MINING MEANING:
THE REINHABITATION OF THE CONCENTRATOR MILL AT BRITANNIA BEACH

by
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DEDICATION

For Anthony
Thank you for what you see in me, how you've inspired me
and all the things you share with me.

For my parents
Thank you for your endless love and support.

CONTENTS

ABSTRACT

Can the introduction of new processes to a dormant process-driven building reactivate that building while remaining true to its iconic status?

This thesis will introduce a water treatment facility to a former copper concentration mill in Britannia Beach, British Columbia, Canada. The building will also be open to the public as an educational facility that will focus on the history of the mine, the mining town and the concentrator mill as well as explain the new water treatment process.

The concentrator mill is an imposing structure that has always played an important role in the life of the area. The goal of the thesis is to remain true to the original spirit and meaning of the building through this new intervention. The introduction of new processes into this building (which was originally built around a process) is perhaps the most important step in this direction. The design of the paths and nodes of both the water treatment process and the visitation process are celebrations of the old and the new in this contemporary incarnation of the concentrator mill.

ACKNOWLEDGEMENTS

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Thank you for your enthusiastic support and guidance. Your unending belief in my thesis is encouraging and infectious.

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Our discussions and discoveries, particularly during the crucial early phases, were invaluable.

Terry Johnson, P. Eng.
General Manager, B.C. Museum of Mining, Britannia Beach, B.C.

Thank you for your interest and unquestioning assistance.

The Britannia Beach Historical Society and the B.C. Museum of Mining

The Squamish - Lillooet Regional District

Introduction

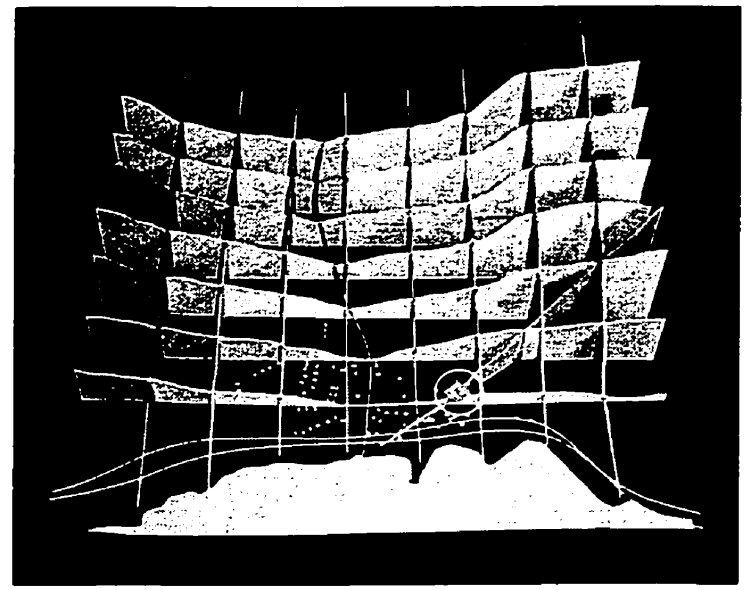
In 1904 mining commenced at Brittania Beach, a force that was to form the core of a community for the next seventy years. Today, the stunningly dilapidated 20 storey high concentrator mill that used to separate the profitable ore from the raw mountain rock silently reclines along one edge of a valley that still houses two hundred residents.

top: view south from north side of valley
bottom: view north from top of concentrator mill

The monumental structure has always been more than the physical focus of the community. It was the town's economy, it dictated the town's schedule, it was the town's iconic and symbolic centre. Its fate/state and the town's have always been inextricably linked. The tattered, empty building now expresses the unfortunate state of the community clustered at its foot. The vast shell is now still and filled with hulks of rusting machinery. The town, lacking a centralizing force, is in danger of being swallowed by a larger, neighbouring town.

The mine left behind another, less visible legacy: a contradiction between the beauty of the site and the poison that is seeping from deep within the moun-

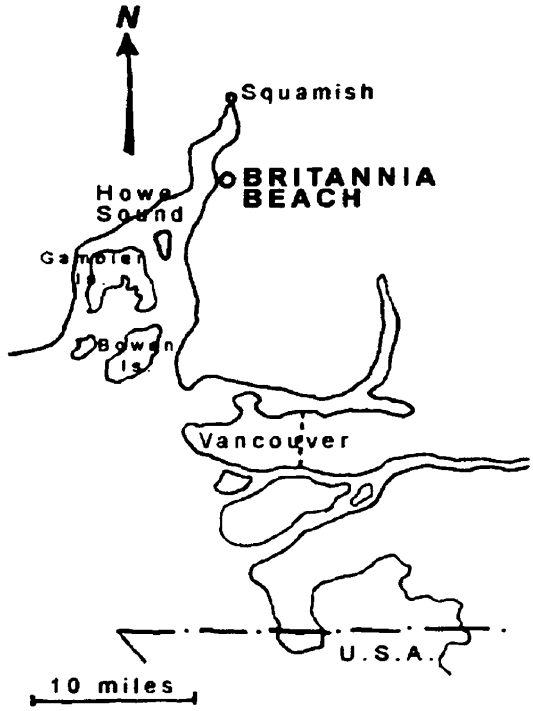
tain in the form of acid mine drainage. Environmental solutions must preclude any significant development of the valley.



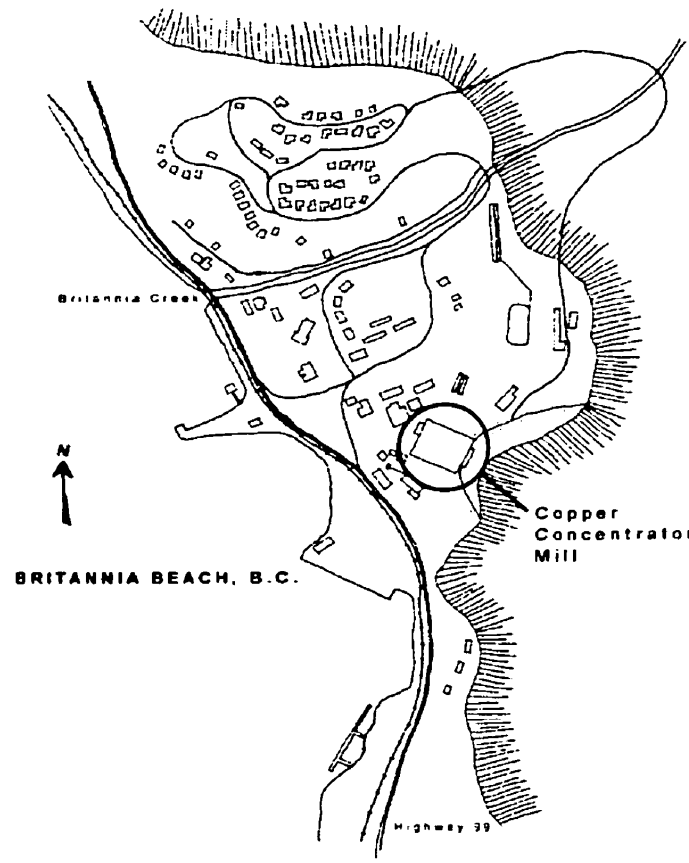
site model of Britannia Beach, with concentrator circled

The concentrator mill steps down to a small, motley collection of buildings from a shared era, severed from the ocean by highway and railway. The buildings at sea level are mainly deserted. The creek that gave the community its name has forced the resilient residents back up the valley walls by regularly overflowing its banks with destructive potential.

The busy road and rail that reinforce the community's estrangement from the sea link Vancouver to the resort municipality of Whistler. Tens of thousands of people race past the community each year, but only a select few are engaged enough by the ruin on the mountain to stop and visit the museum that attempts to sustain Britannia's history.



location of Britannia Beach



site plan of Britannia Beach

Proposal

My proposal chooses to focus on the potential of the old concentrator building. I hope to reactivate the mill, reinhabit the building, and thus recapture its former role as the central focus of the town. Instead of just being a physical icon, it has the potential to actively create a revival of the town. The building will be approached as a foil, a landscape, to which it is necessary to remain true and honest.

The mill was built around the concentration of copper ore and the requirements of that process. Therefore, it is important that the new introduction to the building be another process that can take advantage of the given physical form of the building, rather than an arbitrary program. The unfortunate reality of the environmental pollution at this site presents a logical program for the reactivation of the building. Water treatment has the potential to follow the same gravity-fed route the copper ore once took, moving through consecutive steps in a purification process.

view across Howe Sound from top of concentrator

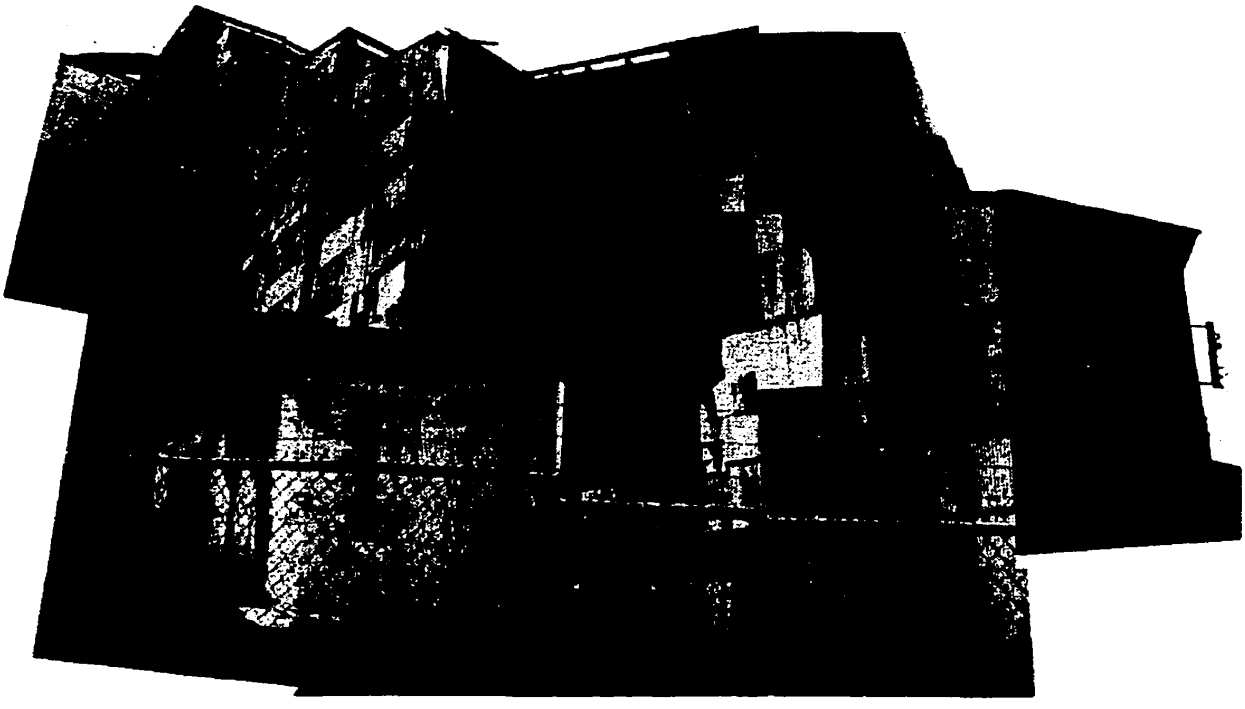
The size of the mill building allows for the inclusion of other contiguous programs. This historical interest and importance of the building make it undesirable to convert the whole mill into a closed treatment plant. Instead, the introduction of this new water-based process may be done in an architectural manner that encourages the education and enjoyment of visitors in an environment that showcases both the Old and the New Concentrator Mill. It is the convergence and negotiation of these two new processes (water treatment and visitation) to

the building that will provide the tension and interest of the project.

Inspiration is taken here from the attitudes of Sverre Fehn, who makes the preservation of a site's meaning the priority in his design process. He lays this notion out in a series of terms to guide the architect's work: Discover, Preserve, Interpret, Manifest, Make Comprehensible (Norberg-Schulz 1997, 58-59). These five "steps" are not discrete entities, and this paper is not intended to be read as five separate sections. The titles are intended as loose guidelines to different conceptual phases of the work. The titles are intended as references to a design theory that I have attempted to form this thesis around.

Thesis Question

Can the introduction of new processes to a dormant process-driven building reactivate that building while remaining true to its iconic status?

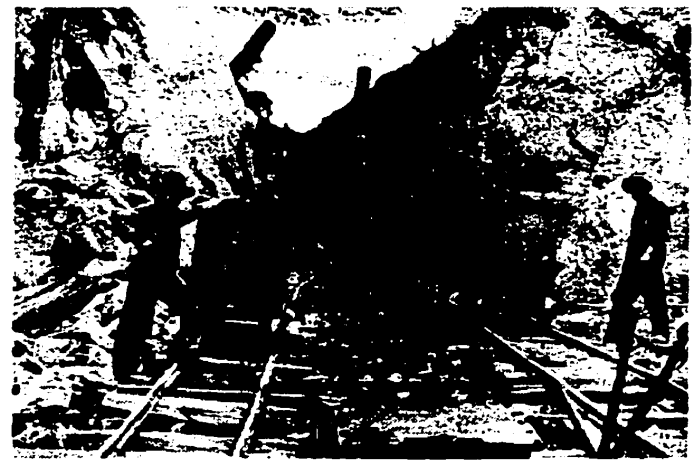


east elevation of concentrator mill

Britannia Beach as seen from the pier

Historical Background

Since their discovery in 1888, the Britannia Mines, international in scope, have had a well documented, illustrious history. They are representative of the key role that mining has played in the development of British Columbia, and present a unique model of the "hard rock" capital intensive mining operations which evolved from the smaller high-grade specialized mines of the nineteenth century. By the end of the 1920s, the Britannia Operation was the largest copper producer in the British Empire. At shutdown in 1974, after seventy years of operation, a multiracial workforce of more than sixty thousand had produced more than fifty million tons of copper ore.



The Britannia Mine, circa 1916
Photo: Britannia Beach Historical Society

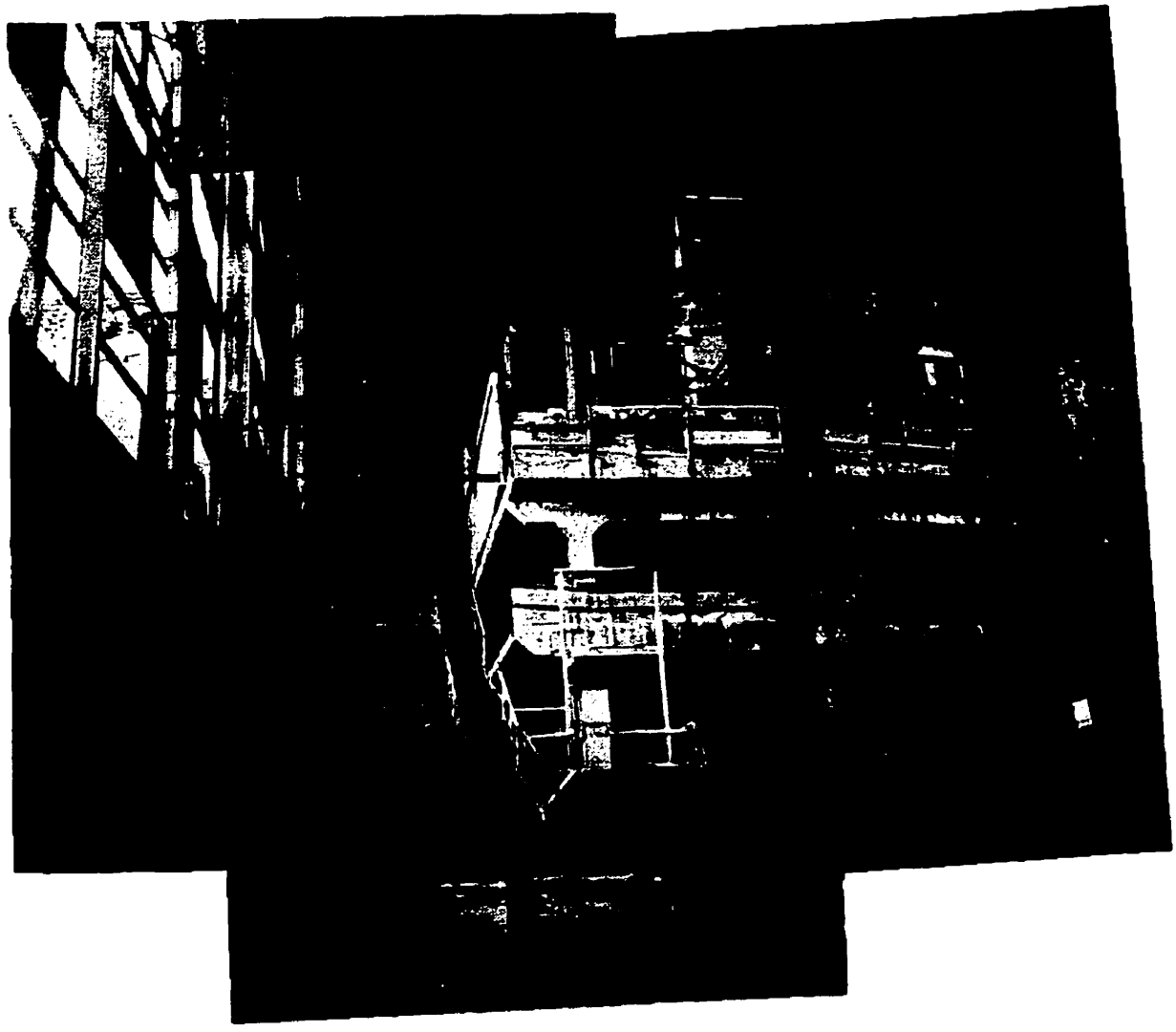
This same workforce lived with their families in two distinct, self-contained communities located at the beach and at the mine site (3.5 miles due east). The communities were to be models for remote coastal resource company towns which would spring up all over the province. Although the mine-site Mount Sheer has been destroyed, the beach community remains as a unique Heritage resource. It is a last remaining, one of a kind, visual reminder of a mining company town. *This is due primarily to current government mining policy which dictates that all evidence of closed operations must be destroyed, the sites reclaimed and the environment restored to nature.* (emphasis added) (B.C. Museum of Mining 1990, 2-3)

The final sentence in the above quotation raises three issues central to my thesis. The first is the simple importance of embracing the opportunity to preserve the concentrator mill. It is an opportunity that will not present itself again. The other two issues are more theoretical, one dealing with the meaning of the reclamation of a site, and the other dealing with the difference between nature and landscape and the value assigned to each.

To reclaim the site in the traditional sense would be to tear down the building, a move that would be devastating to the entire town. The mill is Britannia's icon, its sentinel. To remove it would be to tear out the symbolic and physical core of the community. I propose that the reclamation of this site means a reclamation of the old concentrator mill. A strategic reactivation of the building, bringing the building back to life, rather than allowing it to become (remain) a romantic ruin, has the potential to lead to the revitalisation of the town by returning the building to the role it used to have as a vital economic centre.

front elevation of the concentrator mill

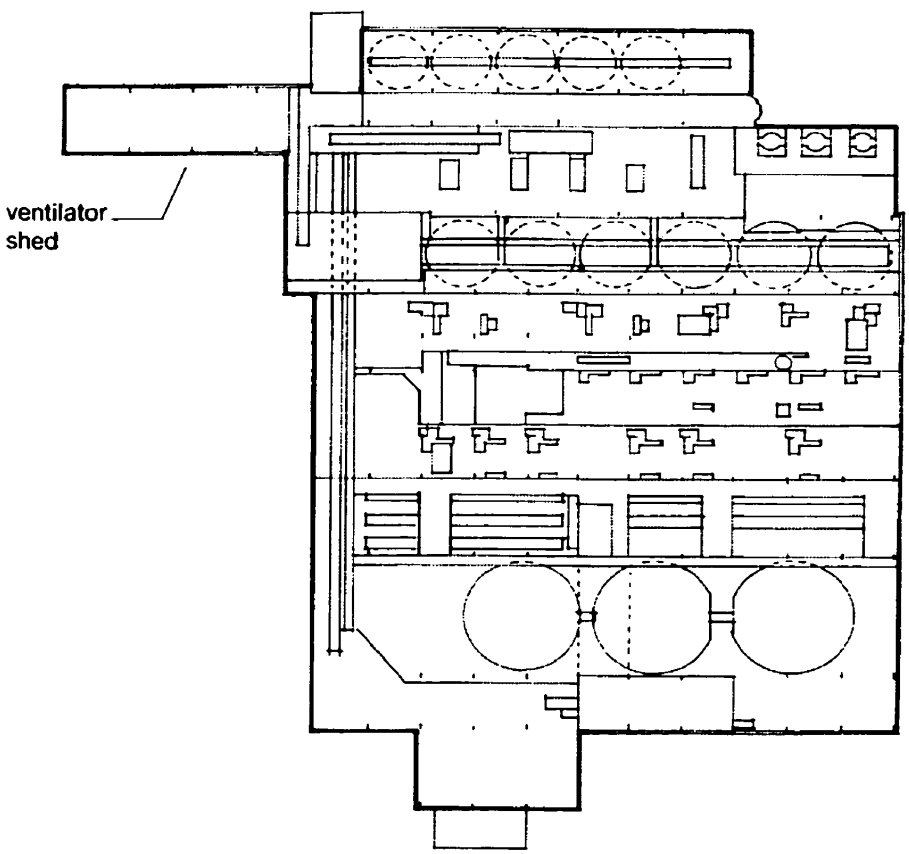
Inherent in this proposal is the notion of what a building means in a landscape. I assert that to have "the environment restored to nature" would be inconsistent with the character and spirit of the place. The concentrator mill is as much a part of the landscape as any of the natural features, such as the mountains, the ocean and the creek. However, there is a tendency to place more value on a natural landscape than a man-made one. To remove the building would be to deny its impact and meaning. This landscape would be incomplete without the concentrator. Its destruction is not a viable option.



interior of concentrator mill, looking up from northeast corner at bottom level

The Concentrator Mill

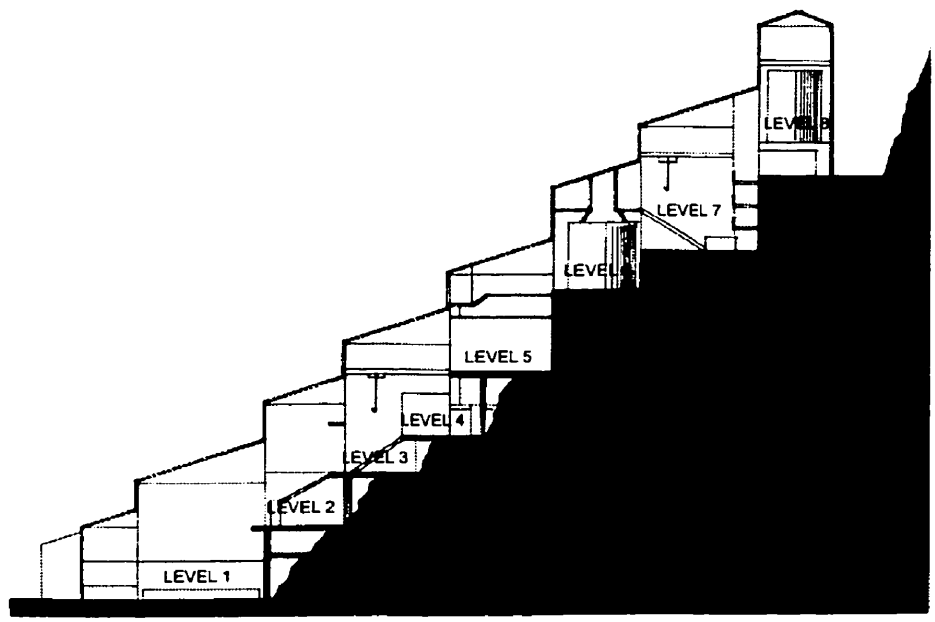
The concentrator mill conveys an impression of immense scale and height, rising up the hillside in eight successive levels. Its overall dimensions are 209 feet in width by 271 feet in depth, while the side wall heights of each stage vary from 50 to 70 feet. With set-backs, the structure rises an estimated 230 feet overall from the base. The building is essentially rectangular in plan, with the exception of the ventilator shed addition on the side and a blower shed projecting from the north facade of the lowest level. Construction of the entire structure, with the exception of the ventilator shed, occurred in 1922-23. The ventilator shed was added three years later.



plan of concentrator mill

The original plans for the building were supplied by Bradley, Bruff and Labarthe, a San Francisco based firm of metallurgical engineers. A variety of on-site modifications were made to the internal mill system over the years, some of which were considered noteworthy innovations within the industry. These included the development of a new type of deep cell and an elevator classifier system, an on-site production of steel grinding balls and mill liners from used rail.

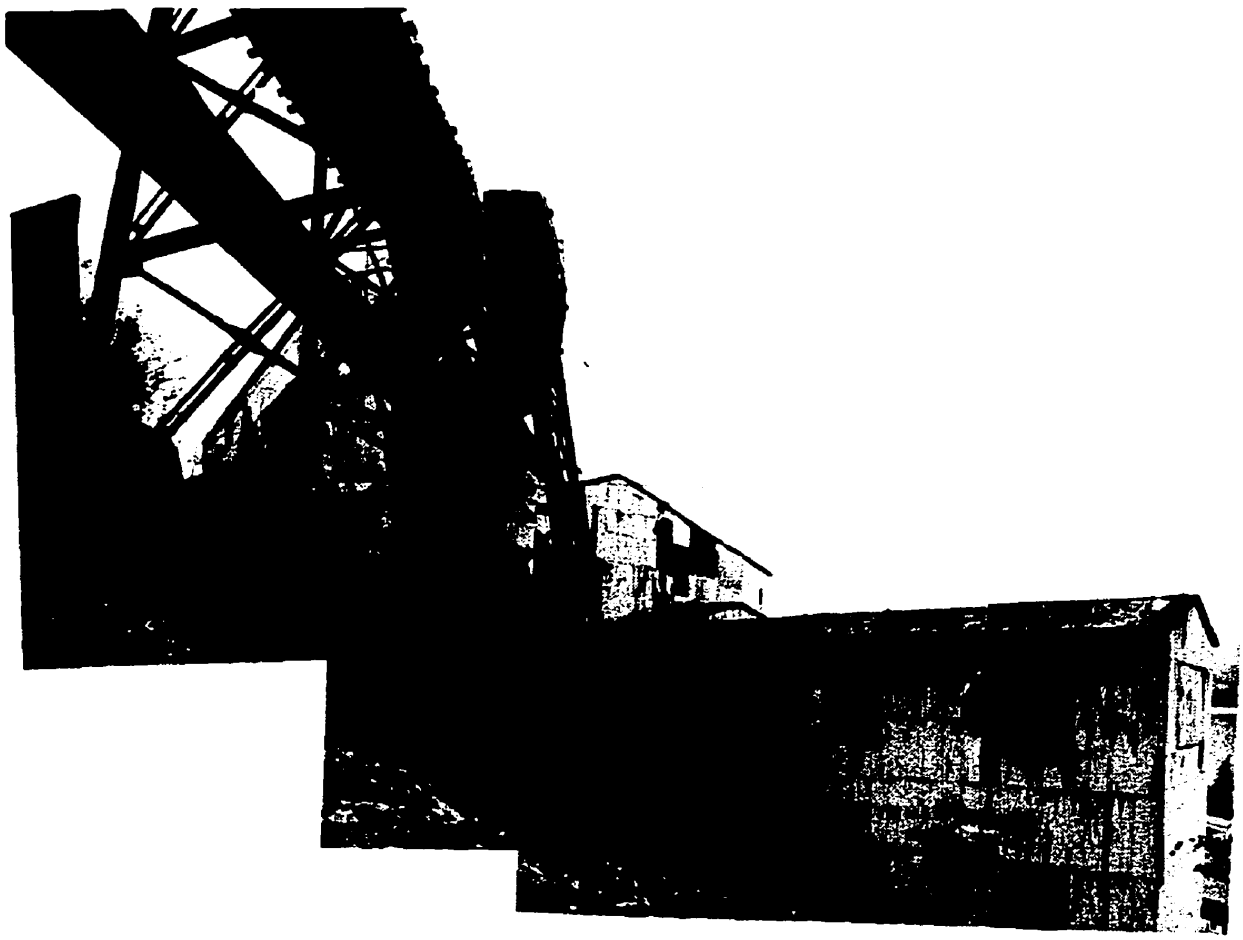
The building's structural framework consists of a combination of concrete piers and columns anchored to the rock face which in turn supports a system of steel columns, trusses and purlins. The concrete substructure built into the hillside of each level carries the steel outer wall framework of the level above. Thus each level functions as a lean-to, attached to the one above it, with the exception of the uppermost level which is free-standing and braced by anchor cables embedded into the rock face. Exterior wall surfaces are sheathed with corrugated metal, pierced on the three outer facades by large window openings. All but the final level are covered with shed roofs that lean against the facades of the levels above. The final (uppermost) level is clad with a gabled roof of similar pitch. Roof surfaces are constructed of two inch wood decking laid over the metal substructures. The decks are in turn covered with asphalt shingles on all but the third and top levels, which are metal clad.



section of concentrator mill

> *Much of the intrinsic interest of the building naturally lies in the close correlation between its layout and successive stages in the concentration process.* Although much of the mill equipment was removed following the closure in 1974, key structural components and remnants of industrial machinery enable the viewer to trace the route from ore intake at the top level to the bottom section where mineral concentrate left the mill by a conveyor system leading to the waiting ships. The visual connections begin with the rail trestles leading in and out of the mill at the uppermost level. In level one, the ore was dumped from rail cars into coarse bins where the primary separation process began. These bins rise from bases on the second level, where the ore was transferred to crushing apparatus, then in turn to grinders (level four), a flotation apparatus (levels five and six), thickeners (level 7), and final filtration (level 8).
>
> Descending through the eight levels, one encounters a succession of corridors, vast open galleries, steel platforms, catwalks, stairs, and piping. The upper levels retain the steel bins and tanks used in the separation process, in addition to overhead cranes, monorails and remnants of machinery used in the extraction process. The horizontal layering of the building is interrupted on the extreme left (eastern) side, where an open corridor containing the rails of an inclined tram system and a parallel staircase pierces the structure from top to bottom. Known as a skipway, this system, which ran on compressed air, was used to convey equipment to and from the various levels. Overhead cranes in turn conveyed the equipment to and from the skipcarriage on each level. (emphasis added) (*Designated Cultural Resources Recording Report* 2000, 11-12)

The building is currently closed to the public due to its deteriorating state. However, the majority of the structural members were found to be in fair to good condition by inspections in 1982 and 1990 (DCRRR 2000, 13). This proposal assumes that the building would be returned to a structurally sound state, with the envelope and interior returned to their original states in designated areas.

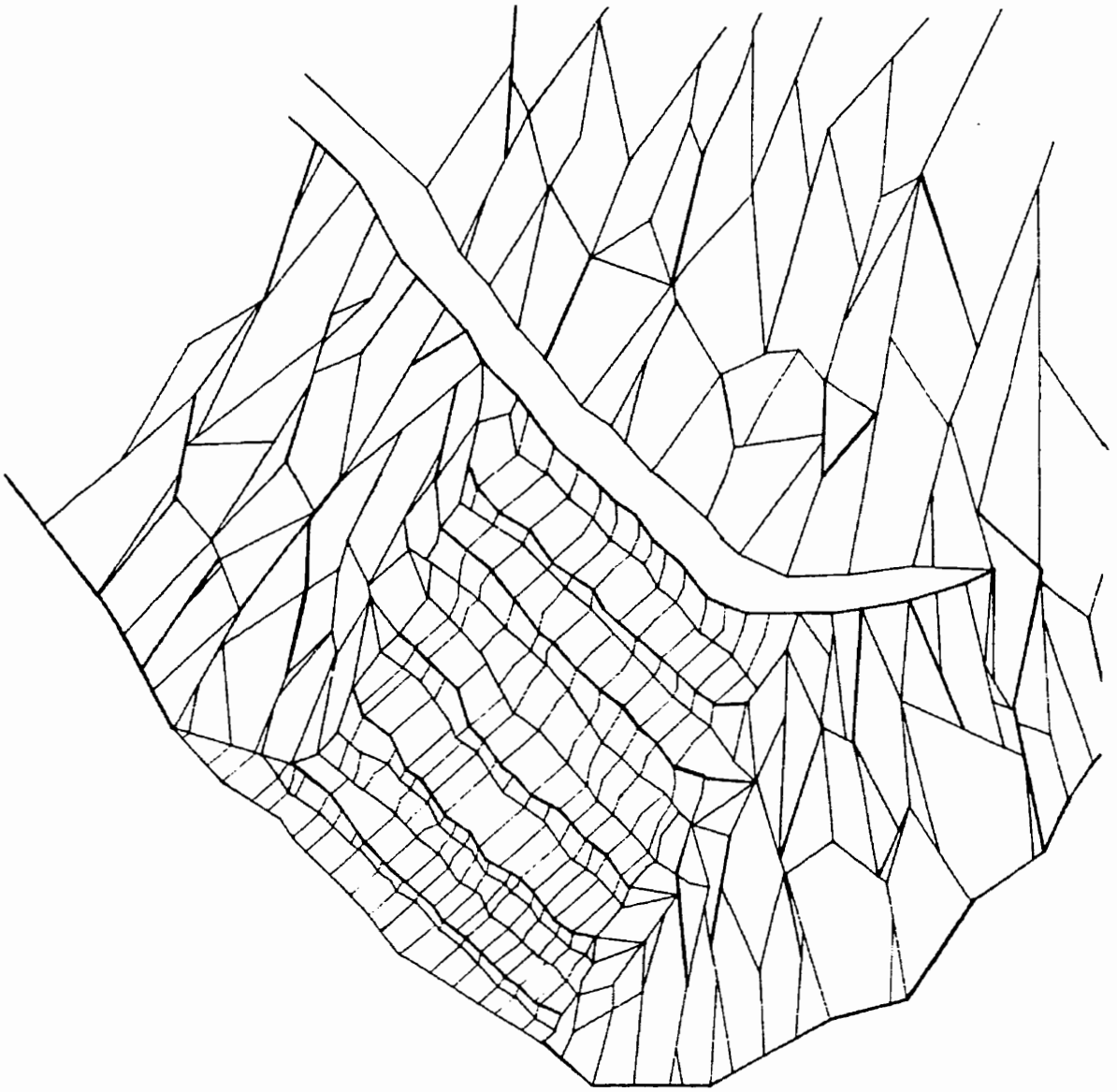


rear of concentrator mill

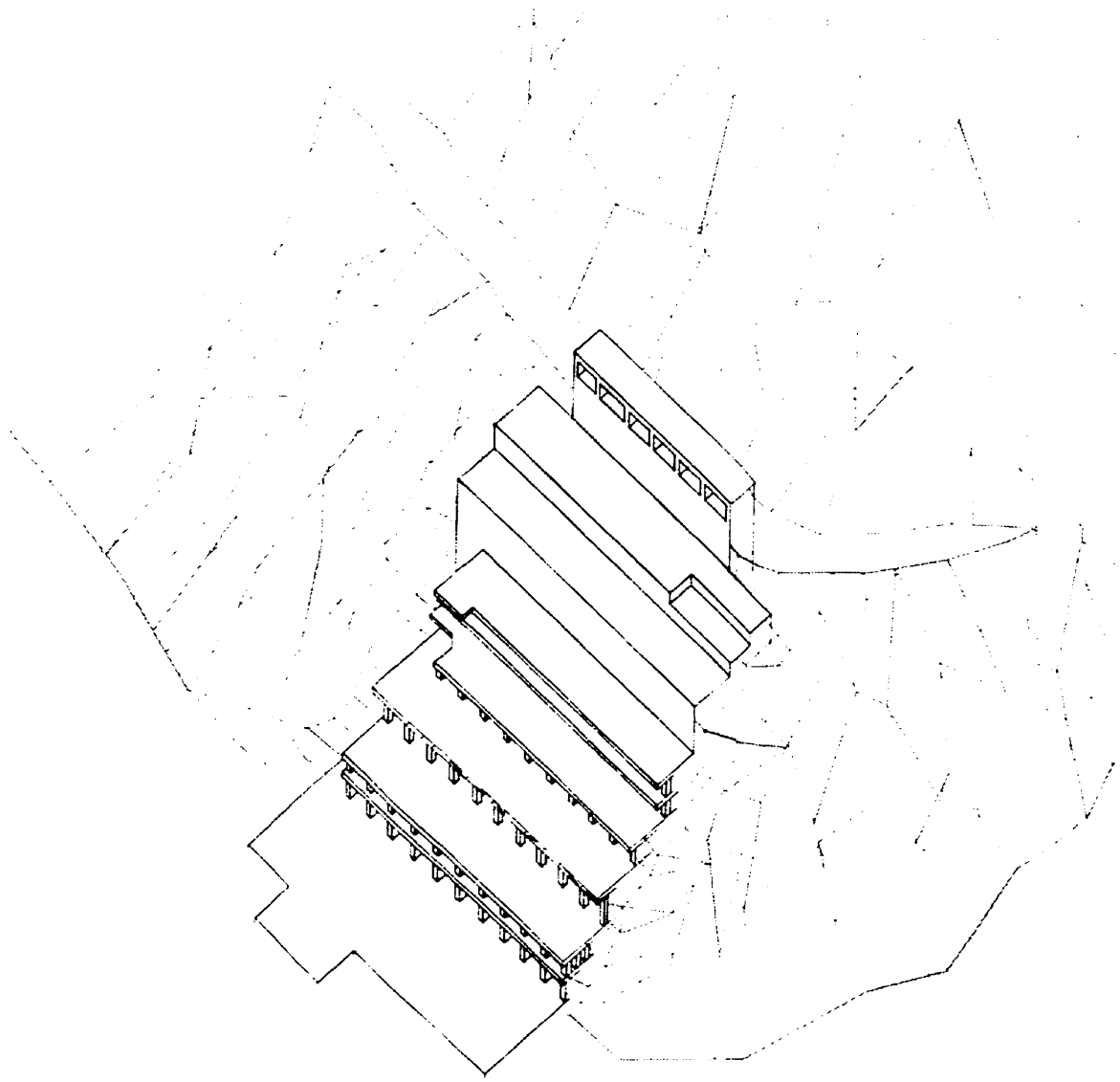
PRESERVE

The concentrator building in its current state can be considered to consist of five elements: the mountain, the concrete substructure, the machinery and equipment, the structure and the envelope. The composition of these elements was dictated by the requirements of the copper concentration process. The machinery and equipment related to the copper process refers most directly to this organization, and can be seen as the hearth of the building.

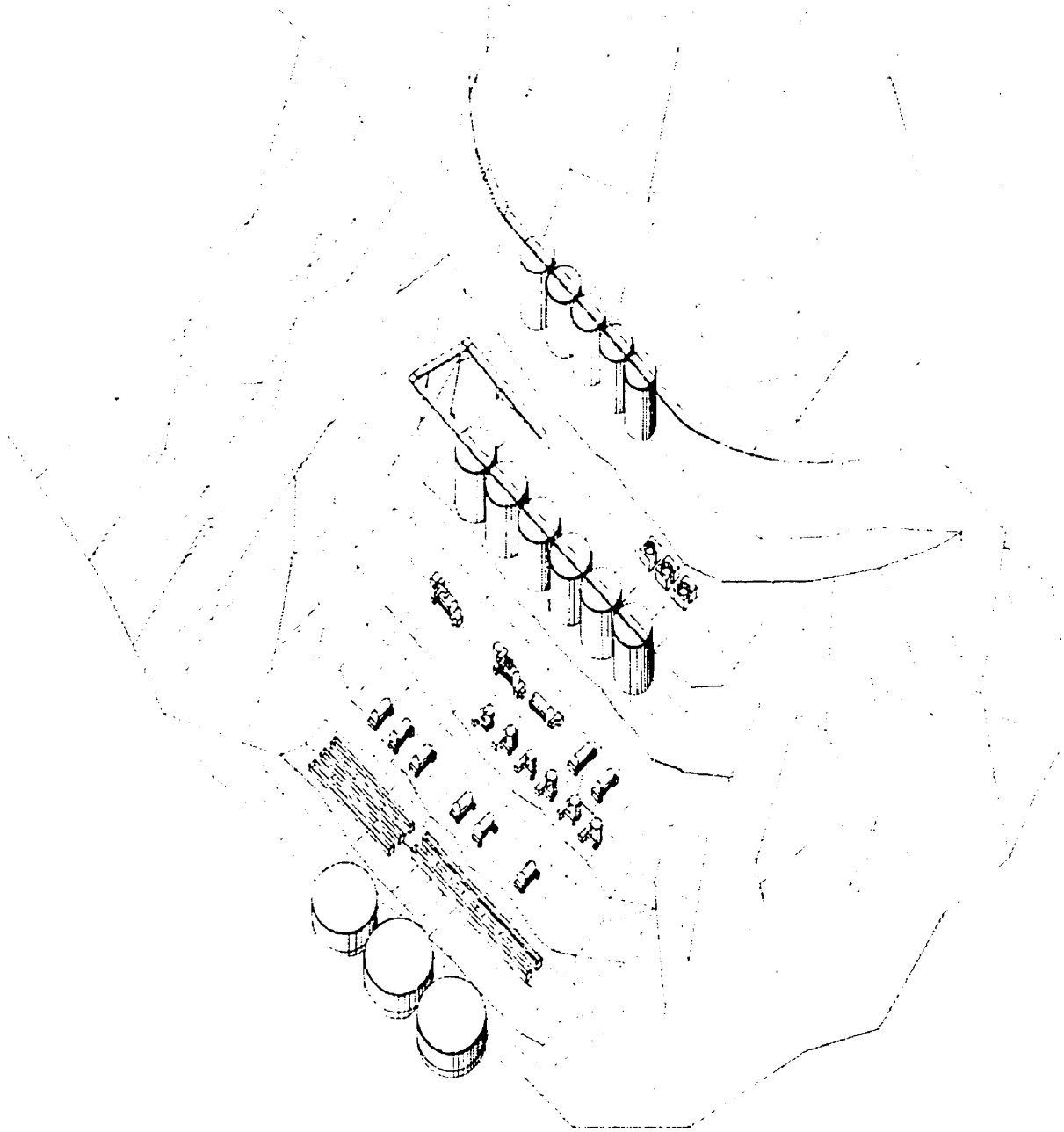
These axonometric drawings are tools to assist in the understanding of this complex building by calling attention to a system of organizing the important elements of the existing building. The designation and separation of these components is meant to recall not only the construction sequence of the mill, but also the original conception of the relationships between each layer. Considering these elements in this manner is intended to provide a framework for the insertion of the new processes that is consistent with the original design and construction of the building around the copper concentration process.



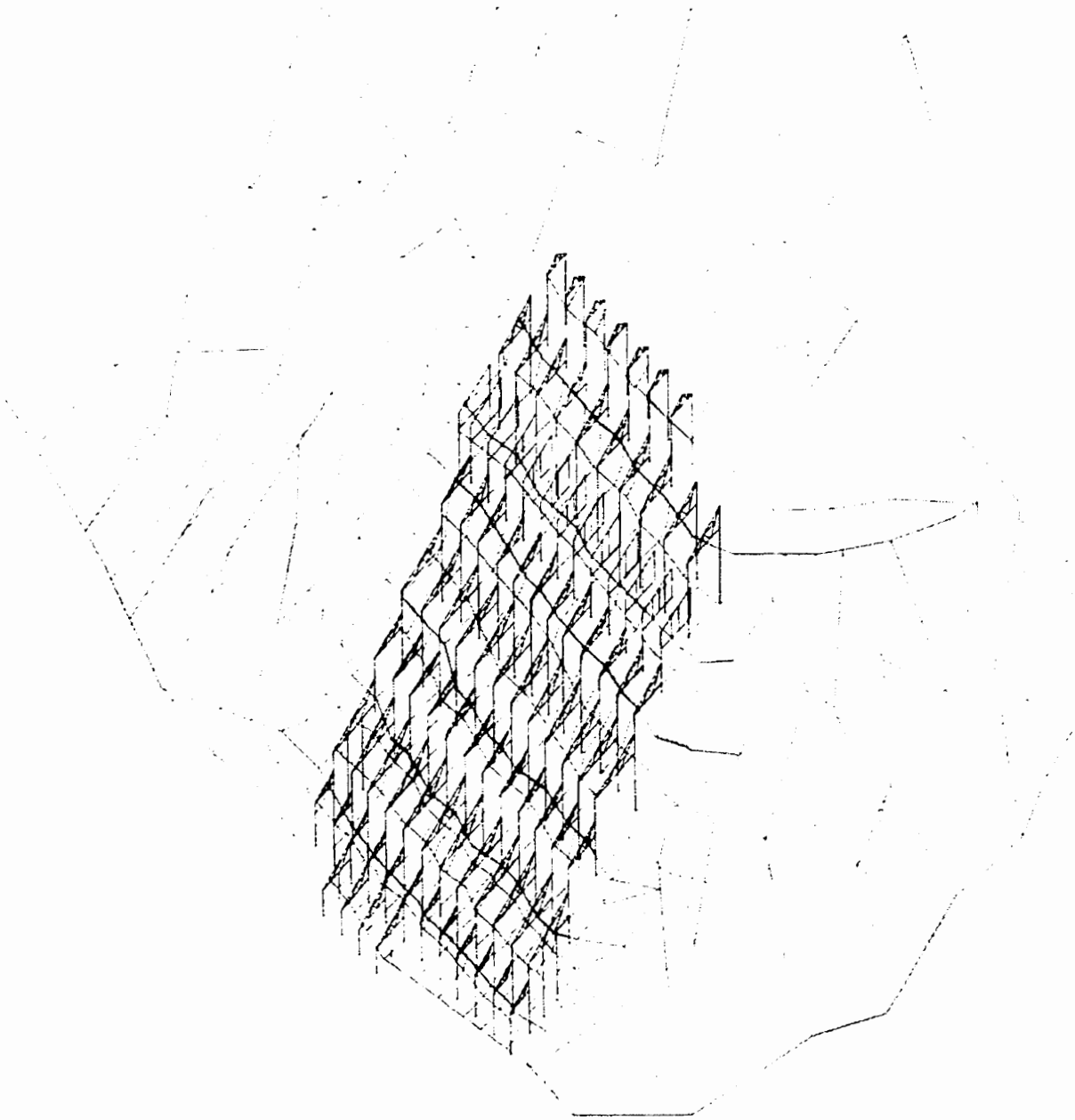
axonometric of site: mountain side prepared for the mill



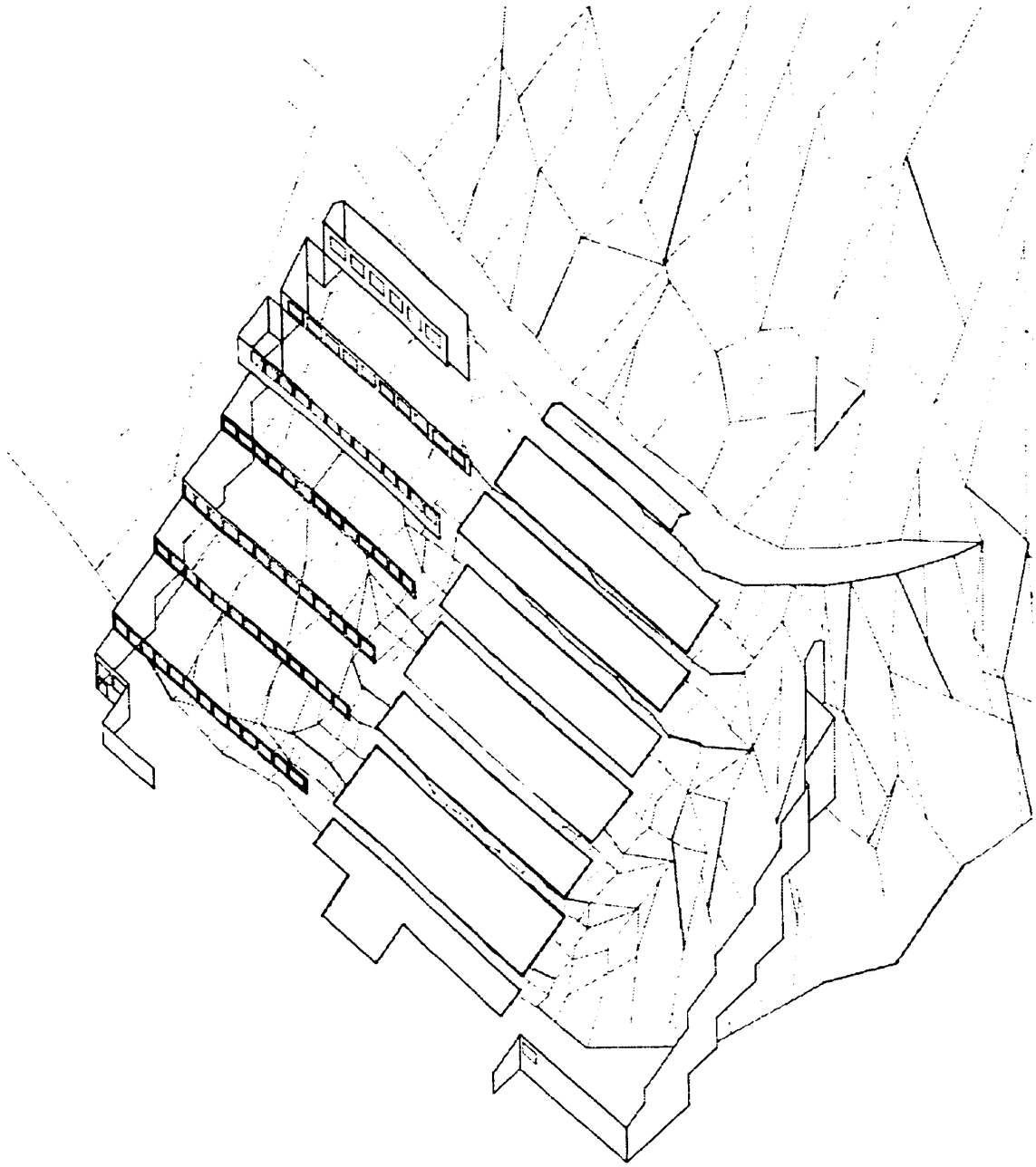
axonometric of concrete substructure of mill



axonometric of machinery and equipment housed in mill



axonometric of structure of mill



exploded axonometric of envelope of mill

Copper Concentration Process

The function of a mill in any industrial process is to convert raw material into usable or saleable products ... The copper sulphide represents about 4 percent of the weight of the ore that is received at the mill and in the milling process is collected as a copper concentrate (containing small amounts of silver and lesser amounts of gold) which is shipped to a copper smelter in Tacoma, Washington ...

interior of no. 3 mill circa 1923
from Bruce Ramsey, *Britannia, The Story of a Mine* (1967).

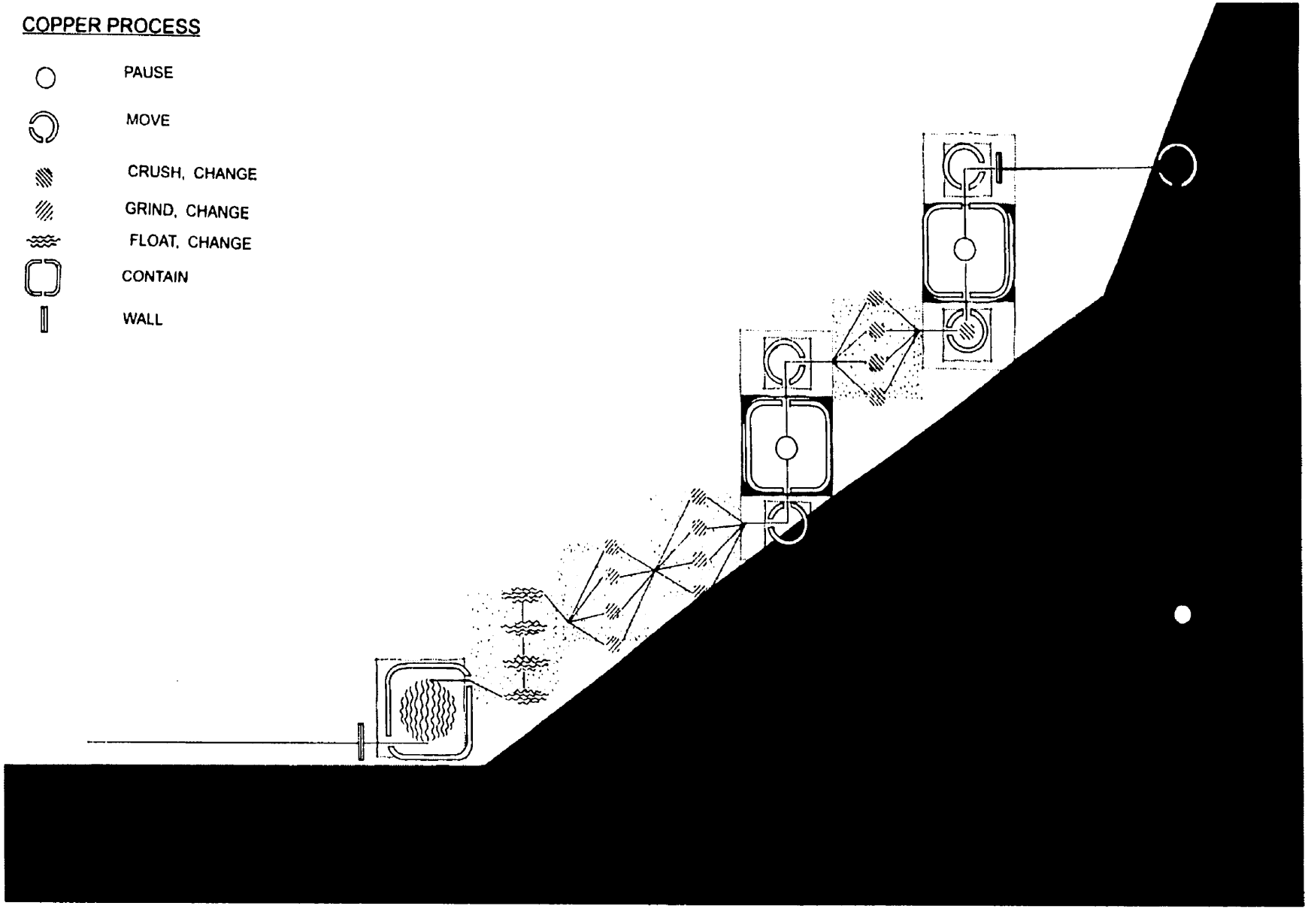
The concentrating process consists of a series of steps all designed to ultimately liberate the valuable minerals from the rock and from each other and to collect each of them into concentrated forms ... At Britannia this means that before the minerals are free the ore must be reduced in size to about 100 mesh or finer - about the size of the finest sugar or salt. The steps involved can be classified into four main categories, namely, crushing, grinding, flotation and dewatering. (Packer 1970, 1-4)

tube mill floor, no. 3 mill, 1923
from Bruce Ramsey, *Britannia, The Story of a Mine* (1967).

The copper concentrating process is further explained in Appendix A. This process was still in use with only minor updates in the equipment in 1974 when the mill closed. The four categories of the process occupied clear zones in the layout of the mill. Each step's particular requirements dictated the form and location of each zone on the sloping site. The mill is a building designed by a process.

The following drawing is of the copper concentration process, diagramming the spatial implications as well as the physical alterations of the ore.

Without the process, the building is without its hearth. This thesis will explore the implications of introducing new processes to this building. The new processes will attempt to occupy the building in a manner that takes its cues from the existing building and its relationship to the original process. The differences in form, material and function of this new introduction will create interesting challenges to a coherent design.


COPPER PROCESS
PAUSE
MOVE
CRUSH, CHANGE
GRIND, CHANGE
FLOAT, CHANGE
CONTAIN
WALL

A Problem and a Solution:

Acid Mine Drainage and High Density Sludge Treatment

One of the new processes to be introduced in this proposal is the treatment of the major environmental problem left by the mine: acid mine drainage.

> Every day, up to 50 million litres of toxic runoff flows from the abandoned mine site on Mount Sheer into Howe Sound ... Two meters of rain a year, five open pits and a network of tunnels estimated to be 210 kilometres long provide perfect conditions for acid mine drainage.
>
> When iron sulphide minerals are exposed to water and air, sulphuric acid is generated. The acid dissolves the heavy metals in the rock, such as copper, zinc, and cadmium, and washes them through the pits and tunnels of Mount Sheer into creeks, streams and eventually Howe Sound.
>
> Mine waste from Britannia Creek is one of the most serious marine pollution problems affecting fish habitat in B.C. (Judd 2000, 28)

A diagrammatic explanation of acid mine drainage and its potential treatment at Britannia Beach can be found in Appendix B. The treatment process for this problem has been explored and researched.

> A waste treatment plant would raise the water's ph level and filter out the heavy metals, so the toxic effects would be reduced significantly and immediately. (Judd 2000, 29)
>
> Based on the results of the testwork and literature review, the 1991 study recommended that a high density sludge treatment system be utilised for Britannia, using either lime of a combination of lime and soda ash. (Simons 1998, 3)

Solar-biological Wastewater Treatment

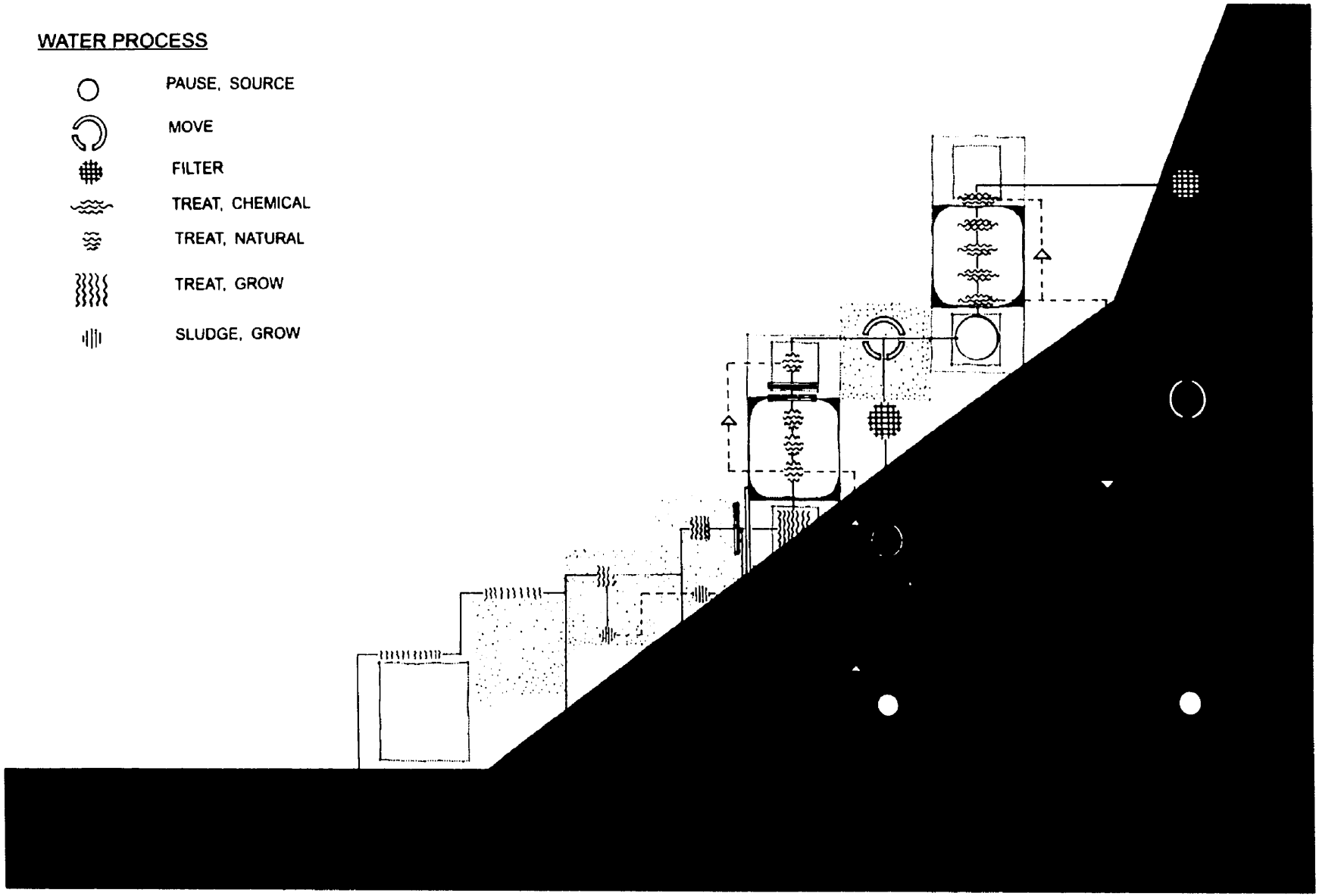
My proposal involves taking the water treatment process a step further. A solar-biological tertiary treatment process will treat the water that results from the above process as well as sewage water from the town. By treating both water sources in this manner, a much purer final water will be introduced to the environment. An example of such a bioaugmentation process employed by the solar aquatics wastewater treatment system is outlined in Appendix C.

The goal of this type of treatment is to create a system that "duplicates, under controlled conditions, the natural purifying processes of fresh water streams, meadows and wetlands." (EDM Information Package, 2000)

The general process is as follows:

> Screens take out grit, sand and plastics, as in a conventional system ... Sewage flows through clear-sided tanks and engineered marshes, where bacteria and algae begin the biological breakdown.
>
> As the sewage water is steadily cleaned by these organisms, the system goes "higher and higher up the food chain," with floating plants, snails, shellfish and fish all playing a part in cleaning the water.
>
> At the top of the food chain, crayfish, tilapia -- a type of fish -- and even carp can be used both to process sewage, eat other things like bacteria and algae, and keep the water stirred up without having to resort to pumps.
>
> When in operation ... the new plant's output will meet or exceed sewage outflow standards, use no chemicals, be virtually odour free (Dunlop 1994, B12)

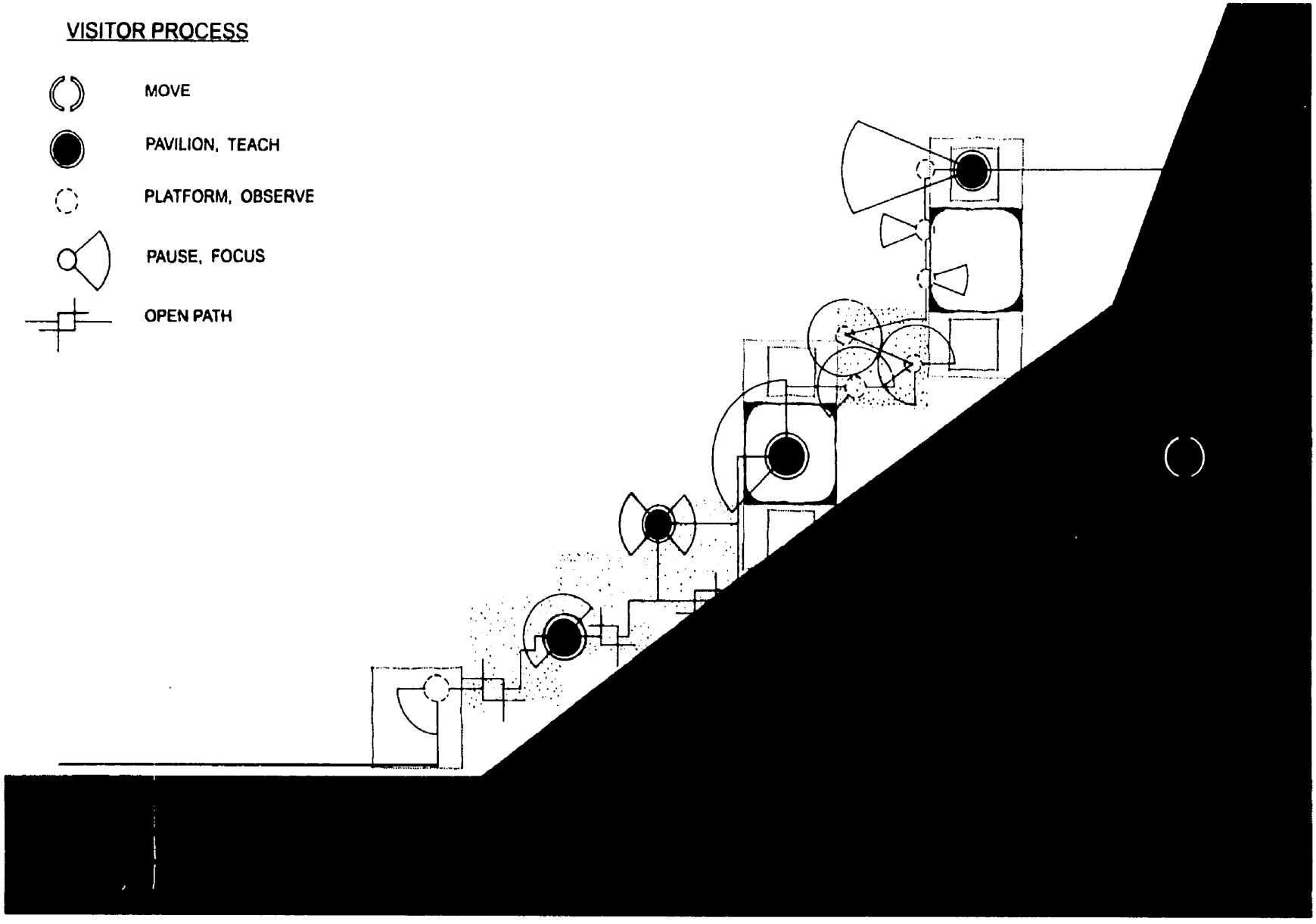
The proposed double water treatment process is diagrammatically analysed in the following drawing.


WATER PROCESS
PAUSE, SOURCE
MOVE
FILTER
TREAT, CHEMICAL
TREAT, NATURAL
TREAT, GROW
SLUDGE, GROW

The Mill and the Visitor

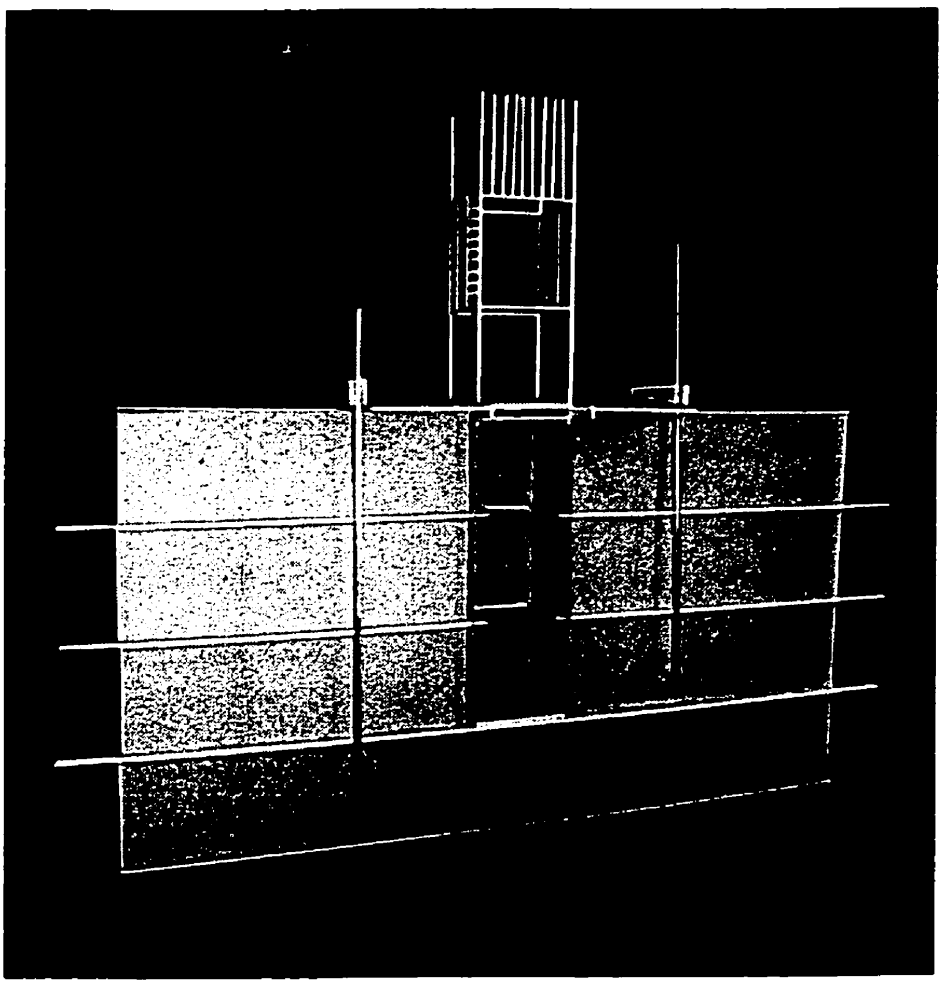
The concentrator mill will be open to the public as an educational facility. The successive stages of the water treatment process will guide the visitor's path through the building. The existing design of the building demands that the visitor's procession through the building be carefully choreographed. Employing this designated route, it is possible to incorporate a historical aspect into the program. Sections of the building will be left as they are, and be recognized as representing the history of the site and of the building. This architecture of recognition will form an internal explanation for the necessity of the water treatment process and be an argument for the continued existence of the building.

The following drawing is a diagram of the visitor's path through the building, showing moments of pause and areas of focus.


VISITOR PROCESS
MOVE
PAVILION, TEACH
PLATFORM, OBSERVE
PAUSE, FOCUS
OPEN PATH

Design Strategies

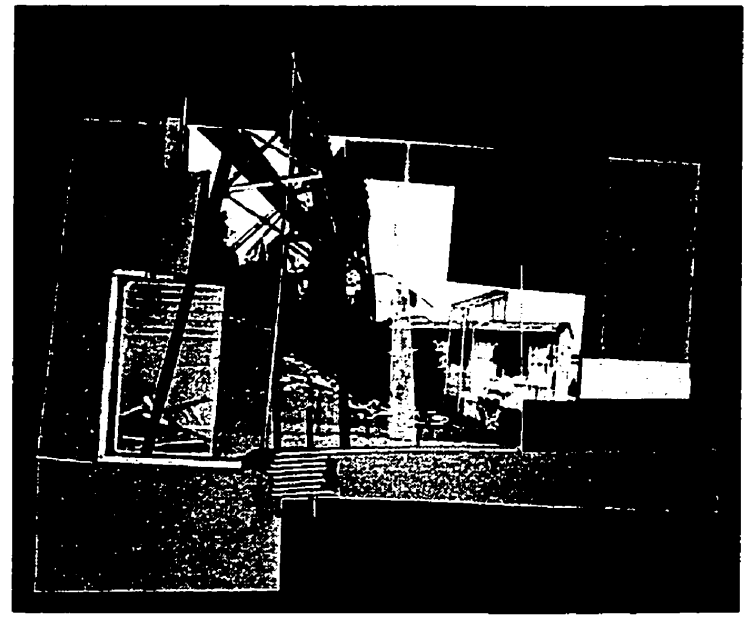
The processes will be the leading forces in the design. Water will be considered architecturally, as a material, a force and a potential form. The existing building will be a foil as well as an inspiration. Moments of the intersection/convergence/ negotiation of all three processes - the copper, water and visitor - will form vital nodes of exploration. The relationship of the intervention to each and/or all of the five elements as described in the axonometric drawings will be emphasized.



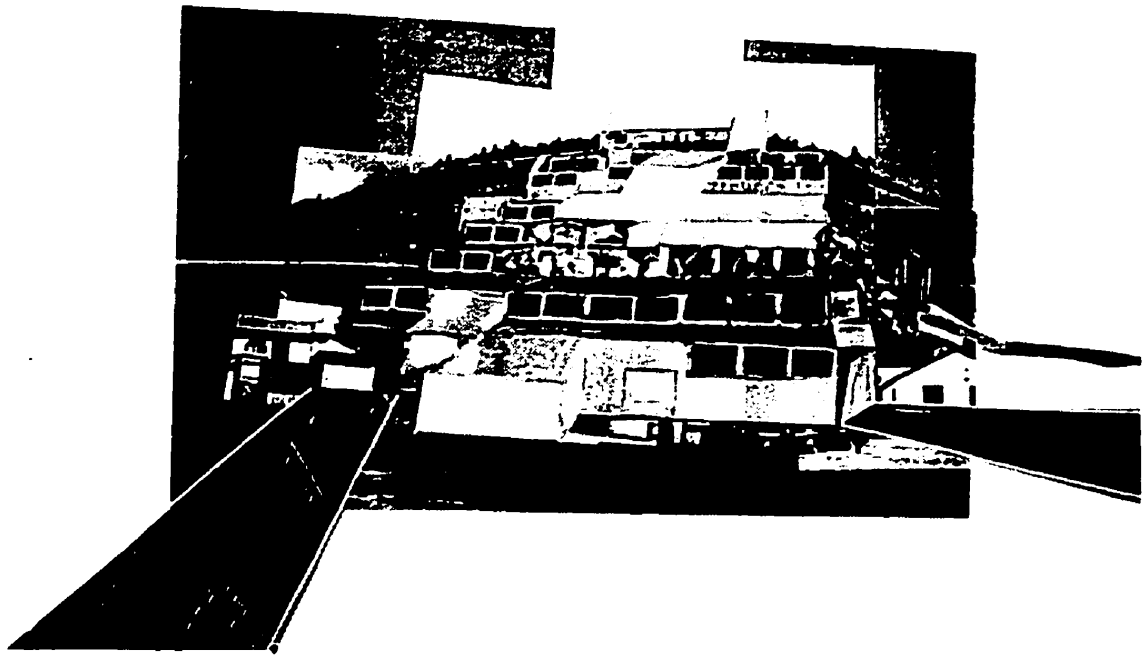
Conceptual model exploring the differences in structure relative to ground relationship. Issues of framing, digging, layering, vertical composition and connections between spaces are introduced.

Collage exploring interior condition of mill, focusing on emphasizing existing rooms within the mill and reopening windows on side elevations (by M. Brady Peters).

Collage of interventions on east elevation, depicting an increased relationship of interior and exterior through extending the mill's geometries into the landscape in order to emphasize hot spots inside.



Collage of interventions on rear of mill, exploring possibilities for embedding new spaces in the mountain and exploding new spaces beyond existing envelope of the mill (by Melissa White).



Collage of exterior impact of manipulation of envelope and potential location for extensions into the landscape.

MAKE COMPREHENSIBLE

Summary

The basis of this thesis lies in its approach to the mill as a proposal, not an artifact. In order to remain true to the original spirit and meaning of the building, it must be seen as possessing the potential to be an integral contributor to the town. This can only be achieved through introducing a program that engages the given physicality of the building in a productive manner.

The analysis of the processes and their architectural introduction into the building are enactments of the reinhabitation of the mill. The manifestation of the vitality of the processes removes the mill from its idle, romanticised situation. The distinction of the water treatment process as the leading form for the incorporation of the visitor procession creates a coherence and clarity that runs through the building.

Materials are kept consistent within their process in order to enhance the clarity of the order of the processes, the visitor process being predominantly wood and steel and the water process being copper and concrete. The material choices reinforce the affinity of each process to one of the five elements of the existing building. The visitor process allies itself with the existing steel structure while the water process is linked to the concrete substructure.

A strategy of recognition directs the architecture of the inhabitation of the mill. Existing situations are emphasized, with small scale interventions, rather than large impositions. Subtraction is frequently employed in an effort to retain and emphasize the character of the mill, most obviously in the treatment of the envelope. Also, two tanks are removed on level 6 to increase the impression of the verticality of the mill. Connections are increased and tightened between levels by extending the system of stairs and bridges and creating visual

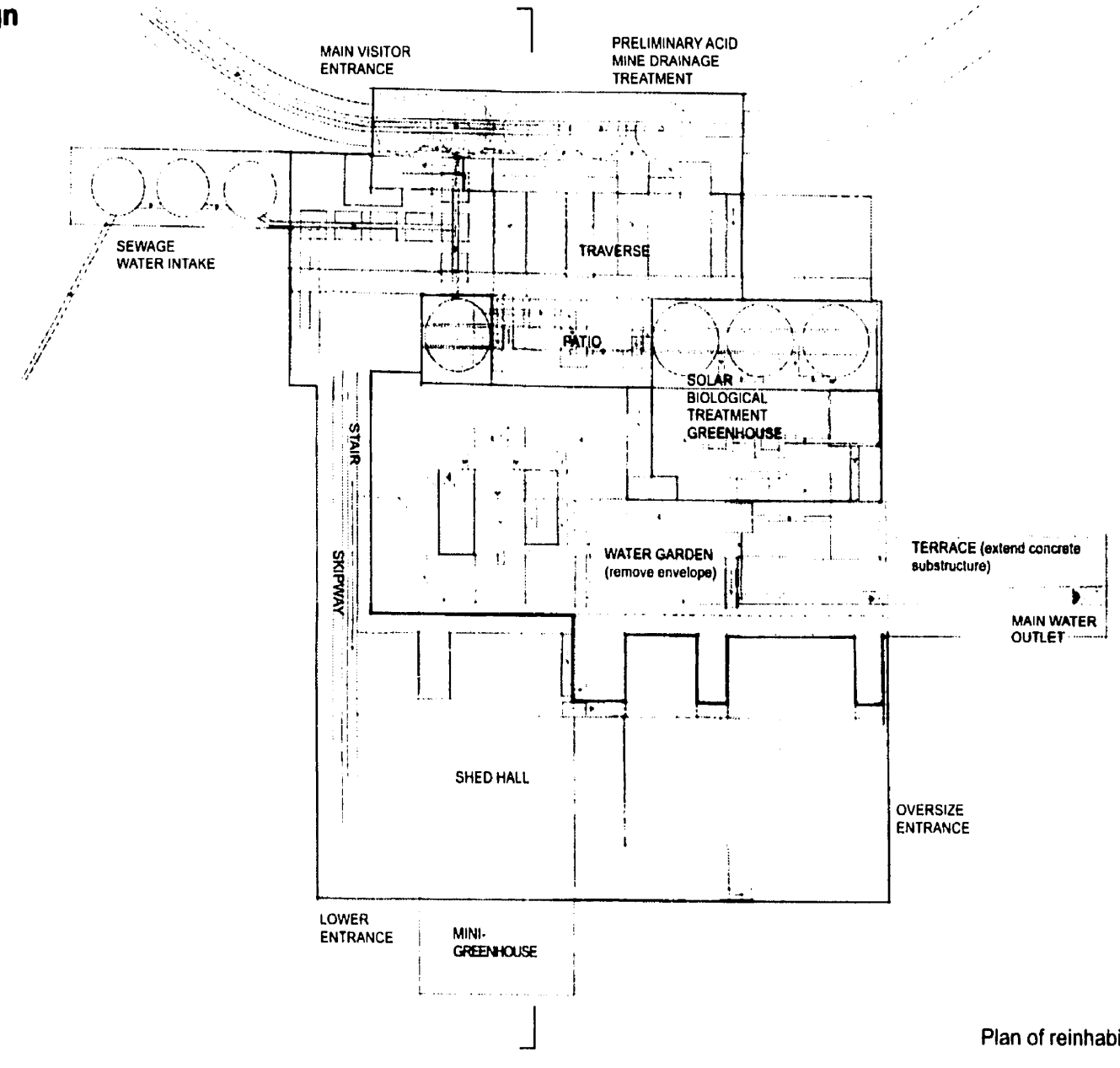
continuities.

Certain areas are left as direct references to the original function of the mill, altered only for structural or envelope integrity. However, these spaces are not programless. The shed hall, on level 1, is intended to function as a community-run facility, for the town's use or for rental to the movie industry. The floor of the traverse area, on level 7, allows for exhibitions by the museum.

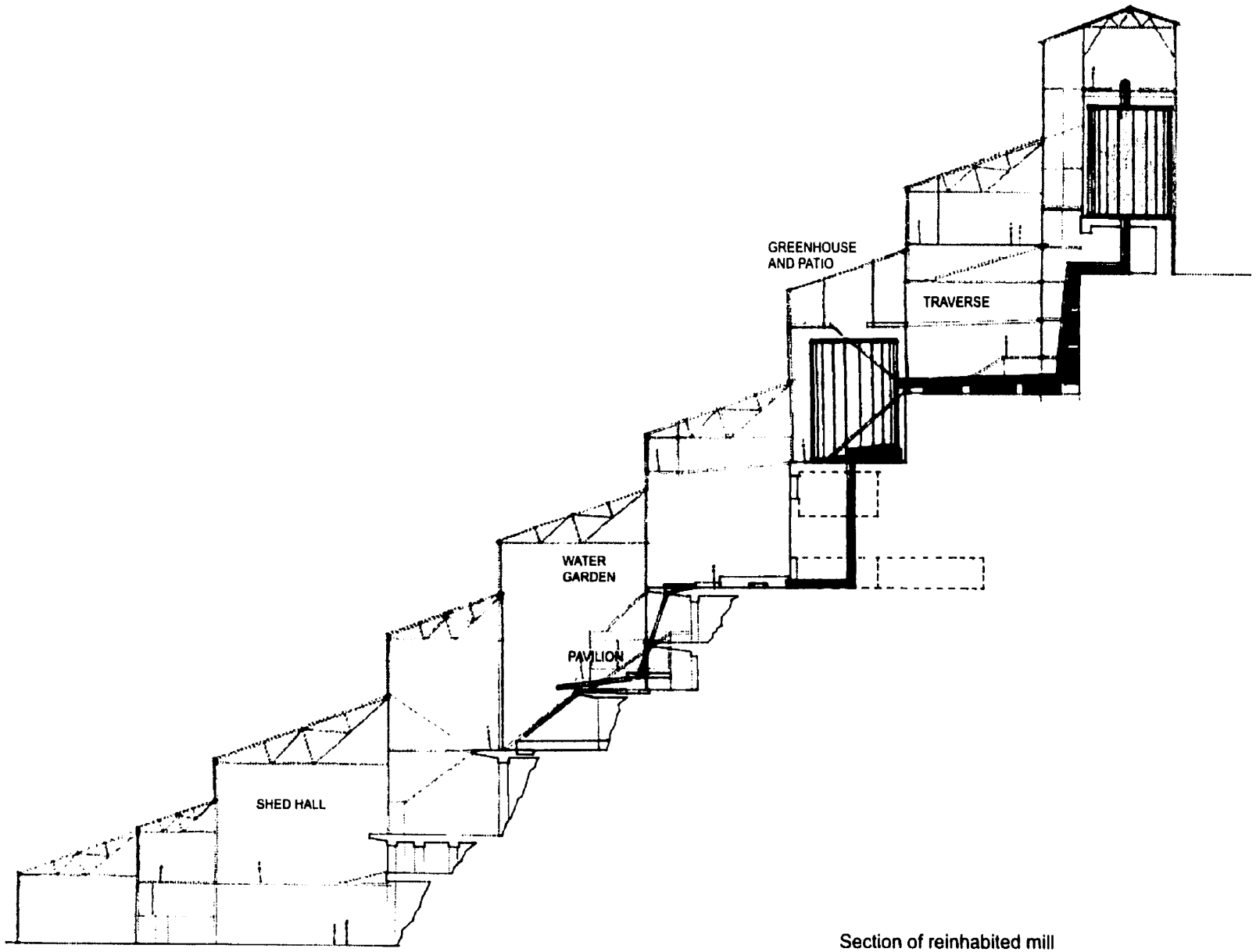
> No place is a tabula rasa, without history; any intervention by any designer is part of a series of interventions, of marks already inscribed or yet to be inscribed on a site. (Beardsley 2000, 60)

The intention of this design is to use the existing mill as a datum, or foil. The existing building sets the standard for form, character, material and significance to which the new intervention must aspire.

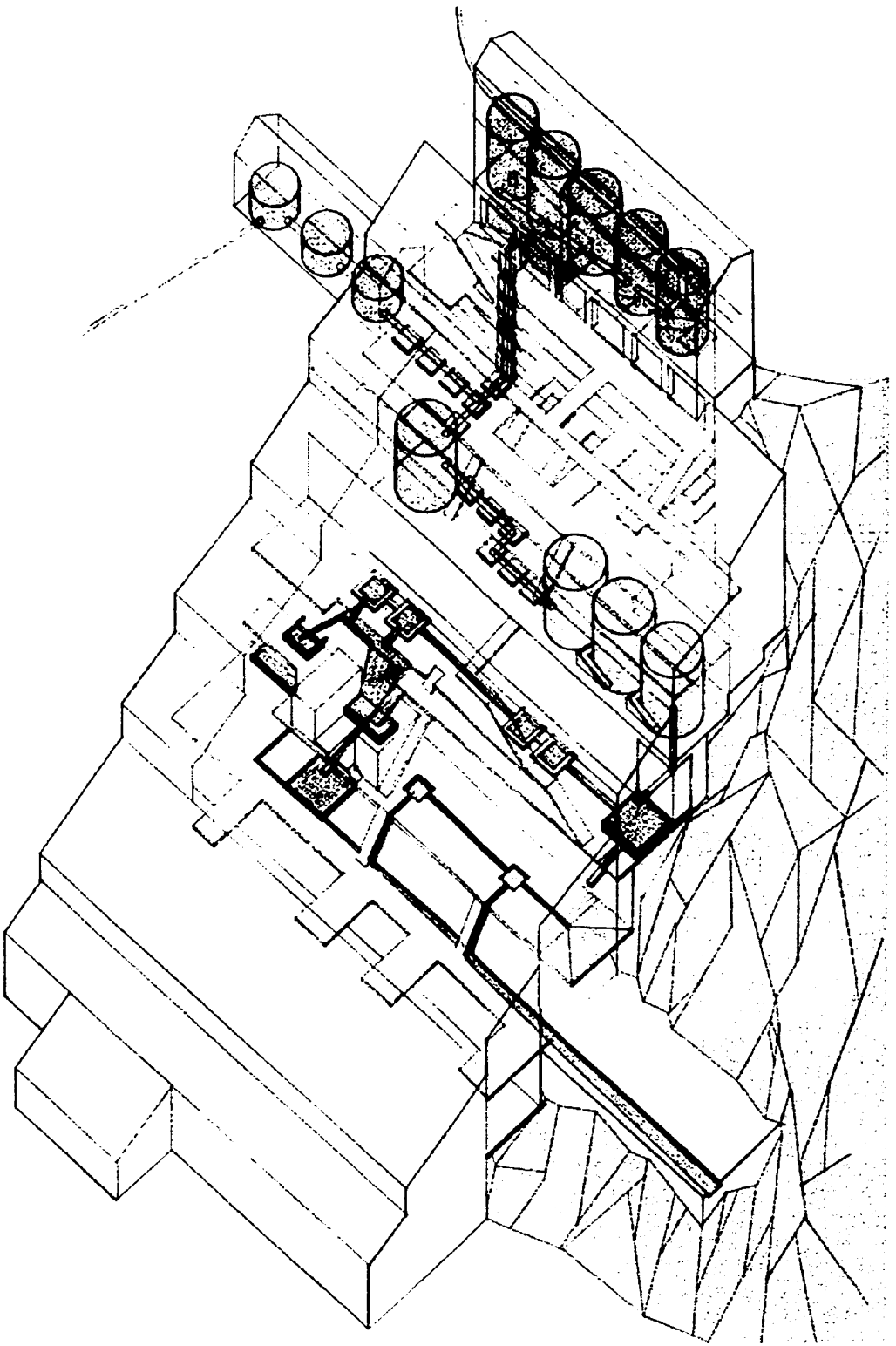
Final Design



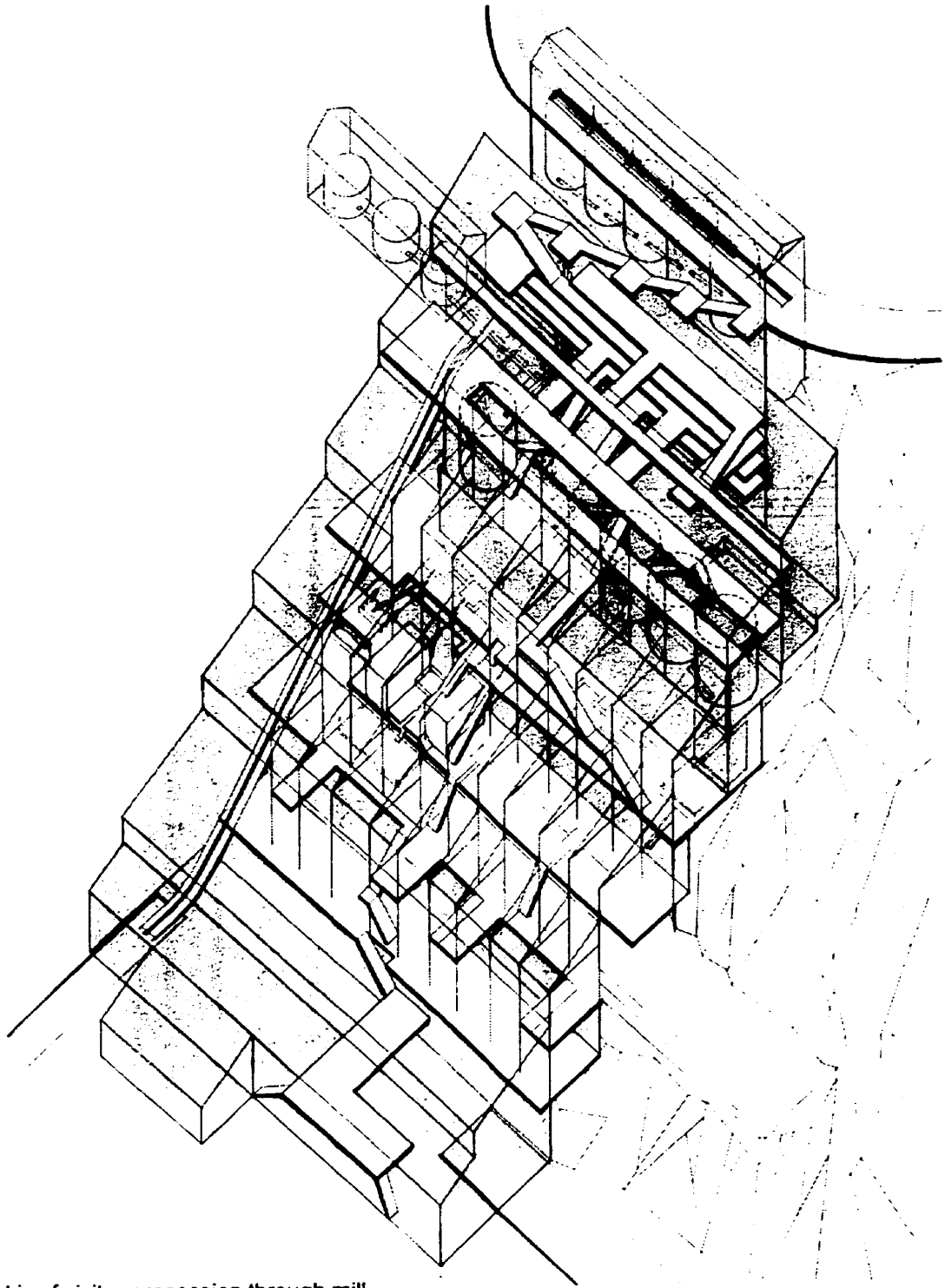
Plan of reinhabited mill



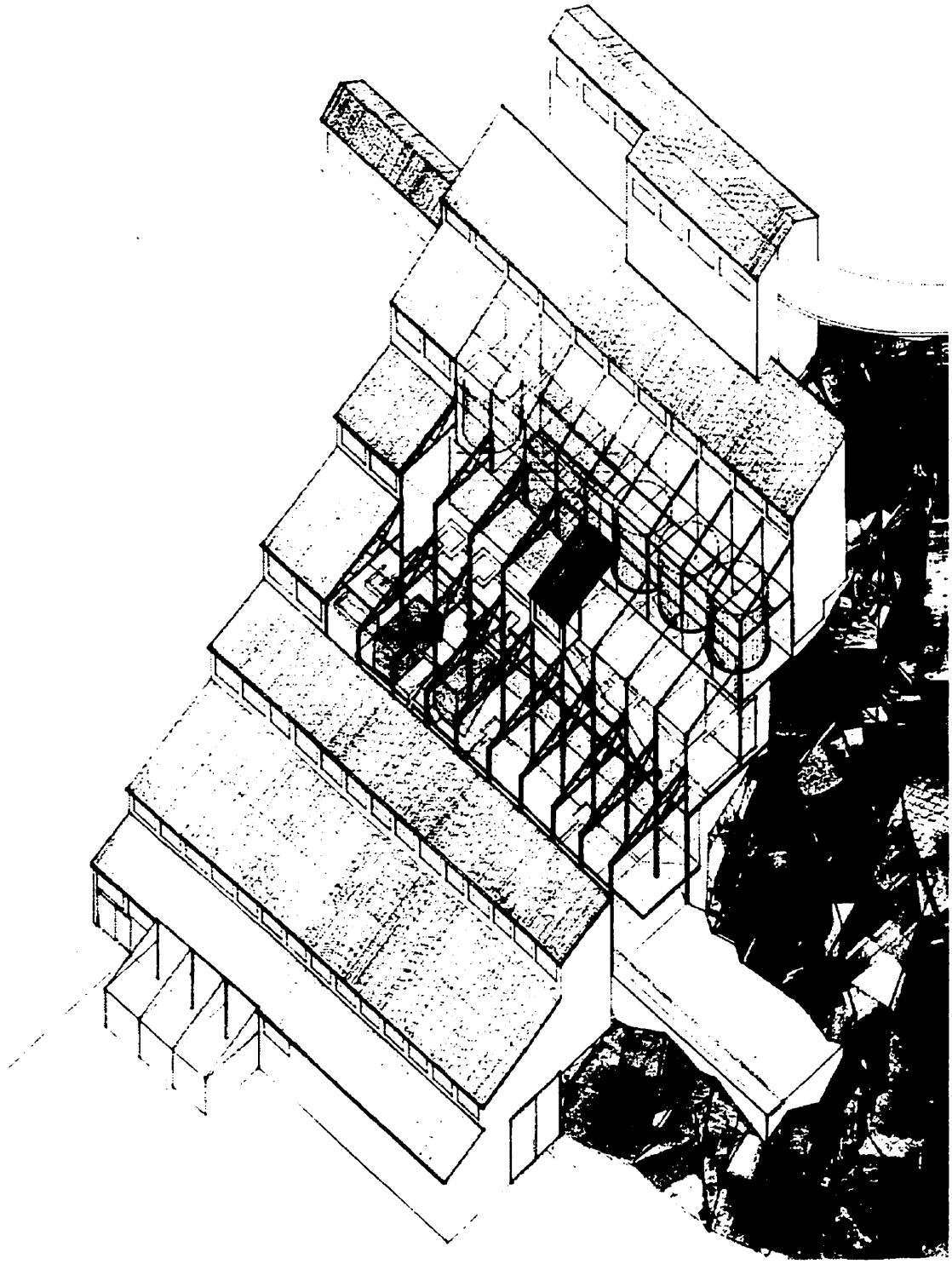
Section of reinhabited mill



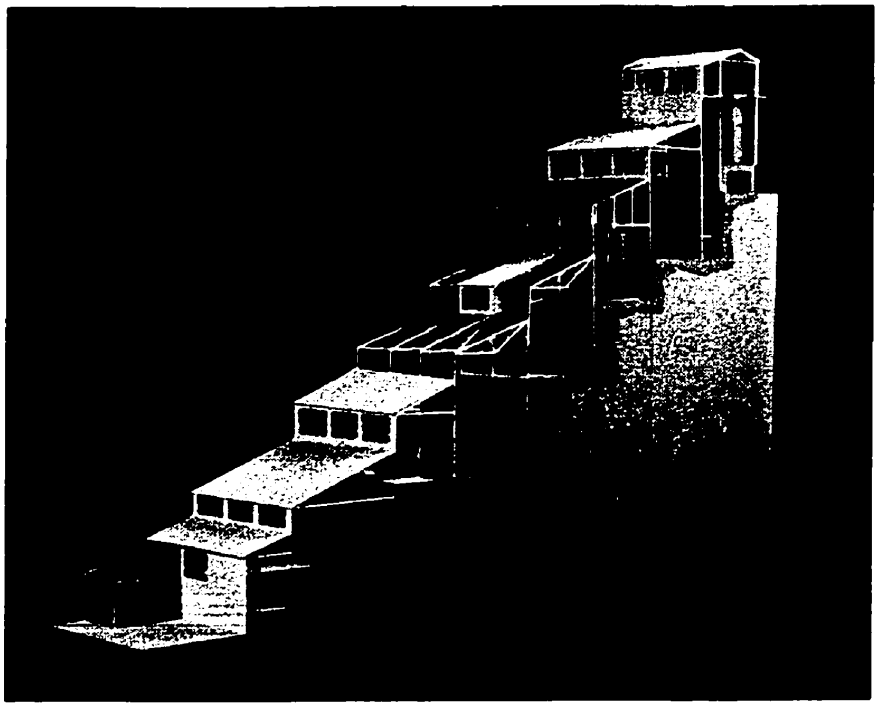
Axonometric of water path through mill, considered as the leading process for visitor procession to follow. Existing tanks in mill are reused (having removed two to create patio area). Tanks in ventilator shed are new. Copper piping carries water until it is sufficiently treated, after which channels and basins are open.



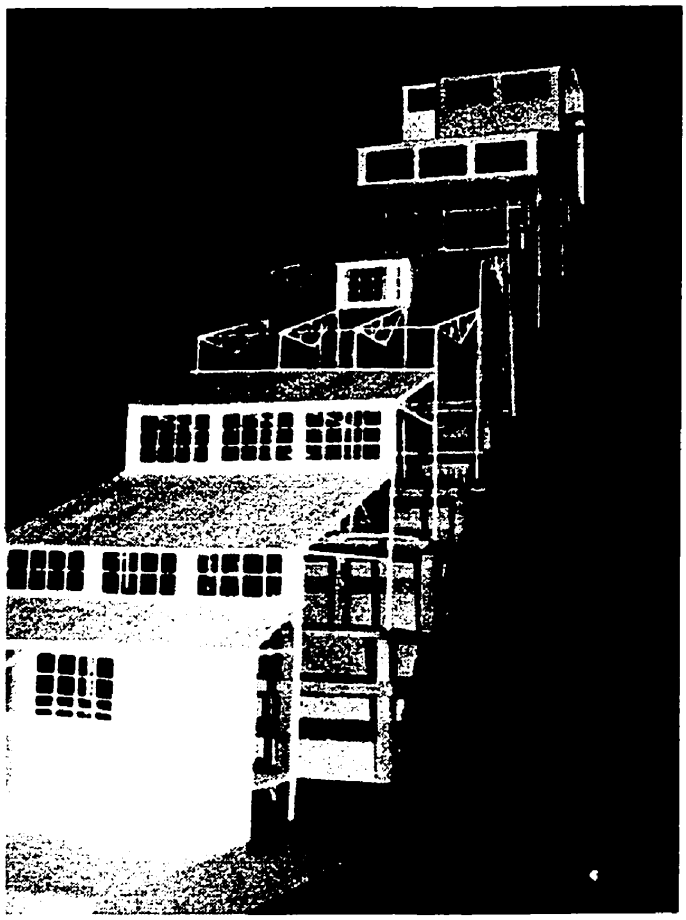
Axonometric of visitor procession through mill, following and experiencing the water path. The use of existing bridges and platforms is balanced with the introduction of new ones in order to create tighter connections between levels. The materials of the new introductions are simple and refer to the existing, in order to balance the complexity of the path.

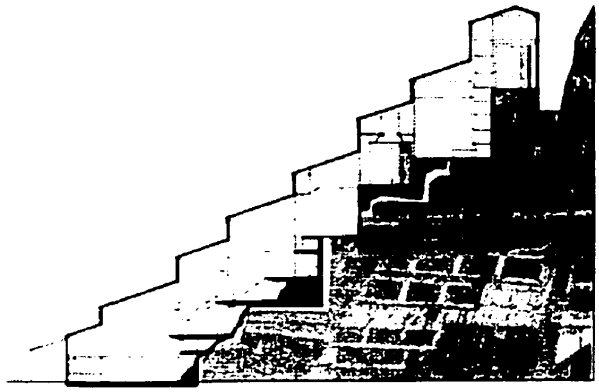


Axonometric of exterior composition of mill. The retention or removal of the envelope is determined by the experiences of the visitor dictated by the water path. Portions with full envelope coverage consist of new materials intended to reference the originals.



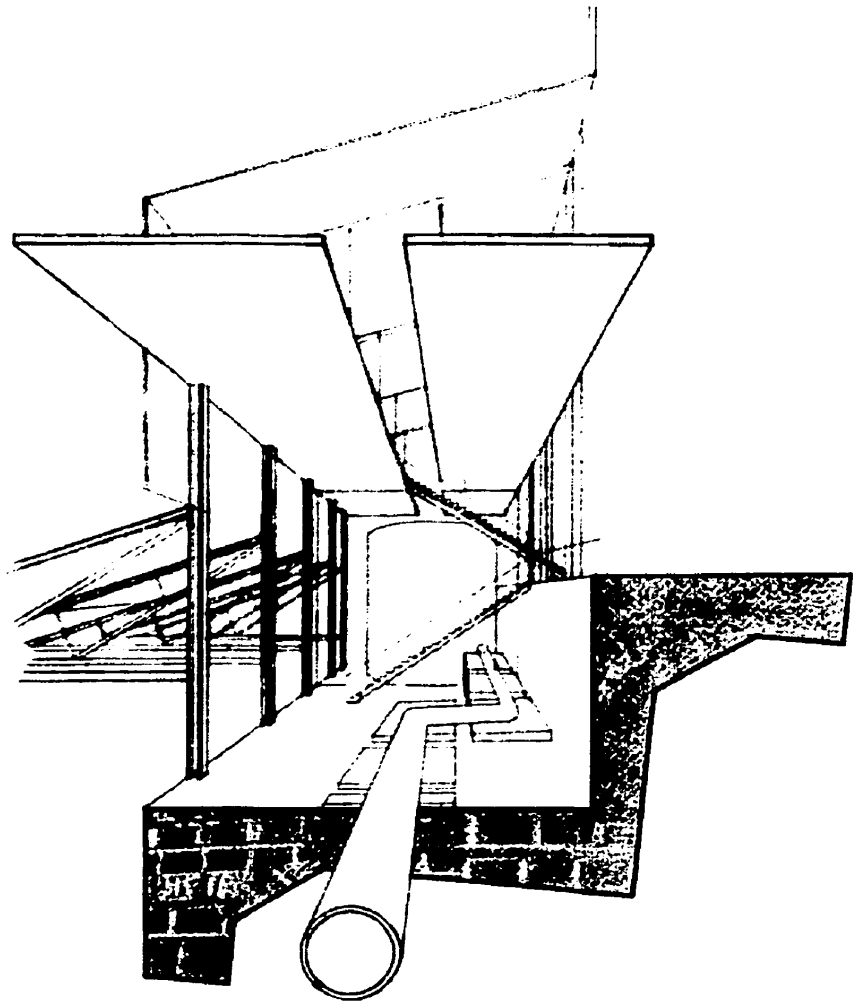
Sectional model depicting an "ideal" section which includes all important interventions.

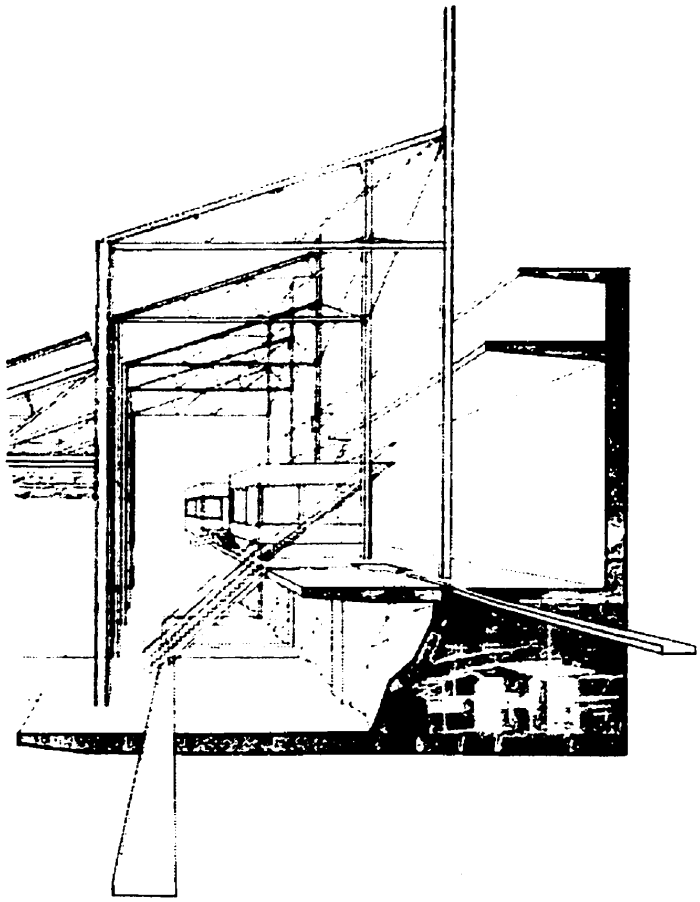




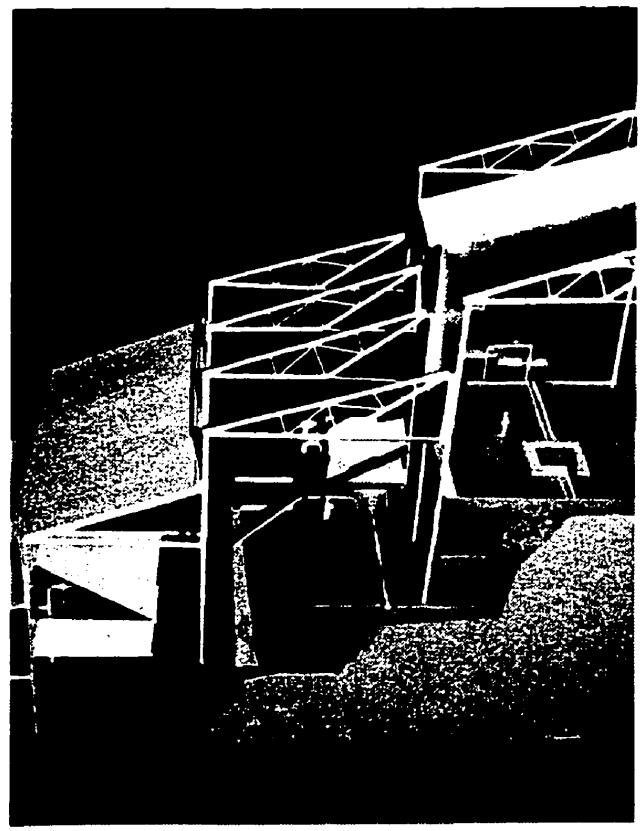
Key section to locate perspective drawings in larger building context.

Sectional perspective of patio, showing the interaction of the visitor procession and the water path. The patio is an important intersection point-of water, visitor, envelope, bridge, new and old.

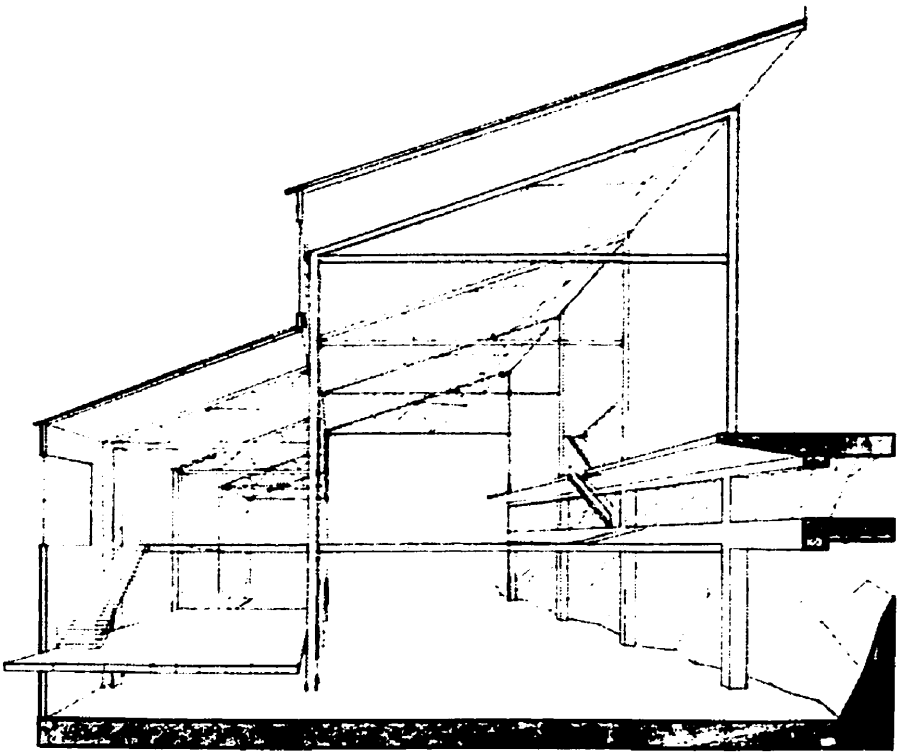




Sectional perspective of water garden with pavilions. The envelope is removed to expose the roof trusses and to create an outdoor area. The pavilions are existing rooms in the mill which would be altered to increase their interaction with the rest of the garden. The water intensifies its relationship with the visitor by cascading between the pavilions and by attaching itself to the stair.

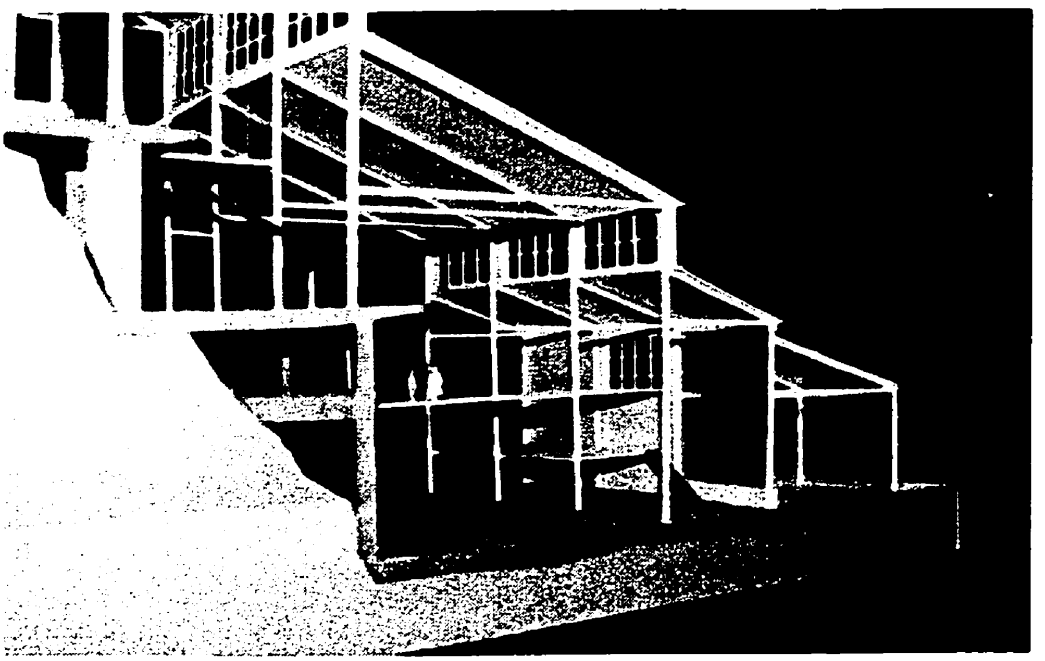


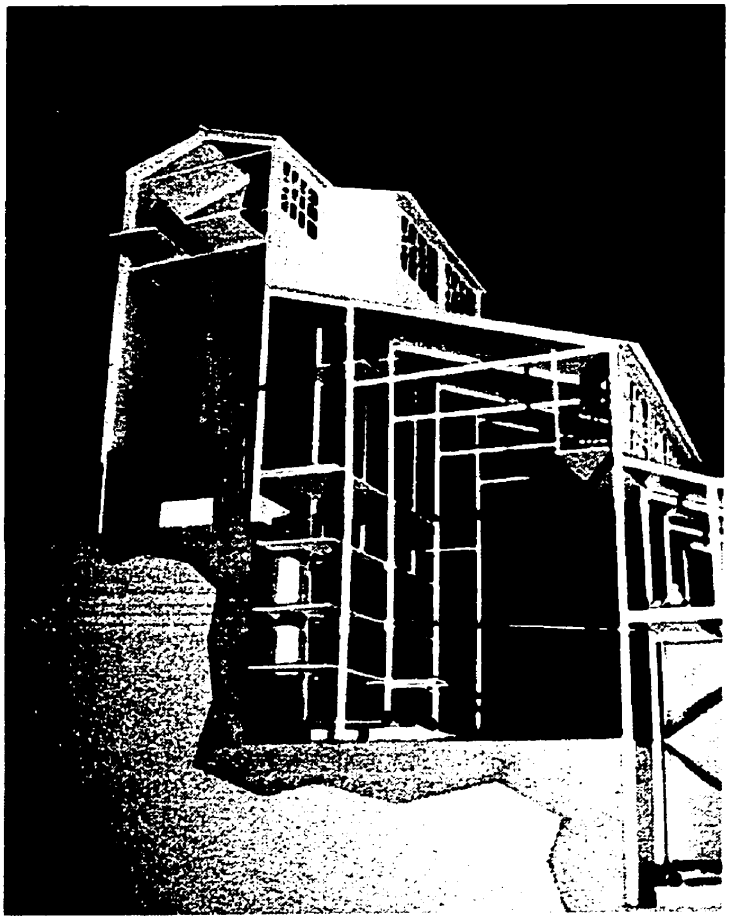
Photograph of model showing water garden. Examples of the potential for choreographed planting to enhance the water garden are shown in the model.



above: Sectional perspective of shed hall. This area is restored with minimal interventions. Programmatically, it is intended to be used by the community for their own uses or to be rented out to the movie industry as a generator of income (as it is now).

below: Photograph of model showing shed hall. The volume of the area makes its potential for live theatre or movies exciting. The mini-greenhouse on the right acts as a suggestion of the more complex process occuring higher in the building.





Photograph of model showing traverse. The negotiation of this space by both the water and the visitor makes for a variety of views both within the mill and out to the surrounding area. Its volume acts as a reference to the scale of the activities that once occured here.

below: Photograph of model showing connection between layers. This visual connection is emphasized throughout the visitor's procession, with moments of pause designed to take advantage of the interior views.

APPENDIX A

The copper concentration process, as described in Packer, 1970:

Normally... 91 percent of the ore would be discarded as in most mills but at Britannia a substantial part of it is sold as high silica sand to cement manufacturers and to construction firms to be used as a filler in asphalt aggregates...

CRUSHING

First is the crushing of the larger pieces of ore. This is done in two stages. The primary crushing at Britannia is done in a jaw crusher which reduces the larger pieces of ore to six inches or less, and whose action may be likened to that of a giant nut cracker. Secondary crushing is done in cone crushers which further reduce the ore to 3/4 inch or less, an action somewhat like that of the common peppermill used in your home.

GRINDING

Here at Britannia grinding is done by two different types of mills - rod mills and ball mills. The rod mills are eight feet in diameter by 12 feet long, and the grinding action is accomplished by many 3 1/2 inch diameter rods over 11 feet long tumbling inside the rotating mill. The ball mills are similar in shape and action to the rod mills except they contain tumbling small iron balls two or three inches in diameter which grind the ore to the desired fineness in order to liberate the valuable mineral particles.

FLOTATION

The third stage in the concentration of minerals is termed flotation and is the most critical. It consists of separating the minerals from the "pulp" as the mixture of prepared ore and water is called...

The principles of flotation include (1) that of surface tension which allows bubbles to form... and (2) the property of minerals when they are not wetted (waterproofed by some sort of oil) to attach themselves to a bubble and be floated to the surface...A mineral particle having become attached to an air bubble is buoyed to the surface of the pulp in somewhat the same manner as a weight is buoyed in the air by a balloon. If, now, a chemical such as an alcohol or an aromatic oil (frothers), which lowers the surface tension of water, is also added to the pulp, there will be formed at the surface a stable froth which will retain the mineral laden air bubble until it can be skimmed off...

DEWATERING

In the fourth stage the mineral-bearing froths are skimmed from the flotation machines and are dewatered. Most of the water is removed in the large wooden thickening tanks where the heavy mineral particles are allowed to settle to the bottom and raked to a centre discharge cone, and then filtered out on canvas under vacuum, leaving the mineral concentrate in the form of a cake which is conveyed to the storage bin on the wharf to await shipment. (Packer 1970, 1-3)

APPENDIX B

Figure 1: Britannia Mine Site — Pre-Mining Conditions

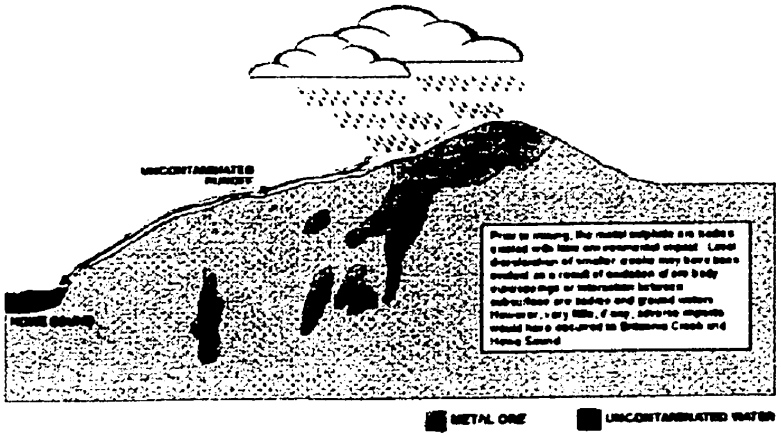


Figure 2: Britannia Mine Site — Post-Mining Conditions

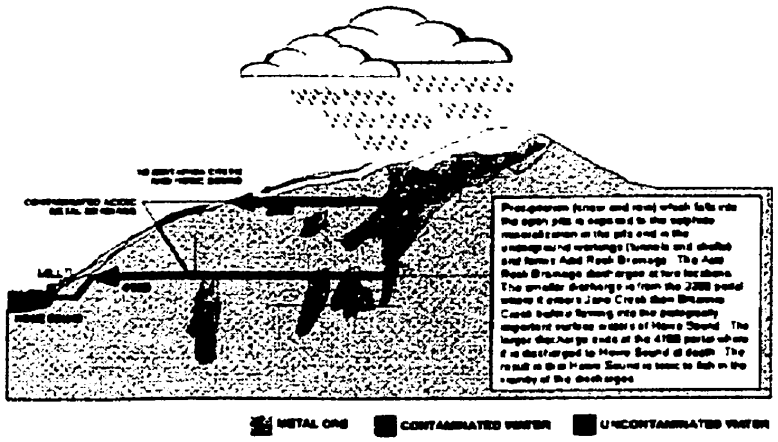


Figure 3: Britannia Mine Site — What is Acid Rock Drainage?

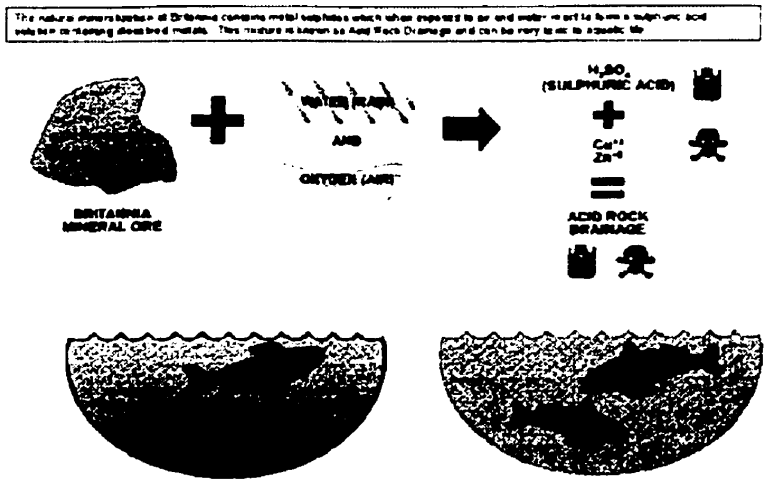


Figure 4: Britannia Mine Site — Necessary Pollution Prevention Measures

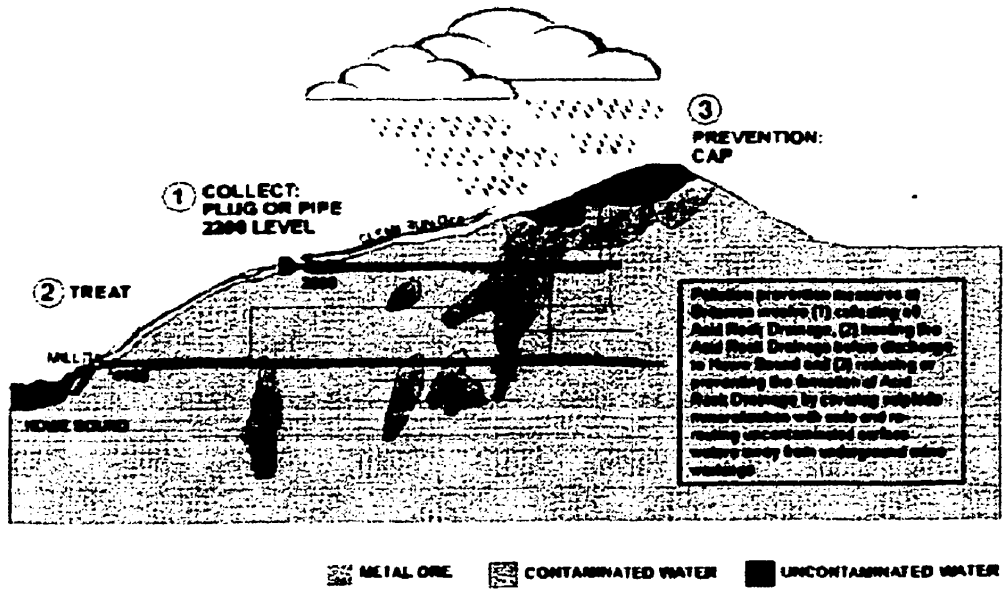
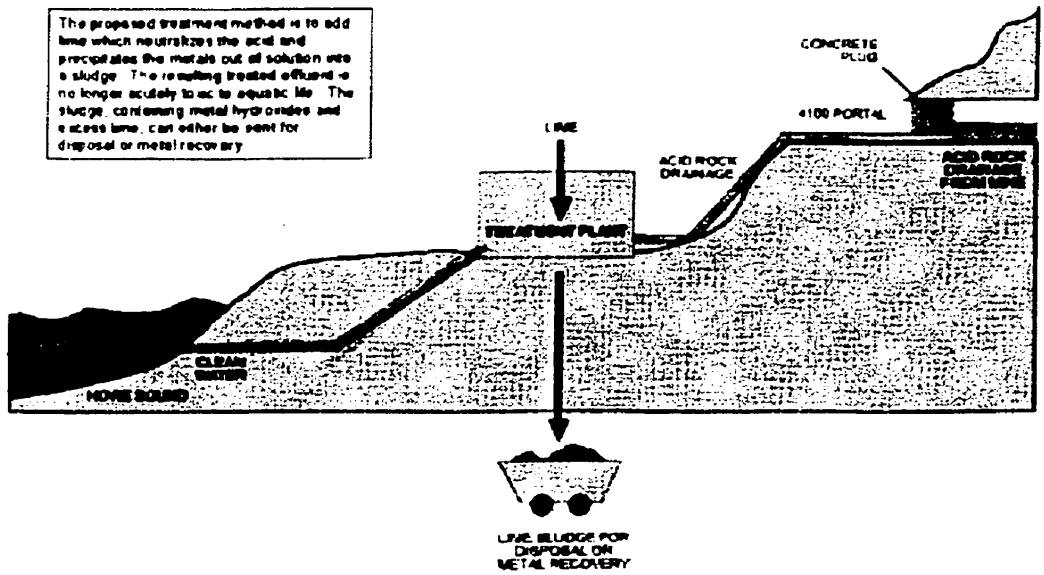
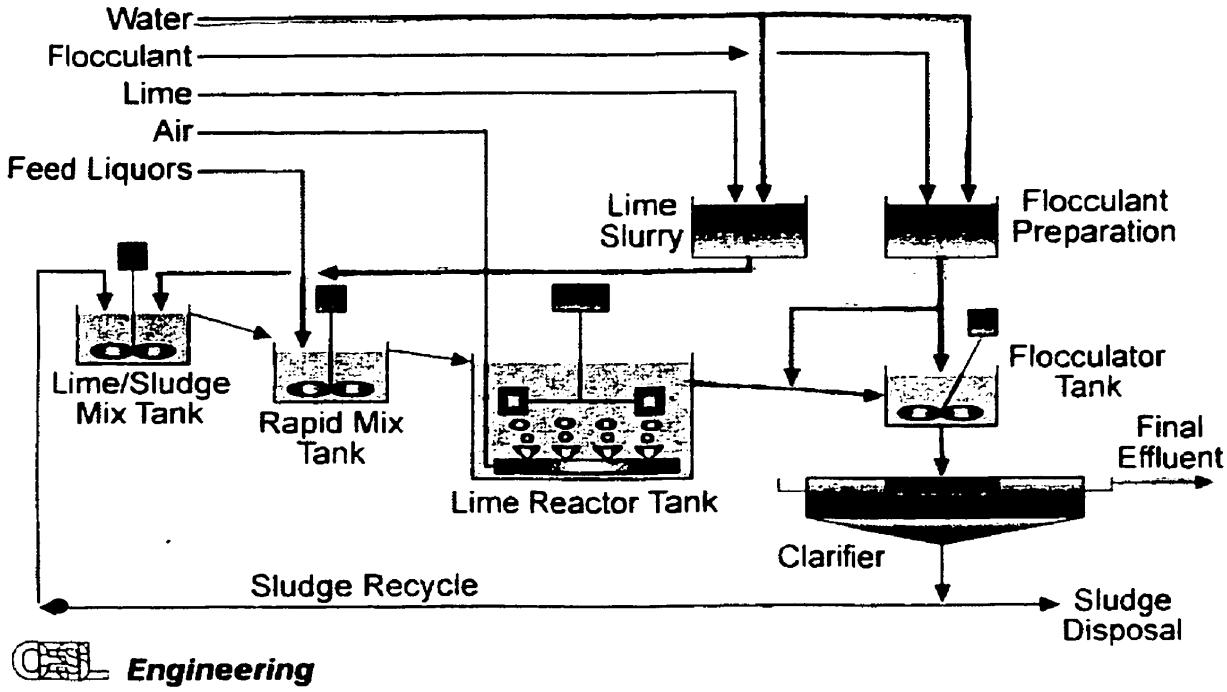


Figure 5: Britannia Mine Site — Treatment Proposal



source: Squamish Lilooett Regional District website



High Density Sludge (HDS) Process
source: Notes for Technical Tour, Anaconda - Britannia Mine, 1997, Fourth International Conference on Acid Rock Drainage.

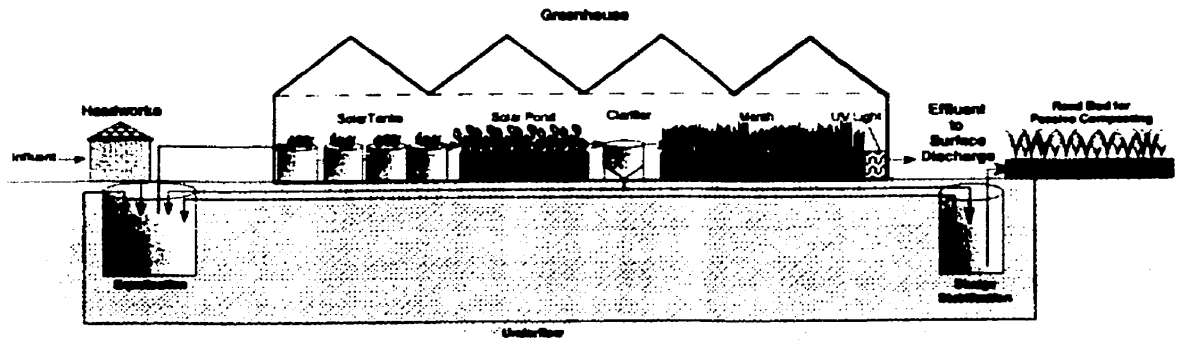
Rain and snowmelt is channelled first into a conduit known as the Jane Portal, 2,200 feet below the mountain top, which empties into Britannia Creek. (Early surveyors measured Britannia downwards from 4,300 feet above sea level, the highest point of the mine.)

What escapes Jane Portal ends up in another pipe about 4,100 feet below Mount Sheer's summit. This empties directly into Howe Sound at a depth of about 130 feet off the mouth of Britannia Creek." (Judd 2000, 29)

The two primary aims of the high density sludge process are (1) to produce a high quality effluent in compliance with all Provincial and Federal Regulations and (2) to generate a dense, free draining, stable sludge for disposal that will not negatively impact the environment. A key feature of the high density sludge process is the addition of lime to recycled sludge in a lime/sludge mix tank at the head of the system. The addition of lime to the sludge assists the process by converting the sludge to a dense, granular, free-draining material

with a relatively low viscosity. Generation of dense sludges ensures that the system carries a high solids inventory which assists in the co-precipitation of metals to produce effluent with very low metal contaminant concentrations. The lime/sludge slurry is mixed with the feed in a reactor to neutralise the acidic feed. This reactor optimises the process chemistry and completes the oxidation and precipitation reactions. The clarifier separates treated effluent from the sludge, which, in turn, is recycled to the lime/sludge mix tank. (Simons 1998, 3-4)

APPENDIX C



Solar Aquatics wastewater treatment system
from EDM Information Package, 2000.

Screening and Grit Removal are conventional primary treatment unit processes... The materials are composted.

Bioaugmentation involves the mixing of activated sludge and, occasionally, a solution of water and bacteria, with the raw, incoming sewage... The purpose of the Bioaugmentation is to maintain the appropriate balance of bacteria (that consume the dissolved organic fraction of the sewage) and the organic feed stock for the bacteria.

The first step in the biological treatment process occurs in the Solar Tanks... that contain sewage, bacteria, plants, snails and other aquatic life forms... Air is pumped into each tank... The purpose of adding air is to keep the fluids and the solids in the tank well mixed, to minimize sedimentation of solids in the tank and to maintain a sufficiently oxygen rich environment to foster the growth and development of the forms of bacteria that are necessary to sustain the process. The biological treatment process is simply the digestion and absorption of organic materials that are both dissolved and suspended in the fluid. The organics are consumed by the various life forms in the tanks. The bacteria and other animal life forms live in the sewage. The plants are rooted in the sewage and suspended by fish netting.

The second part of the biological treatment process occurs in the Solar Pond... the three compartments of the Solar Pond each contain different microbiological life forms. The nature of the different bacteria and the dominant species found in different parts of the biological unit processes is controlled by altering the rate at which air is introduced to the different environments.

Sewage discharged from the third Solar Pond compartment has a fluid component, a suspended solids load and a minimum of dissolved material. The sewage from the Solar Pond is discharged into a Clarifier... (where) a significant portion of the suspended solids load settles out of the fluid... The sewage is introduced near the bottom of the clarifier and is forced to flow upwards through a sloping honeycomb type of passage arrangement. The solids settle out in the honeycombs... a valve on a pipe at the bottom of the Clarifier opens, draining the Clarifier and removing the solids. The solids (called Activated Sludge) are diverted either to the Bioaugmentation unit process or the Sludge Digester.

The sewage effluent discharged from the Clarifier and Micro Screen contains bacteria and minimal amounts of solids and dissolved organic material. The effluent is disinfected... by exposing it to a high concentration of Ultraviolet (UV) light... The effluent and bacteria are exposed to the UV light by running the effluent through the tubes containing the special bulbs. (EDM Information Package 2000)

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Johnson, Terry. General Manager, Britannia Beach Museum of Mining, and member, Britannia Beach Historical Society.

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