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ENVIRONMENT

Subject:
*Single Well Tracer Test and Transducer Study*
Former National Starch & Chemical Company Superfund Site
Salisbury, Rowan County, North Carolina

Date:
August 8, 2016

Contact:
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ARCADIS G&M of North Carolina, Inc.

NC Engineering License # C-1869
NC Surveying License # C-1869

Dear Mr. Bornholm:

On behalf of Akzo Nobel Surface Chemistry LLC (AkzoNobel), Inc., Arcadis G&M of North Carolina, Inc. (Arcadis) is pleased to provide this work plan for the Former National Starch & Chemical Company (NSCC) Superfund Site located at 485 Cedar Springs Road in Salisbury, North Carolina (Site). The Site's location is shown on Figure 1.

The proposed activities are intended to evaluate the potential for offsite migration south and west of the NS-31 well cluster near the southern property boundary of the Site. This work will include two phases. First pressure transducers will be placed in the NS-31 well cluster, EX-02 and NS-32 (shown on Figure 2) to evaluate: 1) if there is a hydraulic connection with the off-site potable wells and 2) the vertical gradients at the NS-31 cluster. Additionally, two stream gauges will be placed in the unnamed tributary adjacent to NS-31 and NS-32 to evaluate the surface water elevation and the relationship between surface water and groundwater. After the hydraulic monitoring is completed, Arcadis will conduct an in-well tracer test to assess the transport potential in the bedrock system.

The objective of this work is to collect two lines of evidence that will assist AkzoNobel in further supporting the validity of the LeGrand piedmont conceptual site model that indicates groundwater flow should converge on the unnamed tributary from the north and south. If the results indicate that the offsite wells are not hydraulically influencing the site wells and transport potential is limited, then no additional characterization will be recommended. If the results of the study

suggest hydraulic connection and significant transport potential, additional characterization will be recommended.

The pressure transducer study will be completed first because a Notice of Intent (NOI) will need to be submitted to the North Carolina Department of Environmental Quality (NCDEQ) Underground Injection Control (UIC) program prior to implementation of the tracer test, and the NOI has a two week waiting period before it is active and the tracer test can be implemented. Also, the in-well tracer test will require removing water from NS-31, which could complicate the transducer study if it were performed immediately afterword. The details of each phase are provided below.

**Pressure Transducer Study**

Pressure transducers will be used to monitor water levels over a period of time in 5 wells, listed below in Table 1. Prior to deploying any pressure transducers, a packer will be installed at a depth of 120 feet, which is below the overlap from adjacent well NS-31B, to isolate the lower portion of the borehole. Isolating the lower interval will help improve the sensitivity of the transducers between the shallow and deeper intervals. Installation of the transducers is further specified in the Table 1.

**Table 1: Transducer Placement**

| Well ID | Aquifer Unit | Screened Interval (ft bgs) | | Transducer Placement (ft bgs) | Rationale |
|---|---|---|---|---|---|
| | | Top | Bottom | | |
| EX-02 | Deep Bedrock | 114.1 | 200.5 | 150 | Provide a monitoring point on the eastern side of the discharge with a well construction similar to NS-31 (i.e., background) |
| NS-31 | Shallow Bedrock | 80 | 150 | Packer at 120, transducer at 130 | Packer will isolate the lower portion of the interval and eliminate overlap with NS-31B. Transducer above and below packer will provide two monitoring intervals. |
| NS-31A | Saprolite | 20 | 30 | 25 | Provides monitoring in the shallow zone to provide understanding of natural fluctuations. |
| NS-31B | Shallow Bedrock | Open hole from 66 to 113 | | 90 | Used to evaluate shallower bedrock and potential interconnection with NS-31. |
| NS-32 | Shallow Bedrock | Open hole from 37 to 145 | | TBD | Evaluate potential hydraulic influence closer to the residential wells. May be difficult to implement with artesian conditions. |

All transducers will be set to monitor water levels every minute and are anticipated to remain in the wells for a period of two weeks. A barometric logger will also be placed in EX-02 near the top of the casing to determine the barometric fluctuations throughout the monitoring period and facilitate data correction

during the evaluation process. After the transducer monitoring is completed, the packer will remain in place for use during the in-well tracer test.

The stream gauges will be installed adjacent to each of the monitoring wells in the unnamed tributary. The gauge will consist of a graduated metal scale that will be manually read on a daily basis during the transducer monitoring. The top of the gauge will be surveyed to allow an actual surface water elevation to be determined.

Once the monitoring has been completed, the data will be evaluated to determine if there are discernable influences from pumping at the off-site wells and establish the temporal trends and magnitude of vertical gradients at the NS-31 well-cluster to further confirm discharge in that area. Additionally, the water levels in the wells will be compared to the surface water elevations to evaluate the groundwater discharge potential along the unnamed tributary.

**NS-31 Tracer Test**

Single well tracer test methods are well developed and generally consist of replacing the water column in a well or borehole with a tracer solution without imposing an artificial head in the aquifer, and then measuring the subsequent decline of tracer concentration in the well. The tests provide an effective method for determining the groundwater flux through a borehole by applying a solution for a well-mixed reactor to the resulting tracer washout from the well (*Groundwater:* Freeze and Cherry, 1979). Details on the implementation of the single well tracer test are outlined below.

Prior to implementing the single well tracer test a Notice of Intent (NOI) will be submitted to the Underground Injection Control (UIC) department at the North Carolina Department of Environmental Quality (NCDEQ). The NOI requires a two week waiting period prior to implementation of the testing.

The single well tracer test will be implemented by fluorescein dye to an approximate concentration of 10 milligrams per liter (mg/L) throughout the interval isolated by the packer (120 to 150 feet bgs). The dye is introduced by creating a vertical recirculation loop to maintain the well at near static conditions during mixing. The mixing will be completed using the following procedures:

- A pump intake will be installed near the base of the well with the discharge routed to a mixing vessel at ground surface.
- The mixing vessel will be fitted with a hose barb near the bottom of the vessel with a length of tubing routing flow from the mixing vessel back to the static water level in the well.
- As the water is pumped from the well, the dye will be added to the mixing vessel and be allowed to flow back in to the well via gravity flow. The result will be a constant head throughout the test that will reduce any gradients that may artificially push the dye in to the formation.
- Dye will be added throughout the removal of the first well volume to provide a more consistent distribution in the water column. Pumping will continue after the dye has been added to mix the tracer across the borehole.
- Mixing will continue until the dye present in the influent is consistent throughout one well volume of pumping.

Once the water column is adequately mixed, a bailer will be used to collect a grab sample from the mid-point of the isolated interval. This sample will be used to determine the starting concentration of the dye and will be the basis for evaluating change in the dye concentration over time. An additional sample will be collected as part of the baseline sampling to be retained onsite as a visual standard for evaluating the change in dye concentrations over time.

Routine sampling of the tracer washout will be completed over time using the same grab methodologies described for baseline sample collection. Samples will be collected on the following schedule:

- Days 1 through 3: twice per day
- Days 4 through 7: once per day
- Week 2: twice per week
- Weeks 3 and 4: once per week

The data will be evaluated as they are available to determine if the sampling frequency is appropriate based on the decline in dye concentration. If the dye washout is occurring faster than anticipated, additional samples will be added to capture the trend of the washout. Conversely, if the dye washout is slow, the monitoring frequency will be reduced and the duration extended.

**Closing**

The transducer deployment is scheduled for August 16, 2016. The transducers will remain in place for a period of two weeks. The transducers will be downloaded after two weeks but remain in the well over the Labor Day weekend to continue monitoring water levels. The in-well tracer will be deployed on September 6, 2016 and is anticipated to last for a period of four weeks. The results will be discussed with USEPA and NCDEQ via teleconference to discuss the next steps once the data are available.

Should you have any further comments regarding this Work Plan, please contact me at 864.987.3918 or via email at Thomas.Darby@arcadis.com.

Sincerely,

Arcadis G&M of North Carolina, Inc.

Thomas Darby II, P.G.
Senior Hydrogeologist

Copies:
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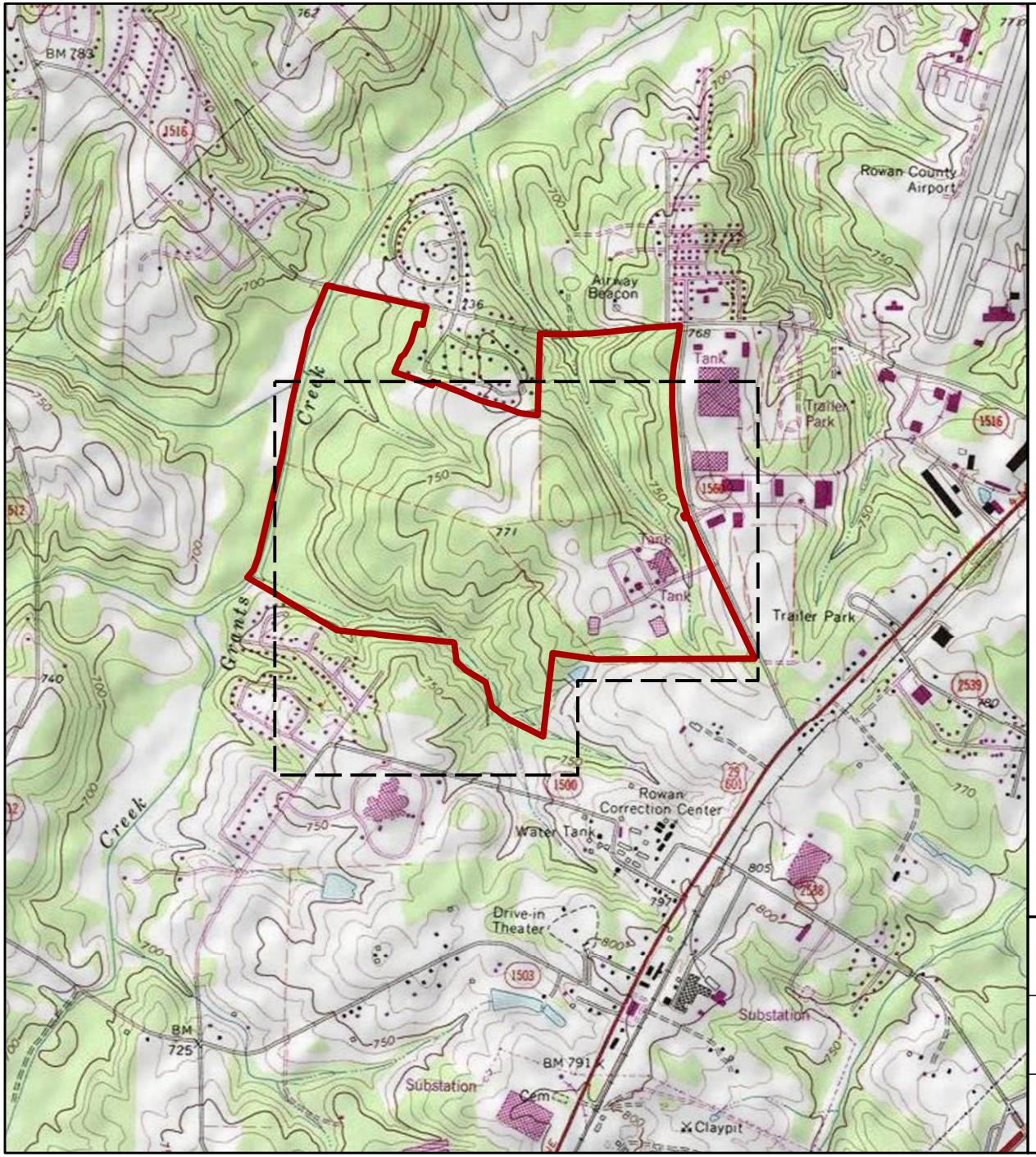
Enclosures:

**Figures**

1 USGS Topographic Map
2 Site Plan

# FIGURES




## SITE LOCATION

## LEGEND

- Approximate site boundary
- Extent of Figure 2 (Site Plan)

## NOTES

· Topographic map source: ESRI USA Topo Maps.

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Feet
0 1,000 2,000
Scale: 1" = 2,000'

NATIONAL STARCH & CHEMICAL COMPANY
CEDAR SPRINGS ROAD PLANT
SALISBURY, NORTH CAROLINA

**USGS TOPOGRAPHIC MAP**

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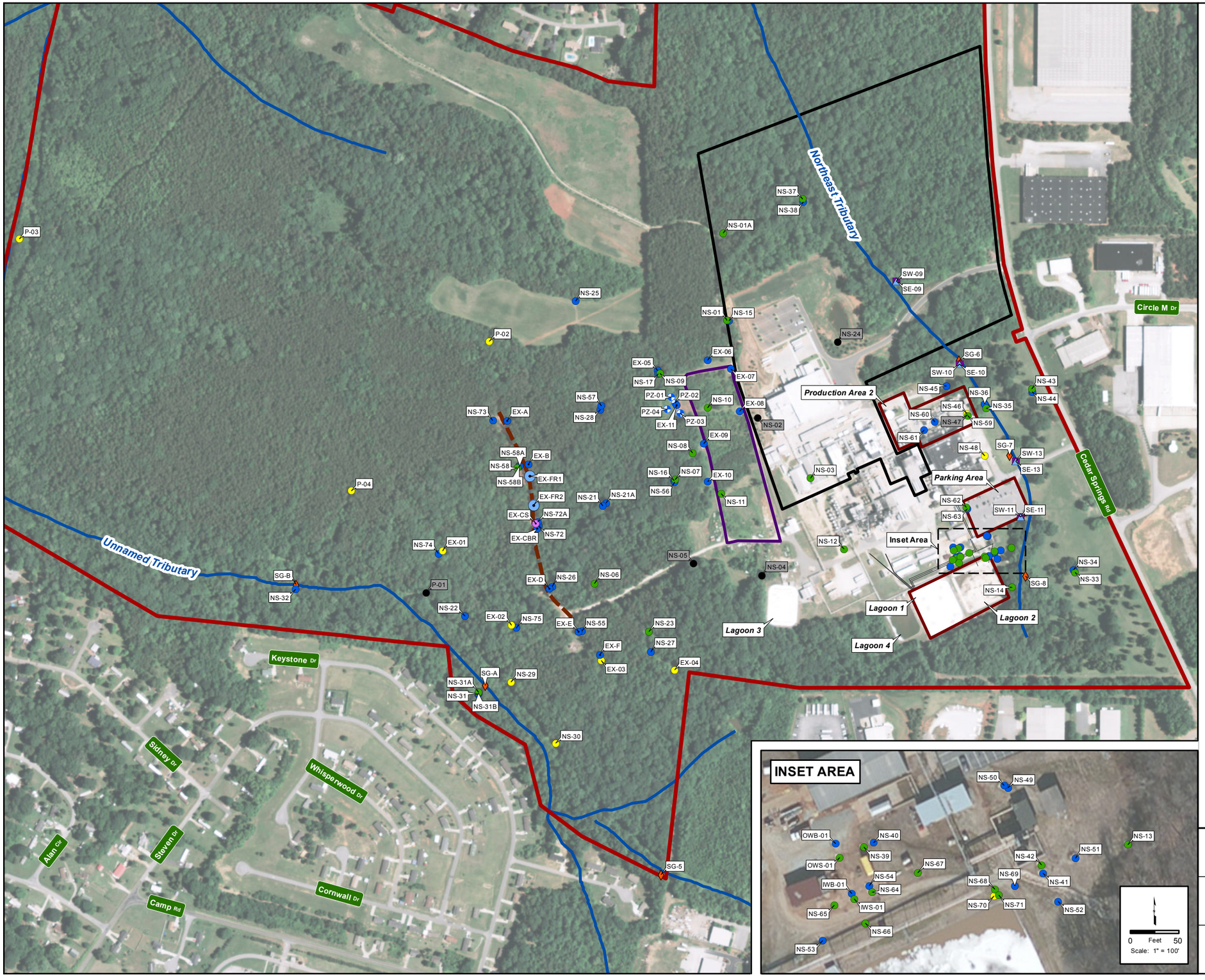
FIGURE
1




## LEGEND

- Site boundary
- Henkel boundary
- Operable Unit 2
- Operable Unit 4
- Stream
- Groundwater monitoring well (saprolite)
- Groundwater extraction well (transition zone)
- Groundwater monitoring well (shallow bedrock)
- Groundwater extraction well (shallow bedrock)
- Proposed groundwater extraction well (shallow bedrock)
- Piezometer (shallow bedrock)
- Groundwater monitoring well (deep bedrock)
- Groundwater monitoring well (abandoned)
- Surface water sampling location
- Sediment sampling location
- Stream gauge
- Abandoned process water piping
- Access road

## NOTES

· Aerial photo source: ESRI World Imagery.

N

0 250 500 Feet

Scale: 1" = 500'

NATIONAL STARCH & CHEMICAL COMPANY
CEDAR SPRINGS ROAD PLANT
SALISBURY, NORTH CAROLINA

**SITE PLAN**

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FIGURE
2

\\Scottsdale-AZ\Project\NSCC\GIS\Projects\Tracer test work plan 08-2016\Figure 2 site plan.mxd 8/4/2016