



OZONE CASE STUDY

Former Manufactured Gas Plant Site Santa Barbara, CA In-Situ Ozone Injection

Background

Soil and groundwater at the Southern California Edison site in Santa Barbara, a former manufactured gas plant (MGP), was contaminated with volatile organic hydrocarbons (VOCs) and poly aromatic hydrocarbons (PAHs). Aggressive soil and groundwater remediation by excavation, SVE and air sparge was partially successful.

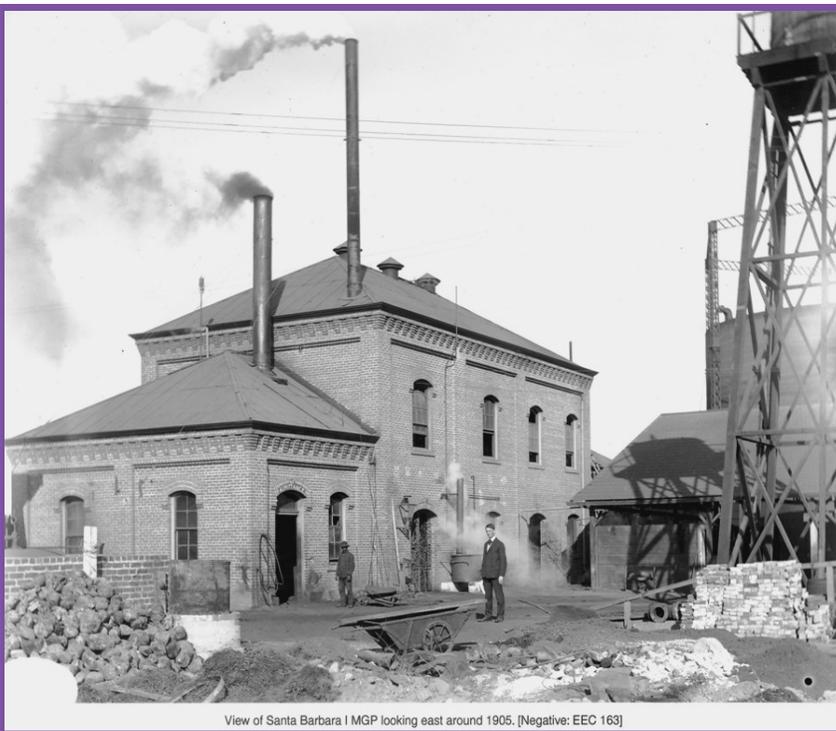
Redeveloped over time, this site included three schools, a courtyard used for public gatherings, a museum, and two historically important adobe structures dating from the early 1800's. Public Health and Safety and minimal impact to the structures were primary concerns, as were cost and time to closure. The project required a large 87 pound per day (PPD) ozone system to treat 27,000 cubic yards of contaminated soil.

Solution

Piper Environmental Group, Inc. worked closely with project engineers, site owners, and regulatory officials to develop a large turn-key ozone injection and control system. Health and Safety was of utmost concern due to site location in close proximity to schools and historical buildings. All potential ozone leak areas were tightly contained and extensive ambient ozone monitoring occurred 24-7. This automated high-output ozone system operated safely around the clock without creating any hazards. Piper provided engineering and design assistance, rebuilt and refurbished ozone and oxygen trailer systems, provide sound attenuation, monitoring and control components, installation, and start-up assistance. The final gas stream composition was 6% ozone and 90% oxygen. Approximated project delivery was 28,000 pounds ozone and 408,000 pounds of oxygen.

Results

Piper Environmental Group, Inc. helped our client remediate the former MGP site using a sophisticated in-situ technology that safely and effectively reduced soil and groundwater contaminants. The treatment system operated for 30 months, continuously injecting ozone and oxygen into the subsurface. Piper Environmental Group, Inc.'s ambient ozone gas monitoring system and other system fail-safe features were effective in maintaining proper system operation. Significant and permanent reductions in dissolved VOC and TPH concentrations were observed in groundwater monitoring wells throughout the treatment area. Slight rebound in dissolved concentrations of VOCs and TPH were observed during the last three years post treatment.



View of Santa Barbara I MGP looking east around 1905. [Negative: EEC 163]



Three-phased Approach

- ◆ Phase I, Limited Soil Excavation near Former Gasholder
- ◆ Phase II, SVE, In-Situ Oxygen & Ozone Sparging for Deep Soils
- ◆ Phase III, Surface Soil Excavation

Phase I, Limited Soil Excavation

- ◆ Source of groundwater contamination
- ◆ Removed 1,500 cubic yards of soil to a depth of 15 foot

Phase II, In-Situ Ozone Sparging

- ◆ SVE Started July 18, 2002
- ◆ Air sparging started July 31, 2002
- ◆ Ozone sparging started August 27, 2002
- ◆ Phase II treatment concluded January 3, 2005

Ozone System Description

- ◆ 27 ozone sparge wells
- ◆ 11 air sparge wells
- ◆ 35 vapor extraction wells
- ◆ 20,000 lineal feet of 3/4-inch Teflon tubing
- ◆ All piping and tubing located below ground in PVC conduits
- ◆ Some wells were nested sparge points on 10 foot vertical increments
- ◆ Sparge point depths varied from 30 to 55 feet below ground surface (bgs)
- ◆ Wire-wrapped sparge screens (0.030 inch slots) are 30 inches long and made of 304 stainless steel
- ◆ Well vault lids coated with urethane glue and impregnated with decomposed granite

Ozone Generation Trailer

- ◆ Ozone generator produces 87 pounds per day
- ◆ Final gas stream composition: ~6% ozone and ~90% oxygen
- ◆ Generator operated at 15 psig at 8 SCFM
- ◆ Total ozone production during project: 28,000 pounds

Ozone Monitoring System

- ◆ Ozone monitors contained in piping distribution vault
- ◆ Ozone monitoring points positioned at 5 and 12 feet below surface around museum basement

Treatment Zone Summary

- ◆ 27,000 cubic yards of soil was treated by ozone sparging
- ◆ 10,000 cubic yards of soil was treated by air sparging
- ◆ Treatment area = 65,000 square feet





Fugitive Ozone and VOC Recovery

- ◆ Nominal flow of 400 SCFM
- ◆ 35 vapor extraction wells
- ◆ Additional (multi-depth) vapor extraction wells installed near museum

Vapor Treatment

- ◆ Activated carbon adsorption
- ◆ Ozone destruct catalyst

Low Impact Building Rationale

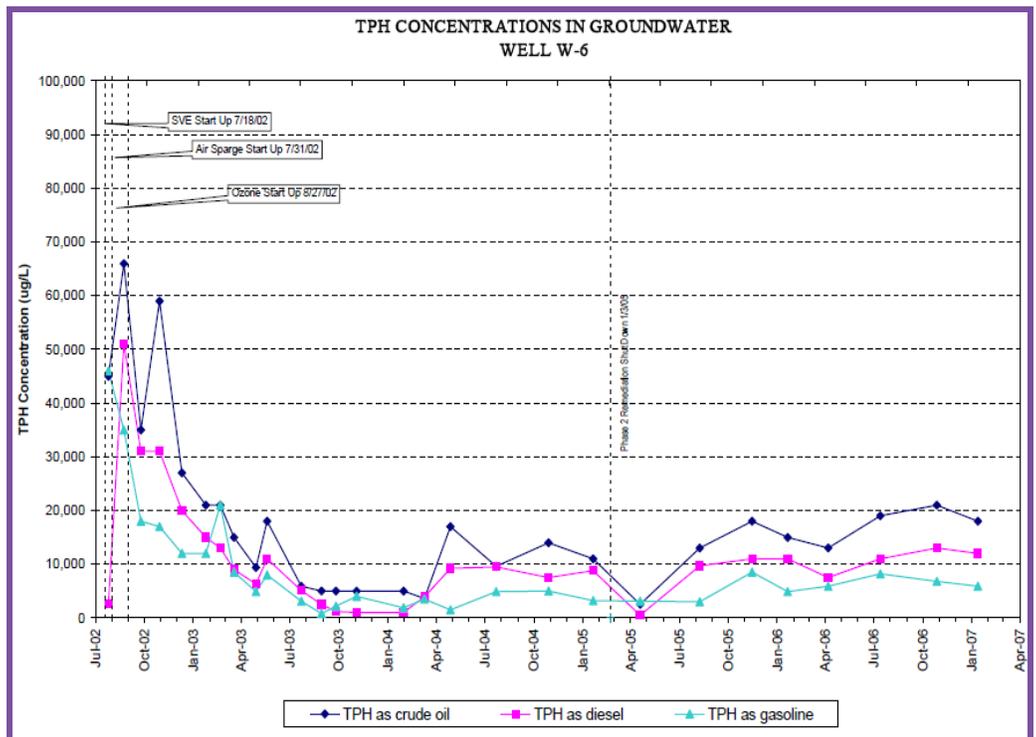
- ◆ Cannot disrupt current land use
- ◆ Dewatering and excavation not feasible because of historic structures
- ◆ Allow uninterrupted operation of nearby schools, museum and park

Treatment Compound

- ◆ Secure Equipment
- ◆ Exterior wall mitigates visual impacts and consistent with museum architecture
- ◆ Designed to attenuate sound below 60 deci

Treatment Compound (cont.)

- ◆ Self-enclosed trailers
 - ◆ Oxygen generation
 - ◆ Ozone generation
 - ◆ Vapor extraction
- ◆ Ozone destruct catalyst vessel
- ◆ Two 2,000 pound carbon vessels
- ◆ Single permitted emission point from Air District
- ◆ Low-impact electric cart for well sampling and maintenance



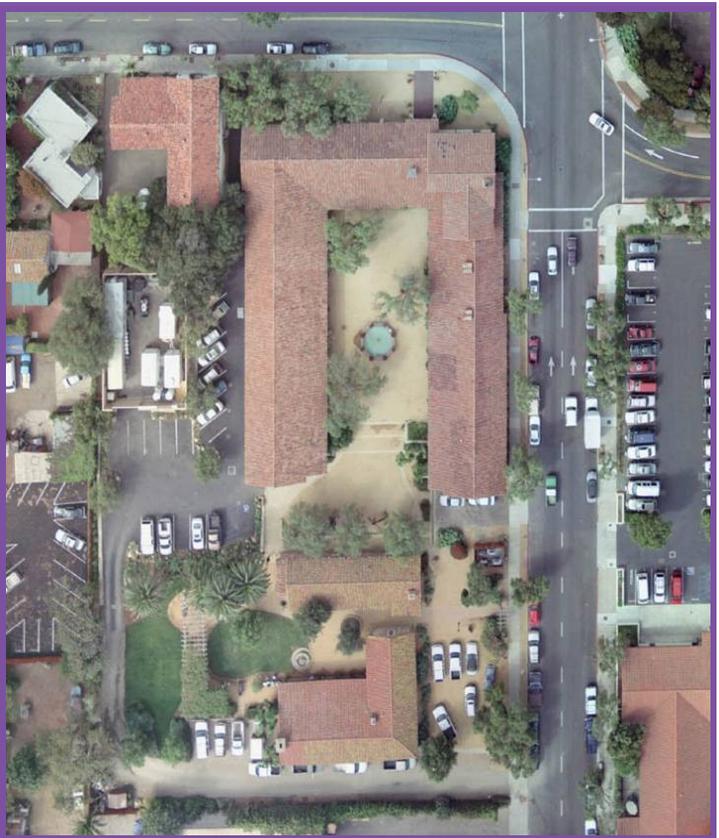
	Maximum Concentrations (ppb)	
	Soil	Water
Benzene	145,000	59,300
Benzo(a)pyrene	133,137	91
Naphthalene	1,290,000	15,700
TPH	29,400	116,000

Cleanup Goals

- ◆ Benzene: 1.0 ppb
- ◆ Benzo(a)pyrene: 0.2 ppb
- ◆ Naphthalene: 21 ppb
- ◆ TPH: 1.0 ppm

Groundwater Treatment Overview

- ◆ Treatment system operation for 30 months
- ◆ Approximately 28,000 pounds of ozone and 408,000 pounds of oxygen were generated and injected into subsurface treatment zone
- ◆ Ambient ozone gas monitoring strategy and PLC operational safeguards were effective
- ◆ Significant, permanent reduction in dissolved VOC and TPH concentrations observed in groundwater monitoring wells
- ◆ Some rebound in dissolved concentrations of VOCs and TPH observed during the last three years post-treatment



Conclusion

The project was successful and paved the way for future use of high-output ozone systems for MGP site remediation, performing safely and cost-effectively. The equipment was reliable, produced desired results, and saved time and money.

Ozone Rental Systems may be found here:

<http://www.peg-inc.com/rentals/ozone-remediation-trailers/>

Additional products and services for in-situ and ex-situ applications are here: <http://www.peg-inc.com>

Company Profile

Piper Environmental Group, Inc. offers ozone technology, equipment, and services for a wide-range of environmental applications. The company designs, manufactures, and integrates ozone systems and related equipment for short and long-term projects, offering equipment for rent or purchase. Services include project design assistance, oxidation pilot studies, contract service, equipment repair, consulting. Our area of expertise is large remediation projects.

