



Case Studies



Case Study #1 – Santa Ana, CA

Scope of Work

CalClean was contracted to conduct a 24-hour high vacuum dual phase extraction pilot test for a confidential client located within the Regional Water Quality Control Board – Santa Ana Region. The subject site exhibited elevated concentrations of petroleum hydrocarbons in the soil and groundwater beneath the site, including contamination from oxygenated gasoline additives; Methyl-tert-butyl ether (MtBE) and tert-amyl methyl ether (TAME).

Lithology

The Site is underlain by alluvial materials consisting of inter-bedded layers of poorly graded fine to medium grained sand, sandy silt, silt, and clay to the total depth explored of 25 feet. Perched groundwater is present at a depth of approximately 7 feet below grade.

Results

The results of the high vacuum dual phase extraction pilot test indicated an effective radius of influence of approximately 29 ft. Approximately **495 pounds** of hydrocarbons were destroyed and the extracted groundwater was treated utilizing CalClean’s mobile high vacuum dual phase system and patent-pending groundwater treatment inlet process tank and carbon trailer. The results of the groundwater samples are presented in Table 1.

Table 1 – Groundwater Analytical Results

| Parameter | Prior To Extraction | After CalClean Inlet Process Tank | Percent Reduction | Carbon Polishing Post Treatment | Percent Reduction |
|---------------|---------------------|-----------------------------------|-------------------|---------------------------------|-------------------|
| MtBE | 360,000 µg/L | 6,740 µg/L | 98% | ND | 100% |
| TPHg | 228,000 µg/L | 11,300 µg/L | 95% | ND | 100% |
| TBA | 3,420 µg/L | ND<10 µg/L | 100% | ND | 100% |
| TAME | 2,590 µg/L | 25.3 µg/L | 99% | ND | 100% |
| Benzene | 33,700 µg/L | 267 µg/L | 99% | ND | 100% |
| Toluene | 52,700 µg/L | 987 µg/L | 98% | ND | 100% |
| Ethly-Benzene | 6,580 µg/L | 162 µg/L | 98% | ND | 100% |
| Xylenes | 40,900 µg/L | 1,497 µg/L | 96% | ND | 100% |
| Napthalene | 10,200 µg/L | 147 µg/L | 98% | ND | 100% |

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #2 – Chino, CA

Scope of Work

CalClean was contracted to conduct a 96 hour HVDPE pilot test, a 15-day event, and (2) 7-day events totaling a combined 33-days for a confidential client located within the Santa Ana Regional Water Quality Control Board. The subject site exhibited elevated concentrations of petroleum hydrocarbons in the soil and groundwater beneath the site including the oxygenated gasoline additive Methyl-tert-butyl ether (MtBE).

Lithology

Soils encountered during drilling operations consisted predominantly of silts and sands from just below the ground surface to approximately 25 ft. bgs, silty sands and sands were present from approximately 25 ft. to approximately 40 ft. Clays and silts were encountered from 40 ft. to 50 ft.

Results

The results of the high vacuum dual phase extraction pilot test indicated an effective radius of influence of approximately 60 ft. During the four events at the site, approximately **13,200 pounds** of hydrocarbons were destroyed. In addition, **61,060 gallons** of extracted groundwater were treated utilizing CalClean's patent-pending dual phase system and groundwater treatment trailer. The results of the groundwater samples are presented in Table 1.

Table 1 – Groundwater Analytical Results

| Parameter | Prior To Extraction | After CalClean Inlet Process Tank | Percent Reduction | Carbon Polishing Post Treatment | Percent Reduction |
|-----------|---------------------|-----------------------------------|-------------------|---------------------------------|-------------------|
| MtBE | 2,170 µg/L | 192 µg/L | 91% | ND | 100% |
| TPHg | 125,000 µg/L | 8,440 µg/L | 93% | ND | 100% |
| Benzene | 7,560 µg/L | 143 µg/L | 98% | ND | 100% |

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #3 – Orange, CA

Scope of Work

CalClean was contracted to conduct HVDPE events for a confidential client located within the Santa Ana Regional Water Quality Board. The subject site exhibited elevated concentrations of petroleum hydrocarbons in the soil and groundwater beneath the site. The Orange County Health Care Agency approved mobile HVDPE to clean up the site to closure. Mobile HVDPE was performed for a total of 44-days to clean up the groundwater, cap fringe and saturated zones. A trailer-mounted HVDPE system (7.5 hp LRP) was used continuously over a one year period to clean-up the vadose zone. Finally, a truck mounted system (25 hp LRP) was used intermittently over a three week period to polish off the remaining hydrocarbons at the site.

Lithology

Near surface sediments are predominately sands and gravel with silty sand to silty clay layers at 45 to 60 feet and 80 to 87 ft bgs. The depth to perched groundwater has fluctuated from 73 ft. to 108 ft.

Results

The results of the high vacuum dual phase extraction indicated an effective radius of influence of approximately 80 ft. Approximately **55,000 pounds** of hydrocarbons were extracted over the 2 year period. Upon final sampling of site there was non-detect (ND) in all groundwater samples taken. The results of the hydrocarbon vapor samples are presented in Table 1.

Table 1 – Hydrocarbon Vapor Analytical Results

| Parameter | Prior To Extraction | After CalClean Inlet Process Tank | Percent Reduction |
|-----------|---------------------|-----------------------------------|-------------------|
| TPHg | 125,000 ppmv | 130 ppmv | 99.9% |
| Benzene | 4,000 ppmv | 5 ppmv | 99.9% |

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer
- Mobile High Vacuum Dual Phase Extraction (7.5 hp LRP)



Case Study #4 – Tallahassee, FL

Scope of Work

CalClean was contracted to conduct HVDPE events for a confidential client located in Tallahassee, FL. The subject site exhibited elevated concentrations of petroleum hydrocarbons in the soil and groundwater beneath the site. Florida Department of Environmental Protection (FDEP) approved HVDPE along with Air Sparging. Three 30-day HVDPE events have already been conducted to date, and four more events are scheduled along with Air Sparge events.

Results

The results of the three HVDPE events indicated an effective radius of influence of approximately 80 ft. A total of **18,000 pounds** of hydrocarbons were extracted during the first three events. The results of the original groundwater samples prior to any remediation are presented in Table 1. Table 2 shows the results after the three HVDPE events. Table 3 provides the calculated percent reduction.

Table 1 – Groundwater Analytical Results 10/21/2010

| Parameter | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 |
|----------------------|-------------|-------------|------------|----------|------------|-------------|
| Benzene | 22,000 µg/L | 17,000 µg/L | 1,600 µg/L | 900 µg/L | 1,100 µg/L | 14,000 µg/L |
| Toluene | 25,000 µg/L | 35,000 µg/L | 650 µg/L | 520 µg/L | 5,400 µg/L | 25,000 µg/L |
| Ethyl-Benzene | 1,500 µg/L | 3,600 µg/L | 1,000 µg/L | 76 µg/L | 1,300 µg/L | 1,900 µg/L |
| Xylenes | 7,000 µg/L | 18,000 µg/L | 2,300 µg/L | 690 µg/L | 7,100 µg/L | 11,000 µg/L |
| MTBE | 190 µg/L | 290 µg/L | 79 µg/L | 82 µg/L | 120 µg/L | 260 µg/L |

Table 2 – Groundwater Analytical Results 2/6/2013

| Parameter | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 |
|----------------------|------------|----------|----------|----------|----------|------------|
| Benzene | 1,200 µg/L | 230 µg/L | 7.5 µg/L | 53 µg/L | 5.5 µg/L | 1,300 µg/L |
| Toluene | 2,200 µg/L | 80 µg/L | ND | 8.3 µg/L | 13 µg/L | 340 µg/L |
| Ethyl-Benzene | 580 µg/L | 300 µg/L | ND | 9.6 µg/L | 11 µg/L | 350 µg/L |
| Xylenes | 2,700 µg/L | 940 µg/L | ND | 32 µg/L | 140 µg/L | 2,100 µg/L |
| MTBE | 8.2 µg/L | 3.1 µg/L | ND | 5.4 µg/L | ND | 7.2 µg/L |



Table 3 – Calculated Percent Reduction

| Parameter | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 |
|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Benzene | 95% | 99% | 99.5% | 94% | 99.5% | 91% |
| Toluene | 91% | 99.8% | 100% | 98% | 99.7% | 99% |
| Ethyl-Benzene | 61% | 92% | 100% | 89% | 99% | 82% |
| Xylenes | 61% | 95% | 100% | 95% | 98% | 81% |
| MTBE | 96% | 99% | 100% | 93% | 100% | 97% |

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #5 – Dade City, FL

Scope of Work

CalClean was contracted to conduct an 8-day HVDPE event for a confidential client located in Dade City, FL. The subject site exhibited elevated concentrations of petroleum hydrocarbons in the soil and groundwater beneath the site. Florida Department of Environmental Protection (FDEP) approved HVDPE.

Results

The results of the HVDPE event indicated an effective radius of influence of approximately 20 ft. A total of **16,260 gallons** of water was extracted during the event. The results of the original groundwater samples prior to any remediation are presented in Table 1. Table 2 shows the results after the HVDPE event. Table 3 provides the calculated percent reduction.

Table 1 – Groundwater Analytical Results 9/1/2009

| Parameter | MW-1 | MW-2 | MW-3 | MW-4 |
|----------------------|---------|------|-----------|------|
| Benzene | 10 µg/L | ND | 826 µg/L | ND |
| Toluene | ND | ND | 4.4 µg/L | ND |
| Ethyl-Benzene | ND | ND | 37.4 µg/L | ND |
| Xylenes | ND | ND | 52.4 µg/L | ND |
| MTBE | 96 µg/L | ND | ND | ND |

Table 2 – Groundwater Analytical Results 5/29/2013

| Parameter | MW-1 | MW-2 | MW-3 | MW-4 |
|-----------------------|------|------|-----------|------|
| Benzene | ND | ND | 28.6 µg/L | ND |
| Toluene | ND | ND | ND | ND |
| Ethyl- Benzene | ND | ND | 1.9 µg/L | ND |
| Xylenes | ND | ND | 2.3 µg/L | ND |
| MTBE | ND | ND | ND | ND |



Table 3 – Calculated Percent Reduction

| Parameter | MW-1 | MW-2 | MW-3 | MW-4 |
|-----------------------|-------------|-------------|-------------|-------------|
| Benzene | 100% | 100% | 97% | 100% |
| Toluene | 100% | 100% | 100% | 100% |
| Ethyl- Benzene | 100% | 100% | 95% | 100% |
| Xylenes | 100% | 100% | 96% | 100% |
| MTBE | 100% | 100% | 100% | 100% |

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #6 – Lake Havasu Landing Resort, CA

Scope of Work

CalClean was contracted to conduct six 30-day HVDPE events for a confidential client located in Lake Havasu Landing Resort, CA. The subject site exhibited elevated concentrations of petroleum hydrocarbons with more than one foot of free product in several wells onsite. The consultant had previously calculated approximately **25,000 gallons** of gasoline had leaked into the environment at the site. A high vacuum was applied for vapor extraction and drawdown of the groundwater table, while vacuum and vapor flow rates were modified to optimize recovery of vapor, free-product and dissolved-phase hydrocarbons.

Lithology

Geologic materials underlying the site include alternating layers of sands, silts, and gravels associated with the Colorado River flood plain. Hydraulic conductivities are high leading to an area of vacuum influence generally sufficient to facilitate extraction of the area with measured free product using the existing site groundwater monitoring wells.

Results

The results of the six HVDPE events were overwhelmingly effective. This technology allowed for hydrocarbons to be simultaneously removed from the vadose zone, capillary fringe, and saturated soil zone. A total of **235,610 gallons** of hydrocarbon-affected groundwater were recovered during the six 30-day events. The extracted groundwater was treated through four 500-pound granular activated carbon vessels in series and discharged/injected to an onsite upgradient well. A total of **112,855 pounds** of hydrocarbons were removed, which equates to **18,064 gallons** of hydrocarbons were extracted and treated.

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #7 – Tempe, AZ

Scope of Work

CalClean was contracted to conduct a 60-day HVDPE event for a confidential client located in Tempe, AZ. The subject site exhibited elevated concentrations of petroleum hydrocarbons with over 1 foot of free product in the soil and groundwater beneath the site. A high vacuum was applied for vapor extraction and drawdown of the groundwater table, while vacuum and vapor flow rates were modified to optimize recovery of vapor, free-product and dissolved-phase hydrocarbons.

Lithology

Native soil types encountered during site characterization activities generally consisted of sandy silt to approximately 25 to 30 feet below ground surface (bgs), silty sand from 25 to 30 feet bgs to 30 to 40 feet bgs and well graded sand with silt and gravel from approximately 30 to 40 feet bgs to at least 80 feet bgs, the maximum depth of exploration.

Results

The results of the 60-day HVDPE event were very effective. This technology allowed for hydrocarbons to be simultaneously removed from the vadose zone, capillary fringe, and saturated soil zone. A total of **11,680 gallons** of hydrocarbon-affected groundwater were recovered during the event. The extracted groundwater was treated through two 500-pound granular activated carbon vessels in series and discharged to the City of Tempe sewer system. In the 60-day event, a total of **25,070 pounds** of hydrocarbons were removed, which equates to **4,013 gallons** of hydrocarbons were vapor extracted and treated.

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #8 – Blythe Commingled Plume #4, CA

Scope of Work

CalClean was contracted to conduct HVDPE events for the City of Blythe at Commingled Plume #4 located within the Regional Water Quality Control Board – Colorado River Basin Region, CA. Blythe Commingled Plume #4 (CP4) is comprised of four individual sites designated by the California Regional Water Quality Control Board - Colorado River Basin Region (RWQCB) as Sites A through D located along West Hobsonway. The plume area contained elevated concentrations of petroleum hydrocarbons in the soil and groundwater. The RWQCB approved mobile HVDPE to clean up the site to closure. HVDPE was performed for a total of 31 days to clean up the groundwater, cap fringe and saturated zones. A truck mounted system (25 hp LRP) was used intermittently over a nine month period to reduce the concentrations to levels acceptable for closure.

Lithology

Commingled Plume #4 is underlain by Quaternary-age alluvium composed of recent floodplain sand, silt, and clay deposited primarily by the Colorado River. The site is located in the western portion of the Sonoran Desert section (Mojave Desert), which is divided by the Colorado River. The dominant geologic feature within the Site vicinity is the north-trending depression known as the Colorado River Trough, formed by flooding of the Colorado River, regional faulting, downwarping and sediment filling. Geologic structures beneath the Site include pre-Tertiary volcanic and sedimentary bedrock, an area of unconformity, middle Miocene Age Fonglomerate, overlain by the basal limestone, interbedded clays, silts, sands and tufa of the Bouse Formation.

Results

The results of the high vacuum dual phase extraction indicated an effective radius of influence of approximately 50 ft. An average of **392 pounds** of hydrocarbons were extracted over the 31-day event. Upon final sampling of site, the concentration of TPH as gasoline and benzene were reduced to levels acceptable for case closure. The results of the groundwater samples are presented in Table 1.

Table 1 – Groundwater Analytical Results

| Parameter | Prior To Extraction | After CalClean Inlet Process Tank | Percent Reduction |
|-----------|---------------------|-----------------------------------|-------------------|
| TPHg | 8,100 µg/L | <50 µg/L | 99% |
| Benzene | 201 µg/L | 100 µg/L | 50% |

* 0.34 feet of free product abated from one well.

* Percent reduction calculated for the specific wells with the associated laboratory data.

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #9 – Blythe Commingled Plume #5, CA

Scope of Work

CalClean was contracted to conduct two HVDPE events for the City of Blythe at Commingled Plume #5 located within the Regional Water Quality Control Board – Colorado River Basin Region, CA (RWQCB). The subject site consists of five individual sites designated by the California Regional Water Quality Control Board - Colorado River Basin Region (301/321 West Hobsonway, 300 West Hobsonway, 231/241 West Hobsonway, 205 West Hobsonway and 140 West Hobsonway). The plume area contained elevated concentrations of petroleum hydrocarbons in the soil and groundwater. The RWQCB approved mobile HVDPE to clean up the site to closure. HVDPE was performed for a total of 91-days to clean up the groundwater, cap fringe and saturated zones. A truck mounted system (25 hp LRP) was used intermittently over a ten month period to reduce the concentrations to levels acceptable for closure.

Lithology

Commingled Plume #5 is underlain by Quaternary-age alluvium composed of recent floodplain sand, silt, and clay deposited primarily by the Colorado River. The site is located in the western portion of the Sonoran Desert section (Mojave Desert), which is divided by the Colorado River. The dominant geologic feature within the Site vicinity is the north-trending depression known as the Colorado River Trough, formed by flooding of the Colorado River, regional faulting, downwarping and sediment filling. Geologic structures beneath the Site include pre-Tertiary volcanic and sedimentary bedrock, an area of unconformity, middle Miocene Age Fanglomerate, overlain by the basal limestone, interbedded clays, silts, sands and tufa of the Bouse Formation.

Results

The results of the high vacuum dual phase extraction indicated an effective radius of influence of approximately 40 lineal ft during the 60-day event and approximately 125 lineal feet during the 31-day event. An average of **7,055 pounds** of hydrocarbons were extracted over the combined 91-day event. Upon final sampling of the site, the concentration of TPH as gasoline and benzene were reduced to levels acceptable for case closure. The results of the groundwater samples are presented in Table 1.

Table 1 – Groundwater Analytical Results

| Parameter | Prior To Extraction | After CalClean Inlet Process Tank | Percent Reduction |
|-----------|---------------------|-----------------------------------|-------------------|
| TPHg | 4500 µg/L | 987 µg/L | 78% |
| Benzene | 170 µg/L | 1.1 µg/L | 99% |

* 0.04 feet of free product abated from one well.

* Percent reduction calculated for the specific wells with the associated laboratory data.

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #10 – Blythe Commingled Plume #2, CA

Scope of Work

CalClean was contracted to conduct HVDPE events for the City of Blythe at Commingled Plume #2 located within the Regional Water Quality Control Board – Colorado River Basin Region, CA (RWQCB). The subject site consists of three former gasoline service station sites across from one another at a prominent intersection. The plume area contained elevated concentrations of petroleum hydrocarbons in the soil and groundwater. The RWQCB approved mobile HVDPE to clean up the site to closure. HVDPE was performed for a total of 93-days to clean up the groundwater, cap fringe and saturated zones. A truck mounted system (25 hp LRP) was used intermittently over a nine month period to reduce the concentrations to levels acceptable for closure.

Lithology

Near surface soils are characterized by unconsolidated, fine- to coarse-grained sands with discontinuous layers of silt and clay from the surface to 100 ft. bgs. The shallow aquifer is characterized by unconfined water table conditions. Infiltration of Colorado River water is the primary means of recharge in the basin. The depth to groundwater has varied from approximately 8 ft. to 10.5 ft.

Results

The results of the high vacuum dual phase extraction indicated an effective radius of influence of approximately 40 ft. Approximately **7,773 pounds** of hydrocarbons were extracted over the 9 month period. Upon final sampling of site, the concentration of TPH as gasoline and benzene were reduced to levels acceptable for case closure. The results of the groundwater samples are presented in Table 1.

Table 1 – Groundwater Analytical Results

| Parameter | Prior To Extraction | After CalClean Inlet Process Tank | Percent Reduction |
|-----------|---------------------|-----------------------------------|-------------------|
| TPHg | 42,700 µg/L | 4,400 µg/L | 90% |
| Benzene | 2,750 µg/L | 99 µg/L | 96% |

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #11 – Blythe Commingled Plume #3, CA

Scope of Work

CalClean was contracted to conduct HVDPE events for the City of Blythe at Commingled Plume #3 located within the Regional Water Quality Control Board – Colorado River Basin Region, CA (RWQCB). The subject site consists of three former gasoline service station sites located across from one another at a prominent intersection. The plume area contained elevated concentrations of petroleum hydrocarbons in the soil and groundwater. The RWQCB approved mobile HVDPE to clean up the sites to closure. HVDPE was performed for a total of 196-days to clean up the groundwater, cap fringe and saturated zones. A truck mounted system (25 hp LRP) was used intermittently over a two year period to remove free product and to reduce the concentrations to levels acceptable for closure.

Lithology

Near surface soils are characterized by unconsolidated, fine- to coarse-grained sands with discontinuous layers of silt and clay from the surface to 100 ft. bgs. The shallow aquifer is characterized by unconfined water table conditions. Infiltration of Colorado River water is the primary means of recharge in the basin. The depth to groundwater has varied from approximately 8.5 ft. to 11 ft.

Results

The results of the high vacuum dual phase extraction indicated an effective radius of influence of approximately 45 ft. Approximately **29,056 pounds** of hydrocarbons were extracted over the 9 month extraction period. Upon final sampling of the sites, free product was no longer present and the concentrations of TPH as gasoline and benzene were reduced to levels acceptable for site closure. The results of the groundwater samples are presented in Table 1.

Table 1 – Groundwater Analytical Results

| Parameter | Prior To Extraction | After CalClean Inlet Process Tank | Percent Reduction |
|-----------|---------------------|-----------------------------------|-------------------|
| TPHg | 101,100 µg/L | 16,600 µg/L | 84% |
| Benzene | 1,500 µg/L | 380 µg/L | 75% |

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #12 – Ventura, CA (Chlorinated Project)

Scope of Work

CalClean was contracted to install and operate a High Vacuum Soil Vapor Extraction (HVSVE) for a confidential client located in Ventura, CA. The subject site was developed as an active dry cleaner facility and subsurface soil were found to contain elevated concentrations of tetrachloroethylene (PCE), a common dry cleaning agent. A soil gas sample collected from 5 feet below grade contained PCE at a concentration of 3,600 µg/L and significantly exceeded the California Human Health Screening Level (CHHSL) of 0.6 µg/L for commercial property.

Soil remediation using HVSVE was completed from March 5, 2014 to June 25, 2014 to reduce concentrations of PCE in the shallow soils to levels acceptable for closure by the Ventura County Cleanup Program (VCCP).

Lithology

The upper 5 to 10 feet of sediment beneath the Site consists of a mixture of silty clay and sandy clay. Underlying the upper clay layer are native alluvial materials composed of silty-gravelly sand containing fine to medium sands interspersed with granule gravel layers to 100 ft bgs. The depth to groundwater is greater than 100 ft. bgs.

Results

Over the approximate 4 month period, 60.07 pounds or 4.46 gallons of PCE were removed during 105 days of extraction. A HVSVE rebound test was conducted for a period of 5 days from July 2, 2014 to July 7, 2014. Total influent concentrations decreased over the period of the test to a final influent concentration of 1.36 µg/L as sampled on July 7, 2014.

Based upon the verification soil vapor sample results, the concentration of PCE in subsurface soil was significantly reduced. The consultant completed an analysis of the human health risk associated with vapor intrusion to indoor air. Based upon the model analysis, residual concentrations of PCE in the subsurface soils do not represent a human health risk greater than generally accepted standards for a commercial property.

Services Used

- Trailer-Mounted Mobile High Vacuum Soil Vapor Extraction (300 CFM Liquid-Ring Blower) and Activated Carbon Treatment System (three 1,000 lbs. vessels).



Case Study #13 – Menlo Park, CA (Chlorinated Project)

Scope of Work

CalClean was contracted to install and operate a High Vacuum Soil Vapor Extraction (HVSVE) for a confidential client located in Menlo Park, CA. The subject site was developed as an active dry cleaner facility and subsurface soil were found to contain elevated concentrations of tetrachloroethene (PCE), a common dry cleaning agent. A soil gas sample collected from 5 feet below grade contained PCE at a concentration of 2,900 ug/l and significantly exceeded the California Human Health Screening Level (CHHSL) of 0.6 ug/l for commercial property. Soil remediation using HVSVE was completed in 2013 to reduce concentrations of PCE in the shallow soils to levels acceptable for closure by the Department of Toxic Substances (DTSC).

Lithology

Soils encountered during site investigations indicate that the site is primarily underlain by fine-grained horizons of silt and clay interbedded with coarse-grained horizons of silty sand, clayey sand, poorly-graded sand, and well-graded gravelly sand. Coarse grained horizons were generally encountered at depths of 20, 40, 60, and 80 feet bgs. The depth to groundwater ranged from 9.6 ft. to 11.40 ft. bgs

Results

Over the approximate 1 month period, 27.92 pounds of PCE were removed during 30 days of extraction. Total influent concentrations decreased over the period of the test to a final influent concentration of 0.36 ug/l.

Based upon the verification soil vapor sample results, the concentration of PCE in subsurface soil was significantly reduced. The consultant completed an analysis of the human health risk associated with vapor intrusion to indoor air. Based upon the model analysis, residual concentrations of PCE in the subsurface soils do not represent a human health risk greater than generally accepted standards for a commercial property and case closure has been requested.

Services Used

- Trailer-Mounted Mobile High Vacuum Soil Vapor Extraction (300 CFM Liquid-Ring Blower) and Activated Carbon Treatment System (two 2,000 lbs. vessels).



Case Study #14 – Prescott, AZ

Scope of Work

CalClean was contracted to conduct HVDPE events for a confidential client located in Prescott, AZ. The subject site is characterized by sedimentary deposits overlying weathered/fractured igneous bedrock and seasonally fluctuating groundwater elevations. The Site exhibited elevated concentrations of petroleum hydrocarbons in the soil and groundwater, including floating free phase hydrocarbon (FPH). Arizona Department of Environmental Quality (ADEQ) concurred with the suggested use of HVDPE with water treatment as a remedial approach for the Site. Previously, dual phase extraction was utilized at the Site periodically over a 7 year span to remove 64 pounds of hydrocarbons in vapor, 1,000 gallons of groundwater, and an undocumented volume of FPH. CalClean conducted a 3-day pilot study and has conducted an additional 120 consecutive days of HVDPE to date.

Lithology

Near surface soils are composed of gravel and clay to depths ranging between 3 ft. and 11 ft. bgs. Unconsolidated soils are underlain by basalt and clayey agglomerate. Ground water at the site is present between 15 ft. and 30 ft. bgs. Movement of the ground water is controlled by fracturing in the basalt which characteristically has low hydraulic conductivity and low horizontal ground water flow velocities.

Results

The results of the two HVDPE events indicated an indeterminate radius of influence with the current well array. The lack of measureable vacuum in similarly constructed observation wells within approximately 20-30 feet of the extracting wells suggests that system vacuum is focused in discontinuous fractures in the bedrock in the vicinity of the extracting well. Even so, a total of **45,800 pounds (approx. 7,330 gallons)** of hydrocarbons as vapor, **130 gallons** of FPH, and **127,700 gallons** of hydrocarbon affected groundwater were extracted and treated/disposed during the 123 days of HVDPE. The results of the original groundwater samples prior to use of CalClean's HVDPE system are presented in Table 1. Table 2 shows the results after the 123 days of HVDPE. Table 3 provides the calculated percent reduction.

FP – Well Contained measureable (greater than 0.01 feet) free phase hydrocarbons at time of sampling. Sample collected from water below the FP layer.

Table 1 – Groundwater Analytical Results 06/29/2014

| Parameter | BOC-3 | BOC-12 | MW-15 FP | MW-16 FP | DP-2 FP | DP-3 FP |
|----------------------|------------|------------|------------|-------------|-------------|------------|
| Benzene | 3,000 µg/L | 2,500 µg/L | 7,900 µg/L | 2,000 µg/L | 12,000 µg/L | 5,200 µg/L |
| Toluene | 450 µg/L | 9,400 µg/L | 2,500 µg/L | 670 µg/L | 2,100 µg/L | 1,100 µg/L |
| Ethyl-Benzene | 210 µg/L | 240 µg/L | 1,500 µg/L | 510 µg/L | 1,800 µg/L | 1,800 µg/L |
| Xylenes | 2,000 µg/L | 360 µg/L | 4,700 µg/L | 2,600 µg/L | 5,600 µg/L | 8,700 µg/L |
| MTBE | 1,800 µg/L | 2,100 µg/L | 5,400 µg/L | 1,400 µg/L | 3,000 µg/L | 1,200 µg/L |



Table 2 – Groundwater Analytical Results (Preliminary Data) 11/11/2014

| Parameter | BOC-3 | BOC-12 | MW-15 | MW-16 FP | DP-2 FP | DP-3 FP |
|----------------------|-------------|------------|------------|------------|------------|------------|
| Benzene | 2,300 µg/L | 1,100 µg/L | 2,500 ug/L | 2,500 µg/L | 3,200 µg/L | 1,200 µg/L |
| Toluene | 200 µg/L | <50 µg/L | 190 ug/L | 610 µg/L | 450 µg/L | 460 µg/L |
| Ethyl-Benzene | 770 µg/L | 59 µg/L | 1,000 ug/L | 350 µg/L | 770 µg/L | 960 µg/L |
| Xylenes | <1,800 µg/L | 140 µg/L | 3,100 ug/L | 2,700 µg/L | 5,300 µg/L | 6,400 µg/L |
| MTBE | 850 µg/L | 920 µg/L | <100 ug/L | 620 µg/L | 2,500 ug/L | 660 µg/L |

Table 3 – Calculated Percent Reduction

(inc. = Indicates an increase in concentration relative to 06/29/2014 sample results)

| Parameter | BOC-3 | BOC-12 | MW-15 | MW-16 FP | DP-2 FP | DP-3 FP |
|----------------------|-----------|--------|-------|----------|---------|---------|
| Benzene | 23% | 56% | 68% | 25% inc. | 73% | 77% |
| Toluene | 63% | 100% | 92% | 9% | 79% | 58% |
| Ethyl-Benzene | 266% inc. | 75% | 33% | 31% | 57% | 47% |
| Xylenes | >10% | 61% | 34% | 4% inc. | 5% | 26% |
| MTBE | 53% | 56% | 100% | 56% | 17% | 45% |

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #15 – Pine Valley Trailer Park, CA

Scope of Work

CalClean was contracted to conduct a seven-day HVDPE pilot test, two 30-day HVDPE events, one 15-day HVDPE event, and one 30-day HVDPE event (total approximately 118 days) for a confidential client located in eastern San Diego County in the community of Guatay, CA. The subject site exhibited elevated concentrations of dissolved petroleum hydrocarbons as well as free product in several wells onsite. After enhanced bioremediation achieved only limited success, the San Diego County DEH approved more aggressive removal of free product. After the pilot test demonstrated the effectiveness of HVDPE, remediation continued using HVDPE to remove the free product and reduce dissolved petroleum hydrocarbon concentrations in groundwater.

Lithology

Groundwater beneath the site occurs in fractured granitic rock. Although individual fracture hydraulic conductivities are high, sufficient wells had to be installed to take advantage of connecting fractures and facilitate extraction of the area with measured free product.

Results

The five HVDPE events were effective at removing the free product and reducing dissolved petroleum hydrocarbons in groundwater. A total of approximately **11,000 pounds** of hydrocarbons were removed, which equates to approximately **1,800 gallons** of hydrocarbons extracted and treated. After the first two 30-day and one 15-day HVDPE events, free product was no longer detected in the site wells, and BTEX concentrations were substantially reduced. However, high dissolved total petroleum hydrocarbons (TPH) were still being reported in site wells within and in close proximity to the former UST and fuel dispenser locations. The DEH considered this condition to be an impediment to site closure and provided several suggestions for options to address this. The option the client chose was to conduct one additional 30-day HVDPE event to evaluate whether significant petroleum hydrocarbon mass was available for remediation. The following table provides a summary of the petroleum hydrocarbon mass removed during the respective HVDPE events:

| Event/dates | Beginning (ppmv) | Highest (ppmv) | Ending (ppmv) | Mass Removed (pounds) |
|------------------------------------|------------------|----------------|---------------|-----------------------|
| Pilot test 9/29-10/6, 2004 | 16,100 | 16,100 | 5,750 | 2,846 |
| HVDPE Event 1 4/11-5/12, 2005 | 3,850 | 3,850 | 1,210 | 2,201 |
| HVDPE Event 2 3/8-4/9, 2007 | 1,660 | 1,860 | 1,300 | 3,632 |
| HVDPE Event 3 11/13-11/28, 2007 | 2,860 | 2,860 | 1,170 | 1,450 |
| HVDPE Event 4 11/17-12/19, 2012 | 270 | 590 | 150 | 871 |

ppmv = parts per million volume



With only approximately 871 pounds of petroleum hydrocarbon removed during the last 30-day event, it was demonstrated that the mass of hydrocarbons had been removed to the extent practicable and the case entered the closure process.

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #16 – Longview, WA

Scope of Work

CalClean was contracted for 5 months to utilize their mobile high vacuum dual phase extraction to aid in the recovery of free product for a confidential client within Southwest Washington. The subject property exhibited free diesel product in the subsurface soil and groundwater throughout the entire site. Greater than two feet of diesel product was observed in several wells located on the down gradient edge of the subject property. To enhance product recovery 64,000 gallons of a surfactant, salt and water mixture was introduced to the subsurface in an attempt to further wash the soils of NAPL.

Lithology

The site is underlain by alluvial materials consisting of silt with inter-bedded fine sand to 6 feet below ground surface (bgs) and medium to fine sand with minimal silt to 20 feet bgs. Groundwater is present at a depth of approximately 9 feet bgs.

Results

Following the 5 months of continuous operation of the high vacuum dual phase extraction system a total of 578,400 gallons of groundwater was extracted and treated utilizing CalClean's groundwater treatment trailer. From this 39,596 gallons of either free product or a diesel/water mixture was recovered disposed of off-site. The remaining 538,804 gallons were re-injected into various recovery wells throughout the subject property. The ease and mobility of the CalClean system made it possible to create mini mounds and depressions in the groundwater throughout the property which aided in product recovery. Concentrations of diesel in the recovery wells prior to extraction were as high as 370,000 ppb. Concentrations of diesel post carbon treatment were all non-detect.

Services Used

- Mobile High Vacuum Dual Phase Extraction (25 hp LRP)
- Groundwater Treatment Trailer



Case Study #17 – Santa Clarita, CA (Chlorinated Project)

Scope of Work

CalClean was contracted to install and operate a High Vacuum Dual Phase Extraction (HVDPE) for a confidential client located in Santa Clarita, CA. The subject site was developed as an active dry cleaner facility and subsurface soil were found to contain elevated concentrations of tetrachloroethylene (PCE), a common dry cleaning agent. A soil gas sample collected from 5 and 10 feet below grade contained PCE at a concentration of 43,100 µg/L and significantly exceeded the California Human Health Screening Level (CHHSL) of 0.6 µg/L for commercial property. The highest PCE groundwater concentrations were around 21,000 ug/L.

Soil and groundwater remediation using HVDPE was completed from 2012 to 2013 to reduce concentrations of PCE in the shallow soils and in groundwater to levels acceptable for closure by the Los Angeles RWQCB. Extracted groundwater was treated to the Los Angeles County Sewer Discharge Permit requirements and discharged to the onsite sewer system.

Lithology

The upper 5 to 15 feet of sediment beneath the Site consists of a mixture of silty clay and sandy clay. Underlying the upper clay layer are native alluvial materials composed of silty-sandy containing fine to medium sands interspersed with granule gravel layers to 80 ft bgs. The depth to groundwater was around 42 ft. bgs.

Results

Over the approximate 9 month period, 92.34 pounds of PCE were removed during 271 days of extraction. An HVDPE rebound test was conducted for a period of 5 days in 2013. Total influent PCE concentrations decreased over the period to a final influent concentration of 0.92 µg/L. An average rate of 3 gpm of groundwater was extracted during the project and groundwater PCE concentrations were reduced to below 5 ug/L.

Based upon the verification soil vapor sample results, the concentration of PCE in subsurface soil was significantly reduced. The consultant completed an analysis of the human health risk associated with vapor intrusion to indoor air. Based upon the model analysis, residual concentrations of PCE in the subsurface soils do not represent a human health risk greater than generally accepted standards for a commercial property.

Services Used

- Trailer-Mounted Mobile 20-hp High Vacuum Dual Phase Extraction (300 CFM Liquid-Ring Blower) and Activated Carbon Treatment System (three 1,000 lbs. carbon vessels).
- Trailer-Mounted Mobile Water Treatment System (two 500-pound granular activated carbon vessels in series)



Case Study #18 – Los Angeles, CA (Oil Field Cleanup)

Scope of Work

CalClean was contracted for 2 years to utilize two mobile high vacuum dual phase extraction systems to aid in the recovery of free product for a confidential client. The subject property had fifteen deep oil wells (around 6,000-7,000' deep) that were capped. However, the shallower soils (to 45') exhibited free oil product (from oil well drilling operations) in the subsurface soil and groundwater throughout the entire site. Greater than nine feet of heavy oil free product was observed in several wells located on the subject property.

Lithology

The site is underlain by alluvial materials consisting of silt with inter-bedded fine sand to 20 feet below ground surface (bgs) and medium to fine silty sand 45 feet bgs. Groundwater is present at a depth of approximately 30 feet bgs.

Results

Following 2 years of continuous operation of the two high vacuum dual phase extraction systems, approximately 50,000 gallons of groundwater was extracted and treated utilizing CalClean's groundwater treatment trailer. Approximately 8,100 gallons of free product heavy oil was recovered and disposed off-site at a crude oil recycling facility. The extracted groundwater was treated through carbon onsite and periodically manifested offsite to a permitted POTW. The ease and mobility of the CalClean systems onsite made it possible to create mini mounds and depressions in the groundwater throughout the property which aided in free product recovery. Concentrations of hydrocarbons in the ground are currently meeting the LARWQCB case closure standards and no free product has shown up in any of the wells for a two month period. A closure report is being submitted by the consultant.

Services Used

- Two Mobile High Vacuum Dual Phase Extraction systems (25 hp LRP each)
- Groundwater Treatment Trailer