Technical Response to the RWQCB Draft Cleanup and Abatement Order

Subject Property
Former Kast Tank Farm
Carousel Housing Tract
Carson, California

January 21, 2014 **Project: 12-219**

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Appendices

List of Terms

Term	Description
"bottom-up" contamination pattern	A contamination pattern where the highest petroleum hydrocarbon concentrations are detected at depth and concentrations progressively decrease in shallower soil samples.
"Explicit-knowledge" or "explicitly known"	This term is from the draft CAO and is used to describe what Barclay knew about petroleum hydrocarbons on the Subject Property during development activities.
"top-down" contamination pattern	A contamination pattern where the highest petroleum hydrocarbon concentrations are detected near the surface or above deeper samples that show lower concentrations that are progressively decreasing with depth.
ASTM	American Society for Testing and Materials
Barclay	Barclay Hollander Corporation, Barclay-Hollander-Curci (BHC), and Lomita Development Company
bgs	below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CAO	Cleanup and Abatement Order
County	County of Los Angeles, Department of Engineering, Building and Safety Division
County Inspectors	Grading inspectors from the County
CPT	Cone Penetrometer Testing
DHS	Department of Health Services
DIPE	Di-Isopropyl Ether
DTSC	Department of Toxic Substances Control
EPA/US EPA	United States Environmental Protection Agency
Gibson Dunn	Gibson Dunn & Crutcher, LLP
HD	The "HD" qualifier indicates that the chromatograph pattern for the sample did not match with the profile for the reference fuel standard, which is consistent with a crude oil source for the detected petroleum hydrocarbon contamination.
IDS	Inactive Disposal Site
J	The "J" qualifier indicates that the result reported were below the laboratory reporting limit but above the laboratory method detection limit.
LNAPL	Light Non-Aqueous Phase Liquid
Lomita Development	Lomita Development Company
mg/kg	milligrams per kilogram or parts per million
Mr. A. Vollmer	Alfred (Al) Vollmer was an equipment operator employed by Vollmer Engineering who worked in Reservoirs 5 and 6 and who performed ripping of the concrete floors and movement of soil from the berms into the reservoirs and completed grading and compaction in the reservoirs.
Mr. Anderson	Lowell Anderson was an employee of Vollmer Engineering and was an equipment operator. Mr. Anderson was onsite for most of the project and performed grading work in all three reservoirs.
Mr. Bach	George Bach was employed by Barclay and was the engineer who was onsite daily to oversee all operations.

List of Terms

Term	Description
Mr. L. Vollmer	Leroy Vollmer was the owner of Vollmer Engineering, the subcontractor hired by Barclay to perform decommissioning and grading of the Subject Property for residential development. Mr. L. Vollmer was onsite on a nearly daily basis performing decommissioning and grading work.
Mr. Zeller	Eugene Zeller was the head of the grading section at the County of Los Angeles Building and Safety Department during the time decommissioning and grading activities occurred at the Subject Property.
Ms. Schultz	Claudine Schultz was the owner of a chicken ranch property south of the pump house area and west of Reservoir 6 who worked on this adjacent property at the time decommissioning and grading activities occurred at the Subject Property.
MTA	Los Angeles County Metropolitan Transportation Authority
NOV	Notice of Violation
OEHHA	Office of Environmental Health Hazard Assessment
OVM	Organic Vapor Monitor
PAH	Polynuclear aromatic hydrocarbon
ppm	Parts per million
PSE	Pacific Soils Engineering, Inc.
ROST	Rapid Optical Screening tool
RWQCB	Los Angeles Regional Water Quality Control Board
Shell	Shell Oil Company, Shell Oil Products US
Shell Investigations	All investigations performed by Shell consultants from 2008 to the present.
Shell's Current CAO	The current CAO No. R4-2011-0046 that was issued by the RWQCB to Shell on March 11, 2011.
Sidewall/floor joint	The edges or perimeters of the reservoirs at the intersection of the reservoir concrete side walls and concrete floors.
Subject Property	Former Kast Property Tank Farm, Carousel Tract
TBA	tert-butyl alcohol
TPH	Total Petroleum Hydrocarbons
TPHd	Diesel fraction of petroleum hydrocarbons. Generally within the carbon range of C_{13}-C_{22}.
TPHg	Gasoline fraction of petroleum hydrocarbons. Generally within the carbon range of C_4-C_{12}.
TPHmo	Motor oil fraction of petroleum hydrocarbons. Generally with a carbon range greater than C_{22}.
TRPH	Total Recoverable Petroleum Hydrocarbons
Turco	Turco Products Facility
URS	Shell's environmental consultant who has performed the majority of the Shell Investigations
UVOST	Ultraviolet Optical Screening Tool
VOC	Volatile organic compound
Vollmer	Vollmer Engineering

List of Terms

Term	Description
Waterstone	Waterstone Environmental, Inc.
WDR	Waste Discharge Requirement
WMC	Wilmington Manufacturing Complex
μg/L	micrograms per Liter or parts per billion

Section 1
Executive Summary

The primary purpose of this document is to provide a technical response to the Draft Cleanup and Abatement Order (draft CAO) prepared by the Los Angeles Regional Water Quality Control Board (RWQCB) and circulated on October 31, 2013. The draft CAO names Barclay Hollander Corporation (Barclay)[1] as a responsible party for the petroleum hydrocarbon contamination that has impacted the Former Kast Tank Farm Carousel Housing Tract in Carson, California (the Subject Property).

I have examined the RWQCB's findings on page 11 of the draft CAO where Barclay is said to have had "explicit knowledge . . . of residual petroleum hydrocarbons and conducted various activities, including partially dismantling the concrete in the reservoirs and grading the onsite materials, thereby spreading the waste." The next sentence of the draft CAO states that "residual petroleum hydrocarbons" are "still present."[2] I have evaluated (i) the residual petroleum hydrocarbons of which Barclay had "explicit knowledge of;" (ii) the extent to which they were removed by Barclay or "still present" at the site during grading and development activities; and (iii) the extent to and circumstance of which they continue to be the basis for cleanup and abatement under the current CAO No. R4-2011-0046 that was issued by the RWQCB to Shell on March 11, 2011 (Shell's Current CAO).

To evaluate what Barclay knew about petroleum hydrocarbons during its site demolition and grading activities performed in the 1960s, I reviewed and compiled information from multiple sources. In this document, I refer to Barclay's knowledge using the terms "explicitly-known" or "explicit-knowledge" to provide the RWQCB with the result of my compiled research describing Barclay's knowledge of residual petroleum hydrocarbons on the Subject Property. I identified only three sources of residual petroleum hydrocarbons that Barclay knew about during its development activities: (i) residual petroleum hydrocarbon materials that it removed from Reservoir 7 and transported offsite; (ii) assumed encounters with residual petroleum hydrocarbons in the soil, which were transported offsite according to protocol; and (iii) the residual petroleum hydrocarbons that were identified in the six borings beneath the floor of former Reservoir 6. These three categories are the universe of Barclay's "explicit-knowledge," but only the third source is "still present." The minor amounts known to Barclay in this third category were not disturbed or spread around by Barclay's grading activities. I distinguish all of these "explicitly-known" residual petroleum hydrocarbons from the residual petroleum hydrocarbons described in the draft CAO as "still present" and of such significance that they are the subject of regulatory requirements under Shell's Current CAO. In my opinion, these two categories of residual petroleum hydrocarbons are: (i) those "explicitly-known" to Barclay and

[1] Barclay Hollander Corporation is a subsidiary of the Dole Food Company (Dole).
[2] Los Angeles Regional Water Quality Control Board. 2013. *Notice of Opportunity to Submit Comments on Proposed Draft Order in the Matter of Cleanup and Abatement Order No. R4-2011-0046, Former Kast Property Tank Farm (SCP No. 1230, Site ID No. 2040330, File No. 11-043).* October 31. p. 11, par. 1.

(ii) those "still present" and subject to the regulatory requirements of Shell's Current CAO, and those do not overlap.

In this document, I will opine on the potential sources, historical site development practices, site characterization, and nature of contaminant transport for the petroleum hydrocarbon contamination at the Subject Property, and provide the bases for my opinions which are summarized below:

Opinion 1 - Historical Crude Oil Storage Operations Conducted on the Subject Property by Shell Are Responsible for All Chemical Releases at the Subject Property

Opinion 2 - TPHd Is an Appropriate Marker for Oil Contamination on the Subject Property, and an Analysis of TPHd Indicates that the Largest Petroleum Hydrocarbon Releases at the Subject Property Are Beneath the Edges of the Former Reservoir Floors

Opinion 3 - Groundwater Impacts Mirror the Deep Soil Contamination Found on the Subject Property

Opinion 4 - There Is No Evidence that Barclay Released Any Chemicals on the Subject Property

Opinion 5 - Residual Petroleum Hydrocarbon Materials Left Onsite by Shell and "Explicitly-Known" to Barclay Were Disposed of Offsite by Barclay and Included Residual Petroleum Hydrocarbon Materials Left in Reservoir 7 and Residual Petroleum Hydrocarbons at the Swing Pit Area

Opinion 6 - Residual Petroleum Hydrocarbon Materials in Reservoir 7 Did Not Impact the Site Between the Time Barclay Entered the Subject Property and the Time Those Materials Were Removed

Opinion 7 - Barclay Adequately Ripped the Concrete Floors of the Former Reservoirs

Opinion 8 - Minor Amounts of Residual Petroleum Hydrocarbons Beneath the Reservoir Floors Left Onsite by Shell and "Explicitly-Known" to Barclay Were Not Disturbed by Barclay

Opinion 9 - There Is No Evidence that Berm Soils Were Impacted with Petroleum Hydrocarbons When Barclay Used Berm Soil to Fill in the Reservoirs

Opinion 10 - Contamination "Explicitly-Known" to Barclay Was Not Present at Other Features on the Subject Property or If Found Was Taken Offsite for Disposal

Opinion 11 - Upward Chemical Migration Was Discovered at Shell Reservoirs 1 & 2

Opinion 12 - Both Shell and the RWQCB Were Familiar with the Decommissioning Activities at Shell Reservoirs 1 and 2, and the Associated Upward Migration of Chemicals through the Fill

Opinion 13 - The Pattern of Migration of Petroleum Hydrocarbons at the Subject Property is Upward Migration and is Similar to Upward Chemical Migration Found at Shell Reservoirs 1 and 2

Opinion 14 - Similarities in the History, Decommissioning, Backfill, and Contamination of Reservoirs 1, 2, 5, 6, & 7 Provide Support for Upward Contaminant Migration in Reservoirs 5, 6, & 7

Opinion 15 - The Soil Contamination Data Collected within the Former Reservoirs Is Consistent With the Upward Chemical Migration Scenario and Does not Support the Hypothetical Downward Migration Scheme

Opinion 16 - The Backfill and Compaction Procedure Used by Barclay in Former Reservoirs 5 through 7 Would Make It Impossible to Create the Pattern of Contamination that the Data from Shell Investigations Shows

Opinion 17 - Concerns and Issues Raised by the RWQCB Staff Were Addressed

Opinion 18 - There Are Well Documented Technical Explanations for Upward Chemical Migration

Opinion 19 - Other Shell Sites Exhibiting Upward Chemical Migration Exist in Southern California

Opinion 20 - Other Non-Shell Case Studies Exhibiting Upward Chemical Migration Exist in Southern California

1.1 Subject Property Description

The Subject Property is a 44-acre site that was undeveloped and vacant until 1923 when it was purchased from Mary Kast by Shell Oil Company (Shell) and developed with the construction of three large oil storage reservoirs, identified as Reservoirs 5, 6, and 7. The three reservoirs located at the Subject Property were part of the Shell Wilmington Manufacturing Complex (WMC) in Carson, California that consisted of two separate facilities, the Wilmington and Dominguez Sections.[3, 4] The Dominguez Section is located approximately 2.3 miles northeast of the Subject Property. The Wilmington Section (Wilmington Refinery), located approximately 1 mile east of the Subject Property,[5] is the location of former Reservoirs 1, 2, 3, and 4 and also included the three Subject Property Reservoirs 5, 6, and 7. All seven reservoirs were initially constructed in 1923.[6] Reservoirs 5, 6, and 7 were used for storage of crude oil and other petroleum hydrocarbon materials. Besides the oil storage reservoirs, other site features included berms, an oil pump house and surrounding pump house area, a swing pipe, sumps, and areas where stormwater ponded (ponds) were located on the Subject Property.

The Subject Property was used actively for petroleum hydrocarbon storage until approximately the late 1950s or early 1960s, at which point it was used on a reserve basis. In October 1965, Shell entered into a purchase agreement for the Subject Property with Richard Barclay of

[3] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August. p. v.
[4] Shell Oil Company. 1929. Engineering Plan. *Dominguez-Torrance Reservoir Filling Line.* Y-1446. July.
[5] Shell Oil Company of California. 1923. *The Very First Operating & Construction Report, Simplex Refining Dept., Wilmington Refinery.* September 30. p. 2. par. 2 and p. 13.
[6] Shell Oil Company of California. 1923. *The Very First Operating & Construction Report, Simplex Refining Dept., Wilmington Refinery.* September 30.

Barclay-Hollander-Curci (BHC) who thereafter nominated Lomita Development Company (Lomita Development) as its designee for purchase of the Subject Property (collectively, “Barclay”).

1.2 Barclay’s First Arrival Onsite and Work Performed

By a letter dated December 15, 1965,[7] Shell granted permission to Barclay to enter the site to begin demolition and grading activities. According to deposition testimony[8] from Mr. Leroy Vollmer (Mr. L. Vollmer), the grading contractor for the project, Barclay first arrived on the Subject Property in late December 1965 to “bid the work to be done” and work began in January 1966.[9] On or before January 7, 1966, the geotechnical engineer, Pacific Soils Engineering, Inc. (PSE) went onto the site to perform testing needed for its Preliminary Soils Report dated January 7, 1966.[10] A grading permit was issued for the project by the County of Los Angeles Building and Safety Division on February, 9, 1966.

Residual liquids and sludge were removed from the reservoirs and disposed offsite, concrete from the bottom and sides of the reservoirs was broken up and left in place at the bottom of each reservoir, and fill soil primarily from the reservoir sidewalls was added in lifts and compacted until each reservoir was brought to grade. Construction of homes began in 1967, and by the early 1970s there were 285 homes on the Subject Property that had been constructed and sold by Barclay.

1.3 Discovery of Petroleum Hydrocarbon Contamination on the Subject Property

An environmental investigation of the neighboring property in 2007 led to the discovery of petroleum hydrocarbon compounds in the subsurface of the Subject Property.[11] Shell was named a responsible party for the site in a Notice of Violation (NOV) issued in 2009 and a CAO was issued to Shell by the RWQCB in March of 2011. Following a request by Shell to name Dole and Barclay as responsible parties, a 13267 Order was issued to Dole in April 2011, to which Dole responded in September 2011. In October 2013 a draft CAO was issued by the RWQCB naming Barclay as a responsible party. This report is Barclay’s technical response to the draft CAO.

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[7] Clark, D. E. 1965. *RE: Wilmington Field Kast Fee – Kast Tank Farm, Your Reference: Lomita Property.* Correspondence from Shell Oil Co. to Barclay. December 15. (SOC000057)

[8] Also see Section 2.2 for further description of deposition testimony reviewed for this report.

[9] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 265: 5-25, p. 266:1-3.

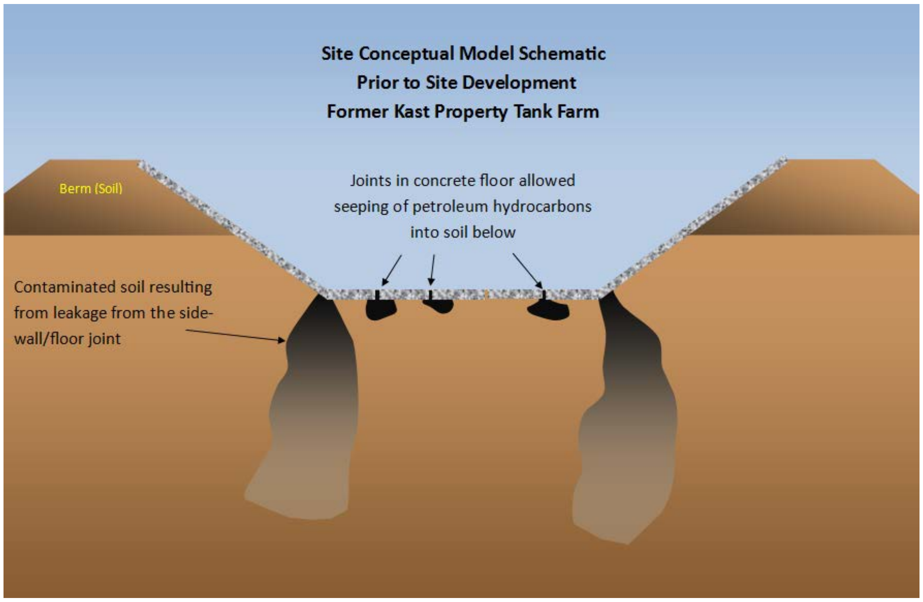
[10] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California*. January 7. (CAR 1)

[11] Los Angeles Regional Water Quality Control Board. 2013. *Notice of Opportunity to Submit Comments on Proposed Draft Order in the Matter of Cleanup and Abatement Order No. R4-2011-0046, Former Kast Property Tank Farm (SCP No. 1230, Site ID No. 2040330, File No. 11-043).* October 31. p. 5, par. 2.

1.4 The Largest Petroleum Hydrocarbon Releases at the Subject Property Are Beneath the Edges of the Former Reservoir Floors

Section 2.4 of this document describes the extent of releases at the Subject Property that are known to be associated with Shell's former site operations. Investigations by Shell's environmental consultant, URS, (Shell Investigations) have shown that releases of petroleum hydrocarbons occurred from the oil reservoirs at the Subject Property during Shell's ownership and historical operations at the site.

Results of soil analysis from Shell Investigations from samples collected deeper than 10-feet below ground surface (bgs) show that deep petroleum hydrocarbon contamination is found primarily at the edges of the reservoirs at the intersection of the reservoir concrete sidewalls and concrete floors (the sidewall/floor joint). Generally, there was less hydrocarbon contamination discovered beneath the interior portions of the reservoir floors. The sidewall/ floor joint leaked most likely because of a failure in the seal between these two surfaces resulting from (i) soil settlement, (ii) pressure exerted on the joint by the fluid in the reservoir, (iii) design or construction flaws, and/or (iv) other unidentified reasons. The Site Conceptual Model below shows that (i) larger leaks occurred beneath the reservoirs at the sidewall/floor joint and (ii) smaller more localized petroleum releases occurred from smaller cracks or joints in the reservoir concrete slab bottom.



The pattern of deep petroleum hydrocarbon contamination illustrated in the Site Conceptual Model depicted graphically above indicates that releases from the reservoirs occurred primarily at the sidewall/floor joint. This concentration of deep soil petroleum hydrocarbon contamination beginning just below the former reservoir floors provided the petroleum hydrocarbon mass for the subsequent upward migration of contaminants via capillary action as presented in this report and is consistent with the results of shallow soil testing performed during Shell Investigations which exhibited a similar pattern concentrated at the perimeters of the reservoirs.

1.4.1 Groundwater Impacts from Deep Contamination Also Exist Beneath the Edges of the Former Reservoir Floors

Similar to the pattern of deep soil petroleum hydrocarbon contamination detected at the former reservoir edges beneath the Subject Property, groundwater impacts are primarily near the perimeter areas of the former oil reservoirs, with the greatest impact located on the western perimeter of Reservoir 5. Based on the groundwater analytical results, significant leaks occurred from the northern edge of Reservoir 7 and along the western edge of Reservoir 6, resulting in dissolved phase petroleum hydrocarbons migrating all the way to groundwater. The groundwater sampling analytical results indicate that the source for the groundwater impacts detected beneath the Subject Property were petroleum hydrocarbon contaminants beneath the edges of each of the three reservoirs.

1.5 Petroleum Hydrocarbons "Explicitly-Known"[12] by Barclay Included Only Three Possible Sources of Petroleum Hydrocarbons on the Subject Property

Section 3 of this document discusses the extent of petroleum hydrocarbon contamination at the Subject Property that was "explicitly-known" by Barclay at the time of site development. There were only three possible sources of petroleum hydrocarbons that could be "explicitly-known" by Barclay at that time: (i) petroleum hydrocarbon materials in Reservoir 7 remaining from Shell operations and that were removed from the site by Barclay; (ii) minor amounts of petroleum hydrocarbons that may have been observed in the soil outside the reservoirs from berms, sumps and other areas onsite that, where observed, were removed from the site by Barclay; and (iii) petroleum hydrocarbon contamination beneath the reservoir floors that leaked during Shell's operation of the Subject Property and were left undisturbed by Barclay.

1.5.1 Petroleum Hydrocarbons "Explicitly-Known" in Reservoir 7 Were Removed from the Subject Property

Deposition testimony by Barclay's onsite grading contractor, Mr. L. Vollmer and Barclay's onsite Engineer, Mr. George Bach (Mr. Bach), indicated Reservoirs 5 and 6 were empty and clean prior to the start of work by Barclay. This fact is corroborated by internal Shell letters and correspondence. The residual liquids and petroleum hydrocarbon materials remaining in Reservoir 7 were removed by Barclay and hauled offsite; therefore, these petroleum hydrocarbons in Reservoir 7 of which Barclay had "explicit-knowledge" are not the source of the current contamination. Shell confirmed via internal memoranda contemporaneous to these operations that all three reservoirs were empty and clean prior to ripping of the concrete bottoms and placement of soil by Barclay. Since Barclay removed all of the petroleum hydrocarbon materials that were

[12] The RWQCB Draft CAO (October 31, 2013) states that Barclay had "explicit knowledge of the presence of…..residual petroleum hydrocarbons.,,". See Section 1, 3rd paragraph for a description of terminology used in this report and Sections 3 and 4 for detailed discussion of Barclay's "explicit-knowledge."

formerly in Reservoir 7 from the site, Barclay did not spread these waste materials during grading or development activities as stated by the RWQCB in the draft CAO.

1.5.2 Petroleum Hydrocarbons "Explicitly- Known" in Areas Outside the Reservoirs Were Minor and, Where Encountered, Were Removed from the Subject Property

Information regarding Barclay's "explicit-knowledge" of petroleum hydrocarbons in other parts of the Subject Property besides the reservoirs is supplied by (i) geotechnical borings performed by Barclay outside the reservoirs; (ii) eyewitness testimony; and (iii) and records indicating the condition of soils and disposition of unsuitable soils. Eight geotechnical borings were completed in areas outside the reservoirs by January 1966 exclusively for geotechnical purposes (no environmental analyses were conducted) and the resulting soil descriptions contained no references to petroleum hydrocarbons, oil staining, or petroleum odor in the soil. There is deposition testimony from onsite eyewitnesses that indicate that whenever wet, emulsified or otherwise unsuitable soils were encountered; those materials were hauled off the Subject Property for disposal offsite.

Although there was no specific testing for petroleum hydrocarbons in the soil outside the reservoirs in the berms and other areas onsite, it is noteworthy that no petroleum hydrocarbons were noted in geotechnical borings from these areas. Geotechnical reports prepared by PSE and eyewitness deposition testimony by Mr. Bach and Mr. L. Vollmer indicate that no petroleum hydrocarbons in soil were noticed during grading and other site development activities. In addition, any petroleum hydrocarbons that were encountered (during pipe removal activities) were removed and disposed of offsite. Further, there is no record of County Inspectors finding or noting berm soils with petroleum hydrocarbons for berm soils that were graded by Barclay. . Therefore any potential petroleum hydrocarbon contamination associated with the soil outside the reservoirs was not "explicitly-known" to Barclay as any residual petroleum hydrocarbons "explicitly-known" were disposed of offsite.

1.5.3 Barclay Did Not Remove or "Spread" the Soil Beneath the Reservoir Floors and Any Petroleum Hydrocarbons Beneath Reservoir 6 Observed by Barclay Represented Minor Amounts of Petroleum Hydrocarbons

Barclay's "explicit-knowledge" of petroleum hydrocarbons beneath the reservoirs was supplied by geotechnical borings and concrete ripping. Six geotechnical borings were completed beneath the concrete floor of Reservoir 6 early in 1966 for the purpose of conducting a drainage study beneath the reservoir floors. With one exception, every individual soil sample collected from each of the six borings beneath the reservoir floor included descriptions that described minor amounts of oil – none of the descriptions indicated the soil was oil-saturated. In general, soil just beneath the concrete floor had indicated more oil with less oil or just odors reported progressively deeper (a "top-down" pattern of hydrocarbon impact). The report concludes:

> "The laboratory results show that even though the soils are oil stained they are still permeable."[13]
>
> ***
>
> "The drainage area is sufficient to handle all expected percolating water."[14]

Geotechnical test pits were made in the other two reservoirs, however, no petroleum hydrocarbons were noted in PSE reports. Ultimately, all three concrete reservoir floors were "ripped" to provide drainage for water but the soil beneath the concrete floors was not otherwise disturbed - it was neither graded nor moved. Deposition testimony from Mr. A. Vollmer indicates he observed soil that was revealed by concrete cuts but he did not note the presence of petroleum hydrocarbons. Other than the small amount of soil removed from geotechnical test pits and borings and the very small amount of soil that might have been disturbed when ripping the concrete floors, at no time was soil beneath the floors visible to Barclay and its subcontractors.

Therefore, the soil with oil staining in the 1966 geotechnical borings was not graded or disturbed by Barclay during site development activities. Hence, Barclay did not spread or otherwise distribute this soil on the Subject Property.

1.6 Barclay Did Not Observe, Grade, or Spread Contaminated Soil from Onsite Berms or Other Locations on the Subject Property

Section 4 describes the other historical features on the Subject Property besides the reservoirs. The draft CAO issued by the RWQCB suggests that Barclay could have spread petroleum hydrocarbon contamination contained in the onsite berms. However, there is no evidence to support the RWQCB's suggestion. Deposition testimony from onsite eyewitnesses including Mr. L. Vollmer, Mr. Lowell Anderson (Mr. L. Anderson was an equipment operator with Vollmer Engineering who performed grading in all three reservoirs) and Mr. Bach, as well as geotechnical reports prepared by PSE indicate there were no observations of oily or stained soil in the berms during the grading process. The testimony consistently indicates that no petroleum hydrocarbons were observed in the soil of the berms from Reservoirs 5, 6, and 7.

This testimony is consistent with what is known about berm soils at the similarly constructed Shell Reservoirs 1 and 2 located on the Shell Wilmington Refinery property. The sample results indicate that berm soils at Shell Reservoirs 1 and 2 were relatively clean except for the deepest samples that were located closest to the reservoir sidewall and the sidewall/floor joint and these were berm areas below the level that required grading which were likely never graded or disturbed when the reservoirs were filled in with the abovegrade berm soil. It is noteworthy these reservoirs operated over 30 years longer than the reservoirs on the Subject Property and, therefore, had 30 more years for degradation and leakage. Additionally, Shell environmental

[13] Pacific Soils Engineering, Inc. 1966. *Subsurface drainage study for reservoir located in the southeast corner of Tract No. 24836 in the County of Los Angeles, California.* March 11. p. 2. par. 3 (CARSON 000252)
[14] Pacific Soils Engineering, Inc. 1966. *Subsurface drainage study for reservoir located in the southeast corner of Tract No. 24836 in the County of Los Angeles, California.* March 11. p. 3. par. 2 (CARSON 000253)

reports for Reservoirs 1 and 2 indicate that visual observations of petroleum hydrocarbon contamination by trained personnel correlated poorly in some cases with laboratory results, indicating that soil with high concentrations of petroleum hydrocarbons did not always appear visibly stained or oily even when trained personnel were logging their observations.

1.6.1 Barclay's Filling of the Reservoirs in Approximately 12-Inch Lifts of Soil during Grading is a Process that Cannot Result in the Contamination Patterns Observed in the Top 10 Feet of Soil Today

Analysis of present petroleum hydrocarbon contamination patterns provides further evidence that Barclay did not spread petroleum hydrocarbon contamination from the onsite berms. The manner in which backfill and compaction of berm soil was conducted to fill the former reservoirs on the Subject Property would make it impossible to place contaminated soil at specific depths or in specific locations within the reservoir. As described by Mr. Anderson in his deposition testimony,[15] the soil was bulldozed from the top of the berms downward and placed into the reservoir in layers with equipment that, in distributing the soil, mixed and homogenized the soil layers placed into the reservoir. The data from the Shell Investigations show that the contamination in the shallow fill soil aligns in columns in a specific vertical pattern and not the random patterns that would be expected with mixing. Instead, the pattern of contamination that exists shows higher concentrations of total petroleum hydrocarbons as diesel (TPHd) near the concrete floor of the former reservoir and gradually lesser amounts of TPHd at shallower depths in the soil closer to the surface (a "bottom-up" contamination pattern). Because soil was placed in the reservoirs in lifts, placing soil in a manner where the above pattern (of contiguous vertical columns) would occur repeatedly in all three reservoirs as, in fact, occurred would be impossible.

In summary, if any petroleum hydrocarbon contamination was present in the berm soil, it would have been placed randomly in the reservoir as fill as there would be no way for operators to decide what soil was contaminated, or the visible degree of contamination, and thus the appropriate burial depth or location within the reservoir. The bottom-up pattern of contamination revealed by data from Shell Investigations could only have been created through the upward migration of contamination left behind by Shell located beneath the former reservoirs. Therefore, the placement of soil in lifts during Barclay's grading process did not result in the contamination pattern demonstrated by Shell Investigations.

1.6.2 Barclay Did Not Spread Soil Contamination Associated with Other Historical Onsite Features

Other features historically present onsite included two sumps, several ponds, a swing pipe pit, pipelines, a pump house and the area surrounding the pump house. There is no evidence Barclay spread petroleum hydrocarbon contamination associated with any of these historical features.

The two sumps include a small sump located north of the pump house area and the former main sump which is a large open area east of Reservoir 5. Evidence that petroleum hydrocarbons

[15] Anderson, L. D. Jr. 2013. *Videotaped Deposition of Lowell Dwaine Anderson, Jr*. December 18. p. 31: 6-25, p. 32: 1-6. 1-25, p. 33: 1-6.

within the former main sump was covered up, partially removed and/or filled in by Shell before Barclay's arrival is provided by Shell Investigation data for this area. In the former main sump, the highest petroleum hydrocarbon concentrations exist at a current-day depth of approximately 5-6.5 feet below ground surface (bgs) which correlates to approximately the 1966 surface grade. The petroleum hydrocarbon concentrations in samples collected at depths greater than 5-6.5 feet bgs in this area progressively decrease as the sample depth increases. This is a typical "top-down" contamination pattern and indicates that petroleum hydrocarbon contamination was present beneath the surface of the main sump prior to Barclay's grading activities.

According to deposition testimony, no evidence of the former sumps was observed by the time Barclay graded the property for development. Deposition testimony regarding the area of the former main sump indicates that at least some of the western berm of the main sump had been taken down prior to Barclay's entry onto the property and aerial photographs indicate that the main sump area shows signs of being flattened and/or reworked, also prior to Barclay's first arrival onsite. Eyewitnesses that were present during the grading or that operated the grading equipment[16] have stated that no petroleum hydrocarbons were observable during grading operations. Eyewitness deposition testimony by Mr. A. Vollmer indicates that no petroleum hydrocarbons were noted in test pits dug for geotechnical purposes in this area. Mr. A. Vollmer's deposition testimony also indicates the main sump area was filled-in by Barclay without over-excavation of any of the existing soil surface.[17] According to deposition testimony by Mr. L. Vollmer and Mr. A. Vollmer, berm soil from the berms at the Subject Property was used to fill in the main sump area.

In summary, the deposition testimony of individuals present and intimate with the grading activities in this area indicates that Barclay did not disturb the surface soil in the main sump area demonstrating that the original petroleum hydrocarbon contamination from Shell's use of the main sump still exists at the 5-6.5 foot depth. If the contamination left by Shell had been disturbed by Barclay, the top-down pattern of contamination exhibited at the former main sump would not be present today. Instead, contamination in this area would have been spread over the entire area graded by Barclay. Barclay did not observe or disturb this soil and had no "explicit-knowledge" of this top-down contamination.

The former above-ground piping and associated structures were removed from the site by Shell prior to Barclay's arrival as well. Where Barclay encountered any below-ground piping or petroleum hydrocarbons in below-ground pipes during grading, the piping and petroleum hydrocarbons were removed from the site including removal and offsite disposal of any soil that was impacted by spilled oil during the piping removal.

The pump house area is in a location where soil was filled to a depth of 18 feet (west side) and cut (east side) as part of the grading plan executed by Barclay. Where the soil was cut, no fill materials were placed. Characterization data from the pump house area where Barclay cut the soil during grading exhibits the highest petroleum hydrocarbon concentrations from Shell Investigations at approximately 2 feet bgs and decreases with depth, in the same "top-down"

[16] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 87-89.
[17] Anderson, L. D. Jr. 2013. *Videotaped Deposition of Lowell Dwaine Anderson, Jr*. December 18.

contamination pattern as the main sump. This pattern again indicates that these materials had not been moved, disrupted or put in place during the grading operations that took place in this portion of the Subject Property. If the contamination left by Shell had been disturbed this top down pattern of contamination would not be observed. Barclay, in cutting this area, never disturbed or observed soil at the 2-foot depth and therefore had no “explicit-knowledge” of the shallow petroleum hydrocarbon contamination in the former pump house area.

1.7 The Upward Migration of Contaminants at Shell’s Reservoirs 1 and 2 Have Contamination Patterns that Are Very Similar to the Bottom-Up Contamination Patterns at Former Reservoirs 5, 6, and 7 at the Subject Property

Section 5 discusses Shell Reservoirs 1 and 2 located on the main portion of the Shell Wilmington Refinery (1 mile east of the Subject Property) that were built at the same time and of the same construction method and materials as Reservoirs 5, 6, and 7. Petroleum hydrocarbon contamination patterns at Shell Reservoirs 1 and 2 show similar petroleum hydrocarbon contamination patterns to those observed in Reservoirs 5, 6, and 7 on the Subject Property.

Shell Reservoirs 1 and 2 were decommissioned and dismantled by Shell in 1995 in accordance with Waste Discharge Requirements (WDRs) issued and approved by the RWQCB. Monthly progress reports provided to the RWQCB by Shell stated that the visual observations and prior sampling results of the berms and soil beneath the reservoirs did not warrant removal of any onsite soil, despite the presence of petroleum hydrocarbon contamination in the samples. When soil analytical results showed concentrations greater than the WDR limits, the berm soils were blended until WDR limits were met and the soil with the petroleum hydrocarbons was used to backfill the reservoirs. Analytical results for soil samples collected beneath the reservoir floors indicate concentrations of TPHd exceeding the WDR limit of 10,000 milligrams per kilogram (mg/kg) and ranging as high as 52,000 mg/kg were left in place and not removed prior to Shell’s reservoir backfill and compaction activities. These procedures were approved by the RWQCB in the 1990s.

In order to “inhibit the **upward migration** of free petroleum hydrocarbons”[18] (emphasis added), a low permeability clay cap was constructed by Shell’s consultants above Shell Reservoirs 1 and 2 following backfill. The initial reservoir backfilling, compaction and capping project was expected to be a final remedy to the reservoir demolition and dismantling; however, after the initial project was completed, petroleum hydrocarbon seepage at the surface originating from upward migration of deeper contamination was observed at the surface around the clay cap.

The existence of upward migration and seepage at the surface warranted an additional soil investigation, soil removal, and the installation of an extension to the existing low permeability cap in 1996 and 1997. The final clay cap was expanded to extend 40 feet beyond the dimensions

[18] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2*. August. Executive Summary. par. 1.

of the reservoir bottom to account for the broad potential upward migration and spread of petroleum hydrocarbon contamination.

The RWQCB oversaw all these activities and was extensively involved in, and had an understanding of, the site characterization, decommissioning, backfilling, soil compaction, and capping of Shell Reservoirs 1 and 2. In addition, the RWQCB was aware of the upward petroleum hydrocarbon migration at the cap edges and understood and approved Shell's additional soil removal, soil treatment and cap extension. As early as 1996, not only was the RWQCB informed that petroleum hydrocarbons in soil were migrating upward, but the RWQCB had also requested a workplan to mitigate the issue and approved the proposed solution to expand the clay cap so that further upward migration could be mitigated.

Section 5 goes on to discuss that the petroleum hydrocarbon contamination patterns found around Reservoirs 5, 6 and 7 at the Subject Property show a very similar pattern of upward petroleum hydrocarbon migration to those observed at Shell's Reservoirs 1 and 2. Waterstone evaluated four potential backfill scenarios to examine possible ways the petroleum hydrocarbon contamination pattern exhibited at the Subject Property could have occurred.

Contaminant plume maps prepared by Geosyntec[19] (a Shell environmental consultant) and Waterstone that plot TPHd impacts show that concentrations of TPHd are greatest at depths nearest the reservoir floors (10-foot depth or depth of boring equipment refusal) and decrease at shallower depths. Figures prepared by Waterstone indicate that the 10-foot TPHd plan view map prepared by Geosyntec includes sample results for soil both above and below the concrete floors. Waterstone has prepared separate maps to show the pattern of petroleum hydrocarbon contamination for i) samples that have been collected immediately above the concrete floors in the fill soils and ii) below the concrete floors (in Shell's left-in-place contaminated soil).

Based on Waterstone's figures of Shell Investigation data plotting TPHd concentrations both above and below the former reservoir floors, the highest TPHd concentrations are generally below the floors of the former reservoirs (in the soil left in place by Shell) – these petroleum hydrocarbons were not observed or disturbed by Barclay. In addition, the highest concentrations and largest areas of soil impact in the top 10 feet (from upward migration) are observed in locations above and near the perimeters of the reservoir floors, in the areas where the highest TPHd concentrations exist beneath the sidewall/floor joints. The petroleum hydrocarbon contamination profile at the reservoirs shows upward migration with the highest concentrations at the bottom and decreasing concentrations in shallower soil samples (a bottom-up contamination pattern) that originates from the contamination left beneath the reservoirs by Shell.

A different pattern of contamination that is not bottom-up is found in areas outside the reservoirs. The vertical profile and pattern of petroleum hydrocarbon contamination found at the former main sump shows that the greatest concentrations of petroleum hydrocarbons were detected at the 5-6.5 foot depth interval with much lower concentrations at ten feet bgs displaying a top-

[19] Geosyntec, 2011. Transmittal of Concentration Contour Maps Former Kast Property, Carson California, Site Cleanup No. 1230, Site I.D. 2040330. April 29. Figures 4-9.

down contamination pattern. Therefore, it can be concluded that, in the main sump, the petroleum hydrocarbon contamination originating near a depth of five feet bgs, decreases with depth, and comes from a different source than contamination found above the former reservoir floors. Similarly, in areas such as the pump house, the vertical contamination profile indicates that a petroleum hydrocarbon source near the surface is responsible for the petroleum hydrocarbon contamination which then migrated downward in the typical top-down contamination pattern.

Based on questions posed by RWQCB staff during my verbal presentation of this information to RWQCB staff in September and October 2013, I evaluated more scenarios to potentially explain contamination patterns exhibited by the data from Shell Investigations. My evaluation indicates that the bottom-up contamination pattern exists throughout the area formerly underlain by the reservoir floors (i) regardless of whether the concrete floors were left in place or completely removed[20] and (ii) whether the current ground surface is paved or not. Therefore, I am able to answer the question posed by RWQCB staff regarding whether the presence of the former reservoir floor impedes upward movement of petroleum hydrocarbons and whether the presence of paving at the current ground surface (preventing downward percolation of water) has any effect on the bottom-up contamination pattern. There is no effect on the bottom-up contamination pattern posed by the presence of the concrete floor or the presence of surface paving. In this report, a case study for the upward migration model is provided using the excavation pilot study and data from Shell Investigations from November 2012 at 24612 Neptune Avenue.

1.8 Upward Migration of Contamination is a Known and Well-Documented Phenomenon

Upward migration of petroleum hydrocarbons in the subsurface is not a new or novel concept and has been observed numerous times at contaminated sites. Section 6 discusses several of the mechanisms for upward chemical migration. In the vadose zone (unsaturated zone), upward migration of fluids (including both water and petroleum hydrocarbons) is primarily driven by capillary action within the soil pores. The height that petroleum hydrocarbons can be transported upward within the vadose zone is determined by the soil pore throat size and the viscosity of the petroleum hydrocarbon, where the greatest distances of upward migration occur where lower viscosity fluids exist in finer-grained soils.

Another driving force for upward migration is buoyancy. Buoyancy forces will also cause petroleum hydrocarbons to migrate upward through the water column in a saturated environment and accumulate at the top of the water table. Once free phase petroleum hydrocarbons accumulate (by floating) on the water table as a light non-aqueous phase liquid (LNAPL) layer, the LNAPL can also be transported upward into the unsaturated zone due to capillary forces, similar to how water is transported upward from the saturated zone and forms the groundwater capillary fringe.

[20] In Reservoir 5, approximately 25% of the western portion of the concrete floor was completely removed.

Pressure is another driving force for natural petroleum seepage upward from depth to the surface. In a pressurized environment, compressed petroleum hydrocarbon fluid will migrate from the area of high pressure toward the ground surface since this is the area of the lowest pressure.

Other documented and agency-reviewed sites also describe known cases of upward contaminant migration indicating that this phenomenon has been observed and is known to occur. Section 7 summarizes several readily-located peer-reviewed case studies of environmental sites in Southern California illustrating upward chemical migration, including eight separate areas located on two different Shell properties.

1.9 Opinions

In forming the opinions stated below I first downloaded the various communications, reports and other technical data that was publicly available from the RWQCB's Geotracker website and made the inquiries necessary to create a functioning database for data evaluation. I then obtained from legal counsel certain documents pertaining to the history of the Subject Property, including decommissioning and grading of the reservoirs at the Subject Property. This included, among other things, all soils reports, grading plans and the depositions of witnesses who had been present during Barclay's work.

I also reviewed academic journals and records from other contaminated sites, some of which were provided by legal counsel at my request and others of which were obtained by my own staff. I reviewed numerous other documents not specifically mentioned above. The documents I specifically relied upon for a particular point are cited in the footnotes of this report, but while the footnotes are intended to demonstrate support that is scientifically sufficient, I made no attempt to make them exhaustive. In other words, there may be multiple supporting documents not cited in a footnote that make the same point. The opinions that follow are based upon this research, my review and study of these documents, and my knowledge, training, and experience.

The opinions stated below are my opinions and, at a minimum, each one of them is stated within a reasonable scientific certainty by which I mean it is more likely than not that they are true. I have formulated the following opinions based on my review of the foregoing information and my own expert scientific analysis.

Opinion 1 - Historical Crude Oil Storage Operations Conducted on the Subject Property by Shell Are Responsible for All Chemical Releases at the Subject Property

Site characterization investigations performed by URS on behalf of Shell since 2008 (Shell Investigations) have shown that releases of petroleum hydrocarbons have occurred from the oil reservoirs at the Subject Property during Shell's operation, primarily at the intersection of the reservoir concrete sidewalls and concrete floors (sidewall/floor joint), and to a lesser degree below the reservoir floor in the interior portion of the reservoirs. Petroleum releases along the western portion of Reservoir 5 were significant enough to migrate approximately 50 feet downward and resulted in the accumulation of free product on the water table in this area of the Subject Property.

Opinion 2 - TPHd Is an Appropriate Marker for Oil Contamination on the Subject Property, and Analysis of TPHd Indicates that the Largest Petroleum Hydrocarbon Releases at the Subject Property Are Beneath the Edges of the Former Reservoir Floors

Following an evaluation of the various analytical results, I selected TPHd as a representative indicator compound for graphics purposes to depict the contaminant patterns and distribution at the Subject Property. The selection of TPHd as the indicator chemical for the Subject Property is based on the physical characteristics of the TPH diesel fraction and its predominance in crude oil. BTEX and TPHg were not selected because these chemicals can easily impact shallow soil as a result of common activities unrelated to the contamination from the former reservoirs such as chemical use associated with recent homeowner surface use activities (lawn care, vehicle maintenance). Finally, PAHs were not selected because of the likely release of PAHs and subsequent shallow soil deposition of PAHs from airborne contaminants associated with vehicle exhaust (especially diesel trucks) from nearby street traffic and/or refineries.

Shell Investigations indicate that TPHd patterns demonstrate that deep contamination is found primarily at the edges of the reservoirs at the sidewall/floor joint and generally, there is less soil impact beneath the interior portions of the reservoir floors. TPHd impacts in other areas of the Subject Property are fairly shallow and attenuate relatively quickly with depth.

Groundwater data from Shell Investigations indicate that the source of the groundwater impacts detected beneath the Subject Property were impacts located beneath the edges of each of the three reservoirs. The contribution of other onsite sources to groundwater impacts is minor and secondary to these larger impacts. This groundwater data further supports the conclusion that the largest petroleum hydrocarbon releases at the Subject Property occurred beneath the edges of the former reservoir floors.

Opinion 3 - Groundwater Impacts Mirror the Deep Soil Contamination Found on the Subject Property

Groundwater impacts primarily exist near the perimeter areas of the former oil reservoirs in a pattern similar to the deep soil contamination detected at the former reservoir edges beneath the Subject Property. The greatest impacts are observed along (i) the western perimeter of Reservoir 5, (ii) the northern perimeter of Reservoir 7, and (iii) the western perimeter of Reservoir 6. Shell Investigations for groundwater indicate that the source of the groundwater impacts detected beneath the Subject Property is petroleum hydrocarbon impacts to the soil located beneath the edges of each of the three reservoirs which resulted from Shell’s historic operation of the reservoirs at the Subject Property.

Opinion 4 - There Is No Evidence that Barclay Released any Chemicals on the Subject Property

As the site developer, Barclay did not store oil or other petroleum hydrocarbons on the Subject Property. Prior to Barclay coming onto the Subject Property, all oil and petroleum hydrocarbon storage and transfer operations by Shell had ceased and Reservoirs 5 and 6 were clean and empty. Barclay removed all liquids and other petroleum hydrocarbon materials from Reservoir 7 and shipped the removed hydrocarbon materials to an offsite disposal facility. Small releases of hydrocarbons contained within below ground pipes removed by Barclay during site development were immediately contained and any impacted soil was collected and sent offsite for disposal. Development activities conducted by Barclay did not result in the release of any chemicals but, in fact, resulted in the removal of petroleum hydrocarbons left onsite by Shell's historical activities that were discovered by Barclay during grading and other site development activities.

Opinion 5 - Residual Petroleum Hydrocarbons Left Onsite by Shell and "Explicitly-Known" to Barclay Were Disposed of Offsite by Barclay and Included Residual Petroleum Hydrocarbon Materials Left in Reservoir 7 and Residual Petroleum Hydrocarbons at the Swing Pit Area

Except for soil beneath Reservoir 6, all of the residual petroleum hydrocarbons "explicitly-known" to Barclay were collected and disposed of offsite. Residual petroleum hydrocarbons left onsite by Shell including (i) tarry, semi-solid petroleum hydrocarbon materials found in Reservoir 7 and (ii) liquid hydrocarbons found in pipes and pipelines on the Subject Property, were collected and disposed of offsite prior to Barclay taking title to the Subject Property. Barclay removed all liquids and other petroleum hydrocarbon materials from Reservoir 7 and shipped the removed hydrocarbon materials to an offsite disposal facility. Small releases of hydrocarbons from below ground pipes removed by Barclay during site development were immediately contained and any impacted soil was collected and sent offsite for disposal.

The residual petroleum hydrocarbons "explicitly-known" to Barclay were removed by Barclay and thus not spread during demolition of reservoirs, site grading, and other site development activities. Residual petroleum hydrocarbons that are the subject of the required regulatory actions under Shell's Current CAO were not "explicitly-known" or spread by Barclay.

Opinion 6 - Residual Petroleum Hydrocarbon Materials in Reservoir 7 Did Not Impact the Site Between the Time Barclay Entered the Subject Property and the Time Those Materials Were Removed

When Barclay first entered the Subject Property, Reservoir 7 contained water and a thick, viscous, tarry, semi-solid petroleum hydrocarbon material that was floating on top of the water. The ability of this tarry material to migrate through cracks and into soil was severely limited by its high viscosity and semi-solid state. In addition, the hydrocarbons were separated from the bottom of the reservoir by a layer of water until the last 3 months before water and hydrocarbon removals were completed. There is little to no chance that petroleum hydrocarbon materials from Reservoir 7 were released to the subsurface at the Subject Property after Barclay entered the site.

Opinion 7 - Barclay Adequately Ripped the Concrete Floors of the Former Reservoirs

All accounts by Barclay personnel, grading contractors, geotechnical engineers, and County Inspectors indicate that the concrete ripping and burial was conducted in accordance with the approved grading plans and the recommendations of PSE.

Shell's environmental consultant, URS, further substantiates that Barclay adequately ripped the concrete floors of the former reservoirs. URS concludes "[l]ack of evidence of significant ponding of water indicates that the reservoir base perforations provide for percolation of infiltrating precipitation and irrigation water. The URS report states: "This conclusion is based on observations from more than 2,400 borings during residential investigations that wet soil conditions are limited in areal extent and rarely exceed 1 foot in soil column height above the concrete." [21]

Opinion 8 - Minor Amounts of Residual Petroleum Hydrocarbons Beneath the Reservoir Floors Left Onsite by Shell and "Explicitly-Known" to Barclay Were Not Disturbed by Barclay

Soil with minor amounts of residual hydrocarbons was identified in geotechnical borings performed by PSE in Reservoir 6. The soil descriptions provided in the soil classification logs describe the soil as stained, oily, or having a petroleum odor. The soil classification descriptions do not indicate that large amounts of contamination or free phase product existed under the former reservoir floors at the locations tested. In addition, hydraulic conductivity testing for stained soil samples conducted by PSE demonstrated significant water conductivity providing additional evidence that the soil porosity was not filled with residual hydrocarbons. PSE reports describing geotechnical studies performed in Reservoirs 5 and 7 did not report observations of petroleum hydrocarbons.

Deposition testimony by Mr. Alfred Vollmer (Mr. A. Vollmer) indicates that he did not see hydrocarbon contamination in soil disturbed by ripping the floors in Reservoirs 5 and 6. Mr. A. Vollmer was an equipment operator employed by Vollmer Engineering who worked in Reservoirs 5 and 6 and who performed ripping of the concrete floors and movement of soil from the berms into the reservoirs as fill and completed grading and compaction in the reservoirs.

Stained soil under Reservoir 6 was not disturbed by Barclay and a minimum of 7 feet of clean soil was placed on top of the former reservoir floors during development. These residual petroleum hydrocarbons were not disturbed or spread by Barclay during property demolition, site grading, and other site development activities. Residual petroleum hydrocarbons that are the subject of required regulatory actions under Shell's Current CAO were not disturbed or spread by Barclay.

Opinion 9 - There Is No Evidence that Berm Soils Were Impacted with Petroleum Hydrocarbons When Barclay Used Berm Soil to Fill in the Reservoirs

There is no evidence which demonstrates that soil within the berms was contaminated with residual petroleum hydrocarbons. All accounts by Barclay personnel, grading contractors, and the geotechnical engineers indicate that no residual petroleum hydrocarbons were observed during site demolition, grading, or other activities conducted by Barclay. Testing performed by Barclay indicates that no petroleum hydrocarbons were

[21] URS Corporation. 2013. *Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slabs, Former Kast Property, Carson, California*. June 28. p. 3-2 and 3-3.

reported in berm soils based on a PSE report dated January 7, 1966[22] and testimony by Mr. Bach[23] and Mr. A. Vollmer.[24] No reports or inspection logs prepared by onsite County Inspectors document the presence of petroleum hydrocarbons in the berm soils used to fill the reservoirs.

In addition, at the time of the development, County Inspectors were primarily concerned with the soil column's ability to drain water properly. All soil testing was performed to evaluate the drainage and load-bearing properties of the soil. Testing for potential petroleum hydrocarbons in berm soil was simply not an issue and analytical test methods for evaluating petroleum hydrocarbons in soil were not available in the mid-1960s. Thus, no petroleum hydrocarbon testing was performed on the berm soil, although soil was examined for classification purposes by PSE. Therefore, Barclay had no "explicit-knowledge" of petroleum hydrocarbons in the berm soil at the Subject Property and all evidence supports this conclusion.

Opinion 10 - Contamination "Explicitly-Known" to Barclay Was Not Present at Other Features on the Subject Property or If Found Was Taken Offsite for Disposal

Other historical features of potential environmental significance included two sumps, several ponds, pipelines, the pump house and surrounding area, and the swing pipe pit. Based on a review of the depositions of Mr. Bach, Mr. L. Vollmer, and Mr. A. Vollmer, who were onsite during the grading and development of the property, there was little evidence of these features remaining when Barclay initiated the development of the property. Where features were still present, no surficial contaminated soil was observed.

Residual oil in below ground pipelines was encountered during demolition of those features remaining onsite; this oil and any impacted soil resulting from oil that spilled from those pipes during removal was collected and disposed of offsite by Barclay. Contaminated soil discovered during site grading and development activities was removed by Barclay and sent offsite for disposal. No petroleum hydrocarbon contamination was "explicitly-known" to Barclay at other features on the Subject Property that was not taken offsite for disposal.

Opinion 11 - Upward Chemical Migration Was Discovered at Shell Reservoirs 1 & 2

During the 1990s, Shell Reservoirs 1 and 2 were decommissioned by Shell in a manner similar to how Barclay decommissioned Reservoirs 5, 6, and 7. Within one year of the completion of the demolition and decommissioning of Reservoirs 1 and 2, Shell observed residual petroleum hydrocarbons that had migrated upwards to the surface around the edge of the cap. To reach the surface, the contaminants had to migrate vertically upward from deeper contamination that remained in place after the reservoir decommissioning. The source of the residual petroleum hydrocarbon contamination could only be that located under the former reservoirs and in the adjacent unexcavated portions of the reservoir berms.

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[22] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. p. 2. (CAR 2)
[23] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 144:9-148:17
[24] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 44: 3-25.

Opinion 12 - Both Shell and the RWQCB Were Familiar with the Decommissioning Activities at Shell Reservoirs 1 and 2, and the Associated Upward Migration of Chemicals through the Fill

The RWQCB involvement in this Shell project to decommission Shell Reservoirs 1 and 2 spanned the time period from March 1994 to August 1997. During this time period the RWQCB reviewed numerous site characterization documents and status reports, and reviewed and approved all of Shell's site remediation and mitigation workplans. The RWQCB was involved in the initial site characterization, decommissioning, backfilling, soil compaction and capping of Reservoirs 1 and 2, as well as the upward hydrocarbon migration at the cap edges and Shell's additional efforts for soil removal, soil treatment and cap extension.

Substantial upward migration (seepage) of hydrocarbons occurred as a result of the reservoir closure activities performed by Shell and approved by the RWQCB. Upward migration of hydrocarbon contamination in this setting is therefore a phenomenon with which both Shell and the RWQCB have been familiar as early as 1996.

Opinion 13 - The Pattern of Migration of Petroleum Hydrocarbons at the Subject Property is Upward Migration and is Similar to Upward Chemical Migration Found at Shell Reservoirs 1 and 2

The contamination profile at the former reservoirs on the Subject Property shows an upward migration pattern where the highest concentrations are at the bottom, just beneath the former reservoir floors, and where concentrations are lower in shallower soil samples (a "bottom-up" contamination pattern) that originates from the contamination left beneath the former reservoirs by Shell. The depth of the highest TPHd concentrations is generally below the floors of the former reservoirs (in the soil left in place by Shell) that was not disturbed by Barclay. In addition, the highest concentrations and largest areas of shallow soil impact (from upward migration) are observed in locations above the perimeters of the former reservoir floors, in the areas of highest TPHd concentrations where significant deep soil impact was found beneath the former reservoir floors.

Waterstone examined four potential backfill scenarios to explain the contamination pattern exhibited at the Subject Property. The result of my examination of these scenarios indicates upward migration of petroleum hydrocarbons is the only plausible explanation for the contamination pattern observed on the Subject Property. This upward migration pattern of petroleum hydrocarbons are similar to those observed and documented as a result of upward migration of residual petroleum hydrocarbons from beneath Shell's Reservoirs 1 and 2.

This same upward migration pattern was documented at Shell Reservoirs 1 and 2 where the highest petroleum hydrocarbon concentrations were detected in the deepest samples and were located at the perimeter of the reservoir floors. The contamination concentrations decrease at shallower depths in the soil column as a result of upward migration of the residual petroleum hydrocarbons that remained (i) beneath the former reservoir floors and (ii) in the unexcavated portions of the reservoir berms.

The initial reservoir backfilling, compaction, and capping was expected to be a final remedy to the Reservoirs 1 and 2 demolition and dismantling project. However, after the initial project was completed, hydrocarbon seepage originating from deeper contaminated soil was observed at the surface around the clay cap. After surface seeps were noted, Shell consultants discovered veins of free product and associated residual hydrocarbon-saturated soil. The resultant upward migration pattern of petroleum hydrocarbons observed at Shell's former Reservoirs 1 and 2 are similar to those observed at Shell's former Reservoirs 5 through 7 at the Subject Property.

Opinion 14 – Similarities in the History, Decommissioning, Backfill, and Contamination of Reservoirs 1, 2, 5, 6, & 7 Provide Support for Upward Contaminant Migration in Reservoirs 5, 6, & 7

Shell operated the Wilmington Refinery on a large tract of land located about 1 mile east of the Subject Property. Shell Reservoirs 1, 2, 3, and 4 were located at the Wilmington Refinery and were used along with the Subject Property Reservoirs 5, 6, and 7 to provide a large storage capacity for Shell's refinery needs. All seven reservoirs were constructed at the same time during 1923 and have very similar construction. A notable difference is that Shell operated Reservoirs 1 and 2 for 68 years compared to approximately 36 years for Reservoirs 5, 6, and 7 at the Subject Property.

Shell Reservoirs 1 and 2 were decommissioned in the mid-1990s using a procedure very similar to Barclay's procedure for decommissioning Reservoirs 5, 6, and 7. Following is a summary of the similarities between Shell's Reservoirs 1 and 2 and the Subject Property Reservoirs 5, 6, and 7:

- The reservoirs were constructed at the same time and in the same way.
- Berm soil showed no free phase hydrocarbons during decommissioning.
- Soil beneath the floor showed no free phase hydrocarbons prior to decommissioning.
- The largest petroleum hydrocarbon releases are at the perimeter of the floors at the sidewall/floor joint.
- There is less impact beneath the interior of the floors at distances that are further from the perimeter of the floors.
- Hydrocarbons have seeped to the surface from contaminated soil below the former floors of the reservoirs.

Shell's data for Reservoir's 1 and 2 indicate the same upward migration pattern of contamination that originated from leakage of petroleum hydrocarbons near the sidewall/floor joint as that known to exist at the Subject Property.

Opinion 15 - The Soil Contamination Data Collected within the Former Reservoirs Is Consistent With the Upward Chemical Migration Scenario and Does not Support the Hypothetical Downward Migration Scheme

Two of the soil contaminant patterns evaluated for the Subject Property were validated by soil analytical data from Shell Investigations, and included a bottom-up migration pattern within the former Reservoirs 5 through 7 and a top-down migration pattern within the former main sump east of Reservoir 5, the pump house, and the area surrounding the pump house. These contaminant patterns were as follows:

- **Bottom-up Migration Within the Former Reservoirs** - Residual petroleum hydrocarbons found in the soil above and near to the former floors of Reservoirs 5, 6, and 7 is a result of the upward migration of residual petroleum hydrocarbon contamination beneath the former reservoirs.
- **Top-down Migration Outside the Former Reservoirs -** Top-down migration was observed within the former main sump east of Reservoir 5 and within the pump house and area surrounding the pump house.

These contamination patterns indicate that the bottom-up contamination pattern of petroleum hydrocarbons within former Reservoirs 5 through 7 can only be explained by upward migration of Shell's residual petroleum hydrocarbons from beneath the former reservoirs floors into the clean berm soil placed in the former reservoirs by Barclay during development activities. The top-down contamination patterns observed at the former main sump, the pump house and the area surrounding the pump house, coupled with the grading record for the Subject Property, indicate that the petroleum hydrocarbons in these areas were the result of Shell's historic operation at the Subject Property and they were not visible to, or disturbed by, Barclay.

Opinion 16 - The Backfill and Compaction Procedure Used by Barclay in Former Reservoirs 5 through 7 Would Make It Impossible to Create the Pattern of Contamination that the Data from Shell Investigations Shows

The soil was bulldozed downward from the top of the berms and placed into the reservoir in layers with equipment that mixed and homogenized the soil as it is was being placed into the reservoir. The data from Shell's Investigations shows contamination in the shallow fill soil aligned in columns that do not show the random patterns that would be expected with mixing; instead, the pattern of contamination that exists shows higher concentrations of TPHd near the concrete floor of the former reservoir and gradually lesser amounts of TPHd found in the soil closer to the surface (bottom-up contamination).

If any petroleum hydrocarbon contamination was present in the berm soil, it would have been placed randomly in the reservoir as there would be no way for operators to create those patterns by design. In order to create the existing contamination pattern, it would have been necessary to decide which soil was contaminated, the degree of contamination, and thus the appropriate burial depth or location within the reservoir. The only way the observed pattern of contamination could have occurred naturally is if the source came from the bottom and migrated upward as described above. Because soil was placed in the reservoirs in lifts, creating the observed pattern in all three reservoirs assumes a level of knowledge, skill, and desire by the operators during the 1960s for which there is no known motivation or evidence. In other words, the observed pattern could not possibly occur if the berm soil had been contaminated before Barclay began spreading it.

Opinion 17- Concerns and Issues Raised by the RWQCB Staff Were Addressed

Waterstone evaluated concerns raised by the RWQCB staff based on their interpretation of the soil contamination data and the operation of contaminant transport mechanisms they believe primarily affect the direction in which contaminants have migrated in the subsurface. These issues include: (i) the effect of the concrete reservoir floors and (ii) infiltration and washing/leaching of contaminants in the vadose zone. In addition, Waterstone compared the areas of the Subject Property where the typical contamination profiles for top-down contamination are evident to the contamination profiles observed inside the perimeter of the former reservoirs. This comparison showed that upward chemical migration is occurring within the former reservoirs, primarily at the perimeter.

Based on this comparison, it was concluded that the presence of the ripped former concrete reservoir floors had no discernible impact on the vertical migration of contaminants or the vertical profile of contaminants within the former reservoirs of the Subject Property; that the presence of landscaped areas or local irrigation had no discernible impact on the vertical profile of contamination at the Subject Property; that the presence of surface caps such as sidewalks or streets had no discernible impact on the vertical profile of contamination at the Subject Property; and that the only plausible explanation for vertical contaminant profile documented within the former reservoirs is the upward migration of petroleum hydrocarbons into the clean reservoir fill soil from residual petroleum hydrocarbons which remained beneath the former reservoirs floors due to Shell’s historic operations at the Subject Property.

Opinion 18 - There Are Well Documented Technical Explanations for Upward Chemical Migration

Upward migration of petroleum hydrocarbons in the subsurface is not a new or novel concept. It can occur in a number of ways. First, in the vadose zone or unsaturated zone, upward migration of fluids (including both water and hydrocarbons) is primarily driven by capillary action within the soil pores. This concept is no different than the well documented and understood capillary action observed in the vadose zone above the water table, referred to as the capillary fringe. In a similar manner to water being transported upward above the water table within the capillary fringe, petroleum hydrocarbons that originated from a release into the vadose zone can migrate both laterally and upward by this same capillary action within the unsaturated soil column.

Capillary action is the ability of a liquid such as water or oil to flow into pore spaces within the unsaturated or vadose zone of the subsurface without the assistance of, and in opposition to, external forces such as gravity. Movement of the fluid occurs because of intermolecular forces between the liquid and the surrounding solid soil surfaces. Capillary action is responsible for moving fluids such as water, pure hydrocarbons, and/or oil in the unsaturated zone from “wet” areas of the soil to “dry” areas.

Second, within a water-saturated environment petroleum hydrocarbons, if present, will float upward to the top of the water table since they are less dense than water and also insoluble. The main mechanism for this type of transport is buoyancy forces causing the petroleum hydrocarbons to migrate upward through the water column.

Third, in a pressurized environment, compressed hydrocarbon fluid will migrate from the area of high pressure towards areas of low pressure. This is one of the common driving forces for natural petroleum seeps such as those that occur at the La Brea Tar Pits and have been common place throughout California where there are thousands of documented naturally occurring seeps.

Opinion 19 - Other Shell Sites Exhibiting Upward Chemical Migration Exist in Southern California

Besides discovering upward chemical migration at Reservoirs 1 and 2, Shell has experienced upward chemical migration at a number of other locations on two of their properties in Carson, California. These other Shell sites are well documented inactive disposal sites in the Shell Wilmington Manufacturing Complex (WMC), Dominguez and Wilmington Sections, which are in close proximity to the Subject Property and have similar soil types to the Subject Property. The petroleum hydrocarbon contamination that seeped vertically upward to the surface at these Shell sites, mostly as tar seeps was, again, similar in nature to the hydrocarbon contamination found at the Subject Property.

At the Shell WMC Dominguez Section, upward chemical migration was found at the Inactive Disposal Site D1, Inactive Disposal Site D2, Inactive Disposal Site D3, Inactive Disposal Site D5, Inactive Disposal Site D6, and Inactive Disposal Site D7. At the Shell WMC Wilmington Section, upward chemical migration was also found at the Inactive Disposal Site W1. Thus, Shell has intimate knowledge regarding the existence of upward chemical migration and situations promoting upward chemical migration.

Opinion 20 - Other Non-Shell Case Studies Exhibiting Upward Chemical Migration Exist in Southern California

There are numerous examples of sites in Southern California where upward migration of petroleum hydrocarbons has been demonstrated. Three examples of local sites where upward migration of petroleum hydrocarbons occurred after filling in excavations and burying residual hydrocarbons are: (i) the Ralph Gray Trucking Co. site, (ii) the Mt. Poso Tank Farm, and (iii) the McColl Landfill site. Two of the three sites (Ralph Gray Trucking Co. site and the McColl Landfill site) are USEPA Superfund Sites and one site (Mt. Poso Tank Farm) is a DTSC site. All three of these cleanup sites provide examples of documented upward petroleum migration where petroleum hydrocarbons migrated up through clean fill soils all the way to the surface.

Section 2
Introduction

2.1 Qualifications and Experience

As Managing Principal Environmental Scientist and owner of Waterstone Environmental, Inc. (Waterstone), and in my past work as Chief Technical Scientist and senior vice-president of a national environmental engineering consulting firm, I have spent the past 33 years using the principles of environmental chemistry, geology, hydrogeology, and engineering as it relates to the investigation and characterization of waste and contamination in soil, soil gas, and groundwater, as well as the remediation, cleanup, and disposal of those media. I am a recognized expert in these subjects and have provided expert testimony regarding these topics for numerous clients.

I hold degrees in biology (B.S.; USC 1975) and chemistry (PhD; USC 1980). I have spent the vast majority of my professional life involved in the evaluation and resolution of environmental issues concerning hazardous chemical releases that resulted in soil, soil vapor, and groundwater contamination. I regularly meet with clients and appear before representatives of various county and municipal environmental health agencies and fire departments, RWQCBs, the Department of Toxic Substances Control (DTSC), the California Environmental Protection Agency (EPA), United States (US) EPA, and the US Department of Justice to provide my expertise on issues related to the extent and nature of contamination in groundwater, fate and transport of chemicals through aquifers, remediation of chemical contamination in aquifers, and costs related to cleanup of soil and groundwater media.

From July 1988 to July 1997, I was employed with McLaren/Hart Environmental Engineering, a consulting firm with 17 office locations in the US. My responsibilities increased over time until I became Senior Vice President in-charge of West Coast operations. During this time, I was an active consultant providing strategy, direction, and work product in the topics listed above as well as responsible for the work product and management of hundreds of technical professional staff consisting of environmental scientists, hydrogeologists, engineers, chemists and toxicologists.

From 1997 to present, I have been the owner and Managing Principal of Waterstone. Using my education and the knowledge gained during my 30+ years of experience, I work actively as a consultant performing soil and groundwater investigations, developing remediation and clean-up strategies, and implementing those strategies in manner consistent with client's needs and regulator's requirements.

My resumé is provided in Appendix A.

2.2 Documents Reviewed

To prepare this document, I downloaded thousands of reports, technical data packages and correspondence documents for the Subject Property that were publicly available from the RWQCB's Geotracker website. In addition, using chemical analysis data available from Geotracker, I created a database to perform various types of data evaluation.

I then obtained from legal counsel certain documents pertaining to decommissioning and grading of the reservoirs at the Subject Property. This included, among other things, the following:

- County of Los Angeles documents from the 1960s that record County approvals and oversight of reservoir decommissioning, grading, drainage, and other building and construction requirements for the development of the Subject Property.
- Shell correspondence from the 1960s pertaining to its sale of the Subject Property to Barclay and its oversight of Barclay's activities during decommissioning of the reservoirs.
- Documents providing a history of Shell's Wilmington Refinery including details of construction.
- Deposition testimony of numerous involved persons including the following people who worked onsite during the decommissioning of the reservoirs and grading of the site and who have personal knowledge of and provided eyewitness testimony describing Barclay's activities in the 1960s:
    - George Bach (Mr. Bach): Barclay's engineer who was onsite daily to oversee all operations.[25]
    - Leroy Vollmer (Mr. L. Vollmer): Owner of Vollmer Engineering, the subcontractor hired by Barclay to perform decommissioning and grading of the Subject Property for residential development. Mr. L. Vollmer was onsite on a nearly daily[26] basis performing the work.
    - Alfred Vollmer (Mr. A. Vollmer): Employee of Vollmer Engineering and equipment operator. Mr. A. Vollmer was onsite for most of the project[27] and performed ripping of concrete floors and placement of berm soils into the reservoirs in Reservoirs 5 and 6 and other grading work including the main sump area.

[25] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 11. p. 68: 10-25, p. 69: 1-25, p. 70:1-25, p. 71: 1-5; Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 70: 5-13, p. 294: 3-10; Anderson, L. 2013. *Videotaped Deposition of Lowell Dwaine Anderson, Jr.* December 18. p. 39: 7-13
[26] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 68: 11-24, p. 72: 6-25, p. 73: 1-3, p. 268: 21-25, p. 269: 1-15
[27] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 24: 1-5

  - o Mr. Lowell Anderson (Mr. Anderson): Employee of Vollmer Engineering and equipment operator. Mr. Anderson was onsite for most of the project and performed grading work in all three reservoirs.[28]

- ➢ Deposition testimony of other persons including:
  - o Mr. Eugene Zeller (Mr. Zeller): the head of the grading section at the County of Los Angeles Building and Safety Department during the time decommissioning and grading activities occurred at the Subject Property.
  - o Ms. Claudine Schultz (Ms. Schultz): the owner of a chicken ranch property south of the pump house area and west of Reservoir 6 who worked on this adjacent property at the time decommissioning and grading activities occurred at the Subject Property.

I also reviewed academic journals and records from other contaminated sites, some of which were provided by legal counsel at my request and others of which were obtained by my own staff. I reviewed many other documents not specifically mentioned above. The documents I specifically relied upon for a particular point are cited in the footnotes of this report, but while the footnotes are intended to demonstrate support that is scientifically sufficient, I made no attempt to make them exhaustive. In other words, there may be multiple supporting documents not cited in a footnote that make the same point. The opinions that follow are based upon this research, my review and study of these documents, and my knowledge, training, and experience.

2.3 Goals and Objectives

In December 2012, Waterstone was hired by Gibson Dunn & Crutcher, LLP (Gibson Dunn) to review and evaluate the site characterization results at the Carousel Tract to determine among other things the extent of Barclay's role, if any, in the release of crude oil and/or other petroleum hydrocarbons at the Subject Property during site demolition, grading, and/or other development activities. In this regard, Waterstone was specifically asked to determine whether Barclay caused or permitted any waste to be discharged or deposited at the Subject Property, and whether Barclay created or threatened to create a condition of pollution or nuisance which could require an order of the RWQCB to clean up the waste or abate the effects of the waste.

Gibson Dunn also requested that I present the results of Waterstone's investigation to the staff of the RWQCB. In that regard, Waterstone made two presentations to certain staff members of the RWQCB - one in September 2013 and the other in October 2013.

Finally, Gibson Dunn has requested that Waterstone prepare this report summarizing the results of our investigations to date and specifically addressing the assertions made by the RWQCB in its most recent draft CAO.

[28] Anderson, L. 2013. *Videotaped Deposition of Lowell Dwaine Anderson, Jr.* December 18. p. 11: 1-25, p. 12: 1-16, p. 48: 6-25, p. 49: 1-25, p. 50: 1-12, p. 64: 17-25, p. 65: 1-25, p. 66: 1-25, p. 67: 1-22; Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 25: 8-19, p. 68: 25, p. 56: 7-13, p. 69: 1-2, p. 73: 4-17

A list of references cited in this report is provided in Appendix B.

2.4 Site Background

The Carousel Tract (Subject Property) is a 44 acre site located in Carson, California (Figure 1). The Subject Property is currently bordered by the Los Angeles County Metropolitan Transportation Authority (MTA) railroad tracks to the north (railroad right-of-way was formerly owned by the BNSF Railway Company), Lomita Boulevard to the south, residential properties of the Monterey Pines Community and the Main Street Business Center[29] to the west, and residential properties to the east (Figure 2).

The Subject Property was undeveloped and vacant until 1923 when it was purchased from Mary Kast by Shell Oil Company, now called Shell Oil Products US (Shell), and developed with the construction of three oil storage reservoirs.[30,31,32] Based on historical records, two reservoirs (Reservoir 5, centrally located, and Reservoir 6, to the south) each with a capacity of 750,000 barrels and one reservoir (Reservoir 7, to the north) with a capacity of 2,000,000 barrels were constructed by 1924 (Figure 3 and Figure 4).[33]

In addition, an oil pump house was located in the southwest portion of the Subject Property, which served to pump oil into and out of the reservoirs via subgrade pipelines.[34] The oil was transported down Lomita Boulevard to the nearby Wilmington Refinery for refining. Besides the reservoirs, other features located on the Subject Property included berms, an oil pump house and surrounding pump house area, a swing pipe, two sumps, and areas where stormwater ponded (ponds).

The three reservoirs located at the Subject Property were part of a larger complex of a total of seven oil reservoirs of similar construction developed by Shell in the 1920s as part of the Wilmington Refinery[35,36] located a mile to the east. Shell documents indicate that the reservoirs at the Subject Property were mostly used to store crude oil, though it is known that bunker oil or heavier intermediate refinery streams may also have been stored in the reservoirs.[37]

The reservoirs had reinforced concrete-lined earthen floors and sloped sidewalls, with wood frame roofs, and were surrounded by earthen berms which were generally about 15 feet in height

[29] The Main Street Business Center is the location of the former Turco Products Facility.
[30] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29.
[31] EDR. 2013. Certified Sanborn Map Report for Kast Property 1924 and 1925.
[32] Shell Co. of Cal. 1923. Land Purchase Description. (SOC 120957)
[33] EDR. 2013. Certified Sanborn Map Report for Kast Property 1924 and 1925.
[34] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29.
[35] Shell Oil Company of California. 1923. *The Very First Operating & Construction Report, Simplex Refining Dept., Wilmington Refinery*. September 30. p. 13.
[36] Beaton, Kendall. 1957. *Enterprise in Oil A History of Shell in the United States*. March. p. 262.
[37] Clark, Durland. Land Department Manager. Shell Oil Company. 1963. *Letter Regarding the Rezoning of the Kast Tank Farm*. August 26.(SOC 120556)

above the surrounding ground surface with 7-foot wide walks on top.[38,39,40]

Barclay's geotechnical engineer, Pacific Soils Engineering, Inc. (PSE) prepared a report indicating that an "old sump reported to be only three feet in depth" was located in the area directly east of the central reservoir, Reservoir 5.[41] This area was a low area on the site based on contour maps[42] of the original grade of the Subject Property before decommissioning and demolition activities. The Subject Property was used actively for petroleum storage until approximately the late 1950s or early 1960s, at which point it was used on a standby basis.[43]

In October 1965, Shell entered into a purchase agreement for the Subject Property with Richard Barclay of BHC who thereafter nominated Lomita Development as its designee for purchase of the Subject Property. Title was transferred to Lomita Development in October 1966. By a letter dated December 15, 1965,[44] Shell granted permission to Barclay to enter the site to begin demolition and grading activities. According to deposition testimony[45] by Mr. L. Vollmer Barclay first arrived on the Subject Property in late December 1965 to "bid the work to be done" and work began in January 1966.[46] On or before January 7, 1966, PSE went onto the site to perform testing needed for its Preliminary Soils Report dated January 7, 1966. A grading permit was issued for the project by the County of Los Angeles Building and Safety Division on or about February, 9, 1966.

Vollmer Engineering was hired by Barclay to remove the oil storage reservoirs and return the site to its natural grade. Available documents indicate that the reservoir concrete floors were abandoned in place and linear trenches were cut into the concrete floors to facilitate water drainage.[47,48,49] Residual liquids and sludge were removed prior to trenching the floors.[50] Concrete from the sides of the reservoirs was reportedly removed and placed in the bottom of the

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[38] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. p. 1. (CAR 1)

[39] EDR. 2013. Certified Sanborn Map Report for Kast Property1924 and 1925.

[40] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29.

[41] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. p. 1. (CAR 1)

[42] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. Plates A-1 through A-4.

[43] Clark, Durland. Land Department Manager. Shell Oil Company. 1963. *Letter Regarding Rezoning Adjacent to Kast.* August 26. (SOC 120556)

[44] Clark, D. E. 1965. *RE: Wilmington Field Kast Fee – Kast Tank Farm, Your Reference: Lomita Property.* Correspondence from Shell Oil Co. to Barclay. December 15. p. 3, par. 4. (SOC000060)

[45] Also see Section 2.2 for further description of deposition testimony reviewed for this report.

[46] Vollmer, L. 2013. *Volumes I and II Videotaped Deposition of Leroy H. Vollmer*. March 15 and April 1. p. 36:10-14, p. 37:16-19, p. 92:20-23, p. 146:25 to p. 146:3, p. 275:18-23.

[47] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. p. 3. (CAR 3)

[48] Pacific Soils Engineering, Inc. 1966. *Concrete burial – Tract No. 24936 in the County of Los Angeles, California.* January 31. p. 1-2. (CAR 259-260)

[49] Pacific Soils Engineering, Inc. 1966. *Concrete burial and additional surface drainage data.* September 20. p. 1-3. (CAR 378-380)

[50] URS Corporation. 2013. *Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slabs, Former Kast Property, Carson, California.* June 28.

reservoirs. Fill soil from the berms was added in lifts on top of the ripped concrete bottoms and were compacted prior to adding a new lift. This process was repeated until the interior of each reservoir was brought to grade.[51] The placement of concrete at the base of the reservoirs was approved by the Los Angeles County, Department of Engineering, Building and Safety Division (County) with the requirement that a minimum of seven feet of fill soil be placed above the concrete left in place.[52]

The County of Los Angeles approved the rezoning of the former Shell site from industrial to residential in October 1966. Construction of homes began in 1967 and 285 homes had been constructed and sold by Barclay by the early 1970s.[53] The layout of the residential parcels relative to the former reservoir footprints is shown in Figure 5. The redeveloped site became known as the Carousel Tract.

A 2007 environmental investigation of the neighboring property, the former Turco Products Facility (Turco), identified petroleum hydrocarbons, benzene, toluene and chlorinated solvents at Turco and in step-out soil borings conducted at the Subject Property. Because petroleum hydrocarbons were not historically used at Turco, an inquiry was made by the Department of Toxic Substances Control (DTSC) to the RWQCB about the regulatory status of the Subject Property.

Prompted by the DTSC inquiry, a Section 13267 Order was issued to Shell by the RWQCB on May 8, 2008 requiring an investigation of the Subject Property. Numerous environmental assessments including groundwater, soil, and soil vapor investigations conducted by URS and Geosyntec on behalf of Shell since 2008 (Shell Investigations), including parcel by parcel and public right-of-way sampling, have identified primarily petroleum hydrocarbons; benzene, toluene, ethylbenzene and xylene (BTEX) compounds; and methane in the subsurface. Additional sampling and remediation pilot testing is currently being conducted by Shell.

In 2009, a Notice of Violation (NOV) was issued to Shell, and a second 13267 Order was issued to Shell in 2010. A Cleanup and Abatement Order (CAO) No. R4-2011-0046 was issued by the RWQCB to Shell on March 11, 2011 (Shell’s Current CAO).

Following a request put forth by Shell to name Dole and Barclay as responsible parties on the CAO, a 13267 Order was issued to Dole and Barclay in April 2011 requiring Dole to provide technical information about the Subject Property. Dole responded to the RWQCB on September 15, 2011 explaining why neither Dole nor Barclay should be named as a responsible party in the Order.

[51] URS Corporation. 2013. *Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slabs, Former Kast Property, Carson, California*. June 28. (Pacific Soils Engineering. 1966. *Concrete Burial and Additional Surface Drainage Data (Work Order 6164)*. September 10.)

[52] URS Corporation. 2013. *Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slabs, Former Kast Property, Carson, California*. June 28. (Los Angeles County Building and Safety Division. 1966. *Plan Correction Sheet marked Recheck – Lomita Blvd. & Island Ave., Plan Check No. 1011, District 12* (signed by Zeller). January 28.)

[53] URS Corporation. 2013. *Assessment of Environmental Impact and Feasibility of Removal of Residual Concrete Reservoir Slabs, Former Kast Property, Carson, California*. June 28.

In July 2013 a representative of the RWQCB advised Dole that it was considering naming Barclay Hollander Corp. as a discharger in the CAO. In September and October 2013, Waterstone participated in two separate meetings with the RWQCB staff in Los Angeles to address why Dole and/or Barclay should not be named as a responsible party(s) in the CAO. The meetings were held with the RWQCB Executive Officer, his staff involved in the Carousel case, and a representative from the Office of Chief Counsel from the State Water Resources Control Board.

During these RWQCB meetings, Waterstone (i) presented its evaluation of the potential sources of contamination at the Subject Property; (ii) presented evidence which demonstrated that the source of contamination currently being addressed at the Subject Property was the result of upward contaminant migration originating from below the former reservoir concrete floors (iii) presented case studies showing similar patterns of upward chemical migration on nearby Shell properties including other similar oil storage reservoirs and other sites in Southern California; and (iv) summarized academic articles discussing the theory of upward chemical migration through capillary action. Additionally, Waterstone presented evidence which demonstrated that the shallow contamination found on the Subject Property was not a result of any actions taken by Barclay during development of the Subject Property, but was the legacy of releases from Shell reservoirs prior to any development actions by Barclay.

On October 31, 2013, a draft CAO was issued by the RWQCB naming Dole as a responsible party.

2.5 Known Shell Releases at the Subject Property

Shell Investigations have shown that releases of petroleum hydrocarbons have occurred from the oil reservoirs at the Subject Property during Shell's operation, primarily at the sidewall/floor joint, and to a lesser degree below the reservoir floor in the interior portion of the reservoirs. Petroleum releases along the western portion of Reservoir 5 were significant enough to migrate approximately 50 feet downward and resulted in the accumulation of free product on the water table in this area of the Subject Property. Eyewitness deposition testimony indicates that berm soils that were placed in the reservoir were not impacted by petroleum hydrocarbons.

Since all oil operations had ceased at the Subject Property in the early 1960s, and all oil had been removed from Reservoir 7 in early 1966, any oil contamination that was on the Subject Property at that point in time had originated from Shell's 35 plus years of petroleum storage operations on the Subject Property. Based on the numerous soil and groundwater investigations conducted by URS on behalf of Shell, it can be surmised that at the time of purchase of the Subject Property in 1965 there were significant petroleum hydrocarbon impacts present beneath all three oil reservoirs from Shell's historic operation of the Subject Property, in addition to numerous lesser impact throughout the facility from releases of crude oil to the surface by Shell. The following sections describe the Shell Investigations that support these conclusions.

2.5.1 Deep Soil and Groundwater Contamination at the Subject Property

Most of the Shell Investigations on the Subject Property to date have focused on the shallow soils in the upper 10 feet beneath the individual residential parcels and much less data has been collected in deeper soils below the bottoms of the former reservoirs. Deeper soil evaluation at depths greater than 10 feet on the Subject Property has included approximately 36 soil borings and 25 soundings using a CPT Rapid Optical Screening Tool (ROST) or an Ultraviolet Optical Screening Tool (UVOST). (See Figure 6 for street sample locations). These deeper locations were limited to the existing streets due partially to the limited access on home lots. Borings were advanced within the interiors of the former reservoirs and in locations around the perimeters of the reservoir floors.[54,55]

The results of these borings show that intermittent columns of the deep contamination are concentrated near the perimeter of the former reservoir floors (at the sidewall/floor joint – See Figures 7 to 9). The contamination in those areas was found at higher concentrations and generally migrated to deeper depths. Generally, there was less soil impact discovered beneath the interior portions of the reservoir floors.

This pattern of deep contamination indicates that releases from the reservoirs occurred primarily at the sidewall/floor joint. This concentration of soil contamination provided the mass for the subsequent upward migration as presented in this report and is consistent with the results of shallow soil testing which exhibited a similar pattern concentrated at the perimeters of the reservoirs.

2.5.1.1 Soil Sampling Data from Shell Investigations Beneath the Sidewall/Floor Joint

The distribution of petroleum hydrocarbons in soil beneath this portion of the Subject Property oil reservoirs is best depicted by the 10-foot deep samples collected at Reservoir 5 (Figure 10). This is because the depths of these samples are almost all located beneath the depth of the reservoir floor (see Figure 11), whereas at Reservoir 7 only samples from approximately the northwest ¼ of the reservoir represent depths beneath the floor. And at Reservoir 6, almost all of the 10-foot deep samples were collected above the reservoir floor (Figure 11). The difference in the floor elevations is due to the fact that the northwest corner of the Subject Property is approximately 10 feet lower than the southeast corner. To evaluate soil impacts beneath the floors of Reservoir 6 and most of Reservoir 7, samples from deeper than 10 feet must be evaluated.

The results for TPHd in soil within selected deep soil borings are summarized in Table 1. The deeper soil borings completed within the streets located near the outer perimeter of the reservoir floors show that the highest concentrations of TPHd were typically found at depths near the

[54] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. Borings 15 Feet bgs or Greater, Figure 3.

[55] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. Figure 9.

floors of the reservoirs, either just above or just below the floor.[56,57,58] For example, results from soil borings DP-4 and MW-3 (see URS Figure 3 in Appendix C), located on Marbella Avenue near the western edge of Reservoir 5, depict a top-down distribution of petroleum impacts beginning at a depth of 10 feet, migrating downward beneath the intersection of the sidewall/floor joint of Reservoir 5. The maximum TPHd concentration at this location was 19,000 mg/kg at 10 feet bgs, a depth just beneath the bottom of the reservoir. The concentration decreased to 11,000 mg/kg at 35 feet bgs and to non-detect at 40 feet bgs. At MW-12, located approximately 30 feet to the west, the soil impact extends to a depth of 45 feet (see URS Figure 2 in Appendix C).

Soil boring DP-7 (see URS Figure 3 in Appendix C), located at the western edge of Reservoir 7, demonstrates this same top-down distribution pattern with 13,000 mg/kg TPHd detected at a depth of 10 feet bgs (below the bottom of the reservoir), increasing to a maximum concentration of 20,000 mg/kg at 15 feet bgs, then decreasing to 1,700 mg/kg at a depth of 25 feet bgs, which was the maximum depth sampled.

Soil boring B-6 (see URS Figure 3 in Appendix C), at the north edge of Reservoir 7, further demonstrates a top-down distribution with a maximum TPHd concentration of 23,000 mg/kg detected at 10 feet bgs decreasing to 3,500 mg/kg at 55 feet bgs which was the deepest sample collected from this soil boring.

The results of CPT ROST/UVOST soundings were consistent with those of the soil borings, both showing significant soil contamination beneath the former reservoir floors extending to depths approaching groundwater.[59] Results at these locations show that the deep contamination is concentrated primarily at the perimeter of the former reservoir floors. Elevated levels of petroleum hydrocarbons in soil extended to a depth approximately 45 feet bgs at Reservoir 5 (in MW-12), 65 feet at Reservoir 6 (in MW-02), and 60 feet at Reservoir 7 (in MW-13) (see URS Figure 2 in Appendix C). All of these soil borings are located at the sidewall/floor joint.

URS (Shell's environmental consultant) concluded that: 1) Deep hydrocarbon impacts to soils do not extend beyond the Site boundary; 2) Deep impacts are localized and occur in the vicinity of the former oil storage reservoirs; and 3) The ROST/UVOST data indicate that deep impacts are limited to near the perimeter of the former reservoirs.[60]

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[56] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. Table 3A p. 1-17

[57] URS Corporation. *Site Characterization Report, Former Kast Property, Carson, California*. October 29. Table 4C, p. 1-3.

[58] URS Corporation. 2009. *Interim Site Characterization Report, Former Kast Property, Carson, California*. August 20. Table 2, p. 1-4.

[59] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. Figures 10B-14B

[60] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. p. 5-9

2.5.1.2 Soil Contamination Identified Below the Reservoir Floors

Although contamination was found beneath the interior portions of the reservoirs, the concentrations and extent were less than that near the sidewall/floor joint and typically it did not extend to any significant depth. These small documented soil petroleum impacts beneath the reservoir floors have originated from lower volume releases within the interior portion of the reservoirs. Based on Shell Investigations analytical results, these petroleum releases were much smaller in size compared to releases that exist at the sidewall/floor joint, both laterally and vertically. Because the reservoirs were filled with oil during the time of Shell's operation, it is likely that these releases found beneath the interior portions of the reservoirs impacted the underlying soil with free phase oil directly beneath the reservoir floors although these releases are smaller than those at the sidewall/floor joint area likely due to the discontinuous nature of small fractures and cracks within the interior of the reservoir floor.

Geotechnical borings drilled to a depth of 12 to 15 feet beneath the floor of Reservoir 6 by PSE (B1 through B6) in 1966 indicated that oil-stained or oily soil was observed directly beneath the floor of the reservoir; however, the actual concentration of petroleum hydrocarbons was not determined.[61]

The number of borings completed during Shell Investigations beneath the reservoir concrete floors within the interior portion of the reservoirs is very limited since the majority of the soil borings on the individual parcels were completed by hand augering, a method where borings are stopped or refused by concrete pieces (such as broken reservoir sidewalls or reservoir bottoms) or other obstructions encountered in the borings. The only locations that could be completed to depth are those within streets where heavy machinery was used to advance the borings and where the concrete floors could be penetrated or passed (through rips or breaks) in completing the boring.

A good example of the smaller releases that are typical of petroleum hydrocarbons detected beneath the interior of the reservoir floors is the soil boring for MW-08 that was drilled in the street and near the center of Reservoir 5 to a total depth of 80 feet bgs.[62] Relatively low concentrations of TPHd (870 mg/kg) were detected in the 10-foot soil sample at this location which is just beneath the reservoir floor, but the deeper 15-foot sample contained non-detect levels. With the exception of a single low-level detection at 20 feet bgs (TPHd of 6.9 mg/kg), all deep samples were non-detect (15-80 feet bgs).

At Reservoir 6, Boring DP-2 was also drilled in the street in a position that is near the center of the reservoir and reached a total depth of 25 feet bgs. TPHd was detected at 3,300 mg/kg at a depth of 10 feet bgs, which, in this location is a depth above the floor of the reservoir. Results from deeper samples from depths of 15, 20, and 25 feet were non-detect.

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[61] Pacific Soils Engineering, Inc. 1966. *Subsurface Drainage Study for Reservoir Located in the Southwest Corner of Tract No. 24836 in the County of Los Angeles, California.* March 11. p. 4-5.

[62] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. Table 3A p. 10-11.

Boring DP-9, drilled to 25 feet bgs near the center of Reservoir 7, had a maximum TPHd concentration of 12,000 mg/kg at 10 feet bgs, a depth just above the floor of the reservoir. Results of deeper samples from depths of 15, 20, and 25 feet bgs were non-detect.

A comparison of these results to those of the samples collected at the intersection of the reservoir bottoms and sidewalls shows that the releases in the centers of the reservoirs were significantly less contaminated based on concentration, and lateral and vertical extent.

2.5.1.3 Groundwater Contamination at the Subject Property

According to the URS Fourth Quarter 2012 Groundwater Monitoring Report, the shallow monitoring well network installed at the Subject Property consists of 17 wells screened across the water table (MW-01 through MW-17). [63] Thirteen of these wells are located onsite, and four are offsite, with one offsite well located up-gradient and three wells downgradient (See URS Figure 2 in Appendix C).

Four dual-completion wells (MW-G01 through MW-G04) are screened in two portions of the Gage aquifer; each has a shallow and deep well (S and D). All of the Gage wells are located onsite (See URS Figures 3 and 4 in Appendix C).

During the 4th Quarter 2012, depth to first groundwater beneath the Subject Property ranged from 51.98 feet (MW-15) to 67.62 (MW-10) feet below the top of casing. The shallow water table reportedly had a northeast gradient of approximately 0.002 feet per foot (See URS Table 4 and Figure 2 in Appendix C).

Depth to groundwater in the Gage aquifer shallow wells ranged from 52.83 feet (MW-G02S) to 62.12 feet (MW-G01S) below the top of casing. Groundwater flow in the shallow Gage wells was to the northeast in the northern part of the Subject Property and to east-northeast in the central to southwestern part of the Subject Property at an approximate gradient of 0.0016 feet per foot (See URS Table 1 and Figure 3 in Appendix C). Depth to groundwater in the Gage aquifer deep wells ranged from 52.89 feet (MW-G02-D) to 62.14 feet (MW-G01D) below the top of casing. In the deeper Gage wells, the gradient was to the east-northeast at approximately 0.0017 feet per foot (See URS Table 4 and Figure 4 in Appendix C).

Light non-aqueous phase liquid (LNAPL) petroleum hydrocarbon contamination has historically been detected in monitoring well MW-03 which is located at the edge of former Reservoir 5 (See URS Figure 2 in Appendix C). LNAPL thickness measured has ranged from a low of 0.14 feet on August 13, 2009 when the well was first installed to a maximum of 14.35 feet on October 17, 2011. Periodic LNAPL recovery has been performed on this well using a pneumatic total fluids pump, with an estimated 69.3 gallons of LNAPL recovered from this well through December 19, 2012. Approximately 3.81 feet of LNAPL were measured in well MW-03 on October 22, 2012 (See URS Table 4 in Appendix C) and 3.33 feet of LNAPL were measured in well MW-03 on December 19, 2012.

[63] URS Corporation. 2013. *Fourth Quarter 2012 Groundwater Monitoring Report, October Through December 2012, Former Kast Property, Carson, California*. January 15.

During the 4th Quarter 2012, TPHd was detected in groundwater samples collected from 14 of the 16 shallow zone wells and ranged in concentration from 33 HDJ[64] µg/L in well MW-17 to a maximum of 2,600 HD in well MW-13, which is located on the northern perimeter of Reservoir 7. During the 4th Quarter 2012, TPHg was detected in water samples collected from 10 of the 16 shallow zone wells sampled at concentrations ranging from 48 HDJ µg/L in up-gradient well MW-07 to 1,800 HD µg/L in well MW-13, which is located on the northern perimeter of Reservoir 7. Total petroleum hydrocarbons in the motor oil range (TPHmo) was detected in groundwater samples collected from 7 wells at concentrations ranging from 350 HD µg/L in MW-06 to a maximum of 1,100 HD µg/L in well MW-13, which is located on the northern perimeter of Reservoir 7. These results are summarized in URS Appendix Table E-1 included in Appendix C.

TPHd was detected during the 4th quarter 2012 monitoring event in three samples from the lower Gage aquifer wells at concentrations of 85 HD µg/L in MW-G0-D, 120 HD µg/L in MW-G03D, and 42 HD J µg/L in MW-G04D. TPHg and TPHmo were not detected in samples from any of the lower Gage wells. Volatile organic compounds (VOCs) such as benzene and chlorinated compounds as well as TPHg and TPHmo were also detected in water samples collected from shallow and/or Gage wells. These results are summarized in URS Appendix Table E-1 included in Appendix C.

As previously mentioned, TPHd was used for Waterstone's evaluation of the Subject Property as a whole to best represent soil impacts. Similarly, TPHd is the TPH fraction to best represent the groundwater impacts beneath the Subject Property. Groundwater impacts exist primarily in the areas of the former oil reservoirs, with the greatest impact noted in well MW-03, located on the western perimeter of Reservoir 5. This well has had measurable LNAPL present since the first sampling event on August 13, 2009 with the maximum LNAPL thickness of 14.35 feet measured on October 17, 2011. This is the only well at the Subject Property that has had measurable LNAPL on the groundwater, indicating that this area had the most significant volume of petroleum hydrocarbons which were released to the subsurface in sufficient volume to migrate from the bottom of Reservoir 5 near well MW-03 approximately 50 plus feet down to groundwater.

Based on the groundwater analytical results indicating that significant leaks occurred in the area of well MW-13 near the northern edge of Reservoir 7 and MW-14 near the western edge of Reservoir 6 that resulted in migration of petroleum hydrocarbons to groundwater causing a dissolved phase plume, the primary source for the groundwater impacts detected beneath the Subject Property are from the reservoirs, and the contribution of other onsite sources to groundwater impacts are minor and secondary to these larger impacts.

[64] According to the laboratory reports, the "HD" qualifier indicates that the chromatograph pattern for the sample did not match with the profile for the reference fuel standard, which is consistent with a crude oil source for the detected petroleum hydrocarbon contamination. The "J" qualifier indicates that the result reported is below the laboratory reporting limit but above the laboratory method detection limit.

2.5.2 Releases to the Berm Sidewalls

Soil samples were not collected from berm soils for chemical analysis by Barclay because there were no analytical methodologies readily available at that time to evaluate TPH in soil (further discussed in Section 3.3.1.3). PSE examined berm soil for geotechnical purposes but did not note the presence of petroleum hydrocarbons (further discussed in Section 4.2). In addition, Mr. Bach, Mr. L. Vollmer, Mr. A. Vollmer, and Mr. Anderson all provide eyewitness testimony that no oil was observed in soil from the berms (further discussed in Section 4.2.2). Therefore, there are no known releases of petroleum hydrocarbons to berm soil before or during development activities by Barclay.

2.5.3 Site Conceptual Model of Contamination Released at the Subject Property

The largest volume of petroleum hydrocarbons released onsite beneath the three oil reservoirs occurred at the sidewall/floor joint. This leaky joint most likely occurred because of a failure in the seal between these two concrete surfaces resulting from (i) soil settlement, (ii) pressure exerted on the joint by the fluid in the reservoir, (iii) design or construction flaws, and/or (iv) other unidentified reasons.

The greatest oil pressure would be exerted on the bottom of the reservoir at this contact joint as a result of the oil pressure head which is directly proportional to the height of the oil in the reservoir at any given time. Waterstone's conclusion that the largest volume of petroleum hydrocarbons released onsite beneath the three oil reservoirs occurred at the sidewall/floor joint is based on an evaluation of laboratory analysis data for soil samples from Shell Investigations since 2009. According to Shell's consultant, URS, the TPHd concentrations in shallow soils, with "the highest concentrations, and greatest density of sample points exceeding 1,000 mg/kg and 10,000 mg/kg, occur in the area of former Reservoir 5. A lower density of elevated concentrations was identified beneath the former location of Reservoir 7. The density of elevated concentrations was even lower beneath former Reservoir 6."[65]

This data indicates that not only are some of the highest concentrations of petroleum hydrocarbons detected at the sidewall/floor joints, but also the deepest contamination is present at this joint location. Shell's environmental consultant, URS, concluded that "deep impacts are localized and occur in the vicinity of the former oil storage reservoirs; and the ROST/UVOST data indicate that deep impacts are limited to near the perimeter of the former reservoirs."[66] Additionally, Shell Investigations indicate that these areas also frequently contained "free phase oil." Figure 10 was compiled by Geosyntec using soil analytical data from sampling performed by URS. The ring-shaped distribution of petroleum impacts beneath the reservoir closely matches the location of the sidewall/floor joint where the major leakage occurred.

[65] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. p. 5-5.

[66] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. p. 5-7.

The graphic in Figure 12 presents a conceptual site model for the demonstrated petroleum hydrocarbon releases that occurred at the Subject Property as a result of Shell's historical use of the reservoirs. The conceptual site model shows that (i) larger leaks occurred beneath the reservoir at the sidewall/floor joint and (ii) smaller more localized petroleum releases occurred from smaller cracks or joints located towards the interior of the reservoir concrete slab bottom.

Section 3
Barclay's "Explicit-Knowledge" of Petroleum Hydrocarbons at the Time of Development

I have examined the findings on page 11 of the draft CAO where Barclay is said to have had "explicit-knowledge … of residual petroleum hydrocarbons and conducted various activities, including partially dismantling the concrete in the reservoirs and grading the onsite materials, thereby spreading the waste." The next sentence of the draft CAO states that "residual petroleum hydrocarbons" are "still present."[67] We have evaluated the extent to which the hydrocarbons of which Barclay had "explicit-knowledge" are "still present" at the site and continue to be the basis for cleanup and abatement under the current order.

To evaluate what Barclay knew about petroleum hydrocarbons during its demolition and grading activities in the 1960s, I reviewed and compiled information from multiple sources. In this document, I refer to Barclay's knowledge using the terms "explicitly-known" or "explicit-knowledge" to provide the RWQCB with the result of my compiled research describing Barclay's knowledge of the presence of residual petroleum hydrocarbons on the Subject Property at the time of Barclay's ownership.

The evidence supports only three possible sources of such "explicitly-known" petroleum hydrocarbons. These are:

1) Petroleum hydrocarbons in Reservoir 7 that remained from Shell operations that were removed from the site.
2) Minor amounts of petroleum hydrocarbons that may have been observed in the soil outside the reservoirs in berms, sumps, and other areas onsite that, where observed, were removed from the site.
3) Petroleum hydrocarbon contamination beneath the reservoir floors that leaked during Shell's operation of the Subject Property.

Waterstone provides a discussion of each of these possible sources of petroleum hydrocarbons in the following sections and concludes that multiple sources of information indicate:

- Residual petroleum hydrocarbons present in Reservoir 7 after Barclay entered the Subject Property did not impact the site because Barclay removed them from the Subject Property and disposed of them offsite.
- Any minor amounts of petroleum hydrocarbons Barclay observed in soil outside the reservoirs was also removed from the Subject Property and disposed of offsite.

[67] Los Angeles Regional Water Quality Control Board. 2013. *Notice of Opportunity to Submit Comments on Proposed Draft Order in the Matter of Cleanup and Abatement Order No. R4-2011-0046, Former Kast Property Tank Farm (SCP No. 1230, Site ID No. 2040330, File No. 11-043).* October 31. p. 11, par. 1.

- Barclay did not have "explicit-knowledge" of significant petroleum hydrocarbons left by Shell beneath the reservoir floors and did not remove or otherwise disturb the soil below the former reservoir floors.
- The minor amount of petroleum hydrocarbons that were "explicitly-known" to Barclay were not disturbed or spread by Barclay.

Information supporting these conclusions is discussed in this section including a detailed analysis of petroleum hydrocarbons related to the reservoirs and a general analysis of features un-related to the reservoirs. The next section, Section 4, provides a detailed analysis of Barclay's "explicit-knowledge" of petroleum hydrocarbons on the Subject Property not related to the reservoirs including berms, sumps, ponds, the pump house area, pipelines, and the swing pipe area.

3.1 Barclay Removed "Explicitly-Known" Petroleum Hydrocarbons in Reservoir 7 and Disposed of Them Offsite

When Barclay entered the Subject Property, the only petroleum hydrocarbon materials inside the reservoirs existed in Reservoir 7 because Reservoirs 6 and 5 were clean and dry. This section provides information on the nature of Barclay's "explicit-knowledge" of petroleum hydrocarbons in Reservoir 7.

3.1.1 Barclay First Procured Shell's Permission to Enter the Subject Property in Mid-December 1965

Barclay did not enter the Subject Property until late December, 1965. In a December 1, 1965 letter to Shell, Barclay requested permission to be onsite "prior to close of sale" to "perform site clearing." It asked permission to remove "liquid waste and petroleum residues" from the reservoirs, indicating that it "will probably be using Chancelor [sic] and Ogden to do this work."[68]

Shell replied in a December 15, 1965 letter which provided permission to begin phase I construction work subject to terms and conditions regarding safety, insurance, and liability including:

> "That all work done by or for you on said lands or in disposing of wastes and residues removed therefrom shall be done in a good, lawful and workmanlike manner. That you shall secure and keep in effect any and all permits and licenses required by any and all public bodies in connection therewith."[69]

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[68] Barclay, Richard. 1965. *RE: Lomita Property.* Correspondence from Barclay to Durland Clark, Shell Oil Co. December 1. p. 1, par. 2. (SOC000056).

[69] Clark, D. E. 1965. *RE: Wilmington Field Kast Fee – Kast Tank Farm, Your Reference: Lomita Property.* Correspondence from Shell Oil Co. to Barclay. December 15. p. 3, par. 4. (SOC000060)

3.1.2 Eyewitness Testimony Indicates Only Reservoir 7 Contained Residual Petroleum Hydrocarbons and Reservoirs 5 and 6 Were Clean and Dry

Eyewitness testimony indicates that when Barclay first arrived at the Subject Property, Reservoirs 5 and 6 were clean and dry and a mixture of water and heavy, very viscous, semi-solid petroleum hydrocarbon materials existed in Reservoir 7. This testimony is provided in deposition transcripts of Mr. L. Vollmer and Mr. Bach, who, on behalf of Barclay, were onsite in 1966 at the time Barclay took possession of the Subject Property. These onsite personnel testified that Reservoir 7 was the only reservoir that held any petroleum hydrocarbon materials at all upon Barclay’s arrival on site, and that, Reservoirs 5 and 6 were clean and dry.

In the following deposition testimony excerpt from Mr. L. Vollmer, he described his onsite presence as “…there were times when I was gone…but otherwise I was pretty much there every day.” [70] The following is Mr. L. Vollmer’s testimony regarding what he observed in the reservoirs when he first arrived at the Subject Property:

> Q Okay. And when you arrived at the site, was there any liquid in the No. 6 reservoir, which is the one at the bottom of the picture?
>
> A No.
>
> Q And the -- when you arrived at the site, was there any liquid in the No. 5 reservoir, which is in the middle of the picture?
>
> A No, they were -- both of them were very clean, really. Just plain concrete.
>
> Q Okay. And when you arrived at the site in 1966, was there any liquid in the reservoir at the top of the picture?
>
> A Yes.
>
> Q That's the No. 7 reservoir?
>
> A Exactly. Yes, it was full of not just clean oil, but kind of an oil mixture and sundry other liquids related to the oil industry, but not just clean oil.[71]

Mr. L. Vollmer went on to state the following about the reservoirs in his deposition testimony:

> Q …So how did it feel to be down inside of them? Did they feel large and massive or did they feel tiny or did they feel confined? How did it feel?
>
> A I didn't spend a great deal of time in the front two because they were -- there was no liquid in them ...[72]

Deposition testimony is also available for Mr. Bach who was responsible for overseeing all onsite activities. Mr. Bach testified he was onsite for part of each morning[73] “almost every

[70] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. I. p. 68:11-17.
[71] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 37:7-24.
[72] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 42:18-25.
[73] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 68: 12-25. p. 69: 21-25. p. 70:13-25. p. 71: 1-5

day.”[74] Regarding his observations of the contents of the reservoirs upon his arrival at the Subject Property, Mr. Bach stated the following:

> Q …And were there any liquids in that tank No. 6 when you arrived?
>
> A No, it was absolutely dry.
>
> Q Absolutely dry on the bottom?
>
> A Yes.
>
> Q Okay. And inside was it -- it was dry. Was it completely -- what was inside of the tank?
>
> A Nothing. You could walk in. As a matter of fact, we did. That's what we did, we went in there and walked around on the bottom of the tank.[75]

Mr. Bach goes on to testify about his observations for Reservoir 5 as follows:

> Q And when you got to the site the first time in 1966, what was the status of Reservoir 5, the one in the middle here?....---was there any liquids inside?
>
> A No, it was clean.
>
> Q Completely cleaned out?
>
> A Yes.
>
> Q And was the concrete still inside?
>
> A Yes.
>
> Q But the concrete was dry?
>
> A Yes.[76]

Mr. Bach also testifies about his observations for Reservoir 7 as follows:

> Q And was there any liquid still in Reservoir 7 at that time? (Note: the question refers to when Mr. Bach arrived at the site the first time in 1966.)
>
> A Yes.
>
> Q About how much?
>
> A Approximately 3 feet.
>
> Q What was -- what was -- what kind of liquid was it?
>
> A It was really heavy what they call bunker C. It's a heavy, dirty fuel oil for tankers, for ships.[77]

Later in his testimony, Mr. Bach describes the material in Reservoir 7 as follows:

> Q How would you describe the substance that you found in the Reservoir 7 when you first got there?
>
> A It was black, sticky, gooey. It was just a heavy, black liquid, semi-liquid almost.

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[74] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 284: 18-19.
[75] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 40: 12-21.
[76] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 50: 7-25. p. 51: 1.
[77] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 51: 15-25.

Q Consisting of what?

A Well, just by looking at it, you couldn't tell. It was my understanding from operations that that's where Shell had put any product there, any petroleum product that was off spec or they didn't want or excess. They pumped in into seven, mixed it up in seven, and then whenever there was a call for bunker C, which was fuel oil for the ships, they would pump it down to the harbor and fuel a ship.[78]

Mr. A. Vollmer testified that Reservoirs 5 and 6 were clean and dry:

Q And at the time that you arrived, were – was Reservoir 5 and 6 both completely clean of any residual --

A Yes. Yeah, it was --

Q I was going to say "residual materials."

A Materials, yes.

Q Were they completely clean of all residual materials?

A They were, yes. [79]

***

Q To your recollection, was the tank bottom that you ripped stained with oil or oil --

A No. No.

Q Do you remember what color it was?

A It was gray. [80]

***

Q Okay. You don't recall seeing any oil stains on the concrete bottom of Tank No. 6 that you performed the ripping operation on?

A No.

Q And with respect to the side walls of Tank 6, do you recall them being stained?

A No.

Q What color do you recall them being?

A They were gray.

Q And then did you perform any of the work with respect to knocking down the side walls?

A Yes, some of it. In the initial part. [81]

***

[78] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 355: 8-22.
[79] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 28: 19 to p. 29:2.
[80] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 73:25 to p. 74:4.
[81] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 75:2-13.

> Q It's your recollection that there were no oil stains on the concrete in Tank No. 6 when you were working in it; correct?
>
> A Absolutely. [82]
>
> ***
>
> Q Now, then, Mr. Loewen asked you about the ripping procedure. Is it your recollection that you actually got off one of your tractors and picked up any of the concrete that comprised the floor of Tank 6?
>
> A Oh, there were occasions when you got off the machine once in a while to look and see what the depth of the breaking up -- how the fracturing was working and what the depth of the tooth was doing, yes.
>
> Q What I'm asking you today is, do you have a recollection of that?
>
> A Oh, yes. Yes.
>
> Q And you have a recollection of actually picking up any of those concrete --
>
> A Yes.
>
> Q -- pieces?
>
> A Yes. I won't say how many times, but I know at least a couple of times, I did.
>
> Q Is it your recollection that those concrete pieces were in fact gray in color?
>
> A Pretty much gray, yes.
>
> Q Is it your recollection that they were not stained with oil to any extent?
>
> A I didn't see it that much.
>
> Q And when you say you didn't see it that much, are you implying that you did see oil stains on the concrete floor that you ripped?
>
> A I should say I didn't see that at all, because I was kind of mystified that there wasn't any staining whatsoever. Like you say, you drop it on your car – or your driveway, you're going to see something. They cleaned that up nice. [83]

3.1.3 Barclay’s Removal and Offsite Disposal of Water and Petroleum Hydrocarbon Materials in Reservoir 7

Barclay removed all liquids and petroleum hydrocarbon materials from Reservoir 7 using a subcontracted company, Chancellor and Ogden. Chancellor and Ogden operated vacuum trucks to gather the liquid in Reservoir 7 and transport it offsite. The material in Reservoir 7 consisted of water and a viscous, semi-solid petroleum hydrocarbon material which could not be pumped after all the water had been removed. Therefore, a soil berm was created by the grading contractor to “push” the remaining tarry petroleum hydrocarbon materials ahead of the berm towards where the vacuum trucks were located. It was necessary to steam heat the tarry petroleum hydrocarbon materials to make it liquid enough to pump. Deposition testimony from eyewitnesses indicates that all of the petroleum hydrocarbon materials from Reservoir 7 were

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[82] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 77:12-15.
[83] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 77:16 to p. 78:22.

removed and hauled offsite. Following are deposition testimony excerpts from Mr. L. Vollmer documenting this process:

> Q And -- and what did Chancellor & Ogden do with the liquids after they removed them?
>
> A They transported it offsite. I'm not familiar with their -- with the places that they dumped it, but definitely offsite.[84]
>
> ***
>
> Q And how did the -- how did Chancellor & Ogden begin -- at the very beginning, how did Chancellor & Ogden begin removing the liquid from Reservoir 7?
>
> A Well, as -- as there -- as was their whole operation, they simply used their vacuum trunks -- trucks to pump it out. Speculation on my part was they pumped out water that had settled to the bottom and was more readily removed and then -- then pumped out the gunk later.[85]
>
> Q Well, there was a time -- there was a time when your company was asked to become involved to give assistance to Chancellor & Ogden in the removal of the liquid; correct?
>
> A Yes.[86]
>
> ***
>
> A It was commented that they had pumped the water out initially from underneath the gunk. And the heavy material that was left behind, the gunk, would not flow to the area that they were using to pump it out. So they needed some help in making that happen.[87]
>
> ***
>
> Q And what solution was worked out?
>
> A I explained to him that I could provide an earthen dam, a movable earthen dam at the far end of the tank and crowd that earthen dam forward, essentially pushing the -- the gunk ahead of me…and closer to their pumping operation.[88]
>
> ***
>
> Q …And the -- eventually when the – there was a time after every -- after the problems were solved and after everything was done when all of the liquids were removed from Reservoir 7; is that right?
>
> A Yes.
>
> Q Okay. And after the liquids were removed, what happened to the earthen -- the dirt from the earthen dam?
>
> A The -- any of the dirt that had been contaminated with the gunk was hauled offsite and the rest of it that was clean was used in the fill.[89]
>
> ***

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[84] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 159: 24-25, p 160: 1-3.
[85] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 160: 21-25. p. 161: 1-5.
[86] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 161: 25-25. p 162:1-3.
[87] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 162: 4-9.
[88] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 165: 2-8.
[89] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 167: 7-18.

> Q And was there any liquid from the reservoir that was disposed of on-site?
>
> A No.[90]

Mr. Bach’s testimony confirmed Mr. L. Vollmer’s account as follows:

> Q Who removed the liquid waste from the site, from the -- from the No. 7 reservoir?
>
> A I subcon- -- Chancellor & Ogden were actually the company that had vacuum trucks that picked up the liquid for it, but it was done – it was coordinated between Lee Vollmer and Chancellor & Ogden.[91]
>
> ***
>
> A ….And the problem here was that the product in the ground was very thick and sticky. It was -- I told you it was a heavy fuel. And in order to get it into the truck, into the tank truck, we had to heat it with steam and liquefy it, make it more liquid. And then the pumps could pick it up, pump it into the truck. Chancellor & Ogden then took the material out to the Montebello class A dump, is where it went.
>
> Q Are you the one who coordinated with Chancellor & Ogden?
>
> A Lee did most of it, but I was aware of what they were doing, but Lee did most of the coordination.[92]
>
> ***
>
> Q …Now, you told us that the liquids from the No. 7 reservoir were removed by vacuum trucks. Now, how did that work exactly? The vacuum trucks put a what, some kind of a hose or something down into the liquid and suck it out or how does that work?
>
> A Yeah, exactly. It's just like you've seen fire trucks put a pipe down to pick water up when they want to pump it. The same thing, only we were doing it with oil. What they did is they pushed the oil liquid -- liquefied product in one place. We put a steam coil down in there, which essentially made it very, very liquid. It just took the viscosity and made a liquid. And then the vacuum truck would pick it up and put it in the truck. And that's what we did.
>
> Q I see. And -- and what was the role of the grading contractor in achieving that objective?
>
> A Well, at this time we were using Lee's equipment, the grading contractor's equipment. This material was so viscous that you could actually push it with a bulldozer. And it would sort of wave up and then sort of settle down, slump down. And he went out into seven and pushed all of this material to the vacuum pickup point.
>
> Q Just pushed it with a blade or did he put something between the blade and --
>
> A Well, at some point -- sometimes we had a berm of sand and he would use the sand kind of as a rolling dike and keep the liquid on one side of it and just kept pushing the sand along.[93]
>
> ***

[90] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 168: 6-8.
[91] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 96: 20-25, 97: 1.
[92] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 97: 6-19.
[93] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 117: 13-25, p. 118: 1-18.

> Q …And what was the purpose of pushing it?
>
> A So that there was enough depth for the vacuum, for the heater and for the vacuum truck to pick it up.[94]
>
> ***
>
> Q … And what happened to the sand and clayey material after you were done cleaning out the liquids?
>
> A That was the final cleanup and that all went to the dump.
>
> Q So that went the way of the saturated soils?
>
> A Yes, with the final cleanup it all went.[95]
>
> ***
>
> A Are you talking about petroleum product?... It was our function to remove it. It was pumped out and exported from the property. We got rid of it all.[96]

This eyewitness testimony indicates that no petroleum hydrocarbon materials from Reservoir 7 were disposed of on the Subject Property. All petroleum hydrocarbon materials were removed offsite for disposal and Barclay has no "explicit-knowledge" that petroleum hydrocarbon materials were left onsite. In addition, because Barclay effectively removed from the site all petroleum hydrocarbon materials that were formerly in Reservoir 7, Barclay did not cause the action of "spreading the waste" during development activities as claimed by the RWQCB in the draft CAO.

3.1.4 Shell Provided Oversight and Final Approval of Barclay's Removal of Petroleum Hydrocarbon Materials from Reservoir 7

In the Shell December 15, 1965 letter, previously mentioned, Shell allowed Barclay's entry and work on the Subject Property prior to close of sale.[97] This permission for entry and the commencement of work was subject to several terms and conditions that were significant requirements addressing safety, insurance, liability and other concerns. These requirements were likely strict due to a tragedy that had recently occurred on the property.[98] In addition, Shell required that Barclay place an "around the clock security guard" on the Subject Property to ensure that no person (including trespassers) "will come to any harm."[99]

[94] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 118: 24-25, p. 119: 1-3.
[95] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 119: 15-22.
[96] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 7. p. 287: 22-25.
[97] Clark, D. E. 1965. *Re: Wilmington Field Kast Fee – Kast Tank Farm, Your Reference: Lomita Property.* Correspondence from Shell Oil Co. to Barclay. December 15. (SOC000058-61)
[98] Salazar, Reuben. 1965. *Brother Leads Hunt for Boy Drowned in Old Oil Reservoir.* Los Angeles Times. March 18. p. A1. (Included in Harkavy, D. 2012. *Videotaped Deposition of Dennis G. Harkavy, Volume II. July 13.* Exhibit 2-38).
[99] Clark, D. E. 1965. *Re: Wilmington Field Kast Fee – Kast Tank Farm, Your Reference: Lomita Property.* Correspondence from Shell Oil Co. to Barclay. December 15. p. 1, par. 2. (SOC000058)

As work by Barclay progressed during 1966, it is evident that Shell paid close attention to the condition of the Subject Property and Barclay’s adherence to Shell’s entry requirements. Among other things Shell monitored (i) the removal of water and residual petroleum hydrocarbon materials from Reservoir 7, (ii) whether it was appropriate to discontinue the 24/7 security patrol (partially funded by Shell) and (iii) whether it should give control of the site entirely to Barclay. An April 14, 1966 internal Shell letter[100] states the status of the reservoirs at that time:

> “Reservoir 6 - empty – clean- all roof and support timbers cleaned up – and walls partially removed by grading.
>
> Reservoir – 5 – Empty and clean, but roof and support timbers essential (sic) intact. Roofing paper removed from roof. Hole in center of roof and some holes around perimeter.
>
> Reservoir 7 – oil, water, and timbers in bottom, partial roof around perimeter. It is our understanding that removal of oil and water from reservoir 7 will continue….”

A later internal Shell correspondence document dated May 4, 1966, states:

> “Mr. Barclay was told by me that we wanted the property put in a safe condition. That this must include the following:
>
> 1) The roofs and all support timbers must be removed completely from reservoirs 5 and 7.
>
> 2) All oil and water must be removed from reservoir 7. Reservoir 5 is now clean.
>
> 3) All wooden debris and scrap lumber laying around should be removed from the Subject Property.”
>
> I told him I could not agree to any extension of the closing date until this work was completed….
>
> In addition to the three items that are listed above, we also want two additional items completed before we agree to any extension of the purchase contract:
>
> 1) Fill in valve box pits that have not yet been filled, so they are level with the ground.
>
> 2) There are some concrete pieces adjacent and overhang the entry-ways that were cut in the walls of reservoirs 5 and 7 that should be knocked down to ground level.”[101]

Shell’s final review of the Subject Property condition is documented in an internal August 15, 1966 Shell letter that states:

[100] Ballman, E.A. 1966. *Kast Fee Property*. April 14. Internal correspondence from Shell Refinery Manager-Wilmington Refinery to D.E. Clark, Pacific Coast Area, Shell Area Land Manager. p. 1. pars. 3, 4. (SOC 120420)

[101] Ballman, E.A. 1966. *Kast Fee Property*. May 4.Internal correspondence from Shell Refinery Manager-Wilmington Refinery to D.E. Clark, Pacific Coast Area, Shell Area Land Manager. p. 1. pars. 3, 5. (SOC 120418)

> "All our minimum safety requirements have been met. The guards were discontinued effective 8 a. m. August 15, 1966. All of the oil has been removed from the reservoirs, all roofs and supporting structure have been removed, and the timber hauled away. All the oil sumps and deep pits have been filled in. This leaves the property so there is almost nothing to burn and no chance of anyone falling in any kind of oil sump or pit."[102]

This correspondence confirms details and timing provided by witnesses concerning the progress of reservoir clean-out. It also shows that Shell was vigilant about how its property was being rehabilitated by Barclay. Shell continued to own the Subject Property until Barclay became sole owner in October 1966. Shell had significant input into ensuring that all liquids were removed and it is highly unlikely given this documentation that Shell would have approved or otherwise condoned any dumping of residual reservoir oil onto the Subject Property.

3.2 Barclay Removed All "Explicitly-Known" Petroleum Hydrocarbons in Soil Outside the Reservoirs and Disposed of It Offsite

The evidence of Barclay's "explicit-knowledge" of petroleum hydrocarbons (or lack of petroleum hydrocarbons) in other parts of the Subject Property besides the reservoirs is supplied by geotechnical reports and eyewitness testimony which are discussed in this section. Section 4 provides a detailed discussion of each specific area of the non-reservoir portions of the Subject Property including berms, sumps, and pits. The eyewitness testimony provided below includes a description of the segregation of unsuitable soil from soils used for fill and also describes the condition of the soil and offsite disposal of unsuitable soil. Based on the eyewitness testimony, no "explicitly-known" petroleum hydrocarbons were left onsite by Barclay.

Geotechnical borings provided Barclay with some knowledge of soil conditions but only in the locations and at the depths observed. All soil sampling performed at any site in the 1960s prior to development was performed only for geotechnical purposes. Soil testing at that time was designed to evaluate soil stability and drainage properties and to determine whether soil was expansive or not. Environmental sampling and analysis was not performed by anyone in 1965- in fact, it would be 5 more years before EPA was even formed and more than 15 years before the first Superfund site was identified.

The sampling performed by Barclay was carried out by its geotechnical contractor, PSE, prior to development and was designed to evaluate i) the effect of leaving concrete floors of the reservoirs in place and ii) the suitability of soil to support development. PSE performed studies[103] to ensure that proper drainage could occur through the broken concrete layers consisting of the former sides of the reservoir and the ripped floors. The borings performed by PSE were logged by a geologist who was lowered via cables and harness down a 24-inch diameter hole into the soil below. The geologist was equipped with a head lamp and able to

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[102] Lehmann, A.S. 1966. *Kast Property Status*. August 15. Internal correspondence from Shell Refinery Manager-Wilmington Refinery to D.E. Clark, Pacific Coast Area, Shell Area Land Manager. p 1. pars. 1 & 2. (SOC 120410)

[103] Pacific Soils Engineering, Inc. 1966. *Preliminary Soils Investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. p. 1.

closely observe *in situ* soil conditions to provide accurate and detailed soil descriptions for purposes of determining the suitability and stability of soil to support buildings and other aspects of development. Geotechnical soil borings were performed to evaluate the soil outside the reservoirs as discussed below.

3.2.1 Geotechnical Borings Outside of the Reservoirs Indicate the Soil Did Not Contain Petroleum Hydrocarbons

Eight (8) 24-inch diameter borings were completed before January 7, 1966 as described in PSE's January 7, 1966 *Preliminary soils investigation on Tract No. 24836*. Pages 5 through 7 (Plate B) of the PSE report include boring logs for the eight borings. The borings, which were located outside of the reservoir footprints, extended to depth of 21-35 feet below ground surface (bgs).

Soil descriptions from the eight borings list the soil type, color, moisture and density and some unique observations (e.g., presence of shells) were noted. Clean, dense fine to medium sands were found to underlie the surface soils at a depth ranging from 10-15 feet. The surface soils encountered in Borings 1 and 2 are lean clays in a soft, (water) saturated state. Soils deeper than 15 feet bgs range from silty sand to fine to medium clean sand.

There were no references in the soil descriptions of petroleum hydrocarbon/oil staining or odor present in the soil. No chemical analysis was performed for any of the soil samples from these eight borings since that type of analysis was not performed in 1966. Therefore, the boring log descriptions indicate Barclay did not obtain any "explicit-knowledge" of petroleum hydrocarbons at the Subject Property from geotechnical testing.

3.2.2 Eyewitness Testimony Indicates Only Minor Petroleum Hydrocarbons Were Observed Outside the Reservoirs that Barclay Removed, Stockpiled, and Disposed of Offsite

There is deposition testimony from eyewitnesses that indicate that whenever oil-saturated soils were encountered, those materials were hauled off the Subject Property. There is evidence from Mr. Bach, Mr. L. Vollmer, and County Inspector's documents discussed in this section that indicate unsuitable materials were not allowed to stay onsite and were, in fact, disposed of offsite.

Following is deposition testimony from Mr. Bach:

> Q Okay. You had a hole in the ground, but there was -- first what was -- was there – was there soil? Would you see any oil or soil or anything like that from all of that or –
>
> A See, what I recall was that the area --when we took the box out, it was kind of mushy in there, just groundwater or whatever it was, anything -- at that point we dug all of that material out of there because we wanted to have a good, sound foundation for the soil we were going to put in. So anything that was not compact – not consolidated, not firm, we took out, exported it, put it -- took it away and then filled the hole back up with compacted fill.
>
> Q The soil that you exported, did that have oil in it?

A I can't say it had oil in it. It was moist, but, you know, it was -- the drainage that had gotten in there and because the drainpipes were no longer functioning, if it rained, the water would sit there until it evaporated or soaked into the ground.

Q At this site did you find places like that, where -- any places where there was saturated -- where there was soil saturated with oil?

A I never saw anything that I would say was saturated with oil, no. There were areas where it was moist, but we attributed it and my belief is that it was mainly just rainwater because if there was rain, there was no way for the water to get away. The drainage system had been dismantled, it wasn't functioning anymore. So the water either had to evaporate or stay there until it soaked into the ground. One or the other.

Q Was any of the soil taken off-site?

A We did take soil off-site, yes.

Q And what was the purpose of taking that soil off-site?

A If we -- if the soil engineer or us or Lee saw material that we didn't feel was appropriate when we put in the fill, it was stockpiled for a while unless there was a lot of it and we could export it all at once. Otherwise we would put it into a place until there was enough of it so that we could haul it away. And that went out to the dump, too.

Q Do you think some of the places that you stockpiled might have -- some of that stockpiled soil might have had oil in it and been the source of contamination?

A It might have had oil in it or an oil/water mixture, an emulsion, maybe a little bit emulsified. But like I said, if it was questionable, we would put it into the stockpile and get rid of it.

Q And take it off-site?

A Yes.

Q Was there any soil that you felt had oil in it that you did not take off-site, that you felt had oil that you thought was a problem?

A As I understand, your question is if there was material there that I did not -- in my opinion was not suitable, whether it was oil or water or whatever it was, would we get rid of it? And the answer was yes. It would not go in the fill. We would say, "Hey, that's not appropriate material. Take it away." And it wasn't based on some -- it was based on my judgment and opinion and Lee's opinion and the soil engineer's opinion. The three of us would look at it and say, "That's" -- "That's got to go."

Q Now, what would -- in your mind would be something that would be a cause for concern in terms of -- let me back up and ask it a different way. What -- what in your mind would make a quantity of oil problematic?...

A …If -- if we looked at material and we said whatever is there, water or whatever, is going to prevent us from compacting it or making a good fill or it looks -- we just don't like the looks of it, it would go off. If it -- if it was moist and we could maybe pick it up and squeeze it to see if it was compactible, it stayed. And so a lot of those things -- the things they are basing on judgment, they are opinion and they have to do with experience and what we felt was appropriate and what wasn't….

Q Did you ever -- did you ever have any -- did you ever see any amounts of oil that you thought were a problem that you left on-site?

A Amounts of oil? The stuff that came out around that pit that we were talking about, you know, the pump, some of that was classified as being -- having too much oily product that was spilled from the pipes. We knew that. Okay. Off it went.

Q You took that off-site?

A It went off.

Q Did you ever see anything that you thought was a problem that you kept on-site?

A No. If it was a problem -- when we started the job, Shurl, the Barclays, everybody, the soils engineer, we met and said, "We're going to get rid of this kind of stuff. It's not acceptable. We don't need it. Take it away." And it was -- it was an agreement. Everybody said, "We're not going to have it. It's not a problem. We're not going to" -- "anything that's a problem is going to go." And it wasn't even a matter of cost. It was "go."[104]

Mr. Bach further testifies:

Q ….And did you ever see any oil-saturated soil?

A The oil -- there was oil-saturated soil around that pit.

Q Around that pit?

A Yeah.

Q And that was taken off-site?

A That was taken off-site.

Q Okay. Other than -- except for the oil-saturated soil around that pit that was taken off-site, did you see any other oil-saturated soil?

A I didn't personally see any other, but I know that the operators from time to time would put oil -- what they thought was oil-saturated soil in the stockpile to be removed.

Q Because that was reported to you?

A Yeah, and I saw the stockpile there. I wasn't there all day. So they would put stuff over there. If the operator thought it was not appropriate, it would go in the pile.[105]

Mr. Bach provides further testimony regarding any oil-saturated soil encountered:

Q …had you heard of any oil-saturated soil?...

A …yes, because the guys would tell me they put it over there.

Q And how much of that did you hear about?

A Not an awful lot. My recollection would be that maybe over the course of the job we hauled material out of there three times, which would mean a big dump truck load of material. You know, we're not going to take a pickup load. We would fill up a dump truck and then we would take it to the dump. So maybe three dump loads -- dump truck loads of it.

Q Okay. And these were located in the sump areas or –

A Well, they were wherever they found it, wherever the operator saw it. And for whatever reason he would put it in there and go.

Q The -- is that the only oil-saturated soil that you saw or heard about while you were at the site?

A Yes. I described what I saw or heard about.

Q Okay. Why was oil-saturated soil taken off-site?...

[104] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p 106: 8-25, 107: 1-19, 108: 21-25, 109:1-12, 110: 1-25, 111: 1-12

[105] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 114:2-21.

> A …There wasn't a technical reason for taking it off. There wasn't a -- it was just --our judgment was that it wasn't an appropriate material to be there. It might be considered by some to be objectionable. Like I said, it was pretty much a judgment call. We just -- if we looked at something and we didn't have a good feeling about it being in the fill, we took it away.
>
> Q Did it cause problems for the equipment?
>
> A It could cause problems with the equipment. It could be hard to compact because it didn't -- because of the way it was emulsified. It could get on somebody's feet or tires. They would take it away. It was -- it was -- I just -- I don't know how to explain it. It was pretty much a judgment. If we didn't like the material, it went.[106]

Mr. Bach further testifies:

> Q Is it your testimony that all of the soil that was contaminated by petroleum product was removed from the property?
>
> A All of the product -- all of the soil that had what we considered, I considered to be contaminated with petroleum was exported from the property.
>
> Q Okay. And to where did you export that soil?
>
> A The Montebello -- Agajanian's Montebello dump….[107]
>
> ***
>
> "….It was any soil that we figured or I figured was not suitable to put in the fill, whether it was -- for whatever reason, it had debris in it or anything else. That was exported from the property."[108]
>
> *******
>
> A Are you talking about petroleum product?... It was our function to remove it. It was pumped out and exported from the property. We got rid of it all.[109]

The deposition testimony of Mr. L. Vollmer indicates that a determination was made to remove soil from the Subject Property that was not suitable for fill:

> Q Okay. And what you were referring to at that point in time was the sand that you were using to help soak up or move the gunk that you had described earlier in reservoir 7; correct?
>
> A "Sand" is not a good word, but the earth that I used to crowd the -- crowd the oil toward the collection area with the vacuum trucks and so forth did indeed push it forward. And necessarily or in actuality, a certain amount of it did become contaminated with the gunk. And it was hauled off-site because it was considered not suitable for fill.
>
> Q Now, other than that material, do you recall any other material being removed from the site during your grading operations?
>
> A I -- it doesn't come to mind. I don't remember.[110]

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[106] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 115: 11-25. p 116: 1-25. p. 117: 1-10.
[107] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 282:5-15.
[108] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p 283, line 9-13
[109] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 287: 22-25.
[110] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 237: 8-24

Mr. A. Vollmer testified he did not see oil on the site:

> Q Okay. And while you were doing that, did you ever see any oil in any of those lifts that were spread out?
>
> A No.
>
> Q And did you get a good vantage point of those lifts when you spread them out?
>
> A Oh, very much so.
>
> Q Do you think if there had been oil contaminants in those soils that you took from the berms that you would have seen it?
>
> A Oh, yes. We would have heard about it, not just see it. We would have heard about it from Turpin, the soil inspector. And then the county had sent inspector by too. I don't remember what his name was, but he was not – he was not there all the time. He would come by on occasion.
>
> Q But you saw the county inspector?
>
> A Yeah. Yeah, he'd come.
>
> Q How often did you see the county inspector?
>
> A You know, it's really hard to say because it was such a big area. But he'd usually come by at least once a day. I think easily once a day, actually. [111]
>
> ***
>
> Q And then when you say you were kind of mystified, did you expect to find oil underneath the concrete bottom of Tank No. 6?
>
> A Well, we really didn't know what to expect, to be honest with you. We knew it was an oil tank farm. So you say oil, okay, you're going to find oil. But we did not find any. [112]
>
> ***
>
> Q Now, you testified earlier that if the soil inspector had detected any oil in the soil, you think you would have heard about that; right?
>
> A Oh, definitely, yeah.
>
> Q Why do you think you would have heard about that?
>
> A That was his job. I mean, it wasn't just oil. It was any contamination or any material that wouldn't have been suitable for fill. [113]
>
> ***
>
> Q The report continues, quote (as read): Most of the soils in the borings had a petroleum odor. Do you recall a petroleum odor in the soils at the site?
>
> A No. I was operating the machine all the time, so you couldn't. But there were times when everything was shut down. We never smelled the oily. It wasn't just myself. [114]

[111] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 44: 3-25.
[112] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 78:23 to p. 79:4.
[113] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 101:14-22.

The County Inspectors used inspection forms to document their observations indicating that materials unsuitable for fill were tracked until they were removed from the property. A County of Los Angeles Supervised Grading Inspection Certificate for Tract No. 28441 was signed by County Inspector William Berg on March 6, 1968 and included the following handwritten note:

> **“Remove all uncompacted stock pile material on lots 1 and 2-Not Approved.”** (Emphasis added.)

A later handwritten note by County Inspector William Cook dated November 7, 1968 states:

> **“Uncompacted fill materials removed Lots 1 and 2 approved.”**[115] (Emphasis added.)

This eyewitness testimony indicates that no visible petroleum hydrocarbons from other areas of the Subject Property outside the reservoirs were left on the Subject Property by Barclay. Barclay’s “explicit-knowledge” at that time indicates all petroleum hydrocarbons encountered outside the reservoirs were removed offsite for disposal and Barclay had no “explicit-knowledge” that any petroleum hydrocarbons were left onsite. In addition, because Barclay effectively removed from the site all petroleum hydrocarbons that were encountered during redevelopment, Barclay did not cause the action of “spreading the waste” during development activities as claimed by the RWQCB in the draft CAO.

3.2.3 Berm Soils that Were Clean Were Used to Fill Reservoirs to Grade Level

The concrete floors of Reservoirs 5, 6 and 7 were all covered with soil originating from the property, specifically the soil that made up the reservoir berms. Deposition testimony indicates that there was a very thin layer of asphalt coating the exterior berms and this material became pulverized and mixed into the berm soil during movement of berm soil into the former reservoirs.[116] The 4-inch thick concrete that covered the interior berm sidewalls was broken and pushed into the reservoir on top of the ripped concrete covering the reservoir floor. The concrete from the berms was then broken up, covered with a layer of soil, and compacted using a vibrating sheepsfoot to fill in the voids.[117] Following is testimony from Mr. A. Vollmer indicating his understanding of the use of the sheepsfoot:

> Q You said the sheepsfoot had two purposes?
>
> A Well, yeah. The vibratory sheepsfoot had two purposes.
>
> Q Yeah, vibratory. Right.

---

[114] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 108:20 to p. 109:16, p. 110:3-11, p. 110:19 to p. 111:2.

[115] Berg, William, 1968. Supervised Grading Inspection Certificate for Tract 28441. March 6. (CARSON000463-464)

[116] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 114-116.

[117] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 110:1 to 112:5.

> A It had -- it would shake and it would help break up the concrete initially, because just sitting on top, it would vibrate. Also, it would also get any material that was loose and it would filter down in through cracks and things. So that would ensure that the compaction was tighter than you would normally hope for. If you just threw dirt on top of it, it might not go filter all the way down.
>
> Q When you talk about "material," you're talking about soil?
>
> A The soil, yes.
>
> Q So you're connecting the soil and making it more compactible?
>
> A Yes.[118]

The use of onsite materials to use as fill material to achieve final grades is described in depositions taken of Mr. Bach, Mr. L. Vollmer, Mr. Anderson, and Mr. A. Vollmer. Mr. Bach described the following:

> Q The top 7 feet of fill that was placed in the area where the homes were built, that was put there by Barclay Hollander?
>
> A … yes, I’m not clear when you say “moved in”. The soil that was on the site in the dikes and in the reservoir walls was re-graded to create the building sites.
>
> Q The soil was taken from one location and moved to grade it and to be used as fill.
>
> A That’s correct.[119]

Mr. L. Vollmer’s testimony further describes the process in his deposition testimony indicating the 4-inch thick concrete that formed walls of earthen berms was broken up and placed on top of reservoir floor. Then six inches of dirt was placed on top of the broken up concrete and compacted using a vibrating sheepsfoot and the rest of dirt from berms was pushed in over that, and compacted in layers.[120]

Mr. Anderson, who performed grading of berm soils in all three reservoirs, describes the process as follows:

> Q Okay. And then could you now just hold up this Exhibit 1 for the camera and describe for us how you would take the soil from the berm and spread it out across in one -- in what you call a lift and compact it. Just describe that for us.
>
> A Okay. Well, first -- first procedure would be to take a bulldozer and push some material out across here, which is economical in this direction, and go to the other side and push the material across here that's economical to where you tie these two together making a -- per se, a road.
>
> Q Turn it toward the camera there. Yeah.
>
> A So then after you've made this road across here and you've made ramps down both sides of your berm, then you can use a rubber-tired scraper and haul the dirt down here (indicating) and dump it on the road. And a dozer would take it and drift it across at the lift that you need, okay, which would be somewhere between, like I said before, six inches, eight inches to a foot, to fill the voids and get compaction.

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[118] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 55:23 to p.56:16.
[119] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach*. March 11. p.364:9-24.
[120] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 110-119.

After you've made that pass or lift all the way to this (indicating) edge, then you could do the same thing on the other side. After you get all of the concrete covered, then you take the scraper and you start in a pattern and you start dumping on this (indicating) edge, all the way down. Scraper is, in those days, was probably 11 feet wide. And you'd take 11 foot all the way across. You have a dozer and a sheepsfoot, which is a vibrating sheepsfoot, following this, compacting it, water if you need it, all the way across.

While you're going across, this – the compactor is following it across, the soils engineer is following you across to tell you whether your work is conforming to the soils report, which I think it was 90 percent compaction then. And that's -- and if that doesn't happen, then we go back and redo it. Which this material was very good. I don't think we had very many issues with compaction.

After you make that complete pass across there, you turn around and start over again. When you finally get to the elevation you want on the outside and the elevation you want to the inside, then you've got your product.

Q Was there any particular methodology that was dictated to you by the soils engineers or anyone else --the County engineer or anybody else, as to how you had to do this?

A No. That -- I mean, it's pretty standard practice in the industry. It's just what I explained here is how it's done.[121]

***

Q Each time that you had a lift spread out in one of these areas, did you have a pretty good visual look at the soil itself?

A Yeah.

Q You personally?

A Yes[122]

***

Q Do you think your vantage point would have given you the ability to see oil if there had been significant amounts in that soil?

A Yes.

Q And did you see any oil in the soil while you were spreading it out and compacting it in those lifts?

A No.

Q And did you ever smell any oil from the fill soil that you were spreading out?

A I don't think so. I -- it was 50 years ago, so...[123]

***

Q Did you ever see any ponded oil on the surface at this site anywhere?

[121] Anderson, L. D. Jr. 2013. Videotaped Deposition of Lowell Dwaine Anderson, Jr. December 18. p. 31: 6-25, p. 32: 1-25, p. 33: 1-6.
[122] Anderson, L. D. Jr. 2013. Videotaped Deposition of Lowell Dwaine Anderson, Jr. December 18. p. 35: 9-4.
[123] Anderson, L. D. Jr. 2013. Videotaped Deposition of Lowell Dwaine Anderson, Jr. December 18. p. 35: 24-25. p. 36: 1-12.

> A Not on the surface. The only place I seen some little ponding was -- I think it was boxes where the fire hydrants or something was, there might have been a little bit around that, which was handled.
>
> Q And where -- what happened to that?
>
> A I believe it was subbed out by a company that was -- was taking care of that part of the project.
>
> Q And where -- and where did it -- where was it taken?
>
> A It went off the site in a truck.
>
> Q Did you ever believe the site -- when you left the site, that the property was contaminated in any way?
>
> A No.
>
> Q Did you ever have any knowledge or belief that there was oil contamination located beneath the tank bottoms?
>
> A No, I didn't -- I wouldn't – no way of believing there was any contamination there.[124]

Mr. A. Vollmer stated that no soil was imported from offsite to finish the grading:

> Q Okay. And -- the soil -- where did that soil come from, again, for that work?
>
> A Well, it came from the -- basically from the berms. The first berm -- the first soil was from the berms around the tanks. Then the next soil that we took was from on the outer edge of the tank farm itself. [125]
>
> ***
>
> Q I see. Okay. And did you ever bring – did Vollmer Engineering ever bring any soil in from off site to finish off any of the grading?
>
> A No. No. Everything was cut and fill. [126]

According to the requirements of the grading permit, fill was placed in approximately 8-inch layers or lifts then compacted with either a vibrator and/or a sheepsfoot roller adding moisture from a water truck, if necessary.[127,128,129,130] Mr. L. Vollmer stated the following in his deposition:

> Q …do you recall how many feet or approximately how deep that additional soil was.
>
> A We were directed to be sure that it was at least 7 feet. Some places are a little bit higher.., but the minimum was 7 feet.[131]

Mr. A. Vollmer testified to the following about the lift thickness:

[124] Anderson, L. D. Jr. 2013. Videotaped Deposition of Lowell Dwaine Anderson, Jr. December 18. p. 41: 11-25. p. 42: 1-12.
[125] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 58:7-12.
[126] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 34: 6-9.
[127] E. L. Pearson and Associates. 1966. *Grading Plan for Lot “B” of German Settlement.* January 21. Sheet 2 of 4.
[128] E. L. Pearson and Associates. 1966. *Grading Plan for Tract No 24836.* January 6. Sheet 2 of 4.
[129] E. L. Pearson and Associates. 1967. *Grading Plan for Tract No 28086.* January 31. Sheet 1 of 1.
[130] E. L. Pearson and Associates. 1967. *Grading Plan for Tract No 28441.* March 7. Sheet 1 of 4
[131] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 289: 21-25. p.290:1

Q About how high were the lifts?

A Oh, we kept them about 6 inches. We like to keep around 6 inches because, especially with material like that, the thinner the lift, the less activity you had to put on in compaction. It compacted a lot quicker and easier, thin material. …[132]

3.3 Barclay Did Not Disturb the "Explicitly-Known" Minor Amounts of Petroleum Hydrocarbon Contamination Observed Beneath the Reservoir Floors

Barclay performed two activities during development of the Subject Property that allowed "explicit-knowledge" of soil conditions and minor amounts of petroleum hydrocarbon contamination beneath the reservoirs. These are: 1) the soil observations made from geotechnical pits and borings and 2) the limited ability to observe a small amount of soil that was revealed when the concrete floors were ripped for drainage purposes. From geotechnical test pits and borings performed at various locations across the former reservoir floors, Barclay observed minor amounts of petroleum hydrocarbon staining and odors described as "trace of oil", "petroleum odor apparent," "oil smell," "heavy oil smell," "oily," "oil stained," or "slightly oily." Barclay did have "explicit-knowledge" of minor amounts of petroleum hydrocarbon contamination beneath the floors and did not disturb, move, or "spread" this material during grading operations. This section provides information on the nature of Barclay's "explicit-knowledge" of the minor amounts of petroleum hydrocarbon contamination beneath the reservoirs.

3.3.1 Soil from Geotechnical Borings Beneath Reservoir 6 Show Minor Amounts of Petroleum Hydrocarbon Staining and Oil

Prior to development, PSE performed drainage studies at the Subject Property in the soil beneath all three reservoirs. Because soil beneath the former reservoir floors was left in the condition it had been during Shell's ownership of the property and no disturbance of this soil was necessary to complete redevelopment, the purpose of the drainage studies was to evaluate whether sufficient drainage could occur through the soil beneath the ripped concrete comprising the left-in-place former reservoir floors.

PSE initially completed six geotechnical borings (B1 through B6) beneath the concrete floor of Reservoir 6 in or about February 1966.[133] At that time, Reservoir 6 was clean and empty of oil and or any other materials. The borings were 24-inch diameter borings drilled to depths of 12 to 15 feet into the soil that would remain in place beneath Reservoir 6. These boring locations were placed in representative locations throughout the floor area to test the soil beneath Reservoir 6 (see Figure 13).

[132] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer*. January 14. p. 59:9-14.
[133] Pacific Soils Engineering, Inc. 1966. *Subsurface drainage study for reservoir located in the southeast corner of Tract No. 24836 in the County of Los Angeles, California*. March 11. p. 1. (Carson 251).

Two other studies were performed in Reservoirs 5 and 7 (discussed in detail in Sections 3.3.1.3). All results indicated that soil beneath the reservoirs was permeable enough to allow sufficient drainage for the new development.

3.3.1.1 Soil Observations Beneath Reservoir 6 Include Descriptions of Minor Oil Odors and Staining

PSE's March 11, 1966 report includes boring logs for geotechnical borings B1 through B6. Soil descriptions list the soil type, color, moisture and density and, if present, notes on visual observation or odors of oil to depths of 12 to 15 feet beneath the reservoir floor. [134]

With one exception, every individual soil sample collected from each of the six borings beneath Reservoir 6 included the following descriptions of oil smell or staining: "trace of oil", "petroleum odor apparent," "oil smell," "heavy oil smell," "oily," "oil stained," or "slightly oily." The exception was the noted "no oil smell" provided in boring B6 for the interval from 9 to 14 feet.

3.3.1.2 Permeability and Percolation Test Results for Soil Beneath the Reservoir Floor Indicates Soil With "Explicitly-Known" Minor Amounts of Petroleum Hydrocarbons Is Permeable

Plate C of PSE's March 11, 1966 report[135] included calculations that utilized laboratory analysis results for permeability for 4 soil samples collected from the geotechnical borings. The permeability tests were performed on samples that were described as follows: Sample 3 (no oil), Sample 2 (trace of oil), Sample 1 (slightly oily), and Sample 4 (oily). The permeability tests were performed on samples that represented the least and most oil noted in the geotechnical borings. This was an appropriate way to choose samples for permeability to evaluate whether the presence of minor amounts of petroleum hydrocarbons would reduce soil permeability and therefore interfere with drainage. The report concluded:

> "The laboratory results show that even though the soils are oil stained they are still permeable."[136]

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> "Based on these calculations utilizing the lowest permeability value obtained from the laboratory results, it is considered that the available drainage area is sufficient to handle all expected percolating water."[137]

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[134] Pacific Soils Engineering, Inc. 1966. *Subsurface drainage study for reservoir located in the southeast corner of Tract No. 24836 in the County of Los Angeles, California*. March 11. p. 4-5. (Carson 255-256).

[135] Pacific Soils Engineering, Inc. 1966. *Subsurface drainage study for reservoir located in the southeast corner of Tract No. 24836 in the County of Los Angeles, California*. March 11. p. 6. (Carson 257).

[136] Pacific Soils Engineering, Inc. 1966. *Subsurface drainage study for reservoir located in the southeast corner of Tract No. 24836 in the County of Los Angeles, California.* March 11. p. 2. par. 3 (CARSON 000252).

[137] Pacific Soils Engineering, Inc. 1966. *Subsurface drainage study for reservoir located in the southeast corner of Tract No. 24836 in the County of Los Angeles, California*. March 11. p. 2. par. 3. p. 3. par. 1. (Carson 252-3).

Permeability test results indicate that the sample noted as "slightly oily" had the lowest permeability and the sample noted as "oily" had a permeability 2 orders of magnitude higher meaning the oily sample was more permeable than the slightly oily sample.[138] The results demonstrate that the "explicit-knowledge" Barclay had of the petroleum hydrocarbon contamination beneath the reservoirs are minor concentrations that did not impede drainage.

A large-scale permeability test was performed by PSE to "justify the calculations" presented in PSE's March 11, 1966 report as documented in a report dated September 20, 1966.[139] An earthen berm was constructed in Reservoir No. 6 to isolate an area measuring 25 feet by 30 feet so that one foot of water could be ponded above the ripped concrete reservoir floor. Two ripped trenches that were one-foot wide and 30-feet long were located within the 25-foot width of the bermed test area (indicating that the distance between the ripped trenches was 23 feet or less). At the end of 42 hours, the level of water had dropped 3.5 total inches. PSE used these results in calculations to estimate the amount of water that could percolate through the ripped concrete floor and concluded "this indicates that drainage should not be a problem in the development of this parcel."[140]

These test results indicate that oil-stained soil beneath Reservoir 6 did not contain enough oil to interfere with soil permeability or the downward percolation of water. Had there been a significant amount of petroleum hydrocarbons in the soil, permeability would have been greatly reduced by oil filling the soil pores. These test results are consistent with the contamination patterns seen at the Subject Property showing that only minor amounts of contamination exist at distances farther away from the edges of the former reservoir floors. Therefore, Barclay's "explicit-knowledge" of petroleum hydrocarbons beneath the floors indicated minor amounts of petroleum hydrocarbons.

The following testimony is from the deposition of Mr. Bach who is questioned about the "explicitly-known" petroleum hydrocarbons documented in the geotechnical soil boring logs from the March 11, 1966, PSE report:

> Q …did you conclude from seeing these boring logs that there was increasing amounts of oil as you got deeper?
>
> A No. it defines it, it says that there was a possible odor, oil odor, but in no place does it really describe any actual oil. It just says it appears to be stained or has an odor.
>
> Q When you were engaged in these – in the field tests, did anybody suggest that further investigations should be undertaken to determine whether there was greater contamination deeper down?
>
> A No. As we went deeper, the staining and the smell dissipated and nobody suggested or required that we go any deeper than that. [141]

---

[138] Pacific Soils Engineering, Inc. 1966. *Subsurface drainage study for reservoir located in the southeast corner of Tract No. 24836 in the County of Los Angeles, California*. March 11. p. 6. Item 1. (Carson 257).

[139] Pacific Soils Engineering, Inc. 1966. *Concrete burial and additional subsurface drainage data.* September 20. (CARSON000378-380).

[140] Pacific Soils Engineering, Inc. 1966. *Concrete burial and additional subsurface drainage data.* September 20. p. 3. (CARSON000380)

[141] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 187: 15-25. p. 188: 1-5.

***

Q Would you agree with me that every single depth demonstrated oil?

A No. What I would agree with is that the observer that saw that, he thought that it was oil. I -- different observers will see things differently. Somebody else might have said it's not oily. It depends on the observer. It's a judgment call.[142]

***

Q Did anyone, to your knowledge, undertake to determine the, quote, "actual" – no, quote, "amount of actual oil contained in the soil"?

A No. It was basically considered to be insignificant or it was just there, not enough to really measure.[143]

***

Q …the references to "oily" what did you interpret that to mean…?

A It could have a shine to it or a little iridescence or something or it could be just that to his eyes it looks like it's oily. You know, if you saw an oily rag, you would say "Okay". It's oily" And he might say the same thing for the sand.[144]

***

Q …what impression did you form based on the information you received?

A My impression was that, yes, we had material the he identified as oil stained or had a little bit of oil. None of it was really significant at that time. Our only thing that he wanted to verify was that he had percolation. Other than that, there wasn't anything that we were really concerned about. The oil smell, it's a VOC, it's benzene or whatever it is, is gone. As soon as it hits the air, it's gone. It wasn't – it was just insignificant stuff.[145]

***

Q Okay. And in terms of quantities, did you have a sense for what kind of quantity of was present under the slab in Reservoir 5? (sic)[146]

A There was no estimate of quantity. Steve identified it as stained, which could be just be a little discoloration, but there was never any – any reason or attempt to say there was this much oil there. It wasn't significant at that time. It was just not a significant amount of oil.

Q And "not significant" meaning a very small amount, very tiny?

A "Insignificant" means that it was so little that you weren't concerned with it.[147]

Mr. A. Vollmer provided the following testimony about the soil observations by PSE:

[142] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 237: 16-23.
[143] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 329: 12-17.
[144] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 336: 13-21.
[145] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 347: 8-22.
[146] Later testimony indicates this discussion is about Reservoir 6.
[147] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 350: 15-25. p. 351: 1-5.

> Q And then we talked about some of the reports of the boring logs. If you look to the second page of the letter here under discussion, and the second paragraph – I don't want to read the whole thing, but let me just ask you to look at the first two sentences here. So it's page 2, the very next page under "Discussion" --
>
> A Yeah.
>
> Q -- where it states, quote (as read): The field investigation reveals that the soils beneath the reservoir conform to those found in our original exploration. Generally, the first 3 feet found directly beneath the slab tend to be silty and clayey sands which are highly oil stained. Do you see that portion?
>
> A Yes.
>
> Q Mr. Vollmer, does that refresh your recollection that the soils that you encountered directly beneath the reservoir were oil -- oily and oil stained? …
>
> …MR. LOEWEN: Yes, you can answer if you can. If you're able. And the question calls for a yes or no. Did it refresh your recollection? Did it change your thinking about this and make you remember something you didn't remember before? That's what "refreshing recollection" means.
>
> THE WITNESS: No. No, it doesn't. I – you know, observations made on this are not the way I remember it.

Mr. Bach’s testimony described petroleum hydrocarbons in the geotechnical boring logs as “just not a significant amount of oil” and “it was so little that you weren’t concerned with it.” Mr. A. Vollmer indicates he does not recall seeing oil in soils underneath the reservoir floors. This is indicative that the oil and staining observed in 1966 did not raise any concerns or motivate additional actions at that time. Therefore, Barclay’s “explicit-knowledge” of petroleum hydrocarbons at the Subject Property based on the geotechnical boring log observations constitutes what was considered a minor amount of petroleum hydrocarbons for the 1966 timeframe.

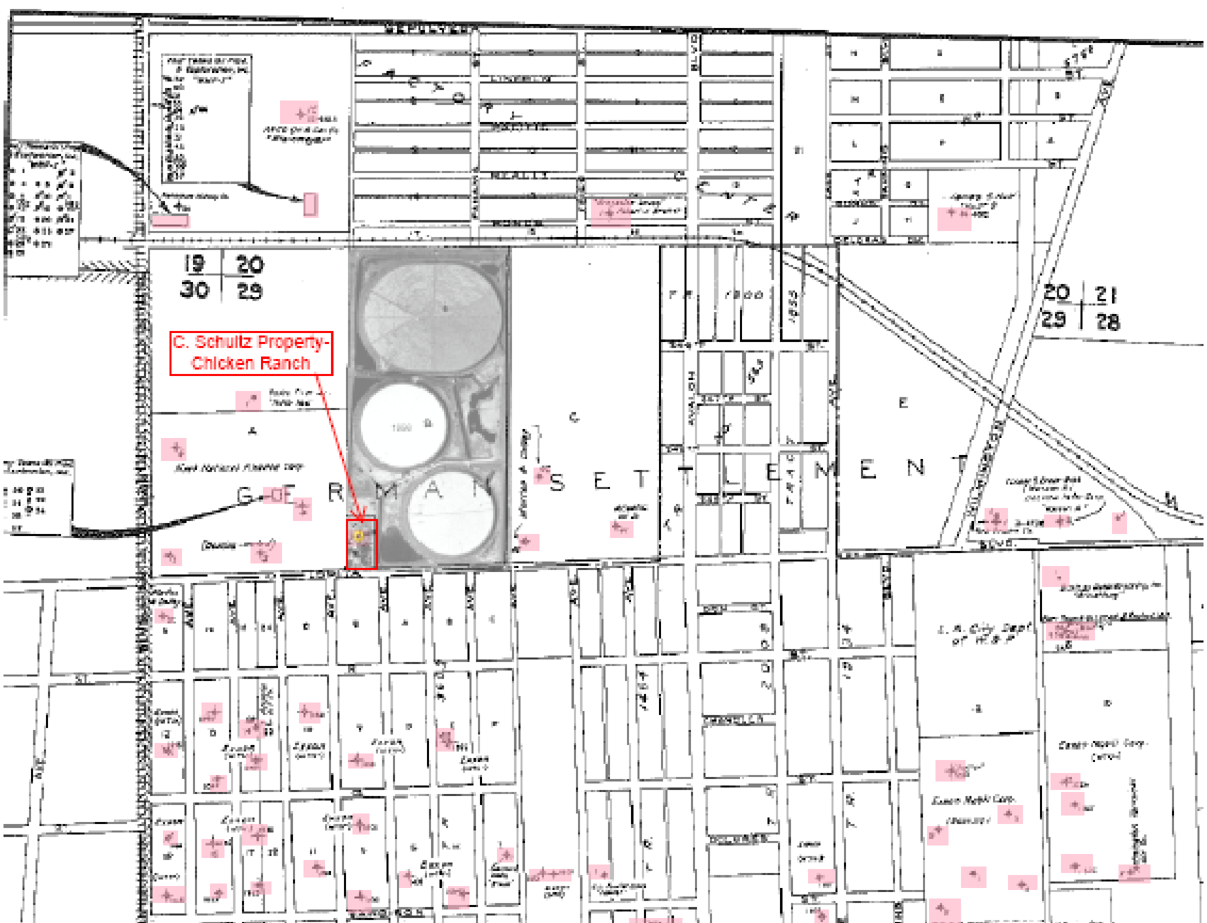
The petroleum hydrocarbons that constitute the current environmental issue at the Subject Property were caused primarily by leakage at the floor/sidewall joint that occurred while Shell was operating the reservoirs. This is further discussed in Section 3.5.5.

3.3.1.3 No Chemical Analysis or Evaluation Was Performed on Soil in the 1960s

There was no chemical analysis performed on any of the soil samples collected from the six geotechnical borings because, this was a time prior to the formation of EPA, environmental standards did not exist, and environment evaluations were not yet performed on re-developed properties. A standard analytical procedure for analysis of petroleum hydrocarbons in soil was not in common use until the mid-1970s when the USEPA began publishing analytical methods for chemical evaluation. In addition, there were no environmental standards in the 1960s that could be used to evaluate petroleum hydrocarbon concentrations in soil. The only way that Barclay could have known what petroleum hydrocarbons were significant was to do laboratory analysis on soil that is available today but was not available then. Because there was no paradigm for evaluation of soil for hydrocarbons, the testing performed was focused on whether the soil would drain properly and whether it was suitable for building. Therefore, Barclay performed the required testing for the purposes required at that time. Even if Barclay had wanted to perform a laboratory analysis to evaluate the concentrations of petroleum hydrocarbons in soil from the geotechnical borings, it would have been difficult or impossible to perform the analysis or evaluate the results.

3.3.1.4 In the 1960s Crude Oil Was Not Considered a Substance that was Hazardous or Unhealthful and No Testing Was Performed to Evaluate the Presence of Crude Oil in Soil at the Subject Property

The fact that soil sampling was not performed to evaluate soils that Barclay encountered at the Subject Property may be further explained by the state of knowledge at that time regarding crude oil and petroleum hydrocarbons. In the 1960s, crude oil was not considered a substance that was hazardous or unhealthful. In addition, nearby residents and workers were familiar with crude oil because of the presence in the area of many oil wells that were part of the Wilmington oil field as shown on the map below. By the 1960s, the area around the Subject Property had already had a long history of the presence of crude oil in oil wells and sumps, many of which were not fenced.



Pink shade shows locations of drilled oil wells.
Area shown is within the mapped borders of the Wilmington Oil Field per the "District 1 Oil Fields" map published by the State of California Division of Oil, Gas, and Geothermal Resources

Deposition testimony is available for Ms. Schultz, the owner of a chicken ranch that was located directly south of the pump house area and directly west of Reservoir 5 (see map above) that provides a description of the impressions generally held at the time about crude oil beginning with her experiences growing up in nearby Torrance next to an oil field, and later, as an adult raising her family while working and/or living next door to the Subject Property:

> Q And about what -- when you lived in the Torrance region, did you -- did you live around where the -- there was oil extraction operations going on?
>
> A Yes.
>
> Q Okay. Did you ever see an oil sump?
>
> A Where my family was located, they – the area was totally agriculture and oil production. And the owner of the property subdivided into lots and sold them to individuals. My family purchased one half acre and built their home on the one half acre. It was actually used for agriculture at the time, but there were oil wells everywhere. And there were oil sumps everywhere. Some of the sumps were very large, like big swimming pools. They all were -- had dikes around the exterior of them and they were not protected at all, not fenced at all. The --
>
> Q Well, listen, I just asked you one little quick question and that was did you ever see a sump? So you answered that.
>
> A That was the sumps. A lot of sumps.
>
> Q Okay. So what did a sump look like?
>
> A It looked like --
>
> Q Tell me what one of these larger sumps looked like.
>
> A Like a big swimming pool.
>
> Q Okay. And what -- and did they have ponded oil in them?
>
> A Yes, and probably rainwater had gone in them too, but they looked black like oil.
>
> Q Okay. And what -- do you know what they were used for?
>
> A I don't know. I guess the products that they used to drill the wells, maybe the by-products. They went in there drilling mud or whatever.
>
> Q And were there -- were there more than one of them near your home?
>
> A Oh, yes, yes.
>
> Q Several?
>
> A The oil wells in those days were not all concentrated in one little group like they are now. They were spread out. And usually every oil well had a sump. And one in particular across the street from us, in the big lot, looked like it was – it looked like a big swimming pool. And even children had built a dock on one end of it so they could take rafts and use it like a big lake. I mean, there was a lot of stuff like that going on.
>
> Q They were big enough to take a raft out and float around on them?
>
> A Yes.
>
> Q And people -- kids did that?
>
> A Yes.
>
> Q Wasn't that dangerous?
>
> A Yes.
>
> Q Did they ever get hurt?

A I had heard some, but I was not aware myself. I know that one of the neighbor children --I saw him standing in the driveway from head to toe just covered with oil. He had fallen into one of them. He was okay, but he did get totally immersed in it...[148]

***

Q Okay. Do you remember any conversations with your husband or anyone else about it being a hazardous waste site?

A No. We were always of the belief that if it's crude oil from the ground, it's not a contaminant unless it's refined. And that's just kind of the way we've always believed because that's what you get out of the ground is oil and that's what it was. [149]

Q Okay. You -- you -- also you said something about -- about crude oil. If it comes out of the soil as crude oil and hasn't been refined yet, that you didn't believe that it was toxic, and then counsel moved to strike as nonresponsive. Can you tell me what you were talking about there?

A Well, I remember when I was a kid, they used to oil the street out in front of our house. It was an unpaved street and it was kind of like tar. And in the summer it would get real hot and we would break off hunks of it and chew it like gum, you know. It just -- I don't know. How kids do it. And it sure never hurt me any.

Q Back in the -- back in the late '60s and early '70s, did you ever have any concern about crude oil being toxic in any way for humans?

A No.

Q Did you know anybody who had concerns like that?

A I can't say if I did or not.

Q Yeah. Well, you had a -- you testified that you had a sump on your property that was affiliated with the or associated with the well on the property; correct?

A Yes, it was a small sump.

Q Yeah, there was oil -- there was an oily substance all the time --

A Right.

Q -- in that sump; correct?

A Right.

Q Okay. And you used to bring your children there to the -- to the ranch; right?

A Yes.

Q And did you ever -- and your children were pretty young in the 1950s?

A Yes.

* * *

Q …So between 1951 and 1956, they were little toddlers. And so between the '50s and the '60s, you had little children that you were bringing to the ranch; right?

A Yes, yes.

Q Did you ever have any concern during that time of having them near a place where you had oil out in the open like that?

---

[148] Schultz, C. 2012. *Videotaped Deposition of Claudine Evelyn Schultz.* October 30. p. 73:24 to p. 76:12.
[149] Schultz, C. 2012. *Videotaped Deposition of Claudine Evelyn Schultz.* October 30. p. 97:1-9.

* * *

Q Did you ever feel like that might be toxic to them in any way?

A No, but they were not exposed to it.

Q But you weren't -- you weren't concerned about having them around it, though --

A No.

Q -- where they were breathing the air and things like that?

A No. [150]

Mr. Bach and Mr. L. Vollmer also provide deposition testimony indicating they did not have knowledge or awareness that petroleum hydrocarbons encountered on the Subject Property were hazardous or toxic. The fact that no petroleum hydrocarbon analysis was performed for soil on the Subject Property is consistent with the general knowledge at that time that crude oil was a natural substance, it was common in the area, and it was not considered a contaminant.

3.3.2 Petroleum Hydrocarbons Were Not Observed by Barclay During Ripping of Reservoir Floors

No grading of soil beneath the reservoir floor was conducted. The concrete reservoir floors were “ripped” to provide water drainage but the soil beneath the concrete floors was not graded or moved. The process of ripping the concrete reservoir floors was described by Mr. Bach in his deposition as follows:

Q Were the bottoms of the reservoirs broken up?

A They were broken up with a ripper tooth on a tractor, yes.

Q: And was that – those bottoms then mixed up with soil around it?

A: They were just left in place then and then… there was dirt and walls were added on top of that so that the bottom stayed essentially – after it was ripped, it just stayed where it was.[151]

Mr. A. Vollmer testified that he did not observe oil through the rips in the concrete floor:

Q When you were ripping the concrete and flooring in Reservoir No. 6, were you ever able to get a look at the dirt underneath the floor?

A Yeah. Because when we would rip, you know, it wasn't like it was cutting a pie. It would rip and it would jumble up and break apart. And you'd look down underneath there, and certainly where the ripper went through, there was always a little furrow so you could see the subsurface really quite well.

Q Did you ever see any oil under there?

A No, never did.

---

[150] Schultz, C. 2012. *Videotaped Deposition of Claudine Evelyn Schultz.* October 30. p. 152:2- to p. 153:21 and p. 154:7 to 155:6

[151] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach*. March 11. p. 338:15 - p. 339:2

> Q Did you ever see any evidence that there had been oil sludge on top of the floor at the time that you did any ripping?
>
> A No. Never did. Never did. That was what we would look for. We just assumed that -- well, when they had the fatality there and it was a few years prior, then that's when they started cleaning everything out. We just assumed that, well, everything had dried up when they cleaned it out. They were under a lot of pressure. [152]
>
> ***
>
> Q And then when you say you were kind of mystified, did you expect to find oil underneath the concrete bottom of Tank No. 6?
>
> A Well, we really didn't know what to expect, to be honest with you. We knew it was an oil tank farm. So you say oil, okay, you're going to find oil. But we did not find any. [153]

Other than the small amount of soil removed from test pits and borings and the very small amount of soil disturbed when ripping the concrete floors, at no time was the soil beneath the floors visible to Barclay and its subcontractors. No grading or movement of any soil beneath the concrete floors was performed with the exception that the soil excavated from geotechnical borings and pits were used to backfill those holes and pits.

3.3.3 The Petroleum Hydrocarbons that Barclay Had “Explicit-Knowledge” of on the Subject Property Were Either Not the Source of Existing Contamination in the Top Ten Feet of Soil or Were Not Disturbed by Barclay

In review, there were only three possible sources of petroleum hydrocarbons that could be “explicitly-known” by Barclay. These are:

1) Petroleum hydrocarbon materials in Reservoir 7 that remained from Shell operations that was removed from the site.
2) Minor amounts of petroleum hydrocarbons in the soil outside the reservoirs that may have been present in berms, sumps, and other areas onsite that, where found, was removed from the site.
3) Petroleum hydrocarbon contamination beneath the reservoir floors that is present due to leaks in the former reservoir floor during Shell’s operation of the Subject Property.

The first two sources of petroleum hydrocarbons that Barclay had “explicit-knowledge” of are those in Reservoir 7 and those in the soil outside the reservoirs from berms, sumps, and other areas onsite. Neither of these sources caused the present day contamination in the top ten feet of soil that is the subject of the draft CAO because Barclay removed these petroleum hydrocarbons and disposed of them offsite as explained in detail in Sections 3.1 and 3.2. Because of the offsite removal, none of these “explicitly-known” petroleum hydrocarbons in the first two sources could have been “spread” on the site as alleged in the draft CAO.

[152] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 61:118 to p. 62:12.
[153] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 78:23 to p. 79:4.

Therefore, the only petroleum hydrocarbons that Barclay had “explicit-knowledge” of that remained in place at the Subject Property are those beneath the reservoir floors. As discussed in detail in Section 3.3, Barclay performed two activities during development of the Subject Property that could have resulted in the “explicit-knowledge” of petroleum hydrocarbons beneath the reservoirs. These are (i) the soil observations made from geotechnical pits and borings and (ii) observations made when the concrete floors were ripped for drainage purposes.

The extent and magnitude of the petroleum hydrocarbon contamination under the former concrete floors of the reservoirs was unknown to Barclay for several reasons:

1. Only six borings under Reservoir 6, as compared to the hundreds of borings performed during the Shell Investigation, were made in Reservoir 6. All that was reported to Barclay was that the soil underneath the concrete floor of the former reservoir was stained and at some depths oily.
2. The testing and characterization that was performed on the soil beneath the concrete floors of the former reservoirs was designed to determine (i) the bearing strength of the soil and (ii) water drainage characteristics of the soil (or hydraulic conductivity).
3. During the time period of the development, petroleum hydrocarbon contamination was only significant to the extent that it impaired the bearing strength of the soil or its ability to drain water. The toxicity of “crude oil” had not been studied and was not a concern among regulators in this context or the community. For this reason, investigations to determine the extent of petroleum hydrocarbon contamination in soil were simply not performed by any residential builders except to determine soil stability and drainage capability.
4. Even if Barclay was interested in testing the soil for petroleum hydrocarbons, it would have been difficult to impossible to accomplish. Gas chromatographs were not in wide spread use and the 8015 gas chromatograph-based petroleum hydrocarbon test had not been invented. The test methods for TRPH 418.1 (an IR Spectrometer-based test) and its precursor (413.1) had not been invented either. There was no commonly available test which Barclay could have performed in an economical manner to determine the petroleum hydrocarbon content of the soil beneath the concrete of the former reservoirs.

The petroleum hydrocarbon contamination under the concrete floors of the former reservoirs was untouched and left in place by Barclay – it was not moved or disturbed during grading operations or other development activities.

Section 4
Barclay's "Explicit-Knowledge" of Petroleum Hydrocarbons in the Berms, Pump House Area, Sumps, Pipeline Areas, and the Swing Pipe Pit

This section includes a detailed discussion of other historical features of environmental significance that were present on the Subject Property and the environmental condition of these features at the time development occurred on the Subject Property. The main historical features included the earthen berms that made up the sides of the three oil reservoirs, the earthen berms that surrounded the oil reservoirs and the perimeter of the Subject Property, sumps, pipelines, the pump house area, and the swing pipe pit.

Information discussed in this section indicates that no visible petroleum hydrocarbons from other areas of the Subject Property outside the reservoirs were left on the Subject Property by Barclay. Barclay's "explicit-knowledge" at that time indicates all petroleum hydrocarbons encountered outside the reservoirs were removed offsite for disposal and Barclay had no "explicit-knowledge" that any petroleum hydrocarbons were left onsite. In addition, because Barclay effectively removed from the site all petroleum hydrocarbons that were encountered during redevelopment, Barclay did not cause the action of "spreading the waste" during development activities as stated by the RWQCB in the draft CAO.

4.1 Berm Soil Did Not Contain Visible Petroleum Hydrocarbons

4.1.1 Description of Berms on the Subject Property

There are two different types of berms that were historically present at the Subject Property. These included the earthen berms that supported the concrete sidewalls of the three reservoirs and the earthen berms that were used throughout the Subject Property as secondary containment around each of the reservoirs and around the perimeter of the Subject Property.

4.1.1.1 Berms Forming the Sidewalls of Reservoirs 5, 6, and 7

The outer earthen walls of the reservoirs were approximately 15 feet in height above the surrounding ground surface of the Subject Property and had a slope ratio of 1.5:1. The bottoms and the inner sides of the reservoirs were lined with a four-inch blanket of concrete that contained a wire mesh to distribute heat more evenly during curing. The reservoirs were nearly 30 feet deep and were covered by wooden roofs. [154] The berms were created by excavating soil to a depth of approximately 15 feet below grade, and using the removed soil to form the berm surrounding each 15-foot deep excavation.[155] The placement of berms extended the reservoir

[154] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. p. 1. (CAR 1)
[155] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29.

sides upward an additional 15 feet from existing grade, to create a reservoir that was approximately 30 feet deep from the top of the berm to the concrete reservoir floor. A flat walkway was constructed on the top of each earthen berm and the outer side of the berm was covered with a thin layer of asphalt material to help prevent erosion and plants from growing on the sides of the berms.[156,157]

4.1.1.2 Berms Surrounding the Perimeter of the Subject Property and Interior Berms Providing Separate Containment Areas for Each Reservoir

Earthen berms ranging in height from ten to fifteen feet were constructed just inside the exterior boundaries of the Subject Property and in interior locations to provide separate containment areas for each reservoir.[158] The majority of these earthen berms were also covered with a very thin layer of asphalt material[159] to help prevent erosion and plants from growing on the sides of the berms.

4.2 Barclay's "Explicit-Knowledge" of Petroleum Hydrocarbons in Berm Soil Caused the Stockpiling and Offsite Disposal of This Material

There was no explicit-knowledge by Barclay or any of the parties involved in the development activities at the Subject Property that the berm soil contained any residual petroleum hydrocarbons/oil. The exception to this is Barclay's knowledge of a very thin layer of asphalt placed on the berms to prevent erosion and discourage vegetation. This thin layer was pulverized during soil movement and mixed in with berm soils.[160] Previously discussed deposition testimony (Section 3.2.2) indicates that soils deemed unsuitable for the redevelopment were removed from the Subject Property.

4.2.1 Berm Soils Were Not Tested for Chemical Concentrations and No Methodology for Testing of Petroleum Hydrocarbons in Soil Existed in the 1960s.

As previously discussed, soil testing was conducted by PSE for geotechnical purposes in onsite areas other than the berms and consisted of soil classification and testing of other physical properties related to the suitability to support structures. No testing for petroleum hydrocarbons in soil was conducted on the berm soil or anywhere else on the Subject Property,[161] however, PSE had an opportunity to examine soil for geotechnical purposes based on cuts that were made in the berms.[162]

[156] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer.* March 15. p. 114-116.
[157] EDR. 2013. Certified Sanborn Map Report for Kast Property 1924 and 1925.
[158] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. p. 1. (CAR 1)
[159] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 265: 5-25, p. 266:1-3.
[160] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 265: 5-25, p. 266:1-3.
[161] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 244: 20-23.
[162] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. p. 1. (CAR 1)

As discussed in detail in Section 3.3.1.2, a standard methodology for laboratory analysis of petroleum hydrocarbons in soil did not exist in 1966 and there were no regulatory agency requirements for chemical testing or interpretation of chemical analysis results. Therefore, even if Barclay had wanted to perform a laboratory analysis to evaluate the concentrations of petroleum hydrocarbons in soil from the geotechnical borings, it would have been difficult or impossible to perform the analysis or evaluate the results. As described in the following sections, soil from the berms was not observed to have any oil and any soil that was considered unsuitable for fill was not left onsite. The lack of visible oil and the offsite disposal of unsuitable materials indicates that no testing for petroleum hydrocarbons was necessary and none was performed.

4.2.2 Barclay Eyewitness Testimony Indicates No Petroleum Hydrocarbons Were Observed in the Berm Soil

Based on review of testimony by all parties in the field during the removal and grading of the berms, there was no petroleum hydrocarbon contamination of berm soils observed by the grading contractor, engineers, or geotechnical engineers, and County Inspectors did not document the presence of petroleum hydrocarbons in berm soil during grading activities.

4.2.2.1 Mr. L. Vollmer Testified that No Petroleum Hydrocarbons Were Observed in Berm Soil

As documented in the videotaped deposition of Mr. L. Vollmer, he did not observe at any time any oil in the berm soil from former Reservoirs 5, 6, or 7 that was used to fill in each of these reservoirs. His testimony follows:

> Q Okay. And while you watched the operation taking place, did you see any oil in the fill that was being placed there?
>
> A No.
>
> Q Not ever?
>
> A Not ever. That's the front two tanks we're talking about.
>
> Q The front two tanks?
>
> A Right, 5 and 6.[163]
>
> ***
>
> Q In No. 7, after all the liquid was removed, there was then -- and the concrete was then ripped and buried
>
> A Yes.
>
> Q We're going to talk in a minute about how that took place.
>
> A Yes.
>
> Q There was then -- the soil from the surrounding berm was brought in and spread out; correct?
>
> A Yes.
>
> Q Much like the soil from the surrounding berm was brought in and spread out from 5 and 6; correct?
>
> A Yes.

[163] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer.* March 15. p. 85: 5-11.

> Q All right. When that -- at that point, after all the liquid was removed and you're watching the -- did you get to see any of the spreading of any of the dirt in 7?
>
> A Oh, yes.
>
> Q Okay. And when that was taking place, did you see any oil in that dirt in that fill there?
>
> A Absolutely none.
>
> Q So basically the same as 5 and 6?
>
> A Yes.[164]

4.2.2.2 Mr. Bach Testified that No Petroleum Hydrocarbons Were Observed in Berm Soil

As documented in Mr. Bach's deposition testimony, he did not observe any oil in the berm soil at the Subject Property. His quoted testimony is as follows:

> Q Was the soil -- based on your observation, as you took the soil from the berms and brought it down to become fill soil, did you observe oil in the berms?
>
> A No.
>
> Q That was clean?
>
> A Yes.[165]

In addition, Mr. Bach indicated that if any wet, oily, or any questionable soil that could be a problem for compaction was identified by him, PSE, the grader, or the County Inspector, anywhere on the Subject Property, it was automatically removed from the fill material and stockpiled onsite (see Section 3.2.2). Once there was a truckload it was properly hauled offsite for disposal at Agajanian's Montebello Dump and not used as onsite fill material.

4.2.2.3 PSE Geotechnical Reports Do Not Document Any Petroleum Hydrocarbons in Berm Soil that was Spread and Used as Fill

PSE prepared final soil engineering reports for each tract which was part of the development that including testing on all of the lots at one or more fill depths. There is no documentation in any of their reports indicating that the berm soil contained residual petroleum hydrocarbons, and no indication that any of the soils used for backfilling activities contained residual petroleum hydrocarbons.

4.2.2.4 Mr. Anderson Testified that No Petroleum Hydrocarbons Were Observed in Berm Soil

Mr. Anderson also testified that he did not observe oil in the soil that he graded on the Subject Property:

> Q Each time that you had a lift spread out in one of these areas, did you have a pretty good visual look at the soil itself?

[164] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer.* March 15. p. 86: 2-25, p. 87:1.
[165] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 143:23-25, p. 144:1-4.

A Yeah.

Q You personally?

A Yes[166]

***

Q Do you think your vantage point would have given you the ability to see oil if there had been significant amounts in that soil?

A Yes.

Q And did you see any oil in the soil while you were spreading it out and compacting it in those lifts?

A No.

Q And did you ever smell any oil from the fill soil that you were spreading out?

A I don't think so. I -- it was 50 years ago, so...[167]

***

Q Did you ever see any ponded oil on the surface at this site anywhere?

A Not on the surface. The only place I seen some little ponding was -- I think it was boxes where the fire hydrants or something was, there might have been a little bit around that, which was handled.

Q And where -- what happened to that?

A I believe it was subbed out by a company that was -- was taking care of that part of the project.

Q And where -- and where did it -- where was it taken?

A It went off the site in a truck.

Q Did you ever believe the site -- when you left the site, that the property was contaminated in any way?

A No.

Q Did you ever have any knowledge or belief that there was oil contamination located beneath the tank bottoms?

A No, I didn't -- I wouldn't – no way of believing there was any contamination there.[168]

4.2.2.5 Mr. A. Vollmer Testified that No Petroleum Hydrocarbons Were Observed in Berm Soil

The deposition testimony of Mr. A. Vollmer describes the work he did to remove the concrete sidewalls and move soil from the berms into the reservoirs. Mr. A. Vollmer also provides his personal knowledge of the condition of the berm soils he observed during movement of this soil into the reservoirs:

[166] Anderson, L. D. Jr. 2013. Videotaped Deposition of Lowell Dwaine Anderson, Jr. December 18. p. 35: 9-4.
[167] Anderson, L. D. Jr. 2013. *Videotaped Deposition of Lowell Dwaine Anderson, Jr.* December 18. p. 35: 24-25. p. 36: 1-12.
[168] Anderson, L. D. Jr. 2013. *Videotaped Deposition of Lowell Dwaine Anderson, Jr.* December 18. p. 41: 11-25. p. 42: 1-12.

Q Can you describe for me how the concrete got taken down from the sides in more detail?

A That was done with a bulldozer, and the machine would start at the top and give itself -- well, they would have to dig away on the berm so they get a position to set themselves. Then they would drop the blade behind the – behind the concrete sheeting or the -- the wall, which was a similar shape to the bottom, about 4 inches thick with similar wire mesh in it. But it had the big advantage with the machine with all its weight. This was a little, small machine. It was a Euclid – was comparable to a D-8. Oh, God, I forgot to mention that thing on there. Anyway, this D-8 or Euclid would drop the blade down in there behind it, and then the weight of the machine would work -- it had gravity working with it. It could push up against it and just gradually push everything right on over. It would take it off in chunks of about 6-feet lengths and then flop it over, and then drop and take another and flop it over. And then they would take -- and when they would get down to the bottom, then they would take and skid it out into the floor and roll over it some, and then the D-9 would come over and roll on too, because it was heavier. Then they would go all the way around the tank area, getting all that wall, clearing off all the wall. [169]

***

Q How did the concrete from the walls get spread out?

A With the dozer. The dozer would bring it down, and they worked off in sheets. And they were pretty -- well, like when we're working on the floor, you always had to contend with the machines being on the floor and working in with the dirt and the sub -- subsurface, whereas on the wall, they could pretty much clean the wall off without taking too much dirt with it. And that gave you more of a opportunity to work the concrete, break up the concrete because there's more space available, if you understand what I mean there. But you would flop it over on the bottom, and it would break up going over and everything. But mostly when you got it down on the bottom, then you take -- dozed it out and ran over it and had the other machine run over it, and it would break up pretty well that way. [170]

***

Q So when you spread it like that, did you have a good vantage point to take a look at it?

A Oh, yeah. Yeah.

Q And did you ever see any oil in the spread out soil?

A No. No.

Q Do you think if it had been contaminated, that from your vantage point -- did you have a good enough vantage point to be able to see oil in it, had it been contaminated?

A Oh, absolutely. That was one of the things we were always looking for. You know, because if anything is going to disrupt the job, then it would be saturated material.

Q Did you smell any oil when you were spreading out all the soil down there?

A No, not really. No. [171]

***

[169] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 51:19 to p. 52:21.
[170] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 53:9-25.
[171] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 59:15 to p. 60:6.

> Q Could you look at the dirt that was immediately behind the concrete walls when they came down?
>
> A Yeah. Yeah.
>
> Q Did you see any oil?
>
> A No, I never saw any oil. Never did. Never could figure that out. [172]

4.2.2.6 County Inspectors Documented Unsuitable Fill Material that was Not Allowed to Remain Onsite but Did Not Document any Observations of Petroleum Hydrocarbons in Graded Soil

The main regulatory organization overseeing the grading and development of the Subject Property was the County of Los Angeles, Department of Engineering, Building and Safety Division. The main grading plan checker for this project was Mr. Eugene Zeller and the onsite grading inspector was Mr. William (Bill) Berg. According to Mr. Zeller, Mr. Berg was the County's most accomplished grading inspector.[173]

Although County Inspector Mr. Berg was onsite regularly to observe grading activities, the approved grading permit required a "called inspection"[174] to witness the placement of the concrete in the bottom of the reservoir, therefore Mr. Berg would have been present to witness these activities and the soil of the berms would have been exposed during reservoir demolition.

As previously discussed at the end of Section 3.2.2, the County Inspectors used inspection forms to document their observations indicating that materials unsuitable for fill were tracked until they were removed from the property. A County of Los Angeles Supervised Grading Inspection Certificate for Tract No. 28441 was signed by County Inspector William Berg on March 6, 1968 and included the following handwritten note:

> **"Remove all uncompacted stock pile material on lots 1 and 2-Not Approved."** (Emphasis added.)

A later handwritten note by County Inspector William Cook dated November 7, 1968 states:

> **"Uncompacted fill materials removed Lots 1 and 2 approved."**[175] (Emphasis added.)

These notes indicate that the County did evaluate soil and deemed that some soil could not remain onsite.

There is no indication in any of the County records that the berm soil was observed as oil-stained or that it contained oil or that any oily soil was used as backfill material within the former reservoirs or anywhere else at the Subject Property. In addition, the County signed off on the

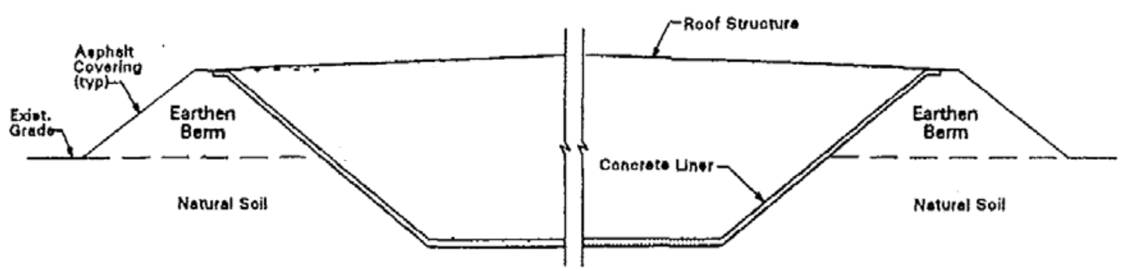
[172] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 54: 14-19.
[173] Zeller, E. 2013. *Videotaped Deposition of Eugene J. Zeller.* March 15. p. 42-43.
[174] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach.* March 11. p. 173.
[175] Berg, William, 1968. Supervised Grading Inspection Certificate for Tract 28441. March 6. (CARSON000463-464)

grading project indicating it had been completed in compliance with the grading permit. The County's district engineer, Mr. Gary Nehrenberg, signed off on the project on January 28, 1970 and released the surety bond for the project, indicating that everything was completed according to the approved permit and there were no outstanding issues.[176]

4.2.3 Reports by Shell Indicate Petroleum Hydrocarbon Contamination Cannot Be Reliably or Consistently Identified by Visual Observations or Odors

4.2.3.1 Shell Reservoirs 1 through 4 at the Wilmington Refinery

Shell operated other reservoirs at its nearby Wilmington Refinery that were identified as Reservoirs 1, 2, 3, and 4 which explains the numbering sequence for Reservoirs 5, 6, and 7 used at the Subject Property. All seven reservoirs were built at the same time in the 1920s. The oil reservoirs at the Subject Property and those at the Wilmington Refinery were constructed using the exact same construction techniques, and Shell Reservoirs 1 and 2 were virtually identical to the three that were constructed on the Subject Property. A cross-section of the reservoir construction is shown below.



Cross Section of Reservoir Structure

Shell Reservoirs 1 and 2 were decommissioned and deconstructed by Shell in 1994 and the berm soils were used to fill in the reservoirs in a nearly identical manner as the procedure used by Barclay to fill in Reservoirs 5, 6, and 7 at the Subject Property (see Section 5.3.1.3). One of the significant differences between the decommissioning processes between the two sites is that Shell consultant, Brown and Caldwell, conducted extensive soil testing of the berm material at Shell Reservoir's 1 and 2 as required by the RWQCB who performed regulatory oversight of Shell's process.

4.2.3.2 Shell's Analysis of Berm Soil at Reservoirs 1 and 2 Indicates Odor is Not a Reliable Methodology for Identifying Petroleum Hydrocarbon Contamination

Brown and Caldwell collected and analyzed 46 soil samples (23 from each reservoir berm) for total recoverable petroleum hydrocarbons (TRPH) using EPA Method 418.1. [177] The soil

[176] Nehrenberg, G. 2013. *Volume I Videotaped Deposition of Gary Nehrenberg.* January 31.p. 90, 122-130.
[177] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. Table 2-1. p. 2-5.

samples were also screened in the field for organic vapors using an organic vapor monitor (OVM) photoionization detector. A detailed discussion of this investigation is provided in Section 5.1.3 of this report.

The berm soil sample results indicated the location at the bottom of the berm closest to the reservoir sidewall/floor joint (designated by Shell as the "H" position about 11 feet above the joint) generally have the highest TRPH concentrations between 30,000 mg/kg and 43,000 mg/kg (see Section 5.1.3 of this report).

Both the OVM screening and the TRPH analysis were used to select samples for additional analysis of hazardous characteristics in accordance with California and federal hazardous waste criteria. Based on the sample analysis results, Brown and Caldwell concluded that the soil samples collected from the berm are not hazardous as defined by federal or state criteria.[178] Therefore the berm soil was used for engineered backfill of the reservoirs.[179]

The TRPH concentrations and OVM readings are included in Table 2. A comparison of the OVM readings and the TRPH concentrations shows that a sample with a high OVM reading did not necessarily have a high TRPH concentration. The OVM measures the volatile fraction of the sample which is also the fraction that causes an odor to be discernible. This comparison of TRPH and OVM results indicates that the presence or absence of petroleum hydrocarbon odors is not a reliable method for evaluating whether or not a sample contains significant petroleum hydrocarbon concentrations.

4.2.3.3 Shell's Analysis of Soil beneath Reservoirs 1 and 2 Indicates Visual Identification Is Not a Reliable Methodology for Identifying Petroleum Hydrocarbon Contamination

During the 1994 study, Shell also sampled the soil underlying Reservoirs 1 and 2 by drilling 21 boreholes beneath the reservoir floors. Reservoir 1 boreholes contained visible petroleum hydrocarbon contamination in all 11 boreholes, with the deepest petroleum hydrocarbon contamination observed at approximately 56 feet below the reservoir bottom. Reservoir 2 contained visible petroleum hydrocarbon contamination in only five of the ten boreholes, while the deepest visible petroleum hydrocarbon contamination was observed 46 feet below the reservoir bottom.

Laboratory analysis of soil samples collected from beneath Reservoir 1 showed the majority of detected TRPH concentrations exceeded 10,000 mg/kg with the highest detected TRPH of 71,000 mg/kg. Each sample was visually examined by trained field personnel to identify visible petroleum hydrocarbons. A comparison of the visual observation was made against the TRPH concentration analyzed in the laboratory for each sample. These results are summarized in Table 3. This comparison indicated there were instances where very high TRPH concentrations existed in samples with no visible petroleum hydrocarbon observations. For example, a sample that

[178] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 2-4.
[179] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 4-2.

contained 50,000 mg/kg TRPH in boring 4 had no visual petroleum hydrocarbon contamination present and only had an OVM reading of 96 parts per million. The Brown and Caldwell study performed on behalf of Shell at Reservoir 1 demonstrated that visual observations cannot be used as a reliable determination of contaminated soil even by the trained field staff.

Soil samples collected from beneath Reservoir 2 also showed significant levels of TRPH, however concentrations were lower than those detected beneath Reservoir 1, with only approximately half of TRPH concentrations detected exceeding 10,000 mg/kg and the maximum TRPH concentration detected was 36,000 mg/kg. As was the case with the berm soils, there was no reliable and consistent correlation between the OVM field concentrations and the detected TRPH concentrations. For example, OVM readings below 100 ppm were measured for clean samples (non-for TRPH) as well as for highly impacted samples where TRPH concentrations exceeded 10,000 mg/kg. Again, similar to the comparison made for samples beneath Reservoir 1, soil samples beneath Reservoir 2 which had no visible petroleum hydrocarbon contamination was found to contain up to 5,600 mg/kg TRPH, this sample also had an OVM measurement recorded of only 9 ppm. These results are summarized in Table 3. The Brown and Caldwell study performed on behalf of Shell at Reservoir 2 demonstrated that visual observations and the presence of odors (or not) cannot be used as a reliable determination of contaminated soil even for the trained field staff.

Section 5 also discusses these Shell sampling results at Reservoirs 1 and 2 in detail and provides an analysis of the same data to evaluate the contamination pattern and compare it against the contamination pattern found at the Subject Property. The soil sampling data collected by Brown and Caldwell both from the berm soils and beneath the oil reservoirs at Shell Reservoirs 1 and 2 provides evidence that the largest amount of contamination is near the sidewall/floor joint. This pattern of contamination at Reservoirs 1 and 2 is very similar to what has been found at the Subject Property indicating a bottom-up migration caused by oil wicking upward from oil-saturated soils that exist beneath the reservoir floors in areas of major leaks as discussed in Section 5.

4.2.3.4 Shell's Study at Reservoirs 1 and 2 Can Be Used to Verify Eyewitness Observations Made by Barclay That Berm Soils Were Not Impacted by Petroleum Hydrocarbons at the Subject Property

As previously discussed at the beginning of Section 4.2, Barclay had no "explicit-knowledge" that the berm soil used for backfill for Reservoirs 5, 6, or 7 contained any residual petroleum hydrocarbons, based on testimony and documentation from the grading contractor, project engineer, PSE, and County Inspectors that were onsite during grading activities. At the time of development in the 1960s there was no soil analytical method that could have been reliably performed to determine whether any contamination was present beneath Reservoirs 5, 6 or 7.

However, Shell's study at Reservoirs 1 and 2 can be used to verify Barclay's eyewitness information about berm conditions at the Subject Property. Because all these reservoirs were constructed at the same time and in the same way, there are similarities regarding where petroleum hydrocarbon releases occurred and how the petroleum hydrocarbons migrated. One significant difference between Shell Reservoirs 1 and 2 and Reservoirs 5, 6, and 7 at the Subject

Property is that Reservoirs 1 and 2 were operated by Shell for approximately 30 years longer than those at the Subject Property. This is very significant because the additional time Reservoirs 1 and 2 were in use allowed more aging and cracking of the concrete and thus the soil beneath Shell's Reservoirs 1 and 2 would have 30 additional years of petroleum hydrocarbon releases through cracks in the reservoir concrete bottoms and sidewalls and be, potentially, more contaminated than the berm soils or soils beneath the former reservoirs at the Subject Property.

It is notable that even with the additional 30 years of operation and potential for petroleum hydrocarbon releases at Shell Reservoirs 1 and 2, laboratory analysis of samples indicates most of the berm soils were relatively free of petroleum hydrocarbon contamination. Only the deepest portions of the berm soils nearest the sidewall/floor joint had significant petroleum impacts. This correlates well with and verifies the eyewitness testimony for berm soil at the Subject Property that indicated berm soils were observed to be free of petroleum hydrocarbon contamination.

4.2.3.5 Shell's Study at Reservoirs 1 and 2 Indicates that Barclay's Visual Observations of Oily Soil in Geotechnical Borings on the Subject Property is Not a Reliable Method for Determining that Barclay Had "Explicit-Knowledge" of Petroleum Hydrocarbons

The sampling Shell performed at Reservoirs 1 and 2 included the collection of soil samples that trained personnel visually identified as containing petroleum hydrocarbons that, after analysis by a laboratory, in many instances did not contain substantial TRPH concentrations. For example the soil sample collected beneath Reservoir 2 from boring 7 at a depth of 0-1.5 feet, was identified as having visible petroleum hydrocarbons, however laboratory analysis indicated a very low TRPH concentration of 73 mg/kg.[180]

Identification of discoloration in a soil sample is the observation most used by trained personnel to evaluate whether a sample is impacted by petroleum hydrocarbons. Typically, crude oil and other heavy hydrocarbons, when present in a soil sample, can cause a dark staining or discoloration to the soil that trained personnel identify and document in field notes as a color change. Today, these observations of discoloration are made in conjunction with numerous other soil observations as well as laboratory analysis to positively determine whether a soil sample is impacted by petroleum hydrocarbons.

However, in 1966, the observations made by Barclay of petroleum hydrocarbons in the geotechnical borings beneath Reservoir 6 were: "trace of oil", "petroleum odor apparent," "oil smell," "heavy oil smell," "oily," "oil stained," or "slightly oily." There is no documentation of the soil's normal color or the color of what was considered oily to go along with these observations and, therefore, no way to know whether Barclay's identification of oil was instead an observation of soil discoloration.

Identification of whether a sample is oily based on discoloration alone cannot be reliably or consistently used to identify contamination. Many soils that are not impacted by petroleum hydrocarbons exhibit a gray to black color, especially organic-rich silts and clays, which can

[180] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. Table 3-2 p. 3-7.

often be mistaken for visually-identifiable petroleum hydrocarbons. A gray to black or blue color ("gleyed"[181] colors) is typical in waterlogged soils where reducing conditions acting on organic carbon in the soil can cause gleyed colors that are typical of wetland soil types, but also typical of soils impacted by petroleum hydrocarbons.

Gleyed soil colors can also be caused by petroleum hydrocarbons in soil due to reducing conditions created by aerobic bacteria that experience population "blooms" because of the rich food source created by petroleum hydrocarbons in soil. The large number of blooming bacteria populations deplete the oxygen in the soil resulting in the same anaerobic conditions as a wetland soil.

Shell's study of soil samples collected from Reservoirs 1 and 2 indicate that the use of color or other visual observations to identify petroleum hydrocarbon contamination is not reliable even when trained personnel are providing the observations. Therefore, Barclay's visual observations of oily soil in geotechnical borings on the Subject Property is not a reliable method for identification of petroleum hydrocarbon contamination and does not provide reliable information indicating Barclay had "explicit-knowledge" of petroleum hydrocarbons at the sampled locations.

4.3 The Current Contamination Pattern in the Top Ten Feet of Soil Could Not Have Been Caused by Previously Contaminated Berm Soil Given the Procedure Barclay Used to Backfill and Compact Berm Soil in the Former Reservoirs

The procedure Barclay used to backfill and compact the berm soil used to fill the former Reservoirs 5 through 7 would make it impossible to place "impacted soil" only at specific depths or in specific locations within the reservoir, which is what would have been required to achieve contamination patterns seen today. Prior to starting the backfilling of Reservoirs 5 through 7, the concrete was ripped. The concrete not ripped as well as the portion ripped into pieces remained on the bottom of the reservoir as the first backfill layer.[182]

The engineering requirement for concrete as described in grading plans is:

> **"the concrete slabs shall be rolled with heavy equipment or otherwise treated so as to crack the slabs for purposed of drainage and compaction."** (Emphasis added.)
>
> **"Concrete to be removed shall be broken up into 1500 square foot pieces with a ripping tooth or equivalent."** [183] (Emphasis added.)

[181] "Gley soil" is a sticky clay soil or soil layer formed in waterlogged conditions with coloration that is primarily gray, blue or greenish.
[182] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer.* March 15. p. 108: 1-25 p. 109: 1-25, p. 110: 1-25, p. 111: 1-25, p. 112: 1-5
[183] E. L. Pearson and Associates. 1967. *Grading Plan of Tract No 28564.* September 1. Sheet 1 of 3.

Deposition testimony indicates that the concrete that formed walls of earthen berms was broken up and placed on top of the ripped reservoir floor.[184] Approximately six inches of dirt was placed on top of the broken up concrete[185] and compacted using a vibrating sheepsfoot. The rest of dirt from berms was bulldozed down the slopes of the berms over the concrete and compacted in layers.[186] Various testimony indicates layers of soil may have been between 6 and 12-inches inches in thickness.

The engineering requirements for compaction as described in grading plans include the following steps:

- Minimum number of compaction tests shall be 1 test per 2 feet of fill, but not less than 1 test per 1,000 cubic yards.
- Method of compaction shall be sheepsfoot roller or equivalent. All fill to be compacted in maximum 8 inch lifts.
- Compaction to be 90% of maximum density per ASTM Soil Compaction Test D-1557-58T modified to consist of three layers.[187]

According to the grading contractor, equipment used for moving soil from the berms into the reservoir during the backfilling operation involved Caterpillar WD series scrapers. Scrapers are moved with a heavy dozer. The scrapers of the time had a cable operated front door on the bottom front of the scraper which is lowered to be the cutting edge of the machine.[188]

Scrapers work by “scraping” up a few inches of soil at the bottom front of the machine through a scraping door. As the soil is scraped up, soil is moved in to the “bowl” of the scraper on a paddle wheel type mechanism. Once the bowl is full, the door is closed. Desirable features of using a scraper to move soil is that only a few inches of soil are scraped up with each pass of the scraper and that the soil is homogenized as it is scraped up as well as when it is deposited.

Soil is distributed by the scraper in a manner similar to the way it is scraped up. The scraper door is raised or lowered to determine the height (or thickness) at which the soil is distributed. As the scraper is pulled along, the soil pours out the bottom to form a level layer.

According to the grading contractor, bulldozers were also used for moving soil from the berms into the bottom of the reservoirs. Once the concrete lining the inside walls of the reservoirs was pushed into the bottom of the berm, the next step in the backfilling process was to push soil from the berms surrounding each reservoir into the reservoir “layer by layer” using a bulldozer.[189]

[184] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 109: 16-25 p. 110: 1-25, p. 111: 1-22.
[185] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 136:6-16, Vol II. p. 289: 4-16.
[186] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 111: 25, p. 112: 1-25, p. 113: 1-25, p. 113: 1-12.
[187] E. L. Pearson and Associates. 1967. *Grading Plan of Tract No 28564.* September 1. Sheet 1 of 3.
[188] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer.* March 15. p. 83: 15-25, p. 84: 1-6.
[189] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 114: 5-12.

Regardless of whether soil was moved into the reservoir using a scraper or bulldozer, the soil was mixed as it was removed from the berm and placed into the reservoir. As described by the grading contractor, the soil was pushed down the berm using bulldozers and placed into the reservoir in layers as shown in Figure 14.

Thus, as stated, if any petroleum hydrocarbon contamination was present in the berm soil, it would have been placed randomly in the reservoir since even if operators had wanted to create the upward migration pattern exhibited by the existing contamination data, there would be no way for operators to decide which soil was contaminated, the degree of contamination, and thus the appropriate burial depth or location within the reservoir. The pattern of contamination revealed by the data could only have been created through the upward migration of contamination left behind by Shell located beneath the former reservoirs. Because soil was placed in the reservoirs in lifts, placing soil in a manner where the bottom-up contamination pattern would occur repeatedly in all three reservoirs as, in fact, occurred would be impossible. As depicted in Figure 15, the location of petroleum hydrocarbon contamination will always be random within the reservoir because of the grading methodology.

Figure 16 shows contamination hypothetically placed in the same location within the reservoir through the numerous lifts. As described above, soil is distributed by opening a door on the scraper or by pushing soil with a bulldozer. Given the methods of soil distribution employed during the grading at the Subject Property, it was not possible to place contaminated soil only in specific locations within the reservoir because soil placement involved numerous small (6 to 12-inch) lifts. Even less possible is a scenario in which the most contaminated soil is placed at the bottom followed by placement of lesser and lesser contaminated soil in subsequent shallower lifts at the same location as illustrated in the profile shown on the right side of Figure 16.

4.4 Petroleum Hydrocarbon Materials from Reservoir 7 Did Not Migrate Into Soil after Barclay Entered the Subject Property

When Barclay first entered the Subject Property, Reservoir 7 contained water and a thick, viscous, tarry petroleum hydrocarbon material that was floating on top of the water. The water and petroleum hydrocarbon materials in Reservoir 7 were subsequently completely removed from Reservoir 7 by August 1966 as previously discussed in Section 3.

There are numerous lines of evidence that, when considered as a whole, provide a strong indication that petroleum hydrocarbon materials from Reservoir 7 did not migrate into surrounding soils or cause a release of petroleum hydrocarbons after Barclay first arrived at the Subject Property including: i) the petroleum hydrocarbon material was too viscous and not liquid enough to enter the small pore spaces in the surrounding soil, (ii) the depth of the material in the reservoir was 6 feet which created a much lower hydraulic pressure than during the decades of normal operation by Shell when the reservoir was full; therefore, there was less head pressure to drive liquids through cracks or spaces in the concrete bottom and sidewalls, thereby lessening the potential for releases, (iii) the thick, tarry petroleum hydrocarbon material was floating on water, thereby creating a buffer between the bottom of the reservoir and the petroleum hydrocarbons, (iv) after Barclay had removed the water, the petroleum hydrocarbon materials were in place for less than 3 months, also minimizing the time period for potential releases of the tarry petroleum hydrocarbon materials, (v) there is no documentation from geotechnical pits performed in Reservoir 7 that significant petroleum hydrocarbons were encountered in soil beneath the reservoir, and (vi) eyewitness testimony indicates that berm soils did not contain any petroleum hydrocarbons.

The ability of this tarry material to migrate through cracks and into soil was severely limited by its high viscosity. In addition, the petroleum hydrocarbon materials were separated from the bottom of the reservoir by a layer of water until the last 3 months before water and hydrocarbon removals were completed. It is highly unlikely that petroleum hydrocarbon materials from Reservoir 7 were released to the subsurface at the Subject Property after Barclay entered the site.

4.4.1 Petroleum Hydrocarbons in Reservoir 7 Were Highly Viscous With Low Volume and Low Head Pressure

The petroleum hydrocarbon material is described by Mr. L. Vollmer in his deposition as follows:

> Q Okay. And -- and when you became -- and what was -- what was the liquid like at the time that you became involved?
>
> A As previously stated, I labeled it "gunk." And whatever that conveyed, it was a -- it was not just oil, it was a tar -- tarry substance.[190]

The following quote from a July 1966 "Officer's Daily Report for Security Service" log indicates the following about the nature of the material in Reservoir 7:

> "Some Shell employee here discussing Kast – was telling us – some years ago Shell was making asphalt – for about 5 months – that they had a direct line to Kast – anything they didn't want – was sent to Kast Reservoir – such as gasoline – oil asphalt – anything and everything – that whoever bought it – could have made some money by reclaiming oil etc – but that it would have to be some asphalt co to do the refining – etc –"[191]

Testimony and documentation indicates the petroleum hydrocarbon materials in Reservoir 7 were not a liquid substance and could not migrate as a liquid at the time that Barclay entered the property as described in numerous eyewitness reports. A Los Angeles Times newspaper article reporting the March 1965 drowning death in this reservoir indicates that the petroleum hydrocarbon materials in Reservoir 7 contained a "6-inch-thick crust of oil and tar" that firemen said "must have held … for a few minutes…"[192] Eyewitness testimony indicates the petroleum hydrocarbon materials in Reservoir 7 were "black, sticky, and gooey"[193] and the "material was so viscous, you could push it with a bulldozer."[194] Further testimony indicates that the petroleum

[190] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 162: 4-9.
[191] American Plant Protection. 1966. *Officers' Daily Report*.: July 14 or 15 (based on date of fire) (LASC 97-99).
[192] Salazar, Reuben. 1965. *Brother Leads Hunt for Boy Drowned in Old Oil Reservoir.* Los Angeles Times. March 18. p. A1. (Included in Harkavy, D. 2012. *Videotaped Deposition of Dennis G. Harkavy, Volume II. July 13.* Exhibit 2-38).
[193] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 355: 11.
[194] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 118: 8-9.

hydrocarbon materials had to be heated with a steam coil to allow pumps to transfer the material into vacuum trucks.[195]

Mr. L. Vollmer's testimony provides information about the amount of water and tarry material as follows:

> Q Okay. And was it all oil that you saw in there, all petroleum products?
>
> A They appeared to be. I'm not an expert.
>
> Q Did you see any water or anything like that?
>
> A Oh, yeah, we knew that water was there because the roof was damaged on that particular tank. And that had been -- I guess everybody knows that a youngster lost his life there falling through the roof. And so that was an indication in part how badly damaged the roof was. And to carry that a little further, then the roof had over a period of -- as I understand it, probably at least 10 years the roof was subjected to rains that were not shed by the roof. And that water fell into the tank. And as water does, the oil products floated on top of the water. And so even though the rain came down on the oil, oil mix, it ultimately was on the bottom, below the oil mix and probably was to a depth of about 2 feet, maybe 3 feet, and then the oil mix was 2 on top of that, which was probably another 2 or 3 feet. So a combination of the two liquids. The entire tank area was covered in 6 feet of liquid.[196]

A depth of 3 to 6 feet in a reservoir the size of Reservoir 7 represents a very low hydraulic head pressure compared to the head pressures that existed when Shell fully operated the reservoir where the pure petroleum hydrocarbon depth could be over 20 feet. The low head pressure of the residual petroleum hydrocarbons when Barclay entered the site would place a relatively low pressure on any cracks or joints that could potentially leak and reduce the likelihood that a release occurred.

The viscous nature of the tarry material, which required steam heating to become pumpable, indicates the petroleum hydrocarbon in Reservoir 7 was too viscous to be mobile. If these "sticky, gooey" petroleum hydrocarbon materials had migrated beneath the concrete floors, the high viscosity would actually plug pore spaces in the soil and prevent any liquid migration into underlying soils which was not the case based on permeability testing by PSE. The lack of mobility of this petroleum hydrocarbon also greatly reduced the likelihood that a release occurred after Barclay entered the Subject Property.

4.4.2 Petroleum Hydrocarbons Remained in Reservoir 7 for Less than Three Months After Barclay Entered the Subject Property

Correspondence from Shell indicates that oil and water still existed in Reservoir 7 as of May 4, 1966[197] and removal of all liquids and petroleum hydrocarbon materials were completed by

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[195] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 117: 24-25, p. 118: 1-3.
[196] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 38: 6-25, p. 39: 1-5.
[197] Ballman, E.A. 1966. *Kast Fee Property*. May 4.Internal correspondence from Shell Refinery Manager-Wilmington Refinery to D.E. Clark, Pacific Coast Area, Shell Area Land Manager. p. 1. (SOC 120418)

August 15, 1966.[198] This documentation indicates that petroleum hydrocarbon materials were not in contact with the reservoir bottom for a time period longer than 3 months. Given the highly viscous, tarry nature of petroleum hydrocarbon materials in Reservoir 7, it is unlikely that any migration occurred during the 3 months of Barclay's operation of the site where petroleum hydrocarbons may have been in contact with the bottom of the reservoir.

4.4.3 Water beneath the Petroleum Hydrocarbons Acted as a Buffer Reducing the Likelihood of Petroleum Hydrocarbon Releases from Reservoir 7

Prior to the removal of water, the water provided a buffer between the bottom of the reservoir and petroleum hydrocarbon materials and effectively stopped any migration from occurring. According to Shell documentation, the water was not completely removed from Reservoir 7 until Barclay had been onsite for at least 5 months.

4.4.4 Geotechnical Testing Indicated Soil beneath the Reservoir Was Permeable and Eyewitness Testimony Did Not Identify Petroleum Hydrocarbons in Berm Soils

It is likely that if the viscous petroleum hydrocarbon materials migrated into soil, plugging of pore spaces would result. However, geotechnical testing indicated that soil beneath Reservoir 7 was porous. In addition, eyewitness testimony indicates that concrete floors were ripped in Reservoir 7 to allow percolation of water. There is no documentation or evidence that more than minor amounts of contamination in underlying soil was observed indicating that petroleum hydrocarbon materials from Reservoir 7 did not migrate to underlying soils in the areas observed by Barclay.

4.5 Barclay's "Explicit-Knowledge" of Petroleum Hydrocarbons Associated with Pipelines, the Pump House, and the Swing Pipe Pit Caused the Stockpiling and Offsite Disposal of This Material

Minor amounts of residual petroleum hydrocarbons in pipelines and in the areas around the pump house and swing pipe pit were encountered during demolition of these features by Barclay. All encountered petroleum hydrocarbons and soil containing petroleum hydrocarbons was stockpiled and removed offsite by Barclay. Therefore, Barclay's "explicit-knowledge" of petroleum hydrocarbons from these non-reservoir sources is that the materials were removed from the site. The details regarding these features at the time Barclay conducted the grading of the property is presented below.

4.5.1 Petroleum Hydrocarbons Encountered During Removal of Underground Pipelines were Stockpiled and Removed Offsite

Eyewitness testimony from Mr. Bach and Mr. L. Vollmer indicates that the aboveground pipes and pipelines were removed by Shell prior to Barclay's arrival on the Subject Property. During

[198] Lehmann, A.S. 1966. *Kast Property Status*. August 15. Internal correspondence from Shell Refinery Manager Wilmington Refinery to D.E. Clark, Pacific Coast Area, Shell Area Land Manager. p. 1. (SOC 120410)

grading by Barclay, underground pipelines were encountered, some of which contained residual petroleum hydrocarbons. In cases where residual oil spilled from pipelines onto the ground during removal from the Subject Property, the oil and oily soil was removed from the site. Mr. Bach testifies about the procedure as follows:

> A … And the piping there went into the reservoir, and also there was a pipe that apparently went south to Shell. And that was from time to time we would dig up a piece of pipe, but we didn't really know what the piping layout was.
>
> Q Do you recall that there was both above-ground and underground piping that serviced these reservoirs?
>
> A The aboveground piping had been taken off by the time I got there.
>
> Q Okay. But you do recall encountering some below-ground piping while you were working on the grading project; correct?
>
> A Sometimes we would hit a pipe, yes.
>
> Q Okay. And when you say you would hit a pipe, you're talking about with a backhoe?
>
> A With the scraper or a backhoe. Usually with a scraper or the bulldozer. [199]
>
> ***
>
> Q And when you would encounter the piping, did you remove it?
>
> A It was removed. Yes.[200]
>
> ***
>
> Q Okay. So your belief is that some of the underground piping remained at the site?
>
> A No. My belief is it ultimately all came out. [201]
>
> ***
>
> Q Okay. And -- and you mentioned to us that from time to time equipment operators when you were not at the site would encounter some oil within the soil; correct?
>
> A Yeah, if they spilled – like they opened a pipe and they spilled some oil on the ground, that would – they would take that out of there.
>
> Q What do you mean by "open a pipe"?
>
> A There were underground pipes that were left by Shell.
>
> Q Yeah.
>
> A And every now and then we would hit them. If that pipe happened to have some oil still in it, when they picked the pipe up, the oil would run out, so then you would have a little pile of dirt with oil in it and they would take it away.[202]

[199] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach*. March 11. p.264:17-p.265:10
[200] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach*. March 11. p.265:21-23.
[201] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach*. March 11. p.266:1-4.
[202] Bach, G. 2013. *Volume II Videotaped Deposition of George Bach*. March 11.p. 327:2-17.

Therefore, Barclay had no "explicit-knowledge" that any petroleum hydrocarbons remained onsite from underground pipelines based on the offsite removal of these materials during grading.

4.5.2 Barclay Did Not Have "Explicit-Knowledge" of Petroleum Hydrocarbons In the Pump House Area

A pump house for Reservoirs 5, 6, and 7 was formerly located west of Reservoir 6, outside the bermed area (on the western edge of the southern part of the Subject Property). This structure is shown on the Shell plot plan dated 1928 in Figure 3 and is also visible on an oblique aerial photograph in Figure 4 taken on March 17, 1949 during Shell operations. Additional aerial photographs taken before Barclay first arrived at the Subject Property show changes to sump areas that occurred sometime between the two photos taken January and September 1965 (Figures 17 and 18, respectively[203]). One of these sump areas (immediately north of the pump house) was associated with the former pump house as shown on Figure 4.

The pump house was present on the Subject Property and was mostly intact at the time Barclay entered the Subject Property. This structure contained a vault that connected pipelines through an underground pipeline corridor used to transfer crude oil and/or refinery products to and from Reservoirs 5, 6, and 7 and the Shell Wilmington refinery to the east.

Mr. L. Vollmer describes the pump house in his deposition testimony as he observed it in 1966 during the initial preparation of the site for development:

> Q But down on the western edge, in the southern part somewhere there was a pump house that you removed; correct?
>
> A Yes. … (indicates that location of the pump house is western edge of southern part near reservoir 6). [204]
>
> ***
>
> A The pump house. And actually, the pump house -- oh, hell, it was probably maybe like about 12 by 14 with a pitted area, and then the front part of it was another maybe about 10 by -- 5 by 10 that was like an office that they must have used. And it was level with the ground. The rear portion of it was below ground, about one story, 10 feet, roughly. And that would make sense relating to the -- to the valves and the piping that we did see, that it would be simpler to have it at that elevation so that they could drain the tanks, I guess….[205]
>
> ***
>
> Q What did you observe in the pump house?

---

[203] Figures 19 and 20 are anaglyph images that allow the photographs to be observed in three dimensions through the red/blue glasses provided with the hard copies of this report.
[204] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p.60:24-p.65:8.
[205] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 285:23-252-p. 286:1-8.

A Well, just simply some large pipes, diameter-wise probably 24 inches. And accordingly, some very large valves fitted onto that piping that would allow someone to, I guess, turn on or off the oil that was being transferred from these sites, for the oil tanks.[206]

***

Q And how deep under the ground did you go, did you look at the pump house?

A Well, the excavated area had a concrete floor and I'm going to say it in a round number. About 8-feet deep from the surrounding ground there was a concrete floor and then above the concrete floor were the pipes and the valves.

Q Did you find out where those pipes were connected to?

A When we removed them, there was nothing that had been connected. But that was what led me to looking around, forward at least, and discovering the vaults that I mentioned that run along the property line out in the street and assuming it went to the refinery.

Q When you say a "vault" you are talking about concrete:

A Yes a chamber, a tunnel, four flat walls, flat ceiling, in that respect, and the pipelines, some of them, were still hanging on the side walls of the vault… The tunnel went east on Lomita Boulevard.[207]

Mr. A. Vollmer describes the pump house in his deposition testimony as he observed it in 1966 during his grading work in this area:

Q Okay. So if you look to the east of Reservoir 5, there's an area there -- that's the spot you're looking at?

A Yeah. It was basically an open area. We needed it for a staging area. And so we went in and the soil inspector was -- looked at the area. We dug a couple little holes to make sure that there was nothing buried there. [208]

***

A Okay. Any time we did any filling in there, you would prep the base material, you know, and make sure there was no debris buried. That was the purpose of these test pits that we dug. [209]

***

Q How was the grading work done in this area?

A Well, initially, before we did anything over there, the soil inspector came over and took a look at it, and he had us dig a couple of small holes in there, 3, 4 feet deep maybe, with the 977, I think it was.

Q And what was your understanding of why you were digging the small holes?

A That was to ensure that there was no debris dumped there, any foreign material dumped in there or certainly, you know, any oil or anything popping up in there.

[206] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p.61:18-25.
[207] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p.62:21-p.64:15.
[208] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 31: 25 to p. 32:7.
[209] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 41: 17-20.

Q Did you understand why he was ensuring that, what the purpose of that was?

A Oh, it was just -- general purpose of the filling on the whole job is to make sure that everything was going to be stable when we finished up there.

Q And was there any particular places where he would have those small holes dug?

A They were random. Usually maybe four off towards each corner. Not in the exact corners, but off that direction. And then one -- one in the middle, maybe two in the middle.

Q Was that ever your assignment, to dig some of those holes?

A No. No. I think Vern did that.

Q And the -- did you ever -- were you ever in a position to look into the holes?

A Yeah. Yeah. I was kind of curious what was going on because we always -- but we never saw much oil anywhere.

Q How did --

THE WITNESS: Never saw any oil anywhere.

BY MR. LOEWEN:

Q Did you ever -- did you see any oil in the holes?

A No.

Q How deep were the holes?

A 3, maybe 4 feet. They may have be 2 feet

THE WITNESS: They were 3 to 4 feet deep.

BY MR. LOEWEN:

Q And did you look at the soil -- did you see the soil that was taken out of the holes?

A Oh, yeah. We didn't haul the soil away. We just dug down and pushed it up on the -- laid it on top of the adjoining -- next to the cut or the hole.

Q Did you see any oil in the soil that was pushed out of it?

A No. [210]

***

Q Do you know what it means to overexcavate?

A Yes.

Q And what is your understanding of the term "overexcavate"?

A Well, you have a designated area that's been contracted out to fill in -- dig out and fill in. But oftentimes when the soils people come along, they will designate that the boundaries in that area are not satisfactory. That material is not satisfactory. Or even the base of the material as you dig it out to prepare for the filling is not satisfactory. They'll have you go down until they find a satisfactory -- I guess best way to explain it, a satisfactory geological situation that the compaction would proceed without any problems.

Q Did you do any overexcavation in this staging area to the east of Reservoir No. 5?

A No.

[210] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 38: 4 to p. 40:3.

Q Did you do any overexcavation anywhere at the Carousel site?

A No. [211]

According to a PSE report dated June 10, 1968, Barclay placed 18-feet of fill in the location of the pump house (see Figure 4) following its removal (these were known as Lots 332 and 33 at the time of the PSE report).[212] The parcels in the immediate vicinity of the former pump house required no filling at all in former berm areas that were cut (Lots 21 and 34-36) and much thinner fill thicknesses of only 0.5 – 1.0 feet on other adjacent lots to the north. The deep fill placed in the pump house area is indicative that the pump house subterranean vault was removed by Barclay and subsequently filled in with fill soil. There is no eyewitness testimony or documentation that indicates any contaminated soil was encountered during the removal of the pump house vault. Therefore, Barclay did not have "explicit-knowledge" that petroleum hydrocarbons existed in this area.

4.5.3 Barclay's "Explicit-Knowledge" of Petroleum Hydrocarbons Encountered During the Removal of Swing Pipe Pit were Stockpiled and Removed Offsite

The swing pipe was a movable piping arrangement to either connect to piping that left the site to transfer materials from the reservoir to the refinery or from pipes entering the site to transfer materials from the refinery into the reservoir and is shown on Figure 4. A description of the swing pipe and associated swing pipe pit that contained the piping arrangement at the time of initial development of the property in 1966 is detailed by Mr. Bach in his deposition:

Q …What is the swing pipe pit?

A swing pipe is that – there's piping that goes into the reservoir and piping that leaves the site. And a swing pipe is where you can switch, take -- a pipe coming from the refinery and want it to go into the reservoir. You have a piping arrangement you can swing into position, connect it up and the pipe now supplies the reservoir. When you want to take the product out of the reservoir, you take the product out of the reservoir, you take the same device and swing it back so that it's drained from the reservoir and goes back in the pipe into the refinery.[213]

***

Q Okay. And when you got to the site in 1966, was all the equipment needed for the operation of the swing pipe mechanism still present?

A No, it was not.

Q Was anything -- were there any remnants of the swing pipe materials still present?

A There was a valve pit there…There was a pit there where the swing pipe had been located and there were a couple of pipes that came into the valve pit and one going out and that was all that was there. All the mechanical equipment had been taken away.[214]

***

[211] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 45: 1-21.
[212] Pacific Soils Engineering, Inc. 1968. *Tract No. 24836, lots 1-62 inclusive in the County of Los Angeles, California.* June 10. p. 1. (Lot No. 32 and 33) (CAR000032)
[213] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach*. March 7. p.55:22-p.56:8.
[214] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach*. March 7. p.56:13-24.

> Q …Could you identify on Exhibit 2 the approximate location of where the remnants were of the materials that you thought were from the swing pipe operation?
> A There's a little triangular area shown at the southwest corner of reservoir seven, and that's where the valve pit and swing pipe I saw were located.[215]

In later discussions regarding the swing pipe pit, Mr. Bach indicated the following:

> Q Okay. And did you ever see any oil saturated soil?
>
> A The oil -- there was oil-saturated soil around that pit.
>
> Q Around that pit?
>
> A Yeah.
>
> Q And that was taken off-site?
>
> A That was taken off-site.[216]
>
> ***
>
> Q Explain to me the occasion on which you saw the oil-saturated soil at the site.
>
> A Okay. The stockpile, the original stockpile started when we dug out the swing pit. We took the concrete out. The soil around there was moist gooey mud. It was – it was not necessarily oil, there was some oil in there because the pipes came out of the ground there was oil in the pipes. When they took this stuff apart, the oil would run out of the pipes. It was there but not a lot. … The oil that was there came out of the pipes. When we took – the pipes came out, the oil went into the pit. And when they – probably when they took the original mechanical stuff out, they might have even – some of it went into the pit, but that's why the pit was there, to catch that stuff…[217]

Based on the details provided above by Mr. Bach, the swing pipe pit contained some mud as it was dug out by Barclay but it was not necessarily oil containing mud. There was some oil-saturated soil around the pit but this was the result of oil spilling into the pit as associated underground pipelines were removed that contained some residual oil. The pit contained this oil and then the oil-saturated soil was removed and placed in a separate soil stockpile which was subsequently disposed offsite. Therefore, Barclay's "explicit-knowledge" of petroleum hydrocarbons in this area is that it was not observed in the soil and what was observed from pipelines was removed and disposed of offsite.

4.5.4 Barclay Did Not Observe or Disturb Areas that Currently Exhibit a "Top Down" Pattern of Soil Contamination in the Pump House Area

Waterstone evaluated soil data from Shell Investigations to determine the depth, distribution and pattern of petroleum hydrocarbon contamination that currently exists in the former pump house area. The highest concentrations of petroleum hydrocarbons were detected in a soil sample collected at 2 feet bgs in sample M24744SF (shown on Figure 19). Based on the fill records provided in PSE's June 10, 1968 report, the area where sample M24744SF is located was cut as part of the grading plan executed by Barclay and no fill materials were placed at this location.

[215] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach*. March 7. p.57:2-9.
[216] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach*. March 7. p.114:2-9
[217] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach*. March 7. p.121:14-p.122:15

The pattern of contaminated soil in the area where sample M24744SF is located indicates that the highest contamination concentrations exist at a depth of 1 and 2 feet bgs and then significantly decrease at a depth of 5 and 10-feet bgs. This “top down” distribution of petroleum hydrocarbons indicates that these materials had not been moved, disrupted or put in place during Barclay’s grading operations in 1966. Therefore, because this area was cut and no fill was placed, the 2 foot depth was never viewed, removed or disturbed by Barclay who did not have “explicit-knowledge” of this contamination left in place by Shell.

4.6 Barclay Did Not Have “Explicit-Knowledge” of Petroleum Hydrocarbons in Soil at Pond and Sump Locations

At the Subject Property, each reservoir was contained within a separate bermed area that consisted of perimeter berms and interior berms as shown on Figures 3 and 4. The individually-bermed containment areas included low areas that were a few feet to over five feet deep according to the contour map of the existing property grade in 1965.[218] These are areas where rainwater runoff from the reservoir roofs would pond and any other liquids potentially spilled from the reservoirs would be contained. “Ponds” are identified on Figure 4 with the associated reservoir number and a sequential number that uniquely identified each separate pond.

Based on Figure 3, Shell’s 1928 plot plan of the Subject Property, only two sumps were identified on the site, the main sump east of Reservoir 5 and the pump house sump located just north of the pump house area (north of the perimeter berm). These are also identified on Figure 4.

Based on a review of aerial photographs and deposition testimony provided by Mr. Bach and Mr. L. Vollmer, there was no standing water on the Subject Property and no areas distinguishable as ponds or sumps when Barclay initiated their onsite activities. In the locations where these former features were present, Barclay did not observe petroleum hydrocarbons as further discussed below. Therefore, Barclay had no “explicit-knowledge” of petroleum hydrocarbons in the pond areas.

4.6.1 Barclay Had no “Explicit-Knowledge” of Contaminated Soil in the Former Pond Areas

In the 1949 aerial photograph shown on Figure 4, the pond areas are identified as P5A through P5D (Reservoir 5), P6A through P6D (Reservoir 6) and P7A through P7G (Reservoir 7). In 1949, all of these pond areas contain fluids which are likely rain water. This oblique photograph shows how the site operated while Shell was performing full operations on the site.

Aerial photographs from January 1, 1965 are presented in Figure 17 as a 3-dimensional anaglyph so topographic differences can be observed. As seen in the January 1, 1965 anaglyph, the ponds exist as low points within the corners of the larger bermed reservoir areas. January 1965

[218] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract 24836 in the County of Los Angeles, California.* January 7. Plates A-1 through A-4.

represents a time when the reservoirs were not in full operation as in the past but were used by Shell for storage of petroleum hydrocarbon on a reserve basis; however Shell still owned and maintained the property. The pond areas visible on January 1, 1965 are similar to the condition of these areas as seen in the 1949 oblique aerial photograph during the full operation period of the property by Shell.

Aerial photographs from September 22, 1965 are presented in Figure 18 as an anaglyph. This is just prior to Barclay's first entry onto the Subject Property to begin development activities. Observations of the September 22, 1965 anaglyph indicate the pond areas are changed from the January 1, 1965 photograph as described below (see Figure 4 for pond locations):

P5A: Pond is dry with some vegetation in a low area (contained fluid in January).

P5B: Pond is dry and relatively flat (contained some fluid in January). Soil does not appear to be stained or discolored.

P5C: Pond is dry with some vegetation (contained fluid in January).

P5D: Pond is dry (contained fluid in January). Marks are visible that may be from equipment and the area appears to be flattened to some degree. Soil does not appear to be stained or discolored.

P6A: Pond is dry with vegetation (contained fluid in January). Marks are visible that may be from equipment and the area appears to be reworked to some degree. Soil does not appear to be stained or discolored.

P6B: Pond is dry (contained fluid in January).

P6C: Pond is dry with some vegetation (contained fluid in January).

P6D: Pond is dry with some vegetation (contained fluid in January).

P7A: Pond is dry and relatively flat (contained some fluid in January). Marks are visible that may be from equipment and the area appears to be flattened and possibly filled in to some degree. Soil does not appear to be stained or discolored.

P7B: Pond is dry (contained some fluid in January). The soil is slightly darker than surrounding soil. Marks are visible that may be from equipment and the area appears to be filled in and flattened to some degree. Soil does not appear to be stained or discolored.

P7C: Pond is dry (contained some fluid in January). Marks are visible in the area just north of the nearby drive down ramp that may be from equipment and the area appears to be reworked to some degree. Soil does not appear to be stained or discolored.

P7D: Pond is dry and the depression is still observable (contained some fluid in January). Soil does not appear to be stained or discolored.

P7E: Pond is dry (contained some fluid in January). Soil does not appear to be stained or discolored.

P7F: Pond is dry and relatively flat (contained fluid in January). The area appears to be flattened to some degree. Soil does not appear to be stained or discolored.

P7G: Pond is dry and relatively flat (contained some fluid in January). Marks are visible that may be from equipment and the area appears to be reworked to some degree. Soil does not appear to be stained or discolored.

The above comparison of the January and September 1965 photos indicates the condition of the pond areas was changed possibly in preparation of transfer of the Subject Property to a new owner. In addition, given that Shell had a great concern for safety based on its December 15, 1965 letter to Barclay outlining the requirement for the development work,[219] it is possible that Shell made an effort to make the site flatter and safer for any persons entering the site following the drowning that occurred in March 1965 before Barclay entered the site. Mr. L. Vollmer provides deposition testimony (see Section 4.6.2) indicating that the berm west of the main sump was partially removed enough to allow vehicles to pass through by the time he was on the site, also indicating that some soil reworking was performed by Shell prior to Barclay's arrival on the site.

Geotechnical borings outside the reservoirs were mostly advanced in pond areas[220] and there was no mention of petroleum hydrocarbon observations in these borings. This is discussed in detail in Section 3.2.1.

In addition, there is deposition testimony from Mr. Bach indicating his observations of areas that were wet with rainwater:

> Q At this site did you find places like that, where -- any places where there was saturated -- where there was soil saturated with oil?
>
> A I never saw anything that I would say was saturated with oil, no. There were areas where it was moist, but we attributed it and my belief is that it was mainly just rainwater because if there was rain, there was no way for the water to get away. The drainage system had been dismantled, it wasn't functioning anymore. So the water either had to evaporate or stay there until it soaked into the ground. One or the other.[221]

Based on this information, Barclay had no "explicit-knowledge" of petroleum hydrocarbons in pond areas and the petroleum hydrocarbons that exist in these areas were not observed by or disturbed by Barclay.

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[219] Clark, D. E. 1965. *RE: Wilmington Field Kast Fee – Kast Tank Farm, Your Reference: Lomita Property*. Correspondence from Shell Oil Co. to Barclay. December 15. (SOC000058-61)

[220] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract 24836 in the County of Los Angeles, California*. January 7. Plates A-1 through A-4.

[221] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach*. March 7. p. 106:6-18.

4.6.2 Barclay Had No "Explicit-Knowledge" of Contaminated Soil in the Former Sump Areas

As previously mentioned, there are two known sump areas on the Subject Property as shown on Shell's 1928 plot plan in Figure 3. The main sump was located on the eastern side of the Subject Property, directly east of Reservoir 5. The main sump can be seen on Figure 4 (identified as S1) during Shell's operations in the March 17, 1949 oblique aerial photograph. The main sump is subdivided by what may be berms and/or differences in depths that allow the formation of separate ponds P7A through P7D on Figure 4. A smaller sump that was formerly associated with the pump house is located north of the pump house and identified as S2 on Figure 4.

As seen in the January 1, 1965 anaglyph (Figure 17) the sumps are low areas and are filled with fluid. Fluids and wet areas show as darker spots on this photograph. This time frame is when the reservoirs were used by Shell for storage of petroleum hydrocarbon on a reserve basis; however Shell still owned and maintained the property. The pond areas on January 1, 1965 are similar to the condition of these areas as seen in the 1949 oblique aerial photograph during the full operation period of the property by Shell.

An anaglyph of the September 22, 1965 aerial photographs is presented in Figure 18. Note that darker areas on the January 1, 1965 photo are now lighter areas where soil appears to be dry. This is just prior to the time Barclay first saw the property and three months before Barclay was given permission from Shell to enter the property for development activities. Changes to the main sump and pump house sump between January 1, 1965 and September 22, 1965, include the following:

- The main sump (S1 on Figure 4) is filled in with soil to some degree from the bermed area separating the main sump from Reservoir 7.
- The main sump is dry except for a limited area at the south end of the sump that is approximately 10 percent of the former sump area.
- In the pump house sump (S2 of Figure 4), fluid is still present but approximately 75 percent smaller in area than present in the January 1, 1965 anaglyph.

The absence of sumps and or observations of any petroleum product in former sumps are detailed by Mr. Bach and Mr. L. Vollmer in their deposition testimony. Neither Mr. Bach nor Mr. L. Vollmer observed sumps during the initial grading of the property. Mr. L. Vollmer's deposition testimony states:

> Q Did you see an active sump anywhere on the site?
>
> A No[222]

***

[222] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p.145:14-15.

> Q (regarding Exhibit 16) if you look at the top right of the drawing – there's an oval there with the words "approximate location of oil sump". … Do you have any recollection of there being an oil sump in that approximate location.
>
> A When we arrived on the site, there was no oil sump there.[223]
>
> ***
>
> Q Now, the -- when you arrived at the site in 1966 -- let me back up a second. Over here in the -- look at the area just to the east of reservoir No. 5, which is the middle reservoir.
> A Okay.
>
> Q There's a -- sort of a big open area there. Do you see what I'm talking about?
>
> A Yes.
>
> Q Okay. And there appear to be kind of ponds there. Do you see that?
>
> A Yes.
>
> Q I don't know what's in them. I don't mean to characterize them for you. Were those -- where there ponds or any kind of liquids ponded in that area when you arrived there?
>
> A My recollection is that there was nothing -- no open oil ponds or any other material ponded. And I don't recall the -- what we're calling a safety berm that's between tank 5 and --and the area that you've described runs right --that berm -- the berm that runs right through there, I believe, had been removed already. And -- because I can't picture it as being -- the berm, the safety berm is essentially --if you visualize coming in at the gate in the front, the safety berms, as they're shown, would essentially keep traffic from being able to drive toward the tank No. 7 in the back. And with that awareness, if my memory serves me right, we were able to drive back there.
> And so I think those -- those safety berms had been removed after -- during the time between when this picture was taken in 1949 and 17 years later when we started the job.[224]

In Mr. Bach's deposition testimony, he indicated that his observations were similar:

> Q Did you see -- did you see any ponded liquids in this area that it says it's the location of oil sump?
>
> A No, I never saw anything ponded in there.
>
> Q Did you see -- did you see soil in the shallow surface area indicating that -- contamination from oil, from an oil sump in that location?
>
> A Contamination, no. There was just whatever may have washed in there with rainwater, whether it was aggregate off the roof or dust or whatever, might have ultimately settled there. There was no oil there.[225]
>
> ***
>
> Q If you look at the middle reservoir here and if you go right to the right of that, there's --it looks like there's some kind of a ponding area here. You see this dark area in the middle up there (indicating)?
>
> A Yes.
>
> Q Okay. Was there -- was there some kind of liquid or ponded area right there when you arrived 1966?
>
> A No, there was no liquid in there. It was just debris on the ground.

[223] Vollmer, L. 2013. *Volume II Videotaped Deposition of Leroy H. Vollmer*. April 1. p. 281:12-22.
[224] Vollmer, L. 2013. *Volume 1 Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 88: 2 to 89:13.
[225] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach*. March 7. p. 141:5-18.

> Q Okay. And then -- and then how about like was there any kind of liquids or anything like that in this -- up in this corner in the upper right area just to the -- on the western edge of the property(indicating) that you can see there?
>
> A The western edge of the property?
>
> Q Oh, I'm sorry. The eastern edge of the property?
>
> A No, there was nothing there. It was just dry.[226]

Based on aerial photographs taken in September 1965 and eyewitness testimony by Mr. L. Vollmer and Mr. Bach there were no sumps on the Subject Property at the time that Barclay first entered the site. Some evidence of former sumps may have been present in low lying areas but no evidence of oil or contaminated soil was observed by Barclay in these areas. In addition, the discussion above indicates that some rework of the main sump was performed by Shell because the berm on the west portion of the main sump had been partially taken down and aerial photography shows some rework of the sump area. Based on this information, Barclay had no "explicit-knowledge" of petroleum hydrocarbons in pond areas and the petroleum hydrocarbons that exist in these areas were not observed by or disturbed by Barclay.

4.6.3 Barclay Did Not Observe or Disturb Areas that Currently Exhibit a "Top Down" Pattern of Soil Contamination in the Main Sump Area

Waterstone evaluated laboratory analysis results from recent soil sampling data to determine the depth, distribution and pattern of petroleum hydrocarbon impacted soil in the former main sump (S1) and pump house sump areas. Impacted soil has been detected in the area of the former main sump (Figure 20). The highest concentrations of petroleum hydrocarbons were detected in soil samples collected at depths of 5 and 6.5 feet bgs. As indicated in Section 4.6.2, at the time of development of the property in 1966 the sump was no longer an active oil sump and no petroleum hydrocarbon contaminated soil was observed in this area. Aerial photographs summarized in Section 4.6.2 show that this area had been partially filled in with soil by Shell prior to Barclay's development of the property.

The distribution of the impacted soil in the former main sump area indicates that contamination concentrations are highest at a depth of 5 and/or 6.5 feet bgs and significantly decrease at a depth of 10-feet bgs indicating the contamination source began at the 5 to 6.5 foot depth. This 5 - 6.5 foot depth may represent the former bottom depth of the sump area during its operation by Shell. This former bottom of the sump was not visible to Barclay at the time of the Subject Property development and was not moved or graded by Barclay.

The distribution of petroleum hydrocarbons in this location indicates a "top down" vertical profile of contamination, which is distinct from the vertical profile of "bottom up" contamination that is present in the soil column above the reservoir floors. The "top down" vertical distribution of contamination indicates a limited amount of impacted soil in this area with no upward migration component. Therefore, the contamination in this area was never viewed, removed or

[226] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach*. March 7. p. 38: 7 to 40: 2.

disturbed by Barclay who did not have “explicit-knowledge” of this contamination left in place by Shell.

Section 5
Upward Chemical Migration at Shell Oil Reservoirs 1, 2, 5, 6 & 7

This section includes an analysis and discussion of data obtained in Shell's detailed assessments and remediation reports of Shell Reservoirs 1 and 2, located east of the Subject Property on the Wilmington Section of the Shell Wilmington Manufacturing Complex (Wilmington Refinery). Shell Reservoirs 1 and 2 were built in the 1920s at the same time and using the same type of construction as Reservoirs 5, 6, and 7 on the Subject Property. The data in the Shell reports demonstrates that significant upward chemical migration occurred at Shell's Reservoirs 1 and 2 after they were decommissioned and berm soil was used to backfill the interior of the former reservoirs in a manner very similar to how berm soils were used to fill the reservoirs on the Subject Property.

In this section, a comparison between the Subject Property Reservoirs 5, 6, and 7 and Shell Reservoirs 1 and 2 is presented. The comparison discusses the reservoir construction details; the deconstruction and backfill procedures; and the environmental conditions that are known to exist on each site. This comparison demonstrates that the procedures used to deconstruct and backfill the former reservoirs and the environmental conditions at the two properties were similar and that upward migration of petroleum hydrocarbons into the fill material placed inside the reservoirs occurred in similar locations within all the reservoirs.

5.1 The Shell Wilmington Manufacturing Complex

The Shell Wilmington Manufacturing Complex (WMC) in Carson, California consisted of the Wilmington and Dominguez Sections.[227,228] The Wilmington refinery was initially constructed in 1923.[229] The Wilmington Refinery included a reservoir farm located approximately one mile west of the main portion of the Wilmington Refinery.[230] The Shell Wilmington Section and adjacent reservoir farm as well as the Dominguez Section of the WMC are shown in a 1930 topographic map as shown in Figure 21.

5.1.1 Oil Storage Reservoirs

Construction of the Wilmington refinery included the construction of seven oil storage reservoirs.[231,232] Reservoirs 1 through 4 were constructed within the main Wilmington refinery

[227] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August 1989. (p. v).
[228] Shell Oil Company. 1929. Engineering Plan. *Dominguez-Torrance Reservoir Filling Line.* Y-1446. July.
[229] Shell Oil Company of California. 1923. *The Very First Operating & Construction Report, Simplex Refining Dept., Wilmington Refinery.* September 30.
[230] Shell Oil Company of California. 1923. *The Very First Operating & Construction Report, Simplex Refining Dept., Wilmington Refinery.* September 30. p. 2. par. 2 and p. 13.
[231] Shell Oil Company of California. 1923. *The Very First Operating & Construction Report, Simplex Refining Dept., Wilmington Refinery.* September 30. p. 13
[232] Beaton, Kendall. 1957. *Enterprise in Oil A History of Shell in the United States*. March. p. 262.

property. Reservoirs 5 through 7 were located approximately one mile west of the main Wilmington refinery property on a reservoir farm is referred to as the "Kast Property Reservoir Farm Shell Oil Co." on a 1928 Shell engineering plan.[233] The name for the reservoir farm property originates from the previous property owner; however the property was conveyed to Shell by Mary Kast, by deed dated June 4, 1923.[234] A plot plan of the main Wilmington refinery property shows the location of Reservoirs 1 through 4 (see Figure 22).[235] A 1928 engineering plan of the Kast Property shows Reservoirs 5 through 7 (see Figure 3).[236]

5.1.1.1 Reservoir Construction and Capacity

The seven reservoirs, constructed to hold crude oil from Signal Hill and Santa Fe Springs prior to refining, were finished and nearly all full by the summer of 1923.

The capacity of each reservoir was noted on fire insurance maps from 1923, 1924 and 1925 as summarized below:[237,238]

Reservoir Number	Capacity (in barrels)
Reservoir 1	800,000
Reservoir 2	1,000,000
Reservoir 3	1,000,000
Reservoir 4	2,100,000
Reservoir 5	750,000
Reservoir 6	750,000
Reservoir 7	2,000,000

All seven reservoirs were constructed with transfer lines and pumping systems to feed the refinery.[239,240] The reservoirs are referred to as concrete-lined earthen reservoirs.[241] Notations on the fire insurance maps describing the construction of the reservoirs are similar for all seven reservoirs and state:

> "crude oil reservoirs have earth slopes, concrete lined - asbestos composition covered wooden roofs on wood posts".[242]

233 Shell Oil Company. 1928. Engineering Plan. *Pipe Lines Wilmington Refinery to Kast Property.* Y-R2257-1. August 21

234 Shell Co. of Cal. 1923. *Fee Land Record*.

235 Shell Oil Company. 1932. Engineering Plan. *Building and Tank Numbers Wilmington Refinery.* R-1799-3. October 5.

236 Shell Oil Company. 1928. Engineering Plan. *Building and Reservoir Numbers Kast Property.* Z-R2340-2. October 5.

237 EDR. 2013. Certified Sanborn Map Report for Wilmington Refinery 1923, 1924, and 1925.

238 EDR. 2013. Certified Sanborn Map Report for Kast Property 1924 and 1925.

239 Shell Oil Company of California. 1923. *The Very First Operating & Construction Report, Simplex Refining Dept., Wilmington Refinery.* September 30. p. 14

240 Shell Oil Company. 1928. Engineering Plan. *Pipe Lines Wilmington Refinery to Kast Property.* Y-R2257-1. August 21.

241 Beaton, Kendall. 1957. *Enterprise in Oil A History of Shell in the United States*. March. p. 262).

242 EDR. 2013. Certified Sanborn Map Report for Wilmington Refinery 1924.

Engineering plans indicate that the concrete lining the inside berm walls and the bottom of the reservoirs was 4-inches thick.[243]

The reservoirs were constructed by excavating native soil from the center of the reservoir and then using the excavated soil to build berms around the outside perimeter of the excavation. The berms were constructed to an elevation of approximately 18 feet above grade and had approximate slopes of 1.5:1 on both the inside and outside walls. The interior berm walls and floors of each reservoir were surfaced with concrete. The top and outside perimeter of the berm walls were asphalt-covered. A roof superstructure supported by a grid of wooden posts provided a canopy over the top of the reservoir.[244] Reservoirs 1 through 7 contained similar material.[245]

5.1.2 Reservoir Decommissioning Dates

5.1.2.1 Reservoirs 1 and 2

In December 1991, Shell sold the former Wilmington Section of the WMC to Unocal. As part of the property transaction, Shell was contractually required to provide closure of Reservoirs 1 and 2 in accordance with the Waste Discharge Requirements (WDRs) for Closure of Two Surface Impoundments (Order No. 94.112), issued by the Los Angeles Regional Water Quality Control Board (RWQCB).[246] The RWQCB held a public hearing on October 31, 1994 to review Order No. 94.112 and an associated Monitoring and Reporting Program (No. CI 7452) and issued the order the same day. Reservoirs 1 and 2 were in continuous uses from the time of their construction until they were drained in December 1991.[247] Reservoirs 1 and 2 were in service for a period of approximately 67 years; the longest period of any of the seven reservoirs. A detailed summary of the decommissioning of these reservoirs is presented below.

5.1.2.2 Reservoirs 3 and 4

Reservoir 3 located within the main Wilmington refinery property is present in a 1981 topographic map.[248] Reservoir 3 was removed in 1982[249] and thus, was in service for approximately 59 years. Reservoir 4 located within the main Wilmington refinery property is present in a 1964 topographic map; however, it is no longer present in a 1972 topographic map

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[243] Parsons. Grading Plan 1993. *Carson Dismantlement Project Reservoirs- RS#1 & RS#2 – Grading Work*. RMP-CE-7800-05 through RMP-CE-7800-09. October 4.

[244] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report Reservoirs 1 and 2*. October. p. 1-1

[245] Shell Oil Company of California, Chemical Department. 1926. *The Explosibility of Natural and Reservoir Gases in the Presence of Oxygen, Nitrogen, Air and Carbon Dioxide.* December 23.

[246] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report Reservoirs 1 and 2.* October. p.1-1

[247] Shell Oil Company. 1994. *Work Plan Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson, California*. November 3. p. 1.

[248] U.S. Geological Survey. *Long Beach quadrangle, Los Angeles*. 1964 map photorevised 1981. 1:24,000. 7.5 Minute Series.

[249] Brown and Caldwell. 1989. *Reservoir Investigation*. March. p. 1-1

of the same area.[250, 251]Its term of service ranges from approximately 41 to 49 years. Details concerning the decommissioning of these reservoirs are unknown.

5.1.2.3 Reservoirs 5, 6 and 7

Reservoirs 5, 6 and 7 located on the reservoir farm were the first series of reservoirs to undergo demolition. The reservoir farm was an active oil storage facility until approximately the early 1960s, when the Subject Property became used on a standby, reserve basis.[252] In 1965, Shell decided it had “no foreseeable need for the Kast Fee property” and determined that the property should be “disposed” of.[253] The reservoir farm property was sold to Barclay in 1966. Reservoirs 5, 6, and 7 were the first of the seven reservoirs to be decommissioned. Their service life was approximately 40 years - the least of the seven reservoirs.

5.1.3 Investigation of Soils Associated With Reservoirs 1 and 2

5.1.3.1 Initial 1988 Soil Sampling

Investigations of the perimeter berms and soil underlying the concrete liner of Reservoirs 1 and 2 were initiated in 1988 and summarized in a report titled “Reservoir Investigation” dated March 1989. The initial investigation consisted of drilling 3 angle borings around the perimeter of Reservoir 1 and 3 angle borings around the perimeter of Reservoir 2. Each boring was started at ground surface adjacent to the outer berm wall. Borings were drilled at an angle of 45 degrees and all but one of the borings extended to a depth of 40 feet. Based on the location of the boring and the angled drilled, it is estimated that the borings extended 27 feet deeper than the reservoir bottom near the reservoir outer edge.[254]

Soil samples were collected at varying depths ranging from 4 feet to 40 feet below ground surface. In total, 49 soil samples were collected and analyzed for Total Petroleum Hydrocarbons (TPH) by EPA Method 418.1 and volatile organic compounds (VOCs) by EPA Method 8020. Of the 49 samples analyzed only three had detectable concentrations of TPH. Detectable concentrations of TPH were 990 milligrams per kilogram (mg/kg) at a depth of 4 feet, 35 mg/kg at a depth of 14 feet and 24 mg/kg at a depth of 39 feet. No benzene, ethylbenzene, or toluene was detected in any of the samples analyzed. Total xylene was detected in two samples at concentrations of 1.9 mg/kg and 3.8 mg/kg at depths of 36 feet and 40 feet respectively.[255]

[250] U.S. Geological Survey. *Long Beach quadrangle, Los Angeles*. 1964. 1:24,000. 7.5 Minute Series.
[251] U.S. Geological Survey. *Long Beach quadrangle, Los Angeles*. 1964 map photorevised 1972. 1:24,000. 7.5 Minute Series.
[252] Clark, Durland. Land Department Manager. Shell Oil Company. 1963. *Letter Regarding Rezoning Adjacent to Kast*. August 26.
[253] Shell Oil Company. 1965. *Shell Properties – Disposable Manufacturing Kast Fee (44.35 acres) Los Angeles County California*. June 23.
[254] Brown and Caldwell. 1989. *Reservoir Investigation*. March. p. 2-1
[255] Brown and Caldwell. 1989. *Reservoir Investigation*. March. Table 3-1, page 3-2

Oil-saturated tarry material encountered at an approximate depth of 5 feet in two boreholes was attributed to the tar covering the outer berm walls. This report concluded that the reservoirs did not appear to be leaking or contributing to the groundwater plume beneath the Shell refinery.[256]

5.1.3.2 Phase 1 - 1993 Berm Soil Sampling

In 1993, an investigation of the soil comprising the berms around Reservoir 1 and 2 and the soil beneath the base of the reservoirs was initiated to:

- Assess whether the berm soil was suitable for use as backfill material for filling in the reservoirs, and
- Determine if "constituents previously contained within the reservoirs have migrated downward into the underlying soil."

Phase 1 of the investigation was conducted in July 1993 and involved characterizing the berm material by collecting and analyzing 46 samples. Twenty-three samples were collected from varying depths around each of the two reservoir berms (Figures 23 and 24).

All of the samples collected from the berms were screened in the field for the visual presence of oil and for organic vapors using an organic vapor monitor (OVM). Soil samples were analyzed for Total Recoverable Petroleum Hydrocarbons (TRPH) by EPA Method 418.1.[257]

Berm soil would be suitable for use as backfill material for filling in the reservoirs if it was found to be suitable "engineered fill".[258] Specifications for on-site soils to be used as engineered fill included the following:

- Material that is free of organics and debris.
- Material that is predominantly silty sand.
- Material can be compacted to achieve a minimum of 90% of the maximum dry density.

Of the 23 samples collected from Reservoir 1, 13 samples had no detectable concentrations of TRPH at a detection limit of 10 mg/kg. Detectable concentrations of TRPH were found in 10 samples and ranged from 23 mg/kg to 43,000 mg/kg.[259]

[256] Brown and Caldwell. 1989. *Reservoir Investigation*. March. p. 4-1
[257] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. Table 2-1, p. 2-5.
[258] Parsons.. 1994. Engineering Plan. *Carson Dismantlement Project Reservoirs – RS#1 & RS#2 – Grading Work Finish Grading & Drainage Plan Notes*. RMP-CE-7800-05 Rev. B. May 17. Sheet 1 of 2. Grading Notes #7, #9, and #11.
[259] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. Table 2-1, p. 2-5.

Of the 23 samples collected from Reservoir 2, 11 samples had no detectable concentrations of TRPH at a detection limit of 10 mg/kg. Detectable concentrations of TRPH were found in 12 samples and ranged from 12 mg/kg to 34,000 mg/kg.[260]

Based on the data collected, it was concluded that the berm material was suitable as backfill material for filling in the reservoirs.[261] Soil was blended within the reservoirs to meet regulatory requirements as discussed in Section 5.1.5.

5.1.3.3 Phase 2 - 1993 Berm Soil Sampling

Phase 2 of the investigation, started in December 1993 and completed in January 1994, involved drilling 21 borings through the reservoir floors "to visually and chemically determine if constituents from the reservoirs had leaked into the underlying soil." Eleven boreholes were completed in Reservoir 1 and 10 boreholes were completed in Reservoir 2. The depth of the boreholes ranged from 10-feet to 61.5 feet below the bottom of the reservoirs.[262]

All of the samples collected from beneath the reservoir floors were screened in the field for the visual presence of petroleum hydrocarbon contamination and for organic vapors using an organic vapor monitor (OVM). Up to six samples per boring were collected and submitted for analysis of TRPH by EPA Method 418.1.[263]

Reservoir 1 contained visible petroleum hydrocarbon contamination in all boreholes, with the deepest petroleum hydrocarbon contamination observed at a depth of 56 feet below the reservoir bottom. Reservoir 2 contained visible petroleum hydrocarbon contamination in five of the 10 boreholes completed. The deepest depth that visible petroleum hydrocarbon contamination was identified below Reservoir 2 was 46 feet below the reservoir bottom.[264]

Based on the data collected, the following was concluded regarding the soil underlying the reservoirs:

- Soil underlying the reservoirs contained "similar hydrocarbons and in similar concentrations as the berm material."[265]

[260] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. Table 2-1, p. 2-5
[261] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 4-1.
[262] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 1-1
[263] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 3-1
[264] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 3-2
[265] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 3-3

- Soil underlying the reservoirs contained "localized areas of heavy hydrocarbons originating primarily from the sump area with the reservoir and cracks in the concrete bottom of the reservoir."[266]
- Soil underlying the reservoirs that was found to be saturated with heavy hydrocarbons would require removal before demolition of the reservoirs.[267]
- Soil underlying the reservoirs that was not saturated with hydrocarbons could remain in place.[268]

5.1.4 Shell Workplans for Reservoir 1 and 2 Decommissioning and Dismantlement

Shell provided the RWQCB its proposed plan for removal of Reservoirs 1 and 2 in work plans dated August 29, 1994 and November 3, 1994. The November 3, 1994 letter transmitting the second work plan also expresses Shell's thanks to the RWQCB for their expeditious processing of Shell's application for WDRs.[269]

Shell's second work plan, dated November 3, 1993, indicates that the work to empty the reservoirs and dismantle the roof structure was completed in March 1994. The purpose of the work plan was to describe the excavation monitoring, characterization of the berm material to be graded into the reservoirs as backfill, placement of a low permeability cover over the filled reservoirs, precipitation and drainage control, and post-closure maintenance. The work plan indicates that the concrete liner within Reservoirs 1 and 2 will be removed, crushed, and used as fill material to fill in the reservoirs. The soil from the reservoir berms is also to be used to fill in the reservoirs. The soil placed in the reservoirs is to be compacted to a minimum of 90% relative compaction.[270]

The workplan indicates that the project scope is to include:

1) Complete removal of the concrete liner.
2) Removal and offsite disposal of residual liquid hydrocarbons and hydrocarbon saturated soils.
3) Collecting representative soil samples at the base of the excavation prior to placement of any fill material.
4) Use of berm material to fill in the reservoir.

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[266] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 4-1

[267] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 4-1

[268] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 4-1

[269] Shell Oil Company. 1994. *Work Plan Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson, California*. November 3.

[270] Shell Oil Company. 1994. *Work Plan Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson, California*. November 3. p. 1.

5) Installation of a low permeability cover.[271]

The RWQCB approved the two workplans in a letter dated December 1, 1994.[272]

5.1.5 Decommissioning and Dismantlement Progress Reporting

The WDRs issued by the RWQCB to Shell included a directive to Shell to submit to the RWQCB monthly progress reports throughout the duration of the Reservoir Removal Project.[273]

The first progress report submitted by Shell to the RWQCB was for the period of October 31, 1994 to November 30, 1994. This report states:

> "the berm soil under the concrete liners did not show any free-phase petroleum hydrocarbons nor any oil saturated soils; therefore, no soils were removed to be disposed of offsite."[274]

The second progress report submitted by Shell to the RWQCB was for the period of December 1, 1994 to December 31, 1994. This report states:

> "The soil under the floor concrete liners did not show any free-phase petroleum hydrocarbons nor any oil saturated soil; therefore, no soils were removed to be disposed of offsite."[275]

The sixth progress report submitted by Shell to the RWQCB was for the period of April 1, 1995 to April 30, 1995. This report states that sampling of the soil beneath the removed concrete was conducted. Also completed during the month of April was that the crushed concrete from the reservoir floor, piles and walls was spread over the reservoir floor to be the base for the backfill phase of the project.[276]

The seventh progress report submitted by Shell to the RWQCB was for the period of May 1, 1995 to May 30, 1995. This report states that sampling of the soil beneath the removed concrete was completed. Sampling of soil from the berms to be used as backfill was started during the reporting month. Data from the berm samples showed that concentrations of xylene were greater

[271] Shell Oil Company. 1994. *Work Plan Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson, California*. November 3. p. 2.

[272] California Regional Water Quality Control Board Los Angeles Region. 1994. *Shell Oil Company, Former Wilmington Plan – 1520 through 1622 East Sepulveda Boulevard in Carson – Removal of Oil Storage Reservoirs (File No. 92-19)*. December 1.

[273] California Regional Water Quality Control Board Los Angeles Region. 1994. *Monitoring and Reporting Program No. CI 7452 for Shell Oil Company 1520 through 1622 East Sepulveda Boulevard Carson California Closure of Two Surface Impoundments (File No. 85-19)*. October 31. p. 1.

[274] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.

[275] Shell Oil Company. 1995. *Progress Report #2 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. December 1 to December 31. p. 1.

[276] Shell Oil Company. 1995. *Progress Report #6 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. April 1 to April 30. p. 1.

than the WDR limits. Because WDR limits were exceeded, the soil was re-blended until all WDR limits were met. After soil met WDR limits it was used in backfilling the reservoirs in lifts of 12 inches and compacted to 90%.[277]

The eighth progress report submitted by Shell to the RWQCB was for the period of June 1, 1995 to June 30, 1995. Sampling of soil from the berms to be used as backfill continued throughout the reporting month. Data from the berm samples continued to show that concentrations of xylene in the berm soil were greater than the WDR limits therefore the soil was re-blended and re-sampled until all WDR limits were met. After soil met WDR limits it was used in backfilling the reservoirs in layers of 12 inches and compacted to 90%.[278]

The ninth progress report submitted by Shell to the RWQCB was for the period of July 1, 1995 to July 31, 1995. Blending and backfilling of both reservoirs was completed on July 20th. The installation of the clay cap was near completion.[279]

The tenth and final progress report submitted by Shell to the RWQCB was for the period of August 1, 1995 to August 31, 1995. Construction of the low permeability clay cap on both reservoirs was completed on August 8th.[280]

5.1.6 Post Concrete Floor Removal Sampling

The soil beneath the reservoir floors was sampled in April of 1995 after the concrete floors had been removed. The purpose of the sampling was to document the concentrations of soil that would remain beneath the former reservoir concrete bottom. Samples were collected at a depth of 2-feet below the bottom of the reservoir.[281] The TPHd data for samples collected from immediately beneath the concrete floors is summarized on Figures 25 and 26, which both show that the most highly contaminated soil beneath the floors is located near the sidewall/floor joint area. Of the 30 samples collected beneath Reservoir 1, 21 had concentrations greater than the WDR limit of 10,000 mg/kg for TPH in the C_{13} to C_{22} range.[282] Of the 38 samples collected beneath Reservoir 2, nine had concentrations greater than the WDR limit of 10,000 mg/kg for TPH in the diesel (C13 to C22) range.[283]

The significance of this data is that soil containing concentrations of TPHd exceeding 10,000 mg/kg and up to 52,000 mg/kg beneath the former reservoir floors were left in place and not

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[277] Shell Oil Company. 1995. *Progress Report #7 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. May 1 to May 30. p. 1.
[278] Shell Oil Company. 1995. *Progress Report #8 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. June 1 to June 30. p. 1.
[279] Shell Oil Company. 1995. *Progress Report #9 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. July 1 to July 31. p. 1.
[280] Shell Oil Company. 1995. *Progress Report #9 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. July 1 to July 31. p. 1.
[281] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. p. 2-1.
[282] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. Table 2-1 p. 2-5 to 2-7.
[283] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. Table 2-2 p. 2-10 to 2-14.

removed prior to reservoir backfill and compaction activities. The conceptual depiction of contamination based on data collected near the joint between the concrete sidewalls and concrete bottoms at the east edge of Reservoir 1 is provided on Figures 27.

5.1.7 Reservoir Backfill, Compaction and Capping

The initial reservoir backfilling, compaction and capping project was summarized in a report titled Backfill and Final Project Completion Report, Reservoirs 1 and 2, dated October 1995.[284] The initial reservoir closure included the installation of a low permeability cap over fill soil to "inhibit the upward migration of free petroleum hydrocarbons". [285] The initial reservoir backfilling compaction and capping project was expected to be a final remedy to the reservoir demolition and dismantling as evident from the summary report title. However, after the initial reservoir backfilling, compaction, and capping project was completed, petroleum hydrocarbon seepage (upward migration) was observed around the clay cap and hence post-closure remediation activities were conducted.

"Post-closure remedial activities" performed to "mitigate hydrocarbon seepage" were conducted in 1996 and 1997.[286] Post closure activities included an additional soil investigation, soil removal, and the installation of an extension to the existing low permeability cap to address the upward migration of petroleum hydrocarbon contamination.

5.1.7.1 Initial Reservoir Backfilling, Compaction and Capping

The initial reservoir backfilling, compaction and capping project included the following:

- Demolition of the interior concrete liners.
- Concrete crushing and removal of reinforcing steel.
- Sampling to document hydrocarbon concentrations in soil beneath the concrete liner of each reservoir.
- Scarifying the reservoir bottoms and compacting the soil at the base of the reservoirs to 90%+ with a "sheeps foot" vibratory compactor.
- Incorporating the crushed concrete into the bottom (or first) layer of the reservoir backfill.
- Excavation of soils from the perimeter berms.
- Sampling and blending of berm soil to verify that soil used for backfilling had contaminant concentrations less than the RWQCB-issued WDRs.

[284] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October.
[285] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Executive Summary.
[286] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. 1-1.

- Backfilling the reservoirs by placing and compacting 6 to 12-inch lifts of soils originating from the berms.
- Certifying that backfill soil was compacted to at least 90% of the maximum dry density.
- Installation of a low permeability clay cap over the top of the former reservoirs.
- Placement of a one foot thick layer of soil over the clay cap.[287]

Engineering plans show that the bottom of the reservoirs was 440 feet across (or 220 feet from the reservoir center).[288] The clay cap was installed to cover 446 feet across (or 223 feet from the reservoir center) across the backfilled area of each reservoir.[289] Based on these dimensions, the clay cap extended 3 feet beyond the dimensions of the reservoir bottom.

5.1.7.2 Upward Petroleum Hydrocarbon Contamination Migration at Cap Edges

The initial reservoir backfilling compaction and capping project was expected to be a final remedy to the reservoir demolition and dismantling; however, after the initial project was completed, hydrocarbon seepage at the surface originating from deeper contaminated soil was observed at the surface around the clay cap. In early 1996, surface soils located beyond the coverage area of the caps **"exhibited localized bleeding of hydrocarbons to the surface".**[290] (emphasis added)

A subsurface investigation at the cap perimeters over former Reservoirs 1 and 2 was conducted in March 1996. The objective of the investigation was to **"estimate the extent of free-phase hydrocarbons present in the reservoir perimeter soils".**[291] (emphasis added)

A workplan for the sampling effort was developed by Shell. The workplan established samples would **"be visually inspected and logged with careful attention to any evidence of hydrocarbon saturation at concentrations which may indicate the soils would provide any geotechnical stability issues or have the propensity for liquid hydrocarbon flowage."**[292] (emphasis added)

The sampling included 109 soil boring locations and the collection of 240 samples.[293]
A qualitative assessment scale developed to visually assess the relative amount of petroleum hydrocarbon contamination present in the samples collected consisted of the following designations:

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[287] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. p. 1-2.
[288] Parsons. Grading Plan 1993. *Carson Dismantlement Project Reservoirs- RS#1 & RS#2 – Grading Work*. RMP-CE-7800-05 through RMP-CE-7800-09. October 4.
[289] Brown and Caldwell. 1996. *Perimeter Investigation Summary Report Former Reservoirs #1 and #2*. April 24. Figure 1 in Attachment A - Workplan for Reservoir Closure Project Sub-Grade Berm Soil Sampling.
[290] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2*. August. p. 1-1.
[291] Brown and Caldwell. 1996. *Perimeter Investigation Summary Report Former Reservoirs #1 and #2*. April 24. p. 1.
[292] Brown and Caldwell. 1996. *Perimeter Investigation Summary Report Former Reservoirs #1 and #2*. April 24. p. 1 of Attachment A - Workplan for Reservoir Closure Project Sub-Grade Berm Soil Sampling.
[293] Brown and Caldwell. 1996. *Perimeter Investigation Summary Report Former Reservoirs #1 and #2*. April 24.

- **No Evidence of Hydrocarbons –** used when no odors or visual staining indicative of hydrocarbons were observed in the soil.
- **Damp with Hydrocarbons –** used to describe soils that exhibited hydrocarbon staining over less than 100% of soil surface area and would transfer a slight oily stain to latex gloves when finger pressure was applied to the sample.
- **Moist with Hydrocarbons –** used to describe soils that exhibited hydrocarbon staining throughout the soil, or throughout a zone within the soil, and would transfer an oily stain or sheen to latex gloves when finger pressure was applied to the sample.
- **Wet with Hydrocarbons –** used to describe soils that exhibited liquid hydrocarbon freely flowing from the soil or bleeding to the surface of the acetate liner, and soils that would bubble or flow hydrocarbons when finger pressure was applied to the sample.

Data collected from the reservoir cap perimeters over former Reservoirs 1 and 2 is summarized on Figures 28 through 33. The data on Figures 28 and 29 shows that of the 109 locations sampled, only 6 samples collected at a depth of 2 feet below ground surface were designated as "wet with hydrocarbons".[294] By contrast, the data on Figures 30 and 31 shows that of the 98 locations sampled, 25 samples collected at a depth of 5 feet below ground surface were designated as "wet with hydrocarbons".[295]

The table below is a summary of the number of samples designated as "wet with hydrocarbons." A greater number of samples "wet with hydrocarbons" were encountered at as the sampling depth increased.

Reservoir	Depth (ft. bgs)	Total Number of Samples	Number of Wet Samples	Percent of Samples Wet
Reservoir 1	2	50	3	6%
	5	40	9	23%
	8	20	7	35%
Reservoir 2	2	60	3	5%
	5	48	16	33%
	8	24	13	54%
Both Reservoirs	2	110	6	5%
	5	88	25	28%
	8	44	20	45%

This data shows that a greater percentage of samples "wet with hydrocarbons" were present at a greater depth and moving up to the surface in an upward migration pattern.

The data on Figures 32 and 33 shows that of the 66 locations associated with the v, w and x sample locations, most borings exhibit a bottom up contamination profile with the highest TPHd

[294] Brown and Caldwell. 1996. *Perimeter Investigation Summary Report Former Reservoirs #1 and #2*. April 24.
[295] Brown and Caldwell. 1996. *Perimeter Investigation Summary Report Former Reservoirs #1 and #2*. April 24.

concentration occurring at the deepest sample depth and decreasing in concentration at shallower sample depths.[296]

A workplan was developed to mitigate the "hydrocarbon seepage by extending the low permeability caps".[297] The primary objective of the cap extension project **"was to install an extension to the existing low permeability caps to inhibit future hydrocarbon seepage."**[298] (emphasis added)

5.1.7.3 Additional Soil Removal, Soil Treatment and Cap Extension

Based on the results of the 1996 investigation at the perimeter of the existing clay cap, the excavation of a 37-foot wide band to a depth ranging from 2.5 to 4 feet was planned around the perimeter of each existing reservoir cap. The planned excavation also included the removal of 5 lateral feet of the existing clay cap.[299] Because the clay cap only extended 3 feet beyond the dimensions of the reservoir bottom (see Section 5.4.3.1), seepage originated from beneath the reservoir bottom as well as from the adjacent former berm area (see Figures 33 and 34). This shows that contaminants were migrating upward from the location where the berm sidewalls intersected with the former reservoir floors. This same phenomenon was seen at the Subject Property.

In addition to the planned excavation, soils encountered at the completion of the planned excavation "which contained residual liquid hydrocarbons or were wet with hydrocarbons were also removed." "There were several areas of subgrade soil containing residual liquid hydrocarbons that required removal." "The removed soils were combined with soils from the planned excavation areas and exported to an offsite thermal treatment facility."[300]

The extension to the clay cap brought the cap diameter to cover 520 feet (or 260 feet from the reservoir center) across the backfilled area of each reservoir.[301] Based on these dimensions, the final clay cap was expanded to extend 40 feet beyond the dimensions of the reservoir bottom.

Thermally treated soil originating from the excavation was reused as a cover soil over the completed clay cap.[302]

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[296] Brown and Caldwell. 1996. *Perimeter Investigation Summary Report Former Reservoirs #1 and #2*. April 24.
[297] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2*. August. Executive Summary.
[298] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2*. August. Executive Summary.
[299] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. 1-3.
[300] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2*. August. p. 2-1.
[301] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. 3-1.
[302] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. 4-1.

5.1.8 RWQCB Involvement in and Understanding of Upward Migration

The RWQCB has been involved in the initial site characterization, decommissioning, backfilling, soil compaction and capping of Reservoirs 1 and 2, as well as, the investigation of the upward hydrocarbon migration at cap edges and Shell's additional efforts for soil removal, soil treatment and cap extension.

Some of the key dates and descriptions of RWQCB involvement in the Shell Reservoirs 1 and 2 removal project are summarized in the following table.

Date	RWQCB Action
March 1994	Reviewed the March *1994 Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2* report and summarized the key findings from this report in the WDRs issued to Shell.[303]
August 29, 1994	Shell submits a workplan for the closure of two surface impoundments, Reservoir 1 and 2 with the RWQCB.[304]
August 31, 1994	RWQCB staff granted Shell "permission to remove and crush the concrete liner covering the interior berm walls and floor of each reservoir and to remove any soils under the liner that are saturated with hydrocarbons for disposal offsite at a licensed point of disposal".[305]
September 30, 1994	The RWQCB issues tentative WDRs to Shell for Closure of Reservoirs 1 and 2.[306]
October 31, 1994	Waste Discharge Requirements were approved at a public hearing held by the RWQCB.[307]
November 1, 1994	The RWQCB issues WDRs to Shell for Closure of Reservoirs 1 and 2.[308]
November 3, 1994	Shell provided the RWQCB an additional proposed plan for removal of the Reservoirs 1 and 2.
November 3, 1994	The letter transmitting the second work plan expresses Shell's thanks to the RWQCB for their expeditious processing of Shell's application for WDRs.[309]
December 1, 1994	Shell submitted proposed sampling procedures for backfill of reservoirs.[310]

[303] California Regional Water Quality Control Board Los Angeles Region. 1994. *Order No. 94-112 Waste Discharge Requirements for Shell Oil Company 1520 through 1622 East Sepulveda Boulevard Carson California Closure of Two Surface Impoundments (File No. 85-19)*. October 31. p. 1.
[304] Shell Oil Company. 1994. *Letter Re: Removal of Oil Storage Reservoirs at the Former Shell Oil Company Facility Located at 1622/1520 East Sepulveda Boulevard in Carson*. November 3. p. 1
[305] California Regional Water Quality Control Board Los Angeles Region. 1994. Order No. 94-112 *Waste Discharge Requirements for Shell Oil Company 1520 through 1622 East Sepulveda Boulevard Carson California Closure of Two Surface Impoundments (File No. 85-19)*. October 31. p. 1.
[306] California Regional Water Quality Control Board Los Angeles Region. 1994. *Cover Letter Re: Shell Oil Company 1520 through 1622 East Sepulveda Boulevard Carson California Waste Discharge Requirements for Closure of Reservoirs One & Two (File No. 85-19)*. November 1. p. 1.
[307] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.
[308] California Regional Water Quality Control Board Los Angeles Region. 1994. *Cover Letter Re: Shell Oil Company 1520 through 1622 East Sepulveda Boulevard Carson California Waste Discharge Requirements for Closure of Reservoirs One & Two (File No. 85-19)*. November 1. p. 1.
[309] Shell Oil Company. 1994. *Letter Re: Removal of Oil Storage Reservoirs at the Former Shell Oil Company Facility Located at 1622/1520 East Sepulveda Boulevard in Carson*. November 3. Page 1
[310] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.

Date	RWQCB Action
December 1, 1994	The RWQCB approves Shells workplans dated November 3, 1994 and December 1, 1994.[311]
December 13, 1994	Shell submitted Progress Report #1 for the period between October 31, 1994 to November 30, 1994 and notified the RWQCB that "The berm soil under the concrete liners **did not show any free-phase petroleum hydrocarbons nor any oil saturated soils therefore, no soils were removed to be disposed of offsite**."[312]
January 17, 1995	Shell submitted Progress Report #2 for the period between December 1, 1994 to December 31, 1994 and notified the RWQCB that "The soil under the floor concrete liners **did not show any free-phase petroleum hydrocarbons nor any oil saturated soils therefore, no soils were removed to be disposed of offsite**."[313]
May 10, 1995	Shell submitted Progress Report #6 for the period between April 1, 1995 to April 30, 1995 and notified the RWQCB that crushed concrete will be used at the base of the reservoir during backfilling.[314]
June 13, 1995	Shell submitted Progress Report #7 for the period between May 1, 1995 to May 30, 1995 and notifies the RWQCB that sampling of soil beneath the former concrete floor of each reservoir has been completed and that soil used for backfilling the reservoirs required re-blending to meet WDRs.[315]
July 11, 1995	Shell submitted Progress Report #8 for the period between June 1, 1995 to June 30, 1995 and notifies the RWQCB that backfilling using berm soil blended to meet the condition in the WDRs and is being placed in 12 inch layers and compacted to 90%.[316]
September 13, 1995	Shell submitted Progress Report #10 for the period between August 1, 1995 to August 31, 1995 and notifies the RWQCB that the clay cap has been completed on both reservoirs.[317]
October 1995	In accordance with WDR requirements, Shell submitted a completion report titled *Backfill and Final Project Completion Report, Reservoirs 1 and 2*.
May 1996	Post-closure site assessment work was performed to determine the nature and extent of "hydrocarbon seeps." The findings of the assessment were documented in a report titles Subgrade Berm Soil Sampling at Reservoirs 1 and 2, dated May 17, 1996. Upon review of this report the RWQCB requested an amended workplan to mitigate the hydrocarbon seeps.[318]

[311] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.
[312] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.
[313] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.
[314] Shell Oil Company. 1995. *Progress Report #6 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. April 1 to April 30. p. 1.
[315] Shell Oil Company. 1995. *Progress Report #7 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. May 1 to May 30. p. 1.
[316] Shell Oil Company. 1995. *Progress Report #8 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. June 1 to June 30. p. 1.
[317] Shell Oil Company. 1995. *Progress Report #10 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. August 1 to August 31. p. 1.
[318] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report*, *Reservoirs 1 and 2.* August. p. 1-1.

Date	RWQCB Action
November 1996	A workplan was developed for the removal and treatment of the affected soils and installation of an extension to the existing low permeability cap. The work plan was reviewed by the RWQCB and approved in November, 1996.[319] The workplan states that it was anticipated that the original demolition, backfilling and capping would have "resulted in a satisfactory closure. However, soils near the surface in the relic berms exhibited localized bleeding of hydrocarbons to the surface."[320]
August 1997	In accordance with WDR requirements, Shell submitted a completion report titled *Low Permeability Cap Extension Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2* to document the post-closure activities. The report discusses the upward migration of hydrocarbons extensively including the following statements: 1) The original installation of caps over each reservoir was to "inhibit the upward migration of free petroleum hydrocarbons."[321] 2) A workplan was developed to mitigate the "hydrocarbon seepage by extending the low permeability caps."[322] 3) "The primary objective of this project was to install an extension to the existing low permeability caps to inhibit future hydrocarbon seepage."[323] 4) "The CRWQCB requested an amended work plan to mitigate the hydrocarbon seeps."[324]

The RWQCB involvement in this Shell project spanned the time period from March 1994 to August 1997. During this time period RWQCB reviewed numerous site characterization documents and status reports; and reviewed and approved all of Shell's site remediation and mitigation workplans. The RWQCB had an understanding of:

1) The concentration, extent and carbon range of petroleum hydrocarbons found within the reservoir berm and beneath the concrete flooring.
2) The lack of any visual identification of free-flowing hydrocarbons during the initial concrete removal on the berm sidewall and beneath the concrete floors of the reservoirs.

[319] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. 1-1.
[320] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Appendix B Amendment No. 1, Work Plan for Closure, Reservoir Removal Project p. 2.
[321] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Executive Summary.
[322] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Executive Summary.
[323] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Executive Summary.
[324] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. 1-1.

3) The concentration, extent and carbon range of petroleum hydrocarbons found within the homogenized backfill materials.
4) The lack of any visual identification of free-flowing hydrocarbons during the backfilling and compaction operations conducted by Shell
5) The size and thickness of the cap placed over each of the reservoirs after they had been backfilled.
6) The timeframe in which hydrocarbon seeps developed around the edge of the cap.
7) The distance from the bottom of the former reservoirs to the surface where the seeps were observed
8) The lack of much significantly oil-saturated soil in area where the seeps were observed
9) Shell's explanation regarding why hydrocarbons were migrating upward in the vicinity of the intersection of the former berm and floor of the reservoirs.

As early as 1996, the RWQCB was informed that hydrocarbons in soil were migrating upward. The RWQCB requested a workplan to mitigate the issue and approved the proposed solution which involved:

1) Removal of soil at the perimeter of the existing clay cap. The removal was at a minimum, 37 feet laterally and 2 to 4 feet deep.
2) Excavation beyond the minimum dimensions listed above also included, soils which contained residual liquid hydrocarbons or were wet with hydrocarbons were also removed.[325]
3) Thermal treatment of excavated soil.
4) Extending the existing clay cap 37 feet.
5) Placing thermally treated soil over the clay cap for drainage control.

5.2 Similarities Between Shell Reservoirs 1 and 2 and Reservoirs 5, 6 & 7 on the Subject Property

Due to the similarities in construction, use, decommissioning, and site restoration between the Shell Reservoirs 1 and 2 at the former Shell Wilmington Manufacturing Complex and the Shell Reservoirs 5, 6, and 7 at the former Kast Tank Farm, it is expected that the contamination patterns observed at one site would be similar to the contamination patterns observed at the other. However, the Shell Reservoirs 1 and 2 were in service approximately 30 years longer than Reservoirs 5, 6, and 7, thus the amount of contamination at Reservoirs 1 and 2 should be greater, all else being equal. The purpose of this section is to determine whether the contamination

[325] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. 2-1.

patterns observed at Reservoirs 5, 6, and 7 are similar to those observed at Reservoirs 1 and 2, and thus indicative of upward chemical migration.

5.2.1 Pattern of Petroleum Hydrocarbon Concentrations in Soil at the Subject Property

Based on a detailed review of the extensive soil sampling data collected beneath and within Reservoirs 5, 6, and 7 at the Subject Property, the nature and extent of soil impacts are virtually identical to the contamination pattern that occurred at Reservoirs 1 and 2 at the Shell Wilmington Refinery. The soil impacts within the footprints of Reservoirs 5, 6, and 7 indicate that the reservoirs leaked during Shell's operation of the facility primarily at the joint between the concrete sidewalls and concrete bottoms. This is the area where the petroleum hydrocarbon concentrations are highest and extend the deepest into the vadose zone, with lesser impacts beneath the more central portions of the reservoir floors.

These soil impacts are less concentrated with depth due to the properties of the soil and crude oil which combine to retain petroleum hydrocarbons within the soil column and, in most locations, the petroleum hydrocarbon concentrations decrease with depth to non-detectable levels before reaching groundwater depth. The exception to this is the western edge of Reservoir No. 5 where the most significant release has been detected and where petroleum hydrocarbon contamination is known to have migrated all the way to the water table with an accumulated thickness of free product floating on the groundwater in monitoring well MW-3.

5.2.2 Contamination Migrated Upward from Beneath the Ripped Concrete Floors into Fill Soil within the Reservoir Footprint

As discussed in detail in Section 4.2, the berm soil had no appearance (visual or olfactory) of petroleum hydrocarbon contamination and was used by Barclay to fill in the reservoirs. Berm soils used as fill were placed by Barclay in a clean condition and, after placement of the berm soil into the reservoirs, contamination that had leaked beneath the reservoirs began migrating upward through the ripped and broken floors of the former reservoirs into the clean berm soil fill material due to capillary action.

This pattern of upward migration created a concentration gradient with higher contamination concentrations near the floor (closest to the source of contamination beneath the floors) with lessening concentrations at shallower depths upward into the fill material. Soil impacts outside the three reservoirs are related to historic soil impacts related to Shell's operations. These releases resulted in surface or near surface impacts with crude oil that attenuated relatively quickly with depth, and do not extend to appreciable depths. Some of these soil impacts correspond to areas that were former low spots or sumps that were filled in or surficially cleaned up during Shell's ownership or control of the facility.

To understand the source of contamination and the process of how it became distributed across the Subject Property, Waterstone performed the following tasks:

- An analysis of four different scenarios to account for the soil contamination patterns observed within the reservoir soils.

- An evaluation of the nature and extent of contamination within the reservoirs and outside of the reservoirs.
- An evaluation of upward migration model to account for the contaminant patterns observed within the reservoir soils.
- An evaluation of the impact that the presence/absence of the ripped concrete reservoir bottoms may have had on the upward migration of petroleum hydrocarbons.
- An evaluation of the impact that surface infiltration of water in the form of irrigation or rainfall may have had on contaminant migration and patterns observed in the subsurface.

5.2.3 Waterstone Examined Four Scenarios to Evaluate Which Is Most Likely to Account for Existing Soil Contamination Patterns at the Subject Property

In order to evaluate the contamination patterns at the Subject Property and determine whether they were similar to those found at Reservoirs 1 and 2, Waterstone evaluated four potential source scenarios for the source of site contamination and the resulting contamination pattern which would be expected to be associated with each.

Scenario 1 – Contaminated Soil Encountered during Grading Activities Was Buried at the Bottom of Former Reservoirs with Clean Soil Placed on Top

In this scenario, contaminated soil from around the site would have been placed at the bottom of the former reservoirs, followed by layers of clean fill soil to the surface. This scenario is summarized in the schematic shown in Figure 36.

This scenario is highly unlikely because of previous discussions in Sections 3 and 4 providing eyewitness testimony that no soil that was observed to be contaminated remained onsite except for the minor contamination found in geotechnical borings beneath Reservoir 6.

Situation A: However, if a hypothetical situation is assumed where contaminated soil were placed at the bottom of the former reservoirs with the result that contamination migrated upward, the following would be expected:

- The migration of contamination from any contaminated soil placed in the reservoirs would currently present as a bottom up contamination profile originating in either a random pattern or all across the former floor of the reservoirs (See Figure 36 – Present Day).
- This scenario does not consider that the number one priority on every grading project is to minimize the amount of soil handling, because the number of times or the amount of time soil is handled substantially increases project costs. The soil in berms around the reservoirs was the closest to the reservoir bottom and was easily pushed down the sides and into the reservoir bottoms with a bulldozer. Berm soil would have been the first soil to be used in the backfilling process because it would involve the least amount of soil handling time. Only after all soil from the berms encircling the reservoirs was used in the backfilling process would soil from farther away areas be used. This is because

movement of soil from other areas would require significantly more soil handling. Cost considerations as well as the descriptions of the backfill procedure by the onsite personnel (Mr. Bach, Mr. L. Vollmer, and Mr. Anderson; see Section 3.2.3) indicates that contaminated soil from areas outside the bermed reservoirs could not have been placed at the bottom of the former reservoirs with clean soil placed on top.

Situation B: If the contaminants from the contaminated soil were placed within the former reservoirs and then migrated downward, the following would be expected:

- The migration of contamination from any contaminated soil placed in the reservoirs would currently present as a top down contamination profile and would merge with the contamination that is beneath the former reservoir concrete floors.
- Additionally, contamination which is known to have leaked from the bottom of the reservoirs would be present as a top down contamination from the former floor of the reservoirs.

For the reasons cited above and since the soil above the former reservoir floors has substantial TPHd levels, Scenario 1 is not the scenario that accurately accounts for the existing soil contamination pattern at the Subject Property.

Scenario 2 – Contaminated Soil from Berms Was Buried at the Bottom of Former Reservoirs with Clean Soil Placed on Top

This scenario is highly unlikely because of previous discussions in Sections 3 and 4 providing eyewitness testimony that no petroleum hydrocarbons were observed in berm soils. However, if an assumption is made that berm soils were contaminated, then Scenario 2 shows a hypothetical situation where contaminated soil from just the berms would have been pushed over the side of the former reservoir and placed at the bottom, followed by layers of clean fill soil to the surface. These profiles are summarized in the schematic shown in Figure 37.

Situation A: If the contaminants from the contaminated berm soil were placed at the bottom of the former reservoirs and then migrated upward, the following would be expected:

- The migration of contamination from any contaminated soil placed in the reservoirs would currently present as a bottom up contamination profile originating all across the former floor of the reservoirs.
- The grading contractor describes the berm soil being pushed into the reservoir "layer by layer" using a bulldozer.[326] Because soil was moved into the former reservoirs in layers or lifts, the soil from the top of the berms was placed at the bottom of the reservoir. Data from the Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2 report[327] summarized on Figures 23 and 24 shows that the soil near the top of the berms,

[326] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 114.
[327] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. Table 2-1, p. 2-5

had little to no petroleum hydrocarbons. Shell Reservoirs 1 and 2 operated 30 years longer than Reservoirs 5 through 7 on the Subject Property and were therefore more heavily contaminated than the soil in a similar location for Reservoirs 5-7. Based on the descriptions from eyewitnesses in Sections 3 and 4 regarding how soil was placed in the reservoirs during backfilling, it is impossible that all contaminated soil could have been placed at the bottom of the former reservoirs with clean soil placed on top.

For these reasons, Situation A does not accurately account for the existing soil contamination at the Subject Property.

Situation B: If the contaminants from the contaminated soil were placed within the former reservoirs and then migrated downward we would see the following:

- The migration of contamination from any contaminated soil placed in the reservoirs would currently present as a top down contamination profile and would merge with the contamination that is beneath the former reservoir concrete floors.
- Additionally, contamination which is known to have leaked from the bottom of the reservoirs would be present as a top down contamination from the former floor of the reservoirs.

For the reasons cited above and since the soil above the former reservoirs floors has substantial TPHd levels, Scenario 2 is not the scenario that accurately accounts for the existing soil contamination pattern at the Subject Property.

Scenario 3 –Former Reservoirs Backfilled with Clean Soil

Scenario 3 proposes that the former reservoirs were backfilled with clean fill soil from the former berms. This scenario reflects the eyewitness testimony in Sections 3 and 4 that no petroleum hydrocarbons were observed in berms soils. If no contaminated soil was placed within the former reservoirs, then only contamination which is known to have leaked from the bottom of the reservoirs would be available to migrate upwards. These profiles are summarized in the schematic shown in Figure 38. If this were the case, then the following petroleum hydrocarbon contamination profiles should exist:

- The upward migration of oil contamination from under the concrete floors within the former reservoirs through (i) the concrete rips and (ii) around the perimeter of the floors would be present as a bottom up contamination profile.
- Additionally, contamination which is known to have leaked from the bottom of the reservoirs would be present as a top down contamination from the former floor of the reservoirs.

Data collected from reservoir floor beneath the concrete in Reservoirs 1 and 2[328] summarized on Figures 25 and 26 shows that the most highly contaminated soil beneath the concrete surrounding the reservoirs was located near the perimeter edge of the reservoir floor. This data is consistent with sampling data from similar locations at Reservoirs 5, 6, and 7.

Based on the soil data collected both above and below the reservoir floors of Reservoirs 5, 6, and 7, the contaminant pattern observed indicates that the highest concentration of petroleum hydrocarbons is detected just beneath the reservoir floors, these concentrations decrease with depth and attenuate rather quickly due to the properties of the soil and crude oil which combine to cause retention of petroleum hydrocarbons within the soil column. The petroleum hydrocarbon concentrations decrease upward through the ripped reservoir floors into the clean fill causing a contamination pattern that indicates upward migration into the clean fill material caused by capillary forces.

This is the only scenario identified that accurately accounts for and matches the contamination pattern observed both below and above the reservoir floors of Reservoirs 5, 6, and 7. These same contaminant patterns were also observed in the soils beneath Shell's Reservoirs 1 and 2, where upward migration of hydrocarbons was also demonstrated, and, in fact, hydrocarbons migrated upward and laterally due to capillary forces and surfaced as seeps outside of the engineered cap that was placed to prevent the anticipated upward migration of contamination. This scenario is discussed further in Section 5.2.5.1 and 5.2.6 and 5.2.7 below.

Scenario 4 – Contaminated Soil Encountered during Grading Activities Was Buried Throughout the Fill Placed in the Former Reservoirs

This scenario is highly unlikely because of previous discussions in Sections 3 and 4 providing eyewitness testimony that no soil that was observed to be contaminated remained onsite except for the minor contamination found in geotechnical borings beneath Reservoir 6. Scenario 4 assumes a hypothetical situation where contaminated soil from around the site or within the berms was placed at random and varying depths within the former reservoirs as the former reservoirs were being backfilled.

This scenario assumes that soil was moved into Reservoirs 5 through 7 using a scraper and/or a bulldozer. Both methods of soil moving inherently result in mixing of the soil as it was removed from the berm and placed into the reservoir. In this hypothetical Scenario 4, the soil was removed from the berms or other on-site locations and placed into the reservoir. Any contamination which might have been present in the soil would have been placed randomly in the reservoir. There would be no way for operators to decide which soil was contaminated, the degree of contamination, and thus the appropriate burial depth or location within the reservoir. These profiles are summarized in the schematic shown in Figure 39.

[328] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. Table 2-1 and Table 2-2.

In this scenario, it is assumed that oil contamination is moving downward through the soil column. If this were the case, then the following petroleum hydrocarbon contamination profiles should exist:

- The migration of contamination from source areas within the fill material place in the former reservoirs would currently be present as a top down contamination profile.
- Additionally, contamination which is known to have leaked from the bottom of the reservoirs would be present as a top down contamination profile from the former floor of the reservoirs.

A top down contamination pattern is not present in the area of the fill above the reservoir floors. For this reason and because eyewitness testimony indicates no petroleum hydrocarbons were in the soil placed in the reservoirs, Scenario 4 is not the scenario that accurately accounts for the existing soil contamination pattern at the Subject Property. However, this top down contamination pattern is observed in other areas on the Subject Property not under the former reservoirs. This scenario is discussed further in Section 5.2.5.2.

5.2.4 The Diesel TPH Fraction (TPHd) Selected As Best Marker for Oil Contamination

A series of drawings prepared for Shell by Geosyntec in 2011 depict the extent of impact in shallow soil at depths of two, five, and ten feet bgs.[329] These drawings present sample locations that have been color-coded based on their analytical results and include isoconcentration contours for six chemicals: benzene; naphthalene; benzo(a)pyrene equivalents; TPHd; TPHg; and TPHmo. These compounds have been target analytes during the numerous investigations conducted at the both the Subject Property and at the former Wilmington Refinery.

Geosyntec's six drawings are generally similar in their depiction of the soil contamination patterns for the various chemicals, with the exception of benzo(a)pyrene. The Geosyntec drawings depicting TPHd, TPHg and benzene are shown in Figures 40 to 42. Most of the chemicals exhibit a pattern in the upper 10 feet of soil of increasing concentrations with depth and being concentrated primarily around the perimeter of the reservoirs. Although benzo(a)pyrene and other poly aromatic hydrocarbons (PAHs) could be the result of crude oil contamination, it's likely that much of the shallow soil PAH concentrations are due to their deposition from local industrial activities such as truck traffic.

Following an evaluation of the various analytical results, TPHd was selected as a representative indicator compound for graphics purposes to depict the general contaminant patterns and distribution at the Subject Property. The selection of TPHd as the indicator chemical for the Subject Property is based on the following:

1) The concentration of TPHd is generally greater than the TPHg, TPHmo, TPH (C_4-C_{12}) and TPH (C_{23}) concentrations in the same sample.

[329] Geosyntec, 2011. Transmittal of Concentration Contour Maps Former Kast Property, Carson California, Site Cleanup No. 1230, Site I.D. 2040330. April 29. Figures 4-9.

2) TPHd is generally the largest fraction of petroleum hydrocarbon material associated with crude oil which was stored on the Subject Property.
3) The ratio of TPHd (or TPH (C_{13}-C_{22})) to the other chemicals listed above remains relatively constant regardless of whether the TPHd detected is several hundred or several thousand mg/kg.
4) BTEX and TPHg can easily be the result of common activities and chemical use associated with recent homeowner surface use activities including:
    - Spills or releases associated with filling lawn mowers or gas-powered recreational vehicles or crafts (motor cycles, scooters, all-terrain vehicles, boats, etc.) with gasoline.
    - Spills or releases associated with maintenance of lawn mowers or gas-powered recreational vehicles or crafts.
    - Application of gasoline to ground surface for controlling grass or weed growth with gasoline.
5) The release of PAHs and subsequent shallow soil deposition of PAHs from airborne contaminants associated with vehicle exhaust (especially diesel trucks) from nearby street traffic and/or refineries.
6) TPHd is less susceptible to volatilization and decomposes more slowly than TPHg and other VOCs.
7) TPHd is more retentive due to the properties of the soil and crude oil which combine to cause greater retention of petroleum hydrocarbons within the soil column.

5.2.5 Three Distinct Shallow Soil Contamination Profiles Were Identified on the Subject Property

Petroleum hydrocarbons move primarily downward through the soil column as a result of gravitational forces. During the migration of free product through the unsaturated zone, a certain amount of the liquid is immobilized in the soil pores by capillary forces. When this occurs, considerable upward movement can occur due to capillary rise.[330]

Studies of kerosene (a compound comprising much of the same carbon chain range as TPHd) in soil have shown that after gravitational drainage, high concentrations can exist within porous media as lenses and ganglia that are immiscible with water. The amount retained in the soil is related to the soils' retention capacity which results from capillary forces and depends on factors such as pore size distribution wettability, fluid viscosity and density ratio, interfacial surface tension and gravity hydraulic gradients.[331] Therefore, TPHd has retentive properties to remain in soil and will not leach out of the soil column.

[330] Nerantzis, P.C., and Dyer, M.R., 2008. Upward Immiscible Displacement Movement of BTEX Compounds in Unsaturated Soil. Hazwaste Management, October.
[331] Jarsjo, J., Destouni, G., and Yaron, B., 1994. *Retention and Volatilisation of Kerosene: Laboratory Experiments on Glacial and Post-Glacial Deposits*. Journal of Contaminant Hydrology 17 (1994) 167-185. p. 168.

Transport experiments using kerosene product to simulate a lens on the groundwater as the source of pollution found that capillary forces will result in upward migration of kerosene in the soil column at a rate of approximately 20% of that of the original rate of downward kerosene movement through the vadose zone.[332]

Contaminants typically migrate through soil from areas of highest concentration to areas of lowest concentration. The vertical contaminant movement is primarily downward but there is an upward component as well. Therefore, based on the observed contaminant concentration gradients in the vadose zone, the source of the contamination exists at the depth exhibiting the highest concentration. Evaluation of the vertical contamination profile provides evidence as to how the chemicals have migrated either downward or upward through the soil.

Three vertical profiles of soil impact were observed and identified based on their differing source areas. The pattern of each profile is visible on the figures for shallow soil prepared by Geosyntec and Waterstone. The vertical profiles are discussed below.

5.2.5.1 Soil Contamination Profile 1 – Bottom-up Migration Within the former Reservoirs

The soil contamination profile within the perimeter of the former reservoirs is bottom-up and originates from the contamination left beneath the reservoirs by Shell. Examples of this pattern are shown on Figure 43 and show that the soil impact originates at the reservoir floors and its concentrations and extent decrease towards the ground surface. This pattern was formed by crude oil migrating upward through the clean soil which was placed over the ripped concrete floors of the former reservoirs to prepare the site for development. The areas of greatest impact are located at the perimeter of the reservoirs where the floor joined the sidewalls which is also where most of the deep soil contamination was identified.

5.2.5.2 Soil Contamination Profile 2 - Top-down Migration within the Former Main Sump East of Reservoir 5

This profile pattern is not consistent with the upward migration found within the reservoir areas and is from a separate source. At the former sump area located east of Reservoir 5, the main source of soil contamination exists at a depth of approximately five to six feet bgs. The vertical profile is top-down contamination beginning at the five to six-foot depth interval with much lower concentrations detected at 10 feet bgs. Examples of this pattern are shown on Figure 20.

The depth of five feet is likely consistent with the grade of the sump during the time which the sump was operational. Although clean soil was placed over this area, the residual contaminant mass was not sufficiently concentrated to result in upward migration to the degree that has occurred within the reservoir areas. Refer to Section 4.4 for a discussion of analytical results in this area.

[332] Acher, A.J. et al., 1989. Soil Pollution by Petroleum Products, I. Multiphase Migration of Kerosene Components in Soil Columns. January 25. Journal of Contaminant Hydrology, 4 (1989) 333-345. p. 343.

This area is located outside of the reservoirs and is free of concrete so very few sampling refusals were encountered. Therefore, 10-foot deep samples were able to be collected at nearly all locations. The analytical results show that the concentrations in soil decrease significantly from their maximum values found at a depth of five to 6.5 feet bgs (at the depth of the likely source) and show a significant reduction after migrating downward to a depth of 10-feet bgs.

Based on the above, this “top-down” contamination pattern shows that the amount of impacted soil in this area is limited and there is no upward migration component. Therefore, the contamination in this area was never viewed, removed or disturbed by Barclay who did not have “explicit-knowledge” of this contamination left in place by Shell. Refer to Section 4.6.3 for further discussion.

5.2.5.3 Soil Contamination Profile 3 – Top-down Migration within the Pump House & Surrounding Areas

In areas such as the Pump House, located in the southwestern portion of the Property, shallow soil contamination was identified near the surface. The highest concentrations of petroleum hydrocarbons were detected in soil samples collected at a depth of two feet bgs. The distribution of impacted soil in this area indicates that contaminant concentrations are at their highest at the one to two-foot bgs depth interval and then significantly decrease at a depth of 5 and 10 feet bgs, as shown in Figure 19. Refer to Section 4.5.4 for a discussion of analytical results.

The vertical profile in this area originates with the source near the surface as indicated by the maximum concentrations found and migrates downward as its extent decreases with depth.

This “top down” distribution of petroleum hydrocarbons indicates that these materials had not been moved, disrupted or put in place during Barclay’s grading operations in 1966. Therefore, because this area was cut and no fill was placed, the 2 foot depth was never viewed, removed or disturbed by Barclay who did not have “explicit-knowledge” of this contamination left in place by Shell. Refer to Section 4.5.4 for further discussion.

5.2.6 Evaluation of Shallow Contamination within the Former Reservoirs Shows Upward Chemical Migration

To evaluate the nature and extent of shallow soil impact as it relates to the former reservoir floors, one must review the results of soil samples collected above and below the floors. Unfortunately, Shell’s consultant, URS, did not design their sampling plan to achieve this goal. Instead, URS generally sampled the shallow soil within Carousel Tract parcels using a hand auger and sampling at intervals of 2-ft, 5-ft, and 10-ft bgs (the 10-ft sample was sometimes unable to be collected where the reservoir floor was shallower than 10 feet bgs). If a hand auger boring was interrupted or refused by the concrete buried within the perimeter of the former reservoir or the concrete floor of the former reservoir, then a sample was taken just above the concrete.

Thus, Geosyntec’s map of the soil impact at the 10-foot depth (see Figure 10) does not provide a representation of the nature and extent of the contamination above or below the reservoir floors.

This is caused by mapping the results of a uniform sampling depth across a ground surface area that has significant changes in elevation.

Although not mapped by Geosyntec, additional results are available and were mapped by Waterstone to better evaluate the extent of TPHd soil contamination above and below the reservoir floors (see Figures 44 and 45). Since data was not collected uniformly above and below the floors across all three reservoirs, only a partial picture exists for the comparison of soil impact found above and below the floors of the reservoirs. This picture is fairly complete for Reservoir 5 but only partially complete for Reservoir 7. Very few samples were collected below the concrete floor for former Reservoir 6 and thus a picture of the soil contamination above and below the concrete floor is not possible for this reservoir.

Typically soil samples were collected, or attempted, at each residential parcel to a total depth of ten feet bgs. Geosyntec's maps show that within the footprint of the former reservoirs, many fewer samples were collected at the ten foot depth than were collected at depths of two feet or five feet. This is due to the many refusals caused by the concrete floors of the reservoirs and other concrete debris or obstructions encountered during sampling. The difference in sampling density at the 10 foot depth in Reservoir 7 shows the demarcation between the southeastern two-thirds of the reservoir where 10-foot deep samples did not hit the floor as opposed to the northwestern portion of the reservoir where refusals were caused by hitting the floor before 10 feet (see Figure 46).

Where refusals occurred, typically a sample was collected at the maximum refusal depth. However, the results of these interim samples collected at refusal depths between five and 10 feet bgs were not presented on the maps prepared by Geosyntec. To properly evaluate the shallow soil impact at these locations, the results of samples collected from these interim depths must also be considered.

Secondly, it is important to note that the changes in ground surface elevation across the site result in dramatic differences in the depths of soil samples as they relate to the floors of the former reservoirs. The bottoms of the reservoirs were relatively flat with a slight slope down towards the center of each reservoir. However, the ground surface across the site varies in elevation by approximately 12 feet from its lowest point at the northwest corner to its highest point at the southeast corner. Even within the bounds of an individual reservoir, the ground surface elevation varies by as much as seven feet.[333,334,335,336] The result of these differences in ground surface elevations is that some of the 10-foot deep samples were collected above the floors of the reservoirs, while others were collected below. Therefore, to properly evaluate the soil impact above and beneath the floors of the former reservoirs, it should be determined which samples were collected above and which samples were collected below the floors of the former reservoirs.

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[333] Bach, George, 1968. *Grading Plan of Tract No 24836*. April 17. Sheet 2 of 3.
[334] E. L. Pearson and Associates. 1967. *Grading Plan of Tract No 28564*. October 11. Sheet 2 of 3.
[335] E. L. Pearson and Associates. 1966. *Grading Plan for Tract No 24836*. January 6. Sheet 1 of 4.
[336] E. L. Pearson and Associates. 1967. *Grading Plan for Tract No 28086*. January 31. Sheet 1 of 1.

Waterstone analyzed the surface elevations of the sample locations as they relate to the elevations of the floors of the former reservoirs and determined which samples were collected above the floors and which were collected below the floors. A detailed explanation of the process used by Waterstone to locate the elevations of the floors of the former reservoirs and determine which soil samples were above and below the floors of the former reservoirs is provided in Appendix D. At Reservoir 5, all of the 10-foot deep samples were below the reservoir floor with the exception of those located at the residences on Ravenna Avenue. At Reservoir 6, all of the 10-foot deep samples were collected from above the floor of the reservoir. At Reservoir 7, the 10-foot deep samples located in the northwestern quarter of the reservoir were collected below the floor while the remainder were above the floor.

Waterstone prepared maps similar to Geosyntec's for the TPHd soil impact at two feet and five feet bgs (see Figures 47 and 48). As is expected, these maps are very similar to those produced by Geosyntec.[337] Although Geosyntec's and Waterstone's maps were generated using different software mapping programs, the extent and patterns of soil contamination are consistent on the 2-ft and 5-ft depth maps. Both Waterstone's and Geosyntec's maps show that the 2-ft depth interval exhibited the least amount of soil impact and that soil impact increases with depth as shown in the 5-ft depth map.

While Geosyntec's drawings for the 10-foot depth are not useful for evaluation of the soil impact as it relates to the reservoir bottoms, it does confirm that the trend of increasing soil impact with depth continues. For the ten foot depth, however, to resolve the discrepancies noted above and to accurately depict the soil impact near the bottoms of the former reservoirs, Waterstone prepared two separate maps to represent the soil impact above and below the floors of the reservoirs (see Figures 44 and 45). These maps plot the results of TPHd soil levels from samples collected at 10-ft bgs and other samples collected at shallower depths considered to have been refused by the concrete floors from the former reservoirs.

Geosyntec's maps of shallow soil impact (at depths of 2', 5' and 10' bgs) and Waterstone's four figures (depths of 2', 5', above the concrete floor, and below the concrete floor) show that the degree of soil contamination increases with depth from the surface to the 10-foot depth or depth of refusal.

Based on Waterstone's Figures 44 and 45, which show the soil impact immediately below and above the floors, the depth of highest soil impact shown on Figure 44 was below the floors of the reservoirs. Figures 44 and 45 also show the highest concentrations and largest areas of shallow soil impact are concentrated near the perimeters of the reservoir floors, which is consistent with the areas of highest concentrations and areas where significant deep soil impact was found. Much less soil impact was found in the central portions of the reservoirs.

Based on the soil data collected both above and below the reservoir floors of former Reservoirs 5, 6, and 7, the contaminant pattern observed shows the following:

[337] Some small discrepancies are noted; however, some of these are ascribed to data differences (the presence or absence of soil data) and some of the discrepancies are the result of the different algorithms and settings used by the soil contamination contouring computer program.

- The highest concentration of petroleum hydrocarbons was detected just beneath the reservoir floors.
- From the point of the concrete floors of the former reservoirs, the concentration of petroleum hydrocarbons decrease vertically upward – the bottom up profile is observed.
- From the point of the concrete floors of the former reservoirs, the concentrations of petroleum hydrocarbons decrease with depth – a top down contamination profile is observed.

Based on the contaminant profiles observed and discussed above, Scenario 3, where reservoirs were backfilled with clean berm soil, is the only scenario identified that matches the contaminant patterns observed both below and above the reservoir floors of former Reservoirs 5, 6, and 7.

5.2.7 Upward Migration of Petroleum Hydrocarbons Has Occurred within the Footprint of the Former Reservoirs

Near-surface soil impact has occurred within the reservoir areas as a result of the upward migration of the crude oil contamination left by Shell beneath the floors of the reservoirs. This section will provide multiple lines of evidence for this upward chemical migration pathway through the soil column.

The most concentrated areas of soil contamination were found beneath the concrete floors and the pattern of soil contamination from the floors to the ground surface is for decreasing concentrations and extent. With the exception of the removal of the concrete floor from the western edge of Reservoir 5 and the ripping of the floors for water infiltration purposes, the concrete remains undisturbed and intact in its original configuration. In some areas a second layer of concrete exists from the placement of the concrete sidewalls that were broken up and placed over the floors.[338] Therefore, the soil beneath the concrete remains undisturbed and Barclay would have had no ability to either access the underlying soil or to have placed the contaminated soil which is known to exist beneath the concrete.

The presence of the concrete did not allow for a complete evaluation of the nature and extent of soil contamination immediately beneath the floors of the reservoirs since very few of the shallow hand auger borings were able to penetrate the concrete. Results below the floor depths were available for those hand auger borings located where the concrete was removed from a portion of Reservoir 5 and where ripping was performed for infiltration. In addition, soil samples were collected beneath the floors (primarily in the streets of the Carousel Tract) in some of the deep borings that were drilled with mechanized equipment.

A case study for this upward migration model is provided by the excavation pilot study performed by Shell in November 2012 at 24612 Neptune Avenue. This is the only location on

[338] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 109: 16-25 p. 110: 1-25, p. 111: 1-22.

the Subject Property where portions of the former concrete floor have been exposed to this degree.

Prior to the pilot study excavation, analysis of soil samples from two geotechnical borings performed found that the highest levels of contamination existed beneath the concrete of the reservoir floor and that the concentrations decreased towards the surface (see Figures 49 and 50).[339,340]

The excavation was performed as three slots (A, B, and C) and had final dimensions of approximately 26 feet long, 12 feet wide and 10 feet deep. From approximately 7.5 to 8.0 feet bgs, field personnel observed sporadic concrete rubble and debris intermixed with dark stained and odorous soil. The concrete slab was encountered at a depth of approximately 8.0 to 8.5 feet bgs. During the excavation of Slot B, a watery/oily liquid was noted seeping from the easterly sidewall of the excavation at a depth of 10 feet, which was below the depth of the concrete slab. URS noted that the soil became increasingly odorous with depth and identified gray to dark gray staining beneath the slab to a depth of about 10 feet bgs.[341] Photographs of the excavation show increasing discoloration and staining with depth and the darkest staining beneath the slab. Little if any staining was present in the upper portion of the soil column (see Figure 51).[342]

Excavation confirmation soil samples were collected at approximate depths of 0.5, 2, 5, 8, 9, and 10 feet bgs. One bottom sample was collected in the center of the excavation at a depth of 10 feet bgs. Sidewall samples collected above the slab were identified as “AS” and below the slab as “BS”. The maximum concentrations of petroleum hydrocarbons were found in those samples located just above and just below the concrete floor, and then decreased towards the surface (see Figure 52).[343]

Observations of soil staining, odors and flowing liquids made during the excavation together with analytical results of soil samples all confirm an upward migration pattern of contamination with the highest degree of soil impact found just beneath the floor of the reservoir which then decreased increasingly at shallower depths towards the surface. These same contaminant patterns were also observed in the soils beneath Shell’s Reservoirs 1 and 2, where upward migration of contamination was also demonstrated, and in fact contamination migrated upward and laterally due to capillary forces and surfaced as seeps outside of the engineered cap that was placed to prevent the anticipated upward migration of contamination.

[339] URS Corporation. 2013. *Excavation Pilot Test, 24612 Neptune Avenue, Former Kast Property, Carson, California*. January 4. Appendix A – Geotechnical Report.
[340] URS Corporation. 2013. *Excavation Pilot Test, 24612 Neptune Avenue, Former Kast Property, Carson, California*. January 4. Table 5B.
[341] URS Corporation. 2013. *Excavation Pilot Test, 24612 Neptune Avenue, Former Kast Property, Carson, California*. January 4. p. 5-4 and 5-5, Figure 3.
[342] URS Corporation. 2013. *Excavation Pilot Test, 24612 Neptune Avenue, Former Kast Property, Carson, California*. January 4. Appendix F, Photograph 14.
[343] URS Corporation. 2013. *Excavation Pilot Test, 24612 Neptune Avenue, Former Kast Property, Carson, California*. January 4. Table 5A.

5.2.8 Concerns and Issues Raised by the RWQCB Were Addressed

This section addresses items that have been raised by RWQCB staff based on their interpretation of the data and theories of transport mechanisms they believe affect the way in which contaminants have migrated in the subsurface. These items include (i) the effect of the concrete reservoirs floors and (ii) infiltration and washing/leaching of contaminants in the vadose zone. In addition, in this section Waterstone compares areas of the Subject Property where the typical contamination profiles for top-down contamination are evident to the contamination profiles observed inside the perimeter of the former reservoirs. These comparisons show that upward chemical migration is occurring inside the perimeter of the former reservoirs.

5.2.8.1 Comparison of Soil Contamination in Areas With and Without Reservoir Concrete Floors Shows There Is No Difference in the Contamination Profile

RWQCB staff have suggested that significant oil contamination was present in the berm soil used to backfill the former reservoirs. The staff has suggested that the petroleum hydrocarbons migrated downwards and that the concrete has selective permeability – it allows the water to flow through and around it thus infiltrating the soil beneath the concrete floors of the former reservoirs but the concrete prevents the petroleum hydrocarbon from migrating past the floors to depths beneath the concrete floors of the former reservoirs. The result of this selective permeability is that the water infiltration is undisturbed but the oil contamination concentrates on the top surface of the concrete.

To examine this theory, Waterstone prepared Figure 53 which presents a comparison of TPHd concentration profiles in boring locations with and without concrete floors. If the RWQCB staff theory is correct then there should be a difference between the migration of oil where the concrete floor is present and where it is absent. Oil should concentrate on top of the concrete where it is present and should continue downwards in places where the concrete is absent. The TPHd contamination profiles for these two conditions should be very different.

Figure 53 shows the concentration profile of increasing concentrations with depth to near the existing or former depth of the concrete is the same for both areas with concrete and those without. This profile shows the highest concentrations near the bottom of the reservoir which then decreases towards the surface. Based on the results of this analysis, it is concluded that the vertical profile of petroleum hydrocarbons is not impacted by the presence or absence of concrete associated with the former reservoir floors. Significant amounts of contamination are migrating upward whether or not concrete is present. This shows that the RWQCB theory regarding the high concentrations of oil on top of the concrete is not correct. The testing results show that the concentrations of oil are greater beneath the concrete floor and that concentrations of oil above the floor are the result of upward chemical migration and not the result of downward chemical migration and the selective permeability of the concrete.

5.2.8.2 Comparison of Soil Contamination in Areas Where Surface Water Infiltration Could Occur and Was Prevented

Part of the above RWQCB staff's theory is that downward chemical migration occurred. The staff has suggested that water infiltration and gravity are responsible for moving the petroleum hydrocarbons downward.

To examine this theory, Waterstone prepared Figure 54 which presents a comparison of TPHd concentration profiles in boring locations where water infiltration can occur (lawns and garden areas) with areas where water infiltration is prevented (streets, sidewalks, driveways, and patios). If the RWQCB staff theory is correct then there should be a difference between the migration of oil where water infiltration can occur and where it is prevented. Oil should migrate faster (farther) in areas with water infiltration and should migrate slower (stay closer to the source) in areas where water infiltration is prevented. The TPHd contamination profiles for these two conditions should be very different.

To evaluate the potential effect of infiltration on the contaminant concentration profile in the soil column, profiles of TPHd were plotted for soil borings located at areas with paved and unpaved surfaces (Figure 54). The borings in paved areas were located within the existing streets which would therefore prohibit the infiltration of water into the soil. Borings in unpaved areas were located in residential front yards and back yards where no surface cap or hardscape exists that would allow for infiltration to occur.

The results depicted on Figure 54 show that the vertical contamination profile is not impacted by the amount of water infiltration associated with paved and unpaved surfaces. This shows that the RWQCB theory regarding the downward movement of oil contaminants in the shallow soil within the perimeter of the former reservoirs is not correct. The testing results show that the petroleum hydrocarbon concentration profiles are unaffected by the presence or absence of water infiltration. The contaminant profiles are the result of upward chemical migration and not the result of downward chemical migration.

5.2.8.3 Comparison of Soil Contamination Profiles in Areas Where Demonstrated Top-Down Contamination Is Occurring to the Soil Contamination Profiles within the Perimeter of the Former Reservoirs

As mentioned above, the RWQCB theory is that downward chemical migration occurred. The staff has suggested that water infiltration and gravity are responsible for moving the petroleum hydrocarbons downward. If the RWQCB theory is correct then the contamination profiles observed throughout the site should be similar. Yet as mentioned above in Section 5.2.3, three distinct contamination profiles have been observed on the Subject Property. These contamination profiles are related to the sources of contamination. Two of the contamination profiles show the typical top down contamination profile – high concentrations of contaminants close to the source with decreasing concentrations of contaminants with increasing depth. The third contamination profile shows the typical upward migration contamination profile - high concentrations of contaminants close to the source with decreasing concentrations of contaminants with increasingly shallower depth.

Figure 55 presents a comparison of TPHd concentration profiles in sample locations with top down and with bottom up contamination profiles. The exhibit shows that the top down contamination profile exists outside of the reservoir footprints and that under this profile the contaminants migrate downward only a short distance. This shows that the crude oil contamination is insoluble in water and highly immobile. Downward contaminant movement is minimal and the highest contamination concentrations are near the surface (2-feet bgs) and are not present at 10-feet bgs.

The sample locations with a bottom up contamination profile show that this profile exists inside the footprints of the reservoirs. This shows that the RWQCB's hypothesis that the crude oil contamination within the reservoir footprints has been washed, leached or migrated downward is inconsistent with the minimal downward migration demonstrated outside of the reservoirs and demonstrates that an upward chemical migration mechanism is operating.

5.2.8.4 Comparison of Soil Contamination Profiles in Areas Where Top-Down Soil Contamination Is Occurring in Deeper Soil to the Soil Contamination Profiles within the Perimeter of the Former Reservoirs

Part of the above RWQCB theory is that downward chemical migration occurred. The staff has suggested that water infiltration and gravity are responsible for moving the petroleum hydrocarbons downward. Deep soil contamination at the Subject Property was described in Section 2.4.1. Deep soil contamination primarily originated from releases of oil from the sidewall/floor joints of the former reservoirs. Movement of this oil downward through the soil column results in another example of the top-down contamination profile.

Figure 56 presents a comparison of a vertical contamination profile for deep soil versus shallow soil within the footprints of the reservoirs. These profiles show a top down contamination profile within the deeper borings from the presumed depth of the crude oil release (at approximately 10 feet bgs). In most cases, the crude oil only migrated approximately 10-15 feet downward (to 25 feet bgs); however, the highest concentrations of crude oil are still associated with the depth of release, which is below the bottom of the reservoir. This shows that the crude oil contamination is insoluble in water and relatively immobile.

The shallow sample locations presented in Figure 56 show that a bottom up contamination profile exists inside the reservoir footprint and in the fill. This shows that the RWQCB's hypothesis that the crude oil contamination within the reservoir footprints has been washed or migrated downward is inconsistent with the minimal downward migration demonstrated from the depth of release in the deep borings. This is further support for the conclusion that an upward chemical migration mechanism is operating. Scenario 3, where reservoirs where backfilled with clean berm soil and contaminated by upward migration of petroleum hydrocarbons from beneath the reservoir floors, is the only scenario identified that matches the contaminant patterns observed both below and above the reservoir floors of Reservoirs 5, 6, and 7.

5.3 Comparison of Upward Contaminant Migration in Reservoirs 1 & 2 with Reservoirs 5, 6 & 7

At the time the concrete was removed from Reservoirs 1 and 2 in December 1994 and January 1995, Shell reported that neither the berm soil nor soil under the floor of the concrete liners showed any free-phase petroleum hydrocarbons nor any oil-saturated soils.[344] This is similar to the conditions observed beneath Reservoirs 5, 6, and 7 based on testimony and documentation from several personnel working for the grading contractor, the project engineer, and PSE that were onsite during grading activities. This testimony and documentation indicates that the berm soil used for backfill for Reservoirs 5, 6, or 7, contained no residual petroleum hydrocarbons. The only residual hydrocarbons noted were in geotechnical borings beneath the floor of Reservoir 6 that were not disturbed by Barclay.

It was not until 1996 that the upward migration of contamination at Shell's Reservoirs 1 and 2 was identified and reported to the RWQCB. In a workplan detailing the steps that would be taken to mitigate the hydrocarbon seepage, Shell states that they believed that the original reservoir demolition, backfilling and capping activities would have resulted **"in a satisfactory closure. However, soils near the surface in the relic berms exhibited localized bleeding of hydrocarbons to the surface."[345]** (emphasis added)

The actions Shell took to remedy the hydrocarbon seeps were approved by the RWQCB and are discussed in Section 5.1.7.3 of this report. At the completion of these activities Shell submitted to the RWQCB a completion report titled *Low Permeability Cap Extension Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2*. The report discusses the upward migration of hydrocarbons extensively including the following statements:

- The original installation of caps over each reservoir was to "inhibit the upward migration of free petroleum hydrocarbons."[346]
- A workplan was developed to mitigate the "hydrocarbon seepage by extending the low permeability caps."[347]
- "The primary objective of this project was to install an extension to the existing low permeability caps to inhibit future hydrocarbon seepage."[348]
- "The CRWQCB requested an amended work plan to mitigate the hydrocarbon seeps."[349]

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[344] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.

[345] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Appendix B Amendment No. 1, Work Plan for Closure, Reservoir Removal Project p. 2.

[346] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Executive Summary.

[347] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Executive Summary.

[348] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Executive Summary.

Substantial upward migration (seepage) of hydrocarbons occurred as a result of the reservoir closure activities for Reservoirs 1 and 2 performed by Shell and approved by the RWQCB. In fact, it is obvious that after 1997, upward migration of hydrocarbon contamination in this setting is a phenomenon with which both Shell and the RWQCB were familiar.

5.3.1 Comparison of Oil Storage Reservoirs

As discussed in Section 5.1.1, Reservoirs 1 through 7 were all constructed at the same time during the initial construction of the Wilmington refinery. The seven reservoirs, constructed to hold crude oil from Signal Hill and Santa Fe Springs prior to refining, were finished and nearly all full by the summer of 1923.[350] All seven reservoirs were constructed with transfer lines and pumping systems to feed the refinery.[351,352]

5.3.1.1 Reservoir Construction

The seven reservoirs are referred to as concrete-lined earthen reservoirs.[353] Notations on the fire insurance maps describing the construction of the reservoirs are similar for all seven reservoirs and state:

> **"crude oil reservoirs have earth slopes, concrete lined - asbestos composition covered wooden roofs on wood posts."[354]** (emphasis added)

Engineering plans indicate that the concrete lining the inside berm walls and the bottom of all of the reservoirs was 4-inches thick.[355] The top and outside perimeter of the berm walls were asphalt-covered.[356] Grading plans show that the berm wall height ranged from 20 to 28 feet above the reservoir bottom with widths ranging from 50 feet to 80 feet.[357,358]

The capacity of each reservoir as noted on fire insurance maps from 1923, 1924 and 1925 ranged from 750,000 to 2,000,000 barrels (see Section 5.1.1.1).[359,360] All of the reservoirs were extremely large, concrete lined earthen oil storage reservoirs.

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[349] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. 1-1.
[350] Beaton, Kendall. 1957. *Enterprise in Oil A History of Shell in the United States*. March. p. 262.
[351] Shell Oil Company of California. 1923. *The Very First Operating & Construction Report, Simplex Refining Dept., Wilmington Refinery*. September 30. p. 14.
[352] Shell Oil Company. 1928. Engineering Plan. *Pipe Lines Wilmington Refinery to Kast Property.* Y-R2257-1. August 21.
[353] Beaton, Kendall. 1957. *Enterprise in Oil A History of Shell in the United States*. March. p. 262.
[354] EDR. 2013. Certified Sanborn Map Report for Wilmington Refinery 1924.
[355] Parsons. 1993. Grading Plan. *Carson Dismantlement Project Reservoirs- RS#1 & RS#2 – Grading Work*. RMP-CE-7800-05 through RMP-CE-7800-09. October 4.
[356] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report Reservoirs 1 and 2*. October. p. 1-1
[357] Parsons. 1993. Grading Plan. *Carson Dismantlement Project Reservoirs- RS#1 & RS#2 – Grading Work*. RMP-CE-7800-05 through RMP-CE-7800-09. October 4.
[358] E. L. Pearson and Associates. 1966. *Grading Plan for Tract No 24836*. January 6. Sheet 1 of 4.
[359] EDR. 2013. Certified Sanborn Map Report for Wilmington Refinery 1923, 1924, and 1925.

5.3.1.2 Reservoir Contents and Period of Use

It is reported that in addition to holding crude oil, Reservoirs 1 and 2 were also used occasionally to store vacuum flasher feed and coker feed.[361] Reservoirs 5 through 7 were reported to possibly also have been used to store bunker fuel in addition to crude oil.[362] The petroleum hydrocarbons held in Reservoirs 1 and 2 was generally the same type of petroleum hydrocarbons held in Reservoirs 5 through 7.[363]

Reservoirs 5, 6 and 7 were in use for approximately 36 years until approximately the early 1960s, when the Kast property became used on a standby, reserve basis.[364] In 1965 Shell decided it had "no foreseeable need for the Kast Fee property" and determined that the property should be "disposed" of.[365] Reservoirs 1 and 2 were used for approximately 68 years from the time of their construction until they were drained in December 1991.[366] Reservoirs 1 and 2 were used over 30 years longer than Reservoirs 5 through 7.

While Reservoirs 1 and 2 are very comparable to Reservoirs 5, 6 and 7, the additional 30 years of use of Reservoirs 1 and 2 would have allowed for 30 additional years of compromise and deterioration of the concrete liner and 30 additional years of seepage of contamination into the soil behind or beneath any crack in the concrete liner.

5.3.1.3 Reservoir Closure

The reservoir closure process for Reservoirs 5 through 7 was nearly identical to the closure process described for Reservoirs 1 and 2. The major steps of the closure process include:

Step 1 – Removing any oil or other fluids from the reservoir and dismantling the roof structure.
Step 2 – Concrete liner demolition.
Step 3 – Removal of oil-saturated soil.
Step 4 – Backfilling using soil from berms.

[360] EDR. 2013. Certified Sanborn Map Report for Kast Property 1924 and 1925.
[361] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report Reservoirs 1 and 2*. October. p. 1-1
[362] Clark, Durland. Land Department Manager. Shell Oil Company. 1963. *Letter Regarding the Rezoning of the Kast Tank Farm*. August 26.
[363] Shell Oil Company of California, Chemical Department. 1926. *The Explosibility of Natural and Reservoir Gases in the Presence of Oxygen, Nitrogen, Air and Carbon Dioxide.* December 23.
[364] Clark, Durland. Land Department Manager. Shell Oil Company. 1963. *Letter Regarding Rezoning Adjacent to Kast*. August 26.
[365] Shell Oil Company. 1965. *Shell Properties – Disposable Manufacturing Kast Fee (44.35 acres) Los Angeles County California*. June 23.
[366] Shell Oil Company. 1994. *Work Plan Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson, California*. November 3. p. 1.

Step 1 – Removing any Oil or other Fluids from the reservoir and dismantling the roof structure

The decommissioning of Reservoirs 5 through 7 involved removal of liquid waste and petroleum residues and removal of metal and wood waste in January 1966.[367] As detailed in Section 3.1.2, Reservoirs 5 and 6 were clean and dry upon Barclay's arrival on site. [368, 369, 370]

The first step that Barclay took to "perform site clearing" was to remove the liquid waste and petroleum residues from Reservoir 7."[371] The process to remove petroleum hydrocarbon materials from Reservoir 7 is detailed in Section 3.1.3 of this report.

For Reservoirs 1 and 2, the work to empty the reservoirs and dismantle the roof structure was completed in March 1994.[372]

For both sets of reservoirs, the first steps of the decommissioning involved removing petroleum hydrocarbon material and other liquids from the reservoir. This was followed by removing the roof structure and disposing of these materials offsite.

Step 2 – Concrete Liner Demolition

The second step in the closure process of Reservoirs 5 through 7 and Reservoirs 1 and 2 involved breaking up the concrete liner. For Reservoirs 1 and 2, the concrete liner was demolished and the reinforcing steel was segregated out. The crushed concrete was then used as the first backfill layer in the bottom of the reservoirs.[373]

For Reservoirs 5 through 7 the concrete flooring was not removed but was ripped up using a bulldozer and ripping blade. The resulting concrete material remained on the bottom of the reservoir as the first backfill layer.[374] The concrete that formed walls of earthen berms was broken up and placed on top of reservoir floor.[375]

In both cases, the concrete flooring was broken up allowing communication between the backfill materials and soil below the former flooring containing petroleum hydrocarbon contamination.

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[367] Barclay, Richard. 1965. *RE: Lomita Property*. Correspondence from Barclay to Durland Clark, Shell Oil Co. December 1.
[368] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 37:7-24.
[369] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 42:18-25.
[370] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 40: 12-21.
[371] Barclay, Richard. 1965. *RE: Lomita Property*. Correspondence from Barclay to Durland Clark, Shell Oil Co. December 1. p. 1, par. 2. (SOC000056).
[372] Shell Oil Company. 1994. *Work Plan Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson, California*. November 3. p. 1.
[373] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. p. 1-2.
[374] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 108.
[375] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p.110-p.119.

Step 3 – Removal of Oil-Saturated Soil

After concrete removal, the planned next step of the reservoir decommissioning process for Reservoirs 1 and 2 was to remove oil-saturated soil. The WDRs specify that Shell is to "remove any soils under the liner that are saturated with hydrocarbons for disposal offsite at a licensed point of disposal."[376] No soil that contained residual liquid hydrocarbons or was deemed hydrocarbon saturated was encountered in the berms or beneath the concrete floor in Reservoirs 1 and 2; therefore, no soil was removed and the RWQCB approved this approach. [377, 378]

During the demolition of Reservoirs 5, 6, or 7, there was no discernible contamination of the berm material was noted by the grading contractor Mr. L. Vollmer.[379] As detailed in Section 3.3.2 of this report, the floors of Reservoir 5, 6, or 7 were to be left in place and there was no reason or need for Barclay's grading contractor to access those soils. No grading or movement of any soil beneath the concrete floors was performed with the exception that soils excavated from geotechnical borings and pits were used to backfill those holes and pits.

As detailed in Section 3.1.5 and Section 3.4 of this report, there is deposition testimony of eyewitnesses that indicate that whatever oil-saturated soils were encountered in part of the Subject Property other than the reservoirs were hauled off of the property.[380] [381]

Step 4 – Backfilling Using Mixed/Homogenized Soil From Berms

Soil from the berms surrounding Reservoirs 1 and 2 was used to fill in these reservoirs as follows:

> **"The blending of the berm soils was accomplished by pushing the berm soils from top to bottom to gaps opened in the berms, then rolling them from outside edge to inside with dozers, spreading them over the bottom in 6-inch lifts with loaders, and then turning them over with 12-inch disks pulled by dozers."**[382] (emphasis added)

In the case of Reservoirs 1 and 2, soil was thoroughly mixed as it was graded into the reservoirs. The soil was placed in horizontal lifts and compacted to at least 90% relative density.[383] Each lift

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[376] California Regional Water Quality Control Board Los Angeles Region. 1994. *Order No. 94-112 Waste Discharge Requirements for Shell Oil Company 1520 through 1622 East Sepulveda Boulevard Carson California Closure of Two Surface Impoundments (File No. 85-19)*. October 31. p. 1.

[377] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.

[378] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.

[379] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 85-87.

[380] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 110: 14-25

[381] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 114:2-21.

[382] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. p. 3-2.

[383] Shell Oil Company. 1994. *Work Plan Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson, California*. November 3. p. 4

of soil placed in Reservoirs 1 and 2 was at an approximate thickness of 6-inches[384] to 12-inches.[385]

For Reservoirs 5 through 7, each lift of soil was placed at an approximate thickness of 8-inches.[386] Deposition testimony indicates that concrete that formed walls of earthen berms was broken up and placed on top of the reservoir floor. Six inches of soil was placed on top of the broken up concrete and compacted using a vibrating sheepsfoot.

The rest of the soil from the berms was pushed over into the reservoir and compacted in lifts.[387] According to the grading contractor, equipment used for moving soil from the berms into the reservoir during the backfilling operation involved scrapers and bulldozers. Scrapers work by "scraping" up soil at the bottom front of the machine through a scraping door. The soil is moved in to the "bowl" of the scraper on a paddle wheel type mechanism. Once the bowl is full, the door is closed. One of the desirable features of using a scraper to move soil is that the soil is homogenized as it is scraped up as well as when it is deposited. Soil is distributed by the scraper in a manner similar to the way it is scraped up. The scraper door is raised or lowered to determine the height at which the soil is distributed. As the scraper is pulled along, the soil pours out the bottom to form a level path. In addition, if oily soil was present inside the scraper it would have been easily noticed and identified. The grading contractor stated this was one reason that he knew the berm soil was not impacted with oil.

According to the grading contractor, once the concrete lining the inside walls of the reservoirs was pushed into the bottom of the berm, the next step in the backfilling process was to push soil from the berms surrounding each reservoir into the reservoir "layer by layer" using a bulldozer.[388]

Regardless of whether soil was moved into Reservoirs 5 through 7 through the use of a scraper or bulldozer, the soil was mixed and homogenized as it was removed from the berm and placed into the reservoir bottom. The soil was bulldozed down the berm and placed into the reservoir in layers. If any contamination was present in the soil it would have been placed randomly in the reservoir as there would be no way for operators to decide which soil was contaminated, the degree of contamination, and thus the appropriate burial depth or location within the reservoir. The engineering requirements for compaction of soil placed in Reservoirs 5 through 7 was "compaction to be 90% of maximum density per ASTM Soil Compaction Test D-1557-58T modified to consist of three layers."[389]

In both Reservoirs 1 and 2 and Reservoirs 5, 6, and 7, the berms were used to backfill the former reservoirs. Both sets of reservoirs used process for backfilling which would have homogenized

[384] Parsons. 1994 Engineering Plan. *Carson Dismantlement Project Reservoirs – RS#1 & RS#2 – Grading Work Finish Grading & Drainage Plan Notes*. RMP-CE-7800-05 Rev. B. May 17. Sheet 1 of 2. Grading Note #9.
[385] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. p. 3-2.
[386] E. L. Pearson and Associates. 1967. *Grading Plan for Tract No 28564.* September 1. Sheet 1 of 3.
[387] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p.110-p.119.
[388] Vollmer, L. 2013. *Volume I Videotaped Deposition of Leroy H. Vollmer*. March 15. p. 114.
[389] E. L. Pearson and Associates. 1967. *Grading Plan of Tract No 28564.* September 1. Sheet 1 of 3.

the soil backfilled in the reservoir. In addition, the soil was placed in both sets of reservoirs in lifts and compacted to 90% of the maximum density.

<u>*Step 5 – Capping*</u>

As discussed in Section 5.1.7 of this report, the initial closure of Reservoirs 1 and 2 included the installation of a low permeability cap over fill soil to “inhibit the upward migration of free petroleum hydrocarbons”. [390] The initial reservoir backfilling compaction and capping project was expected to be a final remedy to the reservoir demolition and dismantling however “post-closure remedial activities” needed to be performed to “mitigate hydrocarbon seepage”.[391] Post closure activities included additional soil investigation, soil removal, and the installation of an extension to the existing low permeability cap.

This final capping step in the closure process of Reservoirs 1 and 2 is the only step not conducted during the closure of Reservoirs 5 through 7. However, a majority of the soil in the Carousel tract is covered by streets and sidewalks; driveways and walkways; home foundations; and other landscaping features.

5.3.1.4 Soil Contamination Levels

Progress report submitted by Shell to the RWQCB during the closure of Reservoirs 1 and 2 reported that the “berm soil under the concrete liners did not show any free-phase petroleum hydrocarbons nor any oil-saturated soils; therefore, no soils were removed to disposed of offsite”.[392] Based on the sample analyses, Brown and Caldwell concluded that the soil samples collected from the berm would not be classified as hazardous based on federal or state criteria and only the deepest portions of the berm soils nearest the reservoirs had significant petroleum impacts as indicated by soil sampling data, indicating that on a volume basis the berm soils were relatively free of significant petroleum impacts. Therefore the berm soil was used for engineered backfill of the reservoirs.[393]

It was similarly reported that “the soil under the floor concrete liners did not show any free-phase petroleum hydrocarbons nor any oil saturated soil; therefore, no soils were removed to be disposed of offsite”.[394] The soil underlying Reservoirs 1 and 2 was characterized by drilling 21 boreholes through the reservoir floors.[395] Leakage from the reservoirs was visible in the

[390] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. Executive Summary.
[391] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2*. August. p. 1-1.
[392] Shell Oil Company. 1994. *Progress Report #1 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. October 31 to November 30. p. 1.
[393] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 2-1 to 2-10.
[394] Shell Oil Company. 1995. *Progress Report #2 Compliance File No. CI 7452 Reservoir Removal Project Shell/Unocal Facility 1520-1622 East Sepulveda Blvd. Carson California*. December 1 to December 31. p. 1.
[395] Brown and Caldwell. 1994. *Berm Material and Underlying Soil Characterization of Reservoirs 1 and 2*. March. p. 3-1 to 3-18.

underlying soils, with the most impacted area occurring near (i) the sumps within the reservoirs, (ii) adjacent to cracks in the concrete bottoms, and (iii) near the sidewall/floor intersection in the former reservoirs. Reservoir 1 boreholes contained visible contamination in all 11 boreholes, with the deepest contamination observed at approximately 56 feet below the reservoir bottom. Reservoir 2 contained visible contamination in only five of the ten boreholes, while the deepest visible contamination was observed 46 feet below the reservoir bottom.

Soil samples collected from beneath Reservoir 1 showed significant levels of TRPH with the majority of TRPH concentrations detected exceeding 10,000 mg/kg. TRPH concentrations as high as 71,000 mg/kg were detected in the soil samples collected from beneath this reservoir. Soil samples collected from beneath Reservoir 2 also showed significant levels of TRPH; however, concentrations were lower than those detected beneath Reservoir 1, with only approximately half of TRPH concentrations detected exceeding 10,000 mg/kg. The maximum TRPH concentration detected beneath this reservoir was 36,000 mg/kg. One soil boring, boring 2, did not contain any detectable TRPH concentrations even though it did have detectable OVM readings ranging from 15 to 72 ppm. There is not good correlation between the OVM field concentrations and the TRPH soil laboratory concentrations detected, and field identification of impacted soils was very difficult.

The soil beneath the Reservoir 1 and 2 floors were further evaluated in April of 1995 after the concrete floors had been removed. Of the 30 samples collected beneath Reservoir 1, 21 had concentrations greater than the WDR limit of 10,000 mg/kg for TPH in the C_{13} to C_{22} range.[396] Of the 38 samples collected beneath Reservoir 2, nine had concentrations greater than the WDR limit of 10,000 mg/kg for TPH in the diesel (C13 to C22) range.[397]

In early 1996, less than one year following decommissioning of Shell's Reservoirs 1 and 2, soils at grade in the exposed relic berms located just outside the low permeability cap constructed over each of the reservoirs exhibited localized bleeding of hydrocarbons to the surface. These hydrocarbon seeps were observed in fine sandy soils located beyond the perimeter of the existing low permeability caps, which were placed on top of the fill soils to inhibit future hydrocarbon seepage. These areas of soil saturated with hydrocarbons located along the perimeter of the low permeability caps are the result of upward migration of petroleum hydrocarbons from beneath the former reservoirs floors up through the engineered fill material and laterally out and around the low permeability caps to the surface. Additional remedial activities were required to bring the closed reservoirs back into compliance with the WDR which consisted of removal of any hydrocarbon saturated soils located outside the perimeter of the cap, replacement with clean fill soils, and extension of the low permeability cap an additional 37 feet at each reservoir to inhibit future hydrocarbon seepage.[398]

[396] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. Table 2-1 p. 2-5 to 2-7.

[397] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report, Reservoirs 1 and 2*. October. Table 2-2 p. 2-10 to 2-14.

[398] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2*. August. Executive Summary.

In comparison, the soil sampling data obtained from the Subject Property from Reservoirs 5, 6, and 7 indicates almost an identical nature and distribution of contaminants to those observed at Shell's Reservoirs 1 and 2, with the highest concentrations detected just beneath the reservoir floors, and attenuating downward into the vadose zone, and attenuating upward into the engineered fill due to capillary forces wicking the contaminants towards the surface into the clean engineered fill material. The distribution of petroleum hydrocarbons in soil beneath the reservoirs at the Subject Property is best depicted by the 10-foot deep samples collected at Reservoir 5 (Figure 10). This is because the depths of these samples are almost all located beneath the depth of the reservoir floor, whereas at Reservoir 7 only samples from approximately the northwest ¼ of the reservoir represent depths beneath the floor. And at Reservoir 6, almost all of the 10-foot deep samples were collected above the reservoir floor (Figure 11). To evaluate soil impacts beneath the floors of Reservoir 6 and most of Reservoir 7, samples from deeper than 10 feet must be evaluated.

The results for TPHd in soil within selected deep soil borings are summarized in Table 1. The deeper soil borings completed within the streets located near the outer perimeter of the reservoir floors show that the highest concentrations of TPH were typically found at depths near the floors of the reservoirs, either just above or just below the floor.[399,400,401] For example, results from soil borings DP-4 and MW-3, located on Marbella Avenue near the western edge of Reservoir #5, depict a top-down distribution of petroleum impacts beginning at a depth of 10 feet, migrating downward beneath the intersection of the sidewall and bottom of Reservoir 5. The maximum TPHd concentration at this location was 19,000 mg/kg at 10 feet bgs, a depth just beneath the bottom of the reservoir. The concentration decreased to 11,000 mg/kg at 35 feet bgs and to non-detect at 40 feet bgs. At MW-12, located approximately 30 feet to the west, the soil impact extends to a depth of 45 feet.

Soil boring DP-7, located at the western edge of Reservoir 7, demonstrates this same distribution pattern with 13,000 mg/kg TPHd detected at a depth of 10 feet bgs (below the bottom of the reservoir), increasing to a maximum concentration of 20,000 mg/kg at 15 feet bgs, then decreasing to 1,700 mg/kg at a depth of 25 feet bgs, which was the maximum depth sampled.

Soil boring B-6, at the north edge of Reservoir 7, demonstrates this distribution further with a maximum TPHd concentration of 23,000 mg/kg detected at 10 feet bgs decreasing to 3,500 mg/kg at 55 feet bgs which was the deepest sample collected from this soil boring.

The results of CPT ROST/UVOST soundings were consistent with those of the soil borings, both showing significant soil contamination beneath the former reservoir floors extending to depths approaching groundwater.[402] Results of these borings show that the deep contamination is

[399] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. Table 3A, p. 1-17

[400] URS Corporation, *Final Phase I Site Characterization Report, Former Kast Property, Carson, California*. October 29. Table 4C, p. 1-3.

[401] URS Corporation, 2009. *Interim Site Characterization Report, Former Kast Property, Carson, California*. August 20. Table 2, p. 1-4.

[402] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. Figures 10B-14B

concentrated primarily at the perimeter of the former reservoir floors. Elevated levels of petroleum hydrocarbons in soil extended to a depth of approximately 45 feet at Reservoir 5 (in MW-12), 65 feet at Reservoir 6 (in MW-02), and 60 feet at Reservoir 7 (in MW-13). All of these soil borings are located along the perimeter of the reservoir where the floor joined the sidewalls.

URS concluded that: 1) Deep hydrocarbon impacts to soils do not extend beyond the Site boundary; 2) Deep impacts are localized and occur in the vicinity of the former oil storage reservoirs; and 3) The ROST/UVOST data indicate that deep impacts are limited to near the perimeter of the former reservoirs.[403]

Although some contamination was found beneath the interior portions of the reservoirs, the concentrations were significantly less and typically did not extend to any significant depth. Based on a detailed review of the extensive soil sampling data collected beneath and within Reservoirs 5, 6, and 7 at the Subject Property, the nature and extent of soil impacts are almost identical in nature and extent at to those observed at Shell's Reservoirs 1 and 2. Based on the soil data collected both above and below the reservoir floors of Reservoirs 5, 6, and 7, the contaminant pattern observed indicates that the highest concentration of petroleum hydrocarbons was detected just beneath the reservoir floors, these concentrations decrease with depth and attenuate rather quickly due to the properties of the soil and crude oil which combine to cause retention of petroleum hydrocarbons within the soil column. The petroleum hydrocarbon concentrations decrease upward through the ripped reservoir floors into the clean fill causing a contamination pattern that indicates upward migration into the clean fill material caused by capillary forces.

[403] URS Corporation. 2010. *Plume Delineation Report Former Kast Property Carson, California.* September 29. p. 5-9

Section 6
Technical Explanation for Upward Chemical Migration

Upward migration of petroleum hydrocarbons in the subsurface is not a new or novel concept. It can occur in a number of ways. For example, within a water-saturated environment, petroleum hydrocarbons, if present, will float upward to the top of the water table since they are less dense than water and are immiscible in water. The main mechanism for this type of transport is buoyancy forces causing the petroleum hydrocarbons to migrate upward through the water column. This is the most common transport mechanism for petroleum hydrocarbon in reservoir sediments and rocks within oil bearing formations, where the petroleum hydrocarbons rise through the saturated zone until they are trapped beneath a fault, anticline, or low permeability layer and accumulate into pools of oil. Also once free phase petroleum hydrocarbons accumulate on the water table as a light non-aqueous phase liquid (LNAPL) layer, the LNAPL can also be transported upward into the unsaturated zone due to capillary forces, similar to how water is transported upward along the groundwater capillary fringe. The finer grained the soil, the larger vertical distance the capillary fringe will migrate upward.

In a pressurized environment, compressed petroleum hydrocarbon fluid will migrate from the area of high pressure towards areas of low pressure. This is one of the common driving forces for natural petroleum seeps such as occur at La Brea Tar Pits and have been commonplace throughout California where there are thousands of documented naturally-occurring seeps. Natural petroleum seeps occur as a result of the cap rock seal above the oil formation being breached, causing a tertiary migration of hydrocarbons towards the surface under the influence of the associated buoyancy forces. The cap rock seal is breached due to the effects of overpressure adding to the buoyancy force, overcoming the capillary resistance that initially kept the crude oil sealed. The petroleum hydrocarbons migrate to the surface since this is the area of the lowest pressure. The most common cause of overpressure is the rapid loading of fine-grained sediments preventing water or hydrocarbons from escaping fast enough to equalize the pressure of the overburden soil.

In the vadose zone or unsaturated zone, upward migration of fluids (including both water and petroleum hydrocarbons) is primarily driven by capillary action within the soil porosity. This concept is no different from the well-documented and understood capillary action observed in the vadose zone above the water table, referred to as the capillary fringe. In a similar manner to water being transported upward above the water table within the capillary fringe, petroleum hydrocarbons that originated from a release into the vadose zone can migrate both laterally and upward by this same capillary action within the unsaturated soil column.

The height that these hydrocarbons can be transported upward within the vadose zone is determined by the soil pore throat size and the viscosity of the petroleum hydrocarbons, where the smaller pore throat size and lower viscosities can be transported upward the greatest distances. Therefore, typically the more fine-grained the soil type, the smaller the pore throat size, and the greater the distance of capillary rise, thus the greatest capillary rise can be expected in clayey soil, followed by silty soil, then followed by silty sands, then followed by fine sand, medium sand, and coarse sand.

Typically gravels, in the absence of any fine grained materials, would have a very small capillary rise on the order of a few inches, due to the large pore throat diameter of the gravel. However, in nature, well sorted materials are not that common, and typically vadose zone soil in alluvial environments such as present at the Subject Property, are very heterogeneous, and therefore, the height of capillary rise can vary greatly depending on the degree of heterogeneity experienced both laterally and vertically throughout the vadose zone. This can result in petroleum hydrocarbons being transported horizontally and vertically in a tortuous path upward as they are drawn up into the finer grained soil exhibiting the greatest capillary forces on the liquid petroleum hydrocarbons.

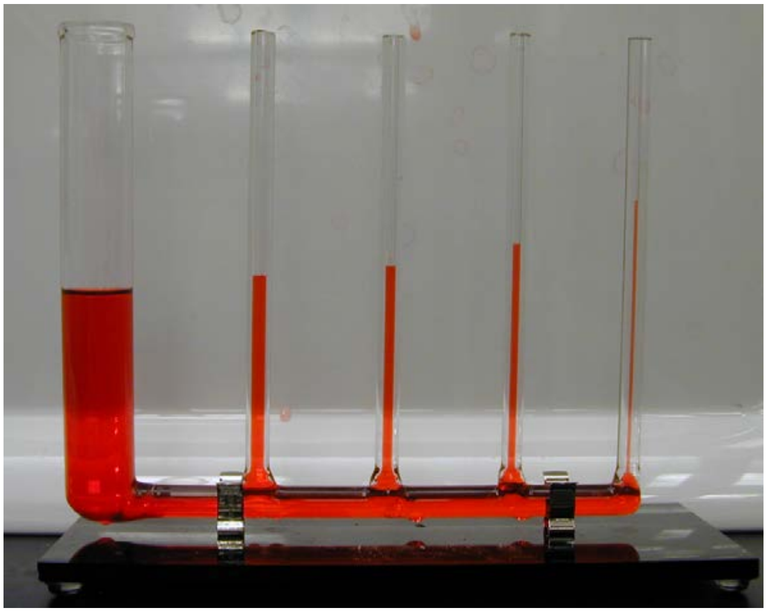
6.1 Theory of Capillary Action

Capillary action is the ability of a liquid such as water or oil to flow in pore spaces within the unsaturated or vadose zone of the subsurface without the assistance of, and in opposition to, external forces such as gravity. Movement of the fluid occurs because of intermolecular forces between the liquid and the surrounding solid soil surfaces. If the diameter of the pore throat in the soil column is sufficiently small; such is the case in clay, silt, and sand; then the combination of surface tension (which is caused by cohesion within the liquid) and adhesive forces between the liquid and soil particles act to move the liquid in a horizontal direction and lift the liquid in a vertical direction. The finer grained the soil particles, the higher the capillary rise expected, since the contact length (around the edge of the pore throat) between the top of the liquid column and the pore throat is proportional to the diameter of the pore throat, while the weight of the liquid column is proportional to the square of the pore throat diameter, so a narrow pore throat will draw a liquid column higher than a wide pore throat. Thus capillary rise is greatest in clay soil, followed by silty soil, followed by sandy soil. Clean gravel soil would experience the smallest capillary rise due to the larger pore throat diameter between the individual gravel particles.

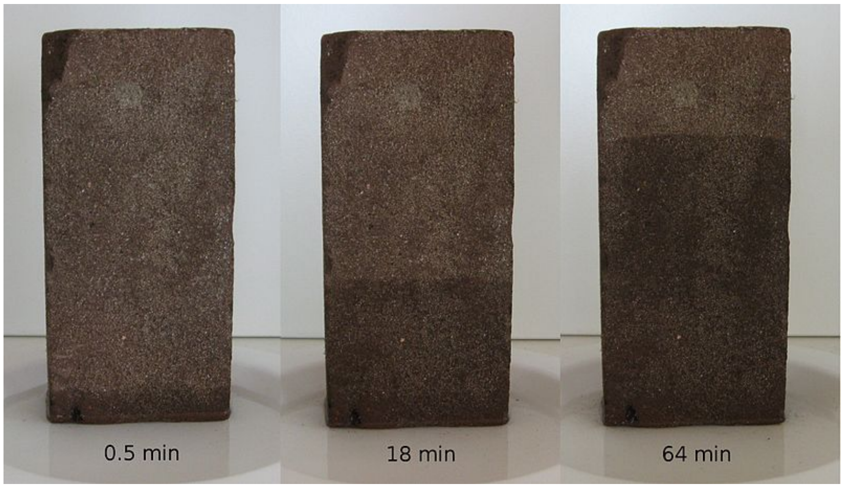
The height h of a liquid column is given by the following equation:

$$h = \frac{2\gamma\cos\theta}{\rho g r}$$

where γ is the liquid-air surface tension (force/unit length), θ is the contact angle, ρ is the density of liquid (mass/volume), g is local acceleration due to gravity (length squared of time), and r is radius of pore throat (length). Thus the thinner the pore throat space, the farther the fluid can travel upwards. See the example, in the picture below for water dyed red.



Capillary action is responsible for moving fluids such as water, pure petroleum hydrocarbons, and/or oil in the unsaturated zone from "wet"[404] areas of the soil to "dry" areas. This is the same phenomenon experienced when a dry porous medium, such as a brick or a wick, is brought into contact with a liquid, it will start absorbing the liquid at a rate which will decrease over time. Eventually, fluid will reach a maximum height. (See picture below.)



For a bar of material with cross-sectional area A that is wetted on one end, the cumulative volume V of absorbed liquid after a time *t* is

[404] "Wet" with refers to soil saturated with water, pure petroleum hydrocarbon, or oil.

$$V = AS\sqrt{t}\ ,$$

where S is the sorptivity of the medium, with dimensions m/s$^{1/2}$ or mm/min$^{1/2}$. The quantity

$$i = \frac{V}{A}$$

is called the cumulative liquid intake, with the dimension of length. The wetted length of the bar, that is the distance between the wetted end of the bar and the so-called *wet front*, is dependent on the fraction f of the volume occupied by liquid. This number f is the porosity of the medium; the wetted length is then

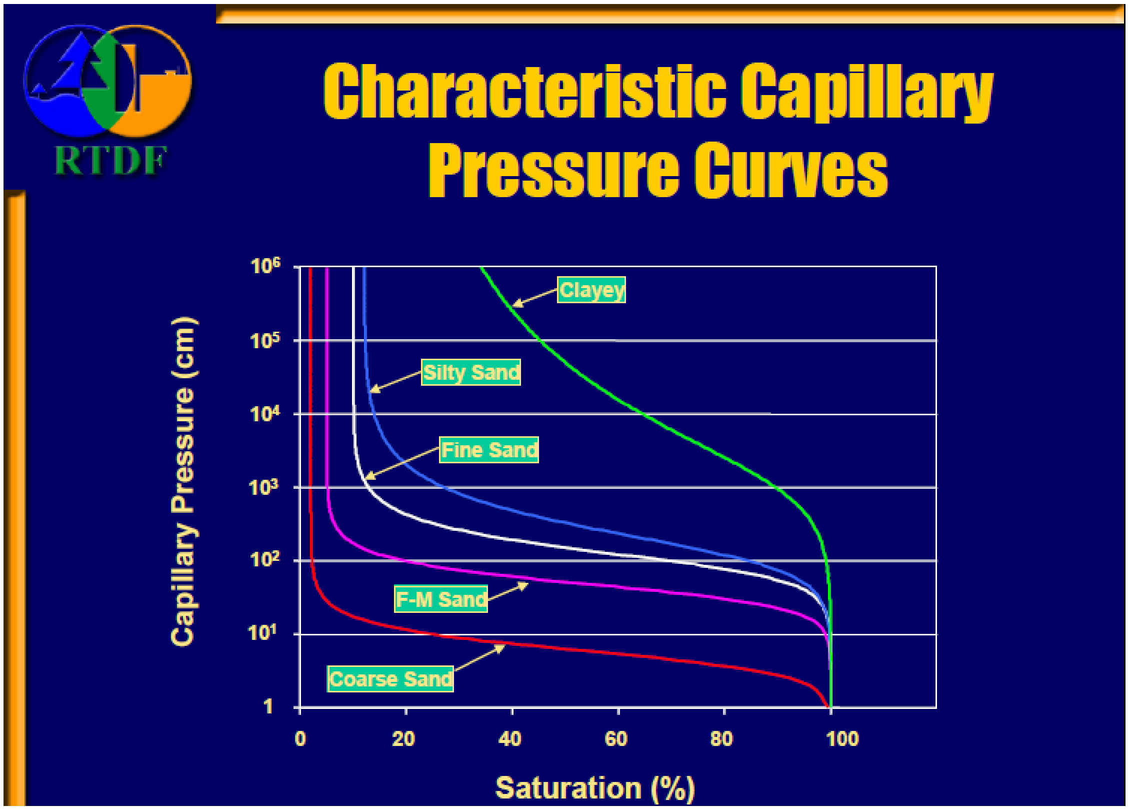
$$x = \frac{i}{f} = \frac{S}{f}\sqrt{t}$$

Sorptivity is a relevant property of building materials because it affects the amount of rising dampness within the building material.

This same relationship holds true for soil, which is also a porous material. If fill soil is placed and compacted on top of in-place soil which either contains (i) free liquid water or oil, (ii) where the in-place soil has a higher saturation level with respect to oil or water than the overlying soil, or (iii) soil to the side of it for that matter, the liquid (water or oil) will be pulled from the in-place soil into the fill soil in the same manner as described above, due to capillary action. This movement of moisture by capillary action can move liquids both in the horizontal direction and vertical direction apposing gravitational forces until moisture equilibrium is reached.

The capillary rise height, or height that fluids (water or oil) can be wicked in the vertical direction, can be significant especially in finer grained soil such as clay and silt. In addition, as the percent saturation of the liquid (water or oil) decreases, its capillary pressure will increase, thus its ability to raise the fluid in the vertical direction becomes even greater. These relationships are graphed in the ideal saturation/capillary pressure curves included below for water in 5 typical soil types including clay, silty sand, fine sand, fine to medium sand, and coarse sand.[405]

[405] The Remediation Technologies Development Forum. 2005. *"The Basics" Understanding the Behavior of Light Non-Aqueous Phase Liquids (LNAPLs) in the Subsurface.* February. p. 15.



Typical maximum values for the capillary rise of water measured in various soil types are as follows:[406]

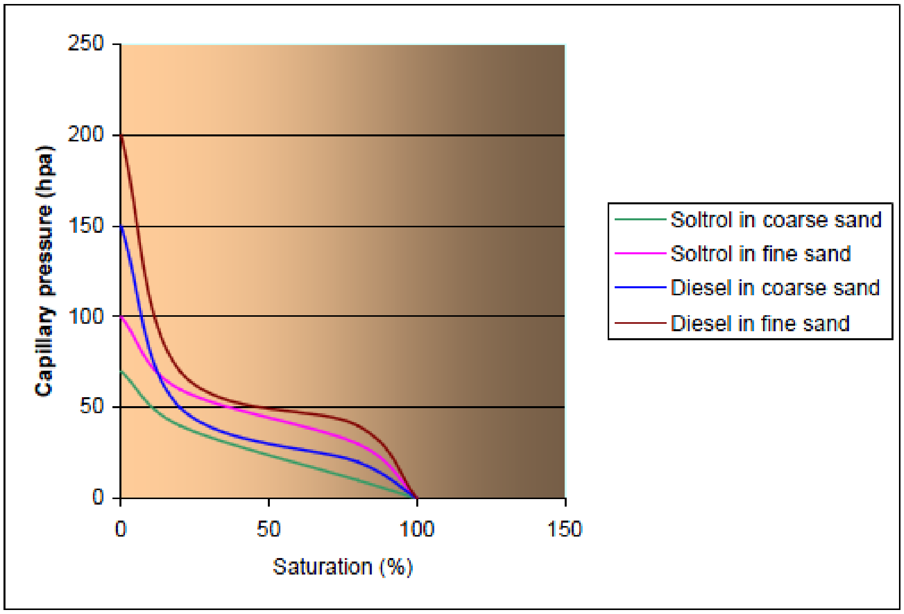
Coarse Gravel	0.1 feet
Sandy Gravel	1.5 feet
Silty Gravel	4.5 feet
Sand	5.0 feet
Silt	11.5 feet
Clay	16.5 feet

If soil types are heterogeneous, as they typically are in southern California, liquid will be lifted the greatest vertical distance by the finer-grained soil, therefore the liquid may in fact be drawn upward in a non-uniform manner in pathways comprised of connected smaller pore throats.

Capillary rise of petroleum hydrocarbons in soil within the vadose zone occurs in the same manner as water within the vadose zone, with the only difference being that the petroleum hydrocarbons will rise slightly less than water because the surface tension of petroleum hydrocarbons is slightly less than water.[407]

[406] Dragun, J. 1998. The Soil Chemistry of Hazardous Materials, Second Edition. p.211 Figure 2-30.
[407] The Remediation Technologies Development Forum. 2005. *"The Basics" Understanding the Behavior of Light Non-Aqueous Phase Liquids (LNAPLs) in the Subsurface.* February. p. 17, par. 5.

Included below is a graph of capillary pressure curves generated in the laboratory for two different soil types, fine sand and coarse sand, and two different product types, diesel fuel and Soltrol (aliphatic hydrocarbon C13-C16).[408]



Pressure-Saturation Curves for Coarse and Fine Sand and both LNAPL
(note: 1 hpa=0.03 feet of water)

Based on these results the author concluded that the fine sand had a higher capillary pressure and capillary rise as a result of the smaller pore throat size for this soil type compared to the coarse sand. These results indicate a maximum capillary rise for diesel fuel and Soltrol are as follows:

Diesel Fuel	
Coarse Sand	5 feet
Fine Sand	6.7 feet
For Soltrol:	
Coarse Sand	2.18 feet
Fine Sand	3.35 feet

These capillary rise values for diesel fuel, which is the primary petroleum hydrocarbon range at the Subject Property, is actually almost identical to the value presented above for water (same to slightly higher), so it can be concluded that the maximum capillary rise expected for silt (11.5 feet) and clay (16.5 feet) for diesel fuel would be very similar to that expected for water.

Free phase petroleum hydrocarbons beneath the Subject Property in the vadose or unsaturated zone are subjected to these capillary forces which can result in the lateral and upward migration

[408] Simantiraki F., Aivalioti, M., Gidarakos, E. 2008. *LNAPL infiltration and distribution in unsaturated porous media–implementation of image analysis technique*. HazWasteManagement. C9.2, p. 8, Figure 4.

of petroleum hydrocarbons within the soil column of the unsaturated zone. The free phase petroleum hydrocarbons do not need to be present as a free product layer on groundwater for capillary forces to move them upward into the soil column of the vadose zone. They only need to be present as free liquid petroleum hydrocarbons. Such conditions existed at the Subject Property beneath the oil reservoirs as a result of years of free phase petroleum hydrocarbons leaking into the soil within this area due to leaks in the oil reservoirs, primarily at the junction between the reservoir sidewalls and bottom. Exceptionally high concentrations of petroleum hydrocarbons do not need to be present for free phase hydrocarbons to be present in soil, and in fact free phase hydrocarbons can be present at relatively low petroleum hydrocarbon concentrations (e.g., 30 mg/kg TPHd).[409]

6.2 Summary of Some Relevant Technical Articles Regarding Upward Chemical Migration

Acher, A.J., Boderie, P., and Yaron, B.
Soil Pollution by Petroleum Products, I. Multiphase Migration of Kerosene Components in Soil Columns
***Journal of Contaminant Hydrology.* 4 (1989) 333-345 Elsevier.**

SUMMARY: In one of the experiments in this article, upward movement of kerosene in soil columns was evaluated. A series of experiments was carried out in order to simulate the contamination of the soil when a kerosene lens lying on the groundwater is the source of the contamination. Since the direction of kerosene penetrations is against gravitational forces, only upward force acting is capillarity, or capillary rise. In this case the rate of the advance of the liquid front was approximately 20% slower than downward movement. An increase in the moisture content of the soil resulted in a decrease in the upward rate of penetration. For samples taken 21 days after kerosene application the height of capillary rise was measured at 7.0, 4.5, and 0.5 cm for 0.0%, 0.8% and 4% moisture contents, respectively. The gas phase extended upwards 23.0 and 30.0 cm for oven- and air-dried soil, respectively. The 4% moisture content also proved to be a barrier for upward vapor penetration, while soil field capacity prevented any kerosene upward movement at all.

Jarsjö, J., Destouni, G., and Yaron, B.
Retention and Volatilization of Kerosene: Laboratory Experiments on Glacial and Post-Glacial Soils
***Journal of Contaminant Hydrology.* 17 (1994) 167-185 Elsevier.**

SUMMARY: The influence of environmental conditions and soil characteristics on the retention and volatilization of kerosene hydrocarbons in soils was investigated through laboratory experiments in six different glacial and post-glacial soils. During the experiments, kerosene was introduced to the soil columns from the bottom through capillary action, pulling the kerosene up through the soil column to residual saturation levels. The soils ranged in density from 0.55 and

[409] Geosphere, Inc., CH2MHILL. 2006. *Maximum Allowable Concentration, Residual Saturation, and Free-Product Mobility, Technical Background Documents and Recommendations, Prepared for Alaska Statement of Cooperation Working Group.* September. p. 2. par. 1.

1.80 g/cm³, porosity from 29% to 70%, organic matter content form 0.4% to 28%, and clay content from 0% to 51%. The combined effects of soil porosity and soil moisture content on the kerosene retention capacity were found to be significant and could be quantified by liner relationships. The experiment concluded that kerosene volatilization preferentially removed the lighter ends of kerosene thus leaving the heavier components in soil, thus altering the composition of kerosene remaining in the soil column. The results for the different soil types indicated that the organic matter content of soil affects the selective volatilization, possibly through hydrophobic adsorption on surfaces, whereas the clay content appears to be less influential.

Simantiraki F., Aivalioti M., and Gidarakos E.
LNAPL Infiltration and Distribution in Unsaturated Porous Media–Implementation of Image Analysis Technique
***HazWasteManagement*: C9.2, (Oct 2008)**

SUMMARY: Light non-aqueous phase liquids (LNAPL) represent a great category of soil contaminants that can consist of a persistent, secondary and long term source of contamination. In order to successfully confront with LNAPL pollution, their infiltration and distribution in the subsurface must be studied. For the laboratory simulation of a LNAPL spill a rectangular cell of 100cm in length, 120 cm in height and 2 cm in depth was made out of glass and filled with coarse sand and fine sand and the two product types were slowly added to the cells. The purpose of this project was to investigate the flow and distribution of two typical LNAPL (Soltrol 220 and Diesel Fuel) in two different types of unsaturated porous media, coarse sand and fine sand. Based on these results the author concluded that the fine sand had a higher capillary pressure and capillary rise as a result of the smaller pore throat size for this soil type compared to the coarse sand. These results indicate a maximum capillary rise for diesel fuel to be approximately 5 feet for coarse sand and 6.7 feet for fine sand, and for Soltrol 220 a maximum capillary rise of 2.18 feet for coarse sand and 3.35 feet for fine sand was observed.[410]

Nerantzis P.C., Dyer M.R.
Upward Immiscible Displacement Movement of BTEX Compounds in Unsaturated Soil
HazWasteManagement: P4, (Oct 2008)

SUMMARY: "Spills of petroleum fuel hydrocarbons can introduce NAPLs into the subsurface, which can migrate into unsaturated soils due to immiscible displacement movement in an upward, downward and lateral direction away from the spill area. The downward component due to gravity is usually the dominant direction of movement. However, considerable upward movement of petroleum fuel compounds can take place due to capillary rise where capillary forces immobilize NAPLs at residual saturation into the unsaturated zone. The purpose of this study was to investigate the importance of the upward capillary movement of BTEX pure products in air-dried sand by conducting soil column experiments. The observed upward movement of BTEX compounds significantly increased the volume of the sand impacted by the

[410] The expected capillary rise for silty sand that exists above the reservoirs at the Subject property would theoretically be expected to be even higher than 6.7 feet.

contaminant with corresponding increased environmental implications due to the upward movement of petroleum fuel NAPLs in unsaturated soils."

Li, Y.Y., Zheng, X.L., Li, B., Ma, Y.X., and Cao, J.H.
Volatilization Behaviors of Diesel Oil from the Soils
***Journal of Environmental Sciences (China)*. 16(6) (2004) 1033-1036**

SUMMARY: Diesel oil is an important petroleum product. Therefore, it is very important to study the fate of diesel oil in the environment. The studies of volatilization of diesel oil in this paper can draw some conclusions. The diesel oil used in this paper evaporates in a power manner, where the loss of mass is approximately power with time. The Shengli crude oil fits either the logarithmic or power equation after different times, as determined by the volatilization time recorded during the short-term volatilization experiment test. The initial diesel oil content in the soil plays a large role in volatilization behavior. Water impacts the upward wicking movement of diesel oil in soil; while appropriate water helps the process, too much water stops it. Therefore, the appropriate water content can help to pull the oil contaminants to the surface of the soil through the wicking phenomenon (capillary forces).

The soil type plays a very important role in diesel oil volatilization from soil. The # 2 soil was a sandy loam and helped the volatilization. While the # 3 soil was the finest soil and showed a lower volatilization rate, however wicking action or capillary rise lasted 432 hours since the beginning of the volatilization experiment. In comparison, the three other soils tested, which consisted of coarser material (higher sand content and lower clay content), experienced a wicking action for only 96 hours.

Jessberg, H.L.
Contaminated Land Reclamation
***Report of the ISSMFE Technical Committee TC5 on Environmental Geotechnics,* Ruhr-Univesität Bochum, (1997).**

SUMMARY: The ISSMFW Technical Committee TC5 on Environmental Geotechnics prepared a thorough guide to contaminated land reclamation. This guide covers site investigation and remedial actions, including contaminated and in-situ techniques of remediation. This article discusses the use of clean cover for use with a large range of contaminants and involves the construction of a capping layer over the surface of the site to prevent future occupants from coming in contact with contaminants. The capping layer in its simplest form may be comprised of a cover of imported soil to reduce the risk of ingestion of the underlying contaminated soil by individuals. Where there is a risk of upward migration of contaminants by capillary action, a low permeability layer (such as clay) incorporating a capillary break (such as gravel) may be used. Where downward percolation of water is a problem, a relatively impermeable barrier, such as geosynthetic membrane (or composite geosynthetic clay layer) may be employed within the capping system.

6.3 Capillary Break

The frequent use of capillary breaks to prevent upward migration of contaminants is further evidence that upward migration is a well-recognized phenomenon. A capillary break is the use of uniform porous material, hydrophobic material, or non-porous material sufficient to stop capillary action. A capillary break is commonly used and often required beneath slab on grade buildings in order to prevent soil moisture from wicking up into the slab and building material. Commonly the capillary break is created by placing a layer of uniformly sized "clean" (meaning no fines) gravel or rock which has numerous air pockets or voids even after it is compacted, so that the voids will break the capillary action of the underlying soil, and water will not rise through the capillary break. The layer of gravel used in the capillary break needs to be thicker than the capillary rise in this material in order to stop the capillary rise through the capillary break and into the material placed on top of the capillary break. This is a common building practice, and capillary rise is well known and documented, thus acknowledging the fact that upward transport of soil moisture (water or any type of fluid including petroleum hydrocarbons) through capillary action is a common occurrence and a real concern.

The use of a capillary break, a common engineering practice, is often incorporated into the remedial design for contaminated sites where underlying contaminated soil is left in place and there is a risk of upward migration of these contaminants by capillary action.[411] In these circumstances the capillary break (such as gravel) is placed as a continuous layer on top of the contaminated soil and is capped with a low permeability layer (such as clay).[412] If uncontaminated engineered fill is placed and compacted on top of soil containing any amount of free phase residual petroleum hydrocarbons within the vadose zone, a capillary break should be installed to prevent the upward or lateral capillary rise of petroleum hydrocarbons into this fill soil to prevent their recontamination by the underlying soil, and possible migration of petroleum hydrocarbons to the surface.

[411] International Society for Soil Mechanics and Foundation Engineering. *Environmental Management (Contaminated Land), Learning Session 7,Capping, Barriers and Encapsulation.*
[412] International Society for Soil Mechanics and Foundation Engineering. *Environmental Management (Contaminated Land), Learning Session 7,Capping, Barriers and Encapsulation.*

Section 7
Case Studies Illustrating Upward Chemical Migration

7.1 Shell Sites with Documented Upward Chemical Migration

The first example is the Shell Wilmington Refinery in Carson California, where two petroleum hydrocarbon reservoirs identical in construction to the Subject Property were demolished, filled in with the berm soil, and capped, and the petroleum hydrocarbons that were present beneath the former reservoirs migrated upward through the fill material and around the cap to the surface. This example demonstrates how the petroleum hydrocarbons beneath the oil reservoir can migrate upward into the fill soil and all the way to the surface, exactly how it occurred at the Subject Property. The remaining other Shell sites are well documented inactive disposal sites in the Wilmington and Dominguez Sections of the Shell WMC, both in close proximity to the Subject Property with similar soil types to the Subject Property, where petroleum hydrocarbons seeped to the surface, mostly as tar seeps, again similar in nature to the Subject Property.

7.1.1 Shell Wilmington Refinery Reservoirs 1 and 2

Shell was contractually required to provide closure of Reservoirs 1 and 2 in accordance with the WDRs for Closure of Two Surface Impoundments (Order No. 94.112), issued by the RWQCB.[413] Shell's Reservoirs 1 and 2 were built in the 1920s using the exact same construction techniques, and in fact these two oil reservoirs were constructed almost identically to the three that were constructed on the Subject Property.

Reservoirs 1 and 2 were decommissioned and deconstructed in 1995 and the berms soils were used to fill in the reservoirs in almost an identical manner to how they were filled in at the Subject Property. The concrete floors and sidewalls were removed and any soil containing liquid petroleum hydrocarbons was also removed. Prior to using the berm soil for fill material, Brown and Caldwell conducted extensive soil testing of the berm material and soil underlying the reservoir floors. Berm soil was relatively clean except for the deepest samples that were located closest to the reservoir sidewalls. Therefore the berm soil was used for engineered backfill of the reservoirs.

Once the reservoirs were backfilled with engineered fill from the berms, a 12-inch minimum thickness low permeability clay cap was placed over the former reservoir areas followed by an additional 12-inch minimum of clean cover. The low permeability cap was part of the remedial design for the project "to inhibit the upward migration of free petroleum hydrocarbons."[414]

In early 1996, seepage originated from beneath the reservoir bottom as well as from the adjacent former berm area. In February 1997 corrective measures were implemented to bring the site into

[413] Brown and Caldwell. 1995. *Backfill and Final Project Completion Report Reservoirs 1 and 2.* October .p. 1-1
[414] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. iii, Executive Summary

compliance which included removing the petroleum hydrocarbon impacted soils in an approximate 37 foot band surrounding the perimeter of each reservoir; excavation of petroleum impacted soils to a depth of 2.5 to 4 feet; thermal desorption of impacted soil offsite and re-use for clean cover; excavation of additional area where soil was visibly impacted with residual petroleum hydrocarbons; backfill and compaction of engineered fill within the areas of impact to proper grade; installation of a minimum 12-inch thick low permeability cap over the excavated area and tie into existing cap; and placement of a minimum of 12-inch thick clean soil cover over the new low permeability cap.[415]

7.2.2 Other Shell Sites

7.2.2.1 Shell Wilmington Manufacturing Complex Inactive Disposal Sites –Dominguez Section

These Inactive Disposal Sites (IDS D1 through D7) were under the oversight of the RWQCB.

<u>Inactive Disposal Site D1</u>

The D1 Inactive Disposal Site (IDS) is part of what was formerly the Dominguez Section of the WMC operated by Shell from approximately 1928 through 1991 when operations at the facility were discontinued and the refinery was razed (Figure 21). The Dominguez Section and adjacent property are the subjects of an existing CAO.

Surface soil at the IDS has been impacted by petroleum hydrocarbons which have migrated to the surface and are ignitable, but do not sustain burning.[416] The waste area is characterized by black, waste-stained soil from the ground surface to a depth of 13 feet below grade, stiff tarry wastes to a depth of five feet, and soft oily wastes at various depths ranging from 2 to 13 feet.

<u>Inactive Disposal Site D2</u>

The D2 IDS is part of what was formerly the Dominguez Section of the WMC operated by Shell (Figure 21). The D2 parcel was used for disposal of tar materials and also exhibits elevated lead concentrations.

The principal contaminant of concern requiring removal for development activities was geotechnically unsuitable tar material which was found as a "viscous liquid seeping to the ground surface, resulting in unstable soil conditions and creating a nuisance."[417] The tarry material that is hard during the cooler months becomes mobile during the warmer months and the material rises to the surface due to thermal expansion of the material and/or surface

[415] Brown and Caldwell. 1997. *Low Permeability Cap Extension - Addendum 1 of the Backfill and Final Project Completion Report, Reservoirs 1 and 2.* August. p. iii, Executive Summary

[416] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August. p. 3-5.

[417] GeoSyntec Consultants. 2005. *Remediation Work Plan-D2/D5 Tar Removal, Shell Carson Terminal, Carson, California*. December 1. p. 5.

loading.[418] The shallow soil that was removed because of the presence of tar also contained localized lead impacts. An estimated quantity of approximately 20,000 cubic yards which was present over a large area from the ground surface to an average depth of 4 to 6 feet bgs.

Inactive Disposal Site D3

The D3 IDS was located on the former Dominguez Section of the Shell WMC. Coke material and surfacing tar are present in the southern portion of the IDS.[419]

Tar seeps are visible on the ground surface and become pliable, soft, and odorous with warmer temperatures. During the warmer months, this material rises to the surface due to thermal expansion of the material and/or surface loading.[420] Surface soil at the IDS is ignitable, but does not sustain burning. The surface tar is toxic based on fish bioassay tests. Black waste-stained soil is present over most of the IDS primarily in the upper 5 feet. Stiff tarry waste is encountered in some areas in the upper 5 feet of soil. Hazardous concentrations of lead were also found.

Inactive Disposal Site D5

The D5 IDS was located on the former Dominguez Section of the Shell WMC. The D5 parcel was used as a coke material storage yard, a pipe lay-down yard, a disposal site for tar wastes, and was occupied by several gas flares, at various times during the facility operation.

The principal contaminant of concern requiring removal for development activities was geotechnically unsuitable tar material which was found as a "viscous liquid seeping to the ground surface, resulting in unstable soil conditions and creating a nuisance."[421] Tar seeps are visible on the ground surface and become pliable, soft, and odorous with warmer temperatures. During the warmer months, this material rises to the surface due to thermal expansion of the material and/or surface loading.[422] The shallow soil that was removed because of the presence of tar also contained localized benzene and lead impacts. An estimated quantity of approximately 20,000 cubic yards which was present over a large area from the ground surface to an average depth of 4 to 6 feet bgs.

[418] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August. p. 2-4.
[419] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August. p. 3-6.
[420] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August. p. 2-4.
[421] GeoSyntec Consultants. 2005. *Remediation Work Plan-D2/D5 Tar Removal, Shell Carson Terminal, Carson, California*. December 1. p. 5.
[422] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August. p. 2-4.

Inactive Disposal Site D6

The D6 IDS was located on the former Dominguez Section of the Shell WMC. Waste material identified at the IDS is black waste-stained soil and surface tar.[423]

Tar seeps are visible on the ground surface and become pliable, soft, and odorous with warmer temperatures. During the warmer months, this material rises to the surface due to thermal expansion of the material and/or surface loading.[424] The surface tar is toxic based on the fish bioassay test, and ignitable, but does not sustain burning. Semi-quantitative results revealed petroleum hydrocarbons at concentrations up to 100,000 mg/kg.

Inactive Disposal Site D7

The D7 IDS, located near the intersection of 213th and Perry Streets, is part of what was formerly the Dominguez Section of the Shell WMC.

The preliminary assessment of this property conducted in 1993 indicated that "a tarry substance seeped to the surface in an area where a surface impoundment and separator box were previously located."[425] Heavy petroleum hydrocarbons encountered in the IDS consisted of a tarry substance and a coke-like substance. These materials were not observed below concrete that was encountered at a depth of 7 feet below ground surface and did not extend laterally beyond the perimeter if the former surface impoundments.

7.1.2.2 Shell Wilmington Manufacturing Complex Inactive Disposal Sites –Wilmington Section

Inactive Disposal Site W1

The W1 IDS was located within Shell's Wilmington Refinery. The site characterization was completed during the initial investigation.

Surface soils at this IDS have been impacted by petroleum hydrocarbons which have migrated to the surface and are ignitable, but do not sustain burning.[426] The waste at this IDS is characterized by black waste stained soil present from the ground surface to a depth of approximately 20 feet, soft oily waste at a depth of 10-15 feet, and crystalline coke material near the surface.

[423] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August. p. 3-9.
[424] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August. p. 2-4.
[425] Brown and Caldwell. 1993. *Investigation Report of Inactive Disposal Site 213th and Perry Streets, Carson Plant*. September. p. iv.
[426] Brown and Caldwell. 1989. *Supplemental Inactive Disposal Site Investigation, Wilmington Manufacturing Complex, Volume III.* August. p. 3-4.

7.2 Other Case Studies in Southern California

There are numerous examples of sites in Southern California where upward migration of petroleum hydrocarbons has been demonstrated. Included in this section of the report, are descriptions of three examples of local sites where upward migration of petroleum hydrocarbons occurred after filling in excavations and burying residual petroleum hydrocarbons.[427] All three of these examples demonstrated upward petroleum hydrocarbon migration where petroleum hydrocarbons migrated up through clean fill soil all the way to the surface.

7.2.1 Ralph Gray Trucking Co.

Beginning in 1936, Ralph Gray collected acid sludge, oil field wastes, and oil refinery wastes and disposed of them in four unlined pits at the farm in Westminster, California.[428] The disposal pits were abandoned in place and remained undisturbed until the construction of 75 homes in the late 1950s. The Hintz Development Co. moved the hazardous substances from the pits and buried it in two unlined trenches cut through the backyard areas of about 25 of the lots before the homes were built (outlined area in photo below). The waste trenches were 16 feet deep and covered with three to four feet of soil. Five homes were built directly over one of the original waste pits.

In general, the hazardous substances in soil at the site were found in two different forms, surface seep material and buried waste. The seep material was a black tar-like material that became fluid at 80 degrees F. The material was very pliable and had a distinct, unpleasant smell and a pH of 1.8 to 2.1. The buried waste was a black, brittle, dense material that became fluid at 180 degrees F and had a pH as low as 0.75. Both forms of the material were comprised of volatile organic compounds (VOCs), various sulfur and organic sulfur compounds, and polynuclear aromatic hydrocarbons (PAHs).

By 1965, some residents reported problems with a black sludge seeping into their yards from the ground. The sludge retained a semi-solid form at the ground surface, but became more fluid in hot weather. The sludge migrated upward through 3 to 4 feet of clean fill to the surface. Some residents also found buried waste material in their backyards during excavation for swimming pools and house additions.

Investigation began in 1983 by the California Department of Health Services. EPA assumed lead responsibility for the site in January 1992. Between 1987 and 1991, DHS conducted annual seep removals and issued an advisory to the residents recommending they not eat vegetables and fruit growing in their yards. EPA "confirmed that the seep material would continue to migrate into yards" and concluded that "this process would continue to occur unless a removal action was

[427] Two under the oversight of EPA and one under DTSC.
[428] United States Environmental Protection Agency. *Pacific Southwest, Region 9 Superfund Site Summary for Ralph Gray Trucking Co.* Retrieved from http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/3dec8ba3252368428825742600743733/af222d1c3e7469ed88257007005e9451!OpenDocument on December 1, 2013.

conducted." EPA authorized a removal action in 1994. Several houses were razed and reconstructed. The site was deleted from the National Priority List in September 2004.

Ralph Gray Trucking Site After Cleanup

7.2.2 Mt. Poso Tank Farm

Witco Corporation historically deposited acidic sludge from its Golden Bear Oil Refinery into approximately twelve large open sumps at its Mount Poso Tank Farm.[429] The acidic sludge was covered with a 3 foot layer of earth and compacted. For many years this method of disposal was the state of the art for petroleum refineries. As environmental standards improved and Witco Corporation eliminated the refining process that generated the acidic sludge, use of the Mount Poso Tank Farm for the storage of the acidic sludge was discontinued. The last time that the acidic sludge was deposited at the Mount Poso Tank Farm was in 1975.[430]

The acid sludge had migrated upward from the buried sumps, up through the 3 foot layer of clean cover, and was exposed at the surface as numerous surface seeps. The acid sludge pits were large open unlined surface impoundments that were filled with an acid tar that consisted of a black asphaltic material. The material left in the pits has a specific gravity that is less than soil.

[429] California Department of Toxic Substances Control. *EnviroStor Database Summary for Tricor Refining LLC Tank Farm.* Retrieved from http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=80001851 on December 1, 2013.

[430] California Department of Toxic Substances Control. 1997. *RCRA Facility Assessment – Witco Corporation, Golden Bear Products, Mt. Poso Tank Farm*. June. p .3

Therefore, when the temperature heats up in Bakersfield, the acid sludge becomes liquid and rises to the surface.[431]

In 1981, approximately 100,000 cubic yards of landfilled acid sludge was unearthed, combined with lime and soil, and buried. [432,433] Approximately 200 cubic yards of untreated acidic tar remaining at the tank farm facility was removed in 2001. [434] DTSC issued a letter of closure and NFA for the Acid Sludge Disposal Site in 2002 based on the assumption that the information provided for the closure was true and accurate. [435]

Acid Sludge Seeps

Acid Sludge Seeps

[431] California Department of Toxic Substances Control. 1997. *RCRA Facility Assessment – Witco Corporation, Golden Bear Products, Mt. Poso Tank Farm*. June. p .3

[432] California Department of Toxic Substances Control. 1997. *RCRA Facility Assessment – Witco Corporation, Golden Bear Products, Mt. Poso Tank Farm.* June. p. 10.

[433] Enviro-Sciences, Inc. 2001. *Site Closure Report*. December 18. p.2

[434] Enviro-Sciences, Inc. 2001. *Site Closure Report*. December 18. p.4

[435] California Department of Toxic Substances Control. 2002. *Approval of Closure and No Further Action Determination of the Witco Oil Sludge Pits.* April 23.

7.2.3 McColl Landfill

From 1942 through 1946, the McColl Superfund Site was a disposal area for petroleum refinery waste.[436] During the 1950s and 1960s, in an attempt to control site odors, three sumps were covered with drilling mud and six sumps were covered with natural fill materials. In 1968, homes were built in the area. The distance from the site to the nearest residence is less than 100 feet. The EPA acknowledges upward migration of contaminants and states that “waste materials have seeped to the surface in the Los Coyotes and Ramparts areas.”

A few decades after 1968, however, the acid waste began oozing up through the surface of the ground at the McColl site. “Seeping of the tar waste has been observed in approximately 50 locations on seven of the sumps.”[437] “Waste seeping to the surface continues to create a direct-contact hazard.” Sumps also leached into groundwater creating groundwater contamination

In October 1981, EPA, the State, and potentially responsible parties agreed on a three-phase cleanup plan: Phase I, a complete site investigation; Phase II, a development and evaluation of remedial alternatives; and Phase III, cleanup of the site. In 1992, EPA published a feasibility study and proposed to solidify the waste; however, in 1995, EPA concluded that technology was not feasible and chose to construct a multi-layer cap over the untreated sumps. A deed restriction was recorded on the Los Coyotes and Ramparts areas and the final inspection was completed in 1997. Subsurface gases are collected and treated. Five Year reviews began in 2008.

[436] Final United States Environmental Protection Agency. *Pacific Southwest, Region 9 Superfund Site Summary for McColl.* Retrieved from http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/ViewByEPAID/CAD980498695 on December 1, 2013.

[437] United States Environmental Protection Agency, Region IX. 1993. *EPA Superfund Record of Decision: McColl, EPA ID: CAD980498695, OU 02, Fullerton, CA*. June 30. p. 11.

Section 8
Opinions

In forming the opinions stated below I first downloaded the various communications, reports and other technical data that was publicly available from the RWQCB's Geotracker website and made the inquiries necessary to create a functioning database for data evaluation. I then obtained from legal counsel certain documents pertaining to the history of the Subject Property, including decommissioning and grading of the reservoirs at the Subject Property. This included, among other things, all soils reports, grading plans and the depositions of witnesses who had been present during Barclay's work.

I also reviewed academic journals and records from other contaminated sites, some of which were provided by legal counsel at my request and others of which were obtained by my own staff. I reviewed numerous other documents not specifically mentioned above. The documents I specifically relied upon for a particular point are cited in the footnotes of this report, but while the footnotes are intended to demonstrate support that is scientifically sufficient, I made no attempt to make them exhaustive. In other words, there may be multiple supporting documents not cited in a footnote that make the same point. The opinions that follow are based upon this research, my review and study of these documents, and my knowledge, training, and experience.

The opinions stated below are my opinions and, at a minimum, each one of them is stated within a reasonable scientific certainty by which I mean it is more likely than not that they are true. I have formulated the following opinions based on my review of the foregoing information and my own expert scientific analysis.

8.1 Opinion 1 - Historical Crude Oil Storage Operations Conducted on the Subject Property by Shell are Responsible for All Chemical Releases at the Subject Property

The Subject Property was undeveloped and vacant until 1923 when it was developed with the construction of three oil storage reservoirs in 1924. The Subject Property was used as an active Shell oil storage facility until approximately the late 1950s or early 1960s, when the Subject Property was used on a standby reserve basis. The reservoirs were primarily used to store crude oil though there is some evidence that bunker oil or heavier intermediate refinery streams may also have been stored in the reservoirs.

Since all oil operations had ceased at the Subject Property in the early 1960s, and all oil had been removed from Reservoir 7 in early 1966, any oil contamination that was on the Subject Property at that point in time had originated from Shell's 35-plus years of petroleum storage operations on the Subject Property. Based on Shell Investigations, at the time of Barclay's purchase of the Subject Property in 1966 there were significant petroleum hydrocarbon impacts present beneath all three oil reservoirs from Shell's historic operation of the Subject Property in addition to numerous lesser impacts throughout the facility from releases of crude oil and other petroleum hydrocarbons to the surface and subsurface by Shell.

Shell Investigations have shown that releases of petroleum hydrocarbons have occurred from the oil reservoirs at the Subject Property during Shell’s operation, primarily at the sidewall/floor joint, and to a lesser degree below the reservoir floor in the interior portion of the reservoirs. Petroleum releases along the western portion of Reservoir 5 were significant enough to migrate approximately 50 feet downward and resulted in the accumulation of free product on the water table in this area of the Subject Property.

8.2 Opinion 2 - TPHd is an Appropriate Marker for Oil Contamination on the Subject Property, and Analysis of TPHd Indicates that the Largest Petroleum Hydrocarbon Releases at the Subject Property Are Beneath the Edges of the Former Reservoir Floors

Following an evaluation of the various analytical results, I selected TPHd as a representative indicator compound for graphics purposes to depict the contaminant patterns and distribution at the Subject Property. The selection of TPHd as the indicator chemical for the Subject Property is based on the physical characteristics of the TPH diesel fraction and its predominance in crude oil. BTEX and TPHg were not selected because these chemicals can easily impact shallow soil as a result of common activities unrelated to the contamination from the former reservoirs such as chemical use associated with recent homeowner surface use activities (lawn care, vehicle maintenance). Finally, PAHs were not selected because of the likely release of PAHs and subsequent shallow soil deposition of PAHs from airborne contaminants associated with vehicle exhaust (especially diesel trucks) from nearby street traffic and/or refineries.

Shell Investigations indicate that TPHd patterns demonstrate that deep contamination is found primarily at the edges of the reservoirs at the sidewall/floor joint and generally, there is less soil impact beneath the interior portions of the reservoir floors. TPHd impacts in other areas of the Subject Property are fairly shallow and attenuate relatively quickly with depth.

Groundwater data from Shell Investigations indicate that the source of the groundwater impacts detected beneath the Subject Property were impacts located beneath the edges of each of the three reservoirs. The contribution of other onsite sources to groundwater impacts are minor and secondary to these larger impacts. This groundwater data further supports the conclusion that the largest petroleum hydrocarbon releases at the Subject Property occurred beneath the edges of the former reservoir floors.

8.3 Opinion 3 - Groundwater Impacts Mirror the Deep Soil Contamination Found on the Subject Property

Groundwater impacts primarily exist near the perimeter areas of the former oil reservoirs in a pattern similar to the deep soil contamination detected at the former reservoir edges beneath the Subject Property. The greatest impacts are observed along (i) the western perimeter of Reservoir 5, (ii) the northern perimeter of Reservoir 7, and (iii) the western perimeter of Reservoir 6. Shell Investigations for groundwater show that fairly significant leaks occurred from the northern edge of Reservoir 7 and along the western edge of Reservoir 6, resulting in dissolved phase hydrocarbons plumes from soil contamination migrating all the way to groundwater. These impacts resulted from Shell's historic operation of the reservoirs at the Subject Property.

8.4 Opinion 4 - There Is No Evidence that Barclay Released Any Chemicals on the Subject Property

As the site developer, Barclay did not store oil or other petroleum hydrocarbons on the Subject Property. Prior to Barclay coming onto the Subject Property, all oil and petroleum hydrocarbon storage and transfer operations by Shell had ceased and Reservoirs 5 and 6 were clean and empty.

Shortly after coming onto the site and prior to becoming the property owner, Barclay removed all liquids and other petroleum hydrocarbon materials from Reservoir 7 and shipped the removed hydrocarbon materials to an offsite disposal facility. The petroleum hydrocarbon materials removed from Reservoir 7 were thick, tarry, and semi-solid. Because of their physical state, it is unlikely that any of these materials were released to the subsurface below Reservoir 7 during the short period they remained in Reservoir 7 prior to removal by Barclay because of the underlying water layer; high viscosity and lack of hydraulic head.

Deposition testimony by Mr. Bach indicates that there may have been small releases of hydrocarbons contained within pipes removed by Barclay during site development. These small releases were immediately contained and any impacted soil was collected and sent offsite for disposal. In fact, any soil that was encountered that had undesirable characteristics, including potential petroleum hydrocarbon contamination, was removed from the Subject Property and shipped offsite for disposal. Development activities conducted by Barclay did not result in the release of any chemicals rather, in fact, resulted in the removal of petroleum hydrocarbons left onsite by Shell's historical activities that were discovered by Barclay during grading and other site development activities.

8.5 Opinion 5 - Residual Petroleum Hydrocarbon Materials Left Onsite by Shell and "Explicitly-Known" to Barclay Were Disposed of Offsite by Barclay and Included Residual Petroleum Hydrocarbon Materials Left in Reservoir 7 and Residual Petroleum Hydrocarbons at the Swing Pit Area

Barclay's "explicitly-known" residual petroleum hydrocarbons are limited to (i) residual petroleum hydrocarbon materials left by Shell in Reservoir 7, (ii) minor petroleum hydrocarbons in soil beneath Reservoir 6, and (iii) instances where contaminated soil was discovered on other portions of the Subject Property besides the reservoirs during site grading and development activities. Residual oil materials left in Reservoir 7 were cleaned up and taken offsite prior to Barclay taking title to the Subject Property. Minor petroleum hydrocarbons beneath Reservoir 6 were not disturbed by Barclay and a minimum of 7 feet of clean soil was placed on top of the former reservoir floors during development. Any soil with petroleum hydrocarbons discovered during site grading and development activities was removed by Barclay and sent offsite for disposal. "Explicitly-known" residual petroleum hydrocarbons were not disturbed or spread by

Barclay during property demolition, site grading, and other site development activities. Residual petroleum hydrocarbons that are the subject of regulatory requirements under Shell's Current CAO were not "explicitly-known" or spread by Barclay.

8.5.1 Residual Petroleum Hydrocarbon Materials Left in Reservoir 7 Were Cleaned Up and Disposed of Off-Site by Barclay Prior to Taking Title of the Subject Property

Documentation from Shell and deposition testimony demonstrates that residual petroleum hydrocarbon materials were not present in Reservoirs 5 and 6 when Barclay entered the site. These reservoirs were clean prior to Barclay entering the property.

Residual petroleum hydrocarbon materials left in Reservoir 7 were cleaned up and disposed of off-site by Barclay prior to Barclay taking title to the Subject Property. Internal letters by Shell Refinery Management personnel to Shell Land Management personnel confirm this fact and verify that no oil products were left in any of the reservoirs which could potentially impact soil at the Subject Property.

In addition, deposition testimony indicates that residual oil materials removed from Reservoir 7 were sent offsite for disposal. Therefore, residual petroleum hydrocarbon materials left in Reservoir 7 were never mixed with soil that was used during site demolition, grading, or other activities conducted by Barclay.

8.5.2 Oily Soil Encountered by Barclay During Grading and Development Activities Was Hauled Off-Site for Disposal

There is deposition testimony from eyewitnesses that indicate that whenever oil-saturated soils were encountered, those materials were hauled off the Subject Property. There is evidence from Mr. Bach, Mr. L. Vollmer, and County Inspectors that indicate unsuitable materials were not allowed to stay onsite and were, in fact, disposed of offsite.

The County Inspectors used inspection forms to document their observations indicating that materials unsuitable for fill were tracked until they were removed from the property. A County of Los Angeles Supervised Grading Inspection Certificate for Tract No. 28441 was signed by inspector William Berg on March 6, 1968 and included the following handwritten note:

> **"Remove all uncompacted stock pile material on lots 1 and 2-Not Approved."**
> (Emphasis added.)

A later handwritten note by inspector William Cook dated November 7, 1968 states:

> **"Uncompacted fill materials removed Lots 1 and 2 approved."** (Emphasis added.)

This eyewitness testimony indicates that no visible petroleum hydrocarbons from other areas of the Subject Property outside the reservoirs were left on the Subject Property by Barclay. Barclay's "explicit-knowledge" at that time indicates all petroleum hydrocarbons encountered outside the reservoirs were removed offsite for disposal and Barclay had no "explicit-knowledge" that any petroleum hydrocarbons were left onsite.

8.6 Opinion 6 - Residual Petroleum Hydrocarbon Materials in Reservoir 7 Did Not Impact the Site Between the Time Barclay Entered the Subject Property and the Time Those Materials Were Removed

When Barclay first entered the Subject Property, Reservoir 7 contained water and a thick, viscous, tarry, semi-solid petroleum hydrocarbon material that was floating on top of the water. The ability of this tarry material to migrate through cracks and into soil was severely limited by its high viscosity and semi-solid state. In addition, the hydrocarbons were separated from the bottom of the reservoir by a layer of water until the last 3 months before water and hydrocarbon removals were completed. Further, the reservoirs had been used for decades of service with a dramatically higher hydraulic head while the reservoirs were full, therefore the downward pressure had been greatly decreased by the low volume of materials in Reservoir 7 during the time Barclay was onsite. There is little to no chance that petroleum hydrocarbon materials from Reservoir 7 added to contamination at the Subject Property after Barclay entered the site.

8.7 Opinion 7 - Barclay Adequately Ripped the Concrete Floors of the Former Reservoirs

PSE performed four subsurface drainage studies for the three reservoirs at the Subject Property to evaluate the feasibility of ripping the concrete reservoir floors for drainage and leaving them in-place. The studies included an evaluation of the soils with respect to water drainage beneath Reservoirs 5, 6, and 7, and a percolation test of the ripped floor. Based on these studies PSE concluded that leaving the existing concrete floor in-place and ripping it to provide proper water drainage would be feasible.

Prior to starting the backfilling of Reservoirs 5 through 7, the concrete was ripped up in accordance with PSE recommendations and the approved grading plan. This ripped floor remained in place as the first backfill layer.

The engineering requirement for concrete as described in grading plans is:

> **"the concrete slabs shall be rolled with heavy equipment or otherwise treated so as to crack the slabs for purposed of drainage and compaction."** (emphasis added)
>
> *******
>
> **"Concrete to be removed shall be broken up into 1500 square foot pieces with a ripping tooth or equivalent."** (emphasis added)

All accounts by Barclay personnel, grading contractors, geotechnical engineers, and County Inspectors indicate that the concrete ripping and burial was conducted in accordance with the approved grading plan and the recommendations of PSE.

Shell's environmental consultant, URS, further substantiates that Barclay adequately ripped the concrete floors of the former reservoirs. URS concluded "[l]ack of evidence of significant ponding of water indicates that the reservoir base perforations provide for percolation of infiltrating precipitation and irrigation water. The URS report states: “This conclusion is based on observations from more than 2,400 borings during residential investigations that wet soil conditions are limited in areal extent and rarely exceed 1 foot in soil column height above the concrete.”

8.8 Opinion 8 - Minor Amounts of Residual Petroleum Hydrocarbons Beneath the Reservoir Floors Left Onsite by Shell and “Explicitly-Known” to Barclay Were Not Disturbed by Barclay

Soil with minor amounts of residual hydrocarbons was identified in geotechnical borings performed by PSE beneath Reservoir 6. The soil descriptions provided in the soil classification logs describe the soil as stained to oily, or having a petroleum odor. The soil classification descriptions by PSE do not indicate that large amounts of contamination or free phase product existed under the former reservoir floors at the locations tested.

The report concludes:

> **“The laboratory results show that even though the soils are oil stained they are still permeable.”** (emphasis added)
>
> ***
>
> **“Based on these calculations utilizing the lowest permeability value obtained from the laboratory results, it is considered that the available drainage area is sufficient to handle all expected percolating water.”** (emphasis added)

In addition, hydraulic conductivity testing on stained soil samples conducted by PSE demonstrated significant water conductivity providing additional evidence that the soil porosity was not filled with residual hydrocarbons. PSE reports describing geotechnical studies performed in Reservoirs 5 and 7 did not report observations of petroleum hydrocarbons.

Permeability test results indicate that the sample noted as “slightly oily” had the lowest permeability and the sample noted as “oily” had a permeability 2 orders of magnitude higher meaning, the oily sample was more permeable than the slightly oily sample. The results demonstrate that the “explicit-knowledge” Barclay had of hydrocarbons beneath the reservoirs are minor concentrations that did not impede drainage.

A large-scale permeability test was performed by PSE to “justify the calculations” presented in PSE’s March 11, 1966 report as documented in a report dated September 20, 1966. An earthen berm was constructed in Reservoir No. 6 to isolate an area measuring 25 feet by 30 feet so that one foot of water could be ponded above the ripped reservoir floor. Two ripped trenches that were one-foot wide and 30-feet long were located within the 25-foot width of the bermed test area (indicating that the distance between the ripped trenches was 23 feet or less). At the end of 42 hours, the level of water had dropped 3.5 total inches. PSE used these results in calculations to estimate the amount of water that could percolate through the ripped concrete floor and concluded:

> **"this indicates that drainage should not be a problem in the development of this parcel."** (emphasis added)

These test results indicate that oil-stained soil beneath Reservoir 6 did not contain enough oil to interfere with soil permeability or the downward percolation of water. Had there been a significant amount of petroleum hydrocarbons in the soil, permeability would have been greatly reduced by oil filling the soil pores.

Deposition testimony by Mr. A. Vollmer indicates that he did not see hydrocarbon contamination in soil disturbed by ripping the floors in Reservoirs 5 and 6. Mr. A. Vollmer was an equipment operator employed by Vollmer Engineering who worked in Reservoirs 5 and 6 and who performed ripping of the concrete floors and movement of soil from the berms into the reservoirs as fill and completed grading and compaction in the reservoirs.

Stained soil under Reservoir 6 was not disturbed by Barclay and a minimum of 7 feet of clean soil was placed on top of the former reservoir floors during development. These residual petroleum hydrocarbons were not disturbed or spread by Barclay during property demolition, site grading, and other site development activities. Therefore, Barclay's "explicit-knowledge" consisted of its observation of minor amounts of petroleum hydrocarbons beneath the floor of Reservoir 6. Residual petroleum hydrocarbons that are the subject of required regulatory actions under Shell's Current CAO were not disturbed or spread by Barclay.

8.9 Opinion 9 - There Is No Evidence that Berm Soils Were Impacted with Petroleum Hydrocarbons When Barclay Used Berm Soil to Fill in the Reservoirs

There is no evidence which demonstrates that soil within the berms was contaminated with residual petroleum hydrocarbons. All accounts by Barclay personnel, grading contractors, and the geotechnical engineers indicate that no residual petroleum hydrocarbons were observed during site demolition, grading, or other activities conducted by Barclay. Testing performed by Barclay indicates that no petroleum hydrocarbons were reported in berm soils based on a PSE report dated January 7, 1966[438] and testimony by Mr. Bach[439] and Mr. A. Vollmer.[440] No reports or inspection logs prepared by onsite County Inspectors document the presence of petroleum hydrocarbons in the berm soils used to fill the reservoirs.

In addition, at the time of the development, County Inspectors were primarily concerned with the soil column's ability to drain water properly. All soil testing was performed to evaluate the drainage and load-bearing properties of the soil. Testing for potential petroleum hydrocarbons in berm soil was simply not an issue and analytical test methods for evaluating petroleum hydrocarbons in soil were not available in the mid-1960s. Thus, no petroleum hydrocarbon

[438] Pacific Soils Engineering, Inc. 1966. *Preliminary soils investigation on Tract No. 24836 in the County of Los Angeles, California.* January 7. p. 2. (CAR 2)
[439] Bach, G. 2013. *Volume I Videotaped Deposition of George Bach.* March 7. p. 144:9-148:17
[440] Vollmer, A. 2014. *Videotaped Deposition of Alfred Vollmer.* January 14. p. 44: 3-25.

testing was performed on the berm soil, although soil was examined for classification purposes by PSE. Therefore, Barclay had no “explicit-knowledge” of petroleum hydrocarbons in the berm soil at the Subject Property and all evidence supports this conclusion.

8.9.1 Visual Inspection of the Berm Soil During Development Activities Did Not Reveal Any Residual Petroleum Hydrocarbon Contamination

During site grading activities, equipment operators, geotechnical engineers, and County Inspectors observed soil from the berms being placed into the former reservoirs and other low points within the Carousel tract in 6-12 inch lifts. According to deposition accounts by equipment operators and Barclay’s engineer, no staining, no odors, and no residual petroleum hydrocarbon contamination were observed. The geotechnical engineers did not document oil or staining of berm soils in geotechnical reports. No reports or inspection logs prepared by onsite County Inspectors document the presence of petroleum hydrocarbons in the berm soils used to fill the reservoirs.

8.9.2 Testing of Berm Soil for Soil Contamination was Not Required or Ordered by Government Agencies at the Time of Development

At the time of the development, County Inspectors were primarily concerned with the property’s ability to drain water properly. All soil testing was performed to determine whether the soil would drain properly. Potential residual petroleum hydrocarbon contamination was simply not an issue.

No soil contamination testing activities were ordered or required for the berm soil by any government agency. The LA County Building and Planning Department was involved in geotechnical and drainage testing at the Carousel development; however, they never ordered any soil contamination testing. No soil contamination testing was performed on the berm soil by Shell, Barclay, or any public agency.

In the 1966 to 1970 timeframe, no environmental regulations required testing of the berm soil. During this timeframe, neither the California EPA nor any other local or state environmental agencies existed. Although the predecessor agency to the current RWQCB did exist, WDR’s did not exist for placement of potentially contaminated materials on land.

In the 1966 to 1970 timeframe, residual petroleum hydrocarbons were not thought to be toxic or harmful to human health or the environment. During this time period, the soil would not have been characterized to determine whether it was impacted by residual petroleum hydrocarbons. Soil testing and characterization were generally limited to geotechnical considerations like soil drainage, soil compaction, soil types, and engineering competency.

8.10 Opinion 10 – Contamination "Explicitly-Known" to Barclay Was Not Present at Other Features on the Subject Property or If Found Was Taken Offsite for Disposal

Other historical features of potential environmental significance included two sumps, several ponds, pipelines, the pump house and surrounding area, and the swing pipe pit. Based on a review of the depositions of Mr. Bach, Mr. L. Vollmer, and Mr. A. Vollmer, who were onsite during the grading and development of the property, there was little evidence of these features remaining when Barclay initiated the development of the property. Where features were still present, no surficial contaminated soil was observed.

Barclay did have knowledge of small amounts of petroleum hydrocarbons in pipes and pipelines within the swing pit area. During pipeline removal, some oil from pipelines was released to the soil; this oil and any impacted soil resulting from oil that spilled from those pipes was removed and disposed of offsite by Barclay. Soil within the swing pit area that may have had some oil was also removed and disposed of offsite by Barclay.

Based both on deposition testimony and aerial photograph review, ponds and sumps were reworked and/or filled in before Barclay entered the Subject Property. Shell Investigations indicate that petroleum hydrocarbons are present in the sump and pond areas at depths that were not observed by Barclay. These petroleum hydrocarbons were left onsite by Shell and were not accessed or visible to Barclay who did not remove or disturb them. Therefore, no petroleum hydrocarbon contamination was "explicitly-known" to Barclay at other features on the Subject Property that was not taken offsite for disposal.

8.11 Opinion 11 - Upward Chemical Migration Was Discovered at Shell Reservoirs 1 & 2

During the 1990s, Shell Reservoirs 1 and 2 were decommissioned by Shell in a manner similar to how Barclay decommissioned Reservoirs 5, 6, and 7. Soil was placed into former Shell Reservoirs 1 and 2 in 6-inch lifts which were homogenized in place and then compacted prior to the placement of the next 6-inch lift. During this process, no free product or residual hydrocarbon saturated soil was reported. At the time of project completion these berm fill soils were documented to be free of liquid petroleum hydrocarbons. Berm soil around Reservoir 1 had an average concentration of petroleum hydrocarbons (C_{13} to C_{22}) of 2,248 mg/kg and ranged from non-detect to 7,400 mg/kg. Berm soil around Reservoir 2 had an average concentration of petroleum hydrocarbons (C_{13} to C_{22}) of 1,366 mg/kg and ranged from non-detect to 8,400 mg/kg.

Within one year of the completion of the demolition and decommissioning of Reservoirs 1 and 2, Shell observed residual petroleum hydrocarbons migrating to the surface around the edge of the cap. To reach the surface, the contaminants had to migrate from deeper contamination upward and around the cap on the surface. Based on Shell's testing and construction process, it must be concluded that the source of residual hydrocarbons that migrated upward is from the contaminated soil beneath the former reservoirs.

The resultant upward migration pattern of petroleum hydrocarbons observed at Shell's former Reservoirs 1 and 2 are almost identical to those observed at Shell's former Reservoirs 5 through 7 at the Subject Property.

8.12 Opinion 12 – Both Shell and the RWQCB Were Familiar with the Decommissioning Activities at Shell Reservoirs 1 and 2, and the Associated Upward Migration of Chemicals through the Fill

The RWQCB involvement in this Shell project to decommission Shell Reservoirs 1 and 2 spanned the time period from March 1994 to August 1997. During this time period the RWQCB reviewed numerous site characterization documents and status reports, and reviewed and approved all of Shell's site remediation and mitigation workplans. The RWQCB was involved in the initial site characterization, decommissioning, backfilling, soil compaction and capping of Reservoirs 1 and 2, as well as the upward hydrocarbon migration at the cap edges and Shell's additional efforts for soil removal, soil treatment and cap extension.

As early as 1996, the RWQCB was informed that petroleum hydrocarbons in soil were migrating upward. The RWQCB requested a workplan to mitigate the issue and approved the proposed solution which involved:

- Removal of soil at the perimeter of the existing clay cap. The removal was, at a minimum, 37 feet laterally beyond the existing cap and 2 to 4 feet deep.
- Excavation beyond the minimum dimensions listed above also included soil which contained residual liquid petroleum hydrocarbons or were wet with hydrocarbons.
- Thermal treatment of excavated soil.
- Extending the existing clay cap 37 feet.
- Placing thermally treated soil over the clay cap for drainage control.

Upward migration (seepage) of hydrocarbons occurred as a result of the reservoir closure activities performed by Shell and approved by the RWQCB. In fact, it is obvious that after 1997, upward migration of hydrocarbon contamination in this setting is a phenomenon with which both Shell and the RWQCB were and are still familiar.

8.13 Opinion 13 – The Pattern of Migration of Petroleum Hydrocarbons at the Subject Property is Upward Migration and is Similar to Upward Chemical Migration Found at Shell Reservoirs 1 and 2

The contamination profile at former reservoirs on the Subject Property show an upward migration pattern where the highest concentrations of TPHd are depths beneath the former reservoir floors, and where concentrations are lower in shallower soil samples (a "bottom-up" contamination pattern) that originates from the contamination left beneath the former reservoirs by Shell. The depth of the highest TPHd concentrations was generally below the floors of the former reservoirs (in the soil left in place by Shell) and this soil was not disturbed by Barclay. In addition, the highest concentrations and largest areas of shallow soil impact (from upward migration) are observed in locations above the perimeters of the reservoir floors, in the areas of highest TPHd concentrations where significant deep soil impact was found beneath the former reservoir floors.

Waterstone examined four potential backfill scenarios to explain the contamination pattern exhibited at the Subject Property. The result of my examination of these scenarios indicates upward migration of petroleum hydrocarbons is the only plausible explanation for the contamination pattern currently observed on the Subject Property. This upward migration pattern of petroleum hydrocarbons is similar to the pattern observed and documented as a result of upward migration of residual petroleum hydrocarbons from beneath Shell's Reservoirs 1 and 2.

This same upward migration pattern was documented at Shell Reservoirs 1 and 2 where the highest petroleum hydrocarbon concentrations were detected in the deepest samples and were located at the perimeter of the reservoir floors. The contamination concentrations decrease in soils from shallower depths in the soil column as a result of upward migration of the residual petroleum hydrocarbons that remained (i) beneath the former reservoir floors and (ii) in the unexcavated portions of the reservoir berms.

The initial reservoir backfilling compaction and capping project was expected to be a final remedy to the reservoir demolition and dismantling. However, after the initial project was completed, hydrocarbon seepage at the surface originating from deeper contaminated soil was observed at the surface around the clay cap. After surface seeps were noted, Shell consultants observed veins of free product and associated residual hydrocarbon-saturated soil in the former berm soil used to fill the former reservoirs. The table below shows that after upward migration of contamination was observed at Shell Reservoirs 1 and 2 that significantly more samples described as "wet with hydrocarbons" existed at depth than at the surface.

Reservoir	Depth (ft. bgs)	Total Number of Samples	Number of Wet Samples	Percent Wet
Reservoir 1	2	50	3	6%
	5	40	10	25%
	8	20	7	35%
Reservoir 2	2	60	3	5%
	5	48	16	33%
	8	24	13	54%
Both Reservoirs	2	110	6	5%
	5	88	26	30%
	8	44	20	45%

The resultant upward migration pattern of petroleum hydrocarbons observed at Shell's former Reservoirs 1 and 2 are similar to those observed at Shell's former Reservoirs 5 through 7 at the Subject Property.

8.14 Opinion 14 – Similarities in the History, Decommissioning, Backfill, and Contamination of Reservoirs 1, 2, 5, 6, & 7 Provide Support for Upward Contaminant Migration in Reservoirs 5, 6, & 7

Shell operated the Wilmington Refinery on a large tract of land located about 1 mile east of the Subject Property. Shell Reservoirs 1, 2, 3, and 4 were located at the Wilmington Refinery and were used along with the Subject Property Reservoirs 5, 6, and 7 to provide a large storage capacity for Shell's refinery needs. All seven reservoirs were constructed at the same time during 1923 and have very similar construction. A notable difference is that Shell operated Reservoirs 1 and 2 for 68 years compared to approximately 36 years for Reservoirs 5, 6, and 7 at the Subject Property.

Shell Reservoirs 1 and 2 were decommissioned in the mid-1990s using a procedure very similar to Barclay's procedure for decommissioning Reservoirs 5, 6, and 7. Soil sampling and analytical data collected during Shell's decommissioning of Reservoir's 1 and 2 indicate the same upward migration pattern of contamination that originated from leakage of petroleum hydrocarbons beneath the reservoir floors as that known to exist at the Subject Property. Following is a summary of the similarities between the Shell's Reservoirs 1 and 2 and the Subject Property Reservoirs 5, 6, and 7:

- The reservoirs were constructed at the same time and in the same way.
- Berm soil showed no free phase hydrocarbons during decommissioning.
- Soil beneath the floor showed no free phase hydrocarbons prior to decommissioning.
- The largest petroleum hydrocarbon releases are at the perimeter of the floors at the sidewall/floor joint.
- There is less impact beneath the interior of the floors at distances that are further from the perimeter of the floors.
- Hydrocarbons have seeped to the surface from contaminated soil below the former floors of the reservoirs.

Shell's data for Reservoir's 1 and 2 indicate the same upward migration pattern of contamination that originated from leakage of petroleum hydrocarbons near the sidewall/floor joint as that known to exist at the Subject Property.

8.15 Opinion 15 – The Soil Contamination Data Collected within the Former Reservoirs Is Consistent With the Upward Chemical Migration Scenario and Does not Support the Hypothetical Downward Migration Scheme

Two of the soil contaminant patterns evaluated for the Subject Property were validated by soil analytical data from Shell Investigations, and included a bottom-up migration pattern within the former Reservoirs 5 through 7 and a top-down migration pattern within the former main sump, the pump house, and the area surrounding the pump house. These contaminant patterns were as follows:

- **Bottom-up Migration Within the Former Reservoirs** - Residual petroleum hydrocarbons found in the soil above and near to the former floors of Reservoirs 5, 6, and 7 is a result of the upward migration of residual petroleum hydrocarbon contamination beneath the former reservoirs.
- **Top-down Migration Outside the Former Reservoirs -** Top-down migration was observed within the the former main sump east of Reservoir 5 and within the pump house and area surrounding the pump house.

It is evident from reviewing Geosyntec's maps of shallow soil impact (at depths of 2', 5' and 10' bgs) within the footprints of the former reservoirs that the degree of soil contamination increases with depth from the surface to the 10-foot depth or depth of refusal. Based on Waterstone's Figures 44 and 45, which uses data from Shell Investigations to show the soil impact immediately above and below the floors, the depth of highest soil impact is below the floors of the reservoirs. The highest concentrations and largest areas of shallow soil impact are concentrated at the perimeters of the reservoir floors, which is consistent with the areas of highest concentrations and areas where significant deep soil impact is found. Much less significant petroleum hydrocarbon soil impact was found in the central portions of the reservoirs.

Based on Shell Investigation soil data for samples collected both above and below the reservoir floors of Reservoirs 5, 6, and 7, the contaminant pattern observed indicates that the highest concentration of petroleum hydrocarbons is detected just beneath the reservoir floors near the perimeters, these concentrations decrease with depth and attenuate rather quickly due to the retentive capacity of the soil for crude oil, and the concentrations decrease upward through the ripped reservoir floors into the clean fill illustrating a pattern where contamination is drawn upward into the clean fill material by capillary forces. Scenario 3, where reservoirs where backfilled with clean berm soil, is the only scenario of those described that matches the contaminant patterns observed both below and above the reservoir floors of Reservoirs 5, 6, and 7.

These contamination patterns indicate that the bottom-up contamination pattern of petroleum hydrocarbons within former Reservoirs 5 through 7 can only be explained by upward migration of Shell's residual petroleum hydrocarbons from beneath the former reservoirs floors into the clean berm soil placed in the former reservoirs by Barclay during development activities. The top-down contamination patterns observed at the former main sump, the pump house and the area surrounding the pump house, coupled with the grading record for the Subject Property, indicate that the petroleum hydrocarbons in these areas were the result of Shell's historic operation at the Subject Property and they were not visible to, or disturbed by, Barclay.

8.16 Opinion 16 - The Backfill and Compaction Procedure Used by Barclay in Former Reservoirs 5 through 7 Would Make It Impossible to Create the Pattern of Contamination that the Data from Shell Investigations Shows

The soil was bulldozed downward from the top of the berms and placed into the reservoir in layers with equipment that mixed and homogenized the soil as it is was being placed into the reservoir. The data from Shell's Investigations shows contamination in the shallow fill soil aligned in columns that do not show the random patterns that would be expected with mixing; instead, the pattern of contamination that exists shows higher concentrations of TPHd near the concrete floor of the former reservoir and gradually lesser amounts of TPHd found in the soil closer to the surface (bottom-up contamination).

If any petroleum hydrocarbon contamination was present in the berm soil, it would have been placed randomly in the reservoir as there would be no way for operators to create those patterns by design. In order to create the existing contamination pattern, it would have been necessary to decide which soil was contaminated, the degree of contamination, and thus the appropriate burial depth or location within the reservoir. The only way the observed pattern of contamination could have occurred naturally is if the source came from the bottom and migrated upward. Because soil was placed in the reservoirs in lifts, creating the observed bottom-up pattern in all three reservoirs assumes a level of knowledge, skill, and desire by the operators during the 1960s for which there is no known motivation or evidence. In other words, the observed pattern could not possibly occur if the berm soil had been contaminated before Barclay began spreading it.

8.17 Opinion 17 - Concerns and Issues Raised by the RWQCB Staff Were Addressed

Waterstone evaluated concerns raised by the RWQCB staff based on their interpretation of the soil contamination data and the operation of contaminant transport mechanisms they believe primarily affect the direction in which contaminants have migrated in the subsurface. These items include (i) the effect of the concrete reservoirs floors and (ii) infiltration and washing/leaching of contaminants in the vadose zone. In addition, Waterstone compared the areas of the Subject Property where the typical contamination profiles for top-down contamination are evident to the contamination profiles observed inside the perimeter of the former reservoirs. This comparison showed that upward chemical migration is occurring inside the perimeter of the former reservoirs.

Based on this comparison, it was concluded that the presence of the ripped former concrete reservoir floors had no discernible impact on the vertical migration of contaminants or the vertical profile of contaminants within the former reservoirs of the Subject Property; that the presence of landscaped areas or local irrigation had no discernible impact on the vertical profile of contamination at the Subject Property; that the presence of surface caps such as sidewalks or streets had no discernible impact on the vertical profile of contamination at the Subject Property; and that the only plausible explanation for vertical contaminant profile documented within the former reservoirs is the upward migration of petroleum hydrocarbons into the clean reservoir fill soil from residual petroleum hydrocarbons which remained beneath the former reservoirs floors due to Shell's historic operations at the Subject Property.

8.18 Opinion 18 – There Are Well Documented Technical Explanations for Upward Chemical Migration

Upward migration of petroleum hydrocarbons in the subsurface is not a new or novel concept. It can occur in a number of ways. First, in the vadose zone or unsaturated zone, upward migration of fluids (including both water and hydrocarbons) is primarily driven by capillary action within the soil pores. This concept is no different than the well documented and understood capillary action observed in the vadose zone above the water table, referred to as the capillary fringe. In a similar manner to water being transported upward above the water table within the capillary fringe, petroleum hydrocarbons that originated from a release into the vadose zone can migrate both laterally and upward by this same capillary action within the unsaturated soil column.

Capillary action is the ability of a liquid such as water or oil to flow into pore spaces within the unsaturated or vadose zone of the subsurface without the assistance of, and in opposition to, external forces such as gravity. Movement of the fluid occurs because of intermolecular forces between the liquid and the surrounding solid soil surfaces. Capillary action is responsible for moving fluids such as water, pure hydrocarbons, and/or oil in the unsaturated zone from "wet" areas of the soil to "dry" areas.

Second, within a water-saturated environment, petroleum hydrocarbons, if present, will float upward to the top of the water table since they are less dense than water and also insoluble. The main mechanism for this type of transport is buoyancy forces causing the petroleum hydrocarbons to migrate upward through the water column.

Third, in a pressurized environment, compressed hydrocarbon fluid will migrate from the area of high pressure towards areas of low pressure. This is one of the common driving forces for natural petroleum seeps such as those that occur at the La Brea Tar Pits and have been common place throughout California where there are thousands of documented naturally occurring seeps.

8.19 Opinion 19 - Other Shell Sites Exhibiting Upward Chemical Migration Exist in Southern California

Besides discovering upward chemical migration at Reservoirs 1 and 2, Shell has experienced upward chemical migration at a number of other locations on two of their properties in Carson, California. These other Shell sites are well documented inactive disposal sites in the Shell Wilmington Manufacturing Complex (WMC), Dominguez and Wilmington Sections, which are in close proximity to the Subject Property and have similar soil types to the Subject Property. The petroleum hydrocarbon contamination that seeped vertically upward to the surface at these

Shell sites, mostly as tar seeps was, again, similar in nature to the hydrocarbon contamination found at the Subject Property.

At the Shell WMC Dominguez Section, upward chemical migration was found at the Inactive Disposal Site D1, Inactive Disposal Site D2, Inactive Disposal Site D3, Inactive Disposal Site D5, Inactive Disposal Site D6, and Inactive Disposal Site D7. At the Shell WMC Wilmington Section, upward chemical migration was also found at the Inactive Disposal Site W1. Thus, Shell has intimate knowledge regarding the existence of upward chemical migration and situations promoting upward chemical migration.

8.20 Opinion 20 - Other Non-Shell Case Studies Exhibiting Upward Chemical Migration Exist in Southern California

There are numerous examples of sites in Southern California where upward migration of petroleum hydrocarbons has been demonstrated. Three examples of local sites where upward migration of petroleum hydrocarbons occurred after filling in excavations and burying residual hydrocarbons are: (i) the Ralph Gray Trucking Co. site, (ii) the Mt. Poso Tank Farm, and (iii) the McColl Landfill site. Two of the three sites (Ralph Gray Trucking Co. site and the McColl Landfill site) are USEPA Superfund Sites and one site (Mt. Poso Tank Farm) is a DTSC site. All three of these cleanup sites provide examples of documented upward petroleum migration where petroleum hydrocarbons migrated up through clean fill soils all the way to the surface.