Appendix 4-2 Computation of Frequency Scores

1. Purpose of Analysis

2. Method of Analysis

3. Result of Analysis

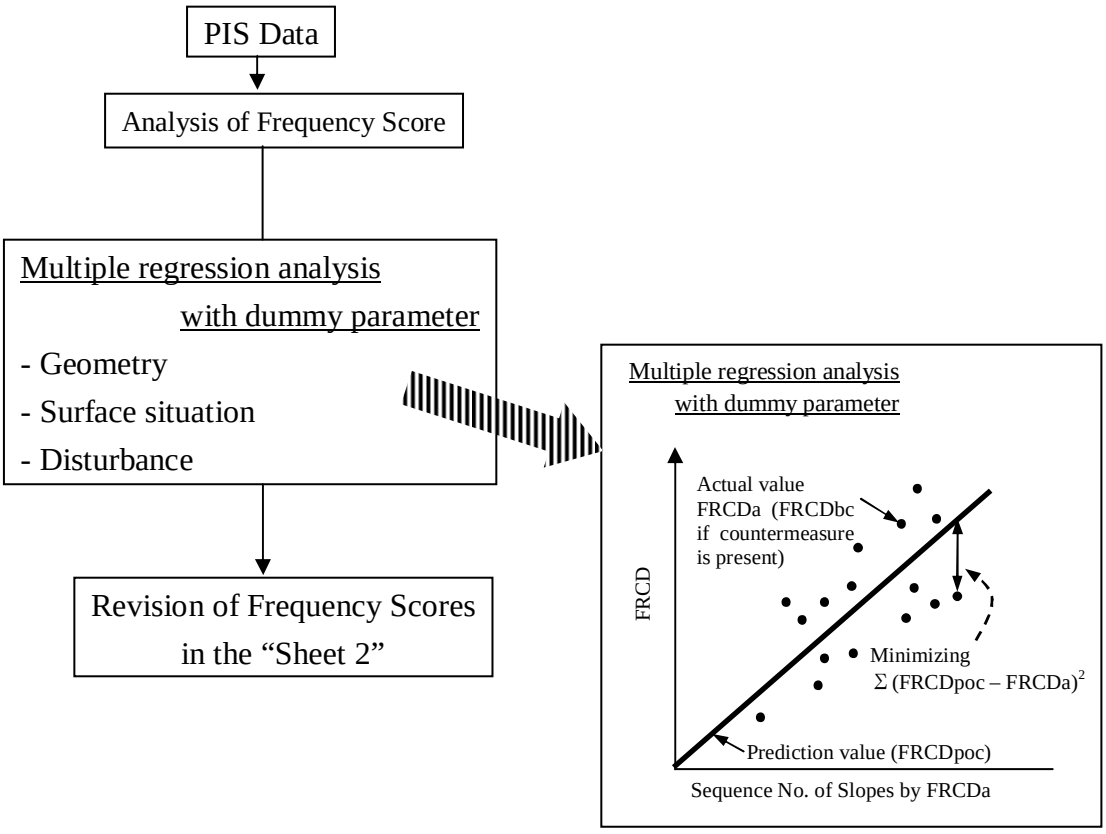
4. Summary

1. Purpose of Analysis

From the result of PIS, the necessity for DIS is evaluated based on whether FRCDa is larger than 0.1 or the visible disturbance is present. But, even at the site where these signs are not present, it cannot be judged that the danger of a slope disaster is low. The danger of a slope disaster is evaluated using slope disaster factors (Geometry, Surface situation, Disturbance, Countermeasure). The evaluation index is FRCDpoc(FRCDp without countermeasure) which is decided from FRCDa (or FRCDbc if the countermeasure is present) and some of the slope disaster factors (Geometry, Surface situation, Disturbance). The purpose of this analysis is to compute the frequency scores of each slope disaster factors.

2. Method of Analysis

FRCDpoc (FRCDp without countermeasure) is decided from FRCDa (or FRCDbc if the countermeasure is present) and some of the slope disaster factors (Geometry, Surface situation, Disturbance) using multiple regression analysis with dummy parameter (Figure 1). The frequency score are calculated so as to minimize the residual sum of squares between the survey value (FRCDa) and the prediction value (FRCDpoc). The frequency scores of countermeasure are determined based on the PIS data. They are decided for every disaster type, and results are described below.



*Multiple regression analysis with dummy parameter is the method of minimizing the residual sum of squares between actual value (FRCDa) and the prediction value (FRCDpoc) using the correlativity of FRCDa and the slope disaster frequency factors.

Figure 1 Flow of the Decision of Frequency Score

3. Result of Analysis

(1) Frequency Score of Geometry, Surface situation and Disturbance

It is analyzed by the multiple regression analysis with dummy parameters about each disaster type except for Landslide (LS), because the number of samples was obtained only for Eight (8) pieces. Table 1 shows the summary of the analysis. It shows the weighting for score range of evaluation items, the maximum FRCDp and the minimum one and the multiple correlation coefficient. The score range means the contribution to FRCDp, and when a value is large, its contribution to FRCDp is large. It is calculated for each item as the difference between the maximum factor score and the minimum one. In Soil Collapse (SC), Debris Flow (DF) and Coastal Erosion (CE), the score range of the disturbance was the highest. And the score range of the geometry was the highest in Rock Slope Collapse (RC), Road Slip (RS) and River Erosion (RE). The maximum FRCDp was around "1.0" in most disaster types, except for about 2.0 in SC, which contains the samples of high FRCDa. The minimum FRCDp was 0 in all disaster types. If the lowest category scores lead to a negative calculated FRCDp, the FRCDp is interpreted as 0, because the frequency of road closure disasters of less than 0 can have no physical meaning.

Table 1 Summary of Analysis

Item	SC	RC	LS	RS	DF	RE	CE
Geometry	23% (40%)	42% (40%)	(26%)	45% (46%)	19% (28%)	62% (46%)	30% (52%)
Surface Condition	23% (36%)	36% (20%)	(20%)	40% (36%)	26% (12%)	17% (8%)	29% (8%)
Disturbance (Sd)	54% (24%)	22% (40%)	(54%)	15% (18%)	55% (60%)	21% (46%)	41% (40%)
Total	100%	100%	(100%)	100%	100%	100%	100%
FRCDp (Max)	2.054	1.066	(0.500)	0.880	0.909	0.781	0.980
FRCDp (Min)	0.0	0.0	(0.025)	0.0	0.0	0.0	0.0
MCC**	0.75	0.45	-	0.57	0.67	0.48	0.68

*The value inside the parenthesis shows the assumed value

**MCC shows the multiple correlation coefficient. It means the prediction accuracy of the frequency score

The detailed result about each type is indicated below.

1) Soil Collapse

Table 2 shows the number of samples used for the analysis. The dense hatch means that the category is eliminated in the analysis if the number of samples in the category is "0". The line hatch means that the categories were integrated if the relevance to FRCDa was small. The relevance between the categories and FRCDa was calculated in the pre-analysis (or the multiple correlation analysis with dummy parameter) before integrating the categories.

Table 2 Number of Samples for Analysis (Soil Collapse)

Total samples: 187

Factor items for FRCDpoc	Factor categories for FRCDpoc			
a: Length of survey section: L	L >= 300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L
	23	22	68	74
b: Height of mountain side slope: H	H >= 90 m	90m > H >= 60 m	60m > H >= 30 m	30m > H
	13	25	71	78
c: Gradient of slope: G	G >= 60°	60° > G >= 40°	40° > G >= 20°	20° > G
	56	72	47	12
d: Distance from road to toe of mountainside slope : D	1 m > D	3m >= D > 1m	5m >= D > 3m	D > 5 m
	47	81	55	4
e: Slope shape	Valley type	Straight type	Ridge type	Combined type
	13	55	25	94
f: Dominant vegetation/surface covering	Bare	Grasses	Trees	Surface protection (without vegetation)
	19	92	76	0
g: Dominant materials of the slope surface	Silt, Clay	Sand	Gravels, Cobbles, or Boulders	Surface protection (without vegetation)
	167	9	11	0
h: Area ratio of bedrock exposure: AR	AR > 40%	40% >= AR > 20%	20% >= AR > 0%	AR = 0%
	24	38	103	22
i: Materials of Bedrock	Fractured rock	Weathered rock	Soft fresh rock	Hard fresh rock
	17	92	22	3
	Unknown			
	53			
j: Spring/Surface water	Present	None		
	20	167		
k: Erosion on the slope	Erosion	Piping hole		
	111	2		
l: Deformation/Collapse	Collapse/Slump	Cracks, Crevices	Fallen/Inclined trees	Depression/Upheaval
	128	10	9	8

As a result of the analysis, the category score was calculated. To calculate the FRCDp, the category score was applied to the corresponding score for FRCDp as indicated in "Sheet 2". Table .3 shows the frequency score for FRCDp.

Table .3 Frequency Score for FRCDp (Soil Collapse)

Factor items for FRCDp	Factor categories for FRCDp			
a: Length of survey section: L	L >= 300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L
	0.160	0.041	-0.005	-0.028
b: Height of mountain side slope: H	H >= 90 m	90m > H >= 60 m	60m > H >= 30 m	30m > H
	0.019	0.019	0.010	0.010
c: Gradient of slope: G	G >= 60°	60° > G >= 40°	40° > G >= 20°	20° > G
	0.092	-0.019	-0.019	-0.054
d: Distance from road to toe of mountainside slope : D	1 m > D	3m >= D > 1m	5m >= D > 3m	D > 5 m
	0.089	0.007	-0.043	-0.043
e: Slope shape	Valley type	Straight type	Ridge type	Combined type
	0.028	0.028	0.002	0.002
f: Dominant vegetation/surface covering	Bare	Grasses	Trees	Surface protection (without vegetation)
	0.051	0.007	0.007	0.000
g: Dominant materials of slope surface	Silt, Clay	Sand	Gravels, Cobbles, or Boulders	Surface protection (without vegetation)
	0.014	-0.005	-0.005	0.000
h: Area ratio of bedrock exposure: AR	AR > 40%	40% >= AR > 20%	20% >= AR > 0%	AR = 0%
	0.046	0.017	0.003	0.003
i: Materials of Bedrock	Fractured rock	Weathered rock	Soft fresh rock	Hard fresh rock
	0.058	0.014	0.014	0.014
	Unknown			
	-0.010			
j: Spring/Surface water	Present	None		
	0.297	-0.023		
k: Erosion on the slope	Erosion	Piping hole		
	0.072	0.654		
l: Deformation/Collapse	Collapse/Slump	Cracks, Crevices	Fallen/Inclined trees	Depression/Upheaval
	0.051	0.229	0.120	0.062

The predictive accuracy of the factor score is checked by a multiple correlation coefficient. When the multiple correlation coefficient is “1”, accuracy is the best and the worst if “0”. The correlation coefficient for “Soil Collapse” was 0.75.

(2) Rock Slope Collapse

Table 4 shows the number of samples and results of the analysis. The dense hatch means that the category was eliminated in the analysis because the number of samples is “0”. The line hatch means that the categories were integrated because the number of samples was too few or the relevance to FRCDa was small. The relevance between the categories and FRCDa was calculated in the pre-analysis. The pre-analysis is the multiple correlation analysis with dummy parameter before integrating the categories.

Table 4 Number of Samples for Analysis (Rock Slope Collapse)

Total samples: 129

Factor items for FRCDp	Factor categories for FRCDp			
a: Length of survey site: L	L >= 300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L
	10	14	37	68
b: Height of mountain side slope: H	H >= 90 m	90m > H >= 60 m	60m > H >= 30 m	30m > H
	4	25	42	58
c: Gradient of slope: G	G >= 60°	60° > G >= 40°	40° > G >= 20°	20° > G
	70	40	16	3
d: Distance from road to toe of mountainside slope : D	1 m > D	3m >= D > 1m	5m >= D > 3m	D > 5 m
	50	56	22	1
e: Slope shape	Valley type	Straight type	Ridge type	Combined type
	9	30	37	53
f: Dominant vegetation/surface covering	Bare	Grasses	Trees	Surface protection (without vegetation)
	42	54	33	0
g: Dominant Materials of slope surface	Fractured rock	Weathered rock	Soft fresh rock	Hard fresh rock
	49	58	9	13
h: Spring/Surface water	Present	None		
	13	116		
i: Deformation/Collapse	Fall, collapse	Open crack below an overhang	Toppling	
	60	22	19	
	Cross open cracks to cause wedge shape slide		Sliding direction open cracks	
	19		14	

As a result of the analysis, the category score was calculated. To calculate the FRCDp, the category score was applied to the corresponding score for FRCDp indicated in "Sheet 2". Table 5 shows the frequency score for FRCDp.

Table 5 Frequency Score for FRCDp (Rock Slope Collapse)

Factor items for FRCDp	Factor categories for FRCDp			
a: Length of survey site: L	L >= 300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L
	0.195	0.024	0.014	-0.017
b: Height of mountain side slope: H	H >= 90 m	90m > H >= 60 m	60m > H >= 30 m	30m > H
	0.067	0.067	-0.013	-0.013
c: Gradient of slope: G	G >= 60°	60° > G >= 40°	40° > G >= 20°	20° > G
	0.019	0.019	0.019	-0.235
d: Distance from road to toe of mountainside slope : D	1 m > D	3m >= D > 1m	5m >= D > 3m	D > 5 m
	0.029	0.029	-0.058	-0.058
e: Slope shape	Valley type	Straight type	Ridge type	Combined type
	0.018	0.018	0.011	0.011
f: Dominant vegetation/surface covering	Bare	Grasses	Trees	Surface protection (without vegetation)
	0.041	0.041	-0.068	0.000
g: Dominant Materials of slope surface	Fractured rock	Weathered rock	Soft fresh rock	Hard fresh rock
	0.031	0.031	0.031	-0.143
h: Spring/Surface water	Present	None		
	0.250	-0.013		
i: Deformation/Collapse	Fall, collapse	Open crack below an overhang	Toppling	
	0.074	0.044	0.116	
	Cross open cracks to cause wedge shape slide		Sliding direction open cracks	
	0.121		0.077	

The predictive accuracy of the frequency score is checked using multiple correlation coefficient. When a multiple correlation coefficient is “1”, accuracy is the best, and the worst if “0”. The correlation coefficient for “Rock Slope Collapse” was 0.45.

(3) Landslide

Multiple regression analysis with dummy parameter could not be used because the number of samples was only 8. The scatter chart of FRCDa and FRCDp (before analysis) is shown in Figure 2. Based on the chart, when FRCDa is 0.2 or less, FRCDp is overestimated. FRCDp is underestimated when FRCDa is greater than 0.2. Since the FRCDp set as the target for the DIS is 0.1 or higher, it is overestimated at the slope of DIS (FRCDa is 0.1 or less). It is evaluated at a safety side. It is satisfactory to just adopt the present score. Analysis can be undertaken only when sufficient number of samples is collected.

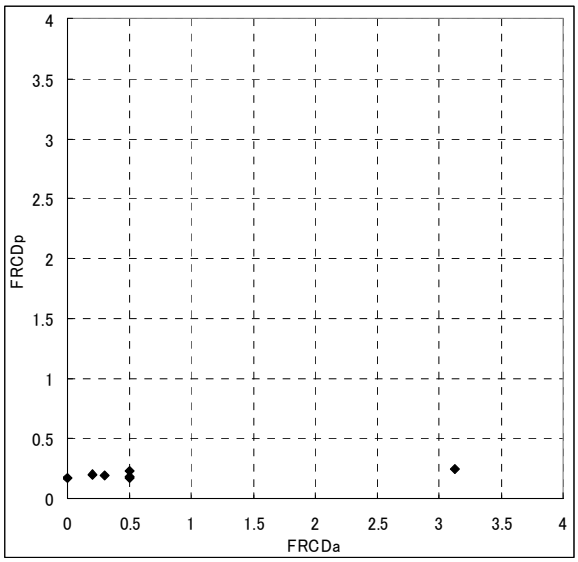


Figure 2 Scatter Plot between FRCDa and FRCDp before Analysis (Landslide)

(4) Road Slip

Table 6 shows the number of samples for analysis. The line hatch means that these categories were integrated because the number of samples was too few or the relevance with FRCDa was small. The relevance between these categories and FRCDa was calculated in the pre-analysis. The pre-analysis is the multiple correlation analysis with dummy parameter before integrating the categories.

Table 6 Number of Samples for Analysis (Road Slip)

Total samples: 326

Factor items for FRCDp	Factor categories for FRCDp			
a: Length of survey section: L	L >= 300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L
	8	17	71	230
b: Height of Valley side slope: H	H >= 90 m	90m > H >= 60 m	60m > H >= 30 m	30m > H
	21	95	114	96
c: Gradient of valley side slope	G >= 60°	60° > G >= 40°	40° > G >= 20°	20° > G
	109	125	64	28
d: Distance from road to head of valley side slope	1 m > D	3m >= D > 1m	5m >= D > 3m	D > 5 m
	36	191	85	14
e: Slope shape	Valley type	Straight type	Ridge type	Combined type
	67	93	4	162
f: Dominant vegetation/surface covering	Bare	Grasses	Trees	Surface protection (without vegetation)
	16	181	126	3
g: Slope type	Embankment slope	Combined or unknown	Natural slope	
	31	180	115	
h: Dominant materials of the slope surface	Silt, Clay	Sand	Gravels, Cobbles, or Boulders	
	281	7	15	
	Fractured rock	Weathered rock	Soft fresh rock	Hard fresh rock
	2	20	0	1
i: Spring/Surface water	Present	None		
	33	293		
j: Rainwater flows from road to valley side slope	Yes	No		
	252	74		
k: Erosion on the slope	Erosion	Piping hole		
	207	0		
l: Deformation/Collapse	Cracks Crevices on road	Depression on road	Fall, Slump in valley side slope	
	39	27	148	

As a result of the analysis, the category score was calculated. To calculate the FRCDp, the category score was applied to the corresponding score for FRCDp indicated in "Sheet 2". Table 7 shows the frequency score for FRCDp.

Table 7 Frequency Score for FRCDp (Road Slip)

Factor items for FRCDp	Factor categories for FRCDp			
a: Length of survey section: L	L >= 300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L
	0.199	0.059	0.022	-0.007
b: Height of valley side slope: H	H >= 90 m	90m > H >= 60 m	60m > H >= 30 m	30m > H
	0.115	0.021	0.004	-0.025
c: Gradient of valley side slope	G >= 60°	60° > G >= 40°	40° > G >= 20°	20° > G
	0.032	0.015	-0.032	-0.032
d: Distance from road to head of valley side slope	1 m > D	3m >= D > 1m	5m >= D > 3m	D > 5 m
	0.048	0.027	-0.045	-0.045
e: Slope shape	Valley type	Straight type	Ridge type	Combined type
	0.029	0.029	0.029	-0.014
f: Dominant vegetation/surface covering	Bare	Grasses	Trees	Surface protection (without vegetation)
	0.104	0.016	-0.014	-0.070
g: Slope type	Embankment slope	Combined or unknown	Natural slope	
	0.102	0.013	-0.026	
h: Dominant materials of the slope surface	Silt, Clay	Sand	Gravels, Cobbles, or Boulders	
	0.015	0.015	-0.036	
	Fractured rock	Weathered rock	Soft fresh rock	Hard fresh rock
	-0.063	-0.063	-0.063	-0.063
i: Spring/Surface water	Present	None		
	0.049	0.003		
j: Rainwater flows from road to valley side slope	Yes	No		
	0.021	-0.038		
k: Erosion on the slope	Erosion	Piping hole		
	0.017	0.017		
l: Deformation/Collapse	Cracks Crevices on road	Depression on road	Fall, Slump in valley side slope	
	0.044	0.046	0.061	

The predictive accuracy of the factor score is checked with a multiple correlation coefficient. When a multiple correlation coefficient is 1, accuracy is best, and worst if "0". The correlation coefficient for "Road Slip" was 0.57.

(5) Debris Flow

Table 8 shows the number of samples for the analysis. The dense hatch means that the category was eliminated in the analysis because the number of sample in the category was "0". The line hatch means that these categories were integrated because the number of samples is too few or the relevance with FRCDa is small. The relevance between these categories and FRCDa was calculated in the pre-analysis. The pre-analysis is the

multiple correlation analysis with dummy parameter before integrating the categories.

Table 8 Number of Samples for Analysis (Debris Flow)

Total samples: 95

Factor items for FRCDp	Factor categories for FRCDp			
a: Width of channel: W	3>=W	5>=W>3	10>=W>5	W>10
	18	19	34	24
b: Area of drainage basin : A	A>=0.5 km2	0.5 km2, >A >=0.15 km2		0.15 km2 > A
	10	22		63
c: Height from channel bottom to road H:	1 m >=H	2 m >=H>1 m	5 m >=H>2 m	H>5m
	42	29	22	2
d: Dominant vegetation of drainage area	Bare	Grasses	Trees	Unknown
	12	36	47	0
e: Dominant materials of river sediment	Cobbles, Boulders	Gravel	Sand, silt, clay	bedrock
	16	9	53	17
f: Slope failure situation in drainage area	More than 5 slope collapses	2-4 slope collapses	1 slope collapse	No slope collapse or Unknown
	5	18	21	51
g: Trace of debris on or beside the road	Present	None		
	38	57		

As a result of the analysis, the category score was calculated. In order to calculate FRCDp, the category score was applied to the corresponding score for FRCDp indicated in “Sheet 2”. Table 9 shows the frequency score for FRCDp.

Table 9 Frequency Score for FRCDp (Debris Flow)

Factor items for FRCDp	Factor categories for FRCDp			
a: Width of channel: W	3>=W	5>=W>3	10>=W>5	W>10
	0.060	0.060	-0.004	-0.004
b: Area of drainage basin : A	A>=0.5 km2	0.5 km2, >A >=0.15 km2		0.15 km2 > A
	0.074	0.074		-0.007
c: Height from channel bottom to road H:	1 m >=H	2 m >=H>1 m	5 m >=H>2 m	H>5m
	0.032	0.032	-0.013	-0.013
d: Dominant vegetation of drainage area	Bare	Grasses	Trees	Unknown
	0.110	0.016	0.001	0.000
e: Dominant materials of river sediment	Cobbles, Boulders	Gravel	Sand, silt, clay	bedrock
	0.141	0.066	-0.012	-0.016
f: Slope failure situation in drainage area	More than 5 slope collapses	2-4 slope collapses	1 slope collapse	No slope collapse or Unknown
	0.358	0.070	-0.015	-0.015
g: Trace of debris on or beside the road	Present	None		
	0.133	-0.054		

The predictive accuracy of the frequency score is checked with a multiple correlation coefficient. When the multiple correlation coefficient is 1, accuracy is best, and it is

worst if “0”. The correlation coefficient for “Debris Flow” was 0.67.

(6) River Erosion

Table 10 shows the number of samples for the analysis. The dense hatch means that the category was eliminated in the analysis because the number of samples in the category was “0”. The line hatch means that these categories were integrated because the number of samples was too few or the relevance with FRCDa was small. The relevance between these categories and FRCDa was calculated in the pre-analysis. The pre-analysis is the multiple correlation analysis with dummy parameter before integrating the categories.

Table 10 Number of Samples for Analysis (River Erosion)

Total samples: 71

Factor items for FRCDp	Factor categories for FRCDp			
a: Length of survey section: L	L >=300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L
	2	6	13	50
b: Distance from low water to road: D	0.5 m > = D	1 m > = D > 0.5 m	2 m > = D > 1 m	D > 2 m
	45	0	1	25
c: Width of river stream at low water discharge : W	W >= 10 m	10 m > W >= 5 m	5 m > W >= 3 m	3 m > W
	32	19	11	9
d: Height from high water to road surface or head of revetment: H	0 m >= H	1 m > H >= 0 m	2 m > H >= 1 m	H >= 2 m
	3	10	11	47
e: Dominant materials of river bank	Cobbles, Boulders	Gravel	Sand	Silt, Clay
	39	9	1	20
	Bedrock	"Artificial structure (without vegetation)"		
	2	0		
f: Dominant materials of river bead	Cobbles, Boulders	Gravel	Sand	Silt, Clay
	47	12	2	9
	Bedrock			
	1			
g: Deformation/Collapse /Erosion	Cracks, Crevices on road	Depression on road	Fall, Slump, Erosion in river side slope	
	2	2	40	

As a result of the analysis, the category score was calculated. To calculate the FRCDp, the category score was applied to the corresponding score for FRCDp indicated in “Sheet 2”. Table 11 shows the frequency score for FRCDp.

Table A5-1.12 Frequency Score for FRCDp (River Erosion)

Factor items for FRCDp	Factor categories for FRCDp			
a: Length of survey section: L	L >=300 m	300m>L>= 200m	200m>L>=100 m	100m>L
	0.141	0.141	0.009	0.009
b: Distance from low water to road: D	0.5m>=D	1m>=D >0.5m	2m>=D >1m	D >2m
	0.057	0.000	-0.034	-0.034
c: Width of river stream at low water discharge : W	W >= 10m	10m>W >=5m	5m>W >=3m	3m>W
	0.045	0.009	0.009	0.000
d: Height from high water to road surface or head of revetment: H	0m>=H	1m>H>=0m	2m>H>=1m	H>=2m
	0.322	0.322	0.013	-0.056
e: Dominant materials of river bank	Cobbles, Boulders	Gravel	Sand	Silt, Clay
	0.051	-0.009	-0.009	-0.009
	Bedrock	"Artificial structure (without vegetation)"		
	-0.009	0.000		
f: Dominant materials of river bead	Cobbles, Boulders	Gravel	Sand	Silt, Clay
	0.043	0.043	-0.069	-0.069
	Bedrock			
	-0.069			
g: Deformation/Collapse /Erosion	Cracks, Crevices on road	Depression on road	Fall, Slump, Erosion in river side slope	
	0.071	0.071	0.071	

The prediction accuracy of the factor score is checked with a multiple correlation coefficient. When a multiple correlation coefficient is 1, accuracy is the best, and it is the worst when it is 0. The correlation coefficient of “River Erosion” is 0.48.

(7) Coastal Erosion

Table 12 shows the number of samples for the analysis. The dense hatch means that the category was eliminated in the analysis because the number of samples in the category was “0”. The line hatch means that these categories were integrated because the number of samples was too few or the relevance with FRCDa was small. The relevance between these categories and FRCDa was calculated in the pre-analysis. The pre-analysis is the multiple correlation analysis with dummy parameter before integrating the categories.

Table A5-1.12 Number of Samples for Analysis (Coastal Erosion)

Total samples: 45

Factor items for FRCDp	Factor categories for FRCDp			
a: Length of survey section: L	L >= 300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L
	5	3	12	25
b: Distance from high water coastal line to road : D	0.5 m > = D	1 m > = D > 0.5 m	2 m > = D > 1 m	D > 2 m
	2	2	32	9
c: Height from high water to road surface or head of revetment: H	0 m >= H	1 m > H >= 0 m	2 m > H >= 1 m	H >= 2 m
	0	39	4	2
d: Dominant materials of coastal bank	Cobbles, Boulders	Gravel	Sand	Silt, Clay
	2	3	17	20
	Bedrock	"Artificial structure (without vegetation)"		
	1	2		
e: Dominant materials of coast	Cobbles, Boulders	Gravel	Sand	Silt, Clay
	3	32	1	1
	Bedrock			
	8			
f: Erosion of coastal side slope	Collapse of revetment	Erosion of revetment foot	Erosion of costal side slope or revetment back fill	
	6	4	25	
g: Deformation/Collapse	Cracks, Crevices on road	Depression on road		
	3	3		

As a result of the analysis, the category score was calculated. In order to calculate FRCDp, the category score was applied to the corresponding score for FRCDp indicated in “Sheet 2”. Table 13 shows the frequency score for FRCDp.

Table 13 Corresponding Score for FRCDp (Coastal Erosion)

Factor items for FRCDp	Factor categories for FRCDp			
a: Length of survey section: L	L >= 300 m	300m > L >= 200 m	200m > L >= 100 m	100m > L
	0.149	0.050	0.050	-0.024
b: Distance from high water coastal line to road : D	0.5 m >= D	1 m >= D > 0.5 m	2 m >= D > 1 m	D > 2 m
	0.027	0.027	0.019	0.019
c: Height from high water to road surface or head of revetment: H	0 m >= H	1 m > H >= 0 m	2 m > H >= 1 m	H >= 2 m
	0.000	0.045	-0.145	-0.145
d: Dominant materials of coastal bank	Cobbles, Boulders	Gravel	Sand	Silt, Clay
	0.053	0.053	0.046	0.004
	Bedrock	"Artificial structure (without vegetation)"		
	0.004	-0.121		
e: Dominant materials of coast	Cobbles, Boulders	Gravel	Sand	Silt, Clay
	0.177	0.012	-0.005	-0.005
	Bedrock			
	-0.005			
f: Erosion of coastal side slope	Collapse of revetment	Erosion of revetment foot	Erosion of costal side slope or revetment back fill	
	0.036	0.031	0.031	
g: Deformation/Collapse	Cracks, Crevices on road	Depression on road		
	0.236	0.160		

The predictive accuracy of the factor score was checked with a multiple correlation coefficient. When a multiple correlation coefficient is 1, accuracy is best, and worst if "0". The correlation coefficient for "Coastal Erosion" was 0.68.

(2) Coefficient of Effectiveness of Countermeasures

The coefficient score of countermeasures is determined based on the PIS data. FRCDbc (FRCD before countermeasure) and FRCDa (FRCD after countermeasure) were obtained if the countermeasure had been constructed in the survey section. The Coefficient of Effectiveness of Countermeasure is computed by dividing FRCDa by FRCDbc (Table 14 – Table 20). In each table, the upper cell shows the countermeasure name, the middle cell, the frequency score, the lower cell the number of samples and "*" shows that the assumed score in "Sheet 2" has not been changed, if the number of samples for the countermeasure is "0". The result is described below.

Table 14 Frequency Scores of Countermeasures (Soil Collapse)

Guard fence	Catch wall	Slope drainage	Shotcrete
0.2*	0.2	0.1	0.2*
0	12	3	0
Retaining wall	Vegetation		
0.1	0.4		
9	5		

Table 15 Frequency Scores of Countermeasures (Rock Slope Collapse)

Guard fence	Catch wall	Shotcrete	Rock shed
0.5*	0.1	0.2	0.01*
0	5	1	0

Table 16 Frequency Scores of Countermeasures (Landslide)

Slope/road drainage	Dewatering method	Cutwork of landslide head	Embankment of landslide toe
0.2	0.2*	0.05*	0.05*
1	0	0	0
Catch wall			
0.5			
1			

Table 17 Frequency Scores of Countermeasures (Road Slip)

Road drainage	Retaining wall
0.05	0.05
14	72

Table 18 Frequency Scores of Countermeasures (Debris Flow)

Small check dam (less than 10m height)	Sabo dam (equal to more than 10m height)
0.05	0.01*
9	0

Table 19 Frequency Scores of Countermeasures (River Erosion)

Revetment	Groin/ spur dike
0.05	0.05
27	2

Table 20 Frequency Scores of Countermeasures (Coastal Erosion)

Revetment without foot foundation	Revetment with foot foundation	Wave absorbing works
0.1	0.05	0.05*
32	1	0

4. Summary

- Analysis of the sample data on important areas was undertaken using multiple regression analysis. Analysis was undertaken for each disaster type except Landslides.

- As a result of the analysis, the score which can be applied was calculated.

- Some important requirements are, however, needed:
  - In RC and RE with especially low multiple correlation coefficient, it is desirable to collect more samples and re-examine each item and category.
  - It is necessary to get accurate PIS data in order to raise factor accuracy. It is therefore desirable for the engineer to have enough experience to investigate and review the data again.

- In the future, re-analysis is desirable when additional survey samples have been collected to raise the evaluation accuracy.

Appendix 4-3 Current Situation of RBIA

1 RBIA' s Concept and Position in BIIPs
2 Basic Elements of RBIA as an Application Software
3 Locational Reference System (LRS)
4 Stored Items in the RBIA Database
5 Data Collection Procedure
6 Procedure for Updating RBIA Data
7 Quality Assurance Procedure
8 RBIA User Interface
9 Utilization of the RBIA at the Regional/District Offices
10. Results of the Questionnaire Survey with Respect to RBIA

A brief description of the RBIA, a database application system of DPWH, is provided in the following sections.

1 RBIA' s Concept and Position in BIIPs

The RBIA is DPWH' s central repository for national road and bridge-related data. RBIA enables network level as opposed to project level analysis.

RBIA' s component code of the Business Improvement Implementation Project (BIIP) is [C02a]. In this section, component code of BIPPs is shown in [ ].

Data collection is part of the component divided into the following sub-systems:

- [C02b] - Road Data Collection; and
- [C02c] - Bridge and Traffic Data Collection.

The output of this data collection activity is also utilized in the other components enumerated below:

- [C01] - Network Planning and Multi-Year Programming;
- [C06] - Routine Maintenance Management System (RMMS); and
- [C07] - Pavement Management System (PMS)/Bridge Management System (BMS).

2 Basic Elements of RBIA as an Application Software

RBIA, as an application software, is composed of the following elements:

a) A core application engine

Confirm TNG - This is a type of off-the-shelf software, which was developed by "Southbank Systems. Ltd" of UK, subsequently acquired in 2004 by MapInfo Co., a famous GIS vendor.

b) Database engine

Sybase - This is one of the better known Relational Database Management System

(RDBMS), which was developed by Sybase Inc. of the U.S.A.

c) GIS engine

ArcGIS - This is the newest version of the GIS product developed by E.S.R.I. Inc. of the U.S.A.

3 Locational Reference System (LRS)

The Locational Reference System (LRS) is a reference system for recording and retrieving location information. It defines the road and bridge network using the following entities:

+ Road Names;
+ Road Sections;
+ Nodes; and
+ Location Reference Points.

A brief explanation for each entity is given below.

a) Road Name

A road has a Road Name (ex. Manila North Road) and a unique Road ID (ex.R00122LZ). A Road ID is of eight (8) characters and consists of:

"R" + 5-digit sequential number within an island + 2-character island code (ex. LZ for Luzon)

b) Road Section

A road is composed of Road Sections, wherein a Road Section has a length and direction characteristic. Direction is usually in a manner of increasing kilometer posts. A Road Section is defined as the road length that goes through without any break or branches and does not cross district boundaries. It is distinguished by a unique ID-Code (ex. S01234LZ), which consists of:

"S" + 5-digit sequential number within an island + 2-character island code (ex. LZ for Luzon)

c) Nodes

Nodes are connectivity elements associated with locations on Road Sections, which express any one of the following:

+ Start or End point of the Road Section.
+ Junction between National Roads.
+ Junction between National Roads and other roads.
+ Administrative boundary on the Road Section.

A Node is distinguished by a unique ID-Code (ex. N01234LZ), which consists of the following:

"N" + 5-digit sequential number within an island + 2-character island code (ex. LZ for Luzon)

d) Locational Reference Point (LRP)

The LRP is a feature on (or adjacent to) the carriageway and its location along the Road Section is known, with usually kilometer posts being used. A location is addressed using 'LRP+Displacement'. Nodes are also referred to as LRPs, for example, referred to as K0085 in the case of kilometer posts.

"K" + 4-digit number on kilometer post.

Note: Kilometer posts must not be moved or unlabeled even if a part of the road alignment is changed in order to keep the LRPs as much as possible in the field.

e) Locational Reference Methods

There are two methods to indicate a location along a Road Section. These are:

+ One is as a distance from the start point of the Road Section.
+ Another is as a reference distance from a LRP (ex. K0025+780 and K0026-220 indicate the same location).

In addition, Cross-Sectional Positions (XSPs) are used in order to indicate the lateral positions (ex. left shoulder, right, etc).

4 Stored Items in the RBIA Database

About 45 road inventory data is stored in the RBIA and grouped into the following "Element Types":

Locational Reference	Points	Median	Guardrails
Junctions	Culverts	Markings	
Place Name	Shoulders	Hazards	
Right of Way	Side Slope	Roadside Friction	
Carriageway Width	Sidewalks	Roadside Structures	
Number of Lanes	Ditches	Horizontal Radius	
Pavement Types	Signs	Vertical Sight	
Pavement Thickness	Lighting	Gradient	
Terrain			

Inventory data are regarded as the attribute of entities from the database viewpoint. As to Road Sections, some attributes (called Road Section Attributes) describe the entire Road Section while others describe certain locations along a Road Section (called Element Attributes).

This is also the case with bridges. Bridge Attributes describe the entire bridge as opposed to Element Attributes, which describe only a part of the bridge.

In the RBIA, the Road Section/Bridge Elements have Start and End Dates. Instead of deleting data from the database, Road Section/Bridge Elements are "End Dated". This enables the user to keep track of changes made even after the Road Section/Bridge Elements are "End Dated".

5 Data Collection Procedure

The data must be used for three primary purposes within the general road management function. They are:

+ as the basis for key performance indicators;
+ as input to PMS/BMS; and
+ assistance with planning of routine maintenance.

As for Road and Bridge Data Survey, the collected data and frequency of its collection are as follows:

+ Visual Condition Surveys (Road)

The data are collected from March to June of each year. After conducting quality audit, data are made available in the RBIA by July or August.

+ Bridge Condition Surveys

(same as above.)

+ Roughness

The data are collected every 1 to 3 years. Only paved roads are surveyed.

+ Video Imaging

The data collection is conducted every 3 years.

6 Procedure for Updating RBIA Data

The data are usually updated by the Regional Offices (ROs) with inputs from the District Engineering Offices (DEOs).

At a DEO,

a. Supervisor submits update together with Activity Sheets of surveys.
b. District Engineer confirms change of conditions.
c. Changes are submitted to the Regional Office using the "Road Inventory Update Sheet".

At the RO,

a. Confirm works.
b. Update data in RBIA.

7 Quality Assurance Procedure

The primary responsibility for the quality assurance of the data is assigned to the Infrastructure Planning Research and Statistics Division (IPRSD). For this purpose, the LRS/GIS Inventory and Data Collection Administration Section is responsible for:

+ agreeing on a quality plan with each survey organizer;
+ ensuring that the DEO or contractor understands their obligations under the plan;
+ ensuring that RO and DEO staffs are trained, and

+ spot-checking any part of the survey or collected data.

The RO is responsible for:

+ coordinating the surveys;
+ verification of data;
+ data entry into RBIA; and
+ training and accrediting DEO staff for the survey.

The DEO and Contractors are responsible for:

+ implementing the Quality Plan; and
+ checking data before submitting to the RO.

8 RBIA User Interface

"Confirm TNS", the central application of RBIA, has abundant functions together with the form-based user interface. Forms are designed to have a consistent look wherever possible in the system.

a. Basic components of the user interface.

The "Main Frame", the main window of "Confirm TNS", implements the Menu Bar, the Frame Bar and the Explorer as user interfaces.

+ Menu Bar contains the various menu options available.
+ Frame Bar works like a toolbar in Windows software to give shortcuts to forms and programs.
+ Explorer contains a tree structure similar to Windows Explorer. For example, Data Queries are done in Explorer.

b. Some common buttons for data manipulation.

In manipulating database records, some common buttons are used.

+ Find: runs a filter when retrieving records.
+ First, Next, Previous, Last: used to navigate amongst the retrieved records.

+ Add: creates a new record.
+ Save, Restore, Delete: performs respective actions against the current record.

c. Report function

For most forms in "Confirm TNS", the "List" button invokes the report function. The resulting report may be printed or exported to a file (ex. Excel format). The report function of RBIA is quite flexible. Users can create not only the usual list-type reports, but also charts such as pie charts or displays of the results of the query on the GIS Map Window. In addition, by using the "Diagram Templates" function, the user can display various types of visual report outputs in a layout designed by the user.

d. Map function

Since GIS software is integrated in RBIA, the user can utilize basic GIS functions. The results from database query can be displayed onto the GIS map.

9 Utilization of the RBIA at the Regional/District Offices

Users in the Central and Regional Offices can access the RBIA via WAN. However, some of the District Offices have no live access to the database server at the Central Office, although they have copies of the database.

In the off-line sites, read-only access to the local database is allowed. The necessary data for updating the local database is periodically sent by the Central Office.

The Study Team has sent survey questionnaires to each Regional/District Office. The completed questionnaires were analyzed to get information on how RBIA is used and how the staff felt about the RBIA in order to develop a user-friendlier database application. Brief explanations of the results are given in the following section.

10. Results of the Questionnaire Survey with Respect to RBIA

The results of the questionnaire survey on the RBIA are reviewed here together with comments from the Study Team. In the survey questionnaire, questions 10.1 to 10.9 relate to the RBIA. As the total number of completed questionnaires from the Regional/District offices was 137 as of 15 October 2006, this was used as the denominator to calculate percentages.

Q10.1 Is RBIA used in your office?

Four possible reply selections were provided. The corresponding number after each reply denotes the number of DPWH responding offices that selected the specific response. Multiple answers were not allowed. These notations were applied to the other questions hereinafter.

	No. of Respondents
a. System is 'Used.'	102
b. 'System is available, but not used.'	10
c. 'System is available in our office'	12
d. 'Not clear'	4
No check	9

Comments were allowed if the respondent so desires to give one (28 comments were given). The figure below shows the distribution of the responses.

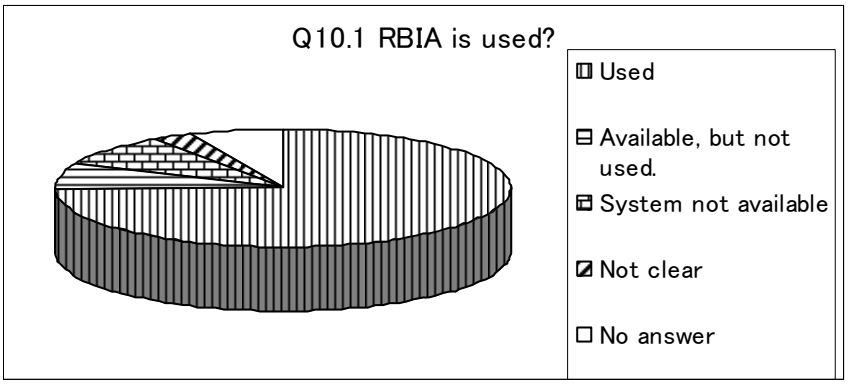


Figure 1 - Answers to Q10.1

There was no intention to limit the users of RBIA to those with direct access to the network and it was therefore expected that all of the users (regardless of whether they had direct access or not) to select 'Used'. Since there might be a misunderstanding in this regard, some off-line users might have selected other answers. It was presumed that the number of such replies would not be significant.

All in all, 74 percent (102 of 137) offices used the RBIA, indicating widespread use. No regional differences or trends were observed.

Comments were given by 28 offices, of which 50% (14 offices) indicated that connection to the

RBIA via the network was not available and was limited access to read-only. While they did not explicitly complain, this indicated that they would like to use the RBIA more actively through a network connection.

Q10.2 How frequent is RBIA used?

The following choices were provided and the number who made each choice is given in the right side. Multiple answers were not allowed.

	No. of Respondents
a. 'More than once a week'	27
b. 'More than once a month'	27
c. 'Two or three times a year'	16
d. 'Not clear'	6
e. 'Others. Please specify.'	30
f. No response	34

The figure below shows the distribution of the responses.

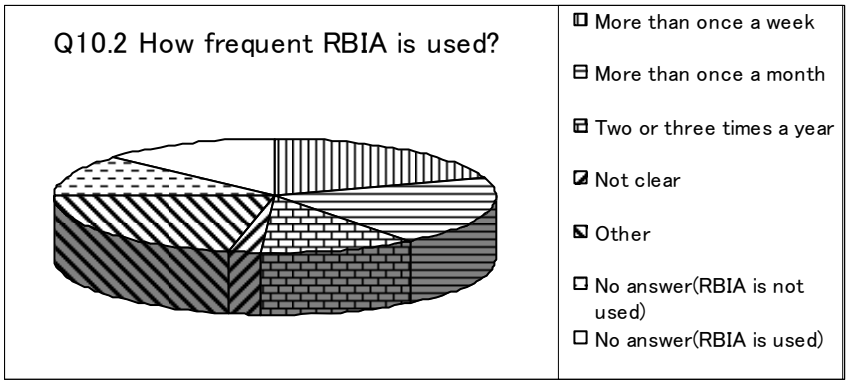


Figure 2 Answers to Q10.2

Of the 34 offices, which gave no answers, 16 selected other choices than 'Used' to Q10.1. In other words, they did not know the frequency of usage since they did not use RBIA. As such reply was expected, the respondents were asked to 'Skip to Q10.5', so that only RBIA users would answer the question. However, a lot of respondents did not follow the directions given.

For the remaining 18 offices, no reason was given why they did not respond to the question. On the other hand, some selected one of the first three choices to the question, although they did not answer that RBIA was used previously. They might actually be using the RBIA. Four offices belonging to Region I selected 'Others' and specified 'always'. In other cases, three

offices in different regions selected 'Others', and specified 'once a year'. The most common answer by 19 offices in 'Others' was 'as needed'. Excluding the 16 offices which do not use the RBIA and gave no answers to Q10.2, about 45% ((27+27)/(137-16)) offices indicated that RBIA is used at least once a month. There were comments such as 'frequently used' or 'almost daily' and three offices mentioned the unavailability of network access to the RBIA.

Q10.3 'What is the main purpose for using the RBIA?'

The following choices were provided and the number who made each choice is given in the right side. Multiple answers were not allowed. The figure shown below shows the distribution of the responses.

	No. of Respondents
a. 'Retrieve/check the inventory survey data of my Region/district'	103
b. 'Retrieve/check the inventory survey data of other Regions/districts'	3
c. 'Not clear'	1
d. 'Others. Please specify.'	4
e. No response	23

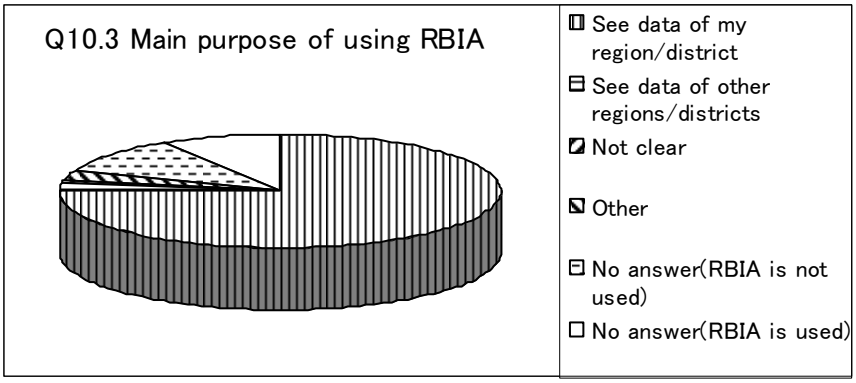


Figure 3 Answers to Q10.3

More than 75% (105 of 137) offices selected the first choice. A number of offices, which answered 'Others' specified 'data update' or 'data storing'. This suggests that they may not have enough time to retrieve and utilize the data for their work.

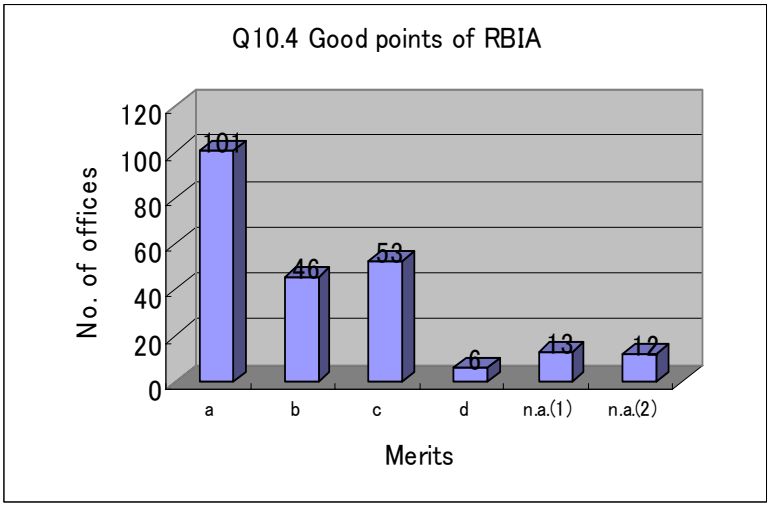
Q10.4 'What are the good points of the RBIA?'

The following choices were provided and the number who made each choice is given in the

right side. Multiple answers were not allowed.

	No. of Respondents
a. 'Required/necessary data is available'	101
b. 'System easy to use'	44
c. 'Many useful functions are provided'	53
d. 'Others. Please specify.'	6
e. No response	25

The number of offices, which made each selection, are displayed in the figure below.



a: Required/necessary data is available
b. System easy to use
c. Many useful functions are provided
e. Other
n.a.(1) No answer (RBIA is not used.)
n.a.(2) No answer (RBIA is used .)

Figure 4 Answers to Q10.4

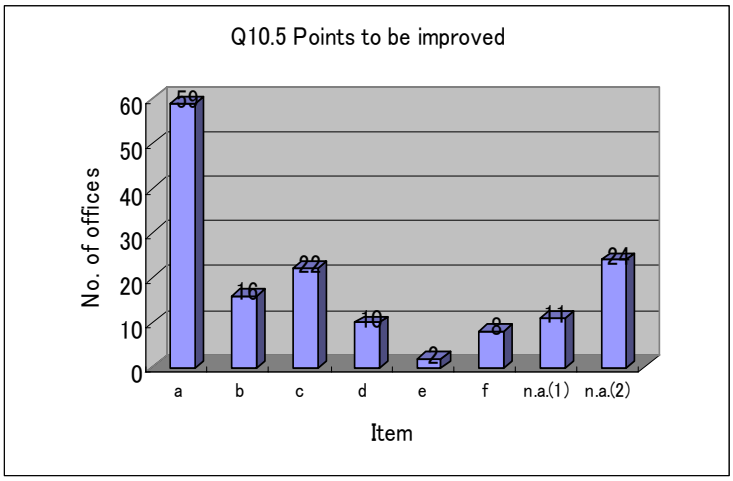
About 74% (101 of 137) offices selected the first choice. On the other hand, only a third (46 of 137) of the offices answered that the RBIA was easy-to-use. This percentage increases for offices in Region V (9 of 12). From the answers to Q10.2, the offices in Region V use the RBIA more frequently than those in other Regions. As they are familiar with RBIA operations, they might feel that it is easy to operate. Three offices commented that they could not access the RBIA via the network, limiting their access to read-only.

Q10.5 'What areas of the RBIA do you think need to be improved? If you do not use RBIA, what are the reasons?'

The following choices were provided and the number who made each choice is given in the right side. Multiple answers were not allowed.

	No. of Respondents
a. 'Everything is satisfactory'	59
b. 'Difficult to use'	16
c. 'Slow response via the network'	22
d. 'Not enough information in the database for my purpose'	10
e. 'Nobody is assigned as RBIA user in my office'	2
f. 'Other. Please specify.'	8
g. No response	35

The number of offices making each choice is shown in the following figure.



a: Everything is satisfactory
b. Difficult to use
c. Slow response via the network
d. Not enough information for my purposes
e. Nobody is assigned as RBIA user
f. Other
n.a.(1) No answer (RBIA is not used.)
n.a.(2) No answer (RBIA is used .)

Figure 5 Answers to Q10.5

A couple of the offices considered the availability of necessary data as the merit of RBIA in the previous question (Q10.4). However, they selected 'Not enough information…' for this question, which seems inconsistent.

The initial impression was that the percentage of offices that answered that everything was satisfactory was fairly high at more than 40% (59 of 137). If we check the answer to this question region by region, the highest percentage of the offices, which answered that everything was "satisfactory" was in Region V (10 of 12 offices). This was against expectations since it was thought that the users would find more weak points to be improved as usage increases. Only 22 offices answered that the response via the network was slow. About 12% (16 of 137) of the offices answered that there was a difficulty in the use of RBIA. Some reasons pointed out by more than one office were as follows:

	No. of Respondents
'No access via network' or its equivalent	5
'Link to video data not available' or its equivalent	2
'Data is not updated' or its equivalent	2

Nine offices checked 'Others' of which 5 commented about having no access via the network and 9 offices of 16 referred to the unavailability of network access.

Q10.6. 'If available, will you use RBIA?'

The following choices were provided and the number who made each choice is given in the right side. Multiple answers were not allowed. The figure shown below shows the distribution of the responses.

	No. of Respondents
a. 'I will definitely use the RBIA'	89
b. 'I would like to try and will use it helps in my work'	9
c. 'No need to use RBIA'	0
d. 'Not clear'	0
f. 'Other. Please specify.'	1
g. No response	38

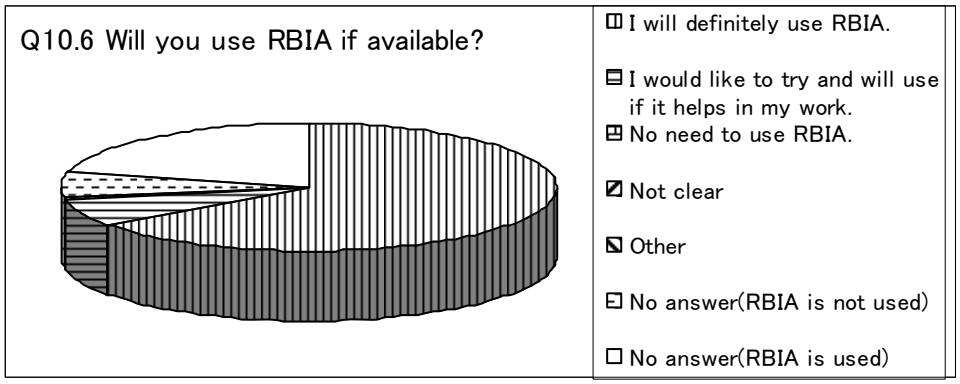


Figure 6 Answers to Q10.6

The target offices of this and succeeding questions are those where RBIA is not used. In each question, there was an instruction to 'Proceed to 10.x' for conditional answers given. If followed, offices where RBIA was used should have skipped Q10.6 and Q10.7. However, most offices where RBIA is used answered these questions.

Thirty-eight offices gave no answers to Q10.7; 29 offices of the 38 answered that they used RBIA in Q10-1. If these 29 offices were ignored, more than 90% (89+9/137-29) of the offices

felt that they use RBIA anyway. None answered that RBIA was not necessary. A high percentage of offices felt that RBIA was necessary whether they used it RBIA or not.

Q10.7 'Do you want to know more about RBIA?'

The following choices were provided and the number who made each choice is given in the right side. Multiple answers were not allowed.

	No. of Respondents
a. 'I would definitely like to know more about RBIA'	77
b. 'I would like to know more time about RBIA given the chance'	19
c. 'Not interested'	0
d. 'Not clear'	0
f. 'Other. Please specify.'	2
g. No response	39

The following figure shows the distribution of the responses.

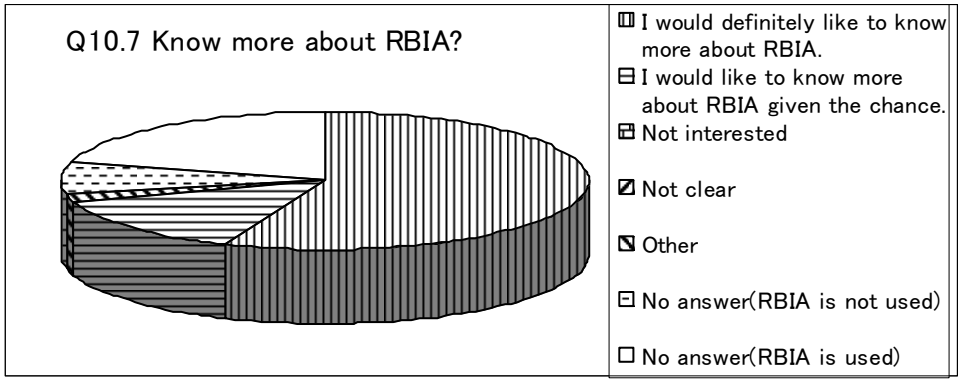


Figure 8 Answers to Q10.7

Thirty-nine offices gave no answers to the question; 28 of the 39 answered that they used RBIA in Q10-1. If we ignore these 28 offices, about 88% (77+19/137-28) of the respondents felt that they would like to know more about the RBIA. There was none that selected 'Not interested'.

Two offices in the same region commented that the information in the RBIA must not be limited to the designated coordinators, but to all of the technical staff. Training for these additional staff members was requested.

Q10.8 'What version of Microsoft Windows is used in the computers in your office on which RBIA is installed and used? If RBIA is not installed in your office, what version

of Microsoft Windows is used in most of the PCs in your office?'

The following choices were provided and the number who made each choice is given in the right side. Multiple answers were not allowed.

	. No. of Respondents
a. 'Windows 98'	13
b. 'Windows ME'	2
c. 'Windows 2000'	60
d. 'Windows XP SP1'	25
f. 'Windows XP SP2'	5
g. No response	32

The following figure shows the distribution of the responses.

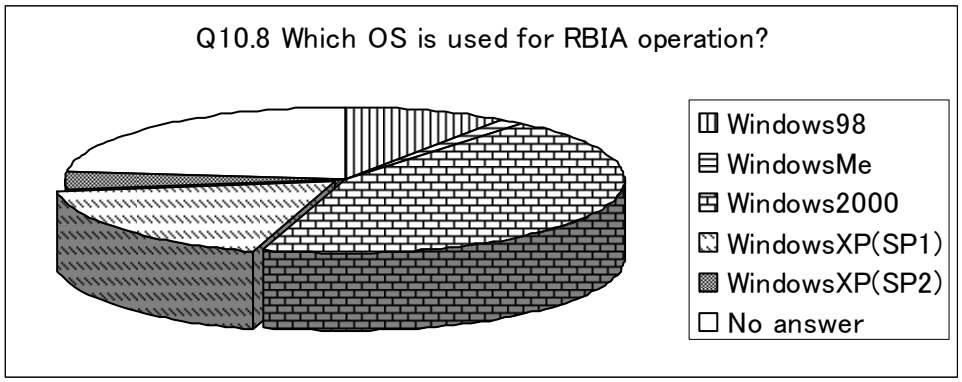


Figure 10 Answers to Q10.8

Four offices checked two OS versions, in which case, the newer OS version was counted. The reason why the Study Team included this question is to determine which OS version would be appropriate when DPWH implements the RSMS database into the RBIA database in the future. The following two aspects should be taken into account:

a) Security via network

If RSMS is utilized via WAN, security is one of the most important items. Microsoft already checks for security breaches and releases OS patches monthly to cope with these security problems. The user can get these patches using the Windows Update function. Such support has ceased for older Window versions such as 98 and ME, and as for Windows XP SP1, support has ceased recently, although there is a way to update for free to Windows XP SP2.

b) Availability of functions of RSMS

There is the possibility that RSMS would be distributed to local DPWH offices with the copy of the database similar to RBIA. As RSMS uses the commercial relational database system software, some of RSMS functions might not operate on the old OS.

The 65% or more (65+25+5/137) of the offices that use Windows 2000 or XP seems good. However, more than 10% (15 of 137) of the offices still use Windows 98 or ME. It is considered that Windows 95 and Windows NT should be included as choices.

Q10-9 'Any comments on RBIA?'

Of the 137 respondents, only 34 gave comments, while 103 did not.

About 25% (34 of 137) of the offices gave comments, the most common of which was that there were no access via network or its equivalent (8 offices); four commented that RBIA was a useful system; 3 complained of insufficient funding or staff; and 3 commented on the need for new PCs to operate the RBIA.

Conclusions to questionnaire answers with regard to RBIA

With the cooperation of a significant number of Regional/District Offices, the study was able to generate important information on how RBIA was used and how the engineers felt about the RBIA, especially its good and weak points.

General trends recognized are summarized below:

1. About 75% of the offices answered that they used RBIA;
2. Although there is a wide range of usage frequency, the purpose for using RBIA in most offices (75%) is to retrieve/check the data for their region/district;
3. The commonly recognized good point is that RBIA has the necessary/required data. As for improvements, more than 40% agreed that everything was satisfactory;
4. No offices answered that they did not need RBIA or that they were not interested in knowing more about RBIA. It is concluded that RBIA's necessity is widely recognized;
5. About 65% of offices use Windows 2000 and later versions. However, if RSMS is used via the network in the future, old OS versions should be updated.

As for comments, a number of offices mentioned that there was no access via the network. Although there might be problems with regard to network response speed and additional licenses, these should be taken into account if the future deployment of RBIA/RSMS is considered.

The summary of the answers to the questionnaire with respect RBIA is shown below.

Two general points are given:

1) The numbers represented by a and b denote the following:

a: the number of offices which sent the completed questionnaires to the Regions.

b: the number of offices in the Region.

For example, Region IV-B (7/9) means that seven of nine offices in Region IV-B answered the questionnaire.

2) The number in each cell denotes the number of offices, which selected the given reply. For example, in the first summary sheet below, we see that six offices in CAR selected "RBIA is used." to Q10.1.

Q10.1 Is RBIA used in your office?

Region	RBIA is used.	System is available, but not used.	System is not available.	Not clear.	No answer	Gave comments
CAR (9/9)	6	0	2	0	1	4
NCR (4/9)	2	1	0	1	0	0
Region I (10/10)	9	0	1	0	0	1
Region II (1/11)	1	0	0	0	0	0
Region III (12/14)	6	0	3	1	2	3
Region IV-A (12/15)	9	0	1	0	2	3
Region IV-B (7/9)	7	0	0	0	0	1
Region V (12/13)	8	2	2	0	0	4
Region VI (14/14)	12	2	0	0	0	1
Region VII (7/13)	3	2	1	1	0	1
Region VIII (8/13)	8	0	0	0	0	0
Region IX (8/8)	5	0	0	0	3	1
Region X (11/12)	7	3	0	0	1	4
Region XI (8/8)	7	0	1	0	0	1
Region XII (6/7)	5	0	0	1	0	2
Region XIII (8/9)	7	0	1	0	0	2
Total (137/174)	102	10	12	4	9	28

Q10.2 'How frequent is RBIA used?'

In the answers below, there are two "No answer", Case1 and Case2. The difference is as follows.

No answer (Case1)- The office did not check any choices. In Q10.1 (RBIA is used?), this office did not select "RBIA is used". In other words, they do not use RBIA.

No answer (Case2)- The office did not check any choices. In Q10.1 (RBIA is used?), this office selected "RBIA is used".

Region	More than once a week.	More than once a month	Two or three times a year	Not clear.	Others	No answer (Case 1)	No answer (Case 2)	Gave comments
CAR (9/9)	2	1	1	0	2	1	2	2
NCR (4/9)	1	1	0	0	1	1	0	0
Region I (10/10)	2	2	1	0	5	0	0	1
Region II (1/11)	0	0	0	0	1	0	0	0
Region III (12/14)	1	3	1	0	1	4	2	1
Region IV-A (12/15)	2	2	0	0	6	1	1	0
Region IV-B (7/9)	2	3	0	0	0	0	2	1
Region V (12/13)	4	2	1	0	1	2	2	2
Region VI (14/14)	5	2	2	0	2	2	1	1
Region VII (7/13)	0	1	2	1	0	3	0	0
Region VIII (8/13)	1	4	2	0	1	0	0	0
Region IX (8/8)	2	1	1	0	1	0	3	0
Region X (11/12)	1	2	1	2	4	0	1	2
Region XI (8/8)	3	0	3	0	1	0	1	2
Region XII (6/7)	0	0	1	0	3	1	1	0
Region XIII (8/9)	1	3	0	0	1	1	2	0
Total (137/174)	27	27	16	3	30	16	18	12

Q10.3 'What is the main purpose for using the RBIA?'

In the answers below, Choice A and Choice B are described below:

Choice A - 'Retrieve/check inventory survey data of my Region/district'

Choice B - 'Retrieve/check inventory survey data of other Regions/districts'

For "No answer", Case1 and Case2, refer to the note in Q10.2

Region	Choice A (See Above)	Choice B (See Above)	Not clear.	Other	No answer (Case 1)	No answer (Case 2)	Gave comments
CAR (9/9)	7	0	0	0	1	1	0
NCR (4/9)	3	0	0	0	1	0	0
Region I (10/10)	9	0	0	0	0	1	0
Region II (1/11)	0	0	0	1	0	0	0
Region III (12/14)	7	0	0	0	3	2	1
Region IV-A (12/15)	10	0	0	0	1	1	0
Region IV-B (7/9)	6	0	0	0	0	1	0
Region V (12/13)	7	1	0	1	2	1	0
Region VI (14/14)	10	0	0	1	2	1	0
Region VII (7/13)	4	0	1	0	2	0	0
Region VIII (8/13)	8	0	0	0	0	0	0
Region IX (8/8)	7	0	0	0	0	1	0
Region X (11/12)	9	2	0	0	0	0	0
Region XI (8/8)	8	0	0	0	0	0	0
Region XII (6/7)	3	0	0	1	1	1	1
Region XIII (8/9)	5	0	0	0	1	2	1
Total (137/174)	103	3	1	4	14	12	3

Q10.4 'What are the good points of RBIA?'

Multiple answers were allowed. As for "No answers", Case1 and Case2, refer to the note in Q10.2

Region	Necessary data available	Easy to use system	Many useful functions.	Other	No answer (Case 1)	No answer (Case 2)	Gave comments
CAR (9/9)	5	4	3	2	1	1	0
NCR (4/9)	2	1	2	0	1	0	0
Region I (10/10)	9	0	2	0	0	1	0
Region II (1/11)	1	0	0	0	0	0	0
Region III (12/14)	7	4	4	0	3	1	1
Region IV-A (12/15)	9	5	5	0	1	1	2
Region IV-B (7/9)	5	3	4	0	0	2	0
Region V (12/13)	9	9	6	0	2	0	0
Region VI (14/14)	9	2	6	0	2	1	1
Region VII (7/13)	6	1	1	0	1	0	1
Region VIII (8/13)	8	2	3	1	0	0	0
Region IX (8/8)	5	3	1	0	0	2	0
Region X (11/12)	10	4	6	1	0	0	2
Region XI (8/8)	8	5	5	0	0	0	1
Region XII (6/7)	4	2	3	1	1	1	1
Region XIII (8/9)	4	1	2	1	1	2	1
Total (137/174)	101	46	53	6	13	12	10

Q10.5 'What areas of the RBIA do you think need to be improved? If you do not use RBIA, what are the reasons?'

Multiple answers were allowed. As for "No answer", Case1 and Case2, refer to the note in Q10.2

Region	Everything is satisfactory	Difficult to use	Slow response via network.	Not enough information	No assigned person	Other	No answer (Case 1)	No answer (Case 2)	Gave comments
CAR (9/9)	2	2	1	1	0	1	1	1	4
NCR (4/9)	1	1	0	2	0	0	0	1	1
Region I (10/10)	4	0	3	3	0	0	0	2	3
Region II (1/11)	0	0	1	0	0	0	0	0	0
Region III (12/14)	3	3	0	0	0	0	0	3	0
Region IV-A (12/15)	6	1	3	0	0	0	0	1	1
Region IV-B (7/9)	2	1	1	1	0	0	0	3	0
Region V (12/13)	10	0	0	0	0	0	0	0	2
Region VI (14/14)	6	1	2	0	1	2	2	2	0
Region VII (7/13)	2	2	0	1	0	1	1	0	0
Region VIII (8/13)	6	0	3	1	0	1	1	0	0
Region IX (8/8)	2	2	1	0	0	0	0	3	0
Region X (11/12)	4	3	3	1	0	2	2	3	1
Region XI (8/8)	6	0	2	0	0	0	0	0	1
Region XII (6/7)	1	0	2	0	0	1	1	2	2
Region XIII (8/9)	4	0	0	0	1	0	0	3	1
Total (137/174)	59	16	22	10	2	8	11	24	16

Q10.6 'If available, will you use RBIA?'

As for "No answer", Case1 and Case2, refer to the note in Q10.2

Region	I will definitely use RBIA	I try and will use if it helps in my work	No need to use RBIA.	Not clear	Other	No answer (Case 1)	No answer (Case 2)	Gave comments
CAR (9/9)	7	1	0	0	0	1	0	0
NCR (4/9)	3	1	0	0	0	0	0	0
Region I (10/10)	8	0	0	0	0	0	2	0
Region II (1/11)	1	0	0	0	0	0	0	0
Region III (12/14)	0	0	0	0	0	6	6	0
Region IV-A (12/15)	7	1	0	0	0	1	3	0
Region IV-B (7/9)	2	1	0	0	0	0	4	0
Region V (12/13)	11	0	0	0	0	0	1	1
Region VI (14/14)	9	2	0	0	0	0	3	1
Region VII (7/13)	6	0	0	0	0	0	1	0
Region VIII (8/13)	6	0	0	0	0	0	2	0
Region IX (8/8)	7	0	0	0	0	0	1	0
Region X (11/12)	7	0	0	0	0	0	4	0
Region XI (8/8)	5	3	0	0	0	0	0	0
Region XII (6/7)	3	0	0	0	1	1	1	2
Region XIII (8/9)	7	0	0	0	0	0	1	0
Total (137/174)	89	9	0	0	1	9	29	4

Q10.7 'Do you want to know more about RBIA?'

As for "No answer", Case1 and Case2, refer to the note in Q10.2

Region	I will definitely like to know more about RBIA	I would like to know more about RBIA given chance	Not interested	Not clear	Other	No answer (Case 1)	No answer (Case 2)	Gave comments
CAR (9/9)	6	1	0	0	1	1	0	3
NCR (4/9)	3	0	0	0	0	1	0	0
Region I (10/10)	7	1	0	0	0	0	2	0
Region II (1/11)	0	0	0	0	0	0	1	0
Region III (12/14)	0	0	0	0	0	6	6	0
Region IV-A (12/15)	7	1	0	0	0	1	3	0
Region IV-B (7/9)	2	1	0	0	0	0	4	0
Region V (12/13)	10	0	0	0	1	0	1	1
Region VI (14/14)	8	4	0	0	0	0	2	0
Region VII (7/13)	5	0	0	0	0	1	1	0
Region VIII (8/13)	3	3	0	0	0	0	2	1
Region IX (8/8)	7	0	0	0	0	0	1	0
Region X (11/12)	8	0	0	0	0	0	3	0
Region XI (8/8)	4	4	0	0	0	0	0	0
Region XII (6/7)	2	2	0	0	0	1	1	0
Region XIII (8/9)	5	2	0	0	0	0	1	0
Total (137/174)	77	19	0	0	2	11	28	3

Q10.8 'What version of Microsoft Windows is used in the computers in your office on which RBIA is installed and used? If RBIA is not installed in your office, what version of Microsoft Windows is used in most of the PCs in your office?'

Region	Windows 98	Windows ME	Windows 2000	Windows XP (SP1)	Windows XP (SP2)	No answer	Gave comments
CAR (9/9)	2	2	2	3	0	0	2
NCR (4/9)	0	0	1	2	0	1	0
Region I (10/10)	3	0	5	0	0	2	0
Region II (1/11)	0	0	1	0	0	0	0
Region III (12/14)	0	0	0	0	0	12	0
Region IV-A (12/15)	1	0	9	1	0	1	0
Region IV-B (7/9)	0	0	2	0	1	4	0
Region V (12/13)	0	0	7	4	0	1	0
Region VI (14/14)	3	0	5	4	1	1	0
Region VII (7/13)	1	0	5	1	0	0	0
Region VIII (8/13)	1	0	4	1	1	1	0
Region IX (8/8)	1	0	3	0	0	4	0
Region X (11/12)	1	0	1	6	2	1	0
Region XI (8/8)	0	0	7	1	0	0	0
Region XII (6/7)	0	0	3	0	0	3	0
Region XIII (8/9)	0	0	5	2	0	1	0
Total (137/174)	13	2	60	25	5	32	2

Appendix 5 Result of Pilot Inventory Survey

Appendix 6-1 Procedure of Feasibility Study

A6-1.1 Engineering Geological Investigation

(1) General Concept to Decide Method of Engineering Geological Investigation

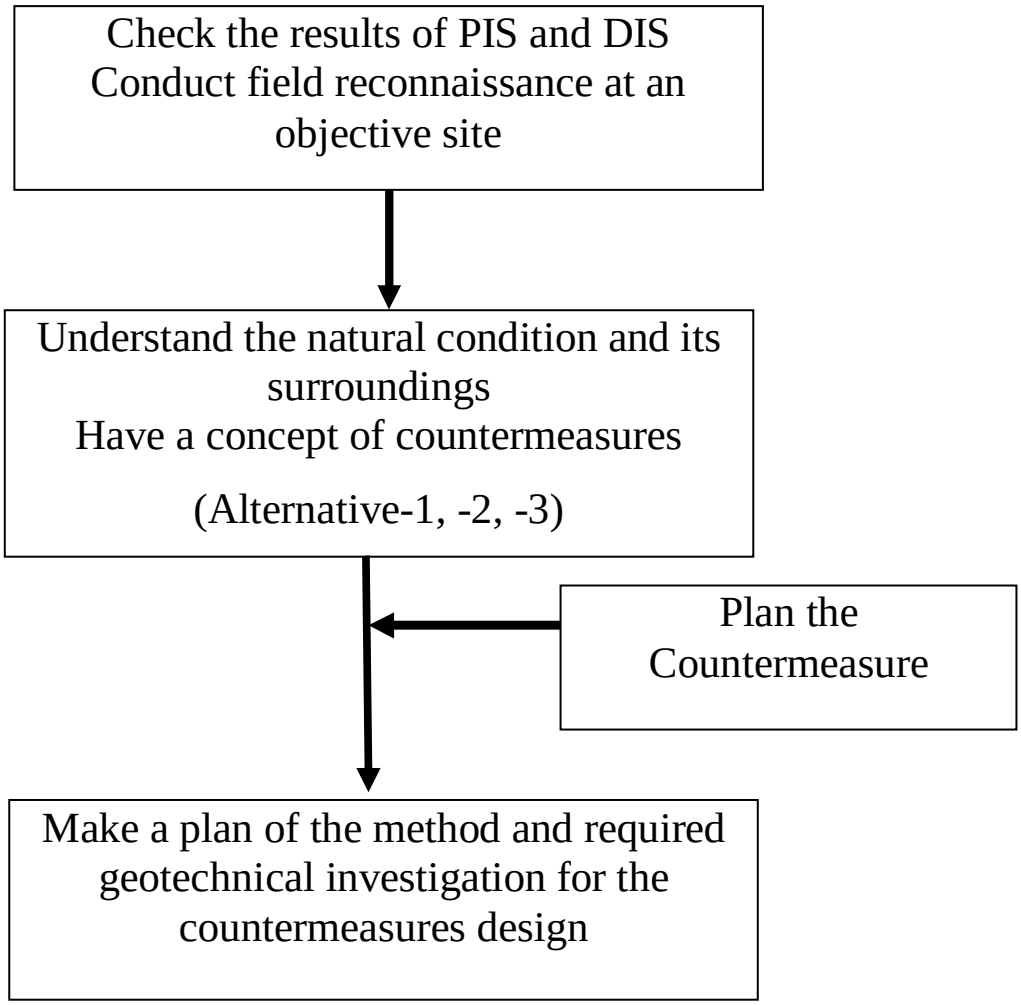


Figure A6-1.1 General Concept to Decide Contents of Engineering Geological Investigation

(2) Prioritization Matrix Based on Disaster Type and Methods of Engineering Geological Investigation as a Guide

Table A6-1.1 Prioritization Matrix Based on Disaster Type and Contents of Engineering Geological Investigation as a Guide

Contents of Geotechnical Investigation \ Disaster Type		SC Soil Slope Collapse	RC Rock Slope Collapse	LS Landslide	RS Road Slip	DF Debris Flow	RE River Erosion	CE Coastal Erosion
1. Aerial Photograph Interpretation		○	○	◎	○	◎	○	○
2. Topography Surveying (plan and cross section)		◎	◎	◎	◎	◎	◎	◎
3. Field Reconnaissance		◎	◎	◎	◎	◎	◎	◎
4. Investigation of Geological Structure	Boring and SPT	○	○	◎	◎	○	◎	◎
	Sounding	◎	△	○	○	◎	○	○
5. Groundwater Level Monitoring		◎	○	◎	◎	○	○	○
6. Groundwater Investigation		○	△	◎	○	△	△	△
7. Investigation of Slip Surface		○	△	◎	○	△	△	△
8. Investigation of Surface Deformation		○	○	◎	◎	◎	○	○
9. Geophysical Exploration		○	○	◎	○	○	○	○

◎: High priority
○: Moderate priority
△: Supplemental (low priority)

(3) Items of Engineering Geological Investigation

(a) Aerial Photograph Interpretation

- To know natural conditions of a site and its surroundings, such as topography features, geomorphological features, geological structure, extraction of unstable area due to natural disaster, etc.
- To make the geotechnical investigation plan

(b) Topographic Survey (plan and cross section)

- To determine topographic conditions
- To see actual phenomenon at the site, such as location of crack, deformation, settlement, groundwater seepage, size of the phenomenon, etc.
- To locate existing facility locations, such as road, buildings, lifelines, properties, etc.
- To mark the investigation locations at the site
- To be used during the field reconnaissance and make the engineering geology map and cross section as the results
- To set up movable stakes as preparation for the investigation of surface deformation.
- To be used for the countermeasure's design

(c) Field Reconnaissance

- To see the actual phenomenon at the site and plat observation on the plan (topography map) and the result is an engineering geology map and cross section
- To determine the mechanism and causes of the disaster

(d) Investigation of Geological Structure

1) Boring

- To know the underlying geological strata
- To determine the groundwater level

- For use in the conduct of in-situ test, installation of groundwater observation well, setting up of instruments for the investigation of slip surface, etc.

2) SPT (Standard Penetration Test)

- To determine the soil/rock characteristics (stiffness, geotechnical properties, etc) and the thickness

3) Sounding (Portable cone penetration test, Dutch cone penetration test, Dynamic cone penetration test, Vane shear test, Swedish weight sounding, etc.)

- To determine the soil/rock characteristics (stiffness, geotechnical properties, etc.) and the thickness

4) Groundwater Level Monitoring

- To get the relationship between rainfall and groundwater level
- To get relationship between groundwater level and displaced material
- To make plan for groundwater control works (countermeasures)
- To come up with control/management criteria for disaster mitigation

(e) Groundwater Investigation

- To come up with a plan on groundwater control works (countermeasures)

1) In-situ Permeability Test

- To determine the coefficient of permeability of each soil/rock layer

2) Groundwater Logging

- To determine the distribution of groundwater channel in the landslide mass (layer)

3) Groundwater Tracing Test

- To trace planar distribution of groundwater channel in the landslide mass (layer)

(f) Investigation of Slip Surface

- To know the depth of the active slip surface
- To determine the speed and direction of movement
- To get the relationship between groundwater level and displace material
- To come up with a control/management criteria for disaster mitigation
- To plan for countermeasures

1) Inclinometer

2) Pipe Strain Gauge

(g) Investigation of Surface Deformation

- To determine the size, activity level and movement direction of a subject phenomena. To get the relationship between groundwater level and volume of displaced/moved materials
- To come up with a control/management criteria for disaster mitigation
- To plan for countermeasures

1) Simple Deformation Detection by Board

2) Extensometer

3) Ground Tiltmeter

4) Movable Stakes

5) GPS (Global Positioning System)

(h) Geophysical Exploration

- To know the state/conditions of a subject phenomena in wide area

(4) Example of Technical Specification

(a) Topographic Surveying

Topographic surveying is carried out to come up with following:

- Planimetric/contour map showing the boring and in-situ test sites (S=1:500, S=1:5,000) by dxf format with Digital Elevation Model (DEM) (2 m grid), and
- Cross section (S=1:500) by dxf format.

1) Scale and Accuracy

- Scale of the topography/contour maps and the cross sections is 1:500.
- Contour line interval is 2 m.
- The standard deviation of the horizontal position of all features shall be within 0.01 m on the topography maps and the cross sections.
- The standard deviation of spot heights shall be within 1/3 of the contour interval (2 m).
- The standard deviation of the heights of contours shall be within 1/2 of the contour interval (2 m).
- Accuracy of the cross section is within 1 cm.

2) Required Instruments

The Contractor shall be required to obtain the authorization of the survey instruments from the JICA Study Team.

A Total Station Instrument (TSI) will be set up in the first station. When there are some areas where a target prism is difficult to position, a prism-less Electronic Distance Measuring device (EDM) shall be used.

It is expected that the following instruments are required for the topographic surveying.

(1) Total Station Instrument

(2) Prism-less EDM

(3) Theodolite

(4) Measuring tape and marking pins

(5) Leveling Rods

(6) GPS

(7) Tripods

(8) Stakes, paints

3) Field Topographic Survey

a) Reconnaissance Survey and Coordination

As an initial activity and to explore the site conditions as well as to ensure the safety of personnel and equipment, a brief reconnaissance survey in each site shall be undertaken. In the field reconnaissance, the control station of the Bureau of Coast and Geodetic Survey (BCGS) shall be determined, or candidates of the suitable location for the temporary benchmarks to use as the horizontal and vertical controls shall be selected by the Contractor, and reported to the JICA Study Team. The Contractor shall make efforts to obtain coordination with the local officials of the nearest barangay.

b) Establishment of Temporary Horizontal and Vertical Control

In areas where a BCGS control station is not available, temporary horizontal and vertical controls shall be established using a GPS instrument. The control point, established in a permanent structure (bridge, road, etc.), shall be marked for use throughout the Study in the site.

When three or more horizontal and vertical controls are required according to the site area, all the points shall be surveyed to loop to a closed traverse in order to determine the allowable error.

c) Field Survey

The field survey for the topography/contour maps and the cross sections is carried out in order to obtain topographic features, deformation conditions on the slope/road and land use. The survey shall be carried out in the following manner:

i) Temporary Bench Mark

The Contractor shall provide temporary bench marks at the appropriate location.

ii) Measurement Method

The mapping of topographic detail shall be measured with a grid interval of approximately 20 m (at least) by using trigonometric method or equivalent.

iii) Investigation of Land Use

Important features of land use such as houses, river/stream, schools, church, public hydrants, office buildings, road, infrastructure/lifeline, and any item instructed by the JICA Study Team (e.g. location of the engineering geological investigation) shall be investigated and described in topographic maps and the cross sections.

iv) Data Items

The data items of the points shall have three-dimensional coordinate values (X, Y for the planimetric location, and Z value for the altitude).

5) Stakes Setting

Stakes (20 cm high) shall be set up at 2 m intervals on the cross section lines and locations of the geotechnical investigation (boring points and dynamic cone penetration test).

d) Processing for the Topographic Map, DEM and Cross Section

The data collected in the memory of the total station instrument shall be down-loaded to a computer in order to make the topographic/contour maps, DEM, and cross sections.

e) Outputs of Topographic Surveying

The following outputs of the topographic surveying shall be submitted to the JICA Study Team by three (3) sets of hard copy and digital files stored in CD-ROM.

i) Raw data (coordinate table: X, Y, Z) of the topographic surveying

ii) Check/validation sheet for accuracy of the topographic surveying

iii) Topographic/contour map (S=1:500, S=1:5,000) (dxf format)

iv) DEM (2 m grid)

v) Cross section (S=1:500) (dxf format)

Location of the geotechnical investigation (boring and dynamic cone penetration test) shall be indicated by setting the stakes at the site and be shown in the topographic/contour maps and cross sections.

(b) Boring, In-situ Test and Monitoring

Activities in boring, in-situ test and monitoring include the following:

(1) Boring

(2) Standard Penetration Test (SPT)

(3) In-situ Permeability Test

(4) Groundwater Logging

(5) Sounding of Soil Depth and Strength

(6) Installation of perforated Pipe and Groundwater Monitoring

(7) Installation of Pipe Strain Gauge and Monitoring

(8) Set-up of Movable Stake and Monitoring

1) Boring (66 mm in diameter)

The purposes of boring are as follows:

To determine geological condition/stratum at the subject slope;

To obtain the depth of slip surface/unstable zone/cavities due to erosion;

To determine the characteristics/strength of soil/rock in unstable zone and in stable zone;

To provide a hole to carry out the standard penetration test;

To install perforated pipe; and

To determine groundwater level.

a) Transportation of Boring Machine and Preparation

The Contractor shall provide all transportation required for the boring operation including the platform and water supply facilities.

b) Equipments and Safety Goods

The Contractor shall provide all equipment and materials necessary for the boring works.

The Contractor shall have full responsibility for the maintenance of equipment. The Contractor shall check/prepare the stock of parts and consumables in advance.

- Main spare parts of boring machines and pumps;
- Bits, core barrels, rods;
- Water; and
- Fuel, oil, grease.

The Contractor shall provide safety helmets (hard-hat), gloves, shoes, long-sleeved shirts, and long pants to ensure the safety of site engineers and workers.

2) Site Engineer and Worker Assignments

The Contractor shall determine the assignments of required engineers and workers for the boring works taking into consideration the following conditions:

One (1) site engineer shall be assigned to every machine as a responsible / contact person in order to manage / control the related boring work and compile the data at the site; and

At least two (2) workers, specifically a machine operator (chief) and an assistant for pump operation and maintenance of water supply facilities, shall be stationed at each boring point.

(2) Mobilization and Demobilization of Boring Machine

The boring location shall be instructed by the Client. If the indicated location is unsuitable for the boring work, it shall be changed subject to the approval by the Client.

The Contractor shall survey the coordinate and elevation of each boring point and dynamic cone penetration test by the above mentioned topographic survey.

In order to perform the boring work stipulated in the specification safely and successfully, the Contractor shall conduct the complete mobilization including the preparation of the equipment, materials, and source of electricity, water and passes for access.

The Contractor shall obtain the permission of the authorities and/or persons concerned to enter the site and perform the boring work, and the Contractor shall make reasonable compensation for disadvantages caused by the boring work. After the approval of the land owner, demobilization (shifting) shall be done immediately.

All accommodations and other expenses (per diem, coordination fee, etc) shall be borne by the Contractor.

Before commencement of the boring work, the Contractor shall investigate about the existence or nonexistence of any buried utilities such as a water supply pipeline, electricity cable, telecommunication cable and so on.

In case of necessity, the Contractor makes a test pit to confirm the buried utilities to avoid any damage.

c) All Core Boring and Non-Core Boring

At first, the all core boring shall be carried out in order to determine the geological conditions at the site. After completion of the all core boring, non-core boring shall be carried out at one (1) meter beside the core boring point in order to carry out the standard penetration test and to install the perforated pipe.

Diameter of the core and non-core boring shall be more than 66 mm.

i) Core Recovery

The core boring shall aim at 100% core recovery in reference to BS 5930 (Section 3), ASTM D 1452 and ASTM D 2113. Core recovery shall be more than 90%, except for the cavities.

ii) Core Sampling and Storing in Core Box

Core samples shall be stored in core boxes as shown in Figure 1. A core box shall be divided into five rows, each one meter in length, and the depth of corresponding core samples shall be described in the box. Each run of core samples shall be separated with a divider. In case that a cavity is encountered in a hole, a bar shall be inserted at the corresponding section in the core box. The boring number and depth of core samples stored in a box shall be clearly written on the side of the core box. The Contractor shall deliver all core boxes to a stockyard designated by the JICA Study Team.

Figure 1 Core Samples in Core Box

iii) Groundwater Level

Groundwater level in boreholes shall be measured and recorded two (2) times in a day, before commencement and after completion of the boring work. This measurement shall be continued during the field work period.

When outstanding loss of boring water or spring-up of groundwater is encountered, its depth shall be recorded accurately.

iv) Daily Boring Report

Dairy boring report of the boring work shall be prepared, and submitted to the relevant District Engineering Office (DEO) and JICA Study Team when it is requested. The daily boring report shall contain the required information as follows:

Boring hours;

Nature of soil/rock in the borehole;

Used bits (diamond or metal);

Used water (L/ min);

Returned water from borehole mouth (L/ min); and

Specific information when proceeding to drill (cavity, color of returned water, water lost, etc.)

v) Photograph

The Contractor shall take the following photos by digital camera.

Before and after the boring work;

Mobilization/Demobilization;

Test pit (if conducted);

Whole view of the borehole;

All core boring/non-core boring;

Core sample stored in core box.;

In-situ test; and

Any setting/installation work.

vi) Data Compilation

After completion of the boring work, the Contractor shall compile every result of the boring (soil stratum with distribution depth, geological characteristics, groundwater level, etc.) into the boring log.

2) Standard Penetration Test

The standard penetration test shall be carried out in accordance with ASTM D 1586 and by one (1) meter interval in depth in the non-core boring hole (Figure 2).

The purpose of the test is to know softness/stiffness of soil/weathered rock which is obtained by N-value.

The standard penetration test shall be carried out using the split spoon sampler (Figure 4) and drive hammer at the non-core boring hole. In advance of each test, mud slime and sediment on the bottom of the hole shall be removed. The sampler shoe with broken or worn edge shall not be allowed for use.

The Contractor shall take the photos of the state of the test by digital camera.

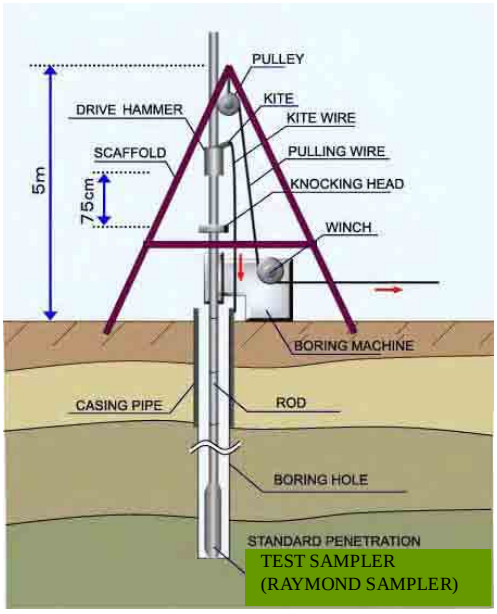


Figure 2 Schematic Diagram of Standard Penetration Test

The procedure of the standard penetration test (Figure 3) is as follows;

a) Boring work shall be stopped at desired depth and remove slime at the bottom of borehole;

b) Split spoon sampler (Figure 4) is connected to boring rod and down to the bottom;

c) Knocking head and drive hammer is set up on the boring rod (Figure 2);

d) Mark the rod in successive each five (5) cm increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 5 cm;

e) Pulling up the drive hammer at the height of seventy-five (75) cm from the knocking head and fall down to the head;

f) When the rod advances fifteen (15) cm from the beginning, the length of advance per each knocking shall be recorded;

g) When the rod advances forty five (45) cm from the beginning, recording shall be completed;

h) When the rod advances fifty (50) cm from the beginning or fifty (50) times of hammer blows have passed, the test shall be finished;

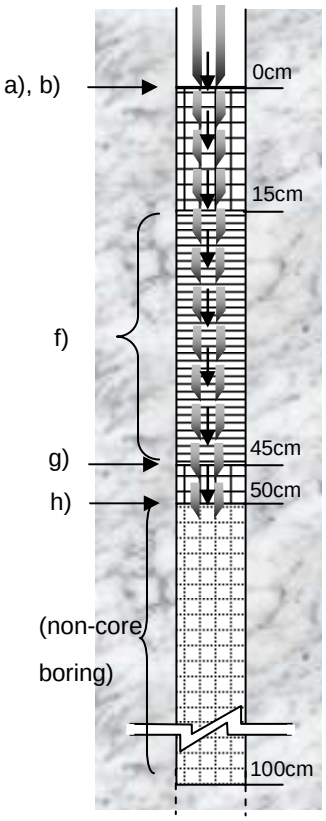
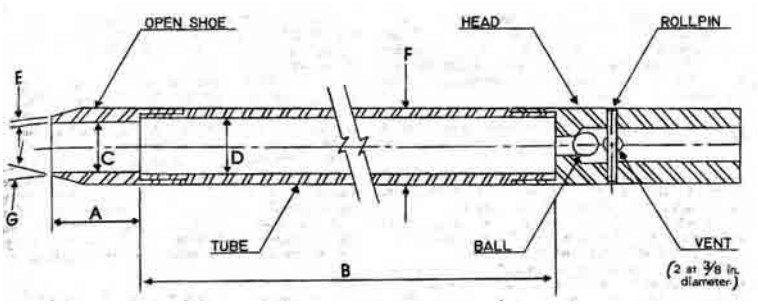


Figure 3 Schematic Diagram for SPT Process in Borehole

i) Bring the sampler to the surface and open and observe the sample;

j) Put the sample into plastic bag at each depth and write the boring number and depth on the surface of bag, and submit to the JICA Study Team; and

k) Compile the results (N value) into the boring log.



Part	A	B	C	D	E	F	G (degree)
Length (mm)	50	860	35	35	0	51	$19^{o}47'$

Figure 4 Detail Design of Split Spoon Sampler for SPT.

3) In-situ Permeability Test

In-situ permeability test in unconsolidated deposits and highly weathered (poorly consolidated) rocks shall be carried out in certain holes specified or indicated by the JICA Study Team.

The method of test shall use the constant head or falling/rising head test in accordance with the characteristics of the formation to be tested. The detailed method of test and analysis shall be proposed by the Contractor and approved by the JICA Study Team prior to the execution.

The test shall be carried out at least one (1) time in each geological layer at the selected hole by the JICA Study Team.

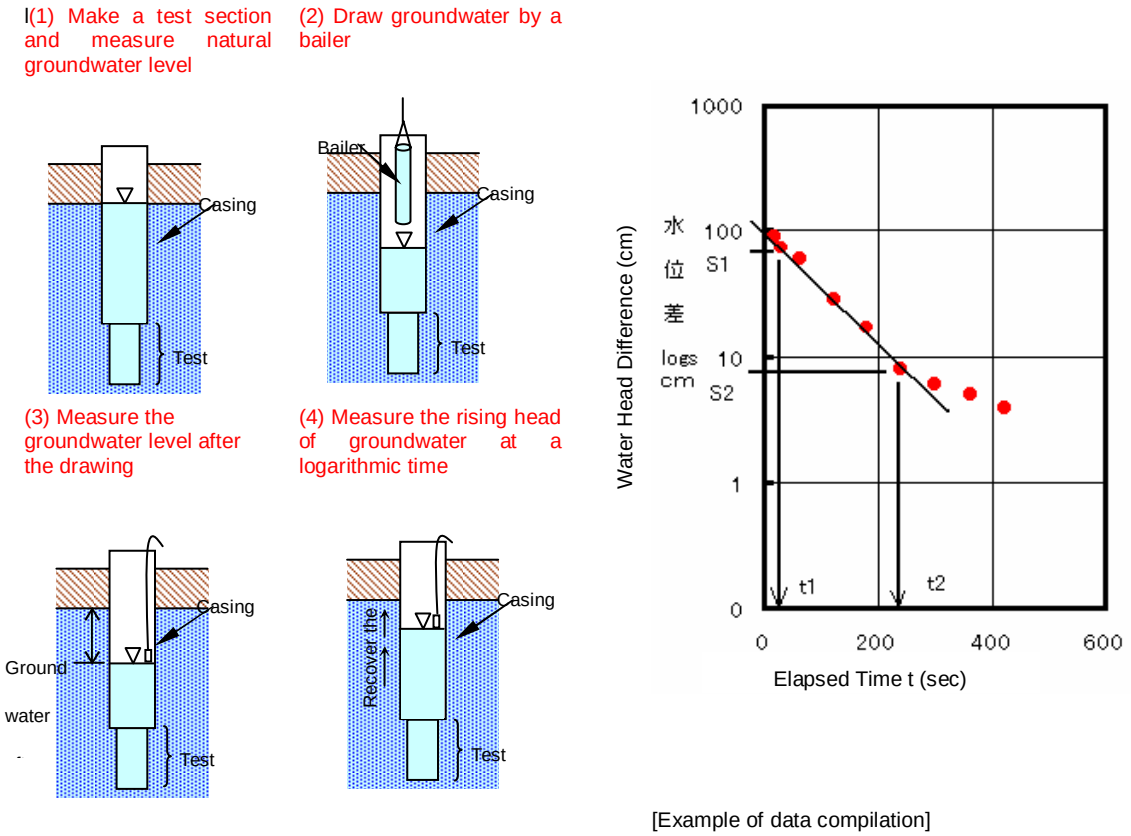


Figure 5 Schematic Diagram of the In-situ Permeability Test (Rising Head Test)

4) Groundwater Logging

Groundwater logging in borehole shall be carried out in the landslide area in order to obtain groundwater flowing portion by measurements of lowering specific depth by electric specific resistance of borehole water following the passage of time after injecting a salt solution into the borehole.

The Contractor shall measure the specific electric resistance in each 50 cm of borehole depth in 10, 30, 60, 120 and 180 minutes, after putting and mixing the salt solution in the borehole.

The Contractor shall prepare the groundwater logging equipment (electric specific resistance meter which can measure 35 meter depth in the borehole).

Boreholes to carry out the groundwater logging are directed by the JICA Study Team.

The Contractor shall prepare the recording measurement results/chart along with the boring logs shown in the Figure 6.

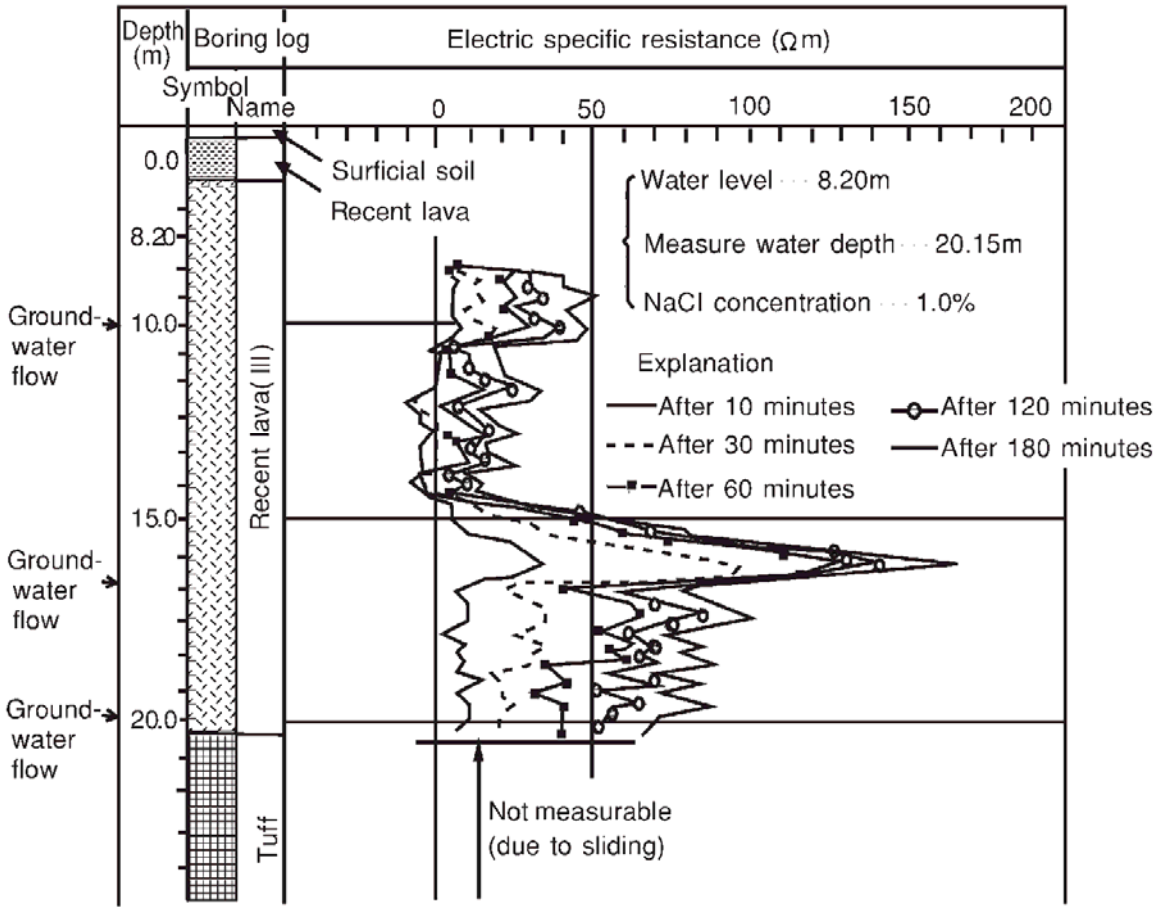


Figure 6 Example of Groundwater Logging

5) Sounding of Soil Depth and Strength

The results of sounding indicate the depth and strength of the soil of about 3 m or less.

Equipment shall be a steel stick with adhered corn or vane. The Contractor proposes and the JICA Study Team approves the equipment, sounding method and estimation method for determining soil strength.

[Example: Portable Cone Penetration Test (Figure 7)]

The weight of required equipment is around 10 to 15 kg (see figure on the right). It is not heavy and portable.

The results correspond with N value of standard penetration test

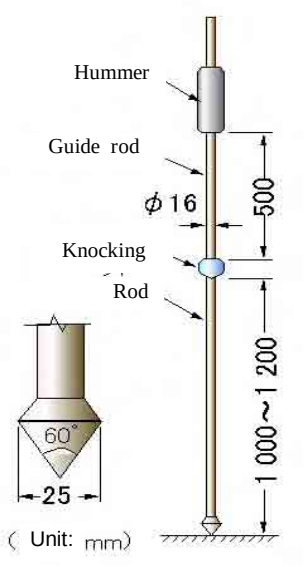


Figure 7 Schematic Diagram of Portable Cone Penetration Test

6) Installation of Perforated Pipe (45 - 50 mm in diameter) and Groundwater Monitoring

a) Installation of Perforated Pipe

Details of perforated pipe for measuring groundwater level installed in the non-core boring hole are shown in Figure 8. The materials of perforated pipes are provided by the Contractor. The pipe is wrapped by filtering materials to prevent clogging.

Gravel or coarse sand is filled into a gap between the borehole and pipes. The Contractor shall take the photos of state of the installation by digital camera.

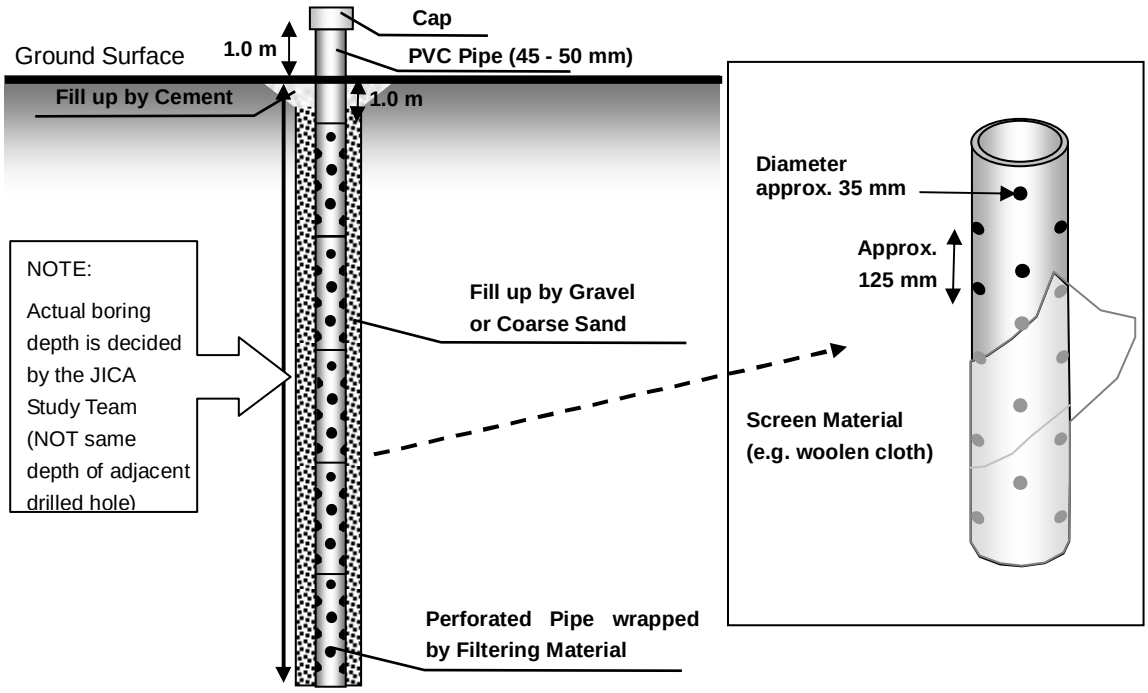


Figure 8 Schematic Diagram of Perforated Pipe

b) Groundwater Monitoring

i) Procedure

After installation of the perforated pipe, the groundwater monitoring shall be carried out five (5) times per one (1) monitoring pipe.

Groundwater level shall be measured with battery-operated electrical indicator. This technique relies on the conductivity of the groundwater to complete a circuit. The Contractor shall take the photos on the state of the monitoring by digital camera.

ii) Outputs of Groundwater Monitoring

The following outputs of the groundwater monitoring shall be submitted to the JICA Study Team to be included in the Final Report.

Raw data of the groundwater level; and

Graph and table of the groundwater level with rainfall data compiled by Excel.

7) Installation of Pipe Strain Gauge and Monitoring

a) Installation of Pipe Strain Gauge

Figure 9 shows the structure of the pipe strain gauge. The materials of pipe strain gauge are provided by the Contractor. The strain gauge shall be set one (1) m in depth with water proof protection.

The installation shall be made with care so as not to damage the waterproof portion of gauge and the lead wire. Measures such as double coating of lead wire to prevent wire breakage, etc. are essential when the gap between the pipe and borehole is to be filled by sand or cement so that the strength/stiffness after consolidation of the cement is adjusted to the same as surrounding layer. Water proof box for lead line shall be set on borehole entrance.

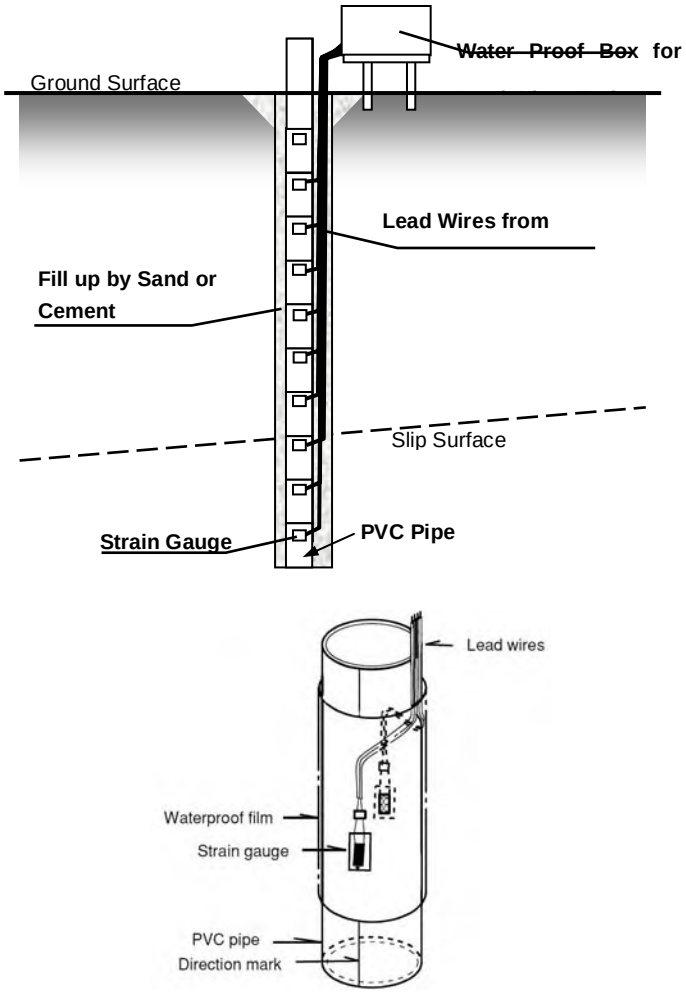


Figure 9 Schematic Diagram of Pipe Strain Gauge

b) Pipe Strain Gauge Monitoring

Monitoring shall be conducted five (5) times for each monitoring pipe. Control and readout unit of the strain gauge shall be prepared by the Contractor, and data shall be arranged into the change chart. (Figure 10).

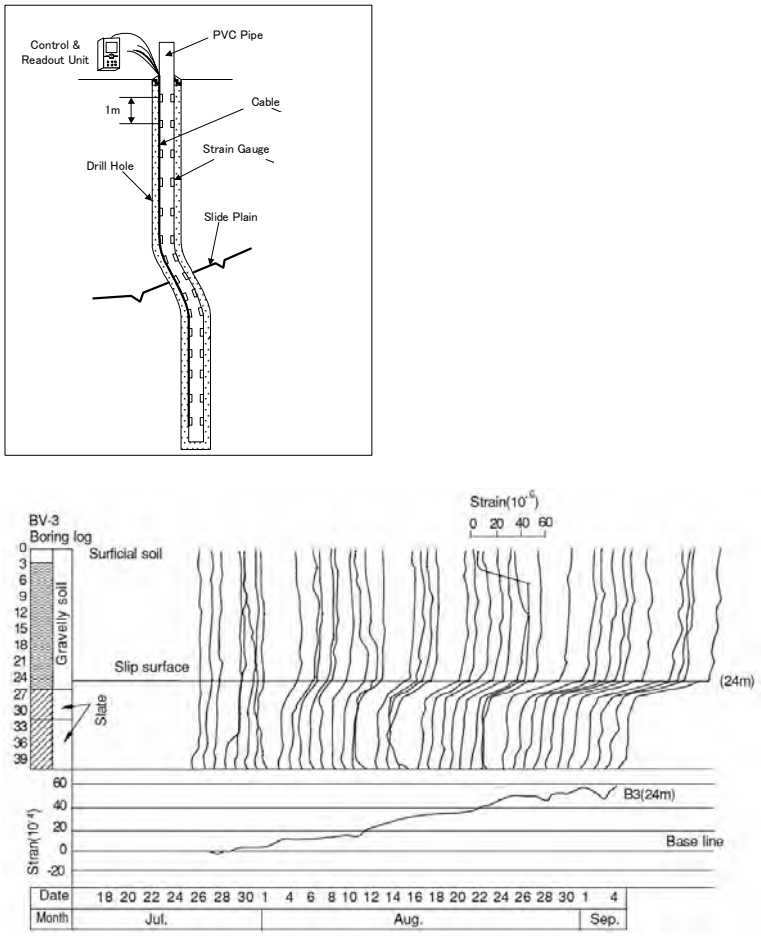


Figure 10 Example of Results of Pipe Strain Gauge Monitoring

8) Setup of Movable Stake and Monitoring

Movable stakes are set up outside and inside the deformation area, such as landslide area, in order to know the relative movement among the stakes (Figure 11).

Set-up points are directed by the JICA Study Team.

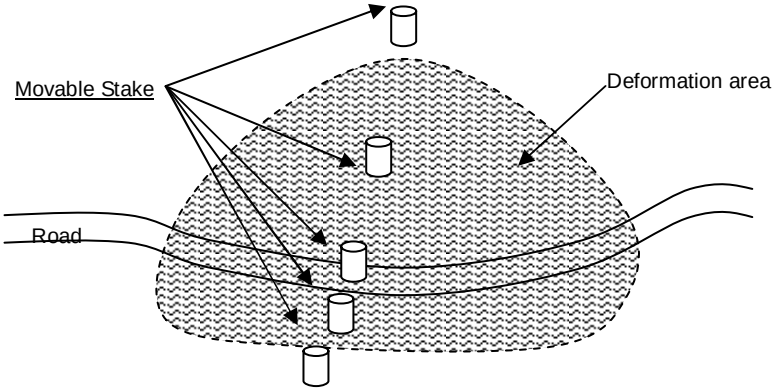


Figure 11 Schematic Diagram of Set-up of Movable Stake

The monitoring of the coordinates and altitude of each stake is obtained by the surveying team, which is conducted periodically; on the other hand, the monitoring interval depends on site conditions.

In this contract, an initial value (coordinate and altitude of the stakes) should be recorded and the results should be handed over to the concerned District Engineering Office (DEO).

(5) Operating Control of Boring Works

Preparation of the Works

CONTRACTOR gets permission to enter a site from a land owner.

CONTRACTOR confirms existence or non-existence of underground facilities (e.g. water pipeline, electricity cable, etc.).

CONTRACTOR submits a letter described in the above mentioned status to DEO.

DEO instructs the start of the works to CONTRACTOR.

Daily Report

CONTRACTOR records the works in a day into a daily report sheet prepared by the CONTRACTOR.

CONTRACTOR informs / submits it to the DEO every day.

Termination of the Drilling

CONTRACTOR judges termination of the drilling based on the purpose of the boring works.

CONTRACTOR informs/explains the work status and the abovementioned judgment to the DEO.

In case the DEO accepts the judgment by the CONTRACTOR, the DEO and the CONTRACTOR decide the date of site inspection.

Inspection of the Works

DEO goes to the site.

CONTRACTOR explains geological/geotechnical conditions to the DEO at the site.

DEO checks the core samples.

DEO inspects the drilling depth using the drilling tools (a core tube with bit and rods) prepared by the CONTRACTOR (see next page).

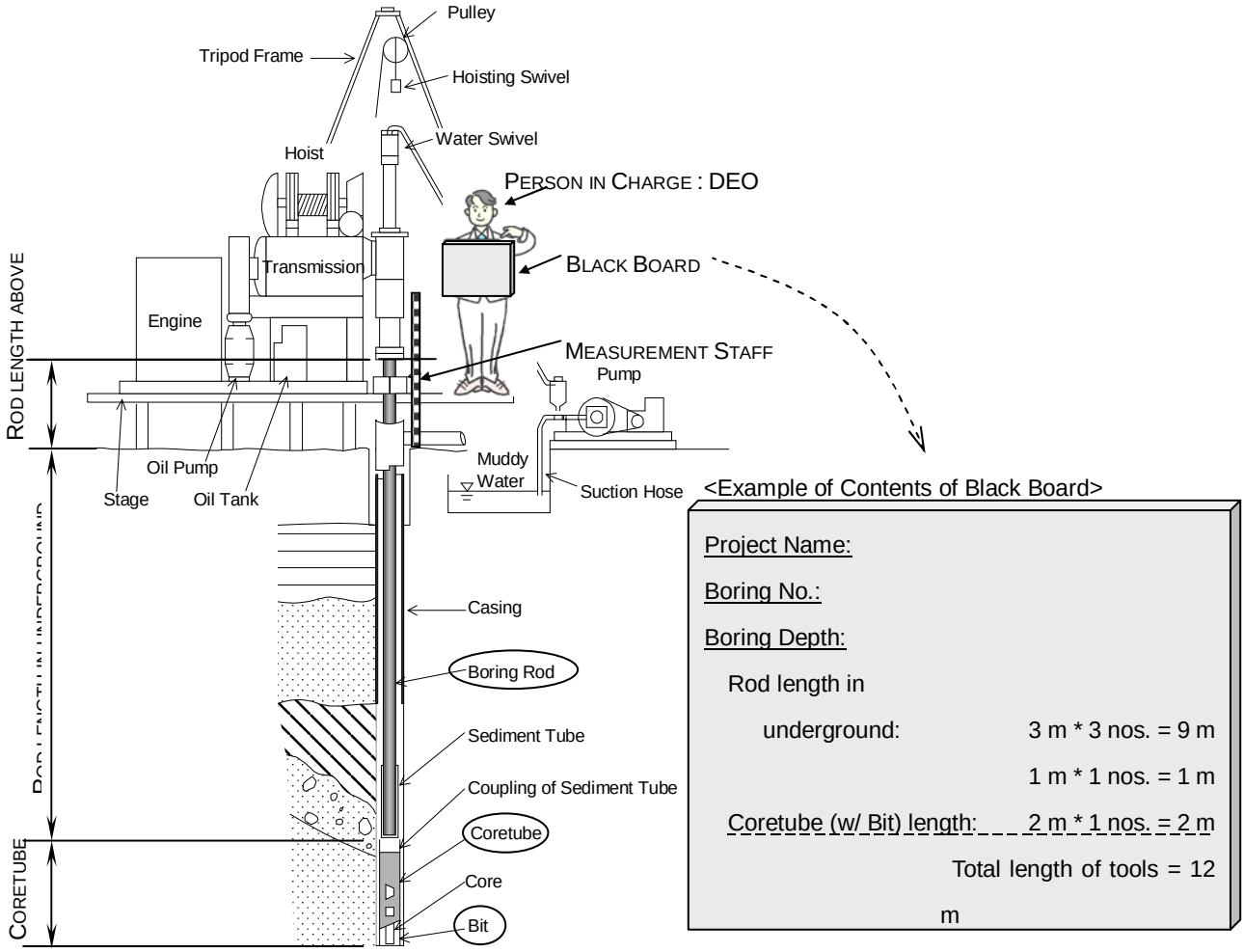
CONTRACTOR takes photos of the inspection by the DEO.

CONTRACTOR pulls the tools up and sets them in line at an applicable flat place (see next page).

DEO checks the number of the tools.

CONTRACTOR takes photos of the checks by the DEO.

[Inspection of the Boring Depth]



<Example of Contents of Black Board>

Project Name:

Boring No.:

Boring Depth:

Rod length in

underground: 3 m * 3 nos. = 9 m

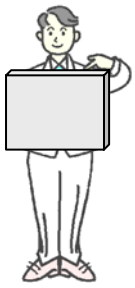
1 m * 1 nos. = 1 m

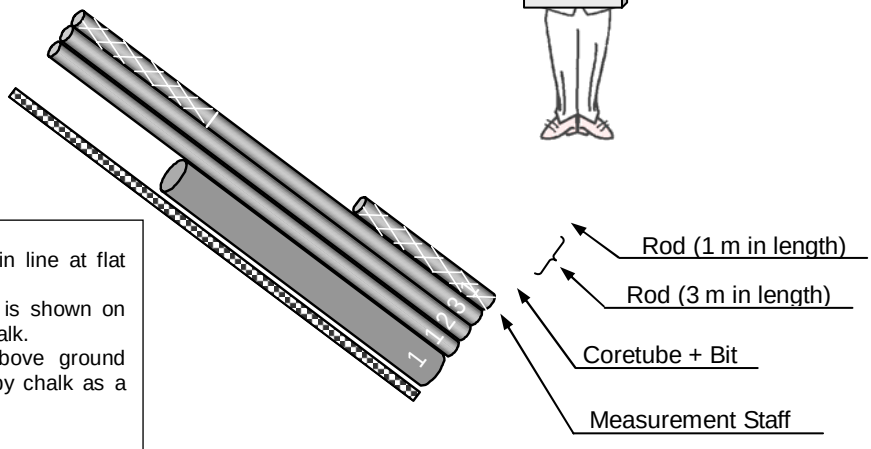
Coretube (w/ Bit) length: 2 m * 1 nos. = 2 m

Total length of tools = 12 m

[Check the length of Boring Tools]

<Example of Setting the Tools in Line>





[Note]
- The tools are set in line at flat place.
- Sequence number is shown on the each tool by chalk.
- The rod length above ground surface is shown by chalk as a hatching.

A6-1.2 Methodology for the Conduct of Social & Environmental Impact Assessment for Construction of Countermeasures for Road Slope Disasters

The proposed framework for the conduct and measurement of Social & Environmental Impact Assessment in the construction of countermeasures for road slope disasters considers both positive and negative impacts that accrue to the project. While evidently, the implementation of said countermeasures is intended to benefit the communities within the project's influence area, it is possible that some negative impacts may be introduced by such infrastructures. This includes relocation of households that are within the project's ROW or would be affected by route realignment or redirection of drainage water runoff. Figure 1 shows the framework for the methodology, and the detailed descriptions of the steps involved are given subsequently.

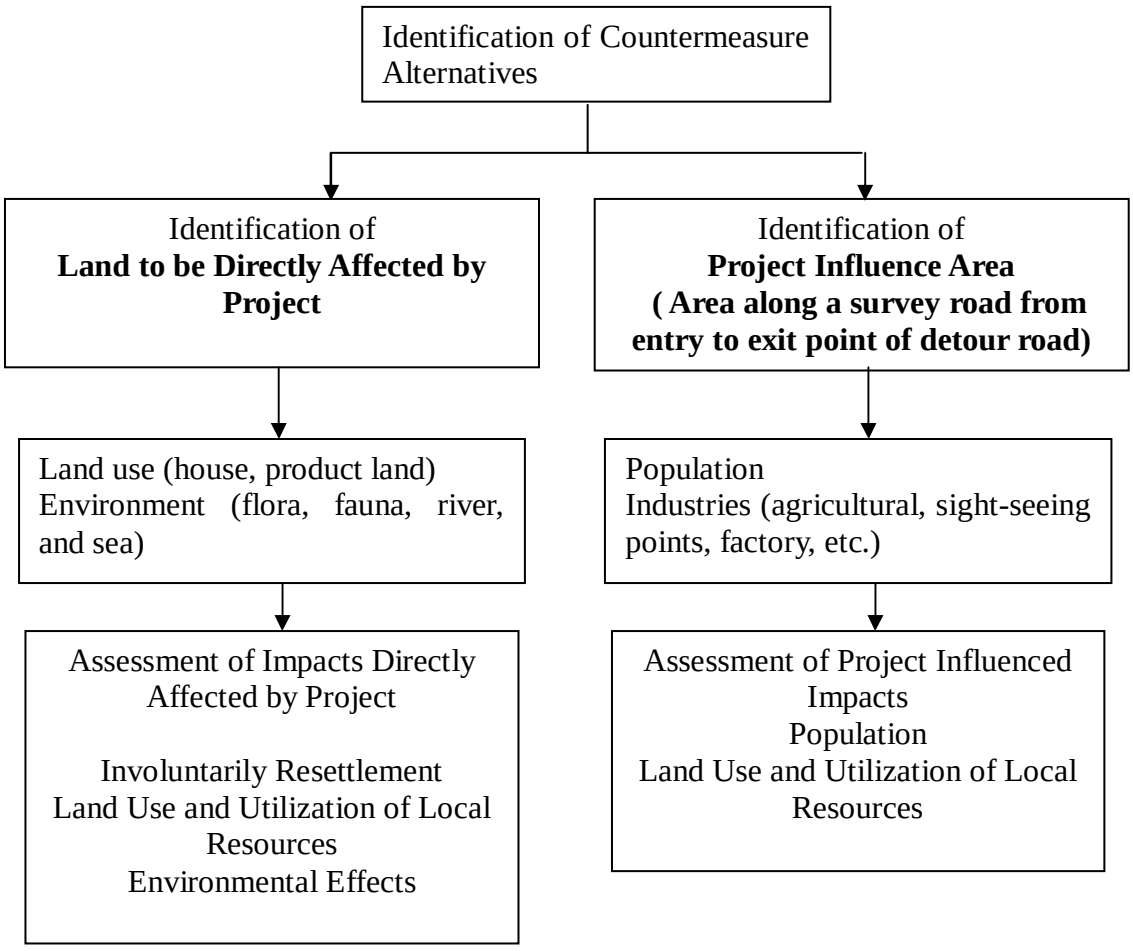


Figure 1 Framework for the Conduct and Measurement of Social and Environmental Impacts Caused by the Implementation of Countermeasures

(1) Identification of Countermeasure Alternatives

This is the initial activity required in the measurement of the social and environmental impacts in the implementation of countermeasures alternatives.

(2) Identification of Land to be directly Affected by the Project

The following areas should be specified:

- Area requirement during construction and upon completion; and

- Area affected by the drainage water at the downstream region.

These areas are the same areas where topographic survey was conducted during the feasibility study. These areas are set as the land to be directly affected by the project.

(3) Identification of Project Influence Area

Project influence area is an area along a road from entry to exit point of detour road. It includes settlement area and agricultural land along the road. Actually, it includes the whole area of the barangays and the road section.

(4) Assessment on Impacts Directly Affecting the Project

Activities during the pre-construction and construction stage shall have a direct impact in the project.

Pre-construction refers to the identification/inventory of the households that would be affected by the construction activity, acquisition of the right of way (ROW) and relocation site for the displaced households.

During construction, certain construction activities would have detrimental impacts on households adjacent/near the countermeasure's construction site, i.e., noise of trucks and construction equipment, accidents, dust, etc.

Survey and assessment items are as follows:

Households requiring relocation;

Agricultural land to be directly affected by the project; and

Negative environment impacts.

(5) Assessment of Project-Influenced Impacts

After completion of the construction of the countermeasure, the post-construction's social and

environmental impacts need to be assessed. Thus, in the feasibility study phase, the following survey need to be undertaken in the Project Influence Area described in section (3).

Survey and assessment items are as follows;

- Population data: It can be generated from the provincial NSO.
- Land use and utilization of local resources: agricultural land

Refer to the land area used for agricultural production in the project's influence area. Data can be generated from the Provincial and Municipal Agriculture Officer and the Bureau of Agricultural Statistics municipal and provincial offices in the area.

Other Industries: Data can be generated from the Department of Trade and Industry Provincial Office.

(6) Survey Forms

Survey forms to be used shall be as follows:

a) Social Survey for Priority Sites;

b) Manual Classified Traffic Count; and

d) Road and Bridges Project: Initial Environmental Examination Checklist (IEE Checklist).

a) Social Survey for Priority Sites

The Study on Risk Management for Sediment-Related Disaster on Selected National Highways

SOCIAL SURVEY FOR FIVE FS SITES

(Note: Please check box and/or indicate approriate answer(s) to each item)

Province/City: _____ Region: _____ Date of Survey: _____

1) Name of Respondent : _____
First Name *Middle Name* *Last Name*

2) Address : _____
Lot No., Name of Street, Name of Barangay/Sitio, Name of Municipality

3) Age :
- ☐ < 21 years old
- ☐ 21 to 30 years old
- ☐ 30 to 40 years old
- ☐ > 40 years old

4) Civil Status :
- ☐ Single
- ☐ Married
- ☐ Legally Separated
- ☐ Others, Pls. Specify: _____

5) Educational Attaintment :
- ☐ Elementary Graduate
- ☐ Highschool Graduate
- ☐ College Graduate
- ☐ Others, Pls. Specify: _____

6) Employment :
- ☐ Self-employed
- ☐ Private Sector
- ☐ Government Sector
- ☐ Others, Pls. Specify: _____

7) Employment Status :
- ☐ Permanent
- ☐ Casual
- ☐ Contractual
- ☐ Others, Pls. Specify: _____

8) Household Income (Peso/Month) :
- ☐ < P5,000.00
- ☐ P 5,000.00 - P10,000.00
- ☐ P10,000.00 - P 20,000.00
- ☐ Others, Pls. Specify: _____

9) Status as Stakeholders of the Project
- ☐ Directly Affected
- ☐ Indirectly Affected

10) For Directly Affected Only

10.1) What is the status of onwership to the affected property?
- ☐ Owner
- ☐ Lessee/Tenant
- ☐ Caretaker
- ☐ Others, Pls. Specify: _____

10.2) What is the type of the affected property?
- ☐ Residential
- ☐ Agricultural
- ☐ Commercial
- ☐ Others, Pls. Specify: _____

11) If Residential

11.1) What is the type of structure?
- ☐ Permanent
- ☐ Semi-Permanent
- ☐ Light Materials
- ☐ Others, Pls. Specify: _____

11.2) What is the floor area?
- ☐ < 30 square meter
- ☐ 30 to 50 sq. m.
- ☐ 50 to 75 sq. m.
- ☐ Others, Pls. Specify: _____

11.3) Assess value of property?
- ☐ House (Peso/sq. m) _____
- ☐ Lot (Peso/sq. m) _____
- TOTAL (Peso/sq.m.) _____

12) If agricultural

12.1) What is the lot area?
- ☐ < 1000 square meter
- ☐ 1000 to 2000 sq.m.
- ☐ 2000 to 5000 sq.m.
- ☐ Others, Pls. Specify _____

12.2) Type of Products?
- ☐ Rice
- ☐ Corn
- ☐ Vegetables
- ☐ Others, Pls. Specify _____

12.3) Volume of production per harvest? _____ Unit _____

12.4) Assess value of property?
- ☐ Lot (Peso/sq. m) _____
- ☐ Products (Peso/unit) _____

13) Personal opinion on the project?
- ☐ Solve road slope disasters
- ☐ Improve traffic function/safety
- ☐ Increase Investment potentials
- ☐ Others, Pls. Specify _____

Surveyed by: APPROVED: NOTED:

Name and Signature of Surveyor/Interviewer *Name & Signature of the District Engineer* *Name & Signature of Concerned Barangay Captain*

b) Manual Classified Traffic Count

MANUAL CLASSIFIED TRAFFIC COUNT
TWO-DIRECTIONAL COUNT FORM

DPWH-NRTSP
VERSION TDEW-1.2

SITE ID:		**REGION:**	VII	**DISTRICT:**	Cebu 4th District Engineering Office
ROAD SECTION ID:	S00304 CB	**ROAD NAME:**	Santander - Barili - Toledo Road		
KM STATION:	171+960 to 172+066	**SITE DESCRIPTION:**	Alegria - Ginatilan		
DIRECTION:			**NUMBER OF LANES:**	2	
DATE:	2007 1 17 (Wednesday)				

	MOTOR-TRICYCLE		PASSENGER CAR		PASSENGER UTILITY		GOODS UTILITY		SMALL BUS		LARGE BUS		RIGID TRUCK 2 axles		RIGID TRUCK 3+ axles		TRUCK SEMI-TRAILER 3 & 4 axles		TRUCK SEMI-TRAILER 5+ axles		TRUCK TRAILERS 4 axles		TRUCK TRAILERS 5+ axles	
HOUR	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC	DEC	INC
0600-0700																								
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0300-0400																								
0400-0500																								
0500-0600																								
TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

c) Road And Bridges Project: Initial Environmental Examination Checklist (IEE Checklist)

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
EMB Building, DENR Compound, Visayas Ave., Quezon City
Tels. 927-15-17/18, 426-48-32, 928-12-15, 925-53-24, 920-22-41/43

ROAD AND BRIDGES PROJECT

Initial Environmental Examination (IEE) Report

GUIDE FOR PROPONENTS

GENERAL INSTRUCTIONS

The accompanying IEE Checklist Report is applicable for the following projects only:

- Road construction with total length less than or equal to 3 km that will traverse an area with critical slope (>50%);
- Road construction with total length exceeding 10 km but less than or equal to 15 km if not traversing an area with critical slope (>50%); or
- Bridge construction of 1 to 2 lanes with length in excess of 50 meters but less than or equal to 80 meters

The Project Proponent or his duly authorized representative/s shall accomplish this checklist. Three (3) copies shall be submitted to EMB Regional Office in the area. Use additional sheets if necessary.

SECTION 1. PROJECT DESCRIPTION

PROJECT NAME	refers to *official* name of project
PROJECT LOCATION	refers to location of the project. Proponent should provide complete description/s of the location of the project (e.g., terminal points, proposed alignments, barangay/sitios traversed, etc.)
PROJECT DESCRIPTION	provide short description of the project (e.g., width of road alignment/ROW, length, material of construction, general/predominant use, etc.)
NAME OF PROPONENT	refers to the *owner* of the project (e.g., DPWH, name of LGU, etc.). (if proponent is municipality – programmatic checklist for arcdp2)
CONTACT PERSON	refers to person/s who is authorized to transact with DENR/EMB on behalf of the Proponent (i.e., mayor)
ADDRESS	refers to *official* address of proponent and contact person/s. The address of contact person/s should also be given if different from that of the proponent.

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indigenous community/s	refers to any indigenous community located within 10 km of the project site. As per definition of RA 8371 (IPRA),, an indigenous community refers to a group of people who have possessed customs, traditions and other distinctive cultural traits different from that of the majority of the Filipinos.
vulnerable group/s	refers to the elderly, youth, young children, physically challenged and other such sectors
sites with cultural/historical significance	(examples) archaeological sites, churches, cemetery, burial sites, monuments, sites of historical battles, etc.
"near"	is interpreted to be within a distance of 100.0 meters from the perimeter/s of Right of Way of the road/bridge.

SECTION 3. PROJECT IMPACTS IDENTIFICATION, ASSESSMENT AND MITIGATION/ENHANCEMENT

Answers under the MITIGATION/ENHANCEMENT MEASURES shall describe ALL the mitigation measures for negative impacts or the enhancement measures for positive impacts.

REQUIRED ATTACHMENTS

- Location map/scale map – a 1:25,000 (or larger scale) topographic map indicating project site (road alignment, location of bridge/s, etc.) and significant landmarks including (but not limited to) the following:
  - Settlements or HH spot marks (settlement map)
  - Trees to be cut
- Documents related to ownership or possession of project site (i.e., OCT, TCT, Deeds of Donation)
- Technical design, plans and other related documents to describe fully the project
- Proposed schedules of activities (construction stage, etc.)
- Barangay Resolution endorsing the Project
- Municipal/City Council Resolution endorsing the Project

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SUMMARY MATRIX OF PROJECT COMPONENTS

Roads

SEC-TION	DESCRIPTION/NAME	LENGTH (km)	GRADIENT/ SLOPE	CONST. MATRLS. USED
1				
2				
3				
4				
5				
6				
7				
8				

Bridges (ONE ENTRY PER BRIDGE)

#	DESCRIPTION/NAME	LENGTH (lineal m.)	BRIDGE DESIGN
1			
2			
3			
4			
5			
6			
7			

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PARAMETERS	ANSWER		MITIGATION/ENHANCEMENT MEASURES (for YES answers)
	YES	NO	
Will there be any drilling, boring and other *noisy* activities?			
Will there be any slope modification or ground levelling?			
Will there be increased traffic movement in the area?			
Will public/community access to or through the area be affected?			
Will there be increased economic activity in the area?			
Will there be displacement or relocation of any person?			
Will local residents be employed by the project?			
Will indigenous people be affected by the project?			
Will women be affected by the project?			
Will any other vulnerable group/s be affected by the project?			
Will there be post-construction demobilization activities?			
Is there a construction spoil disposal plan/program?			

OPERATION AND MAINTENANCE STAGE

PARAMETERS	ANSWER		MITIGATION/ENHANCEMENT MEASURES (for YES answers)
	YES	NO	
Will the drainage or flooding patterns in the area be affected?			
Will the project lead to increased traffic or traffic congestions?			
Will the project affect land values in the area?			
Will the project bring about increased economic activities?			
Will the project affect any wildlife or their habitat?			
Will the project affect any residential or built-up areas?			
Will indigenous people be affected by the project?			
Will women be affected by the project?			
Will any other vulnerable group/s be affected by the project?			

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SOCIO-ECONOMIC IMPACTS

Category/Description	Number	What will happen to them?
Total households affected		
Informal settlers		
Indigenous People		
Women		
Vulnerable Group		

SECTION 4. ENVIRONMENTAL COMMITMENTS

Are you committing yourself to	Answer	
	Yes	No
Comply with existing environmental rules and regulations, guidelines and criteria?		
Comply with all mitigating and enhancement measures as indicated in this Report?		
Properly brief contractors, residents and other stakeholders about the conditions in the ECC and other commitment or agreements in connection with the Project?		

_____
(Project Proponent/Signature or printed name)

_____
(Title/Designation)

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ACCOUNTABILITY STATEMENT

This is to certify that all the information and commitments in this Initial Environmental Examination (IEE) Report are true, accurate, and complete. Should I/we learn of any information which would make the IEE inaccurate, I/we shall bring said information to the attention of the DENR Regional Office concerned

I/We hereby bind myself/ourselves jointly and solidarily for any penalties that may be imposed arising from any misrepresentations or failure to state material information in the IEE.

_____ Date

_____ Project Proponent (Signature over printed name)

_____ Title/Designation

ACKNOWLEDGMENT

BEFORE ME this _____ day of _____, 20__ at (place) _____, personally appeared (Name) _____ with Community Tax Certificate No. _____ issued on _____ at _____, in his/her capacity as (position) _____ of (name of institution) _____ and acknowledged to me that this IEE is his voluntary act and deed, and the voluntary act and deed of the entity he/she represents. This document, which consists of _____ pages, including the page on which this acknowledgment is written, is an Initial Environmental Examination Report Checklist.

Witness my hand and seal on the place and date above written.

_____ Notary Public

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A6-1.3 Feasibility Assessment Method

(1) General

The feasibility assessment method takes off from the Detailed Inventory Survey and refines the methodology used. This requires more detailed description of the site for the proposed countermeasure, a more accurate estimate of the construction and maintenance cost of the proposed countermeasure throughout its estimated life and other benefits that would accrue due to the construction of the specific countermeasure. The following sections discuss in detail the method for the feasibility assessment of the proposed projects.

(2) Costs

(a) Project Costs

The project cost is comprised of construction cost, engineering services cost, administrative cost, land acquisition and compensation cost, physical and price contingencies. This is usually divided into local and foreign cost component if the project is intended for ODA funding.

(b) Project Recurring/Maintenance Costs

Once completed, project sustainability is assured through the conduct of regular maintenance activities. This is expressed in terms of the estimated recurring/maintenance cost that would be required for regular site visits and routine/preventive maintenance costs.

(c) Converting Financial to Economic Costs

The estimated financial costs are adjusted to economic values, using conversion factors to reflect the opportunity cost for unskilled labor and foreign exchange and exclusion of transfer payments. For unskilled labor, the adjustment factor used was 0.65 (unskilled labor wages was computed as 65% of the prevailing minimum wage), while for foreign exchange component, the adjustment factor used was 1.20 (Philippine peso parity rate with the US dollar is computed at 1.2*Prevailing Peso Exchange Rate to the US dollar.

(3) Project Benefits

(a) Risk Reduction

The construction/installation of countermeasures to mitigate against sediment-related disasters along Philippine national highways results in the decreased likeliness of the occurrence of RCDs. This is expressed in terms of the "risk reduction ratio on frequency/magnitude of RCD". Each proposed countermeasure has a risk reduction factor attached to it. This simply means that the installation/construction of a specific countermeasure would reduce the possibility of a RCD occurring. The more expensive the

countermeasure, the implication is that the decrease in risk would be more substantial as compared to cheaper alternatives.

(b) Estimate of Annual Losses due to RCD

1) Road Reopening Cost

The correlation between reopening cost and the accumulated volume of collapsed materials is just the unit cost in m^3 for the activities related to the removal of the collapsed materials. This is the estimate of the cost for clearing and grubbing and the associated mobilization/ demobilization costs. This cost estimate is localized, that is, it is the known current costs for clearing and grubbing plus mobilization/demobilization costs. The equation used to estimate road reopening cost is given below:

$$\mathbf{h= (cg+md)/ m^3}$$

Where:

h = reopening cost/ m^3
cg = clearing and grubbing costs/ m^3
md = mobilization/demobilization costs/ m^3

The estimate of annual reopening costs is given by the equation below:

$$\mathbf{i= g*h}$$

Where:

i = annual reopening costs
g = total accumulated volume of materials on the road
h = reopening cost/ m^3

2) Average Number of Human Deaths per FRCD

The average number of human deaths per RCD is estimated as the total deaths per annum due to RCD divided by the potential FRCD. While a ten-year historical data stream is ideal, this was not available due to the deficiencies/non-existence of the system for collecting mortality statistics primarily attributable to RCD. In the absence of such statistics, the recommended equation would be sufficient to provide indicative estimates of the average number of human deaths per FRCD.

a) Average Value of Human Life

The estimation of the value of human life is a tedious task, but is needed to estimate the annual value of human life lost due to RCDs. While methodologies differ, the simplest would be preferable. One alternative for the estimation of the average value of human life is the mathematical expression given below:

k= (RGDP/pop)*(ale/2)

Where:

k = Average value of human life

RGDP = Regional Gross Domestic Product for the available year in constant prices (latest)

pop = Population of the region

ale = Average life expectancy in province/region (if available) or national.

The alternative was to use the computed value of human life lost due to road accidents in the Study undertaken by the Asian Development Bank.

b) Annual Value of Human Life Lost Due to RCDs

The annual value of human life lost is estimated using the following equation:

l = a*j*k

Where:

l = annual value of human life lost

a = potential FRCD

j = average number of deaths per FRCD

k = estimated average value of human life

3) Detour/Other Delay Costs

The occurrence of RCD results in either of two things: (a) vehicles are forced to take an alternative, usually a roundabout and longer route, or (b) vehicles are forced to wait until such time that the road is reopened.

In the case of (a), the characteristics of the alternative routes are needed and include the following: (i) length of the alternative route/road in km; (ii) estimated AADT on the closed road; and (iii) number of days that the main road is closed.

In the case of (b), the needed information includes the following: (i) travel time cost; (ii) estimated AADT on the closed road; and (iii) number of hours that the main road is closed.

a) Average Detour Cost per Vehicle-km

The DPWH regularly updates its vehicle operating cost statistics which is used in the evaluation of road projects. This is applicable in the analysis of detour cost and the most recent estimate is given in Table 1.

Table 1 Basic Vehicle Operating Cost per km (VOC/km)
(Economic Values at 2006 Price Levels)

Vehicle Type	Running (P/km)		Fixed	Time
	Basic	Adjusted	(P/min)	(P/min)
Cars/Jeep/Van	8.24	9.73	0.35	1.16
Jeepneys	5.69	6.75	1.74	1.71
Bus	8.98	10.59	2.09	6.49
Trucks	11.54	13.62	2.46	-
Motorcycles	1.03	1.22	0.10	0.68
Tricycle	1.26	1.49	1.13	0.26

Note: The adjusted running costs represent the economic price estimates.

b) Annual Detour Cost

The estimate of annual detour cost may be computed in two (2) different ways, namely:

When there is an alternative route to the closed road, the equation to estimate the annual detour cost is given as:

q= a*m*n*o*p

Where:

q = annual detour cost

a = Potential FRCD

m = length of alternative road section

n = AADT on closed road

o = no. of days that the road is closed

p = average detour cost per vehicle-km.

When there is no alternative route, the equation to estimate the annual detour cost is given as:

q= a*m*n*o*w

Where:

q = annual detour cost

a = Potential FRCD

m = length of alternative road section

n = AADT on closed road

o = no. of days that the road is closed

w = average waiting time cost per vehicle

4) Total Annual Losses Due to RCD

The total annual loss due to the occurrence of RCD in the specific site is computed as follows:

r= i+l+q

Where:

r = Total annual loss due to RCD

i = Annual reopening costs

l = Annual value of human life lost

q = Annual detour cost

(d) Cost – Benefit Analysis

1) Measures of Economic Project Worth

The measures of economic project worth used in the feasibility assessment are Economic Net Present Value (ENPV), Benefit – Cost Ratio (BCR) and Economic Internal Rate of Return (EIRR).

a) Economic Net Present Value (ENPV)

The ENPV is computed as:

$$\mathbf{ENPV = \Sigma\ (PVB_r - PVC_r)}$$

Where:

ENPV = Economic Net Present Value at discount rate r

PVBr = Present Value of Benefits at discount rate r

PVCr = Present Value of Costs at discount rate r

r = Discount rate used (assumed at 15% as the estimate of the opportunity cost of capital)

b) Benefit – Cost Ratio (BCR)

The BCR is computed as:

$$\mathbf{BCR = \Sigma\ (PVB_r\ )/\ \Sigma\ PVC_r)}$$

Where:

BCR = Benefit-Cost Ratio at discount rate r

PVBr = Present Value of Benefits at discount rate r

PVCr = Present Value of Costs at discount rate r

r = Discount rate used (assumed at 15% as the estimate of the opportunity cost of capital)

c) Economic Internal Rate of Return (EIRR)

The EIRR is computed as:

$$\mathbf{EIRR = r \quad where \quad \Sigma\ (PVB_r\ ) = \Sigma\ PVC_r)}$$

Where:

EIRR = Economic Internal Rate of Return
PVBr = Present Value of Benefits at discount rate r
PVCr = Present Value of Costs at discount rate r
r = Discount rate where the ENPV = 0

2) Hurdle Rate Criteria

After estimating the project's economic cost and benefit streams, the measures of project worth are then applied using a "hurdle rate". The recommended "hurdle" discount rate is 15% which is the estimated value of the Opportunity Cost of Capital. The project is considered feasible from the economic viewpoint if:

Economic Internal Rate of Return (EIRR) > "Hurdle Rate"

Economic Net Present Value computed at 15% (Hurdle Rate) > 0

Benefit-Cost Ratio computed at 15% (Hurdle Rate) > 1