

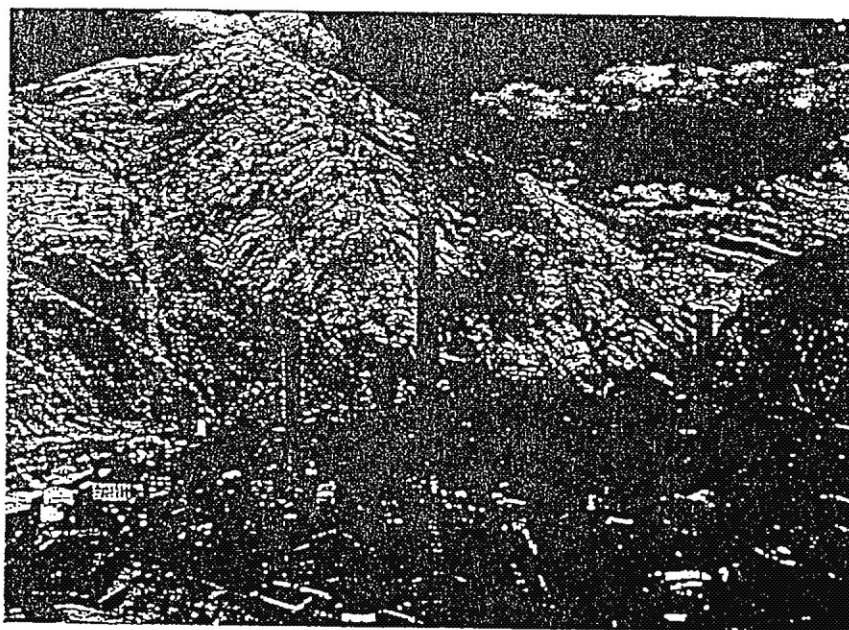


EMPRESA MINERA DEL CENTRO DEL PERU

COMITÉ CENTRAL - PERU
GERENCIA DE PRIVATIZACIÓN
ELECTROTE

DOC. N°

PROGRAMA DE ADECUACION Y MANEJO AMBIENTAL P A M A



Complejo Metalúrgico La Oroya

MINISTRY OF ENERGY AND MINES

DIRECTORAL RESOLUTION No 017-97-EM/DGM

Lima, 13 January 1997

Whereof Files No 1085164 dated August 29 1996 and 1099939 dated October 13 1996, submitted by Centromin Peru S.A., requesting approval of the Environmental Impact Program (EIP, Spanish acronym PAMA) for "La Oroya" Production Unit, located in the district of La Oroya, province of Yauli, department of Junin.

WHEREAS

In accordance with Art. 9 of Regulations for Environmental Protection in Mining and Metallurgic Activities, approved by Supreme Decree No 016-93-EM and Art 3 of Supreme Decree No 059-93-EM that partly modifies Regulations approved by Supreme Decree No 16-93-EM, Environmental Impact Programs will be approved or observed by the General Bureau of Mines by Resolution, taking into consideration the opinion of General Bureau of Environmental Affairs.

With Official letter No 334-96-EM/DGAA dated October 28 1996, the General Bureau of Environmental Affairs observed said Environmental Impact Program.

Centromin Peru S.A. Replied satisfactorily to the observations made to the EIP, receiving a favourable opinion from the General of Environmental Affairs as per Report No 035-96-EM-DGAA-LCP, and Memorandum No 1020-96-EM-DGAA.

In compliance accordance with Regulations approved by S.D. No 016-93-EM and its modification through S.D. No 059-93-EM.

IT IS AGREED:

Article 1.- To approve the Environmental Impact Program of "La Oroya" P.U. of Centromin S.A., located in the district of la Oroya, province of Yauli, department of Junin.

Article 2.- "La Oroya" P.U. of Centromin Peru S.A., will become environmentally sound in a 10-year period starting from this date.

To be registered and reported.

(SIGNATURE ILLEGIBLE)

(STAMP)

CENTROMIN PERU S.A.

REPLAY TO OBSERVATIONS MADE TO THE EIP FOR UNIDAD

METALURGICA LA OROYA

1.0 INTRODUCTION

On 23 October 1996, your office issued a document about the Compliance Assessment of the EIP for Unidad Metalurgica La Oroya. After commenting on the Diagnosis of the environmental problems, Proposed profile solutions, Amounts and investment schedule and sanctions, it was concluded that the EIP did not meet the requirements for a complete assessment of the mitigation program. Observations concerning accuracy and detail required a correction within 60 days. Additionally, on 28 October 1996 we received official letter No 334-96-EM/DGAA containing the list of 37 observations made to the EIP which was the detailed of the Compliance Assessment.

2.0 COMPLIANCE ASSESSMENT OF THE EIP

Comments and observations concern the lack of information, in-depth analysis and investment details that detract from the foundations that the EIP deserves and the law requires.

2.1 DIAGNOSIS OF ENVIRONMENTAL PROBLEMS

We are asked for information submitted and approved at EVAP, as in the case of liquid effluents, solid waste and deposits. Additionally, we are asked for samples of affected soils in the neighborhood of La Oroya to better quantify the effects of pollution and to enforce the best mitigation measures.

2.2 PROPOSED PROFILE SOLUTIONS

It is thought that the proposed solutions for mitigation are descriptive in general. The amounts and schedules are not coherent, particularly regarding the problem of SO₂.

2.3 AMOUNTS AND INVESTMENT SCHEDULE

We need more information regarding amounts and timing, particularly the minimum annual investment, equivalent to 1% of annual sales, as stipulated by law.

2.4 LIST OF OBSERVATIONS

The 37 observations deal with specific items that must be corrected so that the EIP can meet comply with the legal stipulations in force and help achieve acceptable environmental standards in compliance with current environmental levels expected, fitting into the environmental regulations.

3.0 REPLAYS TO OBSERVATIONS MADE

3.1 GENERAL CONSIDERATIONS

The EIP submitted on 30 August, refers repeatedly to the approved EVAP. It's considered there that it was not convenient to repeat the information contained therein. Therefore the EIP omits this information, with the ensuing appearance of being insufficient.

Detailed information regarding the items mentioned was not included in the EIP for simplicity's sake. This was interpreted as an omission.

Most of the proposed solutions for Environmental Control have been developed by acknowledged foreign consultancy companies. They proposed to use highly efficient technologies. Therefore, they are feasible and reliable solutions.

The investments exceed the minimum annual amounts required by law. Thus, there are no risks involved in carrying out the program. These amounts are below those usually managed and do not require extraordinary business management.

3.2 REPLAYS

The EIP has gone through a thorough examination. Details and additional information, occasionally exceeds requests. A better outline makes it easier to understand.

In the enclosed table of Replays we respond to each of the 37 observations made. The table shows the paragraphs, charts, and tables where the respective detailed information can be found.

REPLY TO OBSERVATIONS MADE TO THE EIP - LA OROYA METALLURGICAL UNIT

No	Page	Section	Description	Observation	Reply
1	7	2.1.3	Liquid effluents, treatment and final stipulation	For each effluent, indicate if this is directly poured into the river (Mantaro or Yauli) or if it is mixed with a different effluent for discharge In table No 2, 3A and others you should indicate the referential limit value (LMP) mandated by the General Water Bill or other sources for the elements whose LMP is not included in S.D. 011-96 EM/VMM. To give the reader an idea of the pollution level for each element.	Table 4.1.2/1 (Page 80) shows detail of effluent discharges. Tables No 2, 3A and others have been replaced by tables 4.1.2/2, 2A, 3 and 3A on pages 125 to 128 including maximum allowance limits.
3	15	2.1.3		Indicate if the 7 effluents with the largest show the largest polluting load. You should also indicate the size (flow or load) of compared to other effluents	Tables 4.1.2/4, 3, 4 and 4A, 5 and 5A on pages 129 to 132 detail what is poured into the 7 more polluting effluent, or 94% of the total.
4				Indicate if the average concentrations shown in table 2.4 are arithmetical or weighted averages.	Table 2.4 has been replaced by tables 4.1.2/4 and 4A (pages 129 and 130) The showing reported averages are arithmetical.
5				Correct table No 2, 3B, pH values (>200), concentrations, etc. Values are highly incoherent	Tables No.2 and 3B have been replaced by tables 4.1.2/2 and 2A (Pages 125 and 126) where pH values have been corrected and They correspond to effluents with codes 131 to 137.

6				Report concentration of greases/oils in effluents from Workshops(Chart No 2, 3D	Greases and oils are recirculated to crude oil Bunker tank No 6 as shown in paragraph 4.1.3, Industrial Solid Waste (Chapter IV - Page 85).
7				Table 2.4 show the most important liquid effluents. It should also report Cd, As and Mn concentrations that are extremely high in several of these effluents. The fact that MEM has not established LMP for those elements does not mean in any way that they should not be reported and controlled. Table 2.6 apparently reports average concentrations in the Mantaro and Yauli rivers. The title should be more specific. It is very important to indicate the date of sampling and/or if it is an arithmetical or weighted annual average. River pollution is greater in summer.	Table 2.4 has been replaced by tables 4.1.2/5 and 5A (Pages 131 and 132) where Cd, As and Mn contents are reported. Table 2.16 has been replaced by tables 4.1.2/6 and 6A (Pages 133 and 134) that refer to Mantaro and Yauli rivers and show the date of sampling. Figures reported correspond to annual arithmetical average.
8	16 etc.	2.1.4	Solid waste, treatment and final stipulation	The description of solid wastes is insufficient to characterize it from an environmental point of view. It should be complemented with granulometry, metallic content soluble in water, paste pH, etc., since this waste will be exposed to rainfall and other natural agents. The same goes applies to the information reported in table 2.5. Ideally you should have tested the chemical resistance of natural agents (intemperance) to establish the degree of	Characterization and granulometry of solid waste is shown in Tables 4.1.3/1 and 2A. Additional information requested about chemical resistance is shown in the studies of closure of deposits of arsenic trioxide, Cu and Pb slag and Zinc ferrite prepared out by consultancy companies.

				dissolution metals will experience in the future.	
9				Clarify what is meant by "stored on the banks of the Mantaro river" when talking about manganese dioxide waste. Describe the kind of confinement used to store this waste.	Manganese dioxide is not a waste. It is a reagent of daily consumption and its storage is temporary and minimum. It is kept 100 meters away from river Mantaro shores.
10				The slag stockpiles, muds (ZLR) etc. have not been appropriately described. Indicate area, dimensions, height, depth, humidity, solid %, precise location regarding highway, town, rivers, green areas, etc. and coordinates, slope, perimetric channels to collect run-off if any and, substratum quality. Indicate if this has been made waterproof or not, estimated volume of each stockpile, and lifetime.	The details requested are in Plan No M-03-96-02, Chapter IV, Project No 03 for Cu/Pb slag, for zinc ferrite in plan No M-03-96-04 of Project No 15; and for arsenic trioxide in pictures 1 and 2 of Project No 14, explained in paragraph 4.1.3 (Pages 81, 82, 85).
11	19	2.1.5	Gaseous emissions, treatment and final stipulation	Gases emitted by Coke Plant are not or should not be combustion gases. They are gas emissions during distillation. It is not true that they are a slightly harmful; generally they carry phenols, nitrous gases, etc. and that should have been confirmed/discarded through sampling/analysis. Table 2/ should have included this kind of analysis for gases of the Coque Plant.	Tables 4.1.1/5, 5A, 5B and 5C (Pages 106 to 109), confirm that this concern combustion gases. Gas emissions during distillation are analyzed in Project No 2 Chapter V.
12				Gases emitted at the Anodic Waste Plant	

				should be analyzed to determine the concentration of nitrous gases. (Table 2, 7H)	Table 2, 7H has been replaced by tables 4.1.1/8 and 8A (Pages 114 and 115). Nitrous gases are generated by the use of sodium nitrate in the smelting process. This operation is carried out once a week. There are no analysis of representative nitrous gases. In this regard, we submit Project No 3 of Chapter V for the elimination of sodium nitrate consumption.
13	28	2.2.2	Climate	Specify in what units mm/month, mm/year, etc values of rainfall are expressed. In the explanation of the washing action there should be included a better characterization of the solid wastes. (See note 8).	Units are expressed in mmH OR/year and are specified in Tables 2.1.3/2 and 2.1.3/3 (Pages 34 and 35).
14	29	Air Quality	LMP for gases established by R.M. 315-96 should be included together with concentrations of elements reported during air monitoring. (Table 2.13 and others)		What you request can be found in Tables 2.1.4/2 and 2A (Pages 38 and 39)
15	34	2.2.5	Soils	Clarify the concept "slightly acid" with regard to soils with a pH in the order of 35 (Table 2.1.4). The severity of pollution seems to be greater than that suggested by this comment.	The term "slightly acid" refers to a farming technical term, but it is important to mention that soils are affected by SO ₂ emissions. These are washed by rains. An explanation is found in Chapter IV, Paragraph 4.2.1. (Page 87).

16	35 etc	2.3	Biological Environment	Chart 2.15 about chemical composition of Plants should be compared with an analysis of similar plants from non-polluted sites. Table must be extensively commented. The text describing effects and including pictures should be complemented with location plans of the areas described. The plans of Attachments 8 and 10 should be improved to include topographic information, green areas, lagoons, rivers, etc. and attached to this section of the text. Plans are of poor quality.	Chart 2.15 has been replaced by Table 2.2.2/1 (Page 42) where we indicate the content of the essential elements in the plants, see Diagram 7.2.4/3 and Plan 1-559-01-2008 of Annex No 8. Plans of Annexes 8 and 10 are replaced by Diagram 7.2.4/3 of Chapter VII and Plan 1.3/1 in Annex of Chapter I; also Plan 1-559-01-2008 of Chapter V (Project No 4).
17	37 etc	2.4	Economic and Social Environment	The incidence of one or other kind of illness in La Oroya should be supported by statistics.	After conversations with the Bureau of Environmental Affairs at MEM, that question was eliminated.
18	50	2.5	Environment of Human Interest	You should indicate that La Oroya is the place where the main access roads to Huancayo, Chanchamayo, Huanuco - Pucallpa areas join together. All this traffic is frequently affected by disturbances in the streets of La Oroya, directly or indirectly related to the activities of Centromin Peru.	Although this question was eliminated, the Reply is found in Chapter II, Paragraph 2.3.1 (Pages 30 and 31), (communication access roads).

19	63 etc	4.0	Summary of the Assessment and Analysis of Environmental Effects	Table mentioned in page 65, paragraph 1 is missing as well as table 4.1 mentioned in the text. Therefore it is impossible to understand the text. These are serious omissions.	This table was omitted and this information is shown in Tables 4.1.2/2, 2A, 3 and 3A (Pages 125 to 128). The omitted Table 4.1 is detailed in Paragraph 4.1.1 (Pages 72 to 77).
20				Effects should be more extensively described, at least you should have indicated the load of each metal poured into each river for each liquid effluent. The same should have been done with gaseous emissions and dust. You should have made a historical record of the polluting dust poured in the surroundings to determine if their dissolution will continue to pollute soils and waters. Soil analysis of table No 2.1.4 is insufficient. You should have analyzed, by metallic content, samples of soils of all the area of influence of this activity to have a more "quantifiable" idea of the damage, environmental effect and required measures for mitigation and rehabilitation.	The load poured into each liquid effluent is shown in Tables 4.1.2/3 (Page 127) and 4.1.2/3A (Page 128). Gaseous emissions and dust going through the main smokestack are shown in Table No 4.1.1/3B (Page 100). Table No 2.1.4 has been replaced by Table No 2.1.6/1 (Page 41) showing the results of analyses carried out at the Laboratory of Universidad Agraria.
21	67 etc	5.0	Plan of Mitigation Measures	The cost of the Sulfuric Acid Plant should be correctly expressed (in million dollars). Mitigation measures should have been submitted at least at a "Project Profile" level, it was not and also it did not include	Reply can be found in Project No 1, Chapter V, Page 155 (new sulfuric acid plants).

				important information such as metallurgic balances, flow charts, results of experimental tests, etc.	
22				Acid manufacturing does not solve the environmental problem if there exists no market. The profile should include information about the reason to produce acid. It should also include the reasons why you did not assess other alternatives and if you did, they should be reported. More expensive alternatives such as simple neutralization with limestone, lime, etc. or other methods of sulfur fixation are however the only definitive solutions.	Reply can be found in Project No 1, Chapter V, Page 155 (new sulfuric acid plants).
23				Code 119 project considers treatment of very acid solutions at the Cadmium Plant to avoid their pouring into the river. You should enclose a flow chart and a metallurgic balance proving that the acid additionally fed into that plant will not overflow its capacity and finally it will be poured into the receptor, this means that only the pouring place will be modified and not the polluting load.	It is not a project. The observation refers to the effluent with code No 199 and it is explained separately in Project No 7, Chapter V, Page 197
24				Project description with code 123 should include the chemical composition of the new effluent should included the once Cu	In Project No 8 (Page 198): Plant for Industrial Liquid Effluents Treatment that

				and Ag are recovered, to make sure pollution has been checked	will pour a final effluent into Mantaro river within the maximum allowable levels.
25				Project description with code 118 the chemical composition, pH and TSS of the new effluent should include once the treatment is finished, to make sure pollution has been checked.	It is shown in Project No 10 of Chapter where a recirculation of this effluent is considered.
26				Project description with code 118 showed include the chemical composition, pH and TSS of the new effluent once the treatment is finished, to make sure pollution has been controlled.	Repetition of question 25.
27				Project description with code 126 showed include the chemical composition, pH and TSS of the new effluent should include the once the treatment is finished, to make sure pollution has been controlled. You mention that the company ECOLAB S.R.L. has carried out studies. Results of these studies are missing. A plan with the relative location of the Plant (Cochabamba) should be included.	Similar Reply to question No 24
28				Project description with code 124, should include the chemical composition, pH and TSS of new effluent once the treatment is	Details appear in Page 211 with Project No 11 (Chapter V) where we indicate that the final effluent will be treated according to

				finished, to make sure pollution has been checked.	Project No 8 (Plant for Liquid Effluents Treatment).
29				In the project description with code 136 the time for construction and estimated cost are included. Dimensions, geometry and material for the retaining wall are missing. 5 million dollars is certainly a high amount for a containment wall.	An error in the observation questionnaire. This was Replied by MEM. The amount must be US \$ 5 000 (Five Thousand Dollars). It is detailed in Project No 9, Chapter V.
30				Project with code 135 has a extremely high flow, with metal concentrations far above LMP. However, the investment schedule for this effluent is not described. You simply indicate that it will be the same as in case of "X effluent or neutralization with lime whitewash". We consider this is a very serious omission because it is one of the main polluting effluents poured directly into Mantaro river.	Similar Reply to question No 24.
31				Project description with code R4, should include the chemical composition, pH and TSS of new effluent once the treatment is finished, to make sure pollution has been checked. We presume you have the information of the study carried out by the Department of Metallurgic Research.	Typing error in the EIP. It should be R-1 and it is included in Project No 5 of Chapter V (Page 188).
32				Project description with code R4, should include the chemical composition, pH and	Included Project No 5, Chapter V (Page

				TSS of the new effluent and compared with the previous practice. You should also note that Cu concentration is still above LMP.	188).
33				Several times you quote EVAP as a data source for metal concentration and date shown is April'96 - June'96. EVAP was carried out in March 1995.	We made the corresponding corrections.
34				Although investment schedule in table 5.1 shows that a total of 2 million dollars will be invested to reclaim the area affected by fumes, you do not explain how this will be done. There is no project profile, nor an appropriate diagnosis. See note 20 in this chart.	Explained in Project No 4 of Chapter V (Page 178).
35	98		ANNEXES	Table summarizing (it has no number) mitigation measures and investments is incomplete. It looks like a table of contents because it refers to other sections of the text and records neither the measures nor the cost for each case.	Explained in Chapter V. Table 5.1.1 (Page 141)
36				The new INBA proposed system for slag granulation uses a 10 water/slag ratio. You should indicate what is the value of this ratio regarding current practice. The least you should indicate in a 6.5 million dollars proposal is the flow chart and material balance. Indicate if the new system involves a new granulation system ("state-	The ratio is 1:40. It is state-of-the-art technology and one of these systems operates in Hoboken, Belgium. Flow chart and balance are shown in Project No 12 of Chapter V (Page 212). The main equipment for the system is upon request and its manufacture takes 8 to 12 months.

				of-the-art") or is simply a good method for water recovery that has never been implemented. This helps to establish if the proposed schedule correct.	
37				In the project for Closing Cu and Pb Slag Deposits you mention several studies being carried out. You should include the Study of Chemical Feasibility of those materials. You should also include a study of alternative uses of slag as construction material, "sand blasting" (currently in practice), etc.	According to the report of Rescan S.A. consultancy, slag is chemically stable (Project No 13, Page 220). The company has studied the alternative use of slag for more than 30 years and they have found their feasibility in multiple uses as those indicated in the observations and even for cement and glass wool manufacturing. Although experiments yielded positive results, the high processing cost and limited market for these products do not make them a good choice.

EMPRESA MINERA DEL CENTRO DEL PERU S.A. (CENTROMIN PERU S.A.)

COMPLEJO METALURGICO LA OROYA

Environmental Impact Program (EIP)

EXECUTIVE SUMMARY

INTRODUCTION

CENTROMIN PERU S.A. was established on January 1st 1974 as a State owned Company under Private law It government by the state-owned Companies Act. (Law No 24948) and other regulations in force. It is engaged in non-ferrous mining and metallurgic activity in accordance with regulations contains in the General Mining Act. It operates seven (7) mining centers, its production of concentrates and that from third parties is processed at the La Oroya Metallurgic Complex to produce (11) metals and (9) by-products that are sold in the domestic and international markets.

La Oroya Metallurgic Complex is located in Region Andres Avelino Caceres (Department of Junin), on the eastern slopes of the Andes at 3,750 masl, 175 km northeast of Lima, in the Province of Yauli, District of La Oroya. Site topography is extremely rough.

LEGAL FRAMEWORK

Centromin Peru S.A. must comply with regulations contained in the Code of Environmental and Natural Resources (Leg.D. No 613), title XV of T.U.O. of the General Mining Act (S.D. No 014-92-EM), its rules and amendments (S.D. No 016-93-EM and No 059-93-EM), M.R. No 011-96-EM/VMM Maximum levels allowed for mining and metallurgic liquid effluents (NMP) and M.R., No 315-96-EM/VMM (Maximum allowable levels of elements and compounds existing in gaseous emissions deriving from mining and metallurgic units).

Ministry of Energy and Mines (M.E.M.), has been designated to perform the respective control, inspection and advice actions by Legislative Decree No 613 with the General Bureau of Environmental Affairs (D.G.A.A.) and General Bureau of Mining (D.G.M.) as the enforcing Ministry departments.

STRUCTURE AND DEVELOPMENT

The EIP has been structured and developed considering given guidelines of the corresponding Environmental Guide as well as recommendations and suggestions of involved officers of the Sector, in a common effort to satisfactorily and fully meet legal stipulations in force. Its seven (7) chapters include general information, actions and investment required to incorporate into the operations and metallurgic processes technological developments and/or alternative measures aiming to reduce or eliminate emissions and/or pourings in order to comply with Maximum Allowable Levels established by the Competent Authority.

ENVIRONMENTAL COMPONENTS

Activities of Complejo Metalurgico La Oroya generate gaseous emissions with particles, liquid effluents and solid waste that affect air quality, water streams and soils.

The site has a rough topography, flanked by the Yauli and Mantaro rivers. The weather is cold, dry from May to October, and rainy from November to April. Winds are slow and blow primarily in a Southeast direction.

Water for home use comes from the Tishgo river (185 l/s). For industrial use (1076 l/s), water comes from the Mantaro and Tishgo rivers and the Cuchimachay spring. For emergencies there are Hidro and Mayupampa ground sources. Most of the liquid effluents from homes and industries are poured untreated into the Yauli and Mantaro Rivers.

Gas and particle emissions into the air come from metallurgic processes that are monitored daily in five stations (Huanchan, Sindicato, Hotel Inca, Cushurupampa and Casaracra) distributed in a 10 km radio from the location place of the main transmitter (chimney of 167,5 m height).

The older rocks at the site belong to the Pucara Group and lie over rocks of the Mitu Group. There are also rocks of the Goyllarizquizga and Machay Groups. Near the complex much lime rock lies exposed leaving very small soil areas with scant plant cover.

The site is located in the Steppe Highlands Life Zone in the Western Andes flanks between 1 000 and 3 800 masl. The site is a natural grass steppe. River waters are fast and turbulent, with temperature that varies with height to create water habitats.

With the exception of afforestation carried out by Centromin Peru S.A., flora and fauna in La Oroya are scarce due to geological features, altitude, topography and partly to the action of gas emissions of the Smelter. This is very different from the scenery of perennial grass and pasture found in Casaracra, 10 km away. Water from the Tishgo river is used here at rainbow trout fishfarms. Also present are "puna" gulls, on the Mantaro river banks, even near the Smelter. South of La Oroya, along the course of the Mantaro river, no typical fauna species are found, nor typical vegetation other than some ichu grass. In general, due to site conditions and milieu and quality prevent the use of the land from productive purposes. Some plants brought by Centromin Peru from nearby places or cities have adapted to the site. Also disorderly herding and over-grazing in some areas, hamper grass regrowth and life zone improvements for the development of flora and fauna in that region.

With respect to the social and economic environment of the site, the communities of Huari and Hacienda Quilla are found on the road to Huancayo. The community of Huaynacancha on the way to Lima, and the Hacienda Antahuaru, Paccha and Casaracra communities on the way to Tarma.

In the Province of Yauli out of 67 700 inhabitants 30 900 are from La Oroya. Of these, 3 215 are Centromin Peru S.A. workers and 13 728 depend economically on them.

La Oroya covers two large sectors: Old Oroya situated on the left bank of Mantaro river, northwest from the Smelting facilities, and New Oroya on the right river bank. The "Curipata" housing project is located at 11 km from La Oroya on the way to

Lima. It is sponsored by Centromin Peru S.A. for the benefit of its workers as part of a plan to reorganize the city.

The city is located along the single road to Lima and other cities of the Coast, that also connect it with the rest of the Andes and the Central Amazon region.

Productive activities of La Oroya Metallurgic Complex make possible an important urban area. Handcraft activities have almost disappeared. Prevailing complementary activities are trade (987 establishments), services (228 establishments) and industry (83 establishments). Public Service Companies (Telephone, Mail, Banks, Transportation and Local TV and Radio Stations) are the most important. There are 56 schools of all levels attended by a total 13 192 students. There is a hospital run by the IPSS (Peruvian Institute of Social Security) with 72 beds. The Ministry of Health runs 3 health care centers and Centromin Peru S.A. has a hospital with 50 beds.

There are access roads to cities and places of archaeological interest (Tarma, Jauja, Huancayo), protected natural areas, parks and national reserves (Rock Forest of Huayllay in Cerro de Pasco and Chinchaycocha Lake in Junin), and the touristic circuit (Lima-Tarma-Chanchamayo Valley and Mantaro Valley). They also serve more general.

METALLURGIC OPERATIONS

The Metallurgic Complex consists of 3 integrated circuits for concentrate treatment of copper, lead and zinc concentrates. In 1995, 255 109 t of copper concentrates, 191 575 t of lead concentrate, and 154 710 t of zinc concentrate were processed. Concentrate processing in 1996 should reach similar amounts.

The concentrates are polymetallic nature. The Complex is among within the four (4) world smelters having the capacity to process this kind of raw material to obtain products of well-known international quality.

ENVIRONMENTAL IMPACT

We have identified three sources of impacts: Gas and particle, emissions, liquid effluents and solid waste. In 1995 899.8 t/day of SO₂ and 8.9 t/day of particles were sent to the atmosphere through the main chimney. The last figure represents only 3% of the total generated. The 7.2% of sulfur that enter the process is fixed as sulfuric acid: 4.3% is fixed as solid waste and 80.5% was sent to the atmosphere as liquid sulfur dioxide. Uncontrolled gas emissions also affect the air, but they are difficult to quantify because they are variable and generally spread quickly.

Liquid effluents produced by the Smelter are poured into the Mantaro river by (37) transmitters. Those produced by the copper and lead refineries are poured into the Yauli river by (3) transmitters. Six (6) of them in the smelter and one (1) in the copper refinery are the main polluters. Both rivers, but particularly the Yauli river, arrive in La Oroya carrying with a high content of industrial contaminants.

Industrial solid waste: Copper and lead slag and Zinc ferrites pulp are dumped in the Huanchan site, three (3) Km south of the smelter. Arsenic trioxide, instead, is dumped in the Vado region, 9 Km North from the smelter. Industrial waste is burnt at the smelter and in the copper and lead refineries. Domestic garbage is dumped at a site called Cochabamba, 9 Km south from the smelter. Since these dumps for both

solid waste and garbage were not designed to take into account environmental aspects, they have become sources of pollution to the nearby soils and rivers.

MITIGATION MEASURES

Since 1992, the La Oroya Metallurgic Complex has undergone environmental improvements. However, it has failed to achieve NMP standards currently in force. The need to improve environmental conditions within its area of influence led to the construction and implementation of the New Agglomeration Plant during 1981 and 1983. Between 1990 and 1992 metallurgic tests were performed to change the indexes of the copper layer, resulting in reduced generation of SO₂, slag and particles by 50,000, 80,000 and 1,400 t/year, respectively. In January 1994, the new 312 t/day oxygen plant was finished and in February copper reverberatory furnace with oxy fuel burners was implemented to cut crude oil consumption by 20 000 T/year. To date, the Modernization and Technological Innovation Program has added to several environmental improvements that demonstrate a change of attitude towards more responsible environmental management.

In accordance with environmental regulations, and to mitigate the effects of SO₂ and particles emissions into the atmosphere, two modules are planned to fix 83% of the total SO₂ generated, thus producing sulfuric acid in the amount of 505,000 t/year. The estimated cost of these industrial facilities rises to 90 million dollars and according to schedule, the modules would start operating in 2003 and 2005, respectively.

To mitigate the environmental impact of the Smelter's liquid effluents poured into the Mantaro river, a Treatment Plant is planned using technology recommended by ECOLAB S.R.L. Consultants. The objectives are to reduce the volume of industrial water, partial recirculation of water and elimination of five effluents. The cost of the project amounts to 3.3 million dollars, of which 2.5 correspond to the Plant. Its implementation has been scheduled for years 1998-1999.

The mitigation of liquid and solid pollution of the Mantaro river due to disposal of copper and lead slag requires 2 INBA rotating drainers and a new transportation system for granulated slag at a cost of 6.5 million dollars. The project will be carried out during 1997-1999.

The project for the Closing of Slag Dumps proposed by RESCAN PERU S.A. includes stabilization of slopes, works for collecting infiltration and run-off effluents that pollute soil and water at a cost of 5.25 million dollars. The project also considers recovery and reclamation of the area and will be implemented in 1997-2001. Construction of the new dump in Cochabamba will begin in 2002 at cost of 2.5 million dollars.

A project to close the Arsenic Trioxide dumps at Malpaso and Vado requires encapsulating with geotextile and geomembrane. This solution proposed by ADI INTERNATIONAL INC. requires an investment of 8.7 million dollars. Also planned is a new deposit at the old airport of Vado for an amount of 2.0 million dollars that will be built starting in 1999. This technique is recommended by the EPA from the United States.

The project to close the zinc ferrite dump includes stabilization works, acid effluent control and control of particles blown by the wind. The solution proposed by RESCAN PERU S.A. for 5.6 million dollars includes area land reclamation and will be carried out in 1997-2000. However, due to the high value of metallic contents of zinc ferrites (230 million dollars), they may be recycled using state-of-the-art technology as an alternative. This possibility is under evaluation.

CLOSING PLAN

The importance of the Metallurgic Complex for the social and economic development of the region makes it unlikely that its operations will cease in the long or medium term.

The decision to close it would have to consider not only technical aspects but also economic and political aspects involving actions of detailed planning whose process of fulfillment could be carried out totally or partially. In this direction, we have conceived and structured a Closing Plan/Effective Abandonment aim to protect health and public security, mitigate detrimental environmental effects and promote rapid recovery from the shutdown of metallurgic operations within a feasible, technical and economic framework. Moreover, we consider the continued productive use of site areas in the future.

MONITORING PLAN OF EMISSIONS AND EFFLUENTS

Centromin Peru S.A. is responsible for implementing and maintaining real time monitoring programs based on appropriate sampling systems and on mechanical, physical and chemical analysis, enabling the carrying out of an assessment and control of gas emissions, liquid effluents, solid waste, noise and other elements that can be produced within La Oroya Metallurgic Complex and affect its area of influence.

The environmental monitoring plan for the Metallurgic Complex was prepared on the basis of protocols issued by the respective authority, and will be readjusted as the mitigation projects are implemented. Current infrastructure allows to comply with the requirements in force, anticipating its constant modernization and the acquisition of new instruments. The plan also considers a legal, technical and institutional relations training program.

INVESTMENTS

To solve the environmental problem of the Metallurgic Complex we consider two (2) main investment items:

First, introducing modern technology to change processes and improve levels of competitiveness and environmental improvement health. This will be primarily aimed at reducing SO₂ concentration to facilitate manufacturing of the sulfuric acid. We estimate an investment of 141.0 million dollars.

Second, an Environmental Impact Program (EIP) at an estimated investment of 129,1 million dollars mainly to complement the modernization of processes.

Both items add up to 270,1 million dollars to be invested from 1997 to 2006. This estimated amount was confirmed by KIL-BORN-SNC-LAVALIN EUROPE consultancy company on October 1996.

There is a minimum legal obligation of annual investment for the EIP equivalent to 1% of the value of annual sales. Therefore, the complex would need to make a minimum annual investment of 4,5 million dollars.

If we take into account that the investment level made by the Complex to continue its operations, process improvement and environmental control, has been of 8 to 16 million dollars annually in the last years, without considering modernization projects carried out that surpass the amount established by EIP, we consider the program submitted is feasible and will not affect the economic results of business management.

CONCLUSIONS

The EIP will allow to achieve NPM required by industry authorities.

The program is possible from the technical point of view since it will use recognized and tested technologies. Economically, it will not mean business management deterioration and will be finished in the 10 years determined for adaptation of metallurgic operations.

Investment for EIP amounts 129,1 million dollars, and to 141,0 for modernization.

Gas emissions are the main contaminant agent of the site, thus 70% of program investment is oriented to fix SO₂ in the form of sulfuric acid, which is in great demand due to its worldwide application in megaprojects of Copper deposit, oriented to lixiviation.

Program implementation will place Metallurgic Complex among the companies that will guarantee a sustainable development of its site and millieu, improving the habitat and social and economic levels for future generations.

LA OROYA METALLURGICALAL COMPLEX

1. INTRODUCTION

1.1 Background

Empresa Minera del Centro del Perú S.A. (CENTROMÍN PERÚ S.A.), is a mining company that was created on January 01, 1974, after the Peruvian government expropriated Cerro de Pasco Corporation. Later, a settlement was made through the Cerro de Pasco branch office in Peru.

CENTROMÍN PERÚ S.A., is a state-owned company under private law regime, organized as a corporation (Legislative Decree N° 216), registered in Record Card 10180 of the Company Public Registry of the Lima Public Registry and in entry 4, page 424, Volume 14 of the Mining Company Registry.

It is ruled by its basic law, Executive Order N° 21117; its Company by-law, Supreme Decree N° 019-82-EM/VM; the State-owned Company Activity Act, Act N° 24948 and its Statute, Supreme Decree N° 027-90-MIPRE and other complementary, accessory and modifying regulations among which are the National Budget Law and the Operation and Austerity Regulations of each year and the Law for Private Investment Promotion in State-owned companies, Legislative Decree N° 674 and its Statute, Supreme Decree N° 070-92 PCM.

Operation, water usage and industrial waste dumping licenses are the following:

- a) License resolution for the operation of the plant (MEM) R.D. N° 155-93-EM/DGM.
- b) Authorization for water usage (Ministry of Agriculture)
 - 1. La Oroya - Rio Mantaro - R.S. 853
 - 2. La Oroya - Riachuelo Huaynacancha - R.S. 08
 - 3. Sacco - Riachelo Sacco - R.S. 460
 - 4. La Oroya - Rio Mantaro - R.A. 027/94
 - 5. Paccha - Rio Tishgo - R.A. 028/94
 - 6. Santa Rosa de Sacco - Rio Yauli - R.M. 0142077
 - 7. La Oroya - Riachelo Tinco Cancha - R.A. 086-93
- c) Authorization for dumping industrial wastes (Ministry of Health)
 - 1. Lead Refinery - 023/ V-93
 - 2. Wire rod Mill - 024/ V- 93
 - 3. Smelting and Copper Casting - 025/ V-93
 - 4. Copper Sulfate Crystallization - 026/ V-93
 - 5. Hydrofluosilicic Acid - 027/ V-93
 - 6. Cadmium Pilot Plant - 028/ V-93
 - 7. Zinc Electrolytic Refinery - 029/ V-93
 - 8. Sinter Plant - 030/ V-93
 - 9. Anodic Residues - 031/ V-93

10. Indium Plant - 032/ V-93
11. Copper Smelter - 033/ V-93

Regarding environmental aspects, the company must comply with the Environmental and Natural Resources Act (Leg. D. N° 613), Section XV of the Single Unifying Text of the General Mining Act. (S. D. N°016-93-EM and N°059-93-EM), R.M. N° 315-96-EM/VMM (Maximum permitted levels of elements and compounds present in gas emissions from metallurgical units). Likewise, R.M. N° 011-96-EM/VMM (Maximum permitted levels for liquid effluents from metallurgical processes).

In compliance with the environmental norms established for metallurgical activities, the company presented the Preliminary Environmental Evaluation or EVAP dated March 1995. After providing the requested additional information concerning the EVAP to the General Bureau of Environmental Affairs of the Ministry of Energy and Mines, on July 31, 1995, the company agreed to present the Environmental Impact Program (PAMA) on August 30, 1996.

1.2 PAMA Objectives

The main objectives of PAMA are:

- To evaluate the present situation of natural components that could be affected by the metallurgical activity and other complementary activities and to identify the sources and/or causes of the present and possible environmental degradation.
- To establish actions to mitigate and prevent environmental degradation making the necessary investments to apply the latest technology to the operations and metallurgical process with the purpose of reducing or eliminating emissions and/or waste dumps and thus comply with the rules and procedures established by the M.E.M.
- To point out procedures in execution, investments, monitoring and control of effluents and restoration of the original environment. Also, to establish preventive measures against extreme environmental degradation (Contingency Plan).

1.3 Brief summary of the physical location of the La Oroya metallurgical complex

The complex is located 175 km northeast of the capital of Peru in the high Andean region, on the eastern flank of the western Andes at 3 750 m.a.s.l. in the Cáceres region, with a total area of 9 209 Ha. Its coordinates are:

- | | |
|------------------------------|-------------------------------------|
| - Smelter | 8 126 087.1 north
402 225.3 east |
| - Copper and Lead Refineries | 8 725 007.5 north
399 573.6 east |

Drawings 1.3/1, 1.3/2 and 1.3/3 show the layout of the La Oroya metallurgical complex and its surroundings, in a 10 km radius, the center of which is the main chimney of the

Smelter. These drawings show the contour lines of the topography of the zone, with mountains of 4 400 m.a.s.l. and the mining concession area of the La Oroya unit. They also show the Yauli and Mantaro River courses that form a "Y" intersection near the smelter. Towns and cropland areas are in the vicinity of the Yauli, Mantaro and Tishgo river basins, as well.

1.4 Short history

Company background

The main events preceding the establishment of the Oroya metallurgical complex were:

- 1902 Beginning of mining operations in Cerro de Pasco.
- 1904 Completion of La Oroya-Cerro de Pasco railroad.
- 1906 First blister copper bar made in Tinyahuarco-Cerro de Pasco.
- 1913 Beginning of operations in Morococha.
- 1918 Beginning of operations in Casapalca.
- 1922 Establishment of the La Oroya metallurgical complex.
- 1937 Beginning of operations in San Cristobal, among others.

La Oroya metallurgical complex

In 1922, the La Oroya metallurgical complex was established with just the Copper Smelter. Then, in 1928, the Lead Smelter was built followed by the addition of the Zinc Refinery in 1952.

Since that time, the company has been concerned with environmental problems and has put into effect measures to mitigate and control the environmental impacts of effluents and emissions, as well as handling and disposing of solid residues coming from their operations. Plants for the recovery of subproducts were built as needed.

Following are some main events in chronological order:

- 1922 -The first blister copper bar was made in the La Oroya Copper Smelter.
- 1928 -The lead blast furnaces start operating.
- 1929 -Creation of the Metallurgical Research Department.
- 1937 -Start-up of lead electrolytic refining on an industrial scale in the Anodic Residues Plant
- 1939 -Beginning of operations in the Sulfuric Acid Plant to collect gases from the copper roasters.
- 1941 -Installation of electrostatic precipitators for the recovery of dust (central cottrel system).
 - The Antimony Plant begins to operate.
- 1944 -The coke plant begins to operate.
- 1948 -Completion of the industrial plant for copper electrolytic refining.
- 1950 -Completion of the Silver Refinery
- 1951 -Relocation of the Lead Refinery to Huaymanta, doubling its capacity.
 - Beginning of operations of the Oxygen Plant from liquid air.

- Completion of the zinc electrostatic refining industrial plant.
- The name Cerro de Pasco Copper Corporation is changed to Cerro de Pasco Corporation.
- 1952 -The Zinc Electrolytic Plant starts operating.
- 1954 -Selenium is produced for the first time on a commercial scale.
- 1955 -Telurium is produced for the first time on a commercial scale.
- 1957 -The second oxygen plant from liquid air is built.
 - Widening of copper reverberatory furnaces.
 - Start-up of operations of the Lead Dross Plant.
- 1958 -Installation of the ventilation system in the loading area of the lead furnaces.
- 1960 -The installation of the ventilation system in the Sinter Plant is completed.
 - An electric generator is installed in the Copper Refinery to increase its capacity.
- 1962 -The zinc plant expands to 150 ST/day. (136,4 t/d)
- 1964 -Improvement of ventilation system in the molten slag discharge system of lead furnace, canals and lead pots.
 - Installation of suspended brick system in the copper reverberatory N°2.
- 1965 -Installation of the Asarco Furnace for the smelting of copper cathodes.
- 1966 -A new boiler and air pre-heater installed in the copper reverberatory N°2
 - Ventilation of the Sinter Plant is improved by the installation of gas scrubbers.
 - Ten (10) additional furnaces are installed in the Coke Plant.
 - The fluid bed roaster for zinc is installed.
- 1967 -The new Sulfuric Acid Plant of 200 t/d starts operating
 - The Wire Rod Plant CIDECSA is inaugurated.
 - The modernization of the Central Cottrell starts.
- 1968 -The Roy Tapper continuous extraction system is installed in Lead Furnace N°1.
 - The construction of the Zinc Leach Residue Plant is completed.
 - The Zinc Electrolytic Plant is expanded from 150 to 200 ST/day (181,82 t/d)
- 1969 -The new hot cottrell for the Arsenic Plant starts operating.
 - Beginning of Phase I in the Dust Treatment Plant
 - Installation of a new silicon ITE rectifier in the Copper Refinery.
 - Completion of the modernization program of Central Cottrell.
- 1970 -The continuous slag extraction system is installed in Lead Furnace N° 2.
- 1971 -The suspended brick roof is installed in reverberatory N°1.
- 1974 -On January 1, the Peruvian Government nationalizes "Cerro de Pasco Corporation" and creates "Empresa Minera del Centro del Perú S.A." CENTROMÍN PERÚ S.A.
- 1976 -The Copper Refinery is expanded to 20 blocks.
- 1978 -The new Ajax Furnace for 408 t/d of zinc cathodes starts operating in the Zinc Division.
 - The Flotation Plant for Zinc and Silver Sulfides begins operating.
 - A new wet electrostatic precipitator is installed in the Sulfuric Acid Plant.
- 1979 -The unit for separation of solids of 3 380m³ a day of impure zinc sulfate solution starts operating.
 - A new cupel is installed in the Anodic Residue Plant.
- 1980 -The new Tishgo water pipe is interconnected.
 - The GO 800 Oxygen Plant of 25 t/d, made by the LINDE company starts operating.
- 1981 -Construction of the new Sinter Plant begins.
- 1983 -The new Sinter Plant starts operating on a 810 t/d capacity. One (1) up draft

machine replaces five (5) up draft and six (6) down draft machines (11) in total, with a US\$ 60 million investment.

1987 -Pre-feasibility study of the Oxy-fuel Plant made by SNC.

1990 -Tests to change metallurgical indexes begin in the Copper Smelter. In December 1990, these tests are optimized.

1991 -Evaluation and adjustments on an industrial scale were made of changes in metallurgical indexes in the copper mix bed.

-Lead furnace Nº3 is modified. The intermittent casting was changed to continuous casting; the former design was an Arents siphon and the modified corresponds to a box-type Roy Tapper.

1992 -Change of the metallurgical indexes of the copper mix bed is established based on 70 000 t/year of Cu production, the main results are shown in the oxy-fuel project in 1994.

-The sludge from the Sinter Plant scrubbers in the thickener tank is recirculated, eliminating the Oliver filter. This contributes to reduce contamination in the Mantaro River.

-Civil works of the new LINDE oxygen plant are started in March with a US\$ 24 million investment.

-In October, the bag house (60 bags) is installed to improve working conditions in the screening and crushing unit.

-In December, the automatic operation and processing of continuous leaching starts.

-Two converters are reconstructed and modified; increasing the capacity of converters 2 and 4 by 15%.

1993 -In January, the new (SVEL) ventilation system for the FBR zinc roasters is installed.

-In March, the electrical-mechanical installation of the Oxygen Plant begins, and on December 1, Centromín receives the acceptance and consent certificate of the Oxygen Plant, reaching a plant capacity of 312 t/day, with 95 % pure O₂.

-A 20 000 gal. tank is installed to recycle cooling water from the lead furnace jackets.

-Reverberatory Copper Furnace Nº 2 is shut down to do maintenance work and modifications to change it to the oxy-fuel system.

-A ventilation system for the discharge of copper calcine is installed.

-In October, the Zinc Ferrites Treatment Plant starts operating; in November, the continuous purification system is implemented.

1994 -On January 17, the electrical- mechanical and instrumental installation of the Oxy-Fuel Project concludes. This project was executed by technical personnel of Centromín with technical assistance from INCO, ENICO and SNC LAVALIN of Canada with a US\$ 2 million investment.

-On January 18, the vertical oxy-fuel burner Nº 8 is started up and the conventional horizontal burners are progressively turned off.

-On February 6, the eleven (11) vertical burners are tested at an industrial level in the reverberatory furnace Nº 2. Since then, they operate on an average of six (6) oxy-fuel vertical burners and two (2) horizontal burners. This project increased the capacity of the smelter from 62 000 to 75 000 t/yr of blister copper (potential capacity, 80 000 t/yr).

-In respect to 1989, the results achieved by the change of metallurgical indices and

the oxy-fuel project were:

- Reduction of 100 193 t of pyrites equivalent to 82 158 t of SO₂ and to 127 757 t of H₂SO₄ (index reduction from 1,9899 to 0,07239 t of pyrite/ t Cu between 1989 and 1995).
 - Reduction of 124 800 t of slag (index reduction from 5,52 to 3,13 t of slag/ t Cu between 1989 and 1995).
 - Reduction of fuel oil N° 6 (reduction of indexes from 0,935 to 0,36 t of oil/ t Cu between 1989 and 1995).
 - Reduction of volume of gases generated from 72 600 to 50 220 Nm³ /h (19 000 Nm³ /h theoretical) improving the quality of the air in the surroundings.
 - Reduction in size of the smelter by shutting down reverberatory furnace N° 1, two (2) boilers and six (6) Cu roasters.
 - Dismantling of copper reverberatory furnace N°1 and boilers.
 - Construction of concrete foundations for a new SVEL 4 ventilation system to improve the collection of gases in the lead furnaces.
 - The former Sinter Plant is dismantled.
- 1995 -The Copper Refinery increases its plant capacity to 66 500 t/yr (block N° 22 starts operating).
- Recovery in the Zinc Refinery is increased from 80 % to 86 % reducing the ferrite production to 9 200 t/yr.
 - General repairs in reverberatory furnace N° 2 (oxy-fuel).
 - The number of roasting units is reduced from 18 to 12 (8 for Cu, 2 for Pb, 1 for As and 1 for Sb), improving the collection of gases and powder.
- 1996 -Dismantling of 6 roasters begins. This work will concluded the first trimester of 1997.
- On June 7, the Lead Refinery starts operating the project: recovery of fluorsilicic acid by filtering the anodic lead sludge (LAROX filter), returning the filtered acid solutions to the electrolytic cells closing the circuit. The result was ZERO emission of effluents to the Yauli River.
 - New oil tanks to supply the copper and lead smelters are relocated and installed.
 - The purchase of the copper blister casting turntable is approved making a 20% down payment. The shipping date was fixed for March 10, 1997.
 - On July 1, the twelfth block starts operating, increasing the capacity of the Lead Refinery from 91 000 to 99 000 t/yr.
 - Oxygen pipes were laid for the Sinter and Anodic Residues Plants. The oxygen will increase the capacity of both plants, help generate less dust and gaseous emissions, save on fuel, and eliminate sodium nitrate that generates nitrous gases.

2. ENVIRONMENTAL COMPONENTS DESCRIPTION

Environmental components are grouped into 4 environmental categories:

- Physical Environment
- Biological Environment
- Social-Economic Environment
- Human Interest Environment

2.1 Physical Environment

2.1.1 Topography – La Oroya

The rugged topographic environment of the La Oroya Metallurgic Complex is comprised of large depressions. In its course, the Yauli river, which is tributary to the Mantaro river, flows through a flat topographic belt where several villages have been established.

The Mantaro river crosses La Oroya city from North to South and forms a very narrow valley. Downstream of the Mantaro river, after La Oroya and in the direction of the Huancayo, the valley becomes narrower and rugged where rocky outcrops of great height predominate.

In higher areas, on the right bank of the Mantaro river, the topography is slightly flat with numerous traces of gullies which have formed as a result of intense rains within the area. However, even at the highest elevations, rugged topographic features still prevail.

Charts N°1.3/1 and 1.3/2 of Chapter 1 describe the topographic environment of the area influenced by the La Oroya Metallurgic Complex.

2.1.2. Water Supply

The La Oroya water supply for industrial and human consumption is outlined in diagram 2.1.2/1, and includes the following systems:

Tishgo System: The water supply for this system is the Tishgo river and its collecting point is 14 km north of La Oroya city.

Cuchimachay System: Its water supply is the Cuchimachay spring. Collected water supplies drinking water to La Oroya Antigua village and to the Smelter for steam boilers.

The Mantaro River Pumps: Collected water from the Mantaro river is pumped for use to granulate copper and lead Smelter slag.

Emergency System: These systems initiate when the Tishgo system fails. They include:

- **Hydro Pumps:** This system collects underground water and sends it to the Railway tank.

- Mayupampa Pumps: This system is similar to the previous one. Collected water is sent to the Chulec tank.

The next table shows the physical-chemical analysis of water collected from the three systems.

Physical-chemical Analysis of Water Collected from the Three Systems

Elements	Tishgo River mg/l	Cuchimachay Spring mg/l	Mantaro River mg/l	Water Class III LMP mg/l
Pb	0,12	0,09	0,06	0,10
Cr	0,01	0,01	-	0,05
Ag	0,01	0,01	-	0,05
NO ₃	0,39	0,08	-	0,10
Fe	0,43	0,13	0,37	1,00
Mn	0,26	0,01	1 273,35	0,50
Cu	0,05	0,06	0,07	0,50
Zn	2,22	0,07	1,07	25,00
SO ₄	130,78	629,00	-	400,00
Mg	106,00	91,00	-	150,00
Ca CO ₃	163,00	618,00	-	
OD ⁽¹⁾	9,50	5,00	-	3,00
JTU (Pt) ⁽²⁾	3,02	0,32	-	
pH	8,23	7,80	7,8	5 - 9

(1) Dissolved Oxygen

(2) Joules Turbulent Unit

2.1.3 Climate and Meteorology

The La Oroya climate is frigid with two marked seasons: the humid season experiences frequent precipitation events which can sometime bring snow or hail to the region. Rainfall typically channelizes through small gullies and streams toward the Mantaro river which serves as the primary receiving body for the regional basin. The humid season occurs between November and April. The dry season occurs between April and October.

Weather characteristics influence the atmospheric pollution and its adverse effects in the La Oroya region. Wind direction and wind speed were measured at La Oroya at

three stations: the first station is located in the Smelter area and the other two are at Cushurupampa (NW from the Smelter) and Huanchán, respectively (SE from the Smelter). The last two use Kimoto type 332-TW monitors.

The Meteorological Station at the metallurgic complex was installed in 1925. This station measures parameters such as wind direction and speed, rain pattern, environmental temperature-relative humidity, and barometric pressure. Results from this station, however, were not obtained for use by the Company. Instead the results were incorporated as part of the nationwide meteorologic database. As such, this database was part of the meteorological network of the Meteorology and Hydrology National Service - SENHAMI - stations, and followed this organizations guidelines.

a) Wind Direction and Speed

Wind direction and speed data for the La Oroya region are registered in the diagram 2.1.3/1 and the table 2.1.3/1. From such data we have determined that the morning winds (between 7 and 10 a.m.) typically blow from North to South through the Mantaro valley. After 10 a.m. they blow from South to North. However, wind roses (Diagrams Nº2.1.3/1, 2.1.3/2 and 2.1.3/2A) for the two urban stations clearly show the absence of predominant winds on a daily basis. The lack of predominant wind directions indicate that the wind sources and their trajectory in the La Oroya region frequently occur in all possible directions.

If we relate typical wind direction characteristics to distribution of pollutants, as a preliminary approximation, it is easy to understand that no area is constantly exposed to contaminating particulates or gases. However, diffusion of these elements within the atmosphere is dynamic as it is dependent on varying dispersion circumstances which may or may not stabilize over the narrow Mantaro-Yauli basin.

The average wind speed tables and diagrams show winds travelling under 2m/s. These speeds are considered less favorable for dispersion of atmospheric pollution because they do not allow the desired air to dilute or "clean" the industry impacted air.

An exception to the above phenomenon is illustrated in the wind rose for the Huanchán Station (Diagram 2.1.3/1). This rose shows the winds going from South to West which is favorable for diffusion of air pollutants as the air can travel down the Mantaro canyon and disperse outside the Mantaro valley.

It is noted that micro-climate phenomena and local wind characteristics can develop based on topographical conditions in the region. As such, wind behavior in the La Oroya atmosphere is likely to be greatly influenced by the rugged local topography which restricts the spread of the industrial and urban areas and makes dispersion of pollutants more difficult at times.

b) Rainfall

Typically, January is the rainiest month and July the driest (106,5 mm H₂O and 0,0 mm H₂O respectively) in the La Oroya region. Normally, in areas of atmospheric pollution, precipitation is regarded as beneficial because it "washes" the ambient air.

Nevertheless, in the case of La Oroya it is related to a negative effect as the dust becomes an additional source of pollution to the Mantaro river. This "washing" action occurs on surfaces that have accumulated pollutants over a long time period.

Once precipitation contacts these surfaces these pollutants are dissolved and carried to the rivers Yauli and Mantaro.

The pluvial measurements are taken at both the Smelter station and Mayupampa substation. Annual average values estimate 568,10 mm of water for the Smelter station in a 72-year period and 563,70 for Mayupampa station in a 39-year period (Table 2.1.3/2).

c) Temperature and Relative humidity

The temperature in La Oroya and its surroundings (table N° 2.1.3/3 and diagram 2.1.3/3) range between 26°C in December and the lowest -4°C in May. Relative humidity is also varied, fluctuating from 5% in July-September to 72% in January-March. As a whole, these data do not correspond to normal local weather conditions and generate contradictory weather conditions that might increase or reduce the effects of environmental pollution.

d) Barometric Pressures

Barometric pressures are measuring in the Smelter Station and expressed in KPa (kilo Pascal) units. The average monthly hour values are reviewed in table 2.1.3/4.

These values are critical to estimate emission dispersion. As for monthly averages, the highest pressure typically occurs in October and the lowest in December (66,14 Kpa and 65,14 Kpa respectively).

2.1.4 Air

Ambient air around the La Oroya Metallurgic Complex has suffered quality alterations due to gas emissions and particulate matter, which are characteristic of metallurgical operations.

5 monitoring stations have been placed in different outlying areas of the Smelter (Table 2.1.4/1) to determine and evaluate pollutants according to environmental air quality. The evaluated pollutants include sulfurous gas expressed in SO₂, Suspended Particulate Matters (SPM), and metallic contents (As and Pb).

The monitoring results from these stations are showed in Tables 2.1.4/2, 2.1.4/2A, 2.1.4/3 and 2.1.4/3A. In addition, table 7.2.4/1 of Chapter 7 describes monitoring stations in the areas surrounding the complex.

Air quality values from the Company monitoring system versus the maximum permitted levels are described below.

PARAMETER	UNIT	ENVIRONMENTAL AIR QUALITY AROUND THE COMPLEX (5 MONITORING STATIONS)	MAXIMUM PERMITTED LEVELS RML- 315-96-ENVMM
SO ₂	ppm Arithmetic mean daily	From 0,06 to 0,24 (*)	0,20
Pb	µg/m ³ Arithmetic mean annual	From 0,07 to 2,94 (*)	0,50
As	µg/m ³ Arithmetic mean daily	From 0,1 to 1,7 (*)	6,00
MPS	µg/m ³ Arithmetic mean daily	From 86,0 to 294,0 (*)	350

(*) When thermal inversions occur, highest values appear.

Suspended Particulate Matters (SPM)

Particulate polluting evaluations are conducted using two independent methods. Even though these methods are independent of each other, it is interesting to compare them as they are developed in the same sampling stations.

In one case, Kimoto type 331-TW monitors are capable of evaluating SPM similar to high volume equipment (Hi-Vol). The Hi-Vol equipment or Kimotos manage huge air volumes from where SPM are integrally filtered in a 24-hour period or more. Whereas in the tape samplers, sampling is sequential (every three minutes), thus obtaining maximum, minimum, and average values.

Something even more important is that the paper tape or blot methods evaluate particles that are only fractions lower than 10 microns, known as PM₁₀. That is to say that, the equipment is able to discriminate (by a cyclone system) breathable portions of PM₁₀ (which pose public health concerns) from the total amount of air floating particles.

As mentioned earlier, Hi-Vol collects all non-sedimentary matters, among which we find particles larger than 10 microns. These conceptual and operational differences explain in turn, the differences in the estimated values.

Metallic Contents in SPM

To detect three polluting chemical elements (As, Pb, and Cd) in processed matters, determinations are carried out in SPM samples obtained both by the paper tape or

Hi-Vol methods. These determinations are performed on monthly representative composites using analytical laboratory protocols.

2.A.1 Geology and Seismicity - La Oroya

a. Geology

The oldest rocks found in La Oroya belong to the Pucará Group (Triassic-Jurassic). They are composed mainly of light gray to white shale that may overlay rocks belonging to the Mitu Group (Permian age). There are also rocks from the Goyllarisquizga Group, composed of sandstone and red lutite, and shale layers interstratified with basaltic or diabasic layers. Overlaying these rocks we find the Machay Group, composed of bluish-gray bituminous shale from the Pariatambo Formation and light colored, lutaceous, marly shale and phosphate from the Chulec Formation.

To the South of La Oroya there are outcrops corresponding to the Red Beds of Tertiary age. Several Quaternary deposits overlay this outcropping layer as explained below:

•Alluvial Deposits

These irregular deposits are in the Mantaro and Yauli rivers forming terraces from different ages and dimensions within the Quaternary period. The La Oroya Smelter and Huaymanta Refineries are located above these deposits. Fragment dimensions range from blocks, gravel, fine gravel, and some sand. The composition of these matters is varied.

•Fluvioglacial Deposits

This type of deposit predominates at higher elevations where remnants of ancient glaciers are located. In many cases only remnants of big ancient deposits have endured.

•Colluvial Deposits

These deposits compose the slopes of the rocky escarpments originated by rock erosion. These deposits are small and irregular.

•Elluvial Deposits

In some places it is possible to find rocks turning into soils. These are considered Elluvial depositions a few of which are found in the La Oroya region.

b) Folding and Faulting

Rocks close to the Mantaro river are strongly folded with nearly vertical dips. In some cases they are dislocated from regional faulting. To the southwest and northeast of the river, folding softens and gives way to wide anticlinal and synclinal folds.

c) Geomorphology

The area surrounding La Oroya Metallurgic Complex presents some geomorphologic characteristics such as: the Mantaro river with tributaries like the

Yauli river, Shincamachay, Huashango (Paccha), Pacchapata (La Oroya Antigua), the Seco river and some minor ravines that have been cut through calcareous rocks, sandstone, lutites, etc. of different rock formations. In areas of higher elevation, remnants of the original Puna surface can be identified.

Fluvial terraces which consist of mechanically and chemically weather (travertine) Sacco-Tambo and Shincamachay deposits overlay the riverbeds of the Mantaro and Yauli rivers and other areas to a lesser extent (i.e. La Oroya Antigua - covered by the village).

The elevation at La Oroya varies between 3600 and 4600 m.a.s.l., whereas the Smelter and Refineries are located at an average elevation of 3750 m.a.s.l.

Currently rill formations (erosion crevices) are evident in the La Oroya region. These were produced by acid rains which fell in the La Oroya surroundings and on the soil surface that has been left without natural plant protection (ichu). This erosive effect is intense around the Smelter and decreases gradually as it moves away from this center.

d) Seismic Area

From the tectonic point of view, La Oroya Metallurgic Complex is located in Zone 1 (National Construction Regulation) which corresponds to a highly seismic area. For construction we must take into account the antiseismic parameters established by the Regulation, and construction must be made mainly of two stories or less.

2.1 Soil Evaluation

It is very important to study and evaluate these natural resources for physical, chemical and biological purposes. Soil Studies were carried out on soils samples taken from affected areas, as well as from bordering areas.

In table 2.1.6/1, the results from the analysis show these soils are impoverished without vegetal cover. There is no nitrogen (by the lack of vegetation) nor calcium.

As a whole, soils are slightly acidic due to the lack of calcium, as well as because of the rain on soils with little vegetation and to the adverse effect of Smelter emissions.

In samples taken from La Oroya Antigua, which faces the metallurgical complex, analysis results indicate the presence of calcium carbonate in large percentages. This may be attributed to shale desegregation in the highest part of the mountains. Also the pH of these soils is slightly alkaline and its texture, which is dry and sandy, resemble the texture of the soils located in the Huaynacancha sector.

2.1 Biological Environment

2.2.1 Characterization

The bioregion of the Highland Steppe extends from the La Libertad department to the North of Chile and the western Andes slopes. This bioregion is between 1000 and 3800 m.a.s.l., and borders the coastal desert region to the west and the Puna mountain region to the east. The highland steppe has an interesting ecological formation characterized by its own climatological, edaphic, plant and animal factors. It is called highland steppe due to the predominance of grasses and other vegetation typical to steppe environments. Its climate differs from the coastal desert and the mountain Puna (Diagram 2.2.1/1).

b) Land Ecosystem

The land ecosystem is primarily composed of grass and shrub vegetation including *Lupinus* communities and some herbaceous plants from *Baccharis*, *Polypepis*, *Buddelia* and *Alnus* genera. These are associated to gramineae sp. such as: *Stypa ichu*, *Stypa brachyphylla*, *Calamagrostis vicunarum*, *Calamagrostis antoniana* and *Fetusca heterophylla*, which are used for grazing. (Diagram 2.2.1/2).

In the Highland Steppe, the intense and unmanaged cattle raising destroys wild vegetation. This hampers natural regeneration and propagates soil erosion.

Habitat destruction, originated by natural vegetation loss, is the main cause of species extinction in this area including wild plants and animals and especially endemic species that have a restricted distribution.

Animal populations are well represented by the Viscacha (*Lagidium puna*). The animals of this area are highly influenced by elements of the Puna. Species from Bird populations include the "Peruvian turtledove" (*Euphelia cruziana*), the hummingbird (*Myrtis fanny* and *Thaumastura cora*) the "black" (*Dives warszewiezi*), the "black thrush" (*Molothrus bonariensis*), and the "chisco" (*Mimus longicaudatus*).

c) Aquatic Ecosystem

The rivers of the western slopes are typically rapid and fast-flowing. Their temperature decreases with altitude, thus creating an interesting zoning of aquatic habitats among which we can include: Riverbeds with currents, Andean streams, earth and stone gorges, denuded riverbanks with stones, rocky riverbanks and banks with low vegetation.

Among the birds found in this ecosystem we can include the "duck of the torrents" (*Merganetta armata*) and the "Aquatic blackbird" (*Cinclus leucocephalus*), both of which prefer clear water and fast-flowing streams.

Among the local amphibians we have the "Common Toad" (*Bufo spinolus*) and species like (*Telematobius jelskii* and *Telematobius runac*).

Native fish have not been studied in great detail, however the "Chalwa" (*Oretias* spp.) and trout (*Salmo* spp.) are noted to be naturally occurring and/or introduced to the region.

2.2.2 Ecosystems - La Oroya Metallurgic Complex and its surroundings

The Metallurgical Complex is placed in the valley that forms the basin of the Mantaro and Yauli rivers at 3750 m.a.s.l.

The population center and farming area for La Oroya are located next to the Yauli and Tishgo river basins.

A description of the land and aquatic ecosystems has been carried out in a 10-Km radius with its center at the main chimney of the Smelter.

b) Land Ecosystem

La Oroya Metallurgical Complex is in the mesoandean valleys, with a total surface of 9209.83 Ha, distributed in the following way:

1. Six non-metallic mining concessions : 4500.00 Ha
2. Nine rustic properties : 2669.83 Ha
3. Three quarries : 2040.00 Ha

Geographically, the complex covers the western part of the central Andes between 3700 and 3800 m.a.s.l. La Oroya borders the following states and communities:

- | | |
|----------------------|---------------------------|
| - Antahuaro estate | - Oroya Antigua Community |
| - Tallapuquio estate | - Huaynacancha Community |
| - Huaymanta estate | - Huari Community |
| - Quiulla estate | |

The topographic relief is rugged with steep slopes and acidic soils with reddish and brown tones. Also, fertile soils such as dystic and eutric cambisols have been encountered in small portions.

The plants near the Metallurgic Complex are growing and evolving naturally (spontaneously). A plant chemical analysis is observed in Table 2.2.2/1 (picture 2.2.1/1).

At 10 Km North away La Oroya rises Casaracra. This place is constituted by perennial grasses and herbs among which include *Festuca heterophylla* and the *Stypa ichu*. "Choca" (*Chuquiragua huamanpinta*), the "Caqui Caqui" (*Adesmia spinosisima*) and some cactus also thrive in areas disturbed by grazing. (Picture 2.2.2/2). Animals in the region include sheep and cattle. Birds are scarce but we can mention the "Puna Seagull" (*Larus serranus*).

The few tree species we have observed among all this way shrub-like vegetation

include the colle (*Buddleia coriacea*) and the *Polylepis racemora*. Likewise, brooms and maguey (*Agave americana*) have also been identified.

No typical regional vegetation was observed to the south of La Oroya, at the border of the Mantaro river and in a 7-km radius, except for the *Stypa ichu* which is scarce due to the Smelter emissions. Dense vegetation in this area and on the slopes of the river banks tends to include grasses such as the *Festuca* sp and the *Stypa ichu*. There are also some species as Quishuar and some cactus in the area. (Picture 2.2.2/3).

The effects of Smelter emissions on the ecosystem can be directly observed in the western region of the La Oroya at areas of high elevation (approximately at 4000 m.a.s.l.). An estimated area of 3829 ha has been affected and still requires recovery. The effects of the emissions on these soils is clearly visible (Picture 2.2.2/4).

In the middle of the Huaynacancha valley there is a small lagoon which holds pluvial and ice deposits. Here sheep drink water and birds like the "Huallata" or "Washwa" make their nesting place. Vegetation species such as the padded plant life and gramineae are present in small populations

Trees such as Colle, quenoal, Cypress, Quishuar, etc are located within 10 km of the complex around the employees' residence (Inca Hotel), the complex general offices, and bordering towns.

c) Aquatic Ecosystem

Lotic Environment: Tishgo river, Mantaro river and Yauli river.

The Tishgo river joins the Mantaro by the Casaracra estate. Water from the Tishgo is treated and used for domestic consumption. Some time ago Tishgo waters were used for stocking and fishing "Rainbow Trout". No fish have been found in other aquatic organisms within the La Oroya region. The vegetation by this river is primarily composed of grasses.

The Mantaro river flows from North to South through the La Oroya complex, carrying elevated concentrations of pollutants. As it flows through the complex, the Mantaro receives effluent contributions from the Copper and Lead Refineries (through contributions from the Yauli river which brings some pollutants like tailing residues), the copper and lead slag granulation areas, the main channel N°2 of the Copper and Lead Smelters, the Zinc Electrolytic Plant, the main channel N°1, the channel parallel to point 135, and the Zinc ferrite deposits.

There are no representative organisms of the animals and plants, except the "Puna Seagull" (*Larus serranus*) and the Huallata that were observed near or in the Yauli or Mantaro receiving rivers.

Table 2.2.2/2 shows the monitoring values for the Tishgo, Yauli and Mantaro rivers.

As it can be appreciated, the Yauli and Mantaro rivers contain lead concentrations that exceed the Maximum Permitted Limit. Cadmium, one of the most dangerous elements, is also found in the Mantaro river. Iron increases its concentration when passing by the smelter as does manganese (5 times its concentration). Arsenic is also present. In addition, both rivers receive domestic emissions from the entire village.

2.3 Social-Economical Environment

The La Oroya Metallurgical Complex contributes to the welfare and social-economical development of Central Peru and the country as a whole. It produces refined materials of high quality and sub-products that are useful in both domestic and international industries.

2.3.1 Description of the Social-Economical Component

- b) The locations and description of the La Oroya Metallurgical Complex as a mining settlement and the human settlements surrounding the Complex facilities are derived from records from the city of La Oroya.

The main inhabited areas of the local environment are the following:

On the road to Huancayo: the Huari Community, the Quiulla Estate.

On the way to Lima: the Huaynacancha Community.

On the way to Tarma: the Antahuario Estate and Casaracra area after Paccha.

On the way to La Oroya - Cerro de Pasco, there are 8 more settlements.

The main demographic indexes used for comparison in this PAMA are in the following Table:

Main Demographic Indicators - La Oroya

Indicators	Junin	Yauli	Distric:		
	Department	Province	La Oroya	Paccha	Sta. Rosa Sacco
Total Population (thousands of inhabitants) 1993	1 093,0	67,7	30,9	2,2	12,5
Growth rate 81-93	1,7	-1,4	-1,4	- 0,8	3,2
% Rural Population	36,0	9,0	2,0	32,7	0,5
Illiteracy rate (% 15 years or older)	13,4	9,1	9,1	5,2	6,1
Infant mortality rate (x 1 000)	63,0	56,8			
EAP 15 year or older	50,5	48,7	49,3	45,9	43,1
Economic Dependence Rate	242,6	266,5	251,8	302,9	304,6

SOURCE: INEI Population and Housing Census 1993. Junin department and Centromin data. Map of Unsatisfied Home Basic Needs. INEI 1995.

We can see that La Oroya and Santa Rosa de Sacco districts account for 64,1% of the population in the Yauli province. Both are highly urbanized districts.

As to the Company workers, we found that 92% are married and most of all come from the central part of the country: 79% from Junin, 5% from Cerro de Pasco, 5% from Huancavelica and 11% from other parts.

The 33% of the workers raise 1 to 3 children and 40% 4 to 5 children. Besides, 90,4% of the workers' wives dwell in La Oroya. From 3215 workers, 13728 people are economically dependent. 43% of the workers have between 31 and 45 years old, and 32% more than 46 years. 63% of the workers reached high school education.

On the other hand we must point out the demographic growth in La Oroya is still showing a negative rate compared to 1981. The decrease of La Oroya population between 1981 and 1993 (-1.4) period is due to the streamlining politics that Centromin established during mining crisis times and in the previous process to

privatization.

There is also a floating population of 2500 people that frequently travel to La Oroya for business reasons.

La Oroya Antigua and La Oroya Nueva

La Oroya Antigua.- faces the Smelter at the left bank of the Mantaro River on the road traveling to Huancayo.

It is made up of flat areas near the roads and surrounding streets, and extends to the steep mountain slopes without much planning. Its layout is irregular and disordered.

Buildings are very old, mostly in an advanced stage of deterioration. These facilities currently shelter villagers with no relation with Centromín.

The occupation of urban areas is saturated which causes overcrowding to several alley ways. The area is essentially used for housing, but small businesses and two markets prosper, as well as a church, a public school, three primary schools and a private school.

In this area there are neighborhood assemblies. The primary assemblies which are comprised of members from the population at large include: Mayta Capac, San Luis, Tayaupata and Plaza Libertad.

La Oroya Nueva.- Located at the right bank of the Mantaro river. It is the area where Company facilities are placed, facing La Oroya Antigua. It is located on the road that extends to Tarma and Lima.

The way to Tarma goes from the Paccha district and in the outskirts to Casaracra. In this area we can find the Junín Hotel, the Inca Club and Hotel, La Oroya Hydroelectric Central and the area of Chulec (Picture 2.3.1/1). This area stands out for its urban planning, paved streets and single-person homes for Centromín officers. It has a sports field and a Golf club. Here we find the Hospital of Chulec that also belongs to the Company and the Mayupampa School for the children of Centromín officers.

In front of Chulec, to the other side of the riverbank, there is the John Paul II neighborhood which houses people from Tarma and Jauja and also workers of the Company. They have two-story houses built with brick and mortar, but streets are not suited for vehicle transit. We also have the Shinca Machay neighborhood. Along the way to Paccha, there are few houses and some businesses (little stores, fast-food restaurants, etc.). Paccha is about 10 Km. away from La Oroya and farmers and cattlemen of the area communities inhabit this district.

The local road passes by empty houses on the way to Casacacra

Heading for Lima, we find most of the houses for Centromín workers.

The La Oroya CMP facilities sketch is shown in the diagram 2.3.1/1.

Sectors inhabited by Centromín Perú and non-company workers are shown below.

Centromín Sectors	Non company Sectors
Marcavalle	9 de Octubre Shantytown Alto Marcavalle Neighborhood Shantytown Túpac Amaru Shantytown Santa Anita Shantytown Las Brisas
Buenos Aires	Neighborhood San Pablo II Neighborhood San Vicente de Paúl Neighborhood. Micaela Bastidas Neighborhood. Santa Rosa
Huaymanta	"Victoria Perú" Housing Association
Los Plomos	Neighborhood. Tayapuquio Neighborhood. Leoncio Prado Neighborhood. Enafer Neighborhood Ramiro Prialé Neighborhood Víctor R. Haya de la Torre
Calle Lima	Barrio San Juan
Alto Perú	Neighborhood Las Mercedes Neighborhood Norman King

The main sector is Calle Lima where Centromín workers and employees live. There are also a great number of stands, street sellers and a small market.

Alto Marcavalle (Picture 2.3.1/2), in Yantacancha Hill within Santa Rosa de Sacco District, typifies the urbanization process of population belts in La Oroya surroundings which is comprised of Tambo del Sol (Villa Sol), Muruhuay, María Concepción y Tacarpana. These neighborhoods have similar characteristics and are next to each other sharing common services such as a dish antenna, a radio broadcaster (Super AM) and a stadium.

The largest neighborhood is "Tambo del Sol" where 90% of the inhabitants work for Centromín. These people own 200m² lots with two-story adobe houses sheltering orchards and cattle raising. There are 130 families with no land left. In order to

obtain the lands, people got together and became New Dwellers integrated to the Santa Rosa de Sacco Community, a process that dates back to 1981 (Picture 2.3.1/3).

Curipata Urbanization

The Curipata Urbanization housing project is located 11 km from La Oroya on the way to Lima. Centromín sponsors the project in favor of its workers. It is found beside the road in a plain and well-planned area. (Posts, stadium, school, church and an open market make up the project) (Picture 2.3.1/4).

As for the La Oroya Metallurgical Complex, its production facilities expand in a large enough area (See Diagrams 2.3.1/1 and 2.3.1/2) as explained here:

A grocery store, copper wire plant, Copper and Lead Refinery flourish along the way to Lima throughout the Central Highway and Yauli River in Huaymanta sector.

The "Inca" Club and Hotel, La Oroya Hydroelectric Central, Chulec Sector with the Hospital and Mayupampa School come into view on the way to Tarma.

Along Horacio Zevallos Av are the following:

- Centromín Perú S.A. TV channel, RR.PP, Junín Hotel, Highland Human Resources facilities and Industrial Relationships. To the end of the Horacio Zevallos Av, in front of the La Oroya Antigua (to the other Mantaro riverside), are the Copper Smelter, Lead Smelter, Zinc Refineries, Training and Security Area, Occupational Medicine as well as the Operational Central Agency (Picture 2.3.1/5).

b) La Oroya Economic Activity and its environment

The La Oroya city is surrounded by farming, cattle and mining areas of the Central Highland. These are characterized by mid-sized farming exploitation directed to provide Huancayo, Tarma and Chanchamayo markets with products like meat from Junín; vegetables, potatoes, legumes from Tarma and the Mantaro Valley area; fruits and coffee from Chanchamayo; industrial inputs from ranching sources source (wool); and mining raw material (especially copper, lead, zinc and silver) for the domestic and foreign market coming from Centromín (Morococha, Casapalca, San Cristóbal, Yauricocha, Cobriza and Andaychagua).

La Oroya is a landmark for the supply of food and manufactured products concerning the clothing and furniture market, etc. for the entire Central Amazonian and Mountain area.

Toward Tarma, Huancayo and Junín extend a series of small populations (generally farms or towns belonging to peasant communities) located around the Central Highway. These populations are primarily subsistence farmers or proprietors of and small services which are directed toward transport (restaurants, mechanics).

However, despite being close to La Oroya, their trading relationship is restricted to the two weekly fairs in this city. This is attributed to the fact that most manufactured food products come from Lima. (Picture 2.3.1/6)

Little to no craft activity is performed in the region. 34.1% of the city EAP is made up of the people and its dependant relatives who profit from metallurgical activities. There is a stable 51.9% comprised of people in the trading business and diverse services as well as employees from government and private institutions. Although these ventures depend directly or indirectly of the Company activity, they are different affairs. An example of the said dependency is the fact that the weekly and fortnights fairs in La Oroya and Santa Rosa de Sacco take place on the same days that the workers are paid.

As for the commercial sector, 987 establishments both formal and informal have been counted where 59.9% belong to the food business (groceries, vegetables, etc.), 6.9% to clothing and shoemaking and in a small scale, household items and electrical appliances.

74,8% of the commercial enterprises are family owned and operated, involving more than two relatives.

In the service sector, 228 establishments have been registered where 31,1% are formal restaurants and 8,3% are food street sellers. In addition, there are 29 Factories and Mechanical Facilities to provide service to transporters.

The industrial sector of La Oroya city is comprised of 83 establishments where 36,6% sell alcoholic drinks, 15.6 % sell clothing and bakery items, 21.6% make and sell furniture. There is also a bottling plant and lime and plaster factories.

15,9% of Centromín workers are involved in additional economic activities: 5,9% work in the trading business, 9,2% in services (masonry, plumbing, and mechanics) and 0,78% in other businesses. 13,6% of the workers' wives perform economic activity other than housekeeping (especially commerce, 8,5%, working in La Oroya).

Given the importance acquired by La Oroya city in recent years, different Governmental, Municipal and Private Institutions as well as NGOs are also developing here.

There are 35 Institutions both Governmental and Private.

As for private companies for public services there are: La Telefónica del Perú, Mailing services, Banks, Transport services and local Radio Broadcasters.

There are four Cooperatives including "Cooperativa de Ahorro y Crédito CENTROMIN Coop 299".

In addition, La Oroya provides eight subkitchens run by women of low economic resources and 18 Mother Clubs (Clubes de Madres) take part in the Glass of Milk

Program, PANFAR.

1 Housing Infrastructure and Basic Services - La Oroya

•Housing Infrastructure

The La Oroya housing infrastructure is divided into two types, the first one is run by Centromin Perú Management while the other is run by private groups. The latter is in trouble because of its excessive concentration or overcrowding of people, ill-built facilities, lack of basic services and so on. To make matters worse, invasion of people living at higher elevations where most zones are exposed to gas pollution also occur.

La Oroya has 3395 homes assigned to workers where 1064 (31%) are adequate to live in and the remaining 2331 (69%) are in acceptable condition. These houses lodge approximately 15376 people averaging 5-6 persons per family.

These houses are located in the following sectors:

Tras el Mercado, Calle Lima, Railway, Cantagallo, La Florida, Alto Perú, Plomo 1 floor, Plomo 2 floors, Huaymanta, Buenos Aires "A", Esmeralda, Santa Rosa, Buenos Aires "B", Huampaní, Marcavalle, Tras Estación.

83% of workers live in homes assigned by the Company (742 in private areas) which mostly have two rooms. (Picture 2.3.1/8)

Departments located in blocks have basic services, laundry, and showers inside, but sectors arranged in room blocks have collective latrine, laundry, well and shower services. 38% of workers have their own home (the 9,74% in La Oroya); 27% have land (7,28% in La Oroya). Picture 2.3.1/9.

Average La Oroya housing consists of two-floors and 60m²-land area and 50m-floor construction. They are constructed with good material, mostly with cement floors, wooden windows and wooden and corrugated iron roofs. There are also adobe houses in the non-company area from La Oroya Antigua.

Overall, there are 11 256 houses in La Oroya. The housing conditions in sectors such as Tras el Mercado, Wilson Av, Alto Peru, Tras Estación, Railway and the Plomos show a high deterioration level and excessive concentration of people, so demolition has been scheduled.

Concerning the demolition program for overpopulated and deteriorated housing, to date all houses in the "Club Peruano" sector (there were 460) have been demolished and replaced with grass. In the Smelter area, practically all the existing houses has been demolished and properly removed from the area.

The Curipata Urbanization project sponsored by Centromin Peru for its workers intends to provide houses for displaced workers and move them away from the

industrial area.

•Education

As for education, there are two Educational systems in La Oroya. The first is run by USE (Controlled Educational Services Unit) in charge of 9 Governmental Schools (3 for Initial Education, 4 for Elementary and 2 for High School) for Centromin Peru S.A. They show good infrastructure, equipment and highly qualified staff made up of 296 workers.

These units enjoy academic prestige and include a total number of 4408 students (until September 1996) accounting for 33,5% of the entire school population. (Picture 2.3.1/7). The other 66,5% comes from the 8 744 students from the 45 other educational centers which include Elementary, High School, Technical and Tertiary classes in the private and public sector: There are also computer, nursing and educational institutes.

Nowadays, the 9 Government Educational Centers (C.E.F.) are being transferred to the Education Ministry due to CMP S.A. privatization process.

•Healthcare

As for healthcare, the La Oroya city including Paccha and Santa Rosa de Sacco has three healthcare systems.

- The IPSS (Social Security Peruvian Institute) has a Polyclinic mostly directed to care aged people and a Regional General Hospital with 25 physicians in all specialties, 35 nurses, 72 beds, X ray services and analysis. These professionals perform major and minor surgical procedures as well as provide prevention and consulting services to insured people and their dependents, which mostly are CMP workers.

- Healthcare Ministry has three poorly constructed and ill-equipped facilities that provide services (advice, minor procedures, analysis, and deliveries) for population without insurance. Cases requiring urgent attention are taken to Tarma, Huancayo and Lima.

- Finally Centromin runs the Chulec Hospital that has 14 doctors in different specialties, 13 nurses, 50 beds. These professionals can perform major procedures (16 as a monthly average) as well as minor procedures, X-rays, analysis, echogram, laparoscopies, etc. It services Company workers' relatives who have no insurance rights in the IPSS. See the following table:

KIND OF ATTENTION BY SUB-POPULATION

	Ambu-latory	Hospi-tal	Examen	Work accidents	Emer-gency	Total	%
Superior Administrative List	4 515	138	186	33	451	5 323	25,01
Monthly Superior List	1 749	51	13	30	119	1 962	9,22
Monthly list	957	96	1	31	35	1 120	5,26
Daily list	4 578	370	2	59	153	5 162	24,25
Scholarship Plan	477	24	14	6	83	604	2,84
Familiar Prof.	425	24			17	466	2,19
SECOF	148	4			3	155	0,73
ENTEL	185	5			15	205	0,96
Particular	4 832	650	3		803	6 288	29,54
TOTAL	17 866	1 362	219	159	1 679	21 285	100
Percentage	83,94	6,40	1,03	0,75	7,89	100	

Source: Organizational Analysis Research "Informe Producción y Rendimiento del Hospital General Chulec"

Among the most treated diseases in the various La Oroya Healthcare Centers is diarrhea, gastrointestinal and infectious diseases which accounting for 50% of the visits. Next are the bronchial diseases caused by cold weather and pollution and in small proportion, cystic, endemic (hepatitis), parasitic and rheumatic diseases.

Among labor diseases, trauma due to accidents is frequent, arsenic dermatitis and saturnism (lead poisoning) are regularly controlled. Pneumoconiosis and silicosis seldom appear as observed in the following table:

PERIODIC EVALUATION BY OCCUPATIONAL MEDICINE CENTER

Test types	Exposed Workers	Evaluated Workers	Coverage Percentage (%)
Ophthalmological	5 933	5 701	96,09
By exposition to silicon	3 773	3 733	100
Audiological	6 113	6 113	100

Annual control, not occupational		6 215	
By exposition to Arsenic 1995 - 1.	165	165	100
By exposition Arsenic 1995 - 2.	148	148	100
By exposition to Cadmium 1995 - 1.	49	49	100
By exposition to Cadmium 1995 - 2.	47	47	100
By exposition to Lead 1995 - 1.	1 067	1 066	99,88
	6 500		

Source: Organizational Analysis Research "Informe Producción y Rendimiento del Hospital General Chulec"

- **Drinking Water Supply**

Centromín provides its workers with water freely. There are problems due to weak pressure as a result of indiscriminate use sharpened by the deficient network supply system.

The drainage system which runs through the Municipality is not satisfactory for the houses located at La Oroya Antigua. This region has a channelized sewage system that consists of open or uncovered canals characterized by constant clogging which gives way to sources of waste accumulation and rodent burrows. (Pictures 2.3.1/10 and 2.3.1/11).

Nowadays sewage is not treated prior to discharge to the Mantaro and Yauli rivers. Only the 41,6% of houses have proper sanitary services, 4682 houses have services connected to the public network, 2758 houses have a well. Inhabitants of 742 houses use sanitary service irrigation ditches or canals and 3074 houses use open fields and hillsides to carry out biological necessities. (Picture 2.3.1/12)

Tishgo river natural sources are used: domestic and industrial water and for EMSAPA (Municipal Company of Drinking Water and La Oroya alcantarillado); Cuchimachay: Industrial and for EMSAPA; Mantaro river: industrial water; Marcavalle Well: water for EMSAPA; Pichjapuquio Spring: Water for EMSAPA.

The water amount supplied to EMSAPA is subject to charge from August 1994 when transferred the total control of Marcavalle Well sources and Pichjapuquio Spring to EMSAPA. At the same date, Centromín began supplying domestic water for the said company to be delivered to sectors: Calle Lima and Horacio Zevallos Av. Actually 5 909 houses have connections to the public network, 4302 houses are supplied from public trough, 164 houses with well water, 54 from cistern trucks and 514 from irrigation ditches or springs.

- **Power Supply Service**

Centromín also provides its workers with a power supply which is subject to restrictions beginning at 7:30 a.m. to 10:00 a.m. and 1:30 p.m. to 4:30 p.m.

Electro Centro supplies light to La Oroya in the private sector. As for Centromín, thanks to its interconnected network, it can provide electricity for industrial use and for domestic use for Company employees and their families.

- **Waste and Deposit Treatment**

For industrial waste treatment, the metallurgical complex has two crematory ovens, one in the Smelter and the other in the Copper and Lead Refinery.

With regard to domestic Solid Waste (Garbage), there is no sanitary treatment and garbage is accumulated by Municipal and Centromín collector trucks in the Cochabamba sector located at Huancayo 9 km from La Oroya.

People do not help with the cleaning and often throw trash on the streets, canals and in the Mantaro and Yauli rivers. There are no containers (cylinders or bags) to receive trash along the streets (Pictures 2.3.1/13 and 2.3.1/13 A).

Residents at La Oroya Antigua have created a spot for trash concentration on the Mantaro riverbank.

In the area known as Huanchán in the Huancayo road 3 km from the complex, there are the Zinc ferrites and Copper and Lead deposits. There is an abandoned Arsenic Trioxide deposit 12km from the complex and another used by the same sector in the Antahuario Hacienda Area (Vado).

- **La Oroya Urban Area Treatment – Roads**

As to roads, La Oroya has two land systems (roads and railroad). They turn La Oroya into a strategic area in the central mountains since from here the road branches to the central amazon area (Huánuco, Tingo María, Pucallpa) via Cerro de Pasco, the other side of the Mantaro valley mountain range (Jauja, Huancayo, Huancavelica), and the Chanchamayo valley via Tarma. Currently, the railroad system (ENAFER – PERU S.A.) carries freight to Lima while the Company (CMP) transports its own freight (concentrated, minerals and machines) between Cerro de Pasco and La Oroya.

As for urban area treatment, La Oroya plans to study and implement (September 1997) a land variant in the 156km of Central Highway in a place known as Pachachaca. This variant will directly connect Lima with Cerro de Pasco, skipping La Oroya.

Transport, Communication, Housing and Construction Ministry has the respective financing for the aforesaid Project which is part of the Central Highway Rehabilitation between Santa Anita (Lima) bridge and Tingo María (Huánuco) including La Oroya route.

- **Radio, TV and Telephone Communications**

With regard to communications and entertainment, La Oroya has two TV channels and one station. Some sectors such as Tambo de Sol have a dish antenna.

There are five radio broadcasters, two of which reach the Junín population.

Telefónica del Peru Company has planned the expansion and improvement of Direct Dial Up Service. On the other hand, CMP has a private central telephone and fax communications interconnecting all its branches and encampments including the Lima and Callao branches.

- **Dinners, entertainment and training**

There is a total of 25 sport fields in the city where the most of which are in a fairly well-maintained state. There are also 9 parks for children.

La Oroya lacks green areas for quiet entertainment (parks and plazas). The La Oroya Antigua Golf Course is the only area for open field recreation.

- There are seven dining restaurants

- In addition, the company promotes Entertainment programs for workers and relatives when holidays arrive, through its Social Service department.

The Social Service office offers the following courses: Family Income Planning, Healthcare, Food and Sanitary Control, Housing Use and Cattle Raising, Family Relationship, Mother-son Healthcare, Health Campaigns, Organization and Leadership.

On the other hand, there are worker training courses for different levels and specialties: Administration, Security, Environment, Human Relationships, technical specialties (Metallurgical, Mechanical, etc.).

As for social projection in La Oroya, the Public Relations Department enjoys good and adequate relations with different public and private institutions in the area.

2.4 Interesting Human Environment

2.4.1 Archaeological Resources

La Oroya has no known archaeological resources and is only an access point to the culturally rich resources observed in Tarma, Jauja and Huancayo areas.

2.4.2 Protected Natural Areas

La Oroya has no protected natural areas in its region and is only an access point to the National Parks such as the Hauyllay Stone Woods, Cerro de Pasco and Junín National Reserve around Chinchaycocha Lake (Junín Lake). The Junin Lake is the country's second largest lake and is located on the Junin Plateau north of the La Oroya region. The Yauli thermal baths are close to the area.

2.4.3 Interesting Scientific and Tourist Places

La Oroya is an access point to the Coast-Sierra-Amazon Circuit extending from Lima to Tarma and the Chanchamayo Valley. The other tourist route toward Mantaro valley has guided visits to Ocopa Convent, which dates back to colonial times.

TABLE 2.2.2/1

PLANTS ANALYSIS

Name of the Plant	No. Laboratory	Field Key	N %	P %	K %	Ca %	Mg %	Fe ppm	Zn ppm	Cu ppm	Mn ppm	B ppm
Plantain	642	1	1.51	0.12	1.56	3.02	0.25	3265	290	75	77	47
Achicoria	643	2	2.49	0.21	1.59	2.38	0.35	7790	352	85	164	52
Mint	644	3	2.74	0.23	1.75	3.08	0.24	1103	840	266	45	26
Humanjasha	646	5	1.31	0.03	1.23	4.65	0.42	3170	505	143	122	36
Stipa sp	647	6	0.67	0.06	0.38	0.54	0.11	6750	720	296	129	16
Ishga	648	7	3.27	0.36	5.26	4.47	0.66	3155	795	127	121	57
Rosemary	649	8	1.34	0.19	2.01	2.55	0.30	2660	1455	478	214	62

Adequate content of main elements in the plants	1,00 - 3,00	0,1 - 0,3	1,4 - 4,0	0,05 - 0,15	0,05 - 0,15	300 - 800	30 - 150	5 - 30	30 - 200	50 - 200
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TABLE 2.2.2 / 2
ANALITIC RESULTS OF NATURAL WATER FLOW THROUGH LA OROYA

Period : January - June 1996
Laboratory : Analítico de Centromin Perú S.A.
Source : Control Sampling Information

	Core N°	US conduct	Eh mV	m³/m³ lab	pH	Temp	TSS	DO	NO ₃	SO ₄	TDS	mg/l								DBO	Fec Col c/100 m
												As	Cd	Cu	Fe	Mn	Pb	Zn			
Tishgo River	T-1	344.25	221.95	58.42	8.00	13.06	9.88	28.25	1.33	122.79	239.63	0.02	0.01	0.03	0.30	0.01	0.21	0.65	3.50	3.50	
Mantaro River Chulec Bridge	M-1	430.22	204.43	3,333.67	7.98	12.11	12.25	31.56	0.81	155.86	348.33	0.11	0.00	0.05	1.12	0.33	0.09	0.66			
Mantaro River Joint with Yauil	M-3	587.44	206.59	3,594.24	7.60	12.06	33.17	32.69	1.19	210.13	1,308.60	0.07	0.01	0.08	2.72	1.11	0.10	1.34			
Yauil River	Y-1	1,251.22	207.9	656.37	7.64	12.60	136.94	35.82	3.51	733.83	1,389.11	1.42	0.01	2.35	26.76	5.75	1.25	4.38			
Mantaro River After Effluent 137	M-5	549.11	205.68	4,930.85	7.67	12.97	28.91	36.30	1.38	277.23	504.13	0.21	0.03	0.52	4.49	2.83	0.34	5.31			
LMP, Water Type III																					
					5 - 9			5.00	0.10	400.00		0.20	0.05	0.50	1.00	0.50	0.10	25.00			

Nota: Information given by arithmetic averages

Cuadros.xls; tabla 2.2.2 / 2

TABLE 2.1.6/1

SOIL ANALYSIS

LABORATORY: UNIVERSIDAD NACIONAL AGRARIA - LA MOLINA

Sampling points	Stratus	Key	C.E. mmhos/cm	Sand %	Silt %	Clay %	Texture	pH	CaCO ₃ %	M.O. %	P ppm	K ₂ O Kg/Ha.
Huaynacancha Bajo	Surface	HCIB-A	0.59	66	32	2	Sandy Loam	3.5	0	1.62	46.4	268
Huaynacancha Bajo	Surface	HCIB-B	0.39	76	20	4	Loamy sand	3.7	0	2.36	6.9	349
Huaynacancha Medio	Surface	HCIM-A	0.64	76	20	4	Loamy sand	7	9.32	2.06	37.0	235
Huaynacancha Medio	Surface	HCIM-B	0.42	56	30	14	Sandy Loam	8	21.89	0.59	11.6	79
Huaynacancha Alto	Surface	HCIA-A	1.33	72	26	2	Sandy Loam	3.5	0	1.77	18.2	92
Huaynacancha Alto	Subsurface	HCIA-B	0.59	78	20	2	Loamy sand	3.7	0	1.32	6.0	84
Huaynacancha 2 Bajo	Surface	HC2B-A	2.09	70	28	2	Sandy Loam	3.4	0	2.21	57.7	221
Huaynacancha 2 Bajo	Subsurface	HC2B-B	0.73	64	30	6	Sandy Loam	3.7	0	1.47	19.1	235
Huaynacancha 2 Medio	Surface	HC2M-A	0.57	72	26	2	Sandy Loam	3.5	0	1.77	18.2	396
Huaynacancha 2 Medio	Subsurface	HC2M-B	0.38	66	26	8	Sandy Loam	4	0	0.88	3.1	680
Huaynacancha 2 Alto	Surface	HC2A-A	0.57	80	12	0	Sandy Loam	3.5	0	1.47	12.5	396
Huaynacancha 2 Alto	Subsurface	HC2A-B	0.47	76	16	8	Sandy Loam	3.9	0	1.47	3.1	319
Huari	Surface	HRI-AS	0.29	80	20	0	Loamy Sand	3.5	0	3.1	35.1	652
Huari	Subsurface	HRI-BSb	0.47	74	20	6	Sandy Loam	4.3	0	2.06	4.1	574
Oroya Antigua	Surface	OA-A	2.33	68	26	6	Sandy Loam	7.2	54.26	1.47	88.7	695
Oroya Antigua	Subsurface	OA-B	0.82	50	38	12	Loam	7.9	22.84	2.06	69.9	850
Oroya Antigua Panteón	Surface	OAP-A	0.83	44	36	20	Loam	6.2	0	1.62	37.0	1179
Oroya Antigua Panteon	Subsurface	OAP-B	1.22	46	32	22	Loam	7.5	0	1.32	33.0	811

Cuadros.XLS; Tabla 2.1.6 / 1

TABLE N° 2.1.4 / 3
AIR QUALITY AT THE MONITORING STATIONS OF METALLURGIC COMPLEX OF LA OROYA
GAS ANALYSIS SO₂ AND DUST
PERIOD: Jan - Dec. 1995

Monitoring Stations	SO ₂ : ppb			PM-10 : µg/m ³			MPS : µg/m ³			Metallic Content:µg/m ³			Wind Speed: m/s		
	Max. 1 hr	Max. 24 hrs ¹	Annual Aver. ⁴	Max. 1 hr	Max. 24 hrs ¹	Annual Aver. ⁴	Max. 1 hr	Max. 24 hrs ¹	Annual Average ²	As 24 hrs ¹	Pb 24 hrs ¹	Cd 24 hrs ¹	Max.	Min.	Aver.
1. Hotel Inca	1253	69	40	709.0	59.6	42.9	N/D	214	112	0.3	0.3	0.011	N/D	N/D	N/D
2. Cushurupampa	1038	61	40	N/D	N/D	N/D	N/D	N/D	N/D	0.2	0.2	0.007	8.4	0.0	1.8
3. Worker Union	1392	99	69	579.0	50.8	43.9	N/D	349	138	1.1	1.3	0.024	N/D	N/D	N/D
4. Huanchán	1578	529	153	N/D	N/D	N/D	N/D	N/D	N/D	7.6	11.7	0.394	8.4	0.1	2.0
5. Casaracra	1000	56	28	N/D	N/D	N/D	N/D	N/D	N/D	0.2	0.1	0.014	N/D	N/D	N/D
Peruvian Norms	N/D	200 ¹	60 ⁴	N/D	N/D	N/D	N/D	350 ¹	150 ²	6.0 ¹	0.5 ⁴	N/D	N/D	N/D	N/D
World Bank	N/D	191 ¹	38 ⁴	N/D	N/D	N/D	N/D	260 ¹	75 ²				N/D	N/D	N/D
Canadian Norms	344	115 ¹	23 ⁴	N/D	N/D	N/D	N/D	N/D	N/D				N/D	N/D	N/D
USA Norms	N/D	139 ¹	31 ⁴	N/D	N/D	N/D	N/D	150 ¹	50 ²				N/D	N/D	N/D

TABLA N° 2.1.4 / 3A
AIR QUALITY AT THE MONITORING STATIONS OF METALLURGIC COMPLEX OF LA OROYA
GAS ANALYSIS SO₂ AND DUST
PERIOD: Jan - Dec. 1996

Monitoring Stations	SO ₂ : ppb			PM-10 : µg/m ³			MPS : µg/m ³			Metallic Content:µg/m ³			Wind Speed: m/s		
	Max. 1 hr	Max. 24 hrs ¹	Annual Aver. ⁴	Max. 1 hr	Max. 24 hrs ¹	Annual Aver. ⁴	Max. 1 hr	Max. 24 hrs ¹	Annual Average ²	As 24 hrs ¹	Pb 24 hrs ¹	Cd 24 hrs ¹	Max.	Min.	Aver.
1. Hotel Inca	1157	79		291	27		N/D	165		0.4	0.505	0.018	N/D	N/D	N/D
2. Cushurupampa	1047	61		0	0		N/D	86		0.1	0.158	0.006	8.5	0.0	1.4
3. Labor Union	1836	238		1084	60		N/D	294		0.6	0.778	0.018	N/D	N/D	N/D
4. Huanchán	1836	238		0	0		N/D	294		1.7	2.941	0.137	9.3	0.1	1.7
5. Casaracra	1000	57		0	0		N/D	123		0.1	0.069	0.009	N/D	N/D	N/D
Peruvian Norms	N/D	200 ¹	60 ⁴	N/D	N/D	N/D	N/D	350 ¹	150 ²	6.0 ¹	0.5 ⁴	N/D	N/D	N/D	N/D
World Bank	N/D	191 ¹	38 ⁴	N/D	N/D	N/D	N/D	260 ¹	75 ²				N/D	N/D	N/D
Canadian Norms	344	115 ¹	23 ⁴	N/D	N/D	N/D	N/D	N/D	N/D				N/D	N/D	N/D
USA Norms	N/D	139 ¹	31 ⁴	N/D	N/D	N/D	N/D	150 ¹	50 ²				N/D	N/D	N/D

Quedex XLR Table 2.1.4/3

Notes: (1) Daily arithmetic mean concentration
(2) Annual geometric mean concentration
(3) Arsenic concentration in 30 min. (only once a year).
(4) Annual arithmetic mean concentration
N/D = Not determined standard

ABASTECIMIENTO DE AGUA INDUSTRIAL Y DE CONSUMO DOMESTICO - CENTROMIN PERU - LA OROYA

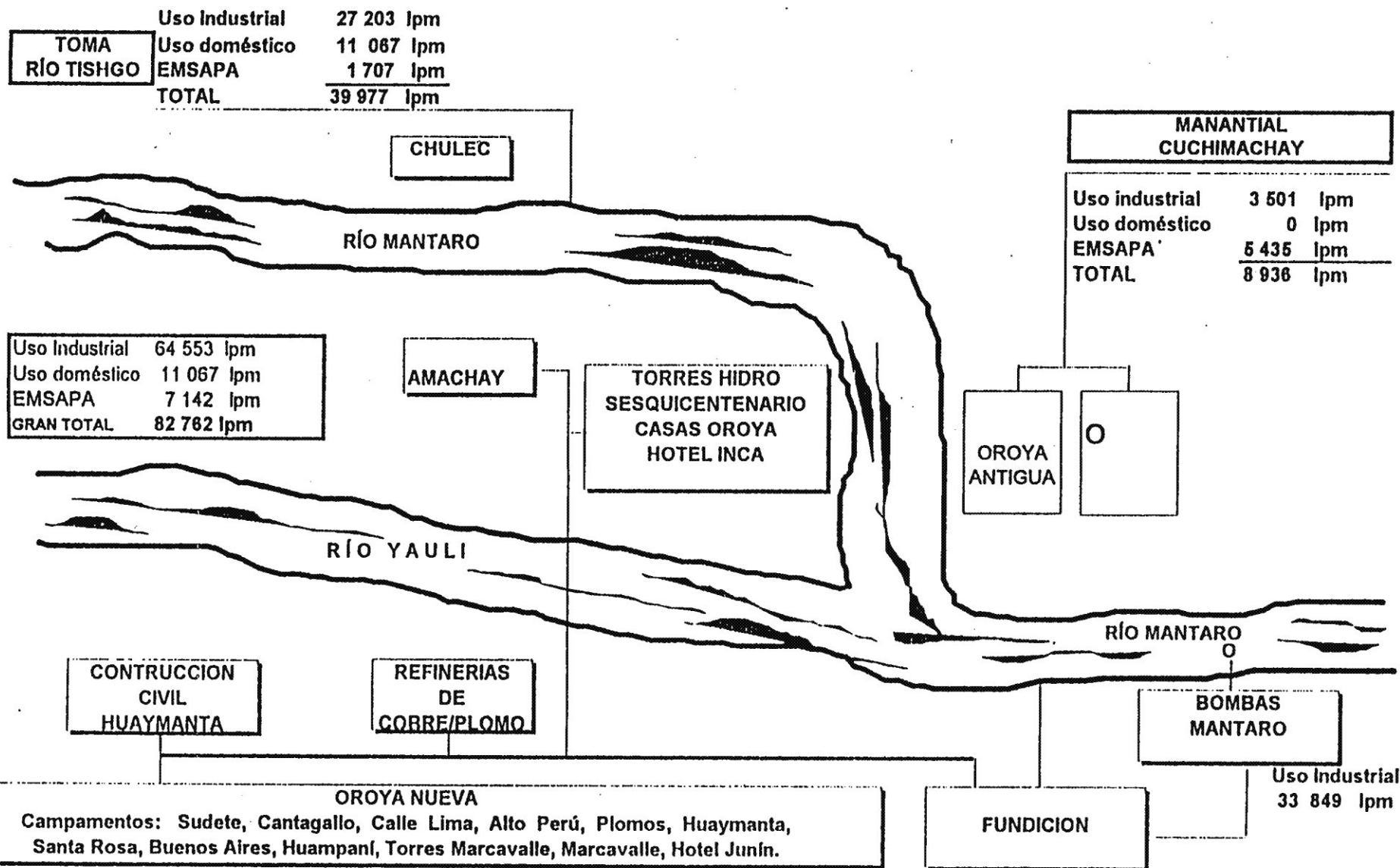


DIAGRAMA 2.1.2/1

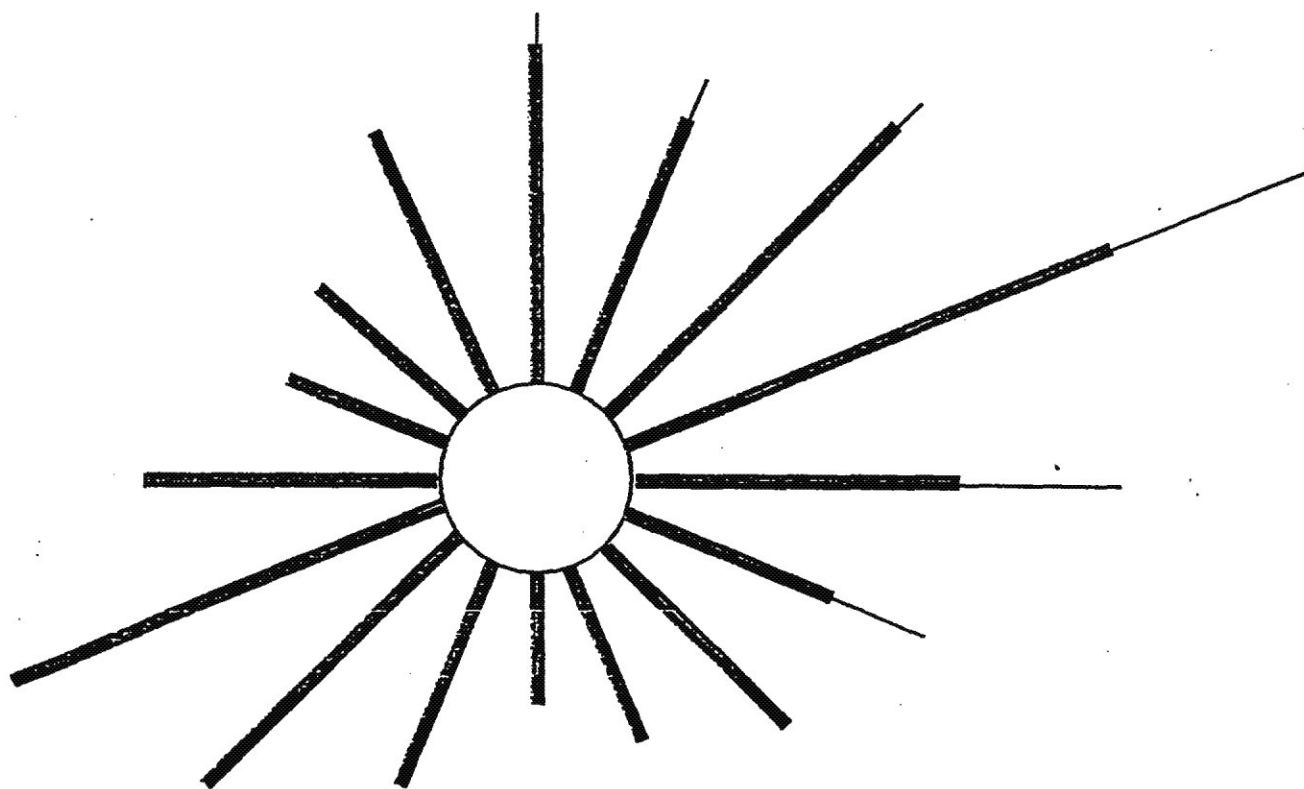
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Diagrama 2.1.2/1

Anexo A

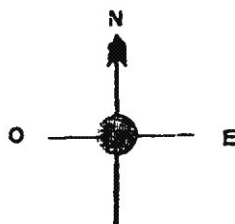
DIAGRAMA 2.1.3/2

ROSA DE VIENTOS - PROMEDIO ANUAL 1995

ESTACION CUSHURUPAMPA



Dirección	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSO	SO	OSO	O	ONO	NO	NNO	TOTAL
Velocidad m/s	1.8	1.5	2.1	2.8	1.7	1.2	1.3	1.0	0.7	1.3	1.8	2.4	1.5	0.8	1.0	1.5	Prom. 1,6 m/s
Frecuencia %	9.9	8.4	11.2	18.4	12.8	8.0	4.9	2.1	2.3	3.4	5.7	3.0	1.2	1.5	2.5	4.8	100 %



ESCALAS

Velocidad: 1 m/s

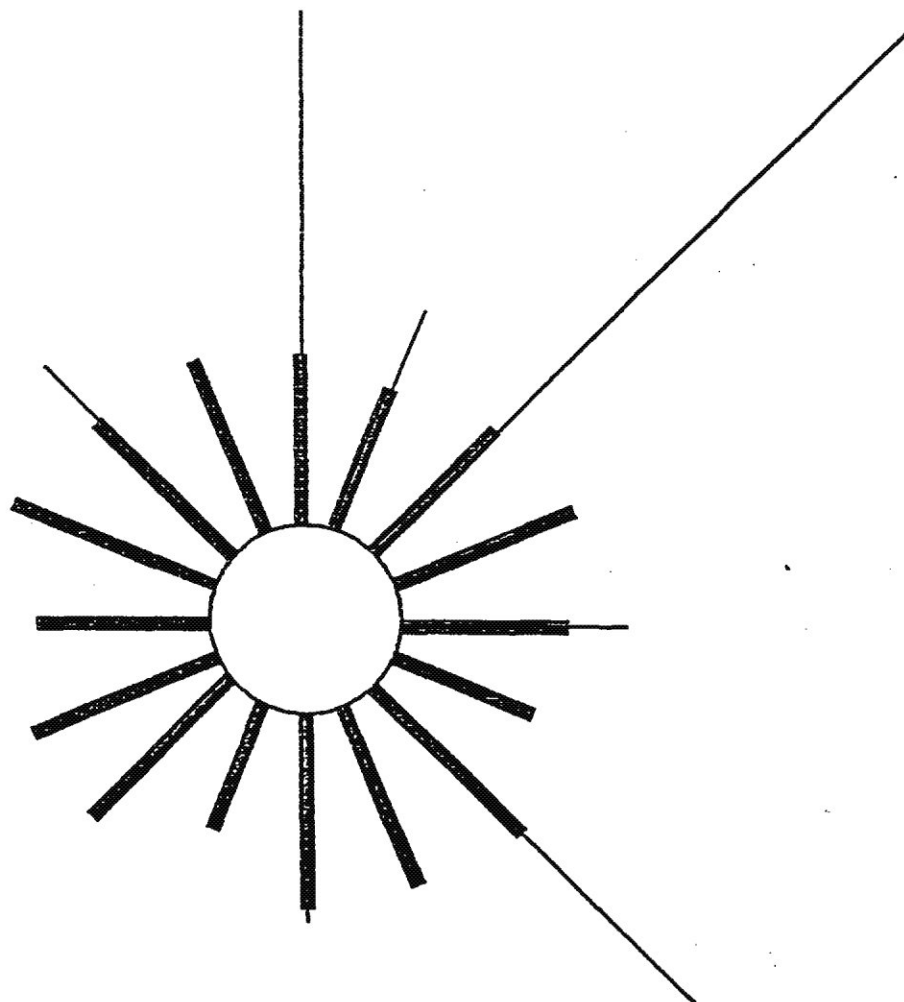
Dirección: 10 %

RENGOGRP-002955

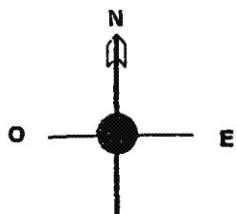
DIAGRAMA 2.1.3/2A

ROSA DE VIENTOS - PROMEDIO ANUAL 1995

ESTACION FUNDICION



Dirección	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSO	SO	OSO	O	ONO	NO	NNO	C	V	TOTAL
Velocidad m/sg	0,9	0,8	0,9	1,0	0,9	0,8	1,1	1,0	1,0	0,7	1,0	1,1	0,9	1,1	0,9	1,0	0,2	1,3	Prom.0,9 m/s
Frecuencia %	13,4	6,3	19,6	4,0	5,7	4,0	12,0	4,8	5,8	2,0	3,6	2,0	4,5	1,7	6,3	3,3	0,4	0,6	100 %



ESCALAS

Velocidad: 1 m/s 

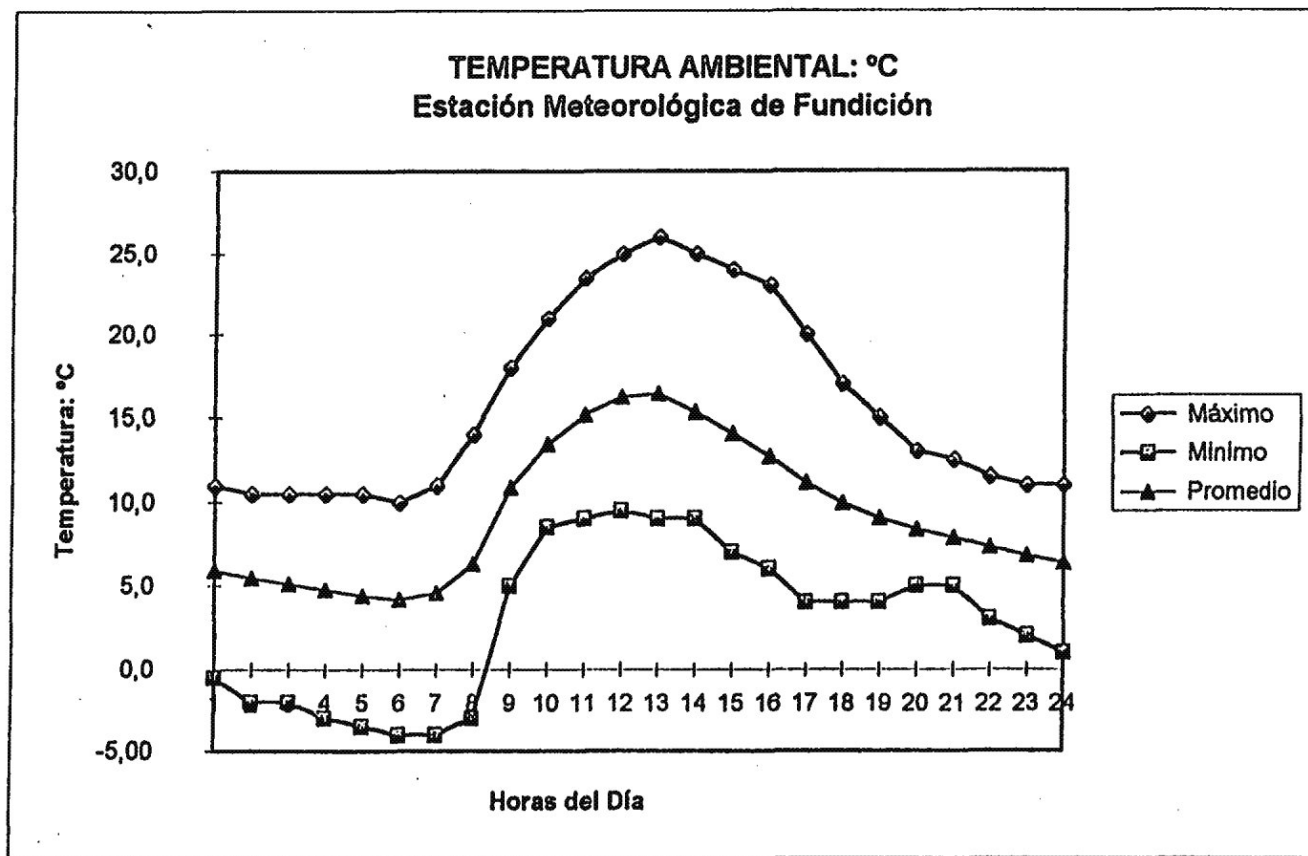
Dirección: 10° 

Temperatura Ambiental: °C
 Estación Meteorológica de Fundición

PERIODO: Ene - Dic 1995

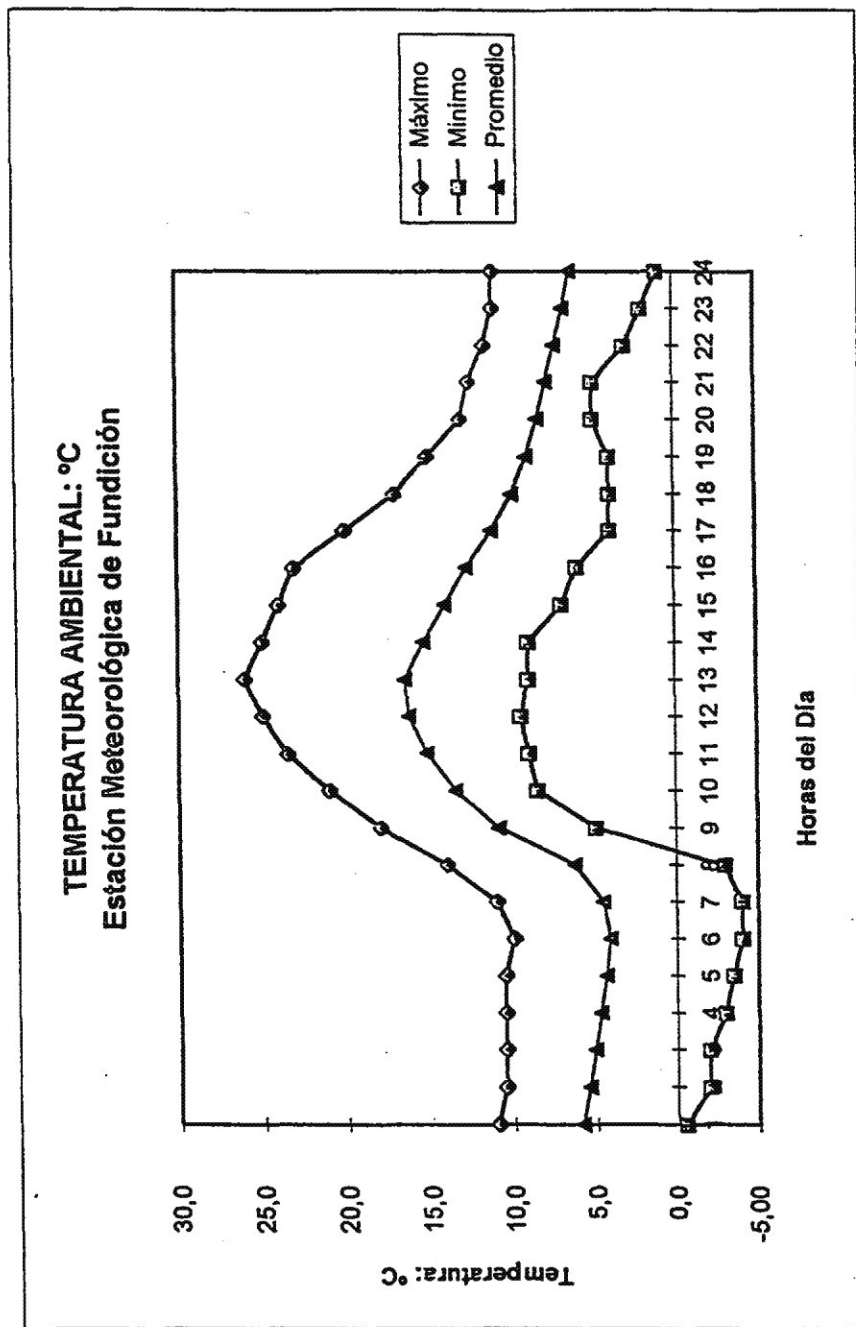
Hora	Máximo	Minimo	Promedio
1	11,0	-0,50	5,9
2	10,5	-2,00	5,5
3	10,5	-2,00	5,1
4	10,5	-3,00	4,8
5	10,5	-3,50	4,4
6	10,0	-4,00	4,2
7	11,0	-4,00	4,6
8	14,0	-3,00	6,3
9	18,0	5,0	10,9
10	21,0	8,5	13,5
11	23,5	9,0	15,2
12	25,0	9,5	16,3
13	26,0	9,0	16,5
14	25,0	9,0	15,4
15	24,0	7,0	14,1
16	23,0	6,0	12,7
17	20,0	4,0	11,2
18	17,0	4,0	9,9
19	15,0	4,0	9,0
20	13,0	5,0	8,4
21	12,5	5,0	7,9
22	11,5	3,0	7,3
23	11,0	2,0	6,8
24	11,0	1,0	6,4

DIAGRAMA 2.1.3/3



Máx.	26,0	10,0	16,6
Mín.	10,0	-4,00	4,2
Prom.	15,3	4,5	9,3

DIAGRAMA 2.1.3/3



PERIODO: Ene - Dic 1995

Temperatura Ambiental: °C
Estación Meteorológica de Fundación

Hora	Máximo	Mínimo	Promedio
1	11,0	-0,50	5,9
2	10,5	-2,00	5,5
3	10,5	-2,00	5,1
4	10,5	-3,00	4,8
5	10,5	-3,50	4,4
6	10,0	-4,00	4,2
7	11,0	-4,00	4,6
8	14,0	-3,00	6,3
9	18,0	5,0	10,9
10	21,0	8,5	13,5
11	23,5	9,0	15,2
12	25,0	9,5	16,3
13	26,0	9,0	16,5
14	25,0	9,0	15,4
15	24,0	7,0	14,1
16	23,0	6,0	12,7
17	20,0	4,0	11,2
18	17,0	4,0	9,9
19	15,0	4,0	9,0
20	13,0	5,0	8,4
21	12,5	5,0	7,9
22	11,5	3,0	7,3
23	11,0	2,0	6,8
24	11,0	1,0	6,4

Máx. 26,0 10,0 16,6
 Mín. 10,0 -4,00 4,2
 Prom. 15,3 4,5 9,3

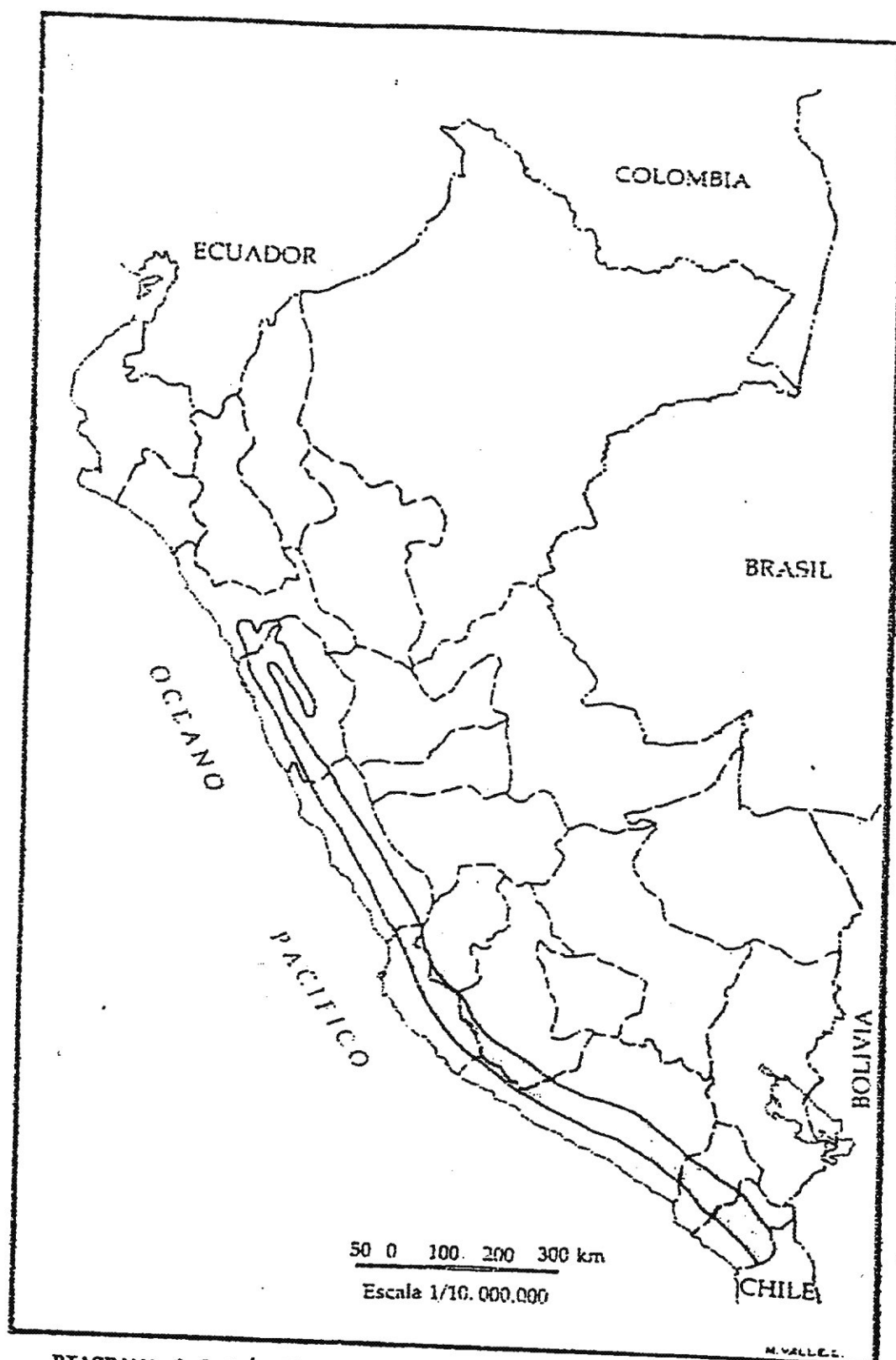


DIAGRAMA 2.2.1/1 Ubicación geográfica de la serranía

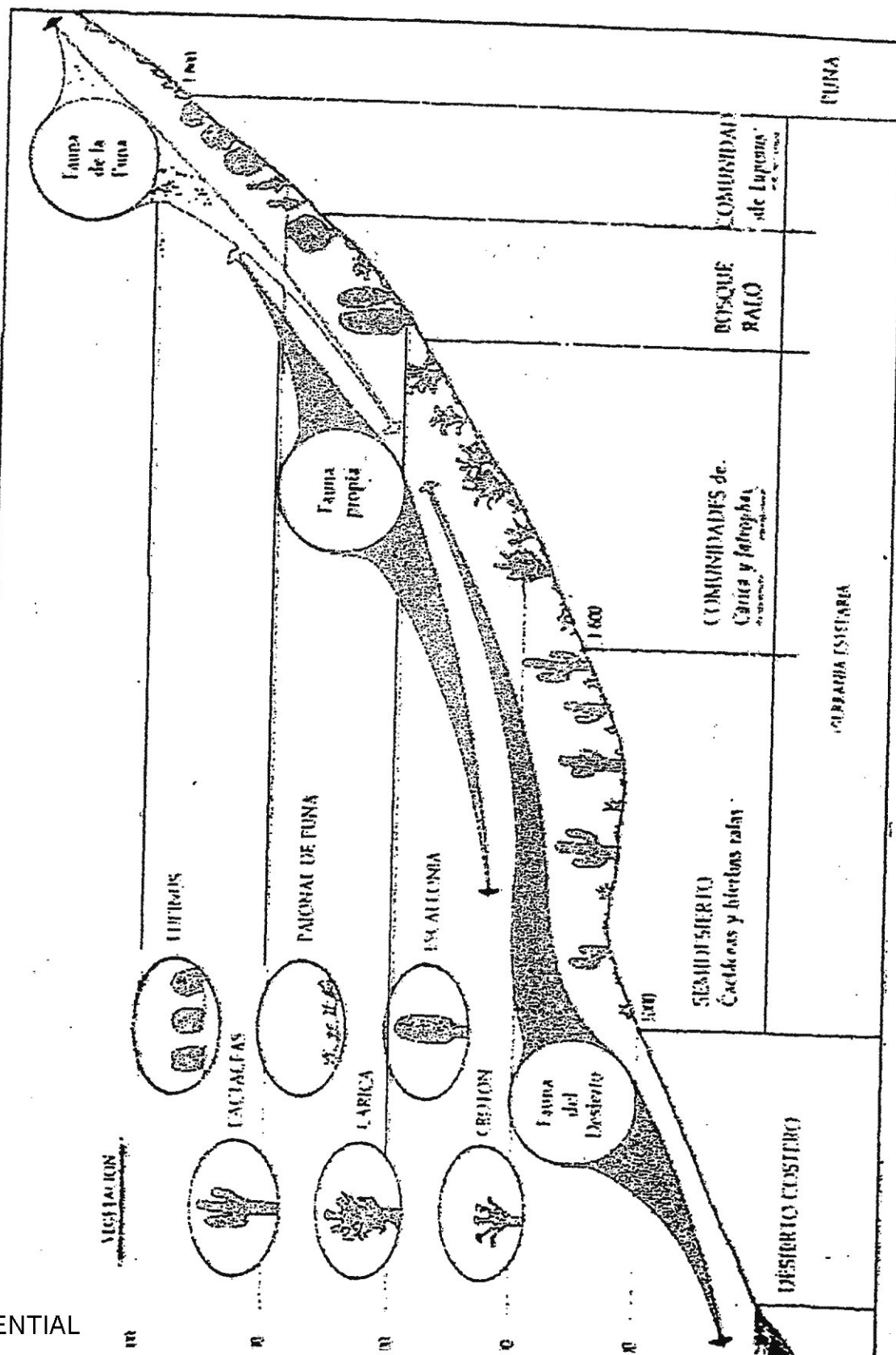
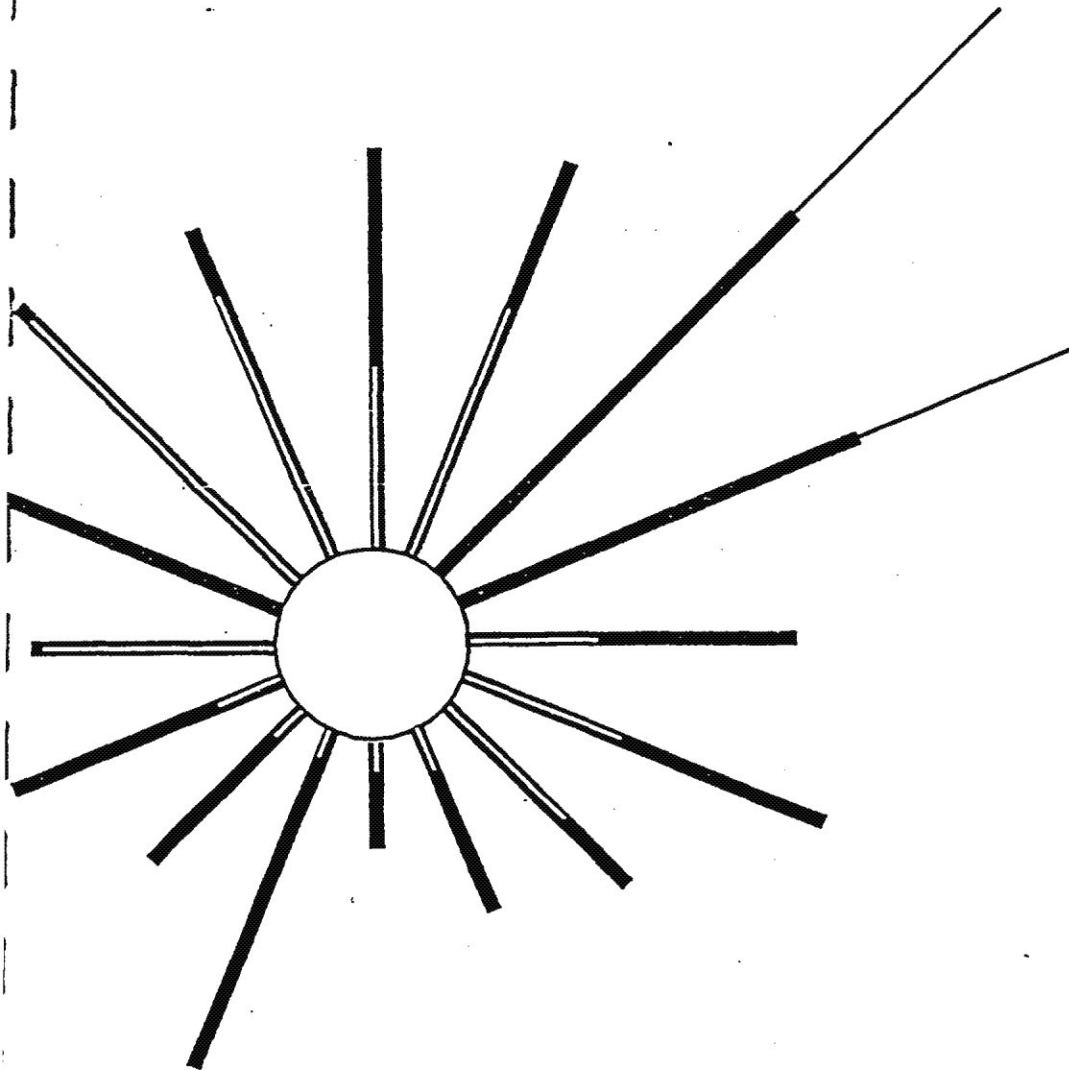


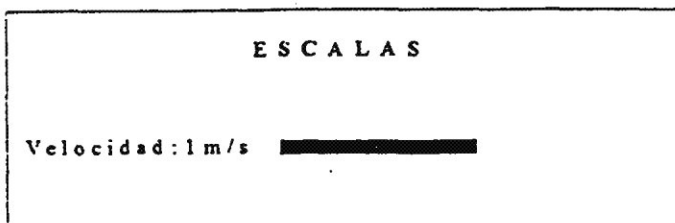
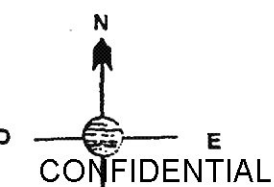
DIAGRAMA 2.2.1/2 PERFIL ECOLOGICO DE LAS VERTIENTES OCCIDENTALES DE LOS ANDES PERUANOS (Koeppke M. 1954)

DIAGRAMA 2.1.3/1

ROSA DE VIENTOS - PROMEDIO ANUAL 1995
ESTACION HUANCHAN



	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSO	SO	OSO	O	ONO	NO	NNO	TOTAL
m/sg	2,1	2,2	2,6	2,2	1,7	2,0	1,2	1,2	0,6	1,9	1,1	1,5	1,3	1,7	2,0	1,8	Prom.1,7 m/s
%	4,1	6,6	21,3	17,0	3,6	4,6	4,3	2,4	0,8	0,6	0,4	2,0	6,1	9,7	9,5	7,1	100 %



CROQUIS DE INSTALACIONES CENTROMIN PERÚ S.A. - LA OROYA

DIAGRAMA 2.3.1 / 1

3.0 OVERVIEW OF METALLURGIC OPERATIONS

Due to its polymetallic material processing, the La Oroya Metallurgic Complex is one of the four largest and most important complexes around the world, and its technology should be compared to that of the following international complexes:

- Union Minere Group HOBOKEN from Belgium
- Boliden Minerals ROONSKAR from Sweden, and
- DOWA Mining from Japan

The particular processes and operations performed at the La Oroya Metallurgic Complex highlight the Environmental Impact Program (known as PAMA) within the mining-metallurgic sector.

3.1 Features

This complex has three integrated and simultaneous circuits (copper, lead, and zinc) which enable it to rely on a high synergetic potential.

In 1995, 255109 tons of copper concentrate, 191575 tons of lead concentrate and 154710 tons of zinc concentrate were processed.

These types of concentrate, particularly copper, are polymetallic with high precious metals and impurity contents, which are subjected to pyro, hydro and electrometallurgical processes to obtain refined metal. There are also plants to recover the subproducts from the processing of the copper, lead and zinc concentrates. Eleven metal elements (Cu, Zn, Pb, Au, Ag, Bi, Se, Te, Cd, In and Sb) and nine chemical subproducts (copper sulfate, zinc sulfate, sulfuric acid, oleum, arsenic trioxide, zinc dust, sodium bisulfite, zinc oxide and zinc-silver concentrate) are obtained.

The La Oroya Metallurgic Complex has undergone some changes, and new processes have been added as described in section "1.4 Short history" in Chapter 1.

3.2 Installed Capacity and Production Increase

Table 2.1 shows changes in installed capacity and a short-term production increase thanks to some improvements in processes and the PAMA. Table 3.2/2 summarizes production of refined metal and subproducts from 1965 to 1995.

3.3 Raw Material Treated at Smelting Circuits

The name, origin and mineralogical characteristics of concentrates, belonging to the company as well as to national and international private companies and used as raw material for operations for La Oroya operations, are listed below.

3.3.1 Copper Concentrates

a) CENTROMIN PERU S.A. Copper Concentrates

Based on the microscopic survey of copper-concentrate samples coming from the plants of Toromocho, Morococha, Mahr Tunel, Yauricocha, Cobriza, and Cerro de Pasco, the following minerals have been found:

- Chalcopyrite (CuFeS_2)
- Covellite (CuS)
- Pyrrhotite (Fe 1-XS)
- Cuprite (Cu_2O)
- Native Copper (Cu)
- Chalcocite (Cu_2S)
- Tetrahedrite (Cu_3SbS_3)
- Sphalerite (ZnS)
- Limonite ($\text{Fe}_2\text{O}_3\text{nH}_2\text{O}$)
- Gangue (SiO_2 + rock)
- Bornite (Cu_5FeS_4)
- Pyrite (FeS_2)
- Galena (PbS)
- Magnetite (Fe_3O_4)

b) Copper Concentrates of National Private Companies

Based on the microscopic survey of copper-concentrate samples coming from national private companies such as Chungar, Cormín, Cemento de Plata de Cormín, Perla, Minera Hill, Atacocha, Austria Duvaz, Santa Rita, Nor Perú, Cerro Verde, Sayapullo, Algamarca, Huarón, Raura, Cemento de Cobre Sogem, CIA Minera Casapalca, Cajamarquilla Concentrado de Cobre, BHL Perú and Tintaya, the following minerals have been found:

- Tetrahedrite (Cu_3SbS_3)
- Pyrite (FeS_2)
- Pyrrhotite (Fe 1-XS)
- Galena (PbS)
- Molybdenite (MoS_2)
- Malachite ($\text{Cu}_2\text{CO}_3 (\text{OH})_2$)
- Gangue (SiO_2 + rock)
- Chalcopyrite (CuFeS_2)
- Covellite (CuS)
- Enargite (Cu_3AsS_4)
- Sphalerite (ZnS)

Cuprite (Cu_2O)
Limonite ($\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$)
Native Copper (Cu)
Chalcosite (Cu_2S)
Bornite (Cu_5FeS_4)
Tennantite (Cu_3AsS_3)
Chrysocolla ($\text{CuSiO}_3 \cdot n\text{H}_2\text{O}$)
Magnetite (Fe_3O_4)

c) Copper Concentrates of International Private Companies

Based on the microscopic survey of copper-concentrate samples coming from international private companies such as El Indio, polvo de cobre El Indio, RST-Australia, Lepanto, Samsung, MC II M/NY/KAMTIN, Gerald Chileno, Chuquimata, and Clarendon - AYSSA, the following minerals have been found:

Chalcopyrite (CuFeS_2)
Galena (PbS)
Cuprite (Cu_2O)
Limonite ($\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$)
Gangue (SiO_2 + rock)
Bornite (Cu_5FeS_4)
Covellite (CuS)
Tetrahedrite (Cu_3SbS_3)
Digenite ($\text{Cu}_2\text{-XS}$)
Arsenopyrite (FeAsS)
Pyrrhotite (Fe 1-XS)
Sphalerite (ZnS)
Molybdenite (MoS_2)
Chrysocolla ($\text{CuSiO}_3 \cdot n\text{H}_2\text{O}$)
Magnetite (Fe_3O_4)
Hematite (Fe_2O_3)
Native Copper (Cu)
Chalcosite (Cu_2S)
Enargite (Cu_3AsS_4)
Pyrite (FeS_2)
Malachite ($\text{Cu}_2\text{CO}_3(\text{OH})_2$)

3.3.2 Lead Concentrates

a) CENTROMIN PERU S.A. Lead Concentrates

Based on the microscopic survey of lead-concentrate samples coming from the plants of Andaychagua, Paragsha, Casapalca, Morococha, San Expedito, Yauricocha and Mahr Tunel, the following minerals have been found:

- Sphalerite (ZnS)
- Tetrahedrite (Cu_3SbS_3)
- Gangue (SiO_2 + rock)
- Galena (PbS)
- Pyrite (FeS_2)
- Arsenopyrite (FeAs_2)
- Chalcopyrite (CuFeS)
- Hematite (Fe_2O_3)

b) Lead Concentrates of Private Companies

Based on the microscopic survey of lead-concentrate samples coming from private companies such as Serminco, Ayssa, B.H.L., Transmine/Yauli, Huaron, Uchuchacua, Buenaventura, etc., the following minerals have been found:

- Sphalerite (ZnS)
- Arsenopyrite (FeAsS)
- Pyrrhotite ($\text{Fe } 1\text{-XS}$)
- Galena (PbS)
- Proustite ($3\text{Ag}_2\text{S} \cdot \text{As}_2\text{S}_3$)
- Alabandite (MnS)
- Pyrite (FeS_2)
- Gangue (SiO_2 + rock)
- Arcanite (K_2SO_4)
- Tetrahedrite (Cu_3SbS_3)
- Bornite (Cu_5FeS_4)

3.3.3 Zinc Concentrates

a) CENTROMIN PERU S.A. Zinc Concentrates

Based on the microscopic survey of zinc-concentrate samples coming from the plants of Mahr Tunel and Paragsha, the following minerals have been found:

- Pyrite (FeS_2)
- Marcasite (FeS_2)
- Calcite (CaCO_3)
- Arsenopyrite (FeAsS)

Chalcopyrite (CuFeS_2)
Magnetite (Fe_3O_4)
Covellite (CuS)
Sphalerite (ZnS)
Hematite (Fe_2O_3)
Tetrahedrite (Cu_3SbS_3)
Gangue (SiO_2 + rock)
Galena (PbS)
Goethite (FeO-OH)

Sphalerite is the prevailing metal in samples. Likewise, pyrite is present in high percentage as free particles or interlaced with other minerals.

3.4 Overview of Production-Extraction Process

3.4.1. Copper Circuit (Figures 3.4.1/1 and 3.4.1/2)

Copper Smelting

This process starts at the Preparation Plant where recycled material, fluxes and concentrates are combined (dosed) to form copper beds. This blend undergoes a process called roasting to reduce the levels of Arsenic (As) and Sulfur (S) as well as Antimony (Sb) and Lead (Pb) concentrations to a lesser extent. Cottrell electrostatic precipitators recover particulate solids contained in process smoke. Arsenic trioxide, which is the product obtained at this plant; is separated from metallurgic processes and transported in bulk to a warehouse in Vado. Due to the low quality of arsenic trioxide produced and the restricted market for such material, this produce is stored and not sold on the international market.

Calcine, a product of roasting, is then smelted in a reverberatory furnace with oxy-fuel burners. At this point, metallic sulfides (FeS and Cu_2S) in calcine are separated from gangue, which produces a copper matte, suitable to be loaded and processed into converters. Gangue is unloaded through oppositely placed openings that lead towards horizontal burners, then granulated with high-pressure water and, finally, transported to the Gangue Warehouse in Huanchán. Water used in granulation reaches a flow speed of 694 liters per second and is unloaded into the Mantaro river. This situation will be eliminated when a Recycling System, currently being on its final stage of evaluation, is implemented.

Once the matte goes to the converters, air is injected to generate ferrous oxides that react with silica producing gangue, which is sent back to the reverberatory furnace. During the next stage, cuprous sulfide is oxidized by air producing blister copper, which is then transferred to a retention furnace to be molded as anode. A molding turntable is now being installed and will use atomized water, which will then enable a better physical status of anodes and a reduction in industrial water used to cool them.

Cottrell precipitators recover solids contained in emissions produced during smelting

and conversion stages. SO₂ gas is vented away through the main chimney.

Copper Refining

In this process, blister copper anodes coming from copper smelting undergo electrolysis to obtain a refined copper cathode that is sold as cathode or smelted and molded as wire bar.

Electrolyte is bled off daily. 30000 liters per day are separated to maintain the suitable level of impurities for the process.

The solution is saturated by evaporation or by adding refined copper scrap to sell copper sulfide. 75% of this solution is sent back as electrolyte, and the remaining 25% undergoes cementation with iron scrap to recover copper. The stripped acid solution is discharged, untreated, into the Yauli river. A new circuit to extract solvents is under study to prevent pollution of this river.

Anode muds are treated at the Anodic Residue Plant.

Asarco Furnace

Refined copper cathodes obtained in electrolytic cells are washed and smelted in an Asarco furnace. The metal is molded in different forms: wire bars, slabs, ingots, channels and molds. Before being poured into the Yauli river, cooling water passes through decantation pools and jute-panel filtration to minimize TSS concentrations.

Wire-rod Mill

Copper bars are hot rolled until they become black 5/16" wire-rods and 6.55-mm diameter triple-threaded wire.

There is a SALEM annealing kiln fueled with diesel oil. 14 wire drawing revolving drums are used to reduce the bar thickness.

3.4.2 Lead Circuit (Figures 3.4.2/1 and 3.4.2/2)

Lead Smelting

This process starts at the Preparation Plant where recycling material, fluxes and concentrates are dosed to form lead beds. Lead beds are treated at the Lead Agglomeration Plant where a process called up-draft roasting reduces sulfur content and generates sinter, a material holding suitable physical characteristics to pass through blast furnaces.

The fine material originated by this process is retrieved by bag filters, and particles from emissions are regained by Cottrell precipitators.

Thick-lead sinter is smelted in blast furnaces using coke, a reducer, and fuel and some iron scrap to prevent formation of magnetite and loss of metals (Pb, Ag) in gangue. The final product is called hearth lead.

After being separated from hearth lead, gangue is granulated by high-pressure water

and then is transported to the Gangue Warehouse in Huanchán. As in the case of the copper circuit, water used in this process is poured into the Mantaro river.

Hearth lead is transported to receiving pots in which it is scummed. The dross is loaded into a reverberatory furnace where copper matte, speiss (Cu-As) and bullion lead are separated. Bullion lead is sent back to the receiving pots to be mixed with clean hearth lead. This mixture is decoppered in order to eliminate impurities (Cu, As and Sb).

Once decoppered, lead is boiled and pumped into pots at 350-380°C at the molding plant to make anodes using two horizontal turntables.

Lead Refining

Boiling lead with Antimony (Sb), Bismuth (Bi) and Silver (Ag) content is electrolytically refined by a modified Betts process at the Huaymanta refinery.

When electrolysis is completed, corroded anodes hold insoluble impurities, and the occluded electrolyte must be retrieved. Then, mud is swept away using pressured water (35000 liters per day) and pulp is sent to a Larox automatic filter. An anode-mud cake with a moisture content of 27% is obtained and is ready to be sent to the Anodic Residue Plant. Solution coming from Larox filter is recycled to the lead-refining circuit.

At the end of cathodic winning, cathodes pass from winning cells to scrubbing tanks so electrolyte can be retrieved and cathodes will be smelted in one of the three 160-tons capacity pots using oil as fuel. Molten lead is heated up to 450°C and vigorously stirred with sodium hydroxide (NaOH) to scum remaining arsenic, antimony and tin. Refined lead is molded in 46-kg bars to be sold.

Hydrofluosilic acid required for electrolysis is made by a calcium fluoride (CaF₂) and sulfuric acid (H₂SO₄) reaction. After condensation, hydrofluosilic acid reacts with fine silica (SiO₂) in a reactor. Solid residue (CaSO₄) is directly unloaded into the Yauli river. A warehouse for this subproduct is under study.

Anodic Residue Plant

This plant processes anode muds from the Copper and Lead refineries to obtain doré (Ag-Au) and other subproducts such as bismuth, selenium and tellurium.

The plant consists of two reverberatory furnaces for mud smelting and one reverberatory furnace to reduce bismuth gangue; four converters; three cupels; seven bismuth pots; and Hydrometallurgy and Electrometallurgy sections to retrieve selenium and tellurium respectively.

Silver Refinery

This refinery electrolytically processes doré (Ag-Au) to separate silver from gold. 124 THUM cells are available here.

3.4.3 Zinc Circuit (Figure 3.4.3/1)

Roasting

Zinc concentrates from Paragsha and Mahr Tunel are processed in three Fluid Bed Roasters (FBR) and one Turbulent Layer Roaster (TLR).

Part of the zinc concentrates is mixed with zinc oxide dust retrieved by the main Cottrell precipitator, and then precipitated using sulfuric acid. Concentrates are later processed in the three Fluid Bed Roasters to obtain calcined pellets, which in turn are sent to the Grinding and Casting Unit. The final product is stored in silos at the Leaching Unit.

Leaching

The main objective of this stage is to dissolve the zinc oxide and zinc sulfate found in calcine.

Leaching occurs inside stirring tanks into which stripped electrolyte and fine calcine are unloaded. Iron reacts with manganese bioxide and precipitates, along with As, Sb and other impurities, as an insoluble compound called zinc ferrite.

Before being sent to the Solid Separation Unit, pulp is sorted out in a hydrocyclone to separate the thick fraction (+100 mesh), which is sent back to the first leaching reactor.

The impure solution (overflow) is separated from the residues (underflow) at the Separation Plant. Residues are washed and filtered to assure maximum extraction of zinc sulfate.

The residue (zinc ferrite) is sent to the Flotation Plant in which zinc and silver concentrates are recovered. One part of the remaining residue (zinc ferrite) is treated at the Zinc Leaching Residues Treatment (Zileret) Plant and the other is sent as pulp to the Huanchán warehouse for eventual treatment.

Purification

The impure solution of zinc sulfate is diverted to the Purification Unit in which impurities such as copper, cadmium, arsenic and antimony are precipitated using zinc dust. This solution is then filtered; the residue is sent to the Cadmium Plant and a purified solution passes to the Electrolysis Unit. The electrolysis of the zinc sulfate solution is performed using an aluminum cathode and a lead-silver anode. At the end of a 16-hour electrowinning stage, cathodes are removed from cells, and electrolytic zinc is delaminated and sent to an induction furnace for smelting.

Smelting and Molding

Electrolitically-obtained zinc cathodes are smelted and molded in 26-kg ingots to be sold.

A 400-tons-per-day capacity Magmathermic Induction Furnace (AJAX) is available here.

Flotation

All leached zinc residues go through the flotation cells to retrieve zinc and silver sulfides, which are sold as concentrates.

Zinc leached residues (115 tons per day), except sulfides, are distributed as follows: 50 tons per day for the Zileret Plant and 65 tons per day to the store ponds in Huanchán, 3 kilometers from the metallurgic complex.

Zinc Leaching Residue Treatment Plant (ZILERET)

A part of residues (zinc ferrite) from the Leaching Plant is processed at the Zinc Leaching Residue Treatment Plant (ZILERET) where, through oxidization and reduction processes, iron is extracted as iron sponge, and copper, lead, zinc, cadmium and indium are extracted as fumes.

At the Zileret Hydrometallurgy Unit, fumed oxides undergo hydrometallurgic processes to retrieve heavy metals. The lead sulfate cake, zinc sulfate solution and indium cement become final products and are respectively sent to the lead beds, the Zinc Electrolytic Plant (Leaching Unit) and the Indium Plant.

3.4.4. Related Processes

a) Sulfuric Acid Plant. Processes include:

Purification of gas generated in the Zinc-Circuit Turbulent Layer Roaster. This gas enters a dry Cottrell precipitator to eliminate dust and then is sent to a scrubbing tower for cooling. Unloading water from the SO₂ saturated tower passes through a gas depurator where airflow extracts most of the SO₂ gas. Retrieved gas is sent back to the tower. Resulting gas goes through a mist precipitator. Once purified, the gas heads to a counterflow drying tower to extract most water vapor.

Conversion of SO₂ into SO₃ is performed in a converter containing several layers of catalyzing agent to speed reaction of SO₂ with oxygen. When the gas leaves the converter, it goes through a cold interchanger that cools SO₃ gas before it enters the Absorption System.

Cold SO₃ gas absorption is achieved by dissolving it into 98.5-98.85% H₂SO₄ solution. Under these conditions, SO₃ joins water in the acid at the Absorption Tower.

b) Coke Plant

This plant consists of two independent, but simultaneously operating units, each with 10 coke furnaces. The coke gas is used for fueling and heating of furnaces.

Coke processing proceeds as follows:

Coal is unloaded from the hoppers to the hammer mill and later sent to the feeding hopper by jugs, keeping a uniform granule size.

Material is loaded onto each horizontal furnace for coke processing.

- During unloading, at the end of coke processing, coke is removed from each

furnace by a so-called "spout push" and transported by a dragging chain device up to a "coke pool" where it is finally cooled by water spraying.

- Hot gases coming out of furnaces are cooled by water spraying. Tar condenses and is sent to a sedimentation tank.

- Water-free tar is sent to a copper reverberatory furnace to be used as fuel. Coke is sent to the lead smelting circuit.

c) Oxygen Plant

This plant breaks liquid air into its components using their different boiling points.

To perform this operation, this industrial plant can:

- Compress air

- Vaporize moisture and carbon dioxide of air

- Cool air up to liquefying temperature

- Generate coldness

- Liquefy air

- Break air into components (rectification)

- Separate impurities

d) Fluorosilicic Acid Plant

The first stage in fluorosilic acid production is performed in a revolving cylindrical furnace into which calcium fluoride dust and sulfuric acid are slowly added. Temperature control is highly important because the initial reaction is violent.

Hydrofluorosilic acid gas in the furnace is ducted into a system of two condensers externally cooled with water. Flowing opposite to the gas, the water absorbs it. Unabsorbed gas passes from the first condenser to the second one through a lead pipe.

Hydrofluorocsilic acid from condensers is sent to a mixing tank in which it reacts with finely granulated silica. This mixture is constantly stirred by air to produce hydrofluorosilic acid solution (H_2SiF_6) for the electrolyte at the Lead Refinery.

3.5 Parameters for Dust Retrieving Equipment, Gas Emission and Liquid Effluent Monitoring

The La Oroya Metallurgic Complex has a Control Test Section at the Process Control Department that is responsible for the following:

- Measuring emissions from the concrete chimney, reverberatory furnace for lead spuming, copper reverberatory furnace, Zileret Plant kiln and coke furnaces.

- Controlling dust temperature, suction force, volume and loss in the various smelting ducts (converters, agglomeration, copper reverberatory furnace, lead furnaces, spuming, copper and zinc roasters, hot Cottrell precipitator efficiency, sulfuric acid plant, arsenic and anodic Cottrell precipitators efficiency, anodic reverberatory furnace ventilation

system, concrete chimney, and copper reverberatory furnace chimney).

- Operating and handling automatic dust sampling devices installed in several ducts of the smelting, copper reverberatory furnace, converters, agglomeration, concrete chimney and copper roaster units.

- Measuring suction force and temperature of copper reverberatory furnace and arsenic cooking devices.

- Measuring gas volume in coke furnaces.

- Measuring rainfall, from data provided by weather stations in La Oroya and Mayupampa.

- Measuring barometric pressure, hourly environment temperature and relative humidity in La Oroya.

- Measuring flow and samples of the 40 liquid effluent monitoring points.

- Controlling and picking data from equipment located in Huanchán: percentage of SO₂, high volume particulate material, and wind speed and direction. At Sindicato de Obreros Station: percentage of SO₂ and high/low volume particulate material. In Casaraca: percentage of SO₂ and high volume particulate material. In Inca Hotel: percentage of SO₂ and high/low volume particulate material. At Cushurupampa substation: percentage of SO₂, high volume particulate material, and wind speed and direction.

3.6 Support Activities/Facilities for Operations

3.6.1. Power-Generating Plants

Centromín Perú has four hydroelectric centers generating 183.4 Mw of power.

Yaupi hydroelectric plant: 108.0 Mw

La Oroya hydroelectric plant: 9.0 Mw

Malpaso hydroelectric plant: 54.4 Mw

Pachachaca hydroelectric plant: 12.0 Mw

The La Oroya Metallurgic Complex and workers' houses use 63.0 Mw.

3.6.2. Analytic Laboratory

The La Oroya Analytic Laboratory performs chemical analysis using modern instrumental analysis techniques as well as traditional methods. This laboratory is equipped with X-ray devices, atomic absorption spectrophotometry, optical emission spectroscopy, X-ray spectrometry, UV VIS, colorimetry, and emission spectrography. Three generations of emission spectrography devices have successively been used. A Varian 20 BQ PLUS Atomic Absorption spectrophotometer with a graphite oven and a VGA-76 hydride generator are currently used for analysis of environmental samples.

Centromín Perú S.A. Analytic Laboratory was registered as participant of the Programa de Capacitación Analítica (Analytic Training Program) in the Programa de Monitoreo (Monitoring Program) established by D.S. N° 016-93-EM and its ammendment D.S. N° 059-93-EM. This laboratory was also registered to complete laboratory performance diagnostic stipulated by the Programa de Monitoreo de Calidad de Agua, Aire y Emisiones (Water, Air and Emission Quality Monitoring Program). Analysis of samples from the "Estudio 01 de Evaluación de Desempeño" (Study 1 of Performance Evaluation) has by now been made as asked by the Dirección General de Asuntos Ambientales de MEM (General Bureau of Environmental Affairs of the Ministry of Energy and Mines).

3.6.3. Workshops

Repair, structural, garage, instrumental, mechanic, electric, security and electronic workshops are in operation.

3.6.4. Industrial and Potable Water

Sources of water supply are:

- Tishgo river: water for household and industrial use. Some water is used by Empresa Municipal de Agua Potable y Alcantarillado de la Oroya (EMSAPA. Potable Water and Sewerage La Oroya Municipal Utility).
- Cuchimachay: Industrial water. Water for EMSAPA.
- Mantaro river: Industrial water.
- Marcavalle well: Water for EMSAPA.
- Pichjapuquio spring: water for EMSAPA.

3.6.5. Sewerage and Waste Handling

The volume of waste water unloaded from residential areas run by the company as well as from the various production and service plants is estimated at 227 liters per second. At the smelter, two septic tanks are available for sewage water treatment.

There are two types of wastes: industrial and household. Industrial trash is treated in two incinerators located at the smelter and at the copper and lead refineries. Domestic garbage is picked up from the houses belonging to the company by trucks and is transported to Cochabamba, nine kilometers from La Oroya. This kind of garbage undergoes no treatment.



DIAGRAMA 3.4.2/1
DIVISION FUNDICION DE PLOMO
ENERO-DICIEMBRE 1995

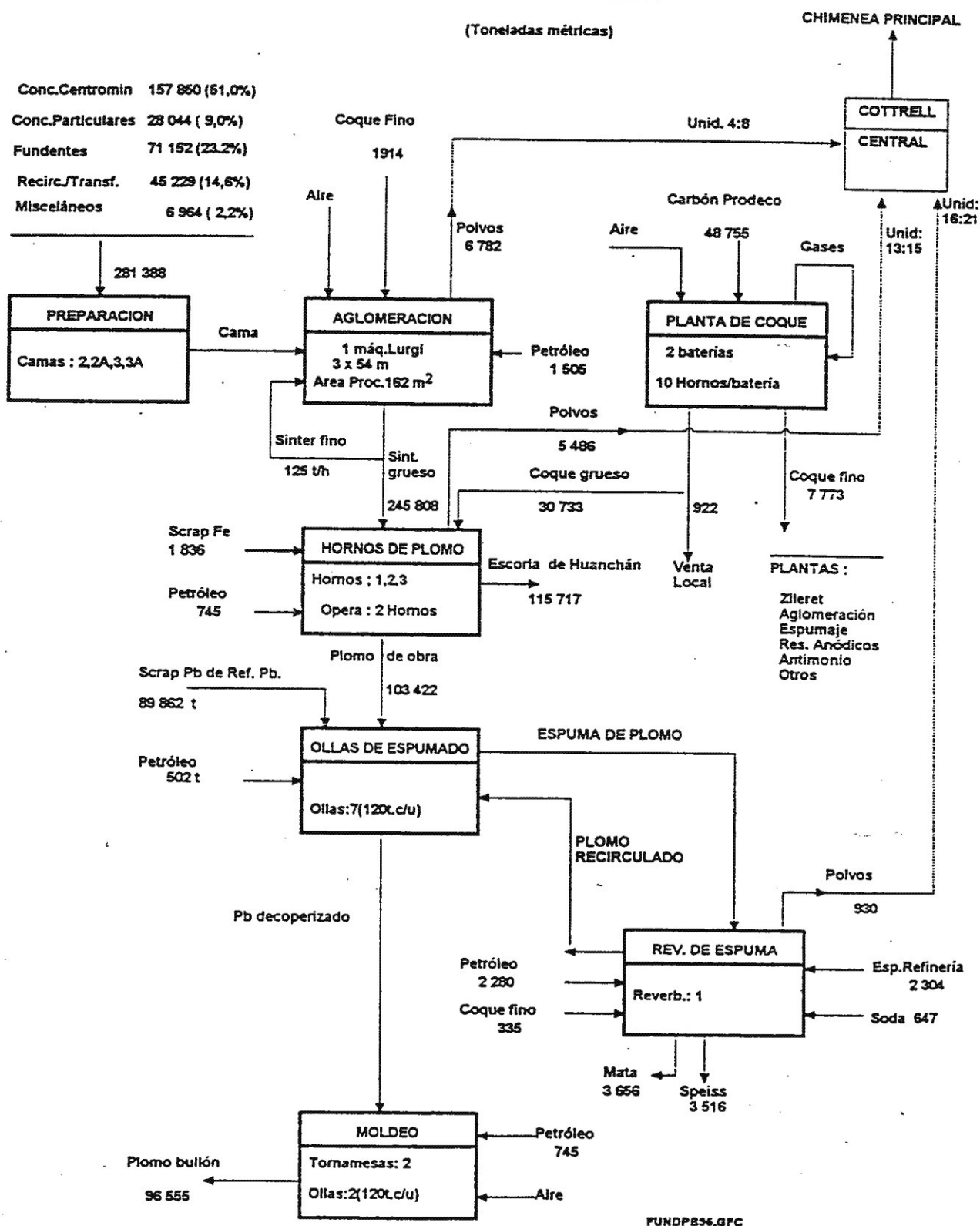


DIAGRAMA 3.4.2/2
REFINERIA DE PLOMO
ENERO - DICIEMBRE 1995
 (toneladas métricas secas)

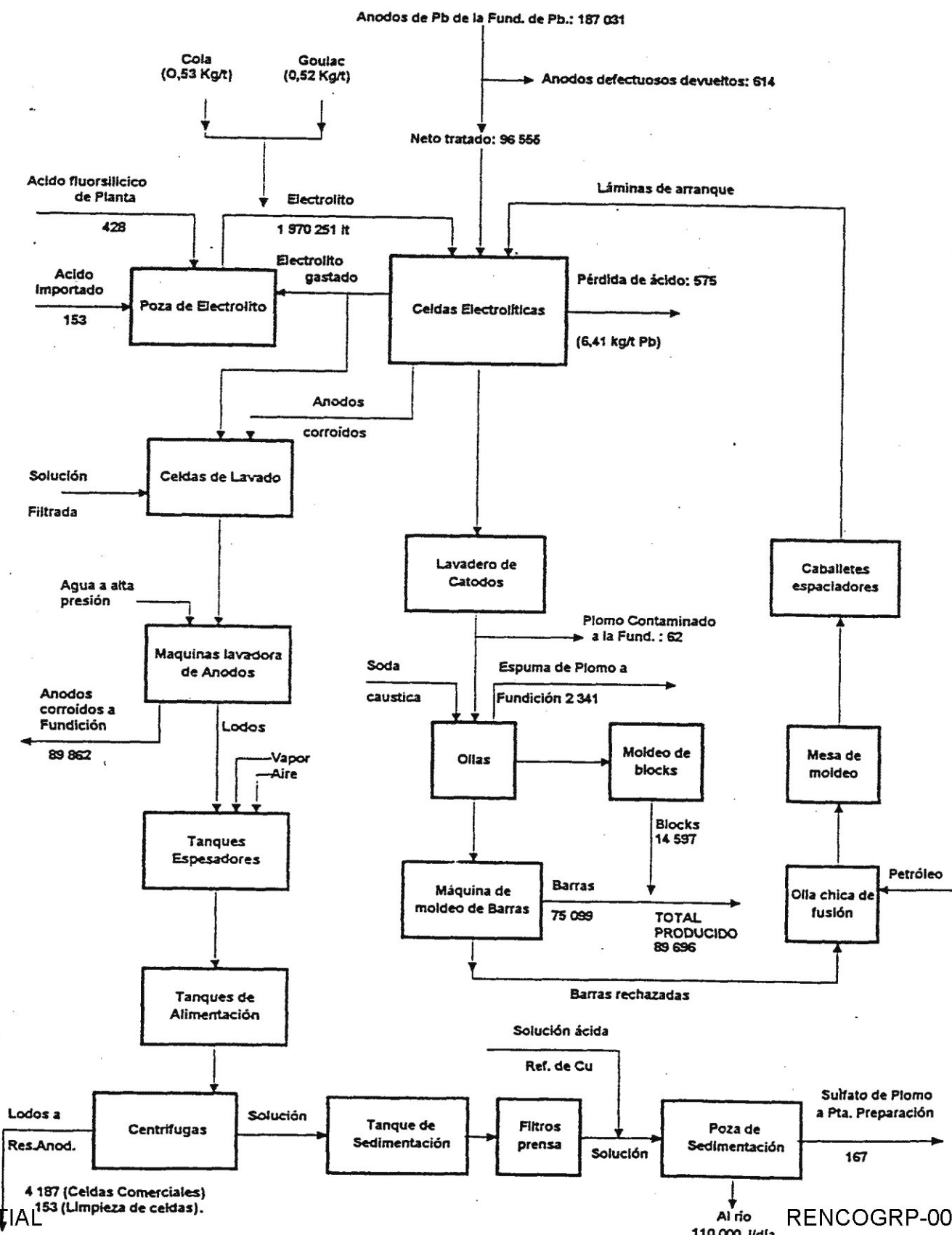


DIAGRAMA 3.4.3/1
DIVISION REFINERIA DE ZINC
ENERO - DICIEMBRE 1995
 (toneladas métricas secas)

Pág. 71

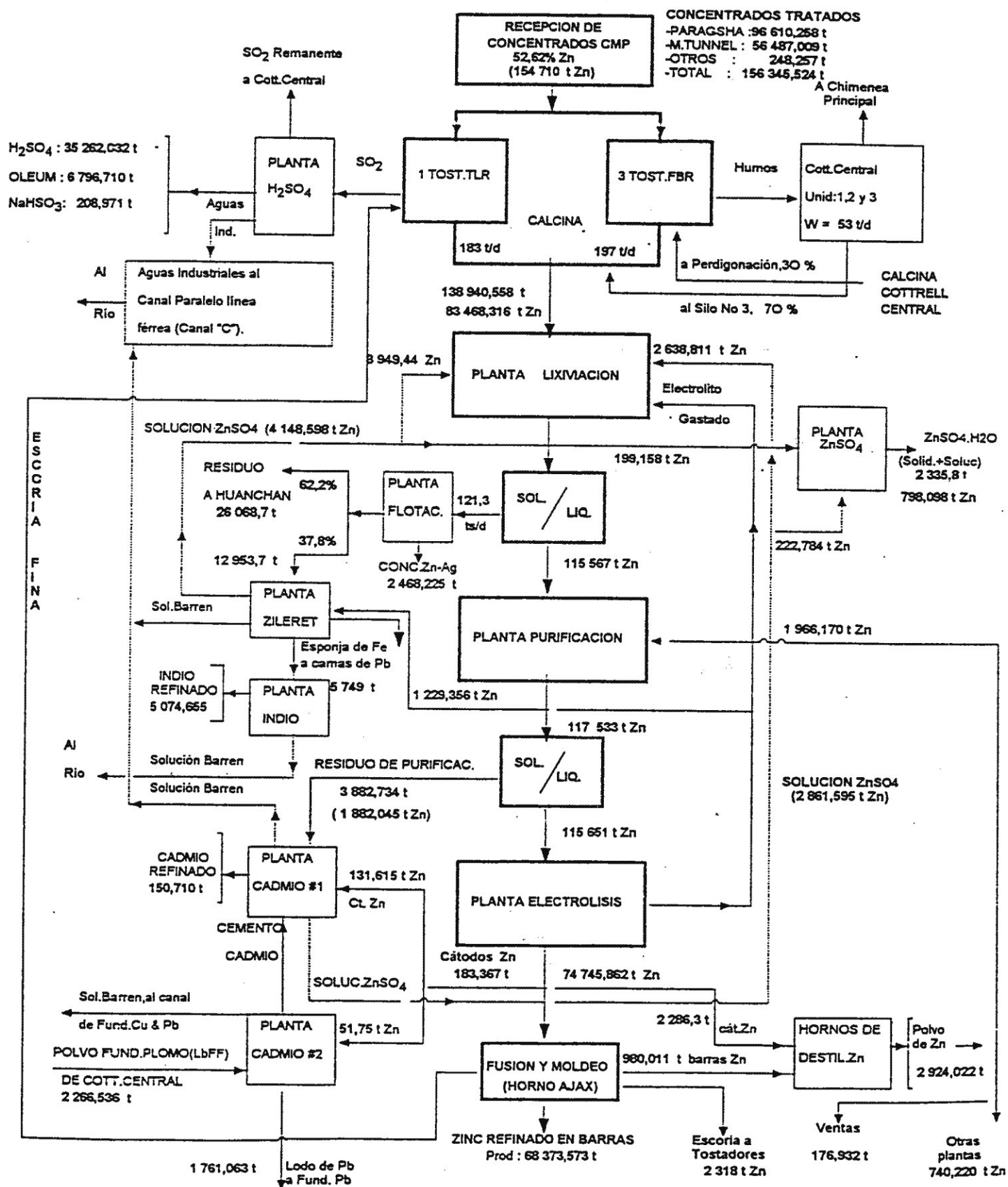


TABLE 3.2 / 1

POTENTIAL INCREASE POTENTIAL IN INSTALLED CAPACITIES DURING THE SHORT TERM
VIA OPTIMIZATION AND INVESTMENTS 1995-1996

	INSTALLED CAPACITY				Potential Increase	
					Cap. Inst.	
	1993	1994	1995	% Increase	1996	% Increase
Blister Copper	62,000	70,000	75,000	7.14	75,000	
Refined Copper	58,000	63,500	66,500	4.72	66,500	
Lead Bullion	90,000	95,000	100,000	5.26	105,000	5.00
Refined Lead	87,000	90,000	91,000	1.11	99,000	8.79
Refined Silver	809	809	809		809	
Gold Bullion	1,720	2,350	2,350		2,350	
Refined Zinc	70,000	70,000	70,000		70,000	
Refined Bismuth	816	1,000	1,000		1,080	8.00
Selenium	24	24	24		24	
Tellurium	21	21	21		30	42.96
Antimony	530	530	530		530	
Cadmium	215	215	215		215	
Indium	3,500	3,500	3,500		5,260	50.29
Sulfuric Acid	45,000	45,000	45,000		45,000	
Glaucon	10,000	10,000	10,000		10,000	
Zinc Oxide	2,200	2,200	2,200		2,200	
Zinc Sulfate	2,270	2,270	2,270		2,270	
Zn/Ag Concentrate	3,000	3,000	3,100	3.33	5,260	69.68
Asenic Trioxide	4,236	4,236	4,236		4,236	
Copper Sulfate	6,000	6,000	6,000		6,000	

(*) Capacity increase via optimization

(**) Capacity increase via optimization and investment

Cuadros.XLS; Tabla 22.3.2 / 1

TABLE 3.2/2

REFINED METALS AND SUB-PRODUCTS PRODUCTION (Kg)

Year	Copper Billets	Copper Refined	Lead Bullion	Lead Refined	Zinc Refined	Gold Bullion	Silver (b) Refined	Platinum (a) Refined	Cadmium Refined	Antimony Grado	Selenium	Tellurium	Indium Refined
1965	39 928 904	40 458 689	91 891 967	86 557 969	61 291 316	1 163.3	630 541.8	745 295	246 690	281 119	8 777	18 138	
1966	42 967 405	36 186 498	92 685 724	88 531 269	61 303 626	1 038.0	620 565.4	747 112	200 464	378 659	6 077	18 344	540.6
1967	40 575 428	35 610 358	86 809 065	81 651 471	61 658 869	1 124.7	593 032.6	774 527	150 684	330 034	4 903	15 008	159.8
1968	55 965 473	38 496 076	95 025 719	86 346 369	65 825 403	1 037.1	544 762.5	791 696	170 097	360 697	5 772	16 049	311.9
1969	49 846 232	34 464 279	80 065 590	77 539 688	62 299 716	1 243.1	486 245.3	652 020	168 555	97 432	6 848	17 322	997.1
1970	50 917 528	36 175 614	77 686 041	71 960 893	68 688 663	1 007.5	566 527.8	763 100	186 245		6 760	28 285	1 557.3
1971	44 205 078	32 561 472	70 829 349	67 103 636	57 196 161	778.3	490 636.5	600 406	171 277		7 076	23 933	1 868.2
1972	54 120 892	39 207 229	91 883 136	85 305 101	67 160 508	1 059.7	661 435.0	677 285	210 376		8 029	1 793	2 397.6
1973	59 453 421	39 375 892	89 543 504	82 854 759	67 095 372	890.3	517 721.2	512 430	211 737		7 659	26 200	3 458.7
1974	58 626 158	38 952 473	86 163 783	80 090 232	68 956 918	928.3	548 969.7	615 039	182 163		7 747	36 474	2 369.2
1975	52 803 567	36 586 867	76 050 022	70 965 675	63 241 284	965.8	555 547.5	500 410	159 302	163 203	6 675	21 208	1 587.4
1976	55 537 734	45 785 495	79 314 258	74 065 995	64 542 279	1 078.6	598 048.5	455 606	173 908	343 007	8 752	12 331	3 271.4
1977	58 425 216	55 021 763	84 389 872	80 844 836	66 950 132	1 006.8	670 975.1	516 148	181 800	627 629	15 936	18 370	3 734.2
1978	55 362 878	51 896 976	79 697 816	74 254 740	62 851 466	1 001.9	649 954.9	610 825	169 553	477 361	12 941	15 418	3 301.6
1979	59 268 355	54 290 172	91 128 993	85 111 992	68 195 607	1 335.5	732 783.3	526 984	190 055	460 034	18 325	21 228	3 484.7
1980	57 957 005	54 104 430	87 535 630	81 976 187	63 828 687	1 320.5	745 568.1	497 607	171 912	426 559	22 308	20 920	3 610.0
1981	53 955 693	50 026 215	85 233 827	79 236 015	67 966 362	1 319.6	741 915.6	638 688	182 344	447 605	22 478	21 310	3 489.0
1982	55 620 833	53 555 517	83 020 838	76 990 188	68 489 173	1 406.4	768 395.0	604 163	178 716	432 274	20 974	20 726	3 673.4
1983	50 868 993	47 259 872	72 812 457	67 733 843	63 941 450	1 592.3	765 731.8	526 144	158 122	322 958	19 553	15 116	2 706.8
1984	54 689 969	50 035 881	75 737 587	70 262 061	64 772 251	1 643.1	733 548.7	651 071	147 327	372 309	20 800	14 084	2 906.0
1985	60 377 661	57 346 095	87 764 331	81 890 910	69 202 221	1 722.3	715 416.0	738 057	176 901	377 117	14 535	15 037	3 867.4
1986	48 753 579	47 053 687	71 115 489	66 324 339	59 765 946	1 566.3	615 147.2	605 296	138 074	358 701	12 035	9 836	3 332.9
1987	54 514 895	51 471 971	71 378 326	66 509 379	66 284 200	935.4	597 358.9	412 476	143 500	318 200	11 438	7 457	3 890.1
1988	31 788 561	30 315 296	46 873 847	44 287 584	50 574 600	769.7	416 988.8	363 030	108 300	346 400	4 937	4 079	2 119.6
1989	53 230 741	53 230 741	73 255 469	68 827 153	64 804 900	918.9	592 212.3	646 573	141 700	304 000	9 384	8 354	3 025.5
1990	52 540 877	49 277 247	74 516 684	69 803 251	61 687 700	1 203.4	588 779.5	520 861	129 600	307 300	8 864	8 143	2 801.3
1991	52 324 400	51 796 664	80 782 050	74 585 504	62 038 300	1 168.4	583 674.0	576 800	137 700	277 700	12 446	13 380	3 145.5
1992	60 022 803	55 042 828	89 677 230	84 036 562	63 197 162	1 013.8	608 893.0	418 547	149 000	311 091	14 425	18 668	3 053.1
1993	62 614 640	60 576 569	94 076 550	87 285 486	66 535 241	1 223.1	539 426.0	887 180	157 122	214 694	17 131	17 399	3 192.5
1994	63 607 990	59 695 441	94 548 554	88 713 625	67 242 825	1 742.9	579 446.0	887 180	145 750	410 789	19 338	28 641	4 049.1
1995	71 170 000	65 120 000	100 000 000	90 000 000	68 373 574	1 596.8	613 361.0	581 962	150 710	230 115	14 549	30 147	5 074.7

Source: Metallurgical reports from 1965 to 1995

(a) Total production of Bi is considered as Bi Refined + Bi Bullion since 1966 until 1972

(b) Refined silver and fine silver + sterling silver (925) production are the same

- Between 1965 a 1986, the productions were reported in English units, since 1987 the production were reported following SLUMP

- Production of 1992 according to Monthly reports of Smelting and Refineries

- Indio production from 1965 to 1986 was taken from "Reporte Estadístico de Produccion de Contabilidad Metalurgica del año 1987 to 1997 del Reporte Anual de F&R"

Copper Refinery enlarged its capacity, from 14 to 20 blocks (640 cells)



4. SUMMARY OF THE ENVIRONMENTAL IMPACT ASSESSMENT AND ANALYSIS

The environmental impact assessment is based on reports such as : the EVAP (Preliminary Environmental Assessment), prepared with monitoring data from 1994, the Statement of Emissions and Effluent Flows based on data from 1995, the Environmental Audit of Emissions and Effluent Flows from June 1996, and the characterization of the environmental components resulting from metallurgical activities, as described in chapters II and III.

4.1 Impact Sources

Three sources of impact due to metallurgical operations at La Oroya have been identified :

- Gas and particles emissions
- Liquid effluents
- Solid wastes

Moreover, other environmental problems identified include: Sewage Effluents and Domestic Wastes.

4.1.1 Gas and Particles Emissions

The emissions generated at the smelter circuits are discharged to the atmosphere through the main chimney (167.5 m in height) and 95 secondary chimneys (variable heights). Of these chimneys, 33 are used for combustion gases, 39 for industrial gases and 23 for water or air steam. Tables 4.1.1/1,2 and 2A show the inventory of main emission points as well as the composition of discharged gases and and particulate matter.

In 1995 the following quantities of gases and particulate matter were discharged to the atmosphere through the main chimney : 899.8 t of SO₂/day and 8.9t/day of particulates. 7.2% of the sulfur that entered the process, was fixed as sulfuric acid, 4.3% was fixed as solid wastes and 88.5% was emitted to the atmosphere as sulfur dioxide. 97% of the particulates generated in the process was recovered in the existing electrostatic precipitators, and 3% was emitted to the atmosphere through the main chimney. The sulfur balance for 1995 is attached in the following table.

Inflow	ton of S	%
Copper concentrate	78 080,1	41.08
Lead concentrate	43 282,5	22,77
Zinc concentrate	51 011,7	26,84
Copper melting	9 441,4	4,97
Lead melting	6 934,0	3,65
Others	1 320,0	0,69
Total inflow	190 069,7	100,00
Fixed	ton of S	%
Sulfuric acid	13 681,7	7,20
Copper slag	4 239,3	2,23
Lead slag	1 427,6	0,755
Zn/Ag concentrate	652,0	0,34
Liquid effluents	551,1	0,20

Zinc ferrites	786,5	0,41
Main stack dust	300,2	0,16
Others(CuSO ₄ , ZnSO ₄ , etc)	224,7	0,12
Total Fixed	21,863,2	11,50

Stack emission and fugitive emission	168 206,6	88,50
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The emission of fugitive gases also impacts the air, but it is difficult to quantify these impacts as they are irregular and disperse quickly.

TABLE No. 4.1.1/1
GAS SOURCES AND DUST

Cod	Emission source	Emission height m	Treatment equipment
1	Main stack	168	Electrostatic precipitator
2	Secondary stack		
	• Iron stack	91	None
	• Coke stack - Battery "A"	19	None
	• Coke stack - Battery "B"	19	None
	• Bismuth Vent. System. - A.R.P.	15	Gas washer
	• Converter Vent. System. - A.R.P.	19	Bag filters
	• Cupellation Vent. System. - A.R.P.	15	Electrostatic precipitator
	• Vent. System Zinc roasters	30	Gas washer, bag filters
	• Emissions from refinery of Cu, Pb and others		19 Ventilation stacks
3	Fugitive Emissions		None

A.R.P. Anodic Residues Plant

a) Emissions through the Main Chimney

See Tables 4.1.1/3 and 4.1.1/3A and Pictures 4.1.1/1 and 4.1.1/2.

• Gas Volume and SO₂ Concentration

The volume of gas and its respective concentration of t SO₂ emitted from the main chimney in 1995 during normal operation conditions were as follows :

	Vol (m ³ /seg)	SO ₂ (mg/m ³)
Main stack	1 145,61	9 379,00

Plants which generate SO₂, distributed according to percentage are :

- Copper Roasters 4.10%
- Copper Reverberation furnace 18.31%
- Copper Converters 24.37%

- Lead Sintering	21.83%
- Lead Furnaces	4.35%
- Zinc Roasters (FBR)	19.32%
- Anodic Wastes	7.72%
TOTAL	100.00%

• **Particulate Matter**

The following table shows the balance of particulate matter emissions generated from different plants and discharged through the main chimney. This table also shows the recovery efficiencies of the different electrostatic precipitators (Cottrelles).

DUST LOAD		CENTRAL COTT.		ARSENIC COTT.		P.R.A. COTT	
CIRCUIT	CONDUIT	INFLOW	OUTFLOW	INFLOW	OUTFLOW	INFLOW	OUTFLOW
COPPER	Roasters			32.704	1.676		
	Reverberation	25.255	0,857				
	Converters	62.139	2.109				
LEAD	Agglomerate	1.582	0,053				
	Pb furnace	15.029	0,510				
	Froth	2.549	0,087				
ZINC	Toast. (FBR)	90.982	3,088				
REF.(ARP)	Rever. Fus Ventilat.					3.615	0.470
							0.046
TOTAL		197,536	6.704 (*)	32.704	1.676	3,615	0.516
EFFICIENCY		96. 6%		94.9 %		87.0 %	

(*) Value determined by estimates

Diagram 4.1.1/1 shows gas and dust handling in the cottrelles.

The amount of solids emitted to the environment in 1995 was :

	Metal Content mg/mg ³			Suspended Solids mg/m ³
	As	Cd	Pb	
Main stack	17,96	0,92	23,25	89,88

The emissions of particulate matter was approximately 8,896 metric tons per day. These emissions are comprised of the following heavy metals:

Lead	2.30t/d
Arsenic	1.78t/d
Zinc	0.33t/d
Antimony	0.24t/d
Cadmium	0.09t/d

The statistics and graphics of gas and particulate matter emissions through the main chimney are attached in Table 4.1.1/3B and graphics 1, 2 and 3, respectively. Based on these data, there appears to be a reduction in both SO₂ and particulate emissions despite the increase in the blister copper smelting capacity from 60,000 to 75,000 t/year. This reduction in

emissions to the environment is primarily due to the change of metallurgical indices and the implementation of the oxy-fuel project.

b)Emissions through Secondary Chimneys

- **Emissions through the Iron Chimney**

The iron chimney is located next to the copper reverberation furnace. The gas and particulate matter emitted through this chimney are derived from the slag and matte ventilation and duct systems. These emissions constitute not more than 9% of the total flow emitted through the main chimney. Nevertheless, the lead and arsenic concentrations within these emissions are significant (see Tables 4.1.1/4 and 4.1.1/4A).

- **Emissions through Coke Plant Chimneys – A and B Batteries**

These chimneys conduct 14.86 Nm³/sec. of gases, known as "waste gases." The gases discharged through the A and B battery chimneys are a result of the combustion activity carried out in the heating chambers of the coking process. Their analyses are shown in Tables 4.1.1/5, 4.1.1/5A, 4.1.1/5B and 4.1.1/5C.

- **Bismuth Buckets Ventilation Systems - Anodic Wastes Plant**

Gas emissions from bismuth boilers N° 4, 5 and 6 are a result of the oxidation and chlorination activities in the bismuth refining stage. Gas emissions are previously purified in a gas scrubber. The emission analysis is shown in Tables 4.1.1/6 and 4.1.1/6A.

- **Converters Ventilation Systems – Anodic Wastes Plant**

Gas emissions from Converters N° 1, 2, 3 and 4 are a produce of the selective oxidation of antimony and bismuth in the converters, and from the reduction of bismuth in Reverberation Furnace N° 3. The particulate matter contained in these gases are recovered in three bag-filter units prior to emission. The emission analyses are detailed in Tables 4.1.1/7 and 4.1.1/7A.

- **Cupelation Ventilation System – Anodic Wastes Plant**

The cupelation ventilation system permits collection of the metallic fumes from the N° 1, 2 and 3 cupels, resulting from the selective oxidation process of selenium, tellurium and other minor elements recovered in the gas scrubber and humid electrostatic precipitator. The remaining gases are expelled through a chimney, whose analyses are shown in Tables 4.1.1/8 and 4.1.1/8A.

- **Zinc Roasters Ventilation System**

These emissions come from the fluid-bed roasters and shot blasting units. Emissions are comprised of SO₂ residual gases, combustion materials, and particulate matter that was not recovered in gas scrubbers and bag-filters. The emission analyses are shown in Tables 4.1.1/9 and 4.1.1/9A.

- **Emissions in Copper, Lead and other Refineries**

The system includes 19 chimneys located in the copper and lead refineries, the ASARCO furnace and wire rod plant.

Due to the nature of the electrorefining process, it is necessary to increase the processes temperature for copper sulfate production and anodic sludge leaching in the copper

refinery, thus generating water vapor emissions as well as sulfuric acid and copper sulfate pollutants to a lesser extent.

ASARCO furnace operations include copper cooling bars that produce water vapor emission which contain inter bone ash particles.

The wire rod plant emits water vapor (free of pollutants) resulting from the cooling of wire rod bars.

In the lead refinery, emissions come from the lead electrorefining process. These emissions are comprised of water vapor and minor amounts of fluorsiliceous acid. There are also emissions of hydrofluoric acid from the fluorsiliceous acid plant.

During the fusion of refined lead cathodes, metallic vapors are produced. These vapors are collected by hoods and sent to a bag-filter, while residual gases are evacuated to the environment. Typical combustion gases are emitted to the environment independently of the fusion gases.

c) Fugitive Emissions

• Copper Smelter

Figurive emissions from the copper smelter are produced in the preparation plant as materials are taken outside the area of the collection hoods. This usually occurs when the cpaacity of the extractors are exceeded

The emission of SO₂ gases and solids from the roaster plants are dishcarged to the environment directly from the loading area as a result of a lack of ventilation (draft) in the main evacuation duct.

Likewise, fugitive gases and dusts which have not been collected by the ventillation hoods have been observed at transfer points between the copper roasters and the lime-burner cars.

The inadequate ventilation system at the converters results in fugitive dust and SO₂ emissions to the environment during the loading of recirculated cooling materials.

In blister copper molding rention furnaces, combustion and SO₂ gases are freely dispersed due to the lack of a collection system.

Table 4.1.1/10 shows the characterization of the emission leakage.

• Lead Smelter

Fugitive emission are recorded at the lead furnace, especially during emergency operations such as when the furnaces stop operating or are being cleaned, or when settling tanks are changed, etc. In addition, fugitive emission occur at the dross treatment plant due to a lack of collection systems.

In the reverberation furnace for dross treatment there are fugitive emissions especially during product casting and load of materials.

The characteristics for these emissions are attached in Table 4.1.1/10

- **Zinc Circuit**

There are particulate matter emissions from the transporation systems at the fluid bed rasters and shot blasting units.

There is a presence of particulate matter in the turbulent -layer roaster (TLR) environment.

There is a presence of water vapor with small amounts of sulfuric acid in the cooling area of the zinc electrolytic plant.

In the zileret plant there are gas and particulate emissions while sponge iron is unloaded from the kiln furnace.

Table 4.1.1/10 summarizes the description of emission leakages in this circuit.

- **Anodic Wastes and Silver Refinery**

There are gas and particulate emissions as the fusion reverberatory furnace is unloaded and when melted materials are decanted to the converters. This situation is worse as time goes on due to the low efficiency of the ventilation systems.

Table 4.1.1/10 shows the characteristics of the emissions leakages in this plant.

4.1.2 Liquid Effluents

There are a total of 40 liquid effluents from metallurgical operations that impact the Yauli and Mantaro Rivers. These effluents are formed by solutions typically produced during the metallurgical processes, the generation of cooling waters for electronic equipment, jackets, etc. Some of these effluents also contain a mixture of sewage waters from bathrooms and washeries.

The 40 effluents, their code numbers and descriptions are specified in the following Table.

LIQUID EFFLUENTS - LA OROYA METALLURGICAL COMPLEX			
POINT	CODE	DESCRIPTION	CIRCUIT
1	R-1	Copper refinery (Ex-Lead Refinery)	Ref. Cu
2	R-2	Eliminated: Alambrón Plant	"
3	R-3	Roaster Plant Asarco - Salida poza de sedimentación	"
4	101	Coque Plant - Waste water	Fund. Pb
5	102	Structural workshop courtyard	Workshop
6	103	Eliminated: Structural workshop and Internal protection (SSHH)	"
7	104	Eliminated: Internal protection- Chief (SSHH)	Services
8	105	Eliminated: Acetilene plant	Workshop
9	106	Iron Smelter - Maestranza, Bodega	"
10	107	Antimony Plant, acid tanks, Instrumental workshop, Workshop office and light equipment	"
11	108	Componentes workshop (SSHH), Garage	"
12	109	Componentes workshop, Courtyard	"

13	110	Instrumental carpentry workshop	"
14	111	Training Center	Services
15	112	Heavy equipment, Fireman station	Workshop
16	113	Eliminated: Industrial Ingeniería	Servicies
17	114	Power house Control tests	Serv./Mantto.
18	115	Ionic Plant, Power House	"
19	116	Oxygen plant, Cable Rail (SSHH)	"
20	117	Old Oxygen plant	"
21	118	Copper and Lead smelter- slag granulation	Cu-Pb Found
22	119	Copper and Lead smelter -main channel No. 2	"
23	120	Zinc Electrolitic Plant - (SSHH)	Zn ref
24	121	Anódic residues plant - Selenium y Telurium Plant discharge and SSHH	Cu-Pb Ref
25	122	Anódicos residues plant - Salida de la Poza de Sedimentación de la Lavandería	"
26	123	Planta Residuos Anódicos - Poza de Sedimentación	"
27	124	Electrolitic Plant Zn-Efluente Anode wash effluent	Ref. Zn
28	125	Electrolitic Plant Zinc - Cooling water	"
29	126	Zinc EW Plant, cooling water and spills from the purification plant	"
30	127	Refrigeración Zinc sub-station plant cooling	"
31	128	Zinc fusion oven, cooling water	"
32	129	Smelter construction - SSHH	Serv./Mantto.
33	130	Construction offices	"
34	131	Pyro Cadmio Plant, D.I.M.	Ref. Zn
35	132	D.I.M., Pilot plant and mechanical workshop	"
36	133	Indium plant barren solución from alkaline wash	"
37	134	Indium Plant - Waste Solución	"
38	135	Main channel No. 1 (Parallel to FF.CC.)	"
39	136	Parallel channel to the Main Channel No. 1	"
40	137	Zinc ferrites effluent	"

Note : The classification by type of effluent is shown on page 199.

The effluents characteristics are shown in Tables 4.1.1/2, 2A, 3 and 3A.

It has been specified that 7 of the of 40 effluents are the main pollutanting contributors to the Mantaro and Yauli Rivers. These 7 effluents represent 94 to 95% of the total load contributed to the receiving rivers. This load includes 29-57,5% of the total As and more than 90% for the following elements : Cd, Cu, Fe, Mn, Pb and Zn, as shown in Tables 4.1.2/4, 4A, 5 and 5A.

According to Tables 4.1.2/6 and 6A the Yauli and Mantaro Rivers reach La Oroya with high amounts of industrial pollutants; nevertheless, these rivers are classified within Peruvian water quality class III, except for the constituent Mn in both rivers and also for Pb in Yauli river.

Both receptor rivers are monitored at the following points :

Receivers: Sampling Points at Mantaro and Yauli River	
POINTS	LOCATION
M-1	Mantaro River, Chulec bridge, 2 m downstream

M-2	Mantaro River, Torres Hydro housing, 15 m downstream
M-3	Mantaro River, Cascabel bridge, 10 m downstream
M-4	Mantaro River. 4 Km from Oroya Huancayo road 100 m from Huanchán deposit
M-5	Mantaro River, 5 Km from Oroya Huancayo road, after Zinc ferrites deposit
Y-1	Yauli River, Marcavalle bridge 2 m downstream
Y-2	Yauli River, Huayamanta bridge 20 m downstream
Y-3	Yauli River, Sudete bridge 15 m upstream

A summary of the sampling points classified according to the water monitoring Protocol, is shown in Table 4.1.2/1, while Diagrams 7.2.4/4, 5 and 6 in Chapter VII detail the location of the sampling points corresponding to the main effluents from the Smelter and Refinery Circuits at La Oroya using the EVAP report as a reference.

Table No. 4.1.2/1

SAMPLING STATIONS

COMPONENT	INFLOW	STATIONS	OUT FLOW	STATIONS	TOTAL	INFLOW/ OUTFLOW
Natural water stream						
- Yauli river	- Upstream	Y-1	- Down stream	Y-2, Y-3	3	4 to 6 regs. Monthly
- Mantaro river	- Upstream	M-1, M-2 and M-3	- Down stream	M-4 and M-5	5	4 to 6 regs. Monthly
Industrial water discharge, Ref. And sewer (Industrial area)						
- Cu - Pb refin.				R-1, R-2 and R-3	3	8 registers monthly
- Smelter				101,102,103,104, 105,106,107,108, 109,110,111,112, 113,114,115,116, 117,118,119,120, 121,122,123,124, 125,126,127,128, 129,130,131,132, 133,134,135,136, and 137	37	8 registers monthly
Processing						
- Tishgo river	Fresh water	T-1			1	4 to 6 regs. Monthly
- Mantaro river	Fresh water	M-3			0	In natural waters
TOTAL					49	Stations

Note: Effluents R-1, R-2 and R-3 discharge to Yauli River
Effluents from 101 to 137 discharge to Mantaro River

4.1.3 Solid Wastes

The primary solid wastes from the Metallurgic Complex that impact the surrounding environment are the copper and lead slags, zinc ferrites and arsenic trioxides, all of which are deposited in distant areas from the industrial zone.

The slags do not have an economic value, while zinc ferrites are considered as a zinc reserve for future exploitation due to the considerable amounts of the said metal they contain.

The arsenic trioxide market is depressed.

Other materials with less impact are thallium wastes and industrial and domestic garbage.

a) Lead and Copper Slags

These slags are generated in the lead-breadth and the copper reverberatory furnaces. After slags are granulated by abrupt cooling with pressurized water, they are transported via gravity in slurry form, separated into liquids and solids, and finally transported via a cable rail system to the "Huanchán" deposit. See Diagram 4.1.3/1.

The water used in granulation process contains suspended elements of fine slag and dissolved materials, and is directly discharged to the Mantaro River.

The following table outlines the analysis results of this solution.

	Cu	Pb	Fe	As	Sb	SO ₂	SO ₄	NO		Solids	
	mg/l	mg/l	mg/l	g/l	g/l	g/l	g/l	mg/l	pH	%	g/l
Pb 1Roaster	0,6	1,0	1,5	0,18	0,03	0,38	0,08	0,68	0,24	2,30	25,2
Pb 2Roaster	0,5	1,0	2,0	0,23	0,04	0,38	0,06	0,59	0,24	2,10	24,3
Reverberation	0,8	0,8	1,5	0,04	0,10	,016	0,18		5,60	1,50	28,5

The following Table summarizes the characteristics of the slag deposits:

DIMENSIONS	
Area	250 000 m2
Height	70 m
CHARACTERISTICS	
Weight	10 millions tons
Chemical Analysis	See Table 4.1.3/2
Humidity	6,0%
Stability	Stable
Granulometry	See Table 4.1.3/2A
Solubility	None
LOCATION	See Drawing M03-96-02, enclosed in this Chapter

The characteristics of this deposit and its proximity to the central highway and the Mantaro River create both potential and actual environmental and stability impacts.

Wind also has an effect on the deposit since it transports and disperses slag particles from the deposit.

b) Arsenic Trioxide

This by-product is generated as a result of roasting the dust recovered in the arsenic cottrell precipitators which is mixed with pyrite. The arsenic from this process becomes volatile and the subsequent vapors are used in the cottrell heating process and subsequently in the cookers to produce a product containing 96% As_2O_3 .

Due to the lack of sales of As_2O_3 , these wastes have been deposited (instead of sold) in two areas. The first deposit is located at Malpaso and was used for approximately 25 years (1967 - 1992). The second deposit which is currently being used is located in the Vado zone.

The characteristics of these deposits are summarized in the following Table :

DIMENSIONS	MALPASO	VADO
Area	18 000 m ²	45 000 m ²
Height	2 to 3 m	2 to 5 m
Depth	2 to 3 m	2 to 5 m
CHARACTERISTICS		
Weight	45 000 ton	115 000 ton
Chemical Analysis	See Table 4.1.3/2	See Table 4.1.3/2
Humidity	2,0%	2,0%
Stability	Unstable	Unstable
Granulometry	See Table 4.1.3/2A	See Table 4.1.3/2A
Solubility	Soluble	Soluble
LOCATION	See Fig. 1 and Drawing 1 chapter 5 addenda, Project No.14	See Fig and Drawing 1 chapter 4 addenda, Project No. 14

Since these deposits are located in alluvial material located close to the Mantaro River, and are exposed to the rain events which intensify between January to March, pluvial waters percolate through the deposits and sometimes dissolve arsenic and other elements which, in turn, flow to and contaminate the Mantaro River.

The water quality assessment of this river which includes analysis of water quality both upstream and downstream of the Vado stock of the was conducted by our Metallurgical Research Division. Results of this assessment are presented as follows(mg/l):

Mantaro River Water Quality Before and After Stock Vado

Date	Upstream of Vado				Downstream of Vado			
	Cu	Pb	Fe	As	Cu	Pb	Fe	As
27-3-95	0,08	0,05	0,52	0,05	0,08	0,04	0,55	0,60
29-3-95	0,06	0,04	0,66	0,04	0,08	0,04	0,47	0,84
31-3-95	0,06	0,04	0,54	0,01	0,06	0,04	0,57	0,06
03-4-95	0,10	0,03	0,53	0,08	0,11	0,08	0,52	0,30
05-4-95	0,04	0,05	0,51	0,05	0,05	0,04	0,46	0,40
07-4-95	0,11	0,04	0,56	0,23	0,04	0,03	0,59	0,01
10-4-95	0,09	0,04	0,39	0,03	0,05	0,04	0,34	0,02
12-4-95	0,06	0,01	0,50	0,06	0,10	0,02	1,70	0,94
15-4-95	0,06	0,01	1,10	0,04	0,12	0,05	0,68	0,45
17-4-95	0,07	0,04	0,55	0,05	0,03	0,06	0,44	0,56
19-4-95	0,05	0,03	0,44	0,01	0,06	0,04	0,26	1,10
21-4-95	0,06	0,04	0,44	0,13	0,05	0,04	0,32	0,36
24-4-95	0,52	0,80	4,40	0,13	0,52	0,28	4,20	0,16
26-4-95	0,42	0,32	4,20	0,01	0,48	0,35	4,30	0,26
28-4-95	0,52	0,35	4,30	0,04	0,55	0,40	3,90	0,44
L.M.P.(1)	1,00	0,40	2,00	1,00	1,00	0,40	2,00	1,00
L.M.P.(2)	0,30	0,20	1,00	0,50	0,30	0,20	1,00	0,50

Source: Memorandum DIM-074-95 del 06-06-1 995.

L.M.P.(1): Maximum permissible limits, any moment (mg/l).

L.M.P.(2): Maximum permissible limits Annual Average Value (mg/l).

From the table it can be inferred that arsenic concentrations in the Mantaro River increase after the Vado stock.

In regards to other elements like copper, lead and iron, there are very small increases downstream of Vado which do not exceed the permissible maximum limits.

Regarding pH, there is no change (significant) as recorded values are 7.3 and 7.8 for both upstream and downstream samples.

Arsenic trioxide deposits are shown in Pictures 4.1.3/2A and 2B.

c) Leached Zinc Wastes (Zinc Ferrite)

These wastes result from the hydrometallurgic process of leaching calcine (tin ash) zinc

43% of the wastes produced (115t/d) are processed in the zileret plant. This process produces iron sponges which can be used in the fusion of layers to create stable slags.

The remaining ferrite is deposited in wells contained by dikes comprised of borrow material. To meet the growing demands for increased holding capacity, dike heights are constantly increasing according to the "upstream" (aguas arriba) methodology which does not use compression nor moisture additions.

The solids from the zinc ferrite pulp are precipitated at one end of each well while the remaining solution is discharged to the Mantaro River via a buried pipe.

Weather events conditions such as wind and precipitation events transport fine particles from the deposits to the environment and dissolve of soluble salts($ZnSO_4$) which are finally discharged to the Mantaro River.

The test control section manages the effluent flows and metallic contents from these deposits which are discharged to Mantaro River. The average for January-August is shown in the following table.

HUANCHAN DEPOSIT LIQUID EFFLUENT DISCHARGED TO RIVER										
AVERAGE JANUARY-AUGUST 1996										
FLOW m3/min.	TEM PC	pH	SUSPENDED	mg/l						
			SOLIDS	As	Cd	Cu	Fe	Mn	Pb	Zn
0,488	16	7,03	40	0,0 8	0,5 0	0,0 5	0,2 5	18,40	1,43	222
MAXIMUM PERMISSIBLE										
			SUSPENDED	mg/l						
			SOLIDS	Ph	As	Cu	Fe	Pb	Zn	
Any moment			100	> 5.5- < 10.5	1,0	2,0	5,0	1,0	6,0	
Annual average			50	> 5.5- < 10.6	1,0	1,0	2,0	0,4	3,0	

According to this table concentration of Zn and Pb exceed the maximum permissible limits. In regards to other elements like Cu, Fe and As, it can be observed that their concentration amounts do not exceed the maximum permissible limits while pH values are close to the established limit.

The characteristics for these deposits are summarized in the following table :

DIMENSIONS	
Area	94 805 m ²
Height	From 6 to 12 m
Depth	From 6 to 12 m
CHARACTERISTICS	
Weight	1 242 797 t
Chemical Analysis	See Table 4.1.3/2
Humidity	20 to 30 %
Stability	Stable
Granulometry	-38 μ m:92,9%
Solubility	Insoluble
LOCATION	See Drawing M04-96-02, enclosed in Chapter 5, Project No.15

The codes for treatment and final disposal of solid wastes resulting from Copper and Lead Smelters and Zinc Refineries (table 4.1.3/2, 2A) are shown in Table 4.1.3/1.

Picture 4.1.3/2 presents a partial view of these deposits.

d) Other Wastes (Thallium Wastes, Industrial and Domestic Garbage)

• **Thallium Wastes**

This solid residue results from the treatment of crude cadmium sponges (Cadmium Plant). The residue is a produce of the purification of cadmium sulfate with potassium permanganate, caustic soda and sodium carbonate.

The material produced is transported by truck to the Huanchán deposit (south from the deposit No.2 of zinc ferrite). Currently, there are 2,428t (4% of the average T1) stored at this site. This material is deposited in the same manner as the ferrite deposits.

The characteristics of this residue are presented in Table 4.1.3/2.

• **Industrial Garbage**

Industrial garbage is produced in the metallurgic complex facilities and is formed by : woods, fabrics, papers, plastic, and resins, among others.

At present two garbage incinerators are operating, one is installed in the smelter and the other is in the Huaymanta Refinery.

Industrial scrap is selected to either be partially recycled or sold, and industrial oils and greases are recycled to the heavy oil tanks (Bunker 6).

• **Domestic Garbage**

This residue is deposited at Cochabamba, 11Km south of the Smelter.

4.2 Environmental Impacts Assessment

4.2.1 Impact on the Physical Environment

- Climate

Gases contribute to the creation of a thermic inversion in the La Oroya region which produces a microclimate for the region.

- Air

The air receives gas and particulate emissions generated from metallurgical processes. These emissions are monitored daily at five stations (Huanchán, Sindicato, Hotel Inca, Cushurupampa and Casaracra) distributed within a 10Km radius of the principal emitter, the main chimney (a 167.5 m in height).

As a consequence of gas dispersion (Tables 4.1.1/2, 4.1.1/2A, 4.1.1/3, 4.1.1/3A, 4.1.1/4, 4.1.1/4A, 4.1.1/5, 4.1.1/5A, 4.1.1/5B, 4.1.1/5C, 4.1.1/6, 4.1.1/6A, 4.1.1/7, 4.1.1/7A, 4.1.1/8, 4.1.1/8A, 4.1.1/9, 4.1.1/9A,) air quality around the Metallurgic Complex environment are within the maximum permissible limits, unless thermic inversion occurs, as shown in the following Table :

PARAMETER	UNIT	AIR QUALITY	MAXIMUM LEVEL PERMITTED RM-315-EM/VMM
SO ₂	ppm Annual arithmetic mean	From 0,06 to 0,24 (*)	0,20
Pb	µg/m ³ Annual arithmetic mean	From 0,07 to 2,94	0,50
As	µg/m ³ Annual arithmetic mean	From 0,08 to 1,72 (*)	6,00
MPS	µg/m ³ Annual arithmetic mean	From 86,0 to 294,0(*)	350

(*) Generally the higher value occurs when there is a thermal inversion.

- Water

The 40 liquid effluents produced as a result of the operations at the Metallurgic Complex which are discharged to the Yauli and Mantaro rivers contain suspended solids and solution materials, the characteristics of which are shown in Tables 4.1.2/1, 4.1.2/2 and 4.1.2/2A.

In addition, domestic liquid effluents are emitted to the said receptors without treatment.

- Soils

The few areas with soils around the Metallurgical Complex are not suitable for production due to their composition as well as the topographic and geologic characteristics of

the zone. Under these conditions, the primary impact to soils is erosion as a result of rain events in the area. Soil erosion is made easier in the region due to the area's steep slopes and as a result of the acidity of the soils caused by the partial dissolution of SO₂ emissions.

Industrial solid wastes like Lead and Copper slags and zinc ferrite pulp impact the soils in the Huanchán deposit area, 3 Km. from the Metallurgic Complex. Likewise, arsenic trioxides have a negative impact on the Vado zone 9 Km from said Complex.

La Oroya has impoverished soils with no plant cover. There is no nitrogen due to the lack of vegetation, and there is lack of calcium due to its removal as a result of water erosion and the harmful effect of the smelter smokes. See Pictures 4.2.1/1 and 4.2.1/2.

La Oroya and the surrounding soils have been studied at the Universidad Agraria de la Molina labs. The characterization of the gases emitted to the environment which affect these soils is detailed in Tables 4.1.1/2, 4.1.1/2A, 4.1.1/3, 4.1.1/3A, 4.1.1/4, 4.1.1/4A, 4.1.1/5, 4.1.1/5A, 4.1.1/5B, 4.1.1/5C, 4.1.1/6, 4.1.1/6A, 4.1.1/7, 4.1.1/7A, 4.1.1/8, 4.1.1/8A, 4.1.1/9 and 4.1.1/9A

Solid wastes such as garbage also impact the soils as they are partially incinerated and/or deposited at Cochabamba 9 Km from the Complex.

- **Geomorphology**

Geomorphology is affected by the modification of the geographic relief in the area. Solid wastes, despite their low solubility, contain pollutanting agents, which are transported to the surface waters.

Tables 4.1.3/1 and Diagram 4.1.3/1 show the volumes, characteristics and location of these wastes while chapter 5 details the projects for closure and mitigation of the deposits and emissions.

Due to wind action, fine particle residues reach the surrounding areas, changing the quality of the surrounding soils.

4.2.2 Impact on the Biologic Environment

The natural landscape reveals that the atmosphere receives gases and particulates from the La Oroya Complex which are ultimately precipitated during rain events. These precipitates alter the existing ecosystem and affect the local flora and fauna. Consequently, this part of the Central Peruvian Andes has become unproductive; some wild species even die out, especially endemic species that have a limited home range and distribution. These species, often times disappear from the region as a result of the loss of natural vegetation.

Water turbidity, especially within the Mantaro and Yauli rivers impedes the penetration of light. This limits photosynthesis activity, reduces the amount of dissolved oxygen in the water, and changes the water temperature. These conditions definitely affect the primary productivity of these rivers. It should be mentioned that this impact begins in the rivers prior to their flow through the La Oroya region. At La Oroya these rivers receive

additional effluent containing industrial wastes from different plants at the Metallurgical Complex.

As previously indicated, the addition of suspended solids to these rivers from the La Oroya are shown in Tables 4.1.2/6 and 4.1.2/6A.

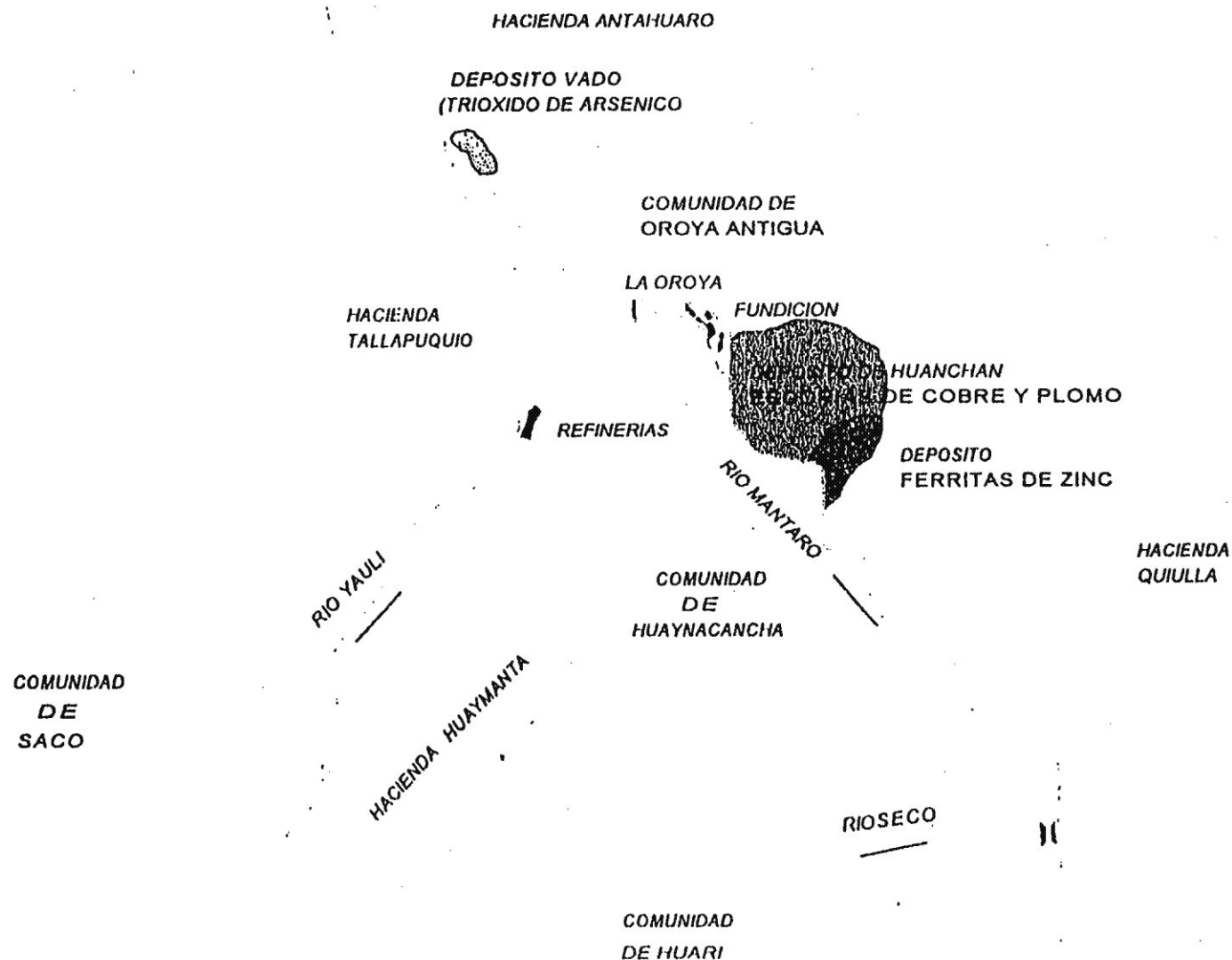
Solid wastes observed in the Huanchán deposits (slags and zinc ferrite) and Malpaso and Vado deposits (As trioxide) are a type of physical contamination which contributes to the alteration of the terrestrial ecosystem (Pictures 4.1.3/1 and 2, 2A and 2B).

4.2.3 Impact on the Socioeconomic Environment

The Metallurgic Complex is the generator of the the socioeconomic development in the zone and of the Central Region Peru.

4.2.4 Impact on the Human Interest Environment

The human interest environment of the site is limited to building an access route to the cities and places with archeological resources (Tarma, Jauja, Huancayo), protected natural areas, parks and national reservations (Huayllay Rock Forest in Cerro de Pasco and Chinchaycocha Lake in Junin), tourist circuits (Lima-Tarma-Chanchamayo Valley and Mantaro Valley).



MAPA N° _____

CENTROMIN PERU S.A. - LA OROYA
DIRECCION DE ASUNTOS AMBIENTALES
COMPLEJO METALURGICO - LA OROYA
DEPOSITO DE RESIDUOS SOLIDOS
PAMA : DIAGRAMA N° 4.1.3/1 FECHA: NOV.96

Fig. 95

MANAGEMENT OF GASES AND DUSTS
JANUARY - DECEMBER 1995
(Dust in metric tonnes per day)

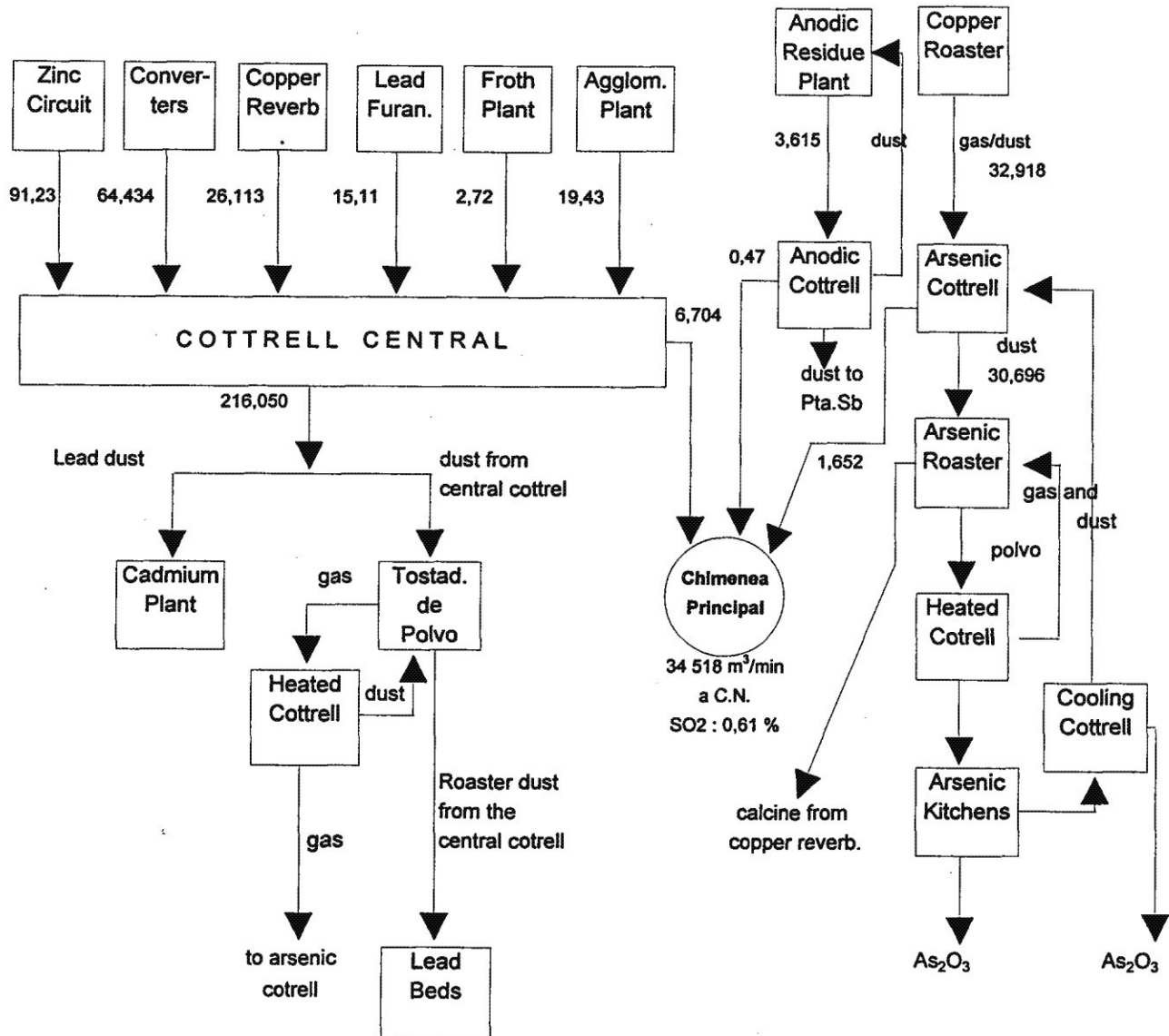


DIAGRAM 4.1.1 / 1

TABLE 4.1.1 / 2

EMISSION SOURCE AND GAS EMISSIONS AND DUST CHARACTERISTICS

Period : Jan. - Dec. 1995

No.	SOURCE OF EMISSION	PHYSICAL INORGANIC							INORGANIC METALL CONTENT: mg/m ³					
		HEIGHT m.	EQUIPMENT OF PRE- POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp.: °C	TIME OF EMISSION		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
1	CONCRETE STACK	168	Electrostatic Precipitator	1145.61	89.88	80	24	365	17.96	0.92	23.25	9,379	n.d.	n.d.
2	IRON STACK	91	None	88.73	46.24	20	24	365	5.68	0.00	2.65	0	n.d.	n.d.
3	COKE STACK - BATTERY A	19	None (1 stack)	14.86	n.d.	278	24	365	n.d.	n.d.	n.d.	8,973	445	34,786
4	COKE STACK - BATTERY B	19	None (1 stack)	14.76	n.d.	287	24	365	n.d.	n.d.	n.d.	6,751	667	34,687
5	VENT. SYSTEM BI INCINERATORS P.R.A	19	Gas Washer	0.45	374.04	22	12	365	n.d.	n.d.	13.89	n.d.	n.d.	n.d.
6	VENT. SYSTEM CONV. P.R.A.	19	Bag filter (3 stacks)	16.85	31.63	37	18	365	n.d.	n.d.	1.72	n.d.	n.d.	n.d.
7	VENT. SYSTEM CUPEL P.R.A.	15	Electrostatic Precip. Bag filter	11.94	46.39	44	18	365	n.d.	n.d.	1.77	n.d.	n.d.	n.d.
8	VENT. SYSTEM ZINC ROASTERS	30	Gas Washer Bag filter	46.07	921.05	59	21	365	n.d.	1.10	11.43	n.d.	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996

EMGAS.XLS, Tabla 4.1.1 / 2

TABLE 4.1.1 / 2A
EMISSION SOURCE AND GAS EMISSIONS AND DUST CHARACTERISTICS
Period : Jan. - Dec. 1996

No.	SOURCE OF EMISSION	PHYSICAL INORGANIC							INORGANIC, METALL CONTENT: mg/m ³					
		HEIGHT m	EQUIPMENT OF PRE POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp. ° C	TIME OF EMISSION		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
1	CONCRET STACK CONCRETO	168	Precipitator Electrostatic	1137.56	81.46	82	24	365	15.26	0.89	22.32	11,557	n.d.	n.d.
2	IRON STACK	91	None	97.60	50.17	19	24	365	10.77	0.00	3.22	0	n.d.	n.d.
3	COKE STACK - BATTERY A	19	None (1 Chimney)	15.08	n.d.	271	24	365	n.d.	n.d.	n.d.	3,920	0	36,533
4	COKE STACK - BATTERY B	19	None (1 Chimney)	13.89	n.d.	309	24	365	n.d.	n.d.	n.d.	3,775	127	43,121
5	VENT. SYSTEM Bi INCINERATOR R.A	19	Gas Washer	0.62	1152.83	21	12	365	n.d.	n.d.	20.72	n.d.	n.d.	n.d.
6	VENT. SYSTEM CONV. P.R.A.	19	Bag filter (3 stacks)	18.83	28.88	41	18	365	n.d.	n.d.	3.32	n.d.	n.d.	n.d.
7	VENT. SYSTEM CUPEL P.R.A.	15	Pricip. Electrostat. Bag filter	12.61	39.83	49	18	365	n.d.	n.d.	1.29	n.d.	n.d.	n.d.
8	VENT. SYSTEM ZINC ROASTERS	30	Gas Washer Bag filter	30.06	926.04	58	21	365	0.00	1.32	13.69	n.d.	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoria Ambiental de Emisiones y Vertimientos, June 1996

EMIGAS.XLS, Tabla 4.1.1 / 2A

TABLE N° 4.1.1. / 3
MAIN STACK EMISSIONS
Period : Jan. - Dec. 1995

Month	SOURCE OF EMISSION	PHYSIC INORGANIC							INORGANIC, METALL CONTENT: mg/m ³					
		HEIGHT m	EQUIPMENT FOR PRE- POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp.: ° C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
Jan	MAIN STACK	168	ELECTROSTATICS	1183.73	87.42	83	24	365	11.54	1.22	24.74	9,757	n.d.	n.d.
Feb			PRECIPITATOR	1146.87	90.58	84	24	365	20.20	1.00	20.74	8,886	n.d.	n.d.
Mar				1109.00	88.37	80	24	365	16.97	0.97	20.85	10,279	n.d.	n.d.
Apr				1150.80	86.05	84	24	365	16.01	0.83	24.61	8,711	n.d.	n.d.
May				1167.75	93.19	82	24	365	18.54	0.83	25.72	10,454	n.d.	n.d.
Jun				1167.90	88.93	79	24	365	25.08	0.76	16.01	9,582	n.d.	n.d.
Jul				1198.67	88.37	82	24	365	18.91	0.97	21.21	9,060	n.d.	n.d.
Aug				1149.27	79.04	76	24	365	17.63	0.95	20.55	9,408	n.d.	n.d.
Sept				1102.72	79.21	75	24	365	16.00	0.51	16.87	9,060	n.d.	n.d.
Oct				1139.08	98.53	82	24	365	17.54	0.99	29.16	8,537	n.d.	n.d.
Nov				1119.52	98.57	79	24	365	18.73	0.99	28.98	9,060	n.d.	n.d.
Dec				1111.97	100.25	79	24	365	18.34	0.97	29.57	9,757	n.d.	n.d.
Aver:				1145.61	89.88	80	24	365	17.96	0.92	23.25	9,379	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports for Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoria Ambiental de Emisiones y Vertimientos, June 1996

EMGAS.XLS; Tabla 4.1.1/3

TABLE N° 4.1.1. / 3A
MAIN STACK EMISSIONS
Period: Jan.- Jun. 1996

Month	SOURCE OF EMISSION	PHYSIC INORGANIC							INORGANIC METALL CONTENT: $\mu\text{g}/\text{m}^3$					
		HEIGHT m	EQUIPMENT FOR PRE- POST TREATMENT	FLOW m^3/sec	SOLIDS mg/m^3	Temp., °C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
Jan	MAIN STACK	168	ELECTROSTATICS	1151.02	97.66	83	24	365	20.70	0.69	22.46	11,151	n.d.	n.d.
Feb			PRECIPITATOR	1148.77	91.06	82	24	365	14.93	0.76	26.41	11,325	n.d.	n.d.
Mar				1146.80	82.50	85	24	365	15.01	1.07	26.15	12,370	n.d.	n.d.
Apr				1117.63	74.08	80	24	365	12.44	0.74	23.26	9,931	n.d.	n.d.
May				1135.62	71.49	84	24	365	12.80	1.22	19.30	12,893	n.d.	n.d.
Jun				1125.50	71.99	78	24	365	15.69	0.86	16.34	11,673	n.d.	n.d.
Jul														
Aug														
Sept														
Oct														
Nov														
Dec														
Aver:				1137.56	81.46	82	24	365	15.26	0.89	22.32	11,557	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoria Ambiental de Emisiones y Vertimientos, June 1996

EMGAS.XLS; Tabla 4.1.1/3A

TABLE Nº 4.1.1./3B
MAIN STACK EMISSIONS
Period : Jan. - Dec. 1995

Year	Flow Nm3/min.	Dust t/d	SO2 t/d	INORGANIC, METALL CONTENT: kg/d											
				Cu	Pb	Ag	Bi	Cd	Au	As	Zn	Sb	Fe	Ins	S
1975	39717	12.12	1039	263.00	0.00	4.74	114	40	0.00	2901.00	759.00	496	404	212	915
1976	41020	13.13	1053	563.00	2152.00	5.61	90	46	0.01	2648.00	821.00	422	802	351	1082
1977	41171	13.25	1043	222.00	2814.00	5.06	112	64	0.00	3355.00	710.00	479	286	189	902
1978	41173	13.37	1062	259.00	2790.00	5.02	117	86	0.00	3259.00	812.00	418	393	203	1012
1979	42595	13.53	1127	172.00	3417.00	5.73	158	71	0.00	3000.00	847.00	445	252	151	958
1980	39728	13.41	999	202.00	3521.00	6.03	147	88	0.00	2763.00	777.00	406	305	174	907
1981	39736	13.57	1033	158.00	4204.00	6.77	155	91	0.00	2711.00	751.00	400	172	154	874
1982	40685	13.88	1132	151.00	4724.00	6.53	195	83	0.00	2601.00	953.00	420	231	152	906
1983	40943	13.58	1130	123.00	4251.00	7.03	241	81	0.00	2528.00	1091.00	395	279	118	872
1984	38651	13.59	1028	162.00	4334.00	8.53	263	95	0.00	2364.00	842.00	335	261	121	955
1985	38220	13.86	1037	201.00	4255.00	9.32	259	107	0.00	2279.00	950.00	324	343	199	1074
1986	34395	12.09	960	198.00	3222.00	8.50	231	83	0.00	1667.00	954.00	340	411	223	1008
1987	39193	12.66	1098	372.00	2847.00	7.27	213	61	0.00	1583.00	1326.00	327	897	284	1060
1988	35403	9.71	906	173.00	2821.00	8.78	157	59	0.00	1237.00	893.00	276	363	163	818
1989	38398	13.58	1078	234.00	3770.00	9.56	279	93	0.00	2351.00	956.00	487	355	255	1014
1990	37625	12.87	1012	176.00	3485.00	9.58	272	97	0.00	2118.00	1309.00	426	251	182	945
1991	37159	10.46	919	142.00	3015.00	6.39	191	76	0.00	1671.00	702.00	324	178	109	921
1992	38531	10.59	845	115.00	3157.00	6.31	225	108	0.00	1620.00	696.00	344	126	119	1112
1993	40024	9.97	908	99.00	2526.00	4.81	204	87	0.00	1373.00	796.00	308	155	159	1103
1994	35416	8.95	813	97.00	2212.00	4.42	158	101	0.01	1538.00	633.00	286	117	92	951
1995	34518	8.9	899	164.00	2304.00	4.50	175	91	0.00	1775.00	426.00	304	94	60	916
1996	28462	7.48	959	101	2172	3326	188	84	0	1345	234	361	52	32	743

Reference : Reports for Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S.A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996
ENIGAS.XLS; Tabla 4.1.1/3

TABLE N° 4.1.1 / 4
SECONDARY STACK EMISSIONS
Period : Jan. - Dec. 1995

Month	SOURCE OF EMISSION	HEIGHT in	EQUIPMENT FOR PRE- POST TREATMENT	PHYSIC INORGANIC				INORGANIC, METALLIC CONTENT, mg/m ³						
				FLOW m ³ /sec.	SOLIDS mg/m ³	Temp. °C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/y						
Jan	IRON STACK	91	NONE	74.43	50.85	18	24	365	9.76	0.00	4.93	0	n.d.	n.d.
Feb				95.60	36.32	19	24	365	11.19	0.00	4.00	0	n.d.	n.d.
Mar				80.65	52.09	22	24	365	10.78	0.00	3.49	0	n.d.	n.d.
Apr				96.00	39.42	21	24	365	6.15	0.00	2.60	0	n.d.	n.d.
May				74.77	59.27	20	24	365	9.01	0.00	2.79	0	n.d.	n.d.
Jun				85.97	46.72	21	24	365	4.77	0.00	2.34	0	n.d.	n.d.
Jul				85.92	47.60	21	24	365	2.48	0.00	2.09	0	n.d.	n.d.
Aug				90.17	52.17	20	24	365	5.89	0.00	2.14	0	n.d.	n.d.
Sept				95.75	45.93	20	24	365	2.89	0.00	1.56	0	n.d.	n.d.
Oct				85.35	48.13	20	24	365	1.83	0.00	2.41	0	n.d.	n.d.
Nov				85.78	43.85	20	24	365	1.80	0.00	1.97	0	n.d.	n.d.
Dec				113.92	32.51	21	24	365	1.66	0.00	1.50	0	n.d.	n.d.
Aver:				88.73	46.24	20	24	365	5.68	0.00	2.65	0	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996

ENCAS.XLS; Tabla 4.1.1/4

TABLE N° 4.1.1 / 4A
SECONDARY STACK EMISSIONS
Period: Jan. - Jun. 1996

Month	SOURCE OF EMISSION	PHYSIC INORGANIC							INORGANIC, METALL CONTENT: mg/m ³					
		HEIGHT m	EQUIPMENT FOR PRE- POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp.: ° C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
Jan	IRON STACK	91	NONE	103.25	42.37	21	24	365	3.14	0.00	1.95	0	n.d.	n.d.
Feb				95.70	54.06	20	24	365	3.30	0.00	2.59	0	n.d.	n.d.
Mar				91.12	49.92	19	24	365	3.49	0.00	2.50	0	n.d.	n.d.
Apr				84.92	58.61	16	24	365	21.63	0.00	5.33	0	n.d.	n.d.
May				116.45	40.75	18	24	365	1.87	0.00	4.40	0	n.d.	n.d.
Jun				94.18	55.30	20	24	365	31.19	0.00	2.54	0	n.d.	n.d.
Jul														
Aug														
Sept														
Oct														
Nov														
Dec														
Aver:				97.60	50.17	19	24	365	10.77	0.00	3.22	0	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoria Ambiental de Emisiones y Vertimientos, June 1996

EMIGAS.XLS; Table 4.1.1/4A

TABLE Nº 4.1.1 / 5
SECONDARY STACK EMISSIONS
Period : Jan. - Dec. 1995

Month	SOURCE OF EMISSION	HEIGHT m	EQUIPMENT FOR PRE POST TREATMENT	PHYSIC/INORGANIC			INORGANIC, METALL CONTENT, mg/m ³							
				FLOW m ³ /sec	SOLIDS mg/m ³	Temp. ° C	EMISSION TIME		As	Cl	Ph	SO ₂	CO	CO ₂
Jan	COKE STACK	19	None	14.94	n.d.	290	h/d	d/a	n.d.	n.d.	n.d.	8,711	0	36,533
Feb	BATTERY A		(1 stack)	12.66	n.d.	283	24	365	n.d.	n.d.	n.d.	5,227	762	33,539
Mar				13.22	n.d.	248	24	365	n.d.	n.d.	n.d.	0	1,524	42,522
Apr				15.07	n.d.	266	24	365	n.d.	n.d.	n.d.	14,809	381	23,956
May				14.95	n.d.	284	24	365	n.d.	n.d.	n.d.	20,036	381	36,533
Jun				15.80	n.d.	311	24	365	n.d.	n.d.	n.d.	17,423	2,287	34,736
Jul				15.26	n.d.	298	24	365	n.d.	n.d.	n.d.	0	0	50,308
Aug				15.12	n.d.	258	24	365	n.d.	n.d.	n.d.	12,196	0	19,764
Sept				15.32	n.d.	271	24	365	n.d.	n.d.	n.d.	15,332	0	35,335
Oct				15.89	n.d.	270	24	365	n.d.	n.d.	n.d.	11,325	0	22,758
Nov				15.82	n.d.	274	24	365	n.d.	n.d.	n.d.	2,613	0	44,319
Dec				14.21	n.d.	279	24	365	n.d.	n.d.	n.d.	0	0	37,132
Aver:				14.86	n.d.	278	24	365	n.d.	n.d.	n.d.	8,973	445	34,786

Maximum permissible limits, Peruvian Laws (MEM)

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996

ENCLOSURE Table 4.1.1 / 5

TABLE N° 4.1.1 / 5A
SECONDARY STACK EMISSIONS
Period : Jan. - Dec. 1996

Month	SOURCE OF EMISSION	PHYSIC INORGANIC							INORGANIC, METALL CONTENT: mg/m ³					
		HEIGHT m	EQUIPMENT FOR PRE POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp: °C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
Jan	COKE STACK	19	None	14.28	n.d.	262	24	365	n.d.	n.d.	n.d.	6,098	0	31,143
Feb	BATTERY A		(1 stack)	15.71	n.d.	277	24	365	n.d.	n.d.	n.d.	0	0	36,533
Mar				16.69	n.d.	306	24	365	n.d.	n.d.	n.d.	0	0	40,127
Apr				14.57	n.d.	235	24	365	n.d.	n.d.	n.d.	0	0	35,335
May				13.81	n.d.	272	24	365	n.d.	n.d.	n.d.	17,423	0	40,726
Jun				15.43	n.d.	275	24	365	n.d.	n.d.	n.d.	0	0	35,335
Jul														
Aug														
Sep														
Oct														
Nov														
Dec														
Aver:				15.08	n.d.	271	24	365	n.d.	n.d.	n.d.	3,920	0	36,533
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996

EMGAS.XLS; Table 4.1.1 / 5A

TABLE N° 4.1.1 / 5B
SECONDARY STACK EMISSIONS
Period : Jan. - Dec. 1995

Months	SOURCE OF EMISSION	PHYSIC INORGANIC							INORGANIC, METALL CONTENT: mg/m ³					
		HEIGHT m	EQUIPMENT FOR PRE POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp. °C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
Jan	COKE STACK	19	None	14.37	n.d.	324	24	365	n.d.	n.d.	n.d.	12,196	0	32,940
Feb	BATTERY B		(1 stack)	16.71	n.d.	308	24	365	n.d.	n.d.	n.d.	14,809	762	31,143
Mar				14.51	n.d.	296	24	365	n.d.	n.d.	n.d.	871	7,241	28,149
Apr				13.34	n.d.	269	24	365	n.d.	n.d.	n.d.	11,325	0	31,143
May				14.97	n.d.	278	24	365	n.d.	n.d.	n.d.	6,098	0	38,929
Jun				14.02	n.d.	293	24	365	n.d.	n.d.	n.d.	10,454	0	37,731
Jul				13.91	n.d.	299	24	365	n.d.	n.d.	n.d.	0	0	50,308
Aug				14.48	n.d.	293	24	365	n.d.	n.d.	n.d.	9,582	0	28,747
Sept				14.78	n.d.	260	24	365	n.d.	n.d.	n.d.	6,098	0	38,330
Oct				15.86	n.d.	290	24	365	n.d.	n.d.	n.d.	8,711	0	28,149
Nov				15.84	n.d.	259	24	365	n.d.	n.d.	n.d.	871	0	40,127
Dec				14.37	n.d.	276	24	365	n.d.	n.d.	n.d.	0	0	30,544
Aver:				14.76	n.d.	287	24	365	n.d.	n.d.	n.d.	6,751	667	34,687

Maximum permissible limits, Peruvian Laws (MEM)	n.d.	100	n.d.			25		25	(*)		
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Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoria Ambiental de Emisiones y Vertimientos, June 1996

EMGAS.XLS; Tabla 4.1.1 / 5B

TABLE N° 4.1.1 / 5C
SECONDARY STACK EMISSIONS
Period: Jan. - Jun. 1996

Month	SOURCE OF EMISSION	PHYSIC INORGANIC							INORGANIC, METALL CONTENT: mg/m³					
		HEIGHT m	EQUIPMENT FOR PRE POST TREATMENT	FLOW m³/sec.	SOLIDS mg/m³	Temp.: ° C	EMISSION TIME		As	Cd	Pb	SO₂	CO	CO₂
							h/d	d/a						
Jan	COKE STACK	19	None	13.59	n.d.	308	24	365	n.d.	n.d.	n.d.	7,840	0	44,319
Feb	BATTERY B		(1 stack)	15.57	n.d.	341	24	365	n.d.	n.d.	n.d.	0	0	49,110
Mar				16.02	n.d.	323	24	365	n.d.	n.d.	n.d.	0	0	33,539
Apr				14.49	n.d.	260	24	365	n.d.	n.d.	n.d.	0	381	44,319
May				6.74	n.d.	315	24	365	n.d.	n.d.	n.d.	14,809	381	43,121
Jun				16.92	n.d.	309	24	365	n.d.	n.d.	n.d.	0	0	44,319
Jul														
Aug														
Sept														
Oct														
Nov														
Dec														
Aver:				13.89	n.d.	309	24	365	n.d.	n.d.	n.d.	3,775	127	43,121
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports from the Testing Control Section, metallic content, etc.

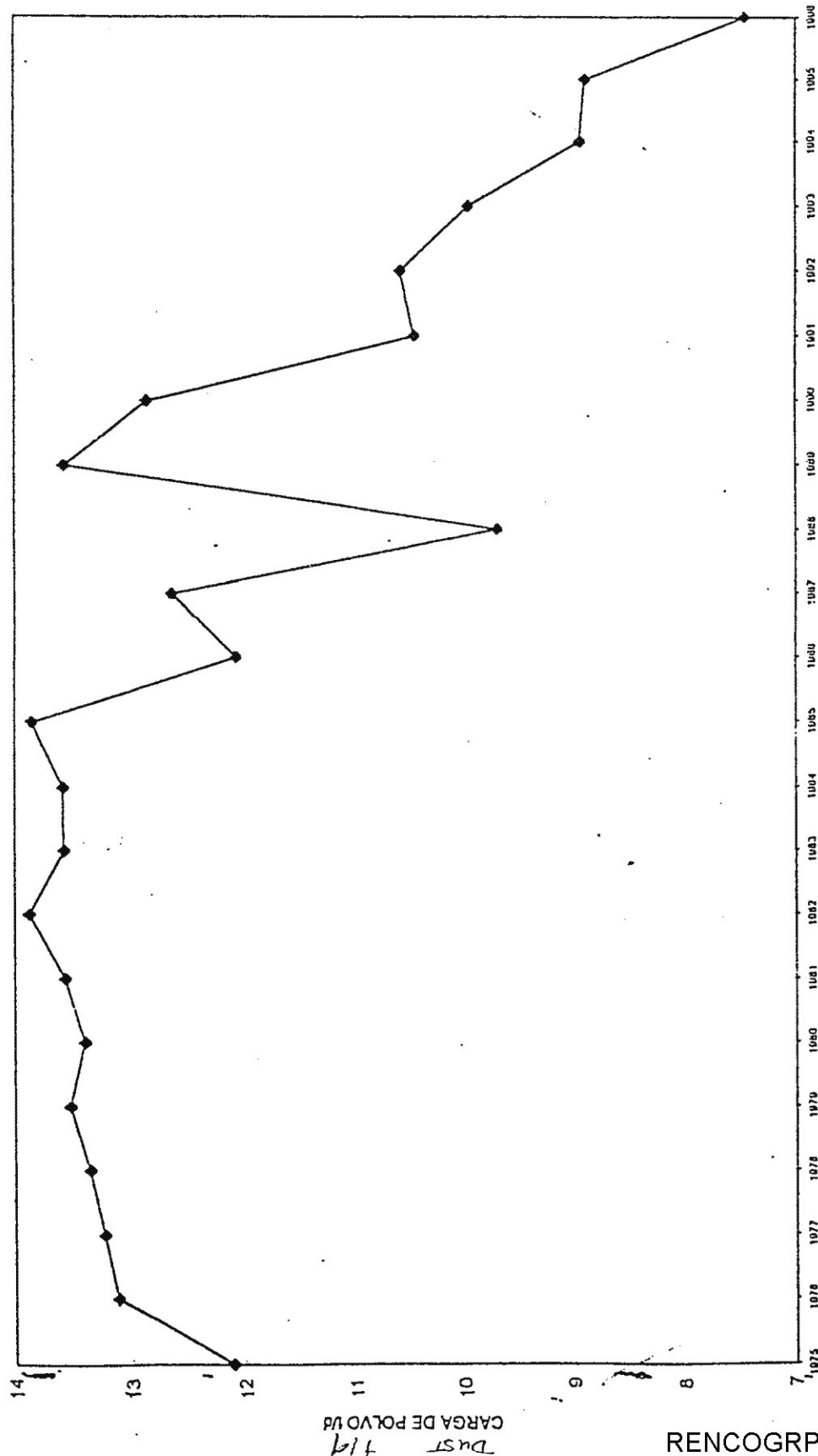
Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996

EMIGAS.XI.5; Tabla 4.1.1 / 5C

Particulate Material Emissions Through The Main Chimney
EMISIÓN DE MATERIAL PARTICULADO POR LA CHIMENEA PRINCIPAL



SO₂ Emissions Through the Main Chimney
EMISIÓN DE SO₂ POR LA CHIMENEA PRINCIPAL

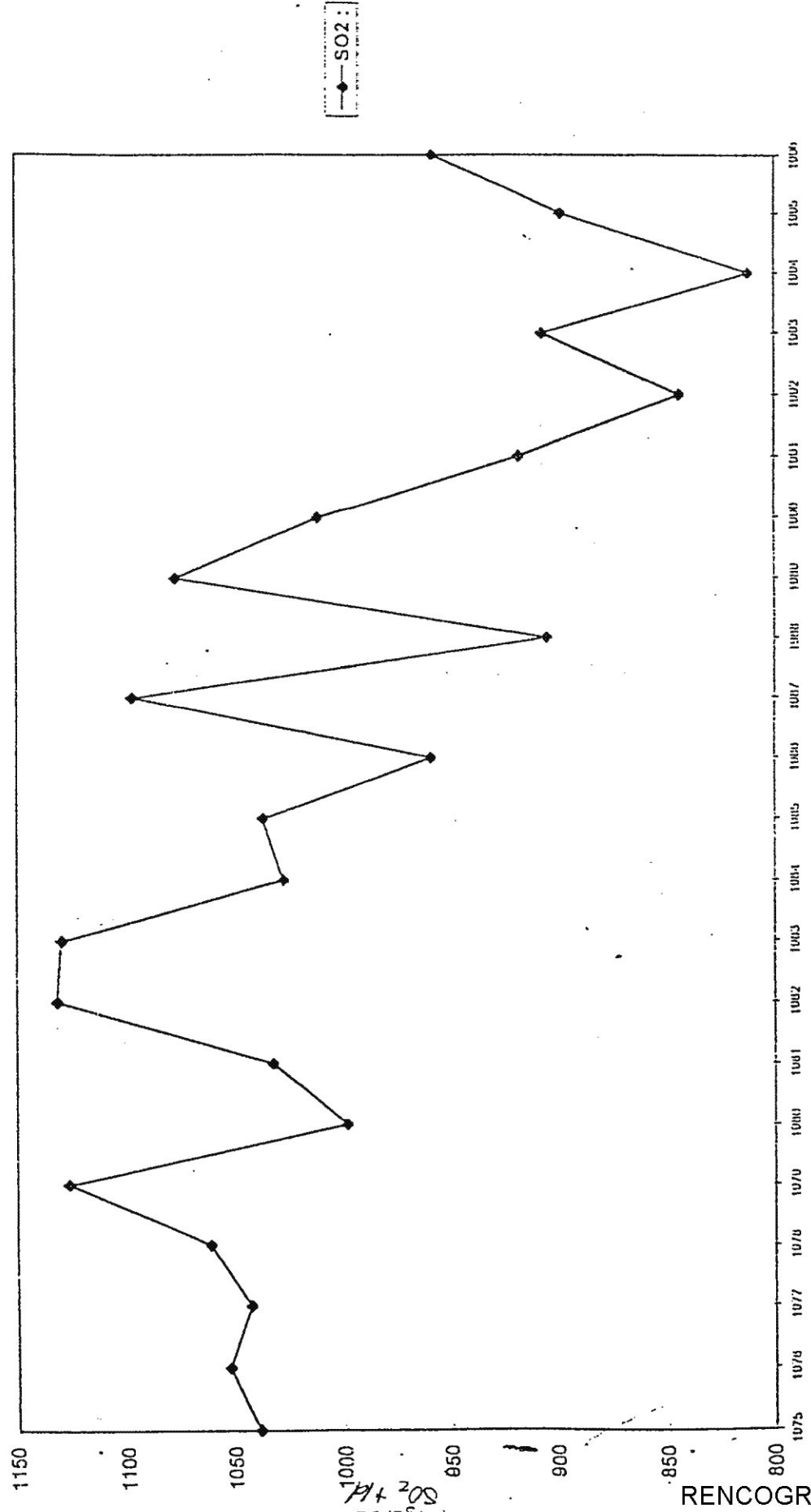


GRAFICO No 2

Pb, Cd, As Emissions Through the Main Chimney
EMISIONES DE Pb, Cd y As POR LA CHIMENEA PRINCIPAL

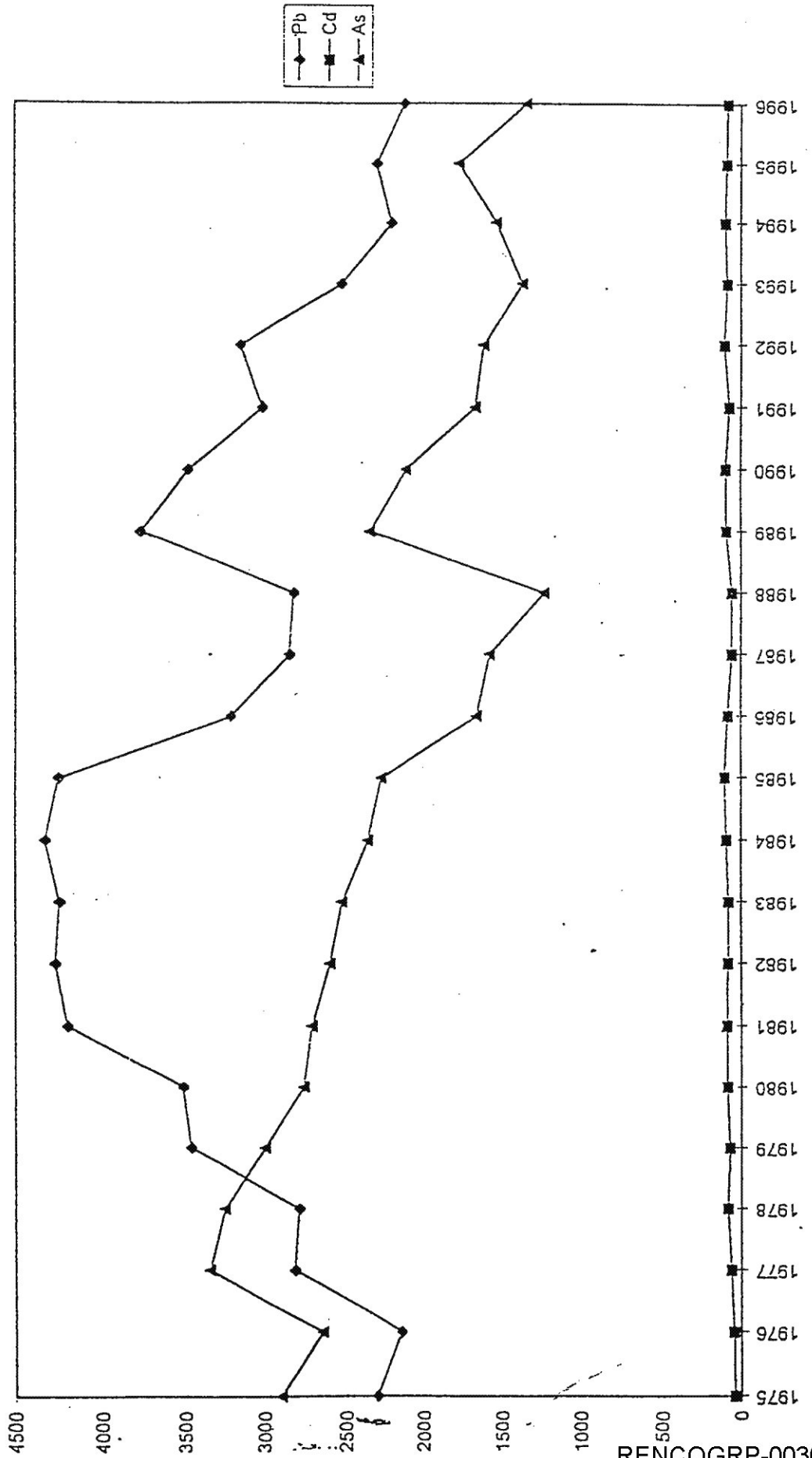


GRAFICO No. 3

TABLE N° 4.1.1 / 6
SECONDARY STACKS EMISSIONS
Period : Jan. - Dec. 1995

Month	SOURCE OF EMISSION	PHYSIC-INORGANIC							INORGANIC, METALL CONTENT: mg/m ³					
		HEIGHT m	EQUIPMENT FOR PRE- POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp.: ° C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
Jan	VENT. SYSTEM	19	Gas washer	0.46	313.56	19	12	365	n.d.	n.d.	16.18	n.d.	n.d.	n.d.
Feb	BISMUTH INCINERATOR			0.46	262.50	24	12	365	n.d.	n.d.	1.35	n.d.	n.d.	n.d.
Mar	ANODIC WASTE PLANT			0.47	334.61	22	12	365	n.d.	n.d.	15.86	n.d.	n.d.	n.d.
Apr				0.44	553.15	26	12	365	n.d.	n.d.	3.03	n.d.	n.d.	n.d.
May				0.45	81.25	20	12	365	n.d.	n.d.	12.98	n.d.	n.d.	n.d.
Jun				0.51	865.47	28	12	365	n.d.	n.d.	4.92	n.d.	n.d.	n.d.
Jul				0.42	220.14	16	12	365	n.d.	n.d.	5.79	n.d.	n.d.	n.d.
Aug				0.45	483.36	24	12	365	n.d.	n.d.	6.70	n.d.	n.d.	n.d.
Sept				0.38	740.70	18	12	365	n.d.	n.d.	37.08	n.d.	n.d.	n.d.
Oct				0.38	95.98	19	12	365	n.d.	n.d.	12.36	n.d.	n.d.	n.d.
Nov				0.34	191.45	25	12	365	n.d.	n.d.	11.19	n.d.	n.d.	n.d.
Dec				0.61	346.34	19	12	365	n.d.	n.d.	39.25	n.d.	n.d.	n.d.
Aver:				0.45	374.04	22	12	365	n.d.	n.d.	13.89	n.d.	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996

EMIOAS.XLS, Tabla 4.1.1 / 6

TABLE N° 4.1.1 /6A
MAIN STACKS EMISSIONS
Period: Jan. - Jun. 1996

Month	SOURCE OF EMISSION	PHYSIC INORGANIC							INORGANIC, METALL CONTENT: mg/m ³					
		HEIGHT m	EQUIPMENT FOR PRE POST TREATMENT	FLOW m ³ /sec	SOLIDS mg/m ³	Temp.: ° C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
Jan	VENT. SYSTEM	19	Gas washer	0.51	619.42	18	12	365	n.d.	n.d.	3.30	n.d.	n.d.	n.d.
Feb	BISMUTH INCINERTOR			0.65	3068.13	20	12	365	n.d.	n.d.	42.39	n.d.	n.d.	n.d.
Mar	ANODIC WAST PLANT			0.63	1226.65	23	12	365	n.d.	n.d.	15.47	n.d.	n.d.	n.d.
Apr				0.56	566.67	23	12	365	n.d.	n.d.	48.76	n.d.	n.d.	n.d.
May				0.65	709.69	20	12	365	n.d.	n.d.	6.88	n.d.	n.d.	n.d.
Jun				0.70	726.39	19	12	365	n.d.	n.d.	7.49	n.d.	n.d.	n.d.
Jul														
Aug														
Sept														
Oct														
Nov														
Dec														
Aver:				0.62	1152.83	21	12	365	n.d.	n.d.	20.72	n.d.	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996

DDOAS.XLS, Tabla 4.1.1 / 6A

TABLE N° 4.1.1 / 7
SECONDARY STACKS EMISSIONS
Period : Jan. - Dec. 1995

Month	SOURCE OF EMISSION	HEIGHT m	PHYSIC INORGANIC				INORGANIC METALL CONTENT mg/m ³						
			EQUIPMENT FOR PRE- POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp. °C	EMISSION TIME h/d	d/a	As	Cd	Pb	SO ₂	CO ₂
Jan	CONVERTER	19	BAG FILTERS	17.61	45.99	31	18	365	n.d.	n.d.	0.48	n.d.	n.d.
Feb	VENT. SYSTEM		(3 Stacks)	15.94	50.84	35	18	365	n.d.	n.d.	0.69	n.d.	n.d.
Mar	ANODIC WASTE PLANT			17.39	22.91	37	18	365	n.d.	n.d.	1.47	n.d.	n.d.
Apr				16.67	27.52	44	18	365	n.d.	n.d.	3.49	n.d.	n.d.
May				15.50	21.54	40	18	365	n.d.	n.d.	1.51	n.d.	n.d.
Jun				17.50	24.85	32	18	365	n.d.	n.d.	1.69	n.d.	n.d.
Jul				17.31	25.45	35	18	365	n.d.	n.d.	0.84	n.d.	n.d.
Aug				15.03	29.67	35	18	365	n.d.	n.d.	3.39	n.d.	n.d.
Sept				17.05	31.01	41	18	365	n.d.	n.d.	0.93	n.d.	n.d.
Oct				18.20	27.60	38	18	365	n.d.	n.d.	2.66	n.d.	n.d.
Nov				17.67	36.18	35	18	365	n.d.	n.d.	2.26	n.d.	n.d.
Dec				16.31	35.96	38	18	365	n.d.	n.d.	1.23	n.d.	n.d.
Aver:				16.85	31.63	37	18	365	n.d.	n.d.	1.72	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)	

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoria Ambiental de Emisiones y Vertimientos, June 1996

ED00ASXLE; Tabla 4.1.1 / 7

TABLE N° 4.1.1 / 7A
MAIN STACKS EMISSIONS
Period: Jan. - Jun. 1996

Month	SOURCE OF EMISSION	HEIGHT m	PHYSIC/INORGANIC					INORGANIC METALL CONTENT mg/m ³						
			EQUIPMENT FOR PRE- POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp. °C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
Jan	CONVERTER	19	BAG FILTERS	16.51	32.81	46	18	365	n.d.	n.d.	1.84	n.d.	n.d.	n.d.
Feb	VENT. SYSTEM		(3 Stacks)	20.17	26.95	40	18	365	n.d.	n.d.	2.51	n.d.	n.d.	n.d.
Mar	ANODIC WASTE PLANT			18.05	30.89	38	18	365	n.d.	n.d.	2.40	n.d.	n.d.	n.d.
Apr				19.18	23.23	40	18	365	n.d.	n.d.	1.83	n.d.	n.d.	n.d.
May				19.87	32.50	39	18	365	n.d.	n.d.	10.42	n.d.	n.d.	n.d.
Jun				19.18	26.91	40	18	365	n.d.	n.d.	0.95	n.d.	n.d.	n.d.
Jul														
Aug														
Sept														
Oct														
Nov														
Dec														
Aver:				18.83	28.88	41	18	365	n.d.	n.d.	3.32	n.d.	n.d.	n.d.

Maximum permissible limits, Peruvian Laws (MEM)

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996

RDG043.XLS, Tabla 4.1.1/7A

TABLE N° 4.1.1 / 8
SECONDARY STACKS EMISSIONS
Period : Jan. - Dec. 1995

Month	SOURCE OF EMISSION	HEIGHT in	PHYSIC INORGANIC					INORGANIC METALL CONTENT mg/m ³						
			EQUIPMENT FOR PRE POST TREATMENT	FLOW m ³ /sec	SOLIDS mg/m ³	Temp. °C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
Jan	CUPELATION	15	ELECTROSTATIC	10.26	39.48	49	18	365	n.d.	n.d.	0.70	n.d.	n.d.	n.d.
Feb	VENT SYSTEM		PRECIPITATOR	11.85	102.59	44	18	365	n.d.	n.d.	0.58	n.d.	n.d.	n.d.
Mar	ANODIC WASTES		AND BAG	11.91	52.73	42	18	365	n.d.	n.d.	0.91	n.d.	n.d.	n.d.
Apr			FILTERS	12.94	35.41	43	18	365	n.d.	n.d.	2.78	n.d.	n.d.	n.d.
May				11.97	37.31	45	18	365	n.d.	n.d.	3.73	n.d.	n.d.	n.d.
Jun				12.24	45.45	45	18	365	n.d.	n.d.	1.88	n.d.	n.d.	n.d.
Jul				12.23	38.85	44	18	365	n.d.	n.d.	2.78	n.d.	n.d.	n.d.
Aug				12.27	35.42	46	18	365	n.d.	n.d.	2.76	n.d.	n.d.	n.d.
Sept									n.d.	n.d.	1.56	n.d.	n.d.	n.d.
Oct				11.64	28.16	42	18	365	n.d.	n.d.	1.51	n.d.	n.d.	n.d.
Nov				12.20	59.44	37	18	365	n.d.	n.d.	1.33	n.d.	n.d.	n.d.
Dec				11.00	48.53	43	18	365	n.d.	n.d.	0.75	n.d.	n.d.	n.d.
				12.72	33.31	43	18	365	n.d.	n.d.		n.d.	n.d.	n.d.
Aver:				11.94	46.39	44	18	365	n.d.	n.d.	1.77	n.d.	n.d.	n.d.

Maximum permissible limits, Peruvian Laws (MIEM)

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996

EMGAS.XLS; Tabla 4.1.1 / 8

TABLE N° 4.1.1 / 8A
SECONDARY STACKS EMISSIONS
Period : Jan. - Dec. 1996

Month	SOURCE OF EMISSION	PHYSIC INORGANIC							INORGANIC METALL CONTENT, mg/m ³						
		HEIGHT m	EQUIPMENT FOR PRE POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp. ° C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂	
							h/d	d/a							
Jan	CUPELATION	15	ELECTROSTATIC	10.70	50.37	50	18	365	n.d.	n.d.	1.43	n.d.	n.d.	n.d.	
Feb	VENT SYSTEM		PRECIPITATOR	13.94	29.11	48	18	365	n.d.	n.d.	1.39	n.d.	n.d.	n.d.	
Mar	ANODIC WASTES		AND BAG	12.80	35.92	46	18	365	n.d.	n.d.	0.96	n.d.	n.d.	n.d.	
Apr			FILTERS	13.20	39.63	45	18	365	n.d.	n.d.	0.91	n.d.	n.d.	n.d.	
May				11.90	51.67	50	18	365	n.d.	n.d.	2.46	n.d.	n.d.	n.d.	
Jun				13.10	32.24	54	18	365	n.d.	n.d.	0.61	n.d.	n.d.	n.d.	
Jul															
Aug															
Sept															
Oct															
Nov															
Dec															
Aver:				12.61	39.83	49	18	365	n.d.	n.d.	1.29	n.d.	n.d.	n.d.	

Maximum permissible limits, Peruvian Laws (MIEM)

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoria Ambiental de Emisiones y Vertimientos, June 1996

BAIGAS.XLS, Tabla 4.1.1 / 8A

TABLE N° 4.1.1 / 9
SECONDARY STACKS EMISSIONS
Period : Jan. - Dec. 1995

Month	SOURCE OF EMISSION	HEIGHT m	PHYSIC INORGANIC					INORGANIC METALL CONTENT: mg/m ³						
			EQUIPMENT FOR PRE- POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp., ° C	EMISSION TIME		As	Cd	Pb	SO ₂	CO	CO ₂
							h/d	d/a						
Jan	VENT. SYSTEM	30	GAS WASHER	37.20	959.84	68	21	365	n.d.	0.96	10.56	n.d.	n.d.	n.d.
Feb	ZINC ROASTERS		BAG FILTERS	34.58	932.06	69	21	365	n.d.	1.12	13.05	n.d.	n.d.	n.d.
Mar				33.47	1103.23	63	21	365	n.d.	1.32	15.45	n.d.	n.d.	n.d.
Apr				198.15	139.60	61	21	365	n.d.	0.15	1.68	n.d.	n.d.	n.d.
May				33.07	1039.57	65	21	365	n.d.	1.56	1.77	n.d.	n.d.	n.d.
Jun				20.70	499.87	37	21	365	n.d.	0.60	7.50	n.d.	n.d.	n.d.
Jul				36.07	1026.26	59	21	365	n.d.	1.23	14.37	n.d.	n.d.	n.d.
Aug				32.28	1303.92	58	21	365	n.d.	1.56	20.86	n.d.	n.d.	n.d.
Sep				26.42	890.29	51	21	365	n.d.	1.07	13.35	n.d.	n.d.	n.d.
Oct				29.33	901.59	52	21	365	n.d.	0.99	13.52	n.d.	n.d.	n.d.
Nov				35.05	1240.95	60	21	365	n.d.	1.40	14.89	n.d.	n.d.	n.d.
Dec				36.57	1015.40	60	21	365	n.d.	1.22	10.15	n.d.	n.d.	n.d.
Aver:				46.07	921.05	59	21	365	n.d.	1.10	11.43	n.d.	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)				n.d.	100	n.d.			25		25	(*)		

Reference : Reports from the Testing Control Section, metallic content, etc.

Note : n.d. (not determined)

(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.

Source : Auditoría Ambiental de Emisiones y Vertimientos, Junio 1996

EM04AS.XLS; T04-4.1.1 / 9

TABLE Nº 4.1.1 / 9A
SECONDARY STACKS EMISSIONS
Period : Jan. - Dec. 1996

Month	SOURCE OF EMISSION	HEIGHT m	PHYSIC INORGANIC					INORGANIC METALL CONTENT mg/m ³				
			EQUIPMENT FOR PRE- POST TREATMENT	FLOW m ³ /sec.	SOLIDS mg/m ³	Temp. °C	EMISSION TIME h/d d/a	As	Ca	Ph	SO ₂	CO
Jan	VENT. SYSTEM	30	GAS WASHER	31.87	1093.24	65	21 365	0.00	1.53	15.31	n.d.	n.d.
Feb	ZINC ROASTERS		BAG FILTERS	25.85	1000.70	63	21 365	0.00	1.20	14.01	n.d.	n.d.
Mar				32.00	1023.58	52	21 365	0.00	1.54	13.31	n.d.	n.d.
Apr				37.08	1003.43	66	21 365	0.00	1.51	16.05	n.d.	n.d.
May				24.52	491.92	44	21 365	0.00	0.74	8.36	n.d.	n.d.
Jun				29.02	943.34	55	21 365	0.00	1.42	15.09	n.d.	n.d.
Jul												
Aug												
Sep												
Oct												
Nov												
Dec												
Aver:				30.06	926.04	58	21 365	0.00	1.32	13.69	n.d.	n.d.
Maximum permissible limits, Peruvian Laws (MEM)												
Reference : Reports from the Testing Control Section, metallic content, etc.												
Note : n.d. (not determined)												
(*) : In case of Centromin Perú S. A., the law establishes to fix 83 % of the inflow sulphur.												
Source : Auditoría Ambiental de Emisiones y Vertimientos, June 1996												
EMOGAS.M.E. Tabla 4.1.1 / 9A												

TABLE N° 4.1.1 / 10

UNCONTROLLED EMISSIONS AND EMISSIONS FROM OTHER SECONDARY SMOKESTACKS

No.	SOURCE OF EMISSION	EMISSION		EMISSION HEIGHT m/s	TYPE OF SOLIDS	TYPE OF GASES	TREATMENT-EQUIPMENT
		TIME	Days/Year				
	PREPARATION PLANT						
	• Emissions from mixer for dust manipulation.	365		N.D.	Dust of unaltered sulfides	Cool air.	Gas washer. Forced draft.
	• Emissions from 7 hoppers that collect and store Cottrell dust.	365		N.D.	Dust of roasted sulfides coming from Cottrells.	Air.	Bag filters. Forced draft.
	• Emissions from 7 hoppers that collect and store Cottrell dust.	365		N.D.	Dust of roasted sulfides.	Air.	Bag filters. Forced draft.
	PLANT OF REVEBERATION COPPER FURNACES						
	• Emissions from entrance to black filter scrubblings from slag and slag channel of Oxy-fuel reverberatory furnace	365		N.D.	Scrub and slag dust.	Acid Gases of SO ₂ y H ₂ S.	None. Forced draft.
	BLISTER COPPER RETENTION FURNACE						
	• Water vapor emissions generated from copper anode cooling, machine No. 1 mol.	365		N.D.	Blister Copper dust.	Water vapor.	None. Natural draft.
	• Water vapor emissions generated from copper anode cooling, machine No. 1 mol.	365		N.D.	Blister Copper dust.	Water vapor.	None. Natural draft.
	AGGLOMERATION PLANT						
	• Emissions from Agglomeration machine and Crushing area.	365		N.D.	Pre-roasted and non-roasted sulfide dust.		Bag filters. Forced draft.
	• Emissions from transportation system of agglomerated product and fine and thick sinter hoppers.	365		N.D.	Sinter dust (roasted sulfides).	Acid diluted gases. SO ₂ .	Bag filters. Forced draft.
	• Emissions from discharge of sinter fines to feeding tanks 3A; 4A; 5A y 6A.	365		N.D.	Sinter dust (roasted sulfides).	Air.	Bag filters. Forced draft.

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No.	SOURCE OF EMISSION	EMISSION TIME		EMISSION HEIGHT m	TYPE OF SOLIDS	TYPE OF GAS	TREATMENT EQUIPMENT
		Days	Year				
	I. Emissions from discharge of dust pump.	365		N.D.	Sinter dust (roasted sulfides).	Air.	Bag filter. Forced draft.
	II. Emissions from FX/203 belt spill over as run-off and from 2165 transporter that conducts sinter 2200 y 2230 hoppers.	365		N.D.	Sinter dust (roasted sulfides).	Air.	Gas washer. Forced draft.
	III. Emissions from 103/104 belts transporting fine sinter.	365		N.D.	Sinter dust (roasted sulfides).	Air.	Gas washer. Forced draft.
	IV. Emissions from transportation belt (2221) and discharge belt (2202) of thick sinter and from discharge belt of sinter fines (2233).	365		N.D.	Sinter dust (roasted sulfides).	Air.	Gas washer. Forced draft.
	LEAD FURNACES PLANT						
	V. Emissions from slag channels of low-blast furnace.	365		19	Slag dust.	Water vapor. H ₂ S.	None. Forced draft.
	VI. Combustion gas emission from Pb melting pan at Melting and Molding section.	365		N.D.	None.	Combustion gases. CO ₂ .	None. Natural draft.
	LEAD FOAMING PLANT						
	VII. Combustion gas emission from pan No. 1 of lead foaming.	365		N.D.	None.	Combustion gases. CO ₂ .	None. Natural draft.
	VIII. Combustion gas emission from pan No. 2 of lead foaming.	365		N.D.	None.	Combustion gases. CO ₂ .	None. Natural draft.
	IX. Combustion gas emission from pan No. 3 of lead foaming.	365		N.D.	None.	Combustion gases. CO ₂ .	None. Natural draft.
	X. Combustion gas emission from pan No. 4 of lead foaming.	365		N.D.	None.	Combustion gases. CO ₂ .	None. Natural draft.
	XI. Emissions from entrance to filter Pb, scrub and speiss of Reverberatory Furnace for Treatment of Lead Foaming.	365		N.D.	Lead dust, speiss.	Combustion gases. CO ₂ gases.	None. Natural draft.
	XII. Emissions of speiss granulation equipment of Reverberatory Furnace for Treatment of Lead Foaming.	365		N.D.	None.	Water vapors.	None. Natural draft.

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CENTROMIN PERÚ
DIRECCIÓN DE ASUNTOS AMBIENTALES

No.	SOURCE OF EMISSION	EMISSION TIME Days/year	EMISSION HEIGHT m	TYPE OF SOLIDS	TYPE OF GAS	TREATMENT EQUIPMENTS
	PURIFICATION AND ELECTROWINNING PLANT					
XXV.	Emissions generated in purification tank No. 1.	365	N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXVI.	Emissions generated in purification tank No. 2.	365	N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXVII.	Emissions generated in purification tank No. 3.	365	N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXVIII.	Emissions generated in purification tank No. 4.	365	N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXIX.	Emissions generated in purification tank No. 5.	365	N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXX.	Emissions generated in purification tank No. 6.	365	N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXXI.	Emissions generated in purification tank No. 7.	365	N.D.	None.	Acids vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXXII.	Emissions in Zn cathode melting at Ajax Furnace.	365	N.D.	Zn Particles.	Combustion gases. CO ₂ .	None. Forced draft.
XXXIII.	Emissions generated from cooling of Zn bars in the molding machine.	365	N.D.	None.	Water vapor.	None. Natural draft.
XXXIV.	Emissions from grinding and classification of Zn foams.	365	N.D.	Dust and Zn particles.	Air.	None. Natural draft.
XXXV.	Emissions from combustion of Morgan Furnace of "scrap" melting of Zn cathodes.	365	N.D.	None.	Combustion gas. CO ₂ .	None. Natural draft.
Zn DUST PLANT						
XXXVI.	Emissions from combustion furnace of Zn volatilization retort No. 1.	365	N.D.	None.	Combustion gas.	None. Natural draft.
XXXVII.	Emissions from combustion furnace of Zn volatilization retort No. 2.	365	N.D.	None.	Combustion gases.	None. Natural draft.
XXXVIII.	Emissions from combustion furnace of Zn volatilization retort No. 3.	365	N.D.	None.	Combustion gases.	None. Natural draft.
XXXIX.	Emissions from combustion furnace of Zn volatilization retort No. 4.	365	N.D.	None.	Combustion gases.	None. Natural draft.
XI.	Emissions in leaching tank of lime-ash in tank No. 4.	365	N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.

No.	SOURCE OF EMISSION	EMISSION		EMISSION HEIGHT m	TYPE OF SOLIDS	TYPE OF GAS	TREATMENT EQUIPMENTS
		TIME Days/yr	car				
	COKE PLANT						
XII.	Emission from tower of water elimination from tar.	365		N.D.	None.	Water vapor, tar, phenols.	None. Natural draft.
	PLANT OF FLUID BED ZN ROASTERS						
XIII.	Emission from collection hopper of roasted pellets. Reactor No. 1.	365		N.D.	Lime-ash dust (oxides of Zn, Pb, Fe, etc.).	Acid gases. SO ₂ .	None. Natural draft.
XIV.	Emission from collection hopper of roasted pellets. Reactor No. 2.	365		N.D.	Lime-ash dust (oxides of Zn, Pb, Fe, etc.).	Acid gases. SO ₂ .	None. Natural draft.
XV.	Emission from collection hopper of roasted pellets. Reactor No. 3.	365		N.D.	Lime-ash dust (oxides of Zn, Pb, Fe, etc.).	Acid gases. SO ₂ .	None. Natural draft.
XVI.	Emission from mechanical transportation of dry green pellets.	365		N.D.	Dust of Zn concentrates.	Air.	Bag filter. Natural draft.
XVII.	Emission from lime-ash transportation (8B belts, cooler, redler 7B1/2).	365		N.D.	Lime-ash dust (oxides of Zn, Pb, Fe, etc.).	Diluted acid gases, SO ₂ .	None. Forced draft.
	PLANT OF TURBULENT BED ZN ROASTERS AND OF SULFURIC ACID						
XVIII.	Emission from transportation of recovered dust of roaster fumes.	365		N.D.	Lime-ash dust (oxides of Zn, Pb, Fe, etc.).	Air.	None. Forced draft.
XIX.	Emission from neutral leaching tank of lime-ash in tank No. 1.	365		N.D.	None.	Acids vapors (H ₂ SO ₄ ; Zn SO ₄).	None. Natural draft.
XX.	Emission from neutral leaching tank of lime-ash in tank No. 2.	365		N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXI.	Emission from neutral leaching tank of lime-ash in tank No. 3.	365		N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXII.	Emission from neutral leaching tank of lime-ash in tank No. 4.	365		N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXIII.	Emission of ferrite tanks 1 and 2.	365		N.D.	None.	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	None. Natural draft.
XXIV.	Emission from pellets mills and fine and thick classifiers. Air transportation system of lime-ash.	365		N.D.	Lime-ash dust (oxides of Zn, Pb, Fe, etc.).	Acid vapors (H ₂ SO ₄ ; ZnSO ₄).	Bag filters. Forced draft.

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No.	SOURCE OF EMISSION	EMISSION		EMISSION HEIGHT	TYPE OF SOLIDS	TYPE OF GAS	TREATMENT EQUIPMENT
		TIME	Days/Year				
	XL I. Emissions from combustion furnace of Zn volatilization retort No. 5.	365		N.D.	None.	Combustion gases.	None. Natural draft.
	XL II. Emissions from combustion furnace of Zn volatilization retort No. 6.	365		N.D.	None.	Combustion gases.	None. Natural draft.
	CADMIUM PLANT No. 1						
	XL III. Emissions combustion chamber of cadmium distillation retort No. 2.	365		N.D.	None.	Combustion gases.	None. Natural draft.
	XL IV. Emissions from air of cadmium weighting.	365		N.D.	None.	Uncontrolled emission of combustion gases	None. Forced draft.
	XL V. Emissions from leaching and purification cadmium tanks.	365		N.D.	None.	Acid vapors.	None. Forced draft.
	XL VI. Emissions from the 5 cementation tanks and the 3 recovery cells.	365		N.D.	None.	Acid vapors (risk of arsenamine).	None. Forced draft.
	CADMIUM PLANT No. 2						
	XL VII. Emissions from 12 precipitation cells of cadmium sponge.	365		N.D.	None.	Acid vapors.	None. Forced draft.
	XL VIII. Emissions from 2 tanks of leaching, 1 of circulation and 1 of testing.	365		N.D.	None.	Acid vapors.	None. Forced draft.
	XL IX. Emissions of ferrous solution tank.	365		N.D.	None.	Acid vapors.	None. Natural draft.
	PLANT FOR ZINC LEACHING WASTE TREATMENT						
	L. Emissions from transportation of waste "cake" and waste drier.	365		N.D.	Mineral dust (Zn ferrite)	Water vapor.	None. Forced draft.
	LI. Combustion gas emission from waste drier.	365		N.D.	None.	Combustion gases.	None. Forced draft.
	LI I. Emissions from bucket mechanical transportation, dry waste and anthracite silos.	365		N.D.	Mineral dust (Zn ferrite).	CO ₂ . Air.	Dust multicyclon. Forced draft.
	LI II. Emissions Kiln furnace.	365		N.D.	Mineral dust (Zn oxides).	Combustion gases.	Bag filter. Forced draft.
	LI V. Emissions in magnetic separation.	365		N.D.	Mineral dust (Fe and oxides).	Air.	None. Forced draft.

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No.	SOURCE OF EMISSION	EMISSION TIME Days/Year	EMISSION HEIGHT m	TYPE OF SOLIDS	TYPE OF GAS	TREATMENT EQUIPMENTS
L.V.	Emissions from neutral leaching tanks, acid leaching, indium precipitation and neutralization tanks.	365	N.D.	None.	Acid vapors.	None. Forced draft.
INDIUM PLANT						
L.VI.	Emissions from 2 indium crucibles, extraction cell by solvents, 4 cementation indium cells and 2 storage tanks (1 of HCl and one organic).	365	N.D.	None.	Acid vapors.	None. Forced draft.
L.VII.	Emissions from acid washing tank, acid leaching tank, alkaline leaching tank, 2 auxiliary tanks, Soln dump, Soln storage tank, "Pregnant", ppn tank, HCl, 1 of ppn, NaOH, among others.	365	N.D.	None.	Combustion gas.	None. Natural draft.
ANODIC WASTE PLANT						
L.VIII.	Fume emissions generated during Sb and Bi oxidation of S in Converters No. 1, No. 2.	365	N.D.	Scarce dust (metallic oxide).	Combustion gases.	Bag filter. Forced draft.
L.IX.	Fume emissions generated during Sb and Bi oxidation of S in Converters No. 3, No. 4.	365	N.D.	Scarce dust (metallic oxide).	Combustion gases.	Bag filter. Forced draft.
L.X.	Fume emissions generated during Bi reduction in Reduction Reverberatory Furnace.	365	N.D.	Scarce metallic dust.	Combustion gases.	Bag filter. Forced draft.
L.XI.	Emissions in furnace of cups No. 1, 2, and 3.	365	N.D.	Scarce dust (metallic oxide).	Combustion gases.	Trombones, gas washer and precipitation. Electrostatic, humid.
L.XII.	Emissions from filter entrance of cups No. 1, 2 and 3.	365	N.D.	Scarce dust (metallic oxide).	Combustion gases.	Bag filter. Forced draft.
L.XIII.	Emissions Bi pans No. 3 and 4.	365	N.D.	Scarce dust (metallic oxide).	Chloride gases.	Bag filter. Forced draft.
L.XIV.	Emissions in combustion chamber of bismuth refining pan No. 1.	365	N.D.	Scarce dust (metallic oxide).	Combustion gases.	None. Natural draft.
L.XV.	Emissions in combustion chamber of bismuth refining pan No. 2.	365	N.D.	Scarce dust (metallic oxide).	Combustion gases.	None. Natural draft.

CHIMESEC.DOC

No.	SOURCE OF EMISSION	EMISSION TIME		EMISSION HEIGHT m	TYPE OF SOLIDS	TYPE OF GASES	TREATMENT EQUIPMENTS
		Days	Year				
LXVI.	Emissions in combustion chamber of bismuth refining pan No. 3.	365		N.D.	Scarce dust (metallic oxide).	Combustion gases.	None. Natural draft.
LXVII.	Emissions in combustion chamber of bismuth refining pan No. 4.	365		N.D.	Scarce dust (metallic oxide).	Combustion gases.	None. Natural draft.
LXVIII.	Emissions in combustion chamber of bismuth refining pan No. 5.	365		N.D.	Scarce dust (metallic oxide).	Combustion gases.	None. Natural draft.
LXIX.	Emissions in combustion chamber of bismuth refining pan No. 6.	365		N.D.	Scarce dust (metallic oxide).	Combustion gases.	None. Natural draft.
LXX.	Emissions in tellurium melting.	365		N.D.	Scarce dust (metallic oxide).	Combustion gases.	Gas scrubber. Forced draft.
LXXI.	Emissions in selenium solution precipitation and purification tank No. 1.	365		N.D.	None.	Acid vapors	None. Natural draft.
LXXII.	Emissions in selenium solution precipitation and purification tank No. 2.	365		N.D.	None.	Acid vapors.	None. Natural draft.
SILVER REFINERY PLANT							
LXXIII.	Emissions of partition pan No. 1 and cementation silver tank.	365		N.D.	None.	Acid vapors. NO ₃ .	None. Natural draft.
LXXIV.	Emissions of partition pan No. 2 and cementation silver tank.	365		N.D.	None.	Acid vapors. NO ₃ .	None. Natural draft.
LXXV.	Emissions of combustion chambers of the 2 partition pans.	365		N.D.	None.	Combustion gases.	None. Natural draft.
LXXVI.	Office and dressing-room ventilation.	365		N.D.	None.	Environmental air.	None. Forced draft.
LXXVII.	Ventilation of skylights by 4 ventilators.	365		N.D.	None.	Environmental air.	None. Forced draft.
LXXVIII.	Ventilation of pan room by 2 ventilators.	365		N.D.	None.	Environmental air.	None. Forced draft.
LXXIX.	Ventilation of machine house by 1 ventilator.	365		N.D.	None.	Environmental air.	None. Forced draft.
LXXX.	Ventilation of room 1 of rectifiers by 1 ventilator.	365		N.D.	None.	Environmental air.	None. Forced draft.

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SAMPLE LOCATIONS

COKE PLANT
PATIO OF STRUCTURAL WORKSHOP
STRUCT. W. AND INTERNAL P. (TOILETS)
ACETYLENE PLANT
MACHINE SHOP, WAREHOUSE
MACHINE SHOP, J. WAREHOUSE, IO, PLANTS,
COMPONENT W. (TOILETS), GARAGE
COMPONENT WORKSHOP, PATIO
WORKSHOPS, CARPENTRY, INSTRUMENTS
TRAINING (WASHING PLACE)
HEAVY EQUIPMENT, PUMP, TRAINING **TAREADOR
INDUSTRIAL ENG., GENERAL OFFICE
POWER HOUSE, CONTROL TESTS
IONIC PLANT, POWER HOUSE
OXYGENE PLANT, CABLE (TOILETS)
OLD OXYGENE PLANT
GRANUL. ESC. AND REFRIG. Cu and Pb SMELTER
MAIN CHANNEL # 2 (Cu and Pb SMELTER)
ELECTROLITIC ZINC PLANT (TOILET)
P.R.A. (Sc, Te), TOILET
P.R.A. (SEDIMENTATION POOL)
FURNACES AND ANODE WASHING. Zn
SKYLIGHT, ELECTROLITIC Zn
ELECT. Zn PLANT, RUN-OFF, LIX., PURIF.
REFRIGERATION, ZINC PLANT SUB-STATION
ZINC MELTING, MOULDING AND STORAGE
OFFICE AND CONSTRUCTION WAREHOUSE
CADMIUM MELTING AND MOULDING, D.I.M. LAB
PILOT PLANT INV. MET. DEP.
IN PLANT, EXHAUSTED SOL, ALCALINE WASHING
IN PLANT, POOL EXIT EXHAUSTED SOL
MAIN CHANNEL # 1 (PARALLEL-TO RAILWAY)
PARALLEL CHANNEL TO MAIN CHANNEL # 1
POOL EFFLUENT ZINC FERRITE
Pb REFINERY EFFLUENT (Now Cu Ref.)
WIRE ROD EFFLUENT
ASARCO EFFLUENT

TABLE N° 4.1.2/2
LIQUID EFFLUENTS - LA OROYA METALLURGIC COMPLEX
Period: January - December 1995

CODE	Sampling Point	Flow m ³ /hr.	Physical Properties			Major chemical compounds, mg/l							
			Suspended solids, mg/l	pH	Temp., °C	Cu	As	Ca	Fe	Mn	Pb	Zn	
101	COKE PLANT	0.053	363	8.97	19	N.A.	0.48	0.26	0.14	0.81	0.37	0.11	2.05
102	PATIO OF STRUCTURAL WORKSHOP	0.013	16	8.01	13	N.A.	0.11	0.01	0.07	0.70	0.21	0.19	0.48
103	STRUCT. W. AND INTERNAL P. (TOILETS)	0.041	13	8.07	13	N.A.	0.04	0.01	0.06	0.46	0.05	0.16	0.16
105	ACETYLENE PLANT	0.023	283	9.47	15	N.A.	0.05	0.01	0.07	0.23	0.01	0.35	0.23
106	MACHINE SHOP, WAREHOUSE	0.033	247	7.95	13	N.A.	0.09	0.03	0.06	0.26	1.08	0.12	1.70
107	MACHINE SHOP, J. WAREHOUSE, IO, PLANTS, P	0.251	38	8.13	16	N.A.	0.22	0.04	0.06	0.12	0.55	0.14	0.55
108	COMPONENT W. (TOILETS), GARAGE	0.003	678	7.74	13	N.A.	0.13	0.03	0.04	0.37	0.08	0.30	2.48
109	COMPONENT WORKSHOP, PATIO	0.010	100	8.02	12	N.A.	0.11	0.02	0.05	0.17	0.18	0.07	0.95
110	WORKSHOPS, CARPENTRY, INSTRUMENTS	0.311	46	7.91	14	N.A.	1.22	0.04	0.16	0.24	0.11	0.09	1.70
111	TRAINING (WASHING PLACE)	0.003	7	8.38	15	N.A.	0.50	0.01	0.08	0.14	0.02	0.07	0.18
112	HEAVY EQUIPMENT, PUMP, TRAINING **TAREA	0.043	406	7.88	14	N.A.	0.70	0.21	0.07	0.24	0.30	0.32	6.80
113	INDUSTRIAL ENG., GENERAL OFFICE	0.065	11	8.13	14	N.A.	0.05	0.01	0.08	0.18	0.02	0.21	0.31
114	POWER HOUSE, CONTROL TESTS	0.473	24	7.89	15	N.A.	0.18	0.15	0.09	0.23	0.04	0.17	1.16
115	IONIC PLANT, POWER HOUSE	0.054	176	10.48	16	N.A.	0.27	0.01	0.06	0.27	0.01	0.24	0.28
116	OXYGENE PLANT, CABLE (TOILETS)	0.070	99	9.97	15	N.A.	22.13	0.04	0.05	0.31	0.31	0.11	2.44
117	OLD OXYGENE PLANT	0.373	129	7.64	19	N.A.	0.33	0.09	0.38	0.29	0.56	0.08	7.72
118	GRANUL. ESC. AND REFRIG. Cu and Pb SMELTER	26.943	287	8.05	18	N.A.	1.06	0.07	0.26	0.41	2.40	0.29	4.25
119	MAIN CHANNEL # 2 (Cu and Pb SMELTER)	2.098	258	6.62	18	N.A.	4.83	8.01	3.44	24.37	1.43	1.47	421.19
120	ELECTROLITIC ZINC PLANT (TOILET)	0.152	31	7.85	14	N.A.	0.12	0.07	0.06	0.30	0.59	0.06	6.32
121	P.R.A. (Se-Te), TOILET	0.120	122	6.03	13	N.A.	1.50	0.02	0.44	1.43	0.15	0.61	3.29
123	P.R.A. (SEDIMENTATION POOL)	0.131	145	2.56	15	N.A.	16.66	0.11	1.00	21.42	0.55	4.13	36.09
124	FURNACES AND ANODE WASHING, Zn	0.187	318	4.51	12	N.A.	0.17	0.64	1.63	1.01	1.27	1.98	144.27
125	SKYLIGHT, ELECTROLITIC Zn	0.096	105	6.02	24	N.A.	0.27	0.15	3.29	0.46	22.01	0.87	206.39
126	ELECT. Zn PLANT, RUN-OFF, LIX. PURIF.	2.363	31	5.94	15	N.A.	0.11	1.13	1.39	10.04	30.98	0.79	385.98
127	REFRIGERATION, ZINC PLANT SUB-STATION	0.142	20	7.93	21	N.A.	0.04	0.01	0.05	0.27	0.42	0.05	1.78
128	ZINC MELTING, MOULDING AND STORAGE	0.189	19	8.19	25	N.A.	0.04	0.03	0.05	0.24	0.02	0.06	0.60
129	OFFICE AND CONSTRUCTION WAREHOUSE	0.086	26	7.85	11	N.A.	0.10	0.07	0.18	1.58	0.08	0.14	5.34
131	CADMIUM MELTING AND MOULDING, D.I.M. LA	0.078	546	8.32	14	N.A.	0.12	8.42	0.09	0.20	19.20	0.08	908.63
132	PILOT PLANT INV. MET. DEP.	0.115	24	8.12	11	N.A.	0.04	0.06	0.05	0.27	0.04	0.08	1.79
133	IN PLANT, EXHAUSTED SOL., ALCALINE WASHI	0.210	5643	7.83	42	N.A.	292.78	14.41	0.05	256.66	48.58	1.03	656.53
134	IN PLANT, POOL EXIT EXHAUSTED SOL	0.014	95	2.13	22	N.A.	35.28	25.38	12.05	410.67	111.60	1.88	916.51
135	MAIN CHANNEL # 1 (PARALLEL-TO RAILWAY)	6.664	73	2.84	21	N.A.	2.59	3.04	0.88	7.88	6.86	2.21	333.40
136	PARALLEL CHANNEL TO MAIN CHANNEL # 1	2.248	304	5.38	17	N.A.	0.55	1.66	0.45	65.48	24.57	1.89	595.30
137	POOL EFFLUENT ZINC FERRITE	0.557	170	6.15	16	N.A.	0.31	1.05	0.26	0.18	27.63	0.95	541.91
R-1	Pb REFINERY EFFLUENT (Now Cu Ref.)	0.198	402	2.34	15	N.A.	169.28	0.14	1,602.13	4,455.75	15.99	6.25	47.55
R-2	WIRE ROD EFFLUENT	0.100	12	5.80	24	N.A.	2.50	0.01	2.30	0.12	0.03	0.20	0.12
R-3	ASARCO EFFLUENT	1.624	69	7.17	42	N.A.	0.19	0.01	0.42	0.51	0.03	0.06	0.12
TOTAL:		46.132											

LMP, Value in any moment : mg/l (MEM)	100	5.5 - 10.5	2	1.0	5	2	1.0	6
LMP, Annual average value : mg/l (MEM)	50	5.5 - 10.5	1	0.5	2	1	0.5	3
LMP, Water type III : mg/l	50	5.0 - 9.0	0.05	0.20	1.00	0.50	0.10	25.00

EFUENTES S.A. Report

TABLE N° 4.1.2 / 2A
LIQUID EFFLUENTS - LA OROYA METALLURGIC COMPLEX
Period: January - June 1996

CODE	SAMPLING POINT	Flow m³/min	Physical Properties			Metallic elements concentration (mg/l)						
			Suspended solids, mg/l	pH	Temp. °C	CN Total, mg/l	As	Cd	Cu	Fe	Mn	Zn
101	COKE PLANT	0.047	142.447	9.1	13	0.026	0.13	0.01	0.17	0.54	0.03	0.38
102	PATIO OF STRUCTURAL WORKSHOP	0.012	15.127	8.2	12	0.002	0.06	0.02	0.06	0.31	0.10	0.34
103	STRUCT. W. AND INTERNAL P. (TOILETS)	0.012	23.420	8.2	13	0.002	0.04	0.01	0.04	0.24	0.01	0.15
105	ACETYLENE PLANT											
106	MACHINE SHOP, WAREHOUSE	0.013	36.978	8.1	15	0.001	0.06	0.03	0.12	0.33	0.09	1.22
107	MACHINE SHOP, J. WAREHOUSE, IO, PLANTS, P	0.117	30.495	7.9	13	0.001	0.17	0.04	0.08	0.31	0.04	0.66
108	COMPONENT W. (TOILETS), GARAGE	0.007	39.440	8.0	13	0.006	0.08	0.01	0.04	0.24	0.05	0.43
109	COMPONENT WORKSHOP, PATIO	0.007	27.697	8.1	13	0.001	0.01	0.02	0.04	0.29	0.05	0.45
110	WORKSHOPS, CARPENTRY, INSTRUMENTS	0.378	23.218	7.7	14	0.001	0.33	0.06	0.11	0.36	0.14	0.73
111	TRAINING (WASHING PLACE)	0.000	55.000	9.0	12	0.003	0.25	0.08	0.37	0.05	0.06	0.01
112	HEAVY EQUIPMENT, PUMP, TRAINING **TAREA	0.038	66.078	8.2	13	0.001	0.15	0.08	0.09	0.17	0.08	0.73
113	INDUSTRIAL ENG., GENERAL OFFICE	0.055	17.790	7.8	14	0.001	0.05	0.04	0.05	0.28	0.03	0.54
114	POWER HOUSE, CONTROL TESTS	0.542	16.552	8.1	14	0.001	0.06	0.01	0.11	0.46	0.03	0.25
115	IONIC PLANT, POWER HOUSE	0.083	26.460	8.0	14	0.007	0.12	0.06	0.08	0.82	0.05	0.97
116	OXYGEN PLANT, CABLE (TOILETS)	0.062	30.617	7.8	15	0.001	0.13	0.04	0.09	1.18	0.06	0.51
117	OLD OXYGEN PLANT	0.243	55.690	7.8	17	0.001	0.35	0.05	0.16	0.33	0.37	0.86
118	GRANUL. ESC. AND REFRIG. Cu and Pb SMELTER	28.097	3,308.208	8.0	17	0.001	0.61	0.06	0.05	0.21	2.08	9.87
119	MAIN CHANNEL # 2 (Cu and Pb SMELTER)	2.288	371.345	6.2	19	0.001	9.41	35.70	1.37	6.09	1.11	1,275.25
120	ELECTROLYTIC ZINC PLANT (TOILET)	0.135	92.945	7.9	15	0.001	0.04	0.03	0.06	0.35	0.23	2.04
121	P.R.A. (Se, Te), TOILET	0.127	83.773	6.9	15	0.001	0.68	0.03	0.30	3.59	0.24	13.67
123	P.R.A. (SE, TELLUR) (SEDIMENTATION POOL)	0.187	113.053	2.5	12	0.002	22.99	0.08	0.47	14.03	0.26	38.48
124	FURNACES AND ANODE WASHING, Zn	0.178	73.137	5.2	11	0.001	0.06	0.03	0.31	1.18	0.53	68.72
125	SKYLIGHT, ELECTROLYTIC Zn	0.145	27.197	5.8	23	0.001	0.04	0.04	1.53	0.31	30.06	216.60
126	ELECT. Zn PLANT, RUN-OFF, LIX., PURIF.	1.702	95.462	6.0	14	0.001	0.06	0.30	0.83	2.48	82.15	405.77
127	REFRIGERATION, ZINC PLANT SUB-STATION	0.165	14.605	8.2	19	0.001	0.02	0.01	0.03	0.22	0.05	0.43
128	ZINC MELTING, MOULDING AND STORAGE	0.052	16.700	8.4	17	0.001	0.05	0.01	0.03	0.72	0.18	0.91
129	OFFICE AND CONSTRUCTION WAREHOUSE	0.118	22.263	8.2	12	0.001	0.03	0.01	0.04	0.19	0.03	0.31
131	CADMIUM MELTING AND MOULDING, D.I.M. L	0.058	238.537	7.1	14	0.002	0.10	22.59	0.05	0.14	9.99	312.69
132	PILOT PLANT INV. MIST. DEP.	0.083	14.252	8.1	11	0.002	0.02	0.17	0.06	0.36	0.11	0.98
133	IN PLANT, EXHAUSTED SOL., ALCALINE WASH	0.130	210.670	11.7	29	0.000	1.065.00	0.04	0.32	0.45	0.05	4.90
134	IN PLANT, POOL EXIT EXHAUSTED SOL.	0.018	199.747	2.2	21	0.001	166.60	32.27	73.07	673.67	310.83	1,919.67
135	MAIN CHANNEL # 1 (PARALLEL-TO RAILWAY)	6.987	50.858	3.0	22	0.002	1.88	0.95	0.71	2.62	1.77	10.00
136	PARALLEL CHANNEL TO MAIN CHANNEL # 1	2.187	238.512	5.9	16	0.001	1.40	5.61	0.71	150.11	98.73	1,284.17
137	POOL EFFLUENT ZINC FERRITE	0.488	40.435	7.0	16	0.001	0.09	0.49	0.05	0.18	10.68	190.33
R-1	Pb REFINERY EFFLUENT (Now Cu Ref.)	0.298	359.082	3.0	17	0.001	18.07	0.04	135.42	404.83	1.05	3.35
R-2	WIRE ROD EFFLUENT											
R-3	ASARCO EFFLUENT	1.938	42.338	8.0	43	0.001	0.36	0.01	0.35	0.27	0.02	0.22
TOTAL:		46.947										0.34

LMP, Value in any moment : mg/l (MEM)	100	5.5-10.5	2	1.0	5	1.0	6
LMP, Annual average value : mg/l (MEM)	50	5.5-10.5	1	0.5	2	0.5	3
LMP, Water type III : mg/l	50	5.0-9.0	0.50	0.20	1.00	0.50	25.00

TABLA N° 4.1.2 / 3
EFLUENTES LIQUIDOS - COMPLEJO METALÚRGICO LA OROYA
Periodo: Enero - Diciembre 1995
CONTENIDO METÁLICO

Código	Punto de Muestreo	Flujo (m³/día)	Contenido Metálico - mg/d							Carga Total kg/d
			Cu	Al	Ca	Cd	Cv	Pb	Mn	
101	COKE PLANT	0.053	N.A.	0.04	0.02	0.01	0.06	0.01	0.03	0.16
102	PATIO OF STRUCTURAL WORKSHOP	0.013	N.A.	0.00	0.00	0.00	0.01	0.00	0.00	0.01
103	STRUCT. W. AND INTERNAL P. (TOILETS)	0.041	N.A.	0.00	0.00	0.00	0.03	0.01	0.00	0.01
105	ACETYLENE PLANT	0.013	N.A.	0.00	0.00	0.00	0.01	0.01	0.00	0.01
106	MACHINE SHOP, WAREHOUSE	0.033	N.A.	0.00	0.00	0.00	0.01	0.01	0.05	0.08
107	MACHINE SHOP, J. WAREHOUSE, JO. PLANTS, P.	0.231	N.A.	0.08	0.01	0.02	0.01	0.01	0.04	0.20
108	COMPONENT W. (TOILETS), GARAGE	0.003	N.A.	0.00	0.00	0.00	0.00	0.00	0.00	0.01
109	COMPONENT WORKSHOP, PATIO	0.010	N.A.	0.00	0.00	0.00	0.00	0.00	0.00	0.01
110	WORKSHOPS CARPENTRY, INSTRUMENTS	0.311	N.A.	0.55	0.02	0.07	0.11	0.04	0.05	0.01
111	TRAINING (WASHING PLACE)	0.003	N.A.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112	HEAVY EQUIPMENT, PUMP, TRAINING **TAREA	0.043	N.A.	0.04	0.01	0.00	0.01	0.02	0.02	0.42
113	INDUSTRIAL ENG., GENERAL OFFICE	0.065	N.A.	0.00	0.00	0.01	0.01	0.02	0.03	0.08
114	POWER HOUSE, CONTROL TESTS	0.473	N.A.	0.12	0.10	0.06	0.16	0.12	0.03	0.79
115	IONIC PLANT, POWER HOUSE	0.054	N.A.	0.02	0.00	0.01	0.02	0.00	0.00	0.02
116	OXYGEN PLANT, CABLE (TOILETS)	0.070	N.A.	2.23	0.00	0.00	0.03	0.01	0.03	0.25
117	OLD OXYGEN PLANT	0.373	N.A.	0.18	0.05	0.21	0.16	0.04	0.30	4.15
118	GRANUL. ESC. AND REFIN. Cu and Pb SMELTER	26.943	N.A.	41.15	2.81	10.02	15.78	11.19	92.95	164.76
119	MAIN CHANNEL # 2 (Cu and Pb SMELTER)	2.098	N.A.	14.59	24.18	10.39	73.60	4.31	4.31	1,272.16
120	ELECTROLYTIC ZINC PLANT (TOILET)	0.152	N.A.	0.03	0.01	0.01	0.07	0.01	0.13	1.38
121	P.R.A. (S&T), TOILET	0.120	N.A.	0.26	0.00	0.08	0.25	0.03	0.03	0.57
123	P.R.A. (SEDIMENTATION POOL)	0.131	N.A.	3.14	0.02	0.19	4.03	0.11	0.10	1.29
124	FURNACES AND ANODE WASHING Zn	0.167	N.A.	0.05	0.03	0.17	0.44	0.78	0.53	6.80
125	SKYLIGHT, ELECTROLYTIC Zn	0.096	N.A.	0.04	0.02	0.45	0.06	0.12	3.04	28.48
126	ELECT. Zn PLANT, RUN-OFF, LIX. PURIF.	2.353	N.A.	0.37	3.85	4.75	34.15	2.70	105.38	1,313.12
127	REFRIGERATION, ZINC PLANT SUB-STATION	0.142	N.A.	0.01	0.00	0.01	0.05	0.01	0.09	0.36
128	ZINC MELTING, MOULDING AND STORAGE	0.199	N.A.	0.01	0.01	0.01	0.05	0.02	0.01	0.16
129	OFFICE AND CONSTRUCTION WAREHOUSE	0.086	N.A.	0.01	0.01	0.02	0.20	0.02	0.01	0.66
131	CADMIUM MELTING AND MOLDING, D.I.M. LA	0.078	N.A.	0.01	0.05	0.01	0.02	0.01	2.17	102.49
132	PILOT PLANT INV. MET. DEP.	0.115	N.A.	0.01	0.01	0.01	0.05	0.01	0.01	0.30
133	IN PLANT, EXHAUSTED SOL, ALCALINE WASH	0.210	N.A.	88.54	4.36	0.44	77.61	0.31	14.69	198.53
134	IN PLANT, POOL EXIT EXHAUSTED SOL	0.014	N.A.	0.72	0.32	0.25	8.38	0.04	2.28	18.70
135	MAIN CHANNEL # 1 (PARALLEL-TO RAILWAY)	6.664	N.A.	24.84	29.19	8.43	75.65	21.18	65.82	3,199.44
136	PARALLEL CHANNEL TO MAIN CHANNEL # 1	2.248	N.A.	1.77	5.36	1.45	21.93	6.12	79.51	3,424.55
137	POOL EFFLUENT ZINC FURRITE	0.357	N.A.	0.25	0.84	0.20	0.14	0.76	22.15	2,232.77
R-1	Pb REFINERY EFFLUENT (Now Cu Ref)	0.198	N.A.	48.11	0.04	455.64	1,267.22	1.78	4.55	434.39
R-2	WIRE ROD EFFLUENT	0.100	N.A.	0.36	0.00	0.14	0.33	0.00	0.02	13.52
R-3	ASARCO EFFLUENT	1.624	N.A.	0.44	0.02	0.99	1.18	0.03	0.06	0.89
TOTAL:		46.13	0.000	227.97	72.46	494.06	1,771.91	50.63	398.18	8,728.44
EFLUENT TOTAL, kg/d										11,743.65

EFLUENT TOTAL, kg/d

TABLE N° 4.1.2 / 3A
LIQUID EFFLUENTS - METALLURGIC COMPLEX LA OROYA
Period: January - June 1996
CONTENIDO METÁLICO

CODEZ	SAMPLING POINT	Flow m3/d	Metal Content - Pp/4								Total kg/d
			LN Total	As	Co	Cd	Cu	Pb	Mn	Zn	
101	COKE PLANT	0.047	0.002	0.01	0.00	0.01	0.04	0.00	0.01	0.03	0.09
102	PATIO OF STRUCTURAL WORKSHOP	0.012	0.000	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02
103	STRUCT. W. AND INTERNAL P. (TOILETS)	0.012	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
105	ACETYLENE PLANT										
106	MACHINE SHOP, WAREHOUSE	0.013	0.000	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.04
107	MACHINE SHOP, J WAREHOUSE, IQ, PLANTS, PREP. AS, SS	0.117	0.000	0.03	0.01	0.01	0.05	0.01	0.01	0.11	0.23
108	COMPONENT W. (TOILETS), GARAGE	0.007	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
109	COMPONENT WORKSHOP, PATIO	0.007	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
110	WORKSHOPS, CARPENTRY, INSTRUMENTS	0.378	0.001	0.18	0.03	0.06	0.20	0.08	0.09	0.40	1.04
111	TRAINING (WASHING PLACE)	0.000	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112	HEAVY EQUIPMENT, PUMP, TRAINING **TAREADOR	0.058	0.000	0.01	0.01	0.01	0.01	0.01	0.03	0.06	0.14
113	INDUSTRIAL ENG., GENERAL OFFICE	0.055	0.000	0.03	0.00	0.00	0.02	0.00	0.01	0.04	0.09
114	POWER HOUSE, CONTROL TESTS	0.542	0.000	0.05	0.01	0.09	0.36	0.02	0.10	0.20	0.82
115	IONIC PLANT, POWER HOUSE	0.083	0.001	0.01	0.01	0.01	0.10	0.01	0.06	0.12	0.32
116	OXYGENE PLANT, CABLE (TOILETS)	0.062	0.000	0.01	0.09	0.01	0.10	0.01	0.04	0.05	0.22
117	OLD OXYGENE PLANT	0.243	0.000	0.12	0.02	0.06	0.12	0.13	0.13	0.30	0.87
118	GRANUL. ESC. AND REFRIG. Cu and Pb SMELTER	28.077	0.020	24.68	2.35	1.94	3.38	84.07	15.78	399.21	536.43
119	MAIN CHANNEL # 2 (Cu and Pb SMELTER)	2.268	0.002	36.74	116.61	4.47	19.89	3.63	2.22	4,165.48	4,343.04
120	ELECTROLITIC ZINC PLANT (TOILET)	0.135	0.000	0.01	0.01	0.01	0.07	0.04	0.01	0.40	0.55
121	P.R.A. (S&T), TOILET	0.127	0.000	0.12	0.01	0.05	0.65	0.04	0.20	2.49	3.57
123	P.R.A. (SEDIMENTATION POOL)	0.157	0.060	6.18	0.02	0.13	3.77	0.07	2.78	10.34	23.29
124	FURNACES AND ANODE WASHING. Zn	0.128	0.600	0.01	0.01	0.06	0.22	6.10	0.31	12.70	13.40
125	SKYLIGHT, ELECTROLITIC Zn	0.145	0.350	0.01	0.01	0.32	0.56	6.23	0.15	45.23	52.06
126	ELECT. Zn PLANT, RUN-OFF, LIX. FURIF.	1.702	0.002	1.15	1.22	2.03	6.08	201.30	1.57	994.30	1,206.64
127	REFRIGERATION, ZINC PLANT SUB-STATION	0.165	0.000	0.01	0.00	0.01	0.05	0.01	0.02	0.10	0.20
128	ZINC MELTING, MOULDING AND STORAGE	0.052	0.000	0.03	0.00	0.00	0.02	0.01	0.01	0.11	0.13
129	OFFICE AND CONSTRUCTION WAREHOUSE	0.118	0.020	0.01	0.00	0.01	0.03	0.00	0.02	0.05	0.13
131	CADMIUM MELTING AND MOULDING, D.I.M. LAB	0.058	0.000	0.01	1.90	0.00	0.01	0.84	0.01	26.27	29.04
132	PILOT PLANT INV. MET. DEP.	0.083	0.000	0.30	0.02	0.01	0.04	0.01	0.01	0.12	0.21
133	IN PLANT, EXHAUSTED SOL, ALCALINE WASHING	0.130	0.000	199.37	0.01	0.06	0.08	0.01	0.92	194.13	394.57
134	IN PLANT, POOL EXIT EXHAUSTED SOL	0.018	0.000	4.40	0.85	1.93	17.84	8.21	0.08	50.68	83.98
135	MAIN CHANNEL # 1 (PARALLEL-TO RAILWAY)	6.987	0.020	18.91	9.56	7.14	26.36	17.81	10.06	100.61	190.47
136	PARALLEL CHANNEL TO MAIN CHANNEL # 1	2.187	0.003	4.41	17.66	2.24	472.67	310.88	4.00	4,043.59	4,855.45
137	POOL EFFLUENT ZINC PERKITE	0.488	0.000	0.06	0.34	0.04	0.13	7.51	0.32	133.84	142.24
R-1	Pb REFINERY EFFLUENT (Now Cu Ref.)	0.298	0.000	7.76	0.02	38.18	173.91	0.45	39.72	1.44	281.48
R-2	WIRE ROD EFFLUENT										
R-3	ASARCO EFFLUENT	1.938	0.001	1.00	0.01	0.99	0.75	0.05	0.61	0.94	4.36
TOTAL :		46.95	0.055	298.27	150.68	79.87	732.04	641.59	79.31	10,183.31	12,165.14

TABLE N° 4.12 / 4
COPPER AND LEAD SMELTING - LA OROYA
Period: January - December 1995

LIQUID EFFLUENTS

CODE	SAMPLING POINT	Flow m ³ /min	Physical Properties			Major chemical components: mg/l							
			Suspended solids: mg/l	pH	Temp. °C	CN Total: mg/l	As	Co	Cd	Fe	Mn	Pb	Zn
101	COQUE PLANT	0.053	363	8.97	19	N.A.	0.48	0.26	0.14	0.81	0.37	0.11	2.05
118	GRANUL. ESC. AND REFRIG. Cu and Pb SMELTER	26.943	287	8.05	18	N.A.	1.06	0.07	0.26	0.41	2.46	0.29	4.25
119	MAIN CHANNEL # 2 (Cu and Pb SMELTER)	2.098	258	6.62	18	N.A.	4.83	8.01	3.44	24.37	1.43	1.47	421.19
TOTAL:		29.093											
LMP, Value in any moment : mg/l (NEM)													
LMP, Annual average value : mg/l (NEM)													
LMP, Water type III : mg/l													
			100	5.5 - 10.5		2	1.0		2	5		1.0	6
			50	5.5 - 10.5		1	0.5		1	2		0.5	3
			50	5.0 - 9.0			0.20	0.05	0.50	1.00	0.50	0.10	25.00

EFUEHS RLA Report

TABLE N° 4.1.2 / 4A
LIQUID EFFLUENTS OF MORE IMPACT - LA OROYA METALLURGIC COMPLEX
Period: January - June 1996

CODE	SAMPLING POINT	Flow m³/mty	Physical Properties			Metal chemical composition mg/l							
			Substrated solid mg/l	pH	Temp. °C	CS Total mg/l	Al	Cd	CH	Fe	Mn	Pb	Zn
R-1	EFUENTE DE REFINERIA Pb (Alura Ref. Cu)	0.298	359.082	3.0	17	0.001	18.07	0.04	135.42	404.83	1.05	92.45	3.35
118	GRANUL. ESC. Y REFRIG. FUND. Cu y Pb	28.097	3,508.208	8.0	17	0.001	0.51	0.06	0.05	0.21	2.08	0.39	9.87
119	CANAL PRINCIPAL # 2 (FUND. Cu y Pb)	2.268	371.345	6.2	19	0.001	9.41	35.70	1.37	6.09	1.11	0.68	1,275.25
126	PTA. ELECT. Zn, DERRAMES LIX, PURIF.	1.702	95.462	6.0	14	0.001	0.06	0.50	0.83	2.48	82.15	0.64	405.77
135	CANAL PRINCIPAL # 1 (PARALELO-FCC)	6.987	50.858	3.0	22	0.002	1.88	0.95	0.71	2.62	1.77	1.00	10.00
136	CANAL PARALELO AL C. PRINCIPAL # 1	2.187	233.512	5.9	16	0.001	1.40	5.61	0.71	150.11	98.73	1.27	1,284.17
137	EFUENTE POZA FERRITAS ZINC	0.483	40.435	7.0	16	0.001	0.09	0.49	0.05	0.18	10.68	0.46	190.33
TOTAL:		42.027											

LMP, Valor en cualquier momento : mg/l (MEN)	100	5.5 - 10.5	2	1.0	5	2	1.0	1.0	6
LMP, Valor en promedio anual : mg/l (MEN)	50	5.5 - 10.5	1	0.5	2	1	0.5	0.5	3
LMP, Agua clase III : mg/l	50	5.0 - 9.0		0.20	1.00	0.50	0.50	0.10	25.00

NOTA: El efluente R-1 ya está siendo reciclado a la operación, así la parte se funcionamiento del Filtrador.

Los datos consignados corresponden a promedios estadísticos.

TABLE N° 4.1.2/5A
LIQUID EFFLUENTS OF MAIN IMPACT - METALLURGIC COMPLEX LA OROYA
Period: January - June 1996
CONTENIDO METÁLICO

CODE	SAMPLING POINT	Flow m ³ /min	CN Total	Metallic Content - kg/d							Total Charge kg/d
				Al	Fe	Cu	Pb	Mn	Pb	Zn	
R-1	Pb REFINERY EFFLUENT (Now Cu Ref.)	0.292	0.003	7.76	0.02	58.18	173.91	0.45	39.72	1.44	281.48
118	GRANUL. ESC. AND REFRIG. Cu and Pb SMELTER	28.097	0.029	24.68	2.35	1.94	8.38	84.07	15.78	399.21	536.43
119	MAIN CHANNEL # 2 (Cu and Pb SMELTER)	2.263	0.002	30.74	116.61	4.47	19.89	3.63	2.22	4,165.48	4,343.04
126	ELECT. Zn PLANT, RUN-OFF LIX. PURIF.	1.702	0.002	0.15	1.22	2.03	6.08	201.30	1.57	994.30	1,206.64
135	MAIN CHANNEL # 1 (PARALLEL TO RAILWAY)	6.987	0.020	18.91	9.56	7.14	26.36	17.41	10.06	100.61	190.47
136	PARALLEL CHANNEL TO MAIN CHANNEL # 1	2.187	0.001	1.11	17.69	2.24	472.67	310.88	4.00	4,043.59	4,855.45
137	POOL EFFLUENT ZINC FERRITE	0.488	0.000	0.06	0.34	0.04	0.13	7.51	0.32	133.84	142.24
TOTAL:		42.027	0.047	86.71	147.75	76.04	707.41	625.65	73.67	9,838.47	11,555.75
RELATION: CHARGE 7 MAIN EFFLUENT/TOTAL CHARGE:		89.570	56.713	29.07	98.05	95.20	96.64	97.52	92.89	96.61	94.99

EFUEM01.XLS, Report

TABLE N° 4.1.2/6
COPPER AND LEAD REFINERIES - LA OROYA
Period: January - December 1995

LIQUID EFFLUENTS

CODE	SAMPLING POINTS	Flow m ³ /day	Physical Properties			Mean chemical concentrations mg/l							
			Suspended solids mg/l	pH	Temp. °C	CN Total mg/l	As mg/l	Ca mg/l	Co mg/l	Pb mg/l	Mn mg/l	Pb mg/l	Zn mg/l
121	P.R.A. (S ₂ Te) TOILET	0.120	122	6.03	13	N.A.	1.50	0.02	0.44	1.43	0.15	0.61	3.29
123	P.R.A. (SEDIMENTATION POOL)	0.131	145	2.56	15	N.A.	16.66	0.11	1.00	21.42	0.55	4.13	36.09
R-1	Pb REFINERY EFFLUENT (Now Cu Ref.)	0.198	402	2.34	15	N.A.	169.28	0.14	1,602.13	4,455.75	15.99	6.25	47.55
R-2	WIRE ROD EFFLUENT	0.169	12	5.80	24	N.A.	2.50	0.01	1.00	2.30	0.12	0.03	0.20
R-3	ASARCO EFFLUENT	1.624	69	7.17	42	N.A.	0.19	0.01	0.42	0.51	0.03	0.06	0.12
TOTAL:		2.173											
LMP, Value in any moment : mg/l. (MEM)													
LMP, Annual average value : mg/l (MEM)			100	5.5 - 10.5		2	1.0		2	5		1.0	6
LMP, Water type III : mg/l			50	5.5 - 10.5		1	0.5		1	2		0.5	3
			50	5.0 - 9.0			0.20	0.05	0.50	1.00	0.50	0.10	25.00

RE USUO Y XL, Report

TABLE N° 4.1.2/5
ZINC REFINERY - LA OROYA
Period: January - December 1995

LIQUID EFFLUENTS

CODE	SAMPLING POINTS	Flow m ³ /min	Physical Properties			Main Chemical Components, mg/l							
			Suspended solid, mg/l	pH	Temp. °C	CN Total, mg/l	As	Ca	Cu	Fe	Mn	Pb	Zn
120	ELECTROLITIC ZINC PLANT (TOILET)	0.132	31	7.85	14	N.A.	0.12	0.07	0.06	0.30	0.59	0.06	6.32
124	FURNACES AND ANODE WASHING Zn	0.187	318	4.51	12	N.A.	0.17	0.10	0.64	1.63	1.27	1.98	144.27
125	SKYLIGHT, ELECTROLITIC Zn	0.096	105	6.02	24	N.A.	0.27	0.15	3.29	0.46	22.01	0.87	266.30
126	ELECT. Zn PLANT, RUN-OFF, LIX. PURIF.	2.363	31	5.94	15	N.A.	0.11	1.13	1.39	10.04	30.98	0.79	385.98
127	REFRIGERATION, ZINC PLANT SUB-STATION	0.142	20	7.93	21	N.A.	0.04	0.01	0.05	0.27	0.42	0.05	1.78
128	ZINC MELTING, MOULDING AND STORAGE	0.189	19	8.19	25	N.A.	0.04	0.03	0.05	0.27	0.02	0.06	0.60
131	CADMIUM MELTING AND MOULDING, D.I.M. LA	0.078	546	8.32	14	N.A.	0.12	8.42	0.09	0.20	19.20	0.08	908.63
132	PILOT PLANT INV. MET. DEP.	0.115	24	8.12	11	N.A.	0.04	0.06	0.05	0.27	0.04	0.08	1.79
133	IN PLANT, EXHAUSTED SOL, ALCALINE WASH	0.210	5,643	7.83	42	N.A.	292.78	14.41	1.44	256.66	48.58	1.03	656.53
134	IN PLANT, POOL EXIT EXHAUSTED SOL	0.014	95	2.13	22	N.A.	35.28	22.38	12.05	410.67	111.60	1.88	916.51
135	MAIN CHANNEL # 1 (PARALLEL TO RAILWAY)	6.664	73	2.84	21	N.A.	2.59	3.04	0.88	7.88	6.86	2.21	333.40
136	PARALLEL CHANNEL TO MAIN CHANNEL # 1	2.248	304	5.38	17	N.A.	0.55	1.66	0.45	65.48	24.57	1.89	595.30
137	POOL EFFLUENT ZINC FERRITE	0.557	170	6.15	16	N.A.	0.31	1.05	0.26	0.18	27.63	0.95	541.91
TOTAL:		13.013											

LMP, Value in any moment : mg/l (MEM)	100	5.5 - 10.5	2	1.0	5	1.0	6
LMP, Annual average value : mg/l (MEM)	50	5.5 - 10.5	1	0.5	2	0.5	3
LMP, Water type III : mg/l	50	5.0 - 9.0		0.20	1.00	0.10	25.00

REFUGIO S.A. Report

TABLE N° 4.1.2/5
LIQUID EFFLUENTS OF MORE IMPACT - LA OROYA METALLURGIC COMPLEX
Period: January - December 1995
METAL CONTENT

CODE	SAMPLING POINT	Flow m ³ /min	Concentrations (mg/L)							Total kg/d
			Cd	As	Cu	Fe	Mn	Pb	Zn	
R-1	EFUENTE DE REFINERIA DE PLOMO	0.298	N.A	48.14	0.04	435.64	1,267.22	4.33	1.78	1,790.89
118	GRANUL. ESC. Y REFRIG. FUND. Cu y Pb	23.097	N.A	41.13	2.81	10.02	15.78	92.95	11.19	338.65
119	CANAL PRINCIPAL # 2 (FUND. Cu y Pb)	2.268	N.A	14.59	24.18	10.39	73.60	4.31	4.43	1,403.66
126	PTA. ELECT. Zn, DERRAMES LIX. PURIF.	1.702	N.A	0.37	3.85	4.73	34.15	105.38	2.70	1,464.29
135	MAIN CHANNEL # 1 (PARALLEL-TO RAILWAY)	6.987	N.A	24.84	29.19	8.43	75.65	65.82	21.18	3,424.55
136	PARALLEL CHANNEL TO MAIN CHANNEL # 1	2.187	N.A	1.77	5.36	1.45	211.93	79.51	6.12	2,232.77
137	POOL EFFLUENT ZINC PERRITE	0.428	N.A	0.25	0.84	0.20	0.14	22.15	0.76	48.74
TOTAL:		42.027	0.000	131.08	66.28	490.88	1,678.47	374.67	48.17	11,113.55
ELATION: CHARGE 7 MAIN EFFLUENT/TOTAL CHARG		91.101	0.380	57.59	91.47	95.36	94.73	95.14	95.37	94.63

EFUENTE ZINCO

TABLE N° 4.1.2 / 6A
RIVERS : MANTARO and YAULI
Period: January - June 1996

CODE	SAMPLING POINT	Flow m ³ /min	Physical Properties			Main chemical components: mg/l							
			Temperature °C	pH	Conductivity µmhos/cm	CN mg/l	As mg/l	Ca mg/l	Fe mg/l	Mn mg/l	Pb mg/l	Zn mg/l	
M-1	Mantaro bridge chuleo	0.052	17	8.4	16.700	0.001	0.05	0.01	0.22	0.18	0.07	0.91	
M-2	Mantaro before union with Yauli River	0.118	12	8.2	22.263	0.001	0.03	0.01	0.19	0.03	0.14	0.31	
M-3	Mantaro bridge Casabel	1,944.113	13	7.9	13.430	0.002	0.15	0.01	0.37	1.35	0.06	1.00	
M-4	Mantaro after smelting	0.058	14	7.1	238.537	0.002	5.10	22.59	0.14	9.99	0.16	312.73	
M-5	Mantaro after feriles deposit	0.083	11	8.1	14.252	0.002	0.02	0.17	0.36	0.06	0.11	0.98	
Y-1	Yauli, bridge Marcevalle	0.488	16	7.0	40.435	0.001	0.09	0.49	0.18	10.68	0.46	190.33	
Y-2	Yauli, bridge Huaymanla	1,432.355	12	8.0	14.030	0.002	0.24	0.01	0.27	0.08	0.07	0.22	
Y-3	Yauli, bridge Sudete	1,706.486	12	7.5	22.190	0.002	0.06	0.01	0.36	5.28	0.06	2.80	
T	Tishgo	62.510	13	8.3	12.390	0.020	0.04	0.01	0.42	0.23	0.14	0.25	
LMP, Water type III			50	5.0 - 9.0	50	0.20	0.05	1.00	0.50	0.50	0.10	25.00	

CHART N° 4.1.2 / 7
TALLERES - LA OROYA
Period: January - December 1995

LIQUID EFFLUENTS

CODE	SAMPLING POINTS	Flow m³/day	Physical Properties			Nutrient (mg/l) components: mg/l							
			Temperature °C	pH	SS mg/l	CN Total, mg/l	As	Fe	Cu	Pb	Mn	Zn	
102	PATIO OF STRUCTURAL WORKSHOP	0.013	13	8.01	16	N.A	0.11	0.01	0.07	0.70	0.21	0.19	0.48
103	STRUCT. W. AND INTERNAL P. (TOILETS)	0.041	13	8.07	13	N.A	0.04	0.01	0.06	0.46	0.05	0.16	0.16
105	ACETYLENE PLANT	0.023	15	9.47	283	N.A	0.05	0.01	0.07	0.23	0.01	0.35	0.23
106	MACHINE SHOP, WAREHOUSE	0.033	13	7.95	247	N.A	0.09	0.03	0.06	0.56	1.08	0.12	1.70
107	MACHINE SHOP, J. WAREHOUSE, 10, PLANTS, P	0.251	16	8.13	38	N.A	0.22	0.04	0.06	0.22	0.12	0.14	0.55
108	COMPONENT W. (TOILETS), GARAGE	0.003	13	7.74	678	N.A	0.13	0.03	0.04	0.37	0.08	0.30	2.48
109	COMPONENT WORKSHOP, PATIO	0.010	12	8.02	100	N.A	0.11	0.02	0.05	0.17	0.18	0.07	0.95
110	WORKSHOPS, CARPENTRY, INSTRUMENTS	0.311	14	7.91	46	N.A	1.22	0.04	0.16	0.24	0.11	0.09	1.70
111	TRAINING (WASHING PLACE)	0.003	15	8.38	7	N.A	0.50	0.01	0.08	0.14	0.02	0.07	0.18
112	HEAVY EQUIPMENT, PUMP, TRAINING **TAREA	0.043	14	7.88	406	N.A	0.70	0.21	0.07	0.24	0.30	0.32	6.80
113	INDUSTRIAL ENG. GENERAL OFFICE	0.065	14	8.13	11	N.A	0.05	0.01	0.08	0.18	0.02	0.21	0.31
114	POWER HOUSE, CONTRQL THSTIS	0.473	15	7.89	24	N.A	0.18	0.15	0.09	0.23	0.04	0.17	1.16
115	IONIC PLANT, POWER HOUSE	0.034	16	10.48	176	N.A	0.27	0.01	0.06	0.27	0.01	0.24	0.28
116	OXYGENE PLANT, CABLE (TOILETS)	0.070	15	9.97	99	N.A	22.13	0.04	0.05	0.31	0.31	0.11	2.44
117	OLD OXYGENE PLANT	0.373	19	7.64	129	N.A	0.33	0.09	0.38	0.29	0.56	0.08	7.72
129	OFFICE AND CONSTRUCTION WAREHOUSE	0.086	11	7.85	26	N.A	0.10	0.07	0.18	1.58	0.08	0.14	5.34
TOTAL:		1.853											

LMP, Value in any moment : mg/l (MEM)	100	5.5 - 10.5	2	1.0	5	2	1.0	6
LMP, Annual average value : mg/l (NEM)	50	5.5 - 10.5	1	0.5	2	1	0.5	3
LMP, Water type III : mg/l	50	5.0 - 9.0		0.20	1.00	0.50	0.10	25.00

ENCUENTRO DEL Reporte

TABLA N° 4.1.3 / 1

ESTABLISHED CODES FOR FINAL TREATMENT AND DISPOSAL OF WASTES

CODE	TREATMENT	CODE	FINAL DISPOSAL
A	Preliminary Maintenance	A	Public Sewage System
B	Biological Treatment	B	Percolation Wells
C	Physio-Chemical Treatment	C	Water Bodies (Ocean, rivers, lakes, etc. indicate name)
D	Biological and Physio-Chem Treatment	D	Mine Fill
E	Segregation	E	Scatter soil/land
F	Other (Specify)	F	Tailing Storage Facility
G	Without Treatment	G	Other (Specify)

To utilize the code in agreement with the treatment type and/or final disposal employed.

Source: EVAP - March 1993

TABLA Nº 4.1.3 / 2
SOLID RESIDUES GENERATED AT COPPER, LEAD AND REFINERIES SMELTER

COPPER AND LEAD SMELTER

No./Nombre	Quant. (t/d)		pH	T. °C	Dens. g/cc	Chemical Composition: % (g/g)						Treat. Cod Cap	Final Disp. Code	Observations
	Real	Est.				Cu	Pb	Zn	Ag	Fe	As	Sb	Qd	
1. Copper reverberation furnace slags	602				3.79	0.64	1.30	2.90	17	*45.6	0.46	0.78		G
2. Lead over slag	366				3.83	0.27	1.94	10.50	13	*34.6	0.18	0.02		G
3. Arsenic Trioxide	11.7				n.d.	0.45	0.45	0.49	54	1.5	81.51	0.88		G
4. Zinc leach. residues	71				n.d.	0.53	4.24	22.10	246	34.5	0.33	0.08	0.12	G
5. Talio residues	0.23				n.d.	0.15		27.00		1.5	2.56	1.03	4.35	G
6. Industrial Garbage	n.d.				n.d.									G
7. Manganese Bioxide	n.d.				n.d.	0.05	14.00	0.50	635	0.26	0.02	0.01	MnO ₂ 69.55	G

COPPER AND LEAD REFINERY

No./Nombre	Quant. (t/d)		pH	T. °C	Dens. g/cc	Chemical Composition: %				Treat. Cod Cap	Final Disp. Code	Observations
	Real	Est.				CaSO ₄	H ₂ SiF ₆	HF				
1. Sulfato de Calcio	4.8			30	2.9	85.2	9.4	0.97		G	C	Pulpa

Fuente: Auditoría Ambiental de Emisiones y Vertimientos - junio 1996

TABLA N° 4.1.3 / 2A

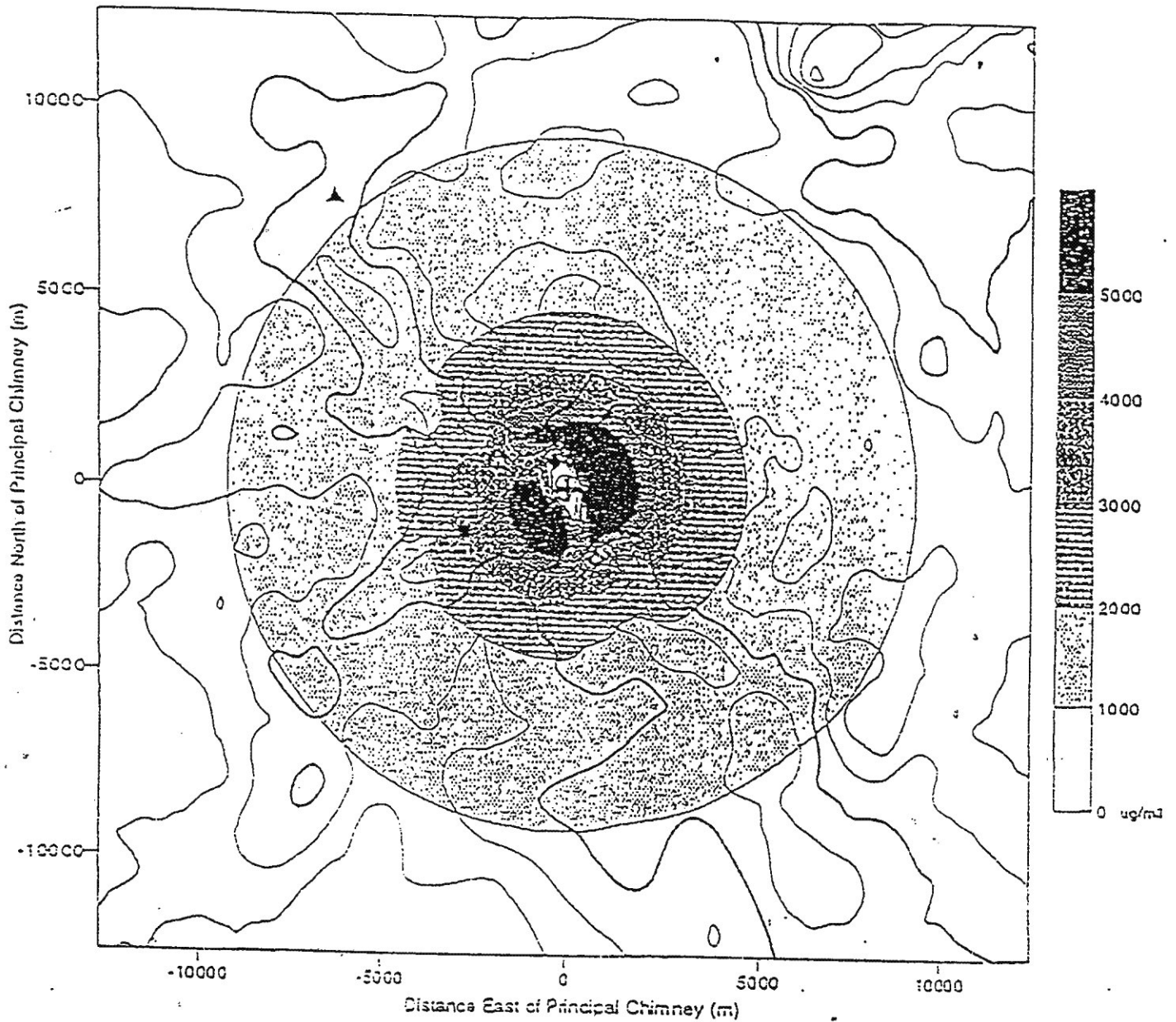
SOLID RESIDUES GRANULOMETRIC GENERATED IN COPPER AND LEAD FOUNDATION

No./Name	Granulometría Malla Tyler, %									
	+8	14	20	48	65	80	100	150	200	-250
1. Copper reverberation furnace slag	2.30	12.00	34.70	44.70	3.00	1.10	1.30	0.20	0.30	0.40
2. Lead oven slag	0.80	2.50	14.00	74.50	1.20	3.10	2.60	0.70	0.60	0.00
No./Name	Abertura de Malla µm									
	1850	425	300	212	150	106	75	45	38	38
3. Arsenic Trioxide	1.79	0.51	0.20	0.18	0.11	0.12	0.12	0.19	0.02	96.76

CODES ESTABLISHED FOR FINAL TREATMENT AND DISPOSITION OF RESIDUES

CODE	TREATMENT	CODE	FINAL DISPOSAL
A	Preliminar Maintenance	A	Landfill
B	Biological treatment	B	Landfill
C	Physical-chemical treatment	C	Waters (Sea, rivers, lakes, etc., indicate names)
D	Physical-chemical treatment	D	Mine filling
E	Segregation	E	Scattered in soil.
F	Other (indicate)	F	Leaching pad
G	Without treatment	G	Other (indicate)

Use code according with type of treatment and/or final disposition used.
Source EVAP mach 1995



- ▲ Casaraca Station
- ◆ Sindicato de Obreros
- Cuzhuurupampa Station
- ⊕ Hotel Inca Station
- ◇ Huanchan Station
- ⊕ Principal Smelter Chimney

Predicted Maximum 1-Hour SO₂ Concentrations: Existing Chimney	TA-6 North 	Figure No. 10	
Cantomin La Oroya Smelter, Peru	Project No. ES-352F-08	Scale: as shown	
		Date: Aug 14, 1995	

5. MITIGATION PLANS

5.1 Introduction

The Plan for Mitigation is oriented towards the physical implementation of environmental control projects. The purpose of this plan is to reduce the concentration of contaminants resulting from metallurgical operations and discharges to the environment to comply with the maximum permissible limits legally established by the Ministry of Energy and Mines.

The Mitigation Plan contained in the Environmental Impact Program (EIP) for La Oroya Metallurgic Complex includes an investment schedule that allows the complex to comply with the regulations for metallurgical operations within a 10 year period. The Program for Environmental Adjustment and Management (PAMA) considers a sum total US\$ 129.12 million. (Table 5.1.1).

It is necessary to mention that the implementation of the mitigation measures is dependent upon additional investments to change the existing technology to accomodate the proposed mitigation plan. This additional investment is in the neighborhood of US\$ 141,04 million. The total investment sum, therefore, is US\$ 270,16 million, and includes technology changes and PAMA implementation for La Oroya Metallurgic Complex. (Table 5.1.2).

The Off Gas and Dust Collection Prefeasibility Study of the Environmental Aspects of Copper, Zinc and Lead Smelter of La Oroya by Kilborn-SNC-Lavalin Europe Consultant Firm, estimates a US\$ 269,00 million investment, which confirms the aforementioned amount (Table 5.1.3).

5.2 Projects Implemented to Control and Reduce Environmental Impacts

The most relevant mitigation projects are as follows:

- 1939: Initiate operation of the Sulfuric Acid Plant to capture gas from the copper roasters.
- 1941: Install the electrostatic precipitators for dust recovery (Central Cottrell System).
- 1960: Complete the ventilation system for the Agglomeration/Sintering Plant.
- 1964: Improve the ventilation in the slag furnaces, ducts and lead wells.
- 1966: Improve the ventilation in the Agglomeration\Sintering Plant by installing a scrubber.
- 1967: Begin operations in the 200 tpd. New Sulfuric Acid Plant.
- 1969: Begin operations at the Arsenic Plant's new Heating Cottrell. Begin Phase I of the Dust Treatment Plant.
- 1970: Install a continuous slag extraction system in Lead Furnace No.2.
- 1978: Install a new humid electrostatic precipitator at the Sulfuric Acid Plant.
- 1983: Begin operation of the new Agglomeration\Sintering Plant. Capacity : 810 t/d. This single up draft machine replaces 11 machines (5 up draft and 6 down draft) with a US\$ 60 million investment.
- 1990: Initiate metallurgic tests to change the metallurgic index in the Copper Smelter. In December 1990 the tests are optimized.
- 1991: Modify Lead Furnace N° 3. The intermittent casting was changed to continuous casting. The previous design corresponding to the Arents siphon was changed to a Roy Tapper Bin.

1992: Recirculate sludge from the thickening tank (from the Agglomeration\Sintering Plant scrubbers), removing the Oliver filter, contributing to the reduction of contaminants to the Mantaro River.

In March, civil works in the New LINDE Oxygen Plant were started with a US\$ 24 million investment.

In October, the Bag House (60 bags) was installed to improve the work environment in the sifting and grinding unit.

1993: Install the new ventilation system (SVEL) for FBR zinc roasters (January). The ventilation system for copper tin ash unload was also installed.

1994: Conclude the electromechanic and instrumental assembly of the Oxy-Fuel Plant on January 17th. This project was executed with a US\$2 million investment by technical personnel from Centromin according to the advice of Canadian enterprises: INCO, EINCO and SNC LAVALIN.

The achievements from the changes in the metallurgic index and the Oxy-Fuel Project between 1989 and 1995 were :

- Reduction of 100,193t pyrites equivalent to 82,158t of SO₂ and to 127,757t of H₂SO₄ (indices reduced from 1,9899 to 0,7239 t of Cu pyrites/t between 1989 and 1995).

- Reduction of 124 800t of slags (indices reduced from 5,52 to 3,13t of Cu slags/t between 1989 and 1995).

- Reduction of 30,220 t of residual oil No.6 (indices reduced from 0,935 to 0,36 t oil/t of Cu between 1989 and 1995).

- Reduction of gas volume from 72,600 to 50,220 Nm³/h (theoretically 19,000 Nm³/h), improving ambient air quality.

- Compacted smelter by deactivationg reverberation Furnace N° 1 and 2 buckets and 6 copper roasters.

- Dismantle copper reverberation furnace N° 1 and buckets.

- Dismantle the old Agglomeration\Sintering Plant.

1995: Reduce the number of roasting units from 18 to 12 (8 for Cu, 2 for Pb, 1 for As and 1 for Sb), improving gas and dust collection.

1996: Initiate the dismantling of 6 roasters. This task will conclude in the first quarter of 1997.

On June 7th, the Lead Refinery started operations. Begin the project to recover fluorsiliceous acid, through filtration and recycling of lead anodic sludge and solutions (LAROX Filter). The filtered acid solutions are recycled to the electrolytic cells that close the circuit eliminating the effluent emissions (from this plant) to the Yauli River.

- Install oxygen pipes in the Agglomeration\Sintering and Residue Plants. The use of oxygen will allow: an increase in production capacity of both plants; a reduction in dust and gas emissions; a reduction in fuel consumption; and an elimination of Sodium Nitrate consumption, which generates nitrous gases.

- Recirculation of some liquid effluents, like a portion of those from the N° 1 canal, the wire plant and others.

- A pilot septic tank was built and used to treat sewage coming from sanitary services and lavatories.

- Forest the banks of the Mantaro River, as well as the entrance of and areas around the smelter.

- Improve the Copper and Lead slags transportation system by cable rail, reducing spills to the Mantaro River.

Table 5.2/1 shows the investment amounts which were budgeted and approved by the Board of Directors in recent years for La Oroya Metallurgic Complex. This table indicates that totals approximatingUS\$ 8 to 15 million per year have been spent without changing the financial and economic results of the metallurgical operations.

TABLE 6.1.1
ENVIRONMENTAL MANAGEMENT PROGRAM (PAMA) INVESTMENT SCHEDULE OF ADJUSTMENT
LA OROYA METALLURGICAL COMPLEX 1987 - 2006

REMEDIATION AND ADJUSTMENT PROJECTS - (Thousand US\$)

Current capacity production levels , 70 000 t/y refined Cu, 100 000 t/y refined Pb and 70 000 t/y refined Zn.

ITEM	PROJECTS	PERIOD: YEAR											Total Effluent	Total Item
		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Sub Total		
Gas	Sulfuric acid plant from Circ. Cu							20 000	21 200			41 200		
	Sulfuric acid plant from Circ. Pb and Circ. Zn									22 500		22 500		
Liquids	Industrial liquid effluents	575	1 000	1 500							26 300	26 300	90 000	
	Slag Management (New syst. (Gran. water)	850	3 362	2 288								3 075	3 075	
Solids	Cu/Pb Slags- Deposits											6 500		
	- New						2 500							
	- Old	750	1 000	1 250	1 250	1 000						2 500		
	Arsenic Trioxide (As ₂ O ₃) - Deposits											5 250		
	- New			1 000	1 000							2 000		
Emissions	- Old (Vado y Malpaso)	1 625	2 000	2 000	1 600	1 475						8 700		
	Zinc Ferrites	500	500	1 200	1 200	1 200	1 000					5 600	30 550	123 625
Public Health	Revegetation of areas affected by smoke	200							554	755	491	2 000	2 000	2 000
	Dewatering/garbage			200	1 100	1 100	1 100					3 500	3 500	3 500
TOTAL		4 500	7 862	9 438	6 150	4 775	4 600	20 000	21 754	23 255	26 791	129 125	129 125	129 125

Closure Plan : US\$ 24 million not included in the chart

remanen1.xls

TABLE 5.1.2
LA OROYA METALLURGICAL COMPLEX
'ENVIRONMENTAL MANAGEMENT PROGRAM (PAMA) INVESTMENT SCHEDULE OF ADJUSTMENT
(Miles de US \$)

Current Capacity Level: 70 000 t/y of refined Cu, 100 000 t/y of refined Pb and 70 000 t/y of refined Zn.

TECH. CHANG. AND ENV. ADJ.	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	TOTAL
COPPER CIRCUIT	0	776	37 700	6 000							44 476
LEAD CIRCUIT	0	1 464	0	0	0	0	40 000	15 000			56 464
ZINC CIRCUIT	0	20 000	20 000			0	0				40 000
Sub total	0	22 240	57 700	6 000	0	0	40 000	15 000	0	0	140 940
MAINTENANCE	0		0								0
Sub total	0	0	0	0	0	0	0	0	0	0	0
ENVIRONMENTAL CONTROL EQUIPMENT	0	0	0	0	0						0
Sub total	0	0	0	0	0						0
TOTAL TECH.CHANG. ENV.ADE	0	22 240	57 700	6 000	0	0	40 000	15 000	0	0	140 940

P. A. M. A.											
Process gas:											
Acid Plant- Cu smelter							41 200				41 200
Acid Plant -Pb/Zn smelter									48 800		48 800
Process liquids:											
Industrial liquid effluent	575	1 000	1 500								3 075
Process solids:											
New Cu/Pb slag management system	850	3 362	2 288								6 500
New Cu y Pb slag deposit						2 500					2 500
Closure of Slag deposit	750	1 000	1 250	1 250	1 000						5 250
New As Trioxide deposit			1 000	1 000							2 000
Closure of As Trioxide Deposit	1 625	2 000	2 000	1 600	1 475						8 700
Closure of Ferrite deposit	500	500	1 200	1 200	1 200	1 000					5 600
Emissions Air Quality:											
Revegetation of areas affected by smoke	200							554	755	491	2 000
Public Health:											
Dewatering/ Garbage			200	1 100	1 100	1 100					3 500
TOTAL P. A. M. A.	4 500	7 862	9 438	6 150	4 775	4 600	41 200	554	49 555	491	129 125
TOTAL	4 500	30 102	67 138	12 150	4 775	4 600	81 200	15 554	49 555	491	270 065

OROWE1.XLS

Table 5.1.3
INVESTMENTS: TECHNOLOGY CHANGE FOR THE ENVIRONMENTAL
ADJUSTMENT AND MANAGEMENT PROGRAM (PAMA)

Period 1997-2006

	Thousands US\$
Change of Technology for Environmental Adjustment Investment	141 040
Adjustment Program and Environmental Management Investment	129 125
Total	270 165

Note : Investments for the operative continuity and improvement of processes are not considered in the US\$ 270,165 million amount.

PREFEASIBILITY STUDY OF THE ENVIRONMENT ASPECTS OF COPPER, ZINC
LEAD
Contract No. SLC079

CIRCUIT	CASE	US\$ MILLION
COPPER	c) 70 000 t/year Cu using CMT for clean concentrates with new dirty concentrate roaster.	125,0
LEAD	f) 100 000 - 110 000 tpy Pb new technology - Install with AUSMELT System	119,0
ZINC	d) 70 000 tpy Zn old F.B.R. replaced with new T.L.R. and replace existing. Sulfuric acid plant to give 99.5% recovery of SO ₂ to acid.	51,8
TOTAL		295,8

NOTE : Each case includes a new acid plant per Circuit. If we consider that the production capacities are the same and that only 2 new sulfuric acid plants are required for a total production of 505 000t/year, instead of 3 acid plants, then the total amount according to Kilborn-SNC-Lavin Europe would be : **US\$ 269,00 million** (295,8 - 26,8 one acid plant value), an amount similar to that estimated by GOME-Centromín Perú S.A., or **US\$ 270,16 million**.

TABLE NO. 5.2/1
ESTIMATED AND APPROVED BUDGET FOR THE OPERATION
'CONTINUITY PROCESS AND PAMA'

La Oroya Metallurgical Complex

DETAIL		YEAR	
		1995	1996
OPERATION CONTINUITY AND PROCESS IMPROVEMENT PROJECT	with PECET	6 448	6 831
	without PECET	355	8 279
PAMA		1 141	860
TOTAL US\$ (THOUSANDS)		7 944	15 970
			13 510

PECET: INVESTMENT PROJECTS WITH ESTABILIDAD TRIBUTARIA

5.3 MITIGATION PROJECTS - INVESTMENT BUDGET

No.	Project Name	Thousands US\$
1	New sulfuric acid plants	90 000,00
2	Elimination of fugitive gas from the Coke plant	*
3	Use of carbonated oxygen in the Anodic Residues Plant	*
4	Smoke Affected Areas	2 000,00
5	Mother Water Treatment -Copper Refinery	500,00
6	Smelter Cooling Water Re circulating System	*
7	Management and disposal of the acid solutions from the dust process - Silver Refinery	*
8	Smelter industrial liquids treatment plant- La Oroya	2 500,00
9	Concrete Retention Wall for lead mud at Zileret Plant-Zinc Division	5,00
10	Re circulation of water used in the granulation of speiss process - Lead Smelter	55,00
11	New Washing Anode System - Zinc Refinery	15,00
12	Copper and Lead Slag Management and disposal	6 500,00
13	Copper and Lead Deposits Closure Abandonment	7 750,00
14	Arsenic Trioxide Deposit, Malpaso deposit closure, Vado deposit closure and new deposit in Vado.	10 700,00
15	Zinc Ferrites	5 600,00
16	Sewage water treatment and garbage disposal at La Oroya	3 500,00
	TOTAL	129,125,00

Gas and Particulate Matter Emissions

Project No.1

PROJECT	NEW SULFURIC ACID PLANTS
Objectives	Fix the SO ₂ of emissions due to the metallurgical operations and reach the maximum permissible level.
Impact	Air, soil, and water contamination which affect the physical, biological and socio economic environment due to the emissions of 899 t/day of SO ₂ and 8,9 t/d of dust.
Mitigation	Two sulfuric acid plants will be installed: Cu smelter acid plant of 235 000t/year Pb/ Zn circuit of 270 000 t/year smelter acid plant Mitigation results: Fix as minimum 83 % of SO ₂ generated. Of the 515t/d (188 261 t/year) of sulfur input to the system, approximately 110t/d of SO ₂ will be emitted to the environment Daily concentration of the SO ₂ will be below 572 ug/m ³ and the dust emissions will be below 100 mg/m ³ as regulated by R.M. N° 315-96-EM/VMM
Execution Schedule	Cu Smelter Acid Plant - 2003 Pb Smelter Acid Plant / Zinc circuit - 2 005
Investment Amount	Cu Smelter Acid Plant US\$41,20 millions Pb Smelter Acid Plant / US\$500 000
Sources	Kilborn SNC Lavalin Europe, Brrok Hunt, E&MJ January 1996, Revista Minería chilena july 1995

Project No.2

PROJECT	ELIMINATION OF FUGITIVE GAS FROM THE COQUE PLANT
Objectives	Eliminate the fugitive emissions to the environment, during loading and unloading from coke furnaces.
Impact	Atmospheric contamination
Mitigation	Lengthen the coke cycle from 18 h to 24 h and buy metallurgic coke from aboard to compensate for the reduction in internal coke production
Investment Amount	Not included in PAMA, considered as "operation continuity and process improvement" Table 5.2/1
Sources	GOME -C.M.P. S.A.

Project No.3

PROJECT	USE OF CARBONATED OXYGEN IN THE ANODIC RESIDUES PLANT
Objectives	Reduce the use of residual petroleum No. 6 used for combustion and eliminate the use of sodium nitrate during the last stage of the Cupelation process
Impact	Contamination of environmental by nitric gases
Mitigation	Use of carbonated oxygen in the Cupelation process
Execution Schedule	First semester 1997
Investment Amount	US\$391 000 Not included at PAMA, considered as "operation continuity and process improvement" Table 5.2/1
Sources	GOME- C.M.P. S.A

Project No.4

PROJECT	AREAS AFFECTED BY SMOKE
Objectives	Determine the area of impact, establish the current status and plan the actions to be taken to restore the damaged areas.
Impact	Area affected = 3,829 ha
Mitigation	Recover for agriculture 1167 ha.
Execution Schedule	Year 1997 US\$200 000 From 2 000 to 2002 US\$ 1,80 millions
Investment Amount	US\$2,00 million
Sources	DIR. DE ASUNTOS AMBIENTALES - C.M.P. S.A

Project No.5

PROJECT	MOTHER WATER TREATMENT - COPPER REFINERY
Objectives	Treat the ferrous acidic solutions from copper refinery that are discharged to Yauli River and obtain a neutralized solution suitable for recycling and/or discharge prior to Nickel recovery. Purify the Raff solution to obtain a final effluent with contents of impurities under the maximum permissible limits set by the M.E.M.
Impact	Contamination of Yauli River
Mitigation	Pre-dilution process, ionic interchange/electrowining (SX -EW), neutralization.
Execution Program	First semester 1997
Investment Amount	US\$500 000
Sources	DIV de INV. METALURGICAS- C.M.P.S.A.

Project No.6

PROJECT	SMELTER COOLING WATER RE CIRCULATING SYSTEM
Objectives	Separate cooling water from contamination sources of the smelter environment
Impact	Increase of contaminated water volume.
Mitigation	Canalization and re circulation of water to power house
Execution Schedule	Year 1997
Investment Amount	US\$41 350 Not included in PAMA, considered as "operation continuity and process improvement" Table 5.2/1
Sources	ENGINEERING DESIGNS - C.M.P.S.A.

Project No.7

PROJECT	MANAGEMENT AND DISPOSAL OF ACID SOLUTIONS FROM PARTITION PROCESS - SILVER REFINERY
Objectives	Avoid Mantaro River contamination, by discharge of acid solutions resulting from the gold partition process at the silver refinery
Impact	Mantaro River contamination because of discharge of acid solutions.
Mitigation	Partial replacement of sulfuric acid use in the zinc circuit with high acid solutions from the silver refinery.
Execution Schedule	Completion by second semester 1996
Investment Amount	Not included in PAMA, considered as "operation continuity and process improvement" Table 5.2/1
Sources	ENGINEERING DESIGNS - C.M.P.S.A.

Project No.8

PROJECT	SMELTER INDUSTRIAL LIQUID TREATMENT PLANT - LA OROYA																											
Objectives	Obtain effluent toward Mantaro River with the elemental contents according to maximum permissible levels (R.M No. 011-96) for metallurgical activity.																											
Impact	Mantaro River contamination by metallic elements and acid solutions																											
Mitigation	Effluent treatment plant implementation, with treatment capacity of 9m³/min. incorporating a neutralization process and precipitation with flocculant. Mitigation results: Final effluent discharged to Mantaro River with the following concentrations: <table><tr><th>Component</th><th>conc. (mg/l)</th><th>Max. perm. level (mg/l) RMN No. 11-96</th></tr><tr><td>As</td><td><0,01</td><td>1,00</td></tr><tr><td>Cd</td><td><0,01</td><td></td></tr><tr><td>Fe</td><td><0,02</td><td>2,00</td></tr><tr><td>Pb</td><td><0,01</td><td>0,40</td></tr><tr><td>Mn</td><td>0,44</td><td></td></tr><tr><td>Cu</td><td><0,01</td><td>1,00</td></tr><tr><td>Zn</td><td>0,06</td><td>3,00</td></tr><tr><td>Total Sol. (kg/h)</td><td>7,19</td><td>50,00</td></tr></table>	Component	conc. (mg/l)	Max. perm. level (mg/l) RMN No. 11-96	As	<0,01	1,00	Cd	<0,01		Fe	<0,02	2,00	Pb	<0,01	0,40	Mn	0,44		Cu	<0,01	1,00	Zn	0,06	3,00	Total Sol. (kg/h)	7,19	50,00
Component	conc. (mg/l)	Max. perm. level (mg/l) RMN No. 11-96																										
As	<0,01	1,00																										
Cd	<0,01																											
Fe	<0,02	2,00																										
Pb	<0,01	0,40																										
Mn	0,44																											
Cu	<0,01	1,00																										
Zn	0,06	3,00																										
Total Sol. (kg/h)	7,19	50,00																										
Execution Schedule	Years 1998 - 2000																											
Investment Amount	US\$2,50 Million																											
Sources	Consular: ECOLAB S.R.L.																											

Project No.9

PROJECT	CONCRETE RETENTION WALL FOR LEAD MUD RESIDUES AT ZILERET PLANT - ZINC DIVISION
Objectives	Install a concrete wall to store the lead mud discharged from the hydro Zileret metallurgical plant
Impact	Contamination of parallel channel with acid solutions and metallic elements
Mitigation	Recover and recirculate the acid solutions to the acid leaching circuit at the hydrometallurgic unit.
Execution Schedule	First semester 1997
Investment Amount	US\$5 000
Sources	GOME - C.M.P.S.A.

Project No.10

PROJECT	RE CIRCULATION OF WATER USED IN THE SPEISS GRANULATION PROCESS LEAD SMELTER
Objectives	Eliminate Mantaro River contamination due to contaminants and suspended solids from speiss granulation waters.
Impact	Mantaro River contamination
Mitigation	Put the speiss granulation waters in a closed circuit
Execution Schedule	First semester 1997
Investment Amount	US\$55 000
Sources	GOME - C.M.P.S.A.

Project No.11

PROJECT	AUTOMATIC WASHING ANODE SYSTEM - ZINC REFINERY
Objectives	Eliminate Mantaro River contamination
Impact	Mantaro River contamination with solids particles and acid
Mitigation	Optimize water consumption through automization of anode washing system Residual volume will be treated in the treatment plant for industrial liquid effluents.
Execution Schedule	Year 1997
Investment Amount	US\$15 000
Sources	GOME C.M.P.S.A.

Project No.12

PROJECT	COPPER AND LEAD SLAG MANAGEMENT AND DISPOSAL
Objectives	Eliminate suspended solids contamination to the Mantaro River from en granulation water derived from copper and lead slags.
Impact	Suspended solids and / or contaminating ions produced at the moment of granulation and slag transportation are discharged to the Mantaro River
Mitigation	Installation of two IBA rotating dewaterers and a new granulation system - new recirculation and transport of water of granulation. With this implementation the discharge of waters of granulation will be eliminated, and will avoid the loss of slags to the Mantaro River.
Execution Schedule	Year 1997 to 1999. Utilize equipment to separate solid/liquid, acquisition of additional equipment to install the circulation and separation system, new transport system.
Investment Amount	Year 1997 US\$850 000 Year 1998 US\$3,36 Million Year 1999 US\$2,29 Million Total US\$6,50 Million
Sources	Consultant: RESCAN PERÚ S.A.

Project No.13

PROJECT	CLOSURE COPPER AND LEAD DEPOSIT ABANDONMENT
Objectives	Evaluate the stability and remaining storage capacity of the Huanchan deposit, and establish the required work to mitigate or eliminate the environmental impacts.
Impact	Static and dynamic stability of deposits Particles and chemical dissolution from runoff and sewage water.
Mitigation	Infrastructure work; diversion canals, concrete retention wall and capping work. Implementation of storage plan which considers the height and slopes of the deposit Recover of the deposit area and construct a new deposit construction.
Execution Schedule	Year 1997 to 2 002.
Investment Amount	US\$7,75 Million
Sources	Consultant: RESCAN PERÚ S.A.

Project No.14

PROJECT	ARSENIC TRIOXIDE DEPOSIT, MALPASO DEPOSIT ABANDONMENT, VADO DEPOSIT CLOSURE, AND NEW DEPOSIT IN VADO
Objectives	Mitigate the environmental contamination from the Malpaso and Vado arsenic trioxide deposits, prepare deposits for closure and construct a new using the best available technology according to environmental control laws.
Impact	Current Malpaso and Vado deposits ,which were built under the standards of the time, generate air and water pollution due to winds erosion and effluent discharges to the Mantaro River by water seepage during rainy season
Mitigation	Contain and cap the deposits, and install a leach detection system designed to control the release of environmental contaminants and control exposure to public resources. Old deposit area will assume its natural appearance, or that of its surroundings. Air quality as well as Mantaro River water will comply with maximum permissible levels by the MEM.
Execution Schedule	Year 1997 to 2 001
Investment Amount	US\$10,70 Million
Sources	Consultant: A.D.I. INTERNATIONAL INC

Project No.15

PROJECT		ZINC FERRITES																																					
This project refers to the zinc ferrites stored at Huanchán, 3 km from the La Oroya Metallurgical Complex. The amount of waste stored is 1 242 739 t valued approximately at US\$230 million due to its metal contents of Zn, Ag, Cd, Cu.																																							
Scenario No.1		Enlargement of deposits three and four, technical closure of four deposits																																					
Scenario No.2		Technical and economical feasibility of zinc ferrites processing.																																					
Scenario No.1																																							
Objective	Technical closure of deposits containing zinc ferrites																																						
Impacto	Contamination of Mantaro River with discharge of diluted Zn, Cd, Fe, and sulphate solutions from the deposits. Zinc Ferrites (Fe ₂ O ₃ ZnO) are comprised of insoluble iron that contain other soluble metal which are transported from the zinc refinery as a sludge. Atmospheric contamination via wind blow dust. Mantaro river contamination risk due to slope failure during a seismic event.																																						
Mitigation	This will be conducted in stages: 1.- Slope reinforcement of four deposits 2.- Infrastructure work, diversion canals; retention wall and capping operations 3.- Channelization of effluent discharged toward the industrial effluent treatment plant. 4.- Impermeablize and eliminate sulphate leaching solution and particulate matter. Mitigation results : Eliminate contingency risk during a seismic event, and make effluents discharged to Mantaro River comply with the maximum permissible levels. <table><tr><td>Component.</td><td>conc.(mg/l)</td><td>Max. level permitted (mg/l)</td><td>R.S.N°11-96</td></tr><tr><td>As</td><td>< 0,01</td><td>1,00</td><td></td></tr><tr><td>Cd</td><td>< 0,01</td><td></td><td></td></tr><tr><td>Fe</td><td>< 0,02</td><td>2,00</td><td></td></tr><tr><td>Pb</td><td>< 0,01</td><td>0,40</td><td></td></tr><tr><td>Mn</td><td>0,44</td><td></td><td></td></tr><tr><td>Cu</td><td>< 0,01</td><td>1,00</td><td></td></tr><tr><td>Zn</td><td>0,06</td><td>3,00</td><td></td></tr><tr><td>Solid. tot. (kg/h)</td><td>7,19</td><td>50,00</td><td></td></tr></table>			Component.	conc.(mg/l)	Max. level permitted (mg/l)	R.S.N°11-96	As	< 0,01	1,00		Cd	< 0,01			Fe	< 0,02	2,00		Pb	< 0,01	0,40		Mn	0,44			Cu	< 0,01	1,00		Zn	0,06	3,00		Solid. tot. (kg/h)	7,19	50,00	
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Execution Schedule	Years 1997 to 2002																																						
Investment Amount	<table><tr><td>Year 1997</td><td>US\$850 000</td></tr><tr><td>Year 1998</td><td>US\$3,36 Million</td></tr><tr><td>Year 1999</td><td>US\$2,29 Millions</td></tr><tr><td>Total</td><td>US\$6,50 Millions</td></tr></table>			Year 1997	US\$850 000	Year 1998	US\$3,36 Million	Year 1999	US\$2,29 Millions	Total	US\$6,50 Millions																												
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Total	US\$6,50 Millions																																						
Source	Consultora: RESCAN PERU S.A.; ECOLAB S.R.L.																																						

Scio N° 2

5.4.1 PROJECT No 1

NEW SULFURIC ACID PLANTS

1. OBJECTIVES:

This project's main objectives are to mitigate adverse effects of SO₂ and particulates contained in the gas emissions derived from La Oroya Metallurgic Complex operations and to comply with emission regulations and air quality guidelines established by M.E.M in accordance with attachments 1 and 3 of Ministerial Resolution No 315-96 EM/DMM.

2. IMPACT ASSESSMENT

2.1 Emissions through Chimneys

Gases and dust produced in the smelting circuits are emitted out to the atmosphere through the main 167,5 m height chimney of 95 secondary chimneys of variable height and some spots of uncontrolled emissions. The volume of gas and discharged and metallic contents of the emissions for 1995 were as follows:

By volume	Nm ³ /seg
Main stack	603,59
Iron stack	54,11

By suspended solids	mg/Nm ³
Main stack	161,05
Iron stack	67,58

By metal content mg/Nm ³				
	As	Cd	Pb	SO ₂
Main stack	26,16	2,22	43,14	15 622,89
Iron stack	11,53	n.d.	5,42	n.d.

The largest gas (816 t of SO₂/day) and metallic particulate (8.4 t/day) emissions come from the main chimney. In 1995 only 11.50% of sulfur entering the process was fixed (7.20% as sulfuric acid and 4.30% as slags, liquid effluents, ferrites, etc.).

2.2 Air Quality

The assessment of atmospheric air quality at La Oroya Metallurgic Complex is conducted through continuous monitoring of SO₂ and suspended particles at 5 stations, as described in Chapters 4 and 7.

2.3 Sulfur Balance

The sulfur balance at La Oroya Metallurgic Complex for 1995 was as follows:

Inflow	ton of S	%
Copper concentrates	78 080,1	41,08
Lead concentrates	43 282,5	22,77
Zinc concentrates	51 011,7	26,84
Copper smelters	9 441,4	4,97
Lead smelters	6 934,0	3,65
Others (*)	1 320,0	0,69
Total input	190 069,7	100,00

Outflow (fixed)	ton of S	% (related to inflow)
Sulfuric Acid	13 681,7	7,20
Copper slag	4 239,3	2,23
Lead slag	1 427,6	0,755
Zn/Ag Concentrates	652,0	0,34
Liquid effluents	551,1	0,20
Zinc Ferrites	786,5	0,41
Main stack dusts	300,2	0,16
Others (**)	224,7	0,12
Total output (fixed)	21 863,2	11,50

Lost through the chimney and fugitive emissions (related to input)	168 206,6	88,50
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Diagram No 1 shows the management of gas and dust and sampling stations inside the smelter.

3. MITIGATION ALTERNATIVES

3.1 Process Selection

To mitigate the effect of SO₂ emissions we have evaluated alternative processes for different fixations of sulfur prior to being emitted through the main chimney (gypsum, ammonium sulfate, liquid SO₂ and elementary sulfur production).

Sulfuric Acid

The production of sulfuric acid was selected as the most viable alternative for the following reasons:

It offers a well-known, disseminated, and tested conventional technology.

There is a potential demand for sulfuric acid in the short and medium terms within the Southamerican market.

The project incorporates an important technological change in operations and processes at the La Oroya Metallurgic Complex, aimed at achieving greater global competitiveness for the Company

Approximately 90% of sulfur production, in all its forms, is fixed as sulfuric acid or is ultimately turned into sulfuric acid, 60% of which is used for the fertilizer industry.

A great number of modern industrial products use sulfuric acid during some stage of their manufacturing. Sulfuric acid is a multiuse product and, due to its low cost and its use as a drying, acidifying, hydrolyzing, polymerizing, neutralizing, dehydrating, oxidizing, absorbing, leaching, or catalyzing agent and as a reagent in the petro-chemical industry and inorganic chemistry.

Income derived from sulfuric acid sales positively influences the net cash-flow of the smelters and occasionally could partially compensate for the fluctuations in copper, lead and zinc prices.

Alternative Products to Sulfuric Acid

a) Gypsum

The process requires gases with low SO₂ concentration (2 to 3%). This would require the dilution of high concentration gases produced by applying new smelting technologies. This plan would also produce a large amount of Gypsum that has little or no contribution to smelting income due to present market price limitations.

b) Ammonium Sulfate (Marine process)

Technically, it is possible to produce this nitrogenous fertilizing material, which is in great demand in the agricultural regions of Mantaro valley such as Tarma and Chanchamayo near La Oroya. However, there are no large scale ammonia producing plants near this area, therefore, it would be necessary to bring import ammonia from far places which would increase the product price.

c) Elementary Sulfur

This process requires gases with SO₂ concentrations between 75 and 80%, oxygen use, and large amounts of coke or hydrocarbonated fuels. Also, elementary sulfur has a high energy cost and since it is easily flammable, it demands special security measures to avoid fires.

d) Liquid SO₂

This project also requires gases with high concentrations of SO₂ (over 60%). Its transportation in pressurized tanks is expensive and the market for liquid SO₂ is very limited.

3.2 Market for Sulfuric Acid:

Consumption in Centromin Peru S.A.

Internal consumption of sulfuric acid is 16,100 t/year.

Local Market

Centromin Peru S.A. supplies the local market with 20,000 t/year of H₂ SO₄ of 98.5% and 6,800 t/year of oil with 24% of free SO₃.

Potential Market in Chile

The potential market for sulfuric acid produced by La Oroya Metallurgic Complex is also focused on mining activity in northern Chile, due both to its location and great demand. The increase in demand is derived through future exploitation of large high value oxidized mineral deposits that will be leached with acid and linked to the SX-EW process which is of low operational cost and is easy to handle and control environmentally.

Sulfuric acid market analyses conducted by the Chilean Commission of Copper (Comisión Chilena del Cobre - Cochilco) in 1997, shows that the Chilean market would have an annual deficit of 1,200,000 t of acid and we estimate that by about 1998 - 2,000, annual demand will reach 4,300,000 t, considering the implementation of important leaching projects such as : Zaldívar, El Abra, Rodomiro Tomic, Collahuasi (an acid demand of 200,000 t/year), Tesoro and Leonor (an acid demand of 100,000 t/year), Lomas y Bayas (an acid demand of 100,000 t/year), Damiana at Div. El Salvador Division (an acid demand of 275,000 t/year), Vanadio and Andacollo (an acid demand of 140,000 t/year), among others (Minera Chile magazine No 169, July 1995).

Potential Market in Peru

Government policy in favour of industry and privatization causes us to anticipate a medium term development of the fertilizer industry after privatization of phosphoric rock deposits in Bayovar. This industry will become a new market for sulfuric acid.

In addition, we estimate that within the next 10 years in Peru numerous copper deposits will be developed using sulfuric acid during their production, among these we have: Toromocho, Antamina, La Granja, Cyprus, Cerro Verde and Magma Copper Tintaya. The country will increase its reserves of oxidized Cu minerals from 14 billion pounds in 1996 to 24 billion of pounds in 2000 (in the spanish document it states 14B de libras, we are assuming 14B means 14 billion), thus becoming a large acid consumer (E&MJ January 1996: "Magma puts the pedal to the metal").

3.3 About the Project

3.3.1 Introduction

The capacity of sulfuric acid plants is estimated based on an annual production of refined 70,000 t/Cu, 100,000 t/Pb and 70,000 t/Zn.

This project is based on the considerations issued by the prefeasibility study developed by Kilborn SNC-Lavalin Europ "Offgas and dust collection. Prefeasibility study of the environmental aspects of the La Oroya copper, zinc and lead smelter."

Modernization with new technologies

The project requires the previous modernization of the three circuits, as detailed as follows:

a) Copper Smelting

A new roaster for dirty concentrates located over the oxyfuel reverberation furnace to replace the eight existing roasters, a drier, and model - *El Teniente* - modified converter, selected for its flexibility and versatility to adapt to different operational conditions and various concentrate mineralogical characteristics, as well as its low investment and operation costs, high productivity in equipment, and high content of SO₂ in the gases produced.

The sulfur input and the concentration of SO₂ in gas emissions obtained after modernization will be: Processed sulfur, 79,283 t/year (equivalent to 235,000 t/year of sulfuric acid).

4.9% of the SO₂ concentration from oxy-fuel reverberation furnace and new roaster.

12 to 16% of the SO₂ concentration from PS and CMT converters.

b) Lead Smelting

An Ausmelt process line will replace the current agglomeration plants and lead furnaces allowing the direct processing of concentrates and secondary lead materials with a sulfur input of 45,693 t/year (equivalent to 135,000 t/year of sulfuric acid), and a gas output with an SO₂ concentration between 10 to 15 %.

c) Zinc Circuit

Installation of a new turbulent bed roaster (T.L.R.) to replace the current T.L.R and the 3 fluid bed roasters (F.B.R.) to allow for a sulfur input of 45,693 t/year (equivalent to 135,000 t/year of sulfuric acid) and gas output with a SO₂ concentration of 6%.

3.3.2 Project Description and Facilities Location

The project includes installation of two new plants to produce double absorption and double contact sulfuric acid to optimize conversion of SO₂ to SO₃. These units should operate with a minimum efficiency of 95% and should fix a minimum of 83% of the SO₂ produced in the three circuits.

a) Sulfuric Acid Plant No 1, with a 235,000 t/year capacity (Copper circuit)
Includes an industrial infrastructure to produce 235,000 t/year of sulfuric acid, processing gases generated through Copper Smelting (PS converters, *El Teniente* modified converter, new roaster for dirty concentrates and current oxy-fuel reverberation furnace).

Gases from the PS and CMT converters after being captured by collector bells are conducted to evaporating refrigeration chambers (one for each converter) where they enter the hot electrostatic precipitator through a high speed tube for dust recovery, and then pass to a gas washing system to remove arsenic and other impurities by means of a washing tower (acid at 50%), scrubbers, cyclones, refrigeration tower and stages of humid electrostatic precipitation (Boliden process). Liquid effluents (used acid with arsenic and other impurities), will be neutralized in a treatment plant and recovered dust will be recirculate to the lead circuit.

Gases produced in the new dirty concentrates roaster and those from oxy-fuel reverberation furnace, after passing through a heat recovery boiler, are treated according to the Boliden process.

During normal operations, gases free from impurities are fed into the sulfuric acid plant, and in case the acid plant is not working well or there is an emergency, the gas current can be diverted to the main chimney.

b) Sulfuric Acid Plant No 2 with a 270,000 t/year capacity (Lead Circuit/Zinc Circuit)

This plant includes an industrial infrastructure to produce 270,000 t/year of sulfuric acid that will process gases from the lead smelter (Ausmelt reactor) and Zinc circuit (new T.L.R.).

Gases coming from the Ausmelt reactor will follow the treatment described above for copper gases. T.L.R. roaster gases for zinc concentrates are fed into the cyclones, after passing through the heat electrostatic precipitator, a heat recovery boiler to the washing system, and to the humid electrostatic precipitators and drying towers to finally enter the acid plant.

Sulfuric acid modules will preferably be located in areas near SO₂ producing plants. As such, acid plant No 1 will be built in the area next to the oxy-fuel reverberation furnace and converters, and acid plant No 2 will be built in the area next to the existing acid plant.

3. ALTERNATIVES FOR RELIEF

3.1 Oxidization – Neutralization Process

This process consists in neutralizing mother water with scrap and copper oxides in a flowing-oxidization medium to promote the precipitation of ferric arsenate and other impurities to obtain a purified solution to be flowed back to the circuit.

This alternative was discarded because was possible to control nickel content in the solution sent back to the tank house, the higher copper recirculation and the difficulty to filter precipitates (iron arsenate).

3.2 Stage electrowinning

In 1984, EW tests with continuous direct current were carried out to obtain impure copper cathodes from the mother water solution. These tests were halted because of high the presence and emission of arsenamine toxic gas (H_3AS).

3.3 Predilution process – SX/EW – neutralization

Developed by the Metallurgic Research Department, this process consists in creating mother water through predilution, solvents-electrowinning extraction and neutralization to obtain an effluent with an impurity content under the permissible maximum levels and to recover cathodic copper. The favorable results obtained in pilot tests confirmed its feasibility for the mitigation project.

4. PROCESS DESCRIPTION (DIAGRAM No. 2)

- The project is aimed at replacing the current copper cementing method with iron shavings with a treatment process in three well defined stages : predilution, SX/EW and neutralization. The most important parameters for each stage are :

Predilution :

pH : 1.23
Cu : 3.2 g/l

SX-EW :

Reactive : ACORGA M5615
pH : 1,23
Cu : 3.20 g/l

Neutralization :

Neutralization 1 :

pH : 3.00
Cu : 0.11 g/l

Neutralization 2 :

pH : 7.00
Cu : 0.01 mg/l

- Pilot Tests : (Diagram N°. 3)

The pilot tests results are shown in the respective diagram.

This alternative was chosen because it got the best results at pilot plant level.

- **Relief Results**

The final effluent presents impurity levels below the permissible maximum allowed levels established by the M.E.M. (Energy and Mining Ministry), as shown in the following table :

Element	Cu	Fe	As	Sb	Bi	Ni	pH
Final Effluent (mg/l)	0,01	0,01	0,01	0,9	0,9	103	7,0
N.M.P.(mg/l)	1,00	2,00	1,00	-	-	-	9,0

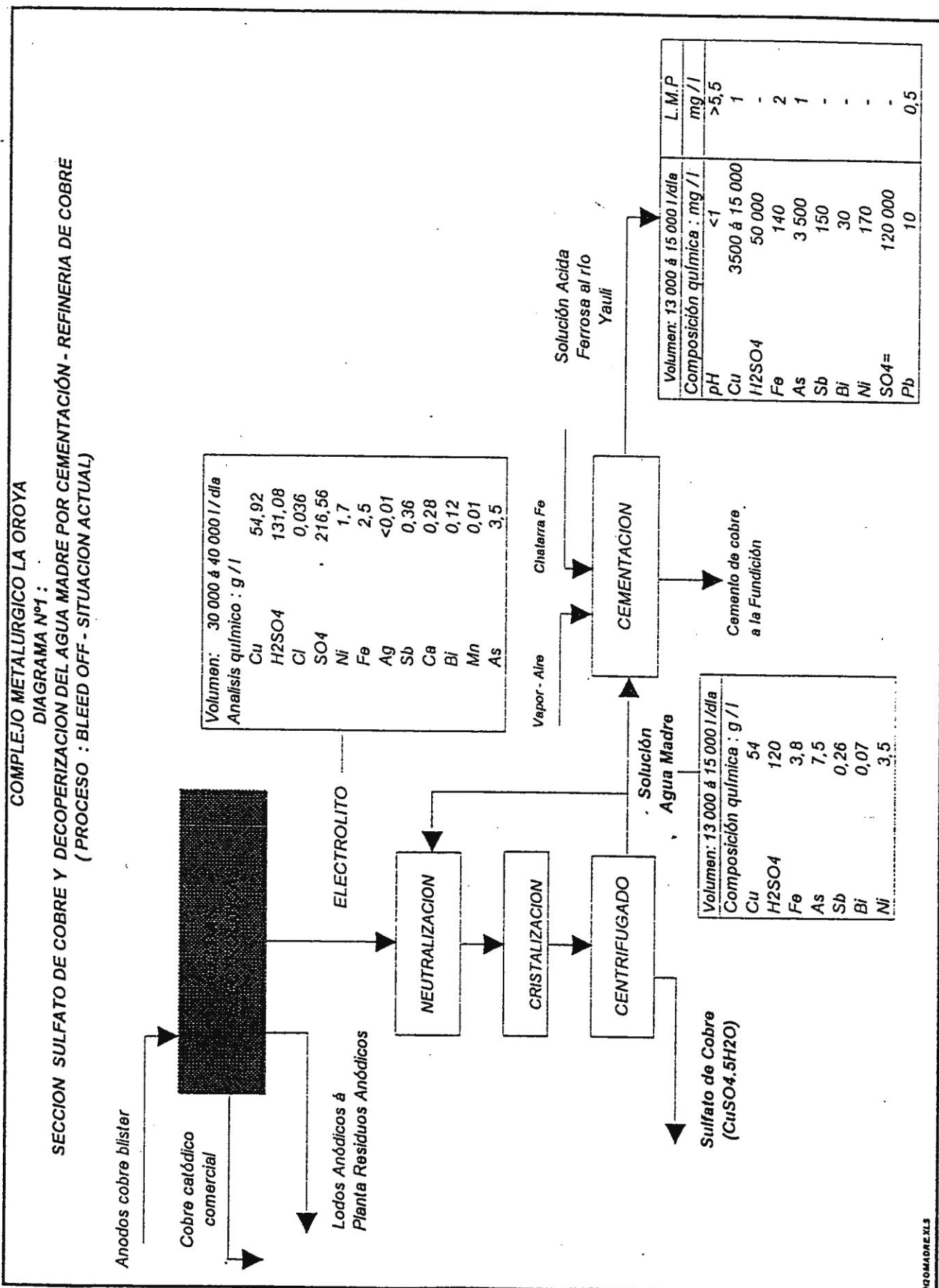
5. INVESTMENT

The estimated cost for executing this project execution is to US\$ 500,000. Below are cost estimates prepared by INEPROSA:

a) Aqueous preparation :	US\$
• General accounts	4,600
• Preliminary works, foundations, structures, closure and finishing.	17,900
• Mechanic, electric and control plants	15,000
• Equipment	57,600
• Sub-total (1)	95,100
 • b) SX - EW Plant	
• General accounts	6,500
• Preliminary works, foundations, structures	2,200
• Mechanic and electric plants	26,100
• Equipment	165,600
• Sub-total (2)	200,400
 • c) Neutralization Plant	
• General accounts	4,700
• Preliminary works, foundations, etc.	54,400
• Mechanic, electric and control plants	21,000
• Equipment	79,000
• Sub-Total (3)	159,100
SUB-TOTAL (3)	159,100
SUB-TOTAL (1+2+3)	454,600
INCIDENTAL EXPENSES	45,400
TOTAL	500,000

6. IMPLEMENTATION PERIOD

A period of 5 months is estimated for implementation. The project may be concluded in the first half of the next year.



HOMADREXLS

3. MITIGATION OPTIONS

ECOLAB S.R.L. consultants were retained to prepare a basic engineering study.

3.1 Effluent management plan

The plan proposes ways to optimize the use of the classified three types of liquid pollutants, namely process, sewerage and refrigeration water. Independent pipe lines and/or branches will prevent mixing the types of water.

The main canal (code 135) and the parallel canal (code 136) will be designed to carry rainwater, and avoid flooding the railway.

The effluent management plan will allow to reduce the number of sampling sites to enhance the use of human resources, equipment and reagents.

3.2 Description of the management plan for liquid effluents

Four main collection canals are envisaged, namely canal number one (code 135), the one running parallel to the railway (code 136), canal number two (code 119), and the electrolytic zinc canal (code 126). Their code numbers and paths (see plans numbers F-TB-00-001, 002, 003 and 004-Plans Attachments) are also described in the following table.

Main Lines	Channels with new code number	Path of Lines
a) Channel N° 1 (135)	1	Channel N° 1 will keep its current path.
b) Channel N° 2 (119)	2	Channel N° 2 will start its path in the current point, at the northeast of Cadmiro No.2 plant. It will cross between the copper and lead plants passing by the east side of the silver and gold refinery and will continue through the perimeter. Along its trajectory it will unite with channel N° 126. It will still be called channel N° 2 until it unites with channel N°1.
c) Parallel channel next to channel No.1 (136)	3	Parallel path will start by the battery limit to the northeast of coke plant, will go parallel to channel No. 1 until Mantaro river by south
d) Electrolytic Zinc channel (126)	4	It will take its current path, starting collection by collect zinc cathode supply, passing through rectificadores, purification and zinc electrolytic plants. Finally it will join channel No.2 which will be the final point of the path.

- Process, refrigeration and sewerage waters from the smelters will be carried by separate pipelines. Piping for the different types of water will be laid according to the following table.

Main Lines	Channels with new code number	Pipelines
a) Channel N° 1 (135)	1	• Pipelines of water in process • Pipelines of acid water from the acid sulfuric plant. • Channel for rain (since sulfuric acid plant).
b) Channel N° 2 (119)	2	• Pipelines of water in process • Pipelines of sewage water
c) Channel	3	• Pipelines for sewage water

4. MITIGATION RESULTS

4.1 New emissions through chimney

As a result of the implementation of new technologies and new acid plants, we estimate that the sulfur balance at La Oroya Metallurgic Complex will be fixed at 89.35%. Details are as follows:

Inflow	ton of S	%
Copper concentrates	85 937	45,65
Lead concentrates	42 577	22,62
Zinc concentrates	48 012	25,50
Copper smelters	5 773	3,07
Lead smelters	1 050	0,56
Others (*)	4 912	2,61
Total input	188 261 (515 t/day de SO₂)	100,00

Outflow (fixed)	ton of S	% (related to inflow)
Sulfuric Acid	162 988	86,58
Copper slag	2 414	1,28
Lead slag	177	0,09
Zn/Ag	522	0,28
Liquid effluents	1 106	0,59
Bisulfate of Na	66	0,04
Others (*)	946	0,50
Total output (fixed)	168 219	89,35

Lost through the stack and fugitive emissions (related to input)	20 042 (110 t/day of SO₂)	10,65
---	---	--------------

(*) Fe sponges, Sb slags, Cottrell Central Dusts, Roasted, soda mate, speiss.

(**) Cu sulfate, Cu cathodes, cleaner, speiss, soda matte.

4.2 SO₂ emission

Fixing 89.35% of S entering the process, the La Oroya Metallurgic Complex will only emit 10.65 % (110 t/day of SO₂ out of 515 t/day of S that comes into the Complex) of the S to the atmosphere, thus meeting the requirements in Attachment 1 of R.M. No 315-96-EM/VMM.

Diagram No 2 shows the new organization of the Smelters with technological innovations for modernization and new plants for sulfuric acid manufacturing.

4.3 Particulate emission

The particulate emission concentrations emitted to the atmosphere will be under 100 mg/m³ (As < 25 mg/m³ and Pb < 25 mg/m³) thus meeting articles 3, 4 and 5 of R.M. No 315-96-EM/VMM.

4.4 Air quality

Daily concentration of sulfurous anhydride in the environment will be less than 572 mg/m³.

Particles in suspension will be under 350 mg/m³, monthly concentration of Pb will be 1,5 mg/m³ as a maximum and daily concentration of arsenic will be less than 6 mg/m³, complying with stipulations from Attachment 3 of R.M. No 315-96-EM/VMM.

5 INVESTMENTS AND PROJECT PERFORMANCE

The fixed investment for new the Acid Plants is estimated as follows:

ACID PLANT N° 1 (Copper circuit) Capacity: 235 000 t/year	41,2 MM US\$
ACID PLANT N° 2 (Lead and Zinc circuits) Capacity : 270 000 t/year	48,8 MM US\$

Source: SC Fenco-Monsanto Acid Plant.

Investments for new converter ducts, reverberation furnaces, refrigeration gas systems and dust precipitators are included in the investment schedule of operational continuity, process improvement and technological change and are estimated separately or within the investment estimations for new equipment.

These investments do not include costs related to installation of deposits for storage or means of transportation for sulfuric acid.

We estimate that the building of each module for sulfuric acid production will take 12 months. The execution of this project is estimated as follows:

ACTIVITY	YEAR
Acid Plant N° 1 (Copper circuit)	2 003
Acid Plant N° 2 (Lead and Zinc circuit)	2 005

the water will be derived to the main channel.

4.2 Joints and accessories

Tapped T-accessory and elbow joints made of molten iron or PVC will be used as required. In segment C to C' we will use 20 meters of isometric pipe made of molten iron with universal tapped joints. The rest of the pipe will be PVC type.

4.3 Ditches

The ditches will be dug to lay the pipes underground. The general redesign and layout of the projected network must ensure piping presents the gradient and depths specified in the plans. Digging will start once the needed piping is already in the premises. The width of the ditches will fluctuate from 0.40 to 0.70 meters. The bottom will be leveled to suit the surface taking into consideration the thickness of the pipe bells. Surfaces must be clean before joining.

4.4 Leveling

The ditches will be covered after the hydraulic test of the installed piping. Materials free from stones, roots and other debris must be used for the first layer of the ditch cover. After compacting the sides of the ditch to secure a firm cover, the successive 0.10 meter must reach a minimum 0.30 meters above the pipe key. The piping must not be moved when placing a final layer of stonefree material.

Factory joints will be used when the pipes are not provide with a pipe bell at the end.

4.5 Cost estimation (in US dollars)

TUBERÍA DE PVC					
DIAMETER ("	2"	4"	6"	8"	10"
LENGTH (m)	53	249	133	206	526
TUBERÍA DE HIERRO FUNDIDO					
DIAMETER ("	10"	8"	4"	2"	
LENGTH (m)	20	40	30	10	

Item	Description	Cost (U.S.\$)
100	Preliminary work	5 500
400	Mechanical Installations	32 092
	SUB TOTAL	37 592
	IMPREVISTOS 10%	3 758
	TOTAL	41 350

5.4.7 PROJECT NO. 7

HANDLING AND DISPOSAL OF ACID SOLUTIONS IN THE FRAGMENTING PROCESS. SILVER REFINERY.

1. OBJECTIVE

The project seeks to stop the pouring into the Mantaro river of highly acid solutions (350 grams of H_2SO_4 per liter of water) resulting from gold fragmentation at the silver refinery.

2. ENVIRONMENTAL IMPACT ASSESSMENT

"Doré" from the anodic residue plant is treated in the silver refinery to obtain fine silver and gold bullion. Gold is separated from silver using concentrated H_2SO_4 . The resulting effluent is a highly acidic solution that is poured into the Mantaro river after cementing it with iron.

The average monthly consumption of sulfuric acid in the silver refinery reaches 17 tons.

3. MITIGATION OPTIONS

3.1 Partial substitution of high acid solutions from the silver refinery for fresh acid used in the zinc circuit.

The project consists of cementing highly acidic solutions from the gold and silver separation process using zinc plates instead of iron shavings. This produces a solution with a high content of zinc sulfate and sulfuric acid that can be used in the zinc circuit to substitute for fresh acid.

4 PROCESS DESCRIPTION

The project includes installation of one pump and pipes to carry highly acidic solutions from the silver refinery to the zinc circuit.

Mitigation results

The highly acid solution from the silver refinery will no longer be poured into the Mantaro river. Instead, it will be used as a reagent in the zinc circuit thus eliminating said effluent.

5. INVESTMENT

The estimated cost for the execution of the project is US\$5,000.

6. IMPLEMENTATION PERIOD

The project will be concluded during the first quarter next year.

5.4.8 PROJECT NO. 8

TREATMENT PLANT FOR INDUSTRIAL LIQUID EFFLUENTS FROM LA OROYA SMELTER AND REFINERY

1. OBJECTIVE

The project seeks to implement a treatment plant for industrial liquid effluents from the metallurgical complex in compliance with regulations about maximum allowable discharges of impure solutions. These regulations are included in Attachments No. 1 and 3 of R.M. No. 011-96-EM/VMM.

2. ENVIRONMENTAL IMPACT ASSESSMENT

The metallurgical operations generate 40 liquid effluents that have an impact on the Yauli and Mantaro rivers. The types of effluents are as follows.

Process effluents: water from metallurgic processes containing metals, suspended solids, and eventually presenting highly acid pH.

Refrigeration water effluents: water discharged into the river after using it for cooling equipment, flows or materials. It is not usually polluting although some may be.

Sewage: waste water from bathrooms and locker rooms.

Wash water effluents: water used in washing floors and equipment, non-polluting but carrying large amounts of solids.

Rainwater effluents: water from rainwater runoff that carry solids found along the way.

Tables 4.1.2/1, 1 A, 2 and 2 A(4), and diagrams 7.2.4/4,5 (Chapter 7) detail and characterize all the effluents from La Oroya smelter and refineries according to the EVAP report. Effluents with codes R-1, R-2 and R-3 are discharged to the Yauli river and effluents with codes from 101 to 137 are poured into the Mantaro river. Details of the effluents classified as process, refrigeration, sewerage, washing and runoff water are presented in the respective table. Also shown are the maximum allowable levels of pollutants.

EFFLUENT CLASSIFICATION	
Type of effluent	Code
Waters from metallurgic process	115, 118, 119, 121, 123, 124, 126, 131, 133, 134, 135, 136, 137 y R-1
Cooling waters	102, 125, 127 y 128
Sewage water	101, 106, 107, 108, 109, 110, 111, 112, 114, 116, 117, 120, 122, 129, 130, 132
Effluents eliminated	103, 104, 105, 113 y R-2
Effluent without contaminants	R-3

Tables 4.1.2/3, 3 A, 4 and 4 A (Chapter 4) show the seven main pollutants, out of the 40 liquid effluents poured into the Yauli and Mantaro rivers.

N°	Effluent Code	Description
1	118	Copper and lead smelter slag granulation
2	119	Main channel No. 2 - Cu - Pb Smelter
3	126	Zinc Electrolytic Plant
4	135	Main Channel No. 1 (parallel to FF.CC)
5	136	Parallel Channel to point 135
6	137	Zinc Ferrites Well
7	R-1	Copper Refinery effluent (Ex-lead)

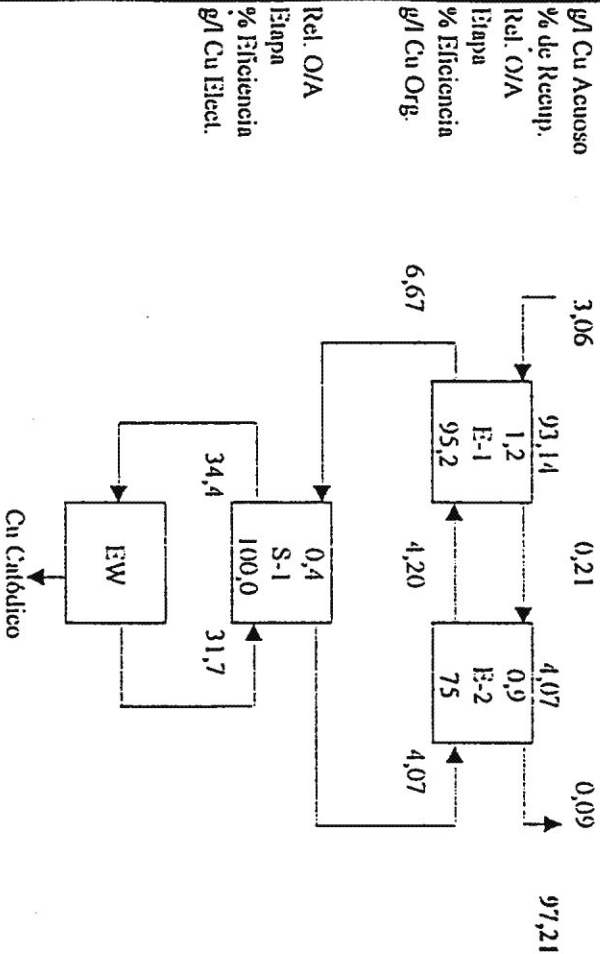
COMPLEJO METALURGICO LA OROYA

DIAGRAMA N° 3

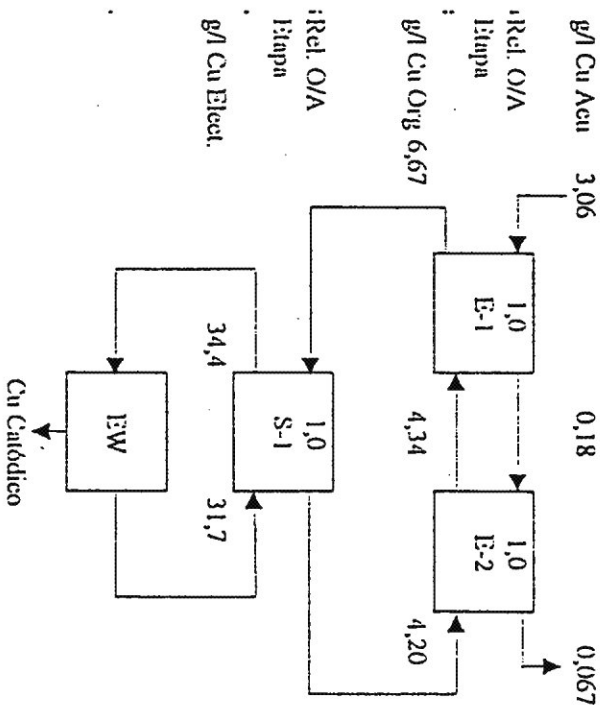
PERFORMANCE DE LA PLANTA PILOTO PARA EL TRATAMIENTO DEL AGUA MADRE DE LA REFINERIA DE CU DE HUAYMANTA

REACTIVO: ACORGA M5615 25 % V/V:

Puntos Operativos:



Puntos de Equilibrio:



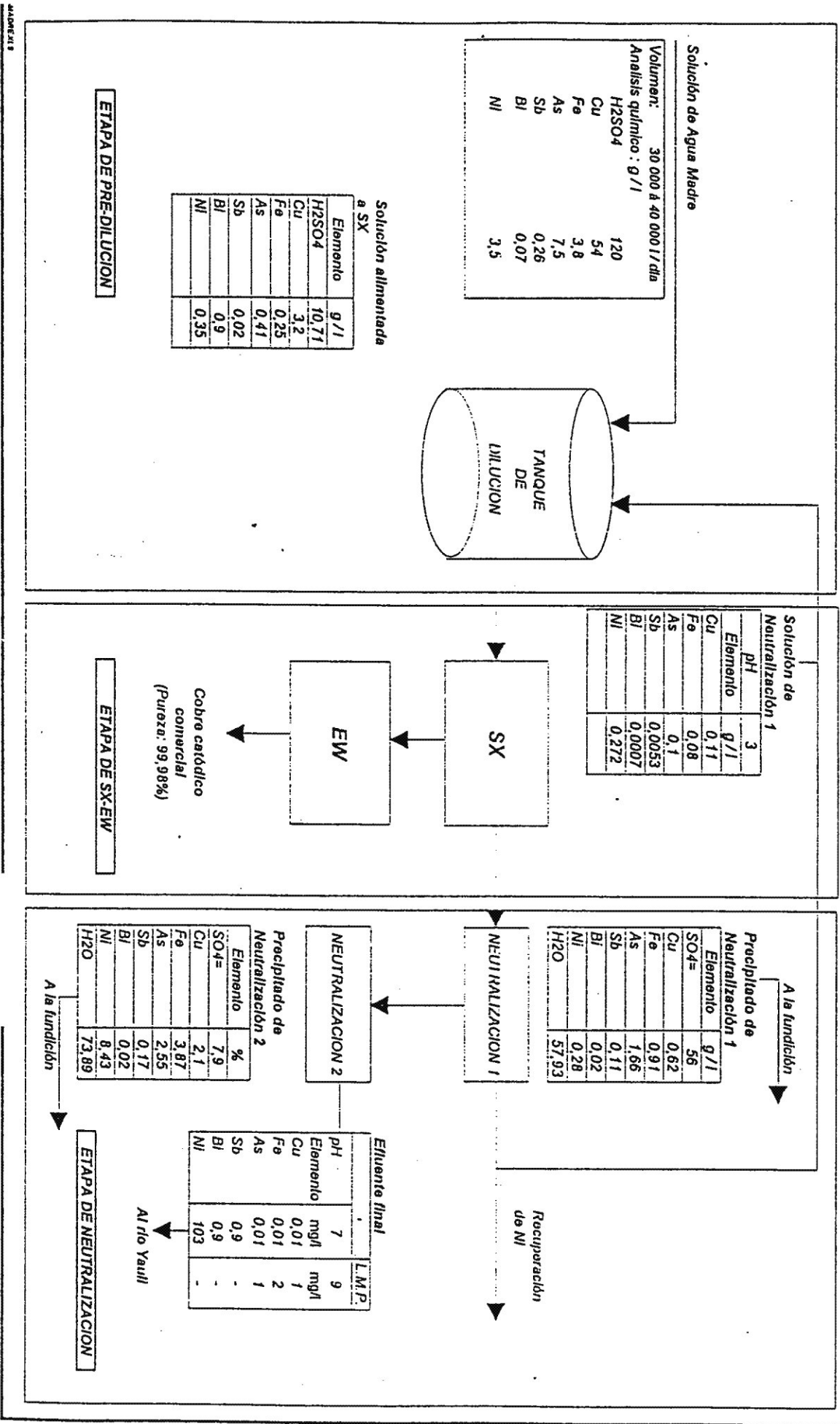
ANALISIS PROMEDIO DE LAS CORRIENTES DEL CIRCUITO DE SX DE LA PLANTA PILOTO

Soluciones de la PLANTA PILOTO	Análisis químico (g/l)		
	Cu	H2SO4	Fe
Solución Alimentación Acuoso E-1	3,06	5,10	0,280
Solución Raff (E-2)	0,21	-	0,280
Orgánico E-2	0,09	9,00	0,280
Orgánico Descargado	4,20		
Orgánico Cargado	6,67		
Electrolito Cargado	4,07		
Electrolito Descargado	34,40	166,10	0,210
	31,70	170,70	0,220

ANALISIS PROMEDIO DE LOS EQUILIBRIOS DEL CIRCUITO DE SX DE LA PLANTA PILOTO

Soluciones de la PLANTA PILOTO	Análisis químico (g/l)		
	Cu	H2SO4	Fe
Solución Alimentación Acuoso E-1	3,06	5,10	0,280
Solución Raff (E-2)	0,18	-	0,280
Orgánico E-2	0,07	9,00	0,280
Orgánico Descargado	4,34		
Orgánico Cargado	6,67		
Electrolito Cargado	4,20		
Electrolito Descargado	34,40	166,20	0,210
	31,70	170,70	0,220

COMPLEJO METALURGICO LA OROYA
 DIAGRAMA N° 2:
 PROYECTO: PLANTA DE TRATAMIENTO DE AGUA MADRE DE LA REFINERIA DE COBRE



5.4.6 PROJECT No. 6

REFRIGERATION WATER RECIRCULATION SYSTEM FOR SMELTER FACILITY

1. INTRODUCTION

Almost all water used currently for industrial refrigeration at La Oroya Smelter is poured into the Mantaro river through open canals or pipes running across the smelter facilities.

These refrigeration waters are often mixed with industrial or domestic effluents thus increasing the volume of polluted waters. Additionally, refrigeration waters are polluted by dust, solids and gases present in the industrial area.

Two alternatives have been proposed to solve this problem.

Alternative one: Separating refrigeration waters from industrial and sewerage effluents and building a closed and independent network to discharge them into the Mantaro river.

Alternative two: A more feasible alternative consists of building a network to recirculate these waters within the smelter and using the pumps in the Mantaro river.

2. OBJECTIVES

- Isolate refrigeration water from existing pollutants in the smelter's premises
- Recover approximately 2,253 gpm of good quality water by recirculating it to the supply system using the pumps in the Mantaro river
- To improve the quality of water coming to the smelter from the pumps in the Mantaro, compared to the river waters. This will permit a longer life of the existing pumping equipment, mostly during periods of large river water flow
- To guarantee water supply to the smelter in times of low water availability

3. PROJECT DESCRIPTION

For recirculation, refrigeration and cooling, water will be taken to the Mantaro river from the different points of discharge along the smelting processes.. This will be accomplished by means of a gravity hydraulic system Pipes of various diameters will cross the industrial areas where there is the highest discharge and carry the water to the Mantaro pumps.

The main contributors are:

CONTRIBUTOR	FLOW (LPS)
Antimonium Plant	0.5
Agglomeration Plant	25.0
Sulfuric Acid Plant	25.2
Zinc Roaster FBR y TLR	38.8
Milling Plant	8.0
Solid Separation Compressor	1.8
Vacuum Pump -Flotation Plant	20.0
Reservoir pumping well for Separation of Solids	1.3
Rectificadores silicon A	5.1
Rectificadores silicon B	0.6
Cooling Froth from Iron Zileret Plant	2.6
Rectificadores silicon C	1.8
Oxygen Plant	6.8
TOTAL FLOW	142 LPS (2253 GPM)

These waters do not need a cooling system since the characteristics of the projected network and the existing distribution system will cool town the water to normal temperature. This would not happen if recirculation were carried out at each of the plants, in which case a sophisticated and costly cooling system would be required.

4. TECHNICAL SPECIFICATIONS

4.1 Piping

Pipes for low traffic areas will be of PVC type. For areas with vehicle or front loader traffic, molten iron pipes will be used. PVC 7.5 class rigid piping will be used for a maximum work pressure of 75 meters of water with resistance to traction of 400 to 500 kilograms per square centimeter.

Molten iron piping will be black type with US tapping ISO-1, schedule 40, in segments 21 feet long. This piping will be laid in the following dimensions.

PVC PIPE					
DIAMETER (")	2"	4"	6"	8"	10"
LENGTH (m)	53	249	133	206	526
TUBERÍA DE HIERRO FUNDIDO					
DIAMETER (")	10"	8"	4"	2"	
LENGTH (m)	20	40	30	10	

Note: To prevent sulfuric acid from coming into contact with water in case of leakage, an automated acidity monitoring system will be put in place. At the detection of acid,

DIAGRAMA No.1
MANEJO DE GASES Y MATERIAL PARTICULADO

DIAGRAMA N° 2
MODULOS PARA LA PRODUCCIÓN DE ÁCIDO SULFURICO

COMPLEJO METALURGICO LA OROYA

Diagrama N°1 MANEJO DE GASES Y MATERIAL PARTICULADO (POLVOS)

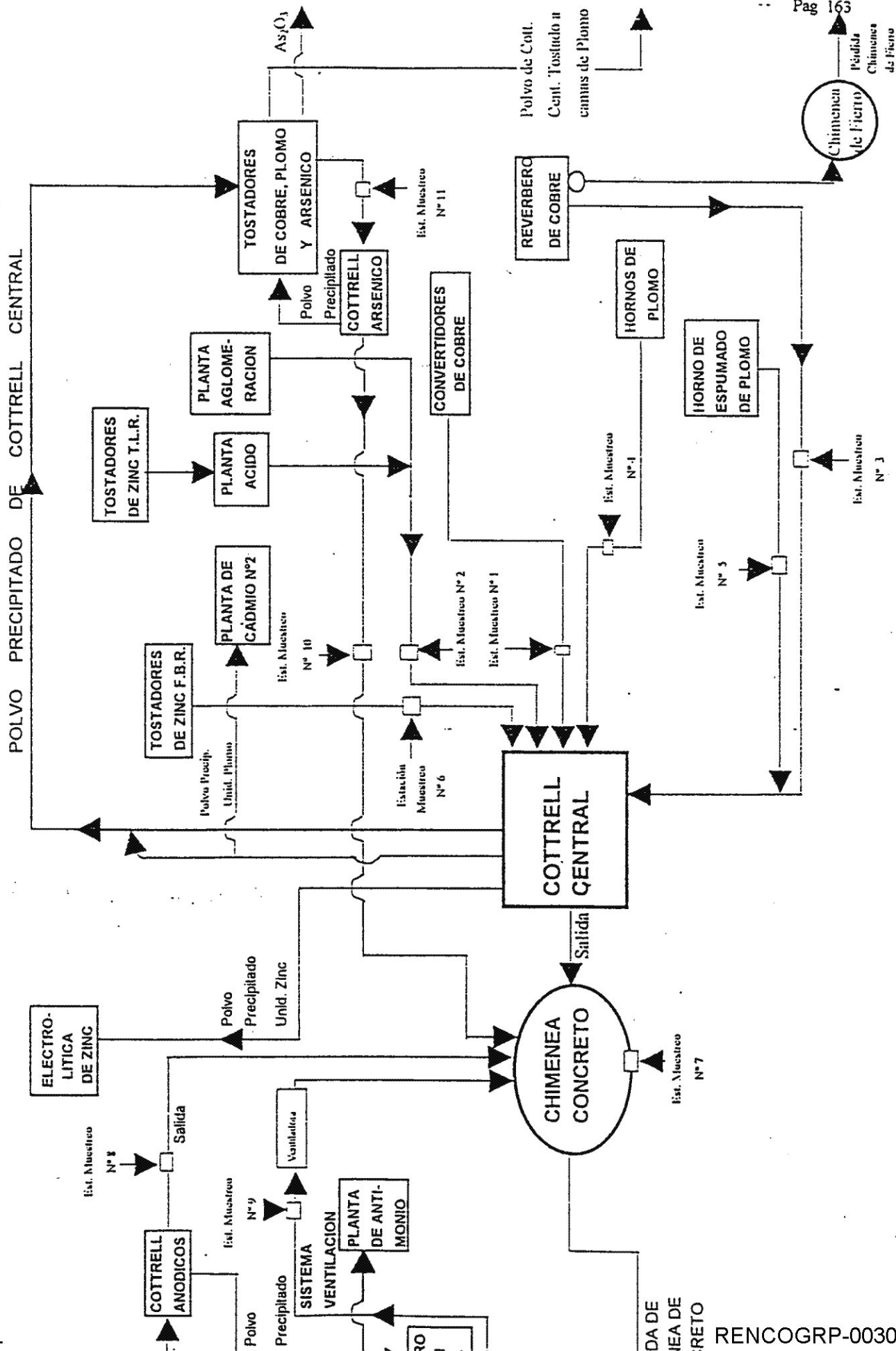


DIAGRAMA N° 2
COMPLEJO METALURGICO LA OROYA
MODULOS PARA LA PRODUCCION DE ACIDO SULFURICO - (TM/AÑO)

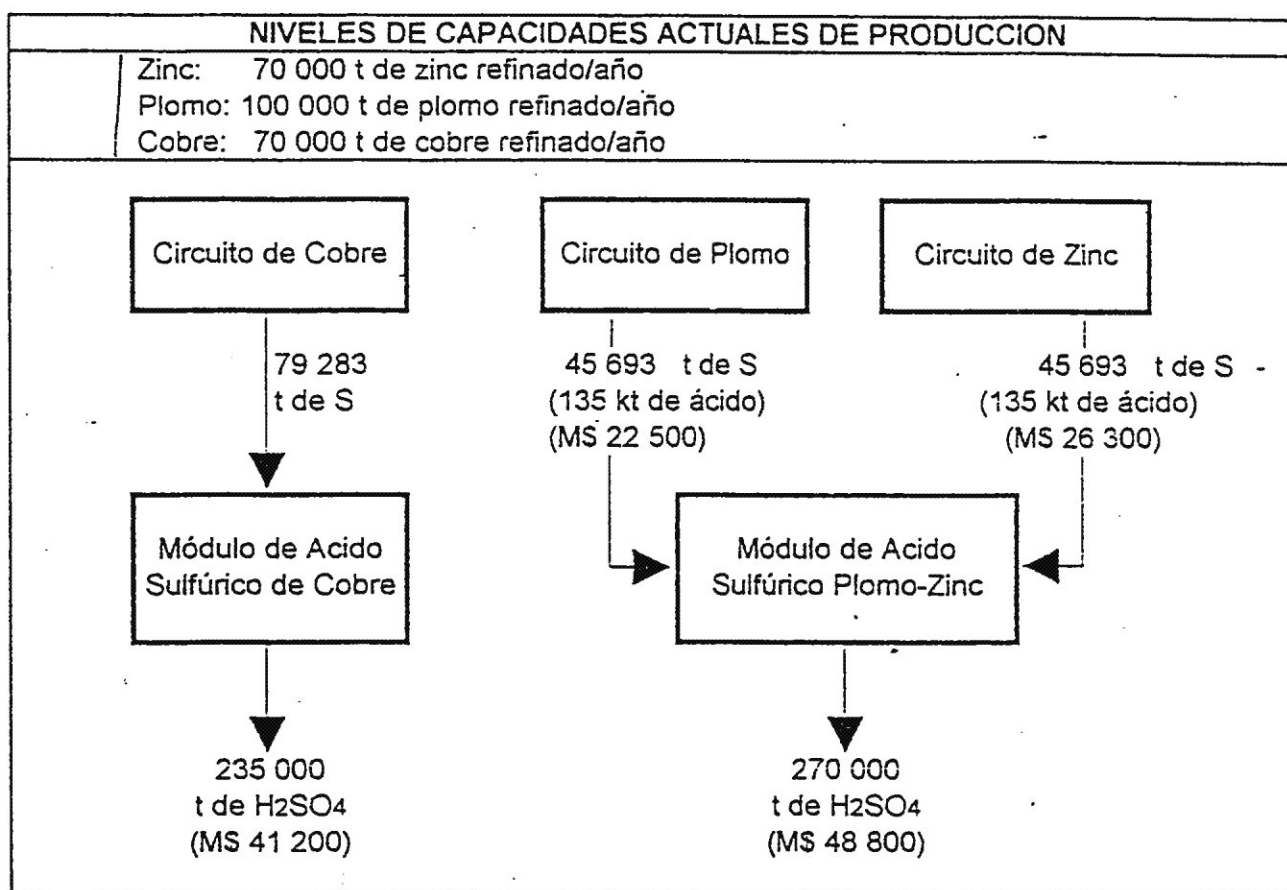
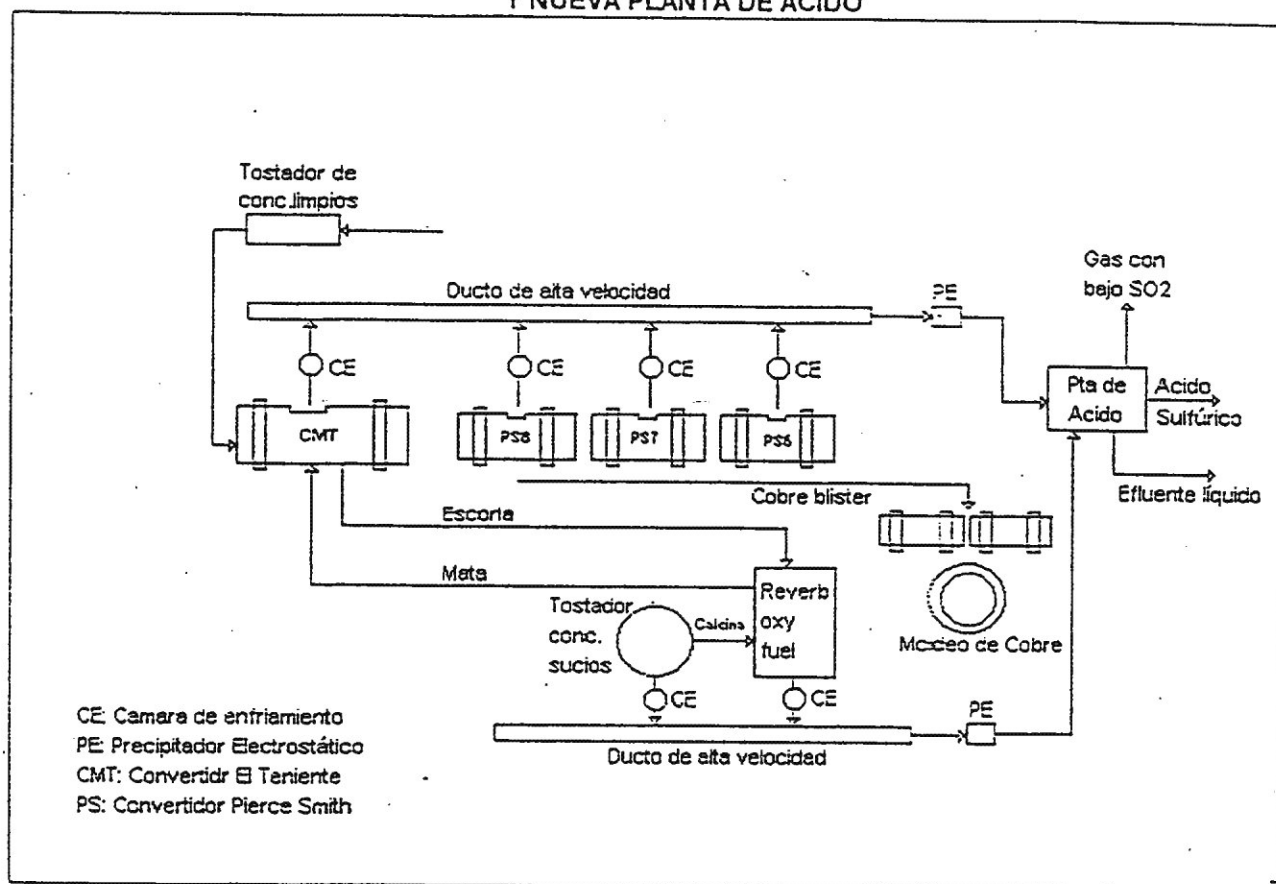


DIAGRAMA N° 3
COMPLEJO METALURGICO LA OROYA
ARREGLO GENERAL DE LA FUNDICION DE COBRE CON NUEVAS TECNOLOGIAS
Y NUEVA PLANTA DE ACIDO



ARREGLO GENERAL DE LA FUNDICION DE PLOMO Y CIRCUITO DE ZINC
CON NUEVAS TECNOLOGIAS Y NUEVA PLANTA DE ACIDO

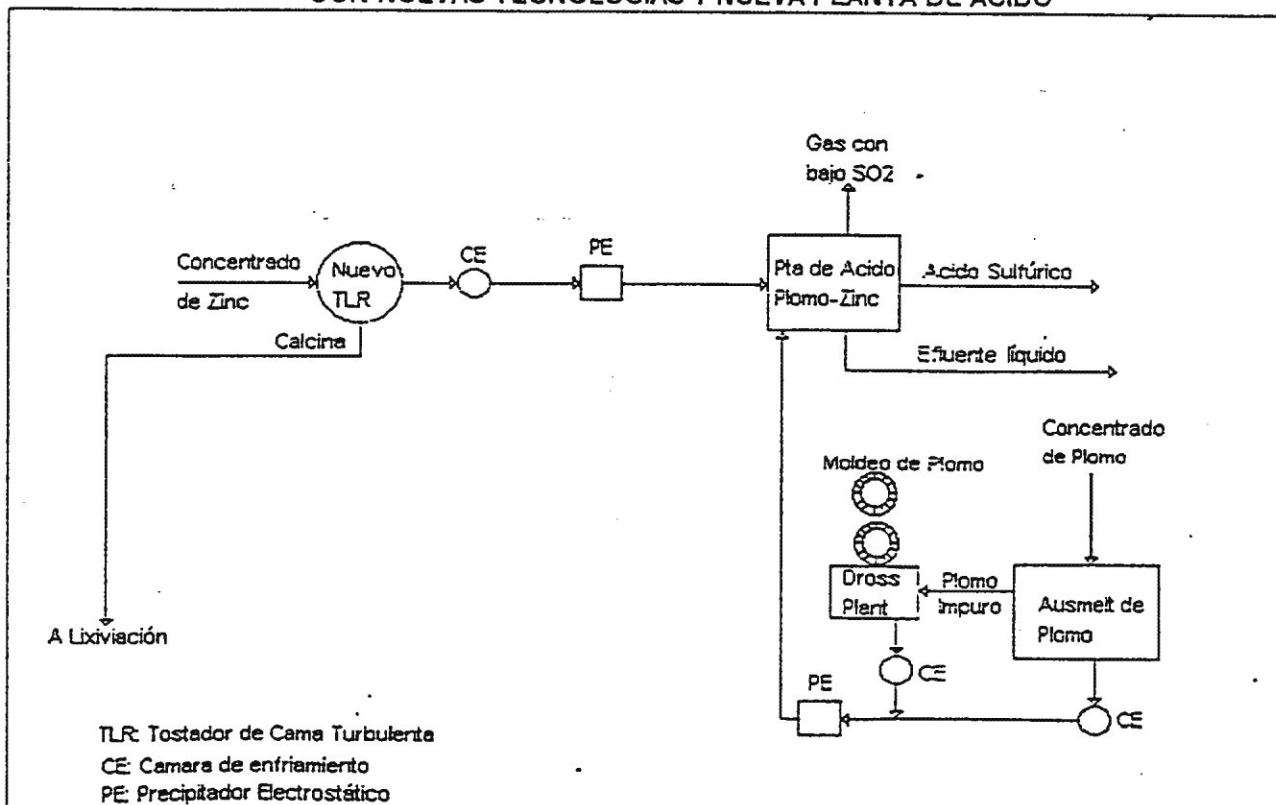


TABLA N° 1
COMPLEJO METALURGICO LA OROYA
BALANCE DE AZUFRE CIRCUITO DE COBRE - CON PROYECTOS AL AÑO 2 006
 (Condición de capacidad actual: 70 000 t de Cu refinado/año)
 (30 % de Concentrados Sucios y 70 % de Concentrados Limpios)

TRATADO CIRCUITO DE COBRE	CON PROYECTOS AL AÑO 2 005			
	t	% S	t Azufre	% Distribución
- Minerales y Concentrados Centromin Perú S.A.	127 600	32,8	41 853	45,3%
- Minerales y Concentrados Comprados	155 547	28,3	44 084	47,8%
- Fundentes	71 266	8,1	5 773	6,3%
- Misceláneos (esponja de fierro)	3 952	4,8	182	0,2%
- Transferencias (mala de soda, speliss, etc.)	7 100	4,6	327	0,4%
SUB-TOTAL	365 466	25,2	92 218	99,9%
- Combustible Bunker 6	9 158	1,0	92	0,1%
TOTAL NUEVO RECIBIDO	374 623	24,6	92 310	100,0%
Inventario inicial	0	0,0	0	
TOTAL NUEVO DISPONIBLE	374 623	24,6	92 310	
Inventario final	0	0,0	0	
TRATADO	374 623	24,6	92 310	100,0%
AZUFRE NO FIJADO (evacuado al ambiente)			13 027	14,1%
AZUFRE FIJADO (ácido sulf., en escorias, etc.)			79 283	85,9%
DETALLE DE AZUFRE NO FIJADO (EMISIONES)				
Gases de tostación, horno oxy-fuel y convertidores P.S.			9 817	10,6%
Gases del Convertidor El Teniente y Pla de Acido			3 210	3,5%
SUB-TOTAL			13 027	14,1%
DETALLE DE AZUFRE FIJADO				
Acido sulfurico (*)	235 757		75 806	82,1%
Escorias de reverberos	221 025	1,09	2 414	2,6%
Canal central - Agua granulación - Bled off (yeso)	6 406 965	0,009	591	0,6%
Sulfato de cobre	3 675	12,8	472	0,5%
Cátodos de cobre	70 000	0,0005	0,4	0,0%
SUB-TOTAL			79 283	85,9%
TOTAL			92 310	100,0%

70(KT30-70

(*) El tonelaje de azufre fijado considera la eficiencia de 95% de la Pla de Acido y el 5% restante, está considerado en las emisiones.

TABLA Nº 2
COMPLEJO METALURGICO LA OROYA
BALANCE AZUFRE CIRCUITO DE PLOMO - CON PROYECTOS AL AÑO 2 006
A Niveles de Capacidad Actual: 100 000 t/año de Plomo Refinado

TRATADO CIRCUITO DE PLOMO	CON PROYECTOS AL AÑO 2 006			
	t	% S	t Azufre	% Distribución
- Minerales y Concentrados Centromin Perú S.A.	159 237	24,0	38 185	79,7%
- Minerales y Concentrados Comprados	19 350	22,7	4 392	9,2%
- Fundentes	61 052	1,7	1 050	2,2%
- Misceláneos (esponja de fierro)	3 096	2,8	87	0,2%
- Transferencias (escoria Sb, PCCT, etc.)	30 171	14,0	4 224	8,8%
TOTAL NUEVO RECIBIDO	272 906	17,6	47 938	100,0%
Inventario inicial	0	0,0	0	
TOTAL NUEVO DISPONIBLE	272 906	17,6	47 938	
Inventario final	0	0,0	0	
TRATADO	272 906	17,6	47 938	100,0%
AZUFRE NO FIJADO (evacuado al ambiente)			3 508	7,3%
AZUFRE FIJADO (ácido sulf., en escorias, etc.)			44 430	92,7%
DETALLE DE AZUFRE NO FIJADO				
Gases de Horno de Espumaje			85	0,2%
Gases Hornos de Esumado			1 000	2,1%
Gases de Hornos de Plomo			2 423	5,1%
SUB-TOTAL			3 508	7,3%
DETALLE DE AZUFRE FIJADO				
Acido sulfúrico	134 552		43 264	90,3%
Escorias de Hornos de Esumado	120 182	0,15	177	0,4%
Canal central - Agua granulación - Bled off (yeso)	5 150 873	0,01	515	1,1%
Spelss	3 500	1,46	51	0,1%
Mala - Soda	3 700	6,15	228	0,5%
Limpiezas	9 211	2,12	195	0,4%
SUB-TOTAL			44 430	92,7%
TOTAL			47 938	100,0%

TABLA N° 3
COMPLEJO METALURGICO LA OROYA
BALANCE AZUFRE CIRCUITO DE ZINC- CON PROYECTOS AL AÑO 2 006
A Niveles de Capacidad de 70 000 t/año de Zinc Refinado

TRATADO CIRCUITO DE ZINC	CON PROYECTOS AL AÑO 2 006			
	t	% S	t Azufre	% Distribución
- Minerales y Concentrados Centromin Perú S.A.	146 826	32.7	48 012	100.0%
TOTAL NUEVO RECIBIDO	146 826	32.7	48 012	100.0%
Inventario inicial	0	0.0	0	
TOTAL NUEVO DISPONIBLE	146 826	32.7	48 012	
Inventario final	0	0.0	0	
TRATADO	146 826	32.7	48 012	100.0%
AZUFRE NO FIJADO (Emisiones)			4 094	8.5%
AZUFRE FIJADO (ácido sulf..en residuos. etc.)			43 918	91.5%
DETALLE DE AZUFRE NO FIJADO				
Residuo producido	48 916	1.5	739	1.5%
Calcina.Efluentes líquidos			648	1.4%
Pérdidas fugitivas			2 707	5.6%
SUB-TOTAL			4 094	8.5%
DETALLE DE AZUFRE FIJADO				
Acido sulfúrico	134 756		43 330	90.2%
Bisulfito de sodio			66	0.1%
Concentrado Zn/Ag	1 939	26.92	522	1.1%
SUB-TOTAL			43 918	91.5%
TOTAL			48 012	100.0%

5.4.2 PROJECT No 2

ELIMINATION OF FUGITIVE GAS EMISSION FROM THE COKE PLANT

1. IMPACT ASSESSMENT

1.1 Fugitive gases from the coke furnaces during coal distillation.

Currently, when furnace hatches are opened to obtain the final coke product and to supply additional coal for the operation, 23,800 m³/d of gases are emitted to the atmosphere, as a result of incomplete coal distillation. Years ago, the volume of these gases was 32,700 m³/day.

Table No 1 summarizes operational information for the Coke Plant:

TABLE No. 1

	BEFORE	CURRENT
Coke Cycle (Hours)	14	19.8
Number of daily discharges	32	24
Net Coke Yield (%)	65	66
INDEX: Fixed Carbon (CF) in Bulk Coke/t-Carbon Supply (t)	0,550	0,574
Production: Fixed Carbon (CF) in Bulk Coke/day (t)	77	78
Ash production (Ash) in Bulk Coke/day (t)	22,9	9,4
GAS EMISSION TO THE ENVIRONMENT (Cubic Meters per day)	1 022x32: 32 700	992x24: 23 800

Environmental assessments of the coke furnace rooves indicate that gases from incomplete coal distillation during the coking process are rapidly diluted in the atmosphere. Table No 2 records the composition of these fugitive gases which are emitted during coke discharges and coal loading. Likewise concentrations of lead and arsenic contaminants are recorded as 0.018 and 0.012 μm^3 respectively, which are less than maximum levels allowed.

TABLE No. 2

VOLUME & COMPOSITION OF THE GASES AT THE ROOF OF THE DISCHARGE BATTERIES				
GASES DISTILLED FROM COAL	Volume (m ³ /d)	23 800	O ₂ (%)	16,6
	CH ₄ (%)	12,0	H ₂ (%)	10,6
	C ₂ H ₆ (%)	3,1	H ₂ S (%)	0
	C ₃ H ₈ (%)	0	CO (%)	4,0
	Lead (µg/m ³)	0,018	N ₂ (%)	53,7
	Arsenic(µg/m ³)	0,012	CO ₂ (%)	0

1.2 Gas waste produced by combustion

Known as "burned gases", these combustion gases are emitted to the environment through the Plant's chimneys (one for each battery). These gases are a product of the combustion process derived from the mixture of the coal distillation gases and preheated air in the same batteries. Their composition and analyses are shown in table No 3.

TABLE No.3

GAS EMISSIONS BY STACKS 10.48 Nm ³ /seg	Gas Disposal analysis (%)			
	SO ₂	CO ₂	O ₂	CO
BATTERY "A"	0,8	1,3	16,9	0,0
BATTERY "B"	0,9	2,2	15,4	0,0

1.3 Coal Distillation Gases Recycling

During the coking process, coal is subjected to temperatures of approximately 1,350°C in an atmosphere free from oxygen where volatile compounds pass to the gaseous phase. At these high temperatures, the gaseous phase, a product of coal distillation, is formed by hydrocarbons. This fluid passes through gas collectors and scrubbers, where it is separated from tar through the use of water which cleans and lowers the temperature of the gas to 45°C. At this stage, the gas is injected to the furnace burners to be used as combustible gas mixed with preheated air.

Gases produced in the coking process primarily consist of hydrogen and methane, besides nitrogen, propane and hydrogen sulfide to a lesser extent. It is necessary to point out that the group of phenols and heavy hydrocarbons form the coal tar that is transported to the reverberation furnaces from the copper smelter to be used as combustible fuel.

The typical composition of the coal distillation gases that are recycled to the same coke furnaces is recorded in the following table:

TABLE No. 4
(Percent Volume of Recycled Gas)

H_2	CH_4	N_2	C_2H_6	CO_2	H_2S	O_2	C_2H_4	CO
55,9	19,7	13,6	3,6	1,4	0,8	0,6	1,5	2,9

2. MITIGATION ALTERNATIVES

The Curran Knowles coking furnaces at Centromin are conventional-type furnaces with subproduct recovery, a design used in the United States since 1941. In these furnaces, coal is loaded and arranged on the heat-resistant floor through the length and breadth of each furnace to form a load of 2.45 m x 9.75 m with a height extending to 0.32 m.

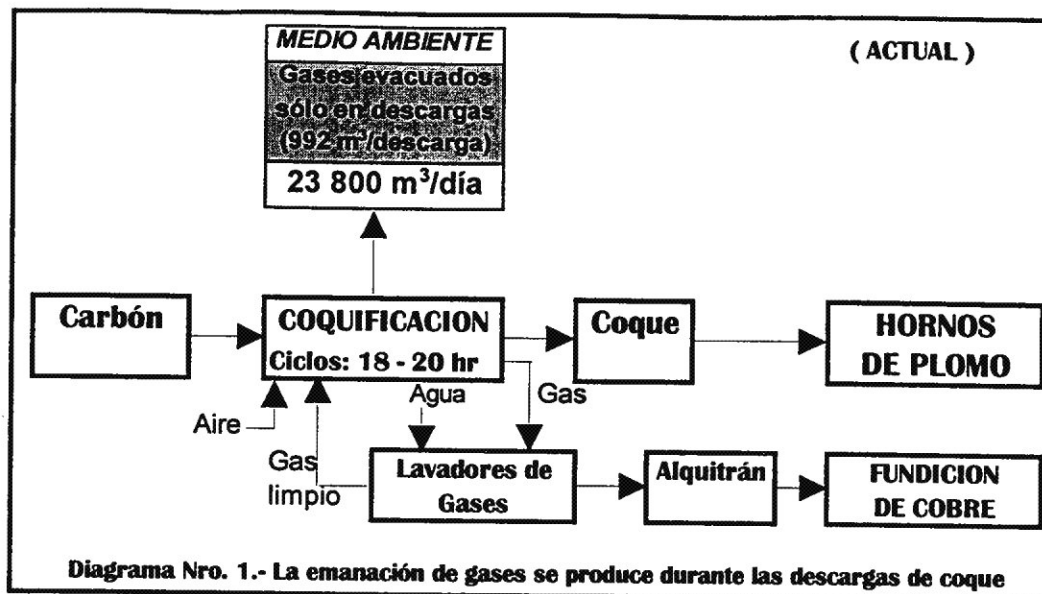
Metallurgic coke production from the Lead Smelter dates back to 1944. Currently, there is a national shortage of bituminous coal suitable for coking and agglomeration to produce porous, resistant coke, with good heating power and little ash content to be used as a fuel and reducer with lead sinters in the low-blast furnace chimneys.

Until the end of 1971, domestic coal (Goyllar) with a high ash content (20%) was used. It had a very short coking cycle (14 hours/furnace), produced almost 33,000 mm³/d of coal distillation gases, whose emission to the atmosphere was of real concern.

Coals from Colombia were processed and mixed with Goyllar coal between 1988 to May 1993. Domestic coal lowered the coke production quality and at the same time prevented the mitigation of distilled gases emitted to the atmosphere.

With the use of Prodeco de Columbia coal in 1988, whose average composition was 23%:MV, 69%:CF and 8% ash, there was an increase in the production capacity of the coke plant and a reduction of distilled gases emitted to the environment.

This project's main objective is to mitigate fugitive gas and dust emission produced in the coking furnaces during acquisition of the final coke. The current operational conditions are described as follows:



The following alternatives are proposed as mitigation measures for the coke plant with regard to the fugitive gas emission produced during coal distillation.

2.1. Selected alternative

2.1.1. Operate furnaces with coking cycles of 24 or 26 hours.

Taking into account future positioning and market dependance on metallurgic coke, we propose to mitigate the problem of fugitive gas emission by operating coking furnaces with 24 to 26 hour cycles, replacing the differential coke amount with imports.

The amount of coal fed to the coking ovens (currently 5.6 t/furnace) fulfills the coking process starting from drying, plasticity, swelling, then graphitation, coke formation and contraction. The final coke product has a porous aspect, and is stable, hard, agglomerated and resistant for its work in with the slag in the the low-blast furnace chimneys.

Generally this coking process should be developed in a minimum time of 24 to 26 hours so as to complete the cycle. This process, however, is currently done in less time, 18 or 20 hours (before it was 14), making the gases and volatiles of the process still in the furnace discharge to the atmosphere when opening the furnace to obtain the coke.

Therefore, one of the alternatives to mitigate gas emissions to the environment is to increase processing time from 4 to 6 hours, that is to say to operate with 24 to 26 hour cycles. With this, there will be a deficit of thick coke for lead furnaces, and according to consumption estimations, the regime of coal and coke acquisition would annually be as follows:

Purchase of 41,000 t of coking coal to produce 27,000 t of thick coke.

Purchase of 8,200 t of thick coke from a third party coke supplier.

2.2. Other alternatives

2.2.1 Installation of Ventilation Systems (SVEL).

Installation of Ventilation Systems to capture 23,800 m³ of gases daily, would involve installation of high temperature resistant iron ducts (650°C), with special valves, scrubbers, ventilators, sedimentation pools, and installation of additional equipment such as quenching cars, close transportation cars, and duct systems. Current production could thus be maintained, with 18 to 20 hour cycles and purchase of extra coke would be avoided. Obviously, the large problem for this alternative is the permanent cost of equipment maintenance and the lack of room available at the coke plant.

2.2.2. Fully substitute coal purchase by metallurgic coke

In 1985 and 1993 the operation of lead furnaces were assessed with Japanese (Mitsubishi) and Colombian (Coals and Minerals) coke. Results have not been totally satisfactory; first because coke was of steel quality and second because the purchase value in comparison to coke prepared at our plant, was greater by almost US\$45 per ton. However, it is possible to look for other coke suppliers so as to "close" the plant and operate the smelter with via coke purchases from third parties similar to that at the Empresa Peñoles de Mexico. However, this would mean an annual average cost of US\$7.5 million dollars compared to the current cost of approximately US\$5.5 million dollars.

2.2.3. Propose a coal supplier to manufacture coke near La Oroya

Invite and induce third parties to produce and supply coke within the region, through contracts or agreements.

2.2.4. Build state-of-the-art coking plants without subproduct recovery.

Request building vertical furnaces with lateral heat transmission, patents from OTTO HOFMAN or KOPPERS-BECKER from the U.S.A., N.A. or KEMBLA COAL AND COKE from Australia.

2.3. Performance schedule for the selected alternative.

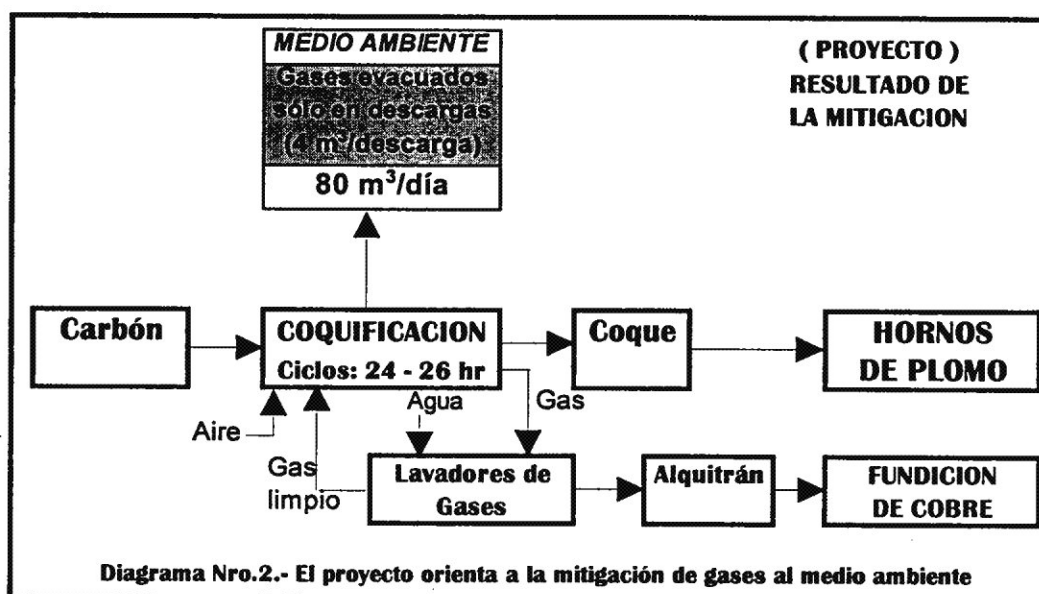
Operating the coke plant with coking cycles of 24 to 26 hours depends on the availability of coke for furnaces. Thus, the performance schedule for this project is primarily aimed at scheduling purchase of metallurgic coke in bulk, as follows:

TABLE No. 5

DATE	ACTIVITY
1 to 15/Dec/96	Contact with manufacturers and providers of metallurgic coke.
15 to 30/Dec/96	Preparation of Bids or Public Award
1 to 19/Jan/96	Reception of coke proposals and samples for pre-studies of quality.
11 to 15/Jan/97	Qualification of proposals
16 to 20/Jan/97	Knowledge and details of the Acquisition with the selected winner.
21 to 30/Jan/97	Coke reception at Callao
1 to 28/Feb/97	Send Coke to La Oroya
1ro. March/97	Coke plant operation with cycles > 24 hours/oven and fugitive gas mitigation to the environment.

3. RESULT OF MITIGATION

3.1. We project environmental decontamination as shown in this diagram:



To achieve this result we estimate there will be an annual additional cost of approximately US\$670,000, which would be justified from an ecological and sustainable development point of view. The evacuation of fugitive gases will be reduced to a minimum (80 m³/day) since the coking furnaces will be operating in cycles greater than those currently used. This will allow the complete processing of coal to coke. Therefore, fugitive gas emissions presently sent to the atmosphere will be captured and scrubbed, then recycled in the furnace where they will be burned with available air in the flammable-combustion ducts in order to keep furnace floors with average temperatures of 1,350°C.

TABLE No. 6

	Current Impact Evaluation (922 m³/discharge)	Mitigation Result (4 m³/discharge)
GAS EMISSION TO THE ENVIRONMENT (Cubic Meters per day)	23 800	80

3.2. Particle Emission

With gas emissions of 80 m³/day (4 m³/discharge) we assure that particle emission to the environment will be less than the maximum level allowed (100 mg/m³), required by the Ministry of Energy and Mining in accordance with Ministerial Resolution No 315-96-EM/VMM.

Also, As and Pb concentrations in these gases are practically null, meeting articles 4 and 5 of the above-mentioned Resolution.

3.3 Air Quality

The concentration of Pb : 0.018 µ/m³ and As: 0.012 µ/m³ in new emissions to the environment will be below the NMP requirements for air quality (attachment 3) according to Ministerial Resolution 315-96-EM/VMM.

5.4.3 PROJECT N° 3

USE OF OXYGEN GASES IN THE ANODIC WASTE PLANT

1. OBJECTIVE

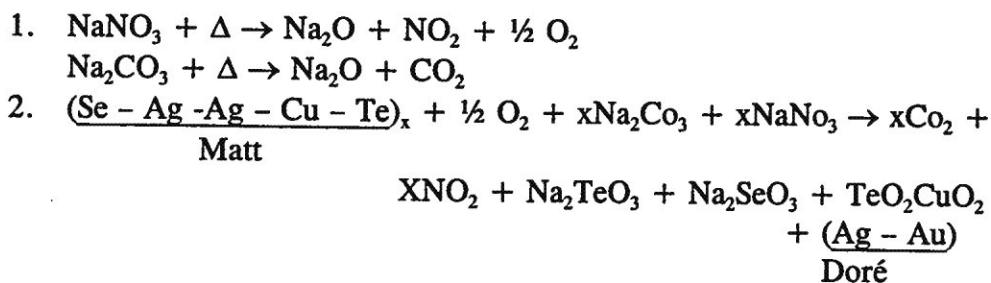
This project's main objectives are to reduce the No.6 residual oil consumption in the Anodic Waste Plant resulting from the use of oxygen-enriched air for combustion, and the elimination of nitric gases produced by sodium nitrate, an oxidizer used in the final stage of the cupelling process.

2. ENVIRONMENTAL IMPACT ASSESSMENT

The Anodic Waste Plant treats anodic sludges from the copper and lead refineries, which constitute the raw material to obtain doré, bismuth, selenium and tellurium. To obtain doré, these anodic sludges are processed in three stages : fusion, conversion and cupelling

The last stage of the batch cupelling process which as a whole lasts around 7 days, is doré “washing” with sodium nitrate. This “washing” stage lasts 24 hours and produces nitric gases that contaminate the environment (Diagram 1).

The average sodium nitrate consumption is 160–180t/year. The following are reactions that may take place during the process:



In the previous reactions, the oxidizer is the oxygen released when sodium nitrate is reduced to NO_2 , the carbonate allows the oxygen reactions to be prolonged.

3. ALTERNATIVES FOR RELIEF

3.1 Gaseous Oxygen Use in the Cupelation Process

This process consists of replacing the sodium nitrate used in the Cupellation process with gaseous oxygen, which would prevent the production of nitric gas contaminants.

4. PROCESS DESCRIPTION

This process is aimed at replacing sodium nitrate with the injection of oxygen gases to the metallic bath through a lance and/or special burner, simulating the **Ausmelt Technology**.

- **Mitigation Results :**

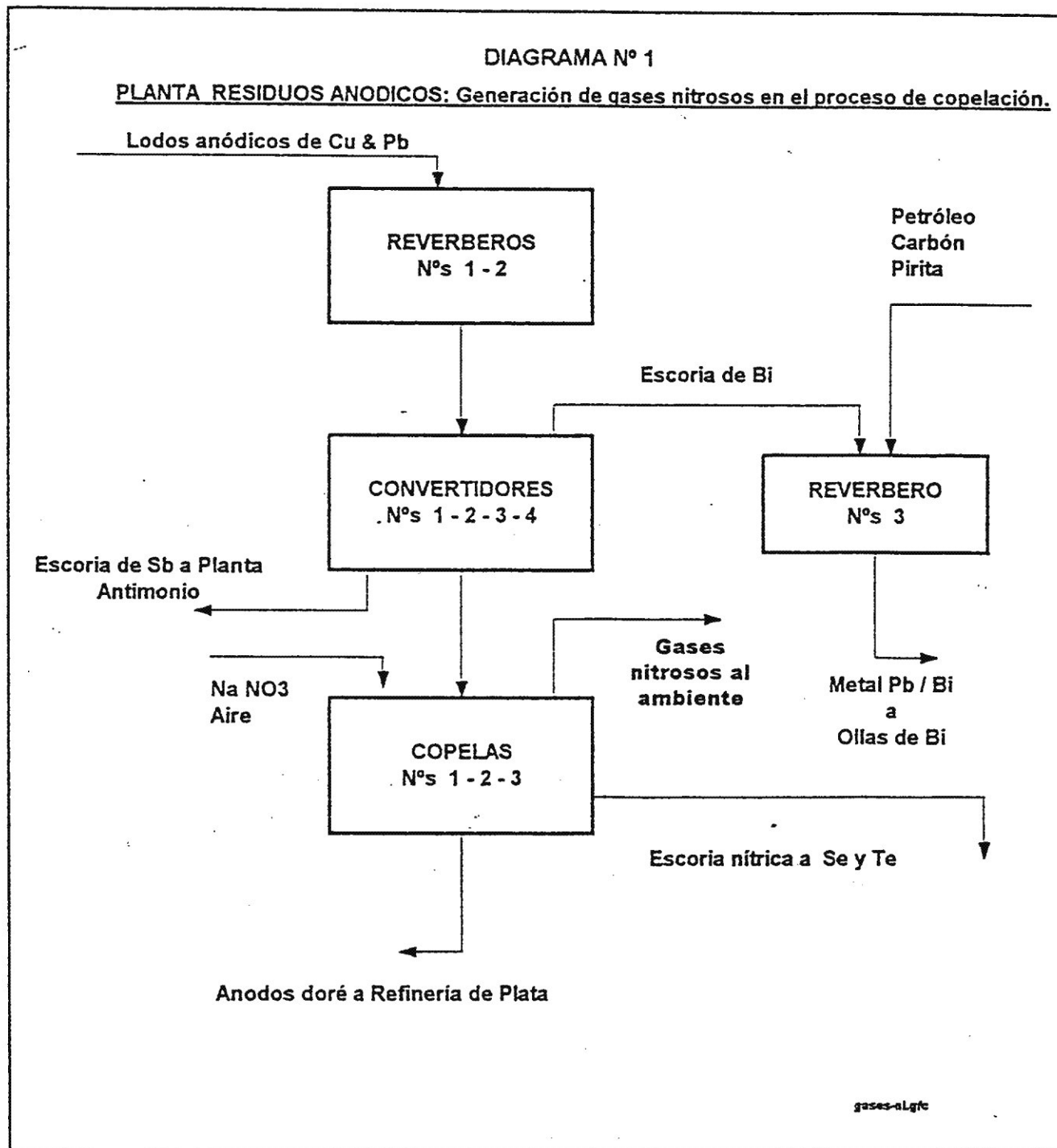
If sodium nitrate use is eliminated from the last stage of the Cupellation process, nitric gases will not be emitted to the environment.

5. INVESTMENT AMOUNT

The estimated cost for this project's execution amounts to US\$ 391,000.

6. SCHEDULE :

Currently, the project being executed. The first stage is about to be finished, that is, the use of oxygen in the residual oil No.6 combustion. The second stage, which includes oxygen use in the Cupelation process, should be concluded next year.



5.4.4 PROJECT N° 4

AREA AFFECTED BY SMOKE

1. OBJECTIVE

To delimit and rehabilitate the area affected by smoke considering the existing flora, fauna, soils, water, etc. Likewise, to establish control points regarding air and soil quality in order to take corrective actions.

The affected rehabilitation area includes four stages:

- Cover crops
- Gully Control through dikes
- Terrace Cultivation and Planting
- Slope Modification

1.1 Study of the Area Affected by Smoke

a) Diagnosis

Lately, the areas affected by smoke have not had as vast a recovery, as that experienced in between 1941-1971 (from 14,190 ha to 4,170 ha). As of January 1996 an affected area of 3,829 ha was recorded.

The time period during which the majority of soils were recovered correspond to the time when electrostatic precipitators were implemented and the process was improved. These measures had a rapid response within its area of influence. Soil recoveries since 1971 has not had as remarkable effects as those mentioned above.

Of course, it can not be ignored that the presence of vegetables in the core of the affected area is showing a slow and spontaneous presence which is a more remarkable recovery than in areas where planned planting and forestation works have been conducted. This evidence indicates that the recovery is advancing slowly, but has not stopped.

With respect to the notable recovery in 1971, the Huaynacancha area recovery is remarkable because the area had no greenness prior to recovery. Today, the landscape is more agreeable, with areas of thick vegetation and other areas with scattered vegetation recovery which probably covers an area similar to that of the concentration of thick vegetation. On the other hand, the current presence of birds and wild animals such as goldfinches, house sparrows, thrushes, ducks and huachuas, as well as vicuña herds, leads us to believe that the expelled smoke were not as harmful as in the past.

b) Environmental situation of the ecosystem and natural resources in the affected area

During the camp visit and the delimitation work, it was possible to observe in situ damage to the original soil cover, the formation of gullies, growth of vegetation resistant to the smelter smoke, as well as spontaneously recovered vegetation. It was also possible to collect soil and water samples and to observe the existing fauna.

c) Inventory and assessment of the vegetation in the affected zone.

This operation includes identification of the existing species in the affected area.

Plant species found in the studied zone include herbaceous plants, shrubs and trees. The herbaceous plants included wild species which spontaneously grew as well as cultivated species such as flowers. Among the shrub species there are also wild and cultivated species. All tree were planted, some of them, typical for this altitude and weather zone and others which were imported from others zones and acclimatized to this area.

Wild herbaceous species : Chicory, plantain, kikuyo, mullaca, yanta, mint, amor seco, etc.

Cultivated herbaceous species : Flowers such as calendula, carnation, pepper cress, pansy, daisy, ,buttercup, copa de oro.

Wild shrub-like species : Chilca

Cultivated shrub-like species : Broom, American broom, agave (maguey).

Wild arboreal species : Depredated.

Cultivated arboreal species : Kolle (Buddleya coriacea), quinoa tree (Polyle-pis racemosa), capulin (Prunus capolinus), cypress (Cupressus Sp.).

Regarding **PASTURES** in areas showing recovery, species and natural pastures associations were determined along with their composition and their ability to revegetate. In the studied zone, the recovery of pasture vegetation is still incipient, thus not being adequate for cattle feed. The local pastures sustain at most three wild vicuña flocks which graze in the area from time to time.

Kikuyo and Festuca sp have not shown real recovery.

Regarding **FORESTRY**, it includes identification of the existing species in the natural woods that correspond to the same ecological level of the study area, including native and imported species.

No spontaneously growing specimen has been found in the affected area.

Cultivated trees identified in the area include native species such as Kolle and Quinoa Tree. These species disappeared not only because of the smelting smoke, but also because of influx of humans. Besides the aforementioned trees, there are other imported species which have been acclimated to the zone; these include Cypress, Capuli, Qishuar, etc. which have adapted to the zone's ecological conditions. Currently local governments and Centromin Perú are interested in forestation.

Regarding FAUNA, it includes inventory and identification of species considering both, wild and domestic fauna.

Within the wild fauna category, three vicuña flocks have been found. These flocks graze and drink within the seriously affected area.

Likewise, wild ducks and a huachua species which utilize the small lagoon located in the mid- Huaynacancha valley were observed. Also there is presence of bird species such as goldfinches and thrushes.

Dogs and cats are raised within the La Oroya community for security and/or pet reasons and as well as hunting. Other wild animals in the area include rats and mice. All the mentioned animal species do not seem to be affected by smelter smoke.

d) Objective

The affected area delimitation project, is aimed at determining the area damaged by smoke, conducting studies to establish the condition of the affected areas regarding flora, fauna, soils, water, etc., as well as establishing control points for air and land quality monitoring which will supply valuable information that will allow us to outline measures to rehabilitate the study area and other appropriate zones.

e) Solution Alternatives

If the rehabilitation is carried out by means of crops, only the increase in organic matter will be effective, but once this increase is achieved, the other chemical and physical effects will take place.

Besides that, it is necessary to use different techniques to prevent further land deterioration and to help the spontaneous recovery process observed in the Huaynacancha zone, through dike construction, gully modification and terrace building.

There are vast areas which could be used to for experimental revegetation plots and perhaps to definitively revegetate the are. There are other areas where soil can be tilled (turned over) as to facilitate pluvial water holding and absorption, and to prepare soil to shelter or anchor seeds produced by surrounding plants and dispersed by the wind. Revegetation through wind dispersal is based on what was observed in different zones where land movement occurred resulting in a spontaneous plant growth. In addition, it may be possible to proceed with reforestation of areas not only on slope and gully bottoms, but also amidst mild hillsides which are abundant in the Huaynacancha zone. To do so, it is necessary to use double cut seedlings which are more developed and stronger, assuring a safe survival.

It is possible to avoid formation of new gullies and growth of existing ones through proper works already described in previous paragraphs, namely planting herbaceous, shrub-like and arboreal vegetation in the big gullies basins. These species can be native or imported, with a specific use or not, the objective is to cover nude areas and prevent further erosion.

It is possible to recover hillside vegetation near the smelter by planting crops or arboreal species, since the soil analysis has had favorable results both in characterization and composition.

All these things will require time and investment, see Table 5.1, "Investment Schedule for the Recovery of the Area Affected by Smoke".

f) Technical and economic feasibility analysis

Recovery plan elaboration

This plan will be aimed at recovering areas where recovery has a likelihood of being achieved. Possibilities of achievement are given by soil characteristics, surface morphology and perhaps in some cases, irrigation possibilities with water sources located in the study area.

Altitude and climate together with soil poverty in the areas to recover, require a rather aggressive environment flora development program to be implemented, thus limiting the species diversity that are numerous in other areas at the same altitude, but with better soils.

Possibly, shrub-like and herbaceous species, native or adapted, will have better results in revegetation. They are aimed at eliminating or moderating the erosion that the studied lands suffer at present due to the action of pluvial waters and wind, which act directly on the denuded soil. At the same time they are aimed at improving the environment.

The conditions of the denuded soil and the local climate are not appropriate for timber wood vegetation, but could be adequate for block woods with native arboreal species such as kolle, quinoa tree and imported species like capuli, cypress and quishuar, which have shown good adaptation to this environment.

From what we have observed in our camp visit, we think that the Huaynacancha valley zone, where the similarly named people settled, is an area where recovery works can be conducted. Recovery could be possible on moderate slopes containing few rocky lands and a somewhat soft subsoil. These slopes should be accommodating to both, plain soil breaking and terrace building in order to settle crops that extend or improve the spontaneous plant growth as observed in its low regions; as well as to carry out vegetation recovery works with native and adapted arboreal species. Likewise, it is necessary and feasible to avoid further extension of existing gullies. This can be done with the works that include filling and clogging of gully heads. Moreover, in the larger parts of the gullies, slope profiles can be modified in order to prevent land slides, and to facilitate its coverage with herbaceous, shrub-like or arboreal vegetation.

As a complement to these actions, it is possible to consider the use of terraces or terreplanes to reduce the speed of soil erosion produced via runoff waters, thus impeding the subsequent gully formation.

We have mentioned that there are various actions we can take to improve and/or help the vegetation recovery in the study area. Among these actions, we mentioned:

Rehabilitation and Conservation of Soils through Crops

Soils within the area that has been seriously damaged by smelter smoke have been denuded of vegetation for years, thus they are freely exposed to erosion and washing of mineral elements due to the seasonal rainfall every year. This compels us to think that rehabilitation of the affected lands will be a slow and expensive process (see Table 5.1A and charts 1-580-00-300 and 1-559-01-2008).

The rehabilitation of the area through crop development will only be effective with an increase of organic matter. Once the organic matter is established other beneficial chemical and physical soil components will develop.

The soil's mineral content will not increase with crop development. However, the mineral content currently present in the soil will be conserved as vegetation cover increases and prevents further reduction of minerals due to soil washing and erosion.

In order to achieve true soil rehabilitation, therefore, a permanent soil cover or prairie is required.

Permanent grass will increase the soil's organic matter especially due to the development of its radicular system.(?)

Herbs that are in good vegetative condition increase their root extensions every year while decomposition of old roots increases organic matter. Most of this matter remains in the soil which can be cultivated again similar to that of a prairie.

Regarding the reposition of mineral elements eliminated from the soil due to washing and erosion, these cannot be restored through plant and crop development, since the minerals within plants and crops are derived from the soil. The addition of lime, phosphorus and potassium that the land requires to support vegetation and rehabilitate the soils are elements that will be supplied by commercial fertilizers.

Nevertheless, when plants restore organic matter, they restore at the same time nitrogen to the soil. Legumes are the plants which rapidly accumulate nitrogen, extracting most of it from the air.

In the case of the study area, vegetation may be used for land rehabilitation. In the lower regions of the Huaynacancha valley, this recovery would be through cultivation of grasses and legume plants which will be planted sporadically to better control erosion.

Plant species used with good success in zones with altitude and weather conditions similar to those of the studied zone are rye grass and white trefoil, species that offer an ample and dense bunch of shoots, giving the soil a very good cover.

Prior to planting the aforementioned vegetation association, it is necessary to fertilize the area with lime and manure to improve the conditions of the soil that will sustain permanent vegetation after many years of washing and erosion.

It is warned that the lime fertilization process throughout the affected region will be a burdensome operation due to the volume and preparation time involved. In the end, the vegetal cover will reduce this lime deficiency, thus solving this problem.

It is also worth it to mention that revegetation through the use of crops also permits plants to preserve the soil only to the extent in which cultivation is compatible with minimal soil removal during plowing operations and in proportion to the soil density and vegetation stability. It has been observed that in some areas, located within the seriously affected zone, where land movement occurred, the removed soil has been entirely covered by herbaceous vegetation, especially grasses. We think that this recovery is due to the fact that soil movement has increased the soils ability to holding and/or absorb pluvial waters, allowing the land to be conditioned for seed anchoring and dissemination, and promoting easier germination and sprouting.

From what has been said, some areas can be planted directly for vegetation cover, while other areas will require tilling before the rainy season in order to facilitate a recovery similar to that observed in many zones affected by smelter smoke.

g) Gully Control

From all the gifts of nature, none is so essential for mankind as land. This complex mixture of animal, plant and mineral material that covers the rocky core of the globe at different depths is one of the four primary elements essential for life.

Together with sun light, air and water, land nourishes plant life and sustains all living beings.

In the area affected by the smelter's smoke, the native vegetation has disappeared; leaving the soil unprotected and exposing topsoil to the forces of erosion. As a result the fertility of the land has been reduced and gullies have formed. These gullies cross Huaynacancha valley and the area located opposite the smelter have formed.

Since gullies tend to drain the soil moisture which is adjacent to the gullies, surrounding fields dry out rapidly, thus hampering the recovery of plant cover in the area.

As the size of gullies increases, they expand into the field. If their development is not stopped, it will be necessary to suspend the recovery project. This is because of the fact that as gullies extend backwards and cross natural depressions, lateral falls and, more gullies appear. This branching process can continue until a gully network covers the entire valley, making it impossible to control such processes due to the magnitude of gully formations and the expenses involved to reclaim them.

Therefore, it is necessary to use different techniques to prevent further land deterioration, and to aid in the spontaneous vegetation recovery process as was observed in the Haynacancha zone.

h) Dike Building

Unless the surface is soon protected with vegetation or the tops of gullies or "caniculus" are erased by means of crop planting or other actions, gullies will continue to expand with each subsequent rain event. The deepest caniculus can increase in size and form gullies that it will be impossible to erase with normal plowing methods, as has occurred with the gullies located across from the smelter and in the Huaynacancha zone. Under such circumstances, it will be necessary to spend money for labor to fill or build dikes in the caniculus course.

The construction of dikes in staggered form in areas where gullies still remain as small furrows will permit allow the gullies to clog with waters that flow down the caniculus loaded with sediments that can be deposited behind the dike. This, in turn, would raise the gully beds and reduce gully formation. This filling by deposition or clogging is facilitated by the dike, which can be built with compact stone and branch piles positioned at the bottom of the gully, and also by vegetation, if any, and other obstacles that can help to reduced the rate of the runoff flow. Besides using stone dikes, mesh and branch dikes can also be used in larger and shallower gullies.

i) Gully Modification

Any gully, regardless of its size and condition, will often be recovered with vegetation, if it has an adequate protection and is located in a region where vegetation can grow.

In affected lands, as those observed in the seriously damaged areas at La Oroya, there are various causes that delay the disappearance evidence of erosion.

One of these causes is the steep slope of gully walls. As long as these walls do not naturally collapse, or are not modified to form a more moderate slope, it will be difficult for plants to establish roots. Thus, modifying slope profiles where gullies are largest will allow revegetation to occur and prevent further erosion from rainfall.

Slopes that have been modified or prepared to facilitate germination of airborne seeds, cultivation plants, and tree species will first support underbrush (thicket or weeds that grow quickly).

Based on our field observations, the underbrush will grow slowly first as it is difficult to establish roots. Then, when the first plants have somewhat improved the soil, new plants will appear. This natural process may take many years in the zone, due to its altitude and extreme weather condition, but it will be faster where humidity is higher. As time passes, the natural revegetation process will cover the gully with the vegetation that prevails in the zone, that is brushes or herbs.

With regards as to how to stop erosion in the affected zone, the vegetation species used are irrelevant. Trees, brushes or grasses may be used. Any type of plant cover will provide good soil protection, if satisfactorily established.

In the study zone, spontaneous vegetation is not enough to counter erosion activities. So we think it is necessary to resort to other means and resources in order to artificially settle vegetation.

When choosing trees, bushes or grasses to be planted in the gully slopes, it is better to choose native plants or those typical to similar regions. These plants have already adapted to the local conditions, and thus are more likely to thrive under the serious growth limitations associated with the gully and climate environment. If useful native plants were not satisfactory, then species brought from other regions should be used.

Planting of native species like Kolla, Quinoa tree, etc. should be extended to other areas, planting in blocks and using double cut seedlings, so these plants will already have an almost ligneous structure, which assures their survival, and speeds up their edaphic action in the surrounding soil.

This action in Huaynacancha valley should be successful, since in steep slopes there are more or less abundant and well developed vegetation has spontaneously grown, probably as a result increased moisture and the microclimate generated as a result of the slope formation.

j) Terrace building

One of the best known methods to stop erosion on slopes is the use of terraces. They are very efficient to correct small shallow gullies where it is not possible to use machines. Terrace building may be difficult and expensive in a zone seriously affected by erosion; nevertheless, it is the most efficient corrective measure for slopes such as those found in the study zone, especially since there are many steep parallel, hard-to-farm gullies in the region.

Terraces are built as a series of flat or almost flat strips of land across the slopes of steep lands. Terraces are one of the oldest artificial means to stop soil erosion, and have been used for many centuries in Peru, due to the scarcity of tillable soils in mountainous regions with favorable weather conditions.

The purpose of the terraces are to intercept water flowing downgradient on flat lying lands that can retain the flow until it trickles down and is absorbed by the plants growing on the platform.

When a terrace is built, it should slope inwards from the outside edge towards the slope base or end, which is almost vertical.

Water will flow along the bank at different speeds according to the type of soil, the terrace length and, of course, rainfall and well-developed plant cover.

An advisable vegetation mix to cover the platform is the joint planting of ray grass and white trefoil, both of which have a leafy cluster of shoots which offer better soil coverage. Generally, it is advisable to use more than one species that are compatible in combinations, because pure shoots are often vulnerable to harmful influences, diseases

	0	3 447	3 447	1 149	8 043
. Sow	0	23	23	8	54
. Seed	1 109	1 109	1 109	0	3 326
. Plants	896	299	896	0	2 091
. Transport	1 589	3 178	3 178	533	8 477
					68 012
5. ADMINISTRATIVE COSTS AND OTHERS	59 353	101 748	101 748	101 748	364 597
TOTAL :	356 824	442 858	406 632	392 477	1 598 790
TOTAL + Taxes :	89 544	111 133	102 043	98 491	401 210
	446 367	553 991	508 674	490 967	2 000 000

5.4.5 PROJECT N°. 5

COPPER REFINERY'S MOTHER WATER TREATMENT PLANT

1. OBJECTIVE :

The main objective of this project is to treat acid-ferrous solutions poured into Yauli river to obtain a neutralized solution that can be discharged after nickel recovery, and to purify the raff solution to obtain a final effluent with contents and impurities below maximum allowable levels (R.M.N. No. 011-96-EM/VMM).

2. ENVIRONMENTAL IMPACT ASSESSMENT

To maintain the level of impurities in the Copper Refinery's electrolyte, 30 to 40 thousand liters are daily extracted from the circuit and then transferred to the neutralizers. In these neutralizers a saturated solution is produced through steam heating, addition of electrolyte copper scrap and copper oxide, and evaporation/oxidization with air. This solution can produce copper sulfate through vacuum crystallization.

CuSO₄ crystals are separated by centrifugation and the resulting mother water is partially recirculated to the neutralizers. The excess is transferred to a precipitation tank where is steam heated, iron scrap added to recover smelted copper, and then returned to the smelter. The copper free acid-ferrous solution (11,000 l/day) is finally discharged to the Yauli river (diag.No.1)

The average analysis in g/l of mother water and effluents flowing to Yauli river show the following results:

Mother water

H ₂ SO ₄	Cu	Fe	As	Sb	Bi	Ni
130	54	2,5	3,5	0,36	0,12	1,7

Effluent:

pH	Cu	Fe	As	Sb	Bi	Ni
2	12	0,14	3,5	0,15	0,03	0,17

and pests.

Before planting, it will be necessary to fertilize the platforms with lime and manure to improve water holding capacity, crop development and good fruit growth which at the end of the vegetative period, will allow seeds to be established to regerminate the terrace's farm soil.

Trees can be planted on the edge of the terrace or platform so their roots will prevent rain water from flowing over the wall-edges. They also can provide windscreens and microclimates for the terraces, as well as protect the terrace vegetation against extremely cold weather or periods of low water availability.

TABLE N° 5.1
INVESTMENT SCHEDULE FOR THE RECOVERY OF AREAS
AFFECTED BY SMOKE
U.S. \$.

ACTIVITY TO DEVELOP	1997	1998	1999	2000	TOTAL
	10 832	14 442	16 248	18 053	59 574
	10 638	10 638	10 638	10 639	42 553
. Seed	66 000	66 000	66 000	66 000	264 000
. Fertilize	116 054	154 739	174 082	193 423	638 298
. Transport	425	425	425	427	1 702
					1 006 128
. Rock transport.	170	0	0	0	170
. Rock placement	426	0	0	0	426
. Mobility	477	0	0	0	477
2.2 MESH DAM	0	0	0	0	1 072
. Make holes	142	0	0	0	142
. Wood	638	0	0	0	638
. Mesh	246	0	0	0	246
. Haulage of materials	85	0	0	0	85
. Planting	851	0	0	0	851
. Transport	340	0	0	0	340
3. GROWING AND PLANTING OF TERRACES					2 302
	12 325	0	0	0	12 325
	7 660	7 681	0	0	15 341
	2 849	1 425	0	0	4 273
	22 860	11 430	0	0	34 291
. Preparation of holes	11 395	11 397	0	0	22 792
. Haulage of materials	1 418	2 128	0	0	3 546
. Plants	4 272	4 275	0	0	8 547
. Seed	6 798	6 798	0	0	13 596
. Sow	1 095	1 097	0	0	2 192
	7 122	7 123	0	0	14 245
	8 063	16 125	1 344	0	25 532
4. SLOPE CHANGES					156 678
. Preparation of soils	0	15 319	20 426	0	35 745
. Preparation of holes	0	0	5 576	0	5 576
	696	350	0	0	1 046
. Haulage	0	170	0	0	170
. Planting	0	1 494	1 494	498	3 485

TABLA Nº 5.1
CRONOGRAMA DE INVERSIONES DEL PROYECTO RECUPERACION
DEL AREA AFECTADA POR LOS HUMOS - en U.S. S.

ACTIVIDAD A DESARROLLARSE	1997	1998	1999	2000	TOTAL
1. CULTIVO DE COBERTURA					
. Roturado	10 832	14 442	16 248	18 053	59 574
. Mano de obra	10 638	10 638	10 638	10 639	42 553
. Semilla	66 000	66 000	66 000	66 000	264 000
. Abonamiento	116 054	154 739	174 082	193 423	638 298
. Movilidad	425	425	425	427	1 702
					1 006 128
2. CONTROL DE CARCAVAS POR DIQUES.					
2.1 DIQUE DE PIEDRAS SECA					
. Acarreo de piedras.	170	0	0	0	170
. Acomodar piedras.	426	0	0	0	426
. Movilidad.	477	0	0	0	477
2.2 DIQUE DE MALLA	0	0	0	0	1 072
. Hacer huecos	142	0	0	0	142
. Madera	638	0	0	0	638
. Malla	246	0	0	0	246
. Acarreo de materiales	85	0	0	0	85
. Plantación	851	0	0	0	851
. Movilidad	340	0	0	0	340
					2 302
3. CULTIVO Y PLANTACION DE TERRAZAS					
. Motoniveladora	12 325	0	0	0	12 325
. Rotulado	7 660	7 681	0	0	15 341
. Abono	2 849	1 425	0	0	4 273
. Abonamiento	22 860	11 430	0	0	34 291
. Preparación de huecos	11 395	11 397	0	0	22 792
. Acarreo	1 418	2 128	0	0	3 546
. Plantas	4 272	4 275	0	0	8 547
. Semillas	6 798	6 798	0	0	13 596
. Sembrio (Mano de obra)	1 095	1 097	0	0	2 192
. Plantación (Mano de obra)	7 122	7 123	0	0	14 245
. Movilidad	8 063	16 125	1 344	0	25 532
					156 678
4. MODIFICACIÓN DE TALUDES					
. Preparación de suelos	0	15 319	20 426	0	35 745
. Preparación de huecos	0	0	5 576	0	5 576
. Abono	696	350	0	0	1 046
. Acarreo	0	170	0	0	170
. Plantación	0	1 494	1 494	498	3 485
. Abonamiento	0	3 447	3 447	1 149	8 043
. Sembrio	0	23	23	8	54
. Semilla	1 109	1 109	1 109	0	3 326
. Plantas	896	299	896	0	2 091
. Movilidad	1 589	3 178	3 178	533	8 477
					68 012
5. COSTOS ADMINISTRATIVOS Y OTROS	59 353	101 748	101 748	101 748	364 597
TOTAL	356 824	442 858	406 632	392 477	1 598 790
IMPREVISTOS	89 544	111 133	102 043	98 491	401 210
TOTAL + IMPREVISTOS:	446 367	553 991	508 674	490 967	2 000 000

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parallel to channel N° 1 (136)		• Pipelines for cooling water • Channel for rain water.
d) Electrolytic Zinc channel (126)	4	• Water of process. • Sewage water

- Refrigeration water will be collected by gravity and piped to the power-house for recirculation.
- Sewage water collected in the parallel canal (code 136), canal number 2 (code 119) and canal number 126 will flow together to canal 119 and then return to the current mixing point on the canal running parallel to the Mantaro river (code 136).
- Process waters from canal number 1 (code 135) and canal number 2 (code 119) will meet at the site where canal number 1 now pours into the Mantaro river (code 135). Process and sewerage water pipes will rest on metal supports. Pipeline design will ensure appropriate effluent circulation by gravity. The plan comprises tasks related to layout, land movement and mechanical installation of pipes.
- Process and sewerage water will be piped to a site across the Huanchan ferrite deposits, three kilometers from the metallurgic compound on the left downstream bank of the Mantaro river where the effluent treatment plant will be located.
- The rainwater sedimentation ponds will be located near the indium plant - zinc circuit. These ponds will collect rain water from the parallel and number 1 canals.
- Floor wash water from the copper agglomeration and roasting plants will pour into canal number 1 to be collected across the agglomeration plant and then pumped to the thickener.
- Process water containing copper and lead slag and effluents from the copper refinery is not covered in this study. Mitigation of their impact is analyzed in other projects.

3.3 Mitigation Project

3.3.1 Selection of options

Treatment of a single effluent combining process and sewerage water from the metallurgic complex and the treatment plant will help mitigate the impact of pollutants on Mantaro river water.

Neutralization to pH=7 - precipitation/flocculation - pH correction to 10.5 - precipitation/flocculation - pH correction to 8/9 - pouring into river.

The separation of solids and liquids to isolate metals from carrying effluents is an old practice in the metallurgical industry. The process takes advantage of the insolubility of metal hydroxides under base pH conditions. The neutralization, increase of pH and subsequent precipitation/flocculation is widespread in the mining and metallurgical industry and in other activities where molten metals are poured, including steel manufacturing, galvanoplastics, lamination, use of high furnaces, and others.

Mud from the two clarifiers used for flocculation/sedimentation is pumped and deposited on a controlled mud deposit provided with a geomembrane lining. Seepage and leached water are recycled upstream to the plant's head site.

Flocculants are necessary because the hydroxide precipitate is jelly-like and will rise to the surface. Therefore, polymers (flocculants) additionally to increasing sedimentation speed, prevent part of the precipitate from floating and escaping with the clarified liquid, thus hampering separation.

Table 3.1.1/1 shows data about plant operation. The plant was designed using Environmental Process Designer, an industrial process simulator for environmental purposes. Diagram 3.1.1/1 shows the plant's flow chart.

3.1.2 Other options

- Precipitation processes using sodium sulfur have been discarded due to their high cost.
- Other metal extraction processes that use solvents, selective ionic exchange, reverse osmosis, electrowinning, etc. were discarded because they exceed the daily treatment threshold and present technical and investment barriers.

4. RESULTS OF THE MITIGATION PROJECT

- The project includes treatment for all zinc smelter and refinery effluents though not those from the copper and lead refinery because effluent R-1 is treated in a separate project (Project No. 5; chapter V). Effluents with codes R-2, 103, 104, 105, and 113 have been removed. Effluent R-3 shows positive pollution levels.
- The treatment plant is designed to process about 9.1 cubic meters per minute, including process (90%) and sewerage (10%) water.
- Output from the effluents treatment plant poured into the Mantaro river will comply with maximum limits set by the Ministry of Energy and Mines for polluting elements. The corresponding figures appear in the following table.

Exiting Flow from NU-103 to River			
Components	Flow Másico (kg/h)	Concentration (mg/l)	N.M.P. (MEM)
As	0,0029	<0,01	1,00
Cd	0,0000	<0,01	-
Fe	0,0952	<0,02	2,00
Pb	0,0478	<0,01	0,40
Mn	2,3579	0,44	-
Cu	0,0000	<0,01	1,00
Zn	0,3086	0,06	3,00
Suspended solids	7,1933	13,4	50,00
pH	-	7,0	>6 <9

5. INVESTMENT BUDGET

The breakdown of the investment required to implement the project appears below.

Global Cost estimates	Amount (US\$)
1. Segregation system cost and Conduction of effluent within the Smelter.	282 742,33
2. Costs to adjust the smelter circuits according to the Effluent Management Plan (Copper, Lead, Zinc Circuits)	113 000,00
3. Cost to implement recirculation system for speiss granulation waters	52 000,00 *
4. Cost to implement domestic waste water treatment system at the Huaymanta Refinery	46 000,00 *
5. Cost to implement the domestic waste water treatment system at the Huaymanta Construction	55 000,00 *
6. Implementation of the sulfate deposits from the calcium plant at the fluorosilicic acid plant	72 000,00 *
7. Cost to connect and have pipes from the smelter to the treatment plant.	235 731,60
8. Installation of the Effluent Treatment Plant in front of Huanchan Ferrites.	2 440 422,14
Total Cost Estimate (±20%)	3 296 896,07

Total project investment amounts to US\$3,296,896 including other projects for which a separate budget has been established. Therefor, the cost of the new treatment plant has been estimated at US\$2.5 million. This reduced budget results from the above mentioned facts concerning effluents R-2, 103, 104, 105 and 113, and reduced amounts of industrial water

thanks to the recirculation of refrigeration water.

(*) Implementation of the Speiss recirculation system for granulation water. Project No. 10, Chapter V.

Implementation of the household sewerage water treatment at the Huaymanta refinery. Project No. 16, Chapter V.

Implementation of the household sewerage water treatment at the Huaymanta construction. Project No. 16, Chapter V.

Implementation of the disposal system for calcium sulfate at the fluoride salicylic acid plant. Project underway.

6. IMPLEMENTATION PERIOD

Project implementation time is estimated at two years.

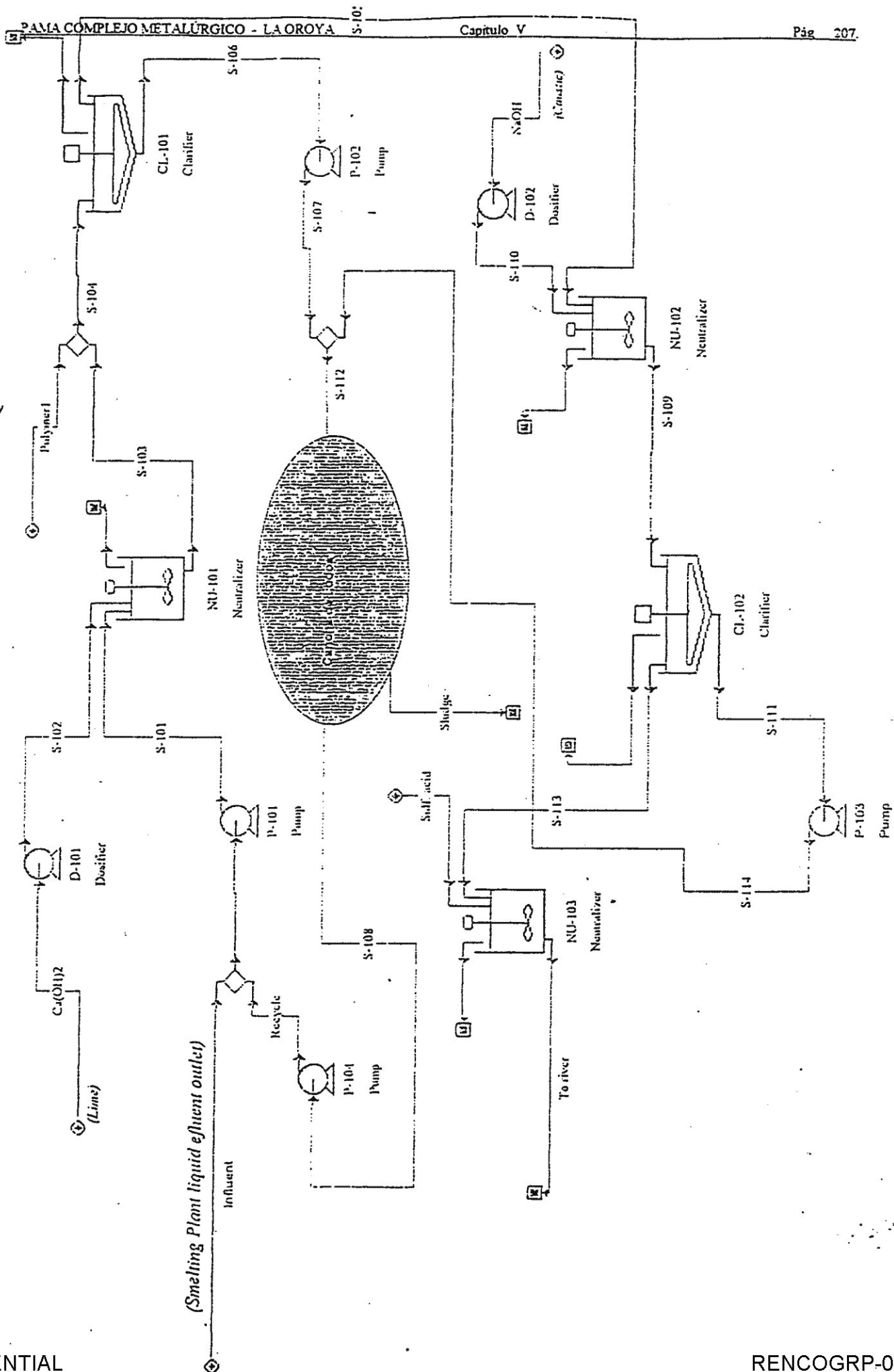
TABLE N° 3.3/1

Design Characteristics of the Plant to Different Operations Condition			
Equipment	Design Characteristics	A percentile 75%	Maximum operation condition
NU-101 Neutralizer	Vol Liq/Vol total	0,85	0,85
	Vol total (m)	161,54	161,54
	Vol liquid (m)	137,31	137,31
	Time de detention (h)	0,25	0,23
	Area (m)	58,85	58,85
	Height (m)	3	3
CL-101 Clarifier	Detention Time (h)	2,10	1,93
	Height (m)	3,5	3,5
	Diameter (m)	20,5	20,5
	Volume (m)	1 153,43	1 153,43
	Surface Area (m ²)	329,6	329,6
	Increase Velocity (m ³ /m ² -d)	42,00	43,61
NU-102 Neutralizer	Vol Liq/Vol total	0,85	0,85
	Vol total (m)	158,59	158,59
	Vol liquid (m)	131,80	134,80
	Detention Time (h)	0,25	0,23
	Area (m)	52,86	52,86
	Height(m)	3	3
CL-102 Clarifier	Detention Time (h)	2	1,8
	Height (m)	3,5	3,5
	Diameter (m)	19,8	19,8
	Volume (m)	1 078,38	1 078,38
	Surface Area (m ²)	308,1	308,1
	Increase Velocity (m ³ /m ² -d)	40,00	46,65
NU-103 Neutralizer	Vol Liq/Vol total	0,85	0,85
	Vol total (m)	158,47	158,47
	Vol liquid (m)	134,70	134,70
	Detention Time (h)	0,25	0,22
	Area (m)	52,82	52,82
	Height (m)	3	3
Mud Dam	Height (m)	4,0	4,0
	Volume (m)	55 797	55 797

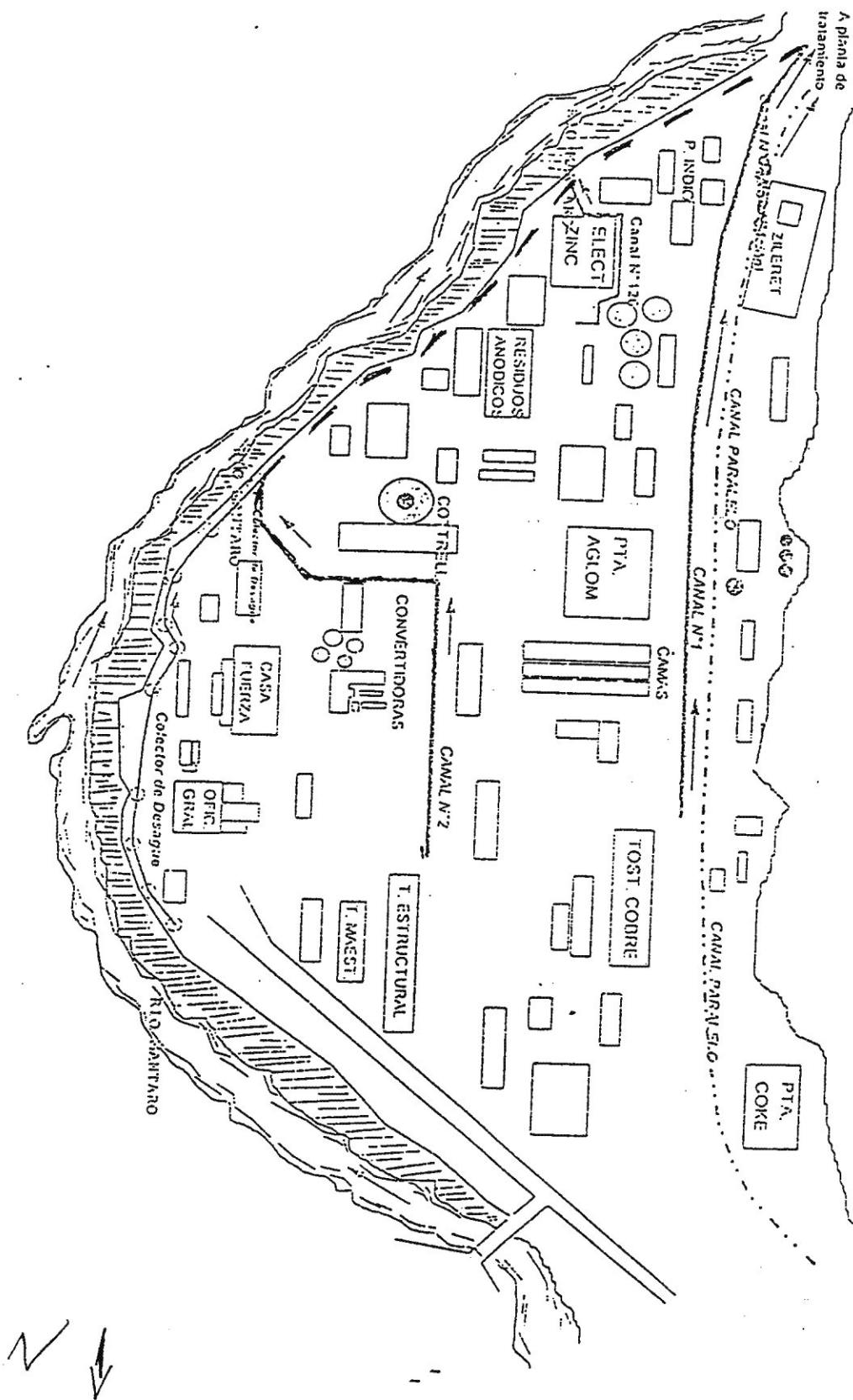
DIAGRAMA 3.1.1/1

TABLA N° 3.3/1

Características de Diseño de la Planta a Diferentes Condiciones de Operación			
Equipo	Características de Diseño	A percentil 75%	Condición máxima de operación
NU-101 Neutralizador	Vol Liq/Vol total	0,85	0,85
	Vol total (m)	161,54	161,54
	Vol líquido (m)	137,31	137,31
	Tiempo de detención (h)	0,25	0,23
	Area (m)	58,85	58,85
	Altura (m)	3	3
CL-101 Clarificador	Tiempo de detención (h)	2,10	1,93
	Altura (m)	3,5	3,5
	Diámetro (m)	20,5	20,5
	Volumen (m)	1 153,43	1 153,43
	Area superficial (m ²)	329,6	329,6
	Velocidad ascensional (m ³ /m ² -d)	42,00	43,61
NU-102 Neutralizador	Vol Liq/Vol total	0,85	0,85
	Vol total (m)	158,59	158,59
	Vol líquido (m)	131,80	134,80
	Tiempo de detención (h)	0,25	0,23
	Area (m)	52,86	52,86
	Altura (m)	3	3
CL-102 Clarificador	Tiempo de detención (h)	2	1,8
	Altura (m)	3,5	3,5
	Diámetro (m)	19,8	19,8
	Volumen (m)	1 078,38	1 078,38
	Area superficial (m ²)	308,1	308,1
	Velocidad ascensional (m ³ /m ² -d)	40,00	46,65
NU-103 Neutralizador	Vol Liq/Vol total	0,85	0,85
	Vol total (m)	158,47	158,47
	Vol líquido (m)	134,70	134,70
	Tiempo de detención (h)	0,25	0,22
	Area (m)	52,82	52,82
	Altura (m)	3	3
Cancha de lodos	Altura (m)	4,0	4,0
	Volumen (m)	55 797	55 797



Canales de colección de aguas de Plantas de Fundición La Oroya



5.4.9 PROJECT NO. 9

CONTAINMENT WALL FOR LEAD MUD DEPOSITS AT THE ZILERET PLANT - ZINC DIVISION

1. OBJECTIVE

To prevent pouring into the Mantaro river the lead mud with high concentrations of impurities that has been accumulated next to the hydro-metallurgy Zileret plant.

2. ENVIRONMENTAL IMPACT ASSESSMENT

The hydro-metallurgy unit generates a lead sludge that accumulates at a site adjoining the plant. The mud returns to the Lead Smelting Circuit. However, while in storage, a leach solution seeps to canal 136 that pours into the Mantaro river. The presence of this effluent substantially increases pollution from this canal. Leaks from the pipes and rainwater runoff make the situation still more severe.

3. MITIGATION OPTIONS

A containment wall in the mud deposit will include a system for collecting the solution drain. It will then be recycled to the plant. Also, as a result of using this approach, it will be possible to isolate mud from rainwater permeating the system.

4. RESULTS FROM MITIGATION

Elimination of the polluting effluent.

5. INVESTMENT

Estimated project cost is US\$5,000.

6. IMPLEMENTATION PERIOD

The project should be concluded by the first half next year.

5.4.10 PROJECT NO. 10

RECIRCULATION OF WATER USED IN SPEISS GRANULATION AT THE FOAM FURNACE. LEAD SMELTER.

1. OBJECTIVE

To prevent contaminated water used in speiss granulation, containing mostly arsenic, antimony and suspended particles, from being poured into the Mantaro river.

2. ENVIRONMENTAL IMPACT ASSESSMENT

The foaming furnace is used to process copper foams recovered from the lead reception buckets. Lead bullion, mate soda and speiss resulting from the process are granulated for easier transportation to the copper smelter where copper and silver contents are recuperated.

The speiss granulation water, contaminated by dissolved elements and suspended particles, is sent to a sedimentation pond and then discharged into canal 2 for pouring into the Mantaro river.

3. MITIGATION OPTIONS

3.1 Use speiss granulation water in a closed loop

The project would fully recycle speiss granulation water to prevent pollution of the Mantaro river.

4. PROCESS DESCRIPTION

Clarified water will be pumped from the sedimentation ponds and sent to a 135 cubic meter tank and then pumped back to the speiss sprayers in a closed loop process.

5. RESULTS FROM MITIGATION

Completely recycling water used in speiss granulation would prevent the effluent from contaminating Mantaro river water.

6. INVESTMENT

Implementing the project would require an investment of US\$55,000.

7. IMPLEMENTATION PERIOD

The project should become operational in the first half of next year.

5.4.11 PROJECT No. 11

NEW ANODE WASHING SYSTEM FOR THE ZINC REFINERY

1. OBJECTIVE

The main objective of the project is to minimize the spillover of anode washing effluents with high acidic residual and metal contents.

2. ENVIRONMENTAL IMPACT ASSESSMENT

An acid effluent produced at the cell house in the Zinc Plant as a result of Pb-Ag anode washing includes suspended solids (manganese dioxide) that are captured in a sedimentation device. Untreated water is then poured into the Mantaro river.

Aritmetic Average January 94 - February 95 (*)

Sample Point	Flow m3/min	pH	Temp ° C	TSS mg/l	Metals (mg/l)						
124	0.12	3.51	13.38	61.672	As 0.2 4	Cd 0.0 8	Cu 0.7 3	Fe 2.54	Mn 7.66	Pb 13.0	Zn 143.16

Nota: (*)Source EVAP Metallurgic Complex of La Oroya.

3. ALTERNATIVES FOR MITIGATION

A semi-automated system for anode scratching, straightening and washing in fixed position is being set up at present. This should allow disposing of solid scarring that will then be sent as pulp to the Pilot Plant and/or to the leaching unit. The remaining liquid effluent will be processed in the industrial liquid effluent treatment plant to reduce metal content below the maximum allowable amounts. (R.M. No. 011-96).

4. RESULTS OF MITIGATION

Control of Mantaro river pollution from liquid effluents.

5. INVESTMENT

The project has been estimated at US\$15,000 financed with internal resources.

6. TIME FOR IMPLEMENTATION

Project implementation should take one year.

7. TIMETABLE

The project should conclude by 1997.

5.4.12 PROJECT NO. 12

COPPER AND LEAD SLAG MANAGEMENT AND DISPOSAL

The main purpose of this project is to eliminate solid and liquid pollution from the Mantaro river due to discharges of contaminated water containing suspended solids and/or contaminating ions resulting from the granulation and transport of copper and lead slag. This project will allow to comply with Ministry regulations on the disposal of solid and liquid emissions included in R.M. No. 315-96-EM/VMM.

1. IMPACT ASSESSMENT

Copper and lead slag is discharged at the La Oroya Metallurgical Complex into the Lead Sleeve Furnace and the Reverberation Furnace. The two types of slag are discharged as liquids at 1,100°C and 1,200°C, respectively. They are then granulated by sudden cool down using pressurized water and transported by gravity as slurry along rectangular section channels to a set of hoppers where liquids and solids are separated.

The slag at the bottom of the hopper is sent by a cable car transportation system to the Huanchan deposit 2.2 kilometers away across the Mantaro river. This system has been in use since 1930. It is now obsolete and creates many operative, maintenance and transportation difficulties.

Water used for granulation pours directly onto the Mantaro river and carries fine and/or suspended slag, as well as dissolved metals, thus creating a serious pollution condition.

Analysis of filtered solutions overflowing from the copper and lead slag tanks

	Cu (mg/l)	Pb (mg/l)	Fe (mg/l)	As (g/l)	Sb (g/l)	SO ₂ (g/l)	SO ₄ (g/l)	NO ₃ ⁻ (mg/l)
Oven Pb 1	0,6	1,0	1,5	0,18	0,03	0,38	0,08	0,68
Oven Pb 2	0,5	1,0	2,0	0,23	0,04	0,38	0,06	0,59
Reverber o	0,8	0,8	1,5	0,04	0,10	,016	0,18	----

Analysis of suspended solids (fine slag) overflowing from the copper and lead slag tanks

	Cu (%)	Pb (%)	Fe (%)	As (%)	Sb (%)	Bi (%)	Ins (%)
Oven Pb 1	0,24	2,30	25,20	0,22	0,13	0,02	20,70
Oven Pb 2	0,24	2,10	24,30	0,33	0,14	0,04	22,40
Reverbero	5,60	1,50	28,50	0,34	0,32	,06	30,40

Analysis of suspended solids (fine slag) overflowing from the copper and lead slag tanks

	pH	SOLIDS	
		(%)	g/l
Oven Pb 1	0,24	2,30	25,20
Oven Pb 2	0,24	2,10	24,30
Reverbero	5,60	1,50	28,50

1.1 Granulation System

Operation time

Slag discharge from the reverberation furnace is intermittent. Discharge usually takes place for 6.5 hours in every 8 hour shift at a flow rate of 34.77 tons an hour (678 tons a day). Lead slag is discharged around the clock at 20.3 t/h or 397 t/day.

Amount of water

The following amounts of water are used at present.

For copper slag granulation: 276 l/s (4,375 gallons per minute)

For lead slag granulation: 224 l/s (3,547 gallons per minute)

Water characteristics

Before granulation water temperature fluctuates between 10 and 14°C, depending on the season of the year. After granulation, water temperature may reach 28°C. Chemical analyses have revealed traces of lead, arsenic, copper, iron and suspended solids in amounts occasionally above the maximum allowed quantities.

Steam

Water steam from granulation is released directly into the atmosphere.

1.2 Transportation system

Equipment

The current cable car transportation has been in use since 1930 and was designed to carry only 600 t/d. An obsolete system, it creates many operation and maintenance difficulties. Given its original design, condition and age, the system cannot be improved upon.

Capacity

The current system is unable to carry the 1,100 tons of slag produced daily to the deposit area in Huanchan. Insufficient transportation capabilities as well as limited storage and withholding capacity of the slag reception hoppers account for this fact.

Granulation water overflowing from the tanks together with refrigeration water from the copper and lead smelters containing the following substances are poured into the Mantaro river.

Inorganic						Primary inorganic ions mg/l				
Cond μS	Eh mV	Flow m3/min	pH	Temp °C	T.S.S. mg/l	CN Total	O.D .	NO 3	SO4 =	T.D.S-
772	-58,3	28,23	8,0	19,3	2251,8	T.r.	10	2,50	260, 0	560

Inorganic Metals mg/l									
As	Cd	Cu	Fe	Mn	Pb	Zn	Sb	Hg	
0,58	0 020	0 07	0,14	2,20	0,30	3,50	0,14	T.r.	

2. MITIGATION OPTIONS

2.1 Processing

Several types of equipment were considered for disposing of used waters, including thickeners, shakers, sedimentation hoppers, INBA rotating devices, and the Denver Sala screw-type water disposal system.

The INBA rotating equipment was chosen because of its minimal component wear features and rapid water/slag separation (filtering) capability.

Alternatives to cable car transportation include the INC Cable Belt, Mitsubishi's capsule pipeline, and the conveyor belt system to carry materials to the left bank of the

Mantaro river. The last option was selected because it presents the lowest cost for the structures supporting the conveyor belt and is cheaper to service.

2.2 The project

2.2.1 Description and location

The project considers the purchase and implementation of the following items.

Solids-liquids separation equipment

We propose to install two state-of-the-art INBA rotating water disposal devices that turn at about 3rpm. The new granulation system operates on a 10-to-one weight proportion between water and slag. Water will be continually recycled to prevent pollution of the Mantaro river. The granulation system used at present operates on a 40::1 water to slag weight rate.

Only 183 l/s (2,900 gpm) of water would be needed using such advanced technology for copper and lead slag granulation.

The new system can also dispose of 1,400 tons of copper and lead slag per day. This capacity can easily accommodate future expansion of the copper and lead plants.

New transportation system

Designed to carry 1,400 t/day, the system largely suffices to cover the current 1,100 tons currently produced every day.

Slag will be carried on conveyor belts to the left bank of the Mantaro river to be disposed of.

The water disposal system will be located near the current slag deposit. The transportation system will start at this point and cross the Mantaro river to its left bank.

2.2.2 Investment

Implementing the project will require investing an estimated US\$6.5 million. A breakdown appears below.

	DESCRIPTION	MMI(US\$)
1.0	Separation System - liquid, solid, granulation and recirculation of water	3,900
2.0	Transport System	1,708
	SUB - TOTAL	5,608
	TAX +/-15%	0,892
	TOTAL	6,500

The investment cost covers project engineering and management, field engineering, outsource engineering, preliminary works and land movement, structures and foundations, mechanical and electric installation, conveyor belt transportation systems, granulation water cooling and re-circulating systems, INBA water disposal devices, slag granulators, electric motors, reducers and control instruments.

2.2.3 Implementation timetable

Implementing the project should take three (3) years, as specified below.

YEAR	ACTIVITY	MMI(US\$)
1997	Manufacturing equipment - liquid solid separation	1,494
1998	Acquisition of additional equipment and installation of a separation system.	3,362
1999	New transport system	1,644
	TOTAL	6,500

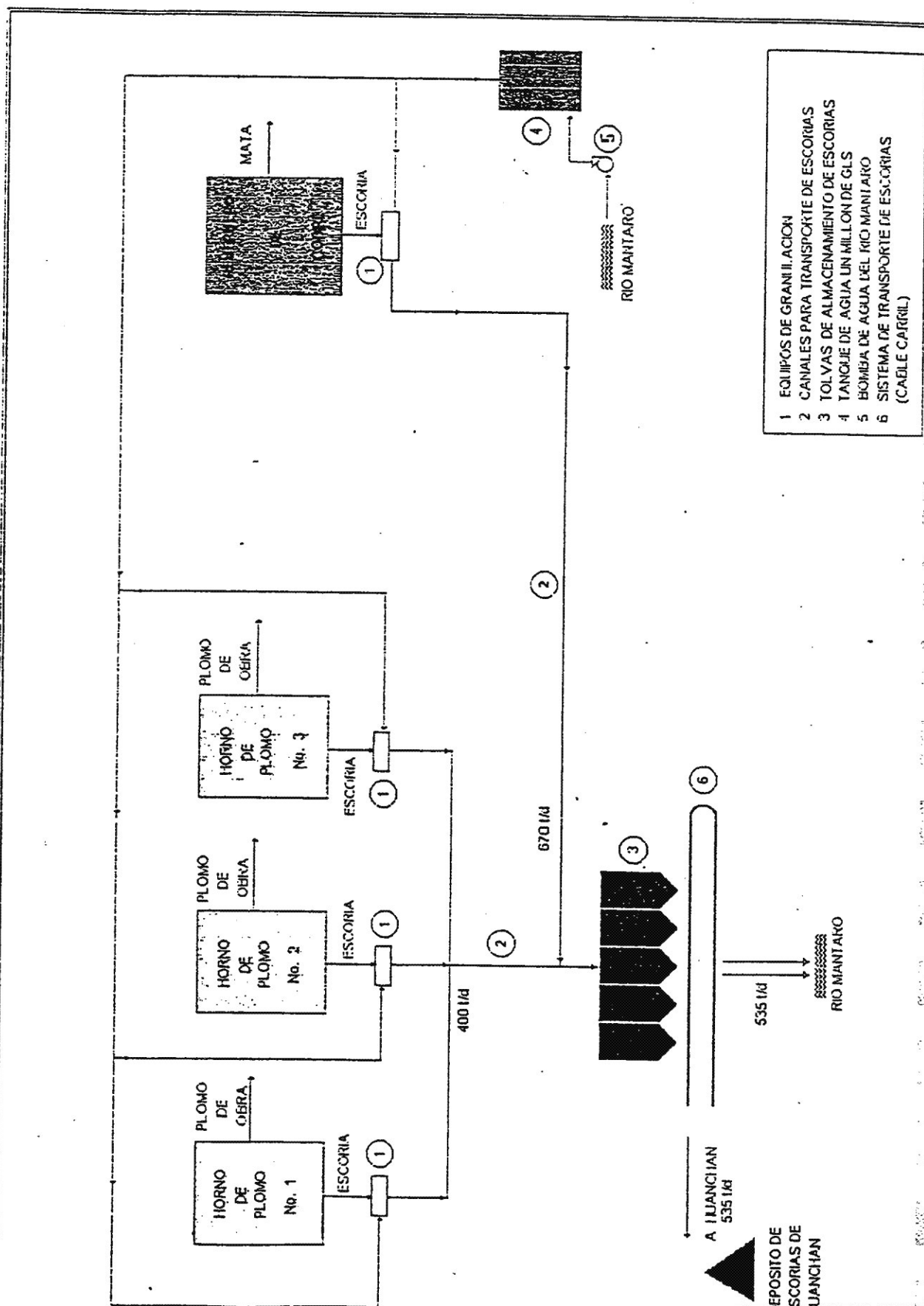
3. RESULTS OF MITIGATION

After the new slag management and disposal system becomes operational, granulation water containing suspended solids and copper and lead residues will no longer be poured into the Mantaro. Thus, it will be possible to achieve the following levels of discharge regulated by R.M. No. 011-96-EM/VMM - Attachment 1.

Parameter	Value at any moment	Annual average value
pH	from 6 to 9	from 6 to 9
Suspended solids (mg/l)	50	25
Lead (mg/l)	0,4	0,2
Copper (mg/l)	1,0	0,3
Zinc (mg/l)	3,0	1,0
Iron (mg/l)	2,0	1,0
Arsenic (mg/l)	1,0	0,5
Cyanide total (mg/l)	1,0	1,0

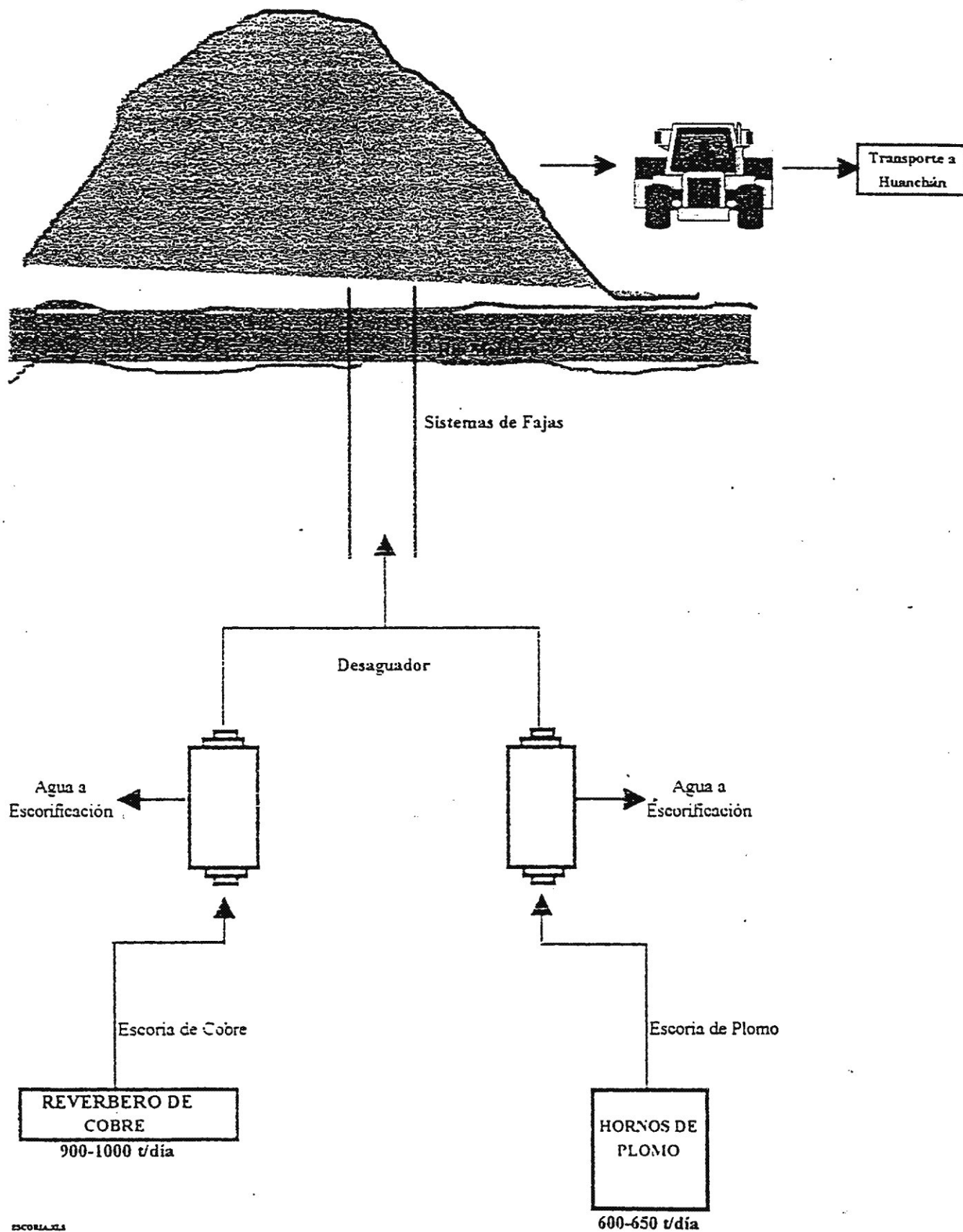
COMPLEJO METALÚRGICO LA OROYA

MANEJO ACTUAL DE LAS ESCORIAS DE COBRE Y PLOMO



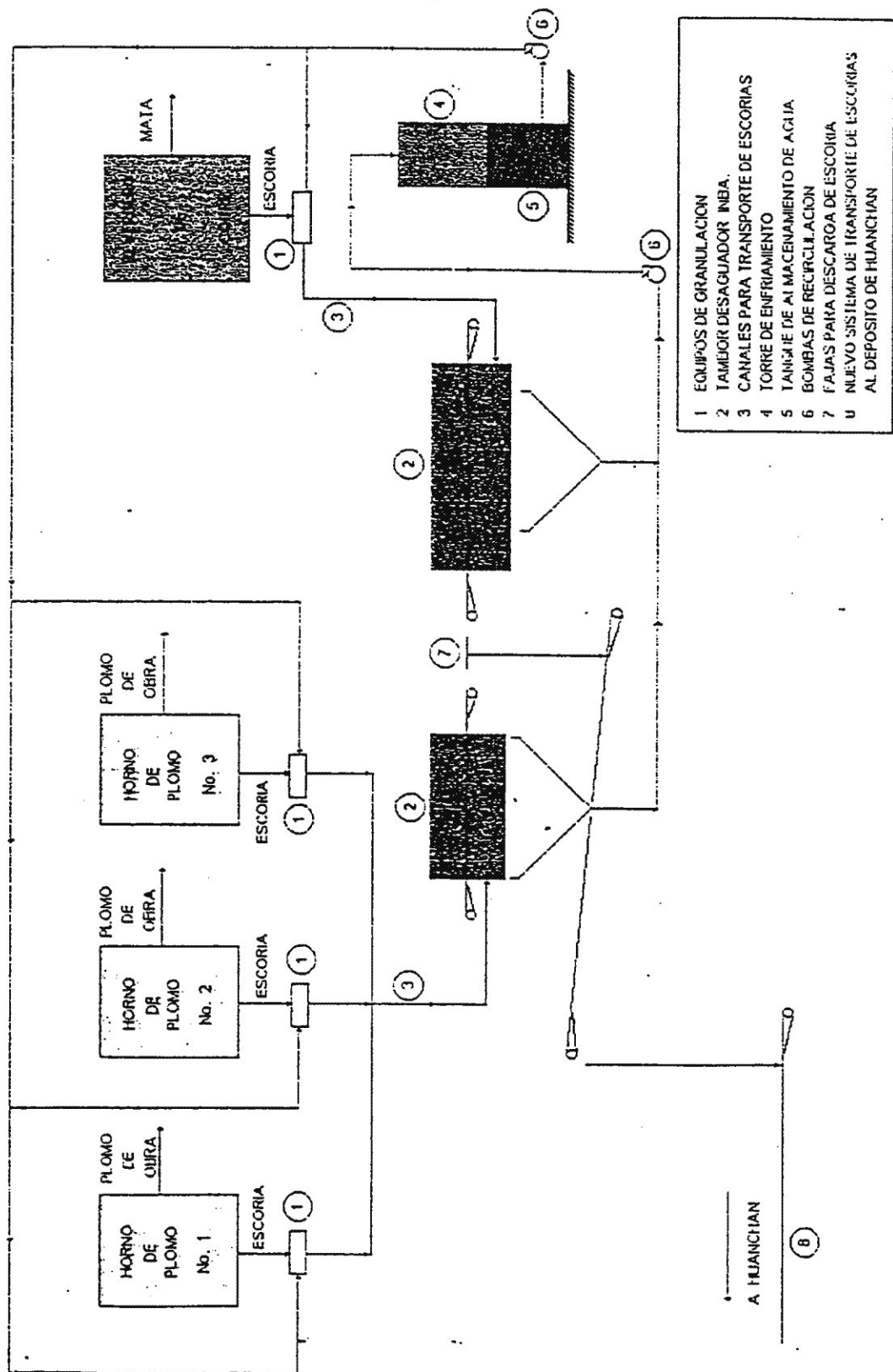
COMPLEJO METALÚRGICO LA OROYA

NUEVO SISTEMA DE EVACUACION DE ESCORIAS



COMPLEJO METALÚRGICO LA OROYA

NUEVO SISTEMA DE MANEJO Y DISPOSICIÓN DE ESCORIAS DE COBRE Y PLOMO



5.4.13. PROJECT NO. 13

CLOSURE OF THE COPPER AND LEAD SLAG DEPOSIT

1. OBJECTIVE

This project seeks to assess the stability and elevation of the slag deposits, and determine the works needed to mitigate or eliminate the environmental impact on the land, water, air and living beings in the area through land reclamation and remedial measures.

Other works include implementing a new deposit following environmental control regulations to accommodate future production increases.

2. IMPACT ASSESSMENT

The slag deposit has been used since 1930 and has accumulated 10 million tons of copper and lead slag. It is located in the Huanchan area, 2.2 kilometers from the smelter on a geological terrace over the left bank of the Mantaro river, along the highway. A cable car carries an average 758 metric tons of slag to the deposit every day.

The slag is piled in cone-shaped mounds about 70 meters height over 25 hectares of land rising between 3,715 and 3,805 meters of altitude above sea level.

Real and potential impacts related to its stability and interaction with the environment result from the deposit's characteristics and location near the Central Highway and the Mantaro river.

2.1 Stability

The amounts of slag deposited on the site, the deposit's elevation, the type of wastes and the proximity to large amounts of water from the Mantaro river create stability problems that should be eliminated or reduced, particularly if we take into consideration the continued use of the area for future metallurgical operations. Should a land slide occur, the solid wastes would pollute not only the river in the La Oroya area, but also towns and settlements downstream.

2.2 Interaction with the environment

The Mantaro river is vulnerable to pollution due to its proximity to the deposit. The main sources of pollution are water flowing at the foot of the deposit, rainwater runoff and drainage into the ground.

The wind acts on the deposit by lifting some of the fine particles contained in the slag.

3. MITIGATION OPTIONS

The project considers the initial closing of the deposits and various engineering works to be carried out until the deposits are definitely reclaimed. We present below the characteristics of the project designed in collaboration with Rescan Peru S.A.

3.1 Studies

- Geo-technical research: field research, laboratory assays, soil classification, stratigraphic profile descriptions, resistance parameters using SPT assays, and others.
- Stability evaluation of existing deposits: deposit wall stability, adjoining slope stability, analysis methods.
- Potential for expansion and remaining capacity.
- Stability to rainwater runoff.
- Seepage control.
- Stability to wind erosion.
- Effluent control.

Containment walls planned around the deposits and the gutters to dispose of seepage must be built with frost and sulfate resistant concrete.

By catching about 45 liters of water per second crowning ditches at a constant slope of five degrees will provide stability against rainwater runoff on the adjoining slopes.

About 8.1 liters per second of seepage water will be collected by a gutter running at the foot of the slag deposit and carried to the Mantaro river.

3.2 Post-closure environmental monitoring

After the deposit is closed it will be necessary to monitor the site's stability and effluents for timely correction of anomalies and to ensure proper environmental conservation. All waterways will get maintenance at least before and after the rainy season that runs from October to April. All effluents, runoff and upwelling from the deposit will be periodically tested to take the appropriate corrective measures, should they be required.

3.3 Storage capacity and new deposit

The maximum recommended superelevation for the existing system is 3,762 masl. The remaining deposit capacity reaches 2.36 million cubic meters estimated over a useful slag accumulation life of 10 to 13 years.

The new deposit will be located in Cochabamba, nine kilometers from La Oroya along the road to Huancayo on the left bank of the Mantaro river. This deposit will respect all safety and environmental regulations.

4. RESULTS OF MITIGATION

Implementing the project will allow to address the following issues.

4.1 Pollution

Reducing pollution of the Mantaro river to a minimum. Chemical tests of drainage and/or runoff water reveal allowable percentage amounts of pollutants that do not jeopardize the quality of water in the area. After precipitation, water collected by the gutters will be poured directly into the Mantaro river. No additional water treatment facilities need to be built.

4.2 Area stability and reclamation

The project will ensure the dynamic and static stability of the deposit mounds in case of overcharge or earthquake, in particular because La Oroya is extremely prone to earthquakes.

The area's recovery and reclamation will be part of the closure plan. When the deposit's useful life concludes, the area will be reclaimed to safety conditions similar to those at the beginning of metallurgical operations.

4.3 Continuity of operations

The Huanchan deposit will remain in operation until the new one becomes fully operational to ensure the uninterrupted disposal of the slag from the copper and lead smelters.

5. INVESTMENT BUDGET

We present below an itemized investment budget for the project.

	DESCRIPTION	AMOUNT (US\$)	SUB-TOTAL (US\$)
1.0	New Cochabamba deposit	2 200 000	2 200 000
2.0	Current Deposit		
2.1	Works for protection and stability	2 000 000	
2.2	Complementary works	550 000	
2.3	Treatment and restauration	2 000 000	4 550 000
	S U B - T O T A L		6 750 000
	Tax +/-15%		1 000 000
	T O T A L		7 750 000

6. IMPLEMENTATION TIMETABLE

Implementing the project should take four (4) years, as specified below.

YEAR	ACTIVITY	AMOUNT (US\$)
1997	Current deposit, work for stability	1 250 000
1998	New Cochabamba deposit	2 500 000
1999	Current deposit, protection, treatment and others	2 500 000
2000	Current deposit, recovering and remediation	1 500 000
	T O T A L	7 750 000

5.4.14 PROJECT NO. 14

PROJECT: CLOSURE OF THE MALPASO ARSENIC TRIOXIDE DEPOSIT. CLOSURE OF THE VADO DEPOSITE. CONSTRUCTION OF A NEW DEPOSIT AT VADO.

1. OBJECTIVES

This project seeks the full mitigation of environmental pollution resulting from the arsenic trioxide deposits accumulated by the La Oroya Metallurgical Complex. It will and thus permit to comply with regulations setting the maximum allowable levels for liquid effluents specified in R.M. No. 011-96-EM/VMM dated January 10th, 1996 and for elements and compounds present in gas emissions from mining and metallurgical operations, as specified by R.M. No. 315-96-EM/VMM from July 16th, 1996 enacted by the Ministry of Energy and Mines.

2. IMPACT ASSESSMENT

Arsenic trioxide results from the smelting of copper and lead. Difficult to sell, the by-product has accumulated for about a quarter century in two areas. One is the Malpaso location used as a deposit until 1992 after having been in continuous operation for about 25 years. The other is the Vado area, currently in use. Although both deposits were built in compliance with then-enforced standards, neither meets current environmental regulations for runoff rainwater and air quality.

2.1 Deposit characteristics

Malpaso deposit

Location: Situated on the Mantaro river alluvial plain about one kilometer downstream from the Malpaso hydropower plant and some 19 kilometers upstream from the La Oroya smelter (see Figure 1).

Volume: Preliminary findings of the investigation carried out by ADI International Consultants from Canada put the estimated current volume of deposit material at some 38,000 cubic meters, or 45,000 tons of residues.

Topography: Most of the deposit is covered with stones found locally and cannot be seen by the naked eye. However, several surveys have identified exposed arsenic trioxide. Local topography appears in Figure 2 - Malpaso Section.

Operating conditions: This deposit was used for about 25 years until 1992.

Vado deposit

Location: Situated on the Mantaro alluvial plain, this deposit is located about 9 kilometer upstream from the smelter in the direction of Cerro de Pasco. It can be reached by either a road in good state of repair or by rail (see Figure 1).

Volume: Preliminary findings of the investigation carried out by ADI International Consultants from Canada put the estimated current volume of deposit material at some 97,000 cubic meters, or 115,000 tons of residues.

Topography: Most of the deposit is exposed. Area topography appears in Figure 2 - Vado section.

Operating conditions: In use.

Average chemical composition:

%As ₂ O ₃	% As	% Sb	% Cu	% Pb	% Zn	g/t Ag	g/t Au	% Ins
88-90	66,5	0,90	0,90	0,80	0,10	34,2	Trazas	0,6

2.2 Water quality

Arsenic and other elements from the deposits located in areas rich in alluvial materials are percolated by nearby riverwater and intense rainfall. The resulting runoff contributes to pollute the Mantaro river.

The following pollutant amounts (in mg/l) were identified by research carried out at our Metallurgical Research Department before and after stock at Vado was taken to determine river water quality.

Date	Upstream of Vado				Downstream of Vado			
	Cu	Pb	Fe	As	Cu	Pb	Fe	As
27-3-95	0,08	0,05	0,52	0,05	0,08	0,04	0,55	0,60
29-3-95	0,06	0,04	0,66	0,04	0,08	0,04	0,47	0,84
31-3-95	0,06	0,04	0,54	0,01	0,06	0,04	0,57	0,06
03-4-95	0,10	0,03	0,53	0,08	0,11	0,08	0,52	0,30
05-4-95	0,04	0,05	0,51	0,05	0,05	0,04	0,46	0,40
07-4-95	0,11	0,04	0,56	0,23	0,04	0,03	0,59	0,01
10-4-95	0,09	0,04	0,39	0,03	0,05	0,04	0,34	0,02
12-4-95	0,06	0,01	0,50	0,06	0,10	0,02	1,70	0,94
15-4-95	0,06	0,01	1,10	0,04	0,12	0,05	0,68	0,45
17-4-95	0,07	0,04	0,55	0,05	0,03	0,06	0,44	0,56
19-4-95	0,05	0,03	0,44	0,01	0,06	0,04	0,26	1,10

21-4-95	0,06	0,04	0,44	0,13	0,05	0,04	0,32	0,36
24-4-95	0,52	0,80	4,40	0,13	0,52	0,28	4,20	0,16
26-4-95	0,42	0,32	4,20	0,01	0,48	0,35	4,30	0,26
28-4-95	0,52	0,35	4,30	0,04	0,55	0,40	3,90	0,44
L.M.P.(1)	1,00	0,40	2,00	1,00	1,00	0,40	2,00	1,00
L.M.P.(2)	0,30	0,20	1,00	0,50	0,30	0,20	1,00	0,50

Fuente: Memorandum Interno DIM-074-95 del 06-06-1 995.

L.M.P.(1): Límites Máximos Permisibles en Cualquier Momento (mg/l).

L.M.P.(2): Límites Máximos Permisibles Valor Promedio Anual (mg/l).

Arsenic concentration in and the resulting pollution of the Mantaro river increases after the Vado stock, as can be gathered from the table.

Other elements such as copper, lead and iron increase only very slightly and do not merit attention.

No significant changes in pH were observed between the two takes. Values ranged from 7.3 to 7.8.

2.3 Air quality

Wind also contributes to pollution from the Vado deposit. Air in the location is continuously monitored by a station locates in Casaracra, about one kilometer from Vado. From January to December 1995, the average amount of airborne arsenic was 0.220 ug/m³ while from January to June 1996, the corresponding figure was 0.086 ug/m³. The lower figure is accounted for by the fact that part of the surface was covered with earth from the surrounding area, and that in the Western end of the area two trial deposits were established in mounds of 500 m² each. One was lined with a geomembrane and the other with clay. In both cases the area was covered with farm soil and planted with grass.

3. MITIGATION OPTIONS

Canadian firm ADI International was retained by Centromin to look into various ways of closing the deposits and establishing a new one that will permit producing arsenic trioxide in the future.

The studies include basic engineering and terms of reference for detailed engineering studies. They comply with requirements and guidelines set forth by Canada's Council of Environmental Ministers described in that country's "National Guidelines for Landfilling of Hazardous Waste," CCME-WM/TR-028E and also with the US Environmental Protection Agency guidelines included in the document on "Lining of Waste Containment and Other Impoundment Facilities," EPA/600/2-88/052.

Also included are the studies on hydrogeological and geotechnical conditions of the areas involved prior to design, the specifications for design and post-construction monitoring system, and the construction specifications for the deposit itself.

The studied closure and decommissioning options included site closure, transfer of materials to a designated alternative site (possibly at the airport), transfer of materials to a safe location in the same site, and cementing the residues using concrete, polymers or other materials. The final decision was made to develop a safe, on site deposit, as is described below.

3.1. Closure and decommissioning of the Malpaso deposit

The required deposit is designed to comprise a lined bottom, a composite cover and a leaching detection and monitoring system. The system will control contaminant emissions to the environment and control potential public exposure.

Designed to allow digging out of approximately 50% of residues from the area and their removal to a temporary site, the system includes the construction of two cells. The first cell will be built in the excavated area. The removed wastes will be moved to the new cell and the wastes from the temporary deposit will be moved to the second cell. The concept appears in Plan No. 1 for the Malpaso site.

Also to be determined are the consequences of surface water runoff which must be taken care of in the design, including peak load management during the construction phase.

The deposit will consist of a double flexible membrane liner placed at the bottom of the deposit, an FML cover on top, and a system to monitor leaching from the bottom layer. Concept and details appear in Plan No. 1 - Malpaso site, as well as cross sections for the top and bottom covers.

The proposal complies with CCME and EPA specifications except for the requirements for leach collection which are unnecessary because the cells will be sealed after placing the wastes and there will be no production of solutions inside the cell.

3.2 Closure of the Vado deposit

Encapsulation work will be similar to that to be carried out at Malpaso and may include some section of the new deposit as the temporary site. These works can also be tackled by modules.

The system design should allow to excavate approximately one third of the wastes and place them in the free area. This procedure will require the building of a new containment wall outside the deposit area to prevent accumulating wastes from escaping the deposit. The excavated area will then be prepared to receive the materials by building a safe deposit.

Next, about one third of the wastes will be deposited there and the cell sealed. This procedure will be repeated two more times to accommodate the remaining wastes. The final result should be three safe deposit cells.

The concept and details appear in Plan No. 1 - Vado Existing Site. The illustration is shows the stages of wastes handling and cell building.

Design of the temporary deposit area will control migration or leaching of contaminated materials while the temporary deposit is in use. This deposit will be closed once the cells are built.

As in the case of the Malpaso deposit, the proposal complies with CCME and EPA specifications except for the requirements for leach collection. These are unnecessary because the cells will be sealed after placing the wastes and there will be no production of solutions inside the cell.

3.3 New deposit (Vado II)

Cell building will take place in the old airport area using the same encapsulation technique and a module by module approach. With production of only 4,000 tons of arsenic trioxide per year, the final expected capacity of 50,000 tons will permit to operate the deposit for 25 years. A multiple cell design must be prepared.

A multiple cell configuration will allow for more flexible storage of arsenic trioxide and monitorig and control of exposure of the waste to outdoor conditions. The cells will remain open for five years at most.

Specifications and details of the proposed systems appear in Plan No. 1-Vado Airport Site.

Since each individual cell of the deposit will remain open for a maximum of 5 years, leaching may occur during the rainy season. Therefor, the system design should include a leachate treatment system to manage lixiviation in the three cells, a sampling tool for leachate monitoring, and a system for loading and unloading treatment water and iron or calcium arsenate wastes that will eventually mix with the arsenic trioxide in the cells.

3.4 Investment

Implementing the described projects will require the following investments.

	DESCRIPTION	AMOUNT US\$
1.0	Malpaso deposit closure	2 800 000
2.0	Vado Deposit closure	4 800 000
3.0	New deposit	1 750 000
	SUB-TOTAL	9 350 000
	Tax	1 350 000
	TOTAL	10 700 000

3.5 Implementation timetable

Implementing the project will take five (5) years, as detailed below.

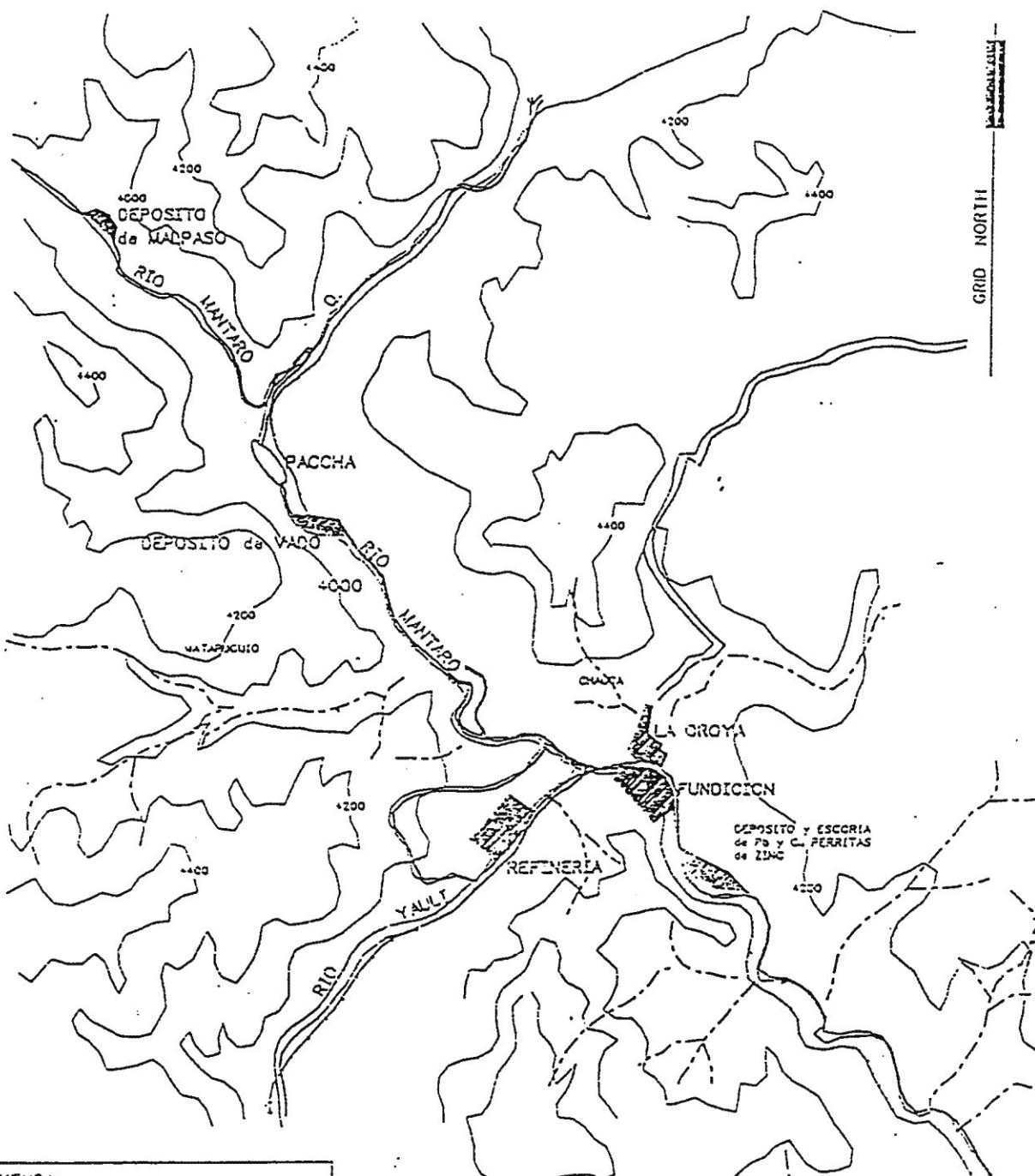
4. MITIGATION RESULTS

A comprehensive solution to pollution problems is the expected outcome of the proposed solution including decommissioning of the existing deposits, and building a new, state-of-the-art deposit that will comply with the highest international standards and requirements.

The old deposit sites will be reclaimed and restored to its original aspect to make it indistinguishable from the surrounding area.

Air and Mantaro river water quality will be monitored to comply with maximum allowable levels established by Ministry of Energy and Mines regulations No. 011-96-EM/VMM from January 10th, 1996 and 315-EM/VMM from July 16th, 1996.

Maximum Permissible Levles for Liquid Effluents from Metallurgical and Mining Units			Effluent to Mantaro River
Parameter	Any Moment Value	Annual Average Value	
pH	>6 y <9	>6 y <9	7-8
Suspended solids (mg/l)	50	25	25
Lead (mg/l)	0,4	0,2	0,2
Copper (mg/l)	1,0	0,3	0,3
Zinc (mg/l)	3,0	1,0	1,0
Iron (mg/l)	2,0	1,0	1,0
Arsenic (mg/l)	1,0	0,5	0,5
Cyanide total	1,0	1,0	1,0
Maximum Permissible Levels - Air Quality			Air Quality Around Deposits Annual $\mu\text{g}/\text{m}^2$ (ppm)
Parameters	Daily Average Concentration $\mu\text{g}/\text{m}^2$ (ppm)	Annual Average Concentration $\mu\text{g}/\text{m}^2$ (ppm)	
Arsenic	6		6



LEYENDA:

- CAPITAL DEL DISTRITO
- CURVAS DEL NIVEL
- RIO
- QUEBRADA

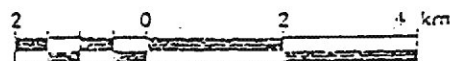
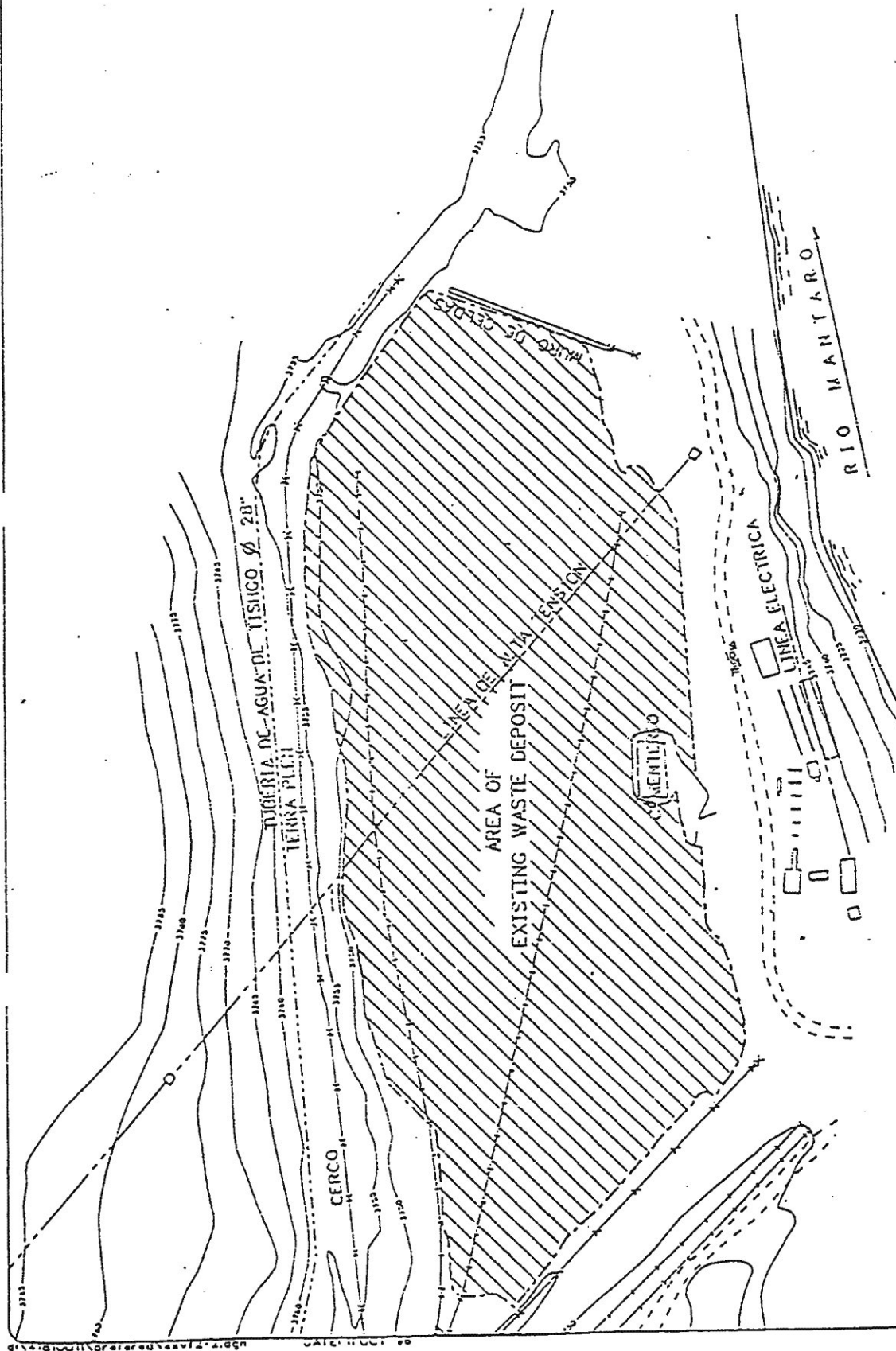


FIGURA 1
PLANO DE UBICACIÓN



Proj. No.	29-4181-001.1		
Dwg. No.	FIGURA 2		
Dwn. By:	GJM	Chk. By:	JJD
Date:	OCT. '96	Rev.	

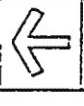
AREA DE VADO

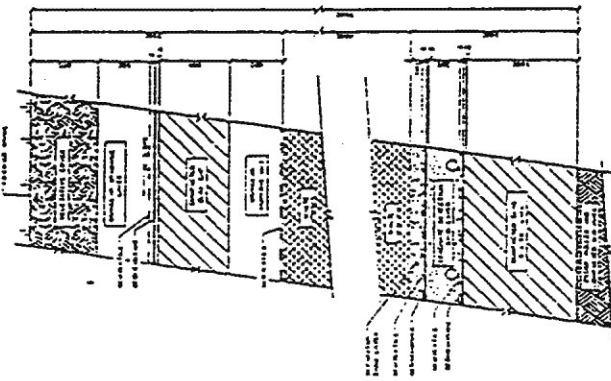
SCALE 1:2000

PLAN DE CIERRE DEL
DEPOSITO DE TRIOXIDO
DE ARSENICO DE VAGO
Y ABANDONO DEL DEPOSITO
DE MALPASO - LA OROYA

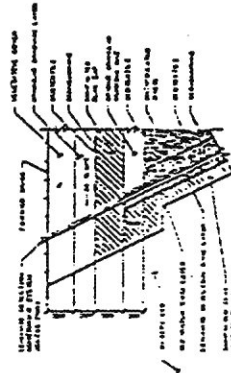
A. LAMAR, ADI International Inc.
Engineering, Consulting, Environmental
Geology, Hydrology
G E O U P

Charlottetown, Montreal, Saint John, Ottawa, Vancouver
Sydney, St. John's, Halifax, Fredericton and Salem, NH

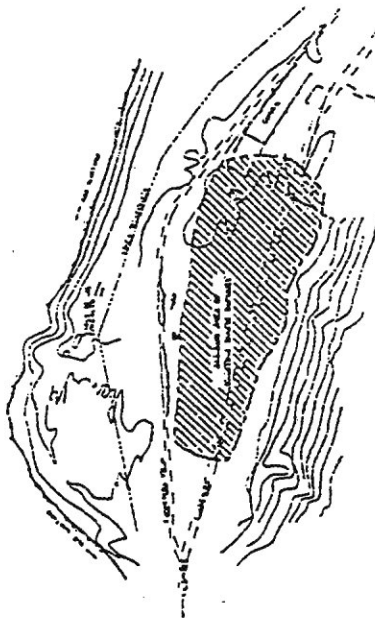
		OCT 1943 Date Name Position	ADI Asesor de Ingeniería Asesor de Ingeniería	PLAN LA CLAYTON, PAI DEPOSITO DE TRUCCO DE ALUMINO DE YAGO Y ALUMINO DEL DEPOSITO DE LA PASO - LA OROYA	MALPASO SITE 20-4161-091.1 PLANO N° 1
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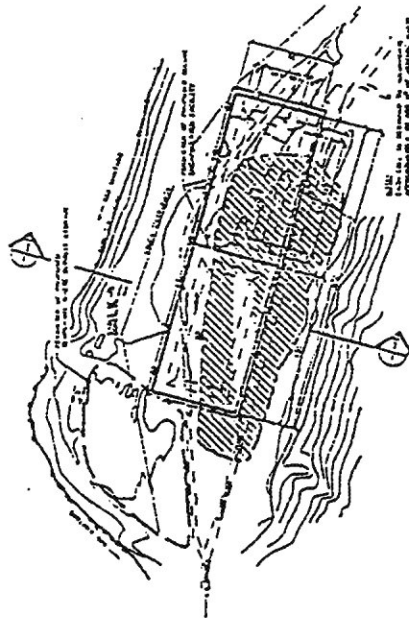
COVER & LINER SYSTEM DETAIL 2 1
ENCAPSULATED SECURE FACILITY 1:20



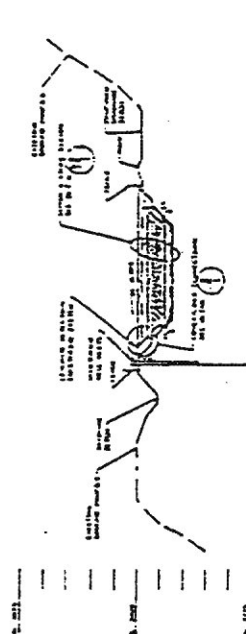
DETAIL 3 1
COVER/LINER CONNECTIONS KTL



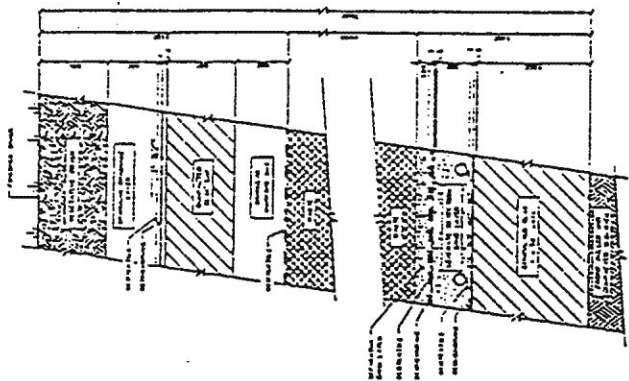
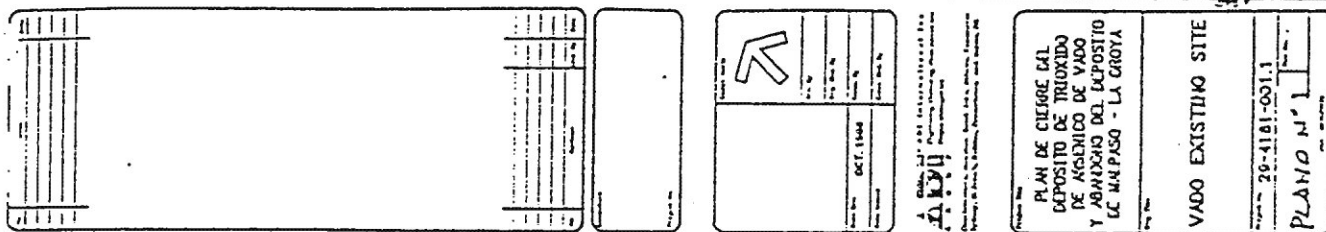
SITE PLAN - EXISTING SITE CONDITIONS



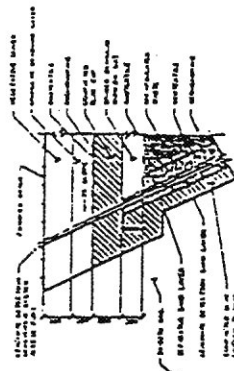
SITE PLAN - PROPOSED SECURE ENCAPSULATED FACILITY



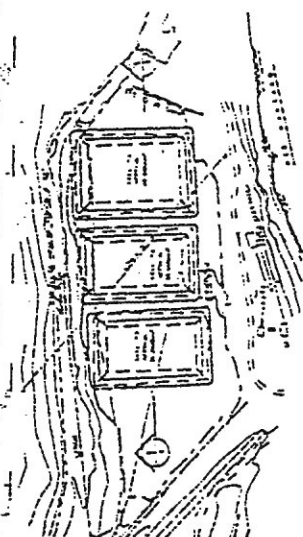
SECTION 1 1
ENCAPSULATED SECURE FACILITY
UNDER HIGH VOLTAGE



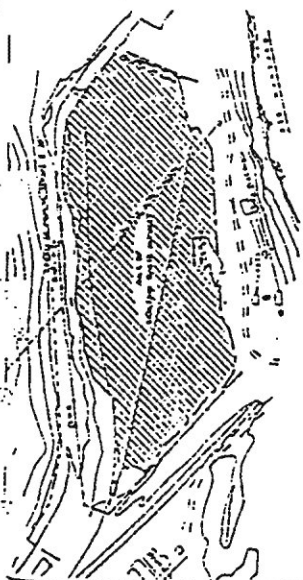
COVER & LINER SYSTEM DETAIL



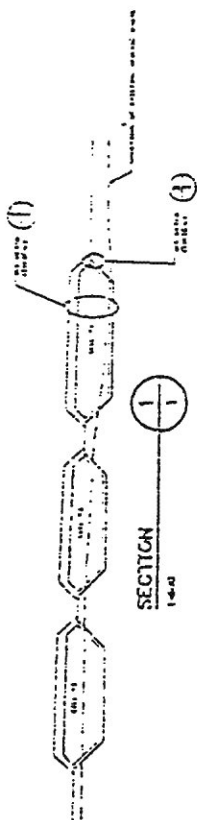
DETAIL	2	1
CONVULSIONS		W14



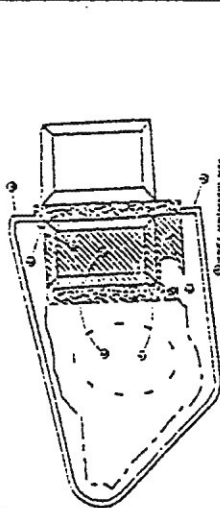
NEW ENGLISH-ARAB FACILITIES



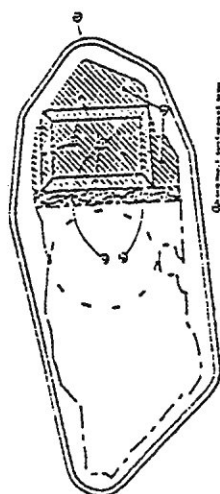
EXISTING SITE CONDITION



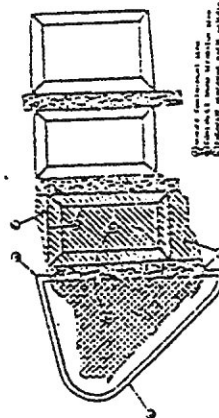
MOLECULES



STAGE 2



STAGE 1



4. 3. 3. 5

CONCEPTUAL CONSTRUCTION STAGES 10-200

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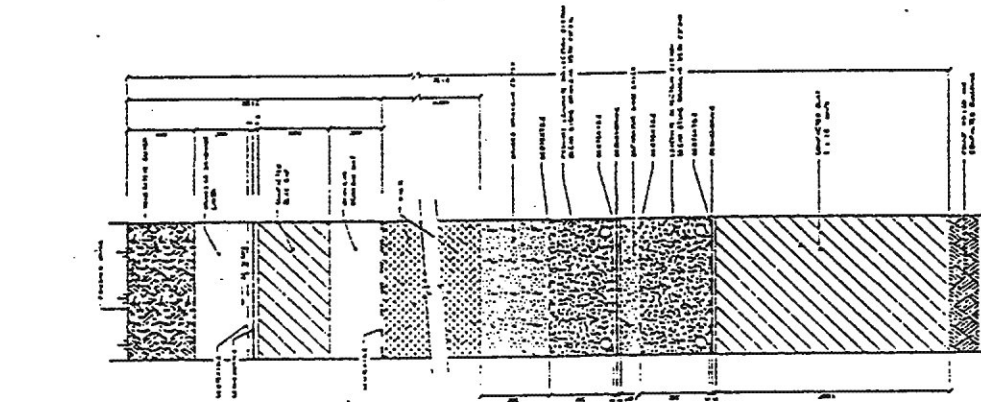
PLAN DE CUBRIMIENTO DEL
DEPOSITO DE TRIOXIDO
DE ARSENICO DE VADO
Y ABANDONO DEL DEPOSITO
DE WALPASO - LA OROYA

VADO AEROPORT SITE

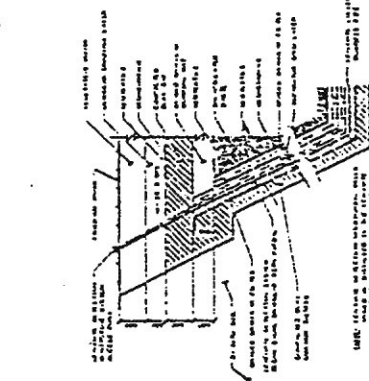
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PLANO N° 1

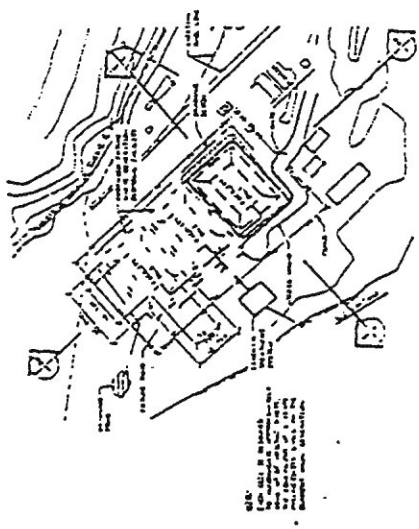
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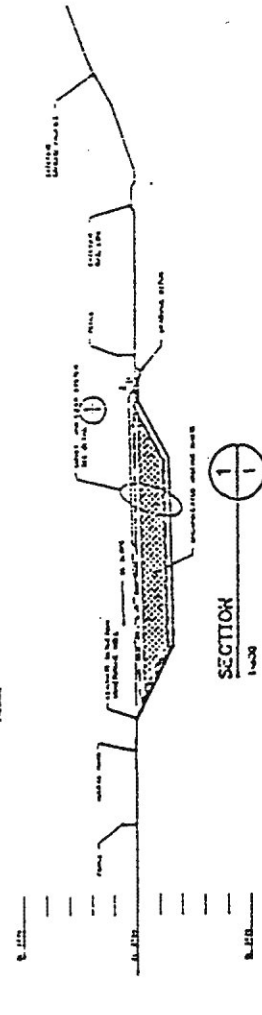
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ENCAPSULATED SECURE FACILITY 100



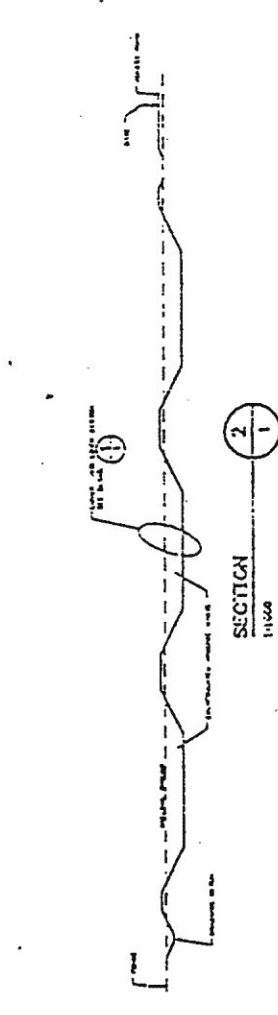
DETAIL
CONCRETE STRUCTURE



SITE PLAN



SECTION



SECTION

5.4.15 PROJECT NO. 15

ZINC FERRITE

1. OBJECTIVE

This project aims at assessing the stability and elevation conditions of the zinc ferrite deposits and subsequently to establish the need for environmental mitigation of impact on land, water, air and living organisms, as well as for land reclamation and recovery.

Two scenarios are contemplated for zinc ferrite mitigation:

- Expanding deposits No. 3 and 4 and technically decommissioning the four other ones
- Studying the technical and economic feasibility of processing the products

2. IMPACT ASSESSMENT

Refined zinc obtained from the zinc sulfur concentrates at the La Oroya metallurgical complex goes through three heat and water metallurgical processes, namely roasting, leaching, purifying, electrowinning, fusion and molding.

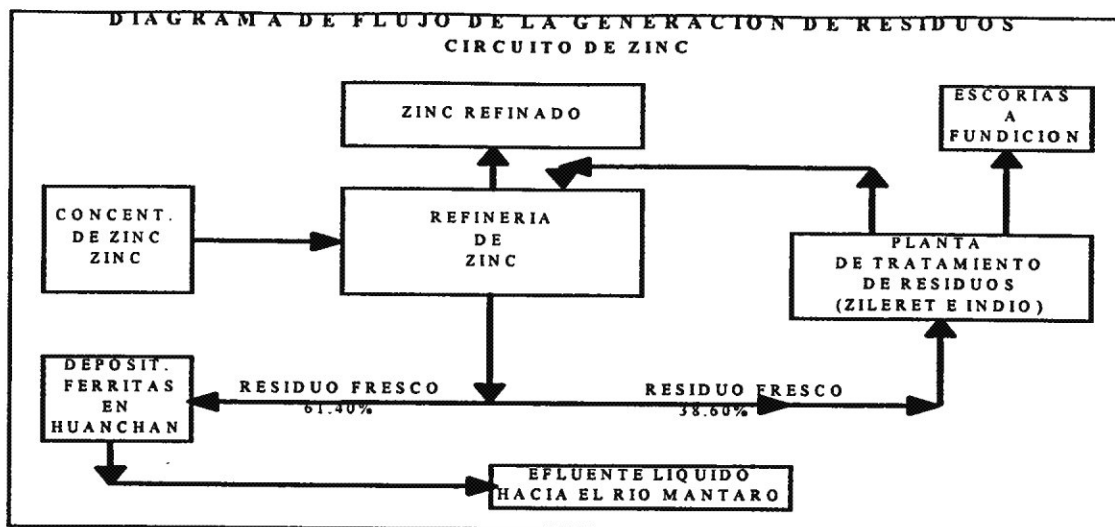
For water leaching, an acid (wasted electrolytic) solution is used to dissolve zinc contained in the calcite produced by concentrate roasting. This results in a zinc sulfate solution and a solid waste that is mostly (75%) made up of zinc ferrite ($\text{Fe}_2\text{O}_3\text{ZnO}$).

The amount of daily residues from leaching (115 tons) largely exceeds the Zileret treatment plant's capacity (50 tons/day). As a consequence the excess has been deposited at the Huanchan deposit some three kilometers from the metallurgical compound. To October 31st, 1996, the deposit had received 1,242,796 tons of residues.

Ferrite pulp is placed in wells surrounded by borrowed materials. To meeting growing capacity demand, the impoundment walls are raised regularly using the upstream methodology without compacting or increasing humidity.

Water contributed by the ferrite sludge is drained at one end of each pond and carried by underground piping to the left bank of the Mantaro river.

Wind and rainfall cause transport fine particle and generate soluble salt solutions (SO_4Zn) that eventually reach the Mantaro river.



2.1 Stability of deposit containment walls

A study carried out by Rescan Peru to assess stability of the deposits' containment walls showed critical conditions in some walls while others approach the minimum regulated standards as shown by the following table.

SECTION	WELL	SLOPE	SECURITY FACTOR		CONDITION
			STATIC	SEISMIC	
1-1	1	LEFT	1.165	0.946	Critical
		RIGHT	1.482	1.158	Stable
2-2	2	LEFT	1.266	0.966	Stable
		RIGHT	2.468	1.692	Stable
3-3	3	LEFT	1.481	1.102	Stable
4-4	3	LEFT	1.423	1.065	Critical
5-5	4	LEFT	1.467	1.090	Critical
6-6	4	LEFT	1.432	1.139	Stable
Seismic Coefficient: 1.5 ; Method utilized : Bishop Method					

2.2 Air quality

Air pollution is caused by airborne particles from sun drying of humid materials deposited in the ponds.

Air is constantly monitored from the station located between the slag and ferrite deposits at Huanchan. The following table shows measurements taken from January to August 1996. The figures are close to the maximum allowable levels, except for lead which, at 2.7 ug/m³, exceeds the top limit. Lead pollution may be accounted for by wind-driven poisonous smoke originating in the compound's main smokestack.

ANALISIS DE MATERIAL PARTICULADO EN HUANCHAN ENERO - AGOSTO DE 1996				
MES	ug/m ³			
	SPM	As	Pb	Cd
ENE	71.517	0.036	0.215	0.007
FEB	120.143	0.493	1.105	0.024
MAR	60.422	0.453	0.906	0.024
ABR	79.713	0.797	1.036	0.032
MAY	175.617	2.107	4.390	0.263
JUN	297.440	6.544	10.113	0.476
JUL	237.019	0.640	0.427	0.095
AGO	121.979	1.134	3.537	0.110
PROM	145.481	1.526	2.716	0.129
NIVELES MÁXIMOS PERMISIBLES				
	SPM*	As*	Pb**	
	350	6.0	1.5	
(*) Concentración media aritmética diaria				
(**) Concentración mensual				

2.3 Water quality

Lixiviation wastes are deposited at sites close to the Mantaro river banks over alluvial ground. Moreover, they are exposed to intense rainfall in winter. The resulting percolation and dissolution of soluble Zn salts and other elements eventually reach and pollute the Mantaro river.

Our control department monitors metal flows and contents of effluents discharged into the Mantaro river. The averages for the January to August 1996 period appear in the following table.

EFLUENTE LÍQUIDO DESCARGADO AL RIO DE LOS DEPOSITOS DE HUANCHAN PROMEDIO ENERO-AGOSTO DE 1996										
FLUJO m3/min.	TEMP. °C	pH	SOLIDOS EN SUSPENSION	mg/l						
				AS	Cd	Cu	Fe	Mn	Pb	Zn
0.488	16	7.03	40	0.08	0.50	0.05	0.25	18.40	1.43	222
NIVELES MAXIMOS PERMISIBLES R.M. N° 011-96 EM/VMM										
			SOLIDOS EN SUSPENSION	mg/l						
				pH	As	Cu	Fe	Pb	Zn	
Anexo N° 2			100	>5.5 <10.5	1.0	2.0	5.0	1.0	6.0	
Anexo N° 1			50	>6.0 <9.0	1.0	1.0	2.0	0.4	3.0	

The table shows zinc and lead concentrations above allowed limits. Other elements such as Cu, Fe and As fall within allowed parameters, as are pH levels.

2.4 Location of deposits

Plan No. M03-96-04 shows the exact location of the zinc (zinc ferrite) leaching deposits.

2.5 Wastes to October 31st, 1996

Well N° 1	102 623,8
Well N° 2	94 429,5
Well N° 3	312 935,0
Well N° 4	732 708,7
Total	1 242 797,0

2.6 Size of deposit mounds

Well N° 1	11 760.0 m ²
Well N° 2	11 600.5 m ²
Well N° 3	25 868.5 m ²
Well N° 4	45 576.0 m ²
Total	94 805.0 m ²

Mound height fluctuates from six to 12 meters.

2.7 Chemical analysis

a.- ANALISIS QUIMICO DEL RESIDUO ALMACENADO EN POZAS ANTIGUAS (ANTES DE 1 980), %												
	Fe	Zn	Pb	SiO ₂	S	Mn	Cu	CaO	Se	Na	Te	e, ppm
Promedio	32.0	25.5	4.4	4.0	2.6	1.6	0.6	0.5	0.5	0.1	0.4	7.0
Variación, +	1.2	0.7	0.3	0.5	0.2	0.1	0.02	0.1	0.1	0.02	0.0	2.0
	Al ₂ O ₃	Cd	In	Sb	Bi	Ga	Ni	Co	Sn	Tl	Ag, g/t	Au, g/t
Promedio	0.2	0.1	0.1	0.1	0.03	0.02	0.01	0.1	0.1	<0,01	302	0.3
Variación, +	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	33	0.1
b. ANALISIS QUIMICO DE LOS REIDUOS RECIENTES, %:												
Fe	Zn	Pb	SiO ₂	S	Mn	Cu	Al	AS	K	Na	g, ppm	e, ppm
32.4	23.5	5.0	2.0	2	1.5	0.6	0.3	0.3	0.1	0.1	<10	7.00
Te	Cd	In	Sb	Bi	Ga	Ni	Co	Sn	Mg	Tl	Ag, g/t	Au, g/t
0.0	0.13	0.1	0.1	0.04	0	0,01	5	0.1	0.1	<0,01	345	0.25

3. MITIGATION OPTIONS

The zinc ferrite project includes various measures and engineering works to full decommissioning of the deposits. Environmental impact mitigation is analyzed in the context of the two scenarios already mentioned.

3.1 First scenario: Technical decommissioning of deposits

3.1.1 Stability

Includes works to be carried out (containment walls, top ditches, gutters, etc.) to ensure the stability of the deposits against their eventual collapse, runoff erosion, and environmental pollution within reasonable parameters for earthquakes and torrential rainfall.

The following studies were carried out.

- Geo-technical research: field research, laboratory assays, soil classification, stratigraphic profile descriptions, resistance parameters using SPT assays, and others.
- Stability evaluation of existing deposits: deposit wall stability, adjoining slope stability, analysis methods.
- Potential for expansion and remaining capacity.
- Stability to rainwater runoff.
- Seepage control.
- Stability to wind erosion.
- Effluent control.

Containment walls planned around the deposits and the gutters to dispose of seepage must be built with frost and sulfate resistant concrete.

Top ditches at a constant slope of five degrees will provide stability against rainwater runoff on the adjoining slopes by catching about 45 liters of water per second.

3.1.2 Storage capacity

Deposits 1 and 2 have almost reached their limit capacity. Their walls should be strengthened and then proceed to decommissioning. Deposits 3 and 4 still show potential for expansion by increasing their height and may continue to receive wastes for a relatively short time. However, some walls will need eventual strengthening to provide physical stability.

3.1.3 Environmental control measures

These include stability and effluent monitoring measures. Reinforcement walls in all four deposits should ensure stability in case of earthquake. Liquid effluents emanating from the deposit sites will be treated at a plant specifically

designed for smelters and refineries, thus ensuring discharges to the Mantaro river will strictly comply with regulations established by the Ministry of Energy and Mines.

3.2 Second scenario: Technical and economic feasibility of processing zinc ferrite

Zinc ferrite deposited at the Huanchan site located 3 kilometers from the La Oroya metallurgical complex (see diagram 4.1.3/1 - Chapter IV) total 1,242,739 tons. Their content of Zn, Ag, Cd and Cu gives them an economic value of US\$230 million. We present below the reasons for proposing their processing.

Processing Technologies for Zinc Ferrites			
Technology	Process	Investment US \$ Millon	Treatment Cost US \$ / t Rem.
AUSMELT	Submerged Lance (New Process)	80,00 Cap. Pta: 175 000 t/y	88,00
LURGI	Waelz Known Process	54,00 Cap. Pta: 60 000 t/y	100,00

Pressurized leaching technology using zinc concentrates

The three fluid bed roasters (FRB) and the turbulent bed roaster (TLC) would be replaced by an autoclaved pressurized leaching plant using the zinc concentrates (sphalerite) and Sheritt pressurized lixiviation technology. The leaching plant would produce 70,000 tons a year of refined zinc at an investment cost of US\$40 million. By contrast, a new TLR would and the corresponding sulfuric acid plant would cost US\$52.9 million.

Pressure lixiviation technology would also allow to use the Zileret plant and its 50 ton/day capacity Kiln-type furnace for the exclusive processing of ferrite from the Huanchan deposit. Additional advantages include:

Eliminating the SO₂ smoke. Sulfur would be fixed as elementary sulfur, notwithstanding its limited demand.

Sulfuric acid transportation and storage problems would be partially solved.

4. RESULTS OF MITIGATION

The following issues are addressed by this project.

4.1 Pollution

Minimal Mantaro river pollution. Discharges into the river from the effluent treatment plant will respect maximum allowable amounts established by the Ministry of Energy and Mines. Likewise, analyses of runoff and drainage water show allowable percent amounts of pollutants. Therefor, water collected by gutters will be poured without treatment into the river after sedimentation without the need to build special treatment plants.

4.2 Physical stability

The project will ensure the dynamic and static stability of the ferrite deposit mounds in case of seismic activity, in particular because La Oroya is located in an area of intense earthquake activity.

4.3 Metal recovery

Use of the above technologies will permit to recover the metals contained in the ferrite and reclaim the site to its original condition.

5. INVESTMENT BUDGET

A breakdown of the required investment follows.

DESCRIPTION	INVESTMENT US\$
Detailed Engineering	160 000
Construction of walls at foot of slope	2 570 000
Cap deposits	740 000
River Bank Wall	216 000
Restoration of soils	400 000
Conduction pipes for effluents and filtrations	480 0000
Channel toward the treament plant	146 000
SUB TOTAL	4 712 000
Taxes	888 000
TOTAL	5 600 000

6. IMPLEMENTATION PERIOD

The project should go in line in four (4) years.

7. SOURCES:

Ausmelt Ltd.,Boart Longyear, Kilborn Lavalin Europe, A.D. Zunkel Consultants Inc

FIGURA 6.5.1/1
FASE DE PLANEAMIENTO DE DETALLE

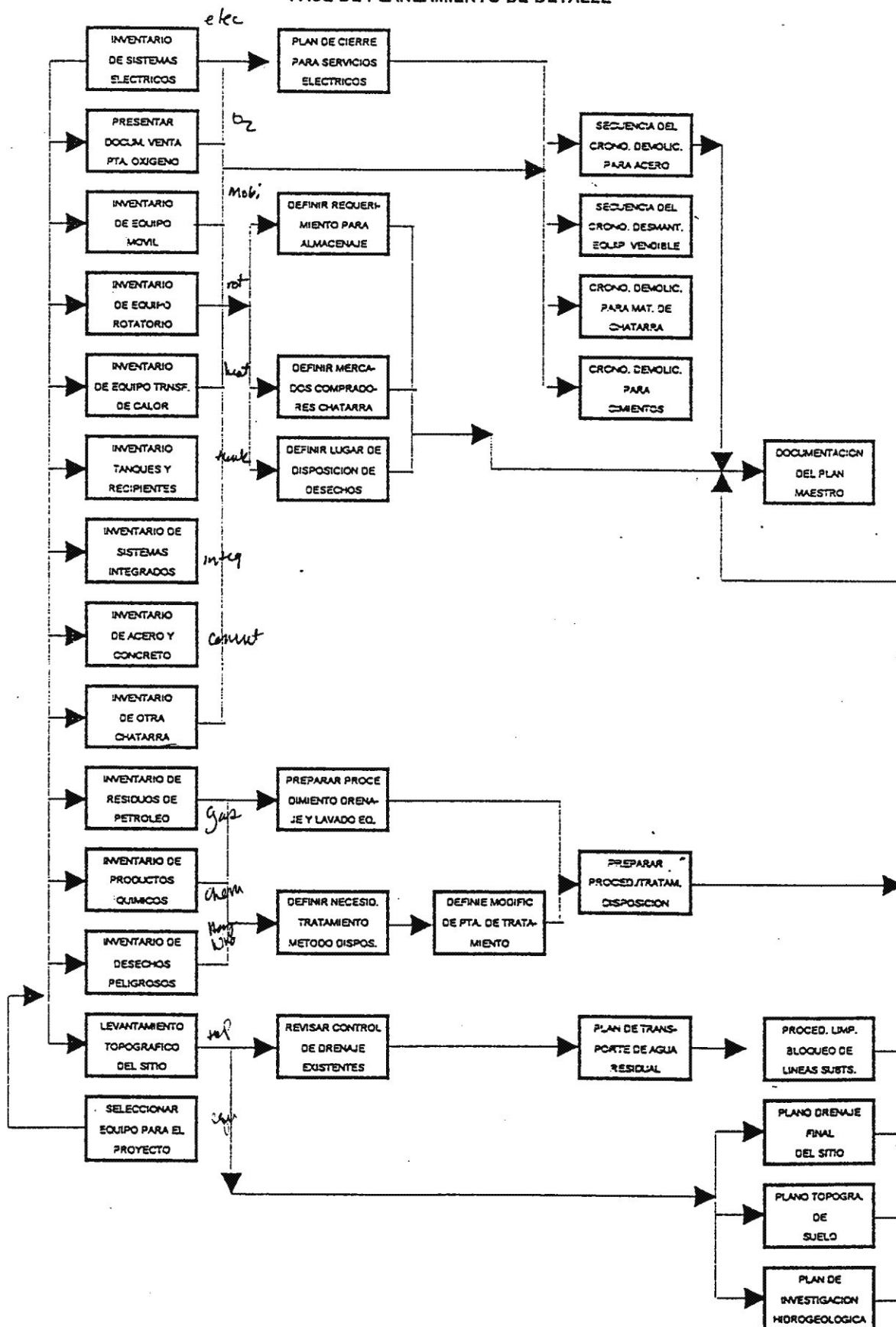


FIGURA 6.5.1/2
ESTABLECIMIENTO DE CONTROLES AMBIENTALES

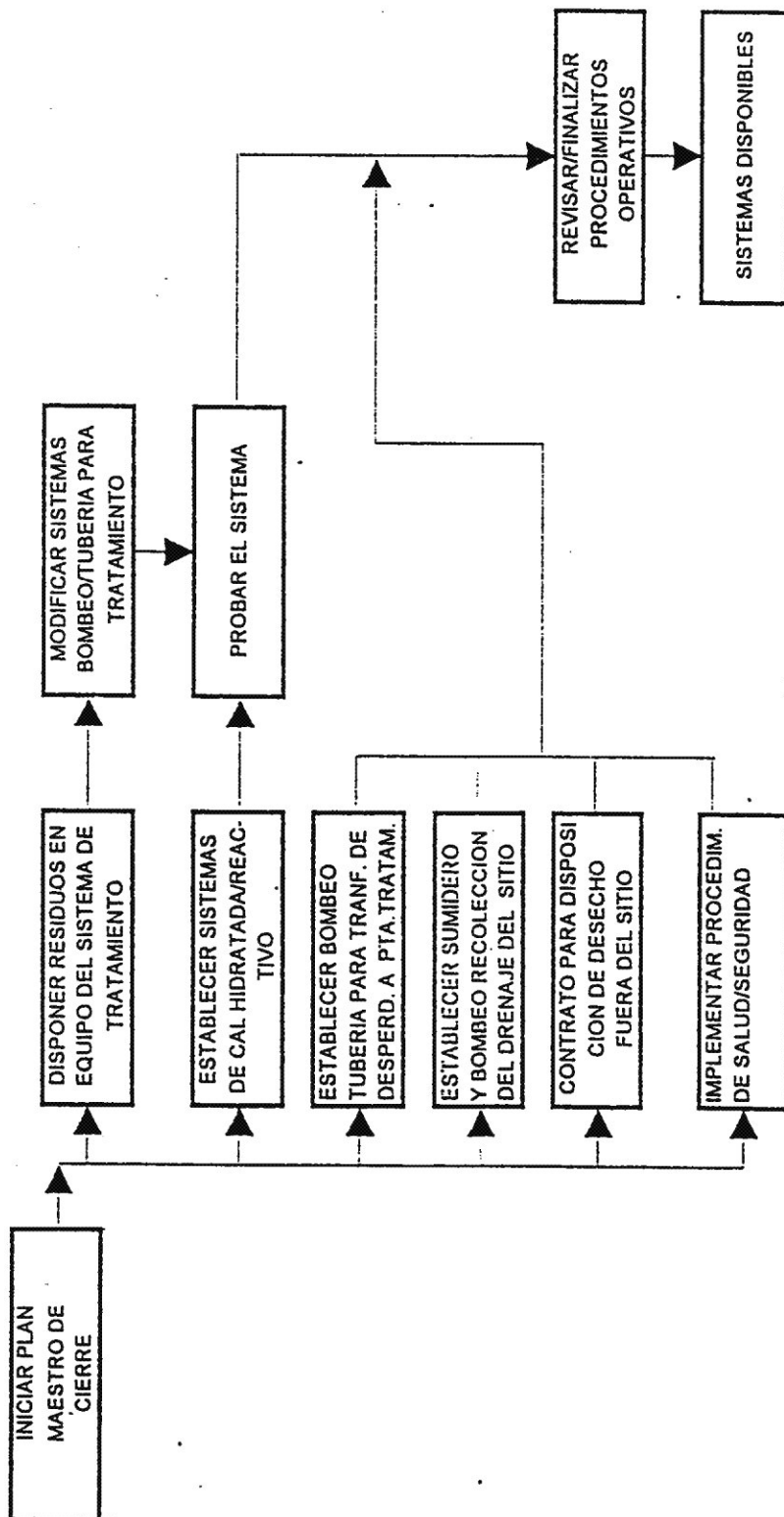
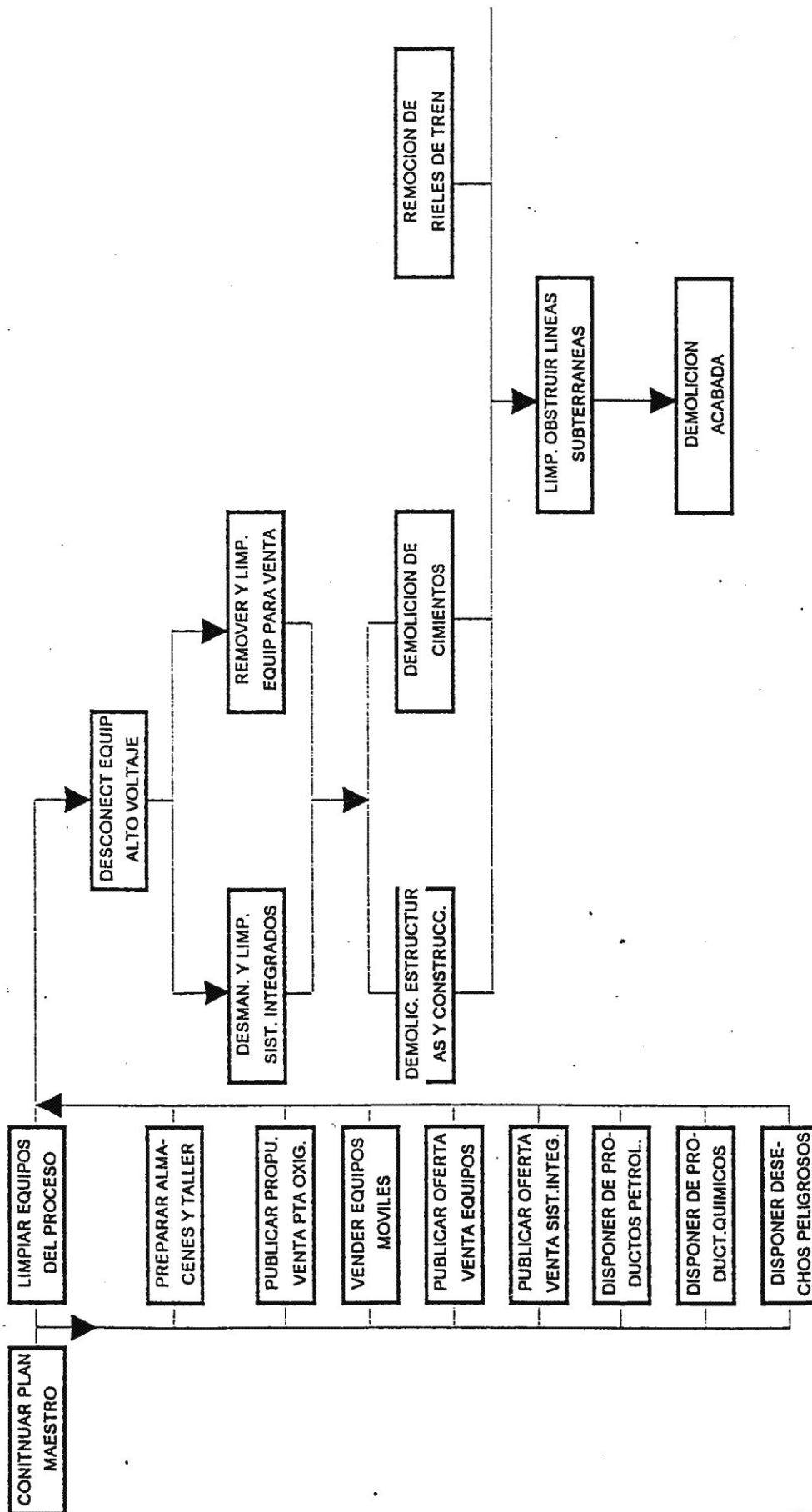


FIGURA 6.5.1/3
FASE DE DESMANTELAMIENTO / DEMOLICION



for the future use of the soil. Future land use categories may include industrial or residential-recreational.

6.6 Investment Budget

The following is the approximate investment budget for the accomplishment of the total closure of the complex:

	DESCRIPTION	AMOUNT (US\$)
1.0	Equipment dismantling	15 000 000
2.0	Dismantling of metallic structures	19 000 000
3.0	Civil works demolition	5 000 000
4.0	Investigation and correction of the area	5 500 000
5.0	Sale of recovered building material and equipment	(22 500 000)
	SUB - TOTAL	22 000 000
	CONTINGENCIES	2 000 000
	TOTAL	24 000 000

6.7 Execution Schedule

The project execution schedule is estimated to require 70 months, according to the following detailed schedule:

	ACTIVITY	TIME (MONTHS)
1.0	Finishing off the inventories	1
2.0	Establishing environmental controls	3
3.0	Dismantling and removal of reusable equipment	9
4.0	Demolition	9
5.0	Site investigations	12
6.0	Site reclamation	36
	TOTAL	70

6.8 Mitigation proposal

An immediate reduction of a high proportion of the polluting agents being released into the environment will occur upon closure of the complex. According to the activity master plan for this closure, pollution from the site will fall far below the established permissible levels.

Another important issue of the mitigation will be reclamation to allow the future acceptable use of the land. Remediation of the environment will help to improve the regional quality of life from an environmental point of view, not only in La Oroya but also in the river bed and the downstream Mantaro river valleys.

6.9 Economic Analysis

The characteristics of the closure plan, which are not directly involved with the production process, do not allow the definition of a profitability type measurable in economic terms for the La Oroya metallurgic complex.

FIGURA 6.5.1/1
FASE DE PLANEAMIENTO DE DETALLE

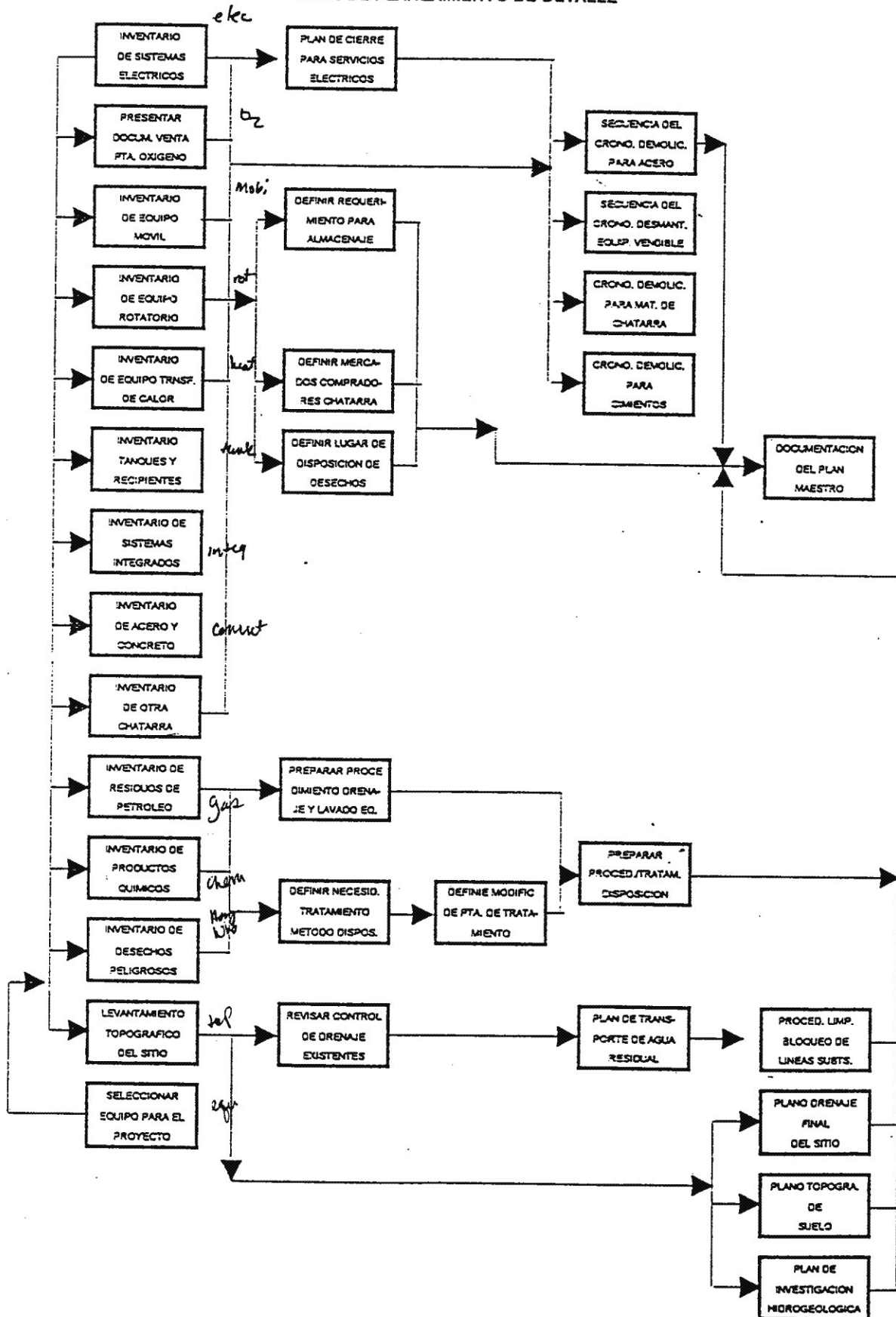


FIGURA 6.5.1/2
ESTABLECIMIENTO DE CONTROLES AMBIENTALES

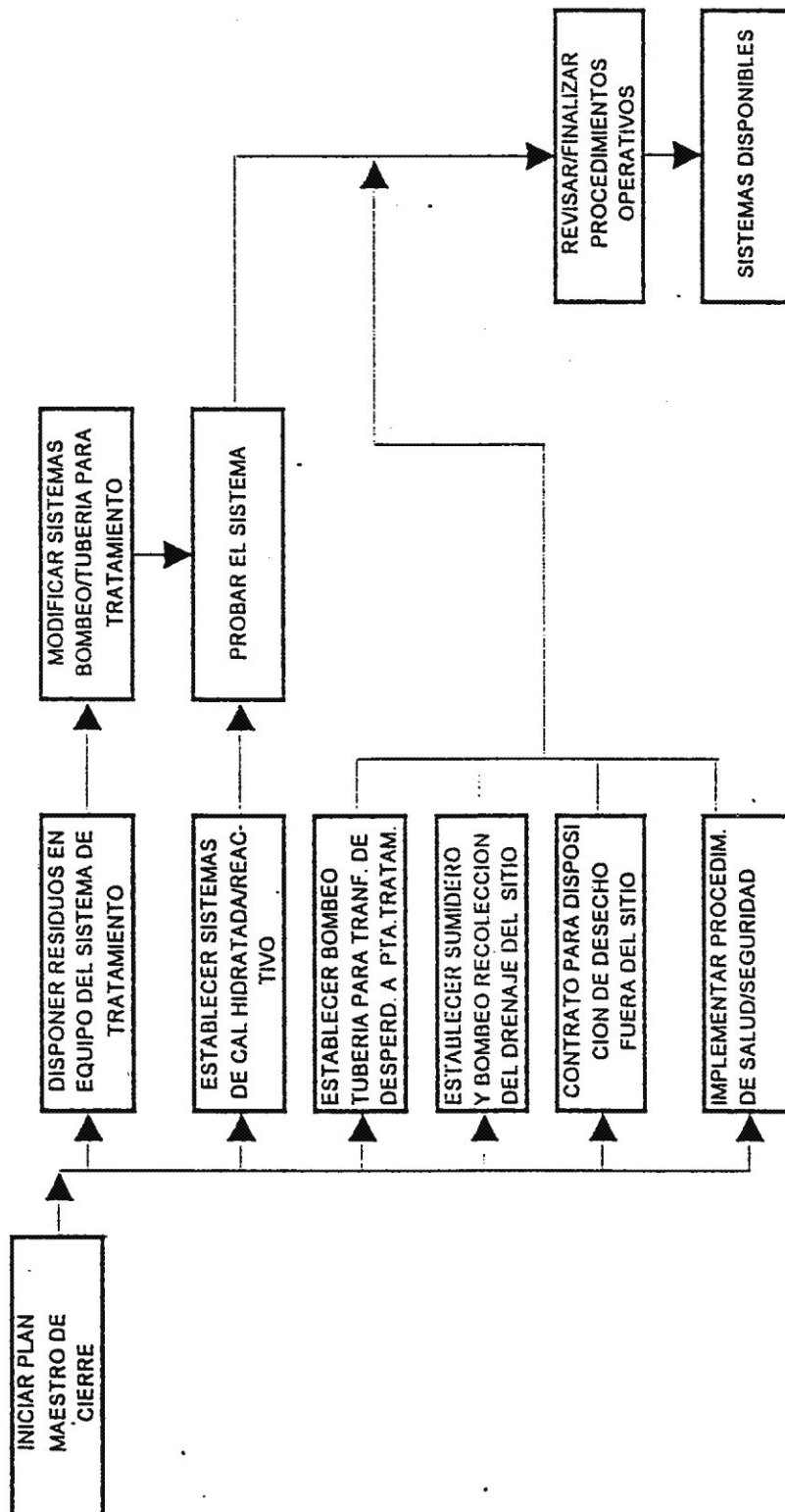


FIGURA 6.5.1/3
FASE DE DESMANTELAMIENTO / DEMOLICION

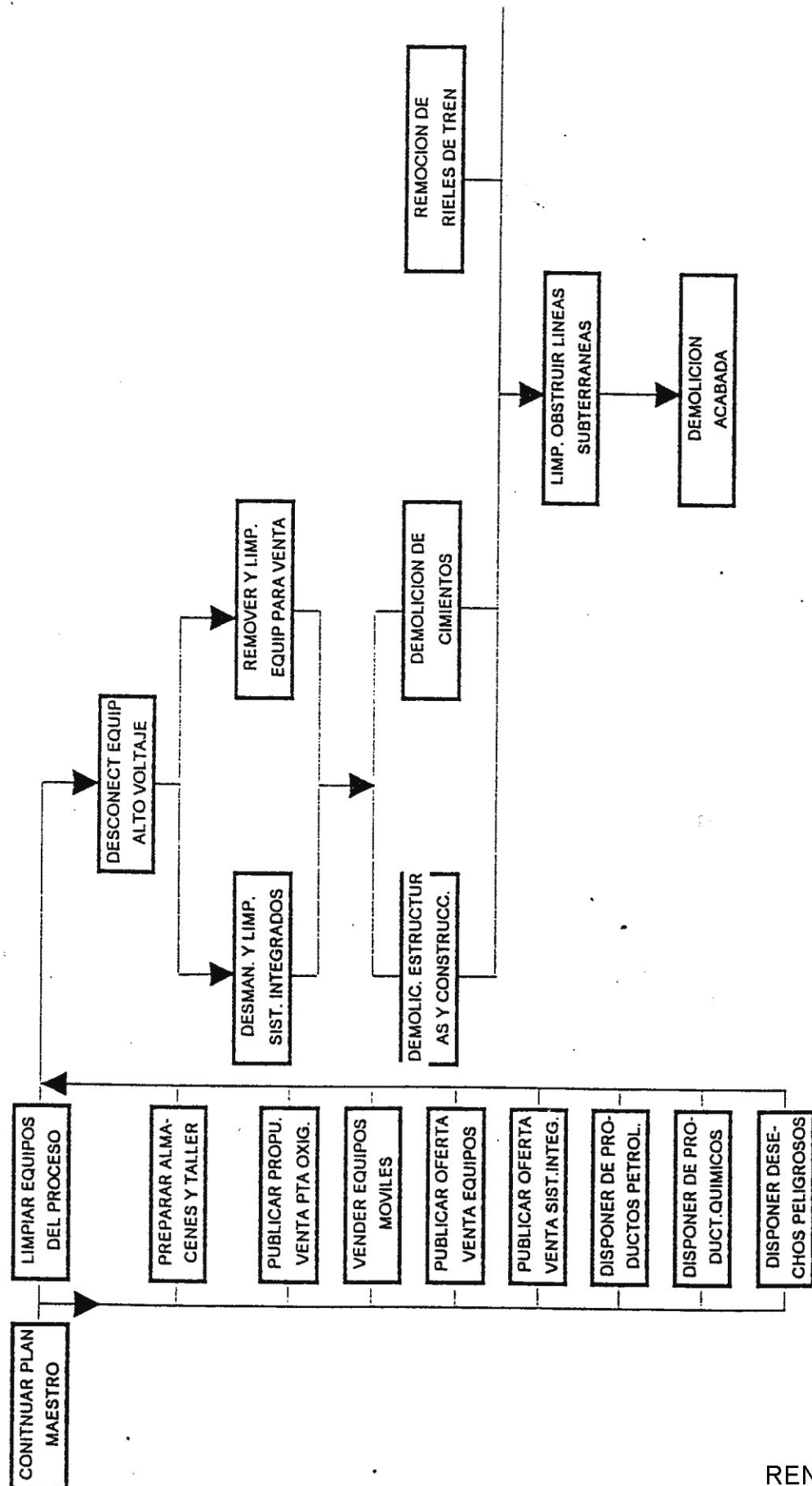
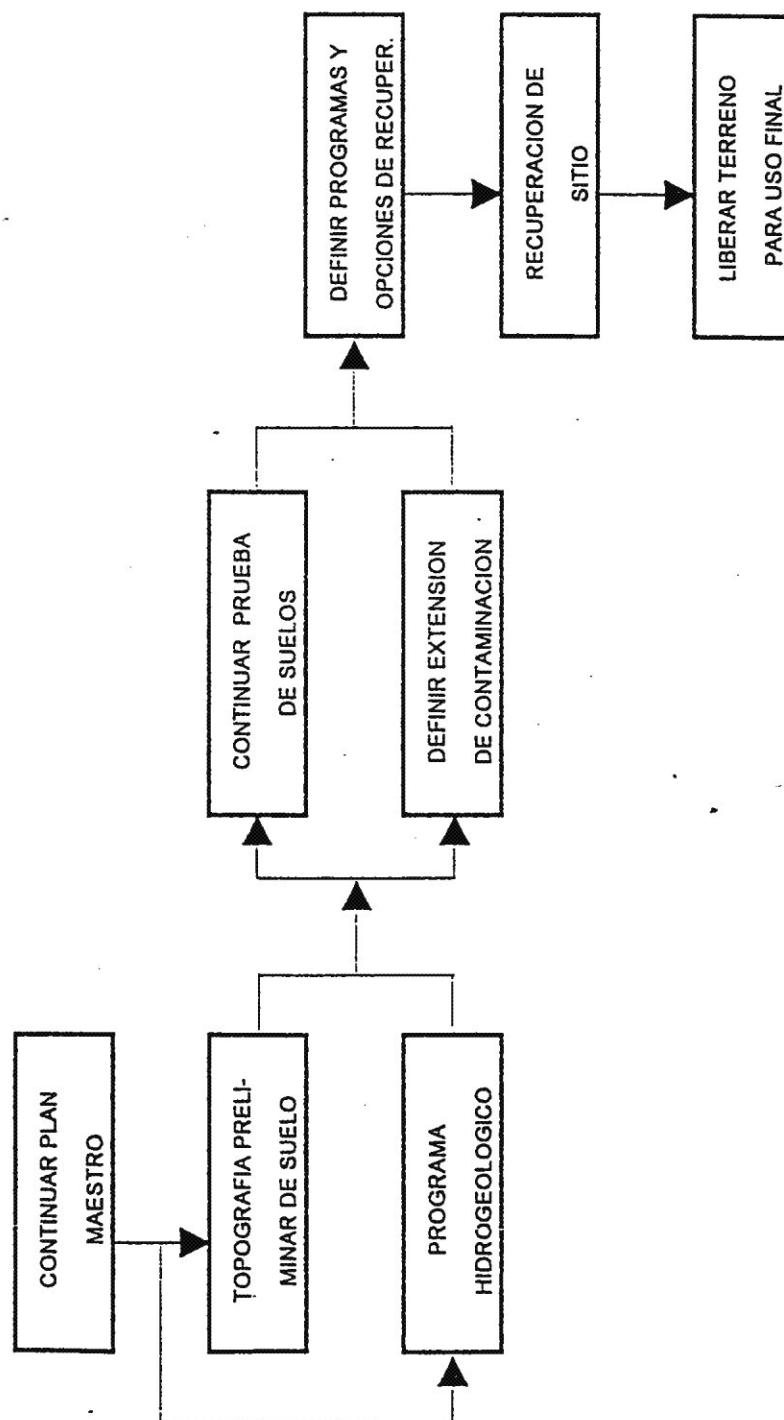


FIGURA 6.5.1/4
FASE DE INVESTIGACION / RECUPERACION DEL AREA



5.4.16 PROJECT No. 16

SEWAGE WATER TREATMENT AND GARBAGE DISPOSAL IN LA OROYA

1. OBJECTIVE

The project seeks to identify the necessary engineering works and purchase and mounting of equipment needed for sewerage water treatment and garbage disposal in residential areas attached to Centromin Peru. This should prevent Mantaro river pollution from these sources in compliance with government regulations.

2. IMPACT ASSESSMENT

Almost all sewerage and runoff water is collected by the existing drain network in the residential areas attached to Centromin. Although the system is in good state of repair, the collected water is poured untreated into the Mantaro river, thus contributing to the river's pollution.

Garbage collection is carried out with a compacting truck that fails to meet current needs. The truck travels an additional nine kilometers from the final collection point.

Garbage is deposited without regard for land filling techniques. The deposit's location on the river's left bank and near its bed have turned to turn the garbage deposit into an additional source of pollution.

3. MITIGATION OPTION

Aquaplan Engineering consulting services were retained to analyze various technical and economic solutions to the above-mentioned problems. An option comprising two activated mud plants using extended ventilation systems was chosen for treating sewerage water. For garbage disposal, the ditch burial method was selected, in compliance with Ministry of Health (DIGESA) regulations.

3.1 Sewerage water treatment

The two plants will be located in the Chulec quarter and across the Inca hotel in the Sudete quarter, respectively. Both plants will serve the residential areas along the Mantaro river bank.

The project includes interception, transport and collection pipes to carry sewerage water to the treatment plant. Pumping stations are required to suit the area's topography.

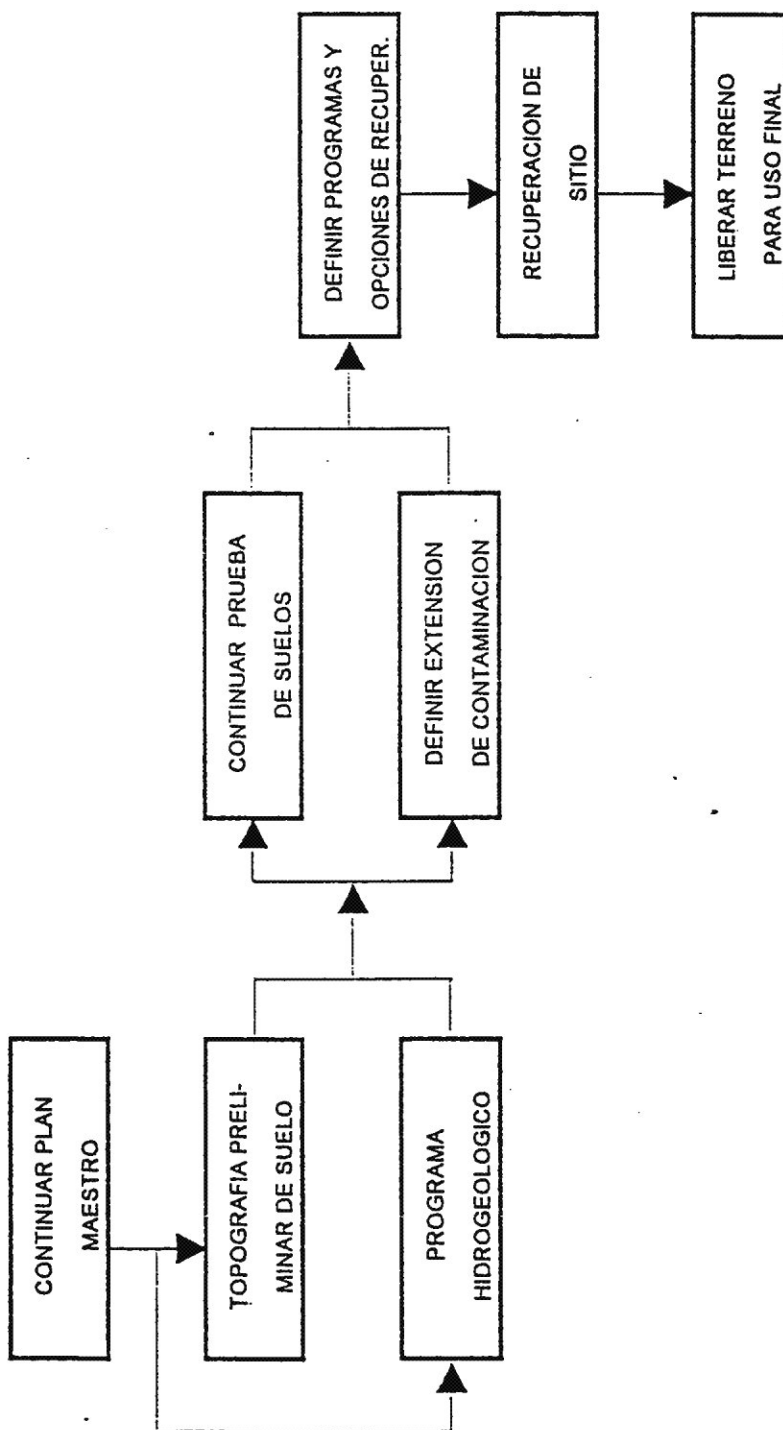
After receiving biological treatment, the effluents will be discharged to the river with an average 40 BOD and 40 ppm of suspended solids.

	• Technical -economical feasibility of processing zinc ferrites			
Objective	Eliminate liquid effluent and dust contamination and reduce the potential risks due to seismic events. Zn, Cd and Ag recovery from zinc ferrites - 1 242 797 t equivalent to US \$ 230,00 Millon			
Impact	Air contamination by dust and Mantaro River contamination by liquid effluent. Soil impact after finishing residue process.			
Mitigation	Technologic alternatives			
	Technology	Process	Investment US \$ Millons	Treat. Cost US \$/t Res.
	AUSMELT	Submerged Lances (New process)	80,00 Cap. Pta: 175 000 t/año	88,00
	LURGI	Waelz (known process)	54,00 Cap. Pta: 60 000 t/año	100,00
	Lixiviación presurizada de concentrados This alternative technology includes replacing pressure leaching of concentrate bed roaster (FBR) and a turbulent bed roaster with direct treatment of the zinc concentrate through pressure leaching (SHERRIT). For this leaching plant to produce 70 000 t.p.y. of raffinated zinc, there is an estimated cost of US \$ 40 millon, compared with the cost of a new TLR and its sulfuric acid plant - US \$ 52,9 millon. The leaching pressure technology will allow the Zileret plant (Oven Kiln of 50 tpd) to be used to process ferrites stored at Huanchán; this technology will also have other advantages like: • Gas SO₂ emission problem will be solved, because sulfur will be fixed as elemental sulfur even when the market is depressed. • It will offset the issues involved with transporting sulfuric acid, as well as the storage capacity.			
Source	Consultoras : AUSMELT LIMITED. : BOART LONGYEAR S.A. : KILBORN. SNC. LAVALIN EUROPE : A. D. ZUNKEL CONSULTANTS INC.			

Project No.16

PROJECT	SEWAGE WATER AND LA OROYA GARBAGE DISPOSAL
Objectives	Execution of work, acquisition and installation of equipment for the sewage water treatment and garbage disposal of the houses from Centromin Perú S.A.
Impact	Mantaro river contamination when discharging sewage water from houses without treatment. Additionally this river is contaminated with garbage because there is no municipal landfill.
Mitigation	Installation of two plants of sewage water treatment, one at Chulec and the other at Sudete to have an effluent of only 30 ppm of DBO and 40 ppm of suspended solids. Get a disposal plant with the technology of a municipal landfill eliminating the river Mantaro contamination.
Execution Program	Three years, from 1999 until 2002
Investment Amount	US\$3,50 Millions
Sources	Consultant: AQUA PLAN INGENIERIA SRL

FIGURA 6.5.1/4
FASE DE INVESTIGACION / RECUPERACION DEL AREA



CAPÍTULO VII

Chulec Plant

Located on the right bank of the Mantaro river in the Lavaropa area, this treatment plant will process 12.5 liters per second. It will cover the Mayupampa, Chupampa, Tortilla and Chulec quarters.

Treatment comprises a two-fold process described below.

Desanding: Sewerage is pumped to a reinforced concrete desanding canal. By differential precipitation, sand falls to the bottom while organic solids remain in suspension. Organic solids are then crushed.

Ventilation for bacterial digestion of organic matter using aerobic microorganisms living in the recycled mud. A concrete pond measuring 12 x 24 x 4 meters and two ventilators 2 HP each will pump 5.8 lbs of oxygen per hour into the liquid mass.

Decanting: separation of the liquid and solid components takes place in a 16.6 x 3.6 x 3 meter reinforced concrete tank over a 4 hour retention period at a maximum surface rate of 30 gal/p2/hour. The tank will be provided with a mechanical cleaning system.

Drying: In two reinforced-concrete drying beds measuring 4 x 10 x 1 meters for speeded-up filtration drying of mud. The supernatant will be pumped back to the ventilation tank.

Monitoring: Test are performed at the 6 x 6 meter laboratory to determine daily values of BOD, SS, pH, dissolved oxygen, volatile solids, and Most Probable Number of Fecal Choliforms.

Sudete Plant

The treatment plant located in the recreational area across the Inca Hotel will treat 18 liters per second. It will cover the Amachay, Hidro, Railway, Hoteles and Sudete areas.

Processes are similar to those described for the Chulec plant. Physical characteristics are as follows.

Desanding will be in a reinforced concrete canal 13.60 meter long to be cleaned by hand, and provided with a Parshall flow gauge and a solids crusher.

Ventilation will be in a trapeze-shaped, reinforced concrete tank of 390 m2 and 4.6 meter deep. Two ventilators of 3.5 HP each will pump 6.8 pounds of oxygen per hour to the liquid mass.

Decanting in two twin, reinforced concrete tanks measuring 24 x 3.8 x 4 meters each will last 4 hours with a maximum surface rate of 30 gallons per square foot per hour.

Each tank will be provided with its own mechanical mud cleaning system. Mud will be pumped to the ventilation tanks. No drying is required at this plant.

Pumping stations

Three pumping stations are needed because of the area's topography. Two will be located in Chulec and one in Sudete.

3.2 Garbage disposal

A sanitary landfill solution was retained. The plant will be located in the Cochabamba quarter over 2.5 hectares.

Cells

Ditch cells 5 meters across and 3 meters deep of various lengths will be lined at the bottom with a geotextile and a Gundle membrane. Garbage will be deposited in layers 0.20 to 0.30 meters thick and compacted with a tractor. After design height is reached they will be covered with a 0.40 meter layer of compacted earth. The design includes exhaust chimneys as well as drains and treatment of liquid emissions in septic wells.

Complementary works

Parking, warehouses, check posts, office space and a perimeter fence are also included.

Equipment

Two compacting garbage trucks with 16 cubic yard capacity.
One D4 or D6 caterpillar tractor.
One cistern truck equipped with a hose and sprayers.
Pump to drain rain water.

4. MITIGATION RESULTS

For the first time ever an environmental sanitation plan will be put into practice in La Oroya. It will ensure the treatment of sewerage water and garbage, and thus contribute to reduce pollution of the Mantaro river. The program falls within the basic principles of environmental protection to guarantee sustainable development.

Currently in the detailed engineering stage, the plan has received the attention of various government agencies, including the Ministry of the Presidency. The adopted solution is likely to be included in the comprehensive environmental sanitation program for La Oroya.

5. INVESTMENT

The sewerage and garbage treatment project will require investments for the following works and equipment. Purchase of only two compacting trucks is included.

	<u>DESCRIPTION</u>	<u>AMOUNT (US\$)</u>	<u>SUB-TOTAL (US\$)</u>
1.1	Intersection and transport	425 000	425 000
1.2	Treatment plant		
	Chulec	1 100 000	
	Sudete	1 100 000	
1.3	Garbage disposal	425 000	2 625 000
	Sub total		3 050 000
	Contingencies		450 000
	Total		3 500 000

6. IMPLEMENTATION TIMETABLE

Implementing the project will take three (3) years.

<u>YEAR</u>	<u>ACTIVITY</u>	<u>AMOUNT (US\$)</u>	<u>SUB-TOTAL (US\$)</u>
1998	Intersection and transportation Mayupampa, Chulec, Amachay and Hidro	500 000	
	Garbage disposal	500 000	1 000 000
1999	Chulec treatment plant	1 250 000	1 250 000
2000	Sudete treatment plant	1 250 000	1 250 000
	Total		3 500 000



6.0 CLOSURE PLAN

6.1 Scenery

The scenery is that of a typical of a high-density industrial zone which should be reverted into a similar condition to the one it had before the initiation of its industrial activity.

6.2. Scope

As stipulated in the environmentally related legal regulations, it is necessary to develop a Closure Plan for every working industrial unit. The purpose of the plan is to develop, at the end of operations, an activity program which guarantees the restoration and reclamation of the project area to acceptable levels for future use.

Accordingly, the La Oroya Metallurgic Complex has developed a closure plan to the level of basic engineering with the support of the Canadian corporation ADI International Inc.

The Closure Plan is expected to be completed in the long term, and therefore many projects to mitigate and modernize processes have been considered in the design of the current PAMA. Closure activities are oriented to improving existing environmental conditions to regulatory standards. In order to reach these levels, the Closure Plan will focus on studying a 55 hectares area that includes locations and industrial areas of the Smelter as well as those of the Copper and Lead Refinery.

6.3 Current Situation

The large number of buildings, mechanical, electrical, and control process equipment, as well as the diversity of the metallurgic processes utilized during smelting and refining operations of 20 metals (products and sub-products), and the age of the La Oroya Metallurgic Complex have contributed to the pollution of part the site.

The importance of the metallurgic complex in the region's social and economic development is due to the fact that it is the region's greatest source of employment and foreign currency. It is also important for its metal production which is exported in great volumes all around the world, therefore, its probability of closing down is not expected in the short or medium term.

The metallurgic complex is one of four smelters in the world capable of processing polymetallic concentrates with a high percentage of impurities. Based on the size, diversity, and complexity of metallurgic operations, the closure plan should consider the effects of planning and execution actions based not only on purely technical decisions, but also economic and political decisions.

6.4 Objective

Development of basic engineering studies will allow the closure plan of the metallurgic complex to take place in accordance to the PAMA's projections. Components of the closure plan include: the removal of the existing facilities, elimination of the sources of

pollution, ground reclamation, and the corresponding remedial work until the area recovers the characteristics it had before the metallurgic operations.

6.5 Closure Plan

The closing of the operational processes in the smelter and refinery complexes will result in a dramatic decrease of the volume and quantity of released polluting agents. However, its development will require a detailed plan of the activities which will begin with the decision to close the facility and end with the implementation of area reclamation and post-closure control methods.

This closure plan will be the most important planning tool, not only at the end of the operations, but also in the case of only partial closure. The detailed planning of the various phases of closure such as demolition and dismantling, restoration of the environmental quality to acceptable levels, and other phases will allow the rational use of resources and will require considerable amounts of time and money.

6.5.1 Closure Phases

A master plan that covers every aspect must be designed to implement closure. Such coverage range from the exhaustion of the stocks in process to the investigation of the area following demolition of facilities.

Four main phases have been considered for the design of this detailed master plan:

- Detailed planning
- Establishment of environmental controls
- Dismantling and demolition
- Area investigation and reclamation

Detailed planning will provide all the necessary information in the master plan for dismantling, demolition and reclamation of the smelter and refinery areas as well as assuring the health, security and environmental standards in a process which will last for several years. Detailed information on activities for this phase are illustrated in figure 6.5.1./1.

Environmental controls can be established before dismantling and demolition works begin to reduce the release of non-treated wastes into the environment and to assure the design of a health and security plan before demolition begins. The main activities for this phase are shown in figure 6.5.1/2. It should be noted that environmental controls will continue during the post-closure stage in order to guarantee a successful closure, and corrective or maintenance works will be made if necessary.

The dismantling and demolition phase must be carried out according to the master plan and bearing in mind the possible reuse of some of the buildings in future activities. The main activities of the dismantling and demolition phase are shown in figure 6.5.1/3.

For the research and reclamation phase, only some of the buildings, roads and railways will remain, facilitating completion of the activities indicated in figure 6.5.1/4, where ground pollution will be the most serious issue for reclamation and

7.0 EMISSION AND EFFLUENT MONITORING PLAN

7.1 Objective

The objective of the emission and effluent monitoring plan is to quantify the results of the mitigation program, whose aim is to achieve compliance with existing environmental laws.

- For Emissions : Ministerial Resolution No. 315-96-EM/VMM (Maximum Permitted Levels of Elements and Compounds in gaseous emissions coming from metallurgic activities – Annexes 1 and 3).
- For Effluents : Ministerial Resolution No. 011-96-EM/VMM (Maximum Permitted Levels for metallurgic Liquid Effluents – Annexes 1 and 2).

The monitoring plan includes: a reduction in monitoring points due to the mitigation projects as well as adequate systems for sampling and analysis, mechanical, physical and chemical analyses as well as analyses of solid wastes, and other elements resulting from the operations at the metallurgic complex. In addition, the plan considers compilation of relevant information to be reported to the General Bureau of Environmental Affairs (DGAA) of the Ministry of Energy and Mines.

7.2 Monitoring Plan

The emission and effluent monitoring plan will be carried out with available and new resources including:

Human resources
Infrastructure and/or equipment
Protocols
Stations and/or monitoring points
Training

7.2.1 Human Resources

The Monitoring Plan execution at the field level will be directed by the Control Testing Department of the Metallurgic Processes Control Bureau at the Metallurgic Operations Central Management. This execution will be under direct supervision of metallurgical engineers.

7.2.2 Infrastructure and/or Equipment

The following is the equipment owned by Centromín Perú S.A.:

7.2.2.1 For Emissions

The equipment used to measure gaseous emissions from the smelter includes sprague pneumatic samplers for manual sampling and vacuum pumps for automatic sampling. Gas flows are measured with pitot tubes and Dwyer draft gauges and gas analyses are made with a COSA electronic analyzer and Orsat and Orsat Universal chemical analyzers.

7.2.2.2 For Air Quality

To monitor air quality, two Japanese Kimoto gas (SO₂) monitors, type 331 B, are used to measure concentrations in ppb.

The monitor functions on the principle of the conductivity phenomenon. The SO₂ is oxidized in the reception medium, resulting in electric energy microcurrents (conductivity) which are electronically recorded. The resulting data can be plotted or printed.

The monitor also detects particulate matter in $\mu\text{g}/\text{m}^3$. The particulate matter is automatically recorded using a paper tape under controlled movement. In this capturing device, ambient air is forced through a filter-band. As the air passes through the band, it deposits materials which stain the paper. This results in blots of different densities (and colors), depending on the sampled air contents. A(beta) beam device is used to then analyze the blots. The device provides particle mass readings that can be used to determine "air dirtiness indices." These samples can also be used to determine specific chemical elements (i.e. arsenic) through laboratory analysis.

In addition, there are two Japanese Kimoto gas (SO₂) monitors type 332 TW capable of measuring concentrations in ppb and wind direction and speed with automatic record. Centromín Perú S.A also owns a Japanese Kimoto gas (SO₂) monitor type DKK, capable of measuring concentrations in ppb.

For air quality monitoring, there are four high volume (High-Vol) KIMOTO portable samplers. These are used in a rotation at all of the stations to measure concentrations of floating particulate matter or environmental dust accumulated in a filter-paper. The monitors are used to obtain weighed measurements from the whole sample, as well as analyses of heavy-metal concentrations such as lead, cadmium, and arsenic in the samples.

7.2.2.3 For Effluents

Monitors to measure liquid effluent emissions and water quality, include: an ORION instrument which measures temperature (°C), pH, Eh in millivolt (mV), a TOA instrument to measure conductivity in uS/cm, a Denver pressure air filter for separation of total suspended solids (TSS), seven ISCO

automatic samplers for monitoring stations in areas of high pollution, a Kay-Ray electric-flow meter; an APIN sample container to prevent physical and chemical changes during collection as well as graduated plastic deposits (buckets) for flow measure; a CASIO chronometer, and a one-gallon dark containers for sample storage.

7.2.2.4 New Equipment to be Purchased

The new weather station will collect data that will be used in the ISC-3 mathematical model (Industrial Source Complex Model, Version-3). This model, developed by the U.S. Environmental Protection Agency (EPA), can be used for emission dispersion simulation.

With modernized equipment to monitor air quality and gaseous emissions, it will be possible to obtain real-time information regarding concentration of pollutants in order to take corrective measures in the operations.

7.2.3 Existing Protocols

7.2.3.1 For Emissions and Air Quality

Air quality and emissions monitoring follows the Air Quality and Emission Monitoring Protocol of the General Bureau for Environmental Affairs of the Ministry of Energy and Mines..

Stations for air quality and emission monitoring have been established following this protocol. At these stations, weather monitoring is to be carried out, because atmospheric phenomena play an important and complex role in the dispersion of polluting agents and the resultant air quality. Data obtained with the weather station include atmospheric stability, wind direction and speed, and air temperature.

The monitoring stations also include wind speed and direction meters, SO₂ analyzers, and high- and low-volume suspended particulate matter analyzers. Such equipment is regularly calibrated under an established program. Sulfur dioxide samples, suspended particulate matter samples, and wind speed and direction measurements are taken each hour.

The following equipment is used in emission monitoring stations: tube samplers for dust capture, dust-capturing cellulose filters (cartridge type), humidity suppresser and condenser, gas counter (gasometer), aspiration pump, and an electronic analytic scale. Pitot tubes (type S), manometers, and thermometers are used for gas flow measurement. Electronic and chemical analyzers are used for gas composition determination. After data is collected, calculations are made to prepare reports. To obtain reliable data there is a

calibration program for this equipment. Composites of these samples are sent to the lab for analysis.

Finally, reports and pertinent evaluations are prepared for presentation to the Ministry of Energy and Mines.

7.2.3.2 Water Quality

The water quality sampling program follows the Water Quality Monitoring Protocol of the General Bureau for Environmental Affairs of the Ministry of Energy and Mines. According to this protocol, monitoring stations have been established to identify all pollutant sources affecting the receiving body.

The metallurgic complex is a processing installation and a disposal area for metallurgic by-products and wastes, as well as waste-water discharges (including sewage). Water samples are collected at the complex and are analyzed for waste quantities and qualities.

These liquid effluents are sampled twice a week for metallurgic evaluation. Likewise, it is necessary to sample the reception body upstream and downstream of processing installations. Parameters measured in water samples include inorganic parameters and physical parameters (total suspended solids, temperature, flow, pH, Eh, conductivity; main inorganic-ions: total dissolved solids, cyanide, dissolved oxygen, nitrates and sulfates), inorganic metals (As, Cu, Fe, Pb and Zn), and organic parameters such as fecal and total coliform.

Sampling carried out in waste effluent streams and rivers consist of repeated sampling for a one month period. Samples are collected twice weekly in clean bottles at room-temperature with physical inorganic parameters determined and duly written down. River sampling is performed by collecting samples from both river banks, and if there is a bridge another sample must be taken from the center of the river. All of these samples collected at a given point along the stream are then combined into a single sample.

Blank and duplicate samples analyses are carried out to obtain optimal results and to maintain quality assurance (QA). Sample blanks are also collected to maintain quality control (QC).

After labeling, the sample composite is put in a container at 4°C, in new dark-colored bottles to prevent chemical changes in the sample. These

samples are then sent to the laboratory for analysis. Once results are obtained, evaluations comparing these results with data previously collected at the sampling sites and other monitoring stations.

7.2.3.3 Other Monitoring

Other monitoring will be implemented to evaluate results of mitigation projects.

7.2.4 Stations and/or Monitoring Points

Monitoring points for liquid effluents may undergo changes based on the mitigation projects discussed in Chapter 5. For example, according to Diagram 3.1.1/1 in item 5.4.8, discharge of industrial liquid effluents will be made at only one location. Competent authorities will be informed of these changes in sampling points.

The following are the stations and/or monitoring points currently used to control gaseous emissions both internally and externally:

7.2.4.1 Emissions

- **Within the Smelter:** (See Picture 4.1.1/1 – Chapter IV, Table 7.2.4/1, Diagram 7.2.4/2).

Concrete Chimney: 167,5m height. This chimney is the main gas emitter (Diagram 7.2.4/1)

Iron Chimney; 91m height. Discharges sweep gases from the matte channel of the reverberation furnace to the environment (Diagram 7.2.4/1).

“A” Battery Coke Chimney; 19m height. Chimney used to discharge furnace’s combustion gases.

“B” Battery Coke Chimney; 19m height. Chimney used to discharge furnace’s combustion gases.

Ventilation System of Bismuth Buckets for Anodic Wastes. This system has two chimneys.

Ventilation System of the Anodic Wastes Plant converters. There are three chimneys discharging gases to the environment.

Zinc Toasters Ventilation System. There are eight chimneys in this system.

- **Outside the Smelter:** (See Table 2.1.4/1, Diagram 7.2.4/3, Table 7.2.4/1).

Huanchán Station

Close to the Cu and Pb slag deposit, 30m from the slag intake, tower 16, 2km from the central chimney in segment "Y", road to Huancayo.

This station has a Japanese Kimoto gas (SO₂) monitor type 332 TW, capable of measuring concentrations in ppb, with automatic recording. The unit also records weather measurements, particularly wind direction and speed.

The station also has a high volume (Hi-Vol) portable sampler to capture floating particulate matter or environmental dust.

Sindicato de Obreros Station

Located in the urban zone (La Oroya Antigua), on the second floor. It's the nearest plant to the main reference source, only 0.8 Km. from the Main Chimney.

It also has a Kimoto SO₂ record unit, type 331 B. The difference from the previous one is that this latter can't take weather records and high volumes.

Hotel Inca Station

Located 2 Km. from the reference point on the "Y" segment in the road to Cerro de Pasco. Its equipment (a Kimoto 331 B monitor) is located on the hotel roof. Samples are performed with a High-Vol non-sedimented particulate matter sampler.

Cushurupampa Station

Only 3Km. from the Main Chimney, in the "Y" segment of the road to Lima. It has a 332 TW High-Vol Kimoto monitor

Casaracra Station

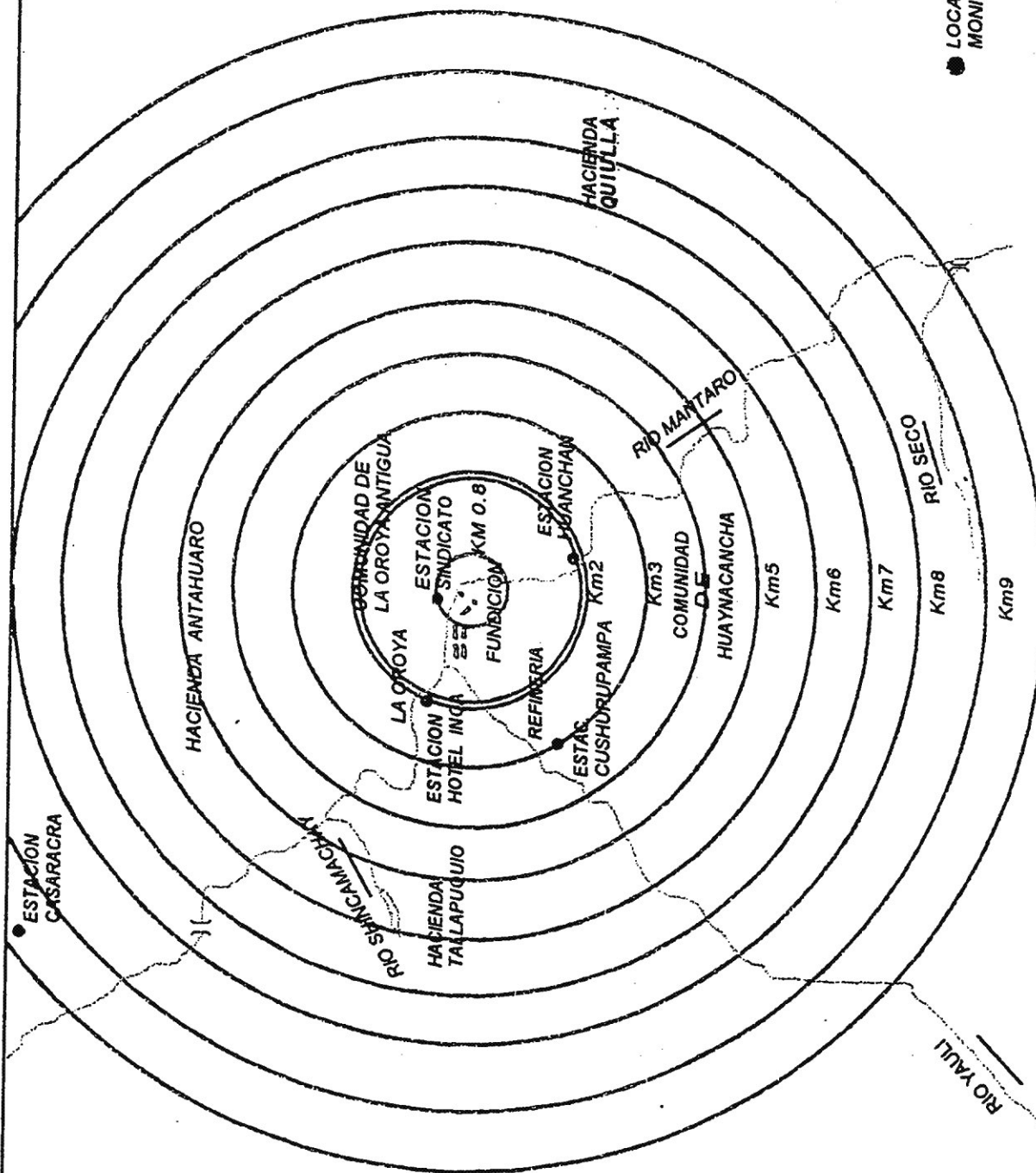
This is the most distant station. It is located on the fish farm of like name, 10 Km from the central reference in the "Y" segment of the railway track and road to Cerro de Pasco. It has a DDK monitor to measure SO₂ exclusively. This monitor is based on the same principle as Kimoto monitor, but doesn't give numerical but rather graphic results which need to be processed to extract figures. This station performs Hi-Vol sampling.

7.2.4.2 Effluents

Details about effluents currently monitored can be found in Chapter 4, Item 4.1.2, Diagrams 7.2.4/4, 7.2.4/5 and 7.2.4/6 and Table 7.2.4/2.

7.2.5 Training

- Integral training will be given to the staff carrying out sampling and analyses. Likewise, staff will receive training regarding operation of new equipment operation and management of new software.
- Training is aimed at the development of skilled and specialized technicians in environmental, technical, legal and institutional relations affairs.



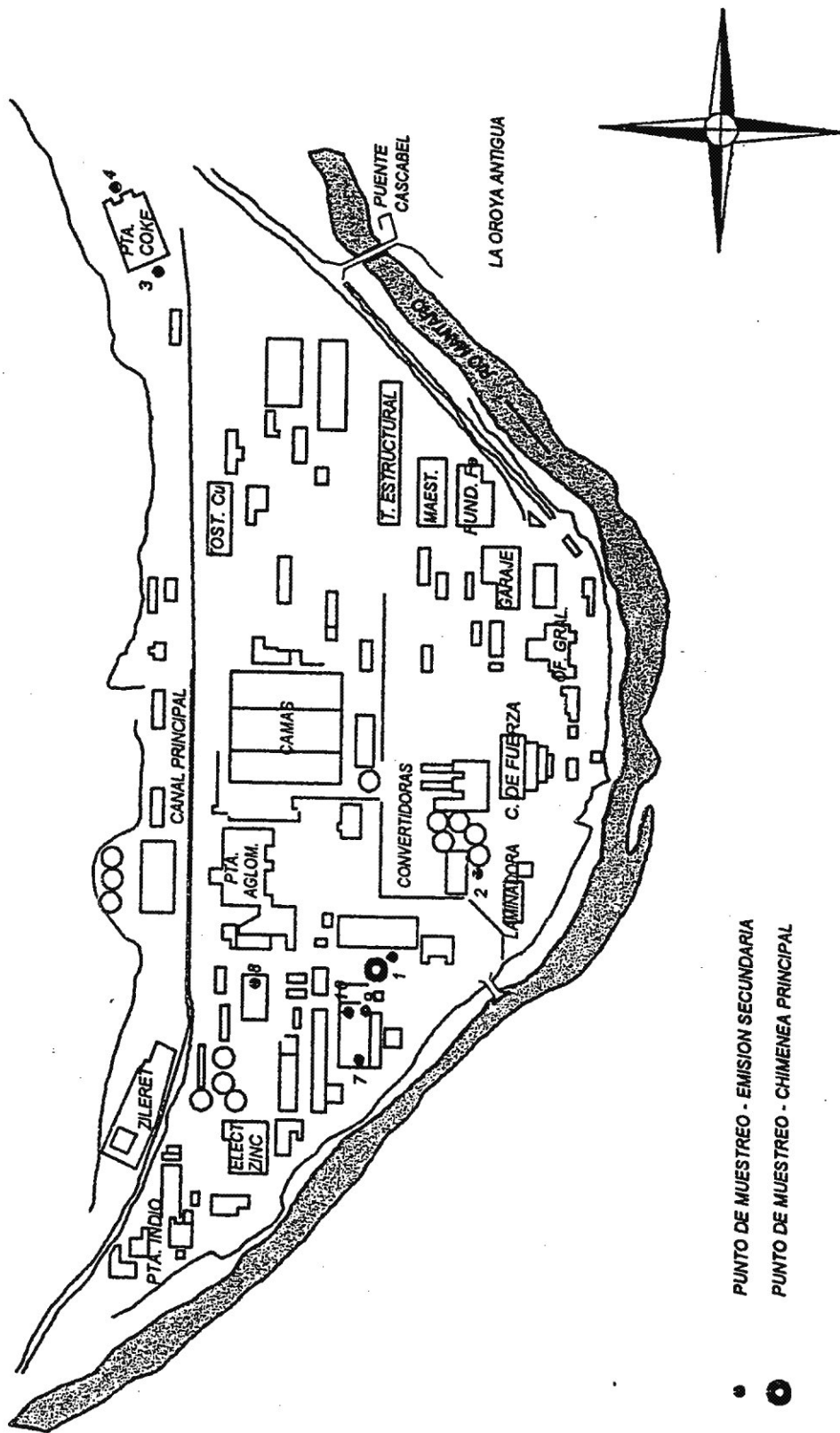
LEYENDA

● LOCALIZACION DE ESTACIONES DE MONITOREO ATMOSFERICO

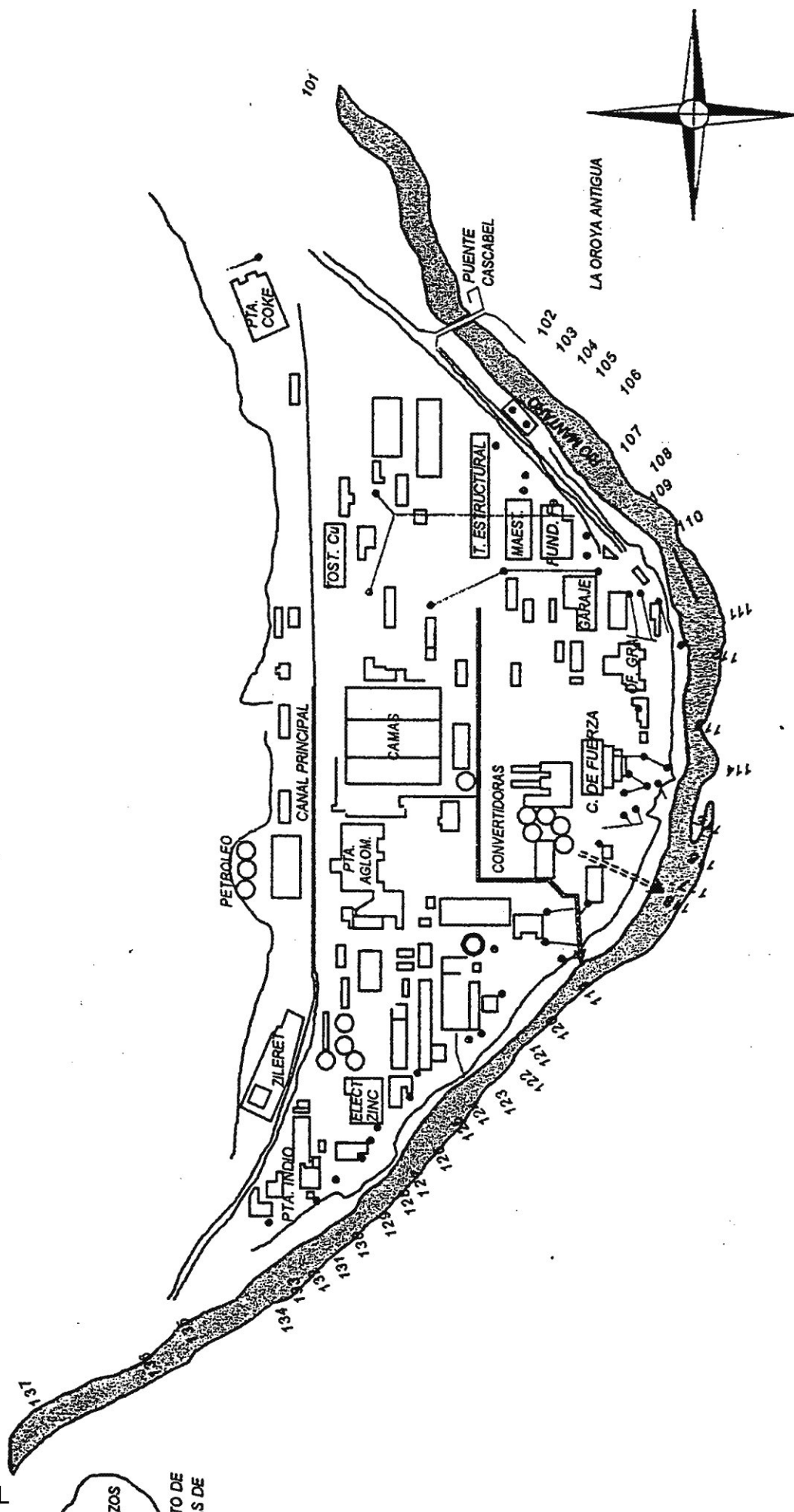
CENTROMIN PERU S.A. - LA OROYA
DIRECCION DE ASUNTOS AMBIENTALES
COMPLEJO METALURGICO - LA OROYA
ESTACIONES DE MONITOREO DE CALIDAD DE AIRE
PAMA : DIAGRAMA N° 7.2.4/3 FECHA: NOV -96

TABLA N° 7-2.4/2
PROGRAMA DE MONITOREO DE EFUENTES LIQUIDOS

ESTACION	UBICACION	PARAMETROS A ANALIZAR	FREC.DE MUESTREO	FREC.DE ANALISIS QUIMICOS Y OTROS	OBSERVACIONES
R-1	Rio Yauli	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
R-3	Rio Yauli	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I15	Casa de fuerza	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I18	Fundición Cu y Pb	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I19	Fundición Cu y Pb	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I23	Residuos Anódicos	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I26	Plta. Elect. de zinc	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I31	Planta de Cadmio	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I34	Planta Indio	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I35	Canal I (paralelo FFCC)	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I36	Canal paralelo al Canal I	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
I37	Pozza ferritas de zinc	Flujo, pH, TSS, Pb, Cu, Zn, Fe, As	8 registros/mes	Uno mensual	Emisor
CALLEJON DE AGUA					
T-1	Rio Tishgo	us, Eh, Flujo, pH, TSS, OD, NO3, 504	4 registros/mes	Uno mensual	Toma de agua
M-1	Rio Mantaro	TDS, As, Cd, Cu, Fe, Mn, Pb, Zn, DBO, col. fec.	4 registros/mes	Uno mensual	Puente Chulec
M-2	Rio Mantaro	us, Eh, Flujo, pH, TSS, OD, NO3, 504	4 registros/mes	Uno mensual	Antes de unión con el Rio Yauli
M-3	Rio Mantaro	TDS, As, Cd, Cu, Fe, Mn, Pb, Zn	4 registros/mes	Uno mensual	Puente Cascabel
M-4	Rio Mantaro	us, Eh, Flujo, pH, TSS, OD, NO3, 504	4 registros/mes	Uno mensual	Después de La Fundición
M-5	Rio Mantaro	TDS, As, Cd, Cu, Fe, Mn, Pb, Zn	4 registros/mes	Uno mensual	Después del Dep. ferritas de zinc
Y-1	Rio Yauli	us, Eh, Flujo, pH, TSS, OD, NO3, 504	4 registros/mes	Uno mensual	Antes de refinación de cobre y plomo
Y-2	Rio Yauli	TDS, As, Cd, Cu, Fe, Mn, Pb, Zn	4 registros/mes	Uno mensual	Después de ref. cobre y plomo
Y-3	Rio Yauli	us, Eh, Flujo, pH, TSS, OD, NO3, 504	4 registros/mes	Uno mensual	Antes de unión con el rio Mantaro

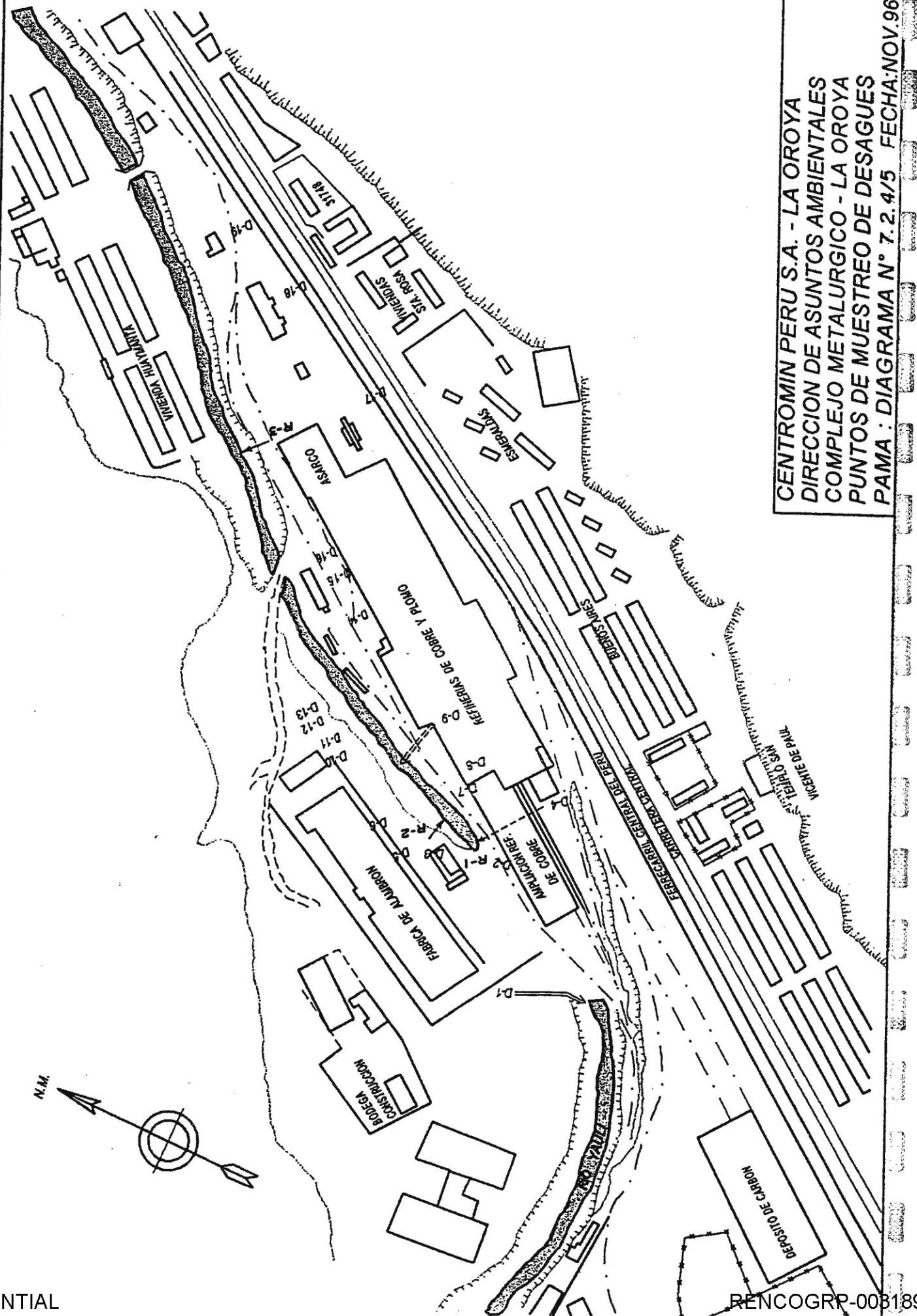


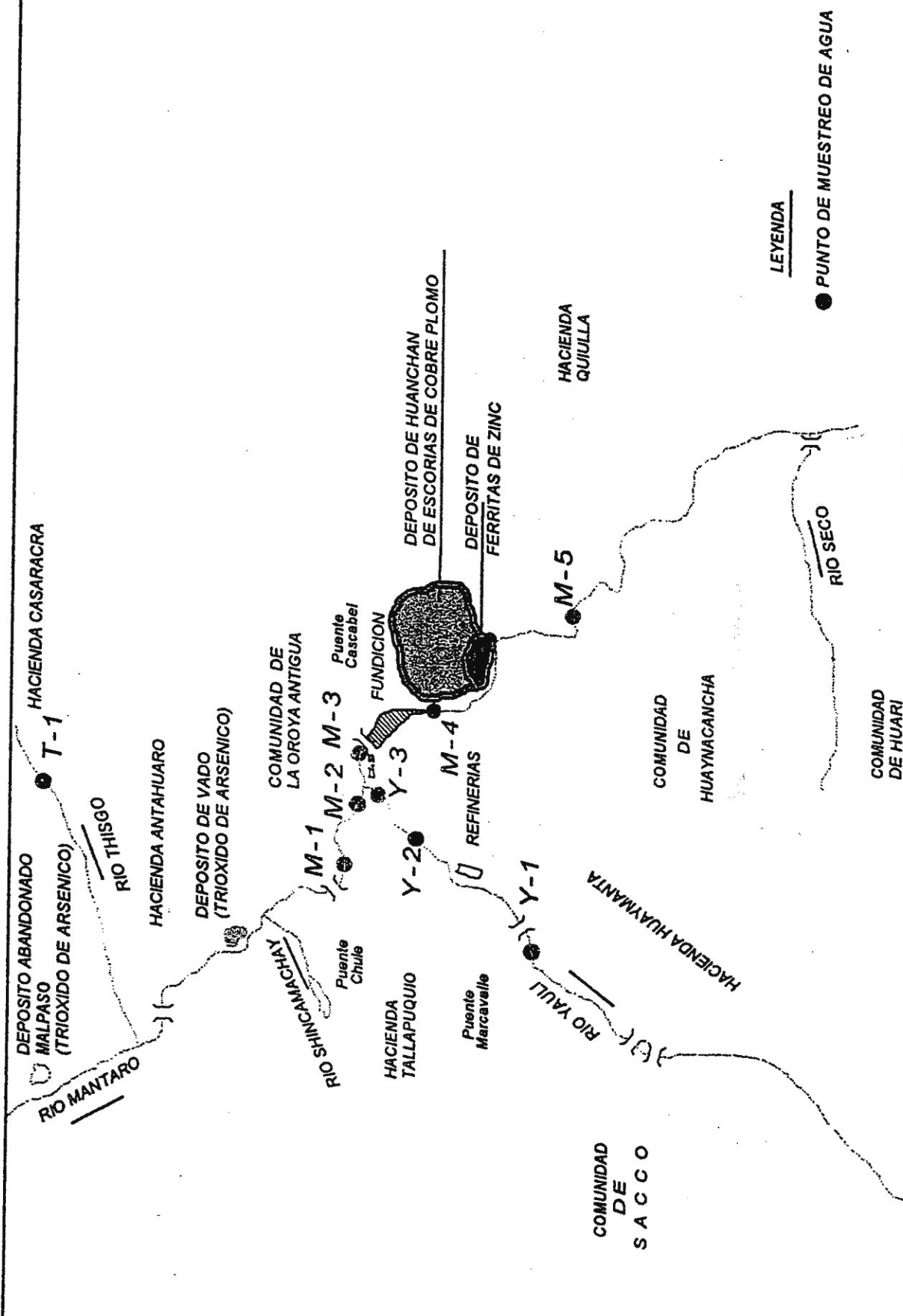
CENTROMIN PERU S.A. - LA OROYA
 DIRECCION DE ASUNTOS AMBIENTALES
 COMPLEJO METALURGICO - LA OROYA
 PUNTOS DE MUESTREO DE EMISIONES GASEOSAS
 PAMA - DIAGRAMA N° 7.2 4/2 FECHA: NOV. 96



CENTROMIN PERU S.A. - LA OROYA
 DIRECCION DE ASUNTOS AMBIENTALES
 COMPLEJO METALURGICO - LA OROYA
 PUNTOS DE MUESTREO DE DESAGUE
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PAMA : DIAGRAMA N° 7.2.4/5 FECHA: NOV.96

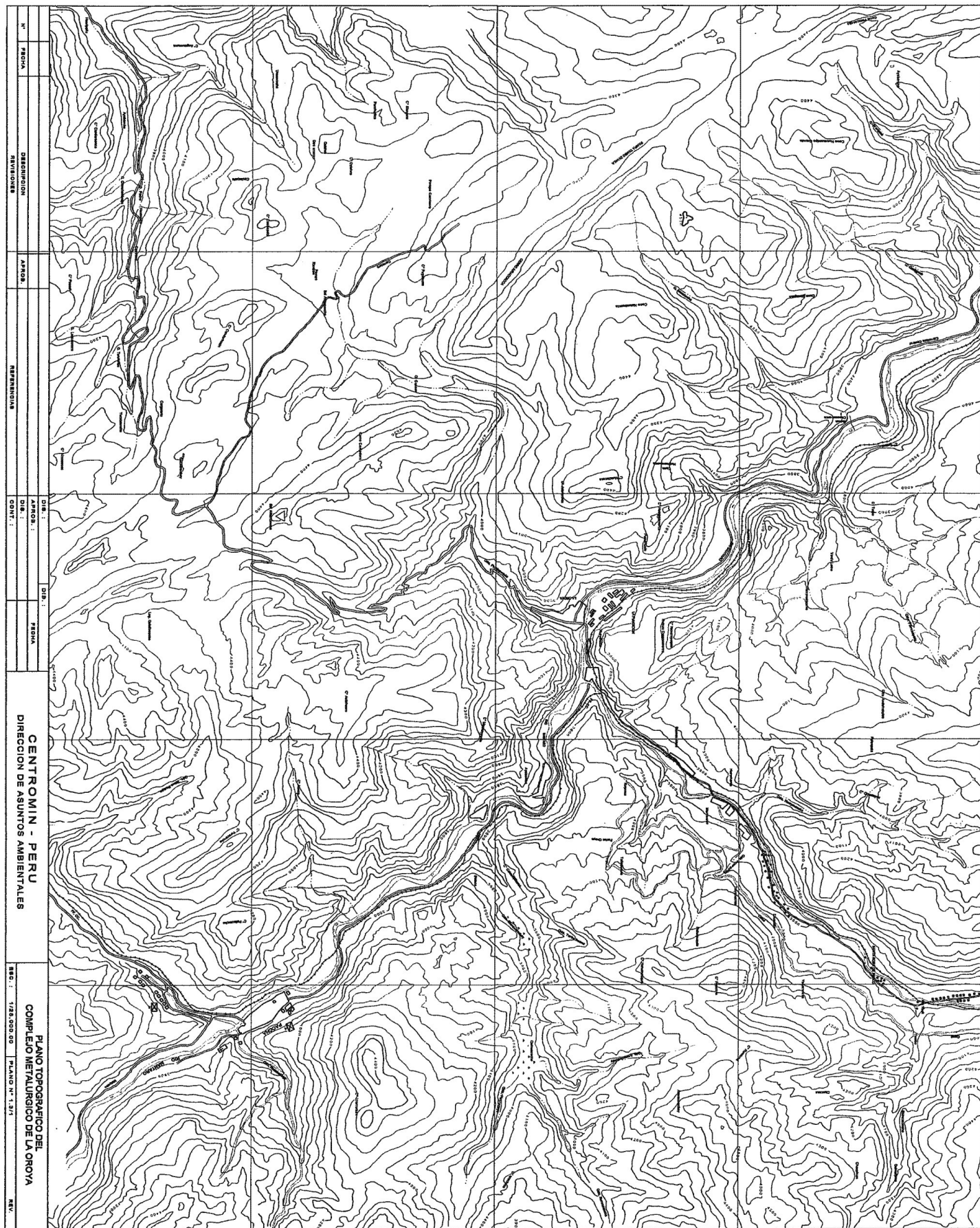


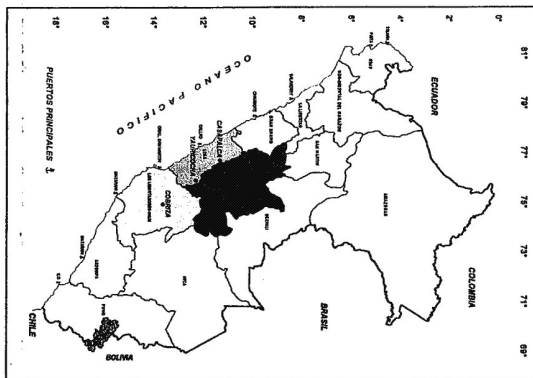


LEYENDA

● PUNTO DE MUESTREO DE AGUA

CENTROMIN PERU S.A. - LA OROYA
DIRECCION DE ASUNTOS AMBIENTALES
COMPLEJO METALURGICO - LA OROYA
PUNTOS DE MUESTREO DE AGUAS
PAMA : DIAGRAMA N° 7.2.4/6 FECHA: NOV.96



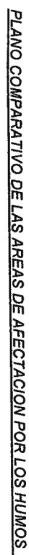
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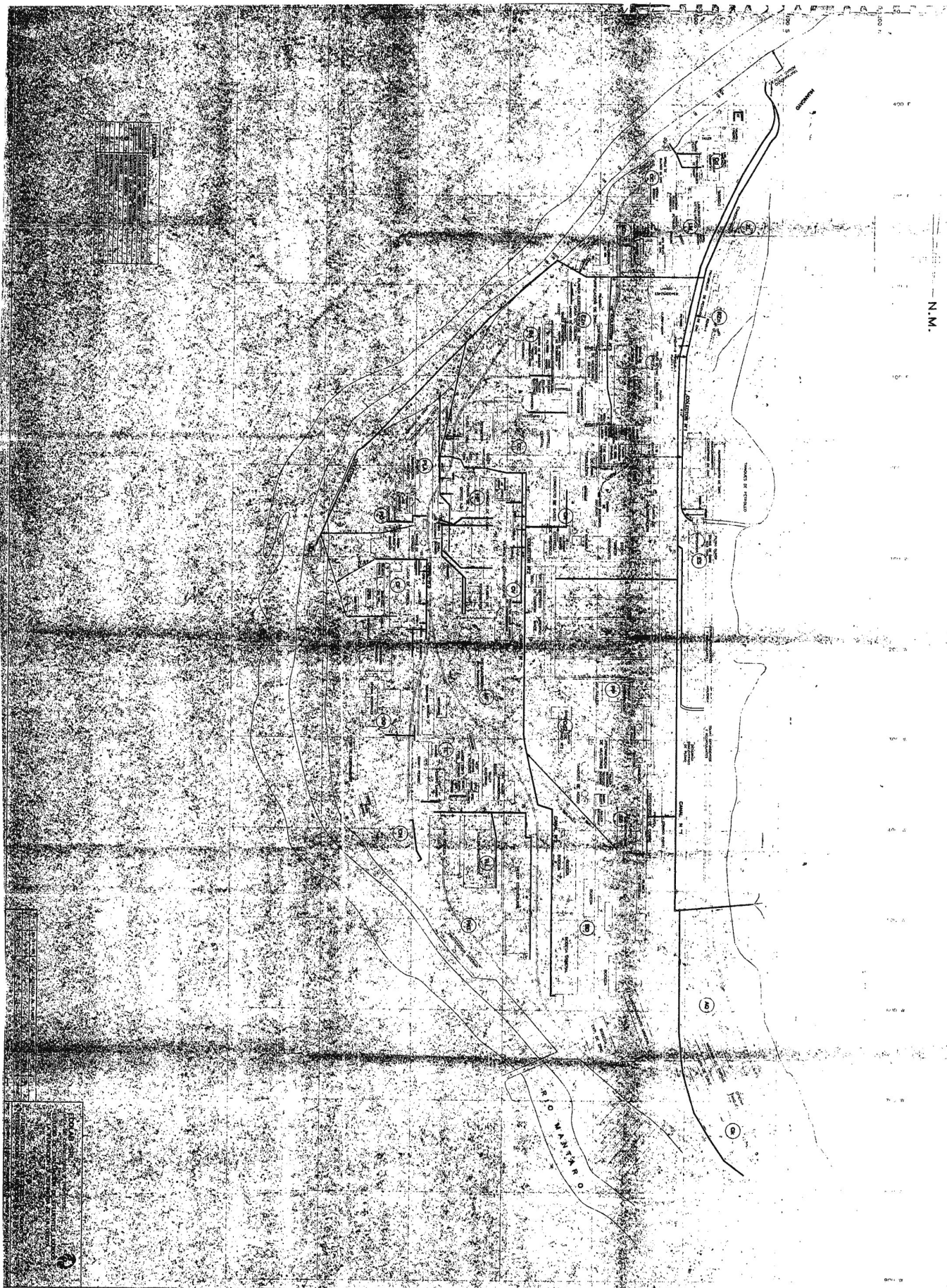
LEYENDA

•	CAMPAMENTOS
Δ	CUIDADO
—	NO
—	CARRETERA
	DIVISION CONTINENTAL
	LINEA PERREA

REGALA 1/1280,000

CENTROMIN - PERU				PLANO REGIONAL	
DIRECCION DE ASUNTOS AMBIENTALES					
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FECHA				APROB. :	FECHA
DESCRIPCION				DIS. :	
REVISIONES				CONT. :	
REFERENCIAS					
			BBO. : 1/1.250.000-00		
			PLANO N° 1.3/3		
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