6.3.4 Ginatilan-Alegria Road, Km 172 (Region VII)

(1) Damage Condition

This disaster, which has caused the collapse of the grouted riprap revetment, as shown in Photo 6.5, was classified as Coastal Erosion (CE). Based on the damage assessment by the Study Team, the following factors are probably the causes of the damage:

- Elevation of the foundation of the existing revetment is approximately +1.0 m above the sea level, and the foundation does not have any embedment. The water level during high tide is presumed to be in the range between +1.0 m and +1.7 m. Therefore, the foundation made of grouted riprap was scoured as shown in Photo 6.5 (a).
- Concerning the quality of the grouted riprap wall, it was observed that the mortar does not fill the inside of the wall, as shown in Photo 6.5 (b), meaning that the structure of the wall body is very weak.
- Holes formed by seepage water on the road shoulder portion were observed. The groundwater encountered underneath the road way on the mountain side was observed to be the same as the sea water level in the boring survey, which means that the holes are apparently caused by seepage water due to the overtopping of waves from the sea.

(a) Side View of Erosion

(b) Inside of Grouted Riprap Wall

Photo 6.5 Condition of Erosion for Grouted Riprap Wall at Km 172

(2) Approach to Countermeasure Planning

The following viewpoints were taken into consideration in the planning of the countermeasures:

- The design sea water elevation should be set based on a statistic analysis of the tide records. However, since an appropriate tide station is not available near the project site, the design water level was estimated in reference with the Dumaguete Port of Negros located on the bank opposite the study site. “Tide and Current Tables Philippines 2007”, published by the Coast and Geodetic Survey Department of the National Mapping and Resource Information Authority under the Department of Environment and Natural Resources, was also used as reference. The design water level is as follows;

- Mean High Water Level : +1.77 m, - Mean Low Water Level : -0.45 m

- The height of the revetment wall should consider the wave height including the overtopping of waves or swash. If the past record of waves is not available, the height of the design wave is assumed as 5.0 m. However, the said height should be reviewed in the detailed design stage.

- The foundation of the new revetment wall should be embedded at a minimum depth of 1.0 m. If the said embedment is difficult to attain, a cut-off wall should be installed under the foundation of the revetment to prevent the ingress of water.

(3) Choosing an Option

The following options were established for the countermeasure design;

Option-1 : Blanket Concrete Type Revetment

Option-2 : Gravity Type (Leaning Concrete Type) Revetment

(a) Blanket Concrete Type Revetment (Option-1)

The typical cross section, plan and side view of option-1countermeasure are shown in Figures 6.20 and 6.21. Major features of the design are described as follows:

- Design crest elevation is determined as follows;

  Design Crest Elevation = Design Tide Level + Design Wave Height + Free Board
  = +1.77 m + 5.0 m + 1.0 m = +7.77 m → +7.80 m

- Since the design crest elevation is higher than the level of the existing road, a recurved parapet wall of 1.0 m in height is proposed on the new revetment.

- The gradient of the revetment slope is designed at 1:1.0, which is the same as the existing revetment, and the foundation concrete is embedded to a depth of 1.0 m.

- The design elevation of the foundation (-1.2 m) is lower than the low water level of daily tide. Therefore, coffering and dewatering works will be required for the construction of the foundation.

- The total length of the new retaining will be 60 m (Km 171+920 to Km 171+980).

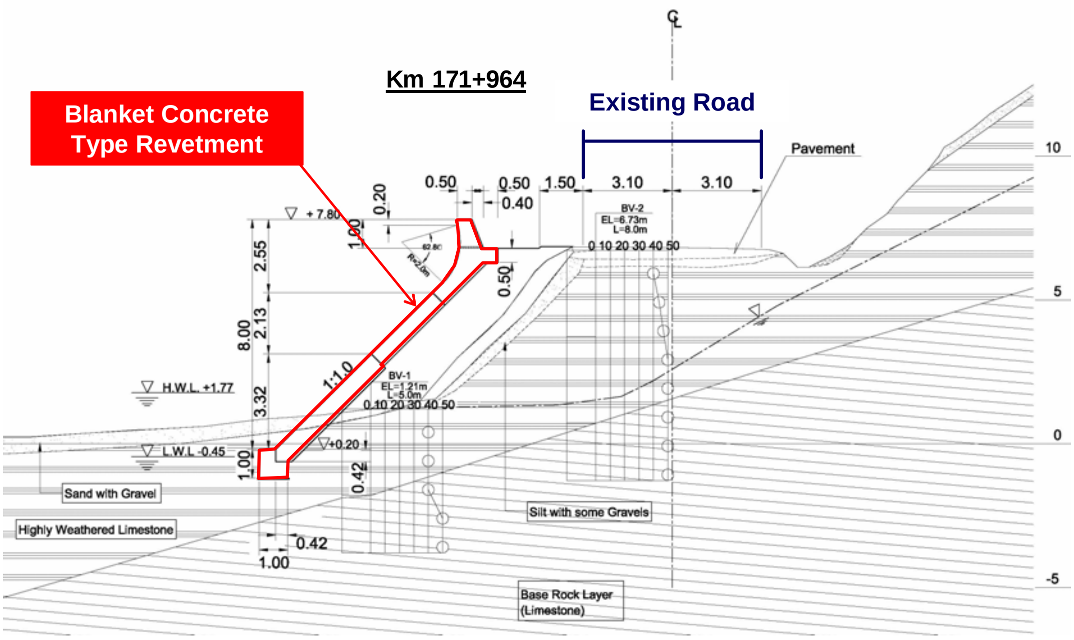


Figure 6.20 Typical Cross Section of Option-1

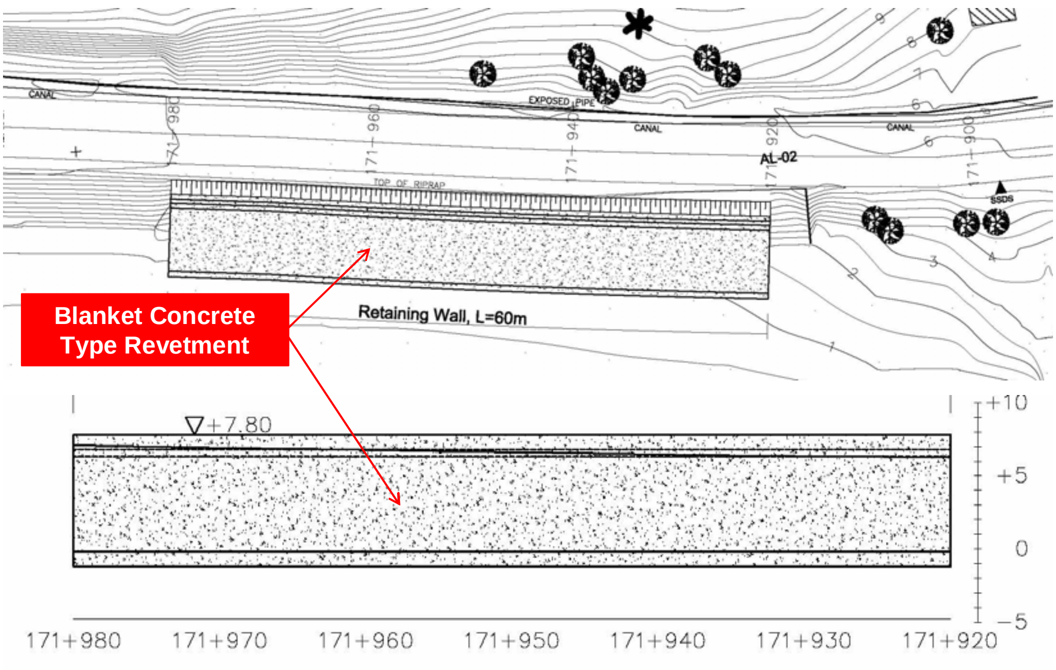


Figure 6.21 Plan and Side View of Option-1

(b) Gravity Type (Leaning Concrete Type) Revetment (Option-2)

Figure 6.22 shows the typical cross section for option-2 countermeasure. The basic design concepts of the design height of the revetment and installation of a re-curved parapet wall are the same as Option-1. The difference with Option-1 are described as follows:

- Considering that the sea water will affect the construction work, the elevation of the bottom of the foundation is designed at +0.8 m, that is approximately the average of daily tide water levels.
- In order to prevent the scouring or outflow of the backfill materials of the revetment, an embedment wall of 0.5 m in depth and sheet piles of 2.0 m in length are proposed to form a cut-off wall to prevent the ingress of water.

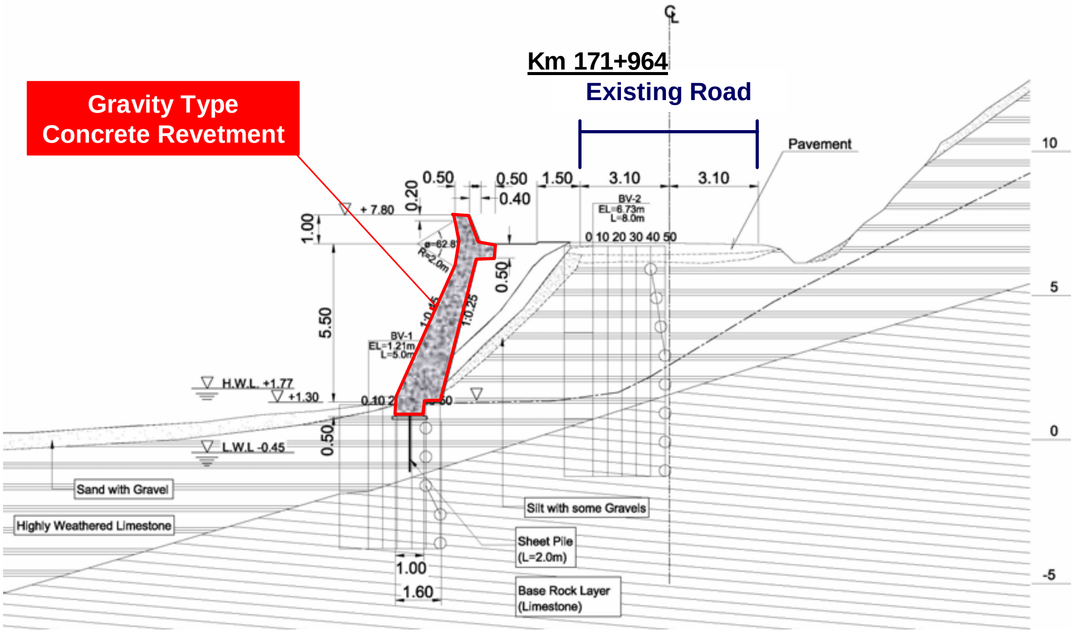


Figure 6.22 Typical Cross Section for Gravity Type Revetment

(4) Cost Estimates

Table 6.12 shows the result of engineering cost estimates for Option-1 and Option-2. Construction costs for each option are estimated as follows:

- Option -1 : 5,601,594 Pesos
- Option -2 : 4,345,788 Pesos

Table 6.12 Cost Estimate for the Countermeasures at Ginatilan-Alegria Road (Km 172)

a) Option-1 : Blanket Concrete Type Revetment

Work Item	Unit	Unit Rate (Pesos)	Q'ty	Amount (Pesos)	Note
1. Revetment					
1) Removal of Existing Riprap Retaining Wall	m^3	550	212	116,391	
2) Sheet Pile for Temporary Cofferdam	m	600	825	495,000	U-shape Type (FPS III)
3) Structure Excavation by Hand	m^3	300	869	260,820	with Dewatering
4) Lean Concrete for Foundation (t=100)	m^3	3,400	7	24,480	
5) Form Work for Above	m^2	340	12	4,080	
6) Foundation Concrete (Class B)	m^3	4,030	49	198,276	
7) Formwork for Above	m^2	340	120	40,780	
8) Lean Concrete for Concrete Blanket (t=100)	m^3	3,400	60	205,020	
9) Formwork for Above	m^2	340	617	209,855	
10) Blanket Concrete (Class B)	m^3	4,030	275	1,109,620	
11) Formwork for Above	m^2	340	971	330,296	
12) Parapet Concrete (Class A)	m^3	4,240	156	660,931	
13) Steel Reinforcing Bars for Parapet (Grade 40)	kg	50	15,588	779,400	
14) Formwork for Above	m^2	340	260	88,230	
15) Weep holes (PVC φ=50)	m	90	314	28,280	
16) Backfilling with Borrow Material	m^3	490	1,599	783,392	Manual backfilling with plate compactor
sub-total :				***5,334,852***	
2. Provisional Sum and Other General Requirements	LS		1	***266,743***	5 % of Construction Cost
Total :				***5,601,594***	

b) Option-2 : Gravity Type (Leaning Concrete Type) Revetment

Work Item	Unit	Unit Rate (Pesos)	Q'ty	Amount (Pesos)	Note
1. Revetment					
1) Removal of Existing Riprap Retaining Wall	m^3	550	212	116,391	
2) Structure Excavation by Hand	m^3	300	247	73,962	with Dewatering
3) Sheet Piles for Cut-off Wall	m	3,250	300	975,000	U-shape Type (FPS III)
4) Lean Concrete for Foundation (t=100)	m^3	3,400	7	24,480	
5) Form Work for Above	m^2	340	12	4,080	
6) Concrete for the Wall (Class B)	m^3	4,030	346	1,393,977	
7) Formwork for Above	m^2	340	687	233,621	
12) Parapet Concrete (Class A)	m^3	4,240	88	371,170	
13) Steel Reinforcing Bars for the Parapet (Grade 40)	kg	50	8,754	437,700	
14) Formwork for Above	m^2	340	270	91,841	
15) Weep holes (PVC φ=50)	m	90	213	19,195	
16) Backfilling with Borrow Material	m^3	490	811	397,429	Manual backfilling with plate compactor
sub-total :				***4,138,845***	
2. Provisional Sum and Other General Requirements	LS		1	***206,942***	5 % of Construction Cost
Total :				***4,345,788***	

(5) Selection of Countermeasure

As a result of comprehensive evaluation as shown in Table 6.13, Option-2, the Gravity Type (Leaning Concrete-Type) Revetment may be selected as the countermeasure.

Table 6.13 Evaluation Results of Options for Ginatilan-Alegria Road (Km 172)

Option	Cost (*3)	Construction (*2)	Structural (*1)	Social Environment (*2)	Total Points
Option-1	Fair (6)	Fair (4)	Good (3)	Good (6)	19
Option-2	Good (9)	Good (6)	Fair (2)	Good (6)	23

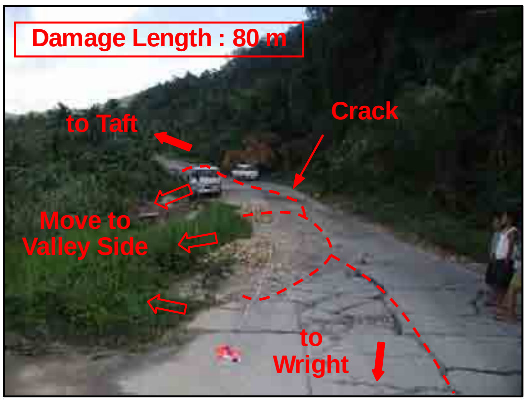
6.3.5 Wright-Taft Road, Km 846 (Region VIII)

(1) Damage Condition

This disaster was classified as a Road Slip (RS) caused by a landslide. Damage observed is 80 m in length (Km 846+810 to Km 846+890) and is manifested by cracks, gaps, falling rock and erosion of the embankment slope as shown in Photo 6.6. Based on the damage assessment by the Study Team, the following factors are presumed as causes of the damage:

- From the topographic condition, the road slip seems to have occurred at the section where the road was constructed by embankment work, and the lower slope of the road, which has a moderately sloping gradient, was established using the surplus soil from the road construction.
- Gabion walls with a height of 7.5 m and 50 m in length were constructed between Km 846+810 and Km 846+890 on a slope approximately 50 m away from the road centerline, as shown in Figure 6.23. The said wall was constructed to serve as a retaining structure. However, the backfill materials have been washed out, and the wall partially collapsed.
- The section has a great deal of rainfall discharge. However, only a side ditch is installed along the road. In addition, the road section at Km 846+870 is waterlogged due to the blockage of the excavated ditch caused by falling rocks, as shown in Photo 6.6 (b).
- The embankment slope materials are over-saturated with groundwater. Actually, confined groundwater was observed from the boring survey point at the lower slope.
- From the above conditions, the embankment materials of the lower slope have acted as a landslide block, and this landslide may cause road damage.

●



(a) Total View of Road Damage **(b) Drainage Condition**

Photo 6.6 Conditions of Wright-Taft Road, Km 846

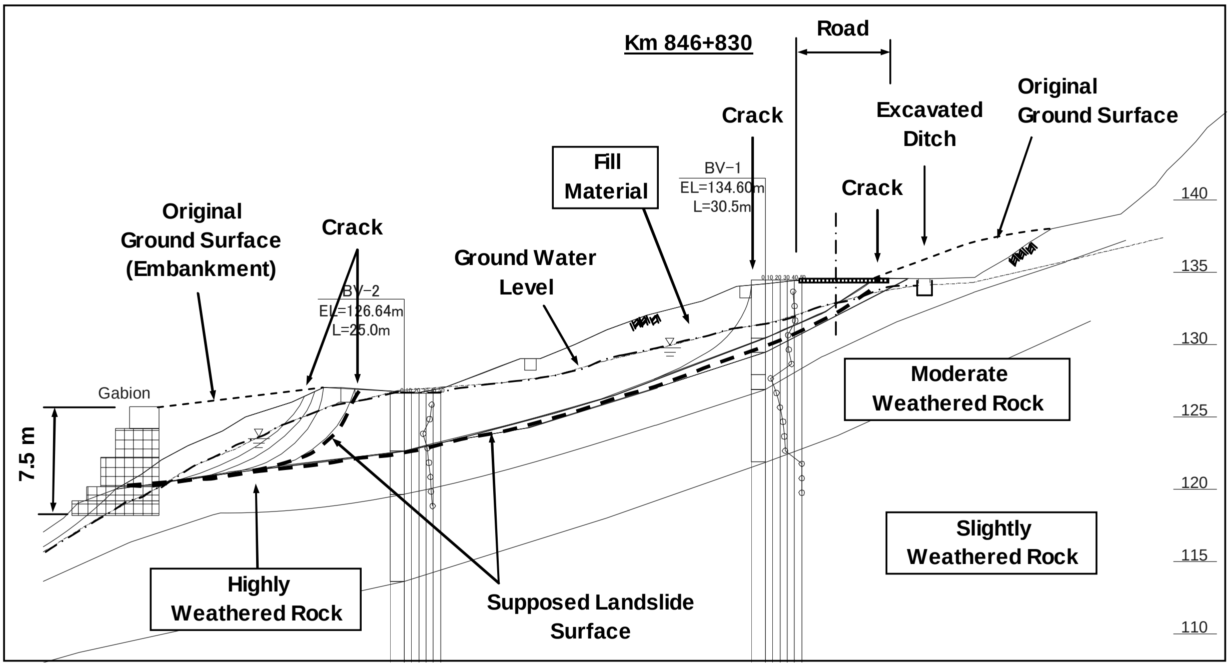


Figure 6.23 Engineering Geological Profiling at Wright-Taft Road (Km 846)

(2) Approach to Countermeasure Planning

The following viewpoints were taken into consideration in the planning of countermeasures:

- The lower embankment slope that has been washed out was restored and a retaining structure was installed at the toe of the slope between **Km 846+810 to Km 846+890.**

- Since the ground-water, which was assumed to be a major cause of the landslide, is located at a higher level than the embankment slope, the said ground-water level should be lowered by horizontal drain holes.
- In addition, in order to prevent the infiltration of rainwater and erosion of the slope, surface drainage structures should be considered in countermeasure planning.

(3) Choosing an Option

The following options were established for the countermeasure design:

Option-1 : Drainage System + Leaning Concrete Wall
Option-2 : Drainage System + Reinforced Concrete Cantilever Wall

(a) Drainage System + Gravity Concrete Wall (Option-1)

The plan and typical cross section for option-1countermeasure are shown in Figure 6.24 and Figure 6.25 respectively. Major features of the countermeasure design are described as follows:

- The safety factor against a large landslide, inclusive of the entire embankment body, was assumed to be Fs=0.98 as a result of the trial circular slip stability analysis, and Fs=1.2 was chosen for a required safety factor for countermeasure design.
- To prevent a large scale landslide, horizontal drain holes should be provided to lower the groundwater level in the embankment, which should be arranged at four locations as shown in Figure 6.24. Then the safety factor may increase to Fs=1.20 from Fs=0.98.
- The embankment slope which was washed out has been restored, and a new gravity concrete wall retaining structure has been installed in the same alignment as the previous gabion wall.
- Concerning the small landslide block behind the retaining wall, a landslide force is taken into consideration as the design external load to act on the retaining wall.
- The existing excavated side ditch along the road is to be replaced by a concrete ditch the size of which is shown in Figure 6.19. Also, pipe culverts are proposed for the cross drains and ditch on the embankment slope for the surface drainage treatment as shown in Figure 6.24.

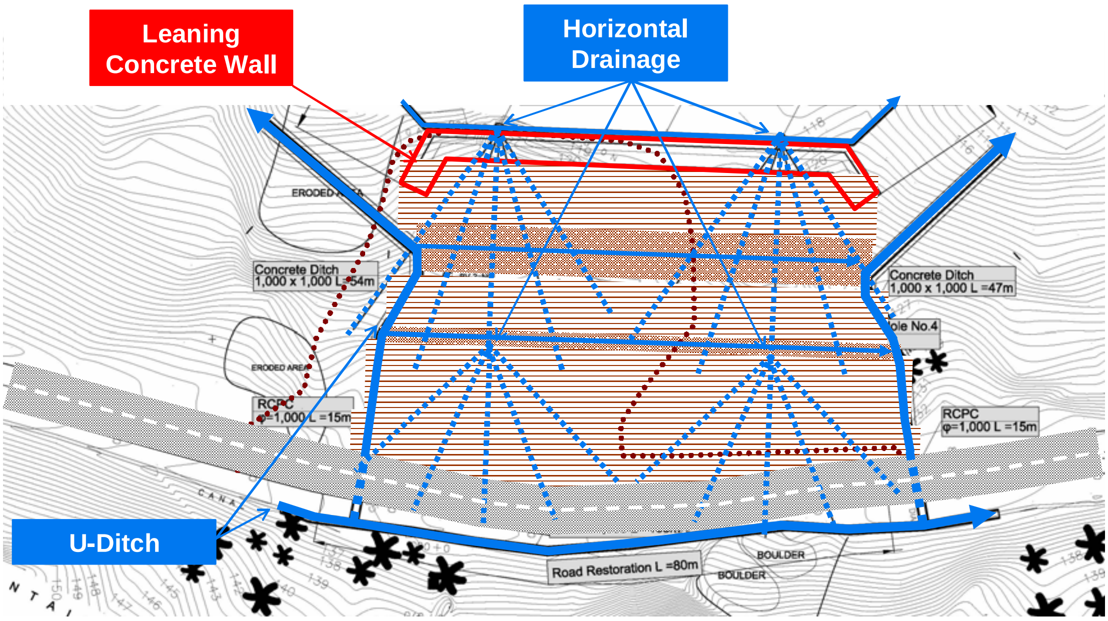


Figure 6.24 Plan of Drainage System

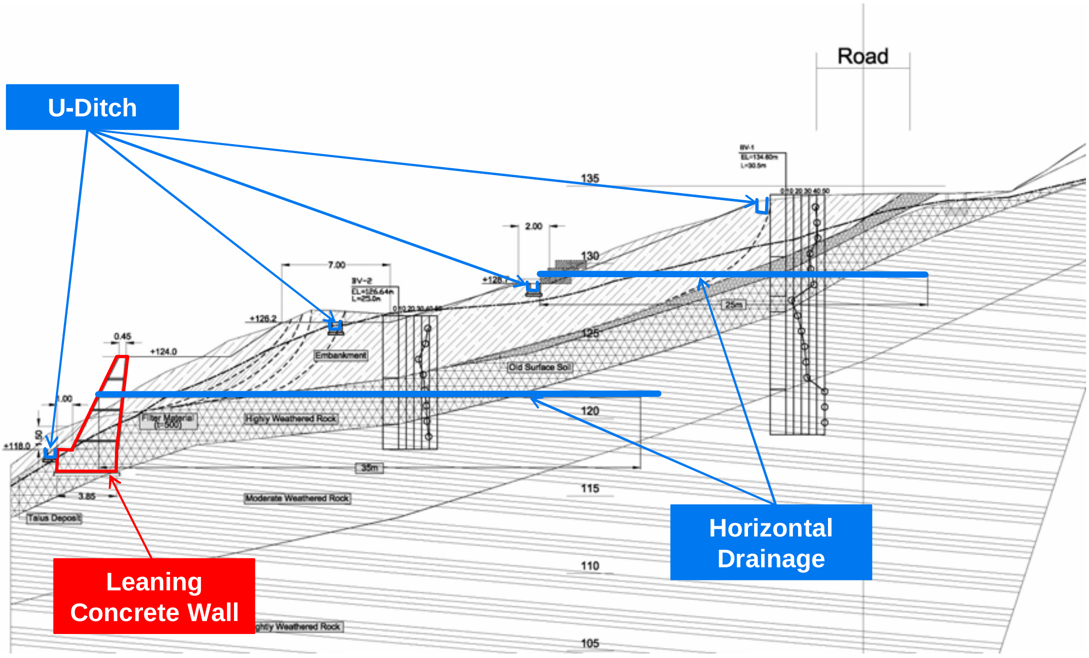


Figure 6.25 Typical Cross Section of Option-1

(b) Drainage System + Reinforced Concrete Cantilever Wall (Option-2)

The type of Retaining wall proposed for Option-2 is a reinforced concrete cantilever wall as shown in Figure 6.26. The drainage treatments for surface water and ground water are the same as Option-1.

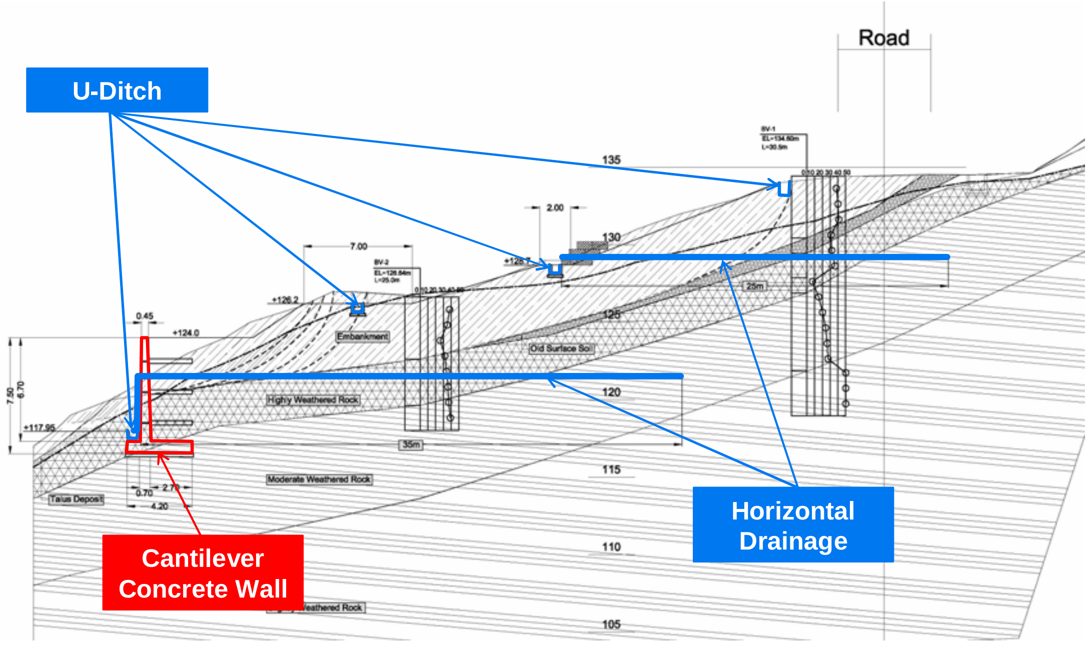


Figure 6.26 Typical Cross Section of Option-2

(4) Cost Estimates

Table 6.14 shows the engineering cost estimates for Option-1 and Option-2. Construction costs for each option are estimated as follows:

- Option -1 : 14,635,846 Pesos
- Option -2 : 16,092,889 Pesos

Table 6.14 Cost Estimate for Countermeasures at Wright-Taft Road, Km 846

a) Option-1 : Drainage System + Gravity Concrete Wall

Work Item	Unit	Unit Rate (Pesos)	Q'ty	Amount (Pesos)	Note
1. Horizontal Drains and Surface Drain					
1) Horizontal Drilling (φ86)	m	5,700	600	3,420,000	
2) Strainer PVC Pipe (φ75)	m	130	600	78,000	
3) Gabion Wall	m^3	1,980	24	47,520	
4) Geotextile Filter Fabric under Gabions	m^2	130	20	2,600	
5) U-shape Concrete Drain Ditch	m	1,770	209	369,930	size : 500 x 500
6) U-shape Concrete Drain Ditch	m	3,890	101	392,890	size : 1,000 x 1,000
sub-total :				***4,310,940***	
Gravity Retaining Wall					
1) Removal of Existing Gabion Wall	m^3	150	629	94,350	
2) Staging Type Scaffolding	m^3	310	900	279,000	assumed 12.5 m^3/m
3) Structure Excavation by Hand	m^3	230	4,164	957,731	
4) Gravel Bedding	m^3	1,320	71	94,090	
5) Class B Concrete	m^3	4,030	1,129	4,548,258	
6) Formwork	m^2	340	1,133	385,266	
7 Weep holes (PVC φ=50)	m	90	548	49,336	
8) Backfill Material	m^3	1,220	43	52,968	- Manual backfilling with plate compactor - Gravel 3/4" ~ 1"
9) Embankment using Borrow Material	m^3	400	2,865	1,145,894	
10) Sodding on Slope Surface	m^2	90	2,390	215,074	
sub-total :				***7,821,967***	
Road Restoration					
1) U-shape Concrete Drain Ditch	m	3,890	103	400,670	size : 1,000 x 1,000
2) Reinforced Concrete Pipe for Cross Drains	m	3,380	30	101,400	
3) Removal of Existing Concrete Pavement	m^2	200	736	147,200	
4) Sub-grade Preparation	m^2	35	736	25,760	
5) Aggregate Sub-base Course (t=200)	m^3	800	147	117,760	including spreading and compaction
6) Aggregate Base Course (t=150)	m^3	860	110	94,944	including spreading and compaction
7) Portland Cement Concrete Pavement (t=250)	m^2	1,160	736	853,760	
8) Removal of Boulders	m^3	430	150	64,500	
sub-total :				***1,805,994***	
4. Provisional Sum and Other General Requirements	LS		1	***696,94***5	5 % of Construction Cost
Total :				**14,635,846**	

b) Option-2 : Drainage System + Reinforced Concrete Cantilever Wall

Work Item	Unit	Unit Rate (Pesos)	Q'ty	Amount (Pesos)	Note
1. Horizontal Drains and Surface Drain					
1) Horizontal Drilling (φ86)	m	5,700	600	3,420,000	
2) Strainer PVC Pipe (φ75)	m^3	130	600	78,000	
3) Gabion Wall	m^3	1,980	24	47,520	
4) Geotextile Filter Fabric under Gabions	m^2	130	20	2,600	
5) U-shape Concrete Drain Ditch	m	1,770	209	369,930	size : 500 x 500
6) U-shape Concrete Drain Ditch	m	3,890	101	392,890	size : 1,000 x 1,000
sub-total :				***4,310,940***	
2. Cantilever Retaining Wall					
1) Removal of Existing Gabion Wall	m^3	150	629	94,350	
2) Staging Type Scaffolding	m^3	310	900	279,000	assumed 12.5 m^3/m
3) Structure Excavation by Hand	m^3	230	5,558	1,278,250	
4) Gravel Bedding	m^3	1,320	71	94,090	
5) Concrete (Class A)	m^3	4,240	519	2,201,985	
6) Steel Reinforcing Bars (Grade 40)	kg	50	51,934	2,596,680	
7) Formwork	m^2	340	1,383	470,065	
8) Weep holes (PVC φ=50)	m	90	209	18,792	
9) Backfill Material	m^3	1,220	179	218,107	- Manual backfilling with plate compactor - Gravel 3/4" ~ 1"
10) Embankment using Borrow Material	m^3	400	4,358	1,743,235	
11) Sodding on Slope Surface	m^2	90	2,390	215,074	
sub-total :				***9,209,627***	
3. Road Restoration					
1) U-shape Concrete Drain Ditch	m	3,890	103	400,670	size : 1,000 x 1,000
2) Reinforced Concrete Pipe for Cross Drains	m	3,380	30	101,400	
3) Removal of Existing Concrete Pavement	m^2	200	736	147,200	
4) Sub-grade Preparation	m^2	35	736	25,760	
5) Aggregate Sub-base Course (t=200)	m^3	800	147	117,760	including spreading and compaction
6) Aggregate Base Course (t=150)	m^3	860	110	94,944	including spreading and compaction
7) Portland Cement Concrete Pavement (t=250)	m^2	1,160	736	853,760	
8) Removal of Boulders	m^3	430	150	64,500	
sub-total :				***1,805,994***	
4. Provisional Sum and Other General Requirements	LS		1	***766,328***	5 % of Construction Cost
Total :				**16,092,889**	

(5) Selection of Countermeasure

As the result of comprehensive evaluation as shown in Table 6.15, Option-1 consisting of the Drainage System + Gravity Concrete Wall may be selected as the countermeasure.

Table 6.15 Evaluation Results of Options for Wright-Taft Road (Km 846)

Option	Cost (*3)	Construction (*2)	Structural (*1)	Social Environment (*2)	Total Points
Option-1	Good (9)	Good (6)	Good (3)	Good (6)	24
Option-2	Fair (6)	Good (6)	Good (3)	Good (6)	21

6.4 Environmental and Feasibility Assessment

The methodology used for the project economic analysis and social and environmental impact assessment is explained in detail in Appendix 6-1.

At this early stage, it is apparent that the viability of any of the countermeasure will be low, given that these interventions should have been done at the time when the road was constructed. Thus, in the conduct of feasibility study for the roads, its viability should have been determined inclusive of the costs of countermeasures to insure that its function would be sustained throughout its economic life.

The summary of the results of the feasibility evaluation of the projects selected for the conduct of feasibility studies are given in the sections below. The details of the feasibility study for each site are given in Appendices 6-4 to 6-8.

6.4.1 Kennon Road, Km 232 (CAR)

(1) Purpose of the Project

The proposed project is intended to ensure that Kennon Road, the traditional access road to Baguio City, the summer capital and a major tourist destination, is open to vehicular traffic even during inclement weather. While the occurrence of sediment-related disasters poses significant risk to the safety of human lives, it is hoped that the construction of the proposed countermeasure will ensure the safety of travelers traversing Kennon Road.

(2) Description of the Project

The proposed project is located at km 227 of Kennon Road, the shortest and traditional route to Baguio City from Manila. Alternatives to Kennon Road include Marcos Highway and Naguilian Road, which are longer in distance.

The proposed countermeasure to be constructed at the site is the Reinforced Embankment Method using a Terre Arme Wall.

(3) Feasibility Assessment

The economic feasibility of the proposed project was determined using the three major criteria which involved the calculation of the project's Economic Net Present Value (ENPV) and Benefit-Cost Ratio (BCR), computed using the estimated value of the Opportunity Cost of Capital as equal to the discount rate, and calculation of the Economic Internal Rate of Return. An economic analysis was undertaken to determine whether the investment required for the proposed countermeasure expressed in economic values (through the deduction of transfer payments and shadow pricing) can be recovered from the benefit streams that would be generated by the project.

The benefits were estimated based on the “with” and “without” project alternates. The economic benefits estimated included savings in detour costs, road reopening costs and the reduction in the loss of human lives. The summary of the results of the economic feasibility assessment is given in Table 6.16.

Table 6.16 Results of the Economic Feasibility Assessment

Feasibility Indicators	Discount Rate		
	12%	15%	
Economic Net Present Value (ENPV)	-13,965,130	-14,044,465	-
Economic Internal Rate of Return (EIRR)	-	-	- 6.00%
Benefit-Cost Ratio	-	0.19	

(4) Sensitivity Analysis

The impact on the measures of the project’s economic worth by important factors such as increase in investment cost requirements or decrease in the estimated benefits to be generated was undertaken during the conduct of the sensitivity analysis. The effects of changes in two factors were measured, taken one at a time. The first is the effect of a 20% increase in investment cost on the computed ENPV, BCR and EIRR. The second is the effect of a 20% decrease in the amount of benefits generated on the computed ENPV, BCR and EIRR

The results are shown in Table 6.17.

Table 6.17 Results of the Sensitivity Analysis

Factor Changes	ENPV		EIRR
	12%	15%	
20% Increase in Investment Cost	-17,264,237	-17,257,509	-7.25%
20% Decrease in Benefits	-14,656,614	-14,599,928	-8.04%

(5) Social and Environmental Impact Assessment

The proposed project is intended to mitigate/avoid the occurrence of sediment-related disasters on national highways and is, thus, not subject to the conduct of an Environmental Impact Assessment. What is needed would be for the DPWH to secure a Certificate of Non-Coverage from the DENR office in the region where the proposed project is located.

As for the social impact, the proposed site has no/minimal human activity and residents.

The environmental management plan for the construction period of the proposed countermeasure is given in Table 6.18.

Table 6.18 Proposed Environmental Management Plan

Impacts (Positive and Negative)	Recommended Mitigating Measures
A. Physical/Natural Environment	
A.1 Air & Noise Pollution	A.2.1 All heavy equipment and machinery shall be fitted with air pollution control and noise dampening devices that are in good operating condition. A.2.2 Vehicles transporting sand and soils shall be covered with a tarpaulin. A.2.3 Stockpiled sand and soils shall be wetted slightly before loading, particularly in windy conditions.
A.2 Vibrations, noise and dust generation.	A.2.1 Advise and monitor the workers in order not to disturb the settlements near the working area. Provide proper devices for noise minimization. Spraying of bare areas with water.
A.3 Accelerated erosion resulting in slope instability, landslides, destruction of vegetation and property, siltation of surface waters and water pollution.	A.3.1 Earth movement will be implemented during the dry season if possible. A.3.2 Appropriate vegetation will be planted. A.3.3 Preserve or replace existing large trees.
A.4 Siltation downstream and riverbank destruction.	A.4.1 The depth of extraction from the river will be limited.
A.5 Accelerated sedimentation, and slope instability if excavated materials are dumped on steep hillsides.	A.5.1 Proper disposal of excavated materials on selected areas.
A.6 Air and water pollution in settlements, dust generation and impact on local crops (agricultural production), other vegetation and water supplies.	A.6.1 Locate concrete batching plants and storage yards away from residential and environmentally sensitive areas. Provide adequate pollution control devices, air filters, etc.
A.7 Wastewater Flow	A.7.1 Wastewater flow maybe affected by the wastes generated from the labor camps, storage yards and construction equipment. This can be mitigated and even avoided by the following recommendations: The contractor shall provide sanitary latrines in the campsites. The location of the campsite facilities shall be away from built-up areas, bodies of water and other sources of water
A.8	used by the communities.

Impacts (Positive and Negative)	Recommended Mitigating Measures
	Proper housekeeping of the campsite.
A.9 Impaired aesthetics and soil erosion.	A.8.1 Site restoration works shall be ensured before the equipment is allowed to leave. A.8.2 Exposed areas shall be planted with suitable vegetation.

B. Biological/Ecological Environment

B.1 Cutting of commonly grown trees and other plants on cultivated areas (e.g., Gemelina, Banana, Mahogany, Ipil, etc.).	B.1.1 Young trees will be balled and replanted. Additional trees will be planted along the roadway. B.1.2 Permits will be secured from the DENR. B.1.3 Strict implementation of DPWH D. O. # 131, Series of 1995: Planting of trees along National Roads.
B.2 Exploitation of natural resources in the area.	B.2.1 Ensure that existing environmental management policies are effectively implemented and properly coordinated with all concerned agencies.

C. Socio-Economic/Human Environment

C.1 Increase in sources of income for local residents and the municipal governments.	C.1.1 Hiring of at least 50 % of unskilled labor and 30 % of skilled labor requirements from the local residents (RA 6685 and DPWH Department Order 51 series of 1990). C.1.2 Adopt a just compensation scheme to avoid future labor and management conflicts.
C.2 Conflicts and disturbance to living conditions and public order that may arise from disagreements on land acquisition or payment for improvements on affected lands due to RROW (widening and/or re-alignment)	C.2.1 Prompt and just compensation will be provided for the improvements on affected lands due to RROW. C.2.2 The DPWH shall ensure that the entire process of acquisition of real properties is in accordance with RA No. 8974.
C.3 Obstruction to traffic	C.3.1 Assign personnel who will regulate traffic flow. C.3.2 Proper use of road signs, reflectorized signboards, or early warning devices, especially at night. C.3.3 Sturdy materials will be installed to prevent the road signs from being stolen.
C.4 Possible pollution as a result of waste disposal from the camps	C.4.1 Coordinate with the LGU on the site of the work camp. C.4.2 Install and maintain a system for the collection and treatment of solid wastes during construction.
C.5 Noise pollution and other disturbances	C.5.1 Location of the work camp should be far from the residential areas.
C.6 Development of temporary work	C.6.1 Ensure abandonment of construction camp after the

Impacts (Positive and Negative)		Recommended Mitigating Measures
camp		completion of the project.
C.7 Increased business potential	C.7.1	Encourage businesses in designated centers.
C.8 Increased delivery of agricultural products and other commodities.	C.8.1	Improvement of the traffic function for accessibility and convenience of traders and farmers.
C.9 Aesthetic View	C.9.1	The proponent and the contractor must enhance the aesthetic view in the area by planting ornamental plants/trees along the countermeasure.

6.4.2 Nueva Vizcaya-Ifugao-Mt. Province Road (Lagawe-Banaue Road), Km 301 (CAR)

(1) Purpose of the Project

The proposed project is intended to ensure that the Lagawe-Banaue section of the Nueva Vizcaya-Ifugao-Mt. Province Road, the traditional access road to Banaue, a major tourist destination with its UNICEF-declared heritage site - Banaue Rice Terraces -, is open to vehicular traffic even during inclement weather. While the occurrence of sediment-related disasters poses significant risk to the safety of human lives, it is hoped that the construction of the proposed countermeasure will ensure the safety of regular travelers including visitors using the Lagawe-Banaue road section.

(2) Description of the Project

The proposed project is located in the Lagawe-Banaue Road section of the Nueva Vizcaya-Ifugao-Mt. Province Road. It is the main access to the Banaue Rice Terraces from the Daang Maharlika in Nueva Vizcaya.

The proposed countermeasure is consisting of a Horizontal Drain Hole and Counterweight Embankment.

(3) Feasibility Assessment

As discussed in 6.4.1(3) above, the economic feasibility of the proposed project was determined using the three major criteria which involved the calculation of the project's Economic Net Present Value (ENPV) and Benefit-Cost Ratio (BCR), all computed using the estimated value of the Opportunity Cost of Capital as being equal to the discount rate, and calculating the Economic Internal Rate of Return. An economic analysis was undertaken to determine whether the required investment for the proposed countermeasure expressed in economic values (through the deduction of transfer payments and shadow pricing) can be recovered from the benefit streams that would be generated by the project.

The benefits were estimated based on the “with” and “without” project alternates. The economic benefits estimated included savings in detour costs, road reopening costs and a reduction in the loss of human lives. The summary of the results of the economic feasibility assessment is given in Table 6.19.

Table 6.19 Results of the Economic Feasibility Assessment

Feasibility Indicators	Discount Rate		
	12%	15%	
Economic Net Present Value (ENPV)	-16,509,742	-16,779,498	-
Economic Internal Rate of Return (EIRR)	-	-	- 3.93
Benefit-Cost Ratio	-	0.21	-

(4) Sensitivity Analysis

The impact on the measures of the project’s economic worth by important factors such as an increase in investment cost requirements or decrease in the estimated benefits to be generated was undertaken during the conduct of the sensitivity analysis. The effects of changes in two factors were measured, taken one at a time. The first was the effect of a 20% increase in investment cost on the computed ENPV, BCR and EIRR. The second was the effect of a 20% decrease in the amount of benefits generated on the computed ENPV, BCR and EIRR

The results are shown in Table 6.20.

Table 6.20 Results of the Sensitivity Analysis

Factor Changes	ENPV		EIRR
	12%	15%	
20% Increase in Investment Cost	-17,477,316	-17,546,744	- 5.88
20% Decrease in Benefits	-20,552,314	-20,717,585	- 5.21

(5) Social and Environmental Impact Assessment

The proposed project is intended to mitigate/avoid the occurrence of sediment-related disasters on national highways and is thus not subject to the conduct of an Environmental Impact Assessment. What is needed would be for the DPWH to secure a Certificate of Non-Coverage from the DENR office in the region where the proposed project is located.

As for the social impact, the proposed site has minimal human activity with some residents occupying the land of the adjacent school. Discussion with the school administration indicated their willingness to relocate the residents that will be affected by the project.

The environmental management plan for the construction period of the proposed countermeasure is given in Table 6.21.

Table 6.21 Proposed Environmental Management Plan

Impacts (Positive and Negative)	Recommended Mitigating Measures
A. Physical/Natural Environment	
A.1 Air & Noise Pollution	A.1.1 All heavy equipment and machinery shall be fitted with air pollution control and noise dampening devices that are in good operating condition. A.1.2 Vehicles transporting sand and soils shall be covered with a tarpaulin. A.1.3 Stockpiled sand and soils shall be wetted slightly before loading, particularly in windy conditions.
A.2 Vibrations, noise and dust generation.	A.2.1 Advise and monitor the workers in order not to disturb the settlements near the working area. Provide proper devices for noise minimization. Spraying of bare areas with water.
A.3 Accelerated erosion resulting in slope instability, landslides, destruction of vegetation and property, siltation of surface waters and water pollution.	A.3.1 Earth movement will be implemented during the dry season if possible. A.3.2 Appropriate vegetation will be planted. A.3.3 Preserve or replace existing large trees.
A.4 Siltation downstream and riverbank destruction.	A.4.1 The depth of extraction from the river will be limited.
A.5 Accelerated sedimentation, and slope instability if excavated materials are dumped on steep hillsides.	A.5.1 Proper disposal of excavated materials on selected areas.
A.6 Air and water pollution in settlements, dust generation and impact on local crops (agricultural production), other vegetation and water supplies.	A.6.1 Locate concrete batching plants and storage yard away from residential and environmentally sensitive areas. Provide adequate pollution control devices, air filters, etc.
A.7 Wastewater Flow	A.7.1 Wastewater flow may be affected by the wastes generated from the labor camps, storage yards and construction equipment. This can be mitigated and even avoided by the following recommendations: The contractor shall provide sanitary latrines in the campsite. The location of the campsite facilities shall be away from built-up areas, bodies of water and other sources of water used by the communities. Proper housekeeping of the campsite.
A.8 Impaired aesthetics and soil erosion.	A.8.1 Site restoration works shall be ensured before the equipment is allowed to leave.

Impacts (Positive and Negative)	Recommended Mitigating Measures
	A.8.2 Exposed areas shall be planted with suitable vegetation.
B. Biological/Ecological Environment	
B.1 Cutting of commonly grown trees and other plants on cultivated areas (e.g., Gemelina, Banana, Mahogany, Ipil, etc.).	B.1.2 Young trees will be balled and replanted. Additional trees will be planted along the roadway. B.1.3 Permits will be secured from the DENR. B.1.4 Strict implementation of DPWH D. O. # 131, Series of 1995: Planting of trees along National Roads.
B.2 Exploitation of natural resources in the area.	B.2.1 Ensure that existing environmental management policies are effectively implemented and properly coordinated with all concerned agencies.
A. Socio-Economic/Human Environment	
C.1 Increase in sources of income for local residents and the municipal governments.	C.1.1 Hiring of at least 50 % of unskilled labor and 30 % of skilled labor requirements from the local residents (RA 6685 and DPWH Department Order 51 series of 1990). C.1.2 Adopt a just compensation scheme to avoid future labor and management conflicts.
C.2 Conflicts and disturbance to living conditions and public order that may arise from disagreements on land acquisition or payment for improvements on affected lands due to RROW (widening and/or re-alignment)	C.2.1 Prompt and just compensation will be provided for the improvements on affected lands due to RROW. C.2.2 The DPWH shall ensure that the entire process of acquisition of real properties is in accordance with RA No. 8974.
C.3 Obstruction to traffic	C.3.1 Assign personnel who will regulate traffic flow. C.3.2 Proper use of road signs, reflectorized signboards, or early warning devices, especially at night. C.3.3 Sturdy materials will be installed to prevent the road signs from being stolen.
C.4 Possible pollution as a result of waste disposal from the camps	C.4.1 Coordinate with the LGU on the site of the work camp. C.4.2 Install and maintain a system for the collection and treatment of solid wastes during construction.
C.6 Development of temporary work camp	C.6.1 Ensure abandonment of construction camp after the completion of the project.
C.7 Increased business potential	C.7.1 Encourage businesses in designated centers.
C.8 Increased delivery of agricultural	C.8.1 Improvement of the traffic function for the

Impacts (Positive and Negative)	Recommended Mitigating Measures
products and other commodities.	accessibility and convenience of traders and farmers.
C.9 Aesthetic View	C.9.1 The proponent and the contractor must enhance the aesthetic view in the area by planting ornamental plants/trees along the countermeasure.

6.4.3 Daang Maharlika (Dalton Pass), Km 222 (Region II)

(1) Purpose of the Project

The proposed project is intended to ensure that the Dalton Pass section of the Daang Maharlika, the shortest access route to Region II from Manila, a major agricultural production area supplying a significant portion of Metro Manila's rice and corn requirements including vegetable production, is open to vehicular traffic even during inclement weather. While the occurrence of sediment-related disasters poses significant risk to the safety of human lives, it is hoped that the construction of the proposed countermeasure will ensure the safety of regular travelers and the unimpeded flow of commodities and agricultural products.

(2) Description of the Project

The proposed project is located at approximately km 222 of the Daang Maharlika in the municipality of Sta. Fe in the province of Nueva Vizcaya.

The proposed countermeasure is comprised of a Double Concrete Block Masonry Wall.

(3) Feasibility Assessment

As discussed in 6.3.1(3) above, the economic feasibility of the proposed project was determined using the three major criteria which involved the calculation of the project's Economic Net Present Value (ENPV) and Benefit-Cost Ratio (BCR), all computed using the estimated value of the Opportunity Cost of Capital as being equal to the discount rate, and computing the Economic Internal Rate of Return. An economic analysis was undertaken to determine whether the required investment for the proposed countermeasure expressed in economic values (through the deduction of transfer payments and shadow pricing) can be recovered from the benefit streams that would be generated by the project.

The benefits were estimated based on the "with" and "without" project alternates. The economic benefits estimated included savings in detour costs, road reopening costs and a reduction in the loss of human lives. The summary of the results of the economic feasibility assessment is given in Table 6.22.

Table 6.22 Results of the Economic Feasibility Assessment

Feasibility Indicators	Discount Rate		
	12%	15%	
Economic Net Present Value (ENPV)	32,877,862	-25,104,791	-
Economic Internal Rate of Return (EIRR)	-	-	97.11%
Benefit-Cost Ratio	-	7.61	-

(4) Sensitivity Analysis

The impact on the measures of the project's economic worth by important factors such as increase in investment cost requirements or decrease in the estimated benefits to be generated was undertaken during the conduct of the sensitivity analysis. The effects of changes in two factors were measured, taken one at a time. The first was the effect of a 20% increase in investment cost on the computed ENPV, BCR and EIRR. The second was the effect of a 20% decrease in the amount of benefits generated on the computed ENPV, BCR and EIRR

The results are shown in Table 6.23.

Table 6.23 Results of the Sensitivity Analysis

Factor Changes	ENPV		EIRR
	12%	15%	
20% Increase in Investment Cost	32,132,326	24,378,704	78.64%
20% Decrease in Benefits	25,515,405	19,324,000	81.83%

(5) Social and Environmental Impact Assessment

The proposed project is intended to mitigate/avoid the occurrence of sediment-related disasters on national highways and is thus not subject to the conduct of an Environmental Impact Assessment. What is needed would be for the DPWH to secure a Certificate of Non-Coverage from the DENR office in the region where the proposed project is located.

As for the social impact, the proposed site has no/minimal human activity and there are no residents at the site.

The environmental management plan for the construction period of the proposed countermeasure is given in Table 6.24.

Table 6.24 Proposed Environmental Management Plan

Impacts (Positive and Negative)	Recommended Mitigating Measures
A. Physical/Natural Environment	
A.1 Air & Noise Pollution	A.1.1 All heavy equipment and machinery shall be fitted with air pollution control and noise dampening devices that are in good operating condition. A.1.2 Vehicles transporting sand and soils shall be covered with a tarpaulin. A.1.3 Stockpiled sand and soils shall be wetted slightly before loading, particularly in windy conditions.
A.2 Vibrations, noise and dust generation.	A.2.1 Advise and monitor the workers in order not to disturb the settlements near the working area. Provide proper devices for noise minimization. Spraying of bare areas with water.
A.3 Accelerated erosion resulting in slope instability, landslides, destruction of vegetation and property, siltation of surface waters and water pollution.	A.3.1 Earth movement will be implemented during the dry season, if possible. A.3.2 Appropriate vegetation will be planted. A.3.3 Preserve or replace existing large trees.
A.4 Siltation downstream and riverbank destruction.	A.4.1 The depth of extraction from the river will be limited.
A.5 Accelerated sedimentation, and slope instability if excavated materials are dumped on steep hillsides.	A.5.1 Proper disposal of excavated materials on selected areas.
A.6 Air and water pollution in settlements, dust generation and impact on local crops (agricultural production), other vegetation and water supplies.	A.6.1 Locate concrete batching plants and storage yards away from residential and environmentally sensitive areas. Provide adequate pollution control devices, air filters, etc.
A.7 Wastewater Flow	A.7.1 Wastewater flow may be affected by the wastes generated from the labor camps, storage yards and construction equipment. This can be mitigated and even avoided by the following recommendations: The contractor shall provide sanitary latrines in the campsite. The location of the campsite facilities shall be away from built-up areas, bodies of water and other sources of water used by the communities. Proper housekeeping of the campsite.
A.8 Impaired aesthetics and soil erosion.	A.8.1 Site restoration works shall be ensured before the equipment is allowed to leave. A.8.2 Exposed areas shall be planted with suitable vegetation.

Impacts (Positive and Negative)	Recommended Mitigating Measures
B. Biological/Ecological Environment	
B.1 Cutting of commonly grown trees and other plants on cultivated areas (e.g., Gemelina, Banana, Mahogany, Ipil, etc.).	B.1.1 Young trees will be balled and replanted. Additional trees will be planted along the roadway. B.1.2 Permits will be secured from the DENR. B.1.3 Strict implementation of DPWH D. O. # 131, Series of 1995: Planting of trees along National Roads.
B.2 Exploitation of natural resources in the area.	B.2.1 Ensure that existing environmental management policies are effectively implemented and properly coordinated with all concerned agencies.
C. Socio-Economic/Human Environment	
C.1 Increase in sources of income for local residents and the municipal governments.	C.1.1 Hiring of at least 50 % of unskilled labor and 30 % of skilled labor requirements from the local residents (RA 6685 and DPWH Department Order 51 series of 1990). C.1.2 Adopt a just compensation scheme to avoid future labor and management conflicts.
C.2 Conflicts and disturbances to living conditions and public order that may arise from disagreements on land acquisition or payment for improvements on affected lands due to RROW (widening and/or re-alignment)	C.2.1 Prompt and just compensation will be provided for the improvements on affected lands due to RROW. C.2.2 The DPWH shall ensure that the entire process of acquisition of real properties is in accordance with RA No. 8974.
C.3 Obstruction to traffic	C.3.1 Assign personnel who will regulate traffic flow. C.3.2 Proper use of road signs, reflectorized signboards, or early warning devices, especially at night. C.3.3 Sturdy materials will be installed to prevent the road signs from being stolen.
C.4 Possible pollution as a result of waste disposal from the camps	C.4.1 Coordinate with the LGU on the site of the work camp. C.4.2 Install and maintain a system for the collection and treatment of solid wastes during construction.
C.5 Noise pollution and other disturbances	C.5.1 Location of the work camp should be far from the residential areas.
C.6 Development of temporary work camp	C.6.1 Ensure abandonment of construction camp after the completion of the project.
C.7 Increased business potential	C.7.1 Encourage businesses in designated centers.
C.8 Increased delivery of agricultural products and other commodities.	C.8.1 Improvement of traffic function for accessibility and convenience of traders and farmers.
C.9 Aesthetic View	C.9.1 The proponent and the contractor must enhance the aesthetic view in the area by planting ornamental plants/trees along the countermeasure.

6.4.4 Toledo-Baliri-Santander Road (Ginatilan – Alegria Road), Km 175 (Region VII)

(1) Purpose of the Project

The proposed project is intended to ensure that the Ginatilan-Alegria section of the Toledo-Baliri-Santander Road is open to vehicular traffic even during inclement weather. While the occurrence of sediment-related disasters poses significant risk to the safety of human lives, it is hoped that the construction of the proposed countermeasure will ensure the safety of regular travelers and the unimpeded flow of commodities and agricultural products. This project is unique since it deals with coastal erosion, the road being located along the seashore and subject to the impacts of waves and tides.

(2) Description of the Project

The proposed project is located at km 175 of the Ginatilan-Alegria Road section of the Toledo-Baliri-Santander Road.

The proposed countermeasure involves the construction of a Gravity Type (leaning Concrete Type) Revetment.

(3) Feasibility Assessment

As discussed in 6.4.1(3) above, the economic feasibility of the proposed project was determined using the three major criteria which involved the calculation of the project's Economic Net Present Value (ENPV) and Benefit-Cost Ratio (BCR), all computed using the estimated value of the Opportunity Cost of Capital as being equal to the discount rate, and calculating the Economic Internal Rate of Return. An economic analysis was undertaken to determine whether the required investment for the proposed countermeasure expressed in economic values (through the deduction of transfer payments and shadow pricing) can be recovered from the benefit streams that would be generated by the project.

The benefits were estimated based on the "with" and "without" project alternates. The economic benefits estimated included savings in detour costs, road reopening costs and a reduction in the loss of human lives. The summary of the results of the economic feasibility assessment is given in Table 6.25.

Table 6.25 Results of the Economic Feasibility Assessment

Feasibility Indicators	Discount Rate		
	12%	15%	
Economic Net Present Value (ENPV)	-100,033	-794,016	-
Economic Internal Rate of Return (EIRR)	-	-	11.65%
Benefit-Cost Ratio	-	0.92	-

(4) Sensitivity Analysis

The impact on the measures of the project's economic worth by important factors such as increase in investment cost requirements or decrease in the estimated benefits to be generated was undertaken during the conduct of the sensitivity analysis. The effects of changes in two factors were measured, taken one at a time. The first was the effect of a 20% increase in investment cost on the computed ENPV, BCR and EIRR. The second was the effect of a 20% decrease in the amount of benefits generated on the computed ENPV, BCR and EIRR

The results are shown in Table 6.26.

Table 6.26 Results of the Sensitivity Analysis

Factor Changes	ENPV		EIRR
	12%	15%	
20% Increase in Investment Cost	-876,104	-1,549,842	9.35%
20% Decrease in Benefits	-902,782	-1,429,139	8.69%

(5) Social and Environmental Impact Assessment

The proposed project is intended to mitigate/avoid the occurrence of sediment-related disasters on national highways and is thus not subject to the conduct of an Environmental Impact Assessment. What is needed would be for the DPWH to secure a Certificate of Non-Coverage from the DENR office in the region where the proposed project is located.

As for the social impact, the proposed site has no/minimal human activity and residents.

The environmental management plan for the construction period of the proposed countermeasure is given in Table 6.27.

Table 6.27 Proposed Environmental Management Plan

Impacts (Positive and Negative)	Recommended Mitigating Measures
A. Physical/Natural Environment	
A.1 Air & Noise Pollution	A.1.1 All heavy equipment and machinery shall be fitted with air pollution control and noise dampening devices that are in good operating condition. A.1.2 Vehicles transporting sand and soils shall be covered with a tarpaulin. A.1.3 Stockpiled sand and soils shall be wetted slightly before loading, particularly in windy conditions.
A.2 Vibrations, noise and dust generation.	A.2.1 Advise and monitor the workers in order not to disturb the settlements near the working area. Provide proper device for noise minimization. Spraying of bare areas with water.
A.3 Accelerated erosion resulting to slope instability, landslides, destruction of vegetation and property, siltation of surface waters and water pollution.	A.3.1 Earth movement will be implemented during dry season, if possible. A.3.2 Appropriate vegetation will be planted. A.3.3 Preserve or replace existing large trees.
A.4 Siltation downstream and riverbank destruction.	A.4.1 The depth of extraction from the river will be limited.
A.5 Accelerated sedimentation, and slope instability if excavated materials are dumped on steep hillsides.	A.5.1 Proper disposal of excavated materials on selected areas.
A.6 Air and water pollution in settlements, dust generation and impact on local crops (agricultural production), other vegetation and water supplies.	A.6.1 Locate concrete batching plants and storage yard away from residential and environmentally sensitive areas. Provide adequate pollution control devices, air filters, etc.
A.7 Wastewater Flow	A.7.1 Wastewater flow may be affected by the wastes generated from the labor camps, storage yards and construction equipment. This can be mitigated and even avoided by the following recommendations: The contractor shall provide sanitary latrines in the campsite. The location of the campsite facilities shall be away from built-up areas, bodies of water and other sources of water used by the communities. Proper housekeeping of the campsite.

Impacts (Positive and Negative)	Recommended Mitigating Measures
A.8 Impaired aesthetics and soil erosion.	A.8.1 Site restoration works shall be ensured before the equipment is allowed to leave. A.8.2 Exposed areas shall be planted with suitable vegetation.
B. Biological/Ecological Environment	
B.1 Cutting of commonly grown trees and other plants on cultivated areas (e.g., Gemelina, Banana, Mahogany, Ipil, etc.).	B.1.1 Young trees will be balled and replanted. Additional trees will be planted along the roadway. B.1.2 Permits will be secured from the DENR. B.1.3 Strict implementation of DPWH D. O. # 131, Series of 1995: Planting of trees along National Roads.
B.2 Exploitation of natural resources in the area.	B.2.1 Ensure that existing environmental management policies are effectively implemented and properly coordinated with all concerned agencies.
C. Socio-Economic/Human Environment	
C.1 Increase in sources of income for local residents and the municipal governments.	C.1.1 Hiring of at least 50 % of unskilled labor and 30 % of skilled labor requirements from the local residents (RA 6685 and DPWH Department Order 51 series of 1990). C.1.2 Adopt a just compensation scheme to avoid future labor and management conflicts.
C.2 Conflicts and disturbances to living conditions and public order that may arise from disagreement on land acquisition or payment for improvements on affected lands due to RROW (widening and/or re-alignment)	C.2.1 Prompt and just compensation will be provided for the improvements on affected lands due to RROW. C.2.2 The DPWH shall ensure that the entire process of acquisition of real properties is in accordance with RA No. 8974.
C.3 Obstruction to traffic	C.3.1 Assign personnel who will regulate traffic flow. C.3.2 Proper use of road signs, reflectorized signboards, or early warning devices especially at night. C.3.3 Sturdy materials will be installed to prevent the road signs from being stolen.
C.4 Possible pollution as a result of waste disposal from the camps	C.4.3 Coordinate with the LGU on the site of the work camp. C.4.4 Install and maintain a system for the collection and treatment of solid wastes during construction.
C.5 Noise pollution and other disturbances	C.5.1 Location of the work camp should be far from the residential areas.

Impacts (Positive and Negative)	Recommended Mitigating Measures	
C.6 Development of temporary work camp	C.6.1	Ensure abandonment of construction camp after the completion of the project.
C.7 Increased business potential	C.7.1	Encourage businesses in designated centers.
C.8 Increased delivery of agricultural products and other commodities.	C.8.1	Improvement of traffic function for the accessibility and convenience of traders and farmers.
C.9 Aesthetic View	C.9.1	The proponent and the contractor must enhance the aesthetic view in the area by planting ornamental plants/trees along the countermeasure.

6.4.5 Wright-Taft-Borongan Road (Wright–Taft Road) Km 846 (Region VIII)

(1) Purpose of the Project

The proposed project is intended to ensure that the Wright-Taft section of the Wright-Taft-Borongan Road, a major access road to Eastern Samar from Samar, Northern Samar and Manila, is open to vehicular traffic even during inclement weather. While the occurrence of sediment-related disasters poses significant risk to the safety of human lives, it is hoped that the construction of the proposed countermeasure will ensure the safety of regular travelers and the unimpeded flow of commodities and agricultural products.

(2) Description of the Project

The proposed project is located at approximately km 846 of the Wright-Taft Road section of the Wright-Taft-Borongan Road in the municipality of Wright, province of Samar.

The proposed countermeasure is comprised of a Horizontal Drain and Concrete Gravity Retaining Wall.

(3) Feasibility Assessment

As discussed in 6.3.1(3) above, the economic feasibility of the proposed project was determined using the three major criteria which involved the calculation of the project's Economic Net Present Value (ENPV) and Benefit-Cost Ratio (BCR), all computed using the estimated value of the Opportunity Cost of Capital as being equal to the discount rate, and calculating the Economic Internal Rate of Return. An economic analysis was undertaken to determine whether the required investment for the proposed countermeasure expressed in economic values (through the deduction of transfer payments and shadow pricing) can be recovered from the benefit streams that would be generated by the project.

The benefits were estimated based on the "with" and "without" project alternates. The economic benefits estimated included savings in detour costs, road reopening costs and a reduction in the loss of human lives. The summary of the results of the economic feasibility assessment is given in Table 6.28.

Table 6.28 Results of the Economic Feasibility Assessment

Feasibility Indicators	Discount Rate		
	12%	15%	
Economic Net Present Value (ENPV)	-6,594,406	-7,650,704	-
Economic Internal Rate of Return (EIRR)	-	-	4.22%
Benefit-Cost Ratio	-	0.49	-

(4) Sensitivity Analysis

The impact on the measures of the project's economic worth by important factors such as increase in investment cost requirements or decrease in the estimated benefits to be generated was undertaken during the conduct of the sensitivity analysis. The effects of changes in two factors were measured, taken one at a time. The first was the effect of a 20% increase in investment cost on the computed ENPV, BCR and EIRR. The second was the effect of a 20% decrease in the amount of benefits generated on the computed ENPV, BCR and EIRR

The results are shown in Table 6.29.

Table 6.29 Results of the Sensitivity Analysis

Factor Changes	ENPV		EIRR
	12%	15%	
20% Increase in Investment Cost	-9,207,977	-10,196,095	2.54%
20% Decrease in Benefits	-8,035,817	-8,785,698	1.97%

(5) Social and Environmental Impact Assessment

The proposed project is intended to mitigate/avoid the occurrence of sediment-related disasters on national highways and is thus not subject to the conduct of an Environmental Impact Assessment. What is needed would be for the DPWH to secure a Certificate of Non-Coverage from the DENR office in the region where the proposed project is located.

As for the social impact, the proposed site has no/minimal human activity and residents.

The environmental management plan for the construction period of the proposed countermeasure is given in Table 6.30.

Table 6.30 Proposed Environmental Management Plan

Impacts (Positive and Negative)	Recommended Mitigating Measures
A. Physical/Natural Environment	
A1. Air & Noise Pollution	A.1.1 All heavy equipment and machinery shall be fitted with air pollution control and noise dampening devices that are in good operating condition. A.1.2 Vehicles transporting sand and soils shall be covered with a tarpaulin. A.1.3 Stockpiled sand and soils shall be wetted slightly before loading, particularly in windy conditions.
A.2 Vibrations, noise and dust generation.	A.2.2 Advise and monitor the workers in order not to disturb the settlements near the working area. Provide proper devices for noise minimization. Spraying of bare areas with water.
A3. Accelerated erosion resulting to slope instability, landslides, destruction of vegetation and property, siltation of surface waters and water pollution.	A.3.1 Earth movement will be implemented during the dry season, if possible. A.3.2 Appropriate vegetation will be planted. A.3.3 Preserve or replace existing large trees.
A4. Siltation downstream and riverbank destruction.	A.4.1 The depth of extraction from the river will be limited.
A5. Accelerated sedimentation, and slope instability if excavated materials are dumped on steep hillsides.	A.5.1 Proper disposal of excavated materials on selected areas.
A6. Air and water pollution in settlements, dust generation and impact on local crops (agricultural production), other vegetation and water supplies.	A.6.1 Locate concrete batching plants and storage yard away from residential and environmentally sensitive areas. Provide adequate pollution control devices, air filters, etc.
A7. Wastewater Flow	A.7.1 Wastewater flow maybe affected by the wastes generated from the labor camps, storage yards and construction equipment. This can be mitigated and even avoided by the following recommendations: The contractor shall provide sanitary latrines in the campsite. The location of the campsite facilities shall be away from built-up areas, bodies of water and other sources of water used by the communities. Proper housekeeping of the campsite.
A8. Impaired aesthetics and soil erosion.	A.8.1 Site restoration works shall be ensured before the equipment is allowed to leave.

Impacts (Positive and Negative)	Recommended Mitigating Measures
	A.8.2 Exposed areas shall be planted with suitable vegetation.

Impacts (Positive and Negative)	Recommended Mitigating Measures
B. Biological/Ecological Environment	
B.1 Cutting of commonly grown trees and other plants on cultivated areas (e.g., Gemelina, Banana, Mahogany, Ipil, etc.).	B.1.1 Young trees will be balled and replanted. Additional trees will be planted along the roadway. B.1.2 Permits will be secured from the DENR. B.1.3 Strict implementation of DPWH D. O. # 131, Series of 1995: Planting of trees along National Roads.
B.2 Exploitation of natural resources in the area.	B.2.1 Ensure that existing environmental management policies are effectively implemented and properly coordinated with all concerned agencies.
C. Socio-Economic/Human Environment	
C.1 Increase in sources of income for local residents and the municipal governments.	C.1.1 Hiring of at least 50 % of unskilled labor and 30 % of skilled labor requirements from the local residents (RA 6685 and DPWH Department Order 51 series of 1990). C.1.2 Adopt a just compensation scheme to avoid future labor and management conflicts.
C.2 Conflicts and disturbances to living conditions and public order that may arise from disagreements on land acquisition or payment for improvements on affected lands due to RROW (widening and/or re-alignment)	C.2.1 Prompt and just compensation will be provided for the improvements on affected lands due to RROW. C.2.2 The DPWH shall ensure that the whole process of acquisition of real properties is in accordance with RA No. 8974.
C.3 Obstruction to traffic	C.3.1 Assign personnel who will regulate traffic flow. C.3.2 Proper use of road signs, reflectorized signboards, or early warning devices, especially at night. C.3.3 Sturdy materials will be installed to prevent the road signs from being stolen.
C.4 Possible pollution as a result of waste disposal from the camps	C.4.1 Coordinate with the LGU on the site of the work camp. C.4.2 Install and maintain a system for the collection and treatment of solid wastes during construction.
C.5 Noise pollution and other disturbances	C.5.1 Location of the work camp should be far from the residential areas.
C.6 Development of temporary work camp	C.6.1 Ensure abandonment of construction camp after the completion of the project.

Impacts (Positive and Negative)	Recommended Mitigating Measures
C.7 Increased business potential	C.7.1 Encourage businesses in designated centers.
C.8 Increased delivery of agricultural products and other commodities.	C.8.1 Improvement of traffic function for the accessibility and convenience of traders and farmers.
C.9 Aesthetic View	C.9.1 The proponent and the contractor must enhance the aesthetic view in the area by planting ornamental plants/trees along the countermeasure.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

7.1.1 Formulation of the Road Slope Management System (RSMS)

(1) Major Outputs of the Study

The Road Slope Management System has been established through close cooperation between the JICA Study Team and DPWH Counterpart Team. It consists of the following three components,

(1) Inventory survey methods for road slopes
(2) Database information system for road slopes (RSMS database)
(3) Risk management planning procedures

All the information needed to design the risk management policy for road slope disasters can be collected and arranged using the Inventory Survey, which provides the information on road slope risk conditions including frequency of road closure disasters (FRCD), disaster magnitudes, annual losses caused by RCDs, preventive countermeasure alternatives and their costs, and indicative feasibility assessment of each preventive countermeasure. Information collected in the Inventory Survey can be encoded into the RSMS database system that was developed in the Study. The RSMS database system is a simple information system designed for policy makers for risk management of road slope disasters. Utilizing information in the RSMS, a reasonable plan for risk management of road slope disasters can be formulated.

(2) Technical Guides

A "Guide to Mitigation and Management of Road Slope Disasters" has been prepared in three Volumes that support actual inventory surveys and risk management planning as follows:

(a) Risk Management Planning (Guide I) ; methodology for risk management planning,
(b) Inventory Survey and Risk Assessment (Guide II); instructions on inventory surveys, and
(c) Design of Countermeasures (Guide III); reference on countermeasure planning.

These technical Guides were prepared considering the current road disaster situation, and revised and refined in the process of executing the pilot Inventory Surveys for eleven road sections totaling 332 km of national highways in six Regions. It has been demonstrated that the "Guides" can be used in practical applications for the Inventory Surveys, database formulation and risk management planning, as described in Chapters 4 to 6.

7.1.2 Capability of DPWH in RSMS

This Study was carried out jointly by the JICA Study Team and the DPWH Counterpart Team, which periodically reported to, and were authorized by, the Technical Working Group and the Steering Committee.

(1) Capability of DPWH Engineers

Throughout the joint work in the Study, the engineers of the Counterpart Team, the Regional Offices and the District Engineering Offices showed their basic competence in completing the model Inventory Surveys for the 332 km of the national highways.

Technical transfer in the procedure for the Inventory Surveys has been conducted in four ways as follows;

(a) Joint work with the JICA Study Team,
(b) On-the-Job training in the Study,
(c) Seminars and Workshops, and
(d) Counterpart training in Japan.

Through the activities in each of the training programs, the DPWH engineers acquired the skills needed to complete the Inventory Surveys properly and they mastered the various kinds of skills needed for the work. DPWH Engineers who worked for the Study were selected from 6 Regions and 14 District Engineering Offices; therefore, it is ensured that engineers competent to execute the Inventory Surveys can be tapped from Regional Offices and District Engineering Offices.

The lack of geotechnical engineers with advanced knowledge of the technology for slope engineering is the only issue affecting the quality of the Inventory Surveys for the nationwide national highways. Thus, securing and training engineers in slope engineering is a key program must be implemented in order to execute the nationwide Inventory Surveys.

(2) Organization of DPWH

Throughout the Study, all the projects have been successfully completed using the existing DPWH command structure and systems. Coordination between the Central Office, Regional Offices and District Engineering Offices has worked smoothly. It has been proven that the

DPWH organization functions adequately to carry out this kind of work independently. It was announced that rationalization of DPWH would start shortly, but the sections that implement the public works will not be drastically changed, but rather enhanced.

The pilot Inventory Survey was a simulation to illustrate how to execute the nationwide inventory surveys, and it demonstrated the potential capability of DPWH for the work in both the technological and institutional aspects.

7.2 Recommendations

7.2.1 New Risk Management for Slopes along National Highways

134 District Engineering Offices nationwide are responsible for managing road slope disasters on all 434 road sections of the 1,774 km of national highways as shown in detail in Table 7.1 and Figures of Appendix 2-1. These were identified by the questionnaire survey in the Study.

Table 7.1 Quantity of Road Sections Affected by Slope Disasters

Region	No. of DEO(total)	Road Sections	Total Length(km)
CAR	9(9)	39	238
I	4(10)	14	82
II	10(11)	39	208
III	11(14)	32	260
NCR	2(9)	3	5
IV-A	11(15)	36	116
IV-B	8(9)	30	157
V	5(13)	19	30
VI	12(13)	48	93
VII	12(13)	32	114
VIII	12(13)	43	88
IX	8(8)	18	103
X	8(11)	20	90
XI	8(8)	17	102
XII	6(7)	27	30
XIII	7(9)	17	59
17 Regions	134 DEO(174)	434 Sections	1,774 km

As described in Chapter 2, around 2,700 road closure disasters take place annually with economic losses of about 2,500 million pesos. To improve this situation and for providing reliable traffic access on the national highways, it is recommended that risk management be applied in a timely manner to the critical sections mentioned above employing the new methods developed in the Study

7.2.2 Organization to Promote Nationwide Road Slope Risk Management

(1) Flow of New Risk Management Method

The implementation flowchart for the proposed nationwide Inventory Survey is shown in Figure 7.1. It is estimated that it will require roughly two years to formulate a risk management plan for road slope disasters on national highways nationwide, including preparatory seminars and workshops, inventory surveys, encoding to a database, and risk management planning.

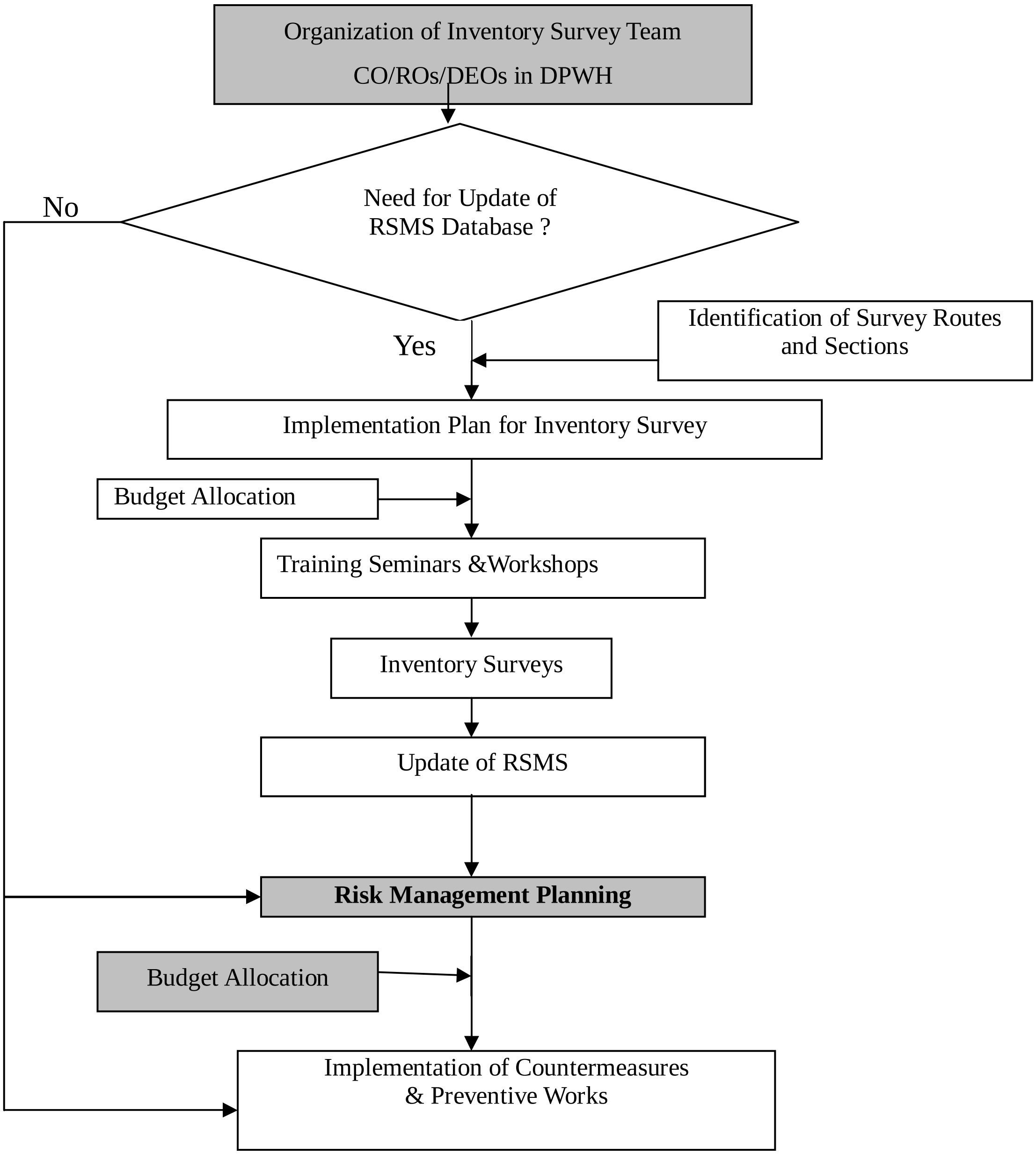


Figure 7.1 Proposed Flow of New Method for Risk Management

(2) Organization for Implementation of Nationwide Road Slope Inventory Surveys

Road slope risk management for national highways nationwide will be implemented by the "Inventory Survey Team", consisting of the Central Office, Regional Offices and District Engineering Offices of DPWH as shown in Figure 7.2. The recommended composition of the "Inventory Survey Team" is basically the same as that used in the pilot Inventory Survey conducted in this Study. The responsible unit in the Central Office is the DPD, Planning Service and the executing units in ROs and DEOs are the Maintenance Divisions and Maintenance Sections, respectively. The ROs and DEOs which conducted the pilot Inventory Surveys shall be the leading units for the prospective nationwide inventory surveys.

Also, the staff who participated in the pilot Inventory Surveys preferably should be assigned as members of the "Inventory Survey Team" to make use of their expertise and experience in the pilot Inventory Surveys, database formulation, and risk management planning.

7.2.3 Formulation of Systematic and Reasonable Risk Management Plan

The PMS (Pavement Management System) and the BMS (Bridge Management System) have been established to support needs analysis, multi-year programming and annual budgeting for the preservation of road pavement and bridges on the national network. These two applications have already been utilized according to Department Order No. 54, Full Institutionalization of the Road and Bridge Information Application (RBIA) and Related Road and Bridge Data Collection Procedure, 2004.

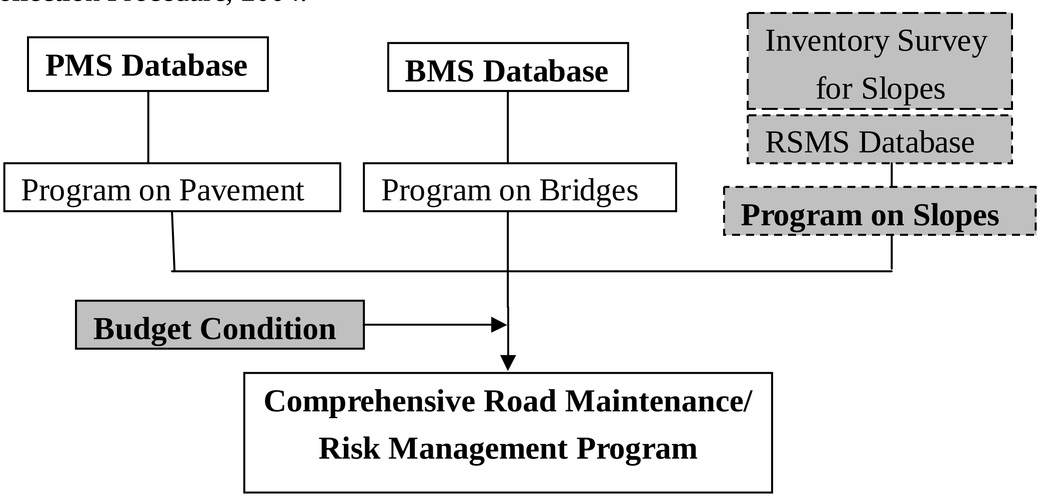


Figure 7.2 Formulation of a Comprehensive Road Maintenance Program

The RSMS developed in this Study is an application to complement the two applications mentioned above. The establishment of the RSMS in close linkage with the PMS and the BMS will enable the formulation of a reasonable and balanced multi-year risk management program for road slopes along the national highways (Figure 7.1).

As shown in the figure above, the constant allocation of resources to the "Comprehensive Road Maintenance and Risk Management Program" is strongly recommended in order to gain control of RCDs on the national highways. Adequate budget support will ensure the success of the program.

7.2.4 Improvement of Design and Construction Methods

Natural phenomena such as weather, earthquakes, hydrography, etc. remind us of the potential danger for slope failures which may obstruct road traffic. By observing and recording slope disasters, engineers can identify the modes, causes, and magnitude of the slope failures. All this information shall be taken into consideration in planning rehabilitation works and preventive countermeasures. One of the major targets in controlling RCDs is the reduction of recurrence. In the Study, the Study Team observed many recurrences of RCDs on the national highways in spite of rehabilitation works or preventive countermeasures having been installed.

To reduce the recurrence of RCDs, the basic procedures for the design and construction methods shall be improved from the viewpoint of slope engineering. For example, as described in Guide III: Design of Countermeasures, suitable drainage works for critical slopes often prevent the progress of deformation, especially in Road Slips or Soil Collapses. Also, a suitable cut slope gradient should be applied to secure slope stability.

The introduction of advanced countermeasure methods to some key slopes is recommended to ensure safe and smooth road traffic flow. In many places, insufficient countermeasures to prevent recurrence of RCDs had been applied on critical and adverse slopes. This is one of the major reasons for recurrence of RCDs. In some cases involving Road Slips on steep slopes with fragile geology, the slopes can only be stabilized through the application of advanced countermeasures such as reinforced soil embankments and anchoring. Also, in such large-scale landslide locations as Agas-agas or the Lagawe-Banaue Road at km 301, RCDs are occurring periodically due to inadequate treatment. Suitable technological development in such engineering fields is very important to suitably treat and manage such dangerous slopes.

As reported above, the Study developed an inventory survey system for road slopes, referred to as the RSMS, or Road Slope Management System. This may be only a part of the activities of DPWH to reform the work processes to provide road users with safe and smooth traffic flow. But the Study Team sincerely hopes that the RSMS would be utilized appropriately, coordinated with PMS and BMS to formulate systematic and reasonable long term programs that will contribute to the improvement of traffic on national highways in the Philippines.