Hazardous Site Archaeology: A Case Study of a Manufactured-Gas Plant

Susan K Stratton, Ph.D., RPA, Barry A. Price, M.A., and M. Colleen Hamilton, M.A., RPA

Remnants of manufactured-gas plants are common industrial archaeological sites in California. Most date to the end of the 19th Century and may be considered important cultural resources, as is the case with a gas plant in Santa Barbara. The Santa Barbara I Manufactured-gas Plant (MGP) is significant because it provided the city with its first gas lights. Groundwater and soil contamination at levels considered hazardous to human health are the result of technologies employed at the plant 100 years ago. Archaeologists conducting research in these locations are presented with the challenges of assuring worker safely while exposing features and recovering and processing contaminated artifacts. The work carried out at Santa Barbara I MGP is a prime example of the challenges confronting the pursuit of archaeology in a contaminated environment.

Manufactured gas was one of the great industrial enterprises of the 19th Century, heating our homes and lighting our cities. From the mid-1800s to the early 1900s, manufactured gas helped transform a nation of farmers into an industrial power, with population increases from seven million to over 100 million.

Gas manufacturing was technologically simple. Coal or oil was baked in a closed vessel called a retort, releasing a blue-green gas and leaving behind only coke. The gas was scrubbed and purified to remove tars, sulfur, ammonia, and oil. Gas holders stored the clean gas until it was distributed through the city main.

In the 1840s and 1850s, communities wanted to have a manufactured-gas plant. It was a source of civic pride. By the 1880s, hundreds of gas companies came into existence. The focus of this study is a former gas plant located in Santa Barbara, California.

Brief History of the Santa Barbara I Manufactured-Gas Plant

Santa Barbara's history includes periods of pre-Chumash, Chumash, Spanish, Mexican, and American occupation. Three major civic developments hastened Santa Barbara's transition from Spanish pueblo to American city. First was the development of the American-style street grid. Second, the establishment of Sterns Wharf in 1872 was a significant influence on regional economics and culture, promoting tourism as well as residential and commercial development. The third development, resulting from the growth of tourism, was the demand for urban amenities such as sidewalks, paved streets, and street lamps.

The first municipal street lighting program took effect in 1872, two years after a group of entrepreneurs founded the Santa Barbara Gas Light Company. The city granted the new company the right to build a gas-manufacturing facility and lay pipes in the streets. The new plant was built at the corner of Santa Barbara and East De La Guerra streets, between the main gate of the old Presidio, built in 1782, and the 1817 adobe home of the prominent Covarrubias family.

The plant went into operation in February 1872. At that time the gas works consisted of a retort house and a purifying room, two gas holders, a coal house, and an office/storage building. The 1888 and 1892 Sanborn maps depict successive expansions and improvements at the gas plant, which continued to operate until 1907. By 1930 most of the gas plant facilities had been demolished. The current Santa Barbara Historical Museum was built on the site in 1963.

Significance and Research Potential

The Santa Barbara I Manufactured-gas Plant (CA-SBA-3505/H) was an important industrial facility that supplied the city with fuel for street lights and other domestic and commercial uses from 1872 to 1907. The gas works played an essential role in Santa Barbara's transition from isolated Spanish pueblo to

Susan K Stratton, Ph.D., RPA, California Environmental Protection Agency, Sacramento, CA
Barry A. Price, M.A., Applied EarthWorks, Inc., Fresno, CA
M. Colleen Hamilton, M.A., RPA, Applied EarthWorks, Inc., Hemet, CA

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Americanized city. The energy produced stimulated commercial development, and helped fuel the growth of tourism. The plant reflects the important historical themes of Americanization, urban industrial/ commercial growth, and tourism development. It was judged to be a significant historical resource according to state and local criteria.

Remediation of contaminated soils at the MGP site involves excavation and removal of substantial volumes of soil as well as installation of ozone injection, extraction, and monitoring wells. These actions have the potential to impact buried industrial archaeo-logical features associated with the gas plant, as well as domestic features associated with the nearby Presidio and historical residences. Such features were not visible on the ground surface but were predicted to be present beneath historic and modern fill. If preserved, such features would have the potential to provide important historical information regarding Spanish colonial settlement and development of the old pueblo; acculturation and Anglo-Hispanic integration; Americanization and the rise of Victorianism; industrialization and the growth of consumerism; and gas manufacturing and technological evolution.

Many potentially significant features were predicted to lie in soils contaminated by gas manufacturing residues. Contact with contaminated soil or water could pose a serious health hazard for archaeologists working in the field or laboratory.

SITE CONTAMINATION

The raw materials, fuels, products, and waste byproducts of gas manufacture were stored and often discarded at the production site. As a result, substantial amounts of hydrocarbon contaminants were left in the soil and groundwater. Studies by Southern California Edison showed that soil contamination at the Santa Barbara I MGP occurred at three levels. The shallow soils contain Polycyclic Aromatic Hydrocarbons (PAHs) and extensive deposits of lampblack. The deeper soils contain PAHs as well as aromatic volatile organic compounds (VOCs) and total petroleum hydrocarbon (TPH). The shallow groundwater contains benzene, other VOCs, and some PAHs.

PAHs are a class of compounds formed during incomplete combustion of organic materials containing carbon and hydrogen. Several of these compounds are readily absorbed through the skin and are known human carcinogens. Others may cause headache, nausea, and other symptoms when inhaled. Contact with lampblack may cause dermatitis or other skin disorders, and inhalation or ingestion could cause respiratory disease or cancer.

Soil and groundwater contamination is areally restricted. The PAHs are primarily bound to soil in the vicinity of the two former gas holders, while lampblack is located primarily in the plant interior where coal was stored. Two areas of the site, referred to as the Cooley lot and the Covarrubias Garden area, were essentially clean of contamination. Nonetheless, the potential existed for archaeologists to be exposed to hazardous materials including PAHs, VOCs, and other contaminants through inhalation, ingestion, or direct contact with the skin during the course of archaeological investigations at the site.

TESTING AND DATA RECOVERY

Archaeological studies were targeted at three areas thought likely to contain significant features: the Covarrubias garden, the Cooley back lot, and the museum courtyard. Previous assessment of the site demonstrated that these three areas had varying levels of contamination. The Garden area was largely uncontaminated, although pipe runs and vapor extraction wells were installed as an element of the remediation procedures. The Cooley lot was also thought to be largely uncontaminated. The museum courtyard and the perimeter around the museum and historic adobe were considered the most heavily contaminated areas, based on soil borings taken across the site.

Prior to fieldwork, Applied EarthWorks (AE) prepared a written safety plan to identify hazardous conditions and define protective actions. Project managers and field supervisors were required to read, sign, and implement the safety plan. Because the greatest concern was for direct contact with the contaminated material, standard archaeological methods had to be modified to ensure personnel safety. Initial safety recommendations required that field crew "avoid contact with potentially contaminated substances ... and whenever possible avoid kneeling, leaning or sitting on the contaminated surfaces."

How, one may ask, can you do archaeology without coming into contact with the soil or ground surface? In consultation with the Department of Toxic Substances Control and the project proponent, AE developed a unique set of procedures to accomplish the archaeological fieldwork safely and efficiently. These included use of mechanized equipment to remove contaminated fill; continuous misting to suppress dust; wet-screening to clean artifacts of contaminated soil prior to handling in the lab; special handling of excavated soil and screen water; use of personal protective equipment (PPE) to reduce crew contact with contaminated soil; daily decontamination of crew members; and special exclusion zones to protect visitors and the public.

The first line of crew protection, beyond engineering controls, involved personal protection equipment (PPE). This included the following:

- Hard hats and ear plugs while working in the vicinity of heavy equipment,
- Eye protection at all times,
- Level-C Tyvek suits when working in contaminated areas,
- Leather boots were permissible for crew members not wet screening.

Wet-screen personnel were further required to use these items:

- Rubber boots,
- Level-C Tyvek suits, and
- Waterproof suits and Nitryl interior and exterior gloves.

The safety plan required that all field personnel have 40 hours of training in Hazardous Waste Operations. Additionally, all crew had to be fit-tested and trained in the use of half face/full face respirators. All subcontractors, including equipment operators, laborers and haulers, also had to be 40-hour certified. Notably, these workers were more easily found than qualified archaeologists.

Because PAHs readily absorb into the soil, dust suppression was critical and was used to limit PAH exposure. AE developed a conservative approach to insure that the greatest level of protection was achieved. Excavators were required to work slowly on the site, not to raise dust, and to continuously wet down the working surface. "No visible dust" became the project mantra.

Prior to beginning field work, statistical modeling was used to estimate the potential for exposure to unacceptable levels of PAHs and to assess the need for respiratory protection. This modeling was most importantly applied in the courtyard, where PAHs were highly concentrated. Modeling strongly suggested that respiratory protection was not required. Additional sampling was performed during field work to confirm the modeling and to ensure that unacceptable exposure levels were not present.

Once actual levels of PAHs were known, the requirements for PPE were adjusted. The maximum recommended level of PPE for the situation was used prior to testing and downgraded or eliminated, as the results of air sampling became known. Sampling and monitoring were overseen by an industrial hygienist, and samples were sent to an accredited laboratory. Results were available within 24 hours.

Archaeological excavations began in areas of low contamination, to establish a routine and to build confidence among the crew. Safety meetings took on a new level of importance. In addition to the standard "slip, trip, and fall" precautions, the concerns about PAHs and the appropriate level of PPE for each area were discussed. Exclusion zones, decontamination procedures, and safety zones were established and reviewed.

Dust suppression involved continuous misting in the excavation area. To contain contaminated soil, all hand-excavated sediment was washed through standard hardware mesh. Filter bins were used to contain water and sediment passing through the screening apparatus. These bins separated contaminated soil and water into two compartments. Water was then pumped into a holding tank and removed from the site via vacuum truck. Waste water was considered a hazardous substance and was hauled from the site and disposed of properly.

Contaminated fill was moved from backhoe to front-end loader to roll-off bins stationed in the excavation area. This minimized the number of times the soil was disturbed. Soil removed by hand was placed into buckets, wetted, and transported to the wet-screening area. All mechanically excavated soil was stockpiled or stored in roll-off bins for removal from the site. Contaminated sediment was hauled from the site and disposed of properly. Clean soil was imported as necessary for backfill, rather than refilling with contaminated soil.

To protect museum visitors and staff, an exclusion zone was established in the museum courtyard. The courtyard perimeter was enclosed with a 6-ft cyclone fence. Personnel working within the exclusion zone passed through a decontamination station upon leaving the fenced area. When leaving the exclusion zone, boots were washed first, removing potentially contaminated sediments, and Tyvek and gloves were discarded. Clean gear was required for reentry. At lunch and the end of each day, Tyvek suits were removed and discarded.

In review, personal air sampling and modeling demonstrated that respirators were not required to ensure personnel safety, as long as dust was controlled. Misting guaranteed that acceptable limits were not exceeded. Tyvek suits insured that no direct contact was made with contaminated soil. Nitryl gloves were used at all times and replaced as needed to guarantee protection. Surgical-style Nitryl gloves allowed closeup work and drawing of standard profiles and scaled feature plans without restrictions.

While disposal and hauling of soil from the site limited the direct monitoring of fill removed from trenches, excavation of control block samples allowed for retrieval of artifacts from key features or zones and permitted determination of the frequency and type of artifacts within the overburden fill. Dust monitors demonstrated that migratory dust was not a serious problem within the courtyard area, and water screening eliminated the problem of inadvertently transporting contaminated sediment to an off-site lab.

CONCLUSIONS

In conclusion, site hazard assessment is a dynamic process. To control the economics of the situation and ensure personnel safety, it is critical to recognize the hazards, evaluate them fully and accurately, compare and prioritize them. A conservative approach ensures that crew safety takes priority. With thorough planning, as in the case of the Santa Barbara I MGP, archaeology in a contaminated environment can be accomplished safely and economically.