Appendix-2

Emergency Repairing Work Plan

CHAPTER 1 STATUS OF THE WORK PLAN

The identification of deteriorations/damages (and those sign) on the target six dams in Masvingo Province is carried out and examination on the found deteriorations/damage if they already affect the safety/stability/operation of the facilities is conducted. Also, examination on the found deteriorations/damages if they expand and affect the safety/stability/operation of the facilities in the future is carried out as well.

The deteriorations/damages found are evaluated and categorized into three ranks as shown in Table 1.1, depending on the timing when the identified deteriorations/damages affect the safety/stability/operation of the facilities.

Table 1.1 Evaluation Ranks of Deteriorations/Damages Found

Rank	Evaluation Standard
A	Deteriorations/damages that are already affecting the safety/stability/operation of the facilities or are feared to affect them in near future.
B	Deteriorations/damages that are not affecting the safety/stability/operation of the facilities at present but may affect them in the long term.
C	No deteriorations/damage or no signal of them

This work plan is emergency repairing plan for deteriorations/damages evaluated as "A", which already affect the safety/stability/operation of the facilities or will affect in near future.

CHAPTER 2 TARGET DETERIORATIONS/DAMAGES

There are two deteriorations/damages which are evaluated as "A", 1) Two large-scale collapses on the right bank side wall of the connection canal, and 2) Exposure of siphon lining concrete on the connection canal bed (see Figure 2.1 and Figure 2.2). In respect to 1), a collapse reaches to the point 6m from the edge of embankment. It would reach to the edge after seven years and affect the stability of embankment. Also, another one reaches to the point 1.5 m from slope protection works for valve house. It would reach to the slope protection works within two years and affect the operation of valve.

While in respect to 2), since rocks are scattered around and upstream of the siphon lining concrete, erosion is likely to occur when rocks are delivered by floods and impact the lining concrete. As the erosion progresses and siphon pipes are damaged, sufficient irrigation water would not be supplied to farmland and the irrigation scheme may be dysfunctional.

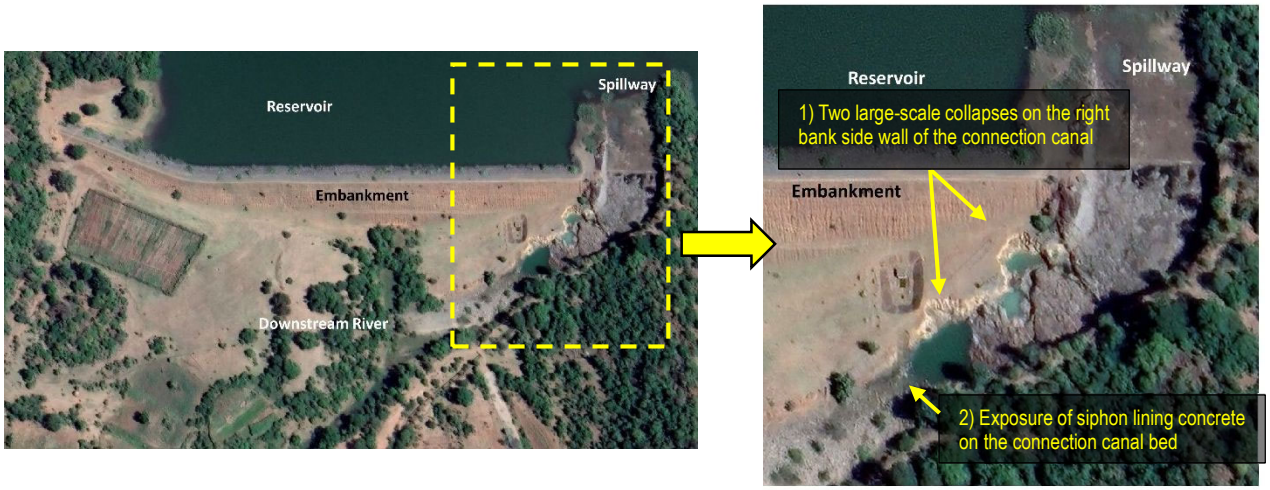
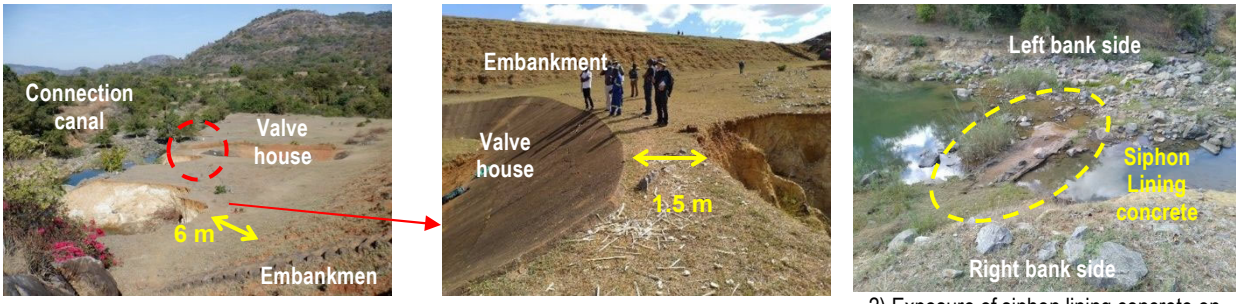


Figure 2.1 Deteriorations/Damages Evaluated as "A"-1



1) Two large-scale collapses on the right bank side wall of the connection canal

2) Exposure of siphon lining concrete on the connection canal bed

Figure 2.2 Deteriorations/Damages Evaluated as "A"-2

CHAPTER 3 SUSPECTED CAUSE OF DETERIORATIONS/DAMAGES

3.1 TWO LARGE-SCALE COLLAPSES ON THE RIGHT BANK SIDE WALL OF THE CONNECTION CANAL

There is a ditch across the connection canal and collapses may be caused by flow along this ditch. Although this part might have a flat surface just after construction, it may have been eroded by floods over the past 30 years since this portion might be relatively soft. It is supposed that the flood flow changed its direction from downstream to right side due to this ditch, and eroded the right bank side wall leading the collapses (see Figure 3.1).

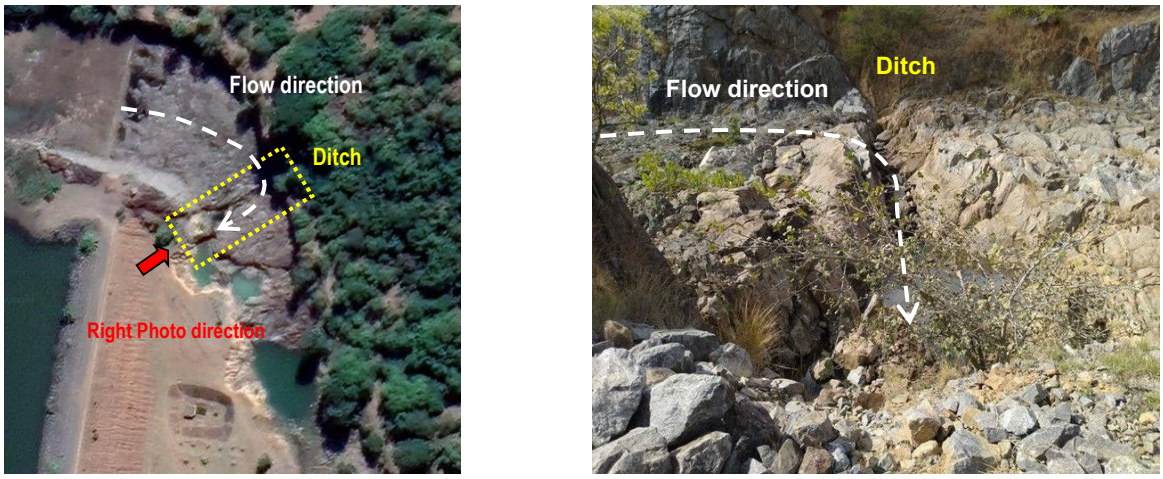


Figure 3.1 Suspected Cause of Collapses on the Right Bank Side (Embankment Side) Wall

3.2 EXPOSURE OF SIPHON LINING CONCRETE ON THE CONNECTION CANAL BED

Since there are many rocks around the siphon lining concrete, the siphon lining concrete might be protected by rock or gabion works, but those have been eroded and washed away by the floods.

CHAPTER 4 EMERGENCY REPARING MEASURES

*See Attachment-1 for basic design drawings

4.1 TWO LARGE-SCALE COLLAPSES ON THE RIGHT BANK SIDE WALL OF THE CONNECTION CANAL

The following measures are planned aiming to 1) Avoid the impact by the flood by changing flood

direction to downstream and 2) suppress the progress of the current collapses,

[Measure 1] Backfilling the ditch across the connection canal, which is a main factor of change in flow direction, by wet masonry

[Measure 2] Construction of retaining wall by wet masonry along the right bank side wall and backfilling the erosion on the canal bed to make flow direction to downstream

[Measure 3] Backfilling the area from retaining wall (to be constructed as measure 2) to the collapse surface with earthen materials and wet masonry

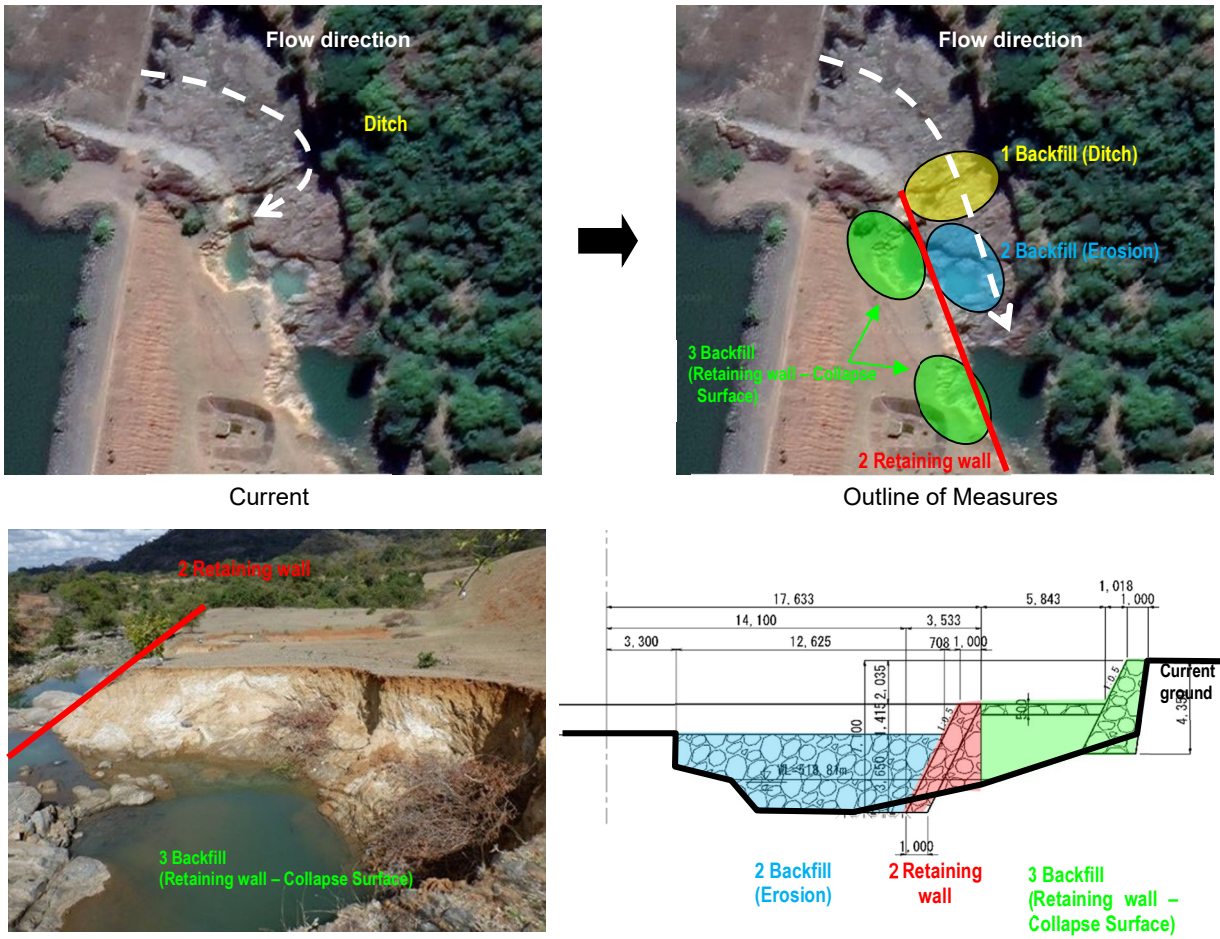


Figure 4.1 Outline of Emergency Repairing Measures: Two Large-Scale Collapses on the Right Bank Side Wall of the Connection Canal

The scale of the emergency repairing measures is the one which any damages will not happen even if Cyclone Idai in 2019 comes again. The target flood discharge is 160 m3/s calculated by rational formula utilizing daily rainfall at the time of the Cyclone Idai, and measures are designed according to the conditions below. The numbers below are consistent with the numbers shown in Figure 4.2.

(i) Retaining wall height: The critical water depth in each cross section during the target flow discharge rate

NOTE: Since canal bed slope in the target section is steep, about 1/6 to 1/9, it is considered that the flow conditions at the time of flood are supercritical in all cross sections. Since the supercritical flow depth is less than the critical water depth, the critical water depth in each cross section is adopted in consideration of the safety side.

(ii) Minimum thickness of retaining wall: 1.0 m in consideration of workability

(iii) Front slope of retaining wall: 1: 0.5 in consideration of workability

(iv) Front protection of retaining wall: Perform rooting work with a thickness of 1.0 m or more

(v) Retaining wall back: Backfill with wet masonry or earthen material

(vi) Area above the retaining wall: The front of the collapsed surface is covered with wet masonry work with a top width of 1.0 m and a front slope of 1: 0.5.

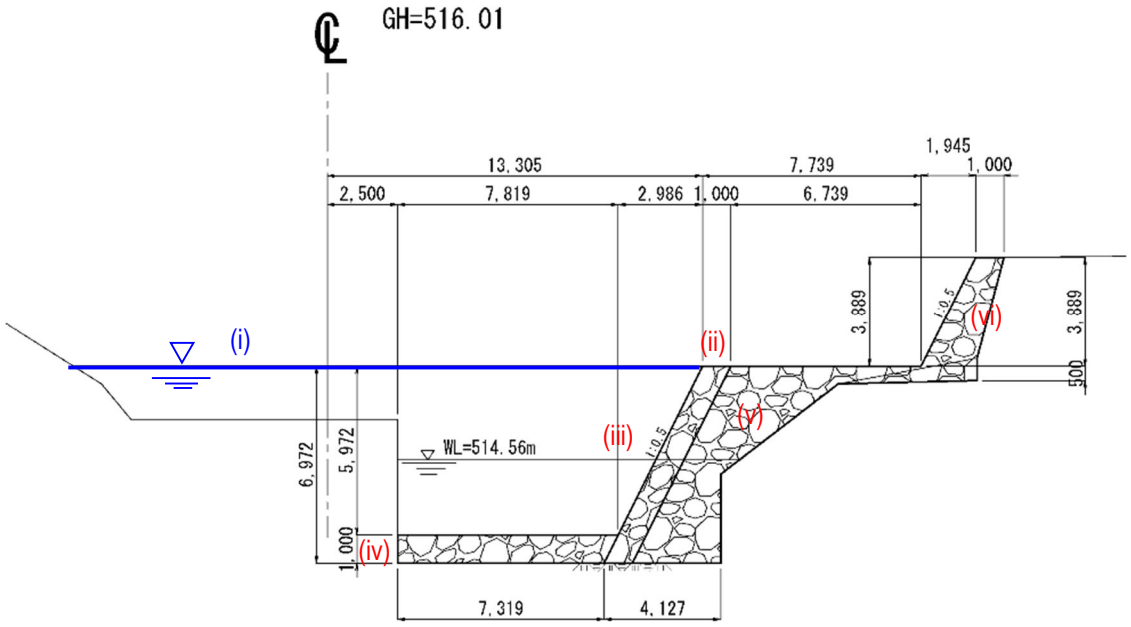


Figure 4.2 Scale of Emergency Repairing Measures: Two Large-Scale Collapses on the Right Bank Side Wall of the Connection Canal

4.2 EXPOSURE OF SIPHON LINING CONCRETE ON THE CONNECTION CANAL BED

Covering the lining concrete by wet masonry (t=0.5) aiming to preventing erosion caused by flood is planned.

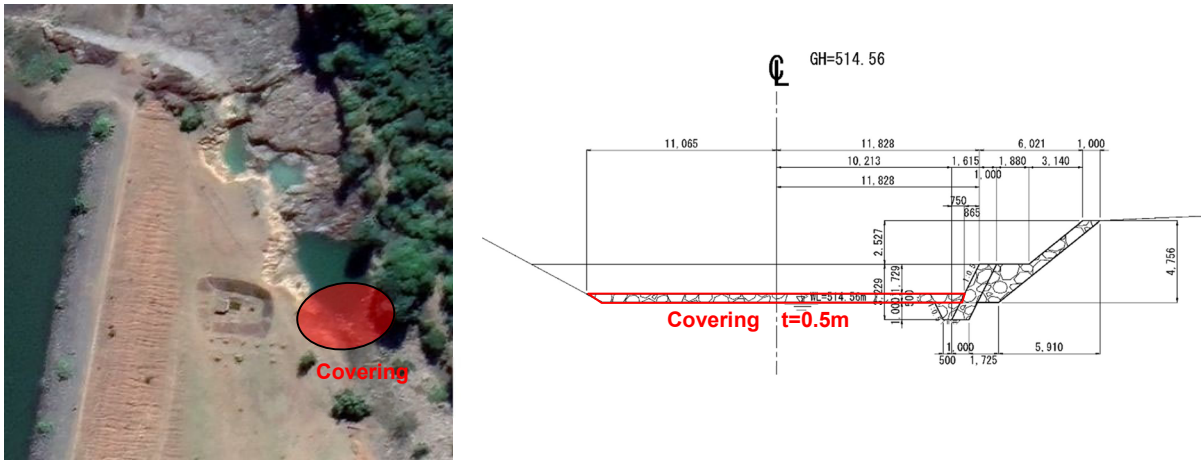


Figure 4.3 Outline of Emergency Repairing Measures: Exposure of Siphon Lining Concrete on the Connection Canal Bed

CHAPTER 5 CAPACITY OF ZIMBABWEAN CONTRACTORS

The capacity of Zimbabwean contractors is assessed through 1) questionnaire survey and 2) inspection of the construction site. Based on the assessment, the feasibility to implement the emergency repairing measures is verified.

5.1 QUESTIONNAIRE SURVEY

The Survey team requested DOI to introduce four contractors in Zimbabwe who have a track record of dam construction and irrigation schemes. The Survey team distributed the questionnaire to the Zimbabwean contractors and requested to answer. The questions consisted of 1) financial status, 2) construction experiences for the last five years, and 3) the number of engineers and construction machineries.

Three out of four contractors submitted the answers. The summary of the answers is shown in Table 5.1 (see Attachment-2 for all the submitted answers). All the three contractors have annual sales from 250,000 USD to 12 million USD in last five years, and all contractors are continuously involved in the dam construction. Additionally, all the contractors have implemented a series of dam construction such as embankments, spillways, pipelines, and irrigation facilities. Further, all of them have enough number of engineers and construction machineries, also have suppliers who can supply sufficient amount of construction materials such as cement, earth & sand, and steel bars.

Table 5.1 Summary of Answers from Zimbabwean Contractors

Contractor Name		E.G. Construction	J R Goddard Contracting (Pvt) Ltd	Multiforce Contractors
Office		Masvingo	Bulawayo, Gweru, Harare	Harare
Financial Condition (1,000USD)	Capital Fund	5,000	17,800	N/A
	Total Debt	250	N/A	N/A
Annual Sales of last 5 years (1,000USD)		250 - 12,000	700 - 6,400 (Dam project only)	1,000 - 3,000
Engineers	1~5years	3	16	4
	5~10years	6	10	10
	10years~	2	6	5
Construction Machineries	Excavator	5	28	5
	Bulldozer	2	14	2
	Dump truck	16	67	7

5.2 INSPECTION OF THE CONSTRUCTION SITE

The Survey team inspected Chivu Dam construction site being carried out by one of the Zimbabwean contractors who answered to the questionnaire survey requested by the Survey team.

Table 5.2 Summary of Chivu Dam Specification

Client	Contractor	Dam Type	Height	Crest Length	Embankment Volume	Storage Capacity	Water Surface Area
ZINWA	E.G. Construction KW Blasting Specialists	Zone type Earth dam	28.2 m	346 m	400,000 m^3	2.6 million m^3	420 ha

At the time of the inspection, main works carried out were curtain grouting, backfilling of core zone, backfilling of shell zone, and spillway foundation excavation. (see Figure 5.1).

The construction site was well organized, and especially for safety measures, 1) a gate with a gatekeeper was installed at the entrance of the construction site so that no one other than the people concerned was allowed to enter (see Figure 5.2), 2) all of workers wore helmets and safety shoes, and 3) "Tool Box Meeting" (confirmation of dangerous places in the work of the day) had been held every morning before starting of works.

In addition, the site manager had a very good understanding of the construction method, quality control (frequency, method, etc.) for each construction item, and environmental & social considerations as well. The workers were employees of the company, and they were dispatched to the site after some training.

Figure 5.1 Construction Site of Chivu Dam

Figure 5.2 Gate at the Entrance of the Site

5.3 CAPACITY TO IMPLEMENT THE EMERGENCY REPAIRING MEASURES

According to the answers for the questionnaire, all of them have 1) stable sales and good financial conditions, 2) enough engineers with sufficient years of experience, 3) enough construction machineries, and 4) construction material suppliers. Additionally, it can be said through site inspection that a contractor has enough construction capacity and management capacity. Thus, it is judged that there is a Zimbabwean contractor who may be able to carry out the planned emergency repairing measures.

In addition, the Survey team interviewed one of the three contractors who answered to the questionnaire survey and found that a company was involved in the construction of six dams under the “Project on Medium Size Dams in Masvingo Province” which was completed 30 years ago under Japanese Grant Aid Project. Therefore, it is judged that there is a contractor who knows required quality and safety measures for the project by the development partners.

CHAPTER 6 PROJECT COST

6.1.1 Implementation Priority

Although it is expected that all the emergency repairing measures for both 1) Two large scale collapses on right bank side wall of the connection canal and 2) exposure of siphon lining concrete on the connection canal bed, are implemented immediately and at once. On the other hand, in consideration of the damage which may happen when the target structure collapses, and the contribution of the repairing measures to the deteriorations/damages extension control, the emergency repairing measures are divided into five construction packages (PKG) according to the priority.

Table 6.1 Construction Package Division of Emergency Repairing Measures

PKG	Target Area	Main target	Priority	Remarks
PKG-1	No. 1 - No.1+7.15	A collapse progressing to a point 6.0m from the embankment * If this collapse extends, it could lead to the collapse of the embankment and loss of life.	1	Backfilling of the ditch across the connection canal which is the main cause of the collapse
PKG-2	No. 1 - No.3+9.95		2	Construction of the retaining wall and backfilling of the back of the wall to control the progression of the collapse
PKG-3	No.4+20.84 - No.6	Exposed siphon protection works * If the siphon pipe is damaged, the irrigation water supply will be interrupted. This may result in impoverishment, but not loss of life.	3	Surface covering to prevent damage on siphon protection works
PKG-4	No.3+9.95 - No.5+6.59	A collapse progressing to a point 1.5m from discharge valve house slope protection works * Even if the slope protection works are damaged, the valve can be operated for a while by removing the earth and sand manually.	4	Construction of the retaining wall and backfilling of the back of the wall to control the progression of the collapse
PKG-5	No.1+7.15 - No.4+20.84	Unevenness on throughout the connection canal bed	5	Backfilling of connection canal bed unevenness (mainly recesses)

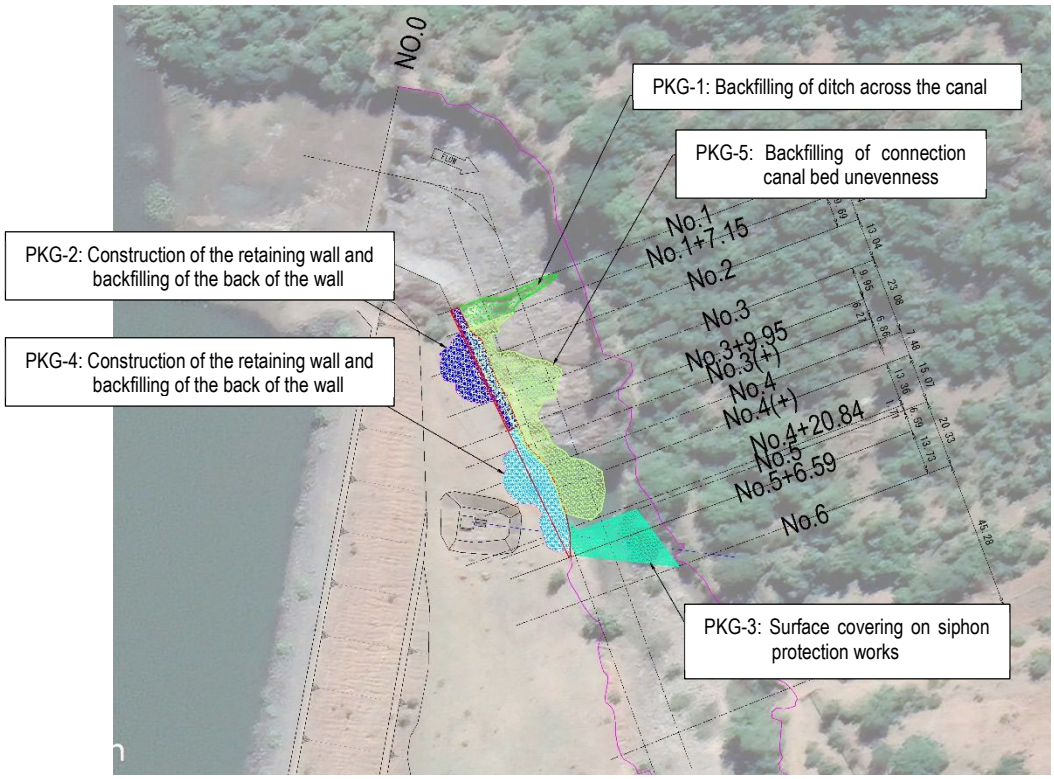


Figure 6.1 Construction Package Division of Emergency Repairing Measures

6.1.2 Project Cost

Table 6.2 shows the project costs by construction PKGs (in case a Zimbabwean contractor implements). These costs are calculated based on the quotation submitted by Zimbabwean contractors (see Attachment-3 for submitted quotations).

Table 6.2 Project Cost of Emergency Repairing Measures by PKGs

Contractors	Construction costs (thousand USD)					
	PKG-1	PKG-2	PKG-3	PKG-4	PKG-5	Total
	Backfilling of connection canal crossing trenches	Backfilling of retaining walls and the back of retaining walls (Upstream)	Surface coating of siphon protection works	Backfilling of retaining walls and the back of retaining walls (Downstream)	Backfilling of uneven floor of connection canal	
Company A	55	240	51	281	331	958
Company B	72	309	66	364	435	1,246
Company C	59	265	54	298	357	1,033
Average	**62**	**271**	**57**	**314**	**375**	**1,079**

CHAPTER 7 REQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

- Identification of the implementation agency of the Zimbabwean side

  *ZINWA or DOI

- Topographic survey

  *Plan, longitude and cross section survey on spillway channel and connection canal

- Detail design
- Construction/procurement plan
- Cost estimation

CHAPTER 8 IMPLEMENTATION AGENCY OF THE EMERGENCY REPAIRING MEASURES

Zimbabwean side is the expected implementation agency of the emergency repairing measures. On the other hand, assuming that Government of Zimbabwe cannot secure the budget. Therefore, the possibility of implementation by the Zimbabwean side and each development partner are assessed.

8.1 Zimbabwean Side (ZINWA)

ZINWA understands the emergency situation of the Magudu Dam and is willing implement a measure in the next financial year (2022 FY) budget. A letter to this effect has been issued to the JICA Zimbabwe Office. However, the project cost, which is in excess of 1.0 million USD, is not a small amount for ZINWA and may be difficult to secure. Therefore, ZINWA is planning to carry out only PKG-1, back filling the ditch across the canal, which is the main cause of collapse. In the aforementioned letter, it is stated that ZINWA requested to JICA to implement other PKGs.

Figure 8.1 Target which ZINWA is Planning to Implement

The effect of PKG-1 is to slow down the rates of erosion and collapse on the side walls by redirecting the flood flow downstream. It should be noted that PKG-1 alone does not prevent erosion and collapse itself, as no countermeasures are taken on the collapse portion. In addition, the rate of erosion and collapse after PKG-1 is implemented is greatly affected by rainfall intensity. Therefore, it should be noted that erosion and collapse may proceed faster than at present depending on the rainfall intensity.

In addition, during the period between the implementation of PKG-1 and the implementation of other PKGs (or between now and the implementation of all PKGs in case ZINWA does not implement PKG-1 at an early stage), it is necessary to monitor collapsed portions mainly by visual inspection to identify signs of collapse of the embankment in particular. If such signs are identified, any measures to avoid collapse shall be taken.

8.2 Development Partners

Questionnaire on the conditions for the use of their funds (scale of project cost, target sectors, need for co-financing, etc.) are distributed to FAO, IFAD, WB, AfDB, and WFP, all of which provide support to the agricultural sector in Zimbabwe. As a result, all the agencies did not have a scheme to fund only the construction of facilities.

8.3 Japanese Scheme

8.3.1 JICA (Grant Aid Project)

The total cost of the emergency repairing measures is just over 100 million JPY, which is too small to be a Grant Aid Project. In addition, the technical difficulty of the project is not high and it can be carried out by Zimbabwean contractors. Taking into account these factors, it is judged to be difficult to implement the emergency repairing measures under this scheme. On the other hand, if the project is implemented not as a stand-alone emergency repairing work, but in combination with the dam improvement plan or new irrigation development, the total cost would be larger and that combined project may be able to be a Grant Aid Project.

8.3.2 Embassy of Japan in Zimbabwe (Grant Assistance for Grass-Roots Human Security Projects)

The project cost under this scheme is basically capped at 10 million JPY but the project cost of the repairing measures exceeds 100 million yen. Although some PKGs have a project cost of less than 10 million JPY, but effect on damage is limited if only individual PKGs are implemented. Therefore, it is judged to be difficult to implement the emergency repairing measures under this scheme.

8.3.3 Japan (Supplementary budget)

Projects with humanitarian purposes and urgency could be funded through the Japanese supplementary budget. The scale of eligible projects is about 100 million JPY. Recently, number of selected projects for Zimbabwe is about 3 or 4 projects per year and the main target of the selected projects is food aid for drought areas in Zimbabwe. Also, the budget is for projects carried out by development partner(s). However, as the deadline for requests is at the end of August. Since the deadline for requests for next year's budget has passed, it is judged to be difficult to implement the emergency repairing measures under this scheme.

Attachment

Attachment-1: Basic Deign Drawings of the Emergency Repairing Measures

MAGUDU

NO. 0

GH=529.00

TYPE OF WORKS	UNIT	VOLUME
SOIL EXCAVATION	m^2	-
ROCK EXCAVATION	m^2	-
WET MASONRY	m^2	-

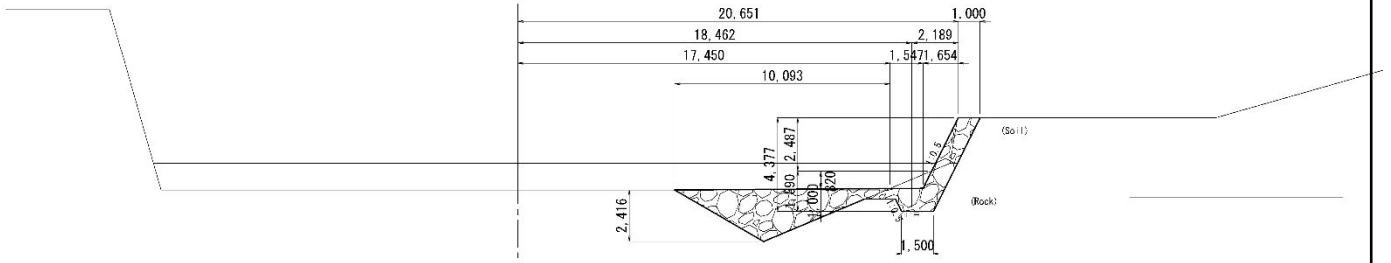
EL=529.00

NO. 1

GH=526.33

TYPE OF WORKS	UNIT	VOLUME
SOIL EXCAVATION	m^2	1.5
ROCK EXCAVATION	m^2	4.3
WET MASONRY	m^2	18.2

EL=526.00



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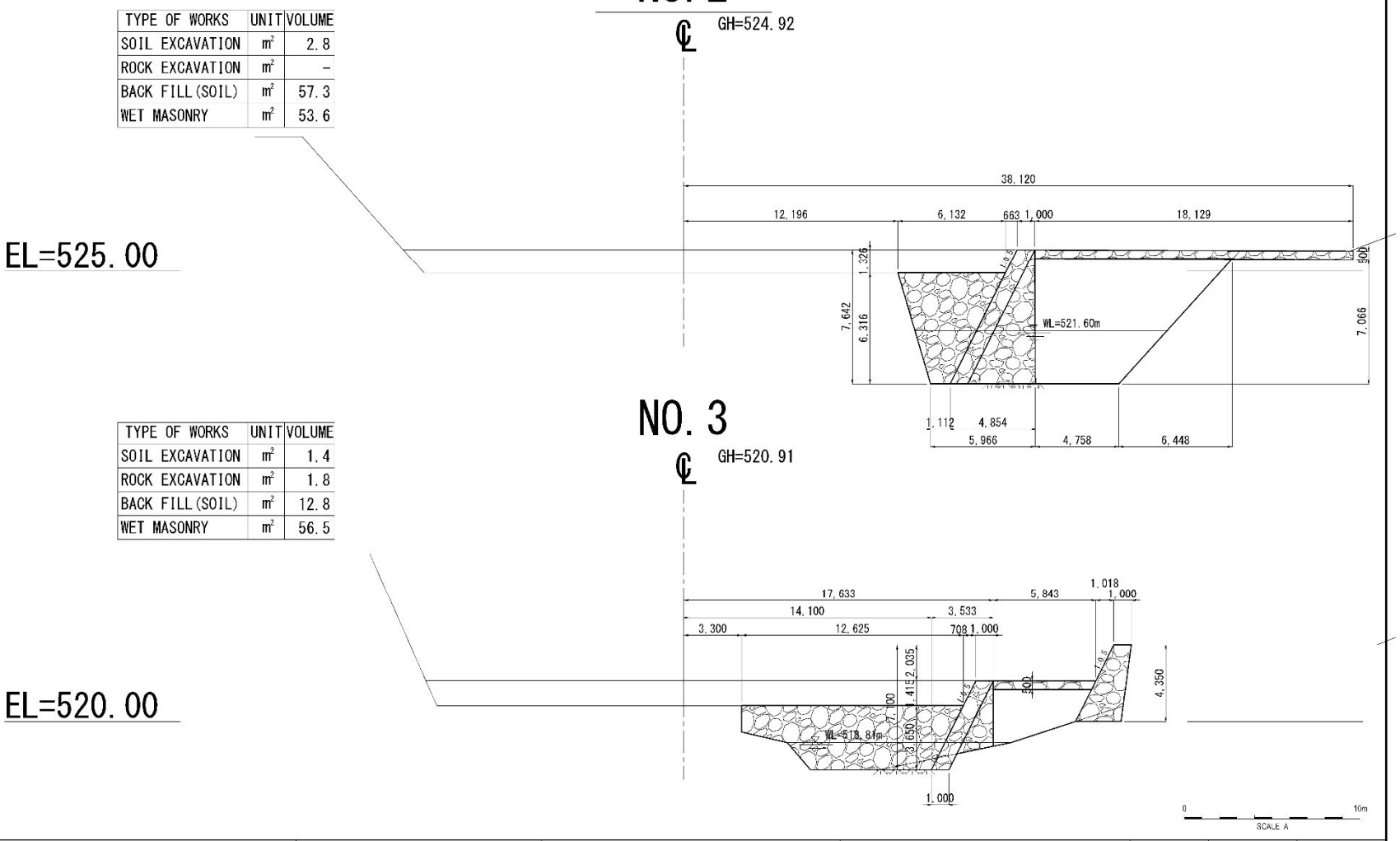
SCALE A

REPUBLIC OF ZIMBABWE MINISTRY OF MECHANISATION AND IRRIGATION DEVELOPMENT	DATA COLLECTION SURVEY ON IRRIGATION AND AGRICULTURE DEVELOPMENT	CROSS SECTION OF SPILLWAY PROTECTION	JAPAN INTERNATIONAL COOPERATION AGENCY SANYU CONSULTANTS INC.	Approved :	Date :	
					Drawing No. :	MAGU - 02(1)

MAGUDU

NO. 2

TYPE OF WORKS	UNIT	VOLUME
SOIL EXCAVATION	m²	2.8
ROCK EXCAVATION	m²	–
BACK FILL(SOIL)	m²	57.3
WET MASONRY	m²	53.6



NO. 3

TYPE OF WORKS	UNIT	VOLUME
SOIL EXCAVATION	m²	1.4
ROCK EXCAVATION	m²	1.8
BACK FILL(SOIL)	m²	12.8
WET MASONRY	m²	56.5

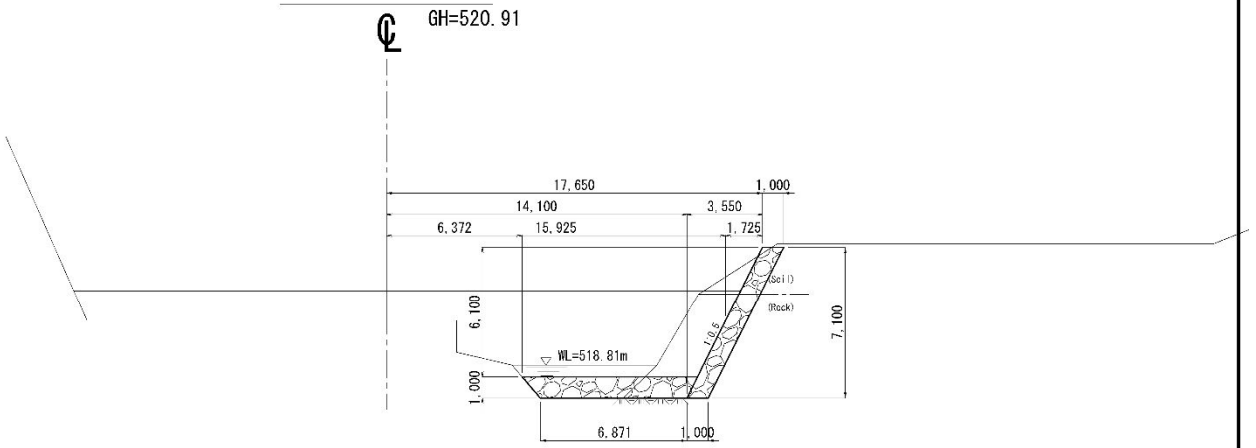
REPUBLIC OF ZIMBABWE MINISTRY OF MECHANISATION AND IRRIGATION DEVELOPMENT	DATA COLLECTION SURVEY ON IRRIGATION AND AGRICULTURE DEVELOPMENT	CROSS SECTION OF SPILLWAY PROTECTION	JAPAN INTERNATIONAL COOPERATION AGENCY SANYU CONSULTANTS INC.	Approved :	Date :	
					Drawing No. :	MAGU – 02(2)

MAGUDU

NO. 3 (+)

TYPE OF WORKS	UNIT	VOLUME
SOIL EXCAVATION	m³	3.8
ROCK EXCAVATION	m³	15.7
WET MASONRY	m³	14.6

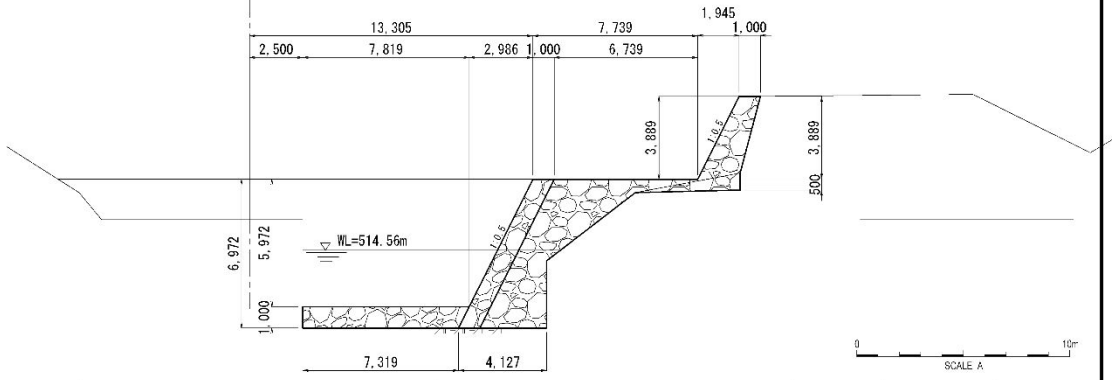
EL=520.00



NO. 4

TYPE OF WORKS	UNIT	VOLUME
SOIL EXCAVATION	m³	2.0
ROCK EXCAVATION	m³	–
WET MASONRY	m³	41.9

EL=516.00



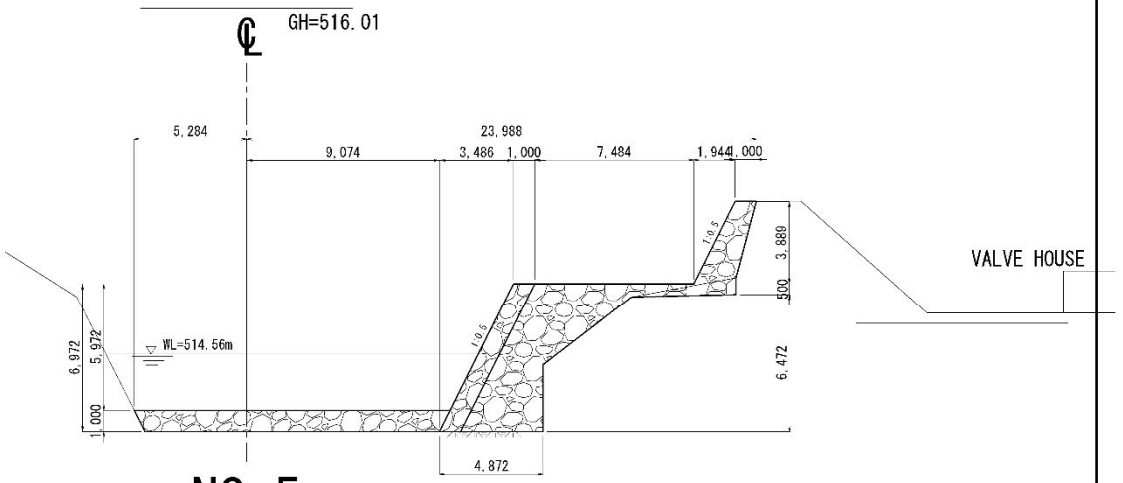
REPUBLIC OF ZIMBABWE MINISTRY OF MECHANISATION AND IRRIGATION DEVELOPMENT	DATA COLLECTION SURVEY ON IRRIGATION AND AGRICULTURE DEVELOPMENT	CROSS SECTION OF SPILLWAY PROTECTION	JAPAN INTERNATIONAL COOPERATION AGENCY SANYU CONSULTANTS INC.	Approved :	Date :	
					Drawing No. :	MAGU – 02(3)

MAGUDU

NO. 4 (+)

TYPE OF WORKS	UNIT	VOLUME
SOIL EXCAVATION	m²	2.0
ROCK EXCAVATION	m²	-
WET MASONRY	m²	53.9

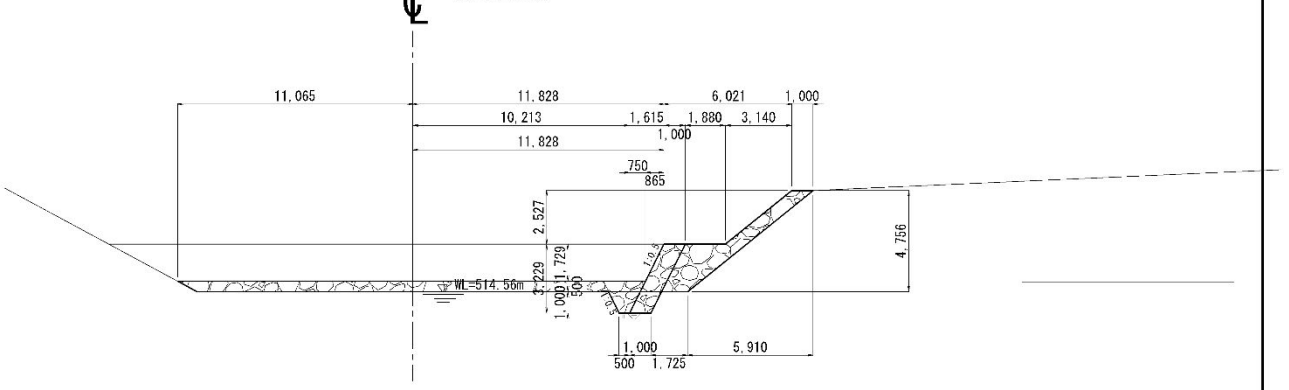
EL=516.00



NO. 5

TYPE OF WORKS	UNIT	VOLUME
SOIL EXCAVATION	m²	-
ROCK EXCAVATION	m²	2.0
WET MASONRY	m²	31.2
WET MASONRY(WALL)	m²	12.3
WET MASONRY(BOTOM)	m²	11.7

EL=515.00



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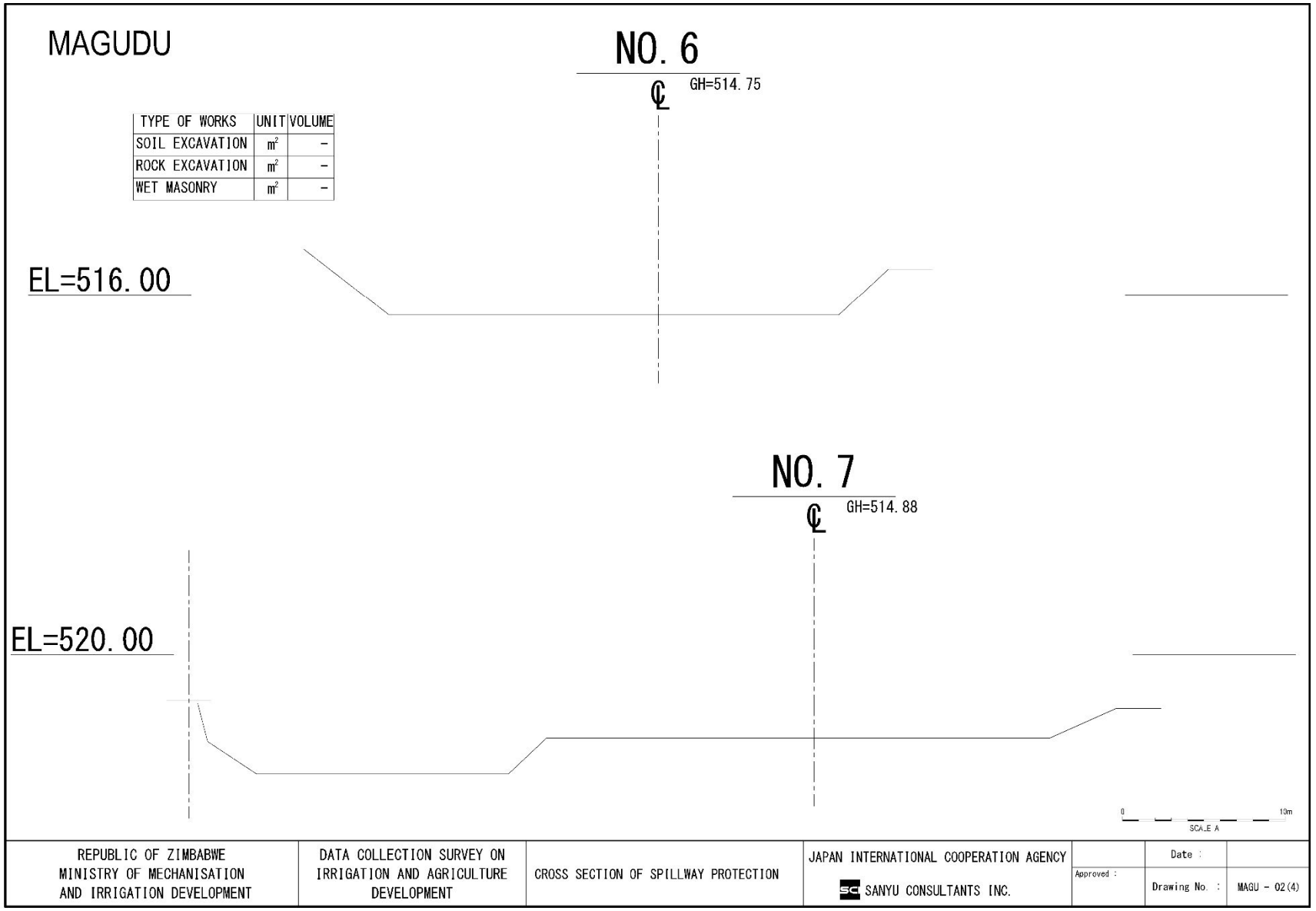
SCALE A

REPUBLIC OF ZIMBABWE MINISTRY OF MECHANISATION AND IRRIGATION DEVELOPMENT	DATA COLLECTION SURVEY ON IRRIGATION AND AGRICULTURE DEVELOPMENT	CROSS SECTION OF SPILLWAY PROTECTION	JAPAN INTERNATIONAL COOPERATION AGENCY SANYU CONSULTANTS INC.	Approved :	Date :	
					Drawing No. :	MAGU - 02(4)


MAGUDU
NO. 6
GH=514.75
TYPE OF WORKS | UNIT | VOLUME
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ROCK EXCAVATION | m² | -
WET MASONRY | m² | -
EL=516.00
NO. 7
GH=514.88
EL=520.00
0
10m
SCALE A
REPUBLIC OF ZIMBABWE
MINISTRY OF MECHANISATION
AND IRRIGATION DEVELOPMENT
DATA COLLECTION SURVEY ON
IRRIGATION AND AGRICULTURE
DEVELOPMENT
CROSS SECTION OF SPILLWAY PROTECTION
JAPAN INTERNATIONAL COOPERATION AGENCY
SANYU CONSULTANTS INC.
Approved :
Date :
Drawing No. :
MAGU - 02(4)

Attachment-2: Answers for the Questionnaire Survey

Questionnaire

Data required for "The data collection survey on Irrigation and Agriculture development (JICA: Japan International Cooperation Agency)".

Please write in English

1.Company Profile(Please, attach your company brochure, if you have.)

4) Capital Fund, Annual Sales, and Total Debt

(for annual sales, please describe the project names and the sales within 05 recent years (from 2016 to 2020) including projects funded by foreign donors.)

Capital Fund (USD): USD5,000,000.00	Total Debt (USD): USD250,000.00

Annual Sales (USD):

Year	Project names	Funding source	Main structure[1)]	Specificaton of main structure[2)]	Contruct amount (USD)
2016	Dulibadzimu Township Extension	SDP and Town Council	Civil construction works	Construction of roads, water and sewer reticulation	USD750,000.00
2017	Dulibadzimu Township Extension	SDP and Town Council	Civil construction works	Construction of roads, water and sewer reticulation	USD250,000.00
2018	Fibre Optics Civil Works Southern Region	Liquid Telecoms Zimbabwe	Civil Works	Excavations and laying of fibre optics cable	USD500,000.00
2019	Chivhu Dam Construction	Government of Zimbabwe	All works	Construction of earth dam, spillway, water treatment plant, pipeline and water reserviours.	USD8,000,000.00
2020	Chivhu Dam Construction	Government of Zimbabwe	All works	Construction of earth dam, spillway, water treatment plant, pipeline and water reserviours.	USD12,000,000.00

Note:

1): Dam, Canal, Land consolidation, Architecture, Plumbing, Electrical, Instrumentation, Road, and other incidental work

2): (ex.) Dam height, Canal length, etc.

5) Number of Technical staff

Years	Number
1-5	3
5-10	6
10-	2

2.Experience in architecture and/or civil engineering works, etc.

1) What kind of construction equipment and machinery do you have?

Equipment	Number	Capacity
Excavators	5	3 x 22ton and 2 x 30ton
Bulldozers	2	2 x D7
Dump trucks	16	10m3
Concrete mixers	4	1 x 4m3, 2 x 750litre, 1 x 400litre
Road roller	2	12ton Vibro
Vibrating roller		

2) Do you have/know the supplier which could provide enough materials(e.g. Cement, Sand, Coarse agregate, Steel bar, Gabions, etc.) promptly for the large-scale construction?

Yes: Larfage and PPC can supply cement, Sand can be extracted from closeby rivers, coarse aggregate can be supplied by several quarries dotted around the country, Steel force and other several companies in the country can supply steel bars and gabion steel.

Questionnaire

Data required for "The data collection survey on Irrigation and Agriculture development (JICA: Japan International Cooperation Agency)".

Please write in English

1.Company Profile(Please, attach your company brochure, if you have.)

4) Capital Fund, Annual Sales, and Total Debt
(for annual sales, please describe the project names and the sales within 05 recent years (from 2016 to 2020) including projects funded by foreign donors.)

Capital Fund (USD): **USD 17.8 MILLION (DAMS ONLY)**	Total Debt (USD): **N/A**

Annual Sales (USD): **DAM CONSTRUCTION PROJECTS ONLY**

Year	Project names	Funding source	Main structure[1)]	Specificaton of main structure[2)]	Contruct amount (USD)
2017	**Mpande Dam**	**Nottingham Estate**	**Zoned Eathfill Dam**	**20m Height**	**USD 5.4 Million**
2019	**Sanjika Dam**	**Landos Farm**	**Zoned Eathfill Dam**	**12m Height**	**USD 1.2 Million**
2019	**Nyabu Dam**	**Pezulu Ranch**	**Arch Dam**	**24m Height**	**USD 6.4 Million**
2020	**Durlstone Dam**	**Durlstone Farm**	**Zoned Eathfill Dam**	**16m Height**	**USD 1.6 Million**
2020	**Golden Acres Dam**	**Golden Acres Farm**	**Zoned Eathfill Dam**	**10m Height**	**USD 0.7 Million**
2021	**Sambok Dam**	**Sambok Farm**	**Zoned Eathfill Dam**	**24m Height**	**USD 2.5 Million**

Note:
1): Dam, Canal, Land consolidation, Architecture, Plumbing, Electrical, Instrumentation, Road, and other incidental work
2): (ex.) Dam height, Canal length, etc.

5) Number of Technical staff

Years	Number
1-5	**16**
5-10	**10**
10-	**6**

2.Experience in architecture and/or civil engineering works, etc.

1) What kind of construction equipment and machinery do you have?

Equipment	Number	Capacity
SEE ATTACHED COMPANY PROFILE FOR EQUIPMENT LIST		

2) Do you have/know the supplier which could provide enough materials(e.g. Cement, Sand, Coarse agregate, Steel bar, Gabions, etc.) promptly for the large-scale construction?

Cement - **PPC**
Sand - **Source from nearest river/Local Commercial Supplier**
Steel - **Steelforce, Pump & Steel, Longden Steel**
Aggregate - **Davis Granite**
Gabions - **Maccaferri (Ex. South Africa)**

Questionnaire

Data required for "The data collection survey on Irrigation and Agriculture development (JICA: Japan International Cooperation Agency)".

Please write in English

1.Company Profile(Please, attach your company brochure, if you have.)

4) Capital Fund, Annual Sales, and Total Debt
(for annual sales, please describe the project names and the sales within 05 recent years (from 2016 to 2020) including projects funded by foreign donors.)

Capital Fund (USD):	Total Debt (USD):

Annual Sales (USD):

Year	Project names	Funding source	Main structure[1)]	Specificaton of main structure[2)]	Contruct amount (USD)
2016	EPPING FOREST	Government	PIPELINE	20 Km	2 million
2017	MUTANG DAM	Government	Dam (22m)	masonry Dam	1 million
2018	Causeway Dam	Government	Dam	15000m³ masonry spillway 20m high Tower	3million
2019	" "	"	"		
2020	"	"	"		

Note:
1): Dam, Canal, Land consolidation, Architecture, Plumbing, Electrical, Instrumentation, Road, and other incidental work
2): (ex.) Dam height, Canal length, etc.

5) Number of Technical staff

Years	Number
1-5	4
5-10	10
10-	5

2.Experience in ~~architecture and~~/or civil engineering works, etc.

1) What kind of construction equipment and machinery do you have?

Equipment	Number	Capacity
Excavators	5	23 ton
Bulldozers	2	D6
Dump trucks	7	10m³
Concrete mixers	10	750/500
Road roller	2	12 ton
Vibrating roller	2	12 ton

2) Do you have/know the supplier which could provide enough materials(e.g. Cement, Sand, Coarse agregate, Steel bar, Gabions, etc.) promptly for the large-scale construction?

Cement - Lafarge.
Sand - Source from nearest River
Steel - BSI Steel.
aggregate - Dawa granite.

Attachment-3: Submitted Quotations

*Project costs are calculated based on the unit cost, indirect cost rate and so on in these quotations.

Bill of Quantity for Emergency Treatments on MAGUDU DAM

No.	Description	Specification	(1) Quantity	Unit	(2) Unit Price (USD)	(3) Amount = (1) x (2) (USD)	Remarks
α.Direct Cost							
	Earth Work						
1	Excavation (soil)	22ton Excavator and 2 tipper trucks	77	m^3	7.00	539	I have assumed that the excavated material is being wasted within 500m. I have also assumed that no treatment of
2	Excavation (rock)	A 10 bar compressor and 3 hand held jack hammers for rock drilling and blasting. 22ton Excavator and 2 tipper trucks for excavating the blasted rock.	270	m^3	45.00	12,150	I have assumed that no further treatment is required on the excavated area.
3	Wet masonry works	A crawler drilling machine and compressor for quarrying masonry rock, 4m3 mobile concrete mixer for masonry mortar, 22ton excavator and 2 tipper trucks for hauling masonry rock and river sand for masonry. 5m3 Water bowser.	6,268	m^3	200.00	1,253,600	I have made the following assumptions: 1. Masonry rock will be won from a designated quarry within 1km from the works. 2. Masonry mortar ration is going to 1:4 (cement:sand) by weight. 3. River sand will be extracted from within 1km from the works. 4. There will be
					Sub total cost	1,266,289	
β.Indirect Cost							
4	Temporary work	Accommodation for Site Agent, Drill and blast Foreman, Drill and blast Charge hand, Building Supervisor, Site surveyor, 5 drillers, 20 builders, cement storeroom, site office, some of the builders and all building assistants will be sourced locally	1	lump sum	40000.00	40,000	
5	Site expenses	Plant movement to and from site, salaries and allowances for site personnel, site vehicles, fuels, insurances, safety compliance, Statutory compliance expenses	1	lump sum	130000.00	130,000	
					Sub total cost	170,000	
γ.Other Cost							
6	Company benefit	Add 5% company overhead costs	1	lump sum	71,814.45	71,814	
7	Administrative expenses		1	lump sum		0	
8	TAX	VAT 14.5% + 2% transaction tax	1	lump sum	248,837.07	248,837	
					Sub total cost	320,652	
δ.Total Cost							
	δ=α+β+γ					1,756,941	

Bill of Quantity for Emergency Treatments on MAGUDU DAM

No.	Description	Specification	(1) Quantity	Unit	(2) Unit Price (USD)	(3) Amount = (1) x (2) (USD)		Remarks
α.Direct Cost								
	Earth Work							
1	Excavation (soil)	Earthworks Foreman, 1 x CAT320 Excavator, 2 x New Holland TS120 Tracor Dumper, Checker, Spotter	77	m^3	8.00	USD	616.00	
2	Excavation (rock)	Earthworks Foreman, 1 x CAT320 Excavator, 2 x New Holland TS120 Tracor Dumper, Compressor + Compressor Gang (6)	270	m^3	40.00	USD	10,800.00	
3	Wet masonry works	2 x Winget R500 Concrete Mixer, Concrete Dumper, CAT428 T L B, Concrete Foreman, Building Gang (8+8), Surveyor + Assistant, Compressor Gang (6)	6,268	m^3	250.00	USD	1,567,000.00	Rate Includes: Cleaning insitu rock for placement of masonry, blasting of rock for use in masonry, setting out, placing masonry
					Sub total cost	**USD**	**1,578,416.00**	
β.Indirect Cost								
4	Temporary work	Dewatering, Temporary Access road	1	lump sum	110000.00	USD	110,000.00	Inspection of site is required to acurately determine temporary work
5	Site expenses	Mobilisation, Camp Establishment, General monthly running costs, Demobilisation	1	lump sum	180000.00	USD	180,000.00	Estimated 3 Months Work (Inspection of site is required to acurately determine duration)
					Sub total cost	**USD**	**290,000.00**	
γ.Other Cost								
6	Company benefit		1	lump sum		USD	-	Markup included in above rates
7	Administrative expenses		1	lump sum	40000.00	USD	40,000.00	
8	TAX	14.5% of Items 1-7	1	lump sum	276720.32	USD	276,720.32	
					Sub total cost	**USD**	**316,720.32**	
δ.Total Cost								
	δ=α+β+γ					**USD**	**2,185,136.32**	

[NOTE]

1) Describe required manpower, expected heavy machineries and so on in the blue cells.
2) Input Unit prices in the yellow cells so that "Total cost" is calculated automatically.
3) The expected heavy machineries to be utilized depends on your side. We do not specify any heavy machineries.
4) How to deliver the heavy equipment depends on your side.
5) How to deliver materials depends on your side, such as deliver suitable size rocks to the site or deliver huge rocks and break at the site.

Bill of Quantity for Emergency Treatments on MAGUDU DAM

No.	Description	Specification	(1) Quantity	Unit	(2) Unit Price (USD)	(3) Amount = (1) x (2) (USD)	Remarks
α.Direct Cost							
	Earth Work						
1	Excavation (soil)		77	m^3	12.00	924.00	
2	Excavation (rock)		270	m^3	30.00	8,100.00	
3	Wet masonry works		6,268	m^3	220.00	1,378,960.00	
	Sub total cost					**1,387,984.00**	
β.Indirect Cost							
4	Temporary work		1	lump sum	20,000.00	20,000.00	
5	Site expenses		1	lump sum	100,000.00	100,000.00	
	Sub total cost					**120,000.00**	
γ.Other Cost							
6	Company benefit		1	lump sum	20,000.00	20,000.00	
7	Administrative expenses		1	lump sum	70,000.00	70,000.00	
			1	lump sum			
	Sub total cost					**90,000.00**	
δ	**Total**					**1,597,984.00**	
	Add 14.5% Vat					231,707.68	
	Sub-Total					1,829,691.68	
	Add 2% Government Tax					36,593.83	
	Grand Total					**1,866,285.51**	

[NOTE]
1) Describe required manpower, expected heavy machineries and so on in the blue cells.
2) Input Unit prices in the yellow cells so that "Total cost" is calculated automatically.
3) The expected heavy machineries to be utilized depends on your side. We do not specify any heavy machineries.
4) How to deliver the heavy equipment depends on your side.
5) How to deliver materials depends on your side, such as deliver suitable size rocks to the site or deliver huge rocks and break at the site.

Appendix-3

Dam Improvement Work Plan

Appendix-3-1

Dam Improvement Work Plan
(Magudu Dam)

CHAPTER 1 STATUS OF THE WORK PLAN

The identification of deteriorations/damages (and those sign) on the target six dams in Masvingo Province is carried out and examination on the found deteriorations/damage if they already affect the safety/stability/operation of the facilities is conducted. Also, examination on the found deteriorations/damages if they expand and affect the safety/stability/operation of the facilities in the future is carried out as well.

The deteriorations/damages found are evaluated and categorized into three ranks as shown in Table 1.1.1. This work plan is a medium/ long-term rehabilitation plan for "Deformation/damage that may affect the safety/stability/operation of the facility in the long term," which was evaluated as "B" in Table 1.1.1. Among the "B" rated damages, the smaller scale damages will be addressed by Zimbabwe through regular operation and maintenance and are excluded from the scope of this draft plan.

Table 1.1.1 Evaluation Ranks of Deteriorations/Damages Found

Rank	Evaluation Standard
A	Deteriorations and damages that are already affecting the safety/stability/operation of the facilities or are feared to affect them in near future.
B	Deteriorations and damages that are not affecting the safety/stability/operation of the facilities at present but may affect them in the long term.
C	No deteriorations and damage or no signal of them

The draft plan is designed to respond to changes in natural conditions (especially the increase in flood volume due to climate change in recent years) and social conditions (demand for expansion of irrigated area due to population growth) since the construction of the target dam, as well as to solve problems in operation and maintenance management. The draft plan also includes the results of the preliminary environmental and social impact assessment for the Plan.

CHAPTER 2 GENERAL OUTLINE OF THE TARGET DAM

Magudu dam was constructed in 1990 as an irrigation dam. The main features of the dam are shown in Table 2.1.1, and the location is shown in Figure 2.1.1.

Table 2.1.1 Main Features of Dam

District		Masvingo	Specification	Dam Type		Zone Type fill dam
Communal Land		Nyajena		Crest Level (EL.m)		533.2
River		Mmedzi		Non-overflow crest Level (EL.m)		532.7
Catchment Area (km^2)		41.9		Basement Level (EL.m)		512.5
Annual Yield (MCM)		2.891		Height (m)		18.8
Water Level (EL.m)	Design flood level	532.0		Crest Length (m)		460
	Full water level	529.0		Crest Width (m)		6.0
	Dead water level	518.5		Upstream slope angle	Upper portion	1:2.0
Submerged Area (km^2)		1.299			Lower portion	1:2.25
Storage Capacity (MCM)	Reservoir Yield	1.012		Downstream slope angle	Upper portion	1:1.8
	Total	8.840			Lower portion	1:2.0
	Effective	5.672		Core zone upstream slope angle		1:0.15
	Dead	0.168		Core zone downstream angle		1:0.15
Spillway	Crest Type	Non-gate crest		Embankment volume (m^3)		160,400
	Design flood discharge (m^3/s)	415	Pump	Type		-
	Specific flow ($m^3/s/km^2$)	9.90		Design discharge (litter/sec)		-
Night Storage	Capacity (m^3)	6,500		Lift (m)		-
	Depth (m)	2.0	Canal	Type		Concrete flume
	Scale (m)	70 × 70		Maximum discharge (litter/sec)		76
Irrigation Type		Gravity		Length (m)		7,940
Intake	Maximum intake volume (litter/sec)	76		Diameter (mm)		-
Beneficial Area	Farmland Area (ha)	70.0	Benefitted households	Population (people)		2,800
	Irrigation Area (ha)	51.1		Livestock (LSU)		2,430

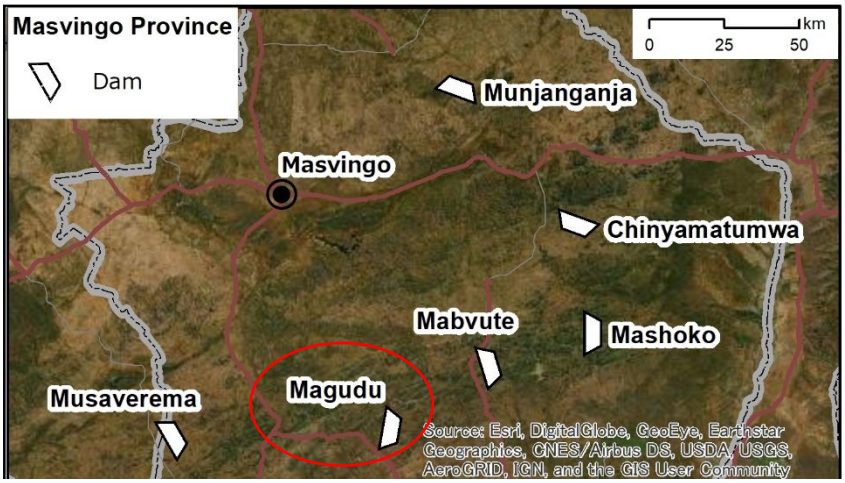


Table 2.1.1 Location of the Target Dam

CHAPTER 3 CONFIRMED DEFORMATIONS/ DAMAGES IN THE FIELD SURVEY AND REHABILITATION POLICY

3.1 SUMMARY

The locations of deteriorations/damages found of Magudu Dam are shown in Figure 3.1.1, and the summary of the evaluation results of each deterioration/damage are shown in Table 3.1.1.

Figure 3.1.1 Locations of Deteriorations/Damages on Magudu Dam

Table 3.1.1 Summary of the Evaluation Results of Deteriorations/Damages on Magudu Dam

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
(1)	Embankment	Crest and upstream slope	B	- Disturbance of riprap, dam body exposure, and erosion
		Downstream slope		- Gully erosion
(2)	Spillway	Weir	B	- Surface concrete peeling at the crest and the edge of the downstream slope
(3)	Connection canal	Right bankside (Embankment side) wall	A	- Two large collapses (one developed 1.5 m from slope protection works for valve house and another 6 m from the edge of the embankment)
		Canal bed	A	- Exposure of siphon lining concrete
		Left bank sidewall (Downstream side)	B	- Collapses on the sidewall and the washed away of a bridge
(4)	Intake	Inlet	B	- Disappearance of the gate operation facilities
(5)	On-farm facilities	Night storage	B	- Broken of the discharge gate
		Canal	B	- Spilling out of backside soil

3.2 "B" EVALUATION DEFORMATION/ DAMAGE AND REHABILITATION POLICY

3.2.1 Embankment

(1) Confirmed Deformations/Damages

[Crest and upstream slope] Disturbance of riprap, dam body exposure, and erosion

[Downstream slope] Gully erosion

Figure 3.2.1 Disturbance of Riprap, Dam Body Exposure, and Erosion (Crest and Upstream Slope)

Figure 3.2.2 Gully Erosion (Downstream Slope)

(2) Rehabilitation Policy for Deformations/ Damages

Disturbance of riprap, dam body exposure, erosion, and trees around the embankment is caused by thinning of the surface riprap due to weathering and livestock invasion on the embankment slope. To repair the embankment and to prevent similar problems in the future, the surface layer (including trees) is removed, the embankment replaced with new material, and riprap is placed on both upstream and downstream sides. Since riprap has not been installed downstream of the Magudu dam, new riprap is installed. In addition, Geotextile is placed between the dam body and the riprap to prevent the runoff of

the dam body.

In addition, there were cases of erosion at the boundary of the embankment, where surface water generated by rainfall tends to collect, at nearby dams. Since this kind of deformation may occur in all dams during long-term operation, a drainage channel at the edge of the embankment will be installed to quickly remove surface water from the surrounding area and prevent erosion.

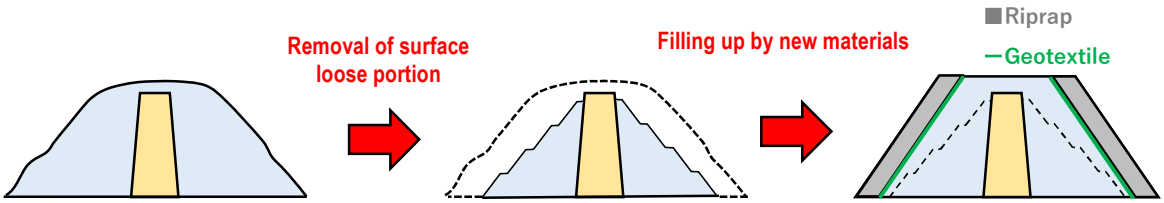


Figure3.2.3 Model of Embankment Rehabilitation Work

A typical cross-section and plan drawings of the embankment rehabilitation are shown in Figure 3.2.4 and Figure 3.2.6. The surface excavation depth is at least 1m for root removal. To increase the boundary area between the excavated surface and the new material, and to ensure accurate compaction at the boundary, the excavated surface of the existing embankment is shaped like steps (1.5 m high, slope 1:0.5), and the compaction width is to be at least 4 m for workability. In addition, the thickness of the newly installed riprap is 1 m. It should be noted that this rehabilitation causes the boundary of the embankment slope to expand in the upstream and downstream directions.

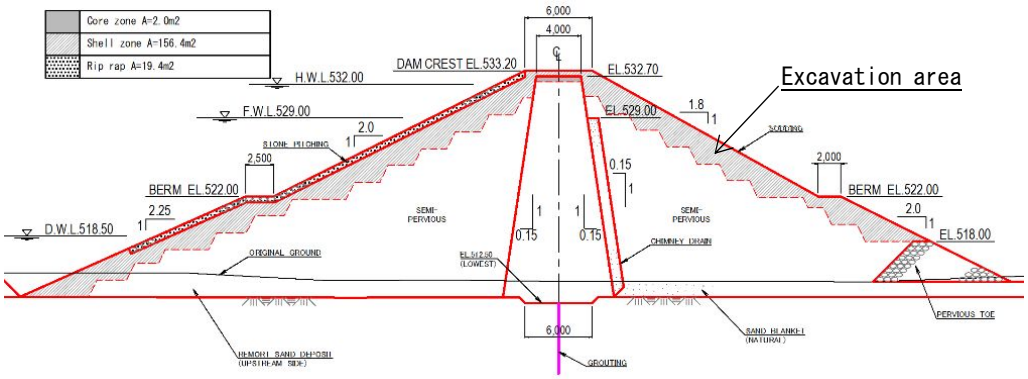


Figure 3.2.4 The Typical Cross-Section of Excavation for Rehabilitation (Magudu dam)

(3) Policy against the Climate Change

Since Magudu dam was designed around 1990, it is suspected that the flood volume at the dam site may have changed from the time of design due to recent climate change. Therefore, it should be verified if the existing facilities can safely discharge floodwaters calculated from recent rainfall. If the dam doesn't have enough capacity, countermeasures are considered.

As a result of the verification, it is judged that existing facility can discharge floods safely.

(4) Policy to Increase the Irrigable Area

An essential condition for the implementation of embankment raising to expand the irrigated area through the increase of water storage capacity is the condition of the topography around the embankment and reservoir. Since embankment height-raising requires a large amount of cost, it is desirable to be able to raise the embankment as high as possible to increase its effectiveness. Therefore, in this feasibility study, the condition for raising the embankment is that the elevation around the embankment and

reservoir must be at least 1 m higher than the crest of the existing embankment.

As a result of confirming the topography around the embankment and examining the possibility of raising the embankment, it was judged that raising the embankment more than 1m was possible. Unfortunately, it is desirable to avoid using the right bank side of the connection canal (embankment side) as the foundation of the expanded embankment because the ground there may be loose due to the collapse. In addition, the water level in the embankment may rise due to the rising FWL caused by the embankment raising, and this may have a negative impact on the stability of the canal and the embankment with the loose basement even if the retaining walls are built in the future. Therefore, the Magudu Dam is excluded from the target of embankment height-raising.

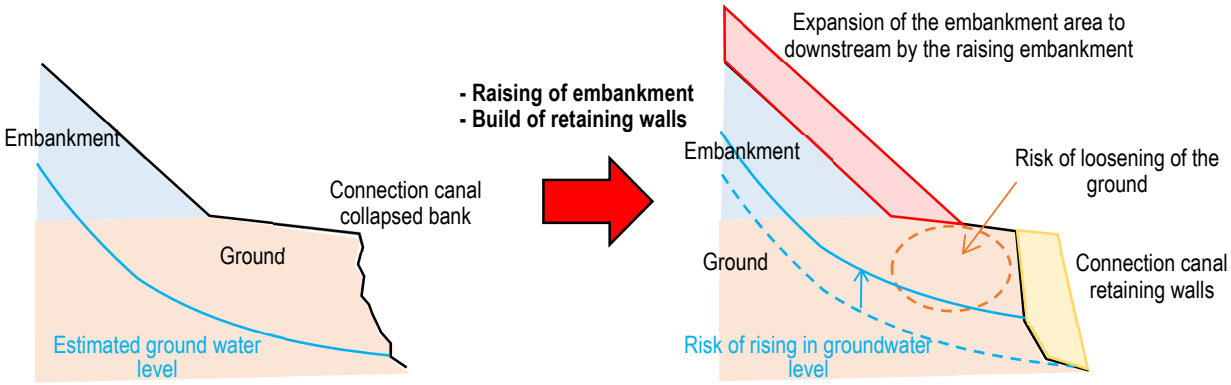


Figure 3.2.5 Drawing of Downstream Situation of Magudu dam

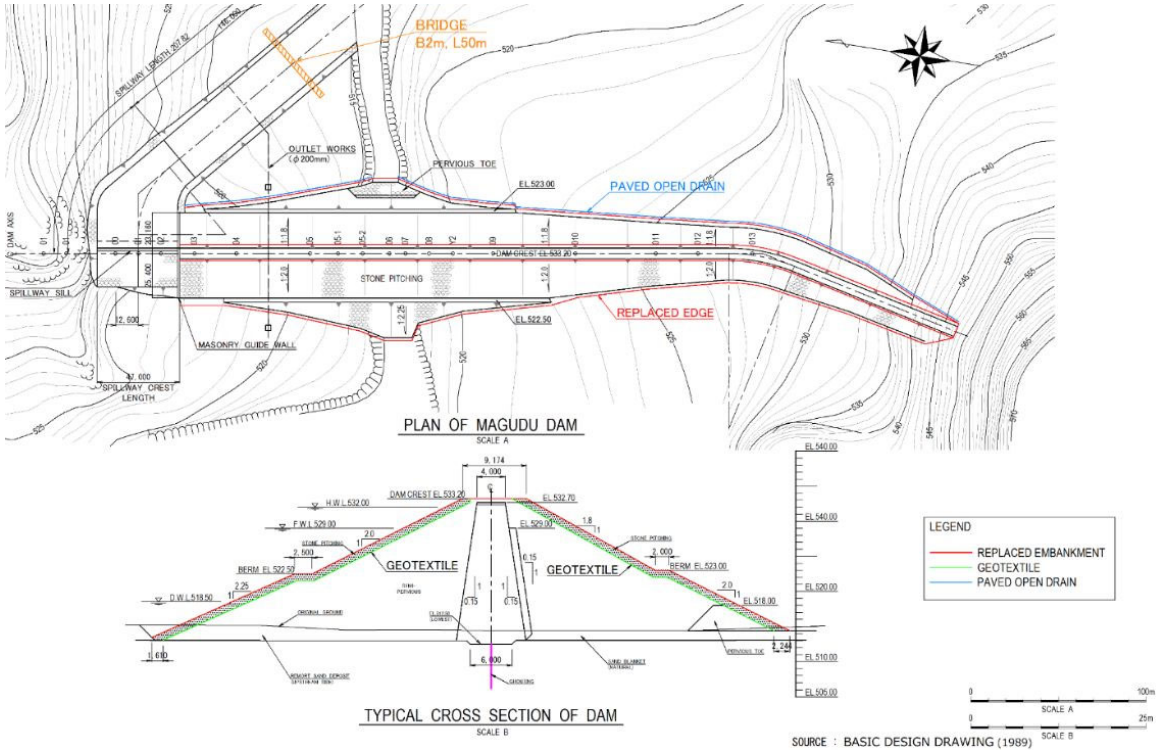


Figure 3.2.6 The Typical Cross-Section and Plan of the Embankment Rehabilitation (Magudu dam)

3.2.2 Spillway

(1) Confirmed Deformations/ Damages

[Weir] Surface concrete peeling at the crest and the edge of the downstream slope

Figure 3.2.7 Surface Concrete Peeling

(2) Rehabilitation Policy for Deformations and Damages

Since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

3.2.3 Connection Canal

(1) Confirmed Deformations/ Damages and Operation & Maintenance Issues

[Left bank side (downstream side) wall] Collapses on the sidewall and the washed away of a bridge

(2) Rehabilitation Policy for Deformations/ Damages and Operation & Maintenance Issues

The washout of the bridge is considered to be due to flood runoff. At present, when there is a flood discharge, it is difficult to cross the canal and go to the valve house, and emergency operation is not possible. Therefore, the bridge should be restored, and the collapsed sidewalls should be built with wet masonry.

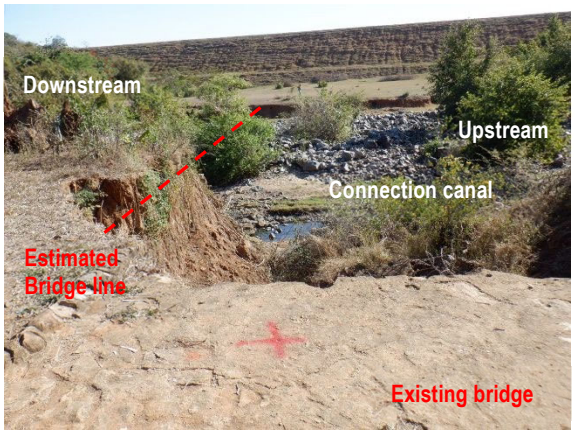


Figure 3.2.8 Collapses on the Left Bank Side Wall, the Washed Away of a

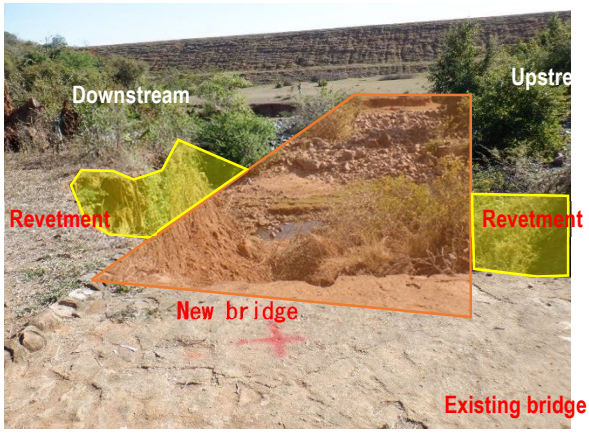


Figure 3.2.9 Rehabilitation of the Bridge on the Left Bank Side (downstream) of the Connection Canal and Construction of the Revetment

3.2.4 Intake

(1) Confirmed deformations/ damages

[Inlet] Disappearance of the gate operation facilities

Figure 3.2.10 Disappearance of the Intake Gate Operation Facilities

(2) Rehabilitation policy for deformations/ damages

To restore the gate operation function and to prevent a similar problem in the future, an operation house is built at the crest and a new winch is installed in it. In addition, the steel wires leading to the intake gate are arranged in the protection pipe set under the riprap at the upstream side to prevent theft and deterioration.

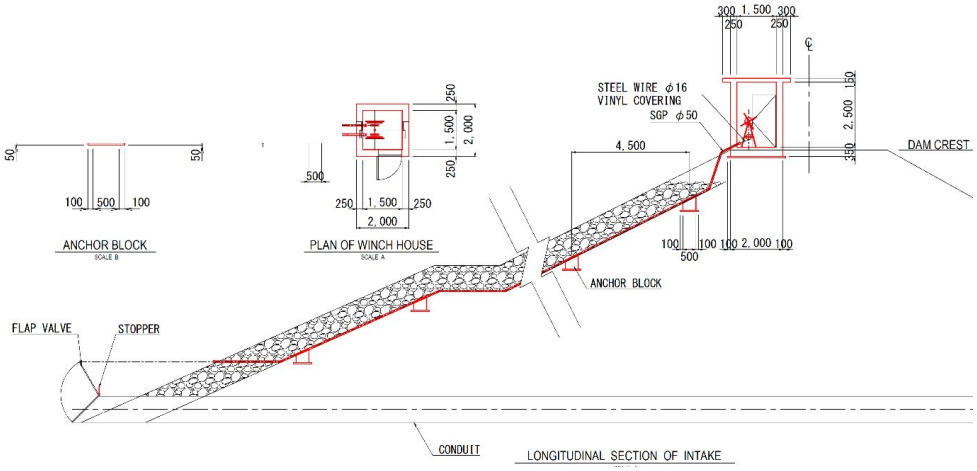


Figure 3.2.11 Layout of the Intake Improvement Plan

3.2.5 On-Farm Facilities

(1) Confirmed Deformations/ Damages

[Night storage] Broken of the discharge gate

[Canal] Spilling out of backside soil

Figure 3.2.12 Broken of the Discharge Gate

Figure 3.2.13 Spilling Out of Canal Back Side Soil

(2) Rehabilitation Policy for Deformations/ Damages

Since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATION

4.1 PROJECT COMPONENT

Magudu dam was constructed in 1990 as an irrigation dam. Therefore, the project component is limited to the rehabilitation of existing agricultural dams. Table 4.1.1 summarizes the project component.

Table 4.1.1 Outline of the Expected Project Component

Rehabilitation Dam	Contents of Works
Magudu Dam	● Rehabilitation of the surface of dam embankments ● Rehabilitation of spillway channel and connection canals (including protection wall installation for canals, installation of access bridge, etc.) ● Rehabilitation of intake facilities (including gate operation facility replacement, etc.)

4.2 PROJECT LOCATION

Magudu dam and its beneficiary area are in Masvingo Province. The land category of the site is Communal Land.

Table 4.2.1 Location of the Project Areas

Rehabilitation Dams	Beneficial Area		Location of the Dams and Beneficial Areas			
	Beneficiaries	Land Size (ha)	Province	District	Land Category	Communal Land Name
Magudu	2,800	70	Masvingo	Masvingo	Communal Lands	Nuajena
Musaverema	2,590	44		Mwenezi		Matibi No.1
Chinyamatumwa	1,610	50		Bikita		Bikita
Mashoko	570	21		Bikita		Matsai
Mabvute	3,930	100		Zaka		Ndanga
Munjanganja	1,710	51		Gutu		Mutra

4.3 ENVIRONMENTAL AND SOCIAL CONDITIONS IN THE PROJECT AREA

(1) Natural Environment

- Meteorology and Hydrology

The annual rainfall is around 800 mm and most of the rainfall is concentrated in the summer season from November to March. The project areas are located in Zone IV (Semi-Extensive Farming Region, with annual rainfall: 450 – 650mm) and/or Zone V (Extensive Farming Region, with annual rainfall: less than 450mm) classified by the agro-ecological zones. Therefore, the necessity for irrigation is high in the project areas.

The river that flows into the target dam is seasonal rivers. The target dam stores river water during the rainy season and discharges for irrigation during the dry season.

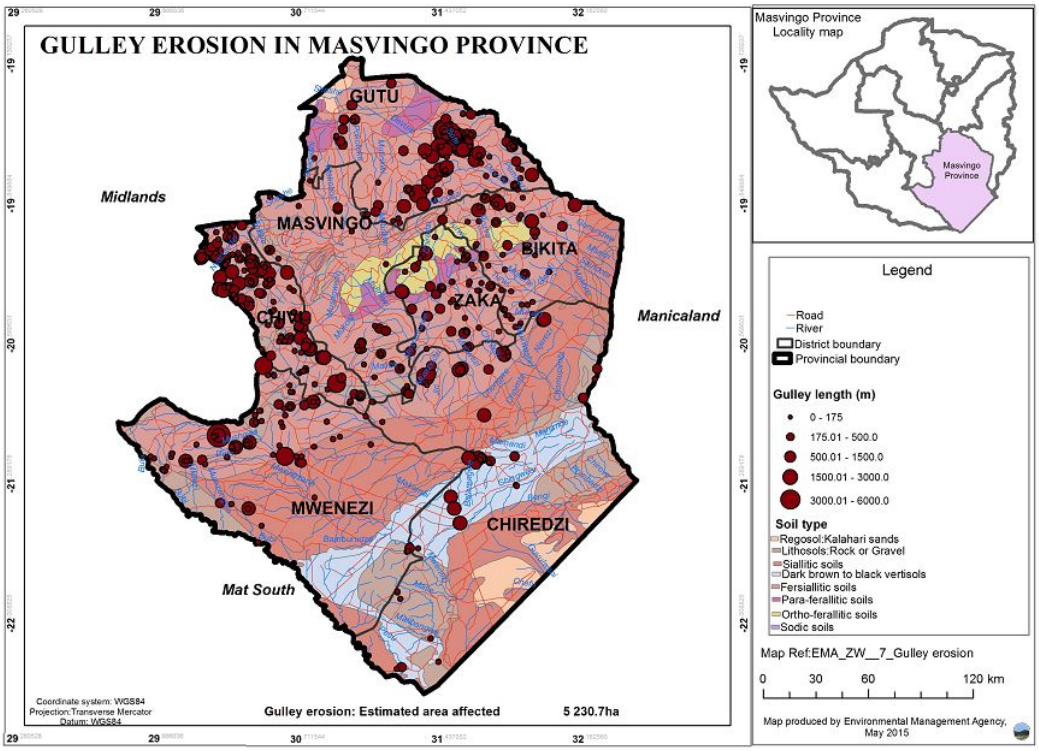
- Eco-system and Habitats

The project area of the target dam (including catchment area and downstream area) and its beneficiary areas are not located in the important ecological habitats such as national parks, Ramsar wetlands, and IBAs. Since the main contents of the dam improvement plan are restoring of original functions of dams through rehabilitation, the way of dam operation is not changed from an existing one. Therefore, it is

assumed there will be no significant changes from the existing ecological condition of the surrounding area of existing dams.

- Erosion and Forestry

Soil deterioration due to gully erosion in farmland and forest lands is a common problem in and around the project area. The Gully erosion distribution map in Masvingo Province is shown in Figure 4.3.1. The gully erosion leads to sedimentation on dam reservoirs. As the countermeasures for the protection from gully erosion, efforts have been made to construct drainage canals in the farmland, to place trees on the counter line, to preserve the forest, and to control illegal tree cutting, generally.

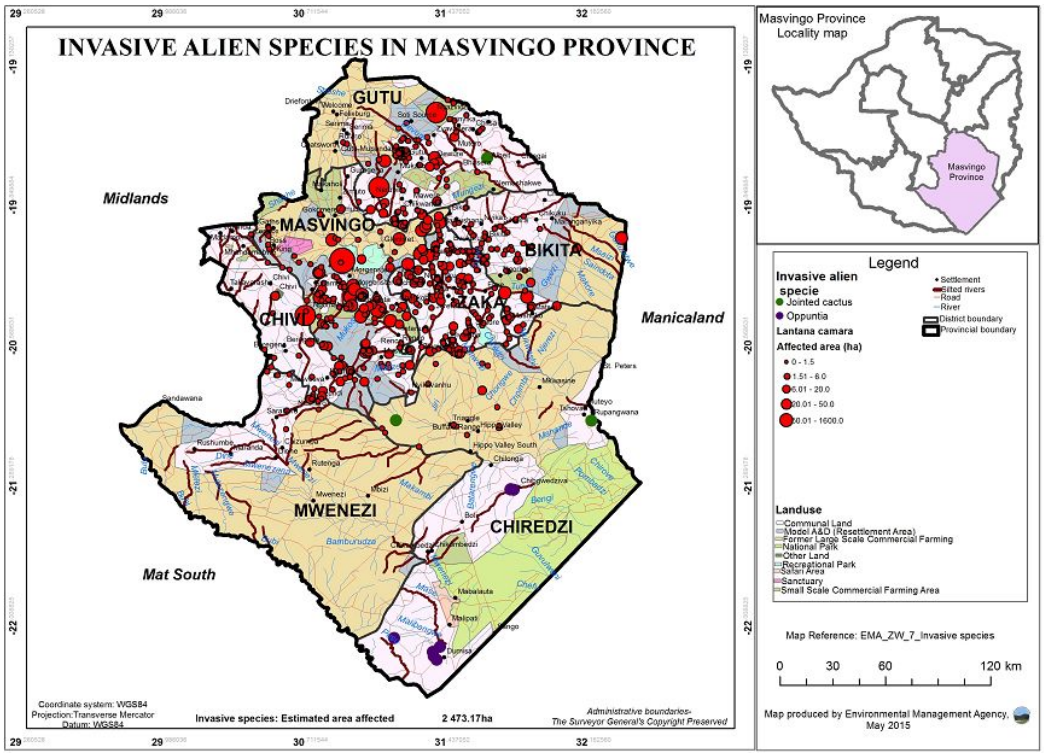


(Source: EMA)

Figure 4.3.1 Gully Erosion Distribution Map in Masvingo Province

- Vegetation

Growing of Lantana Camara, which is one of the invasive species, is a common problem of farmland in the project area. The distribution map of Lantana Camara in Masvingo Province is shown in Figure 4.3.2. On the other hand, the growing of Water Hyacinth in dam reservoirs is one of the problems causing deterioration of water quality due to obstruction of water flow and reduction of dissolved oxygen.



(Source: EMA)

Figure 4.3.2 Lantana Camara Distribution Map in Masvingo Province

(2) Social Environment

- People

The ethnic group living in the project area is the Shona people. Although the official language is English, the Shona language is also used as a local language popularly. There are no tribal conflicts in the project area.

- Livelihood

According to the statistical data of Zimbabwe[1], the average household size living in the Communal Lands is 5 persons/households while the proportion of woman-headed households is around 36%. 98% of people living in Communal Lands are engaged in agriculture and their livelihoods are heavily dependent on it. In general, most of the farmers in Communal Lands are smallholders and the average farmland size is about 1.4 ha/households.

- Decision-Making System by Traditional Custom

The traditional leadership locality called Traditional Leaders (composed of local chiefs, headmen, and village leaders) is functioned and legally recognized in Communal Lands. Traditional Leaders substantially make a role in managing land use and dispute resolution of the community.

4.4 SCOPING

Scoping is carried out as the preliminary environmental and social impact assessment. As the results, most of the major negative impacts on environmental and social aspects are anticipated during construction works, such as water pollution, wastes, and so on. It is necessary to develop an EMP

[1] ZIMSTAT, Zimbabwe Smallholder Agricultural Productivity Survey 2017 Report, March 2019

(Environmental Management Plan) of the project and implement appropriate mitigation measures and monitoring by construction contractor and implementation organization (DOI or ZINWA).

4.5 EVALUATION OF THE ENVIRONMENTAL CATEGORY (PROPOSED)

The scope of the project is limited to rehabilitation works of the existing agricultural dam and the current dam operation will be not changed after the rehabilitation works. Significant negative impacts on the surrounding natural environment and social environment by the project implementation are not anticipated. The project sites are not located in sensitive areas such as national protected areas and other important biodiversity areas. And the large-scale involuntary resettlement and/or land acquisition are not anticipated. For these reasons, it is assumed that the project will fall under Category B in the category classification of JICA environmental and social consideration guidelines.

CHAPTER 5 REHABILITATION COST

It is assumed that this rehabilitation project will be implemented by the Zimbabwean government budget or by the Japanese Grant Aid Project. The estimated project cost in each case is shown as below.

Implementation by the Zimbabwean Government: 4.27 million USD

Implementation by the Japanese Grant Aid Project: 7.39 million USD

CHAPTER 6 REQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

(1) Confirmation of the Implementing Agency of the Project

Determine implementing agencies from ZINWA or DOI.

(2) Natural Conditions Survey

1) Topographical survey

Plan survey, land survey, including the area around the reservoir, and longitudinal & cross-section survey of the embankment.

2) Soil investigation (Existing embankment)

Density, specific gravity, water absorption, water content ratio, grain size, compaction - permeability, liquid plasticity, consolidation, triaxial compression, etc.

3) Soil investigation (Borrow area)

Same test contents as the above soil investigation (Existing embankment)

4) Boring test (Pier foundation)

Standard penetration test (SPT)

(3) Planning of Project Content

1) Outline design

2) Construction/Procurement plan

*When upgrading a reservoir, there are two possible methods: (1) emptying the reservoir and (2) operating the reservoir (with water in the reservoir). Depending on which method is chosen, the scale of temporary facilities required will differ greatly, which will also affect the project cost. Therefore, the construction plan for the upgrading work should be developed with this in mind.

In addition, it is necessary to set the method of implementation after sufficient consultation and agreement with the Zimbabwean side and beneficiary farmers. In particular, it is necessary to inform and agree with the beneficiary farmers in Zimbabwe that if the project is to be implemented with emptying the reservoir, irrigated agriculture will not be possible for the relevant year (and possibly for several years thereafter) and that the beneficiary farmers will need to be guaranteed by the Zimbabwean government.

3) Plan of maintenance & operation

(4) Environmental and Social Considerations (Including Social Condition Survey)

1) Social survey of the target area, study of environmental and social impacts and countermeasures

2) Application and approval of environmental procedures to the EMA (Environmental Management Agency) (submission of Prospectus and support for the preparation of environmental management plans, etc.)

(5) Estimating the Project Cost

CHAPTER 7 BENEFITS OF THE PROJECT

By implementing the project, deformations and damages occurring in each facility will be repaired to extend the service life of the facilities, which will avoid damage to the facilities due to aging and the resulting loss of human lives and assets, as well as ensure the continuation of irrigated agriculture in 51.1 ha by avoiding the suspension of irrigation water supply.

Appendix-3-2

Dam Improvement Work Plan
(Musaverema Dam)

CHAPTER 1 STATUS OF THE WORK PLAN

The identification of deteriorations/damages (and those sign) on the target six dams in Masvingo Province is carried out and examination on the found deteriorations/damage if they already affect the safety/stability/operation of the facilities is conducted. Also, examination on the found deteriorations/damages if they expand and affect the safety/stability/operation of the facilities in the future is carried out as well.

The deteriorations/damages found are evaluated and categorized into three ranks as shown in Table 1.1.1. This work plan is a medium/ long-term rehabilitation plan "Deformation/damage that may affect the safety/stability/operation of the facility in the long term," which was evaluated as "B" in Table 1.1.1. Among the "B" rated damages, the smaller scale damages will be addressed by Zimbabwe through regular operation and maintenance and are excluded from the scope of this draft plan.

Table 1.1.1 Evaluation Ranks of Deteriorations/Damages Found

Rank	Evaluation Standard
A	Deteriorations and damages that are already affecting the safety/stability/operation of the facilities or are feared to affect them in near future.
B	Deteriorations and damages that are not affecting the safety/stability/operation of the facilities at present but may affect them in the long term.
C	No deteriorations and damage or no signal of them

The draft plan is designed to respond to changes in natural conditions (especially the increase in flood volume due to climate change in recent years) and social conditions (demand for expansion of irrigated area due to population growth) since the construction of the target dam, as well as to solve problems in operation and maintenance management. The draft plan also includes the results of the preliminary environmental and social impact assessment for the Plan..

CHAPTER 2 GENERAL OUTLINE OF THE TARGET DAM

Musaverema dam was constructed in 1990 as an irrigation dam. The main features of the dam are shown in Table 2.1.1, and the location is shown in Figure 2.1.1.

Table 2.1.1 Main Features of Dam

District		Mwenezi		Dam Type		Zone Type fill dam
Communal Land		Matibi No.1		Crest Level (EL.m)		683.7
River		Nusaverema		Non-overflow crest Level (EL.m)		683.0
Catchment Area (km^2)		131.6		Basement Level (EL.m)		666.0
Annual Yield (MCM)		4.454		Height (m)		12.7
Water Level (EL.m)	Design flood level	682.5		Crest Length (m)		1,700
	Full water level	680.0		Crest Width (m)		6.0
	Dead water level	675.0	Specification	Upstream slope angle	Upper portion	1:2.25
Submerged Area (km^2)		2.504			Lower portion	1:2.25
Storage Capacity (MCM)	Reservoir Yield	0.757		Downstream slope angle	Upper portion	1:2.0
	Total	7.526			Lower portion	1:2.0
	Effective	6.653		Core zone upstream slope angle		1:0.15
	Dead	0.873		Core zone downstream angle		1:0.15
Spillway	Crest Type	Non-gate crest		Embankment volume (m^3)		23,300
	Design flood discharge (m^3/s)	835	Pump	Type		-
	Specific flow (m^3/s/km^2)	6.34		Design discharge (litter/sec)		-
Night Storage	Capacity (m^3)	4,600		Lift (m)		-
	Depth (m)	2.0	Canal	Type		Concrete flume
	Scale (m)	61 × 61		Maximum discharge (litter/sec)		54
Irrigation Type		Gravity		Length (m)		5,600
Intake	Maximum intake volume (litter/sec)	54		Diameter (mm)		-
Beneficial Area	Farmland Area (ha)	44.0	Benefitted households	Population (people)		2,590
	Irrigation Area (ha)	36.2		Livestock (LSU)		1,800

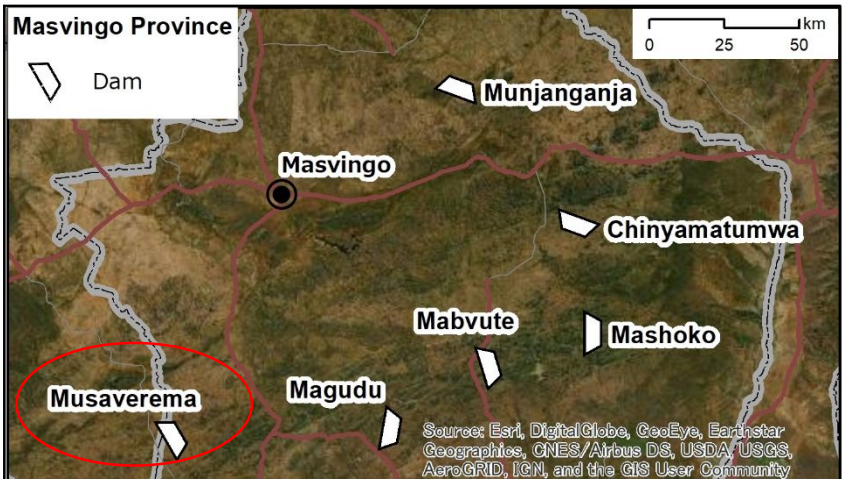


Table 2.1.1 Location of the Target Dam

CHAPTER 3 CONFIRMED DEFORMATIONS/ DAMAGES IN THE FIELD SURVEY AND REHABILITATION POLICY

3.1 SUMMARY

The locations of deteriorations/damages found of Musaverema Dam are shown in Figure 3.1.1, and the summary of the evaluation results of each deterioration/damage are shown in Table 3.1.1.

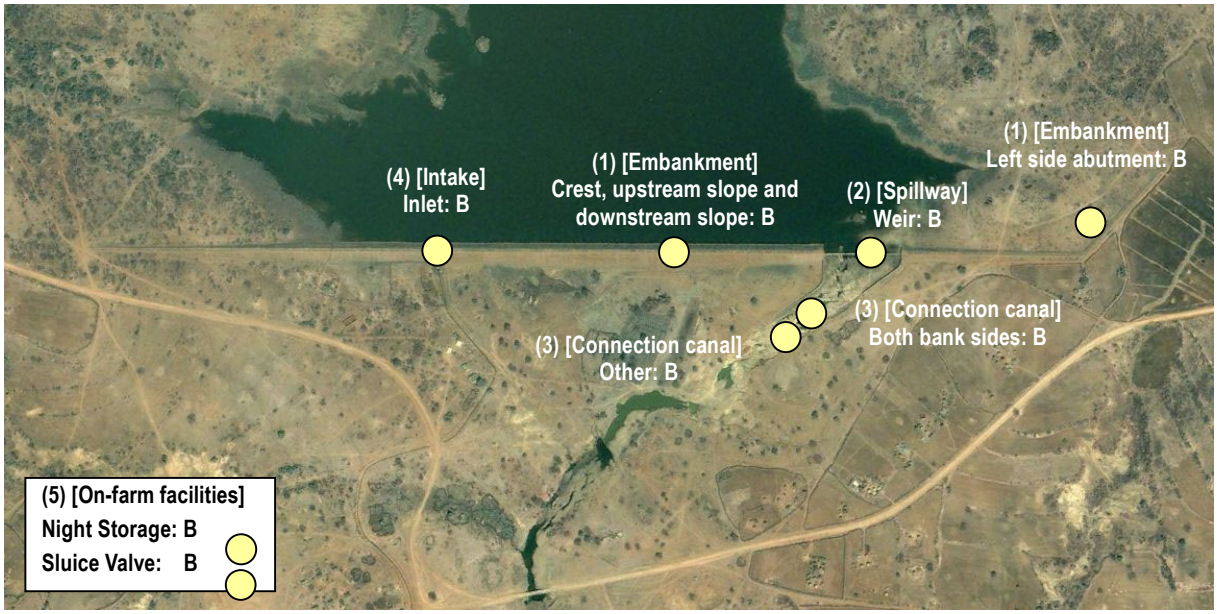


Figure 3.13.1.1 Locations of Deteriorations/Damages on Musaverema Dam

Table 3.1.1 Summary of the Evaluation Results of Deteriorations/Damages on Musaverema Dam

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
(1)	Embankment	Crest and upstream slope	B	· Disturbance of riprap, dam body exposure, and erosion
		Downstream slope		- Gully erosion
		Left side abutment	B	- Many trees on and around embankment surface (higher than FWL)
(2)	Spillway	Weir	B	- Surface peeling and lack of stones at crest

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
				- A slight plant on the left side
(3)	Connection canal	Both bank sides walls	**B**	- Collapse of sidewalls
		Other	**B**	- Crossing road across canal
(4)	Intake	Inlet	**B**	- Missing of the wires - Rusting all over
(5)	On-farm facilities	Night storage	**B**	- Broken of the discharge gate
		Sluice valve	**B**	- Missing parts

3.2 "B" EVALUATION DEFORMATION/ DAMAGE AND REHABILITATION POLICY

3.2.1 Embankment

(1) Confirmed Deformations/ Damages

[Crest and upstream slope] Disturbance of riprap, dam body exposure, and erosion

[Downstream slope] Gully erosion

[Left side abutment] Many trees on and around embankment surface (higher than FWL)

Figure 3.2.1 Disturbance of Riprap, Dam Body Exposure, and Erosion (Crest and Upstream)

Figure 3.2.2 Gully Erosion (Downstream Slope)

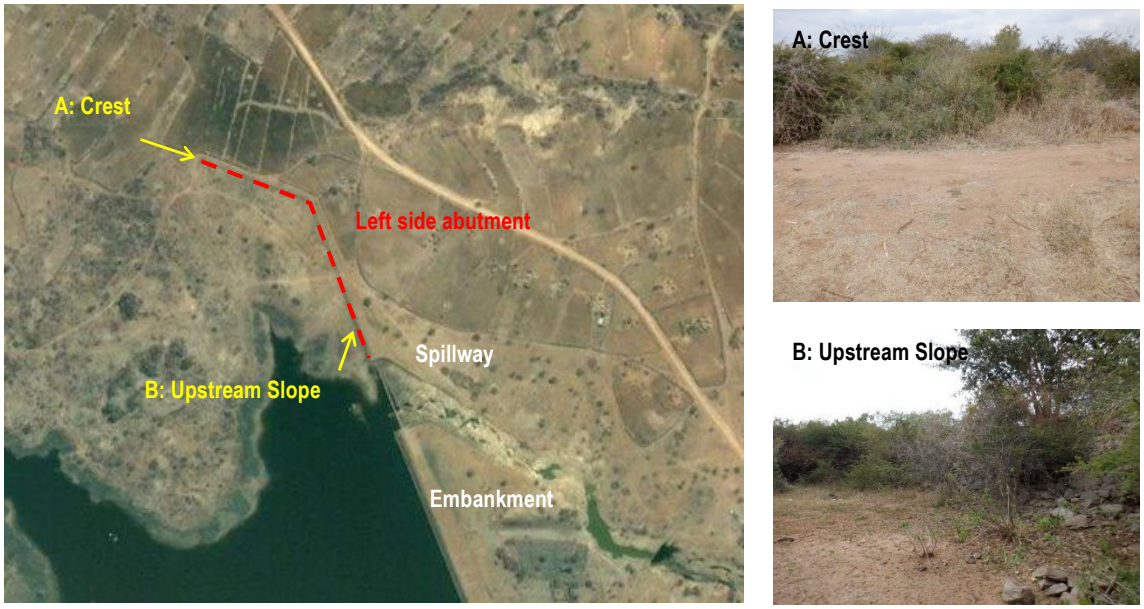


Figure 3.2.3 Trees on and around the Left Side Abutment

(2) Rehabilitation Policy for Deformations/ Damages

Disturbance of riprap, dam body exposure, erosion, and trees around the embankment is caused by thinning of the surface riprap due to weathering and livestock invasion on the embankment slope. To repair the embankment and to prevent similar problems in the future, the surface layer (including trees) is removed, the embankment replaced with new material, and riprap is placed on both upstream and downstream sides. Since riprap has not been installed downstream of the Musaverema dam, new riprap is installed. In addition, Geotextile is placed between the dam body and the riprap to prevent the runoff of the dam body.

In addition, there were cases of erosion at the boundary of the embankment, where surface water generated by rainfall tends to collect, at nearby dams. Since this kind of deformation may occur in all dams during long-term operation, a drainage channel at the edge of the embankment will be installed to quickly remove surface water from the surrounding area and prevent erosion.

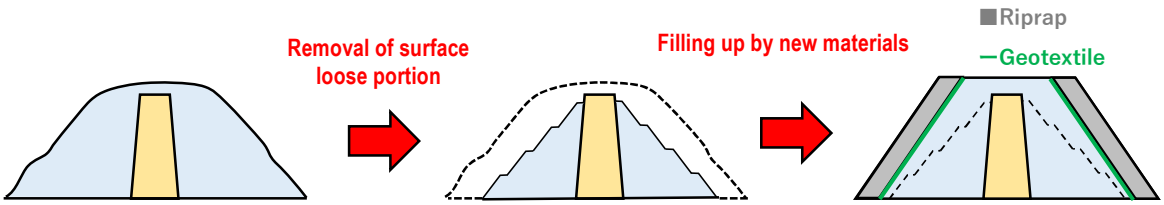


Figure3.2.4 Model of Embankment Rehabilitation Work

A typical cross-section and plan drawings of the embankment rehabilitation are shown in Figure 3.2.5 and Figure 3.2.6. The surface excavation depth is at least 1m for root removal. To increase the boundary area between the excavated surface and the new material, and to ensure accurate compaction at the boundary, the excavated surface of the existing embankment is shaped like steps (1.5 m high, slope 1:0.5), and the compaction width is to be at least 4 m for workability. In addition, the thickness of the newly installed riprap is 1 m. It should be noted that this rehabilitation causes the boundary of the embankment slope to expand in the upstream and downstream directions.

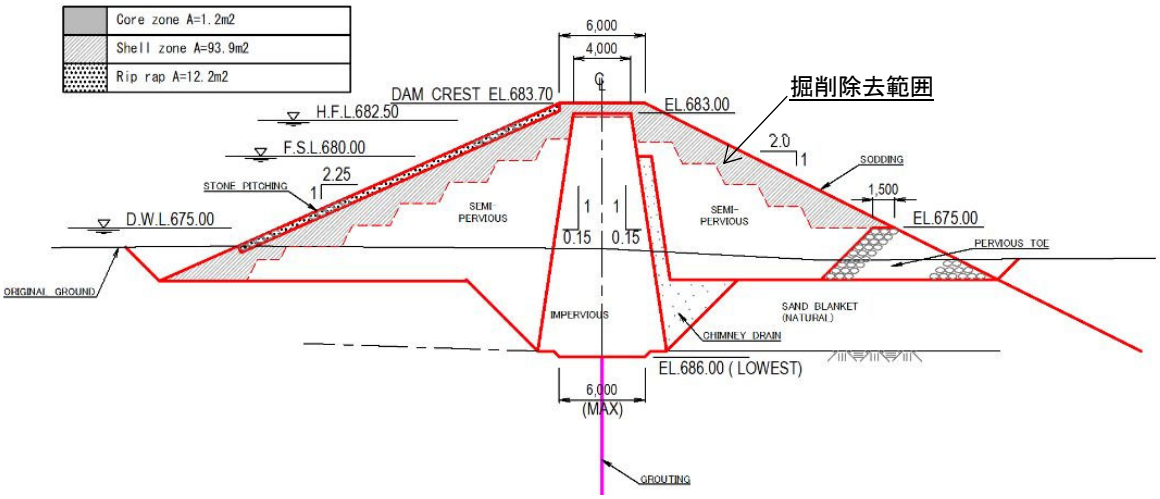


Figure 3.2.3 The Typical Cross-Section of Excavation for Rehabilitation (Musaverema dam)

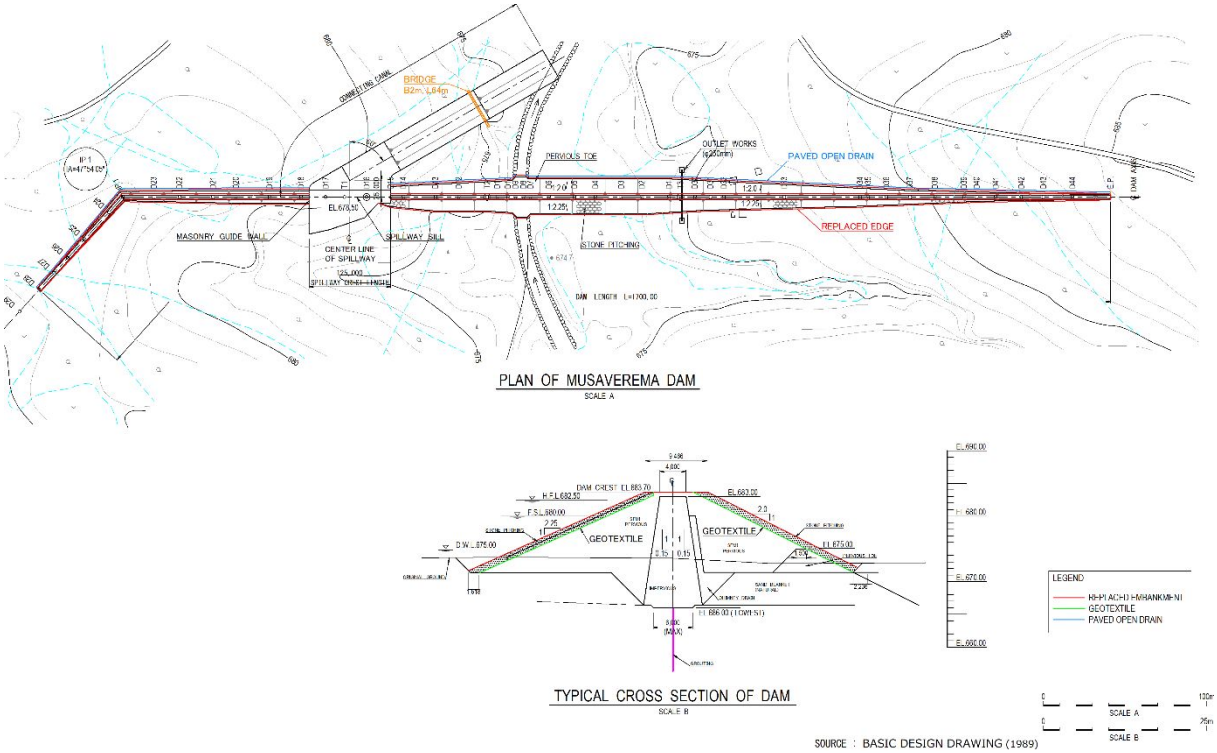


Figure 3.2.4 The Typical Cross-Section and Plan of the Embankment Rehabilitation (Musavwrema dam)

(3) Policy against the Climate Change

Since Museverema dam was designed around 1990, it is suspected that the flood volume at the dam site may have changed from the time of design due to recent climate change. Therefore, it should be verified if the existing facilities can safely discharge floodwaters calculated from recent rainfall. If the dam doesn't have enough capacity, countermeasures are considered.

As a result of the verification, it is judged that existing facility can discharge floods safely.

(4) Policy to Increase the Irrigable Area

An essential condition for the implementation of embankment raising to expand the irrigated area through the increase of water storage capacity is the condition of the topography around the embankment and reservoir. Since embankment height-raising requires a large amount of cost, it is desirable to be able to raise the embankment as high as possible to increase its effectiveness. Therefore, in this feasibility study, the condition for raising the embankment is that the elevation around the embankment and reservoir must be at least 1 m higher than the crest of the existing embankment.

As a result of confirming the topography around the embankment and examining the possibility of raising the embankment, it was judged that raising the embankment more than 1m was impossible.

3.2.2 Spillway

(1) Confirmed Deformations/ Damages

[Weir] Surface peeling and lack of stones at the crest

[Weir] A slight plant on the left side

Figure 3.2.6 Surface Peeling and Lack of Stones

Figure 3.2.5 Plants on the Left Side

(2) Rehabilitation Policy for Deformations/ Damages

Since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

3.2.3 Connection Canal

(1) Confirmed Deformations/ Damages and Operation & Maintenance Issues

[Both bank sides walls] Collapse of sidewalls

[Other] Crossing road across canal

Figure 3.2.9 Collapse of Side Walls on Both Bank Sides

Figure 3.2.7 Crossing Road

(2) Rehabilitation Policy for Deformations/ Damages and Operation & Maintenance Issues

As for the collapse of the sidewall, even if it progresses, the Zimbabwean government will conduct continuous monitoring to determine whether or not countermeasures are necessary, as the impact on other facilities and the surrounding environment cannot be measured at this time.

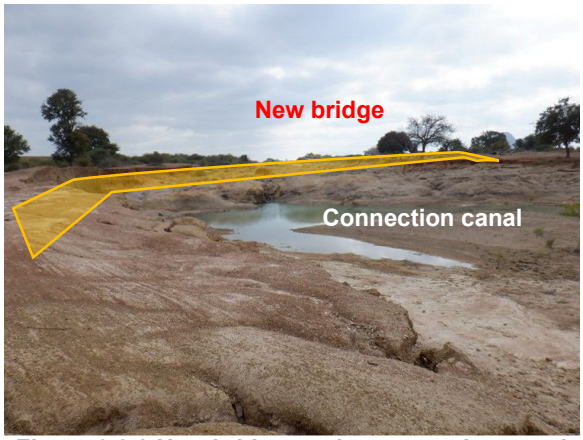


Figure 3.2.8 New bridge on the connection canal

It is predicted that the reason why the inside of the connection canal was used as a passageway is due to the lack of passageway bridges in the surrounding area. Especially during the rainy season, the intrusion into the waterway is very dangerous and must be prevented without fail. Therefore, a bridge for crossing will be installed at an appropriate location in the connection canal.

3.2.4 Intake

(1) Confirmed Deformations/ Damages

[Inlet] Missing of the wires and rusting all over

(2) Rehabilitation Policy for Deformations/ Damages

To restore the gate operation function and to prevent a similar problem in the future, an operation house is built at the crest and a new winch is installed in it. In addition, the steel wires leading to the intake gate are arranged in the protection pipe set under the riprap at the upstream side to prevent theft and deterioration.

Figure 3.2.9 Status of Intake Structure

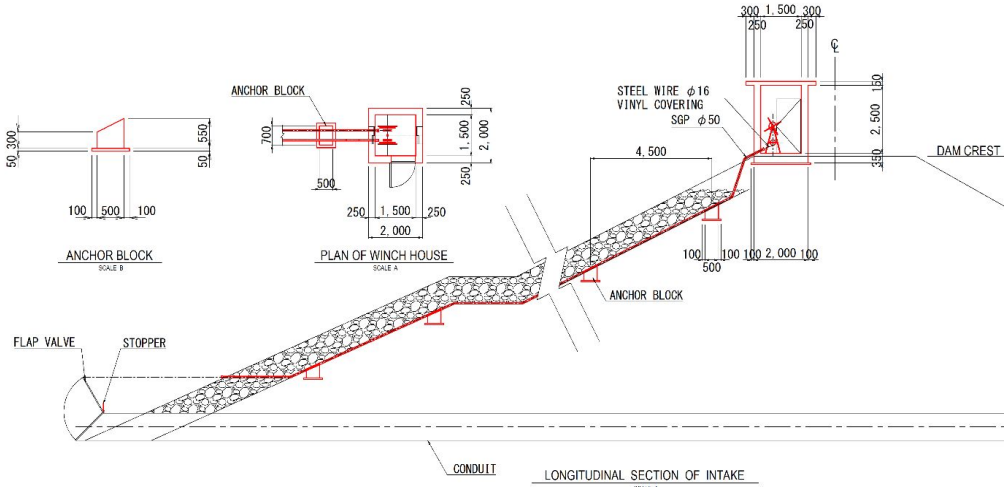


Figure 3.2.10 Layout of the Intake Improvement Plan

3.2.5 On-Farm Facilities

(1) Confirmed Deformations/ Damages

[Night storage] Broken of the discharge gate

[Sluice valve] Missing parts

Figure 3.2.12 Broken of the Discharge Gate

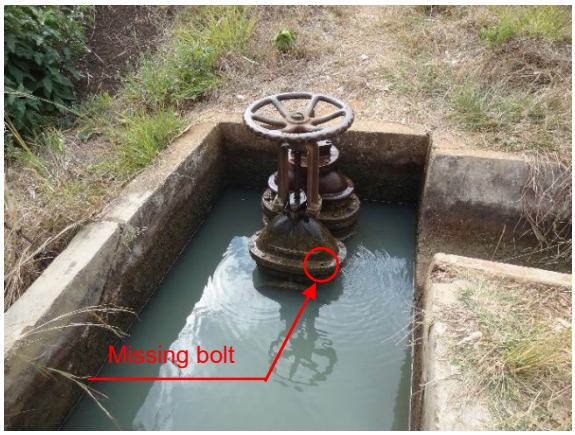


Figure 3.2.11 Missing Parts of Sluice Valve

(2) Rehabilitation Policy for Deformations/ Damages

Since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATION

4.1 PROJECT COMPONENT

Musaverema dam was constructed in 1990 as an irrigation dam. Therefore, the project component is limited to the rehabilitation of existing agricultural dams. Table 4.1.1 summarizes the project component.

Table 4.1.1 Outline of the Expected Project Component

Rehabilitation Dam	Contents of Works
Musaverema Dam	● Rehabilitation of the surface of dam embankments ● Rehabilitation of spillway channel and connection canals (including protection wall installation for canals, installation of access bridge, etc.) ● Rehabilitation of intake facilities (including gate operation facility replacement, etc.)

4.2 PROJECT LOCATION

Musaverema dam and its beneficiary area are in Masvingo Province. The land category of the site is Communal Land.

Table 4.2.1 Location of the Project Areas

Rehabilitation Dams	Beneficial Area		Location of the Dams and Beneficial Areas			
	Beneficiaries	Land Size (ha)	Province	District	Land Category	Communal Land Name
Magudu	2,800	70	Masvingo	Masvingo	Communal Lands	Nuajena
Musaverema	2,590	44		Mwenezi		Matibi No.1
Chinyamatumwa	1,610	50		Bikita		Bikita
Mashoko	570	21		Bikita		Matsai
Mabvute	3,930	100		Zaka		Ndanga
Munjanganja	1,710	51		Gutu		Mutra

4.3 ENVIRONMENTAL AND SOCIAL CONDITIONS IN THE PROJECT AREA

(1) Natural Environmental

- Meteorology and Hydrology

The annual rainfall is around 800 mm and most of the rainfall is concentrated in the summer season from November to March. The project areas are located in Zone IV (Semi-Extensive Farming Region, with annual rainfall: 450 – 650mm) and/or Zone V (Extensive Farming Region, with annual rainfall: less than 450mm) classified by the agro-ecological zones. Therefore, the necessity for irrigation is high in the project areas.

The river that flows into the target dam is seasonal rivers. The target dam stores river water during the rainy season and discharges for irrigation during the dry season.

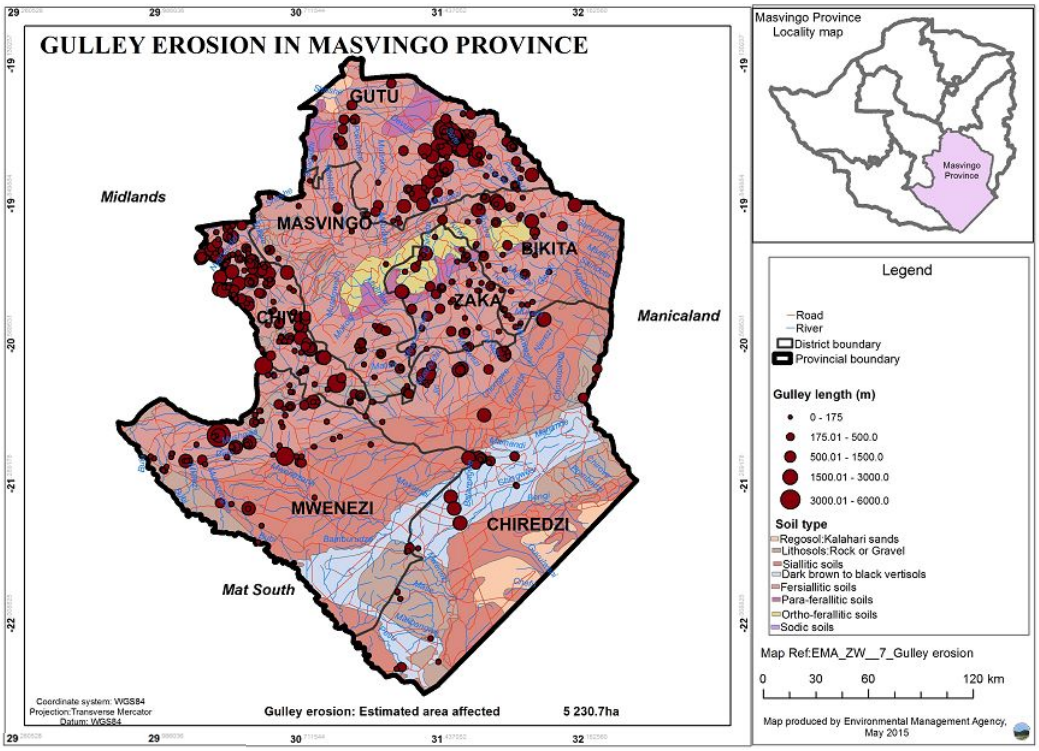
- Eco-system and Habitats

The project area of the target dam (including catchment area and downstream area) and its beneficiary areas are not located in the important ecological habitats such as national parks, Ramsar wetlands, and IBAs. Since the main contents of the dam improvement plan are restoring of original functions of dams through rehabilitation, the way of dam operation is not changed from an existing one. Therefore, it is assumed there will be no significant changes from the existing ecological condition of the surrounding

area of existing dams.

- Erosion and Forestry

Soil deterioration due to gully erosion in farmland and forest lands is a common problem in and around the project area. The Gully erosion distribution map in Masvingo Province is shown in Figure 4.3.1. The gully erosion leads to sedimentation on dam reservoirs. As the countermeasures for the protection from gully erosion, efforts have been made to construct drainage canals in the farmland, to place trees on the counter line, to preserve the forest, and to control illegal tree cutting, generally.

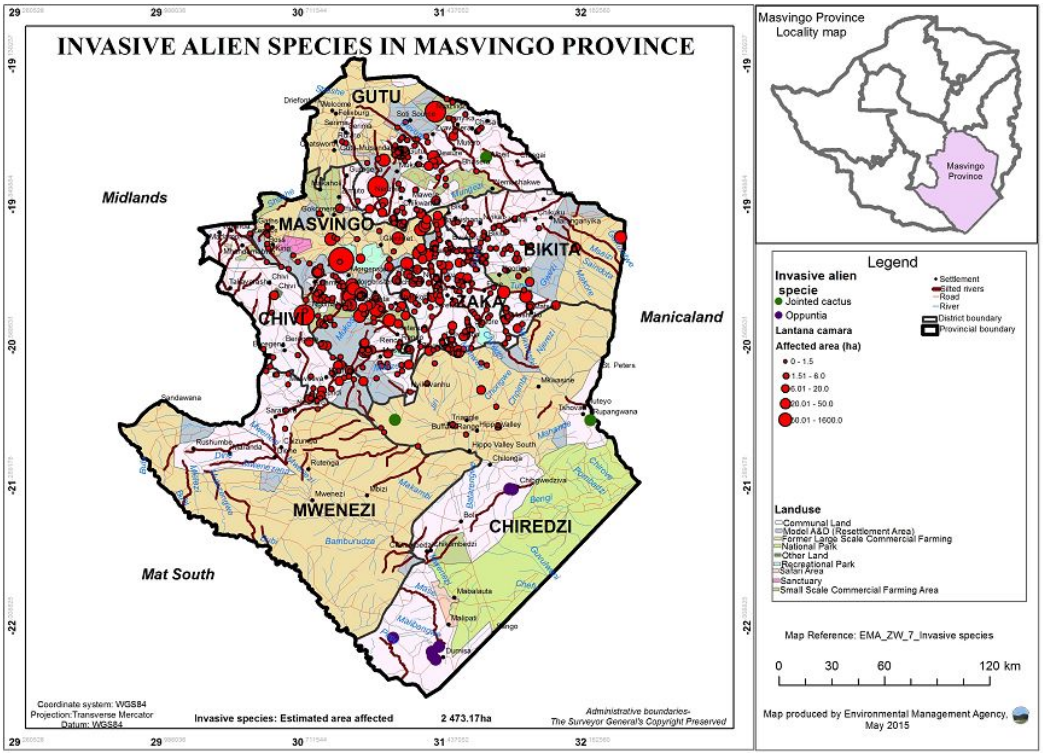


(Source: EMA)

Figure 4.3.1 Gully Erosion Distribution Map in Masvingo Province

- Vegetation

Growing of Lantana Camara, which is one of the invasive species, is a common problem of farmland in the project area. The distribution map of Lantana Camara in Masvingo Province is shown in Figure 4.3.2. On the other hand, the growing of Water Hyacinth in dam reservoirs is one of the problems causing deterioration of water quality due to obstruction of water flow and reduction of dissolved oxygen.



(Source: EMA)

Figure 4.3.2 Lantana Camara Distribution Map in Masvingo Province

(2) Social Environmental

- People

The ethnic group living in the project area is the Shona people. Although the official language is English, the Shona language is also used as a local language popularly. There are no tribal conflicts in the project area.

- Livelihood

According to the statistical data of Zimbabwe[1], the average household size living in the Communal Lands is 5 persons/households while the proportion of woman-headed households is around 36%. 98% of people living in Communal Lands are engaged in agriculture and their livelihoods are heavily dependent on it. In general, most of the farmers in Communal Lands are smallholders and the average farmland size is about 1.4 ha/households.

- Decision-Making System by Traditional Custom

The traditional leadership locality called Traditional Leaders (composed of local chiefs, headmen, and village leaders) is functioned and legally recognized in Communal Lands. Traditional Leaders substantially make a role in managing land use and dispute resolution of the community.

4.4 SCOPING

Scoping is carried out as the preliminary environmental and social impact assessment. As the results, most of the major negative impacts on environmental and social aspects are anticipated during construction works, such as water pollution, wastes, and so on. It is necessary to develop an EMP

[1] ZIMSTAT, Zimbabwe Smallholder Agricultural Productivity Survey 2017 Report, March 2019

(Environmental Management Plan) of the project and implement appropriate mitigation measures and monitoring by construction contractor and implementation organization (DOI or ZINWA).

4.5 EVALUATION OF THE ENVIRONMENTAL CATEGORY (PROPOSED)

The scope of the project is limited to rehabilitation works of the existing agricultural dam and the current dam operation will be not changed after the rehabilitation works. Significant negative impacts on the surrounding natural environment and social environment by the project implementation are not anticipated. The project sites are not located in sensitive areas such as national protected areas and other important biodiversity areas. And the large-scale involuntary resettlement and/or land acquisition are not anticipated. For these reasons, it is assumed that the project will fall under Category B in the category classification of JICA environmental and social consideration guidelines.

CHAPTER 5 REHABILITATION COST

It is assumed that this rehabilitation project will be implemented by the Zimbabwean government budget or by the Japanese Grant Aid Project. The estimated project cost in each case is shown as below.

Implementation by the Zimbabwean Government: 7.54 million USD
Implementation by the Japanese Grant Aid Project: 13.05 millioin USD

CHAPTER 6 REQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

(1) Confirmation of the Implementing Agency of the Project

Determine implementing agencies from ZINWA or DOI.

(2) Natural Conditions Survey

1) Topographical survey

Plan survey, land survey, including the area around the reservoir, and longitudinal & cross-section survey of the embankment.

2) Soil investigation (Existing embankment)

Density, specific gravity, water absorption, water content ratio, grain size, compaction - permeability, liquid plasticity, consolidation, triaxial compression, etc.

3) Soil investigation (Borrow area)

Same test contents as the above soil investigation (Existing embankment)

4) Boring test (Pier foundation)

Standard penetration test (SPT)

(3) Planning of Project Content

1) Outline design

2) Construction/Procurement plan

*When upgrading a reservoir, there are two possible methods: (1) emptying the reservoir and (2) operating the reservoir (with water in the reservoir). Depending on which method is chosen, the scale of temporary facilities required will differ greatly, which will also affect the project cost. Therefore, the construction plan for the upgrading work should be developed with this in mind.

In addition, it is necessary to set the method of implementation after sufficient consultation and agreement with the Zimbabwean side and beneficiary farmers. In particular, it is necessary to inform and agree with the beneficiary farmers in Zimbabwe that if the project is to be implemented with emptying the reservoir, irrigated agriculture will not be possible for the relevant year (and possibly for several years thereafter) and that the beneficiary farmers will need to be guaranteed by the Zimbabwean government.

3) Plan of maintenance & operation

(4) Environmental and Social Considerations (Including Social Condition Survey)

1) Social survey of the target area, study of environmental and social impacts and countermeasures

2) Application and approval of environmental procedures to the EMA (Environmental Management Agency) (submission of Prospectus and support for the preparation of environmental management plans, etc.)

(5) Estimating the Project Cost

CHAPTER 7 BENEFITS OF THE PROJECT

By implementing the project, deformations and damages occurring in each facility will be repaired to extend the service life of the facilities, which will avoid damage to the facilities due to aging and the resulting loss of human lives and assets, as well as ensure the continuation of irrigated agriculture in 36.2 ha by avoiding the suspension of irrigation water supply.

Appendix-3-3

Dam Improvement Work Plan (Chinyamatumwa Dam)

CHAPTER 1 STATUS OF THE WORK PLAN

The identification of deteriorations/damages (and those sign) on the target six dams in Masvingo Province is carried out and examination on the found deteriorations/damage if they already affect the safety/stability/operation of the facilities is conducted. Also, examination on the found deteriorations/damages if they expand and affect the safety/stability/operation of the facilities in the future is carried out as well.

The deteriorations/damages found are evaluated and categorized into three ranks as shown in Table 1.1.1. This work plan is a medium/ long-term rehabilitation plan for "Deformation/damage that may affect the safety/stability/operation of the facility in the long term," which was evaluated as "B" in Table 1.1.1. Among the "B" rated damages, the smaller scale damages will be addressed by Zimbabwe through regular operation and maintenance and are excluded from the scope of this draft plan.

Table 1.1.1 Evaluation Ranks of Deteriorations/Damages Found

Rank	Evaluation Standard
A	Deteriorations and damages that are already affecting the safety/stability/operation of the facilities or are feared to affect them in near future.
B	Deteriorations and damages that are not affecting the safety/stability/operation of the facilities at present but may affect them in the long term.
C	No deteriorations and damage or no signal of them

The draft plan is designed to respond to changes in natural conditions (especially the increase in flood volume due to climate change in recent years) and social conditions (demand for expansion of irrigated area due to population growth) since the construction of the target dam, as well as to solve problems in operation and maintenance management. The draft plan also includes the results of the preliminary environmental and social impact assessment for the Plan.

CHAPTER 2 GENERAL OUTLINE OF THE TARGET DAM

Chinyamatumwa dam was constructed in 1992 as an irrigation dam. The main features of the dam are shown in Table 2.1.1, and the location is shown in Figure 2.1.1.

Table 2.1.1 Main Features of Dam

District		Bikita		Dam Type		Zone Type fill dam
Communal Land		Bikita		Crest Level (EL.m)		753.7
River		Chinyamatumwa		Non-overflow crest Level (EL.m)		753.0
Catchment Area (km^2)		16.4		Basement Level (EL.m)		732.0
Annual Yield (MCM)		1.689		Height (m)		18.8
Water Level (EL.m)	Design flood level	752.5		Crest Length (m)		580
	Full water level	751.0		Crest Width (m)		6.0
	Dead water level	741.0		Upstream slope angle	Upper portion	1:2.0
Submerged Area (km^2)		0.471			Lower portion	1:2.25
Storage Capacity (MCM)	Reservoir Yield	0.642		Downstream slope angle	Upper portion	1:1.8
	Total	2.338			Lower portion	1:2.0
	Effective	2.255		Core zone upstream slope angle		1:0.15
	Dead	0.083		Core zone downstream angle		1:0.15
Spillway	Crest Type	Non-gate crest		Embankment volume (m^3)		186,400
	Design flood discharge (m^3/s)	163	Pump	Type		double suction volute
	Specific flow ($m^3/s/km^2$)	9.94		Design discharge (litter/sec)		74
Night Storage	Capacity (m^3)	4,300		Lift (m)		28.5
	Depth (m)	2.0	Canal	Type		Steel pipe
	Scale (m)	59 × 59		Maximum discharge (litter/sec)		74
Irrigation Type		Pump		Length (m)		870
Intake	Maximum intake volume (litter/sec)	74		径 (mm)		300
Beneficial Area	Farmland Area (ha)	50.0	Benefitted households	Population (people)		1,610
	Irrigation Area (ha)	34.7		Livestock (LSU)		2,000

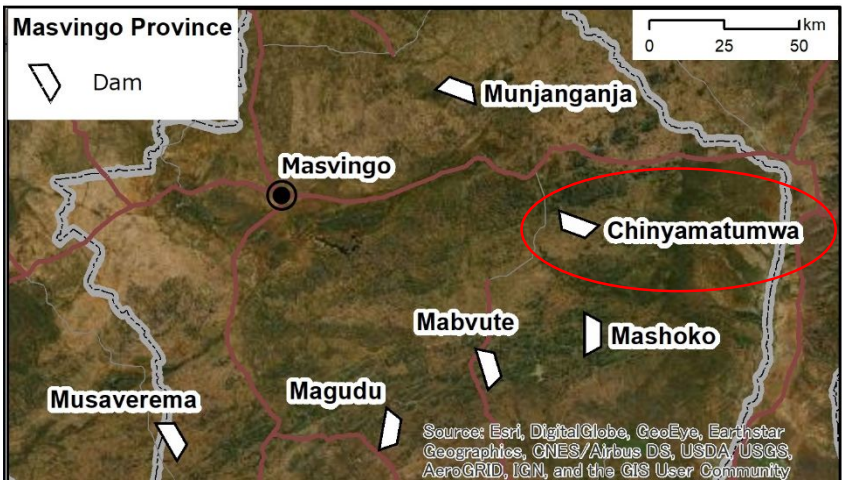


Table 2.1.1 Location of the Target Dam

CHAPTER 3 CONFIRMED DEFORMATIONS/ DAMAGES IN THE FIELD SURVEY AND REHABILITATION POLICY

3.1 SUMMARY

The locations of deteriorations/damages found of Chinyamatumwa Dam are shown in Figure 3.1.1, and the summary of the evaluation results of each deterioration/damage are shown in Table 3.1.1.

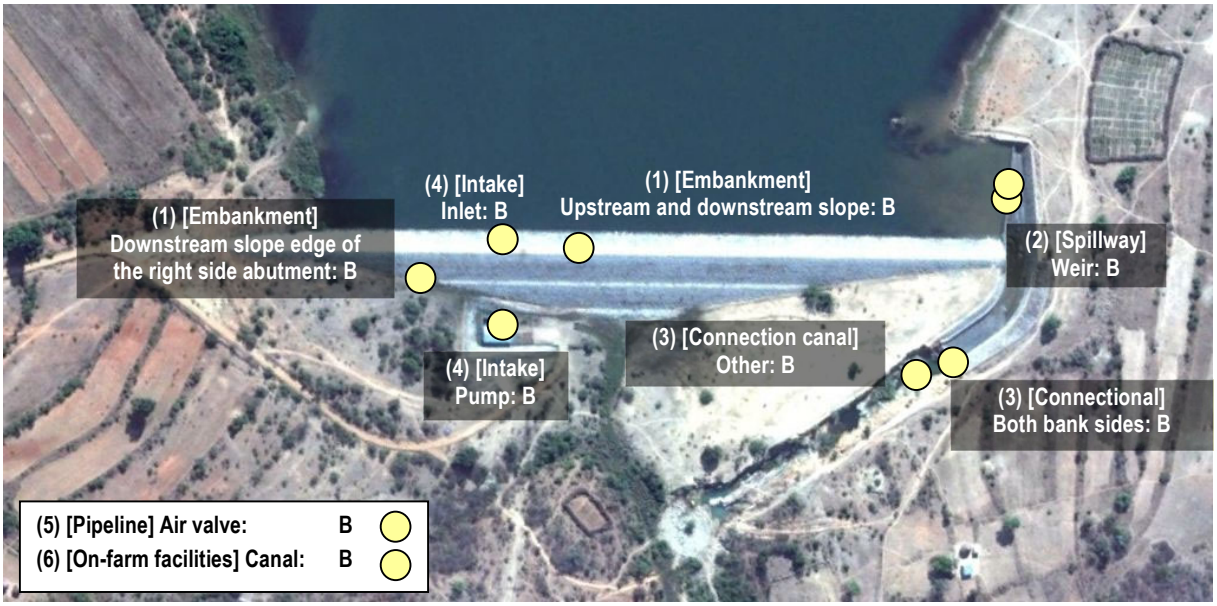


Figure 3.1.1 Locations of Deteriorations/Damages on Chinyamatumwa Dam

Table 3.1.1 Summary of the Evaluation Results of Deteriorations/Damages on Chinyamatumwa Dam

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
(1)	Embankment	Upstream and downstream slope	B	- Disturbance of riprap, gully erosion under riprap, dam body exposure, and trees
		Downstream slope edge of the right side abutment	B	- Seepage and slight flow
(2)	Spillway	Weir	B	- Slight damage on the crest
			B	- Leakage from downstream slope

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
(3)	Connection canal	Both bank sides walls	B	- Collapse of side walls at the end of the spillway channel
		Other	B	- Crossing road across canal
(4)	Intake	Inlet	B	- Disappearance of the gate operation facilities
		Pump	B	- Insufficient supply volume
(5)	Pipeline	Air valve	B	- Small amount of water leakage
(6)	On-farm facilities	Canal	B	- Spilling out of back side soil

3.2 "B" EVALUATION DEFORMATION/ DAMAGE AND REHABILITATION POLICY

3.2.1 Embankment

(1) Confirmed Deformations/ Damages

[Upstream and downstream slope] Disturbance of riprap, gully erosion under riprap, dam body exposure, and trees

[Downstream slope edge of the right side abutment] Seepage and slight flow

Figure 3.2.1 Upstream and Downstream Slope

(2) Rehabilitation Policy for Deformations/ Damages

Disturbance of riprap, dam body exposure, erosion, and around the embankment is caused by thinning of the surface riprap due to weathering and livestock invasion on the embankment slope. To repair the embankment and to prevent similar problems in the future, the surface layer (including trees) is removed, the embankment replaced with new material, and riprap is placed on both upstream and downstream sides. In addition, Geotextile is placed between the dam body and the riprap to prevent the runoff of the dam body.

Figure 3.2.2 Downstream Slope Edge of the Right Side Abutment

In addition, there were cases of erosion at the

boundary of the embankment, where surface water generated by rainfall tends to collect, at nearby dams. Since this kind of deformation may occur in all dams during long-term operation, a drainage channel at the edge of the embankment will be installed to quickly remove surface water from the surrounding area and prevent erosion.

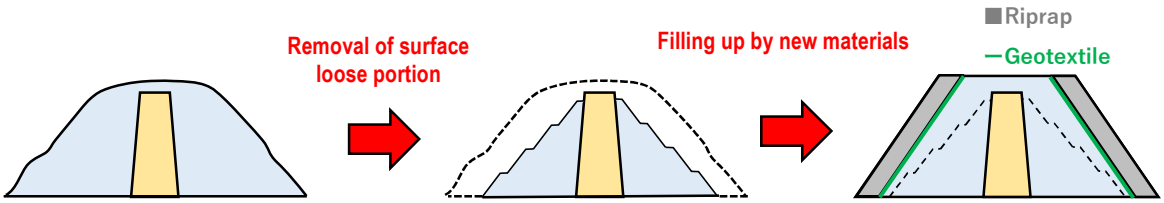


Figure 3.2.3 Model of Embankment Rehabilitation work

A typical cross-section and plan drawings of the embankment rehabilitation are shown in Figure 3.2.4 and Figure 3.2.6. The surface excavation depth is at least 1m for root removal. To increase the boundary area between the excavated surface and the new material, and to ensure accurate compaction at the boundary, the excavated surface of the existing embankment is shaped like steps (1.5 m high, slope 1:0.5), and the compaction width is to be at least 4 m for workability. In addition, the thickness of the newly installed riprap is 1 m. It should be noted that this rehabilitation causes the boundary of the embankment slope to expand in the upstream and downstream directions.

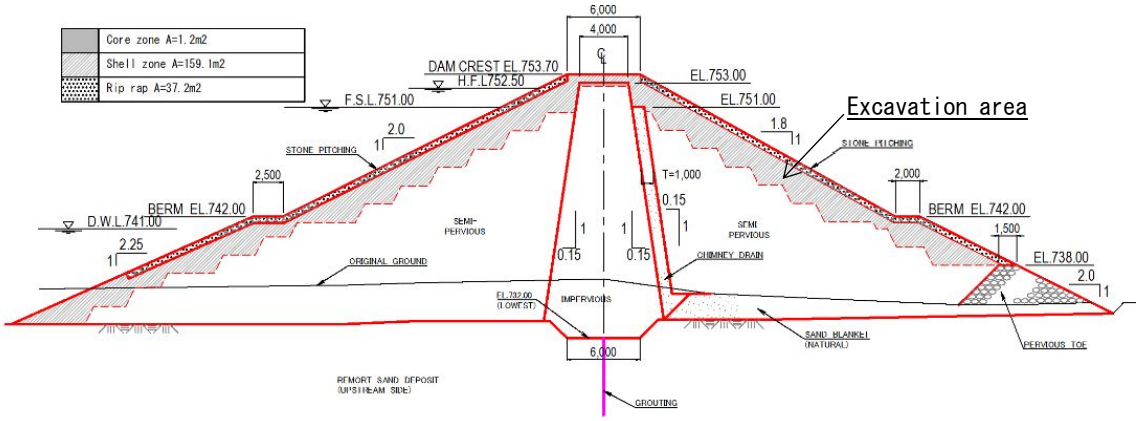


Figure 3.2.4 The Typical Cross-Section of Excavation for Rehabilitation (Chinyamatsumwa dam)

(3) Policy Against the Climate Change

Since Chinyamatumwa dam was designed around 1992, it is suspected that the flood volume at the dam site may have changed from the time of design due to recent climate change. Therefore, it should be verified if the existing facilities can safely discharge floodwaters calculated from recent rainfall. If the dam doesn't have enough capacity, countermeasures are considered.

As a result of the verification, it is judged that the overflow depth of the flood discharge needs to be increased by 30 cm to allow recent floods to flow down the dam. In this case, the separation between the flood level and the top of the dam (freeboard) and the elevation of the core, which work to shut off the water and the freeboard, will be insufficient, thus it is decided to raise the embankment by 30 cm in conjunction with the above-mentioned repair of the embankment surface to secure the freeboard and core elevation.

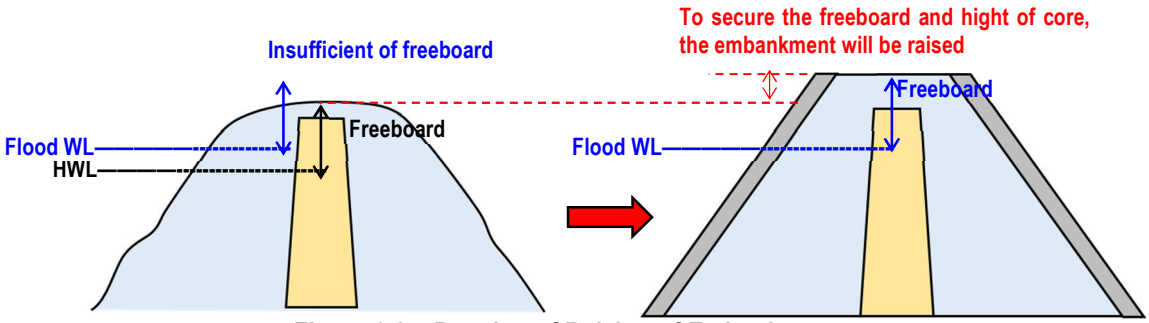


Figure 3.2.5 Drawing of Raising of Embankment

Figure 3.2.6 shows the typical cross-section and plan of the embankment rehabilitation.

On the other hand, due to the increased flood volume, it might be necessary to raise the sidewalls of spillway channels and connection canals. As for the spillway channels, the risk of overflow is low due to the large difference in elevation between the bottom and the top of the canal. Also, because spillway channels have retaining walls (wet masonry), the possibility of it affecting the embankment is considered to be small even if the water level rises.

As for the connection canal, the risk of overflow is low due to the wide width of the canal bed, and there are no houses or other facilities to be protected in the surrounding area. Therefore, the priority of measures such as the construction of protection walls is considered to be low at present.

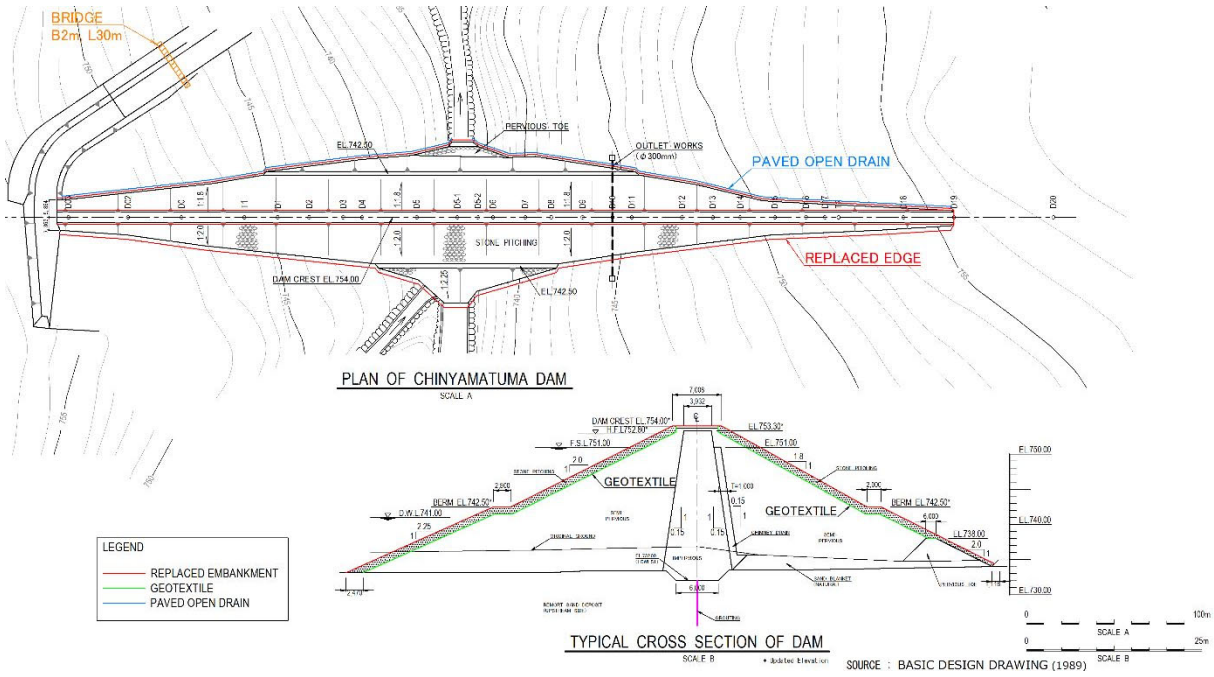


Figure 3.2.6 The Typical Cross-Section and Plan of the Embankment (Chinyamatumwa Dam)

(4) Policy to Increase the Irrigable Area

An essential condition for the implementation of embankment raising to expand the irrigated area through the increase of water storage capacity is the condition of the topography around the embankment and reservoir. Since embankment height-raising requires a large amount of cost, it is desirable to be able to raise the embankment as high as possible to increase its effectiveness. Therefore, in this feasibility

study, the condition for raising the embankment is that the elevation around the embankment and reservoir must be at least 1 m higher than the crest of the existing embankment.

As a result of confirming the topography around the embankment and examining the possibility of raising the embankment, it was judged that raising the embankment more than 1m was impossible.

3.2.2 Spillway

(1) Confirmed Deformations/ Damages

[Weir] Slight damage on the crest

[Weir] Leakage from downstream slope

Figure 3.2.7 Slight Damage on the Crest

Figure 3.2.8 Leakage from Downstream Slope

(2) Rehabilitation Policy for Deformations/ Damages

Since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

3.2.3 Connection Canal

(1) Confirmed Deformations/ Damages and Operation & Maintenance Issues

[Both banks] Collapse of side walls at the end of the spillway channel

[Other] Crossing Road across canal

Figure 3.2.9 Crossing Road

Figure 3.2 Collapse of Side Walls on Both Bank Sides at the End of the Spillway Channel

(2) Rehabilitation Policy for Deformations/ Damages And Operation & Maintenance Issues

Significant erosion and collapse of the side walls will be prevented by installing revetments made of wet masonry.

For use as a crossing in the channel, a bridge for crossing should be installed at an appropriate location between the spillway channel and the connection channel.

Figure 3.2.11 Model of Construction of the Protection Wall

Figure 3.2.12 Model of Installing of New Bridge

Figure 3.2.13 shows the typical cross-section and plan view of the connection canal with protection walls.

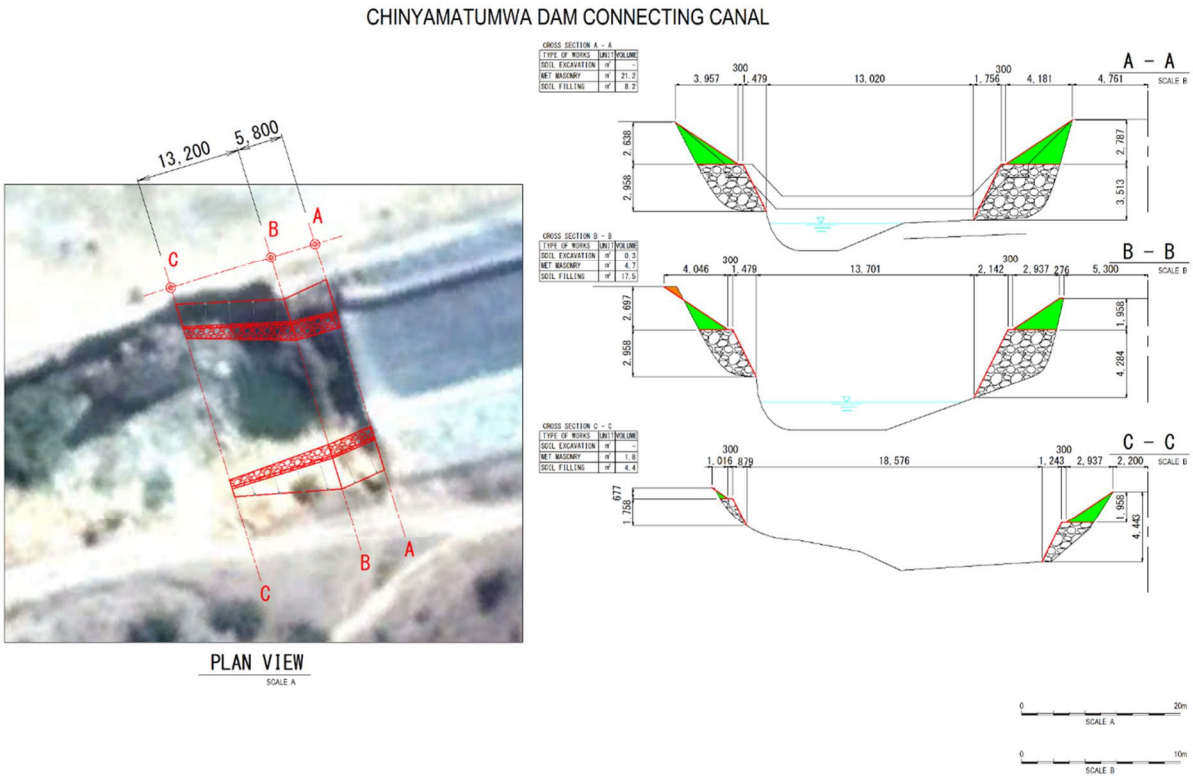


Figure 3.2.13 The Typical Cross-Section and Plan View of the Connection Canal with Protection Walls

3.2.4 Intake

(1) Confirmed Deformations/ Damages

[Inlet] Disappearance of the gate operation facilities

[Pump] Insufficient supply volume

Figure 3.2.14 Disappearance of the Intake Gate Operation Facilities

Figure 3.2.15 Sisutaiton of Pumps

(2) Rehabilitation Policy for Deformations/ Damages

To restore the gate operation function and to prevent a similar problem in the future, an operation house is built at the crest and a new winch is installed in it. In addition, the steel wires leading to the intake gate are arranged in the protection pipe set under the riprap at the upstream side to prevent theft and

deterioration.

The insufficient pump capacity was supposed to be caused by the transformer being located about 500m away from the pumping facility and not being able to supply the required amount of current due to transmission losses. Therefore, relocation of the transformer is planned.

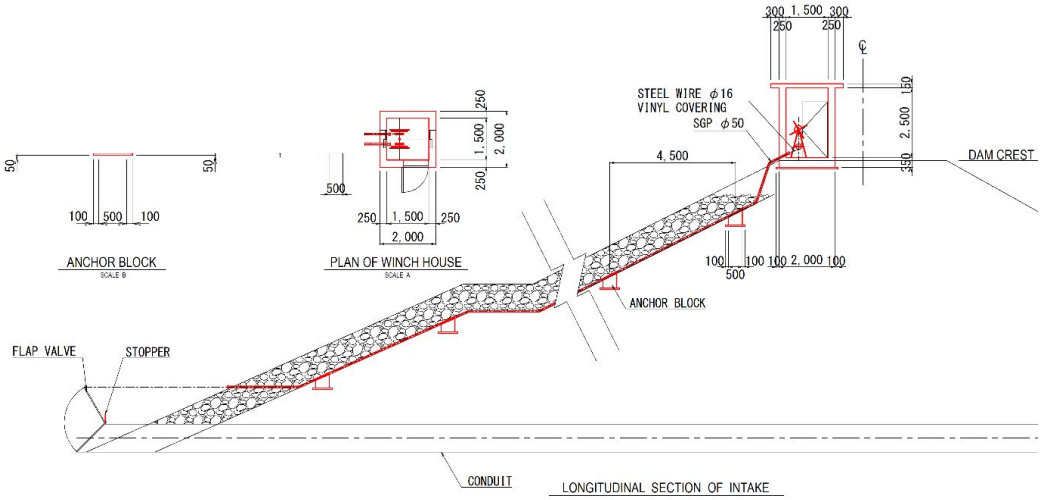


Figure 3.2.16 Layout of the Intake Improvement Plan

3.2.5 Pipeline

(1) Confirmed Deformations/ Damages

[Air valve] Small amount of water leakage

Figure 3.2.17 Mark of Water Leakage from Air Valve

(2) Rehabilitation Policy for Deformations/ Damages

Since the scale of the damage of the air valves is small, the Zimbabwean side will deal with the damage through regular maintenance.

3.2.6 On-Farm Facilities

(1) Confirmed Deformations/ Damages

[Canal] Spilling out of backside soil

Figure 3.2.18 Spilling Out of Canal Back Side Soil

(2) Rehabilitation Policy for Deformations/ Damages

Since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATION

4.1 PROJECT COMPONENT

Chinyamatumwa dam was constructed in 1992 as an irrigation dam. Therefore, the project component is limited to the rehabilitation of existing agricultural dams. Table 4.1.1 summarizes the project component.

Table 4.1.1 Outline of the Expected Project Component

Rehabilitation Dam	Contents of Works
Chinyamatumwa Dam	● Rehabilitation of the surface of dam embankments ● Rehabilitation of spillway channel and connection canals (including protection wall installation for canals, installation of access bridge, etc.) ● Rehabilitation of intake facilities (including gate operation facility replacement, etc.)

4.2 PROJECT LOCATION

Chinyamatumwa dam and its beneficiary area are in Masvingo Province. The land category of the site is Communal Land.

Table 4.2.1 Location of the Project Areas

Rehabilitation Dams	Beneficial Area		Location of the Dams and Beneficial Areas			
	Beneficiaries	Land Size (ha)	Province	District	Land Category	Communal Land Name
Magudu	2,800	70	Masvingo	Masvingo	Communal Lands	Nuajena
Musaverema	2,590	44		Mwenezi		Matibi No.1
Chinyamatumwa	1,610	50		Bikita		Bikita
Mashoko	570	21		Bikita		Matsai
Mabvute	3,930	100		Zaka		Ndanga
Munjanganja	1,710	51		Gutu		Mutra

4.3 ENVIRONMENTAL AND SOCIAL CONDITIONS IN THE PROJECT AREA

(1) Natural Environment

- Meteorology and Hydrology

The annual rainfall is around 800 mm and most of the rainfall is concentrated in the summer season from November to March. The project areas are located in Zone IV (Semi-Extensive Farming Region, with annual rainfall: 450 – 650mm) and/or Zone V (Extensive Farming Region, with annual rainfall: less than 450mm) classified by the agro-ecological zones. Therefore, the necessity for irrigation is high in the project areas.

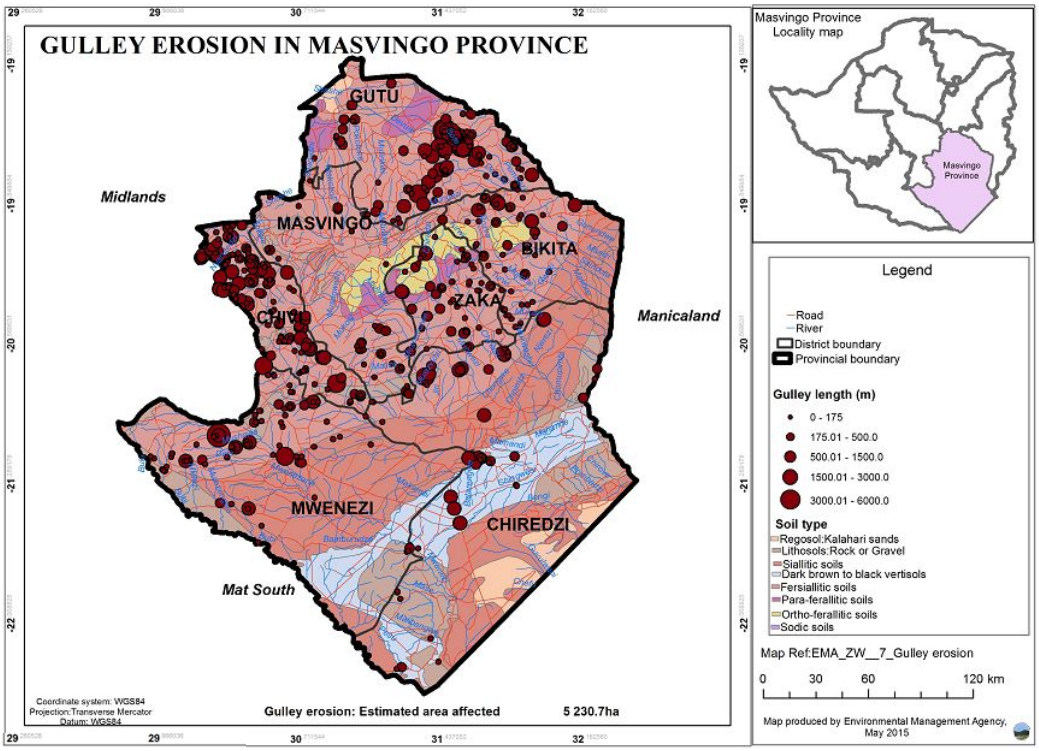
The river that flows into the target dam is seasonal rivers. The target dam stores river water during the rainy season and discharges for irrigation during the dry season.

- Eco-system and Habitats

The project area of the target dam (including catchment area and downstream area) and its beneficiary areas are not located in the important ecological habitats such as national parks, Ramsar wetlands, and IBAs. Since the main contents of the dam improvement plan are restoring of original functions of dams through rehabilitation, the way of dam operation is not changed from an existing one. Therefore, it is assumed there will be no significant changes from the existing ecological condition of the surrounding area of existing dams.

- Erosion and Forestry

Soil deterioration due to gully erosion in farmland and forest lands is a common problem in and around the project area. The Gully erosion distribution map in Masvingo Province is shown in Figure 4.3.1. The gully erosion leads to sedimentation on dam reservoirs. As the countermeasures for the protection from gully erosion, efforts have been made to construct drainage canals in the farmland, to place trees on the counter line, to preserve the forest, and to control illegal tree cutting, generally.

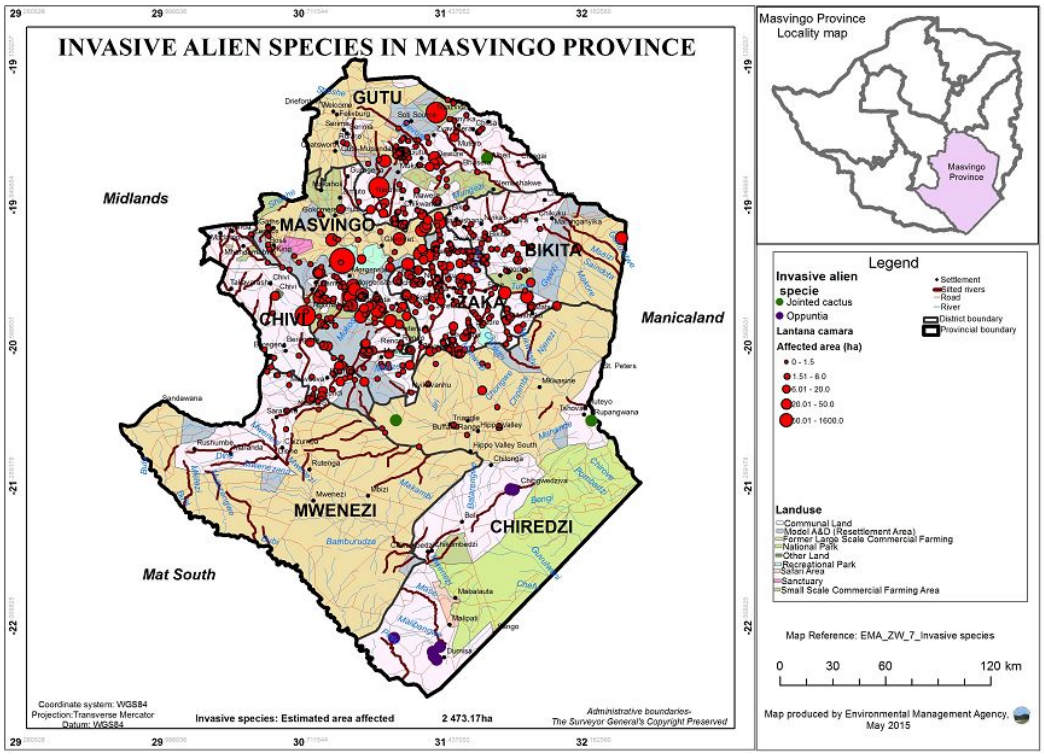


(Source: EMA)

Figure 4.3.1 Gully Erosion Distribution Map in Masvingo Province

- Vegetation

Growing of Lantana Camara, which is one of the invasive species, is a common problem of farmland in the project area. The distribution map of Lantana Camara in Masvingo Province is shown in Figure 4.3.2. On the other hand, the growing of Water Hyacinth in dam reservoirs is one of the problems causing deterioration of water quality due to obstruction of water flow and reduction of dissolved oxygen.



(Source: EMA)

Figure 4.3.2 Lantana Camara Distribution Map in Masvingo Province

(2) Social Environment

- People

The ethnic group living in the project area is the Shona people. Although the official language is English, the Shona language is also used as a local language popularly. There are no tribal conflicts in the project area.

- Livelihood

According to the statistical data of Zimbabwe[1], the average household size living in the Communal Lands is 5 persons/households while the proportion of woman-headed households is around 36%. 98% of people living in Communal Lands are engaged in agriculture and their livelihoods are heavily dependent on it. In general, most of the farmers in Communal Lands are smallholders and the average farmland size is about 1.4 ha/households.

- Decision-Making System by Traditional Custom

The traditional leadership locality called Traditional Leaders (composed of local chiefs, headmen, and village leaders) is functioned and legally recognized in Communal Lands. Traditional Leaders substantially make a role in managing land use and dispute resolution of the community.

4.4 SCOPING

Scoping is carried out as the preliminary environmental and social impact assessment. As the results, most of the major negative impacts on environmental and social aspects are anticipated during construction works, such as water pollution, wastes, and so on. It is necessary to develop an EMP

[1] ZIMSTAT, Zimbabwe Smallholder Agricultural Productivity Survey 2017 Report, March 2019

(Environmental Management Plan) of the project and implement appropriate mitigation measures and monitoring by construction contractor and implementation organization (DOI or ZINWA).

4.5 EVALUATION OF THE ENVIRONMENTAL CATEGORY (PROPOSED)

The scope of the project is limited to rehabilitation works of the existing agricultural dam and the current dam operation will be not changed after the rehabilitation works. Significant negative impacts on the surrounding natural environment and social environment by the project implementation are not anticipated. The project sites are not located in sensitive areas such as national protected areas and other important biodiversity areas. And the large-scale involuntary resettlement and/or land acquisition are not anticipated. For these reasons, it is assumed that the project will fall under Category B in the category classification of JICA environmental and social consideration guidelines.

CHAPTER 5 REHABILITATION COST

It is assumed that this rehabilitation project will be implemented by the Zimbabwean government budget or by the Japanese Grant Aid Project. The estimated project cost in each case is shown as below.

Implementation by the Zimbabwean Government:	4.39 million USD
Implementation by the Japanese Grant Aid Project:	7.61 million USD

CHAPTER 6 REQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

(1) Confirmation of the Implementing Agency of the Project

Determine implementing agencies from ZINWA or DOI.

(2) Natural Conditions Survey

1) Topographical survey

Plan survey, land survey, including the area around the reservoir, and longitudinal & cross-section survey of the embankment.

2) Soil investigation (Existing embankment)

Density, specific gravity, water absorption, water content ratio, grain size, compaction - permeability, liquid plasticity, consolidation, triaxial compression, etc.

3) Soil investigation (Borrow area)

Same test contents as the above soil investigation (Existing embankment)

4) Boring test (Pier foundation)

Standard penetration test (SPT)

(3) Planning of Project Content

1) Outline design

2) Construction/Procurement plan

*When upgrading a reservoir, there are two possible methods: (1) emptying the reservoir and (2) operating the reservoir (with water in the reservoir). Depending on which method is chosen, the scale of temporary facilities required will differ greatly, which will also affect the project cost. Therefore, the construction plan for the upgrading work should be developed with this in mind.

In addition, it is necessary to set the method of implementation after sufficient consultation and agreement with the Zimbabwean side and beneficiary farmers. In particular, it is necessary to inform and agree with the beneficiary farmers in Zimbabwe that if the project is to be implemented with emptying the reservoir, irrigated agriculture will not be possible for the relevant year (and possibly for several years thereafter) and that the beneficiary farmers will need to be guaranteed by the Zimbabwean government.

3) Plan of maintenance & operation

(4) Environmental and Social Considerations (Including Social Condition Survey)

1) Social survey of the target area, study of environmental and social impacts and countermeasures

2) Application and approval of environmental procedures to the EMA (Environmental Management Agency) (submission of Prospectus and support for the preparation of environmental management plans, etc.)

(5) Estimating the Project Cost

CHAPTER 7 BENEFITS OF THE PROJECT

By implementing the project, deformations and damages occurring in each facility will be repaired to extend the service life of the facilities, which will avoid damage to the facilities due to aging and the resulting loss of human lives and assets, as well as ensure the continuation of irrigated agriculture in 34.7 ha by avoiding the suspension of irrigation water supply.

Appendix-3-4

Dam Improvement Work Plan
(Mashoko Dam)

CHAPTER 1 STATUS OF THE WORK PLAN

The identification of deteriorations/damages (and those sign) on the target six dams in Masvingo Province is carried out and examination on the found deteriorations/damage if they already affect the safety/stability/operation of the facilities is conducted. Also, examination on the found deteriorations/damages if they expand and affect the safety/stability/operation of the facilities in the future is carried out as well.

The deteriorations/damages found are evaluated and categorized into three ranks as shown in Table 1.1.1. This work plan is a medium/ long-term rehabilitation plan for "Deformation/damage that may affect the safety/stability/operation of the facility in the long term," which was evaluated as "B" in Table 1.1.1. Among the "B" rated damages, the smaller scale damages will be addressed by Zimbabwe through regular operation and maintenance and are excluded from the scope of this draft plan.

Table 1.1.1 Evaluation Ranks of Deteriorations/Damages Found

Rank	Evaluation Standard
A	Deteriorations and damages that are already affecting the safety/stability/operation of the facilities or are feared to affect them in near future.
B	Deteriorations and damages that are not affecting the safety/stability/operation of the facilities at present but may affect them in the long term.
C	No deteriorations and damage or no signal of them

The draft plan is designed to respond to changes in natural conditions (especially the increase in flood volume due to climate change in recent years) and social conditions (demand for expansion of irrigated area due to population growth) since the construction of the target dam, as well as to solve problems in operation and maintenance management. The draft plan also includes the results of the preliminary environmental and social impact assessment for the Plan.

CHAPTER 2 GENERAL OUTLINE OF THE TARGET DAM

Mashoko dam was constructed in 1993 as an irrigation dam. The main features of the dam are shown in Table 2.1.1, and the location is shown in Figure 2.1.1.

Table 2.1.1 Main Features of Dam

District		Bikita		Dam Type		Zone Type fill dam
Communal Land		Matsai		Crest Level (EL.m)		666.7
River		Chenyere		Non-overflow crest Level (EL.m)		666.0
Catchment Area (km^2)		27.2		Basement Level (EL.m)		646.0
Annual Yield (MCM)		1.306		Height (m)		18.4
Water Level (EL.m)	Design flood level	665.5		Crest Length (m)		700
	Full water level	664.0		Crest Width (m)		6.0
	Dead water level	655.5	Specification	Upstream slope angle	Upper portion	1:2.0
Submerged Area (km^2)		0.356			Lower portion	1:2.25
Storage Capacity (MCM)	Reservoir Yield	0.313		Downstream slope angle	Upper portion	1:1.8
	Total	1.546			Lower portion	1:2.0
	Effective	1.453		Core zone upstream slope angle		1:0.5
	Dead	0.093		Core zone downstream angle		1:0.15
Spillway	Crest Type	Non-gate crest		Embankment volume (m^3)		220,900
	Design flood discharge (m^3/s)	228	Pump	Type		-
	Specific flow ($m^3/s/km^2$)	8.38		Design discharge (litter/sec)		-
Night Storage	Capacity (m^3)	1,400		Lift (m)		-
	Depth (m)	2.0	Canal	Type		Concrete flume
	Scale (m)	44 × 44		Maximum discharge (litter/sec)		23
Irrigation Type		Gravity		Length (m)		800
Intake	Maximum intake volume (litter/sec)	23		Diameter (mm)		-
Beneficial Area	Farmland Area (ha)	21.0	Benefitted households	Population (people)		570
	Irrigation Area (ha)	15.2		Livestock (LSU)		790

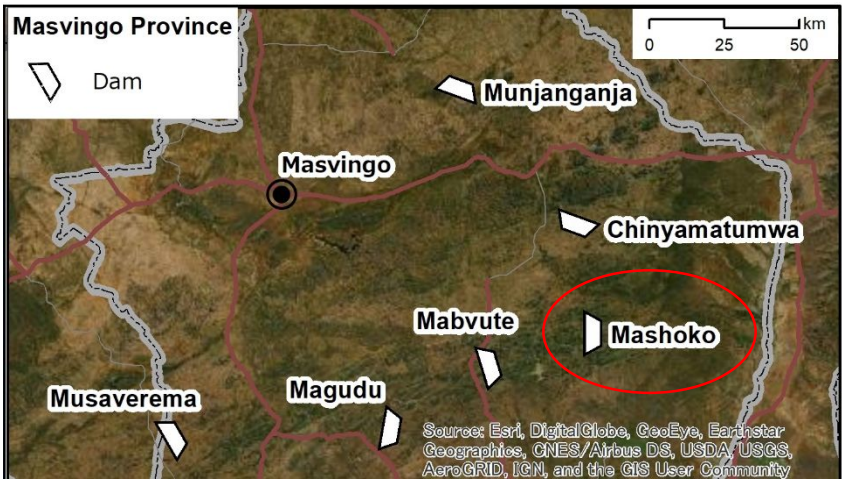


Table 2.1.1 Location of the Target Dam

CHAPTER 3 CONFIRMED DEFORMATIONS/ DAMAGES IN THE FIELD SURVEY AND REHABILITATION POLICY

3.1 SUMMARY

The locations of deteriorations/damages found of Mashoko Dam are shown in Figure 3.1.1, and the summary of the evaluation results of each deterioration/damage are shown in Table 3.1.1.

Figure 3.1.1 Locations of Deteriorations/Damages on Mashoko Dam

Table 3.1.1 Summary of the Evaluation Results of Deteriorations/Damages on Mashoko Dam

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
(1)	Embankment	Upstream and downstream slope	B	- Partial disturbance of riprap and dam body exposure
		Crest, upstream slope and downstream slope	B	- Many trees
(2)	Spillway channel	Other	B	- Crossing road across the canal (basket mat)
(3)	Intake	Inlet	B	- Missing of the wires - Rusting all over

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
(4)	On-farm facilities	Canal	B	- Spilling out of back side soil
		Diversion	B	- Broken of sluice gate

3.2 "B" EVALUATION DEFORMATION/ DAMAGE AND REHABILITATION POLICY

3.2.1 Embankment

(1) Confirmed Deformations/ Damages

[Upstream and downstream slope] Partial disturbance of riprap and dam body exposure

[Crest, and upstream and downstream slope] Many trees

Figure 3.2.1 Partial Disturbance of Riprap, Dam Body Exposure, and Many Trees

(2) Rehabilitation Policy for Deformations/ Damages

Disturbance of riprap, dam body exposure, erosion, and trees around the embankment is caused by thinning of the surface riprap due to weathering and livestock invasion on the embankment slope. To repair the embankment and to prevent similar problems in the future, the surface layer (including trees) is removed, the embankment replaced with new material, and riprap is placed on both upstream and downstream sides. In addition, Geotextile is placed between the dam body and the riprap to prevent the runoff of the dam body.

In addition, there were cases of erosion at the boundary of the embankment, where surface water generated by rainfall tends to collect, at nearby dams. Since this kind of deformation may occur in all dams during long-term operation, a drainage channel at the edge of the embankment will be installed to quickly remove surface water from the surrounding area and prevent erosion.

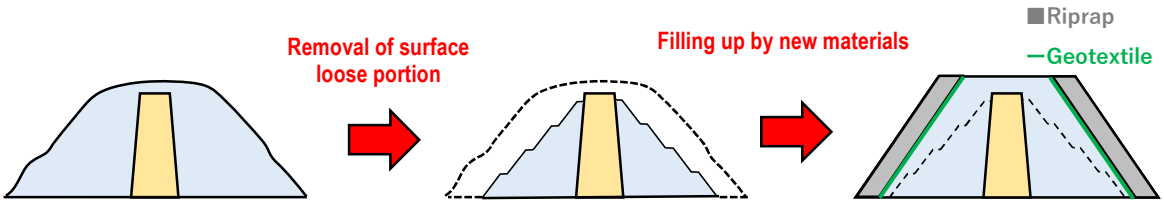


Figure 3.2.2 Model of Embankment Rehabilitation Work

A typical cross-section and plan drawings of the embankment rehabilitation are shown in Figure 3.2.4 and Figure 3.2.6. The surface excavation depth is at least 1m for root removal. To increase the boundary area between the excavated surface and the new material, and to ensure accurate compaction at the boundary, the excavated surface of the existing embankment is shaped like steps (1.5 m high, slope 1:0.5), and the compaction width is to be at least 4 m for workability. In addition, the thickness of the newly installed riprap is 1 m. It should be noted that this rehabilitation causes the boundary of the embankment slope to expand in the upstream and downstream directions.

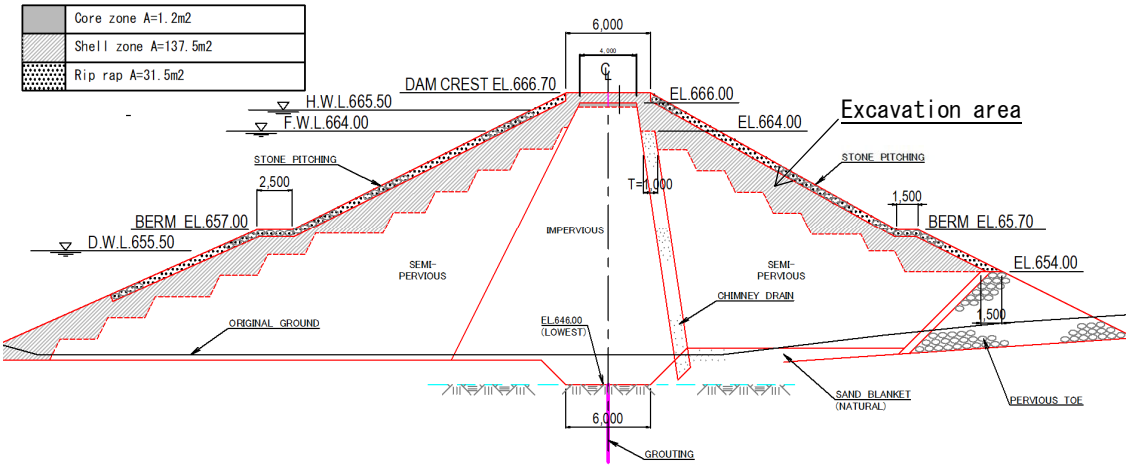


Figure 3.2.3 The Typical Cross-Section of Excavation for Rehabilitation (Mashoko dam)

(3) Policy Against the Climate Change

Since Mashoko dam was designed around 1992, it is suspected that the flood volume at the dam site may have changed from the time of design due to recent climate change. Therefore, it should be verified if the existing facilities can safely discharge floodwaters calculated from recent rainfall. If the dam doesn't have enough capacity, countermeasures are considered.

As a result of the verification, it is judged that the overflow depth of the flood discharge needs to be increased by 10 cm to allow recent floods to flow down the dam. In this case, the separation between the flood level and the top of the dam (freeboard) and the elevation of the core, which work to shut off the water and the freeboard, will be insufficient, thus it is decided to raise the embankment by 10 cm in conjunction with the above-mentioned repair of the embankment surface to secure the freeboard and core elevation.

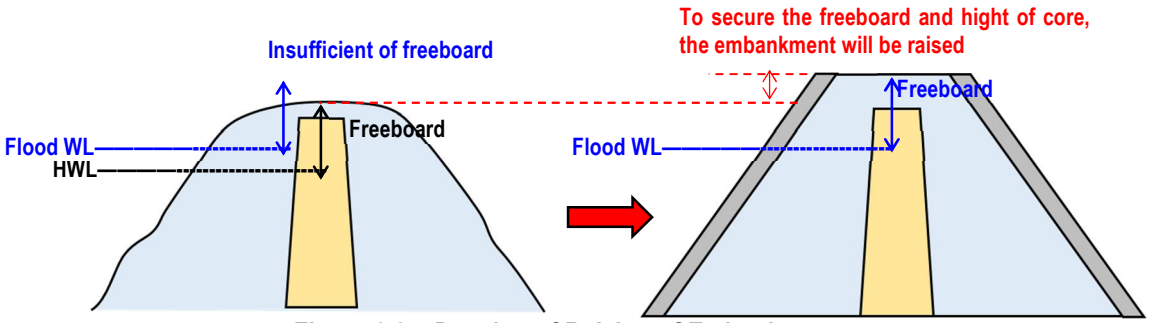


Figure 3.2.4 Drawing of Raising of Embankment

Figure 3.2.6 shows the typical cross-section and plan of the embankment rehabilitation.

On the other hand, due to the increased flood volume, it might be necessary to raise the sidewalls of spillway channels and connection canals. As for the spillway channels, the risk of overflow is low due to the large difference in elevation between the bottom and the top of the canal. Also, because spillway channels have retaining walls (wet masonry), the possibility of it affecting the embankment is considered to be small even if the water level rises.

As for the connection canal, the risk of overflow is low due to the wide width of the canal bed, and there are no houses or other facilities to be protected in the surrounding area. Therefore, the priority of measures such as the construction of protection walls is considered to be low at present.

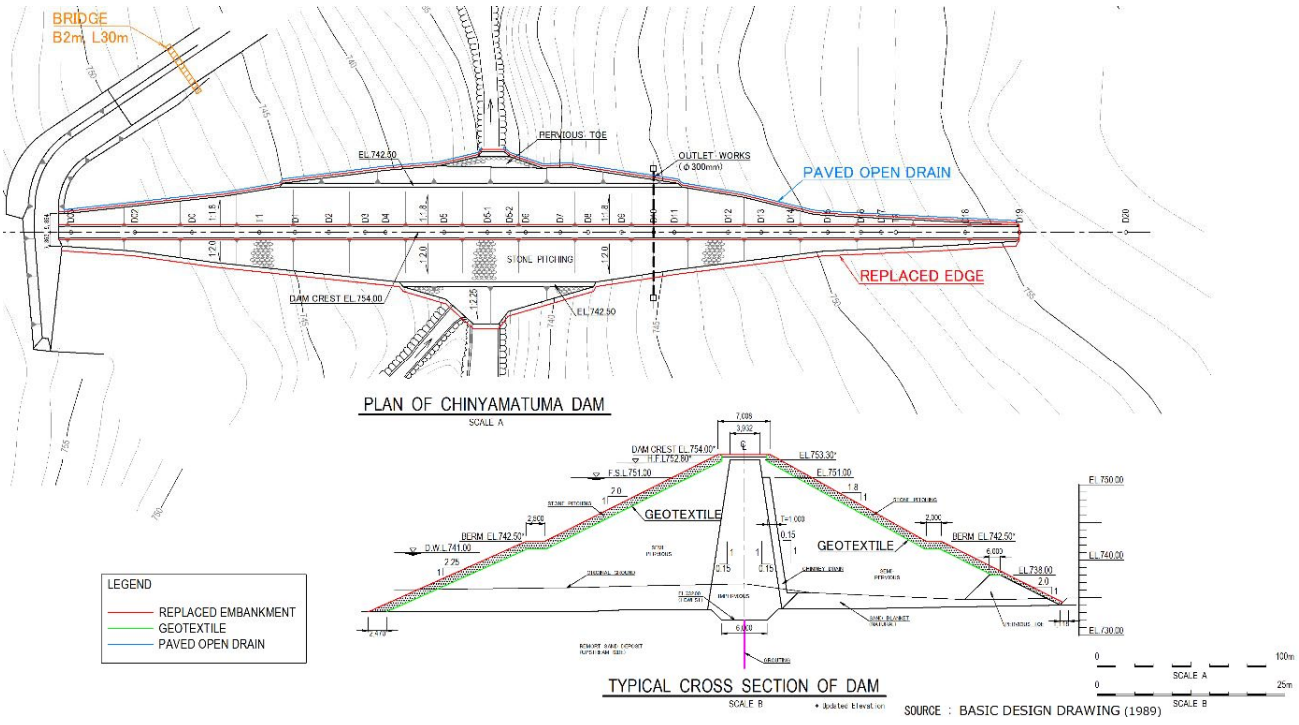


Figure 3.2.5 The Typical Cross-Section and Plan of the Embankment (Mashoko Dam)

(4) Policy to Increase the Irrigable Area

An essential condition for the implementation of embankment raising to expand the irrigated area through the increase of water storage capacity is the condition of the topography around the embankment and reservoir. Since embankment height-raising requires a large amount of cost, it is desirable to be able to raise the embankment as high as possible to increase its effectiveness. Therefore, in this feasibility study, the condition for raising the embankment is that the elevation around the embankment and reservoir must be at least 1 m higher than the crest of the existing embankment.

As a result of confirming the topography around the embankment and examining the possibility of raising the embankment, it is judged that raising the embankment to increase the water storage capacity is possible, because there is at least a 2 m difference in elevation between the topography of the ground and the top elevation of the embankment. Figure 3.2.6 shows the typical cross-section and plan of the embankment when it is raised by 2m. However, a more detailed study should be conducted before the embankment is raised because of the following concerns.

i) It is necessary to determine whether it is possible to secure enough inflow every year to fulfil the increased storage capacity through a multi-year reservoir water balance analysis, which is an analysis based on inflow data calculated from rainfall, and data on water intake and demand in the beneficiary area.

ii) The increase of water storage capacity leads not only increase the irrigated area in the beneficiary area, but also submarginal of some farmlands around the reservoir. Therefore, it is necessary to examine the submerged area and consider the compensation for these submerged areas.

iii) The capacity of facilities for water conveyance and night storage may also need to be revised due to the increase of required water volume caused by the expansion of the irrigated area.

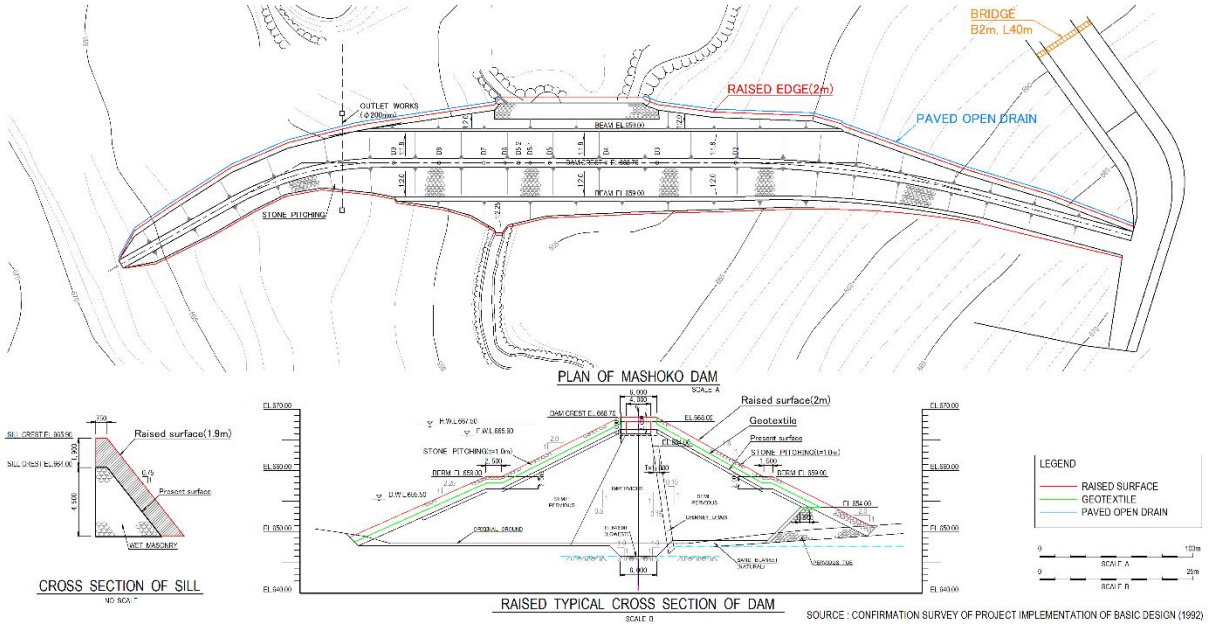


Figure 3.2.6 The Typical Cross-Section and Plan of the Raised Dam (Example of a 2m raise)

3.2.2 Spillway

(1) Confirmed Operation & Maintenance Issues

[Other] Crossing Road across the channel

(2) Rehabilitation Policy for Operation & Maintenance Issues

For use as a crossing in the channel, a bridge for crossing should be installed at an appropriate location between the spillway channel and the connection channel

Figure 3.2.7 Crossing Road across the Channel

Figure 3.2.8 New bridge on the connection canal

3.2.3 Intake

(1) Confirmed Deformations/ Damages

[Inlet] Missing of the wire

[Inlet] Rusting all over

(2) Rehabilitation Policy for Deformations/ Damages

Figure 3.2.9 Winch for Intake Gate Operation

To restore the gate operation function and to prevent a similar problem in the future, an operation house is built at the crest and a new winch is installed in it. In addition, the steel wires leading to the intake gate are arranged in the protection pipe set under the riprap at the upstream side to prevent theft and deterioration.

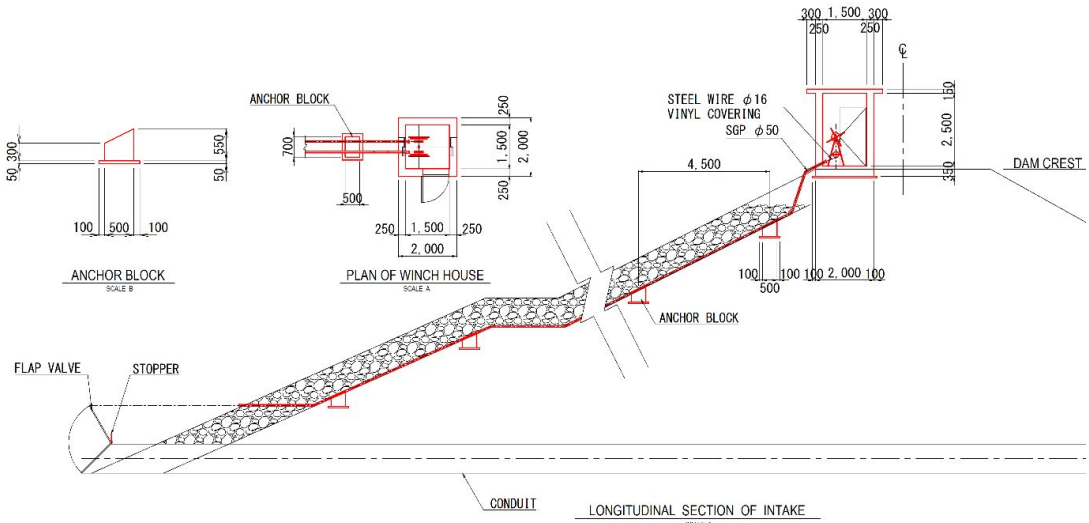


Figure 3.2.10 Layout of the Intake Improvement Plan

3.2.4 On-Farm Facilities

(1) Confirmed Deformations/ Damages

[Canal] Spilling out of backside soil

[Diversion] Broken of sluice gate

Figure 3.2.11 Spilling Out of Back Side Soil

Figure 3.2.12 Broken of Sluice Gate

(2) Rehabilitation Policy for Deformations/ Damages

Since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATION

4.1 PROJECT COMPONENT

Mashoko dam was constructed in 1993 as an irrigation dam. Therefore, the project component is limited to the rehabilitation of existing agricultural dams. Table 4.1.1 summarizes the project component.

Table 4.1.1 Outline of the Expected Project Component

Rehabilitation Dam	Contents of Works
Mashoko Dam	● Rehabilitation of the surface of dam embankments ● Rehabilitation of spillway channel and connection canals (including protection wall installation for canals, installation of access bridge, etc.) ● Rehabilitation of intake facilities (including gate operation facility replacement, etc.)

4.2 PROJECT LOCATION

Mashoko dam and its beneficiary area are in Masvingo Province. The land category of the site is Communal Land.

Table 4.2.1 Location of the Project Areas

Rehabilitation Dams	Beneficial Area		Location of the Dams and Beneficial Areas			
	Beneficiaries	Land Size (ha)	Province	District	Land Category	Communal Land Name
Magudu	2,800	70	Masvingo	Masvingo	Communal Lands	Nuajena
Musaverema	2,590	44		Mwenezi		Matibi No.1
Chinyamatumwa	1,610	50		Bikita		Bikita
Mashoko	570	21		Bikita		Matsai
Mabvute	3,930	100		Zaka		Ndanga
Munjanganja	1,710	51		Gutu		Mutra

4.3 ENVIRONMENTAL AND SOCIAL CONDITIONS IN THE PROJECT AREA

(1) Natural Environmental

- Meteorology and Hydrology

The annual rainfall is around 800 mm and most of the rainfall is concentrated in the summer season from November to March. The project areas are located in Zone IV (Semi-Extensive Farming Region, with annual rainfall: 450 – 650mm) and/or Zone V (Extensive Farming Region, with annual rainfall: less than 450mm) classified by the agro-ecological zones. Therefore, the necessity for irrigation is high in the project areas.

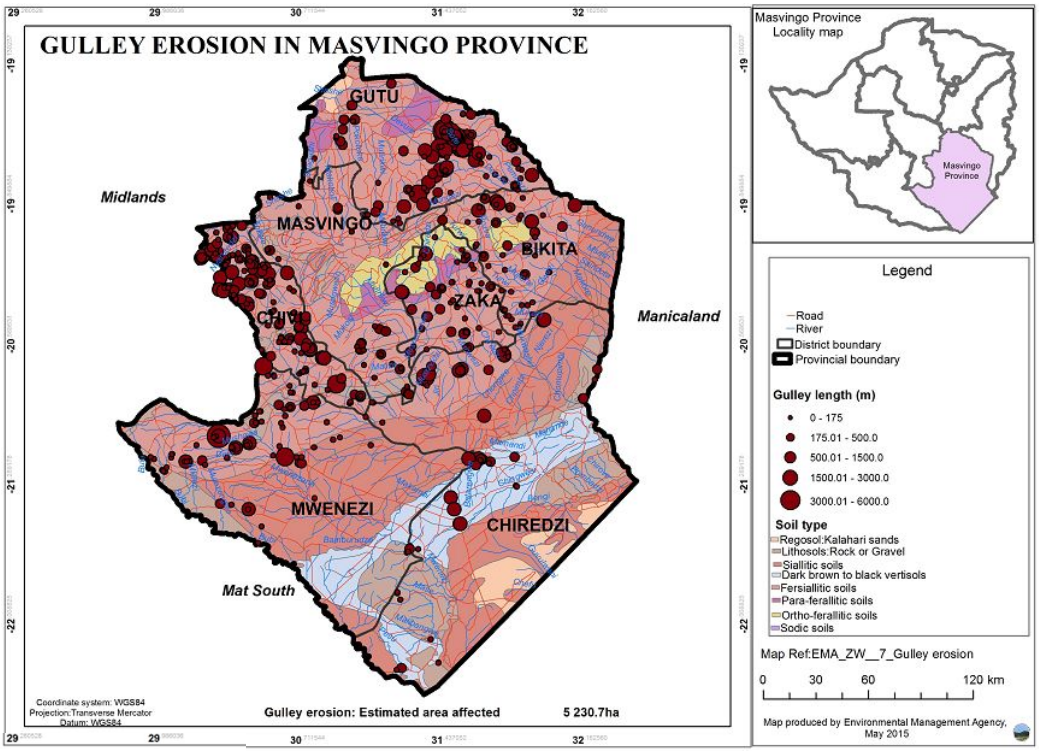
The river that flows into the target dam is seasonal rivers. The target dam stores river water during the rainy season and discharges for irrigation during the dry season.

- Eco-system and Habitats

The project area of the target dam (including catchment area and downstream area) and its beneficiary areas are not located in the important ecological habitats such as national parks, Ramsar wetlands, and IBAs. Since the main contents of the dam improvement plan are restoring of original functions of dams through rehabilitation, the way of dam operation is not changed from an existing one. Therefore, it is assumed there will be no significant changes from the existing ecological condition of the surrounding area of existing dams.

- Erosion and Forestry

Soil deterioration due to gully erosion in farmland and forest lands is a common problem in and around the project area. The Gully erosion distribution map in Masvingo Province is shown in Figure 4.3.1. The gully erosion leads to sedimentation on dam reservoirs. As the countermeasures for the protection from gully erosion, efforts have been made to construct drainage canals in the farmland, to place trees on the counter line, to preserve the forest, and to control illegal tree cutting, generally.

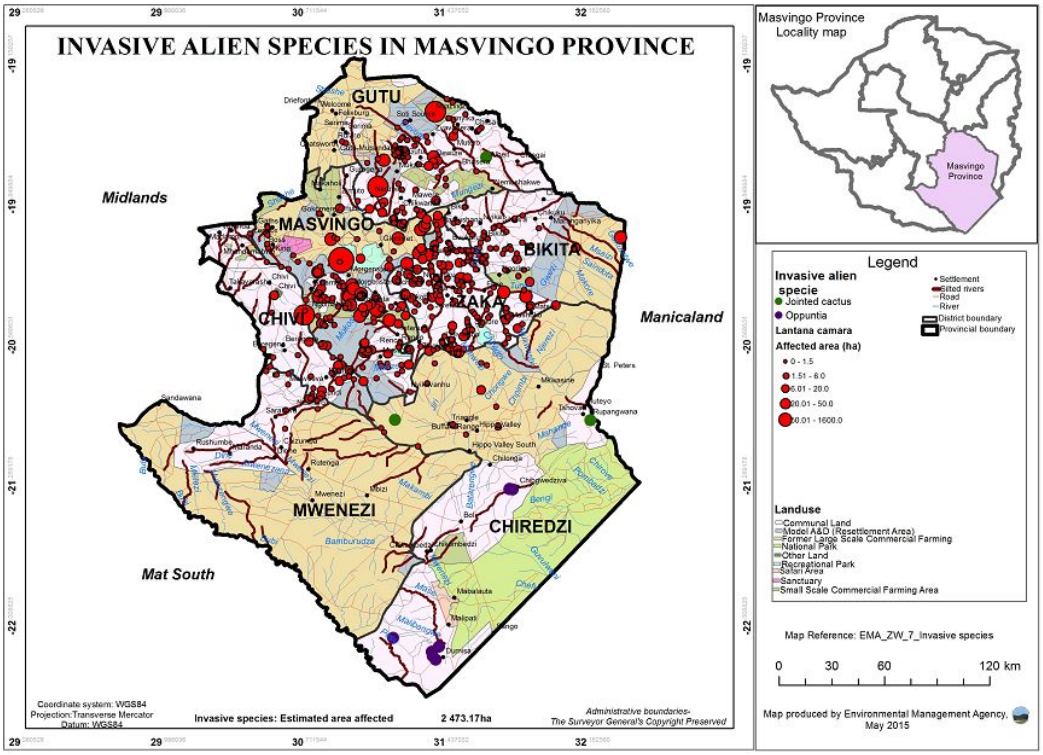


(Source: EMA)

Figure 4.3.1 Gully Erosion Distribution Map in Masvingo Province

- Vegetation

Growing of Lantana Camara, which is one of the invasive species, is a common problem of farmland in the project area. The distribution map of Lantana Camara in Masvingo Province is shown in Figure 4.3.2. On the other hand, the growing of Water Hyacinth in dam reservoirs is one of the problems causing deterioration of water quality due to obstruction of water flow and reduction of dissolved oxygen.



(Source: EMA)

Figure 4.3.2 Lantana Camara Distribution Map in Masvingo Province

(2) Social Environmental

- People

The ethnic group living in the project area is the Shona people. Although the official language is English, the Shona language is also used as a local language popularly. There are no tribal conflicts in the project area.

- Livelihood

According to the statistical data of Zimbabwe[1], the average household size living in the Communal Lands is 5 persons/households while the proportion of woman-headed households is around 36%. 98% of people living in Communal Lands are engaged in agriculture and their livelihoods are heavily dependent on it. In general, most of the farmers in Communal Lands are smallholders and the average farmland size is about 1.4 ha/households.

- Decision-Making System by Traditional Custom

The traditional leadership locality called Traditional Leaders (composed of local chiefs, headmen, and village leaders) is functioned and legally recognized in Communal Lands. Traditional Leaders substantially make a role in managing land use and dispute resolution of the community.

4.4 SCOPING

Scoping is carried out as the preliminary environmental and social impact assessment. As the results, most of the major negative impacts on environmental and social aspects are anticipated during construction works, such as water pollution, wastes, and so on. It is necessary to develop an EMP

[1] ZIMSTAT, Zimbabwe Smallholder Agricultural Productivity Survey 2017 Report, March 2019

(Environmental Management Plan) of the project and implement appropriate mitigation measures and monitoring by construction contractor and implementation organization (DOI or ZINWA).

4.5 EVALUATION OF THE ENVIRONMENTAL CATEGORY (PROPOSED)

The scope of the project is limited to rehabilitation works of the existing agricultural dam and the current dam operation will be not changed after the rehabilitation works. Significant negative impacts on the surrounding natural environment and social environment by the project implementation are not anticipated. The project sites are not located in sensitive areas such as national protected areas and other important biodiversity areas. And the large-scale involuntary resettlement and/or land acquisition are not anticipated. For these reasons, it is assumed that the project will fall under Category B in the category classification of JICA environmental and social consideration guidelines.

CHAPTER 5 REHABILITATION COST

It is assumed that this rehabilitation project will be implemented by the Zimbabwean government budget or by the Japanese Grant Aid Project. The estimated project cost in each case is shown as below.

Implementation by the Zimbabwean Government:	5.06 million USD
Implementation by the Japanese Grant Aid Project:	8.75 million USD

CHAPTER 6 REQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

(1) Confirmation of the Implementing Agency of The Project

Determine implementing agencies from ZINWA or DOI.

(2) Natural Conditions Survey

1) Topographical survey

Plan survey, land survey, including the area around the reservoir, and longitudinal & cross-section survey of the embankment.

2) Soil investigation (Existing embankment)

Density, specific gravity, water absorption, water content ratio, grain size, compaction - permeability, liquid plasticity, consolidation, triaxial compression, etc.

3) Soil investigation (Borrow area)

Same test contents as the above soil investigation (Existing embankment)

4) Boring test (Pier foundation)

Standard penetration test (SPT)

(3) Planning of Project Content

1) Outline design

2) Construction/Procurement plan

*When upgrading a reservoir, there are two possible methods: (1) emptying the reservoir and (2) operating the reservoir (with water in the reservoir). Depending on which method is chosen, the scale of temporary facilities required will differ greatly, which will also affect the project cost. Therefore, the construction plan for the upgrading work should be developed with this in mind.

In addition, it is necessary to set the method of implementation after sufficient consultation and agreement with the Zimbabwean side and beneficiary farmers. In particular, it is necessary to inform and agree with the beneficiary farmers in Zimbabwe that if the project is to be implemented with emptying the reservoir, irrigated agriculture will not be possible for the relevant year (and possibly for several years thereafter) and that the beneficiary farmers will need to be guaranteed by the Zimbabwean government.

3) Plan of maintenance & operation

(4) Environmental And Social Considerations (Including Social Condition Survey)

1) Social survey of the target area, study of environmental and social impacts and countermeasures

2) Application and approval of environmental procedures to the EMA (Environmental Management Agency) (submission of Prospectus and support for the preparation of environmental management plans, etc.)

(5) Estimating the Project Cost

CHAPTER 7 BENEFITS OF THE PROJECT

By implementing the project, deformations and damages occurring in each facility will be repaired to extend the service life of the facilities, which will avoid damage to the facilities due to aging and the resulting loss of human lives and assets, as well as ensure the continuation of irrigated agriculture in 15.2 ha by avoiding the suspension of irrigation water supply.

Appendix-3-5

Dam Improvement Work Plan
(Mabvute Dam)

CHAPTER 1 STATUS OF THE WORK PLAN

The identification of deteriorations/damages (and those sign) on the target six dams in Masvingo Province is carried out and examination on the found deteriorations/damage if they already affect the safety/stability/operation of the facilities is conducted. Also, examination on the found deteriorations/damages if they expand and affect the safety/stability/operation of the facilities in the future is carried out as well.

The deteriorations/damages found are evaluated and categorized into three ranks as shown in Table 1.1.1. This work plan is a medium/ long-term rehabilitation plan for "Deformation/damage that may affect the safety/stability/operation of the facility in the long term," which was evaluated as "B" in Table 1.1.1. Among the "B" rated damages, the smaller scale damages will be addressed by Zimbabwe through regular operation and maintenance and are excluded from the scope of this draft plan.

Table 1.1.1 Evaluation Ranks of Deteriorations/Damages Found

Rank	Evaluation Standard
A	Deteriorations and damages that are already affecting the safety/stability/operation of the facilities or are feared to affect them in near future.
B	Deteriorations and damages that are not affecting the safety/stability/operation of the facilities at present but may affect them in the long term.
C	No deteriorations and damage or no signal of them

The draft plan is designed to respond to changes in natural conditions (especially the increase in flood volume due to climate change in recent years) and social conditions (demand for expansion of irrigated area due to population growth) since the construction of the target dam, as well as to solve problems in operation and maintenance management. The draft plan also includes the results of the preliminary environmental and social impact assessment for the Plan.

CHAPTER 2 GENERAL OUTLINE OF THE TARGET DAM

Mabvute dam was constructed in 1993 as an irrigation dam. The main features of the dam are shown in Table 2.1.1, and the location is shown in Figure 2.1.1.

Table 2.1.1 Main Features of Dam

District		Zaka		Dam Type		Zone Type fill dam
Communal Land		Ndanga		Crest Level (EL.m)		648.2
River		Musuche		Non-overflow crest Level (EL.m)		647.5
Catchment Area (km^2)		31.1		Basement Level (EL.m)		626.5
Annual Yield (MCM)		3.349		Height (m)		19.3
Water Level (EL.m)	Design flood level	647.0		Crest Length (m)		625
	Full water level	644.0		Crest Width (m)		6.0
	Dead water level	633.0	Specification	Upstream slope angle	Upper portion	1:2.0
Submerged Area (km^2)		0.711			Lower portion	1:2.25
Storage Capacity (MCM)	Reservoir Yield	1.298		Downstream slope angle	Upper portion	1:1.8
	Total	3.238			Lower portion	1:1.8
	Effective	3.132		Core zone upstream slope angle		1:0.5
	Dead	0.106		Core zone downstream angle		1:0.15
Spillway	Crest Type	Non-gate crest		Embankment volume (m^3)		192,800
	Design flood discharge (m^3/s)	343	Pump	Type		double suction volute
	Specific flow ($m^3/s/km^2$)	11.03		Design discharge (litter/sec)		151
Night Storage	Capacity (m^3)	8,700		Lift (m)		43
	Depth (m)	2.0	Canal	Type		Steel pipe
	Scale (m)	79 × 79		Maximum discharge (litter/sec)		151
Irrigation Type		Gravity		Length (m)		860
Intake	Maximum intake volume (litter/sec)	151		Diameter (mm)		400
Beneficial Area	Farmland Area (ha)	100.0	Benefitted households	Population (people)		3,930
	Irrigation Area (ha)	70.5		Livestock (LSU)		3,000

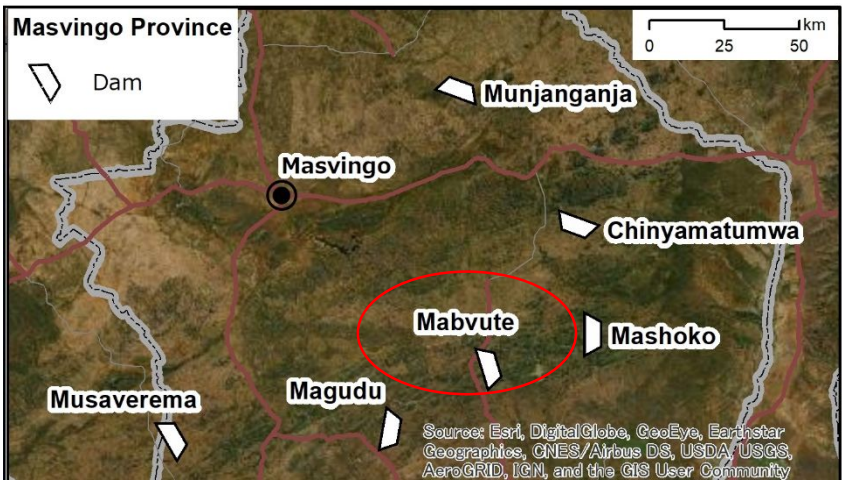


Table 2.1.1 Location of the Target Dam

CHAPTER 3 CONFIRMED DEFORMATIONS/ DAMAGES IN THE FIELD SURVEY AND REHABILITATION POLICY

3.1 SUMMARY

The locations of deteriorations/damages found of Mabvute Dam are shown in Figure 3.1.1, and the summary of the evaluation results of each deterioration/damage are shown in Table 3.1.1.

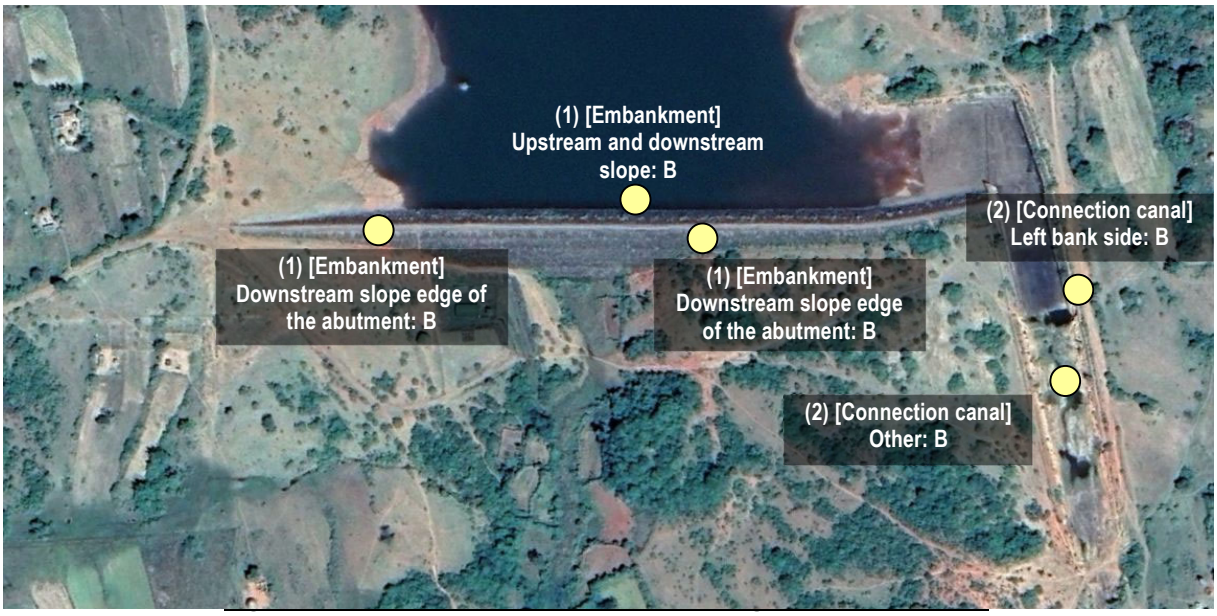


Table 3.1.1 Summary of the Evaluation Results of Deteriorations/Damages on Mabvute Dam

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
(1)	Embankment	Upstream and downstream slope	B	- Disturbance of riprap, gully erosion under riprap, dam body exposure, and trees
		Downstream slope edge of the abutment	B	- Erosion
(2)	Connection canal	Left bank side wall	B	- Collapse of side walls at the end of the spillway channel
		Other	B	- Crossing road across canal

3.2 "B" EVALUATION DEFORMATION/ DAMAGE AND REHABILITATION POLICY

3.2.1 Embankment

(1) Confirmed Deformations/ Damages

[Upstream and downstream slope] Disturbance of riprap, gully erosion under riprap, dam body exposure, and trees

[Downstream slope edge of the abutment] Erosion

Figure 3.2.1 Upstream and Downstream Slope

Figure 3.2.2 Downstream Slope Edge

(2) Rehabilitation Policy for Deformations/ Damages

Disturbance of riprap, dam body exposure, erosion, and trees around the embankment is caused by thinning of the surface riprap due to weathering and livestock invasion on the embankment slope. To repair the embankment and to prevent similar problems in the future, the surface layer (including trees) is removed, the embankment replaced with new material, and riprap is placed on both upstream and downstream sides. In addition, Geotextile is placed between the dam body and the riprap to prevent the runoff of the dam body.

In addition, there were cases of erosion at the boundary of the embankment, where surface water generated by rainfall tends to collect, at nearby dams. Since this kind of deformation may occur in all dams during long-term operation, a drainage channel at the edge of the embankment will be installed to quickly remove surface water from the surrounding area and prevent erosion.

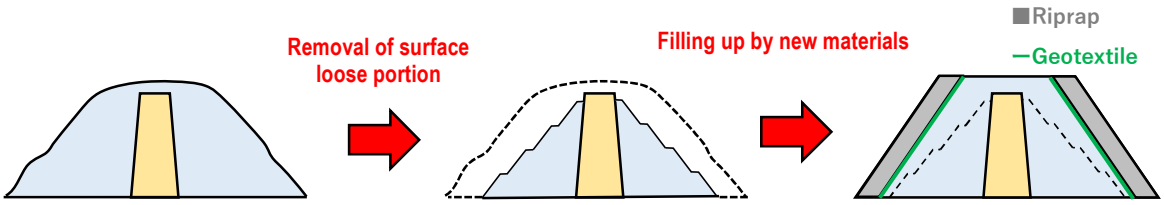


Figure3.2.3 Model of Embankment Rehabilitation Work

A typical cross-section and plan drawings of the embankment rehabilitation are shown in Figure 3.2.4 and Figure 3.2.6. The surface excavation depth is at least 1m for root removal. To increase the boundary area between the excavated surface and the new material, and to ensure accurate compaction at the boundary, the excavated surface of the existing embankment is shaped like steps (1.5 m high, slope 1:0.5), and the compaction width is to be at least 4 m for workability. In addition, the thickness of the newly installed riprap is 1 m. It should be noted that this rehabilitation causes the boundary of the embankment slope to expand in the upstream and downstream directions.

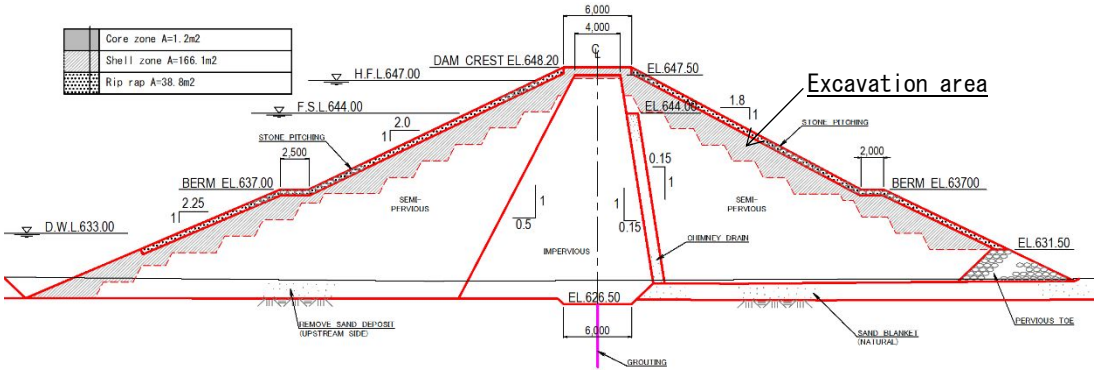


Figure 3.2.4 The Typical Cross-section of Excavation for Rehabilitation (Mabvute dam)

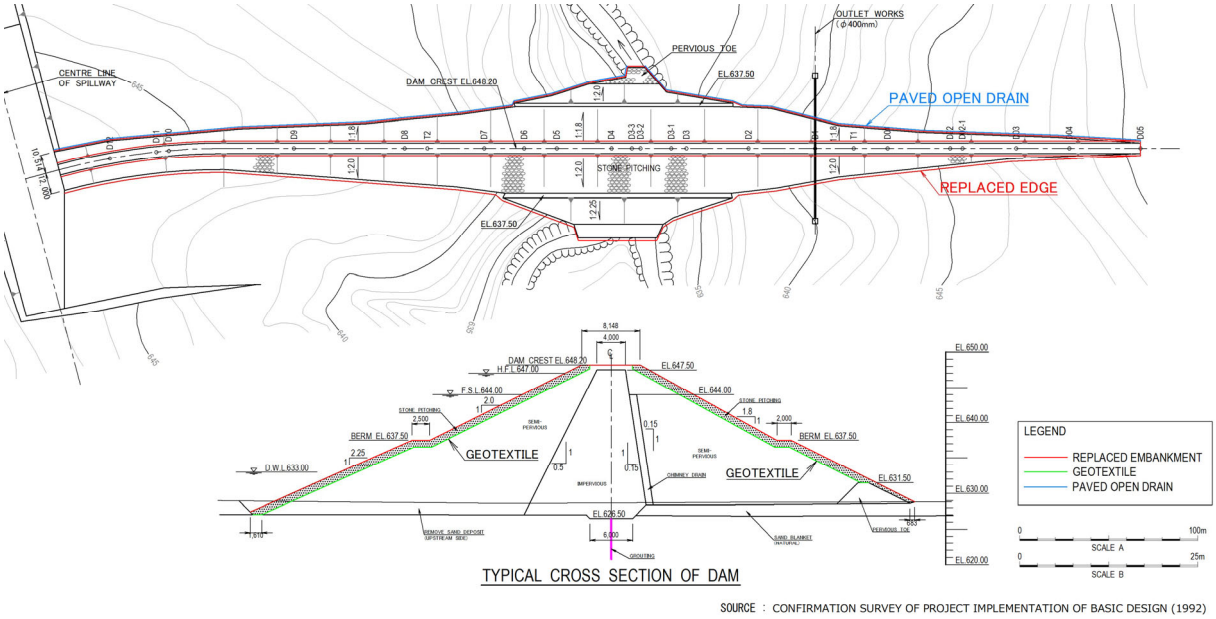


Figure 3.2.5 The Typical Cross-Section and Plan of the Embankment (Mabvute Dam)

(3) Policy Against the Climate Change

Since Mabvute dam was designed around 1993, it is suspected that the flood volume at the dam site may have changed from the time of design due to recent climate change. Therefore, it should be verified if the existing facilities can safely discharge floodwaters calculated from recent rainfall. If the dam doesn't have enough capacity, countermeasures are considered.

As a result of the verification, it is judged that existing facility can discharge floods safely.

(4) Policy To Increase the Irrigable Area

An essential condition for the implementation of embankment raising to expand the irrigated area through the increase of water storage capacity is the condition of the topography around the embankment and reservoir. Since embankment height-raising requires a large amount of cost, it is desirable to be able to raise the embankment as high as possible to increase its effectiveness. Therefore, in this feasibility study, the condition for raising the embankment is that the elevation around the embankment and reservoir must be at least 1 m higher than the crest of the existing embankment.

As a result of confirming the topography around the embankment and examining the possibility of raising the embankment, it was judged that raising the embankment more than 1m was impossible.

3.2.2 Connection Canal

(1) Confirmed Deformations/ Damages and Operation & Maintenance Issues

[Left bank side wall] Collapse of side walls at the end of the spillway channel

[Other] Crossing Road across the canal

Figure 3.2.6 Collapse of Left Bank Side Wall at the End of the Spillway Channel

Figure 3.2.7 Crossing Road

(2) Rehabilitation Policy for Deformations/ Damages and Operation & Maintenance Issues

Significant erosion and collapse of the side walls will be prevented by installing revetments made of wet masonry.

For use as a crossing in the channel, a bridge for crossing should be installed at an appropriate location between the spillway channel and the connection channel.

Figure 3.2.8 Model of Construction of the Protection Wall

Figure 3.2.9 Model of Installing of New Bridge

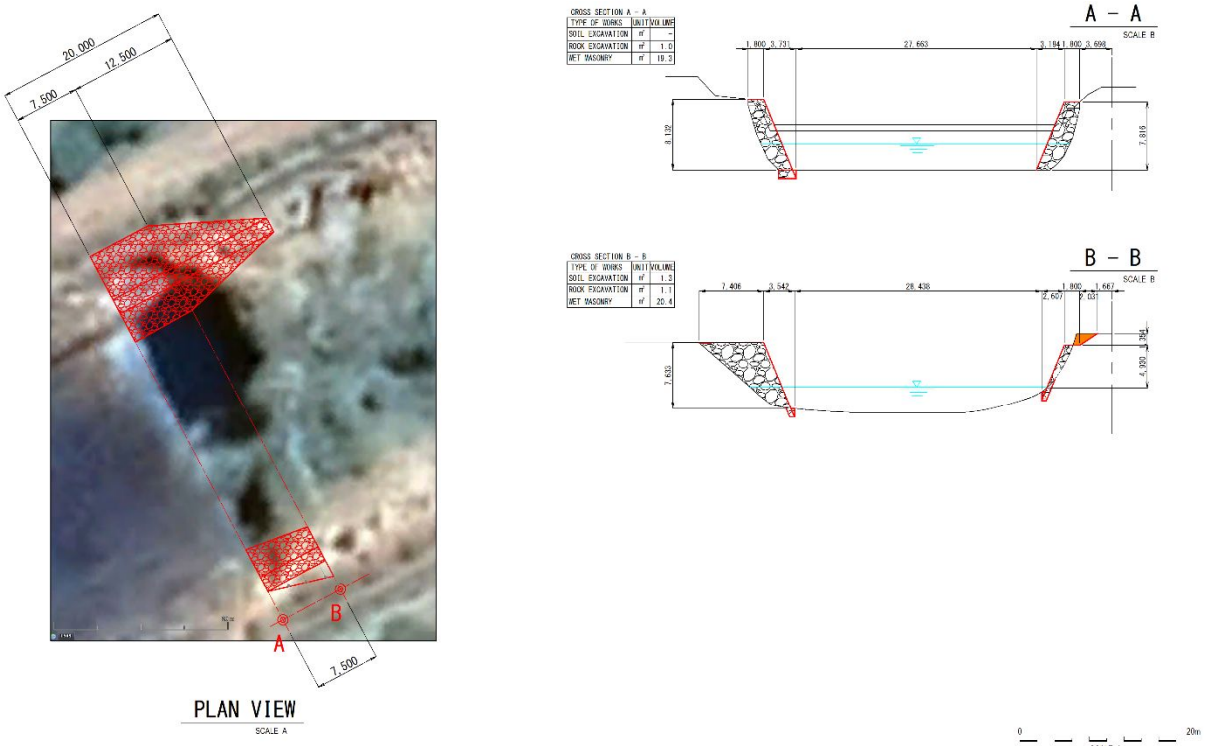


Figure 3.2.10 The Typical Cross-Section and Plan View of the Connection Canal with Protection Walls

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATION

4.1 PROJECT COMPONENT

Mabvute dam was constructed in 1993 as an irrigation dam. Therefore, the project component is limited to the rehabilitation of existing agricultural dams. Table 4.1.1 summarizes the project component.

Table 4.1.1 Outline of the Expected Project Component

Rehabilitation Dam	Contents of Works
Mabvute Dam	● Rehabilitation of the surface of dam embankments ● Rehabilitation of spillway channel and connection canals (including protection wall installation for canals, installation of access bridge, etc.) ● Rehabilitation of intake facilities (including gate operation facility replacement, etc.)

4.2 PROJECT LOCATION

Mabvute dam and its beneficiary area are in Masvingo Province. The land category of the site is

Communal Land.

Table 4.2.1 Location of the Project Areas

Rehabilitation Dams	Beneficial Area		Location of the Dams and Beneficial Areas			
	Beneficiaries	Land Size (ha)	Province	District	Land Category	Communal Land Name
Magudu	2,800	70	Masvingo	Masvingo	Communal Lands	Nuajena
Musaverema	2,590	44		Mwenezi		Matibi No.1
Chinyamatumwa	1,610	50		Bikita		Bikita
Mashoko	570	21		Bikita		Matsai
Mabvute	3,930	100		Zaka		Ndanga
Munjanganja	1,710	51		Gutu		Mutra

4.3 ENVIRONMENTAL AND SOCIAL CONDITIONS IN THE PROJECT AREA

(1) Natural Environment

- Meteorology and Hydrology

The annual rainfall is around 800 mm and most of the rainfall is concentrated in the summer season from November to March. The project areas are located in Zone IV (Semi-Extensive Farming Region, with annual rainfall: 450 – 650mm) and/or Zone V (Extensive Farming Region, with annual rainfall: less than 450mm) classified by the agro-ecological zones. Therefore, the necessity for irrigation is high in the project areas.

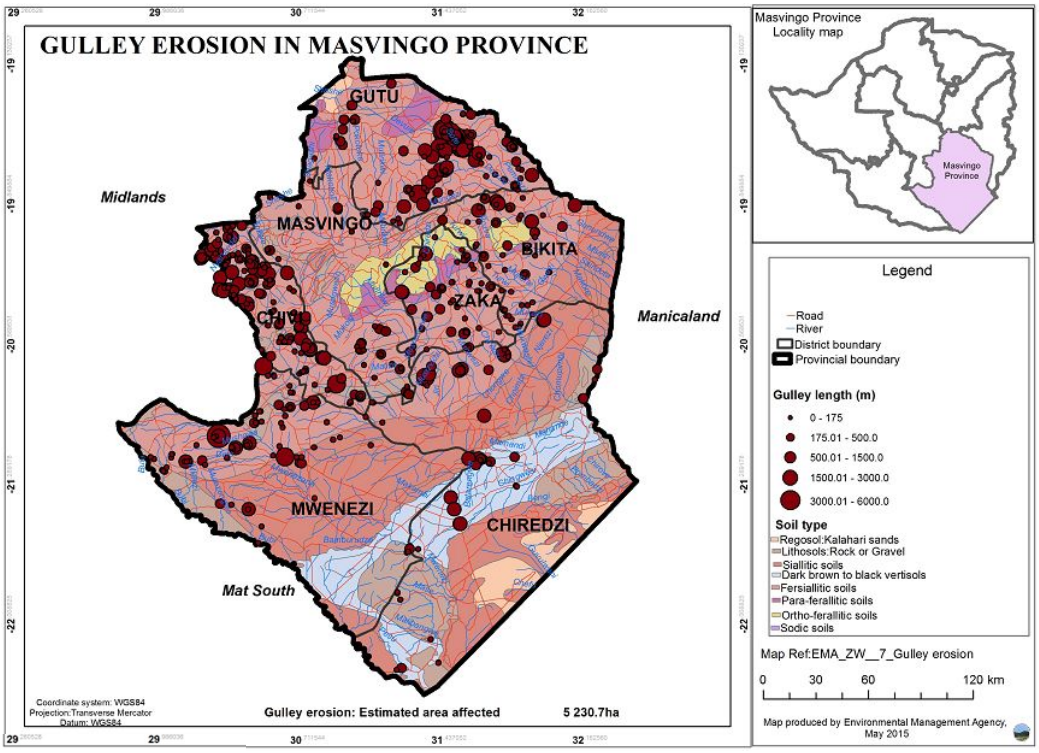
The river that flows into the target dam is seasonal rivers. The target dam stores river water during the rainy season and discharges for irrigation during the dry season.

- Eco-system and Habitats

The project area of the target dam (including catchment area and downstream area) and its beneficiary areas are not located in the important ecological habitats such as national parks, Ramsar wetlands, and IBAs. Since the main contents of the dam improvement plan are restoring of original functions of dams through rehabilitation, the way of dam operation is not changed from an existing one. Therefore, it is assumed there will be no significant changes from the existing ecological condition of the surrounding area of existing dams.

- Erosion and Forestry

Soil deterioration due to gully erosion in farmland and forest lands is a common problem in and around the project area. The Gully erosion distribution map in Masvingo Province is shown in Figure 4.3.1. The gully erosion leads to sedimentation on dam reservoirs. As the countermeasures for the protection from gully erosion, efforts have been made to construct drainage canals in the farmland, to place trees on the counter line, to preserve the forest, and to control illegal tree cutting, generally.

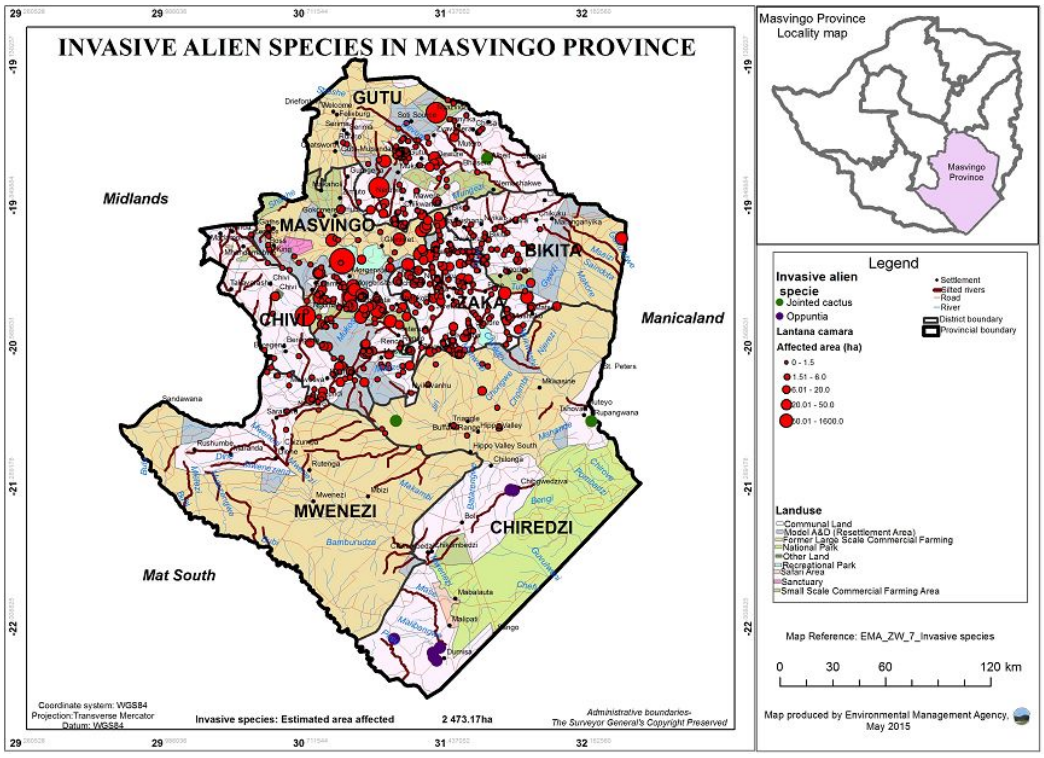


(Source: EMA)

Figure 4.3.1 Gully Erosion Distribution Map in Masvingo Province

- Vegetation

Growing of Lantana Camara, which is one of the invasive species, is a common problem of farmland in the project area. The distribution map of Lantana Camara in Masvingo Province is shown in Figure 4.3.2. On the other hand, the growing of Water Hyacinth in dam reservoirs is one of the problems causing deterioration of water quality due to obstruction of water flow and reduction of dissolved oxygen.



(Source: EMA)

Figure 4.3.2 Lantana Camara Distribution Map in Masvingo Province

(2) Social Environment

- People

The ethnic group living in the project area is the Shona people. Although the official language is English, the Shona language is also used as a local language popularly. There are no tribal conflicts in the project area.

- Livelihood

According to the statistical data of Zimbabwe[1], the average household size living in the Communal Lands is 5 persons/households while the proportion of woman-headed households is around 36%. 98% of people living in Communal Lands are engaged in agriculture and their livelihoods are heavily dependent on it. In general, most of the farmers in Communal Lands are smallholders and the average farmland size is about 1.4 ha/households.

- Decision-Making System by Traditional Custom

The traditional leadership locality called Traditional Leaders (composed of local chiefs, headmen, and village leaders) is functioned and legally recognized in Communal Lands. Traditional Leaders substantially make a role in managing land use and dispute resolution of the community.

4.4 SCOPING

Scoping is carried out as the preliminary environmental and social impact assessment. As the results, most of the major negative impacts on environmental and social aspects are anticipated during construction works, such as water pollution, wastes, and so on. It is necessary to develop an EMP (Environmental Management Plan) of the project and implement appropriate mitigation measures and monitoring by construction contractor and implementation organization (DOI or ZINWA).

4.5 EVALUATION OF THE ENVIRONMENTAL CATEGORY (PROPOSED)

The scope of the project is limited to rehabilitation works of the existing agricultural dam and the current dam operation will be not changed after the rehabilitation works. Significant negative impacts on the surrounding natural environment and social environment by the project implementation are not anticipated. The project sites are not located in sensitive areas such as national protected areas and other important biodiversity areas. And the large-scale involuntary resettlement and/or land acquisition are not anticipated. For these reasons, it is assumed that the project will fall under Category B in the category classification of JICA environmental and social consideration guidelines.

CHAPTER 5 REHABILITATION COST

It is assumed that this rehabilitation project will be implemented by the Zimbabwean government budget or by the Japanese Grant Aid Project. The estimated project cost in each case is shown as below.

Implementation by the Zimbabwean Government:	5.40 million USD
Implementation by the Japanese Grant Aid Project:	9.36 million USD

[1] ZIMSTAT, Zimbabwe Smallholder Agricultural Productivity Survey 2017 Report, March 2019

CHAPTER 6 REQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

(1) Confirmation of the Implementing Agency of The Project

Determine implementing agencies from ZINWA or DOI.

(2) Natural Conditions Survey

1) Topographical survey

Plan survey, land survey, including the area around the reservoir, and longitudinal & cross-section survey of the embankment.

2) Soil investigation (Existing embankment)

Density, specific gravity, water absorption, water content ratio, grain size, compaction - permeability, liquid plasticity, consolidation, triaxial compression, etc.

3) Soil investigation (Borrow area)

Same test contents as the above soil investigation (Existing embankment)

4) Boring test (Pier foundation)

Standard penetration test (SPT)

(3) Planning of Project Content

1) Outline design

2) Construction/Procurement plan

*When upgrading a reservoir, there are two possible methods: (1) emptying the reservoir and (2) operating the reservoir (with water in the reservoir). Depending on which method is chosen, the scale of temporary facilities required will differ greatly, which will also affect the project cost. Therefore, the construction plan for the upgrading work should be developed with this in mind.

In addition, it is necessary to set the method of implementation after sufficient consultation and agreement with the Zimbabwean side and beneficiary farmers. In particular, it is necessary to inform and agree with the beneficiary farmers in Zimbabwe that if the project is to be implemented with emptying the reservoir, irrigated agriculture will not be possible for the relevant year (and possibly for several years thereafter) and that the beneficiary farmers will need to be guaranteed by the Zimbabwean government.

3) Plan of maintenance & operation

(4) Environmental and Social Considerations (Including Social Condition Survey)

1) Social survey of the target area, study of environmental and social impacts and countermeasures

2) Application and approval of environmental procedures to the EMA (Environmental Management Agency)

(submission of Prospectus and support for the preparation of environmental management plans, etc.)

(5) Estimating the Project Cost

CHAPTER 7 BENEFITS OF THE PROJECT

By implementing the project, deformations and damages occurring in each facility will be repaired to extend the service life of the facilities, which will avoid damage to the facilities due to aging and the resulting loss of human lives and assets, as well as ensure the continuation of irrigated agriculture in 70.5 ha by avoiding the suspension of irrigation water supply.

Appendix-3-6

Dam Improvement Work Plan
(Munjanganja Dam)

CHAPTER 1 STATUS OF THE WORK PLAN

The identification of deteriorations/damages (and those sign) on the target six dams in Masvingo Province is carried out and examination on the found deteriorations/damage if they already affect the safety/stability/operation of the facilities is conducted. Also, examination on the found deteriorations/damages if they expand and affect the safety/stability/operation of the facilities in the future is carried out as well.

The deteriorations/damages found are evaluated and categorized into three ranks as shown in Table 1.1.1. This work plan is a medium/ long-term rehabilitation plan for "Deformation/damage that may affect the safety/stability/operation of the facility in the long term," which was evaluated as "B" in Table 1.1.1. Among the "B" rated damages, the smaller scale damages will be addressed by Zimbabwe through regular operation and maintenance and are excluded from the scope of this draft plan.

Table 1.1.1 Evaluation Ranks of Deteriorations/Damages Found

Rank	Evaluation Standard
A	Deteriorations and damages that are already affecting the safety/stability/operation of the facilities or are feared to affect them in near future.
B	Deteriorations and damages that are not affecting the safety/stability/operation of the facilities at present but may affect them in the long term.
C	No deteriorations and damage or no signal of them

The draft plan is designed to respond to changes in natural conditions (especially the increase in flood volume due to climate change in recent years) and social conditions (demand for expansion of irrigated area due to population growth) since the construction of the target dam, as well as to solve problems in operation and maintenance management. The draft plan also includes the results of the preliminary environmental and social impact assessment for the Plan.

CHAPTER 2 GENERAL OUTLINE OF THE TARGET DAM

Munjanganja dam was constructed in 1994 as an irrigation dam. The main features of the dam are shown in Table 2.1.1, and the location is shown in Figure 2.1.1.

Table 2.1.1 Main Features of Dam

District		Gutu		Dam Type		Zone Type fill dam
Communal Land		Gutu		Crest Level (EL.m)		1,151.1
River		Mutora		Non-overflow crest Level (EL.m)		1,150.5
Catchment Area (km^2)		52.8		Basement Level (EL.m)		1,130.5
Annual Yield (MCM)		4.171		Height (m)		18.7
Water Level (EL.m)	Design flood level	1,150.0		Crest Length (m)		920
	Full water level	1,149.0		Crest Width (m)		6.0
	Dead water level	1,143.0	Specification	Upstream slope angle	Upper portion	1:2.0
Submerged Area (km^2)		0.644			Lower portion	1:2.25
Storage Capacity (MCM)	Reservoir Yield	0.659		Downstream slope angle	Upper portion	1:1.8
	Total	2.082			Lower portion	1:2.0
	Effective	1.831		Core zone upstream slope angle		1:0.5
	Dead	0.251		Core zone downstream angle		1:0.15
Spillway	Crest Type	Non-gate crest		Embankment volume (m^3)		164,300
	Design flood discharge (m^3/s)	349	Pump	Type		-
	Specific flow ($m^3/s/km^2$)	6.61		Design discharge (litter/sec)		-
Night Storage	Capacity (m^3)	4,300		Lift (m)		-
	Depth (m)	2.0	Canal	Type		Concrete flume
	Scale (m)	59 × 59		Maximum discharge (litter/sec)		496
Irrigation Type		Gravity		Length (m)		4,720
Intake	Maximum intake volume (litter/sec)	49		Diameter (mm)		-
Beneficial Area	Farmland Area (ha)	51.0	Benefitted households	Population (people)		1,710
	Irrigation Area (ha)	33.3		Livestock (LSU)		1,500

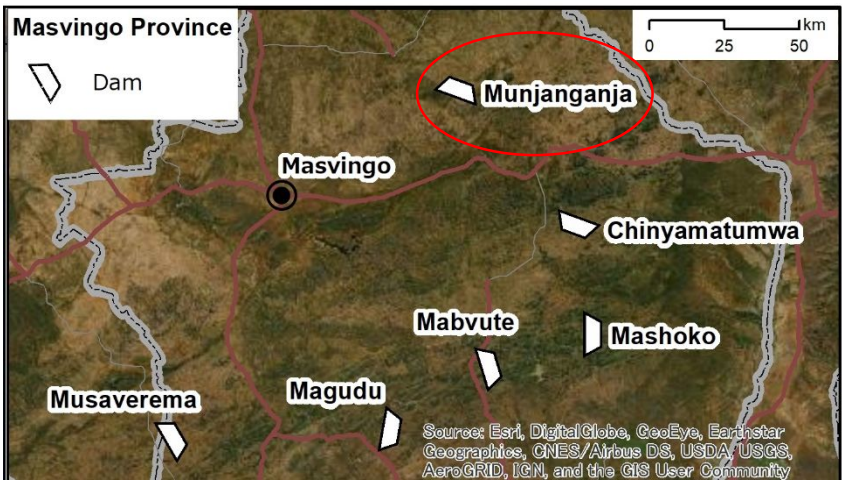


Table 2.1.1 Location of the Target Dam

CHAPTER 3 CONFIRMED DEFORMATIONS/ DAMAGES IN THE FIELD SURVEY AND REHABILITATION POLICY

3.1 SUMMARY

The locations of deteriorations/damages found of Munjanganja Dam are shown in Figure 3.1.1, and the summary of the evaluation results of each deterioration/damage are shown in Table 3.1.1.

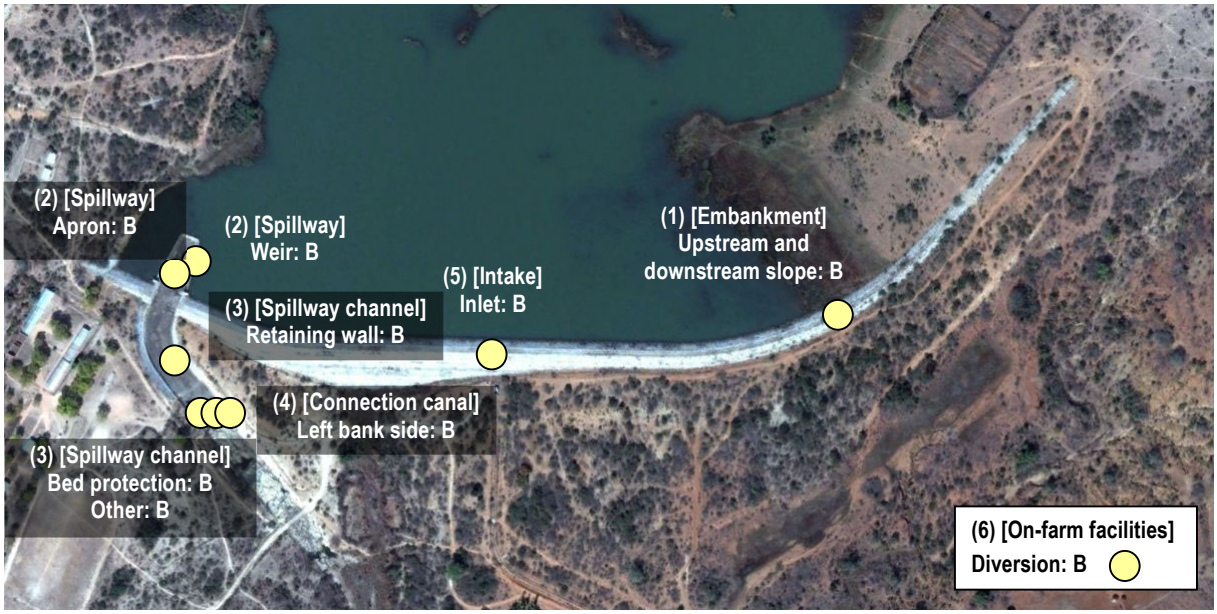


Figure 3.1.1 Locations of Deteriorations/Damages on Munjanganja Dam

Table 3.1.1 Summary of the Evaluation Results of Deteriorations/Damages on Munjanganja Dam

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
(1)	Embankment	Upstream and downstream slope	B	- Disturbance of riprap, gully erosion under riprap, dam body exposure, and trees
(2)	Spillway	Weir	B	- Leakage from downstream slope
		Apron	B	- Open and damaged joints
(3)	Spillway channel	Retaining wall	B	- Cracks at the top of walls
		Bed protection	B	- Spilling out of basket mat on the right bank side

NO.	FACILITIES		EVALUATION (A or B)	CONFIRMED PHENOMENON
		Other	B	- Crossing road across the canal
(4)	Connection canal	Left bank side wall	B	- Collapse of side walls at the end of the spillway channel
(5)	Intake	Inlet	B	- Missing of the wires
(6)	On-farm facilities	Diversion	B	- Broken of sluice gate

3.2 "B" EVALUATION DEFORMATION/ DAMAGE AND REHABILITATION POLICY

3.2.1 Embankment

(1) Confirmed Deformation/ Damages

[Upstream and downstream slope] Disturbance of riprap, gully erosion under riprap, dam body exposure, and trees

Figure 3.2.1 Upstream and Downstream Slope

(2) Rehabilitation Policy for Deformations/ Damages

Disturbance of riprap, dam body exposure, erosion, and around the embankment is caused by thinning of the surface riprap due to weathering and livestock invasion on the embankment slope. To repair the embankment and to prevent similar problems in the future, the surface layer (including trees) is removed, the embankment replaced with new material, and riprap is placed on both upstream and downstream sides. In addition, Geotextile is placed between the dam body and the riprap to prevent the runoff of the dam body.

In addition, there were cases of erosion at the boundary of the embankment, where surface water generated by rainfall tends to collect, at nearby dams. Since this kind of deformation may occur in all dams during long-term operation, a drainage channel at the edge of the embankment will be installed to quickly remove surface water from the surrounding area and prevent erosion.

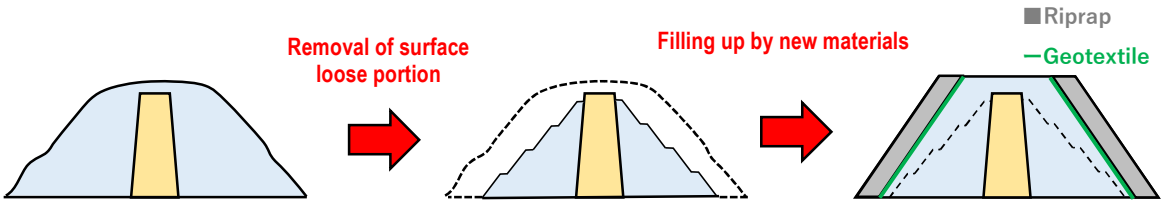


Figure 3.2.2 Model of Embankment Rehabilitation Work

A typical cross-section and plan drawings of the embankment rehabilitation are shown in Figure 3.2.4 and Figure 3.2.6. The surface excavation depth is at least 1m for root removal. To increase the boundary area between the excavated surface and the new material, and to ensure accurate compaction at the boundary, the excavated surface of the existing embankment is shaped like steps (1.5 m high, slope 1:0.5), and the compaction width is to be at least 4 m for workability. In addition, the thickness of the newly installed riprap is 1 m. It should be noted that this rehabilitation causes the boundary of the embankment slope to expand in the upstream and downstream directions.

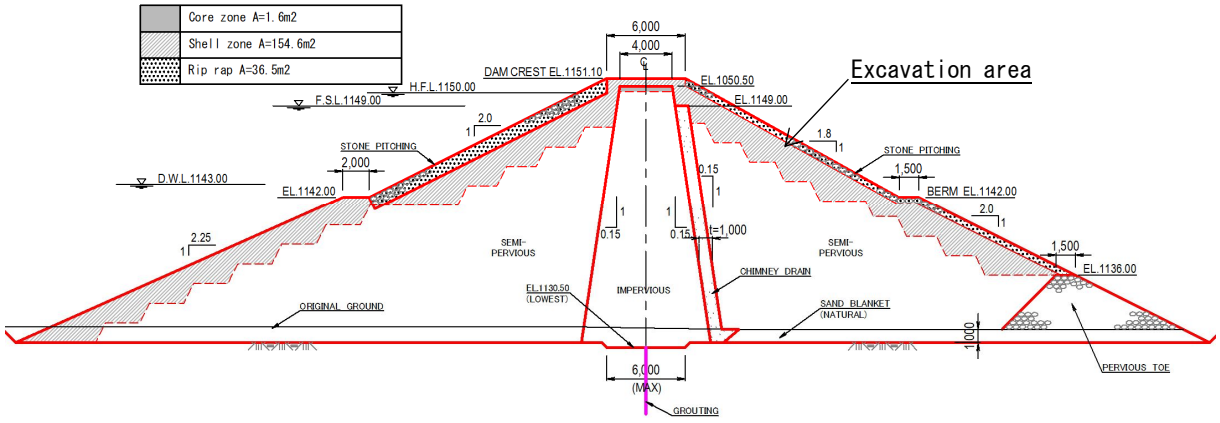


Figure 3.2.3 The Typical Cross-section of Excavation for Rehabilitation (Munjanganja dam)

(3) Policy Against the Climate Change

Since Munjanganja dam was designed around 1994, it is suspected that the flood volume at the dam site may have changed from the time of design due to recent climate change. Therefore, it should be verified if the existing facilities can safely discharge floodwaters calculated from recent rainfall. If the dam doesn't have enough capacity, countermeasures are considered.

As a result of the verification, it is judged that the overflow depth of the flood discharge needs to be increased by 30 cm to allow recent floods to flow down the dam. In this case, the separation between the flood level and the top of the dam (freeboard) and the elevation of the core, which work to shut off the water and the freeboard, will be insufficient, thus it is decided to raise the embankment by 30 cm in conjunction with the above-mentioned repair of the embankment surface to secure the freeboard and core elevation.

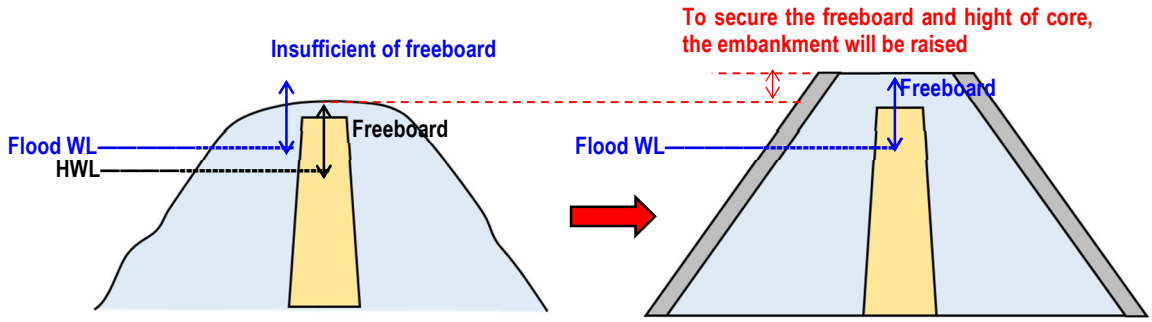


Figure 3.2.4 Drawing of Raising of Embankment

Figure 3.2.5 shows the typical cross-section and plan of the embankment rehabilitation.

On the other hand, due to the increased flood volume, it might be necessary to raise the sidewalls of spillway channels and connection canals. As for the spillway channels, the risk of overflow is low due to the large difference in elevation between the bottom and the top of the canal. Also, because spillway channels have retaining walls (wet masonry), the possibility of it affecting the embankment is considered to be small even if the water level rises.

As for the connection canal, the risk of overflow is low due to the wide width of the canal bed, and there are no houses or other facilities to be protected in the surrounding area. Therefore, the priority of measures such as the construction of protection walls is considered to be low at present.

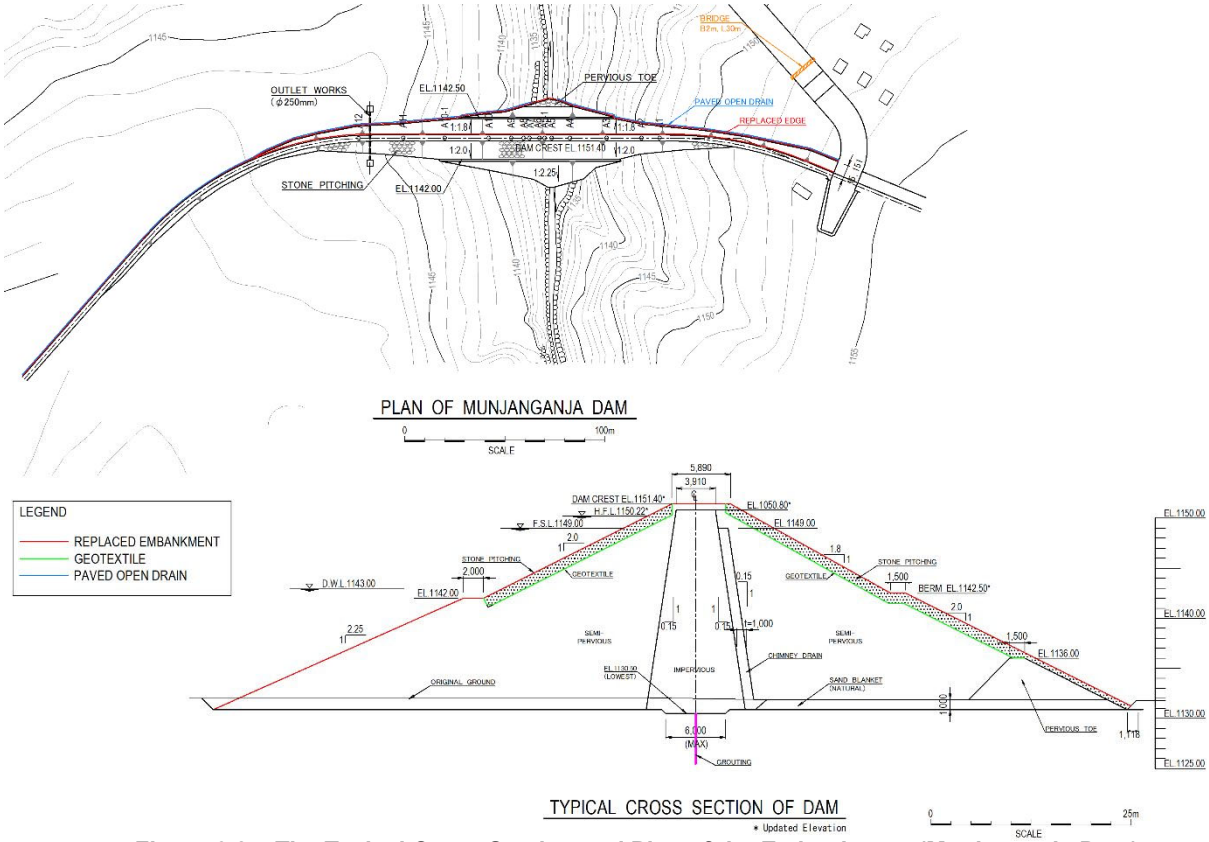


Figure 3.2.5 The Typical Cross-Section and Plan of the Embankment (Munjanganja Dam)

(4) Policy to Increase the Irrigable Area

An essential condition for the implementation of embankment raising to expand the irrigated area through the increase of water storage capacity is the condition of the topography around the embankment

and reservoir. Since embankment height-raising requires a large amount of cost, it is desirable to be able to raise the embankment as high as possible to increase its effectiveness. Therefore, in this feasibility study, the condition for raising the embankment is that the elevation around the embankment and reservoir must be at least 1 m higher than the crest of the existing embankment.

As a result of confirming the topography around the embankment and examining the possibility of raising the embankment, it was judged that raising the embankment more than 1m was impossible.

3.2.2 Spillway

(1) Confirmed Deformations/ Damages

[Weir] Leakage from downstream slope

[Apron] Open and damaged joints

(2) Rehabilitation Policy for Deformations/ Damages

Since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

Figure 3.2.6 Leakage from Downstream Slope

Figure 3.2.7 Joints of the Apron

3.2.3 Spillway Channel

(1) Confirmed Deformations/ Damages and Operation & Maintenance Issues

[Retaining wall] Cracks at the top of walls

[Bed Protection] Spilling out of basket mat on the right bank side

[Other] Crossing Road across the channel

Figure 3.2.8 Cracks at the Top of Retaining Walls

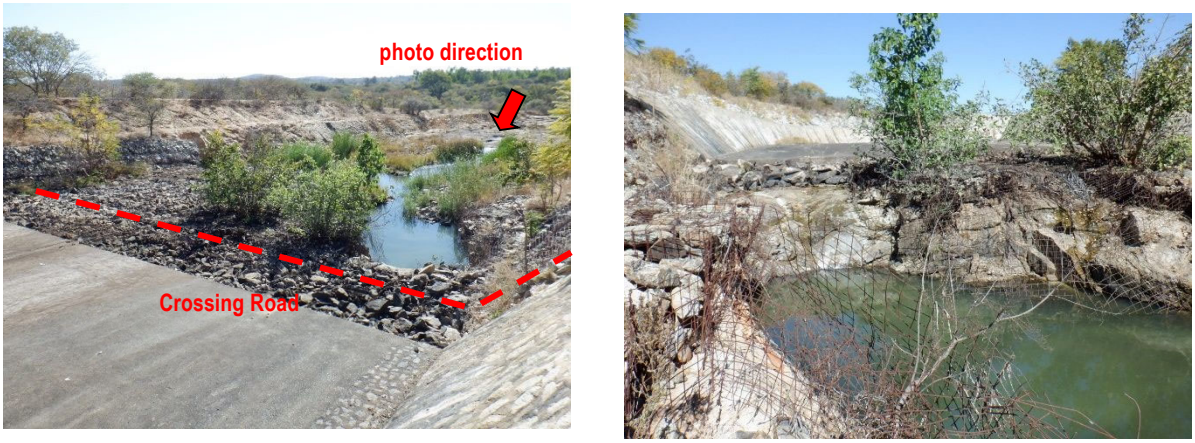


Figure 3.2.9 Spilling Out of Basket Mat at the Right Bank Side

(2) Rehabilitation Policy for Deformations/ Damages and Operation & Maintenance Issues

In the case of the cracks at the top of walls on the left and right side, since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

The basket mat at the end of the spillway channel of the Munjanganja dam is assumed to have deteriorated during its use of more than 30 years. Since it is difficult to prevent deteriorations/ caused by long-term use, the basket mat is reinstated with the same structure as at the time of construction. As for the washed-away part of the basement, it is re-formed by wet masonry.

For use as a crossing in the channel, a bridge for crossing should be installed at an appropriate location between the spillway channel and the connection channel.

Figure 3.2.10 Model of Rehabilitation of Basket Mat and New Bridge

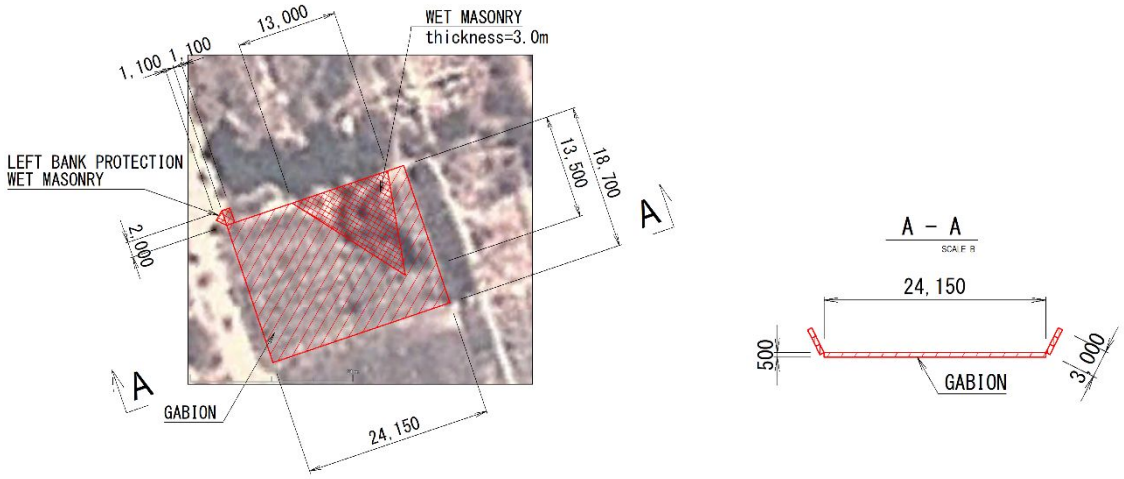


Figure 3.2.11 The Typical Cross-Section and Plan View of Rehabilitation of Basket Mat of the Connection Canal

3.2.4 Connection Canal

(1) Confirmed Deformations/ Damages

[Left bank side wall] Collapse of side walls at the end of the spillway channel

(2) Rehabilitation Policy for Deformations/ Damages

As for the collapse of the sidewalls, erosion will be prevented by the rehabilitation of wet masonry.

Figure 3.2.12 Collapse of Left Side Bank

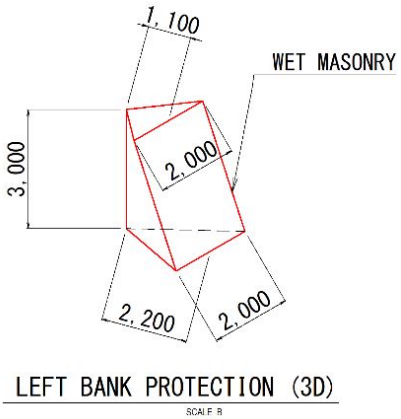


Figure 3.2.13 3D view of Sidewall Protection Work for Connecting Channel

3.2.5 Intake

(1) Confirmed Deformations/ Damages

[Inlet] Missing of the wires

Figure 3.2.14 Winch on the Crest

(2) Rehabilitation Policy for Deformations/ Damages

To restore the gate operation function and to prevent a similar problem in the future, an operation house is built at the crest and a new winch is installed in it. In addition, the steel wires leading to the intake gate are arranged in the protection pipe set under the riprap at the upstream side to prevent theft and deterioration.

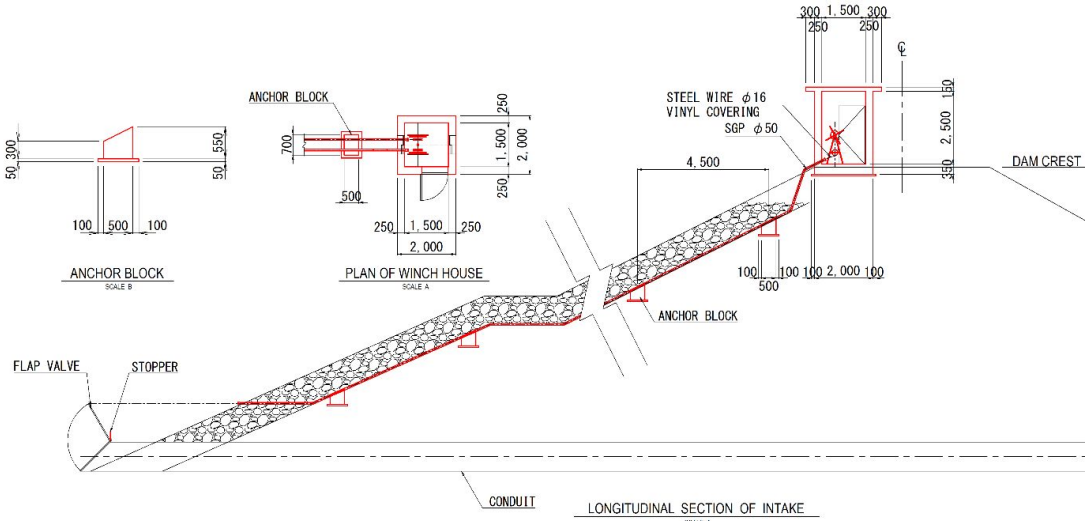


Figure 3.2.15 Layout of the Intake Improvement Plan

3.2.6 On-Farm Facilities

(1) Confirmed Deformations/ Damages

[Diversion] Broken of sluice gate

Figure 3.2.16 Broken Sluice Gate

(2) Rehabilitation Policy for Deformations/ Damages

Since the scale of the damage is small, the Zimbabwean side will deal with the damage through regular maintenance.

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATION

4.1 PROJECT COMPONENT

Munjanganja dam was constructed in 1994 as an irrigation dam. Therefore, the project component is

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Rehabilitation Dam	Contents of Works
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4.2 PROJECT LOCATION

Munjanganja dam and its beneficiary area are in Masvingo Province. The land category of the site is Communal Land.

Table 4.2.1 Location of the Project Areas

Rehabilitation Dams	Beneficial Area		Location of the Dams and Beneficial Areas			
	Beneficiaries	Land Size (ha)	Province	District	Land Category	Communal Land Name
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Mabvute	3,930	100		Zaka		Ndanga
Munjanganja	1,710	51		Gutu		Mutra

4.3 ENVIRONMENTAL AND SOCIAL CONDITIONS IN THE PROJECT AREA

(1) Natural Environmental

- Meteorology and Hydrology

The annual rainfall is around 800 mm and most of the rainfall is concentrated in the summer season from November to March. The project areas are located in Zone IV (Semi-Extensive Farming Region, with annual rainfall: 450 – 650mm) and/or Zone V (Extensive Farming Region, with annual rainfall: less than 450mm) classified by the agro-ecological zones. Therefore, the necessity for irrigation is high in the project areas.

The river that flows into the target dam is seasonal rivers. The target dam stores river water during the rainy season and discharges for irrigation during the dry season.

- Eco-system and Habitats

The project area of the target dam (including catchment area and downstream area) and its beneficiary areas are not located in the important ecological habitats such as national parks, Ramsar wetlands, and IBAs. Since the main contents of the dam improvement plan are restoring of original functions of dams through rehabilitation, the way of dam operation is not changed from an existing one. Therefore, it is assumed there will be no significant changes from the existing ecological condition of the surrounding area of existing dams.

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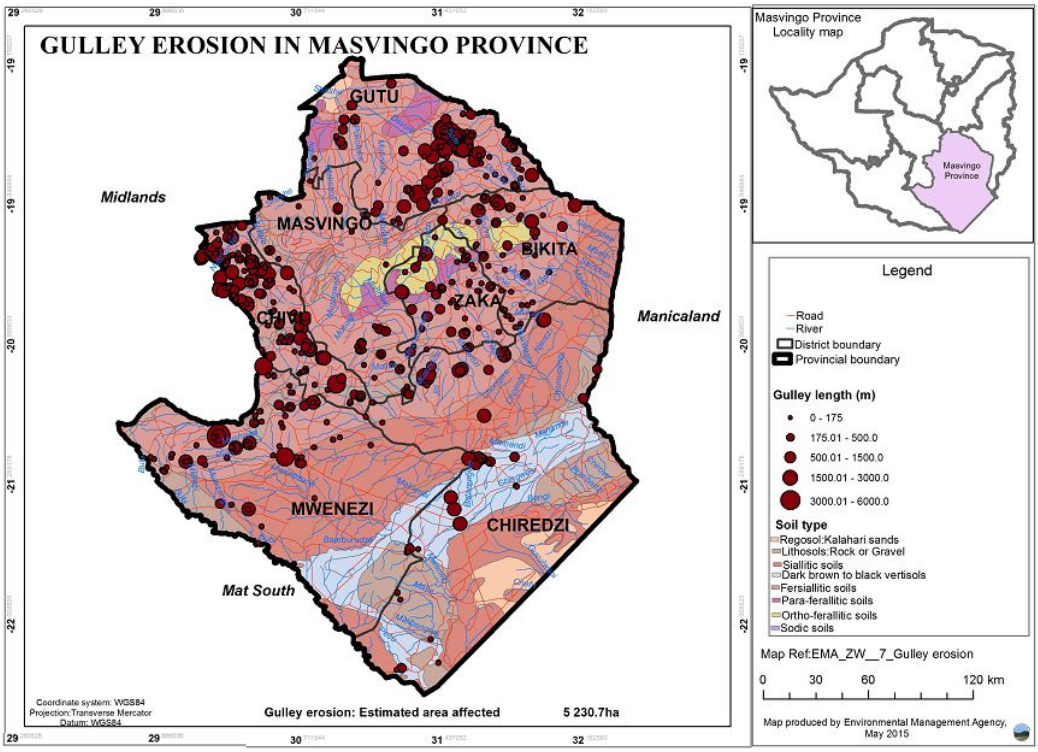
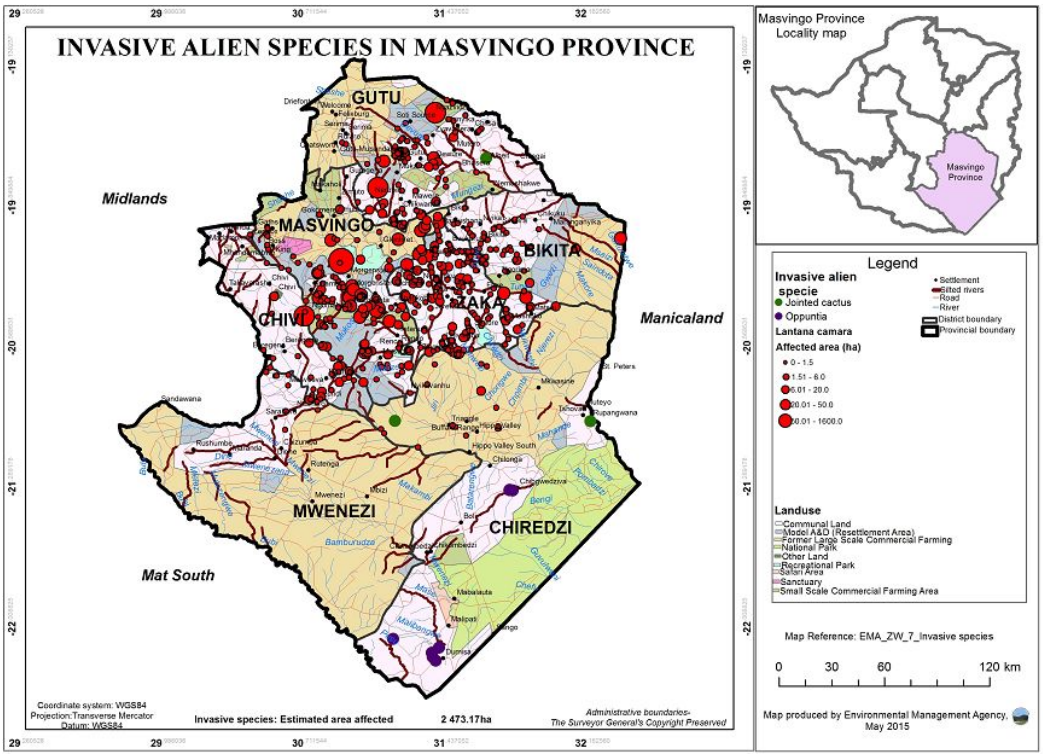


(Source: EMA)

Figure 4.3.1 Gully Erosion Distribution Map in Masvingo Province

- Vegetation

Growing of Lantana Camara, which is one of the invasive species, is a common problem of farmland in the project area. The distribution map of Lantana Camara in Masvingo Province is shown in Figure 4.3.2. On the other hand, the growing of Water Hyacinth in dam reservoirs is one of the problems causing deterioration of water quality due to obstruction of water flow and reduction of dissolved oxygen.



(Source: EMA)

Figure 4.3.2 Lantana Camara Distribution Map in Masvingo Province

(2) Social Environmental

- People

The ethnic group living in the project area is the Shona people. Although the official language is English, the Shona language is also used as a local language popularly. There are no tribal conflicts in the project area.

- Livelihood

According to the statistical data of Zimbabwe[1], the average household size living in the Communal Lands is 5 persons/households while the proportion of woman-headed households is around 36%. 98% of people living in Communal Lands are engaged in agriculture and their livelihoods are heavily dependent on it. In general, most of the farmers in Communal Lands are smallholders and the average farmland size is about 1.4 ha/households.

- Decision-Making System by Traditional Custom

The traditional leadership locality called Traditional Leaders (composed of local chiefs, headmen, and village leaders) is functioned and legally recognized in Communal Lands. Traditional Leaders substantially make a role in managing land use and dispute resolution of the community.

4.4 SCOPING

Scoping is carried out as the preliminary environmental and social impact assessment. As the results, most of the major negative impacts on environmental and social aspects are anticipated during construction works, such as water pollution, wastes, and so on. It is necessary to develop an EMP (Environmental Management Plan) of the project and implement appropriate mitigation measures and monitoring by construction contractor and implementation organization (DOI or ZINWA).

4.5 EVALUATION OF THE ENVIRONMENTAL CATEGORY (PROPOSED)

The scope of the project is limited to rehabilitation works of the existing agricultural dam and the current dam operation will be not changed after the rehabilitation works. Significant negative impacts on the surrounding natural environment and social environment by the project implementation are not anticipated. The project sites are not located in sensitive areas such as national protected areas and other important biodiversity areas. And the large-scale involuntary resettlement and/or land acquisition are not anticipated. For these reasons, it is assumed that the project will fall under Category B in the category classification of JICA environmental and social consideration guidelines.

CHAPTER 5 REHABILITATION COST

It is assumed that this rehabilitation project will be implemented by the Zimbabwean government budget or by the Japanese Grant Aid Project. The estimated project cost in each case is shown as below.

Implementation by the Zimbabwean Government:	5.80 million USD
Implementation by the Japanese Grant Aid Project:	10.05 million USD

[1] ZIMSTAT, Zimbabwe Smallholder Agricultural Productivity Survey 2017 Report, March 2019

CHAPTER 6 REQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

(1) Confirmation of the Implementing Agency of The Project

Determine implementing agencies from ZINWA or DOI.

(2) Natural Conditions Survey

1) Topographical survey

Plan survey, land survey, including the area around the reservoir, and longitudinal & cross-section survey of the embankment.

2) Soil investigation (Existing embankment)

Density, specific gravity, water absorption, water content ratio, grain size, compaction - permeability, liquid plasticity, consolidation, triaxial compression, etc.

3) Soil investigation (Borrow area)

Same test contents as the above soil investigation (Existing embankment)

4) Boring test (Pier foundation)

Standard penetration test (SPT)

(3) Planning of Project Content

1) Outline design

2) Construction/Procurement plan

*When upgrading a reservoir, there are two possible methods: (1) emptying the reservoir and (2) operating the reservoir (with water in the reservoir). Depending on which method is chosen, the scale of temporary facilities required will differ greatly, which will also affect the project cost. Therefore, the construction plan for the upgrading work should be developed with this in mind.

In addition, it is necessary to set the method of implementation after sufficient consultation and agreement with the Zimbabwean side and beneficiary farmers. In particular, it is necessary to inform and agree with the beneficiary farmers in Zimbabwe that if the project is to be implemented with emptying the reservoir, irrigated agriculture will not be possible for the relevant year (and possibly for several years thereafter) and that the beneficiary farmers will need to be guaranteed by the Zimbabwean government.

3) Plan of maintenance & operation

(4) Environmental and Social Considerations (Including Social Condition Survey)

1) Social survey of the target area, study of environmental and social impacts and countermeasures

2) Application and approval of environmental procedures to the EMA (Environmental Management Agency)

(submission of Prospectus and support for the preparation of environmental management plans, etc.)

(5) Estimating the Project Cost

CHAPTER 7 BENEFITS OF THE PROJECT

By implementing the project, deformations and damages occurring in each facility will be repaired to extend the service life of the facilities, which will avoid damage to the facilities due to aging and the resulting loss of human lives and assets, as well as ensure the continuation of irrigated agriculture in 33.3 ha by avoiding the suspension of irrigation water supply.

Appendix-4

New Irrigation Development Work Plan

Appendix-4-1

New Irrigation Development Work Plan

(Mushandike Old Resettlement Area
Village 17C, 18A and 19B)

CHAPTER 1 OUTLINE OF THE TARGET REGION

1.1 LOCATION OF THE TARGET REGION

The target Region comprises Mushandike Old Resettlement Area Village 17C, 18A and 19B, which is located approximately 35 km from the provincial capital Masvingo, and 50 km from the Muzhwi Dam, the water source of the Region (both linear distances). Also, the center of the Region is approximately 1.5 km from Tokwe River, the source of the water intake (see Figure 1.1).

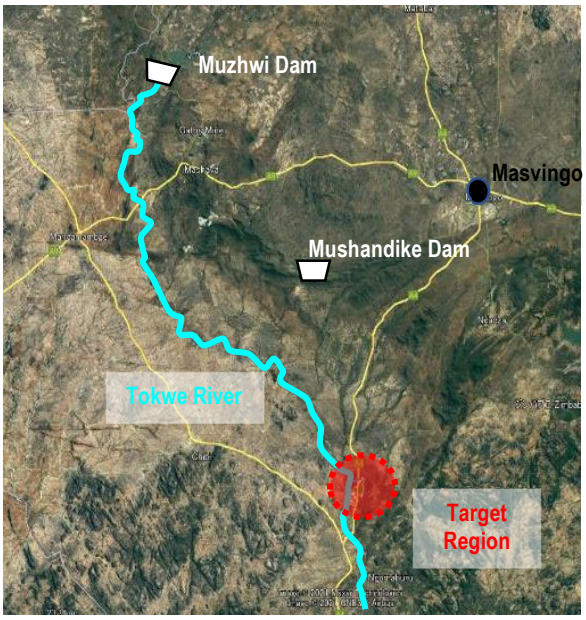


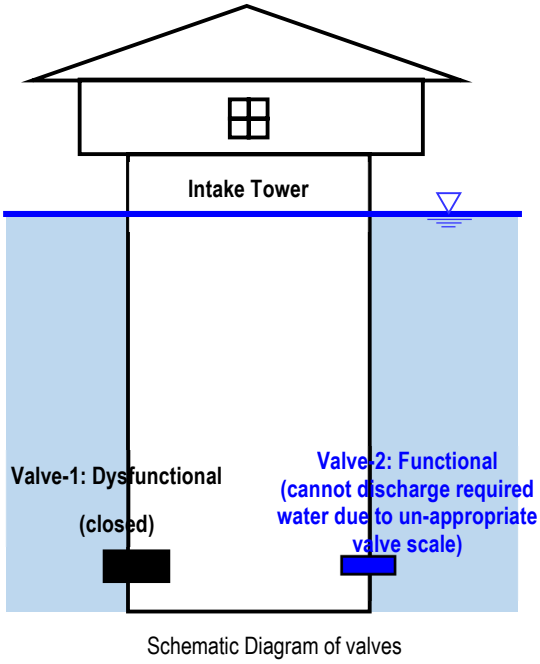
Figure 1.1 Location of the Target Region

1.2 CURRENT STATUS OF WATER BODY STRUCTURE (DAM AND RELATED FACILITIES)

Two intake valve units are set at the bottom of the Muzhwi Dam intake tower, which function is to discharge water into the downstream river.

Both of these two valve units have failed in the past, after then one unit is blocked and dysfunctional, another is in operation with a replaced valve. The replaced valve has smaller scale than the original one as it stated as a temporary measure. However, this valve has been in operation since then without being replaced by valve of the appropriate size (see Figure 1.2)

Therefore, these valves need to be replaced with the appropriate size to supply irrigation water to all the beneficiary area under Muzhwi dam, including the target Region.



Schematic Diagram of valves

Figure 1.2 Status of Valves

1.3 CURRENT STATUS OF THE FARMING ACTIVITIES

1.3.1 Non-Irrigated Area

The typical crop planting period in the non-irrigated area in the Muzhwi-Mushandike Area, which locates near the target Region, is as shown in Figure 1.3. No-cultivation is being conducted in the dry season due to almost no rainfall.

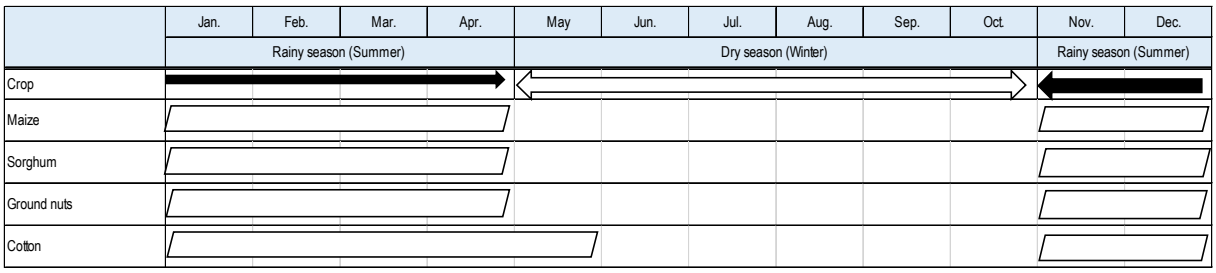


Figure 1.3 Crop Planting Period of the Typical Crops (Non-Irrigated Area)

1.3.2 Irrigated Area

The typical crop planting period in the irrigated area in the Muzhwi-Mushandike Area, which locates near the target Region, is as shown in Figure 1.4.

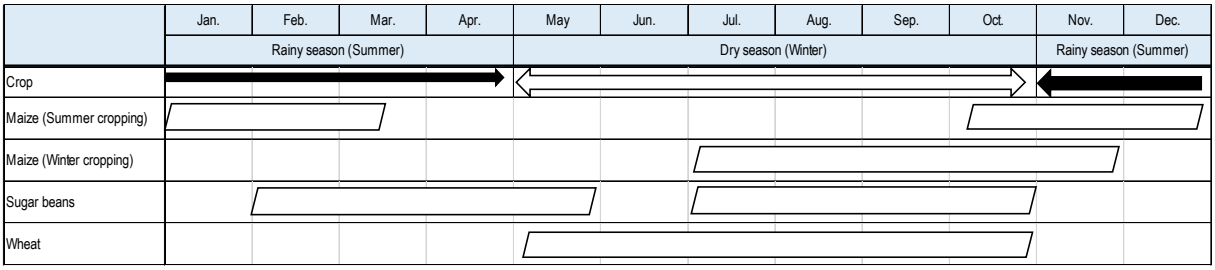


Figure 1.4 Crop Planting Period of the Typical Crops (Irrigated Area)

According to the status in the irrigated area, the conversion from non-irrigated area to irrigated area in the target Region may lead to the significant increase of gross income of farmers since 1) high-priced crops (wheat, sugar beans) can be introduced and 2) land use ratio is improved through planting during dry season (winter cropping).

CHAPTER 2 FACILITY LAYOUT PLAN

2.1 BASIC POLICY

- The maximum pump head shall be 80 m. If it exceeds this value, the pumps shall be arranged in a multi-stage system.
- The pumps are operated in alternating two systems. A pump system is operated for a period of 24 hours (nighttime: 16 hours + daytime: 8 hours) and then 24 hours deactivated.

1) Nighttime (16:00 – 8:00: 16 hours) **2) Daytime (8:00 – 16:00: 8 hours)**

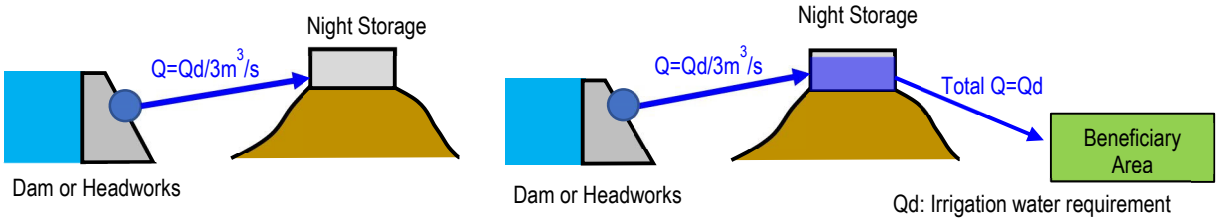


Figure 2.1 Pump Operetaion Plan

- Water-saving irrigation (hose irrigation) is the basis for the following reasons.
  - ✓ To create more beneficiary area and beneficiary farmers
  - ✓ To reduce the scale (cost) of main facilities per unit beneficiary area
  - ✓ To be in line with national development policy (Water-saving irrigation is recommended in the national development policies, such as NDS-1)
- The application efficiency of water-saving irrigation is 1.5 times smaller than that of under surface irrigation (water-saving irrigation can irrigate 1.5 times as much area as surface irrigation with the same amount of water).

2.2 FACILITY LAYOUT PLAN

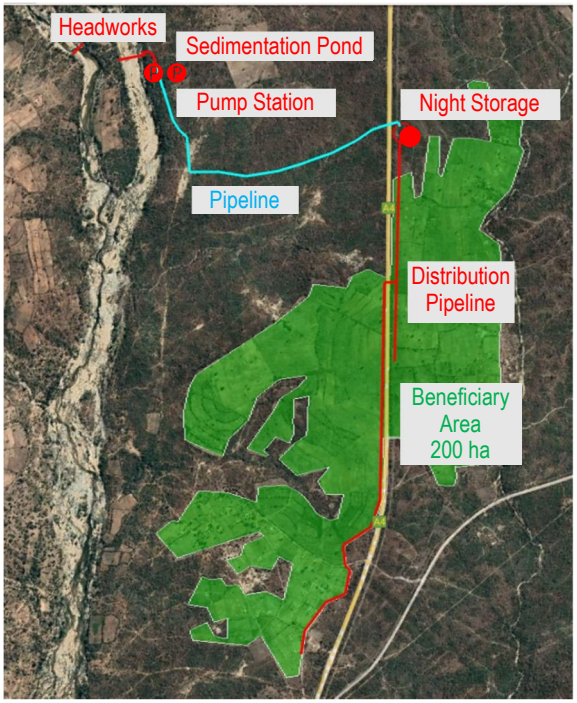


Figure 2.2 Facility Layout Plan

Table 2.1 Specification of the Facilities

Facilities	Specification
Headworks	H =4m B =225m
Sedimentation Pond	1 unit
Pumps	110 kW x 2 units
Pipeline	Φ=400 mm、L=1.7 km
Night Storage	V=9,100 m^3
Distribution Pipeline	Φ=400~500 mm L=4.1 km
Beneficiary Area	Under Surface Irrigation: 200 ha Under Water-saving irrigation: 200 ha * The 200 ha is the maximum area defined by topographical conditions and cannot be increased by introducing water-saving irrigation.

2.3 RELATED FACILITIES

In addition to the main facilities mentioned above, the following related facilities are planned to be installed.

2.3.1 Standby Generator

The results of the interviews with the IMC of the existing irrigation scheme (Biri Extension irrigation scheme in Mundi Mataga Area, irrigated area 145 ha) revealed the followings.

- The electricity supply in Zimbabwe is erratic, and irrigation pumps are deactivated during the daytime, resulting in occasional interruptions of the irrigation water supply.
- On the other hand, sometimes power is restored during the night time, and when this happens, beneficiary farmers have to work in the dark. In addition to the physical dangers of working in the dark, there is a high proportion of women and elderly people working on farms, and a high risk of crime.

Taking into account these situations, a standby generator is planned to be installed to cope with the unstable power supply and to avoid night work.

2.3.2 Storage House

In the past till 2002, GMB has come to the field to buy crops even if the volume of sales was small. Now, however, the GMB only picks up the crop if the volume of sales exceeds 10 ton, and if the volume is less than 10 ton, the beneficiary farmers have to transport the crop to the GMB by themselves.

Taking into account the situation above, a storage house is planned to be installed in order to 1) ensure the volume of agriculture production exceeds 10 tons by gathering from each beneficiary farmers under the IMC, 2) create a situation where GMB comes to the farmland from their side, 3) improve access to markets through 1) and 2), and 4) increase beneficiary farmers' income.

CHAPTER 3 PRELIMINARY ENVIRONMENTAL AND SOCIAL CONSIDERATION

3.1 NATURAL ENVIRONMENT ASPECTS

The source of water for the new irrigation scheme will be Tokwe River which is the downstream of Muzhwi Dam. The water flow of the Tokwe River is low at present because of the low water discharge from the Muzhwi Dam. In case of the development of irrigation scheme, water volume of Tokwe River will be increased with securing the continuous flow from Muzhwi Dam and positive impacts are expected on aquatic biodiversity in the river

Figure 3.1 Condition of Tokwe River at Planned Intake Point

It was confirmed that there are some farmers who use the land of sandbank of river as farmlands near the intake point. Although it is possible to avoid the impacts of water level raising at these farmlands by locating the intake point (headworks) at upstream of those lands, such farmland use should be restricted in the river considering the risk of sudden flooding. Further survey is necessary to confirm if any other similar farmers exist or not in the upstream side of the planned intake point of river. Also, awareness should be given among local people for the safety of the river.

The area around Mushandike Dam reservoir is designated as a protected area of Mushandike Sanctuary. Mushandike Dam is located at around 20 km north of the planned irrigation scheme. Mushandike Dam is not the source of planned irrigation scheme and location of Sanctuary is 20 km far from the scheme. Therefore, the project activities will not affect to the Mushandike Sanctuary. Any other protected areas

or important biodiversity areas (Ramsar wetlands, IBAs) are not located in and around the project area.

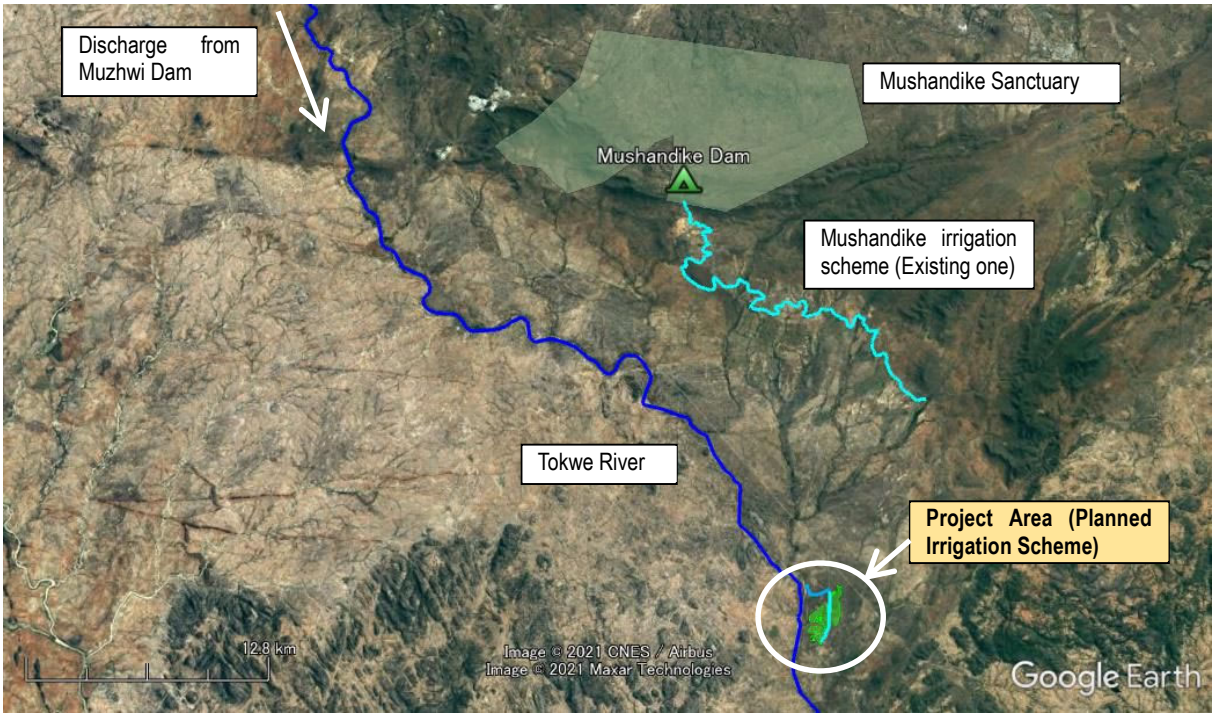


Figure 3.2 Location of the Mushandike Sanctuary (Protected Area) and Planned Irrigation Schem

3.2 SOCIAL ENVIRONMENT ASPECTS

The beneficiary areas of the proposed irrigation scheme are composed of Villages No. 17-C, 18-A and 19-B belonging to the Mushandike Old Resettlement Area. The Old Resettlement Area is the areas that were settled under the Old Resettlement Programme of GoZ (1980-1998).

The whole of the Mushandike Old Resettlement Area comprises villages No.1 to No. 37, which were settled by the people from the neighbouring Communal Lands. Villages are called by only village No. and have no specific name. As the result of the expansion of the villages by the descendants of settlers, the original villages are called A and the enlarged villages are called B or C. The number of farmers in each village ranges from 30 to 100.

Villages No. 10 to 16, 21, 22 and 23 of the Mushandike Old Resettlement Area are irrigated by the existing irrigation scheme named as Mushandike Irrigation Scheme. Other villages are non-irrigated and depend on rain-fed agriculture (See Figure 3.3).

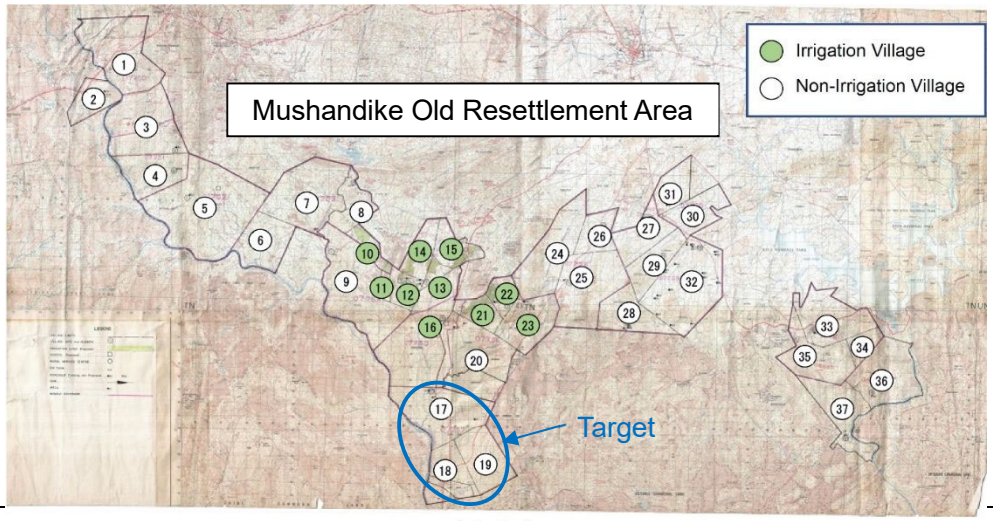


Figure 3.3 General Layout of Mushandike Old Resettlement Area

In case of the development of new irrigation scheme, the plots of the beneficiary area will be allocated equally to the beneficiary farmers of the area, including the current land users. The allocation of plots will be carried out under the management of Traditional Leaders and District Councils.

The acquisition of lands for the proposed construction sites will be taken from the state lands since land ownership of the Old Resettlement Area belongs to the state and land use is managed by Traditional Leaders and District Council. In case of the land acquisition, coordination with those traditional decision-making organizations will be necessary.

3.3 SCOPING

According to the scoping result, most of the major negative impacts on environmental and social aspects are anticipated during construction works, such as water pollution, wastes, and so on. It is necessary to develop an EMP (Environmental Management Plan) of the project and implement appropriate mitigation measures and monitoring by construction contractor and implementation organization (DOI or ZINWA).

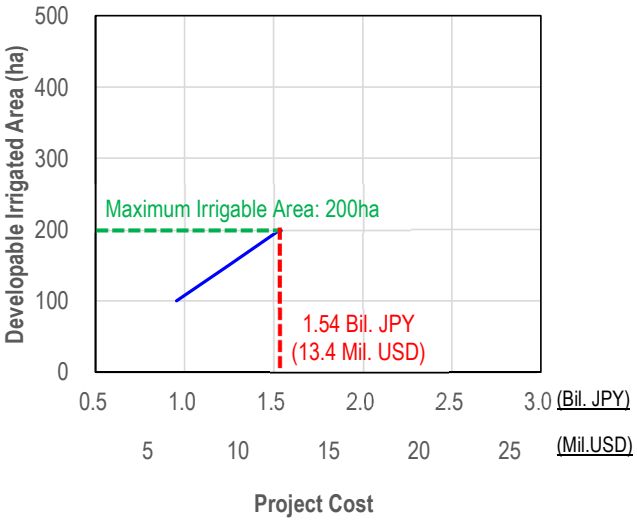
3.4 EVALUATION OF THE ENVIRONMENTAL CATEGORY (PROPOSED)

As the result of preliminary evaluation at screening stage, it is assumed the project will fall under Category B in the category classification of JICA environmental and social consideration guideline with the reasons of 1) the project area is not located in sensitive area such as national protected areas and other important biodiversity areas, 2) large scale involuntary resettlement and/or land acquisition are not expected and the 3) project scale and components of new project are similar to past JICA irrigation project (Nyakomba Irrigation Scheme Development Project) with Category B.

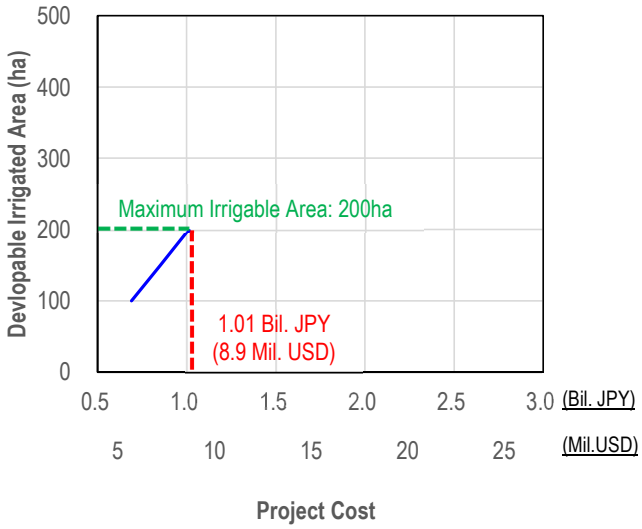
CHAPTER 4 PROJECT COST

The project cost of the new irrigation scheme development is calculated in case it is implemented under the Grant Aid Project. The relationship between the project cost and the developable irrigated area is calculated for two cases, development of on-farm facilities and land development are implemented under the Grant Aid Project or by Zimbabwean side.

The results of the calculations are shown in Figure 4.1. The project cost includes the cost of replacing the valve of the dam intake tower. Also, cost for on-farm facilities is in case of water-saving irrigation. The total area of 200 ha can be irrigated for approximately 1.54 billion JPY (=13.4 million USD) in case the on-farm facilities and land development are implemented under the Grant Aid Project, and for approximately 1.01 billion JPY (= 8.9 million USD) in case they are implemented by Zimbabwean side. However, due to topographical conditions, the irrigated area cannot be increased beyond 200 ha.



1) In case on-farm facilities and land development are implemented under Grant Aid Project.



2) In case on-farm facilities and land development are implemented by Zimbabwean Side

Figure 4.1 Relation between Project Costs and Developable Irrigated Area

CHAPTER 5 REQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

(1) Identification of the Implementation Agency of the Zimbabwean Side

ZINWA or DOI

(2) Natural Condition Survey

1) Topographic survey

Plan survey at each facility point, longitudinal and cross section survey along the pipeline alignment, plan survey of the beneficiary area etc.

2) Geological Survey

Boring survey (Standard Penetration Test: SPT) at each of facility points

3) Hydro-Meteorological Survey

Rainfall, temperature, humidity, wind speed, sunshine hours at the typical point of the beneficiary area

(3) Project Formulation

1) Formulation of farming plan and water use plan

2) Formulation of irrigation plan

3) Facilities design

4) Construction/Procurement Plan

* There are two possible methods to replace valves in dam intake towers 1) with the reservoir empty, or 2) with water in the reservoir (under operating). Depending on which method is chosen, the scale of the temporary works required varies greatly and affects the project cost. It is therefore necessary to

take this into account for construction planning of the rehabilitation works.

The method of implementation of the plan should be fully discussed and agreed with the Zimbabwean side and the beneficiary farmers. In particular, it is necessary to inform and agree with the Zimbabwean side that if the plan is to be implemented with the reservoir empty, irrigated agriculture cannot not be possible for the relevant year (and possibly for several years thereafter), and that the Government of Zimbabwe needs compensation to the beneficial farmers.

5) Formulation of O&M Plan

i) Facility O&M Plan (including water management), ii) Farming activities training plan, iii) Strategic farmers' income increasing plan and iv) O&M structure plan to materialize the sustainable O&M of the developed irrigation scheme.

(4) Environmental and Social Consideration

1) Social survey of the target Region

2) Assessment of environmental and social impact, and examination of those mitigation measure(s)

3) Application to and approval from EMA in respect to procedures related to the environment (submission of Prospectus and assistance in the preparation of environmental management plans, etc.)

(5) Estimation of Project Cost

CHAPTER 6 BENEFIT FROM THE IMPLEMENTATION OF THE PLAN

The implementation of the Plan will increase the irrigated area by 200 ha, and the implementation of dry-season cropping will improve land use, increase agricultural production and increase yields, which will significantly increase the income of beneficiary farmers.

The increased production will also lead to improvement of the food self-sufficiency and contribute significantly to ensuring food and nutrition security, which is a national challenge. In addition, the conversion of rainfed agriculture to irrigated agriculture in the target Region will strengthen resilience to climate change, especially drought.

Appendix-4-2

New Irrigation Development Work Plan

(Dinhe Region)

CHAPTER 1 OUTLINE OF THE TARGET REGION

1.1 LOCATION OF THE TARGET REGION

The target Dinhe Region is located approximately 130 km from the provincial capital Masvingo, and 20 km from the Manyuchi Dam, the water source of the Region (both linear distances). Also, the center of the Region is approximately 2.0 km from Mwenezi River, the source of the water intake (see Figure 1.1).

In the target Region, there are already 30 ha of plots developed by CESVI, an Italian international NGO, but the pumps are not functional and irrigated agriculture is not practiced.

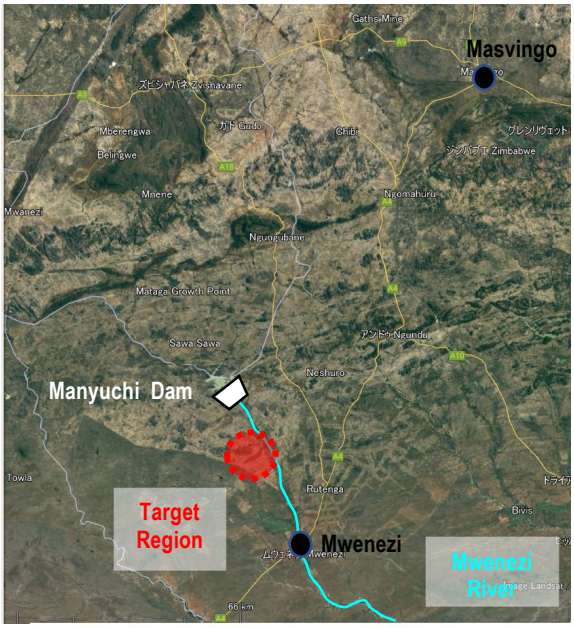


Figure 1.1 Location of the Target Region

1.2 CURRENT STATUS OF WATER BODY STRUCTURE (DAM AND RELATED FACILITIES)

Manyuchi Dam has three units of discharge facilities, and two out of three are equipped with a valve for each. The purpose of the valves is to discharge water into the downstream river, and the remaining unit is for power generation facility to be installed.

The valves on these two units are in good working order (see Figure 1.2) and it has been determined that there are no items that need to be addressed.

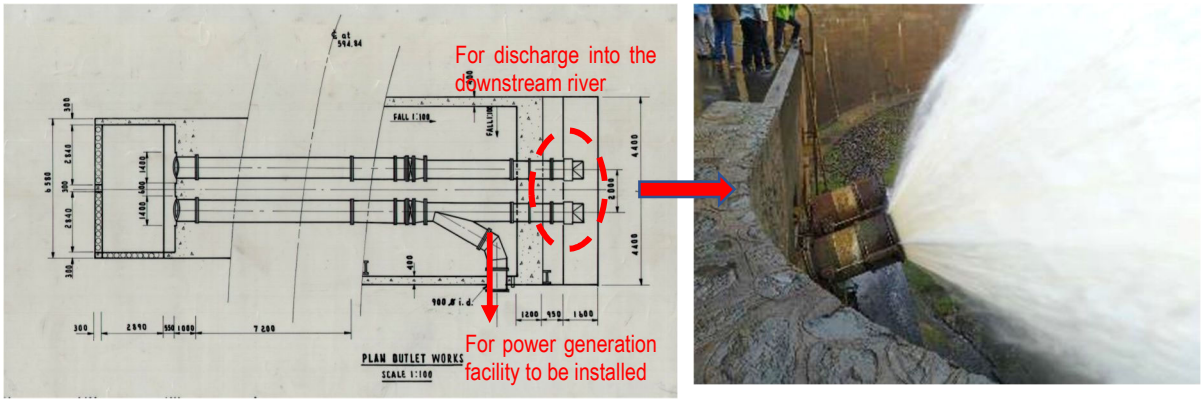


Figure 1.2 Status of the Discharge Facilities

1.3 CURRENT STATUS OF THE FARMING ACTIVITIES

1.3.1 Non-Irrigated Area

The typical crop planting period in the non-irrigated area in the Manyuchi Area, which locates near the target Region, is as shown in Figure 1.3. No-cultivation is being conducted in the dry season due to almost no rainfall.

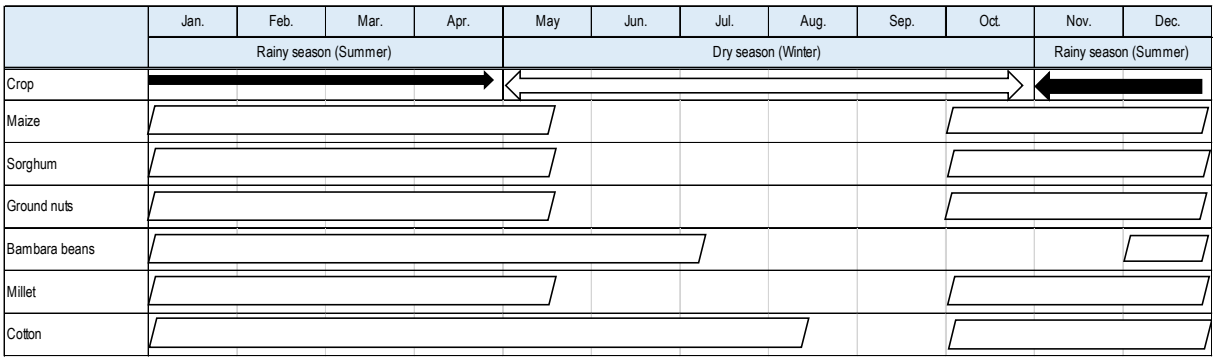


Figure 1.3 Crop Planting Period of the Typical Crops (Non-Irrigated Area)

1.3.2 Irrigated Area

The typical crop planting period in the Irrigated area in the Manyuchi Area, which locates near the target Region, is as shown in Figure 1.4.

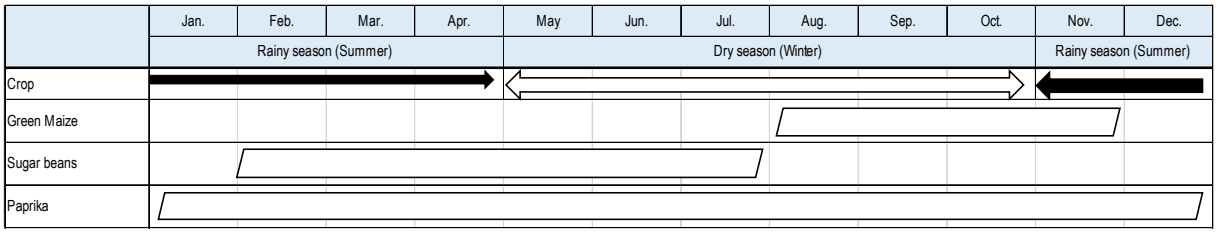


Figure 1.4 Crop Planting Period of the Typical Crops (Irrigated Area)

In the above irrigated areas, irrigation facilities have been developed with the support of CESVI, an international Italian NGO, and a total of 30 ha of land is under contract farming. The selling price is high due to the contract farming and the yield is also high.

This situation suggests that if irrigation water is provided in the target Region, there is a possibility of establishment of contract farming, which would significantly increase farmers' income due to higher yields and higher selling prices.

CHAPTER 2 FACILITY LAYOUT PLAN

2.1 BASIC POLICY

- The maximum pump head shall be 80 m. If it exceeds this value, the pumps shall be arranged in a multi-stage system.
- The pumps are operated in alternating two systems. A pump system is operated for a period of 24 hours (nighttime: 16 hours + daytime: 8 hours) and then 24 hours deactivated.

1) Nighttime (16:00 – 8:00: 16 hours) **2) Daytime (8:00 – 16:00: 8 hours)**

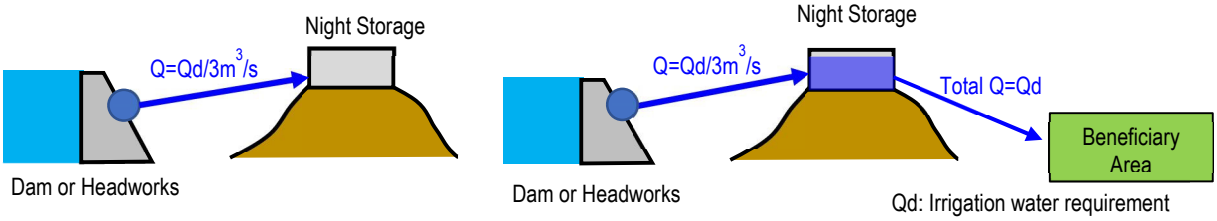


Figure 2.1 Pump Operetaion Plan

- Water-saving irrigation (hose irrigation) is the basis for the following reasons.
  - ✓ To create more beneficiary area and beneficiary farmers
  - ✓ To reduce the scale (cost) of main facilities per unit beneficiary area
  - ✓ To be in line with national development policy (Water-saving irrigation is recommended in the national development policies, such as NDS-1)
- The application efficiency of water-saving irrigation is 1.5 times smaller than that of under surface irrigation (water-saving irrigation can irrigate 1.5 times as much area as surface irrigation with the same amount of water).

2.2 FACILITY LAYOUT PLAN

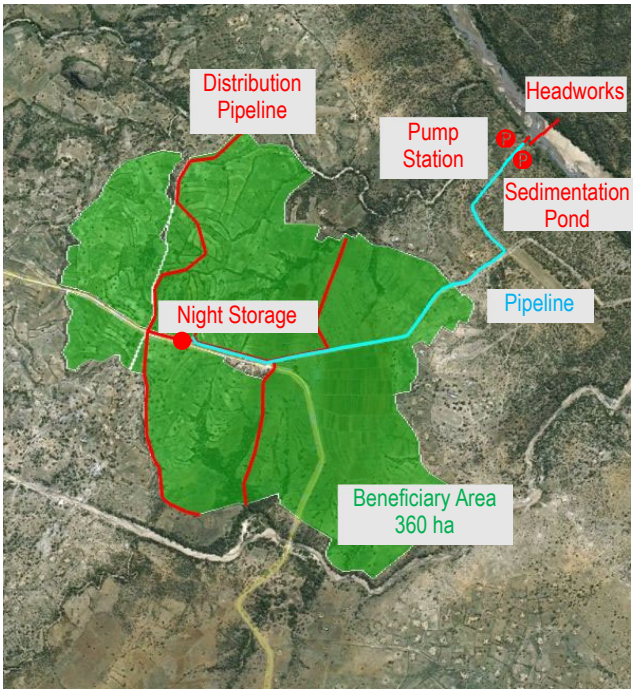


Figure 2.1 Facility Layout Plan

Table 2.1 Specification of the Facilities

Facilities	Specification
Headworks	H＝3 m B＝240 m
Sedimentation Pond	1 unit
Pumps	132 kW x 4 units
Pipeline	Φ=500 mm、L=3.0 km
Night Storage	V= 14,000 m3
Distribution Pipeline	Φ=250~300 mm L=6.6 km
Beneficiary Area	Under Surface Irrigation: 360 ha Under Water-saving irrigation: 360 ha * The 360 ha is the maximum area defined by topographical conditions and cannot be increased by introducing water-saving irrigation.

2.3 RELATED FACILITIES

In addition to the main facilities mentioned above, the following related facilities are planned to be installed.

2.3.1 Standby Generator

The results of the interviews with the IMC of the existing irrigation scheme (Biri Extension irrigation scheme in Mundi Mataga Area, irrigated area 145 ha) revealed the followings.

- The electricity supply in Zimbabwe is erratic, and irrigation pumps are deactivated during the daytime, resulting in occasional interruptions of the irrigation water supply.
- On the other hand, sometimes power is restored during the night time, and when this happens, beneficiary farmers have to work in the dark. In addition to the physical dangers of working in the dark, there is a high proportion of women and elderly people working on farms, and a high risk of crime.

Taking into account these situations, a standby generator is planned to be installed to cope with the unstable power supply and to avoid night work.

2.3.2 Storage House

In the past till 2002, GMB has come to the field to buy crops even if the volume of sales was small. Now, however, the GMB only picks up the crop if the volume of sales exceeds 10 ton, and if the volume is less than 10 ton, the beneficiary farmers have to transport the crop to the GMB by themselves.

Taking into account the situation above, a storage house is planned to be installed in order to 1) ensure the volume of agriculture production exceeds 10 tons by gathering from each beneficiary farmers under the IMC, 2) create a situation where GMB comes to the farmland from their side, 3) improve access to markets through 1) and 2), and 4) increase beneficiary farmers' income.

CHAPTER 3 PRELIMINARY ENVIRONMENTAL AND SOCIAL CONSIDERATION

3.1 Natural Environment Aspects

The source of water for the new irrigation scheme will be Mwenezi River which is the downstream of Manyuchi Dam. The Manyuchi Dam currently discharges water into the Mwenezi River for agricultural purpose and river maintenance purposes. The Gonarezou National Park (505,300 ha) is located at 120 km downstream of Manyuchi Dam and 100 km downstream of the planned irrigation scheme. It is evaluated the impacts on the Gonarezou National Park by the project is not significant since the water intake for the planned irrigation scheme is not large scale and the location of the scheme is 100 km far from national park.

The planned irrigation scheme will consist of the Headworks - Sedimentation pond - Pump station - Night storage – Distribution pipeline - Beneficiary areas. All of the proposed construction sites are located in woodlands (shrubs, bushes, etc.) or agricultural lands where human activities are already carried out. Also, there are no protected areas and important biodiversity areas (Ramsar wetlands, IBAs) in and around the project area.

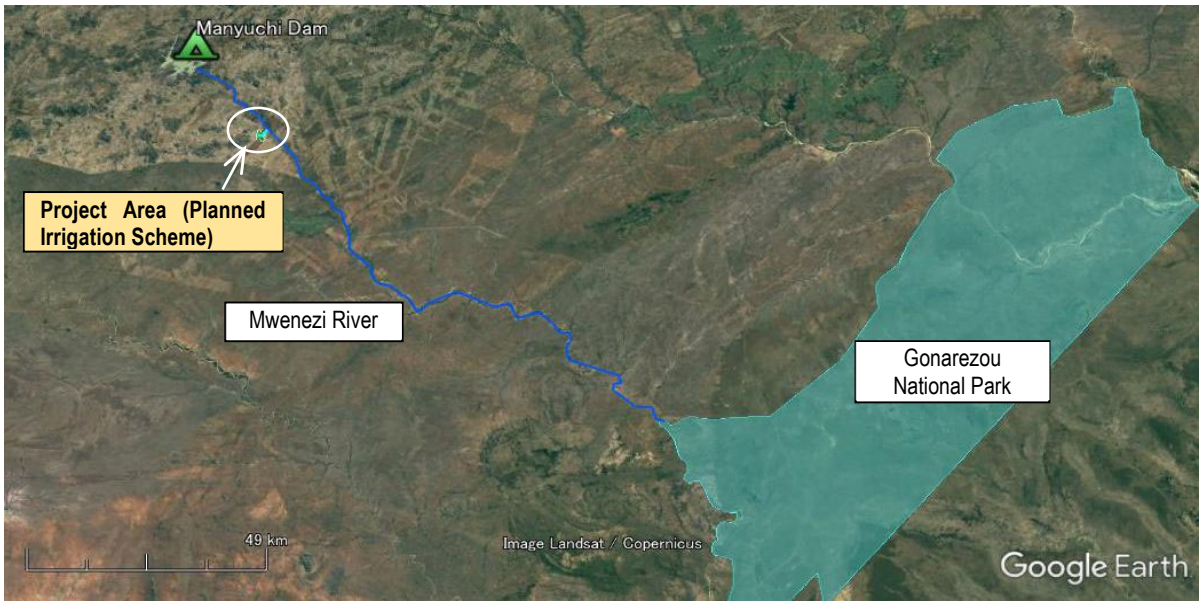


Figure 3.1 Location of the Gonarezou National Park (Protected Area) and Planned Irrigation Scheme

3.2 Social Environment Aspects

The beneficiary area of the planned irrigation scheme is named as Dinhe Region which is located in the Communal Land. The name of the Communal Land is Maranda Communal Land. The Communal Land has been a Tribe Trust Land since around 1930, when people of African descent were forcibly relocated to the area and have lived there ever since. Historically, Communal Land has been allocated to the areas with poor farming conditions, where most of farmers are smallholder and generally subsistence farmers. Farmers in Communal Land strongly desire irrigational agriculture because its advantages in production and productivity against rainfed agriculture.

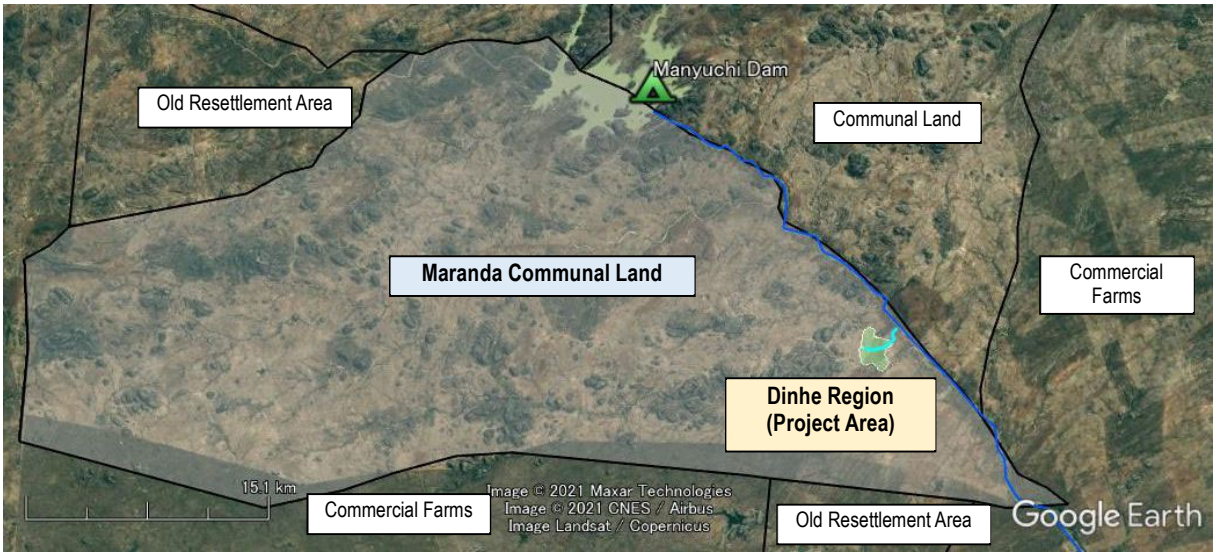


Figure 3.2 Land Category around the Project Area (Dinhe Region)

In the Dinhe Region, there are 30 ha of farming plots which have already been developed by CESVI, an Italian international NGO project. New irrigation scheme will be developed with integration of this existing farming plots. It will therefore require coordination and integration with the existing IMC for managing developed irrigation scheme.

Figure 3.3 Existing Farming Plots Developed by CESVI (30 ha)

In case of the new irrigation scheme development, the plots of farmlands will be allocated equally to the beneficiary farmers of the Region, including the current land users. The allocation of plots will be carried out under the management of Traditional Leaders and District Councils.

The acquisition of lands for the proposed construction sites will be taken from the state lands since land ownership of the Communal Land belong to the state and land use is managed by Traditional Leaders and District Council. In case of the land acquisition, coordination with those traditional decision-making organizations will be necessary.

3.3 SCOPING

According to the scoping result, most of the major negative impacts on environmental and social aspects are anticipated during construction works, such as water pollution, wastes, and so on. It is necessary to

develop an EMP (Environmental Management Plan) of the project and implement appropriate mitigation measures and monitoring by construction contractor and implementation organization (DOI or ZINWA).

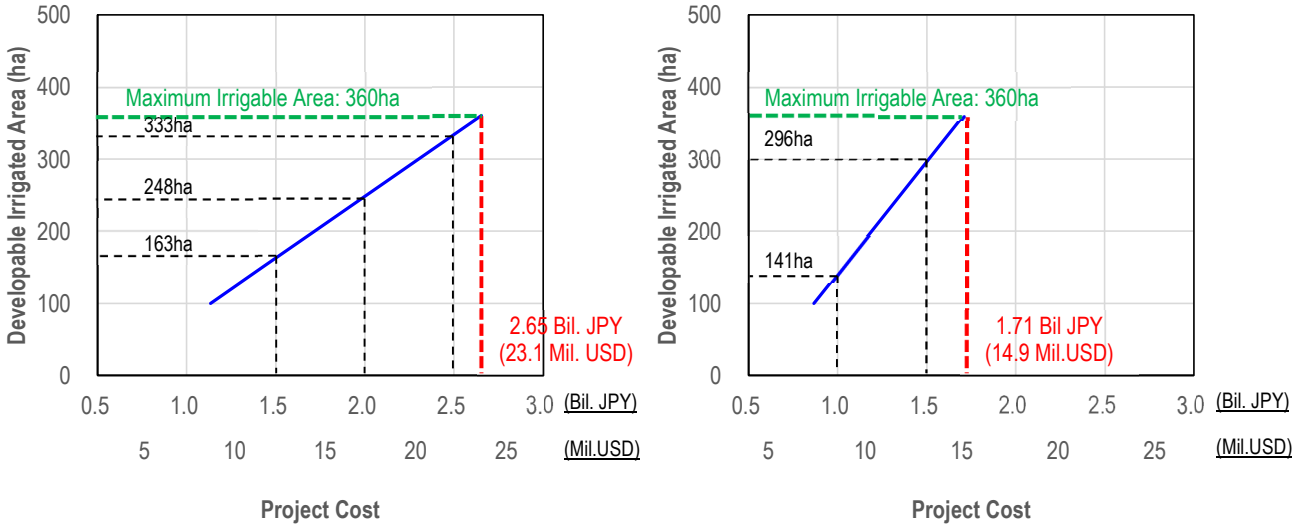
3.4 EVALUATION OF THE ENVIRONMENTAL CATEGORY (PROPOSED)

As the result of preliminary evaluation at screening stage, it is assumed the project will fall under Category B in the category classification of JICA environmental and social consideration guideline with the reasons of 1) the project area is not located in sensitive area such as national protected areas and other important biodiversity areas, 2) large scale involuntary resettlement and/or land acquisition are not expected and the 3) project scale and components of new project are similar to past JICA irrigation project (Nyakomba Irrigation Scheme Development Project) with Category B.

CHAPTER 4 PROJECT COST

The project cost of the new irrigation scheme development is calculated in case it is implemented under the Grant Aid Project. The relationship between the project cost and the developable irrigated area is calculated for two cases, development of on-farm facilities and land development are implemented under the Grant Aid Project or by Zimbabwean side.

The results of the calculations are shown in Figure 4.1. Cost for on-farm facilities is in case of water-saving irrigation. The total area of 360 ha can be irrigated even for approximately 2.65 billion JPY (=23.1 million USD) in case the on-farm facilities and land development are implemented under the Grant Aid Project, and for approximately1.71 billion JPY (=14.9 million USD) in case they are implemented by Zimbabwean side. However, due to topographical conditions, the irrigated area cannot be increased beyond 360 ha.



1) In case on-farm facilities and land development are implemented by Grant Aid Project.

2) In case on-farm facilities and land development are implemented by Zimbabwean side

Figure 4.1 Relation between Project Costs and Developable Irrigated Area

CHAPTER 5 EQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

(1) Identification of the Implementation Agency of the Zimbabwean Side

ZINWA or DOI

(2) Natural Condition Survey

1) Topographic survey

Plan survey at each facility point, longitudinal and cross section survey along the pipeline alignment, plan survey of the beneficiary area etc.

2) Geological Survey

Boring survey (Standard Penetration Test: SPT) at each of facility points

3) Hydro-Meteorological Survey

Rainfall, temperature, humidity, wind speed, sunshine hours at the typical point of the beneficiary area

(3) Project Formulation

1) Formulation of farming plan and water use plan

2) Formulation of irrigation plan

3) Facilities design

4) Construction/Procurement Plan

5) Formulation of O&M Plan

i) Facility O&M Plan (including water management), ii) Farming activities training plan, iii) Strategic farmers' income increasing plan and iv) O&M structure plan to materialize the sustainable O&M of the developed irrigation scheme.

(4) Environmental and Social Consideration

1) Social survey of the target Region

2) Assessment of environmental and social impact, and examination of those mitigation measure(s)

3) Application to and approval from EMA in respect to procedures related to the environment (submission of Prospectus and assistance in the preparation of environmental management plans, etc.)

(5) Estimation of Project Cost

CHAPTER 6 BENEFIT FROM THE IMPLEMENTATION OF THE PLAN

The implementation of the Plan will increase the irrigated area by 360 ha, and the implementation of dry-season cropping will improve land use, increase agricultural production and increase yields, which will significantly increase the income of beneficiary farmers.

The increased production will also lead to improvement of the food self-sufficiency and contribute significantly to ensuring food and nutrition security, which is a national challenge. In addition, the conversion of rainfed agriculture to irrigated agriculture in the target Region will strengthen resilience to climate change, especially drought.

Appendix-4-3

New Irrigation Development Work Plan

(Funye Region)

CHAPTER 1 OUTLINE OF THE TARGET REGION

1.1 LOCATION OF THE TARGET REGION

The target Funye Region is located approximately 150 km from the provincial capital Gweru, and 12 km from the Manyuchi Dam, the water source of the Region (both linear distances) (see Figure 1.1). Mundi Mataga Dam is on the same river as the Manyuchi Dam, but the Mundi Mataga Dam does not have the storage capacity to supply water to Manyuchi Dam (= Mundi Mataga doe not act as a water source of Manyuchi Dam).

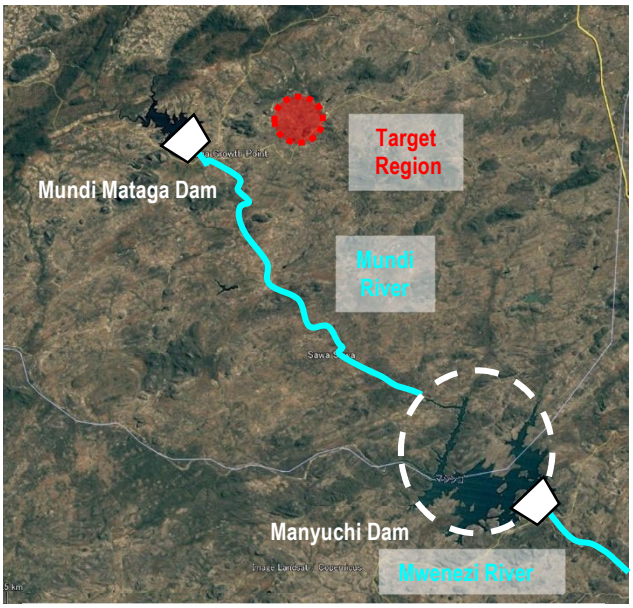
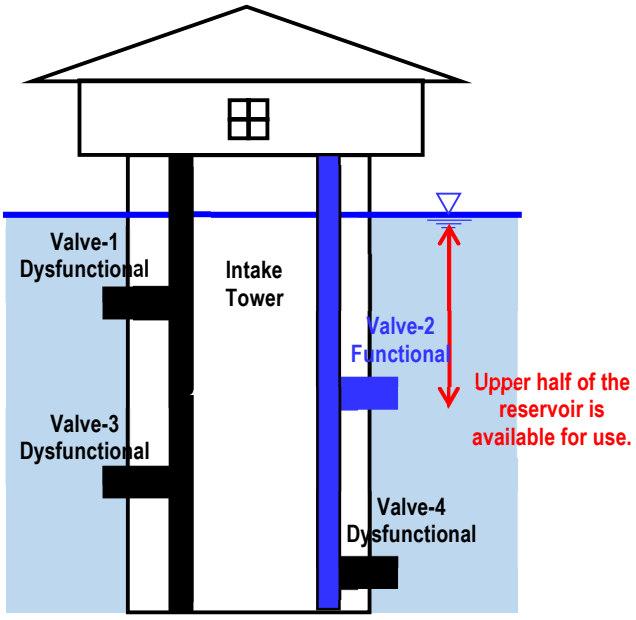


Figure 1.1 Location of the Target Region

1.2 CURRENT STATUS OF WATER BODY STRUCTURE (DAM AND RELATED FACILITIES)

The Mundi Mataga Dam intake tower has a two system of vertical intake pipes, each with two valves at different elevations. Only one out these four valves is in operation and only the upper half of the reservoir is available for use (see Figure 1.2). Therefore, in order to supply irrigation water to the entire beneficiary area under Mundi Mataga Area, including the target Region, it is necessary to replace the inactive three valves.



Schematic Diagram of Valves

Figure 1.2 Status of Intake Valves

1.3 CURRENT STATUS OF THE FARMING ACTIVITIES

1.3.1 Non-Irrigated Area

The typical crop planting period in the non-irrigated area of the Mundi Mataga Area, which locates near the target Region, is as shown in Figure 1.3. No-cultivation is being conducted in the dry season due to almost no rainfall.

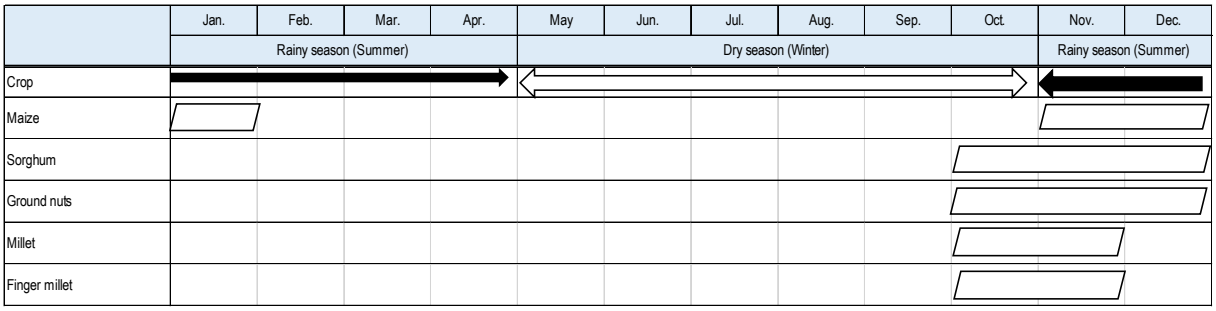


Figure 1.3 Crop Planting Period of the Typical Crops (Non-Irrigated Area)

1.3.2 Irrigated Area

The typical crop planting period in the Irrigated area of the Mundi Mataga Area, which locates near the target Region, is as shown in Figure 1.4 and Figure 1.5. The beneficiary farmers in this area have farmland of 0.5 ha (0.25ha / plot x 2 plots) per one beneficiary farmer. The beneficiary farmers use these two plots and are carrying out the crop rotation.

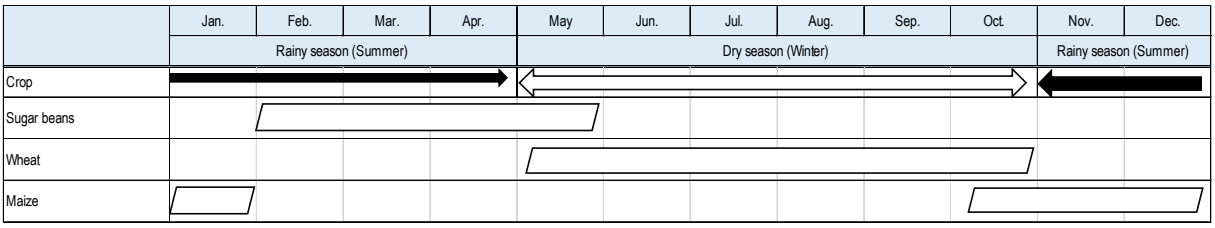


Figure 1.4 Crop Planting Period of the Typical Crops (Irrigated Area: First Year)

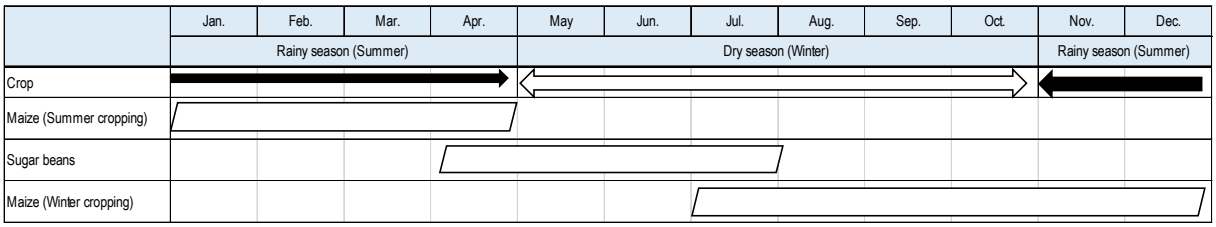


Figure 1.5 Crop Planting Period of the Typical Crops (Irrigated Area: Second Year)

According to the status in the irrigated area, the conversion from non-irrigated area to irrigated area may lead to the significant increase of gross income of farmers since 1) high-priced crops (wheat, sugar beans) can be introduced and 2) land use ratio is improved through planting during dry season (winter cropping).

CHAPTER 2 FACILITY LAYOUT PLAN

2.1 BASIC POLICY

- The maximum pump head shall be 80 m. If it exceeds this value, the pumps shall be arranged in a multi-stage system.
- The pumps are operated in alternating two systems. A pump system is operated for a period of 24 hours (nighttime: 16 hours + daytime 8 hours) and then 24 hours deactivated.

1) Nighttime (16:00 – 8:00: 16 hours) **2) Daytime (8:00 – 16:00: 8 hours)**

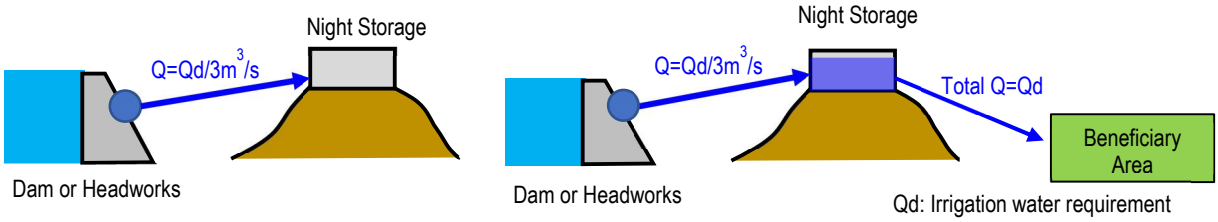


Figure 2.1 Pump Operetaion Plan

- Water-saving irrigation (hose irrigation) is the basis for the following reasons.
  - ✓ To create more beneficiary area and beneficiary farmers
  - ✓ To reduce the scale (cost) of main facilities per unit beneficiary area
  - ✓ To be in line with national development policy (Water-saving irrigation is recommended in the national development policies, such as NDS-1)
- The application efficiency of water-saving irrigation is 1.5 times smaller than that of under surface irrigation (water-saving irrigation can irrigate 1.5 times as much area as surface irrigation with the same amount of water).

2.2 FACILITY LAYOUT PLAN

Two step pump system with a balancing reservoir is planned since total pump head is over 80 m.

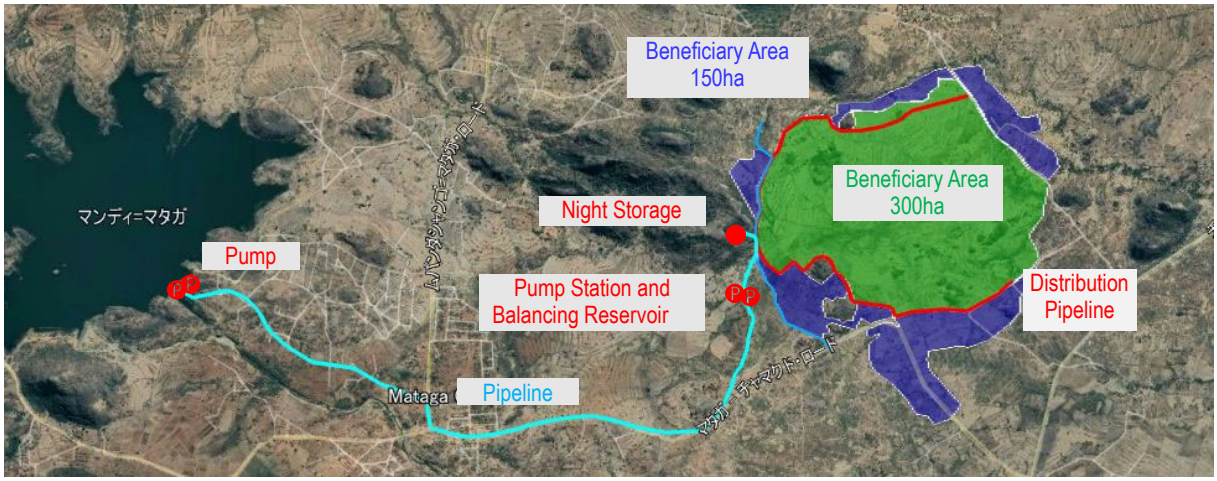


Figure 2.2 Facility Layout Plan

Table 2.1 Specification of the Facilities

Facilities	Specification
Headworks	Nil
Sedimentation Pond	Nil
Pump	110 kW x 12 units (6 units for each step)
Pipeline	Φ=500 mm、L=6.9 km
Balancing Reservoir	H=3.0 m, D=10.0 m, B=10.0m
Night Storage	V=14,000 m3
Distribution Pipeline	Φ=500 mm、L=5.8 km
Beneficiary Area	Under surface irrigation: 300ha (green zone in Figure 2.2) Under water-saving irrigation: 450ha (green + blue zone in Figure 2.2) *The 300 ha is the maximum area defined by the amount of water available at the dam. The irrigated area can be expanded 1.5 doubled with the introduction of water-saving irrigation.

2.3 RELATED FACILITIES

In addition to the main facilities mentioned above, the following related facilities are planned to be installed.

2.3.1 Standby Generator

The results of the interviews with the IMC of the existing irrigation scheme (Biri Extension irrigation scheme in Mundi Mataga Area, irrigated area 145 ha) revealed the followings.

- The electricity supply in Zimbabwe is erratic, and irrigation pumps are deactivated during the daytime, resulting in occasional interruptions of the irrigation water supply.
- On the other hand, sometimes power is restored during the night time, and when this happens, beneficiary farmers have to work in the dark. In addition to the physical dangers of working in the dark, there is a high proportion of women and elderly people working on farms, and a high risk of crime.

Taking into account these situations, a standby generator is planned to be installed to cope with the unstable power supply and to avoid night work.

2.3.2 Storage House

In the past till 2002, GMB has come to the field to buy crops even if the volume of sales was small. Now, however, the GMB only picks up the crop if the volume of sales exceeds 10 ton, and if the volume is less than 10 ton, the beneficiary farmers have to transport the crop to the GMB by themselves.

Taking into account the situation above, a storage house is planned to be installed in order to 1) ensure the volume of agriculture production exceeds 10 tons by gathering from each beneficiary farmers under the IMC, 2) create a situation where GMB comes to the farmland from their side, 3) improve access to markets through 1) and 2), and 4) increase beneficiary farmers' income.

CHAPTER 3 PRELIMINARY ENVIRONMENTAL AND SOCIAL CONSIDERATION

3.1 Natural Environment Aspects

The source of water for the new irrigation scheme is stored water in the reservoir of Mundi Mataga Dam. Water is directly delivered from Mundi Mataga Dam via pump stations through pipelines to the night storage located near beneficiary areas. Existing pump station utilised for the existing irrigation schemes in the Area is expanded as a pump station for new irrigation scheme. There will be no direct impact on the downstream river since no water will be taken from the river.

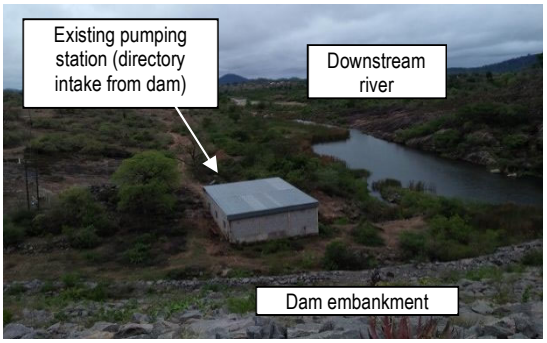


Figure 3.1 Facility Layout at Downstream of Dam (View from Downstream Slope of the Embankment)

The planned irrigation scheme will consist of the Pumping stations – Pipelines- Balancing Reservoir - Night storage - Beneficiary areas. All of the proposed construction sites are located in woodlands (shrubs, bushes, etc.) or agricultural lands where human activities are already carried out. There are no protected areas and important biodiversity areas (Ramsar wetlands, IBAs) in and around the project area.

3.2 Social Environment Aspects

The beneficiary area of the planned irrigation scheme is named as Funye Region which is located in the Communal Land. The name of the Communal Land is Mberengwa Communal Land. The Communal Land has been a Tribe Trust Land since around 1930, when people of African descent were forcibly relocated to the area and have lived there ever since. Historically, Communal Land has been allocated to the areas with poor farming conditions, where most of farmers are smallholder and generally subsistence farmers. Farmers in Communal Land strongly desire irrigational agriculture because its advantages in production and productivity against rainfed agriculture.

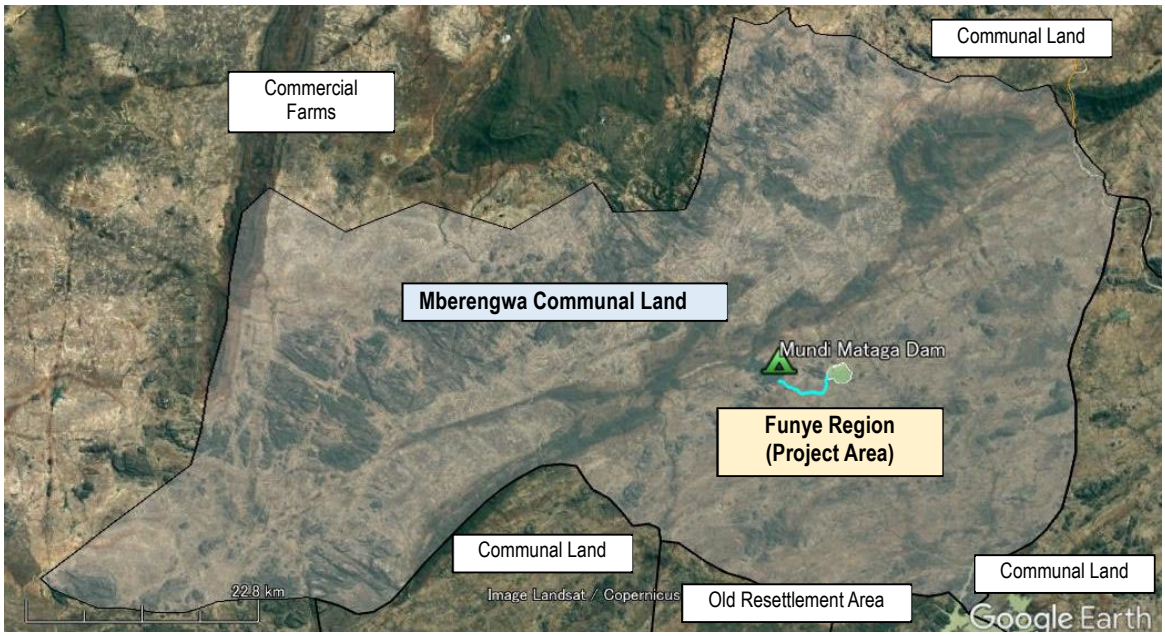


Figure 3.2 Land Category around the Project Area (Funye Region)

A local development centre, which is called as Mataga Growth Point, is located near beneficiary areas. Mataga Growth Point is the centre of the local economy, with housing and retail outlets. The roads around Mataga Growth Point are paved with asphalt and are easily accessible. The pipeline is planned to be laid along the existing road. During construction activities of the pipeline instalment, careful consideration should be given to minimize adverse impacts to the existing local transportation.

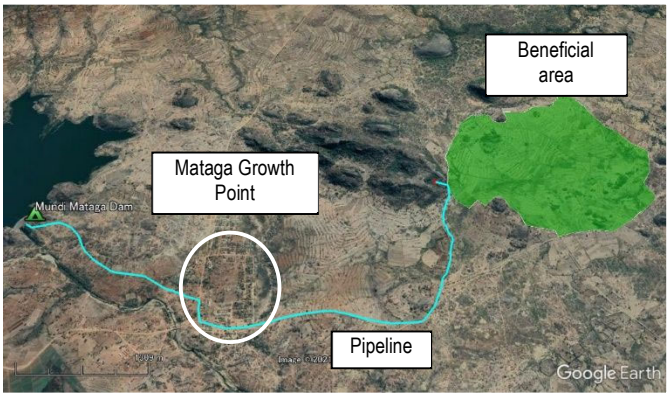


Figure 3.3 Loction of the Mataga Glowth Point and Beneficiary Area

In case of the development of new irrigation scheme, the plots of agricultural fields will be allocated equally to the beneficiary farmers of the Region, including the current land users. The allocation of plots will be carried out under the management of Traditional Leaders and District Councils.

The acquisition of lands for the proposed construction sites will be taken from the state lands since land ownership of the Communal Land belong to the state and land use is managed by Traditional Leaders and District Council. In case of the land acquisition, coordination with those traditional decision-making organizations will be necessary.

3.3 SCOPING

According to the scoping result, most of the major negative impacts on environmental and social aspects are anticipated during construction works, such as water pollution, wastes, and so on. It is necessary to develop an EMP (Environmental Management Plan) of the project and implement appropriate mitigation measures and monitoring by construction contractor and implementation organization (DOI or ZINWA).

3.4 EVALUATION OF THE ENVIRONMENTAL CATEGORY (PROPOSED)

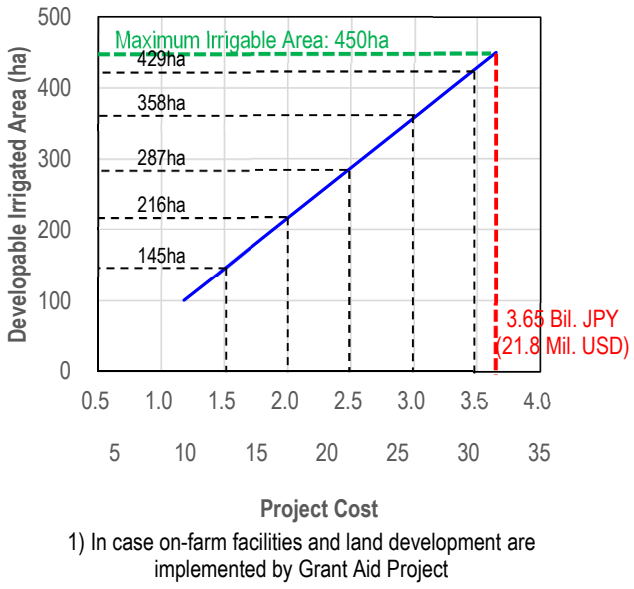
As the result of preliminary evaluation at screening stage, it is assumed the project will fall under Category B in the category classification of JICA environmental and social consideration guideline with the reasons of 1) the project area is not located in sensitive area such as national protected areas and other important biodiversity areas, 2) large scale involuntary resettlement and/or land acquisition are not expected and the 3) project scale and components of new project are similar to past JICA irrigation project (Nyakomba Irrigation Scheme Development Project) with Category B.

CHAPTER 4 PROJECT COST

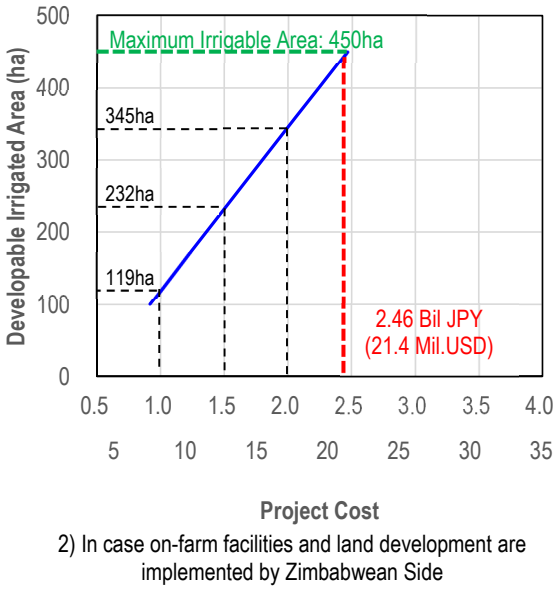
The project cost of the new irrigation scheme development is calculated in case it is implemented under the Grant Aid Project. The relationship between the project cost and the developable irrigated area is calculated for two cases, development of on-farm facilities and land development are implemented under the Grant Aid Project or by Zimbabwean side.

The results of the calculations are shown in Figure 4.1. The project cost includes the cost of replacing the valve of the dam intake tower. Also, cost for on-farm facilities is in case of water-saving irrigation. The total area of 450 ha can be for approximately 3.65 billion JPY (rough indication) (=31.8 million USD) in case the on-farm facilities and land development are implemented under the Grant Aid Project,

and for approximately2.46 billion JPY (=21.4 million USD) in case they are implemented by Zimbabwean side.



1) In case on-farm facilities and land development are implemented by Grant Aid Project



2) In case on-farm facilities and land development are implemented by Zimbabwean Side

Figure 4.1 Relation between Project Costs and Developable Irrigated Area

CHAPTER 5 EQUIRED ADDITIONAL SURVEYS AND STUDIES TO IMPLEMENT THE PLAN

(1) Identification of the Implementation Agency of the Zimbabwean Side

ZINWA or DOI

(2) Natural Condition Survey

1) Topographic survey

Plan survey at each facility point, longitudinal and cross section survey along the pipeline alignment, plan survey of the beneficiary area etc.

2) Geological Survey

Boring survey (Standard Penetration Test: SPT) at each of facility points

3) Hydro-Meteorological Survey

Rainfall, temperature, humidity, wind speed, sunshine hours at the typical point of the beneficiary area

(3) Project Formulation

1) Formulation of farming plan and water use plan

2) Formulation of irrigation plan

3) Facilities design

*There is a plan to irrigate another area using the same route as the planned pipeline alignment (along

the paved road) and coordinated with this plan is requried.

4) Construction/Procurement Plan

* There are two possible methods to replace valves in dam intake towers 1) with the reservoir empty, or 2) with water in the reservoir (under operating). Depending on which method is chosen, the scale of the temporary works required varies greatly and affects the project cost. It is therefore necessary to take this into account for construction planning of the rehabilitation works.

  The method of implementation of the plan should be fully discussed and agreed with the Zimbabwean side and the beneficiary farmers. In particular, it is necessary to inform and agree with the Zimbabwean side that if the plan is to be implemented with the reservoir empty, irrigated agriculture cannot not be possible for the relevant year (and possibly for several years thereafter), and that the Government of Zimbabwe needs compensation to the beneficial farmers.

5) Formulation of O&M Plan

i) Facility O&M Plan (including water management), ii) Farming activities training plan, iii) Strategic farmers' income increasing plan and iv) O&M structure plan to materialize the sustainable O&M of the developed irrigation scheme.

(4) Environmental and Social Consideration

1) Social survey of the target Region

2) Assessment of environmental and social impact, and examination of those mitigation measure(s)

3) Application to and approval from Environmental Management Agency (EMA) in respect to procedures related to the environment (submission of Prospectus and assistance in the preparation of environmental management plans, etc.)

(5) Estimation of Project Cost

CHAPTER 6 BENEFIT FROM THE IMPLEMENTATION OF THE PLAN

The implementation of the Plan will increase the irrigated area by 450 ha, and the implementation of dry-season cropping will improve land use, increase agricultural production and increase yields, which will significantly increase the income of beneficiary farmers.

The increased production will also lead to improvement of the food self-sufficiency and contribute significantly to ensuring food and nutrition security, which is a national challenge. In addition, the conversion of rainfed agriculture to irrigated agriculture in the target Region will strengthen resilience to climate change, especially drought.

Appendix-5

Magudu Dam Monitoring Plan (Draft)

CHAPTER 1 STATUS OF THE MONITORING PLAN (DRAFT)

The identification of deteriorations/damages (and those sign) on the target six dams in Masvingo Province was carried out and examination on the found deteriorations/damage if they already affect the safety/stability/operation of the facilities was conducted. Also, examination on the found deteriorations/damages if they expand and affect the safety/stability/operation of the facilities in the future was carried out as well.

The deteriorations/damages found were evaluated and categorized into three ranks as shown in Table 1.1, depending on the timing when the identified deteriorations/damages affect the safety/stability/operation of the facilities. Also, an "Emergency Repairing Work Plan" was formulated for the found deterioration/damages evaluated as "A" (see Appendix-2)

Table 1.1 Evaluation Ranks of Deteriorations/Damages Found

Rank	Evaluation Standard
A	Deteriorations/damages that are already affecting the safety/stability/operation of the facilities or are feared to affect them in near future.
B	Deteriorations/damages that are not affecting the safety/stability/operation of the facilities at present but may affect them in the long term.
C	No deteriorations/damage or no signal of them

This monitoring plan (draft) sets out the monitoring items required till the completion of the "Emergency Repairing Work Plan".

CHAPTER 2 TARGET DETERIORATIONS/DAMAGES

There are two deteriorations/damages which are evaluated as "A", 1) Two large-scale collapses on the right bank side wall of the connection canal, and 2) Exposure of siphon lining concrete on the connection canal bed (see Figure 2.1 and Figure 2.2). In respect to 1), a collapse reaches to the point 6m from the edge of embankment. It would reach to the edge after seven years and affect the stability of embankment. Also, another one reaches to the point 1.5 m from slope protection works for valve house. It would reach to the slope protection works within two years and affect the operation of valve.

While in respect to 2), since rocks are scattered around and upstream of the siphon lining concrete, erosion is likely to occur when rocks are delivered by floods and impact the lining concrete. As the erosion progresses and siphon pipes are damaged, sufficient irrigation water would not be supplied to farmland and the irrigation scheme may be dysfunctional.

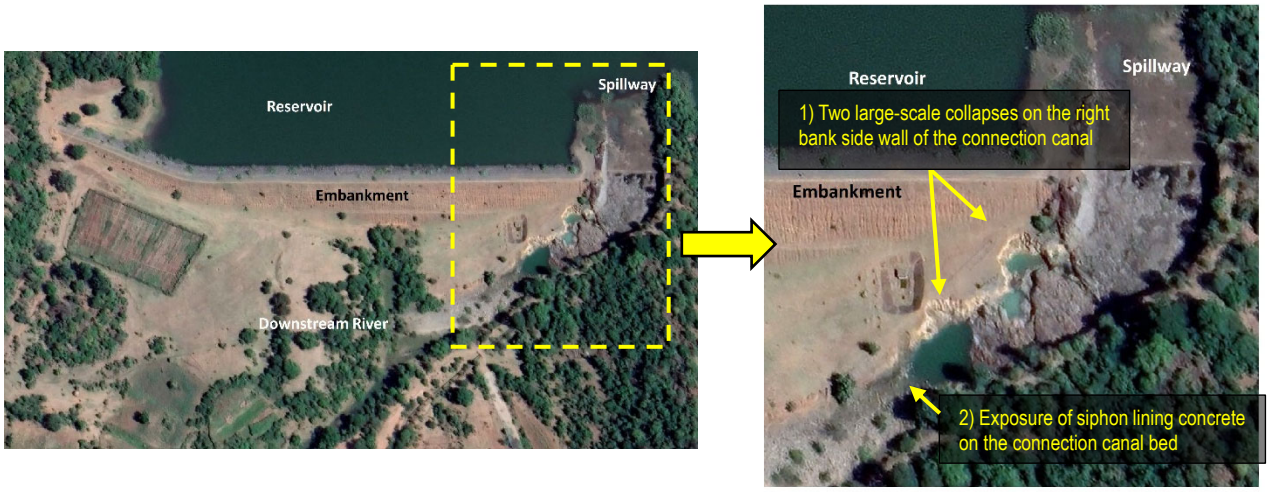
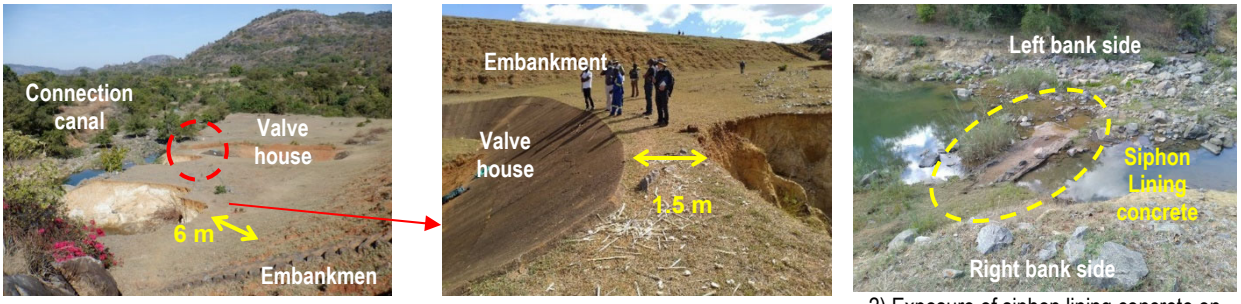


Figure 2.1 Deteriorations/Damages Evaluated as "A"-1



1) Two large-scale collapses on the right bank side wall of the connection canal

2) Exposure of siphon lining concrete on the connection canal bed

Figure 2.2 Deteriorations/Damages Evaluated as "A"-2

CHAPTER 3 EMERGENCY REPAIRING MEASURES

Although it is expected that all the emergency repairing measures for both 1) Two large scale collapses on right bank side wall of the connection canal and 2) exposure of siphon lining concrete on the connection canal bed, are implemented immediately and at once. On the other hand, in consideration of the damage which may happen when the target structure collapses, and the contribution of the repairing measures to the deteriorations/damages extension control, the emergency repairing measures are divided into five construction packages (PKG) according to the priority.

Table 3.1 Construction Package Division of Emergency Repairing Measures

PKG	Target Area	Main target	Priority	Remarks
PKG-1	No. 1 - No.1+7.15	A collapse progressing to a point 6.0m from the embankment * If this collapse extends, it could lead to the collapse of the embankment and loss of life.	1	Backfilling of the ditch across the connection canal which is the main cause of the collapse
PKG-2	No. 1 - No.3+9.95		2	Construction of the retaining wall and backfilling of the back of the wall to control the progression of the collapse
PKG-3	No.4+20.84 - No.6	Exposed siphon protection works * If the siphon pipe is damaged, the irrigation water supply will be interrupted. This may result in impoverishment, but not loss of life.	3	Surface covering to prevent damage on siphon protection works
PKG-4	No.3+9.95 - No.5+6.59	A collapse progressing to a point 1.5m from discharge valve house slope protection works * Even if the slope protection works are damaged, the valve can be operated for a while by removing the earth and sand manually.	4	Construction of the retaining wall and backfilling of the back of the wall to control the progression of the collapse
PKG-5	No.1+7.15 - No.4+20.84	Unevenness on throughout the connection canal bed	5	Backfilling of connection canal bed unevenness (mainly recesses)

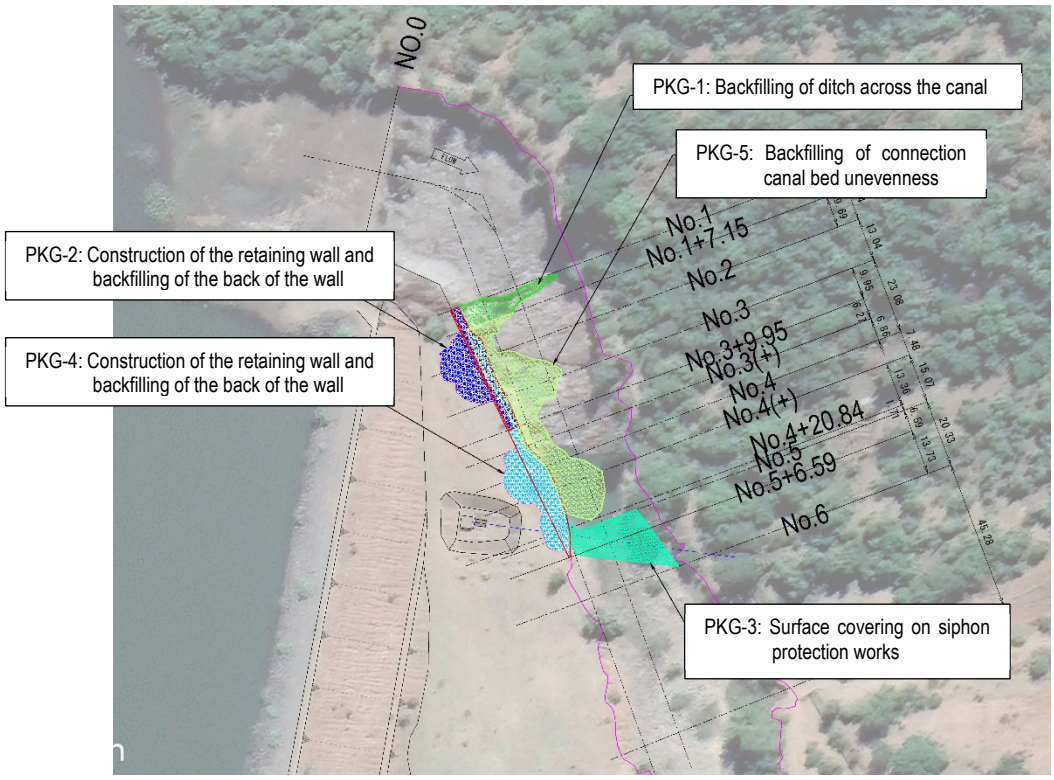


Figure 3.1 Construction Package Division of Emergency Repairing Measures

CHAPTER 4 IMPLEMENTATION AGENCY OF THE EMERGENCY REPAIRING MEASURES

The deteriorations/damages evaluated as "A" requires immediately measures from a humanitarian perspective because it could lead to a disaster that may cause loss of life if left unattended. However, according to the results of a survey to each agency, there is only one agency, ZINWA, who may implement the measure but they may target only PKG-1. The effect of PKG-1 is to slow down the rates of erosion and collapse on the side walls by redirecting the flood flow downstream. It should be noted that PKG-1 alone does not prevent erosion and collapse itself, as no countermeasures are taken on the collapse portion. In addition, the rate of erosion and collapse after PKG-1 is implemented is greatly affected by rainfall intensity. Therefore, it should be noted that erosion and collapse may proceed faster than at present depending on the rainfall intensity.

Therefore, it is necessary to ensure the reliable implementation of PKG-1 by ZINWA and to find an implementing agency for the other PKG-2 - 5 as soon as possible.

In addition, during the period between the implementation of PKG-1 and the implementation of other PKGs (or between now and the implementation of all PKGs in case ZINWA does not implement PKG-1 at an early stage), it is necessary to monitor collapsed portions mainly by visual inspection to identify signals of collapse of the embankment in particular. If such signs are identified, any measures to avoid collapse shall be taken.

CHAPTER 5 MONITORING PLAN (DRAFT)

5.1 RIKS REMAINS AFTER IMPLEMENTATION OF PKG-1

Even if only PKG-1 is implemented by ZINWA, the rate of side wall collapse will be slower than before,

but the erosion and collapse itself will continue. The greatest possible risk in this case is the collapse of the embankment.

5.2 ANTECEDENTS OF RISK

Collapse of a embankment is mainly caused by sliding failure. The main antecedents of the sliding failure are shown in the figure below and all can be identified through visible inspection.

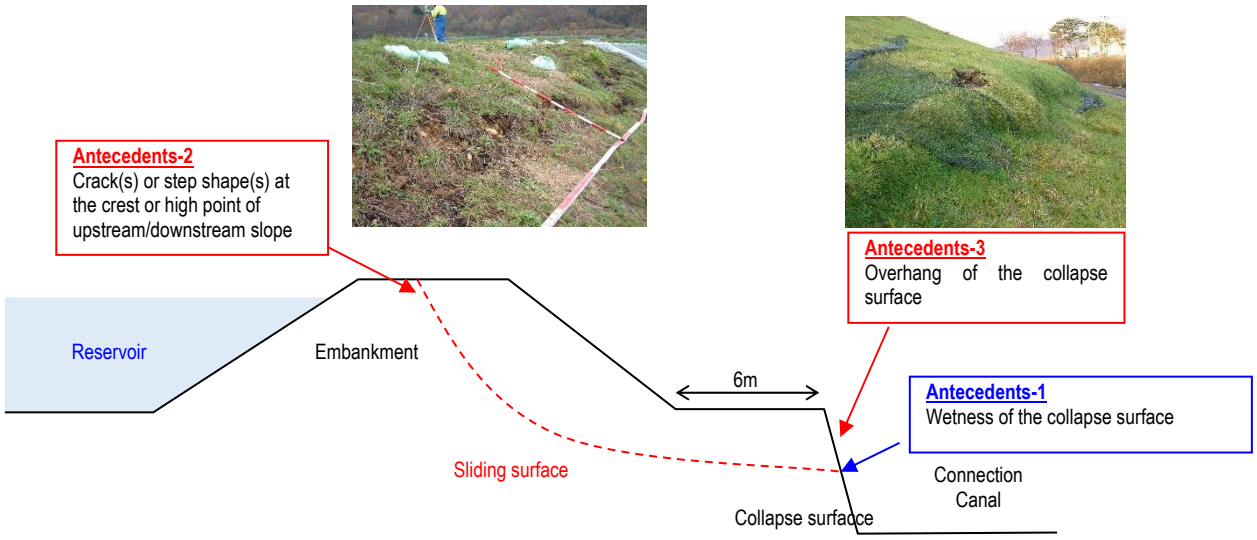


Figure 5.1 Antecedents of the sliding Failure

5.3 MONITORING TO IDENTIFY THE ANTECEDENTS OF RISK

The occurrence of the aforementioned antecedents of risk (sliding failure of the embankment) can be identified by visual inspection. In addition to the daily check, the dam manager (ZINWA) shall do the visual inspection of the occurrence of the aforementioned antecedents phenomenon when the reservoir level rises due to rainfall. Also, ZINWA shall confirm the development of the phenomenon as well. For example, identification of the crack progressing could be checked by displacement of marks on the square timbers connected in L-shape across the crack, as shown in Figure 5.2.

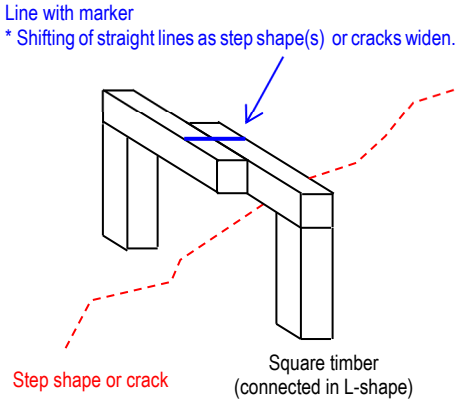


Figure 5.2 A method to Identify the Progress of Antecedent Phenomenon

5.4 REQUIRED ACTIVITIES WHEN SIGNAL OF THE ANTECEDENT IS FOUND

When the aforementioned antecedent phenomena are observed, one of the possible methods to control the sliding failure of the embankment is “counter weight fills method” which the front of the collapse surface is filled with soil or sandbags. However, the height of the collapsed surface is as high as 7m, and the amount of filling work required is huge. In addition, the front of the collapse surface is a side wall of connection canal (flood discharge channel), and filled portion is likely to be washed away by the flood.

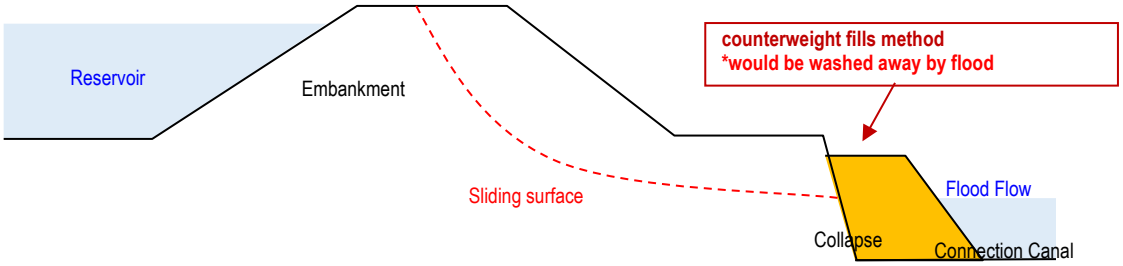


Figure 5.3 Outline of the Counter Weight Fills Method

It is therefore necessary to lower the reservoir level (to make reservoir empty) when antecedent events are identified. This will lower the water level inside of the embankment and foundations (low water level makes sliding failure less likely) and reduce the flood volume in the event of embankment collapse, thus limiting the damage. This situation shall continue until PKG-2 to PKG-5 are implemented (possibly for several years).

In order to lower the reservoir level, it is necessary to (1) open the discharge valve as much as possible (if it is opened too much, the siphon cannot flow the volume and the water tank just below the valve will overflow), and (2) if the canal after the siphon is too small and overflows, create a place to force the water to overflow and return the water to the river. In addition, if necessary, direct drainage from the reservoir to the connection canal using a portable pumps should be used in combination to promote the lowering of the water level.

It should be noted that lowering the reservoir level (emptying the reservoir) will prevent irrigation during the dry season of the year and may require agricultural compensation for the beneficiary farmers.

In addition, there is a possibility that antecedents will continue to develop during the lowering the reservoir level. Therefore, it is necessary to issue an evacuation order to the downstream population when any antecedents are found and evacuate them until the water level drops sufficiently. So, residents in the downstream area should be informed in advance of the need for such a response.