GW - ___28___

PUMP TEST

(1 of 2)

2016

NEW MEXICO
ENVIRONMENT DEPARTMENT

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CERTIFIED MAIL – RETURN RECEIPT REQUESTED

October 12, 2016

Mr. Scott M. Denton
Environmental Manager
HollyFrontier Navajo Refining LLC
P.O. Box 159
Artesia, New Mexico 88211-0159

RE: SHALLOW SATURATED ZONE GROUNDWATER
PUMP TEST WORK PLAN, AUGUST 2016
HOLLYFRONTIER NAVAJO REFINING LLC - ARTESIA REFINERY
EPA ID NO. NMD048918817
HWB-NRC-16-004

Dear Mr. Denton:

The New Mexico Environment Department (NMED) has reviewed the HollyFrontier Navajo Refining LLC - Artesia Refinery's (the Permittee) *Shallow Saturated Zone Groundwater Pump Test Work Plan* (Work Plan), received August 16, 2016. NMED provides the following comments concerning the Work Plan.

The work completed by this Work Plan was completed at-risk. NMED was not provided sufficient time to review and provide feedback on the Work Plan. In addition, notification of a start date for the pilot study was not provided to NMED. Future work plans for studies regarding the design of the reinjection and groundwater treatment systems must be submitted to NMED and OCD for review prior to submission to the Office of the State Engineer (OSE) so that the agencies have the opportunity to provide feedback. It is essential that the agencies are provided sufficient time to review work plans and are included throughout the design process of the reinjection and groundwater treatment systems to ensure the Permittee is meeting all applicable requirements.

Comment 1

The focus of the pump test is mainly on the recovery of product; however, it is important that dissolved phase contaminants are considered when determining the design parameters for the remediation system. The Permittee is responsible for both the free product and dissolved phase contaminants that exceed groundwater cleanup levels. There are several sites in this Work Plan that were investigated, but the focus for recovery must be along the eastern Refinery boundary so that recovery efforts can capture and retain both free product and dissolved phase contaminated groundwater prior to off-site migration. By focusing recovery near the eastern Refinery boundary, the contaminated groundwater that has migrated off property will begin to dissipate over time.

Comment 2

On page 2, paragraph 4, the Permittee states that "[t]he pump test work plan describes the activities that will be conducted to obtain the additional information required to complete the basic design of the reinjection system." The Permittee must describe the design elements of the remediation system and discuss what the Permittee proposes to accomplish with the system in the pump test report.

Comment 3

On page 2, *Scope of Work*, the Permittee states that "dissolved phase groundwater samples from beneath the PSH will be collected and analyzed for constituents of concern (COCs) necessary to determine the amount of treatment required prior to reinjection of the recovered groundwater." The final determination for the "amount of treatment" will be established by the agencies based on regulatory requirements. In addition, it should be noted that the "amount of treatment" is also dependent on the location(s)/point(s) of injection proposed by the Permittee.

Comment 4

On page 2, *Pump Test Locations*, the Permittee states that they will be measuring transmissivity in various areas of interest. The Permittee must provide a discussion about all calculations, assumed values and reference literature to support the site-specific values discussed in the pump test report.

Comment 5

On pages 2 through 4, *Pump Test Locations*, the Permittee describes the three locations and six monitoring and recovery wells that will be used for the pump test. However, NMED is interested in intercepting the free product and dissolved phase plumes at the eastern Refinery fence boundary to control off-site migration. Comment 8 of NMED's September 21, 2016 Disapproval letter for the *Contaminant Migration Evaluation Investigation Report, February 2015* (CME Report) required the Permittee to submit a work plan for an additional pump test and propose a location for a new recovery well located along the eastern Refinery fence boundary

using information from the CME Report. The additional pump test will include the new recovery well, monitoring wells MW-66, MW-99, MW-107 and recovery well RW-19. In addition, a step test must also be conducted prior to beginning the pump test to determine the optimum pumping rate for each of the wells. The additional pump test will determine the appropriate spacing for any additional recovery wells installed along the eastern Refinery fence boundary and focus on recovery of the free product and dissolved phase contaminant plumes in this area.

Comment 6

On page 4, *Field East of Refinery*, paragraph 2, the Permittee states that "[o]ne possibility for the reinjection scenario is to reinject a small amount of treated groundwater outside the existing PSH plume" near the RW-18 trench. In the pump test report, explain why there would be a reinjection point northeast of the plume. In addition, note that the treatment level to reinject treated groundwater in this area will likely be more conservative than the treatment levels needed to reinject on the west side of the Refinery. (*See also* Comment 4)

Comment 7

On pages 4 and 5, *Pump Test Methodology*, the Permittee discusses the methodology for completing the pump test at the six recovery well sites. In this section, the Permittee describes using the dedicated pumps in RW-2R, RW-6R, RW-7R, RW-13R, and RW-19 which have ratings of 10 gallons per minute (gpm). In addition, a submersible electric pump with a rating of 8 to 10 gpm was used at RW-18D. The Permittee provided the ratings for the groundwater recovery well pumps and submersible pump; however, there is no guarantee that the pumps will perform at the designed maximum rate. A step test should have been performed prior to the start of the pump test to determine the optimum continuous pumping rate for the pumps. During a phone conversation with HollyFrontier on August 23, 2016, NMED was informed that the pump test was underway and there was an issue during the pump test with one pump only producing two gpm. Perform a step test prior to beginning the additional pump test referenced in Comment 5 above and include the results from the step test in the additional pump test report.

Comment 8

On page 5, *Pump Test Methodology*, paragraph 4, the Permittee describes measuring groundwater levels for the pumping wells and observation wells before and after the pump test, as well as running the pump test for a minimum of 24 hours. The Permittee did not discuss the frequency at which the measurements would be collected. Indicate if the frequency of collecting measurements would be the same for all wells involved in the pump test and discuss what would occur if there are deviations during the pump test. In the pump test report and the additional pump test work plan, provide the frequency at which the measurements will be collected, indicate if the frequency of collecting measurements would be the same for all wells involved in the pump test and discuss what would occur if there are deviations during the pump test referenced in Comment 5.

Comment 9

On page 6, *Groundwater Sampling*, the Permittee outlines the analytical testing suite for groundwater samples collected from recovery wells RW-6R and RW-13R. The Permittee states that "[t]he analytical suite has been chosen to provide information required to design a groundwater treatment system and includes those constituents that have been observed in shallow groundwater at concentrations above the regulatory screening levels. At this time, the concentration limits for reinjection within the boundary of the shallow groundwater plume have not been determined." Using two recovery wells to provide a snapshot of the current conditions at the facility will be more useful in combination with evaluating data from the annual groundwater reports. In the pump test report, review the annual groundwater monitoring reports along with the new analytical data results from RW-6R and RW-13R when evaluating reinjection concentrations for the closed loop system. (*see also* Comment 3)

Comment 10

On page 7, *Reporting*, the Permittee states that "[t]he letter will include various recommended schemes for improved remediation incorporating groundwater reinjection. These schemes will be discussed with Navajo so that a basis for design may be selected and a basic engineering design can be developed." Describe all aspects of the design in the Report (i.e., extraction rates, reinjection and groundwater treatment systems) so that the agencies are aware of the Permittee's approach to the design and to ensure that the Permittee addresses the regulatory requirements of the agencies.

A revised Work Plan is not required because the work for this pump test has been completed; however, the Permittee must incorporate NMED's comments into the pump test report which must be submitted to NMED no later than **November 1, 2016**. In addition, the additional pump test work plan referenced in Comment 5 must be submitted to NMED no later than **December 31, 2016**.

If you have any questions regarding this letter, please contact Leona Tsinnajinnie at (505) 476-6057.

Sincerely,

John E. Kieling
Chief
Hazardous Waste Bureau

cc: D. Cobrain, NMED HWB
N. Dhawan, NMED HWB
K. Van Horn, NMED HWB
L. Tsinnajinnie, NMED HWB
C. Chavez, EMNRD OCD
R. Combs, HollyFrontier Navajo Refining LLC - Artesia Refinery
M. Holder, HollyFrontier
P. Kruger, Amec Foster Wheeler

File: Reading File and NRC 2016
HWB-NRC-16-004

Chavez, Carl J, EMNRD

From: Chavez, Carl J, EMNRD
Sent: Wednesday, August 17, 2016 1:34 PM
To: 'Combs, Robert'; Goetz, Catherine, OSE
Cc: Denton, Scott; Tsinnajinnie, Leona, NMENV; Griswold, Jim, EMNRD
Subject: RE: Recovery system pump test

Robert, et al.:

The New Mexico Oil Conservation Division (OCD) has reviewed the "Shallow Saturated Zone Groundwater Pump Test Work Plan" dated August 2016.

OCD has the following comments:

1) Proper equipment and operating procedures shall be utilized to prevent explosion, fire, etc. issues at the facility from pump testing in areas susceptible to the aforementioned.

2) The pump tests are expected to comply with standard accepted aquifer pump test criteria to obtain accurate T, S, K, etc. characteristic hydrogeologic values from the shallow saturated zone.

3) Page 6: Environmental analytical testing of groundwater should be consistent with the Facility-Wide Groundwater Monitoring Work Plan (FWGWMWP). An in-line sampling method is preferred to allow for accurate sampling of groundwater during flow conditions.

   There has been a good history of water quality data from historical monitoring information at the facility. OCD observes that HollyFrontier is assessing treatability for injection into the Underground Source of Drinking Water (USDW) at the hydrogeologic upgradient area of the facility. Any discharges into the USDW under the Underground Injection Control (UIC) Program will likely be required to be meet 20.6.2.3103 NMAC Regulations for a Class V Type Well. The exception may be where proper monitoring detects environmental contaminants and confirms that they are not migrating off-property above acceptable limits.

4) Figure 5: 2015 PSH extent in the shallow saturated zone is likely influenced by a higher water table level.

5) OCD expects that HollyFrontier will assess groundwater recovery locations for optimum capture of contaminants with the potential to migrate off-property and pose an imminent threat to receptors, public health, and/or the environment hydrogeologically downgradient from the source(s) of groundwater contamination.

Please contact me if you have questions. Thank you.

Carl J. Chavez, CHMM
Environmental Engineer
Oil Conservation Division- Environmental Bureau
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Santa Fe, New Mexico 87505
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Website: www.emnrd.state.nm.us/ocd
Why not prevent pollution, minimize waste, reduce operation costs, and move forward with the rest of the Nation? To see how, go to "Publications" and "Pollution Prevention" on the OCD Website.

From: Combs, Robert [mailto:Robert.Combs@HollyFrontier.com]
Sent: Friday, August 12, 2016 3:21 PM
To: Goetz, Catherine, OSE <Catherine.Goetz@state.nm.us>
Cc: Denton, Scott <Scott.Denton@HollyFrontier.com>; Chavez, Carl J, EMNRD <CarlJ.Chavez@state.nm.us>; Tsinnajinnie, Leona, NMENV <Leona.Tsinnajinnie@state.nm.us>
Subject: Recovery system pump test

Catherine,
Please see the attached work plan for the pump test that I mentioned earlier this week. The hard copies will be sent out on Monday. As I mentioned, we are planning to conduct the test the week of 8/22/16.
Please give me a call if you have any questions or would like to discuss.
Thanks,
Robert

Robert Combs
Environmental Specialist
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Chavez, Carl J, EMNRD

From: Combs, Robert <Robert.Combs@HollyFrontier.com>
Sent: Friday, August 12, 2016 3:21 PM
To: Goetz, Catherine, OSE
Cc: Denton, Scott; Chavez, Carl J, EMNRD; Tsinnajinnie, Leona, NMENV
Subject: Recovery system pump test
Attachments: Pump Test Work Plan Submittal Final.pdf

Catherine,
Please see the attached work plan for the pump test that I mentioned earlier this week. The hard copies will be sent out on Monday. As I mentioned, we are planning to conduct the test the week of 8/22/16.
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August 11, 2016

Mr. Gary Davis
Mr. Robert Combs
HollyFrontier Navajo LLC
510 East Main Street
Artesia, New Mexico 88210

Shallow Saturated Zone Groundwater Pump Test Work Plan
HollyFrontier Navajo Refinery
Artesia, New Mexico

Dear Gary and Robert:

Amec Foster Wheeler Environmental & Infrastructure, Inc. (Amec Foster Wheeler) has prepared this work plan to describe the activities associated with the planned pump tests at the HollyFrontier Navajo Refining LLC (Navajo) refinery in Artesia, New Mexico (**Figure 1**). The pump tests will be performed to evaluate aquifer characteristics, specifically hydraulic transmissivity, within the known phase-separated hydrocarbon (PSH) plumes and in nearby areas outside the limits of the known plumes. The information obtained will be used to update and calibrate the existing groundwater model, which will then be used to assist in the design of a reinjection option for the existing groundwater recovery system.

Background

There is a known PSH plume on shallow groundwater that extends eastward from the refinery fenceline beneath an open field owned by Navajo. There are also several smaller known PSH plumes located in the northwestern portion of the refinery. Permits issued by the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB)[i] and the New Mexico Energy, Minerals and Natural Resources Department Oil Conservation Division (OCD)[ii] require monitoring and remediation of the groundwater, including recovery of the PSH. **Figure 2** depicts the monitoring well network present at the refinery.

The current remediation system utilizes a series of subsurface interception and recovery trenches and recovery wells installed at various times throughout the past 30 years. During the past 5 years, several upgrades to the remediation system were implemented to improve the reliability and efficiency of the PSH recovery. **Figure 3** depicts the locations of the recovery trenches and recovery wells.

In 2013 and 2014, an extensive investigation of the subsurface lithology and PSH presence in the field east of the refinery fenceline was conducted. The intent of this investigation was to update the conceptual site model (CSM) and develop a better understanding of the distribution of PSH and pathways of potential migration through the area east of the refinery. A report describing the investigation and providing an updated CSM was submitted to NMED in February 2015[iii]. The investigation confirmed the presence of channels of more porous materials (sandy

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gravels) that create preferential flowpaths for contaminant transport. The preferential flowpaths are oriented primarily in a west-to-east pattern, emanating from the southeastern portion of the refinery toward Bolton Road. The investigation report included recommendations to install additional recovery wells within the gravel channels east of the refinery to increase PSH recovery between the refinery fence and Bolton Road. **Figure 4** depicts the preferential flowpaths while **Figure 5** depicts the extent of PSH within the flowpaths.

In late 2014, the New Mexico Office of the State Engineer (OSE) determined that the groundwater pumped as part of the remediation system was a diversion for which Navajo did not have adequate water rights. Therefore, groundwater pumping ceased in late 2014 and only the PSH skimming pumps and a sump dewatering pump were allowed to operate routinely.

A feasibility study was performed during 2015 to evaluate a revision to the remediation system to incorporate reinjection of recovered groundwater to minimize the diversion of groundwater and to enhance the recovery of PSH. Navajo personnel have discussed the potential reinjection of recovered groundwater with personnel from NMED, OCD, and OSE and all agree that the increased efficiency of the remediation system while minimizing groundwater diversion by incorporating reinjection is desirable.

This pump test work plan describes the activities that will be conducted to obtain the additional information required to complete the basic design of the reinjection system.

Scope of Work

A preliminary groundwater flow model was developed as part of the feasibility study. To adequately design a reinjection system, the flow model needs to be updated and calibrated using more accurate aquifer characteristics, primarily transmissivity. Additionally, dissolved phase groundwater samples from beneath the PSH will be collected and analyzed for constituents of concern (COCs) necessary to determine the amount of treatment required prior to reinjection of the recovered groundwater.

Pump Test Locations

In order to measure transmissivity in various areas of interest, pump tests will be performed utilizing six of the existing recovery wells. The groundwater level will be measured in nearby monitoring wells, recovery wells, and existing standpipes within recovery trenches. **Table 1** provides a list of the pumping wells and observation wells. The pumping and observation wells for each area are discussed in the following paragraphs.

Northern Refinery

RW-7R is located in the northern portion of the Refinery, south of the North Colony Landfarm and north of the Diesel Tank Farm. PSH thickness in RW-7/RW-7R fluctuates with groundwater elevation. The highest amount of PSH present at this location was measured at 3.33 feet (ft) in March 2012. Remediation system records indicate that no measurable PSH has been present throughout much of 2016 at this location, with the exception of 0.07 ft of PSH measured on March 15, 2016. A pump test will be conducted at this location, utilizing RW-7R as the pumping

well. Transducers will be used to observe groundwater level responses in RW-7R, RW-7, and the nearest existing standpipe located within the RW-7 trench. These locations will provide information regarding the drawdown of the pumping well and the transmissivity within the recovery trench. A transducer will also be placed in MW-94, which is the nearest monitoring well to the east and downgradient of RW-7. The locations of the RW-7 trench and planned pumping and observation wells are shown in **Figure 6**.

RW-2R is located in the northern portion of the active refinery, east of North Freeman Ave and south of Eagle Draw. PSH thickness in RW-2/RW-2R fluctuates with groundwater elevation. The highest amount of PSH present at this location was measured at 3.61 ft in March 2012. Remediation system records indicate that no measurable PSH was present from January through mid-June 2016 and in late June 2016 approximately 1 ft of PSH was present. A pump test will be conducted at this location, utilizing RW-2R as the pumping well. Transducers will be used to observe groundwater level responses in RW-2R, RW-2, and the existing standpipe located within the RW-2 trench. These locations will provide information regarding the drawdown of the pumping well and the transmissivity within the recovery trench. A transducer will also be placed in MW-97, which is the nearest monitoring well located south and cross-gradient to the RW-2 trench. The locations of the RW-2 trench and planned pumping and observation wells are shown in **Figure 7**.

Southern Refinery

RW-6R is located in the southern portion of the Refinery, between the Southwest Tank Farm and the Southeast Tank Farm, near the upgradient extent of the primary PSH plume. PSH thickness in RW-6/RW-6R fluctuates with groundwater elevation. The highest amount of PSH present at this location was measured at 1.28 ft in 2008. Remediation system records indicate that no measurable PSH has been present through mid-March 2016 at this location, and thicknesses have ranged from 0.01 to 0.19 from mid-March through June 2016. A pump test will be conducted at this location, utilizing RW-6R as the pumping well. Transducers will be used to observe groundwater level responses in RW-6R, RW-6, and the nearest existing standpipe located within the RW-6 trench. These locations will provide information regarding the drawdown of the pumping well and the transmissivity within the recovery trench. A transducer will also be placed in MW-102, which is located to the northeast and cross-gradient to the RW-6 trench. The locations of the RW-6 trench and planned pumping and observation wells are shown in **Figure 8**.

Field East of Refinery

RW-19 is located just east of the refinery fence, north of Highway 82 and east of East 7th Street, at the southwestern corner of the field east of the refinery. RW-19 was installed in 2013 as part of the remediation system upgrades and is utilized as a recovery point but is not associated with a subsurface recovery trench. PSH thickness in RW-19 was measured at 2.89 ft in March 2014. Remediation system records indicate that PSH thicknesses have ranged from 0.29 to 2.05 ft throughout 2016. A pump test will be conducted at this location, utilizing RW-19 as the pumping well. Transducers will be used to observe groundwater level responses in RW-19, KWB-4, and MW-99. These locations will provide information regarding the drawdown of the pumping well

and the transmissivity within the gravel seam in the vicinity of RW-19. The locations of the pumping and observation wells are shown in **Figure 9**.

RW-13R is located just to the west of and near the middle of the recovery trench that is along the western side of Bolton Road, north of Highway 82. The Bolton Road recovery trench is along the eastern boundary of the property owned by Navajo. PSH thicknesses in RW-13R, which was installed in 2012 as part of the remediation system upgrades, have ranged from 3.85 ft in September 2012 to 0.1 ft in April 2015. Remediation system records indicate that PSH thicknesses have ranged from not measurable to 4.03 ft throughout 2016. A pump test will be conducted at this location, utilizing RW-13R as the pumping well. Transducers will be used to observe groundwater level responses in RW-13R as well as RW-12R and RW-14R which are also located within the Bolton Road recovery trench. These locations will provide information regarding the drawdown of the pumping well and the transmissivity within this recovery trench. A transducer will also be placed in MW-113, which is located west of the Bolton Road trench between RW-12R and RW-13R. The locations of the observation wells in relation to RW-13R and the Bolton Road trench are shown in **Figure 10**.

RW-18 is a subsurface trench located in the northern part of the field east of the refinery, within an agricultural field, with six wells installed within the trench. PSH has not been observed in this trench, thus no recovery has occurred at this location. One possibility for the reinjection scenario is to reinject a small amount of treated groundwater outside the existing PSH plume. Thus, a pump test will be conducted at this location, utilizing RW-18D as the pumping well. Transducers will be used to observe groundwater level responses in RW-18A, RW-18C, and RW-18D. These locations will provide information regarding the drawdown of the pumping well and the transmissivity within this trench. A transducer will also be placed in KWB-1A, the nearest monitoring well, which is located to the south and cross-gradient. The locations of the RW-18 trench and nearby monitoring wells are shown in **Figure 11**.

Pump Test Methodology

Prior to implementation of this pump test work plan, all pumps associated with the remediation system will be turned off, with the exception of RW-20. RW-20 is located adjacent to a lined sump at an off-site facility and the pump in this location is used to maintain a specified water level beneath the sumps. The remediation system pumps will be turned off a minimum of 48 hours prior to the pump tests to allow groundwater to equilibrate prior to the tests. Measurements of the depth to PSH and/or groundwater will be made in all of the pump test and observation wells a minimum of 48 hours after the remediation system wells have been turned off and before beginning any of the pump tests.

The transducers will be decontaminated prior to placement in each of the pumping or observation wells. The transducers will be set to record data at routine intervals (likely 1 to 5 minutes) as well as recording large changes in pressure (e.g., >1 psi change from previous reading) and placed in the pumping and observation wells before beginning each pump test. The transducers will be retrieved and the data downloaded from each transducer at the end of each pump test, and the transducers will be decontaminated prior to performing the next pump test.

The dedicated groundwater pumps in recovery wells RW-2R, RW-6R, RW-7R, RW-13R, and RW-19 will be used to perform the pump tests at those locations. Each of these pumps is rated to pump at a constant rate of 10 gallons per minute (gpm) and has a dedicated flowmeter. Each of these recovery wells have dedicated discharge piping that directs discharge to the nearest refinery process wastewater sump. The totalizing flowmeter will be read prior to beginning the pump test, at regular intervals throughout; and, at the end of the pump test to determine the pumping rate throughout the test and to confirm the volume of water discharged.

A submersible electric pump capable of pumping at a constant rate between 8 and 10 gallons per minute (gpm) will be used to perform the pump test at RW-18D. Power will be supplied to the pump via generator or a battery. Temporary discharge hose will be attached to the submersible pump and the discharge from RW-18D will be directed into a frac tank. The frac tank will be emptied via vacuum truck and the produced water will be disposed of in the refinery process wastewater system upstream of the oil/water separator. The volume of water discharged will be measured at the end of the pump test.

Due to sufficient distance between recovery wells to prevent interference, the pump tests will be conducted in pairs, as follows:

- RW-2R and RW-13R
- RW-7R and RW-19
- RW-6R and RW-18

At the beginning of each pump test, the depth to PSH and to groundwater will be measured in each of the pumping wells and observation wells and will be recorded in the field logbook. The pump will then be turned on and allowed to run for a minimum of 24 hours. Measurements of the depth to PSH and groundwater will be made periodically throughout the pump test period. Additionally, the discharge will be monitored periodically throughout the pump test to evaluate whether PSH is present in the discharge liquids.

Once the pump test has been completed, the pumps will be turned off and the depth to PSH and groundwater will be measured in the pumping well and observation wells. The transducers will be retrieved and data will be downloaded from each. This process will be repeated until all six of the pump tests have been completed.

Groundwater Sampling

Samples of dissolved phase groundwater will be collected from beneath the PSH layer at RW-6R and at RW-13R before and after the pump tests at these locations. The groundwater at these two locations is assumed to be representative of impacted groundwater beneath the PSH throughout the refinery.

Samples will be collected by placing disposable tubing on the sample tap on the groundwater discharge line and collecting the discharge liquids into sample containers provided by the

laboratory. The sample containers will be labeled with the sample identifier, date, time, and sampler collector's initials along with the analyses to be performed. Samples will be cooled and shipped to the laboratory under appropriate chain of custody. Each sample will be analyzed for the following:

- pH
- Total organic carbon (TOC)
- Total sulfide
- Chemical oxygen demand (COD)
- Total suspended solids (TSS)
- Total dissolved solids (TDS)
- Hardness (as calcium carbonate)
- Total petroleum hydrocarbons (gasoline, diesel, motor oil ranges)
- Volatile organic compounds
- Semivolatile organic compounds
- Anions/cations (calcium, chloride, fluoride, potassium, nitrate/nitrite, sodium, sulfate)
- Metals (arsenic, boron, chromium, iron, manganese, nickel, selenium, uranium, and vanadium)

The analytical suite has been chosen to provide information required to design a groundwater treatment system and includes those constituents that have been observed in shallow groundwater at concentrations above the regulatory screening levels. At this time, the concentration limits for reinjection within the boundary of the shallow groundwater plume have not been determined. Therefore, the analytical suite has been chosen to include all potential contaminants of concern.

Groundwater Modeling

Information obtained from the pump tests will be used to update the preliminary three-dimensional groundwater model developed during the feasibility study. Data from each pump test will be processed using analytical methods to arrive at site-specific values for hydraulic conductivity, specific yield, and porosity within the areas tested. These results will be used to

develop hydraulic conductivity and yield zones within the groundwater model and the model will be recalibrated using an inverse parameter solver bound by the results of the pump tests.

In addition to the pump test results, the geophysical characterization conducted as part of the contaminant migration evaluation[iii] will be incorporated into the model so that locations and extent of interbedded, high conductivity channels are considered. The updated model will be used to assess potential recovery and reinjection schemes.

Reporting

A letter report will be submitted to Navajo describing the pump test activities, including the duration of each test, the volume of groundwater pumped, the analytical results of the groundwater sampling, and the updated CSM and groundwater model. The letter will include various recommended schemes for improved remediation incorporating groundwater reinjection. These schemes will be discussed with Navajo so that a basis for design may be selected and a basic engineering design can be developed.

Schedule

The pump test will occur within one week of approval of this work plan by Navajo, or as the refinery operations schedule will allow. The pump test is expected to require one week to complete. Data processing and model updates will require three weeks and reporting will require one week. Thus, the summary report will be delivered within four weeks after the pump test has been completed.

If you have any questions or comments, please feel free to contact me at 713-929-5674 or 713-249-8548.

Sincerely,
Amec Foster Wheeler Environment & Infrastructure, Inc.

Pamela R. Krueger
Senior Associate

c: Peter Guerra

Figures:
1 – Site Location
2 – Well Locations
3 – Recovery Trench Locations
4 – Sand and Gravel Channels and Preferential Pathways
5 – PSH Extent in Shallow Saturated Zone
6 – RW-7R Pump Test Plan

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7 – RW-2R Pump Test Plan
8 – RW-6R Pump Test Plan
9 – RW-19 Pump Test Plan
10 – RW-13R Pump Test Plan
11 – RW-18D Pump Test Plan

Tables:
1 – Pumping and Observation Wells for Pump Tests

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[i] NMED 2010. Navajo Refining Company Artesia Refinery Post-Closure Care Permit (NMD048918817). December 2010.
[ii] OCD 2012. Discharge Permit GW-028. August 22, 2012.
[iii] Arcadis 2015. Contaminant Migration Evaluation Investigation Report. February 27, 2015.

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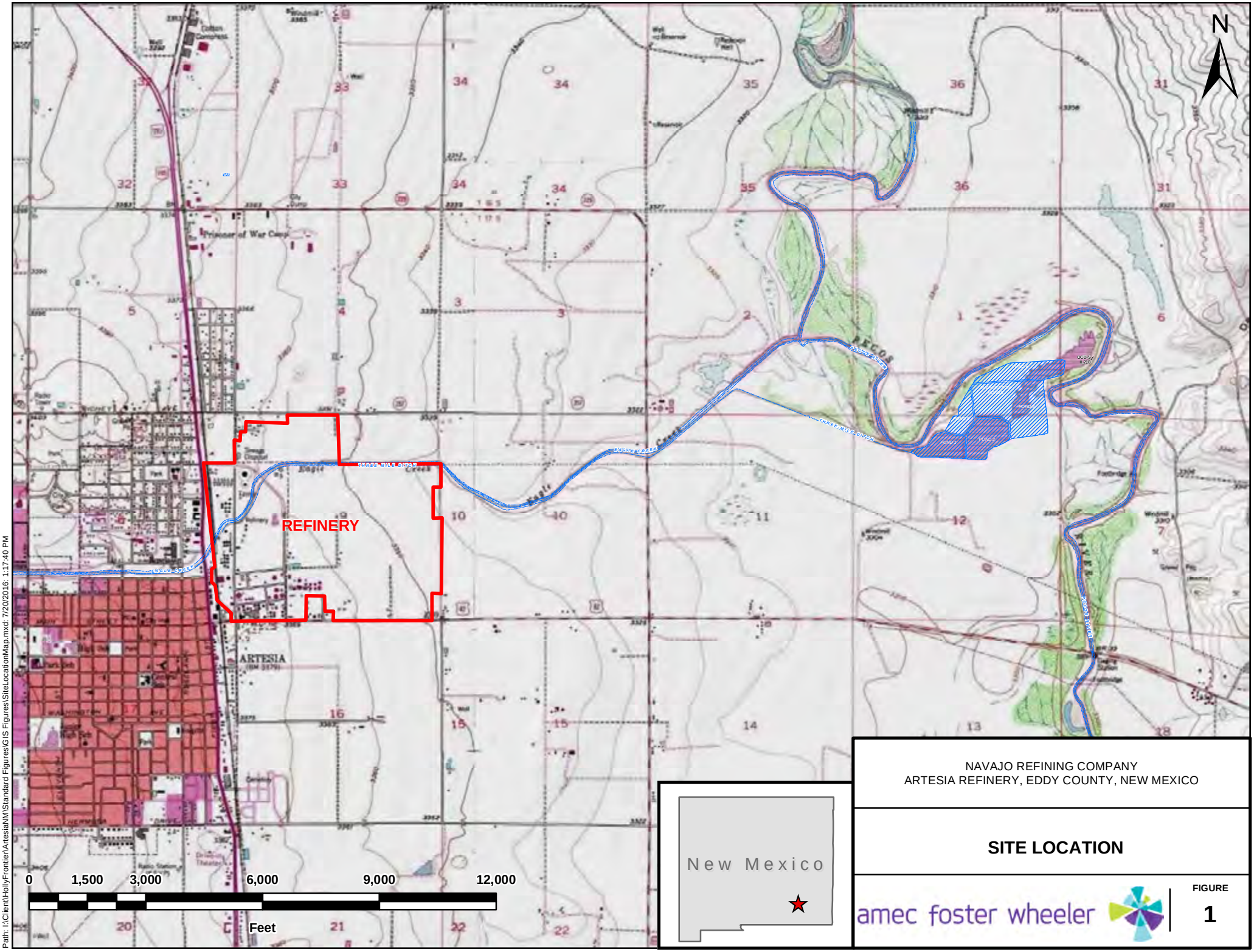
amecfw.com

FIGURES



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

SITE LOCATION

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FIGURE
1

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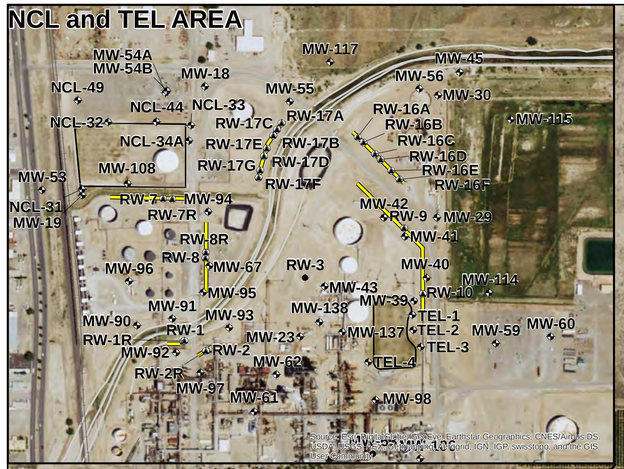
NCL and TEL AREA



Legend

- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- Trenches

Abbreviations

TEL = TETRA ETHYL LEAD

NCL = NORTH COLONY LANDFARM

N

0 400 800 1,600 2,400 3,200

Feet

NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

WELL LOCATIONS

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FIGURE 2

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
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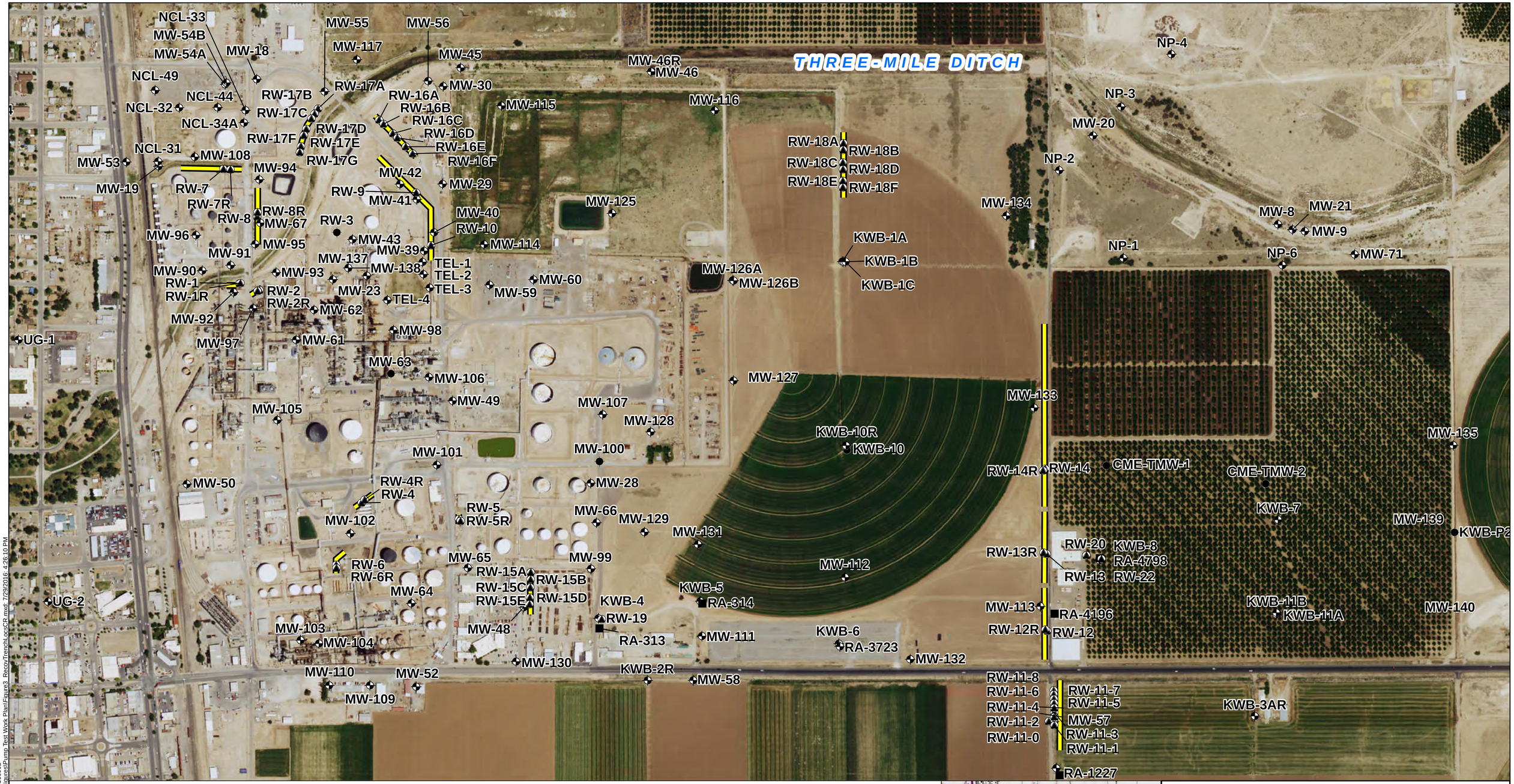


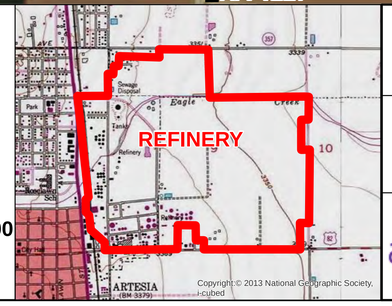
Legend

- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCHES

N

0 300 600 900 1,200

Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

RECOVERY TRENCH LOCATIONS

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FIGURE 3

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
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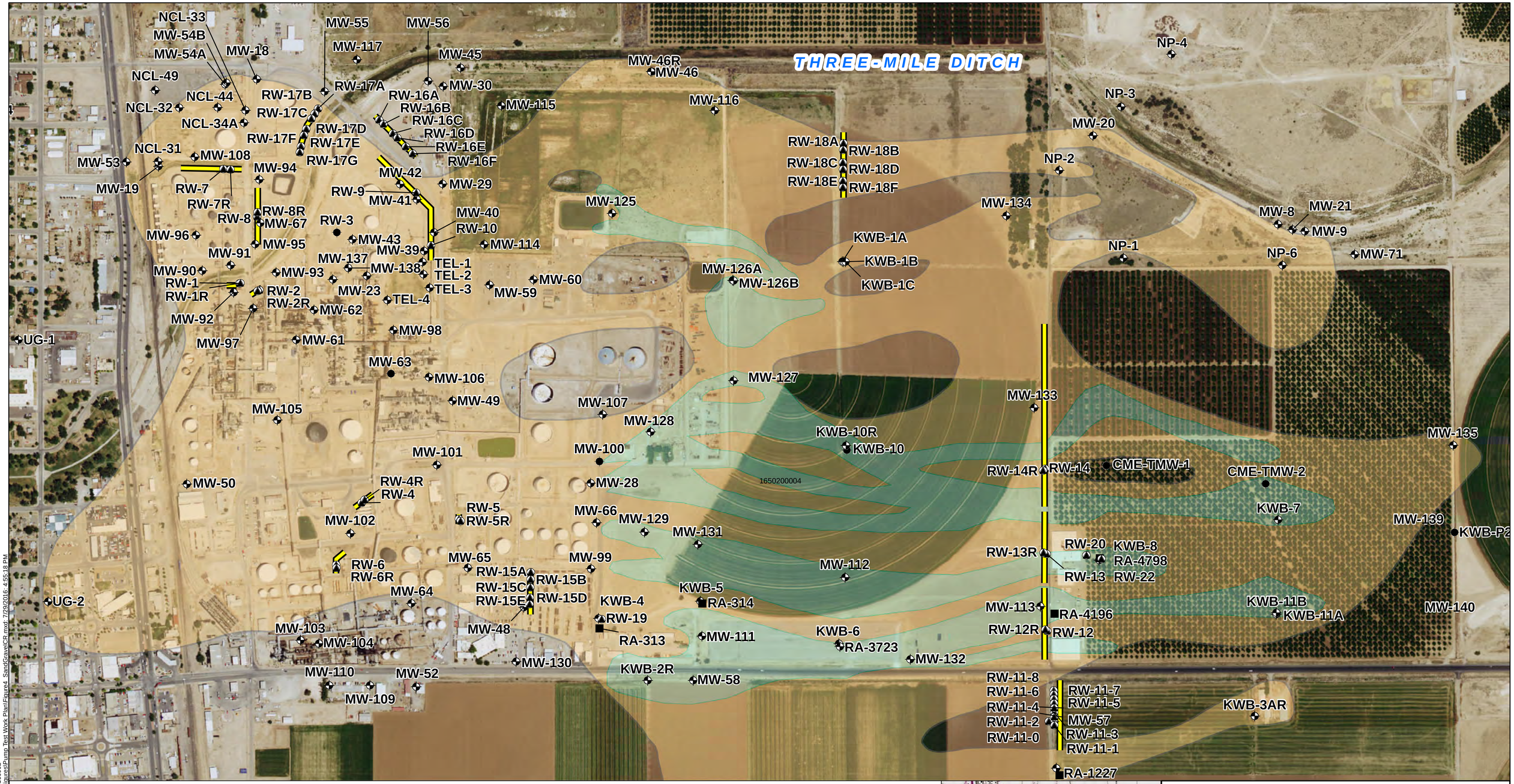


Legend

- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCHES
- INTERPRETED PREFERENTIAL PATHWAYS
- EXTENT OF SAND AND GRAVEL CHANNELS

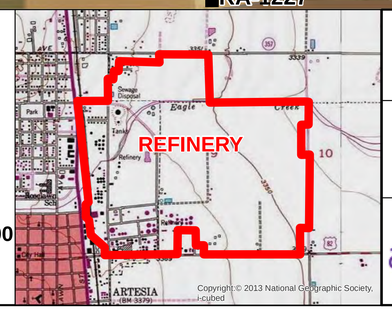
Notes

1. Sand and Gravel Channels extent and Preferential Pathways determined from "Contamination Migration Evaluation Investigation Report" Arcadis, February 2015

N

0 300 600 900 1,200

Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

SAND AND GRAVEL CHANNELS AND PREFERENTIAL PATHWAYS

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FIGURE 4

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
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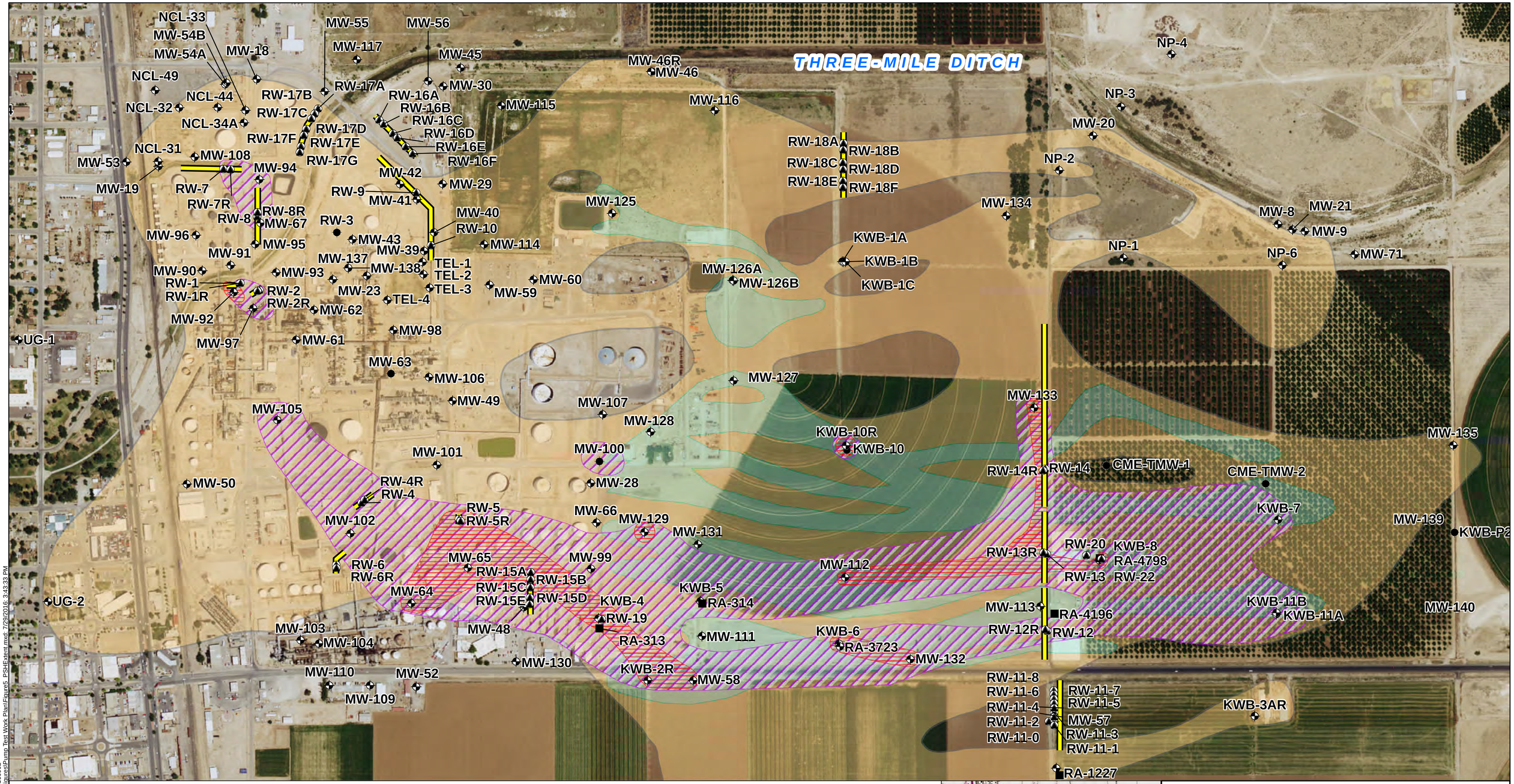


Legend

- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCHES
- INTERPRETED PREFERENTIAL PATHWAYS
- EXTENT OF SAND AND GRAVEL CHANNELS
- 2015 PSH EXTENT IN SHALLOW SATURATED ZONE
- 2014 PSH EXTENT IN SHALLOW SATURATED ZONE

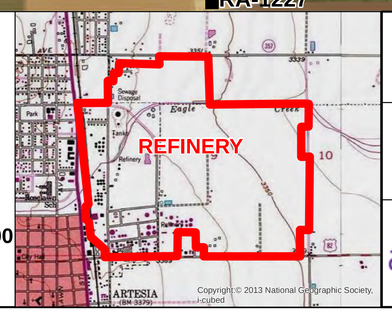
Notes

1. Sand and Gravel Channels extent and Preferential Pathways determined from "Contamination Migration Evaluation Investigation Report" Arcadis, February 2015
2. PSH Depths from "2015 Annual Groundwater Monitoring Report" Arcadis, February 2016

N

0 300 600 900 1,200

Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

PSH EXTENT IN SHALLOW SATURATED ZONE

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FIGURE 5

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NCL-34A
RW-17D
RW-17C
RW-7 STANDPIPE
RW-17F
RW-17E
MW-108
MW-53
NCL-31
RW-17G
RW-7R
MW-19
RW-7
MW-94
RW-8R
RW-8
MW-67
MW-96
RW-3

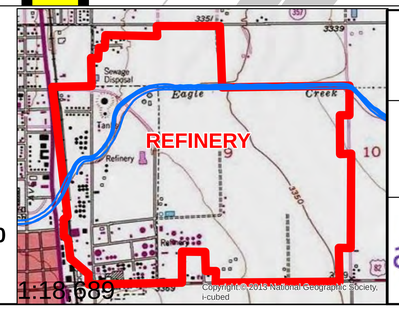
Legend

- Transducer Wells
- Pump Test Recovery Wells
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- Trenches

N

0 25 50 100 150 200

Feet



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NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

7R PUMP TEST WELL LOCATIONS

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FIGURE
6

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
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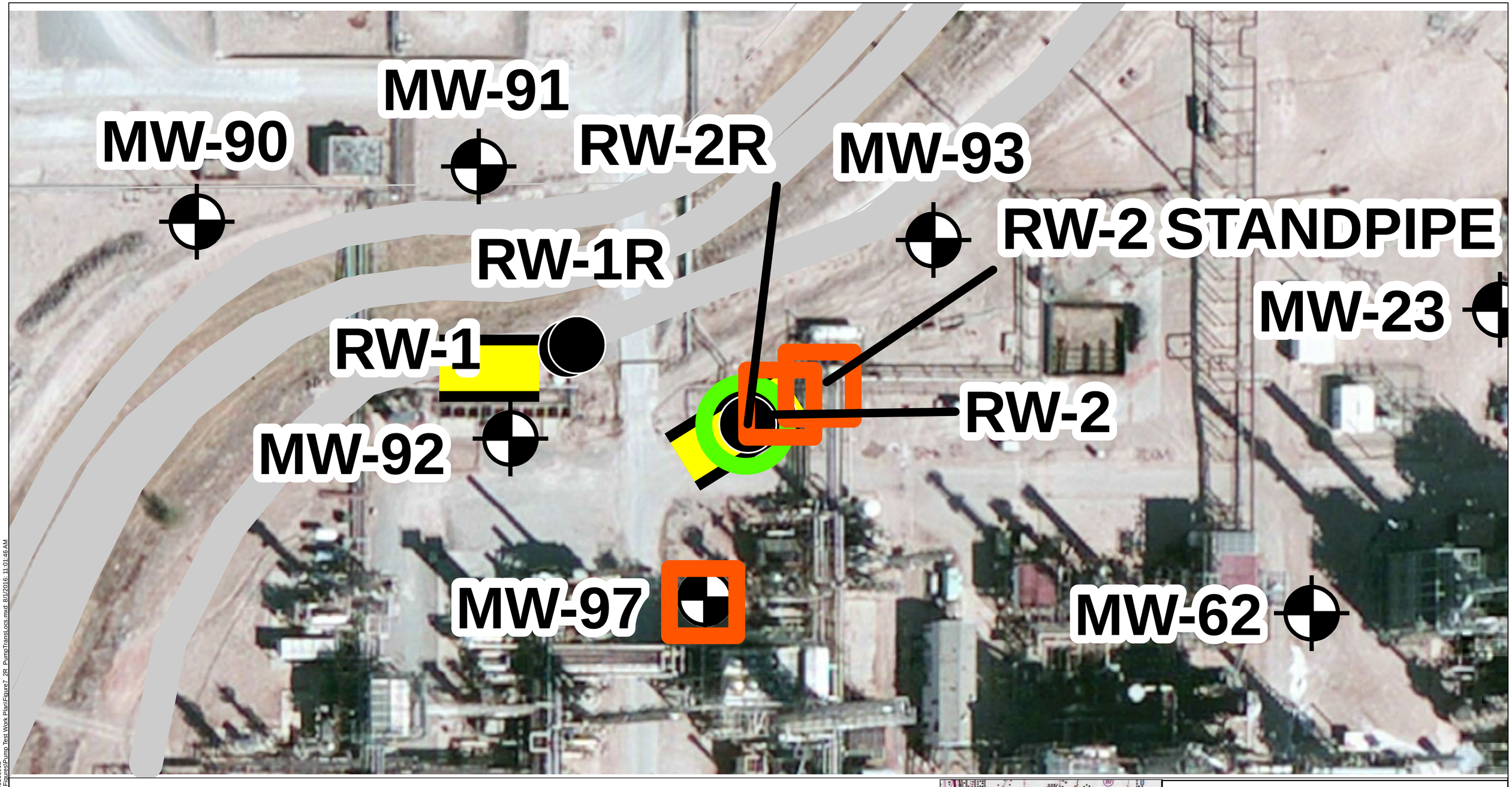


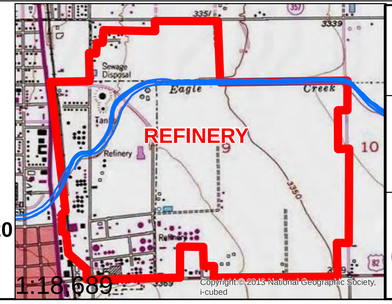
Legend

- Transducer Wells
- Pump Test Recovery Wells
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- Trenches

N

0 15 30 60 90 120

Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

RW-2R PUMP TEST WELL LOCATIONS

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FIGURE 7

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
Path: \\ClientHolly\Frontier\Artesia\MXStandard Figures\GIS Figures\Pump Test Work Plan\Figure7_2R_PumpTransLocs.mxd 8/1/2016, 11:01:46 AM

RW-4R

RW-4

RW-5

RW-5R

MW-102

RW-6 STANDPIPE

RW-6

RW-6R

MW-64

Legend

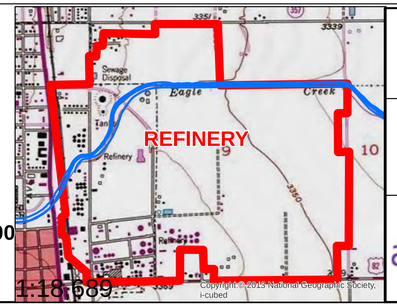
- Transducer Wells
- Pump Test Recovery Wells
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- Trenches

N

0 25 50 100 150 200

Feet

1:18,689



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

6R PUMP TEST WELL LOCATIONS

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FIGURE
8

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
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MW-129
MW-131
MW-65
MW-99
RW-15A
RW-15B
RW-15C
RW-15D
RW-15E
MW-48
RW-19
KWB-4
RA-313
RA-314
KWB-5
MW-111
MW-130
KWB-2R
MW-58

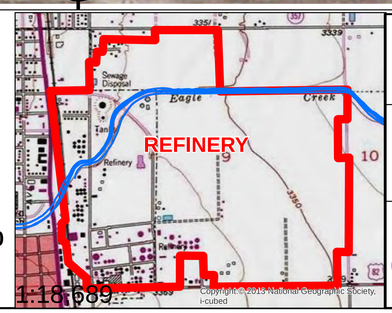
Legend

- Transducer Wells
- Pump Test Recovery Wells
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- Trenches

N

0 30 60 120 180 240

Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

19 PUMP TEST WELL LOCATIONS

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FIGURE 9

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
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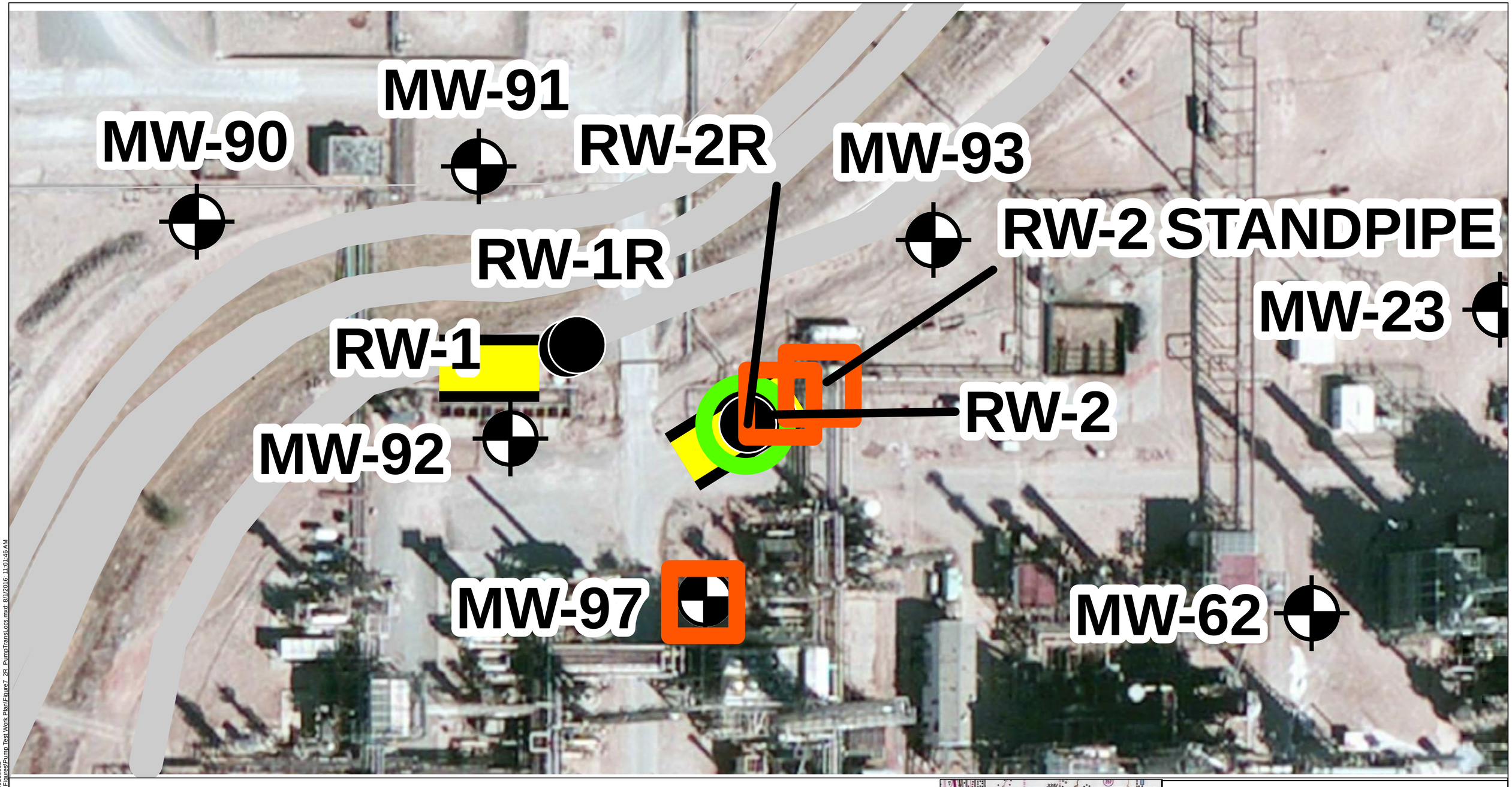


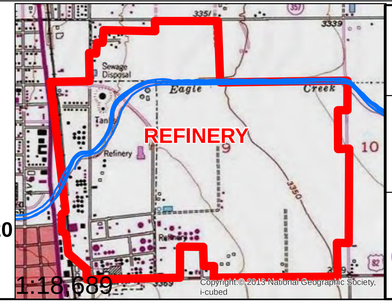
Legend

- Transducer Wells
- Pump Test Recovery Wells
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- Trenches

N

0 15 30 60 90 120

Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

RW-2R PUMP TEST WELL LOCATIONS

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FIGURE 7

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
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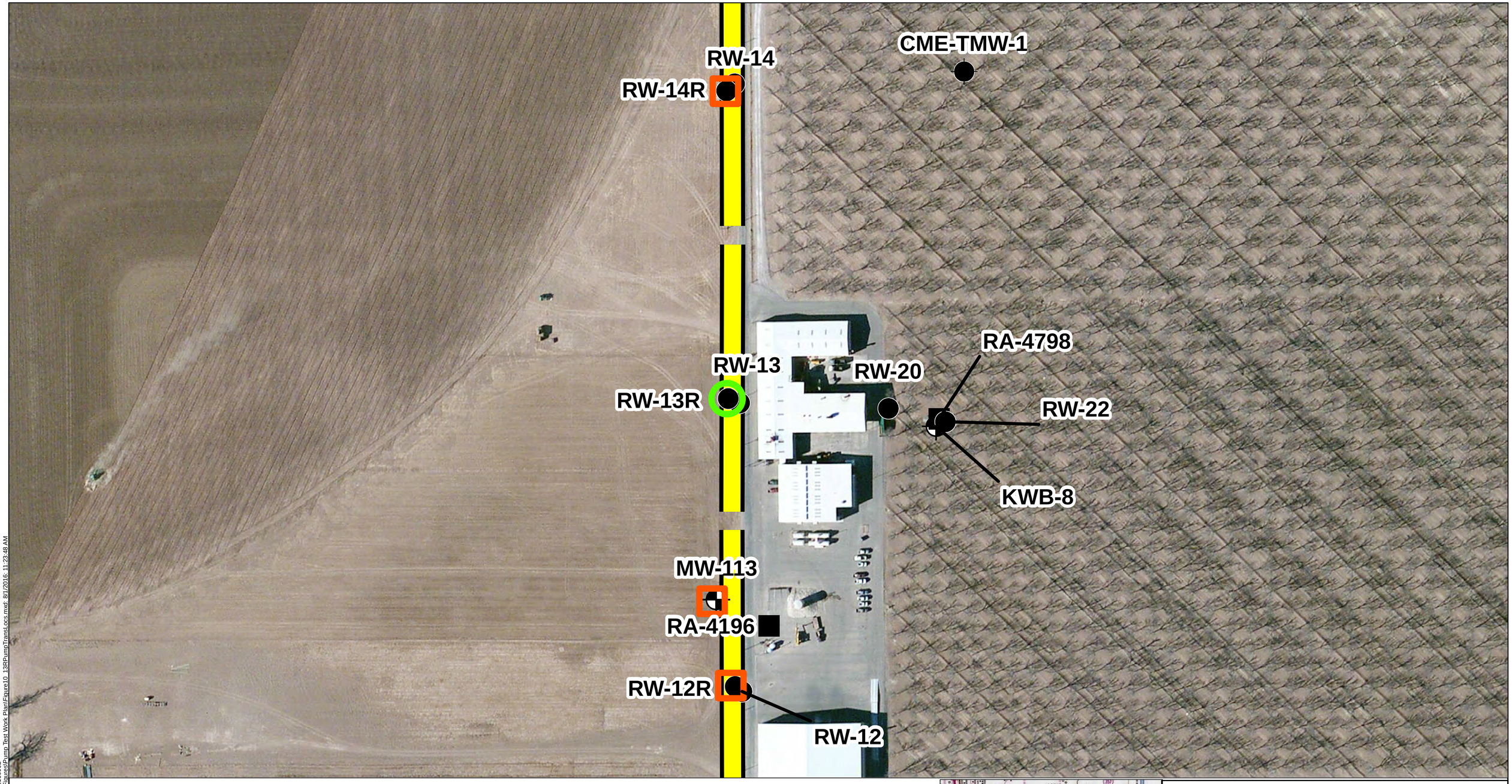


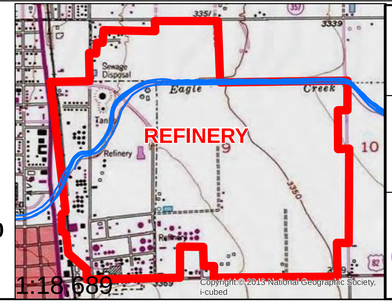
Legend

- Transducer Wells
- Pump Test Recovery Wells
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- Trenches

N

0 40 80 160 240 320

Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

13R PUMP TEST WELL LOCATIONS

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FIGURE
10

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
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RW-18A
RW-18B
RW-18C
RW-18D
RW-18E
RW-18F
MW-134
KWB-1B
KWB-1A
KWB-1C
MW-126B
MW-126A

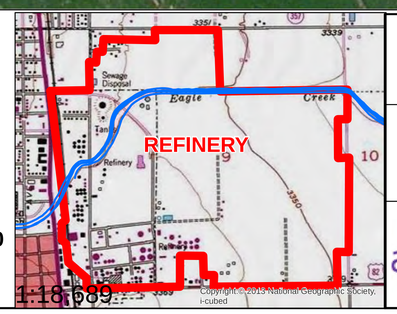
Legend

- Transducer Wells
- Pump Test Recovery Wells
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- Trenches

N

0 35 70 140 210 280

Feet



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NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

18D PUMP TEST WELL LOCATIONS

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FIGURE
11

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160002
Path: I:\Client\Holly\Frontier\Artesia\NM\Standard Figures\GIS Figures\Pump Test Work Plan\Figure11_18PumpTransLocs.mxd: 8/1/2016; 11:33:45 AM

TABLES

Table 1
Pump Test Work Plan
HollyFrontier Navajo Refining LLC

Pumping Well	Observation Wells
RW-7R	RW-7
	RW-7 standpipe
	MW-94
RW-2R	RW-2
	RW-2 standpipe
	MW-97
RW-6R	RW-6
	RW-6 standpipe
	MW-102
RW-19	KWB-4
	MW-99
RW-13R	MW-113
	RW-12R
	RW-14R
RW-18D	RW-18C
	RW-18A
	KWB-1A