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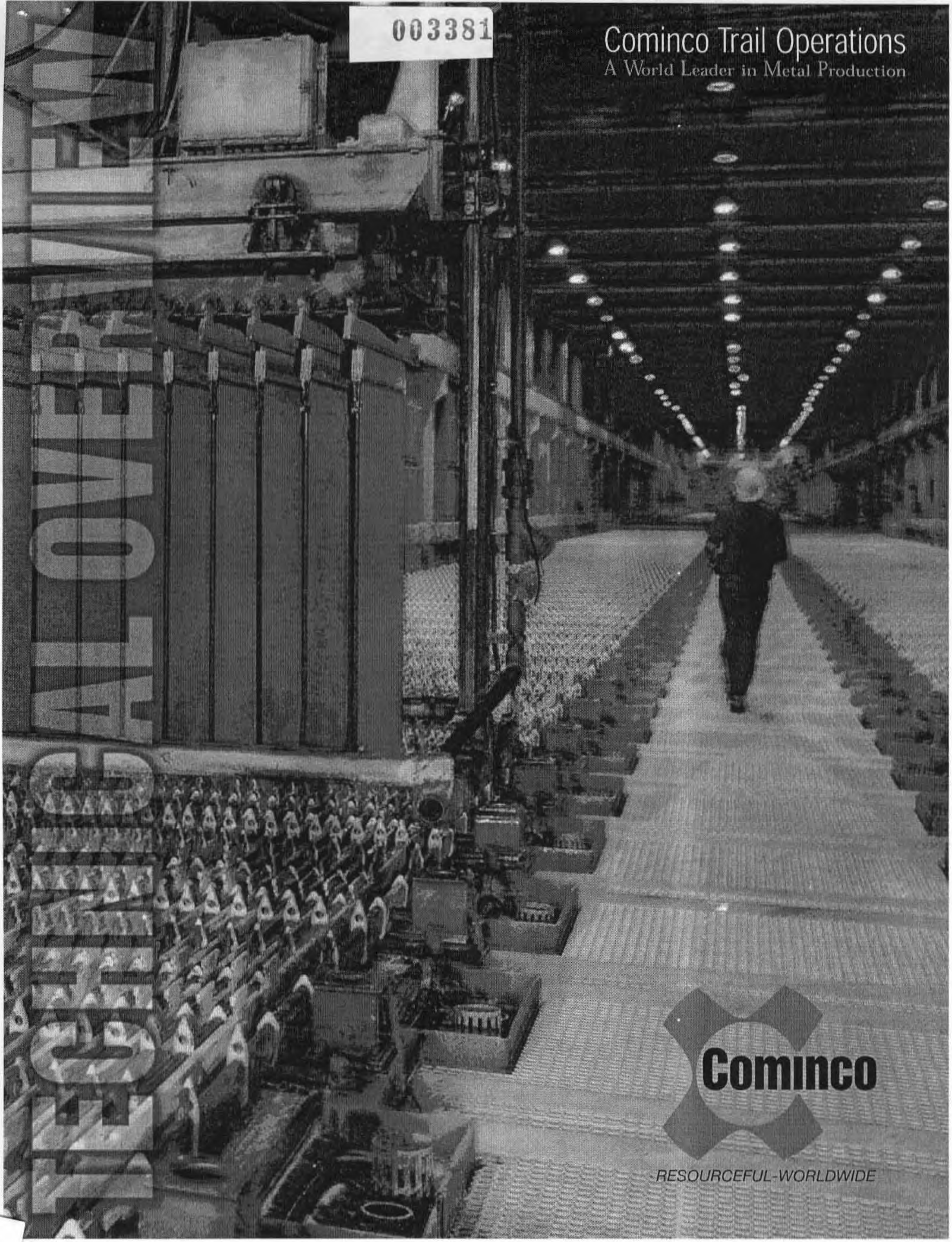
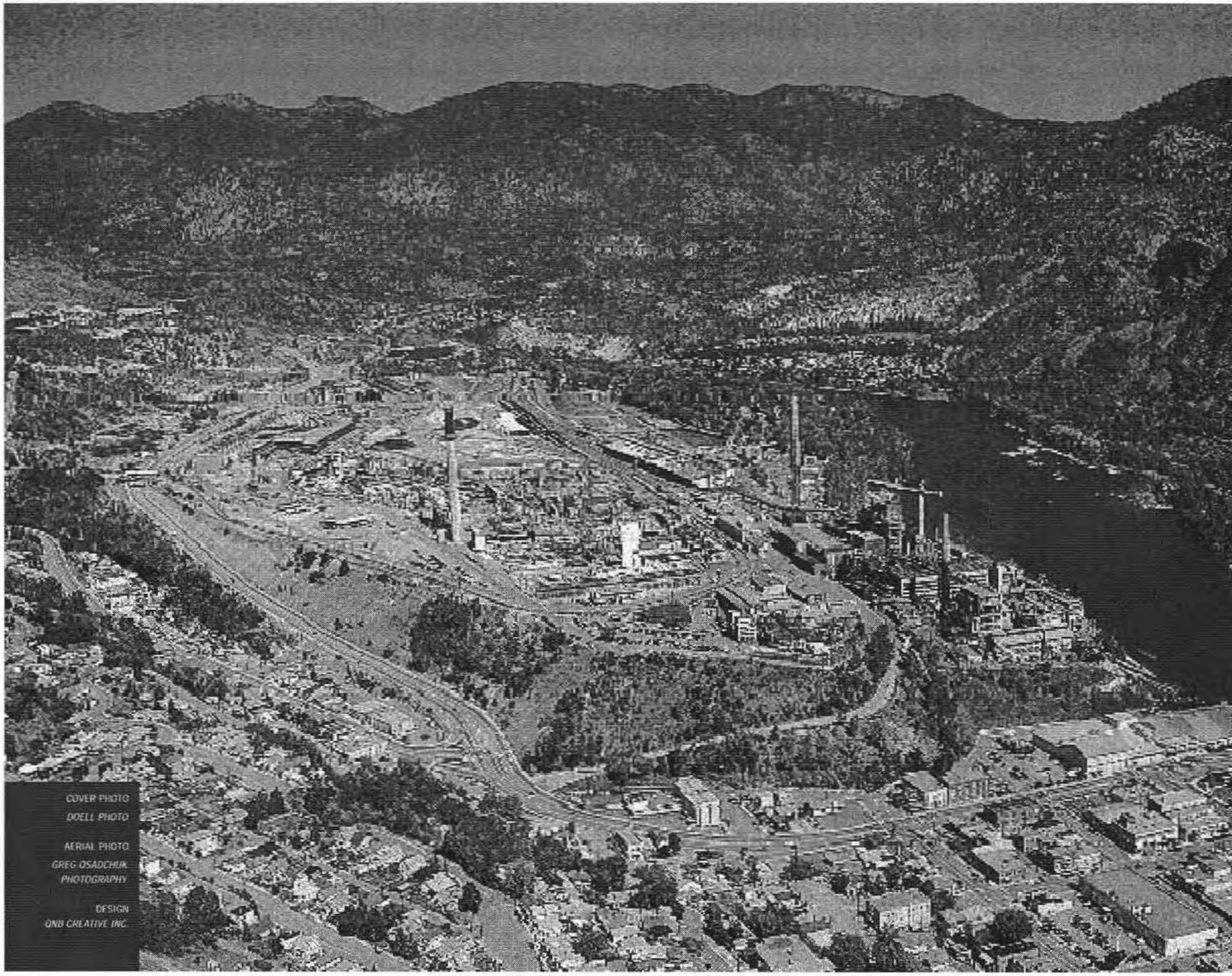
Cominco Trail Operations

A World Leader in Metal Production





COVER PHOTO
DOELL PHOTO

AERIAL PHOTO
GREG OSADCHUK PHOTOGRAPHY

DESIGN
QNB CREATIVE INC.

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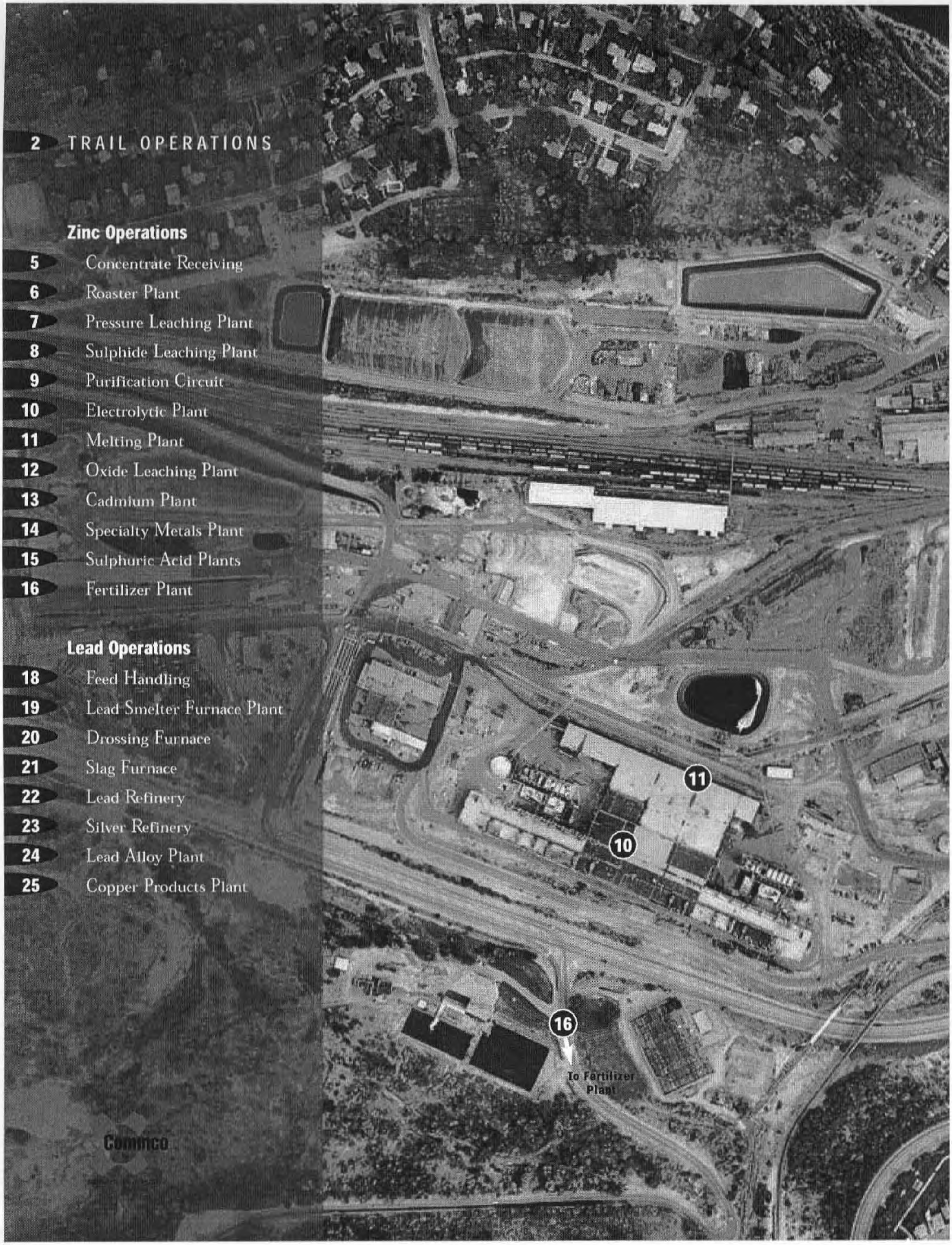
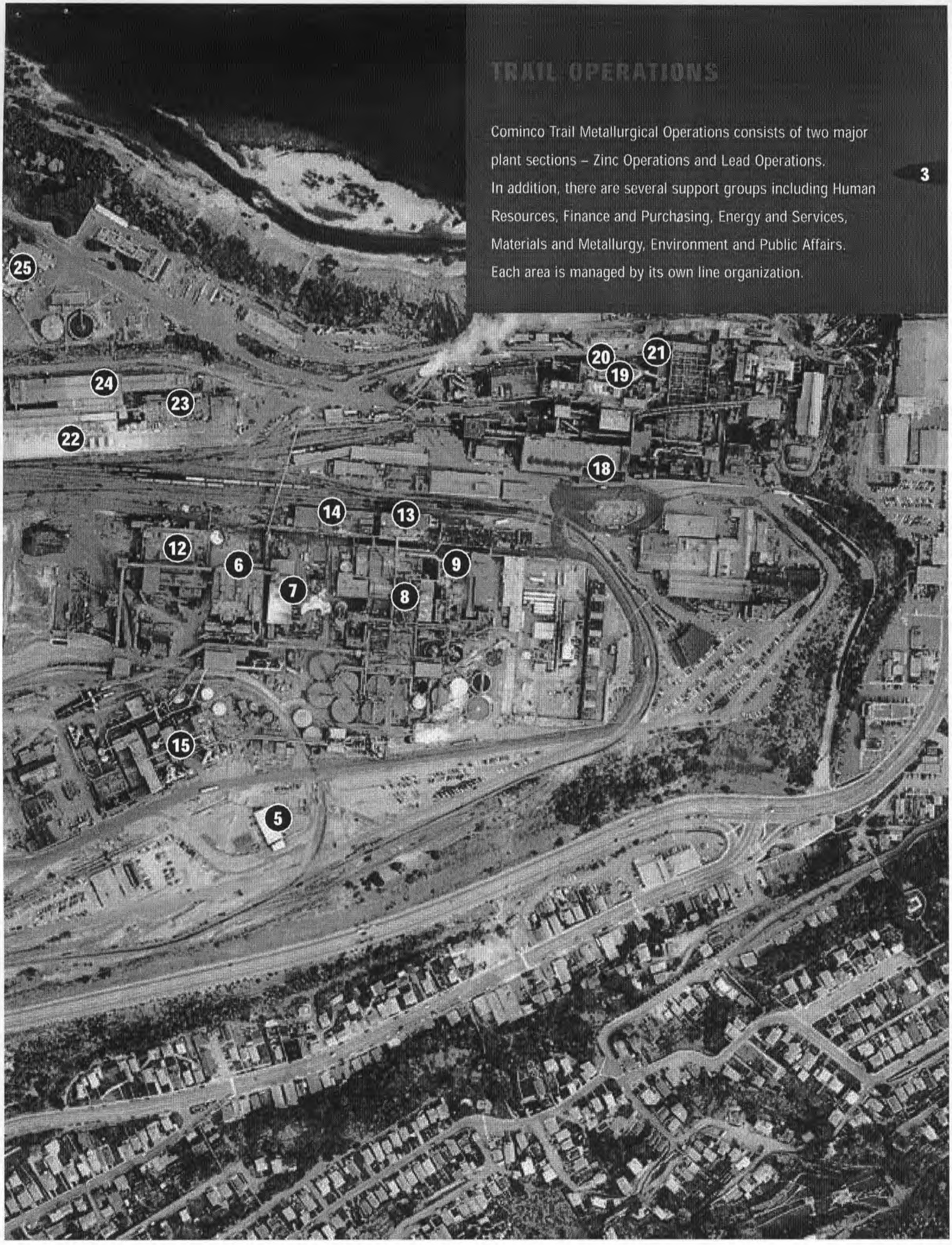


TRAIL OPERATIONS

Cominco Trail Metallurgical Operations consists of two major plant sections – Zinc Operations and Lead Operations. In addition, there are several support groups including Human Resources, Finance and Purchasing, Energy and Services, Materials and Metallurgy, Environment and Public Affairs. Each area is managed by its own line organization.



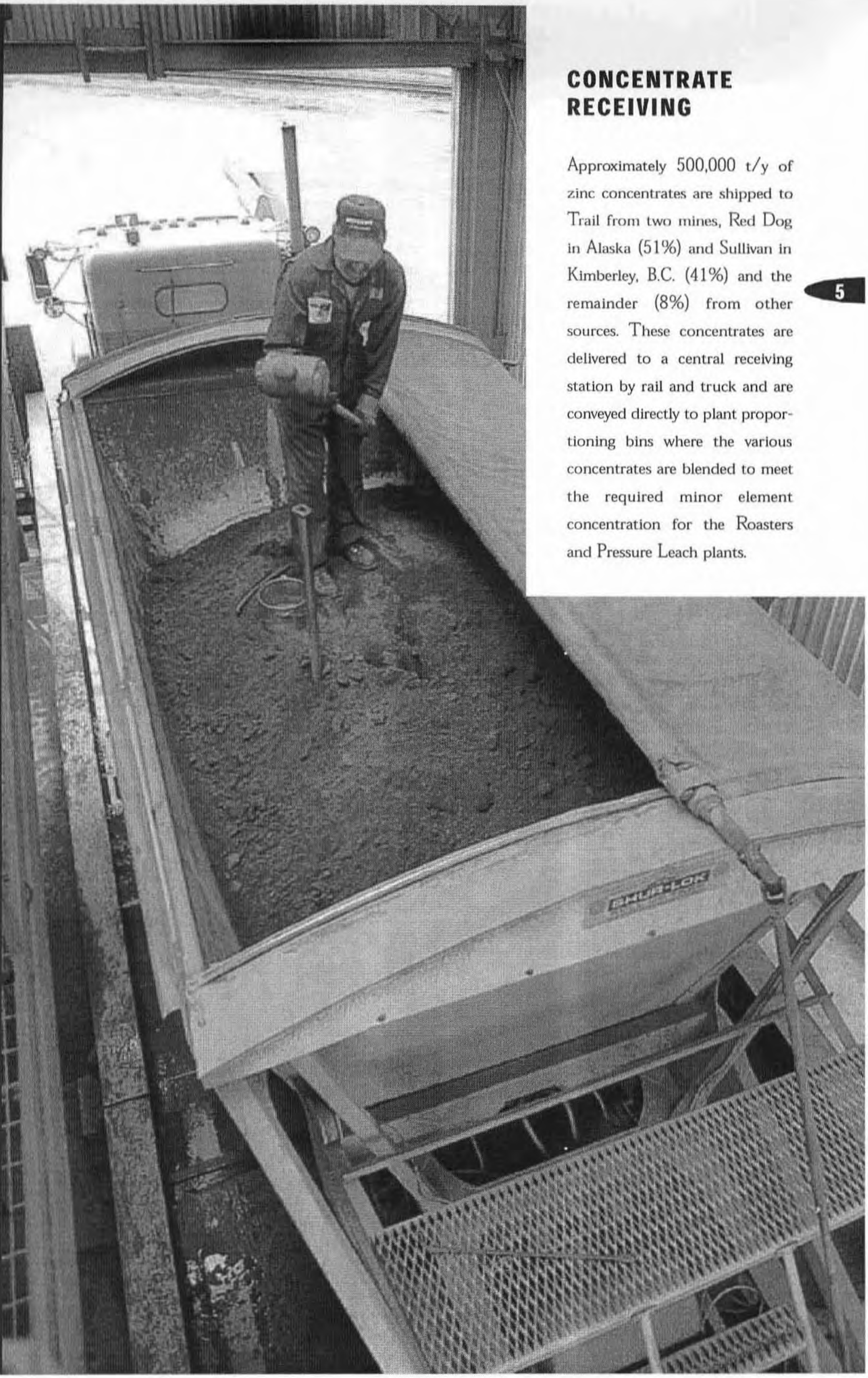
ZINC OPERATIONS

Six major metallurgical plants, one fertilizer plant and two specialty metal plants are included in Zinc Operations. This organization is managed by a manager and each plant area is supervised by a plant superintendent. All maintenance support and technical support personnel report to the plant superintendent.

GREG OSADCHUK PHOTOGRAPHY

CONCENTRATE RECEIVING

Approximately 500,000 t/y of zinc concentrates are shipped to Trail from two mines, Red Dog in Alaska (51%) and Sullivan in Kimberley, B.C. (41%) and the remainder (8%) from other sources. These concentrates are delivered to a central receiving station by rail and truck and are conveyed directly to plant proportioning bins where the various concentrates are blended to meet the required minor element concentration for the Roasters and Pressure Leach plants.



Every truckload of Red Dog Zinc concentrate arriving at Trail Operations is sampled at the Concentrate Receiving Station.

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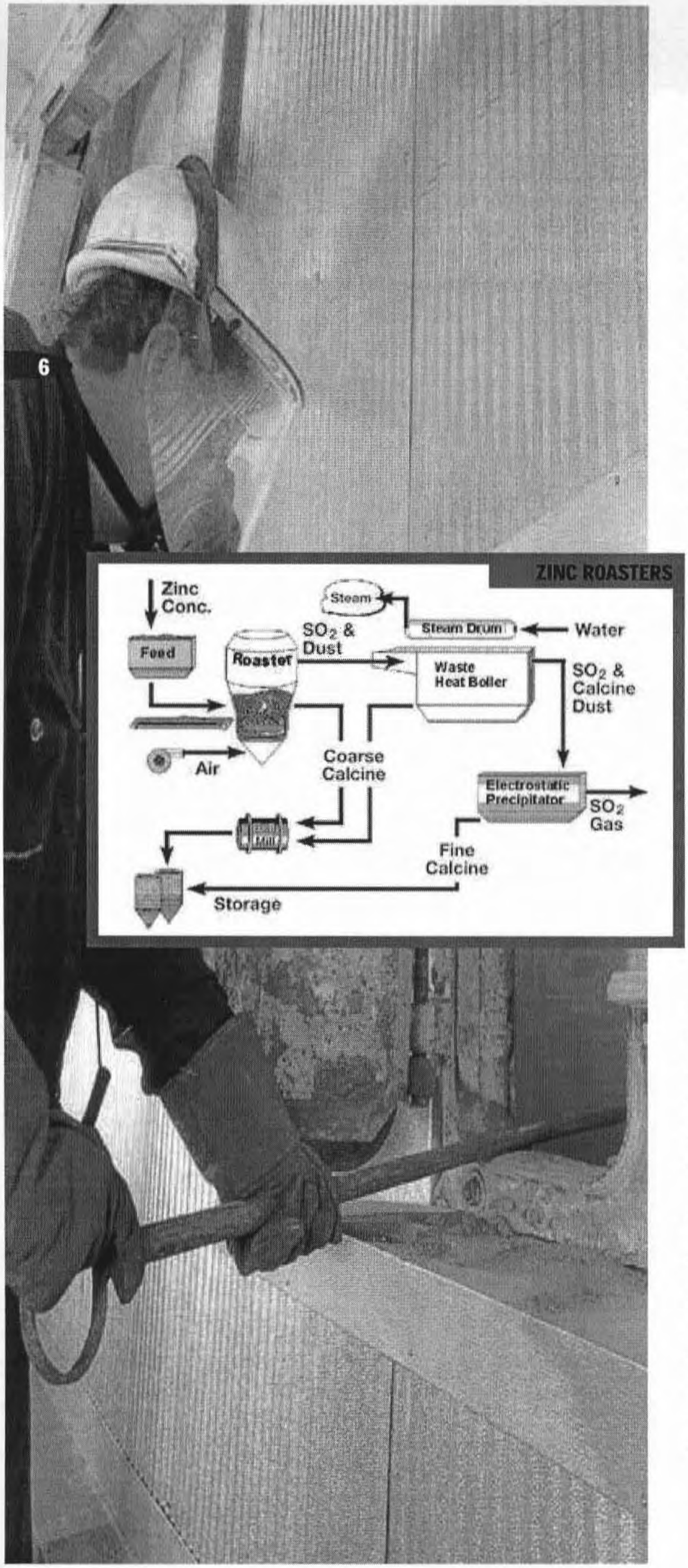


ROASTER PLANT

Two Lurgi Fluo-solid roasters and one suspension roaster treat 77% of the zinc concentrates and the remaining 23% are treated by the Pressure Leach Plant. Zinc calcine (ZnO), produced by burning the sulphide concentrates with air and direct oxygen addition, is the soluble zinc form which is the primary feed for the Leaching Plant. After discharging from the roasters, calcine is cooled, passed through a ball mill, and collected in cyclones and electrostatic precipitators before being pneumatically transported to two 3000-t silos located adjacent to the Leaching Plant.

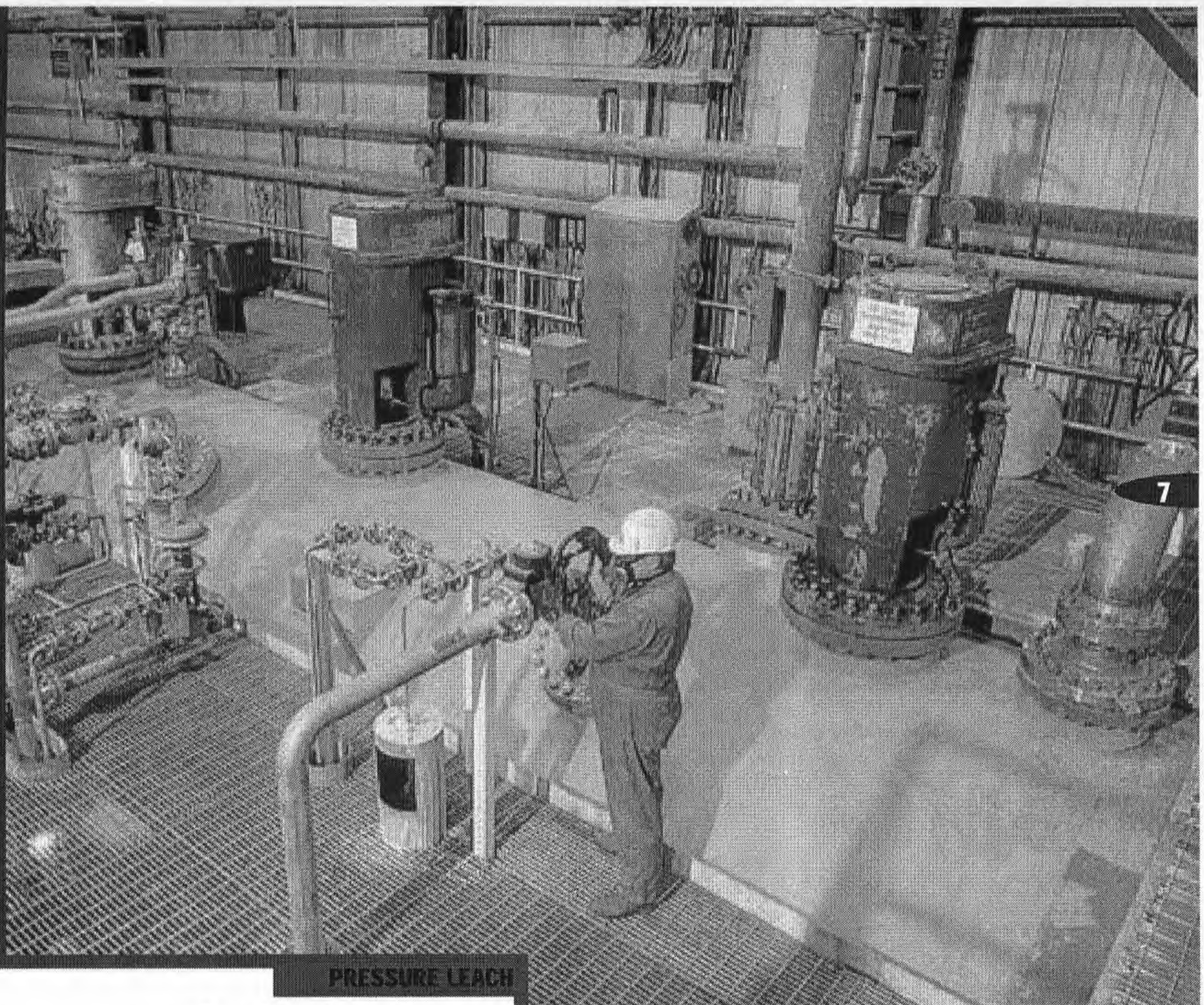
The process gas discharging from the roasters, at 930 C and containing 8% SO_2 gas, passes through heat recovery boilers which generate 600 psi steam for process heating in other plants. Following the boilers, this gas is subjected to several cleaning and cooling steps and a mercury removal unit en route to the sulphuric acid plants.

To ensure maximum extraction efficiency of zinc, consistent production rates, and consistent environmental control, the entire plant is controlled by primary and secondary computer control system, located in a central control room.

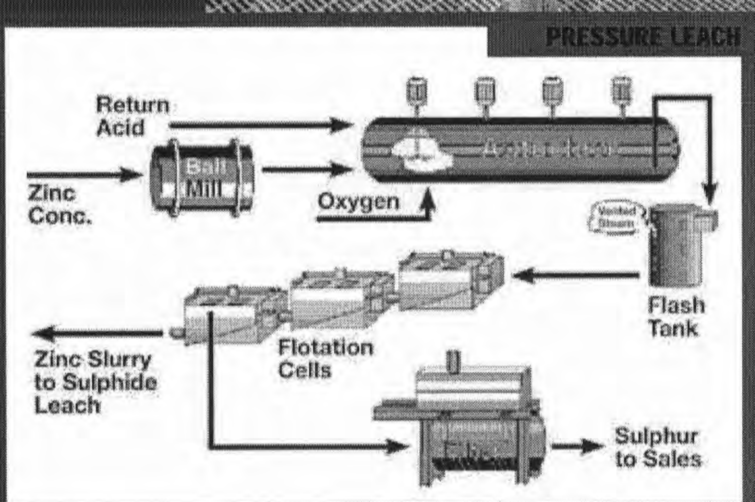
Zinc concentrate is converted to zinc calcine by burning the concentrate in fluid bed roasters.

DOELL PHOTO

DOELL PHOTO



This is the top of the Pressure Leach autoclave, with a view of the agitator motors, where zinc concentrate is dissolved to form zinc electrolyte.



PRESSURE LEACHING PLANT

In 1981, the Pressure Leaching Plant at Trail became the first commercial application of direct leaching of zinc concentrates in the world. A second autoclave with 20% higher capacity was placed in service, to replace the original unit which will remain out of service for renovations. This plant has the capacity to treat 25% of the total zinc concentrate input.

Reground zinc concentrates are pumped into the autoclave with cell house acid and oxygen. The autoclave contents are mixed by five 100-hp agitators and conditions are controlled at 150 C and 1400kPa. Elemental sulphur is separated from the plumbo-jarosite leach residue in a series of flotation cells. After remelting and hot filtration, the elemental sulphur is shipped to markets in rail tank cars. The slurry of zinc sulphate solution and leach residues is pumped to the Sulphide Leaching Plant for further processing.

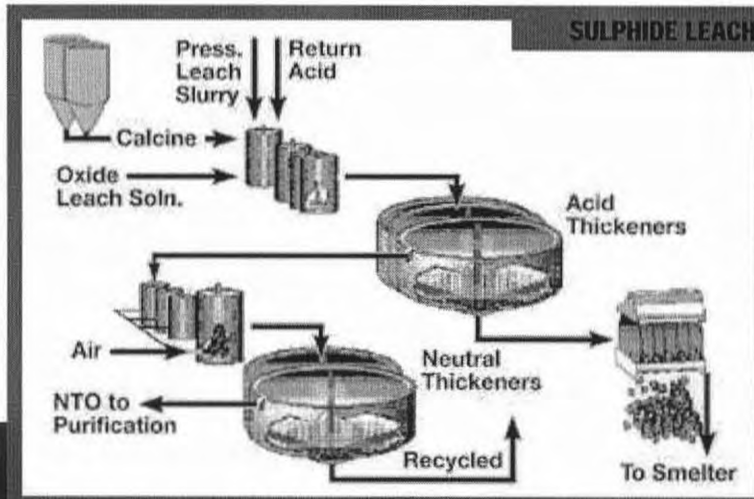
SULPHIDE LEACHING PLANT

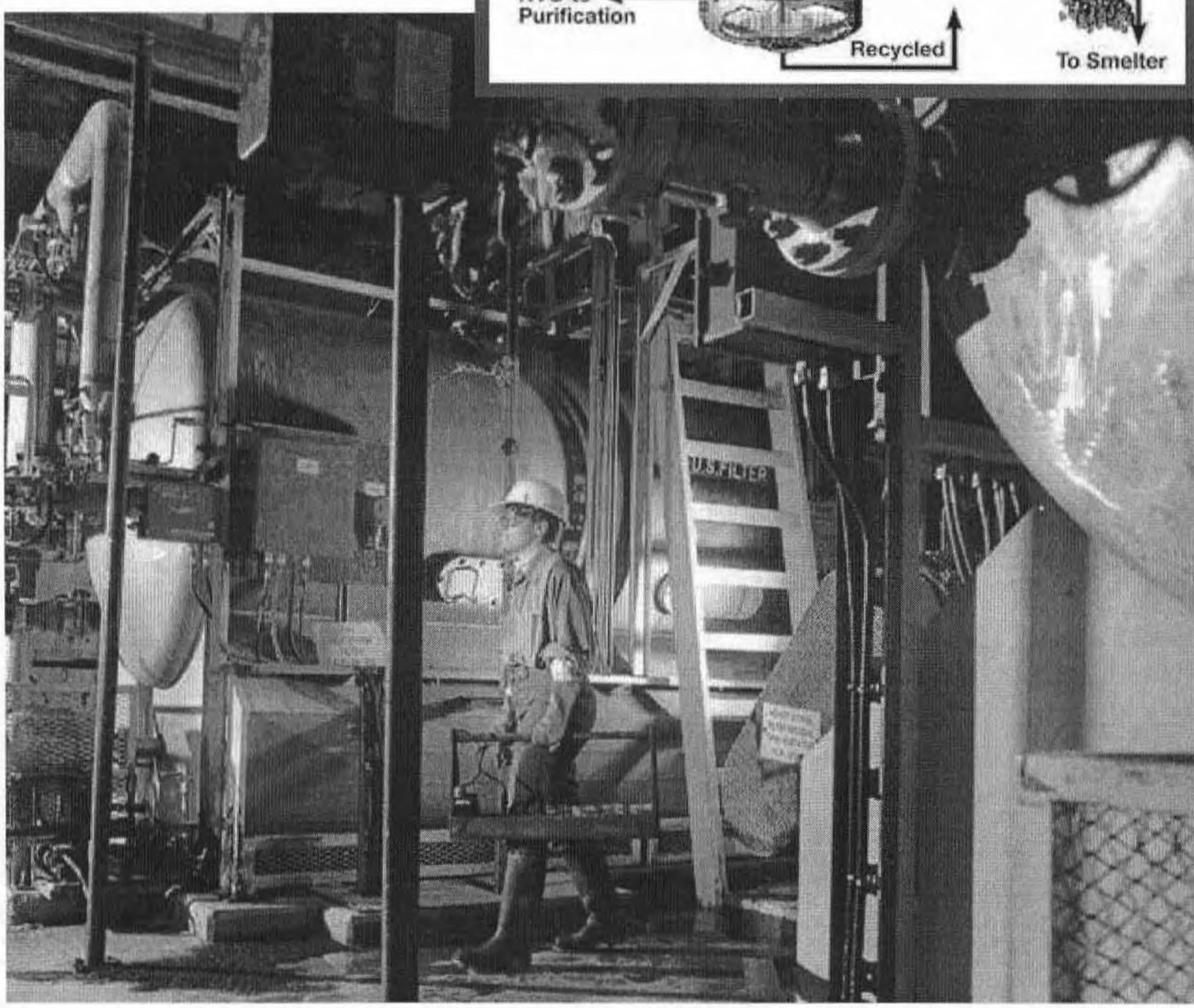
This plant leaches the zinc from 1300 t/d of Roaster zinc calcine and purifies the combined solutions from this plant and the Oxide and Pressure Leach plants.

Zinc calcine, leach solutions and cell house acid are mixed in 11 agitated tanks which are controlled to varied pH, from 1.7 to 3.5, by additions of cell house acid or calcine. Continuous pH monitoring is facilitated by submerged pH cells in controlled tanks.

After leaching, the acid leach slurry is distributed to four 24-m thickeners where the leach residues are separated from the clear zinc sulphate solution. The residues are filtered and washed before being pumped to the Lead Smelter for further processing to recover zinc and other metals. These recovered metals are recycled as a fume to the zinc circuit through the Oxide Leach Plant.

Clear zinc sulphate solution flows continuously from the thickeners to the zinc dust purification circuit. Solution flow rate from this circuit is approximately 450 m/h.





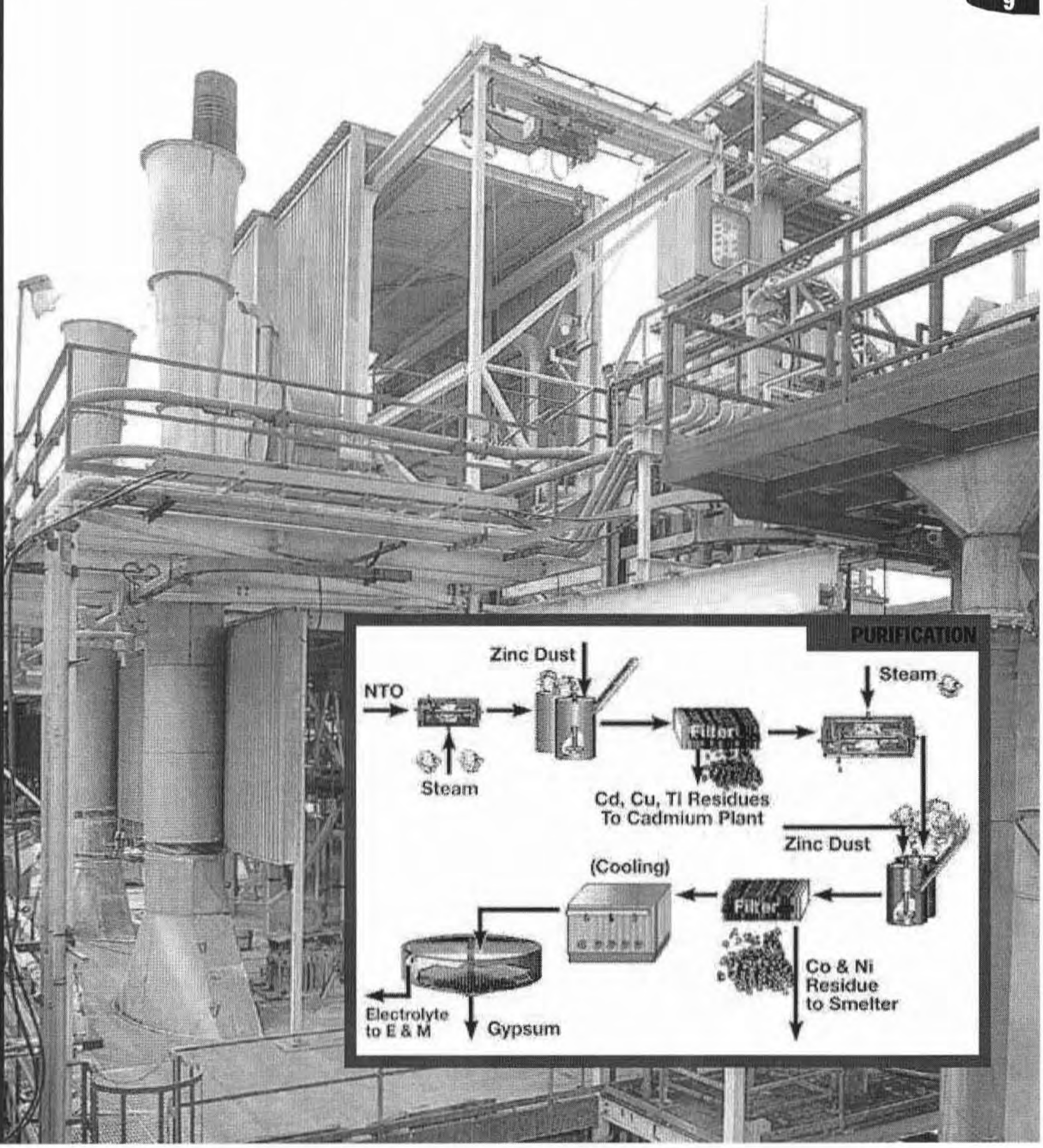
An operator prepares to take a sample from the hot stage filter, which removes residues containing impurities from zinc electrolyte.

RAEFF MILES

PURIFICATION CIRCUIT

Trace impurities of cadmium, cobalt, copper, thallium, and antimony are removed from the solution by adding slurried zinc dust through three stages of purification. The first stage is at normal solution temperature (60 C) to remove copper and cadmium; the second stage is heated to 78 C to remove cobalt; the third stage is a polish stage for removing any residual of the listed impurities. All the solution is filtered between each stage through manual plate and frame filters on the first and third stages and automated pressure filters on the second stage.

Hot solution is cooled in three forced-draft atmospheric cooling towers to precipitate gypsum which is then removed by settling in a 24-m clarifier. The clear purified zinc solution is then pumped to the Electrolytic Plant.

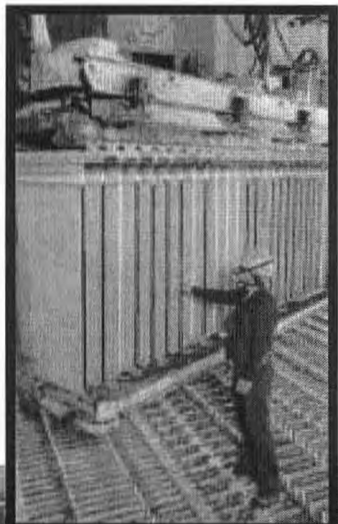


This is an external view of the Purification Circuit in which impurities are removed from zinc electrolyte.

DOELL PHOTO

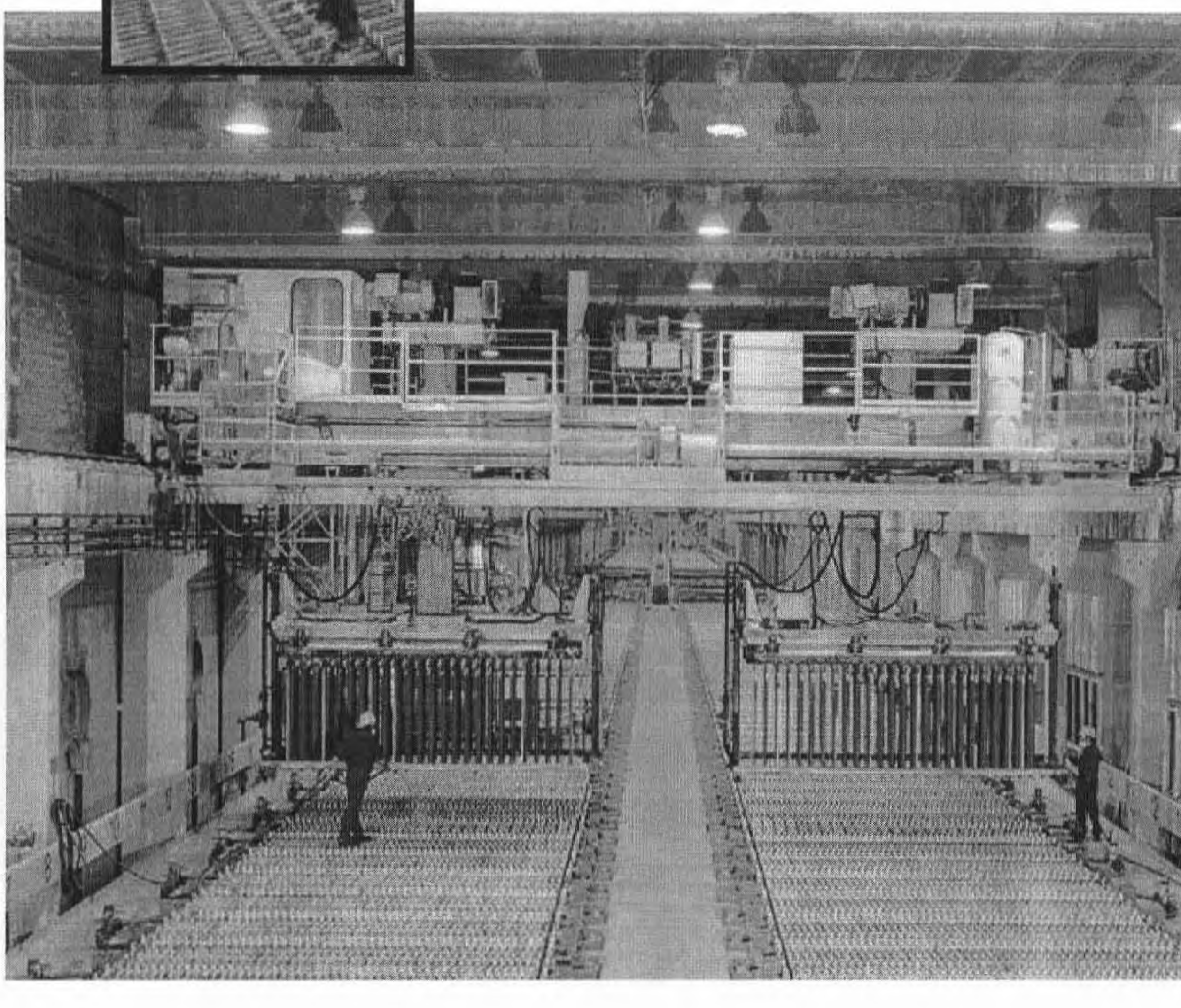
ELECTROLYTIC PLANT

Electrodeposition of zinc is carried out in a 290,000-t/y cell house built in 1983. This cell house contains 548 cells arranged in two sections of 132 cells and two sections of 142 cells, with each section powered by a rectifier with a capacity of 67,000 amps at 450 volts. Four mechanized cathode handling and stripping units strip the 3 m^2 cathodes on a three-day cycle. Four cranes deliver 9000 cathodes and 625 anodes every day to the stripping and cleaning machines.



Electrolyte in the cells is cooled to 35 C by recirculating the solution through 18 forced draft cooling towers. Ambient conditions within the cell house are controlled, to meet regulatory acid mist standards, by maintaining a foam blanket on the surface of the cells and by a ventilation system that moves 1.3 million m^3 of heated air every hour through the cell house building.

Stripped zinc sheets are automatically stacked and conveyed to fork lift stations for delivery to the melting furnaces in the Melting Plant, located inside the same building.

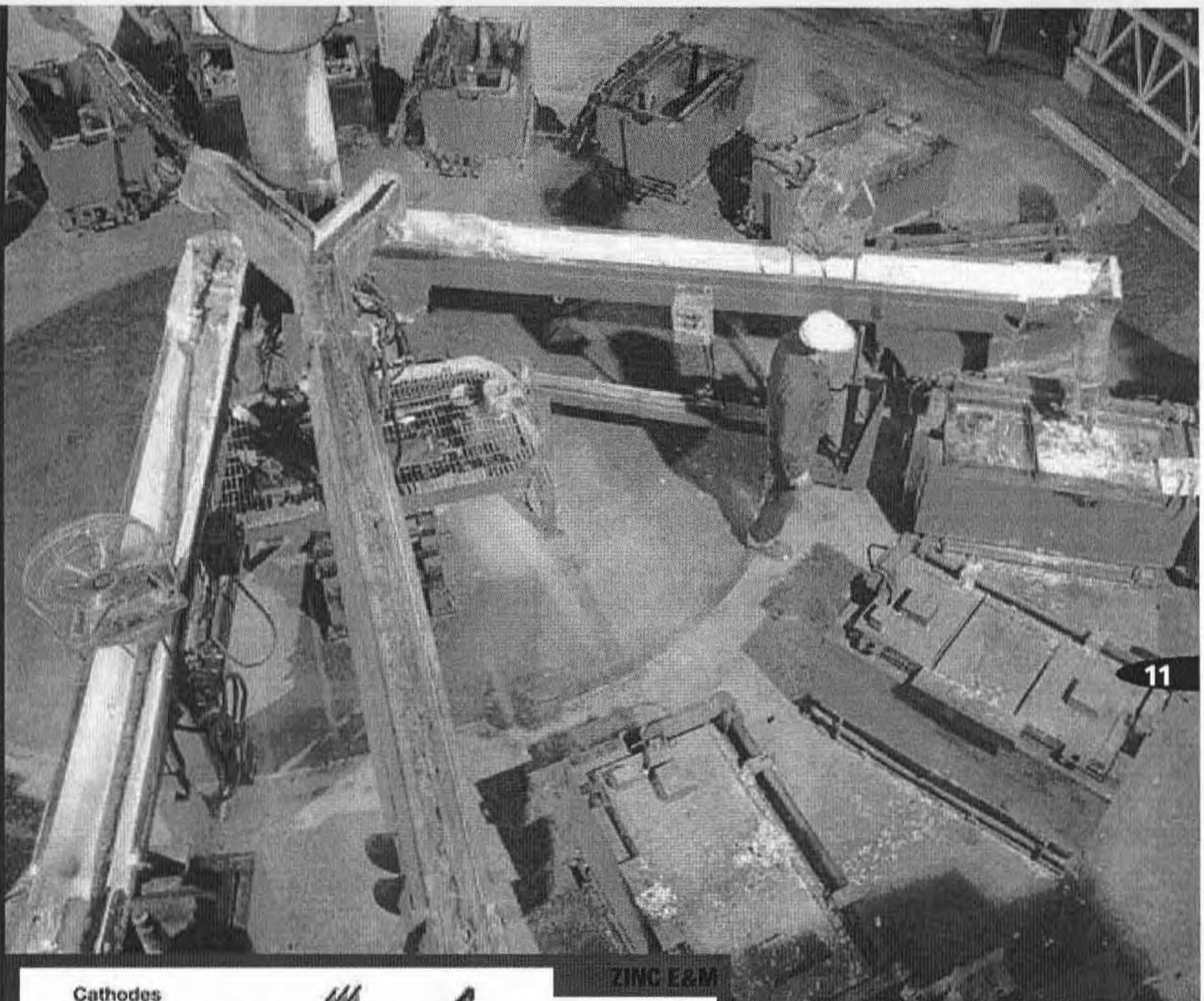


The Electrolytic Plant, which is the size of four football fields, consumes the same amount of power as a city of 250,000 people.

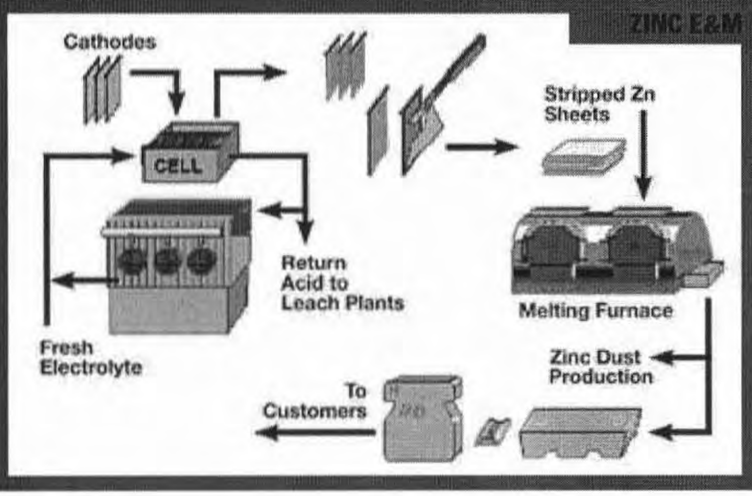
DOELL PHOTO

DOELL PHOTO

An operator casts refined zinc into 1000-kg jumbo ingots at the jumbo casting line.



ZINC E&M



MELTING PLANT

Three electric induction melting furnaces are used to melt up to 950 t/d of zinc cathode sheets. The molten zinc is then discharged through four small alloying furnaces in which alloying metals are added to adjust the chemical specifications to match customers' orders.

Seven casting facilities are available to produce 25-kg slabs, 1000-kg jumbos, 11-kg die cast slabs and C-cast jumbos, which are unique to Cominco. The C-cast jumbo casting machine consists of two small molds that make two void-free six-metre long logs that can be sawn into lengths to meet a customer-required weight. A close weight to length tolerance and unique shape for ease of handling makes the C-cast blocks ideal for alloy producers.

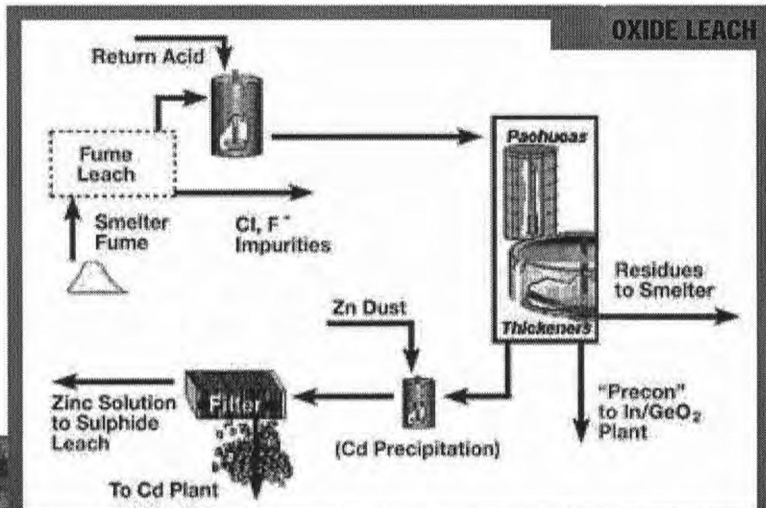
Commitment to product quality in the melting plant was demonstrated by it's 1997 certification to ISO 9002 standards for zinc and zinc alloy products. Customer service and satisfaction are primary objectives of the Melting Plant personnel and the Cominco Metal Sales Group.

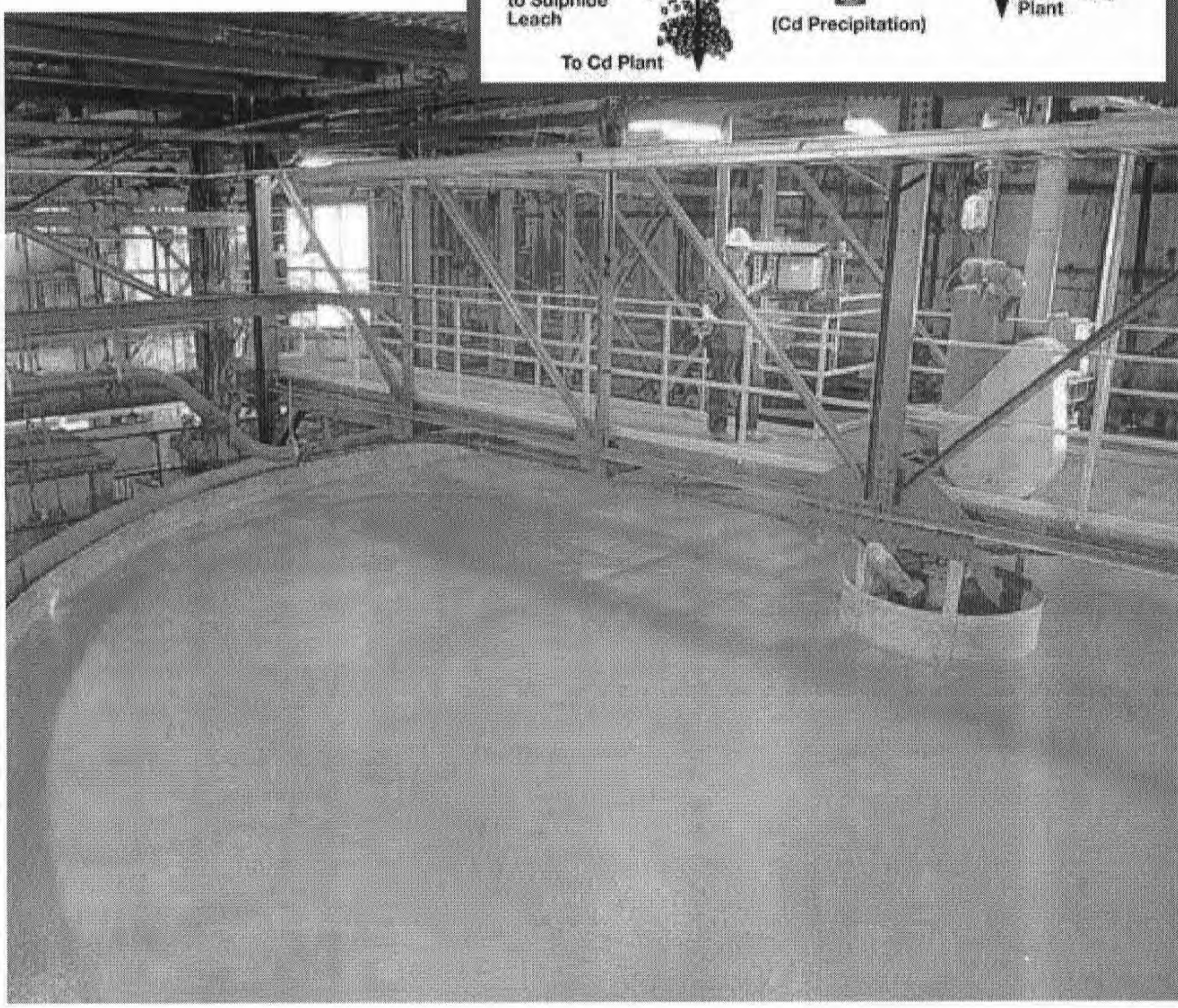
OXIDE LEACHING PLANT

Since the Zinc Plant and the Lead Smelter are on the same site there are processing opportunities to optimize the recovery of lead and zinc and other minor elements contained in the concentrates. As a result, the Oxide Leaching Plant has developed into a treatment plant for recycled and secondary materials which contribute about 10% of the produced zinc.

Zinc oxide fume from the Lead Smelter is the primary feed to this plant. Fume from the slag fuming furnace is treated with sodium carbonate to remove chlorine and fluorine before being used in the zinc circuit. A combined feed of dehalogenated fume and secondary residues is leached with return acid in air agitated pachuca tanks. After this first leach, the slurry is settled to remove a lead oxide residue which is pumped to the Lead Smelter and the clear solution is passed on to the second leach.

In the second leach, the slurry is partially neutralized with direct fume addition and ferric iron to precipitate germanium, indium, arsenic and antimony. This precipitate is the feed for the Germanium Recovery Plant.



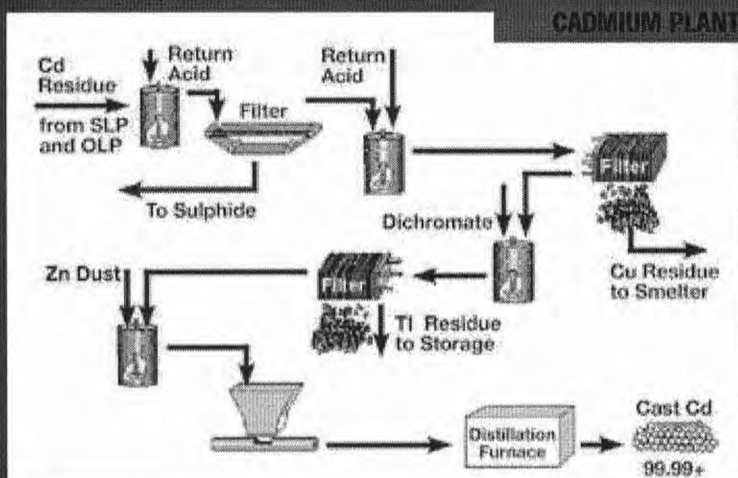


In the Oxide Leaching Plant's thickener tanks, residues are separated from zinc electrolyte solution.

DOELL PHOTO

DOELL PHOTO

Operators prepare to package 510-g cadmium balls. This metal is also produced in 1-kg sticks. Trail's primary customers for cadmium are battery manufacturers.



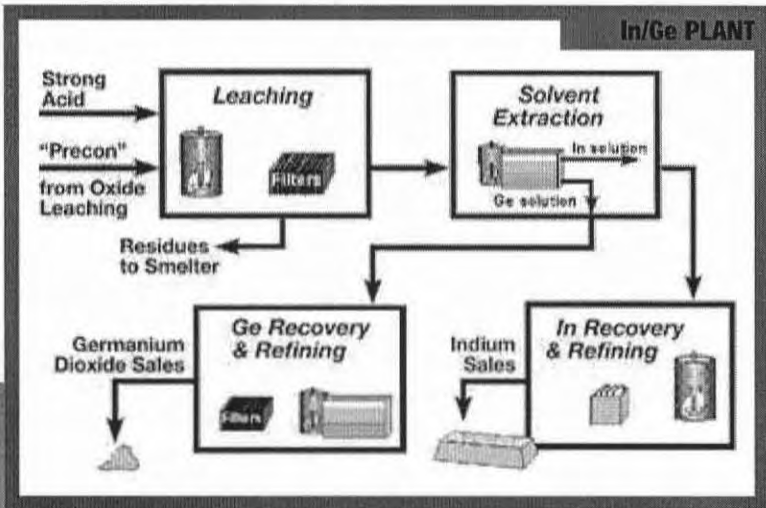
CADMIUM PLANT

A new Cadmium Plant was built in 1991 to process a two-fold increase in cadmium input from the Red Dog mine. Purification residues from the Oxide Leaching Plant and the Sulphide Leaching Plant are leached with cell house acid and filtered through three stages to remove zinc, copper, and thallium prior to prilling the dissolved cadmium.

The final step in purification of cadmium metal is a vacuum distillation process that can produce up to 1400 t/y of an ultra pure cadmium metal. Cadmium is sold in various forms – billets, balls, and sticks – to meet customers' requirements.

SPECIALTY METALS PLANT

Residues from the Oxide Leaching Plant second leach are releached with sulphuric acid to dissolve the contained germanium and indium. After filtration, the clear solution is processed in a solvent extraction unit where both metals are recovered and subsequently reprecipitated to a product for further purification. Each metal product is reprocessed into a product suitable for various customers. This plant can produce 28 t/y.



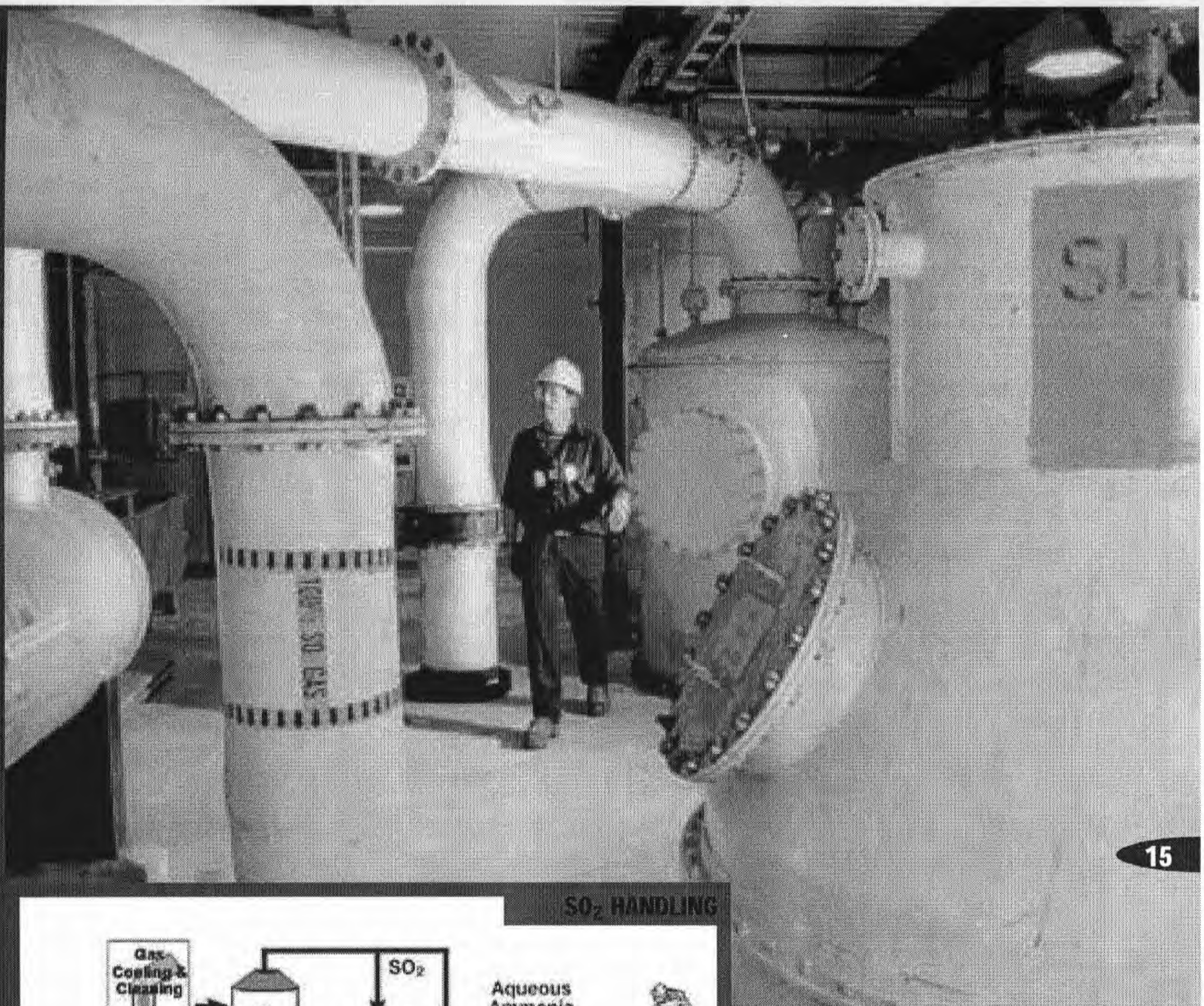
Insert
Germanium dioxide is produced as a greyish-white powder for sale to the fibre optics industry.

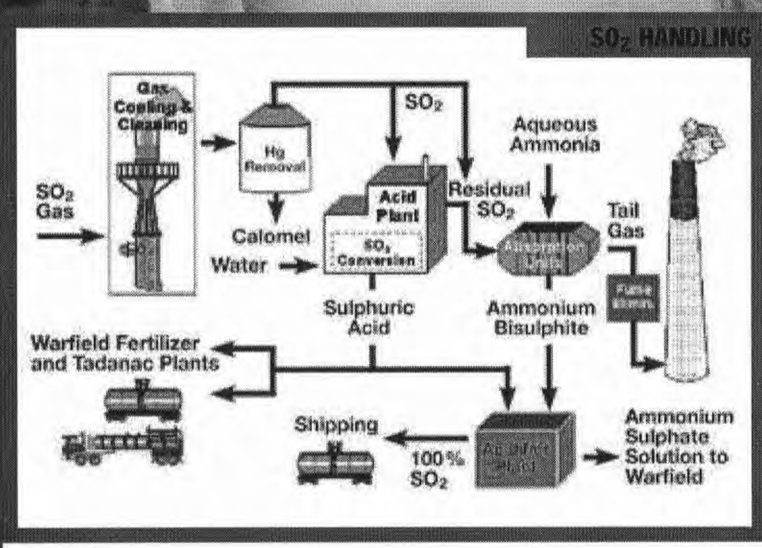
Cominco is one of two Canadian producers of indium. Here, an operator pours 99.999 percent pure ingots. Indium is used in the electronics industry.

DOELL PHOTO

RAFFF MILES

Sulphuric acid is recovered from the sulphur gases from the Roasters and the Lead Smelter.



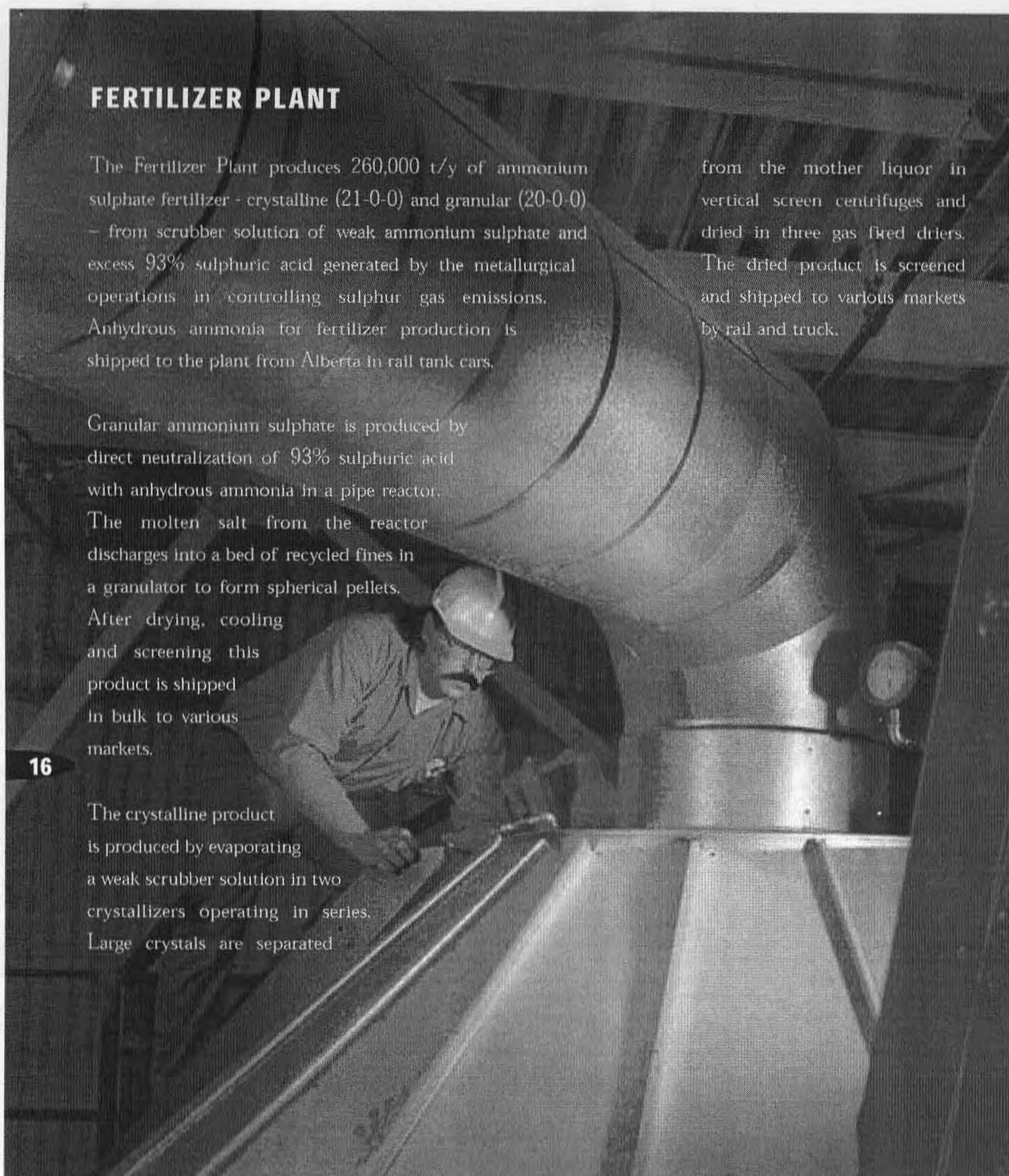


SULPHURIC ACID PLANTS

All the process gas, containing SO_2, from the Roasters and the Lead Smelter is treated by three single contact Monsanto Plants, ranging in capacity from 410 t/d to 820 t/d. These plants convert 95% of the contained SO_2 in the process gas to a marketable 93% sulphuric acid and acid battery acid. The remaining SO_2 in the acid plant tail gas is removed by a Cominco-designed ammonia scrubbing process that reduces the SO_2 to less than 500 ppm in the tail gas. This gas passes through a Brinks plume eliminator before discharging to a 125-m stack.

The ammonia scrubbing system produces an ammonium bisulphite solution that is subsequently acidified with sulphuric acid to produce a pure SO_2 gas and ammonium sulphate solution. The SO_2 gas is dried, compressed and condensed to a liquid for direct sales. This scrubber solution and residual sulphuric acid that is not sold is pumped to the Fertilizer Plant to produce an ammonium sulphate fertilizer.

FERTILIZER PLANT

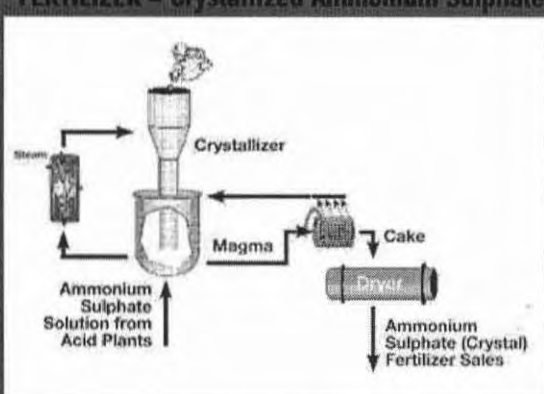


The Fertilizer Plant produces 260,000 t/y of ammonium sulphate fertilizer - crystalline (21-0-0) and granular (20-0-0) – from scrubber solution of weak ammonium sulphate and excess 93% sulphuric acid generated by the metallurgical operations in controlling sulphur gas emissions. Anhydrous ammonia for fertilizer production is shipped to the plant from Alberta in rail tank cars.

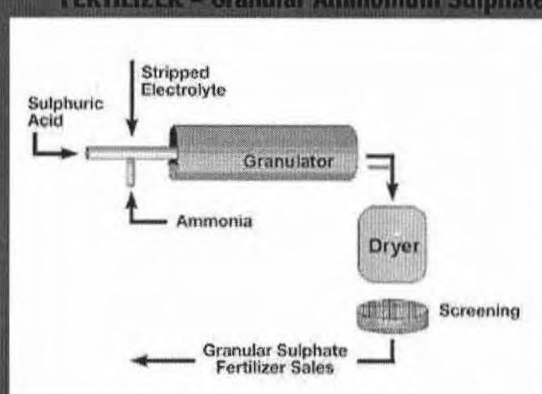
Granular ammonium sulphate is produced by direct neutralization of 93% sulphuric acid with anhydrous ammonia in a pipe reactor. The molten salt from the reactor discharges into a bed of recycled fines in a granulator to form spherical pellets. After drying, cooling and screening this product is shipped in bulk to various markets.

The crystalline product is produced by evaporating a weak scrubber solution in two crystallizers operating in series. Large crystals are separated from the mother liquor in vertical screen centrifuges and dried in three gas fired driers. The dried product is screened and shipped to various markets by rail and truck.

FERTILIZER – Crystallized Ammonium Sulphate



FERTILIZER – Granular Ammonium Sulphate



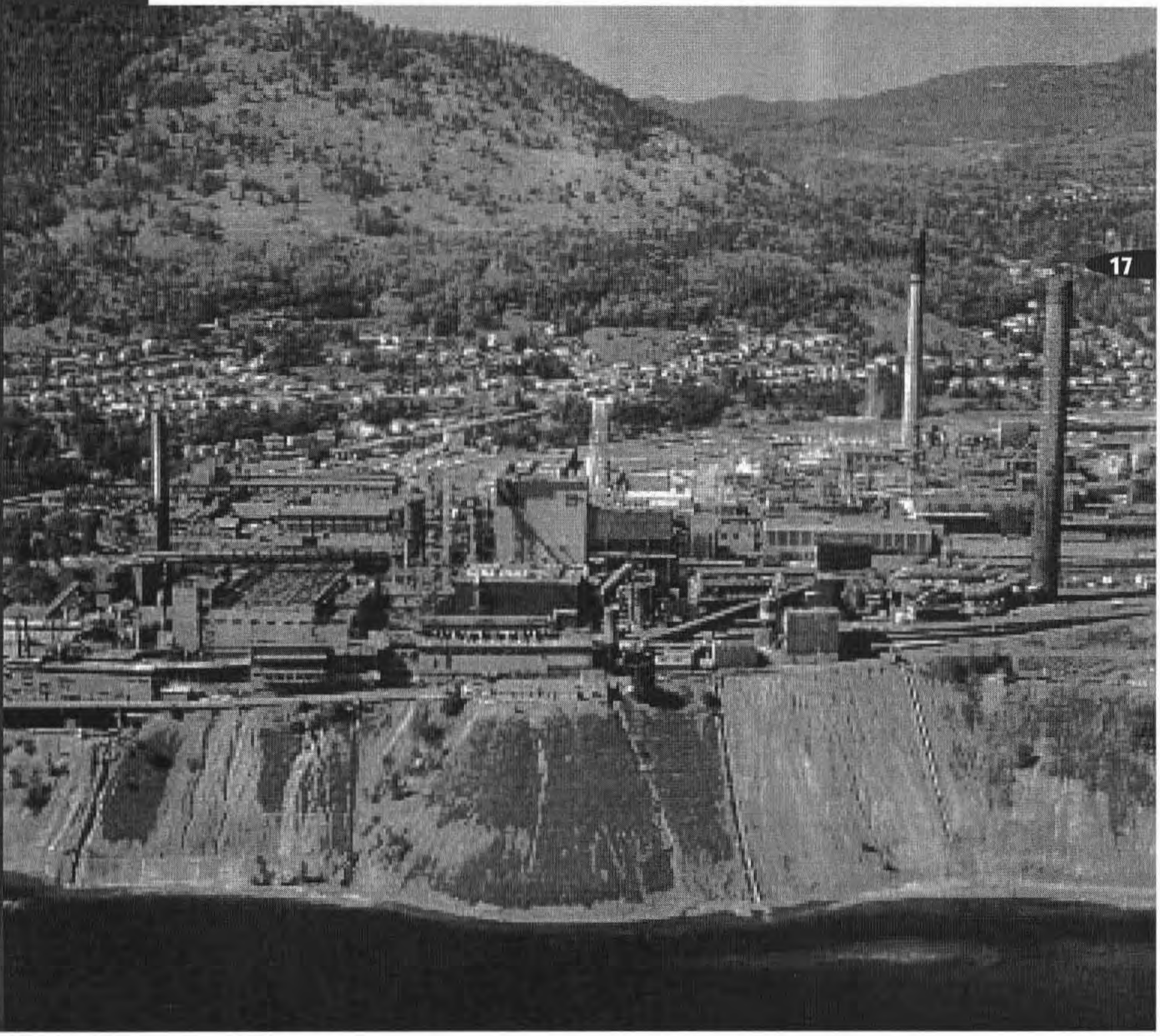
Sulphuric acid is combined with ammonia to produce granulated ammonium sulphate, one of two fertilizer products produced at Trail.

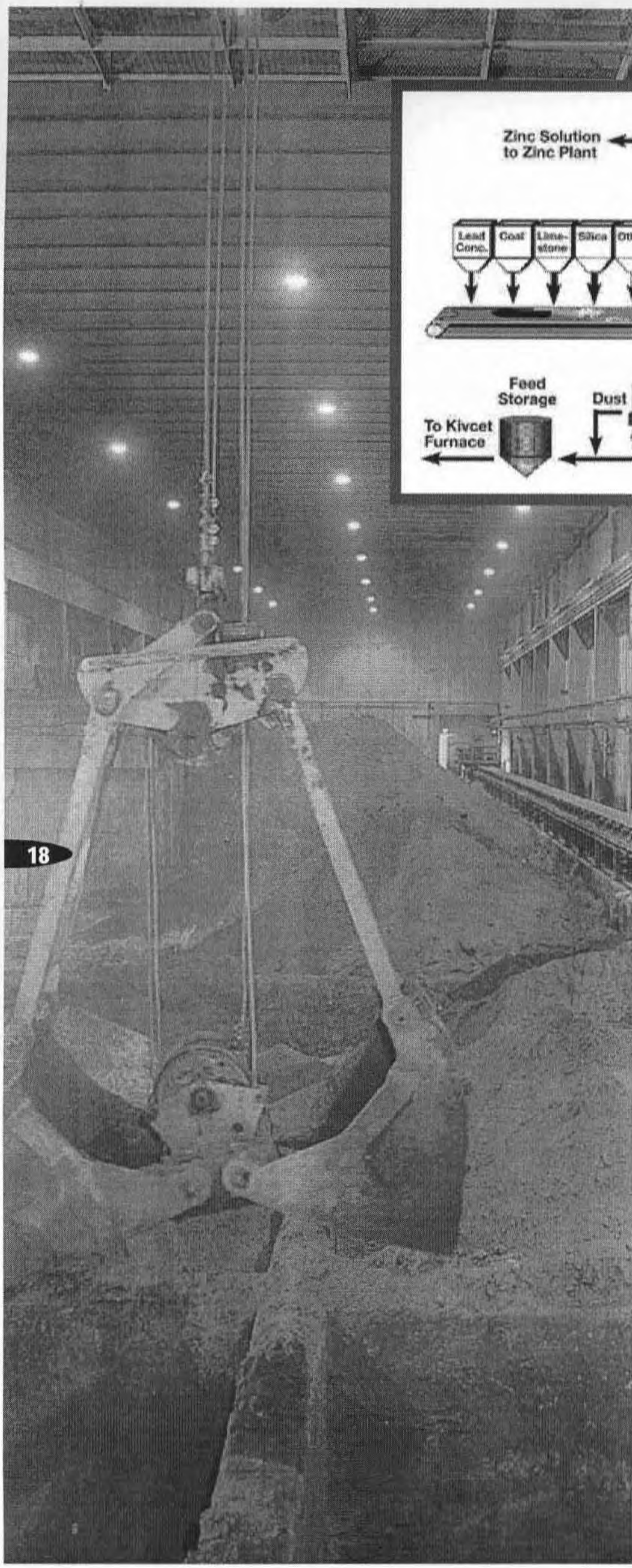
RAEFF MILES

GREG OSADCHUCK PHOTOGRAPHY

LEAD OPERATIONS

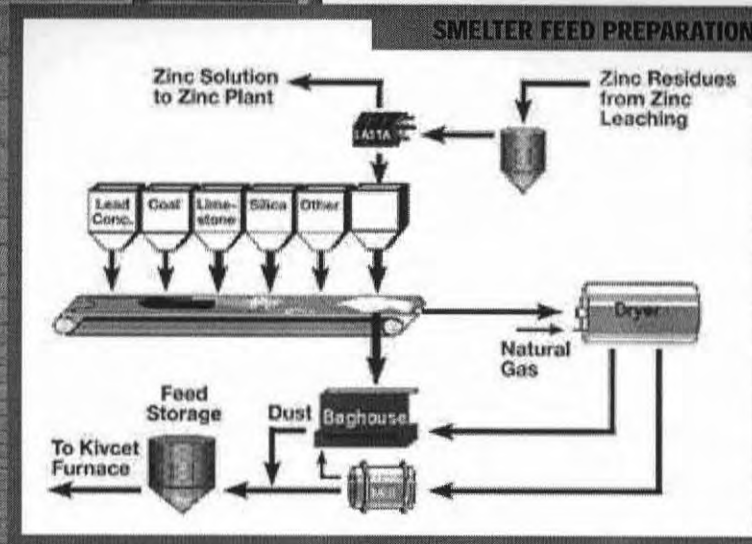
Seven major plants in the Lead Operations primarily produce lead and significant quantities of silver, gold, bismuth, copper, and arsenic products. These plants are designed to treat a wide range of feed materials including lead concentrates, various residues from the zinc plants, recycled lead battery scrap, lead scrap, and scrap copper.





DOELL PHOTO

In the Lead Smelter Feed Plant, with the proportioning bins at the left rear, lead concentrates are mixed with residues and flux materials before being conveyed to the dryer circuit.



FEED HANDLING

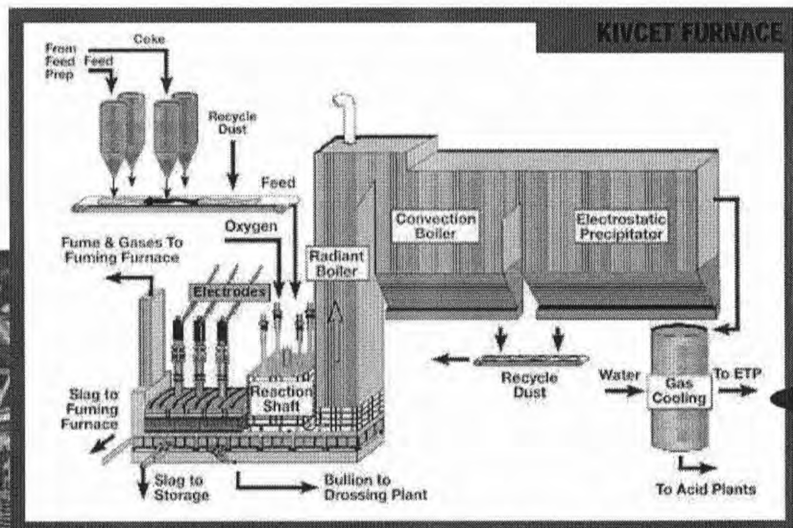
Lead concentrates are received in gondola cars from the Sullivan mine in Kimberley, B.C. and from various other custom concentrators. After sampling and weighing, these concentrates are unloaded into the feed building which consists of twelve bins, each with 90 t capacity for various concentrates, fluxes, silica, residues, and coke. These materials are withdrawn from each bin, according to a charge calculation, by variable speed belts and deposited on a transfer conveyor. This feed mixture is dried and ground to less than one millimetre size before being conveyed to the furnace feed bins. From these bins the feed mixture, coarse coke, and oxygen are fed into the furnace through four reaction shaft burners.

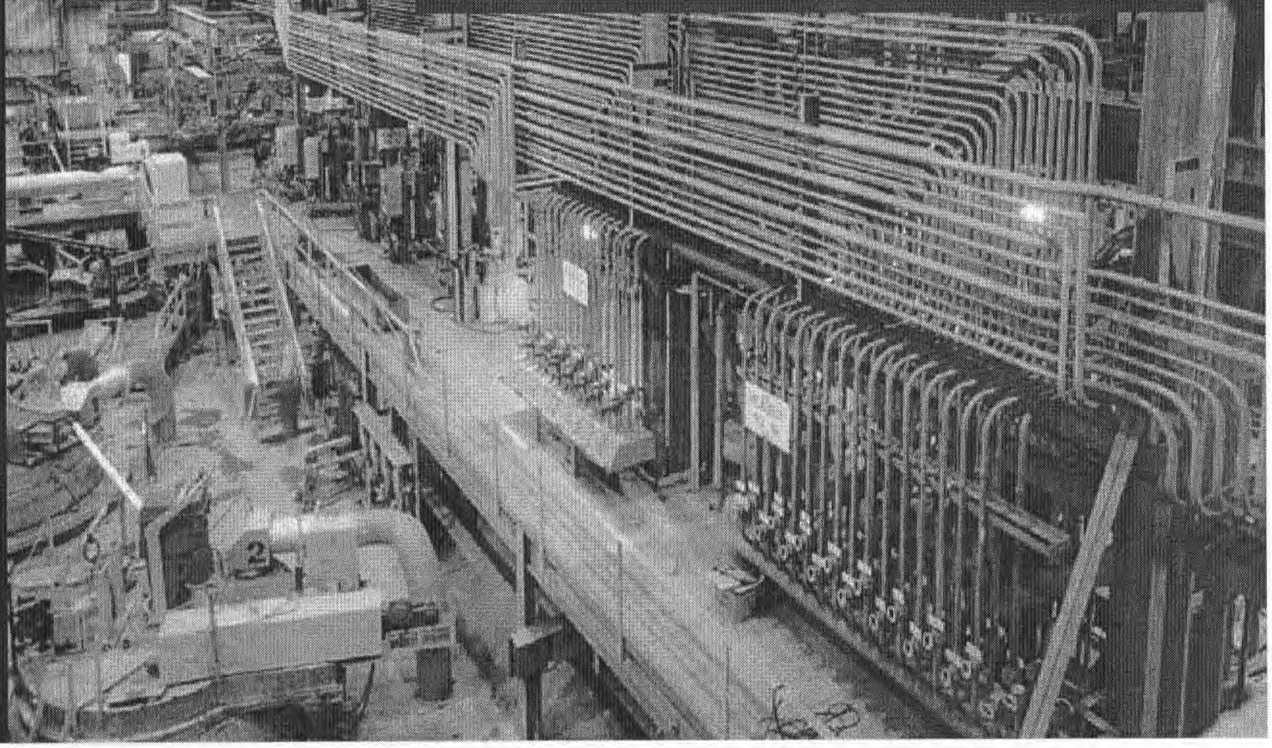
LEAD SMELTER FURNACE PLANT

The Kivcet Furnace is often described as a "flash" smelter because the sulphur in the dry lead concentrates and the fine coal burns instantaneously to form a 15% sulphur dioxide gas. Lead sulphide is converted to a lead oxide in this flash burn. A mixture of lead-zinc-iron oxides and flux agents form a semi-fused slag which collects under a layer of coarse coke called a "coke checker" in the first compartment of the furnace, called the smelting shaft. As this coke sinks through the slag, the lead oxide is reduced to lead bullion. This mixture of bullion and zinc-iron slag then passes under a separation wall from this first compartment to the second compartment where heat is applied by large carbon electrodes. With additional retention time, the lighter slag separates from the bullion to form two distinct layers of product. From this compartment, slag is tapped to the slag furnace and bullion is tapped to the drossing furnace.

About 1200 C gas from the smelting shaft is cooled to 700 C in the radiation boiler and further cooled in a convection boiler before passing through the gas cleaning equipment. The final volume of 22,000 Nm^3/h cleaned sulphur dioxide gas is piped directly to the sulphuric acid plants located in Zinc Operations.

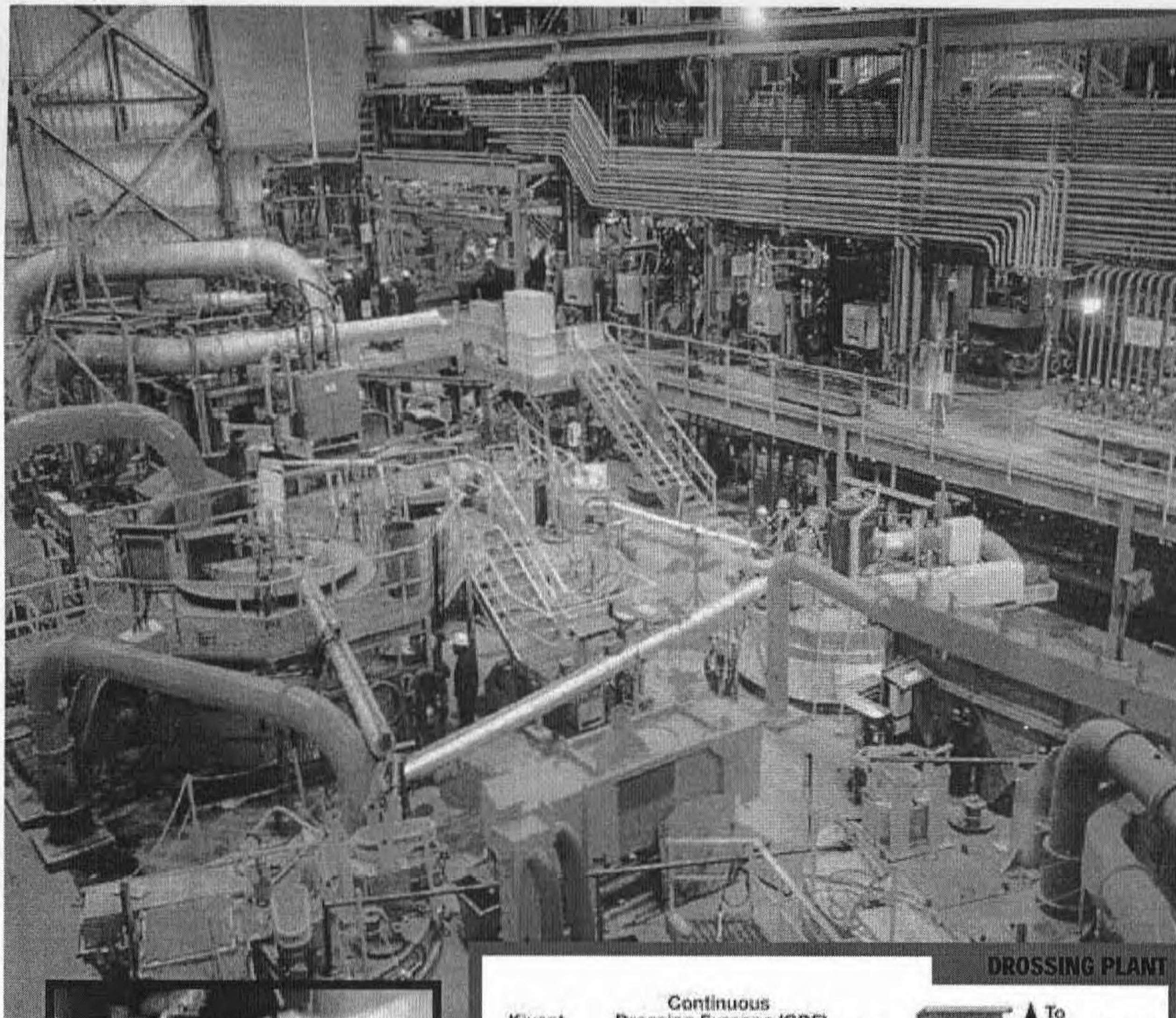
Substantial reduction in dust emissions is attained with this type of smelter. With the elimination of the Sinter Plant and the Blast Furnace, up to 90% less dust and 75% less metallic emissions into the surrounding community are attainable.





The Kivcet furnace, at right, requires complex piping for cooling water. At the top of the stairs is the area where lead bullion is tapped from the furnace to the Drossing Plant at left.

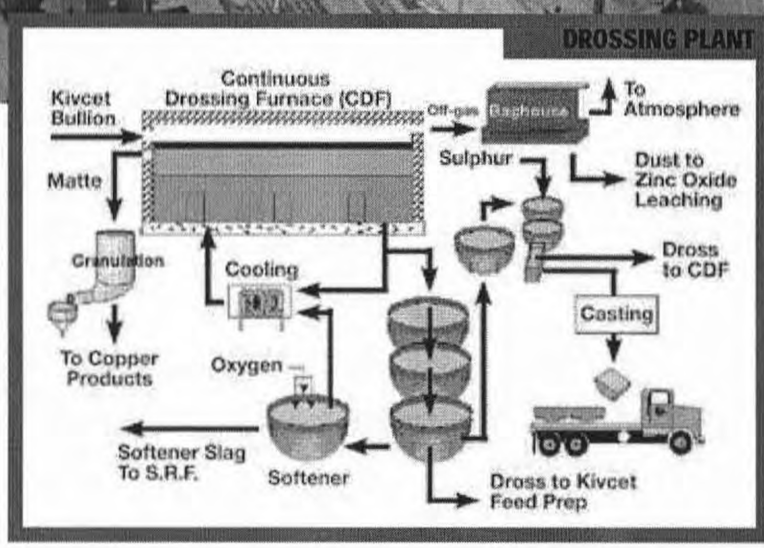
RAEFF MILES



RAEFF MILES

In the foreground is the Drossing Plant in Lead Smelter building. The Drossing Plant removes copper from the lead bullion before it is sent for final refining. The Kivcet furnace is in the background.

Insert:
Lead bullion is poured into "buttons" for transport to the lead refinery where electro-refining will remove silver, gold, bismuth and other metals from the lead for further refining. The resulting refined lead is then ready for shipment to customers.



DROSSING FURNACE

Lead bullion is tapped from the furnace crucible, by launder, to the Continuous Drossing Furnace where the lead is purified by removing copper, arsenic, and antimony.

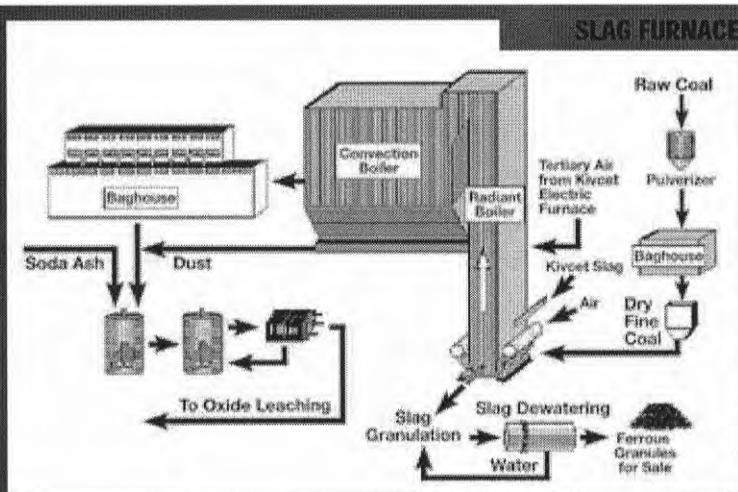
By cooling the bullion from 900 C to 400 C, a copper matte is formed and rises to the surface where it is skimmed for processing in the Copper Products Plant. In a subsequent step called the "softening stage," oxygen is used to oxidize arsenic and antimony to form a slag which can be removed from the surface of the bullion.

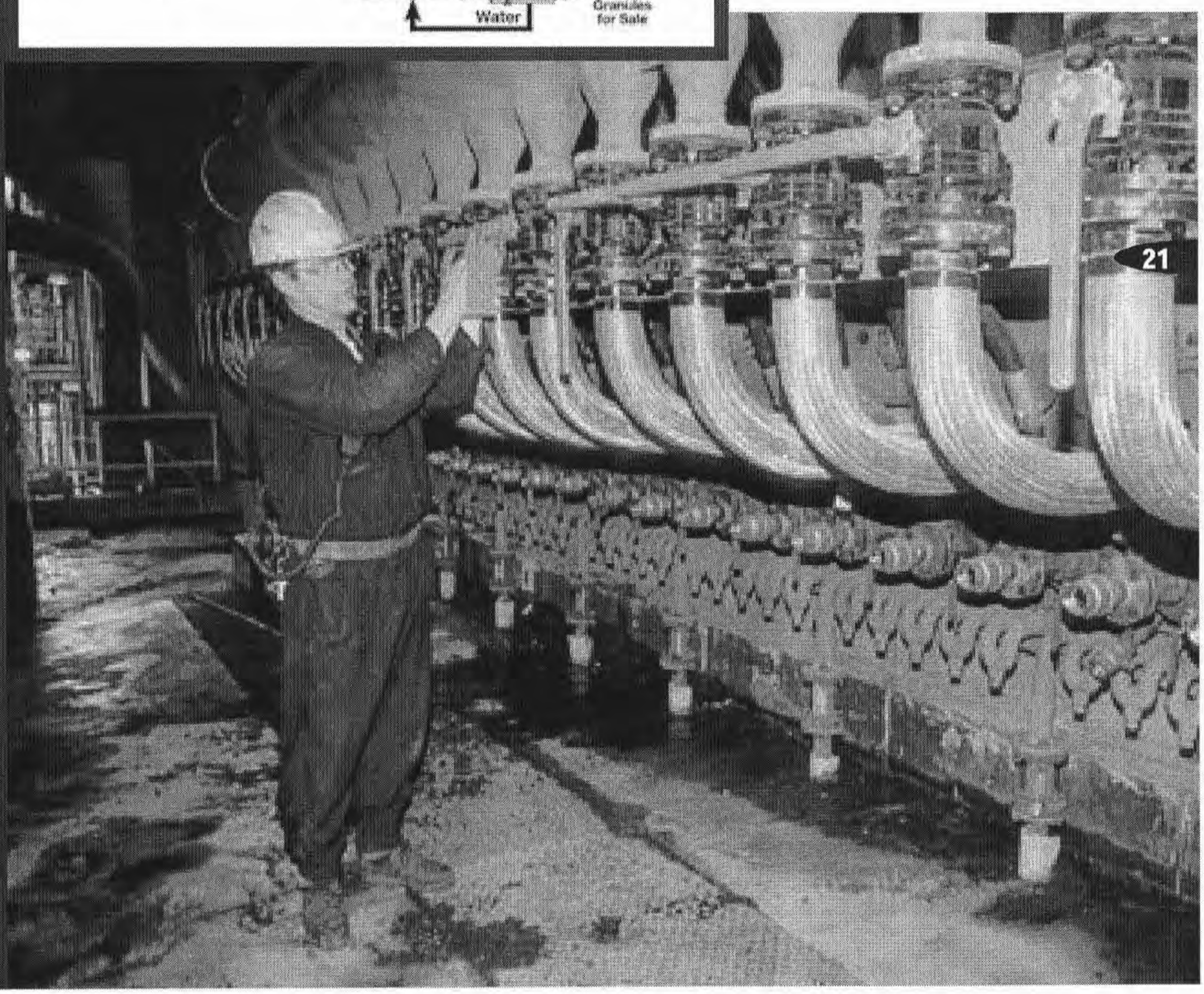
After purification, bullion is poured into 5-t ingots and transferred to the Lead Refinery for electro-refining.

SLAG FURNACE

A metallic slag, containing all of the iron and most of the zinc from the Kivcet Furnace, is transferred in 70-t batches to a coal-fired fuming furnace. To recover the zinc, fine coal and air are injected one metre below the top of the slag bath. The heat generated causes the zinc to fume as a vapour from the furnace bath and is immediately reoxidized by tertiary air above the bath to form zinc oxide fume. This fume and hot gases are cooled in a waste heat boiler before passing through a baghouse to collect the zinc fume for treatment in the adjacent Fume Leach Plant. In this plant, halogens (chlorine and fluorine) are removed by a sodium bicarbonate treatment.

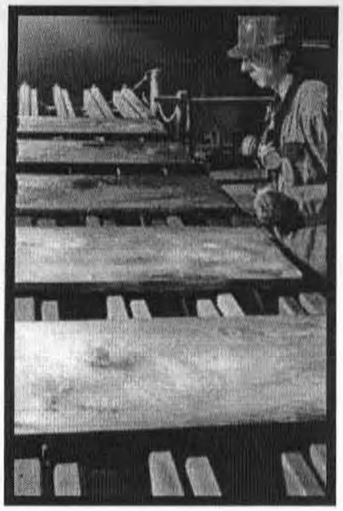
Exhaust and ventilation gases from this entire process are discharged to a tall stack. The molten barren slag is granulated in water then collected for sale to cement manufacturers or sent to land storage.





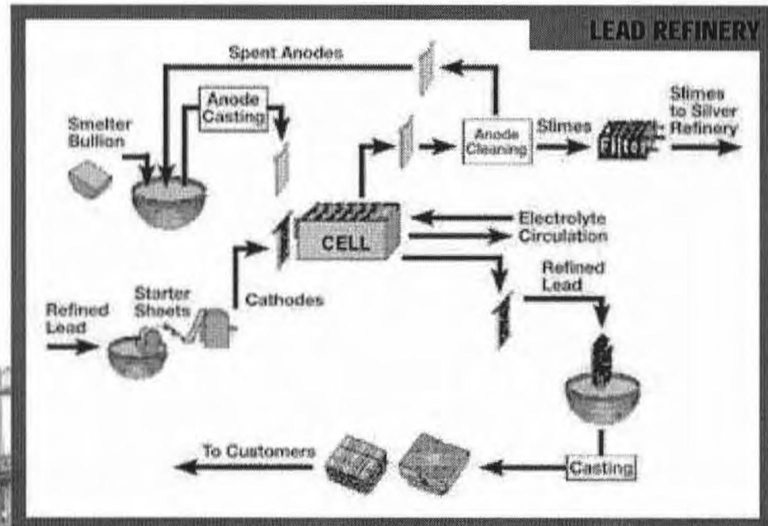
The Slag Furnace is instrumental in the recovery of zinc and co-products from the slag.

GREG OSADCHUK



LEAD REFINERY

The Betts process pioneered by Cominco in 1902 is still used to efficiently purify lead bullion. Bullion from the Kivcet Furnace is melted and cast into anodes for electro-refining in the 1000-cell refinery. Refined lead is cast into thin starter sheets for the cathodes. These anodes and cathodes are set into the cells containing hydrofluosilicic acid (90 g/l) and dissolved lead (70 g/l) for a five-day cycle. Refined lead cathodes are remelted and cast in required shapes for customers.



Insert
In the Lead Refinery, lead bullion is remelted and cast into anodes using an automated casting machine, making the impure lead ready for electrorefining.

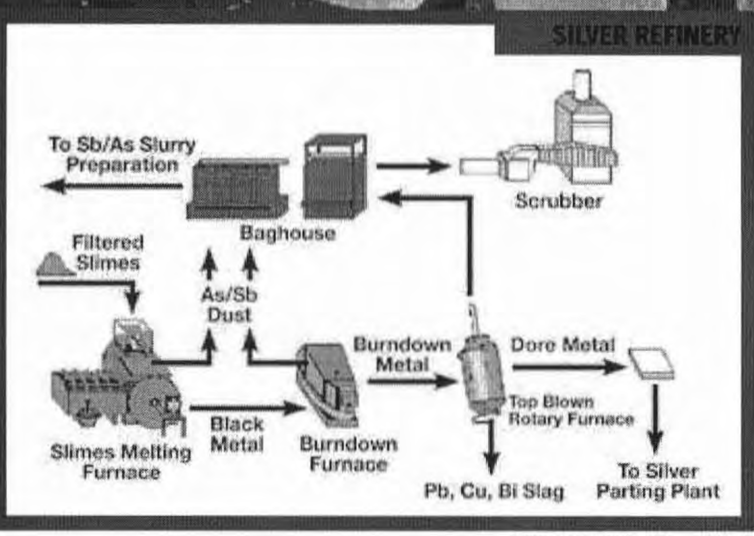
RAEFF MILES

Cell testing is conducted during every shift in the electrolytic Lead Refinery to correct any electrical shorts between the electrodes.

DOELL PHOTO

DOELL PHOTO

1000-oz silver bars are poured in the Silver Refinery.



FLOWSHEET CONTINUES — PAGE 24

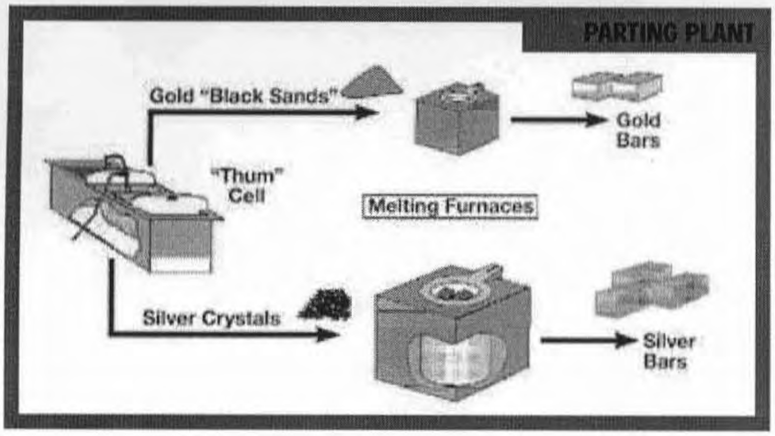
SILVER REFINERY / LEAD ALLOY PLANT

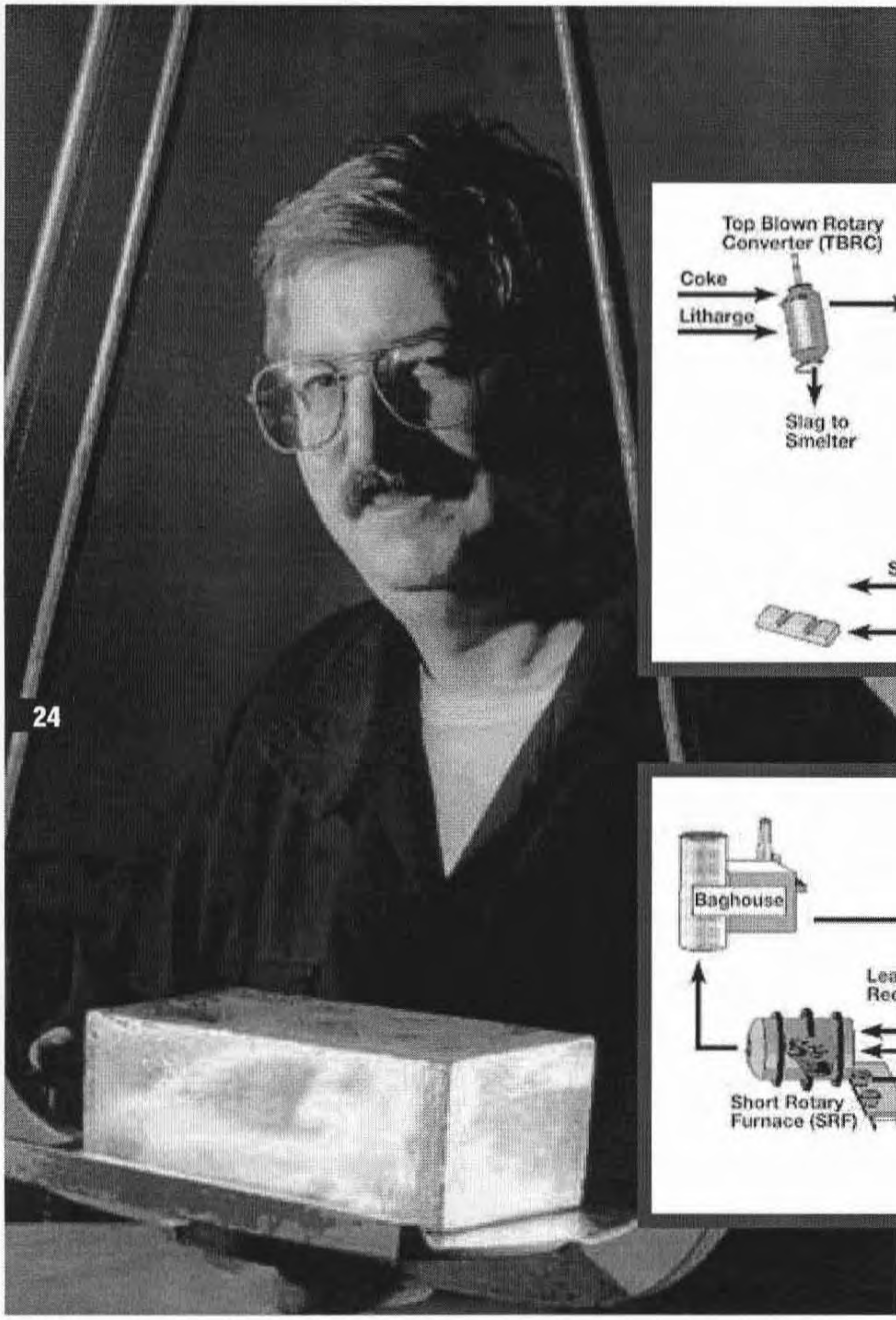
Slimes collected on the corroded anodes are treated in a series of three furnaces to recover silver and gold from the other heavy metals. Other processes are used to recover marketable bismuth, arsenic, and antimony and to recycle unrecovered lead to the Kivcet Furnace. Some of these metals are also used to make various alloys with the purified lead, for specific customers.

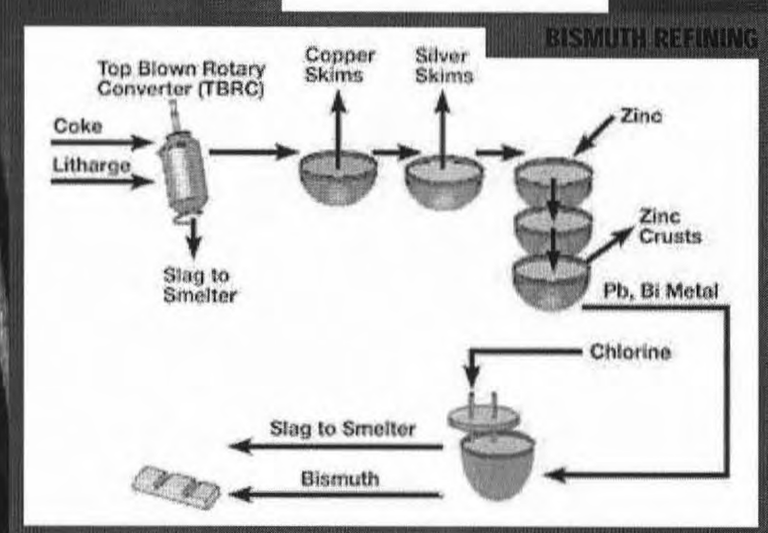
SILVER REFINERY / LEAD ALLOY PLANT

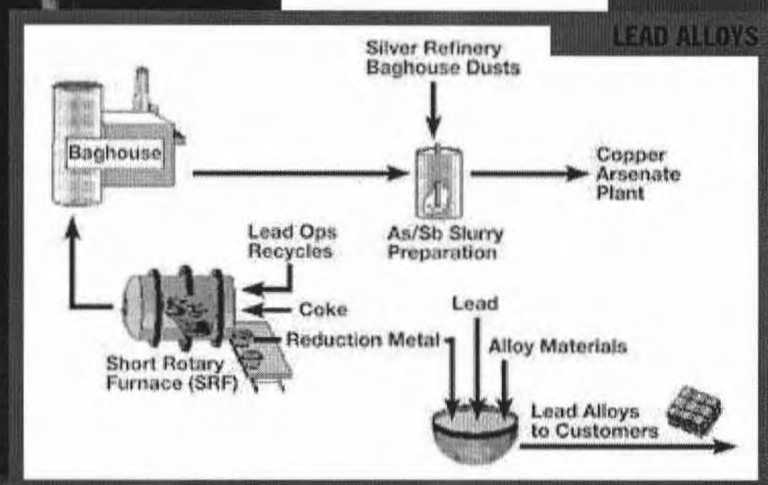
RAEFF MILES

Gold is a co-product of the lead production circuit. Canada's first gold ingot was poured at Trail's smelter, then known as The Canadian Smelting Works, in 1897.









DOELL PHOTO

A shipper loads a bag of copper arsenate, one of the three copper products produced at Trail.

COPPER PRODUCTS PLANT

The Copper Products Plant produces three commercial chemical products: copper sulphate crystals, copper arsenate and sodium antimonate.

ENVIRONMENT

TRAIL OPERATIONS ENVIRONMENTAL POLICY

Our vision is:

Respect for the environment is a key element in Cominco's long-term economic prosperity. Environmental management and pollution prevention will be integrated into all aspects of Cominco's operations at Trail. Our activities will be governed by the principles of stewardship and integrity, and our Operations will have no detrimental effect on public and employees' health, or on the environment.

We will achieve this by:

- **Day-to-day care and protection**
  Day-to-day operations will be conducted in accordance with standards, procedures and controls that prevent adverse impacts and assure compliance with legal requirements.

- **Prevention and continuous improvement**
  Plant processes, management practices and new projects will be implemented to prevent pollution, avoid waste and reduce discharges to air, water and land.

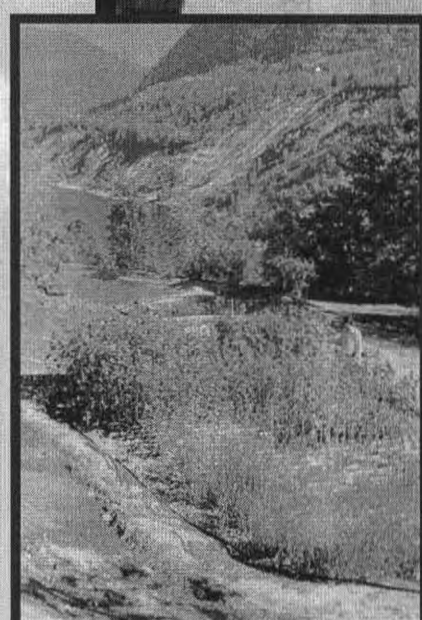
  Our management program will include environmental objectives and targets set in consultation with government and other stakeholders to sustain a healthy environment. Periodic audits and regular management reviews will monitor the effectiveness of the program.

- **Clearly defined responsibilities**
  Managers and supervisors are responsible for providing the resources, management systems, training and direction to ensure compliance with this policy. Managers are accountable for the performance of their function; employees are accountable for their action in carrying out their duties.

- **Cooperative relations and communications**
  Our relations with government agencies, our employees and the community will be open and participative. We will communicate regularly on our environmental performance.

Environment technicians regularly evaluate air emissions and water effluents by computer links.

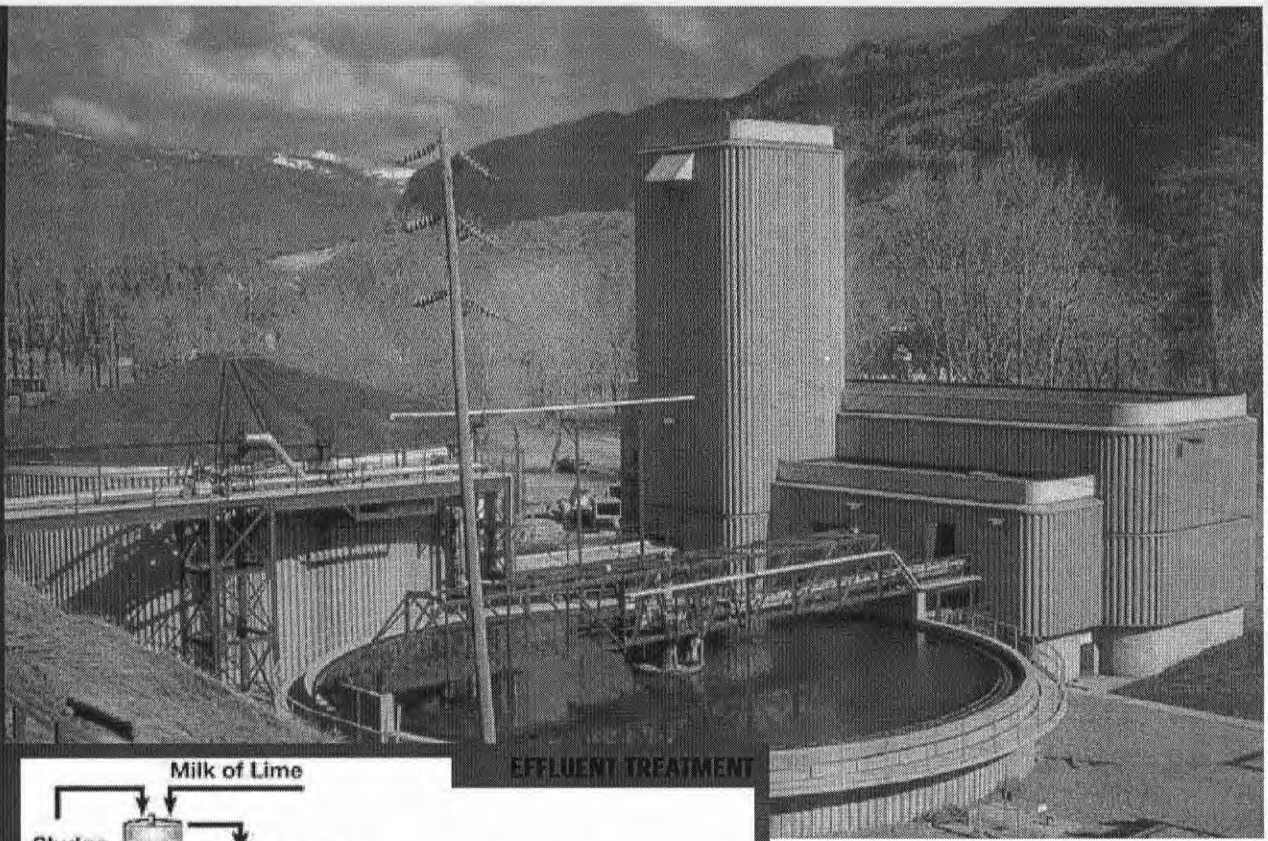
RAEFF MILES



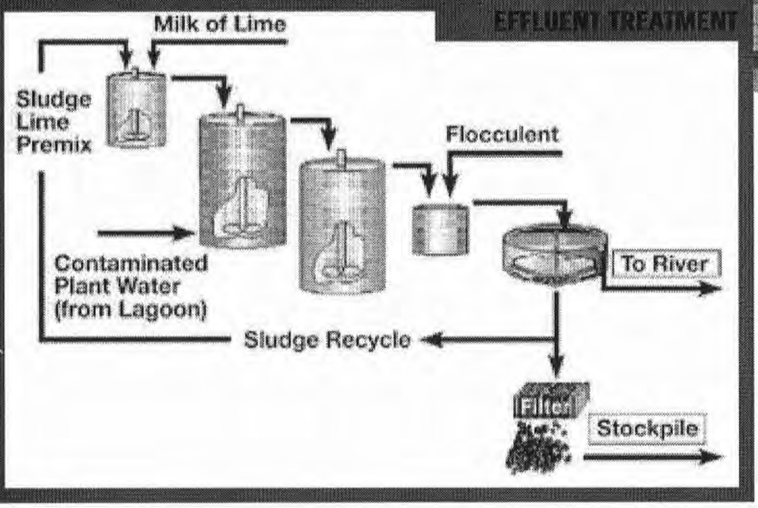
Insert
Trail Operations' biologist inspects a pilot wetlands project, which uses plants to clean up metals and absorb nutrients from contaminated ground water.

DOELL PHOTO

DOELL PHOTO



The Effluent Treatment Plant treats contaminated plant and run-off water to produce clean water that is sent to the Columbia River and a sludge that is recycled in the plants for metal recovery.



THE TRAIL ENVIRONMENTAL MANAGEMENT SYSTEM

An Environmental Management System (EMS) is a structure of policies, organizational, procedures, plans and practices that enables environmental management to become an integral part of the normal business operation.

Trail Operations' EMS conforms to the ISO 14001 framework. ISO 14001 is an international standard that provides organizations with the elements of an effective environmental management system. The EMS can be integrated with other management systems to assist those organizations achieve environmental and economic goals.

Specifically, Trail's EMS provides a methodical and auditable process for assessing all significant environmental aspects in each of the production plants. These aspects are identified through an analysis of the material inputs and outputs and plant processes as they relate with the environment. A team of primarily plant people conducts this review with the assistance of environmental resource people. The aspects are then prioritized, using a set of consistent criteria based on impacts, effects, regulatory considerations and stakeholder concerns. Values are assigned to "frequency" and "severity" to develop a priority ranking matrix. Action plans are then developed to address deficiencies and prevention opportunities. As these plans are completed, lower-ranked aspects are successively addressed, resulting in continued improvement in the plant operation. The plans address all elements of the management system where corrective or improvement action is required, including such items as training and documentation, as well as changes to the process or materials.

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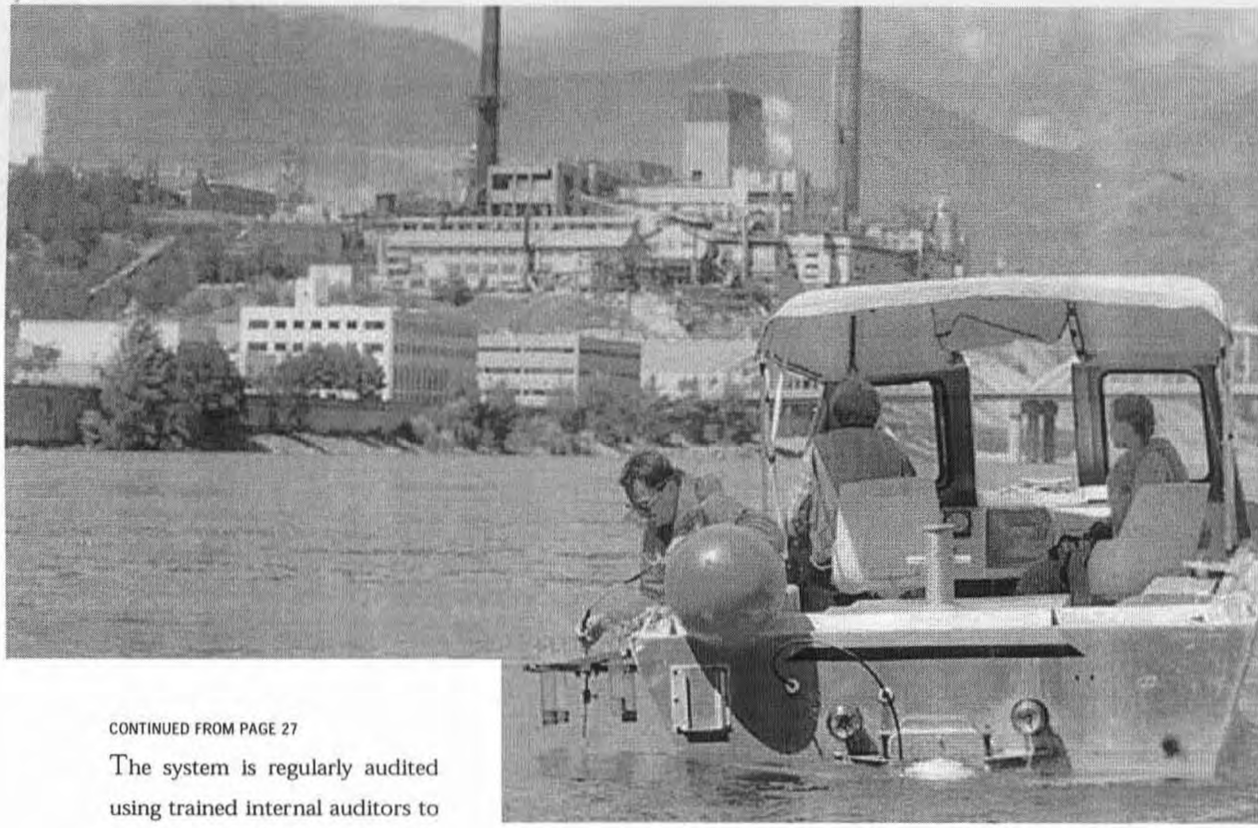


DOELL PHOTO

Trail Operations' biologist samples sediment traps as part of a biological river monitoring program.

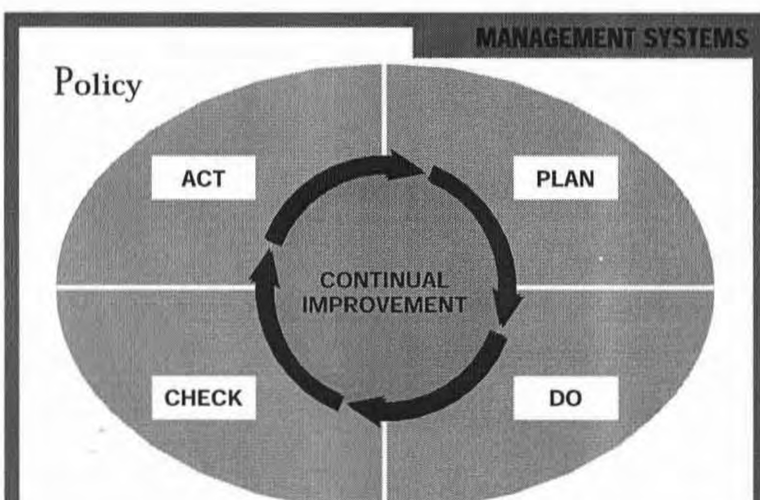
CONTINUED FROM PAGE 27

The system is regularly audited using trained internal auditors to verify the protocols are being consistently followed. In addition, there are periodic external audits initiated by the Cominco Ltd. corporate office.

Quarterly reviews of the status of the individual processing plants' environmental management system programs are conducted in each business area, for example the Roaster/Acid and the Lead Smelter area, and at each functional level, for example Lead Operations and Zinc Operations. The status of the environmental management system in each business area, and at the overall Trail Operations level, is, in turn, reviewed quarterly by the senior management group.

The guiding document for the EMS is the Trail Operations Environmental Policy, which includes a general vision statement. The policy is supplemented by a series of goals, plans and specific objectives that describe management practices and discharge targets. These provide direction to the plants and also provide a basis for prioritizing the allocation of resources at the Trail Operations level. (Please see the introduction page of this section).

The Environmental Management System is consistent with the approaches being applied to product quality, process control, safety and hygiene at Trail Operations. All contribute to process efficiency, risk reduction and the prevention of undesirable outcomes.

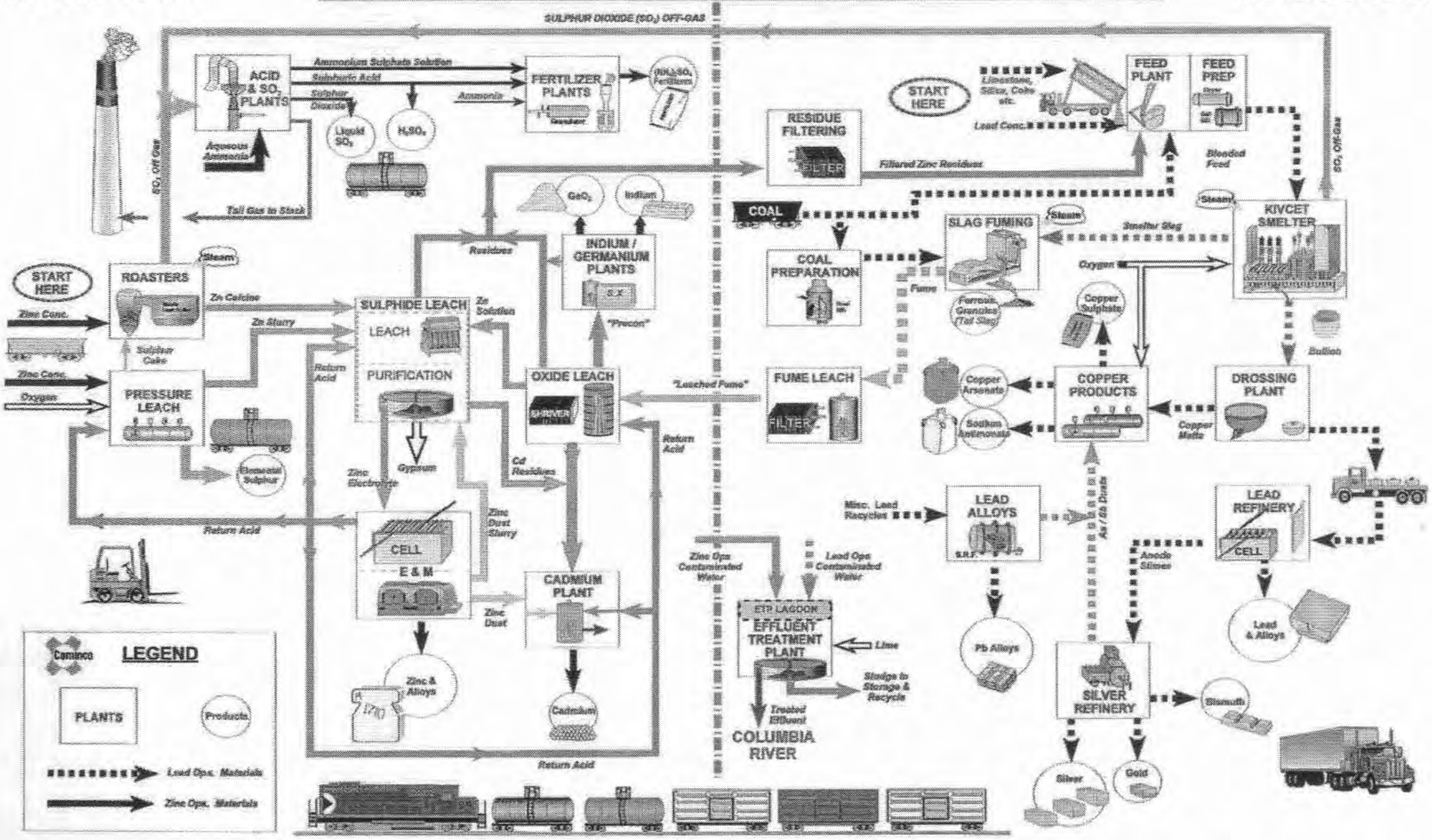


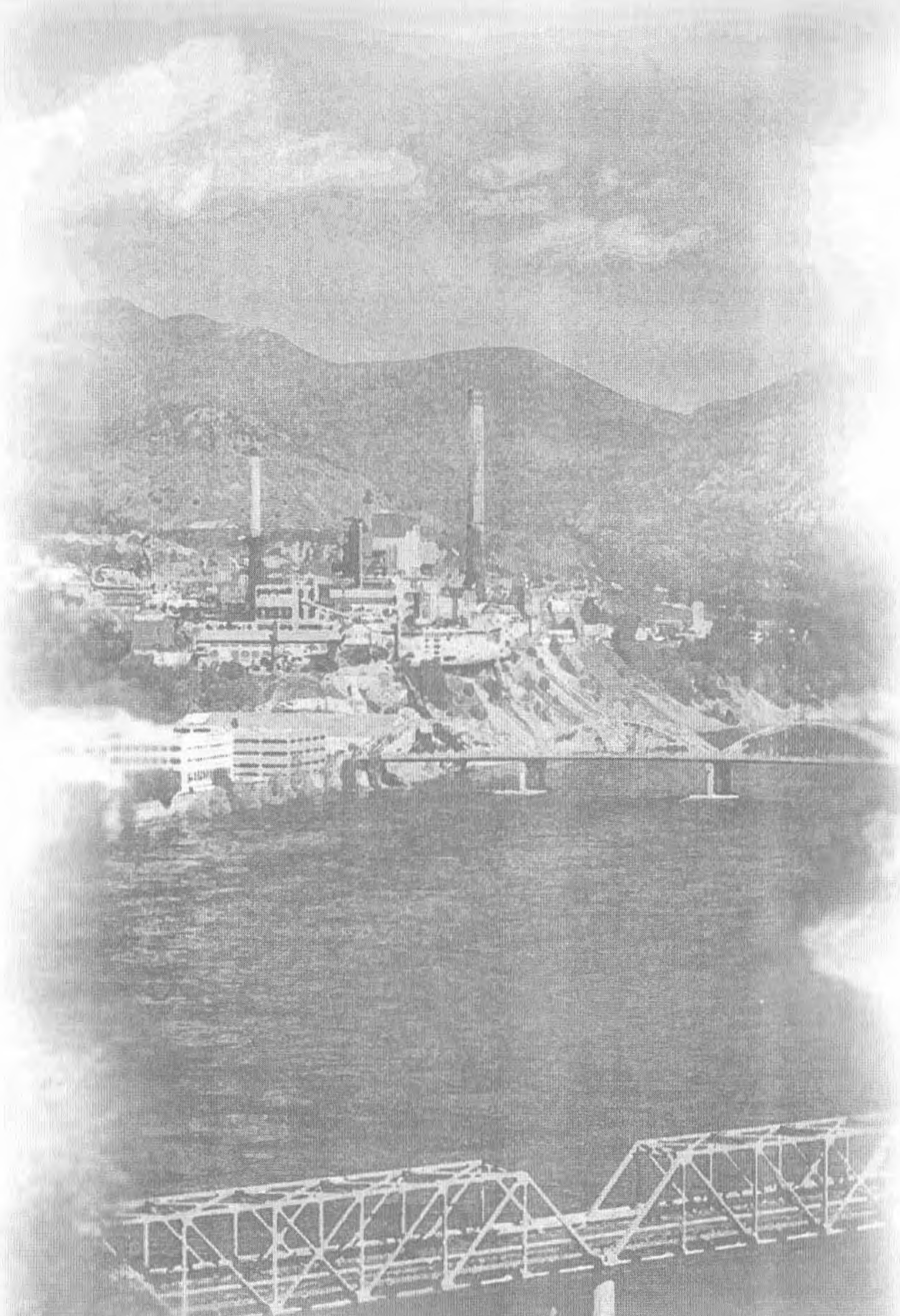
GENERAL FLOWSHEET OF TRAIL OPERATIONS

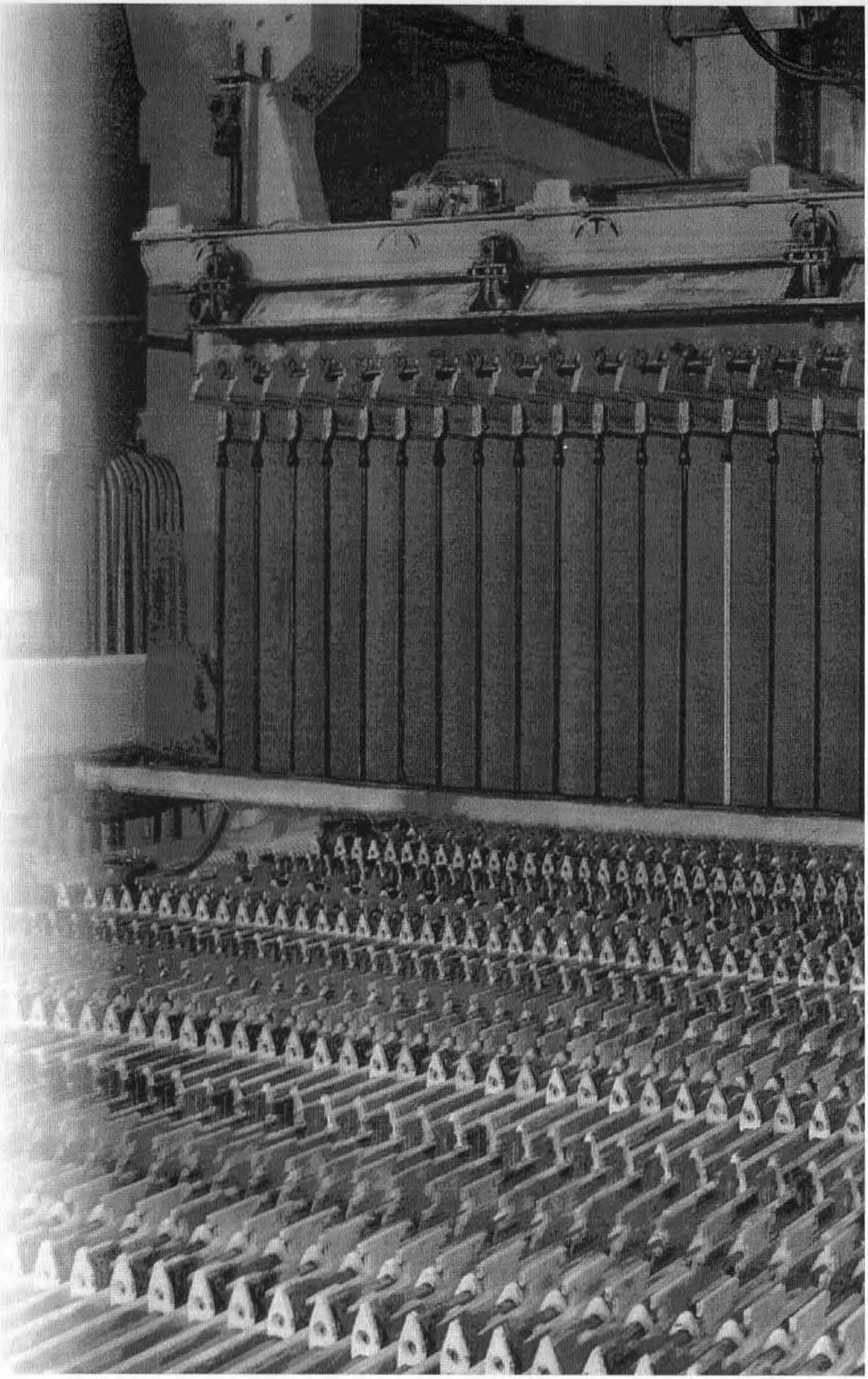
ZINC OPERATIONS

GENERAL FLOWSHEET OF TRAIL OPERATIONS

LEAD OPERATIONS







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