12.2.3 Calculate Construction Quantities and Costs

Construction quantities will be taken-off for all works items in compliance with the MOP standard method of measurement. Using these quantities and the unit costs calculated, the estimated construction cost shall be determined.

12.3 Cost Estimation

12.3.1 Quantities

Construction quantities are calculated by using standard structure of chile. Table 12-1 shows the summary of quantities for preliminary design.

12.3.2 Direct Cost for Construction

Basic unit prices used for the construction are prepared as shown in Table 12-3. The items of work are followed by the item numbers and unit prices as given in the estimation standards of MOP. Some items are added or modified due to the method of work. Unit cost for each work item are calculated by using the unit prices as shown in Table 12-2(1/2) to Table 12-2(2/2). Each construction item number for the unit prices corresponds to the items of the quantities mentioned above.

The direct cost of the construction for each item is calculated as a result of multiplication of the unit cost and the quantity of each work item. Tables 12-9 show the derivation of direct costs for preliminary design.

Table 12-1 Summary of Quantities

Descripción	Unidad	Ensanche	Muro de Retención		Paso superior	Muro de Retención		Llenado	Puente	Muro de Retención			Paso superior	Muro de Retención			Prolongación	Total
Extensión		110	45	55	225	70	55	470	1855	65	40	60	245	60	40	185	400	3980
1. Construcción de Camino																		
Cortadura	M^3	1.936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.936
Llenado	M^3	0	545	3.344	0	4.256	666	24.675	0	1.365	484	3.648	0	3.648	484	0	0	43.115
Fosas de Drenaje	M	220	90	110	450	140	110	940	0	130	80	120	490	120	80	370	800	4.250
Cañería de Drenaje	M	35	0	0	0	0	0	35	0	0	0	0	0	0	0	35	35	140
Subbase	M^3	935	405	495	810	630	495	3.055	0	423	360	540	882	540	360	1.203	2.600	13.733
Pavimento de Hormigón	M^2	2.200	1.215	1.485	2.700	1.890	1.485	2.021	0	280	1.080	1.620	2.940	1.620	1.080	796	1.720	24.132
Pavimento de Asfalto	M^2	0	0	0	3.420	0	0	0	42.374	0	0	0	3.724	0	0	0	0	49.518
Curb	M	440	180	220	900	280	220	1.880	3.710	260	160	240	980	240	160	740	1.600	12.210
Mediana	M	110	45	55	225	70	55	470	1.855	65	40	60	245	60	40	185	400	3.980
Guardarriel	M	0	90	110	0	140	110	0	3.710	0	80	120	0	120	80	0	0	4.560
Franja Marjinal	M	660	270	330	1.350	420	330	2.820	1.113	390	240	360	1.470	360	240	1.110	2.400	23.880
Sistema de Enclavamiento	M^2	660	270	330	1.350	420	330	2.820	0	390	240	360	1.470	360	240	1.110	2.400	12.750
Iluminación	Cada uno	7	3	4	15	5	4	29	124	5	3	4	16	4	3	12	25	264
Señal	Poner	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	4
Señal de Camino	Poner	1	0	0	2	0	0	0	2	0	0	0	2	0	0	1	1	9
Demolición de Hormigón	M^3	660	392	479	810	609	479	0	0	0	0	0	882	522	348	463	1.000	6.644
Trabajo de Saneamiento	M	110	45	55	225	70	55	470	0	0	0	0	245	60	40	185	400	1.960
Trabajo de Electricidad	M	110	45	55	225	70	55	470	0	0	0	0	245	60	40	185	400	1.960
Servicio de Gas y Agua	M	110	45	55	225	70	55	470	0	0	0	0	245	60	40	185	400	1.960
2. Muro de Retención																		
Excavación de Estructura	M^3	0	99	759	0	966	121	0	0	0	88	828	0	828	88	0	0	3.777
Moldaje para Fundació	M^2	0	378	132	0	168	462	0	0	0	336	144	0	144	336	0	0	2.100
Moldaje para Muro	M^2	0	0	1.188	0	1.512	0	0	0	0	0	1.296	0	1.296	0	0	0	5.292
Barra de Refuerzo para Fundación	Ton	0	0	12	0	16	0	0	0	0	0	13	0	13	0	0	0	54
Barra de Refuerzo para Muro	Ton	0	0	18	0	23	0	0	0	0	0	20	0	20	0	0	0	81
Concreto para Fundación	M^3	0	162	198	0	252	99	0	0	0	72	216	0	216	72	0	0	1.359
Concreto para Muro	M^3	0	0	297	0	378	198	0	0	0	144	324	0	324	144	0	0	1.665
Andamiaje	M^2	0	0	440	0	560	0	0	0	0	0	480	0	480	0	0	0	1.960
3.Infraestructura																		
Excavación de Estructu	M^3				6.902				0				6.904					13.806
Excavación para Cajon	M^3				0				48.492				0					48.492
Barra de Refuerzo	Ton				152				2.484				158					2.794
Moldaje	M^2				2.120				35.370				3.032					40.513
Hormigón	M^3				2.064				42.282				2.166					46.512
Andamiaje	M^2				2.568				37.962				2.796					43.326
Plataforma	M^3				1.560				7.398				1.700					10.658
4. Superestructura																		
Barra de Refuerzo	Ton				294				2.970				326					3.590
Cable PC	Ton				50				1.080				83					1.213
Moldaje	M^2				10.217				50.220				11.433					71.870
Moldaje Circular	M				0				17.010				0					17.010
Viga de Hormigón	M^3				1325				31.320				1.518					34.163
Losa de Hormigón	M^3				805				0				878					1.683
Apoyo	Cada Uno				98				240				98					436
Junta de Expansión	M				136				195				136					467
Baranda	M				450				3.710				490					4.650

Table 12-2(1) Unit Cost for Each Construction Item

Descripción	Unidad	Coato Financiero		Economico	Total Financial	Total Económico	Extranjero (%)
		Extranjero	Local	Local			
Trabajo de Anclaje	C/U	67,97	109.274	87.387	138.569	116.682	21,1
Montaje y Desmontaje del Moldaje	Ton	42,00	14.326	12.651	32.428	30.753	55,8
Montaje y Desmontaje del Andamio M	Hora	128.704,80	26.543.650	23.027.05	82.015.41	78.498.816	67.6
Relleno con Uso de Materiales Selector	Cum	3,57	4.830	3.346	6.369	4.885	24,2
Relleno	Cum	1,03	111	94	555	538	80,0
Base por manufactura de Vigos	Lm	0,00	12.223	8.369	12.223	8.369	0,0
Baranda	Lm	11,07	10.405	8.209	15.176	12.980	31,4
Pilote Preexcavado A	C/u	17.966,31	2.013.561	1.708.656	9.757.041	9.452.136	7,94
Pilote Preexcavado B	C/U	0,00	30.968	28.069	30.968	28.069	0,0
Sumidero	C/U	12,77	14.155	11.223	19.659	16.727	28,0
Moldaje circular	Sqm	0,00	10.165	7.853	10.165	7.853	0,0
Hormigón para Fundación	Cum	1,80	36.308	29.225	37.084	30.001	2,1
Hormigón de Muro	Cum	10,20	37.213	29.994	41.609	34.390	10,6
Hormigón 280kg	Cum	2,68	37.698	30.914	38.853	32.069	3.0
Hormigón 360kg	Cum	2,68	44.848	36.777	46.003	37.932	2,5
Hormigón vaciado	Cum	0,00	3.870	2.631	3.870	2.631	0,0
Hormigón vaciado manualmente	Cum	0,00	5.602	3.808	5.602	3.808	0,0
Hormigón vaciado mecánicamente	Cum	8,40	8.568	5.979	12.188	9.599	29,7
Pavimento de hormigón	Sqm	5,04	12.977	10.428	15.149	12.600	14,3
Riostras(30m)	Span	111,01	1.460.773	1.133.676	1.508.618	1.181.521	3,2
Riostras PCI (35m)	Span	124,30	1.619.570	1.256.113	1.673.057	1.309.600	3,2
Solera y Mediana	Lm	4,30	8'090	6.185	9.943	8038	18,6
Cortadura	Cum	2,74	348	288	1.529	1.469	77,2
Losa(35m)	Sqm	7,09	31.764	25.747	34.820	28.803	8,8
Demolición de hormigón	Cum	32,47	9.128	6.865	23.123	20.860	60,5
Fosos de drenaje	Lm	24,66	36.718	28.582	47.346	39.210	22,4
Bomba de drenaje	C/U	2.632,00	507.640	454.020	1.642.032	1.588.412	69,1
Obras de electricidad y teléfono	Lm	0,32	5.197	4.250	5.335	4.388	2,6
Terraplén	Cum	4,75	594	495	2.641	2.542	77,5
Equipamiento de fabricación cable	Día	94,35	28.867	23.738	69.532	64.403	58,5
Equipamiento para Fabricación	Juego	68.969,85	46.321.356	40.089.128	76.047.36	69.815.13	39,1
Excavación para cajon	Cum	19,50	9.623	7.834	18.028	16.239	46,6
Junta de expansión	Lm	62,73	12.607	10.815	39.644	37.852	68,2
Facilidades de andamio movil	Juego	49.521,80	924.742	807.217	22.268.638	22.151.114	95,8
Facilidades de base	Sqm	0,00	170.797	140.026	170.797	140.026	0,0
Puente temporal	Juego	759,88	1.511.665	1.229.591	1.839.173	1.557.099	17,8
Moldaje para base	Sqm	0,65	4.397	3.312	4.677	3.592	6,0
Moldaje para fundación	Sqm	3,72	4.727	3.592	6.330	5.195	25,3
Moldaje para muro	Sqm	1,17	8.733	6.189	9.237	6.693	5,5
Colocación de viga	Ton	0,00	2.993	2.652	2.993	2.652	0,0
Clasificación	Sqm	0,24	150	96	253	199	40,8
Baranda	Lm	1,48	396	369	1.034	1.007	61,7
Guardarriel	Lm	5,73	26.336	21.109	37.426	32.199	29,6
Pilote perfil H	C/U	142,92	1.305	1.057	62.904	62.656	97,9
Hungar de acero	Ton	42,00	6.045	5.198	24.147	23.300	75,0
Instalación guarda canto del cajon	C/U	1.200,00	60.991	50.821	578.191	568.021	89,5
Sistema de enclavamiento	Sqm	5,94	4.294	3.546	6.854	6.106	37,4
Trabajos de lanzamiento de vigas (35m)	Juego	988,53	485.934	409.599	911.990	835.655	46,7
Trabajos de Lanzamiento de vigas	C/U	201,59	407.993	339.956	494.878	426.841	17,6
Equipo mecánico A	Juego	279.212,88	59.363.320	47.492.01	179.704.06	167.832.768	67,0
Equipo mecánico B	Gird	380,87	1.813.512	1.542.564	1.977.667	1.706.719	8,3
Maquinaria y facilidades	Lm	1.080.787,00	2.669.902	2.135.921	468.489.08	467.955.104	99,4
Fabricación de viga HP A	C/U	3.290,67	5.440.166	4.498.911	6.858.445	5.917.190	20,7

Note : Local cost expresed in Ch$ * 1000
Foreign cost expressed in US$ * 1000
Total cost = (Foreign costo) * 431 + (Local cost)
Financial cost and economic cost are explained in Chapter 13.
H.P.: Hormigon Postensado
B.A.: Barra de Acero

Table 12-2(2) Unit Cost for Each Construction Item

Descripción	Unidad	Coato Financiero		Economico	Total Financial	Total Económico	Extranjero (%)
		Extranjero	Local	Local			
Fabricación de Vigas H.P.	C/U	3.941,13	6.049.511	5.003.053	7.748.138	6.701.680	21,9
Fabricación de Losa aliviarada H.P.	Span	162.769,75	9.019.56	211.256.256	329.173.344	281.410.016	21,3
Faja Marginal	Lm	0,33	429	370	571	512	24,9
Excavación Mecánica	Cum	5,07	546	464	2.731	2.649	80,0
Transferencia de Maquinaria	Hora	0,00	657.954	583.411	657.954	583.411	0,0
Cajon Abierta	C/U	31.378,89	56.919.044	46.133.188	70.443.34	59.657.488	19,2
Moldaje Exterior	C/U	1.680,00	1.297.440	1.117.280	2.021.520	1.841.360	35,8
Asemblado de Cable PC	Ton	1.595,80	329.131	284.381	1.016.903	972.171	67,6
Hormigón PC de 440 kg	Cum	8,98	60.725	49.819	64.595	53.689	6,0
Postensado	Cable	14,55	23.266	19.953	29.537	26.224	21,2
Moldaje Prefabricado	Sqm	3,69	23.931	18.956	25.521	20.546	6,2
Vigas de Protección	C/U	0,00	11.710	9.888	11.710	9.888	0,0
Tubería RC	Lm	383,16	144.922	113.376	310.064	278.518	53,3
Trabajo en la Vía Ferrea	Lm	0,00	3.435	2.944	3.435	2.944	0,0
B.A para Fundación	Ton	24,00	411.652	333.81	421.996	344.160	2,5
B.A para Muro	Ton	31,00	436.828	353.952	450.189	367.313	3,0
Desviación de cauce	Lm	233,59	35.015	29.142	135.692	129.819	74,2
Reubicación de Viga	Día	44,40	55.606	49.331	74.742	68.467	25,6
Reubicación de Viga	Día	29,60	54.011	47.976	66.769	60.734	19,1
Muro de Retención	Juego	98,64	243.279	191.791	285.793	234.305	14,9
Cepas de Marco Rigído Each	C/U	8.884,90	22.676.072	18.175.526	26.505.464	22.004.918	14,4
Bancos del Río	Sqm	11,05	16.149	13.287	20.912	18.050	22,8
Construcción de Camino	Juego	906,96	1.079.487	871.353	1.470.387	1.262.253	26,6
Apoyo de neopreno	C/U	92,31	195.359	160.874	278.245	243.760	29,8
Base de apoyo	Lm	2,90	6.654	5.462	7.904	6.712	15,8
Andamio	Sqm	2,94	5.583	4.563	6.850	5.830	18,5
Concreto para Sellar 160 kg	Cm	2,68	33.837	27.600	34.992	28.755	3,3
Obras de Alcantarillado	Lm	40,92	103.898	85.865	121.535	103.502	14,5
Tablestaca	Pza.	104,37	4.918	4.184	49.901	49.167	90,1
Instalación de Señales	C/U	190,79	12.106.213	9.915.218	12.188.443	9.997.448	0,7
Plataforma	Cum	2,40	3.265	2.662	4.299	3.696	24,1
Plataforme A	Cum	27,72	7.895	6.543	19.842	18.490	60,2
Moldaje de Acero	Sqm	4,13	5.979	4.735	7.759	6.515	22,9
Fabricación de moldaje de acero	Sqm	0,00	6.392	5.300	6.392	5.300	0,0
Montaje y desmontaje de moldaje	Sqm	4,13	3.433	2.589	5.213	4.369	34,1
Iluminación de Calle	C/U	56,55	540.776	442.291	565.149	466.664	4,3
Excavación de Estructura para Cepo	Cum	55,86	6.659	5.648	30.735	29.724	78,3
Excavación de Estructura para Muro	Cum	24,88	2.680	2.276	13.403	12.999	80,0
Excavación de Estructura	Cum	16,29	1.916	1.625	8.937	8.646	78,6
Puntal y Tablestaca	Ton	490,99	67.576	56.939	279.193	268.556	75,8
Subbase Gruesa	Cum	0,53	119	86	347	314	65,7
Subbase para Camino	Cum	0,97	411	272	829	690	50,4
Excedente de Tierra	Cum	5,64	608	516	3.039	2.947	80,0
Puente Temporal	Lm	3,40	359	305	1.824	1.770	80,3
Puente Temporal A	Lm	880,96	7.750	6.355	387.444	386.049	98,0
Puente Temporal B	Sqm	7,14	2.629	2.296	5.706	5.373	53,9
Puente Temporal C	Ton	46,76	29.618	25.304	49.772	45.458	40,5
Camino Temporal	Lm	0,53	2.577	2.115	2.805	2.343	8,1
Pilote de Madera	Piles	2,78	3.753	3.065	4.951	4.263	24,2
Señales de Tráfico	C/U	3.226,79	10.372.173	8.297.889	1.762.920	9.688.636	11,8
Andamio Móvil	C/U	0,00	505.904	453.404	505.904	453.404	0,0
Colocación de andamio movil	Hora	11.046,70	1.233.715	1.037.750	5.994.843	5.798.878	79,4
Tratamiento de Pilote H	C/U	0,00	25.658	23.256	25.658	23.256	0,0
Excavación bajo Agua	Cum	13,19	1.581	1.341	7.026	7.026	78,2
Servicio de Gas y Agua	Lm	47,41	43.695	35.891	64.129	56.325	31,9

Note: Local cost expresed in Ch$ * 1000
Foreign cost expressed in US$ * 1000
Total cost = (Foreign costo) * 431 + (Local cost)
Financial cost and economic cost are explained in Chapter 13.
H.P.: Hormigon Postensado
B.A.: Barra de Acero

Table 12-3(1) Unit Cost of Wages by Labour Classification
(Costo de Mano de Obra)

Descripción	Unidad	Financiero		Económico Local (PS)
		Extranjero (US$)	Local (PS)	
Superintendente	hora	0,00	8.571	8.571
Ingeniero Civil	hora	0,00	3.928	3.928
Capataz	hora	0,00	2.500	1.825
Tecnico	hora	0,00	1.571	1.146
Topografo	hora	0,00	2.142	1.563
Capataz del Sector Mecanico	hora	0,00	1.785	1.303
Chofer	hora	0,00	1.071	642
Dibujante	hora	0,00	1.285	938
Jefe Administrativo	hora	0,00	2.000	2.000
Secretaria	hora	0,00	1.785	1.303
Coordinador	hora	0,00	714	428
Guardia de Seguridad	hora	0,00	571	342
Capataz	hora	0,00	2.500	1.825
Mano de Obra Calificada	hora	0,00	1.571	1.571
Mano de Obra no Calificada	hora	0,00	600	360
Soldador	hora	0,00	1.257	917
Carpintero	hora	0,00	1.171	854
Mecànico	hora	0,00	928	677
Operador	hora	0,00	1.171	854
Concretero	hora	0,00	1.171	854
Enfierrador	hora	0,00	814	594
Dinamitero	hora	0,00	1.100	803

Note: Financial cost and economic cost are explained in Chapter 13.

Table 12-3(2) Basic Unit Cost (Machinery Cost)

(Costos de Maquinarias)

Descripción	Costo Operación por Hora			Costo Finalcierо Total	
	Extranjero(US$)	Local			
		Financieron(Ch$)	Económico(Ch$)	US$	Ch$
Rompe Pavimentos	2,2	233	198	2,7	1.164
Bulldozer D6	27,8	3.000	2.550	34,8	14.999
Rompedor Hidráulico	2,2	233	198	2,7	1.164
Cargador de Tractor	7,7	832	707	9,7	4.159
Motoniveladora	9,6	1.034	879	12,0	5.172
Motoniveladora 140G	20,4	2.198	1.868	25,5	10.991
Motoniralla arrastrado por Tractor	35,6	3.836	3.261	44,5	19.180
Rodillo de Neumático A	10,8	1.164	989	13,5	5.819
Rodillo Vibratorio	8,4	905	769	10,5	4.526
Camión	9,3	1.000	850	11,6	5.000
Rodillo Tipo B	19,2	2.069	1.758	24,0	10.344
Camión sistema	7,4	802	681	9,3	4.008
Carreta sistema	7,0	759	645	8,8	3.793
Cargador 950	18,6	2.000	1.700	23,2	9.999
Distribuidor de Asfalto	16,8	1.810	1.539	21,0	9.051
Rociador de Asfalto	13,2	1.422	1.209	16,5	7.112
Afinadora de Asfalto	19,6	2.112	1.795	24,5	10.560
Mezclador de Asfalto	81,6	8.792	7.474	102,0	43.962
Camión de Volteo 6m3	11,6	1.250	1.062	14,5	6.250
Rociador de Concreto	72,0	7.758	6.594	90,0	38.790
Camión de Volteo 12m3	22,8	2.457	2.088	28,5	12.284
Acabadore de Concreto	13,2	1.422	1.209	16,5	7.112
Herrero de Ripio	13,2	1.422	1.209	16,5	7.112
Excavador Hidráulico A	23,6	2.543	2.161	29,5	12.71
Excavador Hidraulico B	11,2	1.207	1.026	14,0	6.034
Compactador Vibratorio	5,1	547	465	6,4	2.737
Cuchañón	65,0	7.008	5.957	81,3	35.040
Camioneta	6,6	715	608	8,3	3.577
Camión Remorque 25t	31,3	3.370	2.865	39,1	16.852
Grúa de orugas 35t	33,4	3.595	3.055	41,7	17.973
Grúa de camión 11t	31,0	3.336	2.836	38,7	16.680
Grúa de camión 25t	60,0	6.465	5.495	75,0	32.325
Grúa de camión 40t	87,2	9.396	7.986	109,0	46.979
Grúa de camión 80t2	292,0	31.463	26.744	365,0	157.31
Martillo Diesel 4.5t	42,9	4.620	3.927	53,6	3.102
Martillo Vibatorio 7.5kw	9,5	1.026	872	11,9	5.129
Equipos de perforación Benoto	127,2	13.70	11.506	159,0	68.529
Mezcladora de Concreto 0.3m3	0,7	73	62	0,9	366
Mezcladora de Concreto 0.5m3	0,8	86	73	1,0	431
Camión Mezclador de Concreto 4.0m3	1,4	155	132	1,8	776
Cubo de Concreto 0.6m3	10,8	1.164	989	13,5	5.819
Mezcladora de mortero 2.0kw	1,6	172	147	2,0	862
Bomba Inyectora 2.4kw	2,2	237	201	2,8	1.185
Bomba de Concreto 15kw	18,4	1.983	1.685	23,0	9.913
Camión Bomba de Concreto 112pzas.	36,0	3.879	3.297	45,0	19.395
Equipo de Pesaje	1,0	108	92	1,3	539
Camión Grúa	6,7	720	612	8,4	3.599
Camión Mezclador 6.5m3	2,9	315	267	3,7	1.573
Vibrador de Concreto	0,9	95	81	1,1	474
Grúa 5t	245,6	26.463	22.494	307,0	132.317
Andarivel fijo 9.5t	186,4	20.085	17.072	233,0	100.423
Torre Grúa 85.5tm	6,6	707	601	8,2	3.534
Grúa de Pórtico	14,8	1.595	1.355	18,5	7.974
Gata Hidráulico 100t	6,0	647	550	7,5	3.233
Cinta Transportadora	1,4	155	132	1,8	776
Carretilla de horquilla elevadora	14,0	1.509	1.282	17,5	7.543
Máquina Soldadora	1,2	129	110	1,5	647
Compresor	10,4	1.121	953	13,0	5.603
Generador 100KVA	18,8	2.026	1.722	23,5	10.129
Perforador	0,0	3.000	2.850	7,0	3.000
Transformador 200KVA	0,8	86	73	1,0	431
Bomba de Agua 4"	0,0	300	285	0,7	300
Bomba de Agua 6"	0,0	650	618	1,5	650
Planta de Hormigón 15m3	19,2	2.06	1.75	24,0	10.344
Huinche Tambor S 15kw	2,6	276	234	3,2	1.379
Huinche Tambor D 15kw	3,6	384	326	4,5	1.918
Linea Marcadora	32,8	3.534	3.004	41,0	17.671
Gato 195t	24,0	258.600	219.810	30,0	12.930
Contador de Alta Velocidad	0,1	12	10	0,14	62
Montacarga, Huinche 1ton	1,5	160	128	1,86	800
Marco Soportante F	43,4	4.679	3.743	44,3	19.087
Trabajo de tirar	33,1	3.571	2.857	41,4	17.856
Trabajo de lanzamiento	11,4	1.231	985	14,3	6.157
Equipo por Andamio Móvil	5,9	640	512	7,4	3.202

Note: Financial cost and economic cost are explained in Chapter 13.

Table 12-3(3) Basic Unit Cost (Material Cost)

(Costos de Materiales)

Descripción	Por Unidad	Extranjero (US$)	Costo Local		Costo Financiero Total	
			Financiero(Ch$)	Económico(Ch$)	Extranjero(Ch$)	Local(Ch$)
Material Bituminoso	1,00 Kg	0,00	85	69	0,20	85
Capa de Imprimación	1,00 Kg	0,00	75	61	0,17	75
Capa Sellante	1,00 Sqm	0,00	200	164	0,46	200
Piedra Chancada	1,00 Cum	0,00	5.540	4.542	12,85	5.540
Suelo Subrasante	1,00 Cum	0,00	825	676	1,91	825
Grava	1,00 Cum	0,00	3.000	2.460	6,96	3.000
Conglomerado de Piedras	1,00 Cum	0,00	3.150	2.583	7,31	3.150
Bloques	1,00 Cum	0,00	20.400	16.728	47,33	20.400
Sistema de Enclavamiento	1,00 Sqm	0,00	3.400	2.788	7,89	3.400
Madera Cuadrada	1,00 Cum	0,00	64.500	52.890	149,65	64.500
Tabla de Madera	1,00 Sqm	0,00	1.550	1.271	3,60	1.550
Madera Laminada	1,00 Sqm	0,00	3.680	3.017	8,54	3.680
Aceite para Molde	1,00 Lt	0,00	365	299	0,85	365
Agente de introducción del	1,00 Lt	0,00	210	172	0,49	210
Plastificante	1,00 Lt	0,00	245	200	0,57	245
Agregado Fino	1,00 Cum	0,00	3.180	2.607	7,38	3.180
Arena Gruesa	1,00 Cum	0,00	3.550	2.911	8,24	3.550
Arena Fina	1,00 Cum	0,00	3.500	2.870	8,12	3.500
Cemento	1,00 kg	0,00	48	39	0,11	48
Cemento rápido	1,00 kg	0,00	55	45	0,13	55
Hormigón Premezclada 80kg/cm2	1,00 Cum	1,80	28.300	23.206	67,46	29.076
Hormigón Premezclada 160k/cm2	1,00 Cum	1,80	29.200	23.944	69,55	29.976
Hormigón Premezclada 200k/cm2	20,00 Cum	1,80	32.400	26.568	76,97	33.176
Hormigón Premezclada 240k/cm2	1,00 Cum	1,80	33.200	27.224	78,83	33.976
Hormigón Premezclada 280k/cm2	1,00 Cum	1,80	34.200	28.044	81,15	34.976
Hormigón Premezclada 360k/cm2	1,00 Cum	1,80	40.700	33.374	96,23	41.476
Hormigón Premezclada 440k/cm2	1,00 Cum	1,80	54.500	44.690	128,25	55.276
Lechada de Mortero	1,00 Cum	0,00	31.800	26.076	73,78	31.800
Barra de Anclaje	1,00 Pzas	0,00	2.500	2.050	5,80	2.500
Pilote de Hormigon armado	1,00 Lm	0,00	51.600	42.312	119,72	51.600
Pozo de Registro	1,00 Pcs	0,00	133.000	109.060	308,58	133.000
Cable para Postensado	1,00 kg	1,10	0	0	1,10	474
Anclaje	1,00 Pcs	14,55	0	0	14,55	6.271
Vaina 2"	1,00 Lm	4,20	0	0	4,20	1.810
Barra de Refuerzo A63-42H	1,00 Ton	0,00	375.000	307.500	870,07	375.000
Viga I	3,00 kg	0,80	0	0	0,80	345
Viga H	1,00 kg	0,80	0	0	0,80	345
Perfil en U 250x50	1,00 kg	1,25	0	0	1,25	539
Riel Simple	1,00 Lm	3,50	9.680	7.937	22,46	9.680
Riel Doble	18,00 Lm	3,85	19.400	15.907	45,01	19.400
Riel Triple	1,00 Lm	0,80	27.500	22.550	63,81	27.500
Perfil en V Angulo 75x75	1,00 kg	0,00	0	0	1,25	539
Perno de Anclaje	1,00 Pcs	0,00	0	0	3,50	1.509
Perno de Alta Resistencia	1,00 Pcs	0,00	0	0	3,85	1.659
Tablestaca	1,00 Lm	0,00	0	0	0,80	345
Placa de Acero Estructural	1,00 kg	0,00	400	328	0,93	400
Guardarriel	1,00 Lm	0,00	33.900	27.758	78,65	33.900
Perno de Cabeza Hexagonal	1,00 Pcs	0,00	450	369	1,04	450
Clavos	1,00 kg	0,00	250	205	0,58	250
Tubo de PVC	1,00 Lm	0,00	670	549	1,55	670
Membrana de Curado	1,00 kg	0,00	545	446	1,26	545
Tubo Redondo	1,00 kg	0,00	435	356	1,01	435
Apoyo de acero A44	1,00 kg	0,00	365	299	0,85	365
Perfil en U 80x80x8	1,00 kg	0,00	320	262	0,74	320
Apoyos de Neoprano	1,00 Pcs	0,00	59.100	48.462	137,12	59.100
Pintura	1,00 Sqm	0,00	1.300	1.066	3,02	1.300
Malla de Alamble de Acero	1,00 Kg	0,00	655	537	1,52	655
Alamble Destemplado	1,00 kg	0,00	235	192	0,55	235
Material Eléctrico	1,00 Lm	0,00	4.600	3.772	10,67	4.600
Baranda	1,00 Lm	0,00	7.170	5.879	16,64	7.170
Guardarriel	1,00 Lm	0,00	19.430	15.932	45,08	19.430
Pilote de Madera	1,00 C/U	0,00	65.000	53.300	150,81	65.000
Andamiaje	1,00 Sqm	0,00	2.800	2.296	6,50	2.800
Andamio tubular	1,00 Cum	0,00	1.400	1.148	3,25	1.400
Vaina 65mm	1,00 Lm	4,20	0	0	4,20	1.810
Barra Redonda	1,00 Kg	0,00	156	127	0,36	156
Tubo de Acero	1,00 kg	0,00	375	308	0,87	375
Cable	1,00 Lm	1,45	0	0	1,45	625
Junta de Expansión	1,00 Lm	62,73	0	0	62,73	27.037
Material de Junta	1,00 Lm	0,00	136	112	0,32	136
Andamio Móvil	1,00 Toa	1.740,00	0	0	1.740,00	749.940
Perno D19	1,00 Kg	0,00	195	160	0,45	195
Luz	1,00 Juego	0,00	238.000	195.160	552,20	238.000
Semaforo	1,00 Juego	0,00	1.269.000	1.040.580	2.944,32	1.269.000
Señales de Tráfico	1,00 Juego	0,00	668.000	547.760	1.549,88	668.000
Guardavivo del Cajón	1,00 kg	1,74	0	0	1,74	750

Note: Financial cost and economic cost are explained in Chapter 13.

12.3.3 General Expense

General expense is the expense for managing the construction project such as the expense for maintaining the construction site office or the expense for quality control. The cost items are generally divided into two parts. One is the the expense for the general purpose such as site preparation, compensation for damaged facility by the construction work. The other includes such items as the expense of maintaining the construction site office, namely, administration expense and staff salaries and allowances.

Assumption was made that the general expenses costs can be estimated by using a percentage of direct construction cost. It is expected that this percentage will give a satisfactory value if suitable estimating data are obtained. The Study Team has investigated the content and amount of general expenses, see Table A.12-1.

Company profit was not included in the general expenses, and therefore the direct cost will include company profit. The general expenses as a percentage of direct construction cost are estimated at 26.5 to 41.23 %.

The recently constructed Maule Bridge included 28.9 % for general expenses. Considering that when projects are large, the general expenses are usually lesser on a percentage basis, it is believed that the general expenses for the New Biobio Bridge would be between 20 % and 25 %.

The Study Team, after consultations with the MOP officials, decided to use 20 % of the direct costs for general expenses.

12.3.4 Engineering Cost and Contingency Costs

Engineering cost include the cost for detail design and construction supervision. The study team used 8 % of the construction costs for the engineering cost.

Construction cost is the sum of Direct Costs and General Expenses. In general, Contingency Costs were assumed to be 10 % of the Construction Costs.

12.3.5 Land Acquisition Costs

Location of land for acquisition was done by using the topographic map and aerial photographs. Data on land cost was obtained from Concepcion city office and are shown in Tables 12-4 and Table A.12-2 for each area as shown in Figure 12-1.

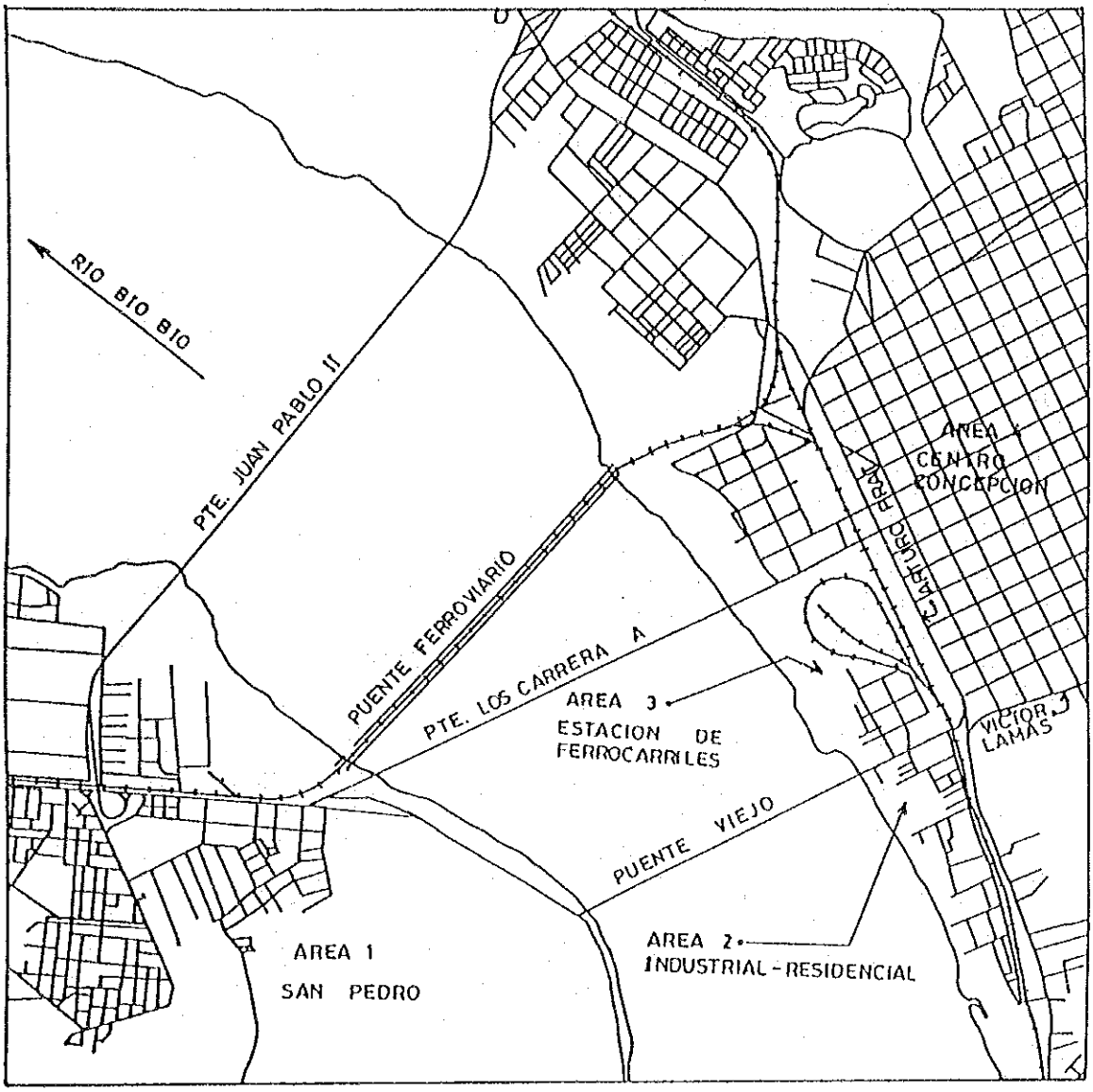


Fig. 12-1 Location of Various Areas in Concepcion

Table 12-4 Land Costs for Various Areas of Concepción

No.	Area	Costo del terreno(UF/m²)
1	Puente Viejo - Paperela	3,0 - 4,5
2	Costanera - Puente Viejo	0,5 - 0,8
3	Puente Viejo - Cerro Chepe	0,5 - 0,5
4	CentroCl(PlazaChacabuco-Prat-Carrera)	13,0 - 18,0

Note : 1 UF is equivalent to 10600 Pesos at January 1994.

The criteria influencing the land acquisition costs are as follows;

(1) Land:

The land area was calculated along the right of way (35.00 m) of the approach road to the bridge. The land area was calculated using the width (Right of way minus width of existing road) and the length of the approach road (where the approach road was widened from its existing width).

(2) Building

The types and costs of buildings are shown in Table 12-5. The condition rating of structures for evaluation of costs are shown in Table 12-6. Small buildings such as private homes shall be compensated for the entire value of such home when all or part of it falls within the right of way. Large buildings such as warehouses or factories shall be compensated for double the area of the portion which falls within the right of way.

Table 12-5 Cost of the Building by the Type of Structure

Tipo de Estructura	Valo(Pesos/m²)
A	105.000
B	60.000
C	30.000

where:

Type A:

1. Construction supported by steel frame, and floors supported by the steel or reinforced concrete.
2. Construction supported by reinforced concrete frame. Floors supported by reinforced concrete.
3. Construction supported by the retaining wall made of brick or masonry or concrete bricks with joints of reinforced concrete. Structures up to four-story.

TYPE B: Construction supported by retaining wall made of bricks or masonry with joints of reinforced concrete. Structure up to two-story.

TYPE C: Construction of timber including partition walls constructed of adobe.

Table 12-6 Condition Rating of the Structur

Calidad	Factor de estado(F.E)
Muy buena	1,00
Buena	0,75
Corriente	0,55
Más que inferior	0,40
Inferior	0,25

The land acquisition costs and the cost of compensation for buildings are shown in Table 12-7 and Table 12-8 respectively.

TABLE 12-7 Land Acquisition Cost

Area	Area 1	Area 2	Area 3	Area 4	Total
Costo unitario de terreno(UF)	3,75	6,50	0,50	16,60	-
Superficiede terreno(m^2)	31.269	0	11.400	0	-
Costo de terreno	1.242.923	0	60.420	0	1.303.343

1UF = 10,6 x 1.000 pesos

Table 12-8 Cost for Compensation for Buildings

Tipo de edificios	A	B	C	Total
Costo unitario (1.000 pesos/m^2)	105	0	30	-
Superficie de edificios(m^2)	2.070	0	2.700	-
Factor de estado(F.E)	0,50	0.00	0,25	-
Costo de indemnización(1.000 pesos)	108.675	0	20.250	128.925

Cost for Compensation for Building	128,925
Land Acquisition Cost	1,303,343
Total (Peso x 1000)	1,432,268

12.3.6 Total Construction Cost

Total construction cost is shown in Table 12-9 and is summarized below.

Local Currency Component	Ch $ 20,989,000,000
Foreign Currency Component	US $ 17,370,000

The Grand total cost is the sum of the above.

Grand Total expressed in Ch $ is 28,476,000,000
Grand Total expressed in US $ is 66,070,000

The currency conversion rate used is Ch $ 431.04 = US $1.00 (December 30, 1993)

Table 12-9 Construction Cost of New Biobio Bridge Project

(1,000 Ch$, 1,000 US$)

Item de Costo	Moneda Extranjera (1,000 US$)	Moneda Nacional (1,000 Ch.$)	Total (X 1,000)	
			en US$	en Ch.$
1 Nuevo Puente Biobío				
Reencauce del Río	956.5	142,448.0	1,287.0	554,690.9
Camino Temporal	1.2	4,917.2	12.6	5,433.1
Infraestructura	1,694.5	3,073,628.4	8,825.8	3,803,940.7
Superestructura	5,599.4	4,782,817.0	16,696.4	7,196,163.9
Accesorios	437.6	848,669.9	2,406.7	1,037,272.2
Orilla del Río	10.3	15,693.0	46.8	20,149.5
Subtotal	8,699.5	8,868,173.5	29,275.3	12,617,650.3
2 Acceso a Concepción	1.1			
Infraestructura	190.0	181,408.6	492.0	212,043.7
Viga PC	5.7	291,723.5	866.8	373,609.3
Viga Lanzadora PC	82.7	74,912.6	179.5	77,375.5
Losa de Cubierta, etc.	51.3	212,937.7	576.7	248,576.3
Muro de Contención	471.6	126,505.1	344.8	148,612.3
Camino de acceso (925m)		561,333.2	1,774.0	764,601.1
Subtotal	872.4	1,448,820.7	4,233.9	1,824,818.2
3 Acceso a San Pedro				
Infraestructura	71.1	181,408.6	492.0	212,043.7
Viga PC	220.8	310,032.2	940.1	405,194.5
Viga Lanzadora PC	6.1	79,358.9	190.2	81,979.8
Losa de Cubierta, etc.	86.7	234,041.6	629.8	271,427.1
Muro de Contención	47.3	116,773.9	318.3	137,180.6
Camino de Acceso (850m)	391.8	466,338.4	1,473.8	635,207.1
Subtotal	823.8	1,387,953.6	4,044.2	1,743,032.7
4 Costo Directo Total	10,395.7	11,704,947.8	36,533.4	16,185,501.2
5 Gastos Generales	2,079.1	2,340,989.6	7,510.7	3,237,100.2
6 Costo de Construcción	12,474.9	14,045,937.4	45,064.0	19,422,601.5
7 Costos de Engeniería	998.0	1,123,675.0	3,605.1	1,553,808.1
8 Imprevistos	1,247.5	1,404,593.7	4,506.4	1,942,260.1
9 IVA	2,649.7	2,983,357.1	9,571.6	4,125,360.6
10 Adquisición de Tierra	0.0	1,432,288.0	3,323.2	1,432,288.0
11 Costo de Construcción Total	17,370.0	20,989,851.2	66,070.3	28,476,318.3

Note: En el precio del año 1994,usando la tasa del cambio de US$ = 1.00 Ch$431

12.4 Implementation Schedule

12.4.1 Construction schedule

A tentative construction schedule is shown in Fig.11-6. The study team assume that the construction of the bridge is implemented by the following schedule.

(1) First year of the construction

1. Detail design of the bridge including access road.
2. Land acquisition for the construction site.
3. Select contractors for the construction.
4. Preparation of the construction of substructure for the bridge in the river and start construction of substructure.
5. Start construction of the access road including the fly-over at San Pedro side.
6. Start construction of the superstructure following where the substructure already constructed.

(2) Second year of the construction

1. Continue the construction of the substructure in the river.
2. Continue the construction of the superstructure in the river.
3. Start construction of flyover at Concepcion side following the accomplishment of the construction of fly-over at San Pedro side.

(3) Third year

1. Continue the construction of the Bridge in the river and fly-over at Concepcion side, and accomplish all the construction work of the structure.
2. Accomplish the access road.

12.4.2 Annual Construction Cost

The cost flow of every half year according the schedule is shown in the Table 12-10.

Table 12-10 Cost flow of every half year

(Millones de Pesos a Volores de 1994)

Item del Costo	1ro.Año		2do.Año		3ro.Año		Total
	1ra.mitad	2da.mitad	1ra.mitad	2da.mitad	1ra.mitad	2da.mitad	
1 Nuevo PuenteBiobío							
Reencauce del Río	221.9	0.0	0.0	166.4	0.0	0.0	554.7
Camino Temporal	1.9	0.0	0.0	3.5	0.0	0.0	5.4
Infraestructura	0.0	1,065.1	1,065.1	380.4	1,065.1	1,065.1	3,803.9
Superestructura	0.0	719.6	2,014.9	2,014.9	1,007.5	1,007.5	7,196.2
Accesorios	0.0	0.0	0.0	311.2	414.9	414.9	1,037.3
Orilla del Río	0.0	0.0	10.1	10.1	0.0	0.0	20.1
Subtotal	223.8	1,784.7	3,090.1	2,487.5	2,145.1	2,145.1	12,617.7
2 Acceso a Concepción							
Infraestructura	0.0	0.0	48.8	137.8	25.4	0.0	212.0
Viga PC	0.0	0.0	130.8	242.8	0.0	0.0	373.6
Viga Lanzadora PC	0.0	0.0	0.0	38.7	38.7	0.0	77.4
Losa de Cubierta, etc.	0.0	0.0	0.0	37.3	211.3	0.0	248.6
Muro de Contención	0.0	0.0	0.0	0.0	148.6	0.0	148.6
Camino de acceso (925m)	0.0	0.0	0.0	229.4	458.8	0.0	764.6
Subtotal	0.0	0.0	179.5	686.0	882.8	76.5	1,824.8
3 Acceso a San Pedro							
Infraestructura	95.4	116.6	0.0	0.0	0.0	0.0	212.0
Viga PC	263.4	141.8	0.0	0.0	0.0	0.0	405.2
Viga Lanzadora PC	0.0	82.0	0.0	0.0	0.0	0.0	82.0
Losa de Cubierta, etc.	0.0	135.7	135.7	0.0	0.0	0.0	271.4
Muro de Contención	0.0	68.6	68.6	0.0	0.0	0.0	137.2
Camino de Acceso (850m)	0.0	388.2	247.0	0.0	0.0	0.0	635.2
Subtotal	358.8	932.9	451.3	0.0	0,0	0.0	1,743.5
4 Costo Directo Total	582.6	2,717.6	3,721.0	3,572.5	3,370.3	2,221.5	1,185.5
5 Gastos Generales	116.5	543.5	744.2	714.4	674.1	444.3	3,237.1
6 Costo de Construcción	699.1	3261.2	4,465.2	4,287.1	4,044.3	2,665.8	19,422.6
7 Costos de Engeniería	466.1	217.5	217.5	217.5	217.5	217.5	1,553.8
8 Imprevistos	69.9	326.1	446.5	428.7	404.4	266.6	1,942.3
9 IVA	222.3	684.9	923.3	888.0	839.9	567.0	4,125.4
10 Adquisición de Tierra	1,432.3	0.0	0.0	0.0	0.0	0.0	1,432.3
11 Costo de Construcción Total	2,889.8	4,489.7	6,052.5	5,821.3	5,506.2	3,716.9	28,476.3

CHAPTER 13 ECONOMIC EVALUATION

13.1 Scope and Methodology of Evaluation

In this chapter, the new Biobio bridge described in Chapter 11 is examined as to whether its implementation is justifiable or not, from the economic point of view, by comparing costs and benefits caused by the project. In addition, the financial capacity of the Chilean Government is studied in order to analyze if the project can be financed with public investment fund without difficulty.

13.1.1 Basic Policy of Evaluation

(1) To follow the Chilean way of evaluation

MIDEPLAN of the Chilean Government issues a guideline for evaluating public investment projects (Inversion publica, Efficiencia y Equidad, Departamento de Inversiones, MIDEPLAN, 1992). MIDEPLAN is also collecting data relevant to project evaluation from each Ministry in charge of public investment to update the parameters for evaluation such as time values of Chilean people, shadow prices, vehicle operating costs, etc. Those parameters are published and the Governmental Agencies and consulting firms are instructed to use them when they carry out a feasibility study or develop a investment planning.

To evaluate the new Biobio bridge in this Study, the method and parameters authorized officially shall be followed as much as possible, in order to make the evaluation results comparable with those of other studies.

(2) To take conservative approach for benefit estimate

Construction of an urban road and bridge will generate a broad variety of benefits, not only mitigation of traffic congestion, but improvement of safety and comfort and in the long-term, acceleration of urban development in the influenced area.

To define and quantify the benefits in this Study, however, a rather conservative approach will be taken, limiting the benefits to the most direct ones, that is, savings in travel time and vehicle operating cost.

13.1.2 Scope of Evaluation

(1) Projection Period

Traffic forecast has been made for the year 1999 when the new bridge is deemed to open and the year 2010 which may be a limit of foreseeable future. Economic benefit by the bridge will be estimated for these two points of years and interpolated for 2000 to 2009 and extrapolated for the years beyond 2010, up to 2019.

(2) Coverage of Traffic

As explained in Chapter 6, vehicle OD matrices were developed by synthesizing two kinds of data: one is the OD matrix from roadside interview data which covers only traffic crossing the river. This interview was made by the Study Team in 1993. The other one is the person trip OD matrices surveyed by SECTRA in 1989.

The vehicle OD matrices used for traffic assignment cover all kinds of vehicles operated in the Study Area. Therefore, estimated benefit is not only from the traffic crossing the river, but also the traffic which does not cross the river which is affected by the traffic to/from the opposite side of the river.

(3) Road Network

Road network used for the traffic assignment is basically same as the present network, with the following exceptions: (a) Closure of the old Biobio bridge, (b) Openning of Av.Costanera, (c) Widening of Los Carrera Av. and Up-grading of Prat Av. The other road projects will be disregarded because they are minor projects or will not affect the traffic crossing the river.

13.1.3 Evaluation Procedure

Economic evaluation of a road or a bridge project will be made with so-called "cost benefit analysis" accordin to the procedure shown in Figure 13-1. the cost and benefit accruing from a project are measured in terms of economic price (social price).

The social cost is the monetary expression of real consumption of goods and services which are needed to implement the project and is derived by using the economic price. For this reason, all the transfer costs (taxes and subsidies) are deducted from the cost. In addition , in order to convert the financial cost of the project (estimated in Chapter 12) into the social cost, shadow wage rates are applied to labor cost and the shadow exchange rate is used as a multiplier to the foreign portion of the total cost.

In case of the new Biobio bridge, Benefits are savings in travel time cost and vehicle operating cost. Those costs are also calculated using social price.

After estimating costs and benefits from the year 1996 to 2020, evaluation indicators are calculated. They are internal rate of return (IRR), net present value (NPV) and benefit to cost ratio (B/C).

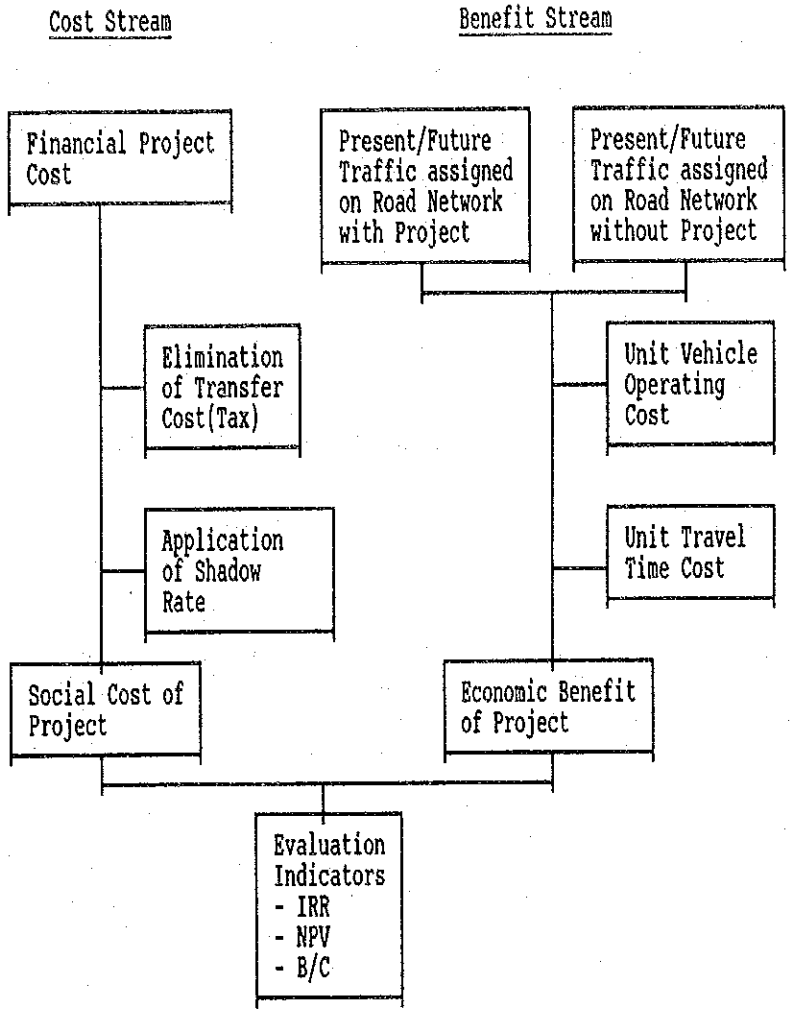


Fig. 13-1 Procedure for Economic Evaluation of Project

13.2 Economic Cost of New Bridge Project

As explained above, two procedures were taken to convert the financial cost of the project into the social cost. One is elimination of transfer cost and the other is application of shadow wage rates and shadow exchange rate.

In the process of cost estimation in Chapter 12, all the compound unit costs of work items are broken down into three basic cost components; labor cost, machinery and equipment cost and material cost. And each of these component is further subdivided into foreign currency portion and local currency portion. One of the reasons of this classification is to make it possible to estimate the economic cost.

The financial cost was modified and converted into the social cost, based on the following information.

1) First of all, The financial cost of the project in Chapter12 includes 18% of value added tax (IVA) and it should be deducted in the social cost.

2) The cost of Imported machinery, equipment and materials imply maximum 11% of import duties to be deducted.

3) According to the Department of Plans and Program of MOP, the shadow wage rates are:

- Skilled labor	1.00
- Semi-skilled labor	0.73
- Unskilled labor	0.60

The simplified Haveman's formula of shadow wage rate(SWR) is:

$$SWR = \left(\begin{array}{c}\text{Wage rate}\\ \text{in Market}\\ \text{Price}\end{array}\right) \times \left(1.25 - \begin{array}{c}\text{Unemploy-}\\ \text{ment}\\ \text{Rate(\%)}\end{array} / 20\right)$$

The Chilean Government reports that recent unemployment is exceeding 10 %. As the SWR is estimated at 0.75 under the unemployment rate of 10 % applying the above formula, the MOP's rates seem reasonable and they are multiplied to semi-skilled and unskilled labor cost included in the project cost.

4) MIDEPLAN estimates the current shadow exchange rate to be 1.1 which means that one US$ is equivalent to Ch.$ 431 at market price and Ch.$ 474 at social price. The latter is applied to the foreign currency portion for the economic evaluation purpose.

5) Contingency is assumed to be 10 % of the construction cost, half of which is regarded as physical contingency and the other half is price contingency. The latter is not considered as social cost because social cost is counted at constant price. Therefore, half of the contingency is deducted from the financial cost.

Making the conversion stated above, the financial cost of the Biobio bridge project is converted into the social cost as shown in Table 13-1. The total social cost is Ch.$ 21,002 million, which corresponds to about 74 % of the financial cost.

Annual investment amounts for the three construction years are shown in Table 12-10 (Chapter 12). They are converted to social cost in the same way. The result is shown in Table 13-2. The first year investment is Ch.$ 5,733.3 million (27.3 %), the second year Ch.$ 8,614.7 million (41.0 %) and the third year Ch$. 6,654.6 million (31.7 %) at social price basis, respectively. These amounts will be input to the cost-benefit cash flow.

Benefit will be counted for up to the year 2019, while the bridge and access roads will remain serviceable. Hence, the initial investment amount is not fully depreciated by that year. Assuming that the durable life of the bridge is 50 years and that of the roads is 60 years, the residual value 20 years after

opening, is calculated to be Ch.$ 10,294 million, about one half of the total social cost. This amount is refunded in 2020, as a negative amount in cost flow.

Table 13-1 Social Cost of New Biobio Bridge Project

(Million Ch.$)

Item del costo	Costo Financiero(F)	Costo Social(S)	S/F*100(%)
1 Nuevo Puente Biobío			
Reencauce del Río	554,7	572,1	103,1
Camino temporal	5,4	4,6	84,7
Infraestructura	3.803,9	3294,5	86,6
Superestructura	7.196,2	6558,4	91,1
Accesorios	1.037,3	889,4	85,7
Orilla del río	20,1	17,8	88,4
Subtotal	12.617,7	11.336,8	89,8
2 Acceso a Concepción			
Infraestructura	212,0	179,1	84,5
Viga PC	373,6	331,5	88,7
Viga Lanzadora PC	77,4	60,8	78,6
Losa de Cubierta, etc.	248,6	211,5	85,1
Muro de Contención	148,6	124,0	83,5
Camino de acceso(925m)	764,6	676,7	88,5
Subtotal	1.824,8	1.583,6	86,8
3 Acceso a San Pedro			
Infraestructura	212,0	179,1	84,5
Viga PC	405,2	361,3	89,2
Viga Lanzadora PC	82,0	64,4	78,6
Losa de Cubierta, etc.	271,4	230,6	84,9
Muro de Contención	137,2	114,5	83,5
Camino de Acceso(850m)	635,2	562,2	88,5
Subtotal	1.743,0	1.512,2	86,8
4 Costo Directo Total	16.185,5	14.432,5	89,2
5 Gastos Generales	3.237,1	2.886,5	89,2
6 Costo de Construcción	19.422,6	17.319,0	89,2
7 Costo de Ingeniería	1.553,8	1.385,5	89,2
8 Imprevistos	1.942,3	865,9	44,6
9 IVA	4.125,4	0,0	0,0
10 Adquisición de la Tierra	1.432,3	1.432,3	100,0
11 Costo de Construcción Total	28.476,3	21.002,7	73,8

Note: * Social cost / Financialcost

Table 13-2 Investment Schedule of New Biobio Bridge Project at Economic Cost

(Million Ch.$ at 1994 price)

Item de Costo	1er. Año		2do. Año		3er. Año		Total
	1ra.mitad	2da.mitad	1ra.mitad	2da.mitad	1ra.mitad	2da.mitad	
1 Nuevo Puente Biobío							
Reencauce del Río	228,8	0,0	0,0	171,6	0,0	171,6	572,1
Camino Temporal	1,6	0,0	0,0	3,0	0,0	0,0	4,6
Infraestructura	0,0	922,5	922,5	329,5	922,5	197,7	3294,5
Superestructura	0,0	655,8	1836,3	1836,3	918,2	1311,7	6558,4
Accesorios	0,0	0,0	0,0	266,8	355,8	266,8	889,4
Orilla del Río	0,0	0,0	8,9	8,9	0,0	0,0	17,8
Subtotal	230,4	1578,3	2767,7	2626,1	2196,4	1947,8	11336,8
2 Acceso a Concepción							
Infraestructura	0,0	0,0	41,2	116,4	21,5	0,0	179,1
Viga PC	0,0	0,0	116,0	215,5	0,0	0,0	331,5
Viga Lanzadora PC	0,0	0,0	0,0	30,4	30,4	0,0	60,8
Losa de Cubierta,etc.	0,0	0,0	0,0	31,7	179,8	0,0	211,5
Muro de Contención	0,0	0,0	0,0	0,0	124,0	0,0	124,0
Camino de acceso(925m)	0,0	0,0	0,0	203,0	406,0	67,7	676,7
Subtotal	0,0	0,0	157,2	597,0	761,8	67,7	1583,6
3 Acceso a San Pedro							
Infraestructura	80.6	98.5	0.0	0,0	0,0	0,0	179,1
Viga PC	234.8	126.5	0.0	0,0	0,0	0,0	331,5
Viga Lanzadora PC	0.0	64.4	0.0	0,0	0,0	0,0	60,8
Losa de Cubierta,etc.	0.0	115.3	115.3	0,0	0,0	0,0	211,5
Muro de Contención	0.0	57.3	57.3	0,0	0,0	0,0	124,0
Camino de Acceso(850m)	0.0	343.6	218.6	0,0	0,0	0,0	676,7
Subtotal	315,4	805,5	391,2	0,0	0,0	0,0	1.512,1
4 Costo Directo Total	545,9	2.383,8	3.131,6	3.213,1	2.958,1	2.015,4	14.432,5
5 Gastos Generales	109,2	476,8	663,2	642,6	591,6	403,1	2.886,5
6 Costo de Construcción	655,1	2.860,6	3.979,3	3.855,8	3.549,8	2.418,5	17.319,0
7 Costos de Ingeniería	415,7	194,0	194,0	194,0	194,0	194,0	1385,5
8 Imprevistos	32,8	143,0	199,0	192,8	177,5	120,9	865,9
9 IVA	0,0	0,0	0,0	0,0	0,0	0,0	0,0
10 Adquisición de Tierra	1,432,3	0,0	0,0	0,0	0,0	0,0	1432,3
11 Costo de Construcción Total	2535,7	3.197,6	4.372,3	4.242,5	3.921,2	2.733,4	21.002,7

As periodical maintenance works, overlay of access roads and minor deck repairs, maintenance of light standards, joint sealing, etc. will be necessary every three to five years, even their cost is not significant. For such works, 0.5 % of the total construction cost is deemed as annual maintenance cost.

13.3 Economic Benefit Acquired by New Bridge

13.3.1 General

Savings in travel time and vehicle operating cost(VOC) are the most direct and visible benefits brought about by a road and bridge construction project. In order to estimate these direct benefits, average time value of Chilean people and vehicle operating cost per unit distance are needed.

In this Study, such unit costs, as time value and VOC, are basically dependent on the data from MIDEPLAN and the Department of Planning and Programing of MOP.

13.3.2 Travel Time Cost

According to MIDEPLAN, unit time value of Ch.$ 210 per hour has been used in the past several years. However, MIDEPLAN reviewed and revised it to Ch.$ 336 per hour in February, 1994. The process to work out this figure is as follows:

```
VST  = a * VSTT + (1-a) * VSTN
VSTT = SPEA = SPH / NTH
VSTN = 0.35 * SPEA
SPH  = IN / NHN
```

where;
- VST : Social Time Value
- VSTT : Social Time Value of Work Trip
- VSTN : Social Time Value of non-Work Trip
- SPEA : Average Monthly Salary of a Permanent Employee
- SPH : Average Monthly Household Income
- NTH : Average No. of Workers in a Household = 1.43 (in Nov. 1992)
- IN : National Household Income = Ch.$ 710,510 Million (in Nov. 1992)
- NHN : No. of Households in Chile = 3,374,893 (in Nov. 1992)
- a : Percentage of Work Trip = 3.08 %

Then;

```
SPH  = 710,510 million / 3,374,893 = Ch.$ 210,528.20
SPEA = 210,528.20 / 1.43           = 147,099.07 ($ in Nov.1992)
     = 147,099.07 * 846.1/714.7    = 174,143.74 ($ in Nov.1993)
VSTT = 174,143.74/192 Hrs          = Ch.$ 906.99 / Hr
VSTN = 906.99 * 0.35               = Ch.$ 317.44 / Hr
VST  = (0.0308 * 906.99)+(0.9692 * 317.44) = Ch.$ 336 /Hr.
```

13.3.3 Vehicle Operating Cost

Vehicle operating cost is divided into two main components: (i) fuel cost and (ii) other cost, which is composed of lubricant cost, tire cost, maintenance and repair cost and depreciation cost, etc.

1) Fuel Cost

Fuel cost is the product of unit price, consumption rate and travel distance. Table 13-3 shows the fuel prices in Concepcion surveyed in January of 1994 and social prices estimated by MIDEPLAN. Both of them are also used for project cost estimation in Chapter 12.

Fuel consumption rate is related to running speed as shown in Table 13-4. As stated in Chapter 6, a type of Q-V curve (traffic volume vs travel speed) is designated on each link. Then, travel speed can be calculated using traffic volume assigned on a link. In the table, "passenger car type" represents passenger car, taxi and wagon/van, while " bus type" represents bus, taxibus and truck.

Table 13-3 Fuel Price in Study Area

(Ch.$/litter)

Tipo de Combustible	Precio de Mercado	Precio Social
Gasolina 93	173,00	85,63
Gasolina 81	173,00	80,88
Diesel	134,00	82,41

Source: MIDEPLAN

Table 13-4 Fuel Consumption Rate by Running Speed

(ml/Km)

Velocidad(km/h)	Tipo Auto de Pasajelos	Tipo Bus
10	160,0	443,7
20	105,3	326,8
30	83,7	268,1
40	74,9	242,6
50	72,8	231,9
60	72,8	229,8
70	76,0	233,8
80	81,3	242,2
90	88,2	255,3
100	97,9	274,4

Source: MIDEPLAN

2) Other vehicle operating cost

Other vehicle operating cost is proportional to running distance. Unit cost per km is a function of road roughness as stated below. In Concepcion, most of roads are paved and kept in good or fair condition. Then, the parameter "P" is assumed to be 3.5. Other operating costs are shown in Table 13-5 by type of vehicles.

$$\text{Passenger Car: } 18.104 + 0.273 * 10^{-1} * BI$$
$$\text{Taxi : } 8.080 + 0.164 * 10^{-1} * BI$$
$$\text{Taxi Bus : } 29.076 + 0.277 * 10^{-1} * BI$$
$$\text{Bus : } 30.600 + 0.318 * 10^{-1} * BI$$

$$BI(mm/Km) = 630 * IRI^{1.12}$$

$$IRI = a + b * R + c * R^2$$
$$a = 5.7138192 * 10^{-2}$$
$$b = 9.5826409 * 10^{-4}$$
$$c = -2.0498208 * 10^{-8}$$

$$R = 636.62 * SQR(189.01 * EXP(-0.9 * P))$$

P = 4.5 for roads in good condition
2.0 for roads in very bad condition
3.5 for roads in Concepcion

Table 13-5 Other Operating Cost

(Ch.$ /Km)

Tipo de vehículo	Costo
Auto de Pasajeros	51,20
Taxi	27,96
Taxibus	62,65
Bus, Camión	69,15

Source: Dept.of Plannig and Programing, MOP

13.3.4 Annual Benefit

Traffic assignment was made onto the two road networks; network with project (new Biobio bridge) and without project and total costs of the three categories mentioned above are calculated for both cases. The total cost of "with project" case is naturally smaller than that of "without project case". The difference is regarded as benefit of the project.

Benefit estimation was made for the year 1999 and 2010. The results are summarized in Table 13-6. The annual benefit in 1999 reaches Ch.$ 3,259 million, and will increase by 2.7 times, Ch$ 8,684 million in 2010. In both years, benefit from time saving stands for about one half of the total benefit.

The first year benefit corresponds to about 16 % of the total investment amount of Ch.$ 21,002 million, which suggests a high return from the project.

Table 13-6 Annual Benefit in 1999 and 2010

(Million Ch.$)

Benefcio	1990	2010
Ahorro de Tiempo	1.672,92	4.215,39
Ahorro de Combustible	296,78	828,45
Ahorro de Otro VOC	1.289,41	3.640,84
Total	3.259,41	8.684,68

13.4 Economic Evaluation Results

13.4.1 Base Case

Base case is the evaluation under the network conditions stated in 13.1.1, which are:

a. Old Biobio bridge is closed before 1999 when the new bridge is completed in order to avoid possible disasters.
b. Costanera Avenue is constructed in this century.

c. Widening of Los Carrera st. and Prat st. are completed before 1999.

d. Other road conditions are same as at present.

Based on these conditions, traffic assignment was done by type of vehicles, by peak time and off-peak time, by "with project" and "without project" and for 1999 and 2010, to estimate benefits in those years.

Annual benefits were estimated up to the year 2019 by simply connecting two points of 1999 and 2010, and then, combining with annual investment schedule, the cost-benefit cash flow was tabulated in order to calculate economic evaluation indicators (Table 13-7).

When calculating NPV and B/C, the discount rate is assumed to be 12 %, which is commonly used to evaluate a project in Chile.

Table 13-7 Cost-Benefit Cash Flow of New Biobio Bridge Project

(Million Ch.$)

Año	Flujo de Caja (Mill. Ch$)			Flujo de Caja Descontado (por12%)
	Costo	Beneficio	B/C	
1 1996	5.733,5		(5.733,5)	(5.733,5)
2 1997	8.614,7		(8.614,7)	(7.691,7)
3 1998	6.654,6		(6.654,6)	(5.305,0)
4 1999	71,1	3.259,4	3.187,7	2.268,9
5 2000	71,1	3.752,6	3.680,9	2.339,3
6 2001	71,1	4.245,8	4.174,1	2.368,5
7 2002	71,1	4.739,0	4.667,3	2.364,6
8 2003	71,1	5.232,2	5.160,5	2.334,3
9 2004	71,1	5.725,4	5.653,7	2.283,4
10 2005	71,1	6.218,6	6.146,9	2.216,6
11 2006	71,1	6.711,9	6.640,1	2.137,9
12 2007	71,1	7.205,1	7.133,3	2.050,7
13 2008	71,1	7.698,3	7.626,5	1.957,5
14 2009	71,1	8.191,5	8.119,7	1.860,8
15 2010	71,1	8.684,7	8.612,9	1.762,4
16 2011	71,1	9.177,9	8.106,1	1.663,7
17 2012	71,1	9.671,1	9.599,4	1.565,9
18 2013	71,1	10.164,3	10.092,6	1.469,9
19 2014	71,1	10.657,5	10.585,8	1.376,6
20 2015	71,1	11.150,7	11.079,0	1.286,3
21 2016	71,1	11.643,9	11.572,2	1.199,7
22 2017	71,1	12.137,1	12.065,4	1.116,8
23 2018	71,1	12.630,3	12.558,6	1.037,9
24 2019	71,1	13.123,5	13.051,8	963,1
25 2020	(10.294,9)		10.294,9	678,2
Total	12.214,5	172.020,9	159.806,5	19.572,8

The accumulated amount of benefit will reach Ch.$172.0 billion in 2020, while accumulated cost will amount to Ch.$ 12.2 billion if deducting the residual value.

The internal rate of return (IRR) implied in the project is as high as 20.8 %, B/C is 2.04 and NPV amounts to Ch.$ 19,573 million, all of which assure high economic returns derived by the implementation of the new Biobio bridge project. (These values of the evaluating indicators are slightly different from those shown in Table 9-5 in Chapter 9, because the estimated project cost has been changed through detailed study.)

13.4.2 Sensitivity Analysis

Sensitivity analyses were made, by changing uncertain but influential conditions such as road network conditions, traffic demand, cost and benefit. The results of analyses are shown in Table 13-8.

1) If Costanera Av. is not constructed:

In "without project" case, there is only one bridge, Juan Pablo II bridge crossing over the river, because the old, bridge is closed by the assumption. Then, all the traffic from the San Pedro side will come into the mid-town of Concepcion via Paicavi st. or 21 de Mayo st. together with traffic from Talcauhuano, which makes traffic conditions worse. Under this situation, construction of the new bridge would become more significant. Thus, the evaluation indicators show much more higher values, more than 2.8 times in NPV. However, this will not occur actually, because the old Biobio bridge would remain in use as long as the new bridge is not constructed.

Table 13-8 Sensitivity Analysis

Caso		TIR (%)	VAN (Millon Ch.$)	B/C
1 Caso Base		20,8	19.572,8	2,04
2 La Av. Costanera no sea construída.		33,7	55.414,5	3,96
3 El Puente antiguo no se cierre.		14,0	3.608,2	1,19
4 Demanda	20 % menor	13,1	1.877,1	1,12
	10 % menor	16,2	9.674,5	1,43
	10 % mayor	23,1	24.083,2	2,34
	20 % mayor	25,2	27.118,0	2,88
5 Beneficio	20 % menor	17,7	11.961,3	1,64
	50 % menor	12,3	544,2	1,03
6 El Valor de	20 % menor	18,6	16.034,2	1,72
	50 % menor	15,2	6.503,9	1,21
7 Cost	20 % mayor	18,6	15.740,3	1.70
	100 % mayor	12,1	410,1	1,01

2) If old Biobio bridge is not closed:

As explained in Chapter 8, the old bridge is too deteriorated to use much longer, without fundamental maintenance work and it is not recommendable to upgrade the bridge because of economic reasons. If such maintenance or upgrading work is carried out to keep it open, the economic return of the new bridge will be drastically reduced. Even in this case, however, the new bridge project will still be feasible, with IRR of 14 %.

3) If traffic demand increases less than expected

If the OD traffic forecast for the year 1999 and 2010 decreases by 10 % for all the OD pairs, IRR will go down to 16.2%. If using the same elasticity of IRR to demand decrease, the project will lose its feasibility only when the demand is 20 % less than the forecast. This will occur if within the next 20 years, the population almost stops to grow or the number of vehicles is less than two times the present number.

4) If benefit increases are lower than expected

Even if the benefits of the new bridge project are overestimated by 50%, the project will be still justified economically, with IRR of 12 %.

5) If cost increases substantially higher than expected

Even if the cost of the project becomes double what is estimated, the project will be still feasible, with IRR of 12.1 %.

Thus, it is concluded that the feasibility of the new bridge project is very favorable and stable.

13.4.3 Optimal Investment Year

It is analyzed, here, which year is economically optimal to start the new Biobio bridge project. According to the MIDEPLAN's guideline for implementation of a feasibility study ("Inverción Publica, Eficiencia y Equidad"), the optimal year is defined as the year which will maximize the net present value of the project. This criterion is quite reasonable from the viewpoint of total economy of the for the long-term.

On the other hand, this maximum NPV method will be less reliable under such situation as in Chile, where regional economy and population are growing rapidly and traffic demand and time value are not easy to forecast for coming 20 to 30 years. By this reason, another more conservative criterion was adopted: "The optimal year for starting operation is the year when annual benefit exceeds the capital opportunity cost of the project for the first time."

After the three year construction period, the actualized value of the total construction cost of the new bridge in the first year of operation is Ch.$ 28,314 millon applying the

compound interest method at 12% of interest rate (Table 13-9). About 12% of the said amount, Ch.$ 3,158 millon, is the capital opportunity cost of the project.

Annual benefit of the project will exceed this amount in the 1999 for the first time. Therefore, the year 1999 is optimal for the commencement of service, and thus, the year 1996 is the optimal to start the construction (Table 13-10).

Table 13-9 Opportunity Cost of new Biobio Bridge Project

(Millones de Ch.$)

Año de Inversión	Inversión al Valor del Primer Año de la Operación
1ro. 2do. 3ro.	$5.733,50 \times 1,12^3 = 8.055,15$ $8.614,70 \times 1,12^2 = 10.806,28$ $6.654,41 \times 1,12^1 = 7.453,15$
Total	26.314,59

Table 13-10 Optimal Year to Start Operation

(Millones de Ch.$)

Año	Beneficio Anual	% del Beneficio al Costo Total (al Valor del Primer Año de la Operación)
1997	2.272,9	8,64
1998	2.766,2	10,51
1999	**3.259,4**	**12,38 (óptimo)**
2000	3.752,6	14,26
2001	4.245,8	16,13
2002	4.739,0	18,01
2003	5.232,2	19,88
2004	5.724,4	21,76
2005	6.218,6	23,63

13.5 Financial Resources and Investment Capacity

13.5.1 Past Investment to Urban Road Sector

Table 13-11 shows the actual road investment in 1991 by MOP, which includes urban roads and inter-city roads. The total amount is Ch.$ 83,151 million (US$ 219 million), of which 95 % came from the budget of the Central Government, 4.4 % from the fund of FNDR and the rest from contribution from private firms or other public sector.

Table 13-11 Urban Road Investment in the Past

(Million Ch.$)

Región	Presupuesto Nacional	F.N.D.R	Contribu ciones	Total
I	4.992,9	328,0	109,9	5.430,8
II	1.486,0	15,0	1,4	1.502,4
III	2.280,6	45,0	0,0	2.325,6
IV	2.474,4	842,5	63,4	3.380,3
V	5.915,3	35,9	0,0	5.951,2
VI	7.403,0	1.040,0	4,9	8.447,9
VII	9.450,3	598,3	0,0	10.048,6
VIII	6.540,2	51,0	0,0	6.591,2
IX	6.010,9	250,9	102,6	6.364,4
X	8.543,6	0,0	16,2	8.559,8
XI	2.791,2	437,1	2,0	3.230,3
XII	3.088,8	0,0	0,0	3.088,8
R.M.	9.244,7	23,4	136,7	9.384,8
Red Vial	3.758,3	0,0	0,0	3.758,3
Total Regiones	73.960,7	3.667,3	441,1	78.069,1
No	4.150,6	0,0	,0	4.150,6
Regionalizados	506,5	0,0	,0	506,5
Estudios	425,4	0,0	,0	425,4
Equipamiento				
Total Servicios	79.042,7	3.667,3	441,1	83.151,1

Source: MOP

Region VIII to which Concepcion belongs was allocated 8 % of the total, Ch.$ 6,5912 million (US$ 17.3 million). This amount corresponds to only 2.3 % of the total cost of the new Biobio bridge (Ch.$ 28,476 million = US$ 66 million).

In Chile, several road development programs have been carried out simultaneously under overlapped schedule such as "Second Road Sector Program" and "Road Rehabilitation and Improvement Program". In general, the Chilean Government generates 35 to 45 % of funding for those programs from external financial organizations such as BID, BIRF and in some cases, Japan EXIM Bank.

13.5.2 Road Investment Plan

After the presidential election in December 1993, MOP of the new Government started to prepare 17-year investment plan targeting for the year 2010. The plan is rather ambitious one, comparing to the investment performance in the past. Total investment is planned to be US$ 33,260 million, of which US$ 7,370 million is allocated to urban road development (see Table 13-12).

Concepcion belongs to the Macro-region of "Central Sur" and it is planned to invest US$ 1,251 million during next 17 years. In this plan, The new Biobio Bridge is already included. The cost of the brigde will stand for 5.4 % of the total. The Government will most probably look for external financial resources for such large scale projects.

Table 13-12 Road Investment Plan

(Million US$)

Sector	Inversiones en el Centro Sur			Plazo		
	Centro Sur	Otros	Total	1994-1995	1996-2000	2001-2010
Vialidad Urbana	1.251	6.119	7.370	561	1.680	5.130
VialidadInterurbana	3.467	15.396	18.863	1.170	6.119	9.768
Puertos	166	560	726	138	229	359
Aeropuertos	16	197	213	21	88	104
Ferrocarriles	0	501	501	41	160	300
Metro	0	1.232	1.232	152	200	880
Riego y Drenaje	535	826	1.361	106	384	871
Agua Potable	112	930	1.042	123	271	649
Sector Sanitario	172	2.045	2.217	257	629	1.332
DrenajeAguasPluviales	30	22	52	0	37	16
Defensas Fluviales	28	79	107	8	48	52
Edific. Públicos	350	1.31	1.381	158	400	823
Total	6.127	28.938	35.065	2.735	10.245	20.284

Source: Departamento de Planes y Programas, MOP

CHAPTER 14 PROJECTS RELATED TO THE NEW BIOBIO BRIDGE

Construction of the new Biobio bridge will not only cause a change in urban traffic flow, but also accelerate urban development, which will be most remarkable in Costanera area (Zone 3). In this connection, it may be useful to suggest a proper urban development scheme for Zone 3 and a guideline for a traffic distributor plan, in order to maximize the positive effects by the new bridge construction.

14.1 Proposal for the Redevelopment of Zone 3

In 1990 the Government of Region VIII started a large-scale urban development project named "The Biobio River North-Dike Area Recovery Project" which covers the area on the north bank of the river extending for 35 km from the mouth of the river to Hualqui. The project area is divided into 6 sub-sections (called "Program"). The Coordinating Committee, which was created in June of 1993 consisting of relevant authorities, gave the top priority for development to Programs 3 and 4 (the area between the Juan Pablo II Bridge and Chiguayante), especially to the section between Chepe Hill and the old Biobio Bridge.

The selected area corresponds to our Zone 3 (Costanera), where a trunk road connecting the planned New Biobio Bridge and Los Carrera Street will pass through almost in the middle. Considering the fact that the construction of the new bridge will have a great impact on the zone from the standpoint of urban development, a proposal for the urban redevelopment in Zone 3 is put forward here.

14.1.1 Existing Conditions of the Project Area

The existing socio-economic conditions of Zone 3 are summarized as follows:

1. Zone area: Total 230.4 ha
   Land 137.0 ha
   Water 93.4 ha
2. Population (1993): 12,500 persons
3. Employment (1993): 3,040 persons
4. Average household income (1993): Ch $ 41,800 per month
5. Number of vehicles: Passenger car 490
   Pickup & van 320
   Truck 25
6. Land use:

Low density residential	7.1 ha	(5.2%)
Industrial	10.3 ha	(7.5%)
Mixed (industrial/residential)	47.1 ha	(34.4%)
Railroad site	39.3 ha	(28.7%)
School	0.5 ha	(0.4%)
Soccer field	1.3 ha	(0.9%)
Park	0.6 ha	(0.4%)
Riverside low land not used	30.8 ha	(22.5%)
Total	137.0 ha	(100.0%)

Fig. 14-1 shows the existing land use of Zone 3. Low density residential and mixed use areas along the existing Costanera Street are formed on public land, without water supply, sewerage and sanitary facilities. The number of families inhabiting this area is about 1,000. A human settlement project was initiated in 1994 through GTZ (the German Agency for Technical Assistance).

The railroad site occupies 39.3 ha in area, which includes an unused workshop yard of rolling stock. A private development company group is planning to convert the yard to commercial and residential purposes.

About one third of the zone is covered by mixed land use (industrial/residential). According to the 1991 Pre-census, there are 22 industrial establishments in Zone 13. Of these, 2 establishments are large-scale, one is a flour mill and the other is a textile factory, which are shown as industrial areas in Fig. 14-1. The other 20 establishments are small-scale and are scattered among the mixed use areas. In addition, 174 commercial/service establishments are also located in the zone.

The riverside low land covers 30.8 ha, nearly one fourth of the total zone area. This low land together with the above-mentioned squatted land presents serious sanitary problems as follows:

1. Discharged sewage forming puddles with dissolved excrements
2. Clandestine big dumps
3. Uncontrolled filling with debris produced by paving and demolition works
4. Presence of insects, rats and swarms of flies
5. Periodic flooding for lack of adequate drainage system

According to the Costanera Section Plan, whose role is to show an urban development guideline of the Coordinating Committee, construction of the New Costanera Avenue and a riverside park is proposed for this unused low land.

14.1.2 Development Target and Policy

The development target of zone 3 can be manifested, in short, as follows:

"Creation of region-wide major activity center with high amenity and environmental quality".

The significance of the phrase can be explained analytically as follows:

1. The word "creation" means the formation of a new center which will be a match for the existing center of zone 1 in both quantity and quality.

2. The extent of the development is shown in the word "region-wide" meaning a core of the Region VIII.

3. The words "major activity center" signify a comprehensive multiple activity center, ranging from residential to

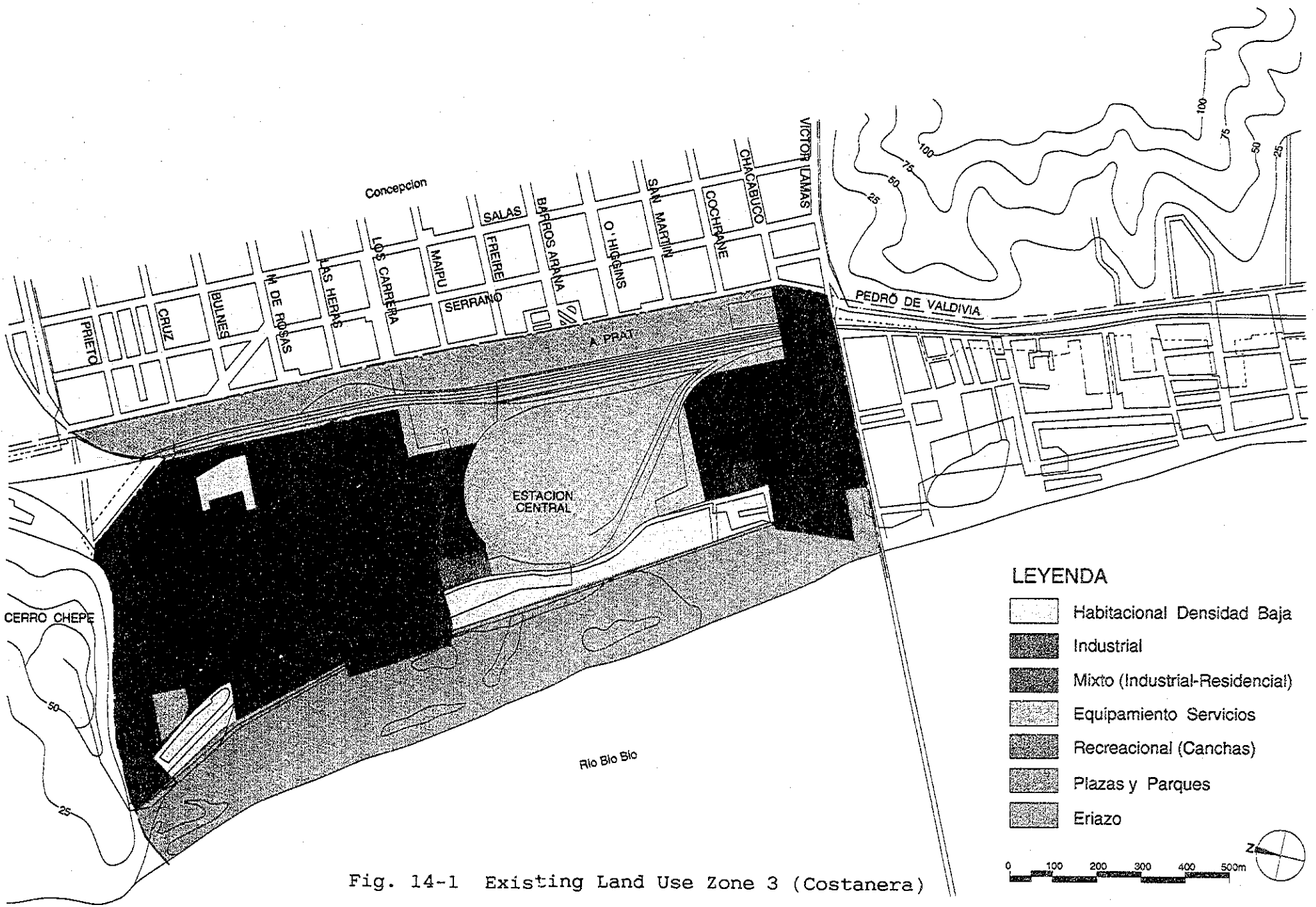


Fig. 14-1 Existing Land Use Zone 3 (Costanera)

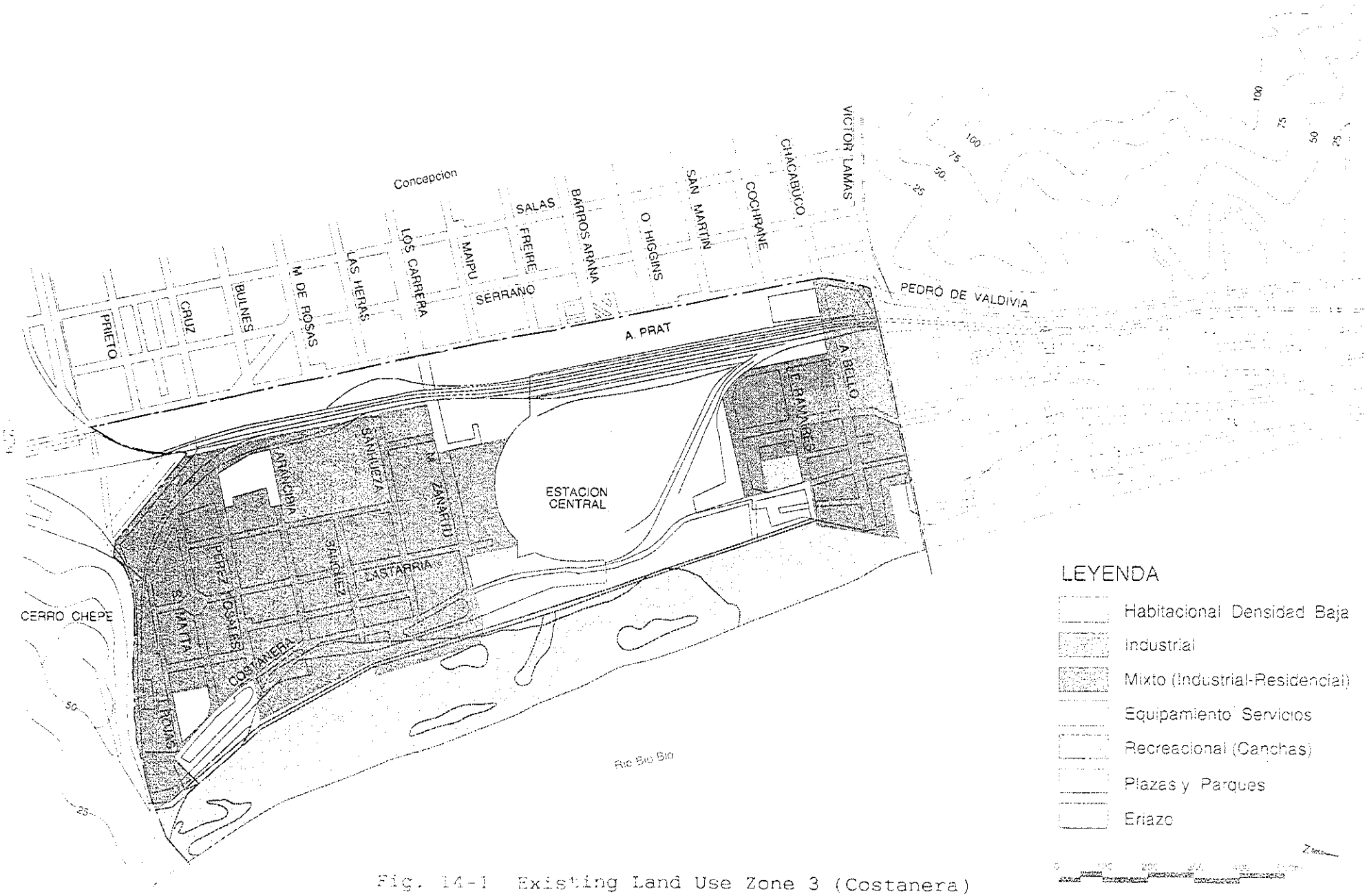
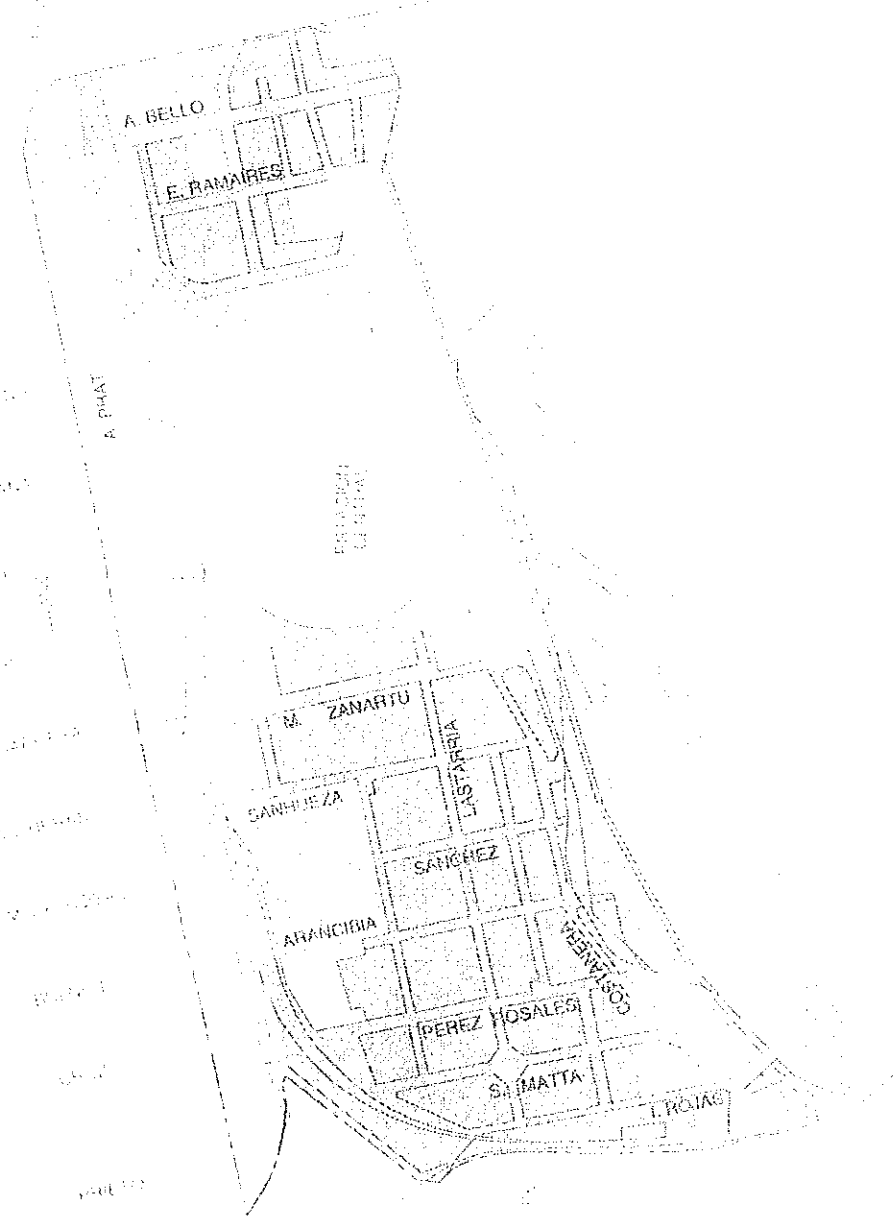


Fig. 14-1 Existing Land Use Zone 3 (Costanera)


A. BELLO
E. RAMÍREZ
M. ZAÑARTU
SANHUEZA
ESTARTE
SÁNCHEZ
ARANCIBIA
PEREZ ROSALES
SAMATTA
LA ROJA

institutional.

4. The qualitative level of the development is expressed in the words "high amenity and environmental quality". "Amenity" is used here to mean comfortable and agreeable social environment for people and any institutions or industries, and "environmental quality" is that of a natural environment.

The development policy is based on the development target. As described in 14.1.1, Zone 3 has many socio-economic and environmental problems. To create the new activity center, the following four strategies are established as the core of development policy.

1. Infrastructure Development:

It is of critical importance to develop an infrastructure in the area to provide favorable conditions for the development. Major elements of infrastructure development are the improvement of drainage by land filling, and provision for public utilities, such as water supply, sewerage, electricity and telephone.

2. Actualization of Rational Land Use:

Taking into account the existing activities and the future framework of Zone 3, a rational combination and configuration of land use should be introduced. A priority in the formation of a future region-wide activity center is the introduction of the Regional Government Offices as well as the commercial and business activities. Furthermore, the introduction of upper-class housing will contribute to the improvement of the image of the zone.The location of industries will be moved or reorganized to serve industrial growth and changes. To secure the amenities of the area, parks and greenery will be introduced to a considerable extent.

3. Installation of Functional and Safe Transportation System:

The construction of the New Biobio Bridge and Costanera Avenue will improve the accessibility of the zone, but at the same time a great volume of through traffic will pass through there. In order to carry smoothly the through traffic and to improve access to and from the zone, the road and street network is to be systematically arranged. A pedestrian way system will be provided to enhance amenities in the zone.

4. Creation of Suitable Environment for an Urban Center:

The major cause of degradation of the natural environment is the contamination of the riverside low land. The low land will be filled and a water-front park will take its place.The other improvement to the environment is the construction of a wide, well-defined, pedestrian walking access (or corridor) from Barros Arana Street to the Water-front Plaza planned at the riverside bank of Biobio River.

14.1.3 Development Framework

(1) Population

The population of Zone 3 is estimated at 12,500 persons in 1993. It is assumed that 1,000 persons will be added by the year 2010 to the present population of 12,500 who inhabit the existing mixed use areas and low density residential areas. A total 1,500 persons or 340 households will be introduced to the planned high-class apartment houses. The total resident population will be 15,000 persons in 2010.

(2) Employment

The number of persons who have jobs in Zone 3 is estimated at 3,040 persons in 1993. It is assumed that existing economic establishments will not change much in number nor employment size by 2010. The core of the planned region-wide major activity center covers about 40 ha in area. The employment density there is planned to be 200 persons per hectare, the same density as the present Zone 1. The total number of employed persons working within Zone 3 will be 11,000 persons in 2010.

14.1.4 Land Use Policy

The function of the zone as the regional activity center will be best organized for efficiency and effectiveness by:

1. Improving Functions in Existing Location

Taking into consideration the existing situation of land use, some activities will remain where they are currently located. Large-scale industrial establishments like the flour mill and the textile factory could be left where they are. But it is necessary for them to improve the exterior for establishing more conformity.

2. Relocating and Improving Functions in Zone 3

Some functions in Zone 3 are to remain but be reorganized and relocated. The relocation will increase their effectiveness and environmental situation.

Two projects exemplify this reorganization: i)creating industrial zones around the existing large-scale factories by relocating small-scale industries scattered in the mixed use areas, and ii)development of a human settlement project in place of the existing squatted areas.

3. Introducing New Functions to Zone 3.

Combined land use will activate this area. To accomplish this the following are elements, not currently in Zone 3, which are to be introduced:

- Regional Government Offices
- High-level commercial activities
- Business activities

- High-class housing
- Cultural and welfare facilities
- Parks and recreational facilities to contribute to the creation of appropriate urban environment and amenities.

14.1.5 Land Use Plan

Taking into consideration the above-mentioned points, the land use plan is prepared as shown in Fig. 14-2.

The characteristics of each land use are as follows:

(1) Residential (21.8 ha)

Two residential areas are planned on both sides of the commercial/institutional center. These areas are objects of the human settlement project carried out with cooperation of Germany. Families which presently inhabit the planned institutional areas will be moved to these areas.

(2) Mixed (industrial/residential) (22.0 ha)

The existing mixed use area located in the north part of Zone 3 will remain there, but some improvements of living environment are required and small-scale industries are expected to move gradually to the planned industrial park.

(3) Industrial (16.6 ha)

Two industrial parks are located including existing large-scale factories. These areas are for the relocation and organization of existing industries, and for the new installation of higher industrial activities such as laboratories or research institutes with better environmental conformity with surrounding areas.

(4) Institutional (5.9 ha)

The new institutional area will be located on a part of the now squatted public land. The Government Office of Region VIII and regional offices of the Central Government Ministries will occupy this area. For the creation of a region-wide activity center it is indispensable to introduce a variety of high-grade activities, and this area will play the role of a stimulus to such activities.

(5) Commercial (7.7 ha, including mall/plaza of 3.6 ha)

A wide and long shopping mall will be constructed, extending from the railroad station to the Plaza Biobio. On both sides of a 50 meter-wide pedestrian way, department stores, large-scale specialty stores, shopping galleries, restaurants, coffee shops, bars, hotels, travel agencies, movie theaters, banks and so on will be lined up similar to the present situation around the Plaza de Armas in Zone 1. (See Fig. 14-3)

(6) Business/residential/cultural (12.5 ha)

These areas are located behind both sides of the commercial belt and are mainly composed of high-rise office buildings and apartment towers. Schools, hospitals and cultural facilities such as museum and library will also be located here.

Most of the tenants of the office buildings are professionals such as lawyers, accountants, architects, civil engineers and doctors and regional branch offices of national scale companies. Assuming the number of office workers is 2,000 persons, the total floor area of the office buildings would be 30,000 m^2 based on the assumed floor area standard unit of 15 m^2 per person. In addition, parking space should be provided.

On the assumption that about one third of the office workers have their own cars and come to the offices by using them, a total area of 20,000 m^2 would be required as parking spaces for the office buildings (standard unit is assumed to be 30 m^2 /car). Two buildings with a total floor area (excluding parking spaces) of 15,000 m^2 (15 to 20 floors) or three buildings of 10,000 m^2 (10 to 12 floors) are envisioned.

It seems to be difficult to provide for all required parking spaces through multistoried garages attached to the office buildings. Three types of parking systems are therefore supplied: attached parking lots at the basement levels, outdoor parking lots and parking buildings.

The apartment towers are planned for the introduction of middle-to upper-class residents into the zone. The planned number of families is 340. An example of architectural concept is as follows:

- Number of towers: 4 buildings
- Number of apartments per tower: 85 units
- Standard unit of floor area: 150 m^2 per apartment (including public spaces such as corridors, stairs and elevator shafts)
- Average floor area per story: 750 m^2
- Parking spaces: 2,550 m^2 per tower (it is assumed that the vehicle ownership is 1 unit/family and the space requirement is 30 m^2/car)
- Attached basement parking lot: 3 floors
- Number of floors: 17 floors plus 3 basement levels

(7) Riverside Park (22.7 ha)

Most of the present unused riverside low land is to be converted to a riverside park. This park is to be planted with a variety of tall trees to become a forest park like the Parque Forestal along the Mapocho River in Santiago. A long riverside pedestrian way is planned, extending from the Railroad Bridge to the Old Biobio Bridge.

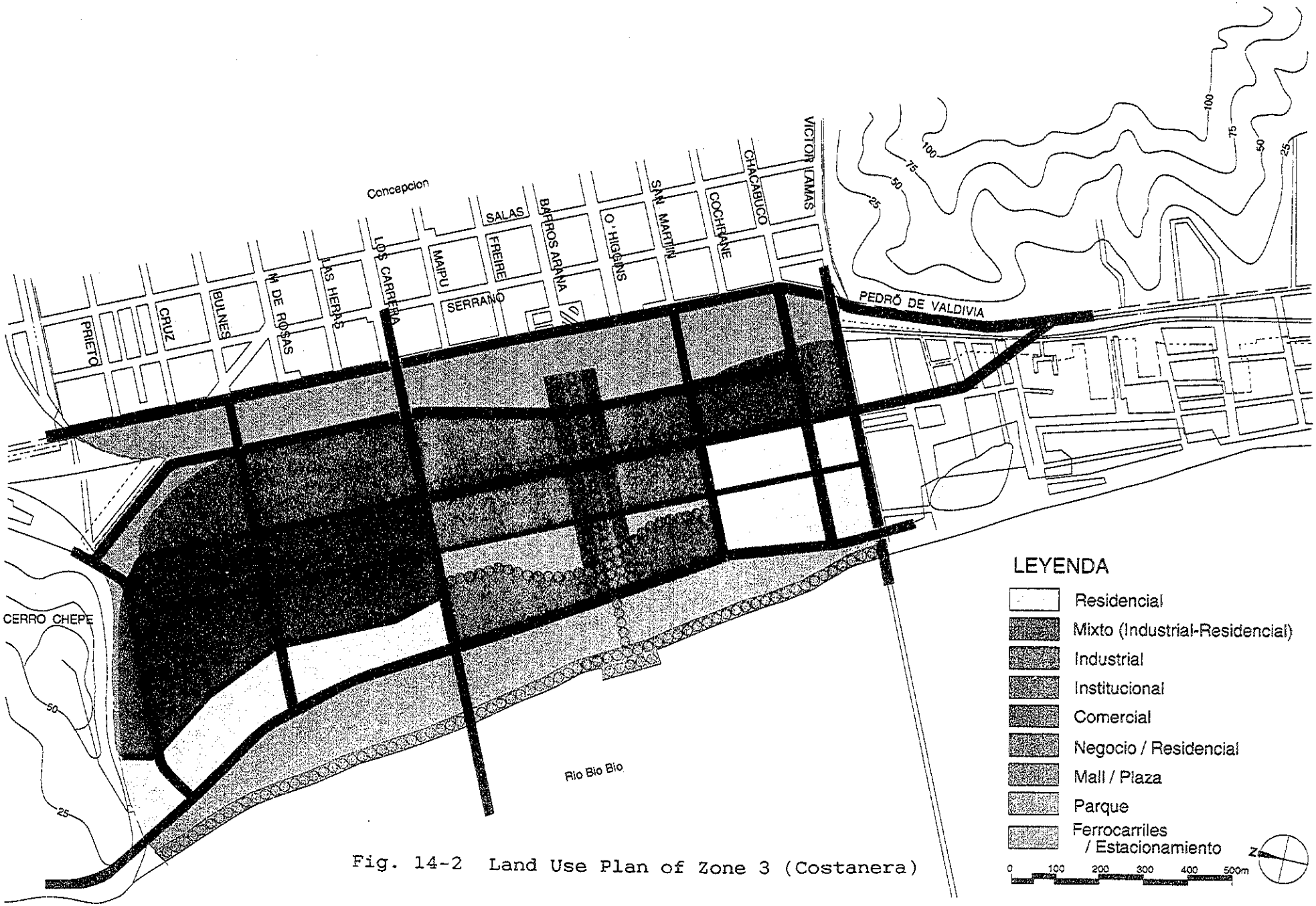


Fig. 14-2 Land Use Plan of Zone 3 (Costanera)

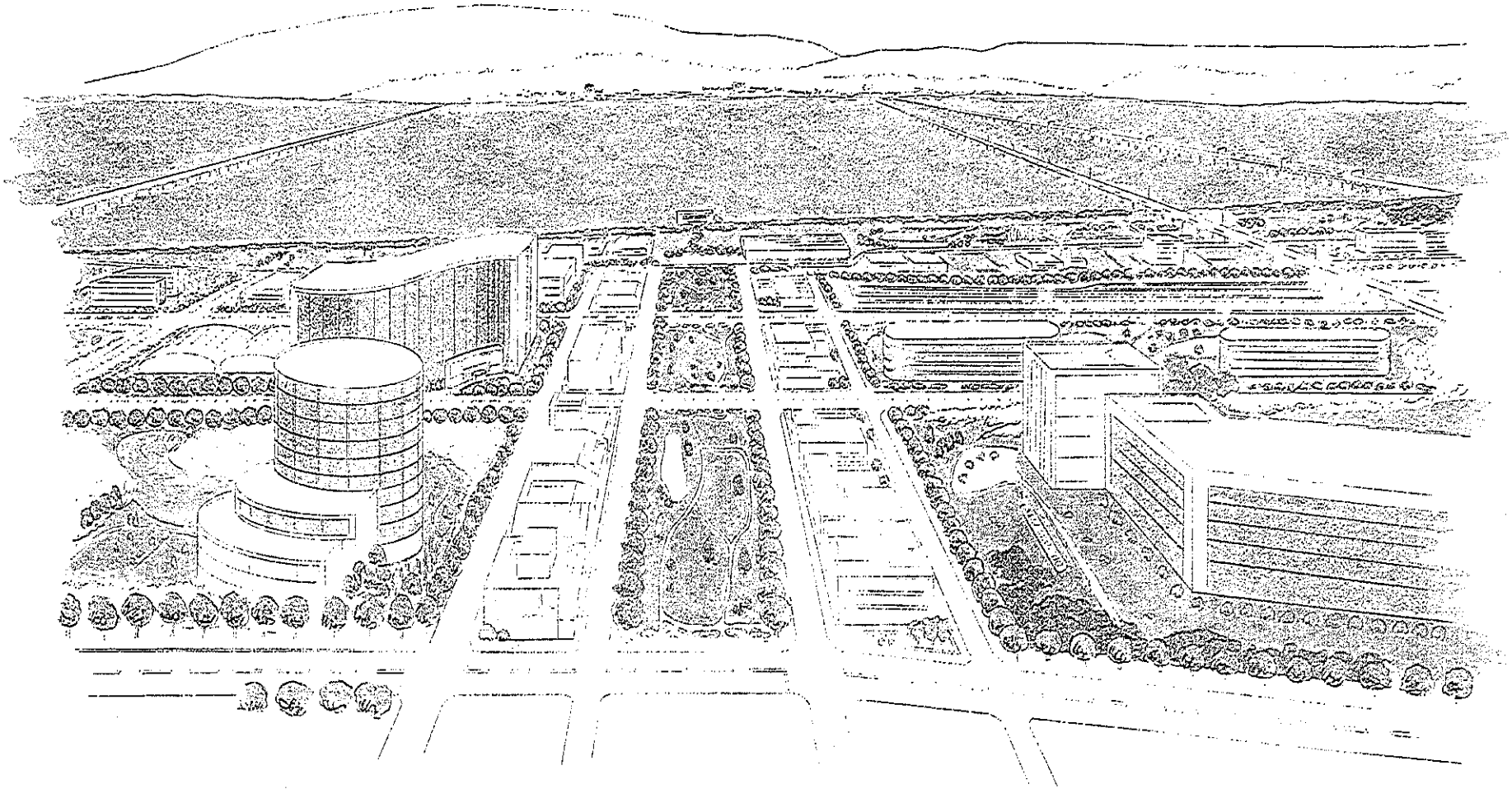


Fig. 14-3 Image of New Activity Center

14.2 Improvement of Road Network in and around Zone 3

14.2.1 General

The extension of Los Carrera Street to the New Biobio Bridge and the proposed New Costanera Avenue are the two major roads which will pass through Zone 3 and will be the east-west and north-south access routes to the zone, respectively. In addition, some improvements of road network in and around zone 3 are indispensable for keeping smooth flow of through traffic and for securing better access to and from the planned region-wide activity center. In order to create appropriate urban amenities, a pedestrian way network should be established.

14.2.2 Concept of Road Network

The concept of road improvement plan related to Zone 3 is shown in Fig. 14-4. The network shows a grid pattern with a main axis in each direction.

The roads are classified as:

1. Arterial road

   - M. Zanartu Street (extension of Los Carrera Street)
   - Costanera Avenue

2. Semi-arterial road

   - T. Rojas Street
   - A. Arancibia Street
   - Bilbao Street
   - A. Bello Street
   - Esmeralda Street
   - Errazuriz Street
   - M. Montt Street

3. Collector

   Other roads

14.2.3 Road Network Improvement Plan

(1) M. Zanartu Street

This four lane road connects the new Biobio Bridge to Los Carrera Street. From the river bank to the point between Lastarria and R. Claro Streets the road runs on ground level and then is elevated gradually to cross over the railroad tracks and A. Prat Avenue. The point where the elevated road goes down to ground level to connect with Los Carrera Street is between Serrano and Salas Streets.

(2) Costanera Avenue

Costanera Avenue proposed in the Costanera Section Plan should be constructed on the reclaimed public land as a boulevard serving not only for carrying traffic but also for comfortable

drives along the Biobio River. At the intersection with M. Zanartu Street, a diamond type separation is adopted. The number of lanes is 4.

(3) Semi-arterial Roads

All semi-arterial roads have 4 lanes. In the east-west direction T. Rojas, A. Arrancibia, Bilbao, A. Bello and Esmeralda Streets are to be improved for conducting through traffic from the New Biobio Bridge to the downtown of Concepcion and for providing better access from the existing center to the planned new region-wide activity center. A. Arrancibia, Bilbao and A. Bello Streets are improved to connect the New Costanera Avenue with A. Prat Avenue, crossing the railroad tracks at grade. T. Rojas Street will serve for conducting traffic from Costanera Avenue to 21 de Mayo Street. Esmeralda Street will be connected with Costanera Avenue at a two-level crossing and with Errazuriz Street at a grade crossing. This road will serve as one of distributors of heavy traffic crossing over the Biobio River as well as an approach to the Old Biobio Bridge.

In the north-south direction Errazuriz and M. Montt Streets are improved as semi-arterials. Errazuriz Street should be extended and widened to be enough for carrying traffic from high-class residential areas located along Pedro de Valdivia Avenue into the New Activity Center. M. Montt Avenue will play the important role of a connector of the two sides separated by M. Zanartu Street. This road will be constructed along the railroad tracks from the existing short section of M. Montt Street to T. Rojas Street.

14.2.4 Pedestrian Way Network

A wide pedestrian shopping promenade will be constructed starting from Plaza Espana at the end of B. Arana Street and extending far to Plaza del Agua at the riverside of the Biobio River. In the north-south direction 3 main routes are planned. One is to connect the Business/residential/cultural areas with the Commercial area, another is for the Institutional areas and the last is a long riverside promenade.

14.2.5 Parking Facilities

Parking demand of inhabitants and employed persons in the zone should be met principally by attached private parking lots to houses and establishments.

For the visitors to the shopping mall and other facilities, a public outdoor parking is planned. The location is between the Institutional area and the Business/residential/cultural area, and the capacity is 1,500 vehicles (4.5 ha in area).

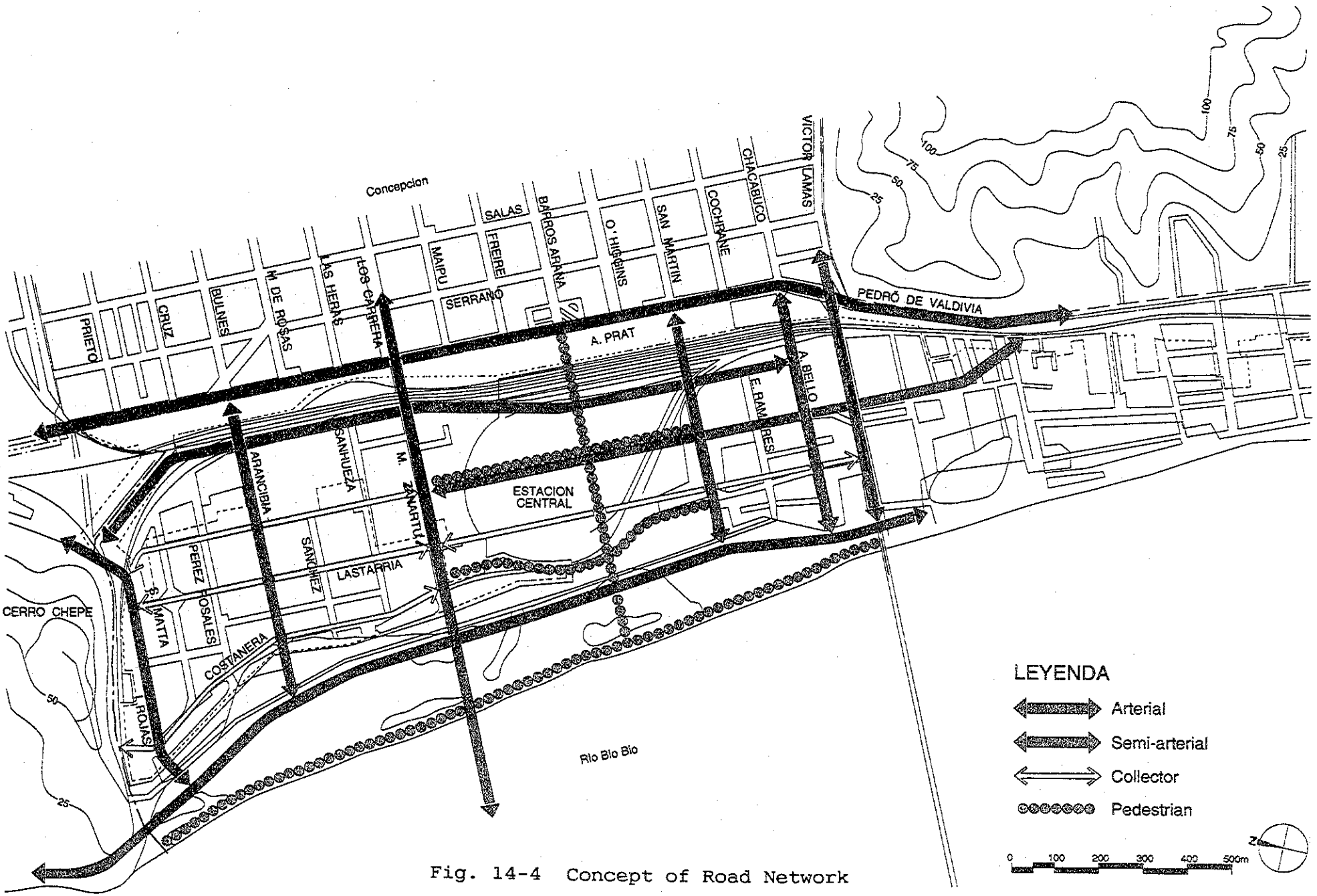


Fig. 14-4 Concept of Road Network

CHAPTER 15 ENVIRONMENTAL IMPACT STATEMENT

15.1 Outline of Study

This study performs an environmental impact assessment of the Biobio River bridge construction project in Concepcion City, and seeks to determine whether or not environmental problems exist as a result of the implementation of this project.

As there are no environmental assessment guidelines in Chile, this study is based on JICA's Guideline of Environmental Considerations. Prior to this chapter an optimal route was selected, and an environmental assessment is being conducted based on this selection.

Implementation of this project will have some impact for the environment in the area. However, air pollution, noise and vibration will increase even without the project because of the expected increase of traffic through economic development in the study area.

It is considered that the effects on the environment of the "without project" case will be worse for the environment than the "with project" case. Air pollution, noise from traffic jams, and traffic detours are considered to be worse in the area if the project is not implemented.

As a result of a site survey, it is considered that there is no large impact to worse the environment. Items classified as a small impact for the environment and it's countermeasures or compensation are listed in the Table 15-1.

Table 15-1 Environmental Impact, Evaluation and Countermeasures

Item	Impacto	Evaluación	Contramedida
Medio Ambiente Social	Relocalización de 29 familias	B	Compensación
	Seguridad de tránsito	C	Señalización y medidas de seguridad
Medio Ambiente Naturaly	Estética	C	Diseño del Puente
Contaminación	Aire	B	Dispersión del Tránsito
	Ruido, Vibración	B	Dispersión, control vehículos pesados
	Agua	C	Método de construcción

Note: A: Se predice un gran impacto
B: Se predice un leve impacto
C: Impacto despreciable

15.2 Environment of the Project Area

15.2.1 Social Environment

Concepcion City is located approximately 500 kilometers south of the Chile's capital, Santiago. Concepcion City has a population of approximately 330,000 (1992), and it is the capital of Concepcion Province (8th Region). Concepcion City and Talcahuano City (approx. 260,000), which is located to the west, form the third largest urban area in Chile.

The major industry is lumbering, with abundant forest resources extending eastward. Talcahuano City is used as a loading port. There is also a large commercial area, with its core located in Centro. The project area crosses the Biobio River, which is located on the west side of Concepcion City. It is connected to Los Carrera, which is located on the right bank, and to the road which extends along the left river bank.

(1) Right Bank

The area between the river bank and the railway is called Zanartu Street, and illegal slums are found along the river bank. Adjacent to the milling factory, west of the railway, relatively new one-story homes face the road.

Widening is almost finished on the east side of the railway. In this area four-story apartments and a school face Los Carrera.

A north bank development plan along the right bank is being implemented by Concepcion City, from the river bank to the railway. This plan will facilitate the removal of slums along the river bank. Residents on the right bank will not be relocated as a result of the construction of the new bridge and the approach road.

(2) Left bank

The project area is connected to the existing road along the railway from the area of old homes on the south side of the railway bridge. A kindergarten is located near the connected area. It will be necessary to relocate the housing near the railway bridge.

15.2.2 Natural Environment

(1) Topography and Geology

Concepcion City is located on a plain which extends along the Bio-Bio River basin. The elevation of the plain is approximately 7 to 20 meters, with a slight slope toward the Biobio River. Looking at the project area, the right bank has been reclaimed near Plat, which at one time was part of the river bank near this area.

The elevation of the land near the bridge location is approximately 8 meters on the right bank and 10 meters on the left bank. The left bank is slightly higher.

(2) Flora and Fauna

The residential and surrounding areas of Concepcion City have been developed for many years. As a result, important plants and animals have been lost to the area. The project area passes through the residential area and across the river. Little vegetation is seen on either side of the river.

(3) Climate

The climate of Concepcion Province is similar to that of a northern mediterranean climate in the northern part and to rain climate in the southern part. The climate is mild, with a rainy season and a dry season.

Information regarding the temperature, humidity, and precipitation (1991) observed in the airport suburb of Concepcion City was reviewed. The annual average temperature is 12.3 degrees. The average maximum in January is 16.1 degrees, while the average minimum in August is 8.7 degrees. There is little change in temperature.

The annual average humidity is approximately 65%, and the annual precipitation is 1142 mm. The rainfall between April and August is heavy, but little rain falls during the summer.

15.2.3 Contamination

The air pollution problem in Santiago has been the focus of concern in Chile; emission control regulations for automobiles and factories have been implemented. However, as pollution problems are not serious in local cities, pollution measurements are rarely performed.

The same can be said for Concepcion City, as there seems to have been no measurements taken in terms of air pollution, noise, or vibration. Fairly old measurements of water pollution near the Juan Pablo II Bridge were obtained. The results are shown in Table 15-2.

Table 15-2 Water Quality Measurement Results (1979)

ITEM	Abril	Mayo	Junio	Julio
DO (ppm)	10	9	10	11
BOD (ppm)	2	2	2	2
COD (ppm)	40	12	-	-
PH	7.7	7.2	7.2	7.3

Source: Archivo de ESBBIO S.A.

Among the items measured, the biochemical oxygen demand (BOD) and the chemical oxygen demand (COD) do not seem to have been measured after 1979. However, hydrogen exponent (PH) and dissolved oxygen (DO) have been regularly measured every year. The measurements taken in 1989 at the mouth of the river show the PH to be 6.95-8.75 and the DO to be 6.8-12.6 ppm.

Air pollution has been measured at the factory of the Petrox Co., Ltd., in Talcahuano City, which is located adjacent to Concepcion City. However, because the measurements were taken at the factory, these results cannot be used as a reference to understand the general environmental conditions.

15.2.4 Others

(1) Biobio River

Fishing is not conducted on the Biobio River in Concepcion City, and the river is not used for agricultural water near the project area. Distant from the bridge location, fishing is conducted by small-scale fishermen at the mouth of the Biobio River.

The water intake facility for drinking water in the San Pedro area is located on the left bank of the upstream side of the bridge in the project area, and 2000 m3/day are taken.

(2) Underground Water Usage

The Hotel Araucano (for its swimming pool) in Centro, on the right bank of the Biobio River, and the San Pedro water intake facility (for drinking water), on the left bank, make large-scale use of underground water. The San Pedro water intake facility pumps up to 4000 m3/day of underground water, in addition to its use of surface water.

(3) Remains and Cultural Assets

There are no remains, and no cultural assets located near the project area.

15.3 Environment Regulations Related to the Project

Chile has joined every major international treaty related to the environment. Chile ratified the Ramsar Convention, the Convention Concerning the Protection of the World Cultural and the Natural Heritage, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and is a signatory of the Basel Convention. Nevertheless, Chile's laws and organization related to the environment are still insufficiently developed.

15.3.1 Basic Laws for the Environment (Ley sobre Bases Del Medio Ambiente)

These laws, now under discussion by the Chilean Congress, aim to establish and enhance the administrative organizations related to the environment and to enforce environmental assessments.

Among the environmental administrative organizations stated in this law, CONAMA: COMISION NACIONAL DE MEDIO AMBIENTE, which was founded in June 1990, will be upgraded to the status of an agency equivalent to the Environment Agency in Japan. The development of personnel and the enhancement of the agency, appropriate to this upgrading, are also scheduled. The development of personnel to be in charge of the environment in each state, and to scrutinize the actual environmental assessments, is one of the important measures related to enforcement of environment assessments.

The technical guidelines to be used for environmental assessments are now being formulated.

15.3.2 Creation of laws related to the regulation of air pollution, noise, and vibration

As yet these individual laws have not been created. As air pollution problems in Santiago have been the focus of concern, the government has begun to address these problems and counter-measures are now being implemented. However, in terms of nation-wide laws, only Law No. 185, which targets soot and dust from stationary sources, has been implemented by the Ministry of Mining.

As a reference, Table 15-3 shows the environment standards related to air pollution applied in the Santiago Metropolitan area.

Table 15-3 Air Pollution Regulation for Metropolitan Area

Contaminante	1 Hr.	8 hrs.	24 hrs.	1 año
CO	35 ppm (1)	9 ppm (1)	-	-
SO_2	-	-	365 Mg/m^3 (1)	80 Mg/m^3 (1)
O_3	160 Mg/m^3	-	-	-
NO_2	-	-	100 Mg/m^3	-
PTS	-	-	260 Mg/m^3 (1)	75 Mg/m^3 (2)
PM_{10}	-	-	150 Mg/m^3 (3)	-

Note: (1) Concentración media aritmética 1.8.24 hs.O anual no debe sobrepasarse este valor más de una vez al año.
(2) Concentración media geométrica anual.
(3) Concentración media aritmética diaria.

15.3.3 Resident Relocation System

Resident relocation will be undertaken as a result of the public works project, based on the law (Ley Organica de Expropiacion) related to relocation, which was enacted in 1978.

The relocation procedures are as follows.

(1) Detailed drawing for relocation created by MOP.

The detailed drawing must confirm the property number, the owner of the property, and the building and land registration. This will act as the basis for procedures in the future.

(2) Establishment of a committee for mediation

A committee called Seremi is established by the local bureau of MOP. The committee consists of the three: Design, Civil Engineering, and Construction specialists. Impartial members will be selected for the committee.

The members of the committee will perform an evaluation of the properties, taking market prices and number of years of inhabitance into consideration, and create a report in approximately one month. The estimated value obtained through this process will be the original plan of MOP.

(3) Conduct negotiations with land owners based on the MOP draft

If negotiations fail, settlements will be made in court.

(4) Tentative contracts

Tentative contracts will be concluded based on negotiated agreements or a court decision. Contracts will be concluded between property owners and the MOP local bureau chief.

(5) Investigation by a lawyer

A third party (lawyer) will study the tentative contract and determine if the value of the contract is appropriate.

(6) Final contract

After the lawyer determines that the value of the contract is appropriate, this will be reported to the headquarters, and a final contract will be concluded. At this time the contract will be concluded between the property owners and the minister of MOP, and the contract will be put in writing. The cost required for the registration procedures will be paid by MOP, and there will be no allowance provided for substitute property.

15.4 Screening

Screening was conducted based on the field study results and the details of the optimal route. Table 15-4 shows the results.

15.5 Scoping

As Table 15-5 shows, among the environmental items affected, the most important are the relocation of residents, air pollution, noise, vibration, and the view. Traffic, living facilities, and water pollution are considered to follow in importance.

Although the screening shows that the river flow will be affected, however this change is not believed to be important. Because, the Biobio River neither supports fishing nor significant aquatic life. A slight change in the river flow presents no problems. Therefore, the river flow is not considered to be an important item.

15.6 Summary

As a result of the implementation of this project, some impact is expected in the areas of residential relocation, air pollution, noise, and vibration. Less impact is expected in transportation, living facilities, the view, and water pollution.

When over 60,000 vehicles are concentrated into the city, local environment problems can be expected. It will be necessary to disperse the traffic entering the central area of the city by implementing the "Biobio River North Dike Area Recovery Project" and the "Costanera Road Project"

Table 15-4 Results of Screening

Environmental Items		Details	Evaluation	Remarks (Reasons)
Social Environment	1. Resident relocation	Relocation accompanied by land possession (conversion of residential rights and land ownership)	Yes No Unknown	Cause the relocation of residence because of the bridge and the approach road
	2. Economic activities	Loss of production opportunities, such as land use and economic structural changes	Yes No Unknown	There are no agricultural and forest lands, or changes in topography and land usage
	3. Traffic and living facilities	Impact on the existing transportation system, schools, and hospitals, such as traffic congestion and accidents	Yes No Unknown	Along with the increase in traffic volume, traffic accidents may also increase
	4. Regional isolation	Isolation of regional society as a result of traffic disruption	Yes No Unknown	
	5. Remains and cultural assets	Loss and the reduction in value of churches and buried cultural assets	Yes No Unknown	No distribution of remains and cultural assets
	6. Water rights and common land	Disruption of fishing rights, water rights, and forest commons	Yes No Unknown	No fishing rights
	7. Health and sanitation	Deterioration of the sanitation environment as result of waste and vermin	Yes No Unknown	No generation of garbage, and health and sanitation conditions will not deteriorate
	8. Waste	Generation of construction leftover materials, dirt, and general waste	Yes No Unknown	Large amounts of waste will not be generated
	9. Disaster (risk)	Increase in the danger of accidents, such as landslides and rock falls	Yes No Unknown	No construction to cause disasters
Natural Environment	10. Topography and geology	Change in topography and geology caused by drilling and banking	Yes No Unknown	No large-scale topographical changes
	11. Soil erosion	Topsoil erosion as result of land development and deforestation	Yes No Unknown	No construction to cause land erosion
	12. Underground water	Depletion by drainage as a result of drilling	Yes No Unknown	Drilling which depletes underground water sources will not be performed
	13. Pond and river flow (flow)	Change in the river flow and the river bed because of drainage inflow and land reclamation	Yes No Unknown	River flow may change because of piers
	14. Coast and sea area	Coastal erosion and sedimentation caused by the ocean and land reclamation	Yes No Unknown	Does not pass through the coastal area
	15. Flora and fauna	Disruption of breeding and extinction of species caused by changes in the habitat	Yes No Unknown	No important flora and fauna
	16. Climate	Change in temperature and wind currents caused by large-scale development and buildings	Yes No Unknown	Impact on the climate cannot be considered
	17. View	Changes in topography caused by development, and disruption of harmony caused by the construction of buildings	Yes No Unknown	View will change because of the bridge and the approach road
Contamination	18. Air pollution	Pollution by the exhaust gas from automobiles and factories, and harmful gases	Yes No Unknown	Impact may be considered because of the increase in traffic volume
	19. Water contamination	Pollution from the inflow of sediment and factory drainage	Yes No Unknown	Impact may occur because of construction in the river
	20. Soil contamination	Pollution from dust, agricultural chemicals, and asphalt emulsion	Yes No Unknown	No generation of hazardous substances
	21. Noise and vibration	Noise and vibration caused by automobiles	Yes No Unknown	Impact can be considered because of the increase in traffic volume
	22. Land subsidence	Land subsidence accompanied by lowered underground water levels and changes in the ground	Yes No Unknown	No weak ground
	23. Odor	Generation of emission gases and malodorous substances	Yes No Unknown	No odor generation
	Comprehensive evaluation: whether or not the development project requires the implementation of EIA or IEE		Required Not required	Impact on many items can be considered

Table 15-5 Results of Scoping

	Environmental Items	Evaluation	Reasons
Social Environment	1. Resident relocation	B	Residents will be relocated because of the bridge and the approach road.
	2. Economic activities	D	
	3. Traffic and living facilities	C	Along with an increase in traffic volume, an increase in traffic accidents may occur.
	4. Regional isolation	D	
	5. Remains and cultural assets	D	
	6. Water rights and common land	D	
	7. Health and sanitation	D	
	8. Waste	D	
	9. Disaster (risk)	D	
Natural Environment	10. Topography and geology	D	
	11. Soil erosion	D	
	12. Underground water	D	
	13. Pond and river flow (flow)	D	The river does not support fishing or significant aquatic life.
	14. Coast and sea area	D	
	15. Flora and fauna	D	
	16. Climate	D	
	17. View	C	The view may change because of the bridge and the approach road.
Contamination	18. Air pollution	B	Impact may be considered because of an increase in the volume of traffic.
	19. Water contamination	C	Possible impact on fishing at the river mouth because of water turbidity which accompanies construction.
	20. Soil contamination	D	
	21. Noise and vibration	B	Impact may be considered because of an increase in traffic.
	22. Land subsidence	D	
	23. Odor	D	

Note 1: Classification of Evaluation
A; Serious impact may be expected
B; Slight impact is expected
C; Unknown Examination is necessary.

D; Not targeted for IEE or EIA because the impact is rarely considered.

CHAPTER 16 CONCLUSIONS AND RECOMMENDATIONS

On the second stage of the study, the optimal type of bridge and road alignment were studied based on the data collected in the First Stage of the study and on a preliminary design. Based on the traffic demand analysis carried out in more detail in this Stage and based on construction cost estimation and the economic analysis, the Study Team arrived following conclusions.

16.1 Conclusions

(1) The JICA Study Team concluded that the new Biobio Bridge along the extension of Los Carrerra St. and along the same alignment (Route Alternative No.4) is the best choice not only for economic reasons but also for the reasons below.

1. Concepcion City Authority is now implementing a project to widen Los Carrera St. into a six lane road, which will give the best access from the San Pedro side.

2. Due to restrictions of topography on the San Pedro side, access road of Alternative 1, 2 and 3 would allow the use of small radius curves. This is not desirable from the viewpoint of traffic safety and traffic control.

3. In case of Alternatives 1 and 2, all the traffic entering the downtown of Concepcion is forced to make left turns, which would not provide the condition for smooth traffic flow.

4. Alternative 4 is considered to be the best route to encourage and accelerate the urban development in the river-side area in Concepcion.

5. Alternative 4 has the least demand for land acquisitions.

(2) The most suitable structural scheme which is recommended is the one using continuous post tentioned hollow slab deck bridge, with 35 m spans supported on solid wall piers supported on caisson foundations.

(3) The total cost of the project is estimated at Ch.$ 28,476 million (US$ 66.1 million) at 1994 price, including approach roads and fly-overs on both sides. Three years will be needed for construction.

(4) The project is judged to be highly feasible, yielding 20 % as the internal rate of return (IRR) and has a net present value (NPV) of Ch.$ 19,573 million. The sensitivity analysis revealed that the feasibility is quite stable against changes in the road network conditions, a smaller increase in car ownership and a large increase in construction cost.

16.2 Recommendations

(1) Since the year 1996 is estimated as the optimal year to start the construction of the new Biobio bridge from the economic point of view, this project should be started as soon as possible.

(2) The Biobio Antiguo Bridge has reached the end of its service life. It should be closed, however, the MOP has expressed interest to keep it open until the new bridge is constructed, in which case certain maintenance works outlined in the report should be instituted, and the traffic should be reduced to passenger cars and emergency vehicles only.

(3) From an engineering and economic point of view, it is not feasible to upgrade the Biobio Antiguo Bridge.

(4) The improvement of road network related to this bridge should be continued. Especially, the improvement of Los Carrera Street, the Construction of the New Costanera Avenue and the development of a road network connecting the old city center in relation to " The Biobio River North-dike Area Recovery Project" should be undertaken.

(5) To disperse traffic concentrate into the central area of the city, construction of Costanera Road should be implemented.

(6) The peak hour traffic volume on the new bridge will exceed its design capacity in 2010. A study to evaluate the need for another bridge is recommended, by means of the evaluation of the traffic volume and trends, shortly after the opening of the New Biobio Bridge.

Based on the agreement for this study between Japanese Government and Chile Government, implementation of detailed study about the urban development plan of the area related to the Biobio Bridge is out of scope. The construction of the New Bridge, however, will have an important impact on the urban planning of Concepcion. It is also recommended to establish a detailed comprehensive urban development plan, to cope with the rapid growth of the south area of Concepcion and to aiming at unifying both sides of the river.

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