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DESERT RESEARCH INSTITUTE
CULTURAL RESOURCES REPORT SR100119-MIT
PROJECT NO. 206312

A Historic Context and Mitigation Documentation for a Portion of the U12n Tunnel Ventilation and Containment Systems, Area 12, Nevada National Security Site, Nye County, Nevada

Prepared by

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October 2020

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Cover Photo: Overview of the U12n.10 Vent Hole system (DRI 2020).

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Prepared for

U.S. Department of Energy
National Nuclear Security Administration
Nevada Field Office, Las Vegas, Nevada

and

U.S. Department of Energy
Environmental Management Nevada Program
Las Vegas, Nevada

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EXECUTIVE SUMMARY

The National Nuclear Security Administration Nevada Field Office (NNSA/NFO) has proposed repurposing the U12n Vent Hole #2 (SHPO Resource S2488) and the U12n.10 Vent Hole (S2489) for water sampling in the U12n Tunnel. The vent holes are part of the historic ventilation system for the tunnel and are contributing elements to the U12n Tunnel Historic District (D84). In consultation with the SHPO, NNSA/NFO determined the undertaking will have an adverse effect on the vent holes. The NNSA/NFO and the SHPO negotiated a memorandum of (MOA) with stipulations to mitigate adverse effects. This submission is to comply with the stipulations in the executed *Memorandum of Agreement Between the National Nuclear Security Administration Nevada Field Office, Environmental Management Nevada Program Office, and the Nevada State Historic Preservation Officer Regarding Repurposing of Portions of the Ventilation System of the U12n Tunnel Complex Located in Area 12 at the Nevada National Security Site.*

In accordance with the MOA, the manuscript provides a historic context that describes the development and functioning of the historic U12n Tunnel ventilation system for underground nuclear tests (Stipulation III.C). High resolution digital color images of the vent hole containment doors, nearby elements, and overviews were obtained and keyed to a map and a photo index (Stipulation III.A) (Appendix A). Lastly, Architectural Resource Assessment (ARA) forms were completed for each of the vent holes and Historic District D84 (Stipulation III.B) (Appendix B).

The documentation including the historic context report, photographs, image files, and resource forms produced to fulfill the terms of the MOA will be archived with the Nuclear Testing Archive in Las Vegas (Stipulation III.D).

ACKNOWLEDGMENTS

Roger Olson (MSTS UGTA Program) generously provided his time to planning and participating in field visits to the U12n Tunnel vent holes. Ken Ortego (UGTA) was invaluable in moving this work forward in the face of an unprecedented pandemic and, alongside Roger, provided detailed information on how the UGTA Environmental Monitoring Program intends to use the vent holes for their important mission. Their help through this project was greatly appreciated. Martha DeMarre, archivist at the Department of Energy Nuclear Testing Archive in Las Vegas, graciously assisted in archival searches for engineering drawings and tunnel test construction summary reports. We were lucky to receive Martha's assistance with this project so soon before her planned retirement. Martha is an irreplaceable resource and we hope that she enjoys some rest and relaxation. Lastly, I'd like to thank my colleagues who patiently reviewed many drafts of this report and provided helpful comments.

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INTRODUCTION

This document has been prepared at the request of the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) in response to a finding of adverse effect to a historic property on the Nevada National Security Site (NNSS). The report provides historical and descriptive documentation for mitigation of the U12n.10 Vent Hole (SHPO Resources S2489) and the U12n Vent Hole #2 (S2488), which are contributing elements to the U12n Tunnel Historic District (SHPO Resource D84). The submission is to comply with the stipulations in the executed *Memorandum of Agreement Between the National Nuclear Security Administration Nevada Field Office, Environmental Management Nevada Program Office, and the Nevada State Historic Preservation Officer Regarding Repurposing of Portions of the Ventilation System of the U12n Tunnel Complex Located in Area 12 at the Nevada National Security Site.*

In accordance with the Memorandum of Agreement (MOA), this report includes the following documentation:

- A historic context that describes the development and functioning of the historic U12n ventilation system for underground nuclear tests (Stipulation III.C);
- High resolution digital color images of the vent hole containment doors, nearby elements, and overviews, with photographs keyed to a map and listed in an index (Stipulation III.A) (Appendix A); and
- Updated Architectural Resource Assessment (ARA) forms (Stipulation III.B) (Appendix B).

The documentation, including the historic context report, photographs, image files, and resource forms produced to fulfill the terms of the MOA, will be archived with the Nuclear Testing Archive in Las Vegas (Stipulation III.D).

PROJECT DESCRIPTION

The NNSA/NFO has proposed repurposing the U12n Vent Hole #2 and the U12n.10 Vent Hole for sampling water from the U12n Tunnel (the undertaking). The vent holes are part of the historic ventilation and containment systems for U12n Tunnel and are contributing elements to the U12n Tunnel Historic District. The vent holes were drilled from the mesa surface to the tunnel complex to provide an exhaust point for ventilation systems during mining and the emplacement of devices and experiments for underground nuclear tunnel tests. The undertaking proposes to remove and replace tube-turn containment doors from each vent hole with new covers designed to hold water sampling equipment. Other modifications will be made to shorten aboveground ventilation ducting, remove part of an overhead walkway and a stationary crane, and move aside other components to create safe working environments around the holes. In consultation with the Nevada State Historic Preservation Office (SHPO), the NNSA/NFO determined that the undertaking will result in an adverse effect to the two vent holes (Reed 2019). The NNSA/NFO sent notification regarding the adverse effect to the Advisory Council on Historic Preservation (ACHP), who declined participation in further consultation (Thompson 2020).

HISTORIC CONTEXT

The Cold War and Nuclear Testing

The NNSS played a crucial role in the U.S. nuclear testing program during the Cold War with the former Soviet Union, a conflict that lasted from shortly after the end of World War II in 1945 until the dissolution of the Soviet Union in 1991 (Anders 1978:4; Blohm 2003; Loeber 2002:80; Ogle 1985:20). An escalating arms race for nuclear weapons superiority led to numerous nuclear explosions worldwide by the United States, the former Soviet Union, and other foreign nuclear powers. The Atomic Energy Commission (AEC) (now the Department of Energy) and the Department of Defense (DOD) conducted these tests for the United States. Most of the tests occurred at the NNSS and included both atmospheric and underground tests. The major purposes of nuclear testing were weapons related testing (testing a device intended for a specific weapon system); weapons effects testing (evaluating the civil or military effects of a detonation); safety experiments (confirming a nuclear detonation would not occur from an accidental detonation of the high explosive associated with the device); joint United States–United Kingdom testing (storage-transportation); and Vela Uniform tests (improving the ability to detect, identify, and locate underground nuclear detonations) (NNSA/NFO 2015).

After the Limited Test Ban Treaty between the United States, the Soviet Union, and Great Britain was ratified in 1963—which effectively banned nuclear weapons testing in the atmosphere, ocean, and space—all weapons related tests were conducted underground (Friesen 1995:6; NNSA/NFO 2015:x). Most underground tests on the NNSS between 1963 and 1992 were conducted either in vertical shafts or in horizontal tunnels. Most vertical shaft tests were for the purpose of developing new weapon systems, whereas the tunnel tests were generally for evaluating the effects of radiation from a nuclear explosion on military hardware and systems (Brady et al. 1989; OTA 1989; Wolff 1984). The vertical shaft tests were the most common, representing over 90 percent of tests, and were primarily placed on Yucca Flat or, if they were large-yield tests, on Pahute Mesa. Horizontal tunnel tests only occurred once or twice a year and were located in tunnels mined into Rainier Mesa and Aqueduct Mesa (OTA 1989:18).

Nuclear Testing in Tunnels

Nuclear testing in tunnels served two purposes. First, with improvements to tunnel testing methodologies and procedures in the mid to late 1960s, tunnel tests provided a reliable method for the containment of underground nuclear explosions following ratification of the Limited Test Ban Treaty in 1963. Second, tunnel tests allowed for the simulation of above ground weapons effects (cavity tests) and radiological effects of nuclear explosions in the upper atmosphere and space (effects tests). Tunnels further provided sufficient room for the study of these effects on increasingly large pieces of military equipment and increasing numbers of components in a single test (DTRA 2002; OTA 1989). The first underground tunnel test, code-named Saturn, took place in U12c Tunnel on August 10, 1957 (Fehner and Gosling 2006; NNSA/NFO 2015). The Rainier tunnel test in U12b Tunnel about a month later on September 19, 1957 was the first underground test that contained a nuclear detonation with no radioactive release detected (Carothers 1995; Fehner and Gosling 2006; Jones et al. 2012; NNSA/NFO 2015). The Hunters Trophy test in 1992 was the last weapons effects tunnel test at the NNSS.

The use of nuclear tunnel tests to study weapons effects by the DOD originated with the Defense Atomic Support Agency (DASA), the successor agency of the Armed Forces Special Weapons Project (AFSWP). The AFSWP was tasked in 1949 with studying radiological warfare and the effects of nuclear weapons on targets that were underwater, underground, and in the atmosphere (DTRA 2002:71-72). The AFSWP later evolved into DASA, and by the early 1960s the agency was tasked with the study of nuclear weapons effects on various weapons storage sites, and the hardening of missile systems against x-rays transmitted in the upper atmosphere or in space (DTRA 2002:188–189). In the late 1970s and early 1980s, during the buildup of the U.S. military and national defense, the agency was reorganized as the Defense Nuclear Agency (DNA) and its objective became survivability from a nuclear attack. Efforts were made to improve and harden communication systems, airplanes and their components, missiles and their components, and underground bunkers (DTRA 2002:259).

DASA innovated new methods to simulate space or high-altitude environments in underground weapons effects tests. One development as early as 1964 was to attach the explosive device to a long, sealed vertical or horizontal line-of-sight (VLOS or HLOS) pipe. Air was evacuated from the pipe to create a near vacuum and samples were exposed to radiation at the time of the explosion (DTRA 2002:189). The Wishbone test, detonated on February 18, 1965, in the U5a shaft was the first weapons effects test driven by an emphasis on high-altitude radiation effects on materials and electronic parts. Diluted Waters—detonated on June 16, 1965, in the U5b shaft—utilized a VLOS system to test effects on materials and electronics. Through the remainder of the mid to late 1960s, DASA made improvements in underground testing techniques primarily focused on the simulation of high-altitude or space conditions with highly evacuated line-of-sight pipes, data gathering techniques, and safety features including fast acting closures for VLOS and HLOS pipes and increasingly sophisticated stemming procedures (DTRA 2002: 190-196).

Although tunnel tests were significantly more expensive and required greater amounts of time to prepare, through the 1960s DASA shifted from using vertical shaft tests to horizontally mined tunnels. The AEC rarely used the more expensive and time-consuming tunnel test configuration. Tunnels allowed for big rooms to be mined out where test chambers with samples for many experiments could be exposed to radiological effects simultaneously, or radiological effects on large pieces of military equipment such as satellites could be tested (DTRA 2002:193-196).

Tunnels were mined horizontally into rock at the base of Rainier Mesa and Aqueduct Mesa to a depth of approximately 1,300 feet, where the amount of soil and rock above the test chamber was adequate to prevent radioactive releases (DTRA 2002:193; OTA 1989:52). The tunnels consisted of a main tunnel that provided access to various line-of-sight and bypass drifts where tests were emplaced. To support mining operations and the test emplacement, alcoves mined into sides of the tunnels served as workshops, power and utilities stations, and recording stations. Sophisticated mechanical systems were employed in the tunnels to support mining and experimental emplacement operations. For example, in U12n.23 for the December 10, 1988 Misty Echo test, the mechanical systems included containment valves and closures, dewatering systems, cooling water systems, gas sampling systems, ventilation systems, tunnel environmental monitoring systems, cavity ventilations systems, alcove vacuum systems, alcove compressed air positive pressure systems, pumping systems, and alcove wash down systems (Rivero 1991).

Twenty-one nuclear tests were conducted in U12n Tunnel between 1967 and 1992 (Table 1; see also Drollinger et al. 2011 for expanded descriptions of each test). Twelve of these tests were sponsored by Lawrence Livermore National Laboratory and DOD and nine were sponsored by the Los Alamos National Laboratory and the DOD (NNSA/NFO 2015). Many of these tests were weapons effects tests that used a HLOS pipe, whereas other tests evaluated different underground test bed configurations and experiments with low yield test designs.

Table 1. Nuclear tests in U12n Tunnel.

Location	Test	Operations	Sponsor	Date
U12n.02	Midi Mist	Latchkey	LLNL/DOD	06/26/1967
U12n.04	Hudson Seal	Bowline	LLNL/DOD	09/24/1968
U12n.05	Misty North	Grommet	LANL/DOD	05/02/1972
U12n.06	Diana Mist	Mandrel	LANL/DOD	02/11/1970
U12n.07	Husky Ace	Arbor	LANL/DOD	10/12/1973
U12n.08	Ming Blade	Arbor	LANL/DOD	06/19/1974
U12n.09	Hybla Fair	Bedrock	LLNL/DOD	10/28/1974
U12n.10	Mighty Epic	Anvil	LLNL/DOD	05/12/1976
U12n.10a	Diablo Hawk	Cresset	LLNL/DOD	09/13/1978
U12n.11	Miners Iron	Guardian	LANL/DOD	10/31/1980
U12n.12	Mini Jade	Phalanx	LANL/DOD	05/26/1983
U12n.15	Huron Landing	Praetorian	LANL/DOD	09/23/1982
U12n.15	Diamond Ace	Praetorian	LLNL/DOD	09/23/1982
U12n.17	Misty Rain	Grenadier	LLNL/DOD	04/06/1985
U12n.18	Tomme/Midnight Zephyr	Phalanx	LLNL/DOD	09/21/1983
U12n.19	Diamond Beech	Charioteer	LLNL/DOD	10/09/1985
U12n.20	Mill Yard	Charioteer	LANL/DOD	10/09/1985
U12n.21	Middle Note	Musketeer	LLNL/DOD	03/18/1987
U12n.22 U12n.22a	Mineral Quarry* Randsburg*	Aqueduct	LLNL/DOD	07/25/1990
U12n.23	Misty Echo	Cornerstone	LANL/DOD	12/10/1988
U12n.24	Hunters Trophy	Julin	LLNL/DOD	09/18/1992

*Simultaneous detonations in separate tunnel drifts for the same test
Source: DOE/NV--209-REV 16 (NNSA/NFO 2015)

Tunnel Ventilation Systems

Downhole vents such as the U12n.10 Vent Hole and U12n Vent Hole #2 were drilled from the surface to the tunnel complex to provide exhaust ventilation to the tunnels. These vents reduced contaminants in the air and maintained pressure and temperature conditions for the mining, construction, and experimental device emplacement operations within the tunnel. The vents were also specifically designed as mechanisms for the containment of nuclear explosions–their tunnel side and mesa side components were elements of the stemming and containment plans for the different tests and were designed to contain the explosive products if containment plugs nearer to the device failed.

Ventilation

Ventilation systems are an essential component of mining operations and, to a varying extent, have shaped the designs of mines and underground tunnels for the past several thousand years. A primary objective of an underground ventilation system is to provide sufficient airflow to dilute contaminants to safe concentrations in areas where personnel are required to work or travel. Ventilation can also maintain environmental conditions for subsurface storage applications, such as sealing high-level nuclear waste from human access in a containment drift (McPherson 2012; Tien 1999).

The first power driven mine ventilation systems began to appear in the mid nineteenth century, taking the form of steam-driven piston-and-cylinder devices and early types of centrifugal fans. For example, Buffalo Blowers, manufactured by the Buffalo Forge Co., New York, are an early type of powered centrifugal fan system used for mine ventilation that were developed in the late nineteenth century and are still produced today (Buffalo Forge Co. 1892; Howden Group 2019). Buffalo Forge Co. Type R Pressure Blowers were used as main fans for tunnel ventilation systems on the NNSS.

In mines and other underground facilities airflow, produced by main fans pulling air from the portal through the mined area, is the primary means of controlling atmospheric conditions in the subsurface. The main fans handle the air that circulates through the underground network of airways. Underground in-line booster fans boost airflow through ducts to specific areas of the mine. Auxiliary fans pass air through ducts to ventilate drifts and tunnels that are not connected to other drifts (blind headings). The distribution of airflow is further controlled by ventilation doors, stoppings, air crossings, and regulators. In some cases, airflow control is not able to cope with all environmental hazards in a mine. Air temperatures may increase due to compression in downcast shafts, and therefore other techniques such as refrigeration systems need to be used (McPherson 2012; Tien 1999).

Containment

One of the goals of conducting underground nuclear tests in tunnels and shafts following the Limited Test Ban Treaty was the containment of nuclear explosions underground to reduce the potential for a nuclear release into the atmosphere. Therefore, with the increased use of tunnel testing and initiatives by DASA to improve the safety and containment of tunnel tests in the 1960s, downhole vents became essential elements of the stemming and containment plans for tunnel tests. Underground nuclear explosions are foremost contained by the sealing nature of a compressive stress field formed around the explosion cavity, which is called a stress containment cage. Other factors include the strength and porosity of the rock, the depth at which a device is buried, and the stemming of the device emplacement (OTA 1989:34). Stemming is put in a tunnel after the emplacement of the device to prevent gas from being released after the explosion. Stemming plugs and varieties of steel gas seal containment doors and closures designed to be impermeable to high pressure and high temperature gases are placed at various distances from the working point, which is the point where the nuclear device is emplaced, and force gases to be absorbed into the surrounding rock (OTA 1989:35). Within the tunnel at the point where ventilation lines met the downhole vents, stemming plugs with steel bulkheads and tube turn containment doors were constructed that closed off the tunnel ventilation system from the mesa vents. Many tunnel tests used these stemming plugs combined with a HLOS pipe to create redundant nested containment vessels. This practice allowed experiment packages to be directly exposed to radiation from the nuclear explosion, prevented damage to the experiment and surrounding drifts from explosive debris and fission products, permitted recovery of the experiment, and provided three levels of protection against accidental nuclear release into the atmosphere (OTA 1989:41).

The concept of three redundant containment vessels nested within each other and sealed from each other with stemming plugs (Figure 1) was developed in 1972 by the Defense Nuclear Agency (DNA), a later evolution of DASA. Each vessel was designed to independently contain the nuclear explosion even if the other vessels failed. Vessel I was the stemmed area designed to prevent damage, allow the recovery of experimental equipment by withstanding the effects of ground shock, and contain the cavity temperature, pressure, and radiation after the explosion. Vessel I contained the working point and extended out for a distance of approximately 600 feet to the ends of stemming in both the bypass and line-of-site drifts. Vessel II protected the tunnel system for later reuse even if Vessel I failed and the experimental equipment was lost. Vessel III was designed to prevent release of radioactive material into the atmosphere even if the experimental equipment was lost and the tunnel system was contaminated (OTA 1989:42). Downhole vents, including the U12n.10 Vent Hole and U12n Vent Hole #2, were elements of Vessel III.

In Vessel I, nearly all of the main and access drifts around the working point were filled (i.e., stemmed) with rock-matching grout and areas farther from the working point were filled with superlean (i.e., low cement, high water content) grout. The remainder of the drifts were filled with high-strength grout or concrete (OTA 1989; Schoengold 1999). The plugs that separated the vessels were constructed from 10- to 30-foot-thick high-strength grout or concrete, with steel sides on the working point side of the Vessel II plugs. Vessel II plugs were designed to withstand pressures up to 1,000 pounds per square inch (psi) and temperatures up to 1,000°F. Vessel III plugs were constructed from concrete and designed to withstand up to 500 psi and 500°F. The vessels were sealed by tube turn type gas seal doors at the entrance of the tunnel system and on the tunnel and mesa sides of the downhole vents systems that were closed prior to detonation. Before each test, the entire tunnel system was pressurized to 2 psi with a gas that contained chemical tracers and the surrounding area was monitored for the presence of the tracer gas (OTA 1989:42). Pressure monitoring valves and gauges are components of the vent hole casings for the U12n.10 Vent Hole and U12n Vent Hole #2.

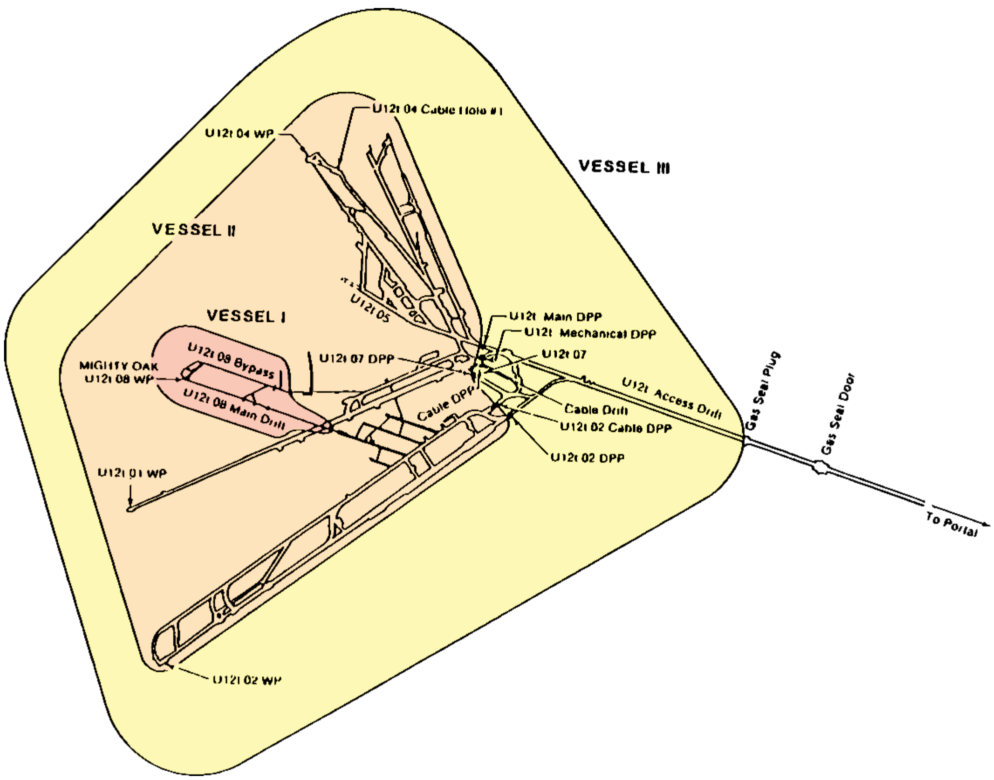


Figure 1. Illustration of the nested vessel containment concept for the Mighty Oak Test (April 10, 1986) in the U12t Tunnel. The red zone is Vessel I and contains the U12t.08 Main Drift. Vessel II is the orange area around Vessel I that contains all of the U12t drifts, each of which is sealed with a drift protection plug (DPP). Vessel III is the yellow area around Vessels I and II and it extends vertically to the drillholes and vent holes on the mesa. The nested vessel procedure was used in the U12n tunnel tests between 1972 and 1992 (modified from DOE NVO 1987).

Engineering and Design Information

From 1975, the U12n.10 Vent Hole (SHPO Resource S2489) located on the mesa surface provided the primary means of exhaust ventilation for mining, construction, and experiment operations in the tunnel complex (Drawing 1). From 1989, the year following its construction, U12n Vent Hole #2 (SHPO

Resource S2488) served as the principal ventilation exhaust system for tests in the U12n Extension tunnel (Drawing 2). These vents were also important elements of the stemming plan and containment procedures for these tests. This section reviews available engineering and design information for these vent holes, as well as information on how these systems functioned as ventilation and containment devices for various tests in the U12n Tunnel.

The U12n.10 Vent Hole No. 1 (known now as the U12n.10 Vent Hole) was drilled in 1975 during construction and mining operations for the Mighty Epic nuclear test the following year (Bennett 1991). The hole was drilled to 1,240 feet and has a diameter of 64 inches near the surface, and 48 inches at the portal end with 55-inch and 30-inch drillhole casings respectively (Farrimond 1978). That same year, the vent drift on the portal side of U12n.10 Vent Hole No. 1 was added to an engineering drawing showing the test bed configuration for Mighty Epic (Holmes and Narver 1975). A cooled water system was also installed on the mesa top at the vent hole. Two 50-ton air-to-water chillers and a back-up 150-ton cooling tower were located on the mesa ventilation pad. Cooled water from these units was drawn down a 4-inch diameter pipe located on the outside of the ventilation pipe to a heat exchanger in the vent drift. Cooled water was distributed from there to different points in the tunnel. Ball valves closed the chilled water lines during a test for containment of the explosion (Farrimond 1978:13).

The operational elements on the mesa surface for the U12n.10 Vent Hole consist of the vent hole casing capped by a tube-turn containment door, a crane, vent lines, Buffalo Blowers, and electrical motors (see Drawing 3). Associated elements on the vent pad include pieces of vent line and valves that likely served as a connecting elbow between the vent hole and the vent lines, an electrical substation, electrical panels, concrete pads, a chilled water system pump skid, and a metal water tank.

The vent hole casing is capped with a metal tube-turn containment door with a manually operated yoke-style closure mechanism (Figure 2). Welded to the outside of the vent hole casing are two four-inch pipes that serve as chilled water lines that extend down the exterior of the downhole vent casing. The chilled water system, including the nearby pump skid and water tank, helped to maintain environmental conditions in the tunnel and experiment chambers.

Figure 2. (Top left) detail of yoke-style closure mechanism with grooved interiors that close around rims on the vent casing and the turn-tube containment door, facing southwest (Photo: DSC_5161, DRI 2020); (bottom right) detail of northern vent line, remote-controlled damper section, and Buffalo Blower, facing east (DSC_5122, DRI 2020).

An overhead pipe-and-beam crane near the vent hole was used to remove and install the 90° elbow that connected the vent hole casing to the ventilation line and fans. This connection point is a flanged opening that splits into two identical 26-foot-long vent line sections. Within the lines are remote-controlled dampers used to control airflow. At the end of the system the vent lines connect to two Buffalo Blower centrifugal fans (See Figure 2).

By the time construction and mining began for the Huron Landing and Diamond Ace tests in the U12n.15 drifts on September 23, 1982, the ventilation system was considered a part of the mechanical systems for the test alongside the gas sampling, dewatering, and chilled water systems, the tunnel environmental monitoring system (TEMS), and containment valves and/or closures. Ventilation for Huron Landing/Diamond Ace was provided by drawing air through various drift branches to a common 36-inch pipe which penetrated a thermal shield plug, and was then drawn up the vertical 30-inch pipe to the mesa by the two Buffalo Blowers at the U12n.10 Vent Hole (LaComb 1996). Ventilation of the U12n.15 line-of-sight and bypass drifts was drawn from vent lines running to the portal area by a Sutorbilt blower. During re-entry to the tunnel system after the test, the portal side of the vent line at each containment plug was opened as the re-entry team progressed. The downhole ventilation system was only used during re-entry when test managers determined concentrations of contaminants were low enough to prevent release (LaComb 1996).

During construction for the Misty Echo test conducted on December 10, 1988, in the U12n.23 drift, ventilation was provided by drawing air through two 26-inch fiberglass vent lines that came to a junction at the convergence of the upper cavity access drift and the lower access drift. On the portal side of the junction, a 125 horsepower (hp) in-line booster fan was located within a 30-inch steel vent line. The 30-inch steel line continued to the U12n Extension south drift where it connected to a 48-inch steel vent line, which ultimately routed to the U12n Extension portal. Three 350 hp in-line booster fans were located along this line. A 30-inch fiberglass vent line, connected to the 48-inch line in the U12n Extension south drift, was routed through the U12n Extension utilities drift to the U12n.05 Drift.

Ventilation for the remainder of the U12n Tunnel complex was provided by the two Buffalo Blowers on the mesa surface, which drew air through a 30-inch vertical pipe casing, which entered the tunnel complex at the U12n.10 Vent Hole. A Sutorbilt Blower at the portal boosted ventilation of the drifts on the portal side of the U12n.08 Drift Protection Plug (DPP).

Construction of U12n Vent Hole #2 (S2488) began in preparation for the Misty Echo test to provide a second ventilation shaft in the U12n Extension region of the tunnel. A 74-inch-diameter steel casing within a 108-inch-diameter vertical shaft was installed from the mesa to the tunnel complex (Bennett 1991). However, the shaft was not completed in time for the test. To seal the pipe casing and the mined shaft, a 74-inch steel tube turn closure rated to 500 psi and 500°F was installed on the mesa side and a steel hemispherical end cap was installed on the tunnel side. The area around the hemisphere and the space around the casing in the vertical shaft were filled with grout (Drawing 4). After the test, the grout around the hemisphere was mined out and the hemispherical end cap was removed to continue construction of U12n Vent Hole #2 for use on subsequent tests. During button-up procedures, the final phase of stemming and close-up of the tunnel system and openings prior to the event, ventilation was interrupted at the containment barriers by breaking the vent lines and closing the tube turn closures. The closures were reopened, and ventilation established during post-detonation reentry mining activities when construction of the vent hole began again (Rivero 1991, 1992).

During construction in 1990 for the Mineral Quarry and Randsburg tests in the U12n.22 and U12n.22a drifts, a 90° elbow and a section of horizontal hard pipe were installed on the underground end of the pipe casing (Drawing 5). During button-up procedures for these tests, the portal side of the U12n Vent Hole #2 pipe was sealed with a steel tube-turn containment door rated to 500 psi and 500°F. A bulkhead was constructed from steel framing and a gas-seal welded-steel skin. During stemming, post-pressure grout holes were drilled 360° circumferentially around the plug center and concrete/grout was pumped in for the vent shaft protection plug.

The operational elements of U12n Vent Hole #2 on the mesa surface consist of the vent hole pipe and containment door, a vent conduit, a crane, and a conduit elbow (Figure 4). Associated elements in the immediate vicinity of the vent hole consist of an electrical substation, a telephone booth, an electrical panel box, a stack of milled lumber, five wood light poles surrounding the vent pad, and an exploratory drillhole.

Figure 3. (Top left) overview of U12n Vent Hole #2 showing, from left to right, the vent conduit, containment door, crane, and conduit elbow (Photo: DSC_5069, DRI 2020); (bottom right) tube-turn containment door and yoke-style clamp mechanism in position over the vent pipe casing (Photo: DSC_5107, DRI 2020).

The vent hole casing is capped with a steel tube-turn containment door that is closed and secured with a motorized yoke-style closure mechanism (See Figure 4). The metal vent conduit has an opening that flairs from north to south with two five-foot-diameter round openings that 350 hp Buffalo Blowers were attached to. The conduit contains internal baffles for controlling airflow that are actuated by right-angle gear drive motors.

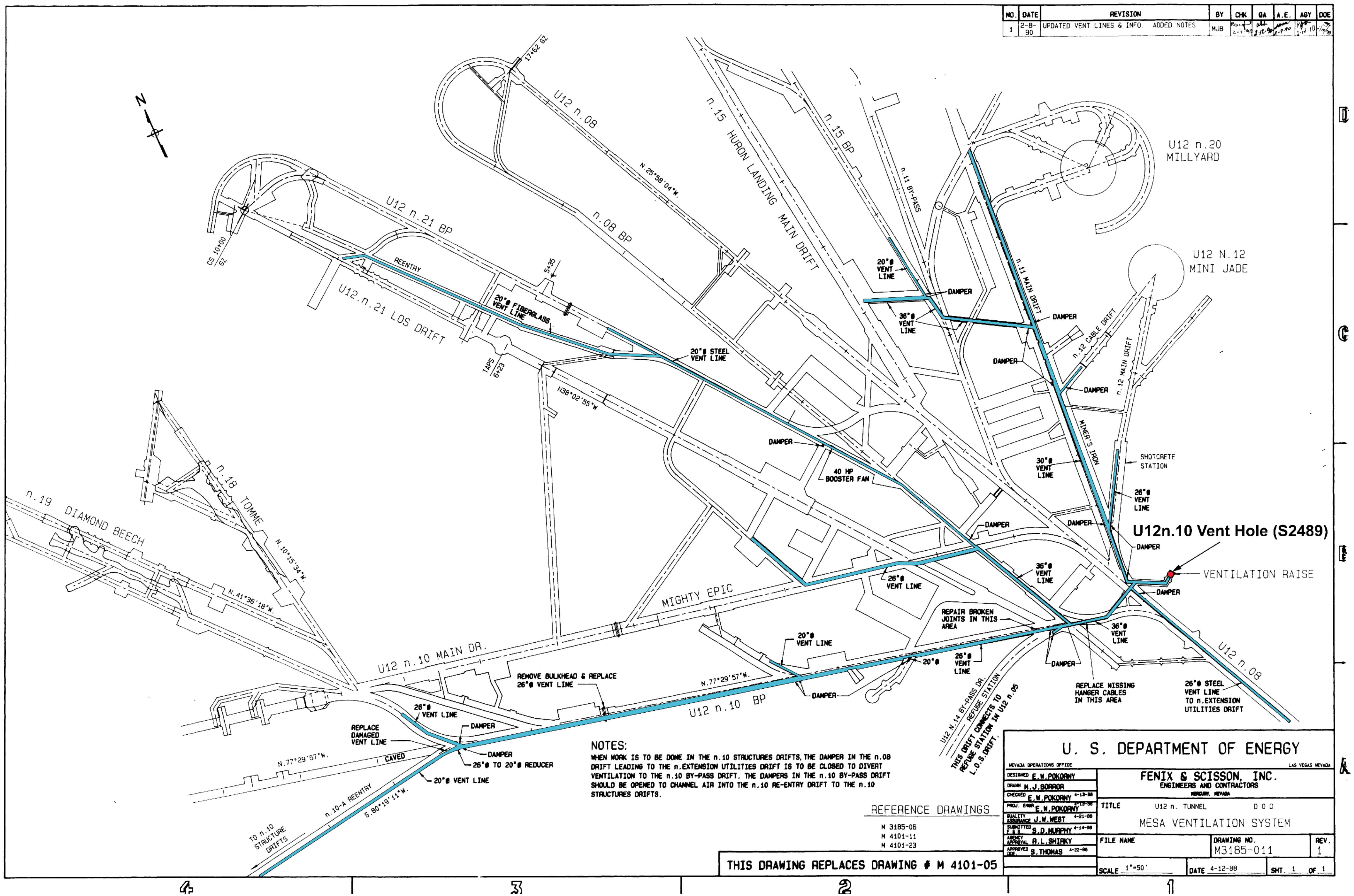
When the ventilation system was in use during mining and experiment emplacement operations in the tunnel, the containment door was opened, and exhaust airflow established by connecting the vent pipe to the vent conduit using the conduit elbow. The conduit elbow is a metal box with internal metal louvers that redirect the air at a 90° angle to the conduit. The conduit elbow was installed and removed with a pipe and beam jib crane permanently mounted next to the vent pipe.

In 1992, the Hunters Trophy test bed in U12n.24 was ventilated by drawing air through the U12n Tunnel Main Drift and the Extension Drift to U12n Vent Hole #2 at the far western end of the U12n Extension. The 350 hp fans on Rainier Mesa exhausted the air 1,200 feet through the U12n Vent Hole #2 shaft. The Hunters Trophy bypass drift was ventilated by ducts with diameters of 20 inches, 30, and 36 inches with a 100 hp in-line fan that exhausted into the 48-inch-diameter main vent line in the U12n South Extension Drift, where it was boosted by a 125 hp fan into U12n Vent Hole #2. Mining for the Hunters Trophy line-of-sight drift was ventilated by ductwork with diameters of 20 inches, 26 inches, and 36 inches boosted by a 200 hp in-line fan that exhausted into the U12n North Extension Drift, and ultimately through U12n Vent Hole #2. The ductwork was updated to 15-inch vent ducts following installation of the HLOS pipe (Rivero 1992:40).

Summary

Much of the U12n Tunnel infrastructure was left in place following the Hunters Trophy test at the end of nuclear testing in 1992. Eighteen years later, Drollinger and others. (2011) recorded the portal and mesa areas as part of the U12n Tunnel Historic District, recognizing the importance of this historic property to Nevada and the Nation in telling the story of the scientific, technological, and human achievements related to nuclear testing operations in the United States. On the mesa area, the U12n.10 Vent Hole and U12n Vent Hole #2 were identified as critical elements of the U12n Tunnel ventilation system. Today, these are used to monitor Rainier Mesa groundwater contamination. Modifications to the vent hole covers will provide safer and more effective water sampling platforms.

The historic context in this report defines the role of the ventilation systems in underground nuclear tunnel tests. Background research revealed that vent holes were a critical system for maintaining safe environmental conditions in the tunnels during mining operations, experiment emplacement, and reentry of the tunnels to retrieve equipment after tests. They were also part of the larger, sophisticated tunnel testing containment system developed in response to the need to conduct increasingly complex tests while minimizing the potential for a release of radiation to the atmosphere as mandated by the 1963 Limited Test Ban Treaty. In addition, the historic context provides a description of the ventilation and containment systems for the U12n Tunnel in particular, as well as a history of the engineering, design, and use of the U12n.10 Vent Hole and the U12n Vent Hole #2 between 1975 and 1992. Although the U12n.10 Vent Hole was used for several tests, the U12n Vent Hole #2 saw relatively limited service due to the timing of its construction near the end of the Cold War.



Drawing 1. Ventilation system for U12n Tunnel as of 1988 with ventilation lines highlighted in blue and the location of the U12n.10 Vent Hole indicated in red (modified from Fenix and Scisson, Inc. 1988).

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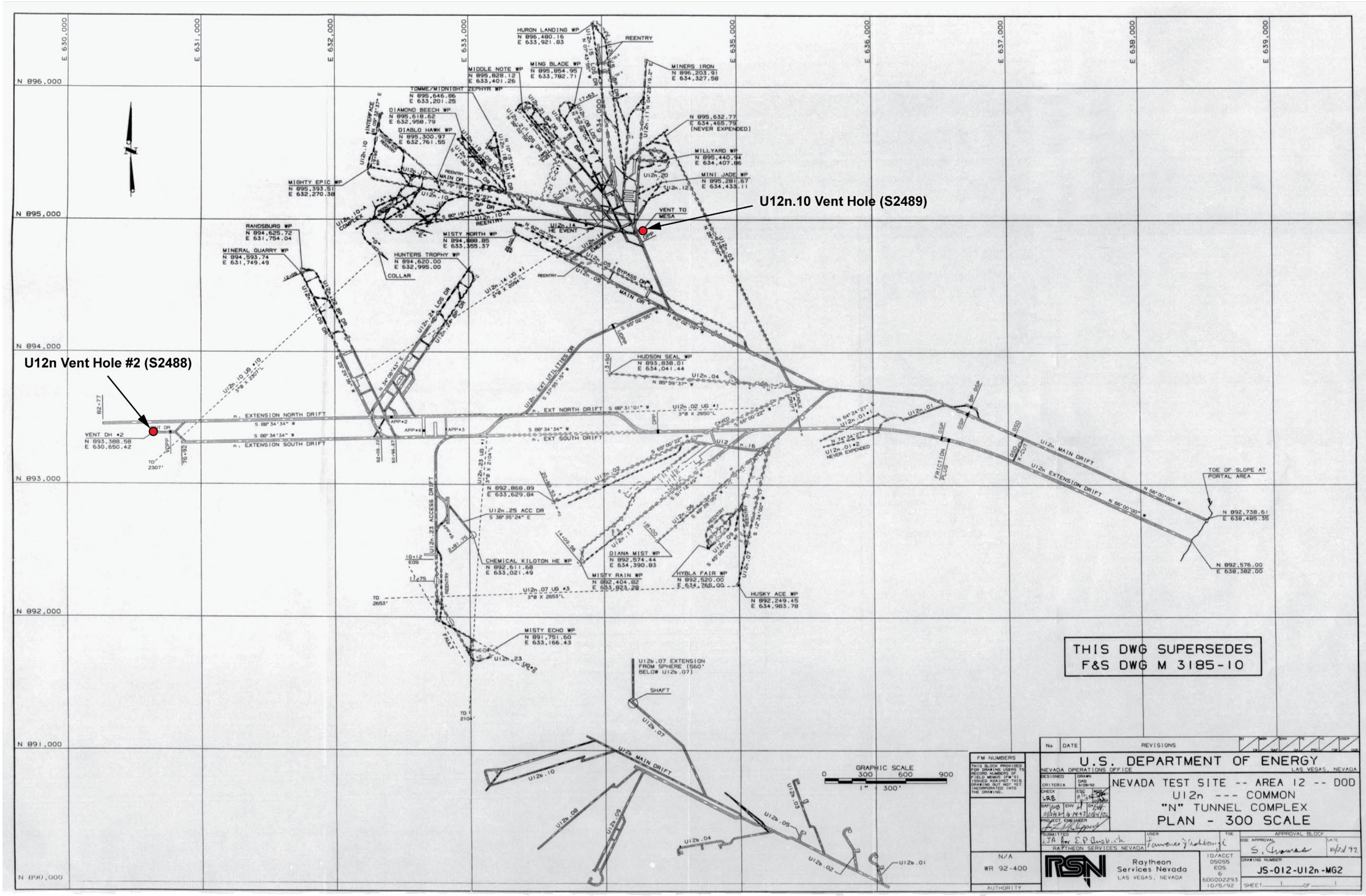

Drawing 2. U12n Tunnel Complex plan map showing the locations of the U12n.10 Vent Hole along the U12n Main Draft and U12n Vent Hole #2 at the west end of the U12n Extension drifts. Drawing modified to show locations of vent holes in red (modified from Raytheon Services Nevada [RSN] 1992).

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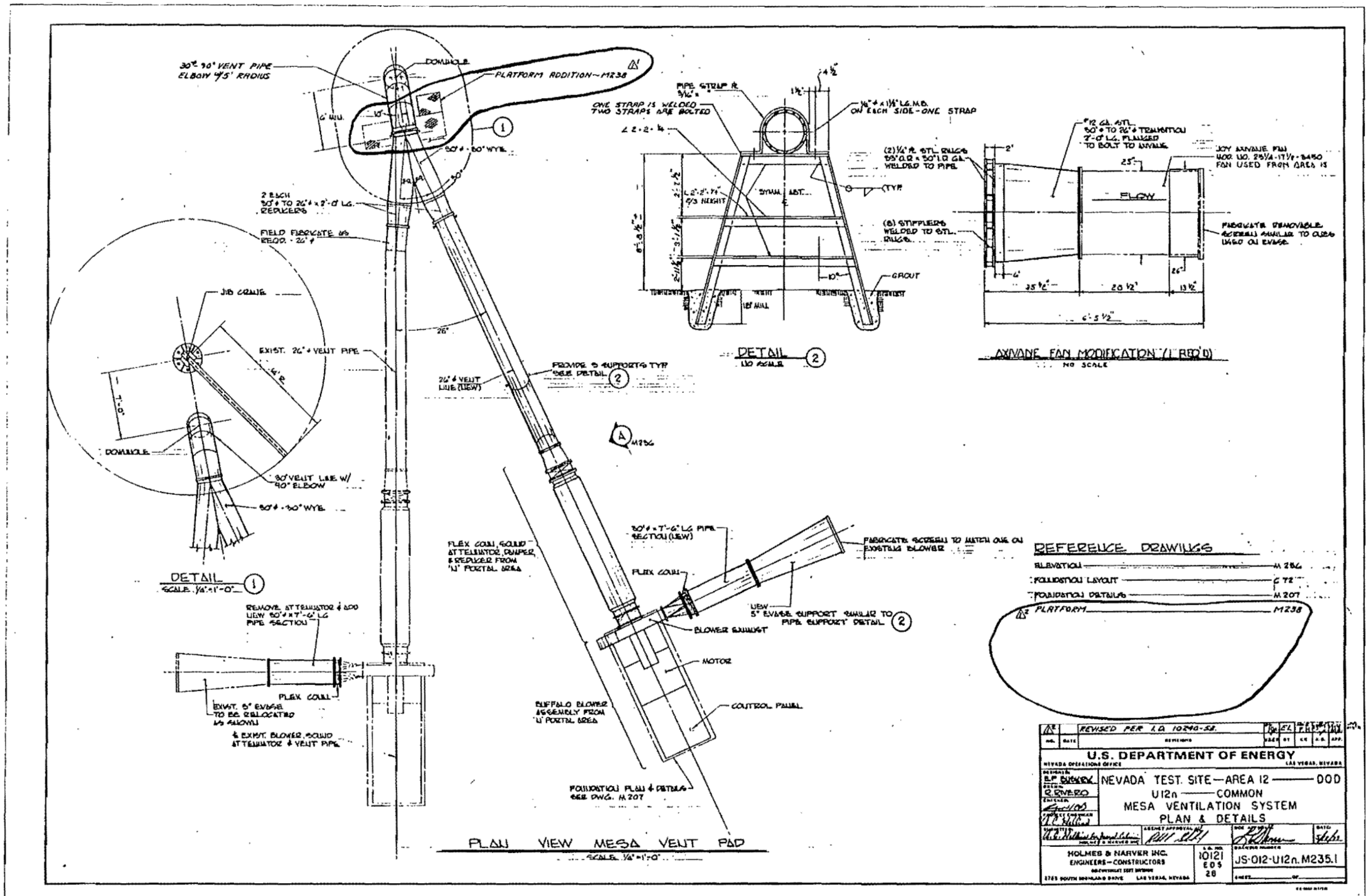

Drawing 3. Plan view and details of the U12n.10 Vent Hole showing principal systems including 350 hp Buffalo Blowers (Holmes and Narver, Inc. 1978).

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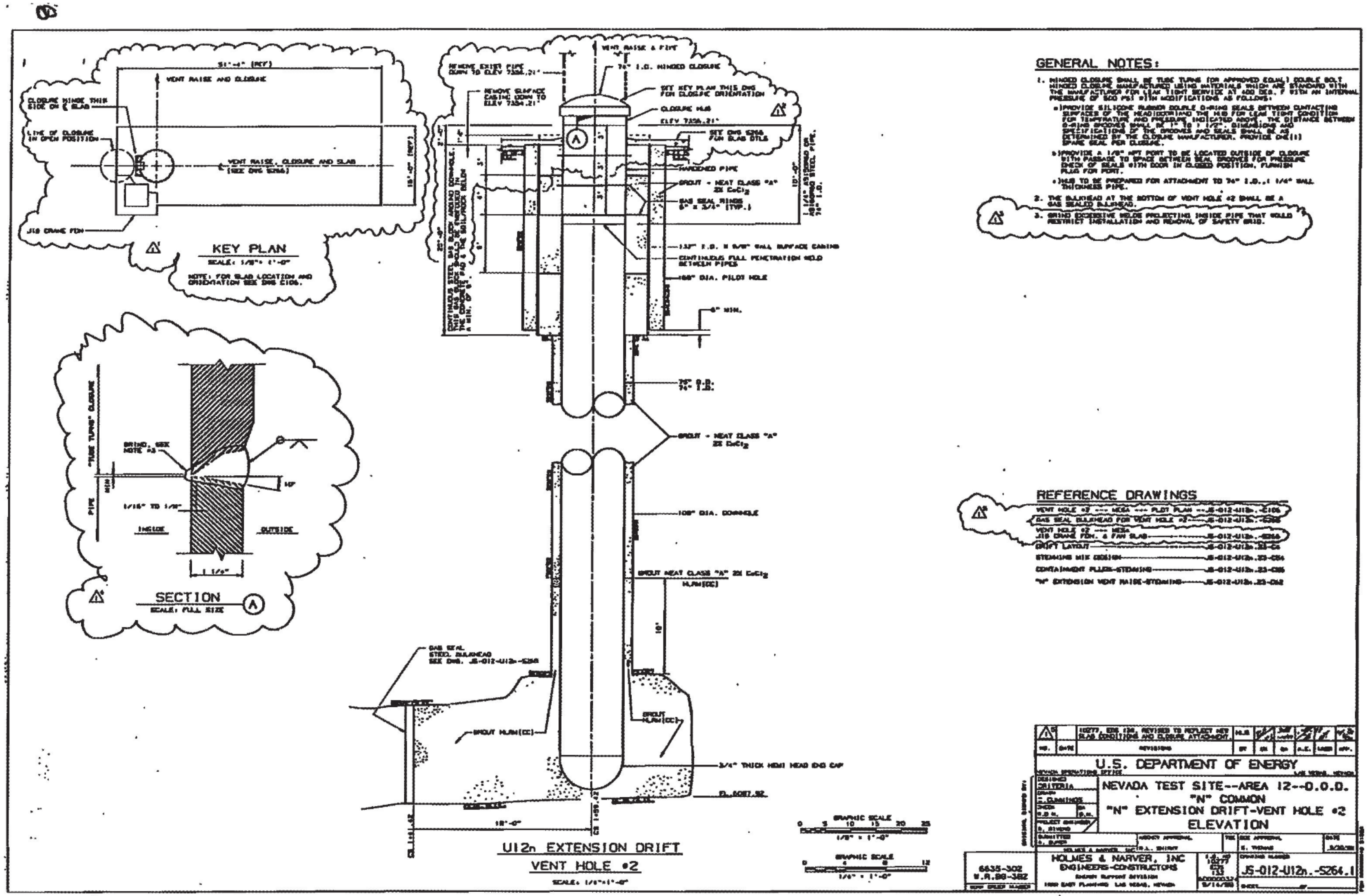

Drawing 4. Details of U12n Vent Hole #2 downhole vent casing and stemming for the Misty Echo test (Holmes and Narver, Inc.1988).

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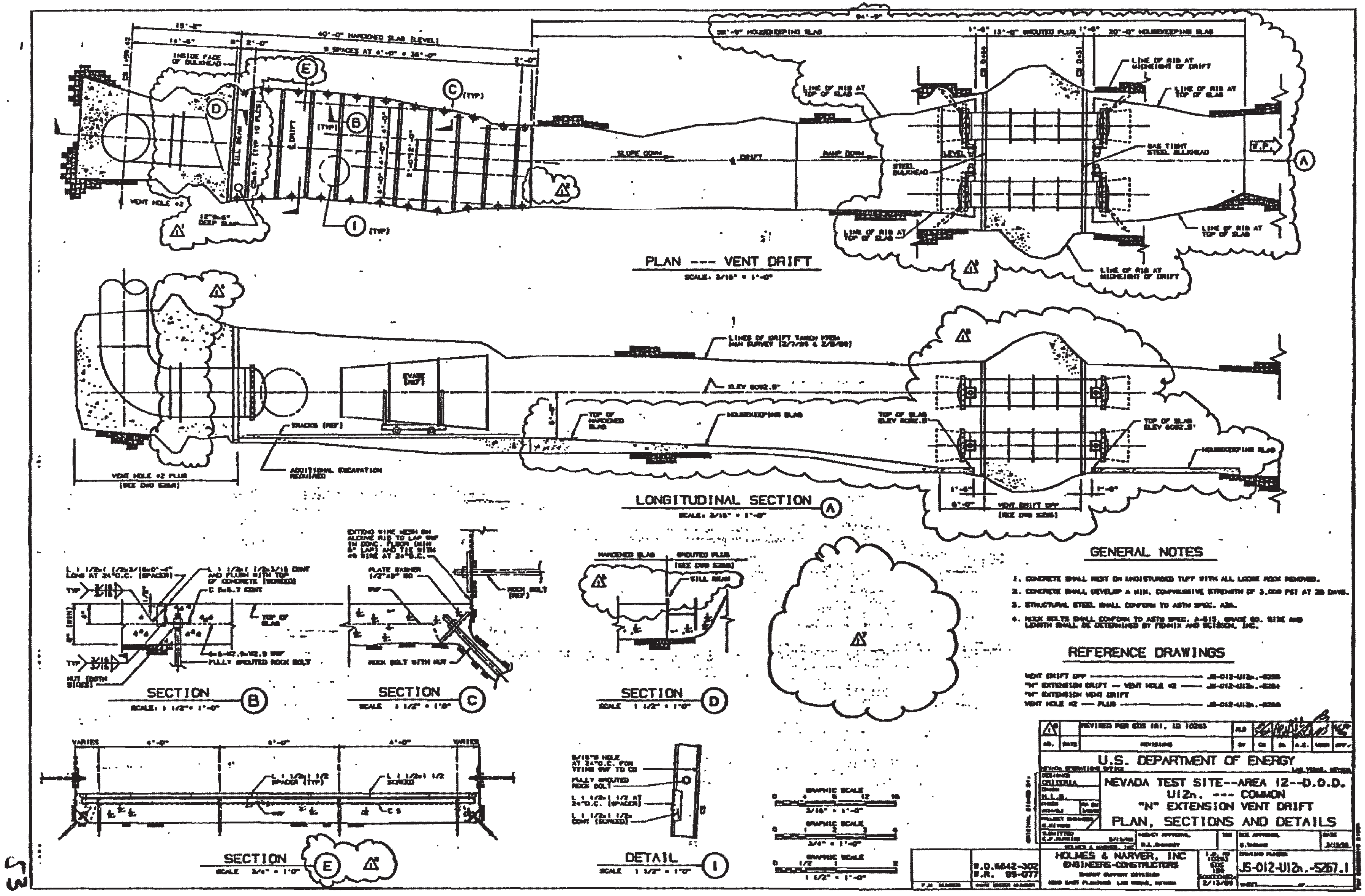

Drawing 5. Details of the underground portion (i.e. portal side) of the U12n Vent Hole #2 during construction for the Mineral Quarry and Randsburg nuclear tests (Holmes and Narver, Inc. 1989).

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APPENDIX A
Photographic Documentation

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BUILDING SURVEY

INDEX TO PHOTOGRAPHS

U12n VENT HOLE #2
Nevada State Historic Preservation Office Resource Number S2488
U12n Tunnel Historic District (D84)
Nevada National Security Site, Area 12, Nye County, Nevada

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NAME, Jeffrey Wedding (DRI), May 2020

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17 CLOSER VIEW OF PIPE AND BEAM CRANE FACING THE SOUTHWEST

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Photo Plan
U12n Vent Hole #2 (SHPO Resource S2488)

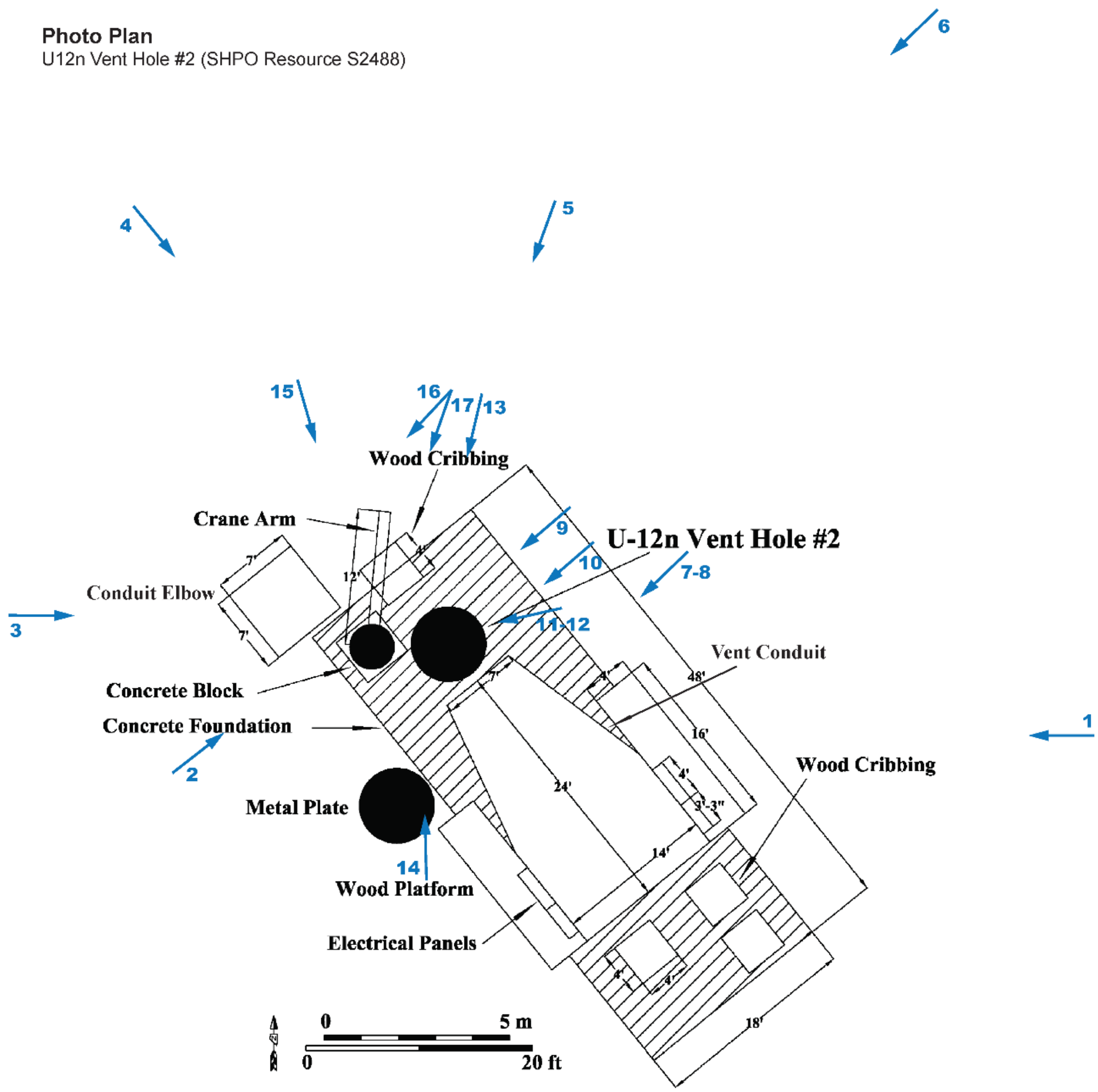

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PHOTO NO. 17   CLOSER VIEW OF PIPE AND BEAM CRANE FACING THE SOUTHWEST

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BUILDING SURVEY

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(DRAFT OCTOBER 2020)

U12n.10 VENT HOLE
Nevada State Historic Preservation Office Resource Number S2489
U12n Tunnel Historic District (D84)
Nevada National Security Site, Area 12, Nye County, Nevada

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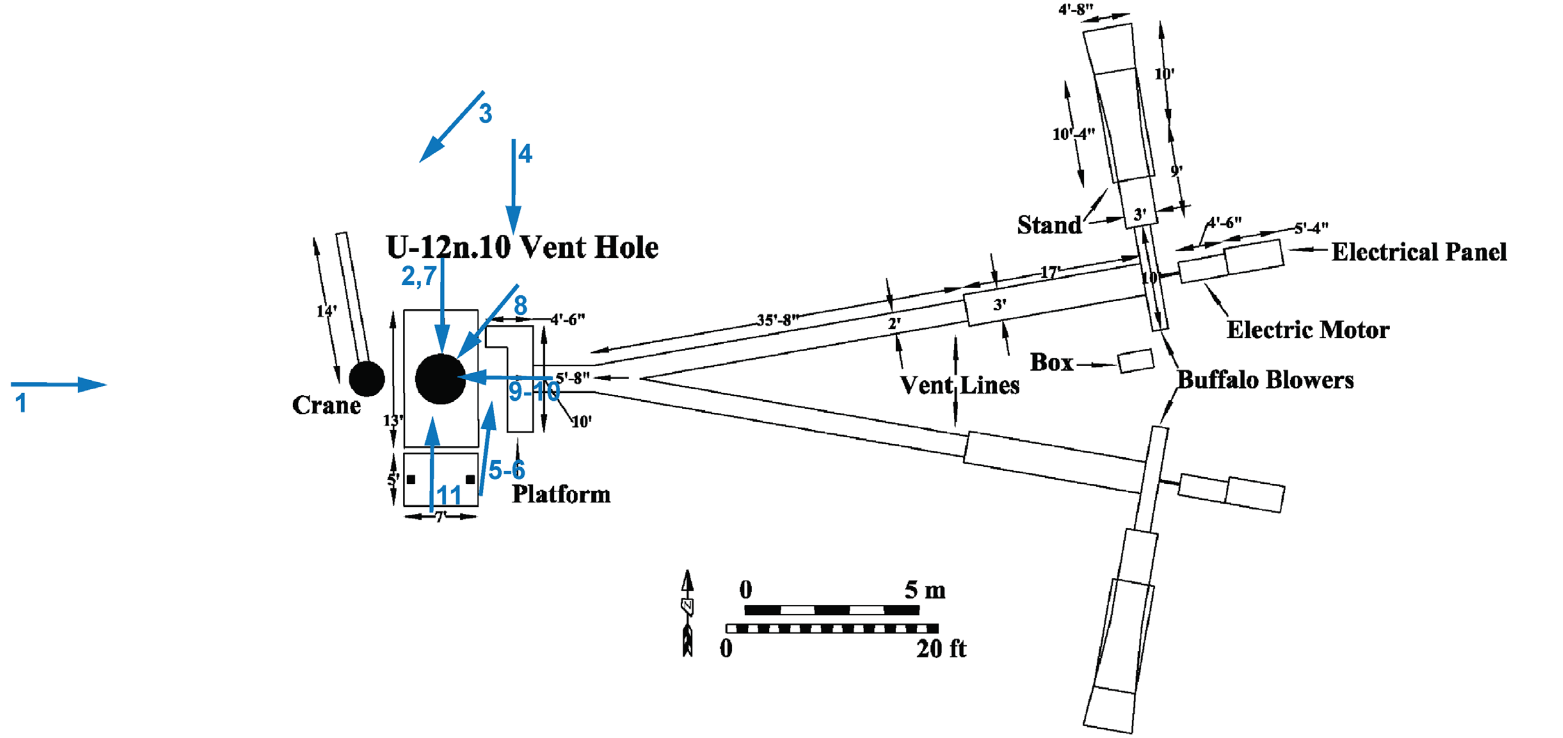
Photo Plan

U12n.10 Vent Hole (SHPO Resource S2489)



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APPENDIX B
ARA Forms

Architectural Resource Assessment Forms

SHPO Resource # S2488, U12n Vent Hole #2

SHPO Resource # S2489, U12n.10 Vent Hole

SHPO Resource # D84, U12n Tunnel Historic District (update)

U.S. Department of Energy Office of Science and Technical Information

A Historical Evaluation of the U12n Tunnel

https://www.osti.gov/biblio/1158562-historical-evaluation-u12n-tunnel-nevada-national-security-site-nye-county-nevada-part

Forms archived at the Nuclear Testing Archive at:
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