SUPPLEMENTAL REMEDIAL INVESTIGATION WORK PLAN – PHASE 3
CHEVRON SERVICE STATION NO. 9-6590
232 East Woodin Avenue
Chelan, Washington

October 18, 2017

Prepared for:
Washington State Department of Ecology
1250 West Alder Street
Union Gap, Washington 98903

Prepared by:
Leidos, Inc.
18939 120th Avenue NE, Suite 112
Bothell, Washington 98011

On Behalf of:
Chevron Environmental Management Company
6001 Bollinger Canyon Road
San Ramon, California 94583

leidos

SUPPLEMENTAL REMEDIAL INVESTIGATION WORK PLAN – PHASE 3
CHEVRON SERVICE STATION NO. 9-6590
232 East Woodin Avenue
Chelan, Washington

October 18, 2017

Prepared for:
Washington State Department of Ecology
1250 West Alder Street
Union Gap, Washington 98903

Prepared by:
Leidos, Inc.
18939 120th Avenue NE, Suite 112
Bothell, Washington 98011

On Behalf of:
Chevron Environmental Management Company
6001 Bollinger Canyon Road
San Ramon, California 94583

Russell S. Shropshire, PE
Principal Engineer

leidos

TABLE OF CONTENTS

1. INTRODUCTION AND OBJECTIVES 1
2. LNAPL TRANSMISSIVITY TESTING..1
    2.1 Baildown Testing Schedule 3
    2.2 Baildown Testing Methods..3
    2.3 Baildown Testing Well Redevelopment..5
    2.4 Baildown Testing Data Analysis 6
3. GEOPHYSICAL SURVEY..6
    3.1 Geophysical Survey Methodology 7
4. INVESTIGATION-DERIVED WASTE MANAGEMENT 8
5. SCHEDULE..8
6. REFERENCES 8

FIGURES

Figure 1: Site Map with Proposed SRI Phase 3 Investigation Locations

SUPPLEMENTAL REMEDIAL INVESTIGATION WORK PLAN – PHASE 3
CHEVRON SERVICE STATION NO. 9-6590

1. INTRODUCTION AND OBJECTIVES

Leidos, Inc. (Leidos), on behalf of Chevron Environmental Management Company (Chevron), prepared this work plan to perform additional Supplemental Remedial Investigation (SRI) activities at Chevron Service Station No. 9-6590 (the Site), located at 232 East Woodin Avenue in Chelan, Washington (Figure 1). SRI activities for the Site are being performed pursuant to the terms of Agreed Order No. DE 10629, which was entered into by Chevron and the Washington State Department of Ecology (Ecology) in June 2014.

The objective of the SRI Phase 3 activities is to expand upon previous work performed to address data gaps regarding the presence of petroleum hydrocarbon contamination and light non-aqueous phase liquid (LNAPL) at the Site. Specifically, this phase of the SRI will include the following investigation elements:

1. Performance of LNAPL baildown testing to collect additional data regarding LNAPL transmissivity at the Site; and
2. Performance of a non-intrusive geophysical survey to investigate the potential that one or more orphaned underground storage tanks (USTs) or other fueling service infrastructure may be present in the vicinity of monitoring well MW-21, and continuing to provide an additional source of gasoline-range petroleum contamination to the Site.

The scope of work proposed by this work plan is not intended to satisfy completion of the SRI required for the Site. Therefore, Leidos anticipates that additional phases of investigation will be performed in the future. The scope of work for future SRI activities will be determined based on the findings of this work and the results of previous remedial investigation activities performed at the Site.

2. LNAPL TRANSMISSIVITY TESTING

As part of the SRI Phase 1 field activities, an evaluation of LNAPL transmissivity by baildown testing was performed in July 2015 to establish a baseline of LNAPL transmissivity values representative of then-current conditions at the Site. As discussed in the SRI Phase 1 report (Leidos, 2015), an understanding of LNAPL transmissivity is considered to be an important component of the Conceptual Site Model (CSM) for LNAPL impacted sites, because it serves as an effective indicator of LNAPL recoverability, the understanding of which is essential for selection of an effective cleanup remedy.

However, developing an understanding of LNAPL transmissivity is complex due to the many variables that can affect transmissivity, and the transient nature of some of those variables (e.g., groundwater elevation). Due to this complexity, developing an understanding of LNAPL transmissivity generally requires a weight-of-evidence approach based on multiple rounds of transmissivity testing.

Since the initial round of LNAPL baildown testing performed in July 2015, results of quarterly groundwater monitoring have indicated a general long-term increase in groundwater elevation throughout the Site. Concurrent with this change, LNAPL gauging data have indicated trends of increasing LNAPL thickness in several monitoring wells, as well as the first occurrence of LNAPL in monitoring well MW-21. Specific examples of recent changes in LNAPL occurrence at the Site are as follows:

- **MW-16** In September 2015, approximately two months following LNAPL baildown testing, LNAPL thickness in MW-16 was measured at 0.23 feet. In March 2016 LNAPL was measured at 9.55 feet, and in June 2017 (most recent measurement) LNAPL thickness in this well was measured at 15.78 feet.
- **MW-21** Monitoring well MW-21 was installed in March 2003 and has been regularly gauged at least annually since that time. Between March 2003 and December 2015 LNAPL was never detected in this monitoring well; however, in March of 2016 LNAPL was found in the well at a thickness of 1.23 feet. Since that time, LNAPL thickness in this monitoring well has increased such that LNAPL is routinely gauged at thicknesses exceeding 15 feet. In June 2017 LNAPL thickness in this well was measured at 15.10 feet.
- **MW-27** Monitoring well MW-27 also was installed in March 2003. Long-term monitoring data for this well indicate that LNAPL was not detected during regular gauging events performed between 2003 and May 2008; however, LNAPL was detected at thicknesses ranging from 0.02 to 0.67 feet between May 2009 and May 2011. LNAPL was not detected in this well during 20 gauging events performed from August 2011 through December 2015. In March 2016, LNAPL was detected at a thickness of 11.73 feet. In June 2017 LNAPL thickness in this well was measured at 11.23 feet.

Based on the apparent change in Site conditions that has resulted in these significant changes in LNAPL occurrence at the Site, Leidos believes that additional LNAPL transmissivity testing is warranted at the Site in order to evaluate whether these changes have had an impact on LNAPL recoverability. Based on recent and long-term LNAPL gauging data for the Site, Leidos proposes to perform testing at the following monitoring wells:

- **MW-9** Although gauging data for monitoring well MW-9 does not indicate an increasing thickness trend since March 2016, data for this well do indicate a long-term trend of LNAPL thickness of one or more feet.
- **MW-10** Although gauging data for monitoring well MW-10 does not indicate an increasing thickness trend since March 2016, data for this well do indicate a long-term trend of LNAPL thickness of several feet or more. This well was included in the baildown testing performed in July 2015. Therefore, data from the currently proposed rounds of baildown testing will be compared against those baseline results.
- **MW-12** Although gauging data for monitoring well MW-12 does not indicate an increasing thickness trend since March 2016, data for this well do indicate a long-term trend of LNAPL thickness of several feet or more. This well was included in the baildown testing performed in July 2015. Therefore, data from the currently proposed rounds of baildown testing will be compared against those baseline results.
- **MW-16** Monitoring well MW-16 was selected due to the recent increasing LNAPL trend discussed above. This well was included in the baildown testing performed in July 2015. Therefore, data from the currently proposed rounds of baildown testing will be compared against those baseline results.
- **MW-21** Monitoring well MW-21 was selected due to the recent increasing LNAPL trend discussed above.

- **MW-27** Monitoring well MW-27 was selected due to the recent increasing LNAPL trend discussed above.

As previously discussed, LNAPL transmissivity is complex and dependent on many variables, one of which is communication of the well with the surrounding formation. For example, a monitoring well with a screen or sand pack that is fouled with bio-growth or fine-grained material may yield lower transmissivity values, when tested, than are representative of conditions in the surrounding formation. This is especially a concern for the Chelan Chevron site due to the age of monitoring wells containing LNAPL and the fine-grained nature of the formation within the screened interval of those monitoring wells. To address this concern, Leidos currently proposed to conduct a minimum of two LNAPL baildown events. The first of which would be performed under current "as-is" conditions and the second would be performed following redevelopment of the wells, when practicable.

The objective of the first test is to collect transmissivity data that could be compared to the results of the July 2015 baildown event, without adding the additional variable that would be caused by redeveloping the wells prior to testing. Ideally, these results would allow us to evaluate the impact that changing groundwater conditions may have on LNAPL transmissivity at the Site.

The objective of the second test would be to determine if redevelopment of the monitoring wells results in a change in LNAPL transmissivity values at the Site.

2.1 BAILDOWN TESTING SCHEDULE

It is anticipated that performance of the first round of baildown testing will be performed as soon as reasonably possible following Ecology approval of this work plan. Following completion of initial LNAPL baildown testing, Leidos will initiate planning for the well redevelopment scope of work. Scheduling for this phase of work will be dependent on coordinating timely offsite transport of the liquid wastes generated, in order to avoid the potential for releases associated with freezing drums. Post-redevelopment baildown testing is expected to be performed at least 30 days after any redevelopment activities, in order to allow fluid levels in the wells to return to equilibrium conditions.

Execution of all field activities associated with this scope of work will be contingent upon weather and highway driving conditions.

2.2 BAILDOWN TESTING METHODS

Baildown testing at the Site will be conducted per the following procedure, which is based upon Section 6.1, *Baildown/Slug Testing Field Methods*, of ASTM E2856-13, *Standard Guide for Estimation of LNAPL Transmissivity*.

1. Prior to beginning a test, Leidos personnel will compile the following information for each well to be tested:
    - Borehole diameter (feet)
    - Casing and screen diameter (feet)
    - Top of screen interval relative to top of casing (feet)
    - Bottom of screen interval relative to top of casing (feet)
    - Total well depth (feet)

This information and all additional baildown test data will be recorded in the field logbook or on a field data form specific to the well being tested.

2. After establishing a safe work zone around the monitoring well to be tested, Leidos personnel will open the well and use an interface probe to measure the depth to air/LNAPL interface (hereafter depth-to-product or DTP) and LNAPL/water interface (hereafter depth-to-water or DTW) , relative to the north side of the top of the monitoring well casing. Following these initial measurements, the well will be left open for a period of at least 10 minutes to allow conditions in the monitoring well casing to come to equilibrium with atmospheric conditions. After approximately 5 minutes, DTP and DTW will be measured again. This process will be repeated until the DTP and DTW measurements from two successive readings do not vary by more than 0.01 foot. At that time, the latest DTP and DTW measurements will be used to define the initial DTP and DTW conditions for the start of the test.
3. The initial DTP and DTW conditions will be used to to approximate the volume of LNAPL within the well casing and borehole, using the following equations.

$$V_{fp} = S_{yf} * b * \pi * (r_b^2 - r_c^2) * 7.481$$
$$V_c = b * \pi * r_c^2 * 7.481$$
$$V_t = V_{fp} + V_c$$

Where:

V_{fp} = Volume of LNAPL in the filter pack (gallons)

V_c = Volume of LNAPL in the casing (gallons)

V_t = Total effective LNAPL volume (gallons)

b = Gauged LNAPL thickness in the well (feet)

r_b = Borehole radius (feet)

r_c = Well casing radius (feet)

S_{yf} = Specific yield or storage coefficient of well filter pack (assumed to be 0.175)

7.481 = Factor to convert volume in cubic feet to gallons.

Well construction data will be reviewed to evaluate if the filter pack exists over the entire gauged interval of LNAPL. If the well screen and filter pack do not exist across the entire gauged thickness, then the filter pack thickness used in the above equations will have to be reduced from the gauged thickness value.

4. Following estimation of the total effective LNAPL volume (V_t) present in the well, LNAPL will be removed from the well using a disposal bailer. LNAPL removal by hand-bailing is necessary at this Site due to the depth at which LNAPL and groundwater is typically encountered (typically depths of 25 to 30 feet or more), which precludes the use of a peristaltic pump for LNAPL removal.

   a. The bailer cord will be marked with the approximate depth of the DTW interface in order to reduce the amount of groundwater removed during the LNAPL removal process.
   b. The start and finish times of LNAPL removal will be recorded in the field log book.
   c. Based on the anticipated duration of the LNAPL baildown testing including recovery (approximately 24 hours), LNAPL removal should be completed during a period not longer than approximately 15 minutes in order to be considered instantaneous. If large volumes (more than 5 gallons) of LNAPL are removed or removal occurs for a relatively long time period (more than 30 minutes), several interim measurements of volume removed and time will be recorded.
   d. LNAPL and water bailed from the test well will be placed into a container that is graduated to measure within 10 percent of the total estimated recovery volume for the well being tested.
5. Upon completing removal of the approximate total effective volume of LNAPL present in the well, the time will be noted and recorded as the starting point for observation of LNAPL recovery. Recovery monitoring will initially consist of collecting DTP and DTW measurements at approximately one-minute intervals for at least the first 10 minutes of the recovery period. After that time, the frequency for gauging LNAPL recovery may be reduced (based on the initial recovery results) to a minimum frequency corresponding to a change in LNAPL thickness that represents 5 percent of the equilibrium gauged thickness or 0.05 feet, whichever is less, for approximately the first 100 minutes of recovery. After the first 100 minutes of recovery, the remainder of the test can be completed by gauging measurements on a frequency corresponding to a change of 5 to 10 percent of the equilibrium thickness.
6. During recovery monitoring, LNAPL thickness data will be plotted versus the log of time to evaluate whether LNAPL thickness in the test well has reached equilibrium conditions. For the purpose of this test, LNAPL thickness will be considered to be at equilibrium conditions when the plotted data indicate a plateau for approximately one quarter to one half of a log cycle, which consists of at least three successive measurements over that period.
7. Recovery monitoring will continue until LNAPL thickness has recovered to equilibrium conditions or for 24 hours, whichever is less.

2.3 BAILDOWN TESTING WELL REDEVELOPMENT

Following completion of the first round of baildown testing, Leidos will evaluate the LNAPL recovery data in order to determine whether redevelopment of one or more of the wells is warranted and practicable. For example, based on the results of the previous LNAPL baildown testing performed in July 2005, it may not be practicable to redevelop monitoring well MW-10, which had recovered an LNAPL thickness of 2.74 feet within the first 30 minutes of recovery monitoring. Also, at the time of that test, monitoring well MW-10 did not contain a sufficient water column to conduct well development activities. However, the results of the July 2015 baildown testing do suggest that redevelopment of monitoring wells MW-12 and MW-15 would have been practicable at that time (based on generally low LNAPL thickness recovery and sufficient water column presence) and similar results would warrant redevelopment of those wells to evaluate whether LNAPL recovery rates could be increased.

Where practicable, baildown testing wells will be redeveloped per the following procedure:

1. Initial fluid measurements (DTW, DTP, total well depth) will be measured using an interface probe and recorded in the field logbook. This information will be used to calculate the volume (in gallons) of water present in the water column.
2. A disposal bailer will be used to remove any LNAPL present to a minimum removable thickness (approximately 0.05 feet or less).
3. Due to the fine-grained nature of the perched aquifer at this Site, aggressive surging (i.e., use of a surge block) will not be performed. Instead, a stainless steel bailer will be used. The bailer will be equipped with a cord marked in 5-foot increments such that the field technician can ensure agitation of the water column throughout the length of the screened interval. Following several minutes of surging action, the well will be bailed to remove particulates suspended in the water column. Surging and bailing of the well will be repeated until a volume of water equal to three times the original water column volume has been removed.
4. To the degree possible, purge water bailed from the wells will be separated from the LNAPL removed, in order to create two discrete waste streams. LNAPL and purge water waste will be managed per the procedures described in Section 4.

2.4 BAILDOWN TESTING DATA ANALYSIS

Following completion of each round of baildown testing, data from the tests will be evaluated both qualitatively and quantitatively to assess the viability of LNAPL recoverability in the monitoring wells tested.

Qualitative analysis will be performed by analysis of product thickness recovery graphs for each test. For example, if the LNAPL thickness in a test well increases rapidly during recovery to a value approaching the initial thickness, that would be a reasonable indicator that LNAPL recovery could be effective in that monitoring well. However, if LNAPL thickness has barely begun to recover after two or more hours of recovery monitoring, those results would indicate that LNAPL recovery efforts would not be effective in that monitoring well under the current conditions at the Site (Hampton, 2003).

Similar to the 2015 SRI Phase 1 transmissivity testing, quantitative analysis of the baildown test data will be performed using the most recent version of the American Petroleum Institute (API) LNAPL Transmissivity Workbook.

3. GEOPHYSICAL SURVEY

As previously discussed in the SRI Phase 2 report (Leidos, 2017), Leidos currently believes that the Site may be impacted from another gasoline source area, not related to the Chelan Chevron service station, which is believed to originate in the vicinity of monitoring well MW-21. As discussed in Section 1.2.2 of the 2006 RI/FS for the Site (SAIC, 2006), the property immediately adjacent to the north of MW-21 (141 East Woodin Avenue) was formerly the location of a garage facility with gasoline pumps from approximately the mid-1920s through the mid-1940s. A Sanborn map from 1929 and photo from the 1930s showing the fuel pump along the sidewalk in front of the building still present at 141 East Woodin Avenue is included in Appendix A of the

2006 RI/FS (SAIC, 2006). Due to the timeframe of fueling service operations on this property, little is known about the operations and no records appear to exist regarding the closure or removal of any USTs or other fueling service infrastructure that were formerly operated there.

Within the 2006 RI/FS, Science Applications International Corporation (SAIC) suggested that petroleum impacts in the vicinity of MW-21 were not associated with the Chelan Chevron service station. This conclusion was based on the occurrence of shallow soil impacts in the vicinity of MW-21, which were unlikely to be sourced from the Chevron service station given the lateral distance between these two areas and the lack of shallow soil impacts encountered in other borings between these two locations. Since that time, additional lines of evidence have been amassed to support this conclusion, including:

- LNAPL fingerprinting analysis, which confirmed significant chemical differences between LNAPL collected from monitoring well MW-21 in comparison to LNAPL collected from monitoring wells located closer to the Chevron service station site (e.g., MW-10 and MW-12); and
- The detection of gasoline-range organics (GRO) in soil at a concentration of 6,800 milligrams per kilogram in the sample collected from approximately 11 feet below ground surface in soil boring LIFB-3 during the SRI Phase 2 field activities in 2016.

Based on the evidence of significant petroleum hydrocarbon impacts in shallow soil that is in close proximity to a known former fueling service operation, and in consideration of the lack of UST closure records for the operation, Leidos proposes to conduct a non-intrusive geophysical survey in the vicinity of monitoring well MW-21 to look for evidence of orphaned USTs or other subsurface fueling service infrastructure that may still be present in that area.

3.1 GEOPHYSICAL SURVEY METHODOLOGY

To perform the geophysical survey, Leidos will subcontract the firm Geophysical Survey, LLC (Geophysical Survey) of Kennewick, Washington. Geophysical Survey has previously performed utility location survey work for Leidos at the Site and is familiar with the utility layout and surface infrastructure in the vicinity of monitoring well MW-21. Based on their understanding for the objective to survey this area for potential orphaned USTs and/or other fueling service infrastructure, Geophysical Survey has proposed the following scope of work:

1. An electro-magnetic (EM) survey will be conducted using a Geonics EM-61HH-MK2 high-sensitivity metal detector. This component of the geophysical survey will be performed to evaluate the potential presence of ferrous and non-ferrous materials within the target survey zone. This instrument is reported to be capable of detecting a single 55-gallon drum at depths of greater than 2 meters, and was selected specifically for this application due to its narrower spatial focus, which allows the unit to collect data in closer proximity to buildings and other sources with less potential for interference. EM data will be collected across the survey area on transects spaced 3 feet apart. Data will be recorded at a rate of five readings per second along each transect and digitally recorded using a data logger. Due to the location of the survey area in close proximity to buildings and other surface obstructions (which would prevent accurate location measurements by a global positioning system (GPS) receiver) location control for the EM survey will be established using a physical grid that will be marked out using a surveyor's tape. Corners of the survey grid will be mapped with a Trimble GNSS receiver, which is capable of

providing sub-foot accuracy. The location of the physical grid and all EM data will be referenced to the North American Datum of 1983 (NAD83) State Plane coordinates during post-collection processing. Geo-referenced EM data will be plotted and contoured to generate a map of EM response within the target survey zone.

2. A ground penetrating radar (GPR) survey will be conducted using GSSI SIR3000 control units and 400 megahertz antennas. This component of the geophysical survey will be performed to look for evidence of subsurface tanks or other infrastructure by analyzing the reflected signals of electromagnetic energy that is transmitted into the ground using a GPR transmitter. Using this method, buried objects and boundaries between differing materials may be located by variations in the return signal received by the GPR antennas. GPR data will be collected across the survey grid in two orthogonal directions, on transects with 3-foot spacing.

Following completion of the geophysical survey field activities, and post-data-collection processing, Geophysical Survey will prepare a report to document the methodology, findings, and interpretation of their survey data.

4. INVESTIGATION-DERIVED WASTE MANAGEMENT

Regulated investigation-derived waste (IDW) associated with the SRI Phase 3 activities is anticipated to include LNAPL and purge water that will be generated during the LNAPL baildown testing and well redevelopment activities. All regulated IDW will be containerized in 55-gallon United States Department of Transportation-approved drums. Drums containing LNAPL will be staged in a lockable secondary-containment storage unit on the Chevron service station property, and drums containing purge water will be staged in a lockable fenced compound behind the service station building, or at another location on the service station property approved by the station manager, until a waste disposal profile can be generated and off-site transportation and disposal can be arranged (typically 6 to 8 weeks). Waste disposal coordination for regulated IDW will be handled by Chevron, with support by Leidos.

Non-regulated IDW, such as nitrile gloves, plastic sheeting, and bailers will be bagged and disposed as standard municipal waste.

5. SCHEDULE

Leidos will begin planning for this project upon receipt of Ecology approval of this work plan. Project planning is expected to require approximately four to six weeks to complete, prior to the initiation of investigation field activities. However, the schedule to begin field work at the Site may also be contingent on Chevron approval, property access, street-use or other permits, contractor availability, staffing resources, and weather concerns.

Leidos will provide Ecology with at least one week's notice prior to the start of any SRI field activities.

6. REFERENCES

ASTM (2013). ASTM Standard E2856-13, "Standard Guide for Estimation of LNAPL Transmissivity." May.

Hampton, D.R. (2003) *Improving Bail-Down Testing of Free Product Wells*, Proceedings of Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Assessment and Remediation Conference 2003, National Ground Water Association, pp. 16-30.

Leidos (2015). "Supplemental Remedial Investigation Report – Phase 1, Chevron Service Station No. 9-6590." December 14.

SAIC (2006). "Final Remedial Investigation / Feasibility Study Report, Chevron Service Station No. 9-6590." December 2006.

LIMITATIONS

This technical document was prepared on behalf of Chevron and is intended for its sole use and for use by the local, state, or federal regulatory agency that the technical document was sent to by Leidos. Any other person or entity obtaining, using, or relying on this technical document hereby acknowledges that they do so at their own risk, and Leidos shall have no responsibility or liability for the consequences thereof.

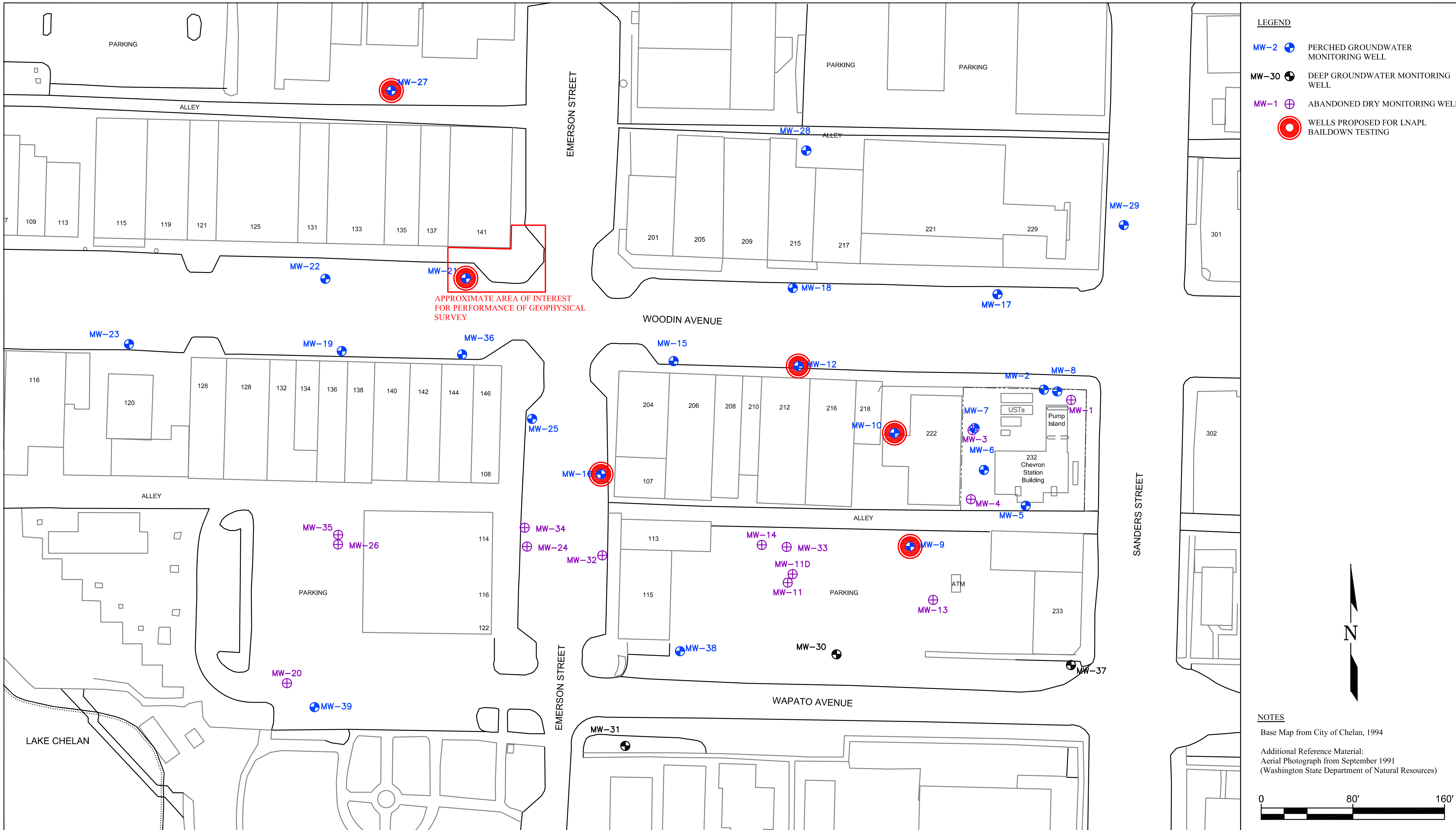
Site history and background information provided in this technical document are based on sources that may include interviews with environmental regulatory agencies and property management personnel and a review of acquired environmental regulatory agency documents and property information obtained from Chevron and others. Leidos has not made, nor has it been asked to make, any independent investigation concerning the accuracy, reliability, or completeness of such information beyond that described in this technical document.

Recognizing reasonable limits of time and cost, this technical document cannot wholly eliminate uncertainty regarding the vertical and lateral extent of impacted environmental media.

Opinions and recommendations presented in this technical document apply only to site conditions and features as they existed at the time of Leidos site visits or site work and cannot be applied to conditions and features of which Leidos is unaware and has not had the opportunity to evaluate.

All sources of information on which Leidos has relied in making its conclusions (including direct field observations) are identified by reference in this technical document or in appendices attached to this technical document. Any information not listed by reference or in appendices has not been evaluated or relied on by Leidos in the context of this technical document. The conclusions, therefore, represent our professional opinion based on the identified sources of information.

Figures



leidos

Chevron Service Station No. 96590
232 East Woodin Avenue
Chelan, Washington

FIGURE 1
Site Map with Proposed SRI Phase 3 Investigation Locations

FILE NAME: 96590_Site Map_2017.dwg

DATE: 10/18/2017