National Irrigation Administration
Region I

REVISED PROJECT DESCRIPTION

CONDUCT OF SOCIAL AND ENVIRONMENTAL IMPACT ASSESSMENT OF CABACANAN SMALL RESERVOIR IRRIGATION PROJECT

October 2021

Test Consultants

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ANNEXES

1 BASIC PROJECT INFORMATION

1.1 PROJECT INFORMATION

Name of Project	Conduct of Social and Environmental Impact Assessmentof Cabacanan Small Reservoir Irrigation Project
Nature of Project	Irrigation Project
Project Location	Cabacanan River in the Municipality of Pagudpud, Ilocos Norte
Location: ***Latitude:*** ***Longitude:***	 18 degrees, 33 minutes, 35.76 seconds 120 degrees, 50 minutes, 6.06 seconds
Project Implementer/Proponent	National Irrigation Administration (NIA)
Office Address	EDSA, Quezon City
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2 PROJECT DESCRIPTION

2.1 PROJECT LOCATION AND AREA

The proposed Cabacanan Small Reservoir Irrigation Project covers the provinces of Ilocos Norte, where the target service area dams and reservoirs including appurtenant structures are located. The Project, through its irrigation canal network, will provide augmentative water supply to the existing irrigated area, and basal water supply to the new service area - to achieve 2 crops of rice in a year, and, through its drainage canal network, to discard any excess water in the service area.

The service area is 560 km from Metro Manila via the Manila – Ilocos Norte national highway, and 77 km north of Laoag City (capital of Ilocos Norte) - bordered on the west by the West Philippine Sea and on the east by the Cordillera Central Mountains and Ilocos Mountain Range. The Cabacanan Small Reservoir Irrigation Project is a development project of the National Irrigation Administration (NIA). The proposed project is located at Cabacanan River in the municipality of Pagudpud, Ilocos Norte, with coordinates 18 degrees, 33 minutes, 35.76 seconds latitude, and 120 degrees, 50 minutes, 6.06 seconds longitude as shown in **Figure 2-1**. Presently access is by walking for about an hour towards the upstream direction thru a winding pathway that crosses the Cabacanan River about five (5) times before reaching the dam site.

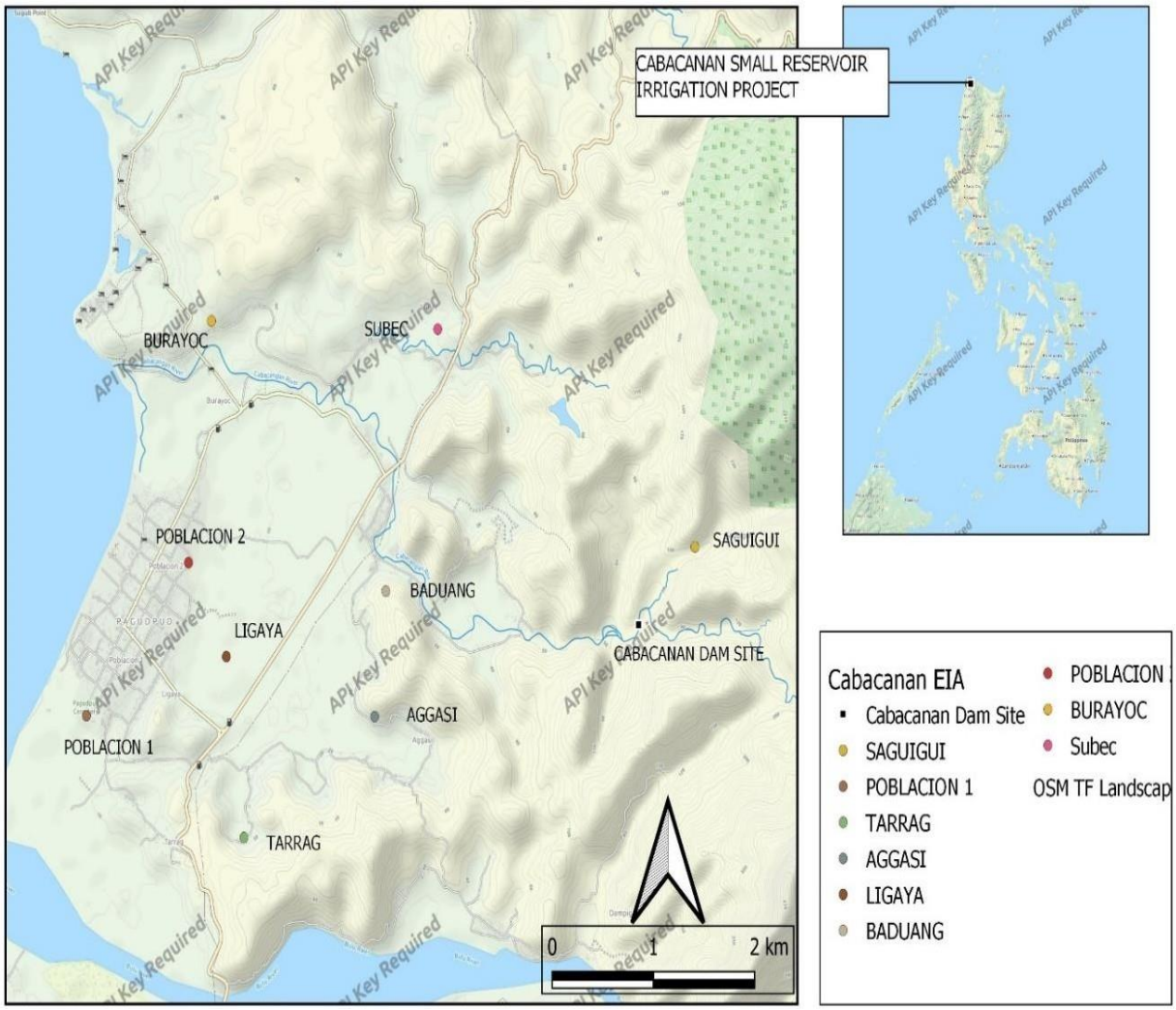


Figure 2-1: Location Map of the Project

2.2 PROJECT RATIONALE

The Project is, as envisioned, the physical intervention that would address the situation relying on its impact of increases cropping intensity and crop yield, which would usher in more farm output, crop income, and better farmers' lives. Poverty incidence is most endemic in rural areas. Presented in **Table 2-1** is the current area about 4,225 hectares which is devotedto agriculture. Conversely, the agricultural profile (**Table 2-2**) shows that rice is the major crop of the province of Ilocos Norte followed by corn and other fruit vegetables.

Table 2-1: Area Devoted to Agriculture

Crops	Area (hectares)	Percent to total Agricultural Land Devoted to crop Production	Percent (%) to Total of Municipality's Land Area	Location Concentration
Rice	1,744	41.28	8.15	All Barangay
Corn	5	0.12	0.02	Caparispisan, Pasaleng, Dampig,Saud, Poblacion 1, Pancian, Balaoi
Garlic	20	0.47	0.09	Saud, Caparispisan, Balaoi, Saud, Tarrag
Squash	20	0.47	0.09	Balaoi, Pancian, Pasaleng, Aggasi,Tarrag
Other crops	2,436	57.66	11.38	
Total	4,225	100	19.73	

Source: CLUP, Pagudpud, Province of Ilocos Norte

Table 2- 2: Updated Agricultural Profile, CY2014

Commodity	Area Harvested, ha	Production, (mt	Yield, mt/ha
Rice	66,681.45	332,079.40	4.98
Corn:			
Yellow	8,511	47,358	5.60
White	3,151	11,295.5	3.60
Fruit Vegetables:			
Ampalaya	349.45	2,988	8.55
Eggplant	728	9,661	13.27
Tomato	1,459	31,326	21.47
Okra	138.50	1,342	9.69
Upo	172	2,194	12.76
Patola	178	1,707	9.58
Leafy Vegetables:			
Pechay	118	1,023	8.65
Legumes:			
Mungbean	4,193	5,810	1.39
Peanut	1,045	1,547	1.48

Source: Provincial Agriculture Office, Laoag City, Province of Ilocos Norte

2.3 SOCIO-ECONOMIC PROFILE OF PAGUDPUD

2.3.1 Location

Pagudpud, is a 4th class coastal municipality in the province of Ilocos Norte. The municipality has a land area of 194.90 square kilometers which constitutes 5.62% of Ilocos Norte's total area. (Atlas)

2.3.2 Population

Based on the 2015 Census of Population (**Figure 2-2**), Pagudpud's population was 23,770 representing 4.01% of Ilocos Norte's total population. Annual growth rate was

1.6% while population density was at 123.1 inhabitants[1] per square kilometer.[2] The proportion of males and females in the population is almost equal.

According to the 2015 Census, the age group with the highest population in Pagudpud was 0-*14 at 41%.* Conversely, the age group with the lowest population was *80 and over at 1%.*

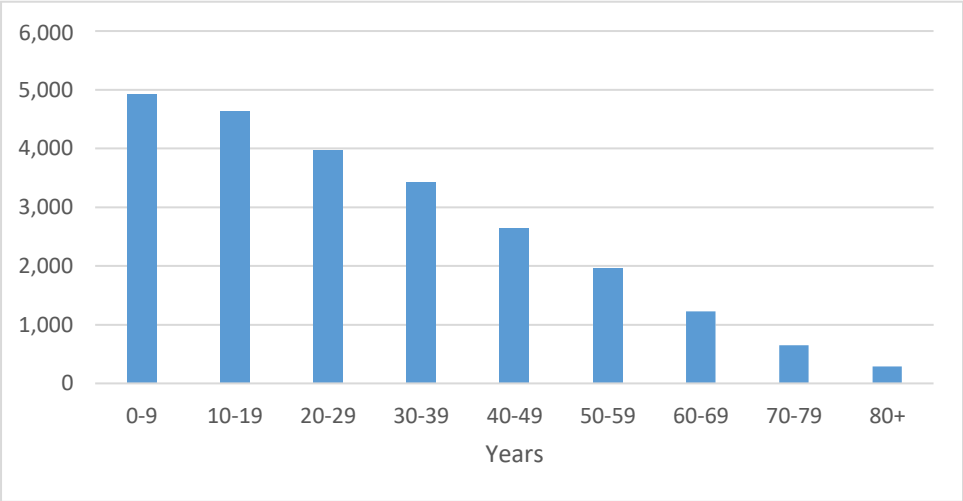


Figure 2-2: Pagudpud Age Distribution of Population

Combining age groups together, those aged *14 and below*, consisting of the young dependent population including infants/babies, children, and young adolescents/teenagers, make up an aggregate of 31.05% (7,381). Those aged *15 up to 64*, roughly, the economically active population and actual or potential members of the work force, constitute a total of 62.84% (14,938). Finally, old dependent population consisting of the senior citizens, those aged *65 and over*, total 6.10% (1,451) in all[3].

Table 2-3: Age Dependency Ratio, Pagudpud

Youth Dependency Ratio	49.41%
Old Age Dependency Ratio	9.71%
Total Dependency Ratio	59.12%
Median age	25.79%

The computed Age-Dependency Ratios mean that among the population of Pagudpud, there were 49 youth dependents to every 100 of the working age population; there were 10 aged/senior citizens to every 100 of the working population; and overall, there were 59 dependents (young and old-age) to every 100 of the working population. The median age of 26 indicates that half of the entire population of Pagudpud were aged less than 26 and the other half were over the age of 26[4].

[1] Pagudpud, Ilocos Norte Profile - PhilAtlas
[2] Pagudpud (Municipality, Philippines) – Population Statistics, Charts, Map and Location (city population)
[3] Pagudpud, Ilocos Norte Profile - PhilAtlas
[4] Pagudpud, Ilocos Norte Profile - PhilAtlas

2.3.2.1 Barangay Saguigui

Meanwhile, the population of Barangay Saguigui, site of the Cabacanan River Small Reservoir Irrigation Project had a population of 872 based on the 2015 Census of Population as shown in **Figure 2-3**. This comprises 4% of Pagudpud's total population.

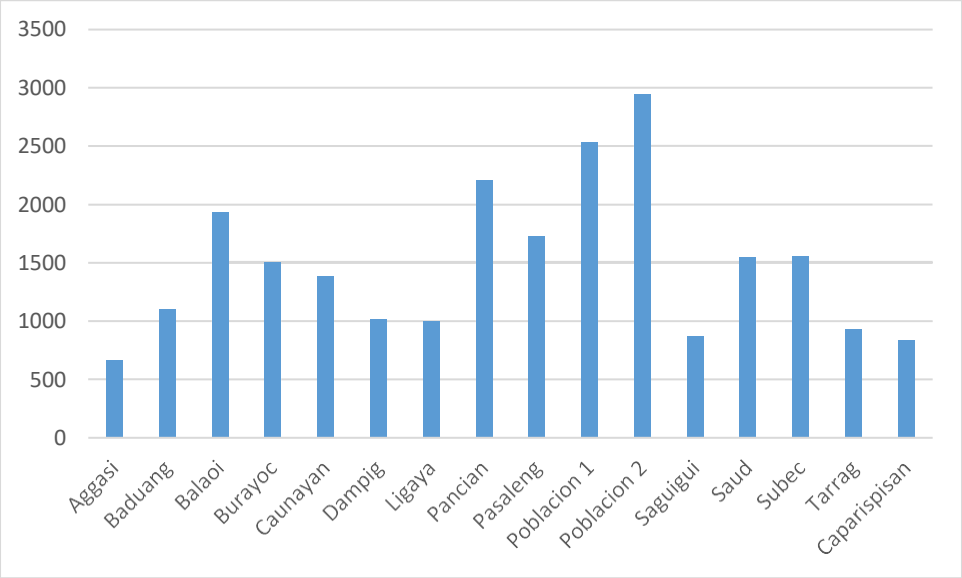


Figure 2-3: Population of Pagudpud by Barangay (August 2015)

The population of Saguigui grew from 676 in 1990 to 872 in 2015, an increase of 196 people. The latest census figures in 2015 denote a growth rate of 1.82%, or an increase of 79 people, from the previous population of 793 in 2010.

The population was dominated by the age group 25-29 years old at 10% while the age group with the lowest population was 80 years old and over at 1.61%.

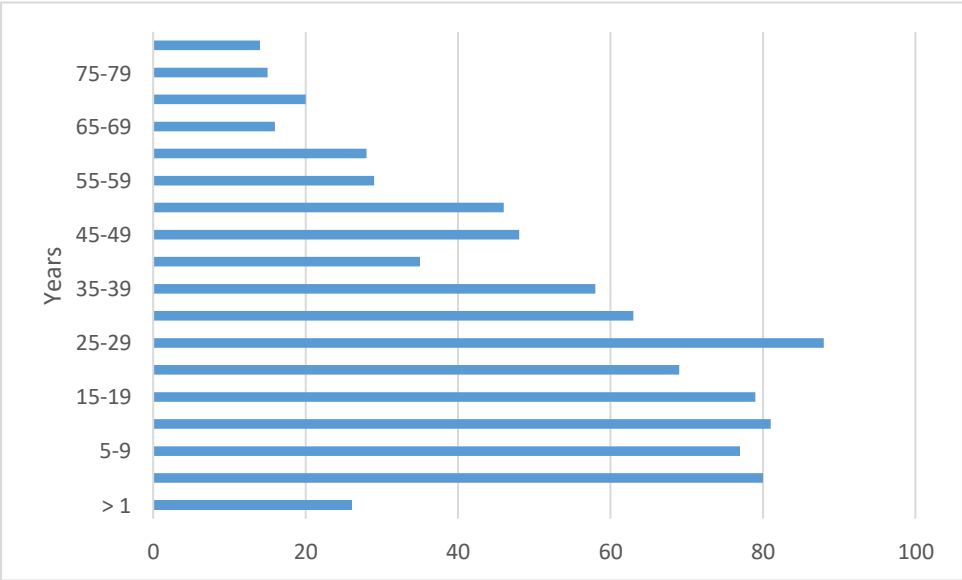


Figure 2- 4: Age Distribution of Population in Barangay Saguigui, Pagudpud

Combining age groups together, those aged *14 and below*, consisting of the young dependent population which include infants/babies, children, and young adolescents/teenagers, make up an aggregate of 30.28% (264). Those aged *15 up to 64*, roughly, the economically active population and actual or potential members of the work force, constitute a total of 62.27% (543). Finally, old dependent population consisting of the senior citizens, those aged *65 and over*, total 7.45% (65) in all[5].

Table 2-4: Age Dependency Ratio, Barangay Saguigui, Pagudpud

Youth Dependency Ratio	48.62%
Old Age Dependency Ratio	11.97%
Total Dependency Ratio	60.59%
Median age	26.36%

The computed Age Dependency Ratios mean that among the population of Saguigui, there are 49 youth dependents to every 100 of the working age population; there are 12 aged/senior citizens to every 100 of the working population; and overall, there are 61 dependents (young and old age) to every 100 of the working population. The median age of 26 indicates that half of the entire population of Saguigui are aged lessthan 26 and the other half are over the age of 26[6].

2.3.3 Economy

Pagudpud is a popular tourist destination because of its resorts and beaches. In addition to tourism, people also make their living through farming, fishing, and subsistence retailing[7]. The annual regular revenue of Pagudpud for the fiscal year of 2016 was ₱135,416,657.97 as shown in **Figure 2-5**.

[5] Pagudpud Ilocos Norte Profile - PhilAtlas
[6] Pagudpud Ilocos Norte Profile - PhilAtlas
[7] Pagudpud Ilocos Norte Profile - Wikipedia

Fiscal Year	Annual Regular Income	Change
2009	49,389,700.32	–
2010	61,901,134.72	25.33%
2011	63,616,743.32	2.77%
2012	63,047,214.47	-0.90%
2013	69,210,655.13	9.78%
2014	94,163,740.61	36.05%
2015	105,566,954.71	12.11%
2016	135,416,657.97	28.28%

End notes:

- *Annual Regular Income* = Locally Sourced Revenue + Internal Revenue Allotment (IRA) Current Year + Other Shares from National TaxCollection
- *Locally Sourced Revenue* = Real Property Tax (General Fund) + Tax on Business + Other Taxes + Regulatory Fees + Service/User Charges + Receipts from Economic Enterprises

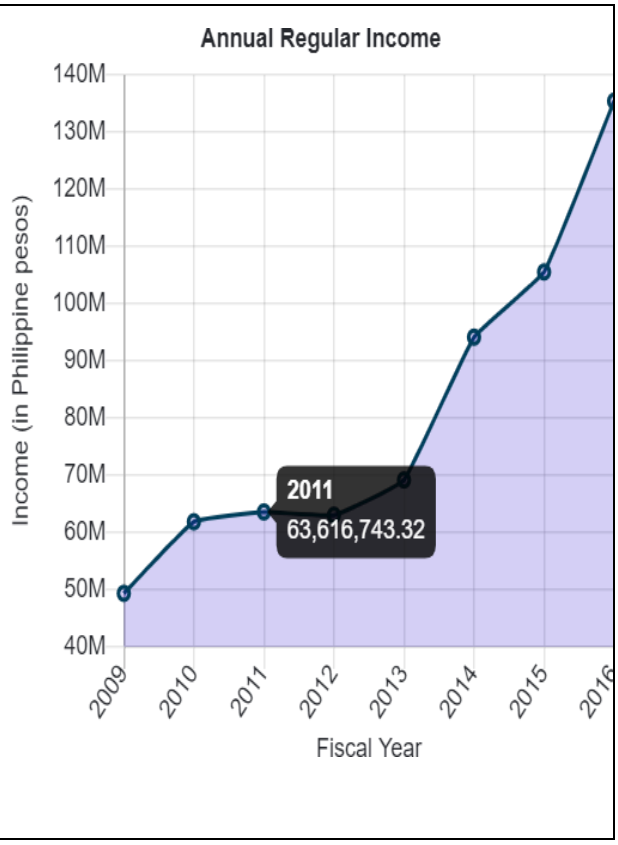


Figure 2-5: Pagudpud Annual Regular Income for Fiscal Year 2009-2016

2.3.4 Water Resources Sub-Sector Existing Situation

2.3.4.1 Potable Water Supply

According to Pagudpud Comprehensive Land Use Plan (CLUP) in 2001, the Municipality of Pagudpud is gifted with virgin forest, and most of the water systems in the different barangayhave springs as their primary source of potable drinking water as shown in **Table 2-5**. Spring is the most common source of potable water for the entire population. Vira-Vira Spring provides the primary source of potable water supply. Conversely, some avail their water supplies from dug wells, artesian well rivers, and creeks. Also, presented in **Table 2-6** the number of water connections per barangay.

Table 2- 5: Pagudpud Waterworks Sysptem (Pagudpud CLUP, 2001)

Name of WaterSystem	Location of Sources	Capacity Liters per Day	Barangay Served	HH Served	Population Served
VIRA-VIRA SPRING		703,300	Ligaya	91	621
1&2			Baduang	152	867
			Saguigui	82	469
			Poblacion 1	189	985
			Poblacion 2	259	1530
			Saud	30	

Name of WaterSystem	Location of Sources	Capacity Liters per Day	Barangay Served	HH Served	Population Served
			Burayoc	114	602
			Subec	42	336
BAOG SPRING		59,200	Tarrag	82	456
NAGSANGO SPRING		11,500	Saud	15	89
BUNGRO SPRING		38,200	Caparispisan	58	294
SUBEC SPRING		52,700	Subec	21	406
MABUABUA SPRING		77,800	Malingay BalaoiBanua	120	599
MATAY SPRING		69,100	Caunayan	109	532
TINAMBUNAN BUGBOG SPRING		125,500	Pancian	164	966
DATAG SPRING		51,200		81	394
KISKIS/BAAG/UMBIGA SPRING		84,200	Pasaleng	135	648
DATAG SPRING		38,600	Aggasi	65	297

Table 2- 6: Number of Water Connections Per Barangay

Barangay	Number of Household	Own Use Faucet	Shared Faucet	Tubed/ Piped	Spring	River
POBLACION 2	472	255	62	155		
POBLACION 1	363	52	145	201		
PANCIAN	313	242		68	2	1
PASALENG	281	156	40	81	3	1
SUBEC	232	216	5	9	1	1
BALAOI	242	189	15	35	1	2
BURAYOC	218	11	2	64		1
CAUANAYAN	224	27		84	1	1
SAUD	194	27	3	85	1	
BADUANG	190	159		40		
LIGAYA	162	115		35		
TARRAG	148	90		58	1	1
DAMPIG	170	159	1		1	1
SANGUIGUI	132	111		6	2	1
AGGASI	144	33	1	71	1	
CAPARISPISAN	111	34	2	43	1	1

Source: Municipal Health Office, 1999Pagdpud, Ilocos Norte

There are eight (8) deep wells constructed at Barangay Subec, Caparispisan, Poblacion 2, Ligaya, Baloi and Pancian. There are also 31 shallow tubes well installed at Barangay Pobacion 1, Tarrag, Caparispisan, Subec, Aggasi, Pancian, Pasaleng, Saud and Vaunayan. These shallow wells are servicing the population who cannot avail of the piped potable water system. The water requirements are illustrated in **Table 2-7**.

Table 2- 7: Water Requirements in Liters; 1999, 2000-2010

Year	Urban	Rural	Total
1999	526, 920	1,402,000	1,928,920
2000	536,400	1,427,200	1,963,600
2005	583,800	1,553,300	2,137,100
2010	630,000	1,675,900	2,305,900

Source: MPDC Office Pagudpud, Ilocos Norte
Standard Requirements: Urban: 120 lcpd Rural: 100 lcpd

Based on the existing water supply conditions as cited in the Pagudpud CLUP, there are further improvements shall be carried out like construction, improvement and repair of water system and installation of pipes to unserviceable area. Alongside, the Pagudpud municipal government should also try to source out other water sources to provide potable water supplyto household with no direct water source.

2.3.5 Irrigation System

Based on the Public Hearing on the Comprehensive Land Use of Pagudpud, Ilocos Norte last23 November 2001, the irrigated agricultural lands are not possible for land conversion. Construction and maintenance of irrigation canals and dams are needed to further enhance the productivity of the farmers that can help them to uplift living conditions. Likewise, communal Irrigation system is the source of water for irrigation with a total serviceable area of 11, 744 hectares.

2.3.6 Power and Electricity Sub-Sector

There are two (2) power and electricity providers in the municipality of Pagudpud, namely Ilocos Norte Electric Cooperative (INEC) and Agua Grande Mini Hydro-Electric Plant. However, the residents do not depend mainly on electric power but also another source. Some residents, especially those who cannot afford to pay monthly dues, use kerosene, candle, firewood, gas, lamps, and used papers for lighting and cooking purposes. These are the alternative source of power during interruptions.

i. INEC

According to Pagudpud CLUP, the source of power supply in the municipality served by the National Corporation (NAPOCOR) relayed through the INEC. The cooperative began its operation with an initial outlay of Php 15.3 million in materials, a loan from the National Electrification Administration. The first energization was launched on September 11, 1973 and the first General Annual Meeting was held in 1974 at Dingras.

In 1975, INEC bought the franchises of four private electric plants in Paoay, Bacarra, Currimao, and Batac. In 1977, the cooperative took over the privately-owned Ilocos Norte Electric Company, thus, the electrification of the entire province was left at the hands of INEC.

INEC struggled in year 1978. There was an acute shortage of construction materials and electrical hardwares needed for expansion. Collection was made through bicycles and some consumers paid in kind such as chicken, vegetables,

and rice among others. However, house connection never stopped and even cynics were surprised to know that in a short period of time, at least 31,311 houses were lighted in September 1978. For this feat, INEC ranked third among the then 121 electric cooperatives in the country as far as house connection is concerned.

By November 14, 1999, INEC was able to achieve 100% barangay level energization with the energization of Brgy. Barangobong in Nueva Era. 40 years after its incorporation, the cooperative finally achieved total rural electrification down to the sitio level when Sitio Bucarot in the municipality of Adams was energized on May 2, 2012.

On January 24, 2006, National Electrification Administration (NEA) issued Certificate of Franchise Number 219 to INEC, to wit, "for the renewal of the franchise granted under NEC Resolution No. 8, dated August 10, 1977 for a period of twenty-five (25) years from the expiry of its original franchise on August 10, 2027 or until August 10, 2052."

INEC's service area covers the whole of Ilocos Norte which is composed of 2 cities, 21 municipalities and 559 barangays with 143,376 member-consumer-owners with 164,550 house connections as of December 31, 2018.

ii. Agua Grande Mini Hydro-Electric Plant

Another power source is the Agua Grande Mini Hydro-Electric Plant in Pacian, generating 4.5 megawatts. The wind turbine generator supplies electricity to about 32 households at Sitio Ayoyo, Caparispisan. The electrification of barangay in the municipality is 100 percent.

The Agua Grande Mini Hydro Project was supplied and commissioned by Gilkes in 1981 as part of a batch of 34 units supplied to the Philippine Government under a UK aid grant. Five turbine-generator units each rated at 910 KW were originally installed in the Agua Grande Power Station. Reliable operation of the plant is critical for the local grid supply and a decline in the availability of the plant was starting to cause problems.

Gilkes, through Bosung Greenpower Co. were invited to inspect the plant with a view to upgrading the original units to bring them back to as new condition and to automate the plant operation after 35 years of manual operation. Following a Gilkes inspection visit and following a review of the condition of the plant with the customer it was decided to only upgrade 2 of the machines. The plant was commissioned into its new state whilst local network upgrades were also ongoing. Gilkes were able to navigate these constraints and provide a successfully commissioned, upgraded plant.

2.4 PROJECT ALTERNATIVES

Comparison between without-project situation and with-project situation, to ascertain the relevance and worthiness, focused on comparison of paddy production, labor requirements, and infrastructure impact. This exercise revealed the comparative advantage of implementing the Project relative to job generation, poverty alleviation, cropping intensification, income enhancement, production upswing, and disaster mitigation.

2.4.1 Scenario without the Cabacanan SRIP

2.4.1.1 Current Land Use and Situation on the Rice Farm Irrigation

The total land area of the municipality of Pagudpud is 21,400 hectares (Philippine Statistics Authority, 2016 - CLUP) comprising of 16 barangays. Of the total land area, 14,803,59 (69.18%) are alienable and disposable and 6,596.41 (30.82%) are timberlands. Agriculture is contributing most of the municipal and provincial income. Majority of the populace earn their living through agricultural crop production.

Present situation indicates that the crop planted in the target project area is rainfed and irrigated paddy rice. Some vegetables and corn are also cultivated within and in the adjacent area but only for home consumption and in very small scale.

The potential service area encompasses two (2) existing communal irrigation systems (CIS), namely the Saguigui and Rancon Communal Irrigation Systems. These systems, however, could only irrigate some 35% (91 ha) of its potential irrigable area both during wet and dry cropping season due to limited or shortage of water supply. Around 60.43% or 169 hectares of the potential service area is dependent to rainfall.

2.4.1.2 Population and Labor Force

According to the Philippine Statistics Authority (2015), the present household population in the project area comprising the municipality of Pagudpud is around 19,553 with an estimated household size of 4.14 members. At a rate of 1.59% per annum, the estimated household population in the project area is projected to increase to 20,868 in 5 years (2020). Labor force participation in this area is at 33.2%. The estimated labor force is around 6,492 and projected to increase at around 6,928 after 5 years. With the regional employment rate in agriculture of about 36.82%, the estimated labor available for agriculture in 2015 and 2020 is around 2,390 and 2,551 man-days respectively (Cabacanan SRIP Final Feasibility Study Report, 2019).

2.4.1.3 Agricultural Land Use, Cropped Area and Cropping Intensity

The study area covers a potential service area of 260 hectares covering two (2) barangays of the municipality of Pagudpud namely Subec and Saguigui. **Table 2-8** shows some basic demographic data of the covered barangays.

Table 2- 8: Basic Demographic Data of the Covered Barangays

Barangay	Population (1015)	Land Area (ha)	No. of Household	Location from Dam site	Crops Planted	Farming System	% Slope
Saguigui	1,014	1,286	203	upstream	Paddy rice	Irrigated/rainfed	0.0 - 5.0*
Subec	1,521	922	304	downstream	Paddy rice	Irrigated/rainfed	0.0 - 5.0*
Total	**2,535**	**2,208**	**507**				

**The service area is generally level to nearly level and slightly undulating*

Of the total potential service area, 91 hectares (35%) wet and dry season cropping respectively, is presently covered/ irrigated by Saguigui and Rincon Communal Irrigation System. Due to shortage of water supply during the dry season cropping, this system was not able to irrigate the entire service area. Around 60.43% of the potential service area is dependent to rainfall. Farmers from these area plants rice

covering around 169 hectares. As shown in Table 2-9, majority of the area (65%) are not planted during the dry season cropping due to unavailability/ shortage of water supply. The annual cropping intensity at present is 135%.

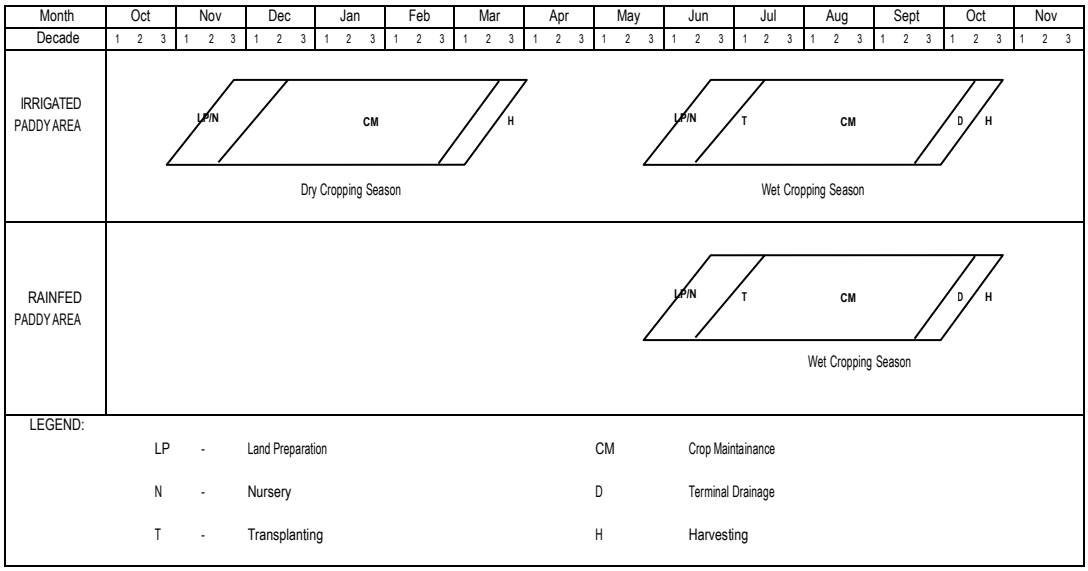
Table 2- 9: Cropped Area, Yield, Production and Cropping Intensity

Particular	Present		
	Area (ha)	Yield (tons/ha)	Production (tons)
Irrigated Area:			
Wet Season			
Paddy Rice	91	3.8	346
Dry Season			
Paddy Rice	91	3.5	319
Vegetables			
Tomato	-		
Bitter gourd	-		
Eggplant	-		
Rainfed Area:			
Wet Season			
Paddy Rice	169	2.6	439
Total	351		1,104
Cropping Intensity, (%)	135		

Source: Final FS Report, Cabacanan SRIP (2019)

2.4.1.4 Present Cropping Pattern

Mono-cropping system is basically practiced by farmers in the project area wherein paddy rice is the major crops cultivated in both the wet and dry season. Paddy rice is planted during the months of June through July and harvested in September to October (**Figure 2-6**).



Source: Final FS Report, Cabacanan SRIP (2019)

Figure 2- 6: Present Cropping Pattern

2.5 FUTURE SCENARIO WITH THE CABACANAN SRIP

Future with project development would require some changes in the project area in terms of land use, Crops and cropping pattern, and farm mechanization to attain the desired crop yield. Without the project, no significant changes are expected to occur in the future.

2.5.1 Future Land Use

The future land use of the project area with project condition would result to the conversion of the present rainfed areas for rice and non-rice into irrigated fields. Farmers tend to put more preference to plant paddy than other crops because of its more stable market, however, integration of diversified crops as vegetables is recommended to increase irrigation coverage during the dry cropping season due to the insufficiency of water. Lands in the project area as founded in the latest Land Resources FS Report are of the dual land classes. These land classes have multiple suitability for lowland rice and diversified crops production. The soils are medium textured moderately deep with good and restricted external and internal drainage. Although the whole potential service area is under irrigated and rainfed cultivation, the farmers are already experienced rice farmers as they are used to executing preventive measures for pest management against weeds, insect diseases and snails. Other use of the project lands especially for the non-arable areas would remain the same.

2.5.1.1 Projected Crop Yields and Production

Main crop in the future with the project would be irrigated paddy rice during wet season and paddy rice in combination with high value crops during dry seasons.

In the future with project condition, around 260 and 140 hectares will be devoted to rice and 105 hectares for high value crops production, resulting to an increase in cropping intensity from 135 percent in the present condition to 194 percent in the future with project condition. Though there is a slight increment in terms of the area planted, the project under future condition will assure a continuous supply of irrigation water throughout the year compared to the present condition wherein it only relies to rainfall. With this, farmers will be expecting a higher yield and production as long as the recommended crop management practices will be applied too (Cabacanan SRIP FSR, 2019).

With the use of improved rice varieties, timing of application and right amount of fertilizers, agro-chemicals and proper crop management, rice yields are expected to increase to 5.0 and 5.5 tons/ha during the wet and dry seasons, respectively. Farmers should increase capabilities in adopting these farming factors of improving rice productions. On the other hand, projected yields for non-rice crops are 15.0, 20.0 and 18.0 tons/ha for tomato, bitter gourd, and eggplant, respectively. Total annual production in the project area will increase from 1,104 tons to 3,925 tons (Table 2-10).

Table 2- 10: Cropped Area, Yield, Production

Particular	Present			Future with Project		
	Area (ha)	Yield (tons/ha)	Production (tons)	Area (ha)	Yield (tons/ha)	Production (tons)
Irrigated Area:						
Wet Season						
Paddy Rice	91	3.8	346	260	5.0	1,300
Dry Season						
Paddy Rice	91	3.5	319	140	5.5	770
Vegetables						
Tomato				35	15.0	525
Bitter gourd				35	20.0	700
Eggplant				35	18.0	630
Rainfed Area:						
Wet Season						
Paddy Rice	169	2.6	439			
Total	351		1,104	505		3945
Cropping Intensity,(%)	135			194		

Source: Final FS Report, Cabacanan SRIP (2019)

2.5.2 Comparison Based on Infrastructure Impact

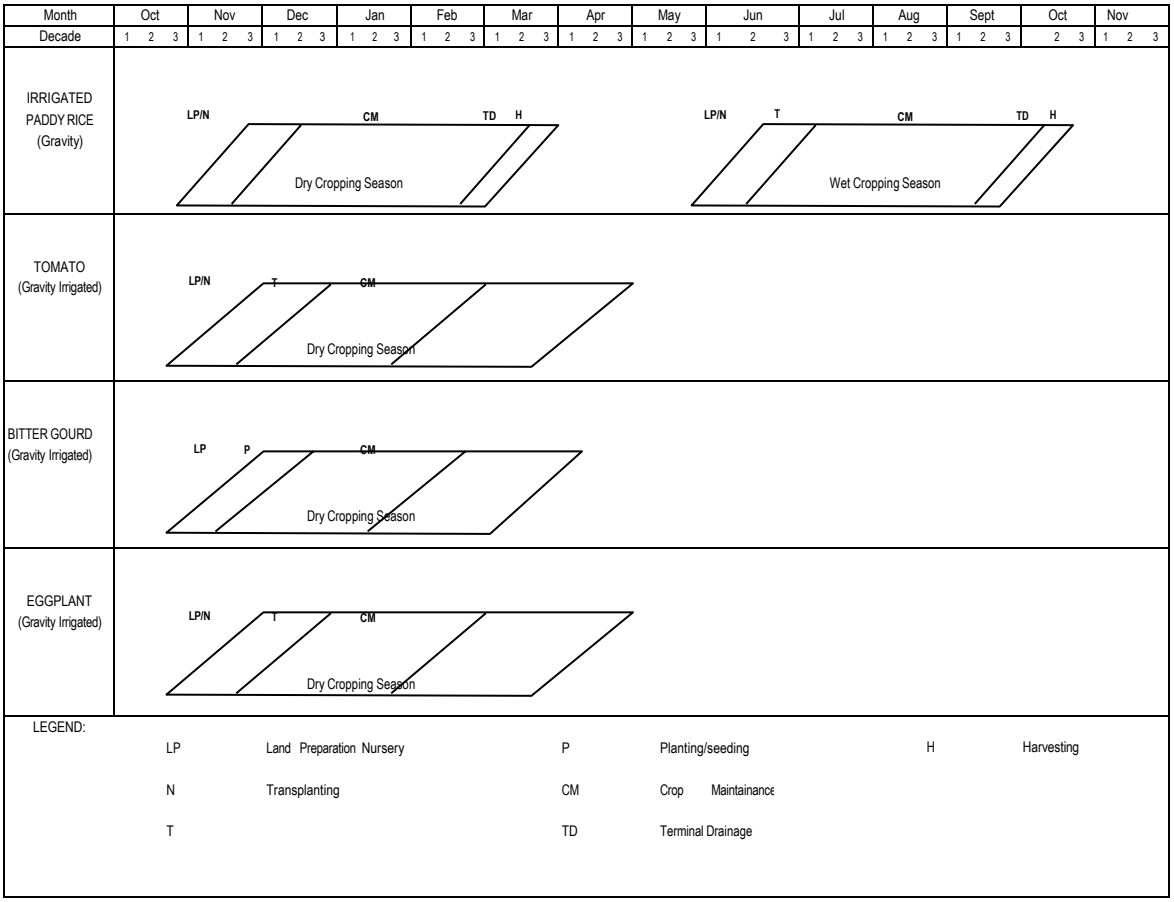
This aspect compares without-project situation against with-project situation, with the later highlighted by the establishment of an irrigation system where right-of-way requirement is the known sole disadvantage. This disadvantage, however, is more than compensated by the advantages ushered in, like less flooding, better accessibility, and secured agriculture, besides higher copping intensity, crop yield, paddy production, and farmers' income.

Table 2-11: Comparison Based on Infrastructure Impact

Details	Future With-Project Situation	Current Without-Project Situation
Reservoir	With inundated area but with stored water	No inundated area but forfeits stored water
Dam Axes	With taken area but controls flooding	No taken area but forfeits flooding control
Primary Canals	With taken area but supports agriculture	No taken area but forfeits water conveyance
Secondary Canals	With taken area but supports agriculture	No taken area but forfeits water conveyance
Tertiary Canals	With taken area but supports agriculture	No taken area but forfeits water conveyance
Service Roads	With taken area but enhances accessibility	No taken area but forfeits enhanced accessibility
Access Roads	With taken area but enhances accessibility	No taken area but forfeits enhanced accessibility

2.5.3 Future Cropping Pattern

Soils of the project area are suitable to paddy rice and for dual purpose crop production. Rice as the Philippine staple food, however, has a relatively more stable market as compared to other crops. As shown in **Figure 2-7**, first cropping for irrigated rice would cover the period from June to mid-November and the second cropping from November to mid-April for the dry cropping season.



Source: Final FS Report, Cabacanan SRIP (2019)

Figure 2- 7: Cropping Pattern for Future with Project, Cabacanan SRIP

2.6 PROJECT BENEFITS

The project will usher in social, environmental, irrigation, aquaculture, and access road benefits, as follows:

Social Benefits

(1) Increased annual farm income and savings;
(2) Boosted community participation in environmental programs;
(3) Enhanced quality of life due to higher paddy output and farm income;
(4) Improved health status of the population as a result of healthier environment;
(5) Enriched stakeholders' participation in development projects;
(6) Improved coordination mechanisms among development partners;
(7) Invigorated farmers' participation in governance of irrigation system; and
(8) Strengthened community-based organizations.

Environmental Benefits

(1) Restored biodiversity habitat through watershed rehabilitation and protection programs, which will ensure long-term ecological balance;
(2) Improved forest, soil and water condition through appropriate conservation

measures, which will ensure resource sustainability;
(3) Minimized *kaingin* cultivation, through intensification of lowland rice cultivationunder irrigated condition, which will preserve forestall areas;
(4) Improved ecological and hydrological condition through responsible watershedmanagement, which will protect the infrastructure's lifespan; and
(5) Increased community awareness for and concern in environmental protection andbiodiversity conservation

Irrigation Benefits

This is primarily derived from the increased values of crop production attributed to adequate irrigation water supply. The net incremental value of crop production is derived from the difference of the "with" and "without" conditions net value of production which is estimated at Php54.194 million at full development stage as presented in **Table 2-12**.

Table 2- 12: Economic Analysis of Net Value of Production at Full Development

Cropping Pattern	Area	Yield	Farmgate Price	Gross Valueof Production	Production Cost	Net Value of Production	Net Return from Project
	(ha)	(tons/ha)	(P/ha)	(P/ha)	(P/ha)	(P/ha)	(P'000)
WITHOUT PROJECT							
Wet Season							
Rainfed Rice	169	2.60	21,983	57,156	18,379	38,777	6,553.35
Irrigated Rice	91	3.80	21,983	83,536	22,665	60,871	5,539.28
Dry Season							
Irrigated Rice	91	3.50	21,983	76,941	20,705	56,236	5,117.45
Total	351						17,210.08
WITH PROJECT							
Wet Season							
Irrigated Rice	260	5.00	21,983	109,916	46,397	63,519	16,514.99
Dry Season							
Irrigated Rice	140	5.50	21,983	120,907	48,656	72,252	10,115.24
Diversified Crops							
Tomato	35	15.00	15,000	225,000	21,876	203,124	7,109.34
Bitter gourd	35	20.00	35,000	700,000	50,594	649,406	22,729.19
Eggplant	35	18.00	30,000	540,000	26,842	513,158	17,960.55
Total	505						
Grand Total							74,429.31
				With		**Without**	
Total Net Value of Production before Costing Labor				74,429.31		17,210.08	
Less: Imputed Cost of Labor				7,008.75		3,983.85	
Net Value of Production				67,420.56		13,226.23	
Net Incremental Value of Production at Full Development					54,194.33		

Aquaculture Benefits

Inland fishery in the reservoir will provide additional income to the residents in the area. About 10% of the reservoir area is allotted for the establishment and operation of fish cages. The fishery benefit is estimated at Php42.708 million annually. Production cost and net value of production are shown in **Table 2-13** and **Table 2-14.**

Table 2-13: Production Cost of One Unit Tilapia Fish Cage per Cropping

	Item	Amount (Pesos)
A	Cost of Cage Materials and Construction	
	1. Materials	3,100
	2. Labor Cost (30% of material cost)	5,235
B	Equipment cost	3,100
C	Total investment cost	25,785
D	Average capital three (3) years life including 18% interest	10,142
E	Operation and Maintenance Costs	84,588
	1. Fingerlings (size 14)	5,400
	2. Feeds	75,888
	3. Labor	1,500
	4. Transportation cost form source to project area including transport materials	1,800
	Total	**84,588**

Table 2- 14: Annual Net Value of Tilapia per Hectare

	Item	Amount
	Annual Income (Php)	
	Production (kgs)	382,500
	Fish sale (Php)	42,075,000
	Average annual capital (Php)	2,694,533
	O & M Cost per year (Php)	12,688,200
	Net income (Php)	26,692,268
B	Economic Benefits derived from reservoir (Php)	42,707,628

Access Road

In the construction of the irrigation canals and laterals, access/service roads will be provided on one side. With the provision of this, the farmers will benefit by enabling them to transport and haul their farm inputs to and farm produce from their farm to their houses and or to the market. As a result, the cost of transport or hauling cost will be decreased. The annual benefit as savings in hauling /transport cost due to provision ofservice roads amounts to Php 0.47 million (**Table 2-15).**

Table 2-15: Benefit from Intransite/Service Roads

Item	Unit	WS	DS
Average Yield per Hectare	ton/ha	5.00	5.50
Average Palay Gate Price	pesos	21,983	21,983
Area planted		230	85
Average Production per year(mt)	mt	1,150	468
% of Harvest Hauled	%	80%	80%
Total Volume of Harvest Hauled	mt	920	374
Average hauling cost per sack	pesos	30.00	30.00
Estimated hauling cost per sack	pesos	12.00	12.00
with intrasite roads			
Savings in hauling cost per sack	pesos	18.00	18.00
Total Number of sacks	cavans	18,400	7,480
Total savings in hauling cost	pesos	331,200	134,640
Total			**465,840**

2.7 GEOLOGICAL CONDITION

The regional geologic and stratigraphic setting of the project area can be divided into two major zones, namely: Ilocos-Central Valley Basin and Luzon Central Cordillera. The first zone is sedimentary basin in character; while the second has arce as its dominant stratigraphic character, it is in fact a mountain range which stretches from Ilocos Highlands to Caraballo Mountains. The Ilocos-Central Luzon Basin flank Western Luzon Island along a generally N-S axis. The northern part of the basin, where the project area is found o filled by Upper Oligocene to Middle Miocene marine detrital sediments derived from the Luzon Central Cordillera Rangel located to the east of the project area.

Along the Luzon Central Cordillera is a ~300 km-long mountain belt that trends N-S and separates the foothills of Ilocos in the west and the Cagayan Basin in the east. More than 50% of this mountain is characterized by slope gradients less than 30 degrees at elevations that reach ~3000m. The geology of this mountain range, including foothills of the Ilocos region, is characterized by basalt ophiolitic bodies overlain by epiclastic and carbonate sedimentary formations that are cut by a number of intrusive bodies.

3 PROJECT COMPONENTS LIST

The Project has the following major component facilities:

Reservoir Dam

The dam would be of the zoned earth fill type, about 36.1 meters high, 294.72 meter long with 10-meterwide crest. The upstream and downstream embankment slopes would be 3:1 and 2.5:1, respectively. The proposed reservoir dam description is shown in **Table 3-1**. The details of the proposed dam storage capacity are presented in **Annex C.**

Table 3-1: Reservoir Dam Description

Zone	Description
1	Impervious Core (clay, silt, sand, and gravel)
2	Pervious shell (Gravel and Sand)
3	Medium to coarse sand-crushed gravel-crushed gravel and blanket drain
4	Rockfill Toe Berm (Boulder)

It is proposed that a zoned embankment dam has been adopted among others due to the abundance of local (embankment) materials in and around the vicinity of the dam site and its relatively simple and easy construction method. Provision will be made for a 10m high cofferdam on the upstream side with a slope of 3H:1V. Similarly, a 10.0 m high rockfill toe berm will be placed on the downstream side, with the outer phase inclined at an angle of 2.5H:1V, and an inner slope of 1H:1V.

The dam site is located in Barangay Saguigui, municipality of Pagudpud, across Cabacanan River. The design of the body of the dam must satisfies the following items:

- The foundation of the dam will be able to resist the loads exerted by the dam; and
- The dam body is effectively cohesive to the foundation.

The section and configuration of the dam maintains safely against the combination of the anticipated loads. The foundation excavation level shall ensure satisfactory stability against sliding and seepage control. These conditions would require excavation of earth materials up to the fresh rock foundation.

Layout Consideration

Due to the substantial presence of sand and gravel, and boulders, their quantities being in that order, it is logical to construct a zoned-type embankment dam. The embankment of this type of dam consists of an impervious embankment core in the middle flanked by pervious embankment shell at upstream side and downstream side. The impervious core may be made up of a combination of clay, silt, sand and gravel or any other impervious soil. The pervious shell is made up of gravel and sand with more quantity of gravel in the combination. The other type of earth dam, the homogeneous type, has the dam embankment all made up of impervious soil. The zoned type is the more stable dam because it has no pore water pressure which tends to destabilize the dam. The source for pervious shell material and boulders can be the Cabacanan River itself while impervious material for the core embankment can be sourced at the vicinity.

Freeboard and Crest

The height of dam depends on the topography of the area and the reservoir volume that adequately satisfy the intended needs of the project. A freeboard will be added to the height of the dam to take care of the rise in the reservoir water due to wave action, etc.

- Freeboard and Crest Elevation of Dam. Freeboard is the difference between the crest elevation and the full water surface level in a reservoir. Freeboard should be greater than or equal to the sum of the height of wave due to wind and height of wave due earthquake. Height of wave due to wind was derived from factors such as fetch and wind speed. Since up rushing height varies considerably with embankment slope and roughness of slope, height of significant wave should be adjusted adequately. The height of wave due to earthquake was obtained using Sato's formula. A horizontal seismic coefficient of 0.2 and 1 second period of seismic wave is used.

- The dam crest elevation was obtained by adding the freeboard and full water surface. The crest will be used as maintenance road, so an additional height is included.

Dam Embankment

For the dam structure to attain the requisite degree of imperviousness, its midsection or central core would be of clayey materials. A downstream sand and gravel filter would be place directly adjacent to the clayey central core with its horizontal segment extending up to the boulder toe drain.

To provide additional structural stability and more protection to the impervious zone, a random fill composed of inorganic materials with low to medium plasticity and preferably, with preponderant gravel particles would blanket in enormous quantity the upstream side of the aforesaid zone, similarly with the downstream side in such a manner that their respective slope requirements could be attained. In turn, the upstream random fill is kept firm and stable against erosion, especially due to run-off and the possible occurrence of wave action arising from high velocity winds, by the placement of boulder riprap mantling its inclined surface area.

Foundation

The dam foundation excavation lines will essentially follow the sound rock strata. The inferred sound rock strata are about 1m to 9 m deep. Overburden materials are stiff very dense transported and residual soil.

Excavation Level

The level down to which it will be necessary to carry the foundation excavation for each of the sections of the dam will vary according to the position of the rock strata and state of weathering.

Fully weathered layers will have to be removed from the foundation areas since these are mechanically weak and potentially semi-pervious. The final excavation levels would be determined upon visual inspection during excavation at construction time.

The sound, defined as the hard rock limiting surface for mechanical excavation, must be reached. The sound rock once exposed will have to be cleaned by the hand excavation and air and water jets. The main purpose of the cleaning is to remove the filling from the joints especially from those joints crossing the axis at angles 90 degrees.

Cofferdam

The cofferdam embankment will consist of a homogenous material with slopes 3:1 on the upstream side and on the downstream side the slopes is 2.5:1. The cofferdam will be incorporated into the main dam body.

It is anticipated that part of the embankment materials would come from the dam and spillway excavations. The cofferdam will divert river's low water flow into the diversion conduit.

Spillway

To accommodate the design flood (500-year flood frequency) estimation of 1 various combination of flood storage and spillway lengths and capacities will be investigated. These investigations required flood routings, spillway layouts and estimates. An ungated structure was chosen for its ability to function under the least maintenance cost- and trouble-free operation.

The hydraulic size and outflow characteristic of the spillway will be determined by routing the design flood. The specific dimensions for the spillway will be developed considering the topography and foundation conditions.

The ungated spillway that is made of class "A" reinforced concrete has an ogee type weir. This will be located on the right abutment. This is designed to safely permit the passage of the routed maximum flood. The spillway is so aligned in order that it would discharge directly to the river streambed. The inclined chute will terminate with a Type II stilling basin. The high-water velocities and large pressures would need to be controlled to avoid serious scour, erosion, or damage to adjacent structures. Constructions of the spillway would require a deep cut and the large volume of excavation could be used for the dam embankment.

Spillway structure size shall be determined by flood routing to accommodate not only the design discharge but also higher discharges and at the same time considering economic considerations so that danger of overtopping the dam is practically eliminated.

Spillway structure size shall be determined by flood routing to accommodate not only the design discharge but also higher discharges and at the same time taking into account economic considerations, so danger of overtopping the dam is practically eliminated. In the case of Cabacanan SRIP, the 10,000-year flood was used to check for overtopping because this discharge is practically equivalent to the Probable Maximum Flood (PMF). According to a report prepared BY Japan International Cooperation Agency (JICA) to the Department of Public Works and Highways (DPWH), these discharges are not that much different. The National Irrigation Administration (NIA) also, is of similar opinion.

Diversion and Outlet Works

To divert river flows during construction conduits be constructed along the river channel. The diversion conduit in combination with a cofferdam would protect against the 5-year flood frequency. After construction, the conduit at the left bank may modified and incorporated into the outlet works for releasing water needed for irrigation. The outlet works would include an inlet trash rack structure, a vertical intake shaft connecting the inlet structure to the horizontal conduit and high-pressure gates installed on a gate house constructed at the terminus of the outlet.

The outlet work for Cabacanan SRIP was located at the left abutment facing upstream. The left abutment is an almost vertical cliff made of rock so that the outlet work will have firm foundation. Based on hydrologic data the 5-year flood frequency discharge of Cabacanan River is fairly large at 259.93 cms. It is estimated that to divert this discharge during construction will require at least two (2) rows of 3-meter diameter conduit at the outlet work. Flood routing was also be employed to the conduits of the outlet work to determine conduit size and height of cofferdam. At early stage of construction, a cofferdam will be constructed to help divert river flow to the conduits. The cofferdam, eventually, will become an integral part of the embankment of the dam. As there are two rows of conduit at the outlet work, one row will become conveyance for irrigation flow and the other row will be plugged. The irrigation water is diverted from the dam through a main diversion canal and distributed to the main canals and sub-laterals.

Reservoir

In a multi-purpose river project, clearing of the reservoir is essential to its operation. Prevailing winds and watershed flow conditions move trees, logs and other debris to

the shoreline and outlets of the reservoir. Under extreme flood conditions with high flows passing through the spillway, large trees and other floating debris could plug the spillway to a certain degree, thereby reducing the spillway outflows to a point of endangering the safety of the dam. In this respect, the project plans anticipate the removal of all trees, brushes, and other structures below the top of the maximum reservoir water surface elevation.

Dam Instrumentation

To monitor the performance of the dam, an extensive package of instruments will be installed in the dam body during construction. These would monitor settlements, deformations, pore pressures and total loads or pressures within the various elements of the structure. The instrumentation package would include piezometers, inclinometers, internal movement and strain gauges, total pressure cells, settlement gauges and surface monuments. In addition, high sensitivity micro-seismic recorders and strong motion seismographs would be installed to monitor seismic activity and the response of the dam to earthquake.

The other dam appurtenances description like Hydraulic Design of Irrigation Canal and the Types of Canal Structures are presented in **Annex A** and **Annex B**, respectively.

3.1 ENVIRONMENTAL SCREENING

3.1.1 Environmental Problems Associated with the Construction Phase

a) Sources of eroded materials. Excavation will be required for the dam and for the irrigation canal. The dam site will be the greatest source of increased sediment as construction will need to be undertaken within the channel bed. Construction/Rehabilitation of the main and lateral canals can be done in a dry environment which will allow sediments to be contained within the system. At the commencement of operation when the canals are first filled, any loose sediment will be carried into the service area, not into the water courses. It is normal practice for NIA to transport any surplus excavated materials to areas where they may be used as base fill for roads and canal to lift these areas above the ground level of the service area. Sediments that enter the system will have little overall impact on aquatic life as this has already evolved under a wide range of turbid conditions. Under non mitigated conditions there may be a small impact on aquatic life and a moderate impact on water quality for water supplies and household use. This impact can be mitigated by ensuring that the contractor uses; (i) good construction practices which are specified within the contract documents (ii) that major excavation work is scheduled for the dry season and (iii) that a Site Protection and Rehabilitation Program is included within the contract documents. During the drawing up of Specifications and Contract Documents the Environmental Unit of NIA will be required to stipulate conditions that will ensure environmental integrity is maintained during construction.

b) Other construction hazards. Workers will be brought into the area and worker camps will need to be properly constructed to provide a safe and healthy work environment. Camps will need to be supplied with potable water and adequate washing and sanitation facilities. This will be the Contractor's responsibility, and this will need to be included as a requirement within the Contract Documents.

3.1.2 Waste Materials that maybe Produces during Construction Phase and Alternatives for Decision for the Proposed Area

During construction, several types of wastes will be generated. Some of thesewill be able to be broken down and assimilated without problem into the environment while others will be resistant to breakdown, and some may also be toxic. It is this last group that will need to be carefully evaluated and properdisposal methods determined.

i. Gravel crushing and screening areas and concrete batching plants should be sited at least 500 m away from camp sites and construction areas so that dust and noise generated by these operations does not impact on workers' health. Washings from these areas should be intercepted and treated. Bulk cement delivery rather than bags should be used wherever possible to reduce dust emissions and eventual problems with disposing of the large number of bags.

ii. Fuel and oil storage areas should be located well away from any water courses and be provided with interceptor traps so that accidental spills do not contaminate the aquatic environment. All waste oil should be stored and disposed to acceptable oil industry standards. Refueling should wherever possible be carried out at the fuel storage area and never allowed within or adjacent to watercourses.

iii. Camp and construction areas will need to be provided with septic sanitation facilities. No untreated human waste should be allowed to enter any water course where this will affect downstream water quality, aquatic environments, and human health.

iv. An industrial waste collection system will be needed to collect and process waste. Plastic containers that have been used for chemicals must be destroyed so that these do not re-enter use as household watercontainers.

v. When construction is completed, the Contractor must be directed to clean up the construction site by removing all equipment and buildings and carry out site remediation work. This will need to be included as a clause within the Contract Documents and specifications determined.

vi. Excavated Earth Materials there will be tremendous amount of excavated materials from river bed down to the rock portion of the proposed damsite. This concern is the same in the riverbank to embed the dam to the rock portion. There are also trees and plants that needs to be cleared. Hence, there will be proper method and procedure to dispose these materials and debris to a place that will be jointly identified by NIA, concerned LGU and other higher authorities, as not

vii. to adversely affect the community. With regards to the construction of irrigation canals and canal structures, some excavated materials shall be used as backfills and the rest be disposed to areas as identified by NIA in coordination with concerned LGU

viii. Eroded Materials due to heavy excavations during construction, there will be disturbance of the natural ground and side hill. Hence, there willbe loose materials that will be eroded and slide down to the river downto the service area and may even flow outside the river due to heavy siltation, if not being properly managed. To mitigate this problem, therewill be proper method and procedure to be followed considering the approved working plans, designed slope at side hills, and other slope stabilization measures to prevent erosion and slides at nearby affectedareas.

ix. Monitoring of construction works. The NIA, the DENR, the LGU will all have supervisory responsibilities about the Contractor's duties in meeting the environmental specifications that will be stipulated in the Environmental Management Plan (EMP) and in the DENR Environmental Compliance Certificate (ECC) requirements. In this case no concerns have been identified regarding this possible impact.

A. Main Environmental Threats

The construction of the reservoir dam and appurtenant structure is expected to improve the agricultural production of Pagudpud. However, the development of irrigation will generate both potential negative and positive impacts to the environment and community. In this situation, an assessment and evaluation of identified impacts is carried out. Using the checklist that contains a listing of the possible impacts that are associated in each stage of development (Pre-construction, Construction and Operation) was carefully assess and presented in **Table 3-2**.

Table 3-2: Summary of Potential Environmental Impacts of Dam Construction

Environmental Aspect	Environmental Impact	Magnitude	Duration
I. PRE-CONSTRUCTION PHASE			
The Land	Soil erosion due to construction area preparation and clearing	low	medium
	Change in land use	moderate	long
	Increased solid waste generation	low	short
The Water	Water quality impacts on water bodiesnearby	moderate	short
	Increased in total suspended solids concentration	low	short
The Air	Increase in air and noise pollution	low	short
The People	Opportunities for employment of local residents	moderate	medium
	Acquisition of Right of Way	moderate	long
II. CONSTRUCTION PHASE			
The Land	Terrain modification	low	long
	Soil and weathered rock displacement	low	short

Environmental Aspect	Environmental Impact	Magnitude	Duration
	Increased soil erosion	low	short
	Siltation of waterways	moderate	short
	Degradation of roads used during hauling of construction materials and heavy equipment movement: -National Roads -Provincial Roads	high	medium
	Increase in generation of solid wastes	low	short
	Land use change and change in landvalue	moderate	long
	Cutting of nearby trees	low	short
	Topography Change	low	long
	Natural drainage alteration	moderate	short
	Inducement land slides	low	short
	Wildlife displacement	low	short
	Loss, disturbance, and damage ofexisting vegetation	low	short
	Degradation of habitat of dependentspecies	low	short
The Water	River water quality changes	moderate	short
	Alteration of aquatic habitat	moderate	short
	Siltation of receiving river/creeks	low	short
	Water Pollution from sewage and machinery wastes	low	short
	Temporary displacement of aquaticspecies	low	short
The Air	Particulates and gaseous emissions increase	low	medium
	Noise level increase	low	medium
	Traffic increase on roads directing to construction / expansion area	moderate	medium
The People	Employment Opportunities	moderate	medium
	Livelihood and business opportunities	low	medium
	Potential health, sanitation, and safety concerns	low	short
	Security, peace, and order issue	low	medium
III. OPERATION PHASE			
The Land	Erosion at discharge points	low	short
	Change in land value	moderate	long
	Damage in landscape	low	short
	Land use conversion	low	long
	Increase in soil fertility	moderate	long
	Increase in vegetation cover	high	long
The Water	Reduction in sediment loads andorganic matter	high	short
	Improved and regulated water discharge and distribution	moderate	long
The Air	Particulates and gaseous emissions increase	low	short
	Noise level increase	low	short
The People	Employment Opportunities	moderate	medium
	Livelihood and business opportunities	low	medium
	Potential health, sanitation, and safety concerns	low	medium
	Migration and population increase	low	short

Environmental Aspect	Environmental Impact	Magnitude	Duration
	Increased accidents	low	medium
	Additional source of revenue	low	long
	Cultural change	low	long
	Technology transfer	moderate	long

Legend:
Low (within the project site only)
Moderate (within and outside the project site)
High (within the primary impact zone and outside the secondary impact zone)Short (0-6 months)
Medium (7 months – 3 years)Long
(more than 3 years)

B. Main Project Consequences

The increasing demand of Pagudpud, Ilocos Norte for fresh water sources as well as energy production has led to constant attention to damming as one of the main pillars of developmental approaches. Moreover, sustainable management of scarce agricultural water resources is an unavoidable necessity for countries facing the incremental water demands and suffering from water deficiencies.

Usually, construction of dams has led to the compulsory purchase of land and displacement of large part of the rural population. However, there will be only few populations that will be relocated to give way in the construction of Cabacanan SRIP. As per the Pagudpud LGU, majority of the land was already acquired by NIA. However, the study team is still in the process of confirming the claim of Pagudpud LGU.

Furthermore, the Pagudpud municipality extracts water for domestic use through Vira-Vira Rural Waterworks and Sanitation, Pagudpud Water and Barangay Saguigui Water Cooperatives. The three (3) water providers of the municipality may relocate some of their pipes to give way to the Cabacanan dam construction.

3.2 PROJECT COST AND DURATION

3.2.1 Project Cost

Below are the estimated costs of the project:

Table 3-3: Summary of Project Cost

Component	Total Cost (Php x1000)
Direct Cost	
Dam Reservoir and Appurtenant Structures including Dam Instrumentation	627,921.33
Irrigation Facilities	21,428.77
LARP/Environmental Concerns	28,983.00
Total (Direct Cost)	678,333.10
(Indirect Cost)	159,408.28
Grand Total	837,741.38

The detailed breakdown of project cost is tabulated in **Table 3-5**.

Table 3-4: Breakdown of Cost Estimates

Item of Work	Unit	Quantity	Unit Cost	Total (1000)
DIRECT COST				
I. DAM, RESERVOIR & APPURTENANT STRUCTURES				
A. PRE-CONSTRUCTION				
1. Right-of-Way and Damages	l.s.	l.s	l.s	20,000.00
2. ROW Negotiation and Documentation	l.s.	l.s	l.s	1,500.00
3. Mob/Demob/Temp. Works and Facilities	l.s.	l.s	l.s	2,033.10
4. Reservoir Clearing	sq.m	159,670.00	3.74	2,194.03
5. Access Road	km	8.10	450,000	3,645.00
6. Diversion & Care of Creek during Pre-construction	l.s.	l.s	l.s	3,444.00
Sub-Total (A.1. to A.6.)				32,816.13
B. DAM FOUNDATION				
1. Stripping	cu.m	70,551.00	115.24	8,130.30
2. Cut-off Trench Excavation				
a. Rock	cu.m	29,363.00	300.00	8,808.90
3. Cut-off Trench Refill	cu.m	29,363.00	400.00	11,745.20
4. Testing	l.s.	L.S	L.S	1,587.30
5. Grouting				
a. Grout Cap				
i. Excavation	cu.m	220.00	325.00	71.50
ii. Concrete	cu.m	220.00	5,637.00	1,240.31
b. Drilling Grout Holes	l.m.	2,200.00	3,000.00	6,600.00
c. Pressure Grouting	each	440.00	6,000.00	2,640.00
d. Cement for Grouting	bags	11,576.92	1,600.00	18,523.08
e. Pipes and Fittings	kg	1,846.15	100.00	184.62
f. Hook up and Accessories	pcs	338.46	500.00	169.23
Sub-Total (B.1. to B.5.)				59,700.43
C. DAM EMBANKMENT				
1. Impervious core	cu.m.	198,171.00	400.00	79,268.40
2. Gravel and sand and gravel filter				
Gravel	cu.m.	1,788.00	103.43	184.93
Sand	cu.m.	1,788.00	103.43	184.93
Gravel	cu.m.	1,788.00	103.43	184.93
3. Random fill				
A) vibratory roller compacted rockfill	cu.m.	563,164.00	400.00	225,265.60
4. Boulders	cu.m.	9,780.00	359.00	3,511.02
Gravel beddings'	cu.m.	6,300.00	994.30	6,264.09
5. Drainage blancket	sq.m.	13,063.00	168.36	2,199.29
6. Rock toe berm	cu.m.	70,551.00	359.00	25,327.81
7. Crest surfacing	cu.m.	900.00	788.59	709.73
SUB-TOTAL (C-1 TO C7)				346,960.61
TOTAL (I-C)				346,960.61
D. SPILLWAY				

Item of Work	Unit	Quantity	Unit Cost	Total (1000)
1. Excavation				
a. Common	cu.m	107,189.00	200.00	21,437.80
b. Rock	cu.m	242,019.00	300.00	72,605.70
2. Class "A" Concrete	cu.m	4,780.00	5,637.	26,948.54
3. Reinforcing Steel Bars	kg	191,200.00	38.00	7,265.60
4. Plain Riprap	cu.m	560.00	520.00	291.20
5. Gravel Bedding	cu.m	1,030.40	994.30	1,024.53
6. Structural Backfill	cu.m	9,866.24	395.00	3,897.16
7. Steel Railing	l.m.	190.00	1,650.	313.50
8. Drilling & Grouting	l.s	L.S	L.S	900.00
Sub-Total (D.1. to D.8.)				113,246.23
E. DIVERSION AND OUTLET WORKS				
1. Excavation in Horizontal Tunnel	cu.m	49,751.00	200.00	9,950.20
2. Class "A" Concrete	cu.m	8,361.36	5,637.	47,139.42
3. Reinforcing Steel Bars	kg	334,454.40	38.00	12,709.27
4. Concrete Plug	cu.m	126.48	5,636.	712.88
5. Trashrack & Miscellaneous Metal Works	l.s	L.S	L.S	2,260.13
6. Structural Backfill	cu.m	112.69	400.00	45.08
Sub-Total (E.1. to E.6.)				72,816.98
F. DAM INSTRUMENTATION	l.s.	L.S	L.S	2,380.95
SUB-TOTAL (F)				2,380.95
TOTAL (I.A TO I.F)				627,921.33
II. IRRIGATION FACILITIES				
A. MAIN CANAL AND LATERAL CANAL				
1. Canalization	L.S	L.S	L.S	16,520.04
2. Canal structure	L.S	L.S	L.S	792.46
Sub-Total (A.1. to A.2.)				17,312.50
B. ON-FARM FACILITIES/ STATION/ QUARTER	L.S	L.S	L.S	3,992.70
Sub-Total (B)				3,992.70
C. GATEKEEPERS QAURTERS				
a. Buildings	sq.m	20.00	5,216.25	104.33
b. Fence and Sanitary Facilities	unit	1.00	19,247.50	19.25
Sub-Total (C)				123.57
TOTAL (II.A TO II.C)				21,428.77
SUB-TOTAL CIVIL WORKS				649,350.10
D. LARP/ENVIRONMENTAL CONCERNS	L.S	1.00		28,983.00
TOTAL (DIRECT COST)				678,333.10

3.2.2 Project Duration

The following duration is projected for this project:

1. Pre-Construction Phase

    - Pre-feasibility Study/Topographic Survey – 1 year
    - Detailed Design – 1 year
    - Procurement & Award - 6 months
    - Right of Way Acquisition – 1 year

2. Construction Phase – 3 years

3. Operational Phase – immediately after test run and commissioning

ANNEXES

Annex A : A HYDRAULIC DESIGN OF IRRIGATION CANAL

Concrete-lined rectangular section, will be adopted in the design of irrigation and drainage facilities as resulted based on the Value Engineering/Value Analysis conducted. This type will give the highest value for a lower cost per linear meter. Although it requires longer construction period and skilled laborers, it is still recommended to have the canals concrete-lined as to reduce loss of water due to conveyance and seepage during transmission. In addition, here are the advantages ofconcrete-lined canals:

- Reduce seepage losses through channels reduces the possibility of damage to the adjoining lands by water logging;
- Reduce the area of cross section, by way of reduced cost of earth works, structures and land compensation, due to increase permissible velocity achieved by reduction in value of roughness coefficient;
- Make steeper side slopes and bed slope possible as the lined section is immune from erosion;
- Permit more winding alignment resulting in saving in embankment and cutting costs; and
- Prevent weed growth thereby resulting in saving of expenditure incurred on weed removal in the case of earthen channels.

Irrigation canals were designed wherein a maximum area could be served with a balance earthworks. The design was based on the National Irrigation Administration (NIA) Standards. One side of the main and lateral canals will be wide enough (standard size) to accommodate light vehicles.

Canal elements were able to determine by the used of Manning's Formula for open channel flow:

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Q = AV = Discharge in cms

Where :

V = mean velocity of flow in the channel, mps
R = hydraulic radius = A/P
A = cross section of flow, m^2
P = wetted perimeter, m
S = Hydraulic gradient (based on NIA criteria)
n = roughness coefficient

Freeboard was provided for flexibility to prevent any overtopping of canal banks. Increase in water level due to storm water inflows, wave action, errors in discharge regulations or any possible reasons that will result to the increase was anticipated. Thefollowing was adopted in formulating the design freeboard:

For d > 2 meter

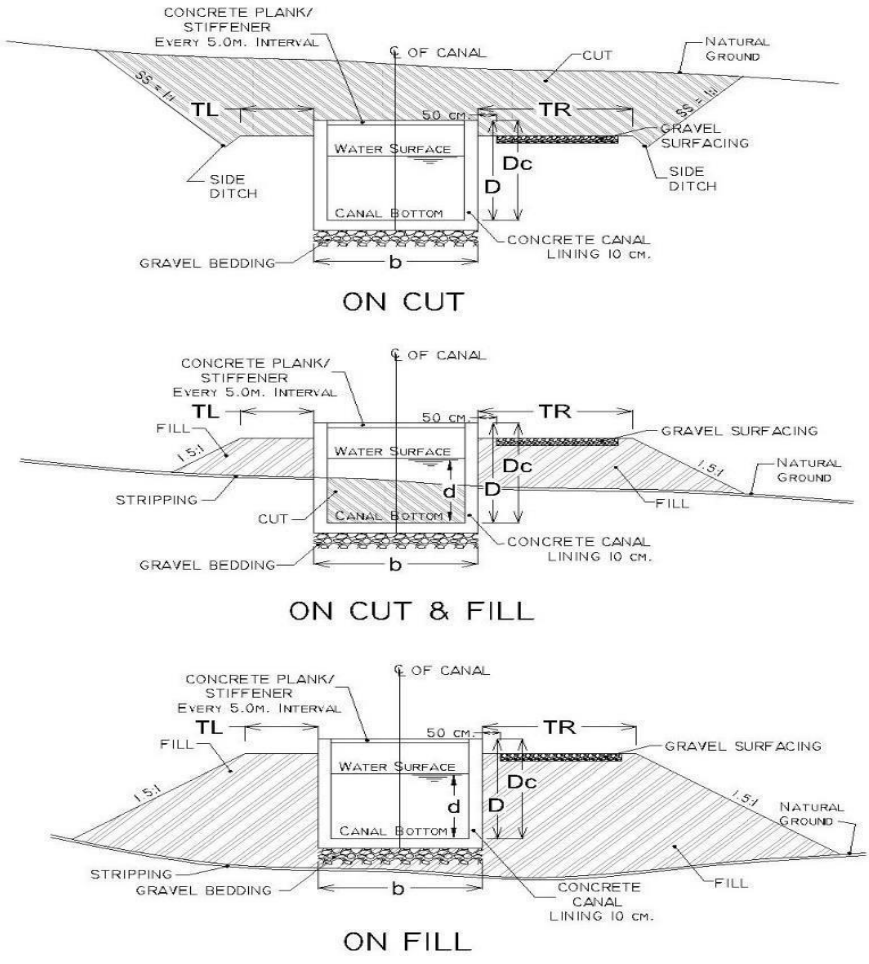
Freeboard, FB = 0.25d + 0.30 (in meters)
Depth of Canal (D) = d + FB

For d < 2 meters

Freeboard, FB = 0.40d (in meters)
Depth of Canal (D) = d + FB

**Note that the Minimum FB = 0.30 meters*

Plan and profile of the proposed main canal, Schematic Diagram and On-farm Level Facilities are shown in the Engineering Drawings.



Typical Canal Section Plan

ANNEX B: STATION AND TYPES OF CANAL STRUCTURES

Table 1: Elements of Main Canal

STATION (m)	DISCHARGE (cms)	VELOCITY (m/s)	ARE A (m^2)	b (m)	d (m)	D (m)	SLOPE	n
0+000.00 to 0+965.73	0.750	2.27	0.33	0.60	0.58	0.90	0.015	0.018
0+965.73 to 1+400.00	0.716	2.25	0.32	0.60	0.57	0.90	0.015	0.018
1+400.00 to 2+062.23	0.716	1.49	0.48	0.70	0.70	1.00	0.005	0.018

Table 2: Elements of Lateral A

STATION (m)	DISCHARGE (cms)	VELOCITY (m/s)	AREA (m^2)	b (m)	d (m)	D (m)	SLOPE	n
0+000.00 to 2+051.67	0.031	0.73	0.05	0.25	0.21	0.55	0.005	0.018

Table 3: Structures along Canals

Station	Type of Structure
- Main Canal -	
0+500.00	Thresher Crossing
0+900.00	Thresher Crossing
0+965.73	Head Gate of Lateral A
1+300.00	Thresher Crossing
1+700.00	Thresher Crossing
2+062.23	End Check
- Lateral A -	
0+450.00	Thresher Crossing
0+900.00	Thresher Crossing
1+400.00	Thresher Crossing
1+600.00	3-m Drop
1+800.00	Thresher Crossing
2+051.67	End Check

ANNEX C: CABACANAN SRIP PROPOSED STORAGE CAPACITY

The proposed project aims to utilize the water resources potential of Cabacanan River for irrigation purposes. It involves the construction of a dam and its appurtenant structures across Cabacanan River in Barangay Saguigui, in the Municipality of Pagudpud, Provine of Ilocos Norte. Other features would include canal network and pertinent structures such as intake, farm ditches, siphon, flume, etc. on farm facilities such a farm ditches,drains and other appurtenant structures are also included.

The project envisaged the construction of a 36.10 m high dam. Water will be impounded during the wet season and releases would be regulated to supply the water demands for irrigation during dry seasons. The service area for irrigation is about 260 hectares of agricultural lands in the municipality of Pagudpud in the province ofIlocos Norte.

The Cabacanan SRIP Feasibility Study described the proposed dam with a height of 36.1 m above the streambed, a dam crest width of 10m and a crest length of 297.72 m. The zoned embankment (with climate change) dam will be located at N 18˚ 33' 35.76"E 120˚ 50' 6.06"with an irrigable area of 260 hectares and 245 hectares for wet and dry season, respectively. **Table 1** shows the proposed dam description.

Table 1- Proposed Dam Description (Cabacanan SRIP FS, 2019)

HYDROLOGICAL DATA		
Source of Water		Cabacanan River
Drainage Area above Dam	Km^2	9.71
Mean Annual Rainfall	mm	2,085.1
DESIGN DATA		
Dam		Zoned Embankment
Type		
Height above streambedCrest	m	36.10
Elevation	m	95.10
Crest Length	m	294.72
Crest Width	m	10.00
Maximum Base Width	m	204.05
Face Slope: Upstream		3:1
Downstream		2.5:1
Riverbed Elevation	m	59.00
Saddle Dike		
Dike Height Crest	m	1
Elevation Crest	m	95.10
Length Crest	m	36.00
Width	m	215
Maximum Base Width	m	3:1
Face Slope: Upstream		2.5:1
Downstream		
Spillway		
Type		Ungated
Spillway width	m	40
Design Capacity (500 years return period with climate change)	cms	588.21

Diversion ConduitType Number/Size (diameter) Design Capacity (5 year Flood)	 m m cms	 Channel 2- 3.0 259.93

Based on the engineering data presented in **Table 2**, the proposed Cabacanan SRIP dam has an approximate minimum, normal, maximum, and effective storage capacity are 0.254 MCM, 2.503 MCM, 3.122 MCM and 2.249 MCM, respectively as shown in Table 2 below.

Table 2 : Cabacanan SRIP Storage Capacity

Particulars	Elevation	Capacity	References
	m	MCM	
Minimum Storage	69.08	0.254	Reservoir Operation Simulation Result of the FSR
Normal Storage	89.22	2.503	Reservoir Operation Simulation Result of the FSR
Maximum Storage	92.89	3.122	Interpolated as per Elevation-Capacity Table of the FSR
Effective Storage		2.249	Normal Storage- Minimum Storage

**FSR – Feasibility Study Report*