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Statement of Site Limits, National Register Eligibility, and Potential Resources in the Proposed APE

Elizabeth Mine
South Strafford
Orange County
Vermont

(HAA #V095)

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Elizabeth Mine, South Strafford, Vermont October 2000

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In conjunction with the EPA, state, and community efforts to address the mine tailing runoff from the Elizabeth Mine, Hartgen Archeological Associates, Inc. has been conducting historical research, reconnaissance, and preliminary mapping to provide baseline information allowing for determination of the limits of the site and a statement of the National Register eligibility.

This report proposes that the Elizabeth Mine is eligible for the National Register of Historic Places as a discontinuous Historic Mining District. The period of operation of the mine can be divided into three general eras. They include (1) Copperas Mining and Production that was carried on from approximately 1809 to the 1870s; (2) Early Copper Mining, Concentration, and Smelting that was carried on from approximately 1830 to 1930; and (3) Late Copper Mining and Concentration that was carried on from 1943 to 1958. Although some limited prospecting was conducted during the 1960s, the mine and mill did not resume operation after 1958.

Copperas (iron sulphate) production was focused on the area of Tailing Pile 3 where the ore was processed and the copperas produced. Two evaporator / concentrator factories, numerous associated structures and features, and some worker housing were located in this area. The ore during this period was extracted from the vicinity of the North Cut and the Old South Mine. The early copper production was spread over the entire district as defined below. The 1830s efforts at copper smelting were undertaken at furnaces on the south side of the Ompompanoosuc River north of the mine. Late 19th century copper smelting was undertaken on Sargent Brook, west of the North Cut, as well as in the vicinity of Tailing Pile 1. During this period ore was obtained from the North Cut and from the underground workings extending to the north. Finally, the mid-20th century copper production was conducted in the mill and associated buildings that are still standing on the site west of Tailing Pile 1. Ore for that period was obtained from the North and South Cuts, and the underground workings that extended to the north side of the river.

Site Limits

National Register Bulletin 36, *Guidelines for Evaluating and Registering Historical Archeological Sites and Districts* (Townsend et al. 1993), provides guidance in determining the boundaries of historic sites and districts. In particular, the bulletin discourages inclusion of "acreage not directly contributing to the significance of the property" (ibid:33). The limits for the proposed district are defined based on the presence of activities known to have been integral to the mine and mill operations. Although the properties and mining rights purchased by the various companies to operate the mine extend over wide areas to the north of the mine, the proposed district boundaries are drawn to focus on the mine workings, the furnace sites, and some associated features and structures. Attached figures illustrate the boundaries to be discussed.

The proposed district includes the Elizabeth Mine open cuts, the area of the underground works, the vicinity of the historic mining standing structures, areas of known or potential archeological features associated with the mine, two early furnace sites along the Ompompanoosuc River, an early furnace site on Sargent Brook, roads in the area that existed prior to the mine and constructed for the mine, and the sites of associated structures and activities. The district is proposed to be discontinuous to include the 1940s depot structure at Pompanoosuc 11.18 kilometers (6.9 miles) to the southeast on the Connecticut River and the site of the early 1900s power station at Sharon 11.6 kilometers (7.2 miles) to the southwest on the White River (Figure 1). The later location may not be relevant for inclusion due to having been destroyed by the flood of 1927. However, there are substantial archeological remains present that may be eligible for the National Register.

Prospect pits and trenches are not included in the district since they are ubiquitous along the trend of the copper ore that runs far north and slightly south of the site. However, they are present in the area of the proposed district, especially north of the North Cut and between the North Cut and the Old South Mine. In addition, the village of South Strafford is not included in the district. Although the mine was active in town affairs during the 1940s and 1950s, the village does not appear to have formed as a mining community. Although there must have been a great deal of interaction between the mining companies and the town, no evidence has been found to date of the mining companies having been heavily involved in community affairs prior to the 1940s.

The limits of the potential Historic Mining District focus along the trend of the copper bearing ore running from the Strafford / Sharon Town Line north to the north side of the Ompompanoosuc River and Route 132 (Figure 2). The east to west width of this area varies from approximately 610 meters (2,000 feet) at the southern end around the "Old South Mine", to 1,980 meters (6,500 feet) in the middle where it extends from the 1880s Tyson smelter on the west to the eastern edge of Tailing Pile #1 on the east, to 3,962 meters (13,000 feet) at the northern end where it extends from Buena Vista farm on the west to the intersection of Lower Bailey Road and Gove Hill Road on the east. The length of this area from north to south is approximately 3,353 meters (11,000 feet). Although the total area controlled by the Vermont Copper Co. in the 1950s reached about 8,000 acres (Abbott 1963:339), the area recommended as the limits of the core area of the historic site is approximately

840 acres. The areas of the discontinuous portions of the proposed district, the Pompanoosuc Depot and the Sharon Power Station sites, are estimated at two acres for the depot and 15 acres for the power station.

Mining History

The Elizabeth Mine is reported to be the oldest large scale mining operation in the United States. It was probably the first large mine-side smelting of copper in the country. It was active during the War of 1812, the Civil War, World War I, World War II, and the Korean War. Much of its success relates to the demand for copperas and copper that was created by these conflicts. However, the activities at the Elizabeth Mine ebbed and flowed according to regional and national economic conditions. (The following historical description is synthesized from several reports including Abbott 1973/2000; Smith 1999; and Johnsson n.d. Smith's article is included as Appendix I).

What became the Elizabeth Mine was started in about 1809 when the first mention of a company appears in the records, the Vermont Mineral Factory Company, was chartered to exploit the ore for copperas. During the period surrounding the War of 1812 the copperas from South Strafford was one of the products protected from lower priced imports by a tariff. The Elizabeth Mine is a rare example of the emphasis on and support given to native industries as a result of the War of 1812. Copperas production continued until the late 1870s when copperas was discovered to be a by product of cleaning steel, so manufacture of copperas was no longer profitable.

During the late 1820s and 1830s the first attempts at producing copper were conducted on the ore from the mine. Although copper was known to be present in the ore from early on, separating it from the sulfides in the ore was difficult. Isaac Tyson, jr. of Baltimore was brought to the site in 1833 to operate the copperas and copper production as well as the mine works. His experiments with hot blast furnaces, alternate fuels, and furnace linings produced results that allowed for profitable smelting of the South Strafford ore and also contributed to advances in metallurgy in general. Tyson was inducted to the National Mining Hall of Fame in 1996.

The introduction of the railroad up the Connecticut River valley in 1848 was undoubtedly an important event for the mine. A depot at Pompanoosuc was constructed and utilized by the mine at least by the 1860s.

Mining, milling, and smelting of the ore continued sporadically during the middle 19th century until the 1880s when the Tyson family again became active in the affairs of the mine. James and Jesse Tyson renamed the mine after James' wife Elizabeth and introduced the first extensive underground access to the ore bed. They excavated a shaft at the top of the hill north of the North Open Cut since they did not own the property of the open cut and were denied access to the ore on their property by Foster and Bryant who controlled the adjacent parcel. The ore was beneficiated near the shaft and probably to the west along the road leading down the hill to Sargent Brook where a smelter was constructed and operated during the 1880s and 1890s. In 1898 they drove an adit into the ore bed

from the east that allowed for much more access to the ore and efficiency in hauling and ventilating the underground workings. Around the turn of the century a more modern mill was built near the adit opening and a smelter was constructed in the vicinity of Tailing Pile 1.

The Tysons conducted successful experiments with chromite furnace linings and hot blasts of various sorts that helped to increase the efficiency of the smelting process. Due to increasing debt they were forced to shut down the mine in 1902. After a series of failed efforts to restart the operation, August Heckscher of New Jersey was able to purchase the mine and built a large smelter at the site and the power station at Sharon in 1907. However, the furnace experienced several dramatic failures that caused it to see very limited operation during 1908 and 1909. The power station was destroyed by the flood of 1927.

Several more attempts were made to reopen the mine and mill, however, none were especially successful. The advent of World War II brought the final large scale activities at the Elizabeth Mine. The need for copper to aid in the war effort prompted the federal government to explore potential copper sources in Vermont, New Hampshire, and Maine and eventually choose the Elizabeth Mine to open. A major improvement in technology in the form of flotation concentration had been developing since it was first introduced in Australia in 1905 (Bunyak 1998). The Elizabeth Mine was outfitted with a 500 ton per day flotation mill that allowed for the low grade ore of the area to be efficiently processed. In addition, a new pump station was constructed on the river near Furnace Flat and a depot building was added at Pompanoosuc at the Boston & Maine railroad line on the Connecticut River. The Elizabeth Mine continued to operate throughout the war, earning a profit during some years due to the high contract price paid by the government. After the war production continued through the efforts of many. However, by 1958 declining profits once again forced closure of the mine.

Outline of Copperas and Copper Production Techniques

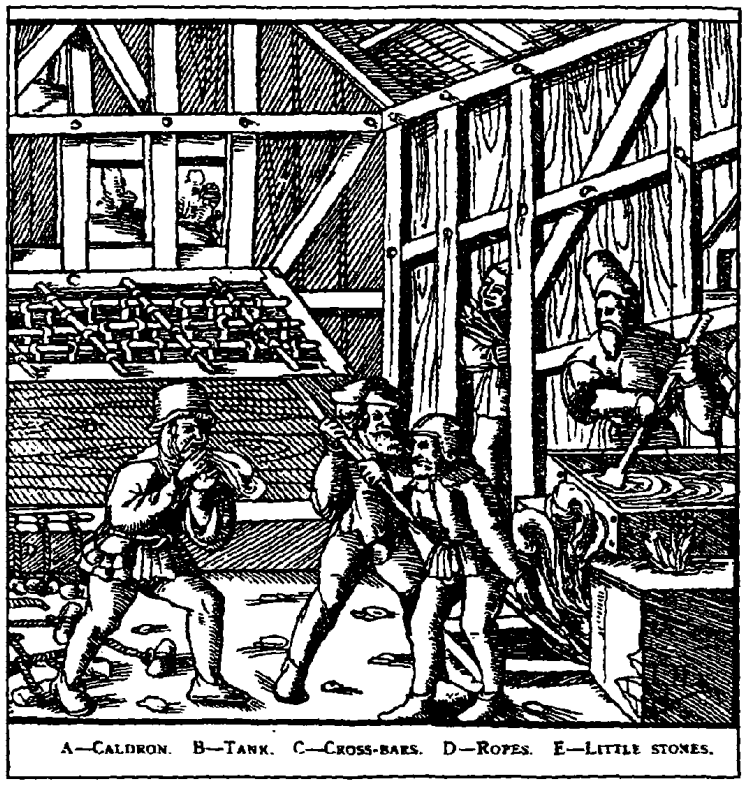
The production of both copperas and copper took advantage of the topography of the site by locating one step of the process down hill from the previous step. Therefore, gravity was utilized as much as possible in moving the ore and the products through the refining process.

Copperas Production

The extraction of copperas from iron sulphate ores is a very old process that changed very little from the 16th to the 19th centuries. Descriptions and illustrations from 1556 (Agricola 1950:575-577) and 1763 (Diderot 1763), and descriptions of the process at the Elizabeth Mine vary little in their fundamental steps and techniques. The basic process includes removing the ore from the mine, cobbing (breaking) the ore into small pieces, and placing the pieces in piles to be exposed to the elements. The piles would spontaneously combust or were sometimes set alight and with regulation a controlled burn of several weeks was accomplished "roasting" the ore. Once the ore was roasted water was applied to leach the copperas out of the ore. The copperas "liquor" was drained off through a system of troughs and tanks to the copperas factories where it was boiled in lead lined vats.

It was then transferred to wooden vats where it was crystalized onto tree branches or wooden dowels. When the crystals were dry they were scrapped off of the sticks and packed in barrels for shipment to market (Thompson 1843:167).

The copperas processing at the Elizabeth Mine was located in the vicinity of Tailing Pile 3. There the slope of the hill side from the North Open Cut to Copperas Brook provided ample opportunity to take advantage of gravity to aide in moving the product from one step to the next. The ore was roasted below the open cut, it was leached and drained down troughs and tanks arrayed along the hillside, and the copperas "liquor" was diverted into the factories located below. The road for transporting the dried crystals was located adjacent to the factories. In this area there are remains of roasting beds, wooden diversion features, brick features, and two copperas factory foundations with associated iron supports for the boiling vats and flues. In addition, there are many foundations of structures that may have served as storehouses for the copperas crystals, residences for the employees, and such facilities as a post office, a hotel, and a store that are reported to have been in the area. Some of these features are located within the boundaries of Tailing Pile 3 and others are directly adjacent or close-by.



1556 illustration of copperas factory in Germany (Agricola 1950:575).

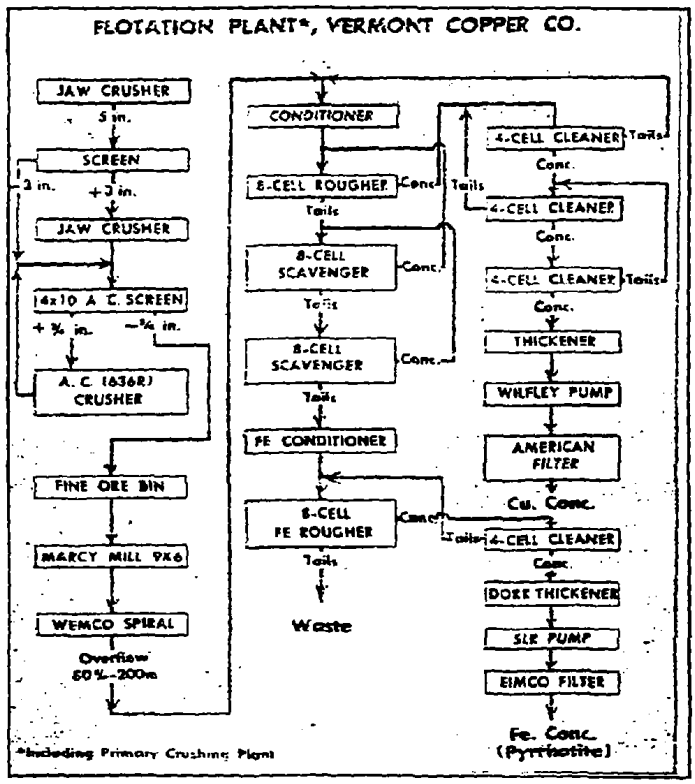
Copper Milling

The milling, concentration, and smelting of copper at the site was undertaken first in the late 1820s and soon supervised by Isaac Tyson, jr. in 1833 and 1834. Throughout the rest of the 19th century and until about 1930 smelting was conducted in various locations around the site. During the 1940s and 1950s a modern flotation mill was constructed where the ore was refined and the resulting concentrate was shipped out to smelters on Long Island.

The flotation mill was a major advancement in milling technology and allowed for efficient recovery of minerals from ore with much smaller percentages than previously feasible. The principle of flotation is that fine grained particles of the copper bearing mineral, chalcopyrite, will adhere to bubbles produced by agitating a solution of water mixed with various oils and alcohols. The

unwanted material can be made to not adhere to the bubbles, so the froth is removed with the concentrated copper. The process includes coarse crushing, fine grinding, flotation, and drying. The Elizabeth mill underwent constant upgrading to accommodate the peculiarities of the local ore and improve efficiency. By 1953 the milling operation consisted of two jaw crushers, a third crusher, and screens to reduce the size of and sort the ore, a ball mill to further reduce the ore particles to a powder, several flotation cells where the powdered ore was placed in a frothing solution, and cleaners and thickeners to remove water and unwanted particles from the concentrate.

The remains of the copper milling and smelting operations at the site are distributed over a wide area. For example, smelters were located at Furnace Flat (both north and south of the river), at Sargent Brook, at Copperas Brook, and slightly up the hill side from Copperas Brook. Mills were located at the North Open Cut and west of Copperas Brook. Features associated with copper production are visible in the form of smelter remains and associated structures and features in all of these locations. The currently standing structures offer the most evocative evidence of the copper production dating to the mid 20th century. The flotation mill buildings have the characteristic sloped construction form utilizing the hill side in moving the ore through the processing stages. In addition, there are many features present such as support buildings, mine entrances, utility poles, roads, and the tailing piles that illustrate the process of the copper production.



Flow chart of the Elizabeth Mine flotation mill in 1953 (Lutjen and Kearney 1953:74).

Historic Mining Landscape and Technology

The following discussion of the historic mining landscape and milling processes is informed by an email sent to Giovanna Peebles from mine archeologist Paul White and a letter and discussions with geoarcheologist Philip C. La Porta. Those documents are included as Appendices II and III respectively.

The first mining was conducted at the locations now known as the North Open Cut and the Old South Mine. The Old South Mine was abandoned fairly early with one unsuccessful attempt to

reopen it during the Civil War (Abbott 1964:272). The North Open Cut was deepened considerably during the WWII era and the South Open Cut was begun with steam shovels working in the cut itself and trucks hauling the ore to the mill (Jim Condict, personal communication August 11, 2000).

The waste products from 150 years of operation are visible in several locations at the mine. The major waste deposits are labeled Tailing Piles 1, 2, and 3 (Figures 3 and 4), although Tailing Pile 3 is, strictly speaking, not composed of tailings since they are defined as deriving from the flotation process that took place only during the 20th century in the valley below Tailing Pile 3. However, there are other areas of tailings, waste rock, and slag that are present around the 1940s standing structures, the Old South Mine, the South Open Cut, the 1830s Tyson furnace, the 1880s Tyson furnace, and the mid to late 19th century furnaces at Furnace Flat (Figures 5 through 7). These areas vary in scale and visible effect on the visitor, as well as the environment. The enormous height and volume of Tailing Pile 1 leaves a profound impression on visitors who begin to understand the scale of this mining operation, albeit a small one by national standards. The relative uniformity of Tailing Pile 1 and Tailing Pile 2 reflect the large scale uniform processing that was being conducted during the 20th century. However, as exemplified by the 1939 aerial photograph (Figure 8), there is potential for considerably smaller tailings and roast beds of differing composition to be present beneath the large deposits.

In contrast, Tailing Pile 3 is composed of the results of a variety of processes including roasting and leaching of the ore for copperas production, roasting of the ore for copper production, milling of the ore for copper production, as well as deposition of waste rock from the North Open Cut and the underground workings. This variety of processes represented in the Tailing Pile 3 demonstrates the complexity of the mining history of the area and the complexity of the archeological deposits. Included in these and other deposits are the remains of timber, brick, and stone constructions related to the mine activities. In particular, the timber structures appear to have been preserved to a great extent by the copperas in the deposits.

Less obvious aspects of the historic mining landscape include the foundations of structures that were associated with the mine. These structures are depicted on historic maps of the area and include mills, smelters, barns, houses, and structures of unknown function (Figures 9 through 12). They tend to be concentrated around the North Open Cut and the smelter sites at the river and Sargent Brook. Most were constructed during operation of the mine, however, some probably existed prior to the mine and were converted into use by the mine owners. In addition, roads utilized by the mine are present in the form of roads still in use today such as Mine Road, New Boston Road, and Turnpike Road. However, there are a number of roads that served the mine that are no longer open. Examples of these include the road running between the mine and the river (1830 - 1920s), the road constructed to allow for greater ease of access to the depot at Pompanoosuc (late 19th century), the road between the North Open Cut and the 1880s Tyson smelter on Sargent Brook, and the town road that crossed the valley and was closed in the 1940s to allow for the growth of the tailing piles. Parts of these roads are still visible in the woods and undergrowth of the site and contribute to the feeling of the mining landscape.

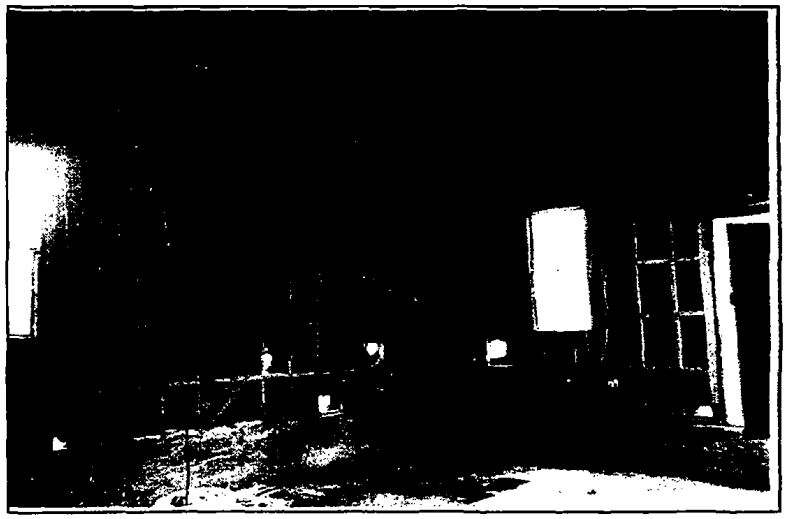
The technology of mining and processing of ore has changed continuously over the years. Remains of the machinery are scattered across the site from the standing structures to parts in the overgrowth around the site to potential artifacts buried in archeological deposits. Phil La Porta and Johnny Johnsson have identified some equipment on the site as parts of a ball mill, a gravity separating machine, and flotation equipment. Ore buckets, railroad wheels, and other items are present across the site, primarily in the area between the standing structures and Tailing Piles 1 and 2. All of these materials could contribute substantially to our understanding of earlier technologies and the specific processes used at the Elizabeth Mine.

Standing Structures (by Walter Wheeler, Architectural Historian)

The extant structures at the Elizabeth Mine largely date to the years 1942-43, when preparations were made to reopen the complex after a number of years lying dormant. A newspaper article of the period details techniques used in the construction of these new buildings.

> The old decrepit buildings were removed to make room for the new ones. Of some two dozen structures at the mining plant itself, only one of the old structures was saved. The new ones all have heavy reinforced concrete foundations; those with machinery have cement floors. Strong seasoned pine timbers, formerly utilized in the Woodbury granite sheds at Bethel, firmly trussed and bolted, support the framework in the mechanical structures. The walls are covered inside and out with gyp-lap sheeting, which is fire resistant and, with its contained air chamber, meets the ordeal of cold weather very well. The outer coating is finished to resemble brick, giving the structures a clean, substantial appearance [*Herald*, 14 December 1944].

Of the approximately thirty structures constructed during the 1942/43 building campaign, eighteen remain. Most of the structures, with the exception of the Mill and Thickener and Drying buildings, were constructed of two inch by six inch studs placed sixteen inches on center, with horizontal stops every two feet. These stops help to create the air cells alluded to in the above quote. The corners of the structures are stabilized with diagonal bracing. Both sides of the exterior partitions of these structures were originally sheathed in gypsum board [or "gyp-lap"]. The exterior finish imitative



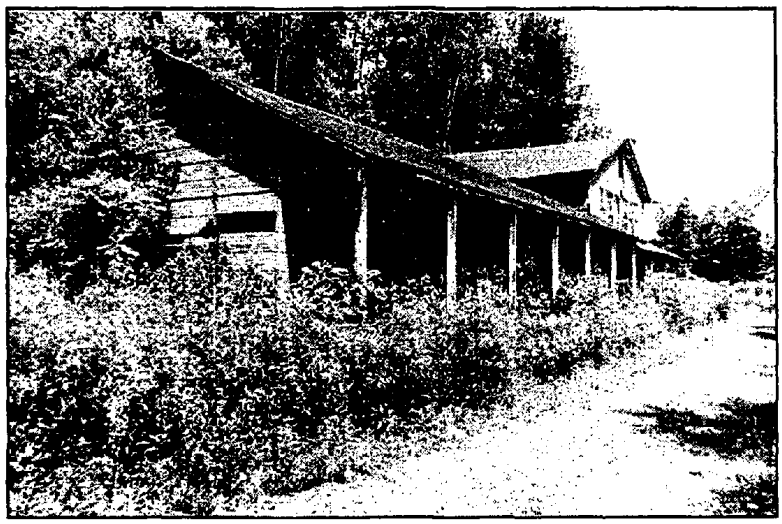
Interior of the Machine Shop, showing typical framing and construction techniques used in the structures built 1942/43.

of brick alluded to in the quote above is an asphalt panel system, imitative of buff colored brick laid in common bond. The windows lighting each structure are typically six over six double hung sash. The roof trusses are typically set at two feet intervals. The reinforced concrete foundations are eight inches in thickness and were cured in forms comprised of planks approximately six inches wide. The Mill and Thickener and Drying buildings, which are said to incorporate reused building material from the Bethel Granite mines, consist of interior heavy timber structures surrounded by a distinct framing system typical of the other buildings dating from the period. The separation of this outer shell from the interior framing served to reduce the effects of the mill operation on the exterior frame. Unless otherwise specified, the materials and detailing used in construction of each building conforms with the above description.

The extant 1940s and 1950s structures include:

Structure 1. Office / Warehouse Building

This structure appears to have been constructed in two sections simultaneously. A two story addition to the west, containing stacked vaults, may date to the 1950s. The interior partitions of the building are comprised of Masonite or pressed wood panels. The building housed a drafting room, a small dormitory, and a pay office .The vaults protected the business records and blueprints. While currently in a good state of repair, a leaky roof is beginning to accelerate the deterioration of this structure.

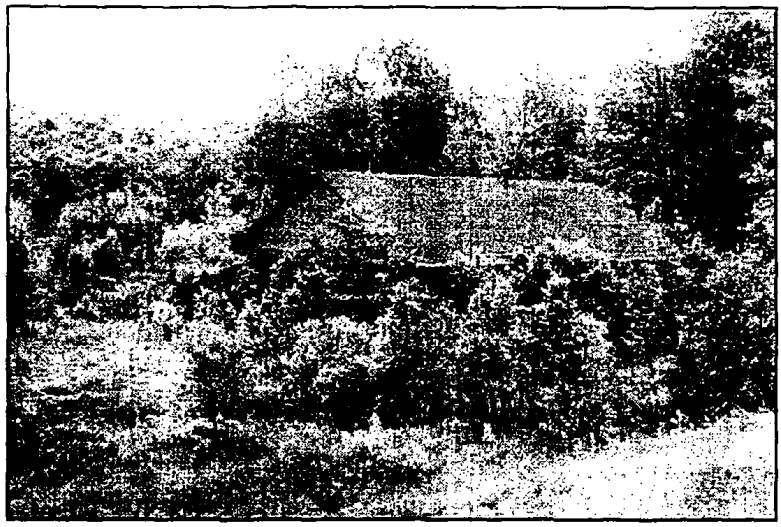


Warehouse / Office Building, view to the northwest.

Structure 2. Change House

A large one and a half story rectangular structure with gabled roof, this building housed the shower and changing rooms utilized by the miners. Two one-story lean-to additions to the east of this structure housed the core house and what appears to have been an emergency stair to the basement that may connect to the underground workings. The main part of the building is in a good state of

repair and integrity; the small additions are in poor condition. That sheltering the staircase to the basement has lost half of its roof and the upper part of its south wall.



Change House, view to the southeast.

Structure 3. Compressor Building

A one story rectangular structure with gabled roof, typical in construction details and techniques of those structures built in 1942/43. The large volume is undivided, and features a poured concrete floor. While generally in a good state of preservation, holes in the roof have caused the collapse of much of the gypsum ceiling. In all other respects, the structure appears to be preserved as originally constructed. Two small structures of square plan and with gable roofs are located directly to the south of the structure, and are tentatively identified as air intakes. A mid-nineteenth century store counter is preserved within this structure; it is massively constructed utilizing Greek Revival detailing and may have an association with the nineteenth century occupation of the site.

Compressor House, view to the northwest.

Structure 4. Storage Shed / Garage *[south of the Change House]*
A one story shed roofed structure of rectangular plan with vertical wood plank siding. Sliding doors comprise the entire north elevation, and provide the only means of entry to the structure. Approximately one third of the roof has caved in; the remainder of the structure is in poor/fair condition. The structure appears to have always been used as a storage shed, and contains mine related materials at this time.

Shed behind Change House, view to the southwest.

Structure 5. Shed *[northeast of the Change House]*
This structure, which is internally divided into two small spaces by a plank partition, appears to have been used as a storage shed. Inside are what appears to be shelving removed from a core house. A rectangular structure with gabled roof and planked walls, the building is in a very poor state of repair. Most of the roof, and the door and windows, are missing.

Shed northeast of Change House, view to the northeast.

Structure 6. Machine Shop

A large one story structure of rectangular plan with a gabled roof featuring three monitors, this structure is in a generally good state of preservation and good state of integrity. The interior is undivided, and features a poured concrete floor. Much of the interior gypsum sheathing has been removed. A later garage door has been inserted on the north elevation. The awning extending along the east elevation of the building appears to be an early alteration to the structure.

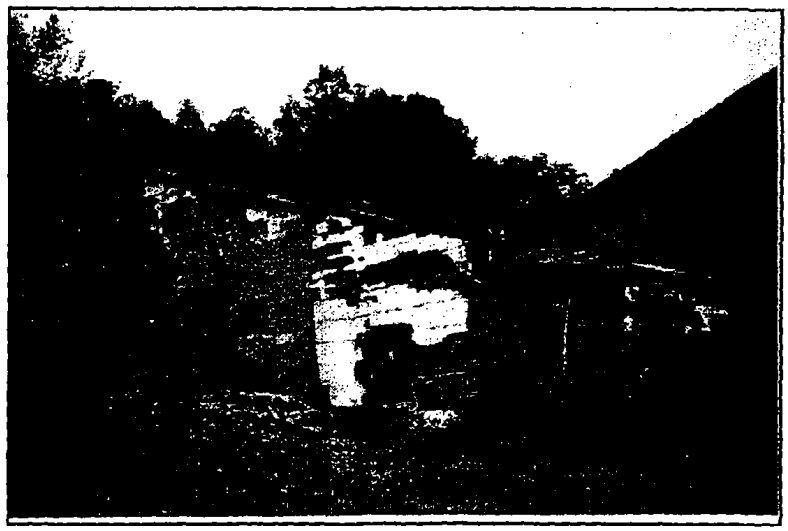
Structure 7. Shed associated with the Machine Shop *[to south of that building]*

A small one story gable roofed structure with no apparent foundation. Despite the fact that one half of the structure's roof has been removed, it is otherwise in a fair/good state of preservation and integrity. The function of this structure is not known.

Machine Shop and small shed, view to the northwest.

Structure 8. Ball Mill and Flotation Mill Building

This structure is partially collapsed. It appears to have been constructed in part by utilizing old timbers and building elements. Roughly rectangular in outline, the building received a number of additions, and may incorporate an earlier structure. A number of doors, datable to the late nineteenth/early twentieth century, were visible in the ruins. Outlines of a number of later additions, now razed, are visible on its various elevations. The building is in poor condition and poor state of integrity.



Mill Building, view to the west / northwest.

Structure 9. Garage associated with Mill

A four bay garage of rectangular plan, with a gable roof. In a good state of preservation and integrity.

Garage near the Mill, view to the northwest.

Structure 10. Thickener and Dryer Building

An immense structure of rectangular plan with a wide gable roof, which has at its core a massive frame comprised of square timbers of eleven inches, bolted together. The exterior sheathing system is attached to a secondary structure which wraps around the building, apparently in order to minimize the shaking of the exterior walls from operation of the equipment inside. This secondary structure is constructed of smaller dimensional lumber, and is sheathed with the asphalt panels featured on most all of the structures dating to 1942/43. The building appears to be five stories tall, but could not be fully explored due to its state of partial collapse. The third floor features locker rooms and showers. While the central part of the east elevation, from the roof to the second floor, has collapsed, the structural elements appear to remain intact with the interior heavy framing in good condition.

Thickener and Dryer Building, view to the north.

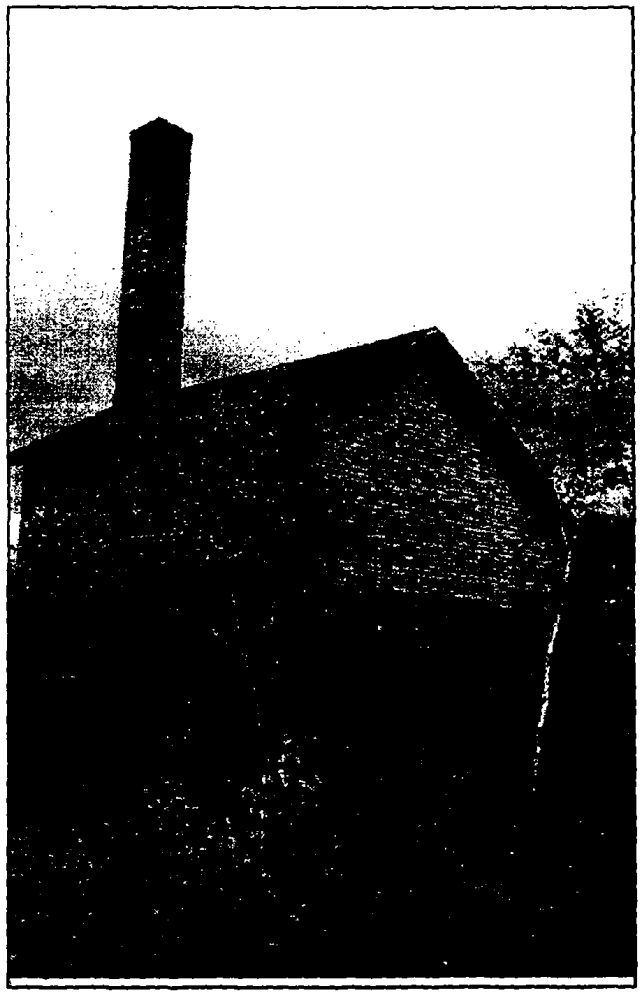
Structure 11. Crushing Plant

This structure, formerly the site of the ore crusher, has entirely collapsed. While none of the wood superstructure is salvageable, the concrete foundation is in a good state of repair. Because of the advanced state of deterioration of the structure further analysis was not possible.

Crusher Plant with adjacent Thickener and Dryer Building, view to the west / southwest.

Structure 12. Heating Plant

A one and a half story building, square in plan, with a gable roof. A small lean-to addition is located on the south elevation. This building makes use of late nineteenth/early twentieth century doors and hardware. The interior was not fully accessible due to its being used for storage at a more recent date. The furnace appears to be intact. In a good/excellent state of preservation, with a high level of integrity.



Heating Plant, view to the northeast.

Structure 13. Laboratory / Assay Office

A one story structure of rectangular plan with a gable roof. Presently used as a residence, the current occupant indicated that no features related to the structure's use as a laboratory building remain. A one story, shed roofed enclosed porch has recently been added to the south elevation of the building. While this porch is in a poor state of repair, the 1942/43 structure is in a good/excellent state of preservation and retains a high level of integrity.

Laboratory / Assay Office, view to the northeast.

Structure 14. Water Tank Building

A tall single- story rectangular structure with gable roof, with a shorter one story rectangular wing featuring a gable roof to the north. The interior of this structure was inaccessible. Its windows and doors were boarded, and their character remains unknown. The exterior suggests that the building is in a good/excellent state of repair and retains a high level of integrity.

Water Tank Building, view to the north.

Structure 15. Trestle

This structure formerly carried unrefined ore to the crushing/milling complex. The trestle was comprised of cast-in-place concrete piers, supporting an iron and wood superstructure. Apparently a fire destroyed much of its wooden components. Stone retaining walls, largely preserved, supported a narrow plateau through which the tracks passed when at grade. What remains of the trestle is in a good state of preservation.

Iron trestle over roadway, view to the northwest.

Structure 16. Club House

A one and a half story wood framed structure of rectangular plan, with a gable roof. While in an excellent state of repair, recent alterations have so disguised the building's original appearance that no original materials or detailing are apparent. The owner conveyed that fire destroyed a section of the building that once extended to the south and during renovation a number of small square rooms of eight feet were discovered in a that part of the structure. He conjectured that these rooms were used as a bordello, although they could have been a dormitory space for housing mine employees. The building retains a poor level of integrity.

Club House, view to the north / northeast.

***Structure 17. Community Center** [by the housing project on the hillside]*
A one story structure of irregular plan, with gabled roofs on a cinder block foundation. Currently occupied as a residence, the owner described its original use as including a Catholic Chapel, in the days before the construction of the Catholic Church. This structure was constructed to serve the recreational needs of the mine workers occupying the federal housing project immediately to the north, now razed.

Community Center at the Worker Housing,
view to the south.

Structure 18. 1940s Pump house
Another structure constructed during the 1940s was a pump house located by the river to provide water to the mine and mill. It was constructed in the same style as the other 1940s buildings and was accessible from the base of Tailing Pile 1 by a roadway. The pump house is now partially collapsed, but still contains the pump from the 1940s and 50s operation.

Structure 19. Pompanoosuc Depot

Apparently constructed during the 1942/3 construction campaign as a storage depot for materials being shipped out via rail. It is a one story gable roofed wood frame structure. A small lean-to shed is attached on the rail side of the building. Although the structure appears to retain much of its structural integrity, alterations to its fenestration have significantly altered its appearance.

Pompanoosuc Depot, view to the north / northwest.

Several late eighteenth / early nineteenth century structures survive which have documented long term associations with the mine and its operations. These structures include:

Structure 20. Adit

This adit, the entrance of which was constructed of stone, was constructed in 1898 by the Tysons. It was widened in 1942. The mortared stone facade is in a good state of preservation, although the adit tunnel immediately behind the facade has collapsed.

1898 Tyson Adit, view to the west.

Structure 21. Copper Castle

This building, which appears to have always served as a residence, likely dates to the middle of the nineteenth century. A photograph of the mine complex dating to c.1905 depicts the structure before the addition of the two tiers of dormer windows that currently light the rooms under its steep roof. The same photograph shows the eyebrow windows that formerly lit the second floor of the house. These details, together with the squarish proportions of the building, suggest a date of c.1840-55 for its initial construction. While the roofscape of the house has been significantly altered, the structure retains many of its original details and is in a good/excellent state of preservation.

Copper Castle, view to the northwest.

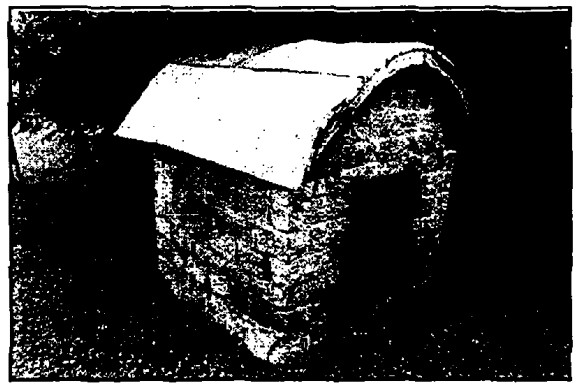
Circa 1905 view of Copper Castle, note eyebrow windows at eaves, view to the west / northwest (photo courtesy of the Strafford Historical Society).

Structure 22. Buena Vista House and Barn Complex

The house known as Buena Vista was originally occupied by the Dow family and purchased by the Tyson family about 1890. The earliest part of the house, identified as "the back kitchen", is a wooden structure of one and a half stories with a gable roof, and is reported to date to 1795. The main body of the house, a large foursquare two and a half story brick structure, features regional details, such as the arches over first floor windows and doors, typical of houses built c.1815-25. However, reports place construction of the brick portion of the house to 1859, possibly indicating conservative construction practices during the mid 19th century. The porch on the west elevation may date to a later construction episode.

Buena Vista (Tyson Homestead), view to the northeast.

Associated structures include a small sugar-loaf roofed structure identified as an ash house, which is constructed of what appear to be granite paving stones set in mortar. A barn complex, most of which likely date to the mid-nineteenth century, also accompanies the house. All of the structures in the house and barn complex are in an excellent state of repair. While minor additions and alterations dating to the second half of the twentieth century are apparent, the structures overall retain a very high level of integrity.



Ash House, view to the east.

Barns attached to Buena Vista house, view to southwest.

Unattached barn and shed at Buena Vista, view to the northwest.

Structure 23. Infirmary / Carpenter Shop

This structure appears to be an assemblage resultant from as many as four different building campaigns. As currently configured, the structure is T-shaped in plan, and composed of a one and a half story pavilion of rectangular plan with gable roof, joined to a one story shed roofed wing to the south. Both the one and a half story pavilion and the shed roofed wing appear to have been constructed during two building campaigns, judging from construction joints. The eastern half of the northern end of the structure appears to be the oldest part of the complex. Its proportions and detailing suggest an initial construction date of c.1850. The shed roofed wing to the south appears to date to c.1860-1880. Both are in an excellent state of preservation, and show signs of recent restoration, sensitively accomplished. The complex sits on a concrete foundation of recent date. The northern end of the structure is said to have been used as an infirmary, while the southern wing was occupied as a carpenter shop during the middle of the twentieth century; the building's use previous to 1943 is not known. The structure is currently occupied as a residence.

Infirmary / Carpenter Shop, view to the southeast.

Summary

While many of the structures associated with the Elizabeth Mine operation over its century and a half period of operations have been razed, twenty one buildings directly associated with the site survive. Taken together, the well preserved structures among this group provide good examples of the occupation of the site during most of its period of operations. The Buena Vista house is associated with early mining operations on the site; the structures known as the First Aid building and Copper Castle represent the mid-nineteenth century mining operations; the Adit to the west of the Change building represents occupation of the site in the late nineteenth century. The balance of the preserved structures document activities at the site during the last period of operations, spanning 1943-1958. Despite the advanced deterioration of some of the key structures associated with the mining operations on the site, the level of integrity of the remaining structures, taken together with the value of the historical engineering record preserved in the manmade landscape resulting from the long term operation of the mine, demonstrate that the existing structures are vital contributing components of the proposed mining district.

National Register Eligibility

The potential eligibility of the Elizabeth Mine site for listing on the National Register lies in the innovations pioneered at the site, the early and long running operation of the mine, the associations with periods important in national and regional history, the association with persons of unusual talent and innovation, and the integrity of much of the original fabric of the site. (The discussion below is informed by Townsend et al. 1993; Noble and Spude 1992; and Bunyak 1998; and the appendicies).

There are four criteria used to determine the significance of properties relative to listing. These criteria include:

A) Association with events and broad patterns of events
B) Association with important person(s)
C) Distinctive characteristics (work of a master, artistic value, distinguishable entity)
D) Data (information potential of archeological deposits)

In addition, the site must retain integrity that can be in the form of:

- location - structures in their original locations
- design - able to illustrate the evolution of the site design
- setting - retaining surrounding features, landscape, and topography that conform with the historic use
- materials - structures retaining their original materials
- workmanship - retaining the layout or structural features of the site

- feeling - the property and features convey a historic sense of the property without encroachment by modern intrusions
- association - presence of features that convey the activities that took place at the site

The Elizabeth Mine site meets many of the criteria for inclusion on the National Register. In regard to **Criterion A**, the site has been associated with many important events in the history of the nation and Vermont, and in the history of technology and mining. Early on the site was an important source of copperas during the early years of the nation, prompting a visit by President Monroe in 1817. The Elizabeth Mine was one of the earliest and longest operating mines in the east and was one of the major suppliers of copperas and copper during the 19th century. It is the only mine in the area to operate extensively during the 20th century. The reopening of the mine for the WWII war effort added another important period of significance to the site. It was deemed an essential component of the war industry and was subsidized by the federal government.

Technological innovations used at Elizabeth Mine include a patent obtained by Isaac Tyson in 1827 for production of copperas. However, the patent has been lost, so the nature of the innovation is unknown. His most important contribution at Strafford was the hot air blast developed in the 1830s during experiments at Furnace Flat for which he received a patent in 1834. He also conducted experiments using anthracite coal as a fuel. During the 1880s to 1902 James Tyson, James Tyson, jr., and the metallurgist William Glenn experimented with chromite furnace linings and water jacket furnaces. The success of the chromite furnace linings was a factor in the success of a latter effort to reduce the steps necessary to produce blister copper from three to two (Johnsson n.d.). During the 20th century efforts to improve the milling process included unsuccessful experiments with magnetic separation (1905), an early flotation plant during WWI (1917) and a flotation plant during the 1940s operation. Considered the beginning of modern mining (Bunyak 1998:23), the flotation process was constantly being refined and fitted to specific ores and sites.

Application of **Criterion B**, association with important persons, to the Elizabeth Mine also is focused on the presence of Isaac Tyson during the 1830s and James Tyson and James Tyson, jr. during the late 19th and early 20th centuries. US Senator Justin S. Morrill, sponsor of the Land Grant Act, had some limited interest in the mine at South Strafford in the mid 19th century. The decision to reopen the mine during the 1940s was associated with former Gov. Stanley C. Wilson who had been active in the Vermont Copper District previously and a number of prominent industrialists, engineers, and geologists such as George Adams Ellis, John V. W. Reynders, Frederick W. Foote, William Y. Westervelt, Hector M. Kingsbury, and Charles G. Doll.

Under **Criterion C**, the Elizabeth Mine standing structures retain distinctive characteristics of their use. Although equipment is missing and some of the structures are in an advanced state of deterioration, much of the layout of the mining and milling operations is intact. Portions of the mill are stable and could provide important information on the evolution and organization of the mill. In addition, the associated buildings such as the office / warehouse, the machine shop, the

compressor building, the change house, the heating plant, and the pump house retain characteristics and some equipment associated with their use. The core house, attached to the change house, appears to be intact although the shelves supporting the cores have fallen over. However, the cores did not fall out of their racks. This resource is especially important as a record of the 1940s and 1950s documentation of the ore body. La Porta emphasizes the importance of these cores for understanding the geologic history as pure research data (Appendix III).

Criterion D refers to the importance of archeological deposits and features for providing information on history and prehistory. These features include house and factory foundations in the woods surrounding Tailing Pile 3, at Furnace Flat north and south of the river, and at the 1880s furnace at Sargent Brook, roasting platforms preserved in the area of Tailing Pile 3, roast beds along the road between the North Open Cut and the 1880s furnace at Sargent Brook, and various foundations and features identified elsewhere on the property. Although materials from structures were probably reused, many structures and features may be buried under Tailing Piles 1 and 2 as well. Such features could include structural remains of furnaces, mills, the boarding house, barns, trestles, roads, a reservoir, and pipe lines. In addition, the numerous prospecting pits and trenches and diamond drill holes along the ore trend provide examples of the prospecting techniques and history.

LaPorta (Appendix III) identifies the area of copperas production, Tailing Pile 3, as well preserved and containing great potential for archeological research. Such investigations could answer questions concerning the techniques of copperas manufacture. Although described in some detail, there are few illustrations of the facilities for extracting copperas and the good preservation at Elizabeth Mine could help to fill out a detailed picture of the processes involved.

Although removed from their original context within buildings or in the areas of their use, there are a number of important artifacts located at the site. These artifacts can be interpreted to develop an understanding of the distinctive characteristics of the mining operation at the site. As mentioned above, the artifacts include milling and mining equipment that are located in buildings, sheds, and scattered on the surface of the site. Some are located on the edges of Tailing Piles 1 and 2 in high brush.

According to White (Appendix II), the tailing piles themselves offer great potential for information concerning a variety of questions. Analysis of the tailings may provide information on the geology of the mine. It may be possible to correlate the stratigraphy of the piles with the location of mining operations underground to identify the ore characteristics at various depths and to assess the techniques and efficiency of the milling technology.

Many of the structure foundations located on the site are probably the remains of residences, the store, the hotel, and post office. Investigations at these locations would help to answer questions about the social context of the mine. Questions about the nature of the hamlets at Copperas Hill and

Furnace Flat could be addressed. Reports of members of various ethnic groups working at the mine throughout its history could be filled in with information about the residential locations of members of different ethnicities, social stratification of such groups, and relative status based on ethnicity and occupation.

There is a potential for precontact Native American sites to be located in the proposed district. In particular, level areas along the Ompompanoosuc River and Copperas Brook that have not been disturbed by the mining operations may contain precontact archeological sites.

Integrity

> "Integrity is the ability of a property to convey its historic significance to meet National Register of Historic Places requirements." (Bunyak 1998:45)

The issue of integrity is a difficult one since there are many factors to consider when determining the site integrity. As described above, factors defining integrity include location, design, setting, materials, workmanship, feeling, and association. Integrity is usually defined based on the presence of most or all of these factors. However, the evolution of mining properties is characterized by phases of development, modification, abandonment, and reopening. Therefore, individual features of the site may not by themselves retain their integrity, but taken as a whole with the entire surrounding features, structures, and landscape do meet the definition of good integrity.

> "For example, buildings may have collapsed, machinery may have been removed, and railroad tracks may have been salvaged. However, the property may still exhibit a labyrinth of paths, roads, shaft openings, trash heaps, and fragments of industrial activity like standing head frames and large tailing piles. Although these individual components may appear to lack distinction, the combined impact of these separate components may enable a property to convey the collective image of a historically significant mining operation."
>
> "In such cases, a mining property may be judged to have integrity as a **system** even though individual components of the system have deteriorated over time." (Noble and Spude 1992:19)

Therefore, the integrity of the site may not at first appear to be high due to the state of deterioration of some of the buildings and the limited amount of equipment present in them. However, there are many factors to consider when determining integrity. The aspects of the site that support a conclusion of good integrity include the following:

- the structures and archeological features are in their original locations,
- the design of the buildings and layout of the operation can illustrate the evolution of the site,
- the surrounding features, landscape, and topography have not been significantly altered from their original use,
- the materials of the buildings are mostly original,

- the workmanship of the structures and features exhibits characteristics of the original design and use,
- the property retains the features and surroundings that convey the feeling of the historic sense of the property,
- and the relationship and layout of the features and structures convey the activities that took place at the site.

Bunyak emphasizes that "... although individual components may lack distinction, the combined impact of separate components may illustrate 'the collective image of a historically significant mining operation'"(Bunyak 1998:45). In the case of the Elizabeth Mine the landscape and the industrial structures along with the extensive archeological remains compose a distinct historic complex that is a vital resource for telling the story of mining in 19th and 20th century Vermont. In addition, the depot at Pompanoosuc, the road constructed to improve access to the depot, and the power station at Sharon contribute to the understanding of the place of the mine in the broader region.

The discussion presented above indicates that the Elizabeth Mine is eligible for the National Register of Historic Places as a discontinuous historic mining district.

Area of Potential Effect and Potential for Historic Resources

Although no plan has been proposed by EPA for this site, cleanup of abandoned mines often involves the following:

- tailings consolidation
- surface water diversion
- regrading tailings to allowable slope angles
- low-permeability cover / cap with revegetation
- ground water / seep control and / or treatment

Previous reports and opinions rendered by several mining professionals indicate that remediation of this site to control the release of acid runoff and metals loading would likely impact:

- all of Tailing Piles #1, #2, and #3
- zones surrounding the tailing piles for a distance of at least 30 meters (100 feet)
- zones down slope from Tailing Pile #1 where treatment may be conducted for an unknown distance
- staging and storage areas
- access roads

Attached figures provide several views of historic maps and the results of the recent GPS mapping overlaid onto the recent orthophoto of the site, allowing for an understanding of the location of

historic features in relation to the proposed remediation effort. Examination of the historic overlays reveals inaccuracy of the process of creating these figures. The inaccuracy derives from inaccuracy of the original maps and poor reproductions (photo copying distortions) that are overlaid onto the orthophoto. Therefore, features that appear on several different figures may be depicted in differing locations.

1874 Plan (Figure 9)
The first figure is the 1874 plan of the Vermont Copperas Company property. It focuses on the copper works and other facilities at Furnace Flat north of the river and the copperas works below the North Open Cut. Depicted at the river are a dam, a saw mill, a cooper's shop, a furnace, a paint mill, a barn, and several houses. A road crosses the river and runs up to the mine past the area where the 1830s furnace was located. This latter area seems to be defined by property boundaries, but no buildings or features are depicted.

On the way up to the mine the road intersects what is now known as Mine Road. The northern quadrant of that intersection was the location of a school house. No traces of the school house are currently visible. It appears to have been located across Mine Road from the standing structure that was once the infirmary / carpenter shop.

In the vicinity of the North Open Cut there are many structures and features shown on the map. Structures shown include two adits, a shaft, a cob shed, a blacksmith shop, evaporators, the agents office, two copperas factories, and approximately 16 houses and three barns. The North Open Cut is not depicted, although it was certainly present. The features that appear to fall within the area of Tailing Pile 3 include one of the adits, possibly the shaft, the cob shed, the evaporators, and one of the copperas factories.

1907 Plan (Figure 10)
A 1907 property map of the Vermont Copper Company illustrates the extent of the company property over the mine area. Of particular interest for the remediation is the location of the mill, the reservoir, an old furnace (probably the Tyson furnace), and Heckscher's trestle, furnace, flue, and stack. Aside from the mill, that falls at the eastern edge of Tailing Pile 2, these features appear to fall within the bounds of Tailing Pile 1. Several features located close to the edge of the pile include the old furnace along the western edge, and the reservoir, Heckscher's furnace, flue and stack along the northern edge. The trestle runs across Tailing Pile 1 from the mill. Two roads cross in this area. The old road that crossed the valley seems to run at the base of Tailing Pile 2. A second road runs from the cross valley road to the north between the old furnace and the reservoir. Several additional structures are located along this road near the mill. They correspond to individual structures shown on the next figure in greater detail, one being the blacksmith shop that was standing as recently as 1979. Others are labeled garage, blacksmith shop, office / storehouse, laborer's house, and barn.

In the vicinity of Tailing Pile 3 are several structures that appear to fall at the edges of the tailing pile and may be the same as those shown on the 1874 plan. However, they could also be later constructions dating to the late 19th century Tyson and other works in the area.

The 1907 plan also depicts some structures and roads at Furnace Flat. Most of these structures replicate those on the 1874 plan. However, there are a few that are shown in addition. A section of the property is shown to extend to the east along the road (Lower Bailey Road) that runs to Gove Hill Road. This parcel seems to reflect the plans to construct that road but the road is not depicted.

Circa 1910 Plan (Figure 11)
Several plans show greater detail of the Tailing Piles 1 and 2 area. One that is not dated, but probably dates to about 1910, shows some of the same features seen on the 1907 plan. The Heckscher smelter, flue, and stack and the reservoir and pump house are shown along the northern edge of Tailing Pile 1. The boarding house, an old furnace building (Tyson), and a "mule barn" are shown along the northwest corner of Tailing Pile 1, an assay office is shown near the center. The road running toward Gove Hill Road is shown along the eastern edge of Tailing Pile 1 with a "Coke Storage" area in the northeast corner of the pile.

At the intersection of Tailing Piles 1 and 2 are several structures that appear on the 1907 plan. They include a garage, a blacksmith shop, an office / storehouse, a laborer's house, and a barn. The mill is shown adjacent to the edge of Tailing Piles 1 and 2. The 1898 Tyson adit and associated structures are also depicted in the vicinity of the current Change House. The associated structures in that area include the forman's office, a dry (change house), a blacksmith shop, stable, and transformer house. Further up the hill is a powder house.

1918 Plan (Figure 12)
The 1918 plan depicts much the same area and features as seen on the circa 1910 plan. However, a few changes are noteworthy. The Heckscher furnace is not shown, although it probably remained as a foundation. The trestles are missing, although there are additional pipe lines running across the valley from the reservoir to a water tank on the hill above the 1898 adit. The road along the eastern edge of Tailing Pile 1 is present.

The most important change is a furnace depicted slightly east of the Mine Road, near the northwest corner of Tailing Pile 1. Examination of this area identified the remains of a furnace with a concentration of brick and some reinforced concrete with a thin layer of slag adhering to one surface. It is not known who constructed this furnace and it appears to be entirely outside of the project APE.

Summary
The map overlays indicate that archeological features might be encountered during the remediation along the north, east, and west edges of Tailing Pile 1, along the intersection of Tailing Piles 1 and 2, and possibly along the western edge of Tailing Pile 2. There is also potential for intact features to be present throughout the middle of the tailing piles. Features such as the Tyson roast beds that

appear on the 1939 aerial photo, the assay office, the boarding house, and other features may be present beneath the tailings.

Most of Tailing Pile 3 has the potential for archeological features relating to the copperas operation and the early Tyson mill at the north end of the North Open Cut. Features from the copperas production are clearly visible in the area between Mine Road and New Boston Road in the form of roast beds with what appear to be collapsed platforms underneath, plank surfaces that may be the remains of roasting platforms, and a large arc of posts below the majority of Tailing Pile 3 that may have formed a retaining or diverting wall related to the copperas production. The area of the Tyson mill is more problematic given the limited surficial evidence of structures and the presence of bulldozing in the area during the 1940s and 1950s (Abbott, personal communication, May 19, 2000).

Aside from the buried archeological features that may be encountered, the forms of the tailing piles themselves are significant historic archeological features.

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Appendix I
Historical Significance of Copperas Hill and the Elizabeth Mine
by Gwenda Smith, Strafford Historical Society

Copperas Hill and the Elizabeth Mine area are more than mere features of the physical geography and geology of Strafford: they are of great historical significance for the town, for the state of Vermont, and even, in some respects, nationally.

Although chiefly associated with copper production, the area was first important for the copperas still remembered in the name of the hill containing the ores. Copperas production was the first significant economic development in Strafford, whose residents were mainly subsistence farmers and the minor tradesmen who supplied them.

Tradition has it that the ore body was discovered by accident in 1793. No one locally had the technical knowledge or the financial resources to develop the deposits, but it was not long before outsiders eager to supply the lack were drawn to the area. Trading in land and mineral rights -- first referred to in a May 1798 deed -- accelerated, and in October 1809 the Vermont legislature approved a corporate charter for the Vermont Mineral Factory Company, the first of a succession of companies to work the copperas and copper ore deposits in this town, producing valuable products for a century and a half.

Because of the embargo against foreign trade, every kind of domestic production was important in the years immediately preceding the War of 1812. Copperas was in demand as a coloring agent in dyes and inks, as a wood preservative and as a powerful disinfectant. From the first, the product manufactured from the Copperas Hill ore was rated as of a very high quality, although much of the early work was experimental. Copperas was so important at the time that its production workers were among those exempted by Vermont law from military duty on training days. In 1812, the Vermont Mineral Factory Company, stating that it believed it could supply the whole country, asked the United States Congress to protect its product by imposing a duty on imported copperas. The works rated a visit from President James Monroe during his 1817 New England tour.

By 1832 the company was shipping to every state of the Union, and in 1842 Vermont historian Zadock Thompson described its facilities as "perhaps unsurpassed in the world." Although it would later be eclipsed by the copper mined from the same hill, this early copperas industry represented a significant achievement and is an important part of our local history and heritage.

As the copperas ore presented itself above the surface of the ground as an outcrop, it was at first mined in what eventually became the original open cut. Preparation of the finished product involved a series of processes in a succession of heaps and containers placed on the southern slope of the hill in such a way that the evolving copperas liquor flowed from each to the next by gravity. Lower down, on the level of the present New Boston Road, two very large factory buildings housed vats

of lead for the final boiling and evaporating operations. The hillside has been much altered, especially during the last period of copper mining, but it is still possible to visualize the historic operations of the seventy years of copperas production. If the ground is not further disturbed, it is even conceivable that archaeologists could some day bring actual evidence to light.

By the 1830s, mining had expanded underground, involving tunneling and a 100-foot ventilation shaft from the top of the hill. Copper ore had long been known to exist along with the source of copperas, and the company now began trying to process it. In furnaces by the Ompompanoosuc, in the area we still know as "Furnace Flat," some important metallurgical experiments were carried out under the supervision of Isaac Tyson Jr. of Baltimore. Tyson had patented a method of making copperas in 1827 and was awarded a patent in 1834 for "Heating and Applying Air to Blast Furnaces." The first U.S. attempt to smelt copper ores at a mine with hot blast was made here under his supervision. Most of the processed copper then used in the United States -- for such things as kettles, ship bottoms, percussion caps -- was imported.

The ores found here and elsewhere in the eastern United States were sulfide ores and difficult to refine, especially when technical knowledge of mining and smelting was still primitive. Copper production in Strafford was halted following the panic of 1837. Production figures for the 1830s are no longer available, but the copper plant, with a sizable capital investment, was probably the most ambitious attempt to smelt copper at a mine in this country up to that time. Though merely embryonic when compared with later developments in the field, the enterprise was significant -- and a worthy part of our history and heritage beyond the purely local scene.

The surviving evidences of the early years of copperas and copper production are also important historically for the impact of this activity on the economy of the time. Tyson reported that eighty men were at work on Copperas Hill in 1833, and one estimate puts the top figure for the early 1800s at two hundred men. In addition to miners and production workers, teamsters earned money by bringing in supplies and hauling out the manufactured products, the local storekeepers saw their businesses prosper, while others boarded the miners, sold wood for fuel or land for expansion and worked on such new developments as a dam, new roads and buildings.

A successor of the old Vermont Mineral Factory Company continued to make copperas until the late 1870s or early 1880s, but by then its major interest had became copper production. It was joined on the scene in the 1880s by a new company, incorporated by James and Jesse Tyson, sons of Isaac, and named the Elizabeth Mining Co. in honor of James's wife. Isaac Tyson Jr. was inducted into the National Mining Hall of Fame a few years ago, a rare achievement for an Easterner. Most of his mining activities were in his native Maryland, but he and his descendants had a historically important influence on Vermont mining also.

Unlike the old company, which worked through horizontal adits connecting with the open cut, the Elizabeth Mining Company reached the ore vein through a 160-foot vertical shaft from the top of the hill. It raised the ore through the shaft, crushed and concentrated it and took it down the west side

of the hill to roast beds and a smelter near the old turnpike. Later development work included driving an adit into the ore from the east side of the hill. This 1899 adit served until 1958 and is one of the few visible Tyson sites to have survived the later reworkings of the mine area by such enterprises as August Heckscher's Anahma Realty Corporation, the Vermont Copper Company of the years 1916-1919, the American Metal Company and the National Copper Corporation of the 1920s. These companies generated little headline news, but while experiencing the market volatility of the period they were an enduring presence in the mining community. Last but far from least came the companies that operated the mine from 1942 to 1958: a new Vermont Copper Company and, later, Appalachian Sulfides, Inc., a subsidiary of the Nipissing mining group.

The buildings still standing today were erected as part of the World War II war effort to produce strategic metals -- with the active participation of the federal government -- and the largest tailings pile contains the pulverized waste product of those years. Before the mine closed in 1958, it had seen production peak above eight million pounds in each of two years; at one time, it employed as many as 220 workers, drawn from sixteen area towns; its annual payroll topped a million dollars, and sales exceeded three million dollars. It had a profound impact on many lives and on the town generally. Strafford Historical Society events related to the mine over the past twenty years have consistently drawn larger regional attendances than events on any other topic.

Relics of World War II on the scale of the surviving structures are not abundant in Vermont, and their historical significance is surely as self-evident as the site's pollution problems. It is for this reason, and because so much has survived from the last period of operations, that some of us dare to hope that moderate remediation can reduce the hazards to acceptable levels while yet leaving a framework intact in which there might some day be created a historical and environmental education center -- in other words, that it will not be necessary to destroy the mine area in order to save it.

Gwenda Smith, November 1999

Appendix II
Email from Paul White to Giovanna Peebles (April 20, 2000)

-----Original Message-----
From: Giovanna Peebles
Sent: Thursday, April 20, 2000 11:44 AM
To: 'ED HATHAWAY'; mikey@dec.anr.state.vt.us;
LOVELY.WILLIAM@epamail.epa.gov; VETTER.JOHN@epamail.epa.gov;
WHITE.SARAH@epamail.epa.gov; maryellen.iorio@usace.army.mil;
scott.e.acone@usace.army.mil; 'tjamison@sover.net'
Cc: Giovanna Peebles; Paul White (E-mail)
Subject: historic values of tailings
Importance: High

hello everybody. I have been thinking about the upcoming preliminary investigations at Elizabeth and particularly the tailings and how we should maximize the potential historic information value of tailings as you proceed with the borings. I thus asked Paul White, historic mining expert, whom you all met in February at the big on-site meeting, if he could provide us with information about the potential historic values of tailings. I attach his very interesting comments below. Please consider how you might best integrate some of his comments into the upcoming studies. One immediate idea is to systematically recover, bag, and label samples from the boring drill from specific depths. And there may be other (and more) desirable measures that can be undertaken readily enough to ensure that important data is not missed. Clearly understand that I am NOT asking for analyses of samples at this time. Rather, I am asking for that level of foresight (that we discussed at the cafe) so that if there is an opportunity to gather data now that may SOME DAY be useful for our historic understanding of the site, then we should do so to the greatest extent possible. I encourage you to contact Paul and discuss any ideas with him to ensure that you are not accidentally "throwing away" important information. Many thanks. Paul's email is above if you have specific questions for him. best regards, giovanna

PAUL'S COMMENTS:
Hi Giovanna,
Following up on your request, here's a few thoughts regarding the information potential of tailings through chemical analysis. As a necessary preface, I would consider any archaeological work in this regard experimental. I am presently unaware of excavations (question-driven or salvage) conducted by archaeologists on tailings for the specific purpose of mapping and sampling stratigraphic profiles and performing chemical analysis. I do, however, see abundant potential. Judging from the last ten years or so, the study of industrial residues is establishing itself.

Particularly, the archaeometallurgical analysis of slags from blacksmithing, bloomery, and catalan forges (all associated with iron-working) have been useful in identifying the technology employed

at sites with little documentary evidence. Of greatest import to the Elizabeth Mine setting, some of these studies have also looked into the finer aspects of process, and have also posited some estimations of operative efficiency. Tailings are a different medium from slags, and with this comes other problems. In any case, hope the following thoughts are of use!

Conceptually speaking, tailings offer the potential to observe two dynamic processes occurring at mine sites. Firstly, tailings can inform at a general level about changes to the ore itself (the instability of abandoned mines prevents sampling rock in the actual tunnels, leaving tailings and overburden piles outside mine entrances as the most accessible source for this information outside of historic records.) The composition of an ore body generally changes with depth. Ores encountered at and near the surface are often oxidized from erosion (a process, which typically enriches the ore and makes them easier to work). At greater depth, however, ores generally decrease in grade and become harder to process because of chemical changes. Tailings, then, preserve (at least to some degree) these general changes in the life cycle of a mine. Since tailings represent processed (if not reprocessed) ore, we cannot expect to reconstruct the "original" ores. Nevertheless, certain aspects of composition may be relatively stable and untouched by the milling process. The study of these chemical signatures over time might indicate important changes to the ore's quality and ease of processing. Such changes were not always mentioned in public documents, such as shareholders reports, which tried, for obvious reasons, to present a positive spin on the situation. Furthermore, it was not unusual practice for mills to engage in "custom milling"where, for a fee, ore from neighboring mines was processed in the facility. If tailings from the mill runs were not separated and removed by the other companies, a tailings deposit could show evidence of these practices, both spatially (i.e., in stratigraphy) and chemically.

Secondly, tailings offer an important glimpse into the intricacies of the milling process. The milling plant was an ever-changing aspect of mining operations. Mills were typically designed with space (or potential space) for the addition of new equipment to meet anticipated increases in production or to accommodate other processing techniques. Technology used in the mill often had to be tweaked to fit the local situation. In the life span of any mill, equipment was frequently modified, augmented, or replaced to best accommodate these needs. Some small-scale modifications may have included altering the proportion of chemicals used in ore dressing (such as mercury for gold mining; or, for additional metals like copper, varying the formula for flotation cells, or ammonia leaching etc. to improve recovery).

Alternatively, the extent of grinding could be modified by making alterations to primary and secondary crushers (i.e., decreasing the gap between jaws, or increasing the mesh size for screens). As a mill's technology worked to achieve the best efficiency for the ore processed, these alterations can be expected to fluctuate. Again, historic documents are generally lacking in detail for these types of intra-site processes. We are left with numerous questions. What changes followed industry trends and which ones were unique to the milling plant? How did different companies process the same ore body? How efficient really were these changes in milling practice? (did they make notable improvements to the recovery of otherwise untreatable ore?) Pursuing these questions offer to give

us a more intimate understanding of technological change and the degree of fit between techniques "in theory" and "as practiced." Tailings offer the archaeologist an independent means to look at process. Chemical signatures might reveal the types of processes, or subtle modifications to one process over time. Changes in particle size may indicate changes to ore grinding (and, one should be able to reconstruct the fineness of grind, i.e., 60 mesh, with relative ease). In places where milling machinery has been salvaged and little is known of the milling technology at the site, an analysis of mine tailings could reveal the likely processing technique.

The above statements assume that common to any cultural material deposited gradually, tailings should retain aspects of their depositional history through both horizontal and vertical stratigraphy. Given that they often worked the same ore, such stratigraphic layering may not be discernable immediately to the eye. Banding may be extremely fineon the order of 2-3 mm. These aspects may hinder sampling techniques, in which case, samples by artificial layers at regular spacing may be the best practice.

As a further precaution, like all archaeological sites, site formation processes occurring to the tailings after their deposition undoubtedly impact the quality of information they can be anticipated to contain. But this will vary from case to case. The general stabilization of tailings over time means, archaeologically speaking, that the concentrations of leachable chemicals recovered from tailings deposits are unlikely to correlate directly to "as milled" percentages. It is entirely possible that the concentration of leachates in samples will more strongly reflect post depositional processes (i.e., greater concentration with depth) than changing techniques and processes employed at the mine. However, as mentioned earlier, not all chemicals are prone to leaching. Archaeologically informed chemical examination is also likely to have non-archaeological payoffs principally, in that it will help to reveal aspects of internal variability and a closer understanding of the stabilization process. It will treat tailings as less of a black box from which we have known or likely processes going in, and hazardous materials going out.

Regards,
Paul

Appendix III
Preliminary Assessment, Elizabeth Mine Project (La Porta & Associates, August 21, 2000)

LA PORTA & ASSOCIATES, L.L.C. **Philip C. La Porta, President**
Geological Consultants
116 Bellvale Lakes Road • Warwick, New York 10990 • Phone: (845) 986-7733 • Fax: (845)988-9988
Philip_C_LaPorta@compuserve.com

To: Tom Jamison, Hartgen Archeological Associates, Inc.
From: LaPorta& Associates, Inc.
Subject: Preliminary Assesment
Elizabeth Mine Project
HAA# V095
Date: August 21, 2000

Mines are not that common in eastern North America. Copper mines winning copper from oxide- and sulfide-ores are extremely uncommon. Any technology associated with the roasting and smelting of oxide- and sulfide-ores is worthy of preservation or special scientific consideration. The dominant oxide mines on the Atlantic seaboard were the magnetite-iron and ilmenite-titanium ores of the eastern Adirondack region. Sulfide deposits are usually extremely small and restricted to zinc occurrences and few iron occurrences. The remains of the Elizabeth Mine, in Strafford, Orange County, Vermont, offer several potential resources for future investigation.

The World War II era mine buildings should be photodocumented and mapped as their level of deterioration is accelerated. The inner workings of each building are strikingly familiar to the mine plan of the original Ogdensburg Zinc Mine, in Ogdensburg, Sussex County, New Jersey. The layout of the mine buildings should also be remapped. The mill site contains architectural remains, which are in very good condition, despite the deterioration of the outer shell of the building. The mill site is worthy of special study.

In the vicinity of the mine buildings there are numerous historic artifacts, including ore buckets, ore car wheels, fly wheels for the head frame of the mine, even segments of rail. These artifacts are worthy of preservation. Certainly, the mine buildings contain a few artifacts which may be of considerable importance to engineering historical societies. The various ore cars and pumps should be considered for preservation. Within the outer buildings of the property are the remains of gravity separating devices and a mechanical ball mill apparatus. Much of this technology is lost, artifacts of this type are rare and much can be learned from the analysis of these objects.

The core house represents a potential fruitful source of pure research data concerning the mineralogy, petrology, geochemistry and structural history of the ores. East coast museums have few or no specimens originating from the Elizabeth Mine. The inventory of minerals found at the mine includes a number of extremely uncommon species, including cubanite, tetrahedrite-tennantite and others. There are very few ore collections, therefore the core collection is certainly worthy of preservation due to its research potential. This type of ore deposit, the Besshi-type stratabound ore deposit, is not completely understood geologically, therefore, the information held within the drill cores, is extremely valuable for future research. Copper mines producing these ores are generally rare. Other copper mines developed along the eastern seaboard, during

the 18th and 19th centuries, were generally winning copper from Mesozoic red bed sequences, e.g., the Schyler and Kingsland mines in North Arlington and Lyndhurst, New Jersey. Other mines operating in the Mesozoic red bed sequence occur in Chimney Rock and Bound Brook, New Jersey. All of these mines sought copper from carbonate ores occurring in Triassic and Jurassic sandstones. The Pahaquarry copper mine in the Delaware Water Gap region took copper from a carbonate originating in a Silurian sandstone. Oxides of copper, such as covellite and chalcocite were noted only in North Arlington and native copper was only abundant at Bound Brook, New Jersey.

The ore roasting technology present at the site is beautifully preserved. Even timbers from the roasting stacks are preserved in place. An archaeological excavation of the roasting areas would prove fruitful in answering questions concerning this beneficiation process. The roasting ores to remove sulfur may have technological links to the ore roasting processes first developed in the Harz Mountain mining district (Brockner and Hegerhorst, 2000). The documentation of this process would provide valuable insights into both the technological process and its links to European mining technology. Also, the production of copperas, most certainly has its roots in European copper technology. Evidence in addressing these issues is the recovery of glass slag, outpouring slag, and bedded slag from the base of the roasting pits. Petrographic and chemical analysis of these slags would reveal a fabulous amount of data concerning the technology of roasting ores. The slags themselves preserve the mineralogical and petrological components which detail the various phases of roasting (pyritic and semi-pyritic processes).

Any archaeological remains associated with the mines, such as community structures, should be considered for preservation. The archaeological remains of community structures are uncommon in eastern American mining towns. The reason for this is, for example, most coal communities are consumed by the open pit activity and are forced to relocate as the mine expands. Underground mines, therefore, provide the best opportunity for the preservation of early community structures. The documentation of historic lifeways and subsistence patterns, in such a harsh environment, is certainly worth noting. Oftentimes the documentation of the industrial revolution includes lavish drawings and photodocuments of machinery layout and blueprints of mills, but people are conspicuously absent. We know very little about life conditions in mining towns, ethnicity and social stratification. Evidence recovered from the Franklin zinc mining district (LaPorta, n.d.) suggests that a rigid hierarchy of task and labor subdivision was accredited to mining communities and the hierarchy was often determined by ethnic composition. Perhaps the archaeological excavations of the mining community will provide insight into these topics through the recovery of objects and their spatial relations on the mining landscape.

References Cited:

Brockner, W., and Hegerhorst, K., 2000, Early Copper, Lead and Silver Production Processes: Scripta Mercaturae, v. 28, in press.

LaPorta, P.C., n.d., The Stratigraphy and Structure of the Cambrian and Ordovician Carbonates of the Wallkill River Valley: The Nature of the Diagenesis of Chert and Its Archaeological Potential: Ph.D. dissertation, City University of New York, The Graduate School and University Center, New York.

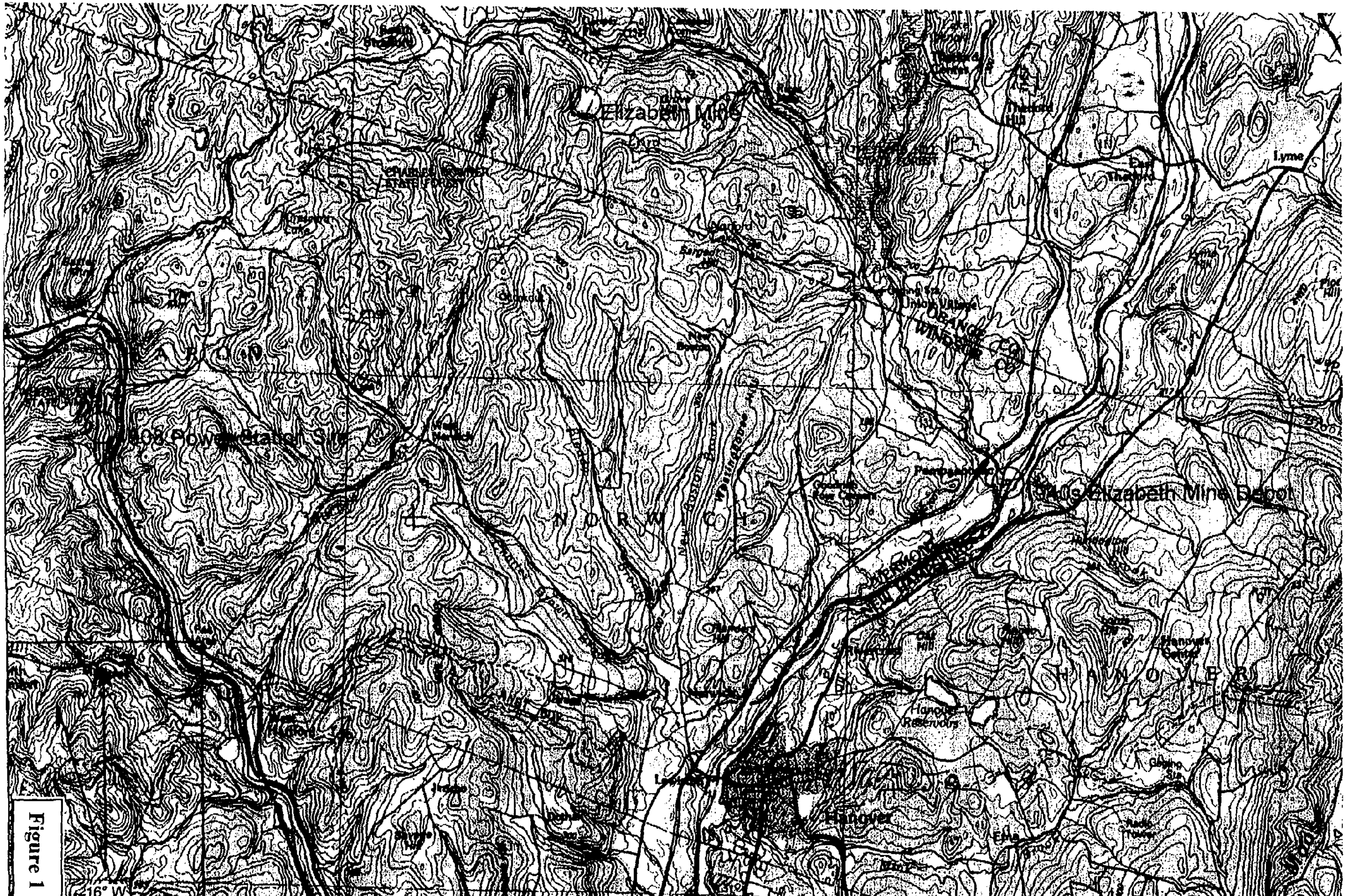

Figure 1

Name: RUTLAND
Date: 10/12/100
Scale: 1 inch equals 1.578 miles

Location: 18 716669 E 4849021 N
Caption: Locations of the Elizabeth Mine, the Sharon Power Station, and the Pompanoosuc Depot

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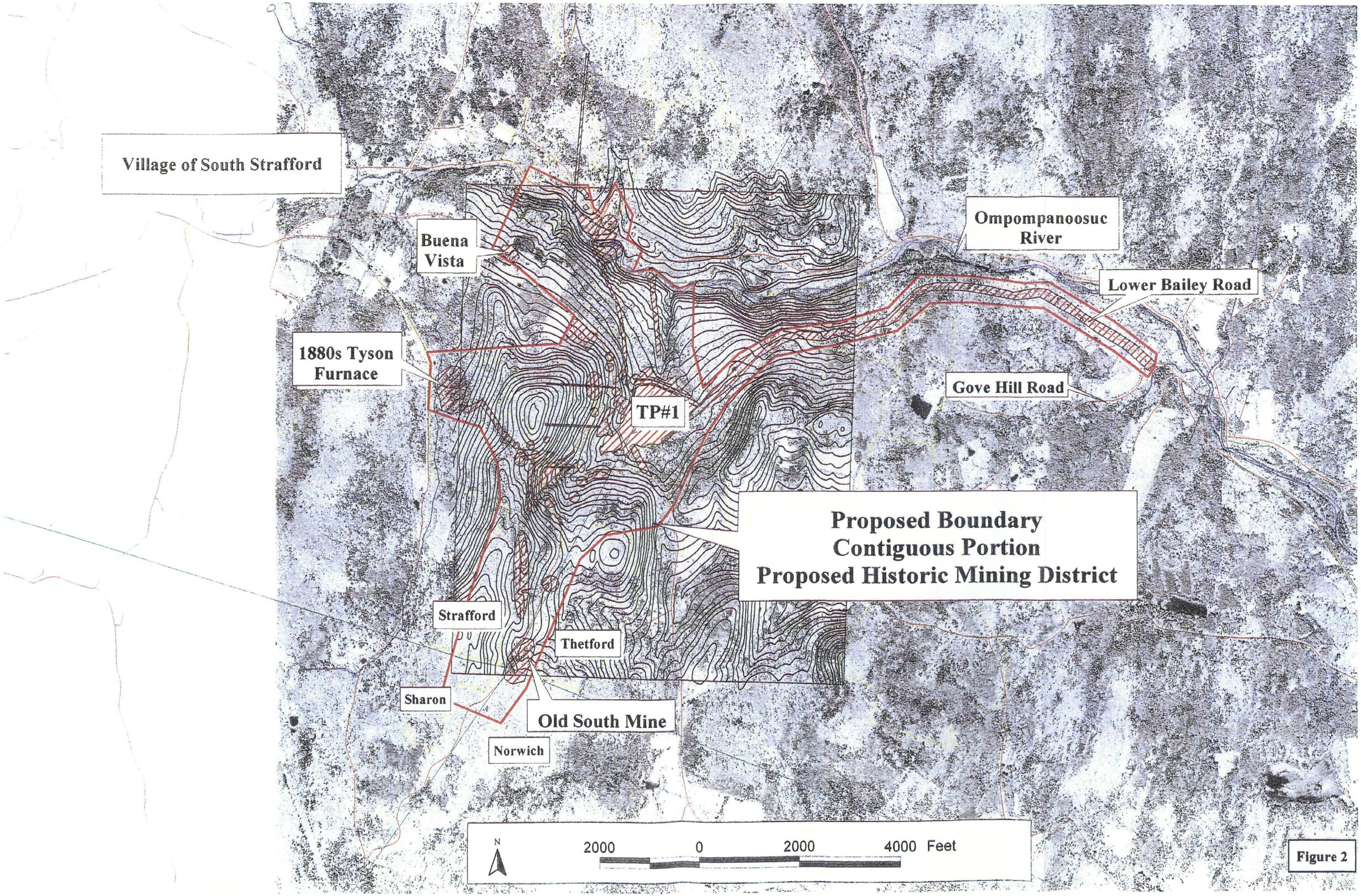

Village of South Strafford
Buena Vista
Ompompanoosuc River
Lower Bailey Road
1880s Tyson Furnace
TP#1
Gove Hill Road
Proposed Boundary
Contiguous Portion
Proposed Historic Mining District
Strafford
Thetford
Sharon
Old South Mine
Norwich
N
2000
0
2000
4000 Feet

Figure 2

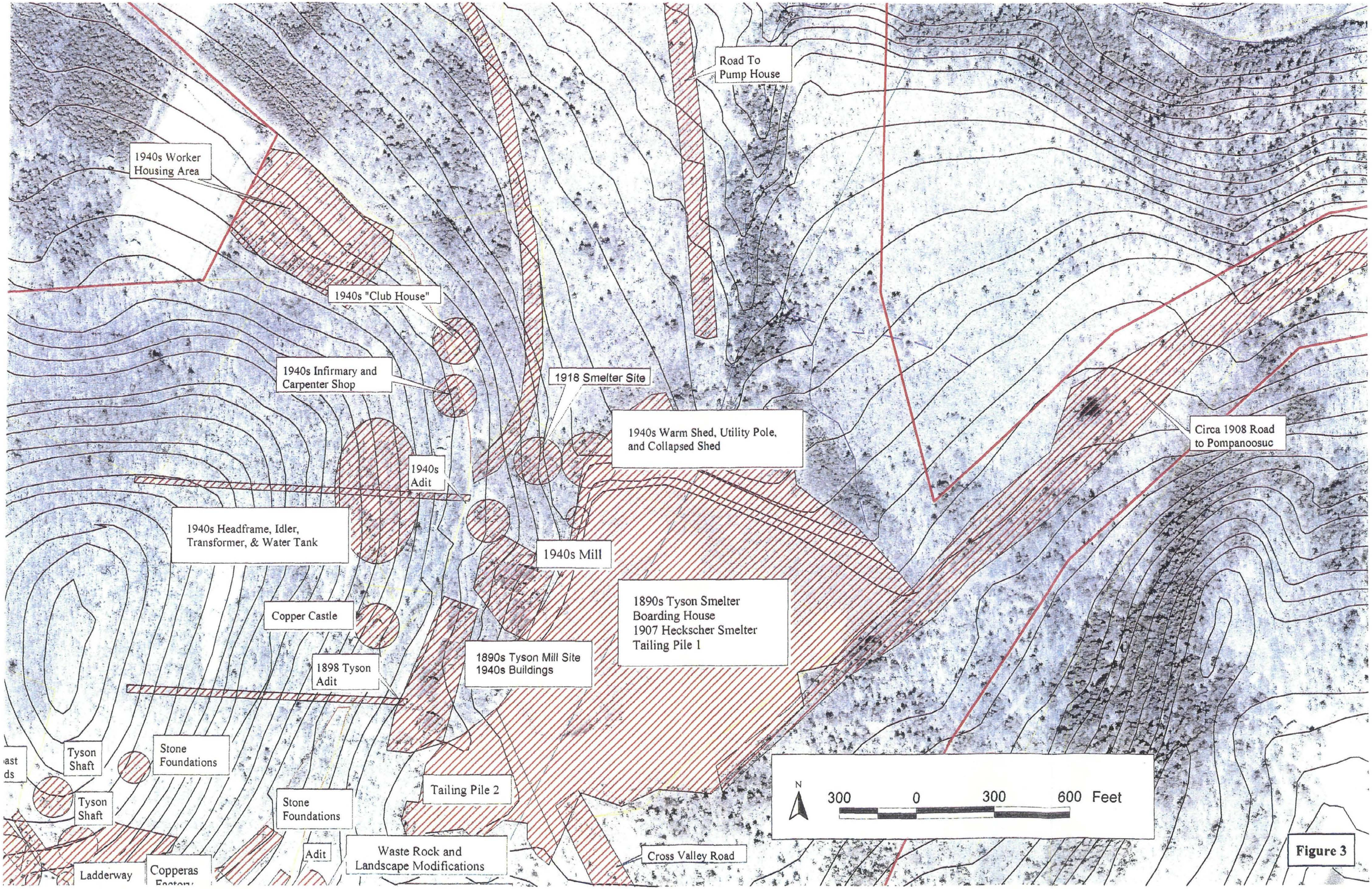

Road To
Pump House
1940s Worker
Housing Area
1940s "Club House"
1940s Infirmary and
Carpenter Shop
1918 Smelter Site
1940s Warm Shed, Utility Pole,
and Collapsed Shed
Circa 1908 Road
to Pompanoosuc
1940s
Adit
1940s Headframe, Idler,
Transformer, & Water Tank
1940s Mill
1890s Tyson Smelter
Boarding House
1907 Heckscher Smelter
Tailing Pile 1
Copper Castle
1890s Tyson Mill Site
1940s Buildings
1898 Tyson
Adit
Tyson
Shaft
Stone
Foundations
Tyson
Shaft
Stone
Foundations
Tailing Pile 2
Adit
Waste Rock and
Landscape Modifications
Cross Valley Road
Ladderway
Copperas
N
300
0
300
600 Feet

Figure 3

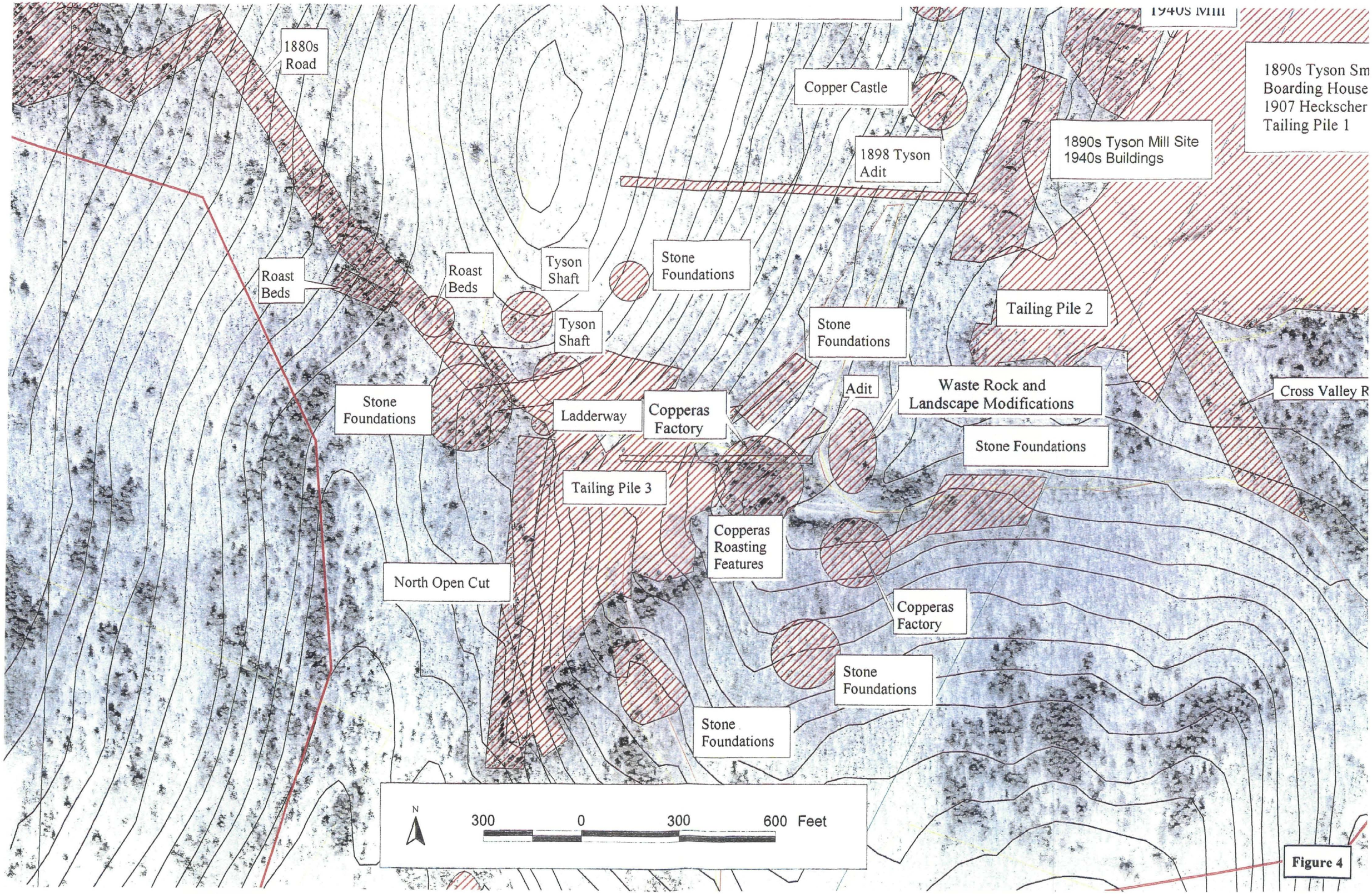
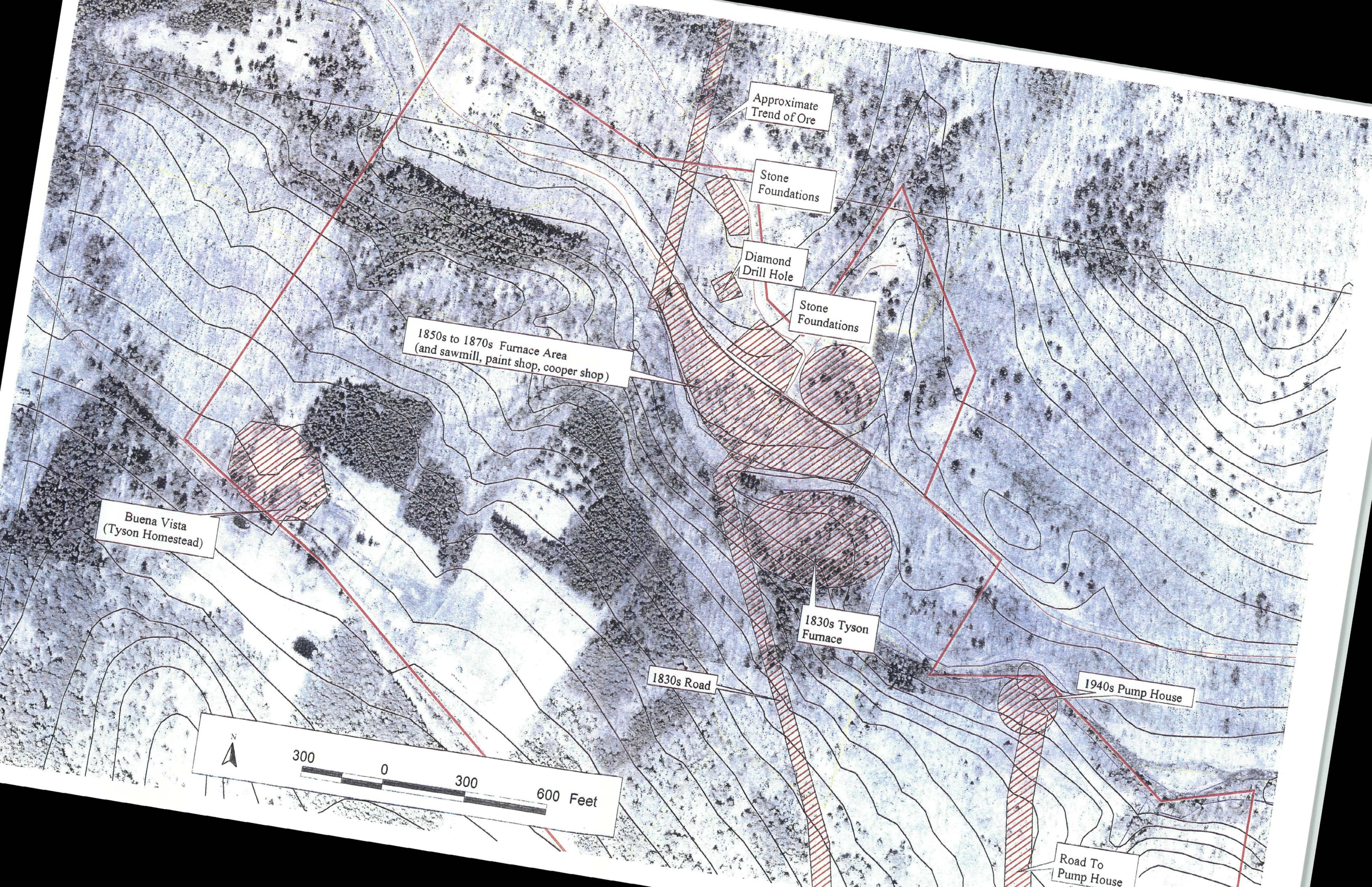

1940s Mill
1880s Road
Copper Castle
1890s Tyson Sm
Boarding House
1907 Heckscher
Tailing Pile 1
1890s Tyson Mill Site
1940s Buildings
1898 Tyson Adit
Roast Beds
Roast Beds
Tyson Shaft
Stone Foundations
Tailing Pile 2
Tyson Shaft
Stone Foundations
Adit
Waste Rock and Landscape Modifications
Cross Valley R
Stone Foundations
Ladderway
Copperas Factory
Stone Foundations
Tailing Pile 3
Copperas Roasting Features
North Open Cut
Copperas Factory
Stone Foundations
Stone Foundations
N
300
0
300
600 Feet

Figure 4


Approximate Trend of Ore
Stone Foundations
Diamond Drill Hole
Stone Foundations
1850s to 1870s Furnace Area (and sawmill, paint shop, cooper shop)
Buena Vista (Tyson Homestead)
1830s Tyson Furnace
1830s Road
1940s Pump House
Road To Pump House
N
300
0
300
600 Feet

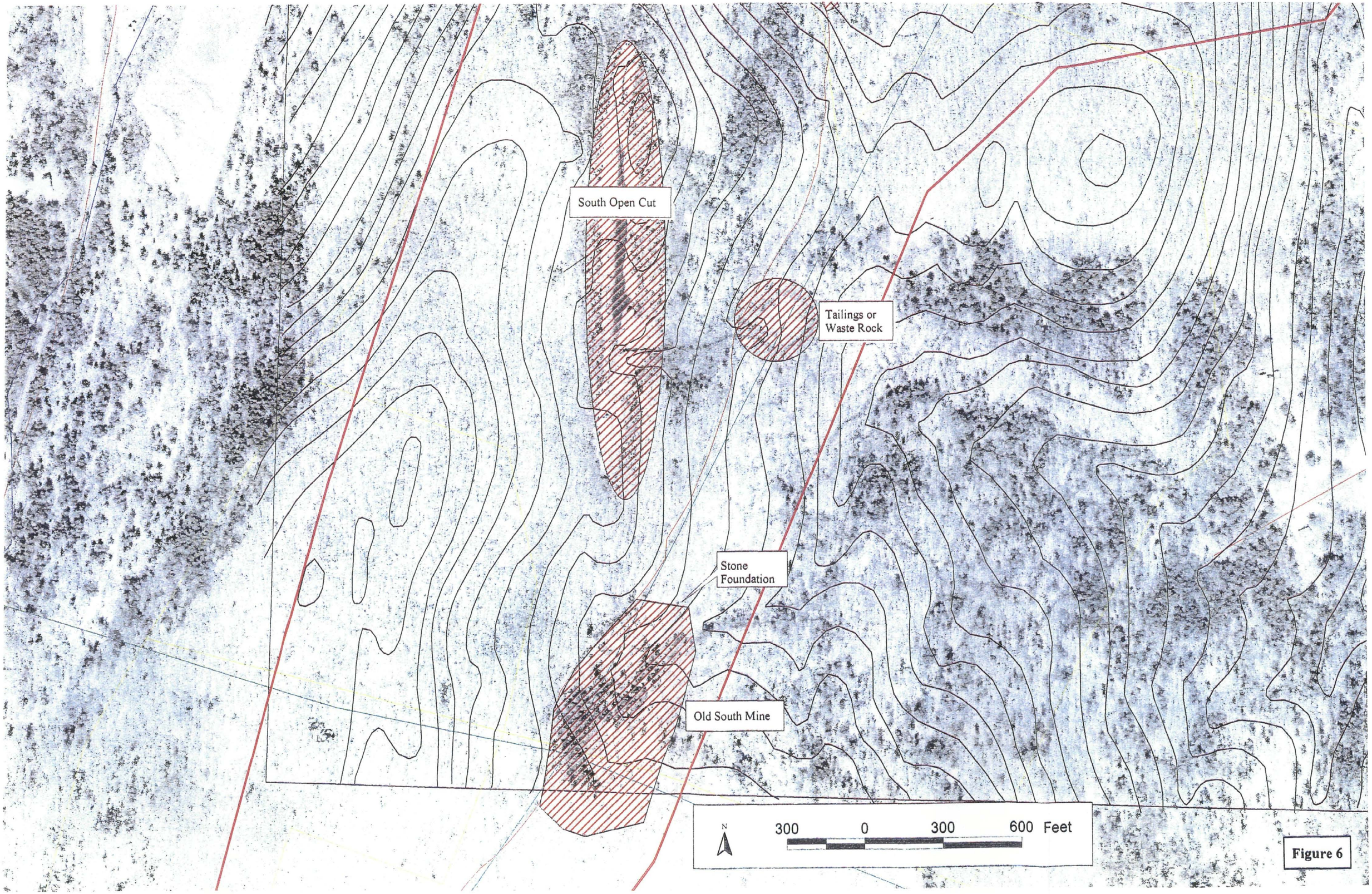

South Open Cut
Tailings or
Waste Rock
Stone
Foundation
Old South Mine
N
300
0
300
600 Feet

Figure 6

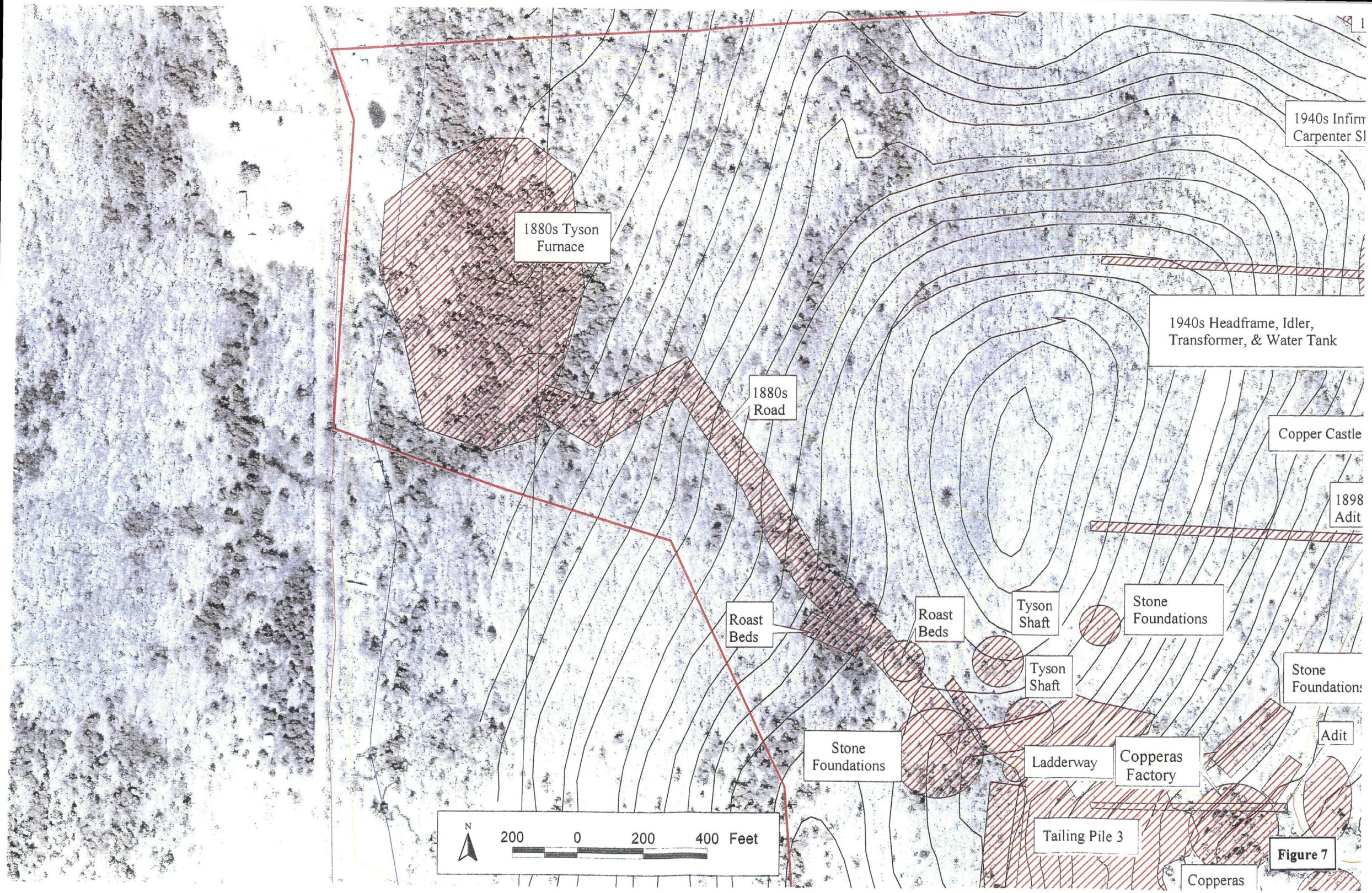
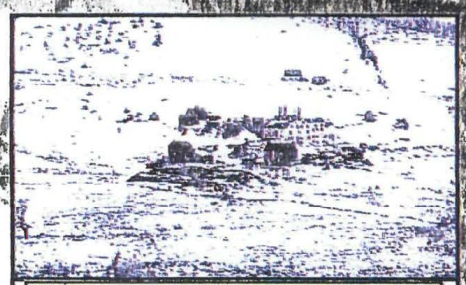

1940s Infirm
Carpenter Sl
1880s Tyson
Furnace
1940s Headframe, Idler,
Transformer, & Water Tank
1880s
Road
Copper Castle
1898
Adit
Roast
Beds
Roast
Beds
Tyson
Shaft
Stone
Foundations
Tyson
Shaft
Stone
Foundations
Adit
Stone
Foundations
Ladderway
Copperas
Factory
Tailing Pile 3
Copperas
N
200 0 200 400 Feet

Figure 7

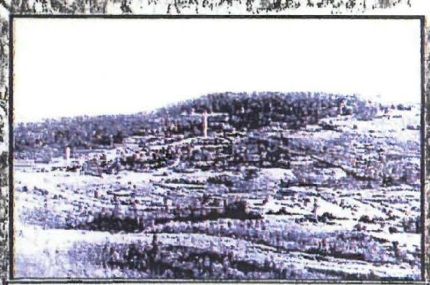
Elizabeth Mine

South Strafford, Vermont

Circa 1900 view of mill and associated structures around 1898 Tyson adit. View to the west.

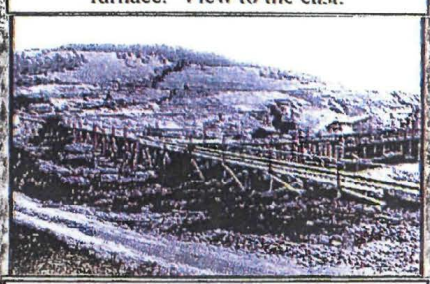


Detail of early 1900s view of mill and associated structures around 1898 Tyson adit. View to the west.



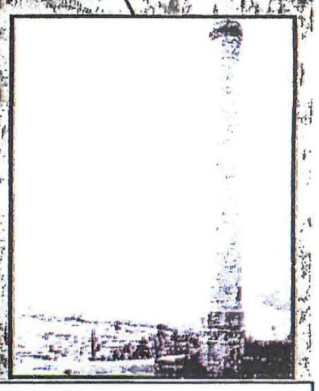
Circa 1907 view of Heckscher's furnace. View to the east.

Circa 1900 view of Tyson smelter and mill. View to the northwest.

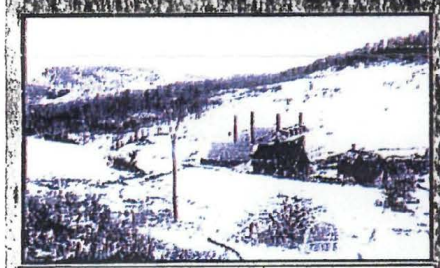


Detail of trestles supplying Heckscher's furnace. View to the east southeast.

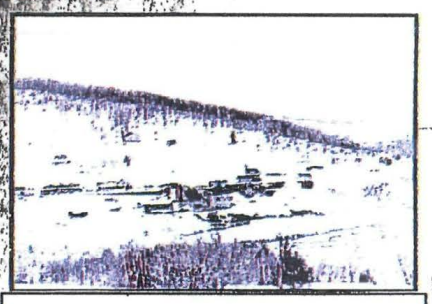
Circa 1900 view of mill and associated structures around 1898 Tyson adit. View to the northwest.



Circa 1908 detail of brick stack of Heckscher's furnace. View to the north.



Circa 1900 view of mill and associated structures around 1898 Tyson adit. View to the northeast.



1950s view of the WWII era mill and associated structures. View to the west.

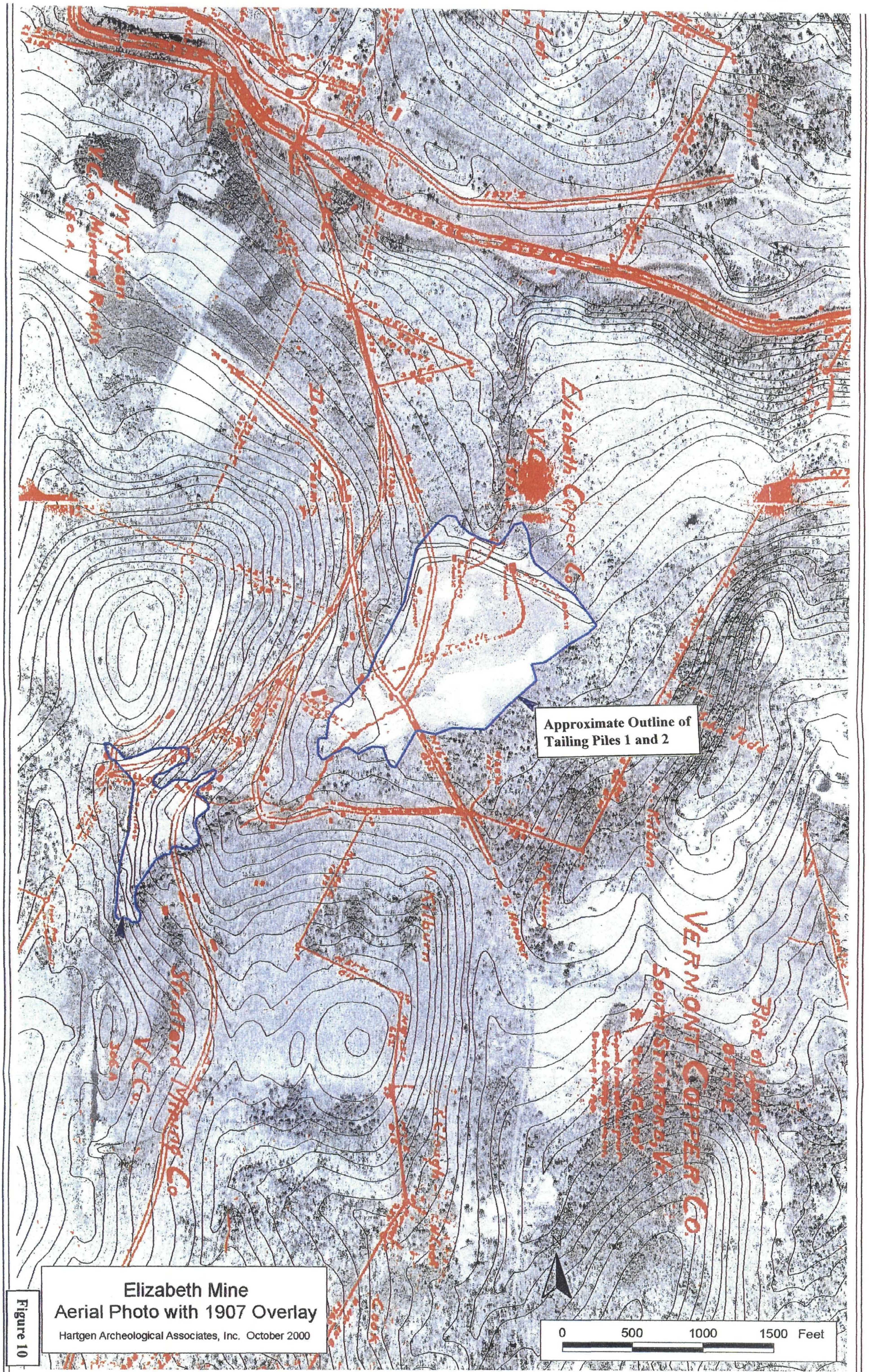
Circa 1880 view of copperas factory with area of Tailing Pile 3 in the background. View to the west.

US Army Corps of Engineers
New England District

1939 Aerial Photo Composite

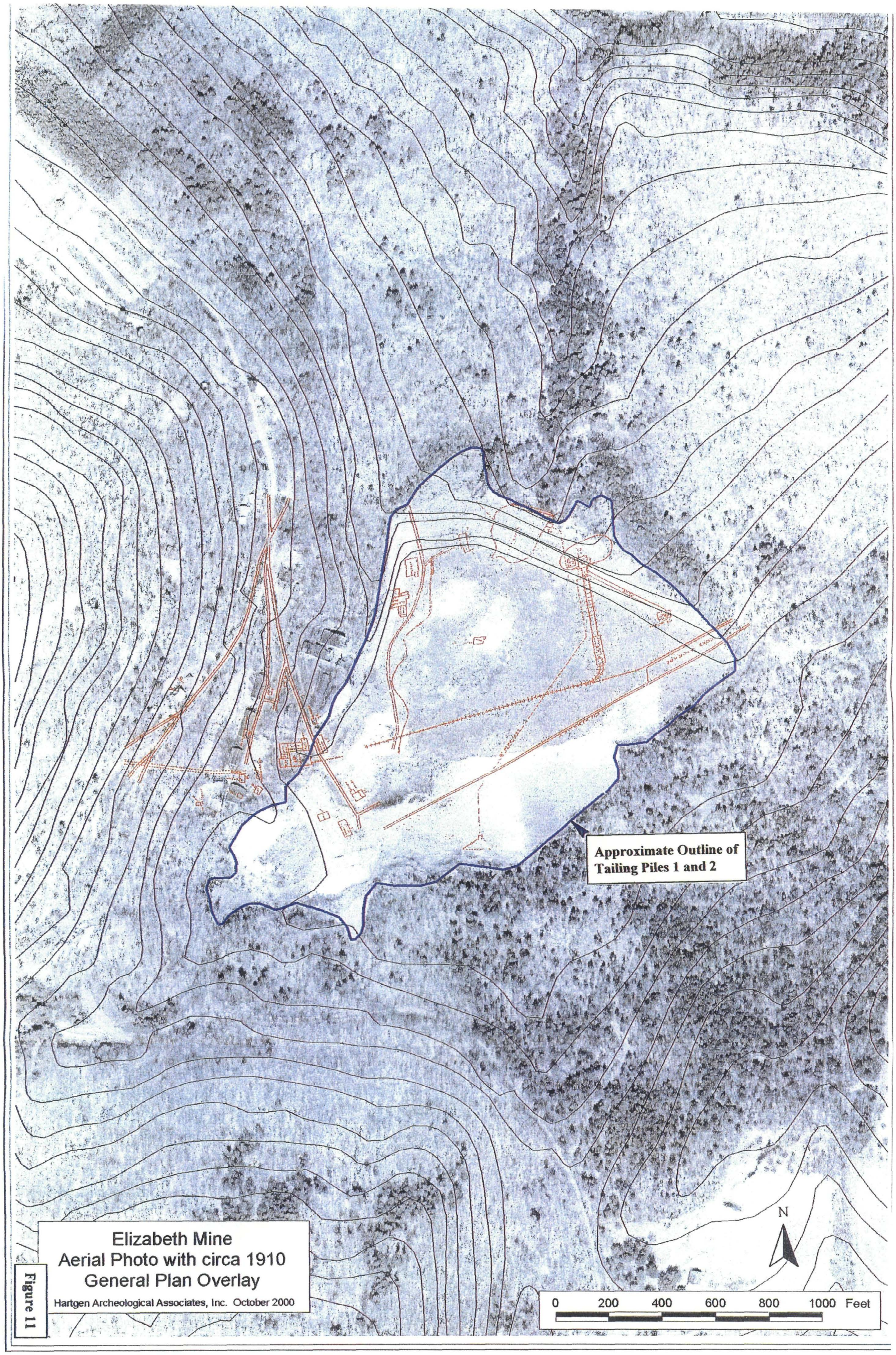
Arthur D Little

Figure 8



Elizabeth Mine
Aerial Photo with 1907 Overlay
Hartgen Archeological Associates, Inc. October 2000

Figure 10



Elizabeth Mine
Aerial Photo with circa 1910
General Plan Overlay

Hartgen Archeological Associates, Inc. October 2000

Figure 11

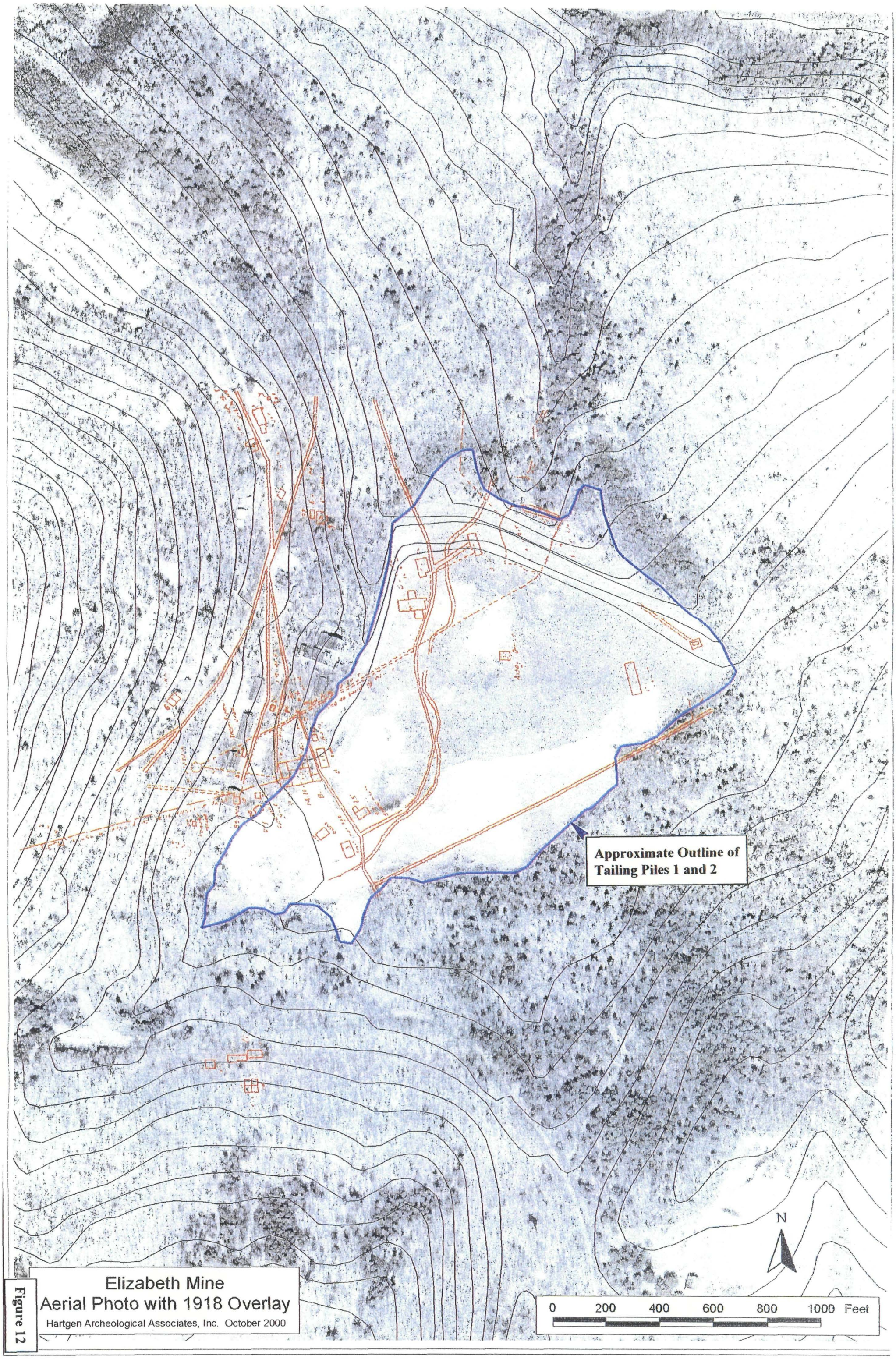


Figure 12

Elizabeth Mine
Aerial Photo with 1918 Overlay
Hartgen Archeological Associates, Inc. October 2000