internal rate of return, benefit cost ratio, and so on. These quantitative benefits are as follows:

a) Running time saving benefit
b) Waiting time saving benefit
c) Vehicle operating cost saving benefit
d) Disaster prevention benefit
e) Accident deduction benefit
f) Transportation cost deduction benefit from refrigerated trucks.
g) Development benefit

The following is a detailed analysis of the above benefits.

C.2.1 Running Time Saving Benefit

As the road surface and horizontal alignment of the project road are significantly improved compared with the existing condition, the current running time for the existing road is expected to be considerably reduced after the completion of the project. The running time saving benefit is estimated on the basis of the difference in vehicle running speed between the existing road and the improved road. However, the vehicle running speed depends on driving conditions such as weather, day time or night, etc. Therefore, before calculating this benefit, the vehicle driving speed should be initialized for each condition.

(1) Setting the driving speed on the existing road

The traffic survey conducted by the Study Team indicated that the time required for traveling between Santa Barbara and Caranavi, and between Caranavi and Bella Vista is as shown below:

Santa Barbara - Caranavi

Road Section	Light & Medium Vehicle	Heavy Vehicle
From Santa Barbara to Caranavi	3:20	3:48
From Caranavi to Santa Barbara	3:45	4:20

Note : The time required from Yolosa (Traffic Survey Point) to Santa Barbara (staring point of this project) is subtracted.

Yolosa to Santa Barbara 20 minutes
Santa Barbara to Yolosa 25 minutes

In addition, the waiting time requirement for passing each other (18 minutes) is subtracted.

Caranavi - Bella Vista

Road Section	Small & Medium Vehicle	Heavy Vehicle
From Caranavi to Bella Vista	2:27	2:42
From Bella Vista to Caranavi	2:14	2:24

Note : The time required from the SNC's Km 53 Camp at Bella Vista (Traffic Survey Point) to Bella Vista Ending point of this project) requires an added 10 minutes.
In addition, the waiting time required for passing each other (2 minutes) is subtracted.

Table C.2-1 summarized the time required by direction and road section together with the average vehicle speed per hour, based on the above results.

Table C.2-1 Time Required and Average Speed

Road Section	Santa Barbara to Caranavi (66.4 km)		Caranavi to Bella vista (51.6 km)	
Vehicle Type	Small & Medium Vehicle	Heavy Vehicle	Small & Medium Vehicle	Heavy Vehicle
From La Paz				
Survey Time	3:35[1]	4:03	2:23	2:41
Adjusted Time	3:17	3:45	2:31	2:39
Average Speed[2]	20.2 km/h	17.7 km/h	22.0 km/h	19.5 km/h
To La Paz				
Survey Time	3:45	4:20	2:31	2:53
Adjusted Time	3:27	4:02	2:29	2:51
Average Speed[2]	19.2 km/h	16.6 km/h	20.8 km/h	18.1 km/h
Average Speed[3]	19.7 km/h	17.2 km/h	21.4 km/h	18.8 km/h
Time required[4]	3.371 hs.	3.860 hs.	2.411 hs.	2.745 hs.

Note : 1) 3:35 means 3 hours 35 minutes
2) Survey time minus waiting time required for passing each other
3) Average speed of From La Paz and To La Paz
4) Distance / Speed

Table C.2-1 indicates the vehicle speed and the time required under normal road conditions ("normal" means the good weather and in the daytime). However, these differ depending on the weather condition and/or the time of day. Through the driver survey conducted at survey points, on the project road, the following results were obtained:

1) On rainy days the driving speed slows by about five km/h if drivers normally drive at speeds of 30 km/h on clear day.

2) The driving speed at night is slightly less than that in the day time (about 10%), however, the total time required is shortened as the waiting time necessary for passing is negligible since there is a smaller traffic volume at night.

From the above results, the vehicle speed on rainy days is considered to decrease by 15 percent (5 km/h / 30 km/h = 0.167) and by 10% from the normal conditions. Consequently, vehicle speeds for the varying conditions were deter-

mined as shown in Table C.2-2.

Table C.2-2 Vehicle Speed under Different Conditions

Road Section	Santa Barbara to Caranavi (66.4 km)		Caranavi to Bella vista (51.6 km)	
Vehicle Type	Small & Medium Vehicle	Heavy Vehicle	Small & Medium Vehicle	Heavy Vehicle
Clear Day				
Speed	19.7 km/h	17.2 km/h	21.4 km/h	18.8 km/h
Time required	3.371 hs.	3.860 hs.	2.411 hs.	2.745 hs.
Rainy Day				
Speed	16.7 km/h	14.6 km/h	18.2 km/h	16.0 km/h
Time required	3.976 hs.	4.548 hs.	2.835 hs.	3.225 hs.
Night (Clear)				
Speed	17.7 km/h	15.5 km/h	19.3 km/h	16.9 km/h
Time required	3.751 hs.	4.284 hs.	2.674 hs.	3.053 hs.
Night (Rainy)				
Speed	15.0 km/h	13.1 km/h	16.4 km/h	14.4 km/h
Time required	4.427 hs.	5.069 hs.	3.146 hs.	3.583 hs.

(2) Determining the vehicle speed after the completion of the project road

From an engineering viewpoint, the design vehicle speed on the project road with an asphalt surface was set at 40km/h. However, according to the survey conducted by the National Research Institute of Police Science in Japan, the practical vehicle speed is said to be 92.5% of the design speed. Therefore, the vehicle speed on the project road with an asphalt surface was considered to be 37km/h for each vehicle type (40 x 0.925). On the other hand, the vehicle speed for the project road having a gravel surface was set at 30km/h, based on the results of the observation in the existing road section between Point (V) and Bella Vista, where road conditions are similar (the road width of this section is about 7m and the road surface is gravel). The vehicle speed on rainy days and at night on the improved road are fixed at 10% below the clear day values from the viewpoint of traffic safety. Tables C.2-3(1) and C.2-3(2) show the vehicle speed on the improved road with an asphalt surface and the gravel surface, respectively.

Table C.2-3(1) Future Vehicle Speed on the Improved Road with an Asphalt Surface

Road Section	Santa Barbara to Caranavi (60.0 km)		Caranavi to Bella vista (48.6 km)	
Vehicle Type	Small & Medium Vehicle	Heavy Vehicle	Small & Medium Vehicle	Heavy Vehicle
Clear Day				
Speed	37.0 km/h	37.0 km/h	37.0 km/h	37.0 km/h
Time required	1.622 hs.	1.622 hs.	1.314 hs.	1.314 hs.
Rainy Day				
Speed	33.3 km/h	33.3 km/h	33.3 km/h	33.3 km/h
Time required	1.802 hs.	1.802hs.	1.459 hs.	1.459 hs.
Night (Clear)				
Speed	33.3 km/h	33.3 km/h	33.3 km/h	33.3 km/h
Time required	1.802 hs.	1.802 hs.	1.459 hs.	1.459 hs.
Night (Rainy)				
Speed	30.0 km/h	30.0 km/h	30.0 km/h	30.0 km/h
Time required	2.000 hs.	2.000 hs.	1.620 hs.	1.620 hs.

Table C.2-3(2) Future Vehicle Speed on the Improved Road with a Gravel Surface

Road Section	Santa Barbara to Caranavi (60.0 km)		Caranavi to Bella vista (48.6 km)	
Vehicle Type	Small & Medium Vehicle	Heavy Vehicle	Small & Medium Vehicle	Heavy Vehicle
Clear Day				
Speed	30.0 km/h	30.0 km/h	30.0 km/h	30.0 km/h
Time required	2.000 hs.	2.000 hs.	1.620 hs.	1.620 hs.
Rainy Day				
Speed	27.0 km/h	27.0 km/h	27.0 km/h	27.0 km/h
Time required	2.222 hs.	2.222hs.	1.800 hs.	1.800 hs.
Night (Clear)				
Speed	27.00km/h	27.00km/h	27.00km/h	27.00km/h
Time required	2.222 hs.	2.222 hs.	1.800 hs.	1.800 hs.
Night (Rainy)				
Speed	24.3 km/h	24.3 km/h	24.3 km/h	24.3 km/h
Time required	2.469 hs.	2.469 hs.	2.000 hs.	2.000 hs.

(3) Setting time value

Time value is attached to only business-minded trips, therefore, it was determined by the average monthly wage weighted by the number of workers by industrial sector. Based on Table C.2-4, the weighted average monthly wage was estimated Bs. 438.3 in 1989.

Table C.2-4 Wages and Number of Workers by Sector

Sector	Workers (person)	Wage (Bs.)	Weighted Wage(Bs.)
Agriculture	838328	424	200.9
Mining	36626	512	10.6
Petroleum	9024	1002	5.1
Manufacturing	125095	404	28.6
Construction	47773	363	9.8
Utility	8670	609	3.0
Trans. & Communic.	130049	520	38.2
Commerce	144204	467	38.1
Bank, etc.	15040	721	6.1
Other Services	414564	418	97.9
Weighted Average per Month			438.3

The above wage and the number of worker's data were obtained from Direction National de Salario and Department de Estadistica of Ministerio de Trabajo y Desarrollo Laboral , respectively. Assuming 52 weeks a year and also 44 a hour working week, time value can be obtained at 0.793 dollars per hour per worker from the following calculation: ($us 1 = Bs 2.9)

$$\text{Time Value} = \{(438.2 \times 12)/ (52 \times 44)\}/2.9 = 0.793$$

The time value by vehicle type (not per person) was estimated, taking into consideration the average occupancy and the composition of business-minded trips ("business" trip and "go to working place" trip) for all trip purposes. Since it is reasonable from the theory of economics that a time value can be attached to only "business" trips and/or "going to working place" trips from the viewpoint of opportunity cost, therefore, using Table B.3-2 Trip Purpose and Table B.3-3 Average Occupancy by Vehicle Type, the time value for each vehicle type can be calculated as shown in Table C.2-5.

Table C.2-5 Current Time Value by Vehicle Type

Vehicle Type	Occupancy (persons)	Trip related to Business (%)*	Time Value per Person ($/Hour)	Time Value per Vehicle ($/Hour)
Passenger Car	4.04			3.123
Bus	23.00			16.324
Light Truck	5.86	89.5	0.793	4.159
Medium Truck	4.23			3.002
Heavy Truck	5.04			3.577

Note : * "Business" trip and "going to working" trip

According to the analysis of Chapter A, the future GDP of Bolivia is forecast to grow at the rate of 4.8 % per annum. On the other hand, as the future population of Bolivia is also increase at the rate of 2.8%, the growth rate of the real wage can be estimated by the following equation:

$$WAGE_{future} = WAGE_{base} \times ((1+0.048)/(1+0.028))^{n}$$

As a result, the future time value by vehicle type was estimated as shown in Table C.2-6.

Table C.2-6 Future Time Value by Vehicle Type
(Unit $/hour/vehicle)

	Passenger Car	Bus	L.Truck	M.Truck	H.Truck
1989	3.123	16.324	4.159	3.002	3.577
2001	3.935	20.570	5.241	3.783	4.508
2010	4.681	24.466	6.233	4.499	5.361
2020	5.675	29.665	7.558	5.455	6.500

(4) Other pre-conditions

Prior to calculating the travel time saving benefit, the following two conditions should be pre-determined:

a. The number of rainy days and/or dense fog days

Bad weather like rain and/or dense fog causes vehicle to slow down as already mentioned. Therefore, based on Table 2.3-2 in Volume I, it is assumed that there are 110 rainy days around the project road.

b. Traffic volume at night

Night time also exerts an influence upon vehicle speeds. The number of vehicles using the project road at night is assumed to be 10 percent of the total traffic volume per day from the survey results conducted by the Study Team.

Using the above-mentioned conditions such as travel time required, time value, and so on, the running time saving benefit was calculated for each alternative by using the following equation:

$$RTB_k = \Sigma\Sigma (vij \times {}_bTSC_{ijk} - vij \times {}_aTSC_{ijk})$$

$$+ \Sigma\Sigma (vij \times {}_bTCB_{ijk} - vij \times {}_aTCB_{ijk})$$

Where,

RTB	Running time saving benefit
v	Time value
TSC	Traffic volume between Santa Barbara and Caranavi
TCB	Traffic volume between Caranavi and Bella Vista
i	Type of vehicle
j	Various weather conditions
k	Year
b	Without project case
a	With project case

Basically, the project benefit was calculated for 2001, 2010 and 2020, however, the benefits in the year 2003 of Case P-2, CASE P-6 and CASE P-7, in 2006 of CASE P-3 and in 2011 of CASE P-4 were estimated by the arithmetic mean of benefit from an asphalt surface and that from a gravel surface in the same year above. The reason is as follows: It is considered that it would take one year to pave the project road with asphalt, however, this pavement work is

done lane by lane and in 100m intervals without obstacles for traffic, to ensure smooth traffic flow during pavement construction.

Table C.2-7 is summarized the running time saving benefit for each alternative. For reference, Tables C.2-8(1) and C.2-8(2) show the above benefit by vehicle type for the road section between Santa Barbara and Caranavi, and the road section between Caranavi and Bella Vista with the paved surface. Tables C.2-9(1) and C.2-9(2) show the benefit by vehicle type for the above same road sections but with unpaved surface. Time saving by vehicle type is shown in Appendix C.1(1) to C.1(6).

Table C.2-7 Time Saving Benefit

(Unit : Dollar)

Year	Road Surface	Santa Barbara and Caranavi	Caranavi and Bella Vista	Total
CASE P-1 & CASE P-5				
2001	(P)	4083728	821234	4904962
2010	(P)	7036595	1565092	8601687
2020	(P)	12162169	2736719	14898888
CASE P-2, CASE P-6 & CASE P-7				
2001	(U)	3102551	643675	3746226
2002	(U)	3325798	691555	4017353
2003	(U&P)	4086856	845386	4932242
2004	(P)	4895819	1018180	5913999
2010	(P)	7036595	1565092	8601687
2020	(P)	12162169	2736719	14898888
CASE P-3				
2001	(U)	3102551	643675	3746226
2005	(U)	4096630	857645	4954275
2006	(U&P)	4958238	1048254	6006493
2007	(P)	5869404	1262357	7131761
2010	(P)	7036595	1565092	8601687
2020	(P)	12162169	2736719	14898888
CASE P-4				
2001	(U)	3102551	643675	3746226
2010	(U)	5798444	1227747	7026191
2011	(U&P)	6778604	1476708	8255312
2012	(P)	7850408	1750161	9600569
2020	(P)	12162169	2736719	14898888
CASE U				
2001	(U)	3102551	643675	3746226
2010	(U)	5798444	1227747	7026191
2020	(U)	10026320	2147928	12174248

Note : P Paved Surface
U Unpaved Surface
U&P Pavement work is done in this year.

Table C.2-8(1) Time Saving Benefit by Vehicle Type
- Paved Surface -
Between Santa Barbara and Caranavi (Unit:Dollar)

Year	Condition	Car	Bus	S.Truck	M.Truck	H.Truck
2001						
	Clear D.T	85293	327521	502788	56184	1210956
	Clear N.T	10561	40359	62254	6956	149220
	Rainy D.T	60880	218806	358877	40105	809002
	Rainy N.T	5673	21527	33441	3737	79593
	Total	162406	608213	957359	106980	2248771
2010						
	Clear D.T	165346	603180	883170	97517	2340494
	Clear N.T	20473	74327	109351	12074	288408
	Rainy D.T	88658	319256	473551	52288	1238798
	Rainy N.T	10997	39645	58740	6486	153835
	Total	285474	1036409	1524812	168366	4021534
2020						
	Clear D.T	296130	1036087	1468334	162031	4106400
	Clear N.T	36666	127672	181804	20062	506012
	Rainy D.T	158783	548389	787312	86880	2173473
	Rainy N.T	19696	68099	97660	10777	269903
	Total	511274	1780247	2535110	279751	7055787

Note : D.T means the day time.
N.T means the night time.

Table C.2-8(2) Time Saving Benefit by Vehicle Type
- Paved Surface -
Between Caranavi and Bella Vista (Unit:Dollar)

Year	Condition	Car	Bus	S.Truck	M.Truck	H.Truck
2001						
	Clear D.T	9907	13511	58057	5714	389370
	Clear N.T	1219	1672	7145	703	48191
	Rainy D.T	5360	7193	31414	3092	207284
	Rainy N.T	661	888	3871	381	25601
	Total	17147	23264	100487	9891	670445
2010						
	Clear D.T	18856	24105	100431	11327	753550
	Clear N.T	2320	2983	12359	1394	93265
	Rainy D.T	10203	12832	54341	6129	401158
	Rainy N.T	1257	1585	6696	755	49545
	Total	32636	41506	173827	19605	1297518
2020						
	Clear D.T	32861	48712	167448	17854	1321376
	Clear N.T	4044	6029	20607	2197	163543
	Rainy D.T	17781	25932	90603	9660	703445
	Rainy N.T	2191	3203	11164	1190	86879
	Total	56877	83876	289822	30901	2275243

Note : D.T means the day time.
N.T means the night time.

Table C.2-9(1) Time Saving Benefit by Vehicle Type
- Gravel Surface -
Between Santa Barbara and Caranavi (Unit : Dollar)

Year	Condition	Car	Bus	S.Truck	M.Truck	H.Truck
2001						
	Clear D.T	66859	272202	394123	44041	1006425
	Clear N.T	8285	33529	48838	5457	123969
	Rainy D.T	36898	146839	217509	24305	542913
	Rainy N.T	5044	19640	29734	3323	72617
	Total	117086	472211	690205	77127	1745924
2010						
	Clear D.T	129611	501302	692296	76442	1945183
	Clear N.T	16061	61749	85787	9472	239604
	Rainy D.T	71530	270426	382064	42187	1049324
	Rainy N.T	8872	33587	47389	5233	130326
	Total	226074	867065	1207536	133333	3364436
2020						
	Clear D.T	232129	861091	1150992	127013	3412826
	Clear N.T	28765	106067	142626	15739	420385
	Rainy D.T	128107	464513	635210	70096	1841041
	Rainy N.T	15890	57692	78788	8694	228657
	Total	404890	1489364	2007616	221541	5902908

Note : D.T means the day time.
N.T means the night time.

Table C.2-9(2) Time Saving Benefit by Vehicle Type
- Gravel Surface -
Between Caranavi and Bella Vista (Unit : Dollars)

Year	Condition	Car	Bus	S.Truck	M.Truck	H.Truck
2001						
	Clear D.T	7143	10622	41863	4120	306108
	Clear N.T	877	1314	5139	506	37882
	Rainy D.T	4032	5804	23629	2326	167259
	Rainy N.T	496	716	2907	286	20645
	Total	12548	18457	73538	7238	531894
2010						
	Clear D.T	13596	18950	72416	8167	592413
	Clear N.T	1669	2345	8891	1003	73313
	Rainy D.T	7674	10355	40875	4610	323698
	Rainy N.T	944	1278	5029	567	39954
	Total	23884	32928	127210	14347	1029378
2020						
	Clear D.T	23695	38296	120739	12874	1038817
	Clear N.T	2909	4739	14823	1580	128557
	Rainy D.T	13374	20925	68150	7266	567615
	Rainy N.T	1645	2583	8384	894	70061
	Rainy	41623	66543	212097	22614	1805051

Note : D.T means the day time.
N.T means the night time.

C.2.2 Waiting time saving benefit

Most of the vehicles driving along the existing road are forced to wait for a while to pass each other on the narrow width of the road. As is often the case, they have to wait for a long time, whenever they encounter heavy trucks. According to the survey by the Study Team, the number of vehicles passing each other was 29.1 vehicles on average on the road section between Santa Barbara and Caranavi and 4.3 vehicles on the road section between Caranavi and Bella Vista (the traffic volume was 301 vehicles for the former road section and 101 vehicles for the latter road section). The average waiting time per vehicle is estimated at 17.8 minutes between Santa Barbara and Caranavi and 2.1 minutes between Caranavi and Bella Vista. Such waiting times are expected to be eliminated completely after the completion of the project road, however, unless the existing road is not improved, the waiting time would undoubtedly be increased proportionally to traffic volume. If the waiting time per vehicle is not altered in the future, the future waiting time per vehicle is estimated as shown in Table C.2-10(1) for the road section between Santa Barbara and Caranavi and Table C.2-10(2) for the road section between Caranavi and Bella Vista.

Table C.2-10(1) Waiting Time for the Road Section Between Santa Barbara and Caranavi

Year	Traffic Volume (vehicle)	No. of Vehicles Passing Each Other (vehicle)	A.V. Waiting Time (minutes)	A.V. Waiting (hour)
1989	301	29.1	17.8	0.297
2001	884	85.5	52.3	0.872
2010	1393	134.7	82.4	1.373
2020	1986	192.0	117.4	1.957

Note : A.V. Waiting Time is "per vehicle".

Table C.2-10(2) Waiting Time for the Road Section Between Caranavi and Bella Vista

Year	Traffic Volume (vehicle)	No. of Vehicles Passing Each Other (vehicle)	A.V. Waiting Time (minutes)	A.V. Waiting (hour)
1989	101	4.3	2.1	0.035
2001	325	13.8	6.7	0.112
2010	521	22.2	10.8	0.180
2020	748	31.8	15.5	0.258

Note : A.V. Waiting Time is "per vehicle".

The waiting time saving benefit is estimated by using the above-mentioned average waiting time, time value in Table C.2-4, and traffic volume. The equation of calculation is as follows:

$$WTB_k = \Sigma\Sigma (v_i \times {}_bW_{ik} \times {}_bTSC_{ik} - v_i \times {}_aW_{ik} \times {}_aTSC_{ik})$$

$$+ \Sigma\Sigma (v_i \times {}_bW_{ik} \times {}_bTCB_{ik} - v_i \times {}_aW_{ik} \times {}_aTCB_{ik})$$

Where,

WTB	Waiting time saving benefit
v	Time value
w	Waiting time
TSC	Traffic volume between Santa Barbara and Caranavi
TCB	Traffic volume between Caranavi and Bella Vista
i	Type of vehicle
k	Year
b	With project
a	Without project

After completion of the project road, the waiting time is assumed to be eliminated, to put it more concretely, ${}_aW_{ik}=0$. Therefore, the above equation can be simplified as follows:

$$WTB_k = \Sigma\Sigma (v_i \times {}_bW_{ik} \times {}_bTSC_{ik})$$

$$+\Sigma\Sigma (v_i \times {}_bW_{ik} \times {}_bTCB_{ik})$$

Using the above equation, the total waiting time saving was calculated as shown in Table C.2-11. Tables C.2-12 (1) and C.2-12 (2) show the waiting time saving benefit by vehicle type on the road section between Santa Barbara and Caranavi, and the road section between Caranavi and Bella Vista, respectively. It must be kept in mind that the waiting time saving benefit is common to all alternatives. The waiting time for passing each other is completely eliminated in every alternative since the project road is planned to have two lanes after its completion.

Table C.2-11 Total Waiting Time Saving Benefit
(Unit : Dollar)

Year	Santa Barbara and Caranavi	Caranavi and Bella Vista	Total
2001	1464220	62113	1526333
2010	4302858	189656	4492514
2020	10580080	474463	11054543

Note : Benefit is common to every alternative.

Table C.2-12(1) Waiting Time Saving Between Santa Barbara and Caranavi
(Unit : Dollar)

Year	Car	Bus	S.Truck	M.Truck	H.Truck
2001	67631	202958	398677	44550	750404
2010	206436	588384	1102644	121751	2283643
2020	526979	1440910	2612979	288343	5710868

Table C.2-12(2) Waiting Time Saving Between Caranavi and Bella Vista
(Unit : Dollar)

Year	Car	Bus	S.Truck	M.Truck	H.Truck
2001	1609	1682	9427	928	48467
2010	4921	4822	26209	2956	150749
2020	12292	13968	82633	6678	378893

C.2.3 Vehicle Operating Cost Saving Benefit

The existing road between Santa Barbara and Bella Vista has numerous small and sharp curves with a gravel road surfaces. This results in a high consumption of gasoline and diesel for more than necessary as well as retarding vehicle speeds. Therefore, vehicle operating costs are considered to be quite high for the existing road. After the completion of the project road, the vehicle operating cost is expected to be reduced considerably.

The vehicle operating cost saving benefit is defined as the difference between the vehicle operating cost on the existing road and that of a newly improved road. The estimation of vehicle operating costs was made by using the "Vehicle Operating Cost Submodel of the HDM-III Model" developed mainly by the World Bank. Therefore, most of the parameters used here are shown in Chapter 5. Vehicle Operating Cost Submodel of the report " The Highway Design and Maintenance Standards Model Volume 1. Description of the HDM-III Model". An explanation of this model is not given here (refer to the above report), however, the necessary information and data are presented below.

(1) Vehicle characteristics

The economic analysis is performed for the five vehicle types, that is, passenger car, bus, light truck, medium truck, and heavy truck. The selected vehicle models for these vehicle types are shown in Table C.2-13 with their characteristics.

Table C.2-13 Selected Vehicle Models and their Characteristics

	Passenger Car	Bus	Light Truck	Medium Truck	Heavy Truck
Maker	Toyota	Mercedes	Volks-Wagon	Nissan	Nissan
Model	Carolla	1618	12-140	CKA31LHL	CWA-45PHL
Loading Capacity (ton)		10.5	6.3	10	16.9
Vehicle Weight (ton)	0.98	4.99	4.05	5.365	9.5
Power (HP)	94	202	131	234	275
Fuel	Gasoline	Diesel	Diesel	Diesel	Diesel
Number of tires	4	6	4	6	10
Tire Weight (kg)	12	50	40	58	60
Tire Price ($)	70	248	150	150	200
Vehicle Price (Bs.)	11,900	45,000	34,300	55,000	75,000

(2) Road rise plus fall and horizontal curvature

In the HDM-III Model the average rise plus fall and the average horizontal curvature are critical factors in determining the vehicle operating costs for a specific road section. In this analysis the project road was divided into six sections. The vehicle operating cost was estimated for each road section and summed up to obtain the total vehicle cost. The rise plus fall and the horizontal curvature of six road sections are shown in Table C.2-14.

Table C.2-14 Rise Plus Fall and the Horizontal Curvature by Road Section

Section	Existing Road		Improved Road	
	Rise Plus Fall (m/km)	Horizontal Curvature (deg./km)	Rise Plus Fall (m/km)	Horizontal Curvature (deg./km)
S/B-(F)	23.1	571	24.7	463
(F)-(K)	31.0	343	20.5	323
(K)-C/V	24.0	473	26.6	366
C/V-(Q)	36.1	579	38.9	435
(Q)-(V)	55.8	725	44.3	541
(V)-B/V	40.2	692	42.9	450

Note : S/B Santa Barbara
C/V Caranavi
B/V Bella Vista
(F) Point F on the project road

(3) Estimated Unit Vehicle Operating Cost

Using the HDM-III Model and nominated parameters, the unit vehicle operating cost were estimated for each road section under the different height above see level, the different road surface condition and the number of lanes. The result is summarized in Table C.2-15.

Table C.2-15 Unit Vehicle Operating Cost by Road Section (Unit : $/km)

Road Section		Passenger Car	Bus	Light Truck	Medium Truck	Heavy Truck
S/B-(F)	E	0.423	1.045	0.745	1.279	1.743
	P	0.174	0.501	0.258	0.581	0.622
	U	0.290	0.574	0.366	0.744	0.970
(F)-(K)	E	0.420	1.046	0.748	1.281	1.744
	P	0.170	0.492	0.238	0.553	0.590
	U	0.287	0.574	0.367	0.745	0.971
(K)-C/V	E	0.422	1.046	0.746	1.280	1.743
	P	0.171	0.502	0.263	0.568	0.629
	U	0.288	0.574	0.367	0.745	0.971
C/V-(Q)	E	0.423	1.057	0.777	1.322	1.794
	P	0.173	0.513	0.290	0.619	0.666
	U	0.290	0.590	0.411	0.803	1.039
(Q)-(V)	E	0.426	1.070	0.817	1.370	1.850
	P	0.176	0.500	0.303	0.632	0.682
	U	0.292	0.593	0.422	0.815	1.054
(V)-B/V	E	0.425	1.059	0.781	1.329	1.802
	P	0.174	0.517	0.303	0.631	0.684
	U	0.290	0.594	0.422	0.814	1.052

Note : E Existing road (Gravel, One lane)
P Paved project road (Asphalt, Two lanes)
U Unpaved project road (Gravel, Two lanes)

(4) Vehicle Operating Cost Saving Benefit

Using the unit vehicle operating cost shown in Table C.2-15, the vehicle operating cost saving benefit was calculated by vehicle type and by road section for each alternative. This benefit can be calculated using the following equation:

$$\text{Benefit} = \text{VOC without Project} - \text{VOC with Project}$$
$$= (UVOC_b \times TV_b \times D_b) - (UVOC_a \times TV_a \times D_a)$$

where, UVOC : Unit Vehicle Operating Cost
TV : Traffic Volume
D : Distance
b : With Project
a : Without Project

The traffic volume is presented in Table B.5-16 and Table B.5-17 and the distance for each road section is as follows:

Road Section	Existing Road(km)	Completion of Project(km)
S/B - (F)	27.0	25.3
(F) - (K)	22.1	21.4
(K) - C/V	14.8	13.3
C/V - (Q)	21.2	19.0
(Q) - (V)	22.6	21.8
(V) - B/V	7.8	7.3

The estimated vehicle operating cost saving benefit is summarized in Table C.2-16. For reference, Tables C.2-17(1) to C.2-17(3) show the vehicle operating cost by vehicle type and by road section for existing road, asphalt surface and gravel surface, respectively.

Table C.2-16 Vehicle Operating Cost Saving Benefit

(Unit : Dollar)

Year	Road Surface	Santa Barbara and Caranavi	Caranavi and Bella Vista	Total
CASE P-1 and CASE P-5				
2001	(P)	18488314	6435990	24924304
2010	(P)	29495865	10176102	39671966
2020	(P)	42278120	14981912	57260032
CASE P-2, CASE P-6 and CASE P-7				
2001	(U)	13448138	4560224	18008362
2002	(U)	14162039	4793155	18955194
2003	(U&P)	17715267	6117569	23832836
2004	(P)	21603262	7497874	29101136
2010	(P)	29495865	10176102	39671966
2020	(P)	42278120	14981912	57260032
CASE P-3				
2001	(U)	13448138	4560224	18008362
2005	(U)	16547154	5557835	22104990
2006	(U&P)	20699490	7185338	27884828
2007	(P)	25242979	8734945	33977924
2010	(P)	29495865	10176102	39671966
2020	(P)	42278120	14981912	57260032
CASE P-4				
2001	(U)	13448138	4560224	18008362
2010	(U)	21420231	7139918	28560149
2011	(U&P)	26390387	9205615	35596002
2012	(P)	31698360	10994699	42693060
2020	(P)	42278120	14981912	57260032
CASE U				
2001	(U)	13448138	4560224	18008362
2010	(U)	21420231	7139918	28560149
2020	(U)	30671061	10604575	41275636

Note: P Paved surface
U Unpaved surface
U&P Pavement work is done in this year.

Table C.2-17 (1) Vehicle Operating Cost in Different Conditions
(Unit : Dollars)
Existing Road

	CAR	BUS	L.TRUCK	M.TRUCK	H.TRUCK
2001					
S/B-(F)	225163	319305	1755138	466481	8982465
(F)-(K)	182798	261444	1441267	382338	7359588
(K)-C/V	123020	175084	963411	255839	4925670
C/V-(Q)	32766	16357	264394	61381	3650538
(Q)-(V)	35101	17659	296623	67807	4012803
(V)-B/V	12095	6028	97795	22707	1349319
2010					
S/B-(F)	366932	494408	2592317	680811	14598653
(F)-(K)	297893	404816	2128733	558007	11961090
(K)-C/V	199494	271098	1425577	373688	8010141
C/V-(Q)	52426	24535	384573	102302	5940799
(Q)-(V)	55888	26155	409970	109057	6333116
(V)-B/V	19352	9042	142248	37845	2195850
2020					
S/B-(F)	542059	700412	3554338	932963	21125110
(F)-(K)	440069	573489	2918716	764676	17308400
(K)-C/V	296160	384056	1951009	511677	11584272
C/V-(Q)	75363	40891	528788	132992	8591950
(Q)-(V)	80732	44146	593245	146915	9444582
(V)-B/V	27818	15069	195591	49199	3175774

Table C.2-17 (2) Vehicle Operating Cost in Different Conditions
(Unit : Dollars)
Asphalt Surface

	CAR	BUS	L.TRUCK	M.TRUCK	H.TRUCK
2001					
S/B-(F)	86836	143332	569266	198408	3004371
(F)-(K)	71850	119234	443533	159950	2410240
(K)-C/V	44835	75504	305259	102072	1596007
C/V-(Q)	12408	7337	91285	26554	1253470
(Q)-(V)	14021	7952	106119	30193	1428081
(V)-B/V	4631	2753	35495	10083	477002
2010					
S/B-(F)	141511	221934	840798	289568	4882821
(F)-(K)	117090	184620	655092	233441	3917217
(K)-C/V	73065	116910	450864	148970	2593893
C/V-(Q)	19854	11005	132778	44256	2039867
(Q)-(V)	22433	11927	154355	50321	2324026
(V)-B/V	7409	4129	51629	16805	776263
2020					
S/B-(F)	209050	314406	1152822	396816	7065730
(F)-(K)	172973	261545	898200	319901	5668443
(K)-C/V	107937	165622	618182	204143	3753516
C/V-(Q)	28540	18341	182570	57533	2950181
(Q)-(V)	32248	19879	212238	65418	3361149
(V)-B/V	10651	6882	70990	21846	1122679

Table C.2-17 (3) Vehicle Operating Cost in Different Conditions
(Unit : Dollars)
Gravel Surface

	CAR	BUS	L.TRUCK	M.TRUCK	H.TRUCK
2001					
S/B-(F)	144612	164259	806713	254372	4686420
(F)-(K)	120866	138939	684933	215360	3968233
(K)-C/V	75389	86350	425283	133783	2465363
C/V-(Q)	20722	8447	129492	34458	1954816
(Q)-(V)	23240	9444	147770	38901	2205263
(V)-B/V	7727	3164	49442	13010	737252
2010					
S/B-(F)	235664	254337	1191505	371246	7616552
(F)-(K)	196966	215131	1011638	314309	6449327
(K)-C/V	122856	133703	628137	195251	4006804
C/V-(Q)	33155	12670	188352	57429	3181221
(Q)-(V)	37184	14166	214938	64836	3588794
(V)-B/V	12363	4746	71916	21684	1199786
2020					
S/B-(F)	348141	360311	1633679	508745	11021599
(F)-(K)	290973	304769	1387061	430720	9332556
(K)-C/V	181491	189413	861242	267567	5798081
C/V-(Q)	47660	21117	258985	74658	4600878
(Q)-(V)	53452	23610	295539	84287	5190335
(V)-B/V	17772	7911	98884	28189	1735204

C.2.4 Disaster Prevention Benefit

The existing road has repeatedly suffered from natural disasters such as land slides, debris flow, rock falls, etc. Whenever these disasters occur, SNC must send their staff and construction machinery to the disaster area. The newly improved project road is provided with sufficient disaster prevention countermeasures. Consequently, after the project road is completed, all this disaster restoration work is expected to be eliminated. Therefore, in eliminating these disasters it brings about a benefit through the reduction of disaster restoration expense. In addition, the waiting time of vehicles during the disaster restoration work is expected to be saved. This benefit composes of two kinds of benefit, that is, cost saving benefit and time saving benefit. The following is process for a estimating these two benefits:

(1) Cost Saving Benefit From Disaster Prevention

This benefit is obtained by eliminating the disaster resto-

ration work cost usually required following a disaster through the disaster prevention measures installed on the project road. The following is an estimation of this benefit.

a) The number of staff and construction machinery necessary for restoration works following disasters

According to the information from SNC, SNC has allocated the following staff and construction machinery for restoration work following the disasters occurring during January and February in 1990 between Cotapata and Santa Barbara:

Disaster Frequency	78	times
Operator	82	(1.051 persons)
Assistant Operator	34	(0.436 persons)
Laborer	6	(0.077 persons)
Chief	12	(0.154 persons)
Wheel loader	31	(0.397 vehicles)
Motor Grader	13	(0.167 vehicles)
Tractor	36	(0.462 vehicles)

Note : ( ) means the necessary number per one disaster

b) The time required for restoration work following disasters

There were 78 disasters occurring within two months between Cotapata and Bella Vista as explained above. As there is no available data on disaster occurring between Santa Barbara and Bella Vista, assuming that the frequency of disaster occurrence is proportional to the road distance, the disaster frequencies between Santa Barbara and Bella Vista can be estimated to be 56.8 times (78 x 118 /(44+118) = 56.8, where, 44 and 118 are the distances (in Km) between Cotapata and Santa Barbara, and between Santa Barbara and Bella Vista) in two months. Therefore, the number of disaster occurrences between Santa Barbara and Bella Vista per year can be estimated to be 340.8 (56.8 / 2 x 12 = 340.8). On the

other hand, with regard to the time required for restoration work following the disaster, usually it takes one to twelve hours, however, the average time required is considered to be two hours, according to SNC's information. As a result, it takes 681.6 hours per year (340.8 x 2 = 681.6) in restoration work for the disasters occurring on the existing road between Santa Barbara and Bella Vista.

c) Cost of staff and construction machinery

According to SNC, the salary of their staff is as follows:

	Per Month	Per Hour	Per Hour
Operator	Bs. 489	Bs. 2.821	$0.973
Assistant operator	Bs. 320	Bs. 1.846	$0.637
Laborer	Bs. 275	Bs. 1.587	$0.547
Chief	Bs. 573	Bs. 3.306	$1.140

Note : Per hour salary is based on 52 weeks per year and 40 hours per week.

The economic cost of construction machinery was obtained from the engineering cost estimation (refer to Engineering Appendix Report) as shown below:

Wheel loader	$38.3 per hour
Motor grader	$46.8 per hour
Tractor	$47.2 per hour

d) Cost saving

Based on the above result, the required cost for disaster restoration work was estimated by multiplying the disaster frequency by unit cost as shown in Table C.2-18. After the completion of the project, this cost would be eliminated. Therefore, $31.6 thousand is the direct benefit from protecting against the disasters along the project road.

Table C.2-18 Cost Saving Benefit From Eliminating Disasters Prevention Work

Staff & Machinery	Necessary Numbers for one Disaster	Cost $ per hour	Frequency Number per year	Necessary Cost $ per year
Operator	1.051	0.973	681.6	697
A.Operator*	0.436	0.637	681.6	189
Laborer	0.077	0.547	681.6	29
Chief	0.154	1.140	681.6	120
Wheel Loader	0.397	38.3	681.6	10364
Motor Grader	0.167	46.8	681.6	5327
Tractor	0.462	47.2	681.6	14863
Total				31589

Note : * Assistant Operator

(2) Waiting time Saving benefit from disaster restoration work

During the disaster restoration work, vehicles passing through the disaster spot on the existing road are forced to stop and wait until completion of this work. After the completion of the project road, this waiting time is expected to be completely eliminated. This elimination of the waiting time resulting from disaster restoration work can be thought of as a benefit. This benefit was estimated using the following steps:

a) The number of vehicles forced to wait for completion of disaster restoration work

There was no available information on the number of vehicles forced to wait for the completion of the disaster restoration work. Since on the project road, more disasters have occurred on the section between Santa Barbara and Caranavi than between Caranavi and Bella Vista, the following analysis is focused primarily on the former road section.

The existing traffic volume on the project road is 301 vehicles per day. Assuming that disaster restoration work is not undertaken at night, the traffic volume encountered with the disaster restoration work during the daytime (12 hours from 6:00 am to 6:00 pm) is 279 vehicles as is already explained in Section C.1.1 (Traffic survey shows that the traffic volume at night is 10% of total traffic volume). Assuming further that the traffic volume is distributed uniformly on the road during the day-time, the number of vehicles encountering any disaster restoration work is one sixth of the total daytime traffic volume. Since it takes two hours for restoration following a disaster as explained above and the day time is assumed to be 12 hours for one disaster (2/12 = 1/6), 47 vehicles are estimated to encounter the disaster restoration work (279 x (1/6) = 47). As the number of disasters is 340.8 per year as explained above, the traffic volume encountering disaster restoration work on the road can be estimated to be 16,018 (47 x 340.8) per year. The above is explained on the total volume of traffic for convenience, however, as the time value differs in the kind of vehicle, the same estimation must be made for each vehicle type. Table C.2-19 shows the result of this estimation.

Table C.2-19 The Number of Vehicles Encountering Disaster Restoration Work by Type of Vehicle

		1989	2001	2010	2020
Pass. Car	A	17	54	88	130
	B	3	8	13	20
	C	869	2760	4499	6646
Bus	A	14	31	48	68
	B	2	5	7	10
	C	716	1585	2454	3476
Light	A	105	239	353	484
Truck	B	16	36	53	73
	C	5368	12218	18045	24742
Medium	A	16	37	54	74
Truck	B	2	6	8	11
	C	818	1891	2760	3783
Heavy	A	149	523	850	1230
Truck	B	22	78	128	185
	C	7617	26736	43452	62878

Note : A Traffic volume per day (vehicles)
B Average traffic volume encountering the disaster restoration work per one disaster (vehicles)
C Traffic volume encountering the disaster restoration work per year (volume)

b) Waiting time saving benefit

The reduction in waiting time gained by eliminating disaster restoration work can be obtained by multiplying the traffic volume listed in the line "B" of Table C.2-19 by the waiting time. As it is assumed the traffic flow is uniformly distributed along the project road and it takes two hours to finish any restoration work, it is reasonable to assume an average waiting time to be one hour. The benefit can be calculated by multiplying this waiting time saving by the time value for each type of vehicle. The time value by vehicle type is shown in Tables C.2-6. Table C.2-20 summarizes this benefit by vehicle type and by year.

Table C.2-20 Waiting Time Saving Benefit From Disaster Prevention

		1989	2001	2010	2020
Passenger	A	869	2760	4499	6646
Car	B	2.765	3.418	4.065	4.928
	C	2403	9434	18288	32751
Bus	A	716	1585	2454	3476
	B	15.740	19.456	23.141	28.058
	C	11270	30838	56788	97530
Light	A	5368	12218	18054	24742
Truck	B	4.010	4.957	5.896	7.149
	C	21526	60565	106446	176881
Medium	A	818	1891	2760	3783
Truck	B	2.895	3.578	4.256	5.160
	C	2368	6766	11747	19520
Heavy	A	7617	26736	43452	62878
Truck	B	3.449	4.263	5.071	6.148
	C	26271	113976	220345	386574
Total		63837	221578	413614	713256

Note : A Total waiting hours (hours)
B Time value ($/hour)
C Waiting time saving benefit from disaster restoration work ($)

(3) Disaster Prevention Benefit

Together with Tables C.2-18 and C.2-20, benefit from disaster prevention can be estimated. This benefit is common to each alternative, since disaster prevention measures are the same for each case. The benefit by year is summarized in Table C.2-21.

Table C.2-21 Disaster Prevention Benefit
(Unit : Dollar)

Year	Cost Benefit	Time Benefit	Total
2001	31589	221578	253167
2010	31589	413614	445203
2020	31589	713256	744845

Note : Benefit is common to each alternative.

C.2.5 Accident Reduction Benefit

Some traffic accidents occur on the existing road every year. Most of these accidents have been caused by unfavorable existing road conditions such as numerous sharp and small curves, narrowness, etc. After the completion of the project road, these accidents are expected to be avoided. The reduction of these traffic accidents should decrease damage, which results in a saving of repair cost to damaged vehicles, medical treatment cost for the injured, and loss of the human life. Therefore, the reduction of traffic accidents is one of the benefits accrued from the completion of this project road.

(1) Traffic accident data

According to the traffic data collected by the police along the project road, the number of the accidents and causalities were as follows:

Year	1986	1987
Traffic Volume (vehicle/day)	181	246
Accidents (case/year)	11	14
No. of the dead (person/year)	6	8
No. of the wounded (person/year)	26	47

With the above data the number of accidents cases per 1000 vehicles is calculated 0.167 in 1986 and 0.156 in 1987 using the following equation:

In 1986 11/(181 x 365) x 1000=0.167
In 1987 14/(246 x 365) x 1000=0.156

Therefore, the average number of accident occurrences can be estimated as 0.162 cases/1000 vehicles for two yeas . On the other hand, the degree of vehicle damage is calculated from the same source as shown below:

Degree of Damage	Accidents (cases)	Share (%)
Severe damage	6	24.0
A little severe damage	14	56.0
small damage	5	20.0

In the above Table the category "Severe damage" includes vehicles which crash into the bottom of the valley and the category "Small damage" means slight damage of a door, windshield, bumper, etc. The number of accidents is combined from both 1986 and 1987 due to the scarcity of accident data.

(2) Benefit from the reduction of vehicle damage

According to the interview survey of auto repair shops conducted by the Study Team, the average damage cost were estimated as follows:

Severe Damage	$ 7,533
A Little Severe Damage	$ 1,600
Small Damage	$ 400

Weighted by the frequency of each kind of accident, average damage cost per vehicle was calculated at 2783.9 dollars ($ 7,533x0.24 + $ 1,600x0.56 + $ 400x0.20). However, considering the cause of these accidents, 6 of the 25 cases were caused by falling asleep while driving, drunken driving, and driving fatigue. These accidents can be by no means eliminated even if the road conditions are improved. Consequently, the number of the accident cases per 1000 vehicles should be modified as follows:

$$0.162 \times (25 - 6)/25 = 0.123$$

Using the above traffic accident cases per 1000 vehicles, the benefit from the reduction of vehicle damage can be calculated as shown bellow:

Year	2001	2010	2020
Benefit (dollar)	110485	174102	248217

Note : Calculation is as follows:
2001 884x365x0.123/1000x2783.9
2010 1393x365x0.123/1000x2783.9
2020 1986x365x0.123/1000x2783.9

(3) Benefit from the reduction of casualties

As already indicated in the above traffic accident data, some people were killed or injured in these traffic accidents. In the case of the injured, some medical treatment cost is necessary. On the other hand, in the case of the dead, the production factor as labor force is lost. Both are considered to be an economic loss from the viewpoint of national economic activities. After improving the existing road, these losses are expected to be avoided. Therefore, these loss can be treated in turn as benefit.

a. Victims per 1000 vehicles

From the above traffic accident data, the injured and the dead per 1000 vehicles can be calculated. As accident data has been only available for two years, the average of data taken over two years was used in this analysis. However, as is the same with vehicle damage, this average should be also modified by excluding accidents caused from falling asleep, drunken driving, etc.

<u>Cases resulting in Injury</u>

In 1986 26/(181x365)x1000=0.394
In 1987 47/(246x365)x1000=0.523

Average	(0.394+0.523)/2=0.459
Modified	0.459x(25-6)/25=0.349

The number of the injured in the future can be calculated as shown bellow by multiplying the traffic volume by 0.349.

In 2001	884x365x0.349/1000=113 (persons)
In 2010	1393x365x0.349/1000=178 (persons)
In 2020	1986x365x0.349/1000=253 (persons)

Cases resulting in Death

In 1986	6/(181x365)x1000=0.091
In 1987	8/(246x365)x1000=0.089
Average	(0.091+0.089)/2=0.09
Modified	0.09x(25-6)/25=0.068

The number of the dead can be also calculated as shown below by multiplying the traffic volume by 0.068.

In 2001	884x365x0.068/1000=22 (persons)
In 2010	1393x365x0.068/1000=35 (persons)
In 2020	1986x365x0.068/1000=49 (persons)

b. Benefit calculation

Using the number of injured and dead calculated above, the benefit from their reduction is estimated. The procedures and the results are as follows:

The Injured Cases

According to the results obtained by an interview to the medical service in Caranavi, the average medical treatment cost for the injured was estimated as follows:

Serious injury	$ 1,333 (Bs. 4,000)
Semi-serious injury	$ 367 (Bs. 1,100)
Slight injury	$ 33 (Bs. 100)

From the above traffic accident data, the composition of "Serious", "Semi-serious", and "Slight" injury is not available. However, the medical service gave the information that 5 people were seriously injured, 12 people semi-seriously injured, and 13 people slightly injured in one traffic accident case. Consequently, the medical treatment cost was estimated using a weighted average as indicated below:

$$1333x(5/25) + 367x(12/25) + 33x(13/25) = 459.9$$

As a result, the benefit from a decrease in the number of injured is estimated as follows:

In 2001	113x459.9= 51969 (dollars)
In 2010	178x459.9= 81862 (dollars)
In 2020	253x459.9=116355 (dollars)

Cases resulting in Death

If a person is killed in a traffic accident, the person is lost from the national labor force, which means the loss of the increment of production. If the person does not encounter the accident, the person can continue to contribute to the production activities. Therefore, a reduction in loss of human life must be a benefit, too. This benefit was calculated in the following way:

Step 1 Estimation of the average age of the labor force

There was no data available on age of those killed by traffic accidents. It is assumed to be same as the average age of labor force from 15 to 60 years old in Bolivia. According to population data by age class from the INE, the average age of the labor force was calculated using a weighted average for age and the population as shown in Table C.2-22. Consequently, the average age of the labor force was estimated to be 31.4 years old.

Table C.2-22 Average Age of Labor Force

Age Class	Medium	Population	Weight	Medium*Weight
15 - 19	17	661434	0.199	3.4
20 - 24	22	565436	0.170	3.7
25 - 29	27	481738	0.145	3.9
30 - 34	32	404362	0.122	3.9
35 - 39	37	341435	0.103	3.8
40 - 44	42	278043	0.084	3.5
45 - 49	47	231099	0.069	3.3
50 - 54	52	197285	0.059	3.1
55 - 59	57	166716	0.050	2.9
Total		3327548		31.4

Step 2 Life expectancy

According to the publication "Economic and Social Progress in Latin America 1989 Report" (Inter-American Development Bank), the life expectancy of in Bolivia is estimated to be 50.7 years. Therefore, unless a person is killed in a traffic accident, a person of average age could continue to live a further 19 years (50.7 - 31.4). As a result, the life expectancy of those killed in traffic accidents is assumed to be 19 years.

Step 3 Benefit from decreasing the number of people killed

Those killed by traffic accidents include not only working people but also non-working people. Therefore, the calculation of this loss is reasonable to be done on the basis of the per capita national income. According to the data from BANCO CENTRAL DE BOLIVIA, GERENCIA DE ESTUDIOS ECONOMICOS, the per capita national income is 633 dollars in 1989 (provisional value). As explained in Section C.2.1 (3) Setting Time Value, the real income

is expected to increase in the future, which is calculated by the following equations:

$$2001 \quad \$633 \times (1.048/1.028)^{12} = \$ \quad 798$$
$$2010 \quad \$633 \times (1.048/1.028)^{21} = \$ \quad 949$$
$$2020 \quad \$633 \times (1.048/1.028)^{31} = \$ \; 1{,}150$$

Unless those are killed in the traffic accident, the benefit from decreasing the number of people killed is calculated by multiplying the above income by the total number of people killed and the above 19 years. The benefit in this category was calculated as follows:

In 2001 798 x 22 x 19 = 333564($)
In 2010 949 x 35 x 19 = 631085($)
In 2020 1,150 x 49 x 19 = 1070650($)

(4) Benefit from the reduction of traffic accidents

From the above analysis, benefit from the reduction of traffic accidents is summarized as shown in Table C.2-23.

Table C.2-23 Benefit from Reduction of Traffic Accidents
(Unit : Dollars)

Item	2001	2010	2020
Vehicle Damage	110385	174102	248217
Reduction of the injured	51969	81862	116355
Reduction of the dead	333564	631085	1070650
Total	495918	887049	1435222

C.2.6 Transportation Cost Reduction Benefit for Refrigerated Trucks

At present, most beef consumed in La Paz city is transported by airplane from the production site in the Beni department or cow are carried by trucks with alive. However, airplanes currently carrying beef are very old and are considered to be difficult to continue operating even in

the near future. Therefore, the beef transportation will be transfered into refrigerated trucks whether the project road is completed or not. At present, some cows are carried by trucks with alive but after the completion of the project road, this transportation will be also converted into the refrigerated trucks. The vehicle operating cost of the refrigerated trucks can be saved if the project road is completed, compared with the existing road situation. Therefore, this saved cost can be counted as one of the benefits obtained from the completion of the project road. This benefit was estimated by the following procedures:

1) Vehicle operating cost of refrigerated truck

Through an interview of a Japanese automobile manufacturing company, it was gained that the vehicle operating cost of a refrigerated truck is almost 1.6 times as that of usual type of truck. The loading capacity of a refrigerated truck was assumed to be 10t. Therefore, the vehicle operating cost of a refrigerated truck was calculated by multiplying the vehicle operating cost of medium truck by 1.6, since the loading capacity of medium truck was also assumed to 10t as shown in Table C.2-13. Based on the vehicle operating cost of medium truck shown in Table C.2-15, the vehicle operating cost of the refrigerated truck was estimated as shown in C.2-24.

Table C.2-24 Vehicle Operating Cost of Refrigerated Truck

(unit: $/km)

Road Section	S/B-(F)	(F)-(K)	(K)-C/V	C/V-(Q)	(Q)-(V)	(V)-B/V
Existing	2.046	1.949	2.048	2.115	2.192	2.126
Paved	0.930	0.885	0.909	0.990	1.011	1.010
Unpaved	1.190	1.192	1.192	1.285	1.304	1.302

Note: Existing: Existing road (Gravel , one lane)
Paved: Paved project road (Asphalt, two lanes)
Unpaved: Unpaved project road (Gravel, two lanes)

2) Benefit of refrigerated truck

The benefit of the refrigerated truck can be obtained by subtracting the vehicle operating cost of refrigerated truck of "with project case" from that of "without project case". The benefit is calculated in the following equation:

$$B = \Sigma TV_i \Sigma (VOCB_{ij} \times DB_i - VOCA_{ij} \times DA_j)$$

B : Benefit of refrigerated truck
TV : Traffic volume per year
VOCB: Vehicle operating cost of without project case
VOCA: Vehicle operating cost of with project case
DB : Distance of without project cas
DA : Distance of with project case
i : Vehicle type
j : Road Section

Using the vehicle operating cost listed in Table C.2-24, distance of the road section mentioned in (4) of section C.2.3, and traffic volume shown in Tables B.5-16 and B.5-17, benefit of refrigerated truck was estimated. The result is summarized in Table C.2-25

Table C.2-25 Transportation Cost Reduction Benefit of Refrigerated Truck

(Unit: $)

Case / Year	Case P-1 Case P-5	Case P-2 Case P-6 Case P-7	Case P-3	Case P-4	Case U
2001	998834	772148	772148	772148	772148
2002	1019275	787950	787950	787950	787950
2003	1040134	922104	804075	804075	804075
2005	1083141	1083141	837321	837321	837321
2006	1105307	1105307	979882	979882	979882
2010	1198601	1198601	1198601	926577	926577
2011	1208233	1208233	1208233	1071128	934023
2020	1217943	1217943	1217943	1217943	1003791

C.2.7 Development Benefit

As already explained in Section B.5 (See 3) Development traffic), the completion of the project road is expected to increase the amount of agricultural products in the influenced areas, since the agricultural potentiality can be developed after the access to the large market (La Paz city) from the influenced areas is significantly improved by the project road. The projected production increment is shown in Table B.5-13. The increase in production means the expansion of economic activities, which results in an increase of the national income in Bolivia. As this increment is brought about by the completion of the project road, it is considered the benefit of this project. In this section, among the agricultural products listed in Table B.5-13, the income from "rice", "maize", "banana", and "yuca" were examined under the available data. The income increment was estimated by subtracting the production cost from the producer price of each agricultural product multiplying by increment by development.

The theoretical ground of this development benefit is provided in Appendix C.7.

(1) Rice

According to the interview survey at INE, the composition of rice production cost is as follows:

Labor Cost	47.4 %
Fixed Cost	27.0 %
Fertilizer & miscellaneous cost	25.6 %

On the other hand, the producer's cost is Bs.40-50 per quintal according to information obtained by interviewing some farmers around Caranavi.

The producer cost differs in its grade. Therefore, it is reasonable to adopt a median value, that is, 1 quintal Bs.45 for producer's cost. Taking into consideration that 1 quintal=46kg and $ 1 = Bs.2.9, the income of farmers is expected to increase by $ 159.9 per ton. The way of calculation is as follows:

Increment of Producer's income per ton

45/46 x 1000 x 0.474/2.9 =159.9 (dollars/ton)

Where:

45 : producer's cost in terms of Bs./quintal
46 : 1 quintal = 46kg (conversion quintal into kg)
1000 : 1 ton = 1000kg (conversion kg into ton)
0.474: Labor cost ratio
2.9 : $.1 = Bs.29 (conversion Bs. into $)

Therefore, the income increment of producer from rice production development was estimated at $159.9 per ton.

(2) Banana

The breakdown of the costs of planting 750 banana trees was obtained through interviewing farmers at Caranavi:

Labor cost	73.9 %
Other cost	26.1 %

The following information on the cost was also obtained from also the same source:

Producer's cost per ton Bs.3.5 per quintar

The income of producers of banana can be obtained by the following calculation: the calculation method is the same as rice.

Increment of producer's income per ton

3.5/46 x 1,000 x 0.739/2.9= 19.4 (dollars)

As a result, the income increment of banana production development was estimated at $ 19.4 per ton.

(3) maize

The cost information on maize was obtained as follows:

Producer's cost Bs.8 per quintal

Since the share of cost items was not available, assume that the cost composition is the same as that of Banana.

Using the above information, producer's income was calculated as follows:

Increment of producer's income per ton

8/46 x 1000 x 0.739/2.9 = 44.3 (dollars)

The increment of maize production development was estimated at $ 44.3 per ton.

(4) Yuca

The cost composition of yuca was estimated by interview as follows:

Labor cost	93.3 %
Other cost	6.3 %

The other information on the cost of yuca was also obtained by interview as follows:

Producer's cost Bs.12.0 per quintal

The producer's income was estimated through the following calculation:

Increment of producer's income per ton

12/46 x 1000 x 0.933/2.9 = 83.9 (dollar)

Consequently, the increment of yuca production development was estimated at $ 83.9 per ton.

Using the income increment estimated above and the future increment production in saved cultivation area in Table B.5-13, the total income increment can be estimated. However, it must be kept in mind that all of this producer's income increment is not attributed to the completion of the project road.

The other road sections between the influenced area and the

market place (La Paz city) also contribute to this income increment. The above estimated increment should be discounted by the rate of road distance of the project road to the total distance. However, the road sections between La Paz and Cotapata, between Bella Vista - San Borja, and between Yucumo and Reyes excluded from the total distance, considering as sunk cost road section. Therefore, based on Fig. C.2-1, the discount rates in each influenced area were calculated.

Pando Traffic generation point is assumed to be El Choro

$$\text{Discount Rate} = \frac{\text{(Santa Barbara-Bella Vista)}}{\text{(El Choro-Reyes)+(Cotapata-Bella Vista)}}$$

$$= \frac{108}{404+157} = 19.3\ (\%)$$

Beni Traffic generation point is assumed to be San Ignacio

$$\text{Discount Rate} = \frac{\text{(Santa Barbara-Bella Vista)}}{\text{(San Borja-San Ignacio)+(Cotapata-Bella Vista)}}$$

$$= \frac{108}{135+159} = 36.7\ (\%)$$

La Paz Traffic generation point is assumed to be Guanay

$$\text{Discount Rate} = \frac{\text{(Santa Barbara-Caranavi)}}{\text{(Cotapata-Caranavi)+(Guanay-Caranavi)}}$$

$$= \frac{48}{91+69} = 30.0\ (\%)$$

Using the above discount rates, the total producer's income increment was estimated about 3.3 million dollars in 2020 as shown in Table C.2-26. This benefit is common to each alternative.

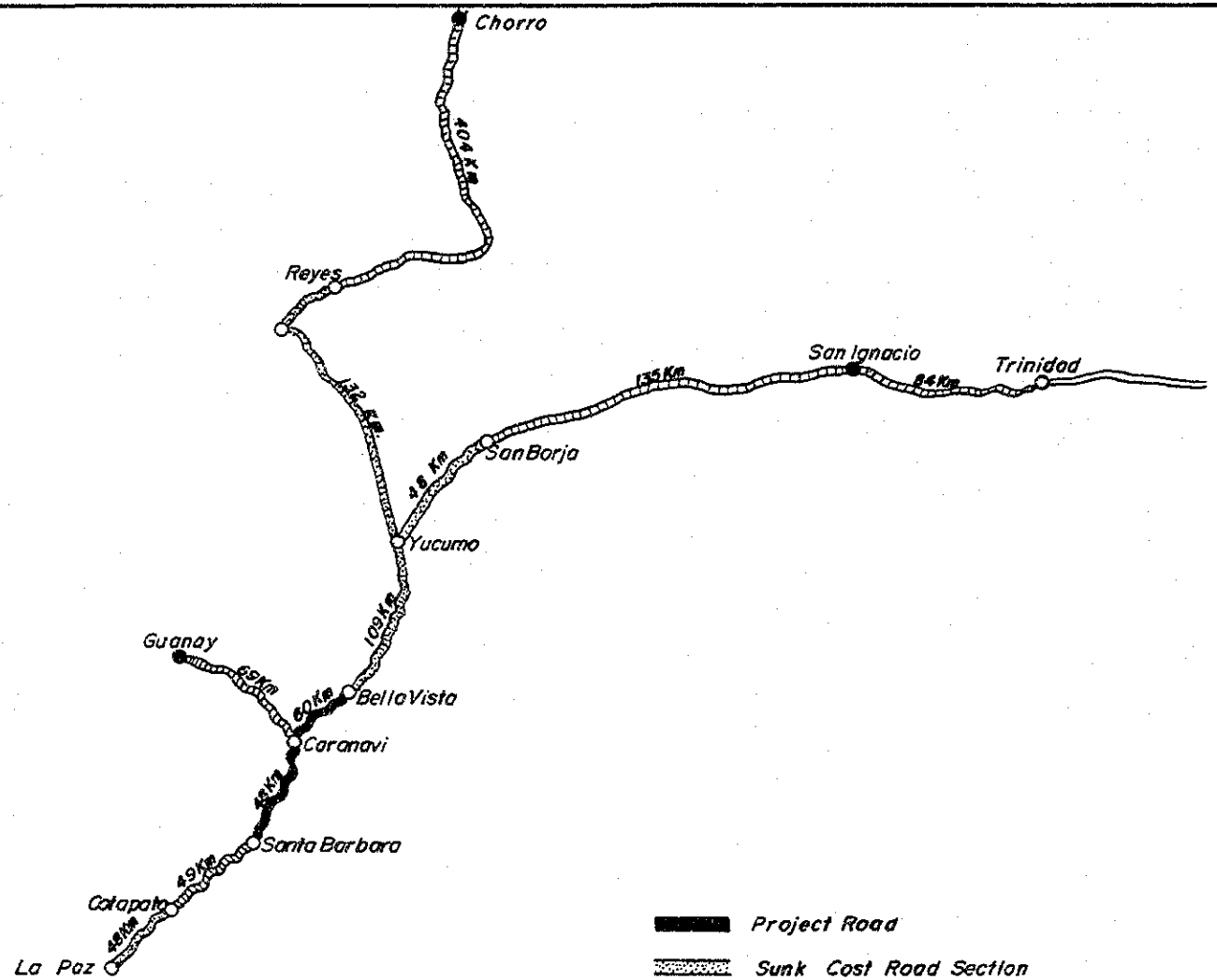


Fig. C.2-i Road Distance to La Paz From the Influenced Area

Table C.2-26 Development Benefit

(Unit : US$)

		Rice	Banana	Maize	Yuca	Total
2001	La Paz	16837	140	2312	76	19365
	Beni	122296	441	9332	1016	133086
	Pando	30706	139	2291	259	33395
	Total	169840	720	13936	1351	185846
2010	La Paz	221861	1845	30394	881	254981
	Beni	1609918	5817	109807	13333	1738874
	Pando	404275	1846	30104	3465	439690
	Total	2236054	9508	170306	17679	2433546
2020	La Paz	301060	2491	41199	1208	345958
	Beni	2184662	7889	148859	18167	2359577
	Pando	548642	2497	40826	4566	596531
	Total	3034363	12877	230884	23941	3302066

Note : Benefit is common to each alternative.

C.3 Economic Costs

The construction and maintenance costs estimated from the engineering study in Chapter 6 of Volume 1 are not the true economic cost since the financial cost includes transfer items such as taxes. As the financial cost does not represent the real figure for the economic analysis, the economic construction and maintenance costs are obtained by subtracting all taxes from their respective financial amount.

C.3.1 Construction and Maintenance Costs for Economic Analysis

The financial construction and maintenance costs indicated in Tables 6.2-1 and 6.2-3 of Volume 1 were converted into economic terms by subtracting the taxes. Tables C.3-1 and C.3-2 summarize the economic construction and economic maintenance costs by alternative and by construction stage, respectively.

Table C.3-1 Economic Construction Costs
(Unit : Thousands Dollars)

Year	CASE P-1	CASE P-2	CASE P-3	CASE P-4	CASE P-5	CASE P-6	CASE P-7	CASE U
1996	17224	15630	15630	15630	16415	15630	15630	15630
1997	34450	31252	31252	31252	32830	31252	31252	31252
1998	34450	31252	31252	31252	32830	31252	31252	31252
1999	34450	31252	31252	31252	32830	31252	31252	31252
2000	34450	31252	31252	31252	32830	31252	31252	31252
:	-	-	-	-	-	-	-	-
2003	-	15025	-	-	-	7099	7099	-
:	-	-	-	-	-	-	-	-
2006	-	-	15338	-	-	-	-	-
:	-	-	-	-	-	-	-	-
2008	-	-	-	-	7099	-	15338	-
:	-	-	-	-	-	-	-	-
2011	-	-	-	15338	-	7099	-	-
:	-	-	-	-	-	-	-	-
2016	-	-	-	-	7099	-	-	-
:	-	-	-	-	-	-	-	-
2019	-	-	-	-	-	7099	-	-

Table C.3-2 Economic Maintenance Costs
(Unit : Thousand Dollars)

Year	CASE P-1	CASE P-2	CASE P-3	CASE P-4	CASE P-5	CASE P-6	CASE P-7	CASEU
2001	147	315	315	315	267	315	315	315
2002	147	315	315	315	267	315	315	315
2003	147	315	315	315	267	7633	7381	315
2004	147	147	628	628	534	267	267	628
2005	147	147	628	628	7633	267	267	3659
2006	294	147	628	628	267	267	267	315
2007	294	147	147	628	267	534	534	315
2008	294	147	147	628	267	7633	534	315
2009	294	294	147	628	534	267	147	628
2010	294	294	147	628	7633	267	147	3659
2011	294	294	147	628	267	267	147	315
2012	294	294	294	147	267	534	147	315
2013	294	294	294	147	267	7633	147	315
2014	294	294	294	147	534	267	294	628
2015	294	294	294	147	7633	267	294	3659
2016	294	294	294	147	267	267	294	315
2017	294	294	294	294	267	534	294	315
2018	294	294	294	294	267	7633	294	315
2019	294	294	294	294	534	267	294	628
2020	294	294	294	294	7633	267	294	3659

C.4 Economic Analysis and Evaluation

C.4.1 Calculation of Economic indicators

In order to assess project viability, the following economic indicators were calculated considering the above-mentioned benefit and cost stream.

a) Benefit Cost Ratio (B/C)

B/C is a ratio of the total present value of economic benefit to the total present value of economic cost. For project viability a B/C of more than 1.0 is required.

$$B/C = \Sigma B_t /(1+i)^t \ / \ \Sigma C_t/(1+i)^t$$

Here, B : Present value of benefit
C : Present Value of cost
i : Discount rate (12%)
t : Year
T : Calculation period

b) Net Present Value (NPV)

NPV is the difference between the total present value of benefit and the total present value of cost. A positive value of NPV is required for project viability.

$$NPV = \Sigma B_t/(1+i)^t - \Sigma C_t/(1+i)^t$$

c) Internal Rate of Return (IRR)

IRR is a discount rate such that the net present value equals zero. The higher the value of IRR, the more desirable the project, however, the value must be higher than the interest rate of the IDB (12%).

$$IRR = \Sigma (B_t-C_t)/(1+i)^t = 0$$

Table C.4-1 summarizes the value of the above three economic indicators by alternative. The benefit and cost stream for each alternative are shown in the Appendix C.2(1) to C.2(7) of this report.

Table C.4-1 Value of Economic Indicators by Alternative

Alternative	B/C	NPV ($)	IRR (%)
CASE P-1	1.890	97625296	19.7
CASE P-2	1.867	91676176	19.4
CASE P-3	1.794	82904640	18.7
CASE P-4	1.700	72061976	18.1
CASE P-5	1.857	94234784	19.8
CASE P-6	1.894	94109362	19.8
CASE P-7	1.877	93097204	19.6
CASE U	1.552	56610392	17.2

According to Table C.4-1, the alternative "CASE P-1" showed the highest value of NPV. The alternative "CASE P-5" (asphalt macadam pavement from the opening year of the project road) and "CASE P-6" (asphalt macadam pavement in 2003) were ranked highest for the value of IRR. On the other hand, the alternative "CASE U" (the unpaved road project) was ranked lowest. However, since the difference of their IRR values is very small (only 2.6%), it can be said that there is no significant difference between the highest ranked alternative and the lowest ranked one. Even for the CASE U, the three economic indicators show sufficiently higher values when compared with those desired for project viability, as mentioned in C.4.1. Consequently, all of the above eight alternatives can be considered to be significantly feasible from this economic analysis. In addition, it is pointed out that the value of the indicators gradually deteriorates as the year designated for pavement work is delayed. Therefore, it is desired to be paved as soon as possible.

C.4.2 Sensitivity Analysis

In addition to the results of the above economic analysis it must be kept in mind that the estimated benefit and cost be examined from the viewpoint of projection errors and future uncertainty. Since the construction of this project is planned to be completed in the year 2000 and project

benefits will continue to be generated for a long time, in the meanwhile, the future social and economic environment might change. This may result from an unexpected change in the political situation, fluctuation of the world economy, weather conditions and so on, which will in turn bring about the enlargement of the projection errors for the estimated benefit and cost. Therefore, in order to examine the above unexpected and uncertain situations for the above economic indicators, a sensitivity analysis was performed on the assumption of a decrease in benefit and an increase in cost (there are no problems for the opposite case since this would make the values of the economic indicators much better).

In this sensitivity analysis the project benefit is assumed to decrease by 5%, 10%, 15% and 20%. On the other hand, the project cost is assumed to increase by 5%, 10%, 15% and 20%. The results of this sensitivity analysis are shown in Appendix C.3(1) to C.3(7). Table C.4-2 shows the results of the worst case (cast 20% up and benefit 20% down). CASE P-1, CASE P-6 and CASE P-7 were feasible even in the worst case.

Table C.4-2 The Worst Case in the Sensitivity Analysis

Alternative	B/C	NPV ($)	IRR (%)
CASE P-1	1.008	1275536	12.1
CASE P-2	0.996	-656064	12.0
CASE P-3	0.957	-6744624	11.5
CASE P-4	0.907	-14426768	11.0
CASE P-5	0.991	-1566016	11.9
CASE P-6	1.010	1602816	12.1
CASE P-7	1.001	154464	12.0
CASE U	0.828	-26467416	10.0

Judging from the above sensitivity analysis, except for CASE P-2, CASE P-3, CASE P-4, CASE P-5 and CASE U, other alternatives are feasible even in most pessimistic situation, that is, a 20% increase in the project cost and a 20%

decrease in the project benefit. Therefore, CASE P-1, CASE P-6 and CASE p-7 can be said to be significantly viable.

C.4.3 Cumulative Financial Cost required until 2020

The above economic analysis provided the project evaluation from the comparison of the project cost and project benefit. However, even if the project road brings about a large benefit, the project might not be viable in the case where the executing agency of the project (SNC) has difficulty in bearing its financial burden including not only the initial project cost and subsequent maintenance cost after the completion of the project. Considering the existing SNC financial situation (the SNC desires to have several large scale road projects desired to be completed in a near future), it is requested to minimize the cumulative financial project cost (including the future maintenance cost) as much as possible. Table C.4-3 shows the cumulative financial cost required up until 2020.

Table C.4-3 Cumulative Financial Cost Until 2020
(Unit : Thousand Dollars)

Alternative	Initial Cost	Maintenance Cost	Total Cost
CASE P-1	192574	5020	197594
CASE P-2	170858	27009	197867
CASE P-3	170858	28413	199271
CASE P-4	170858	30753	201611
CASE P-5	178981	26166	205147
CASE P-6	170858	34143	205001
CASE P-7	170858	35937	206795
CASE U	170858	31540	202398

Table C.4-3 indicates that CASE P-1 is the least cumulative financial cost until 2020, followed by CASE P-2, then CASE P-3. These three alternatives are the asphalt concrete pavement case. On the other hand, the gravel pavement case (CASE U) and the asphalt macadam cases (CASE P-5, CASE P-6 and CASE P-7) require much more cost.

C.4.4 Qualitative benefits

In addition to the quantitative benefits as explained in C.2, the proposed project brings about many qualitative benefits. These qualitative benefits are summarized as follows:

a) In the process of planning and design

- Economic and educational effect

  The various surveys conducted for the proposed project serve as an incentive to private development and private investment. In addition, the advanced technology and experience contributed by foreign consultants in the process of the study can be transferred to local staff.

b) During construction

- Demand effect for construction materials
  During the construction period the demand for local materials is expected to increase.

- Demand effect for employment
  Many skilled and unskilled laborers will be hired during construction, which will decrease the amount of unemployment and underemployment.

- Technology transfer
  Technology related to the construction work is transferred to the local staff.

- Resource development
  In the case that some resources are procured from around the construction site, an area with a high growth potential will be encouraged.

c) After completion of the project

- User's benefit
  The completion of the project will improve driver and passenger comfort and will ensure punctuality between the origin and destination. In addition, it is sure that the damage to goods carried by trucks can be drastically

decreased, especially on the asphalt surface road.

- Energy saving
  Decrease in gasoline consumption will contribute to world energy saving.

Among these qualitative benefit, it must be kept in mind the user's benefit after the completion of the project road. As explained in Chapter B, most of vehicles passing through the project road are estimated to be trucks (90% on the road section between Santa Barbara and Caranavi and 95% on the road section between Caranavi and Bella Vista in 2020). In addition, the number of trucks in 2020 is forecast to increase by about 7 to 8 times compared with the existing volume. Therefore, it makes no doubt that the decrease of the damage to commodity and goods carried by trucks brings about a lot of qualitative benefit in the future. This suggests that the paved road is more desirable than the unpaved road for the project road.

C.4.5 Economic Evaluation

From the above economic analysis, the following points were obtained:

1) From the analysis of the economic indicators

   All alternatives are considered feasible, however, among others, CASE P-1, CASE P-2, CASE P-5, CASE P-6 and CASE P-7 show more than 19.0% of IRR value, more than 1.800 of B/C ratio and more than 90 million dollars of NPV. Moreover, there is no wide difference among values of these economic indicators.

2) From the results of the sensitivity analysis

   CASE P-2, CASE P-3, CASE P-4, CASE P-5 and CASE U are not passable because they are' not feasible in the most pessimistic situation (cost 20% up and benefit 20% down). Other three alternatives are feasible even in the most pessimistic situation. Therefore, CASE P-1, CASE P-6 and CASE P-7 are viable.

3) From the cumulative financial cost

Considering the future financial burden of SNC, the cumulative financial cost is desirable as much smaller as possible. The cumulative financial cost of an asphalt concrete pavement cases was smaller than that of an asphalt macadam pavement cases and that of gravel case. CASE P-1 shows the least cumulative financial cost, followed by CASE P-2.

4) From the viewpoint of qualitative benefit

Judging from the large traffic volume of trucks, damage to goods carried by trucks should be decreased. Therefore, a pavement surface road is significantly desired.

Summarizing the above 1) to 4), CASE U is not recommended from the viewpoint of the sensitivity analysis and qualitative benefit. CASE P-2, CASE P-3 and CASE P-4 are also not recommended from the results of the sensitivity analysis, because they are not feasible in the most pessimistic situation. Moreover, CASE P-5, CASE P-6 and CASE P-7 are not recommended since the cumulative financial cost is high. As a result, the remaining alternative, CASE P-1, is said to be much superior to other alternatives.

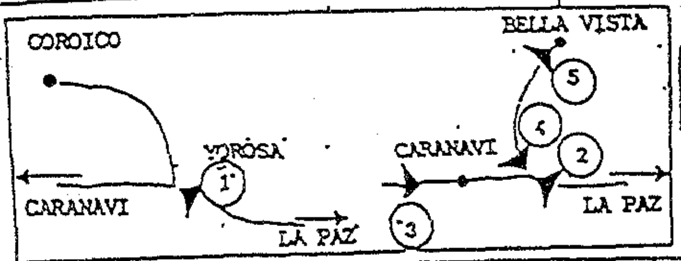
In conclusion, from the above reasons, it is strongly recommended to select CASE P-1 (paved surface from the opening year).

APPENDIX

Appendix B.1 Questionnaire Sheet

FORMULARIO DE ENCUESTA A LOS CONDUCTORES
(ESTUDIO DE MEJORAMIENTO LA CARRETERRA SANTA BARBARA – BELLA VISTA)

1 HARARIO DE CIRCULACATION	2 CLASE DE VEHICULO	3 NUMERO DE PLACA	4 MARCA DEL VEHICULO	5 ENCUESTA PREVIA	6 VIAJE ORIGEN	7 VIAJE DESTINO	8 OBJETO DEL VIAJE	9 CAPACIDAD DE CARGO	10 CARGO TRANSPORTADA ARTICULO	10 CARGO TRANSPORTADA PESO	11 NUMERO DE PASAJEROS
AM :	LO B1 C1 CA			N 3			1 4 7				
	C B2 C2 M			1 4			2 5 8				
PM :	OL B3 C3 O			2 5			3 6				
AM :	LO B1 C1 CA			N 3			1 4 7				
	C B2 C2 M			1 4			2 5 8				
PM :	OL B3 C3 O			2 5			3 6				
AM :	LO B1 C1 CA			N 3			1 4 7				
	C B2 C2 M			1 4			2 5 8				
PM :	OL B3 C3 O			2 5			3 6				
AM :	LO B1 C1 CA			N 3			1 4 7				
	C B2 C2 M			1 4			2 5 8				
PM :	OL B3 C3 O			2 5			3 6				
AM :	LO B1 C1 CA			N 3			1 4 7				
	C B2 C2 M			1 4			2 5 8				
PM :	OL B3 C3 O			2 5			3 6				



1:NEGOCIOS	4:SOCIALES	7:RETORNO A SU VIVIENDA
2:DIRIGIENDOSE AL TRABAJO	5:TURISMO,RECUPERACION FICICA	8:OTROS
3:DIRIGIENDOSE ALA ESCUELA,COLEGIO,ETC.	6:COMPRAS	

L VEHICLE LIVIANO	B1 MICROBUSES,12 A 21 ASIENTOS	C1 CAMIONES PEQUENOS,2.5 TON.(50 QQ) A 5.5 TON.(110 QQ)	CA CAMIONES CON ACOPLADO,3.0 MAS EJES
C CAMIONETA	B2 BUSES MEDIANOS,22 A 35 ASIENTOS	C1 CAMIONES MEDIANOS,6 TON.(120 QQ) A 9.5 TON.(190 QQ)	M MOTOCICLETAS
OL OTROS LIVIANO	B3 BUSES GRANDES,36 O MAS ASIENTOS	C3 CAMIONES GRANDES,10 TON.(200 QQ).O MAS	O OTROS

Appendix B.2 Manual for Surveyors

MANUAL DE ENCUESTA SOBRE EL TRAFICO VEHICULAR PARA EL ESTUDIO DE MEJORAMIENTO DE LA CARRETERA ENTRE SANTA BARBARA Y BELLA VISTA.

INTRODUCCION:

Atendiendo la solicitud del Gobierno de Bolivia, la Agencia de Cooperación Internacional del Japón (JICA) ha enviado un equipo de profesionales (Grupo de Estudio), para estudiar y planificar el mejoramiento del tramo carretero entre Santa Bárbara y Bella Vista en coordinación y colaboración recíproca con el Servicio Nacional de Caminos. Entre una serie de estudios a ser realizados, se encuentra la encuesta sobre el Tráfico Vehicular para el que se requiere la colaboración de Jóvenes entusiastas que tienen inquietud para el desarrollo de las zonas y comunidades en las que habitan. Por esta razón, rogamos la cooperación de cada uno de ustedes que conforman el equipo de encuestadores.

OBJETIVO DE LA ENCUESTA:

El objetivo de la presente encuesta es el de constatar el estado actual del tráfico vehicular, en el tramo carretero comprendido entre Santa Bárbara y Bella Vista; así como obtener las informaciones para el mejoramiento de este tramo carretero. Para tal efecto, se desea investigar acerca de la utilización actual de la carretera, modalidad de transporte etc.

SINTESIS DE LA ENCUESTA:

1.- METODO DE LA ENCUESTA: Se deberá hacer detener en el punto preestablecido, a todos los vehículos que recorren la carretera, encuestando en el mismo punto a los conductores para obtener de ellos las informaciones respectivas.

2.- DIAS Y HORAS DE LA ENCUESTA: Desde horas 8:00am del 20 de Septiembre hasta horas 8:00am del 21 de Septiembre

La Encuesta se realizará durante 24 horas continuas. Sin embargo, en caso de que el día 20 de Septiembre presentara tiempo lluvioso,

existe la posibilidad de posponer la Encuesta y realizarla a partir de horas 8:00am del día 21 de Septiembre hasta 8:00am del 22 de Septiembre, es decir, posponer en 24 horas.

3.- PUNTOS O SITIOS DE LA ENCUESTA: La Encuesta se realizará en los cinco(5) puntos o sitios señalados más adelante. Las personas que se desempeñarán como encuestadores, deberán ubicarse en el punto que se les asignen los miembros de la Misión Japonesa y/o el Servicio Nacional de Caminos, y esperar a los vehículos para proceder con la encuesta, durante 24 horas ininterrumpidas.

4.- PROCEDIMIENTO DE LA ENCUESTA: Se formarán grupos de trabajo (encuestadores) en cada punto de la Encuesta. Cada grupo nombrará un jefe de grupo, debiendo seguir cada miembro del grupo las instrucciones del jefe de grupo. El jefe de grupo será el responsable, debiendo dirigir e instruir a sus compañeros. Los encustadores de un punto estarán sub-divididos en dos grandes grupos, llamense Grupo "A" y "B", los cuales trabajarán alternadamente durante 24 horas, en los lugares y horarios que serán indicados por cada uno de los encargados de la Misión Japonesa y el Servicio Nacional de Caminos (se insinua seguir estrictamente las instrucciones que les serán dadas). Así mismo, se insinua realizar una labor competente para obtener un resultado óptimo y para no perjudicar el desarrollo de la Encuesta.

5.- METODO APLICADO PARA CADA GRUPO, EN LA ENCUESTA: Cada grupo de encuestadores recibirá de la Misión Japonesa los materiales de trabajo, como ser; formularios de encuesta, bolígrafos, banderas, linternas, etc. Durante el día, uno de los encuestadores deberá situarse en los puntos señalados para hacer detener todos los vehículos que transitan por los puntos utilizando, para tal efecto, banderas de color rojo durante el día y linternas durante la noche. Una vez detenido el vehículo y confirmada la seguridad de los encuestadores, los miembros

restantes del grupo procederán con la encuesta. Se insinua ser corteses con los encuestados. En el momento de la entrevista, explíque el objetivo de la misma;pida al mismo tiempo la cooperación del conductor en forma atenta, indicando por ejemplo de la siguiente manera:

"Buenos días (buenas tardes o noches), disculpe la molestia. Estamos realizando una encuesta para el Estudio de Mejoramiento de la Carretera del tramo Santa Bárbara - Bella Vista que realiza la Agencia de Cooperación Internacional del Japón (JICA), en coordinación y cooperación mutua con el Servicio Nacional de Caminos. Estamos encuestando a las personas que en el presente utilizan el camino actual, por lo que rogamos su valiosa cooperación, respondiendo a nuestras preguntas. Muchas gracias!!"

(De igual manera, cuando termine su encuesta, agradecer por la cooperación recibida).

6.- RESULTADO DE LA ENCUESTA: El contenido de la encuesta consta de los siguientes 11 puntos (los resultados de encuesta deberán ser llenados en el formulario del Anexo-A, punto por punto o Item por Item).

1) Horario (Itinerario) de circulación.
2) Clase de Vehículo.
3) Número de placa del vehículo
4) Marca del Vehículo.
5) Si ya ha sido encuestado previamente, en otros puntos o sitios de encuesta.
6) Lugar de procedencia, punto de partida del vehículo.
7) Destino.
8) Objeto del viaje.
9) Capacidad de carga.
10) Carga que lleva (Listado de Carga)
11) Número de pasajeros.

1) REGISTRO DE HORA DE ENCUESTA O LA HORA DE PASO POR EL PUNTO:
Favor registre numéricamente la hora y el minuto, en el MOMENTO que se detuvo el vehículo.
Del número 1 al 3 los encuestadores deberán llenarlos por sí mismos Se repartirán relojes para que anoten la hora en el momento de la encuesta. Anotela por favor.

2) TIPO DE VEHICULO:
Por favor llene el Formulario de Encuesta, con los números de la lista de tipos de vehículos (Lista de vehículos).

3) NUHERO DE PLACA DEL VEHICULO:
Observe el número de placa del vehículo y anote el mismo.

4) HARCA DEL VEHICULO:
Observando el vehículo, anote la marca del vehículo. Si no se puede distinguirla favor pregunte al conductor.

5) EN CASO DE HABER SIDO YA ENCUESTADO:
La encuesta se realizará en 5 puntos del tramo Santa Bárbara-Bella Vista. Por esta razón, pueda que algunos vehículos hayan sido encuestados en los puntos anteriores de encuestas, por lo que pueda haber repeticiones de encuestas en los puntos intermedios. Sin cwbargo, esta repetición es necesaria para esperar la mayor confiabilidad de las encuestas. Los encuestadores deberán preguntar al conductor si pasó antes por la mencionada encuesta, y en caso afirmativo, en que localidad pasó la misma. Luego, se proseguirá con la encusta de rutina.

6) SITIO DE PARTIDA DEL VEHICULO:
Pregunte acerca del Departamento, Ciudad, Provincia, localidad, etc. en donde los primeros pasajeros abordaron el vehículo o cargaron productos por primera vez, dentro del recorrido que hace el vehículo Esto quiere decir el lugar de "Origen" de recorrido del vehículo.
El nombre del Departamento, Ciudad, Provincia, localidad, etc. deberá ser llenado con el número impreso en este manual de encuesta. -4-

7) DESTINO:

Pregunte acerca del Departamento, Ciudad, Provincia, localidad, etc. a los que tiene previsto llegar el vehículo, como destino final del recorrido. El procedimiento de llenado al formulario es el mismo que el indicado en el punto 6) anterior.

8) OBJETO DEL VIAJE:

Se deberá preguntar al conductor, si el vehículo es de uso particular, de turismo, etc.; cuál es el objetivo o actividad del camión, bus?, etc; sobre el cruce en el camino con otros vehículos; los propósitos de los pasajeros que se encuentran en el vehículo, etc. A continuación se detallan los objetivos más representativos, de tal manera, que no es necesario anotar cada objetivo en forma pormenorizada (llénese solamente el objetivo más importante).

1.- NEGOCIOS	Servicio público o del Estado, asuntos comerciales, oficio, etc.
2.- DIRIGIENDOSE AL TRABAJO	Personas que se encuentra en el camino de su casa al trabajo.
3.- DIRIGIENDOSE A LA ESCUELA, COLEGIO, ETC.	Personas que se encuentra en el camino de su casa al centro de estudios.
4.- SOCIALES	Visita a los familiares, saludos protocolares, ceremonias, oficios religiosos, etc.
5.- TURISMO, RECUPERACION FISICA	Descanso, recreación, etc.
6.- COMPRAS	Personas cuyo objetivo principal es la compra.
7.- RETORNO A SU VIVIENDA	Personas cuyo objetivo principal es

regresar a sus domicilios, luego de haber cumplido cualquiera de las actividades indicadas en los puntos 1 al 6.

8.- OTROS: Cualquier otro objetivo que no está incluido en los puntos antes citados.

9) CAPACIDAD DE CARGA:
Pregunte al conductor y anote en el formulario la capacidad máxima de carga del vehículo.

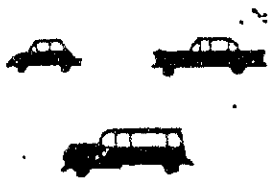
10) CARGA TRANSPORTADA:
Realice la encuesta a los conductores de vehículos sobre los productos que lleva cargados y la cantidad respectiva, excluyendo a LOS automóviles particulares y buses. Anote unos tres productos más importantes y la cantidad respectiva que ese vehículo lleva consigo como carga.

11) NUEHRO DE PASAJEROS:
Anote el número de personas que estan viajando es ese vehículo, incluyendo el conductor y su ayudante. En caso de vehículos de pasajeros (Buses, vagonetas, jeeps, automóviles, etc.), pregunte la capacidad máxima de pasajeros que puedan viajar sentados.

7.- RECOLECCION DE LOS FORHULARIOS DE ENCUESTA: Una vez finalizado el llenado de los formularios de encuesta, el jefe de grupo deberá reunirlos y entregarlos en el lugar donde se realizó la reunión explicatoría el día precedente, hasta el medio día de la fecha de conclusión de la encuesta.

8.- OBSERVACIONES: Se ruega a cada miembro de los encuestadores, tener sumo cuidado en el aspecto de seguridad física de sí mismos frente al tráfico vehicular(estacionamiento de los vehículos, ubicación de encuestadores, etc). Al cruzar por delante de los vehículos, cuide su seguridad, la de su grupo, constatando la seguridad frente a los vehículos.

Appendix B-3 Type of Vehicle

AUTOMOVILES VAGONETAS	CAMIONETAS	OTROS LIVIANOS	MICROBUSES	BUSES MEDIANOS	BUSES GRANDES
					
Descripción Vehículos de pasajeros con capacidad hasta 11 asientos inclusive.	Descripción Vehículos livianos de carga con capacidad hasta 2 Ton. (40 qq), inclusive.	Descripción Vehículos livianos de carga y/o pasajeros como jeeps, furgonetas doble cabina, etc. con capacidad hasta 2 Ton. (40 qq) u 11 asientos.	Descripción Vehículos de pasajeros con capacidad comprendidas entre 12 y 21 asientos inclusive.	Descripción Vehículos de pasajeros con capacidad comprendida entre 22 y 35 asientos inclusive.	Descripción Vehículos de pasajeros con capacidad de 36 ó mas asientos.

CAMIONES PEQUEÑOS	CAMIONES MEDIANOS	CAMIONES GRANDES	CAMIONES CON ACOPLADO	MOTOCICLETAS	OTROS
					
Descripción Vehículos de carga con capacidad comprendida entre 2,5 Ton. (50 qq) y 5,5 Ton. (110 qq), inclusive.	Descripción Vehículos de carga con capacidad comprendid en tre 6 Ton. (120 qq) y 9,5 Ton. (190 qq), inclusive.	Descripción Vehículos de carga con capacidad de 10 Ton. (200 qq) ó más.	Descripción Vehículos de carga con remolque o semiremolque, cuyo número total de ejes (incluyendo camión y remolque) sea 3 ó más.	Descripción Vehículos motorizados de 2 llantas o con small-car, de 1 a 3 pasajeros.	Descripción Vehículos que no se encuentran comprendidos, como ser maquinaria agrícolas o de construcción, vehículos de tracción animal.

Appendix C.1(1) Time Saving by Vehicle Type (Asphalt Surface) At the Year of 2001

		Car	Bus	Light Truck	Medium Truck	Heavy Truck	Car	Bus	Light Truck	Medium Truck	Heavy Truck
2001	V	54	31	239	37	523	10	2	44	6	263
Clear D.T	A	12393	7115	54851	8492	120029	2295	459	10098	1377	60359
	B	41777	27462	184901	28625	463310	5533	1260	24346	3320	165684
	C	20101	11540	88968	13773	194686	3016	603	13269	1809	79311
	D	21675	15922	95934	14852	268624	2518	657	11078	1511	86373
Clear N.T	A	1377	791	6095	944	13337	255	51	1122	153	6707
	B	5165	3387	22860	3539	57134	682	156	3000	409	20475
	C	2481	1424	10982	1700	24032	372	74	1637	223	9785
	D	2684	1962	11878	1839	33101	310	81	1363	186	10690
Rainy D.T	A	5346	3069	23661	3663	51777	990	198	4356	594	26037
	B	21256	13958	94076	14564	235482	2807	639	12349	1684	83969
	C	9633	5530	42637	6601	93302	1784	357	7850	1070	46919
	D	11622	8427	51439	7963	142180	1023	282	4500	614	37051
Rainy N.T	A	594	341	2629	407	5753	110	22	484	66	2893
	B	2630	1729	11639	1802	29162	346	79	1523	208	10366
	C	1188	682	5258	814	11506	178	36	784	107	4687
	D	1442	1047	6381	988	17656	168	43	739	101	5679

V : Total Traffic Volume per Day (Vehicles)
A : Traffic Volume per Year (Vehicle)
B : Total Travel Time without Project (Hours)
C : Total Travel Time with Project (Hours)
D : Time Saving (Hours)

Appendix C.1(2) Time Saving by Vehicle Type
(Asphalt Surface)
At the Year of 2010

		Car	Bus	Light Truck	Medium Truck	Heavy Truck	Car	Bus	Light Truck	Medium Truck	Heavy Truck
2010	V	88	48	353	54	850	16	3	64	10	428
Clear D.T	A	20196	11016	81014	12393	195075	3672	689	14688	2295	98226
	B	68081	42522	273097	41777	752990	8853	1890	35413	5533	269630
	C	32758	17868	131404	20101	316412	4825	905	19300	3016	129069
	D	35323	24654	141693	21675	436578	4028	985	16113	2518	140561
Clear N.T	A	2244	1224	9002	1377	21675	408	77	1632	255	10914
	B	8417	5244	33765	5165	92856	1091	234	4364	682	33320
	C	4044	2206	16221	2481	39058	595	112	2381	372	15924
	D	4374	3038	17544	2684	53797	496	122	1983	310	17397
Rainy D.T	A	8712	4752	34947	5346	84150	1584	297	6336	990	42372
	B	34639	21612	138949	21256	382714	4491	958	17963	2807	136650
	C	15699	8563	62974	9633	151638	2311	433	9244	1444	61821
	D	18940	13049	75975	11622	231076	2180	525	8718	1362	74829
Rainy N.T	A	968	528	3883	594	9350	176	33	704	110	4708
	B	4285	2676	17190	2630	47395	554	118	2215	346	16869
	C	1936	1056	7766	1188	18700	285	53	1140	178	7627
	D	2349	1620	9424	1442	28695	269	65	1074	168	9242

V : Total Traffic Volume per Day (Vehicles)
A : Traffic Volume per Year (Vehicle)
B : Total Travel Time without Project (Hours)
C : Total Travel Time with Project (Hours)
D : Time Saving (Hours)

Appendix C.1(3) Time Saving by Vehicle Type (Asphalt Surface) At the Year 2020

		Car	Bus	Light Truck	Medium Truck	Heavy Truck	Car	Bus	Light Truck	Medium Truck	Heavy Truck
2020	V	130	68	484	74	1230	23	5	88	13	619
Clear D.T	A	29835	15606	111078	16983	282285	5279	1148	20196	2984	142061
	B	100574	60239	374444	57250	1089620	12726	3150	48693	7193	389956
	C	48392	25313	180169	27546	457866	6936	1508	26538	3920	186667
	D	52181	34926	194275	29703	631754	5791	1642	22155	3273	203289
Clear N.T	A	3315	1734	12342	1887	31365	587	128	2244	332	15785
	B	12435	7428	46295	7078	134368	1568	389	6000	886	48190
	C	5974	3125	22240	3400	56520	856	186	3274	484	23030
	D	6461	4304	24055	3678	77848	713	203	2726	403	25160
Rainy D.T	A	12870	6732	47916	7326	121770	2277	495	8712	1287	61281
	B	51171	30617	190514	29128	553810	6455	1596	24699	3649	197631
	C	23192	12131	86345	13201	219430	3322	722	12711	1878	89409
	D	27979	18486	104169	15927	334380	3133	874	11988	1771	108222
Rainy N.T	A	1430	748	5324	814	13530	253	55	968	143	6809
	B	6331	3792	23569	3604	68584	796	197	3045	450	24397
	C	2860	1496	10648	1628	27060	410	89	1568	232	11031
	D	3471	2296	12921	1976	41524	386	108	1477	218	13366

V : Total Traffic Volume per Day (Vehicles)
A : Traffic Volume per Year (Vehicle)
B : Total Tavel Time without Project (Hours)
C : Total Tavel Time with Project (Hours)
D : Time Saving (Hours)

Appendix C.1(4) Time Saving by Vehicle Type
(Gravel Surface)
At the Year of 2001

		Car	Bus	Light Truck	Medium Truck	Heavy Truck	Car	Bus	Light Truck	Medium Truck	Heavy Truck
2001	V	54	31	239	37	523	10	2	44	6	263
Clear D.T	A	12393	7115	54851	8492	120029	2295	459	10098	1377	60359
	B	41777	27462	184901	28625	463310	5533	1260	24346	3320	165684
	C	24786	14229	109701	16983	240057	3718	744	16359	2231	97781
	D	16991	13233	75200	11642	223253	1815	516	7988	1089	67903
Clear N.T	A	1377	791	6095	944	13337	255	51	1122	153	6707
	B	5165	3387	22860	3539	57134	682	156	3000	409	20475
	C	3060	1756	13542	2096	29634	459	92	2020	275	12072
	D	2105	1630	9318	1443	27500	223	64	981	134	8403
Rainy D.T.	A	5346	3069	23661	3663	51777	990	198	4356	594	26037
	B	21256	13958	94076	14564	235482	2807	639	12349	1684	83969
	C	11879	6819	52575	8139	115048	1782	356	7841	1069	46867
	D	9377	7138	41501	6425	120433	1025	282	4508	615	37103
Rainy N.T.	A	594	341	2629	407	5753	110	22	484	66	2893
	B	2630	1729	11639	1802	29162	346	79	1523	208	10366
	C	1467	842	6491	1005	14204	220	44	968	132	5786
	D	1163	887	5148	797	14958	126	35	555	76	4580

V : Total Traffic Volume per Day (Vehicles)
A : Traffic Volume per Year (Vehicle)
B : Total Travel Time without Project (Hours)
C : Total Travel Time with Project (Hours)
D : Time Saving (Hours)

Appendix C.1(5) Time Saving by Vehicle Type (Gravel Surface) At the Year 2010

		Car	Bus	Light Truck	Medium Truck	Heavy Truck	Car	Bus	Light Truck	Medium Truck	Heavy Truck
2010	V	88	48	353	54	850	16	3	64	10	428
Clear D.T	A	20196	11016	81014	12393	195075	3672	689	14688	2295	98226
	B	68081	42522	273097	41777	752990	8853	1890	35413	5533	269630
	C	40392	22032	162027	24786	390150	5949	1115	23795	3718	159126
	D	27689	20490	111070	16991	362840	2905	775	11618	1815	110504
Clear N.T	A	2244	1224	9002	1377	21675	408	77	1632	255	10914
	B	8417	5244	33765	5165	92856	1091	234	4364	682	33320
	C	4986	2720	20001	3060	46162	734	138	2938	459	19645
	D	3431	2524	13763	2105	44694	357	96	1426	223	13675
Rainy D.T	A	8712	4752	34947	5346	84150	1584	297	6336	990	42372
	B	34639	21612	138949	21256	382714	4491	958	17963	2807	136650
	C	19358	10559	77652	11879	186981	2851	535	11405	1782	76270
	D	15281	11053	61297	9377	195733	1639	423	6558	1025	60380
Rainy N.T	A	968	528	3883	594	9350	176	33	704	110	4708
	B	4285	2676	17190	2630	47395	554	118	2215	346	16869
	C	2390	1304	9587	1467	23085	352	66	1408	220	9416
	D	1895	1373	7603	1163	24310	202	52	807	126	7453

V : Total Traffic Volume per Day (Vehicle)
A : Traffic Volume per Year (Vehicle)
B : Total Travel Time without Project (Hours)
C : Total Travel Time with Project (Hours)
D : Time Saving (Hours)

Appendix C.1(6) Time Saving by Vehicle Type
(Gravel Surface)
At the Year of 2020

		Car	Bus	Light Truck	Medium Truck	Heavy Truck	Car	Bus	Light Truck	Medium Truck	Heavy Truck
2020	V	130	68	484	74	1230	23	5	88	13	619
Clear D.T	A	29835	15606	111078	16983	282285	5279	1148	20196	2984	142061
	B	100574	60239	374444	57250	1089620	12726	3150	48693	7193	389956
	C	59670	31212	222156	33966	564570	8551	1859	32718	4833	230138
	D	40904	29027	152288	23284	525050	4175	1291	15975	2360	159818
Clear N.T	A	3315	1734	12342	1887	31365	587	128	2244	332	15785
	B	12435	7428	46295	7078	134368	1568	389	6000	886	48190
	C	7366	3853	27424	4193	69693	1056	230	4039	597	28412
	D	5069	3576	18871	2885	64675	513	160	1961	290	19778
Rainy D.T	A	12870	6732	47916	7326	121770	2277	495	8712	1287	61281
	B	51171	30617	190514	29128	553810	6455	1596	24699	3649	197631
	C	28597	14959	106469	16278	270573	4099	891	15682	2317	110306
	D	22574	15659	84045	12850	283237	2357	705	9017	1332	87325
Rainy N.T	A	1430	748	5324	814	13530	253	55	968	143	6809
	B	6331	3792	23569	3604	68584	796	197	3045	450	24397
	C	3531	1847	13145	2010	33406	506	110	1936	286	13618
	D	2800	1945	10424	1594	35178	290	87	1109	164	10779

V : Total Traffic Volume per Day (Vehicles)
A : Traffic Volume per Year (Vehicles)
B : Total Travel Time without Project (Hours)
C : Total Travel Time with Project (Hours)
D : Time Saving (Hours)

Appendix C.2(1) Benefit and Cost Stream CASE P-1

	BENE-1	BENE-2	BENE-3	BENE-4	BENE-5	BENE-6	BENE-7	C(I)
1996	0.	0.	0.	0.	0.	0.	0.	17224000.
1997	0.	0.	0.	0.	0.	0.	0.	34450000.
1998	0.	0.	0.	0.	0.	0.	0.	34450000.
1999	0.	0.	0.	0.	0.	0.	0.	34450000.
2000	0.	0.	0.	0.	0.	0.	0.	34450000.
2001	4904962.	1526333.	24924304.	253167.	495918.	998834.	185846.	147000.
2002	5220847.	1720849.	26245328.	269554.	529017.	1019275.	247328.	147000.
2003	5557076.	1940153.	27636368.	287002.	564325.	1040134.	329151.	147000.
2004	5914958.	2187406.	29101136.	305579.	601990.	1061420.	438042.	147000.
2005	6295888.	2466168.	30643538.	325359.	642168.	1083141.	582956.	147000.
2006	6701350.	2780456.	32267688.	346419.	685028.	1105307.	775812.	294000.
2007	7132925.	3134797.	33977924.	368843.	730749.	1127927.	1032470.	294000.
2008	7592293.	3534295.	35778800.	392717.	779522.	1151009.	1374036.	294000.
2009	8081246.	3984704.	37675128.	418137.	831549.	1174564.	1828601.	294000.
2010	8601687.	4492514.	39671968.	445203.	887049.	1198601.	2433546.	294000.
2011	9087421.	4915804.	41154800.	468715.	930775.	1208233.	2508963.	294000.
2012	9600585.	5378977.	42693060.	493469.	976657.	1217943.	2586716.	294000.
2013	10142726.	5885791.	44288816.	519530.	1024800.	1227731.	2666880.	294000.
2014	10715482.	6440358.	45944216.	546967.	1075316.	1237597.	2749527.	294000.
2015	11320582.	7047176.	47661496.	575853.	1128323.	1247543.	2834736.	294000.
2016	11959851.	7711170.	49442960.	606265.	1183942.	1257569.	2922586.	294000.
2017	12635219.	8437725.	51291008.	638283.	1242303.	1267675.	3013158.	294000.
2018	13348726.	9232738.	53208132.	671992.	1303541.	1277863.	3106537.	294000.
2019	14102524.	10102658.	55196912.	707482.	1367798.	1288132.	3202810.	294000.
2020	14898888.	11054543.	57260032.	744845.	1435222.	1298484.	3302066.	294000.
TOT.	183815232.	103974616.	806063616.	9385381.	18415992.	23488984.	38121768.	160169040.

BENE-1	Running time saving benefit
BENE-2	Waiting time saving benefit
BENE-3	Vehicle operating cost saving benefit
BENE-4	Desaster prevention benefit
BENE-5	Accident reduction benefit
BENE-6	Transportation cost reduction benefit from refrigerated trucks
BENE-7	Development benefit
C(I)	Construction and maintenance cost

Appendix C.2(2) Benefit and Cost Stream CASE P-2

	BENE-1	BENE-2	BENE-3	BENE-4	BENE-5	BENE-6	BENE-7	C(I)
1996	0.	0.	0.	0.	0.	0.	0.	15630000.
1997	0.	0.	0.	0.	0.	0.	0.	31252000.
1998	0.	0.	0.	0.	0.	0.	0.	31252000.
1999	0.	0.	0.	0.	0.	0.	0.	31252000.
2000	0.	0.	0.	0.	0.	0.	0.	31252000.
2001	3746226.	1526333.	18008362.	253167.	495918.	772148.	185846.	315000.
2002	4017365.	1720849.	18955194.	269554.	529017.	787950.	247328.	315000.
2003	4932242.	1940153.	23832836.	287002.	564325.	922104.	329151.	15025000.
2004	5914958.	2187406.	29101136.	305579.	601990.	1061420.	438042.	147000.
2005	6295888.	2466168.	30643538.	325359.	642168.	1083141.	582956.	147000.
2006	6701350.	2780456.	32267688.	346419.	685028.	1105307.	775812.	147000.
2007	7132925.	3134797.	33977924.	368843.	730749.	1127927.	1032470.	147000.
2008	7592293.	3534295.	35778800.	392717.	779522.	1151009.	1374036.	147000.
2009	8081246.	3984704.	37675128.	418137.	831549.	1174564.	1828601.	294000.
2010	8601687.	4492514.	39671968.	445203.	887049.	1198601.	2433546.	294000.
2011	9087421.	4915804.	41154800.	468715.	930775.	1208233.	2508963.	294000.
2012	9600585.	5378977.	42693060.	493469.	976657.	1217943.	2586716.	294000.
2013	10142726.	5885791.	44288816.	519530.	1024800.	1227731.	2666880.	294000.
2014	10715482.	6440358.	45944216.	546967.	1075316.	1237597.	2749527.	294000.
2015	11320582.	7047176.	47661496.	575853.	1128323.	1247543.	2834736.	294000.
2016	11959851.	7711170.	49442960.	606265.	1183942.	1257569.	2922586.	294000.
2017	12635219.	8437725.	51291008.	638283.	1242303.	1267675.	3013158.	294000.
2018	13348726.	9232738.	53208132.	671992.	1303541.	1277863.	3106537.	294000.
2019	14102524.	10102658.	55196912.	707482.	1367798.	1288132.	3202810.	294000.
2020	14898888.	11054543.	57260032.	744845.	1435222.	1298484.	3302066.	294000.
TOT.	180828192.	103974616.	788054080.	9385381.	18415992.	22912944.	38121768.	160556032.

BENE-1	Running time saving benefit
BENE-2	Waiting time saving benefit
BENE-3	Vehicle operating cost saving benefit
BENE-4	Desaster prevention benefit
BENE-5	Accident reduction benefit
BENE-6	Transportation cost reduction benefit from refrigerated trucks
BENE-7	Development benefit
C(I)	Construction and maintenance cost

Appendix C..2(3) Benefit and Cost Stream CASE P-3

	BENE-1	BENE-2	BENE-3	BENE-4	BENE-5	BENE-6	BENE-7	C(I)
1996	0.	0.	0.	0.	0.	0.	0.	15630000.
1997	0.	0.	0.	0.	0.	0.	0.	31252000.
1998	0.	0.	0.	0.	0.	0.	0.	31252000.
1999	0.	0.	0.	0.	0.	0.	0.	31252000.
2000	0.	0.	0.	0.	0.	0.	0.	31252000.
2001	3746226.	1526333.	18008362.	253167.	495918.	772148.	185846.	315000.
2002	4017365.	1720849.	18955194.	269554.	529017.	787950.	247328.	315000.
2003	4308128.	1940153.	19951808.	287002.	564325.	804075.	329151.	315000.
2004	4619936.	2187406.	21000822.	305579.	601990.	820530.	438042.	628000.
2005	4954311.	2466168.	22104990.	325359.	642168.	837321.	582956.	628000.
2006	6006493.	2780456.	27884828.	346419.	685028.	979882.	775812.	15338000.
2007	7132925.	3134797.	33977924.	368843.	730749.	1127927.	1032470.	147000.
2008	7592293.	3534295.	35778800.	392717.	779522.	1151009.	1374036.	147000.
2009	8081246.	3984704.	37675128.	418137.	831549.	1174564.	1828601.	147000.
2010	8601687.	4492514.	39671968.	445203.	887049.	1198601.	2433546.	147000.
2011	9087421.	4915804.	41154800.	468715.	930775.	1208233.	2508963.	147000.
2012	9600585.	5378977.	42693060.	493469.	976657.	1217943.	2586716.	294000.
2013	10142726.	5885791.	44288816.	519530.	1024800.	1227731.	2666880.	294000.
2014	10715482.	6440358.	45944216.	546967.	1075316.	1237597.	2749527.	294000.
2015	11320582.	7047176.	47661496.	575853.	1128323.	1247543.	2834736.	294000.
2016	11959851.	7711170.	49442960.	606265.	1183942.	1257569.	2922586.	294000.
2017	12635219.	8437725.	51291008.	638283.	1242303.	1267675.	3013158.	294000.
2018	13348726.	9232738.	53208132.	671992.	1303541.	1277863.	3106537.	294000.
2019	14102524.	10102658.	55196912.	707482.	1367798.	1288132.	3202810.	294000.
2020	14898888.	11054543.	57260032.	744845.	1435222.	1298484.	3302066.	294000.
TOT.	176872608.	103974616.	763151296.	9385381.	18415992.	22182780.	38121768.	161558032.

BENE-1	Running time saving benefit
BENE-2	Waiting time saving benefit
BENE-3	Vehicle operating cost saving benefit
BENE-4	Desaster prevention benefit
BENE-5	Accident reduction benefit
BENE-6	Transportation cost reduction benefit from refrigerated trucks
BENE-7	Development benefit
C(I)	Construction and maintenance cost

Appendix C.2(4) Benefit and Cost Stream CASE P-4

	BENE-1	BENE-2	BENE-3	BENE-4	BENE-5	BENE-6	BENE-7	C(I)
1996	0.	0.	0.	0.	0.	0.	0.	15630000.
1997	0.	0.	0.	0.	0.	0.	0.	31252000.
1998	0.	0.	0.	0.	0.	0.	0.	31252000.
1999	0.	0.	0.	0.	0.	0.	0.	31252000.
2000	0.	0.	0.	0.	0.	0.	0.	31252000.
2001	3746226.	1526333.	18008362.	253167.	495918.	772148.	918836.	315000.
2002	4017365.	1720849.	18955194.	269554.	529017.	787950.	967938.	315000.
2003	4308128.	1940153.	19951808.	287002.	564325.	804075.	1019664.	315000.
2004	4619936.	2187406.	21000822.	305579.	601990.	820530.	1074154.	628000.
2005	4954311.	2466168.	22104990.	325359.	642168.	837321.	1131555.	628000.
2006	5312888.	2780456.	23267212.	346419.	685028.	854457.	1192025.	628000.
2007	5697416.	3134797.	24490540.	368843.	730749.	871943.	1255726.	628000.
2008	6109776.	3534295.	25778188.	392717.	779522.	889786.	1322830.	628000.
2009	6551981.	3984704.	27133540.	418137.	831549.	907995.	1393521.	628000.
2010	7026191.	4492514.	28560148.	445203.	887049.	926577.	1467990.	628000.
2011	8255312.	4915804.	35596000.	468715.	930775.	1071128.	1813360.	15338000.
2012	9600585.	5378977.	42693060.	493469.	976657.	1217943.	2182308.	147000.
2013	10142726.	5885791.	44288816.	519530.	1024800.	1227731.	2262681.	147000.
2014	10715482.	6440358.	45944216.	546967.	1075316.	1237597.	2346014.	147000.
2015	11320582.	7047176.	47661496.	575853.	1128323.	1247534.	2432415.	147000.
2016	11959851.	7711170.	49442960.	606265.	1183942.	1257569.	2521999.	147000.
2017	12635219.	8437725.	51291008.	638283.	1242303.	1267675.	2614883.	294000.
2018	13348726.	9232738.	53208132.	671992.	1303541.	1277863.	2711187.	294000.
2019	14102524.	10102658.	55196912.	707482.	1367798.	1288132.	2811038.	294000.
2020	14898888.	11054543.	57260032.	744845.	1435222.	1298484.	2914566.	294000.
TOT.	169324128.	103974616.	711833472.	9385381.	18415992.	20864440.	36354692.	163228032.

BENE-1	Running time saving benefit
BENE-2	Waiting time saving benefit
BENE-3	Vehicle operating cost saving benefit
BENE-4	Desaster prevention benefit
BENE-5	Accident reduction benefit
BENE-6	Transportation cost reduction benefit from refrigerated trucks
BENE-7	Development benefit
C(I)	Construction and maintenance cost

Appendix C..2(5) Benefit and Cost Stream CASE P-5

	BENE-1	BENE-2	BENE-3	BENE-4	BENE-5	BENE-6	BENE-7	C(I)
1996	0.	0.	0.	0.	0.	0.	0.	16415000.
1997	0.	0.	0.	0.	0.	0.	0.	32830000.
1998	0.	0.	0.	0.	0.	0.	0.	32830000.
1999	0.	0.	0.	0.	0.	0.	0.	32830000.
2000	0.	0.	0.	0.	0.	0.	0.	32830000.
2001	4904962.	1526333.	24924304.	253167.	495918.	998834.	185846.	267000.
2002	4582913.	1621447.	26245328.	269554.	516185.	1019275.	247328.	267000.
2003	4921960.	1828097.	27636368.	287002.	537430.	1040134.	329151.	267000.
2004	5286089.	2061084.	29101136.	305579.	559550.	1061420.	438042.	534000.
2005	5677158.	2323764.	30643538.	325359.	582581.	1083141.	582956.	7633000.
2006	6097157.	2619923.	32267688.	346419.	606559.	1105307.	775812.	267000.
2007	6548229.	2953827.	33977924.	368843.	631525.	1127927.	1032470.	267000.
2008	7032671.	3330285.	35778800.	392717.	657518.	1151009.	1374036.	267000.
2009	7552953.	3754723.	37675128.	418137.	684580.	1174564.	1828601.	534000.
2010	8601687.	4492514.	39671968.	445203.	887049.	1198601.	2433546.	7633000.
2011	8569664.	4632011.	41154800.	468715.	757160.	1208233.	2508963.	267000.
2012	9053455.	5068329.	42693060.	493469.	804330.	1217943.	2586716.	267000.
2013	9564558.	5545747.	44288816.	519530.	854437.	1227731.	2666880.	267000.
2014	10104514.	6068135.	45944216.	546967.	907667.	1237597.	2749527.	534000.
2015	10674953.	6639731.	47661496.	575853.	964213.	1247543.	2834736.	7633000.
2016	11277596.	7265169.	49442960.	606265.	1024281.	1257569.	2922586.	267000.
2017	11914261.	7949521.	51291008.	638283.	1088091.	1267675.	3013158.	267000.
2018	12586867.	8698336.	53208132.	671992.	1155877.	1277863.	3106537.	267000.
2019	13297445.	9517686.	55196912.	707482.	1227885.	1288132.	3202810.	534000.
2020	14898888.	11054543.	57260032.	744845.	1435222.	1298484.	3302066.	7633000.
TOT.	173147968.	98951208.	806063616.	9385381.	16378058.	23488984.	38121768.	183607136.

BENE-1 Running time saving benefit
BENE-2 Waiting time saving benefit
BENE-3 Vehicle operating cost saving benefit
BENE-4 Desaster prevention benefit
BENE-5 Accident reduction benefit
BENE-6 Transportation cost reduction benefit from refrigerated trucks
BENE-7 Development benefit
C(I) Construction and maintenance cost

Appendix C.2(6) Benefit and Cost Stream CASE P-6

	BENE-1	BENE-2	BENE-3	BENE-4	BENE-5	BENE-6	BENE-7	C(I)
1996	0.	0.	0.	0.	0.	0.	0.	15630000.
1997	0.	0.	0.	0.	0.	0.	0.	31252000.
1998	0.	0.	0.	0.	0.	0.	0.	31252000.
1999	0.	0.	0.	0.	0.	0.	0.	31252000.
2000	0.	0.	0.	0.	0.	0.	0.	31252000.
2001	3746226.	1526333.	18008362.	253167.	495918.	772148.	1370699.	315000.
2002	4017365.	1621447.	18955194.	269554.	516185.	787950.	1443961.	315000.
2003	4932242.	1828097.	23832836.	287002.	537430.	922104.	1855891.	7633000.
2004	5914958.	2061084.	29101136.	305579.	559550.	1061420.	2294421.	267000.
2005	6295888.	2323764.	30643538.	325359.	582581.	1083141.	2403114.	267000.
2006	6701350.	2619923.	32267688.	346419.	606559.	1105307.	2516956.	267000.
2007	7132925.	2953827.	33977924.	368843.	631525.	1127927.	2636190.	534000.
2008	7592293.	3330285.	35778800.	392717.	657518.	1151009.	2761074.	7633000.
2009	8081246.	3754723.	37675128.	418137.	684580.	1174564.	2891873.	267000.
2010	8601687.	4492514.	39671968.	445203.	887049.	1198601.	3028869.	267000.
2011	8569664.	4632011.	41154800.	468715.	757160.	1208233.	3140404.	267000.
2012	9053455.	5068329.	42693060.	493469.	804330.	1217943.	3256046.	534000.
2013	9564558.	5545747.	44288816.	519530.	854437.	1227731.	3375947.	7633000.
2014	10104514.	6068135.	45944216.	546967.	907667.	1237597.	3500263.	267000.
2015	10674953.	6639731.	47661496.	575853.	964213.	1247543.	3629156.	267000.
2016	11277596.	7265169.	49442960.	606265.	1024281.	1257569.	3762796.	267000.
2017	11914261.	7949521.	51291008.	638283.	1088091.	1267675.	3901358.	534000.
2018	12586867.	8698336.	53208132.	671992.	1155877.	1277863.	4045021.	7633000.
2019	13297445.	9517686.	55196912.	707482.	1227885.	1288132.	4193975.	267000.
2020	14898888.	11054543.	57260032.	744845.	1435222.	1298484.	4348414.	267000.
TOT.	174958400.	98951208.	788054080.	9385381.	16378058.	22912944.	60356424.	176339104.

BENE-1	Running time saving benefit
BENE-2	Waiting time saving benefit
BENE-3	Vehicle operating cost saving benefit
BENE-4	Desaster prevention benefit
BENE-5	Accident reduction benefit
BENE-6	Transportation cost reduction benefit from refrigerated trucks
BENE-7	Development benefit
C(I)	Construction and maintenance cost

Appendix C..2(7) Benefit and Cost Stream CASE P-7

	BENE-1	BENE-2	BENE-3	BENE-4	BENE-5	BENE-6	BENE-7	C(I)
1996	0.	0.	0.	0.	0.	0.	0.	15630000.
1997	0.	0.	0.	0.	0.	0.	0.	31252000.
1998	0.	0.	0.	0.	0.	0.	0.	31252000.
1999	0.	0.	0.	0.	0.	0.	0.	31252000.
2000	0.	0.	0.	0.	0.	0.	0.	31252000.
2001	3746226.	1526333.	18008362.	253167.	495918.	772148.	918836.	315000.
2002	4017365.	1720849.	18955194.	269554.	529017.	787950.	967938.	315000.
2003	4932242.	1940153.	23832836.	287002.	564325.	922104.	1243818.	7381000.
2004	5914958.	2187406.	29101136.	305579.	601990.	1061420.	1537552.	267000.
2005	6295888.	2466168.	30643538.	325359.	642168.	1083141.	1610430.	267000.
2006	6701350.	2780456.	32267688.	346419.	685028.	1105307.	1686762.	267000.
2007	7132925.	3134797.	33977924.	368843.	730749.	1127927.	1766712.	534000.
2008	7592293.	3534295.	35778800.	392717.	779522.	1151009.	1850452.	15244000.
2009	8081246.	3984704.	37675128.	418137.	831549.	1174564.	1938160.	147000.
2010	8601687.	4492514.	39671968.	445203.	887049.	1198601.	2030026.	147000.
2011	9087421.	4915804.	41154800.	468715.	930775.	1208233.	2104790.	147000.
2012	9600585.	5378977.	42693060.	493469.	976657.	1217943.	2182308.	147000.
2013	10142726.	5885791.	44288816.	519530.	1024800.	1227731.	2262681.	147000.
2014	10715482.	6440358.	45944216.	546967.	1075316.	1237597.	2346014.	294000.
2015	11320582.	7047176.	47661496.	575853.	1128323.	1247543.	2432415.	294000.
2016	11959851.	7711170.	49442960.	606265.	1183942.	1257569.	2521999.	294000.
2017	12635219.	8437725.	51291008.	638283.	1242303.	1267675.	2614883.	294000.
2018	13348726.	9232738.	53208132.	671992.	1303541.	1277863.	2711187.	294000.
2019	14102524.	10102658.	55196912.	707482.	1367798.	1288132.	2811038.	294000.
2020	14898888.	11054543.	57260032.	744845.	1435222.	1298484.	2914566.	294000.
TOT.	180828192.	103974616.	788054080.	9385381.	18415992.	22912944.	40452568.	168021040.

BENE-1	Running time saving benefit
BENE-2	Waiting time saving benefit
BENE-3	Vehicle operating cost saving benefit
BENE-4	Desaster prevention benefit
BENE-5	Accident reduction benefit
BENE-6	Transportation cost reduction benefit from refrigerated trucks
BENE-7	Development benefit
C(I)	Construction and maintenance cost

Appendix C.2(8) Benefit and Cost Stream CASE U

	BENE-1	BENE-2	BENE-3	BENE-4	BENE-5	BENE-6	BENE-7	C(I)
1996	0.	0.	0.	0.	0.	0.	0.	15630000.
1997	0.	0.	0.	0.	0.	0.	0.	31252000.
1998	0.	0.	0.	0.	0.	0.	0.	31252000.
1999	0.	0.	0.	0.	0.	0.	0.	31252000.
2000	0.	0.	0.	0.	0.	0.	0.	31252000.
2001	3746226.	1526333.	18008362.	253167.	495918.	772148.	185846.	315000.
2002	4017365.	1720849.	18955194.	269554.	529017.	787950.	247328.	315000.
2003	4308128.	1940153.	19951808.	287002.	564325.	804075.	329151.	315000.
2004	4619936.	2187406.	21000822.	305579.	601990.	820530.	438042.	628000.
2005	4954311.	2466168.	22104990.	325359.	642168.	837321.	582956.	3659000.
2006	5312888.	2780456.	23267212.	346419.	685028.	854457.	775812.	315000.
2007	5697416.	3134797.	24490540.	368843.	730749.	871943.	1032470.	315000.
2008	6109776.	3534295.	25778188.	392717.	779522.	889786.	1374036.	315000.
2009	6551981.	3984704.	27133540.	418137.	831549.	907995.	1828601.	628000.
2010	7026191.	4492514.	28560148.	445203.	887049.	926577.	2433546.	3659000.
2011	7423217.	4915804.	29631512.	468715.	930775.	934023.	2508963.	315000.
2012	7842678.	5378977.	30743064.	493469.	976657.	940023.	2570975.	315000.
2013	8285841.	5885791.	31896312.	519530.	1024800.	945002.	2623288.	315000.
2014	8754046.	6440358.	33092820.	546967.	1075316.	949217.	2668182.	628000.
2015	9248708.	7047176.	34334216.	575853.	1128323.	952841.	2707227.	3659000.
2016	9771321.	7711170.	35622176.	606265.	1183942.	955994.	2741550.	315000.
2017	10323465.	8437725.	36958452.	638283.	1242303.	958767.	2771994.	315000.
2018	10906809.	9232738.	38344856.	671992.	1303541.	961226.	2799203.	315000.
2019	11523116.	10102658.	39783268.	707482.	1367798.	963424.	2823682.	628000.
2020	12174248.	11054543.	41275636.	744845.	1435222.	1003791.	3302066.	3659000.
TOT.	148597664.	103974616.	580933184.	9385381.	18415992.	18037092.	36744920.	161566112.

BENE-1	Running time saving benefit
BENE-2	Waiting time saving benefit
BENE-3	Vehicle operating cost saving benefit
BENE-4	Desaster prevention benefit
BENE-5	Accident reduction benefit
BENE-6	Transportation cost reduction benefit from refrigerated trucks
BENE-7	Development benefit
C(I)	Construction and maintenance cost

Appendix C.3(1) Sensitivity Analysis Case P-1 (- Benefit, + Cost)

		0%	+5%	+10%	+15%	+20%
	B/C	1.890	1.800	1.643	1.453	1.260
0%	NPV	97625296.	92137824.	81162864.	64700416.	42750496.
	IRR	0.197	0.190	0.178	0.163	0.146
	B/C	1.795	1.710	1.561	1.381	1.197
-5%	NPV	87256560.	81769088.	70794128.	54331680.	32381760.
	IRR	0.190	0.183	0.172	0.157	0.140
	B/C	1.701	1.620	1.479	1.308	1.134
-10%	NPV	76887824.	71400352.	60425392.	43962944.	22013024.
	IRR	0.183	0.176	0.165	0.150	0.134
	B/C	1.606	1.530	1.397	1.235	1.071
-15%	NPV	66519088.	61031616.	50056656.	33594208.	11644288.
	IRR	0.175	0.169	0.158	0.143	0.127
	B/C	1.512	1.440	1.314	1.163	1.008
-20%	NPV	56150336.	50662864.	39687904.	23225456.	1275536.
	IRR	0.168	0.162	0.151	0.137	0.121

Appendix C.3(2) Sensitivity Analysis CASE P-2 (- Benefit, + Cost)

		0%	+5%	+10%	+15%	+20%
	B/C	1.867	1.778	1.624	1.436	1.245
0%	NPV	91676176.	86390672.	75819656.	59963120.	38821168.
	IRR	0.194	0.188	0.176	0.161	0.144
	B/C	1.774	1.689	1.543	1.365	1.183
-5%	NPV	81806880.	76521376.	65950360.	50093824.	28951872.
	IRR	0.187	0.181	0.170	0.155	0.138
	B/C	1.681	1.600	1.461	1.293	1.120
-10%	NPV	71937552.	66652048.	56081032.	40224496.	19082544.
	IRR	0.180	0.174	0.163	0.148	0.132
	B/C	1.587	1.512	1.380	1.221	1.058
-15%	NPV	62068240.	56782736.	46211720.	30355184.	9213232.
	IRR	0.173	0.167	0.156	0.142	0.126
	B/C	1.494	1.423	1.299	1.149	0.996
-20%	NPV	52198944.	46913440.	36342424.	20485888.	-656064.
	IRR	0.166	0.160	0.149	0.135	0.120

Appendix C.3(3) Sensitivity Analysis Case P-3 (- Benefit, + Cost)

		0%	+5%	+10%	+15%	+20%
	B/C	1.794	1.709	1.560	1.380	1.196
0%	NPV	82904640.	77685472.	67247136.	51589632.	30712976.
	IRR	0.187	0.181	0.170	0.155	0.139
	B/C	1.705	1.623	1.482	1.311	1.136
-5%	NPV	73540224.	68321056.	57882720.	42225216.	21348560.
	IRR	0.181	0.175	0.164	0.150	0.134
	B/C	1.615	1.538	1.404	1.242	1.077
-10%	NPV	64175808.	58956640.	48518304.	32860800.	11984144.
	IRR	0.174	0.168	0.158	0.143	0.128
	B/C	1.525	1.452	1.326	1.173	1.017
-15%	NPV	54811440.	49592272.	39153936.	23496432.	2619776.
	IRR	0.167	0.161	0.151	0.137	0.122
	B/C	1.435	1.367	1.248	1.104	0.957
-20%	NPV	45447040.	40227872.	29789536.	14132032.	-6744624.
	IRR	0.160	0.154	0.144	0.131	0.115

Appendix C.3(4) Sensitivity Analysis CASE P-4 (- Benefit, + Cost)

		0%	+5%	+10%	+15%	+20%
	B/C	1.700	1.619	1.478	1.308	1.133
0%	NPV	72061976.	66913672.	56617056.	41172144.	20578896.
	IRR	0.181	0.175	0.164	0.149	0.133
	B/C	1.615	1.538	1.404	1.242	1.077
-5%	NPV	63310536.	58162232.	47865616.	32420704.	11827456.
	IRR	0.175	0.169	0.158	0.144	0.128
	B/C	1.530	1.457	1.330	1.177	1.020
-10%	NPV	54559112.	49410808.	39114192.	23669280.	3076032.
	IRR	0.168	0.162	0.151	0.138	0.122
	B/C	1.445	1.376	1.256	1.111	0.963
-15%	NPV	45807736.	40659432.	30362816.	14917904.	-5675344.
	IRR	0.161	0.155	0.145	0.131	0.116
	B/C	1.360	1.295	1.183	1.046	0.907
-20%	NPV	37056312.	31908008.	21611392.	6166480.	-14426768.
	IRR	0.154	0.148	0.138	0.125	0.110

Appendix C.3(5) Sensitivity Analysis Case P-5 (- Benefit, + Cost)

		0%	+5%	+10%	+15%	+20%
	B/C	1.857	1.769	1.615	1.429	1.238
0%	NPV	94234784.	88738088.	77744704.	61254576.	39267776.
	IRR	0.198	0.191	0.179	0.163	0.145
	B/C	1.764	1.680	1.534	1.357	1.176
-5%	NPV	84026320.	78529624.	67536240.	51046112.	29059312.
	IRR	0.191	0.184	0.172	0.156	0.139
	B/C	1.671	1.592	1.453	1.286	1.114
-10%	NPV	73817840.	68321144.	57327760.	40837632.	18850832.
	IRR	0.183	0.177	0.165	0.149	0.132
	B/C	1.579	1.503	1.373	1.214	1.052
-15%	NPV	63609440.	58112744.	47119360.	30629232.	8642432.
	IRR	0.176	0.169	0.158	0.143	0.126
	B/C	1.486	1.415	1.292	1.143	0.991
-20%	NPV	53400992.	47904296.	36910912.	20420784.	-1566016.
	IRR	0.168	0.161	0.150	0.135	0.119

Appendix C.3(6) Sensitivity Analysis CASE P-6 (- Benefit, + Cost)

		0%	+5%	+10%	+15%	+20%
	B/C	1.894	1.804	1.647	1.457	1.263
0%	NPV	94910936.	89601928.	78983928.	63056944.	41820992.
	IRR	0.198	0.192	0.180	0.164	0.147
	B/C	1.799	1.714	1.565	1.384	1.199
-5%	NPV	84856408.	79547400.	68929400.	53002416.	31766464.
	IRR	0.191	0.185	0.173	0.158	0.141
	B/C	1.704	1.623	1.482	1.311	1.136
-10%	NPV	74801848.	69492840.	58874840.	42947856.	21711904.
	IRR	0.184	0.178	0.166	0.151	0.134
	B/C	1.610	1.533	1.400	1.238	1.073
-15%	NPV	64747304.	59438296.	48820296.	32893312.	11657360.
	IRR	0.177	0.170	0.159	0.144	0.128
	B/C	1.515	1.443	1.317	1.165	1.010
-20%	NPV	54692760.	49383752.	38765752.	22838768.	1602816.
	IRR	0.169	0.163	0.152	0.137	0.121

Appendix C.3(7) Sensitivity Analysis Case P-7 (- Benefit, + Cost)

		0%	+5%	+10%	+15%	+20%
0%	B/C	1.877	1.787	1.632	1.444	1.251
	NPV	93097920.	87789080.	77171368.	61244832.	40009456.
	IRR	0.196	0.190	0.178	0.162	0.145
-5%	B/C	1.783	1.698	1.550	1.372	1.189
	NPV	83134144.	77825304.	67207592.	51281056.	30045680.
	IRR	0.190	0.183	0.171	0.156	0.139
-10%	B/C	1.689	1.609	1.469	1.299	1.126
	NPV	73170400.	67861560.	57243848.	41317312.	20081936.
	IRR	0.182	0.176	0.165	0.150	0.133
-15%	B/C	1.595	1.519	1.387	1.227	1.064
	NPV	63206672.	57897832.	47280120.	31353584.	10118208.
	IRR	0.175	0.169	0.158	0.143	0.127
-20%	B/C	1.501	1.430	1.306	1.155	1.001
	NPV	53242928.	47934088.	37316376.	21389840.	154464.
	IRR	0.167	0.161	0.150	0.136	0.120

Appendix C.3(8) Sensitivity Analysis CASE U (- Benefit, + Cost)

		0%	+5%	+10%	+15%	+20%
0%	B/C	1.552	1.478	1.350	1.194	1.035
	NPV	56610392.	51484984.	41234168.	25857936.	5356288.
	IRR	0.172	0.166	0.154	0.140	0.124
-5%	B/C	1.475	1.404	1.282	1.134	0.983
	NPV	48654456.	43529048.	33278232.	17902000.	-2599648.
	IRR	0.165	0.159	0.148	0.134	0.118
-10%	B/C	1.397	1.331	1.215	1.075	0.931
	NPV	40698536.	35573128.	25322312.	9946080.	-10555568.
	IRR	0.159	0.153	0.142	0.128	0.112
-15%	B/C	1.319	1.257	1.147	1.015	0.880
	NPV	32742616.	27617208.	17366392.	1990160.	-18511488.
	IRR	0.152	0.146	0.135	0.122	0.106
-20%	B/C	1.242	1.183	1.080	0.955	0.828
	NPV	24786688.	19661280.	9410464.	-5965768.	-26467416.
	IRR	0.145	0.139	0.128	0.115	0.100

Appendix C.4 Theoretical Ground for Development Benefit

The theoretical ground for enhancing the economic potential in the area influenced by the road improved project is explained as follows;

Let assume that Region 1 be affected by the road project and Region 2 be not affected by it. The potential production functions for these two regions are indicated as Y_1 and Y_2. Y_1 and Y_2 are represented by the following equations;

$$Y_1 = F_1(N_1, K_1, L_1, T, Dist_1)$$

$$Y_2 = F_2(N_2, K_2, L_2, T, Dist_2)$$

Where,

N	:	Labor
K	:	Capital stock and variable cost
L	:	Land
T	:	Technical progress
Dist	:	Distance to La Paz
1	:	Region 1
2	:	Region 2

Based on the theory of economics, the above functions should be satisfied the following first-order condition;

$$\frac{\partial Y_i}{\partial N_i} > 0, \quad \frac{\partial Y_i}{\partial K_i} > 0, \quad \frac{\partial Y_i}{\partial L_i} > 0, \quad \frac{\partial Y_i}{\partial T_1} > 0, \quad \frac{\partial Y_i}{\partial N_1} > 0, \text{ and}$$

$$\frac{\partial Y_i}{\partial Dist_i} < 0 \qquad \text{Where, } i=1,2$$

According to information in "Estrategia de Desarrollo Economico y Social 1989-2000", the future productivity in the agricultural sector is forecast as shown in Table B.5-7. Since this productivity increase is interpreted as the technical progress, the production will be increased through the item, $\partial Y/\partial T$. However, if the demand is constant, the production must also remain at the existing level. In this case, the area of the cultivated land will be decreased because there is no production increase in spite of the technical progress. Therefore, the technical progress means the save of the cultivated land (N and K are assumed to be constant).

If the demand is increased, for example, by population increase, some part of the above saved cultivated land

continue to be cultivated to satisfied the demand. The effect will extend to both regions with the same rate, because the technical progress is assumed to be same as in whole Bolivia.

Consider the road investment project between Region 1 and a large consumption area (ex. La Paz). The investment for the road makes the distance shorter between both areas. Therefore, D_1 becomes shorter and D_2 is constant. In this case, Region 1 is more advantageous than Region 2 through the item, $\partial Y / \partial$ Dist. As a result, the increased demand in large consumption area (La Paz) will depend on the production of Region 1, because the production and transportation conditions become much advantageous compared with conditions before the road improvement project.