 River Cluster Area Scheme 2
(October 2007 Price Level)

Const. Year	Facilities	Quantity	Units	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**1 Source Facility**	1	unit	50	**4,860,000**	**3,357,510**
	1.1 Intake Structure with weir at Loboc River River					
	2 **Water Treatment Plant**	1	unit	50	**291,500,000**	**201,381,496**
	2.1 Rapid Sand Filtration Plant					
	3 Transmission Pipelines				**731,126,760**	**505,095,715**
	3.1 Valves, Fittings, Appurtenances and River Crossings		LS	50	95,364,360	65,882,050
	3.2 150mm	1,416	lm.	50	4,672,800	3,228,183
	3.3 200mm	10,893	lm.	50	43,572,000	30,101,525
	3.4 250mm	8,853	lm.	50	59,315,100	40,977,577
	3.5 300mm	11,775	lm.	50	82,425,000	56,942,950
	3.6 400mm	10,073	lm.	50	105,766,500	73,068,323
	3.7 500mm	9,924	lm.	50	126,034,800	87,070,589
	3.8 600mm	11,539	lm.	50	200,778,600	138,707,015
	3.9 700mm	564	lm.	50	13,197,600	9,117,504
		65,037				
	4 Storage Facilities				**44,450,000**	**30,708,088**
	4.1 Clear Water Reservoir at WTP	1,283	cum	50	12,830,000	8,863,549
	4.2 Reservoir BILa	335	cum	50	4,020,000	2,777,199
	Reservoir BATa	272	cum	50	3,264,000	2,254,920
	4.3 Reservoir CARa	248	cum	50	2,976,000	2,055,957
	4.4 Raw Sump A	356	cum	50	4,272,000	2,951,292
	4.5 Raw Sump B	356	cum	50	4,272,000	2,951,292
	4.6 Raw Sump C	356	cum	50	4,272,000	2,951,292
	4.7 Raw Sump D	356	cum	50	4,272,000	2,951,292
	4.8 Raw Sump E	356	cum	50	4,272,000	2,951,292
	5 Pump Stations				**7,819,336**	**5,565,649**
	5.1 200 Hp LO2	1	unit	15	789,264.00	561,783
	5.2 350 Hp LO2a	1	unit	15	1,289,120.00	917,570
	5.3 350 Hp LO2b	1	unit	15	1,289,120.00	917,570
	5.4 350 Hp LO2c	1	unit	15	1,289,120.00	917,570
	5.5 350 Hp LO2d	1	unit	15	1,289,120.00	917,570
	5.6 250 Hp BILa	1	unit	15	1,014,216.00	721,899
	5.7 125 Hp BATa	1	unit	15	580,104.00	412,907
	5.8 60 Hp CARa	1	unit	15	279,272.00	198,780
2025	**6 Pump Stations**				**9,167,984**	**255,905**
	6.1 250 Hp LO2	1	unit	15	1,014,216.00	28,310
	6.2 400 Hp LO2a	1	unit	15	1,462,608.00	40,826
	6.3 400 Hp LO2b	1	unit	15	1,462,608.00	40,826
	6.4 400 Hp LO2c	1	unit	15	1,462,608.00	40,826
	6.5 400 Hp LO2d	1	unit	15	1,462,608.00	40,826
	6.6 250 Hp BILa	1	unit	15	1,014,216.00	28,310
	6.7 350 Hp BATa	1	unit	15	1,289,120.00	35,983
	6.8 100 Hp CARa	1	unit	15	392,224.00	10,948
	TOTAL CONSTRUCTION COST				**1,088,924,080**	**746,364,363**
	Total Annual Maintenance Cost				85,101,328	**18,912,636**
	Total Annual Pumping Cost (Y2010 - Y2025)				1,456,435,114	**273,412,619**
	TOTAL NET PRESENT WORTH COSTS					**1,038,689,617**

A booster pump is installed downstream the treatment plant at full head which will produce a minimum head of 14 meters at its remotest point/municipality. Hence, a ground reservoir or sump downstream of the water treatment plant is provided to satisfy the water demands for the downstream municipalities. This scheme will require four pump systems with a total capacity of 680 Hp including those at the intake and WTP.

Figure 5-6A shows the schematic diagram of Manaba River Cluster Scheme 1 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

Scheme 2

For Scheme 2, operation from intake to WTP is similar to Scheme 1. From the WTP, water will flow by gravity to Jagna. Booster pumps will be installed along the main transmission mains with head just enough to boost water to the next municipality. Each municipality will also be provided with booster pump and sump to deliver the required minimum pressure of 14 meters at each offtake. Scheme 2 will require nine (9) pumps systems with a total capacity of 724Hp (including those at intake and WTP).

Figure 5-6B shows the schematic diagram of Manaba River Cluster Scheme 2 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

The result of the comparison of costs is presented as follows:

Costs	Scheme 1		Scheme2	
	Total Cost @ October 2007 Prices (PhP)	NPW @12% Discount Rate (PhP)	Total Cost @ October 2007 Prices (PhP)	NPW @12% Discount Rate (PhP)
Construction Cost	922,234,710	635,725,072	909,367,443	626,696,675
Maintenance Cost	70,650,622	15,796,781	69,841,535	15,619,066
Pumping Cost	430,860,058	79,694,245	454,859,652	84,507,964
Total		731,216,098		726,823,705

The above comparison shows that the difference between Schemes 1 and 2 is very negligible at .006%. It is noted that although Scheme 2 is lower in costs, more pumps are required to run the system hence, more manpower requirement.

Tables 5-10A and B show the breakdown of costs of major project components and the details of the net present worth costs for Schemes 1 and 2.

5.3.5 Carood River Cluster

Carood River Cluster will serve seven municipalities shown in **Table 5-3** with a projected bulk demand of is 31,591 cumd (366 L/s). For both schemes 1 and 2, the diversion weir and intake is located at Bgy. Mahayag, Municipality of Alicia. The WTP is located 250 meters away from the intake. The capacity of the WTP is shown in **Table 5-6**, the weir dimensions is shown in **Table 5-5**, and the total reservoir volume for two-hour storage is shown in **Table 5-4.**

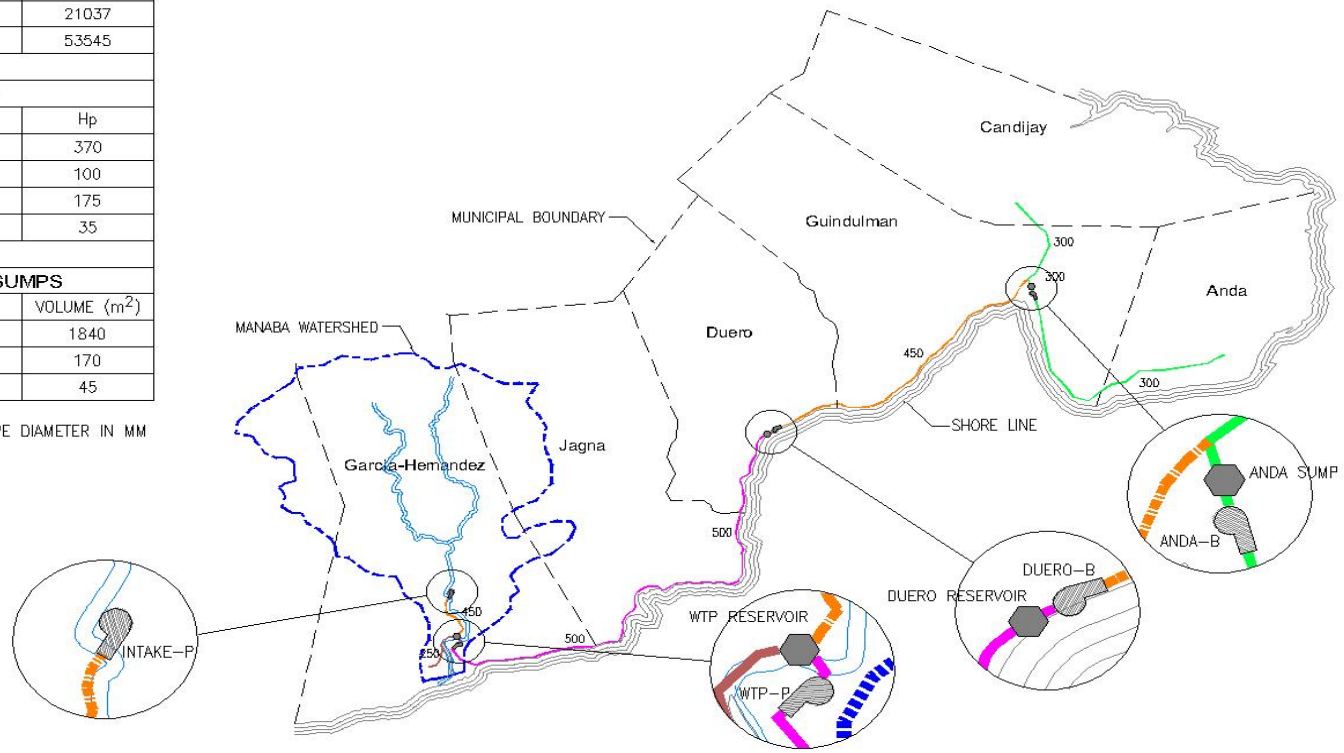
Both schemes will require the installation of 258 Hp pump at the intake to lift water to the WTP.

PIPES	
DIAMETER (mm)	LENGTH (m)
250	2085
300	15825
450	14598
500	21037
TOTAL	53545

PUMPS	
NAME	Hp
INTAKE–P	370
WTP–P	100
DUERO–B	175
ANDA–B	35

RESERVOIRS/SUMPS	
NAME	VOLUME (m^2)
WTP RESERVOIR	1840
DUERO RESERVOIR	170
ANDA SUMP	45

NOTE: 250 = PIPE DIAMETER IN MM



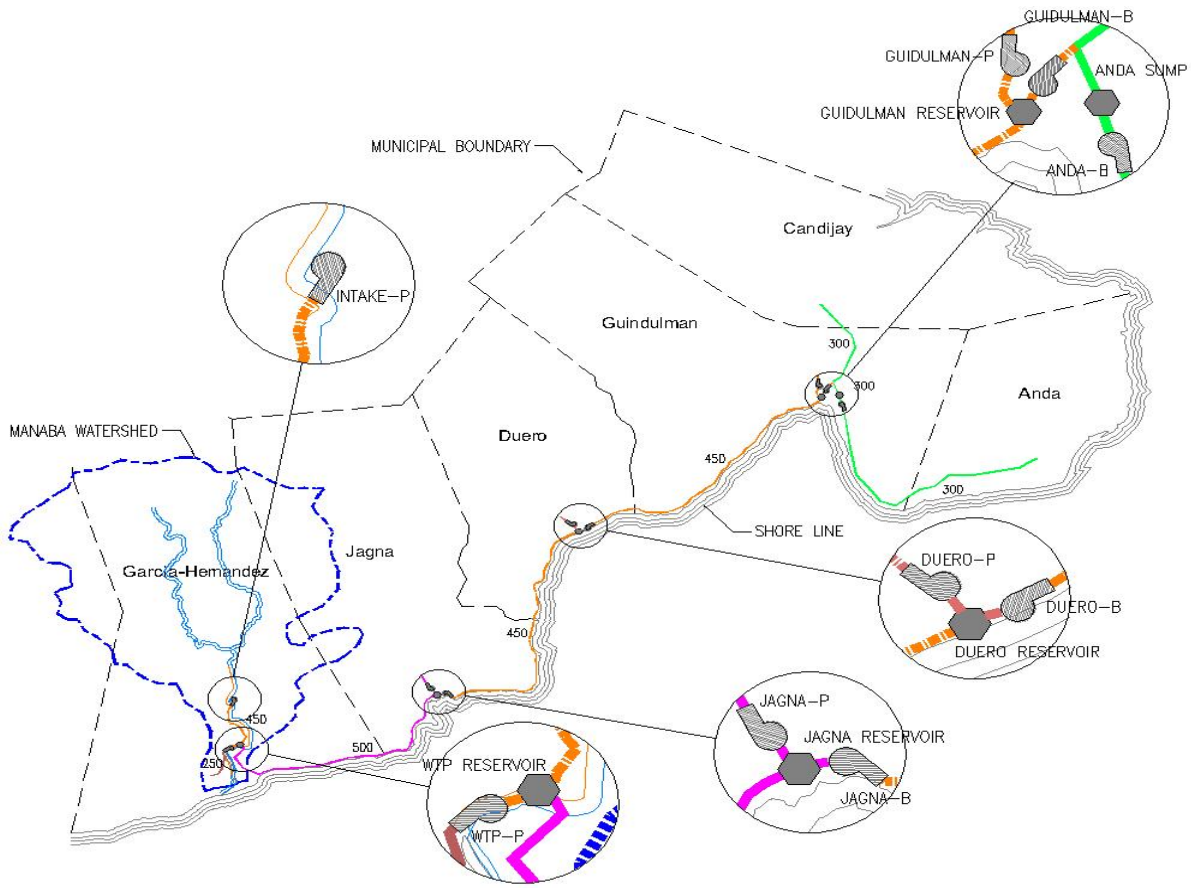
CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Manaba River Cluster Area Scheme 1	5-6A

PIPES	
DIAMETER (mm)	LENGTH (m)
250	2085
300	15825
450	25350
500	10285
TOTAL	53545

PUMPS	
NAME	Hp
INTAKE–P	370
WTP–P	16
JAGNA–B	115
JAGNA–P	20
DUERO–B	70
DUERO–P	8
GUIDULMAN–B	80
GUIDULMAN–P	10
ANDA–B	35

RESERVOIRS/SUMPS	
NAME	VOLUME (m^2)
WTP RESERVOIR	1350
JAGNA RESERVOIR	290
DUERO RESERVOIR	205
GUIDULMAN RESERVOIR	170
ANDA SUMP	45

NOTE: 250 = PIPE DIAMETER IN MM



CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey International development pty. ltd. / WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Manaba River Cluster Area Scheme 2	5-6B

Table 5-10A
Net Present Worth
Manaba River System Scheme 1

(October 2007 Price Level)

Const. Year	Facilities	Quantity	Units	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**1 Source Facility**	1	unit	50	**4,860,000**	**3,357,510**
	1.1 Intake Structure with weir at Manaba River					
	2 **Water Treatment Plant**	1	unit	50	**246,000,000**	**169,948,021**
	2.1 Rapid Sand Filtration Plant					
	3 Transmission Pipelines				**645,438,880**	**445,898,619**
	3.1 Valves, Fittings, Appurtenances and River Crossings		LS	50	84,187,680	58,160,689
	3.2 250 mm dia	2,085	lm.	50	13,969,500	9,650,768
	3.3 300 mm dia	15,825	lm.	50	110,775,000	76,528,423
	3.4 450 mm dia	14,598	lm.	50	169,336,800	116,985,586
	3.5 500 mm dia	21,037	lm.	50	267,169,900	184,573,154
		53,545	lm.			
	4 Storage Facility				**21,105,000**	**14,580,297**
	4.1 Concrete Ground Reservoir at Water Treatment Plant	1,839	cum	50	18,390,000	12,704,651
	4.2 Sump at Duero	170	cum	50	2,040,000	1,409,325
	4.3 Sump at Anda	45	cum	50	675,000	466,321
	5 Pump Stations				**2,640,545**	**1,879,488**
	5.1 365 Hp Pump at Intake Structure	1	unit	15	1,385,995	986,524
	5.2 105 Hp Pump at the Reservoir	1	unit	15	419,205	298,382
	5.3 175 Hp Booster Pump (Duero)	1	unit	15	679,490	483,648
	5.4 35 Hp Booster Pump (Anda)	1	unit	15	155,855	110,935
2025	**6 Pump Stations**				**2,190,285**	**61,137**
	6.1 310 Hp Pump at Intake Structure	1	unit	15	1,181,480	32,978
	6.2 80 Hp Pump at the Reservoir	1	unit	15	340,785	9,512
	6.3 130 Hp Booster Pump (Duero)	1	unit	15	512,165	14,296
	6.4 35 Hp Booster Pump (Anda)	1	unit	15	155,855	4,350
	TOTAL CONSTRUCTION COST				**922,234,710**	**635,725,072**
	Total Annual Maintenance Cost				**70,650,622**	**15,796,781**
	Total Annual Pumping Cost (Y2010 - Y2025)				430,860,058	**79,694,245**
	TOTAL NET PRESENT WORTH COSTS					**731,216,098**

Table 5-10B
Net Present Worth
Manaba River System Scheme 2

(October 2007 Price Level)

Const. Year	Facilities	Quantity	Units	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**1 Source Facility**	1	unit	50	**4,860,000**	**3,357,510**
	1.1 Intake Structure with weir at Manaba River					
	2 **Water Treatment Plant**	1	unit	50	**246,000,000**	**169,948,021**
	2.1 Rapid Sand Filtration Plant					
	3 Transmission Pipelines				**631,018,198**	**435,936,154**
	3.1 Valves, Fittings, Appurtenances and River Crossings		LS	50	81,594,198	56,368,994
	3.2 250 mm dia.	2,085	lm.	50	13,969,500.00	9,650,768
	3.3 300mm dia.	15,825	lm.	50	110,775,000.00	76,528,423
	3.4 450mm dia.	25,350	lm.	50	294,060,000.00	203,150,061
	3.5 500mm dia.	10,285	lm.	50	130,619,500.00	90,237,909
		53,545	lm.			
	4 Storage Facilities				**22,155,000**	**15,305,685**
	4.1 Concrete Ground Reservoir at Water Treatment Plant	1,350	cum	50	13,500,000	9,326,416
	4.2 Jagna Sump	290	cum	50	3,480,000	2,404,143
	4.3 Duero Sump	205	cum	50	2,460,000	1,699,480
	4.4 Guindulman Sump	170	cum	50	2,040,000	1,409,325
	4.5 Anda Sump	45	cum	50	675,000	466,321
	5 Pump Stations				**2,925,145**	**2,082,060**
	5.1 365 Hp Pump at Intake Structure	1	unit	15	1,385,995	986,524
	5.2 20 Hp Pump at the Reservoir	1	unit	15	94,210	67,057
	5.3 20 Hp Pump at Jagna	1	unit	15	94,210	67,057
	5.4 115 Hp Booster at Jagna	1	unit	15	456,390	324,849
	5.5 8 Hp Pump at Duero	1	unit	15	44,895	31,955
	5.6 70 Hp Booster at Duero	1	unit	15	299,690	213,313
	5.7 10 Hp Pump at Guindulman	1	unit	15	53,115	37,806
	5.8 80 Hp Booster at Guindulman	1	unit	15	340,785	242,564
	5.9 35 Hp Booster at Anda	1	unit	15	155,855	110,935
2025	**6 Pump Stations**				**2,409,100**	**67,245**
	6.1 310 Hp Pump at Intake Structure	1	unit	15	1,181,480	32,978
	6.2 12 Hp Pump at the Reservoir	1	unit	15	61,355	1,713
	6.3 16 Hp Pump at Jagna	1	unit	15	77,775	2,171
	6.4 92 Hp Booster at Jagna	1	unit	15	370,865	10,352
	6.5 7 Hp Pump at Duero	1	unit	15	40,785	1,138
	6.6 50 Hp Booster at Duero	1	unit	15	217,500	6,071
	6.7 9 Hp Pump at Guindulman	1	unit	15	49,005	1,368
	6.8 62 Hp Booster at Guindulman	1	unit	15	266,810	7,447
	6.9 32 Hp Booster at Anda	1	unit	15	143,525	4,006
	TOTAL CONSTRUCTION COST				**909,367,443**	**626,696,675**
	Total Annual Maintenance Cost				**69,841,535**	**15,619,066**
	Total Annual Pumping Cost (Y2010 - Y2025)				454,859,652	**84,507,964**
	TOTAL NET PRESENT WORTH COSTS					**726,823,705**

Scheme 1

The transmission main consists of a north, south and western branch. The north branch serves the municipalities of Ubay and Pres. Carlos P. Garcia and has total length of 27,987 meter with diameters ranging from 300 to 700 mm. The south branch which serves the municipality of Mabini is 8289 meters long of 300 mm diameter pipe. The western branch provides the water demands of San Miguel and Danao and has total length of 38,175 meters having diameters from 200 to 450 mm diameters.

Scheme 1 operates a booster pump downstream of the treatment plant at full head which will produce a minimum head of 14 meters at its remotest point/municipality. Hence, a ground reservoir or sump downstream the water treatment plant is provided to satisfy the water demands for the downstream municipalities. Water supply to Danao will require series of three booster pumps and sumps because pipeline will cross ridges with elevations of up to 225 mamsl from elevation of 94mamsl in Alicia. This also applies to Scheme 2.

This scheme require four pump systems with a total capacity of 820 Hp including those at the intake and WTP.

Figure 5-7A shows the schematic diagram of Carood River Cluster Scheme 1 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

Scheme 2

For Scheme 2, operation from intake to WTP is similar to Scheme 1. From the WTP, water is will be pumped to Alicia and Ubay. Booster pumps will be installed along the main transmission mains with head just enough to boost water to the next municipality. Each municipality will also be provided with booster pump and sump to deliver the required minimum pressure of 14 meters at each offtake.
`

Scheme 2 will require nine (9) pumps systems with a total capacity of 834 Hp including those at intake and WTP.

Figure 5-7B shows the schematic diagram of Carood River Cluster Scheme 2 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

The result of the comparison of costs is presented as follows:

Costs	Scheme 1		Scheme2	
	Total Cost @ October 2007 Prices (PhP)	NPW @12% Discount Rate (PhP)	Total Cost @ October 2007 Prices (PhP)	NPW @12% Discount Rate (PhP)
Construction Cost	1,151,962,232	794,010,061	1,152, 402,288	794,169,872
Maintenance Cost	88,422,563	19,782,257	88,504,337	19,790,721
Pumping Cost	503,702,608	88,029,480	399,568,344	71,233,972
Total		901,821,799		885,194,565

The above comparison shows that Scheme 2 is 1.8 % lower than Scheme 1.

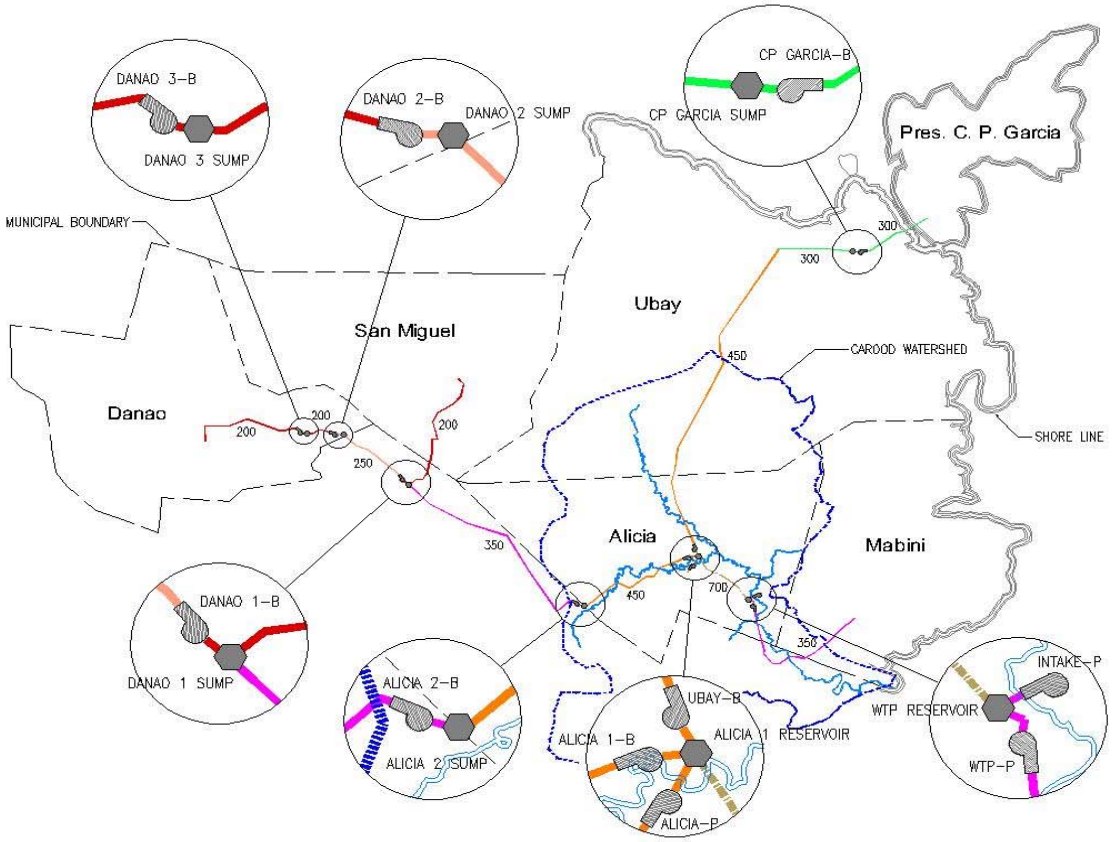
Tables 5-11A and B show the breakdown of costs of major project components and the details of the net present worth costs for Schemes 1 and 2.

PIPES	
DIAMETER (mm)	LENGTH (m)
200	15951
250	3888
300	7438
350	20017
450	23633
500	249
700	3275
TOTAL	74451

PUMPS	
NAME	Hp
INTAKE–P	258
WTP–P	16
ALICIA–P	9
ALICIA 1–B	98
ALICIA 2–B	79
UBAY–B	231
DANAO 1–B	45
DANAO 2–B	45
DANAO 3–B	34
CP GARCIA–B	5

RESERVOIRS/SUMPS	
NAME	VOLUME (m^3)
WTP RESERVOIR	1964
ALICIA 1 RESERVOIR	360
ALICIA 2 SUMP	90
DANAO 1 SUMP	90
DANAO 2 SUMP	41
DANAO 3 SUMP	41
CP GARCIA SUMP	47

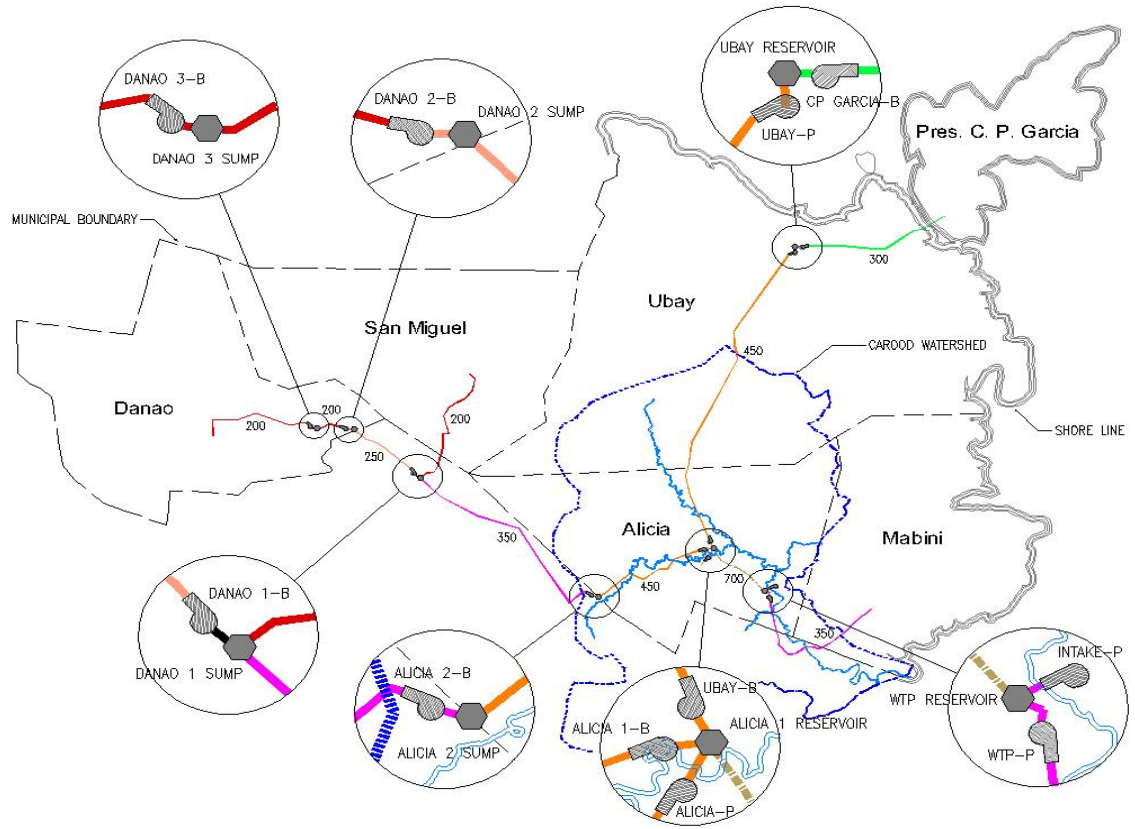
NOTE: 250 = PIPE DIAMETER IN MM



CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Carood River Cluster Area Scheme 1	5-7A

PIPES	
DIAMETER (mm)	LENGTH (m)
200	15951
250	3888
300	7438
350	20017
450	23633
500	249
700	3275
TOTAL	74451
PUMPS	
NAME	Hp
INTAKE–P	258
WTP–P	16
ALICIA–P	9
ALICIA 1–B	98
ALICIA 2–B	79
DANAO 1–B	45
DANAO 2–B	45
DANAO 3–B	34
UBAY–B	191
UBAY–P	40
CP GARCIA–B	19
RESERVOIRS/SUMPS	
NAME	VOLUME (m^2)
WTP RESERVOIR	1782
ALICIA 1 RESERVOIR	360
ALICIA 2 SUMP	90
DANAO 1 SUMP	90
DANAO 2 SUMP	41
DANAO 3 SUMP	41
UBAY RESERVOIR	229

NOTE: 250 = PIPE DIAMETER IN MM



CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Carood River Cluster Area Scheme 2	5-7B

Table 5-11A
Net Present Worth
Carood River System Scheme 1
(October 2007 Price Level)

Const. Year	Facilities	Quantity	Units	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**1 Source Facility**	1	unit	50	**7,120,000**	**4,918,821**
	1.1 Intake Structure with weir at Carood River					
	2 **Water Treatment Plant**	1	unit	50	**315,900,000**	**218,238,129**
	2.1 Rapid Sand Filtration Plant					
	3 Transmission Pipelines				**793,802,680**	**548,395,100**
	3.1 Appurtenances		LS	50	103,539,480	71,529,796
	3.2 200mm dia.	15,951	lm.	50	63,804,000.00	44,078,714
	3.3 250mm dia.	3,888	lm.	50	26,049,600.00	17,996,252
	3.4 300mm dia.	7,438	lm.	50	56,308,000.00	38,900,135
	3.5 350mm dia.	20,017	lm.	50	190,161,500.00	131,372,238
	3.6 450mm dia.	23,633	lm.	50	274,142,800.00	189,390,351
	3.7 500mm dia	249	lm.	50	3,162,300.00	2,184,661
	3.8 750mm dia	3,275	lm.	50	76,635,000	52,942,954
		74,451				
	4 Storage Facilities				**28,595,000**	**19,754,730**
	4.1 Concrete Ground Reservoir at Water Treatment Plant	1,964	cum	50	19,640,000	13,568,208
	4.2 Alicia 1	360	cum	50	4,320,000	2,984,453
	4.3 Alicia 2	90	cum	50	1,350,000	932,642
	4.4 Danao 1	90	cum	50	1,350,000	932,642
	4.5 Danao 2	41	cum	50	615,000	424,870
	4.6 Danao 3	41	cum	50	615,000	424,870
	4.7 Pres. CP Garcia	47	cum	50	705,000	487,046
	5 Pump Stations (Year 2025-2035)				**3,685,808**	**2,623,485**
	5.1 300 Hp Pump Intake Structure	1	unit	15	1,138,480	810,348
	5.2 20 Hp Pump WTP Reservoir	1	unit	15	79,352	56,481
	5.3 10 Hp Pump Alicia	1	unit	15	51,072	36,352
	5.4 100 Hp Booster Alicia 1	1	unit	15	392,224	279,177
	5.5 100 Hp Booster Alicia 2	1	unit	15	392,224	279,177
	5.6 250 Hp Booster Ubay	1	unit	15	1,014,216	721,899
	5.7 50 Hp Booster Danao 1	1	unit	15	203,560	144,890
	5.8 50 Hp Booster Danao 2	1	unit	15	203,560	144,890
	5.9 40 Hp Booster Danao 3	1	unit	15	178,136	126,794
	5.10 5 Hp Booster Pres. CP Garcia	1	unit	15	32,984	23,477
2025	**6 Pump Stations (Year 2010-2025)**				**2,858,744**	**79,796**
	6.1 250 Hp Pump Intake Structure	1	unit	15	1,014,216	28,310
	6.2 15 Hp Pump WTP Reservoir	1	unit	15	79,632	2,223
	6.3 10 Hp Pump Alicia	1	unit	15	51,072	1,426
	6.4 100 Hp Booster Alicia 1	1	unit	15	392,224	10,948
	6.5 50 Hp Booster Alicia 2	1	unit	15	203,560	5,682
	6.6 150 Hp Booster Ubay	1	unit	15	652,456	18,212
	6.7 40 Hp Booster Danao 1	1	unit	15	178,136	4,972
	6.8 30 Hp Booster Danao 2	1	unit	15	127,232	3,551
	6.9 30 Hp Booster Danao 3	1	unit	15	127,232	3,551
	6.10 5 Hp Booster Pres. CP Garcia	1	unit	15	32,984	921
	TOTAL CONSTRUCTION COST				**1,151,962,232**	**794,010,061**
	Total Annual Maintenance Cost				**88,422,563**	**19,782,257**
	Total Annual Pumping Cost (Y2010 - Y2025)				**503,702,608**	**88,029,480**
	TOTAL NET PRESENT WORTH COSTS					**901,821,799**

Table 5-11B
Net Present Worth
Carood River System Scheme 2

(October 2007 Price Level)

Const. Year	Facilities	Quantity	Units	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**1 Source Facility**	1	unit	50	**7,120,000**	**4,918,821**
	1.1 Intake Structure with weir at Carood River					
	2 **Water Treatment Plant**	1	unit	50	**315,900,000**	**218,238,129**
	2.1 Rapid Sand Filtration Plant					
	3 Transmission Pipelines				**793,802,680**	**548,395,100**
	3.1 Appurtenances		LS	50	103,539,480	71,529,796
	3.2 200mm dia.	15,951	lm.	50	63,804,000.00	44,078,714
	3.3 250mm dia.	3,888	lm.	50	26,049,600.00	17,996,252
	3.4 300mm dia.	7,438	lm.	50	56,308,000.00	38,900,135
	3.5 350mm dia.	20,017	lm.	50	190,161,500.00	131,372,238
	3.6 450mm dia.	23,633	lm.	50	274,142,800.00	189,390,351
	3.7 500mm dia	249	lm.	50	3,162,300.00	2,184,661
	3.8 750mm dia	3,275	lm.	50	76,635,000	52,942,954
		74,451				
	4 Storage Facilities				**28,818,000**	**19,908,789**
	4.1 Concrete Ground Reservoir at Water Treatment Plant	1782	cum	50	17,820,000	12,310,869
	4.2 Alicia 1	360	cum	50	4,320,000	2,984,453
	4.3 Alicia 2	90	cum	50	1,350,000	932,642
	4.4 Danao 1	90	cum	50	1,350,000	932,642
	4.5 Danao 2	41	cum	50	615,000	424,870
	4.6 Danao 3	41	cum	50	615,000	424,870
	4.7 Pres. CP Garcia	229	cum	50	2,748,000	1,898,444
	5 Pump Stations (Year 2025-2035)				**3,685,360**	**2,623,166**
	5.1 300 Hp Pump Intake Structure	1	Unit	15	1,138,480	810,348
	5.2 20 Hp Pump WTP Reservoir	1	Unit	15	79,352	56,481
	5.3 10 Hp Pump Alicia	1	Unit	15	51,072	36,352
	5.4 100 Hp Booster Alicia 1	1	Unit	15	392,224	279,177
	5.5 100 Hp Booster Alicia 2	1	Unit	15	392,224	279,177
	5.6 40 Hp Pump Ubay	1	Unit	15	178,136	126,794
	5.7 200 Hp Booster Ubay	1	Unit	15	789,264	561,783
	5.8 50 Hp Booster Danao 1	1	Unit	15	203,560	144,890
	5.9 50 Hp Booster Danao 2	1	Unit	15	203,560	144,890
	5.10 40 Hp Booster Danao 3	1	Unit	15	178,136	126,794
	5.11 20 Hp Booster Pres. CP Garcia	1	Unit	15	79,352	56,481
2025	**6 Pump Stations (Year 2010-2025)**				**3,076,248**	**85,867**
	6.1 250 Hp Pump Intake Structure	1	Unit	15	1,014,216	28,310
	6.2 15 Hp Pump WTP Reservoir	1	Unit	15	72,632	2,027
	6.3 10 Hp Pump Alicia	1	Unit	15	51,072	1,426
	6.4 100 Hp Booster Alicia 1	1	Unit	15	392,224	10,948
	6.5 50 Hp Booster Alicia 2	1	Unit	15	203,560	5,682
	6.6 40 Hp Pump Ubay	1	Unit	15	178,136	4,972
	6.7 150 Hp Booster Ubay	1	Unit	15	652,456	18,212
	6.8 40 Hp Booster Danao 1	1	Unit	15	178,136	4,972
	6.9 30 Hp Booster Danao 2	1	Unit	15	127,232	3,551
	6.10 30 Hp Booster Danao 3	1	Unit	15	127,232	3,551
	6.11 20 Hp Booster Pres. CP Garcia	1	Unit	15	79,352	2,215
	TOTAL CONSTRUCTION COST				**1,152,402,288**	**794,169,872**
	Total Annual Maintenance Cost				**88,504,337**	**19,790,721**
	Total Annual Pumping Cost (Y2010 - Y2025)				**399,568,344**	**71,233,972**
	TOTAL NET PRESENT WORTH COSTS					**885,194,565**

5.3.6 Ipil River Cluster

Ipil River Cluster will serve five municipalities shown in **Table 5-3** with a projected bulk demand 37,792 cumd (437 L/s) by year 2035. For both schemes 1 and 2, the diversion weir and intake is located at Bgy. Hinlayagan Ilaud, Municipality of Trinidad. The WTP is also located at the Municipality of Trinidad, about 2,296 meters away from the intake. The capacity of the WTP is shown in **Table 5-6**, the weir dimensions is shown in **Table 5-5**, and the total reservoir volume for two-hour storage is shown in **Table 5-4**.

Schemes1and 2 will require the 161 Hp and 160 Hp pumps, respectively, at the intake to lift water to the WTP.

Scheme 1

A booster pump is installed downstream the treatment plant at full head which will produce a minimum head of 14 meters at its remotest point/municipality. Hence, a ground reservoir or sump downstream of the water treatment plant is provided to satisfy the water demands for the downstream municipalities. This scheme will require additional pump with a capacity of 340 Hp.

Figure 5-8A shows the schematic diagram of Ipil River Cluster Scheme 1 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

Scheme 2

This scheme will require installation of booster pumps along the main transmission mains with head just enough to boost water to the next municipality. Each municipality will also be provided with booster pump and sump to deliver the required minimum pressure of 14 meters at each offtake. Scheme 2 will require pumps systems with a total capacity of 449 Hp to boost and deliver water for each municipality.

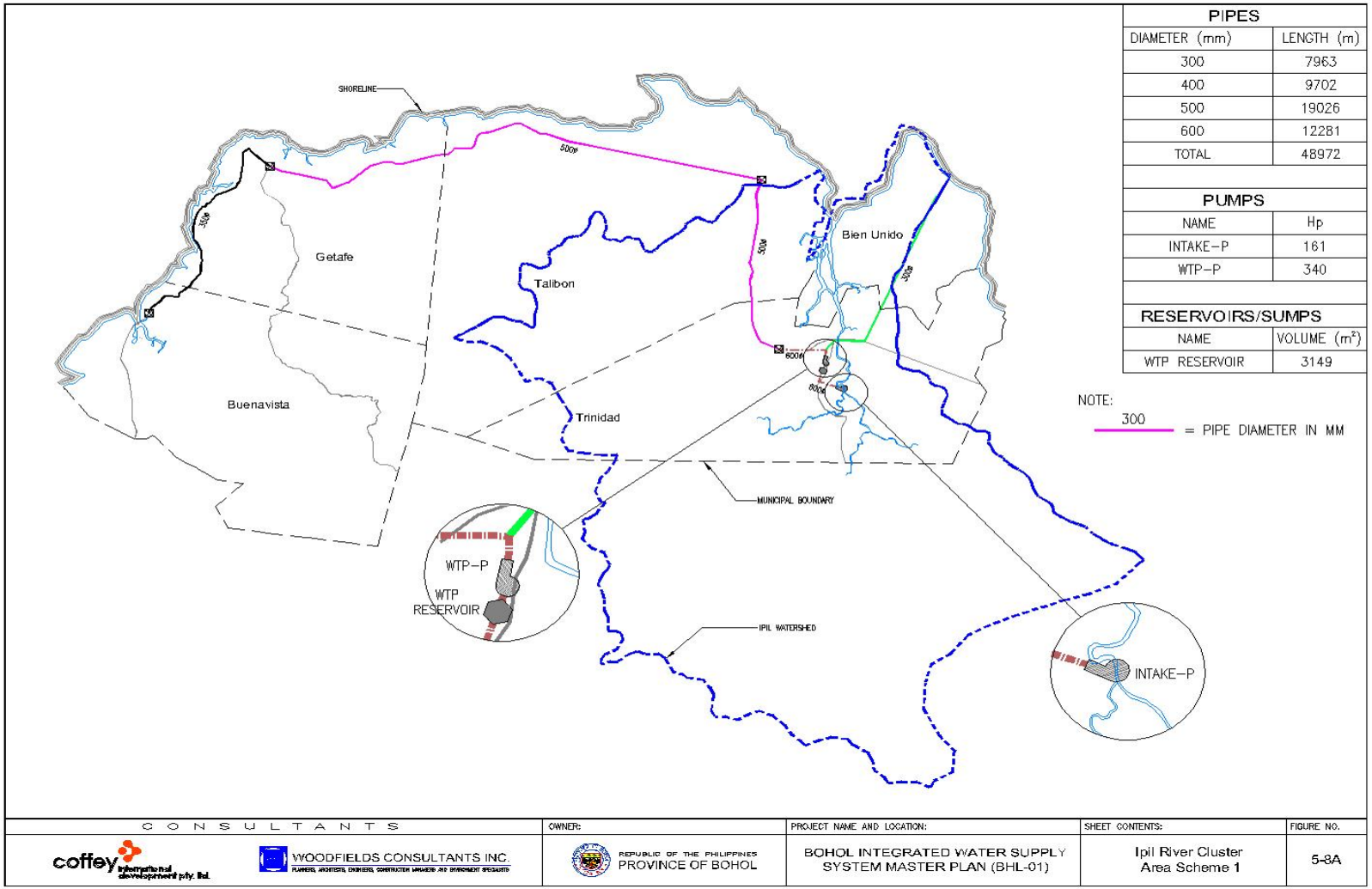
Figure 5-8B shows the schematic diagram of Ipil River Cluster Scheme 1 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

The result of the comparison of costs is presented as follows:

Costs	Scheme 1		Scheme2	
	Total Cost @ October 2007 Prices (PhP)	NPW @12% Discount Rate (PhP)	Total Cost @ October 2007 Prices (PhP)	NPW @12% Discount Rate (PhP)
Construction Cost	1,170,652,472	807,390,964	1,080,367,428	723,512,748
Maintenance Cost	88,780,085	19,793,049	82,390,138	18,351,825
Pumping Cost	294,795,680	47,185,200	346,880,411	56,087,338
Total		874,369,213		797,951,911

The above comparison shows that Scheme 2 is 8.7 % lower than Scheme 1.

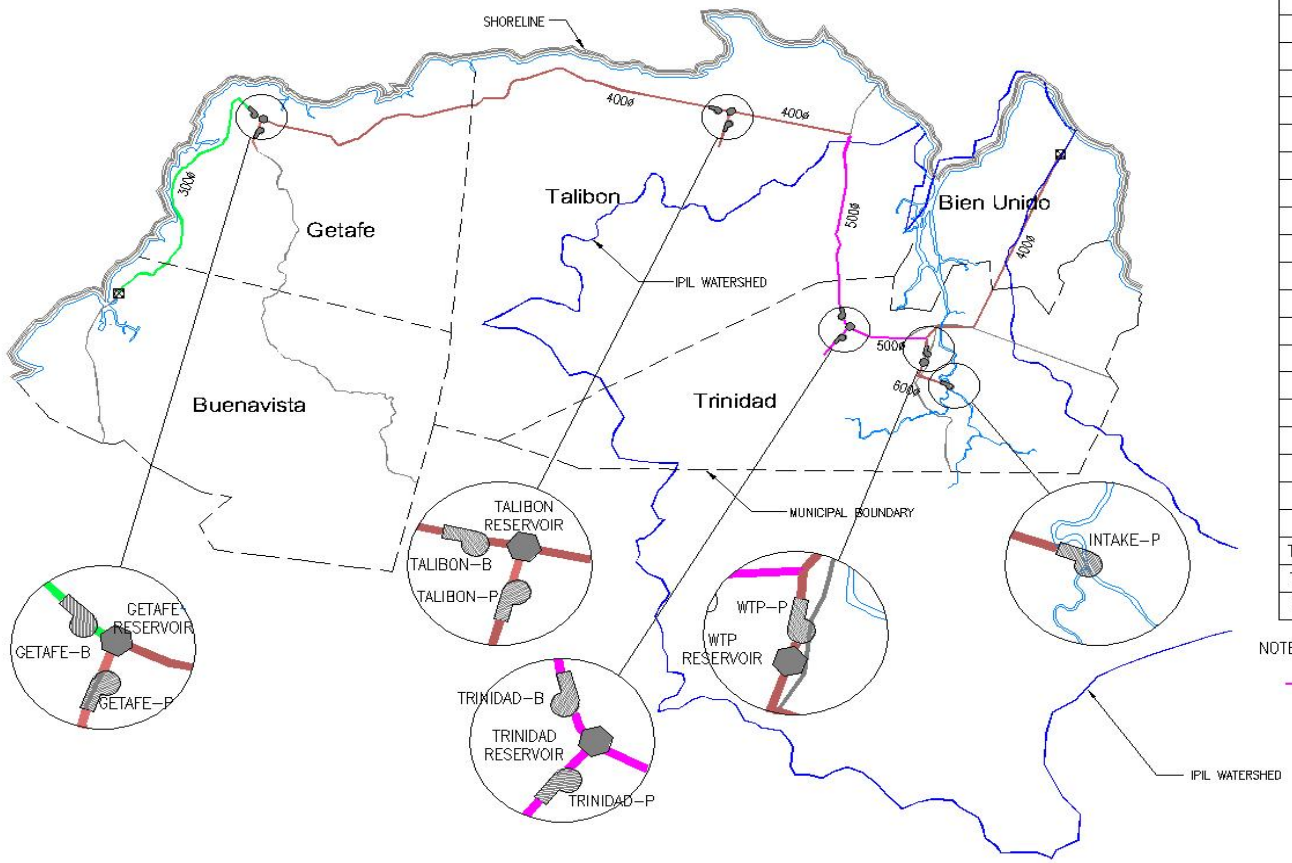
Tables 5-12A and B show the breakdown of costs of major project components and the details of the net present worth costs for Schemes 1 and 2.



PIPES	
DIAMETER (mm)	LENGTH (m)
300	7963
400	9702
500	19026
600	12281
TOTAL	48972

PUMPS	
NAME	Hp
INTAKE-P	161
WTP-P	340

RESERVOIRS/SUMPS	
NAME	VOLUME (m^2)
WTP RESERVOIR	3149



PIPES	
DIAMETER (mm)	LENGTH (m)
300	9702
400	26989
500	9985
600	2296
TOTAL	48972

PUMPS	
NAME	Hp
INTAKE–P	160
WTP–P	52
TRINIDAD–B	230
TRINIDAD–P	13
TALIBON–B	64
TALIBON–P	51
GETAFE–B	20
GETAFE–P	19

RESERVOIRS/SUMPS	
NAME	VOLUME (m^3)
WTP RESERVOIR	2215
TRINIDAD RESERVOIR	428
TALIBON RESERVOIR	370
GETAFE RESERVOIR	136

NOTE:
300 = PIPE DIAMETER IN MM

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Ipil River Cluster Area Scheme 2	5-8B

Table 5-12A
Net Present Worth
Ipil River System Scheme 1
(October 2007 Price Level)

Const. Year	Facilities	Quantity	Units	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**1 Source Facility**	1	unit	50	**7,160,000**	**4,946,455**
	1.1 Intake Structure with weir at Ipil River					
	2 **Water Treatment Plant**	1	unit	50	**453,480,000**	**313,284,669**
	2.1 Rapid Sand Filtration Plant					
	3 Transmission Lines				**675,064,720**	**466,365,501**
	3.1 Valves, Fittings, Appurtenances and River Crossings		LS	50	88,051,920	60,830,283
	3.2 300 mm dia.	7,963	lm.	50	55,741,000	38,508,425
	3.3 350 mm dia.	9,702	lm.	50	92,169,000	63,674,549
	3.4 500 mm dia.	19,026	lm.	50	241,630,200	166,929,164
	3.5 600 mm dia.	11,349	lm.	50	197,472,600	136,423,080
		48,040	lm.			
	4 Storage Facility	3,150	cum	50	**31,500,000**	**21,761,637**
	4.1 Concrete Ground Reservoir at Water Treatment Plant					
	5 Pump Stations				**1,369,368**	**974,689**
	5.1 125 Hp Pump at Intake Structure	1	unit	15	580,104.00	412,907
	5.2 200 Hp Pump at the Reservoir	1	unit	15	789,264.00	561,783
2025	**6 Pump Stations**				**2,078,384**	**58,014**
	6.1 200 Hp Pump at Intake Structure	1	unit	15	789,264.00	22,031
	6.2 350 Hp Pump at the Reservoir	1	unit	15	1,289,120.00	35,983
	TOTAL CONSTRUCTION COST				**1,170,652,472**	**807,390,964**
	Total Annual Maintenance Cost				88,780,085	**19,793,049**
	Total Annual Pumping Cost (Y2010 - Y2025)				294,795,680.25	**47,185,200.36**
	TOTAL NET PRESENT WORTH COSTS					**874,369,213**

Table 5-12B
Net Present Worth
Ipil River System Scheme 2
(October 2007 Price Level)

Const. Year	Facilities	Quantity	Units	Service life, yrs.	Construction / Installation Cost	Net Present Worth at 12%
2010	**1 Source Facility**	1	unit	50	**7,160,000**	**4,946,455**
	1.1 Intake Structure with weir at Ipil River					
	2 Water Treatment Plant	1	unit	50	**453,480,000**	**313,284,669**
	2.1 Rapid Sand Filtration Plant					
	3 Transmission Lines				**582,155,300**	**402,179,436**
	3.1 Valves, Fittings, Appurtenances and River Crossings		LS	50	75,933,300	52,458,187
	3.2 300mm dia.	9,702	lm.	50	67,914,000	46,918,089
	3.3 400mm dia.	26,989	lm.	50	283,384,500	195,774,939
	3.4 500mm dia.	9,053	lm.	50	114,973,100	79,428,662
	3.5 600mm dia.	2,296	lm.	50	39,950,400	27,599,559
		48,040	lm.			
	4 Storage Facilities				**32,773,264**	**1,678,755**
	4.1 Concrete Ground Reservoir at Water Treatment Plant	2,590	cum	50	25,900,000	17,892,901
	4.2 Talibon Sump IP1	140	cum	50	1,680,000	1,160,621
	4.3 Getafe Sump IP2	50	cum	50	750,000	518,134
	4.4 Trinidad Sump IP3	370	cum	50	4,443,264	3,069,609
	5 Pump Stations				**1,885,576**	**1,342,116**
	5.1 125 Hp Pump at Intake Structure	1	unit	15	580,104.00	412,907
	5.2 25 Hp Pump at the Reservoir	1	unit	15	112,336.00	79,959
	5.3 40 Hp Pump IP1 at Talibon	1	unit	15	178,136.00	126,794
	5.4 50 Hp Booster IP1 at Talibon	1	unit	15	203,560.00	144,890
	5.5 20 Hp Pump IP2 at Getafe	1	unit	15	79,352.00	56,481
	5.6 20 Hp Booster IP2 at Getafe	1	unit	15	79,352.00	56,481
	5.7 15 Hp Pump IP3 at Trinidad	1	unit	15	72,632.00	51,698
	5.8 125 Hp Booster IP3 at Trinidad	1	unit	15	580,104.00	412,907
2025	**6 Pump Stations**				**2,913,288**	**81,318**
	6.1 200 Hp Pump at Intake Structure	1	unit	15	789,264.00	22,031
	6.2 60 Hp Pump at the Reservoir	1	unit	15	279,272.00	7,795
	6.3 60 Hp Pump IP1 at Talibon	1	unit	15	279,272.00	7,795
	6.4 75 Hp Booster IP1 at Talibon	1	unit	15	319,928.00	8,930
	6.5 20 Hp Pump IP2 at Getafe	1	unit	15	79,352.00	2,215
	6.6 20 Hp Booster IP2 at Getafe	1	unit	15	79,352.00	2,215
	6.7 15 Hp Pump IP3 at Trinidad	1	unit	15	72,632.00	2,027
	6.8 250 Hp Booster IP3 at Trinidad	1	unit	15	1,014,216.00	28,310
	TOTAL CONSTRUCTION COST				**1,080,367,428**	**723,512,748**
	Total Annual Maintenance Cost				82,390,138	**18,351,825**
	Total Annual Pumping Cost (Y2010 - Y2025)				346,880,411	**56,087,338**
	TOTAL NET PRESENT WORTH COSTS					**797,951,911**

5.3.7 Inabanga Bulk System

Inabanga River Cluster will serve six municipalities shown in **Table 5-3** with a projected bulk demand 57,706 cumd (667.89L/s) by year 2035. For both schemes 1 and 2, the diversion weir and intake is located at Bgy. U-og, Municipality of Inabanga. The WTP is also located at the Municipality of Inabanga. The capacity of the WTP is shown in **Table 5-6**, the weir dimensions is shown in **Table 5-5**, and the total reservoir volume for two-hour storage is shown in **Table 5-4**.

Scheme 1

A booster pump is installed downstream the treatment plant at full head which will produce a minimum head of 14 meters at its remotest point/municipality. Hence, a ground reservoir or sump downstream of the water treatment plant is provided to satisfy the water demands for the downstream municipalities.

Figure 5-9A shows the schematic diagram of Inabanga River Cluster Scheme 1 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

Scheme 2

This scheme will require installation of booster pumps along the main transmission mains with head just enough to boost water to the next municipality. Each municipality will also be provided with booster pump and sump to deliver the required minimum pressure of 14 meters at each offtake.

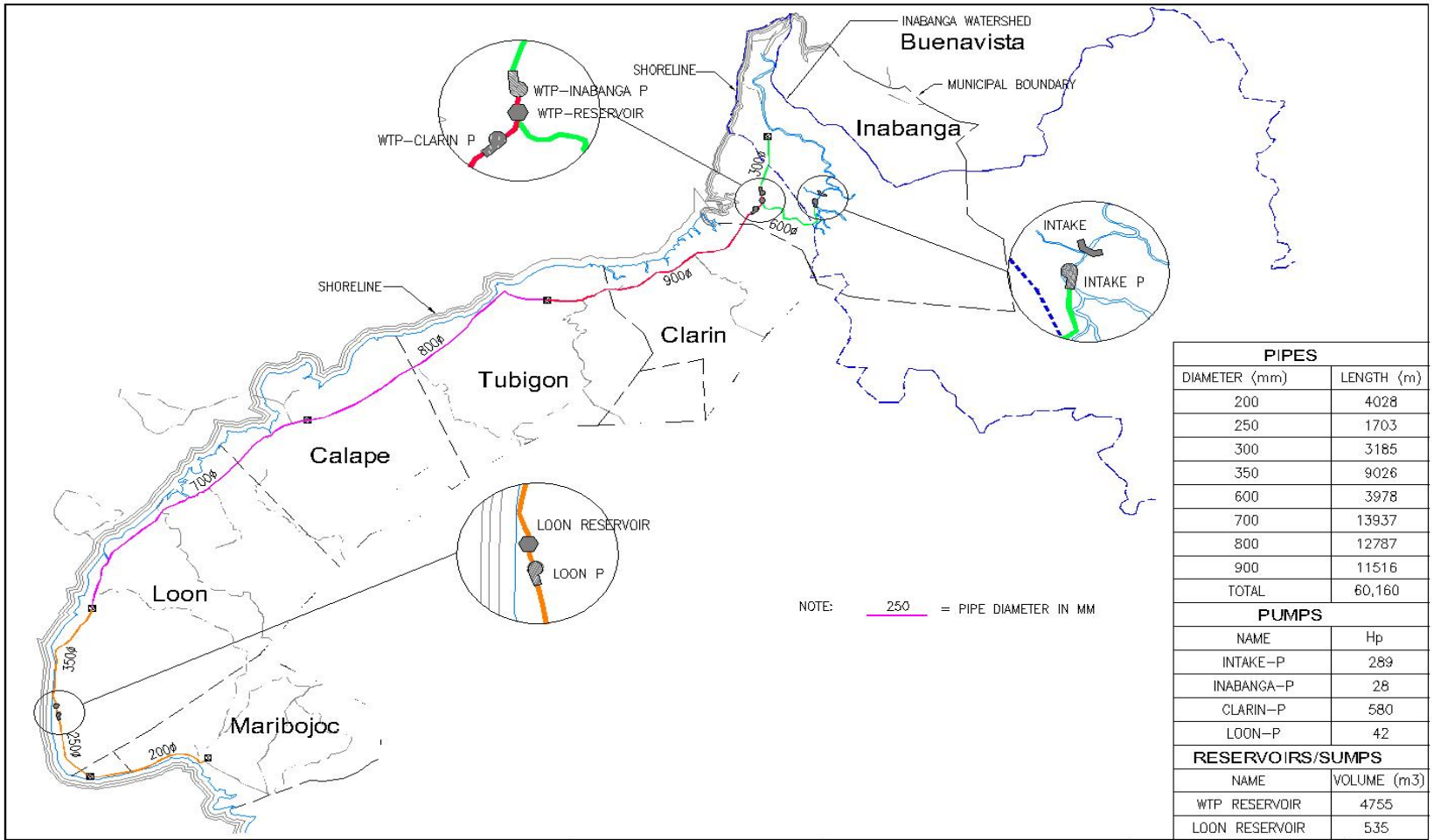
Figure 5-9B shows the schematic diagram of Ipil River Cluster Scheme 1 with information on pipe sizes and lengths, reservoir/sump volumes, and pump capacities.

5.4 RECOMMENDED SCHEME

After a review of the schemes and comparisons of costs and including non-quantifiable parameters, the recommended schemes for each river cluster are as follows:

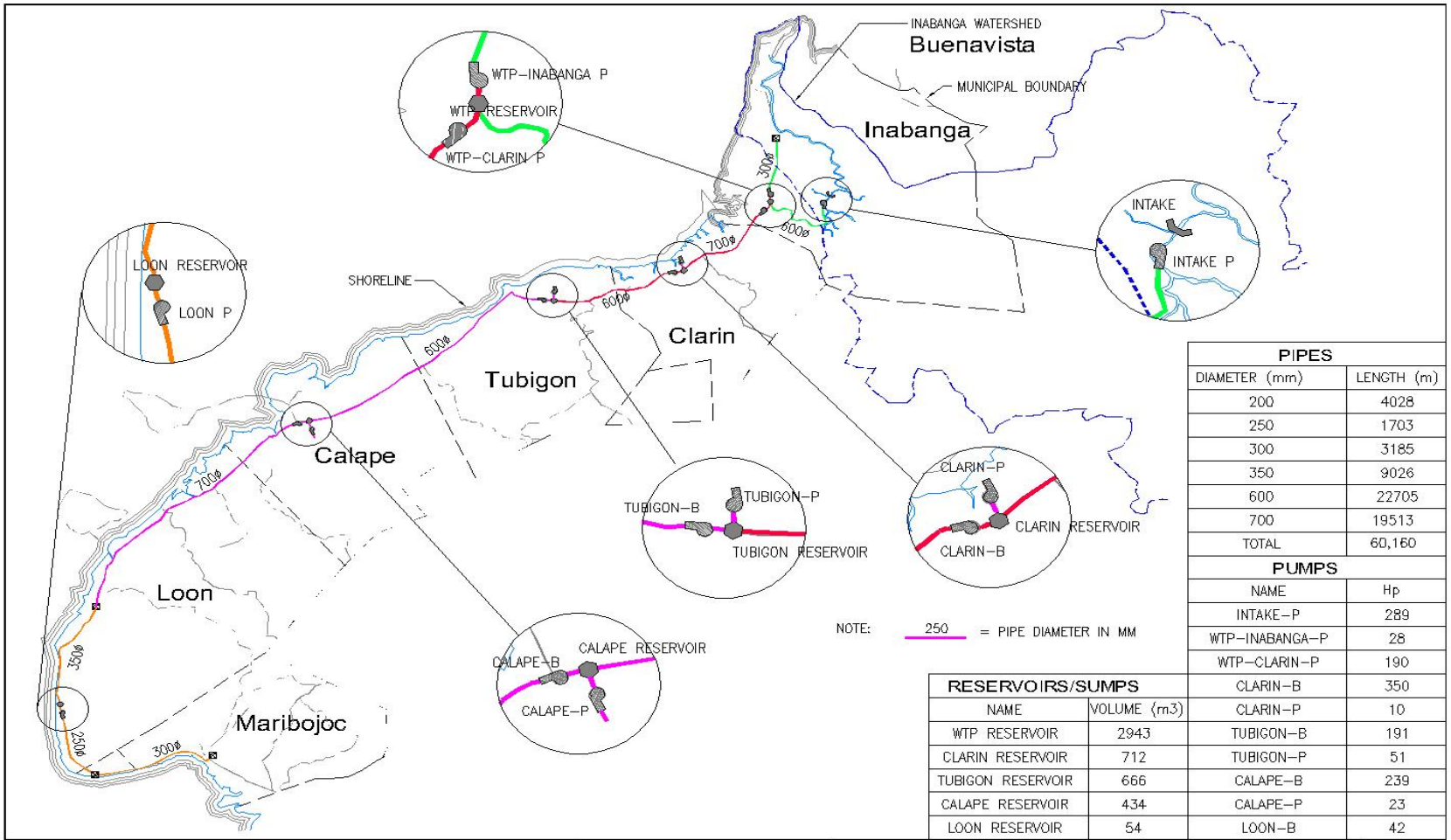
River Cluster	Recommended Scheme
1. Abatan	Scheme 1
2. Loboc 1	Scheme 2
3. Loboc 2	Scheme 1
4. Manaba	Scheme 1
5. Carood	Scheme 2
6. Ipil	Scheme 2
7. Inabanga	Scheme 1

The details of the recommended schemes will be discussed in detail in the succeeding chapter.



PIPES	
DIAMETER (mm)	LENGTH (m)
200	4028
250	1703
300	3185
350	9026
600	3978
700	13937
800	12787
900	11516
TOTAL	60,160
PUMPS	
NAME	Hp
INTAKE–P	289
INABANGA–P	28
CLARIN–P	580
LOON–P	42
RESERVOIRS/SUMPS	
NAME	VOLUME (m3)
WTP RESERVOIR	4755
LOON RESERVOIR	535

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	FIGURE NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC.	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL-01)	Inabanga River Cluster Area Scheme 1	5-9A



PIPES	
DIAMETER (mm)	LENGTH (m)
200	4028
250	1703
300	3185
350	9026
600	22705
700	19513
TOTAL	60,160

PUMPS	
NAME	Hp
INTAKE–P	289
WTP–INABANGA–P	28
WTP–CLARIN–P	190
CLARIN–B	350
CLARIN–P	10
TUBIGON–B	191
TUBIGON–P	51
CALAPE–B	239
CALAPE–P	23
LOON–B	42

RESERVOIRS/SUMPS	
NAME	VOLUME (m3)
WTP RESERVOIR	2943
CLARIN RESERVOIR	712
TUBIGON RESERVOIR	666
CALAPE RESERVOIR	434
LOON RESERVOIR	54

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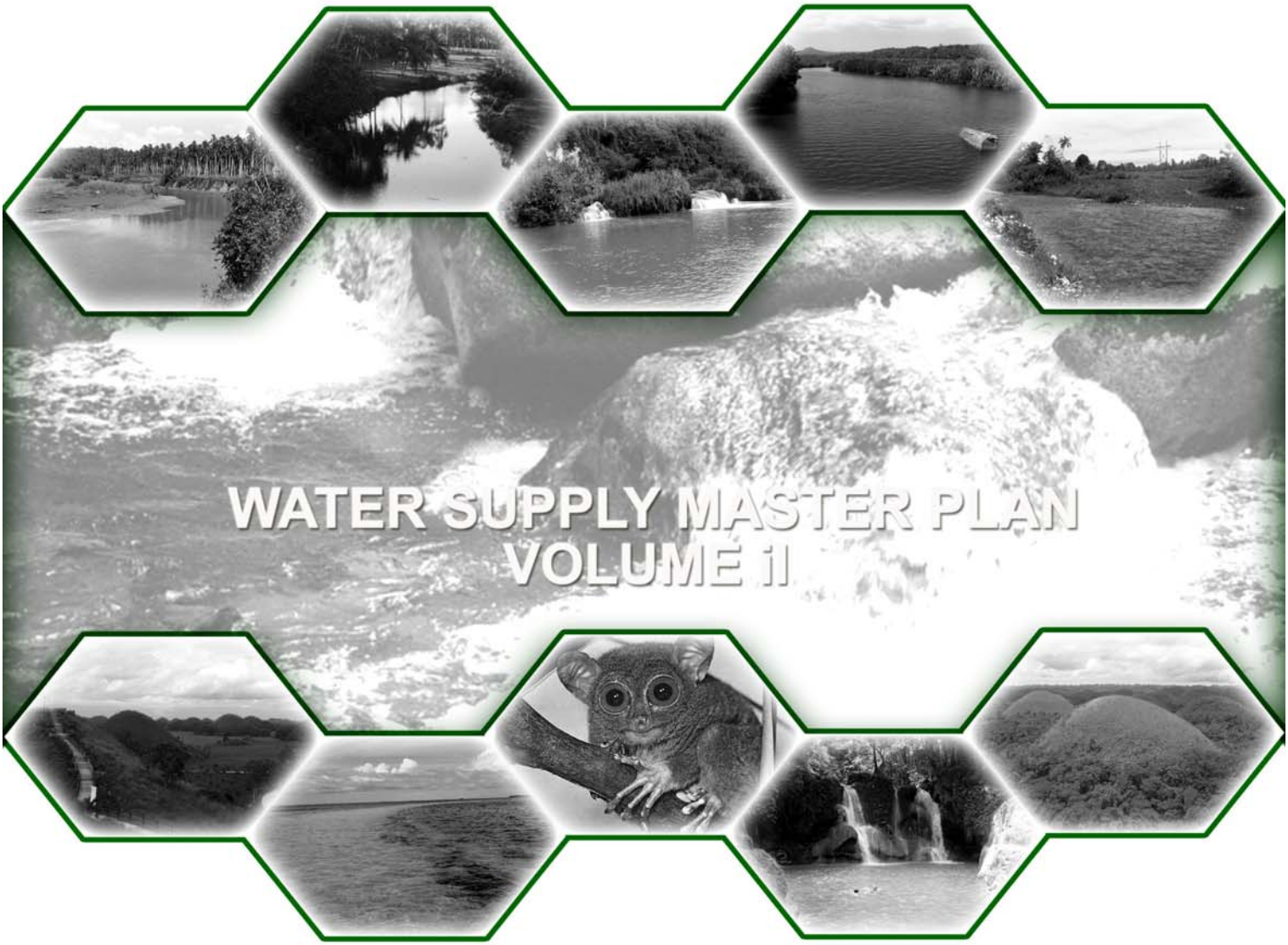


CHAPTER 6
RECOMMENDED STRATEGY

CHAPTER 6 – RECOMMENDED PLAN

6.1 GENERAL

This chapter presents the development program of the selected 7 bulk water supply system clusters up to year 2035. The recommended bulk supply systems will augment the existing water sources of the interconnected municipal/city waterworks that will lead to improved access to safe water coverage of the population in the entire province of Bohol.

The proposed integrated water supply system is envisioned to provide a total average daily production 208,353 cumd benefiting about 1,078,000 population in the Province of Bohol.

The selected schemes for the 7 clusters in the preceding *Chapter 5 – Alternative Analyses* – were adopted and recommended for the development program.

The systems will be designed at constant supply rate based on maximum day demand (MDD) since it is assumed that the bulk supply will be directly conveyed to municipal/city waterworks' reservoirs at a minimum pressure of 14m.

Construction of water facilities will be undertaken commencing in 2010 and completed in 2012. The bulk water supply system is planned to be operationalized by 2013. By 2025, the pumps will be replaced since it is assumed that the service life of each pump would have been reached. The pumps replaced will have bigger capacities designed to accommodate up to year 2035 water demand. In some cases, pump capacities replaced may seem the same because the commercial pump rating may fall within the same range although pumps replaced have higher capacities.

There will be no phasing (construction at later years) of major facilities, such as transmission mains and reservoirs because the ideal timing of phasing based on water demand will be near the initial year of operation which is not economical and practical.

The cost of the development program includes the feasibility study, detailed engineering design, construction supervision, and construction of facilities, including contingency. A separate table represents the annual operation and maintenance cost. The cost estimates used were based on unscalated October 2007 price levels.

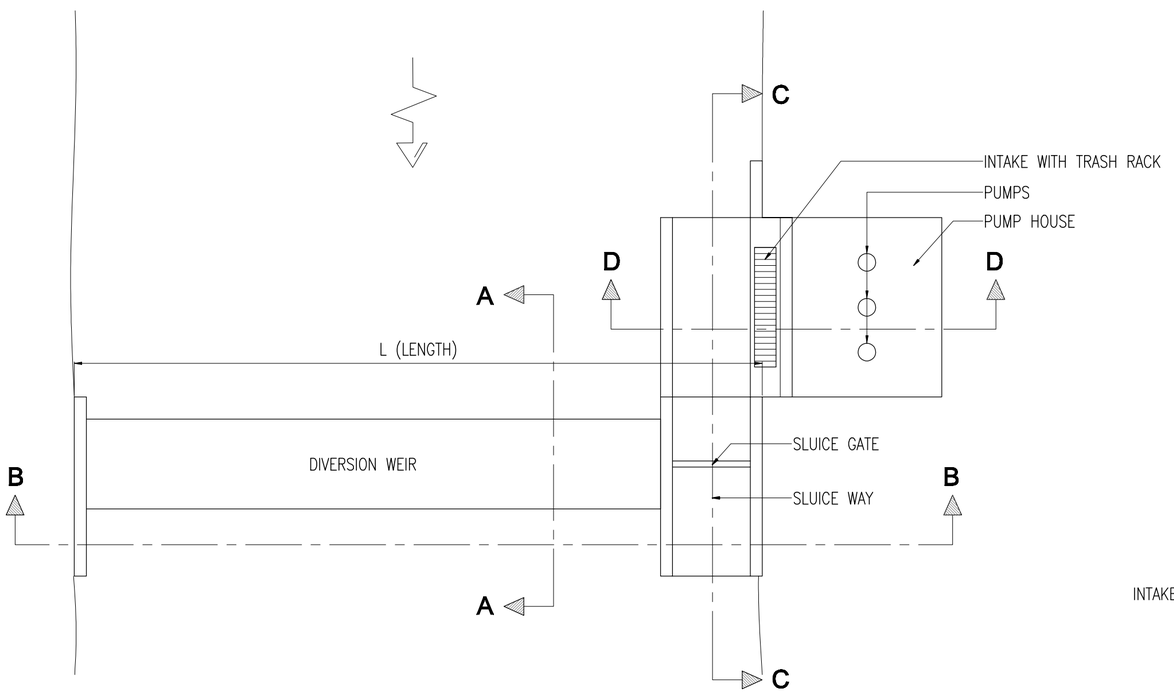
The general description of major water facilities and items are described, as follows:

6.1.1 Source Facility

At the intake point, a diversion weir structure will be constructed across the river where portion of the flow will be diverted into the intake chamber or sump pit of the pump house located at the left or right river bank. In some cases, the weir structure will also prevent salt water intrusion especially during high tide at dry period. A trash rack will be installed at the entrance of the sump to prevent passage of floating debris. The trash rack will be manually cleaned through a raking bucket. Sluice gate will be installed to flush out sediments. The raw water will be lifted by pump and delivered via transmission line into the water treatment plant. Manually operated gantry crane for lifting pumps using chain block will be provided for maintenance or repair works in the pump house. Manually operated sluice gate will be installed for draining water inside the intake chamber for inspection and maintenance works. The proposed typical drawing for river intake structure is shown in **Figure 6-1.**

RIVER INTAKE DIMENSIONS

RIVER BASIN IDENTIFICATION	WEIR LENGTH (m)	WEIR HEIGHT (m)
ABATAN	45.00	4.00
LOBOC	30.00	3.00
MANABA	34.00	2.00
CAROOD	45.00	3.00
IPIL	50.00	2.00
INABANGA	75.00	2.00



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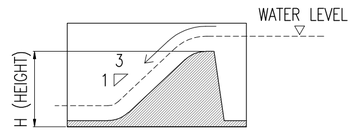
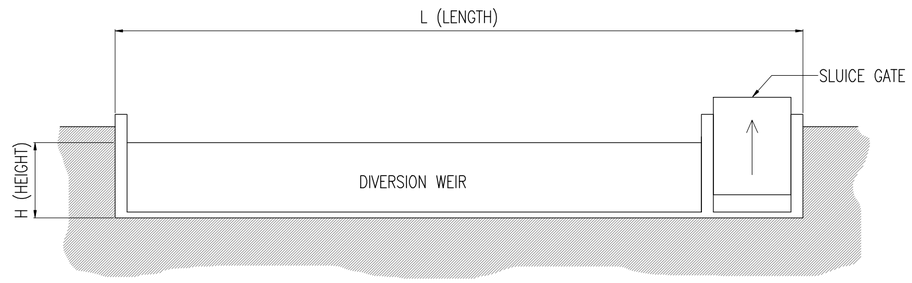
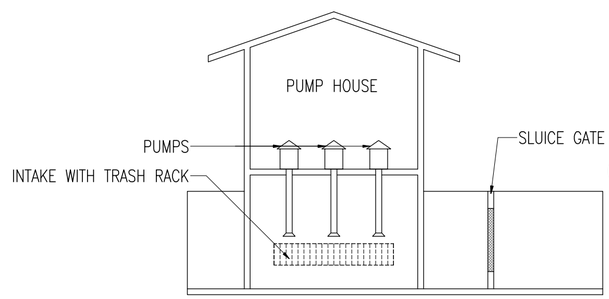


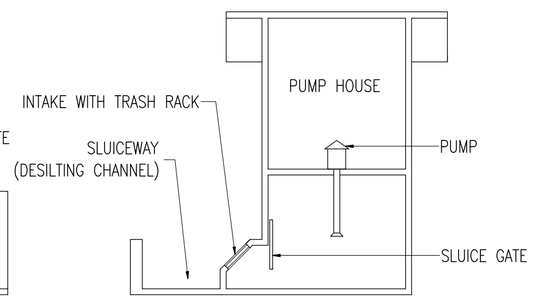
SECTION A-A (DIVERSION WEIR)



SECTION B-B (DIVERSION WEIR)



SECTION C-C (PUMP HOUSE)



SECTION D-D (PUMP HOUSE)

1/1 **RIVER INTAKE STRUCTURE**
N.T.S.

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6.1.2 Water Treatment Plant

The proposed water treatment plant will be designed to adopt conventional rapid sand filtration process, a well proven and reliable technology aimed to minimize dependency from imported materials, parts and proprietary technology. The typical conventional water treatment plant process flow diagram is presented In **Figure 6-2**, and discussed, as follows:

A. Rapid Mixing

Raw water from the river will initially pass through rapid mix tank. The tank will be equipped with rapid mixer. In the rapid mix tank, coagulant, aluminum sulfate, will be fed to the raw water and allowed the chemical to come in contact with water molecules. The rapid mixer will be used to provide complete and thorough mixing of the coagulant and water. The mixing or blending will force multiple contacts between each of the colloidal particles and the product of the coagulation process. This overall process is controlled by hydrodynamic parameters, geometry, molecular properties of the water, and kinetics

B. Flocculation

The 3-Stage flocculation process aggregates destabilized particles into larger and more easily settleable floc. Destabilization results from chemical reactions between the coagulant and the colloidal suspension, while flocculation is the transport step that causes the necessary collision between the destabilized particles.

C. Sedimentation

After coagulation and flocculation process, flocs are settled in the settling tanks. The sedimentation tanks to be used will be long horizontal concrete type. The long horizontal design allows particles to settle efficiently. The sludge that settles at the bottom will be removed by pumping it regularly to the sludge dewatering facility.

D. Filtration

Filtration process involves the separation of suspended particles in water by passing through series of fine and coarse media, typically well-graded sand and gravel. When the pressure head reaches its optimum level due to headloss, filters should be backwashed using backwash pumps to drive the water from the bottom to the surface.

E. Disinfection

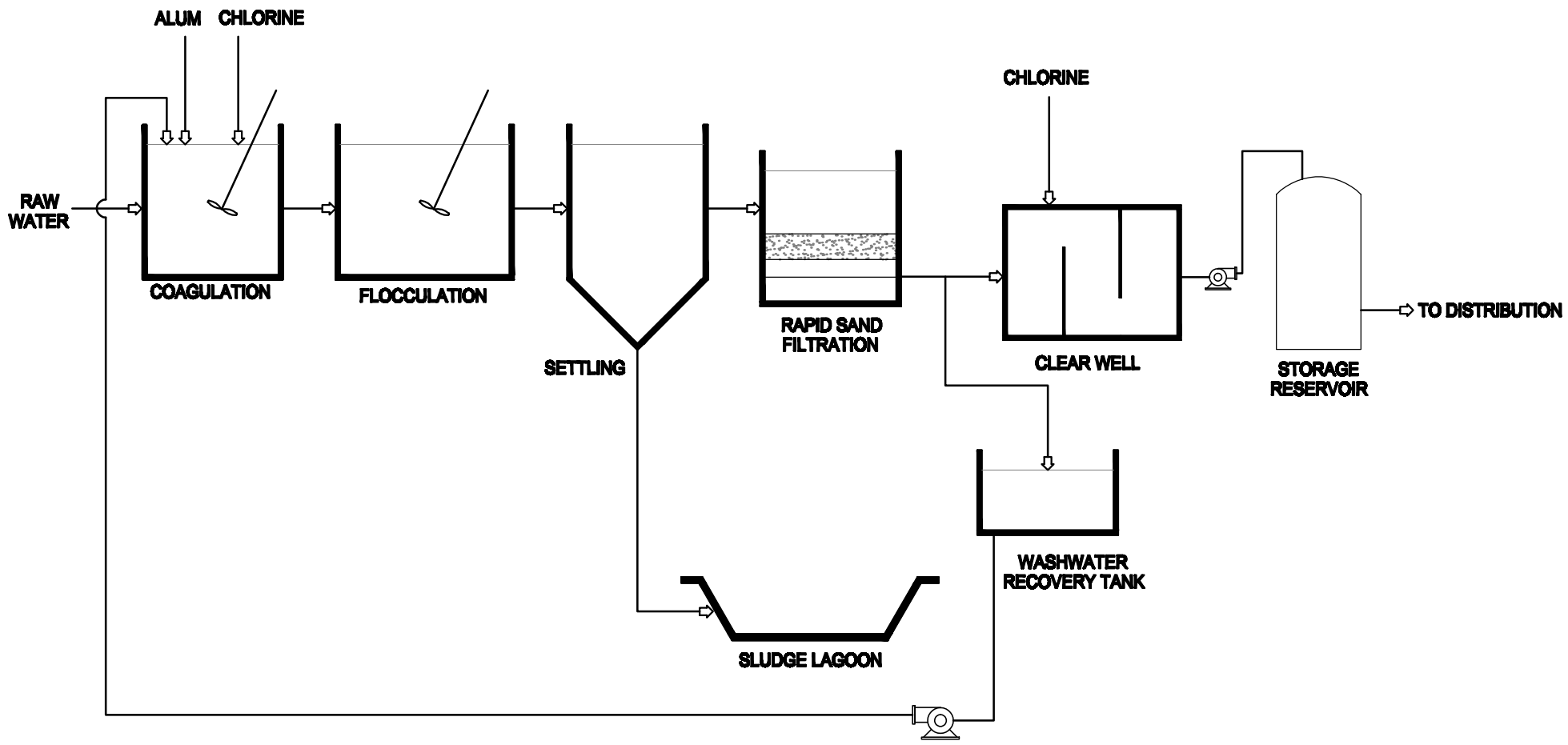
Filtered water will enter in the clear well and be disinfected using sodium hypochlorite solution. The disinfectant will remove all pathogens remaining in the water. A detention time of at least 20 minutes will allow the chlorine to react with the microorganism present in the water before it could be used for human consumption. The disinfected water will finally be stored in the reservoir for distribution. The residual chlorine concentration will be in accordance with the Philippine National Drinking Standards for Drinking Water (PNSDW).

F. Backwashing and Water Recovery

The recovery tank will initially store backwash water. All solids in the backwash water will be allowed to settle in the recovery tank. Clear water called supernatant on top layer will be combined with raw water and returned into the rapid mixing tank.

G. Sludge Handling and Dewatering

Sludge removed from the settling tank will be dewatered using sludge lagoons. The sludge lagoons will separate water in the sludge using natural drying process. Sludge cake produced will be disposed offsite. Filtrate will be combined with raw water.



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Within the proposed treatment plant compound, the following will also be constructed:

a) administration building where the office and operation center of the bulk water system;
b) chemical room and storage for equipment and materials used for operation and maintenance; and
c) power house where the standby generating set.

6.1.3 Storage Facilities

The provision of huge capacity storage requirement to meet the demand in case of emergency, such as breakdown of major water facility, entails high capital expenditures. For economic reasons, however, emergency storage must be reduced to a minimum. Hence, a minimum volume requirement equivalent to satisfy a 2-hour emergency duration, in accordance with the LWUA methodology, has been considered. The total aggregate volume storage of all reservoirs and sumps will be equivalent to 2 hours of maximum day demand or designed flow. The clear well including chlorination facilities will be constructed within the site of the treatment plant.

Pump station with sump or reservoir will provide adequate pressure head and flow to different offtakes. It will also serve as pressure breaker or booster in cases where the terrain is rolling.

To ensure the quality will be free from pathogenic microorganism, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

6.1.4 Transmission Facilities

Air/vacuum release valves will be installed at high points along the pipeline to prevent air locks, while blow off valves will be provided at low points for sediment flushing. Valves such as gate valves, butterfly, non-return valves and pressure reducing valves will be installed, where appropriate, along the transmission line for adequate pressure and efficient flow of water. Likewise, river/creek crossing will be constructed where necessary.

Flow control valves to regulate the flow and prevent back flow will be installed in the raw water pipeline, transmission line, and other critical locations. Flow metering devices will be provided at the production site or treatment plant and offtakes for proper control and monitoring of water accountability.

Where the terrain is rolling, the transmission mains will be designed to a maximum allowable pressure head to prevent bursting and potential leakage, and hydraulically controlled by reservoir, sump, pressure breaker or pipe constriction especially in rugged terrain.

6.1.5 Pump Stations

For reliability and continuity of service, all pumps will be running with 2 sets of duty pumps at any given time in addition to the third as back up in case of pump failure or breakdown. For practical purposes, pumps less than five (5) Hp capacity, only one (1) unit will be used and another one (1) for back up. All pumps will be used on rotating basis for uniform wear and tear.

By year 2025, new sets of pumps, with bigger capacities, designed for year 2035 production, will replace all pumps installed during the initial operation.

6.1.6 Power Source Development

Commercial power will be the primary source of electricity to be used for the operation of the proposed water treatment plant, pump stations, and related facilities. The bulk power supply will be distributed from the existing high voltage transmission, 13.8 kV line to line, 3-phase, 3-wire, 60-Hz system up to the proposed water treatment sites and pumps stations. The power utility company, Bohol Electric Company (BOHECO), will provide transmission poles, high voltage cables, transformers, arresters, cut-off devices, metering instrumentation, etc., as part of the service entrance facility to be provided for the different facilities.

Standby diesel-engine generator set will be provided for emergency power back-up in case of commercial power failure. The standby power will consist of the diesel-engine directly coupled to generator set, control panel, starting battery and charger, fuel tanks and fuel oil transfer facility. A separate building will be constructed far from the water treatment plant for the power generating set and ancillaries.

6.1.7 Land and Right-of-Way (ROW) Acquisition

Where possible, the water facilities, such as treatment plants, reservoirs, sumps and pump stations will be located in low-value areas so that the cost of acquiring required land will be moderate. ROW acquisition for pipeline traversing private property as well as access road development will also be included. The transmission mains alignment will be laid along the national/provincial road to minimize the issues of right-of-way, compensation and resettlement.

6.1.8 Stored Materials, Equipment and Vehicles

Necessary materials, such as pipes, fittings, valves and flow meters as well as equipment like, pumps and motors will be provided for stockpiling for an efficient operation and maintenance of the bulk supply system. A multi-purpose vehicle to be used for effective repair and maintenance will also be considered.

6.2 THE SEVEN RECOMMENDED BULK WATER SUPPLY SYSTEMS

6.2.1 Abatan River Cluster

The proposed Abatan River Cluster will provide an average daily production of 10,179 cumd benefiting about 70,200 population. It will cover 7 municipalities of Antequera, Balilihan, Catigbian, Corella, Sagbayan, San Isidro and Sikatuna. The proposed development plan for Abatan River Cluster is presented in **Figure 6-3**.

A. Source Facility

The site of the proposed intake structure with pumping station will be located in Bgy. Viga, Antequera at an elevation of 60 mamsl. A 4m-high diversion weir structure will be constructed 45m across Abatan River where portion of the flow will be diverted into the intake chamber of the pump house located at the left bank of the river.

B. Transmission Facilities

A total of 59.5km long raw and clean transmission lines with diameters ranging from 200 to 500mm will be installed. The raw water will be lifted 59m by pump and delivered via 4.6km long transmission line with 500mm diameter to the water treatment plant at an elevation of 119 mamsl.

The transmission mains originating from the pump station of the reservoir located in the treatment plant will split into 3 lines. The 16.5km long mains with diameters ranging from 200 350mm going south will serve Balilihan all the way down to Sikatuna and Corella. Only 1 booster pump located at the treatment plant will be enough to deliver water with the required pressure heads at the different offtakes due to gentle sloping down reaching 80mamsl.

With a small capacity 1-Hp pump just enough to deliver water at required pressure, the 9.8km long pipeline with 200mm diameter leading westward will serve Antequera, at an elevation of 81 mamsl.

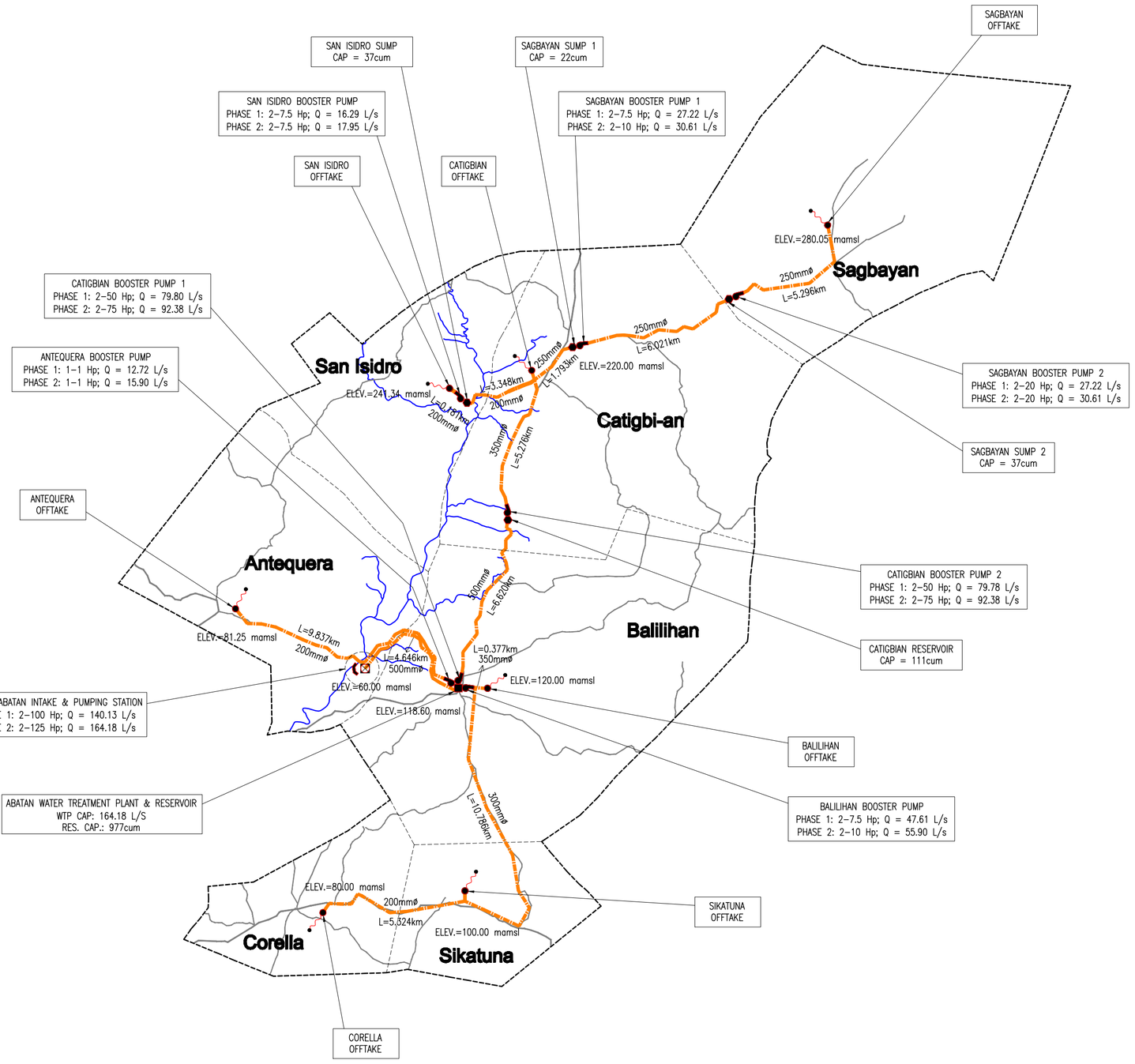
The 28.5km long pipeline going northward will have diameters ranging from 200 to 500mm. There will be 4 boosters with sumps along the pipeline due to higher elevations ranging from 220 to 280 mamsl. The first booster station will be located between the treatment plant and Catigbian offtake, the second will be along the pipeline going to San Isidro, while the third and fourth booster stations will be installed in series along the mains going to Sagbayan.

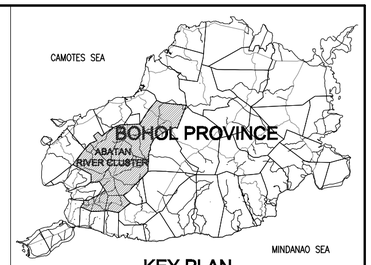
LEGEND:

- NATIONAL/PROVINCIAL ROAD
- MUNICIPAL BOUNDARY
- CLUSTER BOUNDARY
- SHORELINE
- RIVER
- TRANSMISSION LINES
- INTAKE STRUCTURE
- OFFTAKE
- TREATMENT PLANT & TREATED WATER RESERVOIR
- PUMPING STATION
- BOOSTER PUMP STATION
- BREAK-PRESSURE CHAMBER
- RESERVOIR / SUMP
- POST CHLORINATING FACILITY

ABBREVIATIONS:

Q	—	FLOW IN LITERS PER SECOND
km	—	KILOMETER
mm	—	MILLIMETER
cum	—	CUBIC METER
ø	—	DIAMETER
mamsl	—	METER ABOVE MEAN SEA LEVEL
L/s	—	LITER PER SECOND
Hp	—	HORSEPOWER

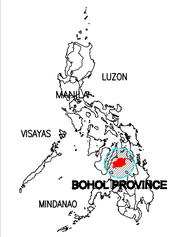




KEY PLAN

MUNICIPALITIES

- CORELLA
- SIKATUNA
- BALILIHAN
- ANTEQUERA
- SAN ISIDRO
- CATIGBIAN
- SAGBAYAN



MAP OF THE PHILIPPINES

N

0 1 2 3 4 5KM

GRAPHICAL SCALE

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C. Pump Stations

In the initial operation in 2013, there will be 8 pump stations. The biggest pumps will have 100-Hp capacity located at the intake structure. While the smallest 1-Hp pumps will be used to boost the pressure along the pipeline going to Antequera. Most of the pumps will be replaced to bigger capacities by 2025.

Table 6-1 summarizes the pumps to be installed in 2010 and the pump replacement by 2025 and is shown below:

Table 6-1 Schedule of Pumps for Abatan River Cluster

2010		2025	
100 Hp Pumps @ Intake	2 units	125 Hp Pumps @ Intake	2 units
1 Hp Booster Pump @ WTP Antequera	1 unit	1 Hp Booster Pump @ WTP Antequera	1 unit
50 Hp Booster Pumps @ WTP Catigbian	2 units	75 Hp Booster Pumps @ WTP Catigbian	2 units
7.5 Hp Booster Pumps @ WTP Balilihan	2 units	10 Hp Booster Pumps @ WTP Balilihan	2 units
50 Hp Booster Pump 1	2 units	75 Hp Booster Pump 1	2 units
7.5 Hp Booster Pump 2	2 units	7.5 Hp Booster Pump 2	2 units
7.5 Hp Pump 3	2 units	10 Hp Pump 3	2 units
20 Hp Pump 4	2 units	20 Hp Pump 4	2 units

D. Storage Facilities

There will be 5 reservoirs and sumps to be constructed at different sites. A 977 cum capacity clean water reservoir including chlorination facilities will be constructed within the site of the treatment plant. The total capacity of these facilities will be 1,184 cum. The storage facilities are summarized as follows:

Reservoir at WTP	:	977 cum
Reservoir for Balilihan	:	111 cum
Sump for Catigbian	:	22 cum
Sump for San Isidro	:	37 cum
Sump for Sagbayan	:	37 cum

E. Treatment Plant

The treatment plant will be located in Bgy. Del Carmen, Balilihan. It will have a design capacity of 164.18 L/s where the raw water will undergo a series of purification process. The proposed plant layout for Abatan water treatment plant is presented in **Figure 6–4**.

F. Disinfection Facilities

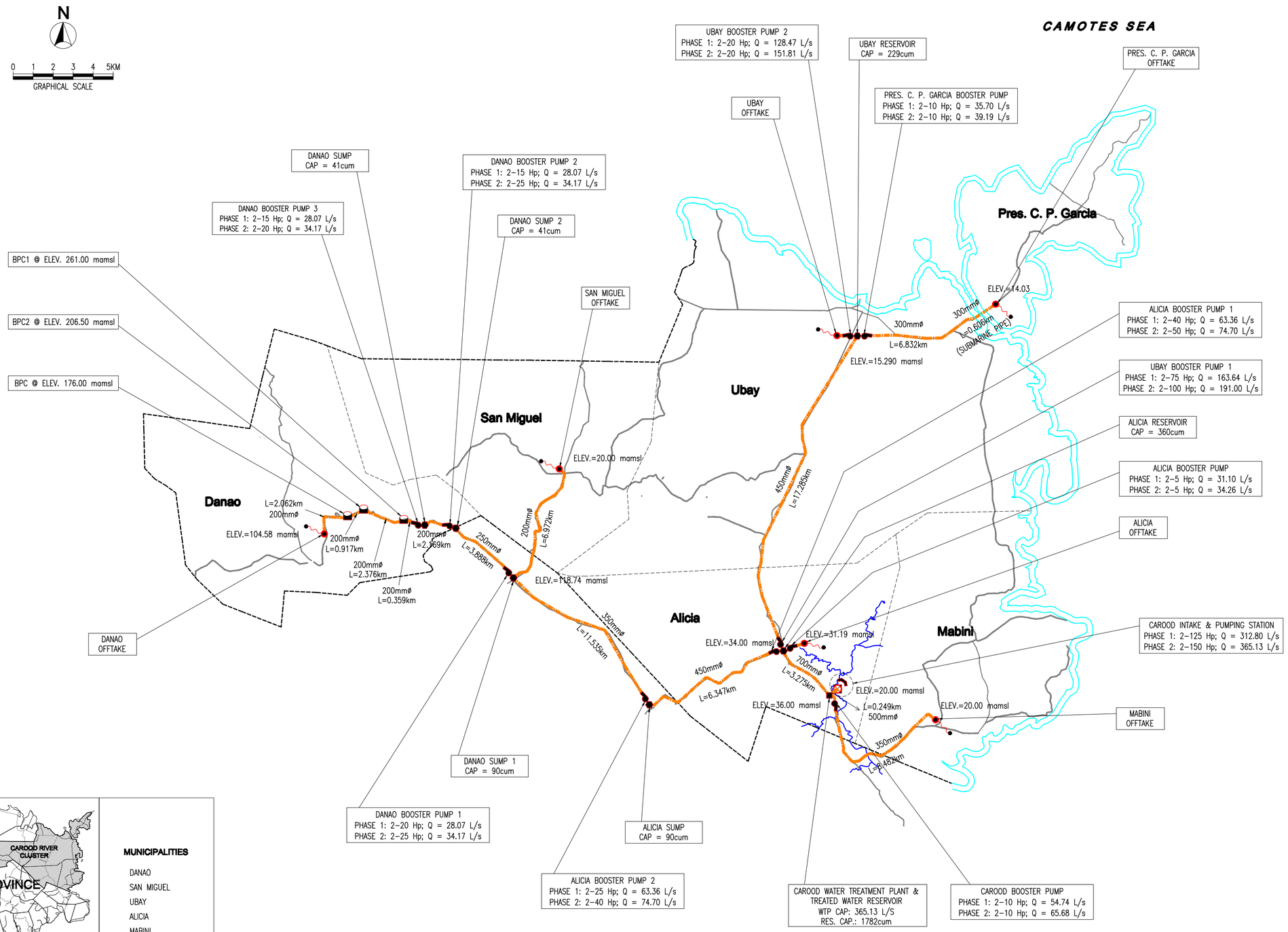
Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

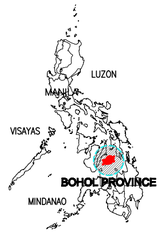
LEGEND:

- NATIONAL/PROVINCIAL ROAD
- MUNICIPAL BOUNDARY
- CLUSTER BOUNDARY
- SHORELINE
- RIVER
- TRANSMISSION LINES
- INTAKE STRUCTURE
- OFFTAKE
- TREATMENT PLANT & TREATED WATER RESERVOIR
- PUMPING STATION
- BOOSTER PUMP STATION
- BREAK-PRESSURE CHAMBER
- RESERVOIR / SUMP
- POST CHLORINATING FACILITY

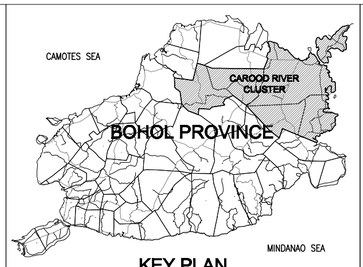
ABBREVIATIONS:

Q	—	FLOW IN LITERS PER SECOND
km	—	KILOMETER
mm	—	MILLIMETER
cum	—	CUBIC METER
ø	—	DIAMETER
mamsl	—	METER ABOVE MEAN SEA LEVEL
L/s	—	LITER PER SECOND
Hp	—	HORSEPOWER





MAP OF THE PHILIPPINES



KEY PLAN

MUNICIPALITIES

- DANAO
- SAN MIGUEL
- UBAY
- ALICIA
- MABINI
- PRES. C. P. GARCIA

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6.2.1.1 Cost Estimates

The total project cost is PhP772,742,000 for 2010 while PhP6,255,000 will be allocated for replacement of pumps by 2025. **Table 6-2 and** shows the breakdown of costs of facilities of the Abatan River Cluster Recommended Plan.

The annual operation and maintenance cost of Abatan River Cluster is presented in **Table 6-3.**

TABLE 6-2 (A) ABATAN RIVER CLUSTER PHASE 1
BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE						
Item No.	Description	Unit	Qty	Unit Cost	Amount (PhPx000)	Amount
A	**FACILITIES/ STRUCTURES**					
1.0	Source Facility					
1.1	Intake Structure with weir at Ipil River	Cu.m.	389	20,000.00	7,780	7,780,000.00
	Sub-Total Cost					**7,780,000.00**
2.0	Transmission Pipelines					
2.1	Pipelines					
	200 mm dia.	lm.	18,690	4,000.00	74,760	74,760,000.00
	250 mm dia.	lm.	13,110	6,700.00	87,837	87,837,000.00
	300 mm dia.	lm.	10,786	7,000.00	75,502	75,502,000.00
	350 mm dia.	lm.	5,653	9,500.00	53,704	53,703,500.00
	500 mm dia.	lm.	11,266	12,700.00	143,078	143,078,200.00
2.2	River/Creek Crossings	ls				434,880,700.00
2.3	Flowmeters and Gauging Points	ls				8,697,614.00
2.4	Valves and Fittings	ls				54,360,087.50
	Sub-Total Cost					**497,938,401.50**
3.0	Pumping Stations					
3.1	Booster Pump					
3.1.1	100 Hp Pumps @ Intake	Unit	3	509,891.20	1,530	1,529,674.00
3.1.2	1 Hp Booster Pumps @ WTP Antequera	Unit	2	24,679.20	49	49,358.00
3.1.3	50 Hp Booster Pumps @ WTP Catigbian	Unit	3	264,628.00	794	793,884.00
3.1.4	7.5 Hp Booster Pumps @ WTP Balilihan	Unit	3	57,148.00	171	171,444.00
3.1.5	50 Hp Booter Pump 1	Unit	3	264,628.00	794	793,884.00
3.1.6	7.5 Hp Booter Pump 2	Unit	3	57,148.00	171	171,444.00
3.1.7	7.5 Hp Pump 3	Unit	3	57,148.00	171	171,444.00
3.1.8	20 Hp Pump 4	Unit	3	103,157.60	309	309,473.00
3.2	Building					
3.2.1	Pump House	Sq.m.	420	9,000.00	3,780	3,780,000.00
	Sub-Total Cost					**7,770,605.00**
4.0	Storage Facilities					
4.1	Reservoir Near WTP	Cu.m.	977	10,000.00	9,770	9,770,000.00
4.2	Reservoir (Balilihan)	Cu.m.	111	12,000.00	1,332	1,332,000.00
4.3	Sump (Catigbian)	Cu.m.	22	15,000.00	330	330,000.00
4.4	Sump (San Isidro)	Cu.m.	37	15,000.00	555	555,000.00
4.5	Sump (Sagbayan)	Cu.m.	37	15,000.00	555	555,000.00
	Sub-Total Cost		**1,184**		12,542	**12,542,000.00**
5.0	Water Treatment Plant				-	
5.1	Rapid Sand Filtration Plant	MLD	14.19	10,000,000.00	141,900	141,900,000.00
	Sub-Total Cost				141,900	**141,900,000.00**
6.0	Power Source Development				-	
6.1	Building	Sq.m.	252	9,000.00	2,268	2,268,000.00
6.2	Commecial Power & Standy Diesel Engine Generat	ls	1	5,724,000.00	5,724	5,724,000.00
	Sub-Total Cost				7,992	**7,992,000.00**
7.0	Land/ROW Acquisition				-	
7.1	Pumping Stations	ls	1	22,204.00	22	22,204.00
7.2	Water Treatment Plant	ls	1	120,800.00	121	120,800.00
7.3	Treated Water Reservoirs	ls	1	22,709.00	23	22,709.00
7.4	Right of Way (ROW)	ls	1	224,495.00	224	224,495.00
	Sub-Total Cost				390	**390,208.00**
					-	
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	7,528,935.00	7,529	7,528,935.00
					-	
B	**TOTAL BASE COST - PHASE 1 (TBC)**				**683,842**	**683,842,149.50**
					-	

TABLE 6-2 (B) ABATAN RIVER CLUSTER PHASE 2

REPLACEMENT OF ALL PUMPS AT YEAR 2025
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE						
Item No.	Description	Unit	Qty	Unit Cost	Amount (PhPx000)	Amount
A	FACILITIES/ STRUCTURES					
3.0	Pumping Stations					
3.1	Booster Pump					
3.1.1	125 Hp Pumps @ Intake	Unit	3	754,135.20	2,262	2,262,406.00
3.1.2	1 Hp Booster Pumps @ WTP Antequera	Unit	2	24,679.20	49	49,358.00
3.1.3	75 Hp Booster Pumps @ WTP Catigbian	Unit	3	415,906.40	1,248	1,247,719.00
3.1.4	10 Hp Booster Pumps @ WTP Balilihan	Unit	3	66,393.60	199	199,181.00
3.1.5	75 Hp Booter Pump 1	Unit	3	415,906.40	1,248	1,247,719.00
3.1.6	7.5 Hp Booter Pump 2	Unit	3	57,148.00	171	171,444.00
3.1.7	10 Hp Pump 3	Unit	3	66,393.60	199	199,181.00
3.1.8	20 Hp Pump 4	Unit	3	103,157.60	309	309,473.00
					-	
	Sub-Total Cost				5,686	5,686,481.00
					-	
B	BASE COST - PHASE 2 (TBC)				5,686	5,686,481.00
					-	
C	Feasibility Study, and Detailed Engineering Design (3.0% of TBC)				-	
					-	
D	Contingency (8.0% of TBC)				455	454,918.00
					-	
E	Construction Management Supervision (2.0% of TBC)				114	113,730.00
					-	
F	PHASE 2 PROJECT COST ESTIMATE				6,255	6,255,129.00
					-	
G	TOTAL PROJECT COST ESTIMATE				778,997	778,996,757.50

Table 6-3 Annual Operation and Maintenance Cost
Abatan River Cluster
(October 2007 Price Level)

Year	Salaries	Energy	Chemicals	Maintenance	Total
2013	3,432,000	8,830,089	419,250	8,045,748	20,727,087
2014	3,432,000	8,896,697	410,453	8,045,006	20,784,156
2015	3,432,000	8,963,305	401,657	8,044,263	20,841,225
2016	3,432,000	9,548,325	432,254	8,046,847	21,459,425
2017	3,432,000	10,133,344	462,852	8,049,430	22,077,626
2018	3,432,000	10,718,363	493,449	8,052,014	22,695,827
2019	3,432,000	11,303,382	524,047	8,054,598	23,314,027
2020	3,432,000	11,888,402	554,644	8,057,182	23,932,228
2021	3,432,000	12,451,754	584,326	8,059,688	24,527,769
2022	3,432,000	13,015,107	614,008	8,062,195	25,123,310
2023	3,432,000	13,578,460	643,689	8,064,701	25,718,851
2024	3,432,000	14,141,813	673,371	8,067,208	26,314,391
2025	3,432,000	14,705,166	703,053	8,095,152	26,935,371
2026	3,432,000	16,130,248	717,797	8,096,397	28,376,443
2027	3,432,000	16,428,303	732,542	8,097,642	28,690,487
2028	3,432,000	16,726,357	747,286	8,098,887	29,004,531
2029	3,432,000	17,024,412	762,031	8,100,133	29,318,575
2030	3,432,000	17,322,466	776,776	8,101,378	29,632,619
2031	3,432,000	17,567,193	788,616	8,102,377	29,890,186
2032	3,432,000	17,811,919	800,455	8,103,377	30,147,752
2033	3,432,000	18,056,646	812,295	8,104,377	30,405,319
2034	3,432,000	18,301,373	824,135	8,105,377	30,662,885
2035	3,432,000	18,546,100	835,975	8,106,377	30,920,452

6.2.2 Loboc 1 River Cluster

The proposed Loboc River Cluster will provide an average daily production of 61,309 cumd benefiting about 237,400 population. It has the highest number of population served covering the largest number of city/municipalities. It will cover 11 city/municipalities of Alburquerque, Baclayon, Cortes, Dauis, Dimiao, Lila, Loay, Loboc, Panglao, Tagbilaran City and Valencia. The proposed development plan for Loboc 1 River Cluster is presented in **Figure 6-5**.

A. Source Facility

The site of the proposed intake structure with pumping station will be located in Bgy. Gotozon, Loboc at an elevation of 34 mamsl. The intake structure will be common for both Loboc 1 and Loboc 2 River Clusters because they will be tapping the same river and location. A 3m-high diversion weir structure will be constructed 30m across Loboc River where portion of the flow will be diverted into the intake chamber of the pump house located at the left bank of the river. \

B. Transmission Facilities

A total of 77km long raw and clean water transmission lines with diameters ranging from 250 to 1000mm diameters will be installed for Loboc 1 Cluster. The raw water will be conveyed through 4.1km long pipeline with diameters ranging from 600 to 1000mm to the treatment plant at an elevation of 31 mamsl.

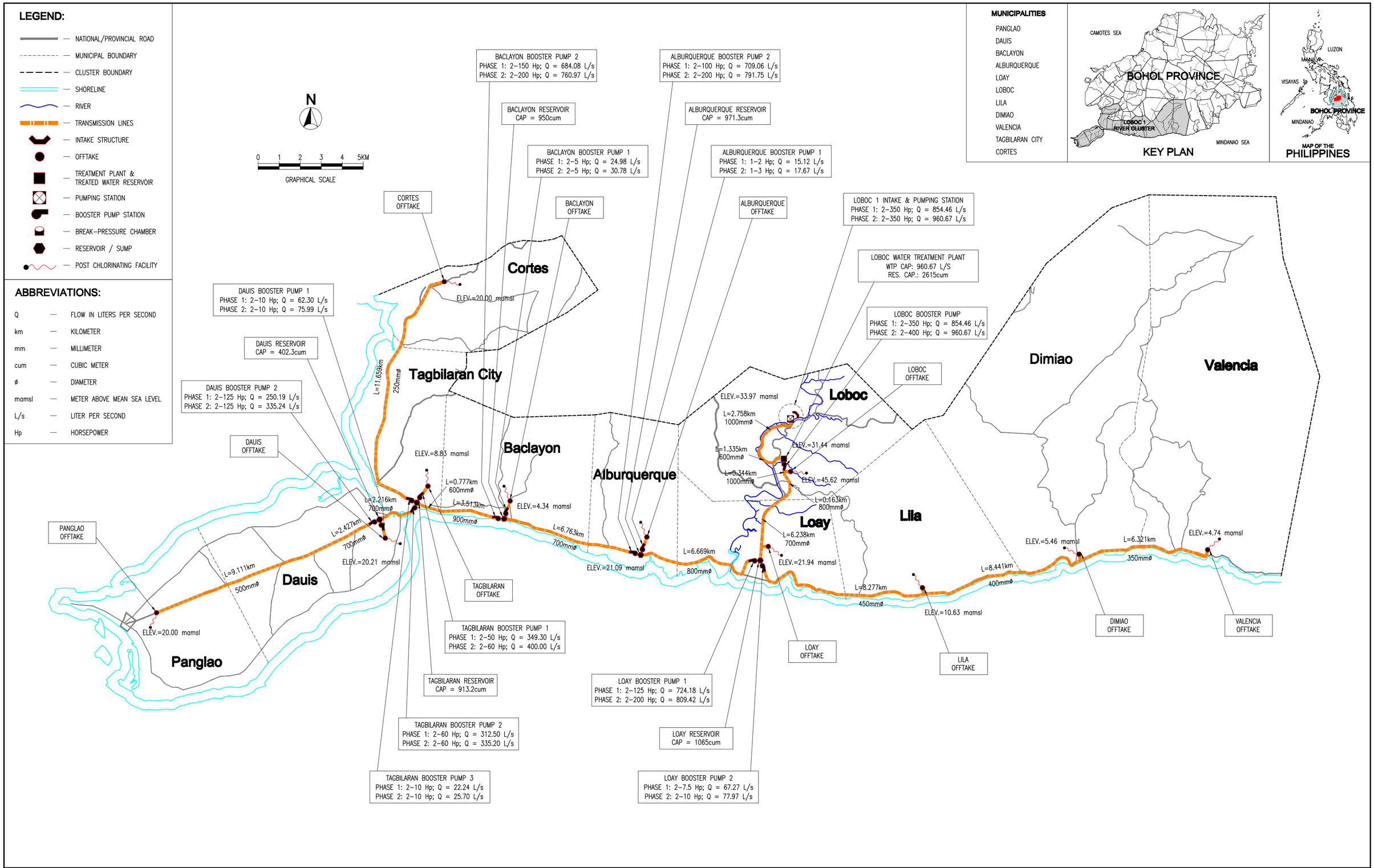
From the treatment plant, the treated water will be delivered to Loboc through a 0.3km long pipeline with 1000mm diameter, and, further south, to Loay via 6.4km long with 700 to 800mm diameters. At the junction, a pump station will be installed where transmission will split into 2 opposite directions. The pipeline going eastward will convey water to Lila, Dimiao and finally to Valencia. This stretch will consist of 23km long pipeline with diameters ranging from 350 to 450mm, gently sloping down from 22 to 5mamsl along the coastal road.

The pipeline going westward will carry the bulk of the water produced. The 17.7km long pipeline with diameters ranging from 600 to 900mm diameters will be installed to cover Alburquerque, Baclayon and Tagbilaran City. At the junction, another pump station will be constructed to convey water northward to Cortes via 11.7km long 250mm diameter pipeline. The other 13.8km long with diameters ranging from 500 to 700m will branch out southwestward crossing the existing bridge serving the 2 island municipalities of Dauis and Panglao.

C. Pump Stations

During the initial year of operation in 2013, there will be 6 pump stations installed with the biggest 400-Hp pump at the treatment plant to the smallest 3-Hp pump in Alburquerque. Most of the pumps will be replaced to bigger capacities by 2025.

Table 6-4 summarizes the pumps to be installed in 2010 and pump replacement by 2025.



C O N S U L T A N T S		OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd.	WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	PROPOSED DEVELOPMENT PLAN FOR LOBOC 1 RIVER CLUSTER	FIGURE NO. 6-5

Table 6-4 Schedule of Pumps for Loboc 1 River Cluster

2010		2025	
500 Hp Booster Pumps @ Intake	2 units	600 Hp Booster Pumps @ Intake	2 units
600 Hp Booster Pumps @ WTP	2 units	700 Hp Booster Pumps @ WTP	2 units
5 Hp Pumps @ Loay	2 units	5 Hp Pumps @ Loay	2 units
7.5 Hp Booster Pumps @ Loay-Lila	2 units	10 Hp Booster Pumps @ Loay-Lila	2 units
200 Hp Booster Pumps @ Loay-Albur	2 units	250 Hp Booster Pumps @ Loay-Albur	2 units
5 Hp Pumps @ Albur	2 units	5 Hp Pumps @ Albur	2 units
100 Hp Booster Pumps @ Albur	2 units	200 Hp Booster Pumps @ Albu	2 units
5 Hp Pumps @ Bac	2 units	5 Hp Pumps @ Bac	2 units
300 Hp Booster Pumps @ Bac	2 units	350 Hp Booster Pumps @ Bac	2 units
50 Hp Pumps @ Tagbilaran	2 units	60 Hp Pumps @ Tagbilaran	2 units
60 Hp Booster Pumps @ Tagbi-Dau	2 units	60 Hp Booster Pumps @ Tagbi-Dau	2 units
125 Hp Booster Pumps @ Tagbi-Cor	2 units	150 Hp Booster Pumps @ Tagbi-Cor	2 units
10 Hp Pumps @ Dau	2 units	10 Hp Pumps @ Dau	2 units
125 Hp Booster Pumps @ Dau	2 units	125 Hp Booster Pumps @ Dau	2 units
5 Hp Pumps @ Cort	2 units	5 Hp Pumps @ Cort	2 units
250 Hp Booster Pumps @ Cort	2 units	300 Hp Booster Pumps @ Cort	2 units
125 Hp Booster Pumps @ Mar	2 units	150 Hp Booster Pumps @ Mar	2 units
25 Hp Pumps @ Tub	2 units	30 Hp Pumps @ Tub	2 units
10 Hp Booster Pumps @ Tub	2 units	10 Hp Booster Pumps @ Tub	2 units

D. Storage Facilities

There will be 6 reservoirs and sumps to be constructed at different sites. A 2,615 cum capacity clean water reservoir including chlorination facilities will be constructed within the site of the treatment plant. The total capacity of these facilities will be 6,916 cum. The storage facilities are summarized as follows:

Reservoir at WTP	:	2,553 cum
Sump (Loay)	:	1,816 cum
Sump (Tagbi)	:	1,625 cum
Sump (Mar)	:	658 cum

Sump (Alb)	:	1,684 cum
Sump (Bac)	:	1,662 cum
Sump (Dau)	:	402 cum
Sump (Cort)	:	743 cum
Sump (Mar)	;	658 cum
Sump (Tub)	;	47 cum

E. Treatment Plant

The treatment plant will be located in Loboc. It will have a design capacity of 960.67 L/s where raw water will undergo a series of purification process. The proposed Loboc 1 water treatment plant layout is presented in **Figure 6-6**.

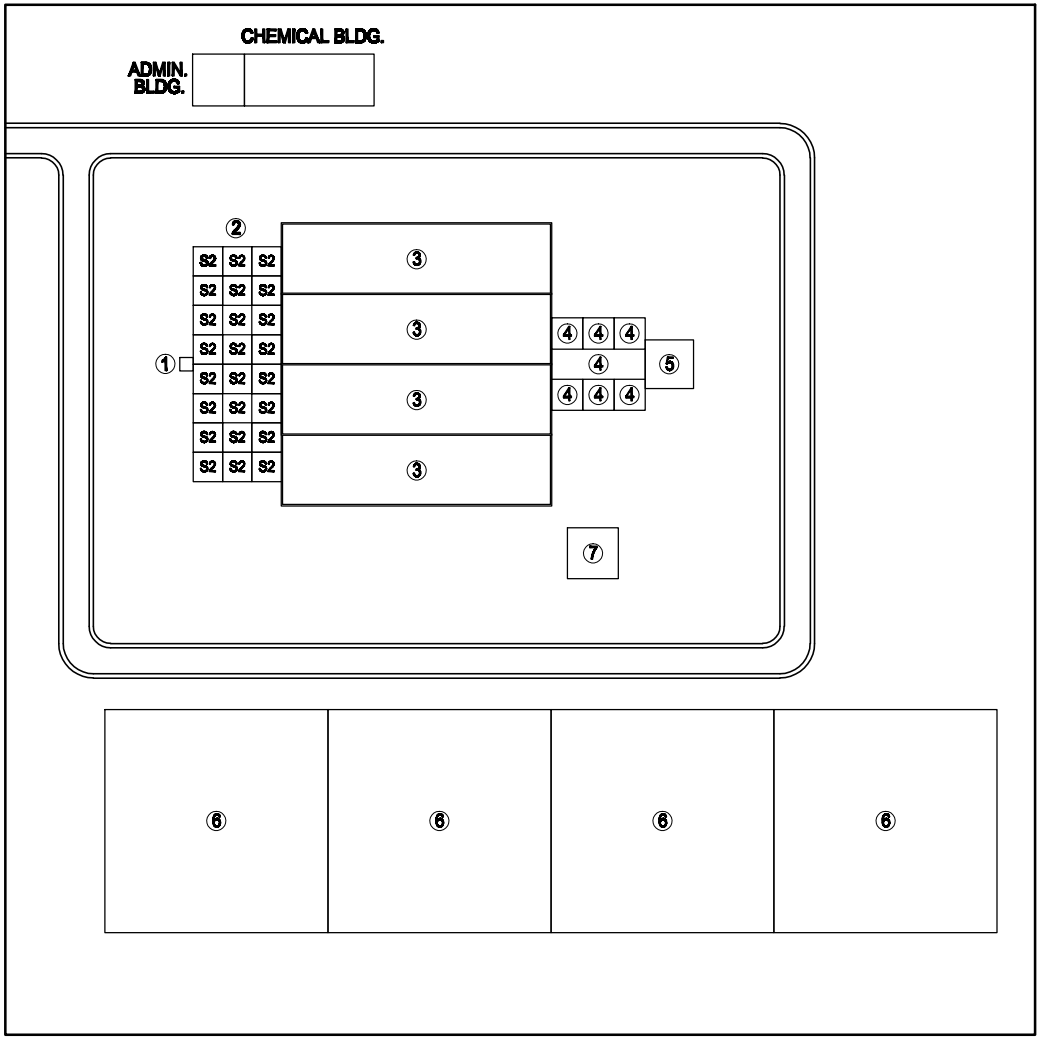
F. Disinfection Facilities

Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

6.2.2.1 Cost Estimates

The total project cost is PhP2,724,100,000 for 2010 and PhP27,726,000 will be allocated for pump replacement by 2025. **Table 6-5** shows the breakdown of costs of facilities of the Loboc 1 River Cluster Recommended Plan.

The annual operation and maintenance cost for Loboc 1 River Cluster is presented in **Table 6-6.**



LEGEND :

① RAPID MIX TANK
② 3 - STAGE FLOCCULATION TANKS
③ SETTLING TANKS
④ RAPID SAND FILTERS
⑤ CLEAR WELL
⑥ SLUDGE LAGOONS
⑦ WASH WATER RECOVERY TANK

PLANT LAYOUT

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd. / WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	PROPOSED LOBOC 1 WATER TREATMENT PLANT	FIGURE NO. 6-6

TABLE 6-5 (A) BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
LOBOC1 RIVER CLUSTER 2010 - OPTION 2
BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir at Loboc River	Cu.m.	199	20,000	3,980,000
	Sub-Total Cost				**3,980,000**
2.0	Transmission Pipelines				
2.1	Pipelines	lm.	**77,002**		
	250 mm dia.	lm.	11,659	6,700	78,115,300
	350 mm dia.	lm.	6,321	9,500	60,049,500
	400 mm dia.	lm.	8,441	10,500	88,630,500
	450 mm dia.	lm.	8,277	11,600	96,013,200
	500 mm dia.	lm.	9,111	12,700	115,709,700
	600 mm dia.	lm.	2,112	17,400	36,748,800
	700 mm dia.	lm.	17,644	23,400	412,869,600
	800 mm dia.	lm.	6,832	30,700	209,742,400
	900 mm dia.	lm.	3,513	33,200	116,631,600
	1000 mm dia.	lm.	3,092	49,800	153,981,600
2.2	River/Creek Crossings	ls			6,842,461
2.3	Flowmeters and Gauging Points	ls			27,369,844
2.4	Valves and Fittings	ls			171,061,525
	Sub-Total Cost				**1,573,766,030**
3.0	Pumping Stations				
3.1	**Booster Pump (2025)**				
3.1.1	350 Hp Booster Pumps @ Intake	Unit	3	1,675,856	5,027,568
3.1.2	350 Hp Booster Pumps @ WTP	Unit	3	1,675,856	5,027,568
3.1.3	7.5 Hp BoosterPumps @ loay-lila	Unit	3	57,148	171,444
3.1.4	125 Hp Booster Pumps @ loay-albu	Unit	3	754,135	2,262,406
3.1.5	100 Hp Booster Pumps @ Alb	Unit	3	509,891	1,529,674
3.1.6	2 Hp Pumps @ Alb	Unit	2	33,779	67,558
3.1.7	150 Hp Booster Pumps @ bac	Unit	3	848,193	2,544,578
3.1.8	5 Hp Pumps @ bac	Unit	3	42,879	128,638
3.1.9	125 Hp Booster Pumps @ dau	Unit	3	754,135	2,262,406
3.1.10	10 Hp Pumps @ dau	Unit	3	66,394	199,181
3.1.11	60 Hp Booster Pumps @ Tagbi-dau	Unit	3	363,054	1,089,161
3.1.12	10 Hp Booster Pumps @ Tagbi-cor	Unit	3	66,394	199,181
3.1.13	50 Hp Pumps @ Tagbi	Unit	3	264,628	793,884
3.2	Building				
3.2.1	Pump House	Sq.m.	932	9,000	8,388,000
	Sub-Total Cost				**29,691,247**
4.0	Storage Facilities				
4.1	Reservoir Near WTP	Cu.m.	2,615	10,000	26,150,000
4.2	Sump (loay)	Cu.m.	1,065	10,000	10,650,000
4.3	Sump (Alb)	Cu.m.	971	10,000	9,710,000
4.4	Sump (bac)	Cu.m.	950	10,000	9,500,000
4.5	Sump (dau)	Cu.m.	402	12,000	4,824,000
4.6	Sump (tagbi)	Cu.m.	913	10,000	9,130,000
	Sub-Total Cost				**69,964,000**
5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	83.10	8,000,000	664,800,000
	Sub-Total Cost				**664,800,000**
6.0	Power Source Development				
6.1	Building	Sq.m.	360	9,000	3,240,000
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	39,096,000	39,096,000
	Sub-Total Cost				**42,336,000**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	587,378	587,378
7.2	Water Treatment Plant	ls	1	362,400	362,400
7.3	Treated Water Reservoirs	ls	1	1,096,745	1,096,745
7.4	Right of Way (ROW)	ls	1	197,774	197,774
	Sub-Total Cost				**2,244,297**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	23,926,039	23,926,039
	Sub-Total Cost				**23,926,039**
B	**TOTAL BASE COST - (TBC)**				**2,410,707,613**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**72,321,228**
D	**Contingency (8.0% of TBC)**				**192,856,609**
E	**Construction Management Supervision (2.0% of TBC)**				**48,214,152**
F	**TOTAL PROJECT COST ESTIMATE**				**2,724,099,603**

TABLE 6-5 (B) BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
LOBOC1 RIVER CLUSTER 2025 - OPTION 2
BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)
OCTOBER 2007 PRICES

Item No.	Description	Unit	Qty	Unit Cost	Amount
A	**FACILITIES/ STRUCTURES**				
3.0	Pumping Stations				
3.1	**Booster Pump (2035)**				
3.1.1	350 Hp Booster Pumps @ Intake	Unit	3	1,675,856	5,027,568
3.1.2	400 Hp Booster Pumps @ WTP	Unit	3	1,901,390	5,704,171
3.1.3	10 Hp BoosterPumps @ loay-lila	Unit	3	66,394	199,181
3.1.4	200 Hp Booster Pumps @ loay-albu	Unit	3	1,026,043	3,078,130
3.1.5	200 Hp Booster Pumps @ Alb	Unit	3	1,026,043	3,078,130
3.1.6	3 Hp Pumps @ Alb	Unit	2	36,400	72,800
3.1.7	200 Hp Booster Pumps @ bac	Unit	3	1,026,043	3,078,130
3.1.8	5 Hp Pumps @ bac	Unit	3	42,879	128,638
3.1.9	60 Hp Pumps @ Tagbi	Unit	3	363,054	1,089,161
3.1.10	10 Hp Booster Pumps @ Tagbi-cor	Unit	3	66,394	199,181
3.1.11	60 Hp Booster Pumps @ Tagbi-dau	Unit	3	363,054	1,089,161
3.1.12	125 Hp Booster Pumps @ dau	Unit	3	754,135	2,262,406
3.1.13	10 Hp Pumps @ dau	Unit	3	66,394	199,181
	Sub-Total Cost				**25,205,838**
B	**TOTAL BASE COST (TBC)**				**25,205,838**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				
D	**Contingency (8.0% of TBC)**				**2,016,467**
E	**Construction Management Supervision (2.0% of TBC)**				**504,117**
F	**TOTAL PROJECT COST ESTIMATE**				**27,726,422**

Table 6-6 Annual Operation and Maintenance Cost
Loboc1 River Cluster (Revised 1)

(October 2007 Price Level)

Year	Salaries	Energy	Chemicals	Maintenance	Total
2013	4,660,500	46,737,399	2,436,159.37	26,001,779	79,835,837
2014	4,660,500	49,975,570	2,574,012.40	26,013,420	83,223,503
2015	4,660,500	53,213,742	2,711,865.43	26,025,061	86,611,168
2016	4,660,500	57,907,484	2,931,265.43	26,043,588	91,542,838
2017	4,660,500	62,601,226	3,150,665.44	26,062,115	96,474,507
2018	4,660,500	67,294,968	3,370,065.45	26,080,642	101,406,176
2019	4,660,500	71,988,710	3,589,465.46	26,099,170	106,337,845
2020	4,660,500	76,682,453	3,808,865.47	26,117,697	111,269,515
2021	4,660,500	78,915,075	3,934,729.18	26,128,325	113,638,630
2022	4,660,500	81,147,698	4,060,592.89	26,138,954	116,007,744
2023	4,660,500	83,380,320	4,186,456.60	26,149,582	118,376,859
2024	4,660,500	85,612,943	4,312,320.31	26,160,211	120,745,974
2025	4,660,500	87,845,566	4,438,184.02	26,229,378	123,173,628
2026	4,660,500	94,941,412	4,501,583.37	26,234,732	130,338,227
2027	4,660,500	96,128,721	4,564,982.72	26,240,085	131,594,289
2028	4,660,500	97,316,031	4,628,382.07	26,245,439	132,850,352
2029	4,660,500	98,503,341	4,691,781.42	26,250,793	134,106,415
2030	4,660,500	99,690,650	4,755,180.77	26,256,147	135,362,478
2031	4,660,500	100,770,361	4,811,138.38	26,260,872	136,502,871
2032	4,660,500	101,850,072	4,867,095.98	26,265,597	137,643,265
2033	4,660,500	102,929,782	4,923,053.59	26,270,323	138,783,658
2034	4,660,500	104,009,493	4,979,011.20	26,275,048	139,924,052
2035	4,660,500	105,089,204	5,034,968.80	26,279,773	141,064,446

6.2.3 Loboc 2 River Cluster

The proposed Loboc 2 River Cluster will provide an average daily production of 19,612 cumd benefiting about 124,000 population. The proposed Loboc 2 River Cluster will cover 7 municipalities, namely: Batuan, Bilar, Carmen, Dagohoy, Pilar, Sevilla and Sierra Bullones. **Figure 6-7** shows the proposed development plan of Loboc 2 River Cluster detailing the major facilities and the covered municipalities.

A. Source Facility

The site of the proposed intake structure with pumping station will be located in Bgy. Gotozon, Loboc at an elevation of 36 mamsl. The intake structure will be common for both Loboc 1 and Loboc 2 Clusters since they will be tapping the same river and location. A 3m high diversion weir structure will be constructed 30m across Loboc River where portion of the flow will be diverted into the intake chamber of the pump house located at the left bank of the river.

B. Transmission Facilities

The raw and clean water transmission lines will have a total length of 65km with diameters ranging from 150 to 600mm. The raw water will be conveyed through a series of 5 booster stations, 8.7km long pipeline with diameters ranging from 400 to 600mm to the treatment plant at an elevation of 329 mamsl

At the water treatment plant with 329 masml, the transmission line will split into 2: westward and northeastward. The westward 6km long transmission pipe with 200 to 250mm diameters will serve Sevilla. A break pressure chamber will be installed due to sloping downhill of the terrain reaching 82masml.

The northeastward 49km stretch pipeline with diameters ranging from 200 to 500mm will be having 2 booster stations to provide adequate pressure to reach the farthest point. The transmission line will serve Bilar, Batuan, Carmen, Dagohoy, Sierra Bullones and Pilar.

C. Pump Stations

During the initial year of operation in 2013, there will be 7 pump stations installed with the biggest 200-Hp pumps located along raw water pipeline and the smallest 20-Hp pumps boosting the pipeline going to Sierra Bullones and Pilar. Most of the pumps will be replaced to bigger capacities by 2025.

Table 6-7 summarizes the schedule of pumps for Loboc 2 River Cluster in 2010 and 2025 and is shown below:

Table 6-7 Schedule of Pumps for Loboc 2 River Cluster

2010		2025	
Lo2 (100Hp)	2 units	Lo2 (125Hp)	2 units
Lo2a (200Hp)	2 units	Lo2a (200Hp)	2 units
Lo2b (200Hp)	2 units	Lo2b (200Hp)	2 units
Lo2c (200Hp)	2 units	Lo2c (200Hp)	2 units
Lo2d (200Hp)	2 units	Lo2d (200Hp)	2 units
A (100Hp)	2 units	A (125Hp)	2 units
B (20Hp)	2 units	B (30Hp)	2 units

D. Storage Facilities

There will be 7 reservoirs and sumps to be constructed at different sites. A 1,727 cum capacity clean water reservoir including chlorination facilities will be constructed within the site of the treatment plant. The total capacity of these facilities will be 3,923 cum. The storage facilities are summarized as follows:

Reservoir Near WTP	:	1,727 cum
Lo2a	:	357 cum
Lo2b	:	357 cum
Lo2c	:	357 cum
Lo2d	:	357 cum
Lo2e	:	357 cum
A	:	298 cum
B	:	113 cum

LEGEND:

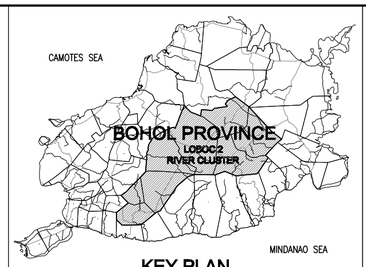
- NATIONAL/PROVINCIAL ROAD
- MUNICIPAL BOUNDARY
- CLUSTER BOUNDARY
- SHORELINE
- RIVER
- TRANSMISSION LINES
- INTAKE STRUCTURE
- OFFTAKE
- TREATMENT PLANT & TREATED WATER RESERVOIR
- PUMPING STATION
- BOOSTER PUMP STATION
- BREAK-PRESSURE CHAMBER
- RESERVOIR / SUMP
- POST CHLORINATING FACILITY

ABBREVIATIONS:

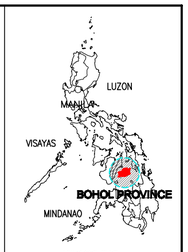
Q	—	FLOW IN LITERS PER SECOND
km	—	KILOMETER
mm	—	MILLIMETER
cum	—	CUBIC METER
ø	—	DIAMETER
mamsl	—	METER ABOVE MEAN SEA LEVEL
L/s	—	LITER PER SECOND
Hp	—	HORSEPOWER

MUNICIPALITIES

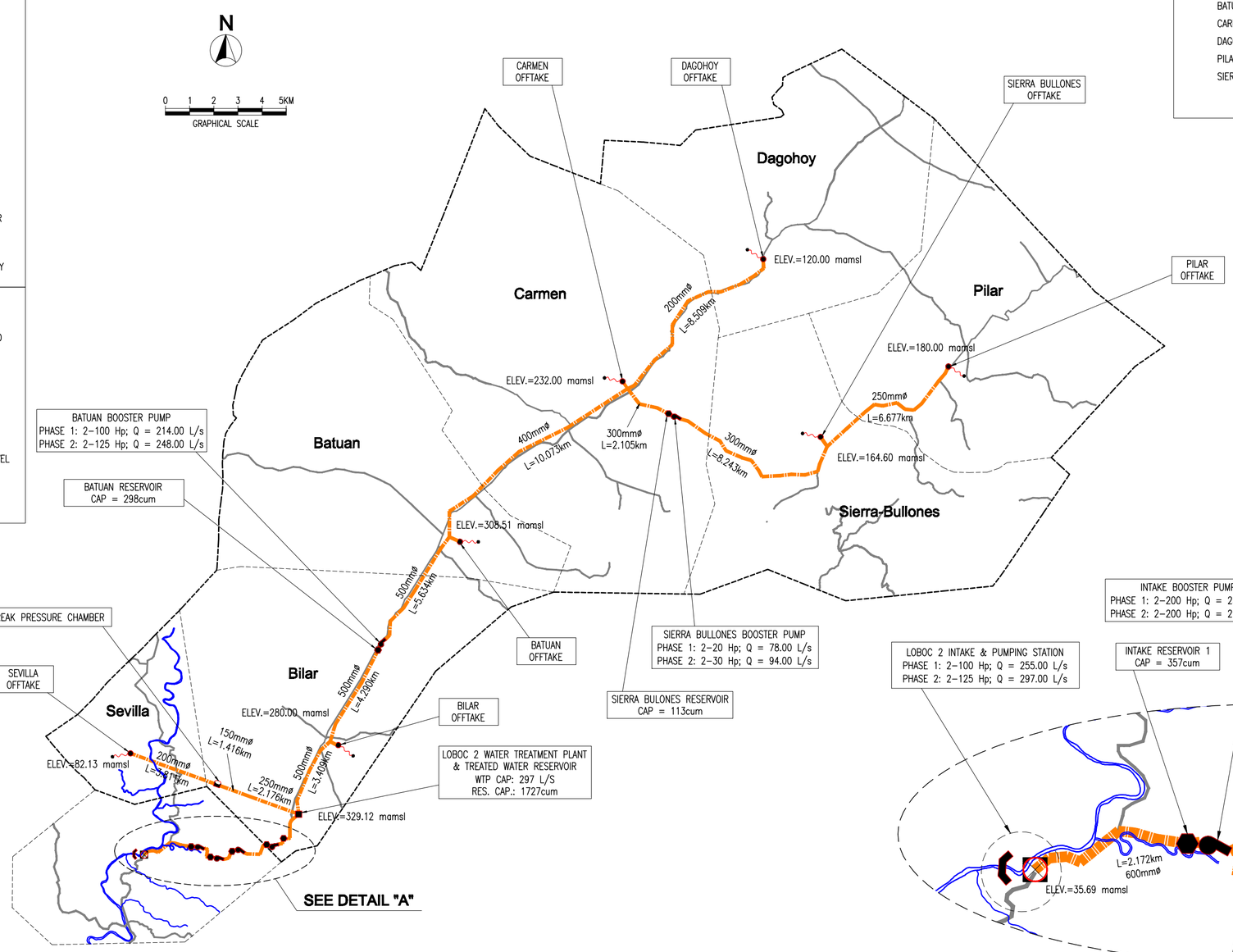
- SEVILLA
- BILAR
- BATUAN
- CARMEN
- DAGOHOY
- PILAR
- SIERRA-BULLONES

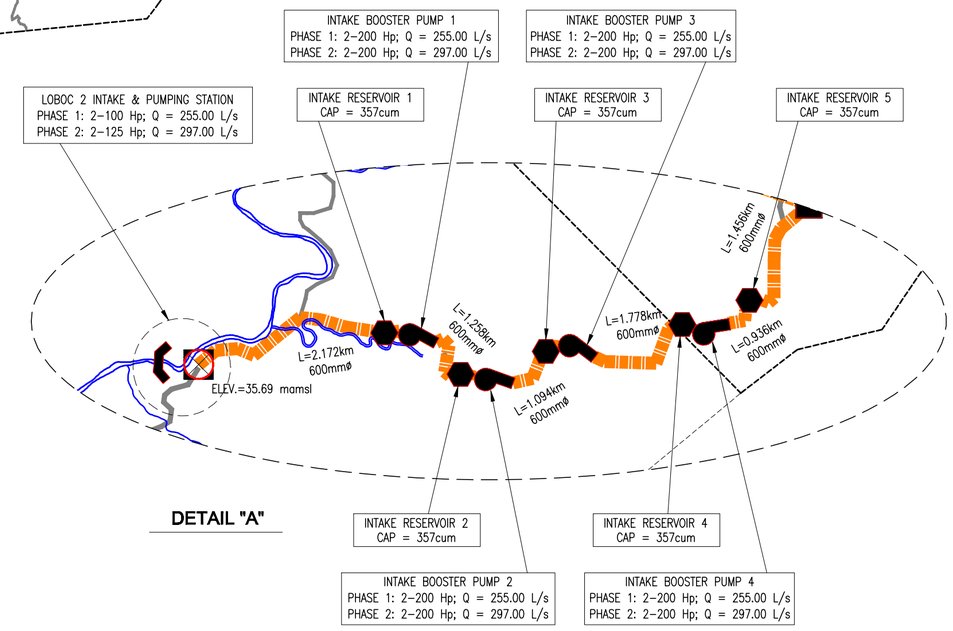


KEY PLAN



MAP OF THE PHILIPPINES





DETAIL "A"

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd. WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	PROPOSED DEVELOPMENT PLAN FOR LOBOC 2 RIVER CLUSTER	FIGURE NO. 6-7

E. Treatment Plant

The treatment plant will be located in Bilar. It will have a design capacity of 296.59 L/s where raw water will undergo a series of purification process.

F. Disinfection Facilities

Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

6.2.3.1 Cost Estimates

The total project cost is PhP1,238,579,000 for 2010 and PhP19,067,000 will be allocated fpr replacement of pumps by 2025. **Table 6-8** shows the breakdown of costs of facilities of the Loboc 2 River Cluster Recommended Plan.

The annual operation and maintenance cost of Loboc 2 River Cluster is presented in **Table 6-9**

TABLE 6-8 (A) LOBOC 2 RIVER CLUSTER PHASE 1

BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir	Cu.m.	38	20,000.00	760,000.00
	Sub-Total Cost				**760,000.00**
2.0	Transmission Pipelines				
2.1	Pipelines				
	150 mm dia.	lm.	1,416	3,300.00	4,672,800.00
	200 mm dia.	lm.	12,320	4,000.00	49,280,000.00
	250 mm dia.	lm.	8,853	6,700.00	59,315,100.00
	300 mm dia.	lm.	10,348	7,000.00	72,436,000.00
	400 mm dia.	lm.	10,073	10,500.00	105,766,500.00
	500 mm dia.	lm.	13,333	12,700.00	169,329,100.00
	600 mm dia.	lm.	8,694	17,400.00	151,275,600.00
2.2	River/Creek Crossings	ls	65,037		3,060,376.00
2.3	Flowmeters and Gauging Points	ls			12,241,502.00
2.4	Valves and Fittings	ls			76,509,388.00
	Sub-Total Cost				**703,886,366.00**
3.0	Pumping Stations				
3.1	**Booster Pump (2025)**				
3.1.1	Lo2 (100Hp)	Unit	3	509,891.20	1,529,674.00
3.1.2	Lo2a (200Hp)	Unit	3	1,026,043.20	3,078,130.00
3.1.3	Lo2b (200Hp)	Unit	3	1,026,043.20	3,078,130.00
3.1.4	Lo2c (200Hp)	Unit	3	1,026,043.20	3,078,130.00
3.1.5	Lo2d (200Hp)	Unit	3	1,026,043.20	3,078,130.00
3.1.6	A (100Hp)	Unit	3	509,891.20	1,529,674.00
3.1.7	B (20Hp)	Unit	3	103,157.60	309,473.00
3.2	Building				
3.2.1	Pump House	Sq.m.	448	9,000.00	4,032,000.00
	Sub-Total Cost				**19,713,341.00**
4.0	Storage Facilities				
4.1	Reservoir Near WTP	Cu.m.	1,727	10,000.00	17,270,000.00
4.1	Lo2a	Cu.m.	357	12,000.00	4,284,000.00
4.2	Lo2b	Cu.m.	357	12,000.00	4,284,000.00
4.3	Lo2c	Cu.m.	357	12,000.00	4,284,000.00
4.4	Lo2d	Cu.m.	357	12,000.00	4,284,000.00
4.5	Lo2e	Cu.m.	357	12,000.00	4,284,000.00
4.6	A	Cu.m.	298	12,000.00	3,576,000.00
4.7	B	Cu.m.	113	12,000.00	1,356,000.00
	Sub-Total Cost				**43,622,000.00**

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	29.15	10,000,000.00	291,500,000.00
	Sub-Total Cost				**291,500,000.00**
6.0	Power Source Development				
6.1	Building	Sq.m.	216	9,000.00	1,944,000.00
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	23,058,000.00	23,058,000.00
	Sub-Total Cost				**25,002,000.00**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	159,564.00	159,564.00
7.2	Water Treatment Plant	ls	1	181,200.00	181,200.00
7.3	Treated Water Reservoirs	ls	1	49,214.00	49,214.00
7.4	Right of Way (ROW)	ls	1	420,094.00	420,094.00
	Sub-Total Cost				**810,072.00**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	10,793,516.00	10,793,516.00
B	**TOTAL BASE COST - PHASE 1 (TBC)**				**1,096,087,295.00**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**32,882,619.00**
D	**Contingency (8.0% of TBC)**				**87,686,984.00**
E	**Construction Management Supervision (2.0% of TBC)**				**21,921,746.00**
F	**PHASE 1 PROJECT COST ESTIMATE**				**1,238,578,644.00**

TABLE 6-8 (B) LOBOC 2 CLUSTER PHASE 2
REPLACEMENT OF ALL PUMPS AT YEAR 2025
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	Description	Unit	Qty	Unit Cost	Amount
A	FACILITIES/ STRUCTURES				
3.1	Booster Pump				
3.1.1	Lo2 (125Hp)	Unit	3	754,135.20	2,262,406.00
3.1.2	Lo2a (200Hp)	Unit	3	1,026,043.20	3,078,130.00
3.1.3	Lo2b (200Hp)	Unit	3	1,026,043.20	3,078,130.00
3.1.4	Lo2c (200Hp)	Unit	3	1,026,043.20	3,078,130.00
3.1.5	Lo2d (200Hp)	Unit	3	1,026,043.20	3,078,130.00
3.1.6	A (125Hp)	Unit	3	754,135.20	2,262,406.00
3.1.7	B (30Hp)	Unit	3	165,401.60	496,205.00
	Sub-Total Cost				17,333,537.00
B	TOTAL BASE COST - PHASE 2 (TBC)				17,333,537.00
C	Feasibility Study, and Detailed Engineering Design (3.0% of TBC)				
D	Contingency (8.0% of TBC)				1,386,683.00
E	Construction Management Supervision (2.0% of TBC)				346,671.00
F	PHASE 2 PROJECT COST ESTIMATE				19,066,891.00
G	TOTAL PROJECT COST ESTIMATE				1,257,645,535.00

Table 6-9 Annual Operation and Maintenance Cost
Loboc 2 River Cluster
(October 2007 Price Level)

Year	Salaries	Energy	Chemicals	Maintenance	Total
2013	4,017,000	33,148,780	742,741.95	62,720	37,971,242
2014	4,017,000	36,755,985	822,398.73	69,447	41,664,830
2015	4,017,000	40,363,189	902,055.50	76,174	45,358,418
2016	4,017,000	42,363,949	946,785.31	79,951	47,407,685
2017	4,017,000	44,364,708	991,515.12	83,728	49,456,951
2018	4,017,000	46,365,468	1,036,244.93	87,505	51,506,218
2019	4,017,000	48,366,227	1,080,974.73	91,282	53,555,484
2020	4,017,000	50,366,987	1,125,704.54	95,059	55,604,751
2021	4,017,000	52,613,890	1,175,919.16	99,300	57,906,109
2022	4,017,000	54,860,793	1,226,133.78	103,540	60,207,467
2023	4,017,000	57,107,696	1,276,348.40	107,781	62,508,825
2024	4,017,000	59,354,599	1,326,563.02	112,021	64,810,183
2025	4,017,000	61,601,502	1,376,777.63	116,261	67,111,541
2026	4,017,000	64,532,296	1,405,898.31	118,720	70,073,915
2027	4,017,000	65,872,609	1,435,018.99	121,179	71,445,808
2028	4,017,000	67,212,922	1,464,139.67	123,638	72,817,700
2029	4,017,000	68,553,235	1,493,260.35	126,098	74,189,593
2030	4,017,000	69,893,548	1,522,381.02	128,557	75,561,485
2031	4,017,000	70,705,500	1,540,023.82	130,046	76,392,570
2032	4,017,000	71,517,451	1,557,666.62	131,536	77,223,654
2033	4,017,000	72,329,403	1,575,309.42	133,026	78,054,739
2034	4,017,000	73,141,355	1,592,952.22	134,516	78,885,823
2035	4,017,000	73,953,307	1,610,595.01	136,006	79,716,908

6.2.4 Manaba River Cluster

The proposed Manaba River Cluster will provide an average daily production of 18,418 cumd benefiting about 114,400 population. The proposed Manaba River Cluster will cover 6 municipalities, namely: Anda, Candijay, Duero, Garcia-Hernandez, Guindulman and Jagna. **Figure 6-8** -shows the development plan of Manaba River Cluster detailing the major facilities and the covered municipalities.

A. Source Facility

The site of the proposed intake structure with pumping station will be located at an elevation of 20 mamsl in Bgy. Canayaon West, Garcia-Hernandez. A 2m-high diversion weir structure will be constructed 34m across Manaba River where portion of the flow will be diverted into the intake chamber of the pump house located at the right bank of the river.

B. Transmission Facilities

The raw and clean water transmission lines will have a total length of 53.5km long with diameters ranging from 250 to 500mm. The raw water will be lifted 34m via 2km transmission line with 450mm diameter to the treatment plant.

The transmission line originating from the pump station of the reservoir located at the water treatment plant will split into 2: going southward and northwestward. The line going westward will provide water for Garcia-Hernandez, while the pipeline going northwestward will be serving Jagna, Duero, Guindulman, Candijay and Anda. The 49km long transmission line with diameters ranging from 300 to 500mm will have 2 booster pump stations to provide adequate pressure head and flow.

C. Pump Stations

During the initial year of operation in 2013, there will be 4 pump stations with the biggest 200-Hp pumps installed at the intake structure. The smallest 20-Hp pumps will be provided to boost the pressure and flow to the pipeline going to Anda. Most of the pumps will be replaced to bigger capacities by 2025.

Table 6-10 summarizes the schedule of pumps to be installed in 2010 and the pump replacement by 2025 and is shown below:

Table 6-10 Schedule of Pumps for Manaba River Cluster

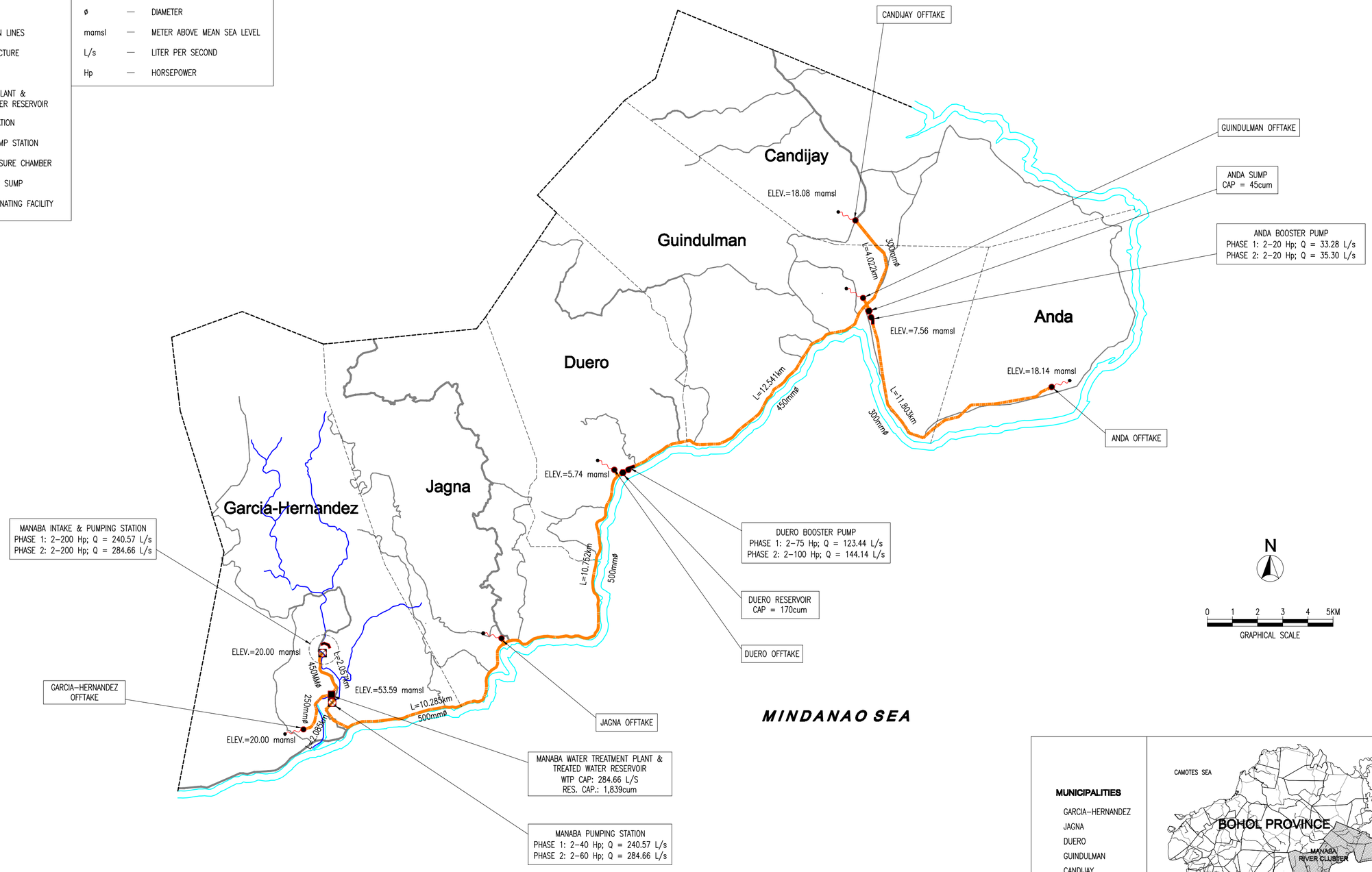
2010		2025	
200 Hp Booster Pumps @ Intake	2 units	200 Hp Booster Pumps @ Intake	2 units
40 Hp Booster Pumps @ WTP	2 units	60 Hp Booster Pumps @ WTP	2 units
75 Hp Booster Pumps @ Duero	2 units	100 Hp Booster Pumps @ Duero	2 units
20 Hp Booster Pumps @ Anda	2 units	20 Hp Booster Pumps @ Anda	2 units

LEGEND:

- NATIONAL/PROVINCIAL ROAD
- MUNICIPAL BOUNDARY
- CLUSTER BOUNDARY
- SHORELINE
- RIVER
- TRANSMISSION LINES
- INTAKE STRUCTURE
- OFFTAKE
- TREATMENT PLANT & TREATED WATER RESERVOIR
- PUMPING STATION
- BOOSTER PUMP STATION
- BREAK-PRESSURE CHAMBER
- RESERVOIR / SUMP
- POST CHLORINATING FACILITY

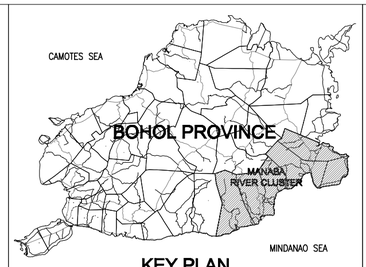
ABBREVIATIONS:

Q	—	FLOW IN LITERS PER SECOND
km	—	KILOMETER
mm	—	MILLIMETER
cum	—	CUBIC METER
ø	—	DIAMETER
mamsl	—	METER ABOVE MEAN SEA LEVEL
L/s	—	LITER PER SECOND
Hp	—	HORSEPOWER

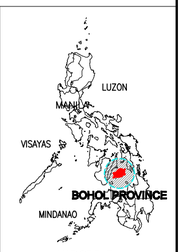


MUNICIPALITIES

- GARCIA-HERNANDEZ
- JAGNA
- DUERO
- GUINDULMAN
- CANDIJAY
- ANDA



KEY PLAN



MAP OF THE PHILIPPINES

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd. WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	PROPOSED DEVELOPMENT PLAN FOR MANABA RIVER CLUSTER	FIGURE NO. 6-8

D. Storage Facilities

There will be 3 reservoirs and sumps to be constructed at different sites. A 1,839 cum capacity clean water reservoir including chlorination facilities will be constructed within the site of the treatment plant. The total capacity of these facilities will be 2,054 cum. The storage facilities are summarized, as follows:

Reservoir Near WTP	:	1,839 cum
Sump (Duero)	:	170 cum
Sump (Anda)	:	45 cum

E. Treatment Plant

The treatment plant will be located in Garcia-Hernandez. It will have a design capacity of 284.66 L/s where raw water will undergo a series of purification process.

F. Disinfection Facilities

Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

6.2.4.1 Cost Estimates

The total project cost is PhP1,068,238,000 for 2010 and PhP6,607,000 will be allocated for pump replacement by 2025. **Table 6-11** shows the breakdown of costs of facilities of the Manaba River Cluster Recommended Plan.

The annual operation and maintenance cost of Manaba River Cluster is presented in **Table 6-12.**

TABLE 6-11 (A) MANABA RIVER CLUSTER PHASE 1

BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)
OCTOBER 2007 PRICES

A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir at Ipil River	Cu.m.	243	20,000.00	4,860,000.00
	Sub-Total Cost				**4,860,000.00**
2.0	Transmission Pipelines				
2.1	Pipelines				
	250 mm dia.	lm.	2,085	6,700.00	13,969,500.00
	300 mm dia.	lm.	15,825	7,000.00	110,775,000.00
	450 mm dia.	lm.	14,598	11,600.00	169,336,800.00
	500 mm dia.	lm.	21,037	12,700.00	267,169,900.00
2.2	River/Creek Crossings	ls			2,806,256.00
2.3	Flowmeters and Gauging Points	ls			11,225,024.00
2.4	Valves and Fittings	ls			70,156,400.00
	Sub-Total Cost				**645,438,880.00**
3.0	Pumping Stations				
3.1	Booster Pump				
3.1.1	200 Hp Booster Pumps @ Intake	Unit	3	1,026,043.20	3,078,130.00
3.1.2	40 Hp Booster Pumps @ WTP	Unit	3	231,576.80	694,730.00
3.1.3	75 Hp Booster Pumps @ Duero	Unit	3	415,906.40	1,247,719.00
3.1.4	20 Hp Booster Pumps @ Anda	Unit	3	103,157.60	309,473.00
3.2	Building				
3.2.1	Pump House	Sq.m.	256	9,000.00	2,304,000.00
	Sub-Total Cost				**7,634,052.00**
4.0	Storage Facilities				
4.1	Reservoir Near WTP	Cu.m.	1,839	10,000.00	18,390,000.00
4.2	Sump (Duero)	Cu.m.	170	12,000.00	2,040,000.00
4.3	Sump (Anda)	Cu.m.	45	15,000.00	675,000.00
	Sub-Total Cost				**21,105,000.00**
5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	24.60	10,000,000.00	246,000,000.00
	Sub-Total Cost				**246,000,000.00**
6.0	Power Source Development				
6.1	Building	Sq.m.	144	9,000.00	1,296,000.00
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	7,488,000.00	7,488,000.00
	Sub-Total Cost				**8,784,000.00**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	105,500.00	105,500.00
7.2	Water Treatment Plant	ls	1	894,000.00	894,000.00
7.3	Treated Water Reservoirs	ls	1	147,760.00	147,760.00
7.4	Right of Way (ROW)	ls	1	612,986.00	612,986.00
	Sub-Total Cost				**1,760,246.00**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	9,761,534.00	9,761,534.00
B	**TOTAL BASE COST - PHASE 1 (TBC)**				**945,343,712.00**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**28,360,311.00**
D	**Contingency (8.0% of TBC)**				**75,627,497.00**
E	**Construction Management Supervision (2.0% of TBC)**				**18,906,874.00**
F	**PHASE 1 PROJECT COST ESTIMATE**				**1,068,238,394.00**

TABLE 6-11 (B) MANABA RIVER CLUSTER PHASE 2

REPLACEMENT OF ALL PUMPS AT YEAR 2025
OCTOBER 2007 PRICES

A	**FACILITIES/ STRUCTURES**				
3.0	Pumping Stations				
3.1	Booster Pump				
3.1.1	200 Hp Booster Pumps @ Intake	Unit	3	789,264.00	3,078,130.00
3.1.2	60 Hp Booster Pumps @ WTP	Unit	3	279,272.00	1,089,161.00
3.1.3	100 Hp Booster Pumps @ Duero	Unit	3	392,224.00	1,529,674.00
3.1.4	20 Hp Booster Pumps @ Anda	Unit	3	79,352.00	309,473.00
	Sub-Total Cost				**6,006,438.00**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1		-
B	**TOTAL BASE COST - PHASE 2 (TBC)**				**6,006,438.00**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				
D	**Contingency (8.0% of TBC)**				**480,515.00**
E	**Construction Management Supervision (2.0% of TBC)**				**120,129.00**
F	**PHASE 2 PROJECT COST ESTIMATE**				**6,607,082.00**
G	**TOTAL PROJECT COST ESTIMATE**				**1,074,845,476.00**

Table 6-12 Annual Operation and Maintenance Cost
Manaba River Cluster
(October 2007 Price Level)

Year	Salaries	Energy	Chemicals	Maintenance	Total
2013	2,847,000	9,934,251	665,220.81	10,373,503	23,819,975
2014	2,847,000	10,562,485	706,164.24	10,376,961	24,492,610
2015	2,847,000	11,190,718	747,107.66	10,380,418	25,165,244
2016	2,847,000	11,919,979	796,097.96	10,384,555	25,947,632
2017	2,847,000	12,649,240	845,088.26	10,388,692	26,730,020
2018	2,847,000	13,378,500	894,078.55	10,392,829	27,512,408
2019	2,847,000	14,107,761	943,068.85	10,396,966	28,294,796
2020	2,847,000	14,837,021	992,059.15	10,401,103	29,077,183
2021	2,847,000	15,656,608	1,046,387.97	10,405,691	29,955,687
2022	2,847,000	16,476,195	1,100,716.79	10,410,278	30,834,190
2023	2,847,000	17,295,781	1,155,045.61	10,414,866	31,712,693
2024	2,847,000	18,115,368	1,209,374.43	10,419,454	32,591,196
2025	2,847,000	18,934,955	1,263,703.25	10,434,187	33,479,846
2026	2,847,000	20,644,987	1,293,555.85	10,436,708	35,222,251
2027	2,847,000	21,077,872	1,323,408.45	10,439,229	35,687,510
2028	2,847,000	21,510,758	1,353,261.06	10,441,750	36,152,769
2029	2,847,000	21,943,643	1,383,113.66	10,444,271	36,618,028
2030	2,847,000	22,376,529	1,412,966.26	10,446,792	37,083,287
2031	2,847,000	22,658,049	1,432,884.82	10,448,474	37,386,408
2032	2,847,000	22,939,570	1,452,803.38	10,450,156	37,689,529
2033	2,847,000	23,221,091	1,472,721.94	10,451,838	37,992,651
2034	2,847,000	23,502,612	1,492,640.50	10,453,520	38,295,772
2035	2,847,000	23,784,132	1,512,559.05	10,455,202	38,598,893

6.2.5 Carood River Cluster

The proposed Carood River Cluster will provide an average daily production of 24,534 cumd benefiting about 147,500 population. The proposed Carood River Cluster will cover 6 municipalities, namely: Alicia, Danao, Mabini, Pres. Carlos P. Garcia, San Miguel and Ubay. **Figure 6-9** shows the development plan of Carood River Cluster detailing the major facilities and the covered municipalities.

A. Source Facility

The site of the proposed intake structure with pumping station will be located in Bgy. Mahayag, Alicia. A 3m-high diversion weir structure will be constructed 45m across Carood River where portion of the flow will be diverted into the intake chamber of the pump house located at the right bank of the river.

B. Transmission Facilities

The transmission line has a total length of 74.5km long with diameters ranging from 200 to 700mm. The raw water will be lifted 16m by pump and delivered via 0.2km long of 500mm diameter transmission line into the water treatment plant.

The transmission line originating from the pump station of the reservoir located at the water treatment plant will split into 2: going southeastward and northwestward. The 8km pipeline with 350mm diameter going southwestward will provide water for Mabini.

While the 66km long pipeline with diameters ranging from 200 to 700mm going northwestward will be serving Ubay, Alicia, San Miguel, Danao and the island municipality of Pres. C. P. Garcia, via 606m long submarine pipeline. The rolling terrain portion of the pipeline going to Danao will require the installation of several booster stations and 3 break pressure chambers in series to hydraulically control the pressure head, preventing the pipeline from bursting and potential leaks.

C. Pump Stations

During the initial year of operation in 2013, there will be 11 pump stations with the biggest 125-Hp pumps installed at the intake structure. The smallest 5-Hp pumps installed in Alicia will boost the pressure along the pipeline. Most of the pumps will be replaced to bigger capacities by 2025.

Table 6-13 summarizes the pumps to be installed in 2010 and pump replacement by 2025 and is shown below:

Table 6-13 Schedule of Pumps for Carood River Cluster

2010		2025	
125 Hp Booster Pumps @ Intake	2 units	150 Hp Booster Pumps @ Intake	2 units
10 Hp Booster Pumps @ WTP Mabini	2 units	10 Hp Booster Pumps @ WTP Mabini	2 units
40 Hp Booster Pump1 @ Alicia	2 units	50 Hp Booster Pump1 @ Alicia	2 units
25 Hp Booster Pump2 @ Alicia	2 units	40 Hp Booster Pump2 @ Alicia	2 units
5 Hp Pump @ Alicia	2 units	5 Hp Pump @ Alicia	2 units
75 Hp Booster Pump @ Ubay	2 units	100 Hp Booster Pump @ Ubay	2 units
20 Hp Pump @ Ubay	2 units	20 Hp Pump @ Ubay	2 units
20 Hp Booster Pump1 @ Danao	2 units	25 Hp Booster Pump1 @ Danao	2 units
15 Hp Booster Pump2 @ Danao	2 units	25 Hp Booster Pump2 @ Danao	2 units
15 Hp Booster Pump3 @ Danao	2 units	20 Hp Booster Pump3 @ Danao	2 units
10 Hp Booster Pumps @ Pres. C. P. Garcia	2 units	10 Hp Booster Pumps @ Pres. C. P. Garcia	2 units

D. Storage Facilities

There will be 7 reservoirs and sumps, and 3 pressure breakers with 10 cum capacity each to be constructed at different sites. A 1,782 cum capacity clear water reservoir including chlorination facilities will be constructed within the site of the treatment plant. The total capacity of these facilities will be 2, 663 cum. The storage facilities are summarized as follows:

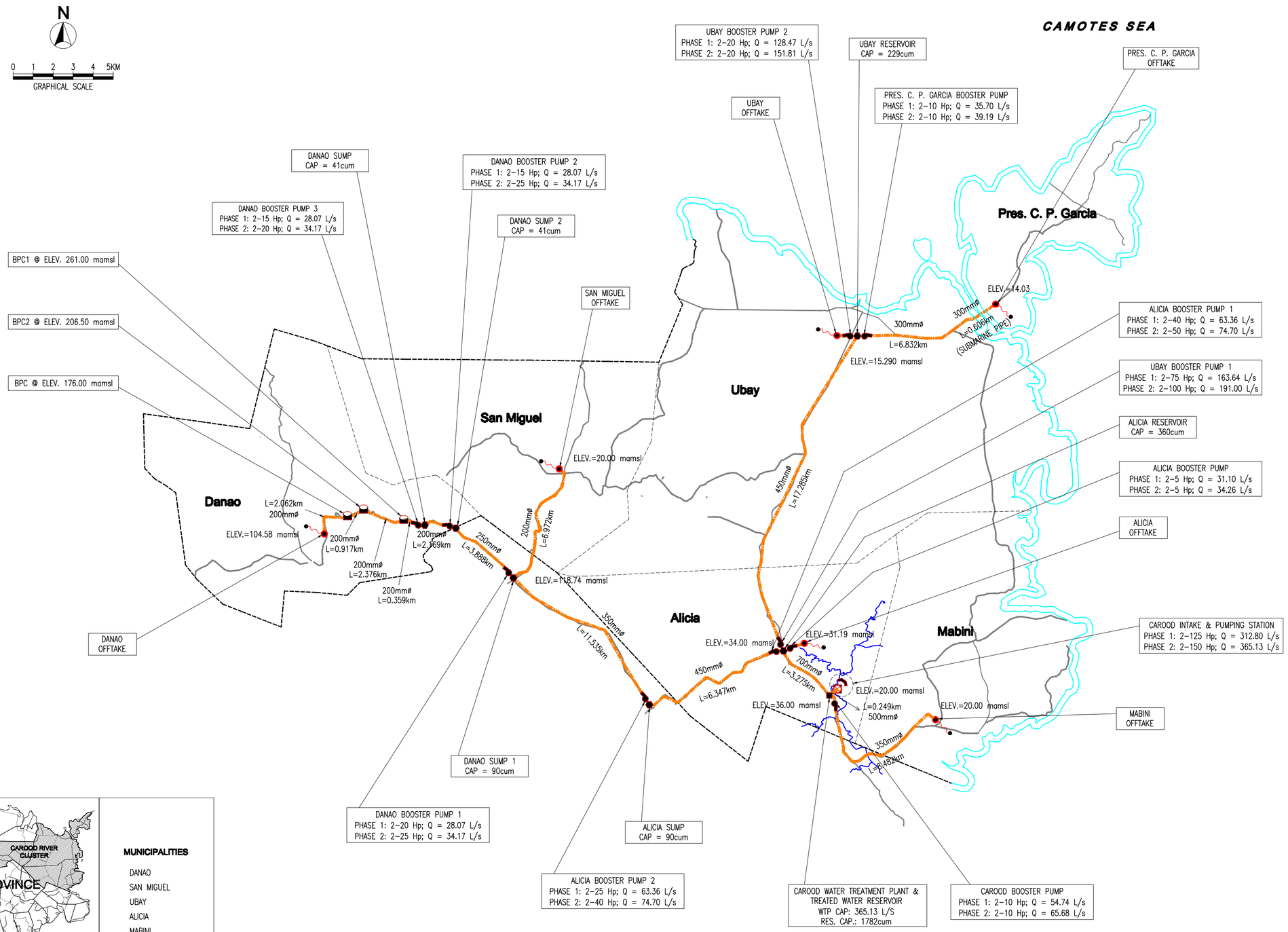
Reservoir at the WTP	:	1,782 cum
Sump Alicia1	:	360 cum
Sump Alicia2	:	90 cum
Sump Danao1	:	90 cum
Sump Danao2	:	41 cum
Sump Danao3	:	41 cum
Sump Ubay	:	229 cum
Pressure Breaker	:	30 cum

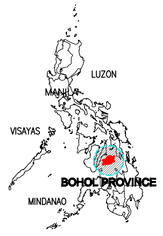
LEGEND:

- NATIONAL/PROVINCIAL ROAD
- MUNICIPAL BOUNDARY
- CLUSTER BOUNDARY
- SHORELINE
- RIVER
- TRANSMISSION LINES
- INTAKE STRUCTURE
- OFFTAKE
- TREATMENT PLANT & TREATED WATER RESERVOIR
- PUMPING STATION
- BOOSTER PUMP STATION
- BREAK-PRESSURE CHAMBER
- RESERVOIR / SUMP
- POST CHLORINATING FACILITY

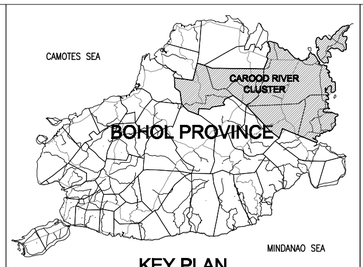
ABBREVIATIONS:

Q	—	FLOW IN LITERS PER SECOND
km	—	KILOMETER
mm	—	MILLIMETER
cum	—	CUBIC METER
ø	—	DIAMETER
mamsl	—	METER ABOVE MEAN SEA LEVEL
L/s	—	LITER PER SECOND
Hp	—	HORSEPOWER





MAP OF THE PHILIPPINES



KEY PLAN

MUNICIPALITIES

- DANAO
- SAN MIGUEL
- UBAY
- ALICIA
- MABINI
- PRES. C. P. GARCIA

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd. WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	PROPOSED DEVELOPMENT PLAN FOR CAROOD RIVER CLUSTER	FIGURE NO. 6-9

E. Treatment Plant

The treatment plant will be located in Bgy. Mahayag, Alicia. It will have a design capacity of 365.64 L/s where raw water will undergo a series of purification process.

F. Disinfection Facilities

Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

6.2.5.1 Cost Estimates

The total project cost will be PhP1,404,519,000 for 2010 and PhP8,344,000 will be allocated for pump replacement by 2025. **Table 6-14** shows the breakdown of costs of facilities of the Carood River Cluster Recommended Plan.

The annual operation and maintenance cost of the Carood River Cluster is presented in **Table 6-15**.

TABLE 6-14 (A) CAROOD RIVER CLUSTER PHASE 1

BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)

OCTOBER 2007 PRICES

A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir at Ipil River	Cu.m.	356	20,000.00	7,120,000.00
	Sub-Total Cost				**7,120,000.00**
2.0	Transmission Pipelines				
2.1	Pipelines				
	200 mm dia.	lm.	15,951	4,000.00	63,804,000.00
	250 mm dia.	lm.	3,888	6,700.00	26,049,600.00
	300 mm dia.	lm.	6,832	7,000.00	47,824,000.00
	350 mm dia.	lm.	20,017	9,500.00	190,161,500.00
	450 mm dia.	lm.	23,633	11,600.00	274,142,800.00
	500 mm dia.	lm.	249	12,700.00	3,162,300.00
	700 mm dia.	lm.	3,275	23,400.00	76,635,000.00
	Submarine HDPE 300 mm dia.	lm.	606	8,500.00	5,151,000.00
2.2	River/Creek Crossings	ls			3,434,651.00
2.3	Flowmeters and Gauging Points	ls			13,738,604.00
2.4	Valves and Fittings	ls			85,866,275.00
	Sub-Total Cost				**789,969,730.00**
3.0	Pumping Stations				
3.1	Booster Pump				
3.1.1	125 Hp Booster Pumps @ Intake	Unit	3	754,135.20	2,262,406.00
3.1.2	10 Hp Booster Pumps @ WTP Mabini	Unit	3	66,393.60	199,181.00
3.1.3	40 Hp Booster Pump1 @ Alicia	Unit	3	231,576.80	694,730.00
3.1.4	25 Hp Booster Pump2 @ Alicia	Unit	3	146,036.80	438,110.00
3.1.5	5 Hp Pump @ Alicia	Unit	3	42,879.20	128,638.00
3.1.6	75 Hp Booster Pump @ Ubay	Unit	3	415,906.40	1,247,719.00
3.1.7	20 Hp Pump @ Ubay	Unit	3	103,157.60	309,473.00
3.1.8	20 Hp Booster Pump1 @ Danao	Unit	3	103,157.60	309,473.00
3.1.9	15 Hp Booster Pump2 @ Danao	Unit	3	94,421.60	283,265.00
3.1.10	15 Hp Booster Pump3 @ Danao	Unit	3	94,421.60	283,265.00
3.1.11	10 Hp Booster Pumps @ Pres. C. P. Garcia	Unit	3	66,393.60	199,181.00
3.2	Building				
3.2.1	Pump House	Sq.m.	684	9,000.00	6,156,000.00
	Sub-Total Cost				**12,511,441.00**
4.0	Storage Facilities				
4.1	Reservoir Near WTP	Cu.m.	1,782	10,000.00	17,820,000.00
4.2	Sump Alicia1	Cu.m.	360	12,000.00	4,320,000.00
4.3	Sump Alicia2	Cu.m.	90	15,000.00	1,350,000.00
4.4	Sump Danao1	Cu.m.	90	15,000.00	1,350,000.00
4.5	Sump Danao2	Cu.m.	41	15,000.00	615,000.00
4.6	Sump Danao3	Cu.m.	41	15,000.00	615,000.00
4.7	Sump Ubay	Cu.m.	229	12,000.00	2,748,000.00
4.8	Pressure Breaker	Cu.m.	30	15,000.00	450,000.00
	Sub-Total Cost				**29,268,000.00**

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	31.59	12,000,000.00	379,080,000.00
	Sub-Total Cost				**379,080,000.00**
6.0	Power Source Development				
6.1	Building	Sq.m	360	9,000.00	3,240,000.00
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	9,072,000.00	9,072,000.00
	Sub-Total Cost				**12,312,000.00**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	364,276.00	364,276.00
7.2	Water Treatment Plant	ls	1	193,280.00	193,280.00
7.3	Treated Water Reservoirs	ls	1	154,661.00	154,661.00
7.4	Right of Way (ROW)(Assume 2m width)	ls	1	18,603.00	18,603.00
	Sub-Total Cost				**730,820.00**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	11,944,878.00	11,944,878.00
B	**TOTAL BASE COST - PHASE 1 (TBC)**				**1,242,936,869.00**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**37,288,106.00**
D	**Contingency (8.0% of TBC)**				**99,434,950.00**
E	**Construction Management Supervision (2.0% of TBC)**				**24,858,737.00**
F	**PHASE 1 PROJECT COST ESTIMATE**				**1,404,518,662.00**

TABLE 6-14 (B) CARCOOD RIVER CLUSTER PHASE 2

REPLACEMENT OF ALL PUMPS AT YEAR 2025

OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	Description	Unit	Qty	Unit Cost	Amount
A	FACILITIES/ STRUCTURES				
3.0	Pumping Stations				
3.1	Booster Pump				
3.1.1	150 Hp Booster Pumps @Intake	Unit	3	848,192.80	2,544,578.00
3.1.2	10 Hp Booster Pumps @WTP Mabini	Unit	3	66,393.60	199,181.00
3.1.3	50 Hp Booster Pump1 @Alicia	Unit	3	264,628.00	793,884.00
3.1.4	40 Hp Booster Pump2 @Alicia	Unit	3	231,576.80	694,730.00
3.1.5	5 Hp Pump @Alicia	Unit	3	42,879.20	128,638.00
3.1.6	100 Hp Booster Pump @Ubay	Unit	3	509,891.20	1,529,674.00
3.1.7	20 Hp Pump @Ubay	Unit	3	103,157.60	309,473.00
3.1.8	25 Hp Booster Pump1 @Danao	Unit	3	146,036.80	438,110.00
3.1.9	25 Hp Booster Pump2 @Danao	Unit	3	146,036.80	438,110.00
3.1.10	20 Hp Booster Pump3 @Danao	Unit	3	103,157.60	309,473.00
3.1.11	10 Hp Booster Pumps @Pres. C. P. Garcia	Unit	3	66,393.60	199,181.00
	Sub-Total Cost				**7,585,032.00**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1		-
B	**TOTAL BASE COST - PHASE 2 (TBC)**				**7,585,032.00**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				
D	**Contingency (8.0% of TBC)**				**606,803.00**
E	**Construction Management Supervision (2.0% of TBC)**				**151,701.00**
F	**PHASE 2 PROJECT COST ESTIMATE**				**8,343,536.00**
G	**TOTAL PROJECT COST ESTIMATE**				**1,412,862,198.00**

Table 6-15 Annual Operation and Maintenance Cost
Carood River Cluster Area
(October 2007 Price Level)

Year	Salaries	Energy	Chemicals	Maintenance	Total
2013	4,017,000	8,630,127	859,138.78	12,840,267	26,346,533
2014	4,017,000	10,077,748	998,214.55	12,852,011	27,944,974
2015	4,017,000	11,525,370	1,137,290.31	12,863,755	29,543,415
2016	4,017,000	12,144,654	1,196,415.92	12,868,748	30,226,818
2017	4,017,000	12,763,937	1,255,541.52	12,873,741	30,910,220
2018	4,017,000	13,383,221	1,314,667.12	12,878,734	31,593,622
2019	4,017,000	14,002,505	1,373,792.73	12,883,727	32,277,025
2020	4,017,000	14,621,789	1,432,918.33	12,888,720	32,960,427
2021	4,017,000	15,240,334	1,489,935.08	12,893,534	33,640,803
2022	4,017,000	15,858,879	1,546,951.83	12,898,349	34,321,180
2023	4,017,000	16,477,424	1,603,968.58	12,903,164	35,001,556
2024	4,017,000	17,095,969	1,660,985.34	12,907,979	35,681,933
2025	4,017,000	17,714,514	1,718,002.09	12,931,237	36,380,753
2026	4,017,000	19,158,222	1,755,458.42	12,934,400	37,865,081
2027	4,017,000	19,576,988	1,792,914.76	12,937,563	38,324,466
2028	4,017,000	19,995,754	1,830,371.09	12,940,726	38,783,852
2029	4,017,000	20,414,521	1,867,827.42	12,943,889	39,243,237
2030	4,017,000	20,833,287	1,905,283.76	12,947,052	39,702,623
2031	4,017,000	21,097,560	1,927,195.42	12,948,902	39,990,658
2032	4,017,000	21,361,834	1,949,107.08	12,950,753	40,278,693
2033	4,017,000	21,626,107	1,971,018.75	12,952,603	40,566,729
2034	4,017,000	21,890,380	1,992,930.41	12,954,453	40,854,764
2035	4,017,000	22,154,654	2,014,842.07	12,956,304	41,142,800

6.2.6 Ipil River Cluster

The proposed Ipil River Cluster will provide an average daily production of 29,968 cumd benefiting about 177,700 population. The proposed Carood River Cluster will cover 5 municipalities, namely: Bien Unido, Buenavista, Getafe, Talibon and Trinidad. **Figure 6-10** shows the development plan of Ipil River Cluster detailing the major facilities and the covered municipalities.

A. Source Facility

The site of the proposed intake structure with pumping station will be located at an elevation of 10mamsl in Bgy. Hinlayagan Ilaud, Trinidad. A 2m-high diversion weir structure will be constructed 50m across Ipil River where portion of the flow will be diverted into the intake chamber of the pump house located at the right bank of the river. The proposed weir structure to be constructed across the Ipil River will also prevent the salt water intrusion inward especially during high tide at dry period.

B. Transmission Facilities

The raw and clean water transmission lines will have a total length of 48km with diameters ranging from 300 to 600mm. The raw water will be lifted 10m by pump and delivered via 2km long of 600mm diameter transmission line into the water treatment plant.

The profile of the transmission line is gently sloping downward from the water treatment plant site to the proposed different offtakes. The transmission line originating from the pump station

of the reservoir located at the water treatment plant will split into 2: going northeastward and going westward. The line going northeastward will provide water for Bien Unido. The pipeline going westward will cover Trinidad, Talibon, Getafe and Buenavista. There will be 3 booster stations with sumps located along the westward pipeline to provide adequate pressure up to Buenavista.

The transmission line will have a total length of 48km with diameters ranging from 300 to 600mm.The profile of the transmission line is gently sloping outward from the water treatment plant site. The transmission line will originate at the reservoir and will split into 2, going eastward for Bien Unido and westward for the municipalities of Trinidad, Talibon. Getafe and Buenavista.

C. Pump Stations

During the initial year of operation in 2013, there will be 8 pump stations with the biggest 60-Hp pumps installed at Trinidad to boost pressure head farther to Talibon, Getafe and Buenavista. The smallest will be 7.5 Hp pumps to be installed for Trinidad sump. Most of the pumps will be replaced to bigger capacities by 2025.

Table 6-16 summarizes the schedule of pumps to be installed in 2010 and the pump replacement by 2025 and is shown below:

Table 6-16 Schedule of Pumps for Ipil River Cluster

2010		2025	
15 Hp Pumps @ WTP	2 units	30 Hp Pumps @ WTP	2 units
60 Hp Pumps @ Intake Structure	2 units	100 Hp Pumps @ Intake Structure	2 units
20 Hp Pumps @ Talibon	2 units	30 Hp Pumps @ Talibon	2 units
25 Hp Booster Pumps @ Talibon	2 units	40 Hp Booster Pumps @ Talibon	2 units
7.5 Hp Pumps @ Trinidad	2 units	7.5 Hp Pumps @ Trinidad	2 units
50 Hp Booster Pumps @ Trinidad	2 units	125 Hp Booster Pumps @ Trinidad	2 units
10 Hp Pumps @ Getafe	2 units	10 Hp Pumps @ Getafe	2 units
10 Hp Booster Pumps @ Getafe	2 units	10 Hp Booster Pumps @ Getafe	2 units

LEGEND:

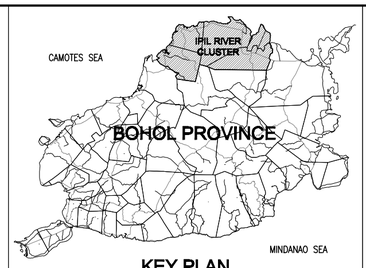
- NATIONAL/PROVINCIAL ROAD
- MUNICIPAL BOUNDARY
- CLUSTER BOUNDARY
- SHORELINE
- RIVER
- TRANSMISSION LINES
- INTAKE STRUCTURE
- OFFTAKE
- TREATMENT PLANT & TREATED WATER RESERVOIR
- PUMPING STATION
- BOOSTER PUMP STATION
- BREAK-PRESSURE CHAMBER
- RESERVOIR / SUMP
- POST CHLORINATING FACILITY

ABBREVIATIONS:

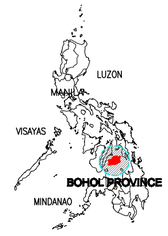
Q	—	FLOW IN LITERS PER SECOND
km	—	KILOMETER
mm	—	MILLIMETER
cum	—	CUBIC METER
ø	—	DIAMETER
mamsl	—	METER ABOVE MEAN SEA LEVEL
L/s	—	LITER PER SECOND
Hp	—	HORSEPOWER

MUNICIPALITIES

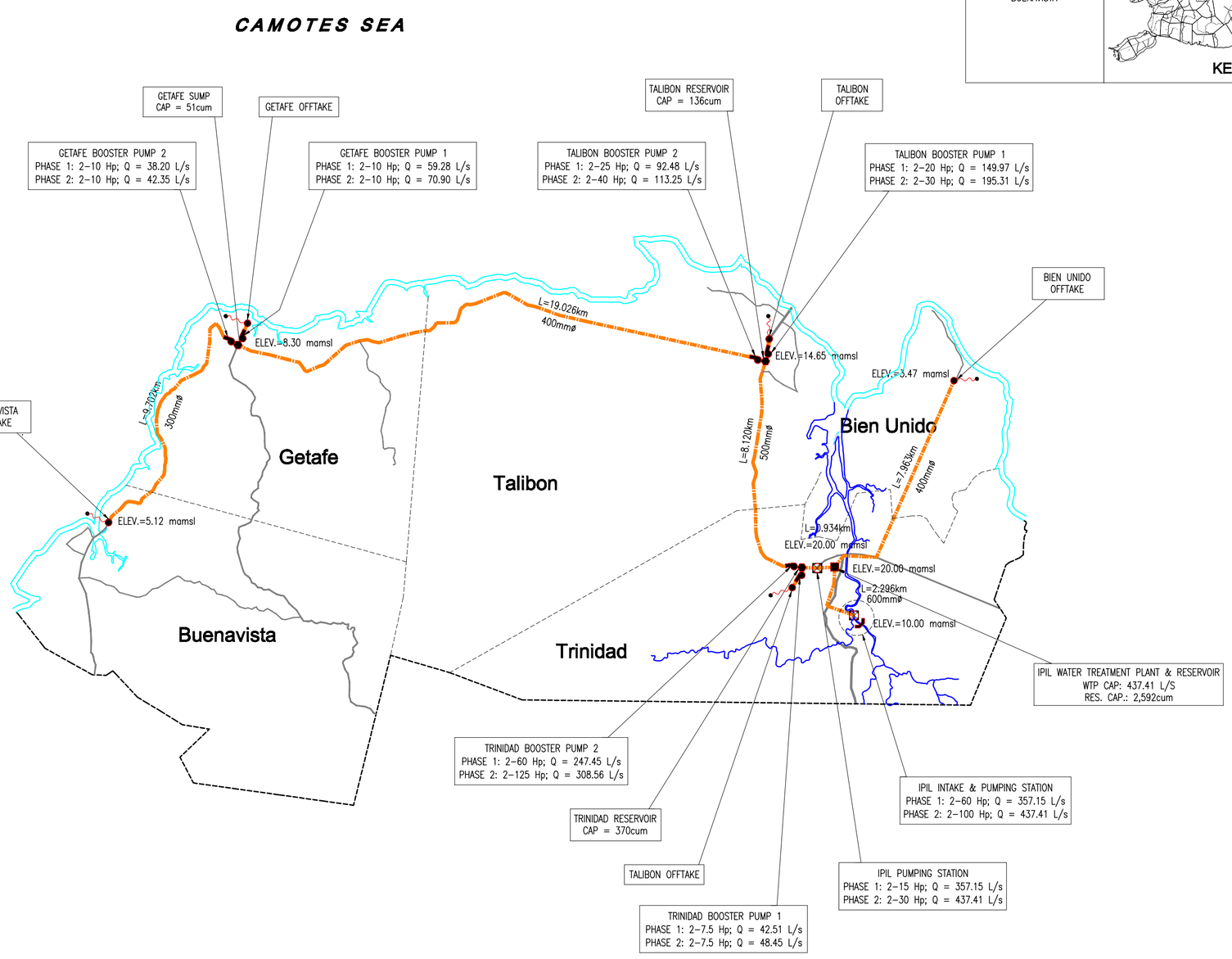
- BIEN UNIDO
- TRINIDAD
- TALIBON
- GETAFE
- BUENAVISTA



KEY PLAN



MAP OF THE PHILIPPINES



CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd. WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	PROPOSED DEVELOPMENT PLAN FOR IPIL RIVER CLUSTER	FIGURE NO. 6-10

D. Storage Facilities

There will be 4 reservoirs and sumps to be constructed at different sites. A 2,592 cum capacity clean water reservoir including chlorination facilities will be constructed within the site of the treatment plant. The total capacity of these facilities will be 3,149 cum. The storage facilities are summarized as follows:

Concrete Ground Reservoir at WTP	:	2,592 cum
Talibon Sump	:	136 cum
Getafe Sump	:	51 cum
Trinidad Sump	:	370 cum

E. Treatment Plant

The treatment plant will be located in Trinidad. It will have a design capacity of 437.41 L/s where raw water will undergo a series of purification process.

F. Disinfection Facilities

Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

6.2.6.1 Cost Estimates

The total project cost is PhP1,240,547,000 for 2010 and PhP6,654,000 will be allocated for pump replacement by 2025. **Table 6-17** shows the breakdown of costs of facilities of the Ipil River Cluster Recommended Plan.

The annual operation and maintenance cost of the Ipil River Cluster is presented in **Table 6-18**

TABLE 6-17 (A) IPIL RIVER CLUSTER PHASE 1

BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)

OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir at Ipil River	Cu.m.	358	20,000.00	7,160,000.00
	Sub-Total Cost				**7,160,000.00**
2.0	Transmission Pipelines				
2.1	Pipelines				
	300 mm dia.	lm.	9,702	7,000.00	67,914,000.00
	400 mm dia.	lm.	26,989	10,500.00	283,384,500.00
	500 mm dia.	lm.	9,053	12,700.00	114,973,100.00
	600 mm dia.	lm.	2,296	17,400.00	39,950,400.00
2.2	River/Creek Crossings	ls			2,531,110.00
2.3	Flowmeters and Gauging Points	ls			10,124,440.00
2.4	Valves and Fittings	ls			63,277,750.00
	Sub-Total Cost				**582,155,300.00**
3.0	Pumping Stations				
3.1	Booster Pump				
3.1.1	15 Hp Pumps @ WTP	Unit	3	94,421.60	283,265.00
3.1.2	60 Hp Pumps @ Intake Structure	Unit	3	363,053.60	1,089,161.00
3.1.3	20 Hp Pumps @ Talibon	Unit	3	103,157.60	309,473.00
3.1.4	25 Hp Booster Pumps @ Talibon	Unit	3	146,036.80	438,110.00
3.1.5	7.5 Hp Pumps @ Trinidad	Unit	3	57,148.00	171,444.00
3.1.6	50 Hp Booster Pumps @ Trinidad	Unit	3	264,628.00	793,884.00
3.1.7	10 Hp Pumps @ Getafe	Unit	3	66,393.60	199,181.00
3.1.8	10 Hp Booster Pumps @ Getafe	Unit	3	66,393.60	199,181.00
3.2	Building				
3.2.1	Pump House	Sq.m.	384	9,000.00	3,456,000.00
	Sub-Total Cost				**6,939,699.00**
4.0	Storage Facilities				
4.1	Concrete Ground Reservoir at WTP	Cu.m.	2,592	10,000.00	25,920,000.00
4.2	Talibon Sump	Cu.m.	136	12,000.00	1,632,000.00
4.3	Getafe Sump	Cu.m.	51	12,000.00	612,000.00
4.4	Trinidad Sump	Cu.m.	370	12,000.00	4,440,000.00
	Sub-Total Cost				**32,604,000.00**
5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	37.79	12,000,000.00	453,480,000.00
	Sub-Total Cost				**453,480,000.00**
6.0	Power Source Development				
6.1	Building	Sq.m.	108	9,000.00	972,000.00
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	5,094,000.00	5,094,000.00
	Sub-Total Cost				**6,066,000.00**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	204,508.00	204,508.00
7.2	Water Treatment Plant	ls	1	157,040.00	157,040.00
7.3	Treated Water Reservoirs	ls	1	167,471.00	167,471.00
7.4	Right of Way (ROW)(Assume 2m width)	ls	1	110,943.00	110,943.00
	Sub-Total Cost				**639,962.00**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	8,784,585.00	8,784,585.00
B	**TOTAL BASE COST - PHASE 1 (TBC)**				**1,097,829,546.00**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**32,934,886.00**
D	**Contingency (8.0% of TBC)**				**87,826,364.00**
E	**Construction Management Supervision (2.0% of TBC)**				**21,956,591.00**
F	**PHASE 1 PROJECT COST ESTIMATE**				**1,240,547,387.00**

TABLE 6-17 (B) IPIL RIVER CLUSTER PHASE 2

REPLACEMENT OF ALL PUMPS AT YEAR 2025

OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	Description	Unit	Qty	Unit Cost	Amount
A	FACILITIES/ STRUCTURES				
3.0	Pumping Stations				
3.1.1	30 Hp Pumps @WTP	Unit	3	165,401.60	496,205.00
3.1.2	100 Hp Pumps @Intake Structure	Unit	3	509,891.20	1,529,674.00
3.1.3	30 Hp Pumps @Talibon	Unit	3	165,401.60	496,205.00
3.1.4	40 Hp Booster Pumps @Talibon	Unit	3	231,576.80	694,730.00
3.1.5	7.5 Hp Pumps @Trinidad	Unit	3	57,148.00	171,444.00
3.1.6	125 Hp Booster Pumps @Trinidad	Unit	3	754,135.20	2,262,406.00
3.1.7	10 Hp Pumps @Getafe	Unit	3	66,393.60	199,181.00
3.1.8	10 Hp Booster Pumps @Getafe	Unit	3	66,393.60	199,181.00
	Sub-Total Cost				6,049,026.00
B	TOTAL BASE COST - PHASE 2 (TBC)				6,049,026.00
C	Feasibility Study, and Detailed Engineering Design (3.0% of TBC)				
D	Contingency (8.0% of TBC)				483,922.00
E	Construction Management Supervision (2.0% of TBC)				120,981.00
F	PHASE 2 PROJECT COST ESTIMATE				6,653,929.00
G	TOTAL PROJECT COST ESTIMATE				1,247,201,316.00

Table 6-18 Annual Operation and Maintenance Cost
Ipil River Cluster
(October 2007 Price Level)

Year	Salaries	Energy	Chemicals	Maintenance	Total
2,013	3,432,000	6,197,866	879,350	9,598,131	20,107,347
2,014	3,432,000	7,458,175	1,055,454	9,613,002	21,558,631
2,015	3,432,000	8,718,483	1,231,558	9,627,873	23,009,915
2,016	3,432,000	9,287,108	1,313,547	9,634,797	23,667,451
2,017	3,432,000	9,855,733	1,395,535	9,641,720	24,324,988
2,018	3,432,000	10,424,357	1,477,523	9,648,644	24,982,524
2,019	3,432,000	10,992,982	1,559,511	9,655,567	25,640,060
2,020	3,432,000	11,561,607	1,641,499	9,662,490	26,297,597
2,021	3,432,000	12,051,410	1,714,310	9,668,639	26,866,359
2,022	3,432,000	12,541,213	1,787,120	9,674,787	27,435,121
2,023	3,432,000	13,031,016	1,859,931	9,680,936	28,003,883
2,024	3,432,000	13,520,819	1,932,741	9,687,084	28,572,644
2,025	3,432,000	14,010,622	2,005,552	9,731,713	29,179,886
2,026	3,432,000	18,390,600	2,051,211	9,735,568	33,609,379
2,027	3,432,000	18,799,071	2,096,869	9,739,424	34,067,364
2,028	3,432,000	19,207,541	2,142,528	9,743,280	34,525,349
2,029	3,432,000	19,616,012	2,188,187	9,747,135	34,983,335
2,030	3,432,000	20,024,483	2,233,846	9,750,991	35,441,320
2,031	3,432,000	20,431,096	2,279,297	9,754,829	35,897,222
2,032	3,432,000	20,837,709	2,324,748	9,758,667	36,353,124
2,033	3,432,000	21,244,322	2,370,199	9,762,505	36,809,026
2,034	3,432,000	21,650,935	2,415,650	9,766,343	37,264,928
2,035	3,432,000	22,057,547	2,461,101	9,770,181	37,720,830

6.2.7 Wahig-Inabanga River Cluster

The proposed Loboc Inabanga River Cluster will provide an average daily production of 44,335 cumd benefiting about 207,400 population. It will cover 6 municipalities, namely, Inabanga, Clarin, Tubigon, Calape, Loon and Maribojoc.**Figure 6-11** shows the proposed development plan of Inabanga River Cluster detailing the major facilities

A. Source Facility

The site of the proposed intake structure with pumping station will be located in Bgy. U-og, Inabanga. A 2m-high diversion weir structure will be constructed 75m across Inabanga River where portion of the flow will be diverted into the intake chamber of the pump house located at the left bank of the river.

B. Transmission Facilities

The profile of the transmission line is gently sloping down reaching the municipality of Inabanga. The transmission line will have a total length of 60.2 km with diameters ranging from 200 to 700mm. The raw water will be conveyed by a pump and delivered through a 4km long 600mm diameter transmission line into the water treatment plant. From the treatment plant, water will be delivered via a 3km long transmission line heading northward to Inabanga Municipality. The other 53km transmission line with diameters ranging from 200 to 700mm going southward will cover Clarin, Tubigon, Calape, Loon, and Maribojoc.

C. Pump Stations

During the initial year of operation in 2013, there will be 5 pump stations with the biggest 200-Hp pump installed at Clarin booster pump and the smallest 15 Hp pumps at Calape and Inabanga booster pumps. Most of the pumps will be replaced to bigger capacities by 2025.

Table 6-19 summarizes the schedule of pumps to be installed in 2010 and pump replacement by 2025 and is shown below:

Table 6-19 Schedule of Pumps for Inabanga River Cluster

2010		2025	
15 Hp Pumps @ WTP	2 units	15 Hp Pumps @ WTP	2 units
25 Hp Pumps @ Intake Structure	2 units	30 Hp Pumps @ Intake Structure	2 units

D. Storage Facilities

There will be 5 reservoirs and sumps to be constructed at different sites. A 2,943 cum capacity clean water reservoir including chlorination facilities will be constructed within the site of the treatment plant. The total capacity of these facilities will be 4,810 cum. The storage facilities are summarized as follows:

Storage Facilities		
Concrete Ground Reservoir at WTP	2,943	Cu.m.
Sump-Cla	712	Cu.m.
Sump-tub	666	Cu.m.
Sump-Cal	434	Cu.m.
Sump-loon	55	Cu.m.

E. Treatment Plant

The treatment plant will be located in Inabanga. It will have a design capacity of 667.9 L/s where raw water will undergo a series of purification process. The proposed water treatment plant layout for Inabanga River Cluster is presented in **Figure 6-12**.

F. Disinfection Facilities

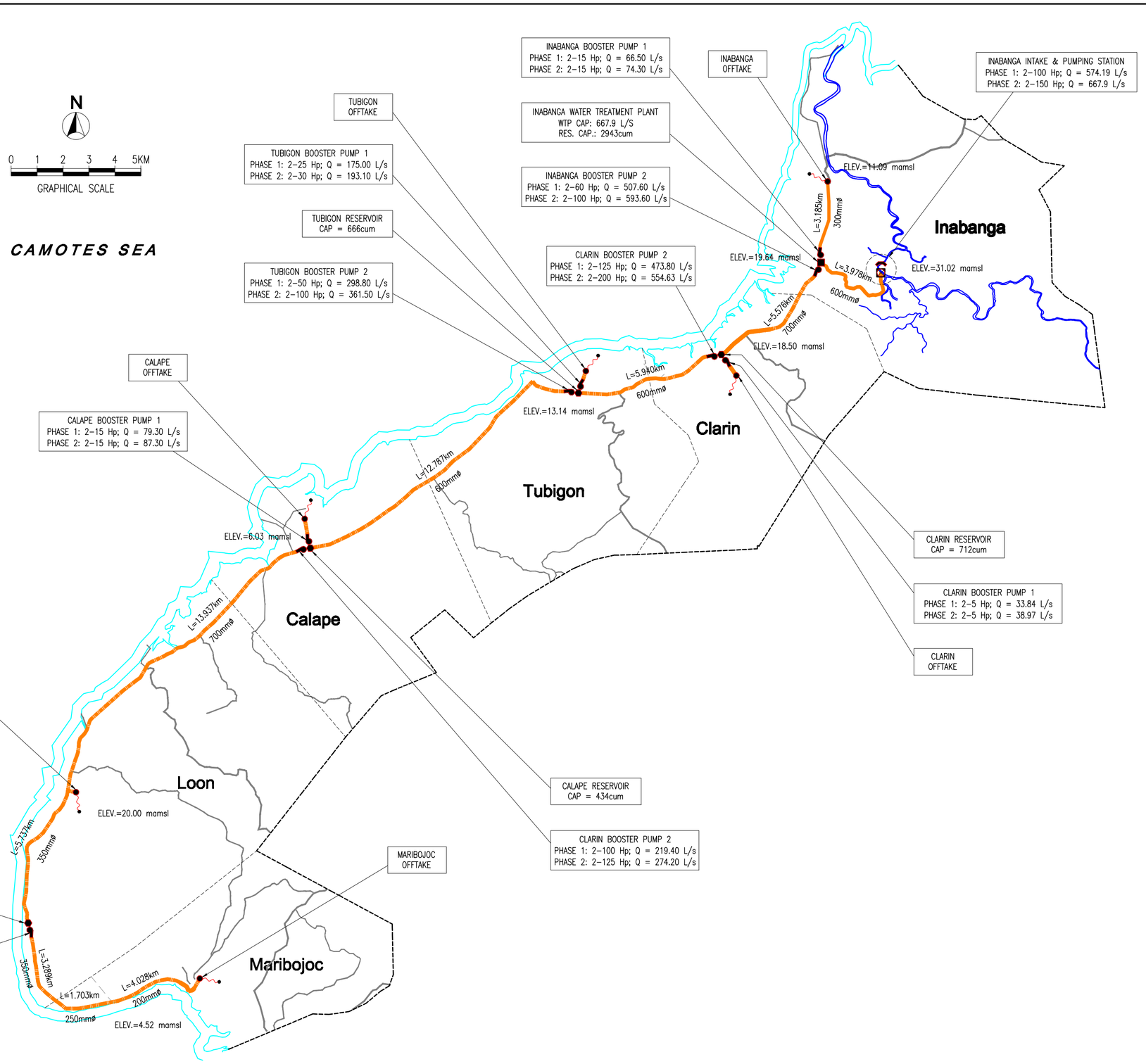
Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

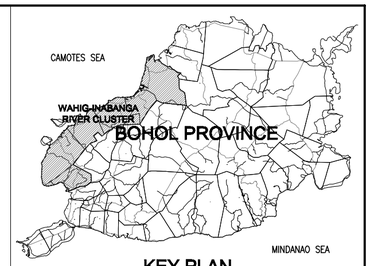
LEGEND:

- NATIONAL/PROVINCIAL ROAD
- MUNICIPAL BOUNDARY
- CLUSTER BOUNDARY
- SHORELINE
- RIVER
- TRANSMISSION LINES
- INTAKE STRUCTURE
- OFFTAKE
- TREATMENT PLANT & TREATED WATER RESERVOIR
- PUMPING STATION
- BOOSTER PUMP STATION
- BREAK-PRESSURE CHAMBER
- RESERVOIR / SUMP
- POST CHLORINATING FACILITY

ABBREVIATIONS:

Q	—	FLOW IN LITERS PER SECOND
km	—	KILOMETER
mm	—	MILLIMETER
cum	—	CUBIC METER
ø	—	DIAMETER
mamsl	—	METER ABOVE MEAN SEA LEVEL
L/s	—	LITER PER SECOND
Hp	—	HORSEPOWER

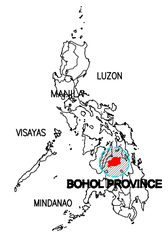




KEY PLAN

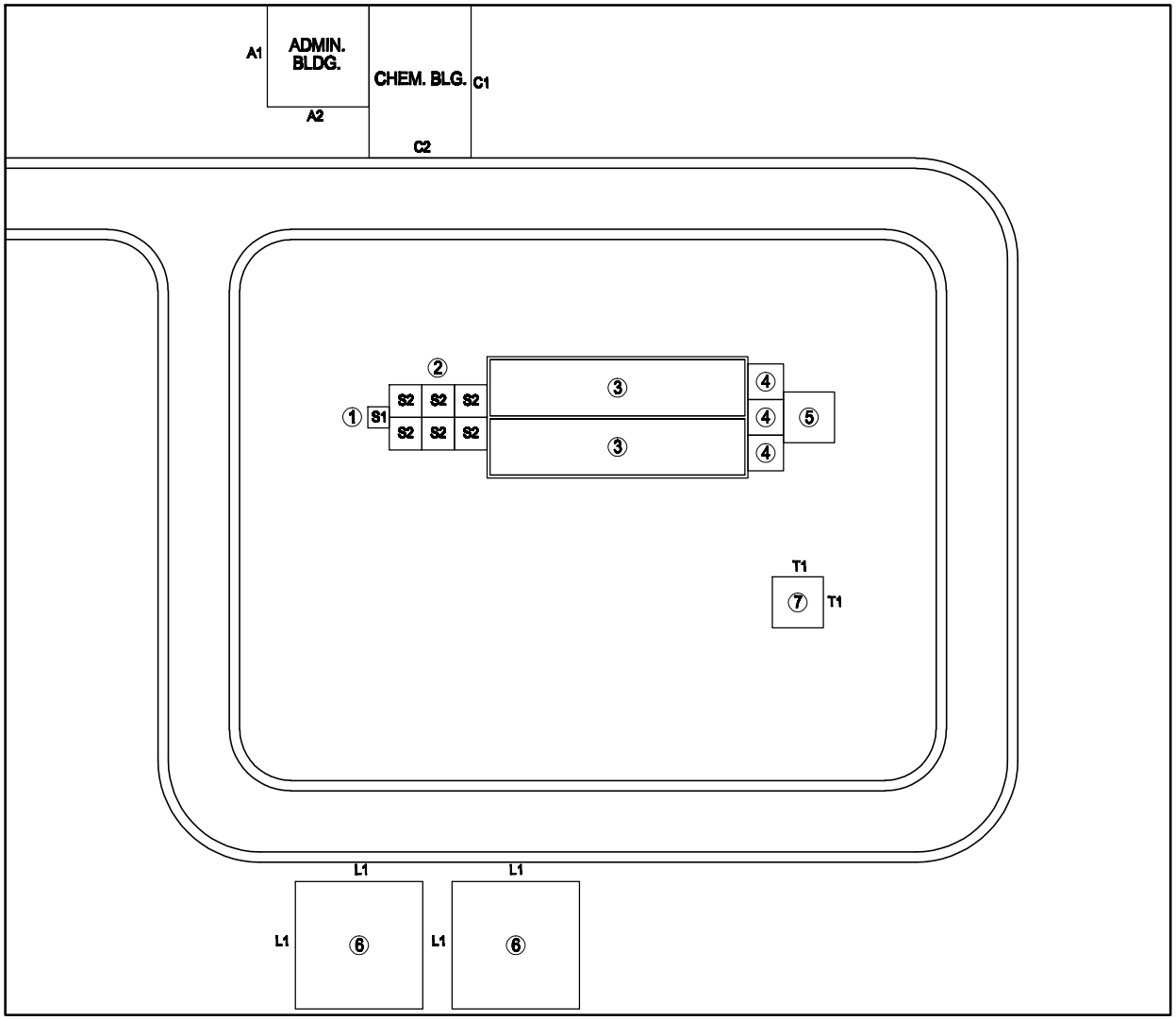
MUNICIPALITIES

- INABANGA
- MARIBOJOC
- LOON
- CALAPE
- TUBIGON
- CLARIN



MAP OF THE PHILIPPINES

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd. WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	PROPOSED DEVELOPMENT PLAN FOR WAHIG-INABANGA RIVER CLUSTER	FIGURE NO. 6-11



LEGEND :

① RAPID MIX TANK
② 3 - STAGE FLOCCULATION TANKS
③ SETTLING TANK
④ RAPID SAND FILTERS
⑤ CLEAR WELL
⑥ SLUDGE LAGOONS
⑦ WASH WATER RECOVERY TANK

PLANT LAYOUT

CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd. WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	PROPOSED INABANGA WATER TREATMENT PLANT	FIGURE NO. 6-12

6.2.7.1 Cost Estimates

The total project cost is PhP2,237,896,000 for 2010 and PhP13,831,000 will be allocated for pump replacement by 2025. **Table 6-20** shows the breakdown of costs of facilities of the Inabanga River Cluster Recommended Plan.

The annual operation and maintenance cost of the Inabanga River Cluster is presented in **Table 6-21**.

TABLE 6-20 (A)BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
INABANGA RIVER CLUSTER 2010
BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir at Inabanga River	Cu.m.	536	20,000.00	10,720,000
	Sub-Total Cost				**10,720,000**
2.0	Transmission Pipelines				
2.1	Pipelines				
	200 mm dia.	lm.	4,028	4,000.00	16,112,000
	250 mm dia.	lm.	1,703	6,700.00	11,410,100
	300 mm dia.	lm.	3,185	7,000.00	22,295,000
	350 mm dia.	lm.	9,026	9,500.00	85,747,000
	600 mm dia.	lm.	22,705	17,400.00	395,067,000
	700 mm dia.	lm.	19,513	23,400.00	456,604,200
2.2	River/Creek Crossings	ls	**60,160**		4,936,177
2.3	Flowmeters and Gauging Points	ls			19,744,706
2.4	Valves and Fittings	ls			123,404,413
	Sub-Total Cost				**1,135,320,595**
3.0	Pumping Stations				
3.1	Booster Pump				
3.1.1	100 Hp Pumps @ Intake Structure	Unit	3	509,891.20	1,529,674
3.1.2	15 Hp Pumps @ WTP-Inabanga	Unit	3	94,421.60	283,265
3.1.3	60 Hp Pumps @ WTP-Cla	Unit	3	363,053.60	1,089,161
3.1.4	125 Hp Booster Pumps @ Clar	Unit	3	754,135.20	2,262,406
3.1.5	5 Hp Pumps @ Clar	Unit	3	42,879.20	128,638
3.1.6	50 Hp Booster Pumps @ Tub	Unit	3	264,628.00	793,884
3.1.7	25 Hp Pumps @ Tub	Unit	3	146,036.80	438,110
3.1.8	125 Hp Booster Pumps @ Cal	Unit	3	754,135.20	2,262,406
3.1.9	15 Hp Pumps @ Cal	Unit	3	94,421.60	283,265
3.1.10	20 Hp Booster Pumps @ Loon	Unit	3	103,157.60	309,473
3.2	Building				
3.2.1	Pump House	Sq.m.	576	9,000.00	5,184,000
	Sub-Total Cost				**14,564,282**
4.0	Storage Facilities				
4.1	Concrete Ground Reservoir at WTP	Cu.m.	2,943	10,000.00	29,430,000
4.2	Sump-Cla	Cu.m.	712	10,000.00	7,120,000
4.3	Sump-tub	Cu.m.	666	10,000.00	6,660,000
4.4	Sump-Cal	Cu.m.	434	12,000.00	5,208,000
4.5	Sump-loon	Cu.m.	55	15,000.00	825,000
	Sub-Total Cost		**4,810**		**49,243,000**

BUDGETARY COST ESTIMATE					
Item No.	Description	Unit	Qty	Unit Cost	Amount
5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	57.70	10,000,000.00	577,000,000
	Sub-Total Cost				**577,000,000**
6.0	Power Source Development				
6.1	Building	Sq.m.	216	9,000.00	1,944,000
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	19,080,000.00	19,080,000
	Sub-Total Cost				**21,024,000**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	278,436.00	278,436
7.2	Water Treatment Plant	ls	1	115,968.00	115,968
7.3	Treated Water Reservoirs	ls	1	275,988.00	275,988
7.4	Right of Way (ROW)	ls	1	191,975.00	191,975
	Sub-Total Cost				**862,367**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	17,170,513.00	17,170,513
	Sub-Total Cost				**17,170,513**
B	**TOTAL BASE COST (TBC)**				**1,825,904,757**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**54,777,143**
D	**Contingency (8.0% of TBC)**				**146,072,381**
E	**Construction Management Supervision (2.0% of TBC)**				**36,518,095**
F	**TOTAL PROJECT COST ESTIMATE**				**2,063,272,375**

TABLE 6-20 (B) BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
INABANGA RIVER CLUSTER 2025 - OPTION 2
REPLACEMENT OF ALL PUMPS AT YEAR 2025
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	Description	Unit	Qty	Unit Cost	Amount
A	**FACILITIES/ STRUCTURES**				
3.0	Pumping Stations				
3.1.1	150 Hp Pumps @ Intake Structure	Unit	3	848,193	2,544,578
3.1.2	15 Hp Pumps @ WTP-Inabanga	Unit	3	94,422	283,265
3.1.3	100 Hp Pumps @ WTP-Cla	Unit	3	509,891	1,529,674
3.1.4	200 Hp Booster Pumps @ Clar	Unit	3	1,026,043	3,078,130
3.1.5	5 Hp Pumps @ Clar	Unit	3	42,879	128,638
3.1.6	100 Hp Booster Pumps @ Tub	Unit	3	509,891	1,529,674
3.1.7	30 Hp Pumps @ Tub	Unit	3	165,402	496,205
3.1.8	125 Hp Booster Pumps @ Cal	Unit	3	754,135	2,262,406
3.1.9	15 Hp Pumps @ Cal	Unit	3	94,422	283,265
3.1.10	25 Hp Booster Pumps @ Loon	Unit	3	146,037	438,110
	Sub-Total Cost				**12,573,945**
					-
B	**TOTAL BASE COST (TBC)**				**12,573,945**
D	**Contingency (8.0% of TBC)**				**1,005,916**
E	**Construction Management Supervision (2.0% of TBC)**				**251,479**
F	**TOTAL PROJECT COST ESTIMATE**				**13,831,340**

Table 6-21 Annual Operation and Maintenance Cost
Inabanga River Cluster Area

(October 2007 Price Level)

2013	4,173,000	10,222,550	1,137,158.00	18,559,105	34,091,813
2014	4,173,000	11,040,535	1,268,477.07	18,570,194	35,052,206
2015	4,173,000	11,858,520	1,399,796.14	18,581,283	36,012,599
2016	4,173,000	14,262,053	1,639,950.33	18,601,563	38,676,566
2017	4,173,000	16,665,586	1,880,104.53	18,621,843	41,340,533
2018	4,173,000	19,069,119	2,120,258.72	18,642,122	44,004,500
2019	4,173,000	21,472,653	2,360,412.92	18,662,402	46,668,468
2020	4,173,000	23,876,186	2,600,567.12	18,682,682	49,332,435
2021	4,173,000	24,879,317	2,702,747.84	18,691,310	50,446,375
2022	4,173,000	25,882,448	2,804,928.57	18,699,939	51,560,316
2023	4,173,000	26,885,580	2,907,109.30	18,708,567	52,674,256
2024	4,173,000	27,888,711	3,009,290.03	18,717,196	53,788,197
2025	4,173,000	28,891,842	3,111,470.76	18,773,730	54,950,042
2026	4,173,000	37,294,891	3,172,533.85	18,778,886	63,419,311
2027	4,173,000	38,079,517	3,233,596.95	18,784,042	64,270,156
2028	4,173,000	38,864,143	3,294,660.04	18,789,199	65,121,002
2029	4,173,000	39,648,769	3,355,723.13	18,794,355	65,971,848
2030	4,173,000	40,433,395	3,416,786.23	18,799,512	66,822,693
2031	4,173,000	41,052,484	3,461,630.25	18,803,299	67,490,412
2032	4,173,000	41,671,572	3,506,474.27	18,807,085	68,158,131
2033	4,173,000	42,290,660	3,551,318.30	18,810,872	68,825,850
2034	4,173,000	42,909,748	3,596,162.32	18,814,659	69,493,570
2035	4,173,000	43,528,836	3,641,006.34	18,818,446	70,161,289

6.3 TOTAL PROJECT COST

The total project cost estimates of the Bohol Integrated Water Supply System Master Plan is PhP10,512,0200,000 for 2010 and PhP88,500,000 will be allocated for pump replacement by 2025. The Bohol Integrated Water Supply System Master Plan will provide an average daily production 208,353 cumd benefiting about 1,078,600 population. The summary of the Master Plan is presented in **Table 6-22.**

The proposed Bohol Integrated Water Supply System Master Plan showing all the proposed bulk supply systems is presented in **Figure 6-13**.

6.4 SEWERAGE AND DRAINAGE CONCEPT

As a result of sufficient water supply, sewerage and drainage development program should be undertaken to mitigate the increasing load of wastewater into the environment. If not controlled, it may result to degradation of environmental sanitation and increase incidence of water borne and related diseases.

A decentralized wastewater treatment system project under the German Technical Cooperation Agency (GTZ) has started implementation in selected sites in Tagbilaran City. In general, there are no public facilities for wastewater disposal in the province of Bohol. Wastewater is usually disposed of in private septic vaults, pit privies, street drainage, open areas and natural waterways. When disposed of through open drainage, and natural waterways, wastewater will pose environmental sanitation and health hazards to residents. The improved water supply brought about by the integrated water supply system project will result to increased volume of wastewater. Likewise, the interrelated problems of storm drainage should also be included. A thorough analysis on the existing condition to come up with a detailed plan formulation to address wastewater and drainage must be carried out by the LGUs. Preparation of sewerage and drainage master plan consistent with Provincial Development Framework Plan should be undertaken.

6.4.1 Sewerage

The existing economic conditions of the LGUs in Bohol Province do not allow the installation of a sewerage system. As economic conditions improve, however, the wastewater disposal system could be planned and upgraded gradually.

The immediate solution is to strictly implement health and sanitation regulations to be led by the city/health health officers. To stimulate compliance and facilitate development of sanitary facilities, a public awareness campaign program on proper usage and conservation of water, and the importance of hygiene and sanitation must be conducted.

6.4.2 Drainage

The existing drainage systems in the study area are mostly consist of network of concrete pipes and culverts, lined and unlined open drainage that ultimately discharge into creeks and rivers and finally into the sea. They are the same systems through which the wastewater is disposed of.

Some of the following activities should be undertaken by the LGUs:

a) Removal of clogging materials and desilting of existing drainage will greatly improve the flow;
b) Regular conduct maintenance of drainage; and
c) Educating residents to keep solid wastes in appropriate containers to prevent indiscriminate disposal of waste into the open drainage, ditches and natural waterways.

TABLE 6-22 SUMMARY OF PROJECT COST COMPONENTS

		In Million Peso at 2007 Prices															
Item No.	Description	Abatan River Cluster		Loboc 1 River Cluster		Loboc 2 River Cluster		Manaba River Cluster		Carood River Cluster		Ipil River Cluster		Inabanga River Cluster		TOTAL	
		2010	2025	2010	2025	2010	2025	2010	2025	2010	2025	2010	2025	2010	2025	2010	2025
A	FACILITIES/ STRUCTURES																
1	Source Facility	7.78		3.98		0.76		4.86		7.12		7.16		10.72		42.38	
2	Pipelines	497.95		1,573.77		703.89		645.45		789.97		582.17		1,135.32		5,928.52	
3	Pumping Stations	7.77	5.69	29.69	25.21	19.71	17.33	7.63	6.01	12.52	7.59	6.94	6.05	14.56	12.57	98.82	80.45
4	Storage Facilities	12.54		69.96		43.62		21.11		29.27		32.60		49.24		258.34	
5	Water Treatment Plant	141.90		664.80		291.50		246.00		379.09		453.48		577.00		2,753.77	
6	Power Source Development	7.99		42.34		25.00		8.78		12.31		6.07		21.02		123.51	
7	Land/ROW Acquisition	0.39		2.24		0.81		1.76		0.73		0.64		0.86		7.43	
8	Stored Materials, Equipment and Vehicles	7.53		23.93		10.79		9.76		11.94		8.78		17.17		89.90	
B	TOTAL BASE COST (TBC)	683.85	5.69	2,410.71	25.21	1,096.08	17.33	945.35	6.01	1,242.95	7.59	1,097.84	6.05	1,825.89	12.57	9,302.67	80.45
C	Feasibility Study, and Detailed Engineering Design (3.0% of TBC)	20.52		72.32		32.88		28.36		37.29		32.94		54.78		279.08	
D	Contingency (8.0% of TBC)	54.71	0.46	192.86	2.02	87.69	1.39	75.63	0.48	99.44	0.61	87.83	0.48	146.07	1.01	744.21	6.44
E	Construction Management Supervision (2.0% of TBC)	13.68	0.11	48.21	0.50	21.92	0.35	18.91	0.12	24.86	0.15	21.96	0.12	36.52	0.25	186.05	1.61
F	PROJECT COST ESTIMATE	772.75	6.26	2,724.10	27.73	1,238.57	19.06	1,068.25	6.61	1,404.53	8.35	1,240.56	6.66	2,063.26	13.83	10,512.02	88.50

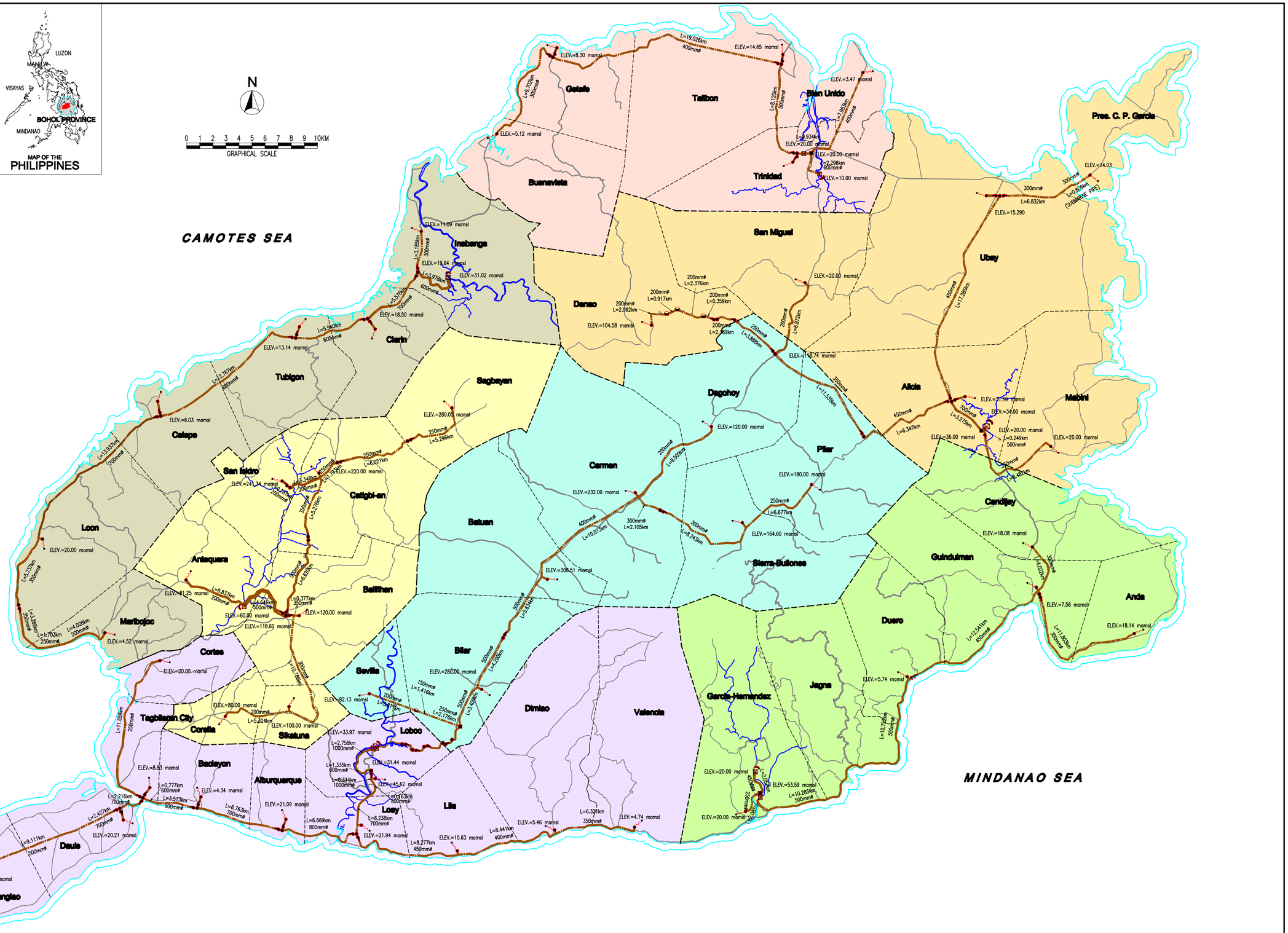
LEGEND:

- ABATAN RIVER CLUSTER
- LOBOC 1 RIVER CLUSTER
- LOBOC 2 RIVER CLUSTER
- MANABA RIVER CLUSTER
- CAROOD RIVER CLUSTER
- IPIL RIVER CLUSTER
- INABANGA RIVER
- NATIONAL/PROVINCIAL ROAD
- MUNICIPAL BOUNDARY
- CLUSTER BOUNDARY
- SHORELINE
- RIVER
- TRANSMISSION LINES
- INTAKE STRUCTURE
- OFFTAKE
- TREATMENT PLANT & TREATED WATER RESERVOIR
- PUMPING STATION
- BOOSTER PUMP STATION
- BREAK-PRESSURE CHAMBER
- RESERVOIR / SUMP
- POST CHLORINATING FACILITY

ABBREVIATIONS:

Q	—	FLOW IN LITERS PER SECOND
km	—	KILOMETER
mm	—	MILLIMETER
cum	—	CUBIC METER
ø	—	DIAMETER
mamsl	—	METER ABOVE MEAN SEA LEVEL
L/s	—	LITER PER SECOND
Hp	—	HORSEPOWER

MAP OF THE PHILIPPINES



CONSULTANTS	OWNER:	PROJECT NAME AND LOCATION:	SHEET CONTENTS:	SHEET NO.
coffey international development pty. ltd. WOODFIELDS CONSULTANTS INC. PLANNERS, ARCHITECTS, ENGINEERS, CONSTRUCTION MANAGERS AND ENVIRONMENT SPECIALISTS	REPUBLIC OF THE PHILIPPINES PROVINCE OF BOHOL	BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN (BHL - 01)	MASTER PLAN FOR BOHOL INTEGRATED WATER SUPPLY SYSTEM	FIGURE NO. 6-13

6.5 MANAGEMENT OF INTEGRATED WATER RESOURCES

Integrated water resource management will contribute to the sustainability and preservation of sources. Consistent with the integrated water resources management framework and with the support of the GIS-based MIS the following measures should be undertaken:

a) A continuous monitoring program of rainfall and flow of surface waters as well as water quality will provide data that will guide future evaluation;

b) The watershed should be regularly monitored and protected from any practice that may lead to deterioration of quantity, quality and rate of runoff;

c) A sanitary zoning plan should be implemented with special emphasis on protection of the most economical water resources. It should be integrated into the general zoning plan.

6.6 UPDATING THE INTEGRATED WATER SUPPLY SYSTEM MASTER PLAN

The recommended master plan must be periodically updated and included in the GIS-based management information system. Master plan updating should be undertaken at least once every five (5) years, or sooner if significant changes occur, Updating is necessary to assess the effectiveness of the current plan, benefits gained, the actual costs, the problems and constraints encountered; and to provide overall review, refinement and direction for the future.

Certain aspects of the plan may change. These aspects are directly or indirectly related to the following areas of change: technology, social goal, land use concept, and population projection.

6.6.1 Considerations in Updating the Master Plan

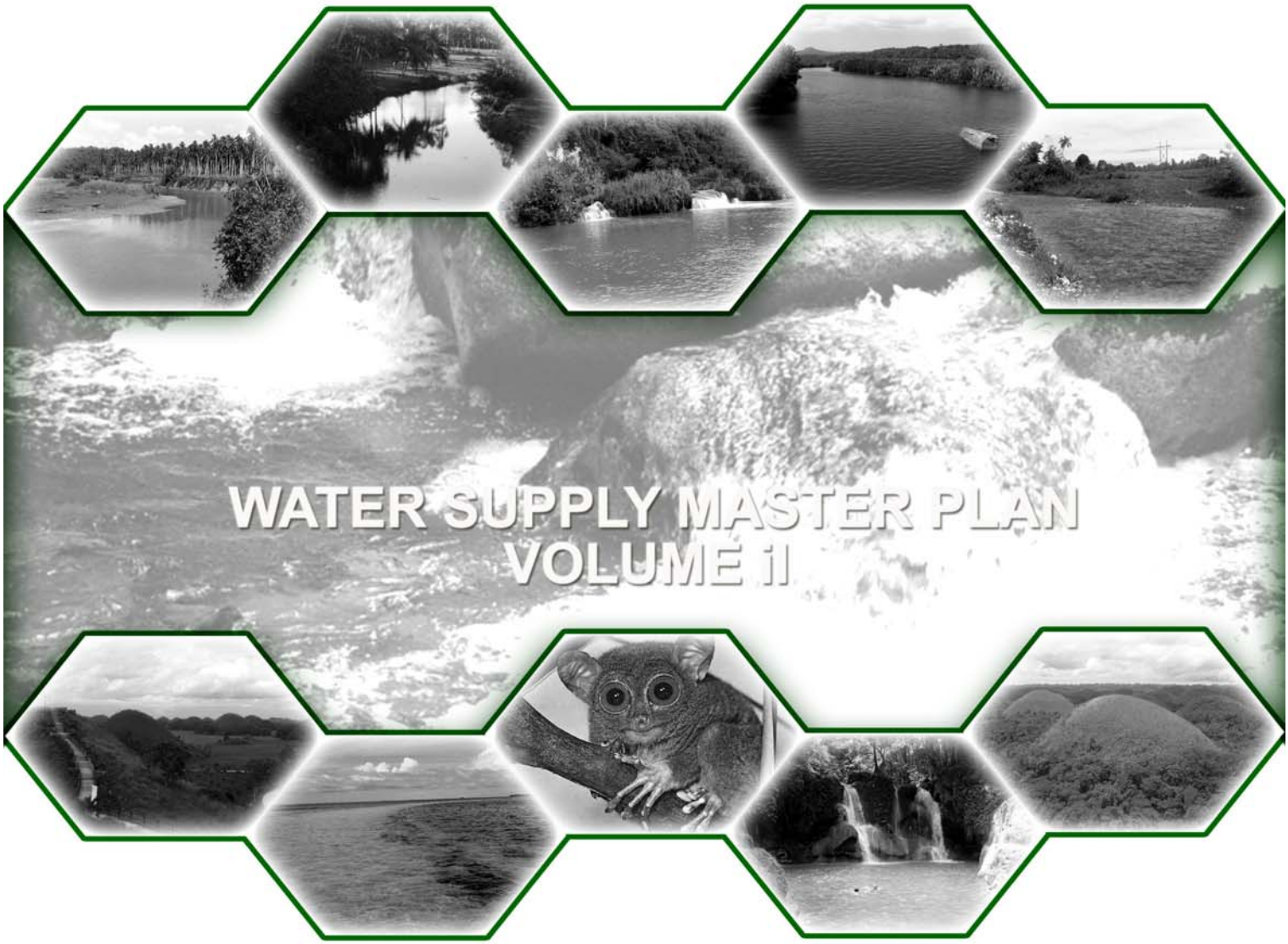
One of the first steps in updating the master plan is to determine the degree and direction of implementation of the previous plan. This step has a dual purpose. First, it will reflect the basic suitability of the original plan and second, it will serve as the basis on which to update the plan. Technological changes in the field of water supply may result in improved design criteria and contemporary construction methods may alter the alternative system analysis results. Social goals may likewise change and there might be greater emphasis on environmental and ecological control.

The use of land may change in some areas thereby altering population distribution and the need for previously planned for water services. Population projections may also be altered as refined information becomes available. Transportation networks and employment opportunities will be the major determinants in the patterns of population distribution.

6.7 CONCLUSION AND RECOMMENDATION

The Bohol Integrated Water Supply System Master Plan (BHL-01) presents the results of the study based on the scope of services. The BHL-01 should be taken within the context of the integrated water resources management framework in order to achieve greater sustainability and optimal utilization of resources. Furthermore, a GIS-based Management Information System (MIS) should support the integrated water resources management framework by way of providing updated and sustained information and data inputs including gender dimensions to come up with an appropriate and efficient management decision

Finally, a more detailed study, ideally by basin approach, should be undertaken to determine the different alternatives in order to come up with the right combination or blend of water resources and phasing. The groundwater resources as an option may be considered for immediate potential sources and gradual phasing out of groundwater while the surface waters would be the ultimate sources.



CHAPTER 7
FINANCIAL FEASIBILITY ANALYSIS

CHAPTER 7 – FINANCIAL FEASIBILITY ANALYSIS

7.1 ANALYTICAL FRAMEWORK

The highlights of the results of the financial feasibility analysis for river cluster areas are discussed in this chapter.

The river cluster areas would tap the major rivers of Bohol and supply bulk water to all the municipalities and city of the province. These river cluster areas are 1) Abatan, 2) Loboc1, 3) Loboc2, 4) Manaba, 5) Carood, 6) Ipil, 7) Wahig-Inabanga and 8) overall for all the Bohol river cluster areas.

The financial feasibility analysis for each river cluster area was based on the following:

- Technical designs based on estimated available water flows and qualities from the specified rivers, and water distribution systems developed with the aid of the water supply distribution software package EPANET, developed by the US Environment and Protection Agency.

- Cost estimates at 2007 constant prices based on cost standards from the Construction Industry ACEL Guidebook and Local Water Works and Utilities Administration (LWUA), and on cost estimates based from canvasses of leading suppliers, recent price quotations and cost curves.

  The major cost items include intake structures, water treatment plants, transmission pipes, pumps, reservoirs, power structures, and rights-of-way acquisitions. The other cost items are stored materials, spare parts & equipment, & vehicles (1.5% of transmission pipes & pumping stations). The sum of these major cost items and other cost items equal to total base cost (TBC). Added to TBC to arrive at Total Estimated Project Cost are feasibility study & detailed engineering (3.0% of TBC), contingency (8.0% of TBC), and construction management & supervision (2.0% of TBC).

- Projected annual bulk water sales based on estimated average day demand per municipality/city net of water supply being provided by existing sources and systems.

- Projected annual operations and maintenance (O&M) expenses including salaries, energy, chemicals and (other) maintenance expenses.

- Depreciation based on 30 years as the economic useful life of civil works and transmission pipes, and 13 years for pumps and power equipment. And,

- Five-year amortization period for feasibility study and detailed engineering cost.

The financial feasibility of each river cluster area was determined at constant 2007 prices without price inflation or escalation, and without exchange rate adjustments. No equity financing nor loan or debt funding were assumed so that the intrinsic overall profitability of each project could be determined.

For each river cluster area, the income statement, cashflow statement and balance sheet were projected from 2010 to 2035. The pre-operating or construction period was from 2010 to 2012, while the operating period was from 2013 to 2035.

The projected financial statements plus the estimated project cost per year and depreciation schedule for each river cluster area are presented in tables found at the end of this chapter.

7.2 RIVER CLUSTER AREAS FOR THE BOHOL INTEGRATED WATER SUPPLY SYSTEM

The highlights of the results of the financial feasibility analysis are presented in **Table 7-1**. The estimated total project cost for all the river cluster areas is PhP10.5 billion at 2007 prices. The Abatan River Cluster Area that would supply bulk water to Anteguera, Balilihan, Catigbian, Corella, Sagbayan, San Isidro and Sikatuna, has the lowest project cost of PhP773 million at 2007 prices. On the other hand, the Loboc1 River Cluster Area has an estimated total cost of PhP2.7 billion at 2007 prices. This covers Alburquerque, Baclayon, Cortes, Dauis, Dimiao, Lila, Loay, Loboc, Panglao, Tagbilaran City and Valencia.

The financial analysis for each river cluster area derived an average bulk water price per cubic meter (CuM) that would achieve a desired financial internal rate of return (FIRR), i.e., 15%, 12% and 0%.

The FIRR is the rate at which the project's yearly cash inflows and outflows are discounted on a compounded basis through time to equal to zero at the initial year.

For a 12% FIRR, the overall average bulk water price for all the Bohol river cluster areas is PhP46.70 per CuM. Among the river cluster areas, the lowest bulk water price is PhP38.19 per CuM for the Ipil River Cluster Area. The highest bulk water price for a river cluster area to earn an FIRR of 12% is PhP71.46 per CuM for the Abatan River Cluster Area.

When compared with present bulk water prices of PhP25.00 per CuM commercially sold by Bohol Water Utilities, Inc. (BWUI) and PhP17.00 per CuM being offered by BWUI to the Municipality of Panglao, the derived bulk water prices for the river cluster areas are much too high to be commercially viable.

For the Ipil River Cluster Area, if sales would increase by 30% and project cost would decrease by 20%, the bulk water price would be PhP24.11 per CuM. The next lowest bulk water price at these two favorable conditions is the Loboc1 River Cluster Area with a bulk water price of PhP25.90 per CuM.

Although near the PhP25 per CuM commercial price offered by BWUI, it would be difficult to plan on the basis of such sensitivity analysis scenarios. One scenario, a 30% sales volume increase or a 20% decrease in project cost would be very difficult to realize, and for both scenarios to happen at the same time would be doubly difficult. Conditions could even be adverse rather than favorable when the projects would have been implemented. These sensitivity analyses would only be beneficially indicative if the projects are profitable or slightly profitable at base case (based on the estimated project cost without any cost reduction, and projected sales volumes without any sales increase).

At 15% FIRR, the derived bulk prices would be much higher. The overall average price would be PhP59.19 per CuM.

On the other hand, at 0% FIRR, bulk water prices would be very attractive and cheap. The overall average bulk water price would be PhP12.79 per CuM, with a low of PhP9.22 per CuM (Ipil River Cluster Area) and a high of PhP19.63 per CuM (Loboc2 River Cluster Area).

However, only the government could implement such projects at 0% FIRR, but at this time, the government does not have funds to subsidize water supply projects. Multilateral and bilateral financial institutions should consider funding water supply projects just like they fund road, bridge, flood control and irrigation projects. The provision of potable water to most of the population is one of the Millennium Goals and alleviates poverty. Governments also derive benefits from such projects since they increase land values and business activities, which expand the tax base that increase government revenues.

Table 7-1 Highlights of Results of Financial Analysis

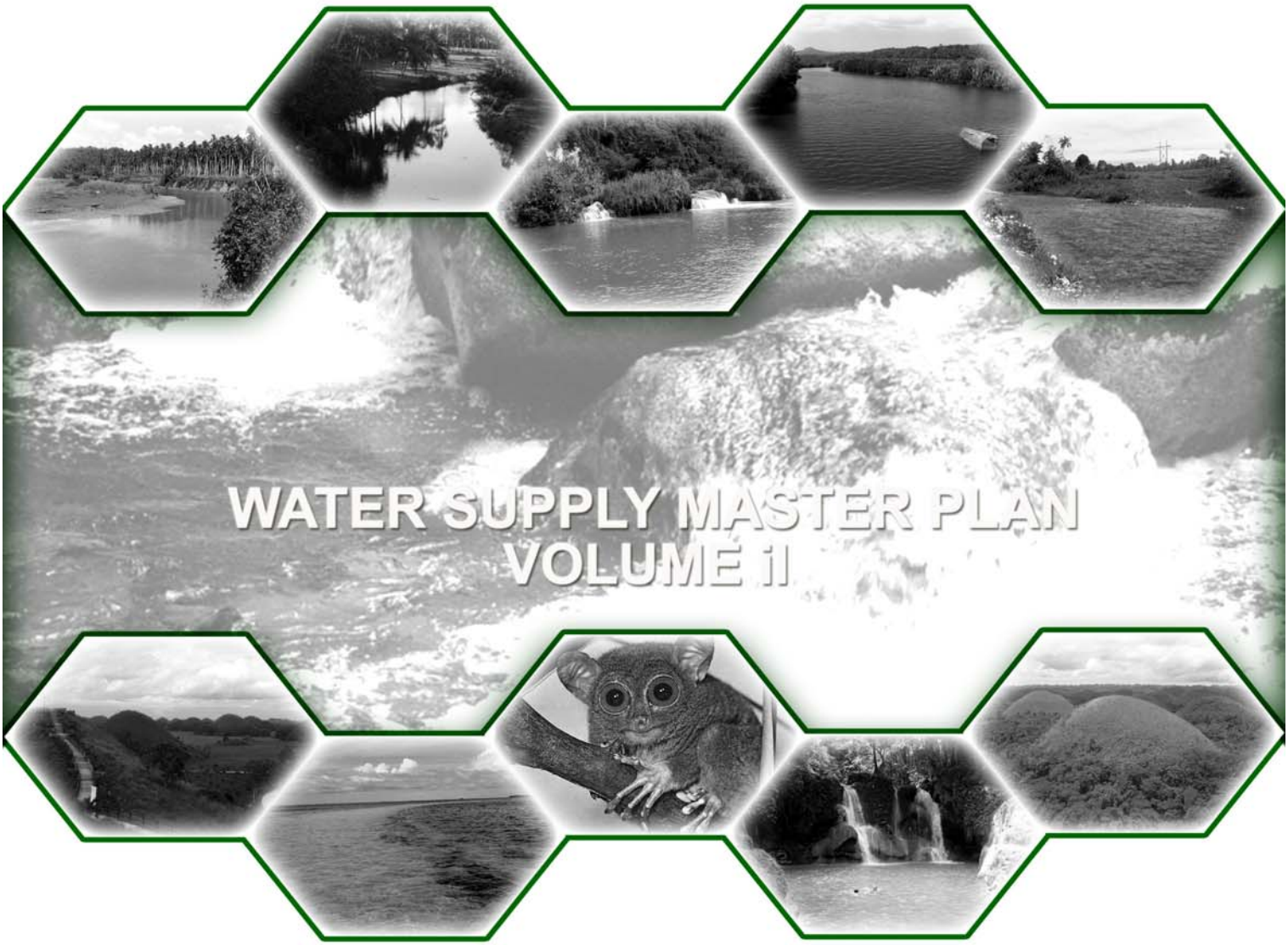
River Cluster Area	LGUs Served	Estimated Project Cost in Million Pesos at 2007 Prices	Pesos at 2007 Prices per Cubic Meter					
			FIRR=15%	FIRR=12%				FIRR=0%
				Base Case	+30% Sales	-20% Cost	+30% Sales & -20% Cost	
Integrated Water Supply System								
Abatan	Antequera, Balilihan, Catigbian, Corella, Sagbayan, San Isidro and Sikatuna	772.74	90.39	71.46	54.97	59.23	45.56	19.48
Loboc1	Alburquerque, Baclayon, Cortes, Dauis, Dimiao, Lila, Loay, Loboc, Panglao, Tagbilaran City and Valencia	2,724.10	50.48	40.33	31.03	33.65	25.90	12.31
Loboc2	Batuan, Bilar, Carmen, Dagohoy, Pilar, Sevilla and Sierra Bullones.	1,238.58	74.62	60.10	46.19	50.36	38.74	19.63
Manaba	Anda, Candijay, Duero, Garcia Hernandez/ Manaba, Guindulman and Jagna.	1,068.24	69.22	54.40	41.85	44.92	34.56	14.14
Carood	Alicia, Danao, Mabini, San Miguel, Pres. Carlos P. Garcia and Ubay	1,404.52	62.84	49.42	38.02	40.65	31.27	12.36
Ipil	Bien Unido, Buenavista, Getafe, Talibon and Trinidad	1,240.55	48.90	38.19	29.38	31.35	24.11	9.22
Wahig-Inabanga	Calape, Clarin, Inabanga, Loon, Maribojoc and Tubigon	2,063.27	58.23	44.99	34.61	36.99	28.45	10.87
Total All Clusters	**All Bohol municipalities and city**	**10,512.00**	**59.19**	**46.70**	**35.92**	**38.68**	**29.76**	**12.79**

7.3 Conclusions and Recommendation

The results of the financial feasibility analysis of the river cluster areas indicate the following:

- The river cluster areas for the Bohol Integrated Water Supply System do not seem to be commercially viable. The derived bulk water prices per river cluster area are higher than the commercial bulk water price of BWUI of PhP25 per CuM at 12% FIRR.

- All the river cluster areas are viable at 0% FIRR, which could only be implemented by the government just like it implements road, bridge, flood control, and irrigation projects. However, level III water supply projects are not implemented on a subsidized basis at this time of the Philippines stage of economic development. Multilateral and bilateral financial institutions should review this policy since provision of potable water to most of the population is one of the Millennium Goals and alleviates poverty.



CHAPTER 8
OPTIONS FOR PRIORITY DEVELOPMENT AREAS

CHAPTER 8 – OPTIONS FOR PRIORITY DEVELOPMENT AREAS

This chapter presents selected options based on the thrusts of the Provincial Government to accelerate the economic development of Bohol, and upon the request of the Provincial Governor to identify and evaluate viable options that will be affordable to consumers.

The development cost of the Bohol Integrated Water Supply System Master Plan if implemented all at the same time may not be attractive for private investor participation, hence, alternatives or options were considered subject to further study considering groundwater abstraction in areas not covered and where surface water utilization may not be affordable to consumers for immediate implementation.

Two priority areas or zones were identified and considered for water supply development that would lower the bulk tariff, namely:

(a) Panglao Island Tourism Estate, Metro Tagbilaran City, and adjacent areas, and

(b) Northeastern Industrial Zone, namely, Wahig-Inabanga Option (composed of Clarin, Inabanga, Buenavista and Getafe) and Ipil Option (composed of Talibon, Bien Unido, Trinidad and Ubay).

The assumptions and considerations in developing these options were:

1. The municipalities that will not be covered by surface waters would be served by groundwater sources through wells or springs;

2. Further extensive hydrogeological investigation is recommended in the follow-through study – Feasibility Study/Detailed Engineeering Design; and

3. An intensified investment and eco-tourism marketing campaign for Bohol to accelerate the economic activities that will result to increased water demand.

There were 2 options considered for Panglao Island Tourism Estate, Metro Tagbilaran and adjacent areas, namely, Abatan-Loboc and Loboc Options. The Abatan-Loboc Option turned out to be the most economical alternative.

The different options are discussed as follows:

8.1 ABATAN-LOBOC RIVER OPTION

The proposed Abatan-Loboc River Option could provide average daily production of 56,325 cumd benefiting about 203,800 population. Initially in 2010, the bulk supply will cover Cortes, Tagbilaran City, Dauis and Panglao and by 2018, the service will be expanded to cover Loboc, Loay, Alburquerque, and Baclayon. To minimize the development cost, the offtake interconnected with the transmission line of Bohol Water Utilities, Inc. (BWUI) will convey water to Dauis and Panglao through bulk supply.

The Abatan-Loboc River Option will initially utilize Abatan River in 2010 up to 2017. By 2018, Loboc River will be tapped to supplement the supply to satisfy the increasing projected water demand. The proposed development plan for Abatan-Loboc River Option is presented in **Figure 8-1.**

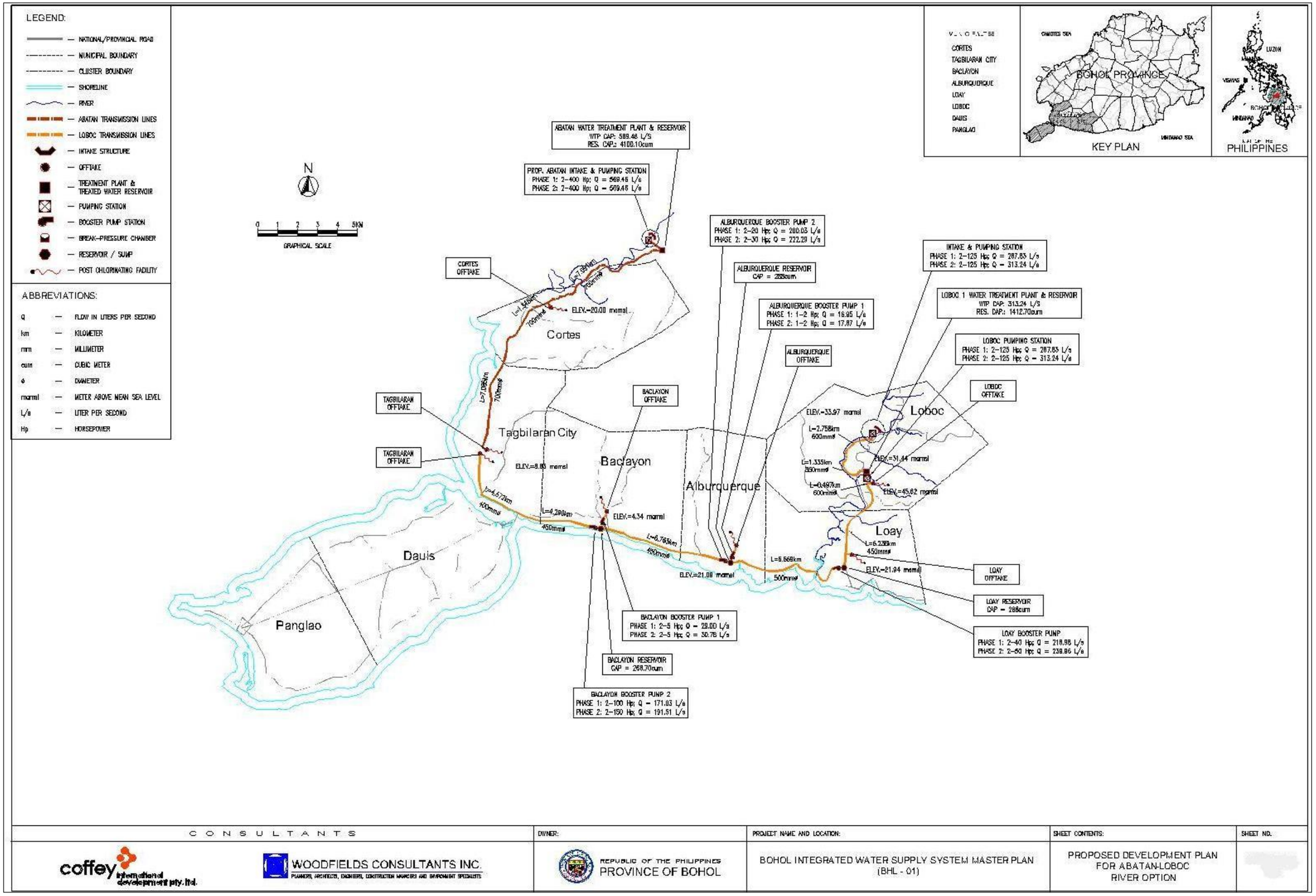


Figure 8-1 Abatan-Loboc River Option

8.1.1 Source Facility

In 2010, the proposed intake structure of Abatan River with pumping station will be developed and located in Antequera at an elevation of 10 mamsl. A 4m-high diversion weir structure will be constructed 45m across Abatan River where portion of the flow will be diverted into the intake chamber of the pump house located at the left bank of the river.

By 2018, the proposed Loboc River intake will be constructed in Bgy. Gotozon, Loboc at an elevation of 34 mamsl. A 3m-high diversion weir structure will be constructed 30m across Loboc River where portion of the flow will be diverted into the intake chamber of the pump house located at the left bank of the river

8.1.2 Transmission Facilities

Abatan River will be initially developed in 2010. A total of 16.6km long raw and clean water transmission lines with diameters ranging from 700mm to 1000mm will be installed. The raw water will be conveyed from the intake structure to the treatment plant at an elevation of 79mamsl through 0.88km long transmission line with 1000mm diameter. From the treatment plant, the treated water will be delivered by gravity to Cortes through 8.6km long pipeline with 700mm diameter, and, further south, to Tagbilaran City via 7.1km long with 700mm diameter. The offtake in Tagbilaran will be interconnected to BWUI for distribution to Tagbilaran, Dauis and Panglao.

By 2018, a total of 33.1km long raw and clean water transmission line with diameters ranging from 350 to 600mm will be installed from Loboc River to Tagbilaran City. The raw water will be conveyed from the intake structure to the treatment plant at an elevation of 31mamsl through 4.1km long transmission line with 350mm, 600mm and 1000mm diameters.

From the treatment plant, the processed water will be delivered to Loboc through a 0.6km long pipeline with 600mm diameter, and, further south, to Loay via 5.2km long with 450 to 600mm diameters. The 22.2km pipeline with diameters ranging from 400 to 1000mm will go to westward along the coastline where it will convey water to Alburquerque, Baclayon and Tagbilaran City.

8.1.3 Pump Stations

During the initial year of operation in 2013, there will be 8 pump stations installed with the biggest 400-Hp pump at the treatment plant in for Abatan River and the smallest 2-Hp pump in Alburquerque.

Table below summarizes the schedule of pumps to be installed in 2010 for Abatan River and 2018 for Loboc River, and pumps will to be replaced by 2025 and 2030, respectively.

Schedule of Pumps for Abatan-Loboc River Option

Year 2010	
400 Hp Pumps @ Intake-Abatan River	2 units
Year 2018	
125 Hp Booster Pumps @ Intake-Loboc River	2 units
125 Hp Booster Pumps @ WTP-Loboc River	2 units
40 Hp Booster Pumps @ loay-albu	2 units
20 Hp Booster Pumps @ Alb	2 units
2 Hp Pumps @ Alb	1 unit
100 Hp Booster Pumps @ bac	2 units
5 Hp Pumps @ bac	2 units

Year 2025	
400 Hp Pumps @ Intake at Abatan River	2 units
Year 2030	
125 Hp Booster Pumps @ Intake-Loboc River	2 units
125 Hp Booster Pumps @ WTP-Loboc River	2 units
50 Hp Booster Pumps @ loay-albu	2 units
30 Hp Booster Pumps @ Alb	2 units
2 Hp Pumps @ Alb	1 unit
150 Hp Booster Pumps @ bac	2 units
5 Hp Pumps @ bac	2 units

8.1.4 Storage Facilities

There will be 6 reservoirs and sumps to be constructed at different sites. A 4,100 cum capacity clean water reservoir including chlorination facilities will be constructed within the site of the treatment plant for Abatan River while a 1,413 cum will be installed for Loboc River. The total capacity of these facilities will be 6,356 cum. The storage facilities are summarized as follows:

Storage Facilities	
Abatan River (2010)	
Reservoir Near WTP-Abatan River	4100 cum
Loboc River (2018)	
Reservoir Near WTP-Loboc River	1,413 cum
Sump (loay)	288 cum
Sump (Alb)	288 cum
Sump (bac)	267 cum

8.1.5 Treatment Plant

There will be 2 treatment plants, one each for Abatan and Loboc Rivers. The treatment plants will be located in Antequera and Loboc. Abatan River treatment plant will have a design capacity of 569.46 L/s while Loboc River treatment plant will have a design capacity of 313.24 L/s.

8.1.6 Disinfection Facilities

Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

8.1.7 Cost Estimates

The total project cost is PhP1,164,221,000 for 2010 in developing Abatan River and PhP898,342,000 in 2018 for tapping Loboc River. **Table 8-1A to 8-1D** shows the breakdown of costs of facilities of the Abatan-Loboc River Option.

The annual operation and maintenance cost for Abatan-Loboc River Option is presented in **Table 8-1E.**

TABLE 8-1 A
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
ABATAN - LOBOC OPTION 2010
BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2018)
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir at Abatan River	Cu.m.	389	20,000	7,785,000
	Sub-Total Cost				**7,785,000**
2.0	Transmission Pipelines				
2.1	Pipelines				
	700 mm dia.	lm.	15,721	23,400	367,871,400
	1000 mm dia.	lm.	880	49,800	43,824,000
2.2	River/Creek Crossings	ls	**16,601**		2,058,477
2.3	Flowmeters and Gauging Points	ls			8,233,908
2.4	Valves and Fittings	ls			51,461,925
	Sub-Total Cost				**473,449,710**
3.0	Pumping Stations				
3.1	Booster Pump				
3.1.1	400 Hp Pumps @ Intake-Abatan River	Unit	3	1,901,390	5,704,170
3.2	Building				
3.2.1	Pump House	Sq.m.	64	9,000	576,000
	Sub-Total Cost				**6,280,170**
4.0	Storage Facilities				
4.1	Reservoir Near WTP-Abatan River	Cu.m.	4,100	8,000	32,800,000
	Sub-Total Cost				**32,800,000**
5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant-Abatan River	MLD	49.20	10,000,000	492,000,000
	Sub-Total Cost				**492,000,000**
6.0	Power Source Development				
6.1	Building	Sq.m.	36	9,000	324,000
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	10,008,000	10,008,000
	Sub-Total Cost				**10,332,000**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	2,416	2,416
7.2	Water Treatment Plant	ls	1	193,304	193,304
7.3	Treated Water Reservoirs	ls	1	29,720	29,720
7.4	Right of Way (ROW)	ls	1	224,523	224,523
	Sub-Total Cost				**449,963**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	7,187,308	7,187,308
B	**TOTAL BASE COST (TBC)**				**1,030,284,151**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**30,908,525**
D	**Contingency (8.0% of TBC)**				**82,422,732**
E	**Construction Management Supervision (2.0% of TBC)**				**20,605,683**
F	**TOTAL PROJECT COST ESTIMATE**				**1,164,221,091**

TABLE 8-1B
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
ABATAN-LOBOC OPTION 2018
BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2018 - 2035)
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir at Loboc River	Cu.m.	199	20,000	3,981,600
	Sub-Total Cost				**3,981,600**
2.0	Transmission Pipelines				
2.1	Pipelines				
	350 mm dia.	lm.	1,335	9,500	12,682,500
	400 mm dia.	lm.	4,572	10,500	48,006,000
	450 mm dia.	lm.	17,291	11,600	200,575,600
	500 mm dia.	lm.	6,669	12,700	84,696,300
	600 mm dia.	lm.	3,255	17,400	56,637,000
2.2	River/Creek Crossings	ls	**33,122**		2,012,987
2.3	Flowmeters and Gauging Points	ls			8,051,948
2.4	Valves and Fittings	ls			50,324,675
	Sub-Total Cost				**462,987,010**
3.0	Pumping Stations				
3.1	**Booster Pump (2035)**				
3.1.1	125 Hp Booster Pumps @ Intake-Loboc River	Unit	3	754,135	2,262,405
3.1.2	125 Hp Booster Pumps @ WTP-Loboc River	Unit	3	754,135	2,262,405
3.1.4	40 Hp Booster Pumps @ loay-albu	Unit	3	231,577	694,731
3.1.5	20 Hp Booster Pumps @ Alb	Unit	3	103,158	309,474
3.1.6	2 Hp Pumps @ Alb	Unit	2	33,779	67,558
3.1.7	100 Hp Booster Pumps @ bac	Unit	3	509,891	1,529,673
3.1.8	5 Hp Pumps @ bac	Unit	3	42,879	128,637
3.2	Building				
3.2.1	Pump House	Sq.m.	484	9,000	4,356,000
	Sub-Total Cost				**11,610,883**
4.0	Storage Facilities				
4.1	Reservoir Near WTP-Loboc River	Cu.m.	1,413	10,000	14,130,000
4.2	Sump (loay)	Cu.m.	288	12,000	3,456,000
4.3	Sump (Alb)	Cu.m.	288	12,000	3,456,000
4.4	Sump (bac)	Cu.m.	267	12,000	3,204,000
	Sub-Total Cost				**24,246,000**

5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	27.06	10,000,000	270,600,000
	Sub-Total Cost				**270,600,000**
6.0	Power Source Development				
6.1	Building	Sq.m.	216	9,000	1,944,000
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	12,042,000	12,042,000
	Sub-Total Cost				**13,986,000**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	100,359	100,359
7.2	Water Treatment Plant	ls	1	144,978	144,978
7.3	Treated Water Reservoirs	ls	1	84,972	84,972
7.4	Right of Way (ROW)	ls	1	197,798	197,798
	Sub-Total Cost				**528,107**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	7,053,628	7,053,628
B	**TOTAL BASE COST (TBC)**				**794,993,228**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**23,849,797**
D	**Contingency (8.0% of TBC)**				**63,599,458**
E	**Construction Management Supervision (2.0% of TBC)**				**15,899,865**
F	**TOTAL PROJECT COST ESTIMATE**				**898,342,348**

TABLE 8-1C
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
ABATAN - LOBOC OPTION 2025
REPLACEMENT OF PUMPS AT YEAR 2025
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
3.0	Pumping Stations				
3.1.1	400 Hp Pumps @ Intake at Abatan River	Unit	3	1,901,390	5,704,170
B	**BASE COST (TBC)**				**5,704,170**
C	**Contingency (8.0% of TBC)**				**456,334**
E	**TOTAL PROJECT COST ESTIMATE**				**6,160,504**

TABLE 8-1D
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
ABATAN-LOBOC OPTION 2030
REPLACEMENT OF PUMPS AT YEAR 2030
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A.	**Replacement of Pumps (2030)**				
3.1.1	125 Hp Booster Pumps @ Intake-Loboc River	Unit	3	754,135	2,262,405
3.1.2	125 Hp Booster Pumps @ WTP-Loboc River	Unit	3	754,135	2,262,405
3.1.4	50 Hp Booster Pumps @ loay-albu	Unit	3	264,628	793,884
3.1.5	30 Hp Booster Pumps @ Alb	Unit	3	165,402	496,206
3.1.6	2 Hp Pumps @ Alb	Unit	2	33,779	67,558
3.1.7	150 Hp Booster Pumps @ bac	Unit	3	848,193	2,544,579
3.1.8	5 Hp Pumps @ bac	Unit	3	42,879	128,637
B	**TOTAL BASE COST - PHASE 1 (TBC)**				**8,555,674**
C	**Contingency (8.0% of TBC)**				**684,454**
D	**TOTAL PROJECT COST ESTIMATE**				**9,240,128**

Table 8-1E
Bohol Integrated Water Supply Master Plan
Annual Operation and Maintenance Cost
Abatan-Loboc River Option

(October 2007 Price Level)

Year	Salaries	Energy	1-Aug	Maintenance	Total
2013	2,398,500	17,500,862	2,261,688.34	8,150,690	30,311,741
2014	2,398,500	18,717,762	2,378,733.72	8,160,574	31,655,570
2015	2,398,500	19,934,662	2,495,779.10	8,170,458	32,999,399
2016	2,398,500	21,519,166	2,701,855.84	8,187,860	34,807,382
2017	2,398,500	23,103,671	2,907,932.58	8,205,262	36,615,365
2018	4,173,000	30,660,256	3,114,009.32	15,974,836	53,922,102
2019	4,173,000	34,702,020	3,320,086.05	15,992,238	58,187,345
2020	4,173,000	38,743,784	3,526,162.79	16,009,640	62,452,587
2021	4,173,000	40,866,535	3,638,611.29	16,019,136	64,697,282
2022	4,173,000	42,989,286	3,751,059.79	16,028,632	66,941,978
2023	4,173,000	45,112,037	3,863,508.28	16,038,127	69,186,673
2024	4,173,000	47,234,788	3,975,956.78	16,047,623	71,431,368
2025	4,173,000	49,357,539	4,088,405.28	16,057,119	73,676,063
2026	4,173,000	50,428,001	4,144,882.88	16,061,888	74,807,771
2027	4,173,000	51,498,462	4,201,360.48	16,066,657	75,939,480
2028	4,173,000	52,568,923	4,257,838.08	16,071,426	77,071,188
2029	4,173,000	53,639,385	4,314,315.68	16,076,196	78,202,896
2030	4,173,000	54,709,846	4,370,793.28	16,080,965	79,334,604
2031	4,173,000	58,849,154	4,421,767.34	16,104,781	83,548,703
2032	4,173,000	59,942,711	4,472,741.41	16,109,086	84,697,539
2033	4,173,000	61,036,269	4,523,715.47	16,113,390	85,846,374
2034	4,173,000	62,129,826	4,574,689.53	16,117,695	86,995,210
2035	4,173,000	63,223,383	4,625,663.59	16,121,999	88,144,045

8.2 LOBOC RIVER OPTION

The proposed Loboc River Option is a variant of Abatan-Loboc River Option. It will also provide average daily production of 56,325 cumd benefiting about 203,800 population and covering the same city/municipalities. Unlike the previous option, it will cover all city/municipalities on the first year of operation - 2010. Dauis and Panglao will be served by bulk supply through the offtake interconnected with the transmission line of BWUI. The proposed development plan for Loboc River Option is presented in **Figure 8-2.**

8.2.1 Source Facility

The proposed Loboc River intake will be constructed in Bgy. Gotozon, Loboc at an elevation of 34 mamsl. A 3m-high diversion weir structure will be constructed 30m across Loboc River where portion of the flow will be diverted into the intake chamber of the pump house located at the left bank of the river.

8.2.2 Transmission Facilities

A total of 33.1km long raw and clean water transmission line with diameters ranging from 600 to 800mm will be installed from Loboc River to Tagbilaran City. The raw water will be conveyed from the intake structure to the treatment plant at an elevation of 31mamsl through 4.1km long transmission line with 600mm and 1000mm diameters.

From the treatment plant, the processed water will be delivered southward to Loboc and Loay and westward to Alburquerque, Baclayon, Tagbilaran, Cortes Dauis and Panglao through 27.7km long transmission pipeline with diameters ranging from 700 to 1000mm.

8.2.3 Pump Stations

There will be 8 booster/pump station that will be installed. The summary of pumps to be installed in 2010 for Loboc River Option and pump replacement by 2025 is shown below.

Schedule of Pumps for Loboc River Option

Year 2010		Replacement of Pumps in Year 2025	
350 Hp Booster Pumps @ Intake	2	400 Hp Booster Pumps @ Intake	2
350 Hp Booster Pumps @ WTP	2	400 Hp Booster Pumps @ WTP	2
125 Hp Booster Pumps @ loay-albu	2	150 Hp Booster Pumps @ loay-albu	2
100 Hp Booster Pumps @ Alb	2	200 Hp Booster Pumps @ Alb	2
2 Hp Pumps @ Alb	2	2 Hp Pumps @ Alb	2
400 Hp Booster Pumps @ bac	2	500 Hp Booster Pumps @ bac	2
5 Hp Pumps @ bac	2	5 Hp Pumps @ bac	2

8.2.4 Storage Facilities

There will be 4 reservoirs and sumps to be constructed at different sites. A 3,463 cum capacity clean water reservoir including chlorination facilities will be constructed within the site of the treatment plant while 3 sumps will be installed for Loboc River with 971 cum capacity. The storage facilities are summarized as follows:

Storage Facilities	
Reservoir Near WTP	3,463 cum
Sump (loay)	971 cum
Sump (Alb)	971 cum
Sump (bac)	950 cum

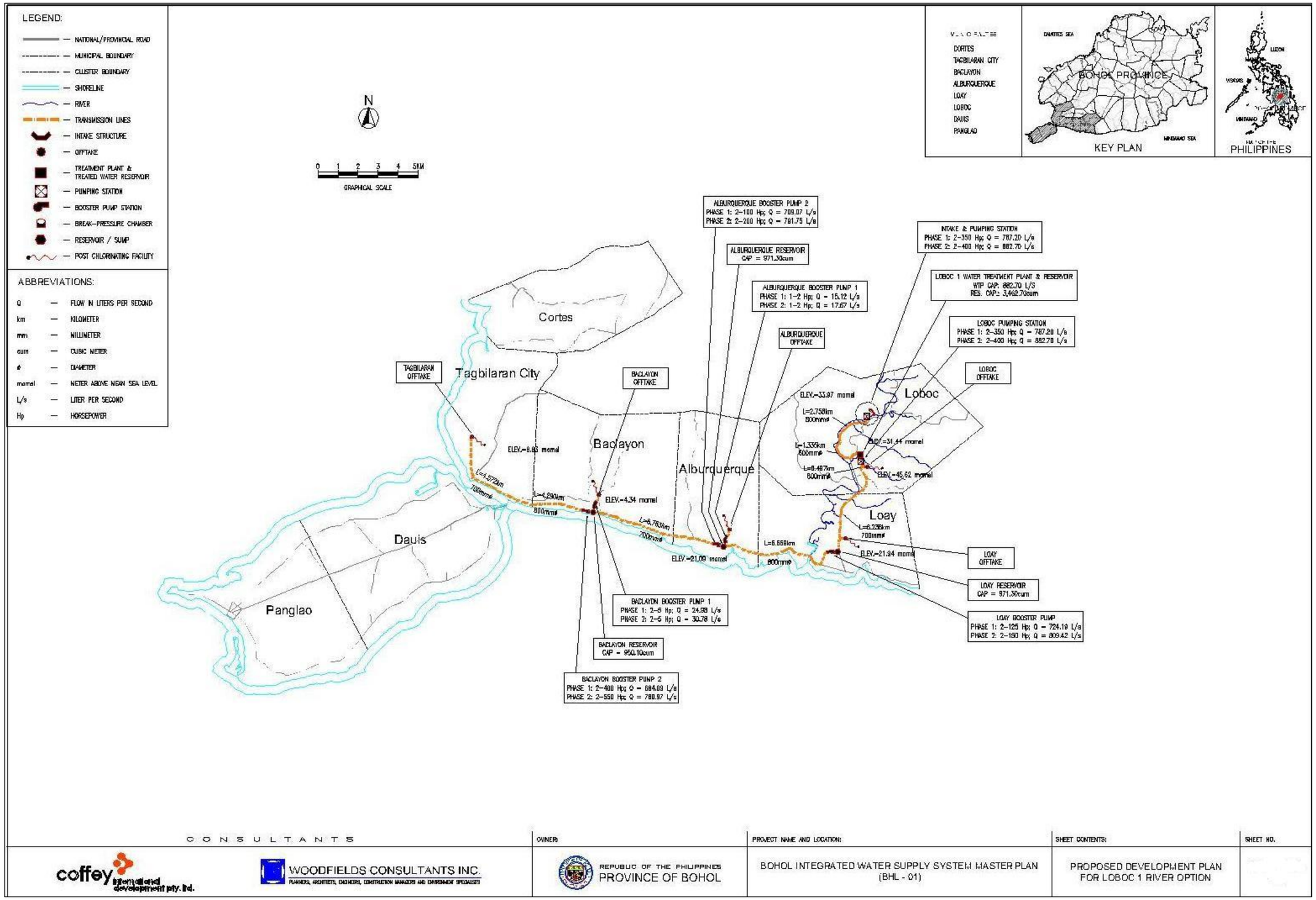


Figure 8-2 Loboc River Option

8.2.5 Treatment Plant

The treatment plant will be located in Loboc. It will have a design capacity of 882.70 L/s. where raw water will undergo a series of purification process.

8.2.6 Disinfection Facilities

Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

8.2.7 Cost Estimates

The total project cost is PhP2,161,381,000 for 2010 in developing Loboc River Option while the cost of pump replacement is PhP25,290,000 by 2025. The breakdown of costs of facilities of the Loboc River Option is presented in **Table 8-2A to 8-2B.**

The annual operation and maintenance cost for Loboc River Option is presented in **Table 8-2C.**

TABLE 8-2 A
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
LOBOC OPTION 2010
BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir	Cu.m.	199	20,000	3,981,600
	Sub-Total Cost				**3,981,600**
2.0	Transmission Pipelines				
2.1	Pipelines				
	600 mm dia.	lm.	1,335	17,400	23,229,000
	700 mm dia.	lm.	17,573	23,400	411,208,200
	800 mm dia.	lm.	14,214	30,700	436,369,800
2.2	River/Creek Crossings	ls	**33,122**		4,354,035
2.3	Flowmeters and Gauging Points	ls			17,416,140
2.4	Valves and Fittings	ls			108,850,875
	Sub-Total Cost				**1,001,428,050**
3.0	Pumping Stations				
3.1	**Booster Pump (2025)**				
3.1.1	350 Hp Booster Pumps @ Intake	Unit	3	1,675,856	5,027,568
3.1.2	350 Hp Booster Pumps @ WTP	Unit	3	1,675,856	5,027,568
3.1.4	125 Hp Booster Pumps @ loay-albu	Unit	3	754,135	2,262,405
3.1.5	100 Hp Booster Pumps @ Alb	Unit	3	509,891	1,529,673

3.1.6	2 Hp Pumps @ Alb	Unit	2	33,779	67,558
3.1.7	400 Hp Booster Pumps @ bac	Unit	3	1,901,390	5,704,170
3.1.8	5 Hp Pumps @ bac	Unit	3	42,879	128,637
3.2	Building				
3.2.1	Pump House	Sq.m.	484	9,000	4,356,000
	Sub-Total Cost				**24,103,579**
4.0	Storage Facilities				
4.1	Reservoir Near WTP	Cu.m.	3,463	10,000	34,630,000
4.2	Sump (loay)	Cu.m.	971	10,000	9,710,000
4.3	Sump (Alb)	Cu.m.	971	10,000	9,710,000
4.4	Sump (bac)	Cu.m.	950	10,000	9,500,000
	Sub-Total Cost				**63,550,000**
5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	76.26	10,000,000	762,600,000
	Sub-Total Cost				**762,600,000**
6.0	Power Source Development				
6.1	Building	Sq.m.	216	9,000	1,944,000
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	38,988,000	38,988,000
	Sub-Total Cost				**40,932,000**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	100,359	100,359
7.2	Water Treatment Plant	ls	1	241,630	241,630
7.3	Treated Water Reservoirs	ls	1	273,787	273,787
7.4	Right of Way (ROW)	ls	1	197,798	197,798
	Sub-Total Cost				**813,574**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	15,317,634	15,317,634
B	**TOTAL BASE COST (TBC)**				**1,912,726,437**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**57,381,793**
D	**Contingency (8.0% of TBC)**				**153,018,115**
E	**Construction Management Supervision (2.0% of TBC)**				**38,254,529**
F	**TOTAL PROJECT COST ESTIMATE**				**2,161,380,874**

TABLE 8-2B
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
LOBOC OPTION
REPLACEMENT OF PUMPS 2025
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	Description	Unit	Qty	Unit Cost	Amount
A	FACILITIES/ STRUCTURES				
1.0	Pumping Stations				
1.1	400 Hp Booster Pumps @ Intake	Unit	3	1,901,390	5,704,170
1.2	400 Hp Booster Pumps @ WTP	Unit	3	1,901,390	5,704,170
1.3	150 Hp Booster Pumps @ loay-albu	Unit	3	848,193	2,544,579
1.4	200 Hp Booster Pumps @ Alb	Unit	3	1,026,043	3,078,129
1.5	2 Hp Pumps @ Alb	Unit	2	33,779	67,558
1.6	500 Hp Booster Pumps @ bac	Unit	3	1,921,192	5,763,576
1.7	5 Hp Pumps @ bac	Unit	3	42,879	128,637
	Sub-Total Cost				**22,990,819**
B	**TOTAL BASE COST (TBC)**				**22,990,819**
C	**Contingency (8.0% of TBC)**				**1,839,266**
D	**Construction Management Supervision (2.0% of TBC)**				**459,816**
E	**TOTAL PROJECT COST ESTIMATE**				**25,289,901**

Table 8-2C
Bohol Integrated Water Supply Master Plan
Annual Operation and Maintenance Cost
Loboc River Option
(October 2007 Price Level)

Year	Salaries	Energy	Chemicals	Maintenance	Total
2013	4,075,500	45,021,548	2,261,688.34	17,200,915	68,559,652
2014	4,075,500	47,599,379	2,378,733.72	17,210,799	71,264,412
2015	4,075,500	50,177,209	2,495,779.10	17,220,683	73,969,172
2016	4,075,500	54,268,307	2,701,855.84	17,238,085	78,283,748
2017	4,075,500	58,359,405	2,907,932.58	17,255,487	82,598,325
2018	4,075,500	62,450,503	3,114,009.32	17,272,889	86,912,902
2019	4,075,500	66,541,601	3,320,086.05	17,290,291	91,227,479
2020	4,075,500	70,632,699	3,526,162.79	17,307,693	95,542,055
2021	4,075,500	72,785,337	3,638,611.29	17,317,189	97,816,637
2022	4,075,500	74,937,975	3,751,059.79	17,326,685	100,091,220
2023	4,075,500	77,090,613	3,863,508.28	17,336,180	102,365,802
2024	4,075,500	79,243,251	3,975,956.78	17,345,676	104,640,384
2025	4,075,500	81,395,889	4,088,405.28	17,355,172	106,914,966
2026	4,075,500	91,456,144	4,144,882.88	17,408,589	117,085,116
2027	4,075,500	92,656,626	4,201,360.48	17,413,359	118,346,845
2028	4,075,500	93,857,108	4,257,838.08	17,418,128	119,608,573
2029	4,075,500	95,057,589	4,314,315.68	17,422,897	120,870,302
2030	4,075,500	96,258,071	4,370,793.28	17,427,666	122,132,031
2031	4,075,500	97,368,024	4,421,767.34	17,431,971	123,297,262
2032	4,075,500	98,477,977	4,472,741.41	17,436,275	124,462,494
2033	4,075,500	99,587,930	4,523,715.47	17,440,580	125,627,725
2034	4,075,500	100,697,883	4,574,689.53	17,444,884	126,792,957
2035	4,075,500	101,807,836	4,625,663.59	17,449,189	127,958,188

8.3 WAHIG-INABANGA RIVER OPTION

The proposed Wahig-Inabanga River Option will provide an average daily production of 15,262 cumd benefiting about 97,300 population. It will cover 4 municipalities, namely, Inabanga, Clarin, Buenavista and Getafe. **Figure 8-3** shows the proposed development plan of Inabanga River Option detailing the major facilities.

8.3.1 Source Facility

The site of the proposed intake structure with pumping station will be located in Bgy. U-og, Inabanga at an elevation of 31 mamsl. A 2m-high diversion weir structure will be constructed 75m across Inabanga River where portion of the flow will be diverted into the intake chamber of the pump house located at the left bank of the river.

8.3.2 Transmission Facilities

The transmission line will have a total length of 34.4 km with diameters ranging from 300 to 500mm. The raw water will be conveyed by a pump and delivered through a 500mm diameter, 4km long transmission line into the water treatment plant at elevation 20 mamsl.

From the treatment plant, water will be boosted and delivered via 24.8km long transmission line with diameters ranging from 350 to 450mm, heading northward to Inabanga, Buenavista and Getafe. The other 5.6km transmission line with 300mm diameter going southward will cover Clarin.

8.3.3 Pump Stations

During the initial year of operation in 2013, there will be 3 pump stations with the bigger 75-Hp pump installed at Inabanga booster station and 2 smaller 7.5 Hp pumps for Clarin booster station and intake pump station.

The table below summarizes the schedule of pumps to be installed in 2010 and pump replacement by 2025 and is shown below:

Schedule of Pumps for Wahig-Inabanga River Option

Year 2010		Year 2025	
7.5 Hp Pumps @ Intake Structure	2 units	7.5 Hp Pumps @ Intake Structure	2 units
7.5 Hp Pumps @ WTP-Clarin	2 units	7.5 Hp Pumps @ WTP-Clarin	2 units
75 Hp Pumps @ WTP-Inabanga	2 units	75 Hp Pumps @ WTP-Inabanga	2 units

8.3.4 Storage Facilities

Only 1 reservoir including chlorination facilities will be constructed within the site of the treatment plant. Its capacity will be 1,613 cum.

8.3.5 Treatment Plant

The treatment plant will be located in Inabanga. It will have a design capacity of 226.52 L/s where raw water will undergo a series of purification process.

Disinfection Facilities

Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtake.

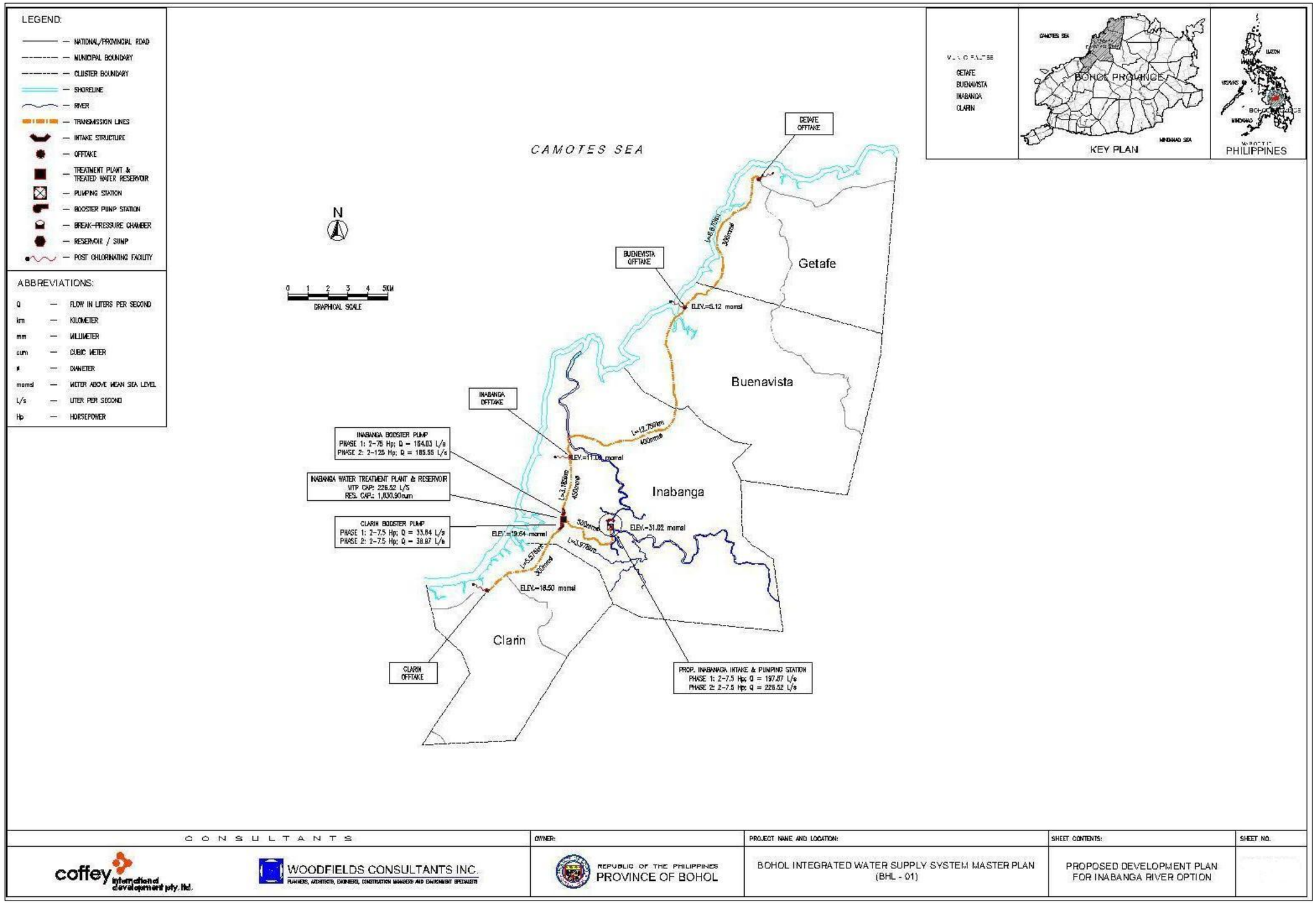


Figure 8-3 Wahig-Inabanga River Option

8.3.6 Cost Estimates

The total project cost is PhP715,511,000 for 2010 and PhP2,814,000 will be allocated for pump replacement by 2025. **Table 8-3A** and **8-3B** shows the breakdown of costs of facilities of the Wahig-Inabanga River Option.

The annual operation and maintenance cost of the Wahig-Inabanga River Option is presented in **Table 8-3C.**

TABLE 8-3A
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
WAHIG-INABANGA RIVER 2010 OPTION
BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir at Inabanga River	Cu.m.	536	20,000	10,725,000
	Sub-Total Cost				**10,725,000**
2.0	Transmission Pipelines				
2.1	Pipelines				
	300 mm dia.	lm.	5,576	7,000	39,032,000
	350 mm dia.	lm.	8,870	9,500	84,265,000
	400 mm dia.	lm.	12,759	10,500	133,969,500
	450 mm dia.	lm.	3,185	11,600	36,946,000
	500 mm dia.	lm.	3,978	12,700	50,520,600
2.2	River/Creek Crossings	ls			1,723,666
2.3	Flowmeters and Gauging Points	ls			6,894,662
2.4	Valves and Fittings	ls			43,091,638
	Sub-Total Cost				**396,443,065**
3.0	Pumping Stations				
3.1	Booster Pump				
3.1.1	7.5 Hp Pumps @ Intake Structure	Unit	3	57,148	171,444
3.1.2	7.5 Hp Pumps @ WTP-Cla	Unit	3	57,148	171,444
3.1.3	75 Hp Pumps @ WTP-Ina	Unit	3	415,906	1,247,718
3.2	Building				
3.2.1	Pump House	Sq.m.	192	9,000	1,728,000
	Sub-Total Cost				**3,318,606**
4.0	Storage Facilities				
4.1	Concrete Ground Reservoir at WTP	Cu.m.	1,631	10,000	16,310,000
	Sub-Total Cost				**16,310,000**

5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	19.57	10,000,000	195,700,000
	Sub-Total Cost				**195,700,000**
6.0	Power Source Development				
6.1	Building	Sq.m.	108	9,000	972,000
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	3,312,000	3,312,000
	Sub-Total Cost				**4,284,000**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	90,600	90,600
7.2	Water Treatment Plant	ls	1	144,978	144,978
7.3	Treated Water Reservoirs	ls	1	16,479	16,479
7.4	Right of Way (ROW)	ls	1	191,999	191,999
	Sub-Total Cost				**444,056**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	5,970,505	5,970,505
B	**TOTAL BASE COST (TBC)**				**633,195,232**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**18,995,857**
D	**Contingency (8.0% of TBC)**				**50,655,619**
E	**Construction Management Supervision (2.0% of TBC)**				**12,663,905**
F	**TOTAL PROJECT COST ESTIMATE**				**715,510,613**

TABLE 8-3B
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
WAHIG-INABANGA RIVER 2025 OPTION
REPLACEMENT OF PUMPS AT YEAR 2025
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
3.0	Pumping Stations				
3.1.1	7.5 Hp Pumps @ Intake Structure	Unit	3	57,148	171,444
3.1.2	7.5 Hp Pumps @ WTP-Cla	Unit	3	57,148	171,444
3.1.3	125 Hp Pumps @ WTP-Ina	Unit	3	754,135	2,262,405
B	**TOTAL BASE COST - PHASE 2 (TBC)**				**2,605,293**
D	**Contingency (8.0% of TBC)**				**208,423**
F	**TOTAL PROJECT COST ESTIMATE**				**2,813,716**

Table 8-3C
Bohol Integrated Water Supply Master Plan
Annual Operation and Maintenance Cost
Wahig-Inabanga River Option
(October 2007 Price Level)

Year	Salaries	Energy	Chemicals	Maintenance	Total
2013	2,106,000	2,901,525	520,523.42	6,510,165	12,038,214
2014	2,106,000	3,422,766	608,306.69	6,517,578	12,654,651
2015	2,106,000	3,944,007	696,089.97	6,524,991	13,271,088
2016	2,106,000	4,176,926	739,075.66	6,528,621	13,550,622
2017	2,106,000	4,409,845	782,061.35	6,532,251	13,830,157
2018	2,106,000	4,642,764	825,047.04	6,535,881	14,109,692
2019	2,106,000	4,875,683	868,032.74	6,539,511	14,389,227
2020	2,106,000	5,108,602	911,018.43	6,543,141	14,668,761
2021	2,106,000	5,308,576	947,194.10	6,546,195	14,907,966
2022	2,106,000	5,508,550	983,369.77	6,549,250	15,147,170
2023	2,106,000	5,708,524	1,019,545.44	6,552,305	15,386,375
2024	2,106,000	5,908,498	1,055,721.10	6,555,360	15,625,579
2025	2,106,000	6,108,472	1,091,896.77	6,573,635	15,880,004
2026	2,106,000	7,967,462	1,114,119.89	6,575,512	17,763,094
2027	2,106,000	8,127,836	1,136,343.01	6,577,388	17,947,568
2028	2,106,000	8,288,210	1,158,566.13	6,579,265	18,132,041
2029	2,106,000	8,448,585	1,180,789.25	6,581,141	18,316,515
2030	2,106,000	8,608,959	1,203,012.37	6,583,018	18,500,989
2031	2,106,000	8,677,524	1,213,087.27	6,583,869	18,580,480
2032	2,106,000	8,746,089	1,223,162.16	6,584,720	18,659,971
2033	2,106,000	8,814,654	1,233,237.06	6,585,570	18,739,462
2034	2,106,000	8,883,219	1,243,311.96	6,586,421	18,818,953
2035	2,106,000	8,951,785	1,253,386.85	6,587,272	18,898,443

8.4 IPIL RIVER OPTION

The proposed Ipil River Option will provide an average daily production of 32,409 cumd benefiting about 180,000 population. The proposed Ipil River Option will cover 4 municipalities, namely: Bien Unido, Ubay, Talibon, and Trinidad. **Figure 8-4** shows the development plan of Ipil River Cluster detailing the major facilities and the covered municipalities.

8.4.1 Source Facility

The site of the proposed intake structure with pumping station will be located at an elevation of 10mamsl in Bgy. Hinlayagan Ilaud, Trinidad. A 2m-high diversion weir structure will be constructed 50m across Ipil River where portion of the flow will be diverted into the intake chamber of the pump house located at the right bank of the river. The proposed weir structure to be constructed across the Ipil River will also prevent the salt water intrusion inward especially during high tide at dry period.

8.4.2 Transmission Facilities

The raw and clean water transmission lines will have a total length of 31.3km with 300, 500 and 600mm diameters. The raw water will be lifted 10m by pump and delivered via 600mm diameter, 2.3km long transmission line into the water treatment plant.

The profile of the transmission line is gently sloping downward from the water treatment plant site to the proposed different offtakes. The transmission line originating from the pump station of the reservoir located at the water treatment plant will split into 2: going northeastward and going westward. The line going northeastward will provide water for Bien Unido and Ubay via 19.9km transmission line with 300mm and 500mm diameters. The pipeline going westward will cover Trinidad and Talibon through 500mm diameter, 9.1km long pipeline.

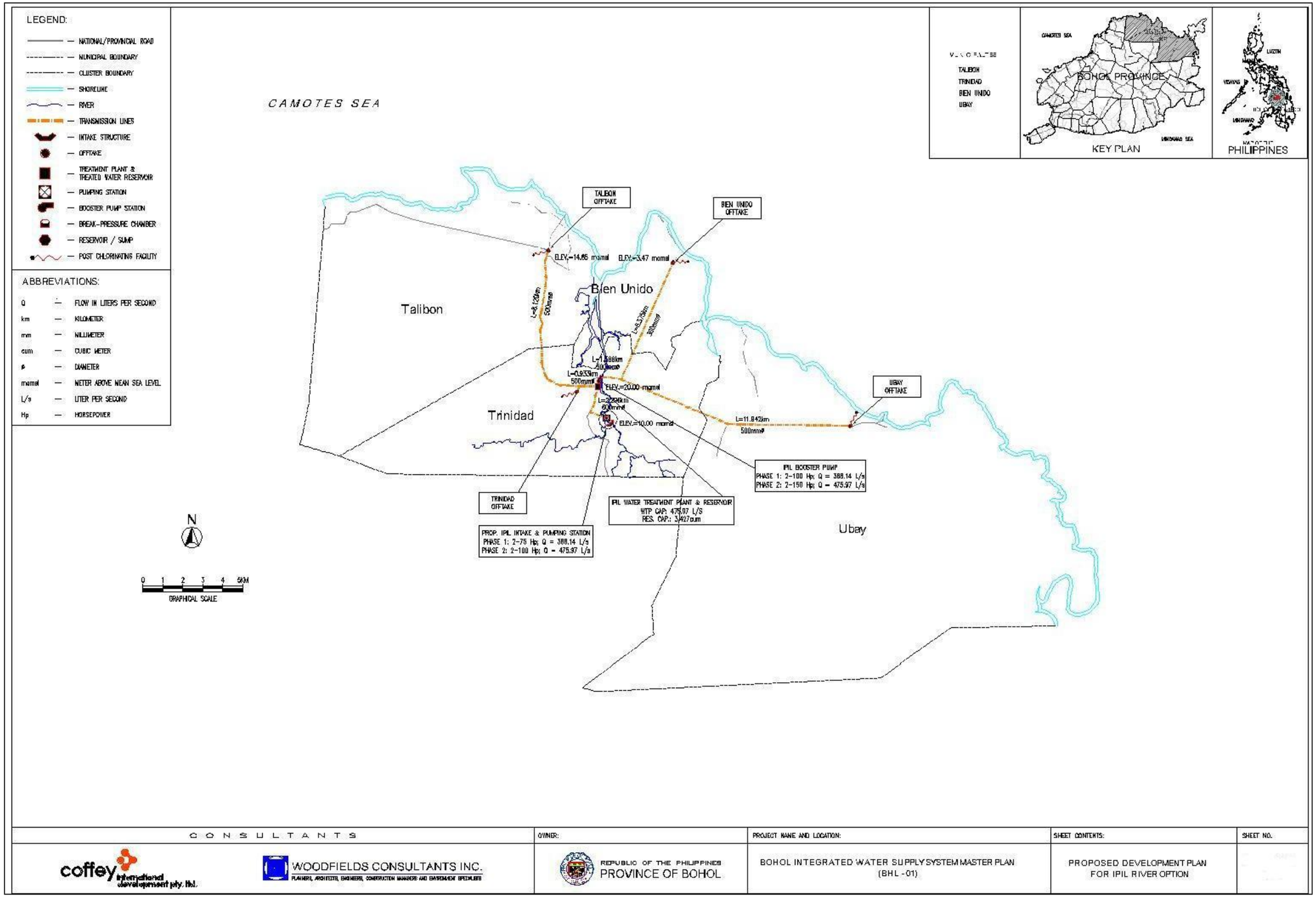


Figure 8-4 Ipil River Option

8.4.3 Pump Stations

During the initial year of operation in 2013, there will be 2 pump stations with 75hp for the intake pump station and 100hp pump for the booster station located at the treatment plant.

Table below summarizes the schedule of pumps to be installed in 2010 and the pump replacement by 2025 and is shown below:

Schedule of Pumps for Ipil River Cluster

Year 2010		Year 2025	
100 Hp Pumps @ Intake Structure	2 units	100 Hp Pumps @ Intake Structure	2 units
150 Hp Pumps @ WTP	2 units	150 Hp Pumps @ WTP	2 units

8.4.4 Storage Facilities

There will be only 1 reservoir including chlorination facilities to be constructed near the treatment plant. It will have a capacity of 3,427 cum.

8.4.5 Treatment Plant

The treatment plant will be located in Trinidad. It will have a design capacity of 475.97 L/s where raw water will undergo a series of purification process.

8.4.6 Disinfection Facilities

Aside from chlorination at the water treatment plant, water will be post disinfected at the sump before it will be delivered to interconnected waterworks through offtakes.

8.4.7 Cost Estimates

The total project cost is PhP1,107,396,000 for 2010 and PhP4,400,000 will be allocated for pump replacement by 2025. **Table 8-4A and 8-4B** shows the breakdown of costs of facilities of the Ipil River Option.

The annual operation and maintenance cost of the Ipil River Option is presented in **Table 8-4C**

TABLE 8-4A
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
IPIL RIVER 2010 OPTION
BREAKDOWN OF PROJECT COST COMPONENTS (AT YEAR 2010 - 2012)
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	**Description**	**Unit**	**Qty**	**Unit Cost**	**Amount**
A	**FACILITIES/ STRUCTURES**				
1.0	Source Facility				
1.1	Intake Structure with weir at Ipil River	Cu.m.	358	20,000	7,150,000
	Sub-Total Cost				**7,150,000**
2.0	Transmission Pipelines				
2.1	Pipelines				
	300 mm dia.	lm.	6,375	7,000	44,625,000
	500 mm dia.	lm.	22,583	12,700	286,804,100
	600 mm dia.	lm.	2,296	17,400	39,950,400
2.2	River/Creek Crossings	ls			1,856,898
2.3	Flowmeters and Gauging Points	ls			7,427,590
2.4	Valves and Fittings	ls			46,422,438
	Sub-Total Cost				**427,086,425**
3.0	Pumping Stations				
3.1	Booster Pump				
3.1.1	75 Hp Pumps @ Intake Structure	Unit	3	415,906	1,247,718
3.1.2	100 Hp Pumps @ WTP	Unit	3	509,891	1,529,673
3.2	Building				
3.2.1	Pump House	Sq.m.	128	9,000	1,152,000
	Sub-Total Cost				**3,929,391**
4.0	Storage Facilities				
4.1	Concrete Ground Reservoir at WTP	Cu.m.	3,427	10,000	34,270,000
	Sub-Total Cost				**34,270,000**
5.0	Water Treatment Plant				
5.1	Rapid Sand Filtration Plant	MLD	41.12	12,000,000	493,440,000
	Sub-Total Cost				**493,440,000**
6.0	Power Source Development				
6.1	Building	Sq.m.	72	9,000	648,000
6.2	Commecial Power & Standy Diesel Engine Generator	ls	1	6,624,000	6,624,000
	Sub-Total Cost				**7,272,000**
7.0	Land/ROW Acquisition				
7.1	Pumping Stations	ls	1	96,700	96,700
7.2	Water Treatment Plant	ls	1	169,141	169,141
7.3	Treated Water Reservoirs	ls	1	23,486	23,486
7.4	Right of Way (ROW)(Assume 2m width)	ls	1	110,956	110,956
	Sub-Total Cost				**400,283**
8.0	Stored Materials, Equipment and Vehicles (1.5% of Pipelines and Pumps)	ls	1	6,447,957	6,447,957
B	**TOTAL BASE COST (TBC)**				**979,996,056**
C	**Feasibility Study, and Detailed Engineering Design (3.0% of TBC)**				**29,399,882**
D	**Contingency (8.0% of TBC)**				**78,399,684**
E	**Construction Management Supervision (2.0% of TBC)**				**19,599,921**
F	**TOTAL PROJECT COST ESTIMATE**				**1,107,395,543**

TABLE 8-4B
BOHOL INTEGRATED WATER SUPPLY SYSTEM MASTERPLAN
IPIL RIVER 2025 OPTION
REPLACEMENT OF ALL PUMPS AT YEAR 2025
OCTOBER 2007 PRICES

BUDGETARY COST ESTIMATE					
Item No.	Description	Unit	Qty	Unit Cost	Amount
A	FACILITIES/ STRUCTURES				
3.0	Pumping Stations				
3.1.1	100 Hp Pumps @ Intake Structure	Unit	3	509,891	1,529,673
3.1.2	150 Hp Pumps @ WTP	Unit	3	848,193	2,544,579
B	TOTAL BASE COST (TBC)				4,074,252
C	Contingency (8.0% of TBC)				325,940
D	TOTAL PROJECT COST ESTIMATE				4,400,192

Table 8-4C
Bohol Integrated Water Supply Master Plan
Annual Operation and Maintenance Cost
Ipil River Option
(October 2007 Price Level)

Year	Salaries	Energy	Chemicals	Maintenance	Total
2,013	2,398,500	4,696,534	965,293	7,277,131	15,337,459
2,014	2,398,500	5,635,414	1,146,433	7,292,427	16,472,774
2,015	2,398,500	6,574,294	1,327,572	7,307,723	17,608,090
2,016	2,398,500	7,011,914	1,415,600	7,315,157	18,141,171
2,017	2,398,500	7,449,534	1,503,628	7,322,590	18,674,252
2,018	2,398,500	7,887,155	1,591,656	7,330,024	19,207,334
2,019	2,398,500	8,324,775	1,679,683	7,337,457	19,740,415
2,020	2,398,500	8,762,395	1,767,711	7,344,891	20,273,496
2,021	2,398,500	9,151,151	1,846,779	7,351,568	20,747,998
2,022	2,398,500	9,539,907	1,925,848	7,358,244	21,222,499
2,023	2,398,500	9,928,663	2,004,916	7,364,921	21,697,000
2,024	2,398,500	10,317,420	2,083,984	7,371,598	22,171,502
2,025	2,398,500	10,706,176	2,163,052	7,397,728	22,665,456
2,026	2,398,500	14,082,799	2,213,497	7,401,988	26,096,784
2,027	2,398,500	14,396,436	2,263,942	7,406,247	26,465,125
2,028	2,398,500	14,710,074	2,314,386	7,410,507	26,833,467
2,029	2,398,500	15,023,711	2,364,831	7,414,767	27,201,809
2,030	2,398,500	15,337,348	2,415,276	7,419,027	27,570,151
2,031	2,398,500	15,649,427	2,464,538	7,423,187	27,935,651
2,032	2,398,500	15,961,505	2,513,800	7,427,347	28,301,152
2,033	2,398,500	16,273,583	2,563,062	7,431,507	28,666,652
2,034	2,398,500	16,585,662	2,612,324	7,435,666	29,032,153
2,035	2,398,500	16,897,740	2,661,587	7,439,826	29,397,653

8.5 SUMMARY OF PROJECT COST ESTIMATES

The summary of project cost estimates of different options is presented in **Table 8-5**. Abatan-Loboc River Option has the lowest development cost among all options evaluated. However, further in-depth study has to be pursued in order to optimize the proposed bulk water supply system.

8.6 FINANCIAL ANALYSIS

8.6.1 Bulk Water Supply to Metro Tagbilaran and Panglao Island Tourism Estate

The results of the financial feasibility analysis (**Table 8-6**) indicate that the Abatan-Loboc River Option could be viable. For an FIRR of 12%, the derived bulk water price is PhP25.73 per CuM. For a scenario of 30% increased sales and 20% decreased project cost, the derived bulk water price is PhP16.42 per CuM. For an FIRR of 15%, the derived bulk water price is PhP31.31 per CuM.

The Consultant looked more closely at the Abatan-Loboc River Option and ran the feasibility analysis of the Phase1. This resulted in a bulk water price of PhP21.14 per CuM at 12% FIRR, well within the BWUI commercial bulk water price of PhP25 per CuM. If sales increase by 30% and project cost decreases by 20%, the derived bulk water price is PhP13.47 per CuM. If the investment proponent would borrow about 60% to 70% of project cost from a local or international financial institution or consortium, return on equity would increase and bulk water price would decrease.

The other alternative to supplying water to Metro Tagbilaran is the Loboc River Option. This alternative could supply the water requirements of Metro Tagbilaran for the demand projection period from 2013 to 2035. However, this alternative is costlier and less viable than the Abatan-Loboc River Option.

The Loboc River Option has an estimated project cost of PhP2.2 billion at 2007 prices, which is nearly PhP100 million more expensive than the Abatan-Loboc River Option.

At 12% FIRR, the derived bulk water price of the Loboc River Option is PhP35.07 per CuM. If sales increase by 30% and project cost decreases by 20%, the bulk water price would be PhP22.59 per CuM, which is below the commercial bulk water rate of PhP25 per CuM. At 15% FIRR, the derived bulk water price is PhP43.72 per CuM.

8.6.2 Bulk Water Supply to the Northeastern Industrial Zone

For the Wahig-Inabanga River Option, at FIRR of 12%, the derived bulk water price is PhP39.91 per CuM. For a scenario of 30% increased sales and 20% decreased project cost, the derived bulk water price is PhP25.18 per CuM. For an FIRR of 15%, the derived bulk water price is PhP51.02 per CuM.

At 12% FIRR, the derived bulk water price of the Ipil River Option is PhP31.22 per CuM. If sales increase by 30% and project cost decreases by 20%, the bulk water price would be PhP19.65 per CuM, which is below the commercial bulk water rate of PhP25 per CuM. At 15% FIRR, the derived bulk water price is PhP40.11 per CuM.

Table 8-5

SUMMARY OF PROJECT COST COMPONENTS

		Options In Million Pesos at 2007 Prices				
Item No.	**Description**	Abatan-Loboc River		Loboc River	Ipil River	**Wahig-Inabanga River**
		2010	**2018**	**2010**	**2010**	**2010**
A	**FACILITIES/ STRUCTURES**					
1	**Source Facility**	**7.79**	**3.98**	**3.98**	**7.15**	**10.73**
2	**Pipelines**	**473.45**	**462.99**	**1,001.43**	**427.09**	**396.44**
3	**Pumping Stations**	**6.28**	**11.61**	**24.10**	**3.93**	**3.32**
4	**Storage Facilities**	**32.80**	**24.25**	**63.55**	**34.27**	**16.31**
5	**Water Treatment Plant**	**492.00**	**270.60**	**762.60**	**493.44**	**195.70**
6	**Power Source Development**	**0.45**	**13.99**	**40.93**	**7.27**	**4.28**
7	**Land/ROW Acquisition**	**0.39**	**0.53**	**0.81**	**0.40**	**0.44**
8	**Stored Materials, Equipment and Vehicles**	**7.19**	**7.05**	**15.32**	**6.45**	**5.97**
B	**TOTAL BASE COST (TBC)**	**1,030.28**	**794.99**	**1,912.73**	**980.00**	**633.19**
C	Feasibility Study, and Detailed Engineering Design (3.0% of TBC)	30.91	23.85	57.38	29.40	19.00
D	Contingency (8.0% of TBC)	82.42	63.60	153.02	78.40	50.66
E	Construction Management Supervision (2.0% of TBC)	20.61	15.90	38.25	19.60	12.66
		1,164.22	**898.34**			
F	**PROJECT COST ESTIMATE**	**2,062.56**		**2,161.38**	**1,107.40**	**715.50**

Table 8-6 Highlights of Results of Financial Analysis

River Cluster Area	LGUs Served	Projected Population to be Served	Estimated Project Cost in Million Pesos at 2007 Prices	Pesos at 2007 Prices per Cubic Meter					
				FIRR=15%	FIRR=12%				FIRR=0%
					Base Case	+30% Sales	-20% Cost	+30% Sales & -20% Cost	
Wahig-Inabanga	Clarin, Inabanga, Buenavista & Getafe	97,351	715.51	51.02	39.91	30.70	32.73	25.18	9.55
Ipil	Talibon, Bien Unido, Trinidad & Ubay	179,790	1,107.40	40.11	31.22	24.02	25.55	19.65	7.23
Abatan-Loboc									
Phase 1 (2013 – 2017)	Cortes, Tagbilaran City, Dauis & Panglao	203,825	1,164.22	26.08	21.14	16.26	17.51	13.47	6.24
Phase 2 (2018 - 2035)	Loboc, Loay, Alburquerque, Baclayon, Tagbilaran City, Dauis & Panglao		898.34	5.23	4.59	3.54	3.84	2.95	2.40
Total Abatan-Loboc			2,062.56	31.31	25.73	19.80	21.35	16.42	8.64
Loboc	Loboc, Loay, Alburquerque, Baclayon, Tagbilaran City, Dauis & Panglao	203,825	2,161.38	43.72	35.07	26.98	29.37	22.59	11.17

8.7 CONCLUSION AND RECOMMENDATION

The results of the financial feasibility analysis of the river cluster areas indicate the following:

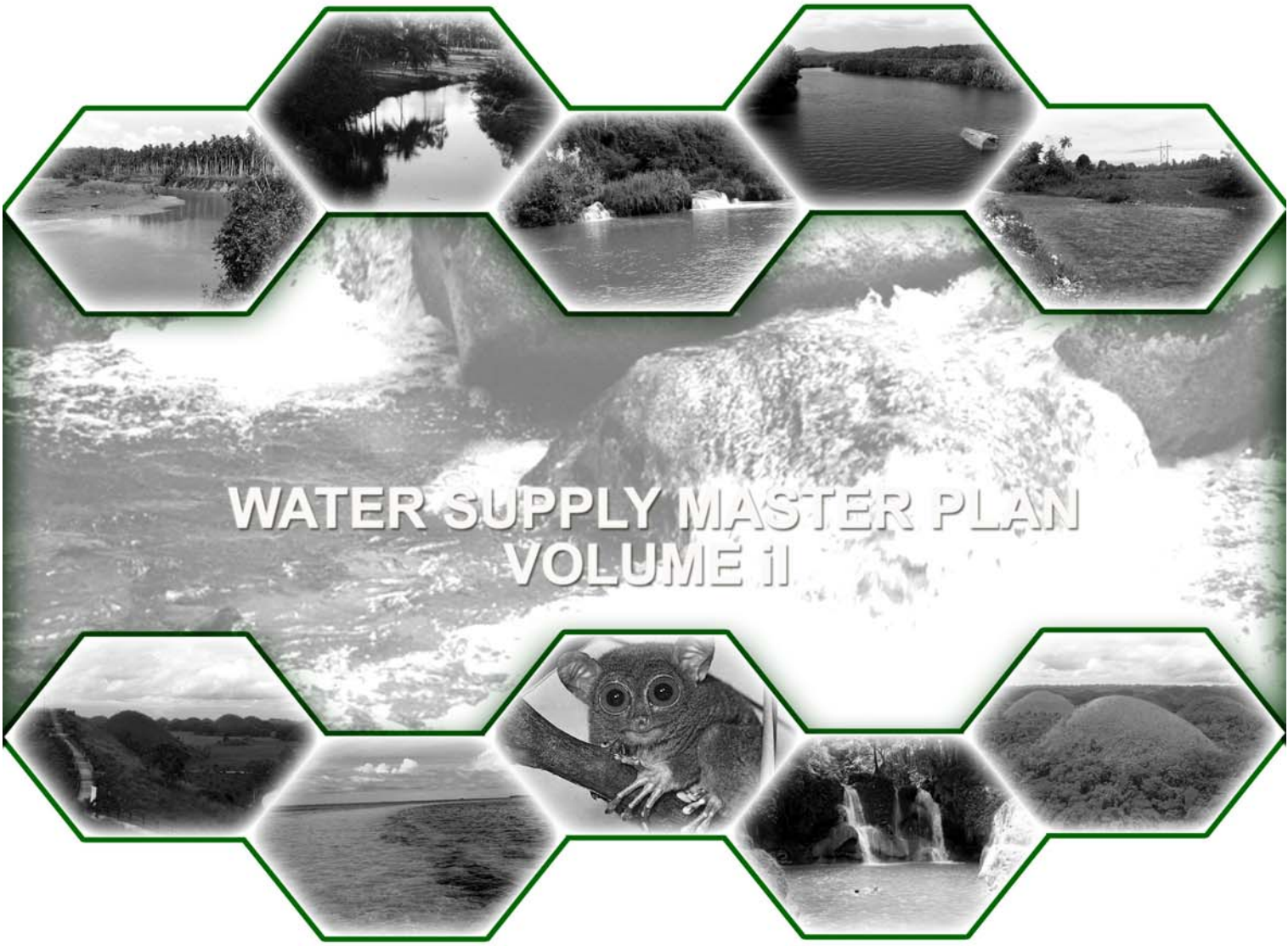
- Among the river options for the priority development areas, the Abatan-Loboc River Option that would supply water to Metro Tagbilaran, appears to be commercially viable, particularly the Phase 1 sub-project that would tap water from the Abatan River.

- The Phase 1 of Abatan-Loboc River Option could be bid out on a build-operate-transfer (BOT) basis or could be implemented by BWUI or Tagbilaran City Waterworks System to increase water supply and upgrade service to Metro Tagbilaran.

  With the implementation of Phase 1 of the Abatan-Loboc River Option, BWUI could update its 20-Year Water Supply Program, strengthen water zones along independent hydraulic boundaries so that these could be considered as small business units and revenue-cost centers, and maximize the distribution system and reduce non-revenue water (NRW).

An attempt by the Consultant (WCI) to come up with an innovative approach to consider different options aimed to reduce water pricing at a level conducive or attractive for private sector participation should be further studied.

In order to further reduce investment costs of different options or clusters presented in the Master Plan and to make it affordable to consumers/residents of Bohol municipalities, it is recommended that a feasibility study focusing on different viable water resources alternatives must be pursued. A need to evaluate groundwater availability with due consideration to safe yield, particularly in areas where population is small and/or sparse, far away from potential surface water sources, and affordability of tariff. The groundwater resources as an option may be considered for immediate potential sources. Gradual phasing out of groundwater will be done when water demand increases which will require the development and use of surface waters as the ultimate sources.



CHAPTER 9
ECONOMIC FEASIBILITY ANALYSIS

CHAPTER 9 – ECONOMIC FEASIBILITY ANALYSIS

9.1 ANALYTICAL FRAMEWORK

The economic feasibility analysis of projects prepared for the Bohol Integrated Water Supply System Master Plan utilized the discounted cashflow approach. These discounts, based on annuities, the annual streams of economic costs and benefits to arrive at the Economic Internal Rate of Return (EIRR) and Net Present Value (NPV) at the discounted rate of 12% per annum.

The EIRR was derived for economic costs and benefits registered over a 26-year period from 2010 to 2035 inclusive of a three-year pre-operating or construction period (2010 to 2012). The EIRR is the discounted rate at which the cash streams of costs and benefits would be zero at year zero. Or, looking at EIRR another way, it is the rate of return of quantified benefits to society, compounded periodically, derived from economic costs disbursed during the construction period.

NPV at 12% discount rate, on the other hand, is the value at year zero of costs and benefits discounted at the compounded rate of 12% per annum. The economic costs and benefits are all expressed at 2007 constant prices.

As with the Financial Feasibility Analysis, two groups of projects or river cluster areas were analyzed. The first group of river cluster areas would tap the major rivers of Bohol and supply bulk water to all the municipalities and city of the province. These river cluster areas are 1) Abatan, 2) Loboc1, 3) Loboc2, 4) Manaba, 5) Carood, 6) Ipil, 7) Wahig-Inabanga and 8) overall for all the Bohol river cluster areas.

The second group, based on the request of Bohol Governor Erico B. Aumentado, are the Abatan-Loboc River Cluster Area and the Loboc River Cluster Area (two alternatives for the Metro Tagbilaran and Panglao Island Tourism Estate), and the Wahig-Inabanga River Cluster Area (for Clarin, Inabanga, Buenavista and Getafe), and the Ipil River Cluster Area (for Talibon, Bien Unido, Ubay and Trinidad). The Wahig-Inabanga River Cluster Area and the Ipil River Cluster Area would supply potable bulk water to the Northeastern Industrial Zone,

The economic feasibility analysis was run for each river cluster area. For each river cluster area, tables on 1) Estimated Project Cost per Year, Local and Foreign, 2) Morbidity and Mortality Rates, 3) Estimated Economic Benefits, and 4) Economic Feasibility Analysis.

9.1.1 Adjustment for Shadow Prices

The economic costs of the integrated water supply projects were adjusted for shadow prices or distortions in market and production systems. The local costs were discounted to 65% of their financial costs to arrive at local economic costs, while the foreign costs were discounted to 70% of their financial costs to arrive at foreign economic costs.

9.1.2 Computation of Economic Benefits

The main economic benefits identified as a result of the implementation of the integrated water supply projects are Savings in Treatment Cost thru Potable Water (Supply), and Savings in Lives from Mortality (Caused by Waterborne Diseases). The waterborne diseases identified are Diarrhea and Acute Gastro Enteritis (AGE), Typhoid Fever and Intestinal Amoebiasis.

Savings in Treatment Cost thru Potable Water was computed based on the reduction of morbidity in Diarrhea/AGE, Typhoid Fever and Intestinal Amoebiasis. The average annual morbidity from 2002 to 2006 per municipality/city were used from data provided by the Bohol Provincial Health Office while population data were gathered from the National Statistics Office.

Based on interviews, about 65% of morbidity caused by waterborne diseases could be attributed to contaminated or polluted water. The others could be the result of food poisoning or other reasons. The 65% incidence factor in morbidity was used in estimating morbidity in the projected population (2013 to 2035) served by bulk water.

The outbreak of waterborne diseases caused by polluted or contaminated water is serious in some areas. For example, according to Loon Rural Health Unit 2, in early 2007, there was an outbreak in several barangays in the Municipality of Loon of amoebic dysentery caused by a bacterial strain called shigella flexneri. It was reported that about 600 people were confined, and the reported death vary from four to eleven. Although some deaths were initially caused by amoebic dysentery, the final causes of death were attributed to other causes like multiple organ failure, myocardial infarction or collapsed lungs. The source of the outbreak was traced to one or more contaminated springs wherein water treatment by the Municipal Engineering Office was found inadequate.

Table 9-1 Estimated Economic Cost of Treatment for Waterborne Diseases; Diarrhea and Acute Gastroenteritis

Cost of Treatment for Diarrhea/Acute Gastroenteritis				% of Cases	Weighted Average Cost - PhP
For Infant Patient - Out-Patient	**Unit Cost-PhP**	**Quantity**	**Cost-PhP**		
Stool examination	50.00	1	50.00		
IV fluid	85.00	1	85.00		
ORESOL/Hydrite	12.50	2	25.00		
Consultation	200.00	1	200.00		
Time of Mother	886.36	2	1,772.73		
Total Treatment for 3 Days			**2,132.73**	**40.0%**	**853.09**
For Pediatric Patient - Out-Patient	**Unit Cost-PhP**	**Quantity**	**Cost-PhP**		
Stool examination	50.00	1	50.00		
ORESOL/Hydrite	12.50	3	37.50		
Consultation	200.00	1	200.00		
Time of Mother	886.36	1	886.36		
Total Treatment for 3 Days			**1,173.86**	**20.0%**	**234.77**
For Adult Patient - Out-Patient	**Unit Cost-PhP**	**Quantity**	**Cost-PhP**		
Stool examination	50.00	1	50.00		
ORESOL/Hydrite	12.50	3	37.50		
Consultation	200.00	1	200.00		
Time of Adult	886.36	3	2,659.09		
Total Treatment for 3 Days			**2,946.59**	**20.0%**	**589.32**
For Infant/Pediatric Patient - Hospitalized	**Unit Cost-PhP**	**Quantity**	**Cost-PhP**		
Total hospital expenses for 3 days	lump sum		4,500.00		
Time of Mother	886.36	3	2,659.09		
Total Treatment for 3 Days			**7,159.09**	**20.0%**	**1,431.82**
Total Average Cost of Treatment per Composite Patient				**100.0%**	**3,109.00**

Table 9-1 presents the estimated economic cost of treating Diarrhea and AGE. Based on interviews with health officers of the Bohol Provincial Health Office and Tagbilaran City Health Office, about 80% of cases are usually out-patients broken down into 40% infants,

20% pediatric patients (one year old up to 14 years old) and adults. Twenty percent of cases, mostly infants, children and old people, are usually confined in hospitals or clinics for a period of three days.

The treatment of infants suffering from Diarrhea/AGE include stool examination to eliminate Intestinal Amoebiasis and other sickness, the administration of IV fluid due to the difficulty of getting infants to drink oral rehydration fluid (ORESOL or Hydrite), and subsequently the provision of ORESOL after the critical period. In lieu of ORESOL it would be the continuous administration of IV fluid. Additional costs include consultation and the value of the time of the mother in caring for the infant and bringing the infant to the doctor for consultation. The assumed average daily value of the mother's time is PhP 15,000 multiplied by 13 months and divided by 220 days, or PhP 886.36 per day (continuous care over the weekend is costed, just like an employee would be working overtime).

The treatment for children would be less costly since the mother could leave her child and go to work once the child's condition has stabilized. It would also be easier to get children to take rehydration fluid, although some take Gatorade that cost about PhP 18.50 per bottle.

For adults, the number of days that the adult would be absent from work was estimated at three days, and the average value per workday was assumed to be the same as the value of a workday of a mother.

For confined patients, the commercial rate for confinement, for the usual duration of three days is PhP 4,500 based on interviews with private hospitals and a government hospital.

The cost of treatment per type of patient or case was weighted based on the typical distribution of cases. This brings the average treatment cost to PhP 3,109 per case.

Table 9-2 shows calculations on the estimated cost of treatment for Typhoid Fever and Intestinal Amoebiasis. Interviews indicate that the typical treatment for Typhoid Fever is hospitalization for about five days. This would cost about PhP 7,500 at commercial rate. The commercial rate was used instead of the government hospital rate because government hospital charges are generally subsidized and do not reflect the economic cost.

The total cost of treatment for Typhoid Fever including the time of the mother, is PhP 11,932 per case.

It was assumed that Intestinal Amoebiasis cases follow a similar distribution of patients as Diarrhea/AGE, wherein 40% of cases are infant out-patients, 20% are pediatric out-patients, 20% are adult out-patients, and 20% are confined to hospitals and clinics for a period of five days.

IV fluid is also administered to infants and Metronidazole suspension or tablets, or Flagil tablets are prescribed as cure for the sickness. Hospitalization would usually take five days.

The weighted average treatment cost including consultation, time of mother or attendant ("bantay") (computed only at eight hours a day although a relative is usually with the patient round-the-clock for hospitalized patients), is PhP 4,512 per case.

The estimated savings in life as a result of the implementation of water supply projects is presented in **Table 9-3**. About 50% of deaths are infants, 20% children, 10% adults and 20% old people.

The assumption is that if these deaths would have been avoided with the implementation of the water supply projects, these people would have lived up to the average life expectancy of Filipinos, which is over 60 years old. Age 60 is currently the retirement age although this is being extended to about 65 years old.

Table 9-2 Estimated Economic Cost of Treatment for Waterborne Diseases; Typhoid Fever and Intestinal Amoebiasis

Cost of Treatment for Typhoid Fever				% of Cases	Weighted Average Cost - PhP
Hospitalization for 5 days	1,500.00	5	7,500.00		
Time of Mother or Adult	886.36	5	4,431.82		
Total Average Cost of Treatment			**11,931.82**	**100.0%**	**11,931.82**
Cost of Treatment for Intestinal Amoebiasis				**% of Cases**	**Weighted Average Cost - PhP**
For Infant Patient - Out-Patient	**Unit Cost-PhP**	**Quantity**	**Cost-PhP**		
Stool examination	50.00	1	50.00		
IV fluid	85.00	1	85.00		
Metronidazole (suspension)	50.00	2	100.00		
Consultation	200.00	2	400.00		
Time of Mother	886.36	2	1,772.73		
Total Treatment for 3 Days			**2,407.73**	**40.0%**	**963.09**
For Pediatric Patient - Out-Patient	**Unit Cost-PhP**	**Quantity**	**Cost-PhP**		
Stool examination	50.00	1	50.00		
Metronidazole (suspension)	50.00	3	150.00		
Consultation	200.00	2	400.00		
Time of Mother	886.36	2	1,772.73		
Total Treatment for 3 Days			**2,372.73**	**20.0%**	**474.55**
For Adult Patient - Out-Patient	**Unit Cost-PhP**	**Quantity**	**Cost-PhP**		
Stool examination	50.00	1	50.00		
Metronidazole (Flagil tablet)	21.90	15	328.50		
Consultation	200.00	2	400.00		
Time of Adult	886.36	3	2,659.09		
Total Treatment for 3 Days			**3,437.59**	**20.0%**	**687.52**
For Infant/Pediatric Patient - Hospitalized	**Unit Cost-PhP**	**Quantity**	**Cost-PhP**		
Total hospital expenses for 5 days	lump sum		7,500.00		
Time of Mother	886.36	5	4,431.82		
Total Treatment for 5 Days			**11,931.82**	**20.0%**	**2,386.36**
Total Average Cost of Treatment per Composite Patient				**100.0%**	**4,511.52**

For infants and children, the estimated working or productive life would be 40 years per person, from about age 21 to about age 60 years old. For the adults, the estimated working life would be 35 years old, from about age 26 to about age 60 years old.

The average earnings per year of the people that would have been saved from death caused by waterborne diseases is PhP 85,000 per month multiplied by 13 months or PhP 1.105 million per year. This assumes that these people would be significantly more productive than the working people now, some probably working in multinational companies and in foreign countries. At PhP 40 to US$1, PhP 85,000 per month would amount to only US$ 2,125 per month, which is starting to be the low range of earnings of OFWs. The mix of professions of OFWs is now favoring more professionals such as nurses, care givers, doctors, engineers and IT experts and programmers. The indicative minimum salary of professional OFWs in the United States, Europe and Japan is about US$ 3,000 per month.

It was assumed that mortality caused by waterborne diseases caused by polluted or contaminated water is 100%. This is because these mortality reports are probably

understated because some deaths that started as waterborne diseases eventually end up as heart attacks, liver or kidney failures or asphyxiations.

Table 9-3 Estimated Economic Cost of Life Saved Through Potable Water Supply and Avoidance of Waterborne Diseases

Age of Deceased	%	Ave. # of Working Years	Weighted Ave. Economic Value (PhP)
Ave. Economic Value PhP/Year			**1,105,000**
Infant (less than one year old)	50%	40	22,100,000
Pediatric (from 1 to 14 years old)	20%	40	8,840,000
Adult (over 14 years old)	10%	35	3,867,500
Over 60 years old	20%	0	0
Total/Weighted Average Savings per Composite Person	**100%**	**n. a.**	**34,807,500**

9.2 HIGHLIGHTS OF RESULTS OF ECONOMIC FEASIBILITY ANALYSES

The highlights of the results of the economic feasibility analyses of the river cluster areas are presented in **Table 9-4**. The overall EIRR for all the river cluster areas is 7.4%. Although relatively high, it is below the 12% hurdle rate set by the National Economic and Development Authority (NEDA) for infrastructure projects. This indicates that the proposed integrated water supply projects, as a whole, appear too economically costly compared with the estimated economic benefits. This somewhat confirms the findings on the financial feasibility analysis wherein the overall average bulk water price for all the river cluster areas, to achieve an FIRR of 12%, is PhP 46.70 per cubic meter, which is too high when compared with the commercial bulk water price of the Bohol Water Utilities, Inc. of PhP 25 per cubic meter.

The overall Economic NPV at 12% per annum for all the river cluster areas is negative PhP 2.16 billion.

The highest EIRR of 24.7% is attributed to the Ipil River Cluster Area with an NPV at 12% per annum of PhP 0.99 billion. This appears economically attractive because of the rates of morbidity and mortality caused by waterborne diseases in the selected municipalities covered by the river cluster area.

The Ipil Option River Cluster Area, which serves Talibon, Bien Unido, Trinidad and Ubay, provides a much higher EIRR of 35.3% and NPV at 12% per annum of PhP 1.88 billion. This indicates the high social desirability of providing potable water to these municipalities to reduce waterborne disease morbidity and mortality rates.

The other economically feasible integrated water supply project is the Wahig-Inabanga Option River Cluster Area that would serve the municipalities of Clarin, Inabanga, Buenavista and Getafe. EIRR is 12.4% and NPV at 12% per annum is PhP 15 million.

Three integrated water supply projects are not economically feasible, namely, Loboc1, Abatan-Loboc1 and Loboc1 Option River Cluster Areas. Their negative Economic NPVs at12% per annum are too high that they approximate the economic project costs.

In these three cases, the economic project costs are too high and could not be justified by savings in reduced incidence of waterborne diseases and reduced mortality. It could also mean that the waterborne morbidity and mortality data for the municipalities and city covered

are understated. However, this is more a job for statisticians and outside the scope of this master plan study.

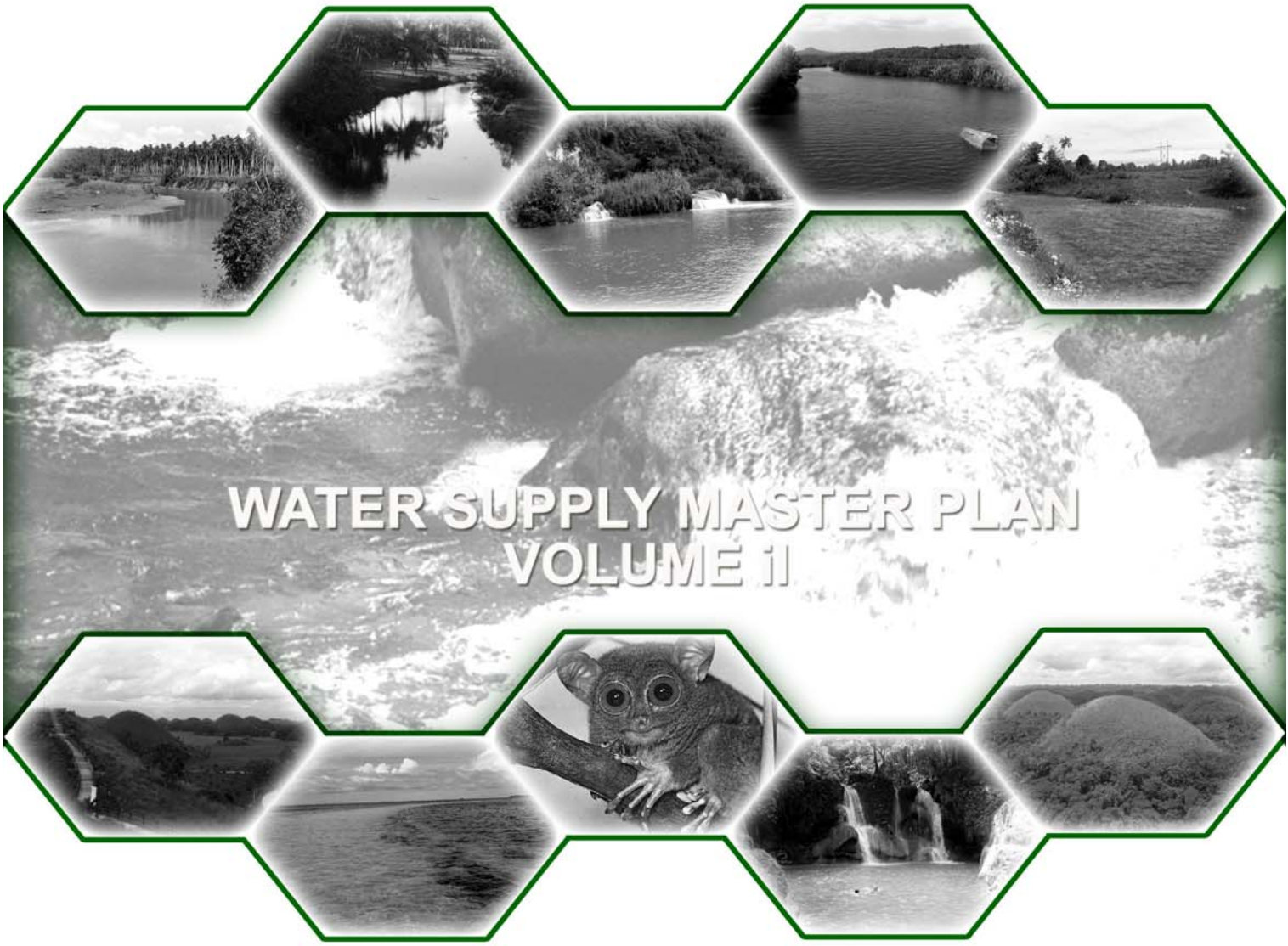
Table 9-4 Highlights of Results of Economic Feasibility Analyses

River Cluster Area	LGUs Served	Estimated Economic Project Cost (in million pesos at 2007 prices)	Economic Internal Rate of Return (EIRR)	Net Present Value @12% Rate per Annum
Integrated Water Supply System				
Abatan	Antequera, Balilihan, Catigbian, Corella, Sagbayan, San Isidro and Sikatuna	525.02	1.4%	(313.34)
Loboc1	Alburquerque, Baclayon, Cortes, Dauis, Dimiao, Lila, Loay, Loboc, Panglao, Tagbilaran City and Valencia	1,851.16	not economically feasible	(1,692.30)
Loboc2	Batuan, Bilar, Carmen, Dagohoy, Pilar, Sevilla and Sierra Bullones.	841.74	8.0%	(219.42)
Manaba	Anda, Candijay, Duero, Garcia Hernandez/ Manaba, Guindulman and Jagna.	725.76	0.1%	(466.47)
Carood	Alicia, Danao, Mabini, San Miguel, Pres. Carlos P. Garcia and Ubay	954.04	9.6%	(156.31)
Ipil	Bien Unido, Buenavista, Getafe, Talibon and Trinidad	842.20	24.7%	988.97
Wahig-Inabanga	Calape, Clarin, Inabanga, Loon, Maribojoc and Tubigon	1,401.55	7.8%	(396.08)
Total All Clusters	**All Bohol municipalities and city**	**7,141.50**	**7.4%**	(2,162.05)
River Cluster Areas for Priority Development Areas				
Wahig-Inabanga Option	Clarin, Inabanga, Buenavista & Getafe	485.82	12.4%	15.26
Ipil Option	Talibon, Bien Unido, Trinidad & Ubay	751.55	35.3%	1,876.91
Abatan-Loboc1				
Phase 1 (2010 - 2012)	Cortes, Tagbilaran City, Dauis & Panglao	790.36	not economically feasible	(924.25)
Phase 2 (2015 - 2017)	Loboc, Loay, Alburquerque, Baclayon, Tagbilaran City, Cortes, Dauis & Panglao			
Loboc1 Option	Loboc, Loay, Alburquerque, Baclayon, Tagbilaran City, Cortes, Dauis & Panglao	1,468.35	not economically feasible	(1,327.66)

9.3 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the economic feasibility analysis of the river cluster areas, sanitary and health officials should look into the high level of incidence and mortality caused by waterborne diseases in the municipalities of Talibon, Buenavista, Getafe, Bien Unido, Trinidad and Ubay. These should include not only consideration for potable water supply but also better hygiene and sanitation.

As with the results of the financial feasibility analysis, more feasible water supply alternatives should be considered. Technical considerations would indicate the use of groundwater sources mixed with surface water sources.



CHAPTER 10
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

CHAPTER 10 – ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

10.0 INTRODUCTION

This Chapter highlights the findings of the preliminary assessment of the project vis-à-vis the environmental, socio-economic and socio-cultural attributes of the project's impact areas. Social and environmental impacts that are considered as potentially significant for the project are individually explained and measures to address these Issues are recommended. The significant issues that have the potential to negatively affect the local people and the environment should be given due consideration in coming up with technical and management decisions regarding the project.

The preliminary assessment was based on analysis of secondary data supplemented by findings of key informant interviews and ocular surveys. The findings may be used as reference in the preparation of future environmental study but the report is not meant to replace the more detailed environmental study of the level that may be required by the EMB Regional Office for environmental clearance purposes. At this level of project development, the environmental and social assessment is focused on screening and initial assessment, hence the recommendation for follow-on studies.

10.1 ENVIRONMENTAL ASSESSMENT

10.1.1 Scope and Objectives

At this stage of project planning (pre-feasibility or master planning stage), the environmental study focused on two fundamental steps in environmental impact assessment: project screening and initial assessment.

The project screening was undertaken to determine the project's category in line with the Philippine EIS system and procedures. The objective is to ensure that recommended follow-on environmental studies would conform to the procedures and requirements for the specific project category.

The initial assessment aims to gauge the project's environmental and social acceptability. The objective is to determine at the early stage of project development the potential negative environmental and social impacts of the various project components during the different stages of project implementation, i.e., pre-construction, construction, operation and maintenance and abandonment phases. Checklist of mitigating measures for identified significant negative impacts or recommendations for further studies or follow-on activities were also formulated. The objective is prevention or minimization of likely negative effects to people, and on the physical and biological attributes of the project area in the event that the proponent decides to push through with project implementation.

10.1.2 Legal Basis

The environmental study was undertaken in accordance with Presidential Decree 1586, otherwise known as The Philippine Environmental Impact Statement (EIS) System. PD 1586 requires the preparation of Environmental Impact Assessment (EIA) report for environmentally critical projects or Initial Environmental Examination (IEE) checklist or report for projects which are located in environmentally critically areas. Submission of environmental study report appropriate for a project is a requirement for issuance of Environmental Compliance Certificate (ECC). Project implementers or proponents are

mandated by law to secure ECC before implementation of projects that fall within the purview of the Philippine EIS system otherwise implementation can not proceed.

The EMB-DENR developed and issued the DAO 96-37 and Procedural Manual to aid proponents in the conduct of the environmental studies. DAO 96-37 was updated with the issuance of DAO 2003-30 and its Procedural Manual. The two manuals were the primary guide in the preparation of this environmental study.

Relevant national laws, rules, regulations and local ordinances were also taken into account in the study. These include: the Clean Water Act (RA 9275) and its IRR (DAO 2005-10); the Clean Air Act (RA 8749) and its IRR; the Solid Waste Management Act (RA9003) and its IRR; the NIPAS Law (RA 7586) and related proclamations; DENR DAO 34/35 and the PNSDW of 2007 (DOH AO No. 2007-0012).

10.1.3 Study Methodology

10.1.3.1 Data Sources

Existing reports, maps and studies provided secondary data and information on the existing conditions in the project area. The data and information obtained from secondary sources were validated through key informant interviews, visual surveys and walks-through. The later activities provided the means to fully understand the socio-political and cultural dynamics in the project area.

The Provincial Framework Plan of Bohol, the municipal CLUPs, and the existing study reports that were listed in the references were the sources of data on the physical, social, demographic and economic conditions. Relevant laws, rules, regulations and local ordinances were the bases for assessing the environmental and social acceptability of the project activities and proposed interventions.

Ocular surveys and interviews with some local government officials and few community residents enabled visualization of the proposed facilities against the environmental, social and cultural setting. The surveys and interviews were conducted intermittently from July to August 2007. Interaction with the different stakeholders including the officials of the provincial and municipal governments, PENRO, CENRO, other government agencies, water-service providers, barangay leaders, NGOs and community members enhanced understanding of the socio-political contexts of natural and water resource management by the local government. Positive experiences as well as problems and issues were surfaced during the dialogues with the different stakeholders, and these were utilized in the preliminary assessment.

10.1.3.2 Environmental Screening Procedure

Project screening was undertaken following the two-level approach in the Procedural Manual of DAO 2003-30. Level 1 is screening to determine if the project is covered or not covered by the Philippine EIS system. Level 2 is identification of the project's category.

The characteristics of the project in terms of size, cumulative nature of potential impacts, natural resource utilization, and the project's potential to generate waste and environment-related nuisance and to cause hazards and risks of accident are the criteria used to judge if the project is covered or not covered by the EIS system. On the other hand, judgment on the project's environmental category was arrived at by comparing the type and characteristics of the project against the category of pre-identified projects and limits in *Table 2-1 of the Procedural of Manual of 2003-30*.

10.1.3.3 Initial Environmental Assessment

The development plan and the recommended project components were screened and assessed to identify potential environmental and social impacts that may result in the event the project is implemented. The option not to implement the project (without the project alternative) was also assessed to help weigh the benefits that will be gained if the project will be implemented against possible negative impacts that could result from project implementation.

An environmental checklist was developed to facilitate the preliminary assessment. The findings of assessment were the primarily bases of the recommended environmental management measures and suggested coverage of monitoring and follow-on studies.

10.1.4 Results of Assessment

10.1.4.1 Project Screening

Table 10-1 summarizes the components and features of the bulk water supply project and **Table 10-.2** shows the project impact areas and the population that are expected to be served by the project.

The project is clearly within the purview of the Philippine EIS system considering the type and size of the facilities to be constructed and the areas that will be affected by its implementation. This implies that the proponent or project implementer should apply for and secure ECC as mandated by law before project implementation.

Table 10-1 Project Components and Features

Water System/ Watershed	Project Component/Features					
	Capacity (lps)	Intake	Storage	Total Pump Requirement at year 2035 (Hp)	Water Treatment (MLD)	Transmission Pipeline
1. Abatan/ Abatan	164	Diversion Weir	1,184	647	14.18	59.5km of 200-500 mm Ø
2. Loboc -1/ Loboc	961	Diversion Weir	6,917	6.050	83	130km of 300-1,200 mm Ø
3. Loboc- 2/Loboc	297	Diversion Weir	3,923	2,160	25.63	65km of 250-500 mm Ø
4. Manaba/ Duero	284	Diversion Weir	2,054	760	24.60	53.5km of 250-500 mm Ø
5. Carood/Wahig-Inabanga	366	Diversion Weir	2,633	910	31.59	75km of 200 to 700 mm Ø
6. Ipil/Wahig-Inabanga	437	Diversion Weir	3,149	705	37.79	48km of 300 to 600 mm Ø
7. Inabanga/ Wahig-Inabanga	668	Diversion Weir	4,809	90	57.70	7.16km of 300 mm Ø

Table 10-2 Project Impact Areas and Project Beneficiaries

Water System	Impact Areas	Projected Population to be Servec		
		Y2015	Y2025	Y2035
1. Abatan	Antequera, Balilihan, Catigbian, Corella, Sagbayan, San Isidro and Sikatuna	37,316	58,996	70,205
2. Loboc -1	Loboc, Loay, Lila, Dimiao, Valencia, Alburquerque, Baclayon, Tagbilaran City, Dauis, Panglao, Cortes	135,319	201,264	237,400
3. Loboc- 2	Sevilla, BIlar, Batuan, Carmen, Dagohoy, Sierra Bullones, PIlar	75,149	105,297	123,958

Water System	Impact Areas	Projected Population to be Served		
		Y2015	Y2025	Y2035
4. Manaba	Anda, Candijay, Duero, Garcia Hernandez/ Manaba, Guindulman and Jagna	82,028	107,649	114,401
5. Carood	Alicia, Danao, Mabini, San Miguel, Pres. Carlos P. Garcia and Ubay	92,995	126,239	147,541
6. Ipil	Bien Unido, Buenavista, Getafe, Talibon and Trinidad	107,834	150,166	177,651
7.Wahig-Inabanga	Inabanga, Maribojoc, Loon, Calape, Clarin, Tubigon	104,666	171,490	207,454

10.1.4.2 Category of the Proposed Project

There are four (4) major categories of projects under the Philippine EIS system, namely:

- Category A or Environmentally Critical Projects (ECPs). These include heavy industries; resource extractive industries; major infrastructure projects like dams, power plants, reclamation projects, roads and bridges; and golf course projects.
- Category B projects are those that are not ECPs but are located in environmentally critical areas (ECAs). ECAs include the following:
  - Areas declared by law as national parks, watershed reserves, wildlife preserves, and sanctuaries
  - Areas set aside as aesthetic, potential tourist spots
  - Areas which constitute the habitat for any endangered or threatened species of indigenous Philippine wildlife (flora and fauna)
  - Areas of unique historic, archeological, geological, or scientific interests
  - Areas which are traditionally occupied by cultural communities or tribes
  - Areas frequently visited and or hard-hit by natural calamities (geologic hazards, floods, typhoons, volcanic activity, etc.)
  - Areas with critical slope (50% or more)
  - Areas classified as prime agricultural lands
  - Recharge areas of aquifers
  - Waterbodies tapped for domestic purposes, within the controlled or protected areas declared by the appropriate authorities or which support wildlife and fishery activities
  - Mangrove areas
  - Coral reefs
- Category C projects are intended to directly enhance environmental quality or provide direct mitigation measures to address existing environmental problems. Examples include seawalls, reforestation projects, artificial reefs, embankment, and riverbank stabilization.
- Category D projects are unlikely to cause adverse environmental impacts and include projects that are not classified as ECPs nor located in ECAs.

ECC is not required for category C and D projects.

Based on the characteristics of the project area, the project falls under **Category B**, new project located in an Environmentally Critical Area (ECA). Projects classified as Category B are required to have an Environmental Compliance Certificate (ECC) from the DENR-EMB Regional Office concerned, in this case EMB Region VII, prior to implementation.

Bohol hosts endemic and protected species of flora and fauna, aesthetic tourist spots, mangrove forests, a man-made forest and several protected watershed areas, thereby qualifying it as an ECA per Section 1.0 (b), Article II of DAO 96-37.

Among the proposed sources of domestic water supply system to be developed are rivers within the three major watersheds that have been declared as protected areas under the NIPAS Law. These are: (a) Loboc River within the Loboc Watershed which was declared a NIPAS area under PP 450, (b) Manaba River within the Duero Watershed which was declared a NIPAS under PP 881), and (c) Ipil and Inabanga Rivers within the Wahig-Inabanga Watershed which was declared a NIPAS under PP No. 468 as amended by PP No. 223. This includes the areas inside the Rajah Sikatuna National Park (PP 127).

Category B projects are categorized further as B-1, B-2 and B-3 depending on whether or not the project is new and on the type of operation. The documentary requirements for ECC application for each project category are shown in **Table 10-3**.

Table 10-3 Documentary Requirements for Category B Projects

CATEGORY		APPLIED TO	DOCUMENTS REQUIRED FOR ECC/CNC APPLICATION
B: Non-Environmentally Critical But located in an ECA	**B-1**:New	Single Project	IEE or IEE Checklist (if available)
	B-2: Existing and to be expanded (including undertakings that have stopped operations for more than 5 years and plan to re-start, with or without expansion)	Single Project	EPRMP (based on a checklist if available)
	B-3: Operating without ECC	Co-located Project	PEPRMP

Source: Table 3-1 of the Procedural Manual of DAO 2003-30

From **Table 10-3**, it appears that the project would fall under Category B-1, being a new project for which an IEE or IEE checklist would be sufficient for ECC application. However, based on Table 2-1 of DAO 2003-30 which is shown in **Appendix II.7-A, Volume III-Databook**, under *Item C (6)-Water Supply Systems*, submission of an EIS is required for projects that involve the construction of more than six (6) production wells and other systems. Furthermore, Level III distribution systems are considered as Category B projects, for which IEE checklist or IEE report would be required depending on the assessment of the EMB Regional Office.

As the bulk water supply project involves the construction of seven (7) complete water supply systems, it is probable that the EMB Regional Office would require the submission of an EIS. If such is the case, there would be a need to carry out a comprehensive environmental impact assessment.

To confirm the level of environmental study that would be required by the EMB Regional Office, a scoping meeting with the EMB may be initiated by the proponent during the feasibility study stage.

10.1.4.3 Initial Environmental Assessment

The initial environmental assessment checklist developed for the project is shown in **Appendix II.7-B, Volume III-Databook**. The identified positive and potentially significant impacts are explained below:

10.1.4.4 Significant Social and Environmental Impacts

(1) Positive Impacts or Benefits

Provision of the domestic water supply, which is a basic need, is the most important direct benefit of the project. Indirectly, the project will uplift the living conditions of almost the entire province of Bohol, particularly the urban areas where 95% of the population will have access to safe water by 2035. In the rural areas, as much as 53% of the population will be served by piped water connection by the year 2035.

Indirectly, the project will boost eco-tourism and other livelihood activities that are dependent on water. Provision of sufficient, safe and reliable drinking water supply for every citizen is a major thrust of the Philippine government. The improvement of the water supply system of Bohol is in line with this thrust and is consistent with the development plans of the provincial and municipal governments. Unquestionably, the project is necessary and there is pressing need to implement it.

(2) Potential Negative Impacts and Proposed Mitigating Measures

(i) <u>During the pre-construction stage</u>

a. Right-of-Way Issues

The only activity during the pre-construction stage that could possibly bring about negative impacts relates to land acquisition for pipe laying works and for the construction of pumping stations and water treatment facilities.

This potential problem can cause delays in project implementation if coordination with the affected private individuals or entities is not undertaken prior to start of construction. Delay in land acquisition could hinder implementation and result in cost overruns. If the necessary funds will be made available prior to actual construction, right-of-way issues may not pose a problem for this project.

b. Public Perception and Social Acceptability

Social acceptability does not seem to be a major issue with respect to the proposed project. Construction of new water supply sources is welcomed by most of the LGUs and residents interviewed during the initial survey. Many residents signified support to the project others even verbally expressed hope that the project will be implemented soon.

The results of the social survey notwithstanding, social acceptability of the project should be secured before any construction activity is started. While there are no known opposing groups or individuals at this time, this may change when the project starts implementation.

Public opposition usually stems either from lack of information or from proliferation of misinformation about a project. Ensuring that only correct information about the project reaches the public, or preventing the spread of misinformation may be the only intervention needed to address public opposition. When public opposition starts to surface, the community leaders at the barangay level can be tapped for assistance in giving out correct

information. However, where there are other reasons for the complaint, amicable settlement with the complainant should be prioritized over other means.

(ii) <u>During the Construction Stage</u>

Potential negative impacts of activities related to project construction include: (a) water pollution attributable to clearing and grubbing, pipe laying, excavation and finishing works; (b) possible effect of activities on existing uses of the rivers, (c) soil erosion and stability of slopes; (d) effects of works on aesthetics, (e) disruption of wildlife particularly in the sanctuary areas, and (f) occurrence of accidents. However, all these impacts are avoidable or preventable, and are not expected to have lasting effects if properly managed.

a. Pollution attributable to clearing and grubbing

Pollutants that may be brought about by construction works include noise, dust, particulate matter, vibration, solid waste and debris from demolition activities and excavation works. These potential impacts could be mitigated with proper construction planning and construction method. Preventive measures should be incorporated in the construction plan.

b. Possible effect of activities on existing uses of the rivers

Construction activities have the potential to affect water quality downstream of the construction sites due to soil erosion from construction activities. This may disturb or cause disruption of existing uses of the river, such as the public bathing areas. Proper construction planning, proper construction techniques and attentive supervision of construction could prevent this from happening.

The present water supply sources, including the sources of water supply by people who are not connected to the piped water supply system may be contaminated during construction activities. This could arise if construction method is not properly planned, the construction method is not appropriate and/or construction works are not properly done. This aspect should be given due consideration because contamination of existing domestic water sources has social implications. It could give rise to complaints that may lead to work stoppages if not properly addressed.

c. Soil Erosion and Effect on Stability of Slope

Soil erosion and stability of slope are among the negative impacts of many construction activities involving excavation or soil movement. Considering that the facilities will be construction mostly near the riverbanks, it is imperative that slope stabilization and soil erosion control be given utmost consideration in choosing construction methods. Proper construction planning, proper construction techniques and attentive supervision of construction could prevent soil erosion. Considering that some areas in Bohol have karst topography, excavation works for pipelines should also be studied thoroughly and planned to avoid soil erosion and disturbance of slopes.

d. Effects on aesthetics

The construction activities will definitely affect aesthetics if not properly planned or managed. While this is not a major environmental concern, improper management of construction activities could stimulate public discontent and negative public perception, more so in popular tourist destinations like Loboc River. This impact could be prevented by proper planning and construction methods as well as design of the facilities. It would

help if the facilities could be designed in such a way that they will blend or harmonize with the surrounding landscape.

It is also advisable to have a plan for proper management of work site, garbage and debris, construction materials, and equipment to prevent this potential impact from occurring.

e. Disruption of Wildlife Particularly in the Sanctuary

In consideration of the fact that Bohol hosts some ecologically valuable species of fauna, including the sensitive tarsier, it is not discounted that construction activities that produce noise or vibration at or near sanctuaries or natural habitats of wildlife could disturb them. Construction at or near such sensitive areas should be avoided. This particular concern should be given due consideration during the feasibility study and design stage.

f. Accidents

Accidents are the worse impact that could happen during construction. Accidents could happen to workers as well as to public. Usual causes are ditches and manholes that are left uncovered at night or during rainy days. Accidents can be prevented by proper construction plan, work method, work supervision and through the provision of safety gadgets and warning signs where needed.

(iii) <u>During the Operation Stage</u>

Impacts that may arise during the operation stage include: (a) conflict regarding water usage, (b) shortage of water supply especially during the dry season, (c) unsatisfactory water quality, (d) contamination of water sources, (e) breakdown of pipelines, impounding reservoir or intake boxes.

a. Conflict regarding water usage

During dry season water shortage give rise to conflict in water usage. When this happens, the people who are connected to the water supply may express dissatisfaction with the services while those who are not connected may complain about their inability to access water. More often than not, when there is water shortage, the domestic uses are prioritized over agricultural uses. Agricultural activities are always the most affected. As many people depend on agriculture for livelihood, lack of water for irrigation and livestock farming would translate to curtailment of opportunity of many people to earn a living. This problem has many overarching implications on existence, well-being, health, peace and harmony among the various communities and sectors competing for water use.

This a major issue that cannot be easily addressed or mitigated by appropriate engineering design or work methodology. This may not even be caused directly by the project operation. Nevertheless, when this happens, the project will likely be blamed.

Recommendations regarding this problem are related to the problem of water shortage as discussed below.

b. Shortage of Water Supply

At this time, the reasons behind the problem of water shortage are apparent. The yield of some of the existing spring sources has apparently gone down over the years.

Potential conflicts in water use may arise in future if the problem of water shortage persists or worsens, considering future demand. It could also impact on sustainability of the project. This highlights the need to have a comprehensive water resource use study that would identify the reasons behind the problem of water shortage and to come up with practical and doable solutions to prevent the problem from worsening.

It is not necessary for the project proponent to address this issue at this time, but the earlier it is studied and seriously taken into the development planning agenda, the more beneficial it would be to many people.

c. Unsatisfactory Water Quality

Unquestionably, public health is a primary consideration in the development of any domestic water source. It is imperative that the water supply is free from any form of bacterial and chemical contamination at all times. While improvement in the quantity and quality of water will be achieved already by the project as indicated by the inclusion of a water treatment facility, this does not automatically guarantee safety or potability of the water as there is always the possibility of contamination of pipelines.

While water quality analysis of the sources have been undertaken as part of this study, it is suggested that a comprehensive water quality analysis of the water sources be undertaken prior to project implementation, preferably during the detailed design stage. The analysis should cover bacteriological, biological, physical and chemical constituents, particularly those that have health significance. Based on the results of water quality analysis, appropriate treatment may be planned.

Periodic testing of the water quality during the operation stage is advisable to monitor compliance with the Philippine National Standards for Drinking Water. Appropriate measures should be instituted whenever any water quality parameter is not met.

d. Contamination of Water Sources

Contamination of the water sources may occur during rainy season when surface runoff containing silt, debris and possibly pathogens accidentally gets into the water supply source or through leaks in the pipelines. Prevention of such phenomenon should be the object of monitoring and maintenance of the facilities. When a source gets contaminated, corrective measures should be implemented immediately and the public should also be warned immediately.

e. Breakdown of Water Pipes, Intake Boxes or Reservoir

Unnecessary breakdown of water pipes, intake boxes or reservoir may occur in future either because of normal wear and tear, water pressure, outside forces or natural catastrophe such as earthquake. Breakdown of any part of the system could result in poor water supply and poor water quality.

Periodic monitoring and provision of funds for regular monitoring and maintenance works would ensure that measures can be instituted immediately when such phenomenon occurs.

f. Sludge from Waste Treatment Facilities

Design of the project facilities should consider the appropriate management and/or disposal of the sludge from the water treatment facilities. Appropriate sludge treatment shall be based on the type of contaminants and volume of the effluent.

10.1.5 Summary of Recommendations for Future Studies

As indicated in DAO 2003-30, IEE Report for water supply source and for the pipe laying works should be prepared and submitted as the basic requirement for application for environmental clearance, however, considering the size and characteristics of the impact areas, there is a possibility that the EMB Region VII would require a more detailed environmental assessment of an EIA level. To confirm the level of study and baseline surveys that should be undertaken, scoping meetings should be held with the EMB Region VII as early as the feasibility study stage.

Among others, the following aspects are recommended for inclusion in the environmental study:

- Comprehensive analysis of the quality of water from each water supply source being considered for development. All constituents of concern as specified in the PNSDW should be analyzed to ensure that the threshold values are not exceeded. In the event that any parameter is not met, recommendations for remedial measures or appropriate treatment of the water prior to distribution should be incorporated in the study.
- Confirm the right-of-way clearance based on the final site of facilities and alignment of water pipeline. Determine the areas affected by right-of-way claims, if any, for information and appropriate action of the proponent.
- Inventory or survey of wildlife habitat areas to ensure that such areas will not be affected by construction activities

10.2 SOCIAL CONSIDERATIONS

10.2.1 Poverty and Water

Using the 2000 FIES[1], the National Statistical Coordination Board placed the poverty incidence in Bohol at 47.3%[2] making it a member of the 44 poorest provinces in the country. Responding to the challenge, a Poverty Reduction Program Framework was prepared and subsequently approved by the Provincial Development Council[3]. The Framework aims to serve as the common basis for formulating poverty-focused policies, plans, programs and projects in the province. Through this strategy, the provincial government aims to reduce poverty incidence to 30% by 2012.

Defining the levels of deprivation at the municipal level, the province ranked each municipality using an indicator system with two of the indicators directly related to water supply and sanitation: access to potable safe drinking water and households with sanitary toilets**.** The indicator assessing the incidence and degree of malnutrition could well be related to water concerns as well. The fourth indicator was on the incidence of school drop-outs. An indicator which is, as can be seen later in the discussion is related as well to the poor's access to water.

In a paper prepared by the Poverty-Environment Partnership (PEP) entitled "Linking Poverty Reduction and Water Management", it was propounded that water management impacts directly on poverty reduction not only is terms of providing the poor with sustainable access to safe potable water. Water, being the source and sustainer of life, impacts on health,

[1] Family Income and Expenditures Survey
[2] Based on Presentation Material entitled "Bohol Development Path" presented by Atty. Juanito G. Cambangay, PPDC during the BIAD Strategic Mapping Workshop Nov 2006, the 2003 Poverty Incidence for the province in CY 2000 is 50.% and in CY 2003 is 29.2%. Current data from the NSCB reflects a figure of 47.3%
[3] Approved June 2003

livelihood, environmental integrity, settlement, education and on addressing gender inequalities.[4] It must be noted that the poor primarily depends on water resources for production: agriculture, fishing, livestock, and even small-scale manufacturing. The health, welfare and food security of the poor hinges on their continued access to safe water.[5]

Integrated Water Resource Management is the leading and internationally accepted approach in water management. This approach takes cognizance of the inter-relationships and inter-dependence of the various capital assets: natural capital; financial capital; social capital, the institutional capital, and intellectual capital.

Therefore, investing in water management within the IWRM approach, as the Bohol Integrated Water Supply System (BIWSS), is an investment for poverty reduction and is consistent with the province's development goals.

10.2.2 Provincial Development Goals and Strategies

The Provincial Medium Term Development Plan (PMTDP CY 2004-2009) has identified the following priority development thrust:

- Food security and institutional sufficiency attainment particularly of the identified poverty groups through their P.O.'s and access to technologies and resources for their engagement to second generation rural enterprises;
- Improved productivity and employment opportunities in the rural production zones would control influx of the population to the urban centers;
- Effective and dependable implementation of forward linkages of crops, fisheries, livestock, poultry and forest products;
- Established effective control and watershed resources management policies supported with zoning ordinances and adherence to firm implementation and management system;
- Increased capability of the LGU's as provider and/or enabler of pro-active strategies in planning, coordinating and managing local resource-based, integrated and participatory development programs, and projects; and,
- Effective participation of the national government agencies, non-government organizations and local resource institutions and mainstreaming of their agencies' resources and services to support the agriculture and natural resources projects and activities.

Consistent with its PMTDP, the province had developed a three-pronged strategy of realizing its plans: eco-cultural tourism; agro-industrialization; and government-private sector collaboration. A fundamental requirement to these strategies is the creation of the necessary and basic infrastructure like the development of the water supply, power supply, and telecommunication facilities. Among the three, water is the most basic.

10.2.3 Linkage to the National Poverty Reduction Strategy

Boosting the confidence of the province as regards the appropriateness of its chosen development strategies is the promulgation of Republic Act No. 9446 ("An Act Declaring the Province of Bohol as an Eco-Cultural Zone"). Through this statute, not only was due recognition accorded but a great impetus was given to the province's efforts.

Further, Agenda 5 of the 10-Point Agenda enunciated by the Honorable President Gloria Macapagal-Arroyo declared that: "The provision of electricity and water supply to barangays nationwide" will be pursued with vigor. This is recognition that water supply (and energy) is a

[4] "Linking Poverty Reduction and Water Management". Poverty-Environment Partnership
[5] "Water and Poverty". Water for All. ADB. Mar 2006

basic public good that must be made accessible and affordable to every Filipino in every barangay. The poor are the primary beneficiaries of a good water supply management as they are the most vulnerable to it. It is noteworthy that a revision in the target for water supply services based on updated conditions were made as a response to this emerging appreciation. Anent to this are the current sector policies and strategies:

1) an integrated water resources strategy for watershed management;
2) promotion of self-reliance and local community management of services;
3) an integrated approach to water, sanitation and hygiene education;
4) cost sharing arrangement;
5) cost recovery of capital and O&M costs; and,
6) private sector participation.

The development plan of the province, and its current activities, supports the over-all national development framework as enshrined in the 2004-2010 Medium-Term Philippine Development Plan (MTPDP). The BIWSS Master Plan is being prepared in accords to these prioritization of policies and strategies.

10.3 INITIAL SOCIAL IMPACT ASSESSMENT

10.3.1 Poverty Analysis

Based on the data generated through the Poverty Database and Monitoring System (PDMS) of the province as indicated in **Table 10-4**, the “unfavorable indicators of deprivation” are the type of poverty situation which are seen as related to water supply and management, or to the inadequacy of it.[6]

As borne from the rapid assessment and interview of selected key informants (KII), there is a high degree of absence to safe water access by nearly two-fifths of urban and rural population. There is a sustained high incidence of water-borne and water-related diseases which identified it as the leading cause of morbidity. This same unsafe water is used for cooking which in some cases maybe the cause of kidney diseases as well. And this may well impact on the nutritional level of children.

If the natural resource is the basic input material of economic activities, it is logical to assume that the incidence, or absence, of water supply have huge impact on productivity, employment, livelihood and income. In an economy predominantly agriculture-based, the adverse effect could be exponential especially on the poor who are most vulnerable.

In areas where water is accessible, these are mostly in the urban, or urbanized areas of the municipalities. And while the cost of water is heavily subsidized, most of the available water is not necessarily safe for drinking. Resorting to “bottled water” may be a viable option to some people but not to the poor.

With the on-going Master Planning for an integrated water supply system, it is envisioned that the target water service coverage will increase to more than 90%. It is imperative that the service coverage considers the needs of the poor, and their capacity to pay for the water service.

[6] “Water and Poverty”. Water for All Water Briefs. ADB. Mar 2006

Table 10-4 Indicators of Deprivation

Indicator	No. of Households / Persons Affected	Remarks
1. Unemployment	83,043 persons	Male = 47,824 Female = 35,219
2. Income Threshold	120,826 Households (HH)	
3. Food Threshold	92,148 HH	
4. Meals Threshold	2,115 HH	
5. Malnutrition	14,398 children	Male = 7,080 Female = 7,318
6. Child Mortality	409 HH	
7. Sanitation	41,471 HH	
8. Water	23,313 HH	
9. School Dropouts	26,179 school-age children	Male = 15,995 Female = 10,184
10. Housing	7,958 HH	
11. Tenure Status	44,306 HH	
12. Crime	4,698 HH	
13. Disability	8,566 persons	Male = 4,842 Female = 3,724

Source: Presentation Material of Atty. Juanito G. Cambangay during the BIAD Strategic Planning Workshop, Nov. 2006 (Data based on the Poverty Database and Monitoring System (PDMS, formerly LPRA)

10.3.2 Stakeholder Participation & Analysis

In the Implementation Plan for the Master Plan study, an initial stakeholder analysis was prepared (**see Appendix II.7-C, Volume III-Databook**). During the course of the actual study and rapid assessment, interviews conducted included key people directly involved in the management and operation of local water utilities/service providers. Also interviewed were local chief executives, the municipal planning officers, municipal engineers, municipal health officers, social workers, civil society members, church-based organization, community members, and the IP community in the municipality of Duero.

In summary, the initial Stakeholder Analysis matrix was more concerned about the issue of social acceptability, and the concern about the degree of participation especially among new elective officials. There was also the concern on the possible conflict of interest along water right.

At this juncture of the study, there is nothing concrete that will justify the concern relative to social acceptability. The general impression one gets is the high degree of social acceptability for the establishment of an integrated water supply system. A common thread of concern is that supplying water for the entire province should be the first priority of the project, anything else is secondary (i.e. supplying water to other provinces).

Further, there is no evidence at this time that will suggest the presence of conflict on water right or water use.

10.3.3 Institutional Analysis (policy environment, policy gaps, institutional arrangements, institutional capacity, gaps)

At the time of the study, there were previous efforts that were directed towards the institutionalization of water supply and sanitation concerns in the province. The creation of the Bohol Integrated Water Resource Management Board (BIWRMB) through the approval and signing of the Provincial Executive Order No. 10 during the 1st Bohol Water Summit was a seminal effort that responds to this need of institutionalizing water supply and sanitation concerns. As a commencement activity, much had been assigned, and much is expected from the BIWRMB: it is tasked to draw the implementing guidelines, and perhaps even the policy measures, relative to an integrated water resource management.

At this time, the Bohol Environmental Management Code is the primary policy instrument that guides the management of resources. There seems to be an absence of initiative to review all pertinent development policies, programs and projects planned and implemented up to this time with a view of reconciling and synchronizing these to the requirements of an IWRM approach. Further, there is no reason to suggest that there are municipal policy counterparts that will give teeth towards the proper implementation of national and provincial policies. There are instances where national environmental policies do not reach down to the level of the municipal and barangay level in the context and intent as originally thought of s regards environmental management.

It was also evident that there are active participation from civil society organizations and groups along the general issue of environmental management, and in particular water resource management. There appears though some confusing overlaps in terms of confederations of organizations and inter-agency bodies: this is the situation when both the confederation and the individual members of the confederation is a member of an inter-agency body; or when the agency resources are spread to thinly in terms of performing cross-functional mandates. Where can accountability be placed: on the individual organization/agency or on the confederation/inter-agency body?

At the level of water service providers, It was discovered that a common drawback among them, whether publicly-owned or private, are the following:

- Inadequate technical, management and operations capacity;
- High incidence of delinquent payment;
- High non-revenue water (NRW) and/or unaccounted-for-water (UFW);
- Relatively high cost of operations and maintenance;
- Heavy government subsidies; and,
- Inadequate water treatment facilities and processes

Some of these water utilities had been in existence for quite some time and the problems they have been encountering have been there for years. With the proliferation of civil society groups, there appears to be a lot of room for expanding the functional and coordinative relationships at the operational level, especially at providing technical support, which remain “unexplored” at this time.

10.3.4 Gender Development

In most LGU-run/-managed water utilities, there is little or no participation among women. Although there are many instances where at the community-level/-managed water utilities, women participation is well noted. Just the same, the participation of women in the latter type of water utilities is not programmatic but more “functional”. In interviews though, women usually plays second-lead role to men and are limited are record-keeping or “secretarial” work.

10.3.5 Social Safeguards & Safety Nets

In the structural design of the integrated water supply system, the distribution channels will be placed along side the road networks and thus, prevents unnecessary displacement of people. In this case, there may not be any need for any resettlement or re-location. And should the project proceed, there is likelihood that the locales, especially those with construction skills, may be hired as hired hand. This will translate to employment and income opportunities. And considering that the distribution channels will be along the road, IP communities who normally reside upland will not be affected.

The greatest challenge will be on the issue of affordability, especially for the poor.

10.4 RECOMMENDATIONS

10.4.1 Institutional Capital

In an IWRM approach, it is a considered opinion that policy measures must provide an enabling environment where integration and convergence can take form and substance. There must be policy reconciliation and synchronization especially at the operational level. A tedious policy review and analysis is perhaps the best way to start off the process. Legislative measures proceed from this policy review and should be the basis of the legislation. Common policy issues are: water right, water use, watershed management, water permitting, regulations, monitoring, etc.

From the results of the policy review, analysis, reconciliation and synchronization, the appropriate and most responsive institutional arrangement could be defined and established. There might be need to recast existing organizations or bodies, or perhaps a realignment of roles and functions. Further, there might crop up a need to review existing horizontal and vertical institutional arrangements for better integration, consolidation and/or streamlining of operations. It is not new for institutional structures that were created before within a certain paradigm to be re-casted within the new IWRM concept.

Finally, strengthening institutions require a participative process where all stakeholders actively, and in mutual inclusivity, share in the policy review and analysis, planning, designing and decision-making. The operative word in IWRM is integrated and there can be no meaningful integration if there is no real and truthful stakeholder participation. Moreover, it should be remembered that there are numerous incidences that the poor are looked as “beneficiaries” of solutions as if they are the problems themselves. The poor are the solutions to the poverty problems and these is the more empowering view.

10.4.2 Social Capital (community participation, empowerment, water management)

Unless the poor are viewed as active participants in the development process, there will hardly be any sustainable solution to the problem of poverty. There is no cut-and-dry template for poverty reduction strategy: only a clear-cut commitment of engaging the poor in the water resource management. Social and cultural dimensions of communities must be genuinely solicited and embedded in all development initiatives.

In areas where community water initiatives had been established, respect must be accorded. A lot of valuable lessons can be gained from their experience. Moreover, since these are community-led initiatives, it can be cost-efficient, and saves government substantial amount of financial resource that can be channeled to further develop capacities of the community water managers.

A rights-based approach to water management is a fertile area for exploration although care must be observed in terms of the possibility of conflict, which should be managed through dialogue and mediation.

10.4.3 Intellectual Capital (capacity development, traditional knowledge, MIS)

Developing capacities and building on tried and tested traditional knowledge is an iterative learning process that is sustainable, and cost-effective. There is no need to “re-invent the wheels”; simply innovate and consolidate. And this knowledge based must be transformed into institutional and social knowledge base.

Capacity development must be designed along competency, or what others refer to as competency-based capacity development. The competency area must proceed from the institutional and social needs and requirements and must be iterative in order to ensure a continuing intellectual resource at the operations, technical and management level.

10.4.4 Financial Capital

> *"Investments in water resources development and management can contribute to meeting the Millenium Development Goals (MDGs) as a whole both through broad interventions designed to promote sustainable development on an area basis- such as a multi-purpose river basin development and aquifer management- and through targeted actions addressing one or more particular goals in a specific location, such as watershed management within degraded areas farmed by poor families. Both types of interventions are important for making many of the MDGs a reality; indeed, holistic approaches to water resources development and management can help to deliver the MDGs more cheaply and sustainably."*[7]

Investing in water infrastructure is a sound economic decision especially if the infrastructure to be built is built right: with community and stakeholder participation. The investment made will have substantial returns in terms of savings made on reduced cost for health services, increased productivity of the natural resource as well as of the people, and increased income. This will drive economic activity and will fuel balanced development. In a study conducted by Asia Water Watch 2015, it was established that "for every US$1 invested in people gaining access to water and sanitation, there will be returns of US$6 in health, livelihood and education benefits".[8]

[7] UN Millenium Task Force on Water and Sanitation (2005). Health, Dignity and Development: What Will It Take?. UN, New York
[8] "The MDG and the Importance of Target 10". Water For All Water Briefs. ADB. Mar 2006