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REPORT

PREFEASIBILTY STUDY

CHILE SULFUR PROJECT

Prepared for

MINERALS EXPLORATION CORPORATION
OF THE AMERICAS

Parsons Job No. 6905-01
November 15,1988

PARSONS

DEF-500079

PARSONS OVERSEAS COMPANY *Worldwide Engineers/Constructors*

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November 16, 1988

Minerals Exploration Corporation
of the Americas
Post Office Box 8511
La Jolla, California 92038

Attention: Mr. E. A. Tovrea, Jr., President

Subject: Job No. 5905-1 - Chile Sulfur Study
Transmittal of Report
Letter No. PM-6

Gentlemen:

Parsons is pleased to present 15 copies of our Prefeasibility Study Report for a 500,000 mtpy sulfur plant in northern Chile. We believe the work presented conforms with the scope of work as defined in the Agreement.

Please be assured that we stand ready to answer any questions you may have relating to this submittal. It is a most interesting project and we would welcome the opportunity of working with you on the next phases.

Very truly yours,

John W. Ekman
Project Manager

cc Mr. Hal Gardner - w/2 copies
Mr. Hugh Wynne, Jr. - w/1 copy
Mr. C. Vander Werff - w/1 copy
Mr. Fred Schultz - w/1 copy

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SECTION 1

INTRODUCTION

Subsequent to discussions during meetings held in Pasadena in the last quarter of 1987, Minerals Exploration Corporation of the Americas (MECA) awarded Parsons a contract to perform a prefeasibility study in connection with their sulfur deposit claims in northern Chile. The agreement became effective on February 3, 1988.

The scope of work to be provided by Parsons included: study management, geological supervision and interpretation of field work (by others), preliminary ore reserve estimate, development of a conceptual mine plan and pit design, mine equipment requirements and costs, mine operating cost estimate, review of metallurgical testwork, development of preliminary flowsheets and material balances, plant equipment selection and cost, plant operating costs, a capital cost estimate and an economic analysis. All of the above to be presented in a final study report.

1.1 STUDY WORK PLAN

The study involved three main phases:

- o Site visit to MECA's sulfur properties.
- o Trenching, sampling and testwork of selected claim areas (by others)
- o Pasadena office engineering and cost estimating effort

The purpose of the site visit was to select the area where the claims appeared to be most promising from a geological standpoint and also one which was reasonably accessible so the trenching and sampling work could be accomplished prior to the harsh conditions that normally exist in the high Andes during the winter months.

A trenching and sampling program was agreed upon during the site visit and work was carried out by a Chilean contractor, a Chilean geologist and MECA supervision. Samples were sent to the Intec-Chile laboratory in Santiago for assaying.

Based on the Intec report, the geological report, as well as several other reports prepared or obtained by MECA, Parsons began work on the development of the scope items noted above.

1.2 STUDY REPORT

In the following sections we have endeavored to explain the bases for our work, the assumptions we made and our concerns for some of these assumptions.

We believe that the methods we used in establishing the ore reserves and ore grade and the subsequent related processes for treating the ore are all professionally sound and acceptable for a prefeasibility study. We are, however, the first to suggest that a more refined study can be provided with further field and laboratory testing.

SECTION 2

EXECUTIVE SUMMARY

This study was undertaken as the first phase of a program to determine the feasibility of developing the MECA sulfur claims in northern Chile. The proposed plant is planned to produce 500,000 MTPY of 99.5% pure sulfur in prill or slate form.

2.1 STUDY BASIS

Based on a minimum amount of geological field work, sampling and assaying, this study considers developing two of the claims which together have minable reserves of 25,317,000 tonnes of 31.2% grade sulfur. The life of the two pits is approximately 11.4 years based on a crusher feed of 8200 tonnes per day.

Conceptual flow sheets and material balances were developed utilizing the above data. From that information, an equipment list including equipment sizes was prepared and used in obtaining budget quotations from vendors.

The base case considers the crushing, screening and grinding facilities located adjacent to the mine with the ground ore slurry piped 89 kilometers to Montandon. The flotation and refinery portion of the plant is located at the pipeline discharge adjacent to existing rail facilities. An alternate case consisting of a flotation plant located near the grinding facility and sulfur concentrate piped to Montandon for refining, is discussed separately in Section 13.

As noted in the following sections, a considerable number of process assumptions were made in developing the flowsheets and material balances. These assumptions will have to be confirmed with additional test work in the next study phase. The results of this additional test work may have considerable effect on the method of processing the ore as well as on the capital and operating costs.

2.2 CAPITAL COSTS

The capital costs for this study are preliminary, but are estimated to be within +/- 25% of final constructed plant cost unless future test work shows major changes in the process are warranted.

Direct and Indirect Costs	107,553,000
Home Office Engineering, Procurement, and Project Management	10,000,000
	117,553,000
Contingency	17,633,000
Base Case Total	$ 135,186,000

It is estimated that the alternate case will reduce the total plant cost by approximately $10,000.000.

2.3 OPERATING COSTS

The operating costs for this study are also preliminary, due to the many assumptions which were made, but they should be well within the acceptable accuracy range expected for a prefeasibility study.

Mine Operating Cost	$ 0.83/ton of ore mined
Total operating cost	$32.33/ton of sulfur produced

2.4 FINANCIAL ANALYSIS

Based on the capital and operating costs as well as certain financing, taxation and sulfur market price assumptions, a financial analysis was made. Sensitivity to changes in the capital and operating costs and sulfur prices were tested to determine the effect that such changes would have on the Internal Rate of Return and Net Present Value of Return on Investment. For the base case these figures are 19.2% and $24,783,000 respectively. The project is greatly sensitive to variations in market price as can be seen in the tables in Section 11.

2.5 CONCLUSIONS

Based on the results of this study, the project appears to be economically viable. It certainly provides sufficient incentive to proceed with a more in-depth feasibility study.

In proceeding with such a study, several items need further investigation, items which are in addition to the test work already noted above and later in the report. These items should include, but are not limited to, the following:

- o A complete geological program of all claims, to establish a more accurate estimate of ore reserves and grade.
- o Establish a known market for the product including base prices and purchase contract terms.
- o Confirm the availability and condition of used bottom dump rail cars.
- o Investigate the availability of Chilectra power in the vicinity of Montandon.

- o Confirm the availability and suitability of water at Montandon and Lagunas Bravas.
- o Ground survey of proposed plantsite areas and a profile of the pipeline route.

Needless to say, with the clarification of the above items and the additional test work, the feasibility study would provide MECA and any financing organization with a much greater degree of confidence to proceed with the project.

SECTION 3

GEOLOGY AND ORE RESERVES

This section covers the geological portion of the study and includes discussions on our site visit, geological description of the deposits, the MECA field work and ore reserve estimates by both MECA and Parsons.

3.1 PARSONS SITE VISIT

In the latter part of March, 1988 Parsons engineers R. Freire and R. Skiles made a trip to Chile for the MECA sulfur project. The objectives of the trip were 1) to visit MECA's Santiago office and receive a briefing on the photo interpretation work being done by geologist Carlos Ulricksen; 2) visit a number of sulfur prospects identified by the photo interpretation work, and 3) make recommendations for a field program to provide data for a pre-feasibility study of a sulfur mining, beneficiation, and shipping operation based on one of MECA's sulfur properties.

The field visits related to 2) above included:

- The Coipa district in the Province of Chanaral where MECA holds several claim groups.
- Volcan de Copiapo, where the relationship of hydrothermal alteration and bleaching to underlying sulfur mantas at a partly developed sulfur property were observed.
- A number of volcanic complexes with sulfur potential (identified by photo interpretation) in the Cordillera Claudio Gay where MECA has several claim groups.
- A number of MECA sulfur properties including the Piedra Amarilla claims north of Lagunas del Jilguero.

At the conclusion of the above field trips, MECA and Parsons met to determine what could be done in the little remaining time before the onset of winter to develop data at one of the sulfur properties so that it could be used as a model for the pre-feasibility study. The decision was made to concentrate all field work for the remainder of the season on the Piedra Amarilla claims because of the large areas of hydrothermal alteration and sulfur indications there and also because of the relatively good access to this property.

Parsons recommended that trenching and sampling be done in the most accessible altered and bleached zones and that a 1:10,000 scale geologic map be prepared showing trenches and sample points. Since it was too late in the season to set up a drilling program, it was conceded that geologic inference would have to provide the estimate for the thickness of mineralization in favorable trenched and/or sampled areas.

3.2 GEOLOGIC DESCRIPTION OF DEPOSITS

3.2.1 REGIONAL SETTING

The Central Andes volcano-plutonic orogen is constructed on a consuming plate margin between the American plate and the Nazca plate. Inactive and active fumarolic volcanos lie along the westernmost margin of the Cordillera, many containing important native sulfur and other mineral deposits. It is within this region that the study area is situated.

3.2.2 STUDY AREA

The area studied by Carlos Ulricksen is located in the high Andes near the border with Argentina between Lat. 26 deg 18 min and 26 deg 22 min S; Long. 68 deg 37 min and 68 deg 42 min W. The area covers 56 km^2, located in Chile's 3rd region. The Lagunas Bravas topographic map (scale 1:50,000) covers the study area. The nearest town, El Salvador, is about 90 km west of the study area. The regions principal city, Copiapo, is located some 200 km southwest of the study area. Access from El Salvador is by gravel road south and east to La Ola and thence northeast by 4-wheel drive dirt tracks..

The general morphology is typical of recent volcanic processes - occasional extinguished volcanic cones, widespread ash flow tuffs and pyroclastics, and extensive lava flows filling depressions. The study area is located 9 km from the Argentine border. The topography has great differences in elevation that are typical of volcanic land forms. Volcanic cones in the area show varying degrees of erosion, from symmetrical cones to deeply eroded complexes with only a remnant of the original cone. The highest peak in the study area is Lagunas Bravas volcano at 5,315 meters above sea level. The Piedra Amarilla properties range in altitude from 4,420 meters to 4,700 meters above sea level.

3.2.3 CHARACTERISTICS OF DEPOSITION

A simple descriptive model for understanding the formation of a volcanic sulfur deposit would begin with an andesite lava extrusion and the formation of an explosive vent and the building of a cone. The ejected, pyroclastics, tuff and ash from the cone form a blanket down the flanks of the cone; later the cone plugs off and pressures build inside the vent. Radial cracks and subsidence occurs and sulfur containing gasses burst through permeable cracks and are reduced to native sulfur-cementing the porous ash. Silicates in ash are altered to clay minerals. Volcanic glass shards (mainly cristobalite) are intimately associated with the finely crystallized native sulfur.

A more complicated model would be a large erupting cone that plugs off the throat with a build-up of gas causing an explosion and the formation of a caldera. New cones form in the bottom of the caldera and coalesce destroying previous structures and possibly reworking and concentrating native sulfur. This type of model is indicated by Ulricksen's work which postulates a complex series of superimposed volcanic episodes dating from miocene age to the present at Piedra Amarilla.

The process of hydrothermal alteration of the porous ash and tuff produces the bleaching in the vicinity of the deposits which is very characteristic. Ulricksen's photo interpretation of the Piedra Amarilla area shows relict volcanic structures and the attendant bleaching and "caliche" outcrops (See Figure 3-1). The term caliche has been in use for some time in Chile to describe the native sulfur cemented volcanic ash. A 1974 edition of World Survey of Sulfur states "the new acid plant (Chuquicamata) uses the sulfur ore known as caliche as a feedstock." The same article refers to two operating mines in Antofagasto Province - "also produce caliche, a sulfur ore containing about 45% sulfur---consumed in the sulfuric acid plant."

Leaching of the caliche mantos is indicated by the trenching experience at Piedra Amarilla where pale bleached caliche gives way in a meter or so of depth to more yellowish sulfur bearing material. This phenomenon was also observed by Parsons engineers at Volcan de Copiapo where two adits cut into a massive sulfur manto which is essentially white on the leached surface but then changes to bright yellow sulfur within a meter or so of the surface.

3.3 TRENCHING AND SAMPLING

Following Parsons visit, MECA moved a Fiat-Allis 21-B bulldozer equipped with a back ripper to the Piedra Amarilla property and prepared access to the claims. A heavy snowfall (10 inches) on May 10th shut down operations temporarily. Thawing in late May and early June was followed by a period of deep polar cold (-30° C) which froze the moisture laden surface and made the dozer ineffective.

The field work that was accomplished fell short of what had been planned by MECA and Parsons, but some trenching was done and samples taken. Little progress was made in the field geology program because of the severe weather conditions.

In September MECA gave Parsons a report outlining the above field work and an ore reserve estimate. Following is a discussion on this field work.

Figure 3-1 shows the locations of the trenching and sampling areas described below. Table 3-1 tabulates the areas referred to in MECA's report and the corresponding ore reserve areas selected by Parsons.

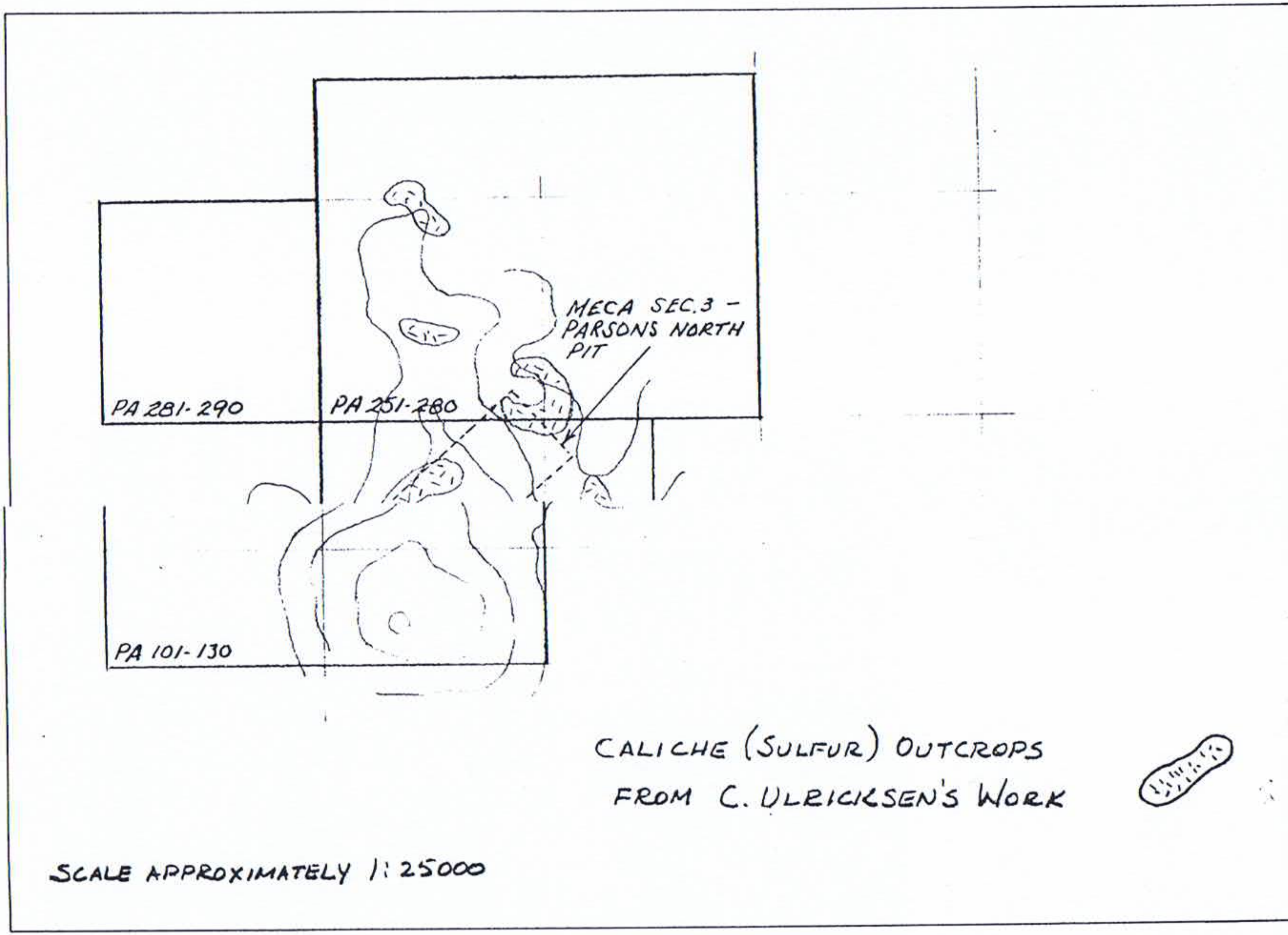


Figure 3-1 - Location of Sulfur Reserve Areas on Piedra Amarillo Claim Groups

TABLE 3-1 - Ore Reserve Estimates

MECA Estimate

CLAIM	EXPLOR-ATION SECTION	EXPLOR-ATION SECTION AREA	LENGTH METERS	WIDTH METERS	THICKNESS METERS	TONNES	AVE. GRADE % SULFUR
PA-161	1	1, 2	400	340	13	3,536,000	18.71
PA-161	1	3	240	160	15	1,152,000	12.85
PA-161	1	4, 5	360	260	6	1,123,000	7.28
PA-131	2	1	550	190	75	15,675,000	30.90
PA-121	3	-	900	200	15	5,400,000	35.17
PARSONS Estimate							
So. Pit*	2	1	700	400	22	13,552,000	30.90
No. Pit*	3	-	800	400	15	10,560,000	35.17

* South Pit corresponds to PA-131, 2, 1 and North Pit corresponds to PA-221,3. Parsons estimated reserves are classified as "Inferred".

3.3.1 SECTION 1, AREAS 1 AND 2

This is located in the southeast corner of Piedra Amarilla claim group PA 161-190 and partly in the northeast corner of PA 131-160. It is an area of strong, hydrothermal alteration and bleaching. A 75 meter north trending trench was bulldozed in Area 1 and three large samples taken along the length of the trench (samples 161-1A, 161-1B, 161-1C). Two shorter cuts were made at right angles to this trench at its northern end and seven vertical samples were taken along an approximately 20 meter zone east of the main trench (samples Zona Plata 1 and Zona Plata 2 at the intersection of the NS and EW trenches, and samples 161-1B1, 161-1B2, 161-1B3, 161-1B4, 161-1B5 to the east).

In Area 2, which is about 200 meters to the southwest of Area 1, an 80 meter long dozer cut was made in a north trending direction and a cross cut about 50 meters long was made at the south end of the first cut. Two samples were taken from the bottom of the north trending cut (samples 161-2A, 161-2B).

3.3.2 SECTION 1, AREA 3

This is a continuation of the hydrothermally altered and bleached zone of Area 1 and 2. A 70 meter north-south cut was made to a depth of about 130 cm and four vertical samples taken in the central part of the trench (samples 161-3A, 3B, 3C, 3D).

3.3.3 SECTION 1, AREAS 4 AND 5

Areas 4 and 5 are approximately 600 meters west of Area 2 above and are still in the hydrothermally altered and bleached zone. Two trenches were cut here: a north-south trench about 80 meters long and 220 cm deep and an east-west trench about 50 meters long and 50 cm deep. Five vertical samples were cut in the former trench (2A, 2B, 2C, 2D, 2E) and four (3A-3B-3C-3D) in the latter.

3.3.4 SECTION 2, AREA 1

This area is in the central part of PA 131-160 on the east flank of a caldera having numerous native sulfur and caliche outcrops. A northwest trending trench approximately 100 meters long was cut along the upper slope of the crater rim and four samples were taken (131-1A, 131-1B, 131-1C, 131-1D).

3.3.5 SECTION 3, AREA 1

This is in the north-central part of PA 221 in a hydrothermally altered and bleached zone containing numerous caliche (sulfur) outcrops. Large samples were taken from three outcrops along an approximately 1000 meter zone. (Samples 221-1, 221-2, 221-3C).

3.4 <u>MECA ORE RESERVE ESTIMATE</u>

3.4.1 SECTION 1, AREAS 1 AND 2

Indicated reserves totaled 3,536,000 tonnes of ore with an average grade of 18.71% in an area 400 meters x 340 meters x 13 meters thick.

3.4.2 SECTION 1, AREA 3

Indicated reserves totaled 1,152,000 tonnes of ore with an average grade of 12.85% in an area 240 meters x 160 meters x 6 meters thick.

3.4.3 SECTION 1, AREA 4 AND 5

Indicated reserves totaled 1,123,000 tonnes of ore with an average grade of 7.28% in an area 360 meters x 260 meters x 6 meters thick.

3.4.4 SECTION 2, AREA 1

Indicated reserves totaled 15,675,000 tonnes of ore with an average grade of 30.9% in an area 550 meters x 190 meters x 75 meters thick.

3.4.5 SECTION 3, AREA 1

Indicated reserves totaled 5,400,000 tonnes of ore with an average grade of 35.7% in an area 900 meters x 200 meters x 15 meters thick.

3.5 PARSONS ORE RESERVE ESTIMATE

3.5.1 COMMENTS

Substantial field work remains to be done on the Piedra Amarilla sulfur properties. MECA's classification of "indicated" (U.S.G.S. classification) is acceptable for a reasonable projection from sample points, especially with the strong geologic evidence, but some projections, especially the 75 meter thickness in Section 3.4.4 above, do not seem to warrant the "indicated" classification, even though the caldera slope does expose a considerable vertical thickness of sulfur mineralization. Using the same data, Parsons has increased MECA's areal projections in two areas (see below), but classifies these tonnages as "inferred" (U.S.G.S. classification). The mining study in Section 4.0 of this report is based on this "inferred" ore only.

3.5.2 PARSONS SOUTH PIT AREA

MECA's Section 2, Area 1 block is given an inferred ore reserve estimate of 13,552,000 tonnes of ore with an average grade of 30.9% and an area 400 meters x 700 meters x 22 meters thick.

3.5.3 PARSONS NORTH PIT

MECA's Section 3, Area 1 block is given an inferred ore reserve estimate of 10,560,000 tonnes of ore with an average grade of 35.17% and an area 800 meters x 400 meters x 15 meters thick.

3.5.4 TONNAGE FACTOR

MECA used a tonnage factor of 2.0 tonnes per cubic meter of one in place. Parsons feels that a factor of 2.2 tonnes per cubic meter is reasonable and have used this factor in recalculating the estimated reserves in 3.5.2 and 3.5.3 above.

3.6 OVERBURDEN

This study assumes that the minable sulfur bodies will lie nearly parallel to the present land form surfaces in the bleached, hydrothermally altered areas. For the south pit overburden is estimated to be from 2 to 3 meters thick and that covering the north pit is estimated to average 2 meters in thickness.

SECTION 4

MINING

This section covers the mining aspects of the study and is based on the findings in Section 3. It includes discussions on minable reserves, cutoff grade, pit design, mining plan, preproduction work, equipment selection and manpower requirements.

4.1 MINABLE RESERVES

4.1.1 GENERAL

The property has not been explored and developed to the point where the grade of ore blocks can be predicted. Scattered trench and outcrop sample results vary from a few percent sulfur to over 90 percent sulfur. Given this situation, the critical factors in determining the break-even cutoff grade (unit costs, commodity price and minimum profit) were not considered in this study.

4.1.2 CUTOFF GRADE

A 20 percent sulfur cutoff grade has been assumed (See Table 4-1, Case C), based largely on the fact that ore with a percentage of sulfur lower than 20 percent will not respond well to the beneficiation process being considered.

Of the areas sampled by MECA, the two with indicated grades well above the 20 percent cutoff (Section 2, Area 1 in PA 131-160 and Section 3 in PA 251-280) were selected for the mine study. Section 2 is referred to as Parsons South Pit and Section 3 as Parsons North Pit.

4.1.3 PIT DESIGN

The design uses the same rectangular outlines (see Figure 3-1), as used for the geological ore reserve estimate which are 400 m x 700 m x 22 m thick for the South Pit and 800 m x 400 m x 15 m thick for the North Pit, and assumes comparatively shallow and flat-lying ore bodies.

Using a front-end loader, CA 992C*, as the loading equipment with its 8.5 meter height of maximum bucket (teeth) lift, the pits will be 2 benches deep for the North Pit and 3 benches deep for the South Pit with an 8 meter bench height. Pit slopes are not an important element for the pit designs because the pits are shallow and are bottomed out as mining progresses.

*Specific equipment noted herein was used for calculation purposes only and is not intended as an endorsement of those vendors.

TABLE 4-1 Ore Reserves

	Geological Reserves		Mineable Reserves	
	Tonnes	% S	Tonnes	% S
CASE A. (Entire Properties)				
Sec. 1, Area 1, 2	3,356,000	18.71	3,712,800	17.82
Sec. 1, Area 3	1,152,000	12.85	1,209,600	12.24
Sec. 1, Area 4, 5	1,123,000	7.28	1,179,200	6.93
Parsons South Pit	13,552,000	30.90	14,229,600	29.43
Parsons North Pit	10,560,000	35.17	11,088,000	33.50
	29,923,000	29.39	31,419,200	27.99
CASE B (Cutoff grade 15% S)				
Sec. 1, Area 1, 2	3,536,000	18.71	3,712,800	17.82
Parsons South Pit	13,552,000	30.90	14,229,600	29.43
Parsons North Pit	10,560,000	35.17	11,088,000	33.50
	27,648,000	30.57	29,030,400	29.50
CASE C (Cutoff Grade 20% S)				
Parsons South Pit	13,552,000	30.90	14,229,600	29.43
Parsons North Pit	10,560,000	35.17	11,088,000	33.50
	24,112,000	32.77	25,317,600	31.21

The remaining pit design parameters are:

Face Slope	1/2:1
Haul Road Width	20 meters
Haul Road Grade	Max. 10%
Ore Density	2.2 tonnes/m^3
Overburden Density	2.8 tonnes/m^3

4.1.4 TABULATION OF MINABLE RESERVES

The minable reserves shown in Table 4-2 are given in 10m increments. Our calculations considered a dilution factor of 5% which increases the tonnage to be mined, but dilutes the average grade relative to the grade of the geological reserves.

TABLE 4-2 Mineable Reserve

	Ore Tonnes		Overburden (Tonnes)	
Elevation	North Pit	South Pit	North Pit	South Pit
4760		532,400		85,800
50		871,200		140,400
40		1,089,000		175,500
30		822,800		132,600
20	272,250	726,000	46,200	117,000
10	264,000	726,000	44,800	117,000
4700	346,500	726,000	58,800	117,000
4690	528,000	689,700	89,600	79,800
80	643,500	665,500	109,200	77,000
70	767,250	641,300	130,200	74,200
60	1,031,250	617,100	175,000	71,400
50	1,311,750	762,300	222,600	88,200
40	948,750	980,100	161,000	113,400
30	618,750	883,300	105,000	102,200
20	536,250	447,700	91,000	51,800
10	536,250	471,900	91,000	54,600
4600	462,000	496,100	78,400	57,400
4590	618,750	689,700	105,000	79,800
80	618,750	435,600	105,000	50,400
70	759,000	278,300	128,800	32,200
4560	297,000		50,400	
Total	10,560,000	13,552,000	1,792,000	1,817,700
%S	35.17	30.90		
Total w/5% dil.	11,088,000	14,229,600		
%S	33.50	29.43		
Total N & S Pits	25,317,000		3,609,000	
%S	31.21			

4.2 MINE PLAN

4.2.1 PREPRODUCTION

Preproduction work will be accomplished in the mild-weather season, one shift only per day. During this period, a 20 meter wide haul road will be constructed between the initial mining sites at the tops of the North and South pits and the feed bin at the plant site, completing preparations for the initial mining operations.

Haul road construction will consist of cutting the road beds and paving with gravel. The volumes for road construction are approximately as shown below:

Cut volume for North Pit haul road	163,000 tonnes
Cut volume for South Pit haul road	203,000 tonnes
Total volume for paving material	366,000 tonnes

The construction will take roughly 2 months on a one shift per day basis.

4.2.2 MINING

The mining operation for ore and overburden will consist of three main activities; ripping, loading and hauling. This study assumes that both caliche ore and overburden can be mined by ripping only without drilling and blasting. We believe this is possible because of the nature of the material and the shallow ore bodies. Handling of oversize material is not considered in this study; however, a further study on ripping or drilling/blasting operations applicable to this property is recommended. A tractor/ripper will do the job of ripping ground and dozing for loading assistance. A highly mobile wheel loader with a fleet of haul trucks will comprise the loading and hauling equipment.

The mining operations are initiated by stripping the tops of both pits and cutting downward by 8 meter increments. The mined-out areas and the area immediately outside the ore limits will be used as overburden dump sites. Because of the near-surface and relatively thin nature of the ore bodies assumed for this study, the haul distance to dump site and the amount of overburden stripped are of minor importance on this property.

4.2.3 HAUL ROAD

The principal factors considered in the haul road design were road width and road grade to optimize construction and operational economy and safety. Haul road width for two-way truck traffic is derived from the conventional estimate of four times the haul truck width. Because of some steep terrain in the area, a road grade of 10% was used, which is the practical maximum.

The haul roads from the North Pit and from the South Pit to the centrally located plant are shown on Figure 4-1.

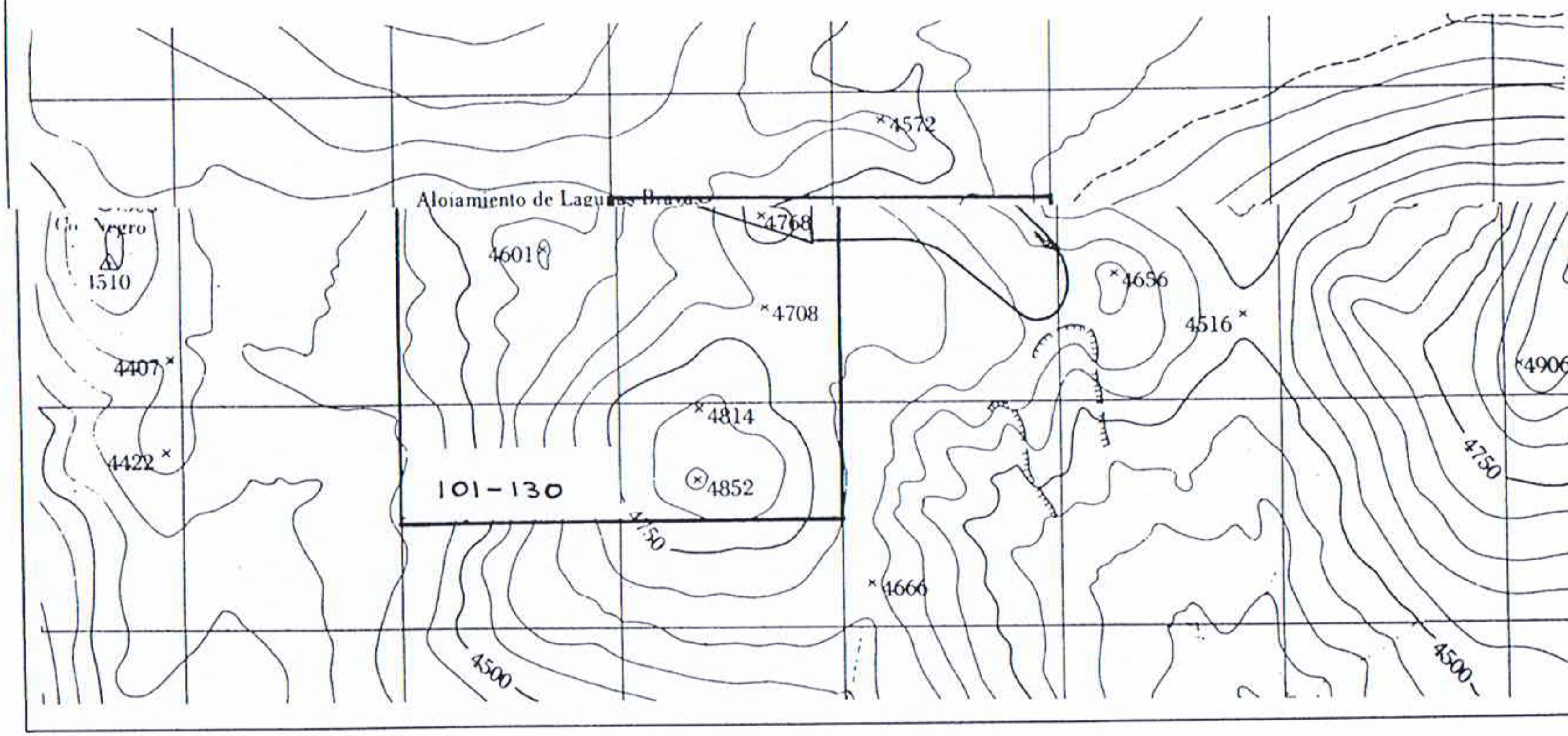


Figure 4-1 - Haul Roads

Table 4-3 shows the haulage road profiles and provides the basis for calculating haulage cycle times.

TABLE 4-3 Haul Road Profile

From the Top of the South Pit to the Bin Feed

Grade %	Distance (meters)	Elevation Diff. (meters)
8	750	4760 - 4700
10	1500	4700 - 4550
6	500	4550 - 4520
4	300	4520 - 4510
8	625	4510 - 4460
6	500	4460 - 4430
4	750	4430 - 4400
0	400	4400 - 4400 (B.F.)
	5325	

From the Top of the North Pit to the Bin Feed

Grade %	Distance (meters)	Elevation Diff. (meters)
10	100	4720 - 4710
8	1750	4710 - 4540
6	1200	4540 - 4470
4	500	4470 - 4450
8	625	4450 - 4400
0	1400	4400 - 4400 (B.F.)
	5570	

4.2.4 PRODUCTION SCHEDULE

The production level for this study was determined by the desired final product quantities. To produce 500,000 tonnes of sulfur per year, 8200 tonnes of ore with an average grade of 31.2% sulfur are required to feed the plant daily and 1340 tonnes/day of overburden must also be stripped.

The North and South Pits will operate concurrently and have the same production. Average grade at the North Pit is higher than at the South Pit by approximately 5 percent. For grade control of the plant feed, the study recommends that two separate stockpiles, one with run-of-mine ore from the North Pit and the other with run-of-mine ore from the South Pit, be established at the plant site. Ore from the two stockpiles will be reclaimed equally and blended into the feed bin to provide a constant grade for the feed stock to the plant.

The North Pit stockpile (higher grade) and the South Pit stockpile (lower grade) are maintained by scheduling the mining operations between the two pits as required. One tractor/ripper, one front-end loader, and a fleet of haul trucks comprise the major pieces of mining equipment and they are scheduled between the two pits as needed to maintain an adequate ore supply in both stockpiles.

4.3 EQUIPMENT SELECTION

4.3.1 RIPPING EQUIPMENT

The study assumes that stripping and mining can be done without drilling and blasting. It is expected that the equipment selected will be subjected to heavy usage and severe application of ripping capability in order to assure adequately broken ore for the loading machine. A Cat. D9 with ripper is recommended for this service and for haul road construction during the preproduction period.

4.3.2 LOADING EQUIPMENT

A front-end loader is selected as the loading equipment for handling the planned tonnages at the lowest unit and operating costs. Two basic elements are considered in sizing the loading equipment, 1) equipment production capacity, which includes availability, utilization and productivity, and 2) the effects of interaction between loader and haulage trucks on productivity.

Tables 4-4 and 4-5 show productivities of FEL CAT 992-B and FEL CAT 992 C with haulage trucks of three different sizes. The combination of FEL 988 B and haulage trucks 773 B is ideal in terms of productivity; however, the combination of FEL CAT 992 B and haulage trucks CAT 773 B is selected mainly because of the match between the truck loading height and the front-end loaders minimum clearance.

In selecting the proper FEL the following criteria was used.

-	Bucket capacity - FEL 992 C	9.5 m^3
-	Bucket capacity - FEL 988 B	5.0 m^3
-	Density in place - Ore	2.2 tonnes/m^3
	O.B.	2.8 tonnes/m^3
-	Swell Factor	67.0 %
-	Bucket Fillability	90.0%
-	Bucket Factor x .67 x .90	0.60
-	Average load per cycle - Ore	6.6 tonnes
	- O.B.	8.4 tonnes
-	Bucket load cycle time	30 sec.
-	Truck spot time	15 sec.
-	Operating Schedule	50 min/hr
		7.5 hrs/shift
		3.0 shifts/day
		270.0 days/yr

- Altitude deration 85.0%
- Mechanical availability 85.0%
- FEL Utilization 0.55
  (50/60 x 7.5/8 x .85 x .85 = 0.55)

TABLE 4-4 - Cat. 988B FEL Productivities

	769 C (31.8t)		773 B (45.4t)		777 B (77.1.t)	
	Ore	O.B.	Ore	O.B.	Ore	O.B.
Buckets per truck	5	4	7	6	12	10
Loading Time (sec)	165	135	225	195	375	315
Tonnes per shift	3,050	3,730	3,200	3,690	3,260	3,880
Tonnes per day	9,150	11,190	9,600	11,070	9,780	11,640
Tonnes per year	2,470,500	3,021,300	2,592,000	2,988,900	2,640,600	3,142,800
Loading height (empty)	3.22	3.22	3.69	3.69	4.14	4.14

988 B's min. clearance is 3.18

TABLE 4-5 - Cat. 992C FEL Productivities

	769 C (31.8t)		773 B (45.4t)		777 B (77.1.t)	
	Ore	O.B.	Ore	O.B.	Ore	O.B.
Buckets per truck	3	2	4	3	7	5
Loading Time (sec)	105	75	135	105	225	165
Tonnes per shift	4,800	6,720	5,330	6,850	5,430	7,400
Tonnes per day	14,400	20,160	15,990	20,550	16,290	22,200
onnes per year	3,888,000	5,443,200	4,317,300	5,548,500	4,398,300	5,994,000
Loading height (empty)	3.22	3.22	3.69	3.69	4.14	4.14

992 C's min. dump clearance is 4.47

4.3.3 HAULING EQUIPMENT

The main elements of the selection of haulage trucks, as with a front-end loader, are productivity and the effects of interaction between loaders and haulage trucks on productivity. The productivity of haulage trucks is dictated by the haulage truck cycle time. The haulage truck cycle times were computed using the Caterpillar Handbook. They are 30.5 minutes for the North Pit and 32.2 minutes for the South Pit. The total number of haulage trucks recommended is six units using 85% utilization.

Following are our calculations for determining number of trucks required.

- N. & S. pit mineable reserve ratio

N. Pit	11,088,000 tonnes	43.8%
S. Pit	14,229,600 tonnes	56.2%
	25,317,600	

- Yearly pit production by the ratio:

N. Pit	969,700 tonnes/yr	3590 tonnes/day
S. Pit	1,244,300 tonnes/yr	4610 tonnes/day
	2,214,000 tonnes/yr	8200 tonnes/day

- Weighted average haul cycle time

$$\frac{(3590 \times 32.2) + (4610 \times 30.5)}{8200} = 31.2 \text{ min.}$$

- Daily round trips per day

$$\frac{7.5 \times 3 \times 50}{31.2} = 36.1 \text{ say } 36$$

Daily tonnes per truck 36 x 45.4 = 1634.4 say 1640 tonnes

- Trucks required for ore hauling

$$\frac{8200}{1640} = 5$$

5 at 85% utilization = 5.9 use 6

4.3.4 AUXILIARY EQUIPMENT

The following is a list of auxiliary equipment required for the mining operation:

	Unit No.
Dozer D-8	1
Grader 15G	1
Water Truck	1
Lube/Fuel Truck	1
Welding Truck	1

Tire Fork Lift	1
Shop Fork Lift	1
Man Bus	1
Ambulance	1
Pickup w/mobile radio	3
Base Station Radio	1
Mobile Light Plant	4

4.4 MANPOWER REQUIREMENTS

Manpower requirements for the mining operations and Engineering Department are as follows:

4.4.1 MINE OPERATION AND MAINTENANCE

		No. of Persons
- Salaried		
Mine Superintendent		1
Pit Shift Foreman	1x4	4
Maint. Shift Foreman	1x4	4
		9
- Hourly:		
FEL Operator	1x4	4
Haul Truck Driver	5x4	20
Dozer Operator	2x4	8
Grader Operator	1x1	1
Light Vehicle Driver	1x4	4
Mechanic	3x4	12
Mechanic Helper	4x4	16
Clerk	1x4	4
		69

4.4.2 ENGINEERING DEPARTMENT

- Salaried:	
Mining Engineer	1
Surveyor	1
Draftsman	1
	3
- Hourly:	
Rodman	1

SECTION 5

COMMINUTION PLANT AND INFRASTRUCTURE

This section covers the installations located in the vicinity of the mine and includes both process facilities and infrastructure. The area is located at approximately 68° 41' W and 26° 19' S at an elevation of about 4365 meters. Drawing SK-01 (in Appendix) shows a conceptual plot plan of the area.

5.1 PROCESS DEVELOPMENT

The following paragraph discusses the methodology used to arrive at the design throughput for all the process facilities. It is followed by assumptions used specifically for the design of the comminution circuits. The work presented in this Section is based upon laboratory and other studies received by Parsons prior to September 1, 1988. A discussion of later laboratory work is contained in Section 12.

5.1.1 DESIGN BASIS

The process plant has been designed using the following parameters:

Overall Sulfur Production, dmtpa	500,000
Refined Sulfur Grade, Percent	99.51
Feed Assay of Ore, Percent Sulfur	31.2
Overall Recovery, Percent	71.83
Operating Hours per Day	24
Operating Days per Year, per Client	270
Availability of Crushing Plant	84.59
Availability Grinding & Beneficiation	95.16

From the above data the hourly crushing rate is calculated as follows:

(500,000 x 0.9951)/(24 x 270 x 0.7183 x 0.312 x 0.8459)
= 405 dmtph.

The throughput in the grinding and beneficiation plants is:

(500,000 x 0.9951)/(24 x 270 x 0.7183 x 0.312 x 0.9516)
= 360 dmtph.

The relatively high availability of the crushing plant has been based on effecting the major repairs during the off season. The following tabulation shows an assumed average use of time, in minutes, in the crushing plant:

Lost Time at Shift Start	10
Lunch	24
Lost Time at Shift End	10
Repairs, Oiling etc.	30
Total Lost Time per Shift	74
Total Available time per shift	480
Operating Time per Shift	406

The repair work will have to be undertaken so as to take maximum advantage of the available time. A scheduled shutdown at fortnightly intervals allows for a complete shift of repair work.

5.1.2 PROCESS ASSUMPTIONS

The flowsheet is based on delivery of ore to a stockpile from which it will be fed into a feed ore bin with a front-end loader. Since there is no information concerning the comminution characteristics of this particular ore, several assumptions have been made, viz.

A. The ore will be crushed in three stages. The first two stages will be in open circuit and the third stage will be in closed circuit.

B. The run-of-mine ore will have the following screen analysis, expressed in terms of cumulative percent passing a given screen:

Screen Size, mm	Cumulative Percent Passing
200 mm	96
150	94
100	88
75	81
50	68
25	38
18	29
12	20
10	15

D. The crushing plant product will average eighty percent passing 9500 microns and will have the following screen analysis expressed as individual percentages retained on a given screen:

Screen Size, mm	Individual Percent Retained
+12 mm	2
+ 6	37
- 6	61

E. After grinding, the product size will average eighty percent passing 90 microns and have the following screen analysis, expressed in terms of individual percentages retained on the Tyler screen meshes shown:

Screen Size, Tyler Mesh	Individual Percent Retained
+65	1.2
+100	4.6
+150	9.8
+200	12.4
+270	12.7
-270	59.3

F. The bulk density of the ore is 1.61 tonne/cubic meter (100 lbs/ft^3).

G. The ore is suitable for single-stage closed-circuit ball milling (using cyclones). It is sometimes necessary to use pebble mills in this application to avoid iron contamination. At this time, Parsons has assumed that conventional ball milling is satisfactory.

H. The assumed Bond Work Index (Avoirdupois) is 7. A note of caution is introduced since the actual work index is unknown and the use of low work indices can be misleading.

I. The selected arrangement is to perform all of the comminution steps at an elevation of about 4365 meters above sea level and then pipe the thickened product to the flotation and refining plant located some 90 kilometers to the West at an elevation of 2400 meters. Some consideration was given to the following alternatives:

- Crushing the ore to the same size as shown in (D) above prior to slurrying with water and piping to the grinding section located alongside the flotation section at the lower elevation. This alternative was rejected because of the lack of experience in handling such large rocks in a slurry pipeline over the type of terrain encountered on this project.

- o Performing all of the comminution and flotation preparations at the high elevation and piping the concentrate to the refinery at the lower elevation. This has the merits of reducing the pipeline size considerably which would also reduce operating costs. This alternative was discounted because it would be very difficult to return any middlings products to the flotation section. This problem is discussed again in Sections 7.1.2.A, 7.1.2.M and 12.5.

The selected system has the advantage that there is ample experience in Chile and elsewhere for piping ground ore downhill in steep terrain. An example is the operation at Compañia Minera Disputada de los Condes, S. A. near Santiago.

J. For the purpose of this preliminary study, Parsons has assumed that sampling and reagent activities will be confined to the beneficiation area only. During the feasibility study we will investigate the use of particle size analyzers and other forms of quality control. Some reagent will almost certainly be required in the long distance pipeline to minimize corrosion.

5.1.3 MATERIAL BALANCES AND FLOWSHEETS

Table 5-1 shows the Crushing Plant Material Balance.

Table 5-2 is the Sulfur Grinding, Pipeline Transportation, Flotation and Refinery Material Balance.

These balances should be read in conjunction with the following block flow diagrams:

Figure 5-1: Flowsheet; Comminution, Pipeline Transportation and Preparation for Flotation.

Figure 5-2: Flowsheet; Flotation and Refining.

Figure 5-3: Water Balance

5.1.4 EQUIPMENT LIST

Table 5-3 shows the major equipment in the Comminution Area. This table also shows horse power per unit, total connected horse power and operating horse power.

Table 5-1 - Material Balance - Total Fine Crushing Plant at 84.4% Availabilty*
(All Quantities in dmtph)

Matl. Size	Equipment (See Legend Below)															
mm	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
-965																
343																
152	59	59				59										
127	41	41				41										
102	53	18	35	35		53										
76	61	20	41	41		61										
65	26	8	18	7	11	15		11		11	11				11	
51	26	8	17	7	10	15	12	22		22	22				22	
38	30		30	12	18	12	32	50		50	50				50	
25	30		30		30		32	62	4	66	34	32	32		66	
20	10		10		10		76	86	8	94	47	47	47		94	
16	10		10		10		25	35	60	95		95	95		95	
12	10		10		10		26	36	29	65		65	58	7	58	7
6	19		19		19		26	45	186	231		231	81	150	81	150
0	31		31		31		27	58	190	248		248		248		248
Total	405	154	251	102	149	256	256	405	477	882	164	718	313	405	477	405

LEGEND:

1	Jaw Crusher Product at 165 mm OSS	9	Short Head Crushers Product at 11 mm CSS
2	127 mm # Top Deck Oversize	10	Total Tertiary Circuit Feed
3	127 mm # Top Deck Undersize	11	38 mm # Top Deck Oversize Screens
4	76 mm # Bottom Deck Oversize	12	38 mm # Top Deck Undersize Screens
5	76 mm # Bottom Deck Undersize	13	12 mm # Bottom Deck Oversize Screens
6	Feed to Standard Crusher	14	12 mm # Bottom Deck Undersize Screens
7	Standard Crusher Product at 32 mm CSS	15	Feed TC Short Head Crushers
8	New Feed to Tertiary Crushing Circuit	16	Product of Crushing Plant

*High availability selected on account major maintenance can be performed at start and end of season.

Table 5-2 - Material Balance - Sulfur Grinding, Pipeline Transportation, Flotation, and Refining

lp gpm	W E Solids	W E Pulp	cu m/hr Water In	Cu m/hr Out	USgpm Water In	USgpm Out
770	163.64	174.77	11.13		49	
666	245.45	605.45				
500		113.48	113.48		500	
935	409.09	893.71				
935	409.09	893.71				
672		1515.38	1515.38		6672	
607	409.09	2409.09				
941	163.64	1803.64				
140		1394.55		1394.55		6140
801	163.64	409.09		245.45		1081
			1640.00	1640.00	7221	7221
801	163.64	409.09	245.45		1081	
140		1394.55	1394.55		6140	
941	163.64	1803.64				
419		549.42	549.42		2419	
997	87.80	907.80				
363	75.83	1445.25				
123	2.65	28.01				
120	90.46	935.82				
0	0.00	0.00				
120	90.46	935.82				
494		566.41	566.41		2494	
305	74.23	750.52				
310	16.23	751.71				
995		453.13	453.13		1995	
491	58.60	565.82				
808	15.63	637.83				
118	31.86	1389.54				
398		226.56	226.56		998	
392	29.20	1588.09				
356	105.04	3033.34		2928.30		12893
266		60.47				
758	58.60	626.28				
173		493.46		493.46		2173
585	58.60	132.83				
319	58.60	72.36				
40		9.12		9.12		40
278	58.60	63.24				
198	45.04	45.04		0.00		
80	13.56	18.20				
20		4.64		4.64		20
60	13.56	13.56		0.00		
			3435.52	3435.52	15127	15127
356	105.04	3033.34	2928.30		12893	
575		2651.59		2651.59		11675
581	105.04	381.75				
198		45.02		45.02		198
483	105.04	336.73		231.69		1020
2	0.45	0.45				
58	13.11	13.11				
200	45.49	45.49				
97		22.00	22.00	22.00	97	97
			2928.30	2928.30	12893	12893
			11.13		49	
			1628.87		7172	
			1394.55		6140	
			245.45		1081	
			234.32		1032	
			245.45		1081	
			3190.06		14046	
			3190.06		14046	
			267.45		1081	
			22.00		97	
			147.68		650	

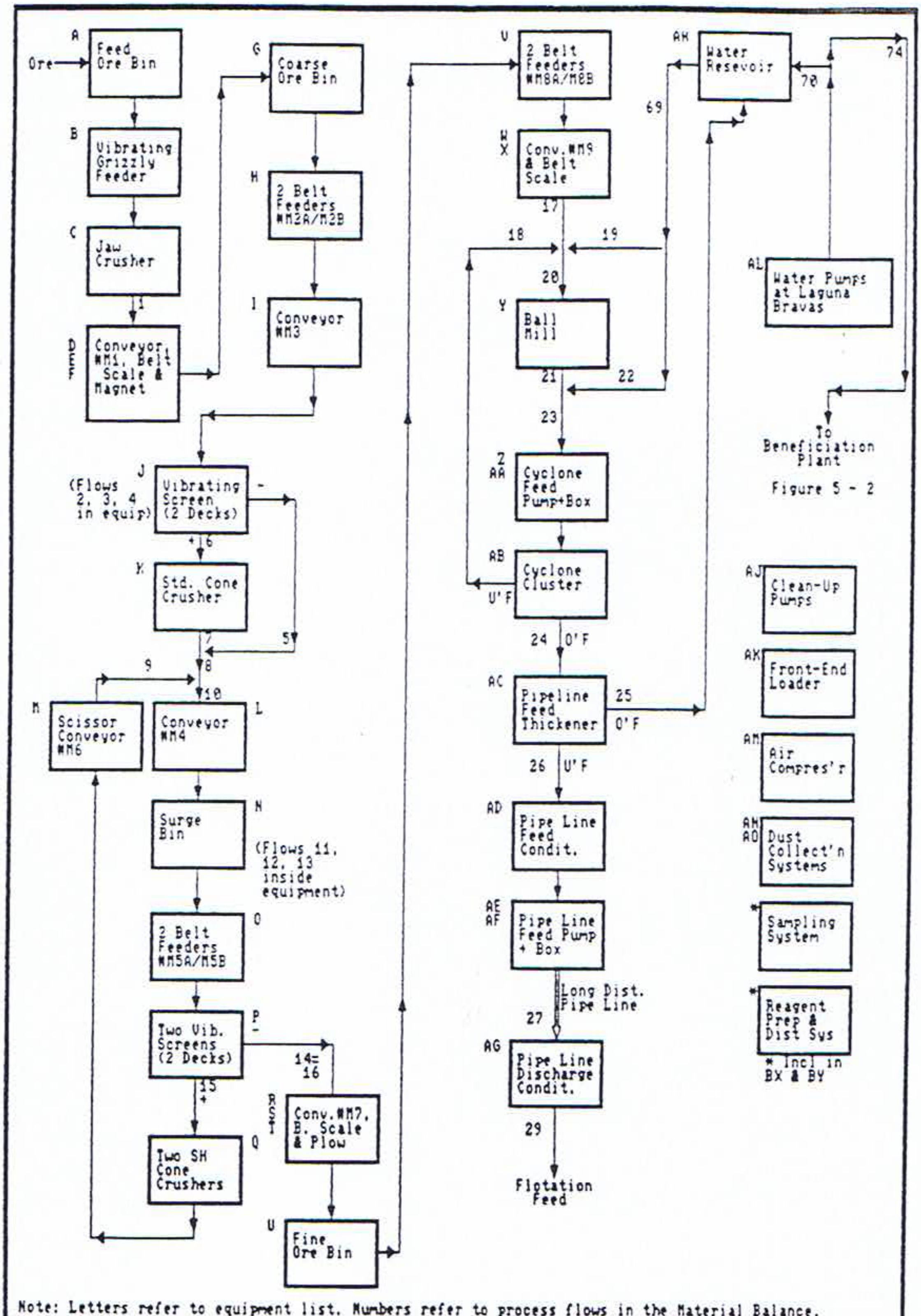
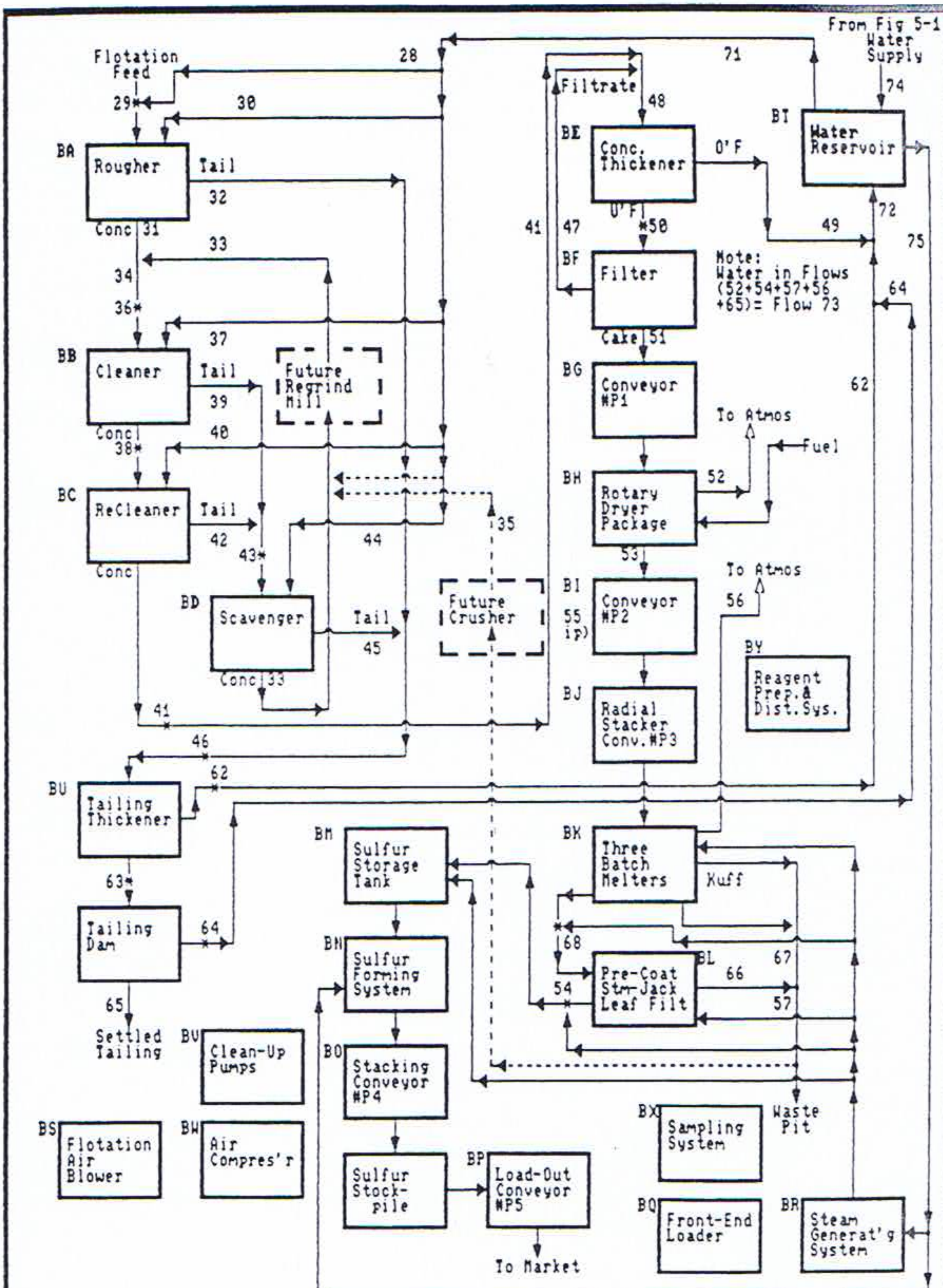


Figure 5-1 - Flowsheet: Comminution, Pipeline Transportation, and Preparation for Flotation



Note: Letters refer to equipment list. Numbers refer to process flows on Material Balance.
Asterisk (*) denotes process flow pump and pump box to handle designated flow.

Figure 5-2 - Flowsheet: Flotation and Refining

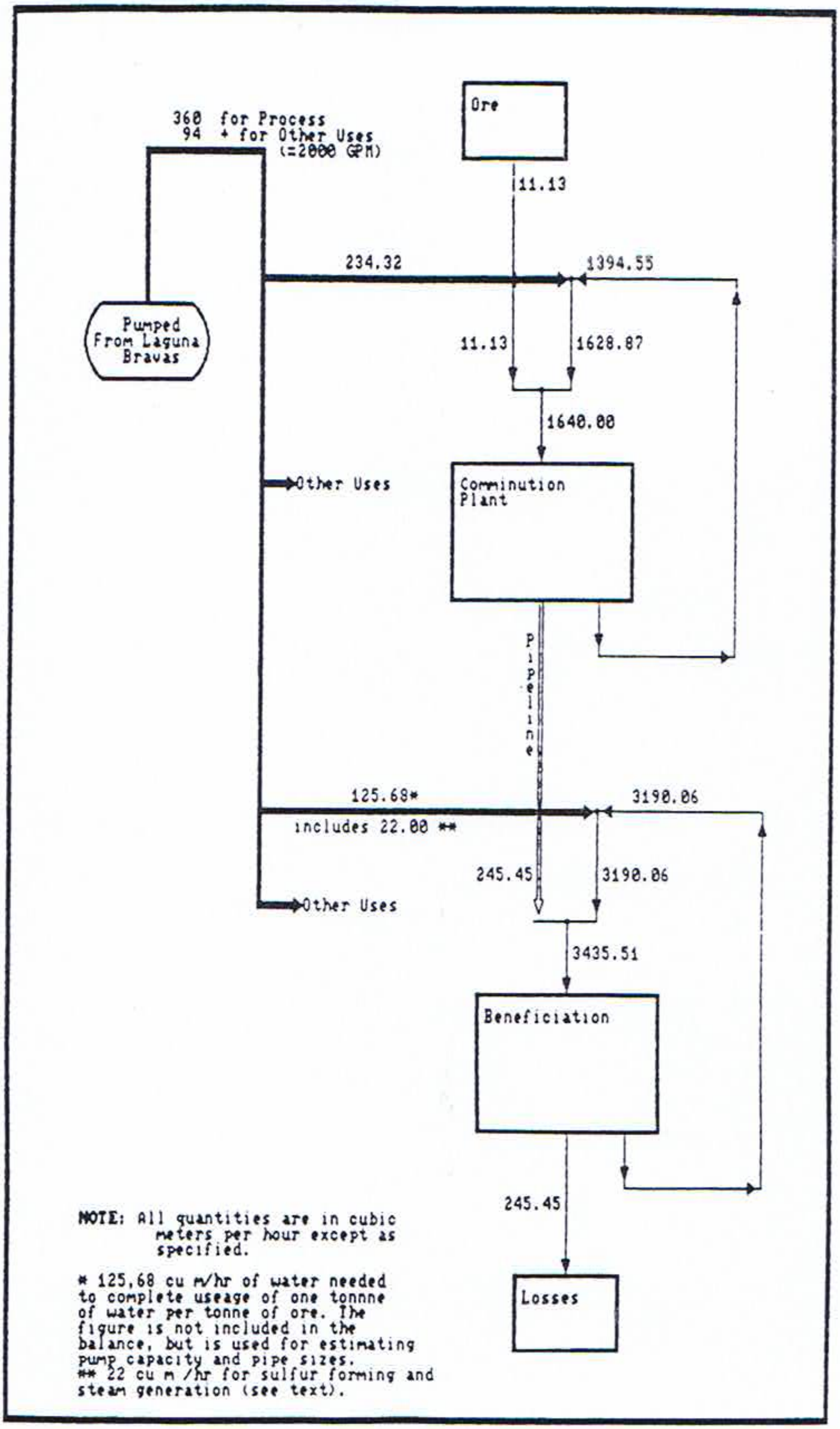


Figure 5-3 - Water Balance

Table 5-3 - Equipment List - Comminution

Key	Description	Size	Connected H P Each	Total Connected H P	Operating H P
A	Feed Ore Bin	250 cu m	0	0	0
B	Vibrating Grizzly Feeder	62" x 18' w/2 x 5' of grizzly	60	60	60
C	Jaw Crusher	48" x 60" - OSS 165 mm	200	200	200
D	Conveyor Belt #M1	30" x 465, 460 fpm	60	60	60
E	Belt Scale, included	30"	0	0	0
F	Tramp Iron Magnet icl. 5 kW Rectifier, incl.	30"	0.2	0.2	0.2
G	Coarse Ore Bin	4000 cu m	0	0	0
H	Two Belt Feeders, #M2A & #M2B	42" x 25', 100 fpm	20	40	40
I	Conveyor Belt #M3	30" x 270', 460 fpm	40	40	40
J	Double Deck Vibrating Screen	8' x 16'w/127 & 76 mm slots	30	30	30
K	Standard Cone Crusher	5-1/2' - CSS 32 mm	400	400	400
L	Conveyor Belt #M4	42" x 440', 485 fpm	150	150	150
M	Scissor Conveyor Belt #M6	30" x 490', 540 fpm	60	60	60
N	Surge Bin	550 cu m	0	0	0
O	Two Belt Feeders, #M5A & M5B	60" x 35', 75fpm	40	80	80
P	Two Double Deck Vibrating Screens	8' x 16'w/38 & 12 mm slots	30	60	60
Q	Two Short Head Cone Crushers	7' - CSS 11 mm	400	800	800
R	Conveyor Belt #M7	30" x 465', 460 fpm	60	60	60
S	Belt Scale, included	30"	0	0	0
T	Plow, included	30"	0	0	0
U	Fine Ore Bin	10000 cu m	0	0	0
V	Two Belt Feeders, #M8A & #M8B	42" x 36', 84 fpm	30	60	60
W	Conveyor Belt #M9	30" x 125', 460 fpm	5	5	5
X	Belt Scale, included	24"	0	0	0
Y	Ball Mill	16'x 21'3"	3500	3500	3500
Z	Cyclone Feed Pump Box	20 cu m	0	0	0
AA	2 Cyclone Feed Pumps	16" x 18"	400	800	400
AB	Cyclone Cluster	6 x 26"	0	0	0
AC	Pipeline Feed Thickener	200' dia x 10' SWD	7.5	7.5	7.5
AD	Pipeline Feed Conditioner	48' dia x 56'	125	125	125
AE	Pipeline Feed Pump Box	3.5 cu m	0	0	0
AF	3 Pipeline Feed Pos. Displ. Pumps (2 op 1 sp)	4-1/8" x 7" w/9 plungers	1500	4500	3000
AH	Water Reservoir	1500000 gallons	0	0	0
AJ	Two Clean-Up Vertical Pumps	3" x 60"	20	40	20
AK	Articulated Front-End Loader	4.5 Cubic Yard Bucket	0	0	0
AL	3 Water Sup. Pumps/2000 gpm @1150'(2 op 1 sp)	13" Imp. 5 St. Vert. Turbine	450	1350	900
AM	Air Compressor & 400 Gallon Receiver	637 ACFM 125 psi	150	150	150
AN	Dust Collection At Jaw Crusher	Allowance	5	5	5
AO	Dust Collection at Fine Crushing Area	Allowance	15	15	15
	Sub-Total Mine Area			12597.7	10227.7

5.2 MINESITE INFRASTRUCTURE FACILITIES

In order to support the mining and process operations at the minesite, the following facilities will be required:

- Maintenance Shop and Warehouse
- Water Supply
- Power Supply
- Campsite
- Access Road

5.2.1 MAINTENANCE SHOP, WAREHOUSE AND OFFICES

These facilities will be housed in one structure about 15 meters wide by 46 meters long. It will include one bay devoted entirely to mine truck repair and maintenance, one bay for mine truck and other mining equipment i.e., front end loader, drill rigs, etc., one bay for small vehicle repair and one bay for a tire shop. The remaining area will be utilized for warehousing. Only tires and frequently used items (for both the mine and process plant) will be stored here. Infrequently required items will be kept at the main warehouse at Montandon and can be delivered on short notice as needed.

Adjacent to the shop will be a combined fuelling and lubrication facility including fuel oil and gasoline storage tanks as well as grease and lube oil storage.

5.2.2 WATER SUPPLY

Water for the Mine, Minesite Plant and Montandon will be obtained from Laguna Bravas. A pumping station will be required on the western side of the lake and a 5 km pipeline installed to a 1,500,000 gallon reservoir at the minesite plant. The same pumping station will also provide water for the plantsite at Montandon.

There will be a distribution system from the reservoirs to the points of need. A portion (100,000 gallons) of the reservoir will be maintained for fire protection purposes. The reservoir will be located at a sufficient elevation above the plant to provide adequate pressure for all uses without pumping.

Potable water will be required primarily at the campsite. The existing laboratory tests do not cover this aspect but it is assumed that the water from Laguna Bravas is not suitable for this purpose. It has been assumed, however, that water from Lagunas Bravas is satisfactory for metallurgical purposes. For this study no costs are included in the capital cost estimate for treating the lake water or establishing a well as another possible source for potable water.

According to the material balance, approximately 1000 gpm of water are required for the process at the minesite. An estimated additional 300 gpm have been allowed for other uses such as truck washing, sprinkling haul roads, power plant cooling water, etc. The reservoir has been sized to hold about two shifts usage in the event the supply system has a minor breakdown.

5.2.3 POWER SUPPLY

It is possible that Chilectra (the National power company) may install a transmission line to the El Hueso Project in the near future, and negotiations could be made to tie into that source for power. That project, however, is still a long distance from the minesite and the additional line may prove to be more costly than a diesel plant. For the purposes of this study it has been agreed that we should install a diesel generating plant to supply power to the minesite area. We have selected 4-3110 kW units, assuming that three will be operating and one on standby (or overhaul).

At Montandon we have assumed that power can be obtained from Chilectra by tying into the line feeding Potrerillos and El Salvador. We understand that that line may be overloaded at the present time, so this should be checked out with Chilectra. We have included the cost of constructing a 10 km line from the tie-in point to Montandon, but if it is necessary to extend the line all the way to Diego de Almagro, the costs will be greatly increased.

5.2.4 CAMPSITE

Due to the isolated location of the mine, a campsite will be required to house and feed the salaried and hourly personnel. All personnel working in this area will be on single status. The estimated camp requirements are based on the figures shown below in Table 5-4. The sizing of the accommodations takes into account the rotation of employees off the site to compensate for a normal work schedule and still maintain 3 shifts/day.

Table 5-4 - Camp Personnel

	Salaried	Hourly
Mine Operation	5	29
Mine Engineering	2	2
Mine Maintenance	4	21
Process Plant Operations	6	16
Power Plant Operations	1	6
Plant Maintenance	1	11
Camp Operations	3	6
Total	22	91

Barrack type structures have been used for the hourly personnel quarters. In sizing the facilities, a common shower, toilet and wash area located in the center of the building was used.

Double bunks were provided in spaces separated by a small closet for keeping personal belongings.

Salaried personnel are housed in motel type structures, i.e. divided into single room units with each unit having its own bathroom facilities.

A combined kitchen/messhall/recreation area is provided to accommodate all personnel.

5.2.5 ACCESS ROAD

It has been assumed that the existing road from Chanaral to Diego de Almagro (C-13) and from Diego de Almagro to La Ola can be utilized for both construction activities as well as during operations. With that assumption, there still remains approximately 50 km of access road to construct to reach the minesite. It is intended to have the slurry and water pipelines as well as the access road follow the same route for the 50 km distance. The construction road for the pipelines can readily be improved for the permanent access road.

The route for this portion of the road begins by turning off the existing road about 11.5 km northwest of La Ola. From that point it will run in a roughly easterly direction until reaching the minesite. Figure 6-1 shows the general routing which takes the best advantage of the terrain to minimize cuts and fills. The figure also shows routing of the pipelines.

SECTION 6

PIPELINES

This section covers the following pipelines:

- Slurry line from minesite to Montandon.
- Water lines from Laguna Bravas to minesite and Montandon.
- Tailing line from Montandon to tailing dam.
- Reclaim water line from tailing dam to Montandon.

Utilizing the data in Chapter 2 of MECA Report, the slurry pipeline routing was located on a map (see Figure 6-1). This routing agrees with the distances and profile in the report and that data was used in our calculations for both the pipeline and pump sizing.

6.1 SLURRY LINE - MINESITE TO MONTANDON

As previously noted, the sulfur ore will go through a crushing, grinding and thickening process at the minesite. The thickener underflow at 59.46% solids by weight, (which we believe is the maximum amount obtainable) is the slurry being piped to Montandon at a rate of 1801 gpm and a specific gravity of 1.48. This data is shown in the material balance, Table 5-2.

Calculations based on the above data indicate the following pipe sizes and wall thicknesses to be used throughout the entire length. The pipe diameter varied to control velocity of flow and wall thickness was adjusted to compensate for the varying pressures developed along the route.

Stations	Length (ft)	Diam.(in)	Wall Thick.(in)
1 - 8	229,250	10	1/3 (.333)
8 - 9	10,260	8	3/16 (.188)
9 -10	52,500	10	1/8 (.125)

The welded joint steel pipe will have a yield strength of 60,000 psi and will be laid on sleepers on a graded surface. Pressure relief valves at high points and blow-off valves at low points will be included as required. For this study we have made an allowance for 10 of each. We have also made an allowance for 100 concrete pipe anchors.

To dissipate the energy developed in the steep drop between Stations 8 and 9, we have included a drop box structure at Station 9.