Location/Identification

MINFILE Number: 082FNE052

National Mineral Inventory Number: 082F9,G12 Pb1

Name(s): SULLIVAN
SULLIVAN MINE

Status: Past Producer

Mining Division: Fort Steele

Mining Method Underground, Open Pit

Electoral District: Columbia River-Revelstoke

Regions: British Columbia

Resource District: Rocky Mountain Forest District

BCGS Map: 082F080

NTS Map: 082F09E, 082G12W

UTM Zone: 11 (NAD 83)

Latitude: 49 42 27 N

Northing: 5506585

Longitude: 116 00 19 W

Easting: 571720

Elevation: 1420 metres

Location Accuracy: Within 500M

Comments: Centre of lower open pit partially within Lot 1386 (Hamlet) on the lower southern slope of Sullivan Hill, north of Mark Creek, 3.5 kilometres north-northwest from the town of Kimberley (NTS Map 82F9).

Mineral Occurrence

Commodities: Lead, Zinc, Silver, Tin, Copper, Gold, Iron, Sulphur, Antimony, Cadmium, Bismuth

Minerals

Significant: Pyrrhotite, Pyrite, Galena, Sphalerite, Tetrahedrite, Pyrargyrite, Boulangerite, Cassiterite, Chalcopyrite, Jamesonite, Scheelite, Stannite, Marmatite, Chalcostibite, Gudmundite, Mcgillite

Significant Comments: Trace chalcostibite and gudmundite.

Associated: Pyrrhotite, Pyrite, Magnetite, Arsenopyrite, Quartz, Calcite, Tourmaline, Mcgillite

Alteration: Tourmaline, Albite, Chlorite, Carbonate, Pyrite, Biotite, Garnet, Calcite

Alteration Comments: Also sphene, hornblende, epidote, muscovite, mica, zircon, scapolite, quartz, sericite, tremolite, actinolite, cordierite, cerussite and pyromorphite.

Alteration Type: Tourmalinz'n, Albitic, Chloritic, Carbonate, Pyrite

Mineralization Age: Middle Proterozoic

Isotopic Age: 1450 Ma **Dating Method:** Lead/Lead **Material Dated:** Galena

Deposit

Character: Stratiform, Stratabound, Massive, Vein

Classification: Syngenetic, Sedimentary, Exhalative, Industrial Min.

Type: E14: Sedimentary exhalative Zn-Pb-Ag, I05: Polymetallic veins Ag-Pb-Zn+/-Au

Shape: Tabular **Modifier:** Faulted

Dimension: 2000x1600x21 metres **Strike/Dip:** 360/23E

Comments: Sullivan orebody; age date data from Geological Association of Canada Special Paper 25.

Host Rock

Dominant Host Rock: Sedimentary

Stratigraphic Age	Group	Formation	Igneous/Metamorphic/Other
Middle Proterozoic	Purcell	Lower Aldridge	------
Middle Proterozoic	Purcell	Middle Aldridge	------
Middle Proterozoic	------	------	Moyie Intrusions

Isotopic Age	Dating Method	Material Dated
------	------	------
------	------	------
------	------	-

Lithology: Quartz Wacke, Mudstone, Intraformational Conglomerate, Lithic Wacke, Tourmalinite, Gabbro, Breccia, Quartz Arenite

Geological Setting

Tectonic Belt: Omineca **Physiographic Area:** Purcell Mountains

Terrane: Ancestral North America

Metamorphic Type: Regional

Grade: Greenschist

Comments: Upper greenschist facies. Upper greenschist facies.

Inventory

Ore Zone: SULLIVAN **Year:** 2000

Category: Proven **Report On:** Y

Quantity: 1,800,000 tonnes **NI 43-101:** N

Commodity	Grade
Silver	17.0000 grams per tonne
Lead	3.2000 per cent
Zinc	6.6000 per cent

Comments:

Reference: Cominco Annual Report 2000.

Summary Production

		Metric		Imperial	
	Mined:	149,173,608	tonnes	164,435,755	tons
	Milled:	150,453,162	tonnes	165,846,222	tons
Recovery	Silver	9,264,200,966	grams	297,850,977	ounces
	Gold	174,863	grams	5,622	ounces
	Lead	8,412,076,665	kilograms	18,545,454,512	pounds
	Zinc	7,944,445,846	kilograms	17,514,505,030	pounds
	Tin	9,702,543	kilograms	21,390,446	pounds
	Copper	5,106,742	kilograms	11,258,439	pounds
	Cadmium	3,094,872	kilograms	6,823,025	pounds
	Antimony	413,700	kilograms	912,052	pounds
	Bismuth	21,880	kilograms	48,237	pounds

Capsule Geology

The Proterozoic Purcell Supergroup in southeastern British Columbia constitutes a thick prism of dominantly clastic sediments exceeding 10,000 metres in thickness with the base unexposed. Earliest known sedimentation are Fort Steele Formation fluvial/deltaic sequences of quartz arenite, quartz wacke and mudstone at least 200 metres thick. Fine-grained clastic beds at the top of the formation grade into very rusty-weathering, fine-grained quartz wacke and mudstone of the Aldridge Formation (1433 Ma +/- 10 Ma), at least 5000 metres thick in the Purcell Mountains. The Aldridge Formation grades upward over 300 metres through a sequence of carbonaceous mudstone with minor beds of grey and green mudstone and fine-grained quartz wacke to the 1800 metre thick Creston Formation, composed of grey, green and maroon quartz wacke and mudstone with minor white arenite. Conformably overlying the Creston Formation are 1200 metres of green and grey dolomitic mudstone, buff-weathering dolomite and minor quartz arenite of the Kitchener Formation. The Kitchener is in turn overlain by 200 to 400 metres of green, slightly dolomitic and calcareous mudstone of the Siyeh Formation. Although poorly defined in the Purcell Mountains west of the Rocky Mountain Trench, the Siyeh is readily recognized in the Rocky Mountains and is conformably and locally unconformably overlain by 0 to 500 metres of basaltic to andesitic flows of the Purcell Lava (1075 Ma) which are taken to mark the close of Lower Purcell sedimentation (1075 to 1500 Ma). To the northwest and west in the Purcell Mountains, the Purcell Lava is only sparsely represented by weathered tuffaceous beds.

Resting with apparent conformity on the Lower Purcell rocks are about 1200 metres of grey to dark grey, calcareous and dolomitic mudstone and minor quartz wacke of the Dutch Creek Formation. This formation is overlain by about 1000 metres of grey, green and maroon mudstone and calcareous mudstone of the Mount Nelson Formation. The close of Purcell sedimentation is marked by folding during the East Kootenay Orogeny (825 to 900 Ma) and disruption of the basin by large-scale vertical faults concurrent with deposition of basal sedimentary rocks of the Windermere

Supergroup.

Middle Proterozoic igneous activity in the Purcell sedimentary basin is dominated by intrusion of gabbroic sills of two ages. The oldest are the Moyie Intrusions which are most common in the Aldridge Formation. Sills and slightly discordant sheets predominate; locally, however, dykes and step-like discordant sheets are abundant near Kimberley. Gabbroic sills can aggregate 2000 metres of thickness in a typical Aldridge section and are most abundant in the lower part of the section. The youngest event of gabbro intrusion is thought to be comagmatic with the Purcell Lavas, and is represented by abundant sills in the upper part of the Creston Formation, and in the Kitchener and Siyeh formations. The pegmatitic Hellroaring Creek stock (Middle Proterozoic) and related satellites intrude metamorphosed and deformed Aldridge sedimentary rocks and Moyie Intrusions sills, in an area about 15 kilometres southwest of the Sullivan mine.

Lower Purcell sedimentary rocks have undergone metamorphism to at least greenschist facies. There is a general increase in metamorphic grade with depth in the stratigraphic pile; minor areas of amphibolite facies are restricted to the cores of fold structures displaying large magnitude structural relief.

Purcell rocks are folded about north trending axes to form the Purcell Anticlinorium. Folds comprising the large structure are open and gentle with north plunging axes. Some folds are overturned to the east and some display axial plane schistosity. Large areas within the anticlinorium have nearly flat-lying strata. Major faults with a history of complex movement disrupt the Purcell terrain and separate large regions further disrupted by block faulting. Two of these major faults, the Moyie and St. Mary faults, pass south of Kimberley and throughout much of their extent have a northerly trend, but then abruptly arc to the east into the Rocky Mountain Trench. Both of these faults repeat Lower Purcell strata on their north and west, upthrown sides. The Sullivan orebody occurs on the east side of this regional structure, on the east limb of an open anticline.

The Middle Proterozoic Aldridge Formation (Purcell Supergroup- Lower Purcell Group), has the characteristics of a flysch sequence at least 3800 metres thick. It is composed of a monotonous and repetitious sequence of alternating beds of very fine-grained quartz wacke and mudstone and lesser amounts of very fine- to coarse-grained quartz arenite. The Aldridge Formation is metamorphosed to middle to upper greenschist facies. The Aldridge Formation in the Purcell Mountains has been divided into three map units; the Lower, Middle and Upper Aldridge. Lower Aldridge sedimentary rocks (at least 1500 metres thick - base not exposed) are composed of a rhythmic succession of thin to medium-bedded, typically graded beds of very fine-grained quartz wacke. Interbedded with the rhythmic sequence of graded beds are laminated sequences of mudstone ranging from a few millimetres to several metres thick. Laminae and discontinuous blebs of pyrrhotite emphasize layering in the laminated mudstone and weathering of the pyrrhotite imparts a conspicuous rusty colour to outcrops. Massive to poorly bedded, elongate lenses of intraformational conglomerate occur locally near the top of the Lower Aldridge. The Middle Aldridge (2000 metres thick) is marked by the appearance of distinctive graded arenaceous beds whose lighter weathering colours contrast sharply with the rusty weathering Lower Aldridge. Thinly bedded, rusty weathering rocks similar to those in Lower Aldridge sequences are interbedded with thicker, graded arenites but are definitely subordinate. The graded arenaceous rocks are mostly turbidites. Thin bedded to laminated carbonaceous mudstone becomes the dominant lithology of the 300 metre thick Upper Aldridge. The contact between the Middle and Upper Aldridge is gradational over stratigraphic thicknesses ranging from a few to tens of metres. Disseminated grains and blebs of pyrrhotite aligned along bedding occur in places in carbonaceous mudstone of the Upper Aldridge and here the rock is rusty weathering.

The Sullivan orebody is located at the western edge of the Rocky Mountain Trench and on the eastern flank of the Purcell Mountains. The orebody is a conformable iron-lead-zinc sulphide lens enclosed by clastic metasedimentary rocks of the Middle Proterozoic (Helikian) Aldridge Formation, the basal formation of the Purcell Supergroup (further subdivided into the Lower Purcell Group). Regional metamorphism is upper greenschist facies. The orebody occurs near the top of the Lower Aldridge Formation and has the shape of an inverted and tilted saucer. The maximum north-south dimension is about 2000 metres and the east-west dimension is about 1600 metres. It has flat to gentle east dips in the west, moderate east to northeast dips in the centre, and gentle east to northeast dips in the east. The footwall rocks are composed of intraformational conglomerate and massive lithic wacke overlain by quartz wacke and pyrrhotite-laminated mudstone. The ore zone is overlain by several upward-fining sequences of quartz wacke and mudstone. The orebody attains a maximum thickness of 100 metres approximately 100 metres northwest of its geographic centre, and thins outward in all directions (averages 21 metres in thickness). To the east, it thins gradually to a sequence of pyrrhotite-laminated mudstone 3 to 5 metres thick that persists laterally for some distance. To the north, the orebody thins less gradually and is truncated by the Kimberley fault. To the west, the orebody thins abruptly and is cut by dyke-like apophyses of the footwall gabbro. The gabbro (of the Middle Proterozoic Moyie Intrusions) lies beneath the orebody and is typically concordant about 500 metres below its eastern edge. To the west, the gabbro rapidly transgresses upward to meet the footwall of the orebody near its western margin but, continuing westward it transgresses downward to resume its sill-like form at approximately its original stratigraphic position. To the south, within the limit of economic mineralization, thickness changes are generally irregular and abrupt.

The Sullivan orebody lies on the folded and faulted eastern limb of a broad north trending anticline. The structure plunges gently to the north and is locally asymmetric and overturned to the east. Detailed structural mapping has revealed three phases of folding. Phase 1 is characterized by isoclinal folds with axial planes parallel to bedding planes and north trending fold axes. Phase 2 is characterized by relatively open folds with gentle north or south plunges and with moderately west dipping axial planes. Both Phase 1 and 2 folds indicate easterly vergence. Phase 3 folds are associated with east dipping thrusts; axial planes have steep dips and folds have variable plunges to northwest and southeast.

The Kimberley, Ryot and Hidden Hand fault systems, the 010 degree trending Sullivan-type faults and other minor faults form an intricate mosaic disrupting the fold limb. The Kimberley and Hidden Hand faults lie across the regional structure and are generally parallel to east trending segments of the Moyie and St. Mary faults. The Kimberley fault dips 45 to 55 degrees north and truncates the ore zone to the north. With over 3000 metres of stratigraphic displacement, the fault juxtaposes rocks of the Creston and Kitchener formations against rocks of the Lower Aldridge. Displacement on the north dipping Hidden Hand fault is of the order of a few hundred metres of apparent normal dip-slip movement. The Sullivan-type faults cut the orebody with a consistent west side down normal displacement ranging from a few metres to 30 metres. The largest member of the group, the Sullivan fault, occurs near the western margin of the orebody. At the northwestern margin of the orebody, a northeast trending fault apparently truncates the westward extension of the Kimberley fault although earlier phases of movement along the Sullivan-type faults may have occurred.

The Sullivan orebody consists of sulphide rock composed of more than 70 per cent sulphides in thick, gently dipping conformable units enclosed by unaltered or altered quartz wacke and mudstone. In the western part, massive pyrrhotite containing occasional wispy layers of galena is overlain by sulphide rock in which conformable layering consists of pyrrhotite, sphalerite, galena and pyrite intercalated with beds of clastic sedimentary rock. The ore passes outward on the north, east and south to delicately-bedded sulphide rock interbedded with fine-grained clastic sedimentary rocks. Eastward across a transition zone, the orebody is composed of five distinct conformable units of well-bedded sulphide rock interbedded with clastic sedimentary rock. Each bed of sulphide rock thins eastward from the transition zone. The transition zone is commonly only a few metres or tens of metres wide. Three bedded sulphide sequences occur above the main orebody, particularly in the area of the transition zone. Locally, these are ore. Sulphide vein mineralization is present in the footwall in and adjacent to a zone of tourmalinite and very rare elsewhere. Irregular veins commonly form networks composed dominantly of pyrrhotite, galena and sphalerite. Generally minor amounts of quartz, arsenopyrite, chalcopyrite, cassiterite, tourmaline or scheelite occur in some veins. Major differences exist in footwall rocks, ore zone and hanging wall rocks in different areas of the mine.

Much of the orebody is underlain by locally derived intraformational conglomerate which is more than 80 metres thick in the west and thins to the east. Footwall rocks are cut by tabular bodies of chaotic breccia containing blocks of conglomerate and bedded sedimentary rock; these extend downward unknown distances from the sulphide footwall in the west. Footwall mineralization consisting of thin conformable laminae, veins and locally intense fracture-filling is common in the west and very rare in the east.

The footwall and hanging wall rocks and locally the orebody in the west have been extensively altered by hydrothermal solutions. A crosscutting zone of tourmalinite underlying the sulphide lens in the west is 1000 by 1500 metres across at the sulphide footwall and extends at least 500 metres beneath the orebody. Albite-chlorite- pyrite alteration occurs in crosscutting zones in the footwall tourmalinite and extends more than 100 metres into the hanging wall over the western part of the orebody. A zone of pyrite-chlorite alteration 300 metres in diameter crosscuts massive sulphide rock immediately overlying footwall albite-chlorite-pyrite alteration zones.

Extensive volumes of altered rock occur below, within and above the ore zone in the western part of the mine. Tourmalinite is included with wallrock alteration because most of the tourmalinite, except for that near the sulphide footwall, has crosscutting relations. Altered rocks unusually rich in chlorite, albite, pyrite, biotite, garnet and calcite occur in restricted crosscutting footwall structures, in a zone which crosscuts the orebody, and also occupy an extensive volume of rock in the hanging wall. Accessory minerals in altered hanging wall rocks include tourmaline, sphene, subordinate white mica, zircon, scapolite, calcite and quartz. Although minerals in altered rock have a metamorphic texture, their occurrence is interpreted as reflecting pre-metamorphic chemical modifications.

Pyrrhotite and pyrite (ratio of 7:3) are the most abundant sulphides in the Sullivan orebody. Galena and sphalerite (marmatite is the iron-rich variety) are the principal ore minerals. Minor but economically important minerals include tetrahedrite, pyrargyrite, boulangerite and arsenopyrite (deleterious). Cassiterite is an important minor constituent in the western part of the orebody. Minerals constituting less than 1 per cent include chalcopyrite, jamesonite, magnetite and less abundant scheelite and stannite. Trace or small amounts of chalcostibite and gudmundite have also been identified along with cerussite and pyromorphite. Principal non-sulphide minerals are quartz and calcite with abundant tourmaline, chlorite, muscovite, albite, pale brown to reddish-brown mica, garnet, tremolite, epidote, actinolite, cordierite and hornblende. Either quartz or calcite may make up 50 to 70 per cent of the non-sulphide suite, chlorite 30 per cent and the other minerals up to about 20 per cent.

In 1945 a pink mineral occurring as open-space fracture-fillings was found in a development raise in the southwest part of the orebody in an area where both ore and enclosing sedimentary rocks are highly manganiferous. This area is now an open pit and the pink mineral, tentatively identified as friedelite, is no longer to be found. Thirty-one years later a routine X-ray check was made from one of many hand specimens stored. Further work identified the mineral as a new mineral, mcgillite, the fifth member of the pyrosmalite group. Mcgillite is most often associated with very dark sphalerite and small amounts of boulangerite, galena, jamesonite and milky quartz.

Processing of Sullivan ore include recoverable amounts of cadmium, gold, bismuth, indium, iron, sulphur and antimonial lead and tin concentrate.

The Sullivan orebody is interpreted as a hydrothermal synsedimentary deposit which formed in a sub-basin on the Aldridge marine floor. It is located directly over conduits through which mineralizing fluids passed. Cross-strata permeability developed along synsedimentary faults and fractures; fluid escape along these led to development of chaotic breccia zones. Footwall conglomerate was extruded from breccia pipes or was laid down when locally oversteepened sediments collapsed. Boron-rich fluids percolated up the zones of cross-strata permeability, soaking adjoining footwall sediments and discharging onto the sea floor. Fluid composition and/or conditions in the sub-basin changed, and sulphides were deposited. Initial sulphide deposition over the vent area was rapid, as evidenced by lack of included clastic sedimentary rock. These features are felt to be consistent with deposition of sulphide particles which issued from the vent area. Waning stages of sulphide deposition were much less violent, and well-layered sulphides intercalated with intermittent clastic sediments became the dominant depositional style. In the upper part of both the eastern and western portions of the orebody, delicate sulphide lamellae consistent with chemical precipitation are widespread. Post-ore sodium-rich hydrothermal fluids altered tourmalinite, sulphide rocks, and hanging wall and footwall rocks over the vent area (Geological Association of Canada Special Paper 25).

Showings of sulphide mineralization were discovered in 1892. In 1909 the property was acquired by Consolidated Mining and Smelting Company of Canada (Cominco Ltd.). Beginning in 1900, the Sullivan mine has been a continuous producer until December 21, 2001, when the mine closed.

The mine is located on the southeast slope of Sullivan Hill, 3.2 kilometres northwest of the center of the city of Kimberley; the concentrator is located at Chapman Creek, 3.2 kilometres southeast of the center of the city. The North Star mine is located about 3.2 kilometres south of the Sullivan, on North Star Hill.

Prospectors Pat Sullivan, John Cleaver, E.C. "Ed." Smith, and Walter Burchett, of the Coeur d'Alene area of Idaho, were prospecting in the Kootenay Lake area in 1893 when they decided to band together for an overland trip to the Fort Steele area. On their arrival they heard stories of the impressive orebody of the North Star mine which had been discovered the previous year. On reaching North Star Hill, they found all of the hill had been staked but decided to prospect in the vicinity. They crossed Mark Creek to prospect the other slope and soon found the outcrop of the Sullivan orebody. They located 3 claims, the Shylock, Hamlet, and Hope (Lots 1385-1387 respectively). One of the partners, Sullivan, was killed in the Coeur d'Alene district in the winter of 1892 but the remaining three continued work on their claims at intervals when finances permitted until 1896.

The claims were bonded in 1896 to A. Hanson, of Leadville, but the bond was not taken up. Later that same year the property was bonded to Col. Ridpath, Judge Turner & associates, of Spokane. These interests organized the Sullivan Group Mining Company, which was registered in British Columbia in March 1897; the 3 original claims were Crown-granted to the company in 1898. From 1896 to 1899 some surface stripping was done and several small shafts sunk but transportation was a limiting factor and serious development was not begun until a branch line of the C.P. Railway was completed from Cranbrook in 1900. During the following years ore was shipped to the Hall Mines smelter at Nelson and the Canadian Smelting Works at Trail. In 1902 the company began the construction of a lead smelter at Marysville, 6.4 kilometres southeast of Kimberley. Due to the many metallurgical difficulties encountered, and also to the depressed condition of the lead market, the smelter was not put into operation until about 1905. The ore could not be treated profitably and both the smelter and mine closed late in 1907 after some 75,000 tons of ore had been smelted. At this stage the company had numerous-creditors and could not raise sufficient money to meet its debts. In 1909 the bond-holders and the creditors re-organized the company under the name of the Fort Steele Mining & Smelting Company, the control of the company being vested in the Federal Mining and Smelting Company, a subsidiary of the American Smelting and Refining Company.

The Consolidated Mining and Smelting Company of Canada (Limited) acquired a lease and bond on the property in December 1909. Subsequent exploration work indicated a large tonnage of complex ore which would become valuable if a satisfactory process of concentration could be developed. Also, these were high-grade ore zones which could be worked during the interval and smelted for lead. Late in 1910 the option on the stock of the Federal company and on that of some of the other shareholders was exercised; purchase of the property was completed in 1913. All of the adjoining claims considered necessary to the operation were purchased by the company in 1910. For the next few years mine development was directed to the discovery of ore sufficiently high in lead and silver, and low enough in zinc to be smelted with the facilities available at Trail. In 1914 the mine became the largest lead producer in Canada.

The future of the mine depended heavily on the improvement of the metallurgy of the ore, particularly the recovery of the contained zinc, and work on this problem began in 1910. Many tests on various processes of separation were carried out until, at last, satisfactory lead and zinc concentrates were produced at Trail by differential flotation in 1920. This new process made it possible to separate the run-of-mine ore into high-grade lead and zinc concentrates, and pyrrhotite concentrate for future use. A concentrator based on this process was built at the Sullivan mine and commenced operating in August 1923 with a capacity of 3,000 tons per day; the capacity was later increased in steps to 8,500 tons, and then to 11,000 tons in May 1949.

Development work on the orebody was initially from small pits and shallow shafts, and later from a main adit at the 1402 metre elevation. After it was proven that the ore went to depth an adit at the 1188.7 metre elevation was driven more than 1.6 kilometres north to the orebody; above it were 4 levels, including the old 1402 metre level. In subsequent operations an inclined shaft was sunk from 1188.7 metre level to the 807.7 metre elevation to establish 9 more levels. By the end of 1949 a new 1127.7 metre level haulageway was completed. Two new shafts, 609.6 metres apart, were put down in 1947 to service below the 1021 metre elevation. In 1960 the main shaft was extended 152.4 metres to provide two new levels. Mining was done initially in square-set stopes but in order to provide a shipping product low in zinc a kind of room and pillar system was introduced; this was modified somewhat when the concentrator was put into operation. Experimental work in backfilling began in 1936 and the practice has continued, utilizing development waste, cemented float fill, glacial till, and caving. Pillar extraction had become a major part of the operation by the 1950's.

An open pit mining operation began in 1951 to recover the remaining ore in the outcrop and nearby areas, and for several years provided about 20 per cent of total mine production. The pit operation was closed temporarily in May 1957 and not re-opened until 1964. During the latter year the remaining open pit ore was removed, providing about 7 per cent of total production for that year.

Tin was discovered in the ore in 1925. A plant for recovery of cassiterite from the flotation tailings was put into operation in March 1941 and an electric smelter for tin was added in April 1942. Traces of indium in the zinc concentrate had been known for many years and a recoverable accumulation was eventually found in slag from the complex lead-zinc smelting process at Trail. Indium was first recovered at Trail in 1941 and production on a commercial scale began in 1955. In 1954 an estimated 10,000,000 ounces of indium was available in by-product stockpiles built up over the years.

In 1960 the company estimated pyrrhotite flotation concentrate reserves at 15,000,000 tons and calculated an equivalent of 350,000 tons would be added to the total annually from production. Roasting of these concentrates to recover contained sulphur as sulphuric acid began on a limited scale in 1953. Facilities for converting the by- product iron oxide sinter to pig iron were installed in 1961.

The company name was changed in 1966 to Cominco Ltd. The property at that time included 678 Crown-granted claims and fractions and 30 recorded claims, and extended southerly to include the former Stemwinder and North Star mines (see 82 F/9 Zn I and Pb 2). In 1975 the company began a modernization program which will, over a number of years, convert the mine to trackless mining methods.

Measured and indicated reserves in the Sullivan mine, as of December 31, 1979, were reported as 54,000,000 tons at 4.5 per cent lead, 5.9 per cent zinc, 37.7 grams per tonne silver (Cominco Ltd., 1979 Annual Report).

Reserves estimated by the company at September 30, 1994 were 13 million tonnes grading 7.91 per cent zinc, 4.53 per cent lead and 25.69 grams per tonne silver, sufficient for about another six years of operation (Information Circular 1995-9, page 8). In 1995, it was the first full year of operation of the new lead-regrind circuit in the mill, resulting in higher grade zinc concentrates, and improved lead and zinc recovery.

In 1995, with Explore B.C. Program support, Cominco Ltd. made substantial progress on a deep drillhole that had been started December 14, 1991 on the Hope 12 claim on Mark Creek to test for the downfaulted extension of the Sullivan horizon. The hole was resumed on August 15, 1995 at 182 metres depth and drilled by October 31, 1995 to 1937 metres, still 214 metres short of the originally planned 2150 metre length. The hole intersected a section of Middle Aldridge sediments and a gabbro considerably thickened by thrusting, and did not reach the Sullivan horizon target, now projected to be at 2500 metres depth (Explore B.C. Program 95/96 - A142). This hole ended at 2600 metres in 1996.

Reserves estimated by the company at January 31, 1996 were 11,435,200 tonnes grading 25.0 grams per tonne silver, 4.5 per cent lead and 8.0 per cent zinc (Information Circular 1997-1, page 10).

Reserves in 1997 are estimated at 6,349,700 tonnes grading 41.1 grams per tonne silver, 6.8 per cent lead and 12.1 per cent zinc; the mine is scheduled to close on December 31, 2001 (T. Schroeter, personal communication, 1997).

Reserves entrusted by the company at January 31, 1997 were 8,800,000 tonnes grading 8.0 per cent zinc, 4.4 per cent lead and 24.0 grams per tonne silver (Information Circular 1998-1, page 9).

Reserves as of December 31, 1997 were 7,100,000 tonnes grading 7.2 per cent zinc, 4.0 per cent lead and 23 grams per tonne silver (Cominco Ltd. Fact Book, October 26, 1998).

Proven and probable reserves as of December 31, 1998 are reported as 6.1 million tonnes averaging 6.6 per cent zinc, 3.7 per cent lead and 20 grams per tonne silver (Exploration in BC 1998, page 73).

Proven and probable reserves as of December 31, 1999 are reported as 4.6 million tonnes averaging 6.4 per cent zinc, 3.3 per cent lead and 18 grams per tonne silver (Information Circular 2001-1, page 6).

Proved reserves as of December 31, 2000 are reported as 1.8 million tonnes averaging 6.6 per cent zinc, 3.7 per cent lead and 17.00 grams per tonne silver.

The mine closed December 21, 2001.

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Date Coded:	1985/07/24	**Coded By:**	BC Geological Survey (BCGS)	**Field Check:**	N
Date Revised:	2015/06/25	**Revised By:**	Sarah Meredith-Jones (SMJ)	**Field Check:**	Y