GW - ___28___

PUMP TEST

(2 of 2)

2016

Chavez, Carl J, EMNRD

From: Combs, Robert <Robert.Combs@HollyFrontier.com>
Sent: Thursday, March 22, 2018 6:03 PM
To: Tsinnajinnie, Leona, NMENV; Chavez, Carl J, EMNRD
Cc: Cobrain, Dave, NMENV; VanHorn, Kristen, NMENV; Suzuki, Michiya, NMENV; Denton, Scott; Sahba, Arsin M.; Holder, Mike
Subject: RE: GW model - recovery and reinjection
Attachments: 2017-03-22 GWRS Presentation.pdf

Leona and Carl,

Please see the attached PDF of the presentation we would like to discuss with you. I imagine you will want time to review before we meet to discuss. We'll be available the 4/10-4/12, but if you need more time, please propose a convenient time to have the WebEx.

I will be out of the office until 4/2, but Scott and Arsin are available if you have any questions before then.

Look forward to discussing this further with you all.

Thanks,
Robert

Robert Combs
Environmental Specialist
The HollyFrontier Companies
P.O. Box 159
Artesia, NM 88211-0159
office: 575-746-5382
cell: 575-308-2718
fax: 575-746-5451
Robert.Combs@hollyfrontier.com

From: Combs, Robert
Sent: Wednesday, March 14, 2018 3:53 PM
To: 'Tsinnajinnie, Leona, NMENV'
Cc: Cobrain, Dave, NMENV; VanHorn, Kristen, NMENV; Suzuki, Michiya, NMENV; Denton, Scott; Sahba, Arsin M.
Subject: RE: GW model - recovery and reinjection

Leona,
Sorry for the delay. We have been revising the model and hope to have the presentation to you soon for review. I'll update ASAP.
Thanks,
Robert

Robert Combs
Environmental Specialist
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fax: 575-746-5451
Robert.Combs@hollyfrontier.com

From: Tsinnajinnie, Leona, NMENV [mailto:Leona.Tsinnajinnie@state.nm.us]
Sent: Tuesday, March 13, 2018 5:01 PM
To: Combs, Robert
Cc: Cobrain, Dave, NMENV; VanHorn, Kristen, NMENV; Suzuki, Michiya, NMENV
Subject: RE: GW model - recovery and reinjection

Robert-

I just wanted to let you know that I am going to be out of the office starting tomorrow, March 14th through March 16th. I should be returning on Monday, March 19th.

How is the final revision coming along? When should we expect to see the figures and presentation? Please include Dave, Kristen and Michiya when you are able to send the figures and presentation.

Thanks,
Leona

From: Combs, Robert [mailto:Robert.Combs@HollyFrontier.com]
Sent: Tuesday, February 27, 2018 1:15 PM
To: Tsinnajinnie, Leona, NMENV <Leona.Tsinnajinnie@state.nm.us>
Cc: Chavez, Carl J, EMNRD <CarlJ.Chavez@state.nm.us>; Cobrain, Dave, NMENV <dave.cobrain@state.nm.us>
Subject: RE: GW model - recovery and reinjection

Leona,
We're making the final revisions to the figures and presentation and will send ASAP. I did not mention that, if at all possible, we would like to have the call within the next two weeks.
Thanks,
Robert

Robert Combs
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Robert.Combs@hollyfrontier.com

From: Tsinnajinnie, Leona, NMENV [mailto:Leona.Tsinnajinnie@state.nm.us]
Sent: Monday, February 26, 2018 5:08 PM
To: Combs, Robert
Cc: Chavez, Carl J, EMNRD; Cobrain, Dave, NMENV
Subject: RE: GW model - recovery and reinjection

Robert-

Can you send us the revised model results/figures so that we have time to review the information before we decide on a meeting date/time?

Thanks,
Leona

From: Combs, Robert [mailto:Robert.Combs@HollyFrontier.com]
Sent: Monday, February 26, 2018 4:35 PM
To: Tsinnajinnie, Leona, NMENV <Leona.Tsinnajinnie@state.nm.us>; Chavez, Carl J, EMNRD <CarlJ.Chavez@state.nm.us>
Cc: Sahba, Arsin M. <Arsin.Sahba@HollyFrontier.com>; Denton, Scott <Scott.Denton@HollyFrontier.com>
Subject: GW model - recovery and reinjection

Leona and Carl,

We have finished the revision to the groundwater model for the recovery/reinjection project and would like to discuss the results with both agencies. We believe that the updated model meets the objectives of the agencies for capture/control, and would like to pursue further discussion on permitting and quality for injected water.

I was wondering, would you mind a WebEx meeting instead of a physical meeting in Santa Fe? Please let me know your preference for how we can meet and what dates/times would be preferable to you.

Thanks,
Robert

Robert Combs
Environmental Specialist
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HollyFrontier Navajo Refining LLC Groundwater Recovery and Reinjection System Upgrade

March 2018

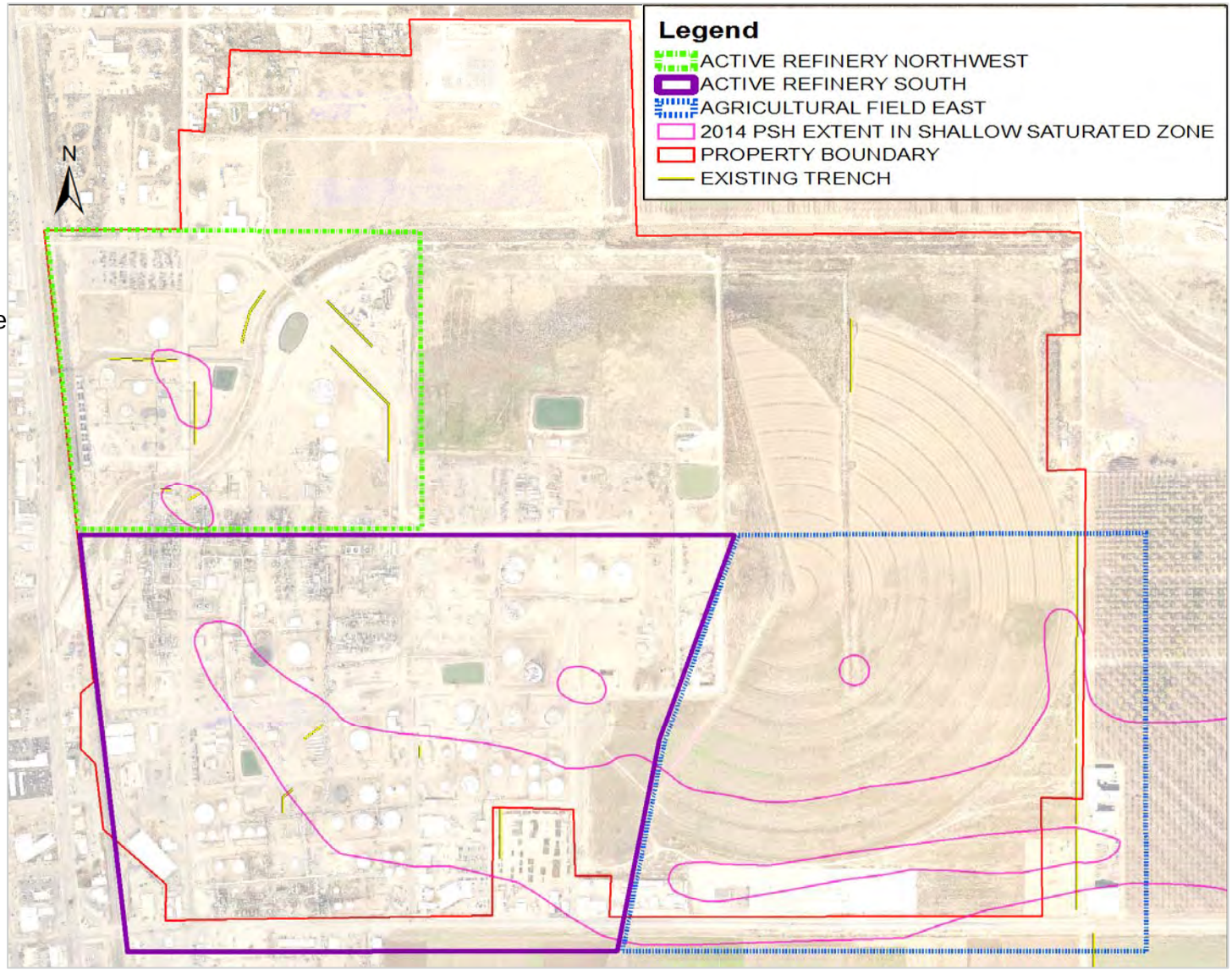
HOLLYFRONTIER®

Agenda

1. Revised objectives, extraction/injection configuration and flow rates
2. Revised model output (particle tracking)
3. Revised model output (potentiometric surface)
4. Groundwater treatment overview
5. Recommended monitoring network
6. Path forward

Revised Objectives

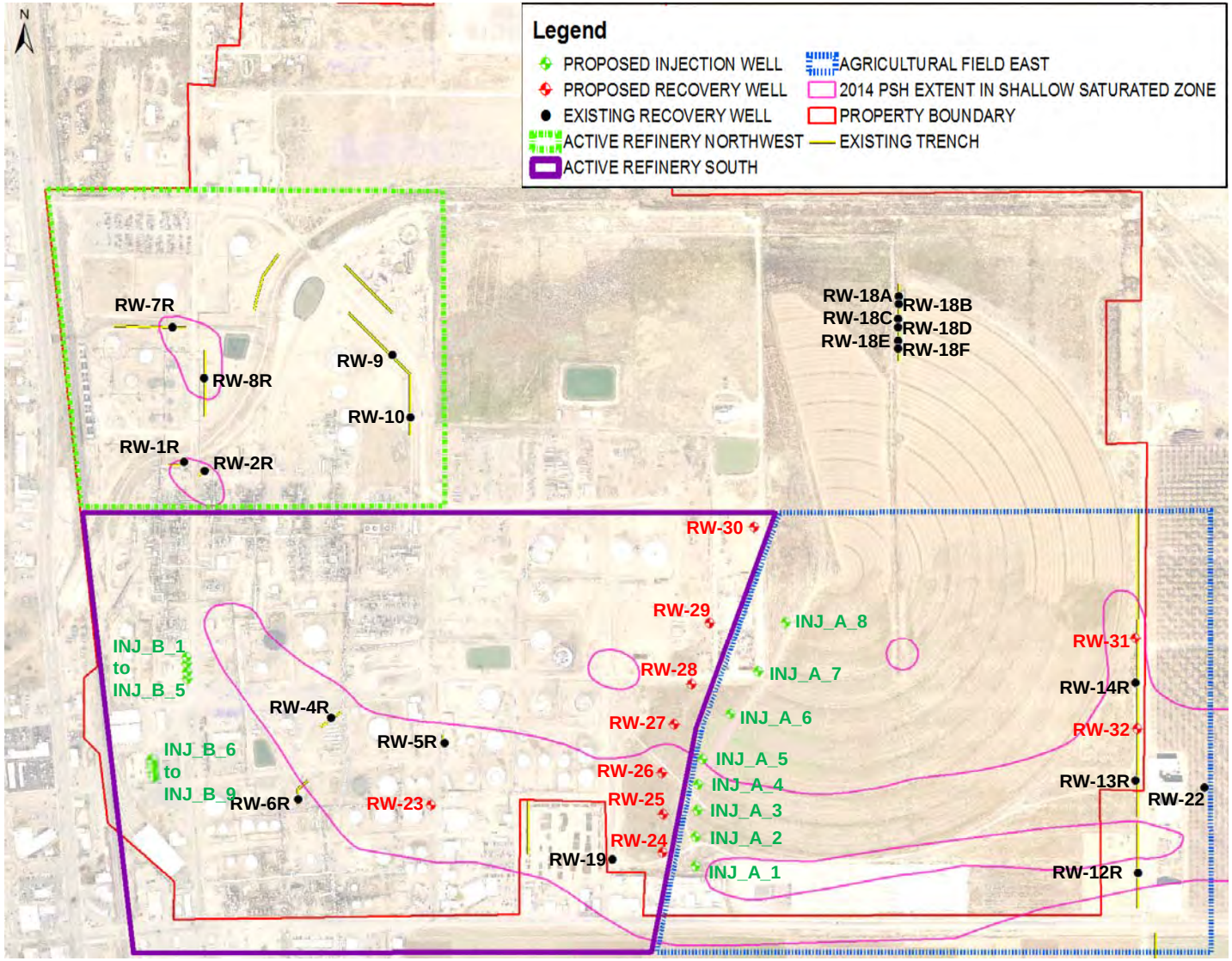
1. Divide known phase-separated hydrocarbon (PSH) plumes into two separate areas:
   - Active refinery area
     - Northwest portion of active refinery
     - South portion of active refinery
   - Agricultural field east of active refinery area
     - East portion of south plume, outside active refinery
2. Inject clean water outside of plumes to balance water rights (RW-9/RW-10 and RW-18)



Revised Configuration

Extraction / injection scenarios developed specific to each area:

- Active refinery - Northwest
  - Existing extraction locations with revised flowrates
  - Injection of clean water in RW-9/RW-10 trench
- Active refinery - South
  - 8 additional extraction wells (interior and east), oriented to separate southern PSH plume near eastern boundary of active refinery
  - Injection gallery near west boundary with 9 injection wells
- Agricultural field - East
  - 2 additional extraction wells (along Bolton Road)
  - Injection gallery with 8 injection wells, oriented to separate southern PSH plume near eastern boundary of active refinery
- Agricultural field – Northeast
  - Injection of clean water into RW-18 trench



Revised Model to Balance Flow Rates

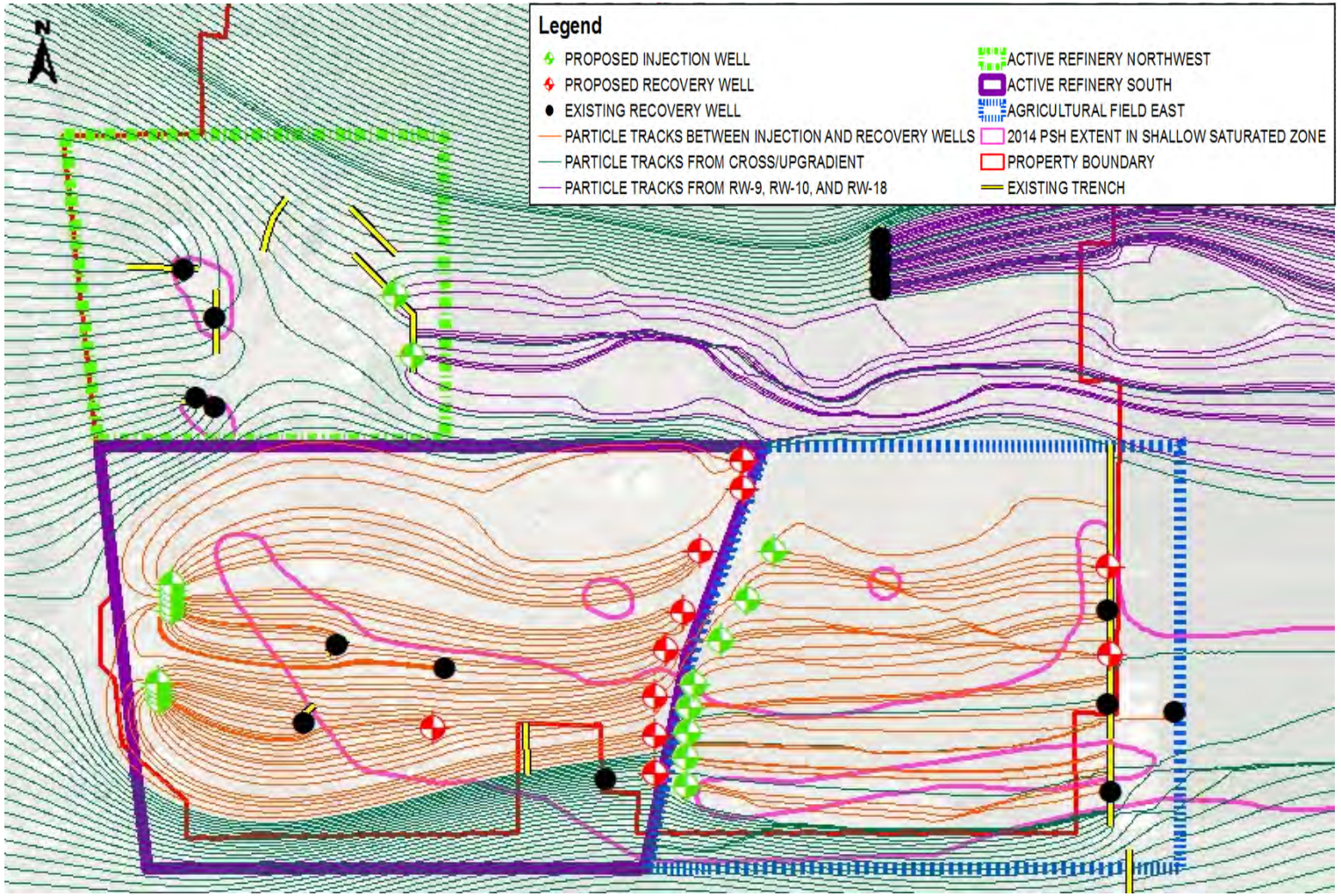
- Active refinery - Northwest
  - Combined extraction rate = 10 gallons per minute (gpm):
    - RW-1R and RW-2R pumped at 2 gpm each
    - RW-7R and RW-8R pumped at 3 gpm each
  - Recovered groundwater to refinery wastewater treatment plant (WWTP) for treatment and disposal or to the secondary reverse osmosis (SRO) for treatment and use in the refinery process
  - Injection of clean water into RW-9/RW-10 trench at 11 gpm
- Active refinery - South
  - Combined extraction rate = 90.5 gpm:
    - RW-23 pumped at 5 gpm
    - RW-4R, RW-5R, RW-6R and RW-25 pumped at 6 gpm each
    - RW-24 pumped at 7 gpm
    - RW-26, RW-27, and RW-28 pumped at 8 gpm each
    - RW-29 pumped at 9.5 gpm
    - RW-19 pumped at 10 gpm
    - RW-30 pumped at 11 gpm
  - Injection into gallery near west boundary = 51 gpm:
    - INJ_B_1, INJ_B_2, INJ_B_5, and INJ_B_6 injected at 6.5 gpm each
    - INJ_B_3, INJ_B_4, INJ_B_7, INJ_B_8, INJ_B_9 injected at 5 gpm each
- Agricultural field - East
  - Combined extraction rate = 75 gpm:
    - RW-22 pumped at 5 gpm
    - RW-12R pumped at 10 gpm
    - RW-13R, RW-14R, RW-31, RW-32 pumped at 15 gpm each
  - Injection into gallery near west boundary = 94 gpm:
    - INJ_A_1, INJ_A_8 injected at 13 gpm each
    - INJ_A_2, INJ_A_3, INJ_A_6, INJ_A_7 injected at 12 gpm each
    - INJ_A_4, INJ_A_5 injected at 10 gpm each
- Agricultural field - Northeast
  - Injection of clean water into RW-18 trench at 19.5 gpm

Area	Extraction (gpm)	Injection (gpm)
Active Refinery – Northwest	-10	11
Active Refinery – South	-90.5	51
Agricultural Field – East	-75	94
Agricultural Field - Northeast	0	19.5
Totals:	-175.5	175.5

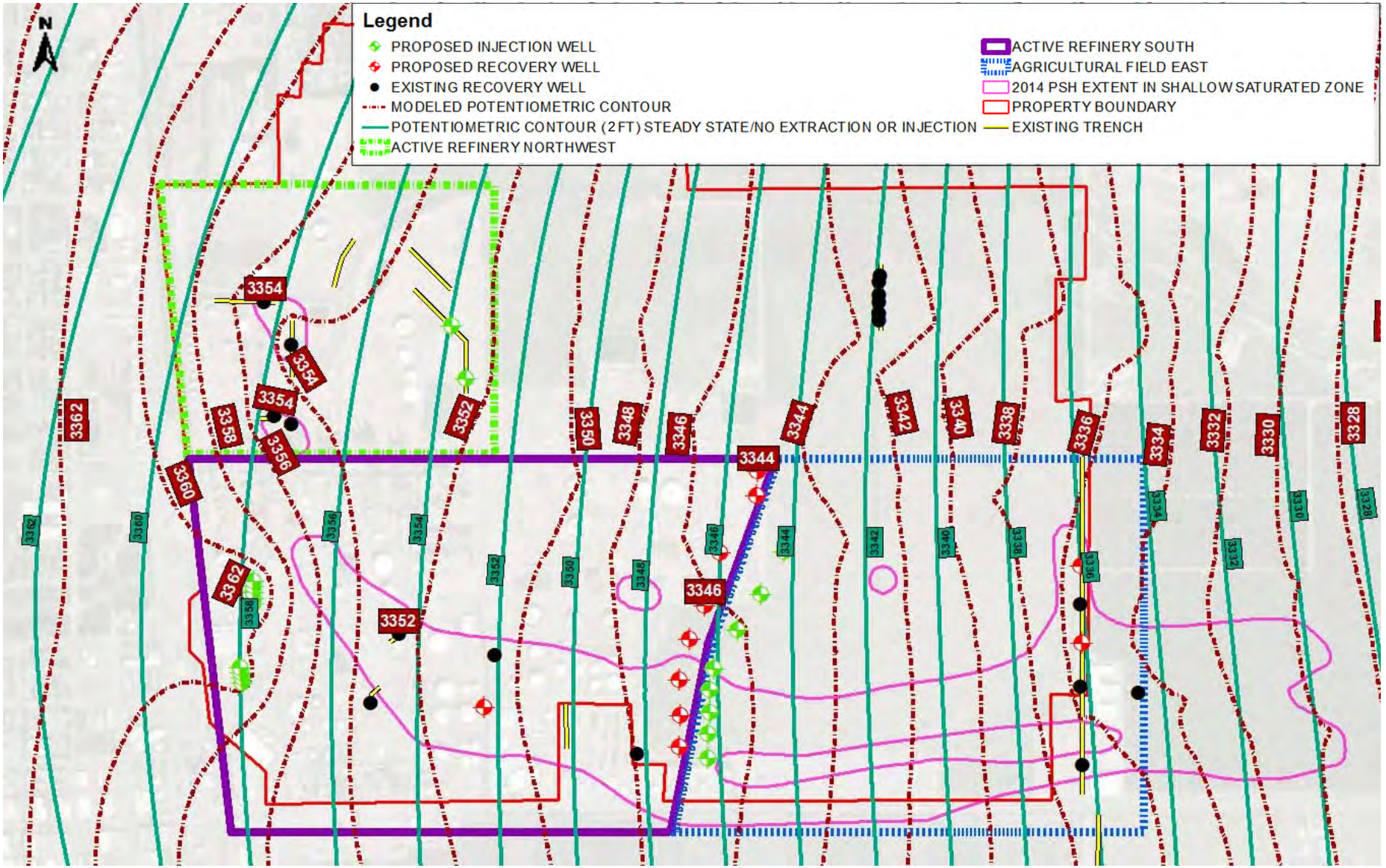
Expected flow rates are based on the revised groundwater model results. Adjustments to actual flow rates will be made, as needed, to maintain the desired groundwater elevation and gradient control, as well as the overall balance of total flow rates (zero consumptive shallow groundwater usage).

Revised Model Particle Tracks

- Particle tracks show the modelled pathways that groundwater will flow using the revised extraction and injection scenario.
- Model shows extraction will capture the injected water in the southern plume areas.
- Clean water injected into shallow water-bearing zone in RW-9/RW-10 and RW-18 will not be captured.



Revised Model Potentiometric Surfaces



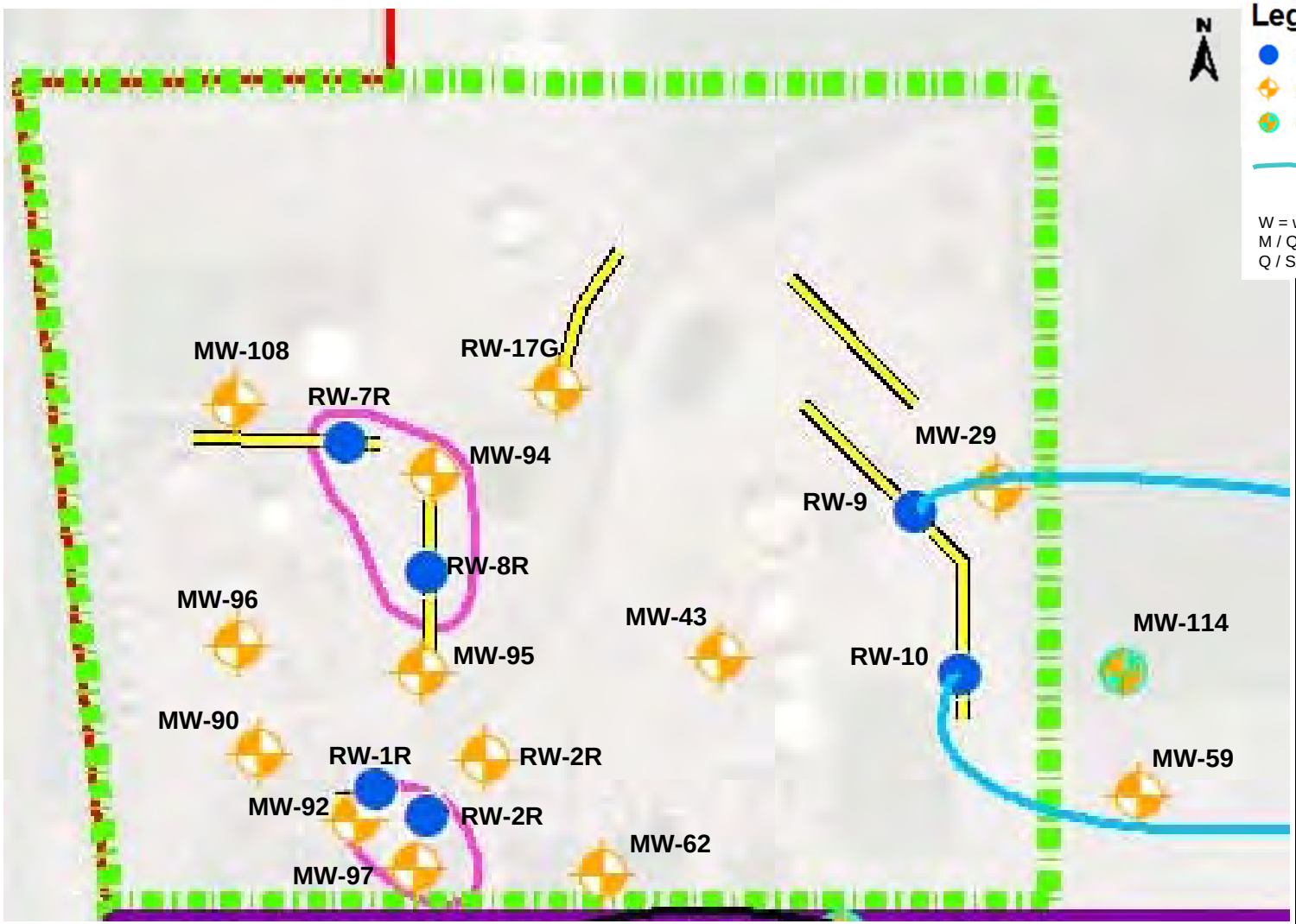
Proposed Groundwater Treatment Process

- Recovery wells each have two pumps:
  - Total fluids pump set to maintain steady flow, groundwater elevation, and gradient
  - PSH pump with intake near PSH/water interface to skim PSH from shallow aquifer
- PSH is pumped to collection tank, then recycled into refinery process stream
- 30.5 gpm of recovered groundwater will be sent to refinery WWTP for treatment and disposal or sent to the SRO unit for treatment and use in the refinery process
- 145 gpm of recovered groundwater will be routed to new groundwater treatment system located within the Active Refinery. The treatment process will include:
  - Removal of residual PSH and suspended solids from recovered groundwater (145 gpm)
  - Injection of 51 gpm into the western injection gallery (INJ_B_1 to INJ_B_9)
  - Additional treatment of remaining recovered groundwater (94 gpm) to reduce dissolved constituent concentrations, as needed, so that concentrations of dissolved phase constituents are equal to or less than current concentrations in groundwater from that area
  - Injection of 94 gpm into the eastern injection gallery (INJ_A_1 to INJ_A_8)
- Preliminary design of the treatment process will be modified, as needed, to meet treatment standards, after approval of the revised extraction/injection scenario and well configuration

Recommended Monitoring Network

- Install 8 additional monitoring wells:
  - 3 downgradient of southern plume, on the eastern side of pecan orchard (MW-139, MW-140, MW-146)
  - 1 south of western injection gallery (MW-141)
  - 2 in agricultural field (MW-142, MW-143)
  - 2 south of Highway 82 (MW-144, MW-145)
  - Final locations of each to be determined based on utility clearance and landowner agreement (if applicable)
- Potentiometric surface monitoring:
  - Each recovery well and injection well to be gauged weekly during operation of system
  - Select monitoring wells located in and around the plumes to be gauged monthly until the system reaches steady state and the desired gradient is achieved; then quarterly (see figures on slides 10 through 12)
- Water quality monitoring:
  - Discharge from treatment system to western injection gallery:
    - Collected weekly for first quarter following system start-up, then once per quarter
    - Evaluated for PSH presence (in graduated cylinder)
    - Laboratory analysis of Total Suspended Solids (TSS)
  - Discharge from treatment system to eastern injection gallery:
    - Collected weekly for first quarter following system start-up, then once per quarter
    - Laboratory analyses of dissolved constituents (see below for recommended analyses)
  - Select monitoring wells, if PSH < 0.03 feet (see figures on slides 10 through 12):
    - Collected quarterly for first year following system start-up, then semi-annually (along with facility-wide monitoring)
    - Laboratory analyses of dissolved constituents (see below for recommended analyses)
  - Recommended laboratory analyses for the eastern injection gallery discharge and monitoring well samples are the constituents listed in the facility-wide groundwater monitoring program. If the first year of monitoring indicates a constituent is not present above the applicable WQCC standard, MCL, or established background/baseline concentration, then that constituent will be removed from the ongoing recovery system monitoring program.

Recommended Monitoring Network - Northwest



Legend

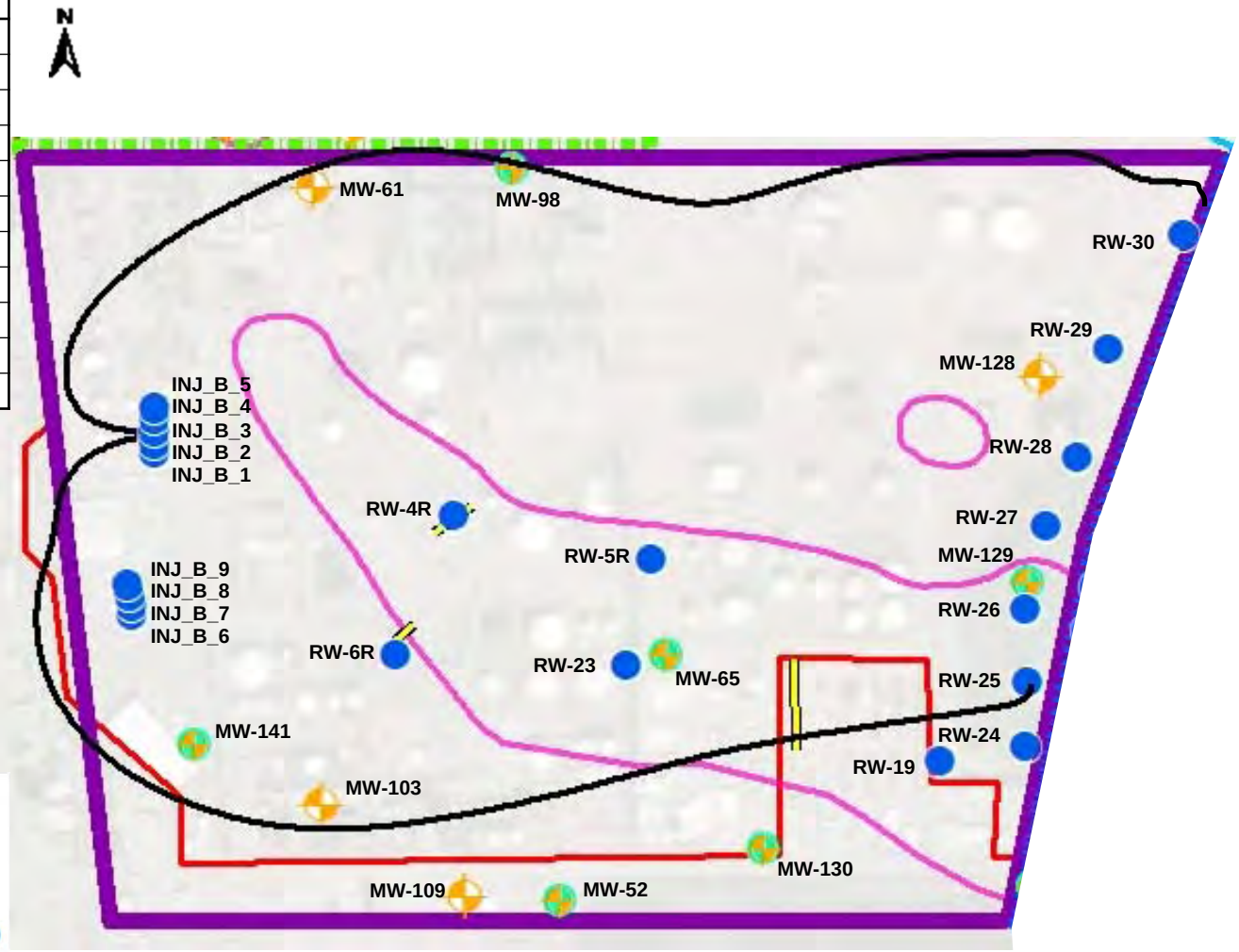
- Gauge (W)
- Gauge (M/Q)
- Gauge (M/Q), Sample (Q/SA)
- Modelled extent of clean water injectate

W = weekly while system operating
M / Q = monthly until stable, then quarterly
Q / SA = quarterly for one year, then semiannually

Well	Gauge	Sample
MW-29	M / Q	
MW-43	M / Q	
MW-59	M / Q	
MW-62	M / Q	
MW-90	M / Q	
MW-92	M / Q	
MW-93	M / Q	
MW-94	M / Q	
MW-95	M / Q	
MW-96	M / Q	
MW-97	M / Q	
MW-108	M / Q	
RW-17G	M / Q	
MW-114	M / Q	Q / SA
RW-1R	W	
RW-2R	W	
RW-7R	W	
RW-8R	W	
RW-9	W	
RW-10	W	

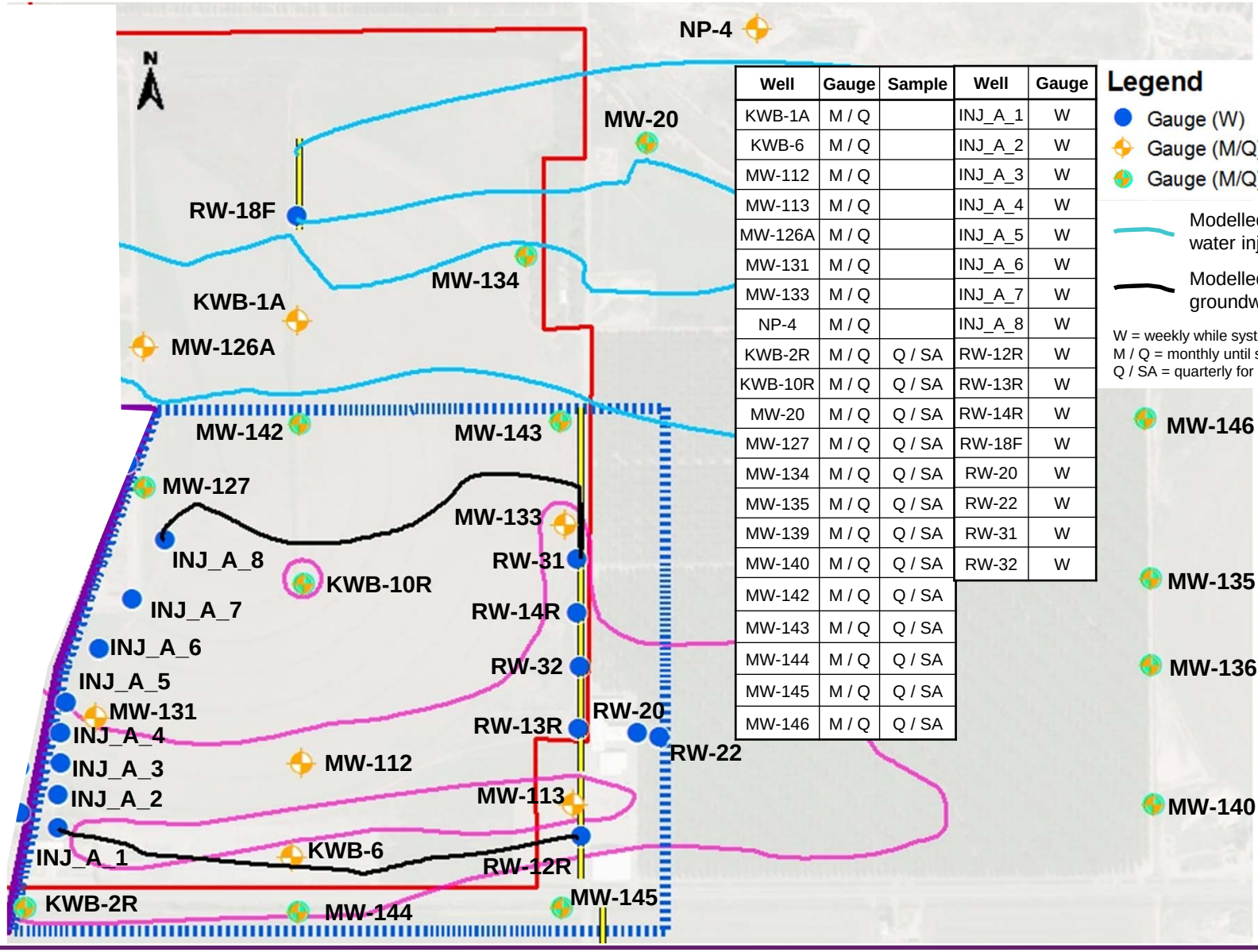
Recommended Monitoring Network - South

Well	Gauge	Well	Gauge	Sample
INJ_B_1	W	MW-61	M / Q	
INJ_B_2	W	MW-103	M / Q	
INJ_B_3	W	MW-109	M / Q	
INJ_B_4	W	MW-128	M / Q	
INJ_B_5	W	UG-2	M / Q	
INJ_B_6	W	MW-52	M / Q	Q / SA
INJ_B_7	W	MW-65	M / Q	Q / SA
INJ_B_8	W	MW-98	M / Q	Q / SA
INJ_B_9	W	MW-129	M / Q	Q / SA
RW-4R	W	MW-130	M / Q	Q / SA
RW-5R	W	MW-141	M / Q	Q / SA
RW-6R	W			
RW-19	W			
RW-23	W			
RW-24	W			
RW-25	W			
RW-26	W			
RW-27	W			
RW-28	W			
RW-29	W			
RW-30	W			



W = weekly while system operating
M / Q = monthly until stable, then quarterly
Q / SA = quarterly for one year, then semiannually

Recommended Monitoring Network - East



Well	Gauge	Sample	Well	Gauge
KWB-1A	M / Q		INJ_A_1	W
KWB-6	M / Q		INJ_A_2	W
MW-112	M / Q		INJ_A_3	W
MW-113	M / Q		INJ_A_4	W
MW-126A	M / Q		INJ_A_5	W
MW-131	M / Q		INJ_A_6	W
MW-133	M / Q		INJ_A_7	W
NP-4	M / Q		INJ_A_8	W
KWB-2R	M / Q	Q / SA	RW-12R	W
KWB-10R	M / Q	Q / SA	RW-13R	W
MW-20	M / Q	Q / SA	RW-14R	W
MW-127	M / Q	Q / SA	RW-18F	W
MW-134	M / Q	Q / SA	RW-20	W
MW-135	M / Q	Q / SA	RW-22	W
MW-139	M / Q	Q / SA	RW-31	W
MW-140	M / Q	Q / SA	RW-32	W
MW-142	M / Q	Q / SA		
MW-143	M / Q	Q / SA		
MW-144	M / Q	Q / SA		
MW-145	M / Q	Q / SA		
MW-146	M / Q	Q / SA		

Legend

- Gauge (W)
- Gauge (M/Q)
- Gauge (M/Q), Sample (Q/SA)
- Modelled extent of clean water injectate
- Modelled extent of treated groundwater injectate

W = weekly while system operating
M / Q = monthly until stable, then quarterly
Q / SA = quarterly for one year, then semiannually

Path Forward

- Establish current water quality baseline conditions beneath Agricultural field – East using dissolved phase samples collected during recent semiannual monitoring events
- Confirm permitting requirements for injection galleries
  - Establish water quality standards for each injection gallery
  - Establish analytical requirements for monitoring and reporting frequency
- Evaluate potential sources of clean water to inject in RW-9, RW-10, and RW-18 for zero water rights balance (such as City of Artesia treated wastewater for reuse), and establish appropriate analytical requirements and compliance standards
- Revise groundwater recovery system engineering design based on preliminary agency approval of revised configuration, monitoring plan, and permit

Q&A

Chavez, Carl J, EMNRD

From: Chavez, Carl J, EMNRD
Sent: Tuesday, December 6, 2016 2:06 PM
To: Tsinnajinnie, Leona, NMENV
Cc: Griswold, Jim, EMNRD
Subject: RE: Artesia Refinery (GW-028) DRAFT Pump Test letter report
Attachments: Pump Test Letter Report-draft_Part 1.pdf; Pump Test Letter Report-draft_Part 2.pdf

Leona:

Received. It would appear that the draft was issued to address NMED's letter with concerns from the work plan.

OCD will abstain from comment in order to allow NMED and HF to address or resolve NMED concerns raised in its letter. OCD does not want to create any additional iterations back and forth on the final report until the final version is submitted to the agencies.

COD will review in consideration of receipt and review of the final report.

Thank you.

From: Tsinnajinnie, Leona, NMENV
Sent: Tuesday, December 6, 2016 11:51 AM
To: Chavez, Carl J, EMNRD <CarlJ.Chavez@state.nm.us>
Subject: DRAFT letter report

You have received 2 secure files from leona.tsinnajinnie@state.nm.us.
Use the secure links below to download.

Carl-

I'm sorry. I forgot that the draft report was two parts. I didn't mean to forward the Work Plan.

This is just a DRAFT report.

Thanks,
Leona

Secure File Downloads:

Available until: **20 December 2016**

Click links to download:

Pump Test Letter Report-draft_Part 2.pdf
5.14 MB, Fingerprint: 1b6d9f3388521693455cf797353883ed (What is this?)

Pump Test Letter Report-draft_Part 1.pdf
6.26 MB, Fingerprint: 3463d1e7e7176cf1422313df13d9e6e0 (What is this?)

November 10, 2016

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

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

Dear Gary and Robert:

Amec Foster Wheeler Environmental & Infrastructure, Inc. (Amec Foster Wheeler) has prepared this letter report to describe the activities associated with the pump tests conducted at the HollyFrontier Navajo Refining LLC (Navajo) refinery in Artesia, New Mexico (**Figure 1**). The pump tests were 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. This letter report summarizes the information obtained for the calibration and execution of the existing groundwater model, which will be used to assist in the design of a reinjection option for the existing groundwater recovery system.

1.0 Background

There is a known PSH plume on shallow groundwater that extends eastward from the refinery fenceline beneath an agricultural field owned by Navajo. There are also 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 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

Amec Foster Wheeler Environment & Infrastructure, Inc.
585 North Dairy Ashford
Houston, Texas 77079
Tel: 713-929-5000
amecfw.com

2015[iii]. The investigation confirmed the extent of subsurface sands to sandy gravels as well as the presence of channels of more porous material (gravels) that create preferential flowpaths for contaminant transport. The preferential flowpaths are oriented primarily in a west-to-east pattern within the subsurface, emanating from the southeastern portion of the refinery toward Bolton Road. The investigation report included recommendations to install additional recovery wells within the preferential flowpaths 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) reviewed the plugging plan for the former recovery wells along Bolton Road (RW-12, RW-13, RW-14) and determined that the revised operation of the remediation system would require additional shallow water rights. At that time, discussion about potential reinjection of recovered groundwater was initiated to conserve shallow groundwater. Shortly thereafter, a feasibility study was performed 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 continued to discuss 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.

The pump tests were conducted to obtain the additional information required to complete the basic design of the reinjection system.

1.1 Field Activities

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

1.1.1 Pump Test Locations

In order to measure transmissivity in various areas of interest, pump tests were performed utilizing six of the existing recovery wells. The groundwater levels were measured manually in the pumping wells and observation wells prior to starting each pump test and after each pump test was completed. Groundwater levels were measured continually with transducers at a one second interval throughout the test. **Table 1** provides a list of the pumping/observation wells and the manual gauging data collected. **Figure 6** depicts the pumping wells and observation wells used for the pump tests and **Table 2** provides pumping times, rates, and total gallons pumped for each pump test.

The pumping and observation wells for each area are discussed in the following paragraphs.

1.1.2 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. On August 22, 2016, 0.01 ft of PSH was measured in RW-7R. A pump test was conducted at this location, utilizing RW-7R as the pumping well. Transducers were deployed in RW-7R, RW-7, MW-94, and the nearest standpipe located within the RW-7 trench. These locations provided information regarding the drawdown of the pumping well and the transmissivity within the recovery trench. The pump was started on August 22, 2016 at 13:48, and ran until August 23, 2016 at 10:27 at an average pumping rate of 13 gpm.

RW-2R is located in the northern portion of the active refinery, east of North Freeman Ave and south of Eagle Draw. On August 23, 2016, no measureable PSH was measured in RW-2R. A pump test was conducted at this location, utilizing RW-2R as the pumping well. Transducers were used to observe groundwater level responses in RW-2R, RW-2, RW-1, and the closest standpipe located within the RW-2 trench. These locations provided information regarding the drawdown of the pumping well and the transmissivity within the recovery trench. The pump test was started on August 23, 2016 at 16:50 and ran until August 24, 2016 at 12:54 at an average pumping rate of 10.58 gpm.

1.1.3 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. On August 25, 2016, 0.01 ft of PSH was measured in RW-6R. A pump test was conducted at this location, utilizing RW-6R as the pumping well. Transducers were used to observe groundwater level responses in RW-6R, RW-6, and the nearest existing standpipe located within the RW-6 trench. These locations provided information regarding the drawdown of the pumping well and the transmissivity within the recovery trench. The pump test was started on August 25, 2016 at 13:02 and ran until August 26, 2016 at 06:51 at an average pumping rate of 3.2 gpm.

1.1.4 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 agricultural 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. On August 22, 2016, 0.37 ft of PSH was measured in RW-19. A pump test was conducted at this location, utilizing RW-19 as the pumping well. Transducers were used to observe groundwater level responses in RW-19, KWB-4, and MW-99. These locations provided information regarding the drawdown of the pumping well and the transmissivity within the gravel seam in the vicinity of RW-19. The pump test was started on August 23, 2016 at 08:40 and ran intermittently until August 24, 2016 at 13:54 at an average pumping rate of 12 gpm. Although the pump did not run continuously as planned, adequate data was obtained for this evaluation.

RW-13R is located just to the west of and near the middle of the recovery trench installed along the western side of Bolton Road, north of Highway 82, and was installed in 2012 as part of the

remediation system upgrades. On August 24, 2016, 0.47 ft of PSH was measured in RW-13R. A pump test was conducted at this location, utilizing RW-13R as the pumping well. Transducers were used to observe groundwater level responses in RW-13R, RW-12R, and RW-14R. Observation wells RW-12R and RW-14R are also located immediately west of the Bolton Road recovery trenches. These locations provided information regarding the drawdown of the pumping well and the transmissivity within this recovery trench. A transducer was also placed in MW-113, which is located west of the Bolton Road trench between RW-12R and RW-13R. The pump test was started on August 24, 2016 at 17:35 and ran until August 26, 2016 at 06:51 at an average pumping rate of 7.5 gpm.

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. On August 25, 2016, 0.01 ft of PSH was measured in both RW-18A and RW-18B. One possibility being considered for the reinjection scenario is to reinject a small amount of treated groundwater outside the existing PSH plume, and this location was considered potentially feasible. Thus, a pump test was conducted at this location, utilizing RW-18A as the pumping well. Transducers were used to observe groundwater level responses in RW-18A, RW-18B, and RW-18D. These locations provided information regarding the drawdown of the pumping well and the transmissivity within this trench and nearby groundwater. A transducer was also placed in KWB-1A, the nearest monitoring well, which is located to the south and cross-gradient. The pump test was started on August 25, 2016 at 19:49 and ran until August 26, 2016 at 07:31 at an average pumping rate of 15.0 gpm.

1.2 Pump Test Methodology

All pumps associated with the remediation system were turned off on August 19, 2016, prior to conducting the pump tests, with the exception of RW-20. RW-20 continued to be operated to maintain the groundwater depth near a lined sump at an off-site facility. Measurements of the depth to PSH and/or groundwater were made in all of the pump test and observation wells before beginning any of the pump tests (**Table 1**).

The transducers were decontaminated prior to placement in each of the pumping or observation wells. The transducers were programmed to record data at one second intervals and placed in the pumping and observation wells before beginning each pump test. The transducers were retrieved and the data downloaded from each transducer at the end of each pump test.

The dedicated groundwater pumps in recovery wells RW-2R, RW-6R, RW-7R, RW-13R, and RW-19 were 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) under typical conditions (with 100 feet of head) 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 was read prior to beginning the pump test and at the end of the pump test to determine the pumping rate throughout the test and to confirm the volume of water discharged (**Table 2**).

A submersible electric pump (Grundfos Redi-Flo3) capable of pumping at a constant rate of 10 gpm with 10 feet of head pressure (anticipated conditions) was used to perform the pump test at RW-18D. Power was supplied to the pump via generator. Temporary discharge hose was attached to the submersible pump and the discharge from RW-18A was directed into a frac tank. The actual flow rate was measured using a 5-gallon bucket and stopwatch. The frac tank was emptied via vacuum truck and the produced water was disposed of at the refinery in a process wastewater sump upstream of the oil/water separator. The volume of water discharged was measured at the end of the pump test and is provided in **Table 2**.

To minimize the overall schedule for the pump tests, and sufficient distance between recovery wells to prevent interference, the pump tests were planned to be conducted in pairs. The actual dates and times the pump tests were conducted are provided in **Table 2**. At the conclusion of the pumping portion of each pump test, the pumps were turned off and the transducers were used to record the depth to PSH and groundwater for the next several hours during recharge. The transducers were then retrieved and data downloaded from each. This process was repeated for each of the pump tests. **Appendix A** contains graphs of the observed groundwater elevations based on the pressure transducer data from each pump test.

1.3 Groundwater Sampling

Samples of dissolved phase groundwater were collected from beneath the PSH layer at RW-6R before and at RW-13R before and after the pump tests at these locations. The work plan stated that samples would be collected before and after the pump test at RW-6R; however, insufficient sample containers were shipped from the laboratory to collect a fourth sample. The groundwater at these two locations is assumed to be representative of impacted groundwater beneath the PSH throughout the refinery, for the purpose of evaluating groundwater treatment system options for design of a reinjection system.

Samples were 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 were labeled with the sample identifier, date, time, and sampler collector's initials along with the analyses performed. Samples were cooled and shipped to the laboratory under appropriate chain of custody (COC). The laboratory report is included in **Appendix B**. Each sample was 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 was chosen to provide information required to design a groundwater treatment system for potential reinjection. The constituents listed above include those that have been observed in shallow groundwater samples collected in the vicinity of the refinery as part of the semiannual facility-wide groundwater monitoring program at concentrations above the regulatory screening levels. Additional constituents were included in the analytical suite that are required for wastewater treatment design (such as COD, TSS, and total sulfide). At this time, the target 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.

Table 3 provides a summary of the analytical data collected during the pump tests. **Table 3** also provides a summary of concentrations of contaminants of concern from monitoring wells located in the vicinity of the recovery trenches obtained from the annual groundwater monitoring reports from 2013 through 2015 along with the maximum, minimum, and average concentrations for each of the two primary areas. The maximum concentrations have been compared to the Water Quality Control Commission (WQCC) standards, both current and proposed future standards.

It should be noted that the range of concentrations presented in **Table 3** is not, and is not expected to be, a comprehensive summary of data from the refinery area wells, but is considered representative of typical concentrations that may require treatment prior to reinjection. The allowable concentration limits for reinjection will be negotiated as part of the permitting process and will be dependent on the area in which reinjection occurs.

2.0 Pump Test Analysis

Data from the pump tests described above were analyzed using the finite-difference numerical groundwater flow model MODFLOW-SURFACT[iv] (MODFLOW). Traditional analytical methods for pump test analyses (e.g., type-curve matching) were not used because all but one of the tests were conducted by pumping from recovery wells located in or immediately adjacent to

PSH recovery trenches. Flow to and around these trenches is not conducive to pump test analysis considering analytical, axisymmetric solutions for flow to a single well.

Analysis of the pump test flow and pressure responses was performed in five steps:

1. Setup a large domain groundwater flow model encompassing the site and including a buffer zone outside the area of influence of the groundwater recovery system. This model has the following general features:
   a. Single-value hydraulic conductivity and storage parameters as follows:
      i. Horizontal hydraulic conductivity (K_x) = 30 feet/day (ft/d)
      ii. Vertical hydraulic conductivity (K_z) = 3 ft/d
      iii. Porosity (n) = 0.33
      iv. Effective Porosity/Specific Yield (S_y) = 0.175
      v. Specific Storage (S_s) = 1 x 10^{-5}
   b. Specified constant head boundaries at the perimeter of the model based on an extrapolation of the November 2014 groundwater gauging data.
   c. Three model layers based on the site topography, groundwater elevations from November 2014, and an assumed saturated thickness of 25 feet.
2. Excise a portion of the large-domain model using the telescopic mesh refinement (TMR) tool in Groundwater Vistas software[v] to generate a refined grid model around each pump test. The boundary conditions, layer geometry, and initial conditions (groundwater heads) for each of these submodels was established in the large domain model.
3. Develop the submodels including placement of trenches (using K- and S-zones), wells and targets (using analytical elements), and transient periods (pumping and recovery times).
4. Set upper and lower boundaries for parameters of interest (K_x, K_z, S_y, and S_s) for each material type (trench and formation) using the parameter estimation tool (PEST) within Groundwater Vistas.
5. Estimate the parameters of interest using PEST and the target pressure response curves (submersible pressure transducer results).

As noted in step 1b, a constant head boundary was determined using select groundwater gauging data from November 2014 (**Table 4**). The data was selected as being representative of "ambient" conditions in wells not affected by pumping or PSH presence. Thus, the groundwater surface modeled represents ambient, steady state conditions.

2.1 Large Domain Model Setup

The setup of the large domain groundwater flow model from which pump test submodels were excised, using TMR, is described in the sections below.

2.1.1 Domain and Grid

The domain and grid of the large domain model is shown in **Figure 7**, along with potentiometric curves based on the November 2014 gauging data. The lower left hand corner or origin of the

model is located at site coordinates x=517,000 feet and y=665,000 feet. The model is 16,000 feet wide (west to east) and 14,000 feet tall (south to north) with 140 rows and 160 columns resulting in cells that are 100 feet by 100 feet.

2.1.2 Layering

The large domain model is divided vertically into three layers:

- Layer 1 (L1) is the top of L1 conforms to the land surface topography while the bottom of L1 is located 15 feet below the November 2014 groundwater potentiometric surface. Groundwater levels from 35 select wells as shown in **Table 4**.
- Layer 2 (L2) is 5 feet thick and immediately below the bottom of L1.
- Layer 3 (L3) is 5 feet thick and is immediately below L2. The bottom of L3 is the bottom of the model.

2.1.3 Boundary Conditions for Ambient Groundwater Flow

The perimeter cells of the large domain model contain constant head (CHD) boundary conditions equal to the ambient groundwater potentiometric surface. The boundary cell CHD values were determined using SURFER[vi] surface modeling software to interpolate and extrapolate potentiometric surface elevations using the same spacing as the model grid.

2.2 Telescopic Mesh Refinement

Submodels for each pump test were excised from the large domain model using the Groundwater Vistas tool TMR. The sections below describe the process for submodel development. Each submodel was first simulated as steady-state, without pumping, to establish initial heads. Well and trench construction information were added to the model along with transient stress periods based on the pump test information. Drawdown targets from submersible pressure transducer results were added to the models and the models were run in PEST to estimate conductivity and storage factors for each pump test area.

2.2.1 Domains and Boundary Conditions

Review of pressure data from each pump test was used to establish a sufficient model area for each pump test submodel. Using the TMR tool, each submodel domain was excised from the large domain model. Submodel domains ranged in size from 1,200 feet by 1,200 feet up to 2,500 feet by 2,500 feet. Grid cell sizes in the submodels were set at 2.22 feet by 2.22 feet.

The large domain groundwater potentiometric surface data was used to set CHD boundary conditions along the each submodel perimeter. Initial heads in each model were established based on the submodel perimeter CHD boundary conditions and the steady state (no pumping) simulation of the submodel.

2.2.2 Conductivity and Storage Zones

Recovery trenches were placed in each model using MODFLOW property zones for conductivity and storage. Trench depths were set using the three layers described for the large domain model, with shallower trenches extending to the bottom of L1 and deeper trenches extending to the bottom of L2. No trenches extended to the bottom of model (L3).

2.2.3 Well and Target Analytical Elements

Recovery wells, monitoring wells, and recovery trench standpipes were placed in the submodel domains based on their site coordinates and well screen elevations. Transient pumping times and rates from the pump tests were added to recovery (extraction) well analytical elements.

Transient data targets, consisting of drawdown data observed during each pump test and at each extraction and observation well, were added to the submodels as additional analytical elements at their respective locations, with the exception of RW-13R.

The RW-13R pump test was initiated at approximately 17:30 on August 24, 2016; however, the transducers stopped recording measurements at approximately midnight on August 25, 2016. The pump in RW-13R was turned off at approximately 13:00 on August 25, 2016 at which time, the lack of readings on the transducers was discovered. The data was recovered from the transducers, the transducers were re-programmed and the pump test was restarted at approximately 17:40 on August 25, 2016 and was run until approximately 06:50 on August 26, 2016. The drawdown and recovery curves in the pumping and observation wells were inconsistent with the expected response to an interrupted pump test; thus, the data from the RW-13R pump test was deemed unusable and was excluded from the modeling.

2.3 Parameter Estimation and Results

Transient simulations of the submodels were run to estimate conductivity and storage terms for the formation and trench materials using PEST. PEST was used to run the pump test submodels to seek out the best fit parameters to match the measured (target) drawdown data. PEST runs a model iteratively, analyzes the statistical difference between the model results and the target data, adjusts parameters based on that statistical difference, then reruns the model repeatedly until the model parameters have reached a best fit to the target data. PEST ran between 94 and 188 simulations of each of the submodels in order to determine the best-fit values for each of the material parameters.

In the submodels containing trench and formation material four parameters (K_x, K_z, S_y, and S_s) were estimated for both the trench and the formation. Thus, for all but the RW-19 submodel (no trench), a total of eight parameters were determined. The modeled drawdown curves using the best fit parameters for each pump test are shown graphed against actual observed drawdown curves in **Appendix C**. **Table 5** provides a summary of the final parameters for each submodel. The values for the trenches are designated as K_{xt}, K_{zt}, S_{yt}, and S_{st} and the values for the formation are designated as K_{xf}, K_{zf}, S_{yf}, and S_{sf}.

3.0 Sitewide Design Evaluation Model

The parameters determined from the submodels were used to update the large domain model and a sitewide design evaluation model was developed to simulate recovery and capture and/or containment of groundwater in the shallow saturated zone.

3.1 Sitewide Design Evaluation Model Setup

The setup of the sitewide design evaluation model from which steady state recovery and capture and/or containment simulations were conducted as described below.

3.1.1 Telescopic Mesh Refinement

The sitewide design evaluation model was excised using TMR from the large domain model and includes the refinery, the agricultural field east of the refinery, and the pecan orchard to the east of Bolton Road.

3.1.2 Domain and Grid

The lower left-hand corner or origin of the model is located at site coordinates x=519,900 feet and y=668,000 feet. The model is 10,000 feet wide (west to east) and 8,000 feet tall (south to north) and is divided into cells that are 10 feet by 10 feet, resulting in 800 rows and 1000 columns.

3.1.3 Layering

The sitewide design evaluation model is divided into three layers consistent with the large domain and pump test submodels.

3.1.4 Boundary Conditions

The sitewide design evaluation model has CHD boundary conditions taken from the TMR and refined to the 10-foot grid spacing using the SURFER analysis of the November 2014 groundwater gauging data.

3.2 Conductivity and Groundwater Head Pilot Points

The conductivity of the formation in the sitewide design evaluation model was established using a two-step process:

1. The pump test results and ambient groundwater potentiometric surface data was added to the model as pilot points, and a formation conductivity matrix was interpolated across the domain using the kriging function of PEST.
2. The resulting matrix of hydraulic conductivities over the sitewide design evaluation model domain was augmented based on mapping provided in the CME Report.

A detailed description of these steps is provided below.

3.2.1 Parameter Estimation for Conductivity Matrix

The variation in formation hydraulic conductivities (horizontal and vertical) over the extent of the sitewide design evaluation model was estimated using pilot points and PEST. Pump test results were placed in the model as hydraulic conductivity pilot points (one for horizontal and one for vertical) at each of the pump test wells and trenches. Next, groundwater potentiometric surface pilot points from the 35 select wells (**Table 4**) were placed in the model. The model was then run to establish a matrix of horizontal and vertical hydraulic conductivities conforming to the ambient groundwater surface and the pump-test results. The resulting matrix was exported from Groundwater Vistas for augmentation, which is described in the section below.

3.2.2 Augmenting the Conductivity Matrix

Preferential pathways (e.g., gravel seams) and low-conductivity zones (e.g., clay lenses) were mapped as part of the CME Report. These features were added to the sitewide design evaluation model hydraulic conductivity matrices (K matrix) using SURFER, as follows:

- The horizontal and vertical K matrices exported from the pilot point PEST model were converted into a coordinate data file (x, y, K_x, K_z).
- Breaklines coinciding with the centerlines of the preferential pathways were developed. K_x and K_z values along the centerlines were set to five times the highest nearby K_x and K_z values from the PEST model.
- Blanking files composed of polygon coordinate files were used to set low conductivity (clay) zones defined in the CME Report. This was accomplished by setting the conductivity values in each area to one-fifth of the surrounding K values.

The resulting, augmented K matrices were then reloaded into each layer of the sitewide design evaluation model. This model was used to simulate four recovery/containment scenarios described in the sections below.

3.3 Remediation Scenario Steady-state Simulations and Particle Tracking Analysis

Four remediation scenarios were simulated using the sitewide design evaluation model. Steady state pumping rates were established for each scenario such that maximum drawdown (inlet of pump) in each recovery well/trench was obtained. Forward particle tracks from the upgradient (western, southwestern, and northwestern) edges of the model and around injection trenches were then simulated using MODPATH[vii]. Each scenario is described below.

3.3.1 Existing Recovery Wells

Twelve existing recovery wells that have historically or currently contained PSH were included in this simulation. The total pumping rate from these wells was estimated at 78.5 gallons per minute (GPM) or approximately 127 acre-feet per year (AFY).

Figure 8 depicts the results of the particle tracking at steady state pumping for the 12 existing wells. The flow rate of each recovery well is shown in the table included in **Figure 8**.

The particle. tracks indicate that recovery and capture of the PSH present in the northwestern and western portions of the site appears to be sufficient. However, there are some particle tracks that escape to the east of Bolton Road, past the RW-12, RW-13, and RW-14 trenches. Additionally, based on particle paths, there is not sufficient recovery or capture within the PSH plume between RW-19 and Bolton Road.

3.3.2 Existing Recovery Wells with Proposed Wells from CME Report

The second simulation included the 12 existing recovery wells considered in the Existing Recovery Wells simulation described above along with 4 additional recovery wells. The locations of these additional wells include the three locations discussed in the CME Report as well as a location west of MW-65 within the southeastern portion of the refinery. The total pumping rate from these wells was estimated at 111 GPM or approximately 179 AFY.

Figure 9 depicts the results of the particle tracking at steady state pumping for the 12 existing wells and the 4 additional wells. The flow rate of each recovery well is shown in the table included in **Figure 9**.

Similar to the Existing Recovery Wells simulation, the particle tracks indicate that recovery and capture of the PSH present in the northwestern and western portions of the site appears to be sufficient. However, there are some particle tracks that escape to the east of Bolton Road, past the RW-12, RW-13, and RW-14 trenches. The additional recovery wells increase the capture zones between RW-19 and Bolton Road; however, there are still some particle tracks that extend east of Bolton Road.

3.3.3 Existing Recovery Wells with Revised Proposed Well Locations

The third simulation included the 12 existing recovery wells considered in the Existing Recovery Wells simulation described above along with 6 additional recovery wells. The locations of these additional wells include the a location west of MW-65 within the southeastern portion of the refinery, three wells within the preferential pathways east of the refinery fence, and two additional wells along the RW-14 trench. The total pumping rate from these wells was estimated at 140 GPM or approximately 226 AFY.

Figure 10 depicts the results of the particle tracking at steady state pumping for the 12 existing wells and the 6 additional wells. The flow rate of each recovery well is shown in the table included in **Figure 10**.

Similar to the first two simulations, the particle tracks indicate that recovery and capture of the PSH present in the northwestern and western portions of the site appears to be sufficient. The revised locations of recovery wells east of the refinery fence and two additional wells along the RW-14 trench show increased capture in the southeastern plume area, with few particle tracks escaping to the east of Bolton Road. The particle tracks that extent to the east of Bolton Road in this simulation are from areas that have shown little to no PSH.

3.3.4 Existing Recovery Wells with Revised Proposed Well Locations with Injection Trenches

The fourth simulation included the 12 existing recovery wells and 6 additional recovery wells included in the simulation "Existing Recovery Wells with Revised Proposal Well Locations". In addition to the 18 recovery (extraction) wells, 3 injection locations were added to this simulation, as follows:

1. RW-15, an existing trench located near the southeastern corner of the refinery
2. A new trench located at the western edge of the facility, upgradient of the PSH impact, in the parking area just north of the southwestern railcar loading facility.
3. A new trench located through the agricultural field east of the refinery, north of the training center parking area, extending from near RW-19 to just north of KWB-6.

The total extracted groundwater rate from these wells was estimated at 140 GPM or approximately 226 AFY. The total injected water flow rate was estimated at 107.5 GPM or approximately 173 AFY. The extracted to injected water ratio is approximately 0.77; or, for each gallon of groundwater extracted 0.77 gallons of recovered groundwater is treated and reinjected to the shallow water bearing zone.

Figure 11 depicts the results of the particle tracking at steady state pumping for 18 recovery wells (12 existing wells and the 6 additional wells) with injection trenches. The black particle track lines indicate the forward particle tracks for particles released at the upgradient (western, southwestern, and northwestern) boundaries while the red particle track lines model the flow of injected treated groundwater at the injection trench locations. The flow rate for each recovery well and for the injection trenches is shown in the table included in **Figure 11**.

In this simulation, recovery of the PSH present in the northwestern and western portions of the site appears to be sufficient. Active recovery within the eastern half of the PSH body between RW-19 and Bolton Road is greatly improved compared with the previous three simulations. The injected water drives PSH (and dissolved phase constituents in groundwater) to recovery locations with shorter pathways, higher saturations of cleaner water, and at a greater gradient.

4.0 Conclusion and Recommendations

The pump tests were completed generally following the plans outlined in the Pump Test Work Plan. The data obtained has been used to update the groundwater model and develop a model capable of evaluating locations for recovery and injection points to optimize the design of upgrades to the recovery system.

Four scenarios were modeled to determine an approach for recovery and reinjection that will maximize capture of PSH and dissolved phase constituents. Based on the model results, it is recommended that recovery includes pumping at the existing 12 recovery wells that have historically had or currently have PSH present and at 6 new recovery well locations (**Figure 11**). Furthermore, a portion (approximately 77 percent) of the recovered groundwater should be treated for reinjection at three locations: RW-15, a new trench in the southwestern portion of the

refinery, and a new trench in the agricultural field east of the refinery. The recovery and reinjection should provide more efficient capture and control of the known PSH and dissolved phase plumes.

Basic design of a treatment system for the recovered groundwater prior to reinjection is currently underway and will be reported separately.

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

David R. Hoffman, P.E.
Vice President

c: Peter Guerra

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3 – Trench and Recovery Well Locations
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1 – Gauging Data
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5 – Aquifer Characteristics

Appendices:

A – Pump Curve for Groundwater Pumps
B – Pump Test Groundwater Elevations
C – Laboratory Report
D – Modeled and Observed Drawdown Curves

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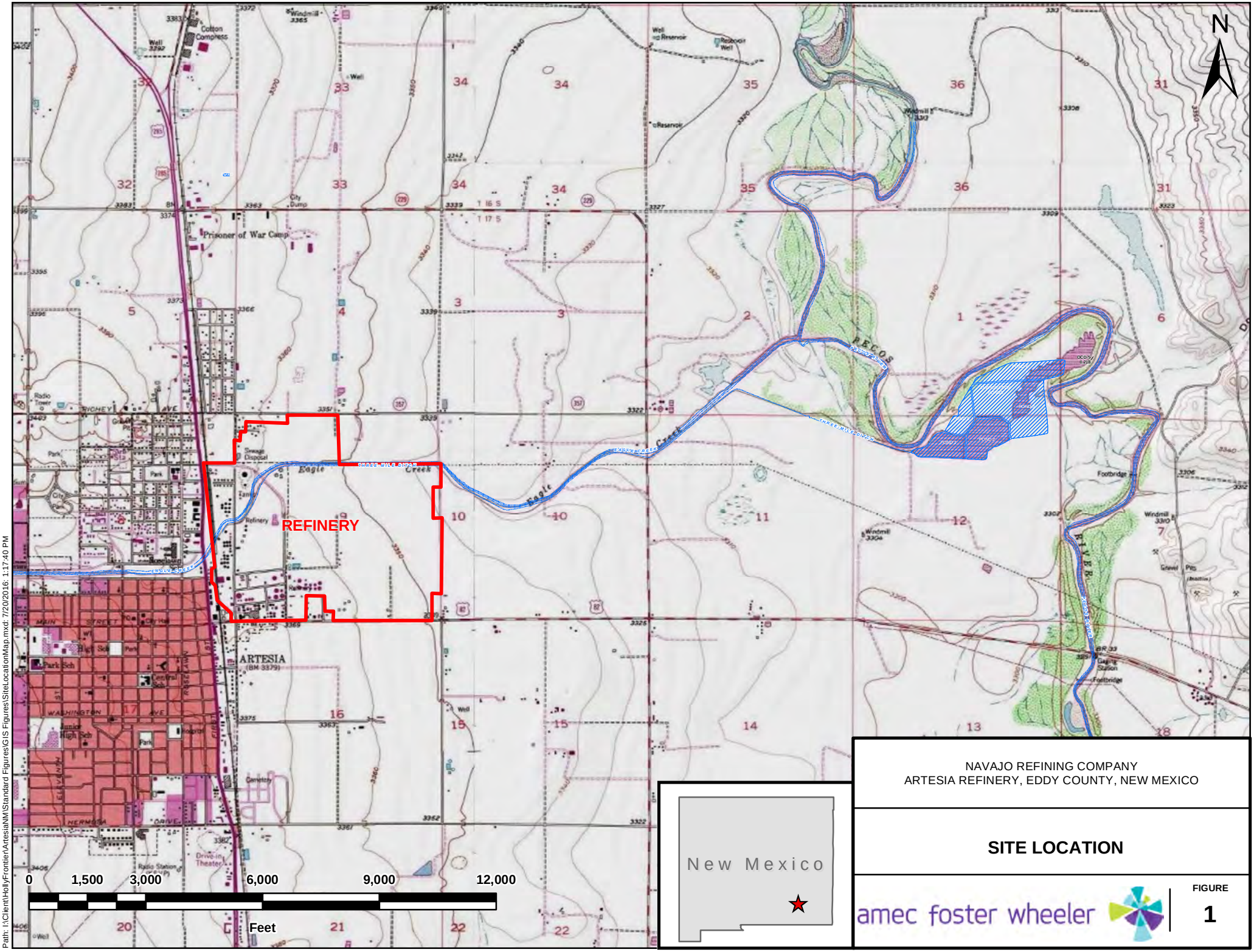
FIGURES



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SITE LOCATION

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FIGURE
1

Legend

- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCH

Abbreviations

TEL = TETRA ETHYL LEAD

NCL = NORTH COLONY LANDFARM

N

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

Feet

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WELL LOCATIONS

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FIGURE 2

DB: C RICHARDS PM: P KRUEGER Project (Project #) 6703160025
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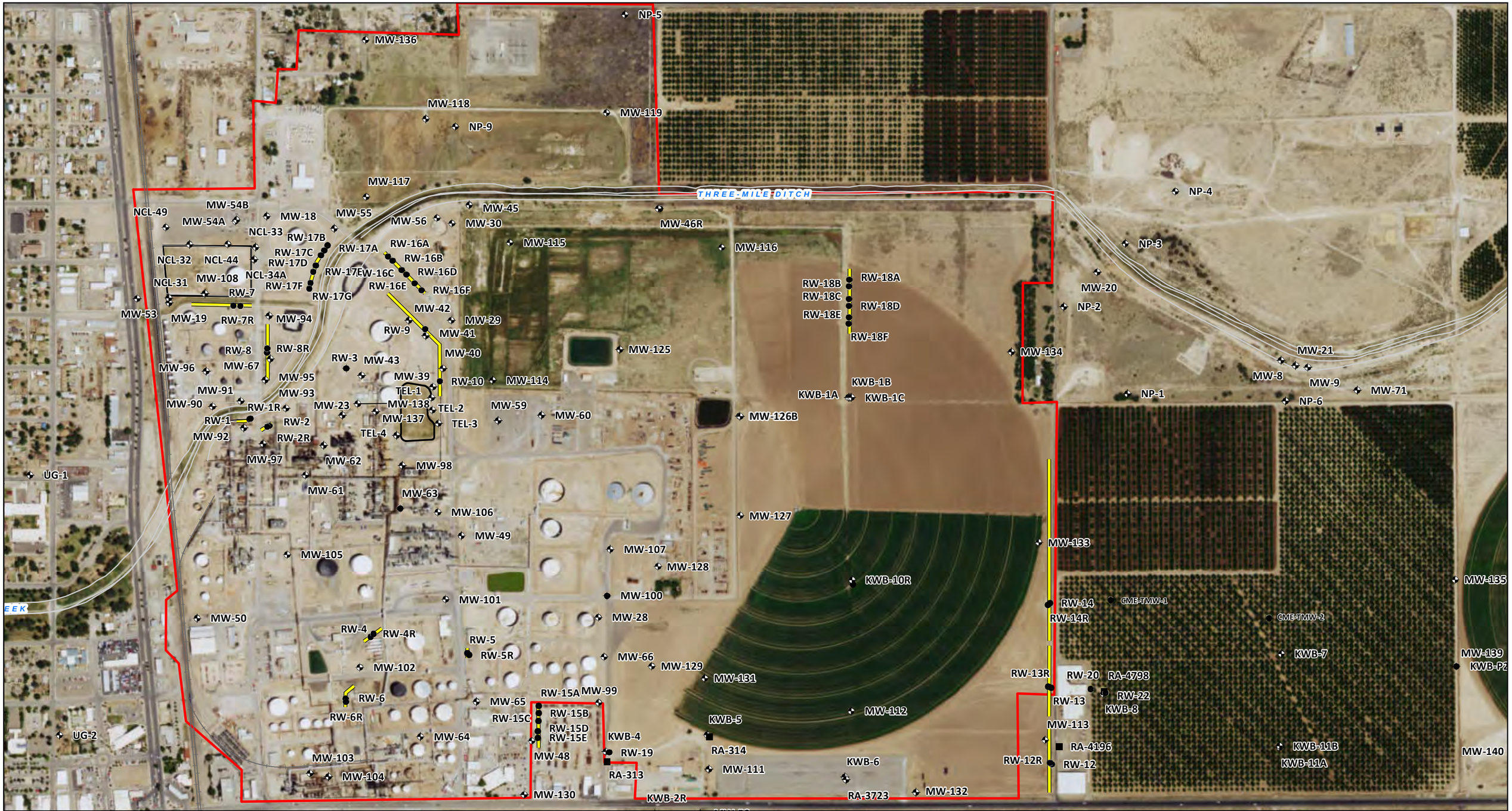


Legend

- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCH

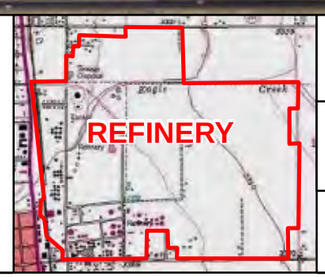
Abbreviations

TEL = TETRA ETHYL LEAD

NCL = NORTH COLONY LANDFARM

N

0 300 600 1,200 1,800 Feet



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TRENCH AND RECOVERY WELL LOCATIONS

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FIGURE 3

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Notes

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

Abbreviations

TEL = TETRA ETHYL LEAD
NCL = NORTH COLONY LANDFARM
IP = INDUCED POLARIZATION

THREE-MILE-DITCH

CREEK

Legend

- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCH
- INTERPRETED PREFERENTIAL FLOWPATHS INFERRED FROM IP RESPONSES
- EXTENT OF SAND AND GRAVEL CHANNELS

N

0 350 700 1,400 2,100 Feet

REFINERY

NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

SAND AND GRAVEL CHANNELS AND PREFERENTIAL FLOWPATHS

amec foster wheeler

FIGURE 4

\\HOU4-FS4\Deptdata\Client\HollyFrontier\ArtesiaNM\Standard Figures\GIS Figures\Pump Test Report\Figure4_SandGravelPrefPath11x17.mxd

Notes

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

Abbreviations

TEL = TETRA ETHYL LEAD
NCL = NORTH COLONY LANDFARM
IP = INDUCED POLARIZATION

THREE MILE DITCH

MW-118 MW-119 NP-9 MW-54A MW-54B MW-55 MW-18 NCL-44 NCL-33 MW-117 MW-56 NCL-49 RW-17A RW-17B MW-45 MW-30 MW-46R RW-17C RW-16A MW-115 MW-116 NP-3 NCL-32 RW-17D RW-16B RW-16C NCL-34A RW-17F RW-16D NCL-31 RW-17G RW-16E RW-16F RW-7 RW-17E RW-18B RW-18A RW-18C RW-18D RW-18E RW-18F MW-20 NP-2 MW-53 MW-19 RW-7R MW-94 MW-42 MW-29 MW-108 RW-9 MW-41 RW-8R MW-96 RW-8 MW-125 MW-134 MW-21 MW-67 RW-3 MW-43 MW-40 MW-8 MW-9 MW-71 RW-1R MW-91 MW-95 MW-39 RW-10 MW-114 KWB-1B KWB-1A KWB-1C NP-1 NP-6 MW-90 MW-93 MW-138 TEL-1 TEL-2 MW-59 MW-60 MW-126B RW-1 RW-2 MW-137 MW-23 TEL-4 TEL-3 MW-92 RW-2R MW-98 UG-1 MW-97 MW-62 MW-61 MW-63 MW-106 MW-127 MW-49 MW-133 MW-105 MW-107 MW-128 KWB-10R MW-135 MW-101 MW-100 RW-14 RW-14R CME-TMW-1 MW-50 MW-28 CME-TMW-2 RW-4 RW-4R RW-5 RW-5R MW-66 KWB-7 MW-139 MW-102 MW-129 MW-131 KWB-P2 MW-65 RW-15A MW-99 RW-13R RW-20A-4798 RW-6 RW-13 RW-22 KWB-8 RW-6R RW-15B MW-112 RW-15C KWB-5 MW-113 UG-2 RW-15D RW-15E KWB-4 RA-4196 KWB-11B MW-140 MW-103 MW-64 MW-48 RW-19 RA-314 KWB-6 RW-12R RW-12 KWB-11A MW-104 RA-313 MW-111 MW-130 RA-3723 MW-132 KWB-2R MW-110 MW-109 MW-52 MW-58 RW-11-8 RW-11-7 RW-11-5 RW-11-6 RW-11-4 RW-11-3 KWB-3AR RW-11-2 RW-11-1 MW-57 KWB-9 RA-1227 KWB-13 KWB-12A KWB-12B

Legend

- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCH
- INTERPRETED PREFERENTIAL FLOWPATHS INFERRED FROM IP RESPONSES
- EXTENT OF SAND AND GRAVEL CHANNELS
- 2015 PSH EXTENT IN SHALLOW SATURATED ZONE
- 2014 PSH EXTENT IN SHALLOW SATURATED ZONE
- REFINERY BOUNDARY

N

0 350 700 1,400 2,100 Feet

REFINERY

NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

PSH EXTENT IN SHALLOW SATURATED ZONE

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FIGURE 5

\\HOU4-FS4\Deptdata\Client\HollyFrontier\ArtesiaNM\Standard Figures\GIS Figures\Pump Test Report\Figure5_PSH11x17.mxd

MW-54B
MW-55
MW-18
NCL-44
NCL-33
MW-117
MW-56
NP-4
NCL-49
RW-17A
MW-45
MW-46R
RW-17B
MW-30
RW-17C
RW-16A
MW-115
MW-116
NP-3
NCL-32
RW-17D
RW-16B
NCL-34A
RW-17F
RW-16C
NCL-31
RW-16D
RW-17G
RW-16E
RW-18B
RW-18A
MW-20
RW-7
RW-17E
RW-16F
RW-18C
MW-53
RW-18D
NP-2
MW-19
RW-7R
MW-94
MW-42
MW-29
RW-18E
MW-108
RW-9
MW-41
RW-18F
RW-8R
MW-96
RW-8
RW-3
MW-43
MW-125
MW-134
MW-67
MW-40
MW-95
MW-39
RW-1R
MW-91
RW-10
MW-114
KWB-1B
MW-93
MW-138
TEL-1
KWB-1A
KWB-1C
NP-1
MW-90
TEL-2
RW-1
MW-137
MW-60
MW-126B
RW-2
MW-59
MW-92
RW-2R
MW-23
TEL-4
TEL-3
UG-1
MW-98
MW-62
MW-97
MW-63
MW-61
MW-106
MW-127
MW-49
MW-133
MW-105
MW-107
MW-128
KWB-10R
MW-101
MW-100
RW-14
RW-14R
MW-50
MW-28
RW-4
RW-4R
RW-5
RW-5R
MW-66
MW-102
MW-129
MW-131
RW-13R
RW-20A-4798
MW-65
RW-15A
MW-99
RW-22
RW-13
RW-6
KWB-8
RW-6R
RW-15B
MW-112
RW-15C
KWB-5
RW-15D
MW-113
UG-2
RW-15E
KWB-4
RA-4196
RW-19
RA-314
RW-12R
RW-12
MW-103
MW-64
MW-48
KWB-6
MW-104
MW-111
RA-313
MW-132
MW-130
RA-3723
KWB-2R
MW-110
MW-109
MW-52
RW-11-8

Legend

- PUMPING WELL
- RECOVERY WELL
- OBSERVATION WELL
- TRENCH
- ABANDONED WELL
- REFINERY BOUNDARY
- IRRIGATION WELL
- MONITORING WELL

N

0 250 500 1,000 1,500 Feet

REFINERY

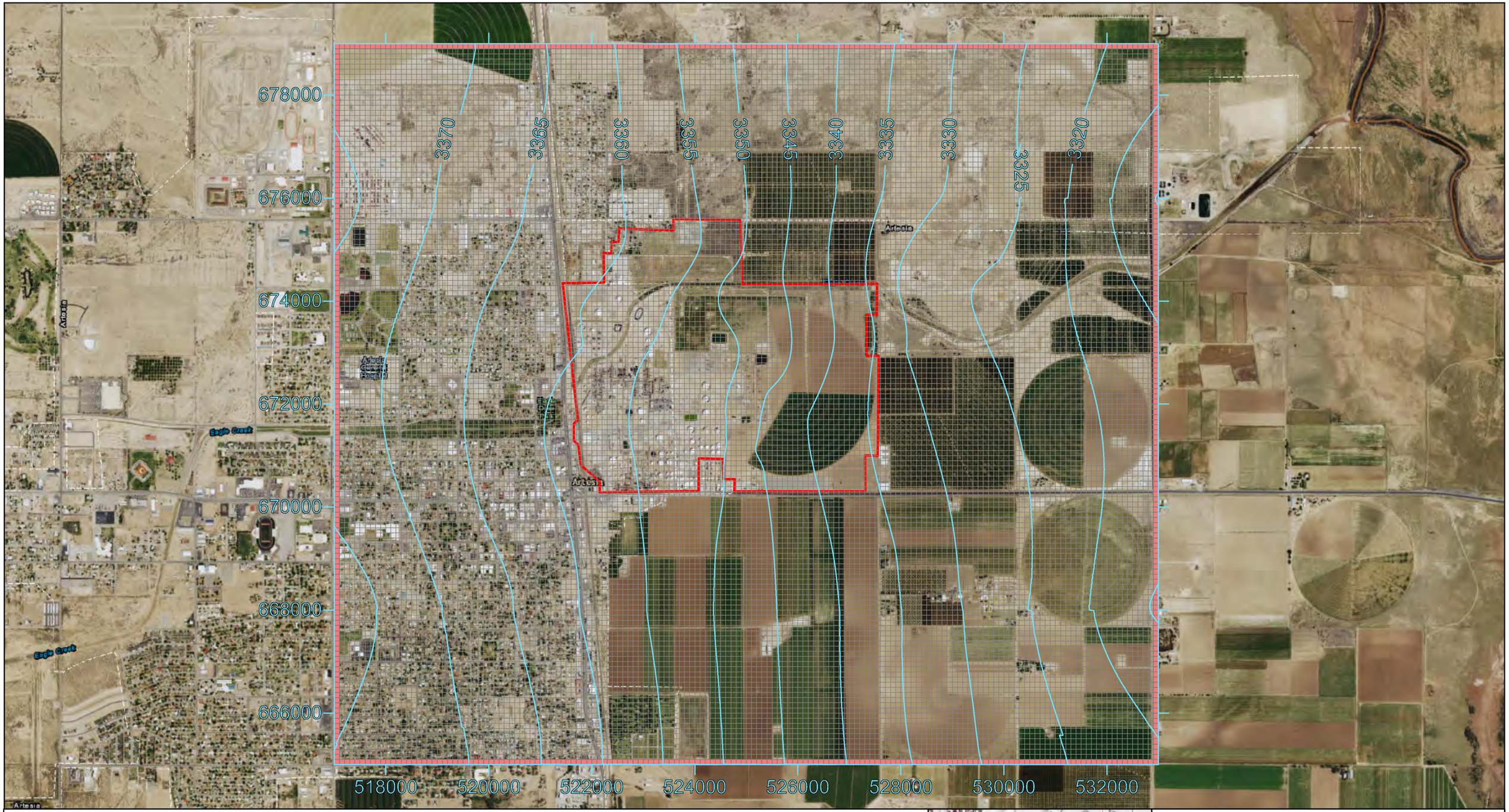
NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

PUMP TEST PUMPING AND OBSERVATION WELL LOCATIONS

amec foster wheeler

FIGURE 6

\\HOU4-FS4\Deptdata\Client\HollyFrontier\ArtesiaNM\Standard Figures\GIS Figures\Pump Test Work Plan_Figure6_PumpTransLocs11x17.mxd

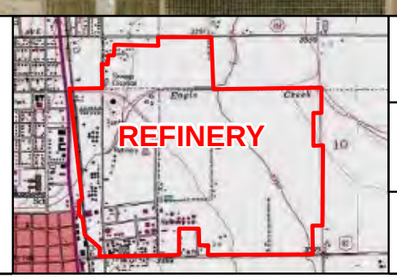


Legend

- GROUNDWATER CONTOURS
- MODEL GRID
- BOUNDARY CONDITIONS/CONSTANT HEAD CELLS
- REFINERY BOUNDARY

N

0 875 1,750 3,500 5,250 Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

LARGE DOMAIN MODEL DOMAIN AND GRID

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FIGURE 7

I:\Client\HollyFrontier\ArtesiaNM\Standard Figures\GIS Figures\Pump Test Report\Figure 7 Grid + Extent\Figure1_Grid_11x17.mxd

Steady State Pumping Rates	
Well ID:	Gallons per Minute (GPM)
RW-1R	2
RW-2R	3
RW-4R	7.5
RW-5R	7.5
RW-6R	7.5
RW-7R	3
RW-8R	3
RW-12R	10
RW-13R	10
RW-14R	10
RW-19	5
RW-22	10

Notes

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

Abbreviations

IP = INDUCED POLARIZATION

Legend

- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCH
- 2014 PSH EXTENT IN SHALLOW SATURATED ZONE
- INTERPRETED PREFERENTIAL FLOWPATHS INFERRED FROM IP RESPONSES
- EXTENT OF SAND AND GRAVEL CHANNELS
- FORWARD PARTICLE TRACKS
- REFINERY BOUNDARY

N

0 300 600 1,200 1,800 Feet

REFINERY

NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

FORWARD PARTICLE TRACKING
12 EXISTING RECOVERY WELLS

amec foster wheeler

FIGURE 8

I:\Client\HollyFrontier\ArtesiaNM\Standard Figures\GIS Figures\Pump Test Report\Figure 8 Existing Wells\Figure1_ExistingWells_11x17.mxd

Steady State Pumping Rates	
Well ID:	Gallons per Minute (GPM)
RW-1R	2
RW-2R	3
RW-4R	7.5
RW-5R	7.5
RW-6R	7.5
RW-7R	3
RW-8R	3
RW-12R	10
RW-13R	10
RW-14R	10
RW-19	5
RW-22	10
PRW-1	7.5
PRW-2	10
PRW-3	5
PRW-4	10

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

Abbreviations
IP = INDUCED POLARIZATION
CME = CONTAMINATION MIGRATION EVALUATION

Legend

- PROPOSED WELLS (CME + 1)
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCH
- FORWARD PARTICLE TRACKS
- 2014 PSH EXTENT IN SHALLOW SATURATED ZONE
- INTERPRETED PREFERENTIAL FLOWPATHS INFERRED FROM IP RESPONSES
- EXTENT OF SAND AND GRAVEL CHANNELS
- REFINERY BOUNDARY

N

0 300 600 1,200 1,800 Feet

REFINERY

NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

FORWARD PARTICLE TRACKING
12 EXISTING RECOVERY WELLS AND
4 PROPOSED WELLS

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FIGURE 9

\\HOU4-FS4\Deptdata\Client\HollyFrontier\ArtesiaNM\Standard Figures\GIS Figures\Pump Test Report\Figure 9 Existing + Proposed CME Wells\Figure2_ProposedCME_11x17.mxd

Steady State Pumping Rates	
Well ID:	Gallons per Minute (GPM)
RW-1R	2
RW-2R	2
RW-4R	7.5
RW-5R	7.5
RW-6R	7.5
RW-7R	3
RW-8R	3
RW-12R	10
RW-13R	10
RW-14R	10
RW-19	10
RW-22	10
PRW-1	7.5
PRW-2	10
PRW-3	10
PRW-4	10
PRW-5	10
PRW-6	10

Notes

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

Abbreviations

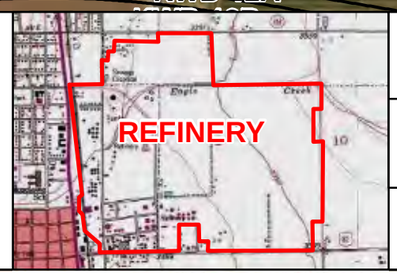
IP = INDUCED POLARIZATION
CME = CONTAMINATION MIGRATION EVALUATION

Legend

- ADDITIONAL RECOVERY WELLS
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- TRENCH
- FORWARD PARTICLE TRACKS
- 2014 PSH EXTENT IN SHALLOW SATURATED ZONE
- INTERPRETED PREFERENTIAL FLOWPATHS INFERRED FROM IP RESPONSES
- EXTENT OF SAND AND GRAVEL CHANNELS
- REFINERY BOUNDARY

N

0 300 600 1,200 1,800 Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

FORWARD PARTICLE TRACKING
12 EXISTING RECOVERY WELLS AND
6 PROPOSED WELLS

amec foster wheeler

FIGURE **10**

\\HOU4-FS4\Deptdata\Client\HollyFrontier\ArtesiaNM\Standard Figures\GIS Figures\Pump Test Report\Figure 10 Existing + Updated CME Wells\Figure3_UpdatedCME_11x17.mxd

Steady State Pumping Rates	
Well ID:	Gallons per Minute (GPM)
RW-1R	2
RW-2R	2
RW-4R	7.5
RW-5R	7.5
RW-6R	7.5
RW-7R	3
RW-8R	3
RW-12R	10
RW-13R	10
RW-14R	10
RW-19	10
RW-22	10
PRW-1	7.5
PRW-2	10
PRW-3	10
PRW-4	10
PRW-5	10
PRW-6	10
East Trench	43
West Trench	48.3
RW-15 Trench	16.2

Notes

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

Abbreviations

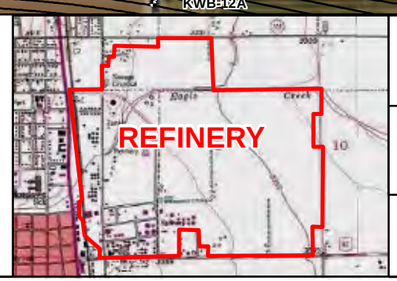
IP = INDUCED POLARIZATION
CME = CONTAMINATION MIGRATION EVALUATION

Legend

- ADDITIONAL RECOVERY WELLS
- ABANDONED WELL
- IRRIGATION WELL
- MONITORING WELL
- RECOVERY WELL
- INJECTION TRENCH
- UPGRADIENT FORWARD PARTICLE TRACKS
- INJECTED FORWARD PARTICLE TRACKS
- TRENCH
- 2014 PSH EXTENT IN SHALLOW SATURATED ZONE
- INTERPRETED PREFERENTIAL FLOWPATHS INFERRED FROM IP RESPONSES
- EXTENT OF SAND AND GRAVEL CHANNELS
- REFINERY BOUNDARY

N

0 300 600 1,200 1,800 Feet



NAVAJO REFINING COMPANY
ARTESIA REFINERY, EDDY COUNTY, NEW MEXICO

**FORWARD PARTICLE TRACKING
12 EXISTING RECOVERY WELLS, 6 PROPOSED WELLS, AND INJECTION TRENCHES**

amec foster wheeler

FIGURE 11

\\HOU4-FS4\Deptdata\Client\HollyFrontier\ArtesiaNM\Standard Figures\GIS Figures\Pump Test Report\Figure 11 Injection Particle Tracking\Figure11_InjectionFPT_11x17.mxd

TABLES

Table 1 - Gauging Data

Pump Test Report
HollyFrontier Navajo Refining LLC

	Date	Time	Depth to Product (ft btoc)	Depth to Water (ft btoc)	Total Depth (ft btoc)
RW-7R Pump Test					
RW-7R	8/22/2016	1202	10.43	10.44	36.92
	8/23/2016	1409	10.96	10.97	
RW-7	8/22/2016	1208	ND	10.14	15.80
	8/22/2016	1429	ND	11.56	
	8/23/2016	937	ND	13.57	
	8/23/2016	1408	ND	10.70	
RW-7 SP1	8/22/2016	1146	Trace	11.33	23.50
	8/22/2016	1426	ND	14.20	
	8/23/2016	938	Trace	15.44	
	8/23/2016	1410	ND	11.86	
MW-94	8/22/2016	1134	ND	11.91	23.54
	8/22/2016	1413	ND	11.83	
	8/23/2016	1405	ND	11.91	
RW-18A Pump Test					
RW-18A	8/25/2016	840	12.35	12.36	17.90
	8/25/2016	1912	ND	13.00	
RW-18B	8/25/2016	842	12.04	12.05	18.46
	8/25/2016	1914	ND	12.66	
RW-18D	8/25/2016	915	ND	12.21	17.35
	8/25/2016	1916	ND	12.16	
KWB-1A	8/25/2016	852	ND	13.23	33.54
	8/25/2016	1925	ND	13.28	
RW-13R Pump Test					
RW-13R	8/24/2016	1625	18.07	18.54	Not Collected
RW-12R	8/24/2016	1633	ND	18.45	37.46
RW-14R	8/24/2016	1651	ND	18.87	34.00
MW-113	8/24/2016	1656	17.26	17.36	37.80
RW-19 Pump Test					
RW-19	8/22/2016	1518	22.80	23.17	27.46
	8/23/2016	1455	22.49	Not Collected	
KWB-4	8/22/2016	1543	22.52	22.61	41.76
	8/23/20216	830	22.59	Not Collected	
	8/24/2016	1439	22.89	22.96	
MW-99	8/22/2016	1502	ND	15.88	27.79
RW-6R Pump Test					
RW-6R	8/25/2016	1158	13.53	13.54	34.9
RW-6	8/25/2016	1159	13.5	13.56	16.94
RW-6 SP1	8/25/2016	1206	13.12	13.12	16.5

Table 1 - Gauging Data

Pump Test Report
HollyFrontier Navajo Refining LLC

	Date	Time	Depth to Product (ft btoc)	Depth to Water (ft btoc)	Total Depth (ft btoc)
RW-2R Pump Test					
RW-2R	8/23/2016	1630	Trace	10.80	36.83
RW-2	8/23/2016	1640	ND	10.94	19.34
	8/24/2016	927	ND	14.28	
RW-2 SP1	8/23/2016	1635	ND	10.94	16.9
	8/24/2016	925	ND	13.23	
RW-1	8/23/2016	1645	ND	8.64	18.6
	8/24/2016	930	ND	8.86	

ft btoc = feet below top of casing
ND = None Detected
Trace = product visually observed, not enough to detect using interface probe

Table 2 - Pumping Data

Pump Test Report
HollyFrontier Navajo Refining LLC

	Date	Time	Flow Rate (gpm)	Total Volume (gal)
RW-7R Pump Test				
Pump On	8/22/2016	13:48		
Pump Off	8/23/2016	10:27		
Average Rate			13.0	
Total Pumped				16107
RW-18A Pump Test				
Pump On	8/25/2016	19:49		
Pump Off	8/26/2016	7:31		
Average Rate			15.0	
Total Pumped				13407
RW-13R Pump Test				
Pump On	8/24/2016	17:35		
Pump Off	8/25/2016	13:00		
Pump On	8/25/2016	18:49		
Pump Off	8/26/2016	6:51		
Average Rate			7.5	
Total Pumped				16744
RW-19 Pump Test				
Pump On	8/23/2016	8:40		
Pump Off	8/23/2016	8:50		
Pump On	8/23/2016	15:28		
Pump Off	8/23/2016	18:35		
Pump On	8/24/2016	8:46		
Pump Off	8/24/2016	13:54		
Average Rate			12.0	
Total Pumped				6060
RW-6R Pump Test				
Pump On	8/25/2016	13:02		
Pump Off	8/26/2016	6:51		
Average Rate			3.2	
Total Pumped				3421
RW-2R Pump Test				
Pump On	8/23/2016	16:50		
Pump Off	8/24/2016	12:54		
Average Rate			10.6	
Total Pumped				12738
Overall Total Volume Pumped				**68477**

Definitions:

gal = gallons
gpm = gallons per minute

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

	WQCC Limits		Northwest Refinery Area												
			RW-1	RW-2	RW-7	RW-8	MW-53			MW-67				MW-90		
Analyte	**Current**	**Proposed**	**4/17/2015**	**4/15/2015**	**4/17/2015**	**4/17/2015**	**4/9/2013**	**4/18/2014**	**4/16/2015**	**10/18/2013**	**11/13/2014**	**4/15/2015**	**10/19/2015**	**4/11/2013**	**10/21/2013**	**4/21/2014**
Water Quality Parameters (mg/L)																
Calcium	--	--	358	726	252	227	284	290	348	167	240	194	192	285	343	270
Chloride	250	250	224	365	237	115	107	95.4	1010	211	170	208	225	157	163	162
Chemical Oxygen Demand	--	--														
Fluoride	1.6	4	1.33	1.75	1.15	0.801	1.2	0.827	0.922	0.793	0.61	0.698	0.589	1.26	1.8	0.892
Hardness	--	--														
Nitrate/Nitrite	10	10	< 0.2	< 0.2	< 0.2	< 0.2	< 1.00	< 0.150	34.5	< 0.500	< 0.02	< 0.2	< 0.197	< 1.00	0.525	< 0.150
Potassium	--	--	3.57	5.55	1.88	0.353	1.06	0.935	1.16	0.461	0.59	0.531	0.533	1	1.52	0.928
Sodium	--	--	210	383	192	209	103	87.6	104	149	160	160	177	186	301	185
Sulfate	600	600	1330	3510	19	473	1080	1190	1290	180	380	329	311	1140	1650	1070
Sulfide	--	--														
Total Dissolved Solids	1000	1000	2410	5310	1500	1600	2570	2060	2810	1580	1600	1510	1450	2700	3560	2600
Total Organic Carbon	--	--														
Totatl Suspended Solids	--	--														
pH (standard units)	6 to 9	6 to 9	6.46	6.76	6.7	6.72	7.07	7.38	6.99	6.81	6.61	7.05	7.18	6.71		7.09
Total Metals (mg/L)																
Arsenic	0.1	0.01	0.00607	0.0264	0.00239	0.00556	< 0.00500	0.00217	0.00179	< 0.00500	0.0018	0.00371	0.0063	< 0.00500	0.00701	0.00439
Boron	0.75	0.75														
Chromium	0.05	0.1	0.0029	0.00553	< 0.00270	< 0.00270	< 0.00500	< 0.00100	< 0.000540	< 0.00500	0.00074	< 0.000540	0.000623	< 0.00500	< 0.00500	< 0.00100
Iron	1	1	0.216	0.381	0.0976	0.427	< 0.200	< 0.0500	0.0338	< 0.200	< 0.05	0.0384	< 0.0150	< 0.200	0.72	0.0589
Manganese	0.2	0.2	0.126	0.313	0.028	0.0556	1	0.778	1.2	0.0771	0.13	0.08	0.0785	0.0647	0.337	0.0745
Nickel	0.2	0.2								< 0.00500	0.0033	0.00198	0.000885			
Selenium	0.05	0.05	0.00302	0.0705	< 0.00190	0.002	< 0.00500	0.00141	0.00566	< 0.00500	0.014	0.000386	0.000445	< 0.00500	< 0.00500	< 0.00100
Uranium	0.03	0.03														
Vanadium	--	--								< 0.005	0.00036	0.00108	0.00164			
Total Petroleum Hydrocarbons (mg/L)																
Gasoline Range Organics	--	--	2.95	18.3	1.05					9.46	0.81	0.784	2.16	0.221	0.157	0.317
Diesel Range Organics	0.2	--	12	19.7	9.7	7.3	< 0.053	< 0.021	0.296	5.5	4.2	8.4	5.18	3.9	6.2	1.4
Oil Range Organics	0.2	--														
Volatile Organic Carbons (mg/L)																
Benzene	0.01	0.005	0.962	5.34	0.0535	0.0412	< 0.0050	< 0.00060	< 0.000330	0.19	0.14	0.143	0.172	< 0.0050	0.016	0.0035
Ethylbenzene	0.75	0.7	0.047	1.02	0.0185	0.00801	< 0.0050	< 0.00050	< 0.000380	0.051	0.005	0.00447	< 0.00768	< 0.0050	< 0.0050	< 0.00050
Isopropylbenzene	--	--	< 0.0160	0.0551	0.0362	0.0204	< 0.0050	< 0.00050	< 0.000330	0.054	0.027	0.0376	0.0301	0.037	0.027	0.027
Methyl tert-butyl ether	--	0.1	< 0.0180	< 0.00370	0.0122	2.41	< 0.0050	< 0.00060	< 0.000370	0.51	0.46	0.869	0.924	< 0.0050	< 0.0050	< 0.00060
Naphthalene	0.03	--	< 0.0500	0.157	0.0112	< 0.0100	< 0.0050	< 0.00070	< 0.00100	0.0088	0.0053	< 0.00100	< 0.0200	< 0.0050	< 0.0050	0.0025
N-propylbenzene	--	--	0.0175	0.0813	0.0441	0.00788	< 0.0050	< 0.00050	< 0.000350	0.046	0.019	0.0234	< 0.00698	< 0.0050	< 0.0050	0.0026
Toluene	0.75	1	< 0.0390	0.115	0.00396	< 0.00780	< 0.0050	< 0.00050	< 0.000780	< 0.0050	< 0.0039	0.0026	< 0.0156	< 0.0050	< 0.0050	< 0.00050
1,2,4-trimethylbenzene	--	--	< 0.0190	0.33	0.0818	0.0071	< 0.0050	< 0.00050	< 0.000370	0.029	0.005	0.00108	< 0.00746	< 0.0050	< 0.0050	< 0.00050
1,3,5-trimethylbenzene	--	--	< 0.0190	0.0772	0.000663	< 0.00390	< 0.0050	< 0.00060	< 0.000390	< 0.0050	< 0.0019	< 0.000390	< 0.00774	< 0.0050	< 0.0050	< 0.00060
Xylenes, total	0.62	10	< 0.0530	0.53	0.0367	< 0.0110	< 0.015	< 0.0015	< 0.00110	0.032	0.0084	0.00291	< 0.0212	< 0.015	< 0.015	< 0.0015
Semivolatile Organics Carbons (mg/L)																
2,4-dimethylphenol	--	--														
Acenaphthene	--	--														
Bis(2-ethylhexyl)phthalate	--	--														
Fluorene	--	--														
Naphthalene	0.03	--														
Phenol	0.005	0.005														

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Northwest Refinery Area (continued)													
	WQCC Limits		MW-90 (continued)			MW-91					MW-93					
Analyte	**Current**	**Proposed**	**11/13/2014**	**4/15/2015**	**10/19/2015**	**10/21/2013**	**4/21/2014**	**11/13/2014**	**4/15/2015**	**10/19/2015**	**4/15/2013**	**10/17/2013**	**4/22/2014**	**11/13/2014**	**4/15/2015**	**10/19/2015**
Water Quality Parameters (mg/L)																
Calcium	--	--	520	302	481	331	251	460	355	361	312	368	414	640	579	516
Chloride	250	250	160	104	22.7	37.6	29	36	32.8	35.7	85	114	173	200	221	251
Chemical Oxygen Demand	--	--														
Fluoride	1.6	4	9.3	2.73	6.77	1.37	0.933	1.3	1.4	1.34	1.24	1.66	1.16	3.1	2.23	2.37
Hardness	--	--														
Nitrate/Nitrite	10	10	4.8	< 0.2	3.44	< 0.500	< 0.150	< 0.02	< 0.2	< 1.97	< 1.00	< 0.500	< 0.150	< 0.02	< 0.0200	2.92
Potassium	--	--	3.5	1.63	2.07	0.727	0.435	1	0.523	0.686	3.21	3.52	3.11	4.7	2.58	5.23
Sodium	--	--	500	286	135	40.4	38.8	37	30.8	35	99.7	87.6	103	130	126	133
Sulfate	600	600	6200	2230	4530	529	240	830	643	854	554	795	645	1700	2050	3070
Sulfide	--	--														
Total Dissolved Solids	1000	1000	8800	3800	5130	1860	1540	2000	1980	2280	1810	2140	2130	3100	3080	3080
Total Organic Carbon	--	--														
Totatl Suspended Solids	--	--														
pH (standard units)	6 to 9	6 to 9	6.88	6.98	7.22	6.57	6.99	6.74	6.75	6.83	6.51		7.07	6.72	6.67	6.57
Total Metals (mg/L)																
Arsenic	0.1	0.01	0.011	0.00709	0.00883	< 0.00500	0.00394	0.0047	0.00509	0.00552	0.00737	0.00708	0.00671	0.003	0.00687	0.00502
Boron	0.75	0.75														
Chromium	0.05	0.1	0.00067	< 0.000540	< 0.000540	< 0.00500	< 0.00100	0.00099	< 0.000540	< 0.000540	< 0.00500	< 0.00500	0.00329	0.0065	0.00442	0.00365
Iron	1	1	0.41	0.473	1.56	< 0.200	0.117	< 0.05	0.0957	0.0165	< 0.200	0.475	0.163	3.2	1.83	1.29
Manganese	0.2	0.2	0.052	0.345	0.0504	< 0.00500	0.0045	0.026	0.00502	0.00246	0.0192	0.183	0.0471	1.3	0.227	0.12
Nickel	0.2	0.2														
Selenium	0.05	0.05	0.021	0.00172	0.0334	< 0.00500	< 0.00100	0.0098	0.0138	0.0248	< 0.00500	0.00632	0.00282	0.013	0.0646	0.0709
Uranium	0.03	0.03														
Vanadium	--	--														
Total Petroleum Hydrocarbons (mg/L)																
Gasoline Range Organics	--	--	0.21	0.242	0.166	7.89	11.9	7.9	14.7	12.2	8.99	9.74	9.9	6.5	3.67	5.14
Diesel Range Organics	0.2	--	2.3	7.68	0.992	6.9	2.9	11	15.9	20.3	6.2	10	14	11	15.3	16.5
Oil Range Organics	0.2	--														
Volatile Organic Carbons (mg/L)																
Benzene	0.01	0.005	0.015	0.0125	< 0.000331	1.5	2.2	2.5	2.91	3.47	2.1	2	1.8	1.3	0.734	1.21
Ethylbenzene	0.75	0.7	0.00039	0.000433	< 0.000384	0.046	0.15	0.17	0.491	0.449	0.05	0.12	0.067	0.039	0.0675	0.0717
Isopropylbenzene	--	--	0.012	0.0185	0.0095	0.13	0.1	0.1	0.0876	0.108	0.069	0.068	0.068	0.05	0.0425	0.0518
Methyl tert-butyl ether	--	0.1	< 0.00037	0.00575	< 0.000367	< 0.0050	< 0.0030	< 0.092	< 0.00370	< 0.00918	< 0.0050	< 0.0050	0.0059	< 0.018	< 0.00370	< 0.00367
Naphthalene	0.03	--	0.00494	0.00178	< 0.00100	0.055	0.062	< 0.25	0.049	0.0884	0.14	0.14	0.12	0.174	0.0554	0.1
N-propylbenzene	--	--	0.0038	0.00291	0.000834	0.14	0.11	0.11	0.0882	0.119	0.1	0.1	0.11	0.074	0.0625	0.0743
Toluene	0.75	1	< 0.00078	0.00194	< 0.000780	0.023	0.41	0.92	1.91	0.652	0.031	0.031	0.019	< 0.039	0.00961	0.017
1,2,4-trimethylbenzene	--	--	< 0.00037	< 0.000370	< 0.000373	0.26	0.22	0.18	0.184	0.226	0.28	0.3	0.37	0.24	0.206	0.241
1,3,5-trimethylbenzene	--	--	< 0.00039	< 0.000390	< 0.000387	0.072	0.064	< 0.097	0.0476	0.0626	0.059	0.067	0.076	0.046	0.0368	0.0414
Xylenes, total	0.62	10	< 0.0011	< 0.00110	< 0.00106	0.47	0.58	0.54	0.852	0.933	0.6	0.56	0.61	0.45	0.319	0.494
Semivolatile Organics Carbons (mg/L)																
2,4-dimethylphenol	--	--														
Acenaphthene	--	--														
Bis(2-ethylhexyl)phthalate	--	--														
Fluorene	--	--														
Naphthalene	0.03	--														
Phenol	0.005	0.005														

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Northwest Refinery Area (continued)													
	WQCC Limits		MW-94		MW-95			MW-96						MW-108		
Analyte	Current	Proposed	11/13/2014	10/19/2015	4/11/2013	4/21/2014	4/15/2015	4/11/2013	10/21/2013	4/21/2014	11/13/2014	4/15/2015	10/19/2015	4/11/2013	10/21/2013	4/17/2014
Water Quality Parameters (mg/L)																
Calcium	--	--	190	109	177	177	178	161	236	154	390	208	230	220	368	316
Chloride	250	250	230	245	207	226	275	165	195	146	220	884	190	110	154	101
Chemical Oxygen Demand	--	--														
Fluoride	1.6	4	0.59	1.01	0.569	0.56	1.02	0.693	1.15	0.606	1.8	1.19	1.23	2.24	3.01	1.58
Hardness	--	--														
Nitrate/Nitrite	10	10	< 0.02	< 0.197	< 1.00	< 0.150	< 0.2	< 1.00	< 0.500	< 0.150	< 0.02	0.211	0.202	< 1.00	< 0.500	< 0.150
Potassium	--	--	0.58	0.224	0.541	0.494	0.655	1.04	1.26	0.891	1.9	1.03	1.21	0.601	3.64	1.07
Sodium	--	--	370	355	136	143	177	232	259	234	310	224	244	58.7	168	89.3
Sulfate	600	600	240	75.8	169	160	359	332	509	286	1200	1730	583	552	1280	1130
Sulfide	--	--														
Total Dissolved Solids	1000	1000	2600	2530	1450	1440	1680	1720	2160	1750	3000	1680	1990	1870	3300	2820
Total Organic Carbon	--	--														
Totatl Suspended Solids	--	--														
pH (standard units)	6 to 9	6 to 9	6.93	7.13	6.85	7.28	6.99	6.68	6.71	7.15	6.73	7.05	6.62	6.71	6.69	7.08
Total Metals (mg/L)																
Arsenic	0.1	0.01	0.017	0.0215	< 0.00500	< 0.00100	0.00133	< 0.00500	0.00531	0.00469	0.0049	0.00421	0.00397	< 0.00500	0.00869	0.0032
Boron	0.75	0.75														
Chromium	0.05	0.1	0.0014	0.00144	< 0.00500	< 0.00100	< 0.000540	< 0.00500	< 0.00500	< 0.00100	0.0021	0.000816	0.000655	< 0.00500	0.00547	0.00333
Iron	1	1	0.081	< 0.0150	1.02	0.0549	0.0357	0.261	< 0.200	< 0.0500	0.37	0.0338	0.132	0.261	< 0.200	0.31
Manganese	0.2	0.2	0.0065	0.00194	0.0567	0.0419	0.0247	< 0.00500	0.0075	0.0025	0.11	0.00352	0.00236	0.0195	0.0551	0.0338
Nickel	0.2	0.2														
Selenium	0.05	0.05	0.0012	0.000935	< 0.00500	< 0.00100	0.000381	< 0.00500	< 0.00500	< 0.00100	0.0019	0.000731	0.00064	< 0.00500	< 0.00500	0.00115
Uranium	0.03	0.03														
Vanadium	--	--														
Total Petroleum Hydrocarbons (mg/L)																
Gasoline Range Organics	--	--	5.5	6.12	0.0526	0.0926	< 0.0310	26.6	25.5	25.8	26	45.1	24.3			
Diesel Range Organics	0.2	--	9.4	25.6	3.4	1.1	7.58	6.4	5.4	2.2	10	12	9.23	4.2	3.6	3
Oil Range Organics	0.2	--														
Volatile Organic Carbons (mg/L)																
Benzene	0.01	0.005	0.37	0.339	< 0.0050	< 0.00060	0.00148	< 0.050	< 0.050	0.056	< 0.0083	0.00288	< 0.166	0.39	0.43	0.39
Ethylbenzene	0.75	0.7	0.58	0.509	< 0.0050	< 0.00050	< 0.000380	< 0.050	< 0.050	< 0.012	< 0.0096	0.00172	< 0.192	< 0.0050	< 0.0050	0.0049
Isopropylbenzene	--	--	0.084	0.0646	0.0053	0.0058	0.007	0.073	0.067	0.076	0.055	0.055	< 0.163	0.034	0.022	0.023
Methyl tert-butyl ether	--	0.1	1.3	0.798	< 0.0050	< 0.00060	< 0.000370	28	29	35	28 E	35	39.2	< 0.0050	< 0.0050	< 0.00060
Naphthalene	0.03	--	0.22	0.202	< 0.0050	< 0.00070	< 0.00100	< 0.050	< 0.050	0.065	< 0.025	0.00126	< 0.5	< 0.0050	0.011	0.0092
N-propylbenzene	--	--	0.13	0.0923	< 0.0050	< 0.00050	< 0.000350	0.064	0.066	0.07	0.044	0.0395	< 0.174	0.027	0.021	0.021
Toluene	0.75	1	0.7	0.553	< 0.0050	< 0.00050	< 0.000780	< 0.050	< 0.050	0.015	< 0.02	0.00156	< 0.39	< 0.0050	0.007	0.0065
1,2,4-trimethylbenzene	--	--	0.54	0.432	< 0.0050	< 0.00050	< 0.000370	< 0.050	< 0.050	0.019	< 0.0093	0.000553	< 0.186	0.03	0.024	0.031
1,3,5-trimethylbenzene	--	--	0.12	0.0857	< 0.0050	< 0.00060	< 0.000390	< 0.050	< 0.050	< 0.015	< 0.0097	< 0.000390	< 0.194	< 0.0050	< 0.0050	0.0034
Xylenes, total	0.62	10	0.71	0.574	< 0.015	< 0.0015	< 0.00110	< 0.15	< 0.15	< 0.038	< 0.026	0.00547	< 0.53	0.05	0.051	0.054
Semivolatile Organics Carbons (mg/L)																
2,4-dimethylphenol	--	--														
Acenaphthene	--	--														
Bis(2-ethylhexyl)phthalate	--	--														
Fluorene	--	--														
Naphthalene	0.03	--														
Phenol	0.005	0.005														

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Northwest Refinery Area (continued)											
	WQCC Limits		MW-108 (continued)			NCL-31								
Analyte	**Current**	**Proposed**	**11/12/2014**	**4/16/2015**	**10/20/2015**	**4/11/2013**	**10/21/2013**	**4/17/2014**	**11/12/2014**	**4/16/2015**	**10/20/2015**	**Maximum**	**Minimum**	**Average**
Water Quality Parameters (mg/L)														
Calcium	--	--	350	289	298	246	245	267	380	266	392	726	109	312
Chloride	250	250	82	78.8	77.5	91.3	94.2	69.6	160	89.5	129	**1010**	22.7	180
Chemical Oxygen Demand	--	--										0	0	--
Fluoride	1.6	4	3.3	2.52	2.3	1	1.26	0.776	1.4	1.25	1.2	**9.3**	0.56	1.64
Hardness	--	--										0	0	--
Nitrate/Nitrite	10	10	0.19	< 0.39	< 0.197	< 1.00	< 0.500	< 0.150	0.11	< 0.2	< 0.197	**34.5**	0.11	5.21
Potassium	--	--	3.2	1.5	1.31	0.261	0.382	0.321	0.43	0.22	0.418	5.55	0.22	1.49
Sodium	--	--	110	76.8	88.9	112	121	112	150	100	125	500	30.8	164
Sulfate	600	600	1200	962	1090	997	849	1030	1300	1240	2100	**6200**	19	1141
Sulfide	--	--										0	0	--
Total Dissolved Solids	1000	1000	2500	2540	2530	2320	2110	2300	2600	2670	3220	**8800**	**1440**	2525
Total Organic Carbon	--	--										0	0	--
Totatl Suspended Solids	--	--										0	0	--
pH (standard units)	6 to 9	6 to 9	6.77	6.81	6.88	6.62	6.72	7.26	6.79		7.16	7.38	6.46	6.87
Total Metals (mg/L)														
Arsenic	0.1	0.01	0.0061	0.00462	0.00399	0.0112	0.0103	0.011	0.026	0.00847	0.00655	**0.0264**	0.00133	0.00728
Boron	0.75	0.75										0	0	--
Chromium	0.05	0.1	< 0.00054	0.00259	0.00226	< 0.00500	< 0.00500	< 0.00100	< 0.00054	0.000989	0.00175	0.0065	0.000623	0.00248
Iron	1	1	< 0.05	0.0411	0.0288	0.939	0.866	1.02	0.95	0.834	1.49	**3.2**	0.0165	0.549
Manganese	0.2	0.2	0.045	0.0256	0.0239	1.78	1.76	1.83	2	1.7	2.28	**2.28**	0.00194	0.378
Nickel	0.2	0.2										0.0033	0.000885	0.00206
Selenium	0.05	0.05	0.0012	< 0.000380	0.00234	< 0.00500	< 0.00500	0.0011	0.00059	< 0.000380	< 0.000380	**0.0709**	0.000381	0.0124
Uranium	0.03	0.03										0	0	--
Vanadium	--	--										**0.00164**	0.00036	0.00103
Total Petroleum Hydrocarbons (mg/L)														
Gasoline Range Organics	--	--										45.1	0.0526	9.42
Diesel Range Organics	0.2	--	7.7	9.03	7.89	1.1	1.3	0.65	2	2.38	2.1	**25.6**	**0.296**	7.39
Oil Range Organics	0.2	--										0	0	--
Volatile Organic Carbons (mg/L)														
Benzene	0.01	0.005	0.41	0.423	0.394	< 0.0050	< 0.0050	< 0.00060	< 0.00033	< 0.000330	< 0.000331	**5.34**	0.00148	0.942
Ethylbenzene	0.75	0.7	0.0056	0.0101	0.00812	< 0.0050	< 0.0050	< 0.00050	< 0.00038	< 0.000380	< 0.000384	**1.02**	0.00039	0.148
Isopropylbenzene	--	--	0.024	0.033	0.0345	< 0.0050	< 0.0050	0.00055	0.0087	0.000622	0.00689	0.13	0.00055	0.0442
Methyl tert-butyl ether	--	0.1	< 0.0018	< 0.00370	< 0.00367	< 0.0050	< 0.0050	0.0006	0.00078	0.000497	< 0.000367	**39.2**	0.000497	9.639
Naphthalene	0.03	--	0.012	0.0113	0.0166	< 0.0050	< 0.0050	0.0021	< 0.0010	< 0.00100	< 0.00100	0.22	0.00126	0.0639
N-propylbenzene	--	--	0.025	0.0311	0.0346	< 0.0050	< 0.0050	< 0.00050	0.00041	< 0.000350	< 0.000349	0.14	0.00041	0.0556
Toluene	0.75	1	0.0078	0.00956	0.00978	< 0.0050	< 0.0050	< 0.00050	< 0.00078	< 0.000780	< 0.000780	**1.91**	0.00156	0.237
1,2,4-trimethylbenzene	--	--	0.039	0.0465	0.0616	< 0.0050	< 0.0050	< 0.00050	< 0.00037	< 0.000370	< 0.000373	0.54	0.000553	0.162
1,3,5-trimethylbenzene	--	--	0.0046	0.00603	0.00805	< 0.0050	< 0.0050	< 0.00060	< 0.00039	< 0.000390	< 0.000387	0.12	0.000663	0.0488
Xylenes, total	0.62	10	0.059	0.0706	0.0855	< 0.015	< 0.015	< 0.0015	< 0.0011	< 0.00110	< 0.00106	**0.933**	0.00291	0.347
Semivolatile Organics Carbons (mg/L)														
2,4-dimethylphenol	--	--										0	0	--
Acenaphthene	--	--										0	0	--
Bis(2-ethylhexyl)phthalate	--	--										0	0	--
Fluorene	--	--										0	0	--
Naphthalene	0.03	--										0	0	--
Phenol	0.005	0.005										0	0	--

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Southern Refinery and Southeastern Field Areas												
	WQCC Limits		RW-4	RW-5R	RW-6	RW-6R PRE	RW-13R-PRE	RW-13R POST	KWB-2R			KWB-5			
Analyte	**Current**	**Proposed**	**4/15/2015**	**4/15/2015**	**4/15/2015**	**08/25/2016**	**08/24/2016**	**08/26/2016**	**11/13/2014**	**4/16/2015**	**10/20/2015**	**10/24/2013**	**11/12/2014**	**4/15/2015**	**10/20/2015**
Water Quality Parameters (mg/L)															
Calcium	--	--	202	4.82	168	242	298	289	330	233	168	221	270	237	228
Chloride	250	250	258	260	414	400	178	182	160	259	228	620	570	518	575
Chemical Oxygen Demand	--	--				2920	185	167							
Fluoride	1.6	4	0.845	0.965	0.628	0.683	0.726	0.689	1.2	0.879	1.21	0.948	0.77	0.687	0.853
Hardness	--	--				1250	1670	1710							
Nitrate/Nitrite	10	10	< 0.0200	< 0.0200	0.0335	2.21	0.165	<0.1	< 0.02	< 0.2	< 0.197	< 0.500	0.2	< 0.0200	0.243
Potassium	--	--	1.67	0.461	0.686	0.804	0.415	0.368	1.2	0.777	1.23	1.19	1	1.79	1.6
Sodium	--	--	144	189	205	197	158	163	200	267	296	212	210	198	203
Sulfate	600	600	468	0.376	129	11.1	868	885	1200	884	418	4.15	12	8.08	6.81
Sulfide	--	--				0.309	38.8	53							
Total Dissolved Solids	1000	1000	1710	565	1650	1650	2550	1850	2600	2450	1970	1690	1500	1500	1540
Total Organic Carbon	--	--				56.2	7.33	5.67							
Totatl Suspended Solids	--	--				6380	4.16	0.874							
pH (standard units)	6 to 9	6 to 9	7	9.13	6.66	7.15	7.21	7.03	6.87	6.81	9.45		6.43		6.55
Total Metals (mg/L)															
Arsenic	0.1	0.01	0.00183	0.00136	0.0332	0.105	0.00282	0.0012	0.0053	0.00281	0.0039	0.0238	0.024	0.0225	0.0209
Boron	0.75	0.75				0.329	0.464	0.523							
Chromium	0.05	0.1	< 0.000540	< 0.000540	< 0.000540	0.0146	0.00178	0.00122	0.0006	0.000702	0.000641	< 0.00500	0.00059	< 0.000540	< 0.000540
Iron	1	1	0.0744	0.0952	13.8	192	12	0.972	0.57	0.329	0.0295	4.79	5.4	3.39	3.22
Manganese	0.2	0.2	0.104	0.0177	0.28	0.398	0.844	0.79	0.31	0.356	0.0529	2.17	2.3	1.57	1.59
Nickel	0.2	0.2				0.149	0.0221	0.00233							
Selenium	0.05	0.05	< 0.000380	< 0.000380	< 0.000380	0.0294	<0.002	0.0263	0.00048	< 0.000380	< 0.000380	< 0.00500	0.00082	< 0.000380	< 0.000380
Uranium	0.03	0.03				0.000691	0.000516	0.000577							
Vanadium	--	--				0.00445	0.00138	0.00125							
Total Petroleum Hydrocarbons (mg/L)															
Gasoline Range Organics	--	--				5.28	19.9	17.6				12.6			
Diesel Range Organics	0.2	--	3.72	6.42	11.4	15.3	2.84	3.06	5.5	5.2	3.95	1.3	1.8	2.3	1.39
Oil Range Organics	0.2	--				0.618	0.442	0.0758							
Volatile Organic Carbons (mg/L)															
Benzene	0.01	0.005	0.0167	2.92	0.636	1.75	3.63	2.81	4.4	1.98	4	0.7	0.41	< 0.000330	1.2
Ethylbenzene	0.75	0.7	0.00245	1.03	0.0476	0.0436	1.45	1.36	2.9	0.992	1.72	< 0.050	0.0095	0.0395	0.0151
Isopropylbenzene	--	--	0.00966	0.0398	0.0173	<0.05	0.0782	0.0713	0.082	0.0698	0.0921	< 0.050	0.0066	0.0146	0.0161
Methyl tert-butyl ether	--	0.1	0.0902	2.15	2.27	1.9	<0.1	<0.2	0.034	0.0186	< 0.0367	10	9.9 E	< 0.000370	10.7
Naphthalene	0.03	--	< 0.00100	0.174	0.0602	<0.25	0.315	0.308	0.51	0.026	< 0.1	< 0.050	0.023	0.0392	0.0156
N-propylbenzene	--	--	0.00458	0.0598	0.0237	0.0267	0.17	0.152	0.16	0.119	0.169	< 0.050	0.011	0.0226	0.0276
Toluene	0.75	1	< 0.000780	2.26	0.0126	0.061	0.157	<1	0.035	0.014	< 0.0780	< 0.050	< 0.0078	0.013	0.00578
1,2,4-trimethylbenzene	--	--	< 0.000370	0.298	0.134	0.0568	0.719	0.645	0.79	0.307	0.317	< 0.050	< 0.0037	0.0158	0.00334
1,3,5-trimethylbenzene	--	--	< 0.000390	0.0558	0.028	<0.05	0.129	0.0884	0.039	< 0.00390	< 0.0387	< 0.050	< 0.0039	0.00419	0.00179
Xylenes, total	0.62	10	< 0.00110	1.91	0.158	0.0648	2.07	1.6	0.74	0.236	0.448	< 0.15	< 0.011	0.0394	0.0166
Semivolatile Organics Carbons (mg/L)															
2,4-dimethylphenol	--	--				0.162	<0.05	<0.05							
Acenaphthene	--	--				0.00185	<0.005	<0.005							
Bis(2-ethylhexyl)phthalate	--	--				0.119	<0.015	<0.015							
Fluorene	--	--				0.00327	0.00197	<0.005							
Naphthalene	0.03	--				0.0208	0.168	0.145							
Phenol	0.005	0.005				0.145	0.00514	0.00278							

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Southern Refinery and Southeastern Field Areas (continued)											
	WQCC Limits		KWB-6			KWB-10R			MW-28					
Analyte	**Current**	**Proposed**	**11/12/2014**	**4/15/2015**	**10/20/2015**	**11/12/2014**	**4/16/2015**	**10/19/2015**	**4/12/2013**	**10/15/2013**	**4/28/2014**	**11/12/2014**	**4/16/2015**	**10/20/2015**
Water Quality Parameters (mg/L)														
Calcium	--	--	260	212	229	170	132	132	190	195	164	590	439	379
Chloride	250	250	240	305	265	190	800	192	168	179	157	140	160	159
Chemical Oxygen Demand	--	--												
Fluoride	1.6	4	0.8	0.366	0.935	0.59	19.7	1.31	0.975	1.47	1.02	0.73	1.59	1.67
Hardness	--	--												
Nitrate/Nitrite	10	10	0.37	0.148	0.273	< 0.02	< 0.2	0.042	< 1.00	< 0.500	< 0.150	< 0.02	< 0.39	0.211
Potassium	--	--	0.2	0.22	0.181	0.51	0.44	0.491	0.497	0.382	0.382	0.92	0.685	0.632
Sodium	--	--	150	193	144	160	141	136	108	107	102	96	89.5	92.7
Sulfate	600	600	330	16.2	264	< 0.077	1.03	0.117	378	174	166	1300	1080	1060
Sulfide	--	--												
Total Dissolved Solids	1000	1000	1600	1460	1410	1200	1190	1090	1680	1420	1560	3000	2760	3000
Total Organic Carbon	--	--												
Totatl Suspended Solids	--	--												
pH (standard units)	6 to 9	6 to 9	6.69	6.7	6.57	6.48	6.78	6.58	6.62	6.8	7.05	7.03	6.66	6.38
Total Metals (mg/L)														
Arsenic	0.1	0.01	0.0095	0.00621	0.0124	0.036	0.0259	0.0217	< 0.00500	< 0.00500	0.00429	0.0067	0.00912	0.00936
Boron	0.75	0.75												
Chromium	0.05	0.1	0.00073	< 0.000540	< 0.000540	0.001	< 0.000540	< 0.000540	< 0.00500	< 0.00500	< 0.00100	0.0017	0.000931	0.000931
Iron	1	1	0.77	0.87	0.558	8.2	7.48	5.84	< 0.200	< 0.200	< 0.0500	0.073	0.0712	0.0744
Manganese	0.2	0.2	2.2	2.16	2.04	0.19	0.149	0.157	0.0354	0.0408	0.0397	0.1	0.0685	0.0261
Nickel	0.2	0.2			0.00186				0.00718	0.00764	0.00817	0.0056	0.00489	0.0036
Selenium	0.05	0.05	0.0013	< 0.000380	< 0.000380	0.00052	< 0.000380	< 0.000380	< 0.00500	< 0.00500	< 0.00100	0.002	0.0204	0.0205
Uranium	0.03	0.03												
Vanadium	--	--			0.00239				<0.005	<0.005	<0.0009	0.0099	0.00634	0.00557
Total Petroleum Hydrocarbons (mg/L)														
Gasoline Range Organics	--	--							6.08	6.19	6.32	16	7.85	9.88
Diesel Range Organics	0.2	--	1.8	4.5	1.41	12	9.16	4.65	2.7	3.1	3	3.7	13	16.2
Oil Range Organics	0.2	--												
Volatile Organic Carbons (mg/L)														
Benzene	0.01	0.005	5.1	15.9	8.61	5.1	5.65	6.77	0.62	0.58	0.81	3.3	3.02	3.05
Ethylbenzene	0.75	0.7	0.81	2.04	0.831	0.4	0.528	0.523	0.0053	< 0.0050	0.0052	0.15	0.0625	0.0441
Isopropylbenzene	--	--	0.04	0.0738	< 0.163	0.04	0.0484	0.0478	0.02	0.022	0.019	0.066	0.0689	0.0671
Methyl tert-butyl ether	--	0.1	0.16	0.119	9.07	5.2	3.87	4.66	3.9	3.9	3.6	2	1.33	1.11
Naphthalene	0.03	--	0.098	0.239	< 0.5	0.19	0.138	0.186	< 0.0050	< 0.0050	0.0042	0.06	< 0.1	< 0.1
N-propylbenzene	--	--	0.058	0.121	< 0.174	0.062	0.069	0.0699	0.019	0.023	0.02	0.081	0.0744	0.089
Toluene	0.75	1	0.53	1.7	< 0.39	0.18	0.141	0.124	< 0.0050	< 0.0050	0.0053	0.054	< 0.0780	< 0.0780
1,2,4-trimethylbenzene	--	--	0.26	0.68	0.325	0.41	0.457	0.358	< 0.0050	< 0.0050	0.00069	0.12	0.095	0.151
1,3,5-trimethylbenzene	--	--	0.047	0.124	< 0.194	0.11	0.136	0.1	< 0.0050	< 0.0050	< 0.00060	0.011	< 0.0390	< 0.0387
Xylenes, total	0.62	10	1.1	3.47	1.33	1.2	1.38	1.08	< 0.015	< 0.015	0.0086	0.22	0.194	0.243
Semivolatile Organics Carbons (mg/L)														
2,4-dimethylphenol	--	--												
Acenaphthene	--	--												
Bis(2-ethylhexyl)phthalate	--	--												
Fluorene	--	--												
Naphthalene	0.03	--												
Phenol	0.005	0.005												

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Southern Refinery and Southeastern Field Areas (continued)												
	WQCC Limits		MW-48			MW-58				MW-65		MW-66			
Analyte	**Current**	**Proposed**	**11/13/2014**	**4/17/2015**	**10/20/2015**	**10/24/2013**	**11/13/2014**	**4/16/2015**	**10/20/2015**	**11/13/2014**	**4/15/2015**	**4/12/2013**	**10/15/2013**	**4/28/2014**	**11/12/2014**
Water Quality Parameters (mg/L)															
Calcium	--	--	190	258	186	223	340	200	234	260	147	152	141	151	140
Chloride	250	250	410	161	391	342	140	149	239	470	382	229	237	209	150
Chemical Oxygen Demand	--	--													
Fluoride	1.6	4	0.29	0.498	0.644	1.15	1.4	1.15	1.35	0.72	1.21	1.12	1.25	1.12	1.2
Hardness	--	--													
Nitrate/Nitrite	10	10	< 0.02	< 0.2	< 0.197	< 0.500	< 0.02	< 0.2	< 0.197	< 0.02	0.0613	< 1.00	< 0.500	< 0.150	< 0.02
Potassium	--	--	2.4	0.68	2.61	0.755	0.55	0.317	0.459	0.89	0.783	0.984	0.935	0.785	1
Sodium	--	--	380	276	355	131	66	58.8	71.5	290	257	188	177	180	160
Sulfate	600	600	260	47.6	235	199	160	9.63	4.8	310	< 0.0770	1.66	0.99	< 0.200	0.51
Sulfide	--	--													
Total Dissolved Solids	1000	1000	1800	725	1940	1770	1300	1150	1240	1900	1410	1160	1100	1170	990
Total Organic Carbon	--	--													
Totatl Suspended Solids	--	--													
pH (standard units)	6 to 9	6 to 9	6.89	6.93	6.89		6.69	6.67	7.96	6.84	6.78	6.61	6.72	7.11	6.98
Total Metals (mg/L)															
Arsenic	0.1	0.01	0.033	0.004	0.0108	0.0511	0.0078	0.0121	0.0081	0.058	0.0186	< 0.00500	< 0.00500	0.003	0.0029
Boron	0.75	0.75													
Chromium	0.05	0.1	0.0031	< 0.000540	0.00069	< 0.00500	0.00083	< 0.000540	< 0.000540	0.00074	< 0.000540	< 0.00500	< 0.00500	< 0.00100	0.00076
Iron	1	1	1.4	0.562	0.131	1.81	0.66	1.76	1.29	8.6	2.88	0.54	0.601	0.397	1.4
Manganese	0.2	0.2	2	0.0948	1.24	0.881	0.094	0.0946	0.117	2.2	0.79	0.283	0.306	0.335	0.28
Nickel	0.2	0.2				< 0.00500	0.0015	0.0014	0.00108			0.00959	0.00981	0.00857	0.0068
Selenium	0.05	0.05	0.0014	< 0.000380	0.00487	< 0.00500	0.0004	< 0.000380	< 0.000380	0.00042	< 0.000380	< 0.00500	< 0.00500	< 0.00100	0.0015
Uranium	0.03	0.03													
Vanadium	--	--				<0.005	0.0043	0.00229	<0.00018			<0.005	<0.005	<0.009	0.00084
Total Petroleum Hydrocarbons (mg/L)															
Gasoline Range Organics	--	--	4.5	3.65	2.99	6.91				27	33.1	7.57	10.7	6.64	23
Diesel Range Organics	0.2	--	4	3.9	2.97	1.7	7.8	9	5.11	15	12.4	2.4	1.4	2.1	3.3
Oil Range Organics	0.2	--													
Volatile Organic Carbons (mg/L)															
Benzene	0.01	0.005	0.14	0.89	0.204	2.5	7.4	6.03	6.89	8.9	9.99	1.2	2	0.89	6.5
Ethylbenzene	0.75	0.7	0.075	0.158	0.0655	0.073	2.4	1.98	2	1.2	1.03	0.0074	0.019	0.0039	0.19
Isopropylbenzene	--	--	0.041	0.0361	0.0549	< 0.050	0.066	0.0732	0.072	0.053	0.0578	0.064	0.073	0.03	0.079
Methyl tert-butyl ether	--	0.1	1.1	0.223	0.832	0.37	< 0.0092	0.0187	< 0.0367	3.4	3.22	2.9	2.4	2.3	1.9
Naphthalene	0.03	--	0.028	0.0245	0.0128	0.067	0.48	0.318	0.354	0.22	0.239	0.081	0.11	0.055	0.224
N-propylbenzene	--	--	0.068	0.0478	0.0857	< 0.050	0.1	0.112	0.125	0.083	0.085	0.088	0.11	0.038	0.12
Toluene	0.75	1	0.03	0.0146	0.012	< 0.050	< 0.02	0.0174	< 0.0780	< 0.039	0.0294	< 0.0050	0.0092	0.0027	0.052
1,2,4-trimethylbenzene	--	--	0.2	0.14	0.211	0.093	0.86	1.04	0.893	0.06	0.0514	< 0.0050	< 0.0050	< 0.00050	0.012
1,3,5-trimethylbenzene	--	--	< 0.0097	0.00962	0.00235	< 0.050	0.098	0.195	0.0651	0.022	0.0228	< 0.0050	< 0.0050	< 0.00060	< 0.0039
Xylenes, total	0.62	10	0.13	0.153	0.125	< 0.15	1.6	2.16	2.18	0.21	0.158	< 0.015	0.025	0.0069	0.12
Semivolatile Organics Carbons (mg/L)															
2,4-dimethylphenol	--	--													
Acenaphthene	--	--													
Bis(2-ethylhexyl)phthalate	--	--													
Fluorene	--	--													
Naphthalene	0.03	--													
Phenol	0.005	0.005													

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Southern Refinery and Southeastern Field Areas (continued)													
	WQCC Limits		MW-66 (continued)		MW-99			MW-101						MW-102		
Analyte	**Current**	**Proposed**	**4/15/2015**	**10/20/2015**	**11/13/2014**	**4/15/2015**	**10/20/2015**	**4/12/2013**	**10/13/2013**	**4/28/2014**	**11/13/2014**	**4/15/2015**	**10/20/2015**	**11/13/2014**	**4/15/2015**	**10/20/2015**
Water Quality Parameters (mg/L)																
Calcium	--	--	120	134	170	48.7	176	175	201	209	280	188	188	290	94.4	193
Chloride	250	250	141	201	180	33.4	249	242	238	217	230	201	236	220	175	219
Chemical Oxygen Demand	--	--														
Fluoride	1.6	4	1.53	1.34	0.42	0.328	0.706	1.24	0.985	0.779	1	0.708	0.993	0.61	0.825	1.13
Hardness	--	--														
Nitrate/Nitrite	10	10	0.0292	< 0.197	< 0.02	0.789	< 0.197	< 1.00	< 0.500	< 0.150	< 0.02	< 0.2	0.23	< 0.02	0.0642	< 0.197
Potassium	--	--	0.858	0.742	3.9	5.3	0.955	0.565	0.5	0.504	0.81	0.485	0.483	0.8	0.419	0.683
Sodium	--	--	134	163	170	23.9	215	145	158	153	150	141	138	430	357	385
Sulfate	600	600	0.596	0.11	140	41.3	127	191	171	161	340	188	206	590	1.75	296
Sulfide	--	--														
Total Dissolved Solids	1000	1000	948	1090	1100	267	1390	1350	1430	1440	1600	1340	1470	2200	1470	1750
Total Organic Carbon	--	--														
Totatl Suspended Solids	--	--														
pH (standard units)	6 to 9	6 to 9	7.06	6.78	7.04	7.75	6.68	6.63	6.63	6.96	6.68	6.6	6.76	7.04	6.83	6.71
Total Metals (mg/L)																
Arsenic	0.1	0.01	0.00298	0.0037	0.012	0.00289	0.00812	0.00878	0.0689	0.032	0.049	0.0939	0.056	0.012	0.01	0.0123
Boron	0.75	0.75														
Chromium	0.05	0.1	< 0.000540	< 0.000540	0.0019	0.000639	0.000832	< 0.00500	< 0.00500	< 0.00100	0.00061	0.000581	< 0.000540	0.0016	< 0.000540	0.00106
Iron	1	1	0.635	0.792	1.2	0.457	0.382	0.294	2.75	1.42	1.8	3.58	2.59	0.1	0.138	0.0723
Manganese	0.2	0.2	0.189	0.22	0.29	0.0802	0.191	0.835	1.23	1.12	0.98	1.08	1.13	0.049	0.0431	0.0273
Nickel	0.2	0.2	0.00613	0.00743												
Selenium	0.05	0.05	< 0.000380	< 0.000380	< 0.00038	0.000808	< 0.000380	< 0.00500	< 0.00500	< 0.00100	0.0012	< 0.000380	0.00344	0.0013	< 0.000380	0.000393
Uranium	0.03	0.03														
Vanadium	--	--	0.000941	0.00175												
Total Petroleum Hydrocarbons (mg/L)																
Gasoline Range Organics	--	--	8.18	8.74	14	6.76	19.4	6.76	1.05	4.56	1.4	0.18	0.0803	36	24.5	31.4
Diesel Range Organics	0.2	--	4.51	1.4	2.5	1.94	1.87	3.5	3.7	4.3	5.3	6	5.08	9.5	9.96	11.4
Oil Range Organics	0.2	--														
Volatile Organic Carbons (mg/L)																
Benzene	0.01	0.005	3.16	4.1	2.6	0.973	7.28	2.1	0.19	1.1	0.22	0.0187	< 0.00166	11	9.83	12.3
Ethylbenzene	0.75	0.7	0.0615	0.0234	0.59	0.252	0.551	0.054	0.025	0.015	0.005	0.00202	< 0.00192	0.99	0.602	1.04
Isopropylbenzene	--	--	0.0266	0.0565	0.037	0.0295	0.0559	0.02	< 0.0050	0.0074	0.0078	0.00279	< 0.00163	0.04	0.0207	0.0583
Methyl tert-butyl ether	--	0.1	1.66	2.42	3.4 E	0.0799	3.96	0.093	0.086	< 0.00060	0.12	0.113	0.0981	2	1.88	2.12
Naphthalene	0.03	--	0.0617	0.133	0.044	0.0376	0.0453	< 0.0050	< 0.0050	0.0029	0.014	< 0.00500	< 0.00500	0.18	0.129	0.256
N-propylbenzene	--	--	0.0342	0.0807	0.052	0.0338	0.0768	0.017	< 0.0050	0.0032	0.005	< 0.00170	< 0.00174	0.057	0.0257	0.0897
Toluene	0.75	1	< 0.0390	0.00722	0.58	0.149	0.221	0.0081	< 0.0050	0.0038	< 0.0078	< 0.00390	< 0.00390	2	1.45	1.2
1,2,4-trimethylbenzene	--	--	< 0.0190	0.00409	0.33	0.337	0.4	< 0.0050	< 0.0050	0.0022	< 0.0037	< 0.00190	< 0.00186	0.26	0.136	0.465
1,3,5-trimethylbenzene	--	--	< 0.0190	0.000859	0.036	0.0706	0.0169	< 0.0050	< 0.0050	0.00092	< 0.0039	< 0.00190	< 0.00194	0.059	0.0278	0.115
Xylenes, total	0.62	10	0.0668	0.032	0.84	0.937	0.604	0.025	< 0.015	0.011	< 0.011	< 0.00530	< 0.00530	1.8	0.846	1.43
Semivolatile Organics Carbons (mg/L)																
2,4-dimethylphenol	--	--														
Acenaphthene	--	--														
Bis(2-ethylhexyl)phthalate	--	--														
Fluorene	--	--														
Naphthalene	0.03	--														
Phenol	0.005	0.005														

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Southern Refinery and Southeastern Field Areas (continued)												
	WQCC Limits		MW-103			MW-104						MW-111			
Analyte	**Current**	**Proposed**	**4/16/2013**	**4/28/2014**	**4/15/2015**	**4/16/2013**	**10/21/2013**	**4/28/2014**	**11/13/2014**	**4/15/2015**	**10/20/2015**	**4/9/2013**	**10/24/2013**	**4/15/2014**	**11/12/2014**
Water Quality Parameters (mg/L)															
Calcium	--	--	19.2	24.5	192	264	247	232	230	208	169	214	219	214	260
Chloride	250	250	661	1040	7890	104	124	86	54	31.4	21	548	559	525	510
Chemical Oxygen Demand	--	--													
Fluoride	1.6	4	6.88	7.45	3.44	1.64	2.22	2.26	2.1	1.67	2.01	1.19	1.34	1.01	2
Hardness	--	--													
Nitrate/Nitrite	10	10	< 1.00	< 0.150	< 0.0200	< 1.00	< 0.500	< 0.150	< 0.02	< 0.0200	< 0.197	< 1.00	< 0.500	0.153	< 0.02
Potassium	--	--	0.759	0.831	2.46	6.85	8.35	5.06	6	4.73	4.92	0.652	0.31	0.456	0.49
Sodium	--	--	1120	1420	6710	89.8	108	95.7	69	42.7	38.6	184	218	198	220
Sulfate	600	600	82.2	< 10.0	19.6	863	798	690	710	856	510	198	188	235	250
Sulfide	--	--													
Total Dissolved Solids	1000	1000	2800	3820	12500	1580	1570	1390	1300	1070	912	2150	1840	2020	1700
Total Organic Carbon	--	--													
Totatl Suspended Solids	--	--													
pH (standard units)	6 to 9	6 to 9	7.33	7.61	7.23	7.28	7.23	7.45	7.5	7.22	7.57	6.45		6.96	6.36
Total Metals (mg/L)															
Arsenic	0.1	0.01	< 0.00500	0.0027	0.00617	< 0.00500	< 0.00500	< 0.00100	0.0018	0.000408	0.0015	0.0136	0.0114	0.0114	0.014
Boron	0.75	0.75													
Chromium	0.05	0.1	< 0.00500	< 0.00100	< 0.0110	< 0.00500	< 0.00500	< 0.00100	< 0.00054	< 0.000540	0.000591	< 0.00500	< 0.00500	0.00252	0.0024
Iron	1	1	< 0.200	< 0.0500	< 0.3	< 0.200	< 0.200	< 0.0500	< 0.05	0.0945	0.0385	6.18	7.88	7.64	8
Manganese	0.2	0.2	< 0.00500	0.00278	0.0125	0.0255	0.0274	0.038	0.031	0.0228	0.0148	1.86	1.72	1.57	1.6
Nickel	0.2	0.2										0.00701			
Selenium	0.05	0.05	< 0.00500	< 0.00100	0.0607	< 0.00500	< 0.00500	< 0.00100	< 0.00038	< 0.000380	< 0.000380	< 0.00500	< 0.00500	< 0.00100	0.00046
Uranium	0.03	0.03													
Vanadium	--	--										<0.005			
Total Petroleum Hydrocarbons (mg/L)															
Gasoline Range Organics	--	--	3.31	1.43	4.15	1.14	0.993	1.42	1.3	0.783	1.05	2.49	2.26	2.36	1.7
Diesel Range Organics	0.2	--	5.4	5.9	8.66	0.99	0.6	0.72	0.7	0.813	1.06	1.7	1.4	1.3	2
Oil Range Organics	0.2	--													
Volatile Organic Carbons (mg/L)															
Benzene	0.01	0.005	0.58	0.76	< 0.000330	0.033	0.076	0.056	0.094	0.0243	0.257	0.09	0.19	0.11	0.18
Ethylbenzene	0.75	0.7	0.036	0.15	0.0879	< 0.0050	< 0.0050	0.0012	0.0021	< 0.000380	0.0126	0.016	0.016	0.0085	0.026
Isopropylbenzene	--	--	0.02	0.031	0.0247	0.075	0.051	0.052	0.037	0.0432	0.0449	< 0.0050	< 0.0050	0.0013	0.0024
Methyl tert-butyl ether	--	0.1	< 0.0050	< 0.00060	0.000441	< 0.0050	< 0.0050	< 0.00060	0.00049	0.00138	0.00189	2.1	1.6	2	1.6 E
Naphthalene	0.03	--	0.013	0.051	0.022	< 0.0050	< 0.0050	0.003	0.00184	< 0.00100	< 0.00500	< 0.0050	< 0.0050	0.0016	0.00644
N-propylbenzene	--	--	0.024	0.046	0.0357	< 0.0050	< 0.0050	0.0046	0.0074	0.00324	0.00458	< 0.0050	< 0.0050	0.00082	0.0022
Toluene	0.75	1	0.006	0.0094	0.0154	< 0.0050	< 0.0050	< 0.00050	< 0.00078	< 0.000780	< 0.00390	< 0.0050	< 0.0050	0.0011	0.0016
1,2,4-trimethylbenzene	--	--	< 0.0050	0.015	0.0102	< 0.0050	< 0.0050	< 0.00050	< 0.00037	< 0.000370	< 0.00186	< 0.0050	0.0053	0.0021	0.0074
1,3,5-trimethylbenzene	--	--	< 0.0050	< 0.00060	< 0.000390	< 0.0050	< 0.0050	< 0.00060	< 0.00039	< 0.000390	< 0.00194	< 0.0050	< 0.0050	< 0.00060	0.0017
Xylenes, total	0.62	10	< 0.015	0.017	0.0137	< 0.015	< 0.015	< 0.0015	< 0.0011	< 0.00110	< 0.00530	< 0.015	< 0.015	0.0057	0.027
Semivolatile Organics Carbons (mg/L)															
2,4-dimethylphenol	--	--													
Acenaphthene	--	--													
Bis(2-ethylhexyl)phthalate	--	--													
Fluorene	--	--													
Naphthalene	0.03	--													
Phenol	0.005	0.005													

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Southern Refinery and Southeastern Field Areas (continued)												
	WQCC Limits		MW-111 (continued)		MW-112	MW-113						MW-127			
Analyte	**Current**	**Proposed**	**4/15/2015**	**10/19/2015**	**11/12/2014**	**4/9/2013**	**10/24/2013**	**4/11/2014**	**11/13/2014**	**4/17/2015**	**10/20/2015**	**4/15/2014**	**11/12/2014**	**4/15/2015**	**10/19/2015**
Water Quality Parameters (mg/L)															
Calcium	--	--	270	227	190	249	270	300	300	285	287	185	290	238	234
Chloride	250	250	427	408	230	219	220	205	180	194	197	275	240	209	243
Chemical Oxygen Demand	--	--													
Fluoride	1.6	4	1.01	1.51	1	< 0.500	0.566	0.282	0.56	0.606	0.503	0.95	0.93	0.902	1.06
Hardness	--	--													
Nitrate/Nitrite	10	10	< 0.0200	0.022	< 0.02	< 1.00	< 0.500	< 0.150	< 0.02	< 0.0200	0.243	< 0.150	< 0.02	< 0.2	< 0.197
Potassium	--	--	0.521	0.415	0.31	0.849	0.723	1.45	0.4	0.526	0.528	0.612	0.99	0.579	0.256
Sodium	--	--	172	222	190	151	151	152	160	151	153	145	160	147	143
Sulfate	600	600	294	473	5.4	756	746	693	800	957	1000	392	620	511	642
Sulfide	--	--													
Total Dissolved Solids	1000	1000	1600	1530	1200	2260	2110	2440	1900	2030	2020	2040	1800	1750	1900
Total Organic Carbon	--	--													
Totatl Suspended Solids	--	--													
pH (standard units)	6 to 9	6 to 9	6.61	6.55	6.54	6.82		6.98	5.53	6.58	6.43	7.03	6.66	6.64	6.64
Total Metals (mg/L)															
Arsenic	0.1	0.01	0.0201	0.0144	0.005	< 0.00500	< 0.00500	0.00326	0.0088	0.00294	0.00366	0.00433	0.0064	0.00626	0.00499
Boron	0.75	0.75													
Chromium	0.05	0.1	0.00167	0.00239	0.0021	< 0.00500	< 0.00500	0.00423	0.00059	0.00171	< 0.000540	0.00192	0.0035	0.00241	< 0.000540
Iron	1	1	5.03	7.14	5.8	0.375	0.261	1.87	0.68	0.559	0.196	1.66	3.9	1.64	0.323
Manganese	0.2	0.2	1.72	1.52	0.31	0.389	0.404	0.408	1.9	0.918	0.765	0.156	0.14	0.109	0.0943
Nickel	0.2	0.2				< 0.00500									
Selenium	0.05	0.05	< 0.000380	< 0.000380	0.0018	< 0.00500	< 0.00500	< 0.00200	0.00044	0.0025	< 0.000380	< 0.00100	0.0012	< 0.000380	< 0.000380
Uranium	0.03	0.03													
Vanadium	--	--				0.0116									
Total Petroleum Hydrocarbons (mg/L)															
Gasoline Range Organics	--	--	1.37	0.674	28	< 0.0500	3.05	17.3	2.4	< 0.0310	< 0.0314	37.7	6.1	9.73	6.54
Diesel Range Organics	0.2	--	1.9	2.1	2.2	0.2	< 0.051	0.23	0.64	0.33	0.115	3.5	1.3	1.68	0.585
Oil Range Organics	0.2	--													
Volatile Organic Carbons (mg/L)															
Benzene	0.01	0.005	0.0755	0.0243	8.5	0.0095	0.64	2.3	1.5	< 0.000330	0.000477	6.8	1.8	4.41	1.51
Ethylbenzene	0.75	0.7	0.00824	0.00615	0.97	< 0.0050	0.19	0.4	0.007	< 0.000380	< 0.000384	0.93	0.24	0.424	0.299
Isopropylbenzene	--	--	0.000607	0.000862	0.057	< 0.0050	< 0.0050	0.013	0.0097	< 0.000330	< 0.000326	0.049	0.012	0.0213	0.0183
Methyl tert-butyl ether	--	0.1	< 0.000370	1.32	1	0.024	0.02	0.01	0.02	0.0178	0.0158	1.4	0.76	0.868	0.73
Naphthalene	0.03	--	0.00294	0.00645	0.2	< 0.0050	< 0.0050	< 0.00070	0.0484	< 0.00100	< 0.00100	0.14	0.04	0.0658	0.0415
N-propylbenzene	--	--	0.000827	0.000839	0.1	< 0.0050	< 0.0050	0.011	0.0033	< 0.000350	< 0.000349	0.081	0.02	0.0335	0.0305
Toluene	0.75	1	< 0.000780	< 0.000780	0.73	< 0.0050	0.07	0.064	0.0046	< 0.000780	< 0.000780	2.4	0.15	0.183	0.216
1,2,4-trimethylbenzene	--	--	0.00256	0.00122	0.35	< 0.0050	0.0097	0.058	0.041	< 0.000370	< 0.000373	0.29	0.078	0.126	0.098
1,3,5-trimethylbenzene	--	--	0.000567	< 0.000387	0.09	< 0.0050	< 0.0050	0.026	0.0071	< 0.000390	< 0.000387	0.063	0.0061	0.00854	< 0.00774
Xylenes, total	0.62	10	0.00881	0.00113	2	< 0.015	0.29	0.91	0.1	< 0.00110	< 0.00106	0.87	0.15	0.296	0.141
Semivolatile Organics Carbons (mg/L)															
2,4-dimethylphenol	--	--													
Acenaphthene	--	--													
Bis(2-ethylhexyl)phthalate	--	--													
Fluorene	--	--													
Naphthalene	0.03	--													
Phenol	0.005	0.005													

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Southern Refinery and Southeastern Field Areas (continued)													
	WQCC Limits		MW-128				MW-129			MW-130				MW-131		
Analyte	**Current**	**Proposed**	**4/29/2014**	**11/12/2014**	**4/16/2015**	**10/20/2015**	**11/12/2014**	**4/15/2015**	**10/19/2015**	**4/15/2014**	**11/13/2014**	**4/17/2015**	**10/20/2015**	**4/15/2014**	**11/12/2014**	
Water Quality Parameters (mg/L)																
Calcium	--	--	207	250	214	202	270	192	169	321	310	81.8	261	147	200	
Chloride	250	250	283	320	307	282	320	302	313	316	250	259	237	337	290	
Chemical Oxygen Demand	--	--														
Fluoride	1.6	4	0.991	1.1	1.22	1.22	0.98	0.9	1.08	0.533	0.73	0.952	0.829	0.637	0.47	
Hardness	--	--														
Nitrate/Nitrite	10	10	< 0.150	< 0.02	< 0.0200	< 0.197	< 0.02	< 0.2	< 0.197	0.975	0.35	0.471	0.495	< 0.150	< 0.02	
Potassium	--	--	0.515	1.2	0.414	0.341	0.8	0.53	0.315	1.34	1	6.71	0.688	0.573	0.64	
Sodium	--	--	106	110	104	105	210	195	194	284	310	125	293	150	160	
Sulfate	600	600	172	250	290	280	52	69.4	57.8	1020	1200	1080	1200	12.2	8.3	
Sulfide	--	--														
Total Dissolved Solids	1000	1000	1380	1400	1490	1560	1300	1330	1280	3080	2600	3710	2380	1360	1200	
Total Organic Carbon	--	--														
Totatl Suspended Solids	--	--														
pH (standard units)	6 to 9	6 to 9	6.88	6.87	6.71	6.56	5.59	6.76	6.62	7.12	6.93	7.77	6.79	7.03	6.38	
Total Metals (mg/L)																
Arsenic	0.1	0.01	0.0549	0.062	0.052	0.0552	0.027	0.0338	0.0271	0.00474	0.0046	0.00718	0.00477	0.0196	0.023	
Boron	0.75	0.75														
Chromium	0.05	0.1	0.00181	0.0051	0.000905	< 0.000540	0.0045	0.00227	< 0.000540	0.00626	0.0025	0.00205	0.000567	0.00159	0.0028	
Iron	1	1	3.53	5	2.94	2.65	7.8	6.42	5.07	2.84	1.2	0.143	0.162	2.25	3.8	
Manganese	0.2	0.2	2.33	2.6	2.42	2.31	1.2	1.21	1.09	0.202	0.12	0.242	0.0921	0.378	0.36	
Nickel	0.2	0.2														
Selenium	0.05	0.05	< 0.00100	0.0012	< 0.000380	< 0.000380	0.0032	< 0.000380	< 0.000380	0.00569	0.0037	< 0.00190	0.00224	< 0.00100	0.0005	
Uranium	0.03	0.03														
Vanadium	--	--														
Total Petroleum Hydrocarbons (mg/L)																
Gasoline Range Organics	--	--	3.19	1.2	1.23	0.644	4.6	3.29	4.11	< 0.0100	< 0.031	< 0.0310	< 0.0314	26.2	9.1	
Diesel Range Organics	0.2	--	2.1	2.4	3	1.78	2.7	2.45	1.31	0.33	0.7	0.96	0.508	3.4	3.7	
Oil Range Organics	0.2	--														
Volatile Organic Carbons (mg/L)																
Benzene	0.01	0.005	0.24	0.12	0.297	0.0297	0.084	0.0372	< 0.0331	< 0.00060	< 0.00033	< 0.000330	< 0.000331	3.1	1.8	
Ethylbenzene	0.75	0.7	0.043	0.012	0.0114	< 0.00768	0.025	0.00131	< 0.0384	< 0.00050	< 0.00038	< 0.000380	< 0.000384	0.21	0.067	
Isopropylbenzene	--	--	0.0063	0.0023	0.0031	< 0.00652	0.0044	0.00198	< 0.0326	< 0.00050	< 0.00033	< 0.000330	< 0.000326	0.036	0.016	
Methyl tert-butyl ether	--	0.1	1.3	0.95 E	1.6	0.86	5.4 E	7.04	5.79	< 0.00060	0.0012	0.00051	0.000449	5.3	5.6 E	
Naphthalene	0.03	--	0.012	0.0061	0.00346	< 0.0200	< 0.01	0.00407	< 0.1	< 0.00070	< 0.0010	< 0.00100	< 0.00100	0.058	0.043	
N-propylbenzene	--	--	0.01	0.0032	0.00369	< 0.00698	0.0048	0.000956	< 0.0349	< 0.00050	< 0.00035	< 0.000350	< 0.000349	0.084	0.03	
Toluene	0.75	1	0.0019	0.00092	0.000928	< 0.0156	0.071	< 0.000780	< 0.0780	< 0.00050	< 0.00078	< 0.000780	< 0.000780	1.4	0.31	
1,2,4-trimethylbenzene	--	--	0.0095	0.0028	0.00374	< 0.00746	0.014	0.00286	< 0.0373	< 0.00050	< 0.00037	< 0.000370	< 0.000373	0.23	0.058	
1,3,5-trimethylbenzene	--	--	0.0045	0.00048	0.000551	< 0.00774	0.0043	0.000679	< 0.0387	< 0.00060	< 0.00039	< 0.000390	< 0.000387	0.066	0.016	
Xylenes, total	0.62	10	0.014	0.0055	0.00326	< 0.0212	0.059	0.00357	< 0.106	< 0.0015	< 0.0011	< 0.00110	< 0.00106	0.65	0.18	
Semivolatile Organics Carbons (mg/L)																
2,4-dimethylphenol	--	--														
Acenaphthene	--	--														
Bis(2-ethylhexyl)phthalate	--	--														
Fluorene	--	--														
Naphthalene	0.03	--														
Phenol	0.005	0.005														

Table 3 - Groundwater Quality Data Summary

Pump Test Report

HollyFrontier Navajo Refining LLC

			Southern Refinery and Southeastern Field Areas (continued)						
	WQCC Limits		MW-131 (continued)		MW-133				
Analyte	Current	Proposed	4/15/2015	10/19/2015	11/12/2014	4/17/2015	Maximum	Minimum	Average
Water Quality Parameters (mg/L)									
Calcium	--	--	168	197	200	163	590	4.82	215
Chloride	250	250	271	295	170	174	**7890**	21.0	358
Chemical Oxygen Demand	--	--					2920	167	1091
Fluoride	1.6	4	0.683	0.787	1.1	1.19	**19.7**	0.282	1.37
Hardness	--	--					1710	1250	1543.3
Nitrate/Nitrite	10	10	< 0.0200	0.038	< 0.02	< 0.2	2.21	0.0220	0.340
Potassium	--	--	0.328	0.622	0.46	0.323	8.35	0.181	1.22
Sodium	--	--	157	161	140 V	122	6710	23.9	265
Sulfate	600	600	9.57	16.1	140	116	**1300**	0.11	358
Sulfide	--	--					53	0.309	30.7
Total Dissolved Solids	1000	1000	1980	1180	1300	1190	**12500**	267	1790
Total Organic Carbon	--	--					56.2	5.67	23.1
Totatl Suspended Solids	--	--					6380	0.874	2128
pH (standard units)	6 to 9	6 to 9	6.68	6.52	5.65	6.72	**9.45**	5.53	6.9
Total Metals (mg/L)									
Arsenic	0.1	0.01	0.022	0.0261	0.019	0.00897	**0.105**	0.000408	0.0184
Boron	0.75	0.75					0.523	0.329	0.439
Chromium	0.05	0.1	0.000747	0.00371	0.0006	< 0.000540	0.0146	0.000567	0.00200
Iron	1	1	2.34	4.71	3.5	5.53	**192**	0.0295	4.92
Manganese	0.2	0.2	0.316	0.337	0.38	0.312	**2.6**	0.00278	0.700
Nickel	0.2	0.2					0.149	0.00108	0.0136
Selenium	0.05	0.05	< 0.000380	< 0.000380	< 0.00038	0.00124	**0.0607**	0.000393	0.00632
Uranium	0.03	0.03					0.000691	0.000516	0.000595
Vanadium	--	--					0.0116	0.00084	0.00408
Total Petroleum Hydrocarbons (mg/L)									
Gasoline Range Organics	--	--	7.68	6.76	9.4	11.3	37.7	0.0803	8.90
Diesel Range Organics	0.2	--	2.8	4	2.8	3.1	**16.2**	0.115	3.89
Oil Range Organics	0.2	--					**0.618**	0.0758	0.379
Volatile Organic Carbons (mg/L)									
Benzene	0.01	0.005	1.91	2.19	0.62	0.788	**15.9**	0.000477	2.74
Ethylbenzene	0.75	0.7	0.0692	0.048	0.3	0.199	**2.9**	0.00120	0.415
Isopropylbenzene	--	--	0.0162	0.022	0.057	< 0.0330	0.0921	0.000607	0.0369
Methyl tert-butyl ether	--	0.1	5.23	4.54	5.6	6.67	10.7	0.000441	2.07
Naphthalene	0.03	--	0.0468	0.0589	< 0.1	< 0.1	**0.51**	0.00160	0.103
N-propylbenzene	--	--	0.028	0.037	0.084	0.0451	0.17	0.000820	0.0521
Toluene	0.75	1	0.215	0.0522	0.1	< 0.0780	**2.4**	0.000920	0.316
1,2,4-trimethylbenzene	--	--	0.0486	0.0231	0.28	0.138	1.04	0.000690	0.212
1,3,5-trimethylbenzene	--	--	0.0119	0.00694	0.053	< 0.0390	0.195	0.000480	0.0431
Xylenes, total	0.62	10	0.145	0.0859	0.22	< 0.11	**3.47**	0.00113	0.572
Semivolatile Organics Carbons (mg/L)									
2,4-dimethylphenol	--	--					0.162	0.162	0.162
Acenaphthene	--	--					0.00185	0.00185	0.00185
Bis(2-ethylhexyl)phthalate	--	--					0.119	0.119	0.119
Fluorene	--	--					0.00327	0.00197	0.00262
Naphthalene	0.03	--					**0.168**	0.0208	0.111
Phenol	0.005	0.005					**0.145**	0.00278	0.0510

Notes and Abbreviations:

Maximum values highlighted in lavendar exceed the lower of the current or proposed WQCC limits

< X = result not detected at reporting limit of X

mg/L = milligrams/Liter

WQCC = Water Quality Control Commission

Table 4 - 2014 Groundwater Elevation Data Used for Model Surface

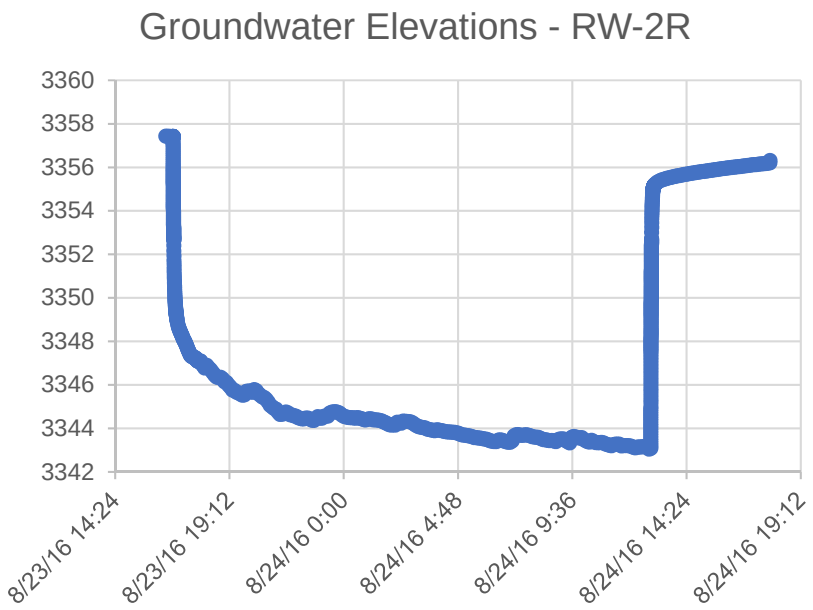
Pump Test Report
HollyFrontier Navajo Refining LLC

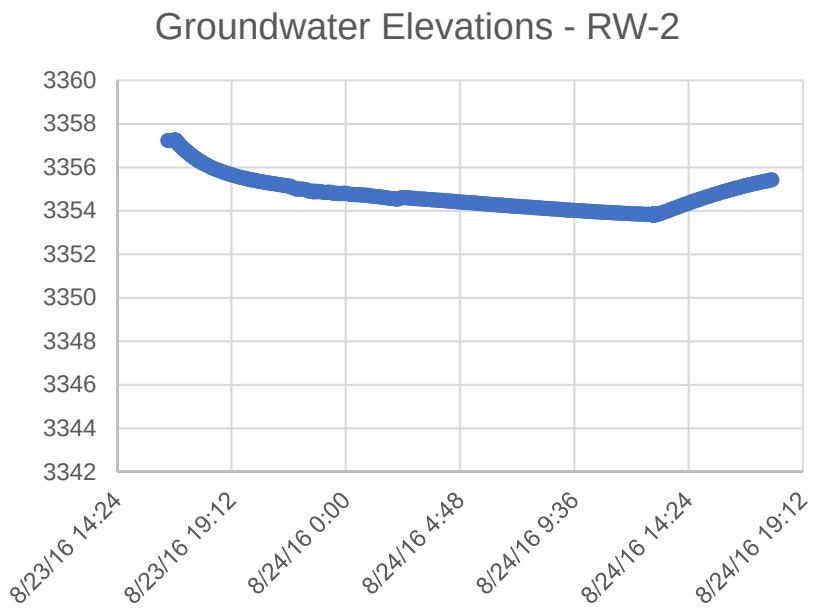
Well	Date	Groundwater Elevation (ft msl)
KWB-5	11/11/2014	3345.64
KWB-10R	11/11/2014	3339.95
KWB-12A	11/11/2014	3336.50
MW-19	11/11/2014	3360.55
MW-20	11/10/2014	3331.84
MW-46R	11/11/2014	3346.03
MW-50	11/10/2014	3356.66
MW-52	11/11/2014	3352.89
MW-53	11/11/2014	3360.28
MW-60	11/11/2014	3353.24
MW-66	11/10/2014	3350.45
MW-67	11/10/2014	3357.87
MW-90	11/10/2014	3359.34
MW-96	11/10/2014	3359.84
MW-98	11/11/2014	3353.58
MW-99	11/10/2014	3350.27
MW-105	11/10/2014	3355.71
MW-107	11/11/2014	3350.03
MW-108	11/11/2014	3359.37
MW-109	11/11/2014	3354.18
MW-110	11/11/2014	3355.71
MW-111	11/11/2014	3345.62
MW-115	11/11/2014	3352.56
MW-116	11/11/2014	3347.27
MW-118	11/10/2014	3358.39
MW-119	11/10/2014	3352.82
MW-125	11/11/2014	3350.57
MW-126A	11/10/2014	3347.87
MW-127	11/10/2014	3344.48
MW-128	11/11/2014	3347.47
MW-130	11/11/2014	3352.98
MW-131	11/11/2014	3344.53
MW-134	11/10/2014	3337.07
NP-1	11/11/2014	3330.38
NP-4	11/10/2014	3326.35

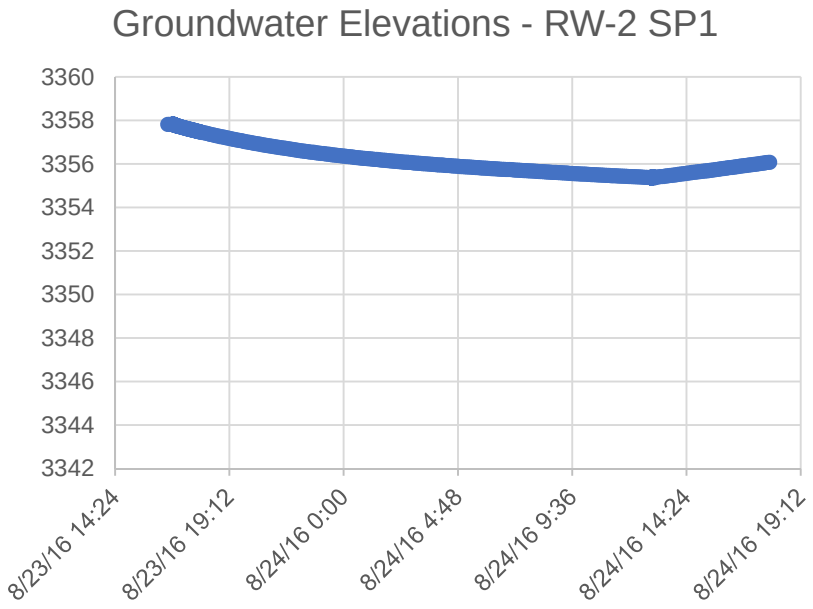
ft msl = feet, mean sea level
Wells shown were selected as representative of the groundwater surface unimpacted by recovery system pumping.

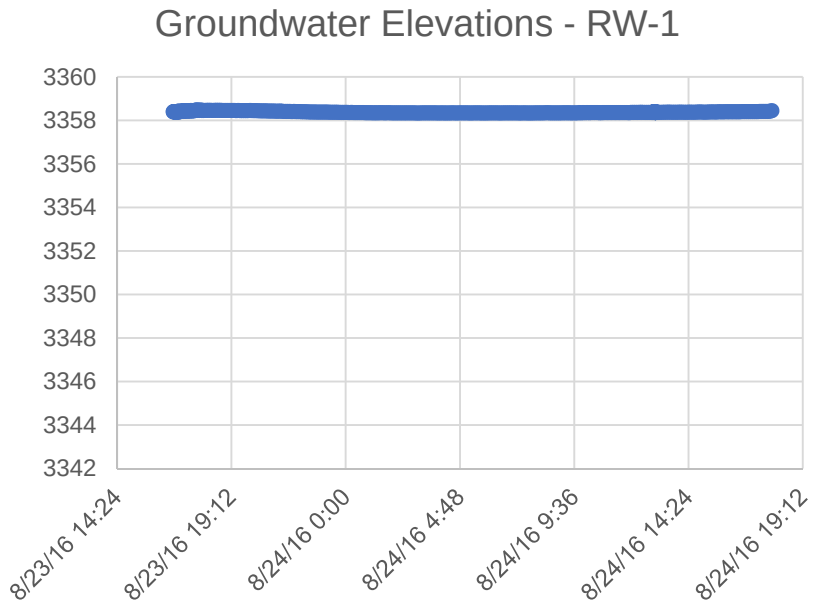
APPENDIX A

RW-2R Pump Test Observed Groundwater Elevations

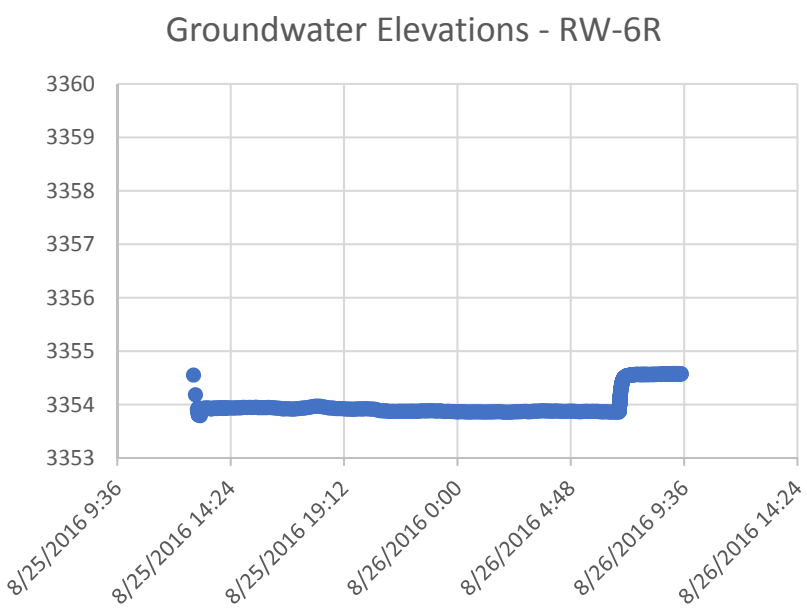


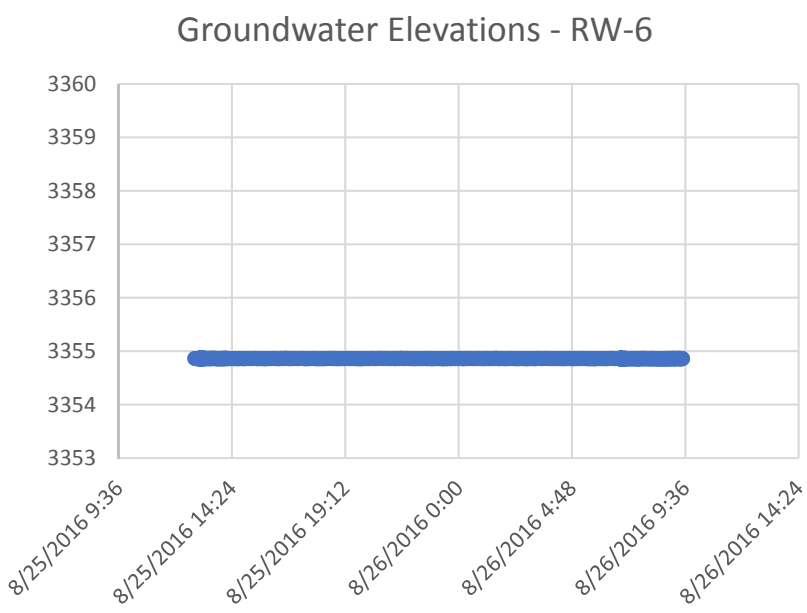


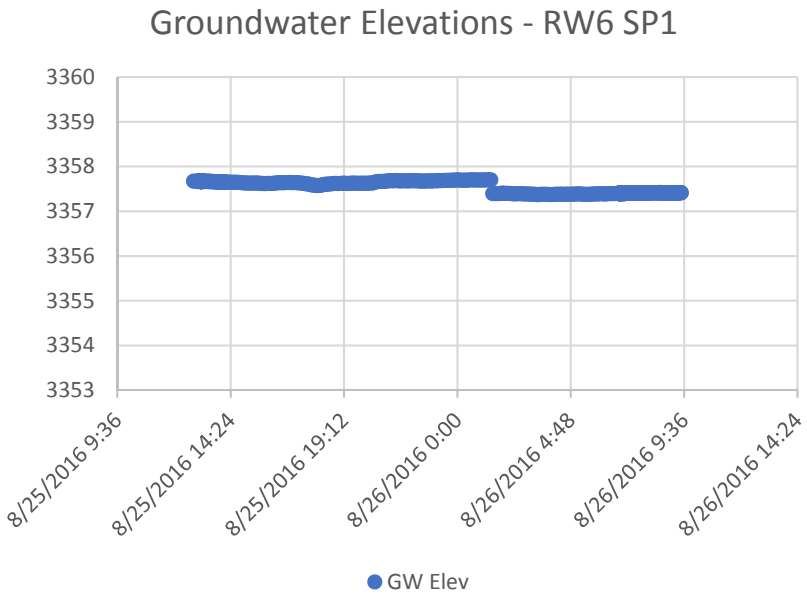




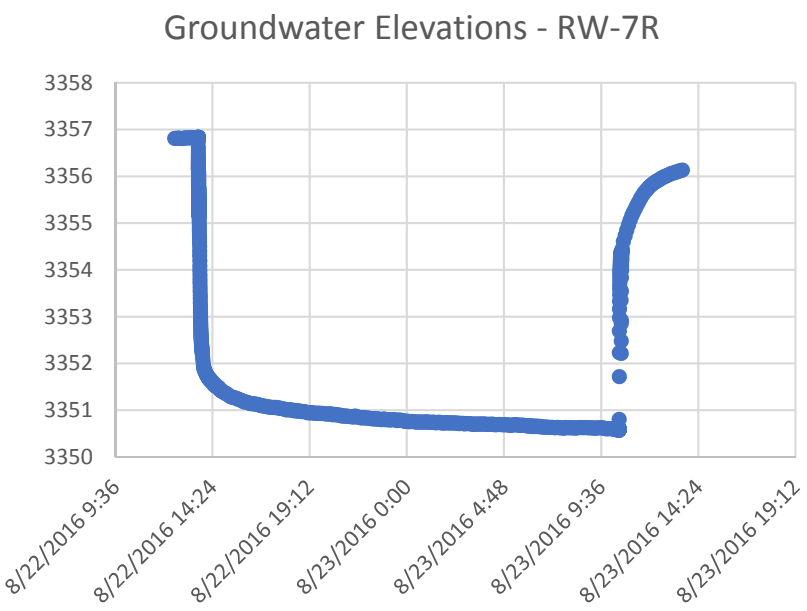
RW-6R Pump Test Observed Groundwater Elevations

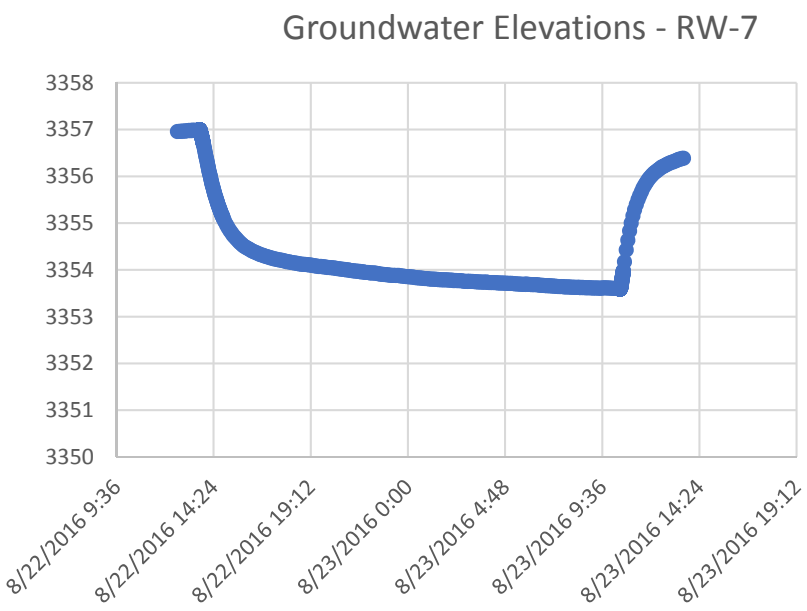


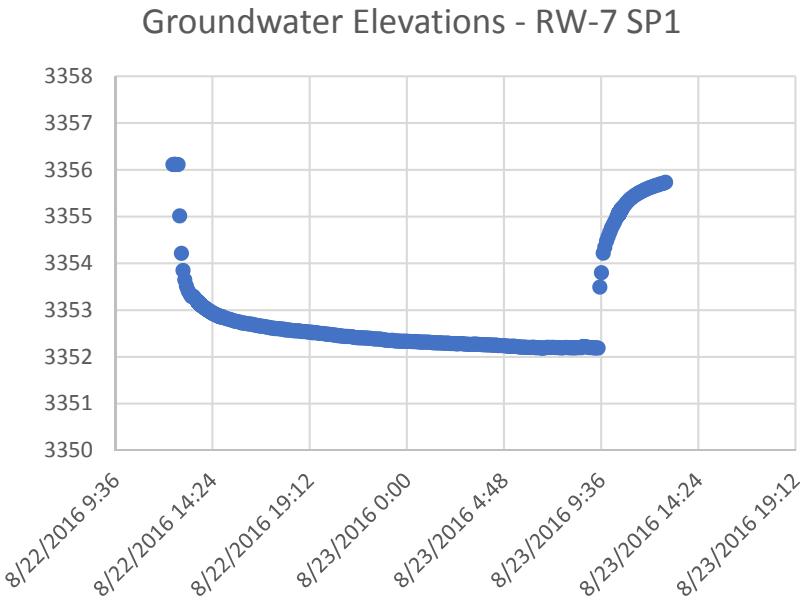


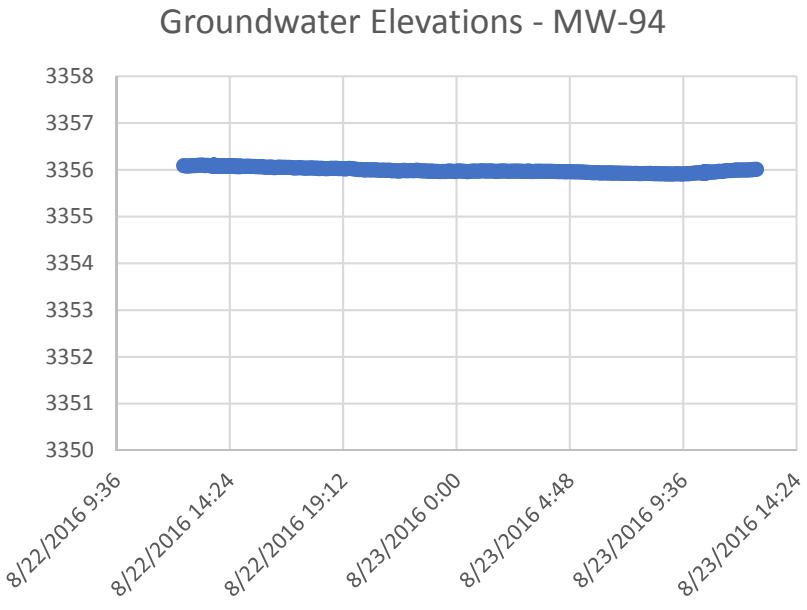


RW-7R Pump Test Observed Groundwater Elevations

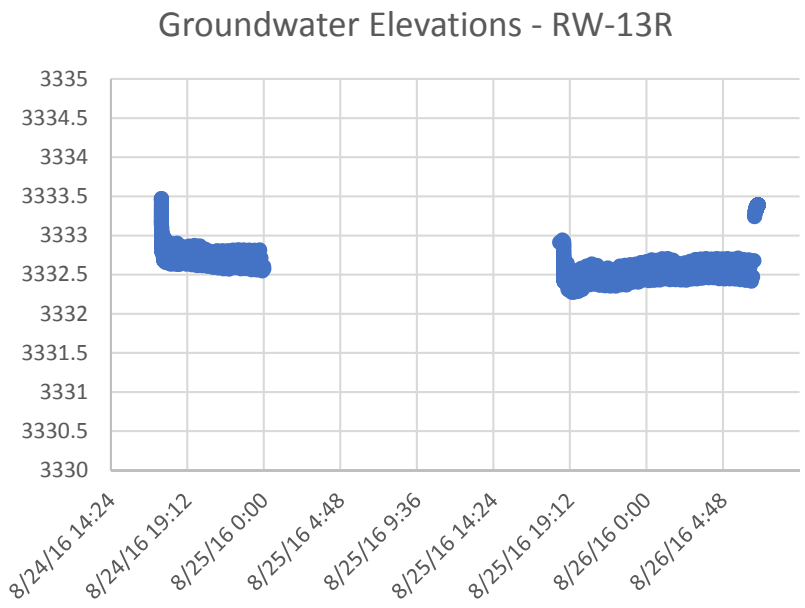


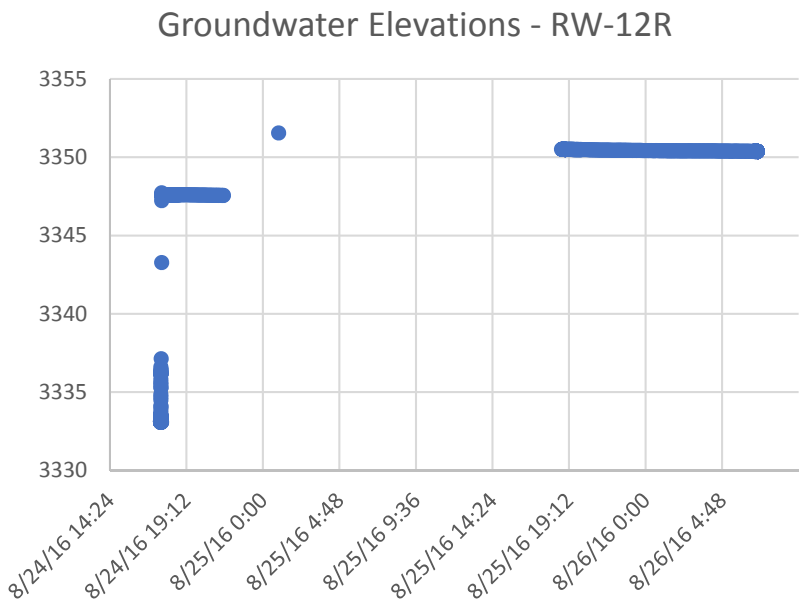


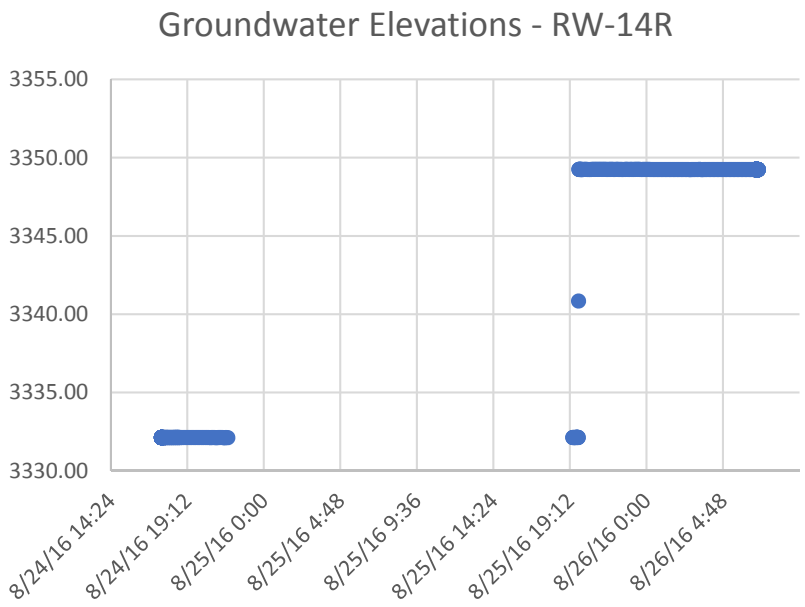


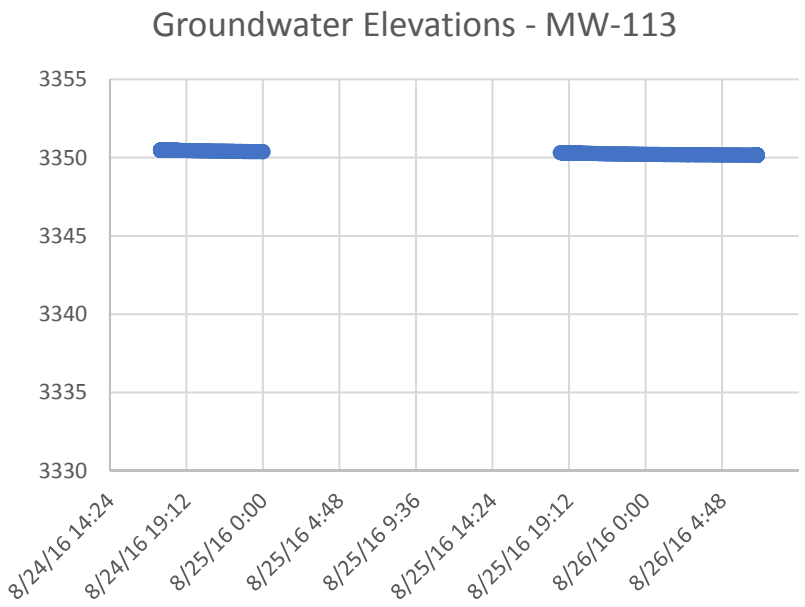


RW-13R Pump Test Observed Groundwater Elevations

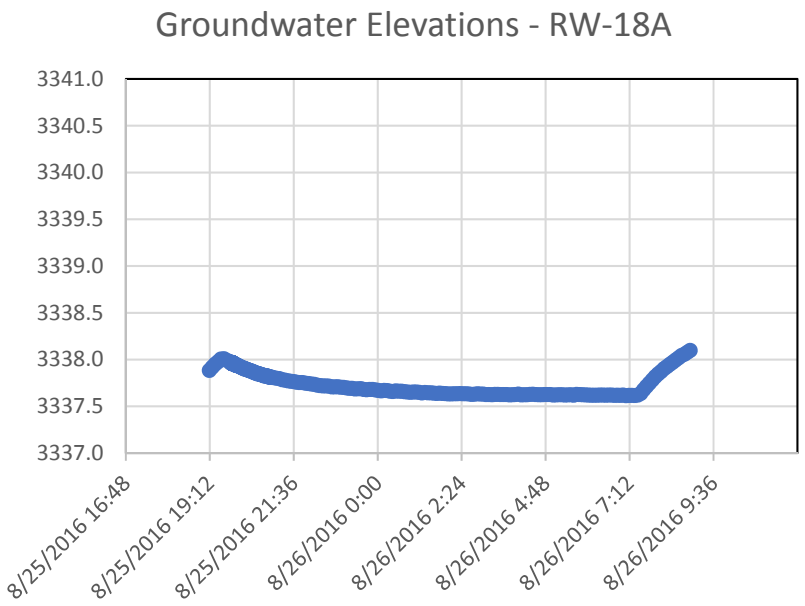


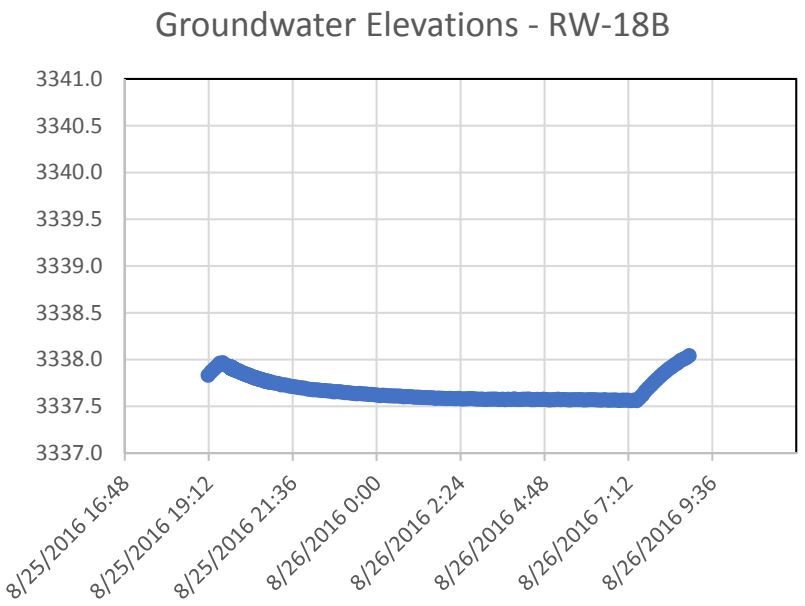


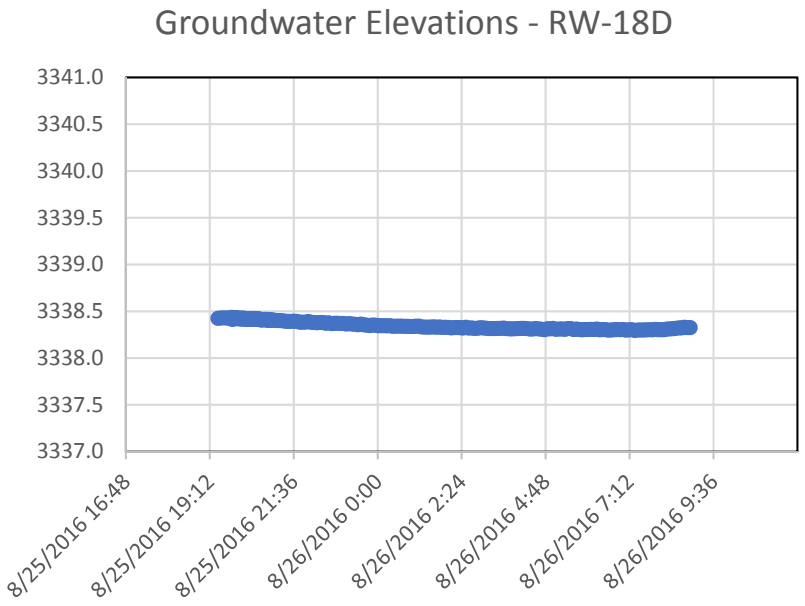


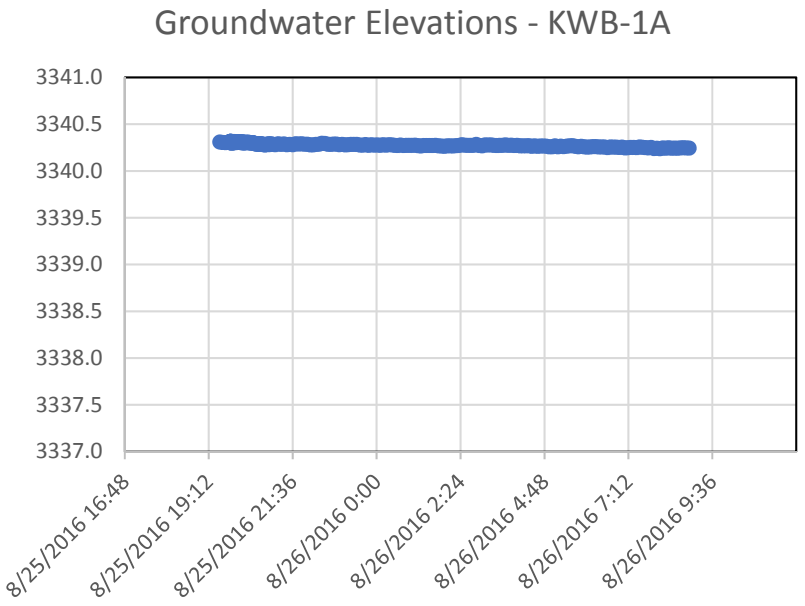


RW-18 Pump Test Observed Groundwater Elevations

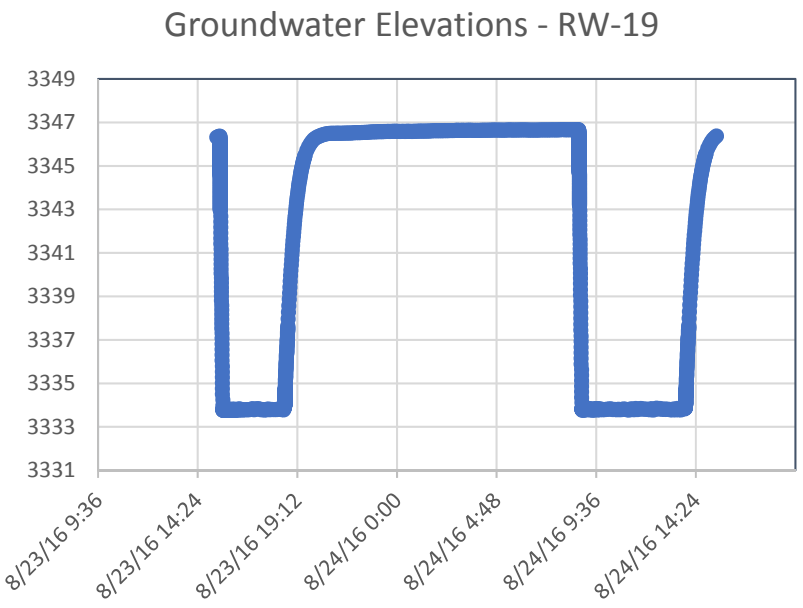


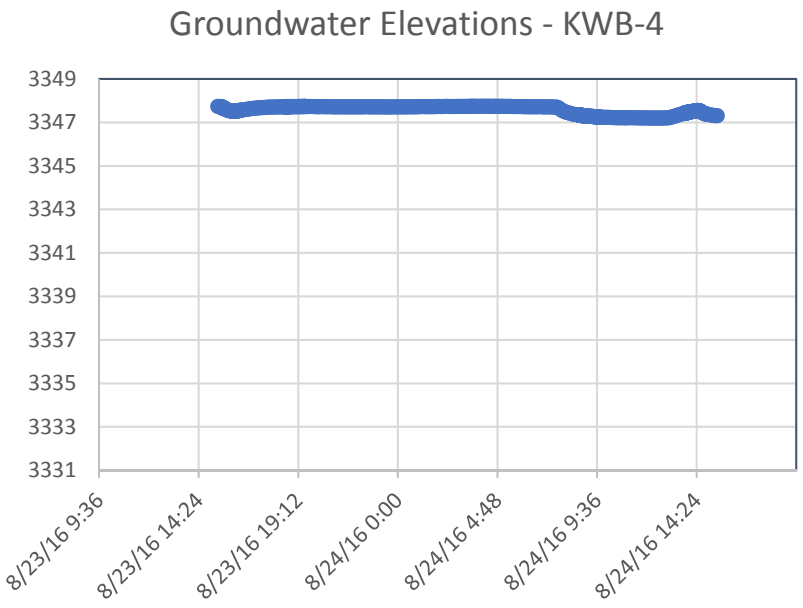


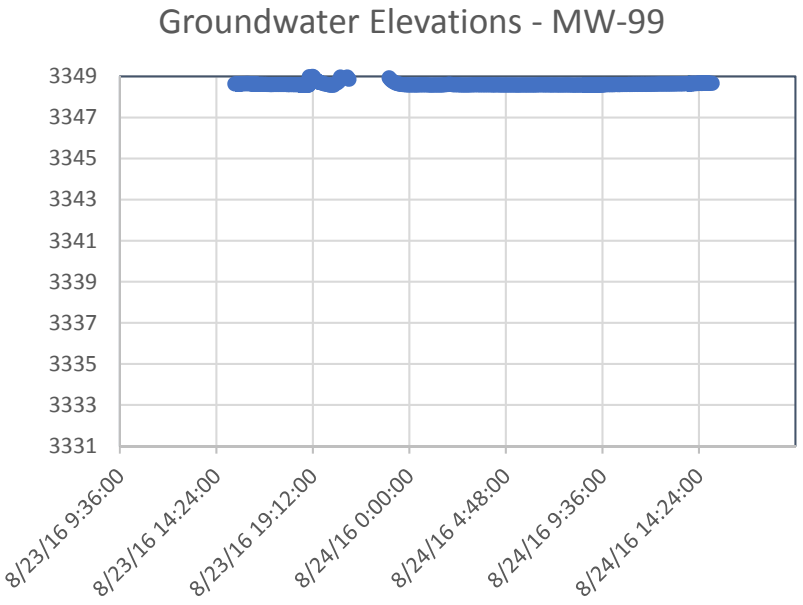




RW-19 Pump Test Observed Groundwater Elevations







APPENDIX B

ANALYTICAL REPORT

September 07, 2016

AMEC Foster Wheeler - Houston, TX

Sample Delivery Group:	L856325
Samples Received:	08/27/2016
Project Number:	
Description:	Pump Test HollyFrontier Navajo

Report To:

Pam Krueger
585 N. Dairy Ashford
Houston, TX 77079

Entire Report Reviewed By:

Chris McCord
Technical Service Representative

RW-13R-PRE L856325-01 GW

Collected by: Casey Richards
Collected date/time: 08/24/16 16:40
Received date/time: 08/27/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Gravimetric Analysis by Method 2540 C-2011	WG903336	1	08/30/16 10:13	08/30/16 10:57	MMF
Gravimetric Analysis by Method 2540 D-2011	WG903329	1	08/30/16 13:21	08/30/16 14:11	MMF
Metals (ICPMS) by Method 6020	WG903802	1	09/01/16 14:10	09/01/16 16:28	VSS
Metals (ICPMS) by Method 6020	WG903802	1	09/01/16 14:10	09/02/16 13:44	JDG
Semi Volatile Organic Compounds (GC/MS) by Method 8270 C	WG904031	5	08/30/16 19:14	08/31/16 18:07	SNR
Semi-Volatile Organic Compounds (GC) by Method 8015	WG903415	20	08/29/16 18:24	09/01/16 18:25	DMG
Volatile Organic Compounds (GC) by Method 8015D/GRO	WG903168	10	09/01/16 01:34	09/01/16 01:34	JAH
Volatile Organic Compounds (GC/MS) by Method 8260B	WG903933	100	09/03/16 08:06	09/03/16 08:06	JHH
Wet Chemistry by Method 130.1	WG903313	10	08/29/16 23:28	08/29/16 23:28	ASK
Wet Chemistry by Method 353.2	WG903504	1	08/31/16 13:32	08/31/16 13:32	DR
Wet Chemistry by Method 410.4	WG903305	1	08/30/16 07:12	08/30/16 09:29	AMC
Wet Chemistry by Method 4500S2 D-2011	WG902744	50	08/29/16 09:32	08/29/16 09:32	AMC
Wet Chemistry by Method 9040C	WG903248	1	08/29/16 14:28	08/29/16 14:28	MHM
Wet Chemistry by Method 9056A	WG903342	1	09/02/16 06:58	09/02/16 06:58	SAM
Wet Chemistry by Method 9056A	WG903342	10	09/02/16 08:01	09/02/16 08:01	SAM
Wet Chemistry by Method 9056A	WG903342	5	09/02/16 07:12	09/02/16 07:12	SAM
Wet Chemistry by Method 9060A	WG903806	5	09/04/16 19:00	09/04/16 19:00	CSU

RW-6R PRE L856325-02 GW

Collected by: Casey Richards
Collected date/time: 08/25/16 12:59
Received date/time: 08/27/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Gravimetric Analysis by Method 2540 C-2011	WG903653	1	09/01/16 05:27	09/01/16 05:44	JM
Gravimetric Analysis by Method 2540 D-2011	WG903449	1	08/31/16 08:51	08/31/16 09:52	MMF
Metals (ICPMS) by Method 6020	WG903802	1	09/01/16 14:10	09/01/16 18:03	VSS
Metals (ICPMS) by Method 6020	WG903802	1	09/01/16 14:10	09/02/16 13:57	JDG
Semi Volatile Organic Compounds (GC/MS) by Method 8270 C	WG904031	5.55	08/30/16 19:14	08/31/16 18:30	SNR
Semi-Volatile Organic Compounds (GC) by Method 8015	WG903667	1	08/30/16 21:12	09/01/16 16:08	DMG
Semi-Volatile Organic Compounds (GC) by Method 8015	WG903667	5	08/30/16 21:12	09/03/16 15:26	TRF
Volatile Organic Compounds (GC) by Method 8015D/GRO	WG903168	1	08/29/16 23:41	08/29/16 23:41	LRL
Volatile Organic Compounds (GC/MS) by Method 8260B	WG903933	50	09/03/16 08:26	09/03/16 08:26	JHH
Wet Chemistry by Method 130.1	WG903313	10	08/29/16 23:29	08/29/16 23:29	ASK
Wet Chemistry by Method 353.2	WG903504	1	08/31/16 15:45	08/31/16 15:45	DR
Wet Chemistry by Method 410.4	WG903305	100	08/30/16 07:12	08/30/16 09:29	AMC
Wet Chemistry by Method 4500S2 D-2011	WG902744	1	08/29/16 09:32	08/29/16 09:32	AMC
Wet Chemistry by Method 9040C	WG903248	1	08/29/16 14:28	08/29/16 14:28	MHM
Wet Chemistry by Method 9056A	WG903342	1	09/02/16 02:24	09/02/16 02:24	SAM
Wet Chemistry by Method 9056A	WG903342	10	09/02/16 02:38	09/02/16 02:38	SAM
Wet Chemistry by Method 9060A	WG903806	5	09/04/16 19:22	09/04/16 19:22	CSU

RW-13R POST L856325-03 GW

Collected by: Casey Richards
Collected date/time: 08/26/16 11:25
Received date/time: 08/27/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Gravimetric Analysis by Method 2540 C-2011	WG903653	1	09/01/16 05:27	09/01/16 05:44	JM
Gravimetric Analysis by Method 2540 D-2011	WG903449	1	08/31/16 08:51	08/31/16 09:52	MMF
Metals (ICPMS) by Method 6020	WG903802	1	09/01/16 14:10	09/01/16 18:06	VSS
Metals (ICPMS) by Method 6020	WG903802	1	09/01/16 14:10	09/02/16 14:00	JDG
Semi Volatile Organic Compounds (GC/MS) by Method 8270 C	WG904031	5	08/30/16 19:14	08/31/16 18:54	SNR
Semi-Volatile Organic Compounds (GC) by Method 8015	WG903667	1	08/30/16 21:12	09/01/16 16:27	DMG
Volatile Organic Compounds (GC) by Method 8015D/GRO	WG903168	10	09/01/16 01:57	09/01/16 01:57	JAH
Volatile Organic Compounds (GC/MS) by Method 8260B	WG903933	200	09/03/16 08:46	09/03/16 08:46	JHH
Wet Chemistry by Method 130.1	WG903313	10	08/29/16 23:29	08/29/16 23:29	ASK

RW-13R POST L856325-03 GW

Collected by: Casey Richards
Collected date/time: 08/26/16 11:25
Received date/time: 08/27/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 353.2	WG904198	1	09/01/16 16:03	09/01/16 16:03	DR
Wet Chemistry by Method 410.4	WG903305	1	08/30/16 07:12	08/30/16 09:29	AMC
Wet Chemistry by Method 4500S2 D-2011	WG902744	50	08/29/16 09:33	08/29/16 09:33	AMC
Wet Chemistry by Method 9040C	WG903248	1	08/29/16 14:28	08/29/16 14:28	MHM
Wet Chemistry by Method 9056A	WG903342	1	09/02/16 02:52	09/02/16 02:52	SAM
Wet Chemistry by Method 9056A	WG903342	10	09/02/16 03:07	09/02/16 03:07	SAM
Wet Chemistry by Method 9060A	WG903806	5	09/04/16 19:34	09/04/16 19:34	CSU

All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Chris McCord
Technical Service Representative

Sample Handling and Receiving

The analysis for 2-Chloroethyl Vinyl Ether was conducted from a chemically preserved container.

ESC Sample ID	Project Sample ID	Method
L856325-01	RW-13R-PRE	8260B
L856325-02	RW-6R PRE	8260B
L856325-03	RW-13R POST	8260B

The following samples were prepared and/or analyzed past recommended holding time. Concentrations should be considered minimum values.

ESC Sample ID	Project Sample ID	Method
L856325-01	RW-13R-PRE	9040C
L856325-02	RW-6R PRE	9040C
L856325-03	RW-13R POST	9040C

Gravimetric Analysis by Method 2540 C-2011

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Dissolved Solids	2550		2.82	10.0	1	08/30/2016 10:57	WG903336

Gravimetric Analysis by Method 2540 D-2011

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Suspended Solids	4.16		0.350	2.50	1	08/30/2016 14:11	WG903329

Wet Chemistry by Method 130.1

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Hardness, Total (mg/L as CaCO3)	1670		14.3	300	10	08/29/2016 23:28	WG903313

Wet Chemistry by Method 353.2

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Nitrate-Nitrite	0.165		0.0197	0.100	1	08/31/2016 13:32	WG903504

Wet Chemistry by Method 410.4

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
COD	185		3.00	10.0	1	08/30/2016 09:29	WG903305

Wet Chemistry by Method 4500S2 D-2011

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Sulfide	38.8		0.325	2.50	50	08/29/2016 09:32	WG902744

Wet Chemistry by Method 9040C

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	su			date / time	
pH	7.21		1	08/29/2016 14:28	WG903248

Sample Narrative:

9040C L856325-01 WG903248: 7.21 at 9.6c

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Chloride	178		0.260	5.00	5	09/02/2016 07:12	WG903342
Fluoride	0.726		0.00990	0.100	1	09/02/2016 06:58	WG903342
Sulfate	868		0.774	50.0	10	09/02/2016 08:01	WG903342

Wet Chemistry by Method 9060A

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
TOC (Total Organic Carbon)	7.33		0.510	5.00	5	09/04/2016 19:00	WG903806

Metals (ICPMS) by Method 6020

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Arsenic	0.00282		0.000250	0.00200	1	09/01/2016 16:28	WG903802
Boron	0.464	O1	0.00150	0.0200	1	09/02/2016 13:44	WG903802
Calcium	298	O1 V	0.0460	1.00	1	09/01/2016 16:28	WG903802
Chromium	0.00178	B J	0.000540	0.00200	1	09/01/2016 16:28	WG903802
Iron	12.0	O1	0.0150	0.100	1	09/01/2016 16:28	WG903802
Manganese	0.844	V	0.000250	0.00500	1	09/01/2016 16:28	WG903802
Nickel	0.0221	O1	0.000350	0.00200	1	09/01/2016 16:28	WG903802
Selenium	U	J3 J5	0.000380	0.00200	1	09/01/2016 16:28	WG903802
Potassium	0.415	J	0.0370	1.00	1	09/01/2016 16:28	WG903802
Sodium	158	O1 V	0.110	1.00	1	09/01/2016 16:28	WG903802
Vanadium	0.00138	J	0.000180	0.00500	1	09/01/2016 16:28	WG903802
Uranium	0.000516	J J3	0.000330	0.0100	1	09/01/2016 16:28	WG903802

Volatile Organic Compounds (GC) by Method 8015D/GRO

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
TPH (GC/FID) Low Fraction	19.9		0.314	1.00	10	09/01/2016 01:34	WG903168
(S) a,a,a-Trifluorotoluene(FID)	*91.5*			*62.0-128*		*09/01/2016 01:34*	WG903168

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Acetone	U		1.00	100	100	09/03/2016 08:06	WG903933
Acrolein	U		0.887	5.00	100	09/03/2016 08:06	WG903933
Acrylonitrile	U		0.187	1.00	100	09/03/2016 08:06	WG903933
Benzene	3.63		0.0331	0.100	100	09/03/2016 08:06	WG903933
Bromobenzene	U		0.0352	0.100	100	09/03/2016 08:06	WG903933
Bromodichloromethane	U		0.0380	0.125	100	09/03/2016 08:06	WG903933
Bromoform	U		0.0469	0.100	100	09/03/2016 08:06	WG903933
Bromomethane	U		0.0866	0.500	100	09/03/2016 08:06	WG903933
n-Butylbenzene	U		0.0361	0.100	100	09/03/2016 08:06	WG903933
sec-Butylbenzene	U		0.0365	0.100	100	09/03/2016 08:06	WG903933
tert-Butylbenzene	U		0.0399	0.100	100	09/03/2016 08:06	WG903933
Carbon tetrachloride	U		0.0379	0.100	100	09/03/2016 08:06	WG903933
Chlorobenzene	U		0.0348	0.100	100	09/03/2016 08:06	WG903933
Chlorodibromomethane	U		0.0327	0.100	100	09/03/2016 08:06	WG903933
Chloroethane	U		0.0453	0.500	100	09/03/2016 08:06	WG903933
2-Chloroethyl vinyl ether	U		0.301	5.00	100	09/03/2016 08:06	WG903933
Chloroform	U		0.0324	0.500	100	09/03/2016 08:06	WG903933
Chloromethane	U		0.0276	0.250	100	09/03/2016 08:06	WG903933
2-Chlorotoluene	U		0.0375	0.100	100	09/03/2016 08:06	WG903933
4-Chlorotoluene	U		0.0351	0.100	100	09/03/2016 08:06	WG903933
1,2-Dibromo-3-Chloropropane	U		0.133	0.500	100	09/03/2016 08:06	WG903933
1,2-Dibromoethane	U		0.0381	0.100	100	09/03/2016 08:06	WG903933
Dibromomethane	U		0.0346	0.100	100	09/03/2016 08:06	WG903933
1,2-Dichlorobenzene	U		0.0349	0.100	100	09/03/2016 08:06	WG903933
1,3-Dichlorobenzene	U		0.0220	0.100	100	09/03/2016 08:06	WG903933
1,4-Dichlorobenzene	U		0.0274	0.100	100	09/03/2016 08:06	WG903933
Dichlorodifluoromethane	U		0.0551	0.500	100	09/03/2016 08:06	WG903933
1,1-Dichloroethane	U		0.0259	0.100	100	09/03/2016 08:06	WG903933
1,2-Dichloroethane	U		0.0361	0.100	100	09/03/2016 08:06	WG903933
1,1-Dichloroethene	U		0.0398	0.100	100	09/03/2016 08:06	WG903933
cis-1,2-Dichloroethene	U		0.0260	0.100	100	09/03/2016 08:06	WG903933
trans-1,2-Dichloroethene	U		0.0396	0.100	100	09/03/2016 08:06	WG903933
1,2-Dichloropropane	U		0.0306	0.100	100	09/03/2016 08:06	WG903933

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
1,1-Dichloropropene	U		0.0352	0.100	100	09/03/2016 08:06	WG903933
1,3-Dichloropropane	U		0.0366	0.100	100	09/03/2016 08:06	WG903933
cis-1,3-Dichloropropene	U		0.0418	0.100	100	09/03/2016 08:06	WG903933
trans-1,3-Dichloropropene	U		0.0419	0.100	100	09/03/2016 08:06	WG903933
2,2-Dichloropropane	U		0.0321	0.100	100	09/03/2016 08:06	WG903933
Di-isopropyl ether	U		0.0320	0.100	100	09/03/2016 08:06	WG903933
Ethylbenzene	1.45		0.0384	0.100	100	09/03/2016 08:06	WG903933
Hexachloro-1,3-butadiene	U		0.0256	0.100	100	09/03/2016 08:06	WG903933
Isopropylbenzene	0.0782	J	0.0326	0.100	100	09/03/2016 08:06	WG903933
p-Isopropyltoluene	U		0.0350	0.100	100	09/03/2016 08:06	WG903933
2-Butanone (MEK)	U	J4	0.393	1.00	100	09/03/2016 08:06	WG903933
Methylene Chloride	U		0.100	0.500	100	09/03/2016 08:06	WG903933
4-Methyl-2-pentanone (MIBK)	U		0.214	1.00	100	09/03/2016 08:06	WG903933
Methyl tert-butyl ether	U		0.0367	0.100	100	09/03/2016 08:06	WG903933
Naphthalene	0.315	J	0.100	0.500	100	09/03/2016 08:06	WG903933
n-Propylbenzene	0.170		0.0349	0.100	100	09/03/2016 08:06	WG903933
Styrene	U		0.0307	0.100	100	09/03/2016 08:06	WG903933
1,1,1,2-Tetrachloroethane	U		0.0385	0.100	100	09/03/2016 08:06	WG903933
1,1,2,2-Tetrachloroethane	U		0.0130	0.100	100	09/03/2016 08:06	WG903933
1,1,2-Trichlorotrifluoroethane	U		0.0303	0.100	100	09/03/2016 08:06	WG903933
Tetrachloroethene	U		0.0372	0.100	100	09/03/2016 08:06	WG903933
Toluene	0.157	J	0.0780	0.500	100	09/03/2016 08:06	WG903933
1,2,3-Trichlorobenzene	U		0.0230	0.100	100	09/03/2016 08:06	WG903933
1,2,4-Trichlorobenzene	U		0.0355	0.100	100	09/03/2016 08:06	WG903933
1,1,1-Trichloroethane	U		0.0319	0.100	100	09/03/2016 08:06	WG903933
1,1,2-Trichloroethane	U		0.0383	0.100	100	09/03/2016 08:06	WG903933
Trichloroethene	U		0.0398	0.100	100	09/03/2016 08:06	WG903933
Trichlorofluoromethane	U		0.120	0.500	100	09/03/2016 08:06	WG903933
1,2,3-Trichloropropane	U		0.0807	0.250	100	09/03/2016 08:06	WG903933
1,2,4-Trimethylbenzene	0.719		0.0373	0.100	100	09/03/2016 08:06	WG903933
1,2,3-Trimethylbenzene	0.263		0.0321	0.100	100	09/03/2016 08:06	WG903933
1,3,5-Trimethylbenzene	0.129		0.0387	0.100	100	09/03/2016 08:06	WG903933
Vinyl chloride	U		0.0259	0.100	100	09/03/2016 08:06	WG903933
Xylenes, Total	2.07		0.106	0.300	100	09/03/2016 08:06	WG903933
(S) Toluene-d8	*111*			*90.0-115*		*09/03/2016 08:06*	WG903933
(S) Dibromofluoromethane	*112*			*79.0-121*		*09/03/2016 08:06*	WG903933
(S) 4-Bromofluorobenzene	*90.5*			*80.1-120*		*09/03/2016 08:06*	WG903933

Semi-Volatile Organic Compounds (GC) by Method 8015

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
C10-C28 Diesel Range	2.84		0.444	2.00	20	09/01/2016 18:25	WG903415
C28-C40 Oil Range	0.442	J	0.236	2.00	20	09/01/2016 18:25	WG903415
(S) o-Terphenyl	*106*	J7		*50.0-150*		*09/01/2016 18:25*	WG903415

Semi Volatile Organic Compounds (GC/MS) by Method 8270 C

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
Acenaphthene	U		0.00158	0.00500	5	08/31/2016 18:07	WG904031
Acenaphthylene	U		0.00154	0.00500	5	08/31/2016 18:07	WG904031
Anthracene	U		0.00146	0.00500	5	08/31/2016 18:07	WG904031
Benzidine	U	J3	0.0216	0.0500	5	08/31/2016 18:07	WG904031
Benzo(a)anthracene	U		0.000255	0.00500	5	08/31/2016 18:07	WG904031
Benzo(b)fluoranthene	U		0.000448	0.00500	5	08/31/2016 18:07	WG904031
Benzo(k)fluoranthene	U		0.00178	0.00500	5	08/31/2016 18:07	WG904031

Semi Volatile Organic Compounds (GC/MS) by Method 8270 C

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
Benzo(g,h,i)perylene	U		0.0000114	0.00500	5	08/31/2016 18:07	WG904031
Benzo(a)pyrene	U		0.000190	0.00100	5	08/31/2016 18:07	WG904031
Bis(2-chlorethoxy)methane	U		0.00164	0.0500	5	08/31/2016 18:07	WG904031
Bis(2-chloroethyl)ether	U		0.00810	0.0500	5	08/31/2016 18:07	WG904031
Bis(2-chloroisopropyl)ether	U		0.00222	0.0500	5	08/31/2016 18:07	WG904031
4-Bromophenyl-phenylether	U		0.00168	0.0500	5	08/31/2016 18:07	WG904031
2-Chloronaphthalene	U		0.00165	0.00500	5	08/31/2016 18:07	WG904031
4-Chlorophenyl-phenylether	U		0.00152	0.0500	5	08/31/2016 18:07	WG904031
Chrysene	U		0.00166	0.00500	5	08/31/2016 18:07	WG904031
Dibenz(a,h)anthracene	U		0.000322	0.00100	5	08/31/2016 18:07	WG904031
3,3-Dichlorobenzidine	U		0.0101	0.0500	5	08/31/2016 18:07	WG904031
2,4-Dinitrotoluene	U		0.00825	0.0500	5	08/31/2016 18:07	WG904031
2,6-Dinitrotoluene	U		0.00140	0.0500	5	08/31/2016 18:07	WG904031
Fluoranthene	U		0.00155	0.00500	5	08/31/2016 18:07	WG904031
Fluorene	0.00197	J	0.00162	0.00500	5	08/31/2016 18:07	WG904031
Hexachlorobenzene	U		0.00170	0.00500	5	08/31/2016 18:07	WG904031
Hexachloro-1,3-butadiene	U		0.00164	0.0500	5	08/31/2016 18:07	WG904031
Hexachlorocyclopentadiene	U		0.0116	0.0500	5	08/31/2016 18:07	WG904031
Hexachloroethane	U		0.00182	0.0500	5	08/31/2016 18:07	WG904031
Indeno(1,2,3-cd)pyrene	U		0.00140	0.00500	5	08/31/2016 18:07	WG904031
Isophorone	U		0.00136	0.0500	5	08/31/2016 18:07	WG904031
Naphthalene	0.168		0.00186	0.00500	5	08/31/2016 18:07	WG904031
Nitrobenzene	U		0.00184	0.0500	5	08/31/2016 18:07	WG904031
n-Nitrosodimethylamine	U		0.00630	0.0500	5	08/31/2016 18:07	WG904031
n-Nitrosodiphenylamine	U		0.00152	0.0500	5	08/31/2016 18:07	WG904031
n-Nitrosodi-n-propylamine	U		0.00202	0.0500	5	08/31/2016 18:07	WG904031
Phenanthrene	U		0.00183	0.00500	5	08/31/2016 18:07	WG904031
Benzylbutyl phthalate	U		0.00138	0.0150	5	08/31/2016 18:07	WG904031
Bis(2-ethylhexyl)phthalate	U		0.00354	0.0150	5	08/31/2016 18:07	WG904031
Di-n-butyl phthalate	U		0.00133	0.0150	5	08/31/2016 18:07	WG904031
Diethyl phthalate	U		0.00141	0.0150	5	08/31/2016 18:07	WG904031
Dimethyl phthalate	U		0.00142	0.0150	5	08/31/2016 18:07	WG904031
Di-n-octyl phthalate	U		0.00139	0.0150	5	08/31/2016 18:07	WG904031
Pyrene	U		0.00165	0.00500	5	08/31/2016 18:07	WG904031
1,2,4-Trichlorobenzene	U		0.00178	0.0500	5	08/31/2016 18:07	WG904031
4-Chloro-3-methylphenol	U		0.00132	0.0500	5	08/31/2016 18:07	WG904031
2-Chlorophenol	U		0.00142	0.0500	5	08/31/2016 18:07	WG904031
2,4-Dichlorophenol	U		0.00142	0.0500	5	08/31/2016 18:07	WG904031
2,4-Dimethylphenol	U		0.00312	0.0500	5	08/31/2016 18:07	WG904031
4,6-Dinitro-2-methylphenol	U		0.0131	0.0500	5	08/31/2016 18:07	WG904031
2,4-Dinitrophenol	U		0.0162	0.0500	5	08/31/2016 18:07	WG904031
2-Nitrophenol	U		0.00160	0.0500	5	08/31/2016 18:07	WG904031
4-Nitrophenol	U		0.0100	0.0500	5	08/31/2016 18:07	WG904031
Pentachlorophenol	U		0.00156	0.0500	5	08/31/2016 18:07	WG904031
Phenol	0.00514	J	0.00167	0.0500	5	08/31/2016 18:07	WG904031
2,4,6-Trichlorophenol	U		0.00148	0.0500	5	08/31/2016 18:07	WG904031
(S) 2-Fluorophenol	*49.4*			*10.0-77.9*		*08/31/2016 18:07*	WG904031
(S) Phenol-d5	*31.6*			*5.00-70.1*		*08/31/2016 18:07*	WG904031
(S) Nitrobenzene-d5	*69.5*			*21.8-123*		*08/31/2016 18:07*	WG904031
(S) 2-Fluorobiphenyl	*60.7*			*29.5-131*		*08/31/2016 18:07*	WG904031
(S) 2,4,6-Tribromophenol	*69.1*			*11.2-130*		*08/31/2016 18:07*	WG904031
(S) p-Terphenyl-d14	*71.8*			*29.3-137*		*08/31/2016 18:07*	WG904031

Sample Narrative:

8270 C L856325-01 WG904031: Dilution due to matrix

Gravimetric Analysis by Method 2540 C-2011

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Dissolved Solids	1650		2.82	10.0	1	09/01/2016 05:44	WG903653

Gravimetric Analysis by Method 2540 D-2011

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Suspended Solids	6380	J3	0.350	2.50	1	08/31/2016 09:52	WG903449

Wet Chemistry by Method 130.1

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Hardness, Total (mg/L as CaCO3)	1250		14.3	300	10	08/29/2016 23:29	WG903313

Wet Chemistry by Method 353.2

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Nitrate-Nitrite	2.21		0.0197	0.100	1	08/31/2016 15:45	WG903504

Wet Chemistry by Method 410.4

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
COD	2920		300	1000	100	08/30/2016 09:29	WG903305

Wet Chemistry by Method 4500S2 D-2011

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Sulfide	0.309		0.00650	0.0500	1	08/29/2016 09:32	WG902744

Wet Chemistry by Method 9040C

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	su			date / time	
pH	7.15		1	08/29/2016 14:28	WG903248

Sample Narrative:

9040C L856325-02 WG903248: 7.15 at 9.3c

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Chloride	400		0.519	10.0	10	09/02/2016 02:38	WG903342
Fluoride	0.683		0.00990	0.100	1	09/02/2016 02:24	WG903342
Sulfate	11.1		0.0774	5.00	1	09/02/2016 02:24	WG903342

Wet Chemistry by Method 9060A

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
TOC (Total Organic Carbon)	56.2		0.510	5.00	5	09/04/2016 19:22	WG903806

Metals (ICPMS) by Method 6020

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Arsenic	0.105		0.000250	0.00200	1	09/01/2016 18:03	WG903802
Boron	0.329		0.00150	0.0200	1	09/02/2016 13:57	WG903802
Calcium	242		0.0460	1.00	1	09/01/2016 18:03	WG903802
Chromium	0.0146	B	0.000540	0.00200	1	09/01/2016 18:03	WG903802
Iron	192		0.0150	0.100	1	09/01/2016 18:03	WG903802
Manganese	0.398		0.000250	0.00500	1	09/01/2016 18:03	WG903802
Nickel	0.149		0.000350	0.00200	1	09/01/2016 18:03	WG903802
Selenium	0.0294		0.000380	0.00200	1	09/01/2016 18:03	WG903802
Potassium	0.804	J	0.0370	1.00	1	09/01/2016 18:03	WG903802
Sodium	197		0.110	1.00	1	09/01/2016 18:03	WG903802
Vanadium	0.00445	J	0.000180	0.00500	1	09/01/2016 18:03	WG903802
Uranium	0.000691	J	0.000330	0.0100	1	09/01/2016 18:03	WG903802

Volatile Organic Compounds (GC) by Method 8015D/GRO

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
TPH (GC/FID) Low Fraction	5.28		0.0314	0.100	1	08/29/2016 23:41	WG903168
(S) α,α,α-Trifluorotoluene(FID)	*94.5*			*62.0-128*		*08/29/2016 23:41*	WG903168

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Acetone	U		0.500	50.0	50	09/03/2016 08:26	WG903933
Acrolein	U		0.444	2.50	50	09/03/2016 08:26	WG903933
Acrylonitrile	U		0.0935	0.500	50	09/03/2016 08:26	WG903933
Benzene	1.75		0.0166	0.0500	50	09/03/2016 08:26	WG903933
Bromobenzene	U		0.0176	0.0500	50	09/03/2016 08:26	WG903933
Bromodichloromethane	U		0.0190	0.0625	50	09/03/2016 08:26	WG903933
Bromoform	U		0.0234	0.0500	50	09/03/2016 08:26	WG903933
Bromomethane	U		0.0433	0.250	50	09/03/2016 08:26	WG903933
n-Butylbenzene	U		0.0180	0.0500	50	09/03/2016 08:26	WG903933
sec-Butylbenzene	U		0.0182	0.0500	50	09/03/2016 08:26	WG903933
tert-Butylbenzene	U		0.0200	0.0500	50	09/03/2016 08:26	WG903933
Carbon tetrachloride	U		0.0190	0.0500	50	09/03/2016 08:26	WG903933
Chlorobenzene	U		0.0174	0.0500	50	09/03/2016 08:26	WG903933
Chlorodibromomethane	U		0.0164	0.0500	50	09/03/2016 08:26	WG903933
Chloroethane	U		0.0226	0.250	50	09/03/2016 08:26	WG903933
2-Chloroethyl vinyl ether	U		0.150	2.50	50	09/03/2016 08:26	WG903933
Chloroform	U		0.0162	0.250	50	09/03/2016 08:26	WG903933
Chloromethane	U		0.0138	0.125	50	09/03/2016 08:26	WG903933
2-Chlorotoluene	U		0.0188	0.0500	50	09/03/2016 08:26	WG903933
4-Chlorotoluene	U		0.0176	0.0500	50	09/03/2016 08:26	WG903933
1,2-Dibromo-3-Chloropropane	U		0.0665	0.250	50	09/03/2016 08:26	WG903933
1,2-Dibromoethane	U		0.0190	0.0500	50	09/03/2016 08:26	WG903933
Dibromomethane	U		0.0173	0.0500	50	09/03/2016 08:26	WG903933
1,2-Dichlorobenzene	U		0.0174	0.0500	50	09/03/2016 08:26	WG903933
1,3-Dichlorobenzene	U		0.0110	0.0500	50	09/03/2016 08:26	WG903933
1,4-Dichlorobenzene	U		0.0137	0.0500	50	09/03/2016 08:26	WG903933
Dichlorodifluoromethane	U		0.0276	0.250	50	09/03/2016 08:26	WG903933
1,1-Dichloroethane	U		0.0130	0.0500	50	09/03/2016 08:26	WG903933
1,2-Dichloroethane	U		0.0180	0.0500	50	09/03/2016 08:26	WG903933
1,1-Dichloroethene	U		0.0199	0.0500	50	09/03/2016 08:26	WG903933
cis-1,2-Dichloroethene	U		0.0130	0.0500	50	09/03/2016 08:26	WG903933
trans-1,2-Dichloroethene	U		0.0198	0.0500	50	09/03/2016 08:26	WG903933
1,2-Dichloropropane	U		0.0153	0.0500	50	09/03/2016 08:26	WG903933

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
1,1-Dichloropropene	U		0.0176	0.0500	50	09/03/2016 08:26	WG903933
1,3-Dichloropropane	U		0.0183	0.0500	50	09/03/2016 08:26	WG903933
cis-1,3-Dichloropropene	U		0.0209	0.0500	50	09/03/2016 08:26	WG903933
trans-1,3-Dichloropropene	U		0.0210	0.0500	50	09/03/2016 08:26	WG903933
2,2-Dichloropropane	U		0.0160	0.0500	50	09/03/2016 08:26	WG903933
Di-isopropyl ether	U		0.0160	0.0500	50	09/03/2016 08:26	WG903933
Ethylbenzene	0.0436	J	0.0192	0.0500	50	09/03/2016 08:26	WG903933
Hexachloro-1,3-butadiene	U		0.0128	0.0500	50	09/03/2016 08:26	WG903933
Isopropylbenzene	U		0.0163	0.0500	50	09/03/2016 08:26	WG903933
p-Isopropyltoluene	U		0.0175	0.0500	50	09/03/2016 08:26	WG903933
2-Butanone (MEK)	U	J4	0.196	0.500	50	09/03/2016 08:26	WG903933
Methylene Chloride	U		0.0500	0.250	50	09/03/2016 08:26	WG903933
4-Methyl-2-pentanone (MIBK)	U		0.107	0.500	50	09/03/2016 08:26	WG903933
Methyl tert-butyl ether	1.90		0.0184	0.0500	50	09/03/2016 08:26	WG903933
Naphthalene	U		0.0500	0.250	50	09/03/2016 08:26	WG903933
n-Propylbenzene	0.0267	J	0.0174	0.0500	50	09/03/2016 08:26	WG903933
Styrene	U		0.0154	0.0500	50	09/03/2016 08:26	WG903933
1,1,1,2-Tetrachloroethane	U		0.0192	0.0500	50	09/03/2016 08:26	WG903933
1,1,2,2-Tetrachloroethane	U		0.00650	0.0500	50	09/03/2016 08:26	WG903933
1,1,2-Trichlorotrifluoroethane	U		0.0152	0.0500	50	09/03/2016 08:26	WG903933
Tetrachloroethene	U		0.0186	0.0500	50	09/03/2016 08:26	WG903933
Toluene	0.0610	J	0.0390	0.250	50	09/03/2016 08:26	WG903933
1,2,3-Trichlorobenzene	U		0.0115	0.0500	50	09/03/2016 08:26	WG903933
1,2,4-Trichlorobenzene	U		0.0178	0.0500	50	09/03/2016 08:26	WG903933
1,1,1-Trichloroethane	U		0.0160	0.0500	50	09/03/2016 08:26	WG903933
1,1,2-Trichloroethane	U		0.0192	0.0500	50	09/03/2016 08:26	WG903933
Trichloroethene	U		0.0199	0.0500	50	09/03/2016 08:26	WG903933
Trichlorofluoromethane	U		0.0600	0.250	50	09/03/2016 08:26	WG903933
1,2,3-Trichloropropane	U		0.0404	0.125	50	09/03/2016 08:26	WG903933
1,2,4-Trimethylbenzene	0.0568		0.0186	0.0500	50	09/03/2016 08:26	WG903933
1,2,3-Trimethylbenzene	0.0226	J	0.0160	0.0500	50	09/03/2016 08:26	WG903933
1,3,5-Trimethylbenzene	U		0.0194	0.0500	50	09/03/2016 08:26	WG903933
Vinyl chloride	U		0.0130	0.0500	50	09/03/2016 08:26	WG903933
Xylenes, Total	0.0648	J	0.0530	0.150	50	09/03/2016 08:26	WG903933
(S) Toluene-d8	*111*			*90.0-115*		*09/03/2016 08:26*	WG903933
(S) Dibromofluoromethane	*110*			*79.0-121*		*09/03/2016 08:26*	WG903933
(S) 4-Bromofluorobenzene	*93.4*			*80.1-120*		*09/03/2016 08:26*	WG903933

Semi-Volatile Organic Compounds (GC) by Method 8015

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
C10-C28 Diesel Range	15.3		0.111	0.500	5	09/03/2016 15:26	WG903667
C28-C40 Oil Range	0.618		0.0118	0.100	1	09/01/2016 16:08	WG903667
(S) o-Terphenyl	*98.5*			*50.0-150*		*09/01/2016 16:08*	WG903667
(S) o-Terphenyl	*104*			*50.0-150*		*09/03/2016 15:26*	WG903667

Semi Volatile Organic Compounds (GC/MS) by Method 8270 C

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
Acenaphthene	0.00185	J	0.00175	0.00555	5.55	08/31/2016 18:30	WG904031
Acenaphthylene	U		0.00171	0.00555	5.55	08/31/2016 18:30	WG904031
Anthracene	U		0.00162	0.00555	5.55	08/31/2016 18:30	WG904031
Benzidine	U	J3	0.0240	0.0555	5.55	08/31/2016 18:30	WG904031
Benzo(a)anthracene	U		0.000283	0.00555	5.55	08/31/2016 18:30	WG904031
Benzo(b)fluoranthene	U		0.000497	0.00555	5.55	08/31/2016 18:30	WG904031

Semi Volatile Organic Compounds (GC/MS) by Method 8270 C

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Benzo(k)fluoranthene	U		0.00197	0.00555	5.55	08/31/2016 18:30	WG904031
Benzo(g,h,i)perylene	U		0.0000126	0.00555	5.55	08/31/2016 18:30	WG904031
Benzo(a)pyrene	U		0.000211	0.00111	5.55	08/31/2016 18:30	WG904031
Bis(2-chlorethoxy)methane	U		0.00182	0.0555	5.55	08/31/2016 18:30	WG904031
Bis(2-chloroethyl)ether	U		0.00899	0.0555	5.55	08/31/2016 18:30	WG904031
Bis(2-chloroisopropyl)ether	U		0.00247	0.0555	5.55	08/31/2016 18:30	WG904031
4-Bromophenyl-phenylether	U		0.00186	0.0555	5.55	08/31/2016 18:30	WG904031
2-Chloronaphthalene	U		0.00183	0.00555	5.55	08/31/2016 18:30	WG904031
4-Chlorophenyl-phenylether	U		0.00168	0.0555	5.55	08/31/2016 18:30	WG904031
Chrysene	U		0.00184	0.00555	5.55	08/31/2016 18:30	WG904031
Dibenz(a,h)anthracene	U		0.000357	0.00111	5.55	08/31/2016 18:30	WG904031
3,3-Dichlorobenzidine	U		0.0112	0.0555	5.55	08/31/2016 18:30	WG904031
2,4-Dinitrotoluene	U		0.00916	0.0555	5.55	08/31/2016 18:30	WG904031
2,6-Dinitrotoluene	U		0.00155	0.0555	5.55	08/31/2016 18:30	WG904031
Fluoranthene	U		0.00172	0.00555	5.55	08/31/2016 18:30	WG904031
Fluorene	0.00327	J	0.00179	0.00555	5.55	08/31/2016 18:30	WG904031
Hexachlorobenzene	U		0.00189	0.00555	5.55	08/31/2016 18:30	WG904031
Hexachloro-1,3-butadiene	U		0.00182	0.0555	5.55	08/31/2016 18:30	WG904031
Hexachlorocyclopentadiene	U		0.0129	0.0555	5.55	08/31/2016 18:30	WG904031
Hexachloroethane	U		0.00202	0.0555	5.55	08/31/2016 18:30	WG904031
Indeno(1,2,3-cd)pyrene	U		0.00155	0.00555	5.55	08/31/2016 18:30	WG904031
Isophorone	U		0.00151	0.0555	5.55	08/31/2016 18:30	WG904031
Naphthalene	0.0208		0.00206	0.00555	5.55	08/31/2016 18:30	WG904031
Nitrobenzene	U		0.00204	0.0555	5.55	08/31/2016 18:30	WG904031
n-Nitrosodimethylamine	U		0.00699	0.0555	5.55	08/31/2016 18:30	WG904031
n-Nitrosodiphenylamine	U		0.00169	0.0555	5.55	08/31/2016 18:30	WG904031
n-Nitrosodi-n-propylamine	U		0.00224	0.0555	5.55	08/31/2016 18:30	WG904031
Phenanthrene	U		0.00203	0.00555	5.55	08/31/2016 18:30	WG904031
Benzylbutyl phthalate	U		0.00153	0.0167	5.55	08/31/2016 18:30	WG904031
Bis(2-ethylhexyl)phthalate	0.119		0.00393	0.0167	5.55	08/31/2016 18:30	WG904031
Di-n-butyl phthalate	U		0.00148	0.0167	5.55	08/31/2016 18:30	WG904031
Diethyl phthalate	U		0.00156	0.0167	5.55	08/31/2016 18:30	WG904031
Dimethyl phthalate	U		0.00157	0.0167	5.55	08/31/2016 18:30	WG904031
Di-n-octyl phthalate	U		0.00154	0.0167	5.55	08/31/2016 18:30	WG904031
Pyrene	U		0.00183	0.00555	5.55	08/31/2016 18:30	WG904031
1,2,4-Trichlorobenzene	U		0.00197	0.0555	5.55	08/31/2016 18:30	WG904031
4-Chloro-3-methylphenol	U		0.00146	0.0555	5.55	08/31/2016 18:30	WG904031
2-Chlorophenol	U		0.00157	0.0555	5.55	08/31/2016 18:30	WG904031
2,4-Dichlorophenol	U		0.00158	0.0555	5.55	08/31/2016 18:30	WG904031
2,4-Dimethylphenol	0.162		0.00346	0.0555	5.55	08/31/2016 18:30	WG904031
4,6-Dinitro-2-methylphenol	U		0.0145	0.0555	5.55	08/31/2016 18:30	WG904031
2,4-Dinitrophenol	U		0.0180	0.0555	5.55	08/31/2016 18:30	WG904031
2-Nitrophenol	U		0.00178	0.0555	5.55	08/31/2016 18:30	WG904031
4-Nitrophenol	U		0.0112	0.0555	5.55	08/31/2016 18:30	WG904031
Pentachlorophenol	U		0.00174	0.0555	5.55	08/31/2016 18:30	WG904031
Phenol	0.145		0.00185	0.0555	5.55	08/31/2016 18:30	WG904031
2,4,6-Trichlorophenol	U		0.00165	0.0555	5.55	08/31/2016 18:30	WG904031
(S) 2-Fluorophenol	*44.5*			*10.0-77.9*		*08/31/2016 18:30*	WG904031
(S) Phenol-d5	*36.8*			*5.00-70.1*		*08/31/2016 18:30*	WG904031
(S) Nitrobenzene-d5	*64.1*			*21.8-123*		*08/31/2016 18:30*	WG904031
(S) 2-Fluorobiphenyl	*67.4*			*29.5-131*		*08/31/2016 18:30*	WG904031
(S) 2,4,6-Tribromophenol	*79.3*			*11.2-130*		*08/31/2016 18:30*	WG904031
(S) p-Terphenyl-d14	*78.0*			*29.3-137*		*08/31/2016 18:30*	WG904031

Sample Narrative:

8270 C L856325-02 WG904031: Dilution due to matrix

Gravimetric Analysis by Method 2540 C-2011

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Dissolved Solids	1850		2.82	10.0	1	09/01/2016 05:44	WG903653

Gravimetric Analysis by Method 2540 D-2011

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Suspended Solids	0.874	J	0.350	2.50	1	08/31/2016 09:52	WG903449

Wet Chemistry by Method 130.1

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Hardness, Total (mg/L as CaCO3)	1710		14.3	300	10	08/29/2016 23:29	WG903313

Wet Chemistry by Method 353.2

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Nitrate-Nitrite	U		0.0197	0.100	1	09/01/2016 16:03	WG904198

Wet Chemistry by Method 410.4

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
COD	167		3.00	10.0	1	08/30/2016 09:29	WG903305

Wet Chemistry by Method 4500S2 D-2011

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Sulfide	53.0		0.325	2.50	50	08/29/2016 09:33	WG902744

Wet Chemistry by Method 9040C

Analyte	Result	Qualifier	Dilution	Analysis	Batch
	su			date / time	
pH	7.03		1	08/29/2016 14:28	WG903248

Sample Narrative:

9040C L856325-03 WG903248: 7.03 at 9.7c

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Chloride	182		0.519	10.0	10	09/02/2016 03:07	WG903342
Fluoride	0.689		0.00990	0.100	1	09/02/2016 02:52	WG903342
Sulfate	885		0.774	50.0	10	09/02/2016 03:07	WG903342

Wet Chemistry by Method 9060A

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
TOC (Total Organic Carbon)	5.67		0.510	5.00	5	09/04/2016 19:34	WG903806

Metals (ICPMS) by Method 6020

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Arsenic	0.00120	J	0.000250	0.00200	1	09/01/2016 18:06	WG903802
Boron	0.523		0.00150	0.0200	1	09/02/2016 14:00	WG903802
Calcium	289		0.0460	1.00	1	09/01/2016 18:06	WG903802
Chromium	0.00122	B J	0.000540	0.00200	1	09/01/2016 18:06	WG903802
Iron	0.972		0.0150	0.100	1	09/01/2016 18:06	WG903802
Manganese	0.790		0.000250	0.00500	1	09/01/2016 18:06	WG903802
Nickel	0.00233	B	0.000350	0.00200	1	09/01/2016 18:06	WG903802
Selenium	0.0263		0.000380	0.00200	1	09/01/2016 18:06	WG903802
Potassium	0.368	J	0.0370	1.00	1	09/01/2016 18:06	WG903802
Sodium	163		0.110	1.00	1	09/01/2016 18:06	WG903802
Vanadium	0.00125	J	0.000180	0.00500	1	09/01/2016 18:06	WG903802
Uranium	0.000577	J	0.000330	0.0100	1	09/01/2016 18:06	WG903802

Volatile Organic Compounds (GC) by Method 8015D/GRO

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
TPH (GC/FID) Low Fraction	17.6		0.314	1.00	10	09/01/2016 01:57	WG903168
(S) α,α,α-Trifluorotoluene(FID)	*93.0*			*62.0-128*		*09/01/2016 01:57*	WG903168

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Acetone	U		2.00	200	200	09/03/2016 08:46	WG903933
Acrolein	U		1.77	10.0	200	09/03/2016 08:46	WG903933
Acrylonitrile	U		0.374	2.00	200	09/03/2016 08:46	WG903933
Benzene	2.81		0.0662	0.200	200	09/03/2016 08:46	WG903933
Bromobenzene	U		0.0704	0.200	200	09/03/2016 08:46	WG903933
Bromodichloromethane	U		0.0760	0.250	200	09/03/2016 08:46	WG903933
Bromoform	U		0.0938	0.200	200	09/03/2016 08:46	WG903933
Bromomethane	U		0.173	1.00	200	09/03/2016 08:46	WG903933
n-Butylbenzene	U		0.0722	0.200	200	09/03/2016 08:46	WG903933
sec-Butylbenzene	U		0.0730	0.200	200	09/03/2016 08:46	WG903933
tert-Butylbenzene	U		0.0798	0.200	200	09/03/2016 08:46	WG903933
Carbon tetrachloride	U		0.0758	0.200	200	09/03/2016 08:46	WG903933
Chlorobenzene	U		0.0696	0.200	200	09/03/2016 08:46	WG903933
Chlorodibromomethane	U		0.0654	0.200	200	09/03/2016 08:46	WG903933
Chloroethane	U		0.0906	1.00	200	09/03/2016 08:46	WG903933
2-Chloroethyl vinyl ether	U		0.602	10.0	200	09/03/2016 08:46	WG903933
Chloroform	U		0.0648	1.00	200	09/03/2016 08:46	WG903933
Chloromethane	U		0.0552	0.500	200	09/03/2016 08:46	WG903933
2-Chlorotoluene	U		0.0750	0.200	200	09/03/2016 08:46	WG903933
4-Chlorotoluene	U		0.0702	0.200	200	09/03/2016 08:46	WG903933
1,2-Dibromo-3-Chloropropane	U		0.266	1.00	200	09/03/2016 08:46	WG903933
1,2-Dibromoethane	U		0.0762	0.200	200	09/03/2016 08:46	WG903933
Dibromomethane	U		0.0692	0.200	200	09/03/2016 08:46	WG903933
1,2-Dichlorobenzene	U		0.0698	0.200	200	09/03/2016 08:46	WG903933
1,3-Dichlorobenzene	U		0.0440	0.200	200	09/03/2016 08:46	WG903933
1,4-Dichlorobenzene	U		0.0548	0.200	200	09/03/2016 08:46	WG903933
Dichlorodifluoromethane	U		0.110	1.00	200	09/03/2016 08:46	WG903933
1,1-Dichloroethane	U		0.0518	0.200	200	09/03/2016 08:46	WG903933
1,2-Dichloroethane	U		0.0722	0.200	200	09/03/2016 08:46	WG903933
1,1-Dichloroethene	U		0.0796	0.200	200	09/03/2016 08:46	WG903933
cis-1,2-Dichloroethene	U		0.0520	0.200	200	09/03/2016 08:46	WG903933
trans-1,2-Dichloroethene	U		0.0792	0.200	200	09/03/2016 08:46	WG903933
1,2-Dichloropropane	U		0.0612	0.200	200	09/03/2016 08:46	WG903933

Volatile Organic Compounds (GC/MS) by Method 8260B

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
1,1-Dichloropropene	U		0.0704	0.200	200	09/03/2016 08:46	WG903933
1,3-Dichloropropane	U		0.0732	0.200	200	09/03/2016 08:46	WG903933
cis-1,3-Dichloropropene	U		0.0836	0.200	200	09/03/2016 08:46	WG903933
trans-1,3-Dichloropropene	U		0.0838	0.200	200	09/03/2016 08:46	WG903933
2,2-Dichloropropane	U		0.0642	0.200	200	09/03/2016 08:46	WG903933
Di-isopropyl ether	U		0.0640	0.200	200	09/03/2016 08:46	WG903933
Ethylbenzene	1.36		0.0768	0.200	200	09/03/2016 08:46	WG903933
Hexachloro-1,3-butadiene	U		0.0512	0.200	200	09/03/2016 08:46	WG903933
Isopropylbenzene	0.0713	J	0.0652	0.200	200	09/03/2016 08:46	WG903933
p-Isopropyltoluene	U		0.0700	0.200	200	09/03/2016 08:46	WG903933
2-Butanone (MEK)	U	J4	0.786	2.00	200	09/03/2016 08:46	WG903933
Methylene Chloride	U		0.200	1.00	200	09/03/2016 08:46	WG903933
4-Methyl-2-pentanone (MIBK)	U		0.428	2.00	200	09/03/2016 08:46	WG903933
Methyl tert-butyl ether	U		0.0734	0.200	200	09/03/2016 08:46	WG903933
Naphthalene	0.308	J	0.200	1.00	200	09/03/2016 08:46	WG903933
n-Propylbenzene	0.152	J	0.0698	0.200	200	09/03/2016 08:46	WG903933
Styrene	U		0.0614	0.200	200	09/03/2016 08:46	WG903933
1,1,1,2-Tetrachloroethane	U		0.0770	0.200	200	09/03/2016 08:46	WG903933
1,1,2,2-Tetrachloroethane	U		0.0260	0.200	200	09/03/2016 08:46	WG903933
1,1,2-Trichlorotrifluoroethane	U		0.0606	0.200	200	09/03/2016 08:46	WG903933
Tetrachloroethene	U		0.0744	0.200	200	09/03/2016 08:46	WG903933
Toluene	U		0.156	1.00	200	09/03/2016 08:46	WG903933
1,2,3-Trichlorobenzene	U		0.0460	0.200	200	09/03/2016 08:46	WG903933
1,2,4-Trichlorobenzene	U		0.0710	0.200	200	09/03/2016 08:46	WG903933
1,1,1-Trichloroethane	U		0.0638	0.200	200	09/03/2016 08:46	WG903933
1,1,2-Trichloroethane	U		0.0766	0.200	200	09/03/2016 08:46	WG903933
Trichloroethene	U		0.0796	0.200	200	09/03/2016 08:46	WG903933
Trichlorofluoromethane	U		0.240	1.00	200	09/03/2016 08:46	WG903933
1,2,3-Trichloropropane	U		0.161	0.500	200	09/03/2016 08:46	WG903933
1,2,4-Trimethylbenzene	0.645		0.0746	0.200	200	09/03/2016 08:46	WG903933
1,2,3-Trimethylbenzene	0.238		0.0642	0.200	200	09/03/2016 08:46	WG903933
1,3,5-Trimethylbenzene	0.0884	J	0.0774	0.200	200	09/03/2016 08:46	WG903933
Vinyl chloride	U		0.0518	0.200	200	09/03/2016 08:46	WG903933
Xylenes, Total	1.60		0.212	0.600	200	09/03/2016 08:46	WG903933
(S) Toluene-d8	*111*			*90.0-115*		*09/03/2016 08:46*	WG903933
(S) Dibromofluoromethane	*111*			*79.0-121*		*09/03/2016 08:46*	WG903933
(S) 4-Bromofluorobenzene	*94.1*			*80.1-120*		*09/03/2016 08:46*	WG903933

Semi-Volatile Organic Compounds (GC) by Method 8015

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
C10-C28 Diesel Range	3.06		0.0222	0.100	1	09/01/2016 16:27	WG903667
C28-C40 Oil Range	0.0758	J	0.0118	0.100	1	09/01/2016 16:27	WG903667
(S) o-Terphenyl	*122*			*50.0-150*		*09/01/2016 16:27*	WG903667

Semi Volatile Organic Compounds (GC/MS) by Method 8270 C

Analyte	Result mg/l	Qualifier	MDL mg/l	RDL mg/l	Dilution	Analysis date / time	Batch
Acenaphthene	U		0.00158	0.00500	5	08/31/2016 18:54	WG904031
Acenaphthylene	U		0.00154	0.00500	5	08/31/2016 18:54	WG904031
Anthracene	U		0.00146	0.00500	5	08/31/2016 18:54	WG904031
Benzidine	U	J3	0.0216	0.0500	5	08/31/2016 18:54	WG904031
Benzo(a)anthracene	U		0.000255	0.00500	5	08/31/2016 18:54	WG904031
Benzo(b)fluoranthene	U		0.000448	0.00500	5	08/31/2016 18:54	WG904031
Benzo(k)fluoranthene	U		0.00178	0.00500	5	08/31/2016 18:54	WG904031

Semi Volatile Organic Compounds (GC/MS) by Method 8270 C

Analyte	Result	Qualifier	MDL	RDL	Dilution	Analysis	Batch
	mg/l		mg/l	mg/l		date / time	
Benzo(g,h,i)perylene	U		0.0000114	0.00500	5	08/31/2016 18:54	WG904031
Benzo(a)pyrene	U		0.000190	0.00100	5	08/31/2016 18:54	WG904031
Bis(2-chlorethoxy)methane	U		0.00164	0.0500	5	08/31/2016 18:54	WG904031
Bis(2-chloroethyl)ether	U		0.00810	0.0500	5	08/31/2016 18:54	WG904031
Bis(2-chloroisopropyl)ether	U		0.00222	0.0500	5	08/31/2016 18:54	WG904031
4-Bromophenyl-phenylether	U		0.00168	0.0500	5	08/31/2016 18:54	WG904031
2-Chloronaphthalene	U		0.00165	0.00500	5	08/31/2016 18:54	WG904031
4-Chlorophenyl-phenylether	U		0.00152	0.0500	5	08/31/2016 18:54	WG904031
Chrysene	U		0.00166	0.00500	5	08/31/2016 18:54	WG904031
Dibenz(a,h)anthracene	U		0.000322	0.00100	5	08/31/2016 18:54	WG904031
3,3-Dichlorobenzidine	U		0.0101	0.0500	5	08/31/2016 18:54	WG904031
2,4-Dinitrotoluene	U		0.00825	0.0500	5	08/31/2016 18:54	WG904031
2,6-Dinitrotoluene	U		0.00140	0.0500	5	08/31/2016 18:54	WG904031
Fluoranthene	U		0.00155	0.00500	5	08/31/2016 18:54	WG904031
Fluorene	U		0.00162	0.00500	5	08/31/2016 18:54	WG904031
Hexachlorobenzene	U		0.00170	0.00500	5	08/31/2016 18:54	WG904031
Hexachloro-1,3-butadiene	U		0.00164	0.0500	5	08/31/2016 18:54	WG904031
Hexachlorocyclopentadiene	U		0.0116	0.0500	5	08/31/2016 18:54	WG904031
Hexachloroethane	U		0.00182	0.0500	5	08/31/2016 18:54	WG904031
Indeno(1,2,3-cd)pyrene	U		0.00140	0.00500	5	08/31/2016 18:54	WG904031
Isophorone	U		0.00136	0.0500	5	08/31/2016 18:54	WG904031
Naphthalene	0.145		0.00186	0.00500	5	08/31/2016 18:54	WG904031
Nitrobenzene	U		0.00184	0.0500	5	08/31/2016 18:54	WG904031
n-Nitrosodimethylamine	U		0.00630	0.0500	5	08/31/2016 18:54	WG904031
n-Nitrosodiphenylamine	U		0.00152	0.0500	5	08/31/2016 18:54	WG904031
n-Nitrosodi-n-propylamine	U		0.00202	0.0500	5	08/31/2016 18:54	WG904031
Phenanthrene	U		0.00183	0.00500	5	08/31/2016 18:54	WG904031
Benzylbutyl phthalate	U		0.00138	0.0150	5	08/31/2016 18:54	WG904031
Bis(2-ethylhexyl)phthalate	U		0.00354	0.0150	5	08/31/2016 18:54	WG904031
Di-n-butyl phthalate	U		0.00133	0.0150	5	08/31/2016 18:54	WG904031
Diethyl phthalate	U		0.00141	0.0150	5	08/31/2016 18:54	WG904031
Dimethyl phthalate	U		0.00142	0.0150	5	08/31/2016 18:54	WG904031
Di-n-octyl phthalate	U		0.00139	0.0150	5	08/31/2016 18:54	WG904031
Pyrene	U		0.00165	0.00500	5	08/31/2016 18:54	WG904031
1,2,4-Trichlorobenzene	U		0.00178	0.0500	5	08/31/2016 18:54	WG904031
4-Chloro-3-methylphenol	U		0.00132	0.0500	5	08/31/2016 18:54	WG904031
2-Chlorophenol	U		0.00142	0.0500	5	08/31/2016 18:54	WG904031
2,4-Dichlorophenol	U		0.00142	0.0500	5	08/31/2016 18:54	WG904031
2,4-Dimethylphenol	U		0.00312	0.0500	5	08/31/2016 18:54	WG904031
4,6-Dinitro-2-methylphenol	U		0.0131	0.0500	5	08/31/2016 18:54	WG904031
2,4-Dinitrophenol	U		0.0162	0.0500	5	08/31/2016 18:54	WG904031
2-Nitrophenol	U		0.00160	0.0500	5	08/31/2016 18:54	WG904031
4-Nitrophenol	U		0.0100	0.0500	5	08/31/2016 18:54	WG904031
Pentachlorophenol	U		0.00156	0.0500	5	08/31/2016 18:54	WG904031
Phenol	0.00278	J	0.00167	0.0500	5	08/31/2016 18:54	WG904031
2,4,6-Trichlorophenol	U		0.00148	0.0500	5	08/31/2016 18:54	WG904031
(S) 2-Fluorophenol	*42.4*			*10.0-77.9*		*08/31/2016 18:54*	WG904031
(S) Phenol-d5	*28.3*			*5.00-70.1*		*08/31/2016 18:54*	WG904031
(S) Nitrobenzene-d5	*50.1*			*21.8-123*		*08/31/2016 18:54*	WG904031
(S) 2-Fluorobiphenyl	*58.0*			*29.5-131*		*08/31/2016 18:54*	WG904031
(S) 2,4,6-Tribromophenol	*69.3*			*11.2-130*		*08/31/2016 18:54*	WG904031
(S) p-Terphenyl-d14	*72.1*			*29.3-137*		*08/31/2016 18:54*	WG904031

Sample Narrative:

8270 C L856325-03 WG904031: Dilution due to matrix

Method Blank (MB)

(MB) R3160717-1 08/30/16 10:57

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
Dissolved Solids	U		2.82	10.0

L856343-04 Original Sample (OS) • Duplicate (DUP)

(OS) L856343-04 08/30/16 10:57 • (DUP) R3160717-4 08/30/16 10:57

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/l	mg/l		%		%
Dissolved Solids	353	353	1	0.000		5

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160717-2 08/30/16 10:57 • (LCSD) R3160717-3 08/30/16 10:57

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
Dissolved Solids	8800	8900	8840	101	100	85.0-115			0.676	5

Method Blank (MB)

(MB) R3160998-1 09/01/16 05:44

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
Dissolved Solids	U		2.82	10.0

L856280-06 Original Sample (OS) • Duplicate (DUP)

(OS) L856280-06 09/01/16 05:44 • (DUP) R3160998-4 09/01/16 05:44

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/l	mg/l		%		%
Dissolved Solids	3.00	3.00	1	0.000	J	5

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160998-2 09/01/16 05:44 • (LCSD) R3160998-3 09/01/16 05:44

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
Dissolved Solids	8800	8020	8210	91.1	93.3	85.0-115			2.34	5

Method Blank (MB)

(MB) R3160480-1 08/30/16 14:11

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
Suspended Solids	U		0.350	2.50

L855768-02 Original Sample (OS) • Duplicate (DUP)

(OS) L855768-02 08/30/16 14:11 • (DUP) R3160480-4 08/30/16 14:11

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/l	mg/l		%		%
Suspended Solids	502	536	1	6.55	J3	5

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160480-2 08/30/16 14:11 • (LCSD) R3160480-3 08/30/16 14:11

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
Suspended Solids	773	804	792	104	102	85.0-115			1.50	5

Method Blank (MB)

(MB) R3160789-1 08/31/16 09:52

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
Suspended Solids	U		0.350	2.50

L856253-01 Original Sample (OS) • Duplicate (DUP)

(OS) L856253-01 08/31/16 09:52 • (DUP) R3160789-4 08/31/16 09:52

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/l	mg/l		%		%
Suspended Solids	184	176	1	4.44		5

L856325-02 Original Sample (OS) • Duplicate (DUP)

(OS) L856325-02 08/31/16 09:52 • (DUP) R3160789-5 08/31/16 09:52

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/l	mg/l		%		%
Suspended Solids	6380	6040	1	5.48	J3	5

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160789-2 08/31/16 09:52 • (LCSD) R3160789-3 08/31/16 09:52

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
Suspended Solids	773	800	772	103	99.9	85.0-115			3.56	5

Method Blank (MB)

(MB) R3160065-1 08/29/16 23:05

Analyte	MB Result mg/l	MB Qualifier	MB MDL mg/l	MB RDL mg/l
Hardness	4.20	J	1.43	30.0

L855766-01 Original Sample (OS) • Duplicate (DUP)

(OS) L855766-01 08/29/16 23:20 • (DUP) R3160065-5 08/29/16 23:21

Analyte	Original Result mg/l	DUP Result mg/l	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Hardness	66.5	65.1	1	2.00		20

L855031-03 Original Sample (OS) • Duplicate (DUP)

(OS) L855031-03 08/29/16 23:45 • (DUP) R3160065-8 08/29/16 23:46

Analyte	Original Result mg/l	DUP Result mg/l	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Hardness	193	189	5	2.00		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160065-2 08/29/16 23:06 • (LCSD) R3160065-3 08/29/16 23:07

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Hardness	150	160	160	107	107	85.0-115			0.000	20

L855766-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L855766-02 08/29/16 23:22 • (MS) R3160065-9 08/29/16 23:49 • (MSD) R3160065-10 08/29/16 23:50

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Hardness	100	65.4	165	166	100	101	1	80.0-120			1.00	20

Method Blank (MB)

(MB) R3160641-8 08/31/16 09:42

Analyte	MB Result mg/l	MB Qualifier	MB MDL mg/l	MB RDL mg/l
Nitrate-Nitrite	U		0.0197	0.100

L856292-02 Original Sample (OS) • Duplicate (DUP)

(OS) L856292-02 08/31/16 09:48 • (DUP) R3160641-11 08/31/16 09:49

Analyte	Original Result mg/l	DUP Result mg/l	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Nitrate-Nitrite	0.322	0.302	1	6.00		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160641-9 08/31/16 09:43 • (LCSD) R3160641-10 08/31/16 09:44

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Nitrate-Nitrite	5.00	4.70	4.89	94.0	98.0	90.0-110			4.00	20

L856292-03 Original Sample (OS) • Matrix Spike (MS)

(OS) L856292-03 08/31/16 09:50 • (MS) R3160641-13 08/31/16 13:30

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MS Rec. %	Dilution	Rec. Limits %	MS Qualifier
Nitrate-Nitrite	5.00	0.506	5.02	90.0	1	90.0-110	

Method Blank (MB)

(MB) R3160966-1 09/01/16 15:58

Analyte	MB Result mg/l	MB Qualifier	MB MDL mg/l	MB RDL mg/l
Nitrate-Nitrite	U		0.0197	0.100

L856789-01 Original Sample (OS) • Duplicate (DUP)

(OS) L856789-01 09/01/16 16:06 • (DUP) R3160966-4 09/01/16 16:12

Analyte	Original Result mg/l	DUP Result mg/l	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Nitrate-Nitrite	1.36	1.37	1	1.00		20

L856926-02 Original Sample (OS) • Duplicate (DUP)

(OS) L856926-02 09/01/16 16:37 • (DUP) R3160966-6 09/01/16 16:38

Analyte	Original Result mg/l	DUP Result mg/l	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Nitrate-Nitrite	28.6	28.7	5	0.000		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160966-2 09/01/16 15:59 • (LCSD) R3160966-3 09/01/16 16:00

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Nitrate-Nitrite	5.00	4.77	4.87	95.0	97.0	90.0-110			2.00	20

L856920-02 Original Sample (OS) • Matrix Spike (MS)

(OS) L856920-02 09/01/16 16:31 • (MS) R3160966-5 09/01/16 16:32

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MS Rec. %	Dilution	Rec. Limits %	MS Qualifier
Nitrate-Nitrite	5.00	2.59	6.90	86.0	1	90.0-110	J6

L856926-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856926-02 09/01/16 16:37 • (MS) R3160966-7 09/01/16 16:39 • (MSD) R3160966-8 09/01/16 16:40

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Nitrate-Nitrite	5.00	28.6	54.2	54.0	102	102	5	90.0-110	E	E	0.000	20

Method Blank (MB)

(MB) R3160128-1 08/30/16 09:26

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
COD	U		3.00	10.0

L856435-02 Original Sample (OS) • Duplicate (DUP)

(OS) L856435-02 08/30/16 09:29 • (DUP) R3160128-8 08/30/16 09:30

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/l	mg/l		%		%
COD	453	457	1	1.00		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160128-2 08/30/16 09:26 • (LCSD) R3160128-3 08/30/16 09:26

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
COD	242	244	242	101	100	90.0-110			1.00	20

L856179-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856179-04 08/30/16 09:28 • (MS) R3160128-6 08/30/16 09:28 • (MSD) R3160128-7 08/30/16 09:28

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	mg/l	%	%		%			%	%
COD	400	35.5	413	410	94.0	94.0	1	80.0-120			1.00	20

Method Blank (MB)

(MB) R3159815-1 08/29/16 09:29

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
Sulfide	U		0.00650	0.0500

L855964-03 Original Sample (OS) • Duplicate (DUP)

(OS) L855964-03 08/29/16 09:30 • (DUP) R3159815-4 08/29/16 09:30

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/l	mg/l		%		%
Sulfide	ND	ND	1	0.000		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3159815-2 08/29/16 09:29 • (LCSD) R3159815-3 08/29/16 09:29

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
Sulfide	0.500	0.563	0.563	113	113	85.0-115			0.000	20

L856004-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856004-01 08/29/16 09:30 • (MS) R3159815-5 08/29/16 09:31 • (MSD) R3159815-6 08/29/16 09:31

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	mg/l	%	%		%			%	%
Sulfide	1.00	ND	0.262	0.260	23.0	23.0	1	80.0-120	J6	J6	1.00	20

L856297-01 Original Sample (OS) • Duplicate (DUP)

(OS) L856297-01 08/29/16 14:28 • (DUP) WG903248-3 08/29/16 14:28

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	su	su		%		%
pH	7.29	7.31	1	0.274		1

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG903248-1 08/29/16 14:28 • (LCSD) WG903248-2 08/29/16 14:28

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	su	su	su	%	%	%			%	%
pH	6.11	6.12	6.13	100	100	98.4-102			0.163	1

Method Blank (MB)

(MB) R3161023-2 09/01/16 20:23

Analyte	MB Result mg/l	MB Qualifier	MB MDL mg/l	MB RDL mg/l
Chloride	U		0.0519	1.00
Fluoride	U		0.0099	0.100
Sulfate	U		0.0774	5.00

L856311-02 Original Sample (OS) • Duplicate (DUP)

(OS) L856311-02 09/02/16 00:28 • (DUP) R3161023-6 09/02/16 00:43

Analyte	Original Result mg/l	DUP Result mg/l	Dilution	DUP RPD %	DUP Qualifier	DUP RPD Limits %
Chloride	4.80	4.62	1	4		15
Fluoride	0.171	0.171	1	0		15
Sulfate	23.9	24.0	1	0		15

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3161023-3 09/01/16 20:38 • (LCSD) R3161023-4 09/01/16 20:52

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Chloride	40.0	39.2	39.2	98	98	80-120			0	15
Fluoride	8.00	7.90	7.91	99	99	80-120			0	15
Sulfate	40.0	39.4	39.4	98	98	80-120			0	15

L856280-04 Original Sample (OS) • Matrix Spike (MS)

(OS) L856280-04 09/01/16 22:19 • (MS) R3161023-5 09/01/16 22:33

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MS Rec. %	Dilution	Rec. Limits %	MS Qualifier
Chloride	50.0	0.208	50.5	101	1	80-120	
Fluoride	5.00	U	5.34	107	1	80-120	
Sulfate	50.0	0.179	52.4	104	1	80-120	

L856280-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856280-01 09/02/16 06:00 • (MS) R3161023-7 09/02/16 06:14 • (MSD) R3161023-8 09/02/16 06:29

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Chloride	50.0	45.1	93.7	93.6	97	97	1	80-120			0	15
Fluoride	5.00	0.388	5.36	5.41	99	101	1	80-120			1	15

L856280-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856280-01 09/02/16 06:00 • (MS) R3161023-7 09/02/16 06:14 • (MSD) R3161023-8 09/02/16 06:29

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Sulfate	50.0	29.6	78.6	78.5	98	98	1	80-120			0	15

Method Blank (MB)

(MB) R3161403-1 09/03/16 14:49

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
TOC (Total Organic Carbon)	U		0.102	1.00

L855797-10 Original Sample (OS) • Duplicate (DUP)

(OS) L855797-10 09/03/16 16:21 • (DUP) R3161403-4 09/03/16 16:37

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/l	mg/l		%		%
TOC (Total Organic Carbon)	0.407	ND	1	2.00	J	20

L856311-02 Original Sample (OS) • Duplicate (DUP)

(OS) L856311-02 09/03/16 20:51 • (DUP) R3161403-7 09/03/16 21:03

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/l	mg/l		%		%
TOC (Total Organic Carbon)	1.43	1.42	1	0.000		20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3161403-2 09/03/16 15:35 • (LCSD) R3161403-3 09/03/16 15:52

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
TOC (Total Organic Carbon)	75.0	72.8	73.0	97.0	97.0	85.0-115			0.000	20

L855968-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L855968-01 09/04/16 17:57 • (MS) R3161403-8 09/04/16 18:15 • (MSD) R3161403-9 09/04/16 18:32

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	mg/l	%	%		%			%	%
TOC (Total Organic Carbon)	50.0	1.44	48.3	46.9	94.0	91.0	1	80.0-120			3.00	20

Method Blank (MB)

(MB) R3160972-1 09/01/16 16:19

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
Arsenic	U		0.00025	0.00200
Calcium	0.0466	J	0.046	1.00
Chromium	0.00187	J	0.00054	0.00200
Iron	0.0188	J	0.015	0.100
Manganese	0.000438	J	0.00025	0.00500
Nickel	0.00117	J	0.00035	0.00200
Potassium	U		0.037	1.00
Selenium	U		0.00038	0.00200
Sodium	U		0.11	1.00
Uranium	U		0.00033	0.0100
Vanadium	U		0.00018	0.00500

Method Blank (MB)

(MB) R3161172-1 09/02/16 13:34

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
Boron	U		0.0015	0.0200

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160972-2 09/01/16 16:22 • (LCSD) R3160972-3 09/01/16 16:25

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
Arsenic	0.0500	0.0499	0.0503	100	101	80-120			1	20
Calcium	5.00	5.08	4.96	102	99	80-120			2	20
Chromium	0.0500	0.0532	0.0524	106	105	80-120			1	20
Iron	5.00	5.46	5.34	109	107	80-120			2	20
Manganese	0.0500	0.0508	0.0547	102	109	80-120			8	20
Nickel	0.0500	0.0543	0.0535	109	107	80-120			1	20
Potassium	5.00	5.03	4.97	101	99	80-120			1	20
Selenium	0.0500	0.0509	0.0495	102	99	80-120			3	20
Sodium	5.00	4.98	4.88	100	98	80-120			2	20
Uranium	0.0500	0.0504	0.0502	101	100	80-120			0	20
Vanadium	0.0500	0.0521	0.0512	104	102	80-120			2	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3161172-2 09/02/16 13:37 • (LCSD) R3161172-3 09/02/16 13:40

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Boron	0.0500	0.0499	0.0501	100	100	80-120			0	20

L856325-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856325-01 09/01/16 16:28 • (MS) R3160972-4 09/01/16 16:34 • (MSD) R3160972-6 09/01/16 16:54

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Arsenic	0.0500	0.00282	0.0434	0.0522	81	99	1	75-125			18	20
Calcium	5.00	298	298	298	0	0	1	75-125	V	V	0	20
Chromium	0.0500	0.00178	0.0492	0.0500	95	96	1	75-125			2	20
Potassium	5.00	0.415	5.10	5.22	94	96	1	75-125			2	20
Iron	5.00	12.0	16.6	16.7	92	95	1	75-125			1	20
Manganese	0.0500	0.844	0.876	0.886	63	83	1	75-125	V		1	20
Nickel	0.0500	0.0221	0.0675	0.0695	91	95	1	75-125			3	20
Selenium	0.0500	U	0.0697	0.0401	139	80	1	75-125	J5	J3	54	20
Sodium	5.00	158	160	159	40	20	1	75-125	V	V	1	20
Uranium	0.0500	0.000516	0.0607	0.0485	120	96	1	75-125		J3	22	20
Vanadium	0.0500	0.00138	0.0492	0.0503	96	98	1	75-125			2	20

L856325-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856325-01 09/02/16 13:44 • (MS) R3161172-5 09/02/16 13:50 • (MSD) R3161172-6 09/02/16 13:53

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Boron	0.0500	0.464	0.510	0.513	92	98	1	75-125			1	20

Method Blank (MB)

(MB) R3160671-3 08/29/16 12:42

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
TPH (GC/FID) Low Fraction	U		0.0314	0.100
(S) a,a,a-Trifluorotoluene(FID)	*96.9*			*62.0-128*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160671-1 08/29/16 11:35 • (LCSD) R3160671-2 08/29/16 11:57

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
TPH (GC/FID) Low Fraction	5.50	5.46	5.61	99.2	102	67.0-132			2.81	20
(S) a,a,a-Trifluorotoluene(FID)				*108*	*108*	*62.0-128*				

L856299-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856299-01 08/29/16 14:33 • (MS) R3160671-4 08/29/16 14:55 • (MSD) R3160671-5 08/29/16 15:18

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	mg/l	%	%		%			%	%
TPH (GC/FID) Low Fraction	5.50	0.958	5.85	5.63	89.0	85.0	1	50.0-143			3.83	20
(S) a,a,a-Trifluorotoluene(FID)					*108*	*106*		*62.0-128*				

Method Blank (MB)

(MB) R3161593-3 09/03/16 01:41

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
Acetone	U		0.0100	1.00
Acrolein	U		0.00887	0.0500
Acrylonitrile	U		0.00187	0.0100
Benzene	U		0.000331	0.00100
Bromobenzene	U		0.000352	0.00100
Bromodichloromethane	U		0.000380	0.00125
Bromoform	U		0.000469	0.00100
Bromomethane	U		0.000866	0.00500
n-Butylbenzene	U		0.000361	0.00100
sec-Butylbenzene	U		0.000365	0.00100
tert-Butylbenzene	U		0.000399	0.00100
Carbon tetrachloride	U		0.000379	0.00100
Chlorobenzene	U		0.000348	0.00100
Chlorodibromomethane	U		0.000327	0.00100
Chloroethane	U		0.000453	0.00500
2-Chloroethyl vinyl ether	U		0.00301	0.0500
Chloroform	U		0.000324	0.00500
Chloromethane	U		0.000276	0.00250
2-Chlorotoluene	U		0.000375	0.00100
4-Chlorotoluene	U		0.000351	0.00100
1,2-Dibromo-3-Chloropropane	U		0.00133	0.00500
1,2-Dibromoethane	U		0.000381	0.00100
Dibromomethane	U		0.000346	0.00100
1,2-Dichlorobenzene	U		0.000349	0.00100
1,3-Dichlorobenzene	U		0.000220	0.00100
1,4-Dichlorobenzene	U		0.000274	0.00100
Dichlorodifluoromethane	U		0.000551	0.00500
1,1-Dichloroethane	U		0.000259	0.00100
1,2-Dichloroethane	U		0.000361	0.00100
1,1-Dichloroethene	U		0.000398	0.00100
cis-1,2-Dichloroethene	U		0.000260	0.00100
trans-1,2-Dichloroethene	U		0.000396	0.00100
1,2-Dichloropropane	U		0.000306	0.00100
1,1-Dichloropropene	U		0.000352	0.00100
1,3-Dichloropropane	U		0.000366	0.00100
cis-1,3-Dichloropropene	U		0.000418	0.00100
trans-1,3-Dichloropropene	U		0.000419	0.00100
2,2-Dichloropropane	U		0.000321	0.00100
Di-isopropyl ether	U		0.000320	0.00100
Ethylbenzene	U		0.000384	0.00100

Method Blank (MB)

(MB) R3161593-3 09/03/16 01:41

Analyte	MB Result mg/l	MB Qualifier	MB MDL mg/l	MB RDL mg/l
Hexachloro-1,3-butadiene	U		0.000256	0.00100
Isopropylbenzene	U		0.000326	0.00100
p-Isopropyltoluene	U		0.000350	0.00100
2-Butanone (MEK)	U		0.00393	0.0100
Methylene Chloride	U		0.00100	0.00500
4-Methyl-2-pentanone (MIBK)	U		0.00214	0.0100
Methyl tert-butyl ether	U		0.000367	0.00100
Naphthalene	U		0.00100	0.00500
n-Propylbenzene	U		0.000349	0.00100
Styrene	U		0.000307	0.00100
1,1,1,2-Tetrachloroethane	U		0.000385	0.00100
1,1,2,2-Tetrachloroethane	U		0.000130	0.00100
Tetrachloroethene	U		0.000372	0.00100
Toluene	U		0.000780	0.00500
1,1,2-Trichlorotrifluoroethane	U		0.000303	0.00100
1,2,3-Trichlorobenzene	U		0.000230	0.00100
1,2,4-Trichlorobenzene	U		0.000355	0.00100
1,1,1-Trichloroethane	U		0.000319	0.00100
1,1,2-Trichloroethane	U		0.000383	0.00100
Trichloroethene	U		0.000398	0.00100
Trichlorofluoromethane	U		0.00120	0.00500
1,2,3-Trichloropropane	U		0.000807	0.00250
1,2,3-Trimethylbenzene	U		0.000321	0.00100
1,2,4-Trimethylbenzene	U		0.000373	0.00100
1,3,5-Trimethylbenzene	U		0.000387	0.00100
Vinyl chloride	U		0.000259	0.00100
Xylenes, Total	U		0.00106	0.00300
(S) Toluene-d8	*110*			*90.0-115*
(S) Dibromofluoromethane	*112*			*79.0-121*
(S) 4-Bromofluorobenzene	*96.3*			*80.1-120*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3161593-1 09/03/16 00:01 • (LCSD) R3161593-2 09/03/16 00:21

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Acetone	0.125	0.202	0.195	161	156	28.7-175			3.58	20.9
Acrolein	0.125	0.110	0.109	88.3	87.1	40.4-172			1.45	20
Acrylonitrile	0.125	0.178	0.174	143	139	58.2-145			2.46	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3161593-1 09/03/16 00:01 • (LCSD) R3161593-2 09/03/16 00:21

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Benzene	0.0250	0.0278	0.0275	111	110	73.0-122			0.860	20
Bromobenzene	0.0250	0.0236	0.0236	94.4	94.3	81.5-115			0.110	20
Bromodichloromethane	0.0250	0.0259	0.0259	103	103	75.5-121			0.0700	20
Bromoform	0.0250	0.0212	0.0213	84.9	85.3	71.5-131			0.410	20
Bromomethane	0.0250	0.0194	0.0188	77.4	75.2	22.4-187			2.90	20
n-Butylbenzene	0.0250	0.0274	0.0274	109	109	75.9-134			0.0500	20
sec-Butylbenzene	0.0250	0.0230	0.0230	92.0	92.1	80.6-126			0.0800	20
tert-Butylbenzene	0.0250	0.0223	0.0220	89.3	88.0	79.3-127			1.45	20
Carbon tetrachloride	0.0250	0.0251	0.0251	100	100	70.9-129			0.0400	20
Chlorobenzene	0.0250	0.0229	0.0232	91.7	92.6	79.7-122			1.06	20
Chlorodibromomethane	0.0250	0.0236	0.0234	94.4	93.4	78.2-124			1.05	20
Chloroethane	0.0250	0.0244	0.0244	97.6	97.7	41.2-153			0.140	20
2-Chloroethyl vinyl ether	0.125	0.147	0.142	118	114	23.4-162			3.38	23.5
Chloroform	0.0250	0.0272	0.0268	109	107	73.2-125			1.30	20
Chloromethane	0.0250	0.0285	0.0284	114	113	55.8-134			0.580	20
2-Chlorotoluene	0.0250	0.0238	0.0239	95.2	95.5	76.4-125			0.340	20
4-Chlorotoluene	0.0250	0.0233	0.0237	93.2	94.8	81.5-121			1.72	20
1,2-Dibromo-3-Chloropropane	0.0250	0.0268	0.0267	107	107	64.8-131			0.230	20
1,2-Dibromoethane	0.0250	0.0242	0.0240	96.8	95.8	79.8-122			1.05	20
Dibromomethane	0.0250	0.0258	0.0256	103	102	79.5-118			0.990	20
1,2-Dichlorobenzene	0.0250	0.0252	0.0252	101	101	84.7-118			0.110	20
1,3-Dichlorobenzene	0.0250	0.0209	0.0211	83.7	84.3	77.6-127			0.620	20
1,4-Dichlorobenzene	0.0250	0.0236	0.0235	94.3	93.8	82.2-114			0.520	20
Dichlorodifluoromethane	0.0250	0.0244	0.0238	97.8	95.1	56.0-134			2.83	20
1,1-Dichloroethane	0.0250	0.0304	0.0303	122	121	71.7-127			0.420	20
1,2-Dichloroethane	0.0250	0.0271	0.0270	108	108	65.3-126			0.290	20
1,1-Dichloroethene	0.0250	0.0212	0.0212	84.9	84.7	59.9-137			0.240	20
cis-1,2-Dichloroethene	0.0250	0.0274	0.0271	110	108	77.3-122			1.25	20
trans-1,2-Dichloroethene	0.0250	0.0265	0.0259	106	104	72.6-125			2.04	20
1,2-Dichloropropane	0.0250	0.0299	0.0293	119	117	77.4-125			1.81	20
1,1-Dichloropropene	0.0250	0.0295	0.0294	118	117	72.5-127			0.320	20
1,3-Dichloropropane	0.0250	0.0268	0.0267	107	107	80.6-115			0.0800	20
cis-1,3-Dichloropropene	0.0250	0.0285	0.0285	114	114	77.7-124			0.0600	20
trans-1,3-Dichloropropene	0.0250	0.0249	0.0248	99.8	99.3	73.5-127			0.440	20
2,2-Dichloropropane	0.0250	0.0254	0.0245	101	97.8	61.3-134			3.65	20
Di-isopropyl ether	0.0250	0.0313	0.0311	125	124	65.1-135			0.720	20
Ethylbenzene	0.0250	0.0221	0.0222	88.3	88.8	80.9-121			0.530	20
Hexachloro-1,3-butadiene	0.0250	0.0248	0.0246	99.0	98.2	73.7-133			0.790	20
Isopropylbenzene	0.0250	0.0224	0.0224	89.7	89.5	81.6-124			0.280	20
p-Isopropyltoluene	0.0250	0.0227	0.0227	90.9	90.9	77.6-129			0.0200	20

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3161593-1 09/03/16 00:01 • (LCSD) R3161593-2 09/03/16 00:21

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
2-Butanone (MEK)	0.125	0.199	0.189	159	151	46.4-155	J4		5.10	20
Methylene Chloride	0.0250	0.0270	0.0267	108	107	69.5-120			1.05	20
4-Methyl-2-pentanone (MIBK)	0.125	0.154	0.146	123	117	63.3-138			5.38	20
Methyl tert-butyl ether	0.0250	0.0272	0.0267	109	107	70.1-125			1.92	20
Naphthalene	0.0250	0.0288	0.0283	115	113	69.7-134			2.02	20
n-Propylbenzene	0.0250	0.0241	0.0239	96.5	95.8	81.9-122			0.800	20
Styrene	0.0250	0.0226	0.0227	90.3	90.8	79.9-124			0.570	20
1,1,1,2-Tetrachloroethane	0.0250	0.0224	0.0223	89.6	89.2	78.5-125			0.480	20
1,1,2,2-Tetrachloroethane	0.0250	0.0254	0.0252	101	101	79.3-123			0.710	20
Tetrachloroethene	0.0250	0.0202	0.0199	80.9	79.6	73.5-130			1.64	20
Toluene	0.0250	0.0245	0.0244	98.0	97.6	77.9-116			0.340	20
1,1,2-Trichlorotrifluoroethane	0.0250	0.0250	0.0237	99.9	94.9	62.0-141			5.16	20
1,2,3-Trichlorobenzene	0.0250	0.0280	0.0283	112	113	75.7-134			0.990	20
1,2,4-Trichlorobenzene	0.0250	0.0275	0.0274	110	110	76.1-136			0.360	20
1,1,1-Trichloroethane	0.0250	0.0261	0.0259	104	104	71.1-129			0.800	20
1,1,2-Trichloroethane	0.0250	0.0247	0.0243	98.9	97.1	81.6-120			1.83	20
Trichloroethene	0.0250	0.0234	0.0230	93.8	92.0	79.5-121			1.95	20
Trichlorofluoromethane	0.0250	0.0216	0.0215	86.5	86.1	49.1-157			0.480	20
1,2,3-Trichloropropane	0.0250	0.0240	0.0236	95.9	94.4	74.9-124			1.60	20
1,2,3-Trimethylbenzene	0.0250	0.0257	0.0258	103	103	79.9-118			0.400	20
1,2,4-Trimethylbenzene	0.0250	0.0227	0.0225	90.7	89.8	79.0-122			0.930	20
1,3,5-Trimethylbenzene	0.0250	0.0223	0.0221	89.1	88.5	81.0-123			0.610	20
Vinyl chloride	0.0250	0.0260	0.0262	104	105	61.5-134			1.00	20
Xylenes, Total	0.0750	0.0654	0.0656	87.2	87.5	79.2-122			0.400	20
(S) Toluene-d8				*109*	*109*	*90.0-115*				
(S) Dibromofluoromethane				*110*	*111*	*79.0-121*				
(S) 4-Bromofluorobenzene				*95.9*	*96.6*	*80.1-120*				

L856303-26 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856303-26 09/03/16 04:46 • (MS) R3161593-4 09/03/16 02:47 • (MSD) R3161593-5 09/03/16 03:07

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Acetone	0.125	U	0.0919	0.111	73.5	88.6	1	25.0-156			18.6	21.5
Acrolein	0.125	U	0.167	0.193	134	154	1	34.0-194			14.2	21.5
Acrylonitrile	0.125	U	0.168	0.197	134	157	1	55.9-161			15.7	20
Benzene	0.0250	0.00142	0.0254	0.0277	96.1	105	1	58.6-133			8.53	20
Bromobenzene	0.0250	U	0.0220	0.0237	88.1	94.8	1	70.6-125			7.30	20
Bromodichloromethane	0.0250	U	0.0240	0.0257	96.0	103	1	69.2-127			6.84	20

L856303-26 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856303-26 09/03/16 04:46 • (MS) R3161593-4 09/03/16 02:47 • (MSD) R3161593-5 09/03/16 03:07

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Bromoform	0.0250	U	0.0202	0.0221	80.7	88.3	1	66.3-140			8.95	20
Bromomethane	0.0250	U	0.0185	0.0193	74.0	77.3	1	16.6-183			4.31	20.5
n-Butylbenzene	0.0250	U	0.0270	0.0289	108	115	1	64.8-145			6.75	20
sec-Butylbenzene	0.0250	U	0.0220	0.0233	88.1	93.1	1	66.8-139			5.49	20
tert-Butylbenzene	0.0250	U	0.0213	0.0222	85.2	88.6	1	67.1-138			3.96	20
Carbon tetrachloride	0.0250	U	0.0228	0.0250	91.2	100	1	60.6-139			9.28	20
Chlorobenzene	0.0250	U	0.0214	0.0228	85.5	91.1	1	70.1-130			6.39	20
Chlorodibromomethane	0.0250	U	0.0214	0.0236	85.6	94.5	1	71.6-132			9.88	20
Chloroethane	0.0250	U	0.0227	0.0244	90.9	97.5	1	33.3-155			6.97	20
2-Chloroethyl vinyl ether	0.125	U	0.0300	0.00611	24.0	4.89	1	5.00-149		J3 J6	132	40
Chloroform	0.0250	U	0.0251	0.0274	100	110	1	66.1-133			8.69	20
Chloromethane	0.0250	U	0.0275	0.0296	110	119	1	40.7-139			7.46	20
2-Chlorotoluene	0.0250	U	0.0226	0.0239	90.6	95.7	1	66.9-134			5.46	20
4-Chlorotoluene	0.0250	U	0.0226	0.0237	90.2	94.7	1	66.8-134			4.88	20
1,2-Dibromo-3-Chloropropane	0.0250	U	0.0235	0.0290	94.1	116	1	63.9-142		J3	21.0	20.2
1,2-Dibromoethane	0.0250	U	0.0217	0.0244	86.8	97.5	1	73.8-131			11.7	20
Dibromomethane	0.0250	U	0.0235	0.0266	93.9	106	1	72.8-127			12.6	20
1,2-Dichlorobenzene	0.0250	U	0.0238	0.0261	95.2	104	1	77.4-127			9.27	20
1,3-Dichlorobenzene	0.0250	U	0.0203	0.0216	81.2	86.3	1	67.9-136			6.08	20
1,4-Dichlorobenzene	0.0250	U	0.0225	0.0243	89.9	97.0	1	74.4-123			7.66	20
Dichlorodifluoromethane	0.0250	U	0.0255	0.0275	102	110	1	42.2-146			7.46	20
1,1-Dichloroethane	0.0250	U	0.0282	0.0307	113	123	1	64.0-134			8.53	20
1,2-Dichloroethane	0.0250	U	0.0248	0.0276	99.3	110	1	60.7-132			10.5	20
1,1-Dichloroethene	0.0250	U	0.0180	0.0196	72.1	78.3	1	48.8-144			8.34	20
cis-1,2-Dichloroethene	0.0250	U	0.0250	0.0273	99.8	109	1	60.6-136			9.14	20
trans-1,2-Dichloroethene	0.0250	U	0.0235	0.0254	94.1	102	1	61.0-132			7.78	20
1,2-Dichloropropane	0.0250	U	0.0273	0.0298	109	119	1	69.7-130			8.75	20
1,1-Dichloropropene	0.0250	U	0.0266	0.0286	107	114	1	61.5-136			6.95	20
1,3-Dichloropropane	0.0250	U	0.0248	0.0273	99.1	109	1	74.3-123			9.76	20
cis-1,3-Dichloropropene	0.0250	U	0.0263	0.0281	105	112	1	71.1-129			6.74	20
trans-1,3-Dichloropropene	0.0250	0.000809	0.0230	0.0252	88.9	97.6	1	66.3-136			9.02	20
2,2-Dichloropropane	0.0250	U	0.0247	0.0253	98.7	101	1	54.9-142			2.52	20
Di-isopropyl ether	0.0250	U	0.0288	0.0318	115	127	1	59.9-140			9.70	20
Ethylbenzene	0.0250	U	0.0208	0.0224	83.3	89.5	1	62.7-136			7.15	20
Hexachloro-1,3-butadiene	0.0250	U	0.0237	0.0256	94.7	102	1	61.1-144			7.88	20.1
Isopropylbenzene	0.0250	U	0.0212	0.0224	85.0	89.6	1	67.4-136			5.28	20
p-Isopropyltoluene	0.0250	U	0.0219	0.0232	87.6	92.7	1	62.8-143			5.67	20
2-Butanone (MEK)	0.125	U	0.131	0.161	105	129	1	45.0-156			20.6	20.8
Methylene Chloride	0.0250	U	0.0251	0.0271	100	108	1	61.5-125			7.83	20
4-Methyl-2-pentanone (MIBK)	0.125	U	0.139	0.167	111	133	1	60.7-150			18.1	20

L856303-26 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L856303-26 09/03/16 04:46 • (MS) R3161593-4 09/03/16 02:47 • (MSD) R3161593-5 09/03/16 03:07

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	RPD Limits %
Methyl tert-butyl ether	0.0250	U	0.0246	0.0278	98.3	111	1	61.4-136			12.4	20
Naphthalene	0.0250	U	0.0257	0.0306	103	122	1	61.8-143			17.3	20
n-Propylbenzene	0.0250	U	0.0230	0.0244	92.0	97.7	1	63.2-139			5.94	20
Styrene	0.0250	U	0.0215	0.0229	86.0	91.7	1	68.2-133			6.38	20
1,1,1,2-Tetrachloroethane	0.0250	U	0.0208	0.0219	83.3	87.8	1	70.5-132			5.16	20
1,1,2,2-Tetrachloroethane	0.0250	U	0.0235	0.0270	93.9	108	1	64.9-145			13.8	20
Tetrachloroethene	0.0250	U	0.0185	0.0194	73.9	77.8	1	57.4-141			5.08	20
Toluene	0.0250	U	0.0227	0.0245	90.9	98.1	1	67.8-124			7.63	20
1,1,2-Trichlorotrifluoroethane	0.0250	U	0.0218	0.0231	87.1	92.6	1	53.7-150			6.05	20
1,2,3-Trichlorobenzene	0.0250	U	0.0259	0.0296	104	118	1	65.7-143			13.2	20
1,2,4-Trichlorobenzene	0.0250	U	0.0262	0.0291	105	116	1	67.0-146			10.3	20
1,1,1-Trichloroethane	0.0250	U	0.0240	0.0258	96.1	103	1	58.7-134			6.92	20
1,1,2-Trichloroethane	0.0250	U	0.0223	0.0248	89.4	99.3	1	74.1-130			10.5	20
Trichloroethene	0.0250	U	0.0212	0.0229	84.7	91.7	1	48.9-148			7.87	20
Trichlorofluoromethane	0.0250	U	0.0200	0.0219	80.2	87.5	1	39.9-165			8.76	20
1,2,3-Trichloropropane	0.0250	U	0.0222	0.0258	88.9	103	1	71.5-134			15.1	20
1,2,3-Trimethylbenzene	0.0250	U	0.0243	0.0262	97.0	105	1	62.7-133			7.87	20
1,2,4-Trimethylbenzene	0.0250	U	0.0211	0.0227	84.6	90.6	1	60.5-137			6.89	20
1,3,5-Trimethylbenzene	0.0250	U	0.0212	0.0223	84.8	89.3	1	67.9-134			5.16	20
Vinyl chloride	0.0250	0.000399	0.0246	0.0268	96.8	106	1	44.3-143			8.47	20
Xylenes, Total	0.0750	U	0.0614	0.0657	81.8	87.6	1	65.6-133			6.81	20
(S) Toluene-d8					*109*	*109*		*90.0-115*				
(S) Dibromofluoromethane					*111*	*112*		*79.0-121*				
(S) 4-Bromofluorobenzene					*95.5*	*95.2*		*80.1-120*				

Method Blank (MB)

(MB) R3160815-1 08/31/16 17:46

Analyte	MB Result mg/l	MB Qualifier	MB MDL mg/l	MB RDL mg/l
C10-C28 Diesel Range	U		0.0222	0.100
C28-C40 Oil Range	U		0.0118	0.100
(S) o-Terphenyl	*97.4*			*50.0-150*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160815-2 08/31/16 18:07 • (LCSD) R3160815-3 08/31/16 18:27

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
C10-C28 Diesel Range	1.50	1.76	1.72	118	115	70.0-130			2.59	20
(S) o-Terphenyl				*103*	*103*	*50.0-150*				

Method Blank (MB)

(MB) R3160816-1 08/31/16 16:50

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/l		mg/l	mg/l
C10-C28 Diesel Range	U		0.0222	0.100
C28-C40 Oil Range	U		0.0118	0.100
(S) o-Terphenyl	*97.5*			*50.0-150*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160816-2 08/31/16 17:08 • (LCSD) R3160816-3 08/31/16 17:27

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/l	mg/l	mg/l	%	%	%			%	%
C10-C28 Diesel Range	1.50	1.77	1.73	118	115	70.0-130			2.62	20
(S) o-Terphenyl				*98.1*	*92.1*	*50.0-150*				

Method Blank (MB)

(MB) R3160807-3 08/31/16 14:13

Analyte	MB Result mg/l	MB Qualifier	MB MDL mg/l	MB RDL mg/l
Acenaphthene	U		0.000316	0.00100
Acenaphthylene	U		0.000309	0.00100
Anthracene	U		0.000291	0.00100
Benzidine	U		0.00432	0.0100
Benzo(a)anthracene	U		0.0000510	0.00100
Benzo(b)fluoranthene	U		0.0000896	0.00100
Benzo(k)fluoranthene	U		0.000355	0.00100
Benzo(g,h,i)perylene	U		0.00000227	0.00100
Benzo(a)pyrene	0.000125	J	0.0000381	0.000200
Bis(2-chlorethoxy)methane	U		0.000329	0.0100
Bis(2-chloroethyl)ether	U		0.00162	0.0100
Bis(2-chloroisopropyl)ether	U		0.000445	0.0100
4-Bromophenyl-phenylether	U		0.000335	0.0100
2-Chloronaphthalene	U		0.000330	0.00100
4-Chlorophenyl-phenylether	U		0.000303	0.0100
Chrysene	U		0.000332	0.00100
Dibenz(a,h)anthracene	U		0.0000644	0.000200
3,3-Dichlorobenzidine	U		0.00202	0.0100
2,4-Dinitrotoluene	U		0.00165	0.0100
2,6-Dinitrotoluene	U		0.000279	0.0100
Fluoranthene	U		0.000310	0.00100
Fluorene	U		0.000323	0.00100
Hexachlorobenzene	U		0.000341	0.00100
Hexachloro-1,3-butadiene	U		0.000329	0.0100
Hexachlorocyclopentadiene	U		0.00233	0.0100
Hexachloroethane	U		0.000365	0.0100
Indeno(1,2,3-cd)pyrene	U		0.000279	0.00100
Isophorone	U		0.000272	0.0100
Naphthalene	U		0.000372	0.00100
Nitrobenzene	U		0.000367	0.0100
n-Nitrosodimethylamine	U		0.00126	0.0100
n-Nitrosodiphenylamine	U		0.000304	0.0100
n-Nitrosodi-n-propylamine	U		0.000403	0.0100
Phenanthrene	U		0.000366	0.00100
Benzylbutyl phthalate	U		0.000275	0.00300
Bis(2-ethylhexyl)phthalate	U		0.000709	0.00300
Di-n-butyl phthalate	U		0.000266	0.00300
Diethyl phthalate	U		0.000282	0.00300
Dimethyl phthalate	U		0.000283	0.00300
Di-n-octyl phthalate	0.000309	J	0.000278	0.00300

Method Blank (MB)

(MB) R3160807-3 08/31/16 14:13

Analyte	MB Result mg/l	MB Qualifier	MB MDL mg/l	MB RDL mg/l
Pyrene	U		0.000330	0.00100
1,2,4-Trichlorobenzene	U		0.000355	0.0100
4-Chloro-3-methylphenol	U		0.000263	0.0100
2-Chlorophenol	U		0.000283	0.0100
2,4-Dichlorophenol	U		0.000284	0.0100
2,4-Dimethylphenol	U		0.000624	0.0100
4,6-Dinitro-2-methylphenol	U		0.00262	0.0100
2,4-Dinitrophenol	U		0.00325	0.0100
2-Nitrophenol	U		0.000320	0.0100
4-Nitrophenol	U		0.00201	0.0100
Pentachlorophenol	U		0.000313	0.0100
Phenol	U		0.000334	0.0100
2,4,6-Trichlorophenol	U		0.000297	0.0100
(S) Nitrobenzene-d5	*63.7*			*21.8-123*
(S) 2-Fluorobiphenyl	*75.6*			*29.5-131*
(S) p-Terphenyl-d14	*90.7*			*29.3-137*
(S) Phenol-d5	*38.9*			*5.00-70.1*
(S) 2-Fluorophenol	*54.1*			*10.0-77.9*
(S) 2,4,6-Tribromophenol	*68.7*			*11.2-130*

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160807-1 08/31/16 13:26 • (LCSD) R3160807-2 08/31/16 13:50

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
Acenaphthene	0.0500	0.0434	0.0417	86.9	83.4	38.7-109			4.11	21.5
Acenaphthylene	0.0500	0.0464	0.0442	92.8	88.4	36.0-106			4.86	21
Anthracene	0.0500	0.0439	0.0433	87.9	86.6	43.6-113			1.48	18.8
Benzidine	0.0500	0.0326	0.0207	65.2	41.4	10.0-165		J3	44.8	40
Benzo(a)anthracene	0.0500	0.0460	0.0465	92.0	93.0	51.2-112			1.12	20
Benzo(b)fluoranthene	0.0500	0.0444	0.0444	88.7	88.9	47.6-111			0.130	20
Benzo(k)fluoranthene	0.0500	0.0437	0.0427	87.4	85.3	49.4-114			2.40	20
Benzo(g,h,i)perylene	0.0500	0.0462	0.0455	92.5	91.0	45.2-117			1.60	20
Benzo(a)pyrene	0.0500	0.0437	0.0436	87.4	87.2	45.6-106			0.220	20
Bis(2-chlorethoxy)methane	0.0500	0.0400	0.0358	79.9	71.6	37.2-111			10.9	24.1
Bis(2-chloroethyl)ether	0.0500	0.0345	0.0299	69.0	59.9	22.6-108			14.2	27.9
Bis(2-chloroisopropyl)ether	0.0500	0.0374	0.0324	74.7	64.7	32.9-100			14.4	25.1
4-Bromophenyl-phenylether	0.0500	0.0469	0.0467	93.8	93.4	40.7-116			0.420	21
2-Chloronaphthalene	0.0500	0.0409	0.0375	81.9	75.0	33.6-105			8.83	23

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160807-1 08/31/16 13:26 • (LCSD) R3160807-2 08/31/16 13:50

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
4-Chlorophenyl-phenylether	0.0500	0.0479	0.0455	95.9	90.9	39.0-113			5.32	20.9
Chrysene	0.0500	0.0443	0.0439	88.7	87.8	54.6-120			0.930	20
Dibenz(a,h)anthracene	0.0500	0.0462	0.0458	92.3	91.7	42.8-118			0.680	20
3,3-Dichlorobenzidine	0.0500	0.0572	0.0503	114	101	27.2-142			12.9	22.3
2,4-Dinitrotoluene	0.0500	0.0517	0.0508	103	102	31.2-105			1.77	22
2,6-Dinitrotoluene	0.0500	0.0446	0.0440	89.3	88.0	30.6-106			1.45	23.1
Fluoranthene	0.0500	0.0463	0.0455	92.5	91.1	45.9-115			1.60	20
Fluorene	0.0500	0.0448	0.0428	89.6	85.6	41.0-112			4.53	20.2
Hexachlorobenzene	0.0500	0.0491	0.0484	98.2	96.8	38.5-116			1.44	20.1
Hexachloro-1,3-butadiene	0.0500	0.0410	0.0344	81.9	68.8	16.1-104			17.4	31.2
Hexachlorocyclopentadiene	0.0500	0.0376	0.0337	75.2	67.3	10.0-121			11.1	27.9
Hexachloroethane	0.0500	0.0325	0.0270	64.9	54.1	16.5-89.8			18.2	30.7
Indeno(1,2,3-cd)pyrene	0.0500	0.0467	0.0468	93.5	93.5	45.0-116			0.0800	20
Isophorone	0.0500	0.0412	0.0386	82.3	77.2	35.4-112			6.43	21.5
Naphthalene	0.0500	0.0361	0.0313	72.3	62.5	32.2-101			14.5	23.8
Nitrobenzene	0.0500	0.0371	0.0322	74.1	64.5	31.4-106			14.0	25.7
n-Nitrosodimethylamine	0.0500	0.0240	0.0197	48.0	39.4	10.0-80.1			19.6	37.5
n-Nitrosodiphenylamine	0.0500	0.0436	0.0427	87.3	85.3	44.4-113			2.23	20
n-Nitrosodi-n-propylamine	0.0500	0.0390	0.0352	77.9	70.5	33.2-106			10.0	23.7
Phenanthrene	0.0500	0.0410	0.0408	82.1	81.6	46.4-113			0.610	20
Benzylbutyl phthalate	0.0500	0.0442	0.0440	88.3	88.1	31.8-123			0.300	20.7
Bis(2-ethylhexyl)phthalate	0.0500	0.0433	0.0444	86.5	88.7	36.9-134			2.54	23.6
Di-n-butyl phthalate	0.0500	0.0462	0.0457	92.4	91.3	41.8-120			1.17	20.2
Diethyl phthalate	0.0500	0.0489	0.0473	97.9	94.6	36.5-129			3.45	20
Dimethyl phthalate	0.0500	0.0470	0.0457	94.0	91.5	35.3-128			2.78	20.8
Di-n-octyl phthalate	0.0500	0.0415	0.0413	83.0	82.6	39.7-112			0.450	21.1
Pyrene	0.0500	0.0432	0.0437	86.3	87.4	46.3-117			1.21	20
1,2,4-Trichlorobenzene	0.0500	0.0384	0.0323	76.8	64.6	22.9-96.1			17.3	27.5
4-Chloro-3-methylphenol	0.0500	0.0419	0.0397	83.9	79.3	35.7-100			5.62	22.9
2-Chlorophenol	0.0500	0.0354	0.0294	70.8	58.7	26.2-91.5			18.7	26.5
2,4-Dichlorophenol	0.0500	0.0431	0.0384	86.2	76.8	31.4-103			11.5	24.9
2,4-Dimethylphenol	0.0500	0.0409	0.0365	81.9	73.1	31.9-107			11.4	25.7
4,6-Dinitro-2-methylphenol	0.0500	0.0434	0.0426	86.7	85.2	18.4-148			1.73	24.4
2,4-Dinitrophenol	0.0500	0.0323	0.0321	64.7	64.2	24.2-128			0.720	20.5
2-Nitrophenol	0.0500	0.0415	0.0381	83.0	76.1	25.9-106			8.64	26.9
4-Nitrophenol	0.0500	0.0253	0.0244	50.5	48.9	10.0-52.7			3.28	40
Pentachlorophenol	0.0500	0.0364	0.0362	72.9	72.4	10.0-97.4			0.620	35.1
Phenol	0.0500	0.0225	0.0188	44.9	37.6	10.0-57.9			17.9	35
2,4,6-Trichlorophenol	0.0500	0.0448	0.0428	89.7	85.5	29.8-107			4.73	24.1
(S) Nitrobenzene-d5				*77.5*	*61.3*	*21.8-123*				

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3160807-1 08/31/16 13:26 • (LCSD) R3160807-2 08/31/16 13:50

Analyte	Spike Amount mg/l	LCS Result mg/l	LCSD Result mg/l	LCS Rec. %	LCSD Rec. %	Rec. Limits %	LCS Qualifier	LCSD Qualifier	RPD %	RPD Limits %
(S) 2-Fluorobiphenyl				*89.4*	*76.9*	*29.5-131*				
(S) p-Terphenyl-d14				*96.9*	*90.1*	*29.3-137*				
(S) Phenol-d5				*46.1*	*36.6*	*5.00-70.1*				
(S) 2-Fluorophenol				*64.1*	*46.4*	*10.0-77.9*				
(S) 2,4,6-Tribromophenol				*110*	*99.2*	*11.2-130*				

Abbreviations and Definitions

SDG	Sample Delivery Group.
MDL	Method Detection Limit.
RDL	Reported Detection Limit.
ND	Not detected at the Reporting Limit (or MDL where applicable).
U	Not detected at the Reporting Limit (or MDL where applicable).
RPD	Relative Percent Difference.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
(S)	Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media.
Rec.	Recovery.

Qualifier	Description
B	The same analyte is found in the associated blank.
E	The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration (ICAL).
J	The identification of the analyte is acceptable; the reported value is an estimate.
J3	The associated batch QC was outside the established quality control range for precision.
J4	The associated batch QC was outside the established quality control range for accuracy.
J5	The sample matrix interfered with the ability to make any accurate determination; spike value is high.
J6	The sample matrix interfered with the ability to make any accurate determination; spike value is low.
J7	Surrogate recovery cannot be used for control limit evaluation due to dilution.
O1	The analyte failed the method required serial dilution test and/or subsequent post-spike criteria. These failures indicate matrix interference.
V	The sample concentration is too high to evaluate accurate spike recoveries.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
***** Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Conneticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1 4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

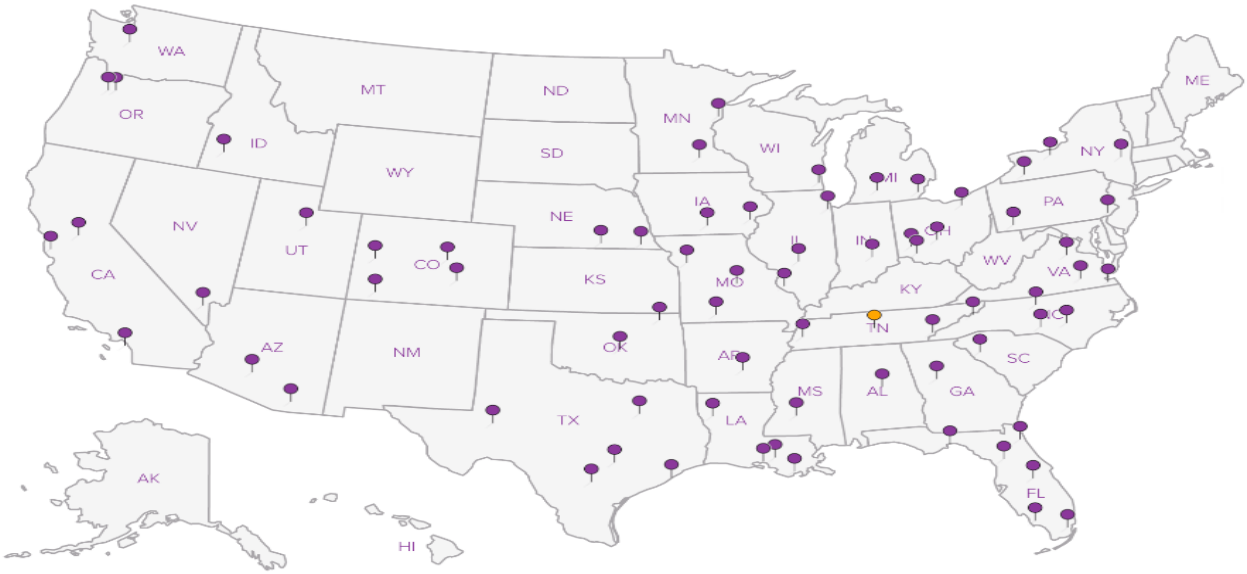
Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

[1.] Drinking Water [2.] Underground Storage Tanks [3.] Aquatic Toxicity [4.] Chemical/Microbiological [5.] Mold [n/a] Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



AMEC Foster Wheeler - Houston, TX
585 N. Dairy Ashford
Houston, TX 77079

Billing Information:
Accounts Payable
585 N. Dairy Ashford
Houston, TX 77079

Report to: **Pam Krueger**

Email To: **pamela.krueger@amecfw.com**

Project Description: **Pump Test HollyFrontier Navajo**

City/State Collected:

Phone: **713-929-5674**
Fax:

Client Project #

Lab Project # **AMECFWHTX-PUMPTEST**

Collected by (print): Casey Richards

Site/Facility ID #

P.O. #

Collected by (signature): Casey Richards
Immediately Packed on Ice N ____ Y ✓

Rush? (Lab MUST Be Notified)
____ Same Day 200%
____ Next Day 100%
____ Two Day 50%
____ Three Day 25%

Date Results Needed: Contact P.M. ★

Email? ___No X__Yes
FAX? ___No ___Yes

Analysis / Container / Preservative

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	8270TX 100ml Amb NoPres	COD,NO2NO3 250mlHDPE-H2SO4	DROOROLVI 40mlAmb-HCl-BT	GRO 40mlAmb HCl	Metals/HARD 500mlHDPE-HNO3	SULFIDE 125mlAmb-S-NaOH+ZnAc	TDS, Anions;pH 500mlHDPE-NoPres	TOC 250mlAmb-HCl	TSS 1L-HDPE NoPres	V8260 40mlAmb-HCl	Rem./Contaminant	Sample # (lab only)
RW-13R PRE	GRAB	GW	—	8-24-16	1640	14	X	X	X	X	X	X	X	X	X	X		01
RW-6R PRE	GRAB	GW		8-25-16	1259	14	X	X	X	X	X	X	X	X	X	X		02
RW-13R POST	GRAB	GW		8-26-16	1125	14	X	X	X	X	X	X	X	X	X	X		03

GR

* Matrix: **SS** - Soil **GW** - Groundwater **WW** - WasteWater **DW** - Drinking Water **OT** - Other_____

Remarks:Metals= As, B, Ca, Cr, Fe, K, Mn, Na, Ni, Se, U and V by 6020.
Anions = Chloride, Sulfate and Fluoride.

pH _____ Temp _____
Flow _____ Other _____

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)
Casey Richards	8-26-16	1800	FedEx
Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)
Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)

Samples returned via: ☐ UPS ☑ FedEx ☐ Courier ☐ _____
Temp: 2.9 °C Bottles Received: 42+1TB
Date: 8-27-16 Time: 900

Hold #
Condition: (lab use only) a BW7
COC Seal Intact: ____ Y ____ N ____ NA
pH Checked: NCF:

Chain of Custody Page 1 of 1

ESC LABORATORY SCIENCES
YOUR LAB OF CHOICE
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L # 956325
Table D182
Acctnum: AMECFWHTX
Template: T114889
Prelogin: P564562
TSR: 526 - Chris McCord
PB: 8-15-16 GH
Shipped Via: FedEx Ground

ESC
L·A·B S·C·I·E·N·C·E·S
YOUR LAB OF CHOICE

Cooler Receipt Checklist

Client: AMEC FWH Tx SDG# 256325

Cooler Received/Opened On: 8-27-16 By :Timiesha Scott

Temperature Upon Receipt: 2.9 °c

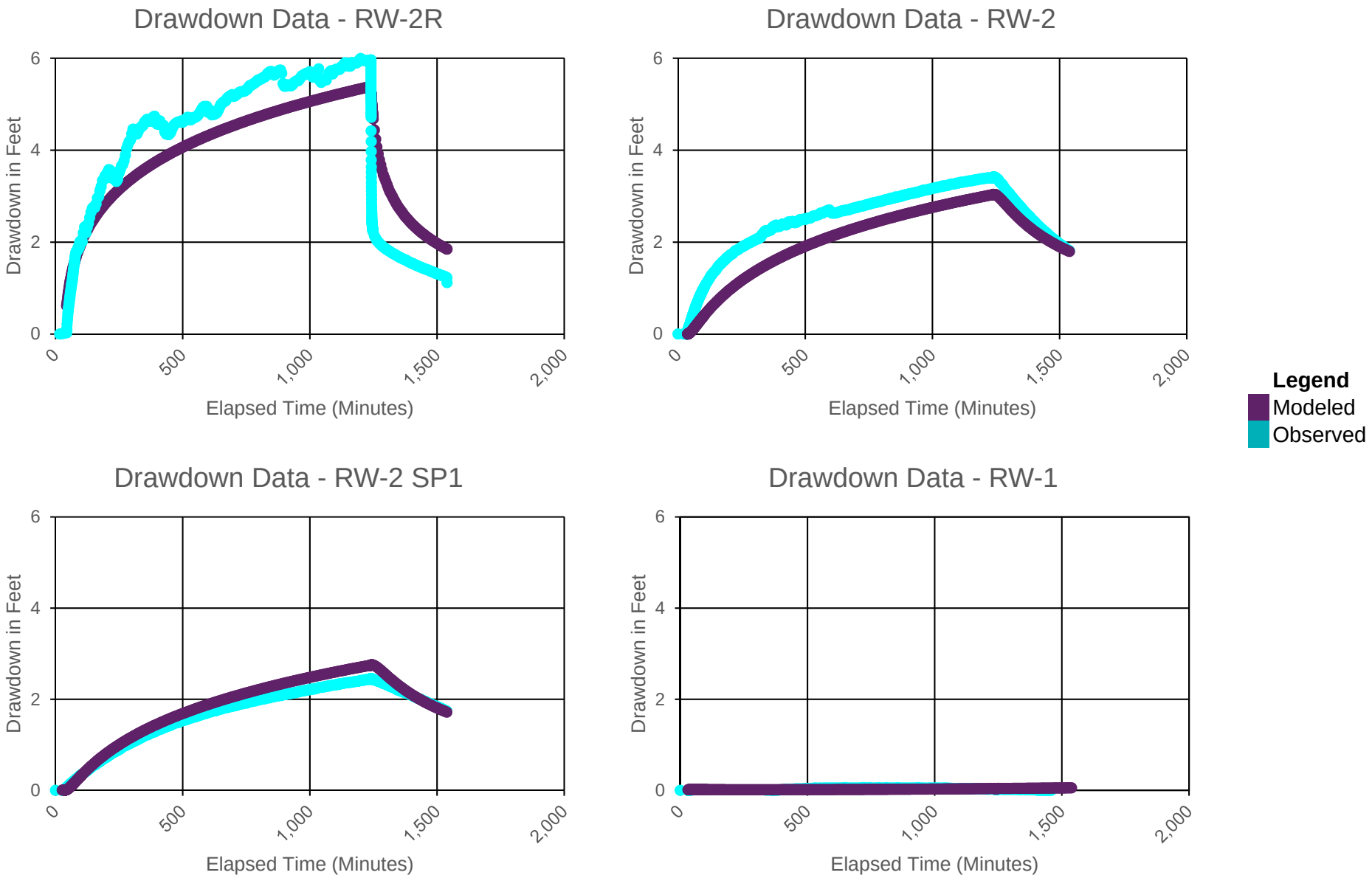
(Signature)

Cooler Receipt Check List	Yes	No	N/A
Were custody seals on outside of cooler and intact?	✓		
Were custody papers properly filled out (ink, signed, etc.)?	✓		
Did all bottles arrive in good condition?	✓		
Were correct bottles used for the analyses requested?	✓		
Was sufficient amount of sample sent in each bottle?	✓		
Were correct preservatives used?	✓		
Were all applicable sample containers checked for preservation? (Any samples not in accepted pH range noted on COC .)	✓		
If applicable, was an observable VOA headspace present?		✓	
Non Conformance Generated? (If yes see attached NCF)		✓	

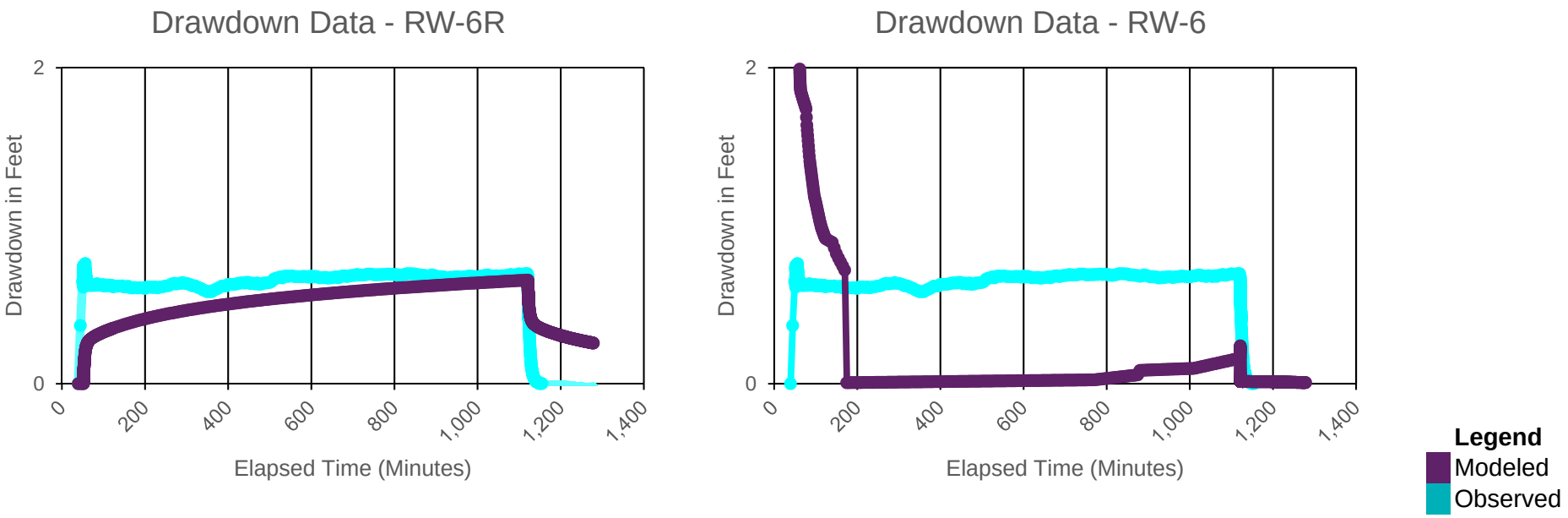
amec foster wheeler

APPENDIX C

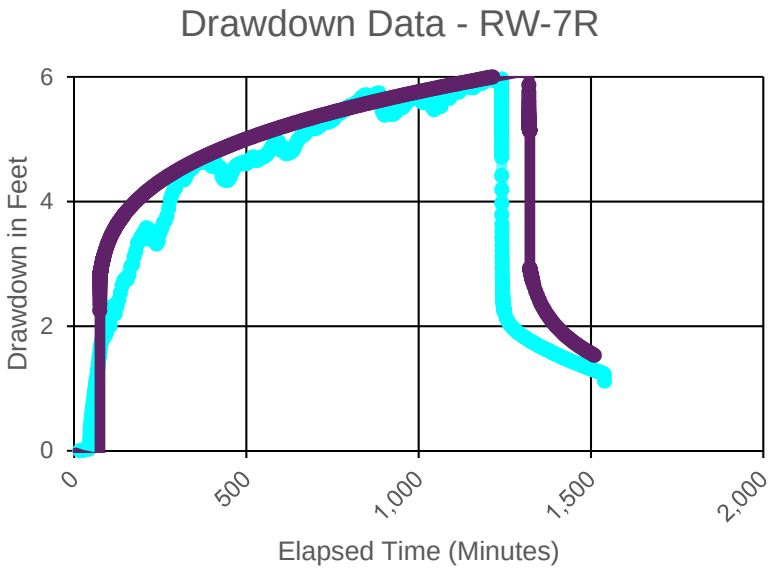
RW-2R Modeled and Observed Drawdown

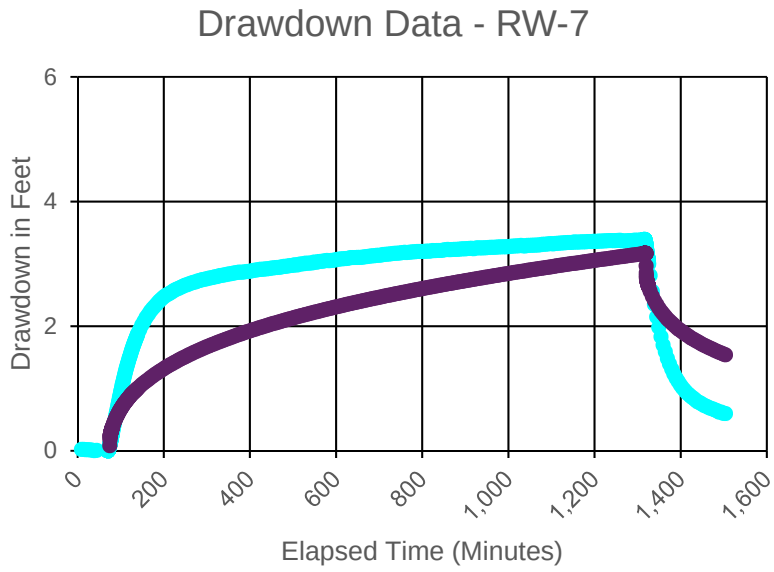


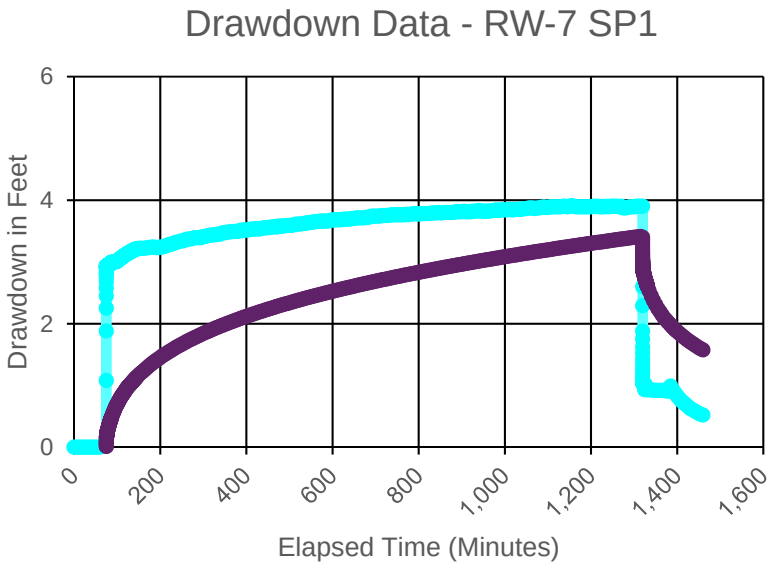
RW-6R Modeled and Observed Drawdown

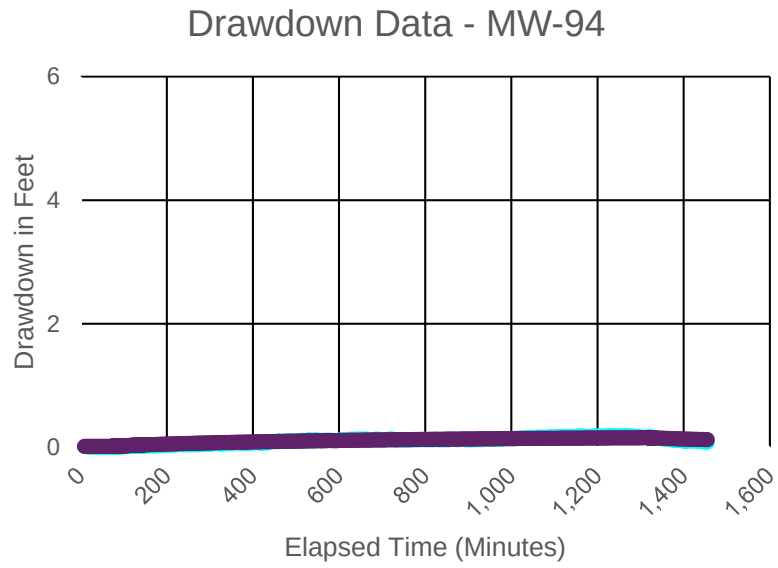


RW-7R Modeled and Observed Drawdown

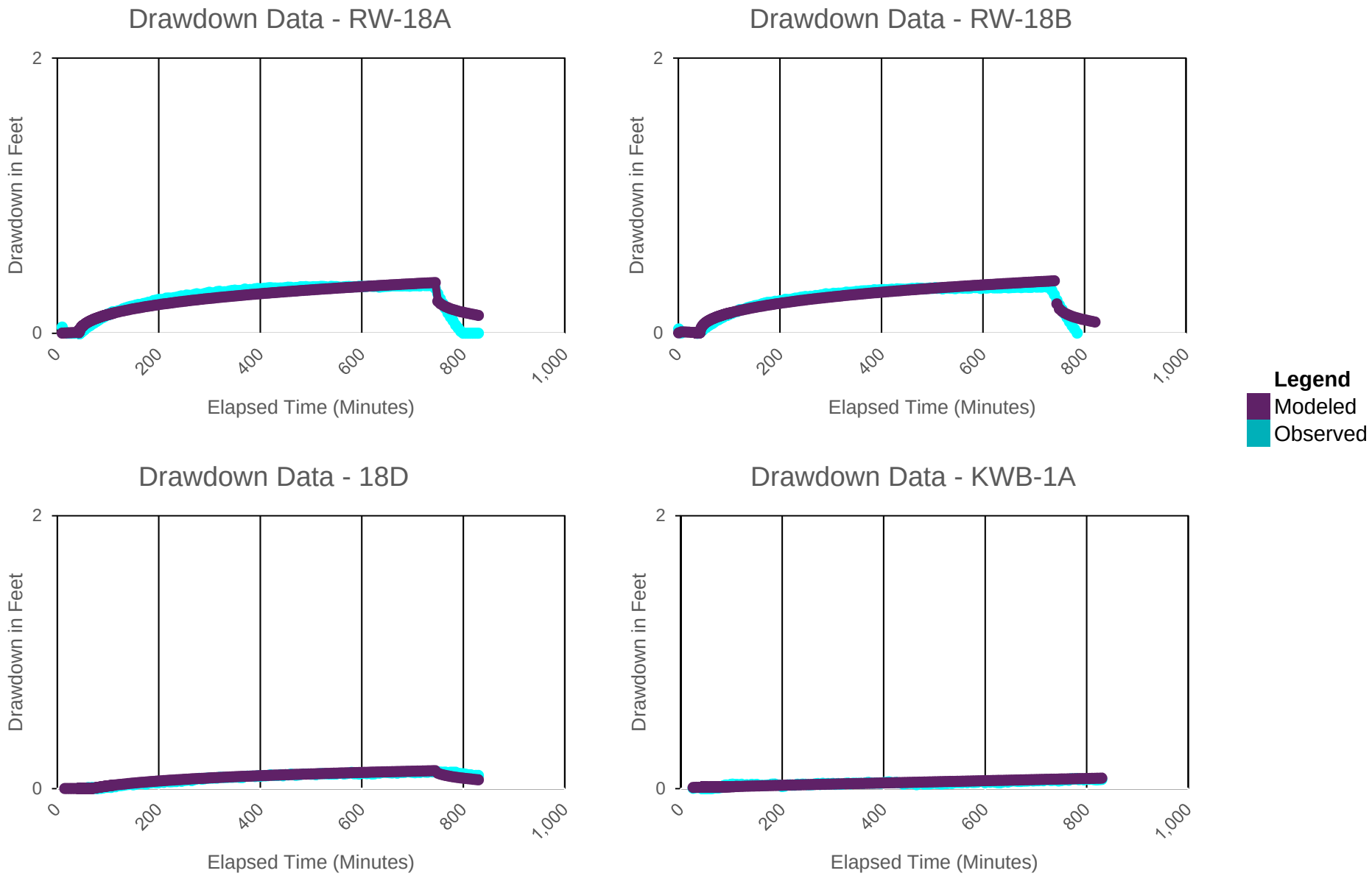








RW-18A Modeled and Observed Drawdown



RW-19 Modeled and Observed Drawdown