

09-MMP-B8 Mine Management and Systems Analysis

National Examination

May, 2018

NAME: _____

DATE: _____

TIME LIMIT FOR EXAM IS 3 HOURS.

ANSWER ALL 4 QUESTIONS FOR A TOTAL OF 100 MARKS.

APPENDIX A WITH DISCOUNTED CASH FLOW TABLES IS ATTACHED.

THIS IS A CLOSED BOOK EXAM - One of two calculators is permitted - any Casio or Sharp approved model.

CLEARLY STATE AND JUSTIFY ANY ASSUMPTIONS THAT YOU MAKE. TOTAL NUMBER OF PAGES IN THIS EXAM IS 6.

PARTS OF QUESTIONS 4 AND 5 CAN BE ANSWERED DIRECTLY ON THESE SHEETS - ANSWER OTHER QUESTIONS AND SECTIONS IN THE BOOKLETS PROVIDED.

RETURN ALL 6 PAGES WITH YOUR EXAM BOOKLETS.

Question 1 - Mine Stages and Financial Analysis. 30 Marks

- a) Name and describe the 5 stages in the life of a mine. (10 Marks)
- b) Describe the 5 stages in terms of typical cash flows and sketch the corresponding cash flow diagram. (5 Marks)
- c) Evaluate the mining project described in the recent press release given below and answer the financial analysis questions that follow. (15 Marks)

Press Release (December 2017):

Snowy River is a gold project located northwestern Ontario. The deposit was discovered in 2001 and then subsequent exploration delineated a world class resource. Regulatory reviews and approvals were concluded in 2012 and mine development commenced in January 2015. The mine will be a conventional shovel and truck open pit operation when it starts production in January 2019.

Stripping operations are nearly 85% completed and energization of all key site overhead power lines and construction of the tailings pipeline corridor have been completed. The primary crusher and conveyor system was successfully commissioned on schedule, and the first crush occurred on December 11, 2017. Commissioning of the ball mill and SAG mill has started and is scheduled to be completed in August 2018. The refining portion of the circuit should be ready to begin commissioning in October 2018, and dry and wet commissioning of the full process circuit is scheduled for late November 2018. Project spending at Snowy River to date is approximately \$295 million, with the remaining capital costs prior to commercial production estimated to be an additional \$220 million.

The January 2011 Feasibility Study for the project estimated a 20,000 tonne per day processing plant operation with combined mining and milling costs estimated at \$90/tonne. Average annual gold production of 485,000 ounces is expected during the first nine years of the mine's anticipated 17-year life, declining to a rate of 180,000 ounces per year during the final mine life. Decommissioning and reclamation costs of \$70 million over 2 years are expected after mining ends. At the time of this press release, gold prices are expected to maintain an average of \$1600 CAD/ounce over the duration of the production life with a 50% probability.

Conduct a discounted cash flow analysis of this project (as outlined below) **clearly stating and justifying all of the economic factors that you interpreted from the press release.** Note that DCF tables are provided in the attached Appendix A. From this information, determine:

- i. The gross and net value of ore per tonne.
- ii. Net Present Value and Present Value Ratio at a discount rate of 10% and payback period on a before-tax basis.
- iii. Based on your analysis, would you recommend this project as an investment opportunity? Justify your recommendation.

Question 2. Shovel-Truck Fleet Analysis. 20 Marks

For a particular working area of a large surface mine, the haul route from the shovel to the crusher is i) 400 m of level in-pit haulage, ii) climbing through 175 m of elevation change up a 10% ramp, and iii) traveling a horizontal distance of 1850 m to the crusher. The rolling resistance of all road surfaces is maintained at approximately 6% and downhill speed limits of 30 km/h are imposed. Time study data for loading and dumping times are given in Fig. 2.1 and the truck performance charts are given in Fig. 2.2. Using these data, determine (a) the expected range of truck cycle times, and (b) the optimum number of trucks to assign to a single shovel. Clearly justify any assumptions you make regarding the use of the provided data.

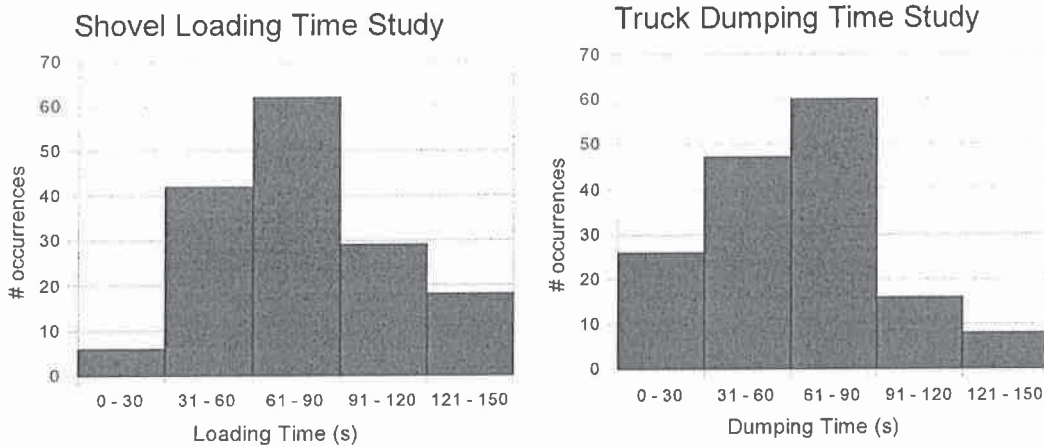


Fig. 2.1 Histograms of shovel loading and truck dumping times.

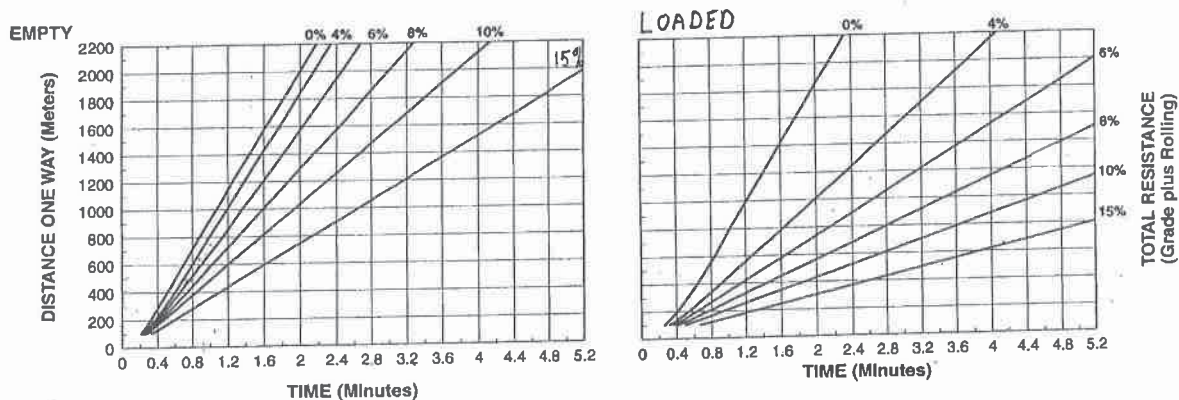


Fig. 2.2 Haul truck performance charts.

Question 4 – Open Pit Limits and Development Planning. 20 Marks

On the provided geological section in Figure 4.1:

- a) Determine the open pit boundaries which satisfy an overall stripping ratio of 2.0 ± 0.1 waste to ore and maximize the amount of ore mined. Note that the floor of the final pit must be horizontal and have a minimum width of 20 m. Use this info in your calculations: (10 Marks)

$$\rho_{\text{ore}} = \rho_{\text{waste}} = 2700 \text{ kg/m}^3$$
$$\text{max slope angle} = 45^\circ$$

- b) Propose and sketch on the geological section a mine development plan that maintains an approximately constant stripping ratio. (10 Marks)

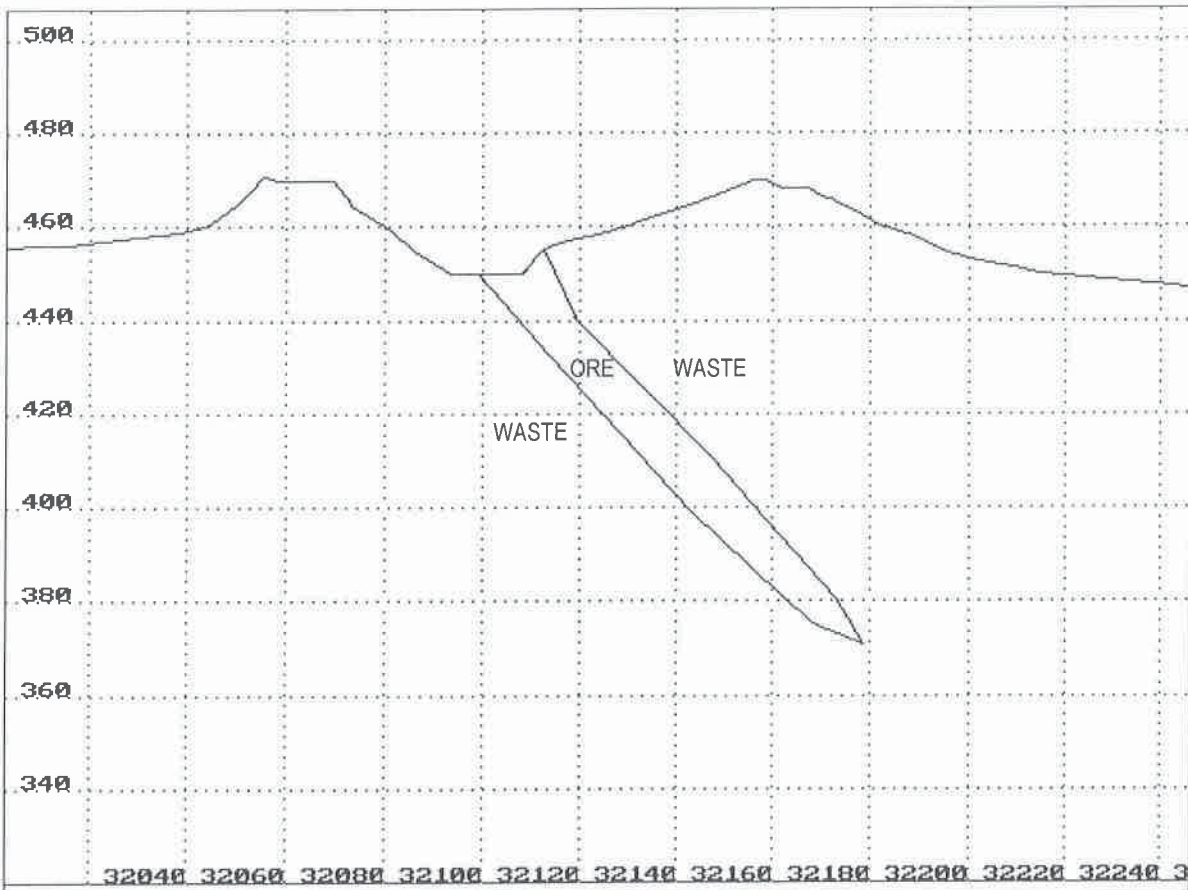
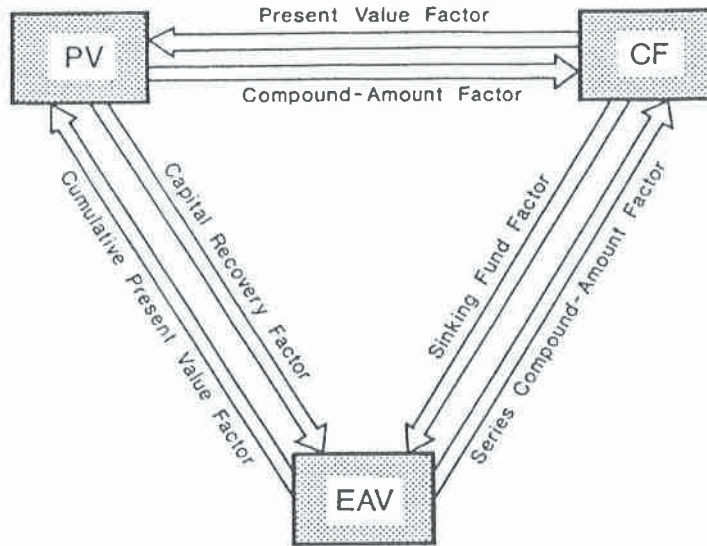


Figure 4.1 Geological section for steeply dipping ore zone. The dimensions shown are meters.

Appendix A – Discounted Cash Flow Analysis Tables and Charts



years	FVF				CFVF				SFF			
	10%	20%	30%	40%	10%	20%	30%	40%	10%	20%	30%	40%
1	0.9091	0.8333	0.7692	0.7143	0.9091	0.8333	0.7692	0.7143	1.0000	1.0000	1.0000	1.0000
2	0.8264	0.6944	0.5917	0.5102	1.7355	1.5278	1.3609	1.2245	0.4762	0.4545	0.4348	0.4167
3	0.7513	0.5787	0.4662	0.3644	2.4669	2.1065	1.8161	1.5669	0.3021	0.2747	0.2506	0.2294
4	0.6830	0.4823	0.3601	0.2803	3.1699	2.5657	2.1662	1.8462	0.2155	0.1863	0.1616	0.1408
5	0.6209	0.4019	0.2863	0.1869	3.7908	2.9906	2.4666	2.0662	0.1636	0.1344	0.1106	0.0914
6	0.5645	0.3349	0.2072	0.1326	4.3553	3.3255	2.6427	2.1660	0.1295	0.1007	0.0784	0.0613
7	0.5132	0.2791	0.1594	0.0949	4.8694	3.6046	2.8021	2.2628	0.1054	0.0774	0.0569	0.0419
8	0.4665	0.2326	0.1226	0.0578	5.3349	3.8372	2.9247	2.3306	0.0874	0.0606	0.0419	0.0291
9	0.4241	0.1938	0.0943	0.0464	5.7590	4.0310	3.0190	2.3790	0.0736	0.0481	0.0312	0.0203
10	0.3855	0.1615	0.0725	0.0346	6.1446	4.1925	3.0915	2.4136	0.0627	0.0365	0.0235	0.0143
11	0.3505	0.1346	0.0568	0.0247	6.4851	4.3271	3.1473	2.4383	0.0540	0.0311	0.0177	0.0101
12	0.3186	0.1122	0.0429	0.0176	6.8137	4.4392	3.1903	2.4589	0.0468	0.0263	0.0135	0.0072
13	0.2897	0.0935	0.0330	0.0126	7.1094	4.5327	3.2238	2.4665	0.0408	0.0206	0.0102	0.0051
14	0.2633	0.0779	0.0254	0.0090	7.3667	4.6106	3.2467	2.4775	0.0357	0.0169	0.0078	0.0036
15	0.2394	0.0649	0.0195	0.0064	7.6061	4.6755	3.2682	2.4839	0.0315	0.0139	0.0060	0.0026
16	0.2176	0.0541	0.0150	0.0046	7.8237	4.7296	3.2832	2.4865	0.0278	0.0114	0.0046	0.0018
17	0.1978	0.0451	0.0116	0.0033	8.0216	4.7746	3.2946	2.4918	0.0247	0.0094	0.0035	0.0013
18	0.1799	0.0376	0.0089	0.0023	8.2014	4.8122	3.3037	2.4941	0.0219	0.0078	0.0027	0.0009
19	0.1635	0.0313	0.0068	0.0017	8.3649	4.8435	3.3105	2.4958	0.0195	0.0065	0.0021	0.0007
20	0.1486	0.0261	0.0053	0.0012	8.5136	4.8686	3.3158	2.4970	0.0175	0.0054	0.0016	0.0005
21	0.1351	0.0217	0.0040	0.0009	8.6487	4.8913	3.3198	2.4979	0.0156	0.0044	0.0012	0.0003
22	0.1228	0.0181	0.0031	0.0006	8.7715	4.9094	3.3220	2.4985	0.0140	0.0037	0.0009	0.0002
23	0.1117	0.0151	0.0024	0.0004	8.8832	4.9245	3.3254	2.4989	0.0126	0.0031	0.0007	0.0002
24	0.1015	0.0126	0.0018	0.0003	8.9847	4.9371	3.3272	2.4992	0.0113	0.0025	0.0006	0.0001
25	0.0923	0.0105	0.0014	0.0002	9.0770	4.9476	3.3286	2.4994	0.0102	0.0021	0.0004	0.0001
26	0.0839	0.0087	0.0011	0.0002	9.1609	4.9563	3.3297	2.4995	0.0092	0.0018	0.0003	0.0001
27	0.0763	0.0073	0.0008	0.0001	9.2372	4.9636	3.3305	2.4997	0.0083	0.0015	0.0003	0.0000
28	0.0693	0.0061	0.0006	0.0001	9.3066	4.9697	3.3312	2.4998	0.0075	0.0012	0.0002	0.0000
29	0.0630	0.0051	0.0005	0.0001	9.3696	4.9747	3.3317	2.4999	0.0067	0.0010	0.0001	0.0000
30	0.0573	0.0042	0.0004	0.0000	9.4269	4.9789	3.3321	2.4999	0.0061	0.0008	0.0001	0.0000