ZONE 1 SOIL VAPOR EXTRACTION

SYSTEM OPTIMIZATION WORK PLAN

HARTFORD PETROLEUM RELEASE SITE

HARTFORD, ILLINOIS

July 25, 2014

Project #: 24S-007-001

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1.0 INTRODUCTION

Apex Oil Company, Inc. (Apex) submitted a technical memorandum to the United States Environmental Protection Agency (USEPA) on January 14, 2014 describing in-home and regional effectiveness monitoring results collected from structures and monitoring locations in Zone 1 of the soil vapor extraction (SVE) system at the Hartford Petroleum Release Site (Hartford Site) in Hartford, Illinois (Figure 1). This technical memorandum was submitted in response to elevated petroleum related constituents measured beneath and within several structures located on West Birch Street (including 107, 125, and 129 West Birch Street) during rapid increases in the Mississippi River stage between March and April 2013. Additional data was collected in Zone 1 between January and June 2014 as part of routine in-home monitoring, river stage triggered monitoring, as well as monthly and quarterly monitoring within select multipurpose monitoring points and nested soil vapor monitoring probes installed along West Birch and West Arbor Streets.

1.1 PURPOSE

The primary objective of the additional in-home and SVE effectiveness monitoring completed between January and June 2014 is to: (1) assess soil vapor conditions in Zone 1 of the Hartford Site, (2) determine the effectiveness of the existing SVE wells installed on West Birch and West Arbor Streets, and (3) evaluate expansion and optimization of the SVE system in this portion of Zone 1. Expansion and optimization of the SVE system along West Birch and West Arbor Streets will be an important input for development of the Multiphase Remedy Framework. Data collected following installation and operation of the additional SVE wells described herein will provide a baseline understanding for future optimization of the SVE system in Zone 1 and other portions of the Hartford Site.

1.2 BACKGROUND

Three refineries were constructed around the Hartford Site between 1907 and 1941, the Amoco Oil Refinery (currently the British Petroleum facility), the Clark Oil Refinery (currently the Premcor facility), and the Shell Oil Refinery (currently the Phillips66 facility). In addition, a bulk petroleum storage facility was constructed north of the Village of Hartford (currently the Hartford Wood River Terminal Oil Company facility). Refining, storage and transport of petroleum hydrocarbons continues to be conducted around the Village of Hartford associated with portions of these refineries. In addition, numerous underground and aboveground petroleum pipelines connected the refineries to the bulk storage terminal, loading and unloading facilities located on the Mississippi River, and to other entities. Numerous releases of petroleum hydrocarbons have been documented within or immediately adjacent to Hartford.

Since the mid-1960s, odor issues have been reported in structures located within the limits of the Hartford Site. Beginning in 1978, detailed records of the odor complaints and associated acute health risks were maintained following

a series of residential house fires believed to be attributed to volatile petroleum hydrocarbons associated with releases from the refineries. Twenty-two fires are believed to have been caused by migration of volatile petroleum related constituents into the basements of structures (commonly referred to as vapor intrusion) at the Hartford Site. The last reported fire attributed to vapor intrusion at the Hartford Site occurred in May 1990.

1.2.1 INTERIM MEASURES

Interim measures performed at the Hartford Site since 1978 have primarily included skimming of light non-aqueous phase liquids (LNAPL) and operation of the SVE system. As documented in prior reports pertaining to the Hartford Site, between 1978 and 2013 approximately 2.25 million gallons of LNAPL has been recovered beneath the Hartford Site with 1.3 million gallons of LNAPL recovered via skimming (USEPA 2010, Gannett Fleming 2013e) and another 0.95 million gallons via operation of the SVE system (URS 2014a).

1.2.1.1 LNAPL SKIMMING

In 1978 and 1979, Clark Oil installed two large diameter groundwater production wells (RW-001 and RW-002) at the Hartford Site for the purpose of skimming LNAPL from the shallow portions of the smear zone in the Main Sand stratum. Between 1978 and 1990, LNAPL skimming was performed within these two production wells, with the exception of a period between 1983 and 1984 when operations were temporarily ceased. Approximately 1,162,000 gallons of LNAPL were recovered from these two wells through 1990. Recovery rates of LNAPL during skimming ranged from approximately 1,000 to 29,000 gallons per month (USEPA 2010).

An additional production well (RW-003) was installed at the Hartford Site by Premcor in 1993. From January 1994 through September 2002, Premcor reportedly recovered an additional 82,700 gallons of LNAPL from the three production wells (USEPA 2010). Beginning in 2004, a consortium of oil companies (referred to as the Hartford Working Group) including Premcor, Shell, British Petroleum, and Sinclair Oil Corporation began managing interim measures, including LNAPL skimming. In 2004, the Hartford Working Group installed three additional wells (RW-004, RW-004A, and RW-005) for the purpose of LNAPL recovery. Approximately 18,000 gallons of LNAPL were recovered via skimming activities between 2004 and 2009. Since 2009, an additional 21,000 gallons of LNAPL have been recovered by the Hartford Working Group and Apex via pilot testing and routine skimming conducted within the groundwater monitoring network across the Hartford Site (Trihydro 2014b).

1.2.1.2 SOIL VAPOR EXTRACTION

The original SVE system was installed by Clark Oil & Refining Corporation (now Premcor) and operated from approximately 1992 until it was upgraded in 2005. The original SVE system consisted of 12 vapor control boreholes

(URS 2013b). The original system was replaced in three phases beginning in 2005 by the Hartford Working Group and currently consists of a network of approximately 120 vapor extraction wells connected through a series of piping and valves. Figure 2 shows the location of the SVE extraction wells and piping, as well as the SVE effectiveness zones (Zones 1 through 6) established for the purpose of evaluating the system performance.

Detailed records of hydrocarbon recovery rates have been documented for the SVE system since it was replaced by the Hartford Working Group in 2005. As shown on Figure 3, approximately 950,000 gallons of volatile petroleum hydrocarbons have been recovered through the SVE system between May 2005 and December 2013 (URS 2014a). Vapor recovery has not reached asymptotic conditions, with the highest daily recovery occurring in late 2012, as low water table conditions were observed beneath the Hartford Site

1.2.1.3 IN-HOME MITIGATION MEASURES

In-home mitigation measures have also been installed in more than 150 structures at the Hartford Site. These mitigation measures generally included one or more of the following primary measures: (1) emplacement of a low permeability vapor barrier in crawlspaces and basements (historically referred to as flowable fill), (2) installation of ventilation blower(s) within the crawlspace or basements, and (3) construction of a sub-slab depressurization system. Additional mitigation measures have been maintained within many of the structures including sealing cracks and utility penetrations in the basement floors and walls, installing combustible gas and carbon monoxide alarms, abandoning unused floor drains, reconstructing active floor drains with Dranjer® seals, and using air purifying systems (e.g., AllerAir™ 5000 Series) within the basements.

1.2.2 IN-HOME EFFECTIVENESS MONITORING

Routine in-home monitoring is currently conducted on a weekly and quarterly basis to determine if the SVE system and in-home mitigation measures are effective at preventing migration of volatile petroleum related constituents into structures present at the Hartford Site. Routine monitoring is performed within those structures where access is granted by the property owner (or tenant, if applicable) in general accordance with the *Final Interim In-Home Effectiveness Monitoring Plan* (Trihydro 2014a). Weekly in-home effectiveness monitoring is typically performed within twelve structures. Quarterly monitoring is conducted (along with inspection and maintenance of in-home mitigation systems, if present) within 44 structures. In-home monitoring includes the following activities:

- Screening indoor air for total volatile petroleum hydrocarbon (TVPH)[1] concentrations and the lower explosive limit using a flame ionization detector (FID), photoionization detector (PID), and multigas meter.
- Screening sub-slab soil vapor for pressure, TVPH, lower explosive limit, and oxygen by connecting a manometer, PID, FID, and multigas meter directly to the sub-slab probes installed within each structure.
- Additional field screening, as well as collection of sub-slab soil vapor and indoor air samples for laboratory analysis if the TVPH measured using the FID is equal to or exceeds 350 parts per million by volume (ppmv) within a sub-slab probe or is equal to or exceeds 10 ppmv in indoor air (and cannot be attributed to an ambient source within the structure).

Between September 2013 and January 2014, monthly in-home effectiveness monitoring was performed within 44 structures (same structures monitored on a quarterly basis) to further evaluate effectiveness of the SVE system. The monthly in-home monitoring events were generally conducted concurrent with SVE system effectiveness monitoring performed by the Hartford Working Group, as described in Section 1.1.3. Routine sub-slab soil vapor and indoor air screening results collected during the weekly, monthly, and quarterly monitoring events between January 2013 and June 2014 are included in Appendix A-1 and A-2, respectively.

1.2.2.1 RIVER STAGE TRIGGERED MONITORING

At times, vapor intrusion events at the Hartford Site have been correlated with a rapid increase in the Mississippi River stage and advective movement of volatile petroleum hydrocarbons associated with increasing groundwater elevations. A river stage triggered monitoring event is defined as rise of two feet in a 24-hour period when the river level at the Mel Price (a.k.a., Alton) Lock and Dam is at or above 14.5 feet (410 feet above mean sea level). Another event cannot be triggered until at least one week later, if there is a subsequent two foot rise in the river over a 24-hour period. Once an event has been triggered, field screening is performed as soon as access can be obtained, in 34 structures across the Hartford Site. Depending upon access, monitoring is typically performed every other day within each of these structures for a period of seven days. Four river stage triggered monitoring events (EBMP-15 through EBMP-18) occurred between March and June 2013. Two additional river stage triggered monitoring events (EBMP-19 and EBMP-20) occurred in April and June 2014. The following table summarizes the timeframe for each of the river stage triggered monitoring events that occurred between March 2013 and June 2014.

[1] For the purposes of this report, TVPH refers to the sum of all volatile constituents measured using a PID or FID. All figures provide the TVPH values recorded using the FID, when plotted.

River Stage Triggered Monitoring Event	Event Start Date	Event Finish Date
EBMP-15	3/11/2013	3/18/2013
EBMP-16	4/12/2013	4/19/2013
EBMP-17	4/21/2013	4/28/2013
EBMP-18	5/29/2013	6/5/2013
EBMP-19	4/4/2014	4/11/2014
EBMP-20	6/8/2014	6/15/2014

The sub-slab soil vapor and indoor air effectiveness monitoring results collected during the six river stage triggered monitoring events conducted between March 2013 and June 2014 are included in Appendix A-1 and A-2, respectively.

1.2.3 SVE EFFECTIVENESS MONITORING

SVE effectiveness monitoring is conducted on a quarterly basis by the Hartford Working Group in accordance with the *Regional Effectiveness Monitoring Plan* (URS 2013a). Effectiveness monitoring entails collecting soil vapor samples and conducting field screening within a 146 multipurpose monitoring points and nested vapor monitoring wells in each of the six SVE effectiveness zones. Pressure, TVPH, and fixed gas concentrations (oxygen, carbon dioxide, and methane) are measured using a manometer, FID, PID, and multigas meter within each of the monitoring locations. Fluid level gauging is also conducted within the multipurpose monitoring points during each event.

Effectiveness monitoring was conducted monthly in SVE Effectiveness Zones 2 through 6 between September 2013 and January 2014. Two additional monthly monitoring events were performed in Zone 1 in February and March 2014. The SVE effectiveness monitoring results recorded between September 2013 and March 2014 were provided to the USEPA on May 8, 2014 by the Hartford Working Group in a correspondence titled *Zone 1 Effectiveness Monitoring Evaluation* (URS 2014b).

In addition, Apex performed monthly SVE effectiveness monitoring in select multipurpose monitoring points and nested vapor monitoring probes installed on West Birch and West Arbor Streets between February and June 2014. Field screening included recording pressure measurements and screening soil vapor samples for TVPH, lower explosive limit, and fixed gas concentrations (oxygen, carbon dioxide, and methane) using a manometer, FID, PID, and multigas meter. In addition, testing of the competency of the bentonite seals within the nested monitoring points or vapor monitoring probes, as well as pneumatic testing to evaluate the soil gas permeability of the formation surrounding the screened interval within each monitoring location was performed during the first monitoring event in February 2014. The historical and monthly screening results for the selected multipurpose monitoring points and nested vapor monitoring probes located on West Birch and West Arbor Streets are included in Appendix B.

1.3 REPORT ORGANIZATION

The remainder of this report focuses on data collected between January 2013 and June 2014 from structures and monitoring locations along West Birch and West Arbor Streets. Additional data used to support the design of the proposed additional SVE wells in this portion of Zone 1 is also discussed within the following sections.

- Section 2.0 – Describes the results of in-home and SVE effectiveness monitoring conducted in 2013 and 2014. This section also describes the lithology and distribution of LNAPL beneath West Birch and West Arbor Streets.
- Section 3.0 – Provides a description of the design and specifications for expansion and optimization of the SVE system along West Birch and West Arbor Streets, as well as a description of contingency measures that may be installed within select structures along West Birch Street if the expanded SVE system is not effective at preventing migration of the vapor intrusion pathway during future river stage triggered events.
- Section 4.0 – Includes a summary of the monitoring results collected between January 2013 and June 2014 and recommendations for optimization of the SVE system. This section also describes future stakeholder coordination necessary to complete installation and connection of the proposed additional SVE wells into the system.

2.0 EFFECTIVENESS MONITORING SUMMARY

During river stage monitoring event EBMP-15, sub-slab and/or indoor air screening measurements from three residential structures located on West Birch Street (107, 125, and 129 West Birch Street) exceeded the sub-slab and/or indoor air threshold levels (350 and 10 parts per million by volume, respectively) requiring the collection of indoor air and sub-slab vapor samples for laboratory analysis. Two petroleum related constituents (butane and isopentane) were measured in the indoor air samples collected from these three structures at concentrations exceeding comparison values established for the Hartford Site. As a result contingency measures were implemented and Needs Assessment Reports were prepared in general accordance with the *Hartford Working Group Contingency Plan* dated March 14, 2007. Contingency measures were performed and included ventilating the indoor air and/or crawlspace beneath the structures. In addition, since operation of the existing SVE wells could not mitigate elevated TVPH concentrations measured beneath these three structures on West Birch Street, supplemental vapor recovery was performed beginning on March 15, 2013 by temporarily connecting monitoring points MP-078B, MP-078C, and MP-079C to SVE wells HSVE-23D and HSVE-26D using flexible hosing. As shown on Table 1, within one week supplemental vapor recovery was successful at reducing elevated TVPH concentrations measured beneath 107, 125, and 129 West Birch Street.

On behalf of Apex, Gannett Fleming, Inc. (Gannett Fleming) submitted Needs Assessment Reports for each of the three homes; *Needs Assessment -107 W. Birch* (April 2, 2013), *Needs Assessment-125 W. Birch* (April 12, 2013), and N*eeds Assessment-129 W. Birch* (April 8, 2013) to the USEPA and Illinois EPA. The USEPA provided a response to the Needs Assessment Reports on April 30, 2013. Gannett Fleming responded to the USEPA comments to the Needs Assessment Reports on May 30, 2013 and recommended the following in-home mitigation measures to prevent vapor intrusion into these structures during future rapid increases in the Mississippi River stage:

- 107 West Birch Street: Installation of a Dranjer® seal or equivalent on the floor drain in the basement, quarterly monitoring and sealing of any cracks that develop in the basement slab and foundation, continued operation and maintenance of the AllerAir™ 5000 Series indoor air purifying system, and installation of a crawlspace ventilation system.
- 125 West Birch Street: Installation of a Dranjer® seal or equivalent on two floor drains in the basement and quarterly monitoring and sealing of any cracks that develop in the basement slab and foundation.
- 129 West Birch Street: Quarterly monitoring and sealing of any cracks that develop in the basement slab and foundation, continued operation and maintenance of the AllerAir™ 5000 Series indoor air purifying system, installation of a sliding window in the basement to facilitate ambient air ventilation, as well as installation of a crawlspace ventilation system.

All of the recommended mitigation measures have been installed within these three structures with the exception of the crawlspace ventilation systems within 107 and 129 West Birch Street. These ventilation systems were not constructed as the USEPA requested Apex and the Hartford Working Group to perform additional in-home and SVE effectiveness monitoring across the Hartford Site between September 2013 and January 2014. The additional evaluation and recommendations provided herein will help to refine future mitigation needed in the event that expansion and optimization of the SVE system along West Birch and West Arbor Streets is not effective at preventing vapor intrusion into these structures.

In addition to the Needs Assessment Reports, Gannett Fleming (on behalf of Apex) submitted the *Area Wide Evaluation and Work Plan for Installation of Four Vapor Extraction Wells* (2013d) to the USEPA and Illinois EPA on June 7, 2013. This work plan proposed installation of four additional SVE wells along West Birch and West Arbor Streets to control migration of volatile petroleum related constituents within the vadose zone during rapid increases in river stage. The USEPA subsequently requested review and recommendations from the Hartford Working Group regarding the necessity for these four additional SVE wells. In correspondence dated December 19, 2013, the Hartford Working Group indicated that improvements to the existing shallow SVE wells installed on West Birch and West Arbor Streets may enhance the zone of capture and preclude the need for the four new SVE wells recommended by Gannett Fleming. The improvements to the existing shallow wells proposed by the Hartford Working Group included sealing surface cracks around the wells with silicone, adding grout, or expandable foam around piping connected to the wells, as well as sealing affected portions of the traffic-rated vaults. Data collected between January and June 2014 to evaluate the effectiveness of these proposed improvements to the shallow SVE wells performed by the Hartford Working Group are described in this section.

2.1 LITHOLOGY

In general, the lithology beneath West Birch and West Arbor Streets can be described as containing alternating fine-grained alluvial deposits of clay and silt separating coarser-grained hydrostratigraphic units. Figure 4 shows the location of two lines of geologic cross sections prepared using lithologic logs recorded during the installation of soil borings, cone penetrometer testing results, and electrical conductivity analysis within Zone 1. Figure 5 presents the lithologic cross-section for monitoring locations installed along West Birch Street and Figure 6 presents the lithologic cross-section prepared along West Arbor Street.

As depicted on these cross sections, asphalt, and fill material was observed between less than 1 foot and 8 feet in thickness beneath this portion of Hartford; however, in general the asphalt and fill does not exceed 3 feet in thickness. The thickness of the fill material generally decreases moving away from the road, meaning that the foundations and

basements of homes along West Birch and West Arbor Streets are likely in contact with undisturbed, native soils. The A Clay is present beneath the fill material and ranges in thickness from 3 to 12 feet. The A Clay contains mixtures of low plasticity silts and clays and is nearly continuous beneath West Birch and West Arbor Streets. The North Olive stratum, composed primarily of fine-grained sand with silts, underlies the A Clay and is located from 4 to 22 feet below ground surface (ft-bgs). The vertical distribution and thickness of the North Olive stratum varies spatially in the area around West Birch and West Arbor Streets, and generally thins out to the west. The B Clay separates the North Olive stratum from the underlying Rand stratum. The B Clay ranges in thickness from less than 1 foot to 10 feet and consists of high plasticity silts and clays. The Rand stratum is composed primarily of fine-grained loose sands and silts and is located between 15 and 28 ft-bgs. The Rand stratum thins and eventually pinches out to the southwest of West Birch Street, much like the North Olive stratum. Underlying the Rand stratum is the C Clay, which consists of dense, low plasticity clays. The C Clay ranges in thickness from 3 to 7 feet, and overlies the Main Sand stratum. The Main Sand consists of fine- to medium-grained, well sorted sands, with lenses of coarse-grained sands and gravels. The Main Sand is encountered between 397 and 405 ft-amsl, and is continuous throughout the Village of Hartford.

2.2 SMEAR ZONE DISTRIBUTION

Between February 2004 and August 2005, four laser induced fluorescence (LIF) borings (HROST-007, -008, -128, and -129) were installed along West Birch and West Arbor Streets to evaluate the nature and distribution of hydrocarbons within the stratigraphic units. The LIF borings were installed using the Rapid Optical Screening Tool (ROST™). The location of these four LIF borings is shown on Figure 4. The observed waveforms were categorized into three general LNAPL types including light-, mid-, and heavy-range hydrocarbons. In this case, heavy-range generally corresponds to LNAPL with a higher proportion of diesel-range compounds than the light-range hydrocarbons, which are comprised almost entirely of gasoline-range compounds.

Figure 7 provides a 3-dimensional depiction of the distribution of LNAPL types beneath SVE Effectiveness Zone 1. In general, all three LNAPL types are observed within Zone 1 indicating multiple sources for releases of the petroleum hydrocarbons. Light-range LNAPL is present in the Main Sand south of West Arbor Street; mid-range LNAPL is generally present within each of the hydrostratigraphic units north of West Arbor Street, and heavy-range LNAPL is primarily distributed within the North Olive and Rand strata to the north of West Rand Avenue.

As shown on Figures 5 and 6, LNAPL is observed in the Main Sand stratum beneath West Birch Street and the western portion of West Arbor Street, while mid-range LNAPL types were identified in the Rand and Main Sand strata along the eastern portions of West Arbor Street. It is important to note that LNAPL was not identified in the North Olive stratum within the historical LIF borings installed along West Birch or West Arbor Streets.

To assess changes in the vertical distribution of the smear zone over the past decade, three additional LIF borings (UVOST-007, UVOST-128, and UVOST-129) were installed along West Arbor and West Birch Streets using the Ultraviolet Screening Tool (UVOST™) in September 2013. The LIF results from these three borings installed via UVOST were compared to the historical LIF borings installed via ROST. A comparison of the LIF results from the three LIF boring locations collected in 2004 and 2005 to the collocated borings installed in 2013 is provided in Appendix C.

Both the ROST and UVOST make use of fluorescence and data acquisition systems developed wholly or in part by Dakota Technologies™. These two methods differ primarily in the laser and associated wavelength used to excite polycyclic aromatic hydrocarbons (PAHs) within the LNAPL (290 and 308 nanometer wavelengths for ROST and UVOST, respectively). The PAH mixtures within the LNAPL emit photons of a distinctive wavelength irrespective of the excitation wavelength, although the intensity of the response may vary. By sampling the total fluorescence at different wavelength channels (which are nearly identical for both tools), a multi-wavelength waveform is generated. The waveform allows simultaneous description of the spectral and temporal qualities of the fluorescence with depth and can be used to identify different product types. The waveform data are referenced and displayed as a percent of the response compared to the calibration reference emitter (RE). The RE is similar to a calibration gas used in a flame ionization or photoionization detector, and is placed on the sapphire probe window before collecting fluorescence data at each boring. The same RE is used for the ROST and UVOST (that is to say, the RE produces the same multi-wavelength waveform). Fluorescence measurements generated in the borings are normalized to the RE measurements which allows for spatial and temporal comparisons of the fluorescence results despite changes in the optics, laser energy drift, window, mirror, etc.

Both the ROST and UVOST readily detect most light- to mid-range product types including diesel and gasoline. The fluorescence response for these product types are generally linear, with higher concentrations of PAHs within a given product type resulting in a greater percent response relative to the RE (excluding any matrix interferences). With respect to gasoline, ROST will potentially have an advantage over UVOST since its laser system produces a shorter wavelength. However, much of this advantage may be normalized through comparison of the LIF results from ROST and UVOST to the same RE.

In general, the LIF results from the borings installed in 2013 are similar to the historical results collected in 2004 and 2005, with the exception of significantly reduced LIF response observed within the Main Sand stratum in the two borings installed along West Birch Street (UVOST-128 and -129). However, these decreases in the maximum fluorescence intensity were not coupled with significant decreases in the vertical thickness of the smear zone observed via the LIF response.

2.3 IN-HOME EFFECTIVENESS MONITORING RESULTS

The sub-slab soil vapor and indoor air screening results collected during the weekly, monthly, and quarterly monitoring events, as well as river stage triggered events conducted across the Hartford Site between January 2013 and June 2014 are included in Appendix A-1 and A-2, respectively. The in-home screening results for SVE Effectiveness Zone 1 have been tabulated separately and are summarized in Tables 1 and 2. Since January 2013 there have been eight structures at the Hartford Site where the TVPH concentrations measured in the sub-slab probes have been equal to or exceeded a threshold concentration of 350 ppmv (described in Section 1.2.2), including 107 West Birch Street, 117 West Birch Street, 125 West Birch Street, 129 West Birch Street, 119 West Cherry Street, 119 West Date Street, 516 North Delmar Avenue, and 715 North Delmar Avenue. Six of these structures are located in SVE Effectiveness Zone 1 while the remaining two structures are located in Zone 2. Sub-slab vapor concentrations were measured above the threshold concentration only during river stage triggered events in all cases except two: (1) 117 West Birch Street between February 24 and March 4, 2014, and (2) 715 North Delmar Avenue on July 23, July 24, and August 28, 2013. The elevated sub-slab concentrations measured beneath 117 West Birch Street are believed to be attributable to a broken sewer lateral near this structure that was subsequently repaired in May 2014. Elevated concentrations measured beneath 715 North Delmar Avenue that occur during low water table conditions may be related to mid- and heavy-range LNAPL present in the North Olive and Rand strata near this structure that are not observed in other portions of Zone 1, as described in the previous section.

Since January 2013, there have been nine structures in which the TVPH concentrations measured in indoor air (excluding measurements collected in floor drains and adjacent to gas transmission lines within the structure) have exceeded the 10 ppmv threshold (described in Section 1.2.2), including 107 West Birch Street, 118 West Birch Street, 129 West Birch Street, 111 West Date Street, 122 West Watkins Street, 504 North Delmar Street, 715 North Delmar Road, 610 North Old St. Louis Road, and 619 North Olive Avenue. Five of these structures are located in SVE Effectiveness Zone 1. Indoor air concentrations were measured above the 10 ppmv threshold concentration during river stage triggered events in all cases with the exception of elevated measurements in indoor air within 504 North Delmar Street and 610 North Old St. Louis Road reported on July 13, 2013. There are three structures in which the TVPH concentrations measured in indoor air exceeded the 10 ppmv threshold at the same time that the sub-slab vapor concentrations were measured equal to or above the 350 ppmv threshold (indicating a completed vapor intrusion pathway) including 107 West Birch Street, 125 West Birch Street, and 129 West Birch Street.

The laboratory analytical results for indoor air and sub-slab soil vapor samples generally collected when TVPH concentrations exceeded threshold values within the sub-slab beneath a structure are summarized in Appendix D. The results for volatile petroleum related constituents are included in Appendix D-1 and fixed gas results are summarized in Appendix D-2. The laboratory analytical reports and data validation reviews for indoor air and sub-slab samples

collected during river stage triggered monitoring in 2014 are provided in Appendix D-3 and D-4, respectively. The laboratory analytical results for SVE Effectiveness Zone 1 have been tabulated separately and are summarized in Tables 3a and 3b. Since January 2013, there are four structures where petroleum related constituents in indoor air exceed the comparison values established by the USEPA for the Hartford Site including 107 West Birch Street, 125 West Birch Street, 129 West Birch Street, and 516 North Delmar Avenue. These exceedances occurred during river stage triggered monitoring events in March and April 2013 (EBMP-15 and EBMP-16) and April 2014 (EBMP-19). As summarized on Table 3a, petroleum related constituents concentrations in indoor air were reduced below the comparison values once supplemental vapor recovery and contingency measures were performed within the three structures on West Birch Street. Supplemental vapor removal activities along West Birch and West Arbor Streets were initiated in response to elevated TVPH measurements within the sub-slab several days after the beginning of river stage triggered monitoring events EBMP-15 and EBMP-16 in 2013 and EBMP-19 in 2014. During subsequent river stage triggered events in 2013 and 2014, supplemental vapor removal was typically conducted once trigger levels had been reached in the river stage and not in response to elevated TVPH concentrations measured beneath the slab of the structures on West Birch Street.

It should also be noted that elevated concentrations measured in the sub-slab and indoor air in 516 North Delmar Avenue only occurred during the river stage triggered event in April 2014 (EBMP-19), and did not occur during any of the four events in 2013 or subsequent event in 2014. This is attributed to transfer of the SVE system operations from Apex to Hartford Working Group in September 2013 (further described in Section 2.5). During the April 2014 river stage triggered event (EBMP-19), Apex and the Hartford Working Group discussed operational improvements in the SVE operations of nearby wells HSVE-004S/R/D that were successful in mitigating migration of vapors into the nearby structures including 516 North Delmar Avenue.

In general, the in-home monitoring results indicate that increase in the TVPH concentrations beneath and within structures in response to rapid rises in the Mississippi River stage are occurring in a limited number of structures across the Hartford Site, with the majority of exceedances of threshold concentrations occurring in SVE Effectiveness Zone 1 along West Birch Street. When increasing concentrations occur in other portions of the Hartford Site (e.g., 516 North Delmar Street), adjustments in operations of the SVE wells near these structures are capable of mitigating migration of vapors into these structures. In contrast, adjustments to the SVE wells installed along West Birch and West Arbor Streets (including wells HSVE-025S/D, -026S/D, and -027S/D) have not successfully mitigated the vapor intrusion pathway into several of the nearby structures during river stage triggered events, which has resulted in the need to perform supplemental vapor removal using the nearby multipurpose monitoring points.

2.4 SVE EFFECTIVENESS MONITORING RESULTS

As described in Section 1.2.3, SVE effectiveness monitoring is conducted within approximately 146 multipurpose monitoring points and nested vapor monitoring wells installed across the lithologic units in each of the six SVE effectiveness zones. SVE effectiveness monitoring is performed within a limited number of monitoring locations screened within the Main Sand stratum. The purpose of this monitoring is to evaluate the radius of influence and induced vacuum from nearby SVE wells, and to monitor TVPH concentrations in the subsurface. SVE effectiveness monitoring results collected within Zone 1 between September 2013 and June 2014 are summarized on Table 4.

Figures 8 and 9 depict the TVPH concentrations measured in the multipurpose monitoring points and nested vapor monitoring wells installed across the A-Clay, North Olive, B-Clay and Rand strata in Zone 1 during December 2013 (low groundwater and river stage) and April 2014 (river stage triggered event), respectively. When the groundwater elevations and river stage are low, elevated TVPH concentrations are only present in two locations within SVE Effectiveness Zone 1, near monitoring points MP-079A and MP-033B. The elevated concentrations in the shallow subsurface near monitoring point MP-079A may be attributed to the break in the sewer lateral near 117 West Birch Street described in the previous section. However, during river stage triggered events, the TVPH concentrations increase within the shallow lithologic units across Zone 1, including significant increases beneath West Birch Street.

Figures 10 and 11 depict the TVPH and oxygen concentrations measured in select multipurpose monitoring points and nested vapor monitoring wells screened across the various lithologic units beneath West Birch Street and West Arbor Street, respectively. When the river stage and the groundwater elevations are low (e.g., unconfined conditions in the Main Sand), the smear zone is exposed in the Main Sand and Rand strata resulting in elevated TVPH concentrations compared to the shallower lithologic units. As the river stage and groundwater elevations increase, TVPH concentrations are observed to decrease within the monitoring locations screened in the deeper strata and increase within monitoring locations screened in the shallower strata. This trend is most apparent in multipurpose monitoring points MP-079 and MP-080 installed along West Birch Street.

The historical SVE effectiveness monitoring results for the multipurpose monitoring points installed along West Birch Street are provided in Appendix B. Figures 12 through 15 provide a summary of the TVPH concentrations measured in nested monitoring points MP-078, -079, and -080, as well as nested vapor monitoring well VMP-027 since SVE effectiveness monitoring began at these locations. This data collected between 2005 and 2014, generally shows that TVPH concentrations in the deeper permeable strata (including the Main Sand and Rand) have remained relatively constant over time (generally measured above 100,000 ppmv). A decreasing trend is generally observed within the shallower units situated above the Rand stratum, with occasional spikes in the concentration over short duration events (on the order of weeks and months). Notable exceptions include the steady or increasing trends observed in the TVPH

concentrations observed in shallow monitoring points MP-078A and -078B installed on West Arbor Street and the increasing trend in shallow monitoring points MP-079A and -079B installed on West Birch Street. The increasing trend observed in shallow monitoring points MP-079A and -079B may be attributable to the break in the lateral sewer line near this structure.

Overall, the data collected as part of the SVE system effectiveness monitoring suggest that during low water table conditions, the SVE wells within Zone 1 are effective at controlling vapor migration into structures and operation of the system has contributed to an overall decrease in TVPH concentrations within the shallow lithologic units. However, during rapid increases in the river stage, TVPH concentrations increase dramatically across Zone 1, particularly along West Birch Street where a completed vapor intrusion pathway has been observed in several structures during river stage triggered events in 2013 and 2014.

2.5 SVE SYSTEM OPERATIONS AND MONITORING RESULTS

There are 22 SVE wells installed within Zone 1 of the Hartford Site. The SVE extraction wells were generally installed as nested pairs targeting the shallow hydrostratigraphic units beneath the Hartford Site. Three of the SVE well pairs were installed along West Birch and West Arbor Streets including HSVE-025S/D, -026S/D, and -027S/D. The wells designated with an “S” are generally screened in the North Olive stratum with some component of the screen situated within the over and underlying clays (A and B Clay); whereas the wells designated with a “D” are screened into the Rand stratum but may have longer screen intervals that may also extend into the shallower strata.

As shown on Figure 5, each of the SVE wells located on West Birch Street (wells HSVE-025S/D and -026S/D) were installed with the top of the screen at shallow depths (top of screen between 6 and 9 ft-bgs). The screen interval in the deep well in these two nested pairs also overlaps with the shallow well screen. In addition, the valve control boxes for these two nested wells were installed between approximately 4 and 5 feet into the A Clay. The overlap of the screen intervals in the shallow and deep SVE wells coupled with the close proximity of the bottom of the valve control box with the top of the screen has resulted in short circuiting of the SVE wells with atmospheric air. As such, vapor recovery using the shallow wells installed on West Birch Street was discontinued between 2008 and 2009 (with the exception of short duration events generally lasting no more than three months between 2010 and 2011). Vapor recovery using these shallow wells was intermittently resumed in late 2013 and early 2014 (Table 5) in order to evaluate efforts made by the Hartford Working Group to eliminate short circuiting within these wells.

Operations and monitoring (O&M) is conducted biweekly to evaluate the performance of each of the SVE wells. O&M activities generally include gauging fluid levels and measuring the vacuum, differential pressure, and air flow

within the operating wells. In addition, samples are collected from the extracted air to measure TVPH and fixed gas (oxygen, carbon dioxide, methane) concentrations using a FID and multigas meter. Table 5 includes a compilation of the O&M data collected from the SVE wells installed in Zone 1. Gannett Fleming operated the SVE wells on behalf of Apex until September 2013 and URS Corporation (URS) operated the system thereafter on behalf of the Hartford Working Group. Table 5 includes O&M data recorded between January 2013 and March 2014 (as the O&M data recorded between April and June 2014 was not available at the time of preparing this report). The data provided on Table 5 has not been validated[2].

As shown on Figure 16 and summarized in the following table, the reported vacuum and air flow within each of the SVE wells operated along West Birch and West Arbor Streets have fluctuated since January 2013.

Location	Parameter	Average	Maximum	Minimum
HSVE-25S	*Vacuum*	-88.6	-102.7	-86.9
	Air Flow	12.26	146.49	7.92
HSVE-25D	*Vacuum*	-103	-122	-87.2
	Air Flow	36.68	76.8	0
HSVE-26S	*Vacuum*	-103.08	-113.6	-89.3
	Air Flow	25.37	50.67	7.37
HSVE-26D	*Vacuum*	-22.92	-87.6	-3.5
	Air Flow	87.63	380.6	56.93
HSVE-27S	*Vacuum*	-98.66	-128	-74.1
	Air Flow	13.22	32.7	0
HSVE-27D	*Vacuum*	-91.05	-115	-2.8
	Air Flow	11.89	31.44	0

[2] It is important to note that in some cases there is overlap between data recorded by Gannett Fleming and URS. Of particular interest is the data measured in well HSVE-26D on September 3, 2013. The vacuum and differential pressure reported by Gannett Fleming and URS were identical; however the calculated extraction rate (referred to as air flow) was significantly different (65.8 scfm by Gannett Fleming versus 147.95 scfm by URS), indicating differences in the calculation used to estimate air flow. Therefore, it is possible that the differences in air flow reported for a SVE well prior to and then following September 2013 may not reflect changes in: (1) operations or maintenance within an SVE well or (2) subsurface conditions near the well but simply a difference in the way that the flow rate is estimated.

This summary only includes vacuum and air flow when the SVE well was open and does not include periods when the well was closed. As previously described, the shallow SVE wells were operated on an infrequent basis. The air flow measured in deep well HSVE-027D is significantly lower than the two wells installed on West Birch Street. As shown on Figure 6, this deep well has a screen interval that only extends across a relatively thin section of the Rand stratum (approximately 3.5 feet) and into the overlying B Clay. The soil gas permeability may be reduced across the well screen, which limits the air flow within the SVE well.

The open screen for each of the wells is also shown graphically on Figure 16. The amount of open screen in the deep SVE wells is related to the groundwater elevation and stinger placement (used to remove water) within the well. Well HSVE-26D generally had more open screen compared to wells HSVE-25D and HSVE-27D. There was only a single instance (in well HSVE-27D) between January 2013 and March 2014 during which there was no open screen (reported on May 13, 2013). The amount of open screen in the shallow wells is generally less than that observed in the deeper wells, primarily due in part to the shorter wells screens and the presence of perched water in the North Olive stratum that remains in the wells when they are closed.

As described in Section 2.3, six river stage triggered events have occurred since March 2013 (EBMP-15 through EBMP-20). The vapor intrusion pathway was complete within one or more structures on West Birch Street (including 107, 125, and 129 West Birch Street) during river stage triggered events EBMP-15, EBMP-16, and EBMP-19. During each of these events in 2013 and 2014 (with the possible exception of EBMP-20), supplemental vapor recovery was performed by temporarily connecting monitoring points MP-078B, MP-078C, and/or MP-079C to SVE wells HSVE-23D and/or HSVE-26D using flexible hosing. During these events, supplemental vapor recovery was effective at reducing TVPH concentrations within the sub-slab soil vapor and indoor air in structures installed along West Birch Street. The success of the supplemental vapor recovery using the multipurpose monitoring points installed on West Birch and West Arbor Streets indicates that additional SVE wells are necessary to mitigate the vapor intrusion pathway into structures present in this portion of Zone 1.

3.0 SOIL VAPOR EXTRACTION SYSTEM OPTIMIZATION

The SVE system, in operation since 1992 and upgraded in 2005, was installed to prevent volatile petroleum hydrocarbons from migrating into overlying structures creating acute and chronic risks to human health. The SVE system also reduces the mass of petroleum hydrocarbons present in the smear zone beneath the Hartford Site. This secondary benefit is enhanced when the groundwater table is low (i.e., unconfined conditions Main Sand) and lower portions of the smear zone are exposed.

The original SVE system consisted of 12 vapor control boreholes, two 75- horsepower (HP) blowers with a combined capacity of approximately 1,500 standard cubic feet per minute (scfm) and a single thermal treatment oxidizer capable of treating up to 27 million British thermal units (BTU) per hour (URS 2013b). The current system consists of a network of approximately 120 vapor extraction wells connected through a series of piping and valves to a single 12-inch pipe. The 12-inch pipe conveys the recovered vapors from the Hartford Site below the Union Pacific, Kansas City Southern, and Norfolk Southern Railroads rights-of-way located east of North Olive Street to four 75-HP blowers located on the Premcor facility. The four blowers have a total capacity of approximately 3,200 scfm. The recovered soil vapor is treated using between one and four thermal oxidizers, each capable of processing 9 million BTUs per hour.

Based on the in-home and SVE effectiveness monitoring, as well as the O&M results from the wells installed along West Birch and West Arbor Streets (discussed in Section 2.0), the SVE system in this portion of Zone 1 does not appear to be controlling the migration of volatile petroleum related constituents within the North Olive and Rand strata. This section describes recommendations for expansion and optimization of the SVE system. Three additional nested SVE wells are proposed to be installed along West Birch and West Arbor Streets in order to eliminate the vapor intrusion pathway into structures during rapid rises in the Mississippi River, which is the primary goal of the SVE system. These additional wells and operational adjustments are also designed to enhance mass recovery of LNAPL from the smear zone over time.

3.1 ZONE 1 SVE SYSTEM EXPANSION NEAR WEST BIRCH STREET

Based on the repeated occurrence of a completed vapor intrusion pathway within one or more of the structures on West Birch Street during river stage triggered events and elevated TVPH concentrations that remain within the Main Sand stratum (as discussed in Section 2.0), three additional nested SVE wells are proposed in Zone 1. As shown on Figure 17, these wells are proposed to be installed near existing wells HSVE-025S/D, -026S/D, and -027S/D in part

because of the success of the supplemental vapor recovery using nearby multipurpose monitoring points installed on West Birch and West Arbor Streets.

As part of installing the new SVE wells, the existing shallow wells HSVE-025S, -026S, and -027S will be disconnected from the system, plugged, and abandoned as these have been demonstrated to either be short circuiting with atmospheric air (HSVE-025S and -026S) or have reduced air flow resulting from installation of the screen within lower permeability zones (HSVE-027S). The existing deep wells at each of these locations contain longer screen intervals that extend from the A Clay to the Rand stratum and will continue to be utilized when the water table is low.

Each proposed nested well will include a shallow SVE well screened within the North Olive unit and a deeper SVE well screened across the smear zone within the Main Sand stratum. The purpose of the shallow well is to prevent vapors from migrating into overlying structures during future river stage triggered monitoring events. The proposed deeper wells will allow for focused mass removal when groundwater elevations in the Main Sand are unconfined. The proposed screen intervals for the proposed wells are displayed on Figures 5 and 6. The exact screen intervals will be determined in the field during installation of the soil boring and observations made by the geologist.

3.1.1 SVE WELL INSTALLATION

Prior to well installation, an approximate 10-inch soil boring will be installed to approximately five feet below the smear zone (approximately 45 to 50 ft-bgs) at each location using a hollow stem auger drilling methodology. A continuous core will be collected, logged, and field screened for TVPH concentrations using an FID. Select intervals from the soil core may be submitted for laboratory analysis of volatile petroleum hydrocarbons (USEPA Method 8260), semivolatile petroleum hydrocarbons (USEPA Method 8270), and total petroleum hydrocarbons (USEPA Method 8015).

The deep SVE well will be constructed following installation of the boring, collection of soil samples, as well as identification of the major lithologic contacts and smear zone limits. The deep well will be constructed with approximately ten feet of 4-inch diameter, polyvinyl chloride (PVC), continuously slotted screen (0.010-inch slot size). A sump consisting of approximately five feet of 4-inch blank PVC casing will be installed below the screen interval. Blank 4-inch diameter PVC casing will be set from the top of the screen to the ground surface. A 10/20 or similar sized sand will be placed from the bottom of the screen boring to approximately one foot above the screen interval. A 2.5-foot bentonite seal will be placed above the sand pack. A concrete-bentonite grout will be placed above the bentonite seal to approximately 4 ft-bgs.

The shallow well will be drilled adjacent to the deep SVE well and constructed in a similar fashion. Soil cores will not be collected during installation of the boring for the shallow SVE well. The total depth of the boring for the shallow SVE well will extend approximately two feet below the bottom of the North Olive stratum based on the lithologic log produced during installation of the deep boring. The shallow SVE wells will be constructed using five feet of 4-inch diameter, polyvinyl chloride (PVC), continuously slotted screen (0.010-inch slot size). A two foot sump consisting of blank 4-inch diameter PVC casing will be set below the screen interval.

3.2 SVE TRANSMISSION LINES, CONTROL VAULTS, AND COMPLETION DETAILS

As shown on Figure 18, existing transmission lines, both in service and spare laterals, will be used for the proposed SVE wells as follows:

- Transmission line for HSVE-026S will be used for well HSVE-105S/D
- An existing spare lateral line will be used for well HSVE-106S/D
- Transmission line for HSVE-025S will be used for well HSVE-107S/D

As it is not anticipated that extraction from both the shallow and deep interval will occur simultaneously, a single control vault is specified for each nested well pair. Therefore, each control vault contains a single Venturi flowmeter and control valve to monitor and adjust the vapor extraction rate, with vapor extraction from either the shallow or deep well controlled via a pair of shut-off valves.

As shown on Figure 17, vacuum extraction at well HSVE-105S/D will be performed using the existing vacuum line extending to well HSVE-026S. Once well HSVE-026S is disconnected, plugged, and abandoned, the existing vault will be removed and a new valve control vault for well HSVE-105S/D will be constructed in its place. Vacuum extraction at well HSVE-107S/D will be performed using the existing vacuum line from well HSVE-025S. Once well HSVE-025S is disconnected, plugged and abandoned, the existing vault will be decommissioned and the 4-inch line leading to well HSVE-025S will be extended to the proposed location of the new vapor control vault for well HSVE-107S/D. A spare lateral emanating from Vault V-25 will be extended to the proposed vapor control vault for well HSVE-106S/D.

The dimensions of the control vaults will be approximately three feet deep by four feet wide by five feet long. The vault box will be underlain by a minimum of 12 inches of aggregate material. Additional details for the control vaults are shown on Figure 18. At approximately 3 ft-bgs, the 4-inch PVC casing from each of the newly installed SVE wells will be cut and transitioned to 6-inch high density polyethylene (HDPE) pipe and connected to the 2-inch HDPE lateral

line from the respective control vault at a depth of approximately 2 ft-bgs. Additional details for the SVE well completions are shown on Figure 19. Care will be taken during installation of the vaults and wells to ensure that short circuiting will not occur, including excavating vaults only as deep as necessary, ensuring SVE wells are screened at appropriate depths, and correct placement of seal materials in the annular well space during well completion.

3.3 CONTINGENCY MEASURES IN SELECT STRUCTURES ON WEST BIRCH STREET

In the event that Zone 1 SVE system expansion and optimization activities do not adequately mitigate vapor intrusion within 107 West Birch Street and/or 129 West Birch Street, contingency measures will be installed in these structures. Contingency measures will include an active crawlspace ventilation system operated under positive pressure. As identified in Needs Assessment Reports (Gannett Fleming 2013a, 2013c), a portion of these two structures consists of a crawlspace identified as a "preferential pathway for vapor intrusion into the home." At 107 West Birch Street, the crawlspace consists of a dirt floor roughly 24 feet square with floor to ceiling heights ranging from 12 to 40 inches. Four fresh-air vents, two each on the east and west walls, are currently installed within the crawlspace. At 129 West Birch Street, the crawlspace, approximately 12 feet by 21 feet, is located under a family room. As the crawlspace is surrounded by a poured concrete foundation with no vents or access points, it has not been visually inspected. However, the homeowner reported that the family room was constructed atop a concrete slab at grade, not a dirt floor.

Despite the disparity in crawlspace configurations, a similar contingency measure of installing a ventilation fan at one corner of the space and a gravity-closing relief air damper at the distal end is proposed. Relief air dampers consist of a solid plate hinged along the top that seals against a gasket due to gravity. Under enough pressure, and if not latched, the damper is forced open allowing crawlspace air to be exhausted. Such a configuration complies with USEPA recommendations that "levels of volatile organic constituents in enclosed crawlspaces can be lowered by ventilating passively (without the use of a fan) or actively (with the use of a fan). When a fan is used it should blow into the space rather than out, to positively pressurize the crawlspace and thus minimize concentrations in the crawlspace." (USEPA 2008). Providing more backpressure than a simple rigid vent, a gravity-closing relief damper should enhance the positive pressure while still allowing for adequate cross flow, and elimination of stagnation points, throughout the crawlspace.

In conjunction with the mechanical system installation, the existing crawlspace ceiling (i.e., the above room floor) will be thoroughly inspected for cracks, opening, and utility penetrations, which may allow for intrusion of vapors from the crawlspace into the home. Identified cracks or other openings in the floor will be sealed with caulk, expanding foam, or other appropriate methods. As crawlspace entry at both homes is prohibitive, subfloor inspection and sealing will be performed from within the home. Reducing the floor crack area will increase the potential for positive pressure

buildup, reduce the potential for vapor intrusion into the occupied space, and is a common practice for both passive and active vapor intrusion mitigation systems for which a liner or other impermeable barrier cannot be installed (USEPA 2008).

At 107 West Birch Street, contingency measures will of consist installation of a supply air fan within the existing northeast fresh-air vent and installation of relief dampers at the remaining three fresh-air vents. While installed at three locations, only the southwest relief damper will be operated (i.e., remaining dampers latched) to promote good cross-flow of air with the crawlspace. At 129 West Birch Street, ventilation ports will be saw-cut into the concrete foundation, one each at a northeast and southwest location, followed by installation of a supply air fan and single relief damper. An on/off switch will be installed for the supply air within the structure at 107 West Birch Street and 129 West Birch Street. The supply air fans would be operated during transient events when TVPH concentrations within the crawlspace exceed in-home threshold values (i.e., 10 ppmv).

4.0 CONCLUSIONS AND PATH FORWARD

Based on the repeated occurrence of a completed vapor intrusion pathway within one or more of the structures on West Birch Street, the existing SVE wells installed in Zone 1 (specifically along West Birch Street and West Arbor Street) are not able to control the migration of volatile petroleum related constituents during river stage triggered events. The existing shallow wells installed in this area are either short circuiting potentially as a result of the connectivity between the screen interval and the control vault (HSVE-025S and -026S) or have restricted air flow due to the screen being installed within low permeability zones (HSVE-027S). Therefore, it is recommended that the existing shallow SVE wells HSVE-025S, -026S, and -027S be disconnected, plugged, and abandoned and that replacement nested wells HSVE-106S/D, -107S/D, and -108S/D be installed. The proposed wells would include a shallow well screened across the North Olive unit and a deeper well installed within the Main Sand stratum. The shallow wells would be operated during river triggered events to mitigate the vapor intrusion pathway into structures on West Birch Street. Whereas, operation of the deep wells would be focused when the river stage is low and groundwater conditions are unconfined in the Main Sand stratum allowing for additional mass removal from the smear zone.

4.1 STAKEHOLDER COORDINATION

In order to complete installation of the proposed SVE wells, connection to the existing system, and begin operations and optimization of vapor recovery within this portion of Zone 1, coordination with multiple stakeholders is required. The following coordination activities will be necessary:

- **Village of Hartford**: A meeting with Village of Hartford will be necessary to coordinate access to the Village right-of-way along portions of West Birch and West Arbor Streets where the proposed SVE wells, vaults, and additional pipeline corridors will need to be installed. Plans will need to be developed to minimize the impact on residents and businesses during the installation of the additional wells and infrastructure.
- **Hartford Working Group**: Apex will approach the Hartford Working Group in order for the parties to develop an agreement for abandoning the shallow SVE wells, connecting the proposed SVE wells into the current system, and initiating vapor recovery from the deep wells. Revisions to the *HSVE Monitoring and Maintenance Manual* (URS 2013b) may also be necessary to define groundwater triggers and O&M activities for the proposed SVE wells.
- **USEPA and Illinois EPA**: Additional discussions with USEPA and Illinois EPA will be performed as needed to gain concurrence with the approach for optimizing the SVE system in this portion of Zone 1. The parties will provide notification to the USEPA and Illinois EPA regarding progress towards: (1) finalizing access to the Village of Hartford right-of-way along West Birch and West Arbor Streets and (2) coordination efforts regarding

abandonment, tie-in, and operation activities. A schedule for installation of the proposed SVE wells, connection to the system, and initiation of vapor recovery using the expanded system will be prepared in collaboration with the USEPA and Illinois EPA.

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