

# Class Exercise

## User Cost and NPV

**Problem Statement:**

A State highway agency is conducting a Life Cycle Cost Analysis of a proposed 6 lane facility (3 lanes per direction). The current AADT is 40000 vehicles per day per direction. The State is considering two proposed alternatives for the initial construction and rehabilitation strategy for one direction. Planned work zones will be in place 24 hours per day during which time the facility is reduced to 2 lanes of operation per direction. Performance lives for two alternative design and rehabilitation strategies are shown in Table 1. *Compute the total Net Present Value (NPV) for each alternative A and B.* Assume a 35 year analysis period. Include in your analysis the effect of salvage value if applicable. Construction cost and days for initial construction and rehabilitation activities can be found in Figures 1 - 4. Real opportunity cost of money to the State highway agency is 4%. The SHA estimates the value of time to be \$10. Routine reactive maintenance cost differences between alternatives are insignificant. Use the formula provided to calculate net present value. Use Table 2 to summarize your selected input values. If needed use Table 3 for the appropriate discount factor. The cost of daily delay is shown in Table 4. Use Tables 5 and 6 as worksheets.

**Table 1.** Input variable ranges for Alternatives A & B.

	Alternative - A				Alternative - B			
	Initial		Rehabs.		Initial		Rehabs.	
	Low	High	Low	High	Low	High	Low	High
<b>Performance (years)</b>	16	24	8	12	10	16	6	8

**Table 2.** Selected input values for Alternatives A & B.

	Alternative - A			Alternative - B				
	Initial	Rehabs.		Initial	Rehabs.			
		1	2		1	2	3	4
<b>Performance (years)</b>								
<b>Construction Cost \$</b>								
<b>Construction Days</b>								
<b>Daily Delay Cost \$</b>								
<b>User Cost \$</b>								

NPV = Initial Cost +

$$\sum \text{Future Cost} \times \left[ \frac{1}{(1+i)^n} \right]$$

Where:

NPV = Net Present Value

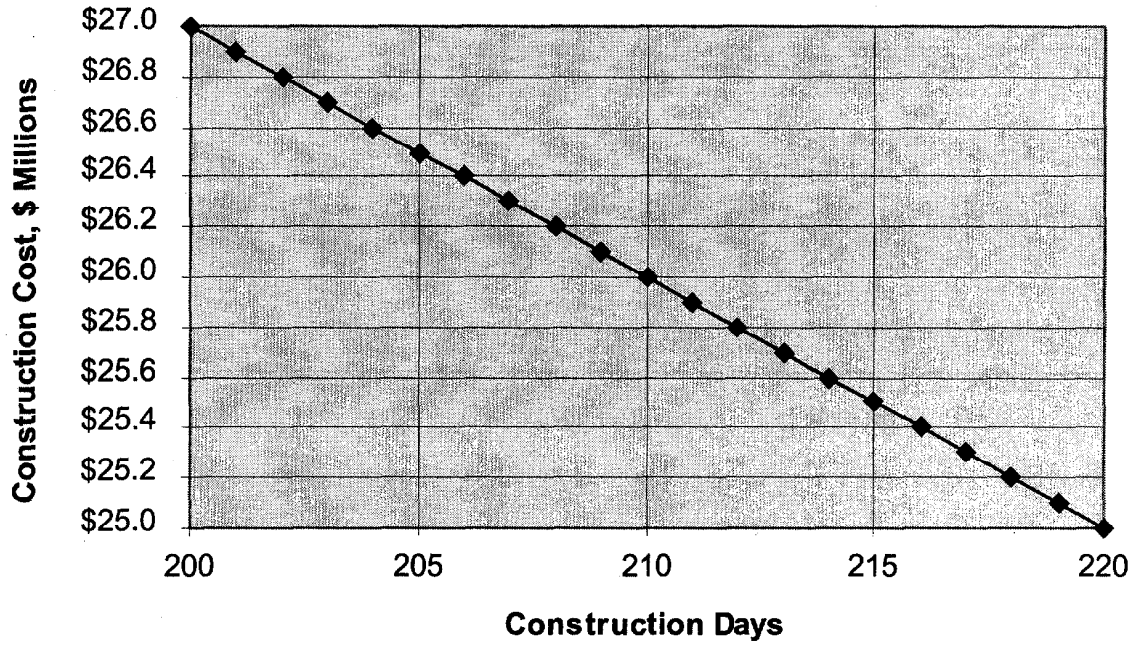
i = discount rate

n = years discounted

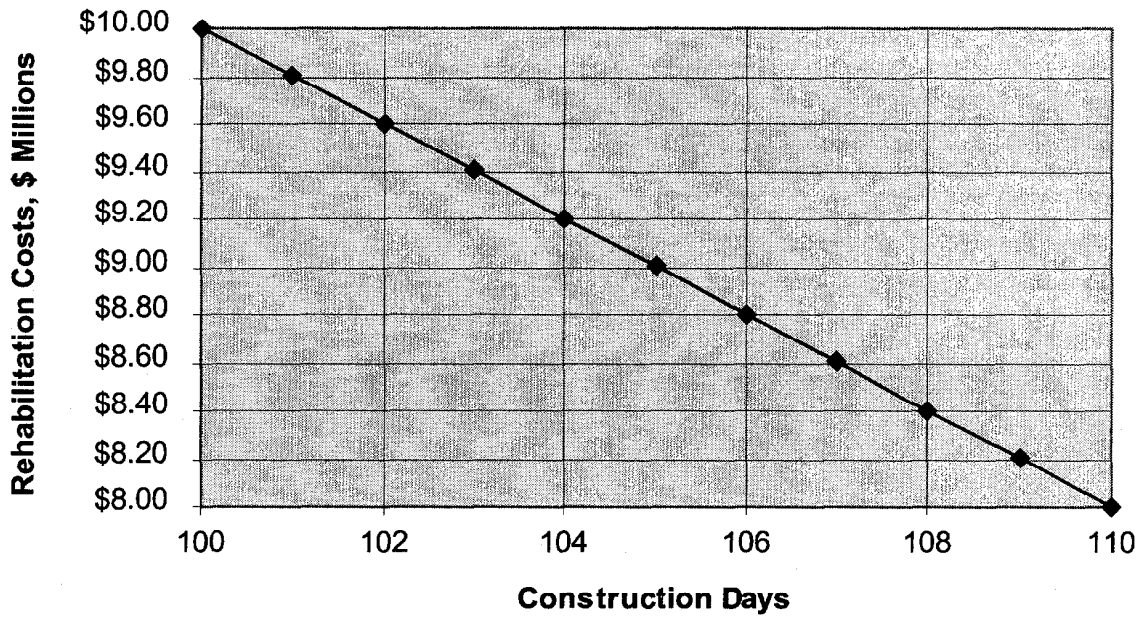
**Table 3. Discount Factors.**

Year	Discount Rate				
n	4.0%	4.5%	5.0%	5.5%	6.0%
0	1.0000	1.0000	1.0000	1.0000	1.0000
1	0.9615	0.9569	0.9524	0.9479	0.9434
2	0.9246	0.9157	0.9070	0.8985	0.8900
3	0.8890	0.8763	0.8638	0.8516	0.8396
4	0.8548	0.8386	0.8227	0.8072	0.7921
5	0.8219	0.8025	0.7835	0.7651	0.7473
6	0.7903	0.7679	0.7462	0.7252	0.7050
7	0.7599	0.7348	0.7107	0.6874	0.6651
8	0.7307	0.7032	0.6768	0.6516	0.6274
9	0.7026	0.6729	0.6446	0.6176	0.5919
10	0.6756	0.6439	0.6139	0.5854	0.5584
11	0.6496	0.6162	0.5847	0.5549	0.5268
12	0.6246	0.5897	0.5568	0.5260	0.4970
13	0.6006	0.5643	0.5303	0.4986	0.4688
14	0.5775	0.5400	0.5051	0.4726	0.4423
15	0.5553	0.5167	0.4810	0.4479	0.4173
16	0.5339	0.4945	0.4581	0.4246	0.3936
17	0.5134	0.4732	0.4363	0.4024	0.3714
18	0.4936	0.4528	0.4155	0.3815	0.3503
19	0.4746	0.4333	0.3957	0.3616	0.3305
20	0.4564	0.4146	0.3769	0.3427	0.3118
21	0.4388	0.3968	0.3589	0.3249	0.2942
22	0.4220	0.3797	0.3418	0.3079	0.2775
23	0.4057	0.3634	0.3256	0.2919	0.2618
24	0.3901	0.3477	0.3101	0.2767	0.2470
25	0.3751	0.3327	0.2953	0.2622	0.2330
26	0.3607	0.3184	0.2812	0.2486	0.2198
27	0.3468	0.3047	0.2678	0.2356	0.2074
28	0.3335	0.2916	0.2551	0.2233	0.1956
29	0.3207	0.2790	0.2429	0.2117	0.1846
30	0.3083	0.2670	0.2314	0.2006	0.1741
31	0.2965	0.2555	0.2204	0.1902	0.1643
32	0.2851	0.2445	0.2099	0.1803	0.1550
33	0.2741	0.2340	0.1999	0.1709	0.1462
34	0.2636	0.2239	0.1904	0.1620	0.1379
35	0.2534	0.2143	0.1813	0.1535	0.1301

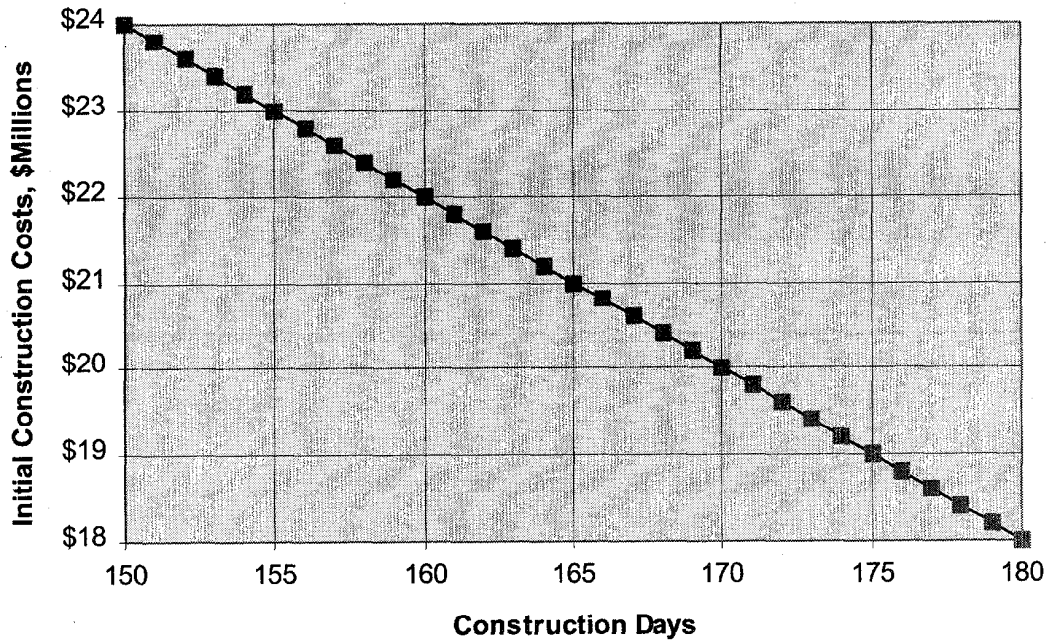
**Figure 1. Initial Construction - Alternative A**



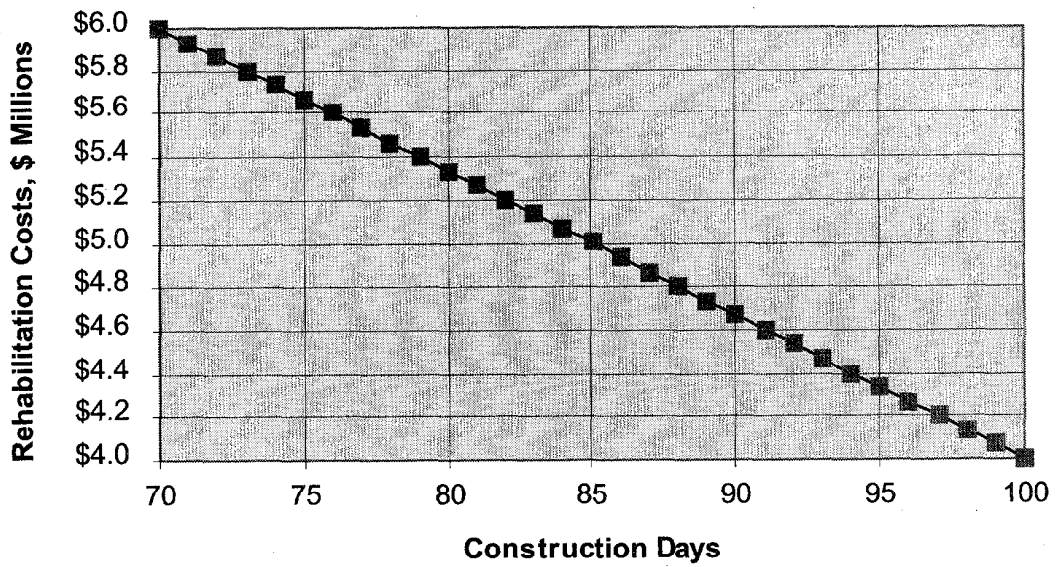
**Figure 2. Rehabilitation Costs - Alternative A**



**Figure 3. Initial Construction Costs - Alternative B**



**Figure 4. Rehabilitation Costs Alternative - B**



**Table 4. Daily cost of delay.**

Value Time \$ 10.00 per hour				
Directional AADT(initial) 40000 vpd				
Traffic Growth Rate 3 percent				
Delay Per Veh. Growth Rate 10 percent				
Year	AADT	Delay/Veh.	Daily Delay	Daily Cost
		min	hours	
0	40000	5.0	3333	\$ 33,333
1	41200	5.5	3777	\$ 37,767
2	42436	6.1	4279	\$ 42,790
3	43709	6.7	4848	\$ 48,481
4	45020	7.3	5493	\$ 54,929
5	46371	8.1	6223	\$ 62,234
6	47762	8.9	7051	\$ 70,511
7	49195	9.7	7989	\$ 79,889
8	50671	10.7	9051	\$ 90,514
9	52191	11.8	10255	\$ 102,553
10	53757	13.0	11619	\$ 116,192
11	55369	14.3	13165	\$ 131,646
12	57030	15.7	14915	\$ 149,155
13	58741	17.3	16899	\$ 168,993
14	60504	19.0	19147	\$ 191,469
15	62319	20.9	21693	\$ 216,934
16	64188	23.0	24579	\$ 245,786
17	66114	25.3	27848	\$ 278,476
18	68097	27.8	31551	\$ 315,513
19	70140	30.6	35748	\$ 357,476
20	72244	33.6	40502	\$ 405,020
21	74412	37.0	45889	\$ 458,888
22	76644	40.7	51992	\$ 519,920
23	78943	44.8	58907	\$ 589,070
24	81312	49.2	66742	\$ 667,416
25	83751	54.2	75618	\$ 756,182
26	86264	59.6	85675	\$ 856,755
27	88852	65.5	97070	\$ 970,703
28	91517	72.1	109981	\$ 1,099,806
29	94263	79.3	124608	\$ 1,246,081
30	97090	87.2	141181	\$ 1,411,809
31	100003	96.0	159958	\$ 1,599,580
32	103003	105.6	181232	\$ 1,812,324
33	106093	116.1	205336	\$ 2,053,363
34	109276	127.7	232646	\$ 2,326,460
35	112554	140.5	263588	\$ 2,635,880
36	115931	154.6	298645	\$ 2,986,452
37	119409	170.0	338365	\$ 3,383,650
38	122991	187.0	383368	\$ 3,833,675
39	126681	205.7	434355	\$ 4,343,554
40	130482	226.3	492125	\$ 4,921,247

**Table 5. NPV Worksheet.**

	Year			
<b>Alternative - A</b>				
Agency Cost (Constant \$)				
Present Worth Factor				
Agency Cost (Present Worth)				
<b>Total NPV (Agency Cost)</b>				
Construction Days				
Daily Delay (Constant \$)				
User Cost (Constant \$)				
Present Worth Factor				
User Cost (Present Worth)				
<b>Total NPV (User Cost)</b>				
<b>Grand Total NPV (all costs)</b>				

	Year			
<b>Alternative - B</b>				
Agency Cost (Constant \$)				
Present Worth Factor				
Agency Cost (Present Worth)				
<b>Total NPV (Agency Cost)</b>				
Construction Days				
Daily Delay (Constant \$)				
User Cost (Constant \$)				
Present Worth Factor				
User Cost (Present Worth)				
<b>Total NPV (User Cost)</b>				
<b>Grand Total NPV (all costs)</b>				