



**INVESTIGATION INTO
THE MERCURY SPILL OF JUNE 2, 2000
IN THE VICINITY OF
SAN JUAN, CHOROPAMPA,
and MAGDALENA, PERU**

July 2000

Report of the Independent Commission
to the Office of Compliance Advisor/Ombudsman
of the International Finance Corporation and
the Multilateral Investment Guarantee Agency

Acknowledgements

The Independent Commission would like to thank the people of San Juan, Choropampa and Magdalena, for the openness and frankness with which they shared their stories and welcomed us to their communities and homes. The full cooperation of the national Peruvian authorities, including the Ministry of Energy and Mines, the Ministry of Health, and the directorate for environmental health (DIGESA) was essential to our work. The regional authorities in Cajamarca and the local authorities of the affected communities were extremely helpful. The Commission thanks the staff of the Regional Hospital in Cajamarca for all their assistance and their willingness to enter into shared professional learning. The Commission also wishes to thank the management and staff of Minera Yanacocha (MYSRL) for their cooperation and the spirit with which they entered into this process. Finally, we would like to thank the drivers and support staff that made the organization of our investigative work in Peru so smooth.

In particular we would wish to acknowledge:

Bruno Aberasturi, Ana Maria Aguilar, Dr. Alejandro Aguinaga, Walter Alban, Dr Marcial Anaya, Dr Rosalia Anaya, Luis Ara, Dr. Danny Arribasplata, Mauricio Athie, David Baker, Britt Banks, Raul Bellatin, Julio Bonelli, Jorge Caillaux, Luis Campos, Roxana Carrillo, Mariano Castro, John Chermak, Jaime Chavez Riva, Nicholas Cotts, Isabella Falco, Yolanda Falcon, Alan Fitzpatrick, Dr. Luiz Galvao, Dr. Carmen Gastanaga, Juan Gavidia, Fernando Gala, Dr. Michael Gochfeld, Ana Maria Gonzalez, David Grander, Felix Guerra, Doug Hock, Dr. Margarita Isla, Dr. Michael J. Kosnett, Esperanza Leon, Douglas Lister, Dr. Paul Lioy, Tom Mahoney, Barbara Mayers, Juan Mendoza, Dan Miller, Dr. Modesto, Peter Orams, Paula Panton, Jorge Posadas, Felipe Pretell, Joachim Puhe, Manuel Pulgar, Felix Remy, Fabiola Rodriguez, Lorena Rodriguez, Estela Rojas, Norberto Romero, Dr. Carol Rubin, Jorge Hoyos Rubio, Patricia Marisol Ruiz, Maritza Salas, Jorge Santistevan, Carlos Santa Cruz, Thomas Shepherd, Azmat Taufique, Dr. Sonia Tavares, Dr. Luis Teran, Luisa Janneth Vichez, Marcos Valdez, Dr. Edgar Valentin, Dr. Miguel Andres Vargas, Javier Velarde, Pedro M, Vidaurre, Jorge Villena Chavez.

Photo credits to C.D. Wren

TABLE OF CONTENTS

1.0 INTRODUCTION.....	1
1.1 Rationale for this Commission	1
1.2 Members of the Commission	2
1.3 Shareholders and Structure of MYSRL.....	2
2.0 PROCESS AND MANDATE OF THE INDEPENDENT COMMISSION.....	2
2.1 Process	3
2.1.1 <i>Establishing the Independent Commission</i>	3
2.1.2 <i>Reporting and Disclosure</i>	3
2.2 Terms of Reference	4
3.0 METHODOLOGY OF THE INDEPENDENT COMMISSION	5
4.0 BACKGROUND	6
4.1 Description of the Area, Geography, People and Culture	6
4.2 MYSRL in Context.....	7
4.3 Mining in Peru	7
4.4 Institutions for Environmental Management in Peru	8
4.5 Transportation in Peru.....	9
4.6 Properties, History and Uses of Mercury	10
4.7 Mercury Production and Transportation at MYSRL	12
5.0 CHRONOLOGY OF THE INCIDENT.....	13
5.1 Chronology of the Spill	14
5.2 Chronology of the Immediate Response.....	15
5.3 Environmental Monitoring and Mitigation	20
5.3.1 <i>Introduction</i>	20
5.3.2 <i>Mercury Recovery and Mercury Balance</i>	21
5.3.3 <i>Identification of Spilled Mercury Locations and Roadside Cleanup</i>	22
5.3.4 <i>Monitoring of Indoor Air Quality and Home Remediation</i>	24
5.3.5 <i>Environmental Monitoring Program</i>	26
5.3.6 <i>Other Programs</i>	27
5.4 Chronology of the Diagnosis and Treatment of Exposed Individuals.....	28
6.0 MERCURY MANAGEMENT AND HANDLING AT MYSRL.....	31
6.1 Formal Audit Processes	38
6.2 Observations on Environmental Management Practice	40
7.0 HUMAN HEALTH ISSUES	40
7.1 Methods Used in the Technical Report.....	41
7.2 Human Health Effects of Elemental Mercury	41
7.3 Human Health Aspects of the Mercury	42

7.4	Diagnosis	42
7.4.1	<i>Screening the Population for Exposure to Mercury</i>	42
7.4.2	<i>Laboratory Analysis of Human Samples for Mercury</i>	43
7.5	Medical Treatment	43
7.6	Public Health Messages.....	43
7.7	Present and Future Risks.....	44
7.8	Occupational Health and Safety for the Refinery and Mitigation Workers	45
7.9	Assessment.....	46
8.0	CONCLUSIONS.....	47
8.1	Commentary.....	47
8.1.1	<i>Direct Causes</i>	47
8.1.2	<i>Underlying Causes</i>	47
8.2	Commentary on the Initial Response	49
8.3	Commentary on the Response once a Health Emergency was Recognized.....	49
8.4	Recommendations	50
8.4.1	<i>Recommendations to Minera Yanacocha SRL</i>	50
8.4.2	<i>Recommendation to MYSRL, IFC and Newmont Mining Corporation</i>	51
8.4.3	<i>Recommendation to Newmont Mining Corporation</i>	52
8.4.4	<i>Recommendations to the International Finance Corporation (IFC)</i>	52
8.4.5	<i>Additional Recommendations on Health</i>	52
APPENDIX A	Environmental Commitment and Loss Control Policies of MYSRL (Unofficial Translation).....	55
APPENDIX B	MAPS	57

1.0 Introduction

1.1 Rationale for this Commission

On the morning of Friday, June 2, 2000, a truck with a staked open flat bed trailer, departed Minera Yanacocha's mine site with a load of 10 empty chlorine cylinders and 9 flasks of elemental mercury, each weighing almost 200 kg. Yanacocha is an open pit gold mine operation located in the district of Cajamarca in northern Peru (Figure 1). As the result of a series of events an estimated 151 kg. of mercury leaked from one of the flasks and was spread along a 40 km section of highway that passed through three villages, San Juan, Choropampa and Magdalena. The spill allegedly went unnoticed by the driver and was not confirmed until the next day. During that interval, however, residents of the villages and surrounding areas found and collected quantities of the mercury.

What happened subsequently is open to conjecture. However, there is no doubt local people directly handled the mercury. In addition some people may have heated mercury in open containers, in poorly ventilated homes, believing it holds medicinal and religious properties, or in the mistaken expectation of recovering gold. Within a few days many villagers became ill and were soon diagnosed with symptoms of acute inorganic mercury poisoning.

In the following days and weeks between two to three hundred villagers were positively identified as having some level of exposure to mercury with varying degrees of illness. As in many emergencies, initial responses involved a certain amount of confusion, disbelief and lack of preparation for such an event.

When all MYSRL's shareholders understood the magnitude and severity of the incident, some two weeks after the spill, they sought an independent investigation from the Office of the Compliance Advisor/Ombudsman (CAO) of the International Finance Corporation (IFC) and Multilateral Investment Guarantee Agency (MIGA).

The CAO was created in 1999 to provide IFC and MIGA with an independent mechanism to strengthen accountability and compliance with the environmental and social safeguard policies of the World Bank Group. The CAO has three main roles:

- ❑ To provide an avenue of complaint for individuals and communities directly impacted or likely to be directly impacted by a project involving IFC and/or MIGA by a variety of mediation and conflict resolution approaches to help redress concerns. Where these are not deemed workable or desirable, the CAO may undertake independent investigations of fact.
- ❑ To undertake independent compliance audits on projects of the IFC and/or MIGA at the request of senior management or as and when the CAO feels appropriate.
- ❑ To act as an independent source of advice to the President of the World Bank Group regarding the environmental and social safeguard policies and the outcomes of the IFC and/or MIGA's portfolio and projects.

In response to MYSRL and its shareholders the CAO decided to form an independent commission comprising experts on mercury and the environment, mercury and human

health, and mining practice. The CAO asked Manuel Rodriguez, a Colombian national and former minister of the environment in Colombia, to chair the commission.

The Independent Commission's mandate and intention was to establish to its satisfaction how and why the spill happened. Therefore, the Independent Commission focused its work on events and issues related to the spill and its context. While the Commission's investigation was comprehensive, it did not explore the entire MYSRL operation. Information has been verified with as many sources as possible. In order to protect attorney-client and doctor-patient privilege, sources are not named. The Commission's conclusions, including its commentary and recommendations are based on all the information it has received and reviewed, the vast majority of which is in the public domain.

1.2 Members of the Commission

Manuel Rodriguez, Chairman.

Christopher Wren, Ph.D. Expert authority on mercury chemistry, toxicology and fate and behavior in the environment with extensive mining experience, .

David Orava, M.Eng., P.Eng. Senior mining engineer with experience in due diligence investigations and auditing procedures in the mining industry.

Technical advisors on health aspects

Alden Henderson. Ph.D., MPH. Centers for Disease Control and Prevention.

Dr. Helen Schurz Rogers, PhD. National Center for Environmental Health

The National Center for Environmental Health (NCEH), and Centers for Disease Control and Prevention (CDC) provided technical assistance to the Independent Commission by evaluating health status and public health capacity related to the mercury spill. CDC provided the Commission with a technical report. CDC did not participate in writing the Independent Commission's report and CDC personnel did not serve as members of the Commission. The findings of the Independent Commission are the sole responsibility of the Commission.

1.3 Shareholders and Structure of MYSRL

Minera Yanacocha SRL (MYSRL) is a joint venture gold mining operation. Newmont Mining Corporation of Denver, Colorado, USA holds a 51.35% interest through its subsidiary, Newmont Second Capital Corporation with the Peruvian mining company, Compania de Minas Buenaventura SA holding 43.65 % through its subsidiary Minera Condesa. The remaining 5% is held by the International Finance Corporation (IFC). Newmont Peru Limited is the manager of MYSRL.

2.0 Process and Mandate of the Independent Commission

The following process document and Terms of Reference form the basis of the agreement for the CAO to convene the Independent Commission.

2.1 Process

It is proposed that an Independent Commission be established under the auspices of the International Finance Corporation (IFC) Office of the Compliance Advisor/Ombudsman to investigate the recent spills in San Juan, Magdalena and Choropampa, Peru and related matters. A draft Terms of Reference are attached.

2.1.1 *Establishing the Independent Commission*

An Independent Commission comprised of experts in the following areas will be appointed by the CAO and will report back to the CAO, in writing, three weeks after formation and acceptance of the Terms of Reference or as soon thereafter depending on the availability of critical documentation.

- ❑ A public health expert with experience in mercury toxicology, other hazardous substances and this industry sector
- ❑ An environmental toxicologist familiar with mercury and other hazardous substances and this industry sector
- ❑ An expert on emergency response planning in this or related industry sectors
- ❑ An expert in risk management and accident reconstruction in this or related industry sectors
- ❑ A generalist to lead and manage the team

2.1.2 *Reporting and Disclosure*

The Independent Commission will submit a written report to the CAO.

The CAO will then invite MYSRL and its shareholders to Washington DC for a briefing on the report by the Independent Commission. MYSRL and the shareholders will be given 10 working days to comment on the report. At this point the CAO will also share the report with the President of the World Bank Group.

Following this period and upon revision of the report by the Independent Commission to reflect comments, if any, at the discretion of the Commission, the CAO will disclose the report to the public in Washington, DC and locally, in Spanish and English, which may be accompanied by the CAO's comments, observations or recommendations.

Regarding disclosure, the CAO will be guided by the operational guidelines of the CAO, which state:

Reports of the CAO that set out her conclusions on an investigation may be publicly released, but the CAO may not publish information received in the course of an investigation if the disclosure of that material is restricted under IFC disclosure policies.

Furthermore, the CAO may exercise her discretion to withhold information from the report in response to any circumstances which justify such withholding of information.

2.2 Terms of Reference

The Independent Commission has been established under the auspices of the Compliance Advisor/Ombudsman of the International Finance Corporation, at the request of Minera Yanacocha SRL and its shareholders.

It is composed of experts appointed by the Compliance Advisor/Ombudsman, to whom they will report as a Commission. The experts will be appointed in their own right and their qualifications and credentials will be judged by the CAO in her sole discretion.

The Commission shall report to the Compliance Advisor/Ombudsman in writing three weeks after agreement of the TOR and composition of the Commission, or as soon thereafter, depending on the availability of critical information. The report shall address the following issues in detail:

- ❑ To establish the events relating to recent spills of hazardous substances to the CAO's satisfaction;
- ❑ To establish to what extent the Emergency Response Plan was adequate, was complied with, and what, if anything, could have made the accident less likely to occur.
- ❑ To make recommendations on immediate additional actions that should be implemented to mitigate the effects of the spill and recommendations on long-term adjustments, if necessary, for emergency response planning.

The Independent Commission's report should include among other details:

1. The precise chronology of events leading up to the recent spills.
2. The precise sequence of events regarding the spills and following the spills.
3. The actions taken by the mine and others subsequent to the event, including reporting to authorities on the spills.
4. The appropriateness of the Emergency Response Plan including, but not limited to, environmental hazard, public health emergency, transportation, communications and community relations.
5. Training of personnel at the mine and contractors, including in the transportation system in handling of hazardous substances.
6. Clarity on the response of Yanacocha and Ransa and their procedures for handling and transportation of hazardous substances.
7. Contractual relations with Ransa and the issues relating to RANSA's understanding of and compliance with the ERP and legal requirements regarding hazardous substances.
8. RANSA's record in handling such hazardous substances.
9. Compliance with Peruvian law and IFC guidelines in the handling, transportation and emergency response planning for hazardous substances, including but not limited to mercury and other substances transported in the consignments involved in the recent spills.

10. The quality of community relations, information and communication systems before and after the incident.
11. Present and future risks resulting from the spills.

3.0 Methodology of the Independent Commission

The Independent Commission was convened in early July 2000, and met in Lima, Peru, on July 23, 2000. The commission traveled to Cajamarca and remained there and in the surrounding area from July 24-30.

To address the specific areas of enquiry in the Terms of Reference the Independent Commission adopted guiding principles for its fieldwork in Peru.

The Independent Commission's expert members undertook a full orientation of the mercury spill, the mine and its various departments and facilities, the responses to the spill, the towns and roads, the social environment and other related aspects. Information was obtained through site visits, interviews with a wide range of people, including members of the general public. The mine was given full opportunity to present its understanding of the spill and its response.

The members of the Independent Commission also undertook a targeted document review.

The Independent Commission, comprised of professionals with extensive experience in the fields of enquiry operated as an independent expert body. The commission was impartial and free of bias in collecting and assessing information and in the preparation and finalization of its report.

In order to familiarize itself with MYSRL, the Independent Commission made the collection of information a priority as well as review and assessment. Information was collected using accepted environmental auditing techniques, including:

- The review of documents and records. The Commission reviewed publicly available information as well as information made available by MYSRL and others.
- The sampling of selected records to obtain information and add to or verify understanding of items of interest.
- Interviews with individuals, including MYSRL employees, the mine's consultants and its expert advisors, transport companies and contractors, the mercury buyer, national, regional and local Peruvian authorities, in the environment, mining, health, social development and related areas; and members of the public.

The Independent Commission did not prepare a Draft Report. The shareholders of MYSRL had a 10-day-review period to verify factual information. The conclusions and recommendations of the Independent Commission were not subject to external review, comment or otherwise modified.

4.0 Background

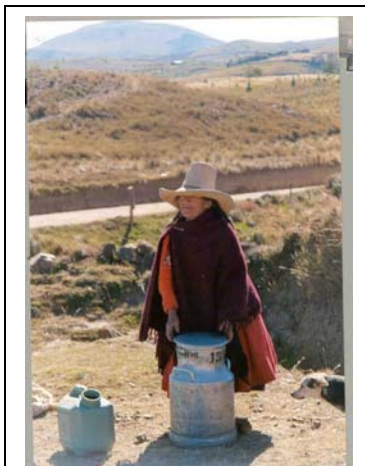
4.1 Description of the Area, Geography, People and Culture

Peru has three major climate regions: a narrow coastal desert, the mountainous and temperate Andes, and the Amazon Basin. Peru's major cities are in the coastal desert and the Pan-American Highway links the coastal cities of Peru to the rest of South America.

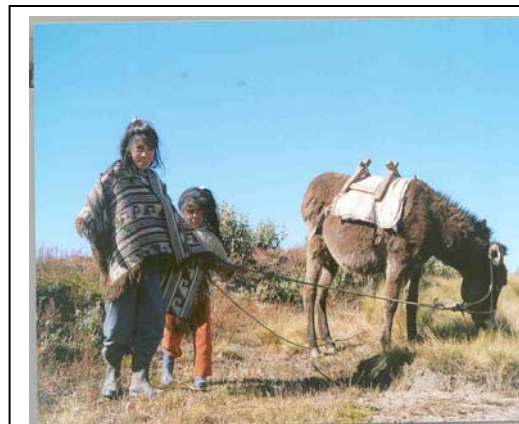
Peru's population is comprised of 54% Indian, 32% Mestizo (mixed European and Indian descent), 12% Spanish descent, 2% Black and an Asian Minority. Over 7 million of 23 million Peruvians live in Lima, the capital, and half of the population lives in the highlands. Spanish is the primary spoken language, however, in certain highland areas, Quechua and Ayamara are the first languages of the population. The rural population lives a traditional lifestyle based on subsistence farming that has remained virtually unchanged for the past few hundred years.

The Minera Yanacocha gold mine is located in the Department of Cajamarca (population 1.3 million) in northern Peru. Agriculture and cattle raising provide the main income for most of the mostly rural population (75.3%). Mineral resources such as gold, silver, coal, and copper are plentiful in the highlands and are being developed. Few houses in the communities near the Minera Yanacocha mine have potable water (11.8%), sanitary facilities (40.0%), electricity (17.2%), and telephone (1%). School enrollment for children aged 6-11 years is 82.3% and 12-17 years of age is 55.5%. Rural illiteracy (87.4%) is significantly higher than urban illiteracy (12.6%). Birth rates in this area (40.2/1000) are higher than in the rest of Peru (33.6/1000). Mortality rates (13.2/100) in communities near the mine are also higher than in the rest of Peru (10/1000). This includes infant (60.7/1000) and child (88.5/1000) mortality rates.

In a community with high childhood mortality, people embrace practices that they believe might prevent disease. In this part of Peru, native healers use mercury to appease the *sani*, spirits that bring on the fear of disease. Mercury may be sprinkled around the bed of a child with night terrors, placed in a pouch sewn into clothing, added to devotional candles or bath water, boiled, or worn in an amulet called "azogue".



Woman in district of
Cajamarca



Young girls living in mountain area near the
mine

4.2 MYSRL in Context

The Yanacocha mine is located approximately 600 km north of Lima, around 48 km north of Cajamarca. It is at an elevation of approximately 4,000 meters. At present it is comprised of four open pit mines – Carachugo, Maqui Maqui, San Jose Sur and Yanacocha. There are three leach pads and two processing facilities. In total the mine covers an area of approximately 25,000 hectares. In 2001 another open pit at La Quinoa is scheduled to go into operation, with reserves of 9.3 million ounces. In 1999 MYSRL also added 356 million ounces of silver to its reserve estimates. In 2000 MYSRL expects to produce 1.6 million ounces of silver.

Peru is the seventh largest global producer of gold. MYSRL alone accounts for almost half Peru's annual gold production and just over 50% of its annual mercury production. MYSRL is by far the largest gold mine in Latin America and produces approximately 2% of global gold production.

In 1999, MYSRL reported 24% growth in production and produced 1.66 million ounces of gold. In 2000 production of gold is projected to reach around 1.75 million ounces. Annual production of mercury for 2000 is projected to reach 48,000 kg, or close to the same quantity of gold. As of December 1999 MYSRL's reserves were estimated at 32.9 million ounces of gold and 356 million ounces of silver. MYSRL has stated that its total cash cost is US\$103 per ounce. The relatively low production cost is largely due to the porous nature of the deposits where porous oxide is found close to the surface, requiring no crushing and offering a quick cyanide leach cycle.

The mine employs approximately 1,200 people and has approximately 2,000 contractors working on construction involved in expansion.

4.3 Mining in Peru

Peru has a long and significant history of mining today. Today, Peru has one of the world's leading mining sectors; it is the seventh largest gold producer, the seventh largest copper producer and the second largest silver producer. It also ranks highly in output of zinc and lead. Minerals have traditionally been the most important source of export revenue, representing up to one-half of total earnings in some years. The sector grew rapidly in the early 1990s as investment was attracted to the country with changes in trade and investment regulations and with the privatization of mining assets.



Gold has been the main success story in the mining sector with MYSRL driving that success. The Yanacocha mine has the largest reserves and contributed to making gold Peru's largest export earner.

Production of copper, Peru's second largest export earner, has risen, following increased investment in the sector.

The outlook for the future is one of strong growth. U.S.\$1.1 billion of foreign direct investment is foreseen for the next 7 years, and mining will account for 50% of Peru's exports.

4.4 Institutions for Environmental Management in Peru

Since 1992 Peru has been engaged in a process to strengthen its environmental management capacity through the enactment and enforcement of laws and regulations, building-up public agencies, and establishing new citizen participation rights and mechanisms related to decisions impacting the environment. Despite many achievements public sector environmental management capacity is far from being able to address major environmental challenges, including those posed by the rapid fast growth of key economic sectors such as mining.

The main environmental and health provisions related to gold mining are contained in different laws¹: However, there are still major gaps and weaknesses in the environmental legal framework. For example there are no regulations on the transportation of hazardous materials. This situation that is now being corrected by the Ministry of Transport, the public agency with responsibility in this area.²

The institutional foundation of environmental policy making was established with the creation of the Environmental National Commission (Comision Nacional del Medio Ambiente, CONAM), a decentralized environmental commission. CONAM is an inter-ministerial coordinating committee of ministries of state with environmental functions. The Ministry of Energy and Mines (MEM) is a member of CONAM. CONAM has relatively few powers of its own. Each of the sectoral ministries retains full responsibility for environmental issues relating to their sector.

CONAM has two main functions: oversight of the implementation of environmental impact assessments (EIA) and reporting; and arbitration of disputes that may arise between ministries. For the most part environmental policy is left to individual ministries. Private consultants, including environmental auditors, play a major role in elaborating EIAs and audits. CONAM has a small technical secretariat. It is mainly focused on pollution control. The management and conservation of forests, water, and other renewable natural resources is a function of INRENA (National Institute for Natural Resources).

Within MEM is a Directorate of Environmental Affairs responsible for setting environmental policies, regulations and guidelines for the mining sector and for approving the Environmental Impact Assessments (EIAs) or modifying the Environmental Management Plans (needed for those projects and companies created before 1993 when requirements for EIAs were established). The Directorate of Mines within MEM is responsible for monitoring and auditing, activities performed by private consultants on behalf of the ministry. The subject of the audit pays for the auditing process. The results are approved by the Directorate of Mines. The Ministry of Energy has a modest technical capacity with approximately 10 -12 professional experts dealing with a wide variety of functions.

Environmental management in Peru is still highly centralized, including for the mining sector. In the Cajamarca region one civil servant has responsibility for all aspects of the mining sector, including the environment. He reports to the Ministry of Energy and Mining, but is part of the CTAR (the transitory regional administration) a regional governmental body attached to the Presidency of Peru. The post lacks technical and administrative support. At

the provincial level, the Environmental Commission of the provincial council is eager to play a significant role, but has few means to do so.

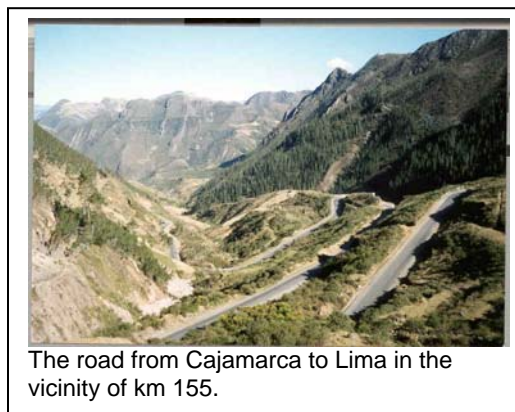
New policies are being implemented in order to strengthen the Peruvian environmental institutions. There is an ongoing process for implementing the Structural Framework for Environmental Management (MEGA) a strategy designed to strengthen regional and local environmental management, build capacity within the sectoral ministries and improve inter-ministerial and agency coordination. Recently, public consultations required as part of the EIA process have been held at the local level, and not in Lima, a former practice that hindered participation of local and regional civil society groups.

According to CONAM “there is a non-structured institutional evolution on environmental management that has been the product of a not very well planned process. In many cases it has led to the creation of environmental units within the ministries that do not have adequate mechanisms to efficiently perform their functions. The growth of many of these environmental offices has happened within a context of a downsizing of the central government -- a situation that has not allowed them a suitable organization to address Peru’s environmental challenges”. CONAM has also stressed that “at present, regional environmental management is underdeveloped regarding functions and facilities because of the actual situation of the Regional Transitory Administrative Councils and the non-transfer of environmental functions from the central government to the regional and municipal governments.”³

At the same time, the sectoral ministries and the regulated private sector have pointed out that CONAM has insufficient technical and administrative capacity and a weak regional presence in relation to its responsibilities.

4.5 Transportation in Peru

Given the topography of Peru, roads provide the principal method of transportation. The Pan America Highway provides an arterial route along Peru’s coastline, through Lima. From Lima, other main highways span out into the hinterland. Away from the coast, many roads wind over severe mountain landscape.



The road from Cajamarca to Lima in the vicinity of km 155.

The roads network has benefited from investment of around \$2bn since 1992, when Peru regained eligibility for loans from multilateral organizations. The country’s two main motorways, roads linking departmental and provincial capitals, rural roads and streets in Andean towns have all undergone extensive repair and resurfacing.

Within Peru there is no comprehensive set of regulations on the transportation of hazardous materials. In the mining sector, regulations exist for the transportation of explosives. Perhaps the reason for regulation in this but no other category of hazardous materials is Peru’s recent history of political struggle.

4.6 Properties, History and Uses of Mercury

Mercury is a naturally occurring element, which is found in different types of rocks in the earth's crust. At room temperature (20° C), it is a silvery grey liquid. It is the only metallic element that remains in liquid form at room temperature.

The modern scientific symbol for mercury is Hg. This is derived from the Greek name *Hydrargyrum*, which means liquid silver.

The CAS (Chemical Abstract System) registry number for mercury is 7439-97-6. Its atomic mass is 200.59. Mercury has high density, with a specific gravity of 13.456. It also has a high vapor pressure of 0.16 Pa (0.0012 mm Hg) at room temperature. Therefore, elemental mercury readily vaporizes at room temperature. The vapor pressure doubles with every increase of 10° C.

Mercury is widely found in the environment in inorganic and organic forms. There are three common valence states of inorganic mercury; elemental or metallic mercury (Hg^0), mercuric (Hg^{++}) with a double positive electrical charge, and mercurous (Hg^+) with a single positive electrical charge. Organic mercury compounds are formed when Hg molecules bind with organic carbon to form stable organic complexes.

Naturally occurring mercury is often found in combination with sulphur (HgS) which forms an ore known as cinnabar. Other precious metals including gold are also sometimes present in these natural deposits. This explains why mercury occurs in the ore body at MYSRL and is produced as a by-product of the gold refining process there.

The unique properties of mercury have long been recognized by humans and it has been used for a variety of purposes for well over 4,000 years. Cinnabar ore was made into red paint by the indigenous peoples of North and South America long before the process of refining it into mercury was discovered. The most ancient specimen of quicksilver was found in a small ceremonial cup in an Egyptian tomb that dates from the fifteenth or sixteenth century B.C.⁴.

The largest mercury mine in the world is located at Almaden, Spain, where mercury has been recovered for over 2,500 years. Roman slaves and prisoners were originally sentenced to labor at the mine. Due to mercurialism, the life expectancy of the workers was less than 3 years. When the Spanish came to Peru they recognized the red substance with which the people decorated their faces. A large mercury deposit was subsequently found at Huancavelica, with other smaller deposits discovered at other locations in Peru. In the early periods, Peruvian mercury was used to extract silver at mines in Bolivia.

Perhaps one of the most celebrated applications of mercury was its use in the textile industry to transform animal hair into felt. It is well established that since at least the fifteenth century many hatmakers in Europe and America were stricken with mercury poisoning. The workers displayed a variety of symptoms including nervous tremors, loss of muscle coordination, blurred vision, loose teeth, skin problems and reduced attention span. The phrase "*mad as a hatter*" was immortalized by the character Mad Hatter, in Lewis Carroll's story *Alice in Wonderland*. Working conditions were improved through legislation and voluntary controls but mercury poisoning remained prevalent in the industry into the early 1900's.

It is important to distinguish between environmental and human health concerns related to elemental mercury, and methyl mercury. Health effects from acute exposure and inhalation of inorganic mercury are very different than health effects due to chronic exposure from consumption of fish contaminated with methyl mercury.

Environmental concern with mercury is primarily associated with methyl mercury, which is the most common organic mercury complex. Methyl mercury is formed when elemental mercury is released into the environment and it is transformed via a methylation process into the organic complexes. This transformation is mediated by bacteria and microorganisms living in soil, water and sediments. Methyl mercury is known to bioaccumulate and bioconcentrate in the food chain. That is, the concentration of mercury increases in organisms higher in the food chain. Thus, for example, mercury concentrations will be progressively higher as one samples water, algae, zooplankton, forage fish, predatory fish and fish eating organisms such as eagles, mink or humans. Virtually all mercury found in animal tissues is in the methyl mercury form.

Mercury was probably the first substance to receive world recognition as an environmental contaminant after large quantities of inorganic mercury were discharged from a vinyl chloride factory into Minamata Bay, Japan. Over 220 tons of inorganic mercury were released from the factory between 1949 and 1953 alone. The mercury was subsequently transformed into organic methyl mercury, which accumulated in the fish and shellfish. These were consumed by local fishermen and their families. During the early 1950's local villagers became fatally ill, with many birth defects and sickness among the children, as well as cats and livestock. Since the symptoms were not the same as classic inorganic mercury poisoning, the causative agent went undiagnosed for several years.

After the tragic incident at Minamata, elevated mercury levels in fish and mercury poisoning of wildlife were observed in Sweden and Canada. These other incidents led to restricted use of mercury for certain industrial applications to curtail direct release to the environment.

The form of mercury involved in the spill from Minera Yanacocha was pure elemental mercury. The properties and chemistry of mercury determine the fate and behavior of the spilled material. Given the relatively high vapor pressure of mercury, a certain proportion would be expected to vaporize or evaporate into the atmosphere. Some mercury not recovered by clean up operations will remain in the liquid elemental form as small particles in the soil. A certain proportion of the mercury that remains in the environment, either in the soil or transported into nearby waterways, can be expected to be transformed into organic methyl mercury.

Detailed figures are not available, but the worldwide mining of mercury is estimated to yield about 10,000 tonnes/year (WHO 1991). This mercury is used for a wide variety of purposes. A major use of mercury is as a cathode in the electrolysis of sodium chloride. Mercury is widely used in the electrical industry for switches and thermostats, in batteries, and in medical and measuring instruments. It is still used in thermometers. In fact, the element was thought to only occur as a liquid or gas until two Russian scientists inadvertently observed that it solidified at approximately -40°C during the cold winter of 1759 in St. Petersburg.

Dental amalgam or silver paste used for filling tooth cavities contains mercury. The paste generally consists of tin, silver and enough mercury to make it pliable while being shaped. It hardens into a strong, abrasion-resistant material that was favored by dentists due to ease of

handling and preparation. However, recent concerns regarding direct exposure to toxic mercury by dentists and patients have led to the replacement of mercury amalgams by other compounds in some developed countries.

Due to its toxic properties, forms of organic mercury were widely used as fungicides, herbicides and pesticides. Mercury is still used in many paint products due to the brilliant hue color imparted by the element.

Mercury is directly released into the environment due to disposal of mercury containing products. Considerable quantities of mercury are released directly into the atmosphere due to the combustion of fossil fuels, and coal in particular. There are natural sources of mercury to the environment including degassing of rocks and seawater and volcanic emissions. However, it is generally accepted that the flux of human-derived mercury greatly exceeds natural sources.

Another source of environmental mercury contamination is its use for the extraction of gold in artisanal gold mining operations. These operations often operate in remote areas. The gold may be present as alluvial deposits in rivers and streams or in veins. In the latter case crushing of the ore is required. Mercury is added to parent material where the gold becomes attached to the mercury. The slurry is sometimes ground to enhance the amalgamation of the two elements. The resulting mixture is heated to drive off the mercury, leaving the precious metal behind. This simple process has been in place for centuries, and was once widely practiced in the mid western United States, Nevada in particular. More recently, attention has been directed toward the large amounts of mercury being used for this practice and directly released into waterways in the Amazon region of South America. In addition to direct exposure to mercury vapors by the workers, the elemental mercury which is released to the environment will eventually be transformed into methyl mercury which accumulates in fish and the wildlife and people that consume the fish.

It is estimated that approximately 84 tonnes of mercury are sold annually in Peru in the legal market⁵. A large proportion of that is used in mining operations for extraction of gold. Gold mining operations using mercury are found near the town of Puerto Maldonado in the southern Peruvian Amazon region. The operations vary in size but may involve up to several thousand workers at any given time.

4.7 Mercury Production and Transportation at MYSRL

MYSRL commenced gold production in late 1993. The production of mercury was not originally anticipated during the Carachugo Stage 1. Mercury issues were first identified in November 1993 when mercury was visible in the refinery. Retorts were subsequently installed in the refinery and operated to separate the mercury. Mercury production has increased steadily in proportion to gold production. Figures from 1994 to date are summarized in Table 4.1.

Table 4.1
MYSRL Mercury Production from 1994 to 2000

Year	Mercury Production (kg)
1994	3,639
1995	13,394
1996	13,088
1997	11,238
1998	19,195
1999	33,266
2000 (to May)	20,944
2000 (projected to year end)	48,000

Mercury containing minerals are not present in all ores at MYSRL. As such, future mercury production is expected to fluctuate over time, and may be reduced from present levels.

The mercury can be considered to be a product of the mine or a by-product of gold processing. Regardless of the classification, it remains a hazardous material.

Mercury produced in the refinery is placed into metal flasks resembling propane gas cylinders. Each flask has a capacity of approximately 200 kg. From the refinery these cylinders were taken to an outdoor warehouse storage area and held until transport to the purchaser in Lima. At the time of the incident, it could be estimated that the mine was producing four or five flasks of mercury per week.

Additional details describing the procedures for handling, storing, loading and transporting the mercury are provided in Chapter 6. The following chapter provides a detailed account of the events surrounding the spill of mercury on June 2, 2000.

5.0 Chronology of the Incident

The following chronology has been compiled from numerous chronologies composed by actors in the spill and the response and from transcripts of interviews conducted with participants of the events. In a number of instances the reports and recollections of key actors contradict each other in details, however the commission feels that the following represents a factually based account of events and their sequence.

The Independent Commission cannot say with any certainty how the mercury was lost. Some mercury may have been removed from the flask while in Cajamarca or at any other place the truck was left unattended. It would appear that the stopper of the flask was not properly secured; though the commission cannot say whether this was due to tampering or human error at the loading site. There appears to be some correlation between the dislodging of one empty chlorine gas cylinder, at Km 155 on the road from Cajamarca to the Pan American Highway, and movement of the mercury flask so that it began to spill.

The chronology is broken into different sections: first, the path of the truck and the events of the spill, and secondly, the chronology of the immediate response. This is then followed by a

commentary on the environmental mitigation and the treatment of the exposed population. Finally, the chronology continues for the diagnosis and treatment of the exposed population.

5.1 Chronology of the Spill

Thursday, June 1

Ransa driver Esteban Blanco arrived at MYSRL driving a 1998 Volvo truck with an open, staked flat bed trailer. The flat bed was built of wooden planks. The truck was loaded with 10 empty chlorine gas cylinders and nine flasks containing metallic mercury. It was loaded by MYSRL staff. The driver secured the load. The mercury flasks were in an ordinary pallet, not the special pallet meant for use with the mercury flasks. The special pallets were built to accommodate eight flasks. The mercury flasks were placed on the trailer last, thus at the end of the platform and away from the truck. The flasks were chained together. Each flask contained just under 200 kg of mercury. The paperwork for the consignment was completed and signed for by the driver, identifying the mercury.

There was some sort of disagreement over the method of loading though the exact nature of the disagreement is not clear.

Blanco was ill with stomach problems. The warehouse supervisor noticed he was ill and suggested that he not drive. Blanco asked for another driver from his supervisor in Cajamarca. As none was available or offered he decided to continue on. The truck left the loading bay, but was intercepted at the security checkpoint on the perimeter of the mine, where the warehouse supervisor caught up with the truck and accompanied the driver to the health post. The driver was treated by the medical staff on duty and was given a lift to Cajamarca where he rested the night, leaving the truck, fully loaded, in an area within the mine perimeter.

Friday, June 2

The Ransa supervisor drove Blanco to the mine early in the morning to collect the truck. Blanco asserted that he was well enough to proceed. Blanco collected the truck and set off for Cajamarca and the Ransa depot in order to collect his bill of lading. He left the truck fully loaded and unattended while he ate and then proceeded on his journey. He was still ill.

At Km 155 from the Pan American Highway one of the empty chlorine gas cylinders falls from the truck and came to rest some 30 meters below the road in a gully.

There are a number of contradictory statements regarding the exact actions of Blanco for the remainder of the day. The confused situation has been exacerbated by the different versions of events offered by the driver in the immediate aftermath of the spill. The GPS system installed on the truck was apparently not functioning that day and there is no independent verification of the exact details of his journey.

However, the following key points are clear and are confirmed from numerous sources.

The first evidence of mercury spilled was close to Km 155, where Blanco stopped after noticing that one of the cylinders had fallen. Each empty chlorine gas cylinder weighs 600kg, too large for one man to handle. Blanco continued on his journey.

Blanco stopped in the village of San Juan. Accounts vary as to precisely what Blanco did in San Juan. He then traveled on to Choropampa and stopped the truck outside

the health post though not to visit the health post, for reasons of his health. Both here and in San Juan the driver asserts that he was unaware of any problem with his load other than the loss of a chlorine gas cylinder. In some accounts the driver picks up local children and gives them a lift for the next few kilometers.

Finally at around 5.30 p.m. Blanco arrived in Magdalena (Km 115). At this point the Ransa supervisor in Cajamarca is informed of the loss of the chlorine gas cylinder. He advised the driver that he will come for him in the morning and that they will take care of it then. It is not clear whether the driver noticed on June 2, 2000 that mercury was spilling from one flask. If he did he appears not to have told his supervisor or to have known how to handle the situation. The driver did seek medical attention at the health post in Magdalena and rested there for the night. It is presumed that he spent the night in the cab of his truck.

5.2 Chronology of the Immediate Response

Saturday, June 3

The Ransa supervisor left Cajamarca to collect Blanco and arrived at Magdalena around 8 a.m. The supervisor and Blanco then retraced the truck's route to Km 155 to retrieve the chlorine gas cylinder. Passing through Choropampa they saw people collecting mercury on the streets, but the driver said nothing. At Km 155 a crane that is passing at the time assists them and they are able to retrieve the empty gas chlorine cylinder.

At 8:30 a.m. Federico Schwalb, duty manager at MYSRL receives a call from Flavio Castro, a resident of Choropampa and friend of Schwalb stating that there appeared to be mercury on the street in Choropampa. Peter Orams and Alberto Herrera of MYSRL's environment department were instructed to go to Choropampa to see the situation for themselves. They checked that there had been a shipment of mercury that had left the mine on June 1. They were unaware of the overnight delay of the shipment.

Peter Orams and Alberto Herrera arrived in Choropampa around 10:30 a.m. After driving around the village they found a young girl playing with what appears to be mercury in the street. The girl immediately ran into her house. The team tried to gain entry to the child's family's house, but no one opened the door. They return to MYSRL and report findings to MYSRL, that there does appear to be a mercury spill, though there is no evidence that it is MYSRL's mercury, or that the spill is extensive.

A logistics team (Jorge Posadas and three staff) left the mine around 10:30 a.m. to look for and clean up the mercury. They carried with them some basic equipment such as buckets, shovels and emergency response equipment. They did not use the emergency response equipment.

On his way to Choropampa, Posadas met the Ransa team recovering the chlorine gas cylinder. They said they did not know of a mercury spill. Posadas then encountered Orams and Herrera who said that the mercury in Choropampa appeared to have been taken by the people. Posadas continued on to Magdalena.

Earlier that morning CTAR called the Regional Hospital in Cajamarca (RHC) to say that there had been an accident in the vicinity of Choropampa and that the local people were asking for an ambulance to transport a casualty to Cajamarca. There

was no ambulance available and the hospital sent a 4 wheel drive vehicle to Choropampa with the district attorney, a representative of the civil defense, the deputy director of the hospital and a journalist from Televisora, the local television station. They arrived in Choropampa around 2 p.m. and met many people who had collected mercury.

A 27 year old woman sought medical attention at the Choropampa health post for a rash and itch. She was diagnosed with contact dermatitis due to mercury exposure and she was provided with symptomatic treatment and was discharged from the health post.

In Magdalena the truck was parked with the mercury flasks in disarray. The stopper on one flask was off and to the side of the flask. Some accounts indicated that a second flask was spitting mercury, but this has not been confirmed.

There are various and conflicting accounts of who arrived when at the truck and who did what. However the following is clear. The logistics team from MYSRL, the team from CTAR, and the mayor of Magdalena and a staff member were all at the truck. The Magdalena police were sealed off the truck and would not allow access to it until it had been cleared by the district attorney. The Ransa supervisor and Blanco arrived back at the truck after collecting the chlorine gas cylinder.

The mercury spill, the loss of the chlorine gas cylinder, and the load in disarray were ruled an accident by the district attorney. Neither the truck, nor the flask was impounded. Blanco, after having made a statement to the police was also freed to go and left unaccompanied around 5 p.m.

The truck was cleaned by a combination of the staff of Ransa, the staff of the mayor of Magdalena and the staff of MYSRL, at different times. The clean up was done with bare hands, buckets and brooms. MYSRL staff took the collected mercury back to the mine.

A number of people, including the doctor, Ransa and MYSRL staff looked in the flask and assessed that around $\frac{3}{4}$ of the mercury had been lost – this would equate to around 150kg of mercury (each flask contains just under 200kg).

The local authorities sent an ambulance to Choropampa with a loud speaker to inform the residents that mercury was toxic and to hand the mercury back at the medical post. The Ransa supervisor accompanied the ambulance.

A town meeting was organized in Choropampa at 6 p.m. and the people urged to give back the mercury. This was not met with great success. A third team of MYSRL staff had been dispatched to Choropampa by this time charged with retrieving the mercury.

After the truck left Magdalena, a staff member of the mayor cleaned up the area below and around the truck.

During the course of Saturday afternoon and evening and Sunday MYSRL personnel prepared a press release for publication in the newspapers on Monday and on local radio, warning of the toxicity of mercury and asking that the mercury be returned. It is

at this time that MYSRL decided that Ransa should assume responsibility for the retrieval of the mercury and the publication of the press release and warnings to the community. Reasons stated include the desire to distance the identity of MYSRL as a gold mine from the retrieval effort, to dampen speculation that there was gold in the mercury or that the mercury had some special value.

Monday, June 5

The press release was published, but referred incorrectly to an 80kg or 4 liter spill. The information also went out on radio and television. This is organized under the auspices of Ransa. Ransa continued efforts to recover the mercury and MYSRL asked Flavio Castro to support Ransa in this. The truck containing the mercury and empty chlorine gas cylinders arrived back in Lima at the Ransa depot.

Tuesday, June 6

Ransa showed little success in retrieving mercury from the population. By now the Ransa depot in Lima was aware of the amount of the mercury lost as were others, including individuals in MYSRL. The clean up operation and public announcements continued, until June 13, to give the impression that the spill was of 80 kg.

Newmont having been informed of the spill on Sunday June 4, informed IFC. Representatives of the municipal authorities of Cajamarca visited Choropampa after learning of the spill from press reports. In Choropampa they learned of the extent of the spill – from San Juan to Magdalena, but they were unaware of the amount of the spill.

Wednesday, June 7

Ransa continued to have little success in retrieving mercury from the communities. It was not yet offering money in exchange.

Thursday, June 8

MYSRL learned from Ransa that health problems are being reported in the local community.

In the evening, the same woman who had presented to the health post in Choropampa on June 3 with contact dermatitis due to mercury exposure arrived at the hospital with her husband and a small flask of mercury. She wished to know if the mercury contained any other substance, for example uranium. Her mercury exposure diagnosis was reconfirmed and she was given treatment and discharged. At this point the health authorities were still unaware that there were medical risks posed by inhalation of mercury fumes, considering that mercury would result in skin contact, or perhaps, ingestion, both being of lesser risk.

Friday, June 9

Media reports in the morning included allegations that people in Choropampa have been poisoned by mercury.

Dr. Vargas, deputy director of the RHC and Dr. Marroquin, epidemiologist, visited Choropampa. They saw nine people who they diagnosed as having contact dermatitis. They were treated symptomatically and discharged. Later in the day the health post in Choropampa called RHC stating that seven of the nine had worsened

and they were brought to the hospital by ambulance. All were diagnosed as having reactions to mercury. Four were eventually hospitalized.

Over the next four weeks a steady stream of people sought medical care for symptoms of mercury intoxication. In the evening, MYSRL for the first time since the discovery of the spill sends personnel to Choropampa. MYSRL staff gave funds to Ransa personnel so that they may start to buy back the mercury at the price of 100 soles per kg (around US\$35). Ransa and MYSRL set up a buy back scheme at a small shop in Choropampa, using the scales owned by the shop owner.

The local authority requested a formal presentation by the mine on the spill and response.

Saturday, June 10

MYSRL started to coordinate clean up on the streets of Choropampa, paying local people to work in teams with brushes, plastic sacks and shovels.

Local people received house calls and sold mercury. Marcos Valdez of MYSRL met with representatives of Magdalena and Choropampa communities to assure them of the mine's commitment to handling the response.

Ms Luisa Arribasplata, a midwife at the Choropampa health post was evacuated to Cajamarca and other people presented to RHC complaining of intoxication or symptoms consistent with poisoning.

Over the weekend the medical team at RHC began to develop case management procedures for those cases with mercury poisoning diagnoses and began to consider in detail how the exposures were occurring.

Sunday, June 11

The health authorities continued to be unsure of the origins of the illnesses reported by the residents of Choropampa and so blood and urine samples were taken.

Monday, June 12

MYSRL informed IFC that only 80kg of mercury have been lost. Blood results showed that of the seven people originally taken into the hospital on Friday night and Saturday, five have very high levels of mercury. Carlos Santa Cruz, MYSRL general manager, begins to verbally inform central government authorities, including MEM and the Congress that there had been an accident. Those informed have alleged that they were told that there was no danger and the risks are minimal. On more than one occasion officials recalled understanding that the incident was not serious and that "this type of mercury was not dangerous". The chairman of the environmental commission of the Peruvian Congress was inclined to make a public statement to assuage the fears of the public and to explain that there was no risk. He did not do so when informed by the Ministry of Health that people were in fact becoming ill and were poisoned.

Dr. Luis Teran, the executive director of the Regional Hospital in Cajamarca contacted MYSRL to discuss the need for medicine to chelate patients diagnosed with mercury intoxication. He also contacted the University of San Marcos and the national toxics center, CICOTOX, for advice and assistance.

Results of the blood tests become available and reveal mercury poisoning.

For the first time MYSRL provides information in person to the Provincial Municipal authorities in a meeting in Cajamarca where Juan Gavidia, MYSRL administrative manager, assured the authorities that the mine would take full moral responsibility. The information given included reports on the health status of the affected populations.

Peter Orams held a town meeting in Choropampa to discuss the medical situation and the need to recover the mercury.

Tuesday, June 13

MYSRL clarified that the amount of mercury lost is in fact 150kg. The Ministry of Health sent a task force from Lima, and an expert in intensive care examines Ms Arribasplata. The director of CICTOX, Dr Rosalia Anaya, arrived at the RHC with medicines for chelation and chelation began.

Reportedly the Civil Defense authorities began to mark contaminated houses with crosses, in preparation for clean up.

Wednesday June 14

Environmental auditors arrived in Choropampa to evaluate the spill on behalf of MEM. A toxicologist arrived in Cajamarca from the University of San Marcos in Lima. Ambient air surveys of the houses in Choropampa using Jerome meters began. MYSRL began water testing. In Denver, Newmont Mining Corporation released information to the public on the spill.

Due to the numbers of people reporting symptoms of mercury poisoning and requesting medical treatment, Dr. Teran, requested assistance from authorities in Lima and was sent three physicians. The district attorney interviewed hospitalized patients. CICOTOX provided results from the first urine analyses and they showed mercury intoxication. CICOTOX and MYSRL met with teachers to organize the testing of students in three schools in Choropampa.

Thursday June 15

Top management from Newmont in Denver arrived in Lima. MYSRL decided to replace the road surface in Choropampa (1.6 km).

RHC retained a pediatrician for children reporting mercury poisoning symptoms. Ms Luisa Arrabisplata is moved from the Intensive Care Unit in Cajamarca to Lima for further treatment. The district attorney took biological samples from the hospitalized patients in the Hospital. In Choropampa, MYSRL and CICOTOX held a meeting with the community to ask for help from adults in getting urine samples from the students.

Friday June 16

Two weeks after the spill in Lima, senior representatives of Newmont Mining Corporation, MYSRL and Buenaventura visited the Prime Minister, the Minister of Health, the Minister of Energy and Mines, expressed their regret and assured the

authorities that they were taking full responsibility for environmental remediation efforts and health care.

RHC formed an Emergency Operations Committee for managing cases. Procedures and a manual were developed. Criteria for hospitalization, treatment, release and follow-up were decided. Mercury samples were tested by DIGESA and the results came back revealing the mercury to be 96% pure. MYSRL tests revealed the mercury to be 99% pure. Medical supplies for the Hospital were purchased by MYSRL.

The Minister of Women and Human Development was in Choropampa and pleaded with the community to give back the mercury.

5.3 Environmental Monitoring and Mitigation

5.3.1 Introduction

This section provides an overview of the monitoring and mitigation activities implemented by MYSRL. Activities directly related to human health including urine and blood analysis and treatment of patients are described elsewhere in the report.

It is apparent that after MYSRL recognized the severity of the consequences of the mercury spill (confirmed incidents of mercury poisoning) they reacted quickly, took ownership of the problem, and put into place a number of actions.

The overall response to the situation during the initial weeks was undeniably hampered by numerous factors including: lack of an emergency response plan dealing with spills off the mine property, confusion regarding “ownership” or responsibility for the incident (transport company versus the mine), confusion over how much mercury was actually lost, in many cases a lack of a cooperation by the local population, poor communication between MYSRL and local authorities, and distribution of the mercury over a wide geographic area. The relatively remote location of the spill (northern Peru) also delayed delivery of clean up and analytical equipment required for the remediation efforts. These factors do not in themselves explain why or how the spill occurred, but contribute to the subsequent responses.

Nevertheless, the situation undoubtedly could have been worse. Knowing the chlorine cylinder was lost, the driver stopped in Magdalena, thus preventing additional and more widespread distribution of mercury along the highway. The exact connection between the fallen chlorine cylinder and the mercury flask will probably never be fully ascertained. There is a strong possibility the two are linked as it appears too coincidental that spilled mercury was first detected at almost the precise location where the chlorine cylinder fell off the truck.

If the incident took place much further from the mine (for all purposes up to the suburbs of Lima), there could have been much greater delay in the mine learning of the spill and assuming clean up responsibilities. As it was, the spill was fortuitously reported by a local citizen from Choropampa to a friend that worked at the mine.

Furthermore, the incident took place at the beginning of the dry season. Had it been during the rainy season some of the spilled particulate mercury may have been washed directly into local watercourses leading to direct contamination of the surface waters. Gaseous mercury vapors may also have been washed from the atmosphere into the environment. In addition,

monitoring and clean up activities would have been severely curtailed by the presence of rain and mud. The clean up crews in Choropampa were able to take advantage of favorable weather conditions.

A variety of monitoring and mitigation efforts were started at different times, and then continued simultaneously. The activities can be broadly grouped into different categories based on objectives and nature of the targets as follows:

- ❑ Mercury recovery and calculated mercury balance.
- ❑ Identification of spilled mercury locations and roadside clean up.
- ❑ Monitoring of indoor air quality and house remediation.
- ❑ Environmental (soil, sediments, water) monitoring program.
- ❑ Other programs.

The above activities are described in more detail in the following section. MYSRL and its consultants subsequently developed detailed protocols and operating procedures for most of the above tasks. These protocols are protected by attorney-client privilege and therefore are not provided in this report.

It must also be noted that at the time of this report remediation efforts and long term planning were in a dynamic state. Therefore, while every effort has been made to identify the major on-going activities this in no way represents a final report, and other initiatives will be subsequently undertaken and reported by MYSRL.

5.3.2 Mercury Recovery and Mercury Balance

Recovery of the spilled mercury from residents in the affected villages began immediately starting on Saturday, June 3. Staff from Ransa and contacts of MYSRL, as well as local authorities, visited several homes and tried to convince residents to return any mercury they had picked up.

In the following days, a local citizen, Flavio Castro (who originally reported the spill to MYSRL) was retained by MYSRL and staff from RANSA acted as agents to purchase mercury back from local residents. Part of the rationale for using RANSA as the lead was to reduce suspicions that the mercury contained trace quantities of gold related MYSRL. The impression was that if citizens thought it contained gold, they would be less likely to return it. RANSA appears to have made little effort to recover the mercury and little is returned during the ensuing few days.

Peruvian government officials have noted that if they had been informed of the full extent of the incident, earlier, they would have been able to contribute resources available to the state to the recovery effort.

Beginning about Friday, June 9, staff from MYSRL used a small store in Choropampa as a central location where mercury could be returned and sold. The mercury was purchased from the residents at the rate of 100 Peruvian Soles (about \$30 US) per kilogram. Some quantities of mercury were returned, but other residents appear to have kept the mercury speculating the price would rise.

A scale from the shop was used to weigh the mercury returned by the local people, and a record was kept of each person that sold mercury and the amount provided. Up to the end of

June, approximately 49.1 kg of mercury was purchased back from the residents. The recovered mercury was returned to the mine for storage.

Samples of the recovered mercury were analyzed for impurities specific to the MYSRL operation to ensure that mercury was not being “imported” from other sources and sold for a profit.

It is known that 151 kg of mercury was originally spilled. Subtracting the approximately 49 kg recovered leaves 102 kg lost to the environment. Certainly, some proportion of this mercury would be recovered by the soil clean up operations. However, the exact quantities recovered are difficult to measure or estimate. The soil gathered during the early recovery efforts would have contained the highest concentrations of mercury. This material was never measured. MYSRL estimates that approximately 17 kg of mercury may have been recovered by soil clean up operations.

Given the high vapor pressure of mercury, evaporation into the atmosphere would also occur. Consultants working on the incident calculated that another 21 kg of mercury may have been vaporized during the weeks following the spill. This leaves approximately 64 kg still unaccounted for.

The commission did not attempt to verify the above amounts. MYSRL obviously devoted some effort to account for the lost mercury. The fact remains that the actual disposition of 102 kg of mercury will never be accurately known and the above mercury balance is based on best professional estimates. Certainly a proportion of the spilled mercury would vaporize, a proportion would be recovered during clean up operations, some amounts are likely still in the hands of local residents, a small proportion was inhaled or ingested by residents, other amounts were vaporized by residents heating the mercury, other unknown amounts may have been sold and transported out of the region, and some of the spilled mercury likely remains in the local environment. The exact distribution of mercury in each of these compartments cannot be determined with any confidence.

5.3.3 Identification of spilled mercury locations and roadside cleanup.

The locations of spilled mercury were initially determined by reconstructing where the transport truck had stopped based on interviews with the driver as well as observations from local residents. The first major attempt at cleaning roadside contamination appears to have been on Saturday, June 10. Portions of the main street in Choropampa were swept clean by staff from MYSRL and villagers, and portions of the road dug up by hand. Later, June 15, the decision was made to lift the top layers of pavement off the highway along a 1.6 km section through the town of Choropampa to ensure complete recovery and removal of any mercury contaminated material. These two photographs show the main street of Choropampa with the asphalt removed, and the clean up crew with full protective clothing and respirators.

After the initial response it was realized that mercury was potentially lost along sections of the highway from Km 155 where the chlorine cylinder was lost, to the town of Magdalena where the driver stopped. Accordingly, MYSRL coordinated a visual inspection of the stretch of highway along a 40 km stretch. A total of 137 people were divided into 30 groups of 4 people in each group. Each group walked a 3 km section of highway. Each section was walked 4 times and the location of any visible mercury was identified.

This process identified 16 spill sites along the road as follows:

Site No.	Area of Spill Sites
1	155.1 km
2	141.4 km
3	141.0 km
4	140.2 km
5	139.8 km
6	134.6 km
7	133.6 km
8	130.8 km
9	130.4 km
10	129.4 km
11	129.1 km
12	Choropampa
13	123.8 km
14	123.5 km
15	120.8 km
16	Magdalena

In addition, sections of road were later walked and airborne readings of mercury taken just above the road or soil surface using a Jerome mercury monitor. The Jerome mercury monitor has a detection limit of approximately 300 ng/m³. The company later switched to Lumex mercury monitors, imported by MYSRL, which have a much lower detection limit of approximately 2 ng/m³.

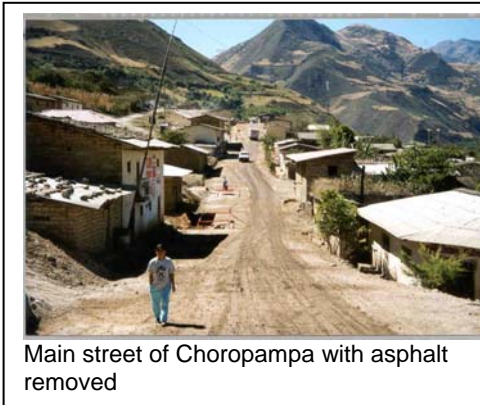
Roadside soil samples were later collected every 100 meters from Km 163 to 141 (San Juan) and thereafter at 500 meter intervals from Km 141 to Km 114 (Magdalena). Detailed mapping of the 16 spill sites was conducted using the Lumex instrument.

A mercury analytical laboratory was set up by Frontier Geophysics, for MYSRL in Cajamarca in early July. The mercury content of soil samples was estimated by using a headspace methodology. In this approach, a soil sample is digested with acid, and mercury vapors released into the sample container. The resultant vapor concentration is measured using the Jerome air monitor. This approach is considered adequate to rapidly screen soil samples for potential mercury contamination but it does not directly measure the mercury content of the soil sample. Other soil samples and digests were sent to a well recognized laboratory in the United States for actual determination of soil mercury content to provide a correlation with the headspace analytical technique used in Cajamarca.

Prior to removal of the road base and shoulder areas, vacuums were used to remove all visible mercury possible from each of the spill locations. Road material excavated was transported to the mine site for storage. The success of remediation is checked using the Lumex instrument and confirmatory soil sampling and analysis.

By the end of July, the road and house clean up crews consisted of about 150 workers. As of the writing of this report, significant work had been completed at 14 of the 16 road sites.

Remediation efforts continue in the three villages, and re-paving of the highway through Choropampa is scheduled for the end of August.



5.3.4 Monitoring of Indoor Air Quality and Home Remediation

Staff from MYSRL accompanied by local authorities began the initial measurements of air quality in homes in Choropampa on June 12. The Jerome air monitor equipment was originally used by the inspection teams as these were available from the mine where they were used to monitor air quality in the refinery. The first of the more sensitive Lumex instruments was delivered June 28. By the end of July MYSRL had purchased and obtained four Lumex monitors at a cost of approximately US\$16,000 each.

In conjunction with local medical authorities from DIGESA, MYSRL quickly developed an indoor air quality action protocol to classify the degree of contamination measured and suspected in individual homes. Homes are classified according to four (4) levels based on the average mercury in air reading:

Level 1: Homes with air readings greater than 0.003 mg/m^3 considered the short-term habitability level. Immediate evacuation is required. The house is remediated using best available technology (BAT) to achieve at least Level 3 habitability.

Level 2: Homes above long term habitability levels (MYSRL standard) with mercury readings above 0.001 mg/m^3 and below 0.003 mg/m^3 . Evacuation is recommended for exposure periods exceeding eight weeks. If clean up cannot be conducted within 3 or 4 weeks, individuals with high-risk profiles should be evacuated, taking into account personal situations.

Level 3: Homes meeting long term habitability levels (MYSRL standard) with mercury readings below 0.001 mg/m^3 , but above 0.0003 mg/m^3 . No evacuation is required, but additional cleaning is warranted if point sources of mercury can be found and removed.

Level 4: Homes meeting world standards for long term levels (MYSRL goal) with mercury readings below 0.0003 mg/m^3 . At this level, no further clean up is required and monitoring will be for assurance that no new sources of contamination enter the house or structure.

MYSRL and DIGESA are in agreement on the standard for short-term habitability. MYSRL has also committed to a more stringent standard for air mercury levels for longer-term habitability. These more stringent performance standards were adapted based on review of current medical knowledge regarding long term exposure to mercury as well as air quality guidelines employed in other countries.

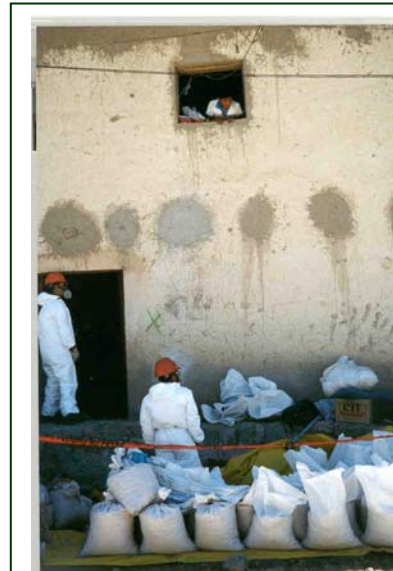
The house clean up and response protocols included one or more of the following:

- ❑ ventilation
- ❑ removal of specific contaminated household items (e.g., clothing, food, furnishings)
- ❑ covering/isolating contaminated surfaces
- ❑ heat interior of a well ventilated home for 3 – 4 days to enhance vaporization
- ❑ active remediation to remove soils and/or building materials (floors, walls, ceilings)
- ❑ active remediation including cement floors, soil amendments, wall coating
- ❑ active remediation including removing/replacing home, remove or relocate residents to a new home.

Many of the homes contained soil floors and adobe walls. This photograph shows a clean up crew removing soil from the floor of a contaminated house in Choropampa. The Independent Commission members were struck by the sharp contrast between the well-protected clean-up staff and the young boy who obviously lives in the house, watching the activities below from his second story window.

Clothing and personal belongings of the residents were also examined for potential mercury contamination using one of the Lumex air monitors. Contaminated belongings or foodstuffs were immediately removed. All contaminated materials including soil from the homes and roads were placed in bags and transported back to the mine site for storage.

It is difficult to ascertain the exact status of the air quality-monitoring program, as it is an on-going exercise. However, MYSRL reports indicate that by the end of July approximately 67 homes within Choropampa alone had been identified to contain some level of mercury contamination (e.g. Level 1,2 or 3) with another 143 homes considered “clean” as follows:



Soil floor being excavated from a house while young boy watches

Level of Mercury	No. of Homes Contaminated
1	21
2	20
3	26
4	143

Access to many houses was not possible because a number of residents were not at home immediately after the spill for a variety of reasons that are not clear. During this period approximately 59 homes were “locked” by residents and access to clean-up crews was denied. At the time of this report access had been provided to 20 of these homes with one

identified as Level 1, and one home identified as Level 2. The unoccupied homes were considered lower priority for clean up.

Remediation efforts were initially focused on homes in Choropampa, which is where the largest spill of mercury occurred, and the highest incidence of mercury poisoning was reported. At the end of July the remediation efforts were cleaning approximately 2 to 3 homes per day. Many were very challenging and recontamination was not uncommon. By early August efforts were begun to survey homes and plan for remediation efforts in San Juan and Magdalena. The early surveys indicated that at least 10 to 20 homes in San Juan would require cleaning.

5.3.5 Environmental Monitoring Program

An environmental monitoring program was quickly developed by MYSRL and its consultants. The program had two specific objectives:

- identify immediate potential impacts to the environment, and
- identify and measure potential long-term exposure. Results of the monitoring program are submitted monthly to the government of Peru and the shareholders of MYSRL.

The monitoring program focused on physical and soluble transport pathways for the spilled mercury. Priority was given to sampling water, soils and sediments in the vicinity of the known mercury spills. By the end of June a total of 35 surface water-sampling stations were established; 13 up-gradient (reference) stations, and 22 down-gradient stations. Sediment samples were also collected at these stations. Other sampling stations were later added.

The first set of water samples were collected on June 14. It should be noted that analysis of trace mercury levels in water samples is difficult and ultra clean techniques are required to provide reliable results. In addition, water samples were analyzed for a wide range of other parameters and metals to establish baseline conditions.

Sediment samples were also screened for mercury content using the headspace approach used for soils as described in section 5.3.3 above.

Water and sediment sampling initially occurred on a weekly basis, it was then changed to bi-weekly for two sampling events, and then was planned to go to monthly until the rainy season begins, at which time it would revert to weekly sampling.

The environmental monitoring program also collected soil samples in the vicinity of the spill and along the roadside to identify additional possible spill sites. By the end of July the number of environment samples collected was as follows:

Environment	Number of Samples Collected
Water	315
Sediment	131
Soil	1243
Total	1689

Early sediment samples showed elevated concentrations of mercury suggesting potential movement of mercury from some spill locations. However, follow up sampling at these locations did not duplicate these results and indicated background mercury levels in sediment samples. MYSRL is continuing the sediment surveys and these discrepancies will be addressed by subsequent analysis and monitoring.

The environmental monitoring program in place would appear sufficient to achieve the stated objectives. However, the Independent Commission has not attempted to verify or interpret any results of this program. This will be the responsibility of the regulatory agencies and MYSRL.

In addition to the environmental monitoring survey initiated for the spill, MYSRL has an extensive on-site routine monitoring program at the mine site. Results of this program are summarized and submitted in annual reports to various reporting agencies. A preliminary review by the commission of monitoring results for the 1998 reporting period indicate elevated concentrations of mercury as well as other parameters in some the groundwater and surface water sampling stations. A thorough review of the monitoring results relative to sources, background levels, water movement patterns and downstream receptors would be appropriate.

5.3.6 *Other Programs*

At the time of this report other environmental initiatives had been started or planned. These were identified in the most recent (August 2, 2000) report from MYSRL to the Ministry of Energy and Mining in Peru as:

- ❑ livestock monitoring in Choropampa
- ❑ terrestrial ecology risk evaluation
- ❑ environmental risk assessment program
- ❑ aquatic baseline study/risk evaluation

Details on these undertakings were not available but it would appear that extensive measurement of mercury in various environmental compartments is planned by MYSRL in the ensuing weeks and months. The data would be used in risk assessment models.

Milk and blood samples (non destructive sampling techniques) were collected during the week of July 25 from livestock selected by SENASA. In addition, tissue samples (destructive sampling) were obtained from chickens and one duck from local farmers. The samples were being analyzed for mercury in the CICOTOX laboratory in Lima. SENASA and MYSRL will continue to coordinate sampling livestock, fruits and foodstuffs.

A terrestrial field study is planned to start at the end of August to sample specific plant and animal receptors. Agricultural and native species will be sampled to provide data that can be used to establish baseline conditions for long term monitoring as well input parameters for risk assessment. Mercury does not generally bioaccumulate in terrestrial plants and vegetation or herbivorous animals so these environmental exposure pathways are not expected to be significant. However, detailed monitoring of these media is supported to confirm the degree of actual exposure to ecological and ultimately human receptors.

An aquatic baseline survey will also be initiated toward the end of August. The program will include a survey of benthic macroinvertebrates as well as fish populations in the Jequetepeque River and the Galleto Ciego Reservoir. A second survey will be conducted in the year 2001 to test the hypothesis that bioaccumulation of mercury is not occurring in the aquatic media as a result of the spill.

An environmental risk assessment will be undertaken to evaluate potential long-term impacts associated with the mercury spill. Initially, a screening level risk assessment will be undertaken to identify pathways, exposure and receptors. Initial risk characterization will be based on literature hazard and toxicity values. The preliminary risk assessment will help focus a more advanced site-specific screening assessment using data obtained from the field surveys and monitoring programs. This information will ultimately be used to determine potential risk to the receptors, assist with interpretation of monitoring data and to assess efficacy of the remediation efforts.

It is apparent that the company is undertaking considerable monitoring activities and plans for extensive evaluation and use of the resultant information. It will be several months, and in some cases, years, before the environmental consequences of this event can be determined with any certainty.

5.4 Chronology of the Diagnosis and Treatment of Exposed Individuals

The following section is extracted from the Technical Report provided to the Independent Commission by the Centers for Disease Control and Prevention (CDC) and the National Center for Environmental Health, Atlanta, Georgia, USA. CDC did not participate in writing of the report and CDC personnel did not serve as members of the Commission. The findings of the Independent Commission are the sole responsibility of the members of the Commission.

Saturday, June 17, 2000.

The Regional Hospital in Cajamarca (RHC) distributes protocols for treatment of mercury-intoxicated patients to RHC physicians and nursing staff. Close to the hospital complex RHC opened a hostel for patients receiving ambulatory care with the support of MYSRL. RHC began daily reporting of patients to the Ministry of Health.

The Ministry of Energy and Mines fined MYSRL an amount in Peruvian soles, the maximum amount possible, approximately equivalent to US\$500,000 for endangering the environment.

Tuesday, June 20, 2000.

RHC developed a computerized registry of laboratory results and patient care. MYSRL noticed that villagers were expressing concern about long-term health effects of mercury.

Wednesday, June 21, 2000.

Teachers from Choropampa visited hospitalized patients.

Thursday, June 22, 2000.

Arrangements were made to send blood and urine samples to DIGESA. RHC made arrangements with MYSRL to procure more penicillamine for chelation.

MYSRL personnel, health post personnel and Magdalena municipal authorities met to coordinate treatment of affected persons in Magdalena.

Choropampa authorities held a town meeting with MYSRL representatives and presented a petition for health, health insurance, life insurance, transportation to Cajamarca to visit hospitalized family members, school improvements, water improvements, road improvement, economic compensation and employment.

Friday, June 23, 2000

CICOTOX reported results of 501 urine samples; 42 samples had mercury levels >100 parts per billion (ppb); 299 in the range of 50-100 ppb; and 160 were <50 ppb. DIGESA reported results of 13 blood samples from patients. All values were in the normal range.

Saturday, June 24, 2000.

Two physicians joined staff at the hostel to support the treatment and management of patients. RHC requested testing of heavy metals for hospitalized patients. Samples were referred to laboratories in Lima.

Sunday, June 25, 2000.

300 urine samples were sent to three laboratories in Lima for heavy metal analysis. The head of the medical post in Choropampa was advised of the penicillamine protocol used at RHC. MYSRL personnel met with Choropampa authorities to discuss formation of work groups and items discussed at meeting on June 22, 2000.

Monday, June 26, 2000

RHC requested results of DIGESA environmental testing in Choropampa to make decisions on releasing patients.

Tuesday, June 27, 2000.

Samples from patients were sent for toxicological exams at DIGESA. RHC consulted with the department of obstetrics and gynecology regarding treatment for pregnant women who were exposed to mercury. MYSRL met with the Pan American Health Organization to discuss coordination of efforts for medical attention.

Wednesday June 28, 2000.

Dr. Marcial Anaya, Chief of Emergency Medicine at the Hospital Arzobispo Loayza, joined RHC team, providing technical expertise on mercury poisoning.

Thursday, June 29, 2000.

RHC directors and staff were interviewed by *Caretas* magazine.

Saturday, July 1, 2000.

The treatment protocol for pregnant women was established by RHC. Dr. Anaya held a conference on treatment of poisoned patients.

Sunday, July 2, 2000.

Doctors from RHC and MYSRL staff traveled to Choropampa for a public meeting.

Tuesday, July 4, 2000.

RHC requested assistance from the Peruvian Society of Obstetrics and Gynecology for the treatment of pregnant women. DMPS, another chelation drug, not available in Peru, nor approved for use in the US, is brought to Peru by MYSRL and is delivered RHC. MYSRL consulted with DIGESA on monitoring cases and coordinating to avoid duplication of efforts. They also update the Regional Director of Education on progression of remediation efforts.

Wednesday, July 5, 2000.

RHC and DIGESA met to coordinate release of patients. MYSRL met CARE-Peru to discuss social programs for the affected villages.

Thursday, July 6, 2000

Caretas report was published with inaccurate information on the hospitalized patient. El Comercio published an article on mercury poisoning indicating there were patients in coma and a high mortality rate. RHC complained of inaccuracies and distortions in both articles. Drs. Lioy and Gochfeld, specialists in toxicology from Rutgers University, New Jersey, United States arrived in Cajamarca at the request of MYSRL. They stay until July 8, 2000 and provide consultation for diagnosis and medical care. They also developed protocols for mitigation of residences contaminated with mercury.

Friday, July 7, 2000.

MYSRL representatives of the Catholic Church in Cajamarca, Forum Cajamarca, and ECOVIDA staff met with RHC physicians and patients to address issues regarding medical care and treatment of patients

Saturday, July 8, 2000.

Laboratories sent results on heavy metal testing on patients. Levels were similar to an unexposed population.

Sunday July 9, 2000

RHC and MYSRL visited San Juan and Magdalena authorities to address rumors.

Monday July 10, 2000

RHC held meeting with hospital personnel to dispel fears of exposure from patients. RHC physicians and MYSRL personnel met with Cajamarca authorities to discuss poisoned patients and possible long term consequences, as well as response plan.

Two civil defense workers who were measuring mercury vapor in houses were hospitalized for mercury poisoning.

Tuesday, July 11, 2000.

Records from DIGESA and medical records were reviewed to determine patients that may return home. The Catholic University at Cajamarca convened a two-day meeting on environment and public health in Choropampa. Minera Yanacocha and SENESA discussed environmental monitoring of animals and plants of area.

Wednesday, July 12, 2000.

Dr. Teran held meeting with all hospital and hostel personnel to clarify misinformation. MYSRL personnel interviewed by Diario El Comercio (national newspaper?)

Thursday, July 13, 2000.

RHC and Regional Health Director discussed the return of patients to their rehabilitated homes. CICOTOX established a laboratory in RHC.

MYSRL and DIGESA personnel met to discuss sharing of database of affected population. MYSRL personnel met with Minister of Transportation to discuss new regulations regarding mercury transportation.

Saturday, July 15, 2000

Eleven patients were released from hostel and allowed to return to their home.

Wednesday, July 19, 2000

MYSRL consultants (toxicologists) met with RHC personnel to discuss case management and treatment of patients. They were then interviewed by local television reporter. A group of 16 hostel patients were released. Hostel patients are released daily from this point on. Twelve patients from hostel left against medical advice.

Saturday, July 22, 2000.

50 patients were released from hostel by this date.

6.0 Mercury Management and Handling at MYSRL

This chapter reviews the environmental management components related to mercury production and handling of hazardous materials at the mine. The Independent Commission has reviewed selected aspects related to mercury production, sale and transportation to the mercury purchaser.

The mercury production process that was in use in the beginning of June 2000, when the mercury spill occurred, involved a number of departments.

Refinery workers take mercury from the retorts (Photograph 8) and place it into metal flasks with a capacity of approximately 200 kg, which are then sealed. The weight of each flask is recorded in a file, as well as on a piece of tape that is placed on the flask (Photograph 9). The mercury flasks are then moved to a special area of the refinery for pick-up by an equipment operator from the Logistics Department.

Each cylinder is closed with a threaded nut that is tightened with a socket wrench. The thread is apparently further sealed with either plumbing tape and/or silicone. It is not clear how the cylinder that was involved in the spill of mercury was sealed.

In recent years loss control procedures have been developed and progressively improved to reduce worker exposure to mercury in the refinery. A forklift operator from the Logistics Department transports the mercury flasks a relatively short distance from the refinery area to the logistics yard where the mercury is placed in a designated area. In the open warehouse storage area, signs are posted warning of the hazards of elemental mercury (Photograph 10). Mercury is stored in this area until loaded onto trucks for shipment to a warehouse in Lima.

At the time of the incident mercury produced at the mine was purchased by Mercantil in Lima. Mercantil is a Peruvian company that has been dealing in mining products for over 20 years. The mercury is then sold to industrial purchasers and the general public. A significant quantity of the mercury is used by small artisanal gold operations.

MYSRL constructed a special pallet to hold up to eight of the mercury flasks. However, this was not used on a regular basis. During the spill incident, the flasks of mercury were being transported on an open pallet, and the special pallet was not used. Photograph 11 shows typical mercury flasks on an open pallet in the foreground, with the specially designed pallet for mercury canisters in the background.

Forklift operators in the Logistics Department load the pallet of mercury flasks onto the contractor's (RANSA) truck. The informal procedure is to use the special pallet and a closed truck to transport the mercury to Lima. On June 1, 2000, a truck with an open staked flat bed trailer was selected for the transportation of ten empty chlorine cylinders and nine mercury flasks.

The trailer loaded by the MYSRL forklift operator, with checks by the yard supervisor and the truck driver. The driver is given shipping manifest(s) for the materials loaded onto the truck. The RANSA truck driver(s) then deliver the mercury to the RANSA warehouse in Lima for pick-up by Mercantil.

The Independent Commission ascertained that the fork lift operator at MYSRL had no formal training in the loading of trucks including regarding weight distribution or placement of load.

The pallet of mercury containers was placed at the rear of the trailer. It was acknowledged that they should have been placed close to the truck, which was the accepted, even if informal, practice. It was acknowledged that the warehouse supervisor had some weeks before insisted that a shipment of mercury be removed from a similar truck and trailer due to its improper positioning.

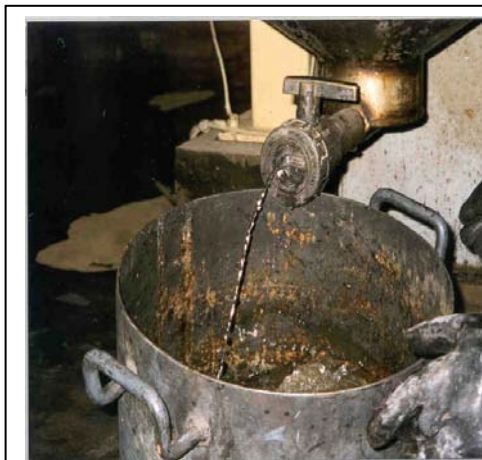
The Independent Commission was told by both RANSA and MYSRL that a closed container was generally preferred for the shipment of mercury. This would infer that both firms understood that a closed container was more appropriate for the shipment of mercury. Upon closer examination, however, it was apparent that open flat bed trucks were used with the same frequency as closed trucks. At the same time RANSA officials maintained they were not even aware that mercury (a hazardous material) was being shipped on their trucks. This seems highly unlikely since the practice had been ongoing for years and mercury was clearly

listed on the shipping manifests which were signed by the driver and at least one RANSA supervisor.

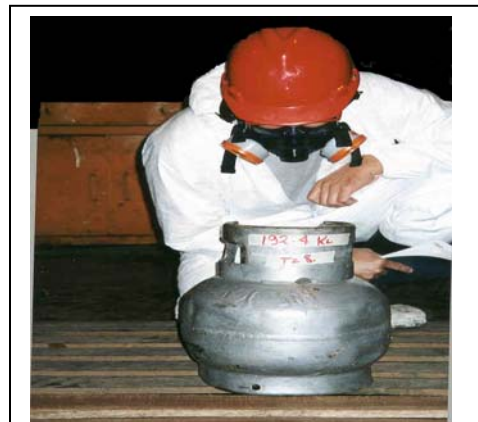
The containers of mercury are weighed prior to leaving the mine site (~4,000 mel), and again in Lima when received by Mercantil. MYSRL administration monitors the quantities of mercury received by Mercantil and compares the values to the quantities shipped from the mine.

The Independent Commission noted some discrepancies between the amount shipped and amount received in Lima for the first 5 months of the year 2000 (only period for which records were made available). The amount received appeared to be consistently less than that shipped.

In response to various concerns related to the handling and disposition of mercury produced at the mine, the Independent Commission learned that MYSRL intends to suspend all sale of mercury within Peru.



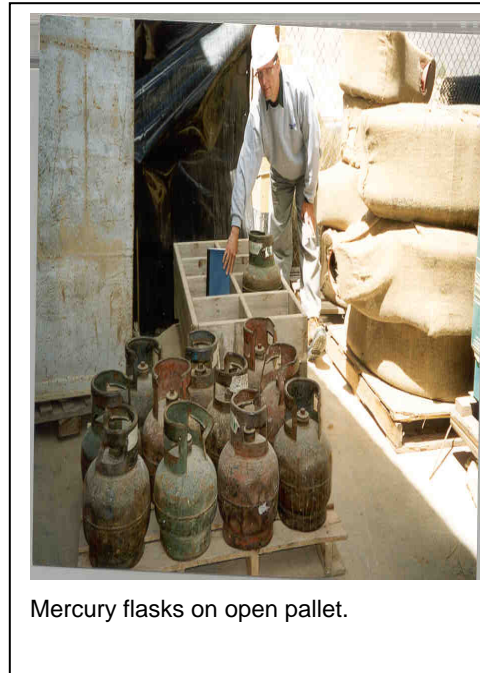
Elemental mercury collected from retorts in the refinery.



Filled flask of mercury with recorded weight.



Sign warning of toxicity of mercury in storage area.



Mercury flasks on open pallet.

Production and handling of mercury in the refinery is under strict control for occupational and worker hygiene procedures. While in the refinery, the mercury is primarily the responsibility of the Refinery Department, with oversight provided by the Loss Control Department with respect to occupational health and safety issues. Once it leaves the refinery it is the responsibility of the Logistics Department.

The MYSRL Loss Control Department provides a range of services including training to mine employees and contractors and subcontractors who work on the mine property. It has a program focused on occupational health and safety, and accident prevention and investigation.

The Loss Control Department has developed many occupational health and safety programs and procedures including, but not limited to, the formal procedures for mercury management within the refinery workplace, and the general induction and training programs given to workers and contractors that work on the mine property. The general induction program includes information regarding chronic poisoning from mercury, possible methods of mercury exposure, how mercury can effect human health, and how to reduce the risk of exposure to mercury.

Once the mercury leaves the refinery, is the responsibility of the Logistics Department. The Logistics Department is responsible for ordering, receiving and shipping materials from the mine. It manages competitive bids, selects suppliers, and then carries out the procurement, receiving and distribution of a wide range of materials. It also ships materials from the mine to other locations/enterprises. The contracted shipment of mercury from the mine to Lima uses the RANSA trucking company.

MYSRL originally used 34.5 kg capacity flasks to transport mercury to Lima. These flasks were of the type approved by the US Environment Protection Agency and fit neatly into well protected boxes. In 1996, when the mine started to sell its mercury to Mercantil, the smaller

flasks were exchanged for much larger containers holding almost 200 kg. There in use at the time of the spill. The rationale for changing flask type was not clear to the Independent Commission. The Independent Commission received conflicting accounts of who ordered the change in flasks. It appears that the change took place without a technical and engineering assessment of the newly specified flasks.

Mercantil has indicated that it checks the mercury flasks for leaks every three months using a procedure that involves filling the flasks with gasoline and the inversion of the sealed flasks to check for leaks.

Records indicate that the number of mercury flasks in each shipment from the refinery varies from 8 to 10.

Each shipment of mercury from the refinery to the Logistics yard is accompanied by a memorandum which details: the date and reference number for the shipment; number of mercury flasks; bottle number, colors and tare and net weights; total weight of flask and mercury and; total weight of mercury in shipment

In 1996, the MYSRL Logistics Department awarded a general contract to RANSA to transport a range of cargo/materials to the mine, and transport materials from the mine to facilities located off the mine site. The latter included the back haul transport of full mercury flasks and empty chlorine cylinders to destinations in Lima.

The transport of cyanide to the mine is conducted by another trucking firm. A comprehensive program for the transport of cyanide including a full emergency response plan was developed by MYSRL, the trucking company and the supplier of cyanide.

It should be noted that there are no regulatory requirements governing the transport of hazardous materials in Peru, other than for explosives.

The MYSRL Environmental Department provides a range of services to the mine. The department has an Environmental Affairs Manager, an Environmental Superintendent and five Environmental Supervisors – the latter are assigned specific areas of the mine.

The Environmental Supervisor for the Plant Area, which includes the refinery and logistics yard, visits these areas on a bi-weekly basis and conducts an assessment of observed conditions using a prepared checklist. The focus of the checklist is to assess the performance of the workplaces being inspected regarding potential impacts to the environment. The results of the checklist are used to develop a numerical scoring, which in turn is reported to the area management for review and discussion at senior on-site management meetings.

The Environmental Department also serves as an environmental resource for the other departments.

Selected MYSRL documents relevant to a discussion of handling and transportation of hazardous materials are summarized below.

Loss Control Manual

MYSRL's Loss Control Manual describes the loss control program that is applicable to activities on the mining property. The manual is comprehensive and details the loss control program including, but not limited to, workplace loss control-related policies, work procedures, health and safety, workplace and equipment checklists and inspection frequencies, operating and maintenance requirements, inspection and reporting requirements, and procedures to be followed in the event of an accident on the mine property

Spill Prevention, Control and Response Plan

MYSRL's Spill Prevention, Control and Response (SPCR) Plan was prepared by its Environmental Department and establishes procedures for the management of hazardous materials stored and used at MYSRL. The hazardous materials addressed under the plan include gasoline, diesel fuel, oils and lubricants, cyanide (including pregnant leach solution), sodium hypochlorite, and various other chemicals and reagents that are stored and used in relatively small volumes. The potential for spills is discussed including scenarios leading to a spill, and a probable pathway that a release would follow. Measures in place for spill prevention are described including inspection routines and where applicable procedures for loading or transfer of these materials. In addition, the SPCR Plan describes the emergency response procedures for these materials. The Plan contains no specific mention of mercury.

While MYSRL conducted a hazard assessment for specific hazardous materials used in the gold mining and recovery process, mercury was not included in the SPCR Plan. Chlorine gas was also not included in any analysis or discussion of hazardous materials. The mine uses approximately 125 tonnes of chlorine gas per year for water treatment during the rainy season.

Industrial Hygiene Program

The Industrial Hygiene Program for Year 2000 is designed to evaluate, prevent and control risks on site. The program includes monitoring for mercury as outlined below.

Mercury Monitoring	Monitoring Frequency
Ambient level air monitoring in the refinery.	Weekly
Personal level air monitoring in the refinery.	Twice per year
Ambient level air monitoring at the Yanacocha and Pampa Larga plants.	Weekly
Personal level air monitoring at the Yanacocha and Pampa Larga plants.	Twice per year
Ambient air monitoring in the geology lab – Furnace No. 4.	Monthly

The above program is supported by the participation of MYSRL personnel from the Loss Control, Engineering, Maintenance, Administration, and on-site Medical Departments.

Training Manual – Course on Dangerous Chemical Products

This concise manual familiarizes on-site workers with significant potential risks associated with the handling, storage, transportation and working with chemical products on the mine property. The manual identifies pathways for organisms (i.e. absorption, inhalation, ingestion), classifications of chemical products (i.e. solids, gases, and liquids), classifications dependent upon physical effects (i.e. inflammable, combustible, cryogenic, and corrosive), classification according to physiological reactions (i.e. irritants, carcinogenic...), severity of risk with regards to concentration, time of exposure and susceptible personnel, methods to control exposure, MSDS information, and labeling including symbols.

Emergency Response Plan

MYSRL's emergency response was developed by the Loss Control Department. The document presents norms, procedures and assigns responsibilities related to the planning, response and control of emergencies. Emergency procedures are detailed for injuries/sickness; fires/explosions; natural disasters; criminal activities; interruption of processes and chemical/leaks/spills. The document provides instructions on how to deal with chemical spills including spills classified as level 4, and that may impact populations living in the vicinity of a plant. The document does not specifically provide measures to be used to respond specifically to mercury or to any spill off the mine property. The mine had responded to spills off the mine site that were in no way connected to MYSRL. This was done to demonstrate their corporate commitment as well to protect the environment in the region surrounding the mine.

Training Plan for Year 2000

This is essentially a planning document for the Loss Control Department. Of specific interest to the Independent Commission is competence training of contractors who work on the mine property. This plan includes the analysis of contractors training, and elaboration of contractor training procedures. On-site contractors receive MYSRL's general induction training which includes reference to mercury hazards.

RANSA Policy, Driver Training and MYSRL Contract

RANSA Comercial S.A. (RANSA) adopted the Mobil Drivers Manual from Colombia as the basis of policy and its truck driver training program in Peru. As a general comment, the Mobil manual provides a reasonable basis as it includes standards and requirements regarding the transportation of dangerous materials based on Colombian hazardous materials legislation, which appears to be similar in aspects to legislation in North America. The Mobil manual is, however, largely focused on training for tanker truck drivers as opposed to drivers of trucks with flat bed or enclosed cargo trailers.

RANSA holds weekly training sessions for drivers focused on their Mobil manual. Drivers are also trained on the proper operation of the Volvo trucks used by RANSA – this training is provided by Volvo. Trucks and trailers are inspected when they arrive at RANSA's facilities, and regular maintenance (oil changes and tire replacements) are completed by RANSA with other specialized maintenance procedures undertaken by Volvo.

The trucks are equipped with a GPS tracking system. The GPS tracking system in the '98 Volvo truck involved in the spill on June 2, 2000 was not operational that day.

RANSA did not have a protocol for mercury shipments from MYSRL to the RANSA warehouse in Lima. The unlabelled cylinders of mercury were held in the warehouse with no special precautions until being picked up by Mercantil. RANSA does, however, use specialized procedures for the transportation of cyanide to another mine.

The Independent Commission understands that the contract of MYSRL with RANSA required them to comply with appropriate regulations and legislation. However, in the absence of regulations, the contract offers little or no protection in the handling of hazardous materials. This situation could have been identified through audits designed to assess and confirm RANSA's ability to respond to a spill of hazardous material. The Independent Commission understands that no such audit or verification, was made of RANSA.

6.1 Formal Audit Processes

Organizations undertake environmental audits or reviews to assess their environmental performance. On their own, such audits or reviews may not be sufficient to provide an organization with the assurance that its performance not only meets, but will continue to meet, its legal and policy requirements⁶. Audits are supported through environmental management. Three audit and supervision processes were in place at MYSRL: MEM, IFC, and Newmont.

The International Finance Corporation (IFC), system of monitoring and supervision requires compliance on occupational health and safety with applicable and local requirements, occupational health and safety guidelines, and IFC requirements. This process generates an Annual Monitoring Report.

The IFC applies extensive guidelines including The World Bank Group's Pollution Prevention and Abatement Handbook, and Occupational Health and Safety Guidelines. In addition, the IFC consults a number of other reference materials in reviewing projects including but not limited to:

- *The Safe Disposal of Hazardous Wastes: Volumes I, II, and III*, World Bank Technical Paper No. 93, 1989.
- *Doing Better Business Through Effective Public Consultation and Disclosure: A Good Practice Manual*, International Finance Corporation.
- World Bank document, *Environment, Health and Safety Guidelines, Mining and Milling – Underground (interim)*, dated August 11, 1995. It provides numerous guidelines including hazardous material handling and storage. The latter is as follows (IFC, 1995):
 - All hazardous (reactive, flammable materials, radioactive, corrosive and toxic) materials must be stored in clearly labeled containers or vessels.
 - Storage and handling of hazardous materials must be in accordance with local regulations, and appropriate to their hazard characteristics.
 - Fire prevention systems and secondary containment should be provided for storage facilities, where necessary or required by regulation, to prevent fires or the release of hazardous materials to the environment.

The Independent Commission observed during its visit to the mine property in July 2000 that the filled mercury vessels were not labeled, as required by IFC.

Mine Safety and Health Audits are completed on a semi-annual basis by Peru-based consultants on behalf of the Ministry of Energy and Mines. These audits examine workplace health and safety on the mine property. The audit reports present conclusions and recommendations directed to the Ministry, MYSRL or both. The audit report is made available to both the Ministry of Mines and Energy, and MYSRL. The Independent Commission has reviewed the conclusions and recommendations of the audits for 1994 to 1999 inclusive.

Given the occupational health and safety focus of these audits, the safe handling of mercury on the MYSRLs mine property was within the scope of the audits. However, the transport of mercury off the mine property by a contractor would have been outside the audit scope. The audit reports do make mention of mercury on the mine property.

In summary, at the time of the spill, the mine had in place the following components of an environmental management system:

- ❑ An Environmental Policy and a Loss Control Policy that addressed environmental protection.
- ❑ Procedures for the production, collection, handling and storage of mercury on the mine property. These procedures were supported by common core type training to MYSRL employees, as well as contractors and subcontractors that work on the mine property, that included general awareness about the hazards associated with mercury.
- ❑ An Emergency Response Plan for spills on the mine property.
- ❑ The contracted transportation of its mercury to a destination in Lima.
- ❑ The contracted sale of its mercury to Mercantil in Lima.
- ❑ The occupational safety and health, and the environmental performance of MYSRL was monitored through:
 - Regular formalized inspections of workplaces on the mine site by MYSRL – including potential releases off the mine site.
 - Semi-annual inspections of the mine property as required by the Peruvian Ministry of Mines and Energy. These audits are largely health and safety orientated with several audit protocols based on the environmental assessment for the mine.
 - Annual supervision of environment and social procedures by the IFC according to the terms of IFC's financial agreement.
 - Periodic audits by Newmont Mining Corporation.

6.2 Observations on Environmental Management Practice

Environmental management by MYSRL appears to have a number of shortfalls. As examples:

- ❑ The focus of MYSRL's Environmental Department, in relation to the handling and transport of mercury, appears to be on monitoring for potential/actual releases of mercury from the mine property to the receiving environment. This focus limits its capacity to identify the potential for mercury spills in locations off the mine property and the need for associated mitigative/response measures.
- ❑ The RANSA contract called for the trucking company to remain in compliance with regulations that do not exist. This important aspect could have been identified had the contract been reviewed by the Environmental Department or others knowledgeable on Peruvian environmental legislation.
- ❑ The presence of mercury in the ore deposits was not known when the original environment assessment for the mine was completed. The environment assessment indicated the mine would have contingency and response plans. These plans should have been updated to address potential mercury spills when mercury was found to be present in the refinery in November 1993.

The Environmental Department may be understaffed, given the growth of the mine. The Loss Control Department was reorganized in 1996, as part of a response to a series of incidents at the mine, and with the implementation of a new accountability system to ensure that all groups including contractors and subcontractors have a strong reporting relationship to the Loss Control Department with regards to health and safety. As part of this program a loss control management audit was conducted to identify weaknesses and develop and implement a corrective action plan.

7.0 Human Health Issues

The following chapter is based on a Technical Report to the Independent Commission by the Center for Disease Control and Prevention and National Center for Environmental Health, Atlanta, Georgia, USA.

The National Center for Environmental Health (NCEH), Centers for Disease Control and Prevention (CDC), provided technical assistance to the Independent Commission by determining the chronology of health-related activities, evaluating health status and public health capacity, and providing recommendations for public health actions related to the mercury spill. CDC provided the Independent Commission with this technical report, which is appended to the Independent Commission's report. CDC did not participate in writing the Independent Commission's report, and CDC personnel did not serve as members of the Commission. The findings of the Independent Commission's report are the sole responsibility of the Commission.

The Independent Commission's Recommendations relating to health are contained in the recommendations Section 8.4.

The activities related to the spill changed dramatically after people began to develop symptoms of mercury intoxication. On June 9, seven people sought medical care at the

Choropampa Health Outpost for fever and rash. In the following days, more people reported to the health outpost with symptoms of mercury poisoning. This intensified the efforts to identify and remove mercury-contaminated materials and to provide medical care for the affected population. By July 23, 260 people were treated for mercury intoxication, contaminated soil was being removed from 16 sites along the road, and elevated levels of mercury vapor were present in 78 houses. A survey among 730 villagers in Choropampa showed an average level of 66 parts per billion (ppb) in urine. In addition, mercury was being monitored in surface water, drinking water, stream sediment, soil, and air.

7.1 Methods Used in the Technical Report

The assessment relied on eyewitnesses to document events related to the episode. If an eyewitness was not available, at least two independent sources were used to corroborate the event. Documents from organizations involved in the event were obtained; these included policies covering activities related to the event, reports that described the event, and policies and procedures developed to address the event. The assessment team also traveled to the affected areas to observe mitigation activities and occupational health and safety practices. A database on the affected people and the environmental monitoring was obtained, but the medical records of the affected people were not available for review by the team.

7.2 Human Health Effects of Elemental Mercury

Mercury has a legacy of use throughout history in alchemy, industry, and medicine. The silvery-grey liquid metal exists in an elemental state or as organic or inorganic compounds. Mercury toxicity varies tremendously by its physical state and the route of exposure. Absorption of elemental mercury by dermal contact or ingestion is minimal (0.01%). Elemental mercury evaporates at room temperature and its vapor is rapidly and efficiently (80-90%) absorbed by the body.

In the body, elemental mercury (Hg^0) is rapidly oxidized to mercuric ion (Hg^{++}) which inhibits cellular function by denaturing proteins and inhibiting enzymes. Mercuric ion has a strong affinity for sulfhydryl, carboxyl, amine, phosphoryl, and amides. Once bound to these groups, it may cause dysfunction of the molecule. Mercuric ion disrupts ion channels, which inhibits membrane transport and activity and the uptake and release of brain neurotransmitters. The ion accumulates in the kidney, bone marrow, spleen, liver, lungs, skin, hair, and erythrocytes. Mercuric ion crosses the placenta and may affect the fetus. Over time it can be excreted in urine, breast milk and feces. Its reported half-life, however, is 30-60 days; thus, once absorbed by the body, half of the mercury is excreted in 30-60 days.

Acute inhalation of large doses of elemental mercury damages the lungs, skin, eyes, and gingiva. Symptoms of acute exposure are cough, dyspnea, chest pain, nausea, vomiting, diarrhea, fever, and a metallic taste in the mouth. Interstitial pneumonitis, increased blood pressure and heart rate, and pulmonary edema may occur with extreme exposures. Elemental mercury that contacts the skin can lead to dermatitis. Children exposed to mercury vapor in the home have developed acrodynia, or "pink's disease." This rare syndrome causes severe leg cramps, irritability, and painful pink fingers and sometimes resulting in peeling of the skin on the hand.

Chronic exposure affects the central nervous system. The major symptoms include a fine tremor, psychological changes (increased excitability), and gingivitis. Insomnia, loss of

appetite, irritability, headache, and short-term memory loss may also occur. The medical literature currently shows no link between chronic exposure to mercury vapor and increased cancer risk. Women with chronic exposure to elemental mercury in an occupational setting have reported more reproductive failures (spontaneous abortions, stillbirths, congenital malformations) and irregular, painful, or hemorrhagic menstrual disorders.

7.3 Human Health Aspects of the Mercury

The occurrence and severity of mercury intoxication depends on the intensity and duration of exposure. In this episode, exposure is complicated by a wide range of factors including the unique properties of elemental mercury; the geology, hydrology, ecology, and climate of the spill area; and the human activities in the spill area and the culture and behaviors toward mercury.

Acute health effects from inhalation of mercury vapor and direct contact with the liquid metal occurred within the first few days to weeks after the spill. Chronic exposures from small spills on the roads and contamination inside houses were minimal because of the mitigation of the contaminated roads and houses. Chronic exposures may occur from the missing or hidden mercury if the vapor escapes or the liquid leaks from the storage container, or in homes that may have been inadequately cleaned. Chronic effects from acute exposures will be discussed in the section on future risk.

7.4 Diagnosis

The physicians relied upon clinical signs and symptoms and a history of contact with mercury to diagnose mercury intoxication. As laboratory capability increased and reporting time was reduced, urine and blood mercury were used to verify a clinical diagnosis. The criteria established on June 16, 2000, by the Regional Hospital in Cajamarca (RHC) for mercury intoxication included a self-reported history of exposure to mercury, presence of signs or symptoms of mercury intoxication, and elevated levels of mercury in blood or urine. This information placed a patient in a diagnostic category of suspected, probable, or confirmed mercury intoxication. To be considered having mercury intoxication, a person had to be in San Juan, Choropampa, or Magdalena on or after the day of the spill. Suspected cases were signs and symptoms related to mercury poisoning after contact with inorganic mercury. Probable cases were itchy rash in addition to the other symptoms. Confirmed cases were positive urine or blood test for mercury in persons with probable cases.

Laboratory criteria used by RHC for mercury intoxication was a total mercury concentration greater than 15 ppb in a 24-hour urine sample. Their reference range for an unexposed population is < 20 ppb. RHC measured mercury in urine of 10 people in an unexposed area. All levels were less than 1.0 ppb. Blood mercury criteria used by RHC to determine mercury intoxication was a mercury level greater than 40 ppb.

7.4.1 Screening the Population for Exposure to Mercury

During June 13-21, Minera Yanacocha workers collected 24 hour urine samples from 730 adults and children living in Choropampa. The children attended school in the village, and the adults volunteered. The mean mercury level was 66 ± 27 ppb. A second sampling from June 22 through July 4 of 630 people showed a mean of 33 ± 19 ppb. The results of both sets of samples indicated a normal distribution of values. DIGESA collected urine samples

from 667 (unconfirmed) people in Choropampa during the first week in July. The results were not available.

7.4.2 Laboratory Analysis of Human Samples for Mercury

Blood and urine samples from the first group of patients treated for mercury intoxication were sent to the CICOTOX laboratory in Lima. Because results took 15-20 days, a CICOTOX laboratory was established at RHC using equipment donated by Minera Yanacocha to measure total mercury in human samples. The new laboratory at RHC was established and staffed by Dr. Rosalia Anaya Pajuelo and Dr. Edgar Valentin from the National University of San Marcos. They measure mercury with a Perkin Elmer Flow Injection Mercury System (FIMS 400). RHC began to report results on July 13. Routine results take 5 days, and an emergency result takes 3 hours.

The RHC laboratory established a limit of detection of 0.1 ppb total mercury in urine and 0.5 ppb total mercury in whole blood. The laboratory runs calibration standards (range 1.0 ppb to 100 ppb) and a quality-control sample with all sample runs. Samples that exceeded the highest calibration standard were diluted and re-analyzed. The FIMS 400 system has the capacity to analyze 160 urine or blood samples and can analyze mercury in breast milk, water, and food. The FIMS 400 system and related equipment were donated by Minera Yanacocha to the laboratory at RHC.

7.5 Medical Treatment

Physicians provided symptomatic treatment to the initial cases. Patients with contact dermatitis caused by mercury exposure were given corticosteroids and antihistamines. As more people sought treatment and laboratory results became available, the RHC staff consulted physicians (local and international) who had expertise treating people with mercury intoxication. With this information, the local health-care providers developed a protocol to treat patients on the basis of laboratory results and presence of signs and symptoms of mercury intoxication.

7.6 Public Health Messages

The messages directed to the public on the day of the spill warned them of the dangers of mercury and asked villagers to return the spilled mercury. The focus changed to health messages after several people became ill and sought medical care. Several approaches were used to convey messages to the public. Authorities gathered villagers in the town square to warn them about mercury; local health professionals delivered messages with a loudspeaker mounted on an ambulance; flyers were posted on buildings; town meetings were organized; and radio, television and newspaper covered the episode and carried press releases from Minera Yanacocha.

Despite these efforts, rumors developed about the health effects of mercury, especially the long-term health effects. Rumors also spread that the spilled mercury contained gold, silver, or uranium. People interviewed commented about a sense of fear in the community. They attributed strange occurrences to mercury; one incident involved the sudden deaths of domestic animals. There was even fear that the condition was infectious.

The physician at the Choropampa health outpost, Dr. Dani Arris Plata Cruis, provided health messages to her patients. She informed them of the symptoms of mercury intoxication and warned them not to touch or “manipulate” mercury.

7.7 Present and Future Risks

Present and future health risks derive from the potential for exposure or the probability for complications. The degree of exposure and the magnitude of the health effects can be measured by the number of houses with elevated levels of mercury vapor, the number of people who had elevated urine mercury levels, and the severity of symptoms by those who required hospitalization. In Choropampa, most of the houses were habitable; four houses contained levels of mercury vapor that prompted immediate evacuation of the residents, and the remaining houses were habitable but needed remediation. Monitoring indicated that 10-20 houses in San Juan and one house in Magdalena required mitigation. Most people had elevated levels of mercury in the urine but their symptoms were mild. A greater proportion of people seeking medical care for mercury intoxication were classified as non-cases, that is, their symptoms were not related to exposure to mercury. In the first 3 weeks after the spill, five of the 105 people seeking care did not have mercury intoxication. This changed over time with 19/47 in week 4, 18/29 in week five and 22/29 in week six.

Table 1. Houses with Mercury Vapor Action Levels in Choropampa

Interior level of mercury vapor (mg Hg/m ³)	Number of Houses	Action
> 0.003	21	Immediate evacuation of occupants. Clean-up of home.
0.001 – 0.003	20	Evacuation of occupants if exposure is expected to exceed 8 weeks. Clean-up of home.
0.0003 – 0.001	26	No evacuation is required. Clean-up required of identified point sources of mercury.
< 0.0003	143	No evacuation or clean-up required.
Not measured	59	Seeking permission to enter house and measure mercury vapor.
Total	269	

Table 2. Number of People Treated for Mercury Intoxication

Level of Care	Number of People Receiving Medical Care on July 23	Total People Treated between June 9 and July 23
Hospitalization		
Lima	1	1
Cajamarca Regional Hospital (RHC)	2	132
Ambulatory		
Cajamarca	56	99
Choropampa	16	235
San Juan	4	39
Magdalena	0	4

Ninety percent of the floors and ten percent of the walls and ceilings of the houses evaluated in Choropampa contained mercury. Personal effects in the houses had detectable mercury vapor in 40% of the contaminated houses. Based on the occurrence of mercury on most of indoor surfaces and household materials of those houses, mitigation workers determined that mercury may have been boiled in four houses.

The course of the exposure was short, and symptoms occurred within a few days. Because the exposure dose was for the most part low, symptoms were mild (headache, fatigue, myalgia, sleep disturbances), and most people were not hospitalized. Once exposed people are removed from exposure, minor symptoms of acute mercury intoxication are reversible.

A criteria for release of hospitalized patients has been developed. The patient must have a normal urine mercury (below 15 ug/L in a 24-hour urine sample) and be symptom free, and their residence must be certified as safe by DIGESA. This certification is based on three consecutive mercury air levels below 0.001 mg/m³. Physicians at RHC and the Choropampa health outpost were aware of this policy when questioned and could state the requirements for reoccupation of a residence.

The future risk for chronic health effects from the spilled mercury that contaminated homes is expected to be low because mitigation of roads and houses removed most of the spilled mercury in these areas. Of more concern is exposure from the unrecovered mercury. Villagers and mitigation workers believe people who have mercury are storing it outside the house, and that there is not much mercury in the villages. Some villagers commented that some of the mercury was sold to outsiders. These could become sources of future exposure. Chronic exposure may occur if mercury vapor escapes or the liquid metal leaks from containers storing mercury and goes undetected.

Local and national health officials do not expect any long term effects in exposed people because most of the acute exposures were of low to moderate dose. However, sequella from acute exposures should be examined in vulnerable groups such as women who are pregnant or want to become pregnant, women who are breastfeeding, and children. Also, the people who received chelation need to be examined and followed.

Physicians treating people with mercury intoxication noticed many stress-related complaints. They suspect adverse social and psychological effects resulting from the exposure and the mitigation.

7.8 Occupational Health and Safety for the Refinery and Mitigation Workers

Environmental sampling in the refinery consists of air sampling three to four times a day with a Jerome 431-X, which has a sensitivity of 0.03 mg/m³. Workplace standards are less than 0.05 mg/m³ for an 8-hour period. Work hours consist of four 12-hour work periods followed by 4 days off. In addition, workers wear mercury sensitive badges for one week. The Occupational and Safety Office plans to use personal air monitors in the future.

Minera Yanacocha established policies (July 18, 2000) regarding workers in their refinery and in homes to be remediated. Workers at the refinery undergo a pre-employment physical that evaluates respiratory, cardiovascular, abdominal, neurologic, and locomotive systems. This also includes hand-writing analysis for tremor detection; testing of hearing; vision; and flexibility; and blood and urine analyses. Mercury monitoring for the 22 men who work in the refinery and two workers engaged in refinery maintenance consists of a random urine

sample for mercury on the first and fourth days of their shift. Every 3 months, a 24-hour urine sample is collected and tested for mercury, creatinine, and protein, along with a sample of handwriting for fine tremor detection. The complete physical is repeated yearly, and at that time a blood sample is taken for mercury analysis.

The action level for refinery workers is a urine mercury value of 100 ppb. If a urine mercury is greater than 100 ppb, morning and afternoon urine samples are collected for the following 3 days. If all analyzed samples are greater than 100 ppb, the worker is moved to another area of the mine until his urine mercury falls below 50 ppb. Return to work in the refinery depends on the results of three consecutive urine samples taken over 3 weeks that are each below 50 ppb mercury.

Minera Yanacocha hired people to remediate homes and roadways contaminated by the mercury. According to "Safe Working Procedures for Mercury" workers must wear personal-protective equipment (PPE), in particular, respirators and skin protection (coveralls, gloves, boots). The CDC assessment team traveled to mitigation sites and observed that crews removing contaminated soil along the road wore respirators, eye protection, gloves, and safety shoes. During interviews with workers, they properly wore their PPE, knew their personal urine mercury level, and were vaguely familiar with the symptoms of mercury vapor exposure.

The mitigation workers are monitored for exposure to mercury vapor by mercury measurements in their urine. They submit urine samples on Monday and Friday (first and last day of shift). To reduce the potential for inadvertent contamination, urine is collected at the beginning of the day. Physical exams of these workers was not described; however, medical evaluation and consultation is part of the described medical surveillance. A blood mercury concentration over 15 ppb is considered an action level, and the employee's job activities are changed to reduce his exposure to mercury. He will return to his original job after his blood mercury level drops below 15 ppb.

7.9 Assessment

The CDC assessment team recommended that preventing any present or future exposure should have the highest priority. Efforts should be made to recover mercury, remove contaminated materials from the roads and homes, and identify other areas that may have mercury. People treated for mercury intoxication should not be allowed to return to a house with elevated mercury. In addition, steps should be taken to identify and prevent complications from mercury poisoning especially in vulnerable populations such as women of reproductive age, children of women exposed while pregnant, and patients who underwent chelation. Surveys should be conducted to determine the extent of the exposure and a registry of exposed people should be created and maintained.

A diagnosis of mercury poisoning should be considered as a sentinel event and initiate an intensive investigation to discover the source of the poisoning, other people who are poisoned, and to guide control activities. The laboratory established at the RHC and other laboratories involved in Lima should be enrolled in an international proficiency program. The local community should receive risk awareness and education programs on the hazards of mercury. Specifically, people should know the short-term and long-term health risks associated with exposure to mercury. The medical staff at RHC and at the village health outposts should also receive health education on this subject and treatment protocols.

Although the probability for developing chronic effects from this mercury exposure is low, assessment and surveillance should be conducted to look for signs of adverse health effects.

8.0 Conclusions

8.1 Commentary

The Independent Commission does not believe there was one single cause for the mercury spill on June 2, 2000, rather that there were a number of direct and underlying contributing factors that cumulatively created the conditions that allowed the incident to occur.

8.1.1 Direct Causes

The truck driver was reported as being sick and was presumed by a MYSRL supervisor and mine doctor unable to carry out his normal duties to the best of his ability while the truck was being loaded. Although he delayed his journey until the next day he remained ill.

The driver was alone, although informal practice of RANSA was that there should always be a second driver.

MYSRL had informal procedures for some parts of the process of loading mercury onto trucks. However, they were not consistently applied. In this incident the special pallet developed for the mercury flasks was not used. The empty chlorine gas cylinders were not properly secured. A truck and open flat bed truck was used instead of a closed trailer. It is also possible the flask involved in the incident was not properly sealed.

For other parts of the process MYSRL has no procedures. In this incident the truck was not loaded appropriately, with the heavy mercury flasks placed at the rear of the trailer. Hazardous materials were combined (mercury, chlorine) in one shipment.

The route from the mine site to the Pan American highway along the coast of Peru is a series of steep gradients, and switchbacks with rough sections of road and potholes, passing through the center of a number of towns and villages.

8.1.2 Underlying Causes

At the time of the incident the transportation of mercury from the mine property was not specifically addressed by MYSRL. In other words, the hazardous nature of mercury was well recognized in the refinery, but it was not provided with appropriate care once it left the refinery.

MYSRL did not adopt regulations for the transportation of hazardous materials from other jurisdictions in the absence of local regulations.

There are no relevant Peruvian regulations regarding the transportation of mercury or other hazardous materials, other than for explosives.

The Environment Directorate, part of the Ministry of Energy and Mines, and the body responsible within the Peruvian government for assessing environmental impact and health

safety of mines does not have sufficient technical and operational capacity to deal with the extent of its responsibilities. This was compounded by the lack of a strong, direct presence in Cajamarca.

Under the present system of decentralization and administrative arrangements operating in Peru, provincial and municipal authorities have little authority and little capacity in the fields of environmental management, and particularly, as indicated by this incident, as it relates to mining and transportation and sectors.

Mercury flasks shipped from the mine site were not labeled to indicate the contents and their hazardous nature. The chlorine cylinders were not accompanied by MSDS (Material Safety Data Sheets) information.

Newmont Mining Corporation, as the major shareholder and parent of the manager of the mine, did not apply global standards to the handling and transport of hazardous materials at MYSRL.

The contract with RANSA provided little safeguard for spill prevention or response in the absence of pertinent legislation in Peru. This is stressed, as RANSA is contractually required by MYSRL to have all required hazardous materials licenses, permits and training, and the necessary supplies in the event of a hazardous materials spill. This situation that could have been identified through audits designed to confirm the capacity of the trucking company to respond to MYSRL's requirements in hazardous materials handling, including spill response.

MYSRL did not appear to have a comprehensive procedure in place to identify and record potential environmental hazards. If this had been the case other incidents related to the shipment of mercury may have reasonably led the company to review its procedures for handling and shipping mercury. These included: reported discrepancies between amounts shipped and amounts received in Lima, the unloading of a pallet of mercury not considered by the yard supervisor as safe a few weeks earlier, and the doubling in volume of mercury shipped from the mine during the past two years.

MYSRL did not appear to have the capacity to apply good practices related to the transportation of other hazardous materials to mercury. In 1999 MYSRL developed a comprehensive procedure for the transportation of cyanide to the mine site. The procedure takes into account various potential risks along the transportation route. This approach was not applied to other hazardous materials including mercury and chlorine.

MYSRL, in its choice of mercury flasks, did not apply its own procedures to identify and control risks to health and safety associated with changes that occur in installations, equipment, materials and operating processes in workplaces. In 1996, the use of approved 34.5 kg capacity mercury flasks and their associated containers was changed in favor of larger flasks with a capacity of approximately 200 kg. A technical (environmental and engineering) assessment was not completed on these larger flasks.

MYSRL's common practice of transporting empty chlorine cylinders (which would be expected to contain residual levels of chlorine) with flasks of mercury is not appropriate.

Numerous monitoring and audit systems failed to identify the lack of control or procedures for handling and transport of hazardous materials.

8.2 Commentary on the Initial Response

These underlying causes, as well as some elements of initial response to the mercury spill indicate MYSRL has, during an extended period of time, had major environmental management failures that have contributed, in a substantive way, to the mercury spill incident.

Initial response to the spill was slow. Factors contributing to this situation include:

- ❑ MYSRL had no emergency response plan applying to mercury spills off their property.
- ❑ The environmental and human health hazards of inorganic mercury were underestimated.
- ❑ The amount of mercury spilled was underestimated and under reported by MYSRL

MYSRL did not provide adequate, nor timely, information on the incident to the public affected, to local authorities in the directly affected communities, the provincial authorities in Cajamarca, and national authorities in Lima.

Ransa did not adequately inform the responsible agencies of the spill. RANSA did participate with local medical authorities in immediate warnings by loud speaker to warn the general public of the hazards of mercury.

There was confusion between MYSRL and RANSA regarding assumption of responsibility for response to the incident. Once mercury intoxication of local people was confirmed, MYSRL did assume lead responsibility for the emergency response and subsequent clean up efforts.

Responsibility was originally given to RANSA to make announcements and recover mercury. RANSA did little else.

8.3 Commentary on the Response once a Health Emergency was Recognized

MYSRL ultimately took control of the emergency response to the spill of mercury that included delineation of the extent of contamination, house and road remediation, environmental monitoring, development of a compensation plan and participation in diagnosis and treatment of the affected population.

The monitoring measures and clean-up efforts now in place appear appropriate. Given the extensive and complex nature of the various ongoing programs it will require continued diligence on the part of MYSRL and its staff to ensure that all details are given proper attention.

It is recognized that although clean-up efforts are well underway, due to the magnitude of the problem, it will likely be several more months before the roads and houses will be fully remediated. Thus, the social fabric and way of life for many villagers will continue to be disrupted for some time.

The period of acute exposure to the spilled mercury is now over, and with increased public awareness of the potential hazards associated with the substance, further direct exposure

should be minimized. However, given that an amount of mercury cannot be accounted for, continued monitoring of the environment and population will be required for some time.

MYSRL will continue to be a major employer and industrial activity in the Cajamarca district. It is essential that the company gains the confidence and trust of the local community including both the general public and government and health agencies.

In light of the above, it is expected that the impacts of the spill will be felt by the local communities long after the initial symptoms of mercury poisoning have passed.

8.4 Recommendations

The Independent Commission has made recommendations to provide a basis upon which MYSRL can manage its handling, transportation and sale of materials including elemental mercury, and to report on their performance in these areas. Throughout its investigation, the IC has repeatedly heard from government authorities their willingness to improve the institutional and legal framework related to the handling and transport of hazardous materials.

8.4.1 Recommendations to Minera Yanacocha SRL:

1. Review existing, develop and implement, new policies and procedures for the handling and transportation of all hazardous materials, to and from the mine and on and off the site, including but not limited to cyanide, chlorine gas and mercury.
2. Develop and follow an Emergency Response Plan (EPR) that deals with the transportation of hazardous materials, and spills and transportation incidents/accidents, to and from the mine sites, and on- and off-site, and in incident/accident locations that are distant from the mine site. Test the EPR using simulations of emergencies across a range of on- and off-site emergency scenarios.
3. Provide additional formal training to MYSRL employees, contractors and subcontractors working on or off-site, as their job responsibilities require, including: i) hazardous materials training including labeling and procedures for the transport of these materials, ii) the loading of highway transport trailers, iii) the Emergency Response Plan, iv) environmental compliance and environmental best management audit processes and procedures, and v) the review and assessment of environmental audit reports and requirements for follow-up
4. Confirm through the use of scheduled formal audits (preferably performed annually), that MYSRL and its contractors, subcontractors and agents have the capacity to fully comply with MYSRL and its shareholders policies, procedures and plans for hazardous materials (items 1, 2 and 3 above). Audits should include as part of the audit team, internationally qualified, third party specialists and the participation of MYSRL's Community Relations and Social Development teams.

In addition, MYSRL, its shareholders and contractors and other relevant authorities establish a mechanism for communication and information to address the issues revealed through the response to the incident, and augment the mine's policies and practices in community relations and establish a protocol for integrated monitoring and evaluation.

5. MYSRL should develop a long-term strategy to recover community confidence based upon due consideration of the impacts of the company on the Cajamarca region.
6. Complete the reconciliation of mercury shipments between mine departure and the mercury buyer destination for the period 1994 to present and address any issues that emerge.
7. Ensure there is an informed community participation of the three impacted communities in the mercury spill remediation process and in particular in relation to:
 - Ongoing monitoring of the health status of the communities
 - Environmental monitoring and remediation
 - Impact of community development measures
 - Evaluation of any compensation measures agreed upon.
8. Withdraw from service all of the 200 kg capacity mercury flasks unless they are verified as acceptable for use by engineering specialists. This recommendation should be considered by any firm or agency using this type of container for the transport of mercury or other hazardous materials.
9. MYSRL should verify that there are no other activities at the mine where the absence of local regulations may have led to procedures or practices of environmental management that are not in line with best practices at the international level.
10. An Environmental Management Audit of MYSRL should be conducted to assess the capacity of each department and of the company as a whole, to prevent and mitigate the impacts on the environment both on and off the mine site. In the remediation efforts, all monitoring procedures, data, and interpretation should be subject to thorough independent review.
11. The environmental monitoring program initiated by MYSRL should be continued until it can be demonstrated that components of the program are no longer required due to absence of mercury or very low risk to the environment and public.

8.4.2 *Recommendation to MYSRL, IFC and Newmont Mining Corporation:*

1. Coordinate the review and audit processes used by the International Finance Corporation and Newmont Mining Corporation to assess the environmental performance of MYSRL and its contractors, subcontractors and agents.

2. The shareholders of MYSRL and regulatory agencies should ensure that all monitoring procedures, data, results and interpretation are subject to thorough review.
3. The monitoring of human health and human mercury levels should be continued until such time that MYSRL can demonstrate that exposure to mercury and associated health effects no longer pose a risk to the population.

8.4.3 Recommendation to Newmont Mining Corporation:

1. Newmont should, in accordance with industry best practice, apply a global standard to all its managed operations worldwide, related to environmental and social impacts, and ensure compliance with that standard.

8.4.4 Recommendations to the International Finance Corporation (IFC):

1. Review and revise the IFC guidelines on the transportation of hazardous materials.
2. Review supervision and monitoring procedures to further strengthen IFC staff in reviews of projects.

8.4.5 Additional Recommendations on health

The Independent Commission recognizes that the health authorities have been able to put in place commendable protocols, procedures and resources for an effective post-emergency response. However, the Commission would like to emphasize certain key areas with the following recommendations based on the technical advice contained in this report.

1. Preventing any further exposure should be the main concern. This means that a priority is placed on efforts to recover mercury, mitigate the roads and homes that are contaminated, and identify other areas that may be contaminated. Homes, in particular, of those of people with high mercury levels in blood and urine, should be monitored for mercury vapor to ensure that return to homes with acceptable levels of mercury vapor.
2. Identify and prevent complications from mercury poisoning. Given that most people suffered from an acute, low to moderate mercury poisoning, vulnerable populations should be monitored, in particular, women of reproductive age, children of women exposed while pregnant, and patients who underwent chelation. As the chelation procedures used were very aggressive the Independent Commission recommends that the chelation be evaluated.
3. Continue to test the urine of the potentially exposed populations, that is to say the populations of San Juan, Choropampa and Magdalena. To this end and for future monitoring, a register of people exposed should be maintained.

4. Diagnosis of mercury poisoning should be considered as a sentinel event, meaning that an intensive follow-up investigation should take place in each case to discover the source of the poisoning, other people who are poisoned, and to guide control measures.
5. The laboratory established at the Regional Hospital of Cajamarca and other laboratories involved in Lima should be enrolled in an international proficiency program.
6. The local community should receive awareness, risk, and education programs. Specifically, the communities should be aware of the short term and long term health risks associated with exposure to mercury.
7. Specialized health education should be provided to the professional staff of the health posts in the impacted communities and at the Regional Hospital.
8. Authorities and MYSRL should not assume that there are no chronic effects from mercury exposure. Given the nature of the first exposures, there is a low risk of chronic effect; however, monitoring and evaluation efforts should be geared to looking for signs of chronic impact. These could include neurological and psychological testing in 12 –24 months of those exposed with high levels of mercury.

END NOTES

N:\cao-ADVISOR\Latin America and The Caribbean\Yanacocha\Independent Commission\report\Independent Commission Report (9-28-00).doc
09/28/00 11:23 AM

- ¹ (i) Environmental and Natural Resources Code (D. L No. 613); (ii) Ley de fiscalizacion a traves de Terceros (D.L No. 25763); (iii) Reglamentation for environmental protection in the mining and metallurgic activities (D.S. No. 01693); (iv) Reglamentation on Mining Health and Safety (D.S. No. 023-92); (v) Law on the National Environmental Authority (L No. 26410).
- ² Information provided by Minera Yanacocha and the Peruvian Society of Environmental Law.
- ³ CONAM (Consejo Naconal del Ambiente), 1999, **Marco Estructural de Gestion Ambiental**, pp, 22-23, Lima: CONAM.
- ⁴ D'Itri and D'Itri 1977
- ⁵ There is an illegal market for mercury, in particular in the Amazon Basin.
- ⁶ ISO, 1996. [ISO International Organization for Standardization. 1996. *Environmental management systems – Specification with guidance for use.* September 1.]