File -> Silvana

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THE DICKENSON MINES LTD., SILVANA DIVISION MINING OPERATION, SANDON B.C.

Silver was discovered in the Sandon area of the Slocan country around 1890. The first claim dates from 1891. Sandon became a town of several thousand people, served by two railroads, by 1900. Silver production reached a peak in 1918, continuing since then at a reduced rate, with total production to date amounting to some 30 million ounces, accompanied by 250 million pounds of lead and 75 million pounds of zinc, having a total value of nearly half a billion dollars at current metal prices.

The property on which the Silvana operations are located has seen several changes in name both prior to and during production. At the time of the discovery of the first new ore zone the Silmonac Mines Syndicate was the exploration company, and it was their drilling from the far west extremity of the 4000 Level in 1968 that showed a new mine might be possible. Drilling from the surface the following year confirmed the discovery, and it was decided to collar a portal at the 4,625 feet elevation about two miles from Sandon and drive South half a mile to test the deposit. The success of this venture led to production in 1970, which has been continuous to this date.

Production to the end of 1982 has been close to 280,000 tons of ore containing 4.0 million ounces of silver and about 27 million pounds each of lead and zinc. * The majority of this has been brought out through the 4625 Level portal and trucked 2.5 miles (4km.) to the Concentrator at the south end of Sandon. Just before the start of 1980, however, new development on the 4000 Level, which had been rehabilitated in 1978, resulted in a new internal ore-handling system of greater efficiency, and now 95% of the ore is trammed out on the 4000 Level. The trucking distance from there is a mile shorter than from the upper level.

* Production from 1970 to the end of 1986 is 372,108 short dry tons (14.89 oz/t Ag (5,542,290 oz), 5.48% Pb (40,759,046 lbs.), 4.98% Zn (37,082,654 lbs.))

The Concentrator currently is operated on a 5 -day week basis, handling 100 to 125 tons per day. Occasionally ore from other mines has been treated there also.

About 40 people make up the payroll, only about 20 of who work in the mine itself. The rest are in the Mill, on the Surface crew or on Staff. Exploration mining on the 4000 Level and most of the diamond drilling on both levels has been done by outside contractors.

The geological structure which is gradually being traced throughout the Silvana property and in which all the orebodies so far mined have occurred is apparently the Main Lode, which is thought to run through the mountains for five miles (8km.) between Silverton and Sandon. By far the largest quantities of silver, lead and zinc mined in the Slocan area have come from orebodies in the Main Lode, several lesser lodes contributing the balance. Much of this structure is unexplored at depth and a large, unexplored segment lies on Silvana property west of the current workings. On the basis of past production and the amount of unexplored ground it could be assumed that Silvana might produce for another ten years, assuming favourable economic conditions to prevail, and a successful exploration program.

Following are summaries of the ways mining and concentration are carried out at the Silvana operation.

THE MINING CYCLE

"Drill - blast - muck out."This is the mining cycle in all mining. There are many different ways of accomplishing this, each mine employing its own variations to suit the material mined, the size of the orebody and its shape and the quantity to be milled each day.

The Silvana operation is described as the small tonnage, high ore grade type. The techniques used are suitable for isolated and variable-sized orebodies of a few feet thickness with large distances between them, and it is not physically possible to establish a large tonnage operation (e.g. 5,000 tons or more per day) with this type of orebody.

The drilling part of the cycle is therefore carried out using the "ordinary" jack-leg drill or the stoper drill, operated by one man and light enough to be carried and set up anywhere.

The blasting part is done after the miner has drilled his round of 24 to 32 8-feet-long (250cm.) holes, the actual number of holes depending on the size of the round and the hardness of the ground. The holes are loaded with sticks of blasting powder, primed with detonators, connected up with fuses and igniter cord. The miner "lights up" at the set blasting time.

Mucking-out is done the following shift. A slusherman goes into the heading, wets down the muckpile and sets up his cables to scrape (or slush) out the round, if it is a subdrift. Alternatively, if the heading is a drift or decline round, a scooptram operator scoops out the muck and delivers it to the wastepass, these large-type headings usually being driven in waste. The equipment used to muck out reflects the size of heading driven, thus a typical subdrift round is 8 feet (250cm.) high to enable rockbolting to be done, and 5 feet (150cm.) wide to accomodate the scraper. A decline or drift round is 8 feet (250cm.) high (for rockbolting) and 10 feet (3.0m.) wide to give the permissible 2.5 feet (75cm.) of clearance on either side of the scooptram. A muck raise may be only 4 feet (125cm.) wide and the same height whereas a manway raise is usually 6 feet by 6feet (1.8m. by 1.8m.) to allow ladders and a slide to be installed. In the case of a subdrift or stope mucked out by scraping or slushing, an air or electrically-powered winch pulls a scraper (also called a bucket or hoe) back and forth via a system of cables and pulley blocks to bring the muck (usually ore) to the muck raise whereby it falls to a stub drift below.

The point where the ore issues from the muck raise into the stub drift is called a drawpoint. Scooptrams remove the material and deliver it to the orepass. The scooptrams (or load-haul-dump units) at Silvana carry about 2.7 tons per scoop. They have 6-cylinder diesel air-cooled motors and travel at about 5 m.p.h. (8 km./hr.).

The main ore and waste passes are over 300 feet long (100m.), are inclined at 50 degrees, and have at their lower ends at the 4000 Level, air-powered chutes that control the flow of material into the rail cars. Capacity of each car is about 4 tons. Four cars make up a train, hauled by battery powered electric locomotive, that travels on 2-feet gauge (60cm.) track for 1.25 miles (2km.) before reaching the surface. The present dumping point requires a loader to pick up the ore and fill the ore truck. A new system to eliminate the use of the loader and allow more ore to be stored outside in winter is expected to be in service sometime in the future.

THE THREE STAGES OF MINING (1)-EXPLORATION

This refers to the routine driving of planned drifts etc. and any diamond drilling accompanying them whilst searching for the Main Lode and any ore within it.

The diagram illustrates an exploration drift being driven 50 to 100 feet (15 to 30 m.) under the expected position of the lode structure, the establishment of a diamond-drilling station and the usual pattern of drilling done to intersect the lode.

In addition to horizontal drifting, declining and ramping are used to bring the exploration headings to their desired positions. Both these terms refer to the use of rubber-tired equipment rather than rail-based in the operation. Instead of sinking a shaft and employing railroad-type machinery which can only be used in horizontal drifting, rubber-tired equipment can go downhill, the heading being called a decline, or uphill, on a ramp. Although the steepest practical limit to driving declines and ramps is 15% (about 8 degrees)-whereas a shaft can be driven vertically if necessary-there is greater flexibility in deciding how best to use these headings for exploration and also for subsequent mining and this is a very important consideration with the Main Lode orebodies.

The diagram is a projection on to a horizontal plane at the scale of 1 in. to 20 feet (1:240). The lode structure position is indicated by contour lines on its upper surface. That the lode is generally lower in elevation to the south rather than to the north is given the geological term "southerly dip" (or the lode is said to dip to the south).

In this illustration, diamond drilling has intersected some ore-bearing as well as some barren areas in the lode. Now a strtegy has to be formulated to reach and mine the ore, as described in the next section.

(2)-DEVELOPMENT

Exploration headings already driven are used as far as practicable to provide places from which development headings are driven to the ore. The accompanying diagram shows a short, stub drift being driven so that raises can be collared, one for access (manway) and one for removing ore (muck raise). If the stub for the diamond drilling station can be used for collaring development, so much the better.

Raises must be driven steeper than 43 degrees from the horizontal for material to be removable from them by gravity alone. 50 degrees is the usual inclination of raises driven at Silvana. Lengths are usually 30 to 75 feet (10 to 23 m.), sometimes longer and take 1 week to several weeks to complete.

Where the raises reach the lode, a connection is made by subdrift, and the technique of subdrifting is then used to outline the block of ore and produce the initial material from it. Subdrifts are flat to shallowly inclined headings 8 feet high and 5 to 6 feet wide.

THE THREE STAGES OF MINING (3)-EXTRACTION

Extraction is the stage that mining people hope will be long-lived, simple and rewarding, but is seldom all three of those. Once access to the ore has been established, and the initial subdrifting has outlined the ore, an attempt is made to remove the ore as efficiently as possible. This process is called stoping.

Stoping consists of "slashing" the walls of subdrifts, using relatively little drilling and blasting, leaving pillars in poorer grade or structurally weak areas. The proportion of pillars left to ore present is kept as small as feasible, usually we aim for 20% left as pillars, or 80% recovery of the ore. To enable such figures to be attained, rockbolting and usually some sort of timbering is vital to support the stope until mining is completed.

When all the ore that can be safely removed has been broken and scraped, final cleanup is done by means of a compressed-air blowpipe, shovelling (mucking) by hand etc. to ensure maximum recovery.

GENERAL CONSIDERATIONS IN THE SILVANA MINING OPERATION

The mining process itself is not that complex, which explains why there are only 10 miners on the payroll. however the other facets of ore production require another 10 people underground, working on such activities as:

- Maintaining adequate ventilation to remove noxious gases produced by diesel equipment, blasting etc.,
- Timbering and ground support to maintain safe access and roadways through unstable ground,
- Servicing equipment: Diesel, compressed-air and electrically powered,
- Removing mined material from the miners' working-places and out of the mine,
- Bringing supplies such as explosives, timber, rockbolts, fuel, oil, repaired equipment and any that needs repair, etc.

In addition, people are needed outside the mine to service and run air compressors, electrical generators, fabricate and repair equipment, cut lumber, run snowplows and do a multitude of other more or less vital jobs to enable mining to proceed and facilitate the ore mined in reaching the Concentrator.

The remaining 10 people are employed in the Concentrator where the ore is crushed, ground, put through a flotation process that separates the valuable mineral particles from the waste ones then filters out moisture to leave lead and zinc concentrates that are shipped to the smelter. The accompanying flowsheets etc. indicate the various steps in some detail.

CONCENTRATION - STAGE 1 - CRUSHING

Ore from the mine is delivered to the crushing plant by truck and dumped into the coarse-ore bin over which is installed a grizzly. Oversize pieces (which are very unpopular!) that do not pass through the grizzly are broken with a sledgehammer.
The ore leaves the coarse-ore bin through a feeder and moves by means of a set of transfer conveyor belts from one operation to the next in the crushing cycle.

First the stream of ore is delivered to a grizzly that separates out material larger than $1\frac{1}{2}$" (4cm.) in diameter and sends it to the jaw crusher. The crushed ore rejoins the smaller diameter portion and everything passes under a magnet and into a transfer chute. The magnet removes unwanted ferrous fragments not spotted earlier in the process, such as wire rope strands, occasionally rockdrill bits, etc.

The next step is screening to separate out larger than $\frac{1}{2}$" (1.25cm.) diameter fragments of ore for delivery to the cone crusher. The screen is a double-deck, vibrating type. Difficulty with the screening process occurs when the ore is wet and sticky, so the mine personnel do their best to get fairly dry material to the Mill.
After reduction to the $\frac{1}{2}$" (1.25cm.) diameter in the cone crusher this material rejoins the smaller-size fraction that passed through the screen and everything goes into the fine-ore bin, ready to be fed into the mills.

CONCENTRATION - STAGE 2 - GRINDING

Feed for the two grinding mills comes from the crushing plant fine-ore bin on the two feed conveyor belts. The ore is ground to particles no larger than sand grains in these rubber-lined mills. Steel balls continuously circulate with the ore and do most of the grinding. Aiding this process are water and chemicals such as $ZnSO4$. Until fairly recently, these mills were much noisier, as they were steel-lined. Rubber liners make them quieter, also less energy is required to turn them as such liners are lighter in weight than steel ones and have to be replaced less frequently.

The ball mill products, which are slurries of ground ore, water and chemicals, pass into one of two machines: a unit cell (material from No. 1 Mill), or a spiral-type classifier (material from No. 2 Mill). The unit cell sends whatever high grade lead-bearing material has already been liberated by the grinding to the filtering stage, bypassing the flotation stage. Remaining material from the unit cell goes into the classifier along with the No. 2 Mill product. The classifier returns any coarse material to the No. 1 Mill for regrinding and sends the rest to the next stage - flotation.

CONCENTRATION - STAGE 3 - FLOTATION

Flotation "floats" the metal-bearing particles off the slurry stream, leaving behind barren rock particles which are sent to the tailings pond. Although it sounds fairly simple it is one of the most complex operations to achieve in concentration, and the skill and expertise of the operators is crucial to the efficiency of the process.

From the classifier the ore slurry passes into the lead circuit cells along with certain chemical reagents including $ZnSO_4$. The flow diagram indicates the stream progressing through "rougher" cells, where it separates into underflow - relatively barren of lead and rich in zinc - and overflow - relatively high in lead and low in zinc portions. The latter goes to a cleaner cell which further concentrates the lead- bearing portion and returns the rest to the rougher cells again. The lead-bearing portion now goes to the filtration stage along with the earlier- made concentrate from the unit cell. The rougher cell tailings - rich in zinc - become the feed for the zinc circuit.

Zinc concentration is more difficult than lead concentration, thus there are more cells and an extra stage of cleaning (called recleaning or super-cleaning). At the head of the circuit chemical reagents different to those for lead are added, including $CuSO_4$ and lime. The products are a zinc concentrate and almost barren tailings.

CONCENTRATION - STAGE 4 - FILTRATION

Streams of lead concentrate slurry and zinc concentrate slurry are pumped to a disc or "american" type filter. This is a vacuum filter whose six discs slowly revolve through the concentrate slurry, picking up concentrate particles and removing water by suction, the caked-on concentrate then being scraped off to fall into a bin or pot. Three discs are used for each product, lead and zinc. Filtered concentrate contains about 10% water.

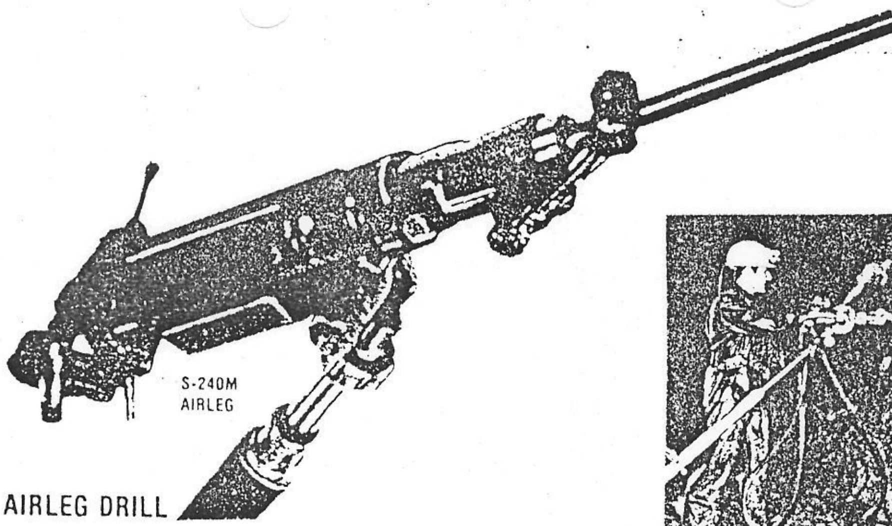
Concentrate in pots is transferred to storage in the millyard until they are freighted by truck to the smelter. Each pot holds 5 to 7 tons of concentrate. Lead concentrate contains about 125 oz. / ton Ag and 75% Pb, 10% Zn.

TAILINGS DISPOSAL

This is not strictly a stage in concentration, nevertheless it is a very important part of the overall mining operation, as adequate and safe disposal of the barren waste material and any accompanying chemicals is an expensive process both in engineering and construction.

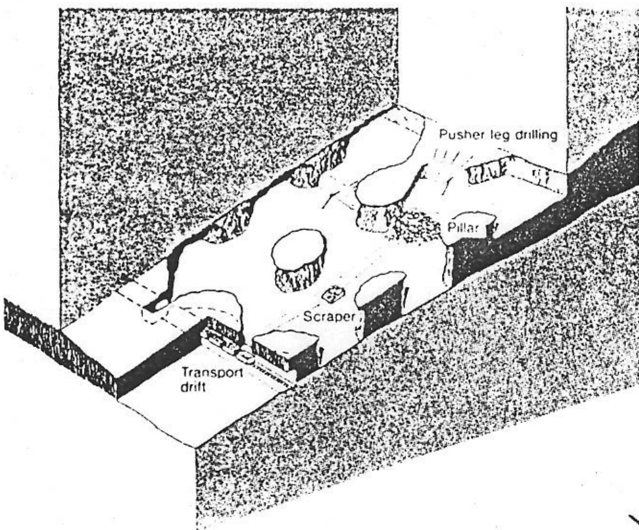
There are two types of waste material: Mill tailings and Mine waste rock. Mill tailings arise from the concentration process as described above, as sand and mud. To this material is added the filtrate from Stage 4 above and the whole is pumped through a pipeline to the tailings storage area. Currently this area is undergoing expansion, as nearly 12 years of milling has almost filled the original area. A system of dikes and dams engineered to withstand floods larger than that which destroyed most of Sandon will enable several more years of mining to proceed.

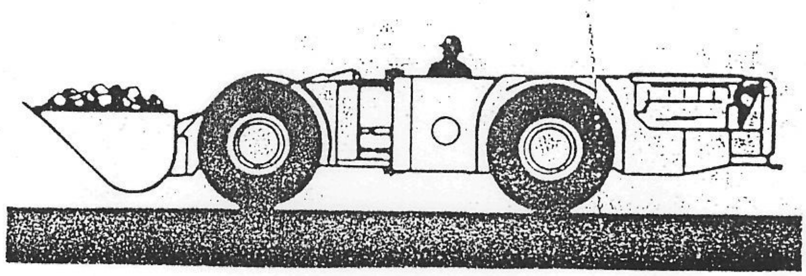
Mine waste rock contains very little metal and minor amounts of lubricating oil from drills, etc. and very little else. It is dumped immediately outside the portals and usually acts as a filter for the water draining from the mine. Although waste dumps can be unsightly they affect the environment but slightly, unless they contain enough leachable, harmful material to affect the water draining through them. This appears unlikely with the Silvana dumps, also testing of the effluent from our tailings ponds routinely shows the system is working efficiently and within government-prescribed limits.



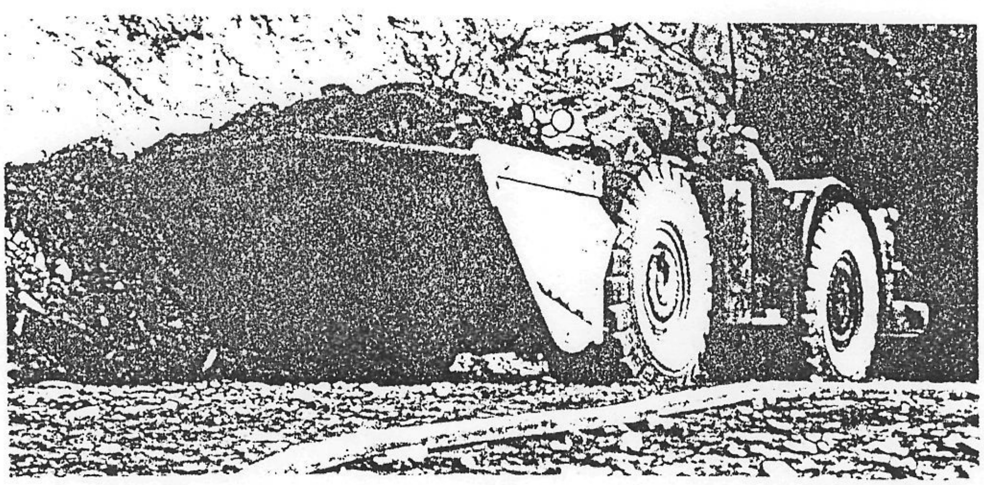
AIRLEG DRILL

Room-and-pillar mining in an inclined deposit





SCOOPTRAM



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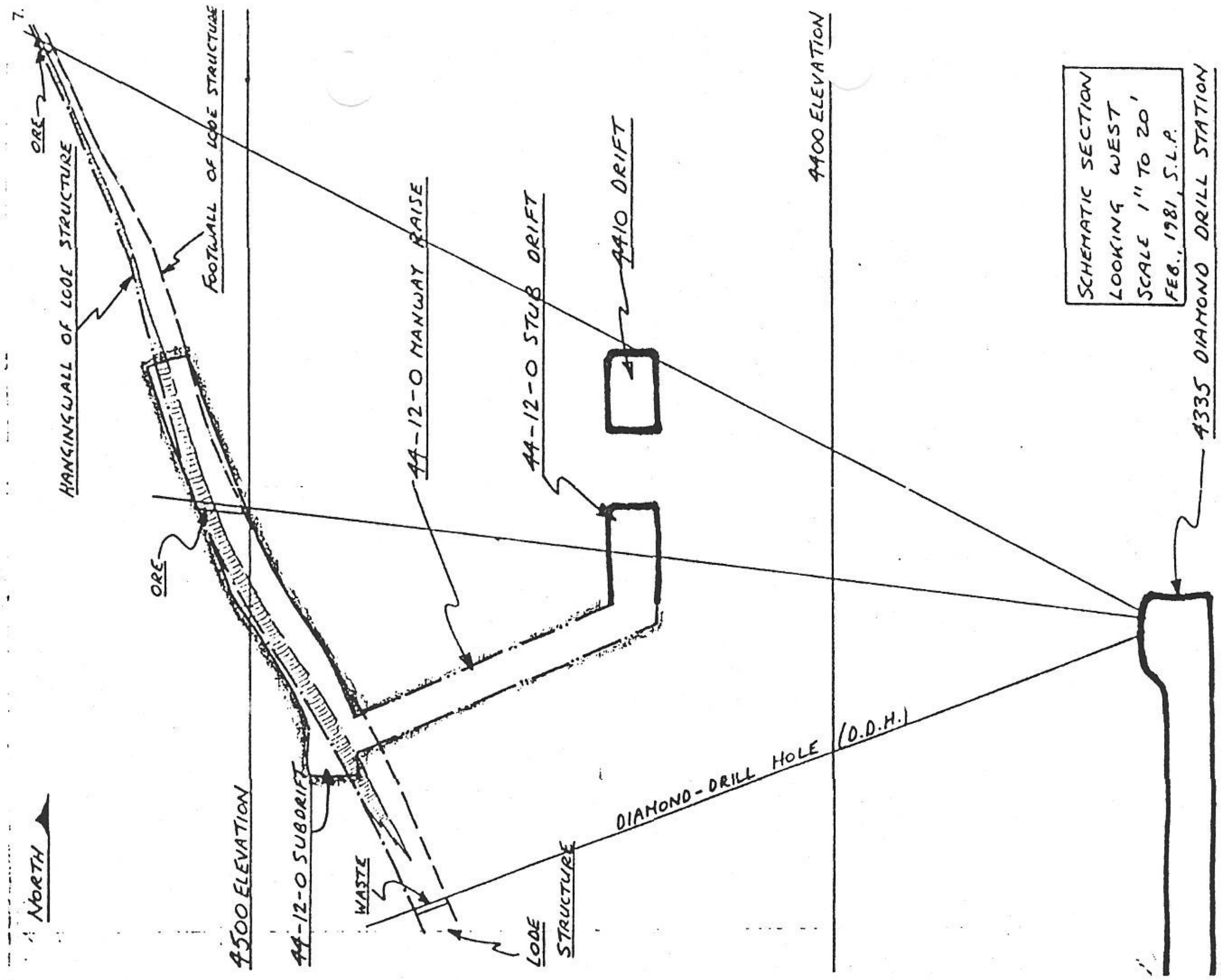
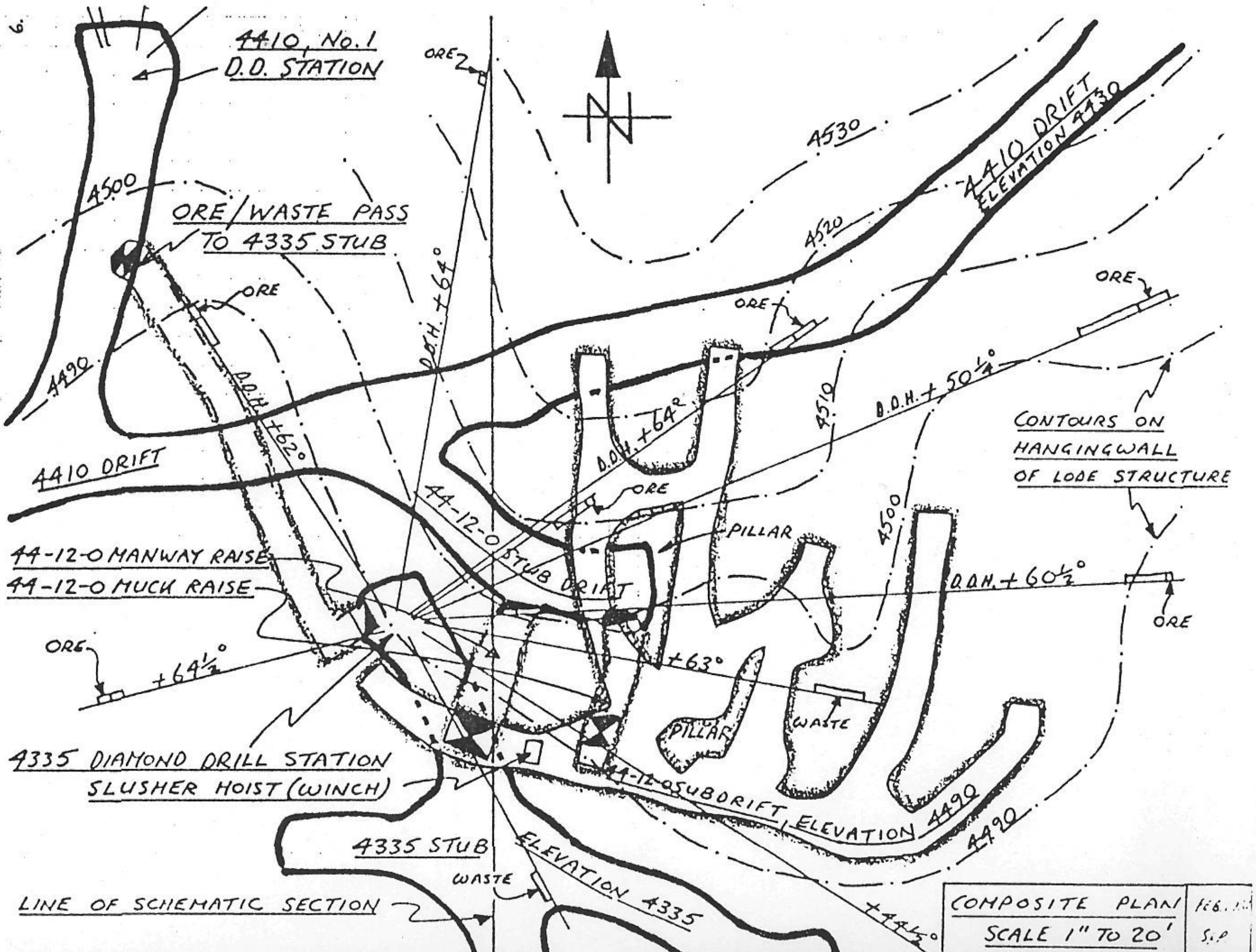


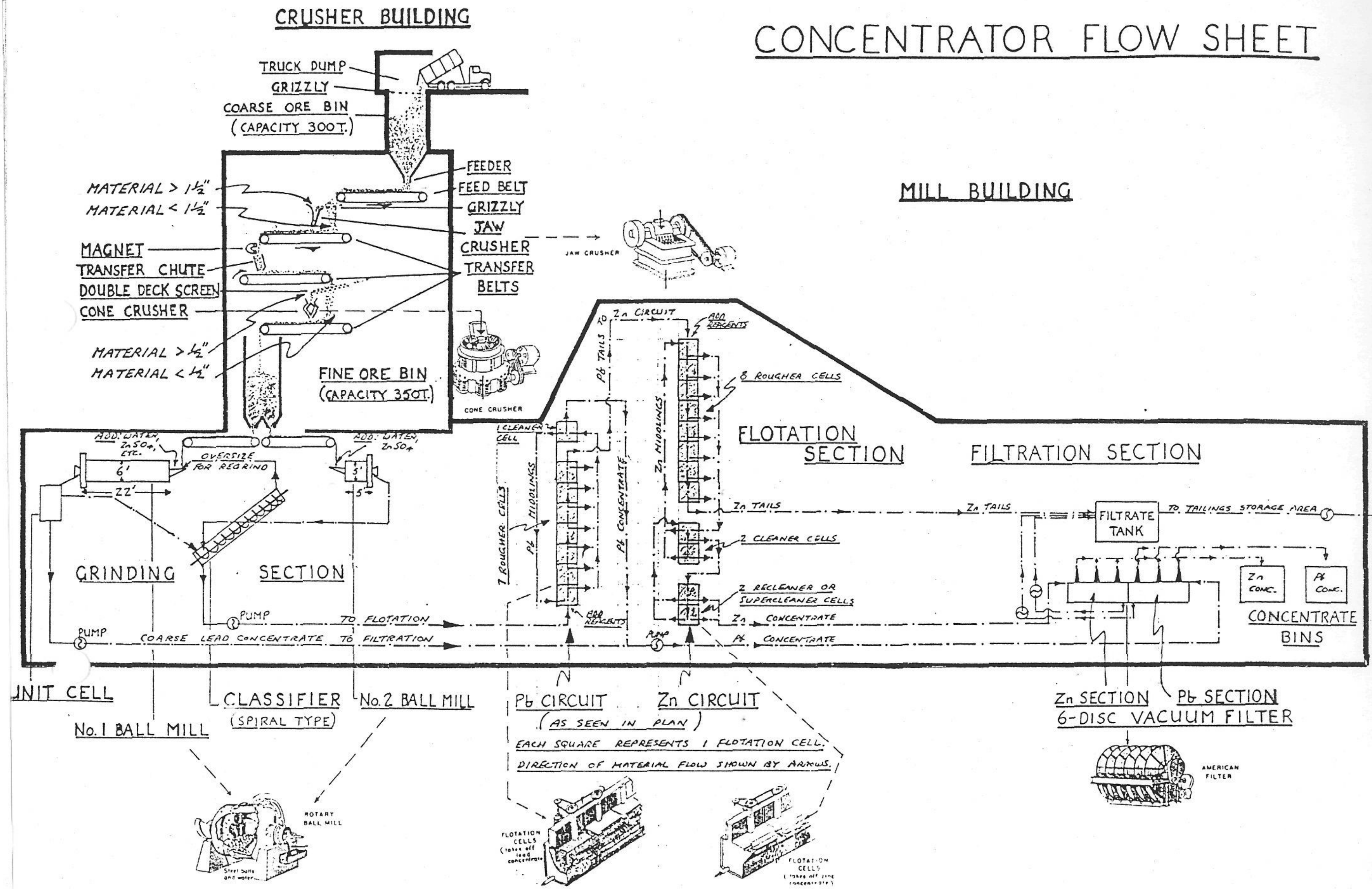
SCHEMATIC SECTION
LOOKING WEST
SCALE 1" TO 20'
FEB., 1981, S.L.P.
4335 DIAMOND DRILL STATION
4335 STUB
4400 ELEVATION
4410 DRIFT
44-12-0 STUB DRIFT
44-12-0 MANWAY RAISE
FOOTWALL OF LODE STRUCTURE
HANGINGWALL OF LODE STRUCTURE
ORE
DIAMOND-DRILL HOLE (D.D.H.)
LODE STRUCTURE
WASTE
44-12-0 SUBDRIFT
4500 ELEVATION
NORTH

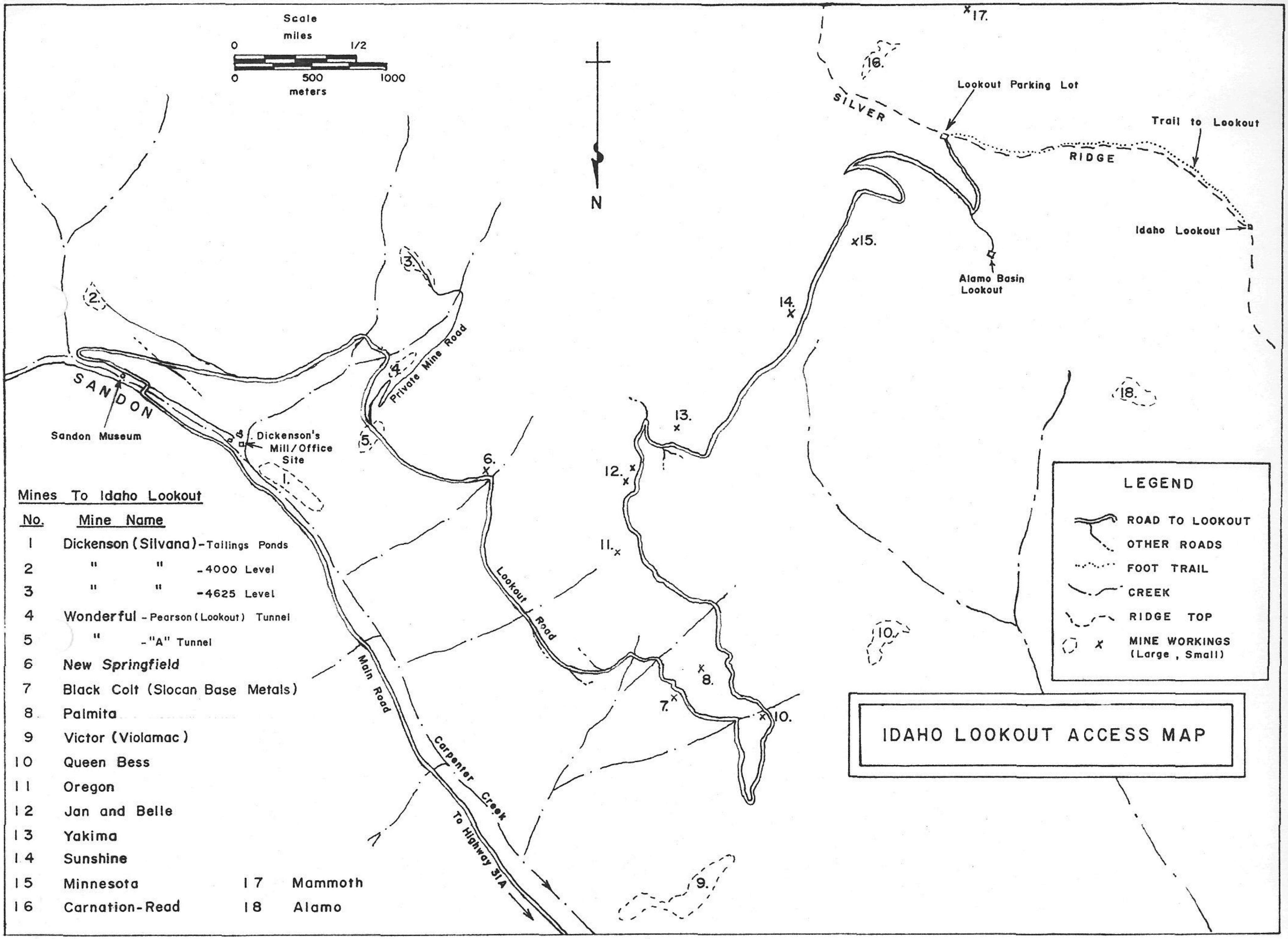
6.



4410, No. 1
D.D. STATION
ORE/WASTE PASS
TO 4335 STUB
4500
4490
4530
4520
4510
4410 DRIFT
ELEVATION 4430
ORE
D.D.H. +64°
D.D.H. +62°
D.D.H. + 50½°
D.D.H. + 60½°
CONTOURS ON
HANGINGWALL
OF LODE STRUCTURE
4410 DRIFT
44-12-0 STUB DRIFT
PILLAR
44-12-0 MANWAY RAISE
44-12-0 MUCK RAISE
+64½°
+63°
WASTE
4335 DIAMOND DRILL STATION
SLUSHER HOIST (WINCH)
44-12-0 SUBDRIFT, ELEVATION 4490
4335 STUB
ELEVATION 4335
LINE OF SCHEMATIC SECTION
COMPOSITE PLAN
SCALE 1" TO 20'
FEB. ...
S.P.

CONCENTRATOR FLOW SHEET





IDAHO LOOKOUT ACCESS MAP
Scale
miles
0
1/2
0
500
1000
meters
N
SILVER
RIDGE
Lookout Parking Lot
Trail to Lookout
Idaho Lookout
Alamo Basin Lookout
SANDON
Sandon Museum
Dickenson's Mill/Office Site
Private Mine Road
Lookout Road
Main Road
Carpenter Creek
To Highway 31A
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
Mines To Idaho Lookout
No. Mine Name
1 Dickenson (Silvana) - Tailings Ponds
2 " " - 4000 Level
3 " " - 4625 Level
4 Wonderful - Pearson (Lookout) Tunnel
5 " - "A" Tunnel
6 New Springfield
7 Black Colt (Slocan Base Metals)
8 Palmita
9 Victor (Violamac)
10 Queen Bess
11 Oregon
12 Jan and Belle
13 Yakima
14 Sunshine
15 Minnesota
16 Carnation-Read
17 Mammoth
18 Alamo
LEGEND
ROAD TO LOOKOUT
OTHER ROADS
FOOT TRAIL
CREEK
RIDGE TOP
MINE WORKINGS (Large, Small)