Date: March 25, 2020
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Remedy Execution
ATTN: IMCR-AR (R. Ober)
Rocky Mountain Arsenal
Commerce City, CO 80022-1748

SUBJECT: Contract W9125F-12-D-0001, Task #: 0165
Fiscal Year 2019 Perfluorinated Compounds Data Summary Report, Revision 0

Dear Ms. Ober:

Please be advised that 1 electronic copy of the Fiscal Year 2019 Perfluorinated Compounds Data Summary Report, Revision 0, is being delivered to DTC for distribution to the regulatory agencies. Hard copies will be provided upon request.

Please contact Scott Ache, Regulatory Compliance Manager, at 720-625-3653 if you have any questions.

Sincerely,
Navarro Research and Engineering, Inc.

Anthony LaChance
Program Manager

OMC-SA
Attachments

cc: DTC
Cable, K.
Greene, S. (w/attach)
SMG (attn Patty) (w/attach)
Swanson, S. (w/attach)
Ache, S. (w/attach)
Luke, N. (w/attach)
Rieger, C. (w/attach)
Thornburg, W. (w/attach)
Trujillo, R. (w/o attach)
File

ROCKY MOUNTAIN ARSENAL

Fiscal Year 2019
Perfluorinated Compounds
Data Summary Report

Revision 0
March 25, 2020

U.S. Department of the Army
Shell Oil Company

Prepared by:

Navarro Research and Engineering, Inc.

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ACRONYMS AND ABREVIATIONS

ARDL	Applied Research and Development Laboratory
AFFF	Aqueous Film Forming Foam
BANS	Basin A-Neck System
CBSG	Colorado Basic Standard for Ground Water
COC	Contaminant of Concern
DQO	Data Quality Objective
DSR	Data Summary Report
EPA	U.S. Environmental Protection Agency
FY	Fiscal Year
IQR	Interquartile Range
LC/MS/MS	Liquid Chromatography/Tandem Mass Spectrometry
LCS	Laboratory Control Spike
LTMP	Long-Term Monitoring Plan
MRL	Method Reporting Limit
MS	Matrix Spike
NBCS	North Boundary Containment System
NWBCS	Northwest Boundary Containment System
OCN	Operations and Maintenance Change Notice
OGITS	Offpost Groundwater Intercept and Treatment System
OMC	Operations and Maintenance Contractor
PFOS	Perfluorooctanesulfonic Acid
PFC	Perfluorinated Compound
PFOA	Perfluorooctanoic Acid
QC	Quality Control
RMA	Rocky Mountain Arsenal
RMAED	Rocky Mountain Arsenal Environmental Database
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
µg/L	Micrograms per Liter

1.0 INTRODUCTION

This Data Summary Report (DSR) has been developed to present the results of the Rocky Mountain Arsenal (RMA) fiscal year 2019 (FY19) perfluorinated compounds sampling program and the review of associated Quality Control (QC) data. This DSR applies to the analysis of samples collected under the Perfluorinated Compounds Sampling and Analysis Plan (SAP) (Navarro 2019a). All actions taken based on analytical results presented in this report are documented in the associated project files.

The objective of the sampling program was to determine the presence or absence of perfluorinated compounds (PFCs) in groundwater at the RMA and assess the concentrations of PFCs in the treatment plants' influent and effluent.

Laboratory data for samples collected in support of the project have been summarized and are provided in later sections. The analytical data contained in this report have been taken from the RMA Environmental Database (RMAED). Data have been subjected to computerized data verification routines as run by the RMA Database Support Contractor. The reported data have been subjected to the formal data validation process; thus, the final accepted data are presented in this report.

2.0 BACKGROUND

Perfluorinated compounds have been classified as emerging contaminants by the U.S. Environmental Protection Agency (EPA). An emerging contaminant is defined as a contaminant that has a reasonably possible pathway to enter the environment; presents a potential unacceptable human health or environmental risk; and does not have a regulatory standard based on peer-reviewed science, or the regulatory standards are evolving due to new science, detection capabilities, or pathways (DoD 2018). Although there is no current standard, EPA has developed a health advisory level for perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) in drinking water of 0.070 micrograms per liter (µg/L), either individually or combined when both are present.

In 2016, the Army issued guidance for evaluating restoration sites for potential PFC contamination to determine the presence/absence of PFCs and evaluate whether response actions are necessary. The two PFCs of interest are PFOA and PFOS, which are typically associated with fire-fighting aqueous film forming foams (AFFF). RMA facilities included a fire station located in the southwest corner of Section 36, which was in operation from 1942 to 2005. On-site fire-fighting engines housed at the station were equipped with tanks that contained AFFF; however, there is no record of the use or discharge of foam at the fire station. A review of RMA records revealed only one documented use of AFFF on site. In 1979, 25 gallons of AFFF were applied to an acetone spill in South Plants north of Building 514 (RMA 1979). The foam was used as a vapor suppressant while the spill was cleaned up. Other applications and chemicals have been related to PFC contamination, including metal plating and other industrial manufacturing, which do not pertain to RMA.

Perfluorinated compounds had not been evaluated previously in RMA groundwater; therefore, no historical PFC groundwater data exist. The Army conducted an investigation from July 2017 to August 2018 to assess the potential for PFC groundwater contamination at the RMA (Navarro 2019c). The results of the investigation determined that PFC contamination exists at the RMA and concluded that further characterization of the PFC contamination was necessary.

The FY19 Perfluorinated Compounds SAP included PFC sampling from a limited group of wells and the treatment plant influents/effluents to verify the 2017/2018 PFC results and determine the extent of potential releases at RMA (Navarro 2019a).

The Perfluorinated Compounds SAP (Navarro 2019a) addresses the procedures and data quality objectives (DQOs) utilized for the characterization of PFCs in groundwater. The Contaminants of Concern (COCs), analytical methods and MRLs are presented in Table 1.

Table 1. Contaminants of Concern and Reporting Limits

Method	Analyte/COC	Method Number	Method Reporting Limit (µg/L)	CBSG (µg/L)
Per- and Polyfluorinated Substances (PFAS) in Water, Soil, Sediments, and Tissue by LC/MS/MS	PFOA and PFOS	537 (Modified)	0.002	NA (0.070 Health Advisory Level)

LC/MS/MS = Liquid Chromatography/Tandem Mass Spectrometry

2.1 DATA QUALITY OBJECTIVES

The following DQOs were included in the SAP.

Identify the Goals of the Study

- To confirm the presence or absence of PFCs in RMA groundwater in select source area wells at concentrations exceeding the Method Reporting Limit (MRL).
- To determine if PFOA and PFOS are present in RMA groundwater in an expanded set of wells downgradient of the source areas at concentrations exceeding the MRL.
- To determine if the PFOA or PFOS concentrations in the RMA treatment plant locations exceed the MRL.

Identify Information Inputs

- Water quality data (PFOA and PFOS) for the selected wells and treatment plants identified on Table 2.

Develop the Analytical Approach

If data from the selected wells indicate that PFOA and PFOS are not present above the MRLs in RMA groundwater, no additional sampling is required. If PFOA or PFOS concentrations exist

above the MRLs, the Army will engage in the discussion with the regulatory agencies to evaluate subsequent actions and determine whether additional characterization is necessary.

The Data Evaluation and Recommendations Section (Section 4.3) in this DSR is intended to address the subsequent actions as part of the consultative process.

3.0 SAMPLE COLLECTION AND ANALYSIS

The monitoring program included the collection of samples from the treatment plant influent/effluent locations and monitoring well locations listed in Table 2. The sample locations are shown on Figure 1. The program was conducted during the following scheduled sampling events:

- PFOA and PFOS well samples collected from March 2019 through September 2019 (two additional samples collected in December 2019 to confirm results).
- Treatment plant samples collected during quarter one, quarter three and quarter four of FY2019 at all four plants.

The 25 wells sampled for PFC analysis included wells that were selected to monitor in and downgradient of the major source areas.

Two additional samples were collected in December 2019 to confirm previous results. Initial sampling in 2017 identified South Plants well 01525 as having a combined PFOA/PFOS concentration of 4.21 µg/L. This well location correlates with a known use of AFFF in South Plants. South Plants well 01078, upgradient of this source area, had a combined concentration of 0.025 µg/L. Samples were collected in these wells in August 2019 to confirm concentrations in the source area; however, results indicated a combined concentration of 5.45 µg/L in upgradient well 01078. The combined concentration in the source area well 01525 was 0.032 µg/L, similar to the previous results for well 01078. As a result, these two wells were resampled in December 2019 to verify the source area. Results indicated a combined concentration of 6.27 µg/L in well 01525 and a combined concentration of 0.024 µg/L in well 01078, confirming that the source area is in the vicinity of well 01525.

The analyte list for this program is limited to PFOA and PFOS. Samples specified in this program were collected in conjunction with existing sampling programs conducted by organizations on the RMA. Analytical results have been incorporated into the RMAED.

Analysis of samples for PFOA and PFOS was subcontracted by Applied Research and Development Laboratory (ARDL) in Mount Vernon, Illinois to TestAmerica Laboratories, Inc. The samples were analyzed at the Sacramento, California laboratory. All samples were shipped to ARDL using Federal Express overnight service. Table 1 shows the analytical method information for the COCs for this effort. Analytical results and laboratory QC results are included in Appendix A. Sample locations are presented on Figure 1. No deviations from the SAP occurred.

4.0 DATA REVIEW

The purpose of the data review is to evaluate data quality with respect to the established DQOs as presented in the Perfluorinated Compounds SAP (Navarro 2019a). The data evaluated in this report were collected in accordance with the SAP. Components of the data review process include; evaluating the data against the data quality indicators precision, accuracy/bias, representativeness, completeness, comparability and sensitivity; review of field and laboratory QC results; data validation of selected analytical data packages; and evaluating the data for suitability based on the intended use. Data validation activities were conducted in accordance with the RMA SQAPP (Navarro 2019b). The range of data reviewed consists of PFOA and PFOS samples collected from March 2019 through December 2019. Refer to Appendix A for all applicable laboratory QC data tables.

The Operations and Maintenance Contractor (OMC) is required to conduct data validation on a minimum of 10 percent of the samples. The OMC validation specialist conducted data validation on 12 percent of the analytical data packages generated for this project. Data Validation checklists were completed and case narratives were reviewed to gain insight into any potential problems that may have occurred or been identified by the analysts.

The QC data for each reported lot have been reviewed, including results reported for the laboratory control samples, method blanks, field blanks, and matrix spikes in each lot. Based on reported results and the review completed, the data quality meets or exceeds the established DQOs and is of the correct type, quality, and quantity to support the intended use. Additional qualification of the data, regarding accuracy, or quality of the analytical results, was not necessary. All QC results and sample data are contained in the RMAED.

A detailed discussion of the data review results and the assessment of the data against the data quality indicators of precision, accuracy, representativeness, comparability, and completeness, is provided below.

4.1 DATA REVIEW RESULTS

4.1.1 Precision

Precision is defined as the measure of agreement among replicate measurements of the same property, under prescribed similar conditions. The field duplicate and corresponding investigative sample result were used to calculate precision. The precision estimate was calculated as the relative percent difference (RPD). RPD calculations less than or equal to 30 percent are considered acceptable. Duplicate results will be evaluated in conjunction with other QC criteria to determine if qualification of the data is necessary. The formula for calculating RPD is:

$$RPD(\%) = \left(\frac{Difference\ between\ concentrations}{Average\ of\ concentrations}\right) \times 100$$

Where:

$$Difference\ between\ concentrations = Investigative\ value - Duplicate\ value$$

$$Average\ of\ concentrations = \frac{Investigative\ value + Duplicate\ value}{2}$$

Due to the limited scope of this project, duplicates were not collected.

4.1.2 Accuracy

Accuracy is the degree of agreement between an observed value (sample result) and an accepted reference value. Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction (high or low). The terms accuracy and bias are used interchangeably in this DSR. Accuracy/bias is indicated by percent recovery calculated from laboratory spike data using the following formula:

$$Recovery\ Rate\ (\%) = (Measured\ value)/(True\ value) \times 100$$

Where:

Measured value = Value after the spike minus the value before the spike
True value = Value of the spike added

Accuracy/bias will be calculated based on results of laboratory control spikes (LCS) and matrix spikes (MS). Laboratory control spikes utilize laboratory grade water with some additions of inorganic constituents to mimic RMA water. Matrix spikes utilize RMA water to account for matrix-related interferences.

Matrix Spikes

Due to the lack of historic data for PFCs, the Interquartile Range (ICR) cannot be calculated with accuracy; therefore, upper and lower limits are estimates derived by the laboratory. The calculated acceptance range for MS recovery for PFOA is 64.0 percent to 124.0 percent and for PFOS is 67.0 percent to 127.0 percent.

One MS sample was analyzed for PFOA and PFOS, associated with the resample of well 01078. The percent recovery for PFOA was 116.8 percent and the percent recovery for PFOS was 135.3 percent. The calculated MS recovery was within the acceptable range. The remaining lots had insufficient sample volume to complete MS analysis. Duplicate LCS samples were substituted for MS samples in accordance with the laboratory SOP. The data are considered acceptable for their intended use and no additional action is considered necessary.

Laboratory Control Spikes

Due to the lack of historic data for the PFCs, the IQR cannot be calculated with accuracy; therefore, upper and lower limits are estimates derived by the laboratory. The calculated acceptance range for LCS recovery for PFOA is 64.0 percent to 124.0 percent and for PFOS is 67.0 percent to 127.0 percent.

A total of 33 LCS and LCS duplicate samples were analyzed, each for PFOA and PFOS. The average percent recovery for PFOA was 101.5 percent and the average percent recovery for PFOS was 100.6 percent. The calculated LCS and LCS duplicate recoveries were all within the acceptable range. The data are considered acceptable for their intended use and no additional action is considered necessary.

4.1.3 Representativeness

Representativeness is a qualitative term achieved by evaluating whether measurements were made and samples were collected in a manner that the resulting data appropriately reflects the sampling unit. The performance criterion is a positive evaluation of representativeness. A review of field and laboratory documentation determined that samples were collected and analyzed as specified for each system or category.

In order to collect samples representative of the sample location, stagnant water was removed from the well casing prior to sample collection. Sample collection occurred after field parameters achieved stabilization criteria. Field instruments utilized to collect field parameters were calibrated according to the respective instrument manual and recorded in the Groundwater Sampling Calibration Record database. Treatment plant samples were considered representative after water was allowed to flow from the respective sample port for a minimum of five minutes. As a result, the data are considered representative of the sampling unit.

4.1.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system, expressed as a percentage of the number of valid measurements compared to the total number of measurements planned in the DQOs. The performance criterion is a completeness calculation result of greater than or equal to 90 percent. Completeness is calculated using the following formula:

$$Completeness\ (\%) = \frac{Amount\ of\ valid\ data}{Amount\ of\ valid\ data\ expected} \times 100$$

The project completeness calculation is 100.0 percent; therefore, the completeness criterion was achieved. In addition, wells 01078 and 01525 were resampled to verify concentrations.

4.1.5 Comparability

Comparability is a qualitative term achieved by using standard techniques to collect and analyze representative samples and reporting data in appropriate units. Standard techniques as identified in the SQAPP (Navarro 2019c) were utilized to collect and analyze samples and the data was reported in the appropriate units. The analytical results reported are equivalent to data obtained from similar analyses and the MRLs met the project goals.

4.1.6 Sensitivity

Sensitivity is the ability of the method or instrument to detect the target analytes at the level of interest. The performance criterion for sensitivity is no analyte detections above the MRL in the

laboratory method blank. Analytical lots with method blank detections of target analytes exceeding the MRL may be qualified.

Method blank samples are analyzed for each analytical lot. A total of 34 method blanks consisting of laboratory water were analyzed. There were no method blank detections.

All data were considered acceptable. No discernible trends or QC issues were observed in the investigative sample data associated with the analytical lot outside the acceptance range. No additional action is considered necessary. The sensitivity criterion for the project is considered achieved.

4.1.7 Field QC Samples

Due to the limited scope of this project, field and rinse blanks were not collected.

4.2 ANALYTICAL RESULTS

The following discussion provides a summary of the sample results for groundwater wells and treatment plant samples. The complete investigative sample results are listed in Appendix A. A brief data evaluation is included to provide recommendations for additional sampling.

Monitoring Wells

PFCs were detected in 19 of the 25 wells sampled. Five had a combined concentration above the health advisory concentration of 0.07 µg/L.

- Well 01525, located in the South Plants source area, had a combined concentration of 5.45 µg/L in September 2019. This well was resampled in December 2019 and had a combined concentration of 6.27 µg/L.
- Well 36168, located just north of the South Plants source area, had a combined concentration of 0.611 µg/L.
- Well 36181, located just north of the South Plants source area had a combined concentration of 1.46 µg/L.
- Well 36210, located to the northwest of Lime Basins had a combined concentration of 0.118 µg/L.
- Well 36631, located to the southeast of Lime Basins had a combined total of 0.139 µg/L.

The combined PFC concentrations at each of the 20 wells with detections below the health advisory ranged from non-detect at 0.004 µg/L to 0.037 µg/L. Sampling results are presented in Table 3 and Figure 1.

Treatment Systems

Treatment plant influent data showed detections of PFCs at Basin A Neck System (BANS), Northwest Boundary Containment System (NWBCS) and Offpost Groundwater Intercept and Treatment System (OGITS), with all concentrations below the health advisory level. Results for

influent at the North Boundary Containment System (NBCS) were typically non-detect with only one detection of PFOA at 0.006 µg/L. All effluent results were non-detect with the exception of the third quarter BANS and NBCS effluents, which had detections of PFOA at 0.0028 µg/L and 0.0038, respectively. Both detections are below the health advisory level. Results of treatment plant sampling are provided in Table 4.

4.3 DATA EVALUATION AND RECOMMENDATIONS

A summary of the analytical results is presented in Appendix A.

- RMA does not appear to be a significant source of PFC contamination in groundwater. Although PFCs were detected in 19 of the 25 wells sampled, there were only five wells that exceeded the health advisory, all located in the vicinity of the South Plants source area. Recommended actions include the addition of PFC analysis to select wells in the *Long-Term Monitoring Plan for Groundwater and Surface Water* (LTMP) (Tetra Tech EC and URS 2010) site-wide water quality tracking network. An Operational Change Notice (OCN) to the LTMP will be prepared to detail the sampling requirements.

5.0 SUMMARY

Data review based on the FY19 Perfluorinated Compounds SAP shows that the data are acceptable for use with no qualification. The DQOs were evaluated using all data collected and it was determined that all project DQOs were met.

Recommended follow up actions include:

- Addition of PFCs to the LTMP site-wide water quality tracking network and continued sampling of treatment plant influent/effluent. An Operational Change Notice (OCN) to the LTMP will be prepared to incorporate the sampling requirements into the long-term monitoring program.

6.0 REFERENCES

DoD (United States Department of Defense)

2018 Department of Defense Instruction 4715.18 Emerging Contaminants (ECs). Change 2, August 31, 2018.

RMA (Rocky Mountain Arsenal)

1979 Fire Department Individual Run Report. 18 Sept 79.

Navarro (Navarro Research and Engineering, Inc.)

2019a Fiscal Year 2019 Perfluorinated Compounds Sampling and Analysis Plan, Revision 0, March 26, 2019.

2019b Sampling Quality Assurance Project Plan, Revision 2, January 30, 2019.

2019c Emerging Contaminants Data Summary Report, Revision 0, January 8, 2019.

Tetra Tech EC, Inc. and URS Corporation

2010 Long-Term Monitoring Plan for Groundwater and Surface Water, Final, March 2010.

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TABLES

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Table 2. FY19 PFC Sample Collection List						
SITE ID	**LAB**	**METHOD NUMBER**	**METHOD NAME**	**FILE TYPE**	**SITE TYPE**	**SAMPLE PROGRAM CODE**
01078 01525 02034 04021 22001 22081 22505 23095 25059 25099 26083 27517 35065 35514 36168 36181 36201 36210 36305 36567 36631 37065 37070 37083 37333	AR*	537	PFCs	CGW	WELL	LWG
PAININ PAEFEF PNININ PNEFEF PPININ PPEFEF PWININ PWEFEF	AR*	537	PFCs	CPC	TPSE	LWG

* Analysis performed by TestAmerica and reported through ARDL.

Table 3. FY19 PFC Groundwater Monitoring Well Results				
Site ID	**Sample Date**	**PFOA Concentration (µg/L)**	**PFOS Concentration (µg/L)**	**Summed Concentration (µg/L)**
01078	2019-09-11	0.0091	0.023	0.0321
01078	2019-12-12	0.0083	0.016	0.0243
01525	2019-09-11	0.15	**5.3**	**5.315**
01525	2019-12-12	**0.17**	**6.1**	**6.27**
02034	2019-09-18	0.0027	LT 0.002	0.0047
04021	2019-09-25	0.0071	0.007	0.0141
22001	2019-03-12	LT 0.002	LT 0.002	LT 0.004
22081	2019-03-12	LT 0.002	LT 0.002	LT 0.004
22505	2019-03-12	LT 0.002	LT 0.002	LT 0.004
23095	2019-09-23	LT 0.002	0.0031	0.0051
25059	2019-09-23	LT 0.002	LT 0.002	LT 0.004
25099	2019-08-07	LT 0.002	LT 0.002	LT 0.004
26083	2019-09-23	0.0028	0.003	0.0058
27517	2019-03-07	0.0029	0.0035	0.0064
35065	2019-09-12	0.0086	0.0025	0.0111
35514	2019-08-28	0.0069	0.01	0.0169
36168	2019-09-16	0.021	**0.59**	**0.611**
36181	2019-09-16	**0.16**	**1.3**	**1.46**
36201	2019-09-12	0.016	0.0065	0.0225
36210	2019-09-16	0.049	**0.069**	**0.118**
36305	2019-09-05	0.027	LT 0.01	0.037
36567	2019-08-29	0.0051	0.0058	0.0109
36631	2019-09-16	0.039	**0.1**	**0.139**
37065	2019-06-11	0.0024	LT 0.002	0.0044
37070	2019-08-26	0.0061	0.008	0.0141
37083	2019-06-12	LT 0.002	0.0034	0.0054
37333	2019-03-11	LT 0.002	LT 0.002	LT 0.004

Note: PCF health advisory of 0.07 µg/L can be exceeded based on individual PFOA and PFOS detections or the summed concentrations of PFOA and PFOS detections. Values in **bold** exceed the health advisory.

Table 4. FY19 PFC Treatment Plant Influent and Effluent Results					
System	**Location**	**Site ID**	**Sample Date**	**PFOA Concentration (µg/L)**	**PFOS Concentration (µg/L)**
BANS	Influent	PAININ	10/3/2018	0.0063	0.0072
BANS	Effluent	PAEFEF	10/3/2018	LT 0.002	LT 0.002
BANS	Influent	PAININ	4/2/2019	0.0051	0.0076
BANS	Effluent	PAEFEF	4/2/2019	0.0028	LT 0.002
BANS	Influent	PAININ	7/11/2019	0.0028	0.0039
BANS	Effluent	PAEFEF	7/11/2019	LT 0.002	LT 0.002
NBCS	Influent	PNININ	10/9/2018	LT 0.002	LT 0.002
NBCS	Effluent	PNEFEF	10/9/2018	LT 0.002	LT 0.002
NBCS	Influent	PNININ	4/3/2019	0.006	LT 0.002
NBCS	Effluent	PNEFEF	4/3/2019	0.0038	LT 0.002
NBCS	Influent	PNININ	7/11/2019	LT 0.002	LT 0.002
NBCS	Effluent	PNEFEF	7/11/2019	LT 0.002	LT 0.002
NWBCS	Influent	PWININ	10/2/2018	LT 0.002	0.0025
NWBCS	Effluent	PWEFEF	10/2/2018	LT 0.002	LT 0.002
NWBCS	Influent	PWININ	4/1/2019	LT 0.002	0.0026
NWBCS	Effluent	PWEFEF	4/1/2019	LT 0.002	LT 0.002
NWBCS	Influent	PWININ	7/11/2019	LT 0.002	0.0024
NWBCS	Effluent	PWEFEF	7/11/2019	LT 0.002	LT 0.002
OGITS	Influent	PPININ	10/1/2018	0.0025	0.0047
OGITS	Effluent	PPEFEF	10/1/2018	LT 0.002	LT 0.002
OGITS	Influent	PPININ	4/4/2019	0.0023	0.0043
OGITS	Effluent	PPEFEF	4/4/2019	LT 0.002	LT 0.002
OGITS	Influent	PPININ	7/11/2019	0.006	0.0073
OGITS	Effluent	PPEFEF	7/11/2019	LT 0.002	LT 0.002

Note: “LT” denotes Less Than the MRL.

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FIGURE

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37070
0.0141 µgl

37065
0.0044 µgl

37083
0.0054 µgl

22505
LT 0.004 µgl

37333
LT 0.004 µgl

22001
LT 0.004 µgl

23095
0.0051 µgl

22081
LT 0.004 µgl

25099
LT 0.004 µgl

Basin F

27517
0.0064 µgl

26083
0.0058 µgl

Basin C

25059
LT 0.004 µgl

36567
0.0109 µgl

35514
0.0169 µgl

36201
0.0225 µgl

Complex
Trenches

35065
0.0111 µgl

Basin A

36305
0.037 µgl

Lime
Basins

Shell
Trenches

04021
0.0141 µgl

36210
0.118 µgl

36631
0.139 µgl

36168
0.611 µgl

South Plants
CPA

01525
5.315 µgl

36181
1.46 µgl

6.27 µgl *

01078
0.0321 µgl
0.0243 µgl *

02034
0.0047 µgl

23 24 19 20
22
27 25 30 29
28 26
33 34 35 36 31 32
4 3 2 1 6 5
9 10 11 12 7 8

Legend

- Slurry Walls
- Source Areas
- Bodies of Water
- RMA Boundary
- PFC Well Results - September 2019
- * Wells resampled - December 2019.

NOTE: PFC results have been summed.
PFC health advisory of 0.07 µgl can be exceeded based on individual PFOA and PFOS detections or the summed concentrations of PFOA and PFOS detections. Values in **bold** exceed the health advisory.

N

State Plane, Colorado North Zone, NAD27, US Survey Feet

Sources: U.S. Army, RMA GIS, PMC, OMC, Shell/URS Corp.

Program Manager
Rocky Mountain Arsenal

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Figure 1

FY19 Perfluorinated Compound (PFC) Monitoring Results

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NL 2/5/2020

APPENDIX A

ANALYTICAL RESULTS AND QUALITY CONTOL TABLES

List of Tables

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Table A-1 – Investigative Data								
Site ID	Sample Date	Test Name	Boolean	Data	UOM	Flag Code	Lot ID	Method ID
01078	2019-09-11	PFOS		0.023	UGL		AIAE	537
01078	2019-09-11	PFOA		0.0091	UGL		AIAE	537
01078	2019-12-12	PFOS		0.016	UGL		AIDE	537
01078	2019-12-12	PFOA		0.0083	UGL		AIDE	537
01525	2019-09-11	PFOS		5.3	UGL		AIAE	537
01525	2019-09-11	PFOA		0.15	UGL		AIAE	537
01525	2019-12-12	PFOS		6.1	UGL		AIDE	537
01525	2019-12-12	PFOA		0.17	UGL		AIDE	537
02034	2019-09-18	PFOA		0.0027	UGL		AIBF	537
02034	2019-09-18	PFOS	LT	0.002	UGL		AIBF	537
04021	2019-09-25	PFOS		0.007	UGL		AIAD	537
04021	2019-09-25	PFOA		0.0071	UGL		AIAD	537
22001	2019-03-12	PFOS	LT	0.002	UGL		AHFU	537
22001	2019-03-12	PFOA	LT	0.002	UGL		AHFU	537
22081	2019-03-12	PFOA	LT	0.002	UGL		AHFU	537
22081	2019-03-12	PFOS	LT	0.002	UGL		AHFU	537
22505	2019-03-12	PFOS	LT	0.002	UGL		AHFU	537
22505	2019-03-12	PFOA	LT	0.002	UGL		AHFU	537
23095	2019-09-23	PFOS		0.0031	UGL		AIAD	537
23095	2019-09-23	PFOA	LT	0.002	UGL		AIAD	537
25059	2019-09-23	PFOA	LT	0.002	UGL		AIAD	537
25059	2019-09-23	PFOS	LT	0.002	UGL		AIAD	537
25099	2019-08-07	PFOA	LT	0.002	UGL		AHXC	537
25099	2019-08-07	PFOS	LT	0.002	UGL		AHXC	537
26083	2019-09-23	PFOS		0.003	UGL		AIAD	537
26083	2019-09-23	PFOA		0.0028	UGL		AIAD	537
27517	2019-03-07	PFOA		0.0029	UGL		AHGA	537
27517	2019-03-07	PFOS		0.0035	UGL		AHGA	537
35065	2019-09-12	PFOS		0.0025	UGL		AIAY	537
35065	2019-09-12	PFOA		0.0086	UGL		AIAY	537
35514	2019-08-28	PFOS		0.01	UGL		AHYQ	537
35514	2019-08-28	PFOA		0.0069	UGL		AHYQ	537
36168	2019-09-16	PFOA		0.021	UGL		AIAY	537
36168	2019-09-16	PFOS		0.59	UGL		AIAY	537
36181	2019-09-16	PFOS		1.3	UGL		AIAY	537
36181	2019-09-16	PFOA		0.16	UGL		AIAY	537
36201	2019-09-12	PFOS		0.0065	UGL		AIAY	537

Table A-1 – Investigative Data								
Site ID	Sample Date	Test Name	Boolean	Data	UOM	Flag Code	Lot ID	Method ID
36201	2019-09-12	PFOA		0.016	UGL		AIAY	537
36210	2019-09-16	PFOA		0.049	UGL		AIAY	537
36210	2019-09-16	PFOS		0.069	UGL		AIAY	537
36305	2019-09-05	PFOA		0.027	UGL		AHZE	537
36305	2019-09-05	PFOS	LT	0.01	UGL		AHZE	537
36567	2019-08-29	PFOS		0.0058	UGL		AHYQ	537
36567	2019-08-29	PFOA		0.0051	UGL		AHYQ	537
36631	2019-09-16	PFOA		0.039	UGL		AIAY	537
36631	2019-09-16	PFOS		0.1	UGL		AIAY	537
37065	2019-06-11	PFOA		0.0024	UGL		AHRS	537
37065	2019-06-11	PFOS	LT	0.002	UGL		AHRS	537
37070	2019-08-26	PFOS		0.008	UGL		AHYQ	537
37070	2019-08-26	PFOA		0.0061	UGL		AHYQ	537
37083	2019-06-12	PFOS		0.0034	UGL		AHRS	537
37083	2019-06-12	PFOA	LT	0.002	UGL		AHRS	537
37333	2019-03-11	PFOS	LT	0.002	UGL		AHFU	537
37333	2019-03-11	PFOA	LT	0.002	UGL		AHFU	537
PAEFEF	2018-10-03	PFOA	LT	0.002	UGL		AGZE	537
PAEFEF	2018-10-03	PFOS	LT	0.002	UGL		AGZE	537
PAEFEF	2019-04-02	PFOA		0.0028	UGL		AHIO	537
PAEFEF	2019-04-02	PFOS	LT	0.002	UGL		AHIO	537
PAEFEF	2019-07-11	PFOA	LT	0.002	UGL		AHUF	537
PAEFEF	2019-07-11	PFOS	LT	0.002	UGL		AHUF	537
PAININ	2018-10-03	PFOA		0.0063	UGL		AGZE	537
PAININ	2018-10-03	PFOS		0.0072	UGL		AGZE	537
PAININ	2019-04-02	PFOA		0.0051	UGL		AHIO	537
PAININ	2019-04-02	PFOS		0.0076	UGL		AHIO	537
PAININ	2019-07-11	PFOA		0.0028	UGL		AHUF	537
PAININ	2019-07-11	PFOS		0.0039	UGL		AHUF	537
PNEFEF	2018-10-09	PFOA	LT	0.002	UGL		AGZF	537
PNEFEF	2018-10-09	PFOS	LT	0.002	UGL		AGZF	537
PNEFEF	2019-04-03	PFOA		0.0038	UGL		AHIO	537
PNEFEF	2019-04-03	PFOS	LT	0.002	UGL		AHIO	537
PNEFEF	2019-07-11	PFOA	LT	0.002	UGL		AHUF	537
PNEFEF	2019-07-11	PFOS	LT	0.002	UGL		AHUF	537
PNININ	2018-10-09	PFOA	LT	0.002	UGL		AGZF	537
PNININ	2018-10-09	PFOS	LT	0.002	UGL		AGZF	537

Table A-1 – Investigative Data								
Site ID	Sample Date	Test Name	Boolean	Data	UOM	Flag Code	Lot ID	Method ID
PNININ	2019-04-03	PFOA		0.006	UGL		AHIO	537
PNININ	2019-04-03	PFOS	LT	0.002	UGL		AHIO	537
PNININ	2019-07-11	PFOA	LT	0.002	UGL		AHUF	537
PNININ	2019-07-11	PFOS	LT	0.002	UGL		AHUF	537
PPEFEF	2018-10-01	PFOA	LT	0.002	UGL		AGZB	537
PPEFEF	2018-10-01	PFOS	LT	0.002	UGL		AGZB	537
PPEFEF	2019-04-04	PFOA	LT	0.002	UGL		AHIP	537
PPEFEF	2019-04-04	PFOS	LT	0.002	UGL		AHIP	537
PPEFEF	2019-07-11	PFOA	LT	0.002	UGL		AHUF	537
PPEFEF	2019-07-11	PFOS	LT	0.002	UGL		AHUF	537
PPININ	2018-10-01	PFOA		0.0025	UGL		AGZB	537
PPININ	2018-10-01	PFOS		0.0047	UGL		AGZB	537
PPININ	2019-04-04	PFOA		0.0023	UGL		AHIP	537
PPININ	2019-04-04	PFOS		0.0043	UGL		AHIP	537
PPININ	2019-07-11	PFOA		0.006	UGL		AHUF	537
PPININ	2019-07-11	PFOS		0.0073	UGL		AHUF	537
PWEFEF	2018-10-02	PFOS	LT	0.002	UGL		AGZB	537
PWEFEF	2018-10-02	PFOA	LT	0.002	UGL		AGZB	537
PWEFEF	2019-04-01	PFOA	LT	0.002	UGL		AHIO	537
PWEFEF	2019-04-01	PFOS	LT	0.002	UGL		AHIO	537
PWEFEF	2019-07-11	PFOS	LT	0.002	UGL		AHUF	537
PWEFEF	2019-07-11	PFOA	LT	0.002	UGL		AHUF	537
PWININ	2018-10-02	PFOA	LT	0.002	UGL		AGZB	537
PWININ	2018-10-02	PFOS		0.0025	UGL		AGZB	537
PWININ	2019-04-01	PFOS		0.0026	UGL		AHIO	537
PWININ	2019-04-01	PFOA	LT	0.002	UGL		AHIO	537
PWININ	2019-07-11	PFOA	LT	0.002	UGL		AHUF	537
PWININ	2019-07-11	PFOS		0.0024	UGL		AHUF	537

Table A-2 – Matrix Spike Recovery											
Site ID	Sample Data	Test Name	Boolean	Data Values	QC Spike Value	UOM	Flag Code	QC Flag Code	Lot ID	Method ID	Recovery Rate
01078	2019-12-12	PFOS		0.0502	0.0371	UGL		N	AIDE	537	135.3%
01078	2019-12-12	PFOA		0.0467	0.04	UGL		N	AIDE	537	116.8%

Table A-3 – Laboratory Control Spike Recovery										
Test Name	Data Value	QC Spike Amount	UOM	Boolean	Flag Code	QC Flag Code	Lot ID	Method ID	Analysis Date	Recovery Rate
PFOA	0.04	0.04	UGL			S	AGZB	537	2018-10-16	100.0%
PFOS	0.0363	0.0371	UGL			S	AGZB	537	2018-10-16	97.8%
PFOA	0.0439	0.04	UGL			S	AGZE	537	2018-10-22	109.8%
PFOS	0.035	0.0371	UGL			S	AGZE	537	2018-10-22	94.3%
PFOA	0.0435	0.04	UGL			S	AGZE	537	2018-10-22	108.8%
PFOS	0.0363	0.0371	UGL			S	AGZE	537	2018-10-22	97.8%
PFOA	0.0375	0.04	UGL			S	AGZF	537	2018-10-23	93.8%
PFOS	0.0351	0.0371	UGL			S	AGZF	537	2018-10-23	94.6%
PFOA	0.0419	0.04	UGL			S	AGZF	537	2018-10-23	104.8%
PFOS	0.0346	0.0371	UGL			S	AGZF	537	2018-10-23	93.3%
PFOA	0.0418	0.04	UGL			S	AHFU	537	2019-03-19	104.5%
PFOS	0.041	0.0371	UGL			S	AHFU	537	2019-03-19	110.5%
PFOA	0.0434	0.04	UGL			S	AHFU	537	2019-03-19	108.5%
PFOS	0.0403	0.0371	UGL			S	AHFU	537	2019-03-19	108.6%
PFOA	0.0436	0.04	UGL			S	AHGA	537	2019-03-16	109.0%
PFOS	0.0405	0.0371	UGL			S	AHGA	537	2019-03-16	109.2%
PFOA	0.0425	0.04	UGL			S	AHGA	537	2019-03-16	106.3%
PFOS	0.0385	0.0371	UGL			S	AHGA	537	2019-03-16	103.8%
PFOA	0.0397	0.04	UGL			S	AHIO	537	2019-04-13	99.3%
PFOS	0.0352	0.0371	UGL			S	AHIO	537	2019-04-13	94.9%
PFOA	0.0405	0.04	UGL			S	AHIO	537	2019-04-13	101.3%
PFOS	0.0362	0.0371	UGL			S	AHIO	537	2019-04-13	97.6%
PFOA	0.0405	0.04	UGL			S	AHIP	537	2019-04-17	101.3%
PFOS	0.0382	0.0371	UGL			S	AHIP	537	2019-04-17	103.0%
PFOA	0.0392	0.04	UGL			S	AHIP	537	2019-04-17	98.0%
PFOS	0.0385	0.0371	UGL			S	AHIP	537	2019-04-17	103.8%

Table A-3 – Laboratory Control Spike Recovery										
Test Name	Data Value	QC Spike Amount	UOM	Boolean	Flag Code	QC Flag Code	Lot ID	Method ID	Analysis Date	Recovery Rate
PFOA	0.0378	0.04	UGL			S	AHRS	537	2019-06-25	94.5%
PFOS	0.0343	0.0371	UGL			S	AHRS	537	2019-06-25	92.5%
PFOA	0.039	0.04	UGL			S	AHRS	537	2019-06-25	97.5%
PFOS	0.0351	0.0371	UGL			S	AHRS	537	2019-06-25	94.6%
PFOA	0.0432	0.04	UGL			S	AHUF	537	2019-07-18	108.0%
PFOS	0.036	0.0371	UGL			S	AHUF	537	2019-07-18	97.0%
PFOA	0.0425	0.04	UGL			S	AHUF	537	2019-07-18	106.3%
PFOS	0.0365	0.0371	UGL			S	AHUF	537	2019-07-18	98.4%
PFOA	0.039	0.04	UGL			S	AHXC	537	2019-08-25	97.5%
PFOS	0.0377	0.0371	UGL			S	AHXC	537	2019-08-25	101.6%
PFOA	0.0381	0.04	UGL			S	AHXC	537	2019-08-25	95.3%
PFOS	0.0371	0.0371	UGL			S	AHXC	537	2019-08-25	100.0%
PFOA	0.0397	0.04	UGL			S	AHYQ	537	2019-09-07	99.3%
PFOS	0.0405	0.0371	UGL			S	AHYQ	537	2019-09-07	109.2%
PFOA	0.0426	0.04	UGL			S	AHYQ	537	2019-09-07	106.5%
PFOS	0.0384	0.0371	UGL			S	AHYQ	537	2019-09-07	103.5%
PFOA	0.0428	0.04	UGL			S	AHZE	537	2019-10-09	107.0%
PFOS	0.038	0.0371	UGL			S	AHZE	537	2019-10-09	102.4%
PFOA	0.0423	0.04	UGL			S	AHZE	537	2019-10-09	105.8%
PFOS	0.0369	0.0371	UGL			S	AHZE	537	2019-10-09	99.5%
PFOA	0.0422	0.04	UGL			S	AIAD	537	2019-10-04	105.5%
PFOS	0.0372	0.0371	UGL			S	AIAD	537	2019-10-04	100.3%
PFOA	0.0416	0.04	UGL			S	AIAD	537	2019-10-04	104.0%
PFOS	0.0367	0.0371	UGL			S	AIAD	537	2019-10-04	98.9%
PFOA	0.0389	0.04	UGL			S	AIAE	537	2019-09-18	97.3%
PFOS	0.0396	0.0371	UGL			S	AIAE	537	2019-09-18	106.7%

Table A-3 – Laboratory Control Spike Recovery										
Test Name	Data Value	QC Spike Amount	UOM	Boolean	Flag Code	QC Flag Code	Lot ID	Method ID	Analysis Date	Recovery Rate
PFOA	0.0395	0.04	UGL			S	AIAE	537	2019-09-18	98.8%
PFOS	0.0384	0.0371	UGL			S	AIAE	537	2019-09-18	103.5%
PFOA	0.039	0.04	UGL			S	AIAY	537	2019-10-09	97.5%
PFOS	0.0374	0.0371	UGL			S	AIAY	537	2019-10-09	100.8%
PFOA	0.0396	0.04	UGL			S	AIAY	537	2019-10-09	99.0%
PFOS	0.038	0.0371	UGL			S	AIAY	537	2019-10-09	102.4%
PFOA	0.0384	0.04	UGL			S	AIBF	537	2019-09-28	96.0%
PFOS	0.0353	0.0371	UGL			S	AIBF	537	2019-09-28	95.1%
PFOA	0.036	0.04	UGL			S	AIBF	537	2019-09-28	90.0%
PFOS	0.0366	0.0371	UGL			S	AIBF	537	2019-09-28	98.7%
PFOA	0.0393	0.04	UGL			S	AIDE	537	2019-12-22	98.3%
PFOS	0.0384	0.0371	UGL			S	AIDE	537	2019-12-22	103.5%
PFOA	0.0404	0.04	UGL			S	AIDE	537	2019-12-22	101.0%
PFOS	0.0379	0.0371	UGL			S	AIDE	537	2019-12-22	102.2%

Table A-4 – Method Blanks

Test Name	Data Value	QC Spike Amount	UOM	Boolean	Flag Code	QC Flag Code	Lot ID	Method ID	Analysis Date
PFOS	0.002	0	UGL	LT		M	AGZB	537	2018-10-16
PFOA	0.002	0	UGL	LT		M	AGZB	537	2018-10-16
PFOS	0.002	0	UGL	LT		M	AGZE	537	2018-10-22
PFOA	0.002	0	UGL	LT		M	AGZE	537	2018-10-22
PFOS	0.002	0	UGL	LT		M	AGZF	537	2018-10-23
PFOA	0.002	0	UGL	LT		M	AGZF	537	2018-10-23
PFOS	0.002	0	UGL	LT		M	AHFU	537	2019-03-19
PFOA	0.002	0	UGL	LT		M	AHFU	537	2019-03-19
PFOS	0.002	0	UGL	LT		M	AHGA	537	2019-03-16
PFOA	0.002	0	UGL	LT		M	AHGA	537	2019-03-16
PFOS	0.002	0	UGL	LT		M	AHIO	537	2019-04-13
PFOA	0.002	0	UGL	LT		M	AHIO	537	2019-04-13
PFOS	0.002	0	UGL	LT		M	AHIP	537	2019-04-17
PFOA	0.002	0	UGL	LT		M	AHIP	537	2019-04-17
PFOS	0.002	0	UGL	LT		M	AHRS	537	2019-06-25
PFOA	0.002	0	UGL	LT		M	AHRS	537	2019-06-25
PFOS	0.002	0	UGL	LT		M	AHUF	537	2019-07-18
PFOA	0.002	0	UGL	LT		M	AHUF	537	2019-07-18
PFOS	0.002	0	UGL	LT		M	AHXC	537	2019-08-25
PFOA	0.002	0	UGL	LT		M	AHXC	537	2019-08-25
PFOS	0.002	0	UGL	LT		M	AHYQ	537	2019-09-07
PFOA	0.002	0	UGL	LT		M	AHYQ	537	2019-09-07
PFOS	0.002	0	UGL	LT		M	AHZE	537	2019-10-09
PFOA	0.002	0	UGL	LT		M	AHZE	537	2019-10-09
PFOS	0.002	0	UGL	LT		M	AIAD	537	2019-10-04
PFOA	0.002	0	UGL	LT		M	AIAD	537	2019-10-04

Table A-4 – Method Blanks									
Test Name	Data Value	QC Spike Amount	UOM	Boolean	Flag Code	QC Flag Code	Lot ID	Method ID	Analysis Date
PFOS	0.002	0	UGL	LT		M	AIAE	537	2019-09-18
PFOA	0.002	0	UGL	LT		M	AIAE	537	2019-09-18
PFOS	0.002	0	UGL	LT		M	AIAY	537	2019-10-09
PFOA	0.002	0	UGL	LT		M	AIAY	537	2019-10-09
PFOS	0.002	0	UGL	LT		M	AIBF	537	2019-09-28
PFOA	0.002	0	UGL	LT		M	AIBF	537	2019-09-28
PFOS	0.002	0	UGL	LT		M	AIDE	537	2019-12-22
PFOA	0.002	0	UGL	LT		M	AIDE	537	2019-12-22