Soil Excavation Work Plan
Quail Crossing Neighborhood
Andover, Kansas

Prepared for:
NuStar Pipeline Operation Partnership L.P.

August 19, 2015
1641-08
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1.0 Introduction

This Detailed Soil Excavation Work Plan (Work Plan) was prepared by Apex Companies, LLC (Apex) on behalf of NuStar Pipeline Operating Partnership L.P. (NuStar) in response to a gasoline release from a NuStar refined-petroleum pipeline. The pipeline release was discovered in 2012 after separate-phase hydrocarbons (SPH) were detected in an irrigation well at 2006 N Colt Court, in the Quail Crossing Neighborhood (the Neighborhood) of Andover, Kansas (the Site; Figure 1). As shown on Figure 2, the NuStar pipeline is located less than 50 feet from the affected irrigation well and the release location is approximately 80 feet north of the affected irrigation well.

In response to the release, NuStar performed a number of emergency response actions, including: (1) inspections and testing of the pipeline; (2) hydrotesting of the identified affected portion of the pipeline; (3) excavation and removal of soil containing petroleum constituents along a 45-foot section of pipeline; (4) replacement of a portion of the pipeline; (5) collection and analysis of water samples from the irrigation well at 2006 N Colt Court; (6) field screening of nearby irrigation wells; (7) vacuum and manual removal of separate-phase hydrocarbons (SPH) and water for the irrigation well at 2006 N Colt Court; and (8) deactivation of the irrigation well at 2006 N Colt Court and irrigation wells at other properties, and connection of the associated irrigation systems to the municipal water supply. In July through September 2013, a Comprehensive Investigation (CI) and groundwater monitoring program were implemented. Based on these investigations, NuStar determined that petroleum constituents were present in the vicinity of the release location. To address the residual petroleum constituents in soil, NuStar proposed to implement a soil interim remedial measure (IRM), consisting of soil vapor extraction (SVE).

NuStar performed an SVE pilot test in December 2013 to evaluate the feasibility of SVE technology for remediating petroleum constituents in soil. The pilot test results, which were presented in the SVE Evaluation and Proposed Soil Investigation Report (Apex, 2014b), indicated that SVE may be an effective remedial technology to remove petroleum constituents from the subsurface. NuStar presented the preliminary results of the SVE pilot test and a conceptual SVE system design to the Neighborhood in a meeting on February 17, 2014. The conceptual design included design enhancements such as noise mitigation, location of infrastructure, and aesthetic elements. Neighborhood representatives indicated that they would not approve of the construction and operation of an SVE system, and cited a number of reasons for not accepting an SVE system.

In consideration of Neighborhood concerns, NuStar evaluated excavation as a method of removing residual petroleum constituents in subsurface soil. Accordingly, in April 2014, a soil investigation was performed to further refine the understanding of petroleum constituents in the subsurface, and to define the extent of the prospective soil excavation. The investigation was performed in accordance with SVE Evaluation and Proposed Soil Investigation Report (Apex, 2014b), which was approved by the Kansas Department of Health and Environment (KDHE) on April 3, 2014. Data collected during the 2014 investigation (Apex, 2014b),
along with previously collected data, indicated that soil containing petroleum constituents appears to be limited to the vicinity of the pipeline release, deeper than approximately seven feet below the ground surface (bgs).

The results of the 2014 investigation were presented in the *Soil Investigation Report and Proposed Soil Excavation Work Plan*. The work plan described proposed excavation methods and a general excavation design for removing vadose zone soil affected by petroleum constituents. KDHE approved the work plan on August 8, 2014. Subsequently, KDHE requested submittal of a detailed excavation work plan to document more specific materials and methods for the planned excavation. In addition to the standard excavation permit normally required for a project of this scope, the City of Andover requested a survey of the current infrastructure elevations and engineered excavation, backfill, and surface restoration plans; NuStar obtained approved from the City of Andover for those items, which are presented herein.

In response to the requests from KDHE and the City of Andover, this Work Plan was prepared. This Work Plan provides a detailed description of the means, methods, and schedule for completing the excavation and restoring the excavation area.

### 1.1 Objectives

The objective of the planned excavation is to remove petroleum constituent mass from the subsurface. Removal of source material will ultimately result in improved groundwater quality at the Site. The purpose of this Work Plan is to describe the means and methods that will be used to complete the soil excavation, document soil conditions at the excavation boundaries, and restore the excavation area.

### 1.2 Report Organization

This report is organized as follows:

- **Section 2** – Previous Subsurface Investigations – This section summarizes subsurface investigations performed at the Site between July 2012 and March 2015.

- **Section 3** – Geology and Hydrogeology – This section describes local and regional geology and hydrogeology.

- **Section 4** – Extent of Petroleum Constituents in Soil – This section presents: (1) a description of the physical setting of the Site; (2) summarizes investigations that have been completed to investigate the nature and extent of petroleum constituents in Site soil; and (3) describes the horizontal and vertical extent of petroleum constituents in soil.

- **Section 5** – Soil Excavation Plan – This section describes the: (1) preparatory activities, including an as-built survey of existing infrastructure, including curb and gutter, underground utilities, and asphalt-concrete (AC) street surface; (2) methodology for the soil excavation, including AC cutting
and removal; (3) management of AC road surface and excavated soil; (4) introduction of oxygen releasing compound (ORC); (5) backfilling and compaction testing; (6) replacement of road and curb surfaces; and (7) traffic control plan.

- **Section 6 – Schedule** – This section describes the work and reporting schedule.

### 2.0 Previous Subsurface Investigations

This section summarizes investigations performed at the Site between July 2012 and March 2015. These investigations include: (1) initial abatement activities – 2012; (2) CI – 2013; (3) soil investigation – 2014; and (4) groundwater pilot test – 2015. As shown on Table 1, 83 soil samples have been collected at the Site and submitted for laboratory analysis during the period July 2012 through March 2015, and many more samples were field screened during that period. As shown on Figure 3, 23 borings were advanced in the immediate vicinity (within 60 feet) of the release location. The data compiled during these investigations refined the understanding of the nature and extent of petroleum constituents in soil. This information is the basis for the excavation design that is presented in Section 5.

#### 2.1 Previous Investigations – 2012 through 2014

This Section summarizes findings of environmental investigations performed between 2012 and 2014. This information has been presented in previous reports (Apex, 2012, 2014a, 2014b). Refer to the previous reports for more details.

##### 2.1.1 Initial Abatement Activities – 2012

Several initial abatement activities were conducted in response to the pipeline release. These activities were described in the *Initial Response Report* (Apex, 2012). Initial abatement activities included excavation and off-site disposal of soil containing petroleum constituents at the pipeline release area. In July 2012, NuStar excavated approximately 16 cubic yards of soil containing petroleum constituents from the pipeline release area and replaced the affected portion of the pipeline. KDHE personnel observed these activities. The lateral extent of the excavation at the release location was limited by buried utility infrastructure, a public roadway, and private property boundaries. The vertical extent of the excavation was limited by lithified/dense material, which limited excavation depth with standard equipment to a maximum of 13 feet bgs (Apex, 2014a). The excavated soil was transported off-site to the NuStar El Dorado landfarm facility for treatment and disposal. The 2012 excavation location and boundaries are shown on Figure 2.

Separate-phase hydrocarbons were not observed in the excavation or soil from the surface to 13 feet bgs. As shown in Table 1 and on Figure 4, soil samples were collected from the south and north sidewalls and the floor of the excavation, at depths of 6 and 13 feet bgs, respectively. The soil samples collected from the north sidewall and the base of the excavation contained concentrations of gasoline-range
organics (GRO), benzene, and/or toluene above the corresponding KDHE Tier 2 Risk-Based Screening Values (RBSVs) for the soil to groundwater pathway.

2.1.2 Comprehensive Investigation Activities – 2013

The CI was performed following the initial response activities; results of the CI were presented in the Comprehensive Investigation Report (Apex, 2014a). Activities completed during the CI included soil screening for indications of SPH, and collection and analysis of 23 soil samples from 16 soil borings. Separate-phase hydrocarbons were not observed in the borings; only one soil sample from boring location B-1 (approximately 30 feet southwest from the release location), contained a benzene concentration above the corresponding KDHE Tier 2 RBSV for the soil to groundwater pathway. This sample was collected from 21 feet bgs, and is representative of material underlying vadose-zone soil. GRO and volatile organic compounds (VOCs) were not detected or were detected at concentrations below the corresponding KDHE Tier 2 RBSVs in the remaining 22 samples.

2.1.3 Soil Investigation – 2014

In April 2014, 12 soil borings (B-2 through B-13) were advanced in the vicinity of the pipeline release location (within approximately 25 feet of the NuStar pipeline, as shown on Figure 3) to further define the extent of petroleum constituents in vadose-zone soil. The results of the investigation were presented in the Soil Investigation Report and Proposed Soil Excavation Work Plan (Apex, 2014c).

Separate-phase hydrocarbons were not observed in the more than 150 soil samples screened for the presence of SPH in borings B-2 through B-13. As listed in Table 1, soil samples were collected for chemical analysis from borings B-2 through B-13. As shown on Figure 3, soil samples collected from locations B-2, B-3, B-4, B-5, B-6, B-7, B-10, and B-12 contained petroleum constituents above KDHE Tier 2 RBSVs in the 6 to 18 foot depth interval. Samples collected from locations B-1, B-8, B-9, B-11, B-13, MW-1, MW-4, and MW-5 at this depth interval did not exhibit petroleum constituent concentrations above KDHE Tier 2 RBSVs; therefore, these borings define the extent of petroleum constituents in vadose-zone soil. In the vicinity of the release, groundwater fluctuates from 18 to 32 feet bgs, so vadose zone soil is present to a depth of 18 feet bgs. As detailed in Section 5.0, the soil represented by samples B-2, B-3, B-4, B-5, B-6, B-7, B-10, and B-12 is targeted for excavation to remove the majority of petroleum constituent mass from the vadose zone.

2.2 Groundwater Pilot Test – March 2015

In March 2015, the Groundwater Pilot Test Work Plan (Apex, 2015a) was initiated. The pilot test included installation of three groundwater monitoring wells, completion of nine temporary borings, injection of ORC Advanced® into temporary borings, and groundwater monitoring. A detailed description of the methods and preliminary results of the pilot test will be presented to KDHE in the third calendar quarter of 2015. This
section presents pilot test observations that are relevant for refining the understanding of subsurface conditions at the site for implementation of the remedial excavation.

In March 2015, 12 soil borings (IB-1 through IB-9 and MW-17 through MW-19) were advanced approximately 20 to 50 feet east of the pipeline release location as shown on Figure 3. These boring locations are shown on Figure 2. The borings were advanced using a sonic drill rig to total depths of 40 to 45 feet bgs. Continuous soil cores were extracted and soil lithology was logged in general accordance with ASTM 2487/2488. Soil samples were field screened for VOCs and SPH using a photoionization detector (PID) and sheen tests, and submitted for laboratory analysis GRO by Iowa Method OA-1 and VOCs by U.S. Environmental Protection Agency (EPA) Method 8260B.

The pilot test was the first phase of investigation at the Site in which borings were advanced using sonic drilling equipment. In general, soil physical properties, PID screening, and analytical data observed during the March 2015 investigation were consistent with the soil data collected during previous investigations. In addition, the continuous soil cores extracted using sonic tooling provided improved information about subsurface conditions, resulting in an improved conceptual site model. Soil analytical data are presented on Table 1 and shown on Figures 3 and 4.

The following conditions were observed during the March 2015 investigation.

- Soil (clay and silty clay) was encountered between the surface and approximately 13 feet bgs.
- The soil was underlain by gray, yellow, and olive brown shale, interbedded clays, and limestone. The observation of shale at approximately 13 feet bgs is consistent with: (1) excavation refusal with standard equipment at that depth in July 2012; and (2) conditions observed during the 2013-2014 investigations and information depicted in area irrigation well logs. Boring logs for the July 2013 and July 2014 activities were provided in previous reports (Apex, 2014a; Apex, 2014b, respectively); boring logs for the 2015 activities are included in Appendix A.
- At the time of drilling, groundwater was encountered in the range of 20 to 30 feet bgs; the shallowest groundwater was encountered at 20 feet bgs in boring IB-4, which is the boring closest to the release location (approximately 15 feet to the southeast of the release location).
- Separate-phase hydrocarbons were not observed in the vadose zone (from the ground surface to 18 feet bgs) in the borings.
- Field screening data (using headspace vapor measurements and sheen testing), performed on approximately 200 soil samples and laboratory analytical data from 15 samples, demonstrate that petroleum concentrations in vadose-zone soil that exceed KDHE Tier 2 RBSVs are generally limited to the area shown on Figures 4 and 5. As detailed in Section 5.0, these soils are proposed for excavation to remove the majority of petroleum constituent mass from the vadose zone.
Petroleum concentrations in soil that exceed KDHE Tier 2 RBSVs were detected in the interval between approximately 19 and 31 feet bgs, corresponding to the seasonally saturated zone. Therefore, petroleum constituent concentrations in this zone are indicative of groundwater concentrations or fluctuating groundwater conditions, and do not represent vadose-zone soil.

### 3.0 Geology and Hydrogeology

This section discusses the physical characteristics of the Site, including geology and hydrogeology. The following discussion is based on data obtained during previous investigations (Apex, 2012, 2014a, and 2014b) as well as information presented in reports prepared by the Kansas Geological Survey (Aber, 1991; O’Connor et al., 1982).

#### 3.1 Geology

The regional geology in Butler County consists of unconsolidated sediments, including Tertiary and Quaternary alluvium and Quaternary loess at the ground surface, overlying lower Permian limestone and shale of the Council Grove and Chase Groups (Aber, 1991). O’Connor et al. (1982) report that the uppermost bedrock unit at the Site is the Permian Wellington Formation, which reportedly consists of up to 100 feet of light gray and green silty shale, with some thin limestone and gypsum beds. The Wellington Formation is underlain by the Nolans Limestone formation, which is approximately 20 to 30 feet thick and consists of a light-buff limestone and dolomite in upper part.

Geological conditions at the Site are generally consistent with regional conditions, based on information presented in irrigation well construction logs (surface to 116 feet bgs) and observations in borings (surface to 65 feet bgs) advanced during the CI. At the Site, yellowish-brown clay (loess) is generally encountered from the surface to depths of approximately 10 to 13 feet bgs. The clay is underlain by gray, yellow, and olive brown shale; interbedded clays; and limestone of the Wellington Formation. The Wellington Formation is weathered at the interface between consolidated and unconsolidated sediments. Thin layers of gypsum are occasionally encountered in the shale.

#### 3.2 Groundwater / Aquifer Characteristics

This Section describes the regional groundwater conditions and those observed at the Site.

##### 3.2.1 Regional Conditions

The Site and surrounding area are generally flat, although regional topography slopes gently to the east, toward the Whitewater River, which is approximately 4 miles east of the Site. O’Connor et al. (1982) report that the uppermost water-bearing unit at the Site is the Wellington Formation. O’Connor et al. indicate that the productivity and quality of water from the Wellington Formation is limited. A regional groundwater
elevation map prepared by O’Connor et al. (1982) indicates that the groundwater level near the Site is approximately 1,320 feet above mean sea level (MSL), with a 0.005 foot per foot (ft/ft) easterly gradient.

O’Connor et al. also report that the shale units in southwest Butler County are relatively impermeable or of very low permeability with respect to vertical groundwater flow below approximately 50 feet. These conclusions indicate that the potential for vertical migration of contaminants in groundwater below approximately 50 feet is low.

3.2.2 Site Conditions

Observations from 23 borings completed between 2012 and 2015 in the immediate vicinity (within 60 feet) of the release location showed that vadose zone occurs between the surface and approximately 18 feet bgs (Apex, 2015b). During the 2015 groundwater pilot test, groundwater was observed at depths ranging from 20 to 30 feet bgs in those borings, with the shallowest groundwater observed in boring IB-4 (approximately 15 feet southeast of the release location). Depth-to-groundwater measurements obtained in April 2015 showed groundwater depths of 21 to 34 feet bgs in the vicinity of the release.

The groundwater interface at the site occurs in lithified material between approximately 18 and 32 feet bgs. Petroleum constituents are generally absent from samples of rock obtained below approximately 31 feet bgs. These conditions are consistent with the description of the Wellington Formation reported by O’Conner et al. (1992), including the reported low potential for vertical migration below approximately 50 feet.

The maximum design depth of the excavation is 17 feet bgs; therefore, groundwater is not expected to be encountered during the work proposed herein.

4.0 Extent of Petroleum Constituents in Soil

The data compiled during the previously discussed multiple investigations have refined the understanding of the nature and extent of petroleum constituents in soil. As shown on Figure 3, 23 borings were advanced in the immediate vicinity (within 60 feet) of the release, with 12 of those borings installed between the release area and the affected irrigation well. Field screening data (sheen test and PID measurements) from over 350 soil samples collected between July 2012 and March 2015 show that there is no indication of SPH in the vadose zone. Laboratory analytical data from 33 borings (80 samples) collected between 2012 and 2015 show that: (1) petroleum constituents either were not detected or were detected at concentrations less than Tier 2 RBSVs) between the surface and approximately six feet bgs (the depth of the NuStar pipeline); and (2) residual petroleum constituents in the vadose zone that exceed KDHE Tier 2 RBSVs are primarily within the interval between approximately 6 and 18 feet bgs.
Table 1 lists soil data collected between July 2012 and March 2015. Figure 4 shows the approximate extent of petroleum constituents in soil from 6 to 18 feet bgs. The lateral extent of soil with petroleum constituents in the vadose zone is approximately defined by borings B-1, B-8, B-9, B-11, B-13, MW-1, MW-4, MW-5, IB-4; these borings did not exhibit vadose zone petroleum concentrations above KDHE Tier 2 RBSVs. As detailed in Section 5.0, the soil represented by samples B-2, B-3, B-4, B-5, B-6, B-7, B-10 and B-12 is targeted for excavation to remove the majority of remaining petroleum constituents in vadose zone soil.

5.0 Soil Excavation Plan

NuStar proposes to excavate vadose-zone soil in the area shown on Figures 4 and 5. Consistent with the City of Andover requirements, NuStar retained ASM Engineering Consultants, LLC, under subcontract to CDH Incorporated (CDH), to develop excavation and site restoration designs required by the City of Andover. These designs, included in Appendix B, have been approved by the City of Andover. The lateral boundaries of the excavation encompass the area where vadose zone soil concentrations exceed KDHE Tier 2 RBSVs. Vertically, the excavation will extend to depths as great as 17 feet bgs however, refusal using standard excavation equipment may occur upon encountering lithified material at shallower depths (e.g., 10 to 13 feet) in some areas.

Depending upon the depth of the excavation, approximately 1,000 cubic yards of soil, partially lithified material, and weathered rock will be removed and transported off-site for treatment and/or management. Prior to backfilling, Advanced Formula Oxygen Release Compound (ORC Advanced®) will be added to the excavation to enhance aerobic microbial degradation of residual petroleum constituents in the subsurface. The ORC amendment process is detailed in Section 5.4. The following section presents the methods and procedures for the soil excavation and site restoration.

5.1 Excavation Area and Depth

The proposed excavation area is shown on Figure 5. A generalized cross-section of the planned excavation is presented on Figure 6; the general engineering design and restoration material are shown on Figure 7. A detailed excavation design, which has been approved by the City of Andover, is included in Appendix B. As shown on Figure 5, the lateral boundaries of the excavation encompass the majority of the area where vadose zone soil contains petroleum constituent concentrations exceeding KDHE Tier 2 RBSVs. The lateral boundaries of the excavation on the north, west, and south extents are limited by private property and underground utilities (natural gas piping on the south and water piping on the north and west). The limits of the excavation are not expected to encroach on the municipal water pipe and natural gas lines.

The vertical extent of the excavation includes soil between the surface and as deep as approximately 17 feet bgs. Target excavation depths may be reduced if excavation refusal using standard excavation equipment is encountered at shallower depths. The maximum excavation depth is limited by the depth of
lithified material, sidewall stability, and requirements for protecting underground utilities. In some peripheral areas, total excavation depth will be limited to the extent necessary for excavation safety.

As shown on Figure 6, the soil beneath the NuStar pipeline was previously excavated to a maximum depth of 13 feet bgs (Apex, 2014a). The proposed excavation area does not include soil in this limited area in order to maintain soil stability in the vicinity of that section of the NuStar pipeline, which was replaced in 2012. When complete, the majority of petroleum affected soil in the vadose zone at the pipeline release area will be removed. Any remaining minimal residual constituents will be beneath impermeable asphalt (Mountain Street); accordingly, the potential for future vertical migration of these constituents is limited.

5.2 Excavation Procedures

This section describes the steps that will be taken to prepare for and implement the planned excavation.

5.2.1 Preparatory Activities

Preparatory activities include Neighborhood notification, the preparation of a health and safety plan (HASP), procurement of subcontractors, finalization of the excavation permit with the City of Andover, identification of underground utilities, and preparation of a traffic control plan.

- The owners of properties in the Quail Crossing Neighborhood will be notified of planned excavation activities a minimum of four weeks in advance of field work. The soil excavation will be performed within: (1) the NuStar Pipeline right-of-way (ROW); and (2) the City of Andover ROW. NuStar executed an access agreement and an excavation permit with the City of Andover in 2013.

- A site-specific HASP is included in Appendix C.

- Apex plans to retain CDH, a NuStar recommended and Kansas-licensed excavation contractor, to implement the planned excavation activities and to restore the site. NuStar retained ASM Engineering Consultants, LLC, under subcontract to CDH, to develop excavation designs required by the City of Andover.

- NuStar coordinated with the City of Andover to provide the information and designs required by the City for issuance of an excavation permit. The City of Andover has provided approval of the excavation design and site restoration plans included in Appendix B.

- Underground utilities in the proposed excavation area have been surveyed by public and private utility locating contractors. Utilities are depicted on designs included in Appendix B. A renewed utility locating request will be submitted at least three days prior to the initiation of excavation activities.

- A traffic control plan included is in Appendix B; that plan was approved the City of Andover on April 13, 2015. The traffic control plan describes the methods that will be used to ensure excavation safety while minimizing traffic disruptions. We anticipate that a small portion of W. Mountain will be
closed to through traffic for a period of 30 days. While the temporary closure may be a minor inconvenience to some Neighborhood residents, it will not prevent access to any Neighborhood properties, as alternative routes are available.

5.2.2 Construction Hours and Schedule

Soil excavation activities, including trucking and site restoration will be limited to the hours between 8:00 AM and 6:00 PM, Monday through Friday. NuStar will coordinate the specific work hours and schedule with the local U.S. Post Office and Andover Public Schools to minimize disruption; these hours will be modified as necessary based on Neighborhood input. The anticipated maximum duration of the work outlined herein is 30 days.

5.2.3 Staging Area

A staging area, used for storage of equipment and materials, will be established at 1607 N Prairie Creek Road. NuStar has an access agreement with the landowner at this address to use the location as a staging area.

5.2.4 Site Security

Prior to implementation of the excavation, an exclusion area will be established by erecting temporary construction fencing around the work area. The fencing will be chain-link style, and a minimum 6 feet high. The fencing will be maintained until the work area is restored. The approximate fencing location is shown in Appendix B.

5.2.5 Traffic Control

A Traffic Control Plan, which was approved by the City of Andover in an email dated April 13, 2015, is presented in Appendix B.

5.2.6 Asphalt-Concrete Pavement Removal

AC pavement will be saw cut at the boundaries of the proposed excavation. AC will be removed with an excavator (CAT 330D) and front end loader (CAT 950K). Soil will be transported in Kenworth T800 and W900 trucks with covered half-round trailers to APAC’s Augusta asphalt plant (11221 SW US Highway 54 in Augusta, Kansas) for recycling. The approximate extent of AC removal is shown in Appendix B. Baserock, present and separable from the underlying soil, will also be transported to APAC’s Augusta asphalt plant.
5.2.7 Soil Excavation

Soil excavation will be initiated on the south side of the pipeline, using an excavator (CAT330D) and front end loader (CAT 950K). It is anticipated that approximately 1,000 cubic yards of material will be excavated. Excavated soil will be direct-loaded into trucks with half round end dump trailers and, pending KDHE approval, will be hauled to the NuStar El Dorado Landfarm for treatment. After placement of the soil at the Landfarm, four grab soil samples will be collected. Soil samples will submitted to an accredited laboratory for analysis of: GRO by Iowa Method OA-1; and BTEX, 2-butanone, n-butylbenzene, naphthalene, n-propylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, cyclohexane, isopropylbenzene, and methylcyclohexane by EPA Method 8260B. Detailed soil sampling procedures are described in the Sampling and Analysis Plan (SAP; Appendix D).

Overburden and underlying petroleum affected soil will not be segregated because the overburden soil is unlikely to be suitable for re-use as backfill. Trucks leaving the Site will be required to comply with applicable state and local codes and any other rules or conditions as required by permit or jurisdiction pertaining to transport of contaminated soil.

The excavation activities will be terminated when the excavation meets the design specifications (Appendix B) or upon practical refusal, whichever occurs first. Excavation equipment will be decontaminated after the excavation is complete.

5.2.8 Truck Route

Trucks will be staged and routed to avoid soil track out from the excavation area. Trucks will enter and exit the excavation area via Lakeside Drive from the east and via Quail Crossing from the west.

5.2.9 Dust Control Measures

Dust control monitoring will be continuous throughout the duration of the project. Street sweeping will be performed at the completion of the project, or at more frequent intervals, if necessary.

Based upon previous observations, we anticipate that soil moisture will be sufficient to keep airborne soil particulates to a minimum during excavation, loading, and unloading. However, the following steps will be implemented, if necessary, to control dust:

- Work will be suspended if wind speed is sufficiently elevated to cause visible airborne dust.
- Water will be applied to the excavation area if necessary.
- Any soil or sediment that enters any streets because of truck traffic from the Site will be immediately cleaned up.
5.2.10 Backfill

The excavation backfill specifications were approved by the City of Andover in an email dated April 13, 2015. As shown on Figure 7, the excavation will be backfilled with controlled-density fill (CDF) from the bottom of the excavation to seven feet bgs. CDF will be obtained from a source approved by the engineer and meet "Flowable Fill" specifications adopted by the City of Andover. The excavation will be backfilled with imported granular fill from seven feet bgs to approximately one foot bgs; imported granular fill will meet the specifications presented in Appendix B, and will be obtained from a source approved by the engineer. Backfilling may be phased if necessary to stabilize excavation sidewalls and or improve excavation efficiency. That is, portions of the excavation may be backfilled prior to completion of soil removal at other areas.

Consistent with BER Policy BER-RS-048, analytical testing for contaminants is not proposed because the backfill material is AB-3 and CDF.

5.2.11 Site Restoration

Ground surfaces will be restored following excavation backfilling. AC, Portland cement concrete (PCC), and landscaped areas will be restored in accordance with the specifications included in Appendix B; in addition, the affected portion of West Mountain Street will be resurfaced. These specifications were approved by the City of Andover in an email dated April 13, 2015.

5.2.12 Water Management

As discussed in Section 6.0, the work outlined herein is proposed for September 2015. Based on groundwater monitoring performed since 2012, we anticipate that the depth to groundwater during typical September groundwater level conditions will exceed the maximum proposed depth of excavation; therefore, groundwater will not likely be encountered. Groundwater monitoring wells in the vicinity of the release location (MW-1, MW-3, MW-4, MW-5, and MW-17 through MW-19) will be gauged to confirm that depths to groundwater are consistent with historical observations; the excavation will be postponed if abnormally high groundwater conditions are observed. As shown in Appendix B, sandbags will be positioned to ensure that surface water runoff (i.e., from precipitation) cannot enter the excavation. In the event that surface water runoff does enter the excavation, it is likely to be limited in volume and will be allowed to infiltrate prior to additional excavation. As shown in Appendix B, stormwater management will include: (1) erosion control best management practices (BMPs) to ensure that stormwater runoff is minimized; (2) storage of excavated soil in drop boxes at the site in accordance with erosion control BMPs; and (3) installation and maintenance of approximately 267 linear feet of silt fence barriers will be installed and maintained. These stormwater management specifications were approved by the City of Andover in an email dated April 13, 2015.
5.2.13 **IDW Management**

Investigation-derived waste (IDW) will consist of decontamination water and personal protective equipment (PPE). A small volume of decontamination water will be generated; it will be managed with the excavated soil. PPE will be disposed of as unregulated solid waste.

5.3 **Confirmation Soil Samples**

As discussed in Section 2, the magnitude and extent of petroleum constituents in soil have been characterized during several previous phases of investigation. Based on these data, the necessary extent of excavation was established in the *Soil Excavation Report* (Apex, 2014), which was approved by KDHE on August 8, 2014. Subsequently collected data (Apex, 2015a) confirm that the previously proposed excavation area is appropriate. Although detailed soil characterization has been completed at the site, confirmation soil samples will be collected to document soil quality at the sidewalls and bottom of the excavation.

During excavation, excavated soil will be logged for lithologic description and field screened for VOCs and SPH using a photoionization detector (PID) and sheen tests, in accordance with Standard Operating Procedure (SOP) 2.1, included in Appendix D. Upon completion of the excavation, samples will be collected from the sidewalls at a frequency of at least one sample per 200 square feet. We anticipate that the sidewall excavation area will be approximately 2,200 ft²; therefore, approximately 11 confirmation soil samples will be collected for laboratory analysis.

Soil samples will be collected from the base of the excavation if the material is not overly lithified. Soil sample locations will be selected based upon the soil that exhibits the most significant evidence of VOCs. In the absence of field indications of petroleum constituents, confirmation soil samples will be collected at random locations. Additional soil samples may be collected if unanticipated conditions are encountered or if deemed necessary to more fully define the nature and extent of residual petroleum constituents in the subsurface. In the event that field screening data and/or confirmation soil sample data suggest that significantly elevated concentrations of petroleum constituents are present in soil outside of the planned boundaries of the excavation, NuStar will perform additional excavation, if practicable. If additional excavation is not feasible (due to utility or private property conflicts), NuStar will coordinate with KDHE.

Soil samples will submitted to an accredited laboratory for analysis of: GRO by Iowa Method OA-1; and BTEX, 2-butane, n-butylbenzene, naphthalene, n-propylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, cyclohexane, isopropylbenzene, and methylcyclohexane by U.S. EPA Method 8260B. Soil samples will be submitted to the lab for 24-hour turnaround time. The expedited turnaround time will provide the opportunity to identify areas that may require additional excavation. Detailed soil sampling procedures are described in the SAP (Appendix D).
5.4 ORC Amendment

When the excavation is complete, and prior to backfilling, ORC Advanced® will be placed on the floor of the excavation to enhance aerobic degradation of residual petroleum constituents that may remain in the subsurface. A variety of oxygen releasing compounds were considered for this purpose (e.g., Oxygen Release Compound [ORC®], Advanced Formula Oxygen Release Compound [ORC Advanced®], PermeOx Plus®, and O-SOX™). ORC Advanced®, a calcium oxy-hydroxide, which produces a controlled release of molecular oxygen into the subsurface, was selected for the Site because it is a safe food-grade compound that has a long track record of success at sites throughout the U.S. It will be mixed with water on-site and applied in a slurry form, which will allow penetration into the formation. Based upon analytical data collected at the Site, the manufacturer recommended the use of approximately 1,350 pounds to line the bottom of the excavation prior to backfilling. The ORC Advanced® is expected to stimulate aerobic degradation of residual petroleum constituents in the vicinity of the application area. This is expected to reduce concentrations of petroleum constituents beneath the pipeline. ORC Advanced® specifications are included in Appendix E.

5.5 Quality Assurance and Quality Control

Quality assurance / quality control (QA/QC) procedures will be used throughout this project and are described in detail in the SAP (Appendix D). The quality assurance/quality control (QA/QC) procedures detailed in the SAP include sampling and custody procedures, QA sampling analyses (such as analysis of duplicates), laboratory detection limit goals, laboratory QC, and QA reporting.

6.0 Schedule

NuStar has targeted the work outlined herein to begin in September 2015; in general, weather conditions and groundwater levels are amenable to excavation in the Andover area at this time of year. The scope of work described herein will be initiated after: (1) KDHE approval of the Work Plan; and (2) Neighborhood review of the methodology outlined herein. It is estimated that the field activities will take approximately four weeks, including restoration. The work outlined herein is weather dependent; accordingly, we anticipate that weather or field conditions may cause significant delays. The results of the excavation will be presented and discussed in a report to be submitted within 60 days following receipt of the analytical data. The report will document the scope, methods, and results of the activities proposed herein.
7.0 References


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## Table 1

Soil Analytical Data—July 2012 through March 2015
Andover Colt Court Release Site
Andover, Kansas

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<td>&lt;0.005</td>
<td>&lt;0.01</td>
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<tr>
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<tr>
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<td>&lt;0.005</td>
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<td>&lt;0.005</td>
<td>&lt;0.005</td>
<td>&lt;0.005</td>
</tr>
</tbody>
</table>

**Notes:**

1. **GRO** = Gasoline-range organics quantified by IOWA OA-1.
2. Volatile organic compounds by U.S. Environmental Protection Agency (EPA) Method 8260B.
3. mg/kg (ppm) = Milligrams per kilogram (parts per million).
4. **Bold** indicates detected concentration above the KDHE screening value.
5. < = Not detected above the method reporting limit (MRL).
6. -- = A KDHE Tier 2 Risk Based Screening Value has not been established.
8. bgs = below ground surface

**Detailed Soil Excavation Work Plan**
Quail Crossing Neighborhood
1641-08
Page 3 of 3
Site Location Map
Excavation Work Plan
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Andover
KANSAS

Approximate Scale in Feet
0 2,000 4,000

Note: Base map prepared from USGS 7.5-minute quadrangles of Andover, KS, dated 2012 as provided by USGS.gov.

Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

Project Number 1641-08
Figure 1

August 2015
Vadose-Zone Soil Analytical Results - 6 to 18 Feet Below Ground Surface

Excavation Work Plan
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

Project Number: 1641-08
Figure 4

August 2015

Legend:

MW-1 Monitoring Well Location
Deactivated Irrigation Well

Boring Location
(IB = Injection Boring Location)

Floor Soil Sample Location

Property Line

Pipeline

Pipeline Easement Boundary

GAS Approximate Gas Line

W Approximate Water Line

Dissolved-Phase Constituent Concentrations > KDHE Tier 2 RBSVs

Dissolved-Phase Constituent Concentrations Not Detected or < KDHE Tier 2 RBSVs

Scale in Feet

Extent of Petroleum Constituents in Soil > KDHE Tier 2 RBSVs

Total Extent of Excavation Area

Sample Depth (Feet)

Concentration in mg/kg

Sample Date

Abbreviations

GRO Total Petroleum Hydrocarbons
Gasoline-Range

BEN Benzene
Legend:

MW-1 Monitoring Well Location
- Deactivated Irrigation Well

B-1 Boring Location (IB = Injection Boring Location)

Floor Soil Sample Location

P Property Line

Pipeline

\[ \text{GAS} \]

\[ \text{W} \] Approximate Gas Line

\[ \text{W} \] Approximate Water Line

A A' Cross-Section Location (See Figure 5)

[2'] Proposed Excavation Area and [Depth in Feet Below Ground Surface]

Extent of Petroleum Constituents in Soil > KDHE Tier 2 RBSVs

Scale in Feet

0 20 40

Soil Excavation Area

Excavation Work Plan
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Aerial photograph provided by Google Earth Pro Maps.com (March 12, 2013).
VARIABLE EXCAVATION DEPTH DEPENDING UPON ABILITY TO EXCAVATE ROCK AND/OR CONSOLIDATED MATERIAL USING STANDARD EXCAVATION EQUIPMENT

Approximate Extent of July 2012 Excavation (Depth and Width Varies)

Legend:

Approximate Extent of July 2012 Excavation

Excavation Extent
Excavation Work Plan
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Legend:

Approximate Extent of July 2012 Excavation

Figure August 2015
Approximate Scale in Feet

0 5 10

Project Number 1641-08
August 2015

Excavation Extent
Excavation Work Plan
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Legend:

Approximate Extent of July 2012 Excavation

Figure August 2015
Approximate Scale in Feet

0 5 10
The diagram illustrates the excavation work plan for the NuStar Pipeline Operating Partnership L.P. in Andover, Kansas. It shows the existing ground surface, natural gas line, and municipal water line. The excavation limits are indicated, and the stabilization zone (corresponding with the 2012 excavation area) is marked. The variable excavation depth depending upon the ability to excavate rock and/or consolidated material using standard excavation equipment is shown. The project number is 1641-08, and the site restoration materials include existing ground surface, 6" topsoil, natural gas line, municipal water line, new pavement and curb, imported granular fill, rock and/or consolidated material (13 feet BGS), orc amendment, flowable fill, and variable excavation.
Sample Descriptions
Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, and grain size, and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
MAJOR CONSTITUENT with additional remarks; color, moisture, minor constituents, density/consistency.

Density/Consistency
Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits and push probe explorations is estimated based on visual observation and is presented parenthetically on test pit and push probe exploration logs.

<table>
<thead>
<tr>
<th>SAND and GRAVEL</th>
<th>Standard Penetration Resistance in Blows/Foot</th>
<th>SILT or CLAY</th>
<th>Standard Penetration Resistance in Blows/Foot</th>
<th>Approximate Shear Strength in TSF</th>
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</thead>
<tbody>
<tr>
<td>Density</td>
<td></td>
<td>Density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very loose</td>
<td>0 - 4</td>
<td>Very soft</td>
<td>0 - 2</td>
<td>&lt;0.125</td>
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<tr>
<td>Loose</td>
<td>4 - 10</td>
<td>Soft</td>
<td>2 - 4</td>
<td>0.125 - 0.25</td>
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<tr>
<td>Medium dense</td>
<td>10 - 30</td>
<td>Medium stiff</td>
<td>4 - 8</td>
<td>0.25 - 0.5</td>
</tr>
<tr>
<td>Dense</td>
<td>30 - 50</td>
<td>Stiff</td>
<td>8 - 15</td>
<td>0.5 - 1.0</td>
</tr>
<tr>
<td>Very dense</td>
<td>&gt;50</td>
<td>Very Stiff</td>
<td>15 - 30</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard</td>
<td>&gt;30</td>
<td>&gt;2.0</td>
</tr>
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</table>

Moisture
Dry   Little perceptible moisture.
Sl. Moist Some perceptible moisture, probably below optimum.
Moist  Probably near optimum moisture content.
Wet   Much perceptible moisture, probably above optimum.

Minor Constituents
Not identified in description
Slightly (clayey, silty, etc.)
Clayey, silty, sandy, gravelly
Very (clayey, silty, etc.)

Sampling Symbols
BORING AND PUSH-PROBE SYMBOLS
口 Recovery
口 No Recovery
口 Temporarily Screened Interval
PID Photionization Detector Reading
W Water Sample
Sample Submitted for Chemical Analysis
NS No Sheen
SS Slight Sheen
MS Moderate Sheen
HS Heavy Sheen
BF Biogenic Film

TEST PIT SOIL SAMPLES
口 Grab (Jar)
口 Bag
口 Shelby Tube

Groundwater Observations and Monitoring Well Construction
Flush Mounted Monument
Concrete Surface Seal
Portland Cement Seal
Well Casing
Bentonite Filter Seal
Groundwater Level on Date or (ATD) At Time of Drilling
12/20 Sand Pack
Well Screen
End Cap
Groundwater Seepage (Test Pits)

Key to Exploration Logs
NuStar Pipeline Operating Partnership L.P.
Andover, Kansas

Project Number 1641-08
Figure Key
April 2015
<table>
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<tr>
<th>Depth, feet</th>
<th>Core Interval/Recovery</th>
<th>Laboratory Sample ID</th>
<th>PID</th>
<th>Sheen</th>
<th>Lithologic Description</th>
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<tr>
<td>5</td>
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<td>NS</td>
<td>05</td>
<td>NS</td>
<td>Grass surface over CLAY (CH); dark brown, slightly moist, very stiff to hard, trace organics, rootlets.</td>
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<td>NS</td>
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<td>NS</td>
<td>— Becomes light brown, trace silt.</td>
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<tr>
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<td></td>
<td>NS</td>
<td>05</td>
<td>NS</td>
<td>— Becomes light gray, trace fine gravel.</td>
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<td>NS</td>
<td>Clayey SILT (ML); light brown, slightly moist, very stiff, moderate plasticity, trace gravel.</td>
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<td>NS</td>
<td>Clayey SILT with gravel (ML); very light brown, slightly moist, very stiff to hard, fine to coarse angular gravel.</td>
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<td>NS</td>
<td>— Partially lithified [shale].</td>
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<td>NS</td>
<td>05</td>
<td>NS</td>
<td>CLAY with gravel (CH); very light brownish-gray, slightly moist, very stiff to hard, fine to coarse angular gravel, partially lithified [shale].</td>
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<td>40-45</td>
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<td>— Becomes moist, soft to medium stiff.</td>
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<td>NS</td>
<td>— Becomes very stiff to hard, slightly moist.</td>
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<td>Silty CLAY with gravel (CH); brownish-gray, moist, soft to coarse angular gravel.</td>
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<td>SHALE/LIMESTONE; white to medium brown, very hard, interbedded.</td>
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<td>120-150</td>
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<td>CLAY (CH); light brown, slightly moist, hard, waxy, high plasticity.</td>
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**Well Construction Details and Notes**

- **Boring Number:** MW-17
- **Project Number:** 1641-08
- **Logged By:** M. Whitson
- **Date:** March 12, 2015
- **Site Conditions:** Grass Yard
- **Drilling Contractor:** Layne Drilling
- **Drilling Equipment:** Mini Sonic
- **Sampler Type:** 10’ Core Barrel
- **Depth to Water (ATD):** Not Measured
- **Surface Elevation:** Not Measured

**Laboratory Sample ID:**

- **Date:**
- **Logged By:** M. Whitson
- **Site Conditions:** Grass Yard
- **Drilling Contractor:** Layne Drilling
- **Drilling Equipment:** Mini Sonic
- **Sampler Type:** 10’ Core Barrel
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- **Drilling Equipment:** Mini Sonic
- **Sampler Type:** 10’ Core Barrel
- **Depth to Water (ATD):** Not Measured
- **Surface Elevation:** Not Measured
**Lithologic Description**

<table>
<thead>
<tr>
<th>Depth, ft</th>
<th>Core Interval/Recovery</th>
<th>PID</th>
<th>Sheen</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
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<tr>
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</table>

**SHALE/LIMESTONE**; very light gray, dry, very hard, lithified.

Silty **CLAY** (CH); very light brown, slightly moist, hard, partially lithified (shale).

Bottom of Boring at 45.0’ BGS.
Lithologic Description

Asphalt concrete road surface (6") over CLAY (CH); dark brown, slightly moist, very stiff to hard, highly plastic.

Becomes light greenish-brown, trace silt.

Silty CLAY (CH); light brown, slightly moist, stiff to very stiff, highly plastic.

4-Inch lens; calcite/gypsum fragments.

Trace gravel.

Becomes very silty.

Clayey GRAVEL (GP); light brown, very dense, slightly moist, fine to coarse angular gravel in a clay matrix.

Clayey SILT with gravel (ML); medium gray/greenish-gray, slightly moist, very stiff, fine to coarse angular gravel.

Becomes very light brown.

Stringers of calcite (crystalline) interbedded with partially lithified silts and clays (shale).

Silty CLAY (CH); very light grayish-brown, slightly moist, very stiff, with trace angular gravel, high plasticity.

Becomes hard to very hard, lithified (shale).

Becomes medium stiff, moist.

Becomes hard to very hard, lithified (shale).

Becomes medium stiff, moist, gravelly (calcite [crystalline]).

Becomes hard, dark brown.

Becomes very light brown, moist to wet, medium stiff.

SILT with gravel (ML); light brown, dry, stiff, mostly lithified, broken up during drilling.

Clayey SILT (ML); medium reddish-brown, dry, hard.

Becomes mostly lithified (shale).

Becomes moist, medium stiff.

Becomes dry, hard, lithified (shale).

Clayey SILT (ML); pale brown, dry, hard.
<table>
<thead>
<tr>
<th>Depth, feet</th>
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<th>Laboratory Sample ID</th>
<th>PID</th>
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<tbody>
<tr>
<td>45</td>
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<td></td>
<td>NS</td>
<td>Becomes lithified (shale).</td>
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<tr>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
<td>Becomes medium stiff to stiff.</td>
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<tr>
<td>Bottom of Boring at 45.0' BGS.</td>
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</table>

**Well Construction Details and Notes:**

- **2" Diameter Schedule 40 PVC Screen**
- **0.010-Inch Slot Size**
- **Bentonite Grout**
- **6" Diameter Borehole**
- **4.5" End Cap**
- **#12/20 Filter Pack Sand**
- **2" Diameter Schedule 40 PVC Screen**

**Lithologic Description:**

- Becomes lithified (shale).
- Becomes medium stiff to stiff.

**Notes:**

- Site Conditions: Road Surface
- Drilling Contractor: Layne Drilling
- Drilling Equipment: Mini Sonic
- Sampler Type: 10' Core Barrel
- Depth to Water (ATD): 45' BGS.
- Surface Elevation: Not Measured

**Project Information:**

- **Boring Number:** MW-18
- **Logged By:** M. Whitson
- **Date:** March 12, 2015
- **Project Number:** 1641-08

**Site:** NuStar Terminals Operations Partnership L.P. Andover, Kansas

**Apex Companies, LLC**
3015 SW First Avenue
Portland, Oregon 97201

**NuStar Terminals Operations Partnership L.P.**
Andover, Kansas

---

**Page 2/2**
Lithologic Description

Asphalt concrete road surface (6") over CLAY (CH); dark brown, slightly moist, medium stiff to stiff. Trace asphalt concrete at surface.

Silty CLAY (CH); medium brown, slightly moist, very stiff, moderate to high plasticity.

Clayey SILT (ML); light brown, mottled brown, slightly moist, medium stiff, low to moderate plasticity.

— Becomes greenish-gray, very hard.

— Becomes medium stiff with calcite (crystalline) gravels (vein).

SHALE; light brown to medium greenish-brown, dry, hard, lithified.

Silty CLAY (CH); light brown, slightly moist, very stiff, trace calcite/gypsum, gravel lenses.

— Becomes medium stiff, reddish-brown, moist.

CLAY with SILT (CH); greenish-gray, dry, very hard, partially lithified, with trace crystalline calcite lens.

— Becomes greenish-brown, waxy.

— Becomes lithified (shale) with calcite veins.

— Becomes pale brown, medium stiff, moist.

— Becomes lithified (shale)

— Becomes very stiff to hard.

— Becomes mostly lithified with calcite (crystalline).
## Lithologic Description

- <5 NS
- 5 NS
- Becomes medium stiff, slightly moist.
- Bottom of Boring at 45.0' BGS.

### Well Construction Details and Notes

<table>
<thead>
<tr>
<th>Depth, feet</th>
<th>Core Interval/Recovery</th>
<th>PID</th>
<th>Lithologic Description</th>
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### Laboratory Sample ID

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<th>Lithologic Description</th>
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<td></td>
</tr>
<tr>
<td>75</td>
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<td></td>
</tr>
</tbody>
</table>
Asphalt concrete road surface (6") over CLAY (CH); dark brown, slightly moist, medium stiff to stiff. High plasticity.

Clayey SILT (ML); very light brown, dry to slightly moist, very stiff, low to moderate plasticity.

CLAY (CH); very dark brown, mottled brown, slightly moist, very stiff to hard, trace silt, high plasticity.

Clayey SILT (ML); light brown, slightly moist, very stiff to hard, low to moderate plasticity.

— Becomes light greenish-gray.

— Becomes partially lithified, crystalline calcite veins.

Gravelly CLAY (CH); medium brown, moist, soft to medium stiff, fine to coarse angular gravel.

— Becomes stiff.

— Silty CLAY (CH) light brown, slightly moist, hard, partially lithified, calcite (crystalline).

— Becomes wet, soft.

— Becomes hard.

— Calcite veins. Becomes partially lithified (shale).
<table>
<thead>
<tr>
<th>Depth, feet</th>
<th>Core Interval/Recovery</th>
<th>Laboratory Sample ID</th>
<th>PID</th>
<th>Sheen</th>
<th>Lithologic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
<td>Asphalt concrete road surface (6&quot;) over CLAY (CH); very dark brown to black, slightly moist, very stiff, high plasticity.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>&lt;5</td>
<td>NS</td>
<td>Silty CLAY (CH); light yellowish-brown, slightly moist, stiff, moderate to high plasticity.</td>
</tr>
<tr>
<td>10</td>
<td></td>
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<td>&lt;5</td>
<td>NS</td>
<td>Becomes very stiff.</td>
</tr>
<tr>
<td>15</td>
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<td>&lt;5</td>
<td>NS</td>
<td>Becomes light gray.</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td>&lt;5</td>
<td>NS</td>
<td>Gravelly CLAY (CH); brownish-gray, moist, soft to medium stiff, fine angular gravel.</td>
</tr>
<tr>
<td>25</td>
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<td></td>
<td>&lt;5 NS</td>
<td>Becomes lithified (shale), very hard.</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td>&lt;5 NS</td>
<td>Becomes stiff to very stiff.</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td>&lt;5 NS</td>
<td>Silty CLAY (CH); grayish-brown, moist, medium stiff to stiff, trace fine gravel.</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td>&lt;5 NS</td>
<td>Becomes hard, partially lithified.</td>
</tr>
<tr>
<td>45</td>
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<td></td>
<td>&lt;5 NS</td>
<td>3-Inch wet lens.</td>
</tr>
<tr>
<td>50</td>
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<td></td>
<td></td>
<td>&lt;5 NS</td>
<td>CLAY with gravel (CH); medium brown, moist, soft to medium stiff, fine to medium angular gravel, high plasticity.</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td></td>
<td></td>
<td>&lt;5 NS</td>
<td>Silty CLAY (CH); medium gray, slightly moist, very stiff to hard, high plasticity, partially lithified.</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td>&lt;5 NS</td>
<td>Becomes lithified (shale).</td>
</tr>
<tr>
<td>65</td>
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<td></td>
<td>&lt;5 NS</td>
<td>2-Inch wet lens.</td>
</tr>
<tr>
<td>70</td>
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<td></td>
<td>&lt;5 NS</td>
<td>Becomes moist, medium stiff.</td>
</tr>
<tr>
<td>75</td>
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<td></td>
<td>&lt;5 NS</td>
<td>Becomes hard.</td>
</tr>
</tbody>
</table>

Bottom of Boring at 40.0' BGS.
Asphalt concrete road surface (6") over CLAY (CH); dark brown, slightly moist, very stiff. High plasticity.

Silty CLAY (CH); light yellowish-brown, slightly moist, stiff, moderate plasticity.

Becomes grayish-brown, moist, with trace gravel.

Becomes yellowish-brown, moist to almost wet.

CLAY (CH); light yellowish-gray, slightly moist to moist, very stiff to hard, high plasticity, trace silt, partially lithified.

Silty CLAY (CH); gray brown, slightly moist, hard, high plasticity, partially lithified.

1-Foot wet lens.

Becomes lithified.

Bottom of Boring at 40.0' BGS.
Boring Number: IB-4
Logged By: M. Whitson
Date: March 18, 2015
Project Number: 1641-08
Drilling Contractor: Layne Drilling
Drilling Equipment: Mini Sonic
Sampler Type: 10' Core Barrel
Depth to Water (ATD): Not Measured
Surface Elevation: Not Measured

Boring Details and Notes:
- Grass surface over silty CLAY (CH); dark brown, moist, soft to medium stiff, moderate to high plasticity.
- CLAY (CH); very dark brown, slightly moist, hard, high plasticity.
- Silty CLAY (CH); light brown, slightly moist, medium stiff, moderate to high plasticity.
- Becomes fine angular gravel.
- Becomes hard, cemented.
- Becomes moist, soft.
- Becomes very hard, mostly lithified, greenish-gray.
- Gravelly CLAY (CH); yellowish-brown, wet, soft, fine to medium angular gravel.
- Becomes dark gray.
- Clayey SILT (ML); reddish-brown, slightly moist to moist, medium stiff, low to moderate plasticity, trace angular gravel.
- CLAY (CH); medium gray, slightly moist, very hard, high plasticity.
- 6-Inch lens of medium stiff material.
- Becomes very soft, saturated.
- Becomes medium stiff with trace gravel.
- Becomes very light gray.
- Becomes partially lithified.
- Becomes shale (12").
- Becomes very hard, medium brown.

Bottom of Boring at 40.0' BGS.
### Lithologic Description

<table>
<thead>
<tr>
<th>Depth, feet</th>
<th>Core Interval/Recovery</th>
<th>Laboratory Sample ID</th>
<th>PID</th>
<th>Sheen</th>
<th>Boring Details and Notes</th>
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<tbody>
<tr>
<td>5</td>
<td></td>
<td>NS</td>
<td>5</td>
<td>NS</td>
<td>Grass surface over silty CLAY (CH); dark brown, moist, very stiff, high plasticity.</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>NS</td>
<td>5</td>
<td>NS</td>
<td>Silty CLAY (CH); reddish-brown, slightly moist, very stiff, moderate to high plasticity.</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>NS</td>
<td>5</td>
<td>NS</td>
<td>Trace gravel.</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>NS</td>
<td>5</td>
<td>NS</td>
<td>Becomes mostly lithified, gray (shale).</td>
</tr>
<tr>
<td>30</td>
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<td>NS</td>
<td>5</td>
<td>NS</td>
<td>Becomes calcite (1-inch crystalline vein).</td>
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<tr>
<td>35</td>
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<td>NS</td>
<td>5</td>
<td>NS</td>
<td>Becomes gray.</td>
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</tbody>
</table>

Gravelly CLAY (CH); light tan, saturated, soft, medium to coarse angular gravel.

Silty CLAY (CH); grayish-brown, slightly moist, very stiff to hard, partially lithified in place.

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Bottom of Boring at 40.0' BGS.
## Lithologic Description

Grass surface over CLAY (CH); very dark brown, slightly moist, stiff to very stiff, high plasticity.

Clayey SILT (ML); pale brown, slightly moist, stiff, low to moderate plasticity.

Silty CLAY (CH); medium brown, slightly moist, stiff to very stiff, high plasticity.

Becomes grayish-brown, hard.

Becomes reddish-brown.

Becomes grayish-brown, very stiff.

Becomes hard.

Gravely CLAY (CH); light brown/pale brown, moist, to almost wet, medium stiff, fine to medium angular gravel.

Silty CLAY (CH); medium brown, slightly moist, stiff, high plasticity.

Becomes mostly lithified, greenish-gray, hard.

Bottom of Boring at 40.0' BGS.
<table>
<thead>
<tr>
<th>Depth, feet</th>
<th>Core Interval/Recovery</th>
<th>PID</th>
<th>Lithologic Description</th>
<th>Details and Notes</th>
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<td>Grass surface over silty CLAY (CH); medium brown, moist, moderate to high plasticity.</td>
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<td>CLAY (CH); dark brown, slightly moist, stiff, high plasticity.</td>
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<tr>
<td>5</td>
<td>NS</td>
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<td>Becomes reddish-brown, very stiff.</td>
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<tr>
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<td>Clayey SILT (ML); tan, mottled white, slightly moist, very stiff.</td>
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<td>NS</td>
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<td>Silty CLAY (CH); light brown, slightly moist, very stiff, moderate to high plasticity.</td>
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<tr>
<td>5</td>
<td>NS</td>
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<td>Becomes very silty clay.</td>
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<td>Clayey SILT (MH); light gray, slightly moist, very stiff to hard, medium plasticity.</td>
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<td>Becomes partially lithified, broken up into gravel size particles.</td>
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<td>CLAY with silt (CH); gray, slightly moist, hard to very hard, high plasticity.</td>
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<td>NS</td>
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<td>Gravelly CLAY with silt (CH); yellowish-gray, slightly moist, medium stiff, fine to coarse angular gravel.</td>
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<td>Clayey SILT (MH); yellowish-brown, wet, soft to medium stiff, high plasticity.</td>
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<td>NS</td>
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<td>Very silty CLAY (CH); grayish-brown, slightly moist, hard to very hard to moderate to high plasticity.</td>
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<td>Becomes wet.</td>
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</tr>
<tr>
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<td>NS</td>
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<td>Becomes silty clay.</td>
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<tr>
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<td>NS</td>
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<td>Becomes moist, very stiff.</td>
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Bottom of Boring at 40.0' BGS.
### Lithologic Description

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<thead>
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<tr>
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<td>40</td>
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</table>

Grass surface over CLAY (CH); very dark brown, slightly moist, stiff, high plasticity.

Silty CLAY (CH); yellowish-brown, slightly moist, stiff, high plasticity.

Clayey SILT (ML); light brown, moist, medium stiff, low to medium plasticity.

Silty CLAY (CH); light brown, slightly moist, stiff, medium to high plasticity.
- Becomes gray.
- Becomes very hard.
- Becomes medium lithified (shale).
- Silty CLAY (CH); yellowish-brown, wet, soft, trace gravel.
- Becomes slightly moist, hard.
- 3-Inch moist, soft lens.
- 1-Inch wet lens.
- Trace gravel, fine to coarse angular gravel, calcite (crystalline).
- Becomes moist, medium stiff.
- Becomes wet, very soft.
- Becomes brownish-gray, hard.
- Becomes greenish-gray, slightly moist, very hard, partially lithified.

Bottom of Boring at 40.0' BGS.
### Lithologic Description

Grass surface over CLAY (CH); very dark brown, slightly moist, medium stiff to stiff.
- Becomes very stiff.

Clayey SILT (ML); reddish-brown, slightly moist, medium stiff, low to moderate plasticity.

- Trace gravel.

Silty CLAY (CH); medium brown, slightly moist, very stiff, high plasticity.
- Becomes mostly lithified (shale).

- Becomes crystalline calcite lens.

Silty CLAY (CH) medium light brown, slightly moist, stiff to very stiff.

- Becomes greenish-gray, hard to very hard.

CLAY with gravel (CH); pale brown, wet, soft to medium stiff, fine to coarse angular gravel, trace silt.
- Becomes medium stiff to stiff.

ROCK (Limestone); grayish-white, very hard, lithified.

Silty CLAY (CH); reddish-brown, slightly moist, very stiff, high plasticity.

Bottom of Boring at 40.0’ BGS.
Appendix C

Health and Safety Plan
1.0 Introduction

This Health and Safety Plan includes both site-specific information (including site-specific activities, health hazards, route to hospital, and toxicity information) and information from the Apex’s general Health and Safety Plan.

1.1 Emergency Contact Summary

<table>
<thead>
<tr>
<th>SITE LOCATION</th>
<th>2006 Colt Court, Andover, Kansas</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEAREST HOSPITAL</td>
<td>1124 West 21st Street Andover, Kansas 67002 (See Figure HSP-1) Telephone: (316) 300-4000</td>
</tr>
<tr>
<td>EMERGENCY RESPONDERS</td>
<td>Police Department: 911</td>
</tr>
<tr>
<td></td>
<td>Fire Department: 911</td>
</tr>
<tr>
<td></td>
<td>Ambulance: 911</td>
</tr>
<tr>
<td>EMERGENCY CONTACTS</td>
<td>Apex Companies, LLC: (503)924-4704</td>
</tr>
<tr>
<td></td>
<td>National Response Center: (800)424-8802</td>
</tr>
<tr>
<td></td>
<td>Poison Control Center: (800)222-1222</td>
</tr>
<tr>
<td></td>
<td>Chemtrec: (800)424-9300</td>
</tr>
</tbody>
</table>

In the event of an emergency, call for help as soon as possible. Give the following information:

- WHERE the emergency is – use cross streets or landmarks
- PHONE NUMBER you are calling from
- WHAT HAPPENED – type of injury
- HOW MANY persons need help
- WHAT is being done for the victim(s)
- YOU HANG UP LAST – let the person you called hang up first

2.0 Corporate Health and Safety Plan

The Apex General Health and Safety Plan, together with the included site-specific information, cover each of the 11 required plan elements as specified in Occupational Safety and Health Administration (OSHA) 1910.120, and meet all applicable regulatory requirements. The reader is advised to thoroughly review the entire plan.
3.0 Site Specific Health and Safety Plan

3.1 Site Location and Description

LOCATION: Quail Crossing Neighborhood in Andover, Kansas.
LAND USE OF AREA SURROUNDING FACILITY: Residential.

3.2 Site Activity Summary

SITE ACTIVITIES: Soil excavation, soil sampling, ORC introduction, backfilling, and site restoration.

PROPOSED DATE OF ACTIVITY: Fall 2015.

POTENTIAL SITE CONTAMINANTS: Benzene, toluene, ethylbenzene, xylenes (BTEX), 2-butanone, gasoline-range organics (GRO), and other volatile organic compounds (VOCs).

POTENTIAL ROUTES OF ENTRY: Skin contact with soil and groundwater, incidental ingestion of soil and groundwater, and inhalation of dust and volatiles.

PROTECTIVE MEASURES: Engineering controls, safety glasses, safety boots, hard hat, gloves, protective clothing (including fire-resistant clothing), and respirators, as necessary.

MONITORING EQUIPMENT: Photoionization detector (PID) with 10.2 eV lamp and olfactory indications.

3.3 Chain of Command

The chain of command for Health and Safety in this project involves the following individuals:

- CORPORATE H&S MANAGER: Adam Reese
- PROJECT MANAGER: Sam Jackson
- PROJECT H&S OFFICER: Sam Jackson
- FIELD H&S MANAGER: Michael Whitson
3.4 Hazard Analysis and Applicable Safety Procedures

The following work tasks will be performed:

- Soil excavation and site restoration oversight;
- Soil sampling;
- ORC Advanced® introduction activities.

The hazards associated with the activities listed above are discussed in detail below.

3.4.1 Soil Excavation

Soil excavation will be conducted by an Apex subcontractor. Apex oversight will occur with appropriate protection, as discussed under personal protective equipment requirements. Employees are cautioned to stand clear of all equipment. Personnel will not enter the excavation, will not stand on the edge of the excavation, and will comply with OSHA rules. Noise protection must also be available and used whenever excavation activities are in progress. In addition, exclusion zones will be established for worker protection and protection of public health.

**Underground Utilities.** Any underground activity that disturbs soil has the potential for disrupting underground utilities. Immediately stop work and evacuate the area pending further evaluation:

- If gas or vapor venting occurs during the activity;
- If the odor of natural gas is detected; or
- If it is suspected a pipeline or utility service has been damaged.

In addition, contact the proper authorities as necessary, and report the incident to the project manager.

If gas or vapor venting occurs from the excavation, or other source, immediately move upwind of the source. If necessary, use respiratory protection. If the odor of natural gas is detected or if it suspected that a pipeline has been hit, immediately stop work, evacuate the area, and contact the proper authorities.

Never continue to work in an area, even if PID readings, lower explosive limit (LEL), and/or hydrogen sulfide tests are acceptable, if you begin to notice strange odors or symptoms of overexposure (such as dizziness, nausea, tearing of the eyes, etc.). Do not resume work until testing shows the hazard has been removed.

**Slips, Trips, and Falls.** The work area will include uneven surfaces, surfaces with limited traction, and debris may be present. Caution will be used to avoid slips, trips and falls.
3.4.2 Soil Sampling

Soil sampling will occur under the assumption the media is contaminated and appropriate personnel protection is required. Apex personnel will not enter the excavation; soil samples will be collected from the excavation bucket after removal from the excavation.

3.4.3 ORC Advanced® Introduction

ORC Advanced® will be placed in the bottom of the excavation. ORC Advanced® is non-hazardous and will be delivered in a pelletized form. Appropriate PPE, including nitrile gloves, dust proof safety googles should be used during ORC Advanced® handling. The MSDS for ORC Advanced® is attached.

3.4.4 Air Monitoring and Action Levels

Air monitoring will be conducted to evaluate air quality inside and outside of the exclusion zone. Inside the exclusion zone, air monitoring will be performed to confirm the adequacy of personal protection equipment. Outside of the exclusion zone, air monitoring will be performed to confirm that VOC concentrations are consistent with background concentrations. The results of the air monitoring will be used as the basis for specifying personal protective equipment, determining the need for upgrading protective measures, and communication with Neighborhood residents.

Air monitoring equipment will be calibrated prior to use (where applicable) as specified by the instrument manuals and results will be documented in the instrument log. All equipment will be maintained as specified by the manufacturer or more frequently as required by use conditions. Repair records will be maintained with the instrument log.

**PID Monitoring.** Air monitoring will be conducted with a PID with 10.2 eV lamp, or equivalent, to measure organic vapor concentrations during site work activities. Background PID measurements will be taken prior to the start of activities to quantify levels associated with the ambient air space in the vicinity of the site. Every hour, a separate PID measurement will be collected from near the edge of the excavation to quantify the potential for VOCs to be released into the breathing space. If any of the PID measurements collected inside or outside the exclusion zone are elevated relative to the previously measured background levels, then detector tube readings will be collected from the breathing space (described below). If the detector tube readings exceed the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) concentrations then site workers exposed to these levels will use air purifying respirators as appropriate. If detector tubes readings are below the REL concentrations, then a PID measurement will be collected from the breathing space. If PID measurements are elevated in the breathing zone above background concentrations, then site workers exposed to these levels will use air purifying respirators as appropriate. If measured concentrations exceed immediately dangerous to life and
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health (IDLH) concentrations, site work will cease and personnel will vacate the work area pending re-evaluation of the situation by the Health and Safety Manager.

Detector Tubes. If VOCs are detected as described above, air monitoring within the breathing space will be conducted for benzene-specific detector tubes for each identified compound. Benzene is targeted for compound-specific analysis because the permissible exposure limits (PEL) is a reliable indicator of many other gasoline constituents.

Olfactory. If olfactory senses detect any unfamiliar odor, work will stop until an assessment can be made to determine whether protective measures should be modified.

3.5 Chemicals of Concern

Based on site information gathered to date, the following chemicals may be present at this site:

- GRO; and
- VOCs [benzene, toluene, ethylbenzene, and xylenes (BTEX)].

Pertinent toxicological properties of these chemicals are discussed below. This information generally covers potential toxic effects which may occur from relatively significant acute and/or chronic exposures, and is not meant to indicate that such effects will occur from the planned site activities. In general, the chemicals which may be encountered at this site are not expected to be present at concentrations which could produce significant exposures. The types of planned work activities should also limit potential exposures at this site. Furthermore, appropriate protective and monitoring equipment will be used as discussed below to further minimize any exposures which might occur.

Standards for occupational exposures to these chemicals are included where available. Site exposures are generally expected to be of short duration and well below the level of any of these exposure limits. These standards are presented below:

- PEL Permissible exposure limit (OSHA).
- REL Recommended exposure limit (NIOSH).
- IDLH Immediately dangerous to life and health (NIOSH)
- TWA Time-weighted average exposure limit for any 8-hour work shift of a 40-hour work week.
- STEL Short term exposure limit expressed as a 15-minute time-weighted average and not to be exceeded at any time during a work day.
- C Ceiling exposure limit not to be exceeded at any time during a work day.
**Total Petroleum Hydrocarbons.** Total petroleum hydrocarbons (TPH) is a term used to describe a broad family of several hundred chemical compounds that originally come from crude oil. In this sense, TPH is really a mixture of chemicals. They are called hydrocarbons because almost all of them are made entirely from hydrogen and carbon. Crude oils can vary in how much of each chemical they contain, and so can the petroleum products that are made from crude oils. Most products that contain TPH will burn. Some are clear or light-colored liquids that evaporate easily, and others are thick, dark liquids or semi-solids that do not evaporate. Many of these products have characteristic gasoline, kerosene, or oily odors. Because modern society uses so many petroleum-based products (for example, gasoline, kerosene, fuel oil, mineral oil, and asphalt), contamination of the environment by them is potentially widespread. Contamination caused by petroleum products will contain a variety of these hydrocarbons. Because there are so many, it is not usually practical to measure each one individually. However, it is useful to measure the total amount of all hydrocarbons found together in a particular sample of soil, water, or air.

TPH can enter and leave your body when you breathe it in air; swallow it in water, food, or soil; or touch it. Most components of TPH will enter your bloodstream rapidly when you breathe them as a vapor or mist or when you swallow them. Some TPH compounds are widely distributed by the blood throughout your body and quickly break down into less harmful chemicals. Others may break down into more harmful chemicals. Other TPH compounds are slowly distributed by the blood to other parts of the body and do not readily break down. When you touch TPH compounds, they are absorbed more slowly and to a lesser extent than when you breathe or swallow them. Most TPH compounds leave your body through urine or when you exhale air containing the compounds.

The compounds in different TPH fractions affect the body in different ways. Some of the TPH compounds, particularly the smaller compounds such as benzene, toluene, and xylene (which are present in gasoline), can affect the human central nervous system. If exposures are high enough, death can occur. Breathing toluene at concentrations greater than 100 parts per million (ppm) for more than several hours can cause fatigue, headache, nausea, and drowsiness. When exposure is stopped, the symptoms will go away. However, if someone is exposed for a long time, permanent damage to the central nervous system can occur. One TPH compound (n-hexane) can affect the central nervous system in a different way, causing a nerve disorder called “peripheral neuropathy” characterized by numbness in the feet and legs and, in severe cases, paralysis. This has occurred in workers exposed to 500–2,500 ppm of n-hexane in the air. Swallowing some petroleum products such as gasoline and kerosene causes irritation of the throat and stomach, central nervous system depression, difficulty breathing, and pneumonia from breathing liquid into the lungs. The compounds in some TPH fractions can also affect the blood, immune system, liver, spleen, kidneys, developing fetus, and lungs. Certain TPH compounds can be irritating to the skin and eyes. Other TPH compounds, such as some mineral oils, are not very toxic and are used in foods. One TPH compound (benzene) has been shown to cause cancer (leukemia) in people. The International Agency for Research
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on Cancer (IARC) has determined that benzene is carcinogenic to humans (Group 1 classification). Some other TPH compounds or petroleum products, such as benzo(a)pyrene and gasoline, are considered to be probably and possibly carcinogenic to humans (IARC Groups 2A and 2B, respectively) based on cancer studies in people and animals. Most of the other TPH compounds and products are considered not classifiable (Group 3) by IARC.

Although there are no federal regulations or guidelines for TPH in general, the government has developed regulations and guidelines for some of the TPH fractions and compounds. These are designed to protect the public from the possible harmful health effects of these chemicals. To protect workers, the OSHA has set a legal limit of 500 ppm in the workplace.

EPA regulates certain TPH fractions, products, or wastes containing TPH, as well as some individual TPH compounds. For example, there are regulations for TPH as oil; these regulations address oil pollution prevention and spill response, stormwater discharge, and underground injection control. EPA lists certain wastes containing TPH as hazardous. EPA also requires that the National Response Center be notified following a discharge or spill into the environment of 10 pounds or more of hazardous wastes containing benzene, a component in some TPH mixtures.

Nearly all states have cleanup standards for TPH or components of TPH (common cleanup standards are for gasoline, diesel fuel, and waste oil). Analytical methods are specified, many of which are considered to be TPH methods.

**Benzene.** Benzene, also known as benzol, is a colorless liquid with a sweet odor. Benzene evaporates into air very quickly and dissolves slightly in water. Benzene is highly flammable. Most people can begin to smell benzene in air at 1.5–4.7 ppm and smell benzene in water at 2 ppm. Most people can begin to taste benzene in water at 0.5–4.5 ppm. Benzene is found in air, water, and soil.

Benzene found in the environment is from both human activities and natural processes. Benzene was first discovered and isolated from coal tar in the 1,800s. Today, benzene is made mostly from petroleum sources. Because of its wide use, benzene ranks in the top 20 in production volume for chemicals produced in the United States. Various industries use benzene to make other chemicals, such as styrene (for Styrofoam® and other plastics), cumene (for various resins), and cyclohexane (for nylon and synthetic fibers). Benzene is also used for the manufacturing of some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene, which include volcanoes and forest fires, also contribute to the presence of benzene in the environment. Benzene is also a natural part of crude oil and gasoline and cigarette smoke.
Most people are exposed to a small amount of benzene on a daily basis. You can be exposed to benzene in the outdoor environment, in the workplace, and in the home. Exposure of the general population to benzene is mainly through breathing air that contains benzene. The major sources of benzene exposure are tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions. Vapors (or gases) from products that contain benzene, such as glues, paints, furniture wax, and detergents, can also be a source of exposure. Auto exhaust and industrial emissions account for about 20% of the total nationwide exposure to benzene. About 50% of the entire nationwide exposure to benzene results from smoking tobacco or from exposure to tobacco smoke. The average smoker (32 cigarettes per day) takes in about 1.8 milligrams (mg) of benzene per day. This is about 10 times the average daily intake of nonsmokers.

Measured levels of benzene in outdoor air have ranged from 0.02 to 34 parts of benzene per billion parts of air (ppb; 1 ppb is 1,000 times less than 1 ppm). People living in cities or industrial areas are generally exposed to higher levels of benzene in air than those living in rural areas. Benzene levels in the home are usually higher than outdoor levels. People living around hazardous waste sites, petroleum refining operations, petrochemical manufacturing sites, or gas stations may be exposed to higher levels of benzene in air.

Benzene can enter your body through your lungs when you breathe contaminated air. It can also enter through your stomach and intestines when you eat food or drink water that contains benzene. Benzene can enter your body through skin contact with benzene-containing products such as gasoline.

When you are exposed to high levels of benzene in air, about half of the benzene you breathe in leaves your body when you breathe out. The other half passes through the lining of your lungs and enters your bloodstream. Animal studies show that benzene taken in by eating or drinking contaminated foods behaves similarly in the body to benzene that enters through the lungs. A small amount will enter your body by passing through your skin and into your bloodstream during skin contact with benzene or benzene-containing products. Once in the bloodstream, benzene travels throughout your body and can be temporarily stored in the bone marrow and fat. Benzene is converted to products, called metabolites, in the liver and bone marrow. Some of the harmful effects of benzene exposure are believed to be caused by these metabolites. Most of the metabolites of benzene leave the body in the urine within 48 hours after exposure.

After exposure to benzene, several factors determine whether harmful health effects will occur, and if they do, what the type and severity of these health effects might be. These factors include the amount of benzene to which you are exposed and the length of time of the exposure. Most data involving effects of long-term exposure to benzene are from studies of workers employed in industries that make or use benzene. These workers were exposed to levels of benzene in air far greater than the levels normally
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encountered by the general population. Current levels of benzene in workplace air are much lower than in the past. Because of this reduction, and the availability of protective equipment such as respirators, fewer workers have symptoms of benzene poisoning.

Brief exposure (5–10 minutes) to very high levels of benzene in air (10,000–20,000 ppm) can result in death. Lower levels (700–3,000 ppm) can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. In most cases, people will stop feeling these effects when they stop being exposed and begin to breathe fresh air.

Eating foods or drinking liquids containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, coma, and death. The health effects that may result from eating foods or drinking liquids containing lower levels of benzene are not known. If you spill benzene on your skin, it may cause redness and sores. Benzene in your eyes may cause general irritation and damage to your cornea.

Benzene causes problems in the blood. People who breathe benzene for long periods may experience harmful effects in the tissues that form blood cells, especially the bone marrow. These effects can disrupt normal blood production and cause a decrease in important blood components. A decrease in red blood cells can lead to anemia. Reduction in other components in the blood can cause excessive bleeding. Blood production may return to normal after exposure to benzene stops. Excessive exposure to benzene can be harmful to the immune system, increasing the chance for infection and perhaps lowering the body’s defense against cancer.

Benzene can cause cancer of the blood-forming organs. The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen. IARC has determined that benzene is carcinogenic to humans, and the EPA has determined that benzene is a human carcinogen. Long-term exposure to relatively high levels of benzene in the air can cause cancer of the blood-forming organs. This condition is called leukemia. Exposure to benzene has been associated with development of a particular type of leukemia called acute myeloid leukemia (AML).

Exposure to benzene may be harmful to the reproductive organs. Some women workers who breathed high levels of benzene for many months had irregular menstrual periods. When examined, these women showed a decrease in the size of their ovaries. However, exact exposure levels were unknown, and the studies of these women did not prove that benzene caused these effects. It is not known what effects exposure to benzene might have on the developing fetus in pregnant women or on fertility in men. Studies with pregnant animals show that breathing benzene has harmful effects on the developing fetus. These effects include low birth weight, delayed bone formation, and bone marrow damage.
The health effects that might occur in humans following long-term exposure to food and water contaminated with benzene are not known. In animals, exposure to food or water contaminated with benzene can damage the blood and the immune system and can even cause cancer.

EPA has set the maximum permissible level of benzene in drinking water at 5 ppb. Because benzene can cause leukemia, EPA has set a goal of 0 ppb for benzene in drinking water and in water such as rivers and lakes. EPA estimates that 10 ppb benzene in drinking water that is consumed regularly or exposure to 0.4 ppb benzene in air over a lifetime could cause a risk of one additional cancer case for every 100,000 exposed persons. EPA recommends a maximum permissible level of benzene in water of 200 ppb for short-term exposures (10 days) for children.

EPA requires that the National Response Center be notified following a discharge or spill into the environment of 10 pounds or more of benzene.

OSHA regulates levels of benzene in the workplace. The maximum allowable amount of benzene in workroom air during an 8-hour workday, 40-hour workweek is 1 ppm. Since benzene can cause cancer, the NIOSH recommends that all workers likely to be exposed to benzene wear special breathing equipment.

**Toluene.** Toluene is a clear, colorless liquid with a distinctive smell. It is added to gasoline along with benzene and tolueneylene. Toluene occurs naturally in crude oil and in the tolu tree. It is produced in the process of making gasoline and other fuels from crude oil, in making coke from coal, and as a by-product in the manufacture of styrene. Toluene is used in making paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber and in some printing and leather tanning processes. It is disposed of at hazardous waste sites as used solvent (a substance that can dissolve other substances) or at landfills where it is present in discarded paints, paint thinners, and fingernail polish. You can begin to smell toluene in the air at a concentration of 8 ppm, and taste it in your water at a concentration of 0.04–1 ppm. (One ppm is equivalent to 1 minute in 2 years.)

Toluene can enter your body when you breathe its vapors or eat or drink contaminated food or water. When you work with toluene-containing paints or paint thinners, the toluene can also pass through your skin into your bloodstream. You are exposed to toluene when you breathe air containing toluene. When this occurs the toluene is taken directly into your blood from your lungs. Where you live, work, and travel and what you eat affect your daily exposure to toluene. Factors such as your age, sex, body composition, and health status affect what happens to toluene once it is in your body. After being taken into your body, more than 75% of the toluene is removed within 12 hours. It may leave your body unchanged in the air you breathe out or in your urine after some of it has been chemically changed to make it more water soluble. Generally, your body turns toluene into less harmful chemicals such as hippuric acid.
A serious health concern is that toluene may have an effect on your brain. Toluene can cause headaches, confusion, and memory loss. Whether or not toluene does this to you depends on the amount you take in and how long you are exposed. Low-to-moderate, day-after-day exposure in your workplace can cause tiredness, confusion, weakness, drunken-type actions, memory loss, nausea, and loss of appetite. These symptoms usually disappear when exposure is stopped. Researchers do not know if the low levels of toluene you breathe at work will cause any permanent effects on your brain or body after many years. You may experience some hearing loss after long-term daily exposure to toluene in the workplace.

If you are exposed to a large amount of toluene in a short time because you deliberately sniff paint or glue, you will first feel light-headed. If exposure continues, you can become dizzy, sleepy, or unconscious. You might even die. Toluene causes death by interfering with the way you breathe and the way your heart beats. When exposure is stopped, the sleepiness and dizziness will go away and you will feel normal again.

If you choose to repeatedly breathe in toluene from glue or paint thinners, you may permanently damage your brain. You may also experience problems with your speech, vision, or hearing, have loss of muscle control, loss of memory, poor balance, and decreased mental ability. Some of these changes may be permanent.

Toluene may change the way your kidneys work, but in most cases, the kidneys will return to normal after exposure stops. If you drink alcohol and are exposed to toluene, the combination can affect your liver more than either compound alone. This phenomenon is called synergism. Combinations of toluene and some common medicines like aspirin and acetaminophen may increase the effects of toluene on your hearing. In animals, the main effect of toluene is on the nervous system. Animals exposed to moderate or high levels of toluene may also show slightly adverse effects in their liver, kidneys, and lungs.

Several studies have shown that unborn animals were harmed when high levels of toluene were breathed in by their mothers. When the mothers were fed high levels of toluene, the unborn animals did not show any structural birth defects, although some effects on behavior were noted. We do not know if toluene would harm your unborn child if you drink water or breathe air containing low levels of toluene, because studies in people are not comprehensive enough to measure this effect. However, if you deliberately breathe in large amounts of toluene during your pregnancy, your baby can have neurological problems and retarded growth and development.

Studies in workers and in animals exposed to toluene indicate that toluene does not cause cancer. IARC and DHHS have not classified toluene for carcinogenic effects. The EPA has determined that toluene is not classifiable as to its human carcinogenicity.
The federal government has developed regulatory standards and guidelines to protect you from the possible health effects of toluene in the environment. OSHA has set a limit of 100 ppm of toluene for air in the workplace, averaged for an 8-hour exposure per day over a 40-hour work week. The American Conference of Governmental Industrial Hygienists (ACGIH) and NIOSH have recommended that toluene in workplace air not exceed 100 ppm (as an average level over 8 hours).

EPA recommends that drinking water should not contain more than 20 ppm for 1 day, 3 ppm for 10 days, or 1 ppm for lifetime consumption. Any release of more than 1,000 pounds of this chemical to the environment must be reported to the National Response Center.

Ethylbenzene. Ethylbenzene is a colorless liquid that smells like gasoline. You can smell ethylbenzene in the air at concentrations as low as 2 ppm. It evaporates at room temperature and burns easily. Ethylbenzene occurs naturally in coal tar and petroleum. It is also found in many products, including paints, inks, and insecticides. Gasoline contains about 2 percent (by weight) ethylbenzene. Ethylbenzene is used primarily in the production of styrene. It is also used as a solvent, a component of asphalt and naphtha, and in fuels. In the chemical industry, it is used in the manufacture of acetophenone, cellulose acetate, diethylbenzene, ethyl anthraquinone, ethylbenzene sulfonic acids, propylene oxide, and -methylbenzyl alcohol. Consumer products containing ethylbenzene include pesticides, carpet glues, varnishes and paints, and tobacco products. In 1994, approximately 12 billion pounds of ethylbenzene were produced in the United States. Ethylbenzene is most commonly found as a vapor in the air. This is because ethylbenzene moves easily into the air from water and soil. Once in the air, other chemicals help break down ethylbenzene into chemicals found in smog. This breakdown happens in less than 3 days with the aid of sunlight. In surface water such as rivers and harbors, ethylbenzene breaks down by reacting with other compounds naturally present in the water. In soil, the majority of ethylbenzene is broken down by soil bacteria. Since ethylbenzene binds only moderately to soil, it can also move downward through soil to contaminate groundwater. Near hazardous waste sites, the levels of ethylbenzene in the air, water, and soil could be much higher than in other areas.

When you breathe air containing ethylbenzene vapor, it enters your body rapidly and almost completely through your lungs. Ethylbenzene in food or water can also rapidly and almost completely enter your body through the digestive tract. It may enter through your skin when you come into contact with liquids containing ethylbenzene. Ethylbenzene vapors do not enter through your skin to any large degree. People living in urban areas or in areas near hazardous waste sites may be exposed by breathing air or by drinking water contaminated with ethylbenzene. Once in your body, ethylbenzene is broken down into other chemicals. Most of it leaves in the urine within 2 days. Small amounts can also leave through the lungs and in feces. Liquid ethylbenzene that enters through your skin is also broken down. Ethylbenzene in high levels is broken down slower in your body than low levels of ethylbenzene. Similarly, ethylbenzene mixed
with other solvents is also broken down more slowly than ethylbenzene alone. This slower breakdown will increase the time it takes for ethylbenzene to leave your body.

At certain levels, exposure to ethylbenzene can harm your health. People exposed to high levels of ethylbenzene in the air for short periods have complained of eye and throat irritation. Persons exposed to higher levels have shown signs of more severe effects such as decreased movement and dizziness. No studies have reported death in humans following exposure to ethylbenzene alone. However, evidence from animal studies suggests that it can cause death at very high concentrations in the air (about 2 million times the usual level in urban air). Whether or not long-term exposure to ethylbenzene affects human health is not known, because little information is available. Short-term exposure of laboratory animals to high concentrations of ethylbenzene in air may cause liver and kidney damage, nervous system changes, and blood changes. The link between these health effects and exposure to ethylbenzene is not clear because of conflicting results and weaknesses in many of the studies. Also, there is no clear evidence that the ability to get pregnant is affected by breathing air or drinking water containing ethylbenzene, or coming into direct contact with ethylbenzene through the skin. Two long-term studies in animals suggest that ethylbenzene may cause tumors. One study had many weaknesses, and no conclusions could be drawn about possible cancer effects in humans. The other, a recently completed study, was more convincing, and provided clear evidence that ethylbenzene causes cancer in one species after exposure in the air to concentrations greater than 740 ppm that were approximately 1 million times the levels found in urban air. At present, the federal government has not identified ethylbenzene as a chemical that may cause cancer in humans. However, this may change after consideration of the new data.

There are no reliable data on the effects in humans after eating or drinking ethylbenzene or following direct exposure to the skin. For this reason, levels of exposure that may affect your health after eating, drinking, or getting ethylbenzene on your skin are estimated from animal studies. There are only two reports of eye or skin exposure to ethylbenzene. In these studies, liquid ethylbenzene caused eye damage and skin irritation in rabbits. More animal studies are available that describe the effects of breathing air or drinking water containing ethylbenzene.

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the EPA, OSHA, and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and NIOSH.

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes
these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for ethylbenzene include the following:

The federal government has developed regulatory standards and guidelines to protect you from possible health effects of ethylbenzene in the environment. EPA's Office of Drinking Water (ODW) set 700 ppb (this equals 0.7 milligrams ethylbenzene per liter of water or mg/L) as the acceptable exposure concentration of ethylbenzene in drinking water for an average weight adult. This value is for lifetime exposure and is set at a level that is expected not to increase the chance of having (noncancer) adverse health effects. The same EPA office (ODW) set higher acceptable levels of ethylbenzene in water for shorter periods (20 ppm or 20 mg/L for 1 day, 3 ppm or 3 mg/L for 10 days). EPA has determined that exposures at or below these levels are acceptable for small children. If you eat fish and drink water from a body of water, the water should contain no more than 1.4 mg ethylbenzene per liter.

EPA requires that a release of 1,000 pounds or more of ethylbenzene be reported to the federal government's National Response Center in Washington, D.C.

OSHA set a legal limit of 100 ppm ethylbenzene in air. This is for exposure at work for 8 hours per day.

NIOSH also recommends an exposure limit for ethylbenzene of 100 ppm. This is for exposure to ethylbenzene in air at work for up to 10 hours per day in a 40-hour work week. NIOSH also set a limit of 125 ppm for a 15-minute period.

**Xylenes.** There are three forms of xylene in which the methyl groups vary on the benzene ring: meta-xylene, ortho-xylene, and para-xylene (m-, o-, and p-xylene). These different forms are referred to as isomers. The term total xylenes refers to all three isomers of xylene (m-, o-, and p-xylene). Mixed xylene is a mixture of the three isomers and usually also contains 6–15% ethylbenzene. Xylene is also known as xylol or dimethylbenzene. Xylene is primarily a synthetic chemical. Chemical industries produce xylene from petroleum. Xylene also occurs naturally in petroleum and coal tar and is formed during forest fires. It is a colorless, flammable liquid with a sweet odor.

Xylene is one of the top 30 chemicals produced in the United States in terms of volume. It is used as a solvent (a liquid that can dissolve other substances) in the printing, rubber, and leather industries. Along with other solvents, xylene is also used as a cleaning agent, a thinner for paint, and in varnishes. It is found in small amounts in airplane fuel and gasoline. Xylene is used as a material in the chemical, plastics, and
Xylene is most likely to enter your body when you breathe xylene vapors. Less often, xylene enters the body through the skin following direct contact. It is rapidly absorbed by your lungs after you breathe air containing it. Exposure to xylene may also take place if you eat or drink xylene-contaminated food or water. The amount of xylene retained ranges from 50% to 75% of the amount of xylene that you inhale. Physical exercise increases the amount of xylene absorbed by the lungs. Absorption of xylene after eating food or drinking water containing it is both rapid and complete. Absorption of xylene through the skin also occurs rapidly following direct contact with xylene. Absorption of xylene vapor through the skin is lower than absorption of xylene vapor by the lungs. However, it is not known how much of the xylene is absorbed through the skin. At hazardous waste sites, breathing xylene vapors, drinking well water contaminated with xylene, and direct contact of the skin with xylene are the most likely ways you can be exposed. Xylene passes into the blood soon after entering the body.

In people and laboratory animals, xylene is broken down into other chemicals especially in the liver. This process changes most of the xylene that is breathed in or swallowed into a different form. Once xylene breaks down, the breakdown products rapidly leave the body, mainly in urine, but some unchanged xylene also leaves in the breath from the lungs. One of the breakdown products of xylene, methylbenzaldehyde, is harmful to the lungs of some animals. This chemical has not been found in people exposed to xylene. Small amounts of breakdown products of xylene have appeared in the urine of people as soon as 2 hours after breathing air containing xylene. Usually, most of the xylene that is taken in leaves the body within 18 hours after exposure ends. Storage of xylene in fat or muscle may prolong the time needed for xylene to leave the body.

Short-term exposure of people to high levels of xylene can cause irritation of the skin, eyes, nose, and throat; difficulty in breathing; impaired function of the lungs; delayed response to a visual stimulus; impaired memory; stomach discomfort; and possible changes in the liver and kidneys. Both short- and long-term exposure to high concentrations of xylene can also cause a number of effects on the nervous system, such as headaches, lack of muscle coordination, dizziness, confusion, and changes in one's sense of balance. People exposed to very high levels of xylene for a short period of time have died. Most of the information on long-term exposure to xylene is from studies of workers employed in industries that make or use xylene. Those workers were exposed to levels of xylene in air far greater than the levels normally encountered by
Appendix C – Site-Specific Health and Safety Plan

the general population. Many of the effects seen after their exposure to xylene could have been caused by exposure to other chemicals that were in the air with xylene.

Results of studies of animals indicate that large amounts of xylene can cause changes in the liver and harmful effects on the kidneys, lungs, heart, and nervous system. Short-term exposure to very high concentrations of xylene causes death in animals, as well as muscular spasms, incoordination, hearing loss, changes in behavior, changes in organ weights, and changes in enzyme activity. Long-term exposure of animals to low concentrations of xylene has not been well studied.

Information from animal studies is not adequate to determine whether or not xylene causes cancer in humans. Both the IARC and EPA have found that there is insufficient information to determine whether or not xylene is carcinogenic and consider xylene not classifiable as to its human carcinogenicity.

Exposure of pregnant women to high levels of xylene may cause harmful effects to the fetus. Studies of unborn animals indicate that high concentrations of xylene may cause increased numbers of deaths, decreased weight, skeletal changes, and delayed skeletal development. In many instances, these same concentrations also cause damage to the mothers. The higher the exposure and the longer the exposure to xylene, the greater the chance of harmful health effects. Lower concentrations of xylene are not so harmful.

EPA estimates that, for an adult of average weight, exposure to 10 mg/L (equal to 10 ppm) of water each day for a lifetime (70 years) is unlikely to result in harmful noncancerous health effects. For a long-term but less than lifetime exposure (about 7 years), 27.3 ppm is estimated to be a level unlikely to result in harmful health effects in an adult.

Exposure to 12 ppm xylene in water for 1 day or to 7.8 ppm of xylene in water for 10 days or longer is unlikely to present a health risk to a small child. EPA has proposed a recommended maximum level of 10 ppm xylene in drinking water.

To protect people from the potential harmful health effects of xylene, EPA regulates xylene in the environment. EPA has set a legally enforceable maximum level of 10 mg/L (equal to 10 ppm) of xylene in water that is delivered to any user of a public water system. OSHA has set an occupational exposure limit of 100 ppm of xylene in air averaged over an 8-hour workday and a 15-minute exposure limit of 150 ppm. These regulations also match recommendations (not legally enforceable) of the American Conference of Governmental Industrial Hygienists. NIOSH has recommended an exposure limit (not legally enforceable) of 100 ppm of xylene averaged over a workday up to 10 hours long in a 40-hour workweek. NIOSH has also recommended that exposure to xylene not exceed 150 ppm for longer than 15 minutes. NIOSH has classified xylene exposures of 10,000 ppm as immediately dangerous to life or health.
EPA and the FDA specify conditions under which xylene may be used as a part of herbicides, pesticides, or articles used in contact with food. The EPA has a chronic drinking water health advisory of 27.3 ppm for an adult and 7.8 ppm for a 10-kilogram child.

EPA regulations require that a spill of 1,000 pounds or more of xylene or used xylene solvents be reported to the Federal Government National Response Center.
Base map prepared from 2012 Google Map data.

Driving Directions:
1: Head north on Colt Court toward W Mountain (157 ft)
2: Turn left onto W Mountain (213 ft)
3: Turn right onto N Quail Crossing Street (433 ft)
4: Turn right onto W 21st Street (0.1 mi)
5: Take the 1st left onto Keystone Pkwy
   Destination will be on the left
6: End at Kansas Medical Center:
   1124 West 21st Street
   Andover, KS  67002
   (316) 300-4000
Section 1 - Material Identification

Supplier:

REGENESIS
1011 Calle Sombra
San Clemente, CA  92673
Phone: 949.366.8000
Fax: 949.366.8090
E-mail: info@regenesis.com

Chemical Description: A mixture of Calcium OxyHydroxide [CaO(OH)\textsubscript{2}] and Calcium Hydroxide [Ca(OH)\textsubscript{2}].

Chemical Family: Inorganic Chemical

Trade Name: Advanced Formula Oxygen Release Compound (ORC Advanced\textsuperscript{TM})

Chemical Synonyms: Calcium Hydroxide Oxide; Calcium Oxide Peroxide; Calcium Oxy-Hydroxide; Calcium Oxyhydroxide

Product Use: Used to remediate contaminated soil and groundwater (environmental applications)

Section 2 – Composition

<table>
<thead>
<tr>
<th>CAS No.</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>682334-66-3</td>
<td>Calcium Hydroxide Oxide [CaO(OH)\textsubscript{2}]</td>
</tr>
<tr>
<td>1305-62-0</td>
<td>Calcium Hydroxide [Ca(OH)\textsubscript{2}]</td>
</tr>
<tr>
<td>7758-11-4</td>
<td>Dipotassium Phosphate (HK\textsubscript{2}O\textsubscript{4}P)</td>
</tr>
<tr>
<td>7778-77-0</td>
<td>Monopotassium Phosphate (H\textsubscript{2}KO\textsubscript{4}P)</td>
</tr>
</tbody>
</table>
### Section 3 – Physical Data

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Powder</td>
</tr>
<tr>
<td>Color</td>
<td>White to Pale Yellow</td>
</tr>
<tr>
<td>Odor</td>
<td>Odorless</td>
</tr>
<tr>
<td>Melting Point</td>
<td>527 °F (275 °C) – Decomposes</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>Not Applicable (NA)</td>
</tr>
<tr>
<td>Flammability/Flash Point</td>
<td>NA</td>
</tr>
<tr>
<td>Auto- Flammability</td>
<td>NA</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>NA</td>
</tr>
<tr>
<td>Self-Ignition Temperature</td>
<td>NA</td>
</tr>
<tr>
<td>Thermal Decomposition</td>
<td>527 °F (275 °C) – Decomposes</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>0.5 – 0.65 g/ml (Loose Method)</td>
</tr>
<tr>
<td>Solubility</td>
<td>1.65 g/L @ 68° F (20° C) for calcium hydroxide.</td>
</tr>
<tr>
<td>Viscosity</td>
<td>NA</td>
</tr>
<tr>
<td>pH</td>
<td>11-13 (saturated solution)</td>
</tr>
<tr>
<td>Explosion Limits % by Volume</td>
<td>Non-explosive</td>
</tr>
<tr>
<td>Hazardous Decomposition Products</td>
<td>Oxygen, Hydrogen Peroxide, Steam, and Heat</td>
</tr>
<tr>
<td>Hazardous Reactions</td>
<td>None</td>
</tr>
</tbody>
</table>
Section 4 – Reactivity Data

Stability: Stable under certain conditions (see below).

Conditions to Avoid: Heat and moisture.

Incompatibility: Acids, bases, salts of heavy metals, reducing agents, and flammable substances.

Hazardous Polymerization: Does not occur.

Section 5 – Regulations

TSCA Inventory List: Listed

CERCLA Hazardous Substance (40 CFR Part 302)
Listed Substance: No
Unlisted Substance: Yes
Reportable Quantity (RQ): 100 pounds
Characteristic(s): Ignitibility

RCRA Waste Number: D001

SARA, Title III, Sections 302/303 (40 CFR Part 355 – Emergency Planning and Notification)
Extremely Hazardous Substance: No

SARA, Title III, Sections 311/312 (40 CFR Part 370 – Hazardous Chemical Reporting: Community Right-To-Know)
Hazard Category: Immediate Health Hazard, Fire Hazard
Threshold Planning Quantity: 10,000 pounds
Section 5 – Regulations (cont)

SARA, Title III, Section 313 (40 CFR Part 372 – Toxic Chemical Release Reporting: Community Right-To-Know

Extremely Hazardous Substance: No

WHMIS Classification: C Oxidizing Material

D Poisonous and Infectious Material

D Material Causing Other Toxic Effects –

Eye and Skin Irritant

Canadian Domestic Substance List: Not Listed

Section 6 – Protective Measures, Storage and Handling

Technical Protective Measures

Storage: Keep in tightly closed container. Store in dry area, protected from heat sources and direct sunlight.

Handling: Clean and dry processing pipes and equipment before operation. Never return unused product to the storage container. Keep away from incompatible products. Containers and equipment used to handle this product should be used exclusively for this material. Avoid contact with water or humidity.
## Section 6 – Protective Measures, Storage and Handling (cont)

### Personal Protective Equipment (PPE)

<table>
<thead>
<tr>
<th>Engineering Controls:</th>
<th>Calcium Hydroxide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ACGIH® TLV® (2000)</td>
</tr>
<tr>
<td></td>
<td>5 mg/m³ TWA</td>
</tr>
<tr>
<td></td>
<td>OSHA PEL</td>
</tr>
<tr>
<td></td>
<td>Total dust–15 mg/m³ TWA</td>
</tr>
<tr>
<td></td>
<td>Respirable fraction–</td>
</tr>
<tr>
<td></td>
<td>5 mg/m³ TWA</td>
</tr>
<tr>
<td></td>
<td>NIOSH REL (1994)</td>
</tr>
<tr>
<td></td>
<td>5 mg/m³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Respiratory Protection:</th>
<th>For many conditions, no respiratory protection may be needed; however, in dusty or unknown atmospheres use a NIOSH approved dust respirator.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Hand Protection:</th>
<th>Impervious protective gloves made of nitrile, natural rubber or neoprene.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Eye Protection:</th>
<th>Use chemical safety goggles (dust proof).</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Skin Protection:</th>
<th>For brief contact, few precautions other than clean clothing are needed. Full body clothing impervious to this material should be used during prolonged exposure.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Other:</th>
<th>Safety shower and eyewash stations should be present. Consultation with an industrial hygienist or safety manager for the selection of PPE suitable for working conditions is suggested.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Industrial Hygiene:</th>
<th>Avoid contact with skin and eyes.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Protection Against Fire &amp; Explosion:</th>
<th>NA</th>
</tr>
</thead>
</table>

## Section 7 – Hazards Identification

<table>
<thead>
<tr>
<th>Emergency Overview:</th>
<th>Oxidizer – Contact with combustibles may cause a fire. This material decomposes and releases oxygen in a fire. The additional oxygen may intensify the fire.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Potential Health Effects:</th>
<th>Irritating to the mucous membrane and eyes. If the product splashes in one’s face and eyes, treat the eyes first. Do not dry soiled clothing close to an open flame or heat source. Any</th>
</tr>
</thead>
</table>
clothing that has been contaminated with this product should be submerged in water prior to drying.

**Inhalation:**
High concentrations may cause slight nose and throat irritation with a cough. There is risk of sore throat and nose bleeds if one is exposed to this material for an extended period of time.

**Eye Contact:**
Severe eye irritation with watering and redness. There is also the risk of serious and/or permanent eye lesions.

**Skin Contact:**
Irritation may occur if one is exposed to this material for extended periods.

**Ingestion:**
Irritation of the mouth and throat with nausea and vomiting.

---

**Section 8 – Measures in Case of Accidents and Fire**

**After Spillage/Leakage/Gas Leakage:**
Collect in suitable containers. Wash remainder with copious quantities of water.

**Extinguishing Media:**
See next.

**Suitable:**
Large quantities of water or water spray. In case of fire in close proximity, all means of extinguishing are acceptable.

Self contained breathing apparatus or approved gas mask should be worn due to small particle size. Use extinguishing media appropriate for surrounding fire. Apply cooling water to sides of transport or storage vessels that are exposed to flames until the fire is extinguished. Do not approach hot vessels that contain this product.

**Further Information:**
After contact with skin, wash immediately with plenty of water and soap. In case of contact with eyes, rinse immediately with plenty of water and seek medical attention. Consult an ophthalmologist in all cases.

**First Aid:**
Flush eyes with running water for 15 minutes, while keeping the eyelids wide open. Consult with an ophthalmologist in all cases.

**Inhalation:**
Remove subject from dusty environment. Consult with a physician in case of respiratory symptoms.
Regenesis - ORC Advanced MSDS

Ingestion: If the victim is conscious, rinse mouth and administer fresh water. DO NOT induce vomiting. Consult a physician in all cases.

Skin Contact: Wash affected skin with running water. Remove and clean clothing. Consult with a physician in case of persistent pain or redness.

Special Precautions: Evacuate all non-essential personnel. Intervention should only be done by capable personnel that are trained and aware of the hazards associated with this product. When it is safe, unaffected product should be moved to safe area.

Specific Hazards: Oxidizing substance. Oxygen released on exothermic decomposition may support combustion. Confined spaces and/or containers may be subject to increased pressure. If product comes into contact with flammables, fire or explosion may occur.

Section 9 – Accidental Release Measures

Precautions: Observe the protection methods cited in Section 3. Avoid materials and products that are incompatible with product. Immediately notify the appropriate authorities in case of reportable discharge (> 100 lbs).

Cleanup Methods: Collect the product with a suitable means of avoiding dust formation. All receiving equipment should be clean, vented, dry, labeled and made of material that this product is compatible with. Because of the contamination risk, the collected material should be kept in a safe isolated place. Use large quantities of water to clean the impacted area. See Section 12 for disposal methods.

Section 10 – Information on Toxicology

Toxicity Data

Oral Route, LD$_{50}$, rat, > 2,000 mg/kg (powder 50%)

Acute Toxicity: Dermal Route, LD$_{50}$, rat, > 2,000 mg/kg (powder 50%)

Inhalation, LD$_{50}$, rat, > 5,000 mg/m$^3$ (powder 35%)

Irritation: Rabbit (eyes), severe irritant
Regenesis - ORC Advanced MSDS

<table>
<thead>
<tr>
<th>Sensitization:</th>
<th>No data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Toxicity:</td>
<td>In vitro, no mutagenic effect (Powder 50%)</td>
</tr>
<tr>
<td>Target Organ Effects:</td>
<td>Eyes and respiratory passages.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 11 – Information on Ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecology Data</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>10 mg Ca(OH)$_2$/L: pH = 9.0</td>
</tr>
<tr>
<td>100 mg Ca(OH)$_2$/L: pH = 10.6</td>
</tr>
<tr>
<td>Acute Exotoxicity:</td>
</tr>
<tr>
<td>Fishes, Cyprinus carpio, LC$_{50}$, 48 hrs, 160 mg/L</td>
</tr>
<tr>
<td>Crustaceans, Daphnia sp., EC$_{50}$, 24 hours, 25.6 mg/L</td>
</tr>
<tr>
<td>(Powder 16%)</td>
</tr>
<tr>
<td>Mobility:</td>
</tr>
<tr>
<td>Low Solubility and Mobility</td>
</tr>
<tr>
<td>Water – Slow Hydrolysis.</td>
</tr>
<tr>
<td>Degradation Products: Calcium Hydroxide</td>
</tr>
<tr>
<td>Abiotic Degradation:</td>
</tr>
<tr>
<td>Water/soil – complexation/precipitation. Carbonates/sulfates present at environmental concentrations.</td>
</tr>
<tr>
<td>Degradation products: carbonates/sulfates sparingly soluble</td>
</tr>
<tr>
<td>Biotic Degradation: NA (inorganic compound)</td>
</tr>
<tr>
<td>Potential for Bioaccumulation: NA (ionizable inorganic compound)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 11 – Information on Ecology (cont)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments: Observed effects are related to alkaline properties of the product. Hazard for the environment is limited due to the product properties of:</td>
</tr>
<tr>
<td>- No bioaccumulation</td>
</tr>
<tr>
<td>- Weak solubility and precipitation as carbonate or sulfate in an aquatic environment.</td>
</tr>
<tr>
<td>Diluted product is rapidly neutralized at environmental pH.</td>
</tr>
<tr>
<td>Further Information: NA</td>
</tr>
</tbody>
</table>
Section 12 – Disposal Considerations

Waste Method: Disposal
Consult current federal, state and local regulations regarding the proper disposal of this material and its emptied containers.

Section 13 – Shipping/Transport Information

D.O.T Name: Shipping
Oxidizing Solid, N.O.S [A mixture of Calcium OxyHydroxide [CaO(OH)₂] and Calcium Hydroxide [Ca(OH)₂].

UN Number: 1479
Hazard Class: 5.1
Label(s): 5.1 (Oxidizer)
Packaging Group: II
STCC Number: 4918717

Section 14 – Other Information

HMIS® Rating
Health – 2
Reactivity – 1
Flammability – 0
PPE - Required

HMIS® is a registered trademark of the National Painting and Coating Association.

NFPA® Rating
Health – 2
Reactivity – 1
Flammability – 0
OX

NFPA® is a registered trademark of the National Fire Protection Association.

Reason for Issue: Update toxicological and ecological data

Section 15 – Further Information

The information contained in this document is the best available to the supplier at the time of writing, but is provided without warranty of any kind. Some possible hazards have been determined by analogy to similar classes of material. The items in this document are subject to change and clarification as more information become available.
1.0 Introduction

This sampling and analysis plan (SAP) presents the field procedures and the analytical testing program that will be used to collect and evaluate soil samples from the sidewalls of the planned excavation in the Quail Crossing Neighborhood near Andover, Kansas (the Site). Quality assurance and quality control (QA/QC) procedures are also discussed in this appendix.

2.0 Field and Sampling Procedures

The scope of work includes excavation of soil, confirmation soil sampling, and site restoration. Analytical data obtained during this project will be used to confirm that soil with gasoline constituents at the Site was removed to the maximum extent practicable and to document residual concentrations in soil. The field and sampling procedures include:

- Soil excavation;
- Field screening of excavated soil;
- Collection of soil samples;
- Selection and containerizing soil samples for laboratory analysis;
- Sample management (e.g., containers, storage, and shipment);
- Sample location control;
- Equipment decontamination; and
- Handling of investigation-derived waste (IDW).

2.1 Preparatory Activities

Property Access. The soil excavation will be performed within: (1) the NuStar Pipeline right of way (ROW); and (2) the City of Andover ROW. NuStar executed an access agreement and an excavation permit with the City of Andover in 2013. The access agreements will be modified as necessary to perform the excavation outlined herein.

Property Owner Notification. The owners of properties in the Quail Crossing Neighborhood will be notified of planned excavation activities a minimum of four weeks in advance of field work.

Underground Utility Location. An underground utility locate request will be submitted through Kansas One-Call Service. A private underground utility locate will also be conducted prior to performing the subsurface work.
Appendix D – Sampling and Analysis Plan: Soil Excavation

Health and Safety Plan. A Health and Safety Plan (HASP) has been prepared and is included as an Appendix D to the Soil Excavation Work Plan (Work Plan). A copy of the HASP will be maintained on-site during field activities.

2.2 Soil Excavation Area and Soil Sample Collection

The planned soil excavation methods and the anticipated horizontal and vertical extents of the excavation are described in detail in Section 5 of the Work Plan. During excavation, excavated soil will be field screened for volatile organic compounds (VOCs) and separate-phase hydrocarbons (SPH) using a photoionization detector (PID) and sheen tests, in accordance with Standard Operating Procedure (SOP) 2.1, included in this appendix. Upon completion of the excavation, samples will be collected from the sidewalls at a frequency of at least one sample per 200 square feet. We anticipate that the sidewall excavation area will be approximately 2,200 ft²; therefore, approximately 11 confirmation soil samples will be collected for laboratory analysis. More samples will be collected if necessary to delineate the extent of gasoline in soil or if unanticipated conditions are encountered.

Soil samples will be collected from the excavation sidewalls using the excavator bucket. Soil obtained from the excavator bucket will consist of material not in direct contact with the bucket. Soil for screening and sampling will be collected from the excavation bucket. Apex staff will not enter the excavation.

2.3 Sample Location Control

Sample locations and the lateral extent of the excavation extent will be recorded using a handheld global positioning system (GPS) instrument and a measuring tape. The GPS instrument will be used to record horizontal position. The measuring tape will be used to measure sample depth and distance from other sample locations.

2.4 Sample Management

Soil Containers. Clean sample containers will be provided by the analytical laboratory ready for sample collection, including preservative if required (the container requirements are listed in Table D-1). Specific container requirements for samples that will undergo multiple analyses will be discussed with the analytical laboratory prior to sample collection.

Labeling Requirements. A sample label will be affixed to each sample container before sample collection. Containers will be marked with the project number, sample number, date of collection, and the sampler’s initials.
Appendix D – Sampling and Analysis Plan:
Soil Excavation

Sample Storage and Shipment. Soil samples will be stored in a cooler chilled with ice or blue ice to 4 degrees Celsius (°C). The cooler lid will be sealed with chain-of-custody seals. The samples will be sent via overnight courier to the analytical laboratory for chemical analysis. Chain of custody will be maintained and documented at all times.

2.5 Decontamination Procedures

Personnel Decontamination. Personnel decontamination procedures depend on the level of protection specified for a given activity. The HASP identifies the appropriate level of protection for the type of work and expected field conditions involved in this project. In general, clothing and other protective equipment can be removed from the area. Field personnel should thoroughly wash their hands and faces at the end of each day and before taking any work breaks.

Sampling Equipment Decontamination. To minimize cross-contamination between sampling events, cleaning of non-disposable items will consist of washing in a detergent (Alconox®) solution, rinsing with tap water, followed by a de-ionized (DI) water rinse. Decontamination water will be handled as described in Section 2.6. The excavator bucket will be broom cleaned on a daily basis.

2.6 Handling of Investigation-Derived Waste

Investigation-derived waste (IDW) will consist of decontamination water and purge water. Decontamination water and purge water will be placed with excavated soil and managed at the NuStar El Dorado Terminal, pending KDHE approval of a modification to the NuStar El Dorado Landfarm Permit BWM #727. Consistent with KDHE Landfarm permit requirements, one grab soil sample per 300 cubic yards (yd³; approximately four samples total) will be submitted for chemical analysis as detailed in Section 3. Disposable items, such as gloves, protective overalls (e.g., Tyvek®), paper towels, etc., will be placed in plastic bags after use and deposited in trash receptacles for disposal.

3.0 Analytical Testing Program

An analytical testing program will be performed to assess the chemical quality of soil samples collected during this project. Analytical laboratory QA/QC procedures are discussed in Section 4 of this appendix.

Soil samples will be submitted for chemical analysis of gasoline-range organics (GRO) and VOCs by Iowa Method OA-1 and Environmental Protection Agency (EPA) Method 8260B, respectively. Table D-2 lists the proposed analytical methods and laboratory detection limit goals. Samples will be collected and handled using methods described in Section 2 of this appendix. Sample container and storage requirements are listed in Table D-1.
4.0 Quality Assurance Program

4.1 Quality Assurance Objectives for Data Management

The general QA objectives for this project are to develop and implement procedures for evaluating soil analytical data. To collect such information, analytical data must have an appropriate degree of accuracy and reproducibility, samples must be representative of actual field conditions, and samples must be collected and analyzed using unbroken chain-of-custody procedures (see Section 4.3).

Method detection limits (MDLs) and analytical results will be compared to action levels for each parameter in media of concern. The detection limits listed in Table D-2 are the expected detection limits, based upon laboratory calculations and experience.

Specific QA objectives are as follows:

1) Establish sampling techniques that will produce analytical data representative of the media being measured.

2) Collect and analyze a sufficient number of duplicate field samples to establish sampling precision. Laboratory duplicates of the same sample will provide a measure of precision within that sample (sample homogeneity).

3) Analyze a sufficient number of analytical duplicate samples to assess the performance of the analytical laboratory.

4) Analyze a sufficient number of duplicate, spiked, and check samples within the laboratory to evaluate results against numerical QA goals established for precision and accuracy.

Precision, accuracy, representativeness, completeness, and comparability parameters used to indicate data quality are defined below.

4.1.1 Precision

Precision is a measure of the reproducibility of data under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average value. For duplicate measurements, precision can be expressed as the relative percent difference (RPD). Analysis of field duplicate samples measures the precision of sampling.
4.1.2 Accuracy

Accuracy is the measure of error between the reported test results and the true sample concentration. True sample concentration is never known due to analytical limitations and error. Consequently, accuracy is inferred from the recovery data from spiked samples.

Because of difficulties with spiking samples in the field, the laboratory will spike samples. For analyses of less than five samples, matrix spikes (MS) may be performed on a batch basis.

Perfect accuracy is 100 percent recovery.

4.1.3 Representativeness

Representativeness is a measure of how closely the results reflect the actual concentration of the chemical parameters in the medium sampled. Sampling procedures as well as sample-handling protocols for storage, preservation, and transportation are designed to preserve the representativeness of the samples collected. Proper documentation will confirm that protocols are followed. This helps to assure sample identification and integrity.

Laboratory method blanks will be run in accordance with established laboratory protocols to ensure samples are not contaminated during sample preparation in the laboratory.

4.1.4 Completeness

Completeness is defined as the percentage of measurements made which are judged to be valid. The completeness goal is essentially that a sufficient amount of valid data be generated to meet the closure requirements.

4.1.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. The objective of this QA program is to assure that data developed during the project are comparable. Comparability of the data will be assured by using EPA-defined procedures which specify sample collection, handling, and analytical methods.

4.1.6 Documentation

Essentially, EPA Level III documentation will be generated during this project. This level of documentation is generally considered legally defensible and consists of the following:
Appendix D – Sampling and Analysis Plan: Soil Excavation

- Holding times;
- Field duplicate data;
- Laboratory method blank data;
- Sample data;
- Matrix/surrogate spike data; and
- Duplicate sample data.

4.2 Sampling Procedures

Sampling procedures for soil are presented above in Section 2.2 of this appendix. These procedures are designed to ensure:

- Samples collected at the Site are consistent with project objectives; and
- Samples are identified, handled, and transported in a manner that does not alter the representativeness of the data from the actual Site conditions.

QA objectives for sample collection will be accomplished by evaluating the following items:

- **Duplicate Samples.** Duplicates will be submitted to evaluate the precision of soil analysis. Three field duplicates are included in the scope for this work.

- **Trip Blank.** A trip blank will be prepared by the analytical laboratory and will accompany the collected soil samples during storage and shipment. One trip blank will accompany and be analyzed for each cooler; therefore, approximately five trip blanks are estimated.

- **Laboratory QA.** Samples will be analyzed by ALS Laboratories, a KDHE-certified laboratory. The ALS Quality Assurance Program Plan has been provided to KDHE previously.

4.3 Sample and Document Custody Procedures

The various methods used to document field sample collection and laboratory operation are presented below.

4.3.1 Field Chain-of-Custody Procedures

Sample chain of custody refers to the process of tracking the possession of a sample from the time it is collected in the field through the laboratory analysis. A sample is considered to be under a person's custody if it is:

- In a person's physical possession;
Appendix D – Sampling and Analysis Plan: Soil Excavation

- In view of the person after possession has been taken; or
- Secured by that person so no one can tamper with the sample, or secured by that person in an area restricted to authorized personnel.

A chain-of-custody form is used to record possession of a sample and to document analyses requested. Each time the sample bottles or samples are transferred between individuals, both the sender and receiver sign and date the chain-of-custody form. When a sample shipment is transported to the laboratory, a copy of the chain-of-custody form is included in the transport container (e.g., ice chest).

The chain-of-custody forms are used to record the following information:

- Sample identification number;
- Sample collector’s signature;
- Date and time of collection;
- Description of sample;
- Analyses requested;
- Shipper’s name and address;
- Receiver’s name and address; and
- Signatures of persons involved in chain of custody.

4.3.2 Laboratory Operations

The analytical laboratory has a system in place for documenting the following laboratory information:

- Calibration procedures;
- Analytical procedures;
- Computational procedures;
- QC procedures;
- Bench data;
- Operating procedures or any changes to these procedures; and
- Laboratory notebook policy.

Laboratory chain-of-custody procedures provide the following:
Appendix D – Sampling and Analysis Plan: Soil Excavation

- Identification of the responsible party (sample custodian) authorized to sign for incoming field samples and a log consisting of sequential lab tracking numbers; and
- Specification of laboratory sample custody procedures for sample handling, storage, and internal distribution for analysis.

4.3.3 Corrections to Documentation

Original data are recorded in field notes and on chain-of-custody forms using indelible ink. Documents will be retained even if they are illegible or contain inaccuracies that require correction.

If an error is made on a document, the individual making the entry will correct the document by crossing a line through the error, entering the correct information, and initialing and dating the correction. Any subsequent error discovered on a document is corrected, initialed, and dated by the person who made the entry.

4.4 Equipment Calibration Procedures and Frequency

Instruments and equipment used during this project will be operated, calibrated, and maintained according to the manufacturer’s guidelines and recommendations. Operation, calibration, and maintenance will be performed by laboratory personnel fully trained in these procedures.

4.5 Analytical Procedures

Samples will be analyzed using GRO by Iowa Method OA-1 and VOCs by EPA Method 8260B. Table D-2 lists analytical parameters and test methods.

4.6 Data Reduction, Validation, and Reporting

The Project Manager will assure validation of the analytical data. The laboratory generating analytical data for this project will be required to submit results that are supported by sufficient backup and QA/QC data to enable the reviewer to determine the quality of the data. Validity of the laboratory data will be determined based on the objectives outlined in Section 4.1 (above). Data validity will also be determined based upon the sampling procedures and documentation outlined in Sections 4.2 and 4.3 of this SAP. Upon completion of the review, the Project Manager will be responsible for assuring development of a QA/QC report on the analytical data. Data will be stored and maintained according to the standard procedures of the laboratory. The method of data reduction will be described in the final report.
4.7 Performance Audits

Performance audits are an integral part of an analytical laboratory’s SOPs and are available upon request.

4.8 Corrective Actions

If the QC audit detects unacceptable conditions or data, the Project Manager will be responsible for developing and initiating corrective action. The Project Manager will be notified if the nonconformance is significant or requires special expertise. Corrective action may include the following:

- Reanalyzing the samples, if holding time criteria permit;
- Resampling and analyzing;
- Evaluating and amending sampling and analytical procedures; and
- Accepting data and acknowledging level of uncertainty or inaccuracy by flagging the data.

4.9 Quality Assurance Reports

The Project Manager will prepare a QA/QC evaluation of the data collected during the project field activities for inclusion in the final report. In addition to an opinion regarding the validity of the data, the QA/QC evaluation will address the following:

- Adverse conditions or deviations from this SAP;
- Assessment of analytical data for precision, accuracy, and completeness;
- Significant QA problems and recommended solutions; and
- Corrective actions taken for any problems previously identified.
Table D-1
Analytical Methods – Sample Container Requirements
NuStar Pipeline Operating Partnership L.P. – Quail Crossing Neighborhood
Andover, Kansas

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Method</th>
<th>Container</th>
<th>Preservative</th>
<th>Storage Temperature</th>
<th>Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOCs</td>
<td>EPA 8260B</td>
<td>2 x 4 oz jar</td>
<td>None</td>
<td>4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>TPH-GRO</td>
<td>Iowa-OA1</td>
<td>1 x 4 oz jar</td>
<td>None</td>
<td>4°C</td>
<td>14 days</td>
</tr>
</tbody>
</table>

Notes:
1. EPA = U.S. Environmental Protection Agency.
2. TPH-GRO = Gasoline-range petroleum hydrocarbons.
3. VOCs = Volatile organic compounds.
4. oz = Ounces
5. °C = Degrees Celsius.
<table>
<thead>
<tr>
<th>Analyte</th>
<th>Method</th>
<th>Anticipated Number of Samples</th>
<th>Units</th>
<th>Detection Limit Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Petroleum Hydrocarbons (TPH) Soil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Petroleum Hydrocarbons as Gasoline (TPH-GRO)</td>
<td>Iowa Method OA-1</td>
<td>15</td>
<td>mg/kg</td>
<td>0.5</td>
</tr>
<tr>
<td>Volatile Organic Compounds (VOCs) Soil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>Cyclohexane</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>Isopropylbenzene</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>Methylcyclohexane</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>Toluene</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>Xylenes, Total</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.003</td>
</tr>
<tr>
<td>n-butylbenzene</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>1,3,5-trimethylbenzene</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>1,2,4-trimethylbenzene</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>2-butane</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
<tr>
<td>n-Propylbenzene</td>
<td>EPA Method 8260B</td>
<td>15</td>
<td>mg/kg</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Notes:
1. EPA = U.S. Environmental Protection Agency
2. TPH-GRO = Gasoline-range petroleum hydrocarbons
3. VOCs = Volatile organic compounds
4. mg/kg = Milligrams per kilogram
Table D-3
Quality Assurance Samples
NuStar Pipeline Operating Partnership L.P. – Quail Crossing Neighborhood
Andover, Kansas

<table>
<thead>
<tr>
<th>QA Sample Matrix</th>
<th>QA Sample Type</th>
<th>Analyses Requested</th>
<th>Anticipated Number of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>Duplicate</td>
<td>TPH-GRO</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Duplicate</td>
<td>VOCs</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Trip Blank</td>
<td>VOCs</td>
<td>5</td>
</tr>
</tbody>
</table>

Notes:
1. QA = Quality assurance
2. TPH-GRO = Gasoline-range petroleum hydrocarbons
3. VOCs = Volatile organic compounds
1. PURPOSE AND SCOPE
This Standard Operating Procedure (SOP) provides instructions for standard field screening. Field screening results are used to aid in the selection of soil samples for chemical analysis. This procedure is applicable during Apex Companies, LLC (Apex) soil sampling operations.

Standard field screening techniques include the use of a photoionization detector (PID) to assess for volatile organic compounds (VOCs), for the presence of separate-phase petroleum hydrocarbons using a sheen test. These methods will not detect all potential contaminants, so selection of screening techniques shall be based on an understanding of the site history. The PID is not compound or concentration-specific, but it can provide a qualitative indication of the presence of VOCs. PID measurements are affected by other field parameters such as temperature and soil moisture. Other field screening methods, such as screening for dense non-aqueous phase liquid (DNAPL) using dye or UV light, are not considered “standard” and will be detailed in the site-specific sampling and analysis plan (SAP).

2. EQUIPMENT AND MATERIALS
The following materials are necessary for this procedure:

- PID with calibration gas (record daily calibration/calibration check in field notes);
- Plastic resealable bags (for PID measurement); and
- Glass jars or stainless steel bowls (for sheen testing).

3. METHODOLOGY
Each soil sample will be field screened for VOCs using a PID and for the presence of separate-phase petroleum hydrocarbons using a sheen test. If the presence of DNAPL is suspected, then screening using dye and UV light may also be completed. For information regarding screening using dye or UV light, refer to the site specific sampling and analysis plan.

PID lamps come in multiple sizes, typically 9.8, 10.6, and 11.7 electron volts (eV). The eV rating for the lamp must be greater than the ionization potential (in eV) of a compound in order for the PID to detect the compound. For petroleum hydrocarbons, a lamp of at least 9.8 eV should be used. For typical chlorinated alkenes (dichloroethene, trichloroethene, tetrachloroethene, or vinyl chloride), a lamp of at least 10.6 eV should be used. The compatibility of the lamp size with the site constituents should be verified prior to the field event and will be detailed in the site-specific SAP.

PID Calibration Procedure: The PID used on-site should be calibrated daily or more frequently if needed. Calibration of the PID should be documented in field notes. Calibrations procedures should be conducted according to the manufacturer’s instructions.

PID Screening Procedure:
- Place a representative portion (approximately one ounce) of freshly exposed, uncompacted soil into a clean resealable plastic bag.
- Seal the bag and break up the soil to expose vapors from the soil matrix.
- Allow the bag to sit to reach ambient temperature. Note: Ambient temperature and weather conditions/humidity should be recorded in field notes. Changes in ambient temperature and weather during the field work should also be recorded, as temperature and humidity can affect PID readings.
- Carefully insert the intake port of the PID into the plastic bag.
- Record the PID measurement in the field notes or boring logs.

Sheen Test Procedure:
- Following the PID screen, place approximately one ounce of freshly exposed, uncompacted soil into a clean glass jar or stainless steel bowl.
- Add enough water to cover the sample.
- Observe the water surface for signs of discoloration/sheen and characterize

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Sheen (NS)</td>
<td>No visible sheen on the water surface</td>
</tr>
<tr>
<td>Biogenic Film (BF)</td>
<td>Dull, platy/blocky or foamy film.</td>
</tr>
<tr>
<td>Slight Sheen (SS)</td>
<td>Light sheen with irregular spread, not rapid. May have small spots of color/iridescence. Majority of water surface not covered by sheen.</td>
</tr>
<tr>
<td>Moderate Sheen (MS)</td>
<td>Medium to heavy coverage, some color/iridescence, spread is irregular to flowing. Sheen covering a large portion of water surface.</td>
</tr>
<tr>
<td>Heavy Sheen (HS)</td>
<td>Heavy sheen coverage with color/iridescence, spread is rapid, entire water surface covered with sheen. Separate-phase hydrocarbons may be evident during sheen test.</td>
</tr>
</tbody>
</table>
Appendix E

ORC Specifications, MSDS, and Manufacturer Recommended Application Rates
Oxygen Release Compound – Advanced Pellets (ORC Advanced® Pellets)
MATERIAL SAFETY DATA SHEET (MSDS)

Last Revised: March 22, 2012

Section 1 - Material Identification

Supplier:

REGENESIS
1011 Calle Sombra
San Clemente, CA 92673
Phone: 949.366.8000
Fax: 949.366.8090
E-mail: info@regenesis.com

Chemical Description: A mixture of Calcium Hydroxide Oxide \([\text{CaO(OH)}_2]\) and Calcium Hydroxide \([\text{Ca(OH)}_2]\).

Chemical Family: Inorganic Chemical

Trade Name: Advanced Formula Oxygen Release Compound (ORC Advanced® Pellets)

Chemical Synonyms: Calcium OxyHydroxide; Calcium Oxide Peroxide

Product Use: Used to remediate contaminated soil and groundwater (environmental applications)

Section 2 – Composition

<table>
<thead>
<tr>
<th>CAS No.</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>682334-66-3</td>
<td>Calcium Hydroxide Oxide ([\text{CaO(OH)}_2])</td>
</tr>
<tr>
<td>1305-62-0</td>
<td>Calcium Hydroxide ([\text{Ca(OH)}_2])</td>
</tr>
<tr>
<td>7758-11-4</td>
<td>Dipotassium Phosphate ((\text{HK}_2\text{O}_4\text{P}))</td>
</tr>
<tr>
<td>7783-28-0</td>
<td>Ammonium Phosphate Dibasic ([(\text{NH}_4)_2\text{HPO}_4])</td>
</tr>
</tbody>
</table>
### Section 3 – Physical Data

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form:</strong></td>
<td>tablets</td>
</tr>
<tr>
<td><strong>Color:</strong></td>
<td>White to Pale Yellow</td>
</tr>
<tr>
<td><strong>Odor:</strong></td>
<td>Odorless</td>
</tr>
<tr>
<td><strong>Melting Point:</strong></td>
<td>527 °F (275 °C) – Decomposes</td>
</tr>
<tr>
<td><strong>Boiling Point:</strong></td>
<td>Not Applicable (NA)</td>
</tr>
<tr>
<td><strong>Flammability/Flash Point:</strong></td>
<td>NA</td>
</tr>
<tr>
<td><strong>Auto-Flammability:</strong></td>
<td>NA</td>
</tr>
<tr>
<td><strong>Vapor Pressure:</strong></td>
<td>NA</td>
</tr>
<tr>
<td><strong>Self-Ignition Temperature:</strong></td>
<td>NA</td>
</tr>
<tr>
<td><strong>Thermal Decomposition:</strong></td>
<td>527 °F (275 °C) – Decomposes</td>
</tr>
<tr>
<td><strong>Bulk Density:</strong></td>
<td>0.5 – 0.65 g/ml (Loose Method)</td>
</tr>
<tr>
<td><strong>Solubility:</strong></td>
<td>1.65 g/L @ 68° F (20° C) for calcium hydroxide.</td>
</tr>
<tr>
<td><strong>Viscosity:</strong></td>
<td>NA</td>
</tr>
<tr>
<td><strong>pH:</strong></td>
<td>11-13 (saturated solution)</td>
</tr>
<tr>
<td><strong>Explosion Limits % by Volume:</strong></td>
<td>Non-explosive</td>
</tr>
<tr>
<td><strong>Hazardous Decomposition Products:</strong></td>
<td>Oxygen, Hydrogen Peroxide, Steam, and Heat</td>
</tr>
<tr>
<td><strong>Hazardous Reactions:</strong></td>
<td>None</td>
</tr>
</tbody>
</table>
### Section 4 – Reactivity Data

<table>
<thead>
<tr>
<th>Stability:</th>
<th>Stable under certain conditions (see below).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions to Avoid:</td>
<td>Heat and moisture.</td>
</tr>
<tr>
<td>Incompatibility:</td>
<td>Acids, bases, salts of heavy metals, reducing agents, and flammable substances.</td>
</tr>
<tr>
<td>Hazardous Polymerization:</td>
<td>Does not occur.</td>
</tr>
</tbody>
</table>

### Section 5 – Regulations

<table>
<thead>
<tr>
<th>TSCA Inventory List:</th>
<th>Listed</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERCLA Hazardous Substance (40 CFR Part 302)</td>
<td></td>
</tr>
<tr>
<td>Listed Substance:</td>
<td>No</td>
</tr>
<tr>
<td>Unlisted Substance:</td>
<td>Yes</td>
</tr>
<tr>
<td>Reportable Quantity (RQ):</td>
<td>100 pounds</td>
</tr>
<tr>
<td>Characteristic(s):</td>
<td>Ignitibility</td>
</tr>
<tr>
<td>RCRA Waste Number:</td>
<td>D001</td>
</tr>
<tr>
<td>SARA, Title III, Sections 302/303 (40 CFR Part 355 – Emergency Planning and Notification)</td>
<td></td>
</tr>
<tr>
<td>Extremely Hazardous Substance:</td>
<td>No</td>
</tr>
<tr>
<td>SARA, Title III, Sections 311/312 (40 CFR Part 370 – Hazardous Chemical Reporting: Community Right-To-Know)</td>
<td></td>
</tr>
<tr>
<td>Hazard Category:</td>
<td>Immediate Health Hazard</td>
</tr>
<tr>
<td></td>
<td>Fire Hazard</td>
</tr>
</tbody>
</table>
Threshold Planning Quantity: 10,000 pounds

Section 5 – Regulations (cont)

SARA, Title III, Section 313 (40 CFR Part 372 – Toxic Chemical Release Reporting: Community Right-To-Know

Extremely Hazardous Substance: No

WHMIS Classification:

<table>
<thead>
<tr>
<th>Code</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Oxidizing Material</td>
</tr>
<tr>
<td></td>
<td>Poisonous and Infectious Material</td>
</tr>
<tr>
<td></td>
<td>Material Causing Other Toxic Effects –</td>
</tr>
<tr>
<td></td>
<td>Eye and Skin Irritant</td>
</tr>
<tr>
<td>D</td>
<td>Material Causing Other Toxic Effects –</td>
</tr>
<tr>
<td></td>
<td>Eye and Skin Irritant</td>
</tr>
</tbody>
</table>

Canadian Domestic Substance List: Not Listed

Section 6 – Protective Measures, Storage and Handling

Technical Protective Measures

Storage: Keep in tightly closed container. Store in dry area, protected from heat sources and direct sunlight.

Handling: Clean and dry processing pipes and equipment before operation. Never return unused product to the storage container. Keep away from incompatible products. Containers and equipment used to handle this product should be used exclusively for this material. Avoid contact with water or humidity.
### Personal Protective Equipment (PPE)

**Engineering Controls:**

- **Calcium Hydroxide**
  - ACGIH® TLV® (2000) 5 mg/m³ TWA
  - OSHA PEL

- Total dust—15 mg/m³ TWA
- Respirable fraction—
  - 5 mg/m³ TWA
  - NIOSH REL (1994)
  - 5 mg/m³

**Respiratory Protection:**

For many conditions, no respiratory protection may be needed; however, in dusty or unknown atmospheres use a NIOSH approved dust respirator.

**Hand Protection:**

Impervious protective gloves made of nitrile, natural rubber or neoprene.

**Eye Protection:**

Use chemical safety goggles (dust proof).

**Skin Protection:**

For brief contact, few precautions other than clean clothing are needed. Full body clothing impervious to this material should be used during prolonged exposure.

**Other:**

Safety shower and eyewash stations should be present. Consultation with an industrial hygienist or safety manager for the selection of PPE suitable for working conditions is suggested.

**Industrial Hygiene:**

Avoid contact with skin and eyes.

**Protection Against Fire & Explosion:**

NA

---

### Section 7 – Hazards Identification

**Emergency Overview:**

Oxidizer – Contact with combustibles may cause a fire. This material decomposes and releases oxygen in a fire. The additional oxygen may intensify the fire.
Potential Health Effects:

Irritating to the mucous membrane and eyes. If the product splashes in one's face and eyes, treat the eyes first. Do not dry soiled clothing close to an open flame or heat source. Any clothing that has been contaminated with this product should be submerged in water prior to drying.

Inhalation:

High concentrations may cause slight nose and throat irritation with a cough. There is risk of sore throat and nose bleeds if one is exposed to this material for an extended period of time.

Eye Contact:

Severe eye irritation with watering and redness. There is also the risk of serious and/or permanent eye lesions.

Skin Contact:

Irritation may occur if one is exposed to this material for extended periods.

Ingestion:

Irritation of the mouth and throat with nausea and vomiting.

---

Section 8 – Measures in Case of Accidents and Fire

After Spillage/Leakage/Gas Leakage:
Collect in suitable containers. Wash remainder with copious quantities of water.

Extinguishing Media:
See next.

Suitable:
Large quantities of water or water spray. In case of fire in close proximity, all means of extinguishing are acceptable.

Self contained breathing apparatus or approved gas mask should be worn due to small particle size. Use extinguishing media appropriate for surrounding fire. Apply cooling water to sides of transport or storage vessels that are exposed to flames until the fire is extinguished. Do not approach hot vessels that contain this product.

Further Information:

After contact with skin, wash immediately with plenty of water and soap. In case of contact with eyes, rinse immediately with plenty of water and seek medical attention. Consult an ophthalmologist in all cases.

First Aid:
### Section 8 – Measures in Case of Accidents and Fire

**Eye Contact:**
Flush eyes with running water for 15 minutes, while keeping the eyelids wide open. Consult with an ophthalmologist in all cases.

**Inhalation:**
Remove subject from dusty environment. Consult with a physician in case of respiratory symptoms.

**Ingestion:**
If the victim is conscious, rinse mouth and administer fresh water. DO NOT induce vomiting. Consult a physician in all cases.

**Skin Contact:**
Wash affected skin with running water. Remove and clean clothing. Consult with a physician in case of persistent pain or redness.

**Special Precautions:**
Evacuate all non-essential personnel. Intervention should only be done by capable personnel that are trained and aware of the hazards associated with this product. When it is safe, unaffected product should be moved to safe area.

**Specific Hazards:**
- Oxidizing substance. Oxygen released on exothermic decomposition may support combustion. Confined spaces and/or containers may be subject to increased pressure. If product comes into contact with flammables, fire or explosion may occur.

### Section 9 – Accidental Release Measures

**Precautions:**
Observe the protection methods cited in Section 3. Avoid materials and products that are incompatible with product. Immediately notify the appropriate authorities in case of reportable discharge (> 100 lbs).

Collect the product with a suitable means of avoiding dust formation. All receiving equipment should be clean, vented, dry, labeled and made of material that this product is compatible with. Because of the contamination risk, the collected material should be kept in a safe isolated place. Use large quantities of water to clean the impacted area. See Section 12 for disposal methods.
### Section 10 – Information on Toxicology

**Toxicity Data**

- Oral Route, LD$_{50}$, rat, $> 2,000$ mg/kg (powder 50%)
- Dermal Route, LD$_{50}$, rat, $> 2,000$ mg/kg (powder 50%)
- Inhalation, LD$_{50}$, rat, $> 5,000$ mg/m$^3$ (powder 35%)

**Acute Toxicity:**

- Rabbit (eyes), severe irritant

**Sensitization:**

- No data

**Chronic Toxicity:**

- In vitro, no mutagenic effect (Powder 50%)

**Irritation:**

- No data

**Target Organ Effects:**

- Eyes and respiratory passages.

### Section 11 – Information on Ecology

**Ecology Data**

- 10 mg Ca(OH)$_2$/L: pH = 9.0
- 100 mg Ca(OH)$_2$/L: pH = 10.6

**Acute Exotoxicity:**

- Fishes, Cyprinus carpio, LC$_{50}$, 48 hrs, 160 mg/L
- Crustaceans, Daphnia sp., EC$_{50}$, 24 hours, 25.6 mg/L (Powder 16%)

**Mobility:**

- Low Solubility and Mobility
  - Water – Slow Hydrolysis.
  - Degradation Products: Calcium Hydroxide

**Abiotic Degradation:**

- Water/soil – complexation/precipitation.
  - Carbonates/sulfates present at environmental concentrations.
  - Degradation products: carbonates/sulfates sparingly soluble

**Biotic Degradation:**

- NA (inorganic compound)

**Potential for Bioaccumulation:**

- NA (ionizable inorganic compound)
Section 11 – Information on Ecology (cont)

Observed effects are related to alkaline properties of the product. Hazard for the environment is limited due to the product properties of:

- No bioaccumulation
- Weak solubility and precipitation as carbonate or sulfate in an aquatic environment.

Diluted product is rapidly neutralized at environmental pH.

Further Information: NA

Section 12 – Disposal Considerations

Waste Method: Disposal
Consult current federal, state and local regulations regarding the proper disposal of this material and its emptied containers.

Section 13 – Shipping/Transport Information

D.O.T Shipping Name: Oxidizing Solid, N.O.S [A mixture of Calcium Hydroxide Oxide \([\text{CaO(OH)}_2]\) and Calcium Hydroxide \([\text{Ca(OH)}_2]\).

UN Number: 1479
Hazard Class: 5.1
Label(s): 5.1 (Oxidizer)
Packaging Group: II
STCC Number: 4918717

Section 14 – Other Information

HMIS® Rating
Health – 2
Flammability – 0
Reactivity – 1
PPE - Required

NFPA® Rating
Health – 2
Flammability – 0
Reactivity – 1
OX

HMIS® is a registered trademark of the National Painting and Coating Association.

NFPA® is a registered trademark of the National Fire Protection Association.
Section 15 – Further Information

The information contained in this document is the best available to the supplier at the time of writing, but is provided without warranty of any kind. Some possible hazards have been determined by analogy to similar classes of material. The items in this document are subject to change and clarification as more information become available.
ORC Advanced® Pellets (ORC-A Pellets) are a pelletized version of REGENESIS’ widely used ORC Advanced and are designed specifically for direct application into excavations, tank pits and trenches. This pelletized, dry application material minimizes airborne dust while eliminating the need for specialized equipment and spray water required for powder-slurry applications. ORC Advanced Pellets are approximately 3-10 mm in size as shown in Figure 1.

- Optimal for use in excavations, tank pits and trenches where enhanced aerobic bioremediation is appropriate
- Pellet size (3-10 mm) minimizes airborne dust during handling and application of the material
- Dry application form eliminates need for water and equipment required for powder-slurry application types
- Patented technology provides long-term, controlled release oxygen for periods of up to 12 months on a single application
- Unique molecular structure delivers highest amount of active oxygen available, up to 15% by weight
- Contains micro-nutrients including: nitrogen, phosphorus and potassium (N,P,K) which may benefit aerobic microorganisms

The primary function of ORC-A Pellets is to provide a controlled-release oxygen source for the enhanced aerobic bioremediation of petroleum hydrocarbons or other aerobically degradable compounds. This is achieved through the use of patented processes which embed phosphates into the crystalline structure of solid peroxygen molecules. This feature slows the reaction that releases oxygen upon hydration, producing an optimized, controlled-release of oxygen over a period of up to 12 months. ORC-A Pellets deliver up to 15% active oxygen by weight and contain micro-nutrients such as: nitrogen, phosphorus, and potassium (N,P,K) which may be beneficial to aerobic biodegradation processes.

Note: Due to the size of the pellets this material is not recommended or designed for use in direct-injection or fixed well applications.
PRODUCT APPLICATION INSTRUCTIONS

Introduction
The features and benefits of controlled-release, ORC Advanced are posted in other areas (product brochure, www.regenesis.com, and MSDS). From the field application standpoint, the benefits of ORC Advanced® Pellets (ORC-A Pellets) are in ease of handling and Health & Safety. Pelletized ORC Advanced is much easier to use because it eliminates the need for water and equipment associated with spray application and Health & Safety are dramatically improved by elimination of ORC Advanced dust and associated respiration issues. The later feature makes the material much easier to handle in open-air application approaches such as excavations and trenches.

Design Considerations
The new configuration of this material does not change the quantity estimated in the design process. The materials’ available oxygen is up to 17% by weight and its physical attributes are designed to be easier to handle through the use of a pelletized version of the product and the elimination of the dust associated with dry application of ORC Advanced powder.

Application Methods
The pelletized form allows the user to simply and easily apply the ORC Advanced in a dry format using existing on-site operations or by manual methods. Some typical methods include:

- Application via the excavator bucket:
  - Simply insert a pre-determined quantity (unit - bucket or bag) of ORC-A Pellets into an excavator bucket and use the excavator to mix and distribute the ORC-A Pellets into previously backfilled soil
- Application via manual or mechanical broadcasting/spreaders:
  - Manually or mechanically broadcast/spread pelletized ORC-A Pellets into the excavation at a pre-determined rate per unit of backfill material or per soil lift (as the soil is being backfilled)
  - Follow the manual broadcast step with mechanically mixing the ORC-A Pellets directly into the backfill using the excavator equipment

Example Estimates:
Using an example unit weight of ORC-A Pellets (40 lb. bag)

For a 0.1% weight of ORC-Advanced to backfill:
- Each 100,000 lbs. of soil
- Apply 100 lbs. (4 buckets) ORC-A Pellets
PRODUCT APPLICATION INSTRUCTIONS

For a 0.2% weight of ORC-Advanced to backfill:
- Each 100,000 lbs. of soil
- Apply 200 lbs. (approx. 5 bags) ORC-A Pellets

Example Estimates (SI Units):

Using an example unit weight of ORC-A Pellets (18.1 kg bag)

For a 0.1% weight of ORC-A Pellets to backfill:
- Each 45 metric tons of soil
- Apply 45 kg (approx. 3 bags) ORC-A Pellets

For a 0.2% weight of ORC-A Pellets to backfill:
- Each 90 metric tons of soil
- Apply 90 kg (approx. 5 bags) ORC-A Pellets
### Project Info

**Quail Crossing**  
El Dorado, KS

**Excavation**

Prepared For:

Sam Jackson - Apex Co.

<table>
<thead>
<tr>
<th>Target Treatment Zone (TTZ) Info</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Area</td>
<td>ft²</td>
<td>2,000</td>
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<tr>
<td>Top Treat Depth</td>
<td>ft</td>
<td>13.0</td>
</tr>
<tr>
<td>Bot Treat Depth</td>
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<td>15.0</td>
</tr>
<tr>
<td>Vertical Treatment Interval</td>
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<tr>
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<td>Treatment Zone Volume</td>
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<td>Soil Type</td>
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<tr>
<td>Porosity</td>
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<tr>
<td>Effective Porosity</td>
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<tr>
<td>Treatment Zone Pore Volume</td>
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<td>Treatment Zone Effective Pore Volume</td>
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<tr>
<td>Fraction Organic Carbon (foc)</td>
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<td>Soil Density</td>
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<td>Soil Weight</td>
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<tr>
<td>Recommended Weight of ORC Advanced/Wt. of Soil</td>
<td>%</td>
<td>0.3%</td>
</tr>
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</table>

**ORC Advanced Pellets Required**  

| lbs | 1,378 |

**Estimated Degradation Capacity as TPH**  

| lbs | 69 |

### ORC Advanced® Pellets Application Design Summary

<table>
<thead>
<tr>
<th>Application Method</th>
<th>Excavation Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation Width</td>
<td>ft</td>
</tr>
<tr>
<td>Excavation Length</td>
<td>ft</td>
</tr>
<tr>
<td>Areal Extent (square ft)</td>
<td>sq. ft.</td>
</tr>
<tr>
<td>Top Application Depth (ft bgs)</td>
<td>ft</td>
</tr>
<tr>
<td>Bottom Application Depth (ft bgs)</td>
<td>ft</td>
</tr>
<tr>
<td>Estimated Saturated Treatment Thickness</td>
<td>ft</td>
</tr>
<tr>
<td>ORC Advanced to be Applied (lbs)</td>
<td>lbs</td>
</tr>
<tr>
<td>ORC Advanced per 1 ft lift</td>
<td>lb/ft</td>
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</tbody>
</table>

### Assumptions/Qualifications

In generating this preliminary estimate, Regenesis relied upon professional judgment and site specific information provided by others. Using this information as input, we performed calculations based upon known chemical and geologic relationships to generate an estimate of the mass of product and subsurface placement required to affect remediation of the site.

**Prepared By:**  
Ashley Cedzo - Northwest District Technical Manager  
5/22/2015
<table>
<thead>
<tr>
<th>Purchasing Information</th>
<th>Site</th>
<th>Treatment Unit</th>
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<tbody>
<tr>
<td>ORC Advanced Required</td>
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<tr>
<td>ORC Advanced Cost*</td>
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<tr>
<td>Estimated Tax and Freight %</td>
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<td>15%</td>
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<td>Estimated Total Product Cost</td>
<td>$</td>
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*Note that the combined tax and freight costs are preliminary estimates only. Please contact your local sales manager or Customer Service at 949-366-8000 to obtain a shipping quote. You will be asked to provide a ship-to address and estimated time of delivery.
NUSTAR PIPELINE EXCAVATION
AND STREET REPLACEMENT PLANS
FOR

ANDOVER, KANSAS

APRIL 2015

GENERAL NOTES:
1. THE CONTRACTOR SHALL PROVIDE A MINIMUM OF SEVENTY (70) DAYS ADVANCE NOTICE PRIOR TO BEGINNING EXCAVATION EXCLUDING WEEKENDS AND HOLIDAYS. THE CONTRACTOR SHALL CONTACT ANY ONE OF THE FOLLOWING TELEPHONE NUMBERS TO Cooperate WITH THE CITY OF ANDOVER IN THE EXCAVATION PROCESS. THE CONTRACTOR SHALL CALL ANY UTILITY COMPANIES MARK ANY EXISTING LINES WITHIN THE PROJECT AREA.
2. LOCATOR OF EXISTING BURIED SERVICE LINES SHOWN IN PLANS ARE APPROXIMATE. THE CONTRACTOR SHALL COORDINATE WITH THE UTILITY COMPANIES AND PRIVATE OWNERS TO IDENTIFY LOCATIONS OF THESE LINES.
3. THE CONTRACTOR SHALL SUBMIT AN ANTICIPATED SEQUENCE OF CONSTRUCTION PRIOR TO THE START OF CONSTRUCTION.
4. THE CONTRACTOR SHALL PROVIDE THE OWNER ONE SET OF PLANS MARKED IN RED INK INDICATING ALL CHANGES MADE TO THE PROJECT INCLUDING ACTUAL BOUNDARY AND TOPOGRAPHIC SURVEY PROVIDED BY ALPHA LAND SURVEYS, INC.
5. PROJECT NO SURVEYS AND RED INK INDICATING ALL CHANGES MADE TO THE PRIMARY LINES OF MARKING CONTRACTOR SHALL ENSURE THAT ALL ELECTRONIC FILES UTILIZED FOR CONSTRUCTION ARE IN US SURVEY FEET AS THE PROJECT WAS SURVEYED AND IS LAID OUT USING US SURVEY FEET AS THE PRIMARY UNIT OF MEASURE. PROJECT NO SURVEYS AND RED INK INDICATING ALL CHANGES MADE TO THE PRIMARY LINES OF MARKING CONTRACTOR SHALL ENSURE THAT All ELECTRONIC FILES UTILIZED FOR CONSTRUCTION ARE IN US SURVEY FEET AND NOT INTERNATIONAL FEET.
6. ALL CONSTRUCTION SHALL COMPLY WITH CITY OF WICHITA STANDARD SPECIFICATIONS AND SPECIAL PROVISIONS.
7. CONTRACTOR SHALL OBTAIN AN EXCAVATION PERMIT FROM THE CITY OF ANDOVER AT LEAST 10 DAYS PRIOR TO BEGINNING CONSTRUCTION.
8. CONTRACTOR SHALL SUBMIT HIS ANTICIPATED SEQUENCE OF WORK PLAN, QUAIL CROSSING NEIGHBORHOOD, ANDOVER, KANSAS AS REQUIRED BY THE CITY OF ANDOVER. CONTRACTOR SHALL OBTAIN AN EXCAVATION PERMIT FROM THE CITY OF ANDOVER AT LEAST 10 DAYS PRIOR TO BEGINNING CONSTRUCTION.
9. THE CONTRACTOR, AT THEIR EXPENSE, SHALL REPLACE ANY CONTROL POINTS ON PROPERTY OWNERS THAT ARE DAMAGED DURING CONSTRUCTION.
10. THE CONTRACTOR SHALL PROVIDE THE OWNER ONE SET OF PLANS MARKED IN RED INK INDICATING ALL CHANGES MADE TO THE PRIMARY LINES OF MARKING CONTRACTOR SHALL ENSURE THAT ALL ELECTRONIC FILES UTILIZED FOR CONSTRUCTION ARE IN US SURVEY FEET AND NOT INTERNATIONAL FEET.
11. CONTRACTOR SHALL PROVIDE WRITTEN NOTIFICATION TO ALL PROPERTY OWNERS AND RESIDENTS WHO WILL BE AFFECTED BY THE PROJECT AT LEAST 5 DAYS PRIOR TO BEGINNING CONSTRUCTION. CONTRACTOR SHALL NOTIFY THE CITY OF ANDOVER OF INTENT TO BEGIN WORK 13. ANTICIPATED START DATE AND EXPECTED DURATION OF THE PROJECT
12. DAYS PRIOR TO BEGINNING CONSTRUCTION. NOTIFICATION SHALL INCLUDE WORK PLAN, QUAIL CROSSING NEIGHBORHOOD, ANDOVER, KANSAS. CONTRACTOR SHALL PROVIDE WRITTEN NOTIFICATION TO ALL PROPERTY OWNERS AND RESIDENTS WHO WILL BE AFFECTED BY THE PROJECT AT LEAST 5 DAYS PRIOR TO BEGINNING CONSTRUCTION.
13. CONTRACTOR SHALL NOTIFY THE CITY OF ANDOVER AT LEAST 10 DAYS PRIOR TO BEGINNING CONSTRUCTION.
CAUTION!! CAUTION!! CAUTION!!
CONTRACTOR SHALL MAINTAIN STREET DRAINAGE DURING CONSTRUCTION

CONSTRUCTION

Saw Cut
Concrete 3' below existing grade
Existing 6" waterline approximately

Within this area contractor shall remove all

Orange Construction Fence

Ty P. SPR INK L ER  B O X

Limits of Excavation

Elevation = 1341.50 to 1338.50

Bottom of Excavation
3/4:1

Excavation Bench

Fill material shall be approved by
Compacted to 95% Std. Proctor

CAUTION!!! CAUTION!!! CAUTION!!!

Bench

Fill Material shall be approved by
Compacted to 90% Std. Proctor

6" Topsoil Backfill

Flowable fill placement to begin
Contractor shall wait 72 hrs after

Water Line Location
Assumed Ex.

Notes:

1. All contaminated soils shall be removed to limits of excavation shown.
2. Excavated soil will be stored in drop boxes on the site, labeled with

Project Name, general contents, and date.
The soil will then be profiled and pending KDHE approval, transported to the El Dorado
Landfill for management. Drop boxes must be stored on site within
the limits of erosion control BMP's. See Apex soil investigation report.

Notes:

1. Materials indicated below are to be removed to a depth of
10'-13' from existing grade. Foundation of contaminated soils
shall be excavated to a depth of 18' below existing grade.

Equipment encounters practical refusal. Otherwise, contaminated soils shall be excavated to a depth of 18' below existing grade.

Equipmentshall terminate at bedrock where standard excavation
Borings indicate bedrock will be encountered at a depth of

CAUTION!! CAUTION!! CAUTION!!
Existing Ground 2015-05-14

5'

Characteristics of soils shall be shown on the plans

CAUTION!! CAUTION!! CAUTION!!
Existing Ground 2015-05-14

5'

Characteristics of soils shall be shown on the plans
**NOTE:** All Spot Elevations & Contours Are To Finished Grade. All Spot Elevations & Dimensions Are To Back-Of-Curb, Where Applicable. Electronic Staking & GPS Files Will Be Provided To Contractor Upon Request. Contractor Shall Maintain Street Drainage During Construction.
1. Cement used for Flowable Fill shall be Type I.
2. Fly Ash shall meet requirements of ASTM C618, Class C, and shall come from a source approved by the engineer.
3. Mineral aggregate particles. The gradation of this material shall be as follows:
4. A air content test shall be performed for each pour by an engineer approved inspector.
5. Flowable Fill shall have a minimum 28-day compressive strength of 75 psi and have a unit weight less than 120 lbs/cf.
6. Set accelerator may be required when flowable fill is placed at a temperature below 60°F and a maximum compressive strength of 250 psi.
7. Base rock shall not have an absorption greater than 5% by weight.
8. Base rock shall not have a loss greater than 14% after 16 freeze-thaw cycles.

EXCAVATABLE FLOWABLE FILL

*Flowable fill specification is adopted from City of Wichita Standard Specifications, Section 5-9, "Flowable FA".

1. Use cement to be provided by the engineer.
2. Fly ash shall meet requirements of ASTM C618, Class C, and shall come from a source approved by the engineer.
3. Mineral aggregate particles. The gradation of this material shall be as follows:
4. A air content test shall be performed for each pour by an engineer approved inspector.

CONCRETE DESIGN

1. Concrete shall have a minimum 28 day compressive strength of 4000 psi (150 MPa) or equivalent. Concrete cube strength shall meet City of Wichita particular concrete specifications below 6%.
2. A maximum of 10% RAP shall be obtained from each course for testing. Excess concrete shall be removed by the engineer.
3. A flow test shall be performed for each course by an engineer approved inspector; minimum allowable concrete slump shall be 2.".

PERMANENT SEEDING

1. This section includes the establishment of temporary grass seedings. The temporary grass seedings shall be provided to the Engineer for review.
2. Seedings shall not be required to be established in areas that are accessible to the public. Areas to be seeded shall be identified by the Engineer.
3. All seedings shall be established with a minimum of 10% covering of seeds. Seedings shall be established by the Contractor.
4. All seedings shall be maintained through the growing season, and reseeded as necessary.
5. All seedings shall be maintained through the growing season, and reseeded as necessary.

NOTES FOR FOUNDATION TREATMENT & COMPACTION

1. Shop 3' cutout where required in subbase. Shop 3' cutout for life support stations shall be incorporated to shop and up to 6' of non-navigation area. The excavated material shall be removed prior to setting concrete.
2. Areas not to be used shall be removed to a depth of 3' and regraded to final grade. This area shall be SUBSIDIARY to "Topsoil." Area shall be a minimum of 3' cutout where required in subbase. Shop 3' cutout for life support stations shall be incorporated to shop and up to 6' of non-navigation area. The excavated material shall be removed prior to setting concrete.
3. Flowable fill specification is adopted from City of Wichita Standard Specifications, Section 5-9, "Flowable FA".
4. Flowable fill specification is adopted from City of Wichita Standard Specifications, Section 5-9, "Flowable FA".
5. Flowable fill specification is adopted from City of Wichita Standard Specifications, Section 5-9, "Flowable FA".
6. Flowable fill specification is adopted from City of Wichita Standard Specifications, Section 5-9, "Flowable FA".

CONCRETE SECTION

1. Concrete shall have a minimum 28-day compressive strength of 4000 psi (150 MPa) or equivalent. Concrete cube strength shall meet City of Wichita particular concrete specifications below 6%.
2. A maximum of 10% RAP shall be obtained from each course for testing. Excess concrete shall be removed by the engineer.
3. A flow test shall be performed for each course by an engineer approved inspector; minimum allowable concrete slump shall be 2.".

BASE ROCK

1. Base rock shall be crushed rock or broken stone (or a mixture of these materials) that are available as 2", 3/4", 1", 3/8", 1/8", and No. 4 sieve. Base rock shall meet the gradation shown in Table 2.
2. Areas in cut not receiving pavement shall be overexcavated to a depth of 3' and regraded to final grade. Lift thickness shall be composed of 4" layers of 2" crushed stone. Compacted layers shall be 95% Std. Proctor density (ASTM D-698). Compacted layers shall be composed of a minimum 28-day compressive strength of 4000 psi (150 MPa) or equivalent. Concrete cube strength shall meet City of Wichita particular concrete specifications below 6%.
3. Areas in cut not receiving pavement shall be overexcavated to a depth of 3' and regraded to final grade. Lift thickness shall be composed of 4" layers of 2" crushed stone. Compacted layers shall be 95% Std. Proctor density (ASTM D-698). Compacted layers shall be composed of a minimum 28-day compressive strength of 4000 psi (150 MPa) or equivalent. Concrete cube strength shall meet City of Wichita particular concrete specifications below 6%.

TOTAL SEEDING

1. Total seeding rate shall be weighed and provided to the Engineer for review.
2. Total seeding rate shall be weighed and provided to the Engineer for review.
3. Total seeding rate shall be weighed and provided to the Engineer for review.
4. Total seeding rate shall be weighed and provided to the Engineer for review.

PERMANENT SEED MIX

1. This section includes the establishment of permanent vegetation. This section shall be performed as per the requirements of the Construction Drawings, Specifications, and the applicable的标准.
2. This section includes the establishment of permanent vegetation. This section shall be performed as per the requirements of the Construction Drawings, Specifications, and the applicable的标准.
3. This section includes the establishment of permanent vegetation. This section shall be performed as per the requirements of the Construction Drawings, Specifications, and the applicable的标准.
4. This section includes the establishment of permanent vegetation. This section shall be performed as per the requirements of the Construction Drawings, Specifications, and the applicable的标准.
NOTE: SIGNS SHOWN FOR ONE APPROACH TO WORK ZONE.

FIGURE 1: TYPICAL SIGNING FOR ROAD CLOSURE

FIGURE 2: TYPICAL SIGNING FOR SIDE ROAD OPEN

FIGURE 3: TYPICAL SIGNING FOR SIDE ROAD CLOSED

FIGURE 4: TYPICAL SIGNING FOR ROAD CLOSURE - LOCAL TRAFFIC ACCESS

NOTE: SIGNS SHOWN FOR ONE APPROACH TO WORK ZONE.
TRAFFIC CONE

Traffic cones may be used as channelizing devices for daytime operations only. They will not be used for nighttime but will be retroactive to some traffic control devices. They will be used to direct the motorist into the intended lane of travel.

DIRECTION INDICATOR BARRICADE

The arrow panel shall be black on fluorescent orange, ASTM Type IV sheating. The striping shall be orange and white, ASTM Type III sheathing, sloping downward to the traffic side for channelization.

TYPE II BARRICADE

For radius less than 36 feet, wide stripes may be used. The entire area of the barricade rails, both front and back, shall be ASTM Type III sheathing. The stripes shall slope downward to the traffic side for channelization.

CHANNELIZER PLACEMENT:

(A) The spacing between devices in transition area (taper) should not exceed a distance in feet equal to 0.5 times the posted speed limit in miles per hour prior to work starting.

(B) The spacing between devices in the advanced warning area and the activity area should not exceed a distance in feet equal to two times the posted speed limit in miles per hour prior to work starting.

(C) Channelizing devices shall be placed for optimum visibility, normally at slight angles to the traffic flow.

(D) Channelizing devices placed along shoulder slopes or in drop-offs shall have a minimum of 2 feet from the top of the channelizing device to the top of the pavement.

TAPER FORMULAS:

\[ L = \frac{W}{250} \text{ for speeds of } 45 \text{ mph or more} \]

\[ L = \frac{W}{750} \text{ for speeds of } 40 \text{ mph or less} \]

\[ W = \text{minimum length of taper in feet} \]

\[ L = \text{minimum width of taper in feet} \]

NON-RETROREFLECTIVE SPACES BETWEEN ADJACENT STRIPES, THEY MAY BE NON-RETROREFLECTIVE. IF THERE ARE SIX OR MORE STRIPES, THERE SHALL BE NO MORE THAN 3 INCHES OF NON-RETROREFLECTIVE SPACE BETWEEN THE ADJACENT STRIPES.

ALL RETROREFLECTIVE STRIPES BETWEEN ADJACENT STRIPES SHALL BE ASTM TYPE III SHEETING. THE WHIRE STRIPES ON CHANNELIZING DEVICES SHALL BE ASTM TYPE III SHEETING. ORANGE STRIPES ON ALL CONICAL DELINEATORS SHALL HAVE ASTM TYPE III SHEETING. THE WHITE STRIPES ON CONICAL DELINEATORS SHALL HAVE ASTM TYPE III SHEETING. ORANGE STRIPES ON ALL CONICAL DELINEATORS SHALL HAVE ASTM TYPE III SHEETING. THE STRIPES SHALL SLOPE DOWNWARD IN THE DIRECTION TRAFFIC IS TO PASS.

THE ENTIRE AREA OF CHANNELIZING DEVICES SHALL BE ASTM TYPE III SHEETING. THE STRIPES SHALL SLOPE DOWNWARD TO THE TRAFFIC SIDE FOR CHANNELIZATION.

THE ENTIRE AREA OF VERTICAL PANELS, BOTH FRONT AND BACK, SHALL HAVE ASTM TYPE III SHEETING. THE STRIPES SHALL SLOPE DOWNWARD TO THE TRAFFIC SIDE FOR CHANNELIZATION.

THE TWO WHIRE FHWA SPECIFIC RETROREFLECTIVE STRIPES SHALL BE ASTM TYPE III SHEETING. SLOPING AS SHOWN FOR UP TO 45°.

THE ARROW PANEL SHALL BE BLACK ON FLUORESCENT ORANGE, ASTM TYPE IV SHEETING. THE DIRECTION INDICATOR BARRICADE SHALL BE USED IN SERIES TO DIRECT THE MOTORIST INTO THE INTENDED LANE OF TRAFFIC.

THE ARROW PANEL SHALL NOT BE VISIBLE TO OPOSING TRAFFIC.

TYPES OF CHANNELIZING DEVICES:

1. Portable
2. Fixed

TUBULAR MARKER

The entire area of vertical panels, both front and back, shall have ASTM Type III sheathing. The stripes shall slope downward to the traffic side for channelization.

CONICAL DELINATOR

The two white FHWA specific retroreflective stripes shall be ASTM Type III sheeting. SLOPING AS SHOWN FOR UP TO 45°.

DRUM

The two white FHWA specific retroreflective stripes shall be ASTM Type III sheeting. SLOPING AS SHOWN FOR UP TO 45°.

VERTICAL PANEL

The entire area of vertical panels, both front and back, shall have ASTM Type III sheathing. The stripes shall slope downward to the traffic side for channelization.

CHANNELIZER PLACEMENT:

(A) The spacing between devices in transition area (taper) should not exceed a distance in feet equal to 0.5 times the posted speed limit in miles per hour prior to work starting.

(B) The spacing between devices in the advanced warning area and the activity area should not exceed a distance in feet equal to two times the posted speed limit in miles per hour prior to work starting.

(C) Channelizing devices shall be placed for optimum visibility, normally at slight angles to the traffic flow.

(D) Channelizing devices placed along shoulder slopes or in drop-offs shall have a minimum of 2 feet from the top of the channelizing device to the top of the pavement.

TAPER FORMULAS:

\[ L = \frac{W}{250} \text{ for speeds of } 45 \text{ mph or more} \]

\[ L = \frac{W}{750} \text{ for speeds of } 40 \text{ mph or less} \]

\[ W = \text{minimum length of taper in feet} \]

\[ L = \text{minimum width of taper in feet} \]

NON-RETROREFLECTIVE SPACES BETWEEN ADJACENT STRIPES, THEY MAY BE NON-RETROREFLECTIVE. IF THERE ARE SIX OR MORE STRIPES, THERE SHALL BE NO MORE THAN 3 INCHES OF NON-RETROREFLECTIVE SPACE BETWEEN THE ADJACENT STRIPES.

ALL RETROREFLECTIVE STRIPES BETWEEN ADJACENT STRIPES SHALL BE ASTM TYPE III SHEETING. THE WHIRE STRIPES ON CHANNELIZING DEVICES SHALL BE ASTM TYPE III SHEETING. ORANGE STRIPES ON ALL CONICAL DELINEATORS SHALL HAVE ASTM TYPE III SHEETING. THE WHITE STRIPES ON CONICAL DELINEATORS SHALL HAVE ASTM TYPE III SHEETING. THE STRIPES SHALL SLOPE DOWNWARD IN THE DIRECTION TRAFFIC IS TO PASS.

THE ENTIRE AREA OF CHANNELIZING DEVICES SHALL BE ASTM TYPE III SHEETING. THE STRIPES SHALL SLOPE DOWNWARD TO THE TRAFFIC SIDE FOR CHANNELIZATION.

THE ENTIRE AREA OF VERTICAL PANELS, BOTH FRONT AND BACK, SHALL HAVE ASTM TYPE III SHEETING. THE STRIPES SHALL SLOPE DOWNWARD TO THE TRAFFIC SIDE FOR CHANNELIZATION.
Erosion Control Notes:

1. All erosion control BMP's and Orange Construction Fence shown shall be installed prior to any work.
2. Sandbags shall be positioned so as to ensure stormwater cannot pass through gaps between rows.
3. Sandbags may be relocated to allow for construction traffic, however, sandbags shall be installed as shown prior to anticipated rainfall and at the end of every work day.

CONTRACTOR SHALL MAINTAIN STREET DRAINAGE DURING CONSTRUCTION

CAUTION!!! CAUTION!!! CAUTION!!!
DOES SEDIMENT NEED TO BE REMOVED FROM BEHIND THE SLOPE BARRIER?

DO THE SILT FENCES SAG EXCESSIVELY?

DOES WATER FLOW UNDER THE SLOPE BARRIER?

SILT FENCE SLOPE BARRIERS MUST BE DUG INTO THE GROUND–SILT FENCE AT GROUND LEVEL DOES NOT STAND UP TO THE CONCENTRATED FLOW. THIS PREVENTS WATER FROM FLOWING UNDER THE SLOPE BARRIER AND THE SILT FENCE SLOPE BARRIER QUICKLY DETERIORATES.

CONCENTRATES, IT OVERTOPS THE BARRIER AND THE SILT FENCE SLOPE BARRIER QUICKLY DETERIORATES.

SHOULD BE PLACED ALONG CONTOURS TO AVOID A CONCENTRATION OF FLOW. WHEN INSTALLED IN THE MANNER, THE SLIGHT BARRIER WILL

LIST OF COMMON PLACEMENT/INSTALLATION MISTAKES TO AVOID:

ATTACH THE SILT FENCE TO THE ANCHORED POST WITH STAPLES, WIRE, ZIP TIES, OR NAILS.

PLACE POSTS NO MORE THAN 4' APART.

JUST DOWNSLOPE OF THE TRENCH, DRIVE POSTS INTO THE GROUND TO A DEPTH OF AT LEAST 18".

LAY THE EXPOSED SILT FENCE UPSLOPE OF THE TRENCH TO CLEAR AN AREA FOR DRIVING IN THE POSTS.

SILT-FENCE FABRIC SHOULD REMAIN EXPOSED.

ON THE UPSLOPE SIDE OF THE TRENCH FOR LATER USE.

BARRIER SHOULD BE PLACED ON NEARLY LEVEL GROUND 5' TO 10' AWAY FROM THE TOE OF A SLOPE.

THE SILT FENCE FABRIC SHOULD BE ATTACHED TO THE WOODEN POSTS WITH STAPLES, WIRE, ZIP TIES, OR NAILS.

THE POSTS USED TO SUPPORT THE SILT FENCE FABRIC SHOULD BE A HARDWOOD MATERIAL WITH THE MATERIAL SPECIFICATION:

THE MATERIAL USED TO FRAME THE TOPS OF THE POSTS SHOULD BE 1" BY 4" BOARDS.

THE WIRE OR POLYMERIC MESH BACKING USED TO HELP SUPPORT THE SILT FENCE FABRIC SHOULD CONFORM TO THE AASHTO M288-96 SILT FENCE SPECIFICATION.

MATERIAL SPECIFICATION:

ATTACH THE WIRE OR POLYMERIC-MESH BACKING TO THE OUTSIDE OF THE POST/FRAME STRUCTURE WITH STAPLES, WIRE, ZIP TIES, OR NAILS.

CONNECT THE TOPS OF ALL THE POSTS WITH A WOODEN FRAME MADE OF 1" BY 4" BOARDS. USE NAILS OR STAPLES TO ATTACH THE WIRE OR POLYMERIC-MESH BACKING TO THE WOODEN FRAME TO HELP SUPPORT THE SILT FENCE FABRIC.

CORNER POSTS IS MORE THAN 4', ADD ANOTHER POST(S) BETWEEN THEM.

EXCAVATE A TRENCH AROUND THE PERIMETER OF THE AREA INLET THAT IS AT LEAST 8" DEEP BY 8" WIDE.

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