

## MEMORANDUM

PMA

TO: P. Dyas

FROM: G. Hope

002157

SUBJECT: LOW GRADE STOCKPILE TESTING

DATE: February 16, 1973

Summary:

Testing performed on samples of the low grade stockpile revealed some definite metallurgical problems. The standard test method yielded very low grades and recoveries. A series of reagent tests showed that increased  $\text{Na}_2\text{CO}_3$  with  $\text{Na}_2\text{SO}_3$ ,  $\text{Na}_2\text{CO}_3$  with  $\text{CaO}$  and  $\text{CaO}$  improved both grades and recoveries to an acceptable level. Testing with  $\text{ZnSO}_4$ ,  $\text{Na}_2\text{S}$  and increased  $\text{Na}_2\text{CO}_3$  proved to be of little benefit and in some cases, detrimental. Poor results are due to a severe oxidation problem in the stockpile samples. The exceedingly low pH's (6.5 to 7.5) for the lead roughing when the standard method was used is indicative of the problem found with oxidized ore.

Test Data:

The samples used in the metallurgical testing were composites of each drill hole in a stockpile drilling survey on October 25, 1972. Samples tested by the standard method were from a major portion of the yellow low grade stockpile and from the perimeter of the red low grade stockpile. Special reagent testing was carried out on a random composite of all the drill holes.

The standard test method was:

$\text{Na}_2\text{CO}_3$	3.0%	) Grind 5)	} 7 mm	(pH range 6.5 to 7.5)	float	4½	PbRC
NaCN	0.15%						
Z-11	0.035%	) Grind 2)	}	(pH range 8.0 to 9.0)	float	5	PbSC
Z-11	0.025%						
CaO	1.25%	) Condition 10	}	(pH range 8.0 to 9.0)	float	5	ZnRC
$\text{CuSO}_4$	0.75%						
Z-11	0.05%	) }	}	(pH range 8.0 to 9.0)	float	6	ZnSC
Z-11	0.025%						

MIBC and DF 1012 were used for frothing the lead and the zinc.

The special reagent tests involved additions to the primary grind. These tests were:

- |     |                          |        |                          |        |         |        |                               |
|-----|--------------------------|--------|--------------------------|--------|---------|--------|-------------------------------|
| 1)  | $\text{Na}_2\text{CO}_3$ | 7.0#,  | $\text{Na}_2\text{SO}_3$ | 2.5#,  | NaCN    | 0.15#  |                               |
| 2)  | $\text{Na}_2\text{CO}_3$ | 7.0#,  | $\text{Na}_2\text{SO}_3$ | 2.5#,  | No NaCN |        |                               |
| 3)  | $\text{Na}_2\text{CO}_3$ | 12.0#, | NaCN                     | 0.15#  |         |        |                               |
| 4)  | $\text{Na}_2\text{CO}_3$ | 6.0#,  | $\text{Na}_2\text{SO}_3$ | 1.5#,  | NaCN    | 0.15#  |                               |
| 5)  | $\text{Na}_2\text{CO}_3$ | 6.0#,  | $\text{Na}_2\text{SO}_3$ | 2.5#,  | NaCN    | 0.15#  |                               |
| 6)  | $\text{Na}_2\text{CO}_3$ | 10.0#, | $\text{ZnSO}_4$          | 2.0#,  | NaCN    | 0.15#, | $\text{Na}_2\text{SO}_3$ 1.5# |
| 7)  | $\text{Na}_2\text{CO}_3$ | 10.0#, | $\text{ZnSO}_4$          | 2.0#,  | NaCN    | 0.15#  |                               |
| 8)  | $\text{Na}_2\text{CO}_3$ | 6.0#,  | $\text{ZnSO}_4$          | 0.50#, | NaCN    | 0.15#  |                               |
| 9)  | $\text{Na}_2\text{CO}_3$ | 6.0#,  | $\text{Na}_2\text{S}$    | 0.50#, | NaCN    | 0.15#  |                               |
| 10) | CaO                      | 2.5#,  | NaCN                     | 0.15#  |         |        |                               |
| 11) | CaO                      | 5.0#,  | NaCN                     | 0.15#  |         |        |                               |
| 12) | $\text{Na}_2\text{CO}_3$ | 3.5#,  | CaO                      | 5.0#,  | NaCN    | 0.15#  |                               |

In each of the above tests the collector and activator quantities and the flotation times remained constant. A test was started with AF 15 for lead flotation but no results were collected as the float was so poor.

Results:

Samples from Yellow Low Grade Stockpile

Sample #	LEAD							ZINC							pH	% -200 $\mu$
	Grade % Pb					Total Rec	p F	Grade % Zn					Total Rec			
	Head	Rchr	Scav	Tail	Comb			Head	Rchr	Scav	Tail	Comb				
581	2.01	14.0	2.8	0.62	11.0	73.2	7.5	4.43	14.3	2.6	0.22	10.0	74.0	10.3	49.4	
586	2.54	19.4	5.8	0.78	15.1	76.7	7.5	5.03	16.7	1.22	0.37	8.6	77.2	10.1	61.8	
583	2.60	9.6	20.6	0.66	15.0	66.5	7.5	4.45	21.2	1.15	0.24	13.2	75.1	10.6	62.3	
590	2.38	18.1	7.7	0.88	14.8	61.8	7.7	2.98	10.9	1.1	0.22	7.4	52.4	10.5	71.1	
593	3.62	16.4	5.0	0.76	14.7	85.6	7.7	5.23	15.9	2.25	0.35	10.7	66.8	10.3	67.9	
589	2.92	24.3	4.8	1.38	14.2	67.8	7.2	4.13	10.7	1.39	0.61	6.7	63.7	10.1	60.6	
585	2.76	19.6	5.0	1.1	14.4	64.9	7.6	3.52	8.5	1.15	0.35	6.2	53.1	10.2	64.3	
594	2.72	18.4	6.6	1.03	15.8	62.9	7.6	4.23	18.5	1.7	0.36	11.2	69.9	10.4	60.9	

Average Results from Yellow Low Grade Stockpile

Product	% Wt	Assay %				Units				Recovery %			
		Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
Pb RC	9.0	17.4	8.3	29.0	0.97	157	75	261	8.7	58.1	17.6	11.5	52.1
Pb SC	4.2	7.9	10.7	31.2	0.40	33	45	131	1.7	12.2	10.6	5.8	10.2
Zn RC	18.6	1.1	14.4	32.5	0.15	20	267	604	2.8	7.4	62.8	26.5	16.8
Zn SC	13.0	0.77	1.5	42.0	0.09	10	20	546	1.2	3.7	4.7	24.0	7.2
Zn ST	55.2	0.91	0.33	13.3	0.04	50	18	734	2.3	18.5	4.2	32.2	13.8
G.H.		2.70	4.25	22.76	0.17	270	425	2276	16.7				
Combined		14.4	9.1							70.3	67.5		

Results:

Samples from Red Low Grade Stockpile

Sample #	LEAD							ZINC							% -200#
	Grade % Pb					Total Rec	p H	Grade % Zn					Total Rec	pH	
	Head	Rghr	Scav	Tail	Comb			Head	Rghr	Scav	Tail	Comb			
596	4.33	27.4	7.0	1.51	14.8	71.6	7.0	6.92	33.8	2.1	0.57	20.5	64.3	10.1	49.1
598	2.50	15.8	2.8	1.25	9.5	63.6	6.8	4.12	13.7	5.1	1.78	9.5	63.1	7.3	43.4
601	3.56	8.7	14.0	1.29	11.7	70.2	6.4	6.22	45.2	5.0	0.81	22.4	73.9	8.9	51.7
603 & 604	3.45	13.9	5.0	1.33	10.0	73.9	6.2	5.62	20.3	3.0	1.11	13.1	55.0	8.5	52.9
606	3.26	15.7	3.1	1.6	10.4	66.6	7.0	5.74	22.9	4.8	1.16	13.2	66.7	8.4	54.5

Average Results from Red Low Grade Stockpile

Product	% Wt	Assay %				Units				Recovery %			
		Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu
Pb RC	10.6	15.8	4.8	34.9	0.69	167	51	370	7.3	48.8	8.9	10.7	52.1
Pb SC	10.3	6.9	8.7	35.9	0.14	71	90	370	1.4	20.8	15.8	10.7	10.0
Zn RC	12.5	1.4	25.7	27.9	0.15	17	321	349	1.9	5.0	56.2	10.1	13.6
Zn SC	11.9	0.92	4.2	42.1	0.06	11	50	501	0.7	3.2	8.8	14.4	5.0
Zn ST	54.6	1.39	1.08	34.4	0.05	76	59	1879	2.7	22.2	10.3	54.2	19.3
C.H.						342	571	3469	14.0				
Combined		11.4	15.2							69.6	65.0		

Results:

Special Reagent Tests Conducted on Composite Samples

Test	LEAD							ZINC							% -200#
	Grade % Pb					Total Rec.	pH	Grade % Zn					Total Rec.	pH	
	Head	Rghr	Scav	Tail	Comb			Head	Rghr	Scav	Tail	Comb			
7.0 Na <sub>2</sub> CO <sub>3</sub> 0.15 NaCN 2.5 Na <sub>2</sub> SO <sub>3</sub>	4.49	35.5	10.8	1.24	31.0	72.6	8.6	6.63	46.8	1.4	0.55	39.5	78.8	9.3	52.1
* Sample of Red Low Grade Stockpile															
7.0 Na <sub>2</sub> CO <sub>3</sub> 2.5 Na <sub>2</sub> SO <sub>3</sub> No NaCN	4.65	33.6	39.9	1.31	36.7	67.1	8.7	7.09	48.3	10.0	0.48	39.6	78.1	9.3	50.0
* Sample of Red Low Grade Stockpile															
12.0 Na <sub>2</sub> CO <sub>3</sub> 0.15 NaCN	3.03	30.3	9.0	1.01	24.0	69.6	8.1	5.0	19.5	1.24	0.52	13.9	76.8	9.2	58.2
6.0 Na <sub>2</sub> CO <sub>3</sub> 1.5 Na <sub>2</sub> SO <sub>3</sub> 0.15 NaCN	3.01	26.9	14.3	0.88	22.4	65.5	7.9	4.99	28.6	3.2	0.51	15.6	74.9	9.2	55.1
6.0 Na <sub>2</sub> CO <sub>3</sub> 2.5 Na <sub>2</sub> SO <sub>3</sub> 0.15 NaCN	2.94	32.1	15.5	0.77	27.2	69.4	8.3	4.96	37.9	4.7	0.46	21.0	76.6	9.0	55.7
10.0 Na <sub>2</sub> CO <sub>3</sub> 2.0 ZnSO <sub>4</sub> 1.5 Na <sub>2</sub> SO <sub>3</sub> 0.15 NaCN	2.89	28.9	15.1	0.77	24.7	69.2	8.7	4.96	35.1	1.9	0.46	16.6	71.7	8.9	56.9
10.0 Na <sub>2</sub> CO <sub>3</sub> 2.0 ZnSO <sub>4</sub> 0.15 NaCN	2.88	20.6	5.8	1.11	15.6	71.2	8.2	5.10	17.8	1.25	0.54	8.6	71.0	8.7	57.5

Results:

Special Reagent Tests Conducted on Composite Samples

Test	LEAD							ZINC							-200#
	Grade % Pb					Total Rec.	pH	Grade % Zn					Total Rec.	pH	
	Head	Rghr	Scav	Tail	Comb			Head	Rghr	Scav	Tail	Comb			
6.0 Na <sub>2</sub> CO <sub>3</sub> 0.5 ZnSO <sub>4</sub> 0.15 NaCN	2.97	18.1	3.1	1.34	11.0	72.1	6.8	5.11	14.6	1.58	0.62	8.8	63.6	8.5	71.9
6.0 Na <sub>2</sub> CO <sub>3</sub> 0.5 Na <sub>2</sub> S 0.15 NaCN	3.05	22.7	18.8	0.79	21.5	64.2	6.8	4.91	27.4	24.2	2.3	25.3	40.8	8.5	52.2
2.5 CaO 0.15 NaCN	3.10	37.8	17.8	0.81	31.2	67.4	7.5	4.94	41.0	10.2	0.44	33.6	81.6	10.7	51.5
5.0 CaO 0.15 NaCN	3.04	44.5	34.5	1.01	40.0	54.0	10.0	4.98	42.8	32.0	0.98	40.0	76.3	10.7	51.3
3.5 Na <sub>2</sub> CO <sub>3</sub> 5.0 CaO 0.15 NaCN	3.02	50.7	21.8	0.95	40.9	59.6	9.9	5.00	46.8	22.8	0.60	39.2	82.4	10.9	52.2

\* For complete results of each individual test see Appendix I.

Discussion of Results:

The averages of the standard tests done on samples from the low grade stockpile indicate that it is not possible to obtain target grades or recoveries. On average standard tests, the lead grade is approximately 45% Pb and the zinc grade is approximately 45% Zn. On the standard test averages of the low grade stockpile samples the lead grades were 14.4% and 11.4% and the zinc grades were 9.1% and 15.2%. This indicates a significant problem in obtaining required grades. The recoveries of both lead and zinc suffered also. The average standard test maintains recoveries of 89% Pb and 80% Zn. The low grade stockpile test averages revealed lead recoveries of 70.3% and 69.6% Pb and zinc recoveries of 67.5% and 65.0% Zn. This also indicates a very serious problem.

In order to alleviate this problem, preliminary work was done using different reagent combinations.

Increasing the  $\text{Na}_2\text{CO}_3$  to 12 lb./Ton increased the concentrate grades to 36.7% Pb and 39.6% Zn, but had very little effect on the metal recoveries.

Varying amounts of  $\text{Na}_2\text{CO}_3$  with  $\text{Na}_2\text{SO}_3$  had some positive effect on both grades and recoveries. Grades and recoveries are still much lower than the normal metallurgy.

The addition of  $\text{ZnSO}_4$  to the grind resulted in very poor grades with slightly better recoveries (70% and 71% for lead and zinc).

The addition of  $\text{Na}_2\text{S}$  had an adverse effect on the recovery with no significant change in grades.

The results of the CaO test show much improved grades at a fair recovery. The overall lead grade was 40% at 54% recovery and the overall zinc grade was 40% at 76.3% recovery. These grades are very close to the grades obtainable on the usual standard tests. The lead recovery has suffered greatly while the zinc recovery is close to the usual standard.

The use of  $\text{Na}_2\text{CO}_3$  with CaO appears to give the best results. The grades are 40.9% Pb and 39.2% Zn, with recoveries of 59.6% Pb and 82.4% Zn. The grades are as good as with CaO alone but the recoveries are significantly higher. The lead recovery is still low but the zinc recovery is higher than the usual standard test.

Conclusions:

*as well as losses on 10.  
(72) (73)*

It appears essential to do extensive test work on this ore in order to develop a method that will produce the required grades at reasonable recoveries. Further investigations at optimum pH, grind, and collectors must be investigated.

APPENDIX I

INDIVIDUAL TEST RESULTS - RED LOW GRADE

Test	Products	Wt. %	Grade %				Recovery %				pH
			Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu	
Test Hole #596	Pb RC	8.0	27.4	9.0	24.9	1.01	50.6	10.4	6.0	57.0	7.0
Red Low Grade	Pb SC	13.0	7.0	10.9	34.3	0.11	21.0	20.5	13.4	9.9	
Standard Test	Zn RC	12.6	2.25	33.8	21.1	0.16	6.5	61.6	8.0	14.1	10.1
	Zn SC	9.1	1.04	2.05	43.0	0.04	2.1	2.7	11.8	2.8	
	Zn ST	57.2	1.51	0.57	35.4	0.04	19.9	4.8	60.9	16.2	
	CH		4.33	6.92	33.27	0.14					
	Comb. Concs.		14.8	20.5			71.6	64.3			
Test Hole #598	Pb RC	8.6	15.8	3.3	35.1	0.72	54.4	6.8	7.7	44.0	6.8
Red Low Grade	Pb SC	8.1	2.8	3.0	42.2	0.13	9.2	5.8	8.8	7.8	
Standard Test	Zn RC	14.0	0.92	13.7	36.8	0.14	5.2	46.6	13.2	14.2	7.3
	Zn SC	13.3	0.60	5.12	42.6	0.07	3.2	16.5	14.5	6.4	
	Zn ST	55.9	1.25	1.78	39.0	0.07	28.0	24.3	55.8	27.7	
	CH		2.50	4.12	39.06	0.14					
	Comb. Concs.		9.5	9.5			63.6	63.1			
Test Hole #601	Pb RC	9.5	8.7	2.8	41.6	0.67	23.3	4.3	11.1	46.0	6.4
Red Low Grade	Pb SC	11.9	14.0	7.4	34.0	0.15	46.9	14.1	11.4	12.9	
Standard Test	Zn RC	8.9	1.73	45.2	14.4	0.22	4.2	64.6	3.6	14.4	8.9
	Zn SC	11.6	1.34	5.0	41.2	0.07	4.5	9.3	13.5	5.8	
	Zn ST	58.1	1.29	0.81	36.8	0.05	21.1	7.6	60.3	20.9	
	CH		3.56	6.22	35.44	0.14					
	Comb. Concs.		11.7	22.4			70.2	73.9			
Test Hole #603 & 604	Pb RC	14.9	13.9	4.8	36.6	0.64	60.0	12.8	16.4	60.1	6.2
	Pb SC	9.6	5.0	12.8	33.6	0.17	13.9	21.9	9.7	10.1	
Red Low Grade	Zn RC	13.8	1.05	20.3	31.8	0.12	4.1	49.8	13.2	10.8	8.5
Standard Test	Zn SC	9.7	0.74	2.99	43.2	0.04	2.0	5.2	12.6	2.5	
	Zn ST	52.0	1.33	1.11	30.9	0.05	20.0	10.3	48.2	16.5	
	CH		3.45	5.62	33.33	0.16					
	Comb. Concs.		10.0	13.1			73.9	55.0			

APPENDIX I (CONTINUED)

INDIVIDUAL TEST RESULTS - RED LOW GRADE

Test	Products	Wt. %	Grade %				Recovery %				pH
			Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu	
Test Hole #606	Pb RC	12.1	15.7	4.8	34.0	0.54	58.3	10.1	12.7	53.7	7.0
Red Low Grade	Pb SC	8.8	3.1	8.5	37.9	0.12	8.3	13.1	10.3	9.1	
Standard Test	Zn RC	13.4	1.12	22.9	29.8	0.13	4.6	53.5	12.3	14.0	8.4
	Zn SC	15.7	0.90	4.81	41.4	0.05	4.3	13.2	20.1	6.6	
	Zn ST	50.0	1.60	1.16	28.9	0.04	24.5	10.1	44.6	16.5	
	CH		3.26	5.74	32.39	0.12					
	Comb. Concs.		10.4	13.2			66.6	66.7			

INDIVIDUAL TEST RESULTS - YELLOW LOW GRADE

Test Hole #581	Pb RC	9.8	14.0	7.8	29.3	0.54	68.2	17.2	15.7	53.5	7.5
Yellow Low Grade	Pb SC	3.6	2.8	7.6	33.6	0.12	5.0	6.1	6.6	4.0	
Standard Test	Zn RC	20.7	0.51	14.3	34.6	0.08	5.5	66.8	39.1	17.2	10.5*
	Zn SC	12.2	0.83	2.6	33.4	0.07	5.0	7.2	22.3	9.1	
	Zn ST	53.8	0.62	0.22	15.54	0.03	16.4	2.7	16.3	16.2	
	CH		2.01	4.43	18.29	0.10					
	Comb. Concs.		11.0	10.0			73.2	74.0			
Test Hole #586	Pb RC	8.8	19.4	6.7	30.8	0.85	67.3	11.7	8.9	49.0	7.5
Yellow Low Grade	Pb SC	4.1	5.8	9.7	33.5	0.25	9.4	8.0	4.5	6.5	
Standard Test	Zn RC	21.5	0.73	16.7	34.5	0.14	6.3	71.4	24.5	19.6	10.4*
	Zn SC	23.6	0.41	1.22	44.5	0.07	3.9	5.8	34.7	11.1	
	Zn ST	41.9	0.78	0.37	19.8	0.05	13.0	3.2	27.4	13.7	
	CH		2.54	5.03	30.30	0.15					
	Comb. Concs.		15.1	8.6			76.7	77.2			
Test Hole #583	Pb RC	5.8	9.6	5.9	37.4	1.21	21.5	7.6	9.0	32.9	7.5
Yellow Low Grade	Pb SC	5.7	20.6	10.8	27.4	0.80	45.0	13.9	6.4	21.6	
Standard Test	Zn RC	15.2	2.4	21.2	29.9	0.35	13.8	72.4	18.7	24.9	10.5*
	Zn SC	10.1	0.85	1.15	45.2	0.12	3.5	2.7	18.9	5.6	
	Zn ST	63.2	0.66	0.24	18.0	0.05	16.2	3.4	47.0	15.0	
	CH		2.60	4.45	24.22	0.21					
	Comb. Concs.		15.0	13.2			66.5	75.1			

\*Extra CaO

APPENDIX I (CONTINUED)

INDIVIDUAL TEST RESULTS - YELLOW LOW GRADE

Test	Products	Wt. %	Grade %				Recovery %				pH
			Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu	
Test Hole #590	Pb RC	6.8	18.1	11.6	25.1	1.56	51.7	26.5	10.3	59.2	7.7
Yellow Low Grade	Pb SC	3.1	7.7	15.6	21.9	0.55	10.1	16.1	4.1	9.5	
Standard Test	Zn RC	13.6	1.56	10.9	34.9	0.18	8.8	49.7	28.6	13.4	10.6
	Zn SC	7.5	1.2	1.1	40.6	0.14	3.8	2.7	18.4	6.1	
	Zn ST	69.0	0.88	0.22	9.3	0.03	25.6	5.0	38.7	11.7	
	CH		2.38	2.98	16.61	0.18					
	Comb. Concs.		14.8	7.4			61.8	52.4			
Test Hole #593	Pb RC	17.9	16.4	7.1	30.7	0.58	81.2	24.3	23.2	61.2	7.7
Yellow Low Grade	Pb SC	3.2	5.0	9.7	31.4	0.28	4.4	5.9	4.2	5.3	
Standard Test	Zn RC	20.2	0.47	15.9	34.2	0.12	2.5	61.4	29.2	14.1	10.6*
	Zn SC	12.3	0.66	2.25	41.1	0.11	2.2	5.4	21.4	8.2	
	Zn ST	46.4	0.76	0.35	11.2	0.04	9.7	3.1	22.0	11.2	
	CH		3.62	5.23	23.67	0.17					
	Comb. Concs.		14.7	10.7			85.6	66.8			
Test Hole #589	Pb RC	6.7	24.3	9.1	24.8	1.78	55.8	14.8	5.5	53.8	7.2
Yellow Low Grade	Pb SC	7.2	4.8	8.5	36.1	0.38	12.0	14.8	8.7	12.2	
Standard Test	Zn RC	22.3	0.80	10.7	37.7	0.12	6.2	57.9	28.1	12.2	10.7*
	Zn SC	17.2	0.69	1.39	44.3	0.09	4.1	5.8	25.4	6.8	
	Zn ST	46.7	1.38	0.61	20.7	0.07	21.9	6.8	32.3	14.9	
	CH		2.92	4.13	29.96	0.22					
	Comb. Concs.		14.2	6.7			67.8	63.7			
Test Hole #585	Pb RC	8.0	19.6	10.9	24.7	1.11	56.9	24.7	8.9	55.3	7.6
Yellow Low Grade	Pb SC	4.4	5.0	13.2	31.1	0.36	8.0	16.5	6.1	9.9	
Standard Test	Zn RC	20.7	1.31	8.5	38.5	0.12	9.8	50.0	35.6	15.5	10.6*
	Zn SC	9.4	0.79	1.15	42.9	0.09	2.5	3.1	18.0	5.0	
	Zn ST	57.5	1.1	0.35	12.2	0.04	22.8	5.7	31.4	14.3	
	CH		2.76	3.52	22.37	0.16					
	Comb. Concs.		14.4	6.2			64.9	53.1			
Test Hole #594	Pb RC	8.4	18.4	8.7	27.0	0.99	57.0	17.3	11.4	59.3	7.6
Yellow Low Grade	Pb SC	2.4	6.6	12.8	27.3	0.28	5.9	7.3	3.3	5.0	
Standard Test	Zn RC	14.9	1.66	18.49	29.5	0.14	9.2	65.2	22.1	15.0	10.5*
	Zn SC	11.6	0.97	1.7	41.4	0.09	4.0	4.7	24.1	7.1	
	Zn ST	62.7	1.03	0.36	12.4	0.03	23.9	5.4	39.0	13.6	
	CH		2.72	4.23	19.90	0.14					
	Comb. Concs.		15.8	11.2			62.9	69.9			* Extra CaO

APPENDIX I (CONTINUED)

INDIVIDUAL TEST RESULTS - YELLOW LOW GRADE

Test	Products	Wt. %	Grade %				Recovery %				pH	
			Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu		
Test Hole #596	Pb RC	8.6	35.5	9.1	18.9	0.78	67.9	11.8	4.8	45.6	8.6	
Na <sub>2</sub> CO <sub>3</sub>	7.0#	Pb SC	1.9	10.8	11.3	27.9	0.46	4.7	3.2	1.6	6.1	
Na <sub>2</sub> SO <sub>3</sub>	2.5#	Zn RC	11.1	1.68	46.8	12.4	0.24	4.2	78.3	4.1	18.4	9.3
NaCN	0.15#	Zn SC	2.1	4.5	1.4	29.3	0.30	2.0	0.5	1.8	4.1	
		Zn ST	76.3	1.24	0.55	38.6	0.05	21.2	6.3	87.6	25.9	
		CH		4.49	6.63	33.61	0.15					
		Comb. Concs.		31.0	39.5			72.6	78.8			
Test Hole #597	Pb RC	4.3	33.6	15.0	14.7	1.61	31.0	9.2	1.8	52.3	8.7	
Na <sub>2</sub> CO <sub>3</sub>	7.0#	Pb SC	4.2	39.9	12.5	14.7	0.15	36.1	7.5	1.8	4.5	
Na <sub>2</sub> SO <sub>3</sub>	2.5#	Zn RC	10.8	2.6	48.3	11.5	0.19	6.0	73.6	3.6	15.9	9.3
NaCN	0	Zn SC	3.2	7.3	10.0	30.8	0.16	4.9	4.5	2.9	3.8	
		Zn ST	77.5	1.31	0.48	39.6	0.04	21.9	5.2	89.8	23.5	
		CH		4.65	7.09	34.17	0.13					
		Comb. Concs.		36.7	39.6			67.1	78.1			

INDIVIDUAL TEST RESULTS - STOCKPILE COMPOSITE

Na <sub>2</sub> CO <sub>3</sub>	- 12#	Pb RC	6.2	30.3	9.2	20.4	1.06	62.0	11.4	4.2	52.4	8.1
NaCN	- 0.15#	Pb SC	2.6	9.0	9.9	32.2	0.46	7.6	5.2	2.8	9.5	
		Zn RC	19.2	1.12	19.5	32.8	0.19	7.3	74.8	21.0	28.6	9.2
		Zn SC	8.4	0.67	1.24	43.6	0.07	2.0	2.0	12.2	4.8	
		Zn ST	63.6	1.01	0.52	28.3	0.01	21.1	6.6	59.9	4.8	
		CH		3.03	5.00	30.06	0.13					
		Comb. Concs.		24.0	13.9			69.6	76.8			
Na <sub>2</sub> CO <sub>3</sub>	- 6.0#	Pb RC	5.6	26.9	10.0	25.4	1.32	50.2	11.2	4.6	57.4	7.9
Na <sub>2</sub> SO <sub>3</sub>	- 1.5#	Pb SC	3.2	14.3	10.8	29.1	0.33	15.3	7.0	3.0	8.5	
		Zn RC	11.7	2.6	28.6	24.5	0.23	10.0	67.1	9.4	20.9	9.2
		Zn SC	12.2	1.2	3.2	41.0	0.08	5.0	7.8	16.4	7.8	
		Zn ST	67.3	0.83	0.51	30.2	0.01	19.6	6.8	66.5	5.4	
		CH		3.01	4.99	30.54	0.13					
		Comb. Concs.		22.4	15.6			65.5	74.9			

APPENDIX I (CONTINUED)

INDIVIDUAL TEST RESULTS - STOCKPILE COMPOSITE

Test	Products	Wt. %	Grade %				Recovery %				pH
			Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu	
Na <sub>2</sub> CO <sub>3</sub> - 6.0%	Pb RC	5.3	32.1	10.7	20.4	1.36	57.8	11.5	3.5	61.0	8.3
Na <sub>2</sub> SO <sub>3</sub> - 2.5%	Pb SC	2.2	15.5	11.5	27.1	0.30	11.6	5.0	1.9	5.9	
NaCN - 0.15%	Zn RC	8.9	2.04	37.9	18.9	0.28	6.1	67.9	5.4	21.2	9.0
	Zn SC	9.2	1.62	4.7	40.4	0.11	5.1	8.7	11.9	8.5	
	Zn ST	74.4	0.77	0.46	32.4	Tr.	19.4	6.9	77.3	3.4	
	CH		2.94	4.95	31.18	0.12					
	Comb. Concs.		27.2	21.0			69.4	76.6			
Na <sub>2</sub> CO <sub>3</sub> - 10.0%	Pb RC	5.6	28.9	13.4	19.6	1.33	56.1	15.1	3.6	61.7	8.7
ZnSO <sub>4</sub> - 2.0%	Pb SC	2.5	15.1	13.2	26.0	0.31	13.1	6.7	2.2	6.7	
Na <sub>2</sub> SO <sub>3</sub> - 1.5%	Zn RC	9.5	2.0	35.1	19.9	0.25	6.6	67.1	6.3	20.0	8.9
NaCN	Zn SC	12.0	1.3	1.9	42.2	0.08	5.5	4.6	16.8	8.3	
	Zn ST	70.4	0.77	0.46	30.5	Tr.	18.7	6.5	71.2	3.3	
	CH		2.89	4.96	30.17	0.12					
	Comb. Concs.		24.7	16.6			69.2	71.7			
Na <sub>2</sub> CO <sub>3</sub> - 10.0%	Pb RC	8.7	20.6	9.8	27.3	0.86	62.2	16.7	7.7	55.6	8.2
ZnSO <sub>4</sub> - 2.0%	Pb SC	4.4	5.8	8.9	36.1	0.28	9.0	7.6	5.1	8.9	
NaCN - 0.15%	Zn RC	18.7	1.05	17.8	32.6	0.16	6.9	65.3	19.7	22.2	8.7
	Zn SC	23.4	0.56	1.25	42.8	0.07	4.5	5.7	32.4	11.9	
	Zn ST	44.8	1.11	0.54	24.2	Tr.	17.4	4.7	35.0	1.5	
	CH		2.88	5.10	30.93	0.13					
	Comb. Concs.		15.6	8.6			71.2	71.0			
Na <sub>2</sub> CO <sub>3</sub> - 6.0%	Pb RC	10.2	18.1	8.7	30.8	0.89	62.3	17.4	10.4	63.6	6.8
ZnSO <sub>4</sub> - 0.5%	Pb SC	9.2	3.1	7.6	38.5	0.13	9.8	13.7	11.7	8.4	
NaCN - 0.15%	Zn RC	20.5	0.86	14.6	34.8	0.08	6.1	58.5	23.6	11.2	8.5
	Zn SC	16.6	0.42	1.58	43.0	0.04	2.4	5.1	23.6	4.9	
	Zn ST	43.5	1.34	0.62	21.4	0.04	19.5	5.3	30.8	11.9	
	CH		2.97	5.11	30.26	0.14					
	Comb. Concs.		11.0	8.8			72.1	63.6			
Na <sub>2</sub> CO <sub>3</sub> - 6.0%	Pb RC	6.4	22.7	10.9	26.6	1.30	47.5	14.3	5.5	58.5	6.8
Na <sub>2</sub> S - 0.5%	Pb SC	2.7	18.8	11.1	23.1	0.29	16.7	6.1	2.0	5.6	
NaCN - 0.15%	Zn RC	2.8	7.9	27.4	19.6	0.27	7.2	15.7	1.8	5.6	8.5
	Zn SC	5.1	4.1	24.2	24.1	0.20	6.9	25.1	4.0	7.0	
	Zn ST	83.0	0.79	2.3	32.1	0.04	21.6	38.9	86.7	23.2	
	CH		3.05	4.91	30.74	0.14					
	Comb. Concs.		21.5	25.3			64.2	40.8			

APPENDIX I (CONTINUED)

INDIVIDUAL TEST RESULTS - STOCKPILE COMPOSITE

Test	Products	Wt. %	Grade %				Recovery %				pH
			Pb	Zn	Fe	Cu	Pb	Zn	Fe	Cu	
CaO - 2.5%	Pb RC	4.5	37.8	7.3	19.9	0.80	54.8	6.7	2.9	25.9	7.5
NaCN - 0.15%	Pb SC	2.2	17.8	10.2	26.6	0.50	12.6	4.5	1.9	7.9	
	Zn RC	9.1	2.7	41.0	15.2	0.38	8.1	75.5	4.4	25.2	10.0
	Zn SC	2.9	3.6	10.2	29.7	0.29	3.2	6.1	2.7	5.8	
	Zn ST	81.4	0.81	0.44	33.9	0.06	21.3	7.3	88.1	35.3	
	CH		3.10	4.94	31.32	0.14					
	Comb. Concs.		31.2	33.6			67.4	81.6			
CaO - 5.0%	Pb RC	2.3	44.5	6.8	13.0	0.72	33.6	3.2	1.0	11.9	10.0
NaCN - 0.15%	Pb SC	1.8	34.5	9.5	13.8	0.33	20.4	3.4	0.8	4.2	
	Zn RC	7.0	5.8	42.8	12.4	0.42	13.5	60.2	2.8	20.3	10.7
	Zn SC	2.5	4.85	32.0	16.8	0.53	3.9	16.1	1.4	9.1	
	Zn ST	86.4	1.01	0.98	33.5	0.09	28.6	17.1	94.0	54.5	
	CH		3.04	4.98	30.78	0.14					
	Comb. Concs.		40.0	40.0			54.0	76.3			
Na <sub>2</sub> CO <sub>3</sub> - 3.5%	Pb RC	2.9	50.7	7.1	11.1	0.45	48.7	4.2	1.1	9.7	9.9
CaO - 5.0%	Pb SC	1.5	21.8	10.4	22.4	0.48	10.9	3.2	1.1	5.2	
NaCN - 0.15%	Zn RC	7.2	3.3	46.8	11.6	0.40	7.9	67.4	2.8	21.6	10.9
	Zn SC	3.3	5.0	22.8	21.7	0.50	5.6	15.0	2.4	12.7	
	Zn ST	85.0	0.95	0.60	33.1	0.08	26.8	10.2	92.7	50.7	
	CH		3.02	5.00	30.36	0.13					
	Comb. Concs.		40.9	39.2			59.6	82.4			