Chapter 14 Design Criteria

14.1 Design Concept

In order to achieve the objectives of the project, the roads, bridges and other structures shall be designed in consideration of providing a high grade road as a national highway which would facilitate:

- Smoother commodity flow,
- more active economic activities,
- improve accessibilities and linkage to other regions

The preliminary design of the road, bridges, and other structures will be executed mainly in accordance with "Design Guideline, Criteria and Standards published by the Department of Public Works and Highway (DPWH-DGCS)" and Japanese standard will be applied to the design as a supplement.

The proposed functional classifications of Sub-Projects and the road network in the study area are shown in **Figure 14.2.1-1**.

Source: JICA Study Team

Figure 14.2.1-1 Proposed Functional Classification of Sub-Projects

14.2 Geometric Design Standards

The following standard is basically applied for this project.

- Design Guidelines, Criteria & Standards Volume 4 Highway Design 2015, BoD, DPWH

Also, the following standards are referred to:

- A Policy on Geometric Design of Highways and Streets, AASHTO 2011, 6th Edition
- Japan Road Association, Road Structure Ordinance, 2015

14.2.1 National Road Classification for Each Sub-Projects

The classification, located area and terrain for Sub-Projects are listed in **Table 14.2.1-1**.

Table 14.2.1-1 Sub-Projects List

Sub-Project No.	Sub-Project Name	Road Classification	Located Area
No.1	Matanog-Barita-Aramada-Libungan Road	Tertiary	Rural
No.2	Parang-Balabagan Road	Secondary	Rural
No.5	Maganoy-Lebak Road	Secondary	Rural
No.6	Tapian-Lebak Coastal Road	Secondary	Rural
No.7	Marawi City Ring Road	Secondary	Rural
No.8	Parang East Diversion Road	Secondary	Rural
No.9	Manuangan-Parang Road	Tertiary	Rural

Source: JICA Study Team

14.2.2 Road Design Criteria for Sub-Projects

(1) Applied Design Criteria in relation with Road Classification

The highway design standard of DPWH in the Philippines basically defines the standard in accordance with traffic volume. However, a National Tertiary Road is not indicated in Highway Design Standard of DPWH. On the other hand, an Expressway is treated as one of functional classification. In AASHTO, an expressway (a freeway) is not a functional class in itself but is normally classified as a principal arterial. In reference with the former highway design standard of DPWH, it is recommended to apply the road classification under the Feasibility Study as follows:

	ADT Range
◆ National Primary Road	More than 2,000
◆ National Secondary Road	1,000 – 2,000
◆ National Tertiary Road	400 – 1,000

(2) Design Target Year for Number of Lanes

In a practical sense, the design volume should be a value that can be estimated with reasonable accuracy and it is believed the maximum design period is in the range of 15 to 24 years. Therefore, a period of 20 years is widely used as a basis for design year from planning stage. Traffic cannot usually be forecast accurately beyond this period on a specific facility. For the Sub-Projects, the design year for number of lanes is proposed as Year 2035.

(3) Geometric Design Criteria for Sub-Projects

The proposed design criteria in Feasibility Study are tabulated in **Table 14.2.2-1**. For the same reason as above, this proposal basically corresponds to the following;

	Design Standard of DPWH
◆ National Primary Road	Desirable, Primary
◆ National Secondary Road	Minimum, Primary
◆ National Tertiary Road	Minimum, Secondary

Table 14.2.2-1 Summary of Geometric Design Standard for Sub-Projects

Road Classification	National Tertiary	National Secondary	National Primary	Reference
Average Dailly Traffic (ADT)	400-1,000	1,000-2,000	More than 2,000	Table 3-1
Design Speed (km/h)				
Frat Topography	70	80	95	Table 3-1
Rolling Topography	60	60	80	Table 3-1
Mountainous Topography	40	50	60	Table 3-1
Min. Horizontal Radhius (m)				
Frat Topography	160	220	320	Table 3-1
Rolling Topography	120	120	220	Table 3-1
Mountainous Topography	50	80	120	Table 3-1
Max. Horizontal Radius for Use of a Spiral Curve Transition (m)				
Frat Topography	290	379	592	Table 3-24
Rolling Topography	213	213	379	Table 3-24
Mountainous Topography	95	148	213	Table 3-24
Max. Vertical Grade (%)				
Frat Topography	5.0	4.0	3.0	Table 3-1
Rolling Topography	6.0	5.0	5.0	Table 3-1
Mountainous Topography	8.0	7.0	6.0	Table 3-1
Min. Crest Vertical Curve Based on SSD (K-value)				
Frat Topography	17	26	52	Table 3-35
Rolling Topography	11	11	26	Table 3-35
Mountainous Topography	4	7	11	Table 3-35
Min. Vertical Curve on Sag (K-value)				
Frat Topography	23	30	45	Table 3-36
Rolling Topography	18	18	30	Table 3-36
Mountainous Topography	9	13	18	Table 3-36
Typical Cross Section (m)				
Cross-fall for Pavement (%)	1.50	1.50	1.50	Table 3-44
Cross-fall for Shoulder (%)	3.00	3.00	3.00	Table 3-44
Carriageway Width (m)	3.35	3.35	3.35	D.O. 22, 2011
Shoulder Width (m)	1.50	2.50	3.00	Table 3-1
Right of Way Width (m)	30	30	30	Table 3-1
Superelevation (%)	6.0 (max)	6.0 (max)	6.0 (max)	Proposed
Non Passin (Stopping) Sight Distance (m)				
Frat Topography	90	115	150	Table 3-1

Rolling Topography	70	70	115	Table 3-1
Mountainous Topography	40	60	70	Table 3-1
Passing Sight Distance (m)				
Frat Topography	490	560	645	Table 3-1
Rolling Topography	420	420	560	Table 3-1
Mountainous Topography	270	360	420	Table 3-1
Surface				
Surface Type	Portland Cement Concrete			

Note:
*: Some is proposed.
Reference is based on DPWH DGCS Volume 4, 2015, if no indication.
Source: JICA Study Team

(4) Maximum Superelevation

The Sub-Project roads not only strengthen the highway network, but also contribute to the enhancement of agro-fishery business. The trucks for this business in ARMM are generally old and over-loaded. When such trucks stop on the curve with high superelevation, it may roll over. Also, for slow-moving vehicles such as agriculture vehicles, pedestrian and bicyclists, high superelevation is uncomfortable, dangerous and may cause accidents. Where there is a tendency to drive slowly, it is a common practice to utilize a lower maximum rate of superelevation, usually 4 to 6 %. The terrain of the Sub-Project areas is mountainous. Therefore, the maximum superelevation is recommended to apply 6.0 %.

(5) Superelevation Rates

When the maximum value of superelevation is applied 6 %, the superelevation rates are shown in the following table:

Table 14.2.2-2 Minimum Radii for Design Superelevation Rates, Design Speeds and e_{max} = 6 %

Design Speed (kph)	20	30	40	50	60	70	80	90	100	110	120	130
NC	194	421	738	1,050	1,440	1,910	2,360	2,880	3,510	4,060	4,770	5,240
RC	138	299	525	750	1,030	1,380	1,710	2,090	2,560	2,970	3,510	3,880
2.2	122	265	465	668	9,191	1,230	1,530	1,880	2,300	2,670	3,160	3,500
2.4	109	236	415	599	825	1,110	1,380	1,700	2,080	2,420	2,870	3,190
2.6	97	212	372	540	746	1,000	1,260	1,540	1,890	2,210	2,630	2,930
2.8	87	190	334	488	676	910	1,150	1,410	1,730	2,020	2,420	2,700
3.0	78	170	300	443	615	831	1,050	1,290	1,590	1,870	2,240	2,510
3.2	70	152	269	402	561	761	959	1,190	1,470	1,730	2,080	2,330
3.4	61	133	239	364	511	698	882	1,100	1,360	1,600	1,940	2,180
3.6	51	113	206	329	465	640	813	1,020	1,260	1,490	1,810	2,050
3.8	42	96	177	294	422	586	749	939	1,170	1,390	1,700	1,930
4.0	36	82	155	261	380	535	690	870	1,090	1,300	1,590	1,820
4.2	31	72	136	234	343	488	635	806	1,010	1,220	1,500	1,720
4.4	27	63	121	210	311	446	584	746	938	1,140	1,410	1,630
4.6	24	56	108	190	283	408	538	692	873	1,070	1,330	1,540

4.8	21	50	97	172	258	374	496	641	812	997	1,260	1,470
5.0	19	45	88	156	235	343	457	594	755	933	1,190	1,400
5.2	17	40	79	142	214	315	421	549	701	871	1,120	1,330
5.4	15	36	71	128	195	287	386	506	648	810	1,060	1,260
5.6	13	32	63	115	176	260	351	463	594	747	980	1,190
5.8	11	28	56	102	156	232	315	416	537	679	900	1,110
6.0	8	21	43	79	123	184	252	336	437	560	756	951

Source: Design Guidelines, Criteria & Standards Volume 4 Highway Design 2015, BoD, DPWH

(6) Traveled-Way Widening on Horizontal Curves

According to the equation in AASHTO, Proposed travelled-way widening on horizontal curves are listed in the following table:

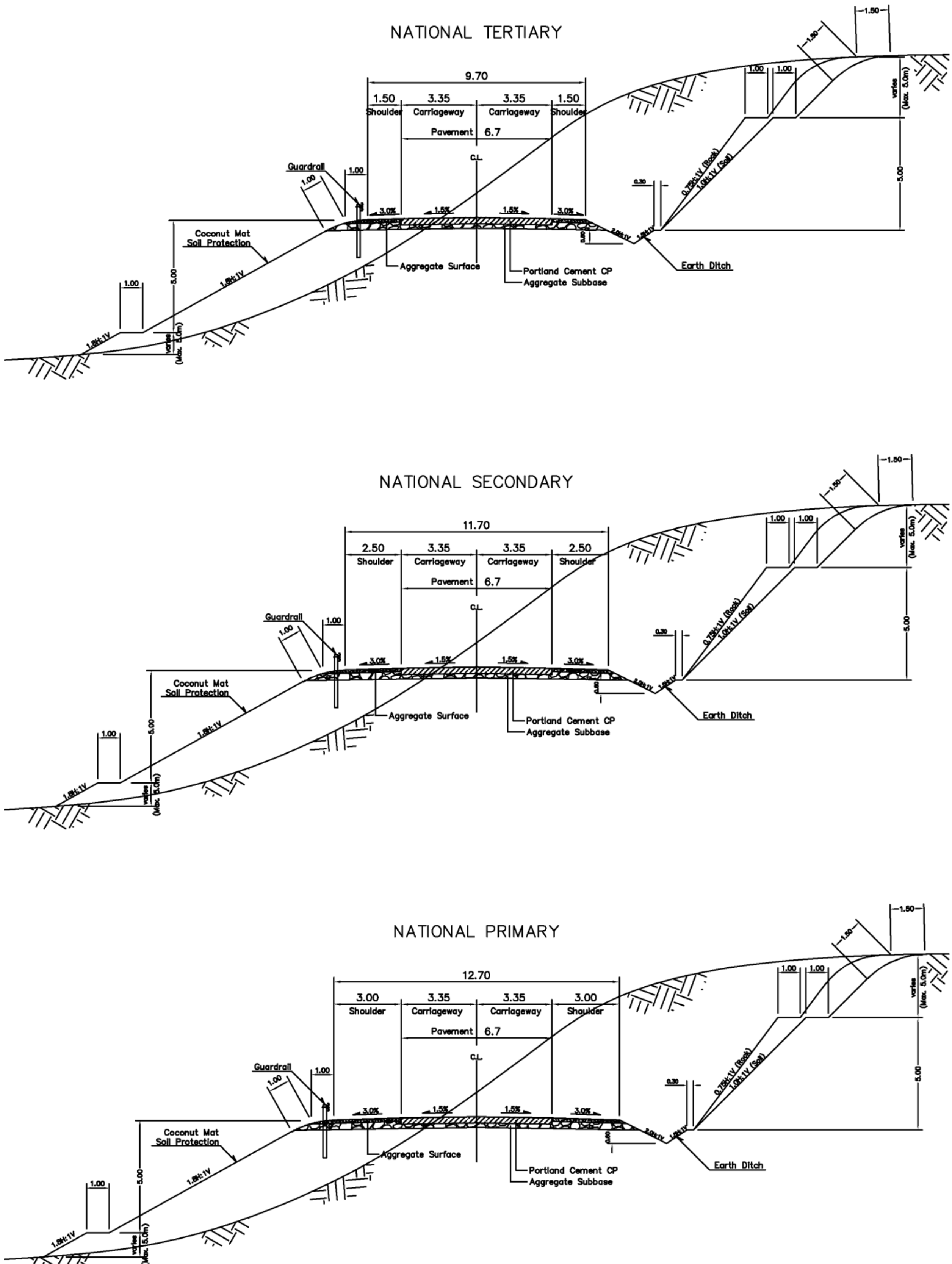
Table 14.2.2-3 Summary of Geometric Design Standard for Sub-Projects

No. of Lanes		2			2			2		
Traveled-way width (m)		6.7			6.7			6.7		
Design Speed (kph)		40	60	70	50	60	80	60	80	95
Ratio of Curve (m)	1,000	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.5
	900	0.3	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.5
	800	0.4	0.4	0.5	0.4	0.4	0.5	0.4	0.5	0.6
	700	0.4	0.5	0.5	0.5	0.5	0.6	0.5	0.6	0.6
	600	0.5	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.7
	500	0.6	0.6	0.7	0.6	0.6	0.7	0.6	0.7	0.8
	400	0.7	0.8	0.8	0.7	0.7	0.9	0.8	0.9	1.0
	300	0.9	1.0	1.0	0.9	1.0	1.1	1.0	1.1	1.2
	250	1.0	1.2	1.2	1.1	1.2	1.3	1.2	1.3	
	200	1.3	1.4	1.5	1.3	1.4	1.5	1.4	1.5	
	150	1.6	1.8	1.9	1.7	1.8		1.8		
	140	1.7	1.9		1.8	1.9		1.9		
	130	1.9	2.0		2.0	2.0		2.0		
	120	2.0	2.2		2.1	2.2		2.2		
	110	2.2			2.3			2.4		
	100	2.4			2.5			2.6		
	90	2.6			2.7					
	80	2.9			3.0					
	70	3.3								
	60	3.9								
	50	4.6								

Source: JICA Study Team

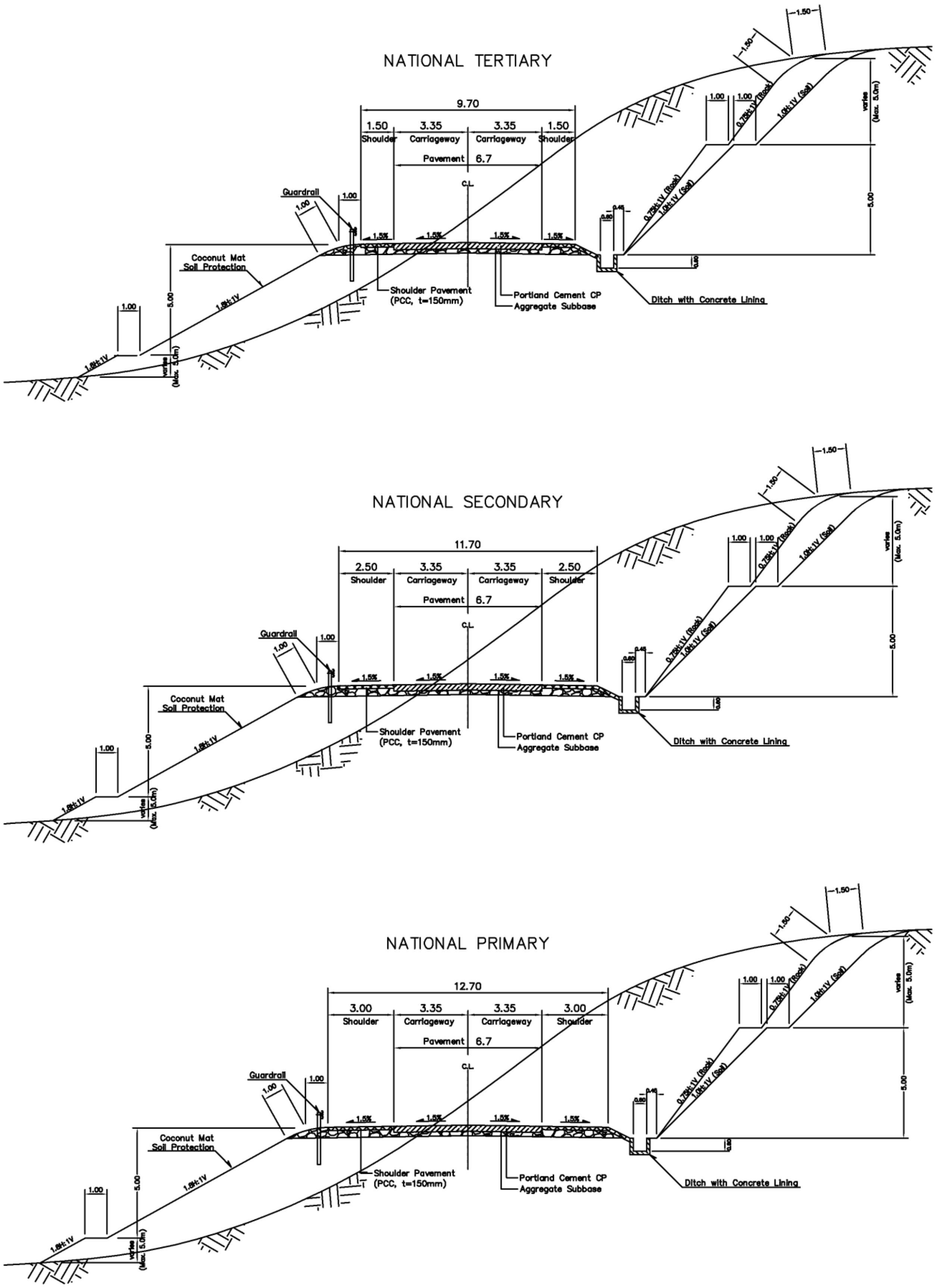
14.2.3 Typical Cross Sections

Typical cross sections by class of road are shown in the following figures:



Source: JICA Study Team

Figure 14.2.3-1 Typical Cross Sections for Sub-Projects Roads (Vertical Grade Less Than 4 %)



Source: JICA Study Team

Figure 14.2.3-2 Typical Cross Sections for Sub-Projects Roads (Vertical Grade 4 % and More)

14.3 Bridge and Structural Design Standards

14.3.1 Specifications

Bridge design standards to be applied in this project shall be set in accordance with the following specifications.

- Design Guidelines, Criteria & Standards Volume 5 BRIDGE DESIGN 2015 (DGCS)
- DPWH Guide Specifications LRFD Bridge Seismic Design Specifications 1st Edition 2013

14.3.2 Load

(1) General

The load types that shall be considered for the design bridge structure and other structures in this project are mainly as follow.

1) Dead load
2) Live load include impact or dynamic effect of the live load and pedestrians load
3) Earth pressure
4) Seismic load

Other loads types such as wind load, temperature change etc. shall in accordance with Design Guidelines, Criteria & Standards Volume 5 BRIDGE DESIGN 2015 (DGCS).

(2) Dead load

Dead loads include all loads that are relatively constant over time, including the weight of the bridge itself and there are three primary types of dead load:

- down drag force (DD),
- dead load of non-structural attachment (DC), and
- dead load of wearing surfaces and utilities, designated as DW

The dead loads shall be the volumes of the member of the structural elements computed based on unit weights of materials. The following unit weights shall be used for dead load.

Table 14.3.2-1 Unit self-weight of the materials.

Materials		Unit self-weight(kg/m3)
Aluminium Alloys		2,800
Bituminous waring Surface		2,250
Cast Iron		7,200
Compacted Sand, Silt or Clay		1,925
Concrete	Normal w/ f'c ≦35MPa	2,400
	Normal w/ 35< f'c≦105	2,250+2.29f'c
Loose Sand, Silt or Gravel and Soft Clay		1,600
Rolled Gravel, Macadam, or Ballast		2,250
Steels		7,850
Stone Masonry		2,725
Wood	Hard	960
	Soft	800

Source: DPWH Design Guidelines, Criteria & Standards Volume 5

(3) Live load

Design live loads of the bridges shall consist of:

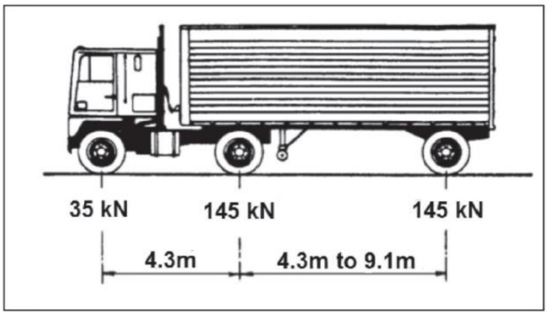
1) the vehicle live load (LL),
2) vehicular dynamic load allowance (IM), and
3) pedestrians live load (PL).

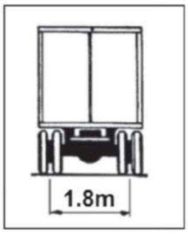
1) Vehicular Live Load (LL)

Vehicular live loading on the road ways of bridges or incidental structures, designated HL-93, and shall consist of combination of the:

- Design truck, and
- Design lane load

The weights and spacing of axials and wheels for the design truck shall be in accordance with **Figure 14.3.2-1**.





Source: DPWH Design Guidelines, Criteria & Standards Volume 5

Figure 14.3.2-1 Characteristics of the Design Truck

The design lane load shall consist of a load of 9.34kN/m, uniformly distributed in the longitudinal direction. Transversely, the design lane load shall be assumed to be uniformly distributed over 3.0m width. The force effects from the design lane load shall not be subject to a dynamic lane allowance.

2) Dynamic Load Allowance (IM) for Bridges

The static effects of design truck, other than centrifugal and braking forces, shall be increased by the percentage specified in **Table 14.3.2-2** for dynamic load allowance in accordance with DPWH Design Guidelines, Criteria & Standards (DGCS).

According to the DGCS, the factor to be applied to the static load shall be taken as: I = (1 + IM/100).

Dynamic load allowance need not be applied to:

- Retaining walls not subject to vertical reactions from the super structure.
- Foundation components that are entirely below ground level.

Table 14.3.2-2 Dynamic Load Allowance (IM)

Component	Limit States	IM
Deck Joints	All Limit States	75%
All Other Components	Fatigue and Fracture	15%
	All Other Limit States	33%

Source: DPWH Design Guidelines, Criteria & Standards Volume 5

3) Dynamic Load Allowance (IM) for Culverts and Other Buried Structures

The factor to be applied to the static load shall be taken as:

$$IM = 33(1.0 - 0.125D_E) \geqq 0\%$$

where:
D_E = the minimum depth of earth cover above the structure (mm)

4) Multiple Presence Factors

Multiple Presence Factors shall be in **Table 14.3.2-3**.

Table 14.3.2-3 Multiple Presence Factors

Number of Loaded Lanes	Multiple Presence Factors
1	1.2
2	1.0
3	0.85
>3	0.65

Source: DPWH Design Guidelines, Criteria & Standards Volume 5

5) Pedestrians Load

A pedestrian load of 3.6kPa shall be applied to all sidewalks wider than 600mm and consider simultaneously with the vehicular design live load in the vehicle lane.

6) Live load for Box Culvert

Live load applied for Box Culvert design shall be estimated in accordance with Article 11.3.2.10 of DPWH Design Guidelines, Criteria & Standards Volume 5.

(4) Earth Pressure

Earth pressure shall be determined in accordance with Chapter 10.15 of DPWH Design Guidelines, Criteria & Standards Volume 5.

(5) Seismic load

Earthquake effects shall be determined in accordance with DPWH Guide Specifications LRFD Bridge Seismic Design Specifications 1st Edition 2013.

1) Condition of seismic design

- Earthquake Ground Motion : Level 1 , Level 2
- Bridge Operation Classification: OC-III

2) Design Response Spectrum

The Design Response shall be in accordance with DPWH Design Guidelines, Criteria & Standards Volume 5.
・For periods less than or equal to T0, the elastic seismic coefficient for the mth mode of vibration,

Csm, shall be taken as:

$C_{sm} = A_S + (S_{DS} - A_S)(T_m/T_0)$ ----(3.6.2-1)

$A_S = F_{pga} PGA$

$S_{DS} = F_a S_S$

Csm : elastic seismic response coefficient

AS : effective peak ground acceleration coefficient

Fpga : site coefficient for peak ground acceleration specified in Article 3.5.3

PGA : peak ground acceleration coefficient on rock (equivalent to AASHTO Site Class B)

Fa : site coefficient for 0.2-sec period spectral acceleration specified in Article 3.5.3

SS : horizontal response spectral acceleration coefficient at 0.2-sec period on rock (equivalent to AASHTO Site Class B)

Tm : period of vibration of mth mode, (s)

T0 : reference period used to define spectral shape = 0.2Ts (s)

TS : corner period at which spectrum changes from being independent of period to being inversely proportional to period = SD1/SDS (s)

・For periods greater than or equal to T0 and less than or equal to Ts, the elastic seismic response coefficient shall be taken as:

$C_{sm} = S_{DS}$ ----(3.6.2-2)

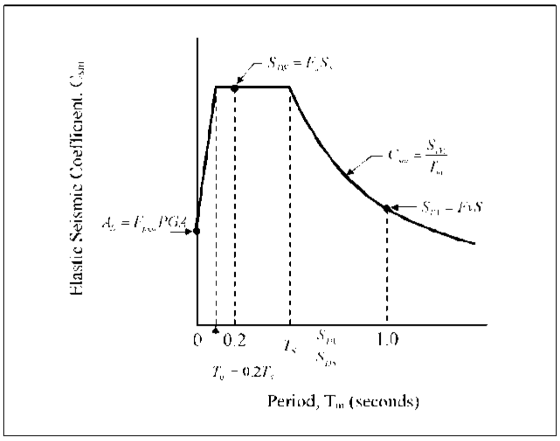
・For periods greater than TS, the elastic seismic response coefficient shall be taken as:

$C_{sm} = S_{D1}/T_m$ ----(3.6.2-3)

Fv : site coefficient for 1.0-sec period spectral acceleration specified in Article 3.5.3.

S1 : horizontal response spectral acceleration coefficient at 1.0 second period on rock

Source: DPWH Design Guidelines, Criteria & Standards Volume 5



Source: DPWH Design Guidelines, Criteria & Standards Volume 5

Figure 14.3.2-2 Design Response Spectrum

14.3.3 Materials

(1) Concrete Strength

The strength of the concrete use for the bridges and other structures design shall be in accordance with **Table 14.3.3-1**.

Table 14.3.3-1 Concrete Strength of concrete elements

Description		Fc'(min) (MPa)
Superstructure	PSC I -girder	38
	Deck Slabs, Cross beam	28
Substructure	Abutment walls, footings	28
	RC Pier coping, columns, footings	28
	PSC Pier coping, Rotating pier head	38
	Bored piles	28
Earth covered RC Box structure		28
Other concrete (normal use)		21
Lean concrete (for leveling)		17
Non Shrink grout		41

Source: DPWH Design Guidelines, Criteria & Standards Volume 5

(2) Reinforcing Steel

Reinforcing steel used for the design of bridge and other structure shall follow.

- ASTM GRADE 40, fy=278Mpa
- ASTM GRADE 60, fy=415Mpa

(3) Prestressing

Ultimate stress of prestressing steel shall be: fs'=1860 MPa

(4) Structural Steel

Structural Steel shall follow in accordance with DPWH Design Guidelines, Criteria and Standards Volume5.

- Steel plate and rolled shapes: ASTM A36,
- Bolts: AASHTO M164(ASTM A325)
- Welds: AWSD1.1 – 183, E70XX series

14.3.4 Concrete Cover for Reinforcing steel

Concrete cover for reinforcing steel shall follow **Table 14.3.4-1**.

Table 14.3.4-1 Concrete Cover

Situation	Cover (mm)
Direct exposure to salt water	100
Cast against earth	75
Coastal	75
Exposure to deicing salts	60
Deck surfaces subject to tire stud or chain wear	60
Exterior other than above	60

Situation	Cover (mm)
Interior other than above • Up to No.36 bar • No.43 and No.57 bars	 40 50
Bottom of cast-in-place slabs • Up to No.36 bar • No.43 and No.57 bars	 25 50
Precast soffit from panels	20
Precast reinforced piles • Noncorrosive environments • Corrosive environment	 50 75
Precast prestressed piles	50
Cast-in-place piles • Noncorrosive environments • Corrosive environments • General • Protected • Shells • Auger-cast, tremie concrete, or slurry construction	 50 75 75 50 75

Source: DPWH Design Guidelines, Criteria & Standards Volume 5

14.3.5 Superstructure Arrangements

(1) Vertical Clearance of Bridge Superstructure

The vertical clearance between the Design Flood Level (DFL) and the lowest member of the bridge superstructure shall not be less than 1.5m for reverse carrying debris in accordance with DPWH Design Guidelines, Criteria and Standards.

Since all roads of this project are National Road, applied flood frequency shall be as follow in accordance with **Table 14.3.5-1**.

- 50years flood frequency shall be applied for the estimation of flood level (DFL)
- 100 years flood frequency shall be used for check the vertical clearance of the bridge superstructure

Table 14.3.5-1 Design Flood Frequency for Bridges

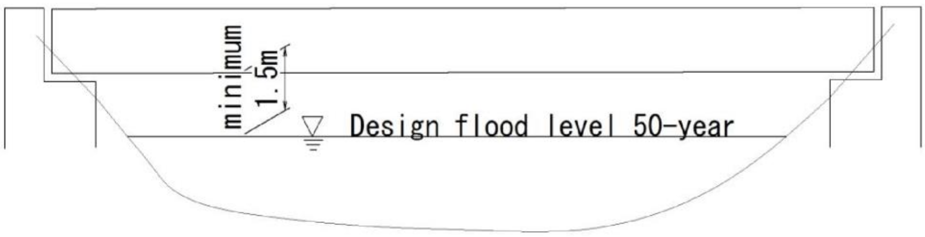
Road Classification	River				Bridge Drainage	
	Structure		Hydraulic Scour			
	Design Flood	Check Flood	Design Flood	Check Flood	Design Flood	Check Flood
Expressway	100 yr	200 yr	*100 yr	*500 yr	25 yr	50 yr
National Road	50 yr	100 yr	*100 yr	*500 yr	10 yr	25 yr
Other Roads	25 yr	50 yr	50 yr	100 yr	5 yr	10 yr

Source: DPWH Design Guidelines, Criteria & Standards Volume 5

From that mentioned above, when the 100 years flood level is more than 1.5m higher than the 50 years flood level, the lowest level of the bridge superstructure shall be kept to be higher than the 100 years flood level (see **Figure 14.3.5-1**).

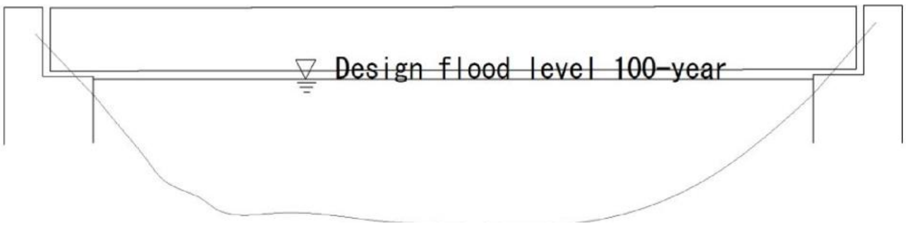
- 50-years Flood frequency

The vertical clearance between the design flood level and the lowest member of the bridge superstructure shall not be less than 1.5m



- Flood frequency by 100-year

The height of lowest member of girders shall be higher than the 100-yr flood frequency water level.



Source: JICA Study Team

Figure 14.3.5-1 Vertical Clearance of Bridge Superstructure

The discharge of the river will be estimated in accordance with DPWH Design Guidelines, Criteria & Standards Volume 3 and 4.

The Criteria for hydrological analysis are described in **Sub-Section 14.6.1** of this report.

(2) Bridge Span length

Minimum bridge span length shall be determined in accordance with Article 4.2 of DPWH Design Guidelines, Criteria and Standards Volume5 using 50 years frequency flood discharge.

The minimum span length will be estimated using following equation.

$$L=20+0.005Q$$

Where:

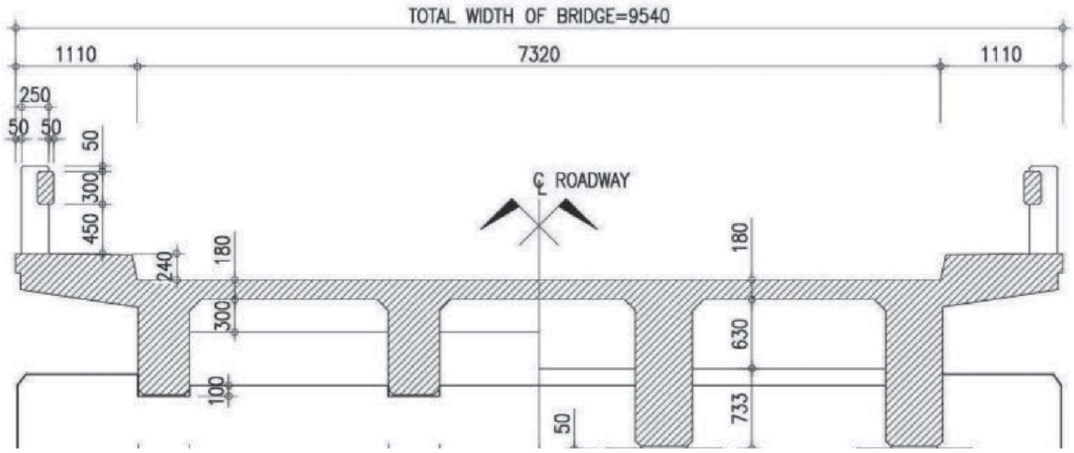
L = desirable minimum bridge span length (m)

Q = Design discharge (m^3/sec)

Source: DPWH Design Guidelines, Criteria & Standards Volume 5

(3) Width of Roadway

The minimum width of a bridge for two lanes shall be 7.32m and the minimum width of the pedestrian sidewalk shall be 750mm, in accordance with DPWH Design Guidelines, Criteria and Standards Volume5. Typical cross section of the bridge is shown **Figure 14.3.5-2**.



Source: DPWH Design Guidelines, Criteria & Standards Volume 5

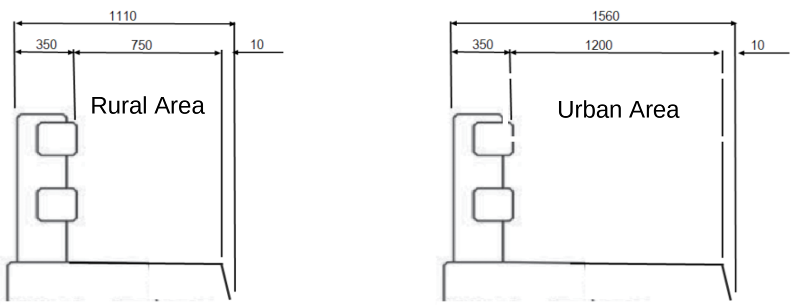
Figure 14.3.5-2 Typical Cross Section of Bridge

(4) Width of Sidewalk

According to DPWH Design Guidelines, Criteria and Standards Volume5, the minimum width of pedestrian sidewalk is specified as follow.

- In rural area: minimum pedestrian width is 750mm
- In urban are: minimum pedestrian width is 1200mm

Width of sidewalk is shown **Figure 14.3.5-3**.



Source: JICA Study Team

Figure 14.3.5-3 Width of Sidewalk

14.3.6 Substructure Arrangement

(1) Seat length

According to DPWH Guide Specifications LRFD Bridge Seismic Design Specifications 1st Edition 2013, the seat length is specified as follow.

The seat length of a girder at its support shall satisfy the equation shown below.

$$S_E = u_R + u_G \geq S_{EM}$$
$$S_{EM} = 0.70 + 0.005l$$
$$u_G = \varepsilon_G L$$

where: 9.9

S_E : Seat length of the grinder at the support, (m). S_E is the length measured from the end of grinder to the edge of the top of the substructure, or grinder length on the hinge/bearing joint, as shown in **Figure 14.3.6-1**.

u_R : Maximum relative displacement between the superstructure and the edge of the top of the substructure due to Level 2 Earthquake Ground Motion, (m). In calcjlationg u_R, the effects of the unseating prevention structure and the structure limiting excesssive displacement shall not be considered. When soil liquefaction and lateral spreading as specified in Section 6 may affect displacement og the bridges, such effects shall be considered.

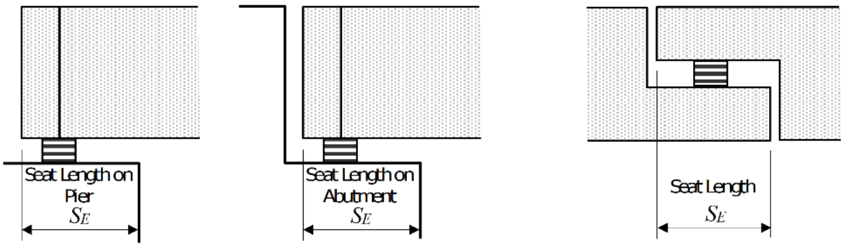
u_G : Relative displacement of the ground caused by seismic ground strain, (m).

S_{EM} : Minimum seating length of a grinder at the support, (m).

ε_G : Seismic ground strain. ε_G can be assumed as 0.0025, 0.00375 and 0.005 for Ground Types Ⅰ, Ⅱ and Ⅲ, respectively.

L : Distance between two substructure for determining the seat length (m).

l : Effective span length (m). When two superstructures with different span lengths are supported on one bridge pier, the longer of the two shall be used.



(a) Girder End Support (b) Intermediate Joint (Hinge/Bearing Joint)

Source: DPWH Design Guidelines, Criteria & Standards Volume 5

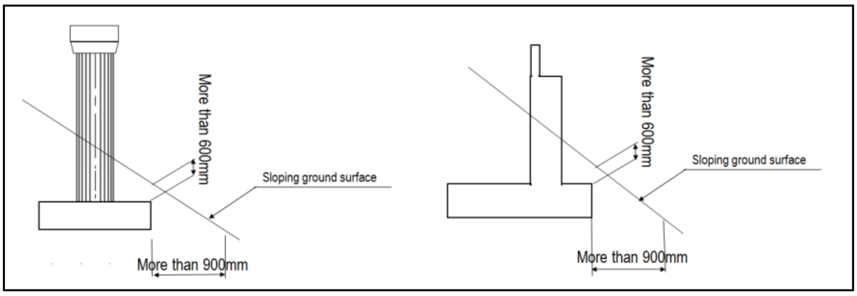
Figure 14.3.6-1 Seat Length of Girder at Support

(2) Depth of Footing

1) Minimum Embedment and Bench Depth (except in water way)

A depth of footing must be satisfies following condition:

- Adequate bearing capacity shall be maintain
- 900mm of the bottom of the footing
- 600mm cover over the footing
- When the spread footing located on a slope, the minimum distance from the lower edge of the footing to the sloping ground surface should be 900 mm (seeFigure **14.3.6-2**)
- Maximum height of abutment is 15.0m



Source: JICA Study Team

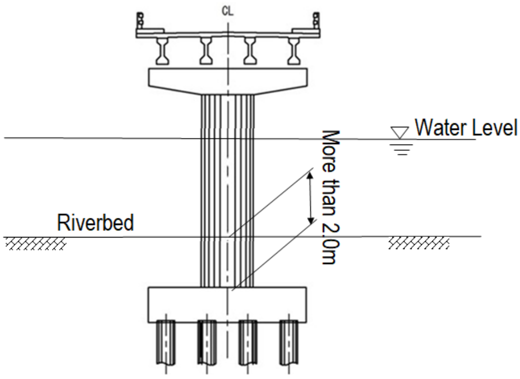
Figure 14.3.6-2 Footing Position on Slope

2) **In Water Way**

According to DPWH Design Guidelines, Criteria and Standards Volume5, the depth of pier footing in water way is specified as follow.

- On soil: top of footing must be located below the scour depth
- On rock: the bottom of footing must be embedded in non-erodible rock

Therefore, in this project, the cover of the top of the foundation from riverbed shall be kept greater than 2.0m based on Japanese Standards (see figure below).



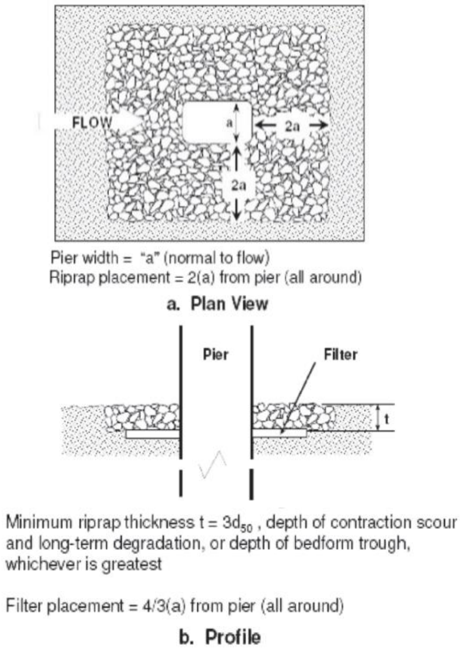
Source: JICA Study Team

Figure 14.3.6-3 Depth of Pier Footing in Waterway

14.3.7 River Protection

(1) Pier Foundation

The pier footing shall be protected against a scouring of river bed by loose bolder apron, gabions, precast concrete blocks and grout-filled or sand/cement-filled bags. The example of the riverbed protection measure at the pier is shown in **Figure 14.3.7-1**

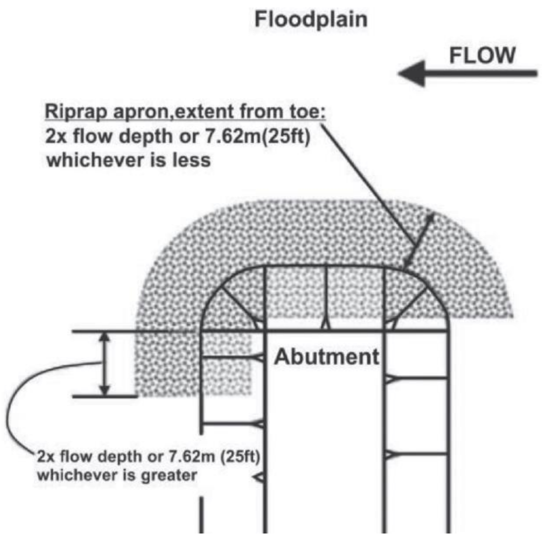


Source: DPWH Design Guidelines, Criteria & Standards Volume 5

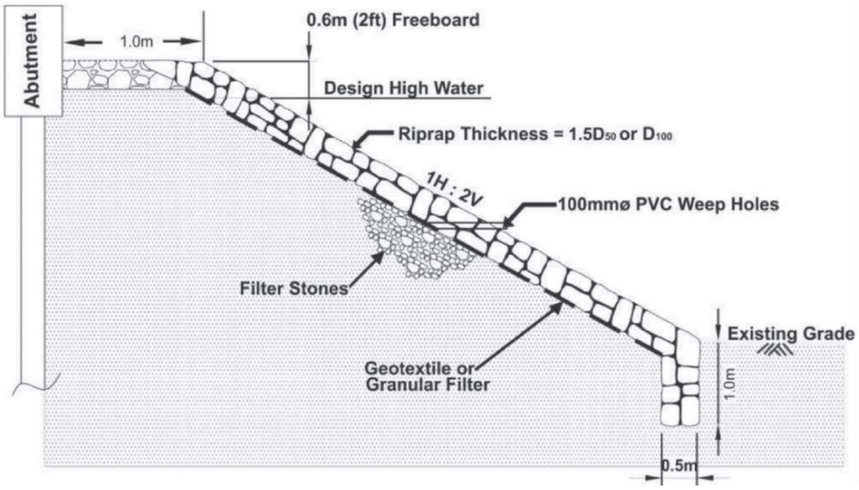
Figure 14.3.7-1 Example of Riverbed Protection (Typical Bolder Apron Layout)

(2) Abutment

The plan of abutment protection and typical cross section of the revetment front of abutment is shown **Figure 14.3.7-2**



1) The plan of abutment protection



2) Typical cross section of the revetment

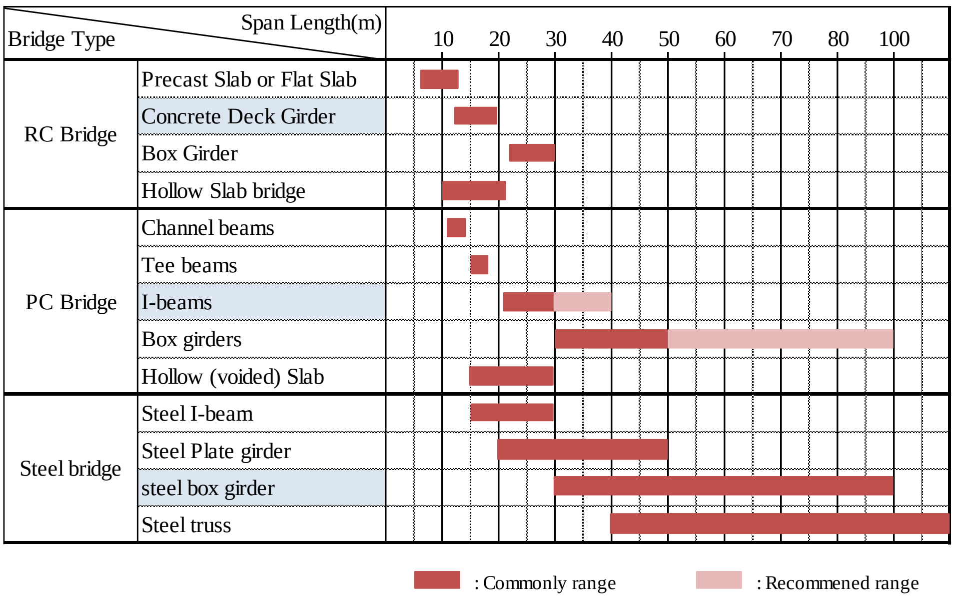
Source: DPWH Design Guidelines, Criteria & Standards Volume 5

Figure 14.3.7-2 Example of Protection for Abutment

14.3.8 Comparative Study to Select Optimum Bridge Type

(1) Span Range for Bridge Type

The normal span range of superstructure type are shown in **Figure 14.3.8-1**



Source: JICA Study Team

Figure 14.3.8-1 Applicable Span of Bridge Type

Table 14.3.8-1 Recommended Superstructure Type for each Span

Bridge Span	Bridge Type
Less than 10m	Culvert
10m - 20m	Concrete Deck Girder
20m - 40m	PC I-Beams
50m	Steel I-Plate Girder

Source: JICA Study Team

(2) Study on Alternative Bridge Types

To make an arrangement of the girder type and span of major bridges, an alternative study based on **Table 14.3.8-1** is shown.

1) Span Arrangement of Major Bridges

Table 14.3.8-2 Type of Bridge to Study

Bridge length		Span Arrangement
	Alternative1	3@RCDG(20m)
60m	Alternative2	RCDG (15m)+PCDG(30m)+RCDG(15m)
	Alternative3	2@PCDG(30m)
	Alternative1	4@PCDG(25m)
100m	Alternative2	PCDG(30m)+PCDG(40m)+PCDG(30m)
	Alternative3	2@STEEL I(50m)
	Alternative1	5@PCDG(30m)
150m	Alternative2	3@PCDG(40m)+PCDG(30m)
	Alternative3	3@STEEL(50m)
	Alternative1	PCDG(25m)+5@PCDG(30m)+PCDG(25m)
200m	Alternative2	5@PCDG(40m)
	Alternative3	4@STEEL I(50m)
	Alternative1	PCDG(25m)+5@PCDG(40m)+PCDG(25m)
250m	Alternative2	3@PCDG(35m)+PCDG(40m)+3@PCDG(35m)
	Alternative3	5@STEEL(50m)

Source: JICA Study Team

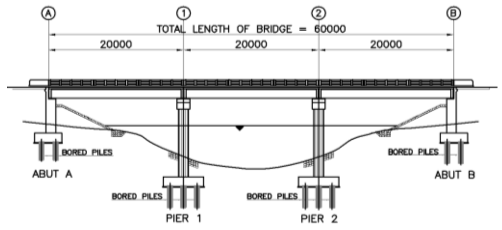
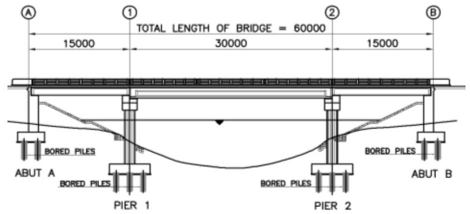
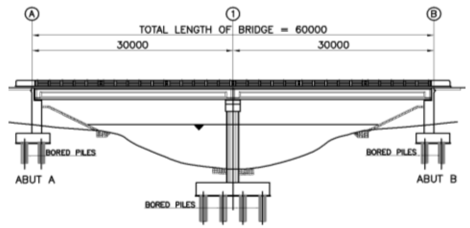
2) Results of Comparison Study

As a result of the study, For the following reasons, the spans of bridge recommend to arranges based on the long span of PCDG type.

- Reducing the number of piers perform the short construction period and economical and the influence on the flow of the river is also less.
- Utilizing prestressed concrete girder facilitate construction. A lot of bridges in Philippines utilize.

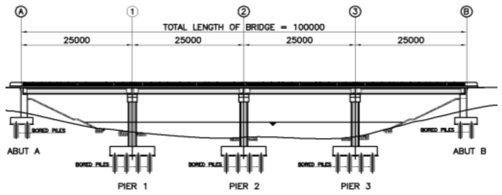
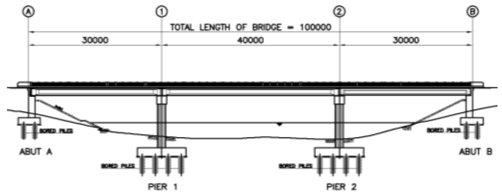
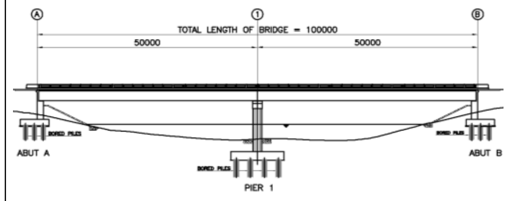
Bridge for comparison and results are as follows;

Table 14.3.8-3 Comparison Study for 60m Length Bridge Type

Bridge Length		60 m		
Alternative No.		1	2	3
Bridge type		3 Spanned Single RC Girder (RCDG) Bridge.	3 Spanned Single RCDG and PCDG Bridge.	2 Spanned Single PC Girder (PCDG) Bridge.
Span Arrangement		20+20+20	15+30+15	2@30
Diagram				
Structural Outlines		1) RCDG is most common type of girder in the Philippines. 2) Apply 20m length RCDG that is the longest girder in the case of applying RCDG because of reducing the number of piers. 3) Two piers in the river where water depth is	1) 15m RCDG is applied to side span and 30m PCDG (TYPE IV-B) is applied to the center span. 2) Two piers in the river where water depth is shallow.	1) Apply 30m length ASSHTO Girder (TYPE IV-B). 2) Only one pier is located in middle of the river where the water depth may be deepest at the time of flood.
Effects of Bridge on the River		1) Support to construct RCDG is necessary in the river therefore construction shall be executed in the dry season. 2) However it is not large that the bridge affect on the river after bridge is completed. (Fair)	1) Since the center span length is 30m, it is unlikely that the bridge will have an affect on the river. 2) However side span is as short as 15m, it might affect on the river flow during flooding. (Fair)	1) Since the pier is in middle of the river, the river flow may be affected 2) And there is risk to occur scouring around the pier. (Not Good)
Construction & Period		1) After complete substructure construction, the construction of superstructure (RCDG) can be commenced. 2) Therefore the construction period is longer than Alternative 2 and 3. (Not Good)	1) After complete substructure construction, the construction of side span girder (15m length RCDG) can be commenced. 2) The center span (30m PCDG) which is fabricated during substructure construction will be elected after side span construction is completed. 3) Therefore the construction period is longer than Alternative 3, but maybe shorter than Alternative 1. (Fair)	1) Temporary yard is required in the middle of river to construct the center pier. 2) Construction period is shorter than Alternative 1 and 2 because the PC girder can be fabricated during substructure construction. (Good)
Maintenance		Normal maintenance method can be applied. (Good)	Normal maintenance method can be applied. (Good)	Normal maintenance method can be applied. (Good)
Economy (Cost Php)	Superstructure	13,357,000	15,396,000	17,436,000
	Substructure	38,506,000	39,444,000	45,990,000
	Total	51,863,000 (864,000 /m) (Good)	54,840,000 (914,000 /m) (Fair)	63,426,000 (1,057,000 /m) (Not Good)
Decision		Recommend	---	---

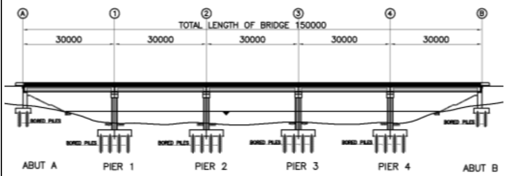
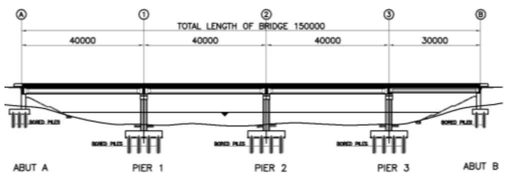
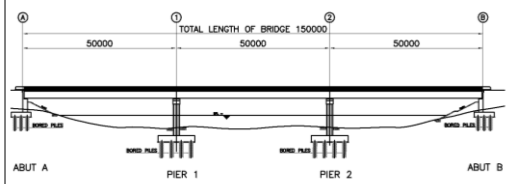
Source: JICA Study Team

Table 14.3.8-4 Comparison Study for 100m Length Bridge Type

Bridge Length		100 m		
Alternative No.		1	2	3
Girder type		4 Spanned Single PC Girder (PCDG) Bridge	3 Spanned Single PC Girder (PCDG) Bridge	2 Spanned Single Steel "I" Girder Bridge
Span Arrangement		4@25	30+ 40 +30	2@50
Diagram				
Structural Outlines		1) Apply 25m length ASSHTO Girder (TYPE-IV). 2) Three piers in the river 3) And the center pier is located at the middle of the river where the water depth may be deepest at the time of flood.	1) Apply 35m length ASSHTO Girder (TYPE V) and 30m ASSHTO Girder (TYPE IV-B) 2) Two piers in the river where water depth is shallow.	1) Apply 50m length Steel Plate Girder. 2) The pier is located in the middle of the river where the water depth may be deepest at the time of flood.
Effects of Bridge on the River		1) Span length is shortest among the three alternatives, as 25m, the river is likely to be affected by the bridge at the time of flood. 2) Since the center pier is at the middle of the river, the river flow might be affected. 3) And there is risk of occure scouring around the pier. (Not Good)	1) Pier can be arranged in shallow position of the river therefore it is unlikelly that the bridge affect on the river. (Good)	1) Since the pier is in middle of the river, the river flow might be affected. 2) And there is risk of occure scouring around the pier. (Not Good)
Construction & Period		1) Since PCDG can be fabricated during substructure construction, the construction period is shortest among the three alternatives. 2) Temporay yard is required in the middle of the river to construct the center pier. 3) Since number of the pier is largest, the construction period is the longest. (Not Good)	1) Since PCDG can be fabricated during substructure construction, the construction period is shortest among the three alternatives. 2) Temporay yard is required in the middle of river to construct the center pier. (Fair)	1) Since steel "I" girder can be fabricated during substructure construction, the construction period is shorter than Alternative 1. 2) Temporay yard is required in the middle of river to construct the center pier. (Fair)
Maintenance		Normal maintenance method can be applied. (Good)	Normal maintenance method can be applied. (Good)	Repaint will be necessary in future. (Not Good)
Economy (Cost Php)	Superstructure	27,002,000	17,436,000	78,990,000
	Substructure	79,116,000	86,434,000	57,264,000
	Total	106,118,000 (1,061,000 /m) (Fair)	103,870,000 (1,039,000 /m) (Good)	136,254,000 (1,363,000 /m) (Not Good)
Decision		---	Recommend	---

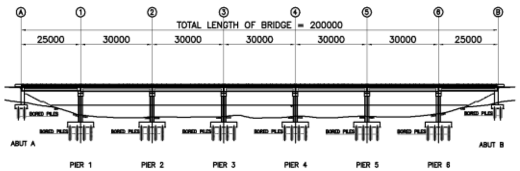
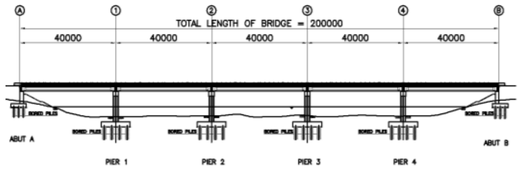
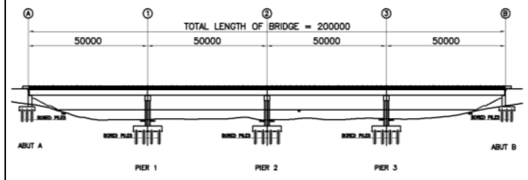
Source: JICA Study Team

Table 14.3.8-5 Comparison Study for 150m Length Bridge Type

Bridge Length		150 m		
Alternative No.		1	2	3
Bridge type		5 Spanned Single PC Girder (PCDG) Bridge	4 Spanned Single PC Girder (PCDG) Bridge	3 Spanned Single Steel "I" Girder Bridge
Span Arrangement		5@30	3@40+30	3@50
Diagram				
Structural Outlines		1) Apply 30m length ASSHTO Girder (TYPE IV-B). 2) Four piers are in the river.	1) Apply 30m length ASSHTO Girder (TYPE IV-B) and 40m ASSHTO Girder (TYPE VI) 2) Three piers are in the river and the center pier is located at middle of the river where water depth is deepest in the time of flood.	1) Apply 50m length Steel Plate "I"Girder. 2) Two piers are in the river
Effects of Bridge on the River		1) Since the number of the piers is largest as four piers, the river is possibly affected compared with other alternatives. (Not Good)	1) Since the pier is in middle of the river, the river flow might be affected. 2) And there is risk of occure scouring around the pier. (Good)	1) The space between piers is 50m therefore the bridge will unlikely to affect on the river. (Good)
Construction & Period		1) PCDG can be fabricated during substructure construction and erected after complete substructure construction. 2) Since the number of piers is largest as four, the construction period is the longest. (Not Good)	1) PCDG can be fabricated during substructure construction and erected after complete substructure construction 2) Since the number of piers and spans is smaller than Alternative 1, the construction period is shorter than Alternative 1. (Fair)	1) Temporay yard is required in the middle of river to construct center pier. 2) Steel "I" girder can be fabricated during substructure construction. 3) Since it is 3-spanned brige, the construction period will be shorter than Alternative 1. (Good)
Maintenance		Normal maintenance method can be applied. (Not Good)	Normal maintenance method can be applied. (Good)	Repaint will be necessary in future. (Not Good)
Economy (Cost Php)	Superstructure	43,590,000	53,117,000	118,486,000
	Substructure	108,270,000	98,971,000	82,658,000
	Total	151,860,000 (1,012,000 /m) (Good)	152,088,000 (1,014,000 /m) (Fair)	201,144,000 (1,341,000 /m) (Not Good)
Decision		---	Recommend	---

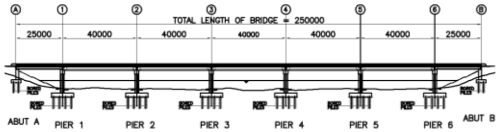
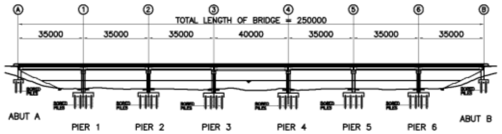
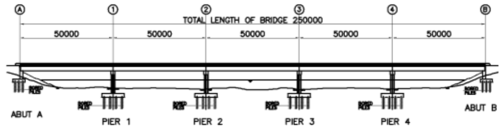
Source: JICA Study Team

Table 14.3.8-6 Comparison Study for 200m Length Bridge Type

Bridge Length		200 m		
Alternative No.		1	2	3
Girder type		7 Spanned Single PC Girder (PCDG) Bridge	5 Spanned Single PC Girder (PCDG) Bridge	4 Spanned Single Steel "I" Girder Bridge
Span Arrangement		25+5@30+25	5@40	4@50
Diagram				
Structural Outlines		1) Apply 25m length ASSHTO Girder (TYPE-IV) in both side spann and 30m length AASHTO Girder (TYPEIV-B) in other 5-spans. 2) Six piers are in the river.	1) Apply 40m length ASSHTO Girder (TYPE-VI). 2) Four piers are in the river.	1) Apply 50m length Steel Plate Girder. 2) Three piers are in the river. 3) Center pier is located at in the middle of the river where the water depth may be deepest at the time of
Effects of Bridge on the River		1) Since the side spanlength is shorter as 25m, the side span might be affect river flow at the time of flood. (Fair)	1) The space between piers is 40m therefore the bridge unlikely to affect on the river. (Good)	1) The space between piers is 50m therefore the bridge unlikely to affect on the river.. 2) However the center pier is in middle of the river, therefore the river flow might be affected. 3) And there is risk to occure scouring around the (Not Good)
Construction & Period		1) PCDG can be fabricated during substructure construction and erected after complete substructure construction. 2) Since the number of piers is the largest, the construction period is longest among the three alternatives. (Not Good)	1) PCDG can be fabricated during substructure construction and erected after complete substructure construction. 2) The construction period is shorter than Alternative 1 and longer than Alternative 3. (Good)	1) Temporay yard is required in the middle of river. 2) Since steel "I" girder can be fabricated during substructure construction, the construction period is shorter than Alternative 1. 3) Since the number of spans and piers is smallest, the construction period is shortest among the three alternatives (Fair)
Maintenance		Normal maintenance method can be applied. (Good)	Normal maintenance method can be applied. (Good)	Repaint will be necessary in future. (Fair)
Economy (Cost Php)	Superstructure	57,091,000	73,998,000	157,981,000
	Substructure	149,851,000	131,192,000	108,052,000
	Total	206,942,000 (1,035,000 /m) (Fair)	205,190,000 (1,026,000 /m) (Good)	266,033,000 (1,330,000 /m) (Not Good)
Decision		---	Recommend	---

Source: JICA Study Team

Table 14.3.8-7 Comparison Study for 250m Length Bridge Type

Bridge Length		250 m		
Alternative No.		1	2	3
Girder type		7 Spanned Single PC Girder (PCDG) Bridge	7 Spanned Single PC Girder (PCDG) Bridge	5 Spanned Single Steel "I" Girder Bridge
Span Arrangement		25+5@40+25	3@35+40+3@35	5@50
Diagram				
Structural Outlines		1) Apply 25m length ASSHTO Girder (TYPE-IV) to both side spann and 40m length AASHTO Girder (TYPE VI) applied to the other five spans. 2) Six piers are in the river.	1) Apply 40m length ASSHTO Girder (TYPE-VI) to center span and 35m ASSHTO Girder applied to other spans. 2) Six piers are in the river.	1) Apply 50m length Steel Plate Girder. 2) Four piers are in the river.
Effects of Bridge on the River		1) Since the side spanlength is shorter as 25m, the side span might be affect river flow at the time of flood. The space between piers is 40m, therefore the bridge unlikely to affect on the river. (Fair)	1) The space between piers is more than 35m therefore the bridge unlikely to affect on the river. (Good)	1) The space between piers is 50m therefore the bridge unlikely to affect on the river. (Good)
Construction & Period		1) PCDG can be fabricated during substructure construction and erected after complete substructure construction. 2) Since the number of piers is six, the construction period is longer than Alternative 3. (Fair)	1) PCDG can be fabricated during substructure construction and erected after complete substructure construction. 2) Since the number of piers is six, the construction period is longer than Alternative 3. (Fair)	1)Since steel "I" girder can be fabricated during substructure construction. 2) The since the numer of the spans and piers is smallest, the construction period is shorter than other Alternatives. (Good)
Maintenance		Normal maintenance method can be applied. (Good)	Normal maintenance method can be applied. (Good)	Repaint will be necessary in future. (Not Good)
Economy (Cost Php)	Superstructure	87,499,000	83,362,000	197,476,000
	Substructure	160,725,000	167,907,000	133,446,000
	Total	248,224,000 (993,000 /m) (Good)	251,269,000 (1,005,000 /m) (Fair)	330,922,000 (1,324,000 /m) (Not Good)

Source: JICA Study Team

14.4 Pavement Design Standards

The following standard is basically applied for this project.

- Chapter 6 Pavement Design, Design Guidelines, Criteria & Standards Volume 4 Highway Design 2015, BoD, DPWH

Also, the following standard is referred to:

- Guide for Design of Pavement Structures, 1993, AASHTO

And, the following Department Orders by DPWH are used:

- Department Order No. 22, Series of 2011, DPWH
- Department Order No. 11, Series of 2014, DPWH
- Department Order No. 40, Series of 2014, DPWH
- Department Order No. 137, Series of 2014, DPWH
- Department Order No. 8, Series of 2016, DPWH
- Department Order No. 32, Series of 2016, DPWH

(1) Design Life for Pavement

In estimating the design volume, the minimum life is commonly assumed to be 20 years for a rigid pavement. The pubic opening is assumed to be Year 2022. Therefore, design life for pavement design is proposed between Year 2022 and Year 2042.

(2) Type of Pavement

In Mindanao Island, the Portland Cement Concrete Pavement (PCCP) is widely used because the cement is produced in sufficient quantites. In consideration with the road maintenance, the PCCP is applied for this project.

(3) Minimum Thickness of PCCP Slab

In accordance with D.O., the minimum thickness of PCCP slab for new construction is adopted 280 mm, if the cumulative equivalent single axle load (CESAL) is more than 7.0×10^6.

(4) Minimum Width of PCCP

In accordance with D.O., the minimum width of PCCP on National Highways for new construction is adopted 6.70 meters.

14.5 Drainage Design Standards

14.5.1 Road Surface Drainage

The following standard is basically applied for this project.

- Chapter 5 Highway Drainage Design, Design Guidelines, Criteria & Standards Volume 4

Highway Design 2015, BoD, DPWH

Also, the following guideline is referred to:

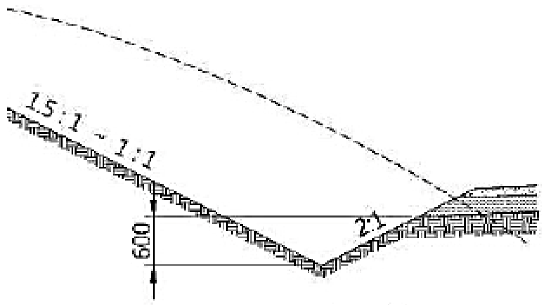
- Guidelines for drainage work: Japan Road Association

(1) Type of Roadside Channel

Between the roadway and cutting slope, the open earth gutters will be provided where the vertical grade is less than 4%. Where the vertical grade is 4% and more, the open concrete ditches will be installed. Also, shoulder shall be paved by PCCP with 150 mm in thickness, and a part between edge of paved shoulder and ditch should be lined by concrete.

(2) Minimum Depth of Roadside Channel

The minimum depth of roadside channel is applied 600 mm from the bottom of pavement as shown in the following figure.



Source: Design Guidelines, Criteria & Standards Volume 4 Highway Design 2015, BoD, DPWH

Figure 14.5.1-1 Minimum Depth of Ditch (sample of Earth Gutter)

14.5.2 Culverts

The following standard is basically applied for this project.

- DPWH Design Guidelines, Criteria & Standards Volume 3 Water Engineering Projects 2015,
- Chapter 5 Highway Drainage Design of DPWH Design Guidelines, Criteria & Standards Volume 4 Highway Design 2015,
- Standard Drawings for Roads and Bridges

(1) Discharge (Hydrologic Analysis)

Discharge (Hydrologic analysis) of river will be estimated in accordance with the standards mentioned above.

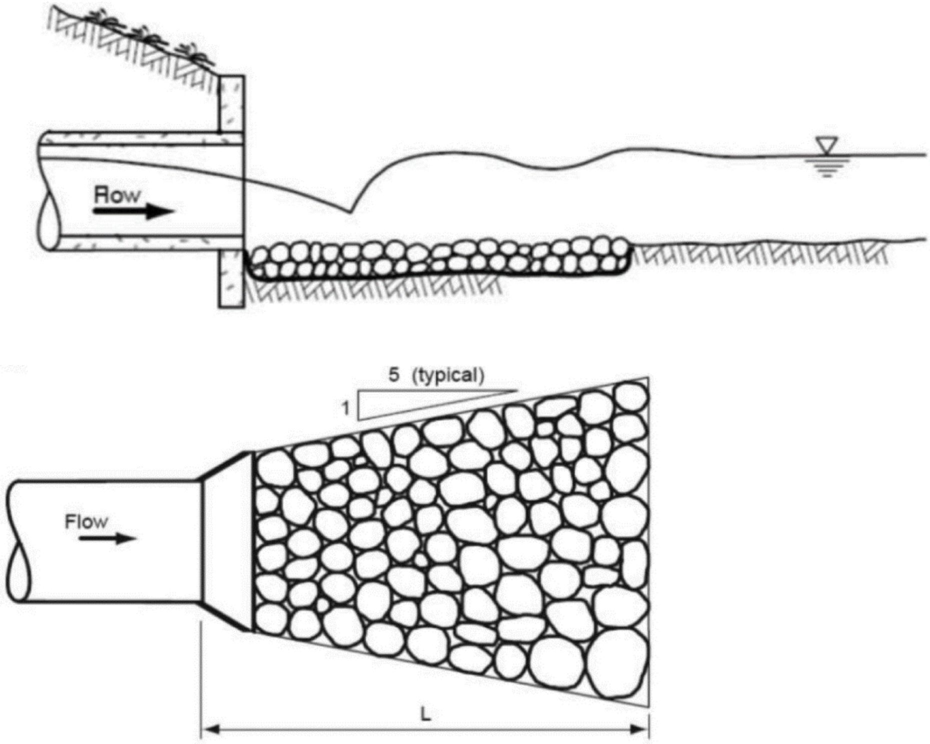
The Criteria for hydrological analysis are described in **Sub-Section 14.6.1**, Hydrological Analysis of this report.

(2) Hydraulic and Structural Design of Culvert

Hydraulic design of culverts will be done in accordance with Chapter 5.8 of DPWH Design Guidelines, Criteria & Standards Volume 4 Highway Design 2015, Criteria for structural design of culvert are described **Chapter 14.3**, Bridge and Structural Design Standards of this report.

In addition above, the Culvert shall be designed in consideration of the items mentioned below.

- Minimum Cover: 0.6m
- Size of Culvert (minimum internal width and clear depth): 0.910m
- Minimum velocity: 0.8m/sec
- Maximum velocity: 5m/sec
- Outlet scour control: refer to **Figure 14.5.2-1**



Source: DPWH Design Guidelines, Criteria & Standards Volume 4 Highway Design 2015

Figure 14.5.2-1 Typical layout of Outlet Scour Control

14.6 Drainage Design Standard

14.6.1 Hydrological Analysis

(1) Adopted Calculation Method of Flood Discharge passing under Road Alignment

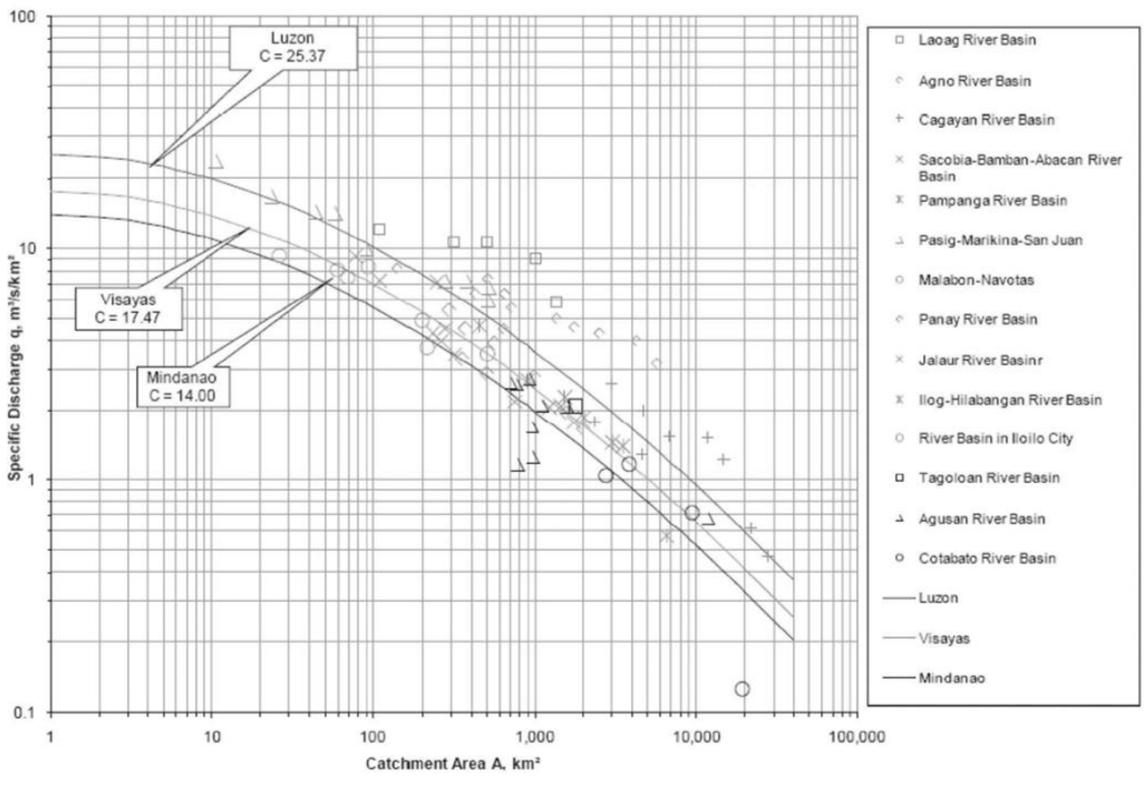
Although it is possible to calculate flood discharge by performing runoff analysis using various types of runoff models, the calculation result would be greatly different depending on the setting of a number of parameters which represents basin’s runoff characteristics such as soil penetration, storage effect and so forth. In order to identify reasonable combination of parameters in runoff analysis, it is necessary to calibrate the model by comparing calculated results with water level and/or discharge data actually observed at the sites at a time of flooding. However, since no flood record has not been confirmed in the study area, it is difficult to obtain a reasonable runoff analysis result. In addition, it is difficult to simulate the traveling process of the river flow, as there is no bathymetric data of river channel in the target section. Even if it is conducted, its accuracy can’t be verified.

Considering that it is difficult to secure the accuracy of runoff analysis due to lack of hydrological observation information, it is one of the applicable measures to estimate the peak flow rate from specific discharge curve using the catchment area as an indicator. At the Design Guidelines, Criteria & Standard 2015 (Volume 3, Water Engineering Projects, hereinafter referred to as "Volume 3 of DGCS 2015") which were complied by DPWH, the relation between size of catchment area and specific discharge is organized by regions based on the data of the major river basins in the Philippines.

With this method, it is possible to reflect the basin's runoff characteristics such as soil infiltration and storage as well as rainfall characteristics of Mindanao region, and it is also possible to consider the difference of runoff characteristics in accordance with the size of the catchment area. Therefore, the **Specific Discharge Curve** described in the Volume 3 of the DGCS 2015 is adopted in the study for estimation of flood discharge.

(2) Specific Discharge Curve to be Adopted in the Study

In accordance with Volume 3 of the DGCS 2015, the relation between size of catchment area and specific discharge for Mindanao (study area) and specific discharge curve to be adopted in the Study for estimation of flood discharge is shown in **Figure 14.6.1-1**.



Source: Design Guidelines, Criteria & Standard 2015 (Volume 3, Water Engineering Projects), DPWH

Figure 14.6.1-1 Specific Discharge Curve by Region in the Philippines

Specific discharge curve shown **Figure 14.6.1-1** is represented with the following equation.

$$q = CA^{(A^{-0.048}-1)}$$

Where q is specific discharge ($m^3/s/km^2$) and A is the size of catchment area (km^2). C is a parameter to reflect local runoff characteristics into the calculation and its value is given by referring to the following **Table 14.6.1-1**.

Table 14.6.1-1 Constant C for Regional Specific Discharge Curve

Region	Return Period					
	2-year	5-year	10-year	25-year	50-year	100-year
Luzon	15.66	17.48	18.91	21.51	23.83	25.37
Visayas	6.12	7.77	9.36	11.81	14.52	17.47
Mindanao	8.02	9.15	10.06	11.60	12.80	14.00

Source: Design Guidelines, Criteria & Standard 2015 (Volume 3, Water Enginnering Projects), DPWH

14.6.2 Hydraulic Analysis

(1) Required Minimum Dimension for Flood Discharge passing under Roads

In accordance with the specific discharge curve in the previous phase (**Sub-Section 14.8.2(2)**), probable flood discharge volumes at each point passing under the road alignment will be calculated in **Section 14.7** in this Chapter. Based on the probable flood discharges, minimum requirements of dimension to be opened at each cross-sectional point with rivers and/or drainage are estimated as follows:

1) Determination of Water Level (Frequency of Flood for Determination of Required Dimension of Bridge and Drainage System passing under Roads)

In this Study, required dimension of bridges and drainage systems passing under designed roads shall be set in accordance with the DGCS 2015. However, there are several methodologies described in each volume of the DGCS. Therefore, each methodology described in each volume of the DGCS 2015 are described in (a), (b) and (c), and adopted methodology in the Study is explained in (d) hereinafter;

(a) Required Dimension described in Volume 5 of the DGCS 2015 (Bridge)

Target flood level passing under a Bridge is given in accordance with Volume 5_Bridge of Design Guidelines, Criteria & Standard 2015 (DGCS 2015) as described below:

- Design Flood: 50-year Return Period Flood
- Vertical clearance between the Design Flood Level and the lowest member of the bridge superstructure shall not be less than 1.50 m.
- Check Flood: 100-year Return Period Flood
- Water level corresponding to the Check Flood shall not be higher than the lowest member of the bridge superstructure.

(Section 5.7 of Volume 4_Highway Design of the DGCS 2015) The design of drainage structures considers estimates of the magnitude of floods based on frequency of occurrence. The selection of flood frequencies normally differ depending on the type of drainage structure or condition being considered.
The design storm frequencies considered desirable for use in the Philippines are provided in Table

(b) Required Dimension described in Volume 4 of the DGCS 2015 (Highway Design)

In Volume 4 (Highway) of the DGCS, the concepts for design of drainage structures are given as described below:

Table 14.6.2-1 Design Flood Frequency

Design Flood Frequencies (Minimum Requirements) for Road								
Road Classification	Culverts		Roadside Ditches & Inlets		Median Ditches & Inlets		Curb Drop Inlets	
	Design Flood	Check Flood	Design Flood	Check Flood	Design Flood	Check Flood	Design Flood	Check Flood
Expressway	50 yr	100 yr	25 yr	50 yr	25 yr	50 yr	25 yr	50 yr
National Road	25 yr	50 yr	10 yr	25 yr	10 yr	25 yr	10 yr	25 yr
Other Roads	20 yr	50 yr	5 yr	10 yr	5 yr	10 yr	5 yr	10 yr

Source: P 5-8, DGCS Volume 4

As described in **Table 14.6.2-1**, design storm frequency for drainage system to be installed for road (expressway) is 50-yr return period for design of road and 100-yr return period for checking dimension of drainage system.

(c) Required Dimension described in Volume 3 of the DGCS 2015 (Water Project)

According to Volume 3_Water Engineering Projects of the DGCS 2015, target flood level passing through Drainage Pipes and/or Culverts is given below:

(Section 6.2 of Volume 3_Water Engineering Projects of DGCS 2015) The design of a stormwater drainage system should consider both the minor and major drainage systems:

- The minor drainage system consists of the components that have been historically considered as part of the “storm drainage system” (FHWA, 2001), such as culverts, pipes and drainage channels. The key aim of the minor system is to minimize relatively frequent and nuisance flooding.
- The major drainage system is intended to provide relief for stormwater flows exceeding the capacity of the minor drainage system (FHWA, 2001). Design should allow for the conveyance of these larger flows along overland flowpaths such as roads, parks, drainage reserves and other features. The major drainage system is intended to protect the community from larger flood events that exceed the minor drainage system capacity.

The capacity of these systems is defined in Table 1.1-4. (In this Report, See **Table 14.6.2-2**.)

Table 14.6.2-2 Flood Discharges by Return Period

Land-use (*1)	Minor System		Major Drainage System
	Design Capacity	Check Capacity	Drainage Capacity (*2)
Drainage Pipes	15-year Flood	25-year Flood	100-year Flood
Culverts (*1)	25-year Flood	50-year Flood	
Esteros/Creeks/ Drainage Channel	15-year Flood	25-year Flood	

Note: *1: Refer to Volume 4 for highway cross drainage structure capacities
*2: Freeboards for buildings are detailed in Volume 6: Public Buildings and Other Related Structures.
Source: P 6-2, DGCS Volume 3

In the DGCS 2015, there is no definition and clarification of River, Minor Drainage and Major Drainage Systems.

In this connection, all river and drainage system to be estimated in this Study (Feasibility Level) shall be calculated as "River" or "Major Drainage" systems.

(d) Flood Scale/Frequency for Required Dimension of Bridges and Drainage Systems (Pipes / Box Culverts)

As explained in (c) above, the definition of flood discharges to determine required dimension of drainage system described in Volume-3 of the DGCS 2015 is vague. In this connection, flood discharge corresponding to 50-year return period flood shall be selected to determine Required Dimension for Rivers/Drainages with freeboard and cross-sectional average flow velocities in accordance with Volume-4 and 5 of the DGCS 2015. Flood discharges corresponding to and 100-year return period flood shall also be selected to check the height of freeboard for "Bridge" and "Drainage Pipes/Culverts".

2) Equations to determine the Required Dimension

Required dimension for "Bridge" and "Drainage Pipes/Culverts" are calculated through theories of flow continuity and uniform flow analysis.

Those two theories/equations can be expressed by the following formulae:

$Q = A \times v$ (Equation of Continuity)

Where,

Q: Flow Discharge (m^3/s) corresponding to each return period

A: Cross Sectional Area of Flow (m^2)

v: Velocity of Flow (m/s) (See below)

$v = \frac{1}{n} \times R^{2/3} \times I^{1/2}$ (Equation of Uniform Flow)

where,

n: Manning's Roughness Coefficient $\left(m^{1/3} \cdot s\right)$

R: Hydraulic Radius (m)

$R = \frac{A}{P}$

where,

P: Cross Sectional Wetted Perimeter (m)

I: Longitudinal Gradient of Riverbed

3) Set-up of Values of Parameters and/or Coefficients

In accordance with two equations mentioned above, minimum cross-sectional area for designated flow discharge are calculated.

In this regard, it is necessary for calculation to envisage parameters and coefficients in the theories of two equations, such as type of shape of cross section, width of riverbed, water depth, n (Manning's Roughness Coefficient) and I (Longitudinal Gradient of Riverbed).

These parameters and coefficients have been fixed as follows:

(a) Type of Shape of Cross Section

According to the DGCS 2015, the gradient side slopes of river/drainage channels shall be set as follows:

> The side slopes should be gentler on both landside and riverside of the embankment than 1V:2H for low embankments (<6.0 m) and 1V:3H for high embankments (>6.0 m).

Therefore, in case of side slope without the revetment, the condition of side slopes on both sides of river/drainage channels shall be set in accordance with the DGCS 2015.

On the other hand, side slopes of required dimension with revetments shall be dependent on the selected type of the revetment/slope protection.

Shape of Cross Section has been decided based on the recommended type of bridges and flow velocity. As for type of bridge, Bridges are basically classified into two (2) types, namely, “Girder Type” and “Box Culvert Type”. In this connection, type of bridge has been selected based on the length of bridge in terms of workability and costs (thickness of beam of girder). In this hydrological analysis, type of bridge has been determined shown in table below.

Table 14.6.2-3 Shape of Cross Section of River/Drainage passing under Road (Draft)

Discharge	Shape of Cross Section	Slope of Low Water Channel (1:m)	Slope of High Water Channel (1:n)	Longitudinal Gradient of Riverbed
Less than or equal to 50m3/s	B.C.	0.0	-	Any gradient
$50m^3/s$ to $200m^3/s$	Trapezoidal section	0.5	-	Any gradient
$200m^3/s$ to $500m^3/s$		0.5		Steeper than 1/200
		2.0	-	1/200 <
More than $500m^3/s$		2.0	-	Steeper than 1/500
	Compound section	3.0	3.0	1/500 <

Note: B.C.: Box Culvert Type

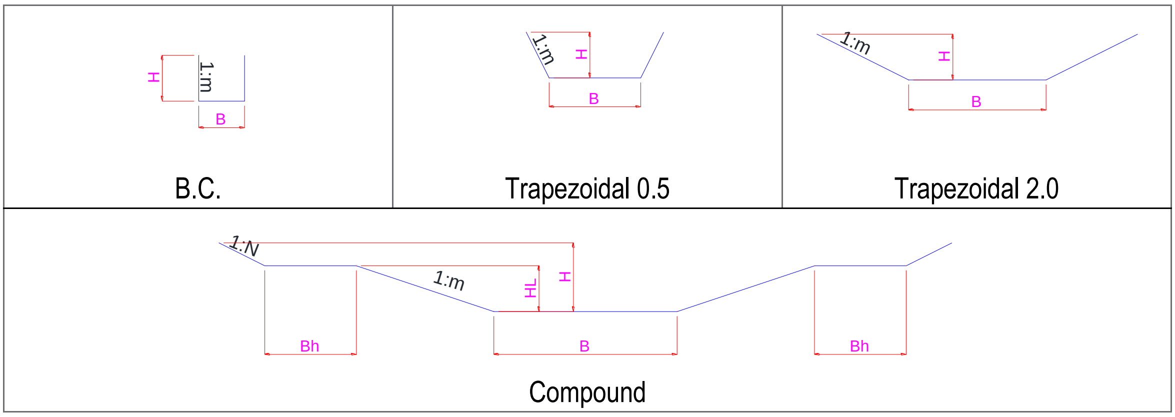


Figure 14.6.2-1 Specific Discharge Curve by Region in the Philippines

(b) Water Depth

Taking into consideration basic site conditions (actual flood situations and topographic information) and hydraulic advantages, water depth for setting cross section has been assumed as follows:

Table 14.6.2-4 Assumed Water Level to Determine Cross Section

Type of Cross Section	Water Level (W.L. (in meter) in 50-yr Return Period	Remarks
B.C.	1.0~3.0	W.L. shall be less than length of width of river/drainage channel.
Trapezoidal section	1.5~3.0	
Compound section	Low Water Channel: 3.0~5.0m High Water Channel: 1.0~3.0m	

(c) Manning's Coefficient

In accordance with "Design Guidelines, Criteria & Standards (Volume-3 Water Engineering Projects, 2015) (Hereinafter, referred to as Volume-3 of DGCS), Manning's Coefficient to be adopted for calculations has been introduced as follows:

Table 14.6.2-5 Manning's Coefficient (Values of Manning's Roughness Coefficient 'n' (Uniform Flow) – Natural Channels))

Description	Minimum	Maximum
Fairly Regular Section		
1. Some grass & weeds, little or no brush	0.028	0.033
2. Dense growth of weeds, flow depth greater weed height	0.033	0.040
3. Some weeds, light brush on banks	0.035	0.050
4. Some weeds, heavy brush on banks	0.050	0.070
5. Some weeds, dense trees	0.060	0.080
For trees within channel, with channel, with branches submerged at high flood increase all above values by	0.010	0.020
6. Winding, some pools & shoals, clean (1.)	0.035	0.045
7. Winding, some pools & shoals, clean, lower stages, more ineffective sections	0.045	0.055
8. Winding, some pools & shoals, clean, some weeds & stones (3.)	0.040	0.050
9. Winding, some pools & shoals, clean, lower stages, more ineffective sections, stony sections	0.050	0.060
10. Sluggish river reaches, rather weedy or with deep pools (4.)	0.060	0.080
11. Very weedy reaches (5.)	0.100	0.150
Irregular sections, with pools, slight meander; increase above values by about	0.010	0.020
Mountain streams, no vegetation in channel, bank steep, tree & brushes along banks submerged at high flood		
1. Bottom of gravel, cobbles & few boulders	0.040	0.050
2. Bottom of cobbles, with large boulders	0.050	0.070
Large Stream Channels (top width greater than 30m) Reduce smaller stream coefficients by 0.10		

Source: Table 4-2, Design Guidelines, Criteria & Standard 2015 (Volume 3, Water Engineering Projects), DPWH

Table 14.6.2-6 Manning's Coefficient (Values of Manning's Roughness Coefficient 'n' (Uniform Flow) – Man-made Channels & Ditches))

Description	Minimum	Maximum
1. Earth, straight & uniform	0.020	0.025
2. Earth bottom, rubble sides / riprap	0.030	0.035
3. Grass covered	0.035	0.050
4. Dredged	0.028	0.033
5. Stone lined & rock cuts, smooth &uniform	0.030	0.035
6. Stone lined & rock cuts, rough & irregular	0.040	0.045
7. Lined - smooth concrete	0.014	0.018
8. Lined - grouted riprap	0.020	0.030
9. Winding sluggish canals	0.025	0.030
10. Canals with rough stony beds, weeds on earth banks	0.030	0.040

Source: Table 4-4, Design Guidelines, Criteria & Standard 2015 (Volume 3, Water Engineering Projects), DPWH

As highlighted descriptions shown in tables mentioned above, average standard value of Manning's Coefficient is 'n=0.03'.

4) Freeboard (Vertical Clearance)

Freeboard for cross sections passing under roads shall be basically secured in accordance with each Volume 3 (Water) and Volume 5 (Bridge) of the DGCS respectively as follows:

Table 14.6.2-7 Freeboard Allowance and Crest Widths for Dikes (in Volume 3 of DGCS 2015)

Design Flood Discharge (m^3/s)	Freeboard (m)	Crest Width (m)
Less than 200	0.6	3
200 and less than 500	0.8	
500 and less than 2,000	1.0	4
2,000 and less than 5,000	1.2	5
5,000 and less than 10,000	1.5	6
10,000 and over	2.0	7

Source：Volume 3, Water Engineering Projects, Design Guidelines, Criteria & Standard 2015 (DGCS 2015), DPWH

Table 14.6.2-8 Freeboard Allowance (Volume 5 in DGCS 2015)

Description	Value (m)	Crest Width (m)
Vertical Clearance between DFL/MFL and the soffit of the lowest member of the bridge superstructure	Shall not be less than 1.50m	For rivers carrying debris
	Shall not be less than 1.00m	For other bridges

Source：P 4-4 (Section 4.4 Freeboard), Volume 5 Bridge, DGCS 2015, DPWH

(2) Slope and Foot Protection Works or Revetments

1) General

All sections of road to be planned in this Study where rivers and/or drainage systems are across and located should carefully be protected by structures for slope protections or revetments. In particular, side slopes of road embankment should be protected not so as to by erosion or scouring of slope at immediately upstream and downstream sections of rivers or drainage system passing under road.

In Volume-5 of DGCS, the design of embankment structures, such as the road structures to be designed in this Study, encroaching on floodplains should carefully be considered as follows:

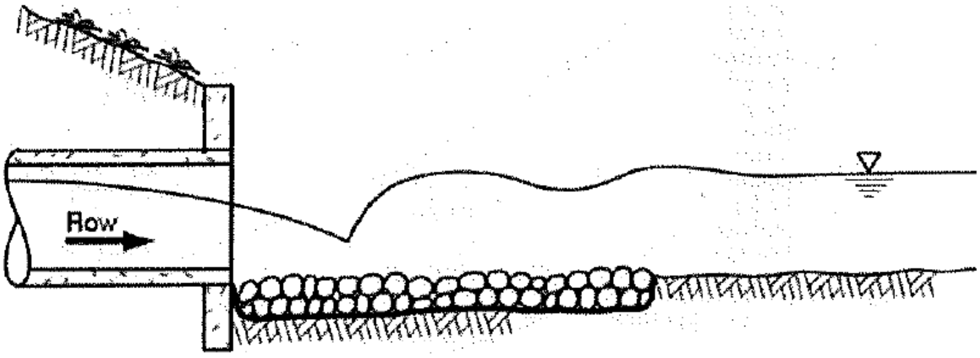
> Embankments that encroach on floodplains are most commonly subjected to scour and erosion damage by overflow and by flow directed along the embankment to the waterway openings. Erosion can also occur on the downstream embankment due to turbulence and eddying as flow expands from the openings to the floodplain and due to overtopping flow.
> The incidence of damage from flow along an approach embankment is probably highest in wooded floodplains where the right-of-way are cleared of all trees and where borrow areas are established upstream of the embankment. Damage to approach embankment is usually not severe, but scour

In addition to considerations of preventing road embankment from erosion and scouring damages mentioned in Volume 5 of DGCS, the definition of revetments is described in Volume 3 of DGCS as follows:

> Revetments are flood control structures constructed along river banks subjected to direct attack of the river flow and along levee slopes for protection against erosion, scouring, riverbed degradation and wave wash….
> A revetment should be designed based on the existing site conditions, such as river flow velocity and direction, embankment material, topographical, morphological, and geological conditions of the riverbank, etc. Further, the revetment should be designed to withstand the lateral forces due to high velocity flow, when located in flow attack zone, on a weak geological condition of riverbank,

Furthermore, inlet / outlet scour control works are imperative as well as slope protection works and revetments as described in Volume 4 of the DGCS 2015.

> Outlet scour control may be required at outlets to reduce flow velocities prior to discharging to watrercourses in order to reduce the risk of erosion. Outlet protection may be required where:
> - The outlet velocity exceeds the scour velocity of the bed or bank material
> - The outlet channel and banks are actively eroding
> - There is a bend in the channel a short distance downstream
> - Protection requirements may range from a riprap apron to stilling basins and concrete structures
>
> In all cases, a concrete cut-off wall is required at the end of the culvert to prevent undermining.
> Rock pad outlets or dry boulder outlets are commonly adopted for culvert outlets. These should generally be considered where outlet velocities are less than 5m/s and the Froude number of the flow is less than 1.7. (See **Figure 14.6.2-2**below.)
> (Source: P 5-18 of the DGCS 2015 (Volume-4))



Source: Figure 5-4 on P 5-18 of the DGCS 2015 (Volume-4) (Original Source: QUDM, 2013)

Figure 14.6.2-2 Dry Boulder (Riprap) Outlet

2) Assumption of the Site and Design Conditions for Setting Parameter

As quoted from DGCS Volume 3 in the Sub-Section (9.8.3 (1) (a)), a revetment should be designed based on several site conditions. In this study, the site conditions for provisional design of slope protections or revetments are fixed as follows:

(a) River Flow Velocity to be considered in Design of Revetments

River/Drainage flow velocity at each section with road planned has been calculated with the calculation for minimum dimension of opening passing under the road. In this connection, the flow velocities calculated for determining "required minimum dimension" in (1) of this Sub-Section are adopted as "Cross Section Average Velocity" for a basic force in order to select the type of revetment and dimensions of materials to be utilized.

The relationship between Average Velocity and "Design Velocity" for construction of revetments has been provided by the following formula based on HEC 23 (2009). Regarding Velocity Adjustment Factor, it may be set by reading off value of "α" corresponding to ratio (Rc/W) between radius of bend of river alignment (R_c) and river width (W) as illustrated in **Figure 14.6.2-3** below.

$$V_{des} = \alpha \cdot V_{avg}$$

where,

V_{des} : $Design\ Velocity$ (m/s)

V_{avg} : $cross\ section\ average\ velocity\ (m/s)$

α : $velocity\ adjustment\ factor, which\ can\ be\ determined\ based\ on$:

For natural channels:

$$\alpha = 1.74 - 0.52 \cdot \log\left({}^{R_c}/_{W}\right)$$

$$\alpha = 1 \quad \text{for } {}^{R_c}/_{W} > 26$$

For trapezoidal channels:

$$\alpha = 1.71 - 0.78 \cdot \log\left({}^{R_c}/_{W}\right)$$

$$\alpha = 1 \quad \text{for } {}^{R_c}/_{W} > 8$$

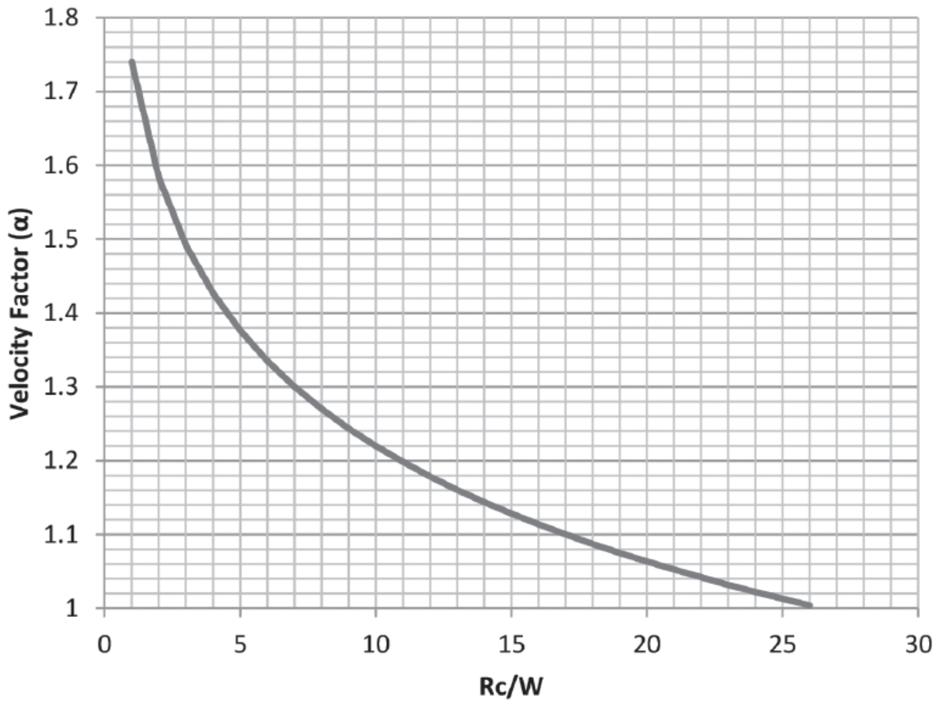


Figure 14.6.2-3 Velocity Adjustment Factor (α) to determine Design Velocity

Regarding river flow direction, original flow of which the direction can be identified from plan views and topographical maps.

In case exiting conditions are unknown, velocity adjustment factor (α) shall be adopted at 1.20.

(b) Road Embankment Material and Topographical/ Morphological / Geological Conditions

It is assumed that Road Embankment Materials shall be selected based on the construction specification to be prepared in Detailed Engineering Design Stage (DED Stage) as a new structure with good embankment materials.

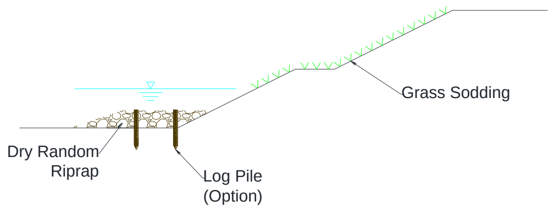
On the other hand, loose and soft materials have been expanded on the sections where bridges / drainage systems are planned and constructed. Most of the rivers across the planned road alignment are naturally intact and untouched flow systems without man-made river facilities, such as dikes, groins (spur dikes) and artificial drainage systems. In this connection, protection footing of road embankment should carefully be considered to select the type of revetment work and riverbed protection work.

3) Types of Revetments / Slope Protections to be considered

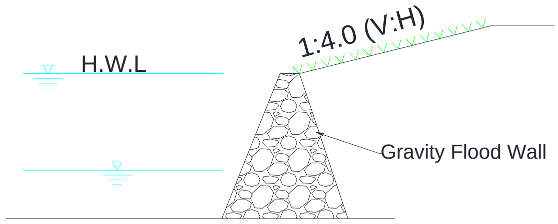
In accordance with the DGCS 2015, all sections where bridges / drainage systems are constructed or installed shall be evaluated and analyzed which type of revetment is the most applicable and suitable. Basic design concepts for the selection of revetment type are as follows:

(a) Types of Revetment to be considered in the Study

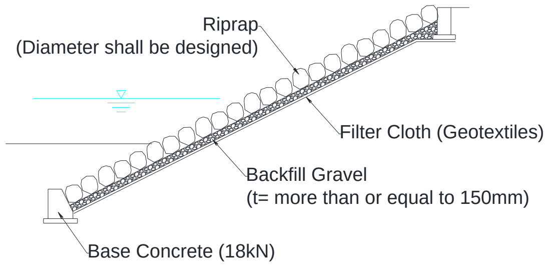
Nine (9) types of Revetments on slope and footing protection works of road embankment shall be considered based on the DGCS 2015. Typical cross sections for each type of Revetments are illustrated as below:



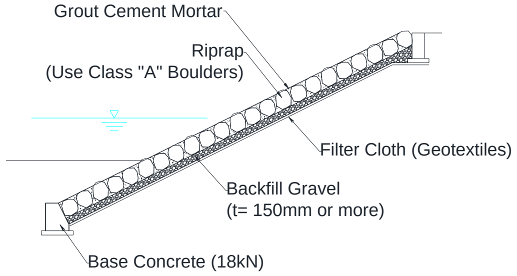
Type-1. (Type SR)
Sodded Riverbank (with Pile Fence)



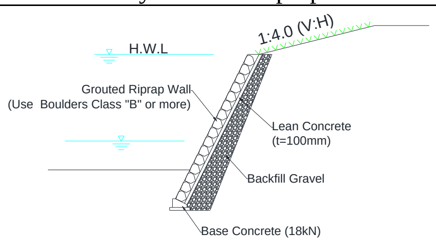
Type-2. (Type GW)
Gravity Wall (with Vegetation Slope)



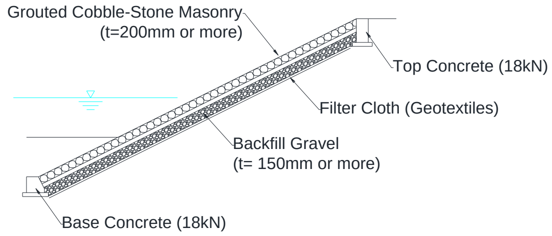
Type -3 (Type DBR)
Dry Boulder Riprap



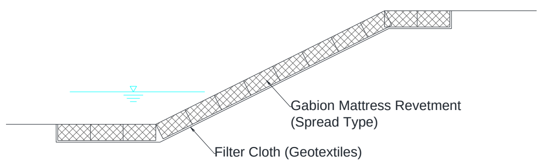
Type-4 (Type GRST)
Grouted Riprap (Spread Type)



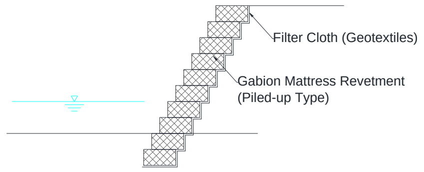
Type-5 (Type GRWT)
Grouted Riprap (Wall Type)



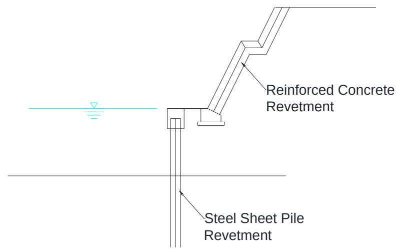
Type-6 (Type RCST)
Rubble Concrete (spread type)



Type-7 (Type GMST)
Gabion (Mattress or Spread Type)



Type-8 (Type GW)
Gabion (Pile-up type)- Gabion Wall



Type-9 (Type SP or Type SPRCR)
Sheet Pile or Sheet Pile with Reinforced Concrete

Source: Prepared by JICA Study Team based on P 5-31 (Table 5-5), DGCS Volume 3

Figure 14.6.2-4 Revetment (Slope Protection) Types to be considered

Table 14.6.2-9 Freeboard Allowance (Volume 5 in DGCS 2015)

Name of Type	Max. D. V. (m/s) *1	Slope (V:H)	Remarks
1. Sodded Riverbank (with Pile Fence)	2.0	Milder than 1:2	Not applicable for places near roads and houses. Diameter and length of wooden pile shall be determined considering past construction records. Note that this is not a common technique used for revetment.
2. Gravity Wall or	5.0	-	Slope of Gravity Wall is dependent on the design calculation.
Gravity wall with Vegetation and Reinforced Grass/ TRM	-	Milder than 1:4 for Vegetation Slope	Typically for the upper section of the protection, where the velocities of flow are lower. Should be located above the ordinary water level to ensure only irregular inundation. Refer to Section ….
3. Dry Boulder Riprap	3.0 to 4.0	Milder than 1:2	Diameter of boulder shall be determined using Table… Height of generally less than 3 to 5m
4. Grouted Riprap (Spread Type)	5.0	Milder than 1:1.5	Use Class “A” boulders for grouted riprap and loose boulder apron
5. Grouted Riprap (Wall Type)	5.0	1:1.5 to 1:0.5	Use Class “B” boulders for grouted riprap *2
6. Rubble Concrete (spread type)	5.0	Milder than 1:1.5	In Japan, this type of revetment is usually adopted for river improvement works.
7. Gabion (Mattress or Spread Type)	5.0	Milder than 1:1.5	Not advisable in rivers affected by saline water intrusion. Not applicable in rivers where diameter of boulders present is greater than 20cm.
8. Gabion (Pile-up type)- Gabion Wall	6.5	1:1.5 to 1:0.5	Not advisable in rivers affected by saline water intrusion. Not applicable in rivers where diameter of boulders present is greater than 20cm.
9. Sheet Pile		Vertical	In cases where ordinary water level is very high.
Sheet Pile with Reinforced Concrete			Minimum thickness of 20cm

Note: *1: D.V.: Design Velocity of Flow
*2: Boulders’ Class to be used for Grouted Wall (Riprap): In DGCS, the class B or more higher class of boulders shall be used for this type revetments although Class A may be recommended in DGCS.
Source: Prepared by JICA Study Team based on P 5-31 (Table 5-5), DGCS Volume 3

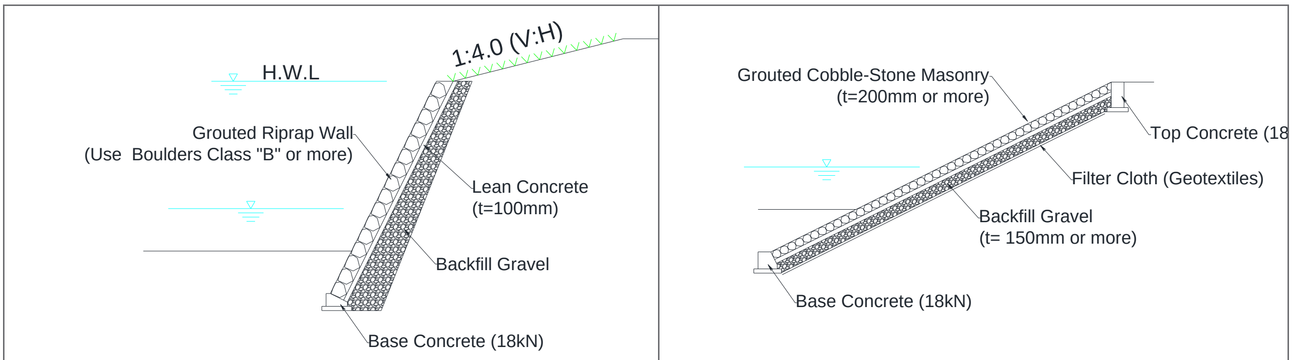
(b) Revetment Type to be selected

Each type of revetments has advantages and disadvantages respectively to select the most suitable structural type. In target areas of this Study, the following features shall be taken into account:

Table 14.6.2-10 Points to be Considered for the Selection of Revetment Type

Major Classification	Points to be Considered	Explanation	Recommended Types
Social Condition	Vandalism	Easy access to market for materials utilizing Revetment is one of disadvantage factors for selection.	Type-1, 2, 3, 4, 5, 6, and 9
	Free maintenance	Low cost for maintenance is one of advantages for selection.	Type-2, 5, 6, and 9
Workability	Weight of Material	The increment of hauling and installation costs for heavy materials is one of disadvantage factors for selection.	Type-1, 2, 5, 6, 7, and 8
	Work in Water	Sump pumping works needed for Concrete works in water are one of disadvantages for selection.	Type-1, 3, 4 and 9
Availability of Materials	Diameter of Stone	It may be difficult to secure lots of huge diameter of stones (riprap) in the Mindanao.	Type-5, 6, 7, 8 and 9

Based on the results of **Table 14.6.2-10** mentioned above, standard types of revetment / slope protection works are Type-5 and Type-6 unless special conditions are considered at site.



Type-5 (Type GRWT)
Grouted Riprap (Wall Type)

Type-6 (Type RCST)
Rubble Concrete (spread type)

Figure 14.6.2-5 Standard Types of Revetment (Slope Protection) to be adopted in Common Conditions

4) Types of Foot Protection

As described in “1) General”, Foot protection works for side slopes at inlet and outlet of river and/or drainage pipes/culverts and and bridge pier shall be protected by “Foot Protection Works”.

Basically, riprap type shall be utilized as foot protection due to the following itemized reasons:

- Most of foot point of slope (revetment) and piers of bridges may be submerged. In this connection, it is expected that workability of riprap type foot protection is easier than other types of foot protection; and
- Periodical maintenance works for foot protection will be recommended due to unexpected phenomena, such as extreme scouring and/or erosion. In this connection, easier repair work for foot protection is recommended. Repair works of Riprap type is the easiest method compared to that of other types;

Gabion mattress type is also recommended for foot protection work due to same reasons mentioned above. However, Gabion type has a disadvantage feature, such as vandalism. Therefore, Gabion type is alternative foot protection work in case it is difficult to obtain materials of riprap (there is no query sites where rocks and boulders designed are not produced).

5) Required Materials for Slope Protection Works (Revetments) and Foot Protection Works (Design Methods for Each Type of Protection Works)

(a) Required Diameter of Loose Boulder for Revetment Type-3 and Type-4 and Foot Protection Work

Revetment Type-3 and Type-4 and Foot protection works for side slopes and bridge pier shall be calculated in accordance with Volume-3 and Volume-5 of the DGCS 2015 as follows:

In case Design Flood Discharge Q1 > 50 m3/s

The rock sizing required for loose boulder apron for side slopes and bridge piers can be estimated and designed based on the equation presented in HEC23 (2009) and provided below:

$$d_{50} = \frac{0.692 \cdot (V_{des})^2}{(S_g - 1) \cdot 2g}$$

Where,

d50 : particle size for which 50% is finer by weight, m

Vdes : design velocity for local conditions at the pier, m/s

Sg : specific gravity of riprap

g: acceleration due to gravity, 9.81m/s2)

The design velocity (Vdes), representing the local conditions at the pier, can be estimated using the following equations:

V_des = K_1·K_2·V_avg

where,

K1 : shape factor equal to 1.5 for round-nosed piers or 1.7 for square-faced piers

K2 : velocity adjustment factor for location in the channel (ranges from 0.9 for a pier near the bank in a straight reach, to 1.7 for a pier locating in the main current of flow around a sharp bend)

V_avg : channel average velocity at the bridge, m/s

For easy determination and selection of class of riprap due to flow velocity, the DGCS also provide designers with Minimum Diameter of Boulder (Riprap Type) as shown in below:

Table 14.6.2-11 Minimum Diameter of Boulder (Riprap Type)

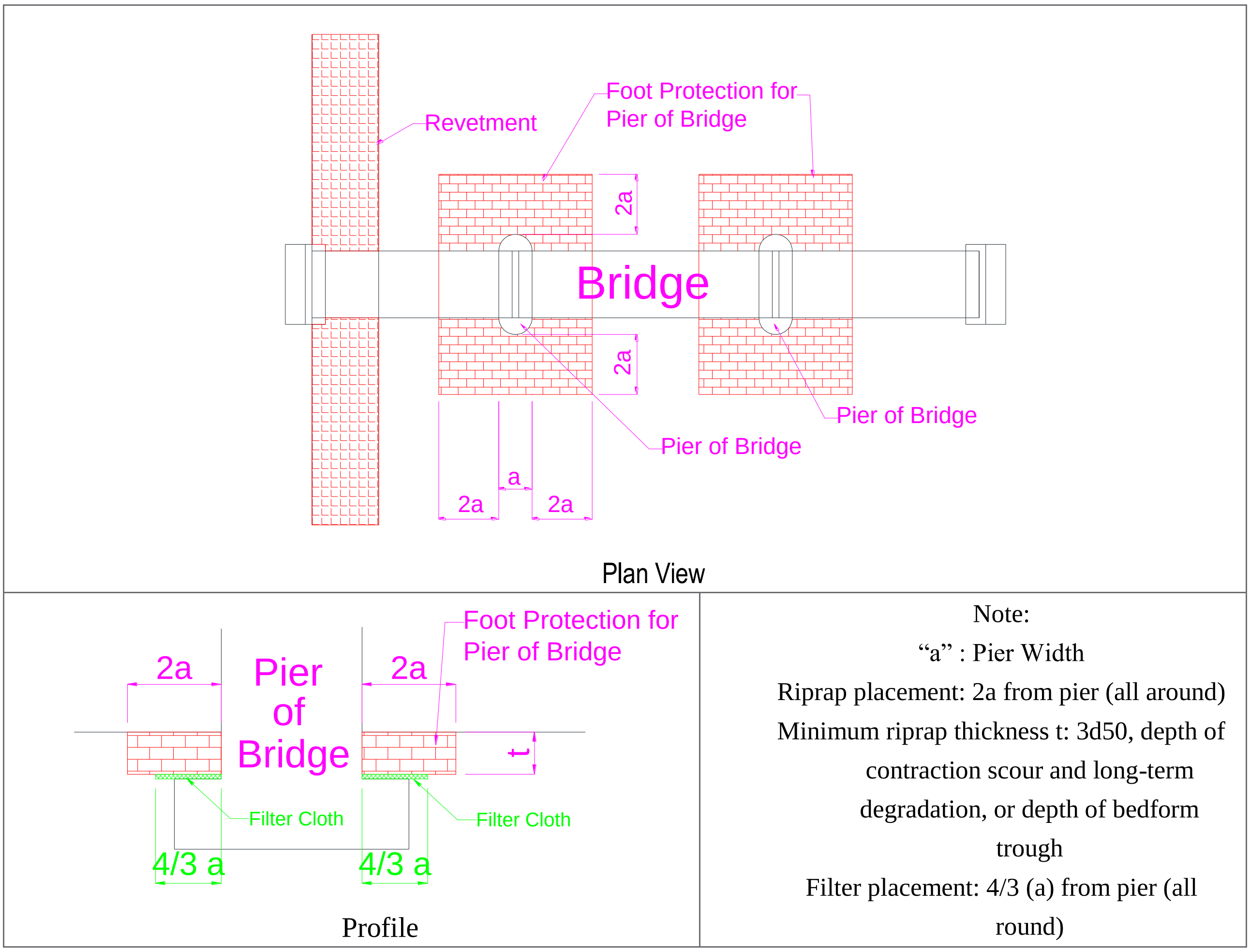
Design Velocity (m/s)	Diameter (mm)
2	200
3	350
4	600
5	950
6	1,350

Source: P5-45, Table 5-8 of Volume-3 of the DGCS 2015

The width of any loose boulder apron protection should be a minimum of 2 times the width of the pier (measured perpendicular to the approach flow) on all sides. It should be placed in a flat pre-excavated hole with the top surface flush with the bed.

The thickness of the loose boulder apron should be 3 times the d50 or the depth of the contraction scour, whichever is the greatest.

Typical scour protection to a pier is illustrated in Figure below:



Source: Prepared by the Study Team based on P 3-29, 3.3.8.1 DGCS-Bridge (Original Source: HEC23, 2009)

Figure 14.6.2-6 Typical Loose Boulder Apron Layout and Requirements for Pier Protection

It is important to understand that loose boulder apron can move over time, particularly after high flow events. Therefore, it is important that the riprap protection be monitored and inspected after each high flow events. Therefore, it is important that the riprap protection be monitored and inspected after each high flow events to ensure that the riprap is stable.

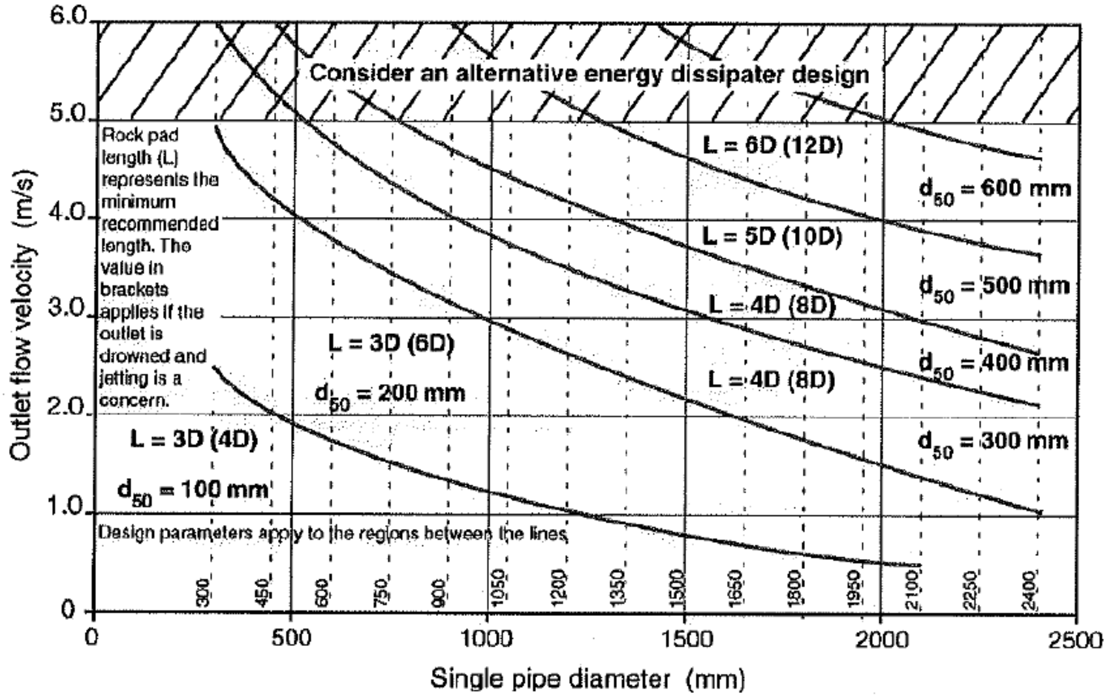
In case Design Flood Discharge Q2 < 50 m3/s

Force for scouring and erosion will comparatively be small in case design flood discharge is small. In this regard, foot protection for drainage system of which flood discharge is equal to or less than 50m3/s shall be designed in accordance with Volume-4 of the DGCS 2015 as follows:

Figure 14.6.2-7 and **Figure 14.6.2-8** provide guidance on the selection of mean rock size (d50) and the length of the dissipator (L). Note that these desugb graphs assume a specific gravity of 2.6.

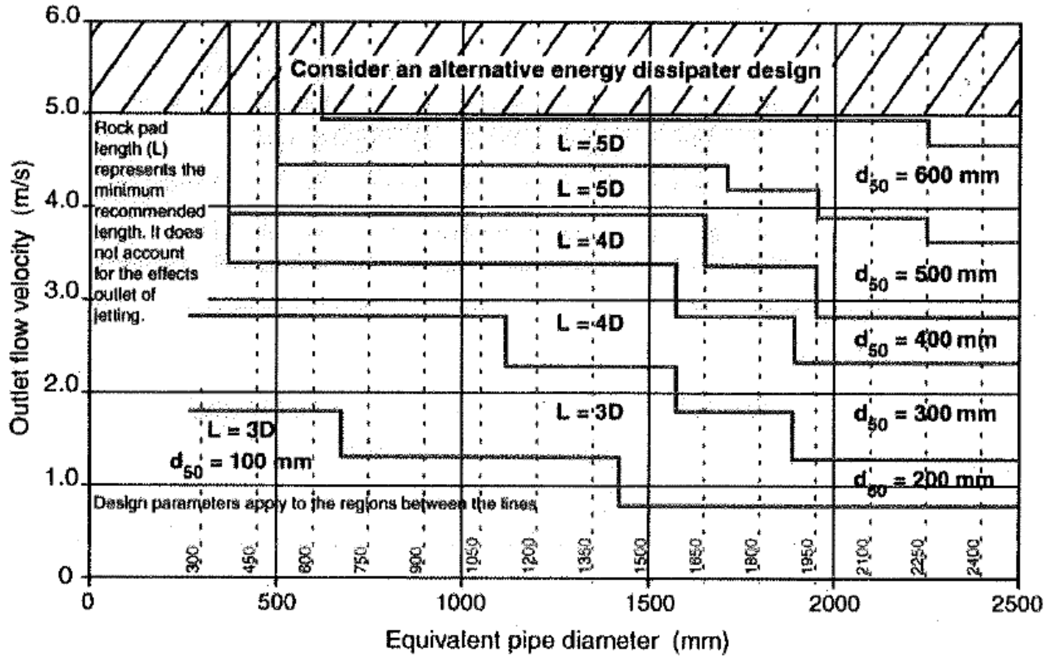
The minimum recommended width of the rock pad is defined as:

- Immediately downstream of the outlet: the width of the outlet apron, or the width of the outlet plus 0.6m (if there is no apron);
- At the downstream end of the rock pad: the above width plus 0.4 times the length of the rock pad (L) as shown in **Figure 14.6.2-9**.



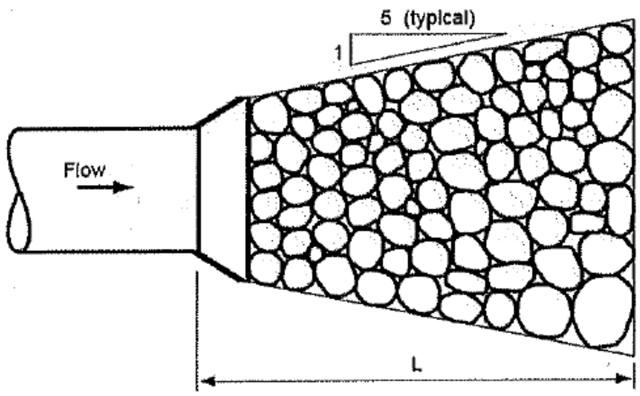
Source: Volume-4 of the DGCS 2015 (Original Source: QUDM 2013)

Figure 14.6.2-7 Sizing of Dry Boulder Outlet Structures for Single Pipe or Box Culverts



Source: Volume-4 of the DGCS 2015 (Original Source: QUDM 2013)

Figure 14.6.2-8 Sizing of Dry Boulder Outlet Structures for Multiple Pipe or Box Culverts



Source: Volume-4 of the DGCS 2015 (Original Source: QUDM 2013)

Figure 14.6.2-9 Typical Road Pad Outlet Configuration

(b) Required Thickness of Cobble Stone for Revetment Type-5 and Type-6

In the DGCS 2015, calculation method for thickness of rubble stone for Revetment Type-5 and Type-6 has not been explained. Instead of calculation method, Class of riprap/rubble stone to be utilized in some types of revetments has been mentioned. For Type-5, Class-B or more bigger classes of Riprap shall be utilized as each material. For Type-6, Class-A or more bigger classes of Riprap shall be utilized as each materials of revetment.

Table 14.6.2-12 Class of Riprap

Class	Weight	Range
Class A	stones ranging from a minimum of 15 kg to a maximum of 25 kg	with at least 50% of the stones weighing more than 20 kg
Class B	stones ranging from a minimum of 30 kg to a maximum of 70 kg	with at least 50% of the stones weighing more than 50 kg

Class	Weight	Range
Class C	stones ranging from a minimum of 60 kg to a maximum of 100 kg	with at least 50% of the stones weighing more than 80 kg
Class D	stones ranging from a minimum of 100 kg to a maximum of 200 kg	with at least 50% of the stones weighing more than 150 kg
Class E	stones ranging from a minimum of 500 kg to a maximum of 700 kg	with at least 50% of the stones weighing more than 600 kg

Source: DPWH Blue Book

(c) Gabion (Type-7 and Type-8)

These types shall not be used for rivers with saline water intrusion and for rivers with riverbed and banks consisting of boulders. The gabions shall be connected to each other. Gabions and gabion mattresses should be designed in accordance with manufacturer specifications. Indicative velocity limits for preliminary sizing are provided in **Table 14.6.2-13**. Note that the critical velocity is the velocity where the mattress reaches the limit of deformation. Mattresses and gabions should be designed in accordance with the critical velocity.

Table 14.6.2-13 Class of Riprap

Type	Thickness (mm)	Rock Fill Size (mm)	D50 (mm)	Critical Velocity (m/s)	Limiting Velocity (m/s)
Gabion Mattress	150	70-100	85	3.5	4.2
	180	70-150	110	4.2	4.5
	230	70-100	85	3.6	5.5
	250	70-150	120	4.5	6.1
	300	70-120	100	4.2	5.5
		100-150	125	5.0	6.4
Gabions	500	100-200	150	5.8	7.6
		120-250	190	6.4	8.0

Source: Volume-3 of the DGCS 2015 (Original Source: DTMR 2013)

14.7 Slope Design Standards

The following standard is basically applied for this project.

- Chapter 7 Earthworks, Design Guidelines, Criteria & Standards Volume 4 Highway Design 2015, BoD, DPWH

Also, the following guideline and manual are referred to:

- Guidelines for road earthwork: Japan Road Association
- Manual for Slope Protection, Highway Earthwork Series: Japan Road Association

The following table is provided in the DPWH standard.

Table 14.7-1 Stability of Cut and Fill Slopes for Different Material Types

Filling Material*	Nature of Material	Height of Cut/Fill (m)	Slope Ratio (H:V)***	Remarks
Well graded sand (SW)	Soil	Less than 5	1.5:1 to 2.0:1	Applied to fills with sufficient bearing capacity at foundation ground, which are not affected by inundation (assumed drained and unsaturated). Consistency assumed to be medium dense (non-cohesive) or stiff (cohesive) or better.
Gravel with Silt (GM)				
Gravel with Clay (GC)				
Well Graded Gravel (GW) Poorly Graded Gravel (GP)		5 to 15	1.8:1 to 2.5:1	
Pooorly Graded Sand (SP)		Less than 10	1.8:1 to 2.5:1	
Silty Sand (SM)		Less than 5	1.5:1 to 2.0:1	
Clayey Sand (SC)				
Hard clayey soils and clay of alluvium, loam (CL)		5 to 10	2.9:1 to 2.5:1	
Soft Clay of high plasticity (CH), Silts (ML, MH)		0 to 5	2.9:1 to 3.0:1	
Medium to High Strength Rock, Slightly Weathered to Fresh	Rock**	Less than 10	0.5:1 to 1.0:1	Assess all rock slopes in cut in accordance with Section 7.3
		10 to 15	0.75:1 to 1.2:1	
Very Low to Medium Strength Rock, Extremely to Distinctly Weathered		Less than 5	0.75:1 to 1.2:1	
		5 to 10	1.0: 1 to 1.5:1	
Residual Soil to Extremeky Low Strength Rock, Extremely Weathered		Less than 5	1.0: 1 to 1.5:1	
		5 to 10	1.5:1 to 2.0:1	

Source: Design Guidelines, Criteria & Standards Volume 4 Highway Design 2015, BoD, DPWH

(1) Filling Slope

Based on the above table, the height, berm and slope ratio for filling slope are applied as follows:

- Max. Height (1 step) : 5.0 m
- Width of Berm : 1.0 m
- Slope Ratio : 1.8H : 1V

The slope protection is adopted the coconut mat soil protection because it is widely used in the Philippines and is economical.

(2) Cutting Slope

Based on the above table, the height, berm and slope ratio for cutting slope are applied as follows:

- Max. Height (1 step) : 5.0 m
- Width of Berm : 1.0 m
- Slope Ratio (Soil) : 1.00H : 1V
- Slope Ratio (Soft Rock): 0.75H : 1V

14.7.1 Slope Protection for Bank of River / Drainage System

Slope and foot protection works for river / drainage system passing across road alignment shall be planned and designed in basically accordance with the DGCS 2015. All considerations as design criteria are described in "(2) Slope and Foot Protection Works or Revetments" of **Sub-Section 14.5.2** in this Chapter.

14.8 Hydrological and Hydraulic Analysis

14.8.1 Methodology of Hydrological Analysis and River Channel Planning for Bridge and Drainage Structure Installation

In order to formulate the basically necessary structural planning and design of bridges and drainage structures passing under the roads planned, hydrological and hydraulic analysis for river/drainage channels at crossing points are carried out for appropriate design for target structures. Procedures for the analysis are as shown in the following chart.

1：Identification of Bridge Crossing Points Based on Existing Topographical Map and Satellite Image

↓

2：Definition of River Basin Boundaries Based on Existing Topographical Map

↓

3：Calculation of Catchment Areas (=A) in Accordance with the Defined Basin Boundaries

↓

4：Determination of Specific Discharges (= q) by Return Period at Each Catchment Area by Referring to "Design Guidelines, Criteria & Standard 2015 (DGCS 2015, DPWH)"

↓

5：Calculation of Flood Discharges by Multiplying Catchment Area and Specific Discharge (= A * q)

↓

6：Calculation of Minimum Requirement of Widths and Water Levels Corresponding to the Calculated Flood Discharges through Uniform Flow Analysis

↓

7：Confirmation of Hydraulic Condition of Each Crossing Point with River / Drainage (Judgement of Necessity of Revetment and Riverbed Protection)

↓

8：Determination of Appropriate Revetment Type and Calculation of Required Materials / Members of Revetment and Riverbed Protection

↓

9：Delineation of Typical Cross Sections for Bridge / Drainage Structures with Revetment and Riverbed Protection Works

Figure 14.8.1-1 Procedures for Hydrological and Hydraulic Analysis for Designing Bridge and Drainage Structures at Crossing Points

14.8.2 Hydrological Analysis and River Channel Planning for Bridge and Drainage Structure Installation

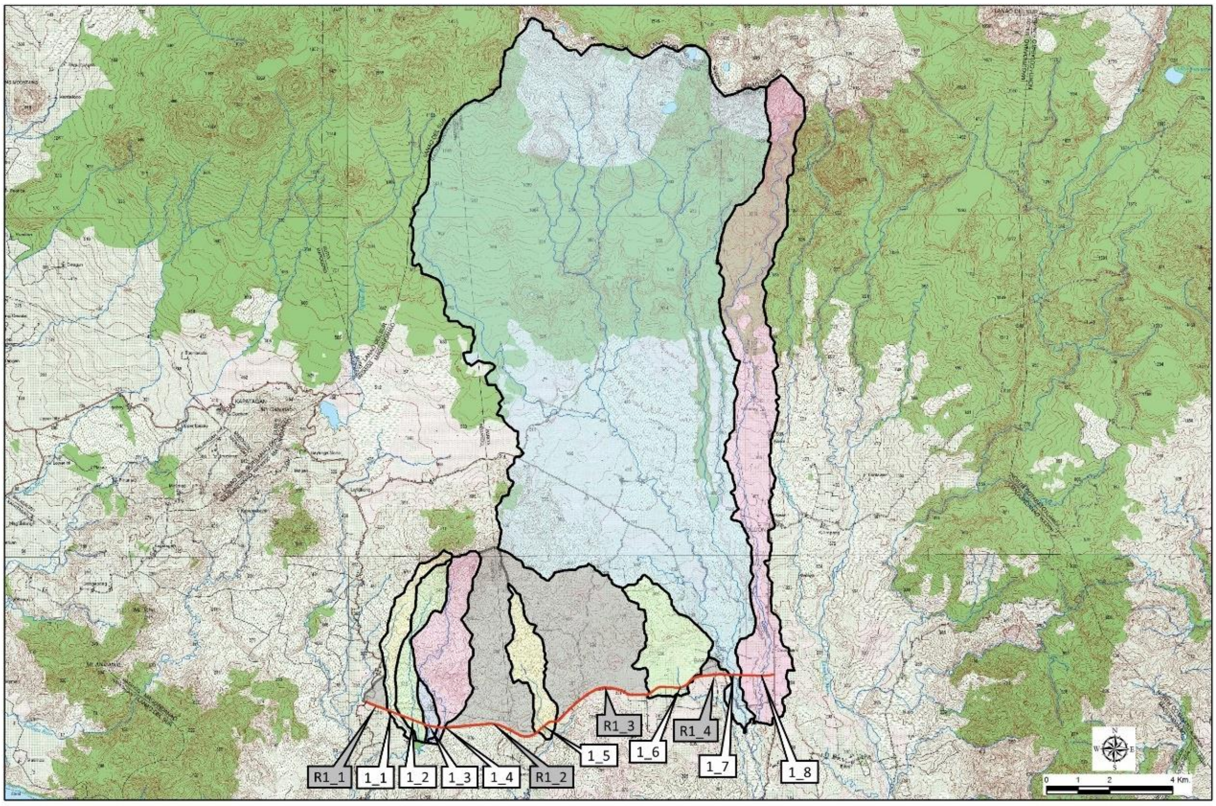
(1) Identification of Crossing Points

1) Definition of Catchment Area

The locations where newly installed road networks are to cross river channels are identified through close inspection of existing topographical map and satellite images. As for the topographical map, the map with the scale of 1: 50,000 which was compiled in the past JICA study of "Topographic Mapping for Peace and Development in Mindanao in the Republic of the Philippines" in 2013 is made use of in the study.

Catchment areas corresponding to each river or drainage are defined based on the aforesaid topographical map with the scale of 1: 50,000.

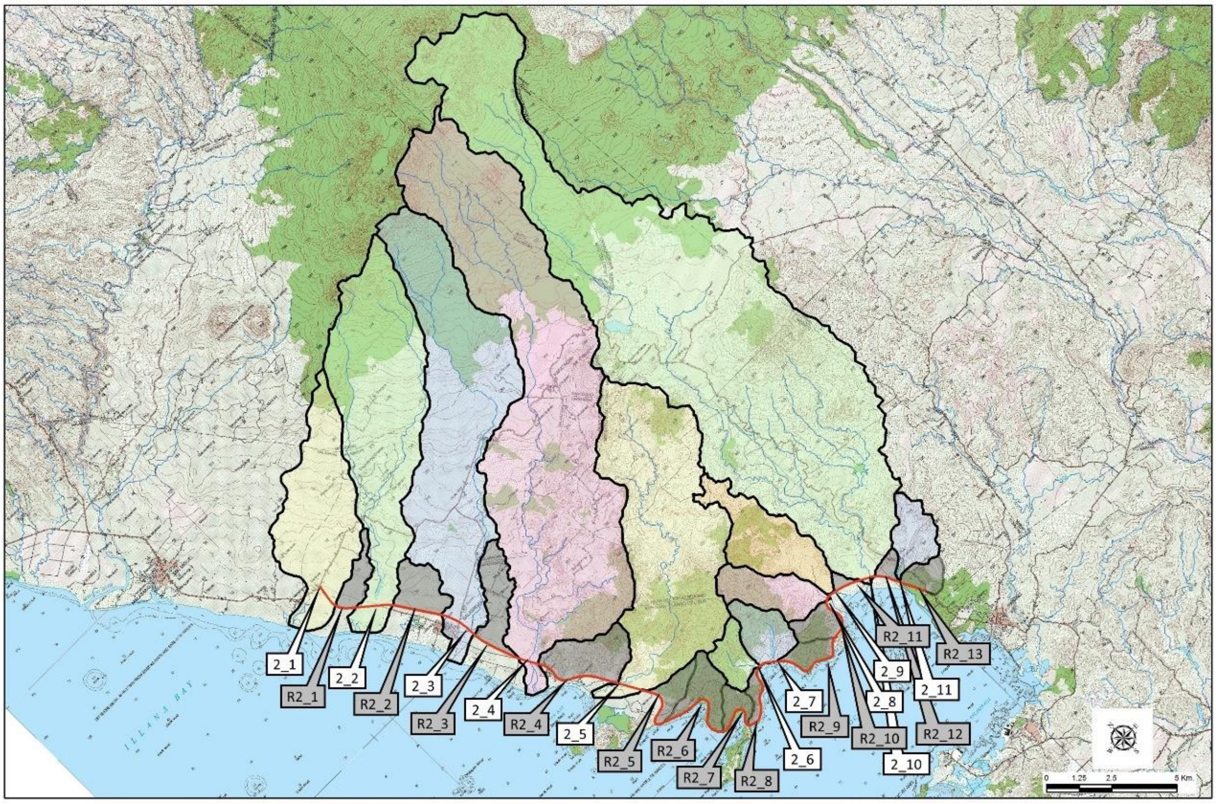
As a result, **Figure 14.8.2-1** to **Figure 14.8.2-8** shown below indicate the delineation of catchment areas.



1. MATANOG-BARIRA-ALAMADA-LIBUNGAN ROAD

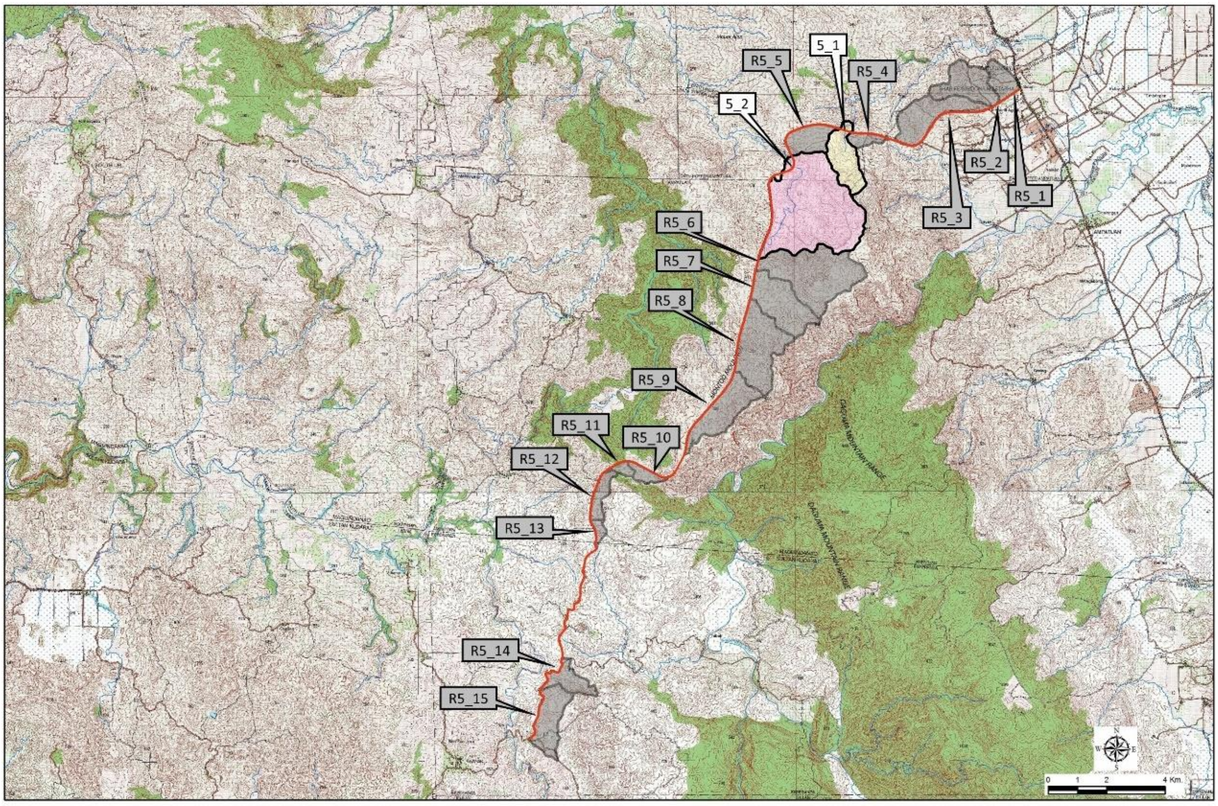
*Catchment areas indicated with grey color are residual basins.

Figure 14.8.2-1 Definition of Catchment Areas (Sub-Project 1)



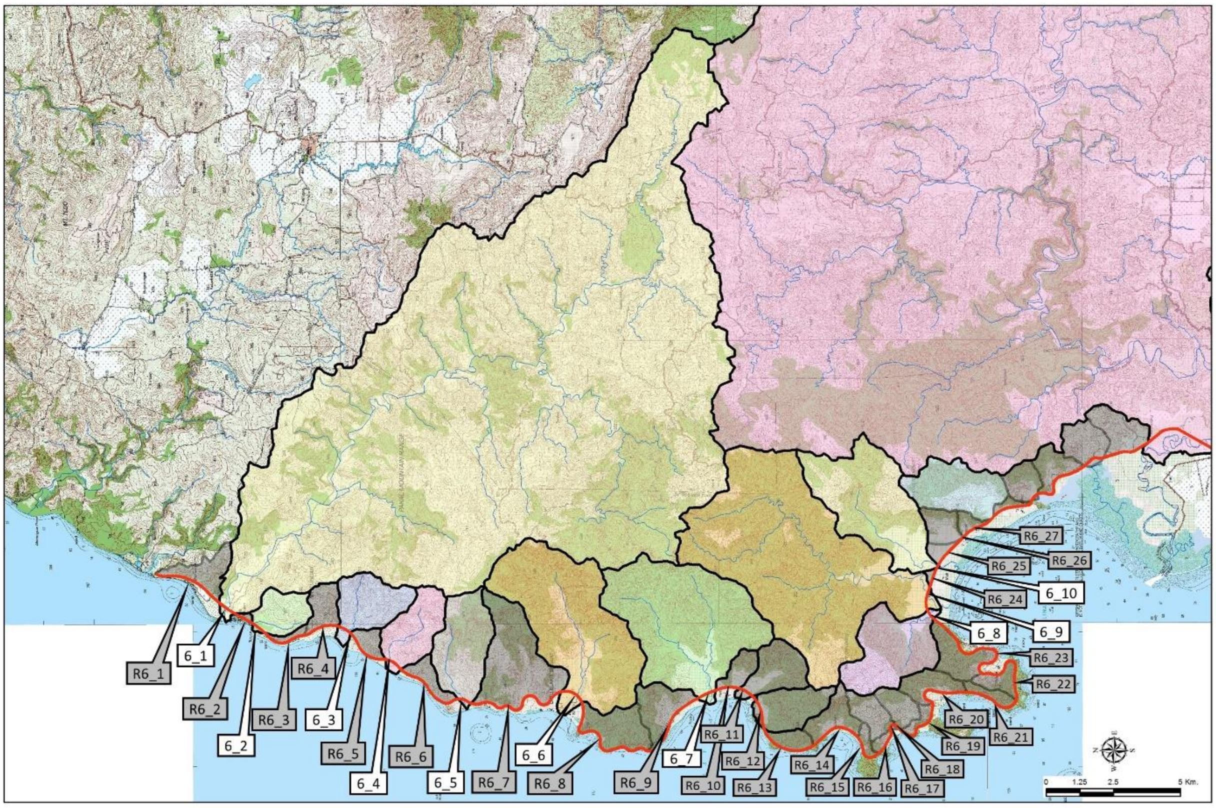
*Catchment areas indicated with grey color are residual basins.

Figure 14.8.2-2 Definition of Catchment Areas (Sub-Project 2)



*Catchment areas indicated with grey color are residual basins.

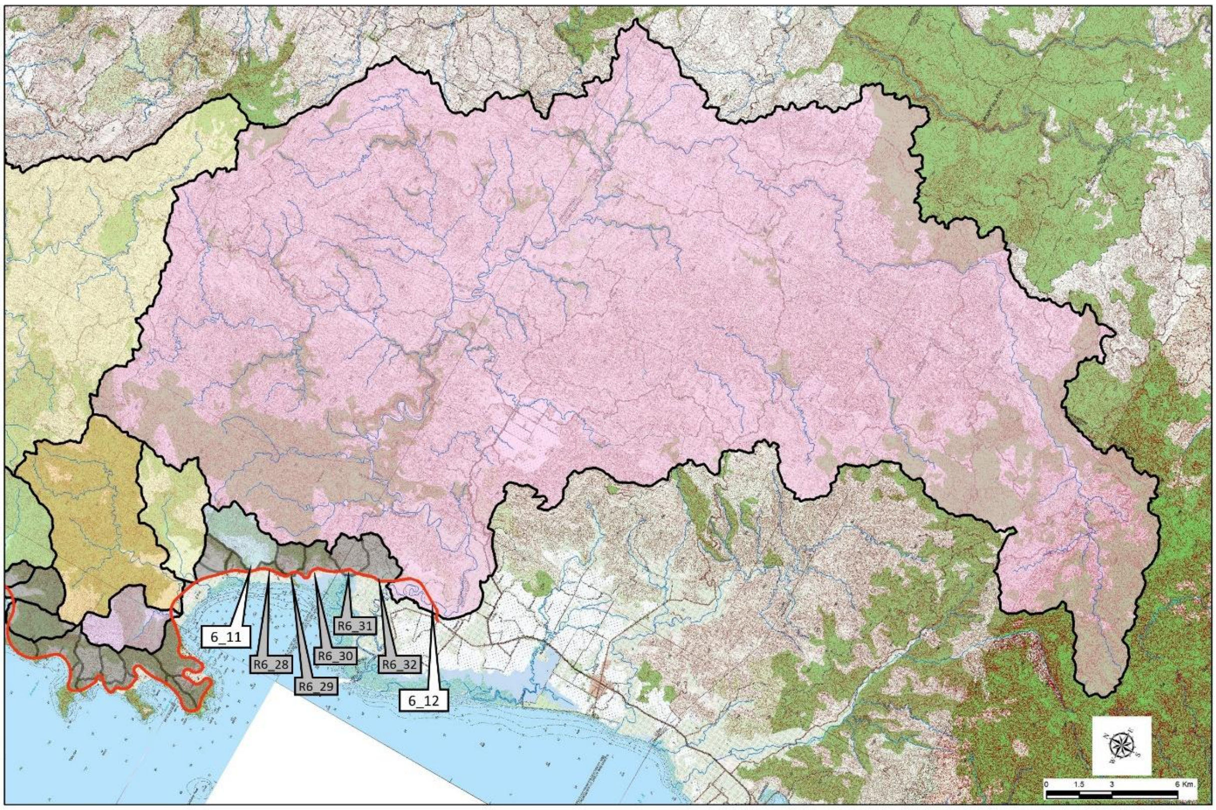
Figure 14.8.2-3 Definition of Catchment Areas (Sub-Project 5)



6. TAIPAN-LEBEK COASTAL ROAD (1/2)

*Catchment areas indicated with grey color are residual basins.

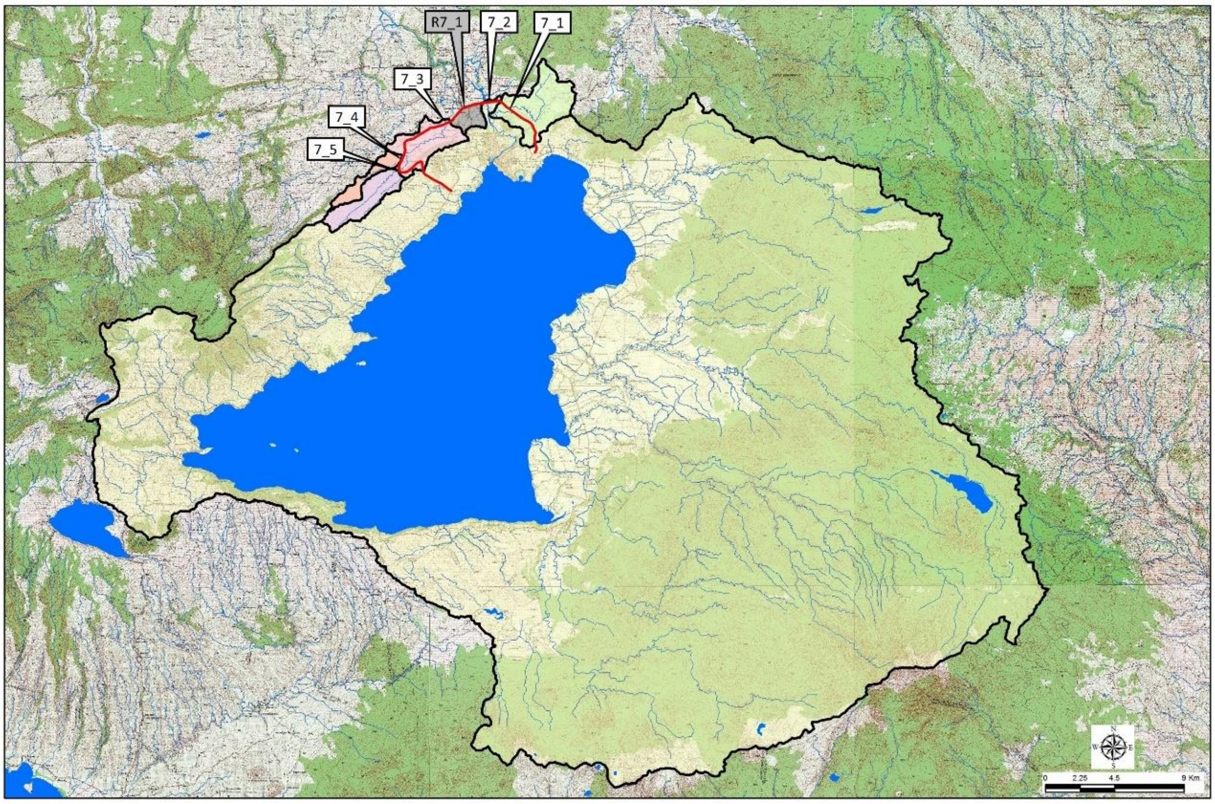
Figure 14.8.2-4 Definition of Catchment Areas (Sub-Project 6 (1/2))



6. TAIPAN-LEBEK COASTAL ROAD (2/2)

*Catchment areas indicated with grey color are residual basins.

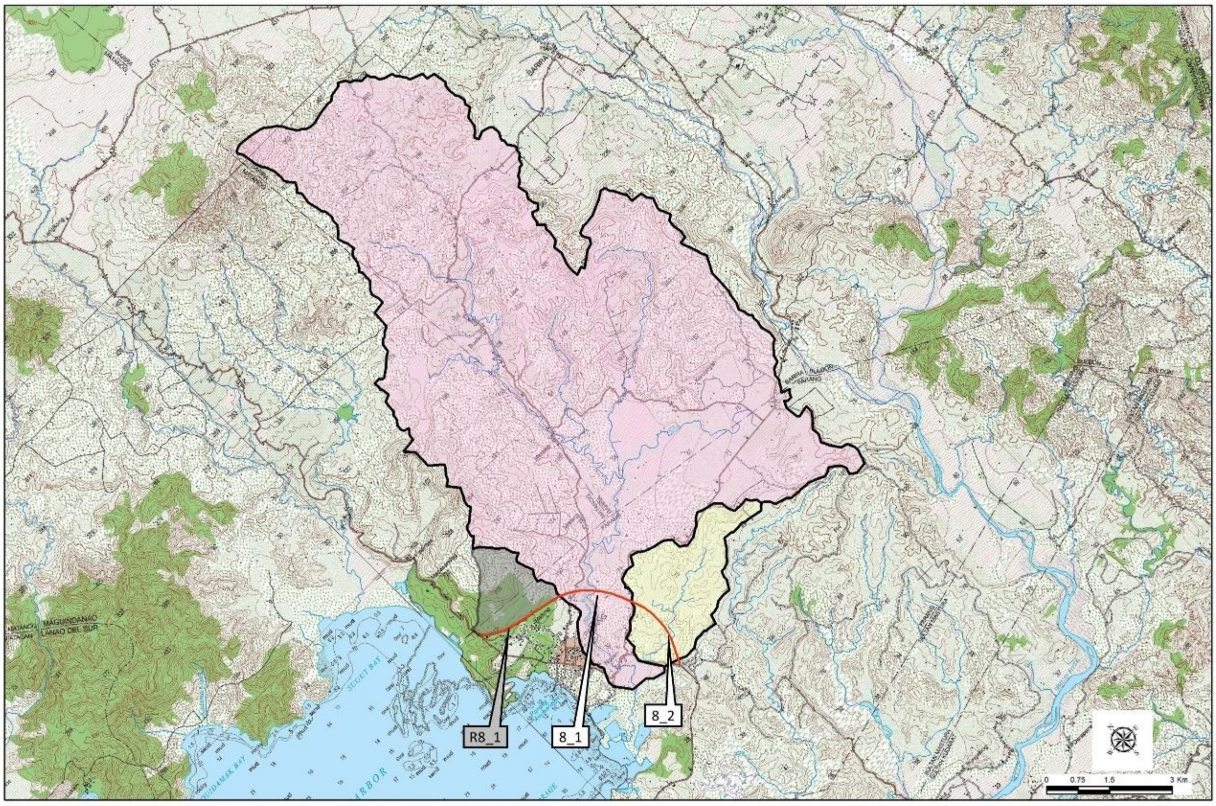
Figure 14.8.2-5 Definition of Catchment Areas (Sub-Project 6 (2/2))



7. MARAWI CITY RING ROAD

*Catchment areas indicated with grey color are residual basins.

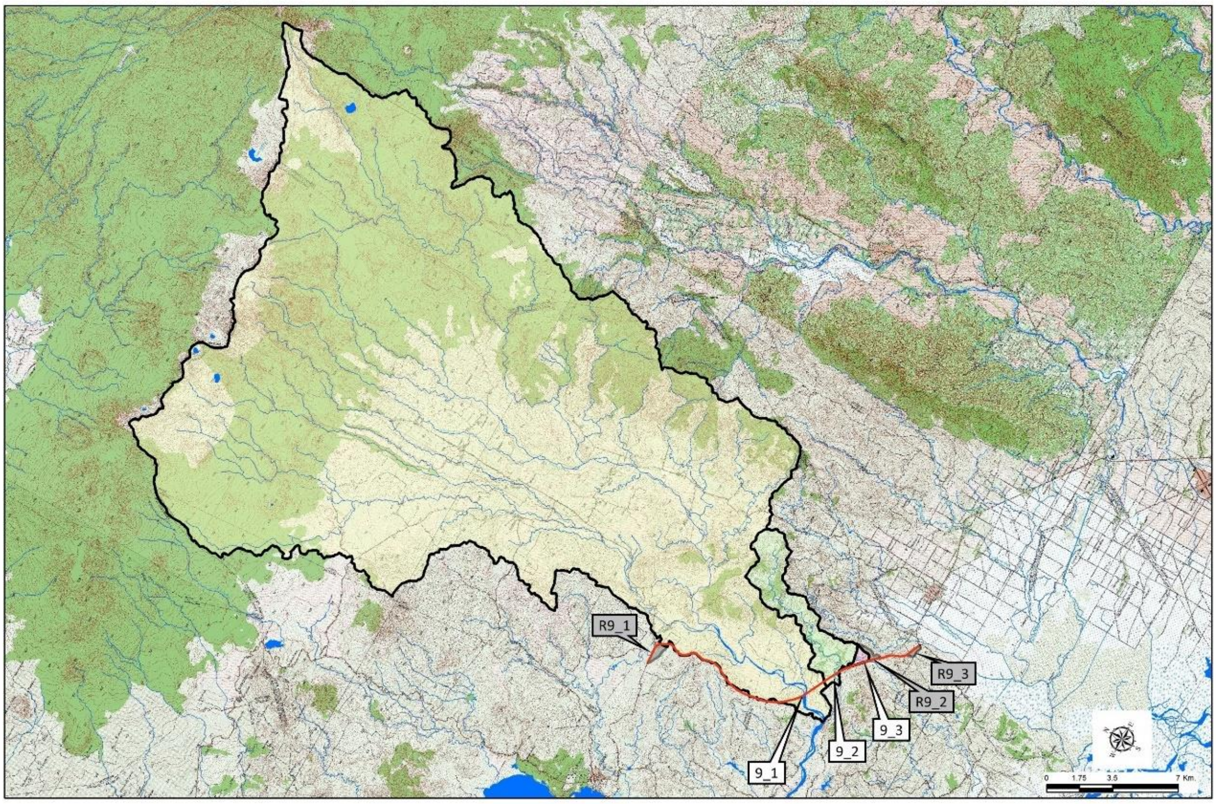
Figure 14.8.2-6 Definition of Catchment Areas (Sub-Project 7)



8. PARANG EAST DIVERSION ROAD

*Catchment areas indicated with grey color are residual basins.

Figure 14.8.2-7 Definition of Catchment Areas (Sub-Project 8)



*Catchment areas indicated with grey color are residual basins.

Figure 14.8.2-8 Definition of Catchment Areas (Sub-Project 9)

2) Calculation of Catchment Area

Based on river/drainage catchment delineated in **Figure 14.8.2-1** to **Figure 14.8.2-8** related to proposed road alignments, each area of catchment has been calculated as shown in **Table 14.8.2-1** and **Table 14.8.2-2** below.

Table 14.8.2-1 Calculated Size of Catchment Areas

Sub-Project No.	Basin Name	Catchment Area (km^2)
1	1-1	2.81
1	1-2	3.47
1	1-3	0.73
1	1-4	6.63
1	1-5	3.38
1	1-6	5.85
1	1-7	148.44
1	1-8	24.55
2	2-1	19.62
2	2-2	35.55
2	2-3	44.61
2	2-4	81.90
2	2-5	40.79
2	2-6	2.84

Sub-Project No.	Basin Name	Catchment Area (km^2)
2	2-7	4.02
2	2-8	5.60
2	2-9	9.88
2	2-10	121.75
2	2-11	3.86
5	5-1	1.91
5	5-2	8.85
6	6-1	217.23
6	6-2	2.98
6	6-3	4.89
6	6-4	4.86
6	6-5	6.96
6	6-6	20.68
6	6-7	21.06
6	6-8	8.00
6	6-9	39.96
6	6-10	13.32
6	6-11	5.96
6	6-12	784.94
7	7-1	14.04
7	7-2	1710.29
7	7-3	21.36
7	7-4	3.96
7	7-5	7.75
8	8-1	88.66
8	8-2	6.59
9	9-1	607.21
9	9-2	14.22
9	9-3	0.58

Table 14.8.2-2 Calculated Size of Catchment Areas (Residual Basins)

Sub-Project No.	Basin Name	Catchment Area (km^2)
1	R1-1	0.47
1	R1-2	8.24
1	R1-3	13.62
1	R1-4	0.32
2	R2-1	1.91
2	R2-2	3.20
2	R2-3	3.99
2	R2-4	5.03
2	R2-5	1.74
2	R2-6	3.00

Sub-Project No.	Basin Name	Catchment Area (km^2)
2	R2-7	1.30
2	R2-8	0.79
2	R2-9	1.51
2	R2-10	1.99
2	R2-11	0.38
2	R2-12	0.70
2	R2-13	1.62
5	R5-1	0.94
5	R5-2	2.08
5	R5-3	2.48
5	R5-4	0.47
5	R5-5	1.29
5	R5-6	4.84
5	R5-7	2.78
5	R5-8	3.51
5	R5-9	2.44
5	R5-10	0.45
5	R5-11	0.28
5	R5-12	0.71
5	R5-13	0.26
5	R5-14	1.05
5	R5-15	1.96
6	R6-1	2.19
6	R6-2	0.12
6	R6-3	0.38
6	R6-4	1.76
6	R6-5	0.93
6	R6-6	1.26
6	R6-7	8.40
6	R6-8	3.25
6	R6-9	2.91
6	R6-10	1.34
6	R6-11	3.55
6	R6-12	3.71
6	R6-13	1.02
6	R6-14	2.12
6	R6-15	0.49
6	R6-16	0.33
6	R6-17	1.75
6	R6-18	1.56
6	R6-19	0.58
6	R6-20	1.88
6	R6-21	0.79

Sub-Project No.	Basin Name	Catchment Area (km^2)
6	R6-22	1.12
6	R6-23	2.55
6	R6-24	0.15
6	R6-25	0.53
6	R6-26	1.58
6	R6-27	0.58
6	R6-28	0.37
6	R6-29	1.62
6	R6-30	1.76
6	R6-31	2.28
6	R6-32	2.56
7	R7-1	2.68
8	R8-1	2.65
9	R9-1	0.40
9	R9-2	0.30
9	R9-3	0.16

(2) Calculation of Flood Discharge of Each Catchment

1) Calculation of Specific Discharge by Return Period

In accordance with the method of calculation of specific discharges described in **Section 14.5** in this Chapter, specific discharges at each point are calculated by flood frequency as summarized in **Table 14.8.2-3** and **Table 14.8.2-4** below.

Table 14.8.2-3 Specific Discharges by Return Period

Sub-Project No.	Basin Name	Specific Discharge by Return Period ($m^3/s/km^2$)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	1-1	7.6	8.7	9.6	11.0	12.2	13.3
1	1-2	7.5	8.5	9.4	10.8	11.9	13.0
1	1-3	8.0	9.2	10.1	11.6	12.8	14.0
1	1-4	6.8	7.8	8.5	9.8	10.9	11.9
1	1-5	7.5	8.5	9.4	10.8	11.9	13.1
1	1-6	6.9	7.9	8.7	10.0	11.1	12.1
1	1-7	2.8	3.1	3.5	4.0	4.4	4.8
1	1-8	5.1	5.8	6.4	7.4	8.1	8.9
2	2-1	5.4	6.2	6.8	7.8	8.6	9.4
2	2-2	4.6	5.2	5.7	6.6	7.3	8.0
2	2-3	4.3	4.9	5.3	6.2	6.8	7.4
2	2-4	3.5	4.0	4.3	5.0	5.5	6.0
2	2-5	4.4	5.0	5.5	6.3	7.0	7.6
2	2-6	7.6	8.7	9.6	11.0	12.2	13.3
2	2-7	7.3	8.4	9.2	10.6	11.7	12.8

Sub-Project No.	Basin Name	Specific Discharge by Return Period (m³/s/km²)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
2	2-8	7.0	8.0	8.8	10.1	11.2	12.2
2	2-9	6.3	7.2	7.9	9.1	10.1	11.0
2	2-10	3.0	3.4	3.7	4.3	4.8	5.2
2	2-11	7.4	8.4	9.2	10.7	11.8	12.9
5	5-1	7.9	9.0	9.9	11.4	12.5	13.7
5	5-2	6.5	7.4	8.1	9.3	10.3	11.3
6	6-1	2.4	2.7	3.0	3.4	3.8	4.1
6	6-2	7.6	8.7	9.5	11.0	12.1	13.2
6	6-3	7.1	8.1	9.0	10.3	11.4	12.5
6	6-4	7.1	8.2	9.0	10.3	11.4	12.5
6	6-5	6.7	7.7	8.5	9.8	10.8	11.8
6	6-6	5.3	6.1	6.7	7.7	8.5	9.3
6	6-7	5.3	6.0	6.6	7.7	8.5	9.2
6	6-8	6.6	7.5	8.3	9.5	10.5	11.5
6	6-9	4.4	5.0	5.5	6.4	7.0	7.7
6	6-10	5.9	6.8	7.4	8.6	9.5	10.3
6	6-11	6.9	7.9	8.7	10.0	11.1	12.1
6	6-12	1.3	1.5	1.6	1.9	2.1	2.3
7	7-1	5.9	6.7	7.3	8.5	9.3	10.2
7	7-2	0.9	1.0	1.1	1.2	1.4	1.5
7	7-3	5.3	6.0	6.6	7.6	8.4	9.2
7	7-4	7.3	8.4	9.2	10.6	11.7	12.8
7	7-5	6.6	7.6	8.3	9.6	10.6	11.6
8	8-1	3.4	3.8	4.2	4.9	5.4	5.9
8	8-2	6.8	7.8	8.5	9.9	10.9	11.9
9	9-1	1.5	1.7	1.8	2.1	2.3	2.6
9	9-2	5.8	6.7	7.3	8.4	9.3	10.2
9	9-3	8.0	9.2	10.1	11.6	12.8	14.0

Table 14.8.2-4 Specific Discharges by Return Period (Residual Basins)

Sub-Project No.	Basin Name	Specific Discharge by Return Period (m³/s/km²)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	R1-1	8.0	9.2	10.1	11.6	12.8	14.0
1	R1-2	6.5	7.5	8.2	9.5	10.4	11.4
1	R1-3	5.9	6.7	7.4	8.5	9.4	10.3
1	R1-4	8.0	9.2	10.1	11.6	12.8	14.0
2	R2-1	7.9	9.0	9.9	11.4	12.5	13.7
2	R2-2	7.5	8.6	9.4	10.9	12.0	13.1
2	R2-3	7.3	8.4	9.2	10.6	11.7	12.8
2	R2-4	7.1	8.1	8.9	10.3	11.3	12.4
2	R2-5	7.9	9.0	9.9	11.4	12.6	13.8

Sub-Project No.	Basin Name	Specific Discharge by Return Period ($m^3/s/km^2$)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
2	R2-6	7.6	8.6	9.5	11.0	12.1	13.2
2	R2-7	8.0	9.1	10.0	11.6	12.8	14.0
2	R2-8	8.0	9.2	10.1	11.6	12.8	14.0
2	R2-9	8.0	9.1	10.0	11.5	12.7	13.9
2	R2-10	7.8	8.9	9.8	11.3	12.5	13.7
2	R2-11	8.0	9.2	10.1	11.6	12.8	14.0
2	R2-12	8.0	9.2	10.1	11.6	12.8	14.0
2	R2-13	7.9	9.1	10.0	11.5	12.7	13.8
5	R5-1	8.0	9.2	10.1	11.6	12.8	14.0
5	R5-2	7.8	8.9	9.8	11.3	12.5	13.7
5	R5-3	7.7	8.8	9.7	11.2	12.3	13.5
5	R5-4	8.0	9.2	10.1	11.6	12.8	14.0
5	R5-5	8.0	9.1	10.0	11.6	12.8	14.0
5	R5-6	7.1	8.2	9.0	10.3	11.4	12.5
5	R5-7	7.6	8.7	9.6	11.0	12.2	13.3
5	R5-8	7.5	8.5	9.3	10.8	11.9	13.0
5	R5-9	7.7	8.8	9.7	11.2	12.3	13.5
5	R5-10	8.0	9.2	10.1	11.6	12.8	14.0
5	R5-11	8.0	9.2	10.1	11.6	12.8	14.0
5	R5-12	8.0	9.2	10.1	11.6	12.8	14.0
5	R5-13	8.0	9.2	10.1	11.6	12.8	14.0
5	R5-14	8.0	9.1	10.1	11.6	12.8	14.0
5	R5-15	7.9	9.0	9.8	11.4	12.5	13.7
6	R6-1	7.8	8.9	9.8	11.3	12.4	13.6
6	R6-2	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-3	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-4	7.9	9.0	9.9	11.4	12.6	13.8
6	R6-5	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-6	8.0	9.1	10.0	11.6	12.8	14.0
6	R6-7	6.5	7.4	8.2	9.4	10.4	11.4
6	R6-8	7.5	8.6	9.4	10.9	12.0	13.1
6	R6-9	7.6	8.7	9.5	11.0	12.1	13.3
6	R6-10	8.0	9.1	10.0	11.6	12.7	13.9
6	R6-11	7.4	8.5	9.3	10.8	11.9	13.0
6	R6-12	7.4	8.4	9.3	10.7	11.8	12.9
6	R6-13	8.0	9.1	10.1	11.6	12.8	14.0
6	R6-14	7.8	8.9	9.8	11.3	12.5	13.6
6	R6-15	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-16	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-17	7.9	9.0	9.9	11.4	12.6	13.8
6	R6-18	7.9	9.1	10.0	11.5	12.7	13.9
6	R6-19	8.0	9.2	10.1	11.6	12.8	14.0

Sub-Project No.	Basin Name	Specific Discharge by Return Period ($m^3/s/km^2$)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
6	R6-20	7.9	9.0	9.9	11.4	12.6	13.7
6	R6-21	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-22	8.0	9.1	10.1	11.6	12.8	14.0
6	R6-23	7.7	8.8	9.7	11.1	12.3	13.4
6	R6-24	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-25	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-26	7.9	9.1	10.0	11.5	12.7	13.9
6	R6-27	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-28	8.0	9.2	10.1	11.6	12.8	14.0
6	R6-29	7.9	9.0	9.9	11.5	12.7	13.8
6	R6-30	7.9	9.0	9.9	11.4	12.6	13.8
6	R6-31	7.8	8.9	9.7	11.2	12.4	13.6
6	R6-32	7.7	8.8	9.7	11.1	12.3	13.4
7	R7-1	7.7	8.7	9.6	11.1	12.2	13.4
8	R8-1	7.7	8.8	9.6	11.1	12.2	13.4
9	R9-1	8.0	9.2	10.1	11.6	12.8	14.0
9	R9-2	8.0	9.2	10.1	11.6	12.8	14.0
9	R9-3	8.0	9.2	10.1	11.6	12.8	14.0

2) Calculation of Flood Discharges

Flood discharges are obtained by multiplying specific discharges and catchment area. As a result, flood discharges by return period is as summarized in the following **Table 14.8.2-5** and **Table 14.8.2-6**.

Table 14.8.2-5 Flood Discharges by Return Period

Sub-Project No.	Basin Name	Flood Discharge by Return Period (m^3/s)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	1-1	22	25	27	31	35	38
1	1-2	26	30	33	38	42	46
1	1-3	6.0	7.0	7.5	8.5	9.5	11
1	1-4	46	55	60	70	75	80
1	1-5	26	29	32	37	41	45
1	1-6	41	47	55	60	65	75
1	1-7	410	470	550	600	700	750
1	1-8	130	150	160	190	200	220
2	2-1	110	130	140	160	170	190
2	2-2	170	190	210	240	260	290
2	2-3	190	220	240	280	310	340
2	2-4	290	330	360	420	460	500
2	2-5	180	210	230	260	290	320
2	2-6	22	25	28	32	35	38
2	2-7	30	34	38	43	48	55

Sub-Project No.	Basin Name	Flood Discharge by Return Period (m^3/s)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
2	2-8	40	45	50	60	65	70
2	2-9	65	75	80	95	100	110
2	2-10	370	420	460	550	600	650
2	2-11	29	33	36	42	46	50
5	5-1	16	18	19	22	24	27
5	5-2	58	66	72	83	92	100
6	6-1	550	600	650	750	850	900
6	6-2	23	26	29	33	37	40
6	6-3	35	40	44	55	60	65
6	6-4	35	40	44	55	60	65
6	6-5	47	55	60	70	75	85
6	6-6	120	130	140	160	180	200
6	6-7	120	130	140	170	180	200
6	6-8	55	65	70	80	85	95
6	6-9	180	210	230	260	290	310
6	6-10	80	95	100	120	130	140
6	6-11	42	48	55	60	70	75
6	6-12	1100	1200	1300	1500	1700	1800
7	7-1	85	95	110	120	140	150
7	7-2	1500	130	150	170	2400	2600
7	7-3	120	34	37	43	180	200
7	7-4	30	60	65	75	47	55
7	7-5	55	1700	1900	2200	85	90
8	8-1	300	350	380	440	480	550
8	8-2	45	55	60	65	75	80
9	9-1	900	1100	1200	1300	1500	1600
9	9-2	85	95	110	130	140	150
9	9-3	5.0	5.5	6.0	7.0	7.5	8.5

Table 14.8.2-6 Flood Discharges by Return Period (Residual Basins)

Sub-Project No.	Basin Name	Flood Discharge by Return Period (m^3/s)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	R1-1	4.0	4.5	5.0	5.5	6.0	7.0
1	R1-2	55.0	65.0	70.0	80.0	90.0	95.0
1	R1-3	85.0	95.0	110.0	120.0	130.0	150.0
1	R1-4	3.0	3.0	3.5	4.0	4.5	5.0
2	R2-1	16.0	18.0	19.0	22.0	24.0	27.0
2	R2-2	25.0	28.0	31.0	35.0	39.0	43.0
2	R2-3	30.0	34.0	37.0	43.0	47.0	55.0
2	R2-4	36.0	41.0	45.0	55.0	60.0	65.0
2	R2-5	14.0	16.0	18.0	20.0	22.0	25.0

Sub-Project No.	Basin Name	Flood Discharge by Return Period (m^3/s)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
2	R2-6	23.0	26.0	29.0	33.0	37.0	40.0
2	R2-7	11.0	12.0	14.0	16.0	17.0	19.0
2	R2-8	6.5	7.5	8.0	9.5	11.0	12.0
2	R2-9	13.0	14.0	16.0	18.0	20.0	21.0
2	R2-10	16.0	18.0	20.0	23.0	25.0	28.0
2	R2-11	3.5	3.5	4.0	4.5	5.0	5.5
2	R2-12	6.0	6.5	7.5	8.5	9.0	10.0
2	R2-13	13.0	15.0	17.0	19.0	21.0	23.0
5	R5-1	8.0	9.0	10.0	11.0	13.0	14.0
5	R5-2	17.0	19.0	21.0	24.0	26.0	29.0
5	R5-3	20.0	22.0	24.0	28.0	31.0	34.0
5	R5-4	4.0	4.5	5.0	5.5	6.0	7.0
5	R5-5	11.0	12.0	13.0	15.0	17.0	19.0
5	R5-6	35.0	40.0	44.0	55.0	60.0	65.0
5	R5-7	22.0	25.0	27.0	31.0	34.0	38.0
5	R5-8	27.0	30.0	33.0	38.0	42.0	46.0
5	R5-9	19.0	22.0	24.0	28.0	31.0	33.0
5	R5-10	4.0	4.5	5.0	5.5	6.0	6.5
5	R5-11	2.5	3.0	3.0	3.5	4.0	4.0
5	R5-12	6.0	7.0	7.5	8.5	9.5	10.0
5	R5-13	2.5	2.5	3.0	3.5	3.5	4.0
5	R5-14	8.5	10.0	11.0	13.0	14.0	15.0
5	R5-15	16.0	18.0	20.0	23.0	25.0	27.0
6	R6-1	18.0	20.0	22.0	25.0	28.0	30.0
6	R6-2	1.0	1.5	1.5	1.5	2.0	2.0
6	R6-3	3.5	3.5	4.0	4.5	5.0	5.5
6	R6-4	14.0	16.0	18.0	21.0	23.0	25.0
6	R6-5	7.5	9.0	9.5	11.0	12.0	14.0
6	R6-6	11.0	12.0	13.0	15.0	17.0	18.0
6	R6-7	55.0	65.0	70.0	80.0	90.0	100.0
6	R6-8	25.0	28.0	31.0	36.0	40.0	43.0
6	R6-9	23.0	26.0	28.0	32.0	36.0	39.0
6	R6-10	11.0	13.0	14.0	16.0	18.0	19.0
6	R6-11	27.0	31.0	34.0	39.0	43.0	47.0
6	R6-12	28.0	32.0	35.0	40.0	44.0	48.0
6	R6-13	8.5	9.5	11.0	12.0	14.0	15.0
6	R6-14	17.0	19.0	21.0	24.0	27.0	29.0
6	R6-15	4.0	4.5	5.0	6.0	6.5	7.0
6	R6-16	3.0	3.5	3.5	4.0	4.5	5.0
6	R6-17	14.0	16.0	18.0	20.0	23.0	25.0
6	R6-18	13.0	15.0	16.0	18.0	20.0	22.0
6	R6-19	5.0	5.5	6.0	7.0	7.5	8.5

Sub-Project No.	Basin Name	Flood Discharge by Return Period (m^3/s)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
6	R6-20	15.0	17.0	19.0	22.0	24.0	26.0
6	R6-21	6.5	7.5	8.0	9.5	11.0	11.0
6	R6-22	9.0	11.0	12.0	13.0	15.0	16.0
6	R6-23	20.0	23.0	25.0	29.0	32.0	35.0
6	R6-24	1.5	1.5	1.5	2.0	2.0	2.5
6	R6-25	4.5	5.0	5.5	6.5	7.0	7.5
6	R6-26	13.0	15.0	16.0	19.0	21.0	22.0
6	R6-27	5.0	5.5	6.0	7.0	7.5	8.5
6	R6-28	3.0	3.5	4.0	4.5	5.0	5.5
6	R6-29	13.0	15.0	17.0	19.0	21.0	23.0
6	R6-30	14.0	16.0	18.0	21.0	23.0	25.0
6	R6-31	18.0	21.0	23.0	26.0	29.0	31.0
6	R6-32	20.0	23.0	25.0	29.0	32.0	35.0
7	R7-1	21.0	24.0	26.0	30.0	33.0	36.0
8	R8-1	21.0	24.0	26.0	30.0	33.0	36.0
9	R9-1	3.5	4.0	4.0	5.0	5.5	6.0
9	R9-2	2.5	3.0	3.5	4.0	4.0	4.5
9	R9-3	1.5	1.5	2.0	2.0	2.5	2.5

(3) Required Minimum Dimension for Flood Discharge passing under Roads

Based on the flood discharge volume calculated in the previous phase (**Sub-Section 14.8.2(2)**) and calculation methodology described in **Sub-Section 14.5.2**, minimum requirements of dimension to be opened at each cross-sectional point with rivers and/or drainage are estimated as follows:

1) Matanog – Barira – Alamada - Libungan Road (Sub-Project 1)

As shown in **Figure 14.8.2-1**, **Table 14.8.2-5** and **Table 14.8.2-6**, there are eight (8) river basins with four (4) residual drainage watersheds. Minimum requirement of cross-sectional areas to be opened at those crossing points are enumerated in **Table 14.8.2-7** shown below.

Table 14.8.2-7 Minimum Required Dimension of Cross-sectional Points (Sub-Project 1)

Basin Name	Catchment Area (km2)	Flood Discharge of 50yr-Return Period (m3/s)	Design Riverbed Gradient (Revised)	Type of Bridge (Recomm.)	Design Width of Riverbed (m)	Design Water Depth	Free-board	Bank Slope Gradient	Width of Water (m)	Required Length of Bridge (m)
1_1	2.8	35	50	B.C.	4.00	1.90	0.3	0	4.00	4.00
1_2	3.5	42	50	B.C.	5.00	1.75	0.3	0	5.00	5.00
1_3	0.7	10	50	B.C.	3.00	1.00	0.3	0	3.00	3.00
1_4	6.6	73	100	B.C.	6.50	2.65	1.5	0	6.50	7.00
1_5	3.4	41	50	B.C.	4.00	2.15	0.3	0	4.00	4.00
1_6	5.9	65	400	B.C.	11.00	2.50	1.5	0	11.00	11.00
1_7	148.4	660	200	Trapezoid2.0	80.00	2.15	1.5	2.0	88.60	95.00

Basin Name	Catchment Area (km2)	Flood Discharge of 50yr-Return Period (m3/s)	Design Riverbed Gradient (Revised)	Type of Bridge (Recomm.)	Design Width of Riverbed (m)	Design Water Depth	Free-board	Bank Slope Gradient	Width of Water (m)	Required Length of Bridge (m)
1_8	24.5	200	100	Trapezoid0.5	40.00	1.30	1.5	0.5	41.30	48.00
R1_1	0.5	6	50	B.C.	3.00	0.70	0.3	0	3.00	3.00
R1_2	8.2	87	100	B.C.	8.00	2.50	1.5	0	8.00	8.00
R1_3	13.6	130	50	Trapezoid0.5	50.00	0.75	1.5	0	50.75	57.00
R1_4	0.3	5	100	B.C.	3.00	0.80	0.3	0	3.00	3.00

2) Parang – Balabagan Road (Sub-Project 2)

As shown in **Figure 14.8.2-2**, **Table 14.8.2-5** and **Table 14.8.2-6**, there are eleven (11) river basins with thirteen (13) residual drainage watersheds. Minimum requirement of cross-sectional areas to be opened at those crossing points are enumerated in **Table 14.8.2-8** shown below.

Table 14.8.2-8 Minimum Required Dimension of Cross-sectional Points (Sub-Project 2)

Basin Name	Catchment Area (km2)	Flood Discharge of 50yr-Return Period (m3/s)	Design Riverbed Gradient (Revised)	Type of Bridge (Recomm.)	Design Width of Riverbed (m)	Design Water Depth	Free-board	Bank Slope Gradient	Width of Water (m)	Required Length of Bridge (m)
2_1	19.6	170	200	Trapezoid0.5	30.00	1.75	1.5	0.5	31.75	38.00
2_2	35.5	260	200	Trapezoid0.5	50.00	1.65	1.5	0.5	51.65	58.00
2_3	44.6	310	200	Trapezoid0.5	50.00	1.85	1.5	0.5	51.85	58.00
2_4	81.9	460	200	Trapezoid0.5	75.00	1.80	1.5	0.5	76.80	83.00
2_5	40.8	290	600	Trapezoid0.5	75.00	1.90	1.5	0.5	76.90	83.00
2_6	2.8	35	200	B.C.	6.00	2.15	0.3	0	6.00	6.00
2_7	4.0	48	200	B.C.	7.00	2.35	0.3	0	7.00	7.00
2_8	5.6	63	500	Trapezoid0.5	12.00	2.25	1.5	0.5	14.25	21.00
2_9	9.9	100	600	Trapezoid0.5	20.00	2.30	1.5	0.5	22.30	29.00
2_10	121.8	580	700	Trapezoid2.0	150.00	2.00	1.5	2	158.00	164.00
2_11	3.9	46	200	B.C.	7.00	2.30	0.3	0	7.00	7.00
R2_1	1.9	24	100	B.C.	5.00	1.55	0.3	0	5.00	5.00
R2_2	3.2	39	100	B.C.	6.00	1.85	0.3	0	6.00	6.00
R2_3	4.0	47	200	B.C.	8.00	2.05	0.3	0	8.00	8.00
R2_4	5.0	58	200	B.C.	8.00	2.40	1.5	0	8.00	8.00
R2_5	1.7	22	50	B.C.	3.00	1.80	0.3	0	3.00	3.00
R2_6	3.0	37	50	B.C.	5.00	1.60	0.3	0	5.00	5.00
R2_7	1.3	17	50	B.C.	3.00	1.50	0.3	0	3.00	3.00
R2_8	0.8	11	50	B.C.	3.00	1.10	0.3	0	3.00	3.00
R2_9	1.5	20	50	B.C.	3.50	1.45	0.3	0	3.50	4.00
R2_10	2.0	25	50	B.C.	4.00	1.50	0.3	0	4.00	4.00
R2_11	0.4	5	300	B.C.	3.00	1.20	0.3	0	3.00	3.00
R2_12	0.7	9	200	B.C.	4.00	1.20	0.3	0	4.00	4.00
R2_13	1.6	21	50	B.C.	4.00	1.35	0.3	0	4.00	4.00

3) Maganoy – Lebak Road (Sub-Project 5)

As shown in **Figure 14.8.2-3**, **Table 14.8.2-5** and **Table 14.8.2-6**, there are two (2) river basins with fifteen (15) residual drainage watersheds. Minimum requirement of cross-sectional areas to be opened at those crossing points are enumerated in **Table 14.8.2-9** shown below.

Table 14.8.2-9 Minimum Required Dimension of Cross-sectional Points (Sub-Project 5)

Basin Name	Catchment Area (km2)	Flood Discharge of 50yr-Return Period (m3/s)	Design Riverbed Gradient (Revised)	Type of Bridge (Recomm.)	Design Width of Riverbed (m)	Design Water Depth	Free-board	Bank Slope Gradient	Width of Water (m)	Required Length of Bridge (m)
5_1	1.9	24	50	B.C.	5.00	1.20	0.3	0	5.00	5.00
5_2	8.9	92	100	Trapezoid0.5	10.00	1.95	1.5	0.5	11.95	18.00
R5_1	0.9	13	50	B.C.	2.00	1.85	0.3	0	2.00	2.00
R5_2	2.1	26	50	B.C.	4.00	1.55	0.3	0	4.00	4.00
R5_3	2.5	31	50	B.C.	4.00	1.75	0.3	0	4.00	4.00
R5_4	0.5	6	50	B.C.	2.00	1.05	0.3	0	2.00	2.00
R5_5	1.3	17	50	B.C.	3.00	1.50	0.3	0	3.00	3.00
R5_6	4.8	60	50	Trapezoid0.5	15.00	0.95	1.5	0.5	15.95	22.00
R5_7	2.8	34	50	B.C.	7.00	1.15	0.3	0	7.00	7.00
R5_8	3.5	42	50	B.C.	7.00	1.35	0.3	0	7.00	7.00
R5_9	2.4	31	50	B.C.	6.00	1.25	0.3	0	6.00	6.00
R5_10	0.5	6	50	B.C.	2.00	1.05	0.3	0	2.00	2.00
R5_11	0.3	4	50	B.C.	2.00	0.75	0.3	0	2.00	2.00
R5_12	0.7	10	50	B.C.	2.50	1.20	0.3	0	2.50	3.00
R5_13	0.3	4	50	B.C.	1.50	1.00	0.3	0	1.50	2.00
R5_14	1.1	14	50	B.C.	3.00	1.30	0.3	0	3.00	3.00
R5_15	2.0	25	50	B.C.	5.00	1.25	0.3	0	5.00	5.00
R5_16	0.5	6	50	B.C.	2.00	1.05	0.3	0	2.00	2.00
R5_17	2.5	31	50	B.C.	5.00	1.45	0.3	0	5.00	5.00
R5_18	2.1	26	50	B.C.	4.00	1.55	0.3	0	4.00	4.00
R5_19	0.9	13	50	B.C.	2.50	1.45	0.3	0	2.50	3.00

4) Tapian – Lebak Coastal Road (Sub-Project 6)

As shown in **Figure 14.8.2-4**, **Figure 14.8.2-5**, **Table 14.8.2-5** and **Table 14.8.2-6**, there are twelve (12) river basins with thirty-two (32) residual drainage watersheds. Minimum requirement of cross-sectional areas to be opened at those crossing points are enumerated in **Table 14.8.2-10** shown below.

Table 14.8.2-10 Minimum Required Dimension of Cross-sectional Points (Sub-Project 6)

Basin Name	Catchment Area (km2)	Flood Discharge of 50yr-Return Period (m3/s)	Design Riverbed Gradient (Revised)	Type of Bridge (Recomm.)	Design Width of Riverbed (m)	Design Water Depth	Free-board	Bank Slope Gradient	Width of Water (m)	Required Length of Bridge (m)
6_1	217.2	820	500	Trapezoid2.0	100.00	2.80	1.5	2	111.20	118.00
6_2	3.0	37	200	B.C.	8.00	1.75	0.3	0	8.00	8.00
6_3	4.9	56	100	Trapezoid0.5	6.00	2.00	1.5	0.5	8.00	14.00
6_4	4.9	56	100	Trapezoid0.5	8.00	1.65	1.5	0.5	9.65	16.00
6_5	7.0	75	200	Trapezoid0.5	10.00	2.15	1.5	0.5	12.15	19.00
6_6	20.7	180	400	Trapezoid0.5	40.00	1.85	1.5	0.5	41.85	48.00
6_7	21.1	180	200	Trapezoid0.5	25.00	2.05	1.5	0.5	27.05	34.00
6_8	8.0	85	400	Trapezoid0.5	15.00	2.20	1.5	0.5	17.20	24.00
6_9	40.0	290	800	Trapezoid2.0	70.00	2.15	1.5	2	78.60	85.00
6_10	13.3	130	400	Trapezoid0.5	25.00	2.05	1.5	0.5	27.05	34.00
6_11	6.0	66	200	Trapezoid0.5	12.00	1.75	1.5	0.5	13.75	20.00
6_12	784.9	1700	2000	Compound	150.00	5.20	1.5	3.00/3.00	201.20	211.00
R6_1	2.2	28	200	B.C.	6.00	1.85	0.3	0	6.00	6.00
R6_2	0.1	2	50	B.C.	1.50	0.60	0.3	0	1.50	2.00
R6_3	0.4	5	50	B.C.	2.50	0.75	0.3	0	2.50	3.00
R6_4	1.8	23	50	B.C.	5.00	1.15	0.3	0	5.00	5.00
R6_5	0.9	12	50	B.C.	2.50	1.40	0.3	0	2.50	3.00
R6_6	1.3	17	50	B.C.	3.00	1.50	0.3	0	3.00	3.00
R6_7	8.4	88	50	Trapezoid0.5	30.00	1.55	1.5	0.5	30.80	37.00
R6_8	3.3	40	50	B.C.	5.00	1.70	0.3	0	5.00	5.00
R6_9	2.9	36	50	B.C.	5.00	1.60	0.3	0	5.00	5.00
R6_10	1.3	18	50	B.C.	4.00	1.20	0.3	0	4.00	4.00
R6_11	3.5	43	200	B.C.	7.00	2.20	0.3	0	7.00	7.00
R6_12	3.7	44	100	B.C.	7.00	2.20	0.3	0	7.00	7.00
R6_13	1.0	14	50	B.C.	4.00	1.00	0.3	0	4.00	4.00
R6_14	2.1	27	50	B.C.	6.00	1.15	0.3	0	6.00	6.00
R6_15	0.5	7	50	B.C.	3.00	0.80	0.3	0	3.00	3.00
R6_16	0.3	5	50	B.C.	2.50	0.75	0.3	0	2.50	3.00
R6_17	1.7	23	50	B.C.	6.00	1.00	0.3	0	6.00	6.00
R6_18	1.6	20	50	B.C.	6.00	1.00	0.3	0	6.00	6.00
R6_19	0.6	8	50	B.C.	2.50	1.05	0.3	0	2.50	3.00
R6_20	1.9	24	50	B.C.	6.00	1.05	0.3	0	6.00	6.00
R6_21	0.8	11	50	B.C.	3.00	1.10	0.3	0	3.00	3.00
R6_22	1.1	15	50	B.C.	4.00	1.05	0.3	0	4.00	4.00
R6_23	2.5	32	50	B.C.	5.00	1.45	0.3	0	5.00	5.00
R6_24	0.1	2	300	B.C.	2.00	0.90	0.3	0	2.00	2.00
R6_25	0.5	7	200	B.C.	3.00	1.30	0.3	0	3.00	3.00
R6_26	1.6	21	50	B.C.	4.00	1.35	0.3	0	4.00	4.00
R6_27	0.6	8	50	B.C.	3.00	0.90	0.3	0	3.00	3.00
R6_28	0.4	5	50	B.C.	2.00	0.90	0.3	0	2.00	2.00

Basin Name	Catchment Area (km2)	Flood Discharge of 50yr-Return Period (m3/s)	Design Riverbed Gradient (Revised)	Type of Bridge (Recomm.)	Design Width of Riverbed (m)	Design Water Depth	Free-board	Bank Slope Gradient	Width of Water (m)	Required Length of Bridge (m)
R6_29	1.6	21	50	B.C.	4.00	1.35	0.3	0	4.00	4.00
R6_30	1.8	23	200	B.C.	6.00	1.50	0.3	0	6.00	6.00
R6_31	2.3	29	50	B.C.	5.00	5.00	0.3	0	5.00	5.00
R6_32	2.6	32	600	B.C.	10.00	1.95	0.3	0	10.00	10.00

5) Marawi City Ring Road (Sub-Project 7)

As shown in **Figure 14.8.2-6**, **Table 14.8.2-5** and **Table 14.8.2-6**, there are five (5) river basins with one (1) residual drainage watershed. Minimum requirement of cross-sectional areas to be opened at those crossing points are enumerated in **Table 14.8.2-11** shown below.

Table 14.8.2-11 Minimum Required Dimension of Cross-sectional Points (Sub-Project 7)

Basin Name	Catchment Area (km2)	Flood Discharge of 50yr-Return Period (m3/s)	Design Riverbed Gradient (Revised)	Type of Bridge (Recomm.)	Design Width of Riverbed (m)	Design Water Depth	Free-board	Bank Slope Gradient	Width of Water (m)	Required Length of Bridge (m)
7_1	14.0	140	500	Trapezoid0.5	35.00	1.85	1.5	0.5	36.85	43.00
7_2	1,710.3	2400	500	Compound	160.00	4.00	1.5	3.00/3.00	204.00	213.00
7_3	21.4	180	400	Trapezoid0.5	40.00	1.85	1.5	0.5	41.85	48.00
7_4	4.0	47	100	B.C.	7.00	1.80	0.3	0	7.00	7.00
7_5	7.8	82	200	Trapezoid0.5	12.00	2.00	1.5	0.5	14.00	20.00
R7_1	2.7	33	50	B.C.	5.00	1.50	0.3	0	5.00	5.00

6) Parang – East Diversion Road (Sub-Project 8)

As shown in **Figure 14.8.2-7**, **Table 14.8.2-5** and **Table 14.8.2-6**, there are two (2) river basins with one (1) residual drainage watershed. Minimum requirement of cross-sectional areas to be opened at those crossing points are enumerated in **Table 14.8.2-12** shown below.

Table 14.8.2-12 Minimum Required Dimension of Cross-sectional Points (Sub-Project 8)

Basin Name	Catchment Area (km2)	Flood Discharge of 50yr-Return Period (m3/s)	Design Riverbed Gradient (Revised)	Type of Bridge (Recomm.)	Design Width of Riverbed (m)	Design Water Depth	Free-board	Bank Slope Gradient	Width of Water (m)	Required Length of Bridge (m)
8_1	88.7	480	200	Trapezoid0.5	65.00	2.00	1.5	0.5	67.00	73.00
8_2	6.6	72	700	Trapezoid0.5	18.00	2.10	1.5	0.5	20.10	27.00
R8_1	2.7	33	50	B.C.	5.00	1.50	0.3	0	5.00	5.00

7) Manungan - Parang Road (Sub-Project 9)

As shown in **Figure 14.8.2-8**, **Table 14.8.2-5** and **Table 14.8.2-6**, there are three (3) river basins with three (3) residual drainage watersheds. Minimum requirement of cross-sectional areas to be opened at those crossing points are enumerated in **Table 14.8.2-13** shown below.

Table 14.8.2-13 Minimum Required Dimension of Cross-sectional Points (Sub-Project 9)

Basin Name	Catchment Area (km2)	Flood Discharge of 50yr-Return Period (m3/s)	Design Riverbed Gradient (Revised)	Type of Bridge (Recomm.)	Design Width of Riverbed (m)	Design Water Depth	Free-board	Bank Slope Gradient	Width of Water (m)	Required Length of Bridge (m)
9_1	607.2	1500	700	Compound	120.00	4.00	1.5	3.00/3.00	164.00	173.00
9_2	14.2	140	400	Trapezoid0.5	30.00	1.90	1.5	0.5	31.90	38.00
9_3	0.6	8	200	B.C.	3.00	1.45	0.3	0	3.00	3.00
R9_1	0.4	6	500	B.C.	3.50	1.40	0.3	0	3.50	4.00
R9_2	0.3	4	100	B.C.	2.00	1.00	0.3	0	2.00	2.00
R9_3	0.2	3	50	B.C.	1.50	0.80	0.3	0	1.50	2.00

(4) Required Type of Revetment to be Installed in each Cross-sectional Point with River / Drainage System

Following the calculation of minimum required dimension for rivers/drainages, type of revetment and required material of riprap for foot protection at each cross0-sectional point are selected and determined based on the flood discharge volume calculated in the previous phase (**Sub-Section 14.8.2(2)**). The results are as follows:

1) Matanog – Barira – Alamada - Libungan Road (Sub-Project 1)

Type of revetment and minimum diameter of riprap for foot protection at crossing points are enumerated in **Table 14.8.2-14** shown below.

Table 14.8.2-14 Selected Revetment and Foot Protection at Cross-sectional Points (Sub-Project 1)

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
1_1	35	B.C.	4.00	4.00	4.00	4.63	1.29	Type-5	d50=0.6m
1_2	42	B.C.	5.00	5.00	5.00	4.81	1.39	Type-5	d50=0.6m
1_3	10	B.C.	3.00	3.00	3.00	3.35	1.28	Type-5	d50=0.5m
1_4	73	B.C.	6.50	6.50	7.00	4.29	1.01	Type-5	d50=0.6m
1_5	41	B.C.	4.00	4.00	4.00	4.83	1.26	Type-5	d50=0.6m
1_6	65	B.C.	11.00	11.00	11.00	2.39	0.58	Type-5	d50=0.4m
1_7	660	Trapezoid2.0	80.00	88.60	95.00	3.77	0.98	Type-6	Minimum 0.6m
1_8	200	Trapezoid0.5	40.00	41.30	48.00	3.83	1.29	Type-5	Minimum 0.6m
1_9	510	Trapezoid2.0	70.00	76.40	83.00	4.40	1.33	Type-6	Minimum 0.95m
1_10	610	Trapezoid2.0	35.00	46.20	53.00	4.51	1.34	Type-6	Minimum 0.95m
1_11	16	B.C.	3.00	3.00	3.00	3.85	1.22	Type-5	d50=0.5m

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
1_12	18	B.C.	3.50	3.50	4.00	3.93	1.30	Type-5	d50=0.5m
1_13	45	B.C.	6.00	6.00	6.00	4.85	1.47	Type-5	d50=0.6m
1_14	110	Trapezoid0.5	40.00	40.75	47.00	3.81	1.69	Type-5	Minimum 0.95m
1_15	55	B.C.	10.00	10.00	10.00	4.61	1.61	Type-5	d50=0.6m
1_16	130	Trapezoid0.5	50.00	50.75	57.00	3.83	1.69	Type-5	Minimum 1.35m
R1_1	6	B.C.	3.00	3.00	3.00	2.88	1.32	Type-5	d50=0.4m
R1_2	87	B.C.	8.00	8.00	8.00	4.44	1.08	Type-5	d50=0.6m
R1_3	130	Trapezoid0.5	50.00	50.75	57.00	3.83	1.69	Type-5	Minimum 1.35m
R1_4	5	B.C.	3.00	3.00	3.00	2.16	0.93	Type-5	d50=0.4m
R1_5	13	B.C.	4.00	4.00	4.00	2.75	0.96	Type-5	d50=0.4m
R1_6	12	B.C.	4.00	4.00	4.00	3.43	1.39	Type-5	d50=0.5m
R1_7	44	B.C.	6.00	6.00	6.00	4.78	1.47	Type-5	d50=0.6m
R1_8	26	B.C.	5.00	5.00	5.00	4.17	1.43	Type-5	d50=0.6m
R1_9	26	B.C.	4.50	4.50	5.00	4.27	1.38	Type-5	d50=0.6m
R1_10	3	B.C.	2.00	2.00	2.00	2.53	1.20	Type-5	d50=0.4m
R1_11	7	B.C.	3.00	3.00	3.00	3.06	1.31	Type-5	d50=0.5m

2) Parang – Balabagan Road (Sub-Project 2)

Type of revetment and minimum diameter of riprap for foot protection at crossing points are enumerated in **Table 14.8.2-15** shown below.

Table 14.8.2-15 Selected Revetment and Foot Protection at Cross-sectional Points (Sub-Project 2)

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
2_1	170	Trapezoid0.5	15.00	17.70	24.00	3.86	0.90	Type-5	Minimum 0.95m
2_2	260	Trapezoid0.5	25.00	27.55	34.00	3.97	0.95	Type-5	Minimum 0.95m
2_3	310	Trapezoid0.5	30.00	32.50	39.00	3.98	0.96	Type-5	Minimum 0.95m
2_4	460	Trapezoid0.5	50.00	52.35	59.00	3.96	0.99	Type-5	Minimum 0.95m
2_5	290	Trapezoid0.5	50.00	52.45	59.00	2.35	0.57	Type-5	Minimum 0.35m
2_6	35	B.C.	6.00	6.00	6.00	2.74	0.72	Type-5	d50=0.4m
2_7	48	B.C.	7.00	7.00	7.00	2.96	0.74	Type-5	d50=0.4m
2_8	63	Trapezoid0.5	12.00	14.25	21.00	2.15	0.55	Type-5	Minimum 0.35m
2_9	100	Trapezoid0.5	20.00	22.30	29.00	2.11	0.53	Type-5	Minimum 0.35m
2_10	580	Trapezoid2.0	90.00	100.60	107.00	2.31	0.54	Type-6	Minimum 0.35m
2_11	46	B.C.	7.00	7.00	7.00	2.93	0.74	Type-5	d50=0.4m
R2_1	24	B.C.	5.00	5.00	5.00	3.24	1.00	Type-5	d50=0.5m
R2_2	39	B.C.	6.00	6.00	6.00	3.65	1.03	Type-5	d50=0.5m
R2_3	47	B.C.	8.00	8.00	8.00	2.89	0.77	Type-5	d50=0.4m

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
R2_4	58	B.C.	8.00	8.00	8.00	3.09	0.76	Type-5	d50=0.5m
R2_5	22	B.C.	3.00	3.00	3.00	4.12	1.18	Type-5	d50=0.6m
R2_6	37	B.C.	5.00	5.00	5.00	4.64	1.40	Type-5	d50=0.6m
R2_7	17	B.C.	3.00	3.00	3.00	3.89	1.22	Type-5	d50=0.5m
R2_8	11	B.C.	3.00	3.00	3.00	3.48	1.27	Type-5	d50=0.5m
R2_9	20	B.C.	3.50	3.50	4.00	4.04	1.28	Type-5	d50=0.6m
R2_10	25	B.C.	4.00	4.00	4.00	4.25	1.33	Type-5	d50=0.6m
R2_11	5	B.C.	3.00	3.00	3.00	1.47	0.51	Type-5	d50=0.3m
R2_12	9	B.C.	4.00	4.00	4.00	1.95	0.68	Type-5	d50=0.3m
R2_13	21	B.C.	4.00	4.00	4.00	4.08	1.35	Type-5	d50=0.6m

3) Maganoy – Lebak Road (Sub-Project 5)

Type of revetment and minimum diameter of riprap for foot protection at crossing points are enumerated in **Table 14.8.2-16** shown below.

Table 14.8.2-16 Selected Revetment and Foot Protection at Cross-sectional Points (Sub-Project 5)

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
5_1	24	B.C.	5.00	5.00	5.00	4.10	1.43	Type-5	d50=0.6m
5_2	92	Trapezoid0.5	10.00	11.95	18.00	4.35	1.19	Type-5	Minimum 1.35m
R5_1	13	B.C.	2.00	2.00	2.00	3.53	1.00	Type-5	d50=0.5m
R5_2	26	B.C.	4.00	4.00	4.00	4.31	1.33	Type-5	d50=0.6m
R5_3	31	B.C.	4.00	4.00	4.00	4.50	1.30	Type-5	d50=0.6m
R5_4	6	B.C.	2.00	2.00	2.00	3.02	1.13	Type-5	d50=0.5m
R5_5	17	B.C.	3.00	3.00	3.00	3.89	1.22	Type-5	d50=0.5m
R5_6	60	Trapezoid0.5	15.00	15.95	22.00	4.26	1.67	Type-5	Minimum 1.35m
R5_7	34	B.C.	7.00	7.00	7.00	4.28	1.53	Type-5	d50=0.6m
R5_8	42	B.C.	7.00	7.00	7.00	4.63	1.53	Type-5	d50=0.6m
R5_9	31	B.C.	6.00	6.00	6.00	4.34	1.49	Type-5	d50=0.6m
R5_10	6	B.C.	2.00	2.00	2.00	3.02	1.13	Type-5	d50=0.5m
R5_11	4	B.C.	2.00	2.00	2.00	2.68	1.19	Type-5	d50=0.4m
R5_12	10	B.C.	2.50	2.50	3.00	3.40	1.19	Type-5	d50=0.5m
R5_13	4	B.C.	1.50	1.50	2.00	2.68	1.03	Type-5	d50=0.4m
R5_14	14	B.C.	3.00	3.00	3.00	3.70	1.24	Type-5	d50=0.5m
R5_15	25	B.C.	5.00	5.00	5.00	4.17	1.43	Type-5	d50=0.6m

4) Tapian – Lebak Coastal Road (Sub-Project 6)

Type of revetment and minimum diameter of riprap for foot protection at crossing points are enumerated in **Table 14.8.2-17** shown below.

Table 14.8.2-17 Selected Revetment and Foot Protection at Cross-sectional Points (Sub-Project 6)

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
6_1	820	Trapezoid2.0	100.00	111.20	118.00	2.84	0.65	Type-6	Minimum 0.6m
6_2	37	B.C.	8.00	8.00	8.00	2.69	0.78	Type-5	d50=0.4m
6_3	56	Trapezoid0.5	6.00	8.00	14.00	4.05	1.10	Type-5	Minimum 0.95m
6_4	56	Trapezoid0.5	8.00	9.65	16.00	3.86	1.15	Type-5	Minimum 0.95m
6_5	75	Trapezoid0.5	10.00	12.15	19.00	3.24	0.85	Type-5	Minimum 0.6m
6_6	180	Trapezoid0.5	40.00	41.85	48.00	2.39	0.67	Type-5	Minimum 0.35m
6_7	180	Trapezoid0.5	25.00	27.05	34.00	3.49	0.93	Type-5	Minimum 0.95m
6_8	85	Trapezoid0.5	15.00	17.20	24.00	2.45	0.63	Type-5	Minimum 0.35m
6_9	290	Trapezoid2.0	70.00	78.60	85.00	1.87	0.49	Type-6	Minimum 0.35m
6_10	130	Trapezoid0.5	25.00	27.05	34.00	2.47	0.66	Type-5	Minimum 0.35m
6_11	66	Trapezoid0.5	12.00	13.75	20.00	2.97	0.86	Type-5	Minimum 0.6m
6_12	1700	Compound	150.00	198.40	211.00	1.98	0.33	Type-6	Minimum 0.35m
R6_1	28	B.C.	6.00	6.00	6.00	2.58	0.73	Type-5	d50=0.4m
R6_2	2	B.C.	1.50	1.50	2.00	2.27	1.12	Type-5	d50=0.4m
R6_3	5	B.C.	2.50	2.50	3.00	2.84	1.26	Type-5	d50=0.4m
R6_4	23	B.C.	5.00	5.00	5.00	4.02	1.44	Type-5	d50=0.6m
R6_5	12	B.C.	2.50	2.50	3.00	3.57	1.16	Type-5	d50=0.5m
R6_6	17	B.C.	3.00	3.00	3.00	3.89	1.22	Type-5	d50=0.5m
R6_7	88	Trapezoid0.5	30.00	30.80	37.00	3.94	1.69	Type-5	Minimum 1.35m
R6_8	40	B.C.	5.00	5.00	5.00	4.75	1.40	Type-5	d50=0.6m
R6_9	36	B.C.	5.00	5.00	5.00	4.64	1.40	Type-5	d50=0.6m
R6_10	18	B.C.	4.00	4.00	4.00	3.89	1.36	Type-5	d50=0.5m
R6_11	43	B.C.	7.00	7.00	7.00	2.88	0.74	Type-5	d50=0.4m
R6_12	44	B.C.	7.00	7.00	7.00	4.07	1.05	Type-5	d50=0.6m
R6_13	14	B.C.	4.00	4.00	4.00	3.60	1.38	Type-5	d50=0.5m
R6_14	27	B.C.	6.00	6.00	6.00	4.17	1.49	Type-5	d50=0.6m
R6_15	7	B.C.	3.00	3.00	3.00	3.06	1.31	Type-5	d50=0.5m
R6_16	5	B.C.	2.50	2.50	3.00	2.84	1.26	Type-5	d50=0.4m
R6_17	23	B.C.	6.00	6.00	6.00	3.89	1.49	Type-5	d50=0.5m
R6_18	20	B.C.	6.00	6.00	6.00	3.89	1.49	Type-5	d50=0.5m
R6_19	8	B.C.	2.50	2.50	3.00	3.24	1.21	Type-5	d50=0.5m
R6_20	24	B.C.	6.00	6.00	6.00	3.99	1.49	Type-5	d50=0.5m
R6_21	11	B.C.	3.00	3.00	3.00	3.48	1.27	Type-5	d50=0.5m
R6_22	15	B.C.	4.00	4.00	4.00	3.68	1.37	Type-5	d50=0.5m
R6_23	32	B.C.	5.00	5.00	5.00	4.45	1.42	Type-5	d50=0.6m
R6_24	2	B.C.	2.00	2.00	2.00	1.17	0.47	Type-5	d50=0.3m

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
R6_25	7	B.C.	3.00	3.00	3.00	1.85	0.62	Type-5	d50=0.3m
R6_26	21	B.C.	4.00	4.00	4.00	4.08	1.35	Type-5	d50=0.6m
R6_27	8	B.C.	3.00	3.00	3.00	3.21	1.30	Type-5	d50=0.5m
R6_28	5	B.C.	2.00	2.00	2.00	2.86	1.16	Type-5	d50=0.4m
R6_29	21	B.C.	4.00	4.00	4.00	4.08	1.35	Type-5	d50=0.6m
R6_30	23	B.C.	6.00	6.00	6.00	2.36	0.74	Type-5	d50=0.4m
R6_31	29	B.C.	5.00	5.00	5.00	4.32	1.42	Type-5	d50=0.6m
R6_32	32	B.C.	10.00	10.00	10.00	1.71	0.47	Type-5	d50=0.3m

5) Marawi City Ring Road (Sub-Project 7)

Type of revetment and minimum diameter of riprap for foot protection at crossing points are enumerated in **Table 14.8.2-18** shown below.

Table 14.8.2-18 Selected Revetment and Foot Protection at Cross-sectional Points (Sub-Project 7)

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
7_1	140	Trapezoid0.5	35.00	36.85	43.00	2.12	0.60	Type-5	Minimum 0.35m
7_2	2400	Compound	160.00	204.00	213.00	3.42	0.64	Type-6	Minimum 0.95m
7_3	180	Trapezoid0.5	40.00	41.85	48.00	2.39	0.67	Type-5	Minimum 0.35m
7_4	47	B.C.	7.00	7.00	7.00	3.74	1.07	Type-5	d50=0.5m
7_5	82	Trapezoid0.5	12.00	14.00	20.00	3.20	0.87	Type-5	Minimum 0.6m
R7_1	33	B.C.	5.00	5.00	5.00	4.52	1.41	Type-5	d50=0.6m

6) Parang – East Diversion Road (Sub-Project 8)

Type of revetment and minimum diameter of riprap for foot protection at crossing points are enumerated in **Table 14.8.2-19** shown below.

Table 14.8.2-19 Selected Revetment and Foot Protection at Cross-sectional Points (Sub-Project 8)

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
8_1	480	Trapezoid0.5	65.00	67.00	73.00	3.57	0.97	Type-5	Minimum 0.95m
8_2	72	Trapezoid0.5	18.00	20.10	27.00	1.84	0.49	Type-5	Minimum 0.35m
R8_1	33	B.C.	5.00	5.00	5.00	4.52	1.41	Type-5	d50=0.6m

7) Manungan - Parang Road (Sub-Project 9)

Type of revetment and minimum diameter of riprap for foot protection at crossing points are enumerated in **Table 14.8.2-20** shown below.

Table 14.8.2-20 Selected Revetment and Foot Protection at Cross-sectional Points (Sub-Project 9)

Basin Name	Flood Discharge of 50yr-Return Period (m3/s)	Type of Bridge	Design Width of Riverbed	Width of Water (m)	Length of Bridge	Mean Flow Velocity (m/s)	Froud Number for Design	Type of Revetments	Diameter of Riprap for Foot Protection
9_1	1500	Compound	120.00	164.00	173.00	2.81	0.54	Type-6	Minimum 0.6m
9_2	140	Trapezoid0.5	30.00	31.90	38.00	2.39	0.66	Type-5	Minimum 0.35m
9_3	8	B.C.	3.00	3.00	3.00	1.92	0.61	Type-5	d50=0.3m
R9_1	6	B.C.	3.50	3.50	4.00	1.26	0.41	Type-5	d50=0.3m
R9_2	4	B.C.	2.00	2.00	2.00	2.10	0.80	Type-5	d50=0.4m
R9_3	3	B.C.	1.50	1.50	2.00	2.50	1.07	Type-5	d50=0.4m
9_1	1500	Compound	120.00	164.00	173.00	2.81	0.54	Type-6	Minimum 0.6m
9_2	140	Trapezoid0.5	30.00	31.90	38.00	2.39	0.66	Type-5	Minimum 0.35m
9_3	8	B.C.	3.00	3.00	3.00	1.92	0.61	Type-5	d50=0.3m
R9_1	6	B.C.	3.50	3.50	4.00	1.26	0.41	Type-5	d50=0.3m
R9_2	4	B.C.	2.00	2.00	2.00	2.10	0.80	Type-5	d50=0.4m
R9_3	3	B.C.	1.50	1.50	2.00	2.50	1.07	Type-5	d50=0.4m

Chapter 15 Preliminary Design

15.1 Sub-Project 1

15.1.1 Geometric Design

The applied geometric design criteria for Sub-Project 1 are shown in **Table 15.1.1-1**. The details of road design criteria are shown in **Section 14.2**.

- Road Classification: National Tertiary
- Located Area: Rural
- Total Length: 13.9 km (Mountainous Terrain: 8.3 km, Rolling Terrain: 5.6 km)

Table 15.1.1-1 Major Geometric Design Criteria for Sub-Project 1

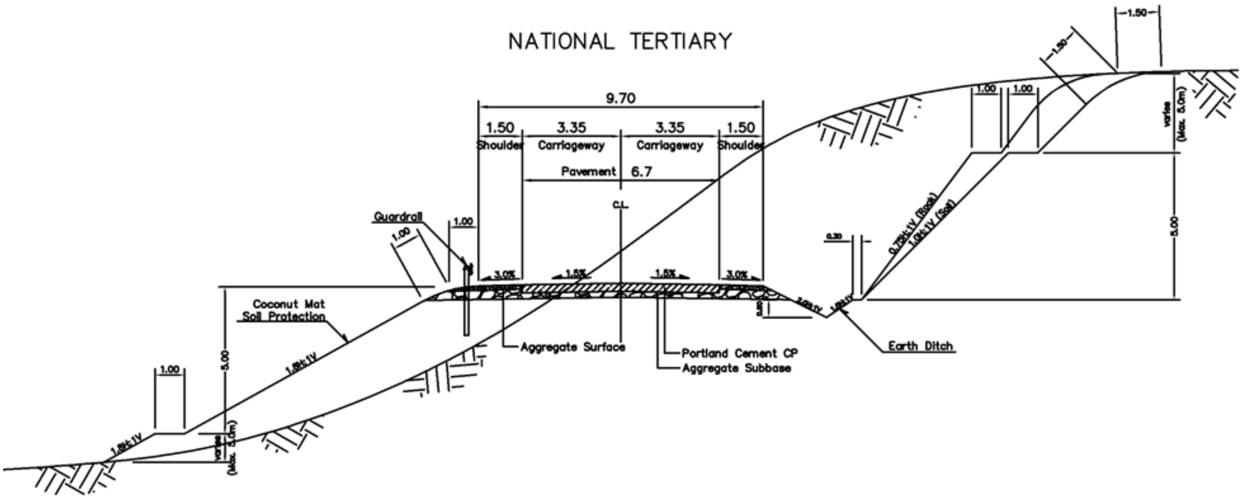
Terrain	Rolling	Mountainous	Remarks
Design Speed (km/h)	60	40	
Min. Horizontal Radius (m)	120	50	
Max. Horizontal Radius for Use of a Spiral Curve Transition (m)	213	95	
Max. Vertical Grade (%)	6.0	8.0	
Min. Crest Vertical Curve Based on SSD (K-value)	11	4	
Min. Vertical Curve on Sag (K-value)	18	9	
Stopping Sight Distance (m)	70	40	
Cross-fall for Pavement (%)	1.5		
Cross-fall for Shoulder (%)	3.0		
Carriageway Width (m)	6.70		
Shoulder Width (m)	1.50		
Right of Way Width (m)	30		
Max. Superelevation (%)	6.0		
Surface Type	PCCP (Min. T = 280 mm)		

Source: JICA Study Team

15.1.2 Typical Cross Section

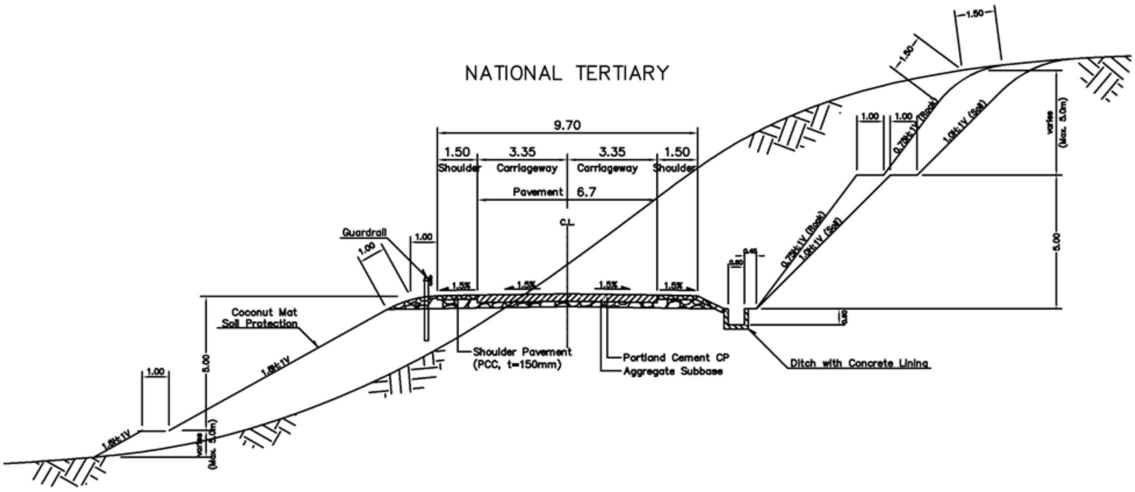
(1) Road

Typical cross sections by class of road are shown in the following figures:



Source: JICA Study Team

Figure 15.1.2-1 Typical Cross Sections for Roads in Sub-Project 1 (Vertical Grade Less Than 4 %)

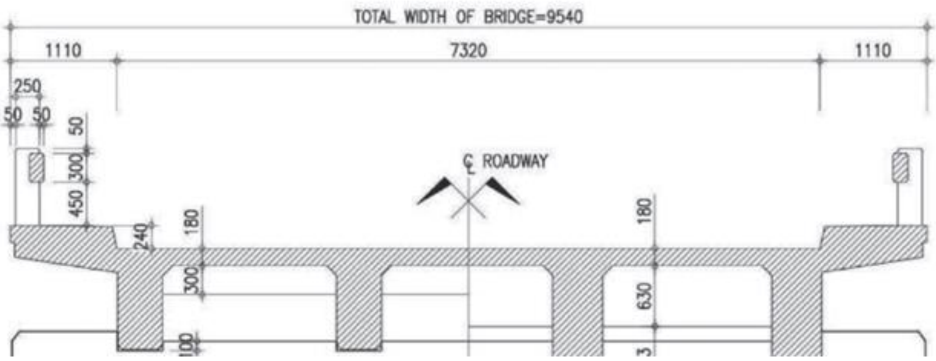


Source: JICA Study Team

Figure 15.1.2-2 Typical Cross Sections for Roads in Sub-Project 1 (Vertical Grade 4% and more)

(2) Bridges

Typical cross section of bridges is shown in the following figure:



Source: JICA Study Team

Figure 15.1.2-3 Typical Cross Section for Bridge in Sub-Project 1

15.1.3 Summary of Preliminary Design

(1) Total Length of Road

The total length of the roads of Sub-Project 1 is listed up in **Table 15.1.3-1**. Also, the total length of paved shoulder is 5.350 km.

Table 15.1.3-1 Total Length of Road for Sub-Project 1

Terrain	Length (km)	Station	
		From	To
Mountainous	8.3	Sta. 0+000	Sta. 8+345.14
Rolling	5.6	Sta. 8+345.14	Sta. 13+908.40
Total	13.9		

Source: JICA Study Team

(2) List of Bridges

Table 15.1.3-2 lists the number of bridges for preliminary design.

Table 15.1.3-2 List of Bridges for Sub-Project 1

Sub-Project 1									
Bridge No.	Beginning Sta.	End Sta.	Bridge Length(m)	Span Arrangement	Price (Nos)	Super Structure	Pire Type	Abutment Type	Foundation Type
1	2 +550	2 +625	75	25+25+25	2	PCDG	T-Type Pier	Reversed T	Bored Pile
2	5 +880	6 + 0	120	40+40+40	2	PCDG	T-Type Pier	Reversed T	Bored Pile
3	7 +200	7 +475	275	35+40+40+40+40+40+40	6	PCDG	T-Type Pier	Reversed T	Bored Pile
4	10 +765	10 +865	100	30+40+30	2	PCDG	T-Type Pier	Reversed T	Bored Pile
5	12 +350	12 +650	300	30+40+40+40+40+40+40+30	7	PCDG	T-Type Pier	Reversed T	Bored Pile
6	13 +510	13 +585	75	25+25+25	2	PCDG	T-Type Pier	Reversed T	Bored Pile
Super Structure	PCDG		945						
	RCDG		0						
	Total Length		945						
Sub Structure	Pire		21						
	Abutment		12						

Source: JICA Study Team

(3) List of Box Culverts

The RCBCs for minor rivers and waterways are listed up in **Table 15.1.3-3**.

Table 15.1.3-3 List of Box Culverts for Sub-Project 1

Sub-Project 1				
Station	Structure	Nos	Size (m)	End Type
0 + 856	RCBC	1	4.00X4.00	Headwall/Wing wall
1 + 717	RCBC	1	4.00X4.00	Headwall/Wing wall
4 + 920	RCBC	1	2.40X2.10	Headwall/Wing wall
Total	4.00X4.00	2		
	2.40X2.10	1		

Source: JICA Study Team

(4) List of Pipe Culverts

The RCPCs for waterways are listed up in **Table 15.1.3-4**.

Table 15.1.3-4 List of Pipe Culverts for Sub-Project 1

Sub-Project 1				
Station	**Structure**	**Nos**	**Size (mm)**	**End Type**
0 + 59	RCPC	1	φ910	Masonry Headwall
0 + 257	RCPC	1	φ910	Masonry Headwall
0 + 479	RCPC	1	φ1220	Masonry Headwall
0 + 742	RCPC	1	φ910	Masonry Headwall
1 + 180	RCPC	1	φ910	Masonry Headwall
1 + 282	RCPC	1	φ1220	Masonry Headwall
1 + 397	RCPC	1	φ910	Masonry Headwall
1 + 947	RCPC	1	φ910	Masonry Headwall
2 + 105	RCPC	1	φ910	Masonry Headwall
2 + 236	RCPC	1	φ910	Masonry Headwall
2 + 413	RCPC	1	φ910	Masonry Headwall
3 + 121	RCPC	1	φ910	Masonry Headwall
3 + 343	RCPC	1	φ910	Masonry Headwall
3 + 561	RCPC	1	φ910	Masonry Headwall
3 + 765	RCPC	1	φ1220	Masonry Headwall
4 + 39	RCPC	1	φ910	Masonry Headwall
4 + 328	RCPC	1	φ910	Masonry Headwall
4 + 573	RCPC	1	φ910	Masonry Headwall
5 + 125	RCPC	1	φ910	Masonry Headwall
5 + 561	RCPC	1	φ910	Masonry Headwall
5 + 759	RCPC	1	φ910	Masonry Headwall
6 + 219	RCPC	1	φ910	Masonry Headwall
7 + 130	RCPC	1	φ910	Masonry Headwall
7 + 690	RCPC	1	φ910	Masonry Headwall
8 + 343	RCPC	1	φ910	Masonry Headwall
8 + 540	RCPC	1	φ910	Masonry Headwall
8 + 786	RCPC	1	φ910	Masonry Headwall
8 + 925	RCPC	1	φ910	Masonry Headwall
9 + 29	RCPC	1	φ910	Masonry Headwall
9 + 490	RCPC	1	φ910	Masonry Headwall
10 + 229	RCPC	1	φ910	Masonry Headwall
11 + 33.1	RCPC	1	φ910	Masonry Headwall
11 + 384	RCPC	1	φ910	Masonry Headwall
11 + 960	RCPC	1	φ910	Masonry Headwall
13 + 154	RCPC	1	φ910	Masonry Headwall
13 + 368	RCPC	2	φ910	Masonry Headwall
13 + 775	RCPC	1	φ910	Masonry Headwall
Total	φ1220	3		
	φ910	35		

Source: JICA Study Team

15.2 Sub-Project 2

15.2.1 Geometric Design

The applied geometric design criteria for Sub-Project 2 are shown in **Table 15.2.1-1**. The details of road design criteria are shown in **Section 14.2**.

- Road Classification: National Secondary
- Located Area: Rural
- Total Length: 35.3 km

([PK-1: 20.6 km] Flat Terrain: 13.9 km, Mountainous Terrain: 6.7 km,
[PK-2: 14.7 km] Mountainous Terrain: 14.7 km)

Table 15.2.1-1 Major Geometric Design Criteria for Sub-Project 2

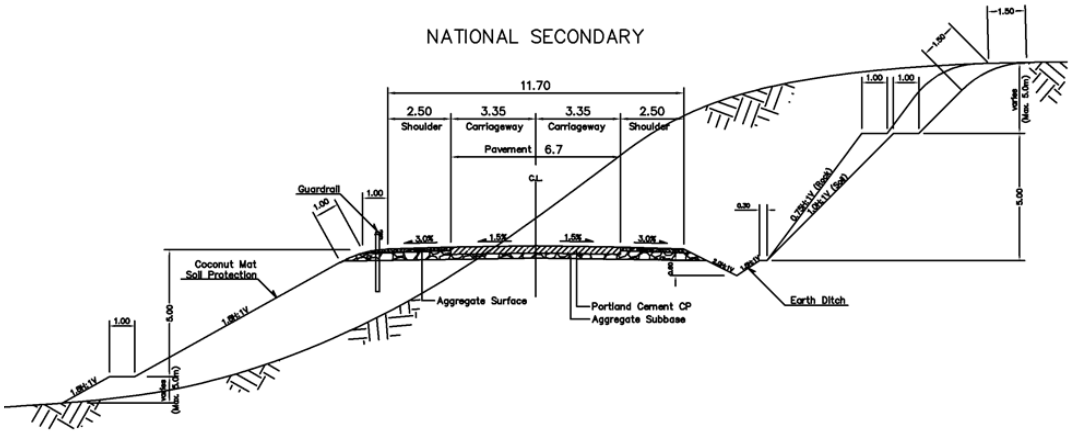
Terrain	Flat	Mountainous	Remarks
Design Speed (km/h)	80	50	
Min. Horizontal Radius (m)	220	80	
Max. Horizontal Radius for Use of a Spiral Curve Transition (m)	379	148	
Max. Vertical Grade (%)	4.0	7.0	
Min. Crest Vertical Curve Based on SSD (K-value)	26	7	
Min. Vertical Curve on Sag (K-value)	30	13	
Stopping Sight Distance (m)	115	60	
Cross-fall for Pavement (%)	1.5		
Cross-fall for Shoulder (%)	3.0		
Carriageway Width (m)	6.7		
Shoulder Width (m)	2.50		
Right of Way Width (m)	30		
Max. Superelevation (%)	6.0		
Surface Type	PCCP (Min. T = 280 mm)		

Source: JICA Study Team

15.2.2 Typical Cross Section

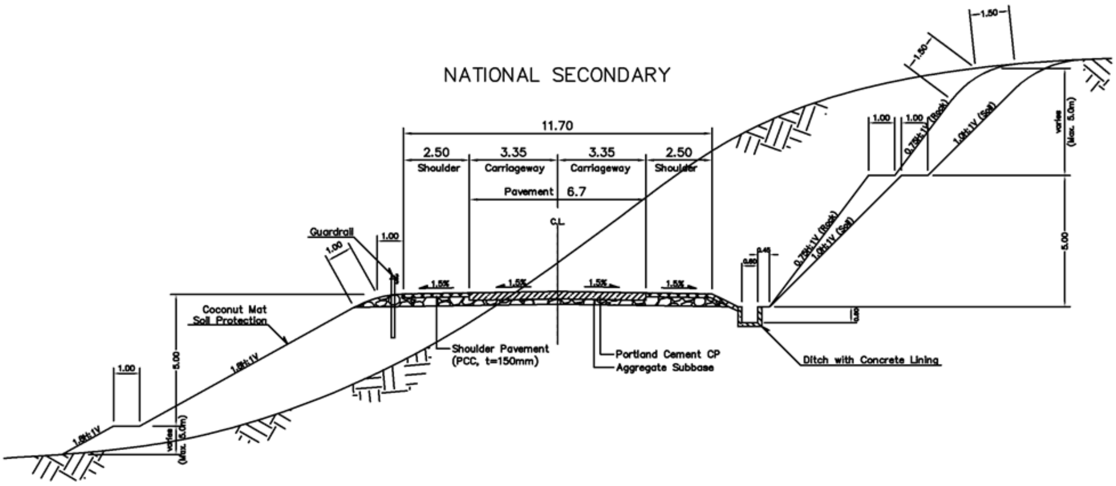
(1) Road

The typical cross sections by class of road are shown in the following figures:



Source: JICA Study Team

Figure 15.2.2-1 Typical Cross Sections for Roads in Sub-Project 2 (Vertical Grade Less Than 4 %)

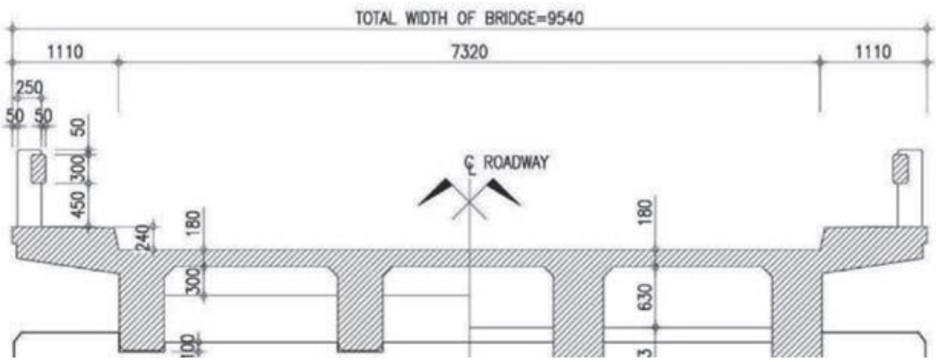


Source: JICA Study Team

Figure 15.2.2-2 Typical Cross Sections for Roads in Sub-Project 2 (Vertical Grade 4% and more)

(2) Bridges

Typical cross section of bridges is shown in the following figures:



Source: JICA Study Team

Figure 15.2.2-3 Typical Cross Section for Bridge in Sub-Project 2

15.2.3 Summary of Preliminary Design for Package 1 in Sub-Project 2

(1) Total Length of Road

The total length of road for Package 1 is listed up in **Table 15.2.3-1**. Also, the total length of paved shoulder for Package 1 is 6.125 km.

Table 15.2.3-1 Total Length of Road for PK-1 in Sub-Project 2

Terrain	Length (km)	Station	
		From	To
Flat	13.9	Sta. 0+000	Sta. 13+930.00
Mountainous	6.7	Sta. 13+930.00	Sta. 20+600.00
Total	20.6		

Source: JICA Study Team

(2) List of Bridges

Table 15.2.3-2 lists the number of bridges for preliminary design in Package 1.

Table 15.2.3-2 List of Bridges for PK-1 in Sub-Project 2

Package 1 in Sub-Project 2									
Bridge No.	Beginning Sta.	End Sta.	Bridge Length(m)	Span Arrangement	Price (Nos)	Super Structure	Pire Type	Abutment Type	Foundation Type
1	0 +575	0 +665	90	30+30+30	2	PCDG	T-Type Pier	Reversed T	Bored Pile
2	2 +210	2 +490	280	40+40+40+40+40+ 40+40	6	PCDG	T-Type Pier	Reversed T	Bored Pile
3	6 + 0	6 + 50	50	25+25	1	PCDG	T-Type Pier	Reversed T	Bored Pile
4	8 +940	10 +140	200	40+40+40+40+40	4	PCDG	T-Type Pier	Reversed T	Bored Pile
5	12 +640	12 +760	120	40+40+40	2	PCDG	T-Type Pier	Reversed T	Bored Pile
Super Structure	PCDG		740						
	RCDG		0						
	Total Length		740						
Sub Structure	Pire		15						
	Abutment		10						

Source: JICA Study Team

(3) List of Box Culverts

The RCBCs for minor rivers and waterways in Package 1 are listed up in **Table 15.2.3-3**.

Table 15.2.3-3 List of Box Culverts for PK-1 in Sub-Project 2

Package 1 in Sub-Project 2				
Station	**Structure**	**Nos**	**Size (m)**	**End Type**
0 + 832	RCBC	1	1.25 x 1.00	Headwall/Wing wall
1 + 150	RCBC	1	3.00 x 3.00	Headwall/Wing wall
1 + 200	RCBC	1	3.00 x 3.00	Headwall/Wing wall
1 + 362	RCBC	1	1.25 x 1.00	Headwall/Wing wall
1 + 600	RCBC	1	1.25 x 1.00	Headwall/Wing wall
4 + 50	RCBC	3	1.50 x 1.80	Headwall/Wing wall
4 + 510	RCBC	2	3.00 x 3.00	Headwall/Wing wall
4 + 846	RCBC	1	1.25 x 1.00	Headwall/Wing wall
5 + 40	RCBC	1	1.25 x 1.00	Headwall/Wing wall
10 + 20	RCBC	1	1.25 x 1.00	Headwall/Wing wall
10 + 625	RCBC	1	1.25 x 1.00	Headwall/Wing wall
11 + 65	RCBC	1	1.25 x 1.00	Headwall/Wing wall
11 + 342	RCBC	1	1.25 x 1.00	Headwall/Wing wall
11 + 430	RCBC	1	1.25 x 1.00	Headwall/Wing wall
12 + 222	RCBC	1	1.25 x 1.00	Headwall/Wing wall
12 + 350	RCBC	1	1.25 x 1.00	Headwall/Wing wall
12 + 925	RCBC	1	1.25 x 1.00	Headwall/Wing wall
13 + 740	RCBC	1	1.25 x 1.00	Headwall/Wing wall
17 + 246	RCBC	1	3.00 x 3.00	Headwall/Wing wall
20 + 275	RCBC	2	3.00 x 3.00	Headwall/Wing wall
Total	3.00 x 3.00	5		
	1.25 x 1.00	19		

Source: JICA Study Team

15.2.4 Summary of Preliminary Design for Package 2 in Sub-Project 2

(1) Total length of Road

The total length of road for Package 2 is listed up in **Table 15.2.4-1**. Also, the total length of paved shoulder for Package 2 is 9.650 km.

Table 15.2.4-1 Total Length of Road for PK-2 in Sub-Project 2

Terrain	**Length (km)**	**Station**	
		From	**To**
Mountainous	14.7	Sta. 20+600.00	Sta. 35+260.05
Total	14.7		

Source: JICA Study Team

(2) List of Bridges

Table 15.2.4-2 lists the number of bridges for preliminary design in Package 2.

Table 15.2.4-2 List of Bridges for PK-2 in Sub-Project 2

Package 2 in Sub-Project 2									
Bridge No.	**Beginning Sta.**	**End Sta.**	**Bridge Length(m)**	**Span Arrangement**	**Price (Nos)**	**Super Structure**	**Pire Type**	**Abutment Type**	**Foundation Type**
1	23 +925	23 +985	60	20+20+20	2	PCDG	T-Type Pier	Reversed T	Bored Pile
2	24 +860	24 +960	100	20+20+20+20+20+20	4	PCDG	T-Type Pier	Reversed T	Bored Pile
3	30 +650	30 +725	75	25+25+25	2	PCDG	T-Type Pier	Reversed T	Bored Pile
4	30 +965	31 +245	280	40+40+40+40+40+ 40+40+40	6	PCDG	T-Type Pier	Reversed T	Bored Pile
5	32 +430	32 +490	60	20+20+20	2	PCDG	T-Type Pier	Reversed T	Bored Pile
Super Structure	PCDG		355						
	RCDG		220						
	Total Length		575						
Sub Structure	Pire		16						
	Abutment		10						

Source: JICA Study Team

(3) List of Box Culverts

The RCBCs for minor rivers and waterways in Package 2 are listed up in **Table 15.2.4-3**.

Table 15.2.4-3 List of Box Culverts for PK-2 in Sub-Project2

Package 2 in Sub-Project 2				
Station	**Structure**	**Nos**	**Size (m)**	**End Type**
32+ 790	RCBC	1	1.25 x 1.00	Headwall/Wing wall
33+ 030	RCBC	1	1.25 x 1.00	Headwall/Wing wall
33+ 530	RCBC	1	4.00 x 3.00	Headwall/Wing wall
Total	4.00 x 3.00	1		
	1.25 x 1.00	2		

Source: JICA Study Team

(4) List of Pipe Culverts

The RCPCs for waterways in Package 2 are listed up in **Table 15.2.4-4**.

Table 15.2.4-4 List of Pipe Culverts for PK-2 in Sub-Project 2

Package 2 in Sub-Project 2				
Station	**Structure**	**Nos**	**Size (mm)**	**End Type**
20+ 700	RCPC	1	φ910	Masonry Headwall
21+ 639	RCPC	1	φ910	Masonry Headwall
21+ 825	RCPC	1	φ910	Masonry Headwall
21+ 991	RCPC	1	φ910	Masonry Headwall
22+ 196	RCPC	1	φ910	Masonry Headwall
22+ 356	RCPC	1	φ910	Masonry Headwall
22+ 541	RCPC	1	φ910	Masonry Headwall
22+ 875	RCPC	1	φ910	Masonry Headwall
23+ 427	RCPC	1	φ1220	Masonry Headwall

Package 2 in Sub-Project 2				
Station	**Structure**	**Nos**	**Size (mm)**	**End Type**
23+ 575	RCPC	1	φ910	Masonry Headwall
23+ 771	RCPC	1	φ910	Masonry Headwall
24+ 141	RCPC	1	φ910	Masonry Headwall
24+ 339	RCPC	1	φ910	Masonry Headwall
25+ 273	RCPC	1	φ910	Masonry Headwall
25+ 416	RCPC	1	φ910	Masonry Headwall
25+ 515	RCPC	1	φ1220	Masonry Headwall
25+ 829	RCPC	1	φ1220	Masonry Headwall
26+ 197	RCPC	1	φ910	Masonry Headwall
26+ 701	RCPC	1	φ910	Masonry Headwall
26+ 964	RCPC	1	φ910	Masonry Headwall
27+ 147	RCPC	1	φ1220	Masonry Headwall
28+ 811	RCPC	1	φ910	Masonry Headwall
28+ 920	RCPC	1	φ1220	Masonry Headwall
29+ 070	RCPC	1	φ910	Masonry Headwall
29+ 291	RCPC	1	φ910	Masonry Headwall
29+ 403	RCPC	1	φ910	Masonry Headwall
29+ 599	RCPC	1	φ910	Masonry Headwall
29+ 883	RCPC	1	φ910	Masonry Headwall
30+ 171	RCPC	1	φ910	Masonry Headwall
30+ 287	RCPC	1	φ910	Masonry Headwall
30+ 442	RCPC	1	φ1220	Masonry Headwall
31+ 978	RCPC	1	φ1220	Masonry Headwall
34+ 402	RCPC	1	φ910	Masonry Headwall
34+ 754	RCPC	1	φ910	Masonry Headwall
35+ 164	RCPC	1	φ910	Masonry Headwall
Total	φ1220	7		
	φ910	28		

Source: JICA Study Team

15.3 Sub-Project 5

Preparation of *Preliminary Design for Sub-Project 5* was cancelled due to **Security Problems** which hinder surveyors to visit the site.

15.4 Sub-Project 6

15.4.1 Geometric Design for Sub-Project 6

The applied geometric design criteria for Sub-Project 6 are shown in **Table 15.4.1-1**. The details of road design criteria are shown in **Section 14.2**.

- Road Classification: National Secondary
- Located Area: Rural
- Total Length: 62.6 km
  ([PK-1: 19.0 km] Mountainous Terrain: 19.0 km,
  [PK-2: 21.3 km] Mountainous Terrain: 21.3 km)
  [PK-3: 22.3 km] Flat Terrain: 12.5 km, Mountainous Terrain: 9.8 km)

Table 15.4.1-1 Major Geometric Design Criteria for Sub-Project 6

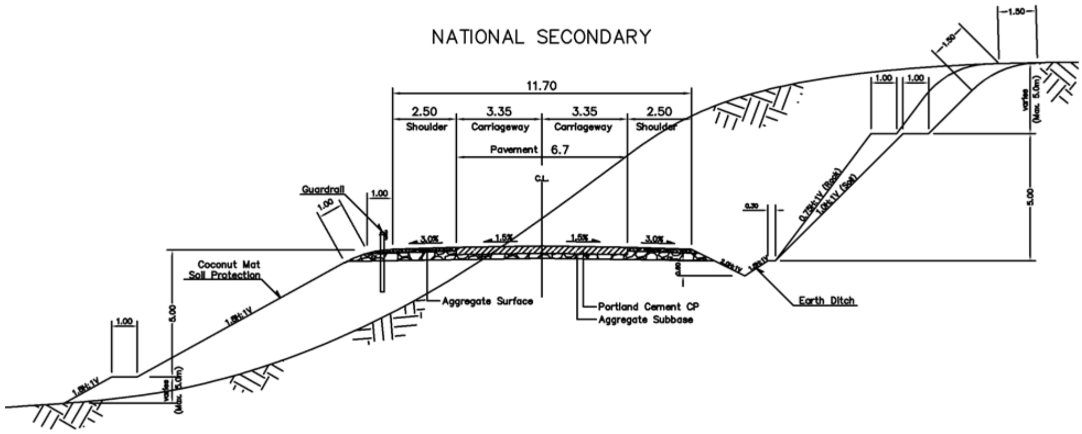
Terrain	Flat	Mountainous	Remarks
Design Speed (km/h)	80	50	
Min. Horizontal Radius (m)	220	80	
Max. Horizontal Radius for Use of a Spiral Curve Transition (m)	379	148	
Max. Vertical Grade (%)	4.0	7.0	
Min. Crest Vertical Curve Based on SSD (K-value)	26	7	
Min. Vertical Curve on Sag (K-value)	30	13	
Stopping Sight Distance (m)	115	60	
Cross-fall for Pavement (%)	1.5		
Cross-fall for Shoulder (%)	3.0		
Carriageway Width (m)	6.7		
Shoulder Width (m)	2.50		
Right of Way Width (m)	30		
Max. Superelevation (%)	6.0		
Surface Type	PCCP (Min. T = 280 mm)		

Source: JICA Study Team

15.4.2 Typical Cross Section

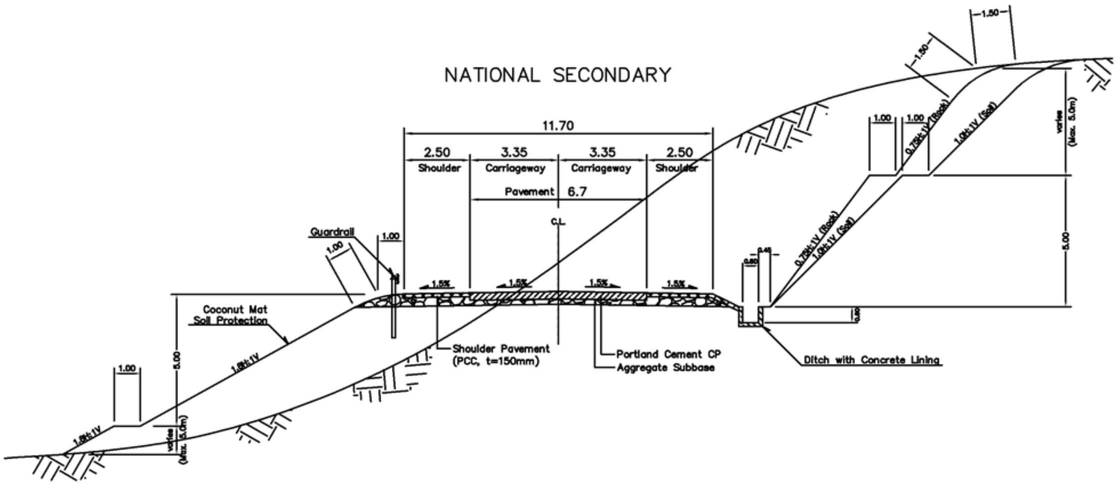
(1) Road

Typical cross sections by class of road are shown in the following figures:



Source: JICA Study Team

Figure 15.4.2-1 Typical Cross Sections for Roads in Sub-Project 6 (Vertical Grade Less Than 4 %)

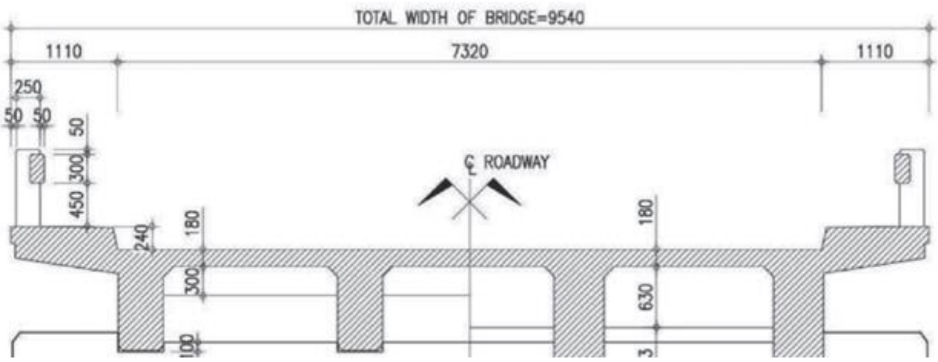


Source: JICA Study Team

Figure 15.4.2-2 Typical Cross Sections for Roads in Sub-Project 6 (Vertical Grade 4% and more)

(2) Bridges

Typical cross section of bridges is shown in the following figures:



Source: JICA Study Team

Figure 15.4.2-3 Typical Cross Section for Bridge in Sub-Project 6

15.4.3 Summary of Preliminary Design for Package 1 in Sub-Project 6

(1) Total Length of Road

The total length of road for Package 1 is listed in **Table 15.4.3-1**. Also, the total length of paved shoulder for Package 1 is 4.985 km.

Table 15.4.3-1 Total Length of Road for PK-1 in Sub-Project 6

Terrain	Length (km)	Station	
		From	To
Mountainous	19.0	Sta. 0+000.00	Sta. 19+000.00
Total	19.0		

Source: JICA Study Team

(2) List of Bridges

Table 15.4.3-2 lists the number of bridges for preliminary design.

Table 15.4.3-2 List of Bridges for PK-1 in Sub-Project 6

Package 1 in Sub-Project 6									
Bridge No.	Beginning Sta.	End Sta.	Bridge Length(m)	Span Arrangement	Price (Nos)	Super Structure	Pire Type	Abutment Type	Foundation Type
1	2 +780	3 +290	510	40+40+40+40+40+40+40+ 40+40+40+40+40+30	12	PCDG	T-Type Pier	Reversed T	Bored Pile
2	4 +300	4 +420	120	20+20+20+20+20+20	5	RCDG	T-Type Pier	Reversed T	Bored Pile
3	4 +540	4 +600	60	20+20+20	2	RCDG	T-Type Pier	Reversed T	Bored Pile
4	7 +890	7 +950	60	20+20+20	2	RCDG	T-Type Pier	Reversed T	Bored Pile
5	10 +745	10 +805	60	20+20+20	2	RCDG	T-Type Pier	Reversed T	Bored Pile
6	13 +695	13 +770	75	25+25+25	2	PCDG	T-Type Pier	Reversed T	Bored Pile
7	18 +800	18 +900	100	30+40+30	2	PCDG	T-Type Pier	Reversed T	Bored Pile
Super Structure	PCDG		685						
	RCDG		300						
	Total Length		985						
Sub Structure	Pire		27						
	Abutment		14						

Source: JICA Study Team

(3) List of Box Culverts

The RCBCs for minor rivers and waterways in Package 1 are listed in **Table 15.4.3-3**.

Table 15.4.3-3 List of Box Culverts for PK-1 in Sub-Project 6

Package 1 in Sub-Project 6				
Station	Structure	Nos	Size (m)	End Type
1+ 608	RCBC	1	1.25 x 1.00	Wing Wall
1+ 859	RCBC	1	1.25 x 1.00	Wing Wall

Package 1 in Sub-Project 6				
Station	**Structure**	**Nos**	**Size (m)**	**End Type**
8+ 360	RCBC	1	3.00 x 3.00	Wing Wall
17+ 125	RCBC	1	3.00 x 3.00	Wing Wall
17+ 975	RCBC	1	1.25 x 1.00	Wing Wall
Total	3.00 x 3.00	2		
	1.25 x 1.00	3		

Source: JICA Study Team

(4) List of Pipe Culverts

The RCPCs for waterways in Package 1 are listed in **Table 15.4.3-4**.

Table 15.4.3-4 List of Pipe Culverts for PK-1 in Sub-Project 6

Package 1 in Sub-Project 6				
Station	**Structure**	**Nos**	**Size (mm)**	**End Type**
0+ 074	RCPC	1	φ910	Masonry Headwall
0+ 433	RCPC	1	φ910	Masonry Headwall
0+ 668	RCPC	1	φ910	Masonry Headwall
0+ 771	RCPC	1	Φ1220	Masonry Headwall
1+ 073	RCPC	1	φ1220	Masonry Headwall
1+ 276	RCPC	1	φ1220	Masonry Headwall
2+ 079	RCPC	1	φ910	Masonry Headwall
2+ 289	RCPC	1	φ910	Masonry Headwall
2+ 411	RCPC	1	φ910	Masonry Headwall
2+ 591	RCPC	1	φ910	Masonry Headwall
3+ 945	RCPC	1	φ910	Masonry Headwall
4+ 825	RCPC	1	φ910	Masonry Headwall
5+ 200	RCPC	1	φ910	Masonry Headwall
5+ 350	RCPC	1	φ910	Masonry Headwall
5+ 453	RCPC	1	φ910	Masonry Headwall
5+ 557	RCPC	1	φ910	Masonry Headwall
5+ 902	RCPC	1	φ910	Masonry Headwall
6+ 181	RCPC	1	φ910	Masonry Headwall
6+ 317	RCPC	1	φ910	Masonry Headwall
6+ 456	RCPC	1	φ910	Masonry Headwall
6+ 780	RCPC	1	φ910	Masonry Headwall
6+ 906	RCPC	1	φ910	Masonry Headwall
6+ 966	RCPC	1	φ910	Masonry Headwall
7+ 108	RCPC	1	φ910	Masonry Headwall
7+ 288	RCPC	1	φ1220	Masonry Headwall
7+ 525	RCPC	1	φ1220	Masonry Headwall
8+ 933	RCPC	1	φ910	Masonry Headwall
9+ 100	RCPC	1	φ910	Masonry Headwall
9+ 239	RCPC	1	φ910	Masonry Headwall
9+ 957	RCPC	1	φ910	Masonry Headwall

Package 1 in Sub-Project 6				
Station	**Structure**	**Nos**	**Size (mm)**	**End Type**
10+ 236	RCPC	1	φ910	Masonry Headwall
10+ 567	RCPC	1	φ910	Masonry Headwall
11+ 550	RCPC	1	φ910	Masonry Headwall
11+ 700	RCPC	1	φ1220	Masonry Headwall
11+ 879	RCPC	1	φ910	Masonry Headwall
12+ 055	RCPC	1	φ910	Masonry Headwall
12+ 292	RCPC	1	φ910	Masonry Headwall
12+ 432	RCPC	1	φ910	Masonry Headwall
13+ 068	RCPC	1	φ910	Masonry Headwall
13+ 240	RCPC	1	φ910	Masonry Headwall
13+ 516	RCPC	1	φ910	Masonry Headwall
14+ 086	RCPC	1	φ910	Masonry Headwall
14+ 167	RCPC	1	φ910	Masonry Headwall
14+ 440	RCPC	1	φ910	Masonry Headwall
14+ 745	RCPC	1	φ910	Masonry Headwall
14+ 925	RCPC	1	φ910	Masonry Headwall
15+ 287	RCPC	1	φ910	Masonry Headwall
15+ 575	RCPC	1	φ910	Masonry Headwall
15+ 810	RCPC	1	φ910	Masonry Headwall
15+ 888	RCPC	1	φ910	Masonry Headwall
16+ 022	RCPC	1	φ910	Masonry Headwall
16+ 299	RCPC	1	φ910	Masonry Headwall
16+ 635	RCPC	1	φ910	Masonry Headwall
16+ 781	RCPC	1	φ910	Masonry Headwall
17+ 419	RCPC	1	φ910	Masonry Headwall
17+ 693	RCPC	1	φ910	Masonry Headwall
Total	φ1220	6		
	φ910	50		

Source: JICA Study Team

15.4.4 Summary of Preliminary Design for Package 2 in Sub-Project 6

(1) Total Length of Road

The total length of road for Package 2 is listed in **Table 15.4.4-1**. Also, the total length of paved shoulder for Package 2 is 14.000 km.

Table 15.4.4-1 Total Length of Road for PK-2 in Sub-Project 6

Terrain	Length (km)	Station	
		From	To
Mountainous	21.3	Sta. 19+000.00	Sta. 40+325.00
Total	21.3		

Source: JICA Study Team

(2) List of Bridges

Table 15.4.4-2 lists the number of bridges for preliminary design.

Table 15.4.4-2 List of Bridge for PK-2 in Sub-Project 6

Package 2 in Sub-Project 6									
Bridge No.	**Beginning Sta.**	**End Sta.**	**Bridge Length(m)**	**Span Arrangement**	**Price (Nos)**	**Super Structure**	**Pire Type**	**Abutment Type**	**Foundation Type**
1	22 +360	22 +420	60	20+20+20	2	RCDG	T-Type Pier	Reversed T	Bored Pile
2	26 +870	27 + 50	180	30+40+40+40+30	4	PCDG	T-Type Pier	Reversed T	Bored Pile
3	28 +865	28 +925	60	20+20+20	2	RCDG	T-Type Pier	Reversed T	Bored Pile
4	29 +165	29 +265	100	30+40+30	2	PCDG	T-Type Pier	Reversed T	Bored Pile
5	37 + 10	37 +245	225	25+25+25+25+25+25+25+ 25+25+25	8	PCDG	T-Type Pier	Reversed T	Bored Pile
6	37 +970	38 + 30	60	20+20+20	2	RCDG	T-Type Pier	Reversed T	Bored Pile
Super Structure	PCDG		505						
	RCDG		180						
	Total Length		685						
Sub Structure	Pire		20						
	Abutment		12						

Source: JICA Study Team

(3) List of Box Culverts

The RCBCs for minor rivers and waterways in Package 2 are listed in **Table 15.4.4-3**.

Table 15.4.4-3 List of Box Culverts for PK-2 in Sub-Project 6

Package 2 in Sub-Project 6				
Station	**Structure**	**Nos**	**Size (m)**	**End Type**
26+ 300	RCBC	1	1.25 x 1.00	Wing Wall
26+ 457	RCBC	1	1.25 x 1.00	Wing Wall
27+ 337	RCBC	1	1.25 x 1.00	Wing Wall
27+ 930	RCBC	1	1.25 x 1.00	Wing Wall
28+ 380	RCBC	1	1.25 x 1.00	Wing Wall
37+ 456	RCBC	1	4.00 x 3.00	Wing Wall
Total	4.00 x 3.00	1		
	1.25 x 1.00	5		

Source: JICA Study Team

(4) List of Pipe Culverts

The RCPCs for waterways in Package 2 are listed in **Table 15.4.4-4**.

Table 15.4.4-4 List of Pipe Culverts for PK-2 in Sub-Project 6

Package 2 in Sub-Project 6				
Station	Structure	Nos	Size (mm)	End Type
19+ 150	RCPC	1	φ1220	Masonry Headwall
19+ 532	RCPC	1	φ910	Masonry Headwall
19+ 638	RCPC	1	φ910	Masonry Headwall
19+ 771	RCPC	1	φ910	Masonry Headwall
20+ 893	RCPC	1	φ1220	Masonry Headwall
21+ 131	RCPC	1	φ910	Masonry Headwall
21+ 530	RCPC	1	φ910	Masonry Headwall
22+ 600	RCPC	1	φ910	Masonry Headwall
23+ 135	RCPC	1	φ1220	Masonry Headwall
23+ 370	RCPC	1	φ910	Masonry Headwall
24+ 550	RCPC	1	φ1220	Masonry Headwall
24+ 936	RCPC	1	φ910	Masonry Headwall
25+ 110	RCPC	1	φ1220	Masonry Headwall
25+ 625	RCPC	1	φ910	Masonry Headwall
25+ 800	RCPC	1	φ910	Masonry Headwall
26+ 025	RCPC	1	φ910	Masonry Headwall
27+ 660	RCPC	1	φ910	Masonry Headwall
28+ 090	RCPC	1	φ910	Masonry Headwall
28+ 200	RCPC	1	φ910	Masonry Headwall
28+ 600	RCPC	1	φ910	Masonry Headwall
29+ 359	RCPC	1	φ910	Masonry Headwall
29+ 515	RCPC	1	φ910	Masonry Headwall
30+ 413	RCPC	1	φ910	Masonry Headwall
30+ 901	RCPC	1	φ1220	Masonry Headwall
31+ 131	RCPC	1	φ910	Masonry Headwall
31+ 300	RCPC	1	φ1220	Masonry Headwall
32+ 040	RCPC	1	φ1220	Masonry Headwall
32+ 115	RCPC	1	φ1220	Masonry Headwall
32+ 225	RCPC	1	φ910	Masonry Headwall
32+ 461	RCPC	1	φ910	Masonry Headwall
32+ 725	RCPC	1	φ910	Masonry Headwall
33+ 065	RCPC	1	φ1220	Masonry Headwall
33+ 260	RCPC	1	φ1220	Masonry Headwall
33+ 400	RCPC	1	φ910	Masonry Headwall
33+ 450	RCPC	1	φ910	Masonry Headwall
33+ 615	RCPC	1	φ1220	Masonry Headwall
33+ 710	RCPC	1	φ1220	Masonry Headwall
34+ 330	RCPC	1	φ910	Masonry Headwall
34+ 537	RCPC	1	φ1220	Masonry Headwall
35+ 226	RCPC	1	φ910	Masonry Headwall
35+ 513	RCPC	1	φ910	Masonry Headwall
35+ 714	RCPC	1	φ910	Masonry Headwall
35+ 977	RCPC	1	φ910	Masonry Headwall
36+ 320	RCPC	1	φ910	Masonry Headwall
36+ 575	RCPC	1	φ1220	Masonry Headwall
36+ 855	RCPC	1	φ910	Masonry Headwall
36+ 950	RCPC	1	φ910	Masonry Headwall
38+ 457	RCPC	1	φ910	Masonry Headwall
38+ 659	RCPC	1	φ910	Masonry Headwall
38+ 905	RCPC	1	φ910	Masonry Headwall

Package 2 in Sub-Project 6				
Station	**Structure**	**Nos**	**Size (mm)**	**End Type**
39+ 171	RCPC	1	φ910	Masonry Headwall
39+ 387	RCPC	1	φ910	Masonry Headwall
39+ 588	RCPC	1	φ910	Masonry Headwall
39+ 762	RCPC	1	φ910	Masonry Headwall
39+ 923	RCPC	1	φ910	Masonry Headwall
Total	φ1220	15		
	φ910	40		

Source: JICA Study Team

15.4.5 Summary of Preliminary Design for Package 3 in Sub-Project 6

(1) Total Length of Road

The total length of road for Package 3 is listed in **Table 15.4.5-1**. Also, the total length of paved shoulder for Package 3 is 7.425 km.

Table 15.4.5-1 Total Length of Road for PK-3 in Sub-Project 6

Terrain	Length (km)	Station	
		From	**To**
Mountainous	9.8	Sta. 40+325.00	Sta. 50+095.67
Flat	12.5	Sta. 50+095.67	Sta. 62+578.06
Total	22.3		

Source: JICA Study Team

(2) List of Bridges

Table 15.4.5-2 lists the number of bridges for preliminary design.

Table 15.4.5-2 List of Bridges for PK-3 in Sub-Project 6

Package 3 in Sub-Project 6									
Bridge No.	**Beginning Sta.**	**End Sta.**	**Bridge Length(m)**	**Span Arrangement**	**Price (Nos)**	**Super Structure**	**Pire Type**	**Abutment Type**	**Foundation Type**
1	50 +395	50 +455	60	20+20+20	2	RCDG	T-Type Pier	Reversed T	Bored Pile
2	50 +840	50 +915	75	30+40+40+40+30	2	PCDG	T-Type Pier	Reversed T	Bored Pile
3	61 +290	61 +390	100	20+20+20	2	PCDG	T-Type Pier	Reversed T	Bored Pile
Super Structure	PCDG		175						
	RCDG		60						
	Total Length		235						
Sub Structure	Pire		6						
	Abutment		6						

Source: JICA Study Team

(3) List of Box Culverts

The RCBCs for minor rivers and waterways in Package 3 are listed in **Table 15.4.5-3**.

Table 15.4.5-3 List of Box Culverts for PK-3 in Sub-Project 6

Package 3 in Sub-Project 6				
Station	**Structure**	**Nos**	**Size (m)**	**End Type**
51+ 525	RCBC	1	1.50 x 1.25	Wing Wall
52+ 312	RCBC	1	2.40 x 2.10	Wing Wall
52+ 480	RCBC	1	1.50 x 1.25	Wing Wall
52+ 995	RCBC	1	1.50 x 1.25	Wing Wall
53+ 680	RCBC	1	1.50 x 1.25	Wing Wall
55+ 035	RCBC	1	1.50 x 1.25	Wing Wall
59+ 855	RCBC	1	1.50 x 1.25	Wing Wall
Total	2.40 x 2.10	1		
	1.50 x 1.25	6		

Source: JICA Study Team

(4) List of Pipe Culverts

The RCPCs for waterways in Package 3 are listed in **Table 15.4.5-4**.

Table 15.4.5-4 List of Pipe Culverts for PK-3 in Sub-Project 6

Package 3 in Sub-Project 6				
Station	**Structure**	**Nos**	**Size (mm)**	**End Type**
40+ 577	RCPC	1	φ1220	Masonry Headwall
41+ 287	RCPC	1	φ910	Masonry Headwall
41+ 459	RCPC	1	φ1220	Masonry Headwall
41+ 634	RCPC	1	φ910	Masonry Headwall
42+ 290	RCPC	1	φ910	Masonry Headwall
42+ 430	RCPC	1	φ910	Masonry Headwall
42+ 547	RCPC	1	φ910	Masonry Headwall
43+ 012	RCPC	1	φ910	Masonry Headwall
43+ 493	RCPC	1	φ1220	Masonry Headwall
43+ 700	RCPC	1	φ1220	Masonry Headwall
43+ 819	RCPC	1	φ910	Masonry Headwall
44+ 040	RCPC	1	φ910	Masonry Headwall
44+ 156	RCPC	1	φ910	Masonry Headwall
44+ 425	RCPC	1	φ1220	Masonry Headwall
44+ 650	RCPC	1	φ910	Masonry Headwall
44+ 813	RCPC	1	φ910	Masonry Headwall
45+ 134	RCPC	1	φ910	Masonry Headwall
45+ 387	RCPC	1	φ910	Masonry Headwall
45+ 518	RCPC	1	φ910	Masonry Headwall
45+ 700	RCPC	1	φ910	Masonry Headwall
45+ 870	RCPC	1	φ910	Masonry Headwall
45+ 996	RCPC	1	φ910	Masonry Headwall
46+ 145	RCPC	1	φ910	Masonry Headwall
46+ 300	RCPC	1	φ910	Masonry Headwall

Package 3 in Sub-Project 6				
Station	**Structure**	**Nos**	**Size (mm)**	**End Type**
46+ 505	RCPC	1	φ1220	Masonry Headwall
46+ 765	RCPC	1	φ910	Masonry Headwall
46+ 825	RCPC	1	φ910	Masonry Headwall
47+ 025	RCPC	1	φ910	Masonry Headwall
47+ 194	RCPC	1	φ910	Masonry Headwall
47+ 355	RCPC	1	φ1220	Masonry Headwall
47+ 550	RCPC	1	φ910	Masonry Headwall
47+ 985	RCPC	1	φ910	Masonry Headwall
48+ 167	RCPC	1	φ910	Masonry Headwall
48+ 360	RCPC	1	φ910	Masonry Headwall
48+ 565	RCPC	1	φ1220	Masonry Headwall
48+ 840	RCPC	1	φ910	Masonry Headwall
49+ 035	RCPC	1	φ1220	Masonry Headwall
49+ 258	RCPC	1	φ910	Masonry Headwall
49+ 382	RCPC	1	φ1220	Masonry Headwall
49+ 472	RCPC	1	φ910	Masonry Headwall
49+ 589	RCPC	1	φ910	Masonry Headwall
49+ 684	RCPC	1	φ1220	Masonry Headwall
49+ 960	RCPC	1	φ1220	Masonry Headwall
54+ 400	RCPC	1	φ910	Masonry Headwall
54+ 575	RCPC	1	φ910	Masonry Headwall
55+ 405	RCPC	1	φ910	Masonry Headwall
55+ 945	RCPC	1	φ910	Masonry Headwall
56+ 055	RCPC	1	φ910	Masonry Headwall
56+ 219	RCPC	1	φ910	Masonry Headwall
56+ 400	RCPC	1	φ910	Masonry Headwall
56+ 650	RCPC	1	φ910	Masonry Headwall
56+ 930	RCPC	1	φ910	Masonry Headwall
57+ 350	RCPC	1	φ910	Masonry Headwall
57+ 575	RCPC	1	φ910	Masonry Headwall
58+ 157	RCPC	1	φ1220	Masonry Headwall
58+ 320	RCPC	1	φ910	Masonry Headwall
58+ 385	RCPC	1	φ910	Masonry Headwall
58+ 490	RCPC	1	φ910	Masonry Headwall
58+ 750	RCPC	1	φ910	Masonry Headwall
59+ 085	RCPC	1	φ1220	Masonry Headwall
59+ 285	RCPC	1	φ910	Masonry Headwall
Total	φ1220	14		
	φ910	47		

Source: JICA Study Team

15.5 Sub-Project 7

15.5.1 Geometric Design

The applied geometric design criteria for Sub-Project 7 are shown in **Table 15.5.1-1**. The details of road design criteria are shown in **Section 14.2**.

- Road Classification: National Secondary
- Located Area: Rural
- Total Length: 19.8 km
  ([PK-1: 8.5 km] Mountainous Terrain: 8.5 km,
  [PK-2: 11.3 km] Mountainous Terrain: 11.3 km)

Table 15.5.1-1 Major Geometric Design Criteria for Sub-Project 7

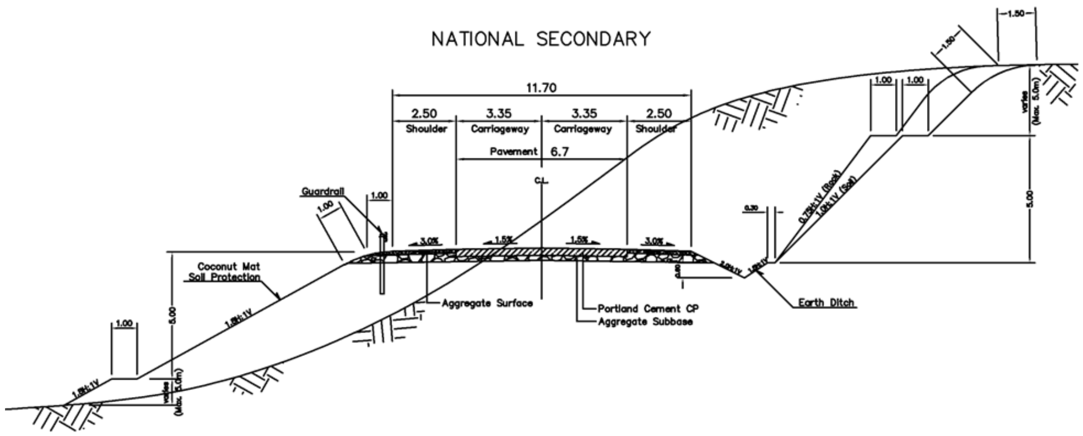
Terrain	Mountainous	Remarks
Design Speed (km/h)	50	
Min. Horizontal Radius (m)	80	
Max. Horizontal Radius for Use of a Spiral Curve Transition (m)	148	
Max. Vertical Grade (%)	7.0	
Min. Crest Vertical Curve Based on SSD (K-value)	7	
Min. Vertical Curve on Sag (K-value)	13	
Stopping Sight Distance (m)	60	
Cross-fall for Pavement (%)	1.5	
Cross-fall for Shoulder (%)	3.0	
Carriageway Width (m)	6.7	
Shoulder Width (m)	2.50	
Right of Way Width (m)	30	
Max. Superelevation (%)	6.0	
Surface Type	PCCP (Min. T = 280 mm)	

Source: JICA Study Team

15.5.2 Typical Cross Section

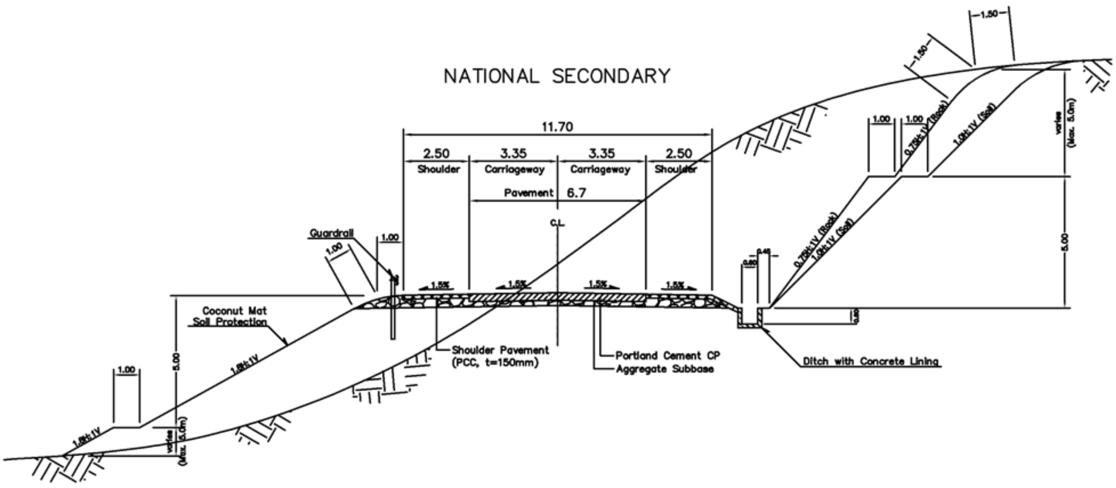
(1) Road

Typical cross sections by class of road are shown in the following figures:



Source: JICA Study Team

Figure 15.5.2-1 Typical Cross Sections for Roads in Sub-Project 7 (Vertical Grade Less Than 4 %)

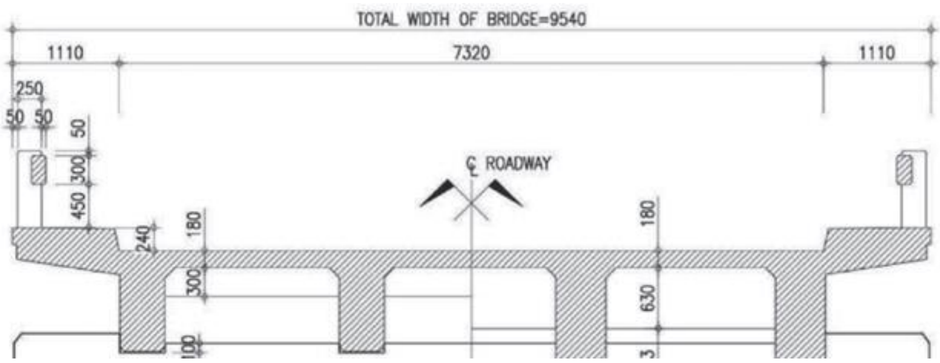


Source: JICA Study Team

Figure 15.5.2-2 Typical Cross Sections for Roads in Sub-Project 7 (Vertical Grade 4% and more)

(2) Bridges

Typical cross section of bridges is shown in the following figure:



Source: JICA Study Team

Figure 15.5.2-3 Typical Cross Section for Bridge in Sub-Project 7

15.5.3 Summary of Preliminary Design for Package 1 in Sub-Project 7

(3) Total Length of Road

The total length of road for Package 1 is listed in **Table 15.5.3-1**. Also, the total length of paved shoulder for Package 1 is 4.888 km.

Table 15.5.3-1 Total Length of Road for PK-1 in Sub-Project 7

Terrain	Length (km)	Station	
		From	To
Mountainous	8.5	Sta. 0+000.00	Sta. 8+500.00
Total	8.5		

Source: JICA Study Team

(4) List of Box Culverts

The RCBCs for minor rivers and waterways in Package 1 are listed in **Table 15.5.3-2**.

Table 15.5.3-2 List of Box Culverts for PK-1 in Sub-Project 7

Package 1 in Sub-Project 7				
Station	Structure	Nos	Size (m)	End Type
0+ 950	RCBC	1	1.25 x 1.00	Wing Wall
5+ 675	RCBC	1	1.50 x 1.50	Wing Wall
Total	1.50 x 1.50	1		
	1.25 x 1.00	1		

Source: JICA Study Team

(5) List of Pipe Culverts

The RCPCs for waterways in Package 1 are listed in **Table 15.5.3-3**.

Table 15.5.3-3 List of Pipe Culverts for PK-1 in Sub-Project 7

Package 1 in Sub-Project 7				
Station	Structure	Nos	Size (mm)	End Type
0+ 430	RCPC	1	φ910	Masonry Headwall
0+ 813	RCPC	1	φ910	Masonry Headwall
1+ 550	RCPC	1	φ910	Masonry Headwall
2+ 075	RCPC	1	φ910	Masonry Headwall
2+ 455	RCPC	1	φ910	Masonry Headwall
2+ 525	RCPC	1	φ910	Masonry Headwall
2+ 868	RCPC	1	φ910	Masonry Headwall
3+ 325	RCPC	1	φ910	Masonry Headwall
3+ 745	RCPC	1	φ910	Masonry Headwall
5+ 440	RCPC	1	φ1220	Masonry Headwall
6+ 044	RCPC	1	φ910	Masonry Headwall
6+ 354	RCPC	1	φ910	Masonry Headwall
6+ 620	RCPC	1	φ910	Masonry Headwall
6+ 725	RCPC	1	φ910	Masonry Headwall

6+ 925	RCPC	1	φ910	Masonry Headwall
7+ 185	RCPC	1	φ910	Masonry Headwall
7+ 385	RCPC	1	φ910	Masonry Headwall
7+ 550	RCPC	1	φ910	Masonry Headwall
8+ 032	RCPC	1	φ1220	Masonry Headwall
Total	φ910	17		
	φ1220	2		

Source: JICA Study Team

15.5.4 Summary of Preliminary Design for Package 2 in Sub-Project 7

(1) Total length of Road

The total length of road for Package 1 is listed in **Table 15.5.4-1**. Also, the total length of paved shoulder for Package 1 is 4.800 km.

Table 15.5.4-1 Total Length of Road for PK-2 in Sub-Project 7

Terrain	Length (km)	Station	
		From	To
Mountainous	11.3	Sta. 8+500.00	Sta. 19+811.76
Total	11.3		

Source: JICA Study Team

(2) List of Bridges

Table 15.5.4-2 lists the number of bridges for preliminary design.

Table 15.5.4-2 List of Bridges for PK-2 in Sub-Project 7

Package 2 in Sub-Project 7									
Bridge No.	**Beginning Sta.**	**End Sta.**	**Bridge Length(m)**	**Span Arrangement**	**Price (Nos)**	**Super Structure**	**Pire Type**	**Abutment Type**	**Foundation Type**
1	13 +815	13 +975	160	40+40+40+40	3	PCDG	T-Type Pier	Reversed T	Bored Pile
2	15 +690	15 +770	80	40+40	1	PCDG	T-Type Pier	Reversed T	Bored Pile
Super Structure	PCDG		240						
	RCDG		0						
	Total Length		240						
Sub Structure	Pire		4						
	Abutment		4						

Source: JICA Study Team

(3) List of Box Culverts

The RCBCs for minor rivers and waterways in Package 2 are listed in **Table 15.5.4-3**.

Table 15.5.4-3 List of Box Culverts for PK-2 in Sub-Project 7

Package 2 in Sub-Project 7				
Station	**Structure**	**Nos**	**Size (m)**	**End Type**
12+ 853	RCBC	1	1.25 x 1.00	Wing Wall
17+ 468	RCBC	1	1.80 x 1.80	Wing Wall
Total	1.80 x 1.80	1		
	1.25 x 1.00	1		

Source: JICA Study Team

(4) List of Pipe Culverts

The RCPCs for waterways in Package 2 are listed in **Table 15.5.4-4**.

Table 15.5.4-4 List of Pipe Culverts for PK-2 in Sub-Project 7

Package 2 in Sub-Project 7				
Station	**Structure**	**Nos**	**Size (mm)**	**End Type**
10+ 354	RCPC	1	φ910	Masonry Headwall
10+ 684	RCPC	1	φ910	Masonry Headwall
11+ 400	RCPC	1	φ910	Masonry Headwall
11+ 546	RCPC	1	φ910	Masonry Headwall
11+ 669	RCPC	1	φ910	Masonry Headwall
11+ 766	RCPC	1	φ910	Masonry Headwall
11+ 925	RCPC	1	φ910	Masonry Headwall
12+ 132	RCPC	1	φ910	Masonry Headwall
12+ 237	RCPC	1	φ910	Masonry Headwall
12+ 525	RCPC	1	φ910	Masonry Headwall
12+ 614	RCPC	1	φ910	Masonry Headwall
12+ 757	RCPC	1	φ910	Masonry Headwall
13+ 462	RCPC	1	φ910	Masonry Headwall
13+ 659	RCPC	1	φ910	Masonry Headwall
14+ 797	RCPC	1	φ910	Masonry Headwall
14+ 912	RCPC	1	φ1220	Masonry Headwall
15+ 022	RCPC	1	φ910	Masonry Headwall
15+ 414	RCPC	1	φ910	Masonry Headwall
15+ 600	RCPC	1	φ910	Masonry Headwall
16+ 116	RCPC	1	φ910	Masonry Headwall
16+ 228	RCPC	1	φ910	Masonry Headwall
16+ 368	RCPC	1	φ910	Masonry Headwall
16+ 458	RCPC	1	φ910	Masonry Headwall
16+ 850	RCPC	1	φ910	Masonry Headwall
17+ 150	RCPC	1	φ910	Masonry Headwall
17+ 595	RCPC	1	φ910	Masonry Headwall
17+ 692	RCPC	1	φ910	Masonry Headwall
17+ 790	RCPC	1	φ910	Masonry Headwall
18+ 038	RCPC	1	φ910	Masonry Headwall
18+ 189	RCPC	1	φ910	Masonry Headwall

18+ 329	RCPC	1	φ910	Masonry Headwall
18+ 442	RCPC	1	φ910	Masonry Headwall
18+ 610	RCPC	1	φ910	Masonry Headwall
18+ 961	RCPC	1	φ910	Masonry Headwall
19+ 088	RCPC	1	φ910	Masonry Headwall
19+ 192	RCPC	1	φ910	Masonry Headwall
19+ 433	RCPC	1	φ910	Masonry Headwall
19+ 574	RCPC	1	φ910	Masonry Headwall
19+ 656	RCPC	1	φ910	Masonry Headwall
19+ 728	RCPC	1	φ910	Masonry Headwall
Total	φ1220	1		
	φ910	39		

Source: JICA Study Team

15.6 Sub-Project 8

15.6.1 Geometric Design

The applied geometric design criteria for Sub-Project 8 are shown in **Table 15.6.1-1**. The details of the road design criteria are shown in **Section 14.2**.

- Road Classification: National Secondary
- Located Area: Rural
- Total Length: 7.0 km (Mountainous Terrain: 7.0 km)

Table 15.6.1-1 Major Geometric Design Criteria for Sub-Project 8

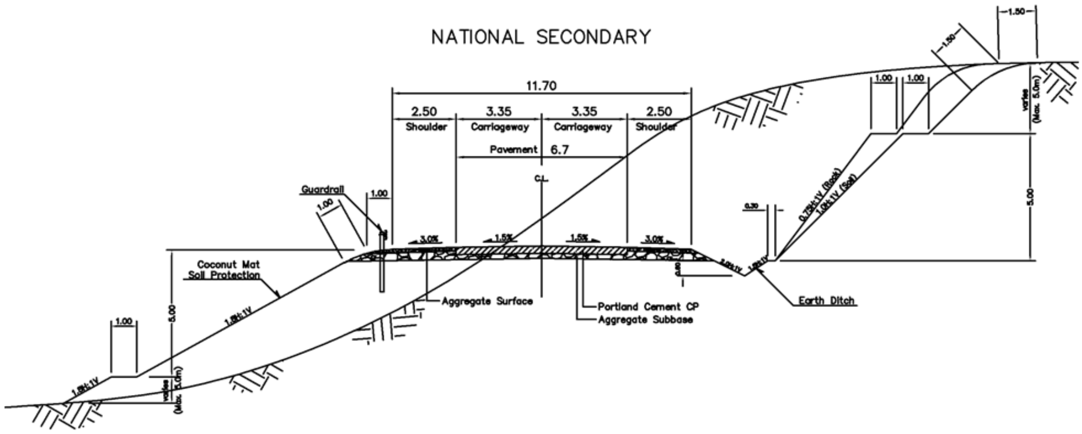
Terrain	Mountainous	Remarks
Design Speed (km/h)	50	
Min. Horizontal Radius (m)	80	
Max. Horizontal Radius for Use of a Spiral Curve Transition (m)	148	
Max. Vertical Grade (%)	7.0	
Min. Crest Vertical Curve Based on SSD (K-value)	7	
Min. Vertical Curve on Sag (K-value)	13	
Stopping Sight Distance (m)	60	
Cross-fall for Pavement (%)	1.5	
Cross-fall for Shoulder (%)	3.0	
Carriageway Width (m)	6.7	
Shoulder Width (m)	2.50	
Right of Way Width (m)	30	
Max. Superelevation (%)	6.0	
Surface Type	PCCP (Min. T = 280 mm)	

Source: JICA Study Team

15.6.2 Typical Cross Section

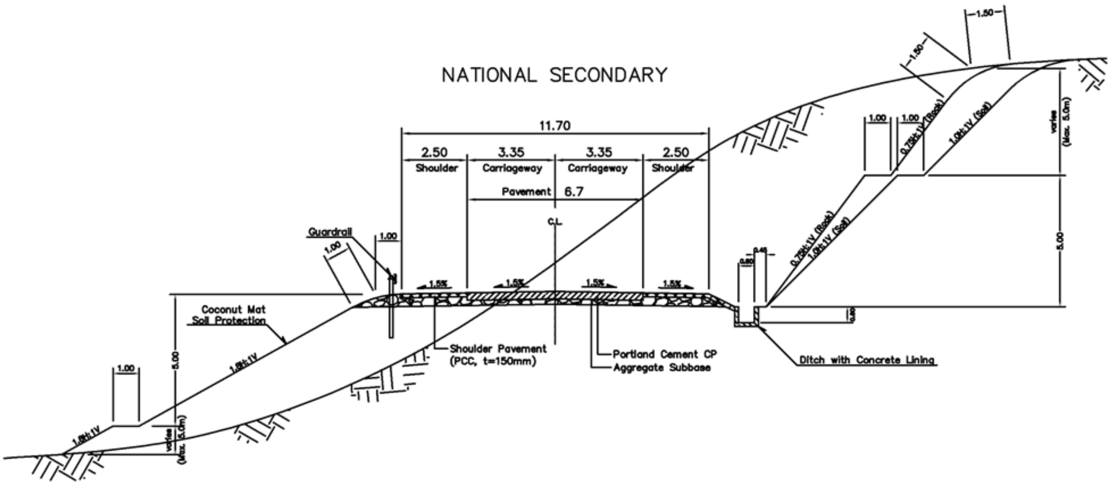
(1) Road

Typical cross sections by class of road are shown in the following figures:



Source: JICA Study Team

Figure 15.6.2-1 Typical Cross Sections for Roads in Sub-Project 8 (Vertical Grade Less Than 4 %)

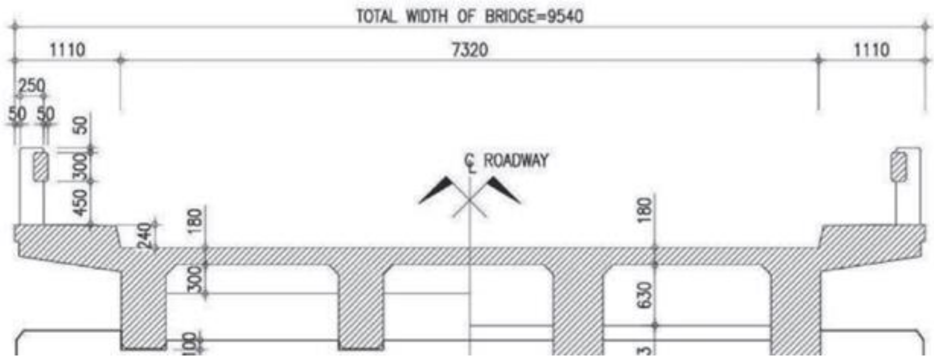


Source: JICA Study Team

Figure 15.6.2-2 Typical Cross Sections for Roads in Sub-Project 8 (Vertical Grade 4% and more)

(2) Bridges

Typical cross section of bridges is shown in the following figure:



Source: JICA Study Team

Figure 15.6.2-3 Typical Cross Section for Bridge in Sub-Project 8

15.6.3 Summary of Preliminary Design

(1) Total Length of Road

The total length of roads is listed up in **Table 15.6.3-1**. Also, the total length of paved shoulder is 3.862 km.

Table 15.6.3-1 Total Length of Road for Sub-Project 8

Terrain	Length (km)	Station	
		From	To
Mountainous	7.0	Sta. 0+000	Sta. 6+963.05
Total	7.0		

Source: JICA Study Team

(2) List of Bridges

Table 15.6.3-2 lists the number of bridges for preliminary design.

Table 15.6.3-2 List of Bridges for Sub-Project 8

Sub-Project 8									
Bridge No.	Beginning Sta.	End Sta.	Bridge Length(m)	Span Arrangement	Price (Nos)	Super Structure	Pire Type	Abutment Type	Foundation Type
1	3 +140	3 +300	160	40+40+40+40	3	PCDG	T-Type Pier	Reversed T	Bored Pile
2	3 +560	3 +620	60	20+20+20	2	RCDG	T-Type Pier	Reversed T	Bored Pile
3	6 +360	6 +385	25	25	0	PCDG	T-Type Pier	Reversed T	Bored Pile
Super Structure	PCDG		185						
	RCDG		60						
	Total Length		245						
Sub Structure	Pire		5						
	Abutment		6						

Source: JICA Study Team

(3) List of Pipe Culverts

The RCPCs for waterways are listed up in **Table 15.6.3-3**.

Table 15.6.3-3 List of Pipe Culverts for Sub-Project 8

Sub-Project 8				
Station	Structure	Nos	Size (mm)	End Type
0 + 318	RCPC	1	φ910	Masonry Headwall
0 + 462	RCPC	1	φ910	Masonry Headwall
0 + 910	RCPC	1	φ910	Masonry Headwall
1 + 155	RCPC	1	φ910	Masonry Headwall
1 + 333	RCPC	1	φ910	Masonry Headwall
1 + 507	RCPC	1	φ910	Masonry Headwall
1 + 745	RCPC	1	φ910	Masonry Headwall
2 + 60	RCPC	1	φ910	Masonry Headwall

Sub-Project 8					
Station		**Structure**	**Nos**	**Size (mm)**	**End Type**
2 +	215	RCPC	1	φ910	Masonry Headwall
2 +	378	RCPC	1	φ910	Masonry Headwall
2 +	865	RCPC	1	φ910	Masonry Headwall
3 +	810	RCPC	1	φ910	Masonry Headwall
4 +	375	RCPC	1	φ910	Masonry Headwall
4 +	619	RCPC	1	φ910	Masonry Headwall
4 +	984	RCPC	1	φ910	Masonry Headwall
5 +	172	RCPC	1	φ910	Masonry Headwall
5 +	242	RCPC	1	φ910	Masonry Headwall
5 +	600	RCPC	1	φ910	Masonry Headwall
5 +	880	RCPC	1	φ910	Masonry Headwall
6 +	13	RCPC	1	φ910	Masonry Headwall
6 +	588	RCPC	1	φ910	Masonry Headwall
6 +	865	RCPC	2	φ610	Masonry Headwall
Total		φ910	21		
		φ610	1		

Source: JICA Study Team

15.7 Sub-Project 9

15.7.1 Geometric Design

The applied geometric design criteria for Sub-Project 9 are shown in **Table 15.7.1-1**. The details of road design criteria are shown in **Section 14.2**.

- Road Classification: National Tertiary
- Located Area: Rural
- Total Length: 16.8 km (Mountainous Terrain: 16.8 km)

Table 15.7.1-1 Major Geometric Design Criteria for Sub-Project 9

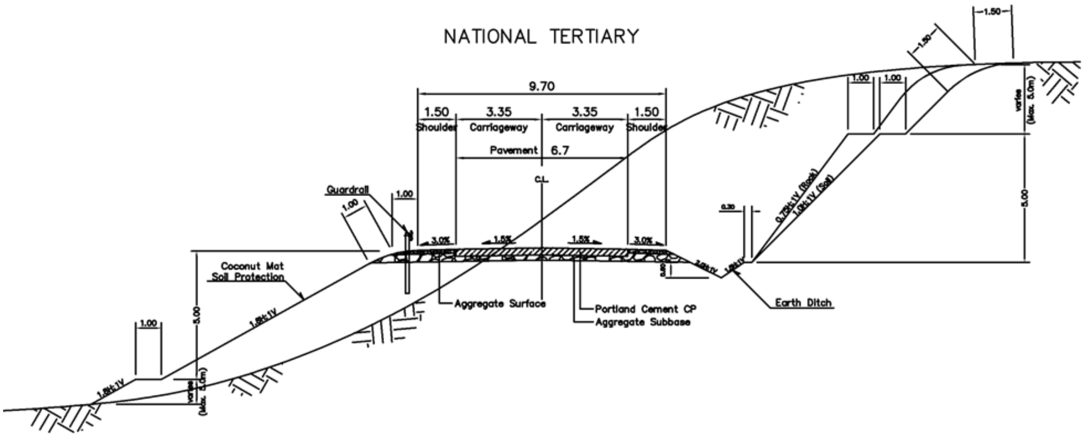
Terrain	Mountainous	Remarks
Design Speed (km/h)	40	
Min. Horizontal Radius (m)	50	
Max. Horizontal Radius for Use of a Spiral Curve Transition (m)	95	
Max. Vertical Grade (%)	8.0	
Min. Crest Vertical Curve Based on SSD (K-value)	4	
Min. Vertical Curve on Sag (K-value)	9	
Stopping Sight Distance (m)	40	
Cross-fall for Pavement (%)	1.5	
Cross-fall for Shoulder (%)	3.0	
Carriageway Width (m)	6.7	
Shoulder Width (m)	1.50	
Right of Way Width (m)	30	
Max. Superelevation (%)	6.0	
Surface Type	PCCP (Min. T = 280 mm)	

Source: JICA Study Team

15.7.2 Typical Cross Section

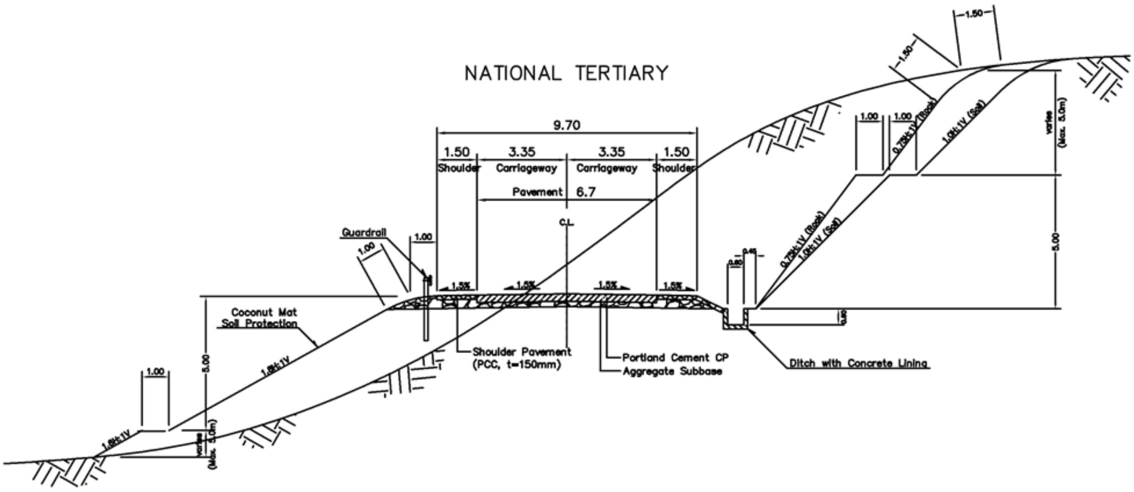
(1) Road

Typical cross sections by class of road are shown in the following figures:



Source: JICA Study Team

Figure 15.7.2-1 Typical Cross Sections for Roads in Sub-Project 9 (Vertical Grade Less Than 4 %)

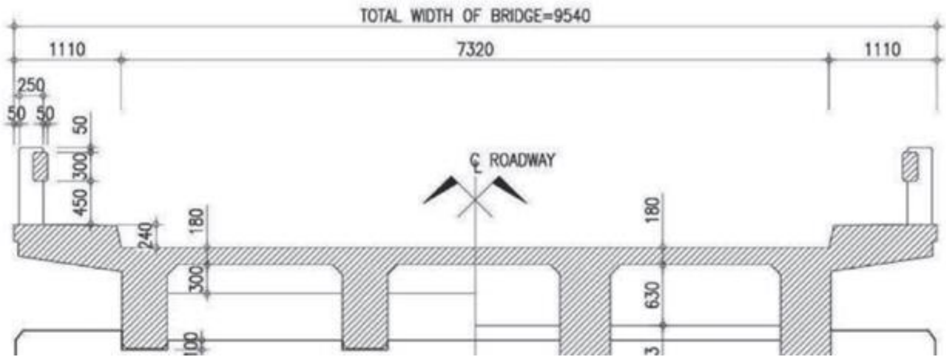


Source: JICA Study Team

Figure 15.7.2-2 Typical Cross Sections for Roads in Sub-Project 9 (Vertical Grade 4% and more)

(2) Bridges

Typical cross section of bridges is shown in the following figure:



Source: JICA Study Team

Figure 15.7.2-3 Typical Cross Section for Bridge in Sub-Project 9

15.7.3 Summary of Preliminary Design

(1) Total Length of Road

The total length of roads is listed up in **Table 15.7.3-1**. Also, the total length of paved shoulder is 3.862 km.

Table 15.7.3-1 Total Length of Road for Sub-Project 9

Terrain	Length (km)	Station	
		From	To
Mountainous	16.8	Sta. 0+000	Sta. 16+771.97
Total	16.8		

Source: JICA Study Team

(2) List of Bridges

Table 15.7.3-2 lists the number of bridges for preliminary design.

Table 15.7.3-2 List of Bridges for Sub-Project 9

Sub-Project 9												
Bridge No.	Beginning Sta.		End Sta.		Bridge Length(m)	Span Arrangement	Price (Nos)	Super Structure	Pire Type	Abutment Type	Foundation Type
1	9	+235	9	+505	270	30+40+40+40+40+40+40	6	PCDG	T-Type Pier	Reversed T	Bored Pile
2	11	+345	11	+495	150	40+40+40+30	3	PCDG	T-Type Pier	Reversed T	Bored Pile
3	11	+659	11	+699	40	20+20	1	RCDG	T-Type Pier	Reversed T	Bored Pile
Super Structure	PCDG				420						
	RCDG				40						
	Total Length				460						
Sub Structure	Pire				10						
	Abutment				6						

Source: JICA Study Team

(3) List of Box Culverts

The RCBCs for minor rivers and waterways are listed up in **Table 15.7.3-3**.

Table 15.7.3-3 List of Box Culverts for Sub-Project 9

Sub-Project 9					
Station		Structure	Nos	Size (m)	End Type
13 +	443	RCBC	1	3.00X2.75	Wing Wall

Source: JICA Study Team

(4) List of Pipe Culverts

The RCPCs for waterways are listed up in **Table 15.7.3-4**.

Table 15.7.3-4 List of Pipe Culverts for Sub-Project 9

Sub-Project 9					
Station		Structure	Nos	Size (mm)	End Type
0 +	272	RCPC	1	φ910	Masonry Headwall
0 +	420	RCPC	1	φ910	Masonry Headwall
0 +	682	RCPC	1	φ910	Masonry Headwall
0 +	765	RCPC	1	φ910	Masonry Headwall
0 +	945	RCPC	1	φ910	Masonry Headwall
1 +	161	RCPC	1	φ910	Masonry Headwall
1 +	361	RCPC	1	φ910	Masonry Headwall
2 +	24	RCPC	1	φ910	Masonry Headwall
2 +	245	RCPC	1	φ910	Masonry Headwall
2 +	571	RCPC	1	φ910	Masonry Headwall
2 +	829	RCPC	1	φ910	Masonry Headwall
3 +	224	RCPC	1	φ910	Masonry Headwall
3 +	328	RCPC	1	φ910	Masonry Headwall
3 +	478	RCPC	1	φ910	Masonry Headwall
3 +	705	RCPC	1	φ910	Masonry Headwall
4 +	163	RCPC	1	φ910	Masonry Headwall
4 +	354	RCPC	1	φ910	Masonry Headwall
4 +	531	RCPC	1	φ910	Masonry Headwall
4 +	643	RCPC	1	φ910	Masonry Headwall
4 +	817	RCPC	1	φ910	Masonry Headwall
5 +	726	RCPC	1	φ910	Masonry Headwall
5 +	882	RCPC	1	φ910	Masonry Headwall
6 +	388	RCPC	1	φ910	Masonry Headwall
6 +	774	RCPC	1	φ910	Masonry Headwall
6 +	971	RCPC	1	φ910	Masonry Headwall
7 +	228	RCPC	1	φ910	Masonry Headwall
7 +	368	RCPC	1	φ910	Masonry Headwall
7 +	553	RCPC	1	φ910	Masonry Headwall
7 +	698	RCPC	1	φ910	Masonry Headwall
7 +	890	RCPC	1	φ910	Masonry Headwall

Sub-Project 9					
Station		Structure	Nos	Size (mm)	End Type
7 +	988	RCPC	1	φ910	Masonry Headwall
8 +	338	RCPC	1	φ910	Masonry Headwall
8 +	524	RCPC	1	φ910	Masonry Headwall
8 +	644	RCPC	1	φ910	Masonry Headwall
8 +	835	RCPC	1	φ910	Masonry Headwall
9 +	958	RCPC	1	φ910	Masonry Headwall
10 +	431	RCPC	1	φ910	Masonry Headwall
10 +	537	RCPC	1	φ910	Masonry Headwall
10 +	640	RCPC	1	φ910	Masonry Headwall
11 +	982	RCPC	1	φ910	Masonry Headwall
12 +	78	RCPC	1	φ910	Masonry Headwall
12 +	365	RCPC	1	φ910	Masonry Headwall
12 +	662	RCPC	1	φ910	Masonry Headwall
13 +	103	RCPC	1	φ910	Masonry Headwall
13 +	275	RCPC	1	φ910	Masonry Headwall
13 +	581	RCPC	1	φ910	Masonry Headwall
13 +	831	RCPC	1	φ910	Masonry Headwall
14 +	1	RCPC	1	φ910	Masonry Headwall
14 +	111	RCPC	1	φ910	Masonry Headwall
14 +	807	RCPC	1	φ910	Masonry Headwall
15 +	72	RCPC	1	φ910	Masonry Headwall
15 +	422	RCPC	1	φ910	Masonry Headwall
15 +	872	RCPC	1	φ910	Masonry Headwall
16 +	395	RCPC	1	φ910	Masonry Headwall
16 +	650	RCPC	1	φ910	Masonry Headwall
Total		φ910	55		

Source: JICA Study Team

Chapter 16 Security Considerations During Detailed Design and Construction stage

16.1 General Security Conditions in the Study Area

16.1.1 Introduction

From September 2017 to March 2018, the study team collected pertinent data and information on general security conditions in the study area, through review of related published reports in both Philippines and Japan, review of security information provided by the Ministry of Foreign Affairs and Embassy of Japan in the Philippines, and security briefing from JICA authorities concerned. In the study area, Philippine staff of the study team executed field survey on security conditions of the prospective Sub-Project sites. In their field survey, they also had contact with mayor or senior municipality government officials, local Philippines National Police (PNP) officials and military officials stationed at the study area. Members of the study team have many friends and acquaintances in the study area. The study team fully utilized these personal networks and could collect update information and verify the reliability of those security related information and data. The following analysis on the security condition of the study area in this **Chapter 16** is the outcome of these survey activities of last seven months.

On May 23, 2017 in Marawi city, Lanao del Sur Province, Mindanao, the Battle of Marawi broke out between the Armed Forces of the Philippine (AFP) and the Maute group and the Islamic State (IS)-inspired militants. The fighting continued for about five months. On October 17, 2017, President Duterte declared that Marawi was "liberated from terrorist influence." Successively, on October 23, 2017, Defense Secretary Delfin Lorenzana announced that the battle finally ended. Because of the battle, the city of Marawi was extensively destroyed. UNHCR reports that about 98% of the city's 200,000 residents (2015) were displaced. Although the situation became calm and stable by March 2018 in Marawi city, the overall security situation in the study area and the rest of Mindanao is still regarded as relatively unstable.

Security related institutions believe that remnants of the Maute group are hiding in Lanao del Sur Province. The Bangsamoro Islamic Freedom Fighters (BIFF) are observed to show off their existence and claims in the province of Maguindanao. Recently, Jamaatul Mujahideen Wal Ansar (JMWA) was reported to have evolved by separating itself from BIFF. Armed clashes between the Armed Forces of the Philippines (AFP) and BIFF/JMWA have been continuing. Ansarul Khalifa Philippines (AKP) and Jemaah Islamiyah (JI), both of which were originally from Indonesia, are reportedly seen in the provinces of Sulu, Maguindanao, and Lanao del Sur. These groups are still regarded as active and expressing their intent to fight for their causes. All of them have pledged allegiance to IS.

The Abu Sayyaf Group (ASG) was organized first in the province of Sulu in 1991 as a group advocating Islamic fundamentalism. But the group has turned into a kidnap-for-ransom (KFR) group over the years. Targeting foreigners, the ASG has combined its purpose as KFR and allegiance to IS. The group has reportedly established a base in the province of Basilan. In 2017, raids by the AFP and the PNP succeeded in reducing the number and scale of ASG attacks on AFP bases and kidnapping activities.

The New Peoples' Army (NPA) is the armed group of the Communist Party of the Philippines (CPP). It has fighters in a few provinces of the Philippines. In Mindanao, its presence was seen along the boundary of the provinces of Maguindanao and Sultan Kudarat.

Gang groups of common criminals also reportedly exist mainly in the urban areas of Mindanao. They are usually composed of 5 to 10 members and act like KFRs. Their major crimes are collection of ransom through kidnapping and human and drug trafficking.

Collateral damages from a family feud (*rido*, meaning revenge and sporadic retaliation) is still happening in the ARMM area.

In addition to the above, just like any other cities and towns of the Philippines, crimes such as armed robbery and petty crimes by common criminals are frequent almost everywhere in the ARMM area and the rest of Mindanao.

A large number of refugees are living in this study area. Their existence is not the security threats and danger, but social instability and unfair treatment in the refugee communities are observed. Some security experts pointed out that such unstable social conditions and frustration among the youth may eventually provide opportunities for radical extremists to expand their influence and to recruit their new members.

In response to a request from President Duterte, on December 13, 2017, the Congress of the Philippines approved an extension of the Martial Law in Mindanao until the end of 2018.

16.1.2 Sub-Project 1

(1) General Security Conditions in the Sub-Project 1 Area

Since 1970's over the years, this area had been one of the main battle grounds between Muslim/Bangsamoro separationists groups such as Moro National Liberation Front (MNLF), Moro Islamic Liberation Front (MILF) and Bangsamoro Islamic Freedom Fighters (BIFF) on one side and the Armed Forces of the Philippines (AFP) with Philippines National Police (PNP) on the other side. During this prolonged warfare, many residents had escaped from the actual fighting zones and became internally displaced people (IDPs). Social confusion and instability took place for a long time in this area. MILF has been dominant, but BIFF had separated from MILF in 2008 and continued armed struggle against AFP and PNP in this area. Abu Sayaaf Group (ASG) is also present. Recently, remnants of the Maute group and Islamic State (IS) inspired militants are reported to be active in recruiting jobless and dissatisfied youth of this remote country side and economically very poor area.

Traditionally this area had many family feud (rido) over the years, which major cause was land disputes. After the major armed struggles were ceased after 2012, municipality and other government agencies and various non-government organizations (NGOs) have been active to solve these family feud (rido). Those efforts are materialized. Peace and social stability is regaining, although it is fragile.

(2) Local Contexts of Security Conditions in the Sub-Project 1 Area

In this Sub-Project 1 area, there are five municipalities. Their names are Matanog, Baria, Buldon, Alamada and Libungan municipalities. In these municipalities, one of the major issues has been traditional family feud *(rido)*. A Right-of-Way problem has also existed. There are MILF members in Barangay Bualan of Baria Municipality. To counter this presence and for security of surrounding areas, the 37th Infantry Division is also stationed in the municipality. In Matanog municipality, MNLF is present, and a MILF camp is near the planned road alignment. To deal with such local issues/problems, resource persons are appointed on ad hoc or regular basis in each municipality. The Iranon Inter-Agency Task Force, which is composed of representatives from the four municipalities of Matanog, Baria, Buldon, and Parang, was formulated. This Task Force has proved effective for mediation and amicable solution among stakeholders of various issues and to maintain sustainably the peace and order in this area.

Because there is presence of military forces and endeavours were carried out by concerned municipalities, this area has been relatively stable. Nevertheless, any potential danger and threat from different terrorist groups still exit.

(3) Institutional arrangements for Security in the Sub-Project 1 Area

This study reviewed on security and safety related institutional arrangements at public works project sites in the conflict affected areas of Mindanao. As an outcome of the field survey and interview of different stakeholders, the idea of the following institutional arrangement was evolved. Actually, this institutional arrangement was practiced and proved to be successful for smooth construction process and security and safety of all the personnel involved. This study recommends formulation of similar institutional arrangement for security and safety in the Sub-Project 1 area, with respect to unique culture and norms of the traditional society.

For effective utilization of this institutional arrangement, this study also strongly suggest appointment of a locally recruited project manager who are very familiar to the unique social system and sensitivity and who are well accepted by the traditional local society. As mentioned in **Sub-Section 16.1.1**, there are very many unidentified dangers and threats in each respective area, it is crucial to appoint such project manager, who has good communication skills. The person will fully mobilize the extensive personal connection and communication channels and can perform the role to complement official institutional mechanism for security and safety in local context.

Table 16.1.2-1 Local Security Framework in the Sub-Project 1

Step 1. Local Level (Sub-Project 1 Site)	<u>Local Stakeholder Meeting at Sub-Project 1 Site</u> (1) The Cotabato project office lead to hold local stakeholder meetings at Sub-Project 1 site, on a regular basis. (2) The subjects are i) updates of the security situation, ii) exchange of security related information, and iii) emergency planning (e.g. emergency exit plan) (3) Prospective members are mayors, barangay captains, PNP & military in municipalities, MILF & BDA, contractors, and the project manager of the Cotabato project office.
Step 2. In the Contractor's Camps (Sub-Project 1 Site)	<u>Tool-box or Gang Meeting at Sub-Project 1 Site</u> (1) This meeting is originally designed to discuss labor safety. However, this occasion is also appropriate to discuss about the security situation at the Sub-Project 1 site. (2) Members of this meeting are supervisor from the contractor's side and road construction workers.

16.1.3 Sub-Project 2

(1) General Security Conditions in the Sub-Project 2 Area

This area, especially planned road alignment area has been one of the strategic path routes which connect Maguindanao province and Lanao del Sur province and eventually connect to Zanboanga City. This area has been severely affected during the armed struggles between Muslim/Bangsamoro separationists groups like Moro National Liberation Front (MNLF) and Moro Islamic Liberation Front (MILF) and the Armed Forces of the Philippines (AFP) with Philippines National Police (PNP) in the past. Possible presence of Abu Sayaaf Groups (ASG) and Jemaah Islamiyah (JI) was reported under such instable security conditions. Remnants of the Maute group and Islamic State (IS) inspired militants are reported to be actively recruiting new members in this area.

Like other areas of conflict affected areas of Mindanao, this area had many family feud (rido) over the years. The main cause was usually land disputes, but quite often other social factors were involved. After the major armed struggles practically ceased between the AFP and MILF in 2012, municipality and other government agencies and various non-government organizations (NGOs) have become active to solve these family feud (rido). These efforts are steadily creating social stability in this area so that peace and order is prevailing. In general, the security condition of this area is safe and stable.

(2) Local Contexts of Security Conditions in the Sub-Project 2 Area

In this Sub-Project 2 area, there are four municipalities. Their names are Parang, Kapatagan, Matanog and Balabagan municipalities. In these municipalities, the major issue had been traditional family feud (rido). There was family feud (rido) in Kapatagan municipality on irrigation issue. This issue was practically solved by ADB irrigation project of 2010-2013, with commitment of the municipality and local PNP. MNLF is present, but MILF has been dominant in this area. Currently MILF became member institution of the Peace and Order Committee of Kapatagan municipality as well as the Ranao Ragat Inter-Agency Task Force. Proper coordination between municipality governments and MILF has been successful. This task force has been also functioning well to maintain peace and order of this area. These consorted efforts are improving the security situation in this area.

Nevertheless, infiltration and attempts of covert activities by various terrorist groups like Abu Sayaaf group, remnants of the Maute group and IS inspired militants are undeniable in this area. Constant attention to the security conditions and coordination among local authorities concerned as mentioned above are very necessary.

(3) Institutional arrangements for Security in the Sub-Project 2 Area

This study reviewed on security and safety related institutional arrangements at public works project sites in the conflict affected areas of Mindanao. As an outcome of the field survey and interview of different stakeholders, the idea of the following institutional arrangement was evolved. Actually, this institutional arrangement was practiced and proved to be successful for smooth construction process and security and safety of all the personnel involved. This study recommends formulation of similar institutional arrangement for security and safety in the Sub-Project 2 area, with respect to unique culture and norms of the traditional society.

For effective utilization of this institutional arrangement, this study also strongly suggest appointment of a locally recruited project manager who are very familiar to the unique social system and sensitivity and who are well accepted by the traditional local community. As mentioned in **Sub-Section 16.1.1**, there are very many unidentified dangers and threats in each respective area, it is crucial to appoint such project manager, who has good communication skills. The person will fully mobilize the extensive personal connection and communication channels and can perform the role to complement official institutional mechanism for security and safety in local context.

Table 16.1.3-1 Local Security Framework in the Sub-Project 2

Step 1. Local Level (Sub-Project 2 Site)	Local Stakeholder Meeting at Sub-Project 2 Site (1) The Cotabato project office lead to hold local stakeholder meetings at Sub-Project 2 site, on a regular basis. (2) The subjects are i) updates of the security situation, ii) exchange of security related information, and iii) emergency planning (e.g. emergency exit plan) (3) Prospective members are mayors, barangay captains, PNP & military in municipalities, MILF & BDA, contractors, and the project manager of the Cotabato project office.
Step 2. In the Contractor's Camps (Sub-Project 2 Site)	Tool-box or Gang Meeting at Sub-Project 2 Site (1) This meeting is originally designed to discuss labor safety. However, this occasion is also appropriate to discuss about the security situation at the Sub-Project 2 site. (2) Members of this meeting are supervisor from the contractor's side and road construction workers.

16.1.4 Sub-Project 6

(1) General Security Conditions in the Sub-Project 6 Area

The location of this area is along the Moro Gulf coast and except some few populated area, most of this area did not have easy access to existing major national roads, commercial and residential areas of Maguindanao Province. Due to this geographical location and limited source of income for people who reside, this area has practically remained as a remote and isolated area. Over the years of different political and military conflicts in Mindanao, there have been no record of major incidents in this area, from security point of view. There has been also no report on the presence and activities of any major terrorist group, too. Although both MILF and MNLF are present, both are now committed for peace and order in this area. The Philippine Marines are stationed for the security of some urban area of Datu Blah Sinsuat Municipality. One of the purposes of the Marines is also regarded as preventive measure against potential entry of any terrorist and/or armed group to the urban area of Awan Airport and Cotabato City.

Because this area has remained as Muslim religion dominated traditional societies for a long time, there have been family feud (rido). This has been the major issue/problem in these municipalities in the past. Currently, municipality governments and local police are working jointly for amicable solution of these land related conflicts. There are communities of Indigenous People (IPs) in this area, but these communities are not regarded as subjects of the security issues and problems.

(2) Local Contexts of Security Conditions in the Sub-Project 6 Area

In this Sub-Project 6 area, there are two municipalities. Their names are Datu Blah Sinsuat and Lebak municipalities. Because these municipalities have been economically poor and socially traditional societies, there have been many family feud (rido) in the past. However, continuous efforts by municipality governments and local police have been successful for amicable solutions of these issues/problems. Both MILF and MNLF are present, but these organizations have been cooperative for security matters now. The stationing of the Philippines Marines is significantly contributing to the peace and order of this area, too.

(3) Institutional arrangements for Security in the Sub-Project 6 Area

This study reviewed on security and safety related institutional arrangements at public works project sites in the conflict affected areas of Mindanao. As an outcome of the field survey and interviews of different stakeholders, the idea of the following institutional arrangement was evolved. Actually, this institutional arrangement was practiced and proved to be successful for smooth construction process and security and safety of all the personnel involved. This study recommends formulation of similar institutional arrangement for attainment of security and safety in the Sub-Project 6 area, with respect to unique culture and norms of the traditional societies.

For effective utilization of this institutional arrangement, this study also strongly suggest appointment of a locally recruited project manager who are very familiar to the unique social system and sensitivity and who are well accepted by the traditional local community. As mentioned in **Sub-Section 16.1.1**, there are very many unidentified dangers and threats in each respective area, it is crucial to appoint such project manager, who has good communication skills. The person will fully mobilize the extensive personal connection and communication channels and can perform the role to complement official institutional mechanism for security and safety in local context.

Table 16.1.4-1 Local Security Framework in the Sub-Project 6

Step 1. Local Level (Sub-Project 6 Site)	Local Stakeholder Meeting at Sub-Project 6 Site (1) The Cotabato project office lead to hold local stakeholder meetings at Sub-Project 6 site, on a regular basis. (2) The subjects are i) updates of the security situation, ii) exchange of security related information, and iii) emergency planning (e.g. emergency exit plan) (3) Prospective members are mayors, barangay captains, PNP & military in municipalities, MILF & BDA, contractors, and the project manager of the Cotabato project office.
Step 2. In the Contractor's Camps (Sub-Project 6 Site)	Tool-box or Gang Meeting at Sub-Project 6 Site (1) This meeting is originally designed to discuss labor safety. However, this occasion is also appropriate to discuss about the security situation at the Sub-Project 6 site. (2) Members of this meeting are supervisor from the contractor's side and road construction workers.

16.1.5 Sub-Project 7

(1) General Security Conditions in the Sub-Project 7 Area

After the temporary takeover of Marawi City by the Maute Group and the Islamic State (IS) inspired militants in May 2017 and the final military victory of the Armed Forces of the Philippines (AFP) with Philippine National Police (PNP) over these terrorist groups in October 2017, the presence of the military forces and PNP in this area has been overwhelming. Moro Islamic Liberation Front (MILF), the major Bangsamoro political and military organization, has been also cooperative to the Government of the Philippines on the overall security issues. The general security condition in Marawi City and its periphery municipalities are regarded as safe and peaceful.

However, existence of large number of unexploded ordnances (UXOs) and improvised explosive devices (IEDs) are confirmed in the city and periphery municipalities. These UXOs and IEDs are immediate danger and threats to the people and for the recovery/reconstruction of the city. The disposal of these UXOs and IEDs is one of the most urgent security and safety related issue.

In addition, both AFP and MILF warned that the remnants of the Maute group and IS inspired militants are still actively recruiting new members. According these intelligence reports, they are again planning to set up a new base in this or nearby area with aim of establishment of “Islamic caliphate”. The immediate danger and threats against the safety and security of this area remains very strong.

(2) Local Contexts of Security Conditions in the Sub-Project 7 Area

As mentioned above existence of unexploded ordnances (UXOs) and improvised explosive devices (IEDs) are immediate danger and threats for the safety of the people and the recovery/reconstruction of the city. It is very difficult to start recovery and reconstruction projects/program without clearance of them, so that this is one of the top priority issues for the people and city. The military force has the specialized skill, know-how and specialist personnel to deal with this issue. The city and other authorities concerned need to coordinate with the military force to expedite this UXO and IEDs disposal activities.

Majority of former residents of Marawi city cannot return to their homes or need new shelters after destruction of the down town area. These people are certainly not security threats and dangers. But if this temporary displacement of many residents continues, there is possibility to create any social instability and disruption of law and order in the city. Consorted endeavours by the national and local authorities concerned are necessary to regain sustainable peace and order in the city.

(3) Institutional arrangements for Security in the Sub-Project 7 Area

This study reviewed on security and safety related institutional arrangements at public works project sites in the conflict affected areas of Mindanao. As an outcome of the field survey and interviews of different stakeholders, the idea of the following institutional arrangement was evolved. Actually, this institutional arrangement was practiced and proved to be successful for smooth construction process and security and safety of all the personnel involved. This study recommends formulation of similar institutional arrangement for attainment of security and safety in the Sub-Project 7 area, with respect to unique culture and norms of the traditional societies.

For effective utilization of this institutional arrangement, this study also strongly suggest appointment of a locally recruited project manager who are very familiar to the unique social system and sensitivity and who are well accepted by the traditional local community. As mentioned in **Sub-Section 16.1.1**, there are very many unidentified dangers and threats in each respective area, it is crucial to appoint such project manager, who has good communication skills. The person will fully mobilize the extensive personal connection and communication channels and can perform the role to complement official institutional mechanism for security and safety in local context.

Table 16.1.5-1 Local Security Framework in the Sub-Project 7

Step 1. Local Level (Sub-Project 7 Site)	Local Stakeholder Meeting at Sub-Project 7 Site (1) The Cotabato project office lead to hold local stakeholder meetings at Sub-Project 7 site, on a regular basis. (2) The subjects are i) updates of the security situation, ii) exchange of security related information, and iii) emergency planning (e.g. emergency exit plan) (3) Prospective members are mayors, barangay captains, PNP & military in municipalities, MILF & BDA, contractors, and the project manager of the Cotabato project office.
Step 2. In the Contractor's Camps (Sub-Project 7 Site)	Tool-box or Gang Meeting at Sub-Project 7 Site (1) This meeting is originally designed to discuss labor safety. However, this occasion is also appropriate to discuss about the security situation at the Sub-Project 7 site. (2) Members of this meeting are supervisor from the contractor's side and road construction workers.

16.1.6 Sub-Project 8

(1) General Security Conditions in the Sub-Project 8 Area

This Sub-Project 8 area is connected to Sub-Project 2 area. This area is strategic path routes which connect Maguindanao province and Lanao del Sur province and eventually connect to Zanboanga City. After the major battles practically ceased between Armed Forces of the Philippines (AFP) and Moro Islamic Liberation Front (MILF) in 2012, volume and frequency of both human traffic and distribution of goods have rapidly increased. This route is used not only for businesses activities and security related operations by the AFP and Philippines National Police (PNP), but also used by terrorist groups such as Abu Sayaaf Group, Bangsamoro Islamic Freedom Fighters (BIFF), and the remnants of the Maute group and the IS inspired militants for pursuit of their own political purposes. Both MNLF and MILF are present, but there have been no reports of major armed crashes or security related incidents. Nevertheless, the strategic value of this area is enhancing more than ever.

In this area, there were family feud (rido) over the years, which original causes were usually land disputes. After 2012, the municipality government and local PNP have succeeded to achieve amicable solutions on this issue in this area. These efforts brought social stability and economic prosperity. In general, the security condition of this area is safe and stable.

(2) Local Contexts of Security Conditions in the Sub-Project 8 Area

In this Sub-Project 8 area, there is only one municipality, which name is Parang municipality. There were traditional family feud (rido) in the past, but they were already solved. Both MNLF and MILF are present, but MILF has been dominant in this municipality. But both institutions have been cooperative and supportive for the peace and security of the municipality. There is no major security related issue at present, and peace and security are maintained in this municipality.

However, because the strategic importance of this area is high, attempts to create social disturbance and instability by various terrorist groups are reported as active. The municipality, AFP and PNP are jointly carrying out constant monitoring and assessment on the security situation of this area.

(3) Institutional arrangements for Security in the Sub-Project 8 Area

This study reviewed on security and safety related institutional arrangements at public works project sites in the conflict affected areas of Mindanao. As an outcome of the field survey and interviews of different stakeholders, the idea of the following institutional arrangement was evolved. Actually, this institutional arrangement was practiced and proved to be successful for smooth construction process and security and safety of all the personnel involved. This study recommends formulation of similar institutional arrangement for attainment of security and safety in the Sub-Project 8 area, with respect to unique culture and norms of the traditional societies.

For effective utilization of this institutional arrangement, this study also strongly suggest appointment of a locally recruited project manager who are very familiar to the unique social system and sensitivity and who are well accepted by the traditional local community. As mentioned in **Sub-Section 16.1.1**, there are very many unidentified dangers and threats in each respective area, it is crucial to appoint such project manager, who has good communication skills. The person will fully mobilize the extensive personal connection and communication channels and can perform the role to complement official institutional mechanism for security and safety in local context.

Table 16.1.6-1 Local Security Framework in the Sub-Project 8

Step 1. Local Level (Sub-Project 8 Site)	<u>Local Stakeholder Meeting at Sub-Project 8 Site</u> (1) The Cotabato project office lead to hold local stakeholder meetings at Sub-Project 8 site, on a regular basis. (2) The subjects are i) updates of the security situation, ii) exchange of security related information, and iii) emergency planning (e.g. emergency exit plan) (3) Prospective members are mayors, barangay captains, PNP & military in municipalities, MILF & BDA, contractors, and the project manager of the Cotabato project office.
Step 2. In the Contractor's Camps (Sub-Project 8 Site)	<u>Tool-box or Gang Meeting at Sub-Project 8 Site</u> (1) This meeting is originally designed to discuss labor safety. However, this occasion is also appropriate to discuss about the security situation at the Sub-Project 8 site. (2) Members of this meeting are supervisor from the contractor's side and road construction workers.

16.1.7 Sub-Project 9

(1) General Security Conditions in the Sub-Project 9 Area

This Sub-Project 9 area was a part of vast battle grounds where the Armed Forces of the Philippines (AFP), Moro National Liberation Front (MNLF) and Moro Islamic Liberation Front (MILF) have fought for 40 years since 1970s. During these prolonged battles, many residents had escaped from the actual fighting zones and became internally displaced people (IDPs). Social confusion and instability took place for a long time in this area. Both MNLF and MILF are present, but MILF has been dominant. Bangsamoro Islamic Freedom Fighters (BIFF) has been continuing armed struggle against AFP and PNP in this area. Presence of Abu Sayaaf Group was also reported. Recently, both MILF and AFP warned that the remnants of the Maute group and Islamic State (IS) inspired militants are active in recruiting new members in this area. There have been no report of major armed crashes and incidents, but the security situation remained unstable and insecure.

In this area, there were also family feud (rido) but the municipality governments and local PNP have succeeded to achieve amicable solutions on this issue. These efforts eventually brought some social stability and security in this area.

(2) Local Contexts of Security Conditions in the Sub-Project 9 Area

In this Sub-Project 9 area, there are four municipalities. Their names are Parang, Sultan Kudarat, Sultan Mastura and Pigcawayan municipalities. In the Sultan Kudarat municipality, there was a notable traditional family feud (rido) in the past, but it was already solved. The head quarter of MILF, Camp Darapanan is also located in Sultan Kudarat municipality and MILF has dominantly maintained security and safety in this area through their own terms. The relationship between MILF and the Government of the Philippines (GPH) has been good so far, so that there is no major security related issue at present in these municipalities.

Because there is a long history of fighting among different political and armed groups, many Internally Displaced People (IDP) are living in this area. General security situation is not completely safe and stable in these municipalities, due to such historical background and existence of many IDPs. The municipality governments, AFP, PNP and MILF need to cooperate each other and to carry out constant monitoring and assessment on the security situation of this area.

(3) Institutional arrangements for Security in the Sub-Project 9 Area

This study reviewed on security and safety related institutional arrangements at public works project sites in the conflict affected areas of Mindanao. As an outcome of the field survey and interviews of different stakeholders, the idea of the following institutional arrangement was evolved. Actually, this institutional arrangement was practiced and proved to be successful for smooth construction process and security and safety of all the personnel involved. This study recommends formulation of similar institutional arrangement for attainment of security and safety in the Sub-Project 9 area, with respect to unique culture and norms of the traditional societies.

For effective utilization of this institutional arrangement, this Study also strongly suggest appointment of a locally recruited project manager who are very familiar to the unique social system and sensitivity and who are well accepted by the traditional local community. As mentioned in **Sub-Section 16.1.1**, there are very many unidentified dangers and threats in each prospective area, it is crucial to appoint such project manager, who has good communication skills. The person will fully mobilize the extensive personal connection and communication channels and can perform the role to complement official institutional mechanism for security and safety in local context.

Table 16.1.7-1 Local Security Framework in the Sub-Project 9

Step 1. Local Level (Sub-Project 9 Site)	Local Stakeholder Meeting at Sub-Project 9 Site (1) The Cotabato project office lead to hold local stakeholder meetings at Sub-Project 9 site, on a regular basis. (2) The subjects are i) updates of the security situation, ii) exchange of security related information, and iii) emergency planning (e.g. emergency exit plan) (3) Prospective members are mayors, barangay captains, PNP & military in municipalities, MILF & BDA, contractors, and the project manager of the Cotabato project office.
Step 2. In the Contractor's Camps (Sub-Project 9 Site)	Tool-box or Gang Meeting at Sub-Project 9 Site (1) This meeting is originally designed to discuss labor safety. However, this occasion is also appropriate to discuss about the security situation at the Sub-Project 9 site. (2) Members of this meeting are supervisor from the contractor's side and road construction workers.

16.2 Fundamental Principles

The following are the fundamental principles for security and safety measures in this Project.

- First, "Safety is everyone's responsibility." Everyone is expected to perform their tasks with safety as their own primary concern. Awareness and constant attention are essential.
- Second, the most important part of safety operations is to establish and practice preventive measures.
- Third, the basic rules in action are "keep a low profile," "being unpredictable," and "stay alert."
- Fourth, detail in logistical arrangements for security and safety makes a lifesaving difference.

16.3 Code of Conduct for Project Consultants and Contractor

This study reviewed security and safety related policies and guidelines published by the Ministry of Foreign Affairs (MOFA) of Japan and the Japan International Cooperation Agency (JICA). This study also examined relevant documents, incident reports, and current and past practices. Then, this study has concluded that the following code of conduct is most appropriate for consultants (including both Japanese and Philippine consultants and staff), contractors, and other stakeholders in this Project.

In principle, the Japanese and Philippine consultants, Philippine project staff and contractors shall follow the instructions from the DPWH national office on safety policies and practice appropriate measures. Regarding the Japanese consultants, if the security situation in the project sites worsens, they will daily report on their safety to JICA Philippines Office.

The following is the specific code of conduct for the Japanese and Philippine consultants and project staff. Contractors are also requested to adhere to the provisions of the code whenever necessary and appropriate.

- First, for the Japanese consultants, the mobilization to the project sites is to be done only upon clearance from JICA, the Embassy of Japan, GPH-CCCH and MILF-CCCH. (Philippine staff members can visit project sites only upon clearance from GPH-CCH and MILF-CCCH).
- Second, the Japanese consultants must be accompanied by security escorts and Philippine staff members who are familiar with local conditions, and other security officials if their accompaniment is required or recommended by police or any local security organizations. (Philippine consultants and staff members do not need to be accompanied by security escorts.)
- Third, the whole travel time from hotel to the project sites, work at the project sites and the return to hotel is specifically from 07:00 to 17:00 of a day. In case of visit to sub project 7, because the site is in Marawi city, Lanao del Sur province, the departure place/hotel is in Iligan city.
- Fourth, during a stay in the major cities in Mindanao, a curfew is in effect by the Martial Law which has been extended until December 31, 2018. In May 2018, the curfew varies in each major city. Cotabato City/10:30p.m. to 3:30a.m with no ID no entry measure, Cagayan de Oro City/only for minors (less than 18 years old) 10pm to 5am, Davao city/only minors (less than 18 years old) 10pm to 5am, Marawi City/8pm to 5pm, Iligan City/11pm to 5pm.
- Fifth, visits to any area with a perceived potential target of terrorism must be minimized. (Potential targets include security-related institutions such as the police, the military, bus stops and terminals, religious facilities and their event halls, and U.S. and European organizations.)
- Sixth, facilities in beach areas (e.g., restaurants, hotels, sea transport facilities), demonstrations and mass meetings must be avoided.
- Seventh, commuting time and the routes, and the use of the facilities for various purposes should be changed as frequently as possible.
- Eighth, each service period of a Japanese consultant in the conflict-affected areas must be kept to a minimum. The appropriate period is one month or 30 days at most.
- Ninth, Philippine consultants and staff members who are dispatched to project sites shall report daily (before 17:00) about their safety condition and the site security situation to the Safety Management Team (SMT) of the Project by phone, e-mail or otherwise.
- Tenth, for all the Japanese and Philippine consultants and Philippine staff must inform the safe completion of the field survey and other activities in the field to the JICA Philippines Office, GPH-CCCH and MILF-CCCH using the prepared form.
- Eleventh, for other guidance and recommendations, observe the articles in the “Manual of Antiterrorism Measures” (in Japanese) and pertinent content specified in Travel Security Advisory.

16.4 Measures Against Terrorism

16.4.1 Basic Principles

- <u>Against bombs and indiscriminate shootings</u>, avoid areas with high risks. Minimize the time of stay in those areas. Remember the three basic rules in action, such as “keep a low profile”, “being unpredictable” and “stay alert”.
- <u>Against individually targeted attacks</u>, avoid following routines in daily life, and do not show an unguarded moment to any outsiders.

16.4.2 Preventive Measures & Response to Bombs and Indiscriminate Shootings

- As preventive measures, keep collecting terrorism-related information. As stated above, avoid visiting places where many and unspecified people gather for any purpose.
- Be sensitive and catch any unusual atmosphere at any place.
- Pay extra attention to any unknown person and places.
- As response to a bomb explosion, get down onto the ground, protect your head and ears with bags and cloths, leave an area where there are scattered glass fragments, and escape from the bomb explosion site. There may be a second explosion nearby.
- As response to an indiscriminate shooting, get down onto the ground, escape from the firing sounds of guns, and hide under a cover nearby.
- If there is no way to escape, calm down, and seek any ways and means to save your own life.

16.4.3 Preventive Measures and Response to an Individually Targeted Attack

- As preventive measures, always have time to spare so that you can respond to a crisis situation. In addition, it is recommended to avoid following routines in daily activities.
- Check your environment in daily life regularly. Pay attention to any car that has been parked for more than 10 minutes and a person idling around the gate of an office or residence. Check if any person or car is trailing you.
- Practice to use an alternative route (e.g., enter from the front entrance and leave from a back door).
- As an expression of vigilance, take pictures of any trailing person.
- Do not show any unguarded moment outdoors by engaging in such activities as lengthy use of the mobile phone, a loud conversation with friends, and any absent-minded behaviour.
- As response to an individually targeted attack, in case of an attack on the road, move immediately to the main road, and call general attention by shouting about the danger. Moreover, run the road in a zigzag manner to avoid accurate gun aim.
- In case of an attack inside a building, avoid the front entrance and the emergency exit, run with a low position, and find an escape route through a porch, gallery, or toilet window.
- If a passing car is attacked, it is important NOT to stop your own car. Drive ahead even if a red light is on at the intersection of the road.

16.5 Emergency Response System

16.5.1 Emergency Response Process

- The Cotabato project office of the project consultants must report immediately any emergency or untoward incident to the project Safety Management Team (SMT), which is organized and designed to deal with any emergency matters in the project. Then the SMT staff will relay the message to the Team Leader of the study team, to seek guidance on the immediate course of action. Depending on the nature of the incident, the SMT shall seek assistance from the Joint GPH & MILF- CCCH, the police, military, LGU, and/or a hospital.
- The SMT shall also relay the emergency matter immediately to both the Philippine and Japanese authorities concerned (DPWH national office, JICA Philippines Office, JICA Cotabato project office ((CCDP Office)), and JICA headquarters in Tokyo) through the Team Leader. Likewise, the same emergency information shall be relayed by the Team Leader to the Tokyo Main Office of the project consultant company, which shall share the same information with the Tokyo Main Offices of other partner consultant companies.

- In dealing with the situation at hand, the SMT must give the highest priority to the safety of the Japanese and Philippine consultants, Philippine staff and contractors.
- The SMT shall maintain official communications with both the Philippine and Japanese authorities, including telephone and e-mail, and monitor the incident continuously.
- If necessary, when conditions are regarded as worsening after consultations with the Philippine and Japanese authorities concerned, the activities on site shall be suspended immediately.
- The SMT shall continue security monitoring in cooperation with Philippine authorities and, if necessary, the JICA Cotabato project office (CCDP Office), and submit situation reports constantly to JICA Philippines Office.
- Based on the situation, the SMT shall seek further advice from JICA Philippines Office on safety and possible evacuation of Japanese and Philippine consultants, Philippine staff and contractors.

16.5.2 Flow Chart of the Emergency Response System (ERS)

With regard to the emergency response system, the following chart identifies the concerned organizations in charge and their basic communication channels.

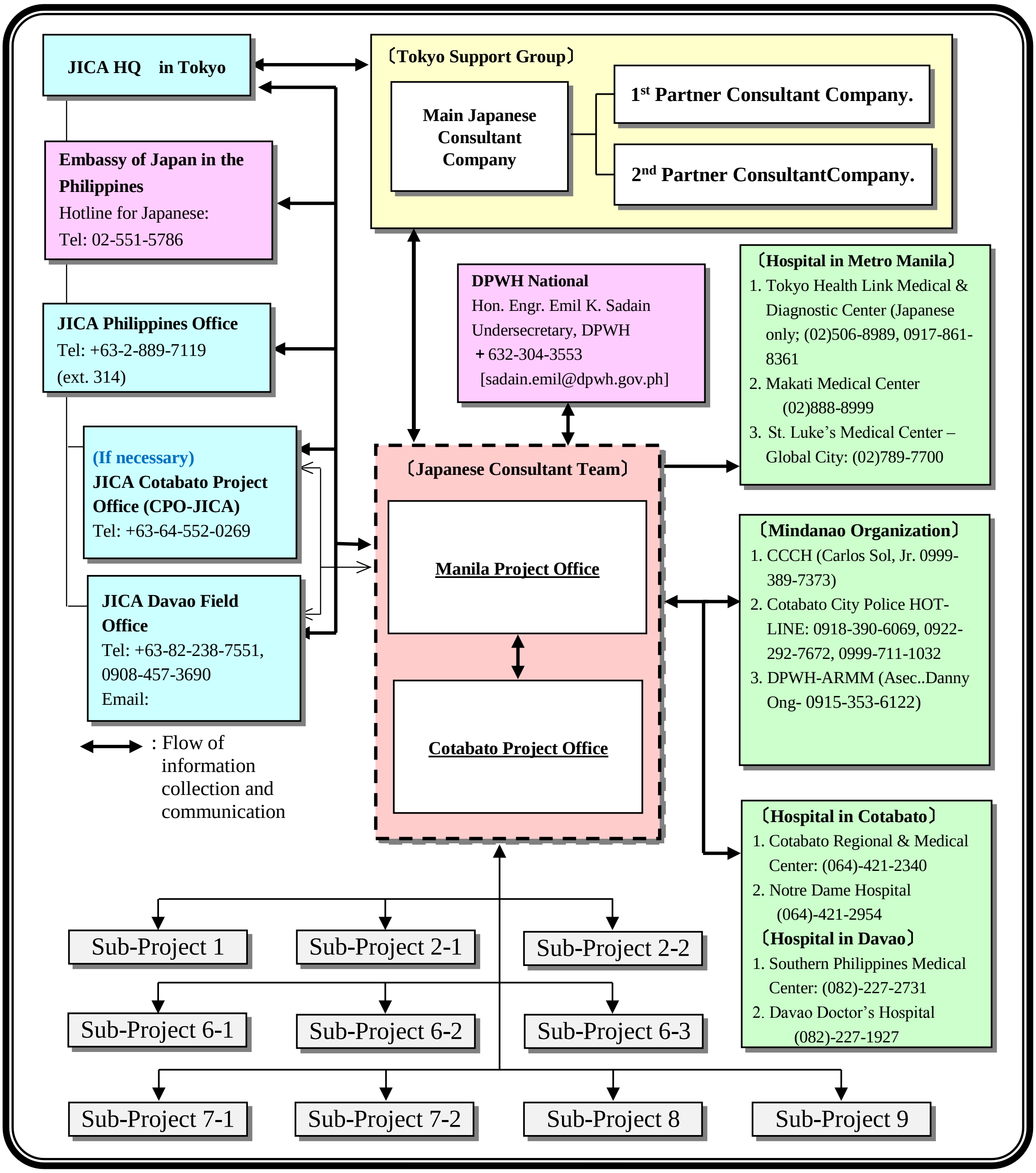


Figure 16.5.2-1 The Emergency Response System of RDNP-CAAM

16.6 General Security Framework

Because the Sub-Projects are in the conflict affected areas of Mindanao, it is necessary to formulate and operate a general security framework during the entire construction period in the RNDP-CAAM. The table below shows the basic concept of the general security framework of the RNDP-CAAM. The Japanese and Philippine consultants are expected to lead the formulation and installation of the general security framework in cooperation with both national and regional government institutions concerned.

Table 16.6.1-1 General Security Framework

Step 1. National Department Level	Signing of MOU among National Departments concerned (1) Signing of Memorandum of Understanding (MOU), among National Departments concerned, for interdepartmental cooperation and coordination on security of the project. (2) Prospective signers are DPWH national, PNP national, Department of National Defense (DND), DILG-national, and Office of Presidential Adviser for Peace Process (OPAPP).
Step 2. Regional Level	Regional High-Level Dissemination Conference & MOU (1) With an initiative of the ARMM government, a regional high-level dissemination conference should be held to attain commitment for the safety and security among major stakeholders. (2) Participants are provincial governors, PNP regional command, military representative, mayors in the Sub-Project areas, MILF & BDA, and International Monitoring Team (IMT). (3) Signing of Memorandum of Understanding (MOU), among these regional stakeholders to confirm their commitment.
Step 3. Local Level (at each Sub-Project Site)	Local Stakeholder Meeting at each Sub-Project Site (1) With the MOUs mentioned above, the Cotabato project office lead to hold local stakeholder meetings at Sub-Project sites, on a regular basis. (2) The subjects are i) updates of the security situation, ii) exchange of security related information, and iii) emergency planning (e.g. emergency exit plan) (3) Prospective members are mayors, barangay captains, PNP & military in municipalities, MILF & BDA, contractors, and the project manager of the Cotabato project office.
Step 4. In the Contractor's Camps (at each Sub-Project Site)	Tool-box or Gang Meeting at each Sub-Project Site (1) This meeting is originally designed to discuss labor safety. However, this occasion is also appropriate to discuss about the security situation at the Sub-Project site. (2) Members of this meeting are supervisor from the contractor's side and road construction workers.

16.7 Construction Safety Measures

In September 2014, JICA published "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects." JICA requests that all stakeholders who undertake Japanese ODA projects, particularly those who participate in yen loan projects, fully use this guidance to prevent and reduce accidents and possible damages from natural calamities. Please download and review this guidance for preparing the Safety Plan and Method Statement on Safety below.

16.7.1 Principles for safety management in construction sites

The following are the eight principles for safety management in construction sites.

- First, all the project stakeholders shall put top priority on safety and prevent possible accidents.
- Second, contractors shall identify potential danger and then eliminate the cause of danger.
- Third, contractors shall calculate in advance the inherent risk of accidents and commence work once preventive measures are applied.
- Fourth, all the project stakeholders shall comply with relevant laws and regulations.

- Fifth, all the project stakeholders shall consider the possible collateral damage to a third party and shall prepare preventive measures against such occurrence.
- Sixth, in the whole implementation process of safety management, the methodology of PDCA (Plan→Do→Check→Action) is recommended to practice.
- Seventh, all the project stakeholders shall share all safety-related information in a manner and at times as appropriate in the circumstances.
- Eighth, all the project stakeholders shall actively participate in safety management related programs and activities at construction sites.

16.7.2 Safety Plan and Method Statement on Safety: Roles and Timing

Each contractor shall prepare the Safety Plan at the pre-construction stage. This is the basic plan for safety management in Japanese ODA construction works at site and establishes guidelines on the general safety management and operation for the entire works at site.

The contractor shall submit the plan to the DPWH national office and the Japanese consultant by the time specified in the contract documents. If no submission deadline is specified, then the contractor shall submit the plan no later than seven (7) days prior to the commencement of the relevant works.

The contractor shall prepare a Method Statement on Safety at the construction stage. This Method Statement on Safety shall define a detailed plan to implement and manage safety in Japanese ODA projects and shall include specifics for the safe execution of works, and safety measures for each type of work in accordance with the execution plans specifying the method or sequence for implementation.

The contractor shall submit the Method Statement on Safety to the DPWH national office and the Japanese consultant prior to commencement of the relevant works according to the execution plans or their equivalent documents. If the submission date of the Method Statements on Safety is specified in the contract or other applicable documents, then this deadline shall be followed.

16.7.3 Preparation of the Safety Plan at Construction Sites

Each contractor shall include the following subjects in the Safety Plan at construction sites. In addition, the contractor shall specify in the Safety Plan any subjects and items that arise with respect to the scope of work and the conditions for construction.

- Application of the eight (8) principles as mentioned above, at construction sites
- Formulation of internal organizational structure for safety at construction sites
- Promotion of the PDCA cycle on safety measures at construction sites
  (Repetition of the “Plan→Do→Check→Act” process)
- Monitoring of compliance with the principles for safety management at construction sites
- Planning and execution of safety education and training at construction sites
- Planning and execution of voluntary safety management activities at construction sites
- Sharing information among stakeholders and with the public on safety at the construction sites
- Development of emergency response procedures (evacuation plan) at construction sites

16.7.4 Contents of the Method Statement on Safety

Each contractor shall formulate a Method Statement on Safety for each type of work based on the design or documents to undertake work accurately and efficiently, to maintain a safe working environment, and to prevent any unsafe action by workers. The contractor shall incorporate the following items in any Method Statements on Safety Construction plant and machinery

- Equipment and tools
- Materials
- Necessary qualifications and licenses
- The order of command for the works
- Work items
- Procedure for the execution of the works

In addition, the contractor shall specify the following for the execution of major work operations for each type of work.

- Foreseeable risks
- Precautionary measures

16.7.5 Requirements of the Government of the Philippines

In addition, for preparation of the construction safety measures in construction works in the Philippines, there are two important official documents. Contractors are required to comply with the requirements specified in these two government documents. They are as follows:

(1) The Department of Labour and Employment D.O. No. 13 (DOLE D.O. No. 13), Series of 1998 otherwise known as the "Guidelines Governing Occupational Safety and Health in the Construction Industry"

(2) The Department of Public Works and Highways D.O. No. 56, Series of 2005.

16.8 Security Cost for the Project

This study carried out cost estimate survey on the security facilities, equipment and personnel services through construction site visits, interviews with major contractors in and around the conflict affected areas and store survey on merchandise, the technical specification and price quotations. This study found out the following characteristics on the security costs in the construction works in the Conflict Affected Areas in Mindanao (CAAM).

- In general, the security costs tend to be comparatively high and there is limited availability of the security related equipment and tools.
- Necessary date and information on security facilities, equipment and personnel services are very limited. In some case on merchandise and services, this survey had to produce the output from consensus and experience among the contractors.
- The contractors indicated from their experience in this CAAM that they had to bear various kinds of indirect costs to carry out construction works safely and efficiently, respecting tradition and common practice succeeded from the past.

16.8.1 Sub-Project 1

(1) Total Security Costs for Sub-Project 1

(Unit: PhP)

Sub-Project 1	Contractors	Consultants	Security Costs of each contract package	Total Security Costs for Sub-Project 1
Contract Package: 1	20,519,400	8,426,600	28,946,000	32,419,520
VAT:12%	2,462,328	1,011,192	3,473,520	
Sub-Total	22,981,728	9,437,792	32,419,520	

(2) For Contractors

1) Security Guard

Sub-Project No. 1	Road Length (km)	Construction Period (Month)	Monthly Payment: (30 days, PhP)	Total Costs of the whole construction Period (PhP)
Contract Package 1	13.9	32	540,000	17,280,000
Remarks	1. Facilities are 5 locations (main camp, sub camp, quarry, road site, project office) 2. Sand and gravel are delivered on call. There is no need for security guards. 3. Some contractors are willing to hire local community people for security reasons.			

Facility	Unit Price/ per day (PhP)	No. of Guards	No. of Shifts per day (PhP)	Monthly (30 days) Payment (PhP)
Main camp (200×200m)	400	3	3	108,000
Sub camp (200×150m)	400	3	3	108,000
Quarry	400	3	3	108,000
Road site	400	3	3	108,000
Project Office	400	3	3	108,000
Sand pit	(not applicable)			
Total				540,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Guards	Total Costs of the whole construction Period (PhP)
5 sites (main camp, sub camp, quarry, road site, project office)	「Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	8 (5 sites + reserves)	56,000
For long distance communication among main camp, sub camp, & road sites)	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	2 (3 sites + reserves)	22,000
Total				48,500
Remarks	Same as above (1) 2. No security guard means no handy Talky.			

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost	No. of Sets	Total Cost (PhP)
Main camp (200×200m) [Sept up at 20m]	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	40	252,000
Remarks	According survey, contractors do not set up this system in sub-camps				

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Main camp (200×200m)	High Definition CCTV Camera System with night vision & recording capability	400,000	100,000	500,000
Remarks	According survey, contractors do not set up this camera system in sub-camps.			

5) Internal security warning system within camps

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit (PhP)
Main camp (200×200m)	[Siren]	(5,000/unit)×2	(1,200/unit)×2	12,400
Sub camp (200×150m)	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000
Total Cost of Siren and Ringing Bell at each Sub-Project				17,400

6) Fencing of the Perimeters of the contractor's camps by Concrete Hollow Blocks: CHB

Facility with size	Item & technical specification	Unit Price (PhP)	Volume of the Blocks	Labour Cost (PhP)	Total Cost for each camp (PhP)
Main camp (800m: 200×200m)	[CHB] 6×8×16in. 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,200,000
Sub camp (700m: 200×150m)	[CHB] 6×8×16in 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,050,000
Total costs					2,250,000

7) Fencing of the Perimeters of quarry by barbed wire with poles

Facility with size	Technical Specification of Barbed Wire & Poles	Unit Price (PhP)	Volume of the Wire & poles	Labour Cost for Set Up (PhP)	Total Cost for each facility (PhP)
Quarry (700m: 200×150m)	Wire: 30kg, 4layers, (Length 130m/roll)	2,000/roll	22 rolls	40,000 (10 labourers ×10 days×400)	132,000
	Pole: 4×4in. 8ft.	200	240		
Remarks	According to survey, contractors do not set up fencing at the perimeters of sand pit and road construction sites				

8) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum) (PhP)	No. of locations	Total Cost (PhP)
Main camp and Sub camp	For emergency treatment of external wounds and sudden illness. (First Aid training is required for the person in charge about use of this kit)	5,000	2	10,000

9) Total Security Costs of Contractors for Sub-Project 1: <u>PhP 20,519,400</u>

(3) For Consultants

1) Security Guard

Assignments	Unit Price/ per day (PhP)	No. of Guards	Shifts per day	No. of Party	Monthly (30 days) Payment (PhP)	Security Service Months	Security Guard Cost (PhP)
(1) Cotabato Project Office (60×60m)	600	3	2	1	108,000	48 (16+32)	5,184,000
(2) Detail Design (3) ROW Acquisition & RAP (4) Procurement of Contractor	600	1	1	3	54,000	16	864,000
(5) Construction Supervision	600	1	1	3	54,000	32	1,728,000
(6) Defect & Liability	600	1	1	1	18,000.	1	18,000
Total							7,794,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Security Guards & Parties	Total Costs of the whole construction Period (PhP)
Cotabato Project Office	Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	2 (guards & Reserves)	14,000
For long distance communication between Cotabato Project Office & 3 mobile parties	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	3 (Cotabato Project Office + 3 parties & reserves)	33,000
For Emergency Communication	Satellite Phone [Procurement in japan]	100,000	1	100,000
Total				147,000

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Cotabato Project Office	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	12 [Set up at each 20m]	75,600

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Cotabato Project Office	High Definition CCTV Camera System with night vision & recording capability	300,000	100,000	400,000

5) Internal security warning system within the project office

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit
Cotabato Project Office	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000

6) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Cotabato Project Office	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	1	5,000

7) Total Security Costs of Consultants for Sub-Project 1: PhP 8,426,600

16.8.2 Sub-Project 2

(1) Total Security Costs for Sub-Project 2

(Unit: PhP)

Sub-Project 2	Contractors	Consultants	Security Costs of each contract package	Total Security Costs for Sub-Project 2
Contract Package: 1	22,139,400	9,722,600	31,862,000	71,370,880
VAT:12%	2,656,728	1,166,712	3,823,440	
Contract Package: 2	22,139,400	9,722,600	31,862,000	
VAT:12%	2,656,728	1,166,712	3,823,440	
Sub-Total	49,592,256	21,778,624	71,370,880	

(2) For Contractors

1) Security Guard

Sub-Project 2	Road Length (km)	Construction Period (Month)	Monthly Payment: (30 days, PhP)	Total Costs of the whole construction Period (PhP)
Contract Package 1/2	17.0 / 17.0	35	540,000	18,900,000
Remarks	1. Facilities are 5 locations (main camp, sub camp, quarry, road site, project office) 2. Sand and gravel are delivered on call. There is no need for security guards. 3. Some contractors are willing to hire local community people for security reasons.			

Facility	Unit Price/ per day (PhP)	No. of Guards	No. of Shifts per day (PhP)	Monthly (30 days) Payment (PhP)
Main camp (200×200m)	400	3	3	108,000
Sub camp (200×150m)	400	3	3	108,000
Quarry	400	3	3	108,000
Road site	400	3	3	108,000
Project Office	400	3	3	108,000
Sand pit	(not applicable)			
Total				540,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Guards	Total Costs of the whole construction Period (PhP)
5 sites (main camp, sub camp, quarry, road site, project office)	「Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	8 (5 sites + reserves)	56,000
For long distance communication among main camp, sub camp, & road sites	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	2 (3 sites + reserves)	22,000
Total				78,000
Remarks	Same as above (1) 2. No security guard means no handy Talky.			

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Main camp (200×200m) [Sept up at 20m]	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	40	252,000
Remarks	According survey, contractors do not set up this system in sub-camps				

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Main camp (200×200m)	High Definition CCTV Camera System	500,000	100,000	600,000
Remarks	According survey, contractors do not set up this camera system in sub-camps.			

5) Internal security warning system within camps

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit (PhP)
Main camp (200×200m)	[Siren]	(5,000/unit)×2	(1,200/unit)×2	12,400
Sub camp (200×150m)	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000
Total Cost of Siren and Ringing Bell at each Sub-Project				17,400

6) Fencing of the Perimeters of the contractor's camps by Concrete Hollow Blocks: CHB

Facility with size	Item & technical specification	Unit Price (PhP)	Volume of the Blocks	Labour Cost (PhP)	Total Cost for each camp (PhP)
Main camp (800m: 200×200m)	[CHB] 6×8×16in. 3m high with 0.5 m barbed wire	1,500/m as set price (material & labour included)	-	-	1,200,000
Sub camp (700m: 200×150m)	[CHB] 6×8×16in. 3m high with 0.5 m barbed wire	1,500/m as set price (material & labour included)	-	-	1,050,000
Total costs					2,250,000

7) Fencing of the Perimeters of quarry by barbed wire with poles

Facility with size	Technical Specification of Barbed Wire & Poles	Unit Price (PhP)	Volume of the Wire & poles	Labour Cost for Set Up (PhP)	Total Cost for each facility (PhP)
Quarry (700m: 200×150m)	Wire: 30 kg, 4 layers, (Length 130m/roll)	2,000/roll	22 rolls	40,000 (10 labourers ×10 days×400)	132,000
	Pole: 4×4in. 8ft.	200	240		
Remarks	According to survey, contractors do not set up fencing at the perimeters of sand pit and road construction sites				

8) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Main camp and Sub camp	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	2	10,000

9) Total Security Costs of Contractors for Sub-Project 2 with 2 contact packages: <u>PhP 44,278,800</u> (One contract package: PhP 22,139,400 ×2=PhP 44,278,800)

(3) For Consultants

1) Security Guard

Assignments	Unit Price/ per day (PhP)	No. of Guards	Shifts per day	No. of Party	Monthly (30 days) Payment (PhP)	Security Service Months	Security Guard Cost (PhP)
(1) Cotabato Project Office (60×60m)	600	3	2	1	108,000	56 (21+35)	6,048,000
(2) Detail Design (3) ROW Acquisition & RAP (4) Procurement of Contractor	600	1	1	3	54,000	21	1,134,000
(5) Construction Supervision	600	1	1	3	54,000	35	1,890,000
(6) Defect & Liability	600	1	1	1	18,000	1	18,000
Total							9,090,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Security Guards & Parties	Total Costs of the whole construction Period (PhP)
Cotabato Project Office	Motorola MH230, Two-Way Radio <u>(Pair)</u>, waterproof, 23mile/36km range」 or <u>equivalent technical capability</u>	7,000	2 guards & reserves	14,000
For long distance communication between Cotabato Project Office & 3 mobile parties	「Motorola MS350R, Two-Way Radio <u>(Pair)</u>, waterproof, 35mile/56km range」 or <u>equivalent technical capability</u>	11,000	3 (Cotabato Project Office + 3 parties & reserves)	33,000

For Emergency Communication	Satellite Phone [Procurement in japan]	100,000	1	100,000
Total				147,000

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Cotabato Project Office (60×60m)	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	12 [Set up at each 20m]	75,600

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Cotabato Project Office	High Definition CCTV Camera System with night vision & recording capability	300,000	100,000	400,000

5) Internal security warning system within camps

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit
Cotabato Project Office	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000

6) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)	No. of locations	Total Cost (PhP.)
Cotabato Project Office	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	1	5,000

7) Total Security Costs of Consultants for Sub-Project 2 with 2 contract packages: PhP 19,445,200 (One contract package: PhP 9,722,600 ×2=PhP 19,445,200)

16.8.3 Sub-Project 6

(1) Total Security Costs for Sub-Project 6

(Unit: PhP)

Sub-Project 6	Contractors	Consultants	Security Costs of each contract package	Total Security Costs for Sub-Project 6
Contract Package: 1	23,759,400	10,694,600	34,454,000	115,765,440
VAT:12%	2,851,128	1,283,352	4,134,480	
Contract Package: 2	23,759,400	10,694,600	34,454,000	
VAT:12%	2,851,128	1,283,352	4,134,480	
Contract Package: 3	23,759,400	10,694,600	34,454,000	
VAT:12%	2,851,128	1,283,352	4,134,480	
Sub-Total	79,831,584	35,933,856	115,765,440	

(2) For Contractors

1) Security Guard

Sub-Project 6	Road Length (km)	Construction Period (Month)	Monthly Payment: (30 days, PhP)	Total Costs of the whole construction Period (PhP)
Contract Package 1/2/3	22.0/22.0/22.0	38	540,000	20,520,000
Remarks	1. Facilities are 5 locations (main camp, sub camp, quarry, road site, project office) 2. Sand and gravel are delivered on call. There is no need for security guards. 3. Some contractors are willing to hire local community people for security reasons.			

Facility	Unit Price/ per day (PhP)	No. of Guards	No. of Shifts per day	Monthly (30 days) Payment (PhP)
Main camp (200×200m)	400	3	3	108,000
Sub camp (200×150m)	400	3	3	108,000
Quarry	400	3	3	108,000
Road site	400	3	3	108,000
Project Office	400	3	3	108,000
Sand pit	(not applicable)			
Total				540,000

2) “Handy Talky” for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Guards	Total Costs of the whole construction Period (PhP)
5 sites (main camp, sub camp, quarry, road site, project office)	「Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	8 (5 sites + reserves)	56,000
For long distance communication among main camp, sub camp, & road sites	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	2 (3 sites + reserves)	22,000
Total				78,000
Remarks	Same as above (1) 2. No security guard means no handy Talky.			

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Main camp(200×200m) [Sept up at 20m]	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	40	252,000
Remarks	According survey, contractors do not set up this system in sub-camps				

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Main camp (200×200m)	High Definition CCTV Camera System with night vision & recording capability	400,000	100,000	500,000
Remarks	According survey, contractors do not set up this camera system in sub-camps.			

5) Internal security warning system within camps

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit (PhP)
Main camp (200×200m)	[Siren]	(5,000/unit)×2	(1,200/unit)×2	12,400
Sub camp (200×150m)	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000
Total Cost of Siren and Ringing Bell at each Sub-Project				17,400

6) Fencing of the Perimeters of the contractor's camps by Concrete Hollow Blocks: CHB

Facility with size	Item & technical specification	Unit Price (PhP)	Volume of the Blocks	Labour Cost (PhP)	Total Cost for each camp (PhP)
Main camp (800m: 200×200m)	[CHB] 6×8×16in. 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,200,000
Sub camp (700m: 200×150m)	[CHB] 6×8×16in. 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,050,000
Total costs					2,250,000

7) Fencing of the Perimeters of quarry by barbed wire with poles

Facility with size	Technical Specification of Barbed Wire & Poles	Unit Price (PhP)	Volume of the Wire & poles	Labour Cost for Set Up (PhP)	Total Cost for each facility (PhP)
Quarry (700m: 200×150m)	Wire: 30kg, 4layers, (Length 130m/roll)	2,000/roll	22 rolls	40,000 (10 labourers ×10 days×400)	132,000
	Pole: 4×4in. 8ft.	200	240		
Remarks	According to survey, contractors do not set up fencing at the perimeters of sand pit and road construction sites				

8) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Main camp and Sub camp	For emergency treatment of external wounds and sudden illness. (First Aid training is required for the person in charge about use of this kit)	5,000	2	10,000

9) Total Security Costs of Contractors for Sub-Project 6 with 3 contact packages: PhP 104,848,200 (One contract package: PhP 34,949,400 ×3=PhP104,848,200)

(3) For Consultants

1) Security Guard

Assignments	Unit Price/ per day (PhP)	No. of Guards	Shifts per day	No. of Party	Monthly (30 days) Payment (PhP)	Security Service Months	Security Guard Cost (PhP)
(1) Cotabato Project Office (60×60m)	600	3	2	1	108,000	62 (24+38)	6,696,000

(2) Detail Design (3) ROW Acquisition & RAP (4) Procurement of Contractor	600	1	1	3	54,000	24	1,296,000
(5) Construction Supervision	600	1	1	3	54,000	38	2,052,000
(6) Defect & Liability	600	1	1	1	18,000	1	18,000
Total							10,062,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Security Guards & Parties	Total Costs of the whole construction Period (PhP)
Cotabato Project Office	Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	2 (guards & Reserves)	14,000
For long distance communication between Cotabato Project Office & 3 mobile parties	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	3 (Cotabato Project Office + 3 parties & reserves)	33,000
For Emergency Communication	Satellite Phone [Procurement in japan]	100,000	1	100,000
Total				147,000

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Cotabato Project Office	「 LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	12 [Set up at each 20m]	75,600

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Cotabato Project Office	High Definition CCTV Camera System with night vision & recording capability	300,000	100,000	400,000

5) Internal security warning system within camps

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit (PhP)
Cotabato Project Office	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000

6) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Cotabato Project Office	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	1	5,000

7) Total Security Costs of Consultants for Sub-Project 6 with 3 contract packages: PhP 32,083,800 (One contract package: PhP 10,694,600 ×3=PhP 32,083,800)

16.8.4 Sub-Project 7

(1) Total Security Costs for Sub-Project 7

(Unit: PhP)

Sub-Project 7	Contractors	Consultants	Security Costs of each contract package	Total Security Costs for Sub-Project 7
Contract Package: 1	18,359,400	7,616,600	25,976,000	58,186,240
VAT:12%	2,203,128	913,992	3,117,120	
Contract Package: 2	18,359,400	7,616,600	25,976,000	
VAT:12%	2,203,128	913,992	3,117,120	
Sub-Total	41,125,056	17,061,184	58,186,240	

(2) For Contractors

1) Security Guard

Sub-Project 7	Road Length (km)	Construction Period (Month)	Monthly Payment: (30 days, PhP)	Total Costs of the whole construction Period (PhP)
Contract Package 1/2	9.1 / 9.0	28	540,000	15,120,000
Remarks	1. Facilities are 5 locations (main camp, sub camp, quarry, road site, project office) 2. Sand and gravel are delivered on call. There is no need for security guards. 3. Some contractors are willing to hire local community people for security reasons.			

Facility	Unit Price/ per day (PhP)	No. of Guards	No. of Shifts per day	Monthly (30 days) Payment (PhP)
Main camp (200×200m)	400	3	3	108,000
Sub camp (200×150m)	400	3	3	108,000
Quarry	400	3	3	108,000
Road site	400	3	3	108,000
Project Office	400	3	3	108,000
Sand pit	(not applicable)			
Total				540,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Guards	Total Costs of the whole construction Period (PhP)
5 sites (main camp, sub camp, quarry, road site, project office)	「Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	8 (5 sites + reserves)	56,000

For long distance communication among main camp, sub camp, & road sites	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	2 (3 sites + reserves)	22,000
Total				78,000
Remarks	Same as above (1) 2. No security guard means no handy Talky.			

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Main camp (200×200m) [Sept up at 20m]	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	40	252,000
Remarks	According survey, contractors do not set up this system in sub-camps				

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Main camp (200×200m)	High Definition CCTV Camera System with night vision & recording capability	400,000	100,000	500,000
Remarks	According survey, contractors do not set up this camera system in sub-camps.			

5) Internal security warning system within camps

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit (PhP)
Main camp (200×200m)	[Siren]	(5,000/unit)×2	(1,200/unit)×2	12,400
Sub camp (200×150m)	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000
Total Cost of Siren and Ringing Bell at each Sub-Project				17,400

6) Fencing of the Perimeters of the contractor's camps by Concrete Hollow Blocks: CHB

Facility with size	Item & technical specification	Unit Price (PhP)	Volume of the Blocks	Labour Cost (PhP)	Total Cost for each camp (PhP)
Main camp (800m: 200×200m)	[CHB] 6×8×16in. 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,200,000
Sub camp (700m: 200×150m)	[CHB] 6×8×16in 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,050,000
Total costs					2,250,000

7) Fencing of the Perimeters of quarry by barbed wire with poles

Facility with size	Technical Specification of Barbed Wire & Poles	Unit Price (PhP)	Volume of the Wire & poles	Labour Cost for Set Up (PhP)	Total Cost for each facility (PhP)
Quarry (700m: 200×150m)	Wire: 30kg, 4layers, (Length 130m/roll)	2,000/roll	22 rolls	40,000 (10 labourers ×10 days×400)	132,000
	Pole: 4×4in. 8ft.	200	240		

Remarks	According to survey, contractors do not set up fencing at the perimeters of sand pit and road construction sites

8) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Main camp and Sub camp	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	2	10,000

9) Total Security Costs of Contractors for Sub-Project 7 with 2 contact packages: PhP 36,718,800 (One contract package: PhP18,359,400 ×2=PhP 36,718,800)

(3) For Consultants

1) Security Guard

Assignments	Unit Price/ per day (PhP)	No. of Guards	Shifts per day	No. of Party	Monthly (30 days) Payment (PhP)	Security Service Months	Security Guard Cost (PhP)
(1) Cotabato Project Office (60×60m)	600	3	2	1	108,000	43 (15+28)	4,644,000
(2) Detail Design (3) ROW Acquisition & RAP (4) Procurement of Contractor	600	1	1	3	54,000	15	810,000
(5) Construction Supervision	600	1	1	3	54,000	28	1,512,000
(6) Defect & Liability	600	1	1	1	18,000	1	18,000
Total							6,984,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Security Guards & Parties	Total Costs of the whole construction Period (PhP)
Cotabato Project Office	Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	2 (guards & Reserves)	14,000
For long distance communication between Cotabato Project Office & 3 mobile parties	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	10,000	3 (Cotabato Project Office + 3 parties & reserves)	33,000
For Emergency Communication	Satellite Phone [Procurement in japan]	100,000	1	100,000
Total				147,000

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Cotabato Project Office	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	12 [Set up at each 20m]	75,600

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Cotabato Project Office	High Definition CCTV Camera System with night vision & recording capability	300,000	100,000	400,000

5) Internal security warning system within the project office

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit (PhP)
Cotabato Project Office	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000

6) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Cotabato Project Office	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	1	5,000

7) Total Security Costs of Consultants for Sub-Project 7 with 2 contract packages: PhP 15,233,200 (One contract package: PhP 7,616,600 ×2=PhP 15,233,200)

16.8.5 Sub-Project 8

(1) Total Security Costs for Sub-Project 8

(Unit: PhP)

Sub-Project 8	Contractors	Consultants	Security Costs of each contract package	Total Security Costs for Sub-Project 8
Contract Package: 1	16,739,400	7,130,600	23,870,000	26,734,400
VAT:12%	2,008,728	855,672	2,864,400	
Sub-Total	18,748,128	7,986,272	26,734,400	

(2) For Contractors

1) Security Guard

Sub-Project 8	Road Length (km)	Construction Period (Month)	Monthly Payment: (30 days, PhP)	Total Costs of the whole construction Period (PhP)
Contract Package 1	7.0	25	540,000	13,500,000
Remarks	1. Facilities are 5 locations (main camp, sub camp, quarry, road site, project office) 2. Sand and gravel are delivered on call. There is no need for security guards. 3. Some contractors are willing to hire local community people for security reasons.			

Facility	Unit Price/ per day (PhP)	No. of Guards	No. of Shifts per day	Monthly (30 days) Payment (PhP)
Main camp (200×200m)	400	3	3	108,000
Sub camp (200×150m)	400	3	3	108,000
Quarry	400	3	3	108,000
Road site	400	3	3	108,000
Project Office	400	3	3	108,000
Sand pit	(not applicable)			
Total				540,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Guards	Total Costs of the whole construction Period (PhP)
5 sites (main camp, sub camp, quarry, road site, project office)	「Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	8 (5 sites + reserves)	56,000
For long distance communication among main camp, sub camp, & road sites	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	2 (3 sites + reserves)	22,000
Total				78,000
Remarks	Same as above (1) 2. No security guard means no handy Talky.			

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Main camp (200×200m) [Sept up at 20m]	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	40	252,000
Remarks	According survey, contractors do not set up this system in sub-camps				

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Main camp (200×200m)	High Definition CCTV Camera System with night vision & recording capability	400,000	100,000	500,000
Remarks	According survey, contractors do not set up this camera system in sub-camps.			

5) Internal security warning system within camps

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit (PhP)
Main camp (200×200m)	[Siren]	(5,000/unit)×2	(1,200/unit)×2	12,400
Sub camp (200×150m)	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000
Total Cost of Siren and Ringing Bell at each Sub-Project				17,400

6) Fencing of the Perimeters of the contractor's camps by Concrete Hollow Blocks: CHB

Facility with size	Item & technical specification	Unit Price (PhP)	Volume of the Blocks	Labour Cost (PhP)	Total Cost for each camp (PhP)
Main camp (800m: 200×200m)	[CHB] 6×8×16in. 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,200,000
Sub camp (700m: 200×150m)	[CHB] 6×8×16in 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,050,000
Total costs					2,250,000

7) Fencing of the Perimeters of quarry by barbed wire with poles

Facility with size	Technical Specification of Barbed Wire & Poles	Unit Price (PhP)	Volume of the Wire & poles	Labour Cost for Set Up (PhP)	Total Cost for each facility (PhP)
Quarry (700m: 200×150m)	Wire: 30kg, 4layers, (Length 130m/roll)	2,000/roll	22 rolls	40,000 (10 labourers ×10 days×400)	132,000
	Pole: 4×4in. 8ft.	200	240		
Remarks	According to survey, contractors do not set up fencing at the perimeters of sand pit and road construction sites				

8) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Main camp and Sub camp	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	2	10,000

9) Total Security Costs of Contractors for Sub-Project 8: PhP 16,739,400

(3) For Consultants

1) Security Guard

Assignments	Unit Price/ per day (PhP)	No. of Guards	Shifts per day	No. of Party	Monthly (30 days) Payment (PhP)	Security Service Months	Security Guard Cost (PhP)
(1) Cotabato Project Office (60×60m)	600	3	2	1	108,000	40 (15+25)	4,320,000
(2) Detail Design (3) ROW Acquisition & RAP (4) Procurement of Contractor	600	1	1	3	54,000	15	810,000
(5) Construction Supervision	600	1	1	3	54,000	25	1,350,000
(6) Defect & Liability	600	1	1	1	18,000	1	18,000
Total							6,498,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Security Guards & Parties	Total Costs of the whole construction Period (PhP)
Cotabato Project Office	Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	2 (guards & Reserves)	14,000
For long distance communication between Cotabato Project Office & 3 mobile parties	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	3 (Cotabato Project Office + 3 parties & reserves)	33,000
For Emergency Communication	Satellite Phone [Procurement in japan]	100,000	1	100,000
Total				147,000

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Cotabato Project Office	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	12 [Set up at each 20m]	75,600

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Cotabato Project Office	High Definition CCTV Camera System with night vision & recording capability	300,000	100,000	400,000

5) Internal security warning system within camps

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit (PhP)
Cotabato Project Office	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000

6) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Cotabato Project Office	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	1	5,000

7) Total Security Costs of Consultants for Sub-Project 8: PhP 7,130,600

16.8.6 Sub-Project 9

(1) Total Security Costs for Sub-Project 9

(Unit: PhP)

Sub-Project 9	Contractors	Consultants	Security Costs of each contract package	Total Security Costs for Sub-Project 9
Contract Package: 1	22,139,400	8,912,600	31,052,000	34,778,240
VAT:12%	2,656,728	1,069,512	3,726,240	
Sub-Total	24,796,128	9,982,112	34,778,240	

(2) For Contractors

1) Security Guard

Sub-Project 9	Road Length (km)	Construction Period (Month)	Monthly Payment: (30 days, PhP)	Total Costs of the whole construction Period (PhP)
Contract Package 1	16.6	35	540,000	18,900,000
Remarks	1. Facilities are 5 locations (main camp, sub camp, quarry, road site, project office) 2. Sand and gravel are delivered on call. There is no need for security guards. 3. Some contractors are willing to hire local community people for security reasons.			

Facility	Unit Price/ per day (PhP)	No. of Guards	No. of Shifts per day	Monthly (30 days) Payment (PhP)
Main camp (200×200m)	400	3	3	108,000
Sub camp (200×150m)	400	3	3	108,000
Quarry	400	3	3	108,000
Road site	400	3	3	108,000
Project Office	400	3	3	108,000
Sand pit	(not applicable)			
Total				540,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Guards	Total Costs of the whole construction Period (PhP)
5 sites (main camp, sub camp, quarry, road site, project office)	「Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	8 (5 sites + reserves)	56,000
For long distance communication among main camp, sub camp, & road sites	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	2 (3 sites + reserves)	22,000
Total				78,000
Remarks	Same as above (1) 2. No security guard means no handy Talky.			

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Main camp (200×200m) [Sept up at 20m]	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	40	252,000
Remarks	According survey, contractors do not set up this system in sub-camps				

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Main camp (200×200m)	High Definition CCTV Camera System with night vision & recording capability	400,000	100,000	500,000
Remarks	According survey, contractors do not set up this camera system in sub-camps.			

5) Internal security warning system within camps

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit (PhP)
Main camp (200×200m)	[Siren]	(5,000/unit)×2	(1,200/unit)×2	12,400
Sub camp (200×150m)	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000
Total Cost of Siren and Ringing Bell at each Sub-Project				17,400

6) Fencing of the Perimeters of the contractor's camps by Concrete Hollow Blocks: CHB

Facility with size	Item & technical specification	Unit Price (PhP)	Volume of the Blocks	Labour Cost (PhP)	Total Cost for each camp (PhP)
Main camp (800m: 200×200m)	[CHB] 6×8×16in. 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,200,000
Sub camp (700m: 200×150m)	[CHB] 6×8×16in 3m high with 0.5m barbed wire	1,500/m as set price (material & labour included)	-	-	1,050,000
Total costs					2,250,000

7) Fencing of the Perimeters of quarry by barbed wire with poles

Facility with size	Technical Specification of Barbed Wire & Poles	Unit Price (PhP)	Volume of the Wire & poles	Labour Cost for Set Up (PhP)	Total Cost for each facility (PhP)
Quarry (700m: 200×150m)	Wire: 30kg, 4layers, (Length 130m/roll)	2,000/roll	22 rolls	40,000 (10 labourers ×10 days×400)	132,000
	Pole: 4×4in. 8ft.	200	240		
Remarks	According to survey, contractors do not set up fencing at the perimeters of sand pit and road construction sites				

8) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Main camp and Sub camp	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	2	10,000

9) Total Security Costs of Contractors for Sub-Project 9: <u>PhP 22,139,400</u>

(3) For Consultants

1) Security Guard

Assignments	Unit Price/ per day (PhP)	No. of Guards	Shifts per day	No. of Party	Monthly (30 days) Payment (PhP)	Security Service Months	Security Guard Cost (PhP)
(1) Cotabato Project Office (60×60m)	600	3	2	1	108,000	51 (16+35)	5,508,000
(2) Detail Design (3) ROW Acquisition & RAP (4) Procurement of Contractor	600	1	1	3	54,000	16	864,000
(5) Construction Supervision	600	1	1	3	54,000	35	1,890,000
(6) Defect & Liability	600	1	1	1	18,000	1	18,000
Total							8,280,000

2) "Handy Talky" for security guards and communication among different sites

Facility	Technical Specification	Unit Price (PhP)	No. of Security Guards & Parties	Total Costs of the whole construction Period (PhP)
Cotabato Project Office	Motorola MH230, Two-Way Radio (Pair), waterproof, 23mile/36km range」 or equivalent technical capability	7,000	2 (guards & Reserves)	14,000
For long distance communication between Cotabato Project Office & 3 mobile parties	「Motorola MS350R, Two-Way Radio (Pair), waterproof, 35mile/56km range」 or equivalent technical capability	11,000	3 (Cotabato Project Office + 3 parties & reserves)	33,000
For Emergency Communication	Satellite Phone [Procurement in japan]	100,000	1	100,000
Total				147,000

3) Lighting system to cover the perimeters in the evening time

Facility	Technical Specification	Unit Price (PhP)	Labour Cost (PhP)	No. of Sets	Total Cost (PhP)
Cotabato Project Office	「LED lights, 50 watts, water proof, day light」 or equivalent technical capability	4,500	1,800	12 [Set up at each 20m]	75,600

4) Surveillance Camera System for the Perimeters

Facility	Technical Specification of the System	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost (PhP)
Cotabato Project Office	High Definition CCTV Camera System with night vision & recording capability	300,000	100,000	400,000

5) Internal security warning system within the project office

Facility	Item & its technical specification	Price of the Each System (PhP)	Labour Cost for Set Up (PhP)	Total Cost of each unit
Cotabato Project Office	[Improvised ringing bell] 220V, AC resettable.	(1,300/unit)×2	(1,200/unit)×2	5,000

6) "First Aid Kit" for immediate treatment of injuries at camp and road construction sites

Facility	Technical Specification	Unit Price (rump-sum)(PhP)	No. of locations	Total Cost (PhP)
Cotabato Project Office	For emergency treatment of external wounds and sudden illness (First Aid training is required for the person in charge about use of this kit)	5,000	1	5,000

7) Total Security Costs of Consultants for Sub-Project 9: PhP 8,912,600

16.8.7 Total Security Cost

The following is the total cost estimate on security of contractors and consultants in RNDP-CAAM (Sub-Project and contract package basis):

Table 16.8.7-1 Security Cost for Sub-Project Sites

(Unit: PhP)

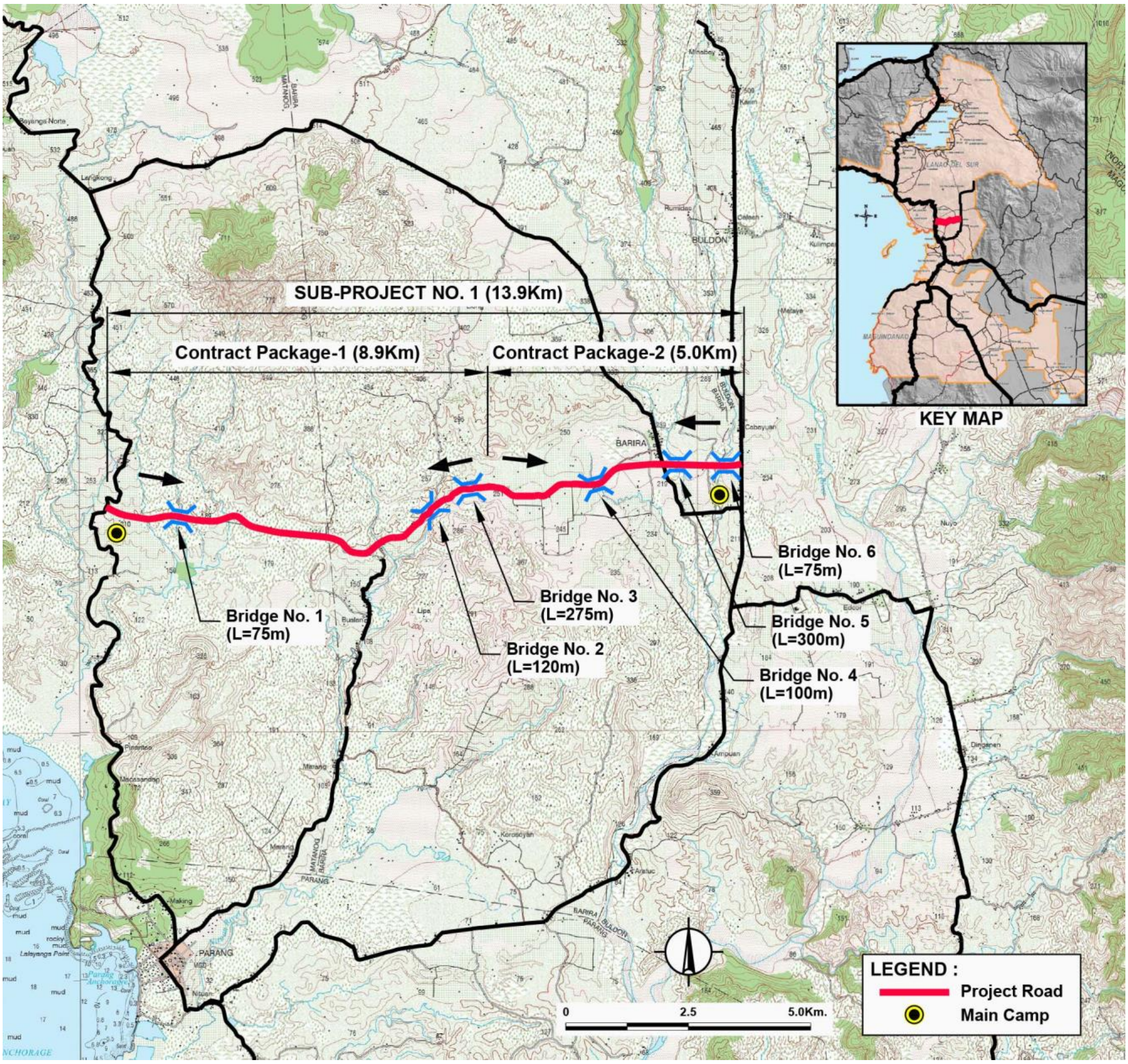
No.	Name of the Sub-Project	Cost estimate of each contract package				Total Costs of each Sub Project (C)
		[Contractors]		[Consultants]		
	(No. of contract package, Km distance, and construction months)	[Contractors] (A)	(A): VAT 12%	[Consultants] (B)	(B): VAT 12%	[(C) = (A) + (B) with VAT12%]
1	Matanog-Baria-Buldon-Alamada-Libungan Road	20,519,400	2,462,328	8,426,600	1,011,192	32,419,520
	13.9 Km, 32 months					
2	Parang-Balabagan Road	44,278,800	5,313,456	19,445,200	2,333,424	71,370,880
	(1/2: 17 Km, 35 months)	(22,139,400)	(2,656,728)	(9,722,600)	(1,166,712)	
	(2/2: 17 Km, 35 months)	(22,139,400)	(2,656,728)	(9,722,600)	(1,166,712)	
6	Taipan-Lebak Coastal Road	71,278,200	8,553,384	32,083,800	3,850,056	115,765,440
	(1/3: 22 Km, 38 months)	(23,759,400)	(2,851,128)	(10,694,600)	(1,283,352)	
	(2/3: 22 Km, 38 months)	(23,759,400)	(2,851,128)	(10,694,600)	(1,283,352)	
	(3/3: 22 Km, 38 months)	(23,759,400)	(2,851,128)	(10,694,600)	(1,283,352)	
7	Marawi City Ring Road	36,718,800	4,406,256	15,233,200	1,827,984	58,186,240
	(1/2: 9.1 Km, 28 months)	(18,359,400)	(2,203,128)	(7,616,600)	(913,992)	
	(2/2: 9 Km, 28 months)	(18,359,400)	(2,203,128)	(7,616,600)	(913,992)	
8	Parang-East Diversion Road	16,739,400	2,008,728	7,130,600	855,672	26,734,400
	7 Km, 25 months					
9	Manuangan-Parang Road	22,139,400	2,656,728	8,912,600	1,069,512	34,778,240
	16.6 Km, 35 months					
Grand total cost estimate on Security for the 10 Sub-Project sites (contract package basis) in RNDP-CAAM		211,674,000	25,400,880	91,232,000	10,947,840	339,254,720

Chapter 17 Construction Planning and Construction Schedule

17.1 Sub-Project 1

17.1.1 Contract Packaging

At the west side of the Sub-Project 1, where the proposed road alignment traverses alongside the mountain, large scale earthwork is required. While, at the east side of the Sub-Project 1, where the road alignment crosses the tributary area of the Simuay River, bridge construction is the main work activity. Six bridges with a total length of 945 lineal meters are constructed along this section.



Source: JICA Study Team

Figure 17.1.1-1 Construction Site and Contract Packages

The construction work is divided into two contract packages, i.e. Contract Package-1 (8.9km) and Contract Package-2 (5.0km) in due consideration of the following:

- In due consideration of availability of experienced contractors, the size of one contract package should be about PhP 1.5 Billion or less.
- Construction material transport routes should be considered in contract packaging.
- Contract package shall be so planned that a contractor can work from both sides (i.e. from both east and west sides) which will contribute to shorter construction period and faster construction.

17.1.2 Construction Plan

(1) Scope of Civil E of Sub-Project 1

Scope of civil work of Sub-Project 1 is shown in **Table 17.1.2-1**.

Table 17.1.2-1 Scope of Civil Work of Sub-Project 1

		Contract Package-1	Contract Package-2	Total
Road Length		8.9 km	5.0 km	13.9 km
Earthwork	Clearing	18.4 ha.	10.4 ha.	28.8 ha.
	Roadway Excavation	16,007 m^3	8,993 m^3	25,000 m^3
	Embankment from Roadway	6,403 m^3	3,597 m^3	10,000 m^3
	Embankment by Borrow	71,072 m^3	39,928 m^3	111,000 m^3
Pavement Work		PCCP (t=280mm), 60,961m^2	PCCP (t=280mm), 34,248m^2	PCCP (t=280mm), 95,209m^2
Shoulder Work		PCC shoulder (t=150mm) =7,918m^2, Gravel Shoulder =3,048m^3	PCC shoulder (t=150mm) =4,449m^2, Gravel Shoulder =1,713m^3	PCC shoulder (t=150mm) =12,367m^2, Gravel Shoulder =4,761m^3
Bridge Work		Bridge No. 1, L= 75m Bridge No. 2, L=120m Bridge No.3, L=275m **Sub-total: 3 Bridges, L=470m**	Bridge No. 4, L=100m Bridge No. 5, L=300m Bridge No. 6, L= 75m **Sub-total: 3 Bridges, L=475m**	**6 Bridges, L=945m**
Drainage and Slope Protection Work	RCPC (910mm)	L=398m	L=223m	L=621m
	RCPC (1220m)	L=49m	L=28m	L=77m
	RCBC	L=36m	L=20m	L=56m
	Grouted Riprap	745m^3	407m^3	1,132m^3
	Stone Masonry	371m^3	209m^3	580m^3
Miscellaneous	Guardrail	4,193m	2,355m	6,548m
	Road Marking	4,898m^2	2,751m^2	7,649m^2
	Coco Net	29,620m^2	16,640m^2	46,260m^2

Source: JICA Study Team

(2) Construction Equipment

Major construction equipment necessary for each contract package of Sub-Project 1 is shown in **Table 17.1.2-2**.

Table 17.1.2-2 Construction Equipment for Sub-Project 1

Category	Equipment	
Earth work	Backhoe (0.8m^3) Bulldozer (20t) Pay loader (1.5m^3)	Dump truck (12yd^3) Vibratory roller (10t) Water truck (15m^3)
Pavement work	Road grader	Concrete screed (5.5hp)

	Transit mixer (30m^3)	Concrete vibrator
Bridge work	Drilling rig (300hp) Crawler crane (190hp)	Generator (300kw)

(3) Material Sources, Labor Force and Equipment

Material sources, Labor Force and Equipment of each contract package is shown in **Table 17.1.2-3**.

Table 17.1.2-3 Procurement and Employment Plan

Item	Conditions
Gravel & Sand	Simuay river quarry (South side 25km of Sub-Project 1)
Other materials	Cotabato City
Labor force	Skilled labor: Employed from Cotabato City and other areas of Mindanao Unskilled labor: Employed from neighbour barangays
Construction equipment	Leased from Cotabato City. If necessary, procured from other areas.

(4) Camp Location

A main camp location is proposed at the western side of the project for the Contract Package-1, whereas a main camp for the Contract Package-2 is proposed at the eastern side of the project as shown in **Figure 17.1.1-1**.

Proposed camp layout for each contract package is shown in **Figure 17.1.2-1**.

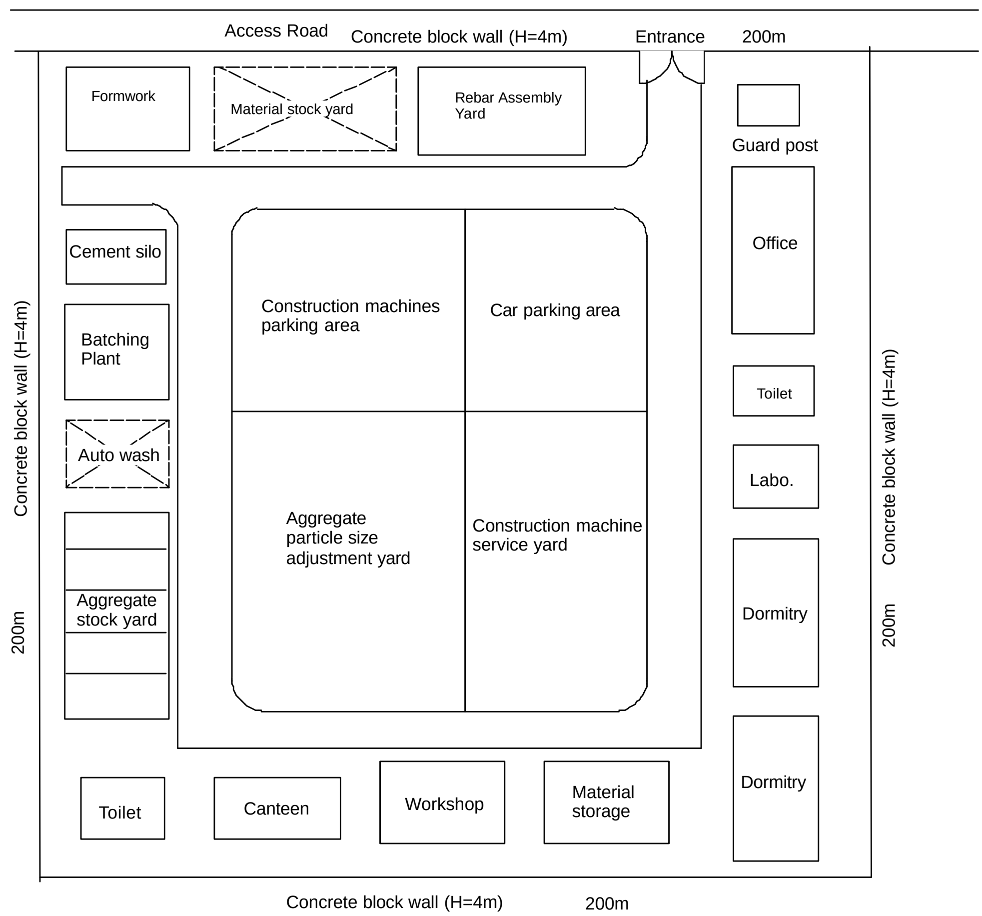


Figure 17.1.2-1 Proposed Typical Main Camp Yard Layout

17.1.3 Construction schedule

Proposed construction schedule is shown in **Table 17.1.3-1**. Total construction period is estimated to be 32 months.

Table 17.1.3-1 Construction Schedule for Sub-Project 1

No.	Activity	MONTHS
1.	Mobilization	
2.	Preparatory work	
3.	Temporary work	
4.	Earthworks	
4-1	Cleaning & Grubbing	
4-2	Excavation & Embankment	
4-3	Sub grade preparation	
4-4	Coco-Net	
5.	Drain. & Slope Protection	
5-1	Pipe Culvert	
5-2	Grouted Riprap	
5-3	Stone Masonry	
6.	Sub base & Surface Course	
6-1	Sub base	
6-2	PCCP(280mm)	
6-3	Shoulder PCCP(150mm)	
6-4	Shoulder Gravel Course	
7.	Bridge Construction	
7-1	Bridge No.1	
7-2	Bridge No.2	
7-3	Bridge No.3	
7-4	Bridge No.4	
7-5	Bridge No.5	
7-6	Bridge No.6	
8	Miscellaneous structure	
8-1	Metal Guardrail	
8-2	Road Marking	
8-3	Others	
9.	Demobilization	

MONTHS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

: Common Work : Contract Package No. 1 : Contract Package No. 2

Source: JICA Study Team

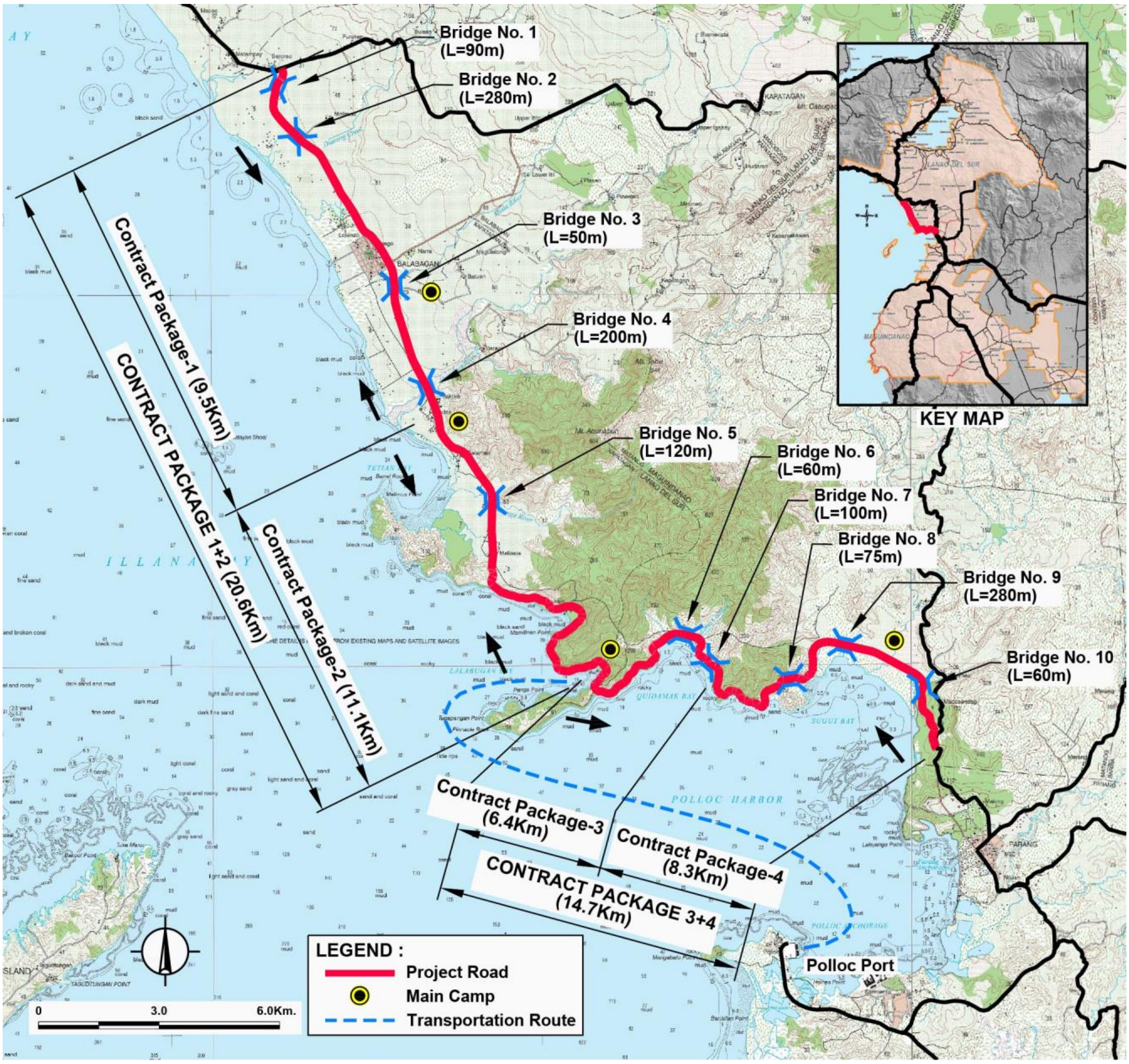
17.2 Sub-Project 2

17.2.1 Contract Packaging

Sub-project 2 has a total road length of 35.3km. There is an existing road along the alignment up to Bridge No. 3. The rest of the road sections are new road. The proposed new road passes along the coast line and also crosses steep mountains at southern sections. The sub-project is proposed to be divided into four (4) contract packages in due consideration of the following:

- The size of one contract package should be about PhP 1.5 Billion or less.
- Construction material transport route needs to selected based on sea transport, therefore, small gulfs are proposed for construction materials landing points. This factor is considered for contract packaging.
- Contract packaging shall be so planned that a contractor can work from both sides of the contract package.

Proposed contract packaging is shown in **Figure 17.2.1-1**



Source: JICA Study Team

Figure 17.2.1-1 Construction Packaging of Sub-Project 2

17.2.2 Construction Plan

(1) Scope of Civil Work of Sub-Project No. 2

Scope of civil work of Sub-Project No. 2 is shown in **Table 17.2.2-1**.

Table 17.2.2-1 Scope of Civil Work of Sub-Project No. 2

		Contract Package-1	Contract Package-2	Contract Package-3	Contract Package-4	Total
Road Length		9.5 km	11.1 km	6.4 km	8.3 km	35.3 km
Earthwork	Clearing	22.9 ha.	26.8 ha.	20.9 ha.	26.5 ha.	97.1 ha.
	Roadway Excavation	29,440 m^3	34,560 m^3	230,120 m^3	292,880 m^3	587,000 m^3
	Embankment from Roadway	118,220 m^3	138,780 m^3	169,840 m^3	216,160 m^3	643,000 m^3
	Embankment by Borrow	48,760 m^3	57,240 m^3	-	-	106,000 m^3
Pavement Work, PCCP (t=280mm)		64,948 m^2	76,244 m^2	48,878 m^2	62,209 m^2	252,279 m^2
Shoulder Work	PCC Shoulder	8,453 m^2	9,922 m^2	21,230 m^2	27,020 m^2	66,625 m^2
	Gravel Shoulder	6,015 m^3	7,060 m^3	1,862 m^3	2,370 m^3	17,307 m^3
Bridge Work		Bridge No. 1 (L= 90m) Bridge No. 2 (L=280m) Bridge No.3 (L=275m) Bridge No.4 (L=200m) **Total - 620m**	Bridge No. 5 (L=120m) **Total - 120m**	Bridge No.6 (L=60m) Bridge No.7 (L=100m) **Total - 160m**	Bridge No. 8 (L=75m) Bridge No.9 (L=280m) Bridge No.10 (L=60m) **Total - 415m**	**10 Bridges, L=1,315m**
Drainage and Slope Protection Work	RCPC (910mm)	L=299m	L=351m	L=271m	L=346m	L=1,267m
	RCPC (1220m)	L=17m	L=20m	L=17m	L=21m	L=75m
	RCBC	L=181m	L=213m	L=23m	L=30m	L=447m
	Grouted Riprap	1,062m^3	1,246m^3	1,197m^3	1,523m^3	5,028m^3
	Stone Masonry	12,967m^3	15,222m^3	21,207m^3	26,991m^3	76,387m^3
Miscellaneous	Guardrail	4,536m	5,324m	4,631m	5,895m	20,386m
	Road Marking	5,212m^2	6,118m^2	3,548m^2	4,515m^2	19,393m^2
	Coco Net	34,574m^2	40,586m^2	33,561m^2	42,713m^2	151,434m^2

Source: JICA Study Team

(2) Construction Equipment

Construction equipment necessary for each contract package of Sub-Project No. 2 is shown in **Table 17.2.2-2**.

Table 17.2.2-2 Construction Equipment of Contract Package 1

Category	Equipment	
Earth work	Backhoe ($0.8m^3$) Bulldozer (20t) Pay loader ($1.5m^3$)	Dump truck ($12yd^3$) Vibratory roller (10t) Water truck ($15m^3$)
Pavement work	Road grader Concrete mixer ($30m^3$)	Concrete screed (5.5hp) Concrete vibrator
Bridge work	Drilling rig (300hp) Crawler crane (190t)	Generator (300kw)
Transportation	Ro/Ro self-propelling flat barge	Self-propelling grab hopper barge

(3) Material Source and Equipment

Material source and other information are shown in **Table 17.2.2-3**.

Table 17.2.2-3 Material Sources and Equipment

Item	Conditions
Gravel & Sand	Simuay River quarry (South side 25km of Sub-Project 2)
Other materials	Cotabato, Parang
Labor force	Skilled labor: Employed from Cotabato and other areas of Mindanao Unskilled labor: Employed from neighbor barangays
Construction equipment	Procured from Cotabato. If necessary procured from other area.

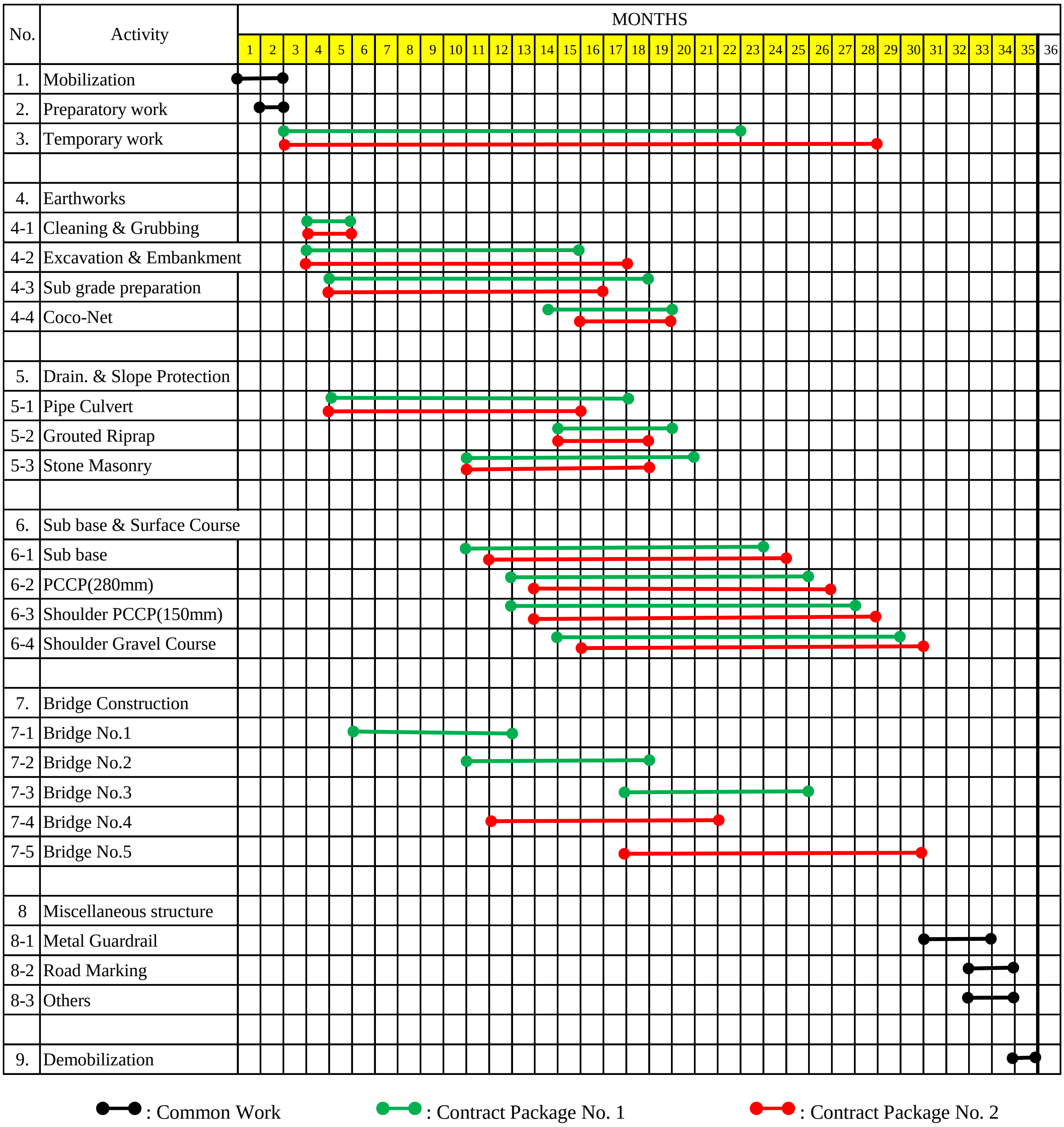
(4) Camp Location and Proposed Camp Layout

Proposed camp location of each contract package is shown in **Figure 17.2.1-1**. Proposed camp layout is shown in **Figure 17.1.2-1** in **Section 17.1.**

17.2.3 Construction Schedule

Proposed construction schedule of Contract Packages 1 and 2 (CP-1 & 2) is shown in **Table 17.2.3-1**. It is estimated that 35 months are required to complete each of Contract Packages 1 and 2.

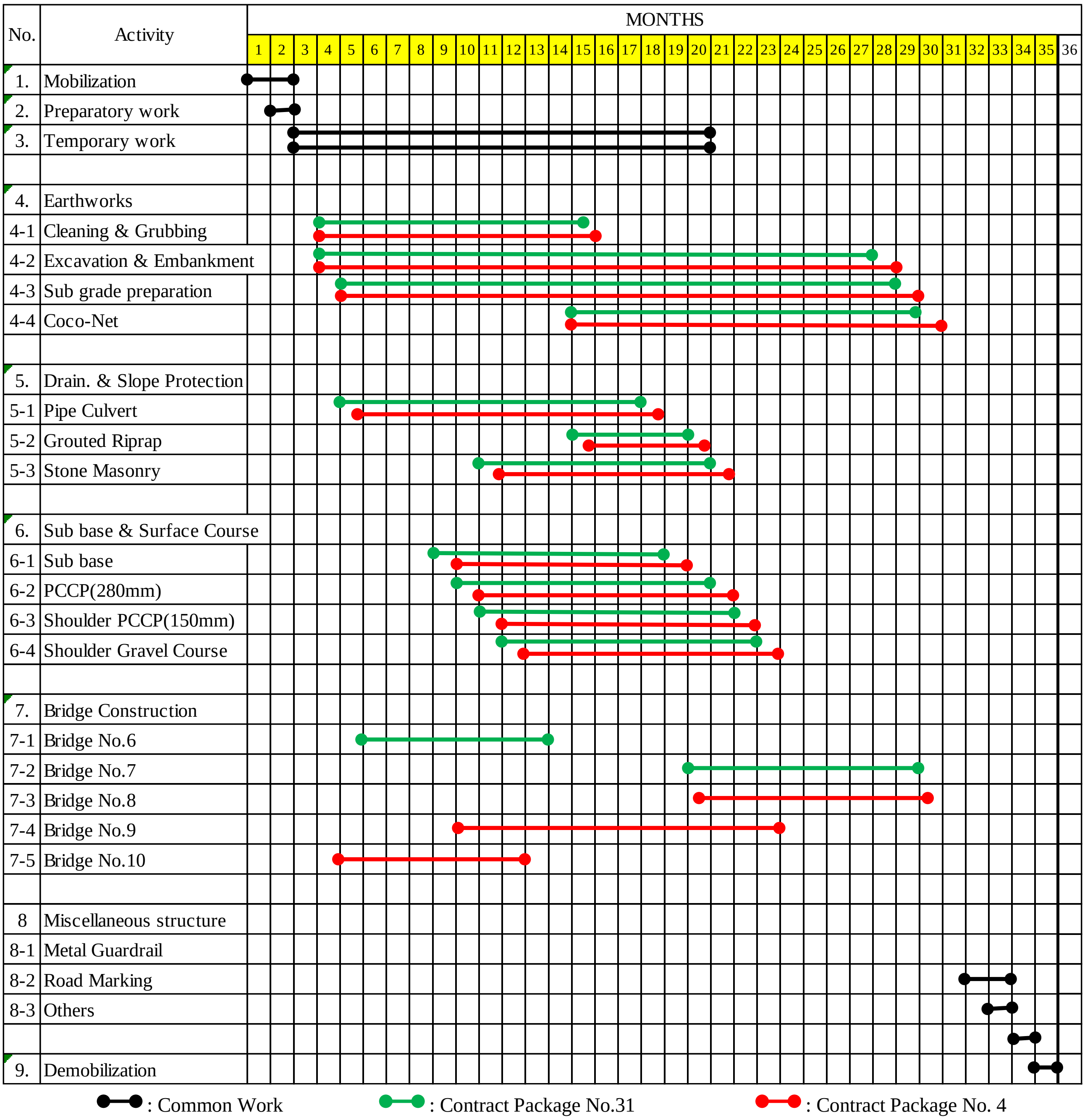
Table 17.2.3-1 Construction Schedule of Contract Packages 1 and 2



Source: JICA Study Team

Construction schedule of each of Contract Packages 3 and 4 is shown in **Table 17.2.3-2**.

Table 17.2.3-2 Construction Schedule of Contract Packages 3 and 4



Source: JICA Study Team

17.3 Sub-Project 6

17.3.1 Contract Packaging

(1) General

The Sub-Project 6 has a total length of 62.6 km, thus it should be divided into several contract packages for implementation. Another characteristics of this sub-project is that there is no land access except at the beginning of north section and at the end of the south section, therefore, the rest of the sections have to rely on the sea access. Appropriate small gulfs should be selected for the sea access points. Followings were considered in contract packaging;

- Size of one contract package should be about PhP 1.5 Billion or less.
- Each contract package has at least one sea access point at an appropriate gulf.
- Contract packaging shall be so planned that a contractor can work from both north and south sides of each contract package.

Figure 17.3.1-1 shows the north, the center and the south section of the Sub-project-6. Each section shall be further divided into two contract packages. A total of six (6) contract packages were planned.

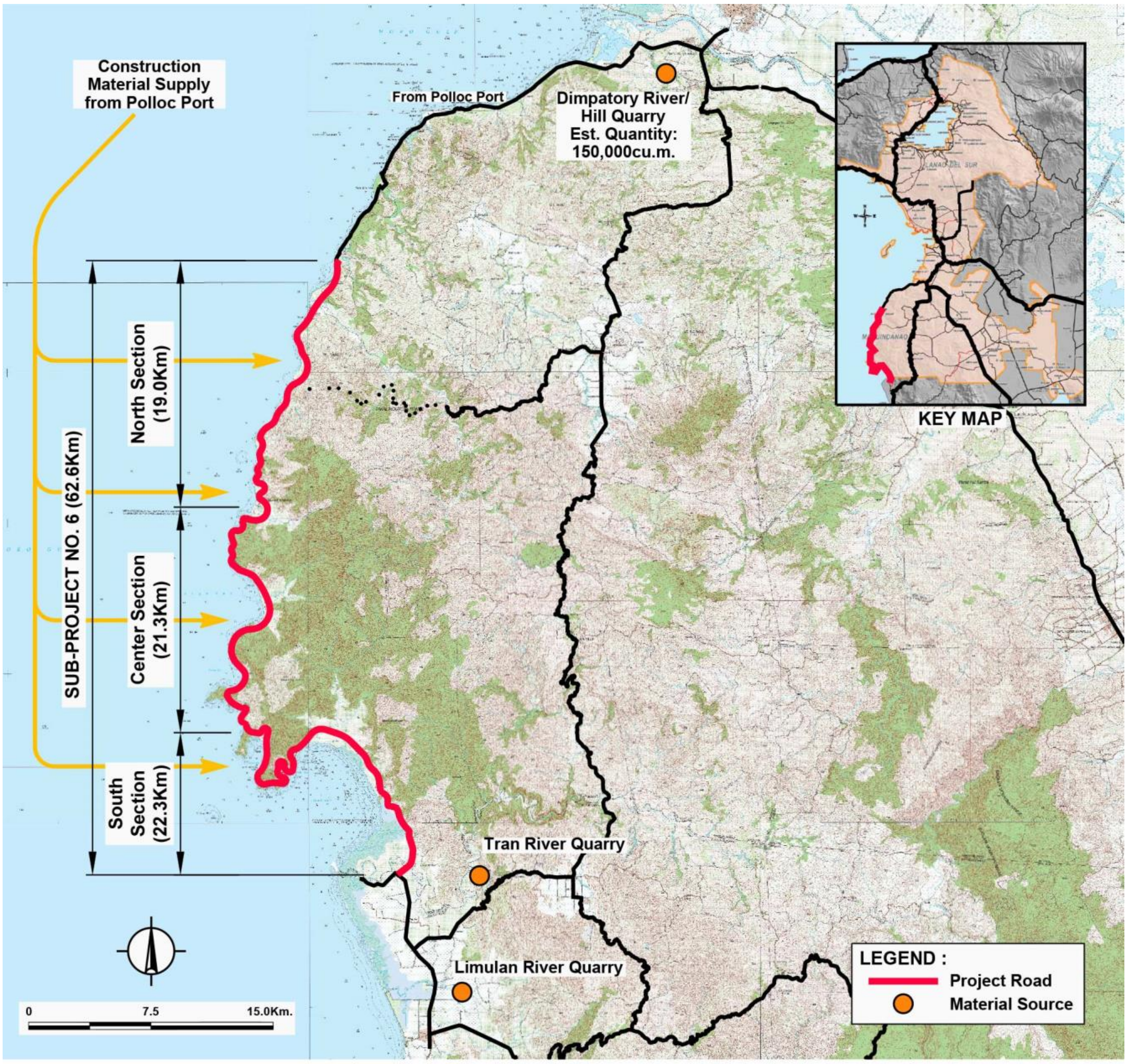


Figure 17.3.1-1 Sections of Sub-Project 6

17.3.2 Contract Packages of North Section

(1) General

The North Section of Sub-Project 6 is further sub-divided into two (2) contract packages as shown in **Figure 17.3.2-1**;

- Contract Package-1: Km. 0+000 – Km.9+000 (L=9.0 km)
- Contract Package-2: Km. 9+000 – Km. 19+000 (L=10.0 km)

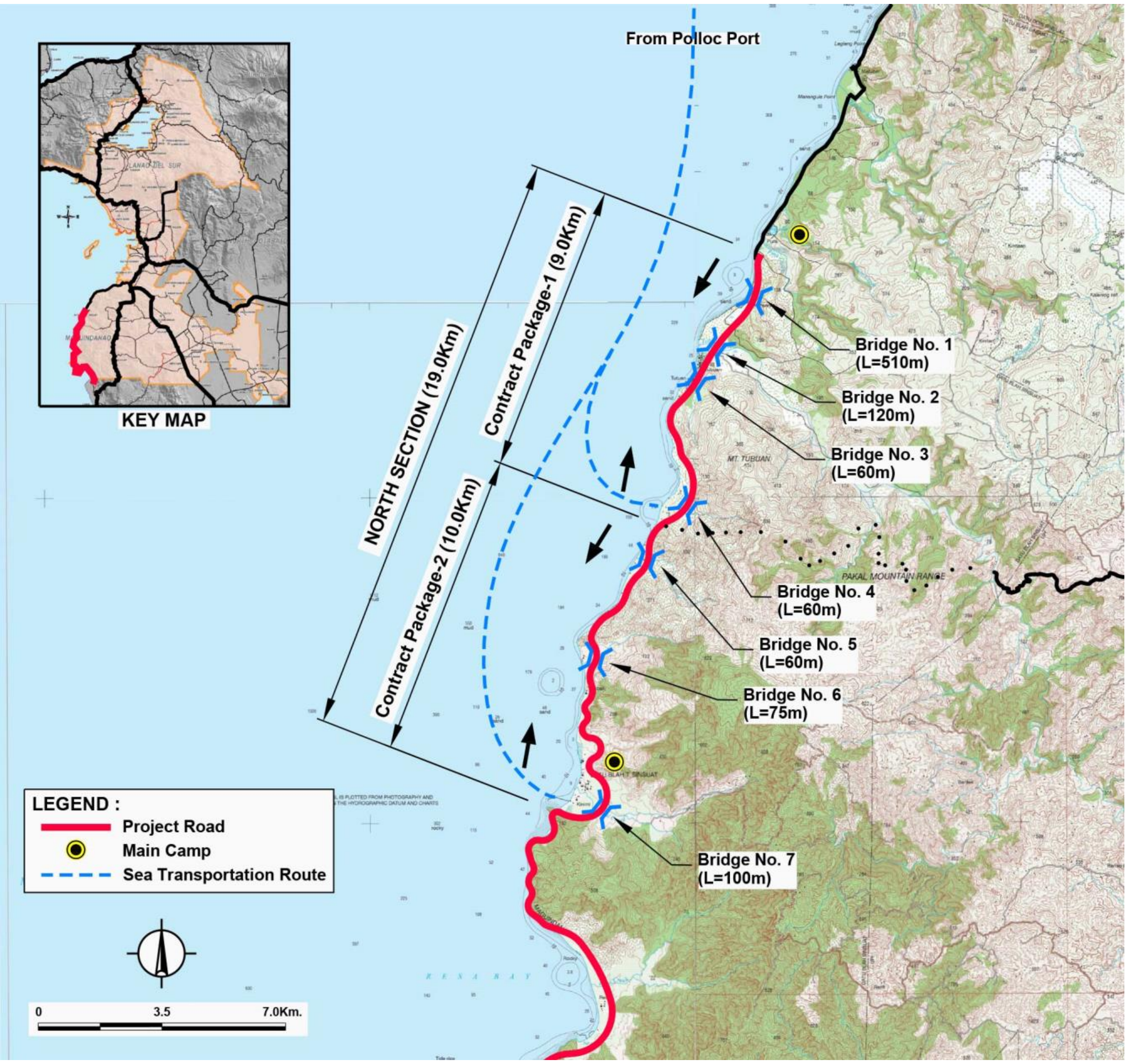


Figure 17.3.2-1 North Section and Contract Packages 1 and 2

(2) Construction Plan

1) Scope of Civil Work of Contract Packages-1 and 2

Scope of Civil Work of Contract Packages-1 and 2 is shown in **Table 17.3.2-1**.

Table 17.3.2-1 Scope of Civil Work of North Section of Sub-Project 6

		Contract Package-1	Contract Package-2	Total
Road Length		9.0 km	10.0 km	19.0 km
Earthwork	Clearing	9.6 ha.	10.7 ha.	20.3 ha.
	Roadway Excavation	17,136 m^3	19,041 m^3	36,177 m^3
	Embankment from Roadway	68,550 m^3	76,166 m^3	144,716 m^3
	Embankment by Borrow	7,240 m^3	8,045 m^3	15,285 m^3
Pavement Work (PCCP, t=280mm)		55,300m^2	65,430m^2	120,730m^2
Shoulder Work	PCC Shoulder	11,805m^2	9,837m^2	21,642m^2
	Gravel Shoulder	5,652m^3	4,710m^3	10,362m^3
Bridge Work		Bridge No. 1 (L=510m), Bridge No. 2 (L=120m), Bridge No. 3 (L=60m), Bridge No. 4 (L=60m), **Sub-total: 4 Bridges, L=750m**	Bridge No. 5 (L=60m), Bridge No. 6 (L=75m), Bridge No. 7 (L= 100m), **Sub-total: 3 Bridges, L=235m**	**7 Bridges, L=985m**
Drainage and Slope Protection Work	RCPC (910mm)	L=213m	L=237m	L=450m
	RCPC (1220m)	L=24m	L=27m	L=51m
	RCBC	L=38m	L=42m	L=80m
	Grouted Riprap	316m^3	352m^3	668m^3
	Stone Masonry	5,400m^3	6,000m^3	11,400m^3
Miscellaneous	Guardrail	7,426m	8,251m	15,677m
	Road Marking	4,950m^2	5,500m^2	10,450m^2
	Coco Net	57,154m^2	63,504m^2	120,658m^2

Source: JICA Study Team

2) Construction Equipment

Construction equipment necessary each of for Contract Packages 1 and 2 are shown in **Table 17.3.2-2**.

Table 17.3.2-2 Construction Equipment of Contract Package 1

Category	Equipment	
Earth work	Backhoe (0.8m^3) Bulldozer (20t) Pay Loader (1.5m^3)	Dump Truck (12yd^3) Vibratory Roller (10t) Water Truck (15m^3)
Pavement work	Road Grader Concrete Transit Mixer (30m^3)	Concrete Screed (5.5hp) Concrete Vibrator
Bridge work	Drilling Rig (300hp) Crawler Crane (190t)	Generator (300kw)
Transportation	Roll-On/Roll-Off type Barge	Self-Propelling grab hopper Barge

3) Material Source, Labor Force and Equipment

Material sources and other information for Contract Packages 1 and 2 are shown in **Table 17.3.2-3**.

Table 17.3.2-3 Material Source, Labor Force and Equipment

Item	Conditions
Gravel & Sand	North Segment: Dimapatoy River quarry (North side 40km) South segment: Simuay River quarry (8km from Polloc Port)
Other materials	Cotabato City
Labor force	Skilled Labor: Employed from Cotabato and other areas of Mindanao Unskilled Labor: Employed from the locality (barangays near project site)
Construction equipment	Procured from Cotabato. If necessary procured from other area.

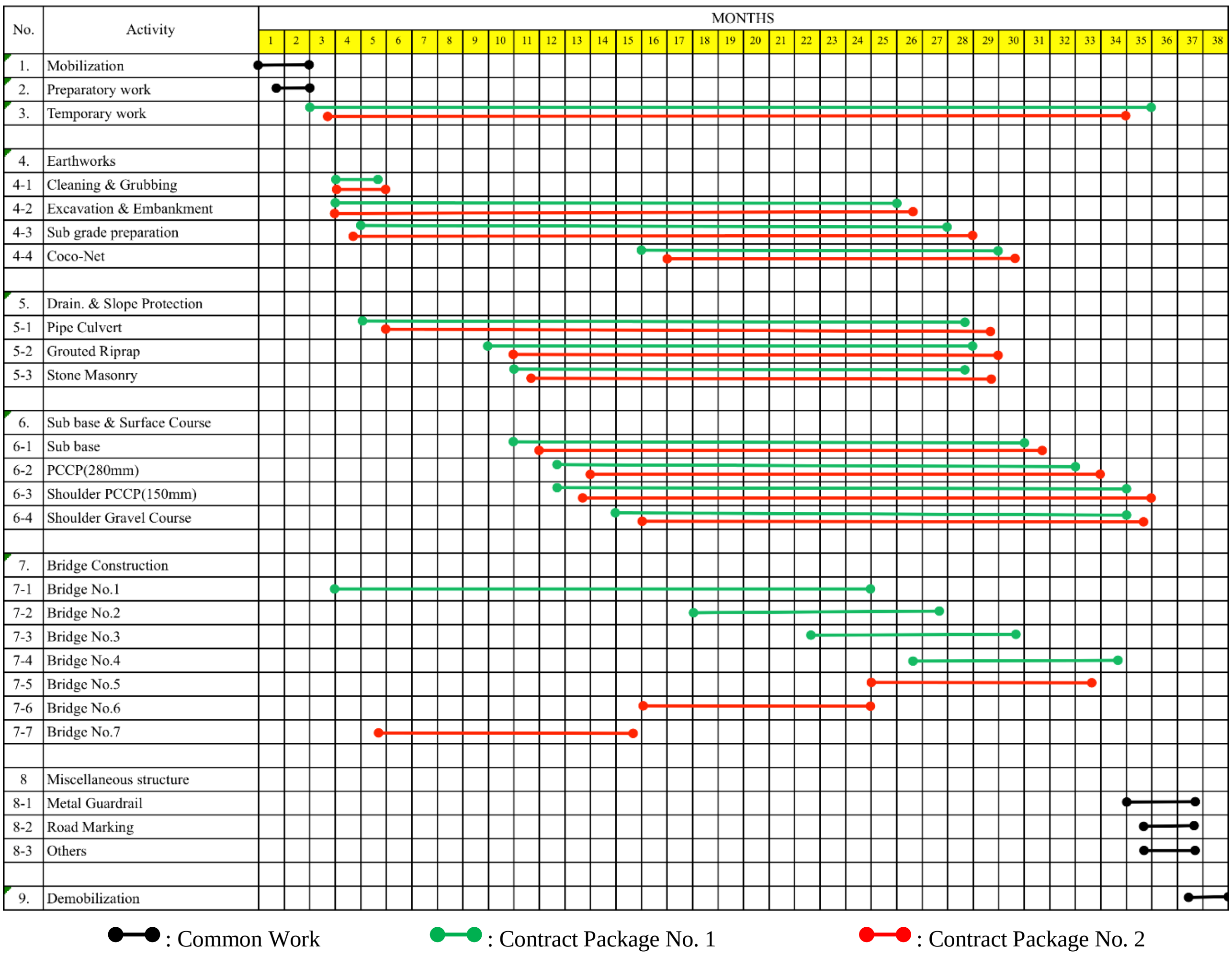
4) Camp Location and Proposed Camp Layout

Proposed camp location is shown in **Figure 17.3.2-1**. Proposed camp layout is shown in **Figure 17.1.2-1** of **Section 17.1.**.

(3) Construction Schedule

Proposed construction schedule of Contract Packages 1 and 2 is shown in **Table 17.3.2-4**. It is estimated that 38 months are required to complete each of Contracts Package 1 and 2.

Table 17.3.2-4 Construction Schedule for Contract Packages 1 and 2



Source: JICA Study Team

17.3.3 Contract Packages of Center Section

(1) General

The center section of Sub-Project 6 is further sub-divided into two (2) Contract Packages as shown in **Figure 17.3.3-1**;

- Contract Package-3: Km. 19+000 – Km. 29+000 (L=10.0 km)
- Contract Package-4: Km. 29+000 – Km. 40+300 (L=11.3 km)

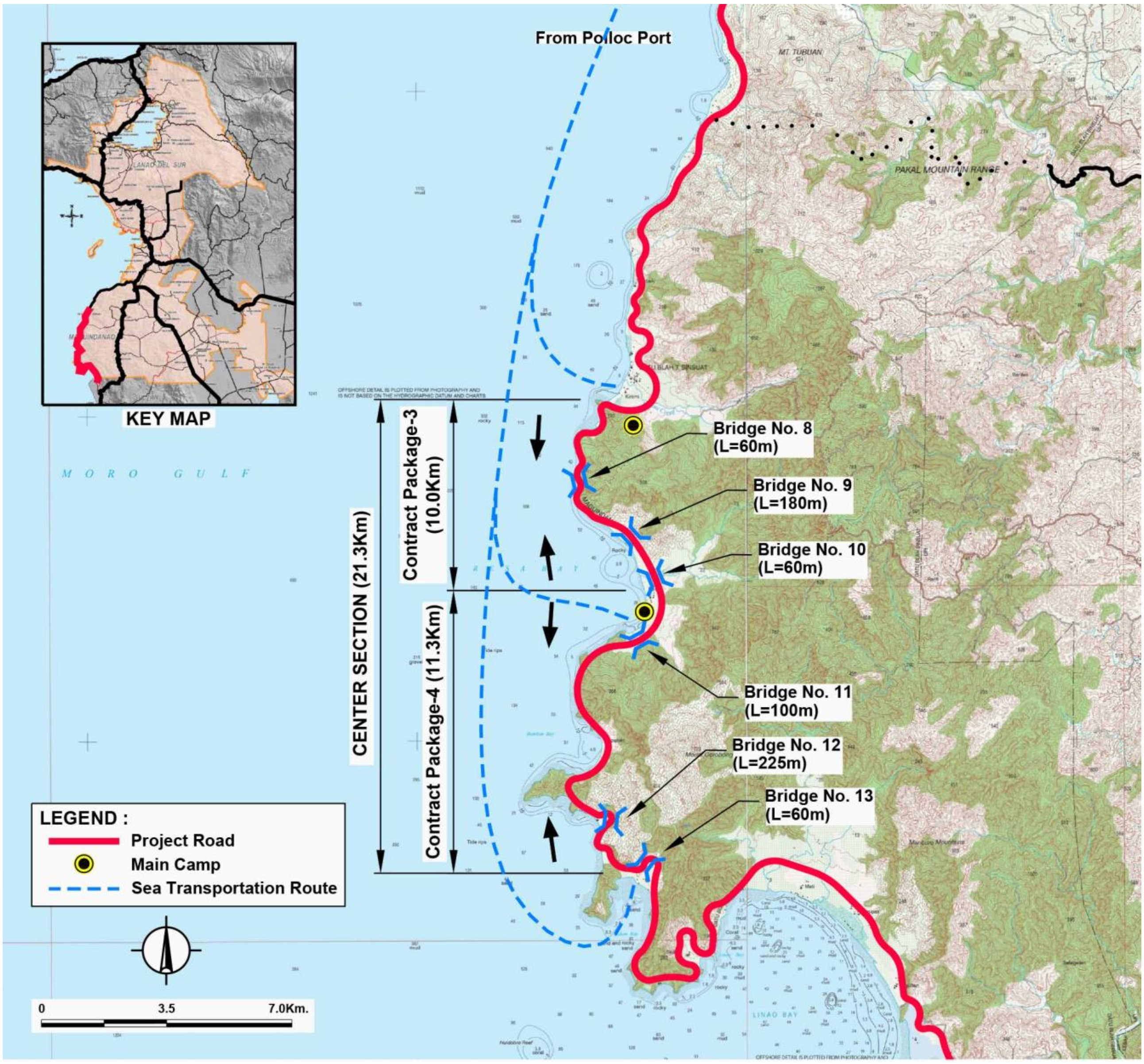


Figure 17.3.3-1 Center Section and Contract Packages 3 and 4

(2) Construction Plan

1) Scope of Civil Work of Contract Packages 3 and 4

Scope of civil work of Contract Packages 3 and 4 is shown in **Table 17.3.3-1**.

Table 17.3.3-1 Scope of Civil Work of Center Section of Sub-Project 6

		Contract Package-3	Contract Package-4	Total
Road Length		10.0 km	11.3 km	21.3 km
Earthwork	Clearing	11.3 ha.	12.7 ha.	24.0 ha.
	Roadway Excavation	17,136 m^3	19,041 m^3	36,177 m^3
	Embankment from Roadway	224,950 m^3	254,194 m^3	479,144 m^3
	Embankment by Borrow	-	-	-
Pavement Work (PCCP, t=280mm)		64,500m^2	73,800m^2	138,300m^2
Shoulder Work	PCC Shoulder (t=15cm)	20,282m^2	22,919m^2	43,201m^2
	Gravel Shoulder	1,954m^3	2,208m^3	4,162m^3
Bridge Work		Bridge No. 8 (L=60m), Bridge No. 9 (L=180m), Bridge No. 10 (L=60m), Bridge No. 11 (L=100m), **Sub-total: 4 Bridges, L=400m**	Bridge No. 12 (L=225m), Bridge No. 13 (L=60m), **Sub-total: 2 Bridges, L=285m**	**6 Bridges, L=685m**
Drainage and Slope Protection Work	RCPC (910mm)	L=60m	L=67m	L=127m
	RCPC (1220m)	L=20m	L=22m	L=42m
	RCBC	L=130m	L=150m	L=280m
	Grouted Riprap	348m^3	393m^3	741m^3
	Stone Masonry	5,482m^3	6,195m^3	11,677m^3
Miscellaneous	Guardrail	5,981m	6,759m	12,740m
	Road Marking	5,507m^2	6,222m^2	11,729m^2
	Coco Net	54,470m^2	61,550m^2	116,020m^2

Source: JICA Study Team

2) Construction Equipment

Construction equipment necessary for Contract Packages 3 and 4 are same as those required by Contract Packages 1 and 2 (refer to **Table 17.3.2-2**).

3) Material Source, Labor Force and Equipment

These requirements are the same as Contract Packages 1 and 2 (refer to **Table 17.2.2-3**).

4) Camp Location and Proposed Camp Layout

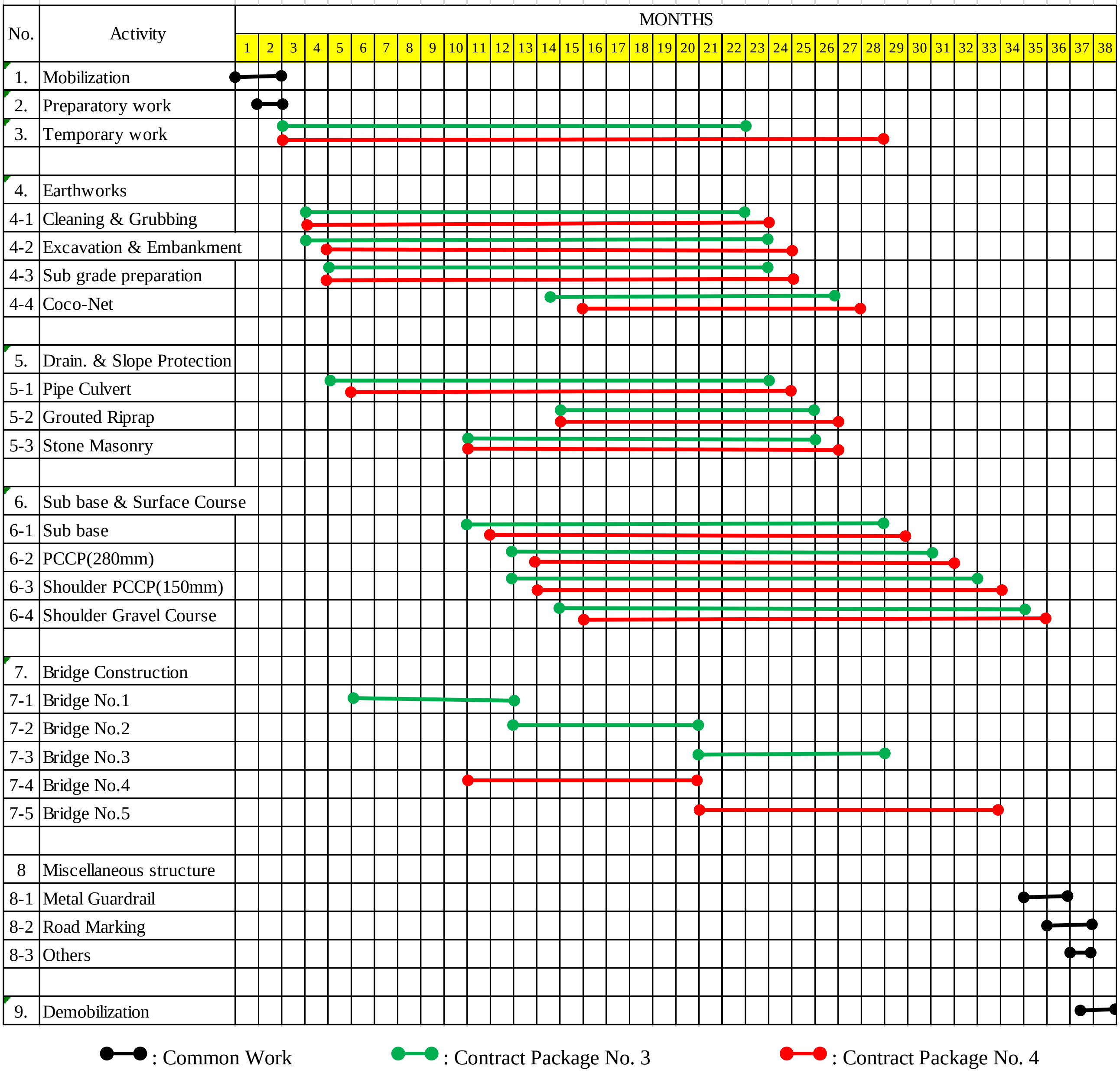
Proposed camp location is shown in **Figure 17.3.3-1**.

Proposed camp layout is shown in **Figure 17.1.2-1** of **Section 17.1**.

(3) Construction Schedule

Proposed construction schedule of Contract Packages 3 and 4 is shown in **Table 17.3.3-2**. It is estimated that 38 months are required to complete Package 3 and 4.

Table 17.3.3-2 Construction Schedule for Contract Packages 3 and 4



Source: JICA Study Team

17.3.4 Contract Packages of South Section

(1) General

The south section of Sub-Project 6 is further sub-divided into two (2) contract packages as shown in **Figure 17.3.4-1**;

- Contract Package-5 : Km. 40+300 – Km. 50+000 (L=9.7 km)
- Contract Package-6 : Km. 50+000 – Km. 62+600 (L=12.6 km)

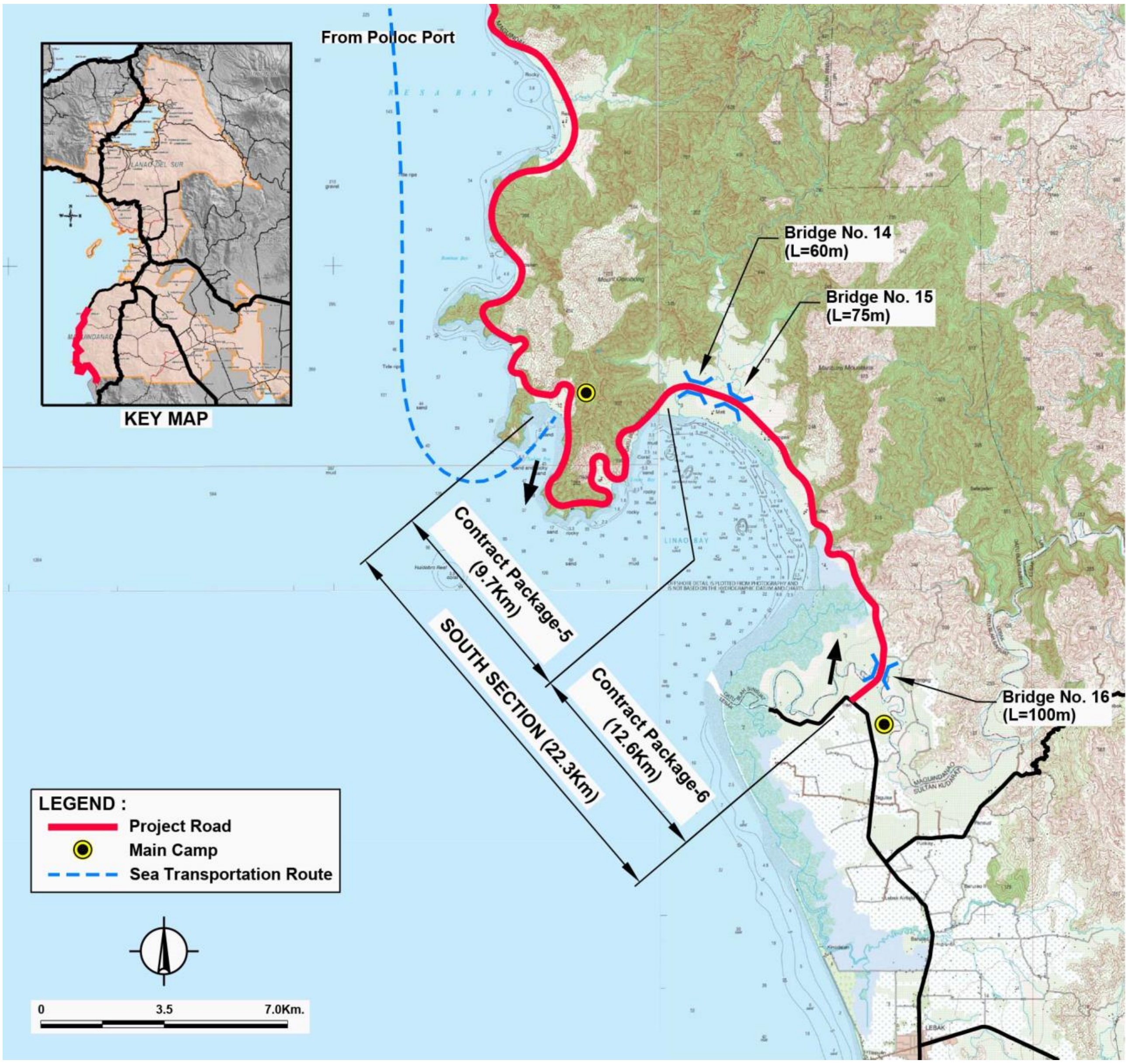


Figure 17.3.4-1 South Section and Contract Packages 5 and 6

(2) Construction Plan

1) Scope of Civil Work of Contract Packages 5 and 6

Scope of civil work Contract Packages 5 and 6 is shown in **Table 17.3.4-1**.

Table 17.3.4-1 Scope of Civil Work of South Section of Sub-Project 6

		Contract Package-5	Contract Package-6	Total
Road Length		9.7 km	12.6 km	22.3 km
Earthwork	Clearing	12.3 ha.	15.9 ha.	28.2 ha.
	Roadway Excavation	68,345 m^3	88,778 m^3	157,123 m^3
	Embankment from Roadway	162,188 m^3	210,678 m^3	372,866 m^3
	Embankment by Borrow	-	-	-
Pavement Work (PCCP, t=280mm)		65,000m^2	83,000m^2	148,000m^2
Shoulder Work	PCC Shoulder (t=15cm)	14,533m^2	18,879m^2	33,412m^2
	Gravel Shoulder	5,534m^3	7,189m^3	12,723m^3
Bridge Work		(No Bridge)	Bridge No. 14 (L=60m), Bridge No. 15 (L=75m), Bridge No. 16 (L=100m), **Sub-total: 3 Bridges, L=235m**	**3 Bridges, L=235m**
Drainage and Slope Protection Work	RCPC (910mm)	L=141.8m	L=184.2m	L=326.0m
	RCPC (1220m)	L=52.2m	L=67.8m	L=120.0m
	RCBC	L=220.0m	L=280.0m	L=500.0m
	Grouted Riprap	363.6m^3	472.0m^3	835.6m^3
	Stone Masonry	5,476m^3	7,113m^3	12,589m^3
Miscellaneous	Guardrail	4,561m	5,924m	10,485m
	Road Marking	5,324m^2	6,916m^2	12,240m^2
	Coco Net	63,438m^2	82,404m^2	145,842m^2

2) Construction Equipment

Construction equipment necessary for Contract Packages 5 and 6 are same as those required by Contract Packages 1 and 2 (refer to **Table 17.3.2-2**).

1) Material Source, Labor Force and Equipment

These requirements are the same as Contract Packages 1 and 2 (refer to **Table 17.2.2-3**).

2) Camp Location and Proposed Camp Layout

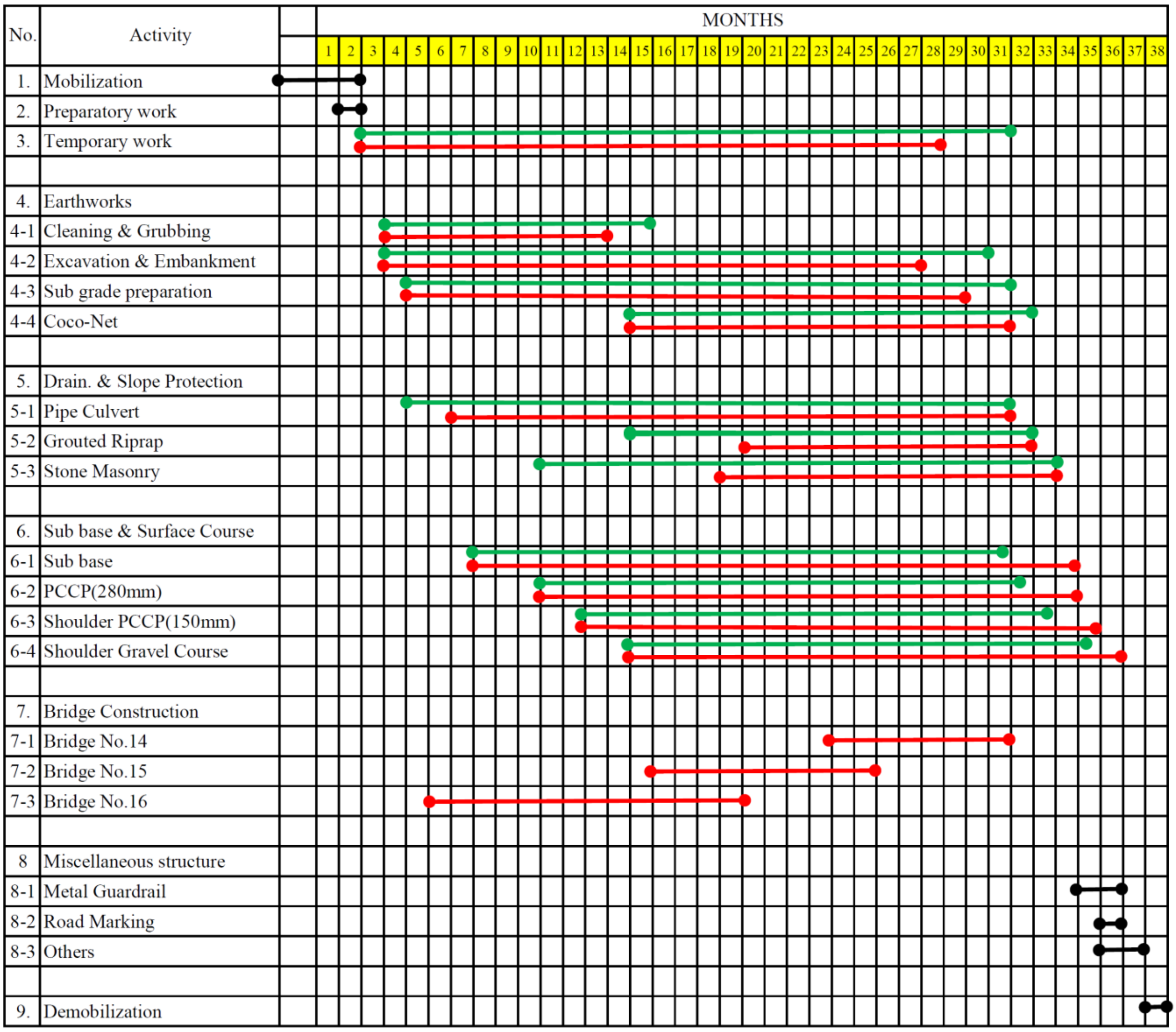
Proposed camp location is shown in **Figure 17.3.3-1**.

Proposed camp layout is shown in **Figure 17.1.2-1** of **Section 17.1**.

(3) Construction Schedule

Proposed construction schedule of Contract Packages 5 and 6 is shown in **Table 17.3.4-2**. It is estimated that 38 months are required to complete each of the Contract Packages of 5 and 6.

Table 17.3.4-2 Construction Schedule for Contract Packages 5 and 6



: Common Work　　: Contract Package No. 5　　: Contract Package No. 6

Source: JICA Study Team

17.4 Sub-Project 7

17.4.1 Contract Packaging

The proposed Marawi City Ring Road captioned as Sub-Project 7 aims to construct an outer ring road in Marawi central area. The west end and the middle part of the road are connected to the National Highway (AH26) while the east end is connected to the Lake Lanao Circumferential Road. The proposed road has a total length of about 19.8 km.

As shown in **Figure 17.4.1-1**, **S**ub-project 7 will be divided into two (2) contract packages (West Side section and East Side section). Access to the west side section can be made by Cotabato-Marawi-Iligan Road (National Road), while access to the east side section is made by Cotabato-Marawi-Iligan Road and Lanao Lake Circumferential Road.

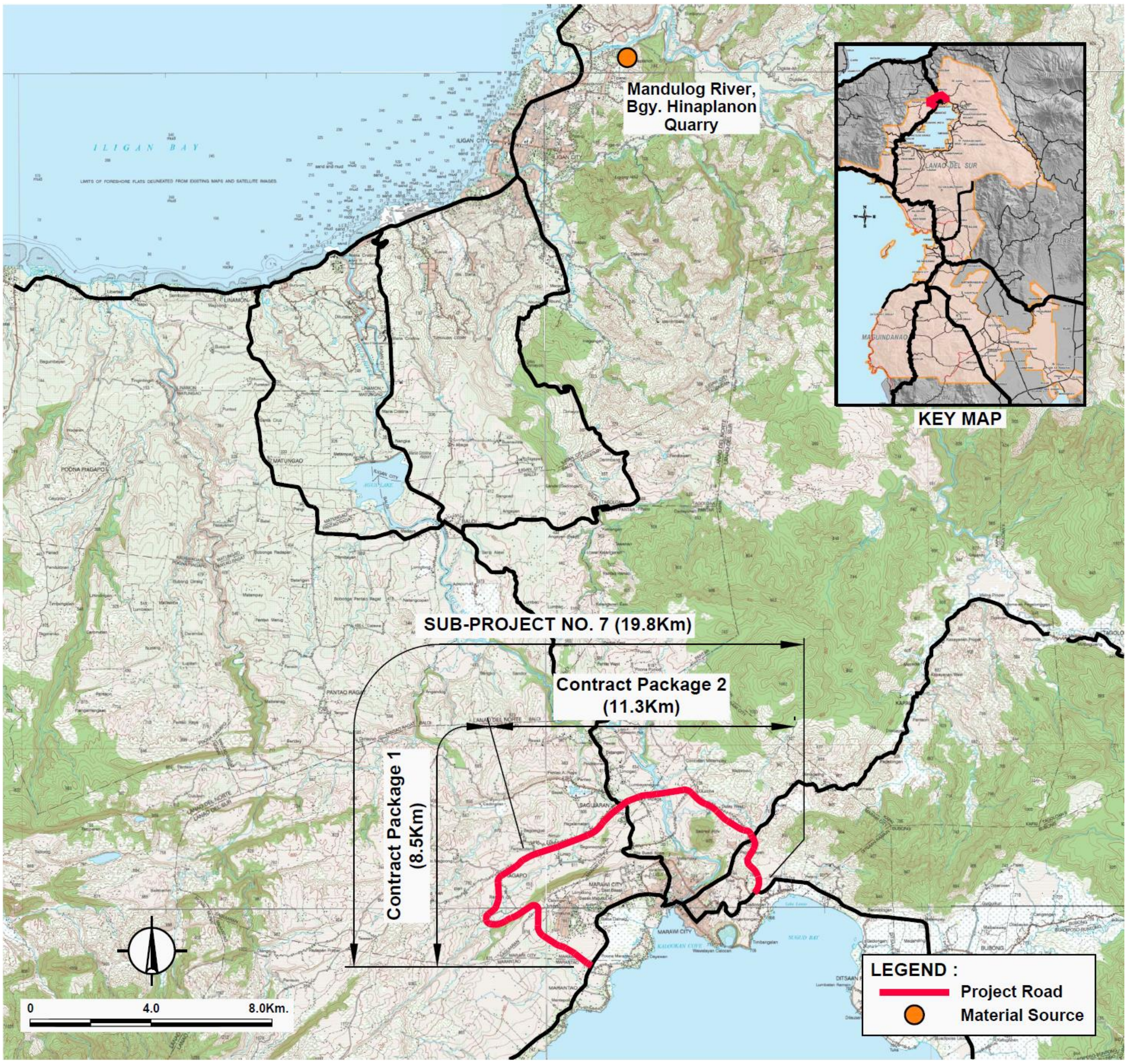


Figure 17.4.1-1 Construction Site and Packages

17.4.2 Contract Package 1 (Sta.0 – Sta.8+500)

Contract Package 1 (CP-1) is one segment with total length of 8.50 Km. For this package, two (2) construction camps: Main and Branch Camps will be prepared at each ends of the Contract Package, as shown in **Figure 17.4.2-1**.

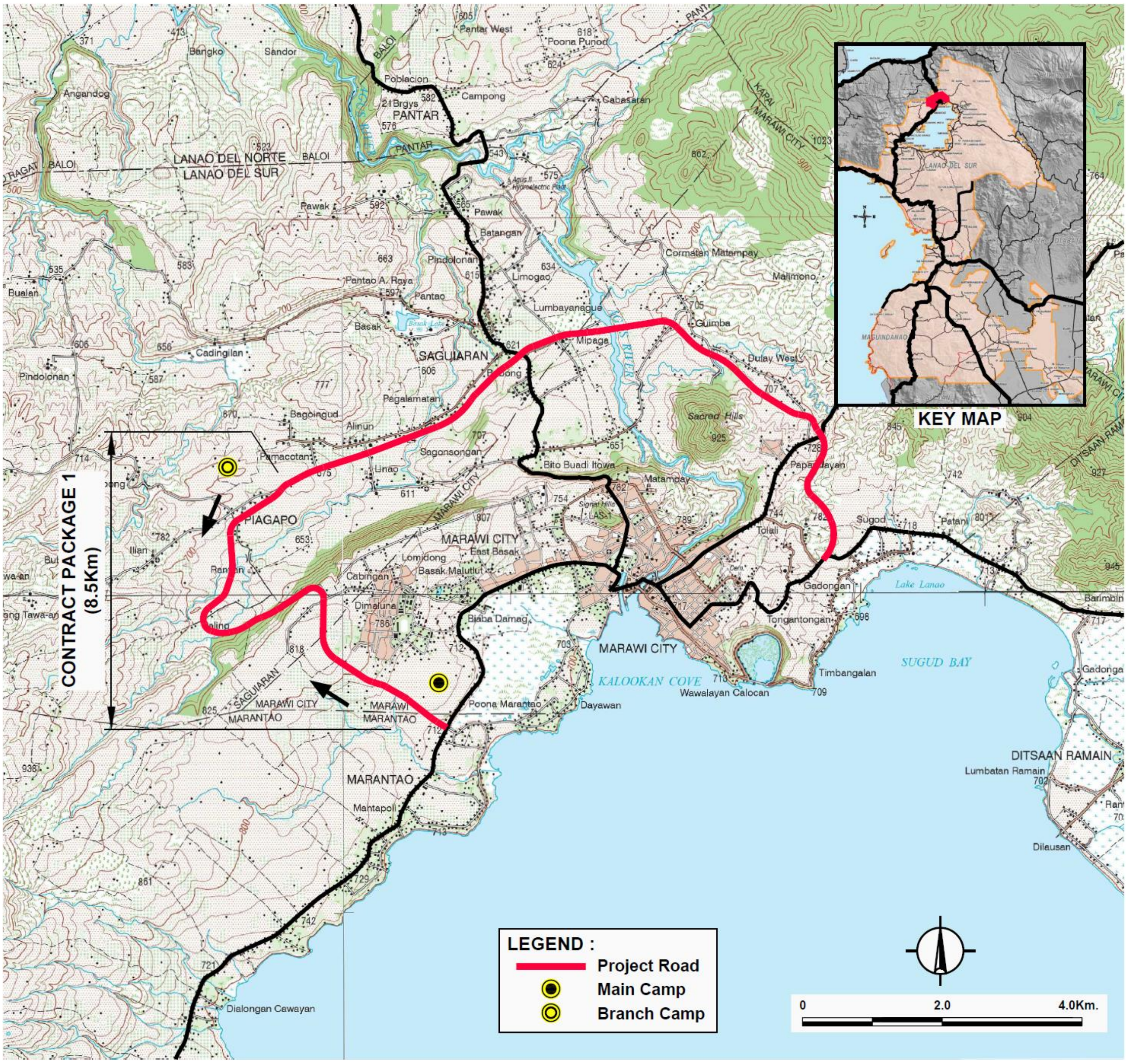


Figure 17.4.2-1 Construction Site for Contract Package 1

(1) Construction Plan

1) Contents of CP-1 Construction Work

Construction items of CP-1 are shown in **Table 17.4.2-1**.

Table 17.4.2-1 Construction Item of CP-1

Item	Contents
Road Length	8.5km (Road Length: 8,500m)
Earth Work	Clearing: 23.40 ha Road Excavation: 193,000m^3, Embankment from Roadway Excavation: 142,000m^3
Pavement Work	PCCP (280mm): 63,734m^2

Item	Contents
Road Shoulder Work	PCCP shoulder (150mm): 24,437m^2 Gravel surface shoulder: 3,330m^3
Drainage & Slope Protection Work	RCPC (910mmR 17places): 340m RCPC (1,220mmR 2places): 39m RCBC (1.25x1.0 place): 16m RCBC (1.5x1.5 1place): 34m Grout Riprap: 625m^3 Stone masonry: 7,554m^3 Hand Laid Rock Embankment: 2,883m^3
Miscellaneous Work	Guardrail: 4,675m Chevron Signs: 339ea Road markings: 2,125m2 Coco-net: 28,099m2

(2) Construction Equipment

Construction equipment necessary for Contract Package 1 is shown in **Table 17.4.2-2**.

Table 17.4.2-2 Construction Equipment of Contract 1

Category	Equipment	
Earth Work	Backhoe (0.8m^3) Bulldozer (20t) Pay Loader (1.5m^3)	Dump Truck (12yd^3) Vibratory Roller (10t) Water Truck (15m^3)
Pavement Work	Road Grader Transit Mixer (30m^3)	Concrete Screed (5.5hp) Concrete Vibrator

(3) Material Source, Labor Force and Equipment

Material source and other information are shown in **Table 17.4.2-3**.

Table 17.4.2-3 Material source, Labor Force and Equipment

Item	Conditions
Gravel & Sand	Mandulog River, Brgy, Hinaplanon quarry (North side 59km)
Other materials	Iligan City
Labor force	Skilled labor: Employed from Iligan and other areas of Mindanao Unskilled labor: Employed from locality (barangays near project site)
Construction equipment	Procured from Iligan. If necessary procured from other area.

(4) Main and Branch Construction Camp

The selection of construction yard for each package is definitely important. Appropriate locations of one main temporary camp and one sub camp for construction should be identified. Although the construction yard is only a temporary site, however, large volume of concrete materials through the concrete batching plant shall be required, hence, an appropriate area for this yard is needed in the east segment. The selection of temporary yard for construction will be decided during the detailed design stage, and the contractor will select the proper location of the construction site and its area size during tender procedure. Proposed Main Camp and Branch Camp Location and size are shown in **Section 17.1**.

(5) Construction schedule of Contract Package 1

Proposed construction schedule of Contract Package 1 is shown in **Table 17.4.2-4**. It is estimated that 28 months are required to complete Package 1.

Table 17.4.2-4 Construction Schedule for Contract Package 1

No.	Activity	MONTHS (1–36)
1.	Mobilization	
2.	Preparatory work	
3.	Temporary work	
4.	Earthworks	
4-1	Cleaning & Grubbing	
4-2	Excavation & Embankment	
4-3	Sub grade preparation	
4-4	Coco-Net	
5.	Drain. & Slope Protection	
5-1	Pipe Culvert	
5-2	Grouted Riprap	
5-3	Stone Masonry	
6.	Sub base & Surface Course	
6-1	Sub base	
6-2	PCCP(280mm)	
6-3	Shoulder PCCP(150mm)	
6-4	Shoulder Gravel Course	
7.	Bridge Construction	
8	Miscellaneous structure	
8-1	Metal Guardrail	
8-2	Road Marking	
8-3	Others	
9.	Demobilization	

17.4.3 Contract Package 2 (Sta.8+500 - Sta.19+800)

Contract Package 2 is one segment with total length of 11.30 Km. For this package, two (2) construction camps: Main and Branch camps will be installed at west side and east end of the Package, as shown in **Figure 17.4.3-1**.

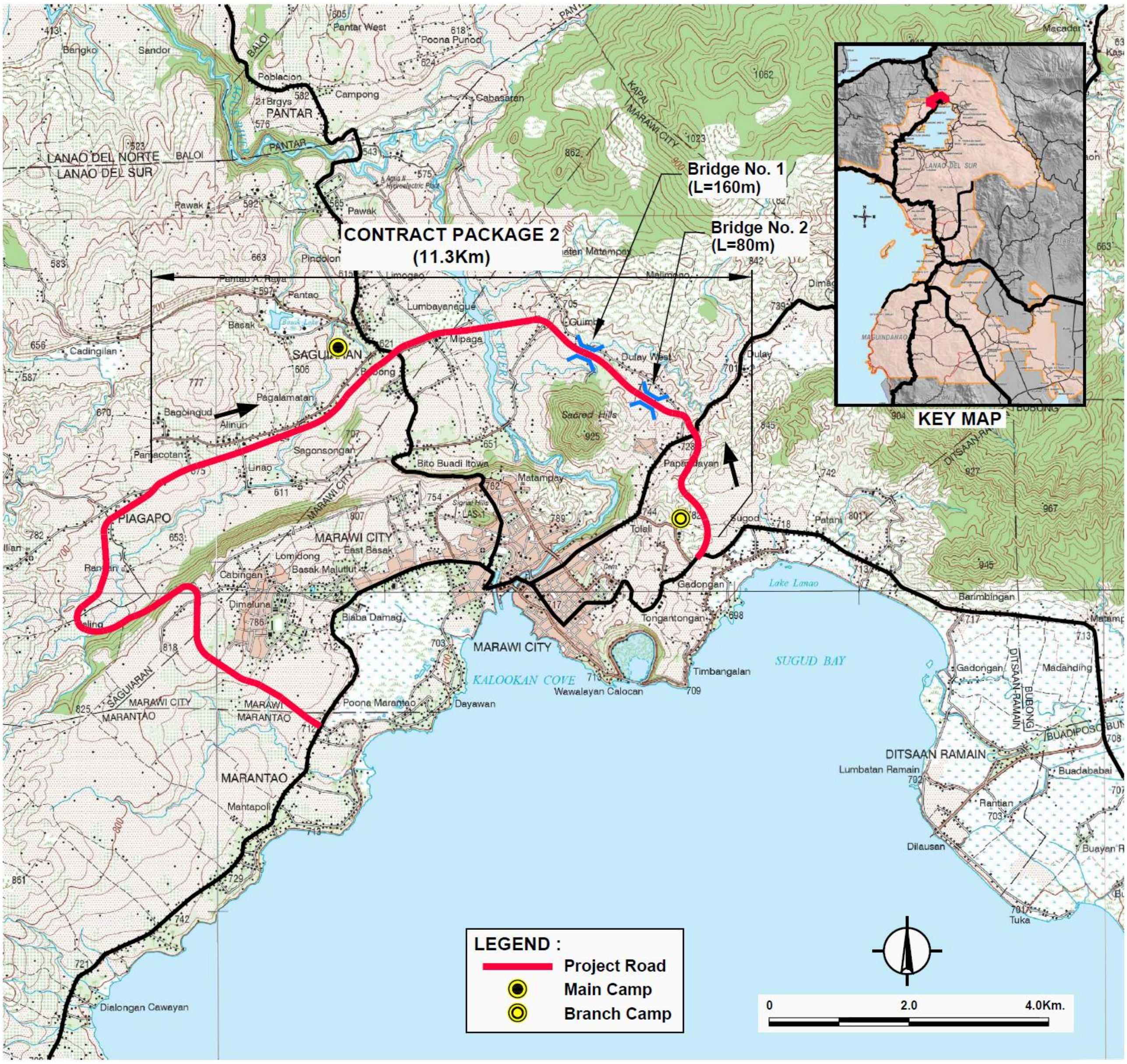


Figure 17.4.3-1 Construction Site for Contract Package 2

(1) Construction Plan

1) Contents of Contract Package 2 Construction Work

Construction items of Contract Package 2 is shown in **Table 17.4.3-1**.

Table 17.4.3-1 Construction Items of Contract Package 2

Item	Contents
Road length	11.312km (Road length: 10,852m, Bridge length: 460m)
Earth work	Clearing: 23.4ha, Road Excavation: 193,000m3, Embankment from Roadway Excavation: 142,000m^3
Pavement work	PCCP (280mm): 63,734m^2
Road shoulder work	PCCP shoulder (150mm): 24,437m^2 Gravel surface shoulder: 3,330m^3
Drainage & slope protection work	RCPC (910mmR 17places): 340m RCPC (1,220mmR 2places): 39m RCBC (1.25x1.0 place): 16m RCBC (1.5x1.5 1place): 34m Grout Riprap: 625m^3 Stone masonry: 7,554m^3 Hand Laid Rock Embankment: 2,883m^3
Miscellaneous work	Guardrail: 4,675m Chevron Sings: 339ea Road markings: 2,125m^2 Coco-net: 28,099m^2

(2) Construction Equipment

Construction equipment necessary for Contract Package 2 is shown in **Table 17.4.3-2**.

Table 17.4.3-2 Construction Equipment for Contract Package 2

Category	Equipment	
Earth work	Backhoe (0.8m^3) Bulldozer (20t) Pay loader (1.5m^3)	Dump truck (12yd^3) Vibratory roller (10t) Water truck (15m^3)
Pavement work	Road grader Transit mixer (30m^3)	Concrete screed (5.5hp) Concrete vibrator
Bridge work	Drilling rig (300hp) Crawler crane (190hp)	Generator (300kw)

(3) Material Source, Labor Force and Equipment

Material source and other information for Contract Package 2 is shown in **Table 17.4.3-3**.

Table 17.4.3-3 Material Source, Labor Force and Equipment

Item	Conditions
Gravel & Sand	Mandulog River, Brgy, Hinaplanon quarry (North side 59km)
Other materials	Iligan City
Labor force	Skilled labor: Employed from Iligan and other areas of Mindanao Unskilled labor: Employed from locality (barangays near project site)
Construction equipment	Procured from Iligan. If necessary procured from other area.

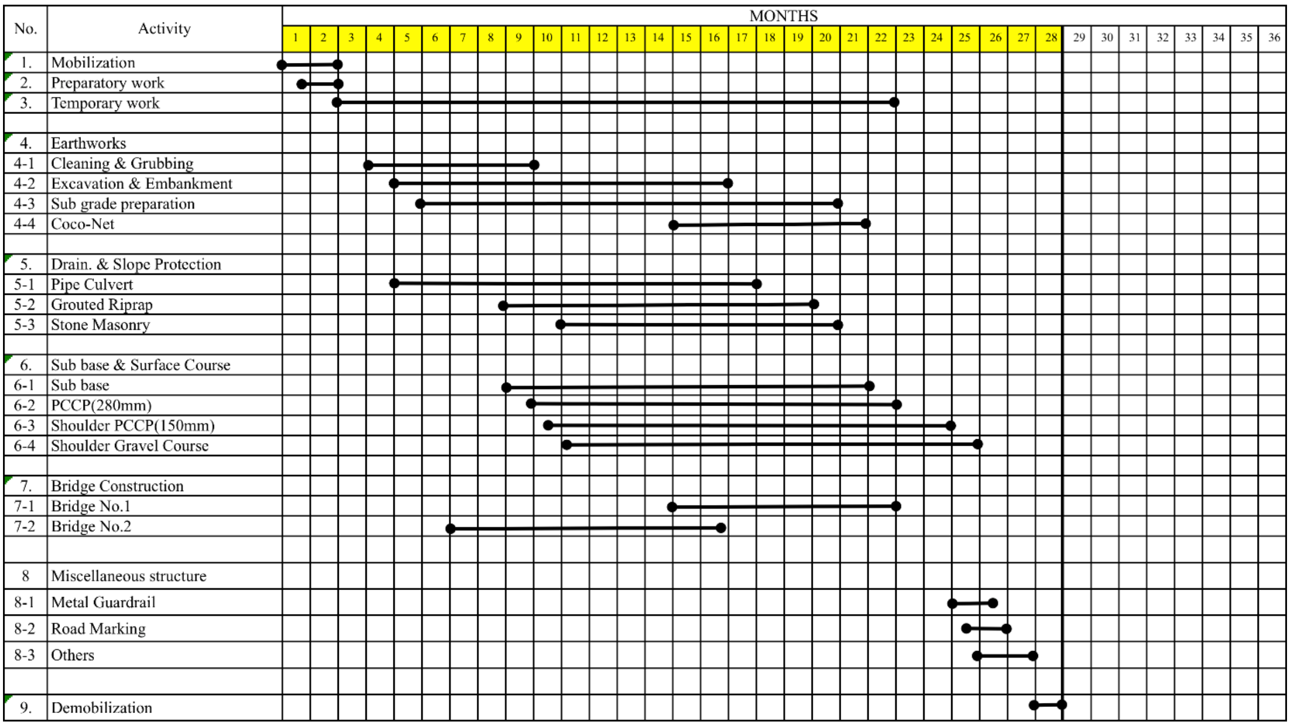
(4) Main and Branch Camp

The selection of construction yard for each package is definitely important. Appropriate locations of one main camp and one branch camp for construction should be identified. Although the construction yard is only a temporary site, however, large volume of concrete materials through the concrete batching plant shall be required, hence, an appropriate area for this yard is needed. Proposed Main Camp and Branch Camp Location and size are shown in **Section 17.1**.

(5) Construction schedule

Proposed construction schedule of Contract Package 2 is shown in. It is estimated that 28 months are required to complete Package 2.

Table 17.4.3-4 Construction Schedule for Contract Package 2



17.5 Sub-Project 8

17.5.1 Contract Packaging

The project is to construct a bypass road of Parang Municipality Center and passes through rolling to mountainous terrain. This sub-project has a total length of 7.0km, therefore, there is no need to divide the sub-project into smaller contract package. A total of Sub-Project 8 constitute one (1) contract package.

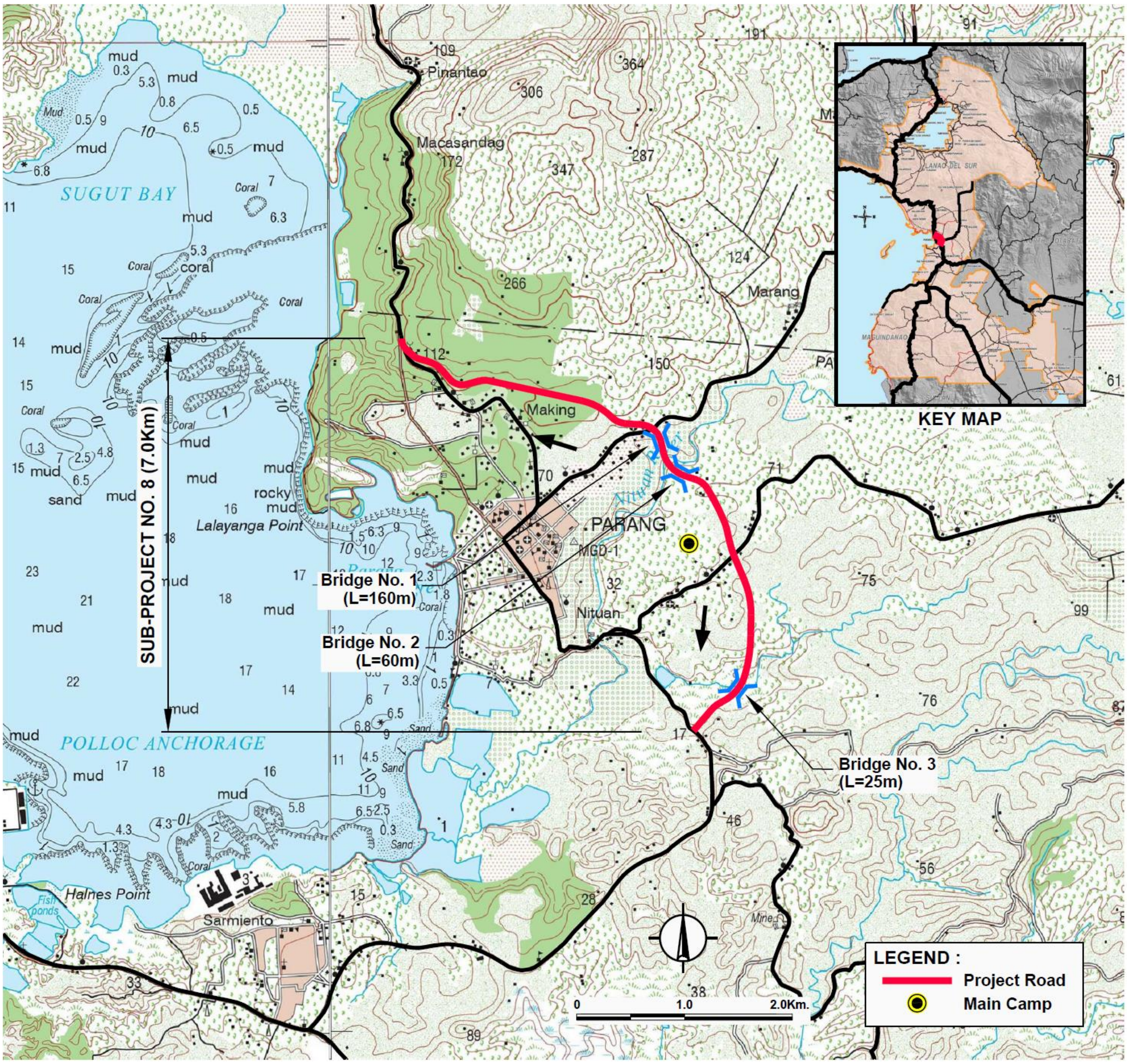


Figure 17.5.1-1 Construction Site

17.5.2 Construction Plan

(1) Contents of Construction Work

Construction work items of Sub-Project 8 are shown in **Table 17.5.2-1**.

Table 17.5.2-1 Construction Work Items of Sub-Project 8

Item	Contents
Road length	6.963km (Road length: 6,718m; Bridge length: 245m)
Earth work	Clearing: 18.4ha Roadway Excavation: 37,000m^3 Embankment from Roadway: 121,000m^3
Pavement work	PCCP (280mm): 52,995m^2
Road shoulder work	PCCP shoulder (150mm): 19,312m^2 Gravel surface shoulder: 2,641m^3
Bridge	Bridge No.1: L=160m, Sta. 3+140- 3+300 Bridge No.2: L=60m, Sta. 3+560- 3+620 Bridge No.3: L=25m, Sta. 6+360- 6+385
Drainage & slope protection work	RCPC (610mmR 1places): 32m RCPC (910mmR 20places) 403m Stone masonry: 600m^3
Miscellaneous work	Guardrail: 4,505m Chevron Signs: 411ea Road markings: 1,741m^2 Coco-net: 29,261m^2

(2) Construction Equipment

Construction equipment necessary for Sub-Project 8 is shown in **Table 17.5.2-2**.

Table 17.5.2-2 Construction Equipment of Sub-Project 8

Category	Equipment	
Earth work	Backhoe (0.8m^3) Bulldozer (20t) Pay loader (1.5m^3)	Dump truck (12yd^3) Vibratory roller (10t) Water truck (15m^3)
Pavement work	Road grader Transit mixer (30m^3)	Concrete screed (5.5hp) Concrete vibrator
Bridge work	Drilling rig (300hp) Crawler crane (190hp)	Generator (300kw)

(3) Material Source, Labor Force and Equipment

Material source and other procurement sources are shown in **Table 17.5.2-3**.

Table 17.5.2-3 Material Source, Labor Force and Equipment

Item	Conditions
Gravel & Sand	Simuay River quarry (South side 12km of Sub-Project -8)
Other materials	Parang, Maguindanao and Cotabato City
Labor force	Skilled labor: Employed from Parang and other areas of Mindanao Unskilled labor: Employed from neighbor barangays
Construction equipment	Procured from Cotabato City. If necessary, procured from other areas.

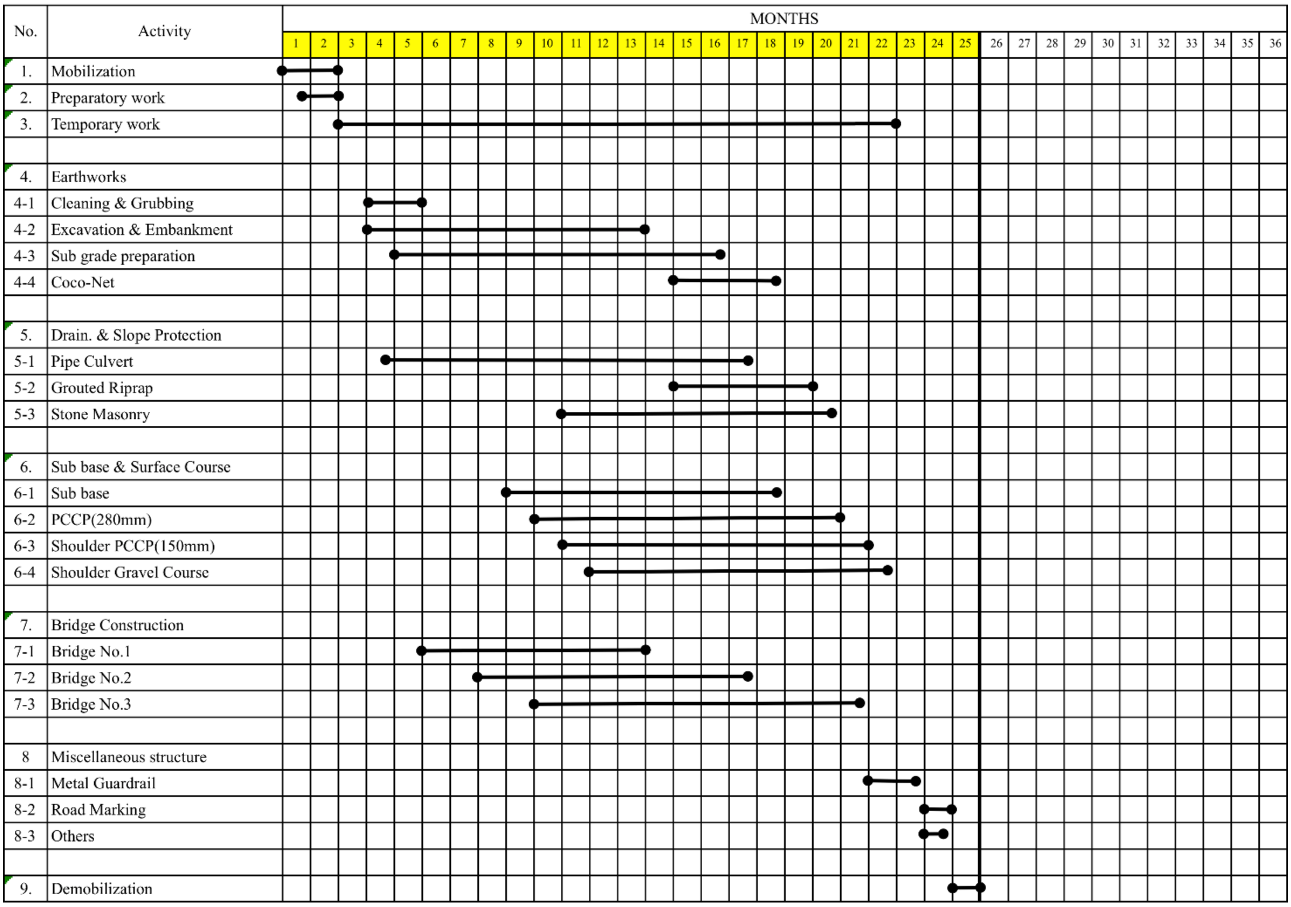
(4) Camp Location

Proposed location of a main camp and size is shown in **Figure 17.5.1-1** and **Section 17.1**.

17.5.3 Construction Schedule

Construction schedule is shown in **Table 17.5.3-1**. It was estimated that 25 months are required to complete the required work.

Table 17.5.3-1 Construction Schedule for Sub-Project 8



17.6 Sub-Project 9

17.6.1 Contract Packaging

The proposed Manuangan-Parang Road with total length of 16.80 Km is planned as a short-cut road to connect the existing Pigcawayan-Sultan Kudarat-Sultan Mastura-Parang National Highway (AH26). The proposed road will also provide access to the productive agricultural areas of the hinterland barangays of the municipalities of Sultan Kudarat, Sultan Mastura and Parang, all in the province of Maguindanao and inner barangays of Pigcawayan, North Cotabato. The alignment crosses a wide river of Simuai River. Therefore, this sub-project is divided into two (2) Contract Packages;

- Contract Package-1 : North of Simuai River
- Contract Package-2 : South of Simuai River

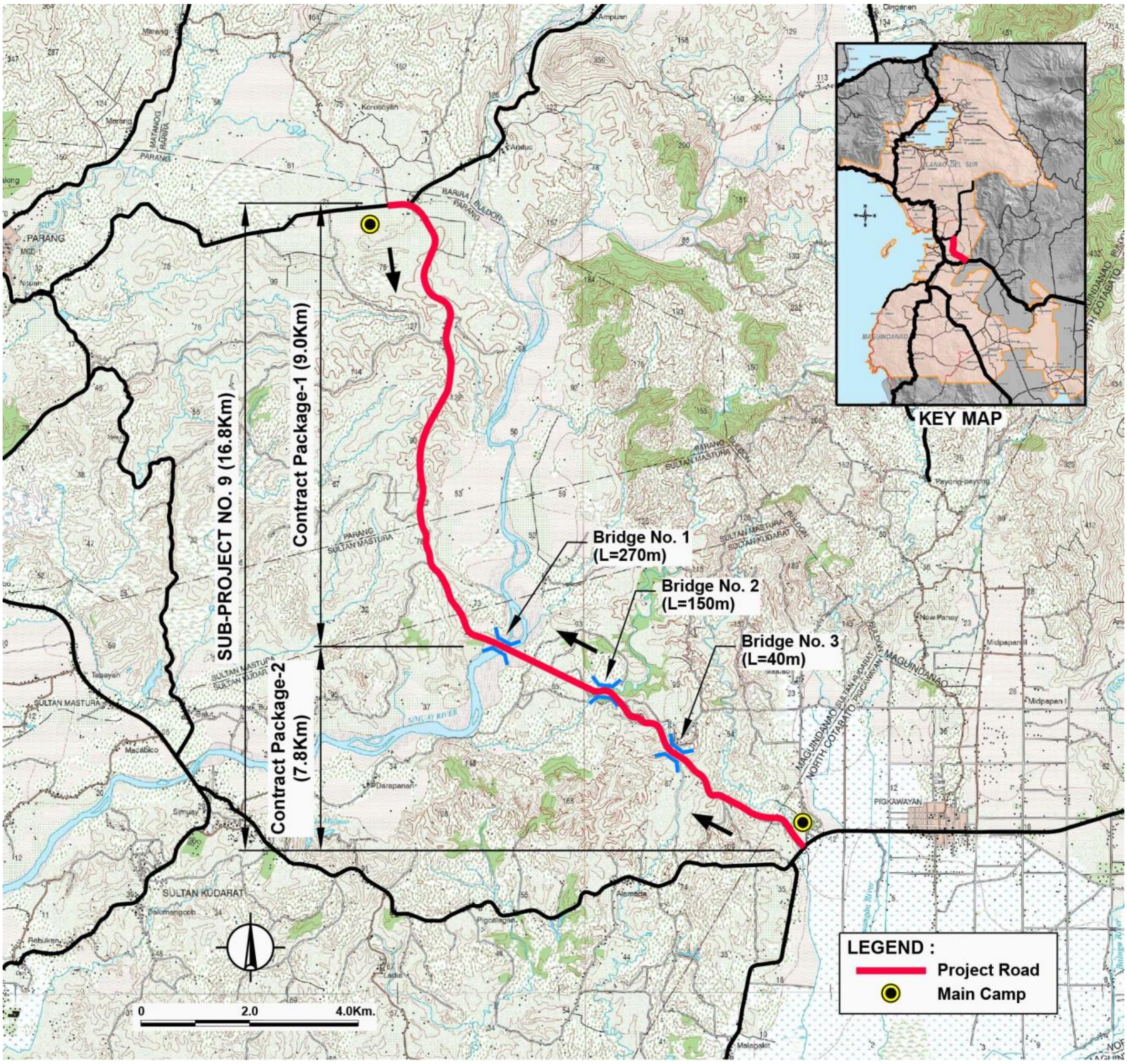


Figure 17.6.1-1 Construction Site and Contract Packages

17.6.2 Construction Plan

(1) Contents of the Sub-Project -9 Construction Work

Scope of civil work of Sub-Project 9 is shown in **Table 17.6.2-1**.

Table 17.6.2-1 Scope of Civil Work of Sub-Project 9

		Contract Package-1	Contract Package-2	Total
Road Length		9.0 km	7.8 km	16.8 km
Earthwork	Clearing	18.8 ha.	16.3 ha.	35.1 ha.
	Roadway Excavation	27,320 m^3	23,678 m^3	50,998 m^3
	Embankment from Roadway	109,281 m^3	94,710 m^3	203,991 m^3
	Embankment by Borrow	15,594 m^3	13,515 m^3	29,109 m^3
Pavement Work (PCCP, t=280mm)		57,673m^2	49,983m^2	107,656m^2
Shoulder Work	PCC Shoulder (t=15cm)	9,546m^2	8,274m^2	17,820m^2
	Gravel Shoulder	2,874m^3	2,491m^3	5,365m^3
Bridge Work		No Bridge	Bridge No. 1 (L=270m), Bridge No. 2 (L=150m), Bridge No. 3 (L=40m), **Total: 3 Bridges, L=460m**	**3 Bridges, L=460m**
Drainage and Slope Protection Work	RCPC (910mm)	L=514m	L=446m	L=960m
	RCPC (1220m)	-	-	-
	RCBC	L=82m	L=63m	L=145m
	Grouted Riprap	357m^3	309m^3	666m^3
	Stone Masonry	468m^3	405m^3	873m^3
Miscellaneous	Guardrail	6,147m	5,327m	11,474m
	Road Marking	4,942m^2	4,284m^2	9,226m^2
	Coco Net	33,628m^2	29,144m^2	62,772m^2

Source: JICA Study Team

(2) Construction Equipment

Construction equipment necessary for Sub-Project 9 is shown in **Table 17.6.2-2**.

Table 17.6.2-2 Construction Equipment for Sub-Project 9

Category	Equipment	
Earth work	Backhoe (0.8m^3) Bulldozer (20t) Pay loader (1.5m^3)	Dump truck (12yd^3) Vibratory roller (10t) Water truck (15m^3)
Pavement work	Road grader Transit mixer (30m^3)	Concrete screed (5.5hp) Concrete vibrator

Category	Equipment	
Bridge work	Drilling rig (300hp) Crawler crane (190hp)	Generator (300kw)

(3) Sources of Material, Labor Force Source and Equipment

Sources of materials, labor force and equipment are shown in **Table 17.6.2-3**.

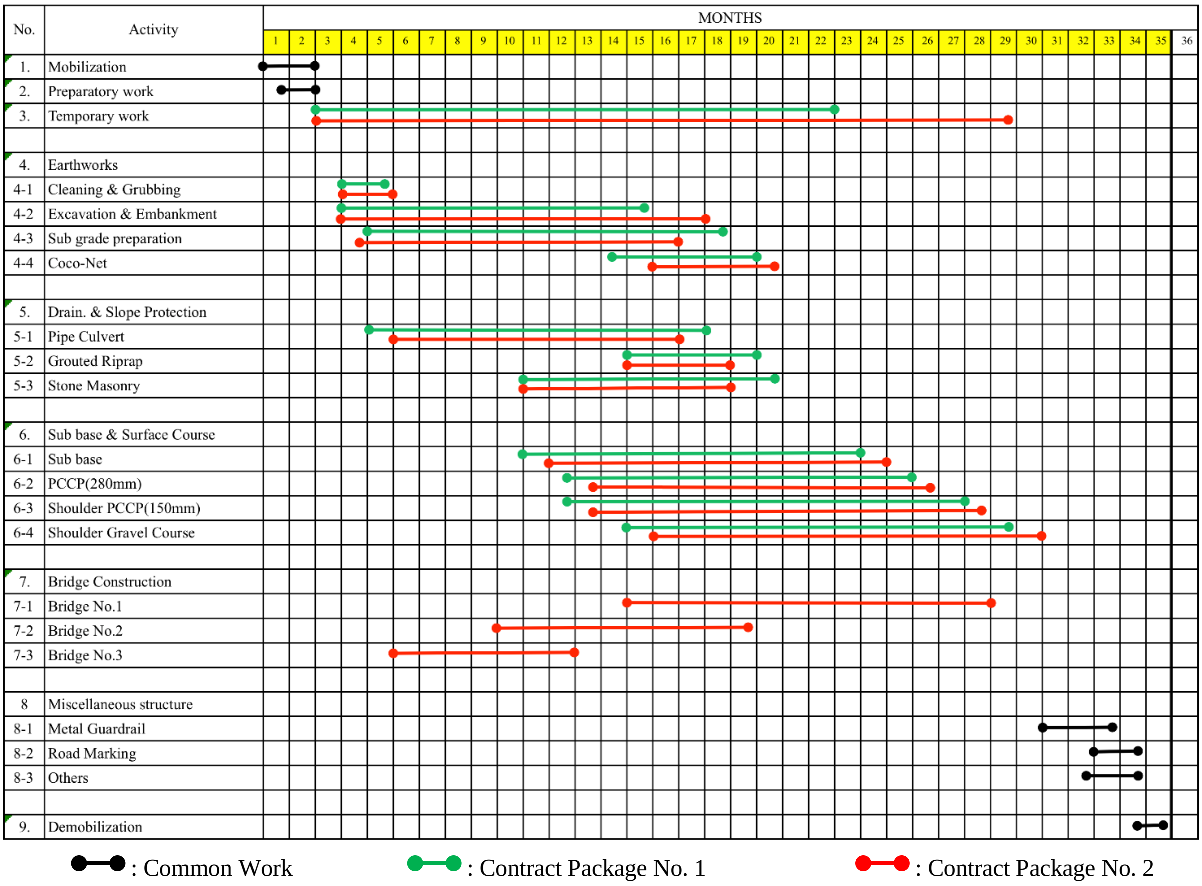
Table 17.6.2-3 Sources of Material, Labor Force and Equipment

Item	Conditions
Gravel & Sand	Simuay River quarry (South side 25km of Sub-Project 9)
Other materials	Cotabato City
Labor force	Skilled labor: Employed from Cotabato City and other areas of Mindanao Unskilled labor: Employed from neighbor barangays
Construction equipment	Procured from Cotabato City. If necessary, procured from other areas.

17.6.3 Construction schedule

Proposed construction schedule is shown in **Table 17.6.3-1**. It is estimated that 35 months are required to complete this sub-project.

Table 17.6.3-1 Construction Schedule for Sub-Project 9



Source: JICA Study Team

Chapter 18 Construction Cost Estimate

18.1 Sub-Project 1

Construction Cost estimates were prepared based on the following parameters:

- Unit prices for civil work items were estimated using year 2017 market prices;
- Facilities for engineers and other general requirements were estimated based on previous costs of similar projects.

Construction cost was composed of nine components, as follows;

A. Facilities for Engineers
B. Other General Requirements
C. Earth Work
D. Subbase and Base Course
E. Surface course
F. Bridge Structure
G. Drainage and Slope Protection
H. Miscellaneous Items
I. Farm to Market Roads

18.1.1 Methodology Adopted in the Preparation of Construction Cost Estimates

The unit price analysis was adopted to come up with unit cost for each item of construction work. Different work items for earthwork, subbase and base course, surface course, bridge construction, drainage and slope protection work, miscellaneous items, and farm to market road were estimated. These unit costs were then applied to estimated quantity of each work item based on preliminary design, to come-up with construction cost for each work item.

While, the provision of facilities and/or field office for engineers and other general requirements, such as, project billboards, occupational safety and health program, traffic management, mobilization/demobilization, etc. were based on costs of previous similar project.

18.1.2 Procedures Undertaken to come-up with Construction Cost Estimate

The following procedures were used to derive the construction cost:

1) Unit price analysis of major construction items were undertaken composing of the following items;

- Labor Costs
- Equipment Costs: Equipment lease cost indicated in Association of Carriers and Equipment Lessors, ACEL was used.
- Material Costs were based on the prices determined and announced by DPWH.

2) Unit prices were broken into its components, namely foreign, local and tax components and also cost of unskilled and skilled laborers, material and equipment.

18.1.3 Unit Price Analysis

The construction cost estimate is basically composed of the direct cost and indirect cost. The computations are in accordance with the DPWH Standard Specifications implementing guidelines and memorandum order relative to unit price analysis.

1) Cost of Material

Cost of materials was based on the cost provided by DPWH.

2) Cost of Equipment

The cost of equipment is based on "ACEL" rental rates which include operator's wages, fringe benefits, fuel, oil, lubricants and equipment maintenance.

3) Cost of Labor

Labor costs used in the analysis are the wages authorized by the Department of Labor and Employment. All fringe benefits such as vacation and sick leaves, Workmen's Compensation Act, GSIS and SSS contributions, allowance, and bonus, are taken into account.

18.1.4 Estimated Construction Cost

(CONFIDENTIAL)

18.2 Sub-Project 2

18.2.1 Procedure of Construction Cost

Procedure of construction cost estimate was discussed in **Section 18.1.2**.

18.2.2 Estimated Construction Cost

(CONFIDENTIAL)

18.3 Sub-Project 6

18.3.1 Procedure of Construction Cost

Procedure of construction cost estimate was discussed in **Sub-Section 18.1.2**.

18.3.2 Estimated Construction Cost

(CONFIDENTIAL)

18.4 Sub-Project 7

18.4.1 Procedure of Construction

Procedure of construction cost estimate was discussed in **Section 18.1.2**.

18.4.2 Estimated Construction

(CONFIDENTIAL)

18.5 Sub-Project 8

18.5.1 Procedure of Construction Cost

Procedure of construction cost estimate was discussed in **Section 18.1.2**.

18.5.2 Estimated Construction Cost

(CONFIDENTIAL)

18.6 Sub-Project 9

18.6.1 Procedure of Construction Cost

Procedure of construction cost estimate was discussed in **Section 18.1.2**.

18.6.2 Estimated Construction Cost

(CONFIDENTIAL)

Chapter 19 Estimated Project Cost

19.1 Basic Condition of Project Cost Estimate

(1) Exchange Rate

Monthly average exchange rate between Japanese Yen and United States Dollars was referred to the central rate information issued by the Bank of Japan. The one between Philippines Pesos and United States Dollars was referred to the International Monetary Fund (IMF) data issued originally from the Philippines Central Bank (Bangko Sentral ng Pilipinas). As a result, the average rates (1 Philippine Peso = 2.08 Japanese Yen, 1 United States Dollar = 108.0 Japanese Yen, hence, 1 United States Dollar = 51.8 Philippine Pesos) were applied in this project.

(2) Construction Cost

(CONFIDENTIAL)

(3) Engineering Services Cost

Engineering services costs were estimated on the following cases;

Case-1: One Engineering Consultant for each Sub-Project

Case-2: All Sub-Projects by One Engineering Consultant

(CONFIDENTIAL)

(4) Right-of-Way Acquisition Cost

Right-of-way acquisition and compensation cost and external monitoring cost are summarized in **Table 19.1-1.**

Table 19.1-1 ROW Acquisition, Compensation and External Monitoring Cost

(Unit: Million PhP)

Sub-Project	ROW Acquisition Cost	Compensation Cost	External Monitoring Cost	Total
SP-1	43.5	2.2	1.0	**46.7**
SP-2	34.9	3.8	1.0	**39.7**
SP-6	63.3	5.2	1.0	**69.5**
SP-7	19.8	3.3	1.0	**24.1**
SP-8	8.0	0.6	1.0	**9.6**
SP-9	13.9	0.9	1.0	**15.8**
Total	**183.4**	**1.6**	**6.0**	**205.4**

Source: RAP Survey of JICA Study Team

(5) Administrative Cost

Administrative cost of the Project includes expenses to be incurred by the Project Management Office of the DPWH during the project period. This cost is estimated at 3.5% of the sum of the construction cost, the engineering service cost and the land acquisition cost.

(6) Physical Contingency

Physical contingency for construction cost and consultancy service cost was applied at 10.0% in this project.

(7) Price Escalation

Price escalation for foreign currency and local currency were applied as 1.83% per annum and 1.00% per annum, respectively.

(8) Value Added Tax (VAT)

VAT component at 12% was calculated separately.

(9) Import Tax

Import tax is applied at 0.0% for the foreign portion of the construction cost.

(10) Interest During Construction

Interest during construction was applied on the construction cost and engineering service cost. Those rates are at 1.5% and 0.01%, respectively.

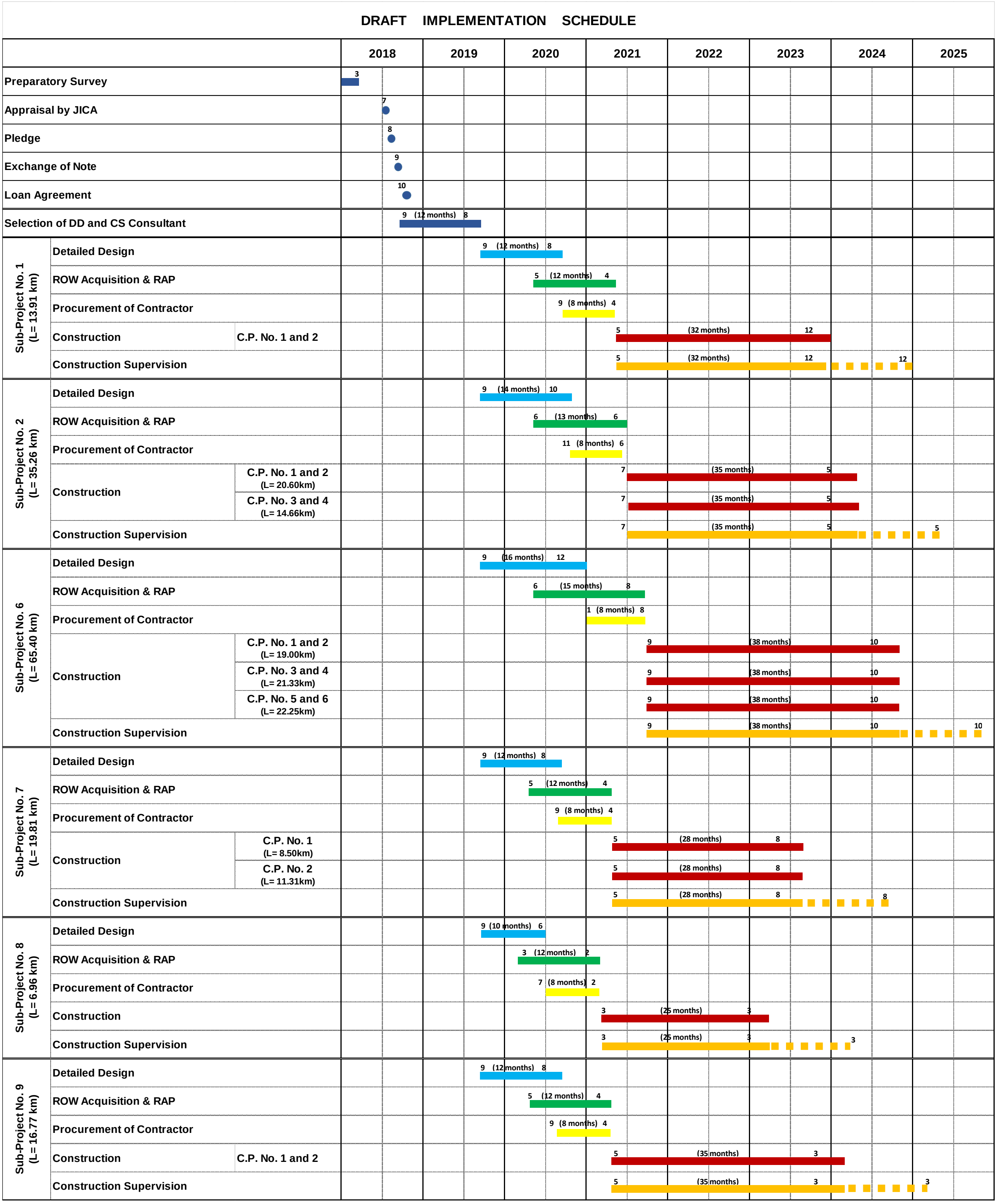
(11) Front End Fee

The rate for front end fee was applied at 0.2% of the total of construction cost, engineering cost and contingencies.

19.2 Implementation Schedule

JICA will decide later during the project appraisal on which Sub-Projects be financed. "Tentative implementation schedule" is prepared on the assumption that the detailed design of all Sub-Projects will start soon after the Engineering Consultant is selected. The Tentative Implementation Schedule is shown in **Table 19.2-1**.

Table 19.2-1 Tentative Implementation Schedule



Note: Since JICA will decide later during the Project Appraisal on which Sub-Projects be financed, above implementation schedule is "Tentative".

Source: JICA Study Team

19.3 Project Cost

There are two options being considered to implement the six (6) Sub-Projects. These are the following:

a. Case 1 – under this option, each Sub-Project is implemented individually hence several teams of consultants and contractors are deployed.

b. Case 2 – under this option, all Sub-Projects are grouped into one and implemented at the same time. Under this option, only single consultant team is needed.

(1) Case 1

1) Project Cost

(CONFIDENTIAL)

Table 19.3-1 Project Cost of Case1

(CONFIDENTIAL)

Table 19.3-2 Project Cost of Sub-Project 1 (2 Packages)

(CONFIDENTIAL)

Table 19.3-3 Project Cost of Sub-Project 2 (4 Packages)

(CONFIDENTIAL)

Table 19.3-4 Project Cost of Sub-Project 6 (6 Packages)

(CONFIDENTIAL)

Table 19.3-5 Project Cost of Sub-Project 7 (2 Packages)

(CONFIDENTIAL)

Table 19.3-6 Project Cost of Sub-Project 8 (1 Package)

(CONFIDENTIAL)

Table 19.3-7 Project Cost of Sub-Project 9 (2 Packages)

(CONFIDENTIAL)

2) Annual Fund Requirement

(CONFIDENTIAL)

Table 19.3-8 Annual Fund Requirement Summary of Sub-Project 1 (2 Packages)

(CONFIDENTIAL)

Table 19.3-9 Annual Fund Requirement Summary of Sub-Project 2 (4 Packages)

(CONFIDENTIAL)

Table 19.3-10 Annual Fund Requirement Summary of Sub-Project 6 (6 Packages)

(CONFIDENTIAL)

Table 19.3-11 Annual Fund Requirement Summary of Sub-Project 7 (2 Packages)

(CONFIDENTIAL)

Table 19.3-12 Annual Fund Requirement Summary of Sub-Project 8 (1 Package)

(CONFIDENTIAL)

Table 19.3-13 Annual Fund Requirement Summary of Sub-Project 9 (2 Packages)

(CONFIDENTIAL)

Table 19.3-14 Detailed Annual Fund Requirement of Sub-Project 1 (2 Packages)

(CONFIDENTIAL)

Table 19.3-15 Detailed Annual Fund Requirement of Sub-Project 2 (4 Packages)

(CONFIDENTIAL)

Table 19.3-16 Detailed Annual Fund Requirement of Sub-Project 6 (6 Packages)

(CONFIDENTIAL)

Table 19.3-17 Detailed Annual Fund Requirement of Sub-Project 7 (2 Packages)

(CONFIDENTIAL)

Table 19.3-18 Detailed Annual Fund Requirement of Sub-Project 8 (1 Package)

(CONFIDENTIAL)

Table 19.3-19 Detailed Annual Fund Requirement of Sub-Project 9 (2 Packages)

(CONFIDENTIAL)

(2) Case 2

1) Project Cost

(CONFIDENTIAL)

Table 19.3-20 Project Cost of Case2

(CONFIDENTIAL)

2) Annual Fund Requirement

(CONFIDENTIAL)

Table 19.3-21 Annual Fund Requirement Summary of Case2

(CONFIDENTIAL)

Table 19.3-22 Detailed Annual Fund Requirement of Case 2

(CONFIDENTIAL)

Chapter 20 Project Implementation Plan

20.1 Key for Successful Completion of the Project

(i) Inclusion in the ARMM's Regional Development Plan

The first step is inclusion of the six (6) Sub-Projects in the ARMM Regional Development Plan to become part of the official plan of the ARMM Government. Once these Sub-Projects become part of the official plan, the Regional Economic Development and Planning Board (REDPB) should table them for review and subsequent endorsement to the Regional Legislative Assembly (RLA). This process will ensure that the Regional Assembly Public Works Act (RAPWA) which is to be enacted into law by the RLA contained the six (6) Sub-Projects.

Memorandum of Agreement (MOA) shall be inked after RAPWA is enacted between the DPWH-ARMM and DPWH-National. The MOA contains a request by the former requesting the latter to lead implementation of the six (6) Sub-Projects to ensure efficient project execution. This MOA will allow DPWH-National to process the project application to NEDA-ICC until its subsequent approval.

(ii) Road Right-of-way Acquisition (ROW) based on the status of land ownership

Learning from the past experiences where delay in road ROW affected the Department's projects, the DPWH created "Unified Project Management Office Right-of-Way (UPMO-ROW) Task Force" and supported by a Technical Working Group (TWG). These two units in the DPWH will play a critical role for successful acquisition of the road ROW.

In the six (6) Sub-Projects, the status of land ownership along the road alignment have been clarified based on the result of RAP Survey Team and classified into five: (a) Land with title and tax declaration, (b) Land with title but without tax declaration, (c) Land without title but with tax declaration, (d) Land without title and without land declaration, and (e) Land inside the military reserved area. Except (a), all other types require further documentation to qualify for full compensation which the Task Force and TWG must be addressed. Table below summarized the land status and action to be taken by land owners/ claimants to receive full compensation from the DPWH.

Table 20.1-1 Status of Land Ownership in the Study Area and Recommendation

Ownership classification		Recommendation for compensation	Legal basis	Further actions maybe taken by land owners/ claimants
a)	Land with title and tax declaration	Full compensation from DPWH	Full compensation at replacement cost based on the current market value of land (R.A 10752) and DPWH Department Order 124, series of 2017	None
b)	Land with title but without tax declaration	Full compensation (after deduction of accumulated tax)	DPWH will pay accumulated taxes to the LGU and the remaining compensation amount will be given to the land owner (DPWH D.O. 152, 2017)	Land owners shall settle their accumulated unpaid taxes at the LGU to receive full compensation from DPWH
c)	Land without title but with tax declaration	Full compensation upon satisfying the check list in the next column	Per DPWH ROW Acquisition Manual - Main Guidelines, Dec 2017, full compensation to land claimant provided the land claimant shall present:	None

Ownership classification	Recommendation for compensation	Legal basis	Further actions maybe taken by land owners/ claimants
		• Tax Declaration showing his and his predecessors' open and continuous possession of the property for at least thirty (30) years. • Certification from the DENR that the land is alienable and disposable (land classified by DENR as timber and mineral lands can't be distributed). • Other documents that may show proof of Ownership.	
d) Land without title and without land declaration	• Compensation for the structures (not for the land) made by the claimants • No compensation for land (perhaps the only way is by donation)	For the case of donation, JICA's Guidelines for Environmental and Social Consideration must be followed which is based on the WB Involuntary Resettlement Sourcebook. The operational words are "informed consent" and "power of choice" by the donors.	Land claimants may apply for land titling by filling for patent at DENR for issuance of land title.
e) Land inside the military reserved area	Discussed further in section (iii) below		

(iii) Road Right-of-way Acquisition (ROW) inside the Military Reserved Areas

For Sub-Project 7 (Marawi City Ring Road) and Sub-Project 8 (Parang East Diversion Road), some sections of both roads are traversing military reservation areas. Outline of Marawi Military Reservation Area is as follows;

a) Brief History

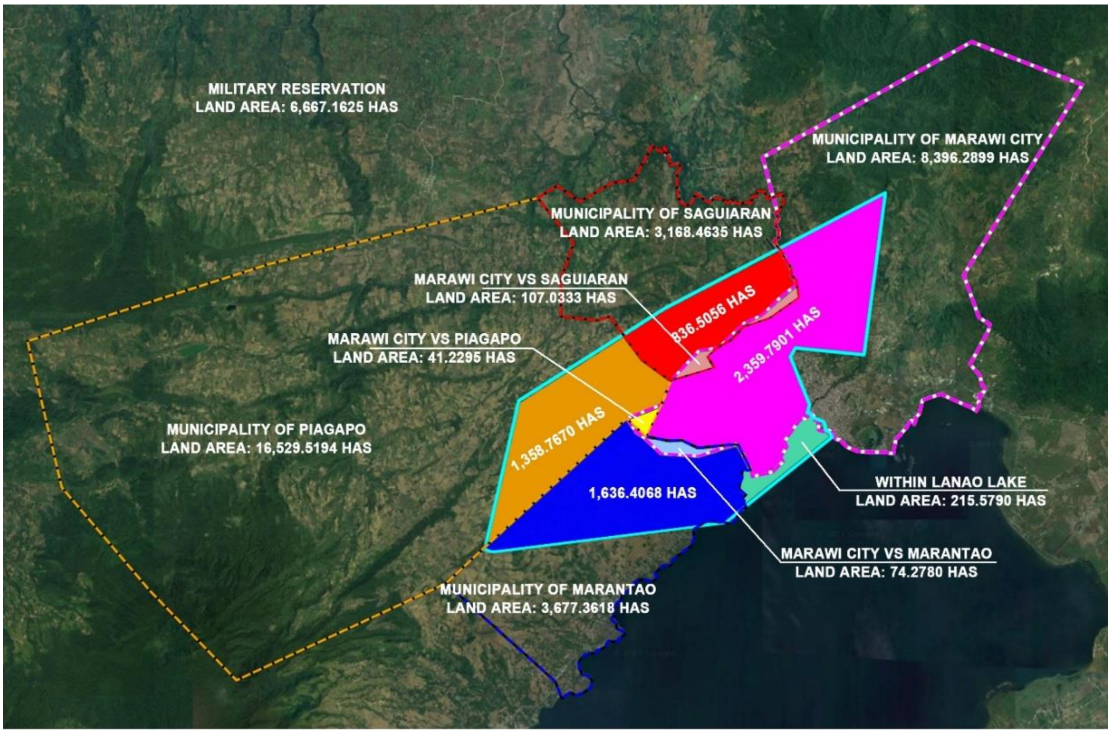
Accordingly, the Camp (now the military reserved area in Marawi) was named after Private Fernando Keithley (now known as Camp Keithly Military Reservation (CKMR)), an American soldier killed by resisting Moros in Marawi in 1903. When the Camp was established by the Americans, it has no defined area like many other camps established by the Americans. The Americans has just acquired sovereignty over the Philippines under the Treaty of Paris (1898) just five (5) years earlier.

Philippines got its independence from the Americans in 1946. And in 1953, the Camp (6,669 hectares of public land in Dansalan City and now Marawi City) was reserved for military purpose thru Presidential Proclamation 453, series of 1953. The title of the proclamation is "Reserving for Military Purposes a Portion of the Public Domain Situated in the City of Dansalan, Island of Mindanao".

In December 4, 1961, Proclamation No. 806 setting aside 999.3560 hectares from the Camp for the Mindanao State University school site.

In Dec. 26, 1956, President Ramon Magsaysay signed Proclamation No. 375 to apportion 171.4514 hectares from the Camp for the Lanao Provincial Capitol.

In December 3, 1974, Proclamation No. 1354 delineates an area of 803.144 hectares in Lumbayanague, Saguiaran for the NPC's Agus II Project. This means that only 4,864 was left to the CKMR.



Source: DENR-ARMM, received on 20 December 2017

Figure 20.2.1-1 Military Reserved Map in Marawi City

b) MILF’s Position

It was widely reported that the delegation of MILF during their meeting with President Duterte in Davao last September 2017 requested the President to “return to the Maranao people” the lands they lost over decades to the government through past Presidential Proclamations.

Accordingly, the MILF conveyed to the President that this act of “return the land” should be part of the President’s pronouncement of “correcting historical injustices on the Moro people”. Per MILF account and reported in major newspapers in the country, the President is said to have verbally agreed. However, even if the President agreed, how to approach the following issues will be critical to its success: how to identify beneficiaries? How to distribute the land? What is the correct size of distribution? Etc.

c) Current Situation

Interview with both government officials in Marawi City and their political leaders revealed that from their perspective, the land is from their ancestors hence they settled first before their land is declared as military reserved area by the Americans and subsequently by the Philippine Government.

RAP Survey revealed that there are 108 land lots to be affected by the Marawi Ring Road. Of these, only four (4) lots are outside the military reserved area. All lots lacked land title and tax declaration. Despite their lack of proper documents, PAP (project affected people) relayed their hope to the RAP Survey Team that their land will be compensated if the road project traverses it.

Since the land is inherited from their ancestors (grandfather), and their ancestors produced many children, some of them already sub-divided the land among them. There's no survey hence demarcation is not clear among the children.

According to them (PAP along the alignment), LGU promised them to give them tax declaration so they would be entitled for compensation. Minutes of public consultation however revealed that the Mayor of Piagapo for example just urged the people to apply for tax declaration to qualify for compensation from the DPWH.

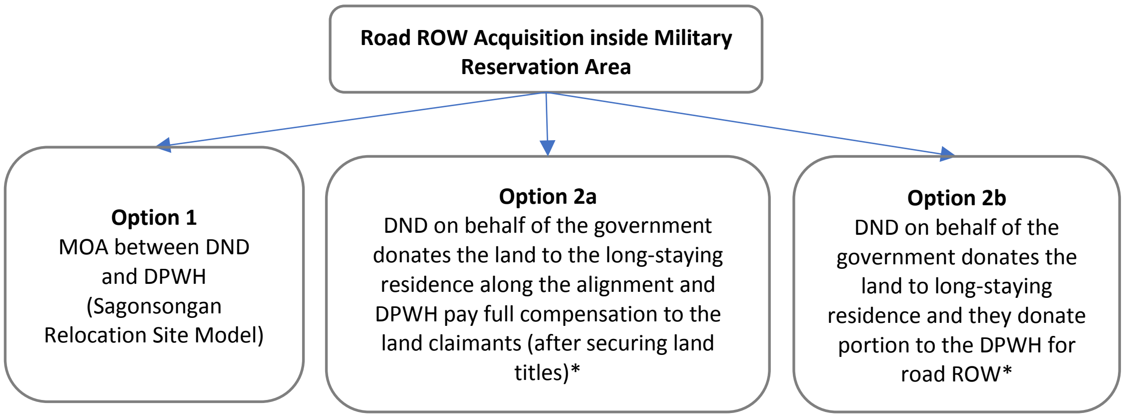
d) Options to Pursue for ROW inside Military Reserved Area

There are three options that may be pursued with regards to ROW acquisition in the Military Reservation Area;

- **Option 1 (Sagonsongan Relocation site Model)** – A Memorandum of Agreement (MOA) will be signed between the Department of National Defence (DND) and the Department of Public Works and Highways (DPWH) which states that part of the military reserved (30 meter width) to be traversed by Marawi Ring Road (Sub-Project 7) and Parang East Diversion Road (Sub-Project 8) will be donated/transferred to the DPWH. DPWH then facilitates registration of the land to become part the right of way of the national road. This option is the same with the arrangement between the DND and the DPWH for the development of Sagonsongan Transitional Shelters for the IDPs.

- **Option 2a-** DND which is the guardian of the military reserved area will donate to the long-staying occupants of the area along the alignment. DENR-ARMM will then assist recipient residents along the alignment to have their land titled. This will allow DPWH to execute full compensation of the affected land.

- **Option 2b** – The procedure is the same with the Option 3a, the difference however is the long-staying residents who will become recipients of the land will allocate portion of their land for road right-of-way. In return, the government will facilitate to make their ownership of the land legal. This type of arrangement where the government assist the residents to title their land is the same with the approach undertaken by the DPWH during the construction of Basilan Circumferential Road (except the area is not a military reserved).



Note: Presidential Proclamation maybe necessary just like when Mindanao State University in Marawi was established inside the military reserved area. A Presidential Proclamation No. 806, series 1961 was issued for such purposes.

Figure 20.2.1-2 Possible Options for Road ROW Acquisition inside the Military Reservation Area

(iv) Security Considerations

Because the Sub-Projects are in the conflict-affected areas of Mindanao, it is necessary to formulate and operate a general security framework during the entire construction period. This is discussed in length in Chapter 13. The idea basically is to gain understanding and support of different stakeholders through holdings of regional-level meetings to be attended by concerned governors, concerned mayors, PNP regional command, MILF and BDA, IMT and other concerned stakeholders. Commitment and support as well creating direct lines with them will ensure swift resolution of issues at regional level.

The same meetings should be undertaken at local level (each Sub-Project) where possible members may include concerned mayors of Sub-Project, barangay captains along the alignment, PNP & military in municipalities, MILF and BDA, contractors, and the project manager of the Cotabato project office. The subjects of the meetings may include: a) updates of the security situation, b) exchange of security related information, and c) emergency planning (e.g. emergency exit plan).

(v) Importance of Farm-to-market Roads for Agricultural Development

During the series of public consultations at barangay level under this Study, the subject of farm-to-market roads (FMR) was always raised by the communities (both consultation with IP communities and non-IP communities) to extend the influence of Sub-Project road to their productive lands (farms). To emphasize its importance to the communities: (i) of the 58 community facilities requested by the IPs along Sub-Project 6, twenty (20) were farm-to-market roads related; (ii) the most popular request by the communities during the Social Survey is for the community to be involved as part of the construction team (laborers) and this is followed by the request for inclusion of farm-to-market roads.

This FMR request by the community is easy to understand since source of income of most of the people (over 90%) in the community is farming. Provision of FMR will bring down transport cost which is rather expensive due to unconventional mode of transport being used such as horses and motorcycles – both with ability to penetrate farms with poor access roads. In view of the above and the fact that dominant industry in the region is agriculture, the road should be planned in a way that it supports the said industry comprehensively. This can be done by including FMRs in the Sub-Projects. Length of each farm-to-market road may extend from 2 km to 5 km depending on the productivity level of target productive land.

20.2 Implementation Priority

20.2.1 Implementation Prioritization Criteria

With due consultation with both DPWH-National and DPWH-ARMM, the implementation prioritization criteria was established.

1) Evaluation Items and Weight of Items

Evaluation items and weight assigned to each item are shown in **Table 20.2.1-1**.

Table 20.2.1-1 Evaluation Items and Weight for Prioritization

Evaluation Items	Subject	Assigned Points	Details	Specific	Weight
Technical Indicators	1. Importance of the road in the total network	5	(i) Primary National Road (highest score)	Primary Road	5
			(ii) Secondary National Road (second highest score)	Secondary Road	3
			(iii) Tertiary National Road (third highest score)	Tertiary Road	1
	2. Economic Return/ Investment Impact (EIRR) - this criteria contains traffic volume + size of agricultural development	15	The higher, the better (best score has the higest points)	Highest IRR group = 14 and above	15
				2nd group=12 to 14	13
				3rd group=10 to 12	11
	3. Traffic Volume attracted to the new road (2020 traffic)	10	The higher, the better	Over 2000	10
				1500 to 2000	8
				1000 to 1500	6
				Less than 1000	4
	4. Degree of Difficulty of Communities Access	10	Travel time of the most difficult to access barangay within the influence area to national road or Cotabato city - the longer, the higher the score	2 hour or more	10
				1 hour to 2 hour	8
				30 to 1 hour	6
			If no land access, only sea access, there is an extra point (2 pts)	30 min or less	4
Social Indicators	5. No. of Beneficiary (NOB) - this criteria includes impact to poverty reduction	10	NOB = (barangay population served by road) / (Road length)	1st group=2000 and above	10
				2nd group=1000 to 2000	8
				3rd group= 500 to 1000	6
				4th group=500 and less	4
	6. Contribution to Peace Building (CPB)	10	(i) Project in displaced communities (IDPs) hence the project could provide job opportunities during construction period and support rehabiliation works	Project located in displaced communities	10
			(ii) Presence of MILF/MNLF camps within the influence area - this supports the government committment in the Peace Process that it will transform the camp into productive community (major camp if among the 6 recognized by the government)	Major camp	8
				Minor camp	6
			(iii) None of the above (no score)	None of the above	4
Difficulty of Project Implementation	7. Affected houses, small stores, etc	10	Projects with less number of affected structures have higher points	Less than 1 house/km	10
				1 to 2 houses/km	8
				2 and above houses/km	6
	8. Number of affected people by losing house	10	Projects with less number of affected people have higher points	Less than 5 people/km	10
				5 to 10 people/km	8
				10 and above people/km	6
	9. Number of land lots without title and claimants are not paying taxes (d)	10	Projects with less land issues have higher points	0 land lot	10
				1 to 2 land lots/km	8
				2 and above land lots/km	6
	10. IP communities are affected or not	10	Projects with less social impacts have higher points	No IP affected (people, house, land)	10
				With IP affected (people, houses, land)	5
	Total	**100**	Bonus points (shaded)		

20.2.2 Evaluation of Implementation Priority

Project's basic data necessary for prioritization is shown in **Table 20.2.2-1**.

Table 20.2.2-1 Project's Basic Data

		SP 1	SP 2	SP 6	SP 7	SP 8	SP 9
Basic Data	Population of influenced barangays (along the alignment)	18,762	22,269	31,231	21,704	13,207	11,892
	Road Length (km)	14	34	63	18	6	17
	Populaton/road length	1,340	655	496	1,206	2,238	700
	Road class	Tertiary	Secondary	Secondary	Secondary	Secondary	Tertiary
	EIRR	11.7	13.7	12.6	14.9	13.1	12.2
	2020 Traffic (veh/day)	927	1,528	1,069	1,657	2,458	1,109
	2030 Traffic (veh/day)	1,186	2,559	1,532	2,493	3,814	1,649
	Travel time of farthest/isolated barangay (within the influence area) to major road/city	30 min	1 hr or more	4 hrs or more	20 min or less	20 min or less	1 hr or more
	Available transport mode of farthest/isolated barangay	Road transport	Sea transport	Sea transport	Road transport	Road transport	Road transport
	Other major projects in the area	Banana plantati	None	None	Trans-central	None	None
	Poverty incidence (number of people below poverty line in the barangays along the alignment)	10,563	14,840	16,987	13,667	9,773	6,836
	Number of people below poverty line/km	755	436	270	759	1,656	402
	Size of agricultural land (ha-municipal)	35,369	29,222	40,923	11,956	10,162	36,105
	a. Size of current cultivated farm (ha - barangay level)	11,371	5,826	19,471	41	8	7,051
	b. Increment of farmers if road constructed (ha)	91	126	304	6	2	163
	Total (a+b)	11,462	5,952	19,775	47	11	7,214
	Fishery (number of household engaged in fishing)		291	1,442			
	Fishery production (kg/household/year)		1,362	807			
	Contribution to Agri Development (CAD) = (size of agricultural land served by road) / (Road length)	819	175	314	3	2	424
	Poverty incidence (average of all municipalities along the alignment)	56.3%	66.6%	54.4%	63.0%	74.0%	57.5%
	Presence of MILF and/or MNLF Camps	Yes, major	Yes, minor	Yes, minor	None	None	Yes, minor
Affected People, Structures, Land	No. of affected houses, small stores, etc	20	8	22	10	20	11
	No. of affected household/families	20	8	21	10	19	11
	No. of affected people by losing house	108	36	119	61	120	76
	a. No of land lot with land title and paying taxes	10	52	6	0	2	14
	b. No. of land lot with land title but not paying taxes	18	65	35	0	2	6
	c. No. of land lot with no land title but paying taxes (Tax Declaration)	13	0	49	0	31	12
	d. No. of land with no land title and no Tax Declaration	57	0	10	4	0	0
	e. No. land lots inside Military Reserved Area	0	0	0	104	0	0
	Total of affected land lots (a+b+c+d+e)	98	117	100	108	35	32
	No. of affected IP houses	0	0	15	0	0	0
	No. of affected IP household/family	0	0	15	0	0	0
	No. of affected IP people by losing house	0	0	86	0	0	0
	No. of affected IP land lot	0	0	2	0	0	0

Source: JICA Study Team

Implementation priority of Sub-Project is shown in **Table 20.2.2-2** and summarized as follows;

Implementation Priority	Sub-Project No.
1	Sub-Project 2
1	Sub-Project 7
3	Sub-Project 9
4	Sub-Project 6
5	Sub-Project 8
6	Sub-Project 1

Table 20.2.2-2 Evaluation of Implementation Priority

Evaluation Items	Subject	Assigned Points	SP 1	SP 2	SP 6	SP 7	SP 8	SP 9	SP 1	SP 2	SP 6	SP 7	SP 8	SP 9
Technical Indicators	1. Importance of the road in the total network	5		secondary	secondary	secondary	secondary			3	3	3	3	
			tertiary					tertiary	1					1
	2. Economic Return/ Investment Impact (EIRR) - this criteria contains traffic volume + size of agricultural development	15				14.0						15		
				13.3	12.5		12.5			13	13		13	
			10.9					11.8	11					11
	3. Traffic Volume attracted to the new road (2020 traffic)	10					2,458						10	
				1,528		1,657				8		8		
					1,069			1,109			6			6
			927						6					
	4. Degree of Difficulty of Communities Access	10			4 hrs or more					10	12			
				1 hr or more				1 hr or more						8
			30 min or less			20 min or less	20 min or less		4			4	4	
Social Indicators	5. No. of Beneficiary (NOB) - this criteria includes impact to poverty reduction	10					2,238						10	
			1,340			1,206			8			8		
				655				700		6				6
					496						4			
	6. Contribution to Peace Building (CPB)	10				IDP yes						10		
			Camp abubakar						8					
				minor camp	minor camp			minor		6	6			6
							none						0	
Difficulty of Project Implementation	7. Affected houses, small stores, etc	10		0.24	0.35	0.56		0.65		10	10	10		10
			1.43						8					
							3.39						6	
	8. Number of affected people by losing house	10		1.06	1.89	3.39		4.47		10	10	10		10
			7.71						8					
							20.34						6	
	9. Number of land lots without title and claimants are not paying taxes (d)	10		-			-	-		10			10	10
					0.16	0.22					8	8		
			4.07						6					
	10. IP communities are affected or not	10	No	No		No	No	No	10	10		10	10	10
					Yes						5			
	Total	100						Total Score	70	86	77	86	72	78
								Ranking	6	1	4	1	5	3

20.3 Organizational Structure for Project Implementation

20.3.1 Organization for Selection of Consultant(s) and Contractor(s)

Selection of consultant(s) and contractor(s) is under responsibility of DPWH Bids and Awards Committee (BAC). The present members of BAC are as follows:

BAC Member

Chairman	:	Assistant Secretary for Technical Services
Vice-Chairman	:	Director, Bureau of Construction
Member	:	Director, Legal Service
Member	:	Director, Planning Service
Member	:	Head of Implementing Office
Member	:	DPWH-ARMM

As this project is located inside ARMM, it is strongly recommended that a representative of DPWH-ARMM is included in the BAC member for this project.

20.3.2 Organization for Detailed Design and Construction Supervision

Organization for detailed design and construction supervision is proposed as shown in **Figure 20.3.2-1**.

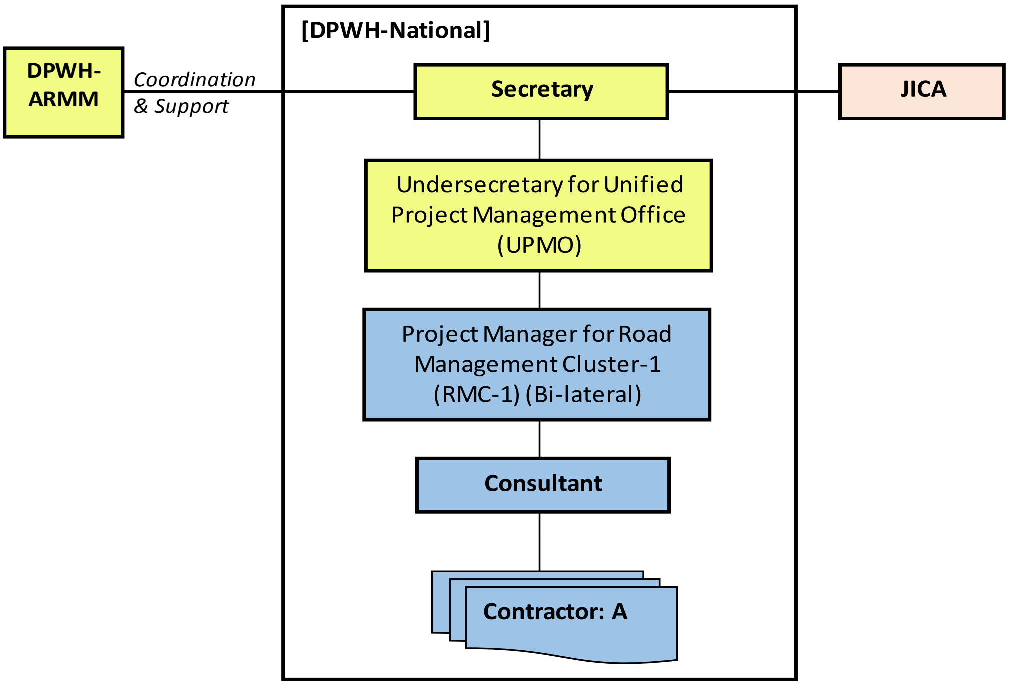


Figure 20.3.2-1 Proposed Organization for Detailed Design and Construction Supervision

20.3.3 Organization for ROW Acquisition

Right-of-way acquisition in the project area is complicated. Some land owners may not have a land title nor tax payment. Another issue is that Cadastral Map is under stage of updating. Updating of Cadastral Map may take some more years.

In view of above, the Implementation Agency (DPWH-National) needs to fully coordinate with local people, LGUs, DENR, DND (for the Military Reserve), and Barangay Captains.

For smooth communication and understanding of local culture, DPWH-National definitely needs support of DPWH-ARMM. It is recommended to organize the Joint ROW Acquisition Team of DPWH-National and DPWH-ARMM. Proposed organization of ROW acquisition is shown in **Figure 20.3.3-1**.

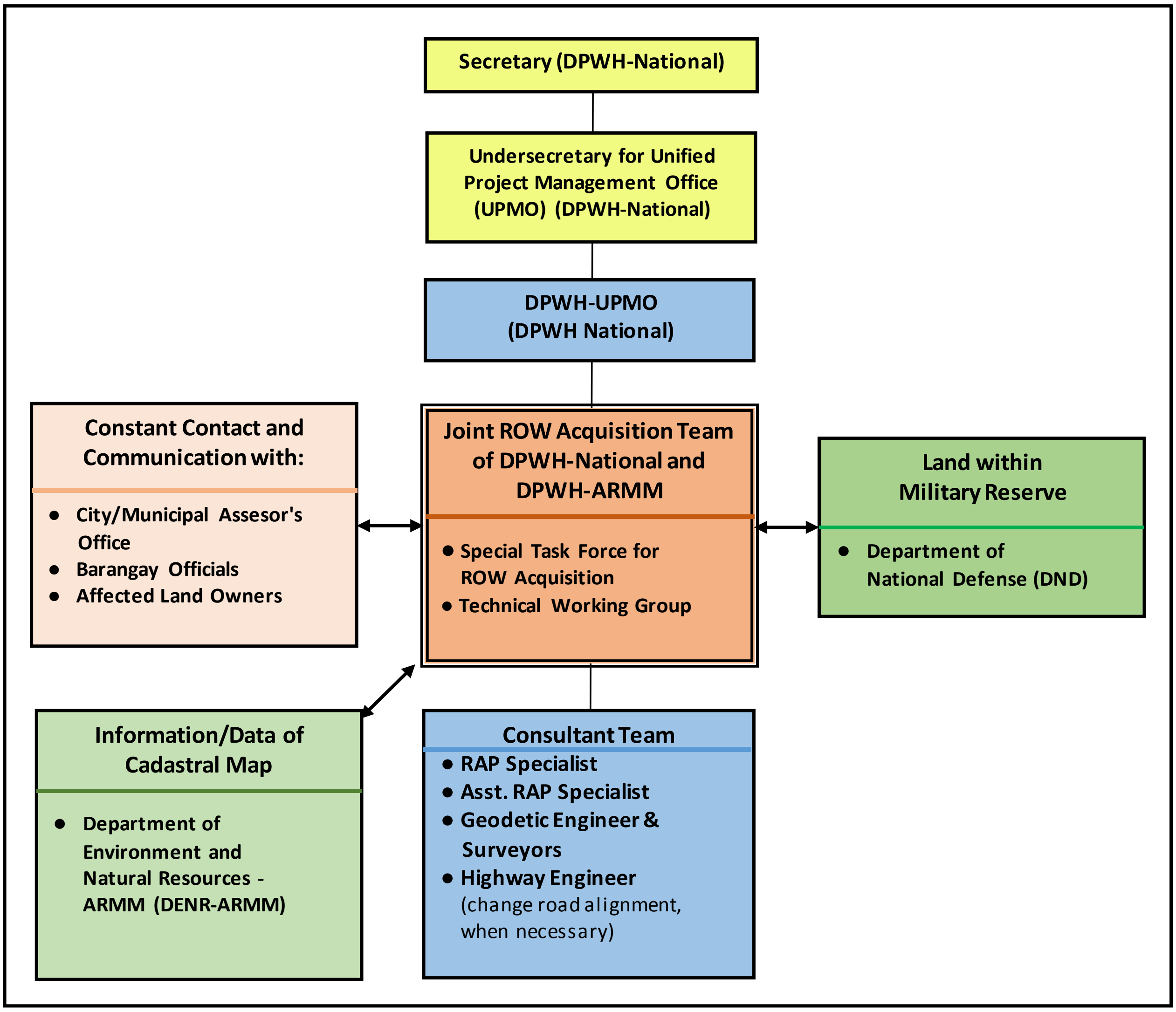


Figure 20.3.3-1 Proposed Organization for ROW Acquisition

20.4 Procurement of Engineering Consultant and Contractor

20.4.1 Procurement of Engineering Consultant

(1) Outline of Engineering Consultant's Scope of Work

The following consultancy services are required for the project;

- Detailed Engineering Design
- Tender Assistance for Selection of Contractor

- Construction Supervision

(a) Detailed Engineering Design

Major scope of work for the consultancy services are as follows;

- Finalization of the road alignment with due consultation with the concerned land owners, barangay residents and local government officials.
- Engineering surveys (topographic survey, soils/material survey, geo-technical survey)
- Detailed Engineering Design
- Parcellary Survey
- Preparation of Tender Documents
- Preparation of Final RAP

(b) Tender Assistance for Selection of Consultant

- Provide assistance to DPWH in all process selecting contractor.
- Monitoring of RAP implementation

(c) Construction Supervision

- Overall construction supervision
- Keep and compile all records including material test results, inspection results, problems encountered, etc.
- Prepare an asset register in including condition assessment.
- Monitoring if environmental requirements.

(2) Procurement of Engineering Consultant

In order to expedite the procurement schedule of engineering consultant, it is recommended that the short list method will be adopted, thus pre-qualification step can be eliminated. Important work is to review and re-align a road center-line in accordance with latest information, topographical and geo-technical conditions, opinions of local residents, LGUs and other concerned government agencies, etc. For this kind of work, it is recommended that foreign consultants in association or in joint venture with local engineering firm(s) be employed.

20.4.2 Procurement of Contractor

In due consideration of security condition of the project area, local culture, politics, etc., it is essential to involve local contractors who are based in ARMM, Region X and Region XII. It is recommended that large scale contractor outside ARMM, or Region X and XII will associate with or joint venture with local contractors in ARMM or nearby ARMM who is (are) quite familiar with the local conditions. In view of the above, it is recommended that contractor(s) will be selected through Local Competitive Bidding (LCB).

Chapter 21 Economic Evaluation

21.1 Sub-Project 1

21.1.1 Economic Benefits Calculation

Economic evaluation for the Sub-Projects was conducted through a cost-benefit analysis by comparing the economic benefit and economic cost. The methodology and result of economic evaluation is shown below.

(1) Condition of Economic Evaluation

Table 21.1.1-1 shows the condition of economic evaluation. The project evaluation period was set at 30 years after road opening to traffic. Economic indicators, i) Economic Internal Rate of Return (EIRR), ii) Benefit-Cost Ratio and iii) Net Present Value (NPV) were calculated for the economic evaluation and the applied discount rate was 10% with reference to NEDA's (National Economic Development Authority)'s ICC Guidelines.

Table 21.1.1-1 Condition of Economic Evaluation

No.	Indicator	Calculation Formula or Value
1	Project Evaluation Period	30 years after road opening to traffic
2	Discount Rate	10% is currently adopted as an opportunity cost (Benchmark for EIRR)
3	EIRR	$\sum \frac{B_n}{(1+r)^n} = \sum \frac{C_n}{(1+r)^n}$ r = satisfying B = Benefit, C = Cost
4	B/C	$\sum \frac{B_n}{(1+DR)^n} = \sum \frac{C_n}{(1+DR)^n}$ DR = Discount Rate
5	NPV	$\sum \frac{B_n - C_n}{(1+DR)^n}$

(2) Conversion to Economic Cost

The financial cost needs to be converted to an economic cost when carrying out an economic evaluation and the method of conversion from financial cost to economic cost is described below. This methodology is based on the NEDA's ICC Guidelines (2004, ICC Project Evaluation Procedure Guideline by NEDA).

- The Shadow Exchange Rate (SER) which is 20% higher than the official rate is used to convert the items of foreign currency portion from Dollar to PhP.
- The Shadow Wage Rate (SWR) which is 60% of the current wage rate is used to convert the unskilled worker cost (10% of the local currency portion) into an economic price.
- The value of VAT (12%) is deducted from all the cost items.

(3) Land Acquisition Cost

Land acquisition cost are estimated in **Section 7.11**. These costs were estimated by current market value of the related agency. **Table 21.1.1-2** shows the summary of land acquisition cost for SPs.

Table 21.1.1-2 Estimated Land Acquisition Cost

Unit: Million Php

		SP1	SP2	SP6	SP7	SP8	SP9	Total
Land Acquisition Cost	Land	40.2	32.1	62.1	19.0	4.6	12.7	170.8
	Structure	2.5	1.9	1.1	0.7	3.3	1.2	10.7
	Improvements	0.8	0.9	0.1	0.2	-	-	1.9
	Sub-total A	**43.5**	**34.9**	**63.3**	**19.8**	**8.0**	**13.9**	**183.5**
External Monitoring	Sub-total B	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**6.0**
Total		**44.5**	**35.9**	**64.3**	**20.8**	**9.0**	**14.9**	**189.5**

Source: JICA Study Team

(4) Estimation of Economic Benefit

With due consideration of the regional characteristics of ARMM, the economic benefit for this project was calculated based on the two (2) viewpoints of traffic and agricultural. Below shows the viewpoint of benefit of traffic and agricultural.

1) Economic Benefit to Traffic

Two main economic benefits were considered i) Saving of Vehicle Operating Cost (VOC) / Travel Time Cost (TTC) and ii) Saving of existing road Operation and Maintenance (O&M) Cost for this project.

i) Saving of VOC and TTC

The economic benefit to traffic was basically calculated based on the product of estimated traffic volume and unit VOC and TTC, respectively.

Unit VOC and TTC in 2015 price (**Table 21.1.1-3**) were provided by the Planning Service of DPWH Central and updated to 2017 price and ARMM condition.

Table 21.1.1-3 Unit VOC and TTC in 2015

	Travel Speed (km/hr)	Vehicle Type			
		Car	Jeepney	Bus	Truck
Vehicle Operating Cost by Vehicle Type (PhP/veh. Km.)	20	10.25	10.84	34.26	55.53
	30	9.08	9.09	28.47	46.58
	40	8.25	7.83	24.14	40.04
	50	7.85	7.21	21.78	36.72
	60	7.68	6.93	20.48	35.10
Travel Cost (PhP/ veh. hr)		545.09	545.45	1,708.37	2,794.67

Source: DPWH Planning Service

These unit VOC and TTC were prepared based on the Metro Manila price converted to the ARMM price using the economic indicators. The conversion rate from Metro Manila to ARMM was an applied comparison of various vehicle cost for unit VOC (Rate: 1.10) and the comparison of average income for unit TTC (Rate: 0.33) as shown in **Table 21.1.1-4** and **Table 21.1.1-5**, respectively.

Table 21.1.1-4 Conversion Rate for Unit VOC Based on Various Vehicle Cost

No.	Items	Unit	Price		Ratio*1		Remarks
			Manila	Cotabato	Manila	Cotabato	
1	Vehicle Price (Fortuner)	PhP	2,260,000.00	2,313,000.00	1.00	1.02	
2	Annual vehicle license fee	PhP	8,000.00	10,000.00	1.00	1.25	
3	Fuel (Gasoline)	PhP/liter	54.42	45.17	1.00	0.83	Petrol Gas Company, 2018/02/20
	Fuel (Diesel)	PhP/liter	39.35	45.57	1.00	1.16	
4	Tires & tubes	PhP	10,000.00	12,500.00	1.00	1.25	
Average					1.00	**1.10**	

*1: Ratio of Cotabato was estimated comparing with Manila Price set as base 1.00
Source: JICA Study Team collected information thru Interview

Table 21.1.1-5 Conversion Rate for Unit TTC Based on Average Income

Region	No. of Families (in Thousand)	Income		Ratio*1 (Based on Average Income)
		Total (in Million PhP)	Average (in Thousand PhP/family)	
NCR	3,019	1,282,823	425	1.00
ARMM	616	85,514	139	**0.33**

*1: Ratio of Cotabato was estimated comparing with Manila Price set as base 1.00
Source: Philippines Statistics Authority

The converted unit VOC and TTC in 2017 price for ARMM is shown in **Table 21.1.1-6**.

Table 21.1.1-6 Unit VOC and TTC in 2017

	Travel Speed (km/hr)	Vehicle Type			
		Car	Jeepney	Bus	Truck
Unit VOC by Vehicle Type (PhP/veh. Km.)	20	12.06	14.12	40.28	65.29
	30	10.68	11.68	33.48	54.76
	40	9.70	9.90	28.39	47.08
	50	9.23	9.00	25.61	43.17
	60	9.03	8.57	24.08	41.27
Unit TTC (PhP/ veh. hr)		557.66	414.68	1,534.47	171.15

Source: JICA Study Team estimated

ii) Saving of Existing Road O&M Cost

Saving of O&M cost in the existing road was calculated under the following points;

- Traffic diverted from other existing roads by the improvement of Sub-Project road is determined to be benefit of saving O&M cost. It is unnecessary to invest the additional O&M cost of the converted traffic on the existing road.
- The converted traffic volume was an estimated comparison between “with project” and “without project”. Saving of O&M cost was estimated by this converted traffic volume and the O&M cost per vehicle.
- It is necessary to calculate the O&M cost per vehicle utilizing the existing O&M cost for road and bridge in 2017 and the existing traffic volume. The O&M cost for national road in ARMM was provided by DPWH- ARMM, amounting to 146 Million PhP/year for a total length of 992.6km national road in ARMM.
- Investment of O&M cost will be dependent on the traffic volume. Thus, traffic volume by section was identified based on the result of existing traffic demand forecast. The traffic volume was calculated based on range 1 to 11 as shown in **Table 21.1.1-7**.

- Total length (a) and vehicle distance (b) were calculated by range. Rate (c) was calculated using vehicle distance (b) and O&M cost (d) was distributed by range. And, O&M cost per vehicle (f) was calculated by O&M cost per km (e) and total length (a).

Table 21.1.1-7 Calculation for O&M Cost per Vehicle

ID	Traffic Volume (veh/day)	(a) Total Length (km)	(b) Vehicle Distance (veh*km)	(c) Rate (%)	(d) O&M Cost (PhP/year)	(e) O&M Cost Per km (PhP/km/year)	(f) O&M Cost per vehicle (PhP/veh /year)
1	Less than 500	336.1	57,971	3.9%	5,672,126	16,867	91
2	501 - 1000	79.8	71,034	4.8%	6,950,267	87,055	99
3	1001 - 2000	281.1	369,111	24.7%	36,115,627	128,497	103
4	2001 - 3000	65.2	160,969	10.8%	15,749,986	241,473	98
5	3001 - 4000	69.2	212,695	14.3%	20,811,091	300,822	98
6	4001 - 5000	47.6	216,677	14.5%	21,200,704	445,238	99
7	5001 - 6000	17.8	91,854	6.2%	8,987,395	506,151	98
8	6001 - 7000	-	-	-	-	-	-
9	7001 - 8000	-	-	-	-	-	-
10	8001 - 9000	-	-	-	-	-	-
11	Over 9001	25.8	311,900	20.9%	30,517,804	1,183,767	90
Total		922.6	1,492,209.7	100.0%	146,005,000	2,909,879	-

Source: Calculated by JICA Study Team based on O&M Cost by DPWH-ARMM

2) Economic Benefit to Agriculture

Economic benefit to agriculture was calculated under the following method;

- To identify the economic benefits of road improvements for agriculture, the transport demand of agricultural produce from farm to market and agricultural production inputs from market to farm are considered.

- For simplicity in the analysis, it is assumed that transport cost savings from the project are passed to the producer. The area of influence is set around the proposed road alignment of each Sub-Project, and it is also assumed that agricultural produce and agricultural production inputs in the area are transported on the improved road.

- Economic benefits of the road improvement for agriculture are estimated with regard to reduced transport costs of agricultural produce and agricultural production inputs. The unit transport costs and the average yield of crops and fish are identified based on social survey results carried out under this Study.

- Total cultivation area by crop type is estimated using social survey results and a vegetation map. Areas identified on the vegetation map such as rice fields, cultivated land, plantations, scrubland, coconut, and cultivated land mixed with coconut are assumed to be under cultivation.

- A reduced rate for transport cost is set based on the appraisal and outcomes of other rural road projects in the Philippines including the Philippine Rural Development Project and the Second Rural Roads Improvement Project financed by the World Bank.

(5) Estimation of Disruption Cost

In case of improvement of the existing road, economic losses will occur during the construction period. Thus, disruption cost should be estimated. The result of disruption cost will be added as a negative benefit during construction period. Sub-Project 1 and Sub-Project 7 will improve the existing roads during the construction period, it should be considered disruption cost for economic evaluation.

(6) Sensitivity Analysis for Cost and Benefit

The sensitivity analysis for cost and benefit was conducted in consideration for decreasing a benefit and increasing an economic cost due to price escalation of material and equipment and reducing vehicle users like as some risks. In this regard, the following nine (9) cases were evaluated.

Table 21.1.1-8 Cases of Sensitivity Analysis

Case	Cost	Benefit
Case-1 (Base Case)	0% Plus	0% Less
Case-2	10% Plus	0% Less
Case-3	20% Plus	0% Less
Case-4	0% Plus	10% Less
Case-5	0% Plus	20% Less
Case-6	10% Plus	10% Less
Case-7	10% Plus	20% Less
Case-8	20% Plus	10% Less
Case-9	20% Plus	20% Less

Source: JICA Study Team

21.1.2 Cost Benefits Calculation

(1) Estimation of Economic Cost

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(2) Estimation of Economic Benefit

1) Economic Benefit to Traffic

Economic benefits in 2020 and 2030 were estimated based on the result of future traffic, unit VOC and TTC and O&M cost per vehicle as shown in **Table 21.1.2-1**. Total benefit is calculated at PhP 120.5 Million in 2020 and PhP 199.0 Million in 2030. The benefit is dependent on the saving of VOC. And, disruption cost was estimated in order to effect the existing road during construction period (24 Months).

Table 21.1.2-1 Result of Economic Benefit to Traffic

(Unit: Million PhP)

	VOC	TTC	O&M	Total
2020	87.3	32.1	1.2	120.5
2030	152.4	45.1	1.5	199.0
Disruption Cost	-0.6	-4.0	-	-4.6

Source: Estimated by JICA Study Team

2) Economic Benefit to Agriculture

Most farmers interviewed for the social survey sell their crops to markets in Parang municipality in Maguindanao province, while some farmers send their crops to markets in Pigcawayan municipality in North Cotabato province and Simuay of Sultan Kudarat municipality in Maguindanao province. Other farmers sell their crops to local traders in neighboring municipalities such as Buldon and Barira. The area of influence of Sub-Project 1 is presumably five kilometers to the north and two kilometers to the south from the alignment. Agricultural produce located further than five kilometers to the north and two kilometers to the south is supposed to be transported on the roads running parallel to one another in the north and south of Sub-Project 1. In addition, some areas along the road that run north to south and cross the alignment of Sub-Project 1 are included.

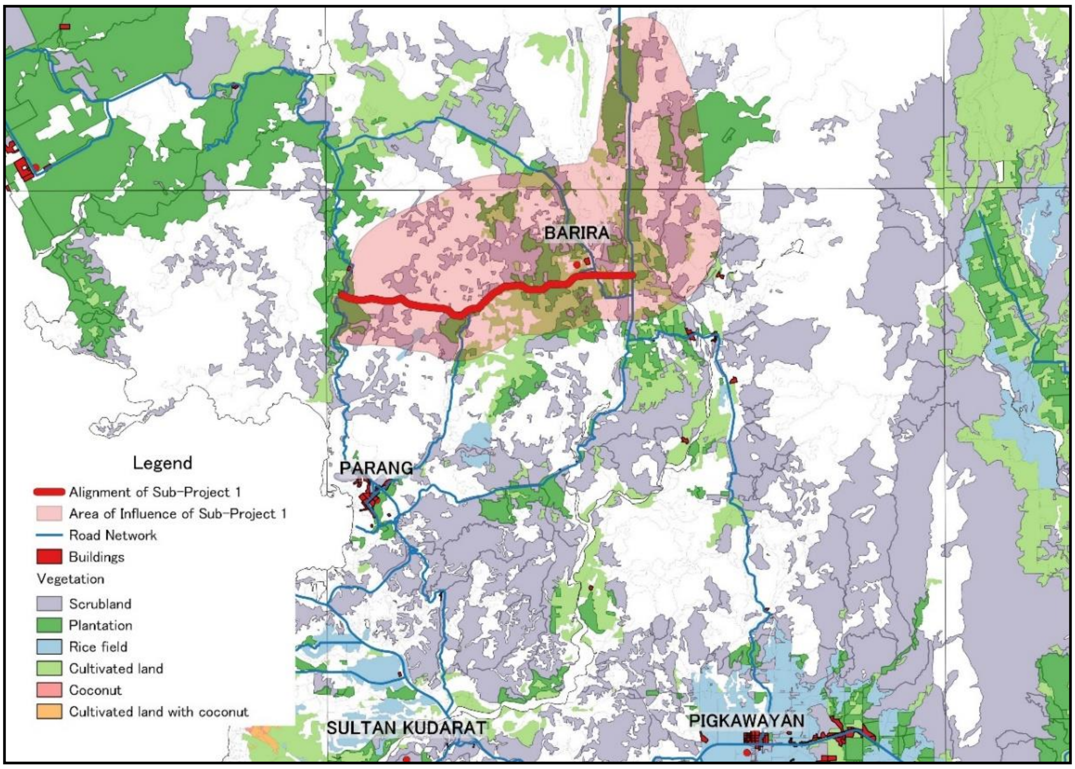

Figure 21.1.2-1 Area of influence of Sub-Project 1 for agriculture

On the basis of farmers' annual incremental net income from reduced transport costs of agricultural produce and agricultural production inputs, the estimated economic benefit of the road improvement for agriculture amounts to PhP 27,452,432.

Table 21.1.2-2 Farmers' annual incremental net income from reduced transport costs of agricultural produce and agricultural production inputs

	production/ha/crop (kg) a	no. of crops /year b	production/ha/year (kg) axb=c	amount of inputs/ha /year (kg) d	labor cost in transporting products/kg (PhP) e	transport cost/kg (PhP) f	transport cost of products/ ha/year cx(e+f)=g	transport cost of inputs /ha /year dxf=h	area under cultivation (ha) i	total transport cost/year (PhP) (g+h)xi=j	reduction in transport cost after road construction (%) k	farmers' incremental net income from cost reduction (PhP) jxk=l
Irrigated Palay	1,075	2.5	2,688	100.0	1.5	0.7	5,913	70	245	1,464,201	40%	585,680
Rainfed Palay	1,731	1.7	2,886	250.5	0.6	1.0	4,550	246	1,774	8,509,138	40%	3,403,655
							transport cost reduction of household rice consumption					-305,242
Yellow Corn	3,564	2.4	8,514	543.6	0.3	0.9	10,018	470	2,519	26,415,169	40%	10,566,068
White Corn	2,186	2.2	4,776	431.5	0.4	0.8	6,032	355	1,855	11,845,053	40%	4,738,021
Coconut	838	3.3	2,742	152.3		1.3	3,564	198	4,028	15,155,497	40%	6,062,199
Others			6,323			1.0	6,323	0	950	6,005,126	40%	2,402,050
											Total	27,452,432

* Transport cost indicated in the flow of coconuts in the social survey report is used.
* The average production/ha/year for others is based on Country STAT data
* The transport cost/kg for other crops is assumed 1.0 PhP/kg.
* Production/ha/crop, no. of crops /year, amount of inputs/ha/year, and labor cost in transporting products/kg are estimated based on the result of the social survey.

The improvement to the road may also make the cultivation of unused land economical, causing an increase in the cultivation area. As an expected impact of the improvement of the road, farmers' incremental net income from the increased cultivation area is estimated based on the social survey results. There may not be enough land for all farming households in the area to expand cultivation as much as household survey respondents are willing to expand. Therefore, farmers' incremental net income was estimated based on the assumption that all uncultivated land identified by barangay captains along the alignment of Sub-Project 1 was brought into production. Over the years, the farmers' incremental net income would gradually increase as farmers fulfilled other conditions such as securing financial resources for investment. It should be noted, however, that unused land would not be converted to agricultural land unless specified in the land use plans.

Table 21.1.2-3 Farmers' annual incremental net income from the increased cultivation area

crops	cultivation area to be increased (ha) by household survey respondents a	share of crops to be increased cultivation area b	uncultivated land in barangays along the alignment to be cultivated (ha) b x total uncultivated land=c	farmers' net income/ha/year (PhP) d	farmers' total net income/year (PhP) cxd=e
palay	2.0	2.2%	31.8	12,010	382,409
corn	40.5	44.8%	644.8	14,238	9,180,348
coconut	26.5	29.3%	421.9	45,000	18,985,127
others	21.5	23.8%	342.3	65,392	22,383,052
Total	90.5	100.0%	1,440.8		50,930,936

* Uncultivated land of the target barangays estimated by barangay captains is 1,440.8 ha in total.
* Total net income of corn is Country STAT yellow corn data, and assumed two crops per year.
* Total net income of palay is Country STAT rainfed palay data, and assumed one crop per year.
* Total net income of coconut is based on social survey.
* Total net income of others is the average of several crops from Country STAT.

21.1.3 Cost Benefits Analysis

Economic evaluation for the Sub-Project 1 was estimated as shown in **Table 21.1.3-1**. Table shows that EIRR (10.9%) was greater than social discount rate (10%) and B/C (1.11) was more than 1.0. These results indicate that the improvement of Sub-Project 1 was appropriate from economic view. The cost-benefit stream of Sub-Project 1 is shown in **Table 21.1.3-2**.

Table 21.1.3-1 Result of Economic Analysis

Economic Benefit		
EIRR	B/C	NPV (Million PhP)
10.9%	1.11	161.2

Source: Estimated by JICA Study Team

Table 21.1.3-2 Cost Benefit Stream for Sub-Project 1

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And, the sensitivity analyses were carried out as shown in **Table 21.2.3-3**. This aims to evaluate the relevance of the Sub-Project 1 under some risks. For example, there may be the case that, the estimated costs would be increased. Other cases would be that, the expected benefit in terms of reduction of VOC and TTC may not be attained as expected. In this regard, the following nine (9) cases were evaluated.

As a result, the strictest condition which is Cost 20% Plus and Benefit 20% Less shows that the EIRR value is way lower than the social discount rate (10%). However, improvement of Sub-Project 1 will be expected to contribution of peace building and development of agriculture and fishery sector.

Table 21.1.3-3 Result of Sensitivity Analyses

Sensitivity Analysis		Benefit		
		0%	-10%	-20%
Cost	0%	10.9%	9.9%	8.9%
	+10%	10.0%	9.1%	8.2%
	+20%	9.3%	8.4%	7.5%

21.2 Sub-Project 2

21.2.1 Economic Benefits Calculation

Methodology of economic benefit calculation is explained **Section 21.1**.

21.2.2 Cost Benefits Calculation

(1) Estimation of Economic Cost

(CONFIDENTIAL)

(2) Estimation of Economic Benefit

1) Economic Benefit to Traffic

Economic benefit in 2020 and 2030 were estimated based on the result of future traffic, unit VOC and TTC and O&M cost per vehicle as shown in **Table 21.2.2-1**. Total benefit is calculated at PhP 380.9 Million in 2020 and PhP 604.9 Million in 2030. The benefit is dependent on the saving of VOC.

Table 21.2.2-1 Result of Economic Benefit to Traffic

(Unit: Million PhP)

	VOC	TTC	O&M	Total
2020	312.6	60.1	8.2	380.9
2030	488.9	101.4	14.6	604.9

Source: Estimated by JICA Study Team

2) Economic Benefit to Agriculture

Most farmers and fishermen interviewed for the social survey sell their crops and fish to markets in Parang municipality in Maguindanao province, as well as markets in Balabagan municipality and Malabang municipality in Lanao del Sur province. The area of influence of Sub-Project 2 is presumably almost halfway between the alignment of Sub-Project 2 and the road that runs parallel to the north of Sub-Project 2. Agricultural produce beyond the halfway point is supposed to be transported on the road that runs parallel and leads to the Parang municipality to the east and Malabang and Balabagan municipalities to the west.

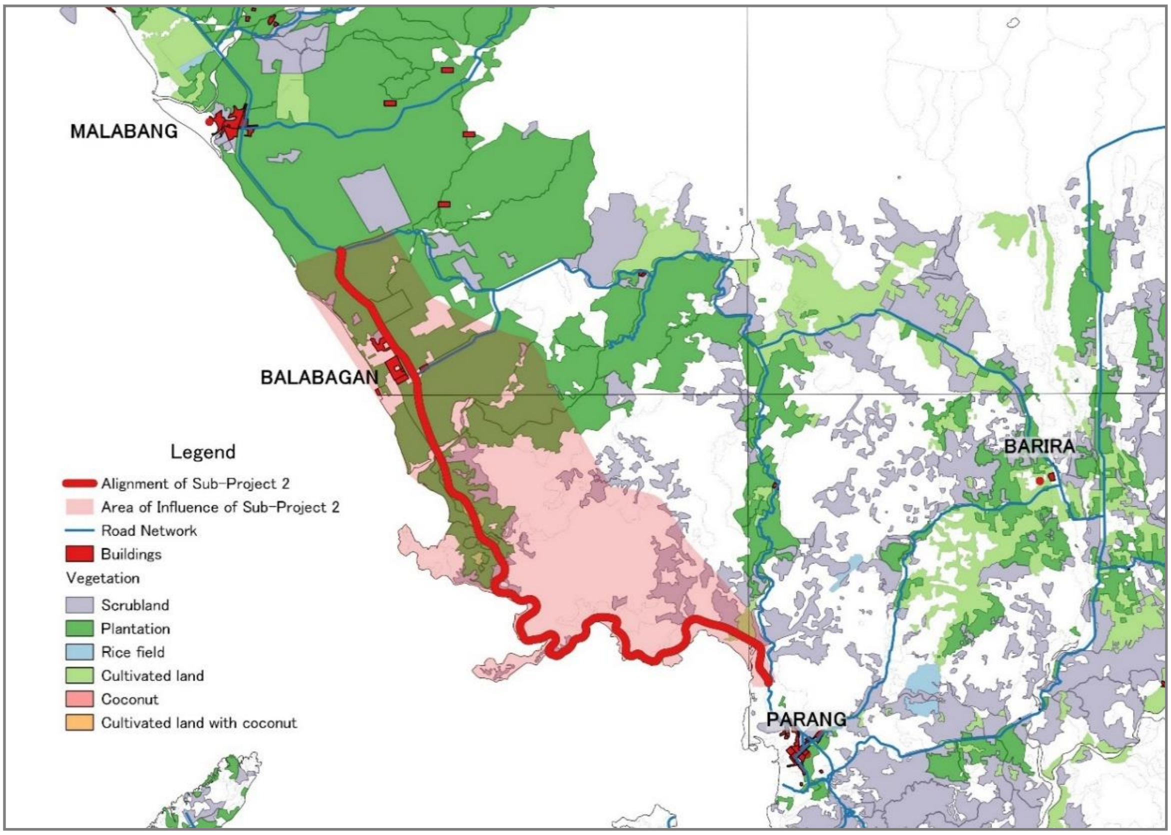


Figure 21.2.2-1 Area of influence of Sub-Project 2 for agriculture

On the basis of farmers' annual incremental net income from reduced transport costs of agricultural produce and agricultural production inputs, the estimated economic benefit of the road improvement for agriculture is PhP 31,060,692.

Table 21.2.2-2 Farmers' annual incremental net income from reduced transport costs of agricultural produce and agricultural production inputs

	production/ha/crop (kg) a	no. of crops /year b	production/ha/year (kg) axb=c	amount of inputs/ha /year (kg) d	labor cost in transporting products/kg (PhP) e	transport cost/kg (PhP) f	transport cost of products/ ha/year cx(e+f)=g	transport cost of inputs /ha /year dxf=h	area under cultivation (ha) i	total transport cost/year (PhP) (g+h)xi=j	reduction in transport cost after road construction (%) k	farmers' incremental net income from cost reduction (PhP) jxk=l
Irrigated Palay	1,717	2.0	3,433	200.0	1.2	2.1	11,050	412	235	2,689,158	40%	1,075,663
							transport cost reduction of household rice consumption					-68,446
Yellow Corn	2,619	2.8	7,380	722.0	0.3	0.9	8,720	650	115	1,081,890	40%	432,756
White Corn	2,620	2.6	6,683	695.7	1.2	2.1	21,510	1432	922	21,148,710	40%	8,459,484
Coconut	941	3.1	2,875	156.1	0.4	0.9	3,759	137	3,145	12,252,913	40%	4,901,165
Cassava			11,991	370.7	1.2	2.1	38,592	763	931	36,657,923	40%	14,663,169
Others			6,323			1.0	6,323	0	478	3,025,104	40%	1,210,042
			production/household/year (kg)		labor cost in transporting products/kg (PhP)	transport cost/kg (PhP)	transport cost of products/ household /year		number of household	total transport cost/year (PhP)		
Fish			1,362		1.3	1.1	3,328		291	967,147	40%	386,859
											Total	31,060,692

* County STAT data of cassava production/ha/year is used.
* The average production/ha/year for others is based on Country STAT data.
* The transport cost/kg for other crops is assumed 1.0 PhP/kg.
* Labor cost and transport cost for white corn is substituted for those costs for palay and cassava.
* Production/ha/crop, no. of crops /year, amount of inputs/ha/year, and labor cost in transporting products/kg are estimated based on the result of the social survey.

The improvement to the road may also make the cultivation of unused land economical, causing an increase in the cultivation area. As an expected impact of the improvement to the road, farmers' incremental net income from the increased cultivation area is estimated based on the social survey results. There may not be enough land for all farming households in the area to expand cultivation as much as household survey respondents are willing to expand. Therefore, farmers' incremental net income was estimated based on the assumption that all uncultivated land identified by barangay captains along the alignment of Sub-Project 2 was brought into production. Over the years, the farmers' incremental net income would gradually increase as farmers fulfilled other conditions such as securing financial resources for investment. It should be noted, however, that unused land would not be converted to agricultural land unless specified in the land use plans.

Table 21.2.2-3 Farmers' annual incremental net income from the increased cultivation area

crops	cultivation area to be increased (ha) by household survey respondents a	share of crops to be increased cultivation area b	uncultivated land in barangays along the alignment to be cultivated (ha) b x total uncultivated land=c	farmers' net income/ha/year (PhP) d	farmers' total net income/year (PhP) cxd=e
Palay	2.8	2.2%	27.8	24,020	668,833
Corn	49.5	39.3%	501.2	12,614	6,322,227
Coconut	25.5	20.2%	258.2	45,000	11,618,893
Cassava	17	13.5%	172.1	40,767	7,017,295
Others	31.3	24.8%	316.4	72,918	23,072,552
Total	126.0	100.0%	1,275.8		48,699,800

* Uncultivated land of the target barangays estimated by barangay captains is 1,275.8 ha in total.
* Total net income of corn is Country STAT yellow corn data, and assumed two crops per year.
* Total net income of palay is Country STAT rainfed palay data, and assumed one crop per year.
* Total net income of coconut is based on social survey.
* Total net income of others is the average of several crops from Country STAT.

21.2.3 Cost Benefits Analysis

Economic evaluation for the Sub-Project 2 was estimated as shown in **Table 21.2.3-1**. Table shows that EIRR (13.3%) was greater than social discount rate (10%) and B/C (1.43) was more than 1.0. These results indicate that the improvement of Sub-Project 2 was appropriate from economic view. The cost benefit stream of Sub-Project 2 is shown in **Table 21.2.3-2**.

Table 21.2.3-1 Result of Economic Analysis

Economic Benefit		
EIRR	**B/C**	**NPV (Million PhP)**
13.3%	1.43	1,201.0

Source: Estimated by JICA Study Team

Table 21.2.3-2 Cost Benefit Stream for Sub-Project 2

(CONFIDENTIAL)

And, the sensitivity analyses were carried out as shown in **Table 21.2.3-3**. This aims to evaluate the relevance of the Sub-Project 2 under some risks. For example, there may be the case that, the estimated costs would be increased. Other cases would be that, the expected benefit in terms of reduction of VOC and TTC may not be attained as expected. In this regard, the following nine (9) cases were evaluated.

As a result, the strictest condition which is Cost 20% Plus and Benefit 20% Less shows that the EIRR value is almost same rate of the social discount rate (10%).

Table 21.2.3-3 Result of Sensitivity Analyses

Sensitivity Analysis		Benefit		
		0%	**-10%**	**-20%**
Cost	0%	13.3%	12.3%	11.2%
	+10%	12.3%	11.4%	10.3%
	+20%	11.5%	10.6%	9.6%

21.3 Sub-Project 6

21.3.1 Economic Benefits Calculation

Methodology of economic benefit calculation is explained in **Section 21.1**.

21.3.2 Cost Benefits Calculation

(1) Estimation of Economic Cost

(CONFIDENTIAL)

(2) Estimation of Economic Benefit

1) Economic Benefit to Traffic

Economic benefit in 2020 and 2030 were estimated based on the result of future traffic, unit VOC and TTC and O&M cost per vehicle as shown in **Table 21.3.2-1**. Total benefit is calculated at PhP 473.2 Million in 2020 and PhP 853.9 Million in 2030. The benefit is dependent on the saving of VOC.

Table 21.3.2-1 Result of Economic Benefit to Traffic

(Unit: Million PhP)

	VOC	TTC	O&M	Total
2020	393.5	64.8	14.9	473.2
2030	702.9	128.0	23.0	853.9

Source: Estimated by JICA Study Team

2) Economic Benefit to Agriculture

Most farmers and fishermen interviewed in the social survey sell their crops and fish to markets in Lebak municipality in Sultan Kudarat province and Cotabato City. Some farm and fish products are also marketed to neighboring barangays. The area of influence of Sub-Project 6 is presumably almost halfway in-between the alignment of Sub-Project 6 and the road which runs parallel to the east of Sub-Project 6. Agricultural produce beyond the halfway point is supposed to be transported on the road that runs parallel towards Lebak municipality to the south and Cotabato City to the north.

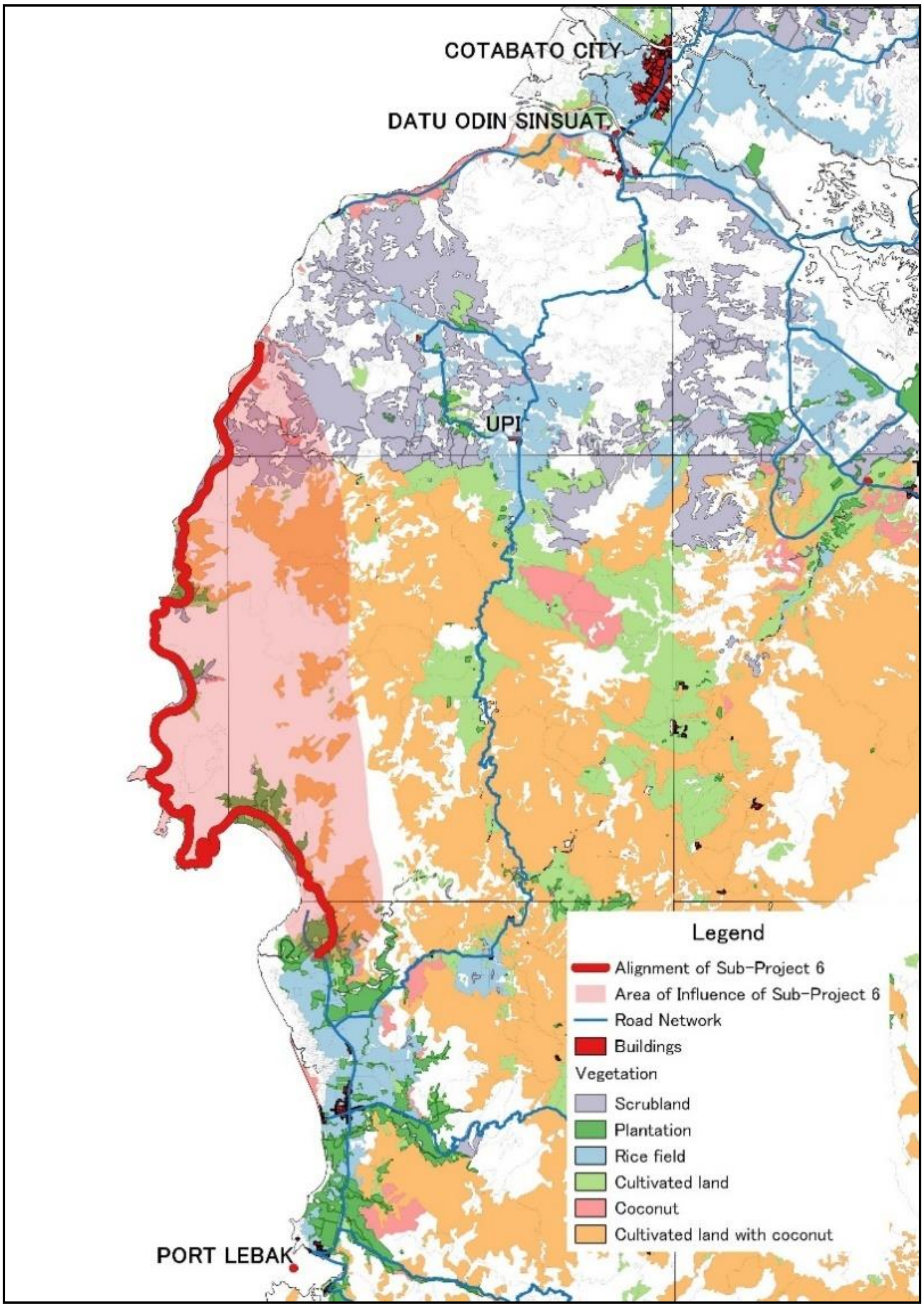


Figure 21.3.2-1 Area of influence of Sub-Project 1 for agriculture

On the basis of farmers' annual incremental net income from reduced transport costs of agricultural produce and agricultural production inputs, the estimated economic benefit of the road improvement for agriculture is PhP 83,241,736.

Table 21.3.2-2 Farmers' annual incremental net income from reduced transport costs of agricultural produce and agricultural production inputs

	production/ha/crop (kg) a	no. of crops /year b	production/ha/year (kg) axb=c	amount of inputs/ha /year (kg) d	labor cost in transporting products/kg (PhP) e	transport cost/kg (PhP) f	transport cost of products/ ha/year cx(e+f)=g	transport cost of inputs /ha /year dxf=h	area under cultivation (ha) i	total transport cost/year (PhP) (g+h)xi=j	reduction in transport cost after road construction (%) k	farmers' incremental net income from cost reduction (PhP) jxk=l
Irrigated Palay	3,827	2.7	10,348	325.0	0.6	0.9	14,874	286	2,927	44,369,226	40%	17,747,690
Rainfed Palay	2,906	1.9	5,641	270.0	0.6	1.8	13,738	498	1,220	17,361,056	40%	6,944,422
							transport cost reduction of household rice consumption					-494,506
Yellow Corn	2,842	2.5	7,165	177.5	0.6	1.8	17,383	323	5,549	98,248,411	40%	39,299,364
White Corn	2,791	2.5	6,977	218.2	0.5	1.7	15,064	363	890	13,734,563	40%	5,493,825
Coconut	679	3.1	2,107		0.4	1.1	3,232	0	6,384	20,631,841	40%	8,252,736
Peanut			1,575			1.0	1,575	0	1,061	1,670,439	40%	668,176
Others			7,273			1.0	7,273	0	1,441	10,478,926	40%	4,191,570
			production/household/year (kg)		labor cost in transporting products/kg (PhP)	transport cost/kg (PhP)	transport cost of products/household/ year		number of households	total transport cost/year (PhP)	reduction in transport cost after road construction (%)	
Fish			807		1.3	1.1	1,973		1442	2,846,147	40%	1,138,459
											Total	83,241,736

* County STAT data of cassava production/ha/year is used.
* The average production/ha/year for others is based on Country STAT data.
* The transport cost/kg for other crops is assumed 1.0 PhP/kg.
* The labor and transport cost for fish is estimated based on the social survey report.
* Production/ha/crop, no. of crops /year, amount of inputs/ha/year, and labor cost in transporting products/kg are estimated based on the result of the social survey.

The improvement to the road may also make the cultivation of unused land economical, causing an increase in the area of cultivation. As an expected impact of the road improvement, farmers' incremental net income from the increased cultivation area is estimated based on the social survey results. There may not be enough land for all farming households in the area to expand cultivation as much as household survey respondents are willing to expand. Therefore, farmers' incremental net income was estimated based on the assumption that all uncultivated land identified by barangay captains along the alignment of Sub-Project 6 was brought into production. Over the years, the farmers' incremental net income would gradually increase as farmers fulfilled other conditions such as securing financial resources for investment. It should be noted, however, that unused land would not be converted to agricultural land unless specified in the land use plans.

Table 21.3.2-3 Farmers' annual incremental net income from the increased cultivation area

crops	cultivation area to be increased (ha) by household survey respondents a	share of crops to be increased cultivation area b	uncultivated land in barangays along the alignment to be cultivated (ha) b x total uncultivated land=c	farmers' net income/ha/year (PhP) d	farmers' total net income/year (PhP) cxd=e
palay	31.5	10.4%	353.0	12,010	4,239,870
corn	96.5	31.8%	1,081.5	13,426	14,520,212
coconut	87.5	28.8%	980.6	45,000	44,128,542
others	88.0	29.0%	986.2	72,918	71,914,297
Total	303.5	100.0%	3,401.4		134,802,922

* Uncultivated land of the target barangays estimated by barangay captains is 3,401.4 ha in total.
* Total net income of corn is Country STAT white and yellow corn data, and assumed two crops per year.
* Total net income of palay is Country STAT rainfed palay data, and assumed one crop per year.
* Total net income of coconut is based on social survey.
* Total net income of others is the average of several crops from country stat.

21.3.3 Cost Benefits Analysis

Economic evaluation for the Sub-Project 6 was estimated as shown in **Table 21.3.3-1**. Table shows that EIRR (12.5%) was greater than social discount rate (10%) and B/C (1.34) was more than 1.0.

These results indicate that the improvement of Sub-Project 6 was appropriate from economic view. The cost benefit stream of Sub-Project 6 is shown in **Table 21.3.3-2**.

Table 21.3.3-1 Result of Economic Analysis

Economic Benefit		
EIRR	**B/C**	**NPV (Million PhP)**
12.5%	1.34	1,628.9

Source: Estimated by JICA Study Team

Table 21.3.3-2 Cost Benefit Stream for Sub-Project 6

(CONFIDENTIAL)

And, the sensitivity analyses were carried out as shown in **Table 21.2.3-3**. This aims to evaluate the relevance of the Sub-Project 6 under some risks. For example, there may be the case that, the estimated costs would be increased. Other cases would be that, the expected benefit in terms of reduction of VOC and TTC may not be attained as expected. In this regard, the following nine (9) cases were evaluated.

As a result, the strictest condition which is Cost 20% Plus and Benefit 20% Less shows that the EIRR value is lower than the social discount rate (10%). However, improvement of Sub-Project 6 will be expected to clear the difficulty of communities access and development of agriculture and fishery sector.

Table 21.3.3-3 Result of Sensitivity Analyses

Sensitivity Analysis		Benefit		
		0%	**-10%**	**-20%**
Cost	0%	12.5%	11.6%	10.5%
	+10%	11.7%	10.7%	9.8%
	+20%	10.9%	10.0%	9.1%

21.4 Sub-Project 7

21.4.1 Economic Benefits Calculation

Methodology of economic benefit calculation is explained **Section 21.1**.

21.4.2 Cost Benefits Calculation

(1) Estimation of Economic Cost

(CONFIDENTIAL)

(2) Estimation of Economic Benefit

1) Economic Benefit to Traffic

Economic benefit in 2020 and 2030 were estimated based on the result of future traffic, unit VOC and TTC and O&M cost per vehicle as shown in **Table 21.4.2-1**. Total benefit is calculated at PhP 225.9 Million in 2020 and PhP 325.9 Million in 2030. The benefit is dependent on the saving of VOC. And, disruption cost was estimated in order to effect the existing road during construction period (24 Months).

Table 21.4.2-1 Result of Economic Benefit to Traffic

(Unit: Million PhP)

	VOC	TTC	O&M	Total
2020	112.6	109.0	4.4	225.9
2030	140.6	176.4	8.8	325.9
Disruption Cost	-1.9	-7.8	0	-9.7

Source: Estimated by JICA Study Team

2) Economic Benefit to Agriculture

Economic benefit to agriculture is not appropriated for Sub-Project 7. Because, functional of Sub-Project 7 road is a bypass, agricultural development has little impact.

21.4.3 Cost Benefits Analysis

Economic evaluation for the Sub-Project 7 was estimated as shown in **Table 21.4.3-1**. Table shows that EIRR (14.0%) was greater than social discount rate (10%) and B/C (1.49) was more than 1.0. These results indicate that the improvement of Sub-Project 7 was appropriate from economic view. The cost benefit stream of Sub-Project 7 is shown in **Table 21.4.3-2**.

Table 21.4.3-1 Result of Economic Analysis

Economic Benefit		
EIRR	**B/C**	**NPV (Million PhP)**
14.0%	1.49	654.5

Source: Estimated by JICA Study Team

Table 21.4.3-2 Cost Benefit Stream for Sub-Project 7

(CONFIDENTIAL)

And, sensitivity analyses were carried out as shown in **Table 21.4.3-3**. This aims to evaluate the relevance of the Sub-Project 7 under some risks. For example, there may be the case that, the estimated costs would be increased. Other cases would be that, the expected benefit in terms of reduction of VOC and TTC may not be attained as expected. In this regard, the following nine (9) cases were evaluated.

As a result, the strictest condition which is Cost 20% Plus and Benefit 20% Less shows that the EIRR value is almost higher than the social discount rate (10%).

Table 21.4.3-3 Result of Sensitivity Analyses

Sensitivity Analysis		Benefit		
		0%	**-10%**	**-20%**
Cost	0%	14.0%	12.8%	11.6%
	+10%	12.9%	11.8%	10.7%
	+20%	12.0%	11.0%	9.9%

21.5 Sub-Project 8

21.5.1 Economic Benefits Calculation

Methodology of economic benefit calculation is explained **Section 21.1**.

21.5.2 Cost Benefits Calculation

(1) Estimation of Economic Cost

(CONFIDENTIAL)

(2) Estimation of Economic Benefit

1) Economic Benefit to Traffic

Economic benefit in 2020 and 2030 were estimated based on the result of future traffic, unit VOC and TTC and O&M cost per vehicle as shown in **Table 21.5.2-1**. Total benefit is calculated at PhP 79.6 Million in 2020 and PhP 137.6 Million in 2030.

Table 21.5.2-1 Result of Economic Benefit to Traffic

(Unit: Million PhP)

	VOC	TTC	O&M	Total
2020	42.3	33.0	4.3	79.6
2030	79.8	51.2	6.6	137.6

Source: Estimated by JICA Study Team

2) Economic Benefit to Agriculture

Economic benefit to agriculture is not appropriated for Sub-Project 8. Because, functional of Sub-Project 8 road is a bypass, agricultural development has little impact.

21.5.3 Cost Benefits Analysis

Economic evaluation for the Sub-Project 8 was estimated as shown in **Table 21.5.3-1**. Table shows that EIRR (12.5%) was greater than social discount rate (10%) and B/C (1.33) was more than 1.0. These results indicate that the improvement of Sub-Project 8 was appropriate from economic view. The cost benefit stream of Sub-Project 8 is shown in **Table 21.5.3-2**.

Table 21.5.3-1 Result of Economic Analysis

Economic Benefit		
EIRR	**B/C**	**NPV (Million PhP)**
12.5%	1.33	230.5

Source: Estimated by JICA Study Team

Table 21.5.3-2 Cost Benefit Stream for Sub-Project 8

(CONFIDENTIAL)

And, the sensitivity analyses were carried out as shown in **Table 21.5.3-3**. This aims to evaluate the relevance of the Sub-Project 8 under some risks. For example, there may be the case that, the estimated costs would be increased. Other cases would be that, the expected benefit in terms of reduction of VOC and TTC may not be attained as expected. In this regard, the following nine (9) cases were evaluated.

As a result, the strictest condition which is Cost 20% Plus and Benefit 20% Less shows that the EIRR value is lower than the social discount rate (10%).

Table 21.5.3-3 Result of Sensitivity Analyses

Sensitivity Analysis		Benefit		
		0%	**-10%**	**-20%**
Cost	0%	12.5%	11.5%	10.5%
	+10%	11.6%	10.7%	9.7%
	+20%	10.9%	10.0%	9.0%

21.6 Sub-Project 9

21.6.1 Economic Benefits Calculation

Methodology of economic benefit calculation is explained **Section 21.1**.

21.6.2 Cost Benefits Calculation

(1) Estimation of Economic Cost

(CONFIDENTIAL)

(2) Estimation of Economic Benefit

1) Economic Benefit to Traffic

Economic benefit in 2020 and 2030 were estimated based on the result of future traffic, unit VOC and TTC and O&M cost per vehicle as shown in **Table 21.6.2-1**. Total benefit is calculated at PhP 51.4 Million in 2020 and PhP 111.0 Million in 2030. The benefit is dependent on the saving of VOC.

Table 21.6.2-1 Result of Economic Benefit to Traffic

(Unit: Million PhP)

	VOC	TTC	O&M	Total
2020	33.2	13.7	4.5	51.4
2030	73.0	26.5	11.5	111.0

Source: Estimated by JICA Study Team

2) Economic Benefit to Agriculture

Most farmers interviewed for the social survey sell their crops to markets in Simuay of Sultan Kudarat municipality and Tapayan of Sultan Mastura municipality in Maguindanao province; and municipalities of Pigcawayan, Libungan and Midsayap in North Cotabato province. The area of influence of Sub-Project 9 is presumably halfway between the alignment of Sub-project 9 and the road that runs parallel to the east and to the south. Agricultural produce beyond the halfway point is supposed to be transported on the roads that run parallel to Pigcawayan municipality towards the east end of Sub-Project 9.

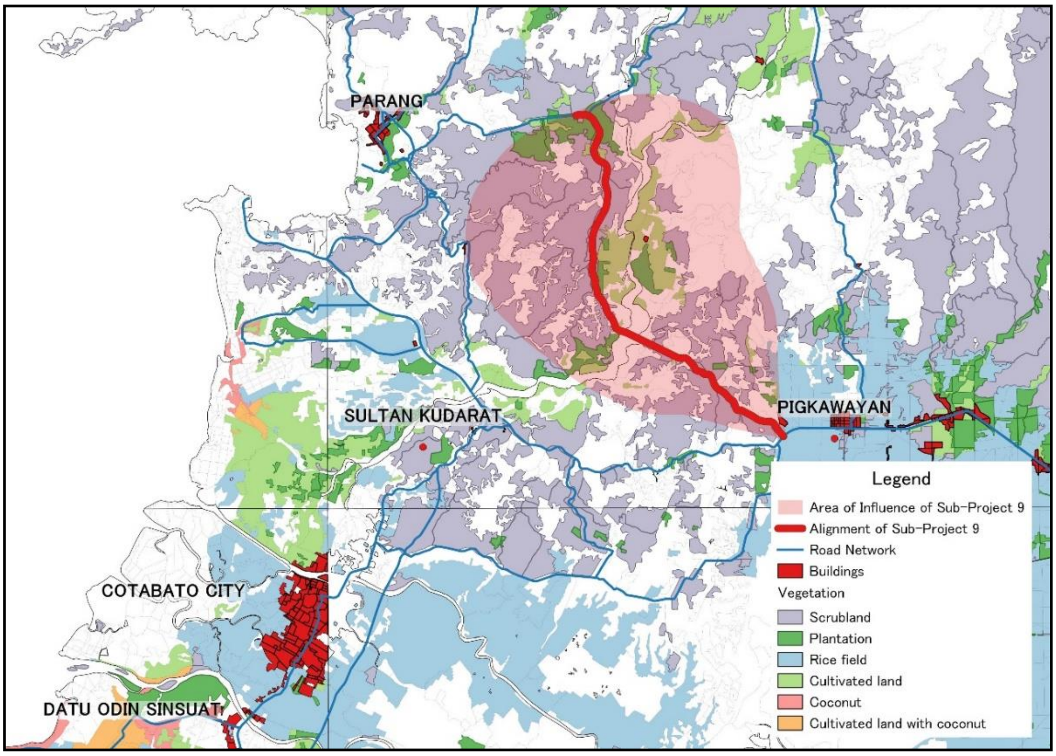


Figure 21.6.2-1 Area of influence of Sub-Project 1 for agriculture

On the basis of farmers' annual incremental net income from reduced transport costs of agricultural produce and agricultural production inputs, the estimated economic benefit of the road improvement for agriculture is PhP 27,284,084.

Table 21.6.2-2 Farmers' annual incremental net income from reduced transport costs of agricultural produce and agricultural production inputs

	production/ha/crop (kg) a	no. of crops /year b	production/ha/year (kg) axb=c	amount of inputs/ha /year (kg) d	labor cost in transporting products/kg (PhP) e	transport cost/kg (PhP) f	transport cost of products/ ha/year cx(e+f)=g	transport cost of inputs /ha /year dxf=h	area under cultivation (ha) i	total transport cost/year (PhP) (g+h)xi=j	reduction in transport cost after road construction (%) k	farmers' incremental net income from cost reduction (PhP) jxk=l
Irrigated Palay	3,598	1.9	6,797	311.7	0.9	0.2	7,610	59	732	5,615,164	40%	2,246,065
Rainfed Palay	2,986	1.6	4,692	290.0	0.5	0.6	5,050	163	560	2,918,687	40%	1,167,475
							transport cost reduction of household rice consumption					-82,599
Yellow Corn	4,886	2.6	12,610	797.6	0.5	0.8	15,303	605	2,644	42,061,810	40%	16,824,724
White Corn	2,397	2.5	6,085	751.0	0.3	0.9	7,340	643	1,200	9,579,107	40%	3,831,643
Coconut			2,100	140.9		1.3	2,625	176	1,129	3,161,620	40%	1,264,648
Peanut			1,575			1.0	1,575	0	112	176,536	40%	70,614
Others			7,273			1.0	7,273	0	674	4,903,784	40%	1,961,514
											Total	27,284,084

* County STAT data of cassava production/ha/year is used.
* The average production/ha/year for others is based on Country STAT data.
* The transport cost/kg for other crops is assumed 1.0 PhP/kg.
* Production/ha/crop, no. of crops /year, amount of inputs/ha/year, and labor cost in transporting products/kg are estimated based on the result of the social survey.

The improvement to the road may also make the cultivation of unused land economical, causing an increase in the cultivation area. As an expected impact of the improvement of the road, farmers' incremental net income from the increased cultivation area is estimated based on the social survey results. There may not be enough land for all farming households in the area to expand cultivation as much as household survey respondents are willing to expand. Therefore, farmers' incremental net income was estimated based on the assumption that all uncultivated land identified by barangay captains along the alignment of Sub-Project 9 was brought into production. Over the years, the farmers' incremental net income would gradually increase as farmers fulfilled other conditions such as securing financial resources for investment. It should be noted, however, that unused land would not be converted to agricultural land unless specified in the land use plans.

Table 21.6.2-3 Farmers' annual incremental net income from the increased cultivation area

crops	cultivation area to be increased (ha) by household survey respondents a	share of crops to be increased cultivation area b	uncultivated land in barangays along the alignment to be cultivated (ha) b x total uncultivated land=c	farmers' net income/ha/year (PhP) d	farmers' total net income/year (PhP) cxd=e
palay	9.5	5.8%	180.5	12010	2,167,454
corn	67.5	41.5%	1,282.3	13,426	17,216,057
coconut	40.5	24.9%	769.4	45,000	34,621,892
others	45	27.7%	854.9	72,918	62,334,623
Total	162.5	100.0%	3,087.0		116,340,025

* Uncultivated land of the target barangays estimated by barangay captains is 3,087.0 ha in total.
* Total net income of corn is Country STAT white and yellow corn data, and assumed two crops per year.
* Total net income of palay is Country STAT rainfed palay data, and assumed one crop per year.
* Total net income of coconut is based on social survey.
* Total net income of others is the average of several crops from Country STAT.

21.6.3 Cost Benefits Analysis

Economic evaluation for the Sub-Project 9 was estimated as shown in **Table 21.6.3-1**. Table shows that EIRR (11.8%) was greater than social discount rate (10%) and B/C (1.23) was more than 1.0. These results indicate that the improvement of Sub-Project 9 was appropriate from economic view. The cost benefit stream of Sub-Project 9 is shown in **Table 21.6.3-2**.

Table 21.6.3-1 Result of Economic Analysis

Economic Benefit		
EIRR	**B/C**	**NPV (Million PhP)**
11.8%	1.23	281.1

Source: Estimated by JICA Study Team

Table 21.6.3-2 Cost Benefit Stream for Sub-Project 9

(CONFIDENTIAL)

And, the sensitivity analyses were carried out as shown in **Table 21.6.3-3**. This aims to evaluate the relevance of the Sub-Project 9 under some risks. For example, there may be the case that, the estimated costs would be increased. Other cases would be that, the expected benefit in terms of reduction of VOC and TTC may not be attained as expected. In this regard, the following nine (9) cases were evaluated.

As a result, the strictest condition which is Cost 20% Plus and Benefit 20% Less shows that the EIRR value is lower than the social discount rate (10%). However, improvement of Sub-Project 9 will be expected to clear the difficulty of communities access.

Table 21.6.3-3 Result of Sensitivity Analyses

Sensitivity Analysis		Benefit		
		0%	**-10%**	**-20%**
Cost	0%	11.8%	10.8%	9.9%
	+10%	10.9%	10.0%	9.1%
	+20%	10.2%	9.3%	8.4%

21.7 6 Sub-Projects

21.7.1 Economic Benefits Calculation

Methodology of economic benefit calculation is explained **Section 21.1**.

21.7.2 Cost Benefits Calculation

(3) Estimation of Economic Cost

(CONFIDENTIAL)

(4) Estimation of Economic Benefit

1) Economic Benefit to Traffic

Economic benefit in 2020 and 2030 were estimated based on the result of future traffic, unit VOC and TTC and O&M cost per vehicle as shown in **Table 21.7.2-1**. Total benefit is calculated at PhP 1,331.5 Million in 2020 and PhP 2,232.3 Million in 2030. The benefit is dependent on the saving of VOC.

Table 21.7.2-1 Result of Economic Benefit to Traffic

(Unit: Million PhP)

	VOC	TTC	O&M	Total
2020	981.4	312.7	37.4	1,331.5
2030	1,637.7	528.7	66.0	2,232.3

Source: Estimated by JICA Study Team

2) Economic Benefit to Agriculture

Economic benefit to agriculture was added up result of economic benefit for Sub-Project 1, 2, 6 and 9 as shown in **Table 21.7.2-2**.

Table 21.7.2-2 Farmers' annual incremental net income from the increased cultivation area

(Unit: Million PhP)

Sub-Projects	Farmers' annual incremental net income from reduced transport costs of agricultural produce and agricultural production inputs	Farmers' annual incremental net income from the increased cultivation area	Total
Sub-Project 1	27.5	50.9	78.4
Sub-Project 2	31.1	48.7	79.8
Sub-Project 6	83.2	134.8	218.0
Sub-Project 9	27.3	116.3	143.6
Total	169.1	350.7	519.8

Source: JICA Study Team

21.7.3 Cost Benefits Analysis

Economic evaluation for the 6 Sub-Projects was estimated as shown in **Table 21.7.3-1**. Table shows that EIRR (12.9%) was greater than social discount rate (10%) and B/C (1.35) was more than 1.0. These results indicate that the improvement of 6 Sub-Projects was appropriate from economic view. The cost benefit stream of 6 Sub-Projects is shown in **Table 21.7.3-2**.

Table 21.7.3-1 Result of Economic Analysis

Economic Benefit		
EIRR	**B/C**	**NPV (Million PhP)**
12.9%	1.35	4,319.8

Source: Estimated by JICA Study Team

Table 21.7.3-2 Cost Benefit Stream for 6 Sub-Projects

(CONFIDENTIAL)

And, the sensitivity analyses were carried out as shown in **Table 21.7.3-3**. This aims to evaluate the relevance of the 6 Sub-Projects under some risks. For example, there may be the case that, the estimated costs would be increased. Other cases would be that, the expected benefit in terms of reduction of VOC and TTC may not be attained as expected. In this regard, the following nine (9) cases were evaluated.

As a result, the strictest condition which is Cost 20% Plus and Benefit 20% Less shows that the EIRR value is lower than the social discount rate (10%). However, improvement of 6 Sub-Projects will be expected to clear the difficulty of communities access.

Table 21.7.3-3 Result of Sensitivity Analyses

Sensitivity Analysis		Benefit		
		0%	**-10%**	**-20%**
Cost	0%	12.9%	11.8%	10.7%
	+10%	11.9%	10.9%	9.9%
	+20%	11.1%	10.1%	9.1%

Chapter 22 Operation and Effect Indicator

22.1 Sub-Project 1

22.1.1 Selected Operation and Effect Indicators

In order to enable project monitoring and evaluation on the basis of consistent indicators, operation and effect indications are introduced for ODA loan projects.

Operation and effect indicators are basically equivalent to the outcome indicators and performance indicators used by the World Bank. For this study, they are defined as follows:

- **Operation indicators**: quantitative measure of the operational status of project.
- **Effect indicators**: quantitative measure of the effects generated by a project.

In order to set the appropriate indicators, the following criteria should be considered.

- **Validity**: This determines whether the set of indictors would really be able to measure the achievement of the project purpose.
- **Reliability**: The set indicators data must yield the same results, regardless of how many times they are measured and regardless of who makes the measurements.
- **Ease of Access**: The indicator data set for the project must be easy to access and must not be too many, considering the cost and time required to gather them.

In view of project objective and expected effects, the following indicators were selected:

Table 22.1.1-1 Operation and Effect Indicators

Operation and Effect Indicators		Data Collection Method
Operation Indicators	Traffic Volume of Sub-Projects (veh./day)	Traffic count survey and result of traffic demand forecast
Effect Indicators	Reduction of Travel Time (min)	Calculation based on result of traffic demand forecast
	Vehicle Time Saving (veh*hour/day)	Calculation based on result of traffic demand forecast
	Travel Time Cost Saving (PhP/Year)	Calculation based on Time Cost and result of traffic demand forecast
	Vehicle Distance Saving (veh*hour/day)	Calculation based on result of traffic demand forecast
	Vehicle Operation Cost Saving (PhP/Year)	Calculation based on Vehicle Operation Cost and result of traffic demand forecast

22.1.2 Traffic Volume of Sub-Project 1

Based on the traffic assignment result, future traffic volume is shown as follows.

Table 22.1.2-1 Estimated Traffic Volume of Sub-Project 1

(Unit: Veh/day)

	Y2017	Y2027 (Target)	Y2030
Car	-	975	1,044
Jeepney		79	88
Bus		46	52
Truck		2	3
Total		**1,102**	**1,187**

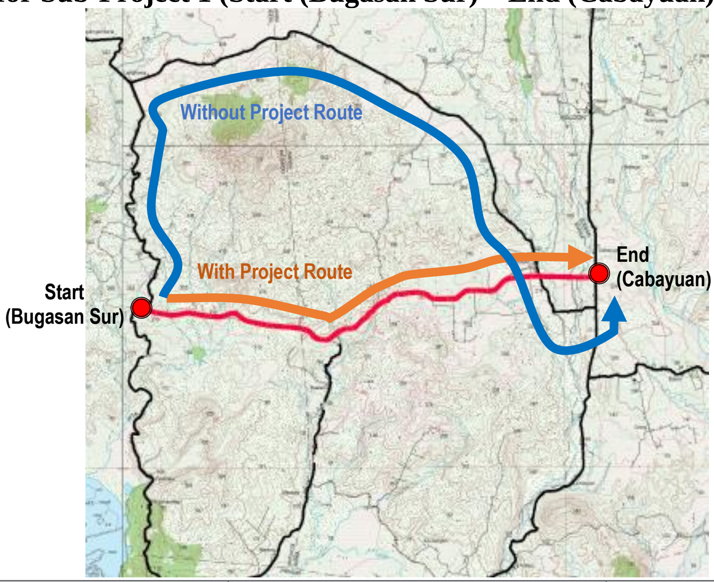
Source: JICA Study Team

22.1.3 Reduction of Travel Time

Based on the traffic assignment result, reduction of travel time is calculated as shown in follows.

Table 22.1.3-1 Reduction of Travel Time (Sub-Project 1)

Route Map for Sub-Project 1 (Start (Bugasan Sur) – End (Cabayuan))



Year	Y2017	Y2027 (Target)
With Project (Yellow Route)	-	21.4 min
Without Project (Blue Route)	78.7 min	79.8 min
Reduction of Travel Time (Without - With)	-	**58.4 min**

Note: Base year of traffic demand forecast is year 2020 and 2030. Estimated travel time in target year was based on year 2030.

22.1.4 Travel Time Saving and Travel Time Cost Saving

Based on the traffic assignment result, vehicle time and travel time cost saving are shown as follows.

Table 22.1.4-1 Travel Time Saving and Travel Time Cost Saving of Sub-Project 1

		Year 2017	Y2027 (Target)	Year 2030
Total Vehicle Hour	W/O Project (veh*hour/day)	327,686	634,153	789,263
	W/ Project (veh*hour/day)	-	634,498	788,889
	Saving per day (veh*hour/day)	-	345	374
	Saving per year (veh*hour/year)	-	126,020	136,510
Travel Time Cost	W/O Project (‘000 PhP/day)	-	190,564	236,643
	W/ Project (‘000 PhP/day)	-	190,677	236,520
	Saving per day (‘000 PhP/day)	-	113	123
	Saving per year (Mill PhP/year)	-	41	45

Source: JICA Study Team

22.1.5 Vehicle Distance Saving and Vehicle Operation Cost Saving

Based on the traffic assignment result, vehicle distance and vehicle operation cost saving are shown as follows.

Table 22.1.5-1 Vehicle Distance and Vehicle Operation Cost Saving of Sub-Project 1

		Year 2017	Y2027 (Target)	Year 2030
Total Vehicle Distance	W/O Project (veh*hour/day)	10,972,924	18,329,600	21,625,244
	W/ Project (veh*hour/day)	-	18,334,860	21,619,493
	Saving per day (veh*hour/day)	-	5,261	5,752
	Saving per year (veh*hour/year)	-	1,920,184	2,099,356
Vehicle Operation Cost	W/O Project (‘000 PhP/day)	-	370,498	445,501
	W/ Project (‘000 PhP/day)	-	370,851	445,083
	Saving per day (‘000 PhP/day)	-	353	418
	Saving per year (Mill PhP/year)	-	129	152

Source: JICA Study Team

22.2 Sub-Project 2

22.2.1 Selected Operation and Effect Indicators

Selected operation and effect indicators are shown in **Sub-Section 22.1.1**.

22.2.2 Traffic Volume of Sub-Project 2

Based on the traffic assignment result, future traffic volume is shown as follows.

Table 22.2.2-1 Estimated Traffic Volume of Sub-Project 2

(Unit: Veh/day)

	Y2017	Y2027 (Target)	Y2030
Car	-	1,514	1,779
Jeepney		207	234
Bus		4	4
Truck		467	542
Total		**2,192**	**2,559**

Source: JICA Study Team

22.2.3 Reduction of Travel Time

Based on the traffic assignment result, reduction of travel time is calculated as shown in follows.

Table 22.2.3-1 Reduction of Travel Time (Sub-Project 2)

Route Map for Sub-Project 2 (Start (Barora) – End (Macasandag))

Year	Y2017	Y2027 (Target)
With Project (Yellow Route)	-	38.7 min
Without Project (Blue Route)	60.3 min	60.9 min
Reduction of Travel Time (Without - With)	-	**22.2 min**

Note: Base year of traffic demand forecast is year 2020 and 2030. Estimated travel time in target year was based on year 2030.

22.2.4 Travel Time Saving and Travel Time Cost Saving

Based on the traffic assignment result, vehicle time and travel time cost saving are shown as follows.

Table 22.2.4-1 Travel Time Saving and Travel Time Cost Saving of Sub-Project 2

		Year 2017	Y2027 (Target)	Year 2030
Total Vehicle Hour	W/O Project (veh*hour/day)	327,686	634,498	789,263
	W/ Project (veh*hour/day)	-	633,605	788,227
	Saving per day (veh*hour/day)	-	894	1,036
	Saving per year (veh*hour/year)	-	326,172	378,180
Travel Time Cost	W/O Project (‘000 PhP/day)	-	190,677	236,643
	W/ Project (‘000 PhP/day)	-	190,439	236,366
	Saving per day (‘000 PhP/day)	-	239	278
	Saving per year (Mill PhP/year)	-	87	101

Source: JICA Study Team

22.2.5 Vehicle Distance Saving and Vehicle Operation Cost Saving

Based on the traffic assignment result, vehicle distance and vehicle operation cost saving are shown as follows.

Table 22.2.5-1 Vehicle Distance and Vehicle Operation Cost Saving of Sub-Project 2

		Year 2017	Y2027 (Target)	Year 2030
Total Vehicle Distance	W/O Project (veh*hour/day)	10,972,924	18,334,860	21,625,244
	W/ Project (veh*hour/day)	-	18,316,006	21,603,581
	Saving per day (veh*hour/day)	-	18,854	21,664
	Saving per year (veh*hour/year)	-	6,881,761	7,907,196
Vehicle Operation Cost	W/O Project (‘000 PhP/day)	-	371,333	446,032
	W/ Project (‘000 PhP/day)	-	370,158	444,693
	Saving per day (‘000 PhP/day)	-	1,175	1,339
	Saving per year (Mill PhP/year)	-	429	489

Source: JICA Study Team

22.3 Sub-Project 6

22.3.1 Selected Operation and Effect Indicators

Selected operation and effect indicators are shown in **Sub-Section 22.1.1**.

22.3.2 Traffic Volume of Sub-Project 6

Based on the traffic assignment result, future traffic volume is shown as follows.

Table 22.3.2-1 Estimated Traffic Volume of Sub-Project 6

(Unit: Veh/day)

	Y2017	Y2027 (Target)	Y2030
Car	-	881	982
Jeepney		9	11
Bus		6	7
Truck		529	613
Total		**1,426**	**1,613**

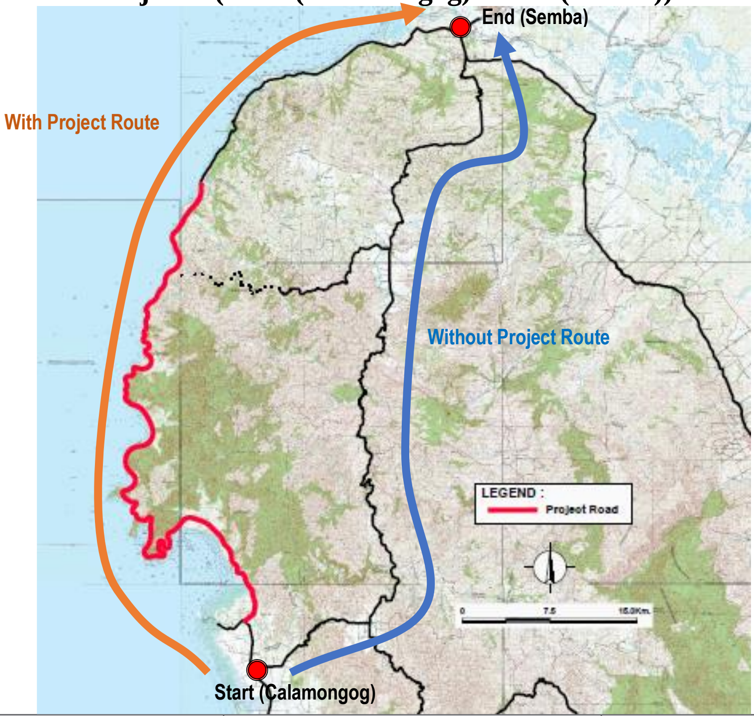
Source: JICA Study Team

22.3.3 Reduction of Travel Time

Based on the traffic assignment result, reduction of travel time is calculated as shown in follows.

Table 22.3.3-1 Reduction of Travel Time (Sub-Project 6)

Route Map for Sub-Project 6 (Start (Calamongog) – End (Semba))



Year	Y2017	Y2027 (Target)
With Project (Yellow Route)	-	143.4 min
Without Project (Blue Route)	182.6 min	185.8 min
Reduction of Travel Time (Without - With)	-	**42.4 min**

Note: Base year of traffic demand forecast is year 2020 and 2030. Estimated travel time in target year was based on year 2030.

22.3.4 Travel Time Saving and Travel Time Cost Saving

Based on the traffic assignment result, vehicle time and travel time cost saving are shown as follows.

Table 22.3.4-1 Travel Time Saving and Travel Time Cost Saving of Sub-Project 6

		Year 2017	Y2027 (Target)	Year 2030
Total Vehicle Hour	W/O Project (veh*hour/day)	327,686	634,706	789,423
	W/ Project (veh*hour/day)	-	633,486	787,932
	Saving per day (veh*hour/day)	-	1,220	1,491
	Saving per year (veh*hour/year)	-	445,482	544,073
Travel Time Cost	W/O Project (‘000 PhP/day)	-	178,826	221,907
	W/ Project (‘000 PhP/day)	-	178,540	221,556
	Saving per day (‘000 PhP/day)	-	286	351
	Saving per year (Mill PhP/year)	-	104	128

Source: JICA Study Team

22.3.5 Vehicle Distance Saving and Vehicle Operation Cost Saving

Based on the traffic assignment result, vehicle distance and vehicle operation cost saving are shown as follows.

Table 22.3.5-1 Vehicle Distance and Vehicle Operation Cost Saving of Sub-Project 6

		Year 2017	Y2027 (Target)	Year 2030
Total Vehicle Distance	W/O Project (veh*hour/day)	10,972,924	18,340,807	21,629,889
	W/ Project (veh*hour/day)	-	18,316,664	21,602,387
	Saving per day (veh*hour/day)	-	24,143	27,502
	Saving per year (veh*hour/year)	-	8,812,358	10,038,358
Vehicle Operation Cost	W/O Project (‘000 PhP/day)	-	371,727	446,514
	W/ Project (‘000 PhP/day)	-	370,109	444,588
	Saving per day (‘000 PhP/day)	-	1,618	1,926
	Saving per year (Mill PhP/year)	-	591	703

Source: JICA Study Team

22.4 Sub-Project 7

22.4.1 Selected Operation and Effect Indicators

Selected operation and effect indicators are shown in **Sub-Section 22.1.1**.

22.4.2 Traffic Volume of Sub-Project 7

Based on the traffic assignment result, future traffic volume is shown as follows.

Table 22.4.2-1 Estimated Traffic Volume of Sub-Project 7

(Unit: Veh/day)

	Y2017	Y2026 (Target)	Y2030
Car	-	1,257	1,448
Jeepney		756	912
Bus		2	2
Truck		101	131
Total		**2,116**	**2,493**

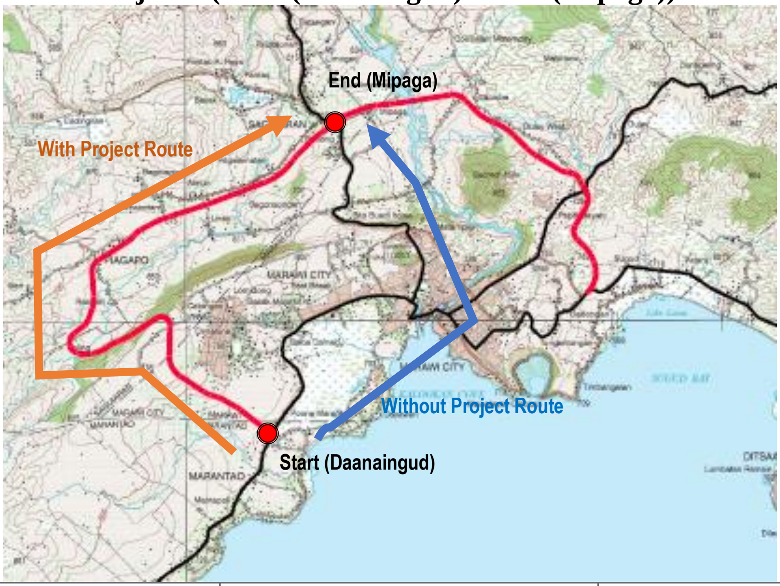
Source: JICA Study Team

22.4.3 Reduction of Travel Time

Based on the traffic assignment result, reduction of travel time is calculated as shown in follows.

Table 22.4.3-1 Reduction of Travel Time (Sub-Project 7)

Route Map for Sub-Project 7 (Start (Daanaingud) – End (Mipaga))



Year	Y2017	Y2026 (Target)
With Project (Yellow Route)	-	15.2 min
Without Project (Blue Route)	27.4 min	30.4 min
Reduction of Travel Time (Without - With)	-	**15.2 min**

Note: Base year of traffic demand forecast is year 2020 and 2030. Estimated travel time in target year was based on year 2030.

22.4.4 Travel Time Saving and Travel Time Cost Saving

Based on the traffic assignment result, vehicle time and travel time cost saving are shown as follows.

Table 22.4.4-1 Travel Time Saving and Travel Time Cost Saving of Sub-Project 7

		Year 2017	Y2026 (Target)	Year 2030
Total Vehicle Hour	W/O Project (veh*hour/day)	327,686	576,433	758,988
	W/ Project (veh*hour/day)	-	574,908	757,045
	Saving per day (veh*hour/day)	-	1,524	1,943
	Saving per year (veh*hour/year)	-	556,406	709,264
Travel Time Cost	W/O Project (‘000 PhP/day)	-	177,501	236,694
	W/ Project (‘000 PhP/day)	-	177,099	236,210
	Saving per day (‘000 PhP/day)	-	401	483
	Saving per year (Mill PhP/year)	-	146	176

Source: JICA Study Team

22.4.5 Vehicle Distance Saving and Vehicle Operation Cost Saving

Based on the traffic assignment result, vehicle distance and vehicle operation cost saving are shown as follows.

Table 22.4.5-1 Vehicle Distance and Vehicle Operation Cost Saving of Sub-Project 7

		Year 2017	Y2026 (Target)	Year 2030
Total Vehicle Distance	W/O Project (veh*hour/day)	10,972,924	17,320,007	21,547,721
	W/ Project (veh*hour/day)	-	17,312,862	21,539,962
	Saving per day (veh*hour/day)	-	7,145	7,759
	Saving per year (veh*hour/year)	-	2,608,062	2,831,893

Vehicle Operation Cost	W/O Project (‘000 PhP/day)	-	332,572	424,635
	W/ Project (‘000 PhP/day)	-	332,213	424,250
	Saving per day (‘000 PhP/day)	-	359	385
	Saving per year (Mill PhP/year)	-	131	141

Source: JICA Study Team

22.5 Sub-Project 8

22.5.1 Selected Operation and Effect Indicators

Selected operation and effect indicators are shown in **Sub-Section 22.1.1**.

22.5.2 Traffic Volume of Sub-Project 8

Based on the traffic assignment result, future traffic volume is shown as follows.

Table 22.5.2-1 Estimated Traffic Volume of Sub-Project 8

(Unit: Veh/day)

	Y2017	Y2026 (Target)	Y2030
Car	-	2,092	2,499
Jeepney		617	731
Bus		4	4
Truck		486	579
Total		**3,199**	**3,813**

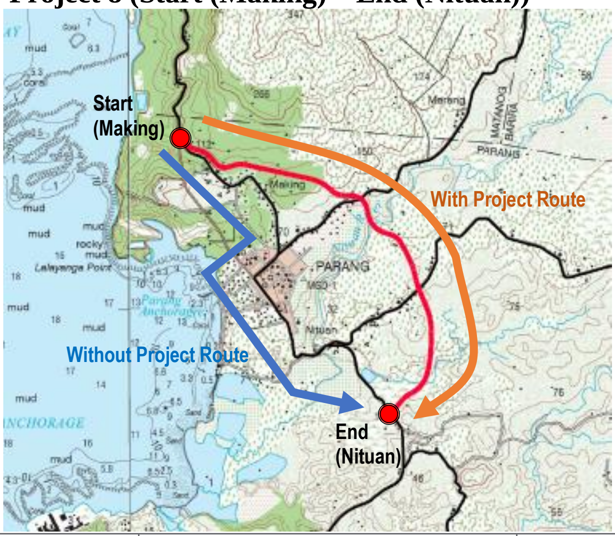
Source: JICA Study Team

22.5.3 Reduction of Travel Time

Based on the traffic assignment result, reduction of travel time is calculated as shown in follows.

Table 22.5.3-1 Reduction of Travel Time (Sub-Project 8)

Route Map for Sub-Project 8 (Start (Making) – End (Nituan))



Year	Y2017	Y2026 (Target)
With Project (Yellow Route)	-	17.5 min
Without Project (Blue Route)	20.1 min	21.3 min
Reduction of Travel Time (Without - With)	-	**3.8 min**

Note: Base year of traffic demand forecast is year 2020 and 2030. Estimated travel time in target year was based on year 2030.

22.5.4 Travel Time Saving and Travel Time Cost Saving

Based on the traffic assignment result, vehicle time and travel time cost saving are shown as follows.

Table 22.5.4-1 Travel Time Saving and Travel Time Cost Saving of Sub-Project 8

		Year 2017	Y2026 (Target)	Year 2030
Total Vehicle Hour	W/O Project (veh*hour/day)	327,686	589,771	789,423
	W/ Project (veh*hour/day)	-	590,192	788,924
	Saving per day (veh*hour/day)	-	422	499
	Saving per year (veh*hour/year)	-	153,866	182,098
Travel Time Cost	W/O Project (‘000 PhP/day)	-	177,382	236,694
	W/ Project (‘000 PhP/day)	-	177,501	236,553
	Saving per day (‘000 PhP/day)	-	119	140
	Saving per year (Mill PhP/year)	-	43	51

Source: JICA Study Team

22.5.5 Vehicle Distance Saving and Vehicle Operation Cost Saving

Based on the traffic assignment result, vehicle distance and vehicle operation cost saving are shown as follows.

Table 22.5.5-1 Vehicle Distance and Vehicle Operation Cost Saving of Sub-Project 8

		Year 2017	Y2026 (Target)	Year 2030
Total Vehicle Distance	W/O Project (veh*hour/day)	10,972,924	17,355,215	21,628,601
	W/ Project (veh*hour/day)	-	17,358,262	21,625,213
	Saving per day (veh*hour/day)	-	3,047	3,389
	Saving per year (veh*hour/year)	-	1,112,275	1,236,857
Vehicle Operation Cost	W/O Project (‘000 PhP/day)	-	348,561	445,267
	W/ Project (‘000 PhP/day)	-	348,707	445,098
	Saving per day (‘000 PhP/day)	-	146	169
	Saving per year (Mill PhP/year)	-	53	62

Source: JICA Study Team

22.6 Sub-Project 9

22.6.1 Selected Operation and Effect Indicators

Selected operation and effect indicators are shown in **Sub-Section 22.1.1**.

22.6.2 Traffic Volume of Sub-Project 9

Based on the traffic assignment result, future traffic volume is shown as follows.

Table 22.6.2-1 Estimated Traffic Volume of Sub-Project 9

(Unit: Veh/day)

	Y2017	Y2027 (Target)	Y2030
Car	-	709	799
Jeepney		147	165
Bus		0	0
Truck		608	685
Total		**1,464**	**1,649**

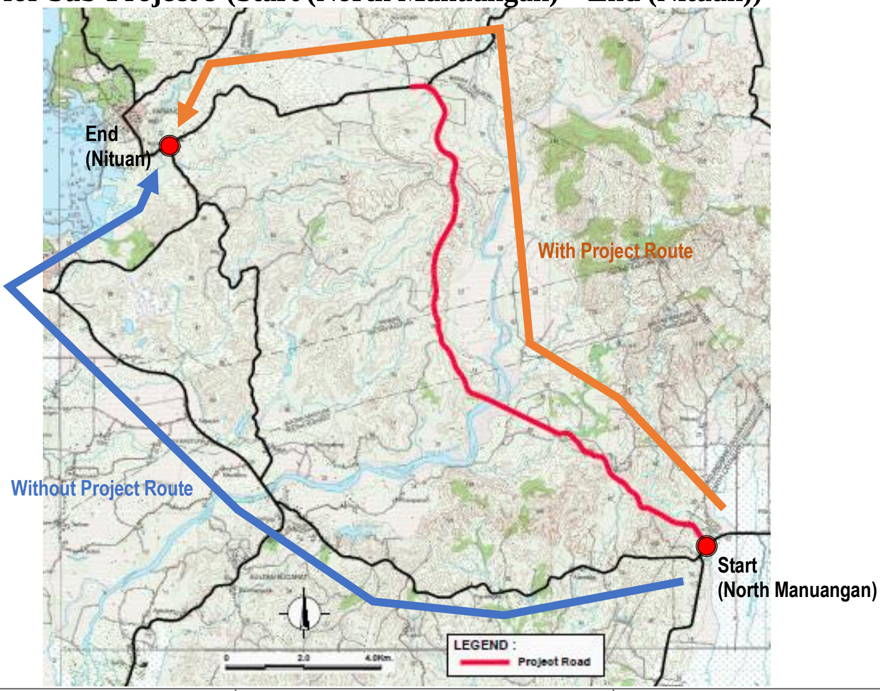
Source: JICA Study Team

22.6.3 Reduction of Travel Time

Based on the traffic assignment result, reduction of travel time is calculated as shown in follows.

Table 22.6.3-1 Reduction of Travel Time (Sub-Project 9)

Route Map for Sub-Project 9 (Start (North Manuangan) – End (Nituan))



Year	Y2017	Y2027 (Target)
With Project (Yellow Route)	-	44.8 min
Without Project (Blue Route)	48.5 min	50.0 min
Reduction of Travel Time (Without - With)	-	**5.2 min**

Note: Base year of traffic demand forecast is year 2020 and 2030. Estimated travel time in target year was based on year 2030.

22.6.4 Travel Time Saving and Travel Time Cost Saving

Based on the traffic assignment result, vehicle time and travel time cost saving are shown as follows.

Table 22.6.4-1 Travel Time Saving and Travel Time Cost Saving of Sub-Project 9

		Year 2017	**Y2026 (Target)**	**Year 2030**
Total Vehicle Hour	W/O Project (veh*hour/day)	327,686	789,126	789,423
	W/ Project (veh*hour/day)	-	634,706	789,126
	Saving per day (veh*hour/day)	-	237	297
	Saving per year (veh*hour/year)	-	86,674	108,270
Travel Time Cost	W/O Project (‘000 PhP/day)	-	190,683	236,694
	W/ Project (‘000 PhP/day)	-	190,742	236,621
	Saving per day (‘000 PhP/day)	-	60	73
	Saving per year (Mill PhP/year)	-	22	27

Source: JICA Study Team

22.6.5 Vehicle Distance Saving and Vehicle Operation Cost Saving

Based on the traffic assignment result, vehicle distance and vehicle operation cost saving are shown as follows.

Table 22.6.5-1 Vehicle Distance and Vehicle Operation Cost Saving of Sub-Project 9

		Year 2017	Y2026 (Target)	Year 2030
Total Vehicle Distance	W/O Project (veh*hour/day)	10,972,924	18,074,277	21,188,838
	W/ Project (veh*hour/day)	-	18,076,702	21,185,922
	Saving per day (veh*hour/day)	-	2,425	2,916
	Saving per year (veh*hour/year)	-	885,080	1,064,296
Vehicle Operation Cost	W/O Project (‘000 PhP/day)	-	370,290	444,861
	W/ Project (‘000 PhP/day)	-	370,425	444,701
	Saving per day (‘000 PhP/day)	-	135	161
	Saving per year (Mill PhP/year)	-	49	59

Source: JICA Study Team