IRRIGATION DEPARTMENT
MINISTRY OF AGRICULTURE AND IRRIGATION
THE REPUBLIC OF THE UNION OF MYANMAR

PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEMS

FINAL REPORT (SUMMARY)

AUGUST 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
SANYU CONSULTANTS INC., JAPAN

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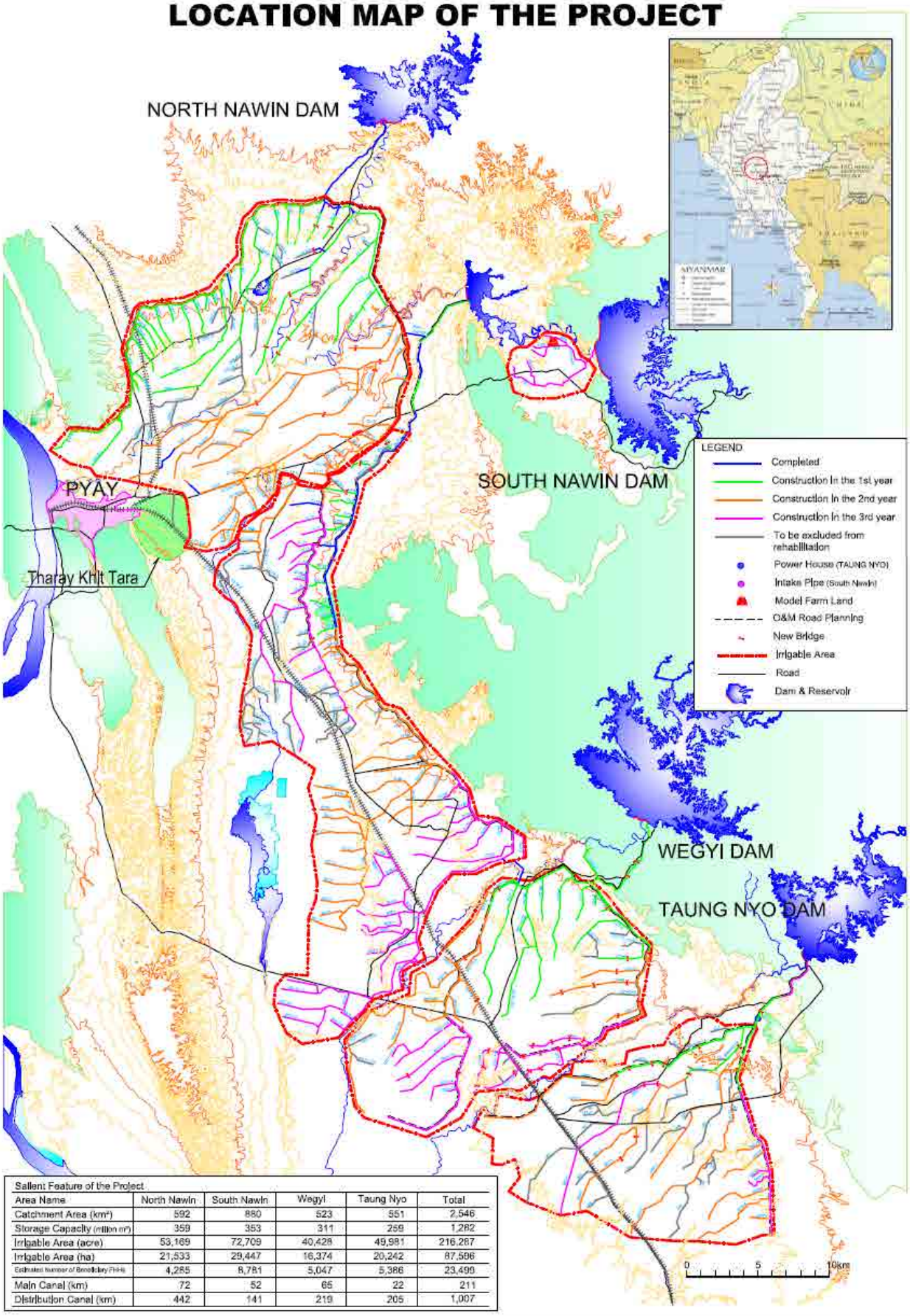
14-066

LOCATION MAP OF THE PROJECT



Salient Feature of the Project

Area Name	North Nawin	South Nawin	Wegyi	Taung Nyo	Total
Catchment Area (km²)	592	880	523	551	2,546
Storage Capacity (million m³)	359	353	311	259	1,282
Irrigable Area (acre)	53,169	72,709	40,428	49,981	216,287
Irrigable Area (ha)	21,533	29,447	16,374	20,242	87,596
Estimated Number of Beneficiary (HH)	4,285	8,781	5,047	5,386	23,499
Main Canal (km)	72	52	65	22	211
Distribution Canal (km)	442	141	219	205	1,007

CONTENTS

ACRONYMS AND ABBREVIATIONS

AED	Agricultural Extension Division
AMD	Agriculture Mechanization Department
CARTC	Central Agriculture Research and Training Centre
CBM	Central Bank of Myanmar
CD	Cooperative Department
CIF	Cost, Insurance and Freight
CSO	Central Statistical Organization
DAP	Department of Agricultural Planning
DAR	Department of Agriculture Research
DOA	Department of Agriculture
DAR	Department of Agriculture Research
ESE	Electricity Supply Enterprise
FAO	Food and Agriculture Organization
FHH	Farm Household
FOB	Free on Board
GAD	General Administration Office
GDP	Gross Domestic Product
GOJ	Government of Japan
GOM	Government of Myanmar
GRDP	Gross Regional Domestic Product
HDI	Human Development Index
HH	Household
ICM	Integrated Crop Management
ID	Irrigation Department
IRR	Internal Rate of Return
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
LBVD	Livestock Breeding and Veterinary Department
MADB	Myanma Agricultural Development Bank
MC	Ministry of Cooperatives
MEPE	Myanmar Electric Power Enterprise
MFI	Micro Finance Institution
MFTB	Myanma Foreign Trade Bank
MICB	Myanma Investment and Commercial Bank
MOAI	Ministry of Agriculture and Irrigation
MOEP	Ministry of Electric Power
MOF	Ministry of Forestry
MOLF	Ministry of Livestock and Fisheries
NGO	Non-Government Organization
NPK	Nitrogen, Phosphate, Potassium
ODA	Official Development Assistance
OFID	OPEC Funded International Development
PPP	Purchasing Power Parity
SLRD	Settlement and Land Records Department
TS	Township (the smallest administrative unit where government institutions are placed)

UNDP	United Nations Development Programme
WFP	World Food Programme
WRUD	Water Resources Utilization Department
YAU	Yezin Agriculture University
YESB	Yangon Electricity Supply Board

FARMLAND TERMS IN MYANMAR

Le	Paddy land or wet land which can be used as paddy land
Yar	Upland
Kaing	Farmlands which appear in the flood lands in Ayeyarwady River as the water recedes
Kyun	Farmlands which appear on the alluvial sandbars in Ayeyarwady River as the water recedes

UNIT CONVERSION

1 basket	Paddy	20.9 kg
1 basket	Wheat	32.7 kg
1 basket	Maize (seed)	24.9 kg
1 basket	Sorghum	28.1 kg
1 basket	Sesame	24.5 kg
1 basket	Mustard	26.1 kg
1 basket	Sunflower	14.5 kg
1 basket	Groundnut	11.4 kg
1 basket	Butter Bean	31.3 kg
1 basket	Sultani	31.3 kg
1 basket	Sultapya	31.3 kg
1 basket	Chickpea	31.3 kg
1 basket	Pebyugalay	31.3 kg
1 basket	Pegyi	31.3 kg
1 basket	Pegyar	31.3 kg
1 basket	Pigeon Pea	32.7 kg
1 basket	Black Gram	32.7 kg
1 basket	Green Gram	32.7 kg
1 basket	Bocate	32.7 kg
1 basket	Soybean	32.7 kg
1 basket	Cowpea	32.7 kg
1 basket	Peyin	32.7 kg
1 basket	Sadawpea	32.7 kg
1 basket	Payazar	32.7 kg
1 basket	Pe-nauk	32.7 kg
1 basket	Other Pulses	31.7 kg

Rice (1) basket	16 pyi
	75 pounds
	34.0136 kilograms
Rice (1) pyi	4.6875 pounds
	2.1258 kilograms
Rice (1) can	0.5859 pound
Rice (1) kilogram	3.7636 cans

1 pyi	8 nohzibu
1 basket	16 pyi

1 viss	1.633 kg
1 viss	3.6 pounds
1 lb (pound)	0.453 592 kg
1 kilogram	2.205 pounds
1 ton (long ton)	2240 pounds
1 metric ton	1000 kilograms
	2204.623 pounds
1 Kg	0.6124 Viss
1 pond	0.4536 kg
1 kg	2.2046 ponds
1 Gallon	4.5461 litre
1 Litre	0.2200 Gallon

1 inch (in.)	2.54 cm
1 feet (ft.)	30.5 cm
1 meter	3.279 feets
1 kilometer	0.621 mile
1 mile	1.601 kilometer
1 acre (ac)	0.40468 ha
1 hectare (ha)	2.471 ac
1 ac-ft	1233.4 cum
1 square kilometer	0.386 sq.mile

CURRENCY EQUIVALENTS (AS AT JUNE 2014)

1 US$	=	101.68 Japanese Yen (TTB)
1 Kyat	=	0.106 Yen
1 US$	=	959 Myanmar Kyats
1 lakh	=	100,000 Kyats

MYANMAR FINANCIAL YEAR

April 1 to March 31

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PART I

REHABILITATION OF IRRIGATION SYSTEMS

CHAPTER 1 RATIONAL AND GOAL OF THE PROJECT

1.1 Rationale of the Project

The Project targets 4 irrigation systems located in two districts of Pyay and Thayarwaddy. Irrigation systems in Pyay and Thayarwaddy districts were firstly planned in "Irrawaddy Development Master Plan, 1980", and its project implementation was commenced from 1980. The area is located at a western part of Bago Yoma (mountain range) and rainfall in the area is rather limited because humid air coming from southern side generates rain just at Bago Yoma, not at the area around. This is one of the major reasons why the irrigation projects were planned and implemented in the area and such irrigation projects have been playing important roles in agriculture sector to secure stable farming.

After commencement of the operation for the irrigation projects, Irrigation Department (ID) under Ministry of Agriculture and Irrigation (MOAI) has carried out maintenance and rehabilitation works for those projects; however, due to shortage of budget allocation under the former government, irrigation systems of such projects have seriously been deteriorated year after year. Consequently, Irrigation Department can now hardly operate the irrigation systems as planned and the farmers have been facing difficulties in obtaining irrigation water in time and in terms of quantity.

Under such situation, Irrigation Department has requested JICA to survey and formulate necessary rehabilitation plans for the 4 irrigation systems put back to the originally planned functional level, possibly bringing about ODA loan for the implementation of rehabilitation works as early as possible. Responding to this request, Japanese Government sent a preliminary survey team in June/August 2012, and concluded the implementation of this Survey as stipulated in the Minutes of Discussions (MD) signed on August 1, 2012. Then, JICA organized a team of experts in charge of the formulation of rehabilitation plan, and the Team had arrived in Myanmar on March 18, 2013 for the conduct of necessary surveys. The Team has completed all the required surveys with the submission of this Report.

1.2 Objectives of the Project and the Survey

Objective of the Project stated in the MD is to increase agriculture production through recovery of the irrigated land by rehabilitating the irrigation systems, whereby contributing to food security and livelihood improvement of the people concerned. Towards the project objective to be achieved, this Survey aims at formulating a rehabilitation plan and also examining the feasibility based upon the project cost and benefit. The Survey starts with status assessment of the target irrigation schemes for rehabilitation, and then conducts identification of works for rehabilitation, cost estimation, benefit estimation, environmental examination, and also project economic analysis, etc.

In addition, farmland consolidation is also one of the project components to be piloted under the Survey. Farmland consolidation is carried out together with the establishment of irrigation and drainage network including farm roads. This farmland consolidation facilitates, aside from increasing harvest thanks to the irrigation and drainage network established, farm mechanization given leveled and consolidated farmland composed of number of rectangular shaped plots. A pilot project, as a model case, is planned to implement in Zabu Thiri township of Nay Pyi Taw City, based on which its idea of farmland consolidation could be applied in those 4 targeted irrigation schemes.

1.3 Scope and Schedule of the Survey

To attain the survey objectives aforementioned, this Survey conducts following activities;

1) Survey for the rehabilitation of main canals,
2) Survey for the repairing of access roads to dams,

3) Survey for repairing inspection roads along the main canals and farm roads running along with distribution canals,
4) Survey for repairing and reconstruction of check gates, secondary gates, and weirs,
5) Survey for the rehabilitation of secondary canals,
6) Identification of works for rehabilitation based on above activities, and cost estimation related,
7) Estimation of project benefits and accordingly economic analysis,
8) Environmental and social examination/ consideration for the rehabilitation projects,
9) Implementation arrangement demarcated by ODA loan and the Government own budget, and
10) Other necessary and relating surveys including pilot farm establishment for land consolidation.

The Survey to formulate rehabilitation plan is completed within 10 months from March to December 2013. On the way, a progress report was prepared and submitted to ID in July 2013, and the draft final report submitted in October 2013. Model farm establishment for land consolidation in Nay Pyi Taw City is carried out over almost one year, completed by mid 2014 taking into account off-farm period, during which the consolidation work can be carried out. Note that this time-frame for the land consolidation work was agreed between JICA and ID at the Inception Report explanation meeting held on April 9, 2013. Following are the overall work schedule of the Survey and the farmland consolidation in Nay Pyi Taw;

Table 1.3.1 Overall Schedule of the Survey and Farmland Consolidation

Year	2013										2014							
Month	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
Survey for rehabilitation	■	■	■	■	■	■	■	■										
Farmland Consolidation		■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Report	IC/R				PR			DFR										FR

Where; IC/R: Inception Report, PR: Progress Report, DFR: Draft FR, FR: Final Reportl

CHAPTER 2 THE SURVEY AREA

2.1 Spatial Settings, Area and Beneficiaries

The Survey area, composed of 4 irrigation systems, is located in an eastern area of Ayeyarwaddy river, just western side plain of Bago Yoma (mountain range). These irrigation systems are lined up from north to south, i.e., North Nawin irrigation system, South Nawin irrigation system, Wegyi irrigation system, and Taung Nyo irrigation system, all of which are located at a northwestern part of Bago region. These systems spread over two districts, i.e. North Nawin, South Nawin, and Wegyi irrigation systems are under Pyay district while Taung Nyo irrigation system falls under Thayarwaddy district.

North Nawin Irrigation System is located at the north edge of the Survey area with about 310 km distance from Yangon. Contrary, the southern edge of the Survey area is at Taung Nyo Irrigation System and it has about 200 km distance from Yangon. The irrigable areas for the 4 irrigation systems given by SLRD and ID are shown in upper rows of Table 2.1.1. The net irrigable area ranges from 40,428 acre (16,361 ha) to 72,709 acre (29,424 ha) with the total area of 216,287 acre (87,527 ha). Note that the original downstream area of North Nawin, 23,732 acre, is now supplied irrigation water by South Nawin system, whereby the area is counted as part of South Nawin.

The number of beneficiary farmers is unfortunately not available. Therefore, to estimate the beneficiary numbers, an average farmland area estimated through a household questionnaire survey

conducted by JICA Survey team is employed. The survey identified an average farmland area per farmer ranging from 8.01 acre to 12.72 acre by irrigation system, with an overall average farmland of 9.91 acre (4.01 ha). Applying this average farmland area to the net irrigable area by irrigation system, the estimated beneficiary households are between 5,047 and 8,781 by system, totaling to 23,394 households equivalent to 116,738 population.

Table 2.1.1 Estimated Irrigable Area and Beneficiaries in Four Irrigation Systems

Items	N. Nawin	S. Nawin		Wegyi	T. Nyo	Total
Net Irrigable Area (acre) 1/	53,168.54	72,708.66		40,428.42	49,981.31	216,286.93
Upstream Area (acre)	27,679.15	26,886.33	(1,440.30)	19,455.36	16,611.77	90,632.61
Midstream Area (acre)	25,489.39	23,949.60	(6,577.00)	10,096.25	18,988.74	78,523.98
Downstream Area (acre)	0.00	21,872.73	(15,715.00)	10,876.81	14,380.80	47,130.34
Original N. Nawin DS Area (acre)	(23,732.30)	-	(23,732.30)	-	-	-
Net Irrigable Area (ha)	21,516.24	29,423.74		16,360.57	20,226.44	87,526.99
Average Farmland (acre) per FHH 2/	12.72	8.28		8.01	9.28	9.91
Average Farmland (ha) per FHH 2/	5.15	3.35		3.24	3.76	4.01
Estimated No. of Beneficiary FHHs	4,180	8,781		5,047	5,386	23,394
Estimated Beneficiary Population, 3/	20,858	43,818		25,186	26,876	116,738

Source: 1/ Irrigation Department, 2/ Household Questionnaire Survey conducted by JICA Survey Team covering 225 sample households in 2013, 3/ Family member is estimated at 4.99 according the Household Questionnaire Survey. Note: Downstream area of North Nawin Irrigation System receives irrigation water from South Nawin Irrigation System, for the downstream area is counted as part of South Nawin (see the numbers in brackets).

2.2 Meteorology, and Water Resources of the Four Irrigation Systems

Rainfall data in the Survey area is available at each of the 4 dam sites while temperature data is available only at Pyay meteorological station. Since the Survey area is located at a southern vicinity of the Central Dry Zone (CDZ), the annual rainfall is not enough to support monsoon paddy, ranging from 1,000 to 1,400 mm only per annum. Average annual temperature recorded at Pyay station comes to 28.1 C^o; January shows the lowest mean temperature of 24.7 C^o while the highest shows up in April with 31.8 C^o.

Water resources of the 4 irrigation systems are dam reservoirs. Bago Yoma is a mountain range running in between Ayeyarwaddy River and Sittaung River, which is the beginning point of the water source. From the mountain range, lots number of rivers flow into the reservoirs. Annual rainfall around the mountain ridges of Bago Yoma reaches as much as 2,000mm or more but that of the Survey area is not enough as aforementioned. This is the major reason why dam reservoirs were planned and constructed as the sources of the irrigation systems.

In Myanmar, dam reservoir is basically designed to have a storage capacity able to store all the mean annual inflow running at the point of the planned reservoir. This is the reason why overflow through the dam spillway occurs not every year; it may take place once in several years only. Following table shows storage and effective capacity by each of the dam reservoirs:

Table 2.2.1 Storage Capacity and Effective Storage Capacity of Reservoirs (4 Reservoirs)

Dam Names	North Nawin	South Nawin	Wegyi	Taung Nyo
River Name	North Nawin	Nawin	Wegyi	Taung Nyo
Average Annual Inflow (million cubic meter)	201.2	300.1	277.1	358.0
Storage Capacity (million cubic meter)	358.8	354.0	311.0	259.0
Dead Capacity (million cubic meter)	41.9	33.3	31.0	26.0
Effective Storage Capacity (million cubic meter)	316.9	320.7	280.0	233.0
Ratio (Effective Storage Capacity/Inflow)	1.58	1.07	1.01	0.65
Net Irrigable Area, acre	53,168.54	72,708.66	40,428.42	49,981.31
Net Irrigable Area, ha	21,516.54	29,424.74	16,361.57	20,226.31
Total Irrigable Area, Acre (ha)	216,287 acre (87,529 ha)			

Source: Irriagtion Department

North Nawin dam reservoir has the largest capacity in comparison with the average annual inflow; wherein 1.58 times of the average annual flow can be stored in the reservoir. Overflow from the North Nawin dam reservoir is therefore recorded only 3 times[1] during the last 38 years since the operation commencement in 1976. Taung Nyo reservoir has a small storage capacity in comparison with the average annual inflow with the ratio of only 0.65, whereby overflow through the spillway takes place almost every year.

2.3 Salient Features of the Target Four Irrigation Systems

2.3.1 North Nawin Irrigation System

Irrigation service of this North Nawin irrigation system started in 1976, which means a period of 38 years has passed to date. Due to the limited budget allocation for maintenance works, there has been no major repairing works implemented for the major as well as appurtenant facilities. Partial repairs, though, for emergency cases were done by the Maintenance Division (Bago West). As is the case, presently, the system is in the condition to supply quite insufficient quantity of irrigation water against the demands due to various difficulties such as siltation in the canals, excessive vegetation of grasses and weeds on the canal surface, collapsing of brick and concrete lining, etc. Further to mention, the designed flow sectional area can not be secured in places due to the collapsed side slope of canals and damages on gate facilities for water diversion.

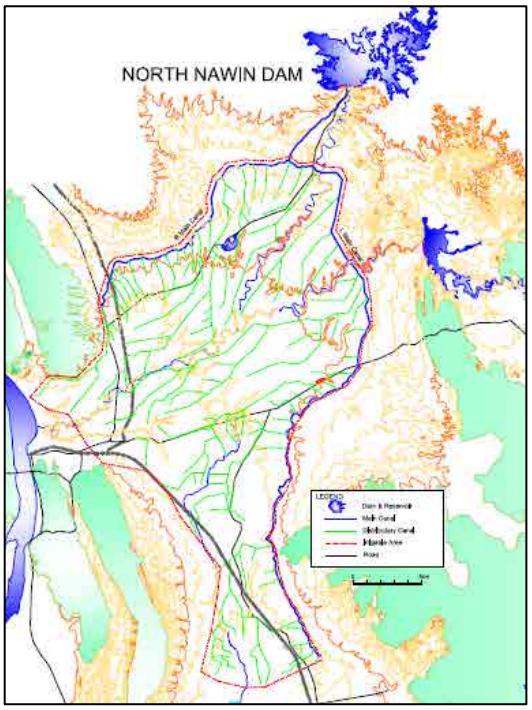


Figure 2.3.1 North Nawin Irrigation System
Source: Irrigation Department

Most of the irrigable area of North Nawin irrigation system is located on the eastern part from the national railway line and this area consists of mainly sandy soil and silty loam soil according to a design report[2] of the project. According to a site survey by the JICA survey team, damages were often observed at the places where back-filled soil beneath lining material seemed to be washed out by rainfall or water level decrease in the canals.

Based on the information provided by Irrigation Department, the Survey team examined a present irrigation area (2012-2013) for summer paddy plus black gram that it is limited only to 18,326 acre (7,416 ha), which is about 34% of the potential irrigable area[3] in this period. Through rehabilitation works, Irrigation Department estimates that the system can increase the supply capacity for an additional area of 25,371 acre (10,267 ha), whereby with the rehabilitation completed, a total area of 43,697 acre (17,683 ha) can be irrigated.

Salient feature of the North Nawin Irrigation System is summarized below;

1. Location	Near Sesongong Village, Pyay Township, Bago Region
2. Map Reference	985 M/SZ-768172 (1 inch=1 mile scale)

[1] Overflow is recorded in year of 2002, 2007, and 2011 only.
[2] North Nawin Irrigation Scheme Final Design, Volume 1, Irrigation and Drainage, General, Energoprojekt Engineering and Consulting Co., Yugoslavia, 1966
[3] Potential irrigable area means the area which can be irrigated if released water is fully utilized for irrigation for summer paddy and black gram cultivation.

3. Name of River	North Nawin Chaung
4. Catchment area	228.6 Square miles (591.8 km^2)
5. Average Annual Rain Fall	45.43 inches (1,154mm): 2000-2010
6. Average Annual Inflow	149,750 acre-feet (184.7 million m^3)
7. Type of Dam	Earth Dam (Zone Type)
8. Height of Dam	115 feet (35.1m)
9. Length of Dam	5,300 feet (1,615m)
10. Storage Capacity of Full Tank	291,000 acre-feet (358.8 million m^3)
11. Dead Storage Capacity	34,000 acre-feet (41.9 million m^3)
12. Water Spread Area of F.T.L	78,000 acre (96.2 million m^3)
13. Type of Conduit	Outer: R.C.C. pipe; Inner: Steel Pipe
14. Size of Conduit	8' (2.4m) φ Steel Pipe X 1 number
	13.5' (4.1m) φ R.C.C. Pipe X 1 number
15. Length of Conduit	414 feet (126 m)
16. Conduit Design Discharge	810 cubic feet/sec (22.9 m^3/sec)
17. Type of Spillway	Reinforce cement concrete (Duck Bill Type)
18. Width of Spillway	66 feet (20.1 m)
19. Spillway Design Discharge	21,200 cubic feet/sec (599 m^3/sec)
20. Length of Main Canal	45 miles (72 km)
21. Length of Distributary Canal	275 miles (442 km)
22. Canal Structures	2,967 numbers
23. Irrigable Area	96,769 acre (39,160 ha) at planning time
24. Estimated Cost of Project	250 million Kyats
25. Construction Commencement	1967-1968
26. Construction completion	1981-1982

2.3.2 South Nawin Irrigation System

South Nawin Irrigation System was inaugurated and started irrigation in 1996, meaning that 18 years have passed since the commencement of operation to date. During the period, there has been substantially no full scale repairing works for the system, though there were some partial repairing works of emergency nature done by the Maintenance Division (Bago West) of Irrigation Department. As is the case, the condition of the system has been deteriorated due to the following reasons and the system can hardly secure the designed flow sectional area, thereby not capable to supply the irrigation water as required.

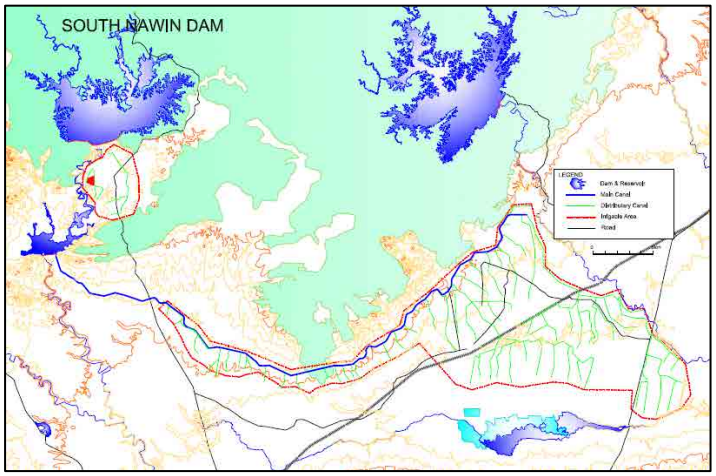


Figure 2.3.2 South Nawin Irrigation System
Source: Irrigation Department

- ✓ Siltation at the canal bed,
- ✓ Excessive vegetation by grasses and weeds on the canal bed, sometimes on collapsed side surfaces,
- ✓ Collapse in brick lining, and
- ✓ Collapse in canal sections at non-lining parts.

In particular, it is found that the collapsing of canal side slopes is more evident in case that the geological condition of the location is of sandy nature. While, geologically, the eastern part (east of railway line of the beneficiary area) is of sand and sandy loam and the western part is of clayey loam nature. Most of the main canal and lateral canals are brick-lined while no lining is predominant for the canal sections where clayey loam soil prevails.

According to the Irrigation Department, present flow capacity of the main canal is 400 cu.ft/sec (11.3 cum/sec), which is only one-third of the designed capacity of 1,161 cu.ft/sec (32.9 cum/sec). Such condition has resulted only in 14,253 acre (5,768ha) of irrigation area of black gram as a winter crop in 2012-2013. With the rehabilitation completed, the irrigable area for black gram will be increased by 58,456 acre (23,656 ha; 410 % increase). Accumulated irrigable area for black gram will therefore be 72,709 acre (29,424 ha) in total.

Salient feature of the South Nawin Irrigation System is summarized below;

	Main Dam	Diversion Dam
1. Location	Pauk Khaung TS, Pyay District, Bago.	
2. Map Reference 1 inch=1 mile scale	85N/9E-918970	85N/5E-819015
3. Name of River	Nawin Chaung	South Nawin Chaung
4. Catchment area	247 Square miles (639 k m^2)	93 Square miles (241 km^2)
5. Average Annual Rainfall	49.25 inches (1,251 mm): 2000 - 2010	
6. Average Annual Inflow	210,000 acre-feet (259 million m^3)	75,800 acre-feet (93.5 million m^3)
7. Type of Dam	Earth Dam	Earth Dam
8. Height of Dam	141 feet (30.0 m)	68.6 feet (20.9m)
9. Length of Dam	16,674 feet (5.1km)	3,100 feet (945m)
10. Storage Capacity of Full Tank	287,000 acre-feet (354 million m^3)	21,000 acre-feet (93.5 million m^3)
11. Dead Storage Capacity	27,000 Acre-feet (33.3 million m^3)	10,549 acre-feet (13.0 million m^3)
12. Water Spread Area of F.T.L	10,980 acres (4,443ha)	2,075 acres (840 ha)
13. Type of Conduit	R.C.C	RCC
14. Size of Conduit	φ8.2 ft x1No	11.48ft x11.48 ft x4Nos
15. Length of Conduit	690 feet (210 m)	470 feet (143m)
16. Conduit Design Discharge	960 cuft/sec (27.2m^3/sec)	1,161.8 cuft/sec (4.6 m3/sec)
17. Type of Spillway	R.C.C (Duck Bill)	R.C.C (Broad Crest)
18. Width of Spillway	250 feet (76.2m)	197 feet (60m)
19. Spillway Design Discharge	11,650 cuft/sec (330 m^3/sec)	29,311 cuft/sec (830 m^3/sec)

20. Length of Main Canal	32 Miles (52 km)
21. Length of Distributary Canal	88 miles (141 km)
22. Number of Canal Structure	1,433 numbers
23. Irrigable Area	58,058 acre (23,495 ha)
24. Project Cost	1742.65 Million (Kyats)
25. Construction Commencement	1985-1986
26. Construction completion	1994-1995

2.3.3 Wegyi Irrigation System

Wegyi dam project was listed as one of the reservoir irrigation projects under "Irrawaddy Development Master Plan, 1980". Out of 19 projects proposed in the master plan, Wegyi irrigation project was classified into Phase II group with Taung Nyo irrigation project. Myanmar government decided to allocate budget for this project through the Special Projects Implementation Committee meeting in October 1995. Reservoir dam construction was completed in July 1999. With the dam construction completed, the canal construction was commenced and completed in May 2001; it was about 2 years behind the reservoir dam completion.

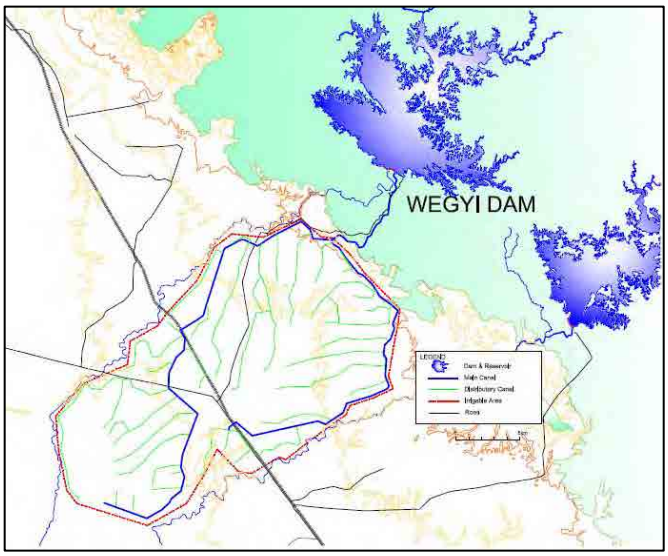


Figure 2.3.3 Wegyi Irrigation System
Source: Irrigation Department

Given strong demand for early completion of the canal system, canal lining was omitted from the construction. Concrete structures were placed at the locations of hydraulic-drops, check-points, and bifurcation points; however, concrete structure with adequate length for erosion protection could not always be placed. Thus, serious erosion is observed in many places after 13 years of operation.

Salient feature of the Wegyi Irrigation System is briefed below;

1. Location	Near Paung Ai Village, Paung De TS, Bago Region
2. Map Reference 1 inch=1 mile scale	1 inch= 1 mile scale, 85N/10E-945605
3. Name of River	Wegyi Chaung
4. Catchment area	202 square miles (523 km^2)
5. Average Annual Rain Fall	45.23 inches (1,149mm): 2000 - 2010
6. Average Annual inflow	298,311 acre-feet (368 million m^3)
7. Type of Dam	Earth Dam
8. Height of Dam	115 feet (35 m)
9. Length of Dam	4,170 feet (1,271 m)
10. Storage Capacity of Full Tank	252,000 acre-feet (311 million m^3)
11. Dead Storage Capacity	25,000 area-feet (31 million m^3)
12. Water Spread Area of F.T.L	12,500 acres (5,059 ha)

13. Type of Conduit	Reinforced Cement Concrete
14. Size of Conduit	4 feet x 6 feet x 3 Numbers
15. Length of Conduit	240 feet (73 m)
16 Conduit Design Discharge	1,200 cubic feet / sec (34m^3/sec)
17. Type of Spillway	Reinforced Cement Concrete (Broad Crested Type)
18. Width of Spillway	100 feet (30m)
19. Spillway Design Discharge	5,630 cubic feet /sec (159 m^3/sec)
20. Length of Main Canal	40 miles (65 km)
21. Length of Distribution Canal	136 miles (219 km)
22. Nos of Canal Structure	913 Numbers
23. Irrigable Area	45,000 acre (18,211 ha)
24. Estimated Cost of Project	1225 million Kyats
25. Construction Commencement	1998-1999
26. Construction completion	2000-2001

2.3.4 Taung Nyo Irrigation System

Taung Nyo irrigation system is located at the most southern place among the 4 systems. Location of this irrigation system falls in Thayarwaddy district while other three projects are in Pyay district. Dam construction was started in November 1994 and completed in March 1996. Given similar design and construction modality with Wegyi system, canal lining for this Taung Nyo irrigation system was also omitted, which in turn has caused serious erosions along the canals after one and half decade operation. Salient feature of the Taung Nyo Irrigation System is summarized below;

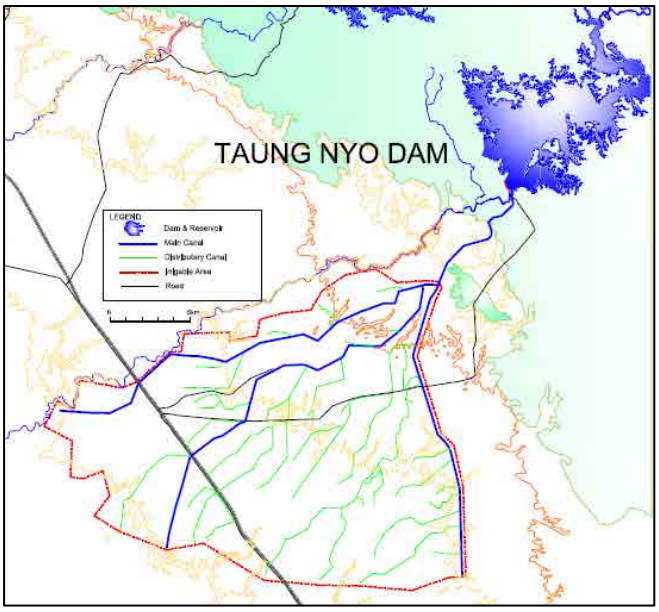


Figure 2.3.4 Taung Nyo Irrigation System
Source: Irrigation Department

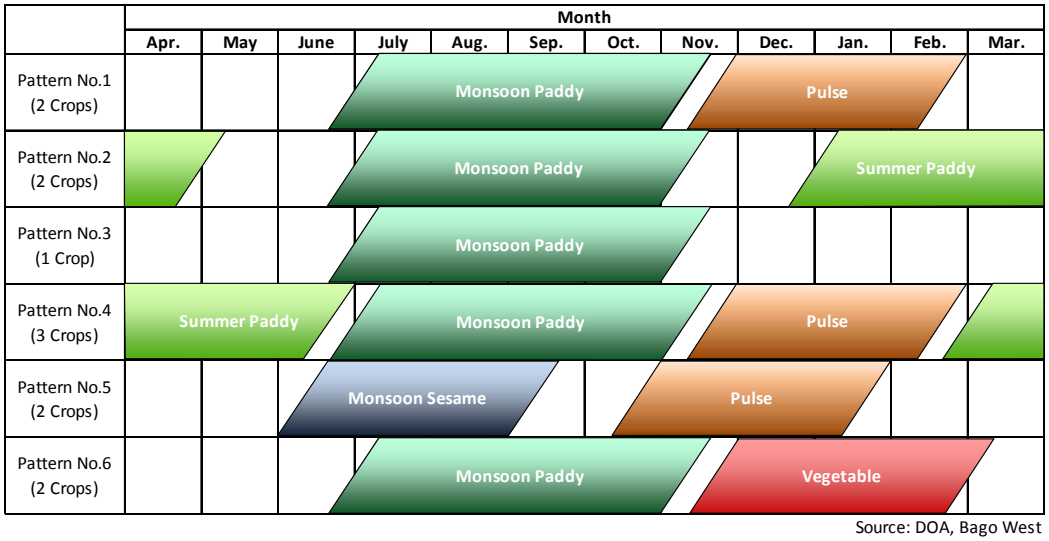
1. Location Nttalin Township, Bago Region	
2. Map Reference 1 inch=1 mile scale	1 inch= 1 mile scale, 85N/10E-066495
3. Name of River	Taung Nyo Chaung
4. Catchment area	213 square miles (551 km^2)
5. Average Annual Rain Fall	54.60 inches (1,387 mm): 2000 - 2010
6. Average Annual Inflow	180,000 acre-feet (222.0 million m^3)
7. Type of Dam	Earth Dam
8. Height of Dam	110 feet (33.5m)
9. Length of Dam	3,400 feet (1,036 m)
10. Storage Capacity of Full Tank	210,000 acre-feet at WL 255 ft (259 million m^3, 77.7m).
11. Dead Storage Capacity	21,200 acre-feet at WL 217 feet (26 million m^3, 66m)

12. Water Spread Area of F.T.L	8,600 acres (3,480 ha)
13. Type of Conduit	Reinforced Cement Concrete
14. Size of Conduit	4 feet x 6 feet x 3 Numbers
15. Length of Conduit	338 feet (103 m)
16. Conduit Design Discharge	1,000 cubic feet / sec (28 m^3/sec)
17. Type of Spillway	Reinforced Cement Concrete (Ogee Type)
18. Width of Spillway	90 feet (27m)
19. Spillway Design Discharge	49,714 cubic feet/sec (1,407 m^3/sec)
20. Length of Main Canal	13.5 miles (22 km)
21. Length of Distribution Canal	127 miles (205 km)
22. Numbers of Canal Structures	1,371 numbers
23. Irrigable Area	50,000 acre (20,234 ha)
24. Estimated Cost of Project	1,225 million Kyats
25. Construction Commencement	1993-1994
26. Construction completion	1995-1996

2.4 Agriculture in the Project Area

2.4.1 Present Cropping Patterns

There are three major crop seasons in the Survey area such as; 1) monsoon season, 2) winter season and 3) summer season. During the monsoon season (July to October), cultivation field can use monsoon rainfall and most of the cultivated crop is paddy under rain-fed. Winter season (November to February) is called dry season with low temperature. Amount of rainfall is small in this season, and low water requirement crops (i.e. pulses) are mainly planted without much irrigation water. Summer season (March to June) falls in dry season with high temperature. All crops in this summer season need irrigation water to grow.



Source: DOA, Bago West

Figure 2.4.1 Typical Cropping Calendar During 2008 to 2013

Source: DOA, Bago West

According to the actual sown area data in the Survey area from 2008 to 2013, six types of typical cropping patterns were found (see Figure 2.4.1). Of the 6 cropping patterns, one pattern entails 3-cropping cultivation in a year; four patterns do 2-cropping cultivation, and the remaining one does

single cropping. Five types of cropping patterns include monsoon paddy; 2 types include summer paddy while the remaining 3 types include pulse. Rice being the staple food for the population, paddy cultivation is dominant in the area. Pulse is cultivated as main cash crop.

Average actual sown area with the percentage in the irrigable area from 2008/09 to 2012/13 is shown in Table 2.4.1. Almost 90% of the irrigable area was in fact planted with monsoon paddy (pattern 1, 2, 3, 4, and 6) and more than 30% of the area was planted with summer paddy (pattern 2 and 4). In addition, even single crop with monsoon paddy reached 20.7% (pattern 3) in spite of the existence of irrigation system. Pulse was planted during the winter season with more than 40% of the total irrigable area (patterns 1, 4 and 5).

Table 2.4.1 Area and Percentage of Cropping Pattern for the Target 4 Irrigation Systems

Pattern No.	Monsoon Season	Winter Season	Summer Season	Actual Sown Area	
				Acre	%
1	Paddy	Pulse		78,340.8	32.1
2	Paddy		Paddy	57,058.8	23.4
3	Paddy			50,431.6	20.7
4	Paddy	Pulse	Paddy	20,037.2	8.2
5	Sesame	Pulse		9,461.2	3.9
6	Paddy	Vegetable		8,995.6	3.7
7	Others			19,656.6	8.1
Total				243,981.8	100.0

Source: DOA, Bago West

2.4.2 Yields by Location for the Irrigation Systems

Yield survey for the last 2 years was conducted in May-June 2013 covering 360 households in 12 villages which are located at upper position, middle position and lower position for the irrigation canals of the Survey area (see Table 2.4.2). For the paddy, lower position showed the highest yield for both monsoon and summer paddies (monsoon: 60.8 baskets, summer: 70.8 baskets), followed by upper position (monsoon: 60.3 baskets, summer: 66.6 baskets) and lastly middle position (monsoon: 51.2 baskets, summer: 59.2 baskets). According to a previous report[4], soil of the lower position contains clay more than upper position. It means that the high productivity in the lower position may have been caused by rich soil.

Table 2.4.2 Yield of Crops by Locations in Irrigation Systems, basket/acre

Land Category	Season	Crop name	Upper position			Middle position			Lower position		
			2011	2012	Avg.	2011	2012	Avg.	2011	2012	Avg.
Lowland	Monsoon	Paddy	58.0	62.6	60.3	49.8	52.5	51.2	59.6	61.9	60.8
	Winter	Black gram	15.7	16.4	16.0	18.4	19.2	18.8	9.8	11.0	10.4
		Green gram	7.5	10.0	8.8						
		Groundnut	26.7	26.7	26.7						
	Summer	Paddy	62.2	71.0	66.6	57.1	61.4	59.2	69.6	72.0	70.8
		Sesame	5.3	5.1	5.2						
Upland	Monsoon	Groundnut	33.5	34.1	33.8	21.8	22.8	22.3			
		Pigeon pea	5.9	6.1	6.0						
		Sesame	4.3	5.2	4.7				4.0	5.3	4.7
	Winter	Black gram	16.0	16.0	16.0	8.0	8.0	8.0	12.5	12.5	12.5
		Green gram	5.1	5.7	5.4						
		Groundnut				16.1	20.0	18.0			
		Lab Lab bean	8.3	8.3	8.3						

Source: Yield Interview Survey, the Survey Team (2013)

For the winter crops planted in the irrigation systems, upper position was planted with three kinds of

[4] Main Report, The Master Plan Survey Report on the Irrawaddy Basin Integrated Agricultural Development, March 1980, JICA

pulses such as black gram, green gram and groundnut while other positions were planted only with black gram. The average productivity for the black gram by position is different from that of paddy; the highest yield shows up in the middle position (18.8 baskets), then upper position (16.0 baskets), and lastly lower position (10.4 baskets). Water availability in the lower position is less than mid and upper positions, whereby the yield of lower position may have resulted in such lowest one.

Upland field was planted with pulse and sesame. The upper position shows varieties of crops with higher production for all of the crops except for groundnut in winter season which is planted only in the middle position. One of the reasons, of why upper position shows higher yield, may be attributed to the availability of irrigation water. It can be thought that irrigation water availability is higher in the upper position than mid and lower positions. It is therefore able to achieve higher yield with various crops in the upper position.

2.4.3 Farmland Holdings for the Irrigation Systems

Farmland holding was surveyed by the JICA survey team under the household questionnaire survey covering total 225 farm households divided into 3 areas equally such as upper position, mid position and lower position within the irrigated area. The result shows that the farmers have 3 major types of agricultural land use such as lowland, upland and shoal or riverbank field in the Survey area. In fact, all farmers surveyed have lowland field with 1,833.9 acre in total. The maximum lowland farm size owned by a farmer was 30 acre while the minimum one was 0.5 acre, and the average lowland farm holding per farmer household came to 8.2 acre.

Eighty seven (87) farmers have upland farmland with an aggregated total area of 375.3 acre. For the upland farmland, the maximum size owned by a farmer was 20 acre; minimum one was 0.3 acre only, and the average arrived at 4.3 acre. Three farmers have shoal or riverbank field with 7.0 acre in total. Others include gardens such as banana plantation, backyard small kitchen garden, etc. whose total area is only 12.9 acre owned by 20 farmer households in total.

Total area of the farmlands owned by the 225 sampled households arrives at 2,229 acre. Therefore, a typical average farmer household is supposed to own 9.901 acre (4.01 ha), which is in fact quite big as compared to other parts of the Country. Reason given by interviews to farmers revealed that since Pyay is not so far from Yangon, there have been migrant people to those urban areas, leaving their farmland behind. The present farmers have been purchasing such farmlands from peer farmers and relatives. This high transaction may have contributed to keep such bigger farmland area per farmer household.

Table 2.4.3 Farm Land Holdings in the Project Area

Items	Lowland	Upland	Shoal or Riverbank Field	Others	Total/ Average
No. of HH (N=225)	225	87	3	20	225
Total Area (Acre)	1,833.9	375.3	7.0	12.9	2,229
Maximum Area (Acre)	30.0	20.0	4.0	2.0	30.0
Minimum Area (Acre)	0.5	0.3	1.0	0.1	0.1
Average Area (Acre)	8.2	4.3	2.3	0.6	9.907 (4.01ha)

Source: Questionnaire Household Survey, the Survey Team (2013)

2.4.4 Farm Economy for the Irrigation Systems

Estimated gross profit, cost and net profit per household are summarized in Table 2.4.4 by position and by crop. The largest net profit of monsoon paddy per farmer is recorded at lower position villages (1,257,939 Kyat) and net profit ratio is also the highest in the lower position (66.4%). The highest net profit of summer paddy shows up in lower position villages (677,154.8 Kyat) same as the monsoon paddy. However, the ratio of the net profit becomes the highest in upper position village (53.1%). The net profit of black gram per farmer is the highest in the middle position villages (1,660,329 kyat) and

so does the net profit ratio (76.7%).

Table 2.4.4 Net Profit from Farming per Household

Crops and Location		% of cultivation household	Area Harvested	Gross Profit	Total Cost of Input	Cost of Labor & Outsource	Total Net Profit	Net Profit Ratio
		(%)	(Acre)	(Kyat)	(Kyat)	(Kyat)	(Kyat)	(%)
Monsoon Paddy	Upper Position	97.3	6.0	1,265,153.4	128,989.7	329,723.1	806,440.6	63.7
	Middle Position	100.0	9.5	1,703,889.6	188,541.3	478,253.0	1,037,095.3	60.9
	Lower Position	100.0	8.4	1,893,392.3	174,755.3	460,698.0	1,257,939.0	66.4
	Total Ave.	99.1	8.0	1,630,847.4	164,410.3	423,727.0	1,042,710.1	63.9
Summer Paddy	Upper Position	92.0	4.1	832,241.3	137,898.6	252,654.3	441,688.4	53.1
	Middle Position	80.0	5.1	839,256.0	200,925.0	303,413.3	334,917.7	39.9
	Lower Position	46.7	6.2	1,401,730.2	244,800.0	479,775.4	677,154.8	48.3
	Total Ave.	72.9	4.9	963,806.8	183,771.3	319,695.7	460,339.8	47.8
Pulses (Black Gram)	Upper Position	50.7	6.4	1,601,068.4	249,157.9	235,311.8	1,116,598.7	69.7
	Middle Position	25.3	6.6	2,164,800.0	244,473.7	259,997.4	1,660,328.9	76.7
	Lower Position	52.0	5.7	874,914.3	88,094.9	211,687.2	575,132.2	65.7
	Total Ave.	42.7	6.2	1,408,832.6	182,799.0	230,600.0	995,433.6	70.7

Source: Questionnaire Household Survey, the Survey Team (2013)

Table 2.4.5 shows the gross profit, cost and net profit for the major crops per unit area. In sum, for the lower position villages, paddy cultivation both monsoon and summer seasons can get high profit per unit area while winter crop (black gram) does lower profit. Percentage of cultivation household of summer paddy is lower in the position (46.7%), and to increase the percentage of it would contribute to increase the crop production. In the middle position, net profit ratio of paddy cultivation is lower (monsoon paddy: 60.8%, summer paddy: 40.2%) while winter crop profit and the ratio get higher (76.7%).

Table 2.4.5 Net Profit from Farming per Acre/ Ha

Crop and Positions		% of cultivation household	Gross Profit	Total Cost of Input	Cost of Labor & Outsource	Total Net Profit		Net Profit Ratio
		(%)	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ha	(%)
Monsoon Paddy	Upper Position	97.3	210,858.9	21,407.9	54,722.7	134,728.3	332,351.9	63.9
	Middle Position	100.0	179,356.8	19,867.4	50,395.5	109,094.0	269,493.7	60.8
	Lower Position	100.0	225,403.8	20,697.4	54,563.5	150,142.9	370,492.0	66.6
	Total Ave.	99.1	203,758.8	20,541.5	52,940.6	130,276.7	321,817.5	63.9
Summer Paddy	Upper Position	92.0	202,985.7	33,789.1	61,907.5	107,289.1	264,862.7	52.8
	Middle Position	80.0	164,560.0	39,204.9	59,202.6	66,152.5	163,390.0	40.2
	Lower Position	46.7	226,085.5	39,483.9	77,383.1	109,218.5	270,252.2	48.3
	Total Ave.	72.9	196,085.2	37,388.0	65,041.7	93,655.5	231,189.2	47.7
Pulse (Black Gram)	Upper Position	50.7	250,166.9	38,684.4	36,534.6	174,947.9	433,970.4	70.0
	Middle Position	25.3	328,000.0	37,085.8	39,440.7	251,473.5	622,099.0	76.7
	Lower Position	52.0	153,493.7	15,476.1	37,188.3	100,829.3	249,798.5	65.7
	Total Ave.	42.7	228,459.3	29,643.1	37,394.6	161,421.7	400,800.5	70.8

Source: Questionnaire Household Survey, the Survey Team (2013)

CHAPTER 3 PROJECT PLANNING AND DESIGNING

3.1 Identification of the Rehabilitation Components

The project undertakes rehabilitation and upgrading of 4 irrigation systems in order to reduce maintenance cost and to improve irrigation efficiency. The component of the rehabilitation covers canals, hydraulic structures and road networks. Some components need detailed designs before the project implementation. The following table shows a summary of rehabilitation components of the targeted 4 irrigation systems:

Table 3.1.1 Summary of Rehabilitation Components for Each Irrigation System

Items	North Nawin	South Nawin	Wegyi	Taung Nyo
Canal and hydraulic structures	- Canal lining (rehabilitation) - Replace of small gates and water drop structures	- Canal lining (rehabilitation) - Replace of small gates and water drop structures, including old North Nawin system	- Canal lining (upgrade) - Replace of small gates and water drop structures	- Canal lining (upgrade) - Replace of small gates and water drop structures
Necessity of Detailed Design	- Basically not required	- Basically not required	- Detailed design required.	- Detailed design required.
Inspection road and farm road	- Inspection road rehabilitation - Access road rehabilitation / upgrade	- Inspection road rehabilitation	- Inspection road rehabilitation	- Inspection road rehabilitation

Source: JICA Survey Team (2013)

3.2 Design Criteria and Standard Design for the Rehabilitation

Three criteria are employed and applied to this rehabilitation project; namely, 1) canal cross section should have enough flow area for irrigation, 2) gates should be able to control irrigation water flow according to the irrigation plan, and 3) relevant structures of the systems should contribute to area development, e.g. road and bridge rehabilitation. The Survey Team and Irrigation Department have discussed and proposed the following points as the principals of rehabilitation;

- ✓ All places of main canals shall be rehabilitated with concrete lining except for recently rehabilitated portions since back side of lining works may have collapsed and/or been eroded, which are usually invisible because they are behind of the lining structures,
- ✓ Brick lining will be employed for distribution canals, and the bricks shall be made of concrete taking into account the availability of materials,
- ✓ Required water flow area of canals shall be kept after the rehabilitation, for which the water flow condition shall be able to follow the original designs,
- ✓ Inspection road along the main canals are to be reshaped by 2.5 m design width,
- ✓ Road width expansion should be confined to the area within the government owned-land, and
- ✓ If farmers request to expand road width, it shall not be included in this project and it shall be considered as one of components for farm land consolidation in future.

Canals, hydraulic structures, roads are the major rehabilitation items under the project. With reference to the hydraulic structures in the original South Nawin irrigation system which are not collapsed, standard designs of the hydraulic structures shall be based on those of South Nawin irrigation system. Since this rehabilitation project starts up with voices of farmers that there is no irrigation water at the end points of irrigation systems, restoration of the functional irrigation network is the first priority. With these, the standard design modality is briefed below:

Table 3.2.1 Standard Designs for Rehabilitation of Irrigation Systems

Facilities	Main Canal Portion	Distribution Canal portion
Canal	- Concrete lining with in-site concrete placement - Sand bed: 7.5 cm thickness before concrete placement - Concrete thickness: 12.5cm at canal bed, slopes - Weep holes with 0.9m interval	- Cement brick lining - Sand bed: 7.5 cm thickness before brick placement - Brick thickness: 11.3 cm at bed, 7.5 cm at slopes - Weep holes in cement brick with 0.9m interval
Hydraulic structures	- Refer to South Nawin irrigation system (turn out, syphon, drop, bridge)	- Refer to South Nawin irrigation system (turn out, syphon, drop, bridge)

Facilities	Main Canal Portion	Distribution Canal portion
Road	- Base concrete without reinforcement bar: 7.5cm - Reinforced concrete pavement (D5@180mm), 12.5cm thickness - Concrete design mix: Cement: Sand: Gravel = 1:3:6 for base concrete - Concrete design mix: Cement: Sand: Gravel = 1:2:4 for reinforced concrete - 2.5 m width for inspection road, 4.8 m width for access road	- Gravel clay pavement: 10cm - 2.5 m width if it is available

Source: Irrigation Department, JICA Survey Team (2013)

3.3 Rehabilitation for Irrigation Systems

3.3.1 North Nawin Irrigation System

Irrigation canals located downstream of North Nawin irrigation system receive irrigation water from the canals of South Nawin irrigation system. This is because water storage of North Nawin reservoir is not reliable and not sufficient either to cover all the designed irrigable area of the system. Total 17 canals in the North Nawin irrigation system are currently receiving irrigation water from the South Nawin irrigation system (see table below). Thus, rehabilitation works of these canals are integrated into those of the South Nawin irrigation system.

Table 3.3.1 Water Diversion from South Nawin irrigation System to North Nawin Irrigation System

Diversion Points of Canals in South Nawin	Canals receiving diversion water in North Nawin
DO 9	CL 18, CL 19, CL 20, CL 21, CL 22, CL 23, CL 24, CL 25, CL 26, CL 27,
DY 18	CL 30, CL 31
DY 20	CL 32, CL 33, CL 34
DY 22	CL 35, CL 36

Source: Irrigation Department

Irrigation Department commenced rehabilitation works of North Nawin irrigation system in 2011. Rehabilitation of the main canal has already been completed while other parts of the irrigation system require further rehabilitation, i.e., distributary canals, hydraulic structures, and roads. Rehabilitation period is divided into 3 years and each of the quantity of rehabilitation works by year and by component is summarized below:

Table 3.3.2 Proposed Rehabilitation Works in North Nawin Irrigation System

Distribution Canal Rehabilitation		Unit	Quantity			
			1st year	2nd year	3rd year	Total
Distribution canals	Preparatory Works	m	233,711	92,674	12,436	338,822
	Earth Works	m^3	797,412	337,146	143,569	1,278,127
	Lining Works	m^2	5,613	696	317	6,626
Hydraulic structures	Rehabilitation of Turn Out	Nos	55	74	11	140
	Rehabilitation of Syphon	Nos	7	2	3	12
	Rehabilitation of Bridge	Nos	18	16	6	40
	Rehabilitation of Drop	Nos	20	28	11	59
	Outlet Steel at Intake	Unit	0	0	1	1
Roads	Main Canal Road	km	0.0	11.0	3.0	14.0
	Distribution Canal Road	km	0.0	43.0	17.0	60.0

Source: JICA Survey Team (2013)

3.3.2 South Nawin Irrigation System

Some distribution canals of North Nawin irrigation system receive irrigation water from South Nawin irrigation system as aforementioned. Therefore, such North Nawin distribution canals are counted as the facilities of the South Nawin irrigation system, and thus the required rehabilitation works are planned under those of South Nawin irrigation system. In fact, there are no hydraulic structures to be

rehabilitated in the original South Nawin irrigation system though parts of the main and distribution canals should be rehabilitated. Rehabilitation works with the quantity divided into 3 years are summarized below:

Table 3.3.3 Proposed Rehabilitation Works in South Nawin Irrigation System

Canal Rehabilitation		Unit	Quantity			
			1st year	2nd year	3rd year	Total
Main Canal	Preparatory Works	m	6,099	0	0	6,099
	Earth Works	m^3	31,350	238	105	31,692
	Concrete Lining Works	m^3	15,696	24,154	11,558	51,408
Distribution Canal	Preparatory Works	m	29,526	133,069	110,478	273,073
	Earth Works	m^3	48,541	598,329	654,620	1,301,490
	Brick Lining Works	m^2	911	2,462	3,850	7,222
Hydraulic Structures	Rehabilitation of Turn Out	Nos	0	44	64	108
	Rehabilitation of Syphon	Nos	0	0	3	3
	Rehabilitation of Bridge	Nos	0	19	13	32
	Rehabilitation of Drop	Nos	0	23	29	52
Road	Main Canal Road	km	0.0	17.0	13.0	30.0
	Distribution Canal Road	km	0.0	6.0	2.0	8.0

Source: Irrigation Department, JICA Survey Team (2013)

3.3.3 Wegyi Irrigation System

Rehabilitation works for Wegyi irrigation system are on-going since 2011; however, the progress is very little, which is estimated only about 5%. Canal lining was not provided to this irrigation system, so that severe erosions are identified especially at some changing points of hydraulic gradient along canals. Some hydraulic structures were completely flushed away. During rainy season, wet soil at the surface of road becomes muddy, and it turns to quite bumpy condition in dry season. Thus, canal lining and also rehabilitation of roads are planned. Proposed rehabilitation period is limited to 3 years and the quantity of works is summarized below:

Table 3.3.4 Proposed Rehabilitation Works in Wegyi Irrigation System

Canal Rehabilitation			Unit	Quantity			
				1st year	2nd year	3rd year	Total
Main Canal		Preparatory Works	m	7,772	0	0	7,772
		Earth Works	m^3	219,056	0	0	219,056
		Concrete Lining Works	m^3	29,151	0	0	29,151
Distribution Canal		Preparatory Works	m	92,793	104,205	85,103	282,102
		Earth Works	m^3	661,923	697,232	634,535	1,993,690
		Brick Lining Works	m^2	4,789	6,140	4,388	15,317
Hydraulic and Other Structures	Main Canal	Rehabilitation of Bridge	Nos	2	0	0	2
		Construction of Drop	Nos	1	0	0	1
	Distribution Canal	Rehabilitation of Turn Out	Nos	14	11	4	29
		Rehabilitation of Syphon	Nos	0	1	0	1
		Rehabilitation of Bridge	Nos	7	2	1	10
		Construction of Bridge	Nos	0	1	0	1
		Construction of Drop	Nos	15	5	0	20
Road		Main Canal Road	km	0.0	21.5	8.5	30.0
		Distribution Canal Road	km	0.0	35.5	14.5	50.0

Source: Irrigation Department, JICA Survey Team (2013)

3.3.4 Taung Nyo Irrigation System

Taung Nyo irrigation system has a relatively steep topography from the dam site to the terminals point and this slope has caused severe damage on the irrigation system. Some hydraulic structures in the irrigation system have completely been flushed away and canal-beds of the structures were scraped off

by 2.0m or more from the original bed elevation. Sandy soil is dominant in this area, causing much erosion. Irrigation Department has carried out rehabilitation works since 2011, though it is only partial. Proposed rehabilitation period is 3 years and the quantity of rehabilitation works is shown as follows:

Table 3.3.5 Proposed Rehabilitation Works in Taung Nyo Irrigation System

Canal Rehabilitation		Unit	Quantity			
			1st year	2nd year	3rd year	Total
Main Canal	Preparatory Works	m	8,239	0	13,405	21,644
	Earth Works	m^3	80,196	0	106,970	187,166
	Concrete Lining Works	m^3	26,990	0	30,035	57,026
Distribution Canal	Preparatory Works	m	19,477	90,379	17,355	127,211
	Earth Works	m^3	95,238	252,899	46,996	395,133
	Brick Lining Works	m^2	237	5,545	1,412	7,194
Hydraulic and Other Structures	Rehabilitation of Bridge (main canal)	Nos	2	0	0	2
	Construction of Bridges (main canal)	Nos	0	2	0	2
	Rehabilitation of Drop (main canal)	Nos	5	0	5	10
	Rehabilitation of Drop (distribution canal)	Nos	30	47	10	87
Road	Main Canal Road	km	0.0	15.0	7.1	22.1
	Distribution Canal Road	km	0.0	29.0	20.5	49.5

Source: Irrigation Department, JICA Survey Team (2013)

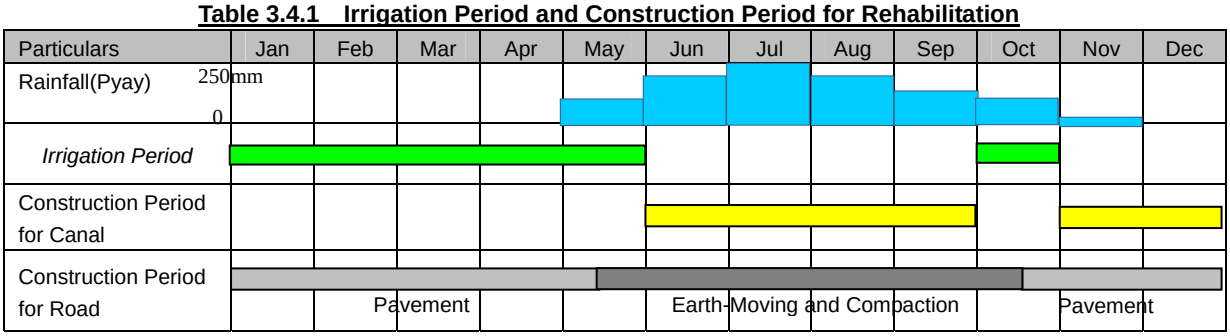
3.4 Procurement of Machineries and Equipment

Construction modality for this project is a direct force account carried out by Irrigation Department. In fact, Irrigation Department has constructed a number of irrigation schemes to date by utilizing her own staff and also machineries. However, the machineries that the Irrigation Department owns are not enough in terms of both number and capacity to manage all the on-going construction projects. Irrigation Department will deploy own machineries and also procure new machineries in order to complete rehabilitation works within the 3 years for each irrigation system.

3.4.1 Construction Period

The rehabilitation includes such major works as 1) earth works, 2) canal lining works and 3) road construction aside from other appurtenant works. Of the major construction works, canal rehabilitation should be implemented during total 6 months composed of 4 months (Jun-Sep) and 2 months (Nov-Dec). The road construction works are, on the other hand, continued throughout a year except for concrete pavement. Concrete pavement should be carried out only during the dry season. The effective annual working days are thus set at 154 days for canal rehabilitation works, and 292 days for road construction works.

Table 3.4.1 Irrigation Period and Construction Period for Rehabilitation



Note: From January to May, later cultivation period of winter crop and also summer paddy need irrigation water. From June to September, monsoon paddy can grow by rainfall whereby no irrigation water is needed. In October, irrigation water is needed for planting winter crop, e.g. black gram. From November to December, the planted winter crop, e.g. black gram, can grow by utilizing residual moisture., Source: JICA Survey Team

3.4.2 Planning of Construction Machineries and Equipment

Mechanical engineers of Irrigation Department recommend relatively small to medium scale construction machines in order to meet the working conditions at site. In addition, excavators should equip with super long arm so that it can reach the bottoms and slopes of the main canals. To enter and operate on the roads of distributary canals, mini sized hydraulic excavators can be effective to work. Irrigation Department owns large sized track dozers (or bulldozers) and dump trucks, which are in fact not suitable for canal rehabilitation works. The following types of machineries are therefore recommended under the Project:

Table 3.4.2 Recommended Specifications of Machineries and Equipment by Irrigation Department

Kind of Work	Construction Machinery	Capacity	Power Output	Equivalent Maker & Model
Earth work of canal banks and dredging work for main canals	Hydraulic Excavator (super long arm)	Bucket 0.5m^3	158hp (118kW)	Hitachi EX220-5 (LC track, super long arm)
Earth work of canal bank and excavating work for distributary canals	Hydraulic Excavator (mini)	Bucket 0.07m^3	21hp (15.7kW)	Komatsu PC20 MR-2
Dozing work of main canals and large distributary canals	Track Dozer (class-2)	-	124hp (92.5kW)	Komatsu D53A-17
Compacting work of access road	Road Roller	21 ton weight	150hp (112kW)	Dyanapac CC431
Concreting work	Concrete Pump	35m^3/hr	56hp (41.8kW)	Symtec MKW35SVH
Transport of concrete	Concrete Mixer Truck	3m^3	225hp (167.8kW)	Mitsubishi Fuso FP418-A
Removing of slug and mud	Portable Mud Pump	0.16m^3/min	7.6hp (5.7kW)	Bomag BW160A

Source: Mechanical Section of Construction Circle No.2, July 2013

3.4.3 Quantities of Machineries and Equipment

In determining quantities of the construction machineries and equipment, three working units will be formed for each irrigation system. For each working unit, Irrigation Department shall appoint the Assistant Engineer to supervise and manage machineries. One of three units will work for main canal, and two will work for distributary canal except North Nawin where one unit is required for the rehabilitation of access road to the dam, which is to be sifted to the main canal upon completion. These working units will, of course, be shifted to other irrigation areas according to the progress by site. The summary of the machineries to be procurement is presented below:

Table 3.4.3 Types and Quantities of Machinery and Equipment for Procurement

Proposed Machinery	Unit(s)	Purposes of Use
Standard excavator with crane	16 units	For gravel clay loading at quarry, earth works, access road rehabilitation
Super long arm excavator	8 units	For excavation and embankment of canal banks, slope trimming, dredging
Small sized excavator	20 units	For earth works for distributary canals
Hydraulic breaker	1 unit	For the demolishment of deteriorated concrete pavement of access road
Tracked dozer class-II (medium)	8 units	For access road rehabilitation and canal rehabilitation
Tracked dozer class-III (small)	8 units	For access road rehabilitation and canal rehabilitation
Wheel loader	2 units	For loading gravelly clay at quarry sites
Earth work vibration roller	5 units	For main canal inspection path construction works (4), access road (1)
Agitator truck (concrete mixer truck)	10 units	For canal lining (8), access road (2)
Low-bed semi-trailer truck	4 units	For transportation
Dump truck (6-7ton)	10 units	For distributary canals
Concrete pump truck	3 units	For concreting works
Workshop equipment	3 units	For mobile workshops (2), a workshop tool (1)

Source: Irrigation Department, JICA Survey Team (2013)

3.5 Farmer Organization: Water Users Association (WUA)

Establishment of hydraulically decentralized WUAs is proposed in conformity with a head gate that

controls the flow into relevant irrigation area. The WUA is stratified, starting with on-farm water users group (WUG), whose irrigation area is commanded by an outlet. There will be a total of 132 WUAs for the 4 irrigation systems. The area coverage by a WUA ranges from 1,009 to 3,124 acre with an average of 1,649 acre while the number of farmer members will range from 79 to 337. Number of WUGs per WUA will be 16 to 53.

Table 3.5.1 Water Users Association and Water Users Group by Irrigation System

System	Command Area, Acre (acre)	No. of WUAs (no. of distributary canal)	Av. area coverage per WUS (acre)	No. of WUGs	Average No. of WUGs per WUA	Av. No. of farmers per WUA 1/	Av. No. of farmers per WUG 1/	Av. farm land (acre)
North Nawin	54,506	54	1,009	1,828	34	79	3	12.72
South Nawin	72,709	35	2,077	719	21	250	12	8.28
Wegyi	40,429	27	1,497	430	16	187	12	8.01
Taung Nyo	49,981	16	3,124	852	53	337	6	9.28
Total/ave (acre)	217,624	132	1,649	3,829	29	166	6	9.91
Total/ave (ha)	88,068		667					4.01

Note: 1/To estimate the average number of farmers by WUA/WUG, an average farmland area owned by a typical farmers was applied.

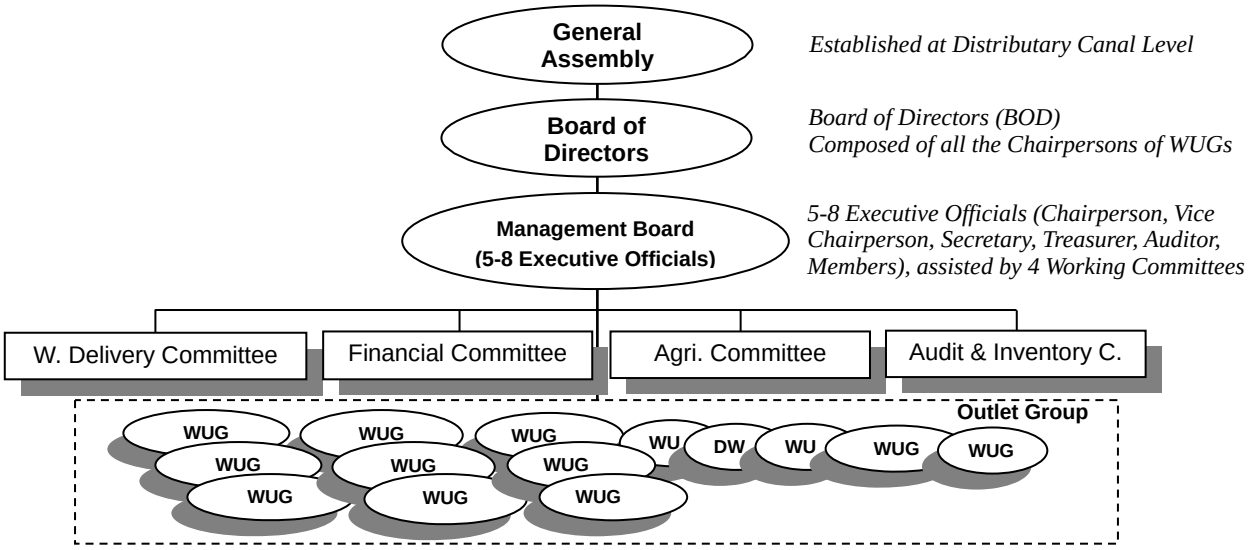


Figure 3.5.1 Organizational Structure of WUA for Distributary Canal

A proposed structure of WUA is presented above. The general assembly (GA) or the board of directors (BOD) exercises the responsibility in decision making. Under the board of directors, a management board comprising of chairperson of the WUA, vice chairperson, secretary, treasurer, auditor and probably some members is established to implement a plan according to the decision made by the GA or the BOD. There should be some committees in charge of planning such as water delivery, financial matter, agriculture development issues, etc. The base of WUA is composed of number of water user groups established at each level of outlets.

3.6 Agriculture Development and Land Use Plan

3.6.1 Current Irrigable Area and Irrigation Capacity

The Survey Team has identified that records of the irrigated area from June 2012 to May 2013 can be reliable and show actual situation of the irrigation systems while data before April 2011 do not reflect actual cropping conditions due to political circumstances of the former government. The identified irrigable areas of 4 irrigation systems are summarized below, ranging from 40,428 acre being the smallest in Wegyi to 72,709 acre being the largest in South Nawin:

Table 3.6.1 Revised Current Irrigable Area for 4 Irrigation Systems

Irrigation System	North Nawin	South Nawin	Wegyi	Taung Nyo	Total
Original Data from Irrigation Department (ac)	83,993.24	48,976.36	43,078.42	49,981.31	226,029.33
Area Transfer (ac)	-23,732.30	23,732.30	0.00	0.00	0.00
Private Irrigation (ac)	-7,092.40	0.00	-2,650.00	0.00	-9,742.40
Current Irrigable Area (ac)	53,168.54	72,708.66	40,428.42	49,981.31	216,286.93

Source: Irrigation Department, JICA Survey Team (2013)

The following figures are employed for calculating the irrigation water requirement (irrigation demand by crop) with reference to the design standards set by Irrigation Department. In calculating the irrigation water requirement, rainfall above 5 mm per day is considered to be effective for crop water supply while such rainfalls less that that is neglected. In calculating the irrigation capacity by irrigation system, an average irrigation supply from each of the dam reservoirs is employed.

Table 3.6.2 Irrigation Demand of Crops for 4 Irrigation Systems

Crops	Monsoon Paddy	Summer Paddy	Winter Crop (Black Gram)
Crop Water Demand (Including losses)	457 mm	1,829 mm	305 mm
Cropping Season	Jun/Jul – Early Oct/Nov	Feb/Mar – May/Jun	Mid-Oct/Mid-Nov–Jan/Feb

Source: Irrigation Department

3.6.2 Crop Selection

The top priority for crop selection in the project area should be given to monsoon paddy since all farm households require their own staple food and also the environment in terms of soil and rainfall is conducive for paddy growing. Winter crop, e.g. black gram, is then recommended as the second priority because of its low irrigation demand, which usually requires only 10% of summer paddy irrigation demand. The third position is thus given to the summer paddy.

Table 3.6.3 Crop Selection by Prioritization for 4 Irrigation Systems

Crops	Monsoon Paddy	Summer Paddy	Winter Crop (Black Gram)
Staple Crop	✓	✓	
Irrigation demand	457 mm (relatively low)	1,829 mm (high)	305 mm (low)
Cultivation Period	3.5 months	3.5 months	3 months
Yield (lowland)	60.3 basket/acre	66.6 basket/acre	8.8 basket/acre
Net Profit (average)	130,277 Kyat/acre	93,656 Kyat/acre	161,422 Kyat/acre
Profit per mm of irrigation	285 Kyat/acre/mm	51 Kyat/acre/mm	529 Kyat/acre/mm
Export Potential	✓	✓	✓
Priority by this table	1	3	2

Source: Irrigation Department, JICA Survey Team (2013)

3.6.3 Prospected Benefit

The recommended cropping pattern for the project entails 3 crops a year starting from monsoon paddy, followed by winter crop (black gram), and finally by summer paddy. In fact, monsoon paddy has been planted almost all over the project area supported by rainfall. Therefore, no expansion for the monsoon paddy takes place under the project, but winter cop with higher priority and then summer paddy on condition that there is still enough irrigation water in the reservoirs. With the data records of 2012-2013, area expansion for winter crop and summer paddy is estimated upon completion of the rehabilitation with those benefits as follows:

Table 3.6.4 Case Studies on Cropping Pattern and their Profits (Unit: acre, million Kyat)

Crops	Winter Crop (Black Gram)					Summer Paddy					Total
Case	N. Nawin	S. Nawin	Wegyi	T. Nyo	Sub total	N. Nawin	S. Nawin	Wegyi	T. Nyo	Sub total	
2012-2013	35,451	14,852	6,651	26,002	82,956	981	2,802	36	5,217	9,036	91,992
Million Kyat	7,744	2,469	1,025	4,196	15,434	105	241	4	554	904	16,338

Crops	Winter Crop (Black Gram)					Summer Paddy					Total
Case	N. Nawin	S. Nawin	Wegyi	T. Nyo	Sub total	N. Nawin	S. Nawin	Wegyi	T. Nyo	Sub total	
Average	25,371	58,456	2,702	30,715	117,244	0	0	0	0	0	117,244
Million Kyat	5,600	10,535	441	5,381	21,957	0	0	0	0	0	21,957

Source: Irrigation Department, the Survey Team (2013)

The first one was calculated by applying the same irrigation supply for 2012-2013. Same irrigation supply in winter season is allocated to black gram while same amount of summer season irrigation supply is allotted to summer paddy. Total 91,992 acre will be additionally irrigated with total 16 billion Kyats of profit increase in this case. The second one is calculated based on optimized irrigation supply towards enlarging winter crop area as much as possible. There will be a potential of increasing the area of black gram by 177,244 acre in total, which generates an additional 22 billion Kyat benefit.

In sum, the area increase of winter crops, e.g. black gram, will be a key element for agricultural development in the project area from farm economic point of view. On the other hand, summer paddy area shall be kept at the same level as current condition. It is therefore recommended that upon completion of the rehabilitation works, the dam reservoir operation should be so conducted as to enlarge the winter crop area as much as possible while keeping the summer paddy area to be the same as that of 2012-2013.

3.7 Technical Assistances Required

To carry out a loan project, consultants shall be employed under the loan mainly for the 2 works such as; 1) detail design and also tender documents preparation, and 2) supervision for the construction works. The detail design and the tender documents preparation shall be carried out under a Task Concept while the supervision is to be under an Assistant Concept. The task concept means that the responsibility for the works done by the consultants shall be with the consultants subject to the approval from Irrigation Department. Under the assistance concept, main responsibility of the consultants is to assist Irrigation Department in implementing the works required under the Project.

Along with rehabilitation implementation, technical assistances for soft components may be required such as strengthening of agriculture extension services, demonstration of farm mechanization coupled with land consolidation pilot implementation, establishment of water users association, and enhancement of water management coordinated with established WUAs, etc. Such aspects are basically categorized into 2 major areas of; 1) agriculture extension, and 2) irrigation management. It is therefore basically recommended to deploy 2 teams of experts undertaking each of the 2 major areas, apart from the consultants aforementioned.

CHAPTER 4 IMPLEMENTATION ARRANGEMENT

4.1 Construction Modality

Irrigation Department has employed direct force account system for construction of dams and irrigation schemes. This direct force account system can be seen in other ministries as well. Consequently, there is no private company in Myanmar, which knows well about the construction of irrigation systems. Irrigation Department has accumulated adequate experiences for the force account system in the long history for implementing irrigation projects. All rehabilitation procedures for the 4 irrigation systems shall thus utilize the force account system as much as possible.

4.2 Implementation Schedule

Currently, irrigation in the 4 targeted irrigation systems is provided from January to May mainly for summer paddy, and from June to December irrigation is not carried out, not necessary due to the

rainfall, except for October. October is the month for flowering and maturing period of monsoon paddy, which needs more water than what is provided by rainfall. Construction period for canal rehabilitation is therefore planned based on this current irrigation practice. The following table shows irrigation practice and available construction period for the canal rehabilitation;

Table 4.2.1 Irrigation Period and Construction Period for Canal Rehabilitation

Practices	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Irrigation Period	▒	▒	▒	▒	▒					▒		
Construction Period						▨	▨	▨	▨		▨	▨

Source: Irrigation Department, modified by the Survey Team (2013)

Under the project, rehabilitation of the inspection roads, which run alongside the main canals, is also planned as one of the project components. Road rehabilitation requires soil embankment, so that dry works are essential for this component. If the soil embankment is carried out during rainy season, necessary compaction can hardly be obtained. Therefore, inspection road work will be carried out during dry season. After or before the canal rehabilitation work, inspection road rehabilitation and upgrading of minor road will be carried out accordingly.

Three years are planned for each of the rehabilitation of 4 irrigation systems with road rehabilitation/ upgrading. Out of the 4 irrigation systems, North Nawin and South Nawin systems do not need full-level detailed design because Irrigation Department has conducted certain surveys on these systems and necessary portions of canal rehabilitation have already been identified and work volume has been calculated. In fact, ID has been implementing partial rehabilitation works since 2 years ago.

On the other hand, remaining 2 irrigation systems, Wegyi and Taung Nyo, need to have detailed design because little designs are available only for some structures. This detailed design stage will take about 1 year. Under such situation, there should be one-year for the selection of consultant, following which another one-year is needed to complete detail design. It means that the rehabilitation of the 2 irrigation systems could be started 2 years later from the commencement of the North and South Nawin irrigation systems. Therefore, though each 3 years are needed for the rehabilitation work for each of the irrigation systems, total 5 years are to be required to complete the 4 irrigation systems:

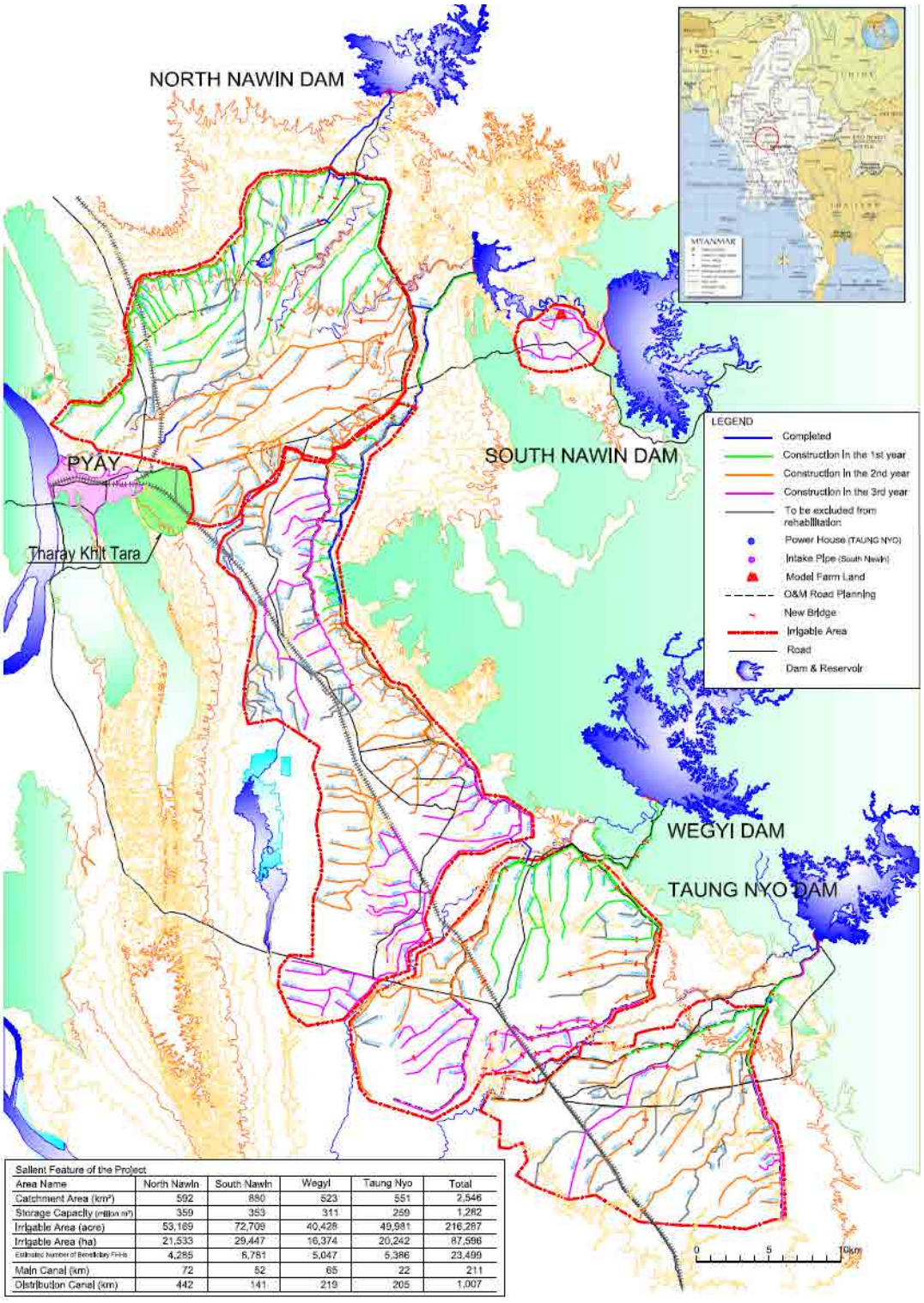
Table 4.2.2 Proposed Rehabilitation Plan for the 4 Irrigation Systems

Project	Items for Implementation	Implementation Year				
		1st Year	2nd Year	3rd Year	4th Year	5th Year
North Nawin	Rehabilitation	▬	▬	▬		
	Construction Machinery	▬				
	Project management	▪▪▪	▪▪▪	▪▪▪		
	Consultation (Engineering)	▪▪▪	▪▪▪	▪▪▪		
South Nawin	Rehabilitation	▬	▬	▬		
	Construction Machinery	▬				
	Project management	▪▪▪	▪▪▪	▪▪▪		
	Consultation (Engineering)	▪▪▪	▪▪▪	▪▪▪		
Wegyi	Rehabilitation			▬	▬	▬
	Construction Machinery					
	Project management			▪▪▪	▪▪▪	▪▪▪
	Consultation (Engineering)			▪▪▪	▪▪▪	▪▪▪
Taung Nyo	Rehabilitation			▬	▬	▬
	Construction Machinery					
	Project management			▪▪▪	▪▪▪	▪▪▪
	Consultation (Engineering)			▪▪▪	▪▪▪	▪▪▪

Source: Irrigation Department, JICA Survey Team (2013)

Figure 4.2.1 shows rehabilitation plan for each irrigation system; blue color shows the canal potions

that the Irrigation Department has already implemented major rehabilitation; green color shows canal areas for which rehabilitation will be carried out in the 1st year; orange color shows for the 2nd year implementation and red color shows for the 3rd year implementation. Note that the 1st, 2nd and 3rd years mean its implementation year from the commencement of each of the irrigation systems, not corresponding to the scheduled year for the case of Wegyi and Taung Nyo indicated in Table 4.2.2. Likewise, it doesn't mean that the canal portions of same color in different systems will be implemented simultaneously either.



Sallent Feature of the Project

Area Name	North Nawin	South Nawin	Wegyi	Taung Nyo	Total
Catchment Area (km²)	592	880	523	551	2,546
Storage Capacity (million m³)	359	353	311	259	1,282
Irrigable Area (acre)	53,189	72,709	40,428	49,981	216,287
Irrigable Area (ha)	21,533	29,447	16,374	20,242	87,596
Estimated Number of Beneficiary Farms	4,285	6,781	5,047	5,386	23,499
Main Canal (km)	72	52	65	22	211
Distribution Canal (km)	442	141	219	205	1,007

Figure 4.2.1 Irrigation Systems for Rehabilitation and their Schedule

Source: Irrigation Department, JICA Survey Team (2013)

4.3 Institutional Setup for Project Implementation

4.3.1 Implementation Body at Central Level: Project Implementation Committee (PIC)

For the ODA loan scheme, PIC should be established in order to ensure smooth work for project implementation. The composition of PIC consists of existing administration of the head office of Irrigation Department such as mechanical, planning & works, procurement, design, and account sections. It should monitor the project status during the implementation period and also can report some necessary information to the concerned donor organization and deliver its feedback to the Project. Thus, it can work as information and financial hub between the donor organization and the Project.

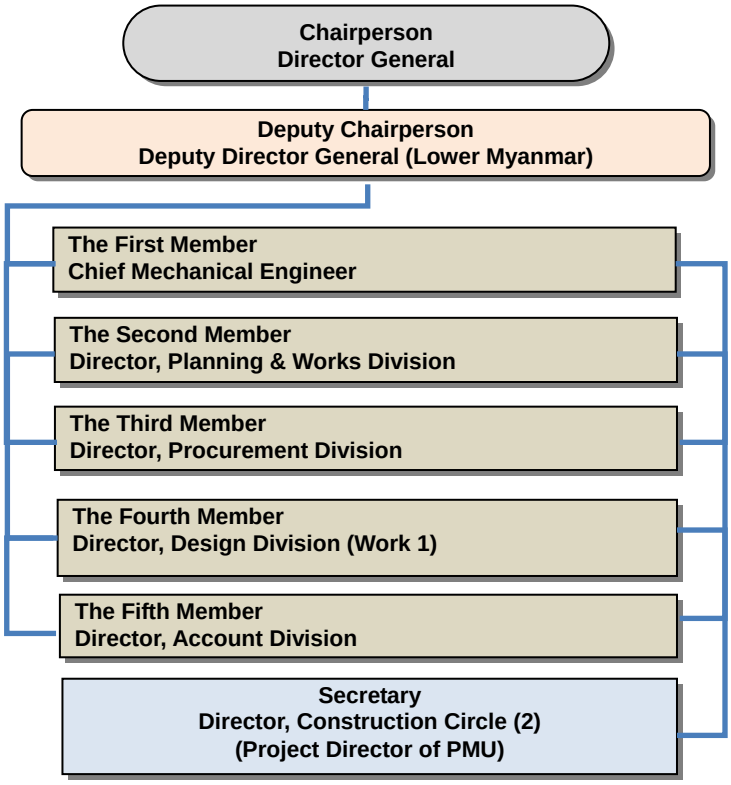


Figure 4.3.1 Organization Chart of Project Implementation Committee (PIC), Central Level

Source: Irrigation Department

4.3.2 Implementation Body at Site: Project Management Unit (PMU)

For this project, Project Management Unit (PMU) will be organized in West Bago region, merged by Construction Division (2) and a part of Maintenance Division (West Bago). PMU itself is the specific project implementation body under the PIC, and PMU will implement this Project according to the guidance and instructions from the PIC. The organization of PMU mainly consists of engineers under Construction Division (2) and Maintenance Division (West Bago). Head of the PMU is the Director of Construction Division (2) who will also be the secretary of the PIC. Thus, PMU is an appropriate and functional entity which can smoothly share information of the project with the PIC.

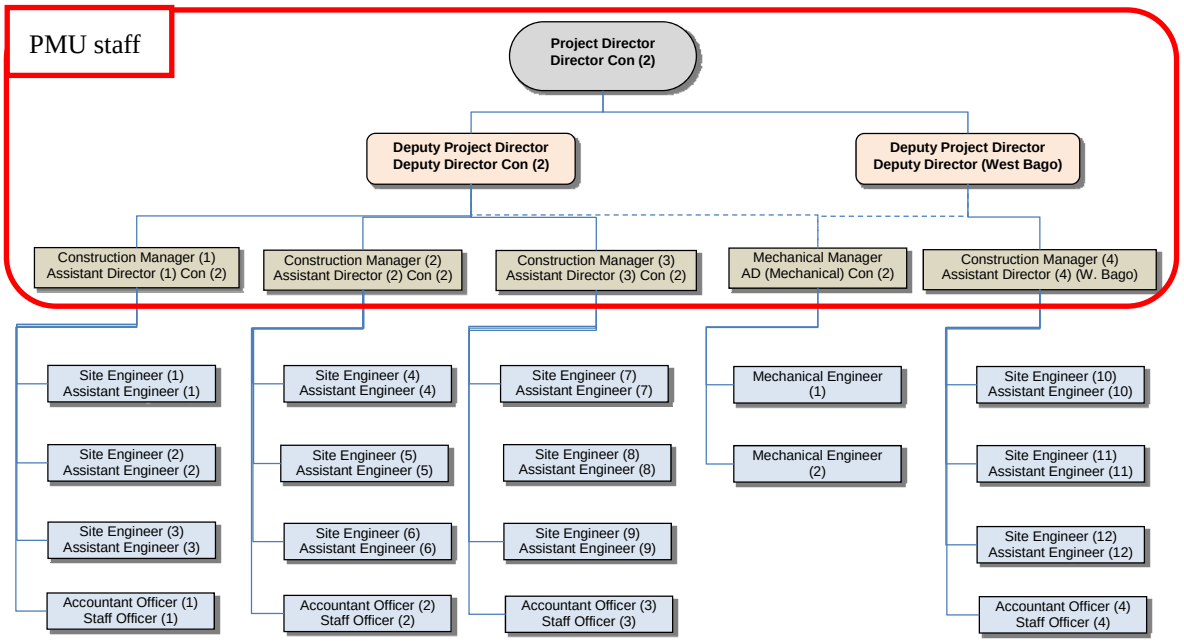


Figure 4.3.2 Organization Chart of Project Management Unit (PMU), Regional Level

Source: Irrigation Department

4.3.3 Staff Allocation for Project Implementation

Based on the experiences of direct force account works implemented by ID so far, necessary arrangement of the project staff is summarized below by construction site and by year (see Table 4.3.1). In fact, operators for heavy machineries play a key role while the other workers are to be assigned under each group of the construction machineries. Irrigation engineers are responsible for supervising and managing those operators and workers.

Table 4.3.1 Staff Allocation for the Project Implementation

Site	Allocation	2014	2015	2016	2017	2018
North Nawin	Assistant Engineer	4	4	4		
	Sub-assistant Engineer	12	12	12		
	Machine Operator	40	40	40		
	Machine Mechanic	6	6	6		
	Worker	600/month	600/month	600/month		
South Nawin	Assistant Engineer	4	4	4		
	Sub-assistant Engineer	12	12	12		
	Machine Operator	40	40	40		
	Machine Mechanic	6	6	6		
	Worker	600/month	600/month	600/month		
Wegyi	Assistant Engineer			4	4	4
	Sub-assistant Engineer			12	16	16
	Machine Operator			40	40	40
	Machine Mechanic			6	6	6
	Worker			600/month	600/month	600/month
Taung Nyo	Assistant Engineer			4	4	4
	Sub-assistant Engineer			12	16	16
	Machine Operator			40	40	40
	Machine Mechanic			6	6	6
	Worker			600/month	600/month	600/month
Total	Assistant Engineer	8	8	16	8	8
	Sub-assistant Engineer	24	24	48	24	24
	Machine Operator	80	80	160	80	80
	Machine Mechanic	12	12	24	12	12
	Worker	1,200/month	1,200/month	2,400/month	1,200/month	1,200/month

Source: JICA Survey Team/ ID

4.4 Project Cost and Disbursement Plan

The project cost is firstly categorized into; 1) consultant fee, 2) civil and structure works, 3) machineries and equipment, 4) supporting activities, 5) price escalation, 6) physical contingency, 7) general administration expense, 8) tax and duties, 9) compensation, etc. Note that land acquisition and compensation do not take place since all the works are to be managed within the existing project areas owned by the project owner, ID.

This Project is to be funded by a Japanese ODA (Yen) loan, for which there should be a demarcation between loan eligible and non-eligible portions. Following table summarizes the portions eligible and non-eligible for the loan; namely, direct costs and those relevant supportive costs including inflation and contingency are covered by loan while administration cost, tax and duties, and land and property acquisition including compensation should be born by the recipient county, Myanmar.

Table 4.4.1 Eligible and Non Eligible Portion for Japanese Yen Loan

Name of Portion		Contents of portion	Investor
1.	Consultant Fee	(1) Detail Design	Donor
		(2) Procurement, management, etc	
2.	Civil and Structure Works	(1) Construction materials (cement, sand, gravel, brick, reinforcing bar, etc.)	Donor
		(2) Wage of labor (common labor, technician, mason, machine driver, etc.)	
		(3) Consumables for machineries (fuel, oil, lubricant cost etc)	
		(4) Construction cost for creation and removal	
		(5) Miscellaneous for construction	
3.	Machinery and Equipment	(1) Construction machineries, etc	Donor
		(2) Spare parts for construction machineries, etc	
		(3) Operation and maintenance training for construction machineries, etc	
		(4) Hiring car cost in the construction site (including driver, fuel etc)	
4.	Supporting Activities	(1) Procedures for raising funds	Donor
		(2) Supervision of tender & contract (buyer and supplier)	
		(3) Pre-shipment inspection and loading inspection for machineries	
		(4) Other supporting activities	
5.	Price Escalation	(1) Construction materials, fuel, Labor cost, etc	Donor
6.	Physical Contingency	(1) Extreme weather phenomena, earthquake, flood, etc	Donor
		(2) War, terrorism, labor troubles etc	
7.	General Administration Expense	(1) Wage of ID staff including various allowance	Myanmar
		(2) Depreciation cost for existing machineries	
		(3) Maintenance cost of storage facilities in mechanical division	
		(4) Material management cost (repairs cost for warehouse, etc)	
		(5) Inland transportation for construction machineries	
		(6) Other general administration expense	
8.	Tax and Duties	(1) Customs duty	Myanmar
		(2) Value-added tax etc	
9.	Purchase of Land	(1) Purchase of land for irrigation system, etc	Myanmar
10.	Compensation	(1) Compensation for moving	Myanmar
		(2) Land on lease for construction	
11.	Other Indirect Items	(1) Testing material cost in Irrigation Technology Center	Myanmar
		(2) Transportation cost for labors	
		(3) Labor management cost	

Source: JICA Survey Team

Total project cost was estimated, and the loan eligible portion shares 90% while the rest shares the non-eligible portion. By component, civil and structure construction shares the most; namely, 66% of the total project cost. By irrigation system for the civil and structure construction cost, Wegyi need a huge amount of lining work, and whereby the cost goes very high followed by Taung Nyo irrigation system.

Disbursement of the fund should be made as per the construction schedule; namely, 1) North Nawin and South Nawin irrigation systems are to start the construction from year 2014 and need 3 years for

the completion, and 2) Wegyi and Taung Nyo irrigation systems are to commence from year 2016 and need another 3 years to complete the required rehabilitation works. It means that the disbursement for the former 2 irrigation systems is from 2014 to 2016 while that of the later 2 systems is from 2016 to 2018.

CHAPTER 5 PROJECT EVALUATION

5.1 Condition of Economic Evaluation of the Project

The major component of the project is to rehabilitate main and distributary canals of the 4 irrigation systems in order to make the water reach down to the terminal points. To accelerate the work, machineries are to the procured and also arranged by ID. In addition, road improvement and pavement are planned under the Project. Given these investment, the systems are to produce more agricultural products and also reduce the transportation cost of those products, which are the major benefits. The following are the basic assumptions of the economic evaluation:

1) Referring to other similar projects in the irrigation/agriculture sector, the economic life of the Project is designed to be 30 years. It means that economic evaluation is encoded over a period of 30 years considering the initial investment and also operation and maintenance costs to be accrued. For the operation & maintenance cost, 0.3% of the initial investment cost is counted as the base case, and in addition, as a sensitivity analysis, 3% O&M cost is also examined.
2) The opportunity cost of capital in Myanmar is not established yet; however a range of 12% to 15% can be applied as a reference opportunity cost of capital with reference to practices that the World Bank, ADB and JICA have done so far in the sector of irrigation/agriculture development. In this economic evaluation, EIRR should therefore be at least more than 12% and targeted at 15% or more, or otherwise the investment cannot be justified.
3) Transfer costs such as tax and duties are eliminated from the economic cost. Also, price contingency (inflation) cost is not counted in the economic evaluation while physical contingency is counted in the evaluation.
4) Prices employed in the evaluation refer to the prevalent market ones in year 2013. After having collected those market prices, conversion factors are applied to estimate economic costs/prices, or border prices, from the financial market ones. Note that conversion factors are not standardized in Myanmar, so that FOB, CIF cost/prices and import and export duties have been examined to establish such factors, presenting the following factors:

Table 5.1.1 Applied Conversion Factors in Economic Evaluation

Particulars	Factor	Remarks
Standard Conversion Factor (SCF)	0.990	Based on export/ import & duties for 2010/11 – 2012/13
Pulses	1.070	Estimated based on FOB at Yangon Port
Rice	0.784	ditto
Fertilizer	0.770	Estimated based on CIF at Yangon Port
Agricultural Inputs	0.770	Assumed same as fertilizer
Skilled Labor	1.000	Assumed placed under competitive market
Unskilled Labor/ Family labor	0.600	Assumption with reference to rural unemployment

Source: JICA Survey Team

5.2 Cases for Project Evaluation

5.2.1 Base Cases for Project Evaluation

Table 5.2.1 shows the cases to examine the project economic variability; namely, there are 5 cases in total. Base 0 takes into account only the area expansion of black gram as the project benefit, not

considering other benefits such as the benefit from road improvement and yield increase. Base 1 considered, on top of Base 0, the benefit accrued from road improvement as reduction of fuels for transporting agricultural products. Base 2 further considers, on top of Base 1, the remaining value of procured machineries after having completed the use in the project. For these 3 basic cases, no yield increase is counted but area expansion of black gram only for a direct agriculture related benefit.

Aside from the basic 3 cases, there are 2 more cases; Case Ext. Service takes into account yield increase both for rice and black gram given an appropriate extension services. Last case, Case Road Only, undertakes the project cost of road improvement only and the benefit to be accrued from the road improvement only. The benefit is estimated how much transportation cost will be reduced with the improvement of the road mainly by the reduction of the fuel cost for Trollergyi. Note that though road improvement will facilitate rural transportation, such benefit is not counted since it is difficult to estimate.

Table 5.2.1 Cases for Project Evaluation

Case	Monsoon Paddy	Summer Paddy	Black Gram	Remarks
Base 0	Yield not changed	Yield not changed	Yield not changed	Benefit from road improvement not considered.
	Area not changed	Area not changed	Area to expand by 117,243ac (47,446ha)	
Base 1	Yield and Area same as Base 0			Benefit from road improvement considered.
	In addition to Base 0, benefit from road improvement considered.			
Base 2	Yield and Area same as Base 0			Road benefit and machineries' remaining value considered.
	In addition to Base 1, remaining value of procured machineries considered.			
Ext. Service	Yield increase by 15%*1	Yield increase by 13%*1	All yields to the MD*2 (highest) one	Road benefit and machineries' remaining value NOT considered.
	Area not changed	Area not changed	Area to expand by 117,243ac (47,446ha)	
Road Only	Cost for road improvement only considered with the benefit from the road improvement only			Only for road cost/benefit

Note; *1 Yield increases were recorded by the pilot project under Development Study on Sustainable Agricultural and Rural Development for Poverty Reduction Programme in the CDZ, July 2010
*2 Yield of black gram for midstream area (MD) is 20.5 basket/acre while those of upstream and downstream are 15.7 and 10.1 basket per acre respectively (Source: Household Questionnaire Survey, 2013 by JICA Survey Team

5.2.2 Cases for Sensitivity Analysis

Aside from above basic cases, there should be a sensitivity analysis to know to what extent the project variability is affected by such factors as hike of construction cost, reduction of benefit, delay of construction schedule, etc. Table 5.2.2 shows the cases of sensitivity analysis where total 5 cases are to be examined against a base case, which is the Base 1 where the benefits from area expansion of black gram and road improvement are taken into account. The 5 cases are; cost increase by 10%, benefit reduction by -10%, cost increase together with benefit reduction of each 10%, construction delay by 2 years, and increase of O & M cost to 3% from the base 0.3% of the initial investment cost:

Table 5.2.2 Cases for Sensitivity Analysis (against Base 1)

Case	Cost	Benefit	Base Cost and Benefit	Remarks
SA 1 (C+10%)	+10%	No change	Base 1	
SA 2 (B-10%)	No Change	-10%	Base 1	
SA 3 (C+10B-10)	+10%	-10%	Base 1	
SA 4 (+2years)	Construction delayed by 2 years		Base 1	
SA 5 (O&M 3%)	No Change	No change	Base 1	0.3% for base O&M

Source: JICA Survey Team

5.3 Results of the Project Economic Evaluation

Table 5.3.1 shows the results of the economic analysis; EIRR shows up over 15% in all the cases including the Base 0 where only area expansion of black gram is counted as the project benefit. By

case, the minimum EIRR shows up in Base 0 as 19.4%, and then Base 1 shows 22.2% up by 2.8% from the Base 0 by undertaking the benefit from the road improvement. By considering the remaining value of procured machineries, not much hike in EIRR takes place as indicated in Case Base 2, only 0.7% top up on the Base 1.

If conducting extension services, relatively high return is expected as EIRR 22.8 % as indicated under Case Ext. Service even without considering the benefit of road improvement and remaining value of the machineries. Road improvement generates the highest return, though the scale of the NPV is not much large as compared with other cases since only fuel reduction is counted as the project benefit. B/C ratios are in all the cases higher than 1.0, justifying the investment.

Table 5.3.1 Summary of the Project Evaluation Analysis

Cases	Financial Price/Cost			**Economic Price/Cost**		
	FIRR	NPV (M Kyats)	B/C	**EIRR**	**NPV, (M Kyats)**	**B/C**
Base0	12.7%	4,948	1.04	19.4%	48,894	1.48
Base1	15.3%	24,089	1.22	22.2%	67,176	1.66
Base2	15.9%	27,797	1.26	22.9%	71,016	1.72
Ext. Service	17.0%	38,299	1.34	22.8%	78,645	1.73
Road Only	32.9%	11,290	2.45	32.6%	11,100	2.42

Source: JICA Survey Team

Table 5.3.2 summarizes the results of the sensitivity analysis against the case Base 1. Base 1 has generated a high return of 22.2% as indicated in the EIRR above, and this EIRR never goes down below 15% under all the 5 sensitivity analysis cases. Therefore, it is concluded that the project investment still keeps viability under such cases of 10% increase of cost, 10% reduction of benefit, both events taking place, 2 years construction delay, and even with 3% cost in O&M against the initial investment cost. All these results conclude that the Project should be viable under the planned investment, whereby the project owner, ID, be recommended to make the investment.

Table 5.3.2 Cases for Sensitivity Analysis (against Base 1: EIRR 22.2%)

Cases	Cost	Benefit	Economic Price/Cost		
			EIRR	NPV (M Kyats)	B/C
SA 1 (C+10%)	+10%	No change	19.9%	57,188	1.51
SA 2 (B-10%)	No change	-10%	19.6%	50,270	1.49
SA 3 (C+10%, B-10%)	+10%	-10%	17.5%	40,282	1.36
SA 4 (+2years)	Construction delayed by 2 years		16.2%	24,278	1.24
SA 5 (O&M 3%)	No change	No change	19.5%	49,117	1.41

Source: JICA Survey Team

CHAPTER 6 ENVIRONMENTAL AND SOCIAL CONSIDERATION

6.1 Results of Environmental and Social Examination

Environmental and Social Examination was carried out based on the site surveys, review and examination of the contents of the works, information obtained through interviews to relevant beneficiary farmers as well as non-beneficiary villagers, and technical discussions with the concerned government officials, etc. The evaluation results are summarized in Table 6.1.1 comparing those at the scoping stage and the ones after environmental and social examination has been done. Of those, environmental parameters which may cause negative impacts indentified through the examination are as follows:

1) No.1 Air Pollution

Major construction machineries to be used are excavator, dozer, breaker, roller, loader, truck, and

trailer truck. These machineries emit exhaust gasses to some extent, and therefore the machineries should be well maintained in order not to emit excessive hazardous exhaust gasses. Dust may also be expected to take place during the construction and when transporting necessary materials to the construction site. In this case, spraying water along and at the construction site should be observed, which can greatly reduce such dust.

3) No.3 Wastes

Wastes are generated out of excavation of soils, removal of bricks from dilapidated canal portion, and removal of concrete pavement from the dilapidated portions of the access road to North Nawin dam site. After having re-used such wastes as much as possible in repairing lining, backfilling, paving village roads, etc., remaining wastes shall properly be disposed of. In this regard, disposal site(s) and/or proper disposal methods should be established prior to the commencement of the work.

4) No.5 Noise / Vibration

Public institutes such as hospital and schools are not located near the construction site. In addition, residential areas are not located near the construction sites in most cases either. Therefore, noise and vibration generated from the construction work will not give noticeable impacts on them. However, approach roads for the construction sites may have to pass through villages in some cases. In such cases, attention should be paid not to cause noticeable impact to the villagers.

6) No.22 Labor Environment and No.23 Accident

If the construction schedule is made tight or otherwise operators/workers are not allotted with enough numbers, labor environment will be deteriorated leading to an accident. In addition, if pre-explanation to workers employed at sites are not made well for the contents of the works together with safety measures, there may be some accidents to take place. Vehicles which are passing near villages may become a cause of traffic accident due to the increase of the transport. Therefore, safety measures should be addressed prior to the commencement of the project.

7) No. 24 Hazards (Risk), Infectious diseases such as TB, HIV/AIDS, etc.

There will be number of labors during the construction stage. Under such situation, there may be a possibility of diffusing infectious diseases such as TB, HIV/AIDS among the labors, though with reference to similar construction works, no noticeable examples have been reported. The supervisors of the contractor, or CON (2) and Maintenance Division (west Bago), should always pay attention to the labors' health condition, and should there be such possibility, the supervisors shall inform the health office of the township as well as the Consultant office. Also, awareness creation on HIV/AIDS shall be made among the labors, which can be initiated by the township health office.

Table 6.1.1 Environmental Evaluation at Scoping and After Examination

Environmental Parameters	Evaluation at Scoping		Evaluation based on the result of Environmental and Social Examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
1. Air Pollution	B-	D	B-	D	**Under construction:** With regard to rehabilitation works, heavy machinery and trucks are supposed to emit exhaust gas, and a little serious degree of air pollution would take place. In addition, dust is generated when vehicles pass. **During the use:** Once offered for use, no impact of air pollution arises.

Environmental Parameters	Evaluation at Scoping		Evaluation based on the result of Environmental and Social Examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
2. Water Pollution	B-	D	D	D	**Under construction:** Accompanying with rehabilitation works, turbid water may occur in the canals; however the level is very minimal and it can be confined within a reach of the canal. Therefore, negative impact is not conceivable. **During the use:** Once offered for use, no impact of water pollution arises.
3. Wastes	B-	D	B-	D	**Under construction:** Wastes and scraps (mostly excavated soils and bricks of existing canals) are resulted from excavation and other construction works to some extent. **During the use:** Once offered for use, no waste is generated
4. Soil Pollution	D	D	N/A	N/A	The Project is to supply irrigation water throughout the canal system; hence no soil pollution arises during both the construction and operation phases.
5. Noise and Vibration	B-	D	B-	D	**Under construction:** Transport of materials by heavy machinery and trucks takes place toward the construction sites. Though serious noise / vibration are not generated from these activities, consideration should be needed to pay when the heavy machinery and trucks pass through the living quarters. **During the use:** Once offered for use, no noise/ vibration is emitted.
6. Land Subsidence	D	D	N/A	N/A	Since no groundwater lifting is planned in this Project, no land subsidence takes place.
7. Odor Emission	D	D	N/A	N/A	Since the Project deals with irrigation water supply, no cause of odor is resulted from the construction work and operation stage either.
8. River Bottom State	D	D	N/A	N/A	Since the Project has the objective of irrigation water supply, no erosion of river bottom is resulted from the work, and operation stage either.
9. Protected Area	D	D	N/A	N/A	There is no protected area in and around the Project site (Note that a heritage site called “Tharay Khit Tara” is discussed under 18. Cultural Heritage).
10. Ecosystem	D	D	N/A	N/A	As the Project undertakes rehabilitation of existing canals and there is no rare species of animal or plant in this area, no impact of ecosystem is expected.
11. Hydrological Situation	D	D	N/A	N/A	No hydrological situation for existing rivers and drainages will change by the Project, whereby no impact on it.
12. Topography/ Geology	D	D	N/A	N/A	Since this Project deals with rehabilitation of existing facilities, no topographical and geographical change by the works will be caused, whereby no impact is expected.
13. Evacuation, Removal of Local Population	D	D	N/A	N/A	Since the contents of the construction in the Project undertake rehabilitation of the existing canal systems which are located on/along public lands

Environmental Parameters	Evaluation at Scoping		Evaluation based on the result of Environmental and Social Examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
					owned by the Government, non-voluntary/ forcible removal of the inhabitants will not arise.
14. Vulnerable Strata, Ethnic Minority	D	D	N/A	N/A	No minority ethnic exists in the target Project area. Also, no impact thereon arises from activities of the Project.
15. Such local economy as employment and livelihood means	B^+	B^+	B^+	B^+	**Under construction:** Since hiring opportunities of local inhabitants are generated by the construction work, possibly beneficial impact on local economy is expected. **During the use:** Upon completion of the Project, increase of crop production is to take place, hence local economy will improve not only for the farm households but also it is to provide more job opportunities to farm casual labors. In addition, pavement of the roads along the main canals and improvement of the roads along distributary canals will significantly facilitate and improve transportation along all these roads.
16. Water Use	D	A^+	D	A^+	Since the Project carries out rehabilitation works for the existing facilities, water distribution will be improved upon completion of the project.
17. Biased Benefit and Damage Distribution	D	D	D	D	Agricultural benefits arising from the Project are equitably distributed among all the beneficially farmers according to the farm size the farmers own. By this reason, no biased distribution of benefits and suffering takes place from the Project.
18. Cultural Heritages	B^-	B^-	N/A	N/A	Letter from the Ministry of Culture forbids any rehabilitation work within the "Tharay Khit Taya". Therefore, the related canal is excluded from the rehabilitation works.
19. Landscape	D	D	N/A	N/A	Since the Project carries out rehabilitation works for the existing facilities, no change of landscape is resulted from the work.
20. Resettlement	D	D	N/A	N/A	Since the project deals with rehabilitation of existing facilities, no resettlement by the works will take place, whereby no impact is expected on the resettlement.
21. Ethnic Minorities and Indigenous Peoples	D	D	N/A	N/A	There are no ethnic minority and indigenous peoples in and around the project area, whereby no impact is expected on such ethnic minorities and indigenous peoples.
22. Labor environment (including labor safety)	B^-	B^+	B^-	B^+	**Under construction:** Careful consideration on possible accidents during the construction phase is required. **During the use:** Since canal systems including gates are rehabilitated, system operation especially gate operation is made easier resulting in improved labor condition.
23. Accident	B^-	D	B^-	N/A	**Under construction:** Potential risk of accidents would arise from the

Environmental Parameters	Evaluation at Scoping		Evaluation based on the result of Environmental and Social Examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
					Project such as possibility of traffic accidents caused by vehicles of the construction work giving damages to local inhabitants. **During the use:** No accident is expected during the operation stage.
24. Hazards (Risk), Infectious diseases such as HIV/AIDS	B-	D	B-	D	**Under construction:** Potential risk of infectious diseases, such as TB and HIV/AIDS, may arise since there will be big number of labors coming together to the construction sites. **During the use:** No impact is expected during the operation stage.
25. Global Warming	D	D	N/A	N/A	No global warming by the works is anticipated.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

6.2 Mitigation Measures and Monitoring

6.2.1 Mitigation Measures and Cost

Some adverse effects are anticipated by the project, and in general they are limited to construction phase only, e.g. air pollution, wastes, noise/vibration, labor environment and accidents. The damages are thus tentative and recoverable. As per possible measures to alleviate and to avoid such negative impacts, following countermeasures are considered necessary. These impact alleviating or avoiding measures can be realized to put into practice within the indirect cost included in the management of the construction cost, thus no additional cost is required for taking them.

Table 6.2.1 Mitigation Measures to/against the Negative Impacts

Negative impact	Alleviating or avoiding measures	Responsible Agency
1. Air pollution Exhaust gas emission takes place. Dust occurs during the passage of construction vehicles.	• Utilize such construction machines equipped with gas emission reduction system. • Conduct regular check and full maintenance of construction machineries and vehicles. • Spray water in and around entrances of construction sites and on the road, along which machineries are to move.	CON(2) and MD ID
2. Wastes Excavated earth evolves from some construction works. In rehabilitating the existing canals, waste scrap pieces evolves. In improving the access road to North Nawin dam, concrete debris will take place.	• Re-use excavated soils as back-filling materials for collapsed canal portions as much as possible. • Dispose of such soils containing organic matters in the lands running alongside the canals, the lands of which are owned by ID. • Confine turbid water which may take place during canal rehabilitation works within the canals, so that no such turbid water will be discharged out of the construction sites. • Re-use the removed bricks out of the dilapidated main canal portions for the protection/lining of distributary canals. • Re-use the dilapidated concrete portions for the access road to North Nawin dam, after having been crushed, for the basement of concrete pavement of the inspection roads along the main canals. • Further, distribute the removed bricks and concrete debris to	CON(2) and MD ID

Negative impact	Alleviating or avoiding measures	Responsible Agency
	villages upon requests where the villagers hope to use them for, e.g., simple pavement of village road. • Remaining ones which can not be re-used will be dumped and buried in the ID owned lands stretching alongside the main and distributary canals. • Finally, entrust proper disposal of waste, which can not be reused, though such waste will be minimal.	
5. Noise/ vibration During construction work, noise/ vibration evolve from the operation of back-hoes and passage of trucks., etc.	• Employ construction machinery mounted with silencers and adequate mufflers to minimize the noise emission. • Refrain construction work at night in such areas where residential quarters are located.	CON(2) and MD ID
22. Labor environment 23. Accident During construction work, traffic and/or site-work accidents may take place.	• Identify if there is too tight operation schedule or not, and if so rectify it. • Place traffic control staff along the construction roads. • Explain contents of the work to the workers with necessary care taking for their safety prior to the start of the work, and make daily confirming safe meeting before starting the work.	CON(2) and MD ID
24. Hazards (Risk), Infectious diseases such as HIV/AIDS During construction stage, infectious diseases such as TB and HIV/AIDS may take place among the workers.	• Pay attention to the workers' health condition, and if there is a possibility of incident of infectious diseases taking place, immediately inform the township health office and the Consultant office. • Request the township health office to carry out awareness creation on HIV/AIDS among the workers and recommend them to voluntary check the status of HIV/AIDS.	CON(2) and MD, Township Health Office

Source: JICA Survey Team

6.2.2 Monitoring Plan

Anticipated environmental impacts are limited to construction phase, and thus related monitoring will be implemented during the period. Since the environmental parameters which can be affected by the construction works are air pollution, wastes, noise/vibration, labor environment and accidents, and infectious diseases such as HIV/AIDS, those items shall be monitored. The monitoring is basically conducted every day, and the results are recorded in monthly progress report submitted to ID head office.

The environment monitoring is to be made by CON(2) and Maintenance Division (West Bago) using prescribed forms. A statement of dissatisfaction or claim from neighbor villagers is to be received by a sub-assistant engineer at site. Then, CON(2) and Maintenance Division should report it to the Consultant, and the Consultant should report to ID head office recorded in the monthly progress report and also taking such opportunity of periodical site inspection or site meeting by the ID head office.

CHAPTER 7 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Taking into account the following points, this Survey concludes that the project to enhance and further develop the irrigation performance for the target 4 irrigation systems should be implemented as soon as possible. The GOM should therefore take immediate action toward requesting the required funds for Japanese ODA loan. Appropriation from the Government coffer should also be made available for the project management, arrangement of the construction machineries, and other supportive components such as agriculture extension services, etc.

1) The Project, from the viewpoint of national development, gives EIRR 19.4 % higher than the opportunity cost of capital, 12-15 %, applied in most of the development projects even at the Base

Case 0 where no yield increase is considered but only area for pulses is to increase. It is expected with the Project that the cultivation area of pulses, e.g. black gram, will increase to 183,370 acre (74,206 ha) from the current 66,127 acre (26,760 ha) for the 4 irrigation systems, up by 117,243 acre (47,446 ha) equivalent to 277 % increase. For the overall beneficial area, the original irrigable area of 319,901 acre (129,457 ha) will increase to 437,144 acre (176,903 ha), up by 117,243 acre (47,446 ha).

2) The Project will realize the beneficiaries' long lasting wishes; that is agricultural income increase well supported by irrigation water especially for those farmers at the downstream areas where irrigation water has hardly reached. For the Base Case 0 where only cultivated areas of black grams are to increase without yield increase, the total annual net profit of the back gram for the 4 irrigation systems is to increase from 12,475,579,897 Kyats to 34,318,259,212 Kyats, up by 21,842,679,315 Kyats. For the overall net profit, the original overall net profit of 43,891,290,930 Kyats per annum will increase to 65,733,970,245 Kyats, up by the same 21,842,679,315 Kyats.

3) The Project furthermore will facilitate rural transportation by rehabilitating the access road to the North Nawin dam, upgrading the gravel clay inspection roads alongside the main canals to concrete paved roads, and improving the inspection roads alongside the distributary canals to well rehabilitated gravel clay ones. These improvements will greatly reduce the transportation cost for agriculture products and also facilitate rural transportation in general. As for the benefit accrued from the road improvement, the EIRR estimated only on road construction/rehabilitation arrives at a very high 32.9 %.

7.2 Recommendations

1) The consultants to be engaged in the Project will be availed from year 2015; namely spending year 2014 for the selection of the consultants under ICB. It means that the ID shall seek a way of preparing for the detail design of the conduit pipe to be replaced for the North Nawin intake as well as for the tender documents of the machinery procurement within year 2013 to early part of 2014, e.g. by requesting JICA for another arrangement apart from the loan. Otherwise, North Nawin needs total 4 years to complete and also the machineries procurement would be delayed by at least one year.

2) Since the construction period for each of the 4 irrigation systems is scheduled only for 3 years and the canal rehabilitation work is limited only during rainy season, machinery procurement shall be started as early as possible after the loan agreement has become effective between the counties. In this regards, arrival of procured machinery at Yangon port shall not be later than the end of March 2015. After machinery has arrived at Yangon port, custom clearance, machine operation training, and transportation to the site will take about 2 months and it will be at the beginning of June 2015 when the machinery can be engaged in the rehabilitation and construction works at sites.

3) Since machineries which are to be procured under this Project are equipped with sophisticated electric and hydraulic control systems, OJT training on safe operation and daily maintenance shall be emphasized and organized before Irrigation Department deploys such machineries to the sites. The trainings are to be incorporated as a part of the supplier's task responsibilities under the procurement contract. Irrigation Department shall mainly send heavy-machinery operators to such training.

4) Irrigation Department shall arrange construction machinery required for the first year rehabilitation works; namely the works of year 2014, since the machinery procurement will need about one year to be completed under ICB. Machineries that the ID shall arrange are; Hydraulic Excavator (6 NOS), Hydraulic Breaker (1 NOS), Tracked Dozer (6 NOS), Wheel Loader (1 NOS), Earth Work Vibration Roller (2 NOS), Concrete Mixer (12 NOS, 1cum), Lowbed Semi-Trailer

Truck (1 NOS), Dump Truck (5 NOS). ID is requested to avail of all these machineries well in advance of the commencement of works, May 2014.

5) Logistic management on such construction materials as diesel oil, cement, reinforcement bars, etc. should be carefully carried out throughout the construction period. Shortage of fuel and materials will directly affect the construction progress. In addition, much amount of labor force procurement is estimated during canal rehabilitation period while it is the time for summer paddy harvesting and monsoon paddy seeding. Labor force demands in this period are estimated to overlap each other between ID and farmers, thus the arrangement of labor force shall be made well in advance and also by covering wider areas for the recruitment.

6) Irrigation Technology Center (ITC) shall be fully utilized for quality control such as the checking of concrete mortar strength, confirmation of design mixture of concrete and mortar, and the level of soil compaction, etc. These test results shall be sent to the consultants for their approval before the commencement of relevant construction works. In case that testing equipment and tools are not enough, procurement or otherwise availing of existing equipment from relevant laboratories shall be arranged.

7) Wasting of irrigation water through un-controlled gate operation is considered as the main reason of irrigation water shortage at the downstream and terminal areas of those 4 irrigation systems. In order to rectify such fundamental issue, employment and deployment of appropriate number of gate keepers are essential at this moment. Self-centered gate operation by farmers shall be banned, and participatory dissemination of irrigation system management is recommended to all the beneficiary farmers upon the completion of the rehabilitation works. Participatory dissemination can be the starting point of establishing water users associations, which are expected to take care of all the distributary canals under the concept of IMT or PIM in future.

8) Taking into account the present low yields of paddy and black gram, there could be a lot of potential of increasing the yields given appropriate agriculture extension services together with irrigation water to be enough availed upon completion of the rehabilitation works. To enhance the extension services, there should be a technical assistance provided by an international institute or donor. ID together with DOA should consider of inviting a team of agricultural experts, which can be requested to JICA apart from the loan arrangement of the Project. In order to increase effectiveness of farm works, farmland consolidation shall also be considered, which can be tried as pilot together with the dissemination of the said agriculture extension services.

PART II
MODEL FARMLAND CONSOLIDATION PROJECT

CHAPTER 1 RATIONALE OF THE MODEL FARM ESTABLISHMENT

1.1 Rationale of Land Consolidation

Land consolidation aims at ensuring high productivity for agriculture supported by effective mechanized farming and rationalized water management to meet future agricultural requirements. The works accompany rearrangement and consolidation of farmland plots, improvement/upgrading of irrigation and drainage canals, and farm road construction. Land consolidation works will therefore result in improving and consolidating overall farm conditions, including related farmland-use rights.

Furthermore, the overall shape of farm plots will be improved by farmland consolidation works; therefore each of the beneficially farmers is supposed to reallocate their farmland. Reallocation works of farm plot is very important since farmland is a due important asset for every farmer, which shall have to be exchanged amongst the beneficiaries towards achieving more productive farmland as a whole. Reallocation plan should therefore be investigated closely by obtaining full consensus from all the beneficiaries before the commencement of the construction works.

1.2 Process of Farmland Consolidation

Table 1.2.1 describes the process of farm land consolidation work; namely,

1) Confirmation of farmland consolidation area: Confirmation of the target project area with reference to topographic and cadastral maps shall be carried out as the first step, and then investigation of environmental and social conditions will start,

Table 1.2.1 Process of Farm Land Consolidation Works

No	Activities
1	Confirmation of Land Consolidation Area
2	Planning and Designing of the Farmland Consolidation
3	Identification of Farmland Use Right Holders.
4	Participatory Stakeholder Meetings
5	Farmer Organization Set-up in Charge
6	Reallocation Plan for Farm Plots, and it's Settlement

Source: JICA Survey Team

2) Planning and designing of the farmland consolidation: Upon confirmation of the target area, draft design of the model farmland for the consolidation should be prepared clearly indicating re-allocation of farmland plots, irrigation and drainage canals together with farm roads. Note that the design will be modified, as needs arise, by obtaining feed-back from the concerned farmers,

3) Identification of farmland-use-right holders: Before executing the farm land consolidation works, the names of all the beneficiary farmers and how many plots they have must be clearly identified,

4) Participatory stakeholder meetings: After having identified all the concerned farmland use holdings, explanation meeting has to be held inviting all the concerned farmers and government offices (ID, AMD, DOA, SLRD and Cooperative Department) on the farmland consolidation works,

5) Farmer organization set-up in charge: Farmer organization which is a legal entity must be established, to which the legal right of owing and managing farm roads, and irrigation and drainage canals is to be vested, and

6) Reallocation plan for farm plots: Reallocation plan for farm plots shall be prepared and the settlement of the plan amongst all the concerned farmers shall be made before the commencement of the farm land consolidation work. Note that the established farmer organization should take the lead-responsibility of settling the reallocation of farmlands amongst the member farmers facilitated by SLRD and CD.

1.3 Implementation Structure

At this model farmland consolidation project, ID, SLRD, AMD and DOA, which are under MOAI,

and GAO (General Administration Office), CD (Cooperative Department) and also the Management Committee of the Farmers Organization concerned should be involved as the project implementer as well as facilitator. The relationship among the organizations is shown in Figure 1.3.1 with the farmer organization at the center, and major responsibilities by each organization are summarized below:

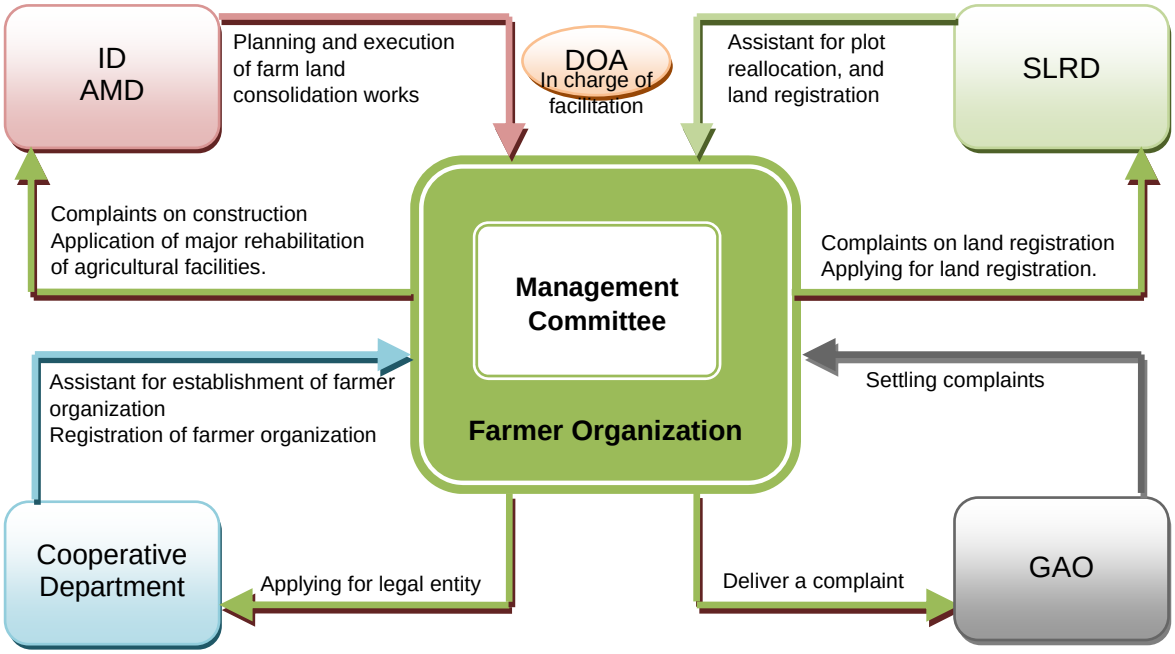


Figure 1.3.1 Implementation Structure of Land Consolidation Project

Source: JICA Survey Team, 2014

1) ID (Irrigation Department): Planning and designing of farm land consolidation project together with AMD, and execution of farmland consolidation works for the parts of farm roads, irrigation and drainage canals,
2) AMD (Agriculture Mechanization Department): Planning and designing of farm land consolidation project together with ID, and land leveling by using farm machineries (in general, tractors 70HP and 90HP), making plot boundary levees within one-acre standard plot, and first-time harrowing and ploughing for the preparation of cultivation,
3) SLRD (Settlement and Land Record Department): Assistance to farmer origination to establish farm plot reallocation plan, conduct of the farmland area survey upon completion of consolidation works, and issuing of registration certificate for the right of cultivating farmland,
4) DOA (Department of Agriculture): Facilitation and coordination in respective necessary tasks which have to be done between beneficiaries and concerned government departments,
5) CD (Cooperative Department): Assistance to farmers in establishing farmer organization, acceptance of application of registration and issuing of the registration certificate,
6) GAO (General Administration Office): Responsible office for coordination between farmer organization and concerned government departments, and consultation to solve complaints/ grievances from concerned farmers, and
7) Management Committee: Responsible body established under the farmer organization in coordinating and negotiating respective issues with the government organizations noted above.

Upon completion of the farm land consolidation works, farmer organization established will take responsibility of daily O&M of farm road, and irrigation and drainage canals. Furthermore, if a farmer or organization itself has complaints/ grievances, the management committee under the farmer organization takes the responsibility to solve them. If the committee cannot solve the complaints/

grievances, the committee will deliver the claim to the respective government offices.

CHAPTER 2 THE MODEL FARM AREA

2.1 Location of the Model Farmland

To demonstrate the effect of farmland consolidation work, there is a model farmland area prepared by the Irrigation Department (ID) together with Agricultural Mechanization Department (AMD). The model farm consolidation site is located in Zabu Thiri Township, Nay Pyi Taw City. The area is sandwiched by Nay Pyi Taw Council Road at its western part and Yangon – Mandalay Road at its eastern part. Nay Pyi Taw City council is located at about 1km north from the farm land consolidation site.

2.2 Area and Beneficiary Farmers for the Model Farmland

A census survey conducted by JICA survey team has identified total 138 farmers who have their own right of using the plots within the target farm land consolidation area (see Table 2.2.1). Figure 2.2.1 shows farm size together with the number of farmers who own the farm size within the model farm land consolidation area. Total area of the farmland is estimated at 338.23 acre (136.87 ha), and therefore the average of the farmland area per farmer comes to 2.45 acre (0.99 ha). The number of farmers who have less than 1 acre counts at 38 farmers, sharing 28%. It means around one out of every 4 farmers has less than 1 acre of farmland within the model farm land area.

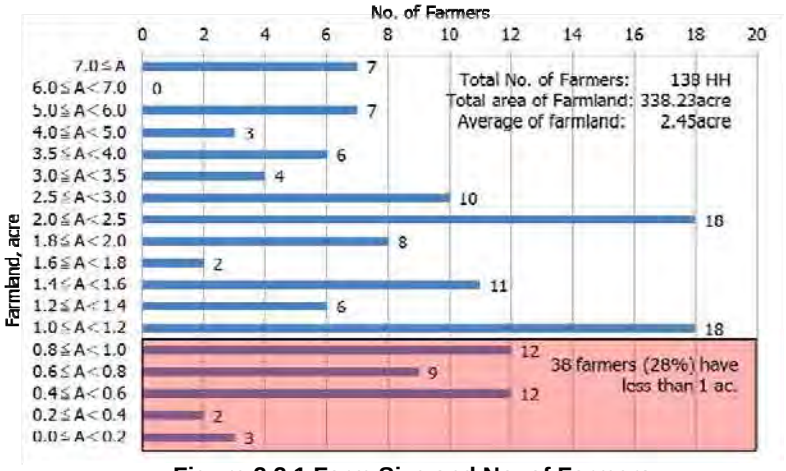


Figure 2.2.1 Farm Size and No. of Farmers

Source: Census Survey by JICA Survey Team, April, 2013

Table 2.2.1 Number of Households and Population affected by Farmland Consolidation

Village Tract	Village	Households	Male	Female	Total
Te Gyi Gone	Gone Min Ein	53	156	159	315
	Te Gyi Gone	5			
	Shar Taw	16			
Aung Zabu	Aung Zabu	24	56	55	111
Ayinlo	Ayinlo	32	66	83	149
Kan Oo (pyin ma nar)	Kan Oo	9	23	27	50
Total		138	301	324	625

Source: Census Survey by JICA Survey Team, April, 2013

CHAPTER 3 PLANNING AND DESIGNING OF THE MODEL FARM

3.1 Planning of Model Farmland Consolidation

Figure 3.1.1 presents the current land parcels (actual situation of the farm land) in the left figure and the design of the farm land consolidation in the right side. In fact, within the total 338.23 acre, there was a government owned land running from north-west to south-east as indicated in the left figure below. The land was once purchased from the farmers for the purpose of constructing a new highway

road but it has been already cancelled. The government land was once returned to the original farmers during the planning of the model land consolidation works, and undertaken same as individually owned farmlands.

Table 3.1.1 Land within the Target Land Consolidation Project Area

Land	Acre	Ha	%	Remarks
Farmer owned land	309.47	125.24	91.5	
Government owned land	28.76	11.64	8.5	Purchased for road construction purpose
Total	338.23	136.87	100.0	

Source: Settlement and Land Registration Department (SLRD)

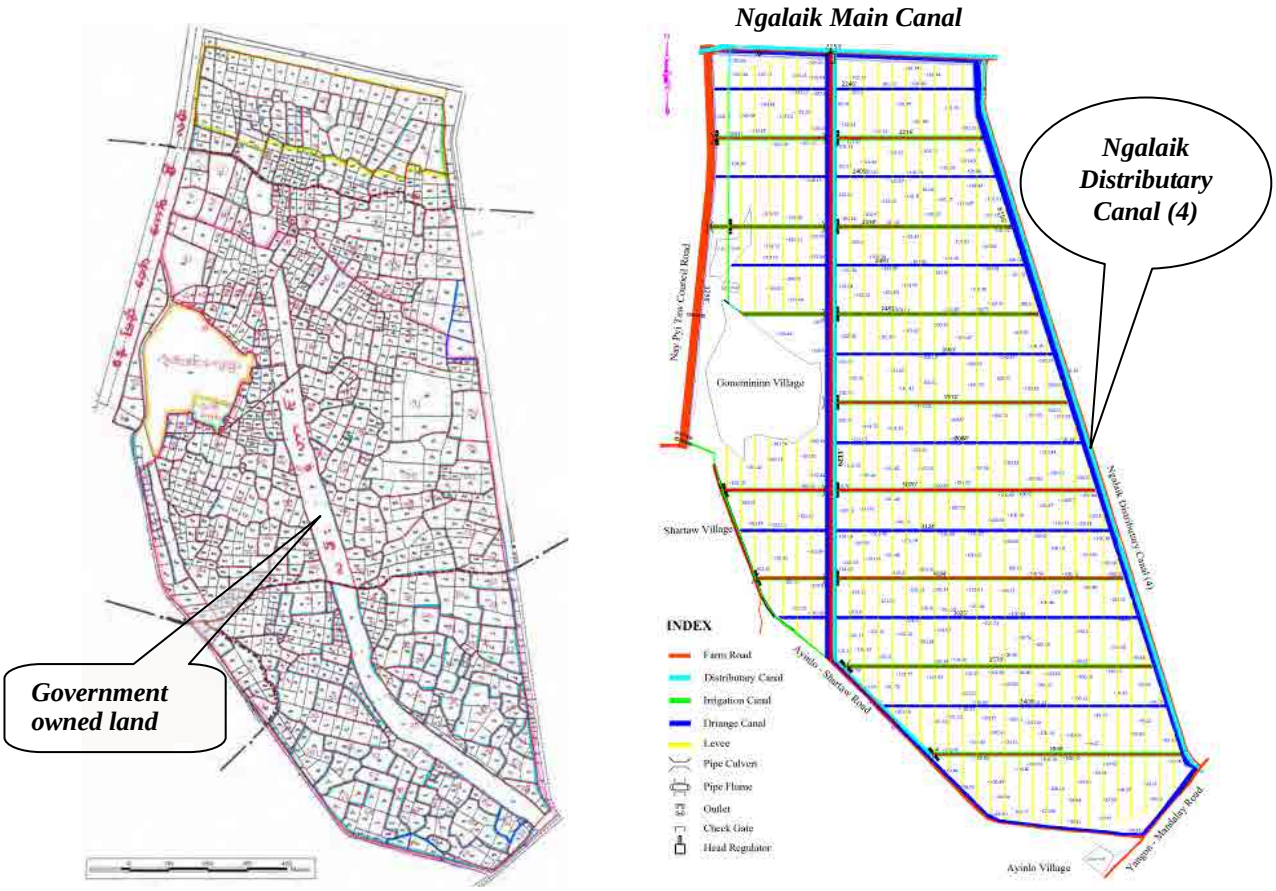


Figure 3.1.1 Actual Situation and Design Drawing of the Model Farm Land

Source: SLRD (Left figure), ID/JICA (Right figure)

3.2 Basic Design of Land Consolidation Model Farm

Within the consolidation area, a main irrigation canal is to be constructed, running almost center from the north straight down to the south. The irrigation canal functions as the dominant irrigation canal combined with the main farm road. The irrigation canal takes irrigation water from the existing Ngalaik main canal running along the northern peripheral. Two major drainage canals are to be constructed; one will run in parallel with the main irrigation canal sandwiching the main farm road in between, and the other one runs along the existing distributary canal of Ngalaik No.4.

Given the network of the main irrigation canal, major drainage canals and the main farm road, supportive irrigation canals, drainage canals and farm roads are all aligned running east-west direction as indicated in the above Figure 3.1.1 (right). The supportive irrigation canals and drainage canals are allocated alternately, and supportive farm roads are aligned alongside the supportive irrigation canals.

3.3 Standard Plot Arrangement and Reallocation

The standard plot to be constructed with the land consolidation work is set to be 1 acre each (0.405 ha each). The examples are indicated by number of rectangular squares as in the right of Figure 3.1.1. The rectangular square is constructed having longer size along north-south direction while the east-west direction is set shorter taking into account the setting of the network of supportive irrigation and drainage canals.

Plot re-allocation plan shall be prepared by the management committee of farmer organization. After the preparation of re-allocation plan, the management committee will negotiate with each and every farmer to finalize the consolidation plan under the support of SLRD, ID, Cooperative Department and JICA survey team. Every plot will be shaped at 1 acre; however, in fact 28% farmers have less than 1 acre of farm land within the target area. Those farmers have to share or divide one farm plot of 1 acre with other farmers by putting up a small earthen band.

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATION

4.1 Environmental and Social Examination

Environmental and social examination was conducted referring to the model farmland consolidation map, plan and design of the farmland consolidation, interviews to concerned beneficiary farmers and government organizations such as ID, AMD, DOA, Zabu Thiri Township Office, etc. Through the examination, following environmental parameters which may cause negative impact were identified, sot that the relevant monitoring should be conducted during and after the consolidation works:

- ✓ Air pollution: Considering that the farmland consolidation work period is limited only in two months and the number of heavy machines are not so many, i.e. Crawler Tractor x 2, Hydraulic Excavator x 2, Dump Truck x 2, Vibrater x 1 and Mini Back hoe x 2, significant negative impact is not expected and any noticeable air pollution by other similar projects has not been reported either. It is however noted that there is a residential area nearby at a western part from the model farm land area, so that all the heavy machineries should be well maintained to minimize the air pollution during the farmland consolidation work phase.
- ✓ Water pollution: Considering that the farmland consolidation works period is relatively limited and furthermore what is to be undertaken under this farmland consolidation work is an earth work, any large scale negative impact for water pollution is not expected and any large scale water pollution by other similar projects has not been reported either. However, sedimentation basin should be prepared in the field to prevent the sediment from draining into Ngalaik main canal and Ngalaik distributary canal (4) running northern and eastern peripherals of the model farmland area.
- ✓ Noise/vibration: There is a primary school at a western part of the model farm land. To minimize the noise/vibration, the machineries should be well maintained. It is also noted that there is a residential area around the primary school, whereby the construction works should be stopped from 18:00 to 8:00 near the residential area in order not to give annoyance to the residents.
- ✓ Land recovery/ loss: After the farmland consolidation works, 26.2acre (10.6ha) area will be changed to farm road, irrigation canal and drainage canals. Therefore, each and every beneficiary farmer is supposed to surrender a part of their farmland proportionally according to the area presently owned. The total project area arrives at 338 acre (137 ha) while the land to be lost is 26.2 acre (10.6ha), thereby each farmer has to surrender 7.8% of what they own at

present (10.6 divided by 137 ha). The process of surrendering the land shall be well monitored in order to keep equal and proportional loss of the land.

- ✓ Misdistribution of benefit and damage: During the re-allocation of the farm plots, some farmers may insist in moving to profitable plot (for example, plots near the main farm road). In addition, some farmers may insist in surrendering less percentage of the farmland required for the establishment of farm road and canals, regardless the fact that all the farmers shall surrender part of their farmlands proportionally to the extent of area they own at present. In order to prevent these cases, the management committee shall discharge their responsible duty, and the process shall be well monitored by respective government offices.

- ✓ Working environment. (including working safety): This kind of farmland consolidation works deal mainly with earth work and it is not complex work by nature. However, still such machineries are used as Crawler Tractor x 2, Hydraulic Excavator x 2, Dump Truck x 2, Vibrater x 1 and Mini Back hoe x 2, and therefore working safety should be enforced by the supervisor appointed by the Irrigation Department (ID) during the construction phase.

- ✓ Accident: The heavy machineries employed for the works will be carried into the field at the first time of the consolidation works, and not go outside of the field during the work phase until the completion of works, resulting in little possibility of accidents to passersby. For the fuel supply to the heavy machines, however, one refueling car will have to access into the field every day. Access way into the field is limited only at southern part of the field, and watchman should check the access of refueling car every time and pay attention to passersby not to be near the site. There should be a need to allocate the watchman to avoid any traffic accident.

4.2 Needs of and Compensation Measures against Land Acquisition

An ordinal farmland consolidation works construct new farm road, irrigation canal and drainage canal. Therefore the area for new farm road, irrigation and drainage canals shall be procured out of the beneficially farmers' farmland. On this model farm land consolidation project, total 338.2 acre of farmland will be consolidated and 26.2acre out of the 338.2 acre (7.7 percentage of farmland) will have to be availed for the construction of the new farm road, irrigation and drainage canals.

Basically, PAPs (project affected persons) under this project are also the beneficiaries of the project. Under this special condition, no direct compensation will be arranged in this project; however as specified in the JICA Guideline as 'compensation must be based on the full replacement cost as much as possible', it should be noted as a pre-condition of implementing the project that the value of the land and also increase of the crop production with the project should be made more than those having been generated from the original farmland.

It means that the land value and also the crop production upon the project completion should increase at least by 8% than those from the original area, since they are to surrender 8% of the originally owned area. Following are the summery of the examination, and it can be concluded that the benefit accrued from the land consolidation work will surpass the loss of land that is 8% of what they own at present:

- ✓ Land value is to be increased by about 2 times more with reference to an example of land consolidation work carried out just beside the project area where 400% hike took place over 2 years after the completion of land consolidation (note that during the 2 years inflation index marked 190%, and therefore considering the index, the net increment is calculated at 211%),

- ✓ Crop yields are to increase by 18%, 19%, and 17% for monsoon paddy, summer paddy and black gram respectively with reference to the same example, which are all higher than the land loss of 8%,

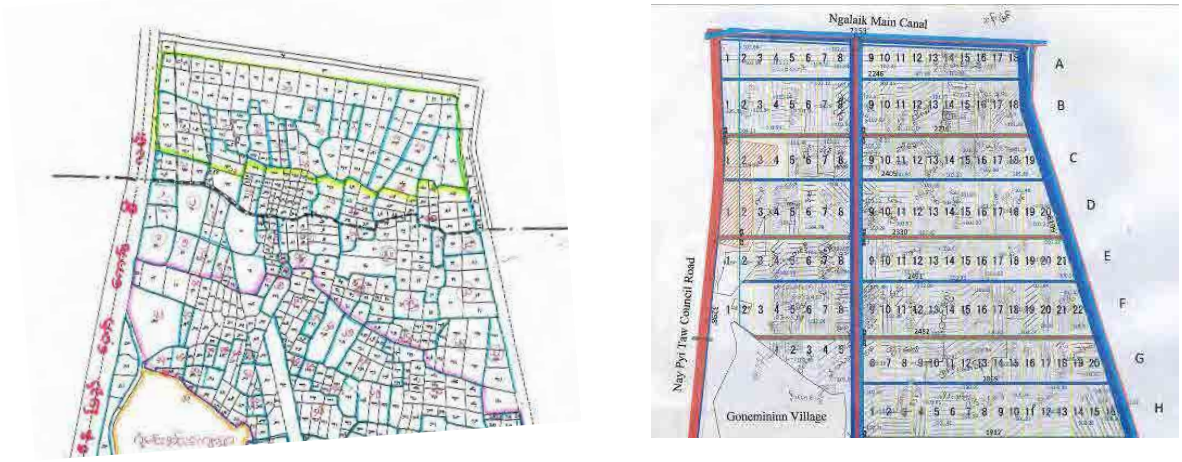
- ✓ According to a farm budget analysis, net profits are to increase by 54%, 42%, and 37% for monsoon paddy, summer paddy and black gram respectively with reference to the same example, which are all much higher than the land loss of 8%,
- ✓ In addition to above, loss which takes place on the course of ferrying out the harvested crops is to reduce by about 7% for the case of monsoon paddy in the neighboring farmland, almost commensurate to what they have to surrender, 8% of the farmland, and
- ✓ Further in the target project area, approximately two thirds of the farmers cannot cultivate summer paddy due to the absence of irrigation canal at present. Provided with such canal by the consolidation project, these farmers can cultivate summer paddy, enjoying 3-time cropping in a year. It means that about two thirds farmers can have an opportunity of increasing their income by 150% based on the change from 2 crops to 3 crops per annum.

CHAPTER 5 IMPLEMENTATION OF MODEL FARMLAND CONSOLIDATION

5.1 Farm Plot Reallocation and Registration

In preparing the farm plot reallocation plan, following points were taken into account;) allocate a newly constructed plot area, whether whole one-acre area or a part of it, to the original farmer who used to cultivate in that same area as much as possible; namely, keep the same location of their farm lands wherever possible, and 2) if a farmer has more than one farm plot scattered in the project area, collect all the pieces of lands he/she owns, and allocate a newly constructed plot area, whether whole one-acre area or a part of it depending on the total farm acreage, equal to the accumulated farm areas.

Based on the above procedure and upon consensus from all the beneficiary farmers, the management committee has prepared the farm plot reallocation plan under the support from JICA survey team. To generate a farm plot reallocation plan, 2 kinds of maps are necessary as presented below; left map shows the original farm plots while the right one shows the arrangement of consolidated farm plots by one-acre rectangular plot as the standard. The table below comparatively indicates original farm plots and newly allocated ones by consolidation works:



No	Village Tract	Village	Name	Before						After						Signature
				1	2	3	4	5	Total	1	2	3	4	5	Total	
				Block	Block	Block	Block	Block		Block	Block	Block	Block	Block		
				Plot	Plot	Plot	Plot	Plot	Acre	Plot	Plot	Plot	Plot	Plot	Acre	
				Acre	Acre	Acre	Acre	Acre		Acre	Acre	Acre	Acre	Acre		

Figure 5.1.1 Preparation of Draft Farmland Plot Reallocation

Source: JICA study team (2014)

During the preparation of the draft farm plot reallocation plan, some farmers came to an idea of selling out their farm plot to the farmer(s) who has the neighboring plot especially in case that he/she owns very small plot e.g. less than 0.25 acre. Likewise, some farmers wanted to purchase his/her neighboring plots. To facilitate the process, 3 parties of management committee, JICA survey team and SLRD discussed and set a fix price of 3 million kyat per acre. In fact, this fixed price was applied only during the stage of finalizing the farm plot reallocation plan.

Necessary materials for registration of farm plot are "1) plan-drawing of the project area completed for the construction", "2) completed reallocation list which was already agreed among all the concerned farmers" and "3) completed reallocation map". The management committee has prepared farm plot registration table based on these three materials. SLRD township officer has checked the table of farm plot registration together with plots for each of the farmers at site.

5.2 Construction for Model Farmland Consolidation

Types of work contents are divided into 5 categories; namely, 1) ploughing and harrowing, 2) farm road construction, 3) drainage canal construction, 4) irrigation canal construction and 5) farmland leveling. Earthwork is the major work in the farmland consolidation works. The construction works started from northern part of the target model farmland area. Having completed the construction of first farm block line, the construction works moved to next south farm block line. These construction works was commenced on February 10, 2014 and completed on April 25, 2014. Table 5.2.1 shows the construction schedule actually implemented:

Table 5.2.1 Implementation of Model Farmland Consolidation

	Month	February			March			April			Days
	Date	10	20	30	40	50	60	70	80	90	
AMD Work	Remove of Levee										5
	Ploughing and Harrowing										29
	Renewal of Levee										5
	Levelling (Rough)										18
	Levelling (Final)										18
	Sum										75
ID Work	Main Farm Road										8
	Branch Farm Road										20
	Filling Pavement on Farm Road										9
	Irrigation Canal										19
	Drainage Canal										19
	Sum										75

Source: JICA Study Team, 2014

Total cost for the model farmland consolidation is around 561 million Kyats. Of the total cost, diesel, lubricant and grease together come to 184 million Kyat (33%); the construction materials cost 247 Kyat (44%); ploughing and harrowing cost 21 million Kyat (4%); and labor cost 109 million Kyat (19%). Table 5.2.2 summarizes the model farmland consolidation cost by major category:

Table 5.2.2 Construction Cost for Model Farmland Consolidation Project

Number	Item	Cost (Kyat)	Cost (Yen)	Percentage
1	Diesel, Lubricant, Grease	184,382,052	19,360,115	33 %
2	Construction Materials	247,363,463	25,973,164	44 %
3	Ploughing, Harrowing	20,760,000	2,179,800	4 %
4	Labor	108,504,165	11,392,937	19 %
Total		**561,009,680**	**58,906,016**	**100 %**

Source: JICA Survey Team (2014). Cost (Yen) is calculated by 1kyat=0.105Yen (JICA Rate, 2014, May)

5.3 Monitoring Result for Environmental and Social Consideration

Expected negative environmental impacts are air pollution, water pollution, noise/vibration, working environment including accident, which were identified through scoping and environmental examination. These impacts are, if any, to take place only during the farmland consolidation works phase. Therefore, necessary monitoring was implemented during the construction period. As a result, no negative impact was reported during the farmland consolidation works.

CHAPTER 6 RECOMMENDATIONS TOWARD FUTURE WORKS

During the process of undertaking the model farmland consolidation project, the JICA Team encountered a number of issues that lead to the recommendations presented below. These recommendations are by no means exhaustive and may need to be changed or modified, depending upon the prevailing condition. Nevertheless, the ones covered here constitute broader issues on which the implementation of the future land consolidation works will have to be pursued:

1) Before executing the farmland consolidation, SLRD should examine the number of concerned farmers, the area of farm plots and their addresses where they live. This information are quite important for obtaining consensus on the project implementation among all the concerned farmers, establishment of farmer organization, preparation of plot reallocation plan and registration of the farm plots. In case this information not completed, successive process will be very much hindered.

2) Consolidation works shall not commence till all the beneficiary farmers have agreed necessary arrangement for the project implementation, e.g. establishment of farmer organization, loss of farmland for the purpose of constructing farm roads and irrigation & drainage canals (so-called non-substitute re-plotting), reallocation of consolidated farm plots, etc. Among issues, loss of farmland and farm plot reallocation are the major issues that the farmers need time to agree and settle.

3) Farmer organization should be established upon making consensus among the concerned farmers. Under the farmer organization, management committee is established by selected farmer representatives. The committee is in charge of taking contact with every farmer and also of arbitration if a problem occurs among farmers for the farmland consolidation. This farmer organization shall be in charge of maintaining such agricultural infrastructure as farm roads and irrigation & canals constructed within their jurisdiction.

4) The benefits accrued from land consolidation should be more than that of the land the farmers are to lose for the construction of farm roads and irrigation & drainage canals, and the ratio of the land loss should preferably be less than 10% of what the farmers own at present. If the ratio of the land loss comes to more than 10%, ID and AMD staff should review the plan and modify the designing of the farm road and canals in order not to lose more than 10% of the farmland.

5) To execute farmland consolidation project, ID, AMD, SLRD, Cooperatives Department, DOA, GAO should participate and assist the farmers. After the farmer organization has been established, management committee of the farmer organization will be in charge of holding general assembly or making consensus among all the famers. In every stage, respective government office should assist the farmer organization through the management committee.

6) Close collaboration and information sharing of respective works is necessary among the concerned government departments. After the farm land consolidation project has started, more than one government department have to discharge respective responsibility at the same time

(e.g. designing by ID and AMD, obtaining information for beneficiary farmers and their farm plots by SLRD, registration of farmer organization by Cooperative Department, etc). To keep pace together among the concerned departments, collaboration and information sharing are due required.

7) Environmental examination and social consideration should be carried out prior to the implementation of the farmland consolidation project. All the environmental parameters which may give negative impacts during and after the project implementation should be identified and monitoring plan thereof shall be established. Monitoring especially during the project implementation phase shall be carried out, and when negative impacts are to occur, necessary measures should be undertaken.

8) Loss of income opportunity during the construction period, if any, should be compensated. To avoid this, the construction should be carried out during off-crop season. In Myanmar, monsoon paddy is the dominant crop, and therefore winter season coming after the monsoon season and/or summer season coming before the monsoon season could be the off-crop season. The construction schedule shall consider these off-crop seasons, or compensation may not be avoided.

9) Any properties, e.g. house, trees, etc. existent within the project area should be compensated, provided that they had been existing before the cut-off date. It is noted that no compensation can be made on the properties constructed after the cut-off date. Cut-off date here means the date when the project is officially announced, e.g. the date stakeholder meeting for the purpose of explaining the project is held or census survey covering the beneficiary farmers is commenced.

10) Complaint-handling mechanism should be established prior to the commencement of the construction woks. Under farmland consolidation project, management committee may receive complaint from colleague farmers, and the committee should at first try to solve the complaint within the farmer organization. If they cannot solve the complaint within them, the management committee will bring the complaint to the concerned government office and claim the staff to solve the complaint.