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**Final Report**

# *HIPROTECT AT JOSHUA TREE NATIONAL PARK*

***PIT Grant #MT-0424-5-NC-021***

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NCPTT's Preservation Technology and Training Grants program develops partners in non-profit organizations, universities and government agencies throughout the United States to complete critical research, training, and information management work, and lends significant support to developments in the conservation and preservation community.

# I. INTRODUCTION

The Preservation Science and Technology Unit (PSTU) at the University of California, Riverside was awarded a grant by the National Center for Preservation Technology and Training (PTT Grant #MT-424-5-NC--021) to install and test HIPROTECT, a prototype archaeological site-monitoring system designed for a desert environment. A site at Joshua Tree National Park (JOTR) with both historic and prehistoric components was chosen for the test. In addition to testing HIPROTECT in the extremes of a desert environment, there were several other goals for the project. (1) Reduction in size of the components (i.e., the energy package [solar panels and storage batteries], computer-processor, transmitters and receivers, sensor packages,) because of problems of portability and visibility. (2) The system needed to be reconfigured into modules so that selected components could be used in design as needed and combined for site-specific needs. (3) Cellular telephone communication system needed up-grade because of the nonreliable nature of commercial cellular telephone systems.

The PSTU engineers for the HIPROTECT project were selected on the basis of previous experience with monitoring systems, willingness to work with a very limited budget, and the ability to design technology for innovative approaches to site-protection problems.

The PSTU archaeologists and engineers designed a system for the protection of the entrances to Keys Desert Queen Ranch, a National Register of Historic Properties site at JOTR. Because of the limited budget available for the JOTR test of HIPROTECT, a minimal system was designed that incorporated all the basic components except for video camera. In addition, a voluntary local support organization for JOTR agreed to accept responsibility for the monthly charges for the cellular telephone, incorporated into the HIPROTECT system.

The original plans called for the project to be completed during a single calendar year. During the course of the project, it was necessary to request several time extensions: (1) an extension was first granted from September 30, 1996 to December 31, 1996; a second no-cost extension was granted to extend the project deadline to March 31, 1997 (see Attachments 1, 2).

In preparation for installation of the HIPROTECT system designed specifically for a location at Keys Desert Queen Ranch, Dr. Joan Schneider of the PSTU and the project engineers visited the ranch, decided on the optimal placement of the system so as to afford the best sensor coverage to prevent intrusions, mapped the location to scale, made plans for camouflage of the HIPROTECT unit, and tested cellular telephone communication from that location.

## HIPROTECT INSTALLATION AT KEYS DESERT QUEEN RANCH

On July 16, 17, 1996, the PSTU team installed HIPROTECT at Keys Desert Queen Ranch. A survey for surface archaeological materials was made in preparation for the installation.

Although no artifacts were located where the system would be installed, there were eight artifacts within a 10-meter radius of the location of installation. At this time, it was discovered that the cellular telephone communication, that had tested well on our previous visit to the location, was not performing adequately (i.e., the unit was not able to call out, although signals indicated that there was full coverage). Numerous attempts were made, in and around the area of installation, to establish cellular communication.

The local cellular telephone company, Cellular Systems, Inc., with which arrangements had been made to provide service to the HIPROTECT cellular module, was contacted regarding the lack of coverage in the area where coverage was previously available. We were informed that the local cell, located at the summit of Copper Mountain, was not operating at full power because there was little customer use. Cellular Systems suggested that an additional antenna would enhance the signal and would provide one for testing the following day. That test had negative results.

It was decided that another location within JOTR be chosen for the HIPROTECT test. A number of JOTR personnel, in particular rangers, ‘were consulted about the performance of cellular communication in different areas at JOTR. The HIPROTECT team traveled throughout JOTR testing locations for cellular communication with a hand-held cellular telephone. We were able to determine that the lookout at Keys View, the southern tier of JOTR, and the Visitor Center at the Oasis of Mara, at the northern edge of JOTR, were the only places where reliable year-round cellular communication could be relied upon. A decision was made to seek permission to temporarily install HIPROTECT at the Oasis of Mara Visitors Center while a more suitable location at an archeological site needing protection could be sought.

## INSTALLATION OF HIPROTECT AT THE OASIS OF MARA

Transfer of the HIPROTECT system from Keys Ranch to the Oasis of Mara took place on July 22 and 23, 1997. The installation at the oasis was at the edge of a mesquite thicket at the furthest loop of a trail system at the Visitor Center. A small shallow excavation was necessary for placement of the main control box under the camouflage rock (Fig. 1). The immediate area of the installation was surveyed for surface cultural materials; an iron rebar and a rusted tin can with “church key” opening were found. The excavation for the control box was in arbitrary 6-cm. levels with trowel and dustpan to a depth of 18 cm. All soil was passed through 1/8 inch screening. Cultural materials found during excavation were limited to one small piece of cloth found near the surface. A clearance report was submitted to JOTR Cultural Resources office for this project (Schneiderl996; Attachment 3).

Conditions during installation were extremely difficult. Air and ground temperatures exceeded 115° F; all tools were hot and difficult to handle. All components were reassembled, set in place, and bolted together (Fig. 2). The artificial rock, constructed to camouflage the main control/battery box, was carried to the site on a rolling cart and placed over the control box (Fig.

Fig. 1. Excavation for HIPROTECT core module placed beneath camouflage rock.

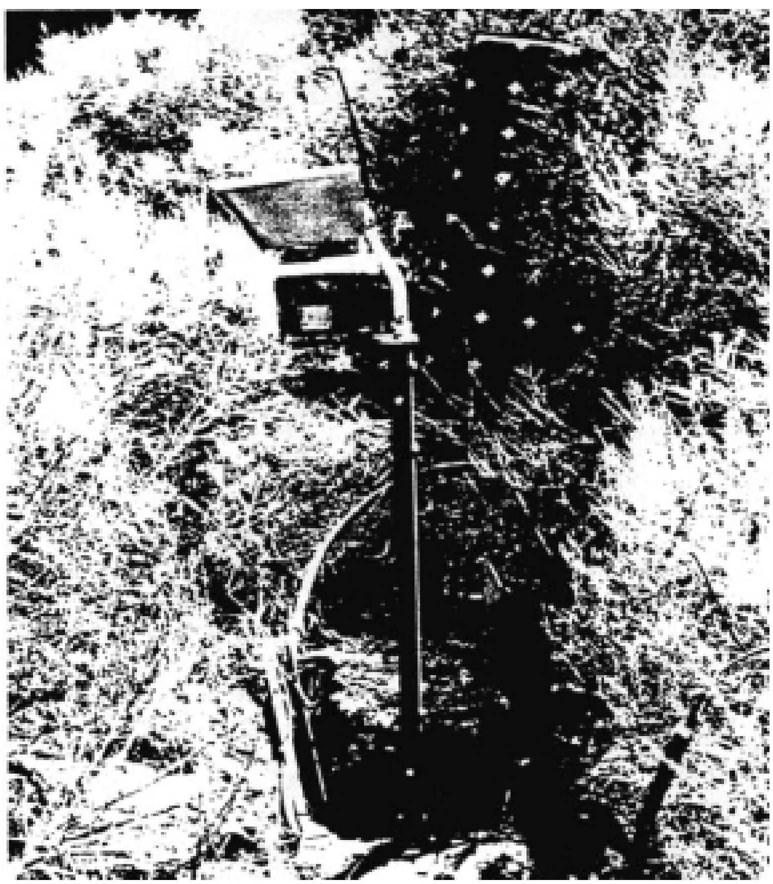


Fig. 2. Assembly of HIPROTECT at the Oasis of Mara. Sensor modules mounted.

3). The unit was camouflaged with camouflage paint and natural vegetation (Fig. 4). Sensors were tested by the PSTU team and adjusted as needed. The cellular telephone was responding to sensor triggers. At this time, the cellular telephone was calling the laboratory telephone number in San Diego and messages were received there.

Dr. Schneider returned to JOTR to consult with cultural resources and law enforcement staff regarding an alternative installation location for HIPROTECT. A site would have to be identified within JOTR that had, in the past, been subject to trespassing, looting, or vandalism, that was a National Register property, one that had cellular telephone communication, and one that funds would be available for paying the cellular telephone bill. With the help of JOTR personnel, and Rosie Pepito, Cultural Resources Specialist, in particular, the Lost Horse Gold Mill was identified (Attachment 4).

## INSTALLATION OF HIPROTECT AT LOST HORSE GOLD MILL

A reconnaissance trip to the Lost Horse Gold Mill was made by Dr. Schneider who inspected the structure for potential HIPROTECT installation and tested cellular telephone communications at the mill site. The HIPROTECT system was dismantled at the Oasis of Mara and transferred to Lost Horse Gold Mill by the PSTU team on October 15 and 16, 1997. Access to the mill was by extremely steep, narrow, and hazardous mining road (Fig. 5). The mill structure was surveyed for placement and camouflage of HIPROTECT components.

Plans called for mounting the solar panel on 2x4 lumber between the topmost beams of the mill, over the ore bin (Fig. 6). The beams were stained to match the old wood of the mill. An extant entry to space within the ore bin, under the ore chutes, was large enough to crawl through. This space would be an ideal place to hide the main control box with the microprocessor, computer, battery, and cellular telephone since it was both accessible to us, but completely hidden from view (Fig. 7). The box housing the components, however, was too large to fit through the small entry, so the box would have to be dismantled and reassembled within the ore-bin space. The solar panel would be cabled to the control box.

The Passive Infrared/Microwave (PIR) sensor components were mounted beneath heavy overhead timbers of the mill, one on each of the deck levels (Figs. 8, 9). Since the mill is surrounded by a 10-foot chain-link fence to prevent access, it was determined that the optimal use of the PITR sensor technology would be to detect movement within the mill itself and on the access deck, walkways, and stairs surrounding the mill. The PIR sensors would detect movement and vibration as well as large moving iron-bearing objects. The sensor components were installed so that they would be visually nonobtrusive to visitors outside the fence and intruders at the mill (Fig. 10). All sensor enclosures and cabling were painted with iron-oxide color paint so they appeared to be similar to the rusted metal of the mill. Every effort was made to use as few nails or screws as possible Most cable attachments were by plastic strapping.

Fig. 3. Artificial camouflage rock placed over core HIPROTECT control box at the Oasis of Mara. Sensor modules mounted above the rock.

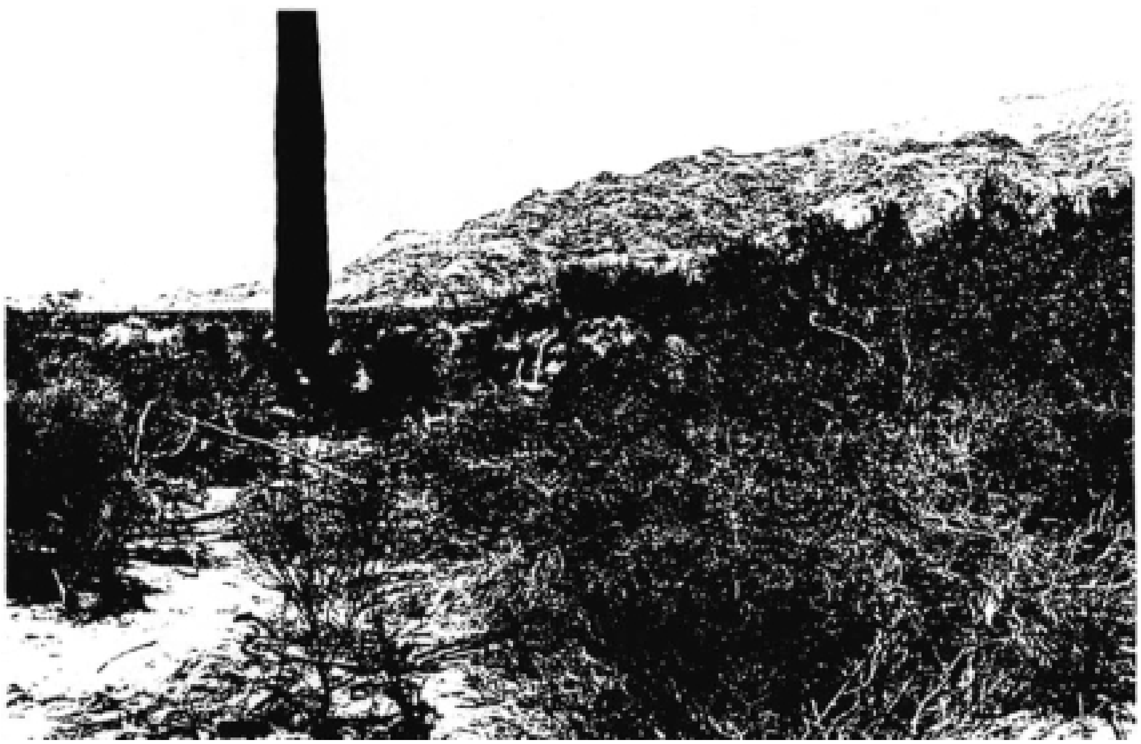


Fig. 4.Camouflaged HIPROTECT unit at Oasis of Mara. View north.

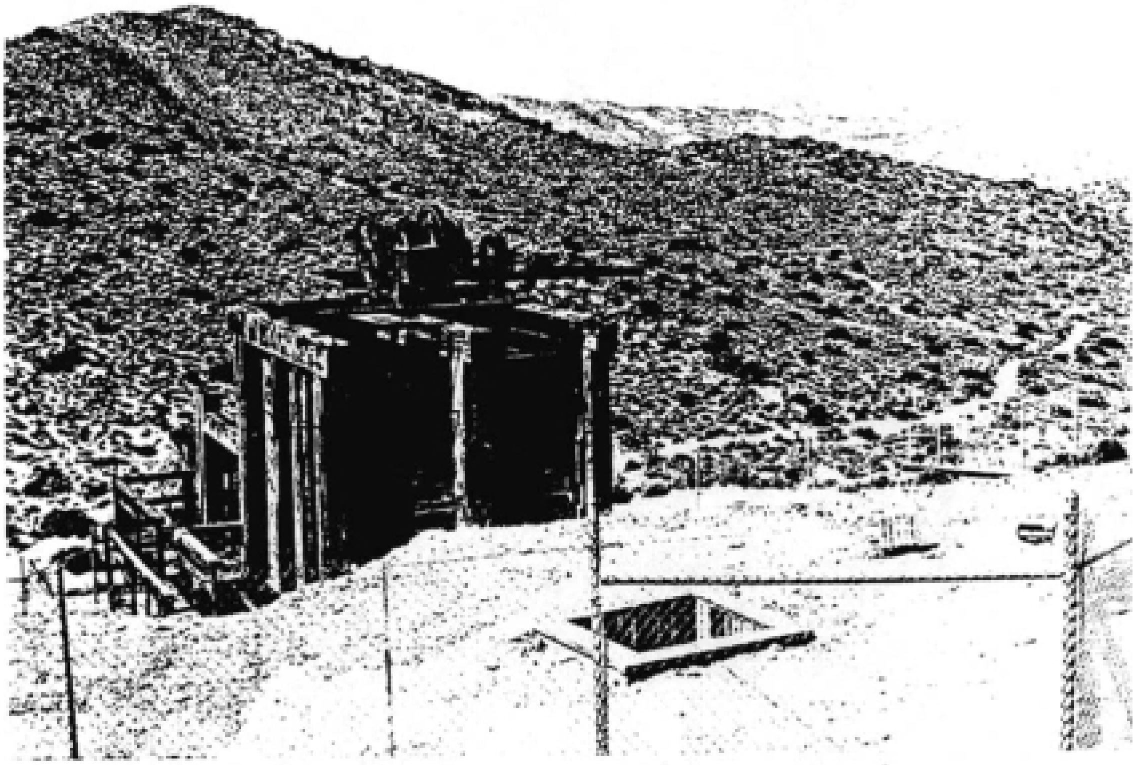


Fig. *5*. Lost Horse Gold Mill with mining road leading to site. View to west.

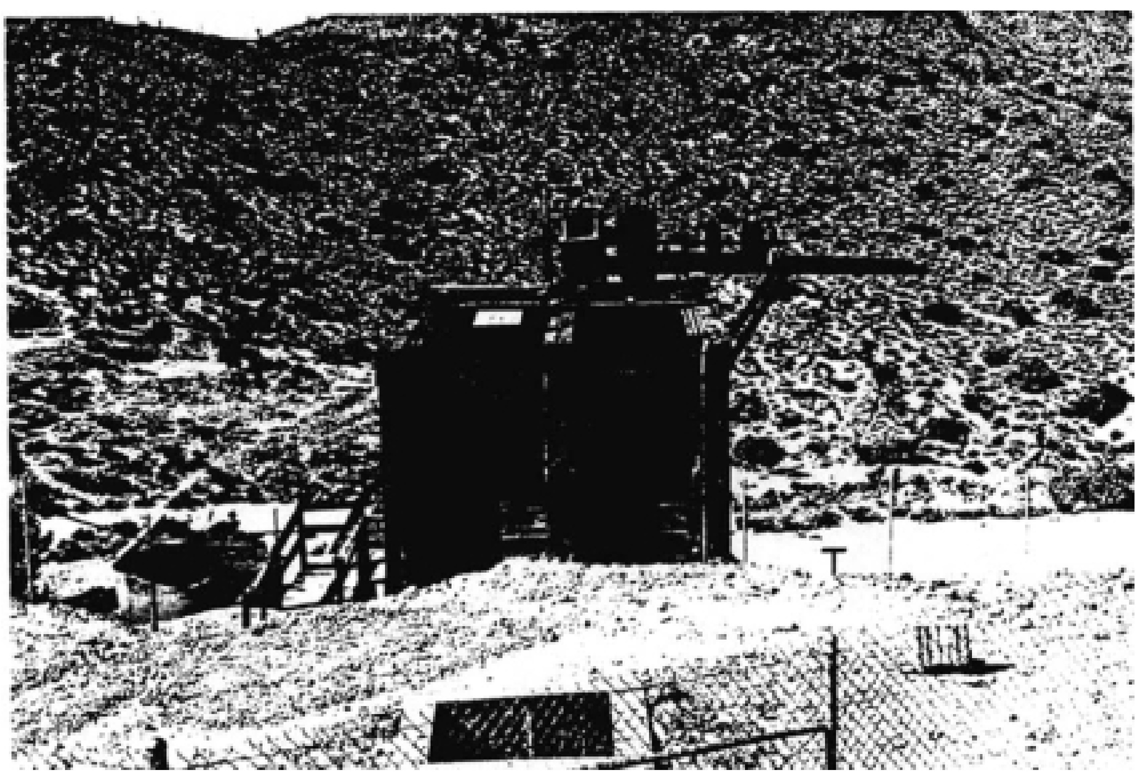


Fig. 6.Solar panel mounted at the top of ore bin at Lost Horse Gold Mill.

Fig. 7. Small entry to the ore bin on north side of Lost Horse Gold Mill. PSTU engineer entering the space below the ore chutes where core components were placed.

Fig. 8. Sensor module mounted below overhead timbers on top deck of Lost Horse Gold Mill. Passive infrared sensor aimed at walkway.

Fig. 9. Passive infrared sensor mounted on overhead timbers on lower deck of the Lost Horse Gold Mill.

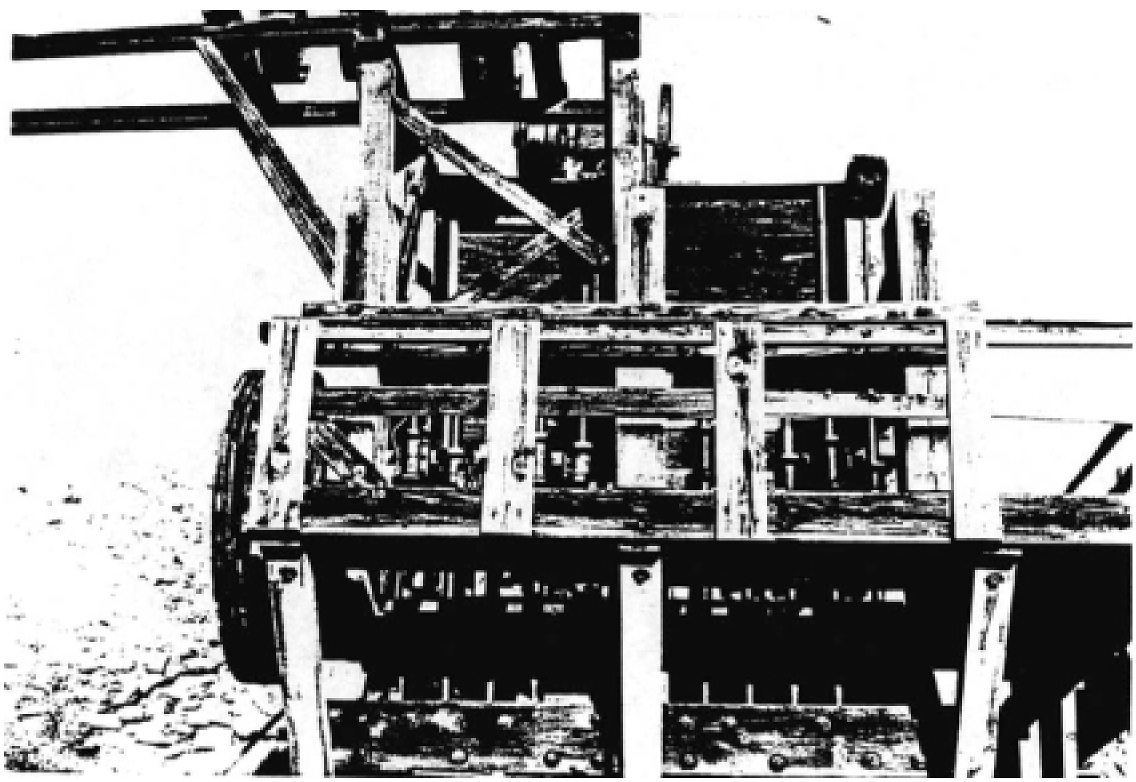


Fig. 10. HIPROTECT installation completed at the Lost Horse Gold Mill. Note that none of the components are visible on approach to mill. View east.

Upon confirmation that cellular telephone service had started, we were able to contact the office computer in San Diego. There was some difficulty with the reliability of out-going calls (i.e., calls were completed, but communication dropped out after several seconds). Attempts to correct the problem were made by moving the location of the antenna.

The system was periodically tested remotely from the San Diego office between November 1996 and January 1997. During this period there was two-way communication (operational information was delivered to the San Diego computer and input from the sensors at the Lost Horse Gold Mill were received in San Diego on command). Some difficulty was detected regarding the cellular telephone; the microprocessor and cellular phone were able to turn themselves off and resume resting state but did not respond upon sensors -provoked triggers. These difficulties were eventually traced to a problems with the level of power generated from the single solar panel and stored in the battery pack (see below).

## RESULTS OF THE TESTING PROGRAM

The HIPROTECT system remains installed at Lost Horse Gold Mill. Because of these problems, cellular service was discontinued until funds were available to correct the situation (see below). The computer and monitor (destined for the monitoring office), provided as part of the system, remains in possession of the PSTU. Response protocol to be followed by JOTR or San Bernardino County law enforcement personnel has been developed but not implemented because system problems have not been resolved due to lack of funding.

Upgrading of power requirements and software were developed for a HIPROTECT system in the process of installation at an historic adobe site at Edwards Air Force Base, California. The PSTU team anticipates that the improvements made for this system (although communication media is different) could be used to resolve some of the problems with the JOTR Lost Horse Gold Mill installation. This could be carried out in the near future if minimal funding were available.

## ASSESSMENT AND RECOMMENDATIONS

Overall the system performed adequately, but there were significant hardware and software limitations. Combined, these limitations impacted the system and resulted in high cellular telephone charges. Several modifications were made after installation and by February 1997, the system software was performing well. Cellular service was terminated at the end of this project in March 1997.

Software modifications or core software significantly decreased telephone activation (and excess calling charges) and helped to identify and verify other system limitations: (1) The system draws more power than anticipated. Laboratory calculations based on various vendorsupplied specifications were inadequate to properly estimate and provide adequate power. The performance specifications were depended upon for planning the power supply for HIPROTECT and these specifications were not tested prior to installation and should be planned for in the future. Given the maximum sunlight exposure at the location at Lost Horse Gold Mill, this was not considered a problem in the planning phase. (2) Because of the power difficulties, the system was severely impacted in its ability to retain the sensor settings. Effectively, the system was using enough power to eventually shut itself down, erasing uploaded sensor settings. The next day, with absorption of sunlight on the solar panels, the system reactivated and the sensors were reinitialized, but to the default settings which were too sensitive. This factor contributed to multiple alarms and excessive phone usage. Software modifications in place at the project's conclusion addressed the problem by providing a method for saving several key settings in nonvolatile memory. (3) As a result of the power difficulties, eventually, the cellular telephone module would also reset and completely lose internally stored software. In addition, significant limitations of the cellular phone module were discovered in the course of the project. The unit does not have the ability to store its internal configuration in nonvolatile memory. As a result, a single dip in the power supplied would result in the system becoming nonfunctional. This occurred several times during the course of the project and necessitated trips into the field to correct the situation.

In addition to the cellular phone problems within the system, external problems with the availability of cellular service were experienced. Dealing with cellular companies is difficult. The local providers of accounts are only the first layer in the system. There are other layers that include a service provider to the cellular account, a trunking-system provider to the service provider, and a cell owner providing the connection between the trunking service and the telephone. Information is difficult to get regarding service provision and coverage (see above re:
problems at Keys Desert Queen Ranch). Furthermore, cellular coverage is apparently sporadic in this area, as demonstrated by calls that were completed, but dropped during use. Local weather conditions (especially cloud cover) also affected cellular phone connections.

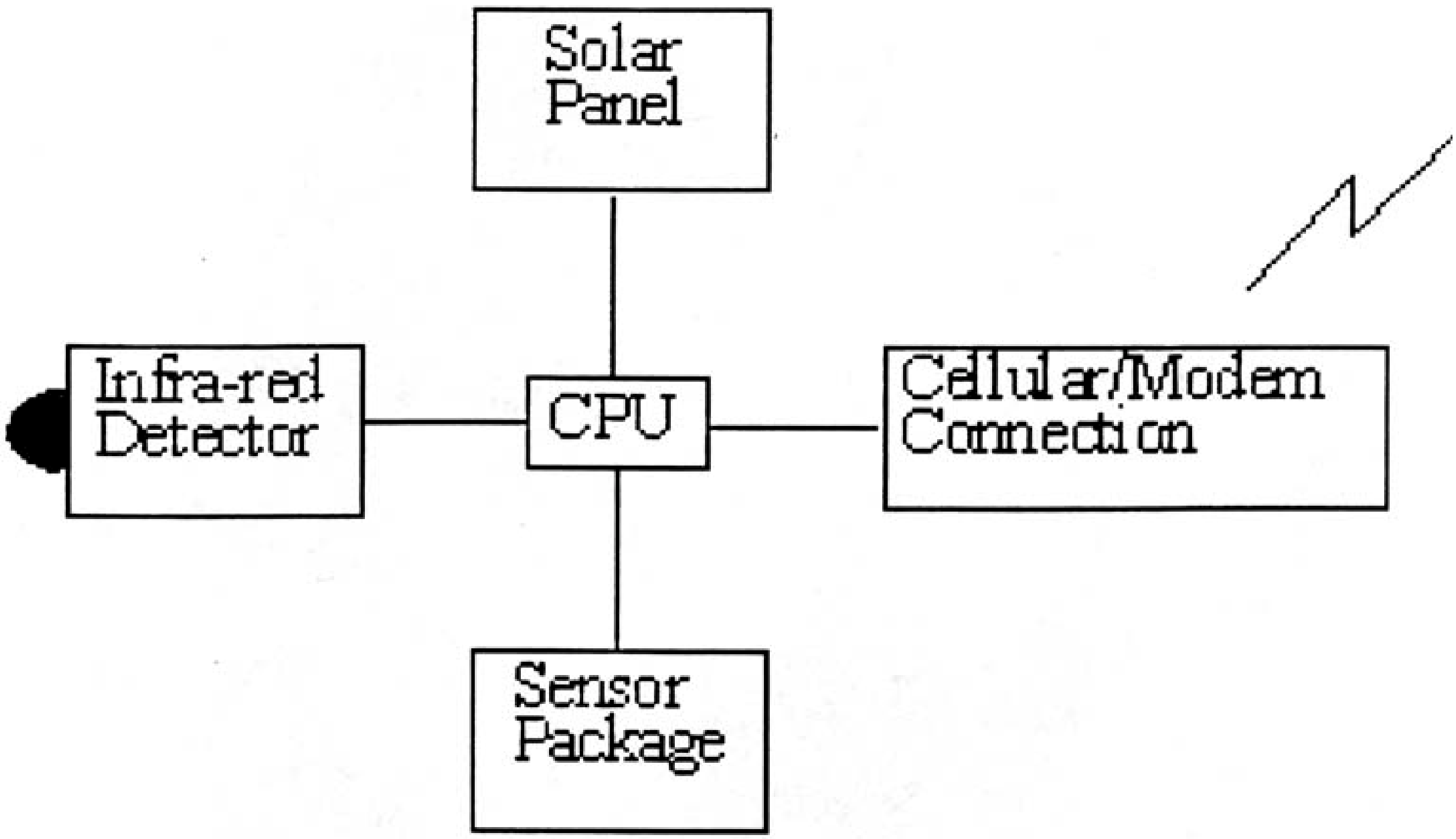
Recommendations for the HIPROTECT system at Lost Horse Gold Mill include (1) new versions of software to control the cellular phone hardware; (2) upgrading of cellular telephone hardware to provide reliability; (3) new core software version installed and operating satisfactorily at the conclusion of the project should be used; (4) additional solar panel and/or battery should be installed to insure that additional power to the system and additional power storage is available so that system will not power itself down; (5) sensor software can be modified to better retain settings, even after power loss to keep false alarms to a minimum. Wireless technology developed for our next HIPROTECT project can reduce reliance on the core of the system and reduce energy needs. Much can be done to improve performance in the harsh environment of the desert, but the Lost Horse Gold Mill installation project has provided the opportunity to test the HIPROTECT concept and has provided a solid basis for improvement.

## ACKNOWLEDGEMENTS

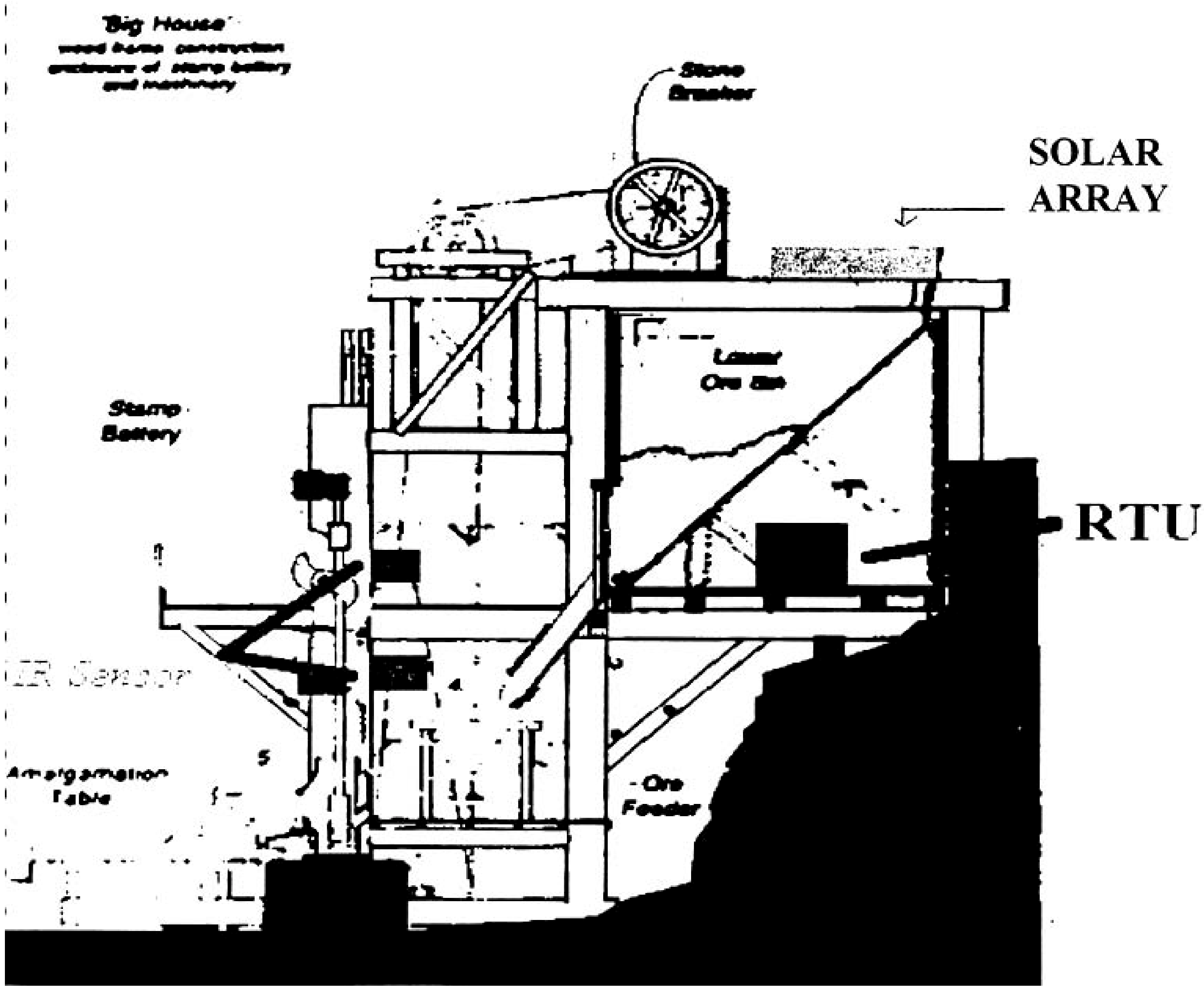
The PSTU thanks the NCPPT for the opportunity to test HIPROTECT at Joshua Tree National Park. The PSTU team has learned a great deal from this project and anticipates that application of that knowledge will be a major advantage in future HIPROTECT projects and hopefully in the continuation of the project at JOTR. Ernest Quintana (Park Superintendent) Patricia McClanahan (Chief of Resources), Rosie Pepito (Cultural Resources Manager), and Gary Garrett (VIP Ranger) at JOTR not only provided encouragement, but provided financial and physical assistance and support. We thank Mark Gilberg, Research Coordinator at NCPPT for his patience and for the extensions granted during the course of our trials and tribulations during the project. A special thanks to Nelda and Harmon King, caretakers at Keys Desert Queen Ranch, Melanie Spoo and Stephanie Schmidt of the Cultural Resources office at JOTR , and Rangers Todd Swain and Jeff Ochs of JOTR Law Enforcement.

**APPENDIX**

**TECHNICAL INFORMATION**
**LOST HORSE MILL HIPROTECT FIELD TEST**
**JOSHUA TREE NATIONAL PARK**




**I. Schematic drawing of the Lost Horse Mill Hiprotect System.**




**II. Cut-away Drawing of the HIPROTECT installation at the Lost Horse Mill.**

## III. List of Component Parts.

The main system components are listed below:

System -- Ampro XT+Core Module
PCSI UB2000 Cell Modem Module
Photocomm Marine Deep Cycle Battery
Photocomm 85 W Solar Array
Photocomm ProStar Charge Controller

Sensors -- Geospace Geophone Seismic Sensor
Protech Dual Micro-wave/Passive IR Sensor

All other parts consist of small items for board assembly, wire, connectors, conduit, EPROM for software, etc.

ATTACHNENT 3

# REPORT OF SURVEY AND EXCAVATION IN ASSOCIATION WITH INSTALLATION OF HIPROTECT AT THE OASIS OF MARA

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July 29, 1996

## INTRODUCTION

Temporary installation of HIPROTECT at the Oasis of Mara, necessitated the excavation of a 50 x 50 cm unit to the depth of 18 cm. The excavation was needed so that a portion of the main battery/control/cellular phone box could be sunk beneath the ground surface so that it could be concealed under a large artificial camouflage rock and for optimum functioning of the seismic sensor enclosed in the box. The following is a report of the excavation and the results. The work took place on July 23, 1996.

## METHODS

A 20-m diameter circular area centered around the place of the installation (Figs. 1, 2) was surveyed. Ground visibility was approximately 30 percent (70 percent ground cover) in the immediate area of installation of the equipment and about 50 percent (50 percent ground cover) in the surrounding area. Vegetation consisted of mesquite, saltbush, fallen palm fronds. One rusted tin can with a modern “church-key” opening and a bent iron rebar was observed within the surveyed area. No other cultural remains were noted. Previous archaeological work at the Oasis of Man (Tagg 1983) had not noted any historical structures at the installation locality, although Test Pit 016 contained several aboriginal sherds, lithics, and one historical artifact (Tagg 1983:52, 60).

A 50 cm x 50 cm unit was outlined on the surface at the installation locality (see Fig. 3). Since it was necessary to sink the main HIPROTECT box 6 in into the ground, an 18 cm-deep unit was planned. The unit was excavated in three 6 cm-levels using a trowel and dustpan; all soil was passed through 1/8 in wire mesh. The initial location was changed slightly (i.e., the unit was moved to the south 10 cm) due to the discovery of a very large root just under the surface.

After the unit was excavated, two extensions to the south were excavated to accommodate brackets for the solar array. In addition, a 2-cm deep and 5-cm wide trench was dug in the floor of the unit to accommodate a conduit running from the main box to the solar array. The additional soils were individually screened (Fig. 3).

## RESULTS

The 0 - 6-cm level contained a great deal of organic debris, gravel, soil clods, clumps of organic debris, rabbit feces, and scattered bits of charcoal. One small piece of cloth (white with turquoise-colored pattern) was found (Exhibit A) at 3 cm depth in the area later abandoned due to existence of large root.

The 6 - 12-cm level contained the same type of deposit until about 7 -9 cm depth when a compact sandy silt layer with less organic debris was encountered. Compactness of the soil made excavation somewhat more difficult. No artifacts or significant ecofacts were found.

The 12 - 18-cm level continued as compact sandy silt. No artifacts or significant ecofacts were found. The additional soils from the extensions of the unit contained no artifacts or ecofacts. The location, outline, orientation, and soil profile of the excavated unit is shown in Figs. 2, 3.

## SUMMARY

Survey of the area of installation of HIPROTECT revealed a modern rusted can and an iron rebar. These were left in place. Excavation of a unit to accommodate the installation of HIPROTECT equipment revealed one small piece of cloth and no aboriginal or historical artifacts.

## REFERENCES CITED

Tagg, Martyn D.
1983 Excavations at the Oasis of Mara: Archeological Investigations at Joshua Tree National Monument. National Park Service Western Archeological and Conservation Center Publications in Anthropology No. 21.

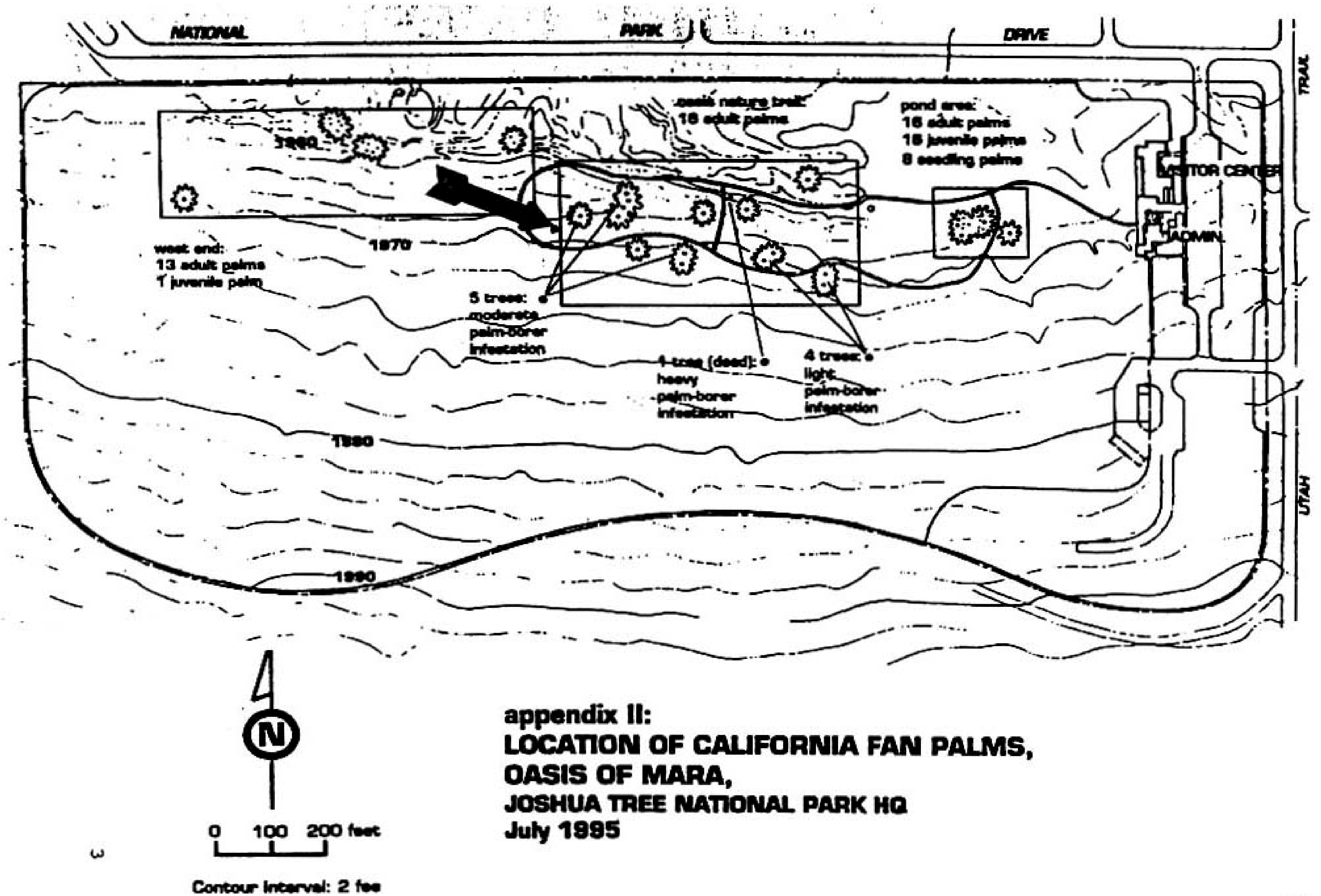



Fig. 1 Approximate location of HIPROTECT at the Oasis of Mara

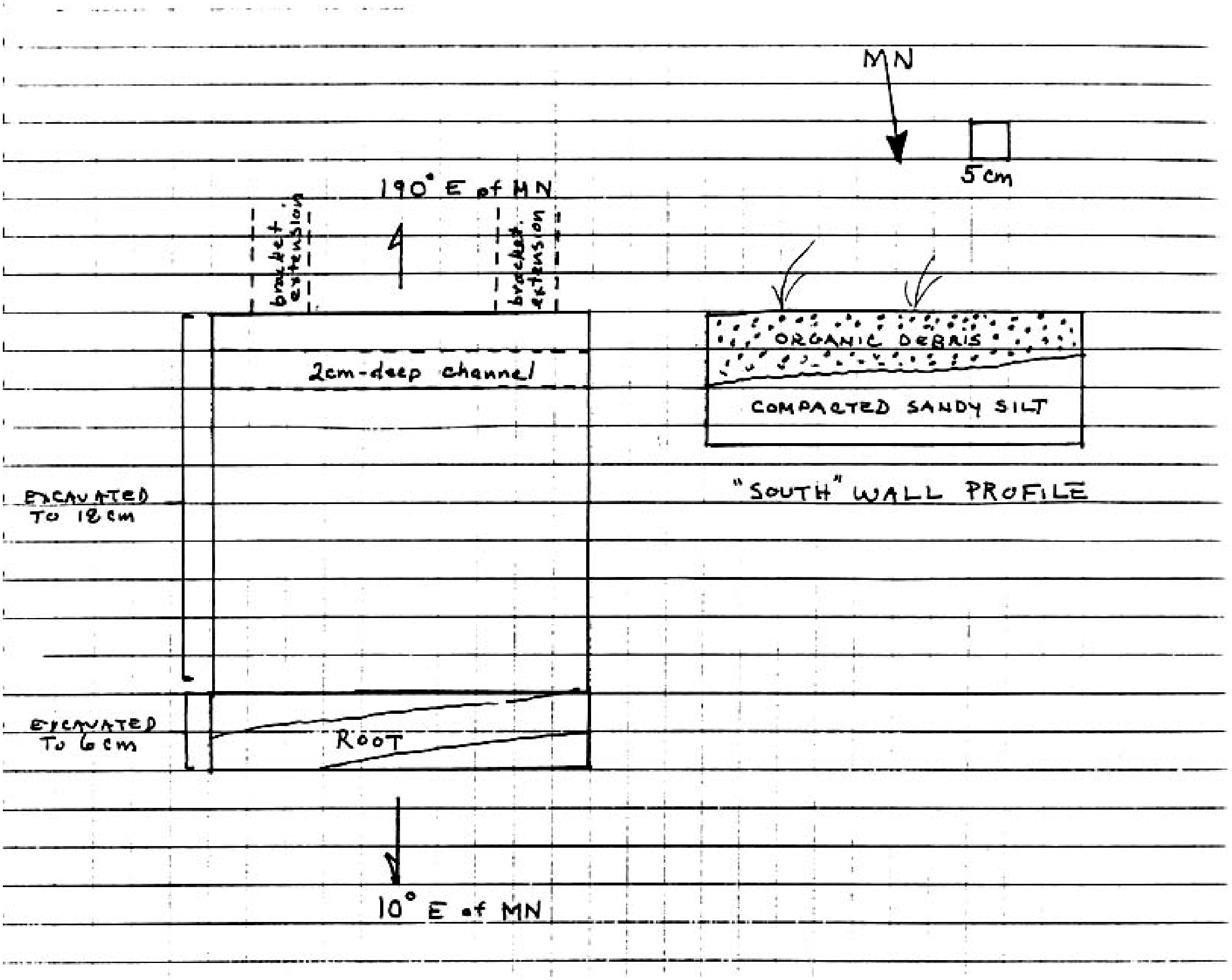



Fig. 3 Plan view and south wall stratigraphic profile of excavation unit.

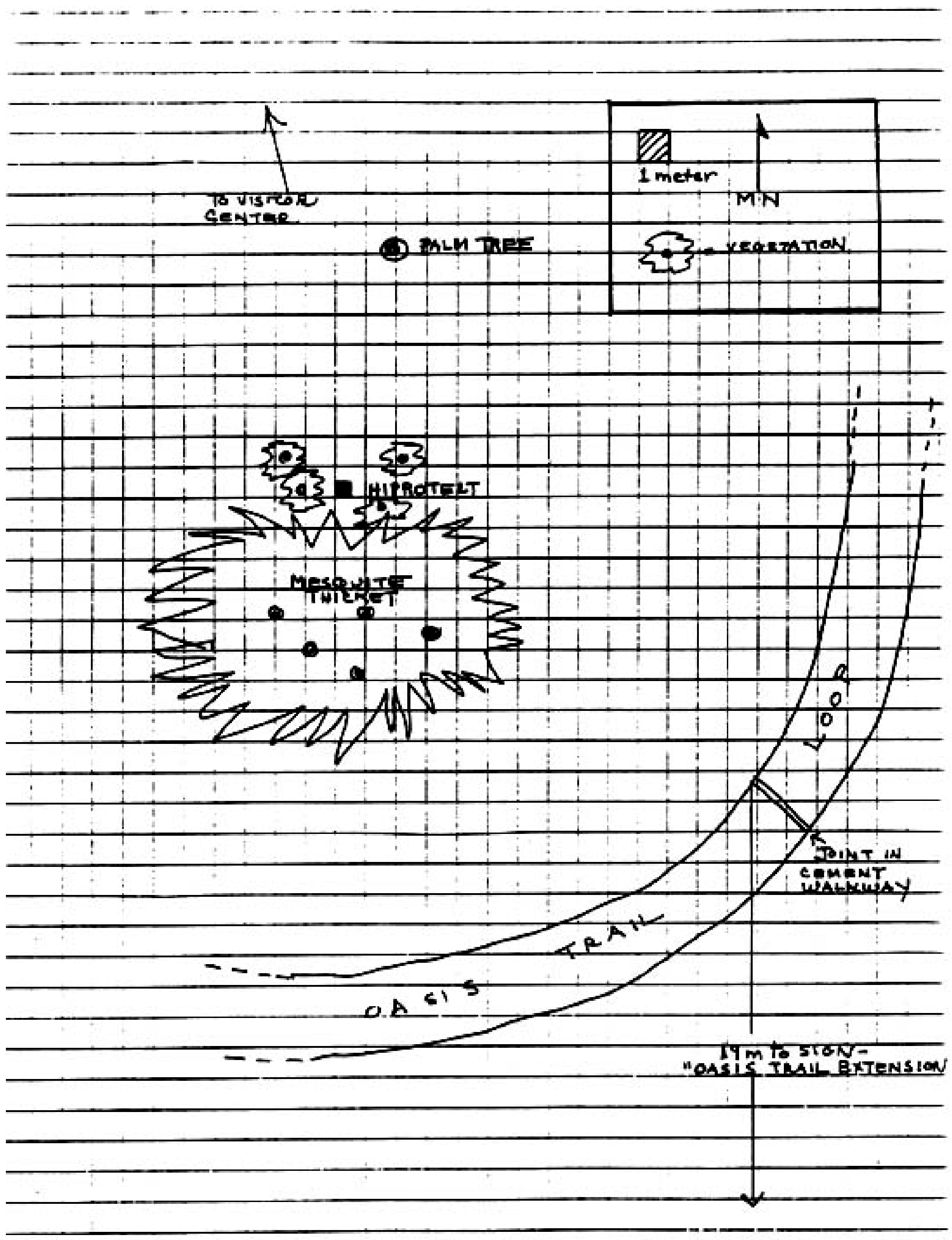
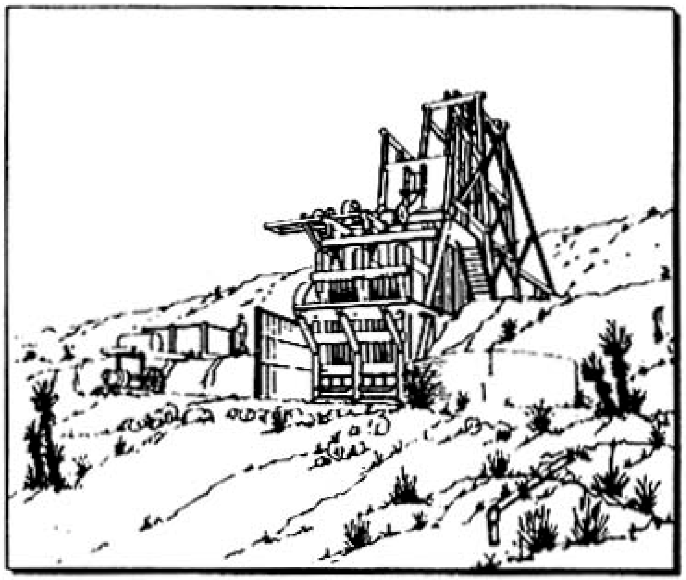



Fig. 2 Location of HIPROTECT installation within Oasis Trail 1oop.

ATTACHMENT 4


# LOST HORSE GOLD MILL

## JOSHUA TREE NATIONAL MONUMENT · CALIFORNIA

The Lost Horse Gold Mine and Mill exhibits turn of the century gold mining technology of the southern California deserts. It is significant because of the efficiency of its operation and the size of its mill, which sits directly over the shaft being mined. Because of these features the Lost Horse Gold Mine and Mill is being considered for placement on the National Register of Historic Places. The mill site is southwest of Twentynine Palms, California, in the Mojave Desert and is situated 5,000 feet above sea level in the Lost Horse Mountain range. The mill used amalgamation and, later, cyanidization to remove gold from hard rock ore. The mill was moved in 1895 from the Sterling Mine in the Chuckawalla Mining District at the Colorado River. The mine was in continuous operation from 1893 until 1908 with intermittent processing of ore into the 1930's. The Lost Horse Gold Mine and Mill became part of Joshua Tree National Monument in 1967.

The mill structure and supporting machinery are examples of industry production items of the era. The site includes remnants (25 percent) of a heavy timber framed gold processing mill which supports two adjacent five stamp batteries (Fraser and Chambers, Chicago), an ore crusher (Fraser and Chambers, Chicago), and ore bins and chutes. Except for concrete added in 1931 to reinforce the mill structure beneath the stamp batteries, the mill structure is of heavy timber and wood planking throughout. The mill was enclosed by a wood frame construction shelter known as the "Big House".

As the main quartz vein began to run out, ore processing shifted in the 1930's to cyanidization or primary ore processing of the tailings on the site using an extensive aerial cable system and a three compartment cyanide vat. Other features on the site include three corrugated iron water tanks, two stone water reservoirs, a 3.5 mile long water pipeline to the mill's water source at Lost Horse Well and a steam powered winch. The mill used a gasoline engine (Hoyt) which powered an air compressor and machines through a system of shafts, belts and pulleys. The site also includes numerous building foundations, at least seven ore excavation areas, tailings piles, and a large road system leading to and throughout the site. Vernacular features were probably associated with the early mining period at the site and were found in work and habitation structures which survive today only in the form of archeological depressions and a few foundations.

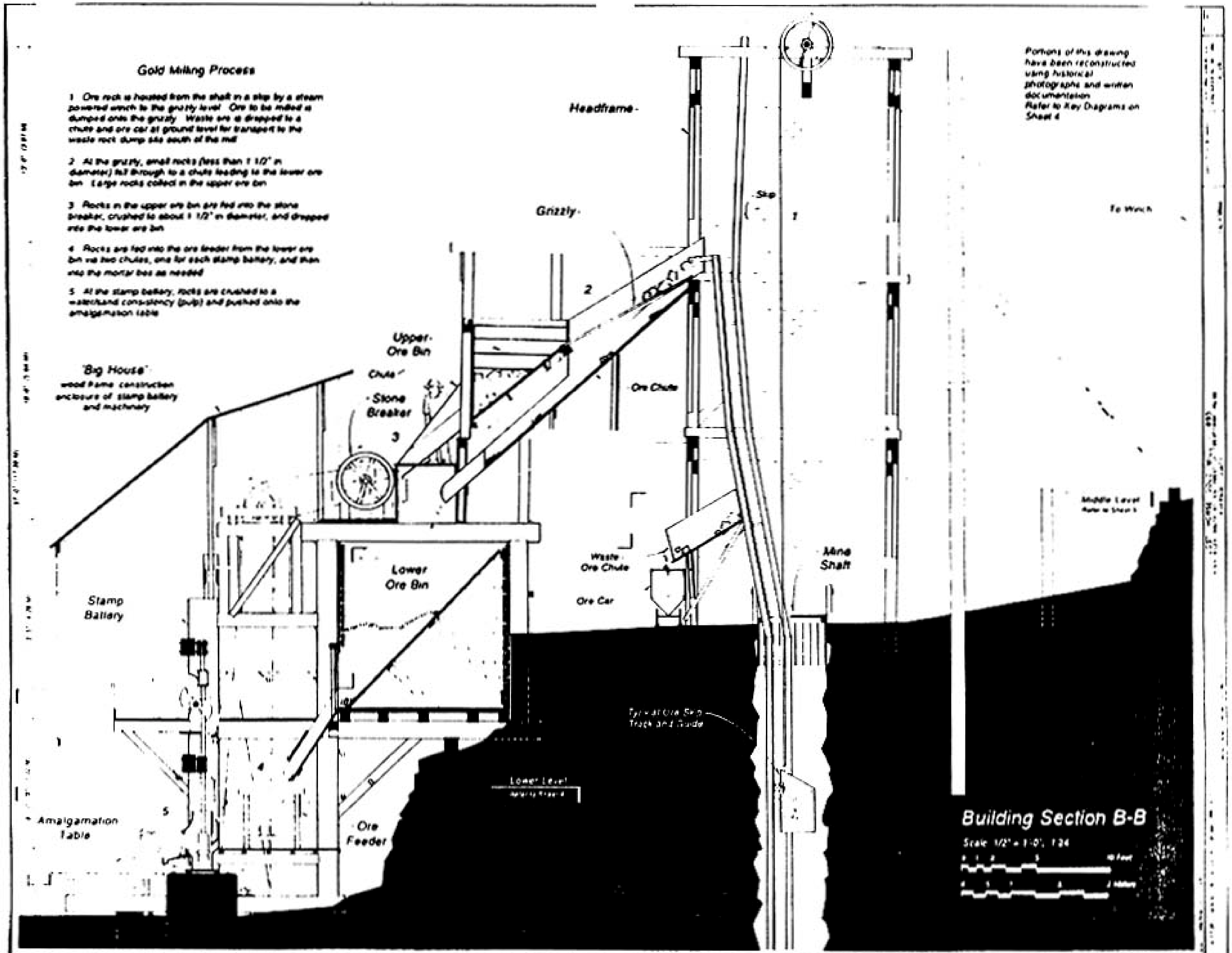
Although others also have claimed credit for the discovery of the Lost Horse gold vein, local oral tradition holds Johnny Lang discovered it when he went looking for his lost horse one day and found an outcropping of gold instead. On December 28, 1893, George W. Lang, Johnny Lang, Ed Holland, and James J. Fife (Alfred G. Tingman was included on other claims) filed a notice of location on a gold bearing lode. The group formed a partnership which provided the necessary resources for a viable mining enterprise: capital by the Langs, who were wealthy cattlemen, and access to ore processing facilities owned by Tingman and Holland. During 1894 the group formed the Lost Horse Mining Company and hauled their ore to the Piñon Well mill site for processing.

Development at the mine and mill site consisted of a 550-foot vertical shaft, an adit, a winze, as well as several shallow shafts, 300 and 500 feet east of the main shaft. The original discovery shaft may be buried beneath the tailings piles downhill from the mill. A large labor force was used to construct the access road, 3.5 mile water pipeline, and cut down piñon and juniper trees for the boilers which ran the well pumps and mill machinery. During the mines' heyday as many as 35 workers were employed to operate the mine, mill and the Lost Horse Well. Including their families, the mill population may have been as high as 80 people.

Reports place total profits of the Lost Horse Mine and Mill at $350,000 before 1900. Some estimates place production totals on the order of 10,500 ounces of gold and 16,000 ounces of silver.

This recording project is part of the Historic American Engineering Record (HAER), a long-range program to document historically significant engineering and industrial works in the United States. The HAER program is administered by the National Park Service, U.S. Department of the Interior. The Lost Horse Gold Mill recording project was cosponsored during the summer of 1992 by the Historic American Buildings Survey / Historic American Engineering Record under the general direction of Dr. Robert J. Kapsch, Chief, Joshua Tree National Monument, David E. Moore, Superintendent, and Park Historic Preservation, Western Region Office, N.P.S., Thomas Mulhern, Chief.

The field work, measured drawings, historical reports, and photographs were prepared under the direction of Eric DeLony, Chief of HAER. The recording team consisted of Karl Stumpf, Supervisory Architect (Falls Church, VA), Richard Vidutis, Historian (Takoma Park, MD), Martine Dion, ICOMOS Architecture Technician (McGill University, Quebec, Canada), and Carolyn Kiernat, Architecture Technician (Arizona State University). Formal photography was done by Jet Lowe, HAER Photographer (Washington, D.C.). Rosie Pepito, Cultural Resources Specialist, served as park liaison. Dr. Donald Hardesty (University of Nevada - Reno) and Lester Ross (San Bernardino County Museum) provided an archeological inventory of the project.


Gold Milling Process
1 Ore rock is hoisted from the shaft in a skip by a steam powered winch to the grizzly level. Ore to be milled is dumped onto the grizzly. Waste ore is dropped to a chute and ore car at ground level for transport to the waste rock dump site south of the mill.
2 At the grizzly, small rocks (less than 1 1/2" in diameter) fall through to a chute leading to the lower ore bin. Large rocks collect in the upper ore bin.
3 Rocks in the upper ore bin are fed into the stone breaker, crushed to about 1 1/2" in diameter, and dropped into the lower ore bin.
4 Rocks are fed into the ore feeder from the lower ore bin via two chutes, one for each stamp battery, and then into the mortar box as needed.
5 At the stamp battery, rocks are crushed to a watery/sand consistency (pulp) and pushed onto the amalgamation table.
Portions of this drawing have been reconstructed using historical photographs and written documentation. Refer to Key Diagrams on Sheet 4.
Headframe
Grizzly
Skip
To Winch
Upper Ore Bin
Chute
Stone Breaker
Ore Chute
'Big House'
wood frame construction enclosure of stamp battery and machinery
Lower Ore Bin
Waste Ore Chute
Ore Car
Mine Shaft
Middle Level
Stamp Battery
Typical Ore Skip Track and Guide
Lower Level
Ore Feeder
Amalgamation Table
Building Section B-B
Scale 1/2" = 1'-0", 1:24