FINAL
Preliminary Assessment Report
Fargo Army Aviation Support Facility #2
North Dakota

Perfluorooctane-Sulfonic Acid (PFOS) and Perfluorooctanoic Acid (PFOA) Impacted Sites
ARNG Installations, Nationwide

August 2020

Prepared for:

Army National Guard Bureau
111 S. George Mason Drive
Arlington, VA 22204

UNCLASSIFIED

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Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AECOM	AECOM Technical Services, Inc.
AFFF	Aqueous Film Forming Foam
ANG	Air National Guard
AOI	Area of Interest
ARNG	Army National Guard
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	Conceptual Site Model
bgs	below ground surface
EDR™	Environmental Data Resources, Inc.™
°F	Degrees Fahrenheit
FTA	Fire Training Area
HA	Health Advisory
NDANG	North Dakota Air National Guard
NDARNG	North Dakota Army National Guard
PA	Preliminary Assessment
PFAS	per- and poly-fluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
RSL	Regional Screening Limit
SI	Site Inspection
UCMR3	Unregulated Contaminant Monitoring Rule 3
US	United States
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VSI	Visual Site Inspection

Executive Summary

The Army National Guard (ARNG) is performing Preliminary Assessments (PAs) and Site Inspections (SIs) for Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA) Impacted Sites at ARNG Facilities Nationwide. A PA for per- and polyfluoroalkyl substances (PFAS)-containing materials was completed for North Dakota Army Aviation Support Facility #2 (Fargo AASF #2; also referred to as the “facility”) in Fargo, North Dakota, to assess potential PFAS release areas and exposure pathways to receptors. The Fargo AASF #2 is constructed on a parcel of land that is owned by Fargo Jet Center LLC and operated by the North Dakota ARNG (NDARNG) from 2012 to 2015 and from 2016 to present. The performance of this PA included the following tasks:

- Reviewed available administrative record documents and Environmental Data Resources, Inc. (EDR)™ report packages to obtain information relevant to potential PFAS releases, such as: drinking water well locations, historical aerial photographs, Sanborn maps, and environmental compliance actions in the area surrounding the facility;
- Conducted a site visit 13 September 2019 and completed visual site inspections at locations where PFAS-containing materials were suspected of being stored, used, or disposed;
- Interviewed current NDARNG personnel, NDARNG environmental managers, operations staff and Fargo Airport personnel
- Completed a visual site inspection at known or suspected potential PFAS release locations and documented with photographs
- Developed a preliminary conceptual site model to outline the potential release and pathway of PFAS for the Area of Interest (AOI) and the facility

One AOI related to potential PFAS releases was identified at the Fargo AASF #2 during the PA. The AOI is shown on **Figure ES-1** and described in **Table ES-1**.

Table ES- 1: AOI at Fargo AASF #2

Area of Interest	Name	Used by	Potential Release Date
AOI 1	Hangar	Unknown	Unknown

Based on potential PFAS releases at this AOI, there is potential for exposure to PFAS contamination in media at or near the facility. The preliminary CSM for the Fargo AASF #2 is shown on **Figure ES-2**, which presents the potential receptors and media impacted. Based on the US Environmental Protection Agency (USEPA) Unregulated Contaminant Monitoring Rule 3 (UCMR3) data, it was indicated that no PFAS were detected in a public water system above the USEPA lifetime Health Advisory (HA) within 20 miles of the facility. The HA is 70 parts per trillion for PFOS and PFOA, individually or combined. PFAS analyses performed in 2016 had method detection limits that were higher than currently achievable. PFAS analyses performed in 2016 had method detection limits that were higher than currently achievable. Thus, it is possible that low concentrations of PFAS were not detected during the UCMR3 but might be detected if analyzed today. Potential off-facility PFAS release areas exist adjacent to the Fargo AASF #2. Because these areas include property downgradient of the facility, it is unknown whether AFFF releases at the off-facility sources affect the Fargo AASF #2.

CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Fargo AASF #2, ND			
REVISED	6/19/2020	GIS BY	MS	6/19/2020
SCALE	1:2,400	CHK BY	JW	6/19/2020
Base Map: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	RG	6/19/2020

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Summary of Findings

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Figure ES-1

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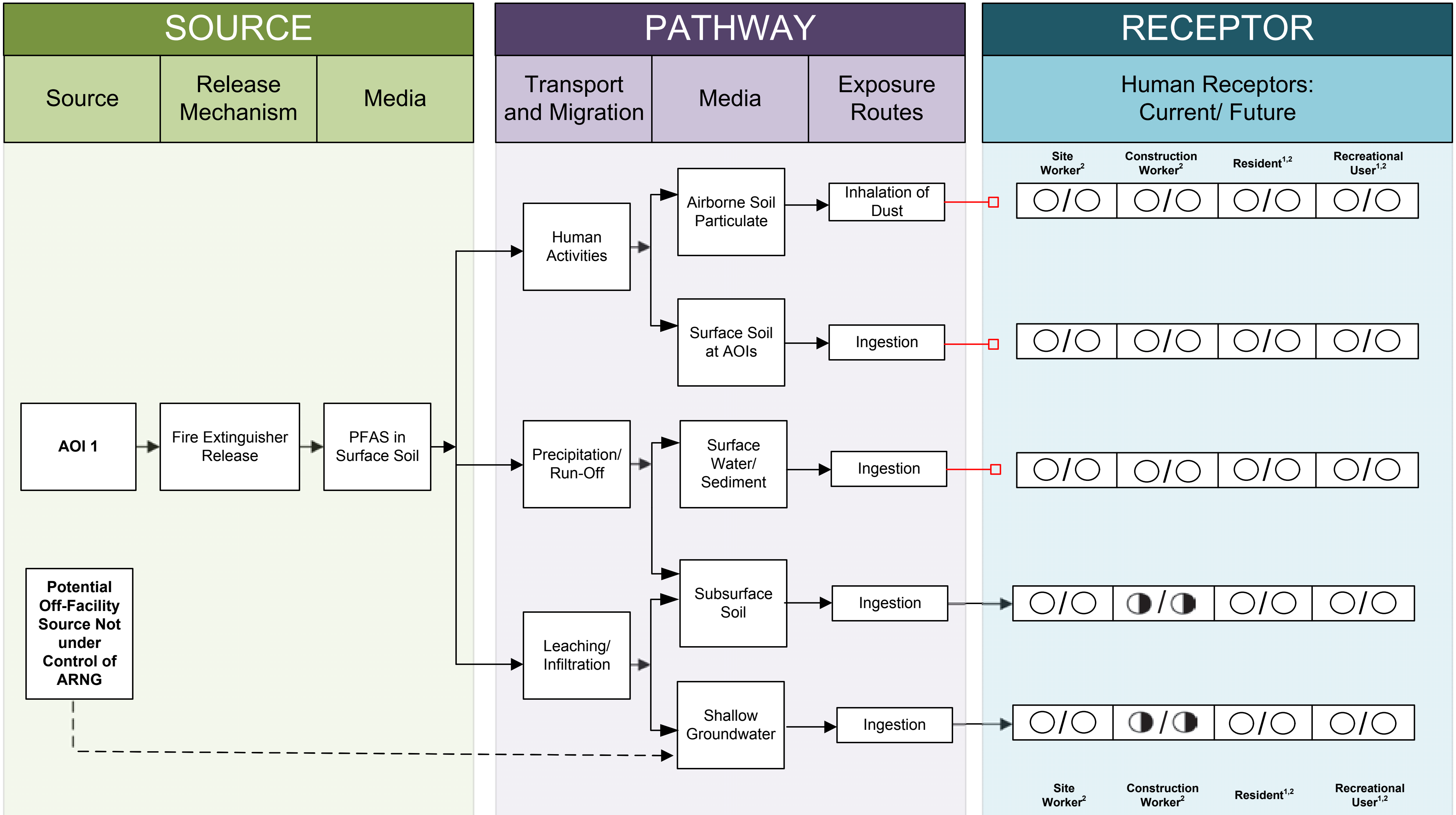


LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway
- Complete Pathway

Notes:

1. The resident and recreational users receptors refer to an off-facility resident and off-facility recreational users.
2. Dermal contact exposure pathway is incomplete for PFAS.

Figure ES-2
Preliminary Conceptual Site Model
Fargo AASF #2, North Dakota

1. Introduction

1.1 Authority and Purpose

The Army National Guard (ARNG)-G9 is the lead agency in performing *Preliminary Assessments (PAs) and Site Inspections (SIs) for Perfluorooctanesulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA) at Impacted Sites at ARNG Facilities Nationwide*. This work is supported by the United States (US) Army Corps of Engineers (USACE) Baltimore District and their contractor AECOM Technical Services, Inc. (AECOM) under Contract Number W912DR-12-D-0014, Task Order W912DR17F0192, issued 11 August 2017.

The ARNG is assessing potential effects on human health related to processes at facilities that used per- and poly-fluoroalkyl substances (PFAS), primarily in the form of aqueous film forming foam (AFFF) released as part of firefighting activities, although other PFAS sources are possible. In addition, the ARNG is assessing businesses or operations adjacent to the ARNG facility (not under the control of ARNG) that could potentially be responsible for a PFAS release.

PFAS are classified as emerging environmental contaminants that are garnering increasing regulatory interest due to their potential risks to human health and the environment. PFAS formulations contain highly diverse mixtures of compounds. Thus, the fate of PFAS compounds in the environment varies. The regulatory framework at both federal and state levels continues to evolve. The US Environmental Protection Agency (USEPA) issued Drinking Water Lifetime Health Advisories (HAs) for PFOA and PFOS in May 2016, but there are currently no promulgated national standards regulating PFAS in drinking water. The HA is 70 parts per trillion for PFOS and PFOA, individually or combined.

This report presents the findings of a PA for PFAS-containing materials at the North Dakota Army Aviation Support Facility #2 (Fargo AASF #2; also referred to as the “facility”) in Fargo, North Dakota, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations Part 300), and Army requirements and guidance.

This PA documents the known locations where PFAS may have been released into the environment at the AASF #2, and potential adjacent sources. The term PFAS will be used throughout this report to encompass all PFAS chemicals being evaluated, including PFOS and PFOA, which are key components of AFFF.

1.2 Preliminary Assessment Methods

The performance of this PA included the following tasks:

- Reviewed available administrative record documents and Environmental Data Resources, Inc. (EDR)™ report packages to obtain information relevant to potential PFAS releases, such as: drinking water well locations, historical aerial photographs, Sanborn maps, and environmental compliance actions in the area surrounding the facility;
- Conducted a site visit on 13 September 2019 and completed visual site inspections (VSIs) at locations where PFAS-containing materials were suspected of being stored, used, or disposed;
- Interviewed current and retired North Dakota ARNG (NDARNG) personnel, NDARNG environmental managers, and operations staff

- Completed a visual site inspection (VSI) at known or suspected potential PFAS release locations and documented with photographs
- Developed a preliminary conceptual site model (CSM) to outline the potential release and pathway of PFAS for the Area of Interest (AOI) and the facility

1.3 Report Organization

This report has been prepared in accordance with the USEPA *Guidance for Performing Preliminary Assessments under CERCLA* (USEPA, 1991). The report sections and descriptions of each are:

- **Section 1 – Introduction:** identifies the project purpose and authority and describes the facility location, environmental setting, and methods used to complete the PA
- **Section 2 – Fire Training Areas:** describes the fire training areas (FTAs) at the facility identified during the site visit
- **Section 3 – Non-Fire Training Areas:** describes other locations of potential PFAS releases at the facility identified during the site visit
- **Section 4 – Emergency Response Areas:** describes areas of potential PFAS release at the facility, specifically in response to emergency situations
- **Section 5 – Adjacent Sources:** describes sources of potential PFAS release adjacent to the facility that are not under the control of ARNG
- **Section 6 – Preliminary Conceptual Site Model:** describes the pathways of PFAS transport and receptors for the AOIs and the facility
- **Section 7 –Conclusions:** summarizes the data findings and presents the conclusions of the PA
- **Section 8 – References:** provides the references used to develop this document
- **Appendix A** – Data Resources
- **Appendix B** – Preliminary Assessment Documentation
- **Appendix C** – Photographic Log

1.4 Facility Location and Description

The Fargo AASF #2 is in Cass County, approximately 1-mile northwest of Fargo, North Dakota (**Figure 1-1**). The AASF is adjacent to Hector International Airport. The facility is accessible from North University Drive from the east and 19th Avenue N from the south.

Fargo AASF #2 is constructed on a parcel of land that is owned by the Fargo Jet Center LLC and has been operated by the NDARNG from 2012 to 2015 and from 2016 to present (**Appendix A**). The current lease ends in September 2020. Before 2012, the Fargo Jet Center LLC leased the site to other operators who used the hangar facility for aircraft and other equipment storage. Fargo AASF #2 consists of one hangar and one administrative building.

1.5 Facility Environmental Setting

The Fargo AASF #2 lies within the Red River Valley of North Dakota, which is characterized by glacial lake sediments. The facility is bordered to the east and south by residential and commercial areas and bordered to the west and north by agricultural land. The facility is approximately 2 miles east of the Red River and approximately 5 miles southwest of the Sheyenne River. The elevation of the facility is approximately 904 feet above mean sea level.

1.5.1 Geology

The Fargo AASF #2 lies within the southeastern side of the North Dakota, in Cass County, within the Drift Prairie and Red River Valley areas. Fargo is a part of the Central Lowland, which is covered with glacial deposits. In the glacier deposits in Cass County, there are four major surface units; they are defined as ground moraine, lake plain, shore, and deltaic deposits. Ground moraine can be found within the first 20 feet below the surface and is composed of till, silt, gravel, sand heterogeneous mixture of clay, and boulders with clay and silt predominating. The lake plain deposits consist of silt and clay that can be found as two separate layers in the lake plain deposit. The silt unit comprises the surface deposits with a lower level clay unit. The two layers are marked by desiccation and vegetal remnant. The deposits known as “shore” border the lake plain on the west side and consist of silt, clay, sand, and gravel. They are typically the smallest layer and only range to 15 feet maximum depth. Deltaic deposits consist of fine to medium sand and silt and can range to 120 feet deep. These four layers overlie sedimentary rocks from the Cretaceous age, except in places where the Cretaceous shale eroded, in which case, the layers sit on Precambrian crystalline rocks.

The underlying rock from the glacial deposits are 3 Cretaceous bedrock units that can be defined as the Greenhorn Formation, Graneros Shale, and Dakota Sandstone. The Greenhorn Formation lies 200 to 420 feet below the surface and is a black calcareous shale with white specks. The Greenhorn Formation typically covers the Graneros Shale, but it can also be covered by Dakota Sandstone. Graneros Shale is a black, silty, noncalcareous shale that has fine white sand. Dakota Sandstone can be found at a deeper range from 300 to 650 feet and consists of interbedded black shale and fine to coarse sand. In a few areas, Precambrian crystalline rocks can be found consisting of red and green clay derived from granite, but these rocks are only found at depths of over 900 feet below ground surface (North Dakota Geological Survey, 1949).

1.5.2 Hydrogeology

The Fargo AASF #2 is just east of the Red River of the North Drainage Basin, located to the north west of the West Fargo North, Nodak and Fargo Aquifers, where it drains into Clay County, Minnesota. The closest aquifer to the facility is the Nodak Aquifer, which is composed of relatively impermeable sands and gravels. The aquifer is estimated to be about 68 feet thick and spans 2.6 square miles. The groundwater within the Nodak aquifer flows into the Fargo, West Fargo North and the West Fargo South Aquifers (Ripley, 2000).

Depth to groundwater in the area typically ranges from 4 to 10 feet below ground surface (bgs). However, the groundwater depth fluctuates seasonally with the depth to the high water table of 1 feet bgs in April or June. The groundwater is inferred to flow generally west to east across the facility (**Figure 1-2**). The average groundwater flow velocity near the Fargo AASF #2 facility is very slow due to the small hydraulic gradient of approximately 1 to 2 feet per mile, and the low permeability rate of the soils (ANG, 2019).

No potable water wells are located within the boundary of the facility; however, monitoring/observation, industrial, and irrigation wells exist within 2 miles of the facility (**Figure 1-2**). Drinking water for the facility is supplied by the City of Fargo, which uses the Red River, Sheyenne River, and Lake Ashtabula as its drinking water sources (City of Fargo, 2019). Based on the USEPA Unregulated Contaminant Monitoring Rule 3 (UCMR3) data, no PFAS were detected in a public water system above the USEPA lifetime HA within 20 miles of the facility. The HA is 70 parts per trillion for PFOS and PFOA, individually or combined. PFAS analyses performed in 2016 had method detection limits that were higher than currently achievable. Thus, it is possible that low concentrations of PFAS were not detected during the UCMR3 but might be detected if analyzed today.

1.5.3 Hydrology

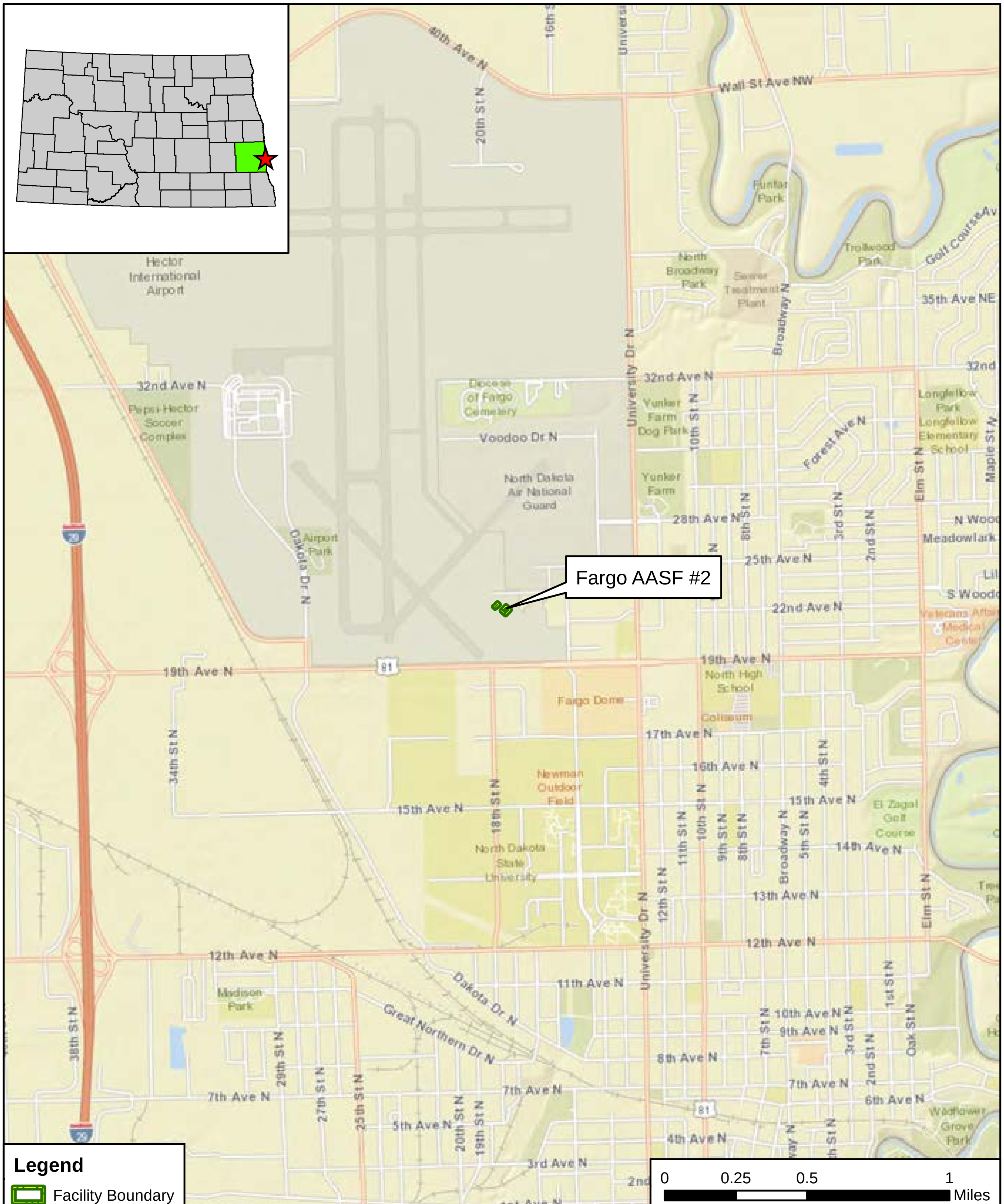
No naturally occurring drainage systems, streams, or bodies of water are located on the facility. Natural drainage at the facility and surrounding airport are not well defined due to the flat topography. Stormwater runoff is carried away by a series of storm sewers, culverts, and ditches that flow to several open man-made ditches; these in turn flow north and east to the Red River, which lies about 2 miles east of the facility (ANG, 2019). Due to the man-made features, the surface water flow at the facility flows to the northeast (**Figure 1-3**). The recharge to the aquifers can happen in two possible ways: through precipitation from upland areas and water that comes from the sandstone layers, as it moves laterally into the recharge areas, and from percolation in gravel aquifers, which extends into lake deposits resting on underlying till (North Dakota Geological Survey, 1968).

1.5.4 Climate

The climate at Fargo AASF #2 consists of four clearly separated seasons, with shorter, warm summers and freezing, snowy, cloudy, windy winters. Temperatures vary from average highs of 70.2 degrees Fahrenheit (°F) to average lows of 6.3 °F. The average annual temperature is 40.5 °F. Average precipitation is 20.8 inches of rain (World Climate, 2019).

1.5.5 Current and Future Land Use

The Fargo AASF #2 is a controlled access facility with public roads and is adjacent to the Hector International Airport. The facility consists of one hangar and one administrative building. Reasonably anticipated future land use is not expected to change from the current land use; however, future infrastructure improvements, land acquisitions, and land use controls at the Hector International Airport are unknown. In 2016, the Hector International Airport proposed an $81 million dollar expansion and improvement project. Some improvements include runway expansion, additional hangars/buildings, main terminal expansion, and additional public parking additions.



CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Fargo AASF #2, ND			
REVISED	1/9/2020	GIS BY	MS	1/9/2020
SCALE	1:31,680	CHK BY	JW	1/9/2020
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	RG	1/9/2020

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Facility Location

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Figure 1-1

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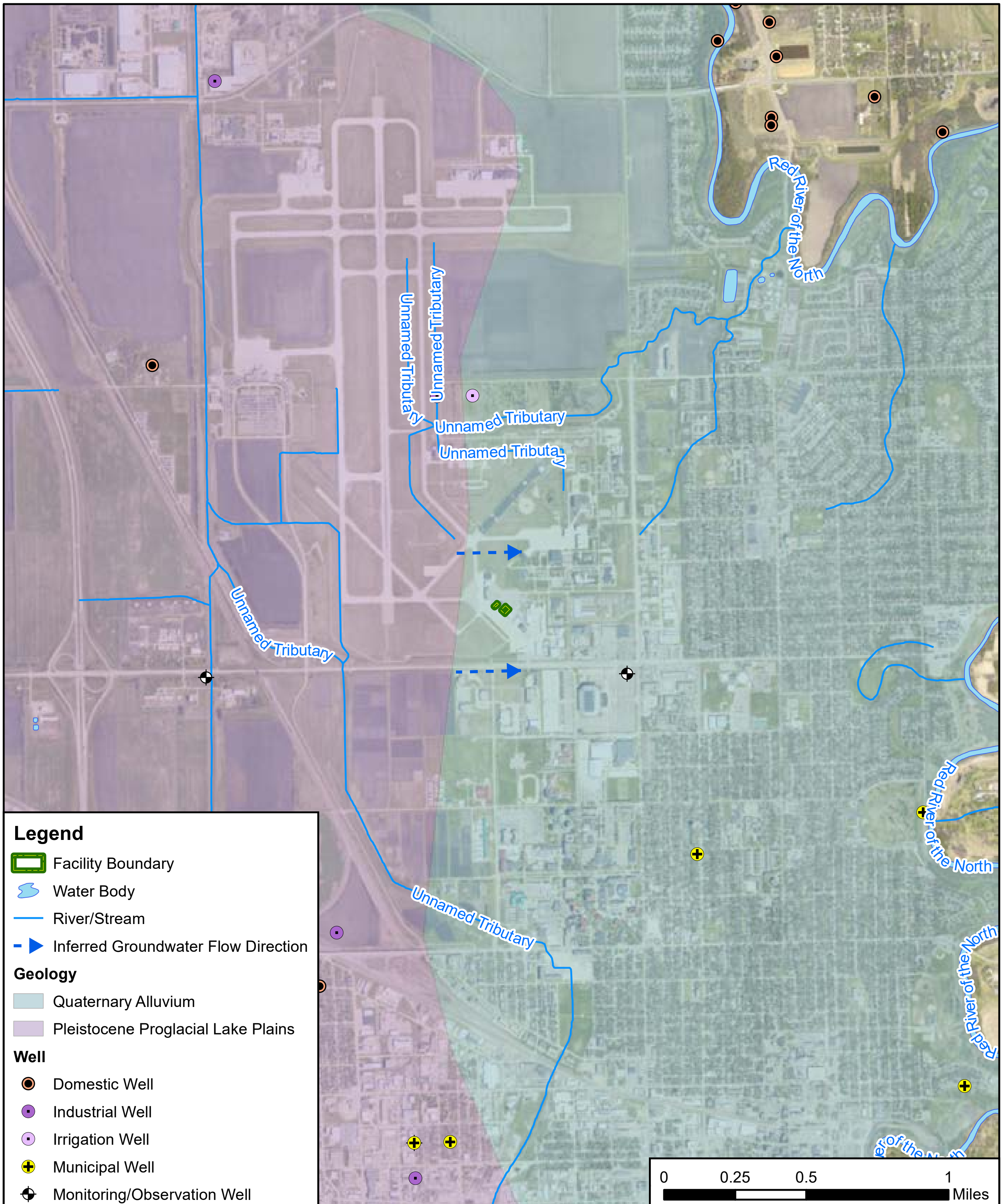

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NOTES	Preliminary Assessment for PFAS at Fargo AASF #2, ND					
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Base Map: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	RG	5/20/2020		

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Groundwater Features

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Figure 1-2

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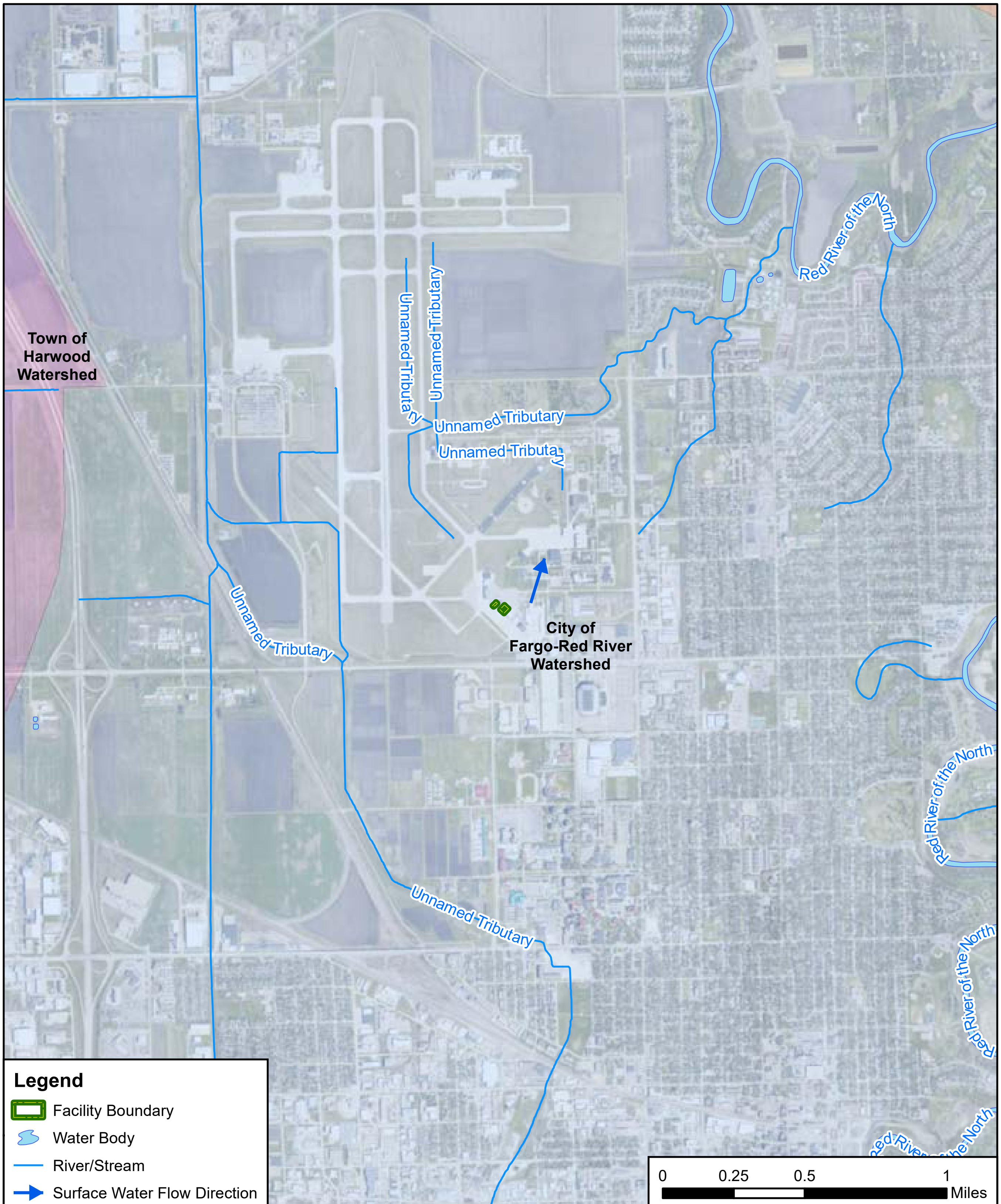

CLIENT	ARNG				N	Surface Water Features	
NOTES	Preliminary Assessment for PFAS at Fargo AASF #2, ND						
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SCALE	1:31,680	CHK BY	JW	5/20/2020			
Base Map: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	RG	5/20/2020			

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2. Fire Training Areas

No FTAs were identified within the facility during the PA through interviews (**Appendix B**) or document review (**Appendix A**). Fire training exercises for the NDARNG were not conducted at the Fargo AASF #2.

3. Non-Fire Training Areas

In addition to FTAs, the PA evaluated areas where PFAS-containing materials may have been broadly used, stored, or disposed. This may include buildings with fire suppression systems, paint booths, AFFF storage areas, and areas of compliance demonstrations. Information on these features obtained during the PA are included in **Appendices A** and **B**. One non-FTA was identified at the Fargo AASF #2. During the PA, interviewees indicated that AFFF had not been used or released at the facility (**Appendix B**). There are no fire suppression systems, firetruck storage, or bulk AFFF storage at the facility. A description of the non-FTA is presented below and shown on **Figure 3-1**.

3.1 TriMax30™ Fire Extinguisher

During the interviews, it was reported that there were ABC and Purple K™ fire extinguishers at the facility, and that there were never AFFF fire extinguishers. However, during the VSI, one TriMax30™ fire extinguisher was found under tarps and other supplies. Personnel were not aware that the TriMax30™ was at the facility, where the fire extinguisher originated from, or how long it was at the facility. One interviewee indicated that the TriMax30™ has not been used since NDARNG arrived at the facility in 2012. There was no visible leaking or corrosive markings on the TriMax30™ fire extinguisher. The drains in the hangar lead to an oil/water separator and ultimately to the Fargo Sanitary Waste Water Treatment Plant (WWTP).

CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Fargo AASF #2, ND			
REVISED	1/9/2020	GIS BY	MS	1/9/2020
SCALE	1:1,200	CHK BY	JW	1/9/2020
Base Map: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	RG	1/9/2020

Non-Fire Training Area

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Figure 3-1

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4. Emergency Response Areas

No emergency response areas were identified within the Fargo AASF #2 during the PA through interviews (**Appendix B**) or document review (**Appendix A**). The Hector International Airport provides fire emergency services for the Fargo AASF #2.

5. Adjacent Sources

Twelve off-site PFAS sources adjacent to the Fargo AASF #2 were identified during the PA through interviews and document review (**Appendix A** and **Appendix B**). A SI was completed at the 119th Wing of the North Dakota Air National Guard (NDANG) at Hector International Airport, Fargo, North Dakota (ANG, 2019). **Table 5-1** summarizes the findings of the SIs completed at the 119th NDANG at Hector International Airport. **Figure 5-1** presents the location of potential Fargo AASF #2 adjacent source areas.

5.1 NDANG

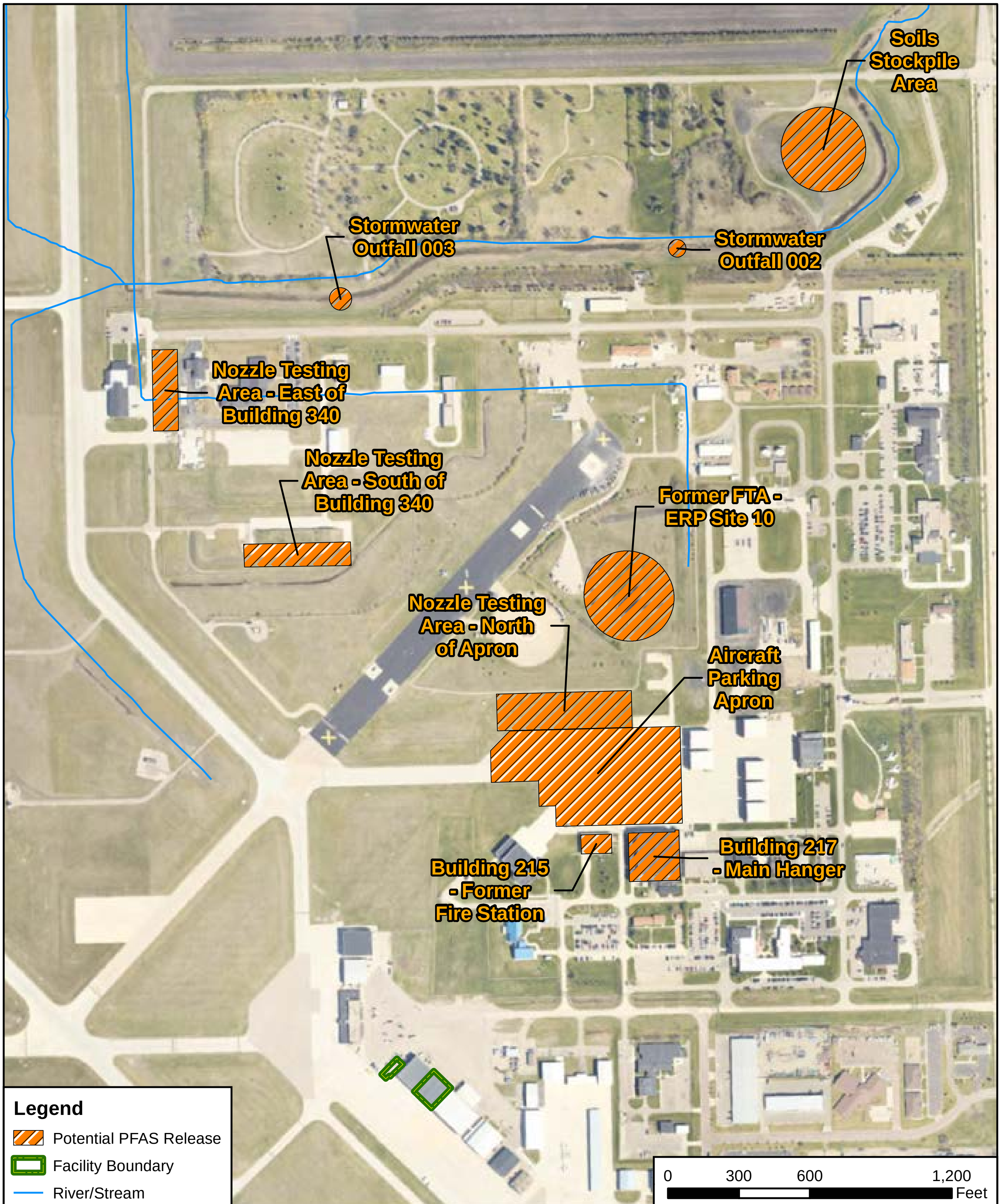
Hector Field is the home of the 119th Fighter Wing. The NDANG was first formed in January 1947 as host to the 178th Fighter Interceptor Squadron; the squadron was reorganized into the 119th Fighter Interceptor Group in 1956. The primary mission of the 119th Wing has been an Air Defense Mission that has included intercepting, identifying, and destroying enemy airborne objects. The NDANG occupies approximately 209 acres of the Hector International Airport. The SI indicated that ANG operations (i.e., FTAs, AFFF storage areas, fire stations, firefighting equipment testing areas, and emergency response) could have contributed to PFAS contamination in soil, groundwater, sediment, and surface water (ANG, 2019). The findings of the ANG SI are presented in **Table 5-1**.

Table 5-1: Adjacent Sources

Area	Description	SI Findings
Former FTA – ERP Site 10	Former on-Base FTA used from the 1950s through mid-1989. AFFF likely utilized during this time.	PFAS contamination levels in soil exceeded the residential risk-based screening level for PFOS and additional sampling was proposed to determine the nature and extent in the vertical/horizontal directions. Although groundwater samples did not exceed the screening criteria, additional sampling was proposed to determine the nature and extent in the vertical/horizontal directions.
Building 217 – Main Hangar	Main Base Hangar with AFFF fire suppression systems since 1992. Regular AFFF fire suppression system testing from 1992 to 2014.	Although the soil samples did not exceed the screening criteria, additional sampling was proposed to determine the nature and extent in the vertical/horizontal directions. PFAS contamination levels in groundwater exceeded the screening criteria, additional sampling was prosed to determine the nature and extent in the vertical/horizontal directions.

Area	Description	SI Findings
Building 215 – Former Fire Station	Main Base Fire Station from the 1950s to 2011. AFFF was stored in fire rescue vehicles, and a known discharge of 180 gallons of AFFF into the building's floor drains occurred in 2001.	Although the soil samples did not exceed the screening criteria, additional sampling was proposed to determine the nature and extent in the vertical/horizontal directions. PFAS contamination levels in groundwater exceeded the screening criteria, additional sampling was prosed to determine the nature and extent in the vertical/horizontal directions.
Nozzle Testing Area – East of Building 340	Documented nozzle testing in this area using AFFF.	Although the soil and groundwater samples did not exceed the screening criteria, additional sampling was proposed to determine the nature and extent in the vertical/horizontal directions.
Nozzle Testing Area – South of Building 340	Documented nozzle testing in this area using AFFF.	Although the soil and groundwater samples did not exceed the screening criteria, additional sampling was proposed to determine the nature and extent in the vertical/horizontal directions.
Nozzle Testing Area – North of Apron	Documented nozzle testing in this area using AFFF.	Although the soil samples did not exceed the screening criteria, additional sampling was proposed to determine the nature and extent in the vertical/horizontal directions. PFAS contamination levels in groundwater exceeded the screening criteria, additional sampling was prosed to determine the nature and extent in the vertical/horizontal directions.
Aircraft Parking Apron	Aircraft loading/parking area where potential AFFF releases may have occurred.	Although the soil samples did not exceed the screening criteria, additional sampling was proposed to determine the nature and extent in the vertical/horizontal directions. PFAS contamination levels in groundwater exceeded the screening criteria, additional sampling was prosed to determine the nature and

Area	Description	SI Findings
		extent in the vertical/horizontal directions.
Stormwater Outfall 002	Receives stormwater from several potential release locations and may be impacted by AFFF use.	Although the sediment samples did not exceed the screening criteria, additional sampling was prosed upstream of the outfall and downstream outside the facility boundary to determine the nature and extent in the vertical/horizontal directions. PFAS contamination levels in surface water exceeded the screening criteria, additional sampling was prosed upstream of the outfall and downstream outside the facility boundary to determine the nature and extent in the horizontal direction.
Stormwater Outfall 003	Receives stormwater from several PRLs and may be impacted by AFFF use.	Although the sediment samples did not exceed the screening criteria, additional sampling was prosed upstream of the outfall and downstream outside the facility boundary to determine the nature and extent in the vertical/horizontal directions. PFAS contamination levels in surface water exceeded the screening criteria, additional sampling was prosed upstream of the outfall and downstream outside the facility boundary to determine the nature and extent in the horizontal direction.
Soils Stockpile Area	Received post land-farmed soils from Former FTA – ERP Site 10.	Although the soil samples did not exceed the screening criteria, additional sampling was proposed to determine the nature and extent in the vertical/horizontal directions. PFAS contamination levels in groundwater exceeded the screening criteria, additional sampling was prosed to determine the nature and extent in the vertical/horizontal directions.



CLIENT	ARNG				
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SCALE	1:7,200	CHK BY	JW	1/9/2020	
Base Map: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	RG	1/9/2020	

Adjacent Sources

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Figure 5-1

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6. Preliminary Conceptual Site Model

Based on the PA findings, one AOI was identified at the Fargo AASF #2: AOI 1 Hangar. The AOI location is shown on **Figure 6-1**. The following sections describe the CSM components and the specific CSM developed for AOI 1. The CSM identifies the three components necessary for a potentially complete exposure pathway: (1) source, (2) pathway, (3) receptor. If any of these elements are missing, the pathway is considered incomplete.

6.1 Pathways

In general, the potential PFAS exposure pathways are ingestion and inhalation. Human exposure via the dermal contact pathway may occur, and current risk practice suggests it is an insignificant pathway compared to ingestion; however, exposure data for dermal pathways is sparse and continues to be the subject of PFAS toxicological study (National Ground Water Association, 2018).

Potential AFFF releases at the AASF may have occurred on paved surfaces. AFFF releases to the paved surfaces could have infiltrated the subsurface via cracks in the pavement or joints between areas that are paved with different materials. Ground-disturbing activities may result in potential exposure to subsurface soils and groundwater via ingestion.

6.2 Receptors

Receptors include construction workers. These receptors as they pertain to the facility are described below:

- Construction workers are considered workers who represent a utility worker or other worker who would be exposed to surface and/or subsurface conditions through ground-disturbing activities.

The preliminary CSM for the AASF indicates which specific receptors could potentially be exposed to PFAS. The preliminary CSM for the AOI at the Fargo AASF #2 is shown on **Figure 6-2**.

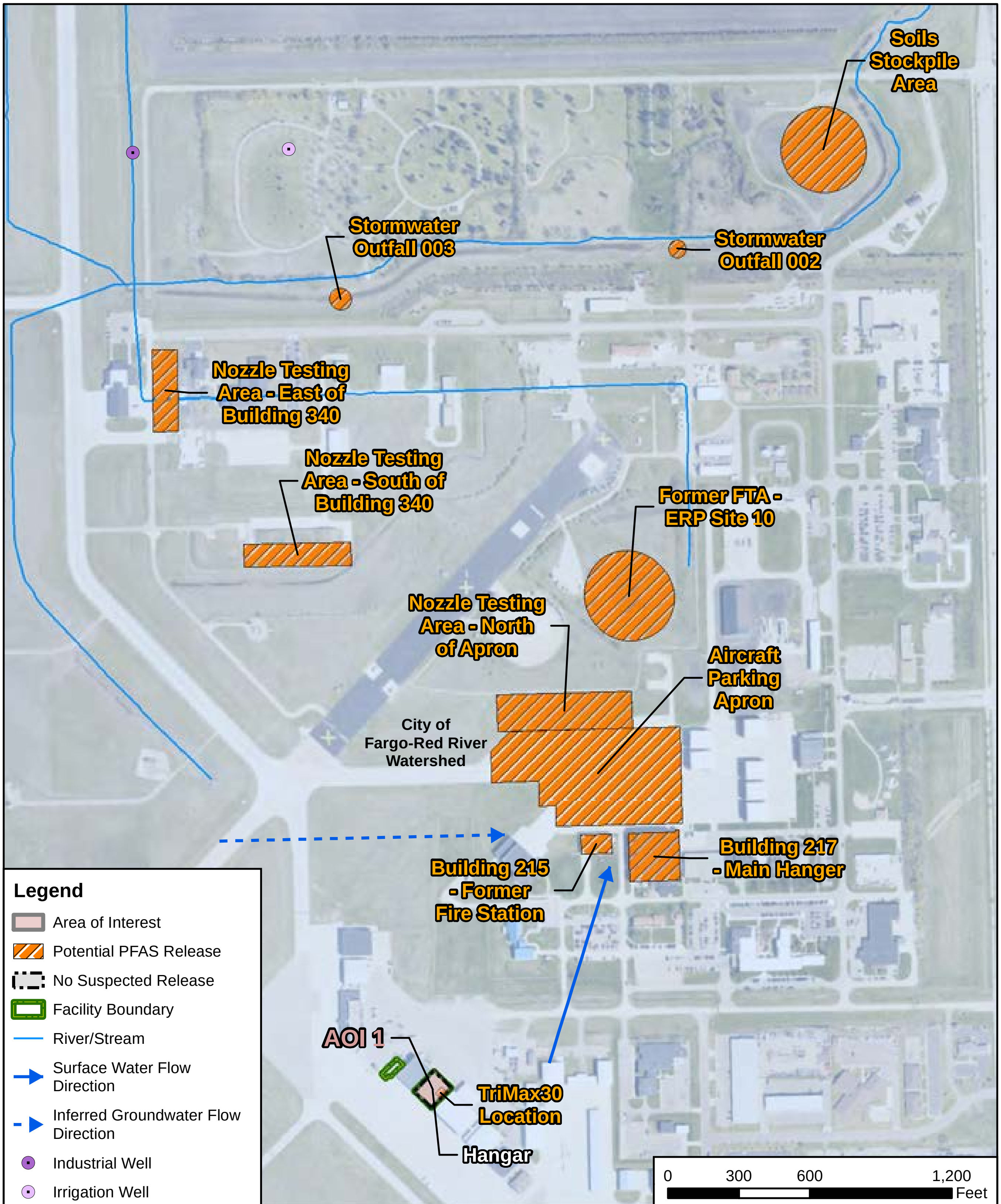
6.3 AOI 1 Hangar

One TriMax30™ fire extinguisher found in the hangar at the Fargo AASF #2 during the VSI. The current personnel and interviewees were not aware the TriMax30™ extinguisher was in the hangar or when it arrived at the facility. None of the NDARNG personnel had ever worked or trained with the TriMax30™ extinguisher. Due to the lack of information regarding the TriMax30™ fire extinguisher, the hangar was identified as an AOI. There are trench drains in the hangar that leads to an oil/water separator and then to the Fargo Sanitary WWTP.

Potential PFAS exposure pathways resulting from releases at AOI 1 are described in **Table 6-1**.

Table 6-1 Exposure Pathways at AOI 1

Pathway	Receptor
Subsurface Soil	Considered a potentially complete pathway to construction workers via ingestion or inhalation of dust
Groundwater	Considered a potentially complete pathway to construction workers via ingestion



CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Fargo AASF #2, ND			
REVISED	1/9/2020	GIS BY	MS	1/9/2020
SCALE	1:7,200	CHK BY	JW	1/9/2020
Base Map: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	RG	1/9/2020

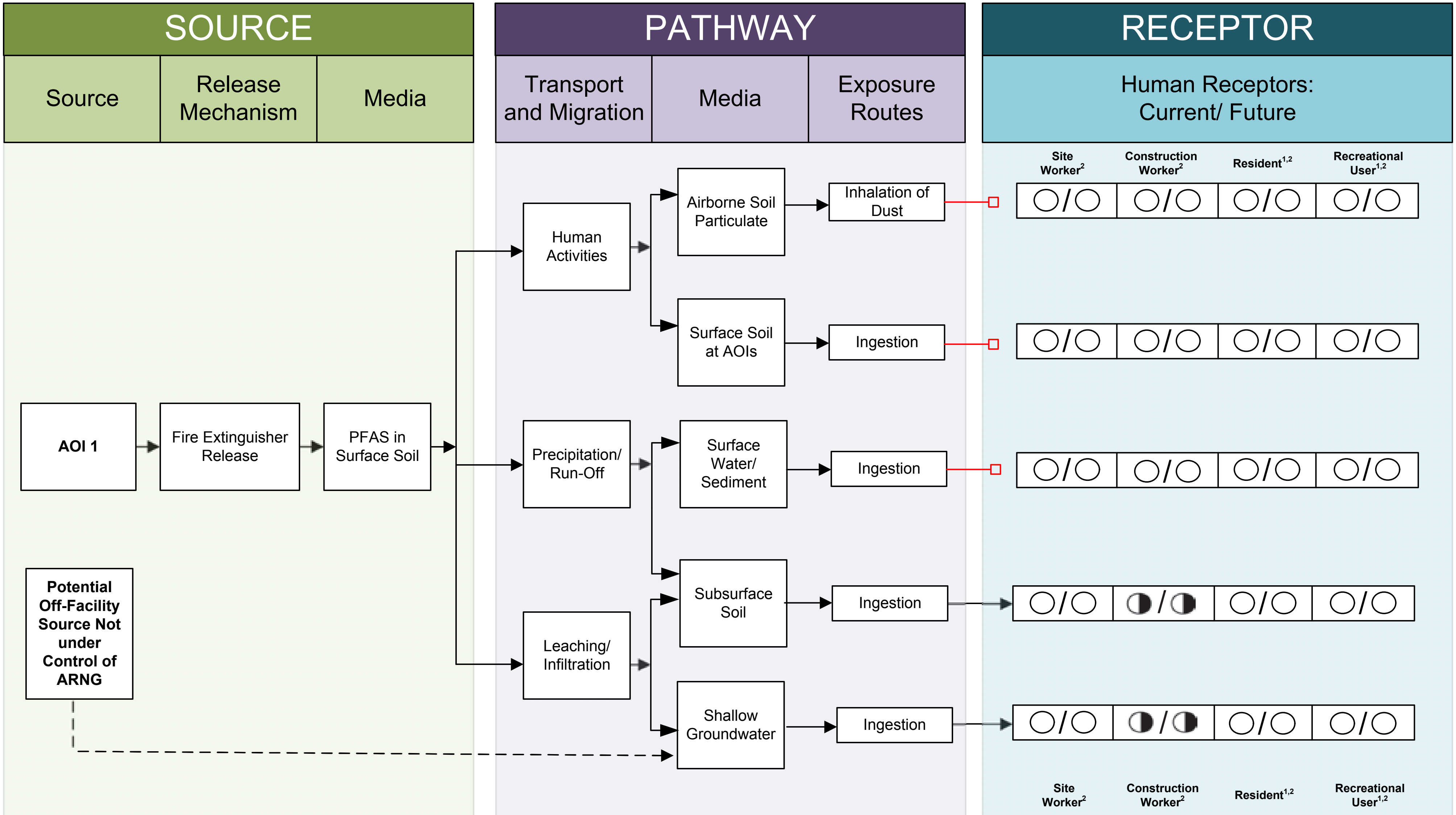
N

Area of Interest

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 6-1

Q:\Projects\ENV\GEARS\GEO\ARNG PFAS\900-CAD-GIS\920-GIS or Graphics\MXD\ND\Fargo_AASF_Figures\Fig_6-1_Fargo_AASF_AOI.mxd



LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway
- Complete Pathway

Notes:

1. The resident and recreational users receptors refer to an off-facility resident and off-facility recreational users.
2. Dermal contact exposure pathway is incomplete for PFAS.

Figure 6-2
Preliminary Conceptual Site Model
AOI 1 Hangar

7. Conclusions

This report presents a summary of available information gathered during the PA on the use and storage of AFFF and other PFAS-related activities at the Fargo AASF #2. The PA findings are based on the information presented in **Appendix A** and **Appendix B**.

7.1 Findings

One AOI related to a potential PFAS release was identified (**Table 7-1**) at Fargo AASF #2 during the PA (**Figure 7-1**). Additionally, ten off-facility adjacent sources were identified (**Table 5-1**).

Table 7-1: AOI at Fargo AASF #2

Area of Interest	Name	Used by	Potential Release Dates
AOI 1	Hangar	Unknown	Unknown

Based on information obtained during interviews conducted with facility personnel, facility observations, and reviewed documentation, it is unknown if AFFF has ever been used, or released at the Fargo AASF #2; therefore, because documentation was not available to support that the TriMax30™ fire extinguisher was not used at the facility, the hangar was identified as an AOI.

The preliminary CSM for the AASF is shown on **Figure 6-2**, which presents the potential receptors and media impacted.

7.2 Uncertainties

A number of information sources were investigated during this PA to determine the potential for PFAS-containing materials to have been present, used, or released at the facility. Historically, documentation of PFAS use was not required because PFAS were considered benign. Therefore, records were not typically kept by the facility or available during the PA on the use of PFAS in training, firefighting, or other non-traditional activities, or on its disposition.

The conclusions of this PA are based on all available information, including: previous environmental reports, EDRs™, observations made during the VSI, and interviews. Interviews of personnel with direct knowledge of a facility generally provided the most useful insights regarding a facility's historical and current PFAS-containing materials. Sometimes, the provided information was vague or conflicted with other sources. Gathered information has a degree of uncertainty due to the absence of written documentation, the limited number of personnel with direct knowledge due to staffing changes, the time passed since PFAS were first used (1969 to present), and a reliance on personal recollection. Inaccuracies may arise in potential PFAS release locations, dates of release, volume of releases, and the concentration of AFFF used. There is also a possibility the PA has missed a source of PFAS, as the science of how PFAS may enter the environment continually evolves.

In order to minimize the level of uncertainty, readily available data regarding the use and storage of PFAS were reviewed, retired and current personnel were interviewed, multiple persons were interviewed for the same potential source area, and potential source areas were visually inspected. **Table 7-2** summarizes the uncertainties associated with the PA.

Table 7-2: Uncertainties

Area of Interest	Source of Uncertainty
Fargo AASF #2	The NDARNG took possession of the hangar in 2012. Direct interviewee knowledge is not available before 1993. Whether potential use, storage, or release of PFAS-containing materials occurred at this facility prior to 1993 is unknown.
AOI 1	Personnel were not aware that the TriMax30™ was at the facility, where the fire extinguisher originated from, if the unit was ever used, or how long it was at the facility. NDARNG has never used the TriMax30™ fire extinguisher.

7.3 Potential Future Actions

Interviews and records (covering 1993 to present) indicate that current ARNG or former non-ARNG activities may have resulted in potential PFAS releases at the one AOI identified during the PA. Based on the CSM developed for the AOI, there is potential for receptors to be exposed to PFAS contamination in soil and groundwater at this AOI. **Table 7-3** summarizes the rationale used to determine if the AOI should be considered for further investigation under the CERCLA process and undergo a SI.

ARNG evaluates the need for an SI at the AASF based on the potential receptors, the potential migration of PFAS contamination off the facility, and the availability of resources.

Table 7-3: PA Findings Summary

Area of Interest	AOI Location	Rationale	Potential Future Action
AOI 1 Hangar	46°54'27.3"N; 96°48'27.4"W	One TriMax30™ fire extinguisher was found under tarps and other supplies. Personnel were not aware that the TriMax30™ was at the facility, where the fire extinguisher originated from, or how long it was at the facility. It is unknown if any AFFF was released from the TriMax30™ fire extinguisher.	Proceed to an SI, focus on soil and groundwater.

CLIENT	ARNG			
NOTES	Preliminary Assessment for PFAS at Fargo AASF #2, ND			
REVISED	6/19/2020	GIS BY	MS	6/19/2020
SCALE	1:2,400	CHK BY	JW	6/19/2020
Base Map: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS,		PM	RG	6/19/2020

N

Summary of Findings

AECOM

12420 Milestone Center Drive
Germantown, MD 20876

Figure 7-1

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8. References

Air National Guard (ANG). 2019. *Site Inspection Report for Perfluorooctane Sulfonate and Perfluorooctanoic Acid at Hector Field Air National Guard Base, Fargo, North Dakota.* November.

Ripley, David. 2000. *The Water Resource Characteristics of the West Fargo Aquifer System*.

The City of Fargo. 2019. *Water Treatment.* December.

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United States Geological Survey (USGS). 1949. *Geology and Ground-Water Resources of Parts of Cass and Clay Counties North Dakota and Minnesota.* October.

World Climate. 2019. Available at http://www.worldclimate.com/climate/us/north-dakota/fargo. (Accessed November 12, 2019).

Appendix A
Data Resources

Data Resources will be provided separately on CD. Data Resources for Fargo AASF.

Fargo AASF #2 Deed, Leases, Licenses, and Permits

- 2018 Fargo AASF #2 Property Lease

Fargo AASF #2 Documentation

- 1968 County Ground Water Studies 8 Geology and Ground Water Resources of Cass County, North Dakota Part I
- 1968 County Ground Water Studies 8 Geology and Ground Water Resources of Cass County, North Dakota Part II
- 1968 County Ground Water Studies 8 Geology and Ground Water Resources of Cass County, North Dakota Part III
- 2019 Site Inspection Report for Perfluorooctane Sulfonate and Perfluorooctanoic Acid at Hector Field Air National Guard Base, Fargo, North Dakota.

EDR Report

- 2019 Fargo AASF #2 EDR Report

LEASE

This lease agreement is made and entered into by and between the State of North Dakota, acting through the Office of the Adjutant General (NATIONAL GUARD), and Fargo Jet Center LLC (LANDLORD), owner of subject property located at Fargo, North Dakota.

1. LEASE OF PREMISES

The LANDLORD, in consideration of the covenants to be performed by the NATIONAL GUARD, hereby leases to the NATIONAL GUARD, the following described premises situated in the City of Fargo, County of Cass and the State of North Dakota, to-wit:

> Approximately 11,730 square feet of commercial hangar rental space (the leased premises) identified as 1748 and 1756 23rd Ave N Fargo, ND 58102 and approximately 3,000 square feet of commercial administrative rental space (the leased premises) identified as 1760 23rd Ave. Fargo, ND 58102 and associated lots.

2. TERM OF LEASE

The term of this lease shall be for a period of two years (24) months, commencing on the 1st day of October 2018, and terminating on the 30st day of September 2020. NATIONAL GUARD may option to extend this lease for two (2) additional two year (24) month terms by providing thirty (30) days written notice to the LANDLORD. Base rent shall be renegotiated at the time of the extension. All remaining terms and conditions of this lease, with the exception of base rent, shall remain in full force and effect.

3. RENTAL PAYMENTS

NATIONAL GUARD agrees to pay a base rent for the premises of $8,610.00 per month. The Rent will be paid in advance by the 7th day of each month, beginning on the 1st day of October, 2018.

4. LANDLORD'S OBLIGATIONS

LANDLORD agrees:

a. To pay all property taxes charged against the premises during the term of this lease or any renewals or extensions thereof.

b. That if other portions of the building are leased to other parties, or retained for the LANDLORD's use, the LANDLORD shall not permit any activity to be conducted in other portions of the building or grounds that will materially interfere with the NATIONAL GUARD's use and enjoyment of the leased premises.

c. That the NATIONAL GUARD may install items which it deems necessary for maximum and optimum utilization of the Premises, subject to the approval of the LANDLORD, which approval shall not unreasonably be withheld, unless such installations will affect the structural integrity of the building or increase the insurable risk of damage or loss to the LANDLORD. Upon termination or expiration of this lease the NATIONAL GUARD shall remove from the Premises all fixtures and other equipment, unless the NATIONAL GUARD and the LANDLORD consent to other arrangements. NATIONAL GUARD agrees to repair any damages that may be done to the leased premises resulting from the removal of said items.

d. To maintain the premises, at its expense, and in the absence of damage due to the negligence of the NATIONAL GUARD, and provide all necessary repairs and replacements related to perimeter walls, plate glass in windows, foundation, electrical, mechanical, plumbing, roof and structural portions of the buildings located upon the premises.

e. The NATIONAL GUARD may place decorations, wall hangings, signs and directories upon entrance doors, in hallways leading to its leased premises, or doors within such premises and on walls thereof. The NATIONAL GUARD shall have the right to maintain a sign on the buildings or grounds showing the NATIONAL GUARD'S presence in the building, as well as have the right to maintain signage on its exclusive use areas. Signs shall conform to existing ordinances and regulations of the City of Fargo, conform to the LANDLORD's sign criteria and all sign costs shall be the responsibility of the NATIONAL GUARD.

f. To comply at its own expense with all federal, state, county, and city laws and ordinances and lawful rules, regulations, or orders of any duly constituted authority, present or future, affecting the leased premises.

g. To obtain fire and extended coverage insurance on the premises.

h. To provide automobile parking spaces for use by NATIONAL GUARD, its agents or designees, in a lot provided for use by building tenants.

5. NATIONAL GUARD'S OBLIGATIONS

NATIONAL GUARD agrees:

a. To pay rent when due.

b. To pay monthly telephone service and utilities for space leased.

c. To keep the leased premises in a clean and healthful condition, and to maintain the leased premises in such repair as existed at the commencement of the term, except for reasonable use of wear, or damage by fire and casualty covered by insurance required to be maintained by LANDLORD.

d. Not to make any unlawful, improper, or offensive use of the premises, and to observe all the laws of the State of North Dakota and the ordinances of the City of Fargo in force from time to time relating to the leased premises or the use thereof.

e. To keep the walkways and parking areas of the premises free of accumulations of snow and to cut and care for the grass on the premises.

f. To permit the LANDLORD at all reasonable times to enter upon and examine the premises and to make necessary repairs for the protection of the premises.

g. To surrender the leased premises to LANDLORD at the expiration of the term in as good condition and repair as the same were in when the term began, reasonable wear and tear and damage by fire and other unavoidable casualty excepted. Also, in default of payment of any rent due or failure to perform any of the terms or conditions of this lease, then to surrender the premises upon demand made by the LANDLORD.

h. To maintain at its own expense and assume responsibility for all office equipment, furniture, and fixtures installed by the NATIONAL GUARD.

6. TERMINATION OF LEASE

It is expressly understood and agreed that NATIONAL GUARD has no obligation under this lease for the initial or succeeding terms if it fails to secure appropriated funds to defray the full rental costs. This lease agreement in no way acts to bind the State of North Dakota beyond the current biennium's appropriation. NATIONAL GUARD, without any liability, may terminate this lease on thirty (30) days' written notice if it fails to secure appropriated funds or if its authority to spend its appropriations is reduced or limited by law or by reductions in federal or other grant funds to a point that the NATIONAL GUARD, in its sole discretion, deems insufficient to pay the full rental cost for the remainder of term of this lease.

If funding is not an issue it is understood and agreed that the LANDLORD or NATIONAL GUARD during the term of this lease or any renewal or extension thereof, may terminate this lease on thirty (30) days' written notice.

7. **MERGER**

This lease is the entire agreement between the parties, and no modification of this lease shall be binding unless evidenced by written agreement signed by the parties.

8. **SEVERABILITY**

The parties agree that if any term or provision of this lease is declared by a court of competent jurisdiction to be invalid, the validity of the remaining terms and provisions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the lease did not contain the particular term or provision held to be invalid.

9. **APPLICABLE LAW**

This lease shall be governed by and construed in accordance with the laws of the State of North Dakota.

10. **BINDING EFFECT OF LEASE**

This lease shall not be assigned or underlet by NATIONAL GUARD without the LANDLORD's written consent to such assignment or underletting. This lease shall not terminate by reason of any sale of the premises by the LANDLORD to a third party, but shall continue throughout the entire term.

11. **INDEMNIFICATION**

Landlord agrees to indemnify, save and hold harmless the State of North Dakota, its agencies, officers and employees (National Guard), from any and all claims of any nature, including all costs, expenses and attorney's fees, which may in any manner result from or arise out of this agreement, except for claims resulting from or arising out of the NATIONAL GUARD's sole negligence. Provided, however; that LANDLORD shall not be liable to NATIONAL GUARD or NATIONAL GUARD's employees, agents, or visitors for any injury to person or property on or about the leased premises caused by the sole negligence or misconduct of the NATIONAL GUARD, its agents, servants, or employees, and NATIONAL GUARD agrees to carry damage and liability insurance to save LANDLORD harmless. In no event shall LANDLORD be responsible for any injury to an employee of the NATIONAL GUARD, which injury is subject to North Dakota's Workers Compensation laws, and LANDLORD shall not pay any workers compensation premium for NATIONAL GUARD employees.

12. LIABILITY INSURANCE.

LANDLORD shall secure and keep in force during the term of this agreement, from insurance companies, government self-insurance pools or government self-retention funds authorized to do business in North Dakota, commercial general liability insurance governing the LANDLORD for any and all claims of any nature which may in any manner arise out of or result from this agreement. The minimum limits of liability required are $250,000 per person and $1,000,000.00 per occurrence.

NATIONAL GUARD agencies, officers, and employees shall be endorsed on the commercial general liability policy as additional insureds. LANDLORD shall furnish a certificate of insurance and a copy of the additional insured endorsement to the undersigned State representative prior to commencement of this agreement. Said endorsement shall contain a "Waiver of Subrogation" waiving any right of recovery the insurance company may have against the NATIONAL GUARD as well as provisions that the policy and/or endorsement may not be canceled or modified without thirty (30) days' prior written notice to the undersigned representative, and that any attorney who represents the NATIONAL GUARD under this policy must first qualify as and be appointed by the North Dakota Attorney General as a Special Assistant Attorney General as required under N.D.C.C. Section 54-12-08.

This insurance may be in policy or policies of insurance, primary and excess, including the so-called umbrella or catastrophe form and be placed with insurers rated "A" or better by A.M. Best Company, Inc.

The NATIONAL GUARD will be indemnified, saved and held harmless to the full extent of any coverage actually secured by the LANDLORD in excess of the minimum requirements set forth above.

13. TERMINATION OF THE LEASE IN EVENT OF DESTRUCTION OF PREMISES

It is agreed that in the event the leased premises are destroyed or damaged by fire or the elements to the extent they become untenable, then this lease shall immediately terminate, unless the LANDLORD, within twenty (20) days of the happening of such event, gives written notice of intention to restore the building and shall fully restore such premises within a reasonable time thereafter. During the term between the destruction and restoration of the premises rent shall not be due.

14. HOLDING OVER

If NATIONAL GUARD remains in possession of the premises after the lease expires, and the LANDLORD accepts rent from it, the lease shall be deemed renewed month to month.

15. USE OF PREMISES

The leased premises are to be used by NATIONAL GUARD to operate an Army Aviation Support Facility (AASF) II. Said premises shall not be used for any other purposes without the prior written consent of the LANDLORD.

16. LEASEHOLD IMPROVEMENTS

The parties agree that all leasehold improvements made to the property during the term of the lease will be owned by LANDLORD and shall remain the property of LANDLORD after the termination of the Lease agreement.

17. CONDEMNATION

If any part of the leased premises shall be taken or condemned for a public or quasi-public use (or any transfer is made in lieu thereof), and such condemnation has a negative impact on the NATIONAL GUARD's use of the premises, the NATIONAL GUARD may terminate this lease. If all of the leased premises shall be taken or condemned, the NATIONAL GUARD may thereupon terminate this lease. All compensation awarded upon any such condemnation or taking shall go to the LANDLORD and NATIONAL GUARD as provided by law.

18. ASSIGNMENT, MORTGAGE AND SUBLEASE

This lease shall not be assigned or underlet by NATIONAL GUARD unless the LANDLORD endorses its written consent to such assignment or underletting. This lease shall not terminate by reason of any sale of the premises by the LANDLORD to third parties, but shall continue throughout the entire term.

**[REMAINDER OF PAGE INTENTIONALLY LEFT BLANK;
SIGNATURE PAGE FOLLOWS]**

Dated this 6th day of August, 2018.

Fargo Jet Center LLC

By: [signature]

STATE OF NORTH DAKOTA)
)ss.
COUNTY OF CASS)

The foregoing instrument was acknowledged before me this 6th day of August, 2018, by Randall Jenson, Lessor.

Julie Hanson
Notary Public
My commission expires:

JULIE HANSON
Notary Public
State of North Dakota
My Commission Expires Feb. 25, 2021

NATIONAL GUARD

By: [signature]
Alan S. Dohrmann
Major General, ND National Guard
The Adjutant General

STATE OF NORTH DAKOTA)
)ss.
COUNTY OF BURLEIGH)

The foregoing instrument was acknowledged before me this 19th day of July, 2018, by Alan S. Dohrmann, on behalf of the National Guard.

Paul H. Zent
Notary Public
My Commission Expires: Oct. 5, 2018

PAUL H. ZENT
Notary Public
State of North Dakota
My Commission Expires Oct. 05, 2018

NORTH DAKOTA GEOLOGICAL SURVEY

WILSON M. LAIRD, *State Geologist*

BULLETIN 47

NORTH DAKOTA STATE
WATER CONSERVATION COMMISSION

MILO W. HOISVEEN, *State Engineer*

COUNTY GROUND WATER STUDIES 8

GEOLOGY and GROUND WATER RESOURCES of CASS COUNTY, NORTH DAKOTA

PART I

GEOLOGY

By

ROBERT L. KLAUSING

Geological Survey

United States Department of the Interior

Prepared by the United States Geological Survey in co-operation with the North Dakota State Water Commission, North Dakota Geological Survey, and Cass County Board of Commissioners.

GRAND FORKS, NORTH DAKOTA

1968

This is one of a series of county reports published cooperatively by the North Dakota Geological Survey and the North Dakota State Water Conservation Commission. The reports are in three parts; Part I describes the geology, Part II represents ground water basic data, and Part III describes the ground water resources. Part III will be published later and will be distributed as soon as possible.

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ILLUSTRATIONS

TABLES

GEOLOGY AND GROUND WATER RESOURCES of Cass County, North Dakota

Part I - Geology

by Robert L. Klausing

ABSTRACT

Cass County comprises an area of 1,749 square miles in the southeastern corner of North Dakota. About one-fourth of the county is in the Drift Prairie physiographic province; the rest is in the Red River Valley (Lake Agassiz basin) physiographic division.

The major stratigraphic units are, in ascending order: crystalline rocks of Precambrian age; Winnipeg Formation of Ordovician age; and Dakota Sandstone, Graneros Shale, and Greenhorn Formation of Cretaceous age. No indurated rocks younger than the Greenhorn are known to be present in the county.

Pleistocene glacial drift covers the entire county. The known thickness of the drift, including the Lake Agassiz deposits, ranges from 132 to 447 feet. All the surficial features of the county are late Pleistocene in age. Drift, probably deposited by more than one ice sheet, is present in the subsurface, but older drift can be differentiated in only a few places. Local zones of oxidized till, extensive bodies of buried outwash, and buried lake clays are valid indications of older drift in the subsurface.

The major surficial features in the county are the ice-marginal drainage channels and the channel of the proglacial Maple River. Minor features include kames, eskers, terraces in the proglacial Maple River channel, ground moraine, and local recessional features referred to as washboard moraines. The trends of the washboard moraines show, at least in part, the configuration of the ice margin at the time they were formed.

The flatness of the Red River Valley is interrupted by the escarpment of the Sheyenne delta and the beaches of glacial Lake Agassiz. The Sheyenne delta covers an area of about 60 square miles in the south-central part of the county. It consists of sand and silt as much as 120 feet thick. The lake-floor deposits include two distinct lithologies; the upper unit is mainly silt and the lower unit is mainly plastic clay.

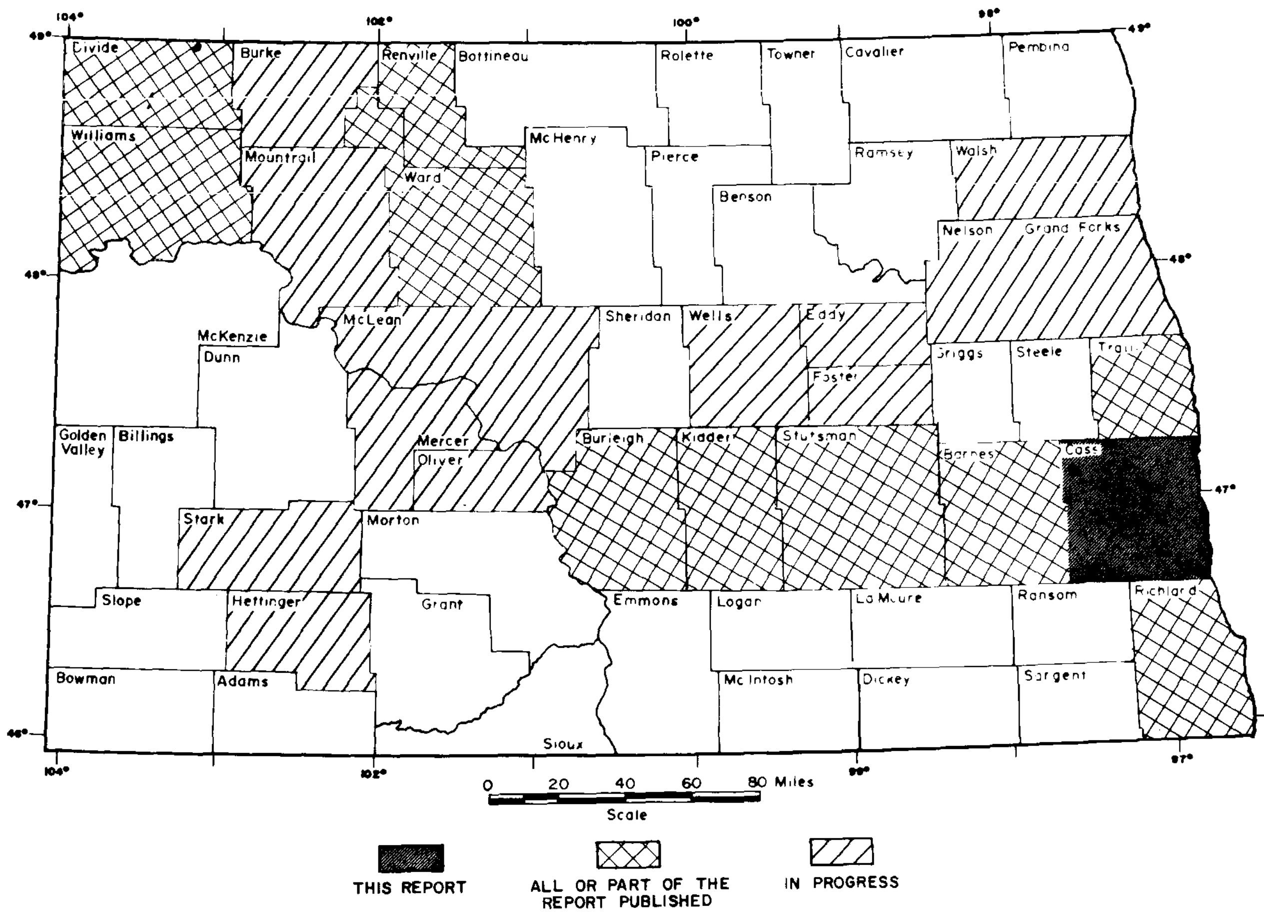


FIGURE 1. County ground-water studies in North Dakota.

INTRODUCTION

This is the first of three reports describing the results of a study of the geology and ground-water resources of Cass County (fig. 1). The study was made during the period 1962-66 by the U.S. Geological Survey in cooperation with the North Dakota State Water Commission and the North Dakota Geological Survey. The initial request for the study was made by the Cass County Board of Commissioners.

The second report "Geology and Ground Water Resources of Cass County, North Dakota, Part II, Ground Water Basic Data," is a compilation of the data collected during the study (Klausing, 1966). The third report "Geology and Ground Water Resources of Cass County, North Dakota, Part III, Ground Water Resources," is an evaluation of the ground-water resources of the county and will be published later.

Purpose of study

The primary purpose of the study was to determine the occurrence, availability, and quality of ground water in Cass County. This report describes the geology of the county to the extent necessary to provide a framework for the discussion of the ground-water resources.

Fieldwork and acknowledgments

The surficial geology of the county was mapped by the author during the field seasons of 1964 and 1965. Field data were plotted on topographic quadrangle maps (scale 1:24,000) where available, and on aerial photographs (scale 1:20,000) in areas not covered by topographic maps. The data were later transferred to a base map (scale 1:63,360), which had been compiled from the North Dakota State Highway Department general highway maps of Cass County.

Subsurface data were obtained mainly from 92 test holes drilled during the field seasons of 1963, 1964, and 1965. The test holes were drilled by the North Dakota State Water Commission, Frederickson's Inc., and Lako Drilling Co. The test holes were logged by personnel of the North Dakota State Water Commission and the U.S. Geological Survey. The data collected during 1963-65 were supplemented with test-hole data collected during previous ground-water studies and with logs of wells and test holes provided by other State and Federal agencies and by private firms. The logs of most of these test holes were given by Byers and others (1946), Dennis and others (1949), Dennis and others (1950), Brookhart and Powell (1961), and Klausing (1966) and are not repeated in this report.

The following companies and agencies were particularly helpful in supplying data and material: Frederickson's Inc., Lako Drilling Co., U.S. Soil Conservation Service, U.S. Bureau of Reclamation, North Dakota State Highway Department, and the Cass County Road Department.

Previous work

The glacial deposits in Cass County were described first by Warren Upham in 1895. He gave a detailed description of the beach and deltaic deposits laid down in glacial Lake Agassiz; he also described certain aspects of the morainal terrain bordering the former lake basin.

In 1905, C.M. Hall and D.E. Willard described the geology of the Casselton and Fargo quadrangles (scale 1:125,000), and in 1909, D.E. Willard described the geology of the Tower quadrangle (scale 1:125,000). Willard's map shows some of the morainal tracts and outwash channels in southwestern Cass County that are described in this report.

Simpson (1929) gave a general summary of the geology and hydrology of Cass County in his report on the ground-water resources of North Dakota.

Leverett (1912, 1932) mapped the southern end and outlet of the Lake Agassiz basin, and described the geology in the extreme southern and western parts of Cass County.

Byers and others (1946) summarized the geology in the Fargo area in a report on ground water in the Fargo-Moorhead area, North Dakota and Minnesota.

Dennis and others (1949) described the geology and ground water resources of Cass and Clay Counties, North Dakota and Minnesota.

Dennis and others (1950) described the geology of the Kindred area in a report on ground water in the Kindred area, Cass and Richland Counties, N. Dak.

Horberg (1951), Colton (1958), and Clayton and others (1965) described and presented differing theories regarding the occurrence of intersecting low ridges on the plain of glacial Lake Agassiz.

Brookhart and Powell (1961) described the geology and ground-water resources in the vicinity of Hunter, N. Dak.

Cass County is included in the map by Colton and others (1963), which shows the general glacial features of North Dakota.

Well-numbering system

The wells, springs, and test holes in the county are numbered according to a system based on the location in the public land classification of the U.S. Bureau of Land Management. It is illustrated in figure 2. The first numeral denotes the township north of a base line, the second numeral denotes the range west of the fifth principal meridian, and the third numeral denotes the section in which the well is located. The letters a, b, c, and d designate, respectively, the northeast, northwest, southwest, and southeast quarter sections, quarter-quarter sections, and quarter-quarter-quarter sections (10-acre tract). For example, well 138-50-15daa is in the NE1/4NE1/4SE1/4 sec. 15, T. 138 N., R. 50 W. Consecutive terminal numerals are added if more than one well is recorded with a 10-acre tract.

GEOGRAPHY

Location and general features

Cass County is in the southeastern part of North Dakota and has an area of 1,749 square miles. In 1960, the population of the county was 66,947. Fargo, the largest city in North Dakota, had a population of 46,662, and South West Fargo had a population of 3,328. The next largest city is Casselton, with a population of 1,394. There are 15 communities in the county having populations of less than 600. The area is served by the Northern Pacific and Great Northern Railways, both of which have main lines and numerous trunk lines crossing the county. Two Federal highways provide access to the area. U.S. Highway 81 crosses from north to south along the eastern edge of the county. U.S. Interstate Highway 94 crosses the county from east to west. State and county highways that are paved or gravel surfaced generally are accessible throughout the year.

Physiography and topography

Cass County is in the western lake section of the Central Lowland physiographic province of Fenneman (1938, p. 559), and occupies parts of the Drift Prairie and Red River Valley divisions, as described by Simpson (1929, p. 4-7) (fig. 3).

About 480 square miles in the western part of the county is in the Drift Prairie. This area is a youthful glaciated plain, which is interrupted only by minor glacial

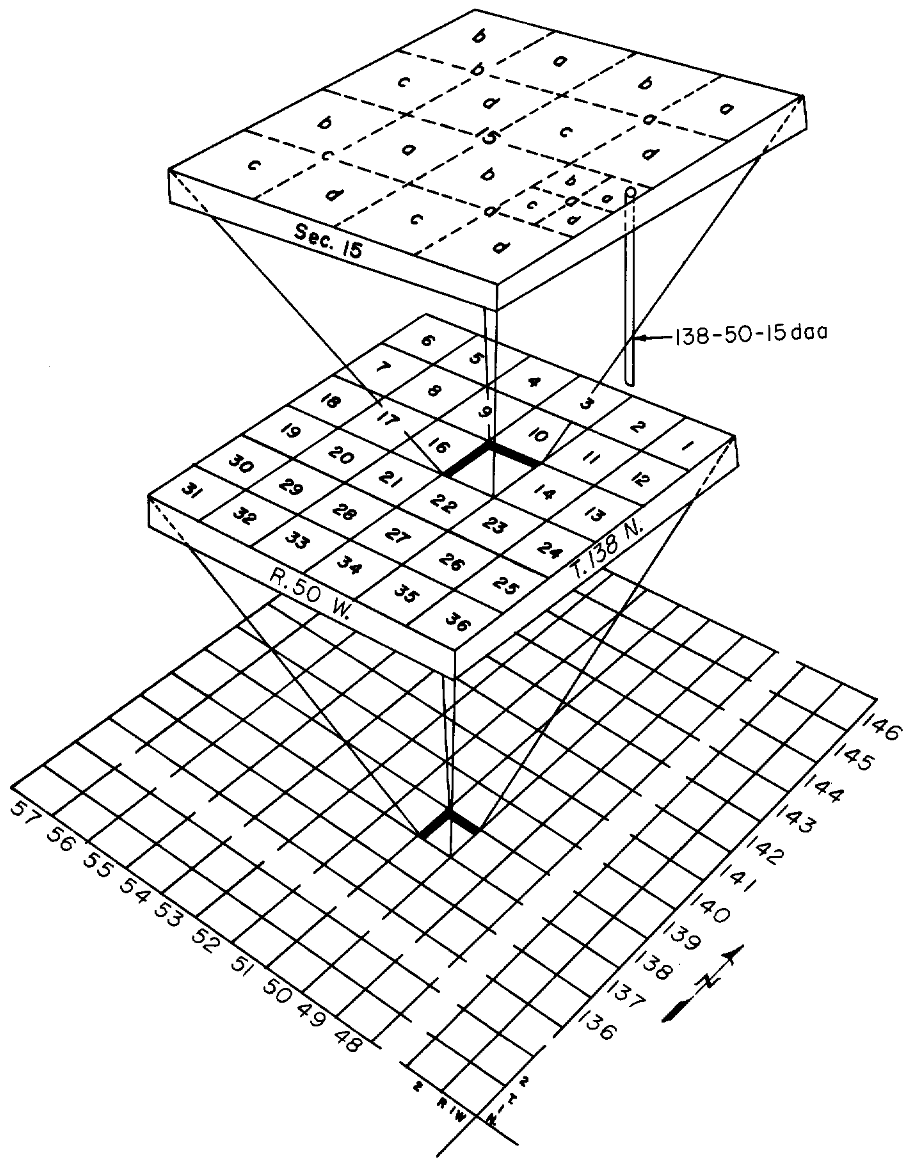


FIGURE 2. System of numbering wells, springs, and test holes.

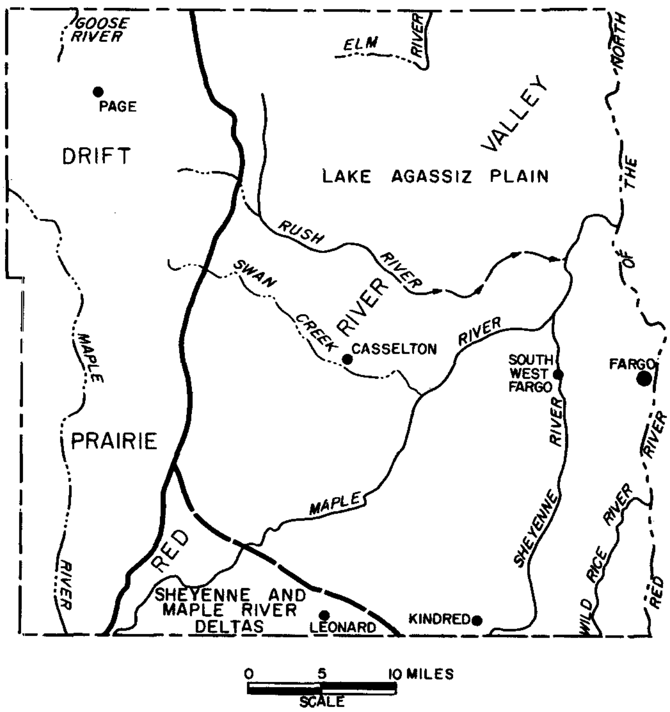


FIGURE 3. Physiographic divisions and drainage.

landforms and stream valleys. The land surface varies from strongly rolling to nearly flat. Local relief generally ranges from 10 to 20 feet per mile, but in some areas it may be as much as 40 feet.

The Red River Valley area can be divided into two units: (1) the Sheyenne and Maple River deltas, which together occupy an area of about 70 square miles; and (2) the flat, nearly featureless plain once occupied by glacial Lake Agassiz.

Northeast of Leonard, the Sheyenne delta rises 75 to 100 feet above the lake plain. To the west, it merges with the Maple River delta and the shore deposits of glacial Lake Agassiz. The surface of the Sheyenne delta in Cass County is relatively flat, and the local relief usually does not exceed 5 feet. Relief on the Maple River delta ranges from 5 feet per mile to 20 feet per mile. The Maple River crosses the delta in a northeasterly direction through a valley that ranges from a quarter of a mile to three-quarters of a mile wide and is as much as 50 feet deep.

The Lake Agassiz plain is a flat, nearly featureless plain that has a northward slope of about 1-1/2 feet per mile and an eastward slope that ranges from 2 feet per mile near the Red River to 20 feet per mile farther west. The most prominent relief features of the lake plain are the north-south trending beaches that lie along the western edge of the plain, and a few isolated ridges in the eastern part of the plain. These features rarely exceed 15 feet of height and generally range from 5 to 10 feet in height. The Red River of the North and its tributaries are entrenched 15 to 30 feet into the plain. Except in the vicinities of the beaches, isolated ridges, and stream valleys, local relief is generally less than 5 feet.

Drainage

The Red River of the North, which flows north along the east edge of the county, is the major stream in the area (fig. 3). Natural drainage in the lake plain is not well integrated, and a large part of the runoff is through manmade drains. The Elm River heads in the northern part of the county and drains northward. Swan Creek flows southeastward across the lake plain and empties into the Maple River a few miles southeast of Casselton. The Rush River heads in the NE cor. T. 143 N., R. 53 W., and flows south for a distance of about 13 miles before turning in a southeasterly direction. About 6 miles southeast of Amenia, the channel disappears. During periods of runoff, water flowing down the Rush River is channeled into the Sheyenne River through a manmade drain. The Wild Rice River enters the county near the southeastern corner and flows in a northeasterly direction for a distance of about 10 miles before entering the Red River of the North. The Sheyenne River, which enters the county about 1 mile southeast of Kindred, flows northward for about 30 miles before emptying into the Red River of the North, north of Fargo.

Drainage in the Sheyenne and Maple deltas is largely subsurface. The surficial drainage pattern is poorly developed because the soils and underlying deposits are highly permeable. The Maple delta is drained in part by the Maple River, which flows in a northeasterly direction across the delta. Surficial drainage in the Sheyenne delta consists of a few short, deep gullies in the northeast-facing slope of the delta. These gullies carry runoff only during periods of heavy rainfall and (or) snow melting.

Drainage in the Drift Prairie is mostly interior. Numerous small depressions collect runoff during periods of melting snow and heavy rainfall. The Drift Prairie is also drained by the Maple River, Swan Creek, and the south branch of the Goose River. The Maple River flows from north to south through the western part of the county. It leaves Cass County at the southern edge of sec. 34, T. 137 N., R. 55 W. and then reenters the county about 3 miles to the east. From this point, the river flows northeasterly across the Maple delta and the lake plain before emptying into the Sheyenne River about 3 miles north of South West Fargo.

Soils and land use

Most of the soils in Cass County are characterized by a thick black organic topsoil and limey subsoil. Omodt and others (1961) divided the soils of Cass County into the following general types: Barnes-Hamerly clay loam, Barnes-Svea clay loam, Glyndon-Gardena loam, Embden-Ulen sandy loam, Hecla-Hamar sandy loam, Fargo clay, Bearden clay, and Hamerly-Svea-Tetonka clay loam (fig. 4). The Fargo clay is the dominant soil type, and, along with the Bearden clay, it covers the greater part of the lake plain. The Glyndon-Gardena loam and the Embden-Ulen sandy loam cover an area that roughly corresponds to the zone of littoral deposits bordering the lake plain on the west. The Hecla-Hamar sandy loam covers most of the area occupied by the Sheyenne-Maple River deltas. The Barnes-Hamerly, Barnes-Svea, and Hamerly-Svea-Tetonka clay loams cover most of the Drift Prairie.

Most of Cass County is cultivated; however, portions of the county lying in the Sheyenne delta are used only for grazing because the light sandy soils are subject to wind erosion when tilled. Parts of the Drift Prairie, also, are used mainly for grazing because they have considerable relief and are subject to erosion by water.

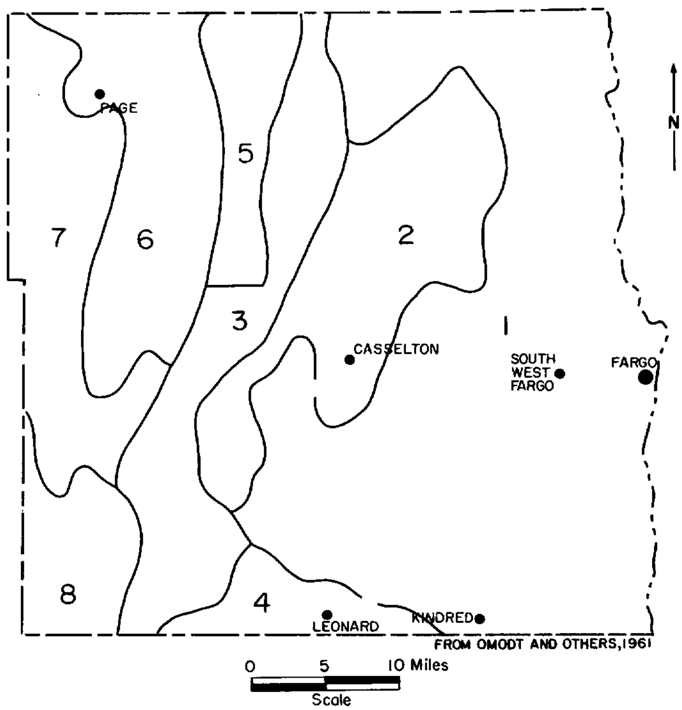
Climate

The climate of the area is characterized by long, cold winters and short summers. During the winter, temperatures as low as 35° F below zero have been recorded. The summers are usually warm, and midday temperatures occasionally rise to 100° F. However, the average maximums are in the 80's. The mean annual temperature is 39.9 degrees. Mean annual precipitation for the period 1939 through 1963 was 19.30 inches; most of the precipitation falls between May and September.

PRE-PLEISTOCENE GEOLOGY

Stratigraphy of pre-Pleistocene rocks

Cass County is covered with a thick mantle of glacial drift and no outcrops of pre-Pleistocene rocks exist in the county. Information obtained from well logs and test holes indicates that no rocks of Tertiary age are present. In most parts



EXPLANATION

1 FARGO CLAY

2 BEARDEN CLAY LOAM

3 GLYNDON-GARDENA LOAM

4 HECLA-HAMAR SANDY LOAM

5 EMBDEN-ULEN SANDY CLAY

6 BARNES-SVEA CLAY LOAM

7 HAMERLY-SVEA-TETONKA CLAY LOAM

8 BARNES-HAMERLY CLAY LOAM

FIGURE 4. General soil types.

of the county, the pre-Pleistocene rocks immediately below the glacial drift are of Cretaceous age. The Cretaceous rocks generally rest on Precambrian rocks; however, in the northwestern part of the county, they may overlie Paleozoic rocks. The stratigraphic relations of the bedrock units and the overlying drift are shown in table 1.

TABLE 1. Stratigraphic sequence and lithologic characteristics of bedrock units.

(U.S. Geological Survey nomenclature)

Era	System		Formation	Description	Thickness
Cenozoic	Quaternary	Recent	Alluvium	Silt and clay on flood plains of modern streams.	0-15
		Pleistocene	Glacial drift	Glacial till, glaciofluvial deposits, and glacial lake deposits.	132-447
Mesozoic	Cretaceous		Greenhorn Formation	Shale, grayish-black, calcareous; thin beds of limestone, abundant white specks and shell fragments.	0-110
			Graneros Shale	Shale, dark-greenish-gray to black, noncalcareous; interbedded silt and fine sand, commonly laminated, carbonaceous.	0-157
			Dakota Sandstone	Sandstone, mostly fine-grained with interbedded black shale and silt, some carbonaceous material.	0-143
Paleozoic	Ordovician		Winnipeg Formation	Greenish-gray shale with a thin basal sandstone.	0-200
Precambrian			Undifferentiated crystalline rocks	"Granite," dark-green to red on fresh surface; weathered granite commonly consists of red, green, or white clay.	Unknown

PRECAMBRIAN CRYSTALLINE ROCKS

The crystalline rocks underlying Cass County are referred to the Precambrian and commonly are termed "granite." Very little is known about the composition of these rocks because drilling is generally stopped when hard rock is reached. Because Precambrian granite crops out in southwestern Minnesota, it is assumed that the crystalline rocks underlying Cass County are also of granitic composition.

In the eastern part of the county, the depth to the crystalline rocks ranges from 132 to 300 feet. In the central and south-central parts, they are from 400 to 600 feet below land surface. No test holes or wells are known to have reached the Precambrian in the western part of the county. However, wells tapping Cretaceous aquifers at depths of as much as 900 feet below land surface indicate that the Precambrian rocks lie below this depth.

In most places, the upper part of the Precambrian rocks consists of varicolored clay that is generally referred to as "weathered granite." This material commonly contains granitic fragments and angular quartz grains, and is believed to be the weathered residuum of granitic rocks that were exposed to prolonged subaerial erosion.

In most of the area, the Precambrian rocks are overlain by Cretaceous rocks; however, locally the Cretaceous rocks are absent and the Precambrian is overlain directly by glacial deposits. The maximum thickness of Precambrian rocks penetrated by test drilling is 243 feet.

PALEOZOIC ROCKS

Winnipeg Formation

According to Ballard (1963, pl. 3), the Winnipeg Formation of Middle Ordovician age extends into the northwest corner of the county. In eastern North Dakota, the Winnipeg Formation is composed mainly of greenish-gray shale that generally has a thin basal sandstone member (Ballard, 1963, p. 5). Where it has been identified in eastern North Dakota, the Winnipeg unconformably overlies Precambrian rocks.

The Winnipeg Formation is not known to have been penetrated by any wells or test holes drilled in Cass County.

CRETACEOUS ROCKS

Cretaceous rocks underlie most of Cass County. These rocks have been extensively eroded in the central and eastern parts of the county; consequently, their distribution is not well known. The Cretaceous rocks tentatively are subdivided into the Dakota Sandstone, Graneros Shale, and Greenhorn Formation.

Dakota Sandstone

The oldest Cretaceous rocks in eastern North Dakota generally are referred to as the Dakota Sandstone. However, lack of knowledge concerning the thickness and lithology of these rocks prevents definite correlation with the Dakota Sandstone in areas farther west and south. The basal Dakota generally consists of fine to coarse white sand, but in some places it consists of interbedded silt, sand, and gray clay. The sand is generally clean, well sorted, angular to subrounded, and is composed largely of quartz. The sand beds are generally poorly cemented or not cemented at all. The upper part of the Dakota consists of interbedded black and gray shale, silt, and very fine, gray sand. Locally, lignite and other carbonaceous materials are present. The variation in lithology and a general decrease in grain size from east to west indicate that the Dakota Sandstone in Cass County is probably a littoral deposit formed in a transgressing sea.

The thickness of the Dakota Sandstone in Cass County ranges greatly. The greatest thickness of Dakota penetrated was 143 feet in test hole 3119 (139-52-27aaa). In the eastern part of the county it is considerably thinner, and a maximum of 20 feet was penetrated in test hole 3099 (143-50-31ccc2). The formation seems to be absent in many places in the eastern part, even where younger Cretaceous shales are present.

Graneros Shale

In previous geologic studies of Cass County, the Cretaceous shales were grouped under the general term Benton Shale (Brookhart and Powell, 1961, p. 70). Collection of additional subsurface data, however, has permitted differentiation of the shales into the Greenhorn Formation and the Graneros Shale -- based on lithologic correlations with similar rocks described by Flint (1955, p. 23-25) in northeastern South Dakota, and Baker (1967, p. 14-19) in southeastern North Dakota.

The Graneros Shale is predominantly a black, silty, noncalcareous to calcareous shale containing white or gray silt laminae and thin beds and lenses of fine white sand. Lignite and other carbonaceous material, pyrite crystals, and fish scales are locally abundant. The presence of thin beds and lenses of sand, carbonaceous material, and pyrite indicates that the shale probably was deposited in a shallow-water environment of restricted circulation.

The Graneros Shale underlies all of the county except the eastern part, where it probably was removed by preglacial erosion. In western Cass County, the Graneros conformably overlies the Dakota Sandstone, but in the eastern part of the county, the Graneros, in places, unconformably overlies the Precambrian rocks. The Graneros Shale is known to range in thickness from 0 to 157 feet; the greatest thickness penetrated was in a well drilled completely through the Graneros and into the Dakota Sandstone (143-51-18dad).

Greenhorn Formation

The Greenhorn Formation is a grayish-black marine shale that contains thin strata of limestone. The shale is highly calcareous and commonly contains abundant white specks and unidentifiable shell fragments of apparent marine origin.

Formerly, the Greenhorn Formation probably was coextensive with the Graneros Shale and covered the entire county. However, post-Cretaceous erosion removed the Greenhorn from the approximate eastern two-thirds of the county.

The Greenhorn Formation ranges in thickness from 0 to 110 feet. The greatest thickness penetrated was in a well drilled to the Dakota Sandstone at 140-54-19cdd (Klausing, 1966, p. 139).

Four test holes penetrated Cretaceous bedrock in the westernmost range of townships in Cass County. These were located 2 to 6 miles east of the Cass-Barnes county line, and the youngest Cretaceous unit penetrated was the Greenhorn Formation. However, Kelly (1964, p. 68, 131) reported the Carlile Shale and the Niobrara Formation in test holes located 1 to 2 miles west of the Cass County boundary. It is not known if these units extend into Cass County.

Topography of the bedrock surface

The topography of the bedrock surface in Cass County (pl. 1 in pocket) was formed during Tertiary time by subaerial erosion and later was altered by glacial erosion. The map is based entirely on subsurface data, and is therefore somewhat conjectural.

The bedrock surface in the western part of the county seems to be rather flat, but in the central and eastern parts it is greatly dissected. The general slope of the bedrock surface is to the east. The most prominent features are the two northward-trending valleys in the central and eastern parts of the county. The two valleys differ in that the westernmost one is wider and generally not so steep sided as the one to the east. The eastern valley is a northward continuation of a valley originating in southern Richland County (Baker, 1967, pl. 2). This valley, which may be the ancestral Red River, turns east at Fargo and extends into Minnesota.

Pre-Pleistocene history

Very little is known about the geologic history of the Precambrian to Cretaceous interval in Cass County. The area is located on the eastern flank of the Williston Basin and may not have received sediments during the Paleozoic and Mesozoic

Eras, with the possible exception of the Middle Ordovician (Ballard, 1963, p. 30). Rather, it seems likely that much of Cass County, especially the eastern part, was topographically high during most of Paleozoic and Mesozoic time. During this long interval, the Precambrian rocks were deeply weathered and probably served as sources for some of the basin sediments to the west.

When the Cretaceous seas invaded the area, they covered an irregular and deeply weathered surface. The first advance of the sea was slow, and shallow water probably covered all of the area except for hills and knobs of Precambrian rocks that protruded above the sea as islands. The sediments deposited during this advance consist of interbedded clay and sand that were deposited in a littoral environment. The rock unit formed from these sediments is called the Dakota Sandstone.

Later in Cretaceous time, the area was completely covered by water. The sediments deposited were mostly black organic mud (Graneros Shale). The presence of pyrite and carbonaceous material in the shale indicates a brackish-water environment; numerous thin beds and lenses of fine sand suggest that the shoreline was not far away. Apparently, the brackish-water conditions gave way to a marine environment resulting in the formation of carbonate sediments interspersed with calcareous muds. These sediments, on compaction and lithification, formed the Greenhorn Formation. The younger Cretaceous deposits that are present farther west (Carlile Shale, Niobrara Formation, and Pierre Shale) are not known to be present in the county. Undoubtedly the sediments forming these rocks were deposited in the county, but were subsequently removed.

After the Cretaceous seas receded, the area was subjected to subaerial erosion. This period of erosion lasted throughout the Cenozoic Era and was terminated when the Pleistocene glaciers overrode the area.

PLEISTOCENE GEOLOGY

Cass County is completely covered with glacial drift. The thickness of the drift (including the glacial Lake Agassiz deposits) ranges from 132 to 447 feet and averages more than 250 feet. The variations in thickness are due primarily to bedrock irregularities, as shown on plate 1.

The surficial deposits of the county were formed as the last ice sheet receded from the area in late Wisconsin time. However, evidence of older drift deposits in several parts of the county was discovered by test drilling. The age of the older drift deposits is largely unknown.

Subsurface units

The major subsurface units discussed in this section are buried outwash, undifferentiated stratified drift, older till, and buried lake deposits.

OLDER TILL

Studies made by Flint (1955) in South Dakota and by Lemke and Colton (1958) and others in North Dakota indicate that eastern North Dakota was glaciated several times during Pleistocene time. Thus, it seems reasonable to assume that the relatively thick deposits of drift underlying Cass County are composed of several tills of different ages. There are, however, no outcrops in the county in which more than one till has been differentiated; and differentiation of tills by examination of drill cuttings is very uncertain.

The till penetrated in the test holes drilled during this study was chiefly light to olive gray in color, but in places the test holes penetrated both olive-gray and dark-greenish-gray till. The darker till appeared to have no common horizon and its color may be a local phenomenon caused by included bedrock fragments.

Seven test holes, 139-49-28bab, 140-49-14dcd, 140-49-29ddd, 141-49-9baa2, 141-51-25ddd, 142-50-3bbb, and 142-53-1bab, drilled during the course of this study, penetrated brown, oxidized (?) till at depths of 116 to 332 feet below land surface. These oxidized (?) zones, which range in thickness from 4 to 42 feet, are evidence of older till underlying the surficial drift. Dennis and others (1949, p. 26-29) recognized older till in the subsurface in the vicinity of Casselton; however, a reevaluation of their sample logs indicates that the older till is not as thick and extensive as previously indicated. The altitudes of the weathered zones vary greatly, and several older drift sheets may be represented.

The paucity of weathered zones within the till probably is a result of glacial erosion. As each ice sheet moved across the area, it probably removed much of the drift left by the preceding ice sheet, including most of any weathered surface that had formed.

BURIED OUTWASH

Test drilling revealed the presence of a few bodies of buried outwash. The approximate boundaries of the outwash bodies are shown on figure 5.

The most extensive outwash body underlies an area of about 155 square miles in the northwestern part of the county. The outwash body is overlain and underlain by glacial till, and its top is between 40 and 140 feet below land surface.

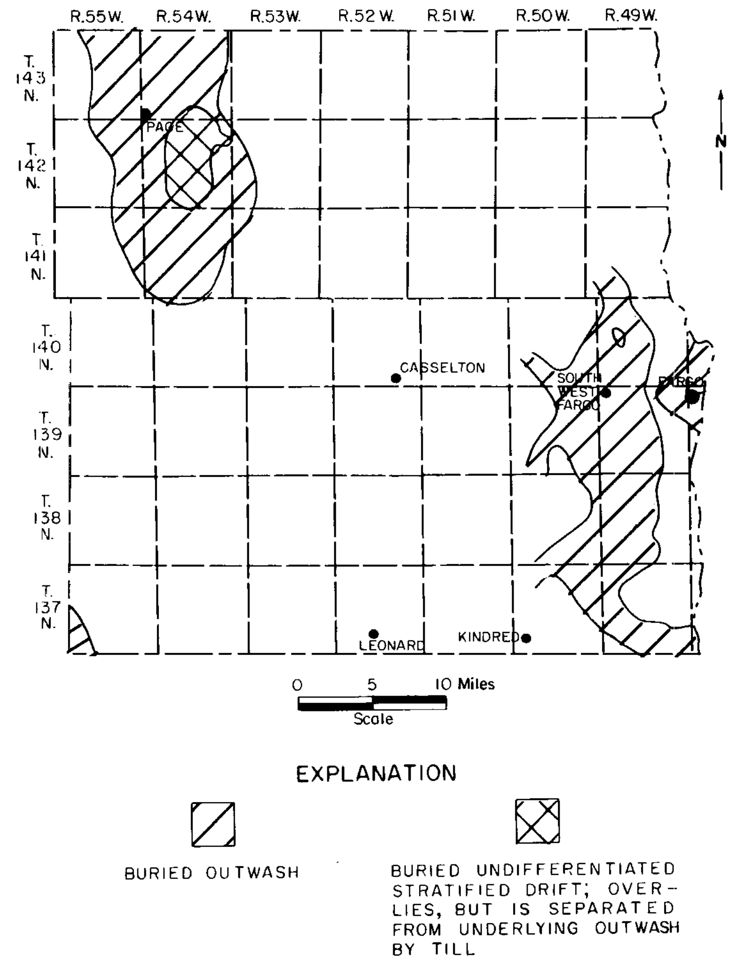


FIGURE 5. Approximate location of larger bodies of buried outwash.

The deposits range in texture from fine sand to coarse gravel, but the dominant texture is fine to medium sand. This outwash body, which ranges in thickness from 0 to 51 feet, is a water-supply source for the city of Page and surrounding farms.

A large body of outwash underlies the community of West Fargo. Test-hole data and well records indicate that the deposit underlies parts of Tps. 137 to 140 N., R. 49 W. South of T. 140 N., the thicker parts of the outwash body are confined to two separate channels that extend southward and converge into a single outwash channel. This channel trends south and east and probably extends into

Minnesota.

The outwash in the vicinity of West Fargo is overlain by till and generally rests on Cretaceous or Precambrian rocks; however, in a few places it rests on till. The outwash body lies between 90 and 140 feet below land surface and is composed of materials ranging in size from fine sand to boulder. The thickness of this unit ranges from 0 to 140 feet.

Large quantities of ground water are withdrawn from this outwash body. Dennis and others (1949, p. 34) identified the aquifer associated with the deposits as the "West Fargo aquifer."

A small buried outwash deposit underlies an area of about 6 square miles in the vicinity of Fargo. This deposit is overlain by till and rests either on till or granite. Generally its top lies between 90 and 150 feet below land surface. The deposit consists of sand and fine gravel and ranges in thickness from 0 to 160 feet. Test-hole data and well records indicate that the outwash body extends into Minnesota. A few industrial wells in Fargo withdraw water from this outwash deposit, and Dennis and others (1949, p. 34) named the aquifer the "Fargo aquifer."

A buried outwash deposit underlies an area of about 10 square miles in the southwestern part of the county. This deposit is overlain by 5 to 30 feet of till and rests on till. It consists of sand and coarse gravel and has a known maximum thickness of 80 feet. Sand and gravel, believed to be part of this deposit, is exposed along the south wall of an intermittent stream channel in the NE1/4 sec. 31, T. 137 N., R. 55 W. These deposits have an exposed thickness of 10 to 15 feet. The uppermost part consists of poorly sorted gravel that overlies laminated, fairly well-sorted sand (fig. 6). Several farm wells pump water from an aquifer associated with this outwash body.

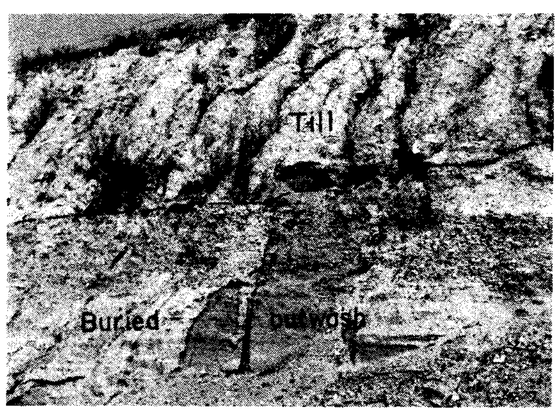


FIGURE 6. Buried outwash exposed on south side of intermittent stream channel (NE1/4 sec. 31, T. 137 N., R. 55 W.).

BURIED STRATIFIED DRIFT, UNDIFFERENTIATED

Deposits of silt and very fine sand, capped by 1 to 5 feet of till, are exposed in a railroad cut in the NE1/4NW1/4 sec. 20, T. 142 N., R. 53 W. These deposits have an exposed thickness of 10 to 20 feet (fig. 7). Similar deposits are exposed in railroad cuts in secs. 21 and 28, and in several other localities in T. 142 N., R. 54 W. Fine to coarse sand, overlain by 9 to 14 feet of till, was penetrated in two test holes (142-54-1bbb and 142-54-8ddd) drilled in the northern part of T. 142 N. Fine to medium, clayey sand, capped by 19 feet of till, was penetrated in a test hole drilled near the south edge of the township. The silt and sand deposits are not known to be continuous, but the similarity of stratigraphic position suggests that they may represent a single large body of stratified drift. The deposits are known to range in thickness from 10 to 78 feet.

FIGURE 7. Buried stratified drift, undifferentiated, exposed in railroad cut in NE1/4 NW1/4 sec. 20, T. 142 N., R. 53 W. (view looking north).

BURIED LAKE DEPOSITS

Dennis and others (1949, p. 26) described older lake deposits within the till near Casselton and discussed the probability that a lake existed in that area prior to the formation of glacial Lake Agassiz. The "older lake deposits" described by Dennis and others (1949) are not extensive, and very few examples of older lake clay were found within the Lake Agassiz basin during the present study. This is to be expected, however, because much of such a deposit probably would be destroyed by glacial erosion.

Thick deposits of silt and clay were penetrated in two test holes drilled in the northeastern part of the county. The silt and clay are as much as 180 feet thick (pl. 2, section A-A'; in pocket), and probably represent a former glacial lake.

Drift of late Wisconsin age

TILL AND ASSOCIATED STRATIFIED DRIFT

The surficial features in Cass County are composed of glacial drift of late Wisconsin age, and have been altered very little by post-Pleistocene erosion. The features can be separated into till and associated stratified drift deposits of the Drift Prairie physiographic division, and the lacustrine deposits of the Red River Valley physiographic division. Surficial geologic features are shown on plate 3 (in pocket).

Upham (1895) and Leverett (1912, 1932) mapped separate end moraines in western and southwestern Cass County. However, work done during the present study did not reveal any evidence of end moraines in the county. The proposed end moraines do not coincide with existing topographic "highs," and aerial photographs do not show any lineation patterns coincident with the courses described. Most of the area through which Upham's "Fergus Falls moraine" (1895, pl. XIX) passes is nearly flat to slightly rolling and has none of the characteristics generally ascribed to end moraines. Also, according to Upham (1895, p. 160), the eastern boundary of the Fergus Falls moraine in Cass County was marked by numerous kames of sand and gravel. However, no kames were found in this area. T.E. Kelly (oral communication) did not identify the Fergus Falls moraine in adjacent Barnes County. Leverett (1912, fig. 1; 1932, p. 111) mapped a north-south "morainal belt" in southwestern Cass County; however, there are no topographically high areas or other indications of morainal deposition in that part of the county.

Till

The composition of the till varies greatly. In places it consists chiefly of silt, but in other places it consists largely of clay intermixed with sand and gravel. Boulders are common but not abundant; cobbles are locally abundant. In surface exposures, the color of the till is moderate yellowish brown because of oxidation. The thickness of the zone of oxidation generally ranges from 10 to 30 feet.

No exposures of unoxidized till are known to occur within the county, but samples from test holes are olive gray to dark greenish gray.

Three till landforms have been recognized in Cass County: ground moraine, washboard moraine, and a kettle chain.

Ground moraine.--Areas of till having low relief and lacking definite linear trends are called ground moraine (Flint, 1955, p. 111).

Ground moraine covers about 480 square miles in western Cass County (pl. 3), and extends into Barnes and Steele Counties. It is bounded on the east by beach deposits of glacial Lake Agassiz. The topography varies from nearly flat to strongly rolling, with local relief ranging from 5 to 50 feet.

Washboard moraines.--Washboard moraines are characterized by numerous

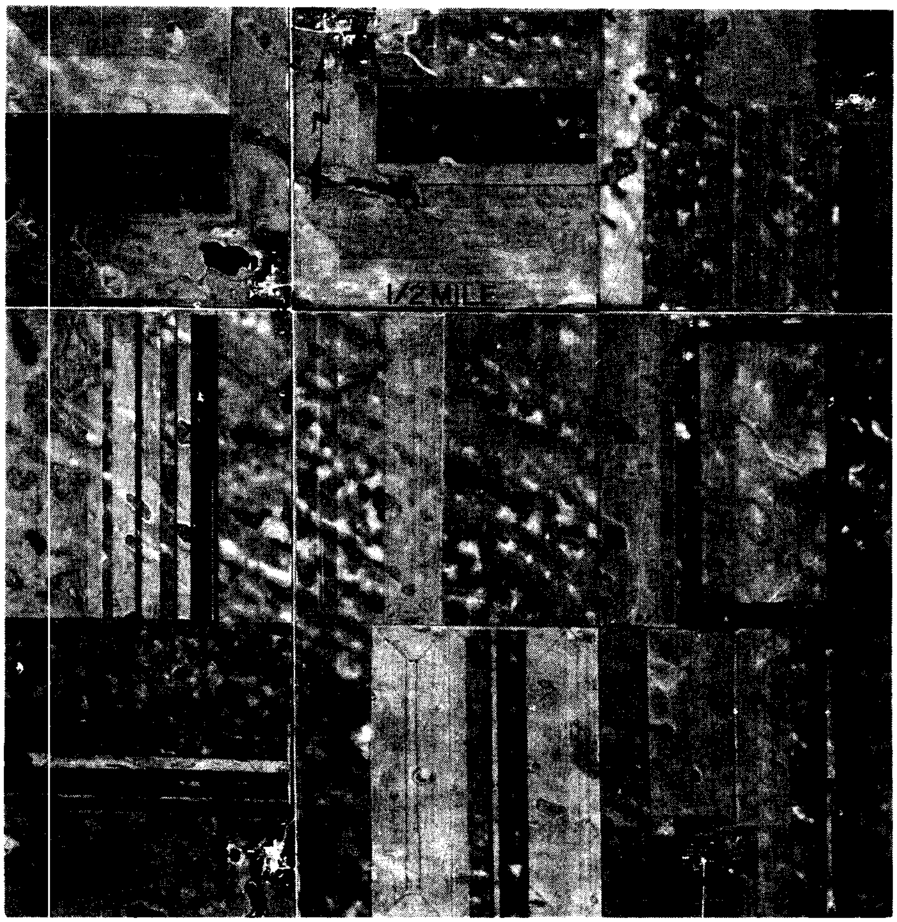


FIGURE 8. Washboard moraines in southwestern Cass County. Vertical airphoto.

low, subparallel, discontinuous ridges of till. In Cass County, these ridges trend northwest-southeast and rise from 10 to 15 feet above the surrounding terrain. The ridges are minor recessional features that mark cyclic pauses of the ice front during deglaciation (Winters, 1963, p. 19). They are slightly convex to the southwest, indicating that the last ice sheet receded in a northeasterly direction. The linear pattern displayed by the ridges and the intervening depressions is not apparent in the field, but is easily seen on aerial photographs (fig. 8). Washboard moraines are common in the southwestern part of the county and extend into adjacent areas in Barnes and Ransom Counties.

Kettle chain.--A kettle is a depression in the drift caused by the wasting away of a completely or partially buried ice block. According to Flint (1953, p. 148), the largest and most conspicuous kettles result from the melting of relatively thick projecting ice masses. This type of kettle has steep-sided slopes that were formed by slumping of the sediment when the supporting ice melted away. Smaller buried ice masses result in shallow kettles.

A rather prominent chain of kettles extends south of Alice for about 8 miles in southwestern Cass County. The kettles are elongate in a north-south direction and some are as much as 1-1/2 miles long. They range in width from about half a mile or less to nearly a mile, and have flat bottoms and steep sidewalls in which till is exposed. Some are as much as 25 feet deep, nearly all contain lakes or marshes that become dry during periods of prolonged drought.

Stratified drift

Surficial deposits of stratified drift in Cass County consist of kames, eskers, outwash channel deposits, and river terrace deposits. The location of these units is shown on plate 3.

Kames.--Kames are low mounds and irregular-shaped hills composed of washed drift that was deposited within, or at the edge of, glacial ice by melt-water streams. The kames in Cass County range in height from 5 to 25 feet and have gently sloping sides (fig. 9). They are composed of poorly sorted silt, sand, and gravel. The sand and gravel deposits generally are poorly stratified, but well-stratified silt and sand beds are not unusual. The bedding ranges from horizontal to tilted. The tilted bedding was caused by slumping after the supporting ice walls melted.

Many of the kames or kamelike features are closely associated with eskers, and in places the two types of features cannot be differentiated; therefore, they are shown on the landforms map as one unit.

Eskers.--Eskers, which are sinuous ridges of stratified drift deposited by melt-water streams flowing in tunnels or channels in the glacial ice, are unusually

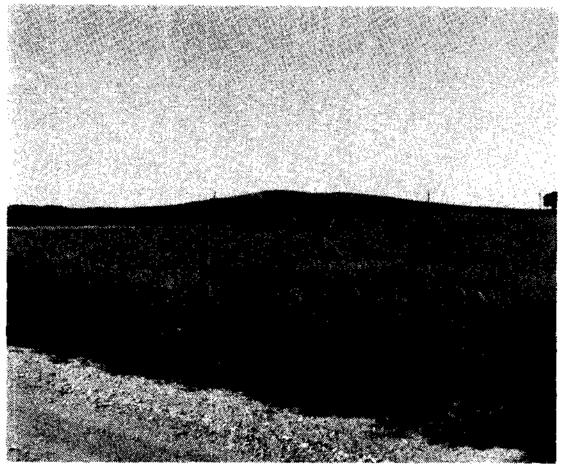


FIGURE 9. Typical kame in NE cor. sec. 3, T. 137 N., R. 55 W. View looking southwest.

common in western Cass County. They are most abundant in the vicinity of Page where they stand from 10 to 40 feet above the adjacent ground moraine. Most of the larger eskers consist of sinuous to nearly straight segments that are as much as 1-1/2 miles in length. The gaps between the segments generally are less than a quarter of a mile in length. The longest esker in the county is 1 mile west of Page and has a total length of about 7 miles, including the gaps. It consists of a series of steep-sided, irregular ridges and mounds that rise between 10 and 20 feet above the adjacent ground moraine.

Most of the eskers are composed of poorly sorted sand and gravel. Generally the range in grain size is small, but some deposits range widely in grain size. Till is commonly draped over the flanks of the eskers and, in places, forms a thin mantle on their crests (fig. 10). In some eskers, till is locally intermixed with sand and gravel. The degree of bedding in the sand and gravel varies considerably. Some of the deposits are distinctly bedded, but in others the bedding is very indistinct (figs. 10 and 11). The bedding is horizontal to tilted.

Exposures of eskers in pits and road cuts show thicknesses of stratified drift ranging from 3 to 10 feet. Auger holes, drilled by the Cass County Road Department in an esker in the NW1/4 sec. 36, T. 143 N., R. 55 W., showed thicknesses of as much as 20 feet.

Maple River deposits and associated terraces.--The proglacial Maple River valley extends southward from the north edge of T. 140 N., R. 55 W. into Ransom County. The valley ranges in width from about one-tenth to half a mile and has gently to steeply sloping walls. North of its confluence with the outwash channel that extends southeasterly from Tower City, the Maple River valley is from 10

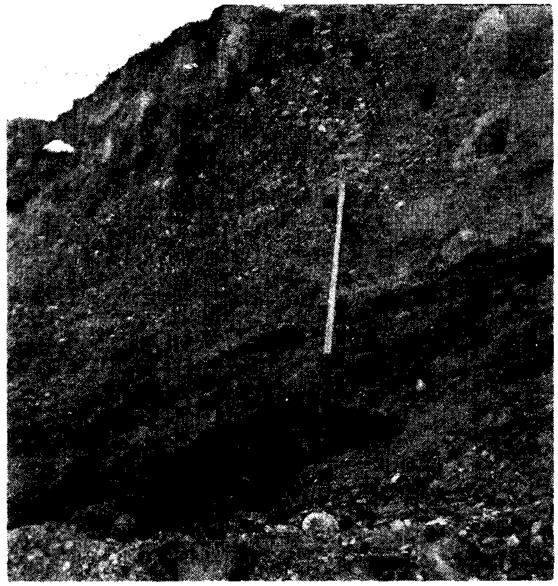


FIGURE 10. Poorly bedded sand and gravel in esker, NE1/4 sec. 17, T. 138 N., R. 54 W. View looking south.

FIGURE 11. Bedded sand and gravel in esker, SE1/4 sec. 28, T. 141 N., R. 55 W. View looking south.

to 20 feet deep. South of the confluence, the valley is 20 to 40 feet deep.

The valley of the Maple River is mantled with alluvium, which has a maximum known thickness of 6 feet. Test holes drilled in secs. 22 and 27, T. 140 N., R. 55 W., penetrated 1 to 2 feet of alluvium underlain by glacial outwash. The outwash consists of yellow clay, sand, and gravel that has a maximum thickness of about 14 feet. The sand and gravel beds are thin, ranging from 2 to 7 feet in thickness. It is not known if outwash underlies the alluvium in the Maple River valley south of T. 140 N. Several holes were augered to a depth of 6 feet, but none of them completely penetrated the alluvium.

Near the SW cor. T. 137 N., R. 55 W., the bottoms of three "hanging" channels are as much as 20 feet above the bottom of the southeasterly-trending channel to which they are tributary. The tributary channels contain outwash of undetermined thickness that is overlain by 1 to 2 feet of alluvium.

The "hanging" channels probably are diversion channels that were formed during earlier phases of the Maple River. When the ice east of the channels melted, a lower drainageway formed and the channels were abandoned.

Terrace remnants, which are most numerous along the east wall of the Maple River valley, are from 5 to 30 feet above the present flood plain. The terrace remnants range from a few hundred feet in length and width to more than a mile long and half a mile wide. North of the confluence of the Maple River and the outwash channel that extends southeasterly from Tower City, there is only one terrace, but south of the confluence there is evidence of two terraces. Where there are two terraces, the lower one is generally well defined, having a relatively flat surface and an abrupt scarp (fig. 12). The higher terrace remnants, which stand 10 to 20 feet above the lower terrace, generally are mantled by deposits of collu-

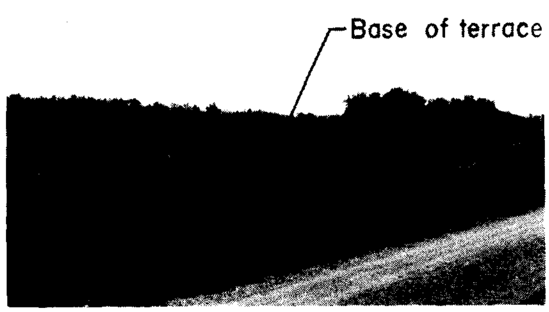


FIGURE 12. Lower terrace, east side of Maple River in NW1/4 sec. 3, T. 138 N., R. 55 W. View looking east.

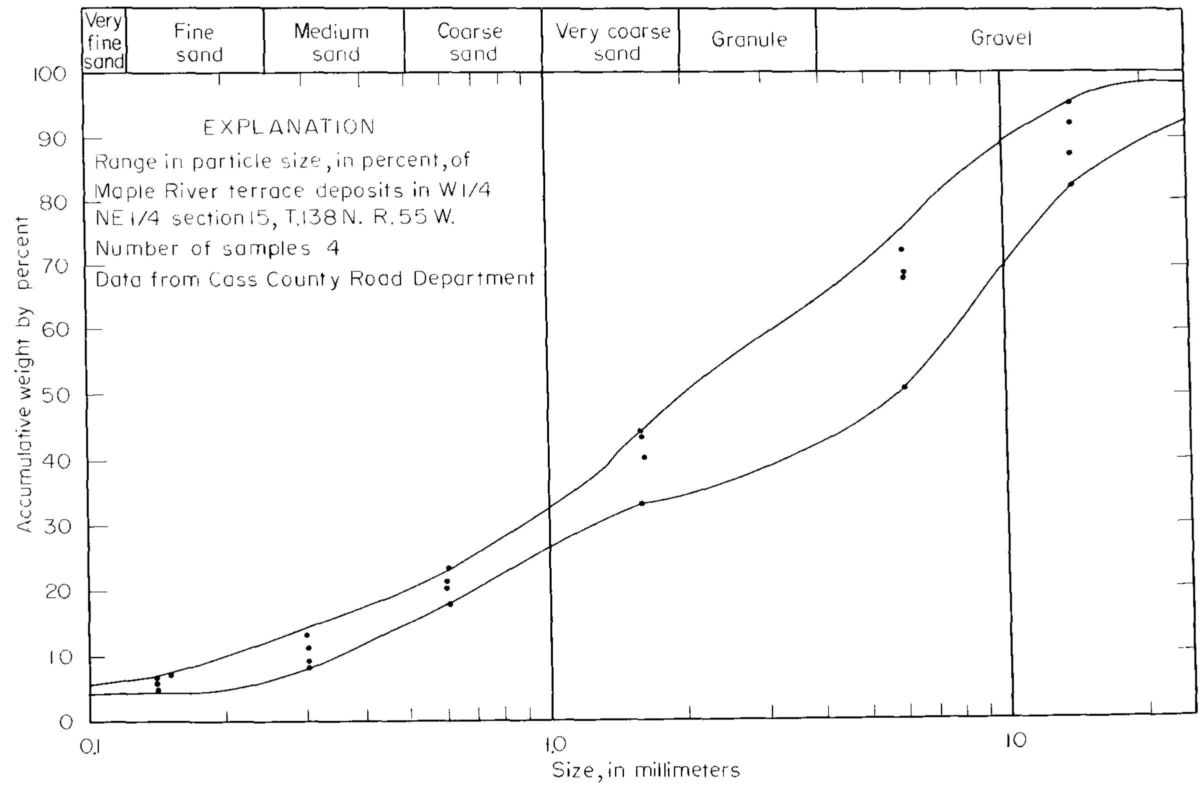


FIGURE 13. Particle size distribution of samples from terrace remnant (W1/2NE1/4 sec. 15, T. 138 N., R. 55 W.).

vium, and are less distinct.

The terrace deposits are composed of silt, sand, gravel, and boulders, but sand and gravel are the dominant size fractions (fig. 13). The deposits generally are poorly bedded, but well-stratified beds of sand and gravel are not uncommon (fig. 14). The deposits range in thickness from 0 to 20 feet.

The Maple River terraces are erosional remnants of an early period of valley development that occurred during the retreat of the ice from the area. The terraces probably were formed during the early stages of glacial Lake Agassiz; however, correlation of the terraces with separate stages of the lake cannot be made.

During the formation of the Maple River valley south of the north edge of T. 140 N., glacial ice apparently occupied the area to the north. This is evidenced by the absence of outwash or terrace deposits along the river north of T. 140 N. Also, there is no distinguishable valley associated with this part of the river, indicating that the Maple River north of T. 140 N. is of postglacial origin.

Ice-marginal outwash channels and associated deposits.--During melting of the last ice sheet, several outwash channels were eroded along successive margins of the northeasterly receding ice sheet. T. E. Kelly (written communication) mapped seven such outwash channels in eastern Barnes County. Six of the channels were reported to trend southeastward from Barnes County and into Cass County, but only three could be identified as outwash channels in Cass County. The other three channels are represented in the county by small, linear bodies of stratified

FIGURE 14. Stratified sand and gravel in terrace deposit, east side of Maple River in NW1/4 sec. 15, T. 138 N., R. 55 W.

drift that were laid down on or adjacent to stagnant ice. A brief discussion of each of the outwash channels and stratified drift bodies follows.

The outwash channel extending southeasterly across the northwestern part of T. 137 N., R. 55 W., ranges in width from one-tenth to a quarter of a mile. It has a gently concave bottom and steep-sided walls that rise as much as 40 feet above the channel floor. Locally, terrace remnants flank the walls of the channel, but most of the terraces are of minor extent and are not differentiated from the channel deposits in plate 3. The channel deposits are composed of sand and gravel and have a known maximum thickness of 6 feet. The thickness of the terrace deposits is not known, but is probably less than 6 feet. The channel deposits are overlain by 2 to 3 feet of alluvium and, in places, the terraces are covered with a thin veneer of slope wash.

The outwash channel extending southeasterly across the southwestern part of T. 140 N. and the northwest part of T. 139 N., R. 55 W., ranges in width from one-tenth to half a mile. This channel has a relatively flat floor and gently sloping walls that rise 20 to 30 feet above the channel floor. The channel deposits are composed of sand and gravel that are as much as 22 feet thick. The sand and gravel deposits are overlain by 1 to 2 feet of alluvium and are underlain by till. The sand and gravel deposits in this channel are saturated, and serve as a water-supply source for Tower City.

The outwash channel in the NW cor. T. 141 N., R. 55 W., ranges in width from one-tenth to half a mile. The channel has a flat floor bordered by gently sloping walls 5 to 10 feet high. The western part of the channel contains no outwash, but the eastern part contains fine to coarse sand of unknown thickness.

The outwash deposit in the SW cor. T. 142 N., R. 55 W., is topographically higher than the floor of the intermittent stream channel with which it seems to be associated, and lies at about the same level as the adjacent ground moraine. Local relief generally is less than 5 feet. The deposit is known to be as much as 6 feet thick, and is composed chiefly of sand and fine gravel. The topographic position and the linear form of the deposit suggest that it was laid down in a channel that was at least in part floored on stagnant ice and was subsequently lowered unto the underlying till when the ice melted.

The western part of the small outwash body in the SW cor. T. 143 N., R. 55 W., is confined to a shallow channel, but the eastern part is unconfined and lies on nearly flat ground moraine. Local relief is generally less than 5 feet. The outwash is composed of sand and gravel, and is overlain by 1 to 2 feet of alluvium. The outwash is known to be at least 6 feet thick, but the maximum thickness is unknown. The eastern part of the outwash body probably was laid down in water that was ponded in front of stagnant ice.

The outwash body in the NW cor. T. 143 N., R. 55 W., occupies an area of about 3 square miles. The deposits in the western part of the body have no definite topographic expression, but the deposits in the eastern part stand 5 to 10 feet above the surrounding terrain. There is a gradual increase in altitude from west to east and the eastern part generally is 15 to 20 feet higher than the western part. The deposits are composed chiefly of sand and gravel, but boulders as much as 2 feet in diameter are intermixed with the sand and gravel in a gravel pit located in the SW cor. sec. 6. The deposits are as much as 25 feet thick in the aforementioned gravel pit. Most of these deposits were laid down on or adjacent to stagnant ice by melt water discharging from an outwash channel in adjacent Barnes County (Kelly, 1967, pl. 1). Some of the sand and gravel deposits probably are collapsed outwash.

LAKE AGASSIZ DEPOSITS

Most of Cass County, about 1,270 square miles, lies below the highest shoreline and within the area covered by glacial Lake Agassiz. The Lake Agassiz deposits in Cass County can be divided into the Sheyenne delta, Maple delta, shore deposits, and lake-plain deposits. The locations of these deposits are shown on plate 3.

Sheyenne delta

The Sheyenne delta was named and described by Upham (1895, p. 315-317). Leverett (1912, 1932) and Elson (1957) believed that the feature was a deposit of ice contact stratified drift. Later studies made in Cass County (Dennis and others, 1950) and in Richland County (Baker, 1967) support Upham's theory of deltaic origin. Data collected from test holes and surface exposures during the present study also indicate that the feature is of deltaic origin.

The Sheyenne delta occupies an area of about 60 square miles in the south-central part of Cass County. Northeast of Leonard, the edge of the delta is marked by a rather steep northeastward-facing escarpment that rises 75 to 100 feet above the lake plain. To the west, the deposits merge with the smaller Maple delta, and to the northwest, with the littoral deposits of glacial Lake Agassiz. The northeast-facing escarpment of the Sheyenne delta is continuous with the Campbell beach and is believed to be a wave-cut slope formed during the Campbell stage of the lake.

The Sheyenne delta deposits in Cass County consist chiefly of finely laminated silt and very fine to medium sand. In some exposures along the face of the delta, the deposits consist of silt and very fine sand interbedded with thin layers of dark-gray clay.

The exact thickness of the deposits at any given location is difficult to determine. The lower beds of the delta have essentially the same texture and composition as the lake-floor deposits. Therefore, no definite boundary can be drawn between the delta and lake-floor deposits. The greatest thickness of silt and sand penetrated during test drilling on the Sheyenne delta was 121 feet in test hole 137-52-31bbb.

If the escarpment of the Sheyenne delta was formed during the Campbell stage of glacial Lake Agassiz, the time of formation of the delta is fixed. Most of the delta probably was formed before the lake declined to the Campbell level.

Maple delta

The Maple delta is located in the southwest part of T. 137 N., R. 54 W. It is a small northeast-southwest-trending deposit bordered on the northwest by the littoral deposits of glacial Lake Agassiz, and on the southeast by the Sheyenne delta. The Maple delta is deeply entrenched along its long axis by the northeastward-flowing Maple River. The boundaries of the delta, as shown on plate 3, enclose only the sand and gravel facies of the deposit. The complete extent of the delta deposits is unknown because the finer sediments cannot be differentiated from the adjacent littoral deposits of Lake Agassiz and deltaic deposits of the Sheyenne River.

The Maple delta deposits are composed of silt, sand, gravel, and a few boulders. The predominant lithology is fine to coarse sand. The boulders are probably ice-rafted erratics.

Little is known concerning the thickness of deposits in the Maple delta. The only test hole (137-54-32ddd) drilled in the delta penetrated 49 feet of sand and gravel and 10 feet of silt before reaching the underlying till. It is not known if the silt is deltaic or lacustrine in origin.

The time of formation of the Maple delta is not definitely known, except that it probably was contemporaneous with the Sheyenne delta.

Shore deposits

A 4- to 10-mile wide belt of stratified gravel, sand, silt, and clay, which was formed along the western shore of Lake Agassiz, extends from the Maple River in southern Cass County northward to the northern edge of the county (pl. 3). The shore deposits were formed on a wave-eroded till surface; they are poorly sorted to well sorted and range in thickness from 0 to as much as 15 feet (fig. 15).

In most places, the deposits have little surface expression except a gentle eastward slope. However, in places well-defined beach ridges are discernible on the ground and in aerial photographs, and the crests of these ridges are shown in

FIGURE 15. Typical beach deposit in SW1/4 sec. 1, T. 141 N., R. 53 W. View of Tintah beach looking west.

plate 3. Upham (1895) described eight beaches that cross Cass County. These he named from oldest to youngest: Herman, Norcross, Tintah, Campbell, McCauleyville, Blanchard, Hillsboro, and Emerado. However, work done during this study revealed no evidence of the Blanchard and Emerado beaches in Cass County, and the McCauleyville and Hillsboro beaches are not as extensive as Upham indicated. Upham (1895, p. 221) believed that the five upper beaches (Herman through McCauleyville) were formed during the time Lake Agassiz drained southward through the Minnesota River. The lower beaches, according to Upham, were formed during the time that the lake drained to the northeast. Leverett (1932, p. 139) disagreed with Upham's interpretation of the time of formation of the McCauleyville beach, and concluded that Lake Agassiz had no connection with the southern outlet during the McCauleyville stage.

The four upper beaches extend in a southwesterly direction from the north edge of the county and merge with the Sheyenne and Maple deltas southeast of Alice. Of the lower beaches, only the McCauleyville and Hillsboro, which are prominent east of Hunter, extend into the county (pl. 3).

Herman beach.--The highest continuous shoreline of Lake Agassiz was named the Herman beach by Upham (1895, p. 317). The beach enters the north end of the county in sec. 6, T. 143 N., R. 53 W., and extends in a southerly direction almost the entire length of the county to the north edge of sec. 31, T. 137 N., R. 54 W. where it becomes indistinct.

The Herman shoreline is represented both by beach ridges and wave-cut slopes. In the northwestern part of T. 143 N., R. 54 W., the shoreline is a wave-cut escarpment in the till. A short distance to the east the escarpment is paralleled by a low ridge of sand and gravel that probably formed as an offshore bar. From Erie southward to the north edge of T. 138 N., R. 54 W., the Herman beach consists of sand and gravel and has the appearance of a wave-cut slope. South of T. 138 N., R. 54 W., to its terminus at the north edge of sec. 31, T. 137 N., R. 54 W., the beach is a low ridge of sand and gravel.

Norcross and Tintah beaches.--The Norcross and Tintah beaches parallel the Herman beach on the east. Generally they are low discontinuous ridge segments, but in a few places they appear to be wave-cut slopes. Generally the beach deposits consist of sand and gravel. In the western part of T. 143 N., R. 52 W., the Tintah beach is a broad prominent ridge consisting chiefly of sand.

Campbell beach.--The Campbell beach is a prominent wave-cut slope that enters the county about 2-1/2 miles north of Hunter. It extends in a south to southwesterly direction to the north edge of sec. 5, T. 138 N., R. 53 W. From this point the beach extends in a southeasterly direction and leaves the county about 6 miles southeast of Leonard. Southeast of the Maple River, the Campbell beach has been eroded into the northeast-facing slope of the Sheyenne delta. The exact location of the beach is not definitely known because there are no prominent erosional features with which the beach can be correlated; however, the beach probably corresponds to the 1,000-foot contour.

The Campbell beach rises 5 to 25 feet above the adjacent lake floor and consists for the most part of silt and sand.

Lower beaches.--The two beaches below the Campbell are the McCauleyville and Hillsboro. The McCauleyville is a low wave-cut slope eroded in clay. The east-facing slope is fairly prominent where it crosses the section line road between secs. 24 and 25, T. 143 N., R. 52 W.

The Hillsboro beach, which is the more prominent of the two lower beaches, enters the county at the north edge of sec. 6, T. 143 N., R. 50 W., and extends southwesterly for a distance of about 12 miles to the south edge of T. 142 N., R. 51 W. The beach is composed chiefly of silt and very fine sand. Upham (1895, p. 450) correlated the Hillsboro beach with the Maple ridge; however, the features are unrelated in origin.

Lake-plain deposits

The Lake Agassiz plain occupies approximately the eastern half of the county and lies, for the most part, between the altitudes of 895 and 1,000 feet above sea level. The plain is flat and featureless except for a few low ridges. The lake-plain deposits consist almost entirely of silt and clay.

Dennis and others (1949, p. 18,20) divided the lake-plain deposits into two units, an upper "silt" unit and lower "clay" unit. They concluded that the lake had been drained and refilled at least once, and that the silt unit had been laid down in shallow water during the later lake stage. Brophy (1963, p. 23A) provided additional evidence of two lake intervals when he reported the presence of plant remains and a dessication zone at the contact between the silt and clay units. Radiocarbon dates reported by Brophy indicate that deposition of the silt unit began about 9,900 years ago. Test-hole data collected during the present investigation verify the existence of two lake deposits throughout most of the county east of the Campbell shoreline.

Differentiation of the silt and clay units is generally based on changes in texture; however, in many places it is extremely difficult to differentiate the two units from drill cuttings. In such cases, color is used as a criterion for distinguishing the two units. The silt unit is generally yellowish brown to yellowish gray, whereas the clay unit is almost always olive gray to dark greenish gray.

Silt unit.--In Cass County, the silt unit is the predominant lake-floor deposit. It rests disconformably upon the clay unit and is composed chiefly of yellowish-brown to yellowish-gray silt. Locally the "silt" unit may consist entirely of clay or sand. It ranges in thickness from 0 to as much as 54 feet in test hole 143-52-36ddd.

In many places deposits of sand underlie or are associated with the silt unit. The presence of these deposits at the base of the silt suggests that a fluvial environment existed prior to deposition of the silt unit. In the vicinity of Kindred, the silt unit, locally, is underlain by very fine to coarse sand that is as much as 50 feet thick. Dennis and others (1949, p. 25) concluded that part of this sand body had been eroded from the face of the Sheyenne delta and redistributed lakeward by wave action during the Campbell stage of Lake Agassiz, and that the rest was deposited by the Sheyenne River during the interlake period preceding deposition of the silt. Dennis and others (1949, p. 25) believed also that the sand thickened toward the delta. The available data, however, indicate that the sand does not thicken toward the delta (pl. 1, section C-C'). The proximity of the shallow sand deposits to the Sheyenne River, and the apparent absence of sand in the area between Kindred and the Sheyenne delta, suggest that the sand deposits at Kindred are fluvial in origin.

Clay unit.--The clay unit underlies the silt unit and rests unconformably upon the till and associated deposits. This unit consists of olive-gray to dark-greenish-gray plastic clay. Locally it is silty, and, occasionally ice-rafted sand, gravel and boulders are found in the clay. Test drilling and well records indicate that the clay unit ranges in thickness from 0 to as much as 82 feet in test hole 140-49-36aaa.

Maple and Sheyenne ridges.--Two long ridges, which rise 5 to 20 feet above the surrounding lake plain, are the most prominent features in the southeastern part of the county (pl. 3). The ridges consist of silt, sand, and gravel. The upper 10 to 25 feet consists of silt; it is underlain by sand and gravel that may be as much as 25 feet thick. The sand and gravel deposits, in turn, are underlain by lake clay.

The westernmost ridge, called the Maple ridge by Upham (1895, p. 450), lies northwest of the Maple River, and parallels the river for a distance of about 15 miles. The Sheyenne ridge lies east of the Sheyenne River, and parallels the river for a distance of about 12 miles. It stands 5 to 10 feet above the lake plain and extends northward from the NW cor. T. 137 N., R. 49 W. to the SW part of T. 139 N., R. 40 W. At this point, the ridge bifurcates and forms the Fargo and West Fargo ridges (Dennis and others, 1949, p. 11). This ridge has a lithologic sequence similar to that of the Maple ridge, and is believed to have had a similar origin.

Upham (1895, p. 450) suggested that the Maple ridge was part of the Hillsboro beach. He believed that it had formed as a result of deposition of material eroded from the margin of the Sheyenne delta and from the adjacent lakebed. Dennis and others (1949, p. 37) proposed that the sand and gravel deposits underlying the Maple River, Fargo, and West Fargo ridges could have originated either as near-shore deposits in a transgressing lake, or as fluvial deposits laid down during an inter-lake period. They further postulated (p. 37-38) that after recession of lake waters from the area, the ridges were formed as a result of differential compaction of the sediments. The sand and gravel deposits underlying the ridges were compacted less than the silt and clay deposits adjacent to the ridge.

The origin of the sand and gravel deposits underlying the ridges is questionable; however, the proximity and similarity of the trends of the ridges and the present streams, and the fact that the sand and gravel deposits extend down into the lake clay, suggest that the deposits were laid down by streams flowing across the lakebed during the inter-lake period. The main objection to a near-shore lacustrine origin is that there would be no source for coarse clastic material in a lake transgressing across a thick deposit of plastic lake clay. If the sand and gravel deposits extended farther south than the present limits of the ridges, they probably were redistributed by currents or wave action during the second stage of the lake.

Intersecting minor ridges.--Numerous intersecting lineations are present in the lowest and flattest part of the Lake Agassiz plain along the Red River. These features, which are apparent only on aerial photographs, extend northward from Fargo, N. Dak. into Canada. Horberg (1951) described the features as northwest-southeast-trending ridges that are 3 to 10 feet high, 75 to 100 feet wide, and as much as 6 miles long. According to Clayton and others (1965, p. 655) the lineations in Walsh and Pembina Counties, N. Dak. are predominantly ridges; but in

Cass County, the lineations are predominantly grooves. Horberg (1951, p. 15-16) concluded that the lineations are an unusual type of tundra or permafrost patterned ground. As an alternate theory, he proposed that the ridges are fracture fillings formed in lake ice. Colton (1958, p. 76) agreed with Horberg's alternate theory and suggested that the ridges probably were formed by squeezing up of the soft lake sediment into cracks in thick lake ice when the level of Lake Agassiz was at a low stage. Other workers (Nikiforoff, 1952, p. 99-103; and Elson, 1961, p. 70) proposed different origins for the linear features. Clayton and others (1965, p. 655) concluded that most of the intersecting ridges and grooves on the Lake Agassiz plain were formed by the dragging of thick sheets and blocks of wind-driven lake ice across the nearly flat bottom of glacial Lake Agassiz. According to them, this is the only theory that explains the pattern, orientation, and curvature of the ridges and grooves. They do not imply, however, that all the linear features in the Lake Agassiz basin were formed by the above mentioned process.

This writer agrees with Clayton and others in that most of the linear features were caused by dragging of wind-driven ice blocks across the lakebed.

RECENT DEPOSITS

Alluvium and dune sand are grouped under deposits of Recent age; however, these deposits probably range in age from late Pleistocene to Recent.

Alluvium

The alluvium consists of clay, silt, sand, and fine gravel that was deposited by postglacial streams. Only the alluvial deposits that form the flood plains of the larger streams were mapped. Thin deposits, laid down by the smaller intermittent postglacial streams, were not mapped. Likewise, thin deposits of clay and silt in undrained depressions in the ground moraine, as well as deposits of colluvium along the valley walls of some of the streams, were not differentiated from the underlying unit.

It is difficult to determine the thickness of the alluvium because of the lack of exposures. Augering in stream valleys and examination of exposures in undercut banks indicate that the alluvium is as much as 15 feet thick in places.

Dune sand

Mappable areas of dune sand are present on the Sheyenne delta in the vicinity of Leonard (pl. 3). The sand areas are characterized by hummocky topography, rather than distinct dunes, and the local relief is less than 10 feet. The dune sand was derived from the delta; consequently, the grain sizes (silt to fine sand) are about the same as those of the deltaic deposits. The surficial sand is usually grayish brown in color because of the presence of decayed organic matter. The color becomes brown to yellowish brown with depth as the dune sand grades imperceptibly into the underlying deltaic deposits.

PLEISTOCENE AND RECENT HISTORY

During Pleistocene time, Cass County probably was covered several times by continental glaciers. Drift of pre-Wisconsin age has not been recognized in eastern North Dakota, but Flint (1955, p. 30-41) identified drift of Nebraskan, Kansan, and Illinoian age in South Dakota. The distribution of pre-Wisconsin drift in South Dakota indicates that the glaciers advanced southward via the James River and Red River lowlands. During Wisconsin time, Cass County probably was covered by glacial ice three and possibly five times (Lemke and others, 1965, p. 13-26).

Each of the advancing ice sheets that crossed the county left deposits of drift, and each succeeding ice sheet removed and redistributed these deposits. The deposits left by the various ice sheets are so similar in lithology that they cannot be easily differentiated. Evidence of more than one drift sheet in the county can be found only in a few places.

Great thicknesses of glacial drift were deposited in the county and by the time of the last glacial recession, the pre-Pleistocene topography was completely buried. The northwest-southeast-trending washboard moraines and ice-marginal outwash channels located in the western part of the county indicate that the last ice sheet receded in a northeasterly direction. As the ice receded from the northward-sloping Red River Valley, a large proglacial lake, called Lake Agassiz, was formed in eastern North Dakota and western Minnesota. About three-fourths of Cass County was covered by the lake waters.

At its maximum, Lake Agassiz extended from northeastern South Dakota into Canada, where its area exceeded that in the United States. According to Upham (1895, p. 215), the average width of the lake was about 150 miles. The greatest depth of Lake Agassiz in Cass County during its maximum (Herman) stage was about 150 feet. The lake had an outlet to the south through a valley now occupied by the Bois de Sioux River and a chain of lakes and marshes. Differential erosion of the bottom of the channel was accompanied by rapid declines of the lake level and resulted in the formation of well-defined shorelines. As the ice continued to recede, outlets were uncovered to the northeast, and Lake Agassiz gradually receded from Cass County.

Some of the more prominent features in Cass County were formed during the time glacial Lake Agassiz I occupied the Red River Valley. During the highest stage of Lake Agassiz, a well-defined shoreline (Herman shoreline) was formed, and an extensive delta, which extended into Cass County was formed at the mouth of the Sheyenne River. Another prominent shoreline (Campbell shoreline) probably was formed before Lake Agassiz I drained. The prominence of the Herman and Campbell beaches indicates that the lake stood at these levels longer than at any other.

After Lake Agassiz I receded from Cass County, the lake plain was subjected to subaerial erosion and, in places, there was abundant plant growth. During this interlake period, two streams, probably predecessors of the Sheyenne and Maple Rivers, deposited sand and gravel in shallow channels eroded into the lake plain.

The interlake period terminated about 9,900 years ago when a readvance of glacial ice blocked the northern outlets and caused the basin to be refilled to about the level of the Campbell beach.

When the glacial ice again receded sufficiently to uncover the northeastern outlets, the lake level lowered and gradually receded from Cass County. The lake must have been relatively shallow and of short duration because the shoreline features that were formed during this stage of the lake are not conspicuous. During this last stage of Lake Agassiz, wave action smoothed the lake floor and a blanket of silt was laid down on top of the existing lake clays.

After Lake Agassiz II had receded from Cass County, the lake plain had essentially the same form that is seen today. Recent erosion has produced no prominent changes in the late Pleistocene landscape.

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NORTH DAKOTA STATE
WATER CONSERVATION COMMISSION

MILO W. HOISVEEN, *State Engineer*

COUNTY GROUND WATER STUDIES 8

GEOLOGY and GROUND WATER RESOURCES of CASS COUNTY, NORTH DAKOTA

PART II

GROUND WATER BASIC DATA

By

ROBERT L. KLAUSING

Geological Survey

United States Department of the Interior

Prepared by the United States Geological Survey in cooperation with the North Dakota State Water Commission, North Dakota Geological Survey, and Cass County Board of Commissioners.

GRAND FORKS, NORTH DAKOTA

1966

This is one of a series of county reports published cooperatively by the North Dakota Geological Survey and the North Dakota State Water Conservation Commission. The reports are in three parts; Part I describes the geology, Part II represents ground water basic data, and Part III describes the ground water resources. Parts I and III will be published later and will be distributed as soon as possible.

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GEOLOGY AND GROUND WATER RESOURCES OF CASS COUNTY, NORTH DAKOTA
PART II - GROUND WATER BASIC DATA

By

Robert L. Klausing

INTRODUCTION

Purpose and Scope

The purposes of the investigation of the geology and ground-water resources of Cass County, North Dakota were to determine the location and extent of the ground-water reservoirs (aquifers); to evaluate the occurrence and movement of ground water, including the source of recharge and discharge; and to determine the chemical quality of the ground water. The investigation should provide sufficient information about the occurrence of ground water to plan its safe and intelligent development for irrigation, domestic, industrial, and municipal purposes (fig. 1).

The investigation has been made cooperatively by the U. S. Geological Survey, North Dakota State Water Commission, North Dakota Geological Survey, and the Cass County Board of Commissioners. The results of the investigation will be published in three separate parts of the bulletin series of the North Dakota Geological Survey and the County ground-water studies series of the North Dakota State Water Commission. Part I is an interpretive report describing the geology, Part II is a compilation of the ground-water basic data, and Part III is an interpretive report describing the ground-water resources. Part II makes available data collected during the investigation and functions as a reference for Parts I and III.

The information in this report was collected between 1962 and 1964 and consists of the following: (1) data on about 1,600 wells, springs, and test holes; (2) water-level measurements in 140 observation wells; (3) chemical analyses of 151 water samples; and (4) logs of about 150 test holes and selected wells.

The data in this report are useful for predicting geologic and ground-water conditions in Cass County. For example, a person considering the construction of a new well can locate the proposed site on figures 3 and 4. The characteristics of nearby wells may be determined from table 1 and the water-level fluctuation in the area may be determined from table 2. The chemical quality of water in adjacent wells may be determined from table 3 and the type of material encountered in nearby wells may be determined from table 4. Extrapolations based on these data should be conservative because of the irregular distribution of the water-bearing rocks.

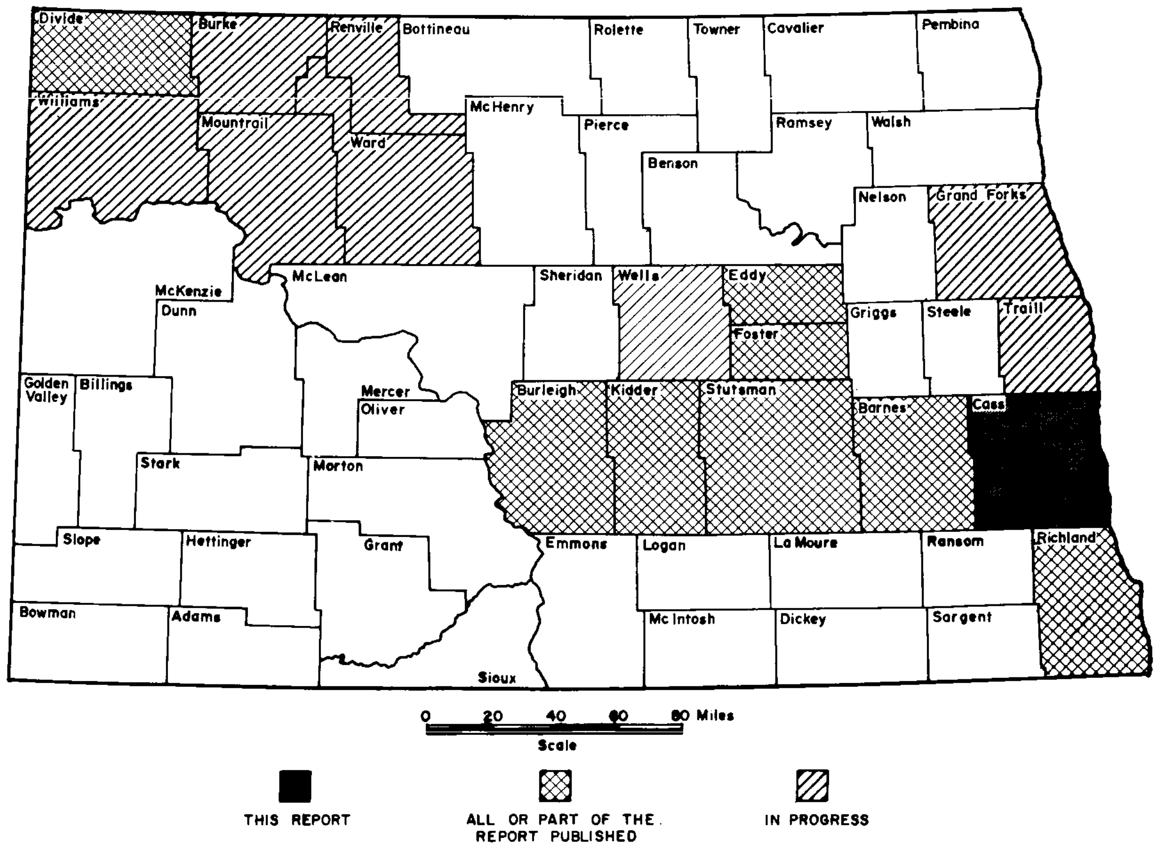

FIGURE 1.–Map of North Dakota showing the location of Cass County.

Well-Numbering System

The wells, springs, and test holes in the tables are numbered according to a system based on the location in the public land classification of the United States Bureau of Land Management. It is illustrated in figure 2. The first numeral denotes the township north of a base line, the second numeral denotes the range west of the fifth principal meridian, and the third numeral denotes the section in which the well is located. The letters a, b, c, and d designate, respectively, the northeast, northwest, southwest, and southeast quarter sections, quarter-quarter sections, and quarter-quarter-quarter sections (10-acre tract). For example, well 138-50-15daa is in the NE¼NE¼SE¼ sec. 15, T. 138 N., R. 50 W. Consecutive terminal numerals are added if more than one well is recorded within a 10-acre tract. The location of each well, spring, and test hole listed in the tables is shown on figures 3 and 4 (in pocket).

Acknowledgments

Thanks are due to the County Commissioners, township assessors, and the people of Cass County for their cooperation in the collection of these data. The geologic logs were compiled principally by R. W. Schmid and L. L. Froelich of the North Dakota State Water Commission. The author is especially grateful to Fredrickson's Inc., Great Northern Railway, U. S. Bureau of Reclamation, Layne-Minnesota Co., and McCarthy Well Co. and other drillers who supplied logs and information for this report.

EXPLANATION OF TABLES

Most of the numbered test holes listed in table 1 were drilled as part of this investigation. Test holes 1322-1 to 1322-6 were drilled by the North Dakota State Water Commission as part of a special study for the Village of Amenia. Test holes 1-12 were drilled by a private contractor for the Village of Buffalo. The location of each test hole is shown on figure 4. The locations of about 50 selected wells for which subsurface data were available are also shown on figure 4.

Excepting the Buffalo test-hole logs, the numbered test-hole logs are a composite from the drillers log, sample analysis log, and electric log (where available). Logs of the Buffalo test holes and the unnumbered test holes and wells were furnished by the company or agency shown in the heading of the log. The

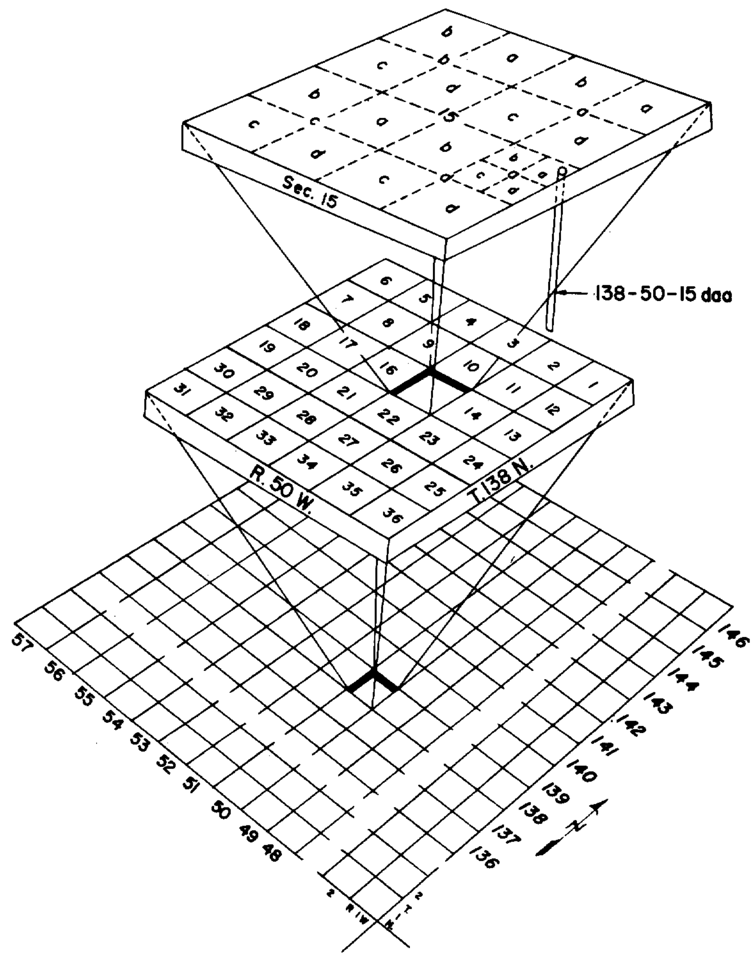

FIGURE 2.–System of numbering wells, springs, and test holes.

terminology used is that of the individual driller with the exception that the order has been changed to present the principal lithology first.

The well logs noted in table 1 but not listed in table 4 may be obtained from the U. S. Geological Survey, Bismarck, North Dakota, or from the North Dakota State Water Commission, Bismarck, North Dakota.

Sample description logs for all test holes having numbers greater than 1300 were prepared at each test-hole site. Visual examination, while the samples were still wet and fresh, was made by using a binocular microscope. Color descriptions were determined by comparing the sample with the color charts of Goldman (1928). If the cuttings reacted (effervesced) when treated with diluted hydrochloric acid, the material was described as calcareous. Grain-size determinations used in the logs refer to the Wentworth (1922) size scale. Plastic is a term generally applied to clay and indicates that the material may be molded into any form without fracturing. Cohesion is used to indicate the capacity of the material to stick together. Because most clays and silts are cohesive to some degree, the term was used only to differentiate cohesive silt from non-cohesive silt.

The term "till" indicates an unsorted, unstratified, cohesive, agglomeration of rock particles ranging from clay to boulders. Generally clay is the dominant particle size. If a particle size other than clay is dominant, that particle size is used as a modifying term. Consequently, terms such as clayey, silty, sandy, or gravelly are textural terms used to indicate that the material described contains an appreciable, but not a dominant amount of the modifying material.

Observation wells were developed in selected test holes. These consist for the most part of 1¼-inch plastic pipe slotted in the lower 10 or 20 feet, or screened in the lower 5 feet. They were pumped for a few hours and a water sample was collected for chemical analysis (table 3).

The monthly water-level measurements listed in table 2 were made during this investigation. Records of water-level fluctuations in wells in Cass County prior to this study have been published in the following Water-Supply Papers of the U. S. Geological Survey: 845, p. 351; 886, p. 533; 908, p. 246-251; 938, p. 191-197; 946, p. 236-240; 988, p. 310-314; 1018, p. 235-240; 1025, p. 225-229; 1073, p. 314-318; 1098, p. 294-298; 1128, p. 264-267; 1158, p. 303-306; 1167, p. 141-143; 1193, p. 169-170; 1223, p. 165-167; 1267, p. 180-182; 1323, p. 199-200; 1406, p. 196-197; 1456, p. 47-48; 1781, p. 90-93.

All natural waters contain dissolved mineral matter. Water in contact with soils or rock, even for only a few hours, will dissolve some mineral matter. The quantity of dissolved mineral matter in a natural water depends primarily on the type of rocks or soils with which the water has been in contact and the length of time of contact. Ground water is generally more highly mineralized than surface water because it remains in contact with the rocks and soils for much longer periods.

The mineral constituents and physical properties of natural waters reported in the table of analyses include those that have a practical bearing on the value of the waters for most purposes. The analyses generally include determinations of silica, iron, calcium, magnesium, sodium, potassium (or sodium and potassium together calculated as sodium), alkalinity as carbonate and bicarbonate, sulfate, chloride, fluoride, nitrate, boron, dissolved solids, pH, and specific conductance. The source and significance of the different constituents and properties of natural waters are discussed in the following paragraphs.

Mineral Constituents in Solution

Silica (SiO_2)

Silica is dissolved from practically all rocks. Some natural waters contain less than 5 ppm (parts per million) of silica and few contain more than 50 ppm, but the more common range is from 10 to 30 ppm. Silica affects the usefulness of a water because it contributes to the formation of scale in pipes, water heaters, and boilers.

Iron (Fe)

Iron is dissolved from many rocks and soils. On exposure to air, normal basic waters that contain more than 1 ppm of iron soon become turbid with the insoluble reddish ferric oxide produced by oxidation. Surface waters, therefore, seldom contain as much as 1 ppm of dissolved iron, although some acid waters carry large quantities of iron in solution. Ground waters commonly contain up to 10 ppm. Rarely, concentrations over 50 ppm may occur in waters with a pH of 5 to 8 (Hem, 1959). Iron causes reddish-brown stains on porcelain or enameled ware and fixtures and on fabrics washed in the water. The U. S. Public Health Service (1962) recommends an upper limit of 0.3 ppm of iron in drinking water.

Calcium (Ca)

Calcium is dissolved from almost all rocks and soils. Calcium and magnesium cause hard water and are largely responsible for the formation of scale in pipes, water heaters, and boilers. Water associated with granite or silicious sands may contain less than 10 ppm of calcium, whereas water associated with dolomite and limestone may contain from 30 to 100 ppm. Water that has been in contact with deposits of gypsum may contain several hundred parts per million of calcium.

Magnesium (Mg)

Magnesium is dissolved from many rocks, particularly from dolomitic rocks. Its effect in water is similar to that of calcium. The magnesium in soft waters may amount to only 1 or 2 ppm, but water in areas that contain large quantities of dolomite or other magnesium-bearing rocks may contain from 20 to 100 ppm or more of magnesium.

Sodium and potassium (Na and K)

Sodium and potassium are dissolved from practically all rocks. Sodium is the predominant cation in some of the more highly mineralized waters found in the western United States. Natural waters that contain only 3 or 4 ppm of the two together are likely to carry almost as much potassium as sodium. As the total quantity of these constituents increases, the proportion of sodium becomes much greater. However, the potassium concentration in water does not often exceed 50 ppm. Moderate quantities of sodium and potassium have little effect on the usefulness of the water for most purposes, but waters that carry more than 50 or 100 ppm of the two may require careful operation of steam boilers to prevent foaming. More highly mineralized waters that contain a large proportion of sodium salta may be unsatisfactory for irrigation. The presence of several hundred parts per million of sodium in water makes it unsuitable for use in sodium-restricted diets used as therapy for cardiovacular diseases.

Bicarbonate and carbonate (HCO_3 and CO_3)

Bicarbonate and carbonate are sometimes reported as alkalinity. Since the major causes of alkalinity in most natural waters are carbonate and bicarbonate ions dissolved from carbonate rocks, the results are usually reported in terms of these constituents. Although alkalinity is primarily due to the presence of carbonate and bicarbonate, other ions also contribute to alkalinity such as silicates, phosphates, borates, possibly fluoride, and certain organic anions which may occur in colored waters. The significance of alkalinity to the domestic, agricultural, and industrial user is usually dependent upon the nature of the cations (Ca, Mg, Na, K) associated with it. However, moderate amounts of alkalinity do not adversely affect most use.

Sulfate (SO_4)

Sulfate is dissolved from many rocks and soils--in especially large quantities from gypsum and from beds of shale. It is formed also by the oxidation of sulfides of iron and may therefore be present in considerable quantities in mine waters. The concentration of sulfate in waters is generally limited to about 1,500 ppm by the solubility of calcium sulfate. Sulfate in waters that contain much calcium and magnesium causes the formation of hard scale in steam boilers and may increase the cost of softening the water. The U. S. Public Health Service (1962) recommends that 250 ppm of sulfate should be the upper limit for drinking water.

Chloride (Cl)

Chlorides are generally very soluble compounds and are found in most rocks so that chlorides are found in all natural waters. Large quantities of chloride may affect the industrial use of water by increasing the corrosiveness of waters that contain large quantities of calcium and magnesium. The U. S. Public Health Service (1962) recommends an upper limit of 250 ppm of chloride for drinking water.

Fluoride (F)

Fluoride has been reported as being present in igneous and some sedimentary rocks to about the same extent as chloride. However, most fluorides, unlike the chlorides, are low in solubility so that the quantity of fluoride in natural waters is ordinarily very small compared to that of chloride. Hem (1959) reported that fluoride concentrations in excess of 10 ppm are rare. Investigations have proved that fluoride concentrations of about 0.6 to 1.7 ppm reduced the incidence of dental caries and that concentrations greater than 1.7 ppm also protect the teeth from cavities but cause an undesirable black stain (Durfor and Becker, 1964). U. S. Public Health Service (1962, p. 8) states, "When fluoride is naturally present in drinking water, the concentration should not average more than the appropriate upper control limit (0.6 to 1.7 ppm). Presence of fluoride in average concentrations greater than two times the optimum values shall constitute grounds for rejection of the supply."

Concentration higher than the stated limits may cause mottled enamel in teeth, endemic cumulative fluorosis, and skeletal effects.

Nitrate (NO_3)

Nitrate in water is considered a final oxidation product of nitrogeneous material and may indicate contamination by sewage or other organic matter. U. S. Public Health Service (1962) sets 45 ppm as the upper limit for nitrate because ingestion of water containing more than this may result in infantile methemoglobinemia. If the concentration is sufficiently great, both man and animals can be poisoned by nitrate.

Boron (B)

Boron in small quantities has been found essential for plant growth, but irrigation water containing more than 1 ppm boron is detrimental to navy beans and other boron-sensitive crops.

Dissolved solids

The reported quantity of dissolved solids--the residue on evaporation--consists mainly of the dissolved mineral constituents in the water. It may also contain some organic matter and water of crystallization. Waters with less than 500 ppm of dissolved solids are usually satisfactory for domestic and some industrial uses. Water containing several thousand parts per million of dissolved solids are sometimes successfully used for irrigation where practices permit the removal of soluble salts through the application of large volumes of water on well-drained lands, but generally water containing more than about 2,000 ppm is considered to be unsuitable for long-term irrigation under average conditions.

Properties and Characteristics of Water

Temperature

Temperature is an important factor in properly determining the quality of water. This is very evident for such a direct use as an industrial coolant. Temperature is also important, but perhaps not so evident, for its indirect influence upon concentrations of dissolved gases and distribution of chemical solutes in ground water. Normally, the temperature of ground water within 60 feet of the surface approximates the mean annual air temperature and increases 1° F for each 60 to 100 feet increase with depth.

Hardness

Hardness is the characteristic of water that receives the most attention in industrial and domestic use. It is commonly recognized by the increased quantity of soap required to produce lather. The use of hard water is also objectionable because it contributes to the formation of scale in boilers, water heaters, radiators, and pipes, with the resultant decrease in rate of heat transfer, possibility of water heater or boiler failure, and loss of flow.

Hardness is caused almost entirely by compounds of calcium and magnesium. Other constituents--such as iron, manganese, aluminum, barium, strontium, and free acid--also cause hardness, although they usually are not present in quantities large enough to have any appreciable effect.

Generally, bicarbonate and carbonate determine the proportions of "carbonate" hardness of water. Carbonate hardness is the amount of hardness chemically equivalent to the amount of bicarbonate and carbonate in solution. Carbonate hardness is approximately equal to the amount of hardness that is removed from water by boiling and is termed temporary hardness.

Noncarbonate hardness is the difference between the hardness calculated from the total amount of calcium and magnesium in solution and the carbonate hardness. If the carbonate hardness (expressed as calcium carbonate) equals the amount of calcium and magnesium hardness (also expressed as calcium carbonate) there is no noncarbonate hardness. Noncarbonate hardness is about equal to the amount of hardness remaining after water is boiled. The scale formed at high temperatures by the evaporation of water containing noncarbonate hardness commonly is tough, heat resistant, and difficult to remove.

Although many people talk about soft water and hard water, there has been no firm line of demarcation. Water that seems hard to an easterner may seem soft to a westerner. In this report hardness of water is classified as follows:

Hardness range (calcium carbonate in ppm)	Hardness description
0-60	Soft
61-120	Moderately hard
121-180	Hard
more than 180	Very hard

For public use, water with hardness about 200 ppm generally requires softening treatment (Durfor and Becker, 1964).

Sodium-adsorption-ratio (SAR)

The term "sodium-adsorption-ratio (SAR)" was introduced by the U. S. Salinity Laboratory Staff (1954). It is a ratio expressing the relative activity of sodium ions in exchange reaction with soil and is an index of the sodium or alkali hazard to the soil. Sodium-adsorption-ratio is expressed by the equation:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

where the concentrations of the ions are expressed in milliequivalents per liter (or equivalents per million for most irrigation waters).

Waters are divided into four classes with respect to sodium or alkali hazard: low, medium, high, and very high, depending upon the SAR and specific conductance. At a conductance of 100 micromhos per centimeter the dividing points are at SAR values of 10, 18, and 26, but at 5,000 micromhos the corresponding dividing points are SAR values of approximately 2.5, 6.5, and 11. Waters range in respect to sodium hazard from those which can be used for irrigation on almost all soils to those which are generally unsatisfactory for irrigation.

Specific conductance (micromhos per centimeter at 25° C)

Specific conductance is a convenient, rapid determination used to estimate the amount of dissolved solids in water. It is a measure of the ability of water to conduct an electrical current. Commonly, the amount of dissolved solids (in parts per million) is about 65 percent of the specific conductance (in micromhos). This relation is not constant from well to well and it may even vary in the same source with changes in the composition of the water (Durfor and Becker, 1964).

Specific conductance of most waters in the eastern United States is less than 1,000 micromhos, but in the arid western parts of the country, a specific conductance of more than 1,000 micromhos is common.

Hydrogen-ion concentration (pH)

Hydrogen-ion concentration is expressed in terms of pH units. The values of pH often are used as a measure of the solvent power of water or as an indicator of the chemical behavior certain solutions may have toward rock minerals.

The degree of acidity or alkalinity of water, as indicated by the hydrogen-ion concentration, expressed as pH, is related to the corrosive properties of water and is useful in determining the proper treatment for coagulation that may be necessary at water-treatment plants. A pH of 7.0 indicates that the water is neither acid nor alkaline. pH readings progressively lower than 7.0 denote increasing acidity and those progressively higher than 7.0 denote increasing alkalinity. The pH of most natural ground waters ranges between 5.5 and slightly more than 8.

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TABLE 1.–Records of wells, springs and test holes, Cass County, N. Dak.

Owner: USGS, United States Geological Survey; USBR, United States Bureau of Reclamation

Depth to well: Reported depths are given in feet; measured depths are in tenths.

Type of well: B, bored; Dr, drilled; Du, dug; Dv, driven; J, jetted.

Depth to water: Reported depths are given in feet; measured depths are in hundredths.

Yield: Reported and estimated yields are given in gallons per minute; measured yields are given in tenths; reported or estimated yields of less than 1 gallon per minute are indicated by the symbol 1.

Use of water: D, domestic; DS, domestic-stock; Ind, industrial; O, observation; PS, public supply; U, unused; T, test hole.

Water-bearing material: C, clay; G, gravel; S, sand; S & C, sand and clay; S & G, sand and gravel, St, silt.

Geological source: Kd, Dakota Sandstone; Qow, outwash deposits of sand and gravel; Qla, Lake Agassiz silt, sand and gravel deposits; Qd, glacial drift and associated sand and gravel deposits; Qsd, Sheyenne River delta sand and gravel deposits.

Pump type: Cen, centrifugal; Cy, cylinder; J, jet; R, rotary; S, submersible; T, turbine.

Remarks: L, log available; E, electric log available; MP measuring point; A, adequate; I, inadequate; C, chemical analysis; P, partial chemical analysis; TH, test hole.

Location no. (1)	Owner or name (2)	Depth of well (feet) (3)	Diameter or size (inches) (4)	Type (5)	Date completed (6)	Depth to water below land surface (feet) (7)	Date of measurement (8)	Use of water (9)	Water-bearing material (10)	Geologic source (11)	Pump type (12)	Specific conductance (micromhos at 25°C.) (13)	Date of measurement (14)	Elevation of land surface (15)	Remarks (16)
137-48															
6bdd	Arthur Anderson	180	4	Dr	1959	.....	....	D,S	S	Qd	Cy	.....	....	910	
7baa	Orville Haugstad	97	3	Dr	1928	.....	....	D,S	S&G	Qd	Cy	.....	....	910	
18baa	Wm. Bye	137	4	Dr	1958	.....	....	D,S	S	Qd	Cy	.....	....	910	
30ccd	Ole Mathison	160	4	Dr	1930	.....	....	D	S&G	Qd	J	.....	....	915	
31cbd	Bruce Harris	150	2	Dr	1930	.....	....	D,S	S	Qd	J	.....	....	915	
137-49															
2adb	Elvin Egge	190	3	Dr	1950	.....	....	D,S	S	Qd	Cy	811	11-18-64	911	C.
3daa	Louis Duval	100	6	Dr	1930	.....	....	D,S	G	Qd	Cy	.....	....	913	
4baa	Ernest Dubard	80	14	B	1923	.....	....	D,S	S	Qd	Cy	.....	....	911	
5baa	E. Duval	123	4	Dr	1955	.....	....	D,S	S	Qd	J	.....	....	914	
6bcb	Einer Sjorbotten	150	6	Dr	1925	.....	....	D,S	...	Qd	Cy	2,200	6-24-64	920	C.
7add	Henry Montplaiser	90	3	Dr	1957	.....	....	D,S	S	Qd	Cy	.....	....	917	
8aaa	Frank Burnette	85	4	Dr	1961	.....	....	D,S	S	Qd	Cy	.....	....	913	
9ccc	Armand Richard	90	4	Dr	1948	.....	....	D,S	...	Qd	Cy	.....	....	913	
9dcd	Adrian Richard	75	3	Dr	1952	.....	....	D,S	G	Qd	Cy	1,350	11-18-64	911	C.
10dac	J. Hanson	117	2	Dr	1958	.....	....	D,S	S	Qd	J	.....	....	911	
12bbb	Leonard Egge	176	3	Dr	1933	.....	....	D	S	Qd	Cy	.....	....	906	
12cdd	Arthur Bye	98	3	Dr	1951	.....	....	D,S	S	Qd	Cy	1,220	5-13-65	911	C.
14cbc	Ramstad Bros.	160	2	Dr	1951	.....	....	D,S	S	Qd	J	.....	....	911	
14ddc	Jay Stoutenburg	86	3	Dr	1962	.....	....	D	S	Qd	Cy	.....	....	911	
17aaa	Test hole 2347	210	..	..	6-10-65	.....	....	T	S&G	Qd	..	.....	....	914	L.
17daa1	Trottier Bros.	102	4	Dr	5-60	26	5-60	D,S	S	Qd	Cy	1,270	11-18-64	911	L. C.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
<u>137-49</u> Cont.															
17daa2	Trottier Bros.	104	.	B	5-55	26.71	10-24-63	U	...	Qd	..	.....	....	911	MP 1.85 above ls.
18bbd	Paul Johnson	105	4	Dr	1950	.....	....	D,S	S	Qd	Cy	2,390	6-17-64	920	C.
19bbb	Henry Owen	83	6	Dr	....	.....	....	D,S	...	Qd	J	3,000	11-18-64	924	C.
19dcc	Fred Broderud	94	3	Dr	1927	.....	....	D	S	Qd	Cy	.....	....	924	
20bdd	B. A. Bale	107	4	Dr	1928	.....	....	D,S	S	Qd	Cy	.....	....	920	Supply reported I.
21bba	Egbert Gilbertson	86	4	Dr	9-61	24	9-61	U	S	Qd	..	.....	....	911	L.
22cdd	George Roen	127	2	Dr	....	.....	....	D	...	Qd	J	.....	....	915	
24aaa	Elmer Bakke	175	4	Dr	1955	.....	....	D,S	G	Qd	Cy	.....	....	911	
24bda	Carl Sall	107	3	Dr	1962	.....	....	D	S	Qd	J	861	11-17-64	914	C.
25aac	Nate Smith	80	6	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	914	
25ccc	Test hole 3158	240	1 1/4	Dr	8-19-64	25.56	9-3-64	O	S	Qd	..	1,760	8-21-64	919	MP 2.0 ft above ls, E, L, C., TH depth 257.
26ccb	Grant Sundet	88	3	Dr	1963	.....	....	D,S	S	Qd	Cy	.....	....	920	
26dad	Olaf Brekke Est.	100	..	Dr	1959	.....	....	D,S	...	Qd	Cy	.....	....	917	
28cdd	Melford Oldegaard	190	4	Dr	6-60	31	6-60	D,S	S	Qd	S	1,110	11-18-64	915	L, C.
29aaa	Gordon Grinaker	110	2	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	921	
30aaa	Test hole 3138	180	1 1/4	Dr	7-31-64	25.57	9-3-64	O	S&G	Qd	..	.....	....	919	MP 2.0 ft above ls, E, L.
30cdc	Allen Christianson	80	4	Dr	1913	.....	....	D,S	...	Qd	Cy	.....	....	928	
32ddd	John Nellermoe	89	4	Dr	1962	34	1962	D,S	S	Qd	Cy	.....	....	920	L.
34bda	K. Sundet	86	3	Dr	1955	.....	....	D,S	S	Qd	Cy	.....	....	921	
<u>137-50</u>															
1bba	E. Krabbenhoft	120	3	Dr	1961	.....	....	D,S	S	Qd	Cy	.....	....	917	
2bdd	Alfred Johnson	180	3	Dr	....	.....	....	D,S	S	Qd	J	.....	....	916	
3ddc	M. A. Severson	80	42x42	Du	....	.....	....	S	...	Qd	Cy	.....	....	925	
4baa1	R. L. Lahren	177	3	Dr	6-61	25	6-61	D	S	Qd	Cy	.....	....	924	L, P.
4baa2	..do...	147.1	3	B	1938	30.90	5-17-63	U	...	Qd	..	.....	....	924	MP 6.7 ft below ls.
5dcc	Carl Lahren	167	3	Dr	....	.....	....	U	...	Qd	Cy	.....	....	925	
6bab	Arvid Haugen	132	36	Dr	....	.....	....	D	...	Qd	Cen	.....	....	919	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
137-50 Cont.															
6ddc	Clarence Jermstad	178	3	Dr	1936	.....	....	D,S	...	Qd	Cy	.....	....	924	
7daa1	Herman Gust	125	4	Dr	1954	.....	....	D	...	Qd	Cy	.....	....	928	
7daa2	..do...	145	4	Dr	....	.....	....	S	S	Qd	Cy	.....	....	928	
8caa	M. G. Kruse	142	4	Dr	7-60	95	7-22-60	D,S	S	Qd	Cy	810	11-17-64	928	L, C.
8ddd	Elder Braaten	240	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	930	
9dcc	..do...	88	12	B	1934	.....	....	D	...	Qd	Cy	.....	....	928	
10dca	Eveleyn Scott	60	6	Dr	....	.....	....	D,S	...	..	J	.....	....	927	
11dba	Willie Perhus	107	3	Dr	1928	.....	....	D,S	S&G	Qd	Cy	.....	....	925	
11ddd	Test hole 3137	212	..	Dr	7-31-64	.....	....	T	...	Qd	..	.....	....	926	L, E.
13ccc	Henry Trangsrud	133	5	Dr	1930	.....	....	D,S	S	Qd	Cy	.....	....	931	
14bdb	F. Hendrickson	135	12	Dr	....	.....	....	D	G	Qd	J	.....	....	930	
15cdd	Henry Fjelstad	120	3	Dr	1943	.....	....	D,S	...	Qd	J	.....	....	936	
16add	Ingewald Braaten	188	3	Dr	1958	.....	....	D,S	S	Qd	Cy	.....	....	932	
17dcb	S. A. Rustad	165	4	..	....	.....	....	U	...	Qd	Cy	.....	....	936	
17dcc	..do...	20	18	Du	....	.....	....	D	...	Qla	Cy	.....	....	937	
18ddd	Alex Hedland	140	3	Dr	1928	.....	....	D,S	...	Qd	Cy	.....	....	936	
19ddc	Morris Frosaker	246	3	Dr	1936	.....	....	D,S	...	Qd	Cy	4,040	6-17-64	939	C.
20cdc	Henry Borreson	370	4	Dr	....	.....	....	D	...	Qd	Cy	.....	....	939	
20dac	Edwin Overboe	154	3	Dr	1-60	.....	....	D	S	Qd	..	.....	....	941	L, P.
21cdb	Peter Lykken	20	36	Du	1945	.....	....	D	...	Ql	J	.....	....	941	
22dcd	Stella Hertsgaard	126	3	Dr	1925	.....	....	D	...	Qd	Cy	.....	....	937	
25bdb	Ole Olsgard	100	3	Dr	....	.....	....	D	S	Qd	J	.....	....	926	
26daa	Englebret Brakke	108	4	Dr	10-58	.....	....	D	S	Qd	Cy	2,590	11-18-64	931	L, C, Supply rept'd I.
28abc	Irvin Hemsing	60	18	Du	1940	.....	....	D,S	...	Qla	Cy	.....	....	945	
29dad	City of Kindred	49	8	Dr	1961	.....	....	P,S	S	Qla	S	.....	....	943	L, P.
29dca	..do... 1/	65.17	12	..	....	8.27	1-20-64	U	...	Qla	..	.....	....	942	MP at land surface.
30cad	Herman Olson	183	3	Dr	1940	.....	....	D	...	Qd	Cen	3,340	11-17-64	937	C.
31aaa	Irvin Braaten	167	3	..	....	.....	....	D	...	Qd	Cy	.....	....	939	

1/ Well 137-50-29dca formerly published as 137-50-29dda5 in WSP 1128, p. 267 by J. E. Powell (1948).

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
137-50 Cont.															
32aab	N. B. Swenson	270	..	Dr	....	.....	....	D	...	Qd	Cy	.....	....	942	
33dac	L. A. Perhus	100	15	B	1930	.....	....	D,S	S	Qd	Cy	.....	....	941	
34cdb	Arnold Nipstad	106	2	Dr	1953	.....	....	D,S	S	Qd	J	.....	....	941	
35ccb	Joe Fjelstad	138	4	Dr	7-58	.....	....	D	C	Qd	..	.....	....	933	L, yield 3 gpm.
36bba	Einar Erstad	100	4	Dr	1920	.....	....	D	S	Qd	Cy	.....	....	933	
137-51															
1bbb1	Alvin Nockleberg	100	3	..	....	.....	....	D	...	Qd	S	.....	....	918	
1bbb2	Davenport School	147	6	Dr	1957	.....	....	P,S	G	Qd	S	.....	....	917	
1bbd	Otto Nockleberg	132	4	Dr	1955	.....	....	D	...	Qd	Cy	.....	....	918	
1bcb	Great Northern Railway	140	6	Dr	6-23	.....	....	S	S	Qd	..	.....	....	922	L, well destroyed.
2ddd	Allen Mickleson	153	3	Dr	4-62	.....	....	D,S	G	Qd	J	.....	....	924	
4ddd	Paul Schroeder	235	4	Dr	5-63	.....	....	D,S	S	Qd	Cy	.....	....	925	
5aba	Milton Hans	85	..	Du	....	.....	....	D,S	...	Qd	J	.....	....	924	
6cbb	W. A. Plath	107	3	Dr	1948	.....	....	D,S	G	Qd	Cy	1,300	11-17-64	935	C.
8ddd1	Kellerman Bros.	313	4	Dr	1958	.....	....	...	SS	Qd	..	.....	....	...	L, well destroyed.
8ddd2	..do...	200	4	J	1960	.....	....	S	S	Qd	Cy	.....	....	931	
10bca	Paul Schroeder	207	3	Dr	1910	3.18	6-14-63	D	...	Qd	..	.....	....	924	MP 1.0 ft above ls.
11ccc	Edwin Simenson	185	3	Dr	....	.....	....	D,S	...	Qd	Cen	.....	....	926	
14acb	Oscar Liudahl	207	6	Dr	1948	.....	....	D	...	Qd	Cy	.....	....	930	
14bab	George Enger	320	3	Dr	....	.....	....	U	...	..	Cy	......	....	928	
15ddd	Alfred Vangness	160	3	Dr	....	.....	....	D,S	...	Qd	S	.....	....	931	
16bba	Erwin Johnson	267	2	Dr	....	Flow	6-14-63	D	...	..	..	3,740	8-63	932	
16ddd	John Myher	188	3	Dr	1917	Flow	6-14-63	D	...	..	..	3,030	8-63	935	Yield 0.5.
17aaa1	D. Kellerman	280	3	B	....	2.50	6-14-63	D	...	..	..	.....	....	933	MP 0.5 ft above ls.
17aaa2	..do...	276	3	Dr	1946	.....	....	S	...	..	Cy	3,690	8-63	934	
18cbb	Rheinhold Greuel	102	6	Dr	1957	.....	....	D,S	...	Qd	S	.....	....	947	
19bcb1	Edwin Nygaard	90	4	Dr	1955	.....	....	D	S	Qd	Cy	.....	....	953	
19bcb2	..do...	300	..	Dr	1900	Flow	6-14-63	S	..	..	J	4,130	8-63	953	
20baa	Morris Lahren	105	3	Dr	1947	....	....	D,S	..	Qd	Cy	.....	....	946	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	)15)	(16)
137-51 Cont.															
21bcc	Henriette Nygard	167	1 1/4	Dr	.....	Flow	6-14-63	D,S	...	Qd	..	2,320	6-25-64	945	C, yield 3.0 gpm.
22bab	J. Milton Myhre	178	3	Dr	4-62	.....	....	D	...	Qd	J	2,810	8-63	931	
24ddd	Peder Borreson	168	4	Dr	1958	.....	....	D	S	Qd	Cy	.....	....	935	
25ccc	Oscar Trom	150	..	..	....	.....	....	U	...	Qd	Cy	.....	....	941	
26ccc	Archie Rich	330	4	Dr	4-61	Flow	....	D,S	S	..	S	.....	....	944	L, Yield 3 gpm.
27ddd	M. L. Vangerud	270	3	Dr	10-61	.....	....	D	...	..	S	.....	....	945	
28cdc	Lloyd Andvik	84	2	Dr	....	Flow	6-13-63	D,S	...	..	..	1,240	6-24-64	955	C.
28dcc	Melvin Anderson	96	2	..	....	Flow	6-13-63	U	...	..	..	1,080	8-63	954	
29cda	D. Taylor	143	4	Dr	8-17-62	.....	....	D,S	S	Qd	Cy	.....	....	968	L, yield 4 gpm.
30dcd	R. Thomeson	29	2	Dr	1913	.....	....	S	S	Qsd	Cy	.....	....	993	
31bac	Lester Olson	55	..	J	1947	.....	....	S	S	Qsd	Cy	.....	....	1,025	
32daa	Elma Swiggum	46	..	B	1945	.....	....	S	S	Qsd	Cy	.....	....	1,005	
34ccc	Erick L. Lee	205	4	Dr	1-58	.....	....	D,S	S	Qd	S	.....	....	984	Yield 20 gpm.
35bbb	T. G. Simmons	330	4	Dr	3-14-58	.....	....	D	...	...	S	.....	....	946	L, yield 3 gpm.
35cdd1	Thorwald Andvik	188	3	Dr	1935	124.90	10-24-63	U	...	...	..	.....	....	960	MP 1.05 ft above ls.
35cdd2	..do...	207	4	Dr	6-59	.....	....	D	S	Qd	S	3,090	11-17-64	960	L, C.
137-52															
2cdd	Ray Heuer	...	..	Dr	....	Flow	6-16-63	D,S	...	...	..	.....	....	945	
3cdb	Earl Roesler	290	4	Dr	1945	Flow	7-10-63	S	G	...	..	.....	....	950	
4dad	Arthur Wickmann	97	18	B	....	14.77	7-10-63	D,S	G	Qd	Cy	.....	....	949	MP 1.3 ft above ls.
6daa1	Carl C. Laske	135	..	..	....	.....	....	D	S	Qd	Cy	3,800	9-64	958	
6daa2	..do...	286	3	..	....	Flow	7-10-63	S	S	..	..	.....	....	958	Yield 1.5.
7ddc	Donald Heuer	420	1	Dr	....	Flow	7-11-63	D,S	..	..	..	3,750	9-64	992	Yield< 1.
8bcc	Ervin Dittmer	285	4	Dr	....	Flow	7-11-63	S	..	..	..	3,950	9-64	969	Yield 6 gpm.
9ada	W. Salzwedel	180	3	Dr	....	Flow	7-11-63	D	G	..	..	3,300	9-64	955	
10baa	Earl Roesler	62	4	Dr	1938	....	....	D,S	S	Qd	Cy	.....	....	950	
11dcd1	Gust Heller	115	1 1/4	Dr	1948	....	....	...	S	Qd	J	.....	....	.....	
11dcd2	..do...	410	3	Dr	1930	Flow	7-16-63	S	..	..	..	.....	....	951	Yield < 1 gpm.
12cdd	David Gust	100	2	..	....	....	....	D,S	G	Qd	Cy	.....	....	947	
13dbb	Woods Farmers Coop.	350	3	Dr	1935	Flow	7-16-63	D	..	..	..	3,450	9-64	950	Yield 4 gpm.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
137-52 Cont.															
14baa	Reinhold Haak	415	4	Dr	1940	Flow	7-16-63	D,S	S	..	J	.....	....	952	Reported corrosive.
14ddd	Ben Gust	328	3	Dr	1959	Flow	7-16-63	S	S	..	..	.....	....	955	Yield 5.0 gpm.
15bcc	John Toussaint	203	4	Dr	1947	Flow	7-16-63	D,S	G	Qd	Cy	.....	....	968	
16ddc	Frank Schroeder	160	36	Dr	1938	+0.43	10-24-63	S	S	Qd	Cy	3,480	11-17-64	991	C, MP 2.46 ft above ls.
17cdd	R. D. Roesler	38	2	Dr	1958	.....	....	D,S	S	Qsd	J	.....	....	1,030	
19cdd	Edwin Sandvig	26	1 1/4	Dr	....	20	1962	D,S	S	Qsd	J	.....	....	1,051	
19ddc	Peter Frey	20	1 1/4	Dr	....	4.84	7-11-63	S	S	Qsd	Cy	.....	....	1,051	MP at land surface.
20ddd	..do...	20	36x36	Du	....	11.02	1-20-64	D,S	S	Qsd	Cy	.....	....	1,051	MP 1.6 ft above ls.
22ccc	E. A. Goltz	82	1 1/4	Dr	....	.....	....	D,S	S	Qsd	J	680	9-24	1,042	
23cca	Lee Nesemeir	525	4	Dr	....	.....	....	S	S	..	Cy	4,400	9-24	1,004	
24aaa	John Heuer	340	4	Dr	1948	Flow	7-16-63	D,S	G	..	J	.....	....	950	
25ccd1	Christ Hoyum	170	2	Dr	1960	.....	....	D,S	S	Qd	Cy	.....	....	1,031	
25ccd2	..do...	177	3	Dr	1923	34.14	7-12-63	U	S	Qd	..	.....	....	1,031	MP 2.0 ft above ls.
25ccd3	..do...	39	1 1/2	Dr	....	.....	....	S	S	Qsd	Cy	.....	....	.....	
27aaa	Test hole 3156	471	..	Dr	8-14-64	.....	....	T	...	..	..	.....	....	1,025	L, E.
27cbb	Walter Stevens	90	2	Dr	....	.....	....	D,S	S	Qd	Cen	.....	....	1,048	
28cbd	Harriet Scilley	25	1 1/4	Dr	1920	.....	....	D,S	S	Qsd	Cy	.....	....	1,051	
28dba	City of Leonard	23	216	Du	....	11.00	7-12-63	P,S	S	Qsd	Cen	.....	....	1,051	MP 5.25 ft below ls.
29cdd	Lyle Olson	17	1 1/4	Dv	1961	.....	....	D	S	Qsd	Cy	.....	....	1,056	
31bab	Leon Beadles	55	2	Dr	....	.....	....	D,S	S	Qsd	Cy	853	11-17-64	1,055	C.
31bbb	Test hole 3157	20	1 1/4	Dr	8-18-64	5.66	9-3-64	O	S	Qsd	..	818	8-19-64	1,056	TH depth 317, L, C, E.
32ddd	Ole Pearson	17	1 1/4	Dv	1945	....	....	D	S	Qsd	Cy	1,050	9-64	1,060	
33oba	Clarence Haney	27	1 1/4	Dv	1947	....	....	S	G	Qsd	Cy	.....	....	1,055	
137-53															
1ccb	Andrew L. Watt	435	1 1/4	Dr	1910	Flow	7-25-63	D,S	...	Kd	..	.....	....	986	Yield 1.5 gpm.
2bdc	Richard Zick	450	3	Dr	....	Flow	7-25-63	D,S	S	Kd	..	.....	....	981	Yield 1.0 gpm.
3ddc	Elmer Greuel	495	3	Dr	1908	Flow	7-25-63	D,S	S	Kd	..	4,590	9-64	1,012	P.
4bdc	John H. Morris	420	3	Dr	....	Flow	8-2-65	D,S	...	Kd	..	.....	....	1,000	
4dbb	E. Erbstoesser	420	2 1/2	Dr	1957	Flow	8-2-63	D,S	...	Kd	..	4,630	11-17-64	1,000	C.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
<u>137-53</u>	Cont.														
5aad1	John Vining	15	12	Du	1961	.....	....	S	S	Qsd	Cy	.....	....	1,025	Supply reported I.
5aad2	..do...	34	24	B	1964	18	1964	D	S	Qsd	Cy	650	9-64	1,025	
6add	Floyd Bullis	465	3	Dr	1919	Flow	8-2-63	D,S	S	Kd	..	.....	....	1,035	Yield 0.5 gpm.
6baa	E. Manthei	435	3	Dr	....	Flow	8-2-63	D,S	S	Kd	..	.....	....	1,040	Yield 3.0 gpm.
6ccc	Wm. J. Martin	490	3	Dr	....	Flow	8-2-63	D,S	S	Kd	..	.....	....	1,051	
7dcc	D. Speikermeir	460	3	Dr	1960	Flow	8-2-63	D,S	S	Kd	..	.....	....	1,036	Yield 2.0 gpm.
8ccc	Glennis Hamre	600	3	Dr	1950	Flow	8-2-63	D,S	S	Kd	..	3,650	9-64	1,036	Yield 3.0 gpm.
9bda	Rueben Haugen	460	3	Dr	1942	Flow	8-2-63	D,S	S	Kd	..	.....	....	982	Rept'd unfit for watering plants.
9dad	Clarence Schimming	465	3	Dr	1914	Flow	7-25-63	D,S	...	Kd	..	.....	....	1,032	Yield 1.5 gpm.
10acc	Paul Grauel	516	3	Dr	1960	Flow	7-25-63	D,S	S	Kd	..	.....	....	1,025	Yield 1.3 gpm.
10cbb	Koetz Bros.	460	3	Dr	1948	Flow	7-25-63	D,S	...	Kd	..	.....	....	1,032	
11bab	Gordon Linke	496	3	Dr	1948	Flow	7-25-63	D,S	...	Kd	..	.....	....	1,005	Yield 3.0 gpm.
12bac	Alex Watt	425	3	Dr	1930	Flow	7-25-63	D,S	S	Kd	..	.....	....	988	Yield 2.0 gpm.
14baa	F. Erbstoesser	26	1 1/2	Dv	1960	.....	....	D,S	...	Qsd	S	.....	....	1,032	Supply rept'd I.
15abb	Gordon Zaeske	...	3	Dr	....	Flow	7-25-63	D,S	...	..	..	.....	....	1,038	Yield 1.3 gpm.
15bbb	Test hole 2205	105	..	Dr	10-10-63	....	....	T	...	..	..	.....	....	1,036	L, E.
15ccb	Francis Saunders	...	2 1/2	Dr	....	Flow	7-25-63	U	...	..	..	.....	....	1,041	Yield 3.0 gpm.
17bbb	Malford Hamre	590	3	Dr	1960	Flow	8-2-63	D,S	...	Kd	..	.....	....	1,040	Yield 1.5 gpm.
18cdb	Elmer Geyer	350	3	Dr	....	Flow	8-2-63	D,S	S	..	..	3,740	9-64	991	Yield 3.0 gpm.
19bcd	Ted Schimming	450	2 1/2	Dr	....	Flow	7-26-63	D,S	...	Kd	..	3,750	9-64	1,051	Yield 3.0 gpm.
19ccb	Walter Golz	33	22	B	1960	....	....	D,S	S	Qsd	Cy	2,770	11-17-64	1,061	C.
20aaa	Theo. A. Thompson	456	2 1/2	Dr	1939	Flow	7-26-63	D,S	S	Kd	..	.....	....	1,050	Yield 2.0 gpm.
20bcc	Rudolph Schimming	115	2	Dr	....	....	....	D,S	S	Qd	Cy	530	9-64	1,054	
21ddd	Richard McAtee	530	2 1/2	Dr	....	Flow	7-26-63	D,S	S	Kd	..	.....	....	1,051	Yield 3.0 gpm.
22abc	Fred Thompson	17	36	..	....	6.56	6-25-63	S	S	Qsd	Cy	.....	....	1,048	MP at ls.
23bcc	Francis Saunders	225	2	Dr	1914	Flow	7-25-63	S	S	..	..	2,800	9-64	1,049	Yield 1.3 gpm.
24aab	D. Randy	16	1 1/4	Dv	....	....	....	S	...	..	Cy	.....	....	1,043	
26dad	Hilman Mehus	25	1 1/4	Dv	....	....	....	S	S	Qsd	Cy	.....	....	1,056	
27dcc	Albert Gust	22	1 1/4	Dr	1948	....	....	D	S	Qsd	Cy	.....	....	1,059	
28daa	Laurence Baarstad	22	1 1/2	Dr	1945	....	....	D	...	Qsd	J	.....	....	1,055	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
137-53 Cont.															
29dad	Barfuss Bros.	27	1 1/4	Dv	....	.....	....	S	S	Qsd	Cy	.....	....	1,057	
30aad	USBR	25	..	..	....	.....	....	...	S	Qsd	..	.....	....	1,059	L, Well destroyed.
30abc	Walter Golz	600	2	Dr	....	Flow	7-26-63	U	...	Kd	..	.....	....	1,060	Yield 1.5 gpm.
30ccc1	Wilbert Kellerman	589	3	Dr	1960	Flow	7-26-63	D,S	S	Kd	..	.....	....	1,060	Yield 17 gpm.
30ccc2	..do...	587	3/4	Dr	....	Flow	7-26-63	D,S	S	Kd	..	.....	....	1,060	Supply rept'd I.
31baa	E. Koetz	15	2	Dr	....	.....	....	D,S	S	Qsd	Cy	1,880	9-64	1,061	
32aad	Manfred Walhood	492	1	Dr	1948	Flow	7-26-63	D,S	S	Kd	..	.....	....	1,061	Yield 6.0 gpm.
34abb	Harold Kurtz	23	1 1/4	Dr	....	.....	....	S	S	Qsd	Cy	.....	....	1,060	
34ccc	Test hole 2206	40	1 1/4	Dr	10-31-63	+1.06	10-31-63	O	S	Qsd	..	.....	....	1,058	L, E, MP 2.1 ft above ls. TH depth 136.
35aaa	Gertrude Loebrick	22	1 1/2	Dr	....	.....	....	S	S	Qsd	Cy	.....	....	1,060	
36ccc	Roger Morris	65	2	Dr	1961	.....	....	P,S,D	S	Qsd	J	.....	....	1,059	Reported hard.
137-54															
1bcb	Gerold Shea	550	2	Dr	....	Flow	7-29-63	D,S	...	Kd	..	.....	....	1,067	
2cbc	Max Scharbow	610	1 1/2	Dr	1955	Flow	7-29-63	D,S	G	Kd	..	.....	....	1,070	Yield 3 gpm
4dad	Harold Luther	620	2	Dr	1948	Flow	7-29-63	D,S	...	Kd	..	.....	....	1,086	
6bbc	John Bryon	271	3	Dr	1957	Flow	7-29-63	D,S	G	..	..	4,450	9-64	1,111	Yield 3 gpm.
7ccd	Ernest Utke	...	2	Dr	1929	Flow	7-29-63	D,S	...	..	..	.....	....	1,082	Yield 3 gpm.
8cbb	Wendell Klockman	586	2	Dr	....	Flow	7-29-63	S	...	Kd	..	.....	....	1,082	
9aad	Glenn Sprunk	40	18	B	1962	.....	....	D	G	Qd	J	.....	....	1,071	L.
9ada	..do...	530	3/4	Dr	1910	Flow	7-29-63	S	...	Kd	..	.....	....	1,070	Yield 3 gpm.
11aaa	Roger Shea	500	1 1/2	Dr	1910	Flow	7-29-63	D,S	...	Kd	..	3,350	9-64	1,066	
12daa	Charles Zaeske	33.6	30	..	....	7.58	4-4-64	U	...	..	Cy	.....	....	1,056	MP 1.1 ft above ls.
13daa	J. Bartholomay	12	1 1/4	Dv	....	.....	....	D,S	S	Qow	J	1,780	9-64	1,015	
17bbc	James Runck	600	2	Dr	1953	Flow	8-2-63	D,S	..	Kd	..	.....	....	1,080	
17ccb	..do...	...	1 1/2	Dr	1951	Flow	8-2-63	U	..	..	..	.....	....	1,085	Yield 10 gpm.
18cbb	Fred Oehlke	650	1 1/4	Dr	1942	Flow	7-20-63	D,S	..	Kd	..	3,410	9-64	1,085	
20bbb	Maynard Lindemann	600	1 1/4	Dr	1910	Flow	8-2-63	D,S	..	Kd	..	.....	....	1,080	Yield 4 gpm.
21dba	Arthur Pfefferle	15	1 1/4	Dr	....	.....	....	D,S	..	Qow	Cy	.....	....	1,029	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
137-54 Cont.															
22cdd	Frank Mark	500	2	Dr	1951	Flow	7-26-63	D,S	...	Kd	..	.....	....	1,065	Yield 4.5 gpm.
23cba	Harold Reynolds	560	3/4	Dr	1916	Flow	7-26-63	D,S	...	Kd	..	.....	....	1,066	Yield 2 gpm.
25dcc1	Ken Kellerman	...	1	Dr	....	Flow	7-26-63	S	...	..	..	.....	....	1,055	Yield 1.0 gpm.
25dcc2	..do...	40	2	Dr	1961	....	....	D	...	..	J	.....	....	1,055	
26dba	Robert Kellerman	586	1	Dr	1949	Flow	7-26-63	D,S	...	Kd	..	.....	....	1,061	Yield 7 gpm.
27cbc1	Fred Menge	537	2	Dr	1920	Flow	7-26-63	S	...	Kd	..	.....	....	1,063	Yield 2.5 gpm.
27cbc2	..do...	54	24	B	1961	.....	....	D	S	J	..	3,600	9-64	1,063	
28ccc	John Anderson	12	1 1/4	Dr	1960	.....	....	D,S	S	Qow	Cen	833	11-17-64	1,033	
29ddd	Miller Bros.	800	3	Dr	1924	Flow	7-29-63	D,S	S	Kd	..	3,580	9-64	1,031	Yield 5 gpm.
30ccd	Robert Geske	600	1 1/4	Dr	1920	Flow	7-29-63	D,S	...	Kd	..	.....	....	1,096	Yield 3 gpm.
32ccd	Benson Hjilmer	24	2	Dv	....	.....	....	D,S	S	Qow	Cy	.....	....	1,065	
32ddd	Test hole 3146	227	..	Dr	3-8-63	.....	....	T	...	..	..	.....	....	1,072	L, E.
34ccc	Leon Heuer	565	2	Dr	1961	Flow	7-26-63	D,S	S	Kd	..	3,820	9-64	1,067	Yield 7 gpm.
34dbd	E. Spitzer	561	2	Dr	1960	Flow	7-26-63	D,S	...	Kd	..	.....	....	1,060	Yield 3 gpm.
35abd	Robert Offerman	554	2 1/4	Dr	1926?	Flow	7-26-63	D,S	S	Kd	..	.....	....	1,057	Yield 4 gpm.
36bba	George Becker	548	2	Dr	1960	Flow	7-26-63	D,S	...	Kd	..	.....	....	1,063	Yield 2 gpm.
36ccc	Test hole 2204	20	1 1/4	Dr	10-15-63	8.93	10-15-63	O	St	Qd	..	.....	....	1,064	L, E, Destroyed TH depth 231.
137-55															
1ccd	Elmer Utke	430	1 1/2	Dr	1910	Flow	8-15-63	D,S	...	..	..	3,510	9-64	1,106	Yield 2 gpm.
2aad	G. Schatzke	820	1 1/2	Dr	1942	Flow	8-14-63	D,S	S	Kd	..	.....	....	927	Yield 4.0 gpm.
3bcb	Evan Mueller	680	1 1/4	Dr	1910	Flow	8-15-63	D,S	...	Kd	..	.....	....	1,152	Yield 1.5 gpm.
4ccb	Eva Lindeman	780	2	Dr	1960	Flow	8-15-63	D,S	S	Kd	..	.....	....	.....	Yield 4.0 gpm.
4ccd	..do...	650	2	Dr	1946	Flow	8-15-63	S	...	Kd	..	3,690	9-64	.....	Yield 3.0 gpm.
7cbb	Janz Bros.	7	24	B	1955	....	....	D	G	Qd	J	1,750	9-64	.....	Supply rept'd I.
8bab	Leo Lemna	650	1 1/2	Dr	1945	Flow	8-16-63	D,S	...	Kd	..	.....	....	.....	Yield 5 gpm.
10cbb	Alfred Huske	680	1 1/4	Dr	1944	Flow	8-15-63	D,S	...	Kd	..	.....	....	1,145	Yield 2 gpm.
11baa	Myron Golz	685	1 1/2	Dr	1943	Flow	8-14-63	D,S	...	Kd	..	.....	....	1,136	Yield 2.5 gpm.
12dac	Martha Wendlandt	580	1 1/2	Dr	1910	Flow	8-15-63	D,S	...	Kd	..	.....	....	1,092	Yield 3.0 gpm.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
137-55 Cont.															
13dac	Alvin Kurtz	600	1	Dr	1925	Flow	8-15-63	D,S	...	Kd	..	.....	....	1,086	Yield 2 gpm.
14ccd	Emil Geske	630	1 1/2	Dr	1940	Flow	....	D,S	...	Kd	..	.....	....	1,128	Yield 3.0 gpm.
15dad	Eldon Schatzke	...	1 1/2	Dr	....	Flow	8-14-63	D,S	...	..	..	.....	....	1,135	
17bab	Anton Johnson	60	36	B	1928	22.69	1-21-64	D,S	S,G	Qd	Cy	4,500	9-64	.....	MP 0.5 ft above ls.
18bbb	Vernon Johnson	18	12	B	1960	....	....	D	...	Qd	J	.....	....	.....	Rept'd unfit for drinking.
18ddd	Test hole 3140	62	..	Dr	8-5-64	....	....	T	...	Qd	..	.....	....	1,182	L, E.
20ccc	Verner Lindemann	835	1 1/2	Dr	1953	Flow	8-16-63	D,S	...	Kd	..	5,400	6-25-64	.....	C, yield 1 gpm.
24cdd	Paul Peck	608	1 1/4	Dr	1956	Flow	8-15-63	D,S	...	Kd	..	3,920	9-64	1,100	Rept'd corrosive and unfit for watering plants.
26ddd	Hubert Bleese	...	1 1/2	Dr	1948	Flow	8-15-63	D,S	...	..	..	.....	....	1,105	Yield 3 gpm.
27ddd	F. W. Petrich	700	1 1/2	Dr	1900	Flow	8-14-63	D,S	...	Kd	..	3,510	9-64	1,116	Rept'd corrosive.
28bab	E. H. Kraft	825	1 1/2	Dr	1937	Flow	8-16-63	D,S	...	Kd	..	.....	....	.....	Rept'd corrosive.
28dad	Leonard Anderson	400	1 1/2	Dr	1910	Flow	8-15-63	D,S	...	..	..	.....	....	1,105	
29aaa	Test hole 3142	62	..	Dr	8-6-64	....	....	T	...	..	..	.....	....	1,157	L, E.
29ddd	Test hole 3143	77	..	Dr	8-6-64	....	....	T	...	..	..	.....	....	1,155	L, E.
30abb	Harold Spitzer	29.6	36	B	1942	23.20	8-16-63	D,S	...	Qd	Cy	.....	....	.....	MP 0.75 ft above ls.
30bcb	Test hole 3139	80	1 1/4	Dr	8-4-64	22.46	9-2-64	O	S,G	Qd	..	1,780	8-6-64	1,179	L, C.
30cbb	Gordon Lund	48	30	B	1930	.....	....	D,S	..	Qd	Cy	.....	....	.....	
31cdd	Robert Hanson	30	18	B	....	.....	....	S	G	Qd	Cy	.....	....	.....	
32ddd1	Arthur Ritter	63	28	B	1949	.....	....	S	G	Qd	Cy	.....	....	.....	Supply rept'd I.
32ddd2	Test hole 3144	77	..	Dr	8-6-64	.....	....	T	S	Qd	..	.....	....	1,155	L, E., TH depth 137.
33cdd	E. N. Kittelson	52.8	24	B	....	38.57	8-16-63	U	G	Qd	Cy	.....	....	.....	MP 2.3 ft above ls.
34cdc	John Hanson	700	1 1/2	Dr	1930	Flow	8-14-63	D,S	...	Kd	..	.....	....	1,125	Yield 2.5 gpm.
34dcb	Edwin Fernow	621	1 1/4	Dr	1953	Flow	8-14-63	D,S	...	Kd	..	.....	....	1,114	Yield 16.0 gpm.
35ddc	Erwin Utke	60	1 1/2	Dr	1951	.....	....	D,S	S	Qd	J	.....	....	1,115	
35ddd	Test hole 3145	125	1 1/4	Dr	8-7-64	47.90	9-2-64	O	S	Qd	..	1,440	8-16-64	1,114	L, C, E.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-48															
7bdt	Fred M. Hector	180	4	Dr	1957	.....	....	D,S	...	Qd	T	1,120	6-64	904	
7ccc	F. B. Sharp	146	4	Dr	8-61	41.86	10-4-63	D	S	Qd	S	930	6-64	900	Yield 100 gpm, L.
7ccd	Bud Anderson	136	4	Dr	6-61	38.48	1-30-64	D	S	Qd	S	950	6-64	900	L, MP 1.5 ft above ls.
7cdd	..do...	153	4	Dr	7-60	40	7-11-60	D	S	Qd	S	1,030	11-13-64	900	L, C.
18acd	David Johnson	200	4	Dr	5-62	34.20	5-14-63	D	S	Qd	S	.....	....	892	L, P, MP 1.3 ft above ls.
18adc	L. Frederickson	148	4	Dr	5-61	.....	....	U	S	Qd	..	.....	....	890	L, P, Yield 5 gpm.
18add	Dr. V. G. Borland	146	4	Dr	5-61	.....	....	U	S	Qd	..	.....	....	888	
18bda	Dr. H. J. Weyers	180	4	Dr	12-59	36	12-16-59	D	S	Qd	S	2,870	6-64	893	L, C, yield 5 gpm.
18dab1	Harold Erpelding	148	4	Dr	4-61	47	4-27-61	D	S	Qd	S	.....	....	895	L, P, Supply rept'd I.
18dab2	Rolf Hofstad	191	4	Dr	12-59	30	12-7-59	U	S	..	..	.....	....	895	L, E.
19bbb	Ivan Cossette	92	4	Dr	5-59	.....	.....	D	...	Qd	Cy	1,110	6-64	906	
30dcd	Harold Anderson	140	4	Dr	5-62	28	5-28-62	D	S	Qd	Cy	960	6-64	910	L, P, Yield 4 gpm.
138-49															
1abb	Ralph Scilley	325	4	Dr	4-58	.....	....	D,S	...	..	Cy	2,320	6-64	905	
2aaa	Orville Young	273	3	Dr	10-62	43	10-3-62	D	S	Qd	Cy	.....	....	906	L.
3aab	T. MacDonald	120	3	..	....	.....	.....	D	...	Qd	Cy	1,040	6-64	907	
4aaa	Test hole 3104	150	1 1/4	Dr	6-4-54	38.48	7-1-64	O	S&G	Qd	..	670	6-6-64	905	L, E, TH depth 355.
5bbb	John C. Rusted	123	4	Dr	1950	.....	.....	D,S	...	Qd	Cy	1,180	6-64	901	
6bca	T. O. Grant	165	4	Dr	9-46	.....	.....	D,S	...	Qd	Cy	2,000	6-64	906	
6dca	Hammer Farms	75	16	B	1936	39.62	6-5-63	D	...	Qd	Cy	1,730	6-64	901	MP 1.0 ft above ls.
6ddb	Paul Berg	42	4	Dr	11-62	.....	.....	D	...	..	Cy	.....	....	901	
8aab	Gust Arneson	97	4	Dr	1919	.....	.....	D,S	...	Qd	Cy	1,150	6-64	906	
8ccd	Test hole 2346	252	..	Dr	6-8-65	.....	.....	T	S	Qd	..	.....	....	915	L.
10dcd	Alpha Rheault	90	24	B	1940	.....	.....	D,S	...	Qd	Cy	1,540	6-64	905	
12aab	P. E. Peterson	320	2	Dr	1956	80	.....	D	...	..	J	5,680	11-13-64	907	C.
12aba	Homer Berglund	89	4	Dr	6-59	.....	.....	D	...	Qd	Cy	1,200	6-64	906	
12ddd	Cyril Walsh	138	4	Dr	4-63	42.82	1-30-64	D	S	Qd	S	.....	....	906	L, MP 3.0 ft above ls.
13aaa	Wm. J. Martin	132	4	Dr	6-62	44.16	11-2-64	D	S	Qd	S	1,000	11-13-64	906	L, C, MP 1.2 ft above ls.
13baa	Test hole 3114	302	..	Dr	7-7-64	.....	.....	T	...	...	..	.....	....	906	L, E.
13dad	Paul Knox	250	4	Dr	....	.....	.....	D	S	Qd	S	.....	....	907	L.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-49 Cont.															
15aad	G. Geauvauglaw	235	4	Dr	1950	.....	....	D,S	S	Qd	Cy	700	6-64	903	
15bab	Leon Burnelle	179	..	Dr	1956	.....	....	D,S	...	Qd	Cy	577	6-25-64	906	C.
16ccd	Alfred Trottier	84	4	..	....	.....	....	D,S	...	Qd	Cy	1,230	6-64	905	
16ddd	Test hole 3105	319	..	Dr	6-5-64	.....	....	T	...	..	..	.....	....	907	L,E.
17ddc	Marian Tessier	...	4	..	....	.....	....	D,S	...	..	Cy	1,140	6-64	905	
18ddc	Village of Horace	112	4	Dr	11-62	44.20	6-4-63	P,S	...	Qd	S	.....	....	910	MP 1.0 ft above ls.
19aaa	Horace School District	303	4	Dr	1958	.....	....	P,S	S	Qd	J	1,660	3-4-64	916	C.
20bbb	Village of Horace	110	4	Dr	1955	.....	....	P,S	...	Qd	J	1,210	11-13-64	914	C.
20dda	Lowell Ramsett	75	10	Dr	1934	.....	....	S	S	Qd	Cy	4,740	6-64	906	Supply rept'd I.
21bab	Anna Richard	66.9	8	Dr	....	23.01	6-11-63	U	...	Qd	Cy	.....	....	907	MP 2.0 ft above ls.
21ddc	Adrian Rheault	74	20	..	....	.....	....	D,S	...	Qd	..	1,270	6-64	911	
22bab	Anthony Richard	56	8	B	1893	44	1956	D,S	...	Qla	Cy	830	6-64	906	Supply rept'd I.
24cbc	Anton Rutten	80	12	Dr	....	.....	....	D,S	S	Qd	J	1,060	6-64	910	
25aba	D. G. Tessier	100	24	Dr	....	.....	....	D	...	Qd	Cy	1,670	6-64	906	Adequate for house only
26daa	Orie Langseth	143	6	Dr	1950	.....	....	D,S	S	Qd	J	1,050	6-64	910	
27baa	Henry Tessier	240	2	Dr	1948	.....	....	D,S	S	Qd	Cy	745	11-13-64	909	
27ddd	Francis Bellemare	183	3	Dr	1954	.....	....	D,S	S	Qd	Cy	760	6-64	909	
28dcc	Lionel Trottier	90	4	Dr	1951	.....	....	D,S	G	Qd	J	1,160	11-13-64	910	C.
29bbb	Arthur Bailly	187	3	Dr	1960	.....	....	D,S	S	Qd	Cy	1,380	6-64	916	
29ccc	Test hole 3115	280	1 1/4	Dr	7-7-64	32.17	8-1-64	O	S&G	Qd	J	2,020	8-20-64	912	MP 2.0 ft above ls. E, L, C, TH depth 317 ft.
30bbb	Adolf Clemenson	217	4	Dr	1958	.....	....	D,S	S	Qd	J	4,040	6-64	916	
31bab	A. M. Johnson	243	4	Dr	1930	.....	....	D,S	...	Qd	Cy	2,820	11-13-64	916	C.
32adb	Ovila Rheault	83	3	Dr	1949	.....	....	D,S	S	Qd	J	1,080	6-64	910	
34ccc	Test hole 3106	100	1 1/4	Dr	6-6-64	25.04	6-30-64	O	S&G	Qd	..	858	6-11-64	910	MP 1.98 ft above lsd, L,C, E, TH depth 345 ft.
34ccd	Servet Cossette	115	3	Dr	1945	.....	....	D	G	Qd	Cy	810	6-64	910	
35adb	Clarence Solberg	135	3	Dr	1938	.....	....	D,S	S	Qd	Cy	1,060	6-64	910	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-49 Cont.															
36aca	Reitan Bros	64	18	B	1940	.....	....	D,S	G	Qd	J	1,360	6-64	910	
36dda1	KXGO Inc.	138	4	Dr	6-61	.....	....	D	S&C	Qd	Cy	1,510	6-64	910	L, P.
36dda2	..do...	70	3	Dr	....	20.70	5-15-63	U	...	Qd	..	.....	....	910	MP 1.65 ft above ls.
138-50															
1bdc1	Jerome Qualley	90	4	Dr	1945	.....	....	D,S	...	Qd	Cy	1,750	6-64	904	Well used to flow.
1bdc2	..do...	89	4	Dr	6-18-63	39	6-19-63	D,S	S	Qd	S	.....	....	904	L.
2ddd	Howard Qualley	150	4	Dr	1940	8	1940	D,S	S	Qd	Cy	1,370	6-64	905	
3bdd	R. S. Lewis Estate	100	3	Dr	1956	.....	....	D,S	...	Qd	Cy	.....	....	908	
4cda	Adele Hajek	108	3	Dr	1959	.....	....	S	G	Qd	Cy	1,960	6-64	912	
4dcc	Ray Eggert	133	3	Dr	1956	.....	....	D,S	S	Qd	Cy	1,680	6-64	911	
5add	Frank Parsley	455	3	..	1938	.....	....	D	...	Kd	Cy	3,790	3-4-64	913	C.
5bbb	Test hole 3116-A	240	1 1/4	Dr	7-10-64	18.81	8-1-64	O	S&G	Qd	..	1,440	7-14-64	913	MP 0.7 ft above ls, L, C, E, TH depth 377 ft.
8cdc1	Thom Ebens	70	18	..	....	.....	....	D,S	...	Qd	Cy	1,860	6-64	910	
8cdc2	L. G. Sautebin	182	4	Dr	3-64	35	3-64	D,S	S	Qd	S	.....	....	910	Yield 75 gpm, L.
9bbb	Emil Hendrikson	150	6	..	....	20	1956	D,S	...	Qd	Cy	1,810	6-64	913	
11aad	H. M. Skrove	90	3	Dr	1948	.....	....	D	S	Qd	Cy	1,170	6-64	906	
12ddc	Leseth Trygve	80	3	Dr	1953	.....	....	D	...	Qd	Cy	2,690	6-64	908	
13bcb	A. Libbrecht	123.0	4	Dr	4-60	26.17	10-23-63	D,S	S	Qd	S	1,740	11-13-64	909	L, C, MP 0.5 ft. above ls.
14aad	Martin Rustad	289	4	Dr	1955	.....	....	D,S	...	Qd	Cy	3,080	6-64	909	
16bba	Arthur Benson	160	3 1/2	Dr	....	40	1960	D,S	...	Qd	Cy	1,350	6-64	914	
17ddd	Delmer Schultz	85	3	..	....	20	1962	D	S	Qd	J	.....	....	920	
20aab	Driscoll Bros.	300	4	..	....	21	1962	D	...	..	Cy	2,050	6-64	911	
20cdd	Ray Huhner	180	4	Dr	5-61	35	5-61	D,S	S	Qd	S	1,660	11-13-64	918	L, C, Yield 100 gpm.
24cad	Oscar Wester	115	3 1/2	Dr	1943	.....	....	D	...	Qd	Cy	1,530	6-64	912	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-50 Cont.															
25bcb	Andrew Stenberg	40	48x48	Du	....	.....	....	U	...	Qla	Cy	.....	....	914	
27bcc	Robert Brodhaug	90	4	Dr	1940	.....	....	D,S	...	Qd	Cy	950	6-64	914	
27ddd	Curtis Sorenson	134	4	Dr	1947	.....	....	D	...	Qd	Cy	.....	....	915	
28bcc	August Alber	18	10	B	1961	.....	....	D	...	Qla	Cy	.....	....	916	Supply rept'd I.
28cbd	John Broselle	80	4	Dr	....	.....	....	D	...	Qd	Cy	1,090	6-64	916	
29add	Oline Lahren	22	10	B	1953	.....	....	D	...	Qla	Cy	2,130	6-64	916	Supply rept'd I.
31dbb	Louis Swisher	248	4	Dr	1962	.....	....	D,S	...	Qd	S	2,700	6-64	918	
32dcd	C. O. Sorenson	90	18	Dr	.....	.....	....	D	...	Qd	Cy	1,600	6-64	918	Supply rept'd I.
33bcd	Walter Gulsvig	312	3	Dr	1961	.....	....	D,S	G	..	Cy	1,650	6-64	916	
34ccc	Joseph Engen	131	4	Dr	5-60	32	5-60	D,S	S	Qd	Cy	1,160	6-64	920	L, P.
35aaa	Test hole 3136	100	1 1/4	Dr	7-30-64	27.56	12-9-64	O	S	Qd	..	1,920	7-31-64	913	L, C, MP 0.7 ft above land surface, E, TH depth 227 ft.
36bdd	Adolf Johnson	120	3	Dr	1948	.....	....	D,S	S	Qd	Cy	2,140	6-64	917	
138-51															
1cba	Marvin Erdman	45	48	Du	1913	.....	....	U	...	Qla	Cy	.....	....	911	
2bcb	Willie Miller	130	4	Dr	....	.....	....	D	G	Qd	Cy	1,670	6-64	911	
3bbc	..do...	325	8	Dr	....	.....	1962	S	S	..	Cy	5,090	6-64	914	
4bbb	Leslie Bucholz	380	6	Dr	1943	6	1962	S	...	..	Cy	5,650	7-24-64	918	
5bcb	Hilbert Baumgarten	337	3	Dr		1	1962	D,S	...	..	Cy	4,120	6-64	920	
5cab	Leo Vanisch	180	3	Dr	....	.....	....	D	...	Qd	Cy	2,820	6-64	920	
5dcc	Raymond Bernstein	215	4	Dr	9-63	.....	....	D,S	S	Qd	S	.....	....	923	L.
7ada	W. Bernstein	231	3	Dr	1950	6.64	7-9-63	D	S	Qd	J	.....	....	926	MP 1.2 ft above ls.
8bad	Ralph Powers	193	4	Dr	1960	15	1960	D,S	S	Qd	S	2,910	6-64	920	L, P, E.
9ccd	Victor Gohdes	80	48x48	Du	1920	51.97	7-9-63	D,S	G	Qd	Cy	1,770	11-18-64	920	MP 1.6 ft above ls, Supply I.
10ddd	L. E. Cromwell	87.0	16	B	....	8.90	6-27-63	U	...	Qd	Cy	.....	....	916	MP 0.5 ft above ls.
11ddd	Arthur Schneider	350	4	Dr	1917	27.69	6-27-63	D,S	...	..	Cy	.....	....	915	MP 1.1 ft above ls.
12bcc	Allen Hans	125	3	..	....	.....	....	S	...	Qd	Cy	.....	....	913	
14bcb	Eleanor Schwarz	90	48	Du	....	19.60	6-27-63	S	...	Qd	Cy	5,260	....	916	MP 1.0 ft above ls.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-51 Cont.															
17baa	Ben Stange	80	..	B	1959	.....	....	S	G	Qd	Cy	2,060	6-64	925	
18bab	Irvin Piper	68	18	B	1933	12.90	1-22-64	D	...	Qd	Cy	.....	....	925	MP 0.8 ft above ls.
19ccb1	Clifford Glasow	75	10	B	....	32.10	7-10-63	D	...	Qd	J	3,100	6-64	928	MP at ls.
19ccb2	..do...	378	..	..	....	12.70	7-10-63	S	...	..	Cy	3,890	6-64	928	MP 1.3 ft above ls.
20cba	Allen Hans	80	48x48	Du	....	30.60	7-10-63	D,S	...	Qd	Cy	.....	....	923	MP 0.3 ft above ls.
21bba	Hubert Hans	80	24	B	....	35	1962	D,S	...	Qd	Cy	1,570	6-64	923	
24ccb	Robert Cockerill	80	24	B	....	.....	....	D,S	...	Qd	J	1,620	11-18-64	915	C.
26abc	Minnie Westphal	80	3	Dr	....	30	1962	...	...	Qd	..	1,430	6-64	915	
29ddc	Irvin Friese	82	3	Dr	1948	.....	....	D	G	Qd	Cy	1,030	6-64	923	
30bca	John Bucholz	80	24	B	....	10.80	7-10-63	U	S	Qd	Cy	.....	....	929	MP 0.5 ft above ls.
32cbb	Albert Piper	69	4	Dr	8-5-62	23	8-5-62	D,S	S	Qd	S	1,530	11-18-64	925	L, Yield 30 gpm.
32dcd	Lawrence Ottow	85	36	Du	1909	.....	....	D,S	...	Qd	J	1,950	6-64	923	
33cbd	Clemens Hans	87	3	Dr	1932	.....	....	D	...	Qd	Cy	1,330	6-64	922	
33cca	..do...	227	3	Dr	1959	.....	....	D,S	S	Qd	J	3,520	6-64	922	
34ddd	Donald Kellerman	118	4	Dr	....	.....	....	U	...	Qd	Cy	1,830	6-64	920	
35bbc	Carl Grindberg	165	3	Dr	1935	17	1958	D	S	Qd	J	2,060	6-64	917	
35cdd	Carl Heuer	148	3	Dr	1957	8	1957	D	G	Qd	S	1,760	6-64	915	
36ddd	A. L. Stenjem	96	3	Dr	1945	.....	....	D	...	Qd	J	1,280	6-64	917	
138-52															
1aba	Hoffman Bros.	27	1 1/4	Dr	1948	.....	....	D,S	S	Qla	J	3,690	6-64	926	
2bab	Berthold Jahnke	300	4	Dr	1930	.....	....	D,S	...	..	Cy	1,980	6-64	925	
3aab	Myrtle Jahnke	390	4	Dr	1959	.....	....	D,S	S	..	S	5,850	6-64	940	L, P, Yield 40 gpm.
3bba	A. K. Stolzman	22	36	Du	1920	.....	....	D	...	Qla	Cy	1,300	6-64	936	
3cbc	Elmer Saar	410	3	Dr	1920	Flow	7-18-63	D,S	...	..	..	5,700	6-64	935	
4cab1	Richard Wiesbach	120	3	Dr	1935	Flow	7-18-63	S	G	Qd	..	.....	....	.....	
4cab2	..do...	69	6	Dr	1948	.....	....	D	G	Qd	Cy	1,660	6-54		
5dab	Ernie Buchholz	384	2	Dr	1920	Flow	7-18-63	D,S	...	..	J	5,710	6-64	.....	Yield 1 gpm.
7dad	Hilton Saewert	365	2	Dr	1900	Flow	7-18-63	D,S	S	..	..	5,330	6-64	.....	
8dad1	Ted Piper	300	2	Dr	1930	.....	....	U	...	..	..	.....	....	.....	Well used to flow.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-52 Cont.															
8dad2	Ted Piper	80	3	Dr	1949	14	1963	D,S	...	Qd	Cy	940	6-64	.....	
9add	Clark Baumgartner	71	4	Dr	6-59	11.67	1-22-64	S	S&C	Qd	S	.....	....	.....	L, P, MP 1.55 ft above ls.
9ccc	Ted Piper	160	3	Dr	1958	25	1958	D	S	Qd	Cy	970	6-64	.....	
10cbb	A. Miller	71	3	Dr	1962	.....	....	S	...	Qd	Cy	2,160	6-64	945	
11ccc	W. L. Haggert	276	4	Dr	1959	Flow	6-4-59	D,S	G	..	..	4,800	11-10-64	935	L, C, Yield 200 gpm.
12aab	William Piper	18	1 1/2	Dv	....	.....	....	D	G	Qla	Cy	2,710	6-64	930	
13aab	A. Ratchenski	16	3	Dv	1940	4	7-63	U	S	Qla	..	1,640	6-64	930	
15aaa1	Hugo Greuel	74	36	Dr	1934	12	7-63	D,S	S	Qd	Cy	1,660	6-64	937	
15aaa2	..do...	58	24	B	....	8	7-63	U	S	Qd	..	1,330	6-64	937	
16ddd	Wesley Priewe	15	36	Du	....	9.90	7-18-63	D	S	Qla	Cy	3,260	6-64	940	MP at ls.
17dcd	Bill Powers	119	3	Dr	1952	60	7-63	D,S	G	Qd	Cy	1,410	6-64	.....	
18baa1	Ruth Peeler	81	5	Dr	1963	.....	....	D	S	Qd	S	1,500	6-64	.....	L.
18baa2	..do...	570	3	Dr	1928	Flow	7-18-63	U	S	Kd	..	.....	....	.....	
19ddd	George Paulson	72	3	Dr	1953	.....	1953	D,S	S	Qd	Cy	2,690	6-64	950	
21aad	Dora Seiwert	25	48	B	....	11.67	7-17-63	D,S	G	Qla	Cy	.....	....	940	MP 1.0 ft above ls.
23bcb1	John Runck	65	6	Dr	1933	.....	....	D	S	Qd	Cy	1,290	6-64	935	
23bcb2	..do...	400	3	Dr	1958	Flow	7-17-63	D,S	G	..	..	4,780	6-64	935	
24abc	Ed Piper	375	3	Dr	1935	Flow	....	D,S	...	..	..	4,780	6-64	930	Yield 1 gpm.
25bbb	Harold Glasow	311	4	Dr	....	.....	.....	D,S	S	..	S	.....	....	932	L, P.
26bba	Fred Zick	82	3	Dr	1952	20	7-63	D,S	G	Qd	J	1,510	6-64	932	
27daa	Herman Salzwedel	130	48	B	1900	5.25	7-17-63	D,S	...	Qd	Cy	1,560	6-64	935	MP 0.8 ft above ls.
28bcd	E. C. Wichmann	500	6	Dr	....	Flow	7-17-63	D	G	Kd	..	4,750	6-64	946	Yield 1 gpm.
28ccb1	E. Powers	85	4	Dr	8-61	20	1961	D,S	G	Qd	Cy	1,360	6-64	945	
28ccb2	..do...	60	12	B	....	9.44	4-3-64	U	...	Qd	..	.....	....	945	MP 0.3 ft above ls.
29dcb	Gordon Roesler	480	4	Dr	1953	Flow	7-17-63	D,S	S	Kd	...	5,210	6-64	946	
29ddc	Wesley Belter	387	3	Dr	1953	Flow	7-17-63	D,S	S	..	..	4,700	6-64	945	Yield 2.0 gpm.
30bcb	Lester Friese	380	3	Dr	....	Flow	7-17-63	D,S	G	..	..	5,100	6-64	948	Yield 2.0 gpm.
32ccd	Harold Dittmer	300	1	Dr	1913	Flow	7-17-63	D,S	...	..	..	4,410	6-64	956	Yield 6.0 gpm.
34ddd	Elmer Heuer	68	21	B	1953	10.50	7-16-63	D	S	Qd	Cy	2,350	6-64	940	MP 1.5 feet above ls, Supply I.
36cdd1	Herbert Buchholz	40	48	Du	1900	9.9	7-16-63	S	S	Qla	Cy	.....	....	938	MP 1.5 ft above ls, Supply I.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-52 Cont.															
36cdd2	Herbert Buchholz	260	3	Dr	1953	Flow	7-16-63	D	...	..	J	.....	....	938	Yield 1.0 gpm.
138-53															
1aba	Martha Schwager	86	4	Dr	1948	.....	....	D,S	G	Qd	Cy	2,830	6-64	.....	
2cdd	Gordon Krueger	300	3	Dr	....	Flow	7-23-63	D,S	...	..	..	5,590	6-64	.....	Yield 2.0 gpm.
3ddc	Ervin Pfeiff	360	3	Dr	1903	Flow	7-23-63	D,S	...	..	..	5,000	6-64	.....	..Do...
4baa	Lawrence Baumler Jr.	360	3	Dr	....	Flow	7-23-63	D,S	...	..	..	5,250	6-64	.....	Yield 1.5 gpm.
4dcd	W. Allan Watt	435	3	Dr	1949	Flow	7-23-63	D,S	S	Kd	..	4,540	6-64	.....	Yield 1.1 gpm.
5aba	Leonard Brown	275	3	Dr	1933	Flow	7-23-63	D,S	...	..	..	4,030	6-64	.....	Yield 3.0 gpm.
5bdc	Robert Reed	398	2	Dr	....	Flow	7-23-63	D,S	...	..	..	4,110	6-64	.....	Yield 1.3 gpm.
6abb	Wes Summerfield	32	42	B	....	10.64	6-23-63	D,S	...	Qla	Cy	2,610	11-10-64	.....	C, MP 0.3 ft above ls.
7add	Alfred Kickertz	...	4	Dr	....	Flow	7-23-63	D,S	...	..	..	4,190	6-64	.....	Yield 3.0 gpm.
8add1	Wm. Freitag	30	30	B	....	3.94	7-23-63	S	...	Qla	Cy	.....	....	.....	MP 0.4 ft above ls.
8add2	..do...	83	63	B	1958	.....	....	D	S	Qd	J	3,030	6-64	.....	Yield 6 gpm.
9daa	Lewis Levos	378	3	J	6-63	Flow	6-63	D,S	S	..	..	4,360	6-64	.....	Yield 15 gpm.
10cdd	C. M. Dahl	424	4	Dr	1961	Flow	7-22-63	D,S	S	Kd	..	4,700	6-64	.....	L, E.
10dcc	Dennis Pagel	110	4	Dr	11-25-60	11	11-25-60	D	S	Qd	Cy	.....	....	.....	L, P.
10dcd1	Donald Slocum	67	3	Dr	1949	5	1949	D	S	Qd	J	2,140	6-64	.....	
10dcd2	Village of Chaffee	375	3	Dr	1900	Flow	7-22-63	U	...	..	..	.....	....	.....	
10ddc	Chaffee Public School	115	4	Dr	1961	.....	....	P,S	S	Qd	Cy	2,500	11-11-64	.....	C, Yield 14 gpm, L.
11acd	Louis Hahn	420	3	Dr	1918	Flow	7-23-63	D,S	S	Kd	..	5,890	6-64	.....	Yield 1.0 gpm.
13aad	Keith Jensen	360	..	Dr	1959	Flow	7-22-63	D,S	...	..	..	5,050	6-64	.....	
13bab1	James Jensen	68	4	Dr	1950	.....	....	D,S	...	Qd	Cy	3,510	6-64	.....	Supply rept'd I.
13bab2	..do...	415	2	Dr	7-63	Flow	....	S	...	Kd	..	.....	....	.....	L.
14aaa	Melvin Pagel	483	1 1/2	Dr	1923	Flow	7-22-63	D,S	S	Kd	..	6,170	6-64	.....	Yield 0.3 gpm.
14bbb	Franklin Liebenow	...	2 1/4	Dr	1951	Flow	7-22-63	D,S	...	..	..	4,600	6-64	.....	Yield 2.0 gpm.
16bbb	Wm. Martin	440	2	Dr	1912	Flow	7-23-63	D,S	...	Kd	..	4,190	6-64	.....	Yield 3.0 gpm.
16ddd	Henrietta Oertlie	408	1 1/4	Dr	1924	Flow	7-19-63	D,S	...	..	..	4,360	6-64	.....	Yield 2.0 gpm.
17aaa	Adolph Kensak	420	3	Dr	....	Flow	7-23-63	D,S	...	Kd	..	5,380	6-64	.....	..Do...
18bcc	..do...	400	3	Dr	....	Flow	7-23-63	D,S	...	..	..	4,110	6-64	.....	Yield 1 gpm.
19aba	Leo Heger	...	..	Dr	....	Flow	7-19-63	D,S	...	..	..	4,100	6-64	.....	Supply rept'd I.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-53 Cont.															
20ddc	Lonley Vining	390	1 1/4	Dr	1908	Flow	....	D,S	...	..	..	4,540	6-64	1,005	
21abb	H. E. Combs	53.3	36	B	....	17.18	6-19-63	S	...	Qd	Cy	.....	....	.....	MP 1.0 ft above ls.
22aaa	Walter Martin	490	3 1/2	Dr	1920	Flow	7-22-63	D,S	...	Kd	..	4,540	6-64	.....	
22bbb	E. P. Bracht	40	36	Du	....	11.00	7-19-63	U	...	Qla	..	.....	....	.....	MP 1.5 ft above ls.
24ccd	Mike Havelange	68	16	B	1948	.....	....	D,S	G	Qd	Cy	1,960	6-64	944	
24dcd	Edwin Pietsch	...	2 1/4	Dr	1913	Flow	7-22-63	D,S	...	..	..	5,190	6-64	955	Yield 1.5 gpm.
25aac	A. O. Bartholomaus	85	4	Dr	1960	.....	....	D	S&G	Qd	Cy	1,350	6-64	950	
25adb	..do...	390	..	Dr	....	Flow	7-22-63	S	...	..	..	.....	....	950	Yield <1 gpm.
25ccb	Fred Zaeske	400	..	Dr	1940	Flow	7-17-63	D,S	...	..	..	4,910	6-64	960	Yield 0.5 gpm.
26cdc	Margaret Watt	500	4	Dr	....	Flow	7-22-63	D,S	...	Kd	..	4,700	6-64	970	Yield 5 gpm.
26ddc	August Zaeske	375	3 1/2	Dr	1957	Flow	7-17-63	D,S	S	..	..	4,910	6-64	960	Yield 6.0 gpm.
27bbc	D. Watt	400	3	Dr	1944	Flow	7-19-63	D,S	...	..	..	4,910	6-64	979	
28ccd	Max Billing	600	2 1/2	Dr	....	Flow	7-19-63	D,S	...	Kd	..	4,310	6-64	1,005	
28dcc	Clarence Liebenow	...	2	Dr	....	Flow	7-19-63	D,S	...	..	..	4,000	6-64	999	Yield 3.0 gpm.
30ada	Clarence Ziek	...	2	Dr	....	Flow	7-19-63	S	...	..	..	.....	....	1,025	
30cbb	..do...	481	2	Dr	1916	Flow	7-19-63	D,S	...	Kd	..	3,950	6-64	1,051	Yield 2.0 gpm.
31ccd	Arthur T. Zaeske	461	2 1/2	Dr	1930	Flow	7-19-63	D,S	...	Kd	..	3,750	6-64	1,048	Yield 9 gpm.
32daa1	Hamilton Wills	427	2 1/4	Dr	1923	Flow	7-19-63	S	...	Kd	..	4,270	6-64	1,016	Yield 0.75 gpm.
32daa2	..do...	140	4	Dr	1957	.....	....	D,S	S	Qd	Cy	1,930	6-64	1,018	
33ddd	Verne Sprunk	460	2 1/2	Dr	....	Flow	7-19-63	D,S	...	Kd	..	4,390	6-64	975	Yield 1.5 gpm.
34add	John Jackson	360	3	Dr	1913	Flow	7-17-63	D,S	S	..	..	4,500	6-64	965	Yield 2.0 gpm.
35abd1	O. R. Hagen	250	1	Dr	1913	Flow	7-17-63	S	...	..	..	710	6-64	960	
35abd2	..do...	19	30	Du	1948	.....	....	D	S	Qla	Cen.	700	6-64	965	
35abd3	..do...	19.3	36	Du	1910	11.69	6-17-63	S	S	Qla	Cen.	.....	....	960	MP 1.3 ft above ls, Supply I.
36cbb	Emilie Zaeske	300	1	Dr	1925	Flow	7-12-63	D,S	...	..	..	4,910	6-64	960	
138-54															
1aaa	E. Schobinger	20	..	Du	1903	.....	....	D	S	Qla	Cy	1,910	6-64	.....	
1ddd	Russel Quisberg	22	32	B	1945	.....	....	D,S	S	Qla	Cy	.....	....	.....	
2cdd	Fred Zierke	13	24	Du	1957	.....	....	D	S	Qla	Cy	780	6-64	.....	
3acb	Gibbard & Schmidt	494	3	Dr	....	Flow	7-24-63	S	...	Kd	..	4,120	6-64	.....	Yield 10.0 gpm.
4bcc	Frank Schmidt	522	2	Dr	....	Flow	7-24-63	D,S	...	Kd	..	.....	....	.....	Yield 3.0 gpm.
6cbb	Lawrence Dimmer	102	24	Dr	1962	.....	....	D,S	G	Qd	S	4,420	6-64	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-54 Cont.															
6ddd	Test hole 3148	152	..	Dr	8-11-64	.....	....	T	...	..	..	.....	....	1,126	L, E.
7baa	Dimmer Bros.	103	48	Du	1890	20	1961	D,S	G	Qd	S	1,930	6-64	.....	
8bbb	F. W. Olson	70	36	B	1920	Flow	7-24-63	D,S	G	Qd	Cy	1,650	6-25-64	.....	C.
9dad	Verrill Sprunk	...	2	Dr	1941	Flow	7-24-63	D,S	...	..	..	.....	....	.....	
10ddc	Fred Luther	450	1 1/4	Dr	1913	Flow	7-24-63	D,S	...	Kd	..	4,170	6-64	.....	Yield 2 gpm.
12abb	Sherwood Monroe	450	3	Dr	....	Flow	7-23-63	D,S	...	Kd	Cy	1,980	6-64	.....	
14baa	Edwin Grabow	640	3	Dr	1920	Flow	7-24-63	D,S	...	Kd	..	4,040	6-64	.....	
17ddc	Mary Schmidt	125	4	Dr	1953	.....	7-24-63	S	...	Qd	Cy	1,400	6-64	.....	
18bbc	Clemens Heinz	665	4	Dr	1960	Flow	7-25-63	D,S	...	Kd	..	.....	....	.....	Yield 15 gpm.
18cbd	E. Ralph	80	36	Du	1921	.....	....	D,S	...	Qd	Cy	1,380	6-64	.....	MP 0.6 ft below ls.
20bbb	Dimmer Bros.	60.0	12	..	....	11.51	1-22-64	U	...	Qd	..	.....	....	.....	
20ccb	Julius Christl	86	32	Dr	1936	.....	....	D,S	...	Qd	Cy	2,070	6-64	1,109	
22aaa	Albert Summerfield	610	3	Dr	1957	Flow	7-24-63	D,S	...	Kd	..	4,120	6-64	.....	Yield 1 gpm.
23bcb	Frank Erdman	645	2	Dr	....	Flow	7-24-63	D,S	...	Kd	..	4,580	6-64	.....	
25bab	Leo Blumer	13	36	Dr	1955	.....	....	D,S	S	Qla	..	2,170	6-64	1,071	
26bcc	Eugene Beck	500	3	Dr	1900	Flow	7-25-63	D,S	...	Kd	..	4,230	6-64	1,092	Yield 2 gpm.
28dad	Art Scharbow	535	3	Dr	....	Flow	7-25-63	D,S	...	Kd	..	.....	....	1,115	
30daa	Howard Kemmer	630	4	Dr	1949	Flow	7-25-63	D,S	...	Kd	..	.....	....	1,110	Yield 3.0 gpm.
31ccc	Art Scharbow	636	3/4	Dr	1954	Flow	7-29-63	D,S	...	Kd	..	4,150	6-64	1,111	Well reported to have flowed 47 gpm in 1962.
32aad	Lester Kemmer	72	30	Du	1924	.....	....	D,S	S	Qd	Cy	2,670	6-64	1,106	
32bbc	R. Kemmer	637	3	Dr	1963	Flow	7-25-63	D	S	Kd	..	.....	....	1,103	
33bbc1	Edwin Luther	635	3	Dr	1945	Flow	1945	S	...	Kd	..	.....	....	1,120	Yield 3 gpm.
33bbc2	..do...	70	24	B	1961	13.00	7-25-63	U	S	Qd	..	.....	....	1,120	MP 0.2 ft above ls.
34baa	Joe Blasl	450	3	Dr	1916	Flow	7-25-63	D,S	...	Kd	..	.....	....	1,095	Yield 1 gpm.
35dcc	G. Fleischfresser	630	4	Dr	1950	Flow	7-25-63	D,S	...	Kd	..	.....	....	1,071	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
138-55															
1add	C. Boyle	670	3	Dr	1958	Flow	8-15-63	D,S	...	Kd	..	5,150	6-64	.....	Yield 20.0 gpm.
3ccc	John Hanson	56	28	B	....	.....	...	D	...	Qd	Cy	3,120	6-64	.....	
5cac	A. J. Kapaun	750	2	Dr	1943	Flow	8-15-63	S	...	Kd	..	2,670	6-64	.....	
6bbc	Rudolph Lindner	900	3	Dr	1953	Flow	8-15-63	D,S	...	Kd	..	5,770	6-24-64	.....	C, yield 5 gpm.
7add	D. Anderson	800	3	Dr	....	Flow	8-15-63	S	...	Kd	..	.....	....	.....	Yield 1.0 gpm.
8ddd	Eldon Langer	870	2	Dr	1951	Flow	8-15-63	D,S	...	Kd	..	5,420	6-64	.....	Yield 5.0 gpm.
9dca	J. Kapaun	65	30	B	....	.....	.....	D	...	Qd	Cy	4,380	6-64	.....	
11cbb	Julius Langer	700	2	Dr	....	Flow	8-16-63	D,S	...	Kd	..	5,420	6-64	.....	Yield 6.0 gpm.
12bba	Lee Habiger	750	4	Dr	1928	Flow	8-15-63	D,S	...	Kd	..	5,720	6-64	.....	Yield 7.5 gpm.
13aad	Jules Wellentin	650	2	Dr	1959	Flow	8-15-63	D,S	...	Kd	..	5,330	6-64	.....	Yield 9.0 gpm.
13ddd	Max Scharbow	70	4	..	....	.....	....	D	S	Qd	Cy	1,910	6-64	.....	
14aaa	Rodney Hartl	565	2	Dr	1949	Flow	8-15-63	D,S	...	Kd	..	5,570	6-64	.....	Yield 4 gpm.
15ddd	Ernest Laufenberg	70	18	B	1960	.....	....	D,S	S	Qd	J	2,020	6-64	.....	
17bbb	Frank Langer	790	4	Dr	....	Flow	8-15-63	D,S	...	Kd	..	5,720	6-64	.....	Yield 1.5 gpm.
20add	Jewell Wadeson	738	2	Dr	....	Flow	8-16-63	S	...	Kd	..	4,290	6-64	.....	Yield 3.0 gpm.
21cca	F. L. Wadeson	735	2	Dr	1935	Flow	8-16-63	D,S	...	Kd	..	4,480	6-64	.....	Yield 2.0 gpm.
22ccc	Harvey Dehn	650	2	Dr	1946	Flow	8-16-63	D,S	...	Kd	..	5,330	6-64	1,141	Yield 2.0 gpm.
24ccc	Julius Hartl	65	30	B	1941	.....	....	D,S	S	Qd	Cy	2,730	11-10-64	1,127	C.
26bab	Ernest Kapaun	650	2	Dr	....	Flow	8-16-63	D	...	Kd	..	5,330	6-64	1,145	Yield 3.0 gpm.
26ddd	Frank Hartl	635	2 1/2	Dr	1943	Flow	8-16-63	D,S	...	Kd	..	4,730	6-64	1,135	Yield 8.5 gpm.
28ddd	Frank Fruhauf	16	24	B	....	.....	.....	D,S	S	Qow	J	1,310	6-64	1,117	
29aab	Richard Wavra	700	2	Dr	1943	Flow	8-16-63	D,S	...	Kd	..	4,290	6-64	.....	Yield 3.8 gpm.
30aab	Darrell Wadeson	32	30	B	1960	18.52	1-21-64	D	S	Qd	J	.....	....	.....	MP 1.0 ft above ls.
30bcc	Frank Schlagel	48	24	B	1949	.....	....	D,S	C	Qd	J	3,810	6-64	.....	
31bbb	Test hole 3141	62	..	Dr	8-6-64	.....	....	T	...	Qd	..	.....	....	1,138	L.
32aaa	Virgil Warner	35	24	B	1959	.....	....	D	...	Qd	J	4,520	6-64	.....	
34aba	Teresa Stangler	65	36	B	....	25	8-16-63	D,S	...	Qd	Cy	2,820	6-64	1,152	
36cdd	Test hole 3147	287	..	Dr	8-10-64	.....	....	T	...	Qd	..	.....	....	1,100	L, E.
139-48															
6ccd	The Pierce Co.	180	6	Dr	1923	48.88	1-11-63	Ind.	S&C	Qd	J	.....	....	899	L, MP 5.0 ft below ls.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-48 Cont.															
6cdd	Gardner Hotel	382	18	Dr	....	.....	....	U	...	..	..	.....	....	898	
7acc	City of Fargo	228.0	10	Dr	....	46.43	1-11-63	U	G	Qd	..	.....	....	896	MP 2.80 ft above ls,L, well abandoned.
19acb	Fargo Country Club	150	4	Dr	1956	.....	....	Irr	...	Qd	Cy	.....	....	904	
139-49															
1cbd	City of Fargo	191.7	24	Dr	1936	.....	....	U	S&G	Qd	..	.....	....	901	See ND GW Study no. 11 for drillers log,L, well abandoned.
1cdb	Cass-Clay Creamery	192	16	Dr	1956	32	2-1-56	Ind	S&G	Qd	T	.....	....	900	Yield 5.0 gpm, L.
2bdd	James Stack	200	4	Dr	....	.....	....	D	...	Qd	Cy	.....	....	898	Supply rept'd I.
2caa	Clifford Johnson	20	48	Du	1923	10	5-24-63	S	S	Qla	Cy	3,780	9-64	898	Rept'd unfit for drinking.
2ccc	Nodak Supply	357	4	Dr	1962	74.95	10-1-63	Ind	...	..	S	.....	....	898	L, MP 1.5 ft above ls.
2ccd1	Import Motors	25	24	Du	1959	.....	....	Ind	...	Qla	S	1,380	5-13-65	900	C, rept'd unfit for drinking.
2ccd2	Self Service Furniture	27	24	Du	1957	.....	....	Ind	...	Qla	S	.....	....	900	..Do...
3aaa	Steve Dubois	110	4	Dr	1955	.....	....	D	...	Qd	Cy	.....	....	898	
3acd	Marvin Miller	132	4	Dr	8-59	80	8-59	D	S	Qd	Cy	.....	....	899	Yield 2 gpm, L.
3ada1	John Preboske	134	4	Dr	1945	.....	....	D	S	Qd	Cy	.....	....	898	
3ada2	Kenneth O'Leary	198	..	Dr	1949	.....	....	D	...	Qd	J	.....	....	898	
3cdc	N. Dak. Wool Growers	290	3	Dr	1957	.....	....	Ind	S	Qd	J	.....	....	900	
3cdd1	F. Persellin	250	5	Dr	1959	.....	....	Ind.	...	Qd	Cy	.....	....	900	Reported unfit for drinking.
3cdd2	International Harvester Co.	358	6	Dr	1961	.....	....	Ind	S	..	Cy	.....	....	900	L, E, supply rept'd I.
3dcc	Dayton Warehouse	171	4	Dr	8-62	.....	....	Ind	S	Qd	S	.....	....	900	L, reported unfit for drinking.
3dcd	Pierce Trailer Court	247	8	Dr	1958	.....	....	P,S	S	Qd	T	.....	....	900	
3ddd1	Trading Post	20	30	Du	1957	.....	....	Ind	S	Qla	J	.....	....	900	..Do...
3ddd2	Fargo Grain King Inc.	25	36	Du	1958	.....	....	Ind	S	Qla	J	.....	....	900	..Do...
4bbb	Arch Jacob	13	..	Du	....	.....	....	D	...	Qla	Cy	.....	....	900	
4bbc	John A. Hanson	135	3	J	1959	70	1963	D	G	Qd	Cy	.....	....	898	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-49 Cont.															
4bcb	Mike Flink	18	60	Du	1963	6	1963	D	G	Qla	Cy	......	....	898	Not used for drinking.
4bcc	Herman Suket	16	16	Du	....	3	1963	D	...	Qla	..	.....	....	898	Reported unfit for drinking.
4dcc1	George Thoemke	135	3 1/2	Dr	1930	.....	....	D	...	Qd	Cy	.....	....	900	
4dcc2	Martin Dahl	122	3 1/2	Dr	1958	.....	....	Ind	...	Qd	J	.....	....	900	
4dcc3	Richard Fuller	132	4	Dr	1938	97	1962	D	S	Qd	Cy	.....	....	900	
4dcc4	Texaco Inc.	157	6	Dr	11-59	100	8-11-59	Ind	S	Qd	S	.....	....	900	L, P, Yield 15 gpm.
4dcc5	Earl Benton	115	4	Dr	1935	.....	....	U	...	Qd	Cy	.....	....	900	Supply rept'd I.
4dcd1	R. Gaughan	154	4	Dr	1-14-59	48	1-14-59	P,S	S	Qd	S	.....	....	899	L, Yield 100 gpm.
4dcd3	Oscar Eurey	120	..	..	....	.....	....	D	...	Qd	Cy	.....	....	899	
4ddc1	Dakota Trailers Inc.	...	4	Dr	1952	.....	....	P,S	...	..	J	.....	....	900	
4ddc2	..do...	159	6	Dr	1958	.....	....	P,S	...	Qd	S	.....	....	900	Yield 75 gpm.
4ddc3	Home Sweet Home Motel	170	4	Dr	1958	.....	.....	P,S	...	Qd	Cy	.....	....	900	
4ddd1	M. A. Berend	150	3 1/2	Dr	1947	.....	....	Ind	...	Qd	Cy	.....	....	899	
4ddd2	Bert Hemm	110	4	Dr	1942	.....	....	D	...	Qd	Cy	.....	....	899	
5add	Wally Kensinger	122	4	Dr	1961	100.48	10-22-63	D	S	Qd	S	.....	....	896	L, MP 0.9 ft above ls.
5baa	Goldena Mills	170	4	Dr	1962	96	1962	Ind	S	Qd	S	.....	....	897	Yield 75 gpm, ..
5ddd	WDAY Inc.	94	4	Dr	....	.....	....	Ind	...	Qd	Cy	.....	....	900	
6aba1	Balthauser & Moyer	186	8	Dr	1957	.....	....	S	S&G	Qd	T	.....	....	892	
6aba2	..do...	183	8	Dr	1948	.....	....	D,S	S&G	Qd	T	.....	....	892	
6abd	Union Stockyards	240	24	Dr	....	.....	....	U	S&G	Qd	..	.....	....	892	Log in ND GW Study No. 11.
6acc	..do...	208	16	Dr	10-31-57	78	10-31-57	S	S&G	Qd	T	1,760	6-14-65	892	L, C.
6acd	..do...	236	8	Dr	....	.....	....	S	S&G	Qd	Cen.	.....	....	891	L, Log in ND GW Study No. 11.
6adb 2/	..do...	230	8	Dr	....	104.95	1-11-63	O	S&G	Qd	...	.....	....	891	MP 0.4 ft above ls, L.
6bcc	Kenneth Pyle	283.5	6	Dr	....	90.30	7-17-63	U	S&G	Qd	...	.....	....	896	MP 1.6 ft above ls, L.
6bda	Siouxland Dressed Beef Co.	210	16	Dr	1960	90	10-5-60	Ind	S&G	Qd	T	.....	....	893	L.
6cdd	Goldberg Feed & Grain Co.	191.7	8	Dr	....	.....	....	D	S&G	Qd	S	2,280	3-13-64	900	C.

2/ Well 139-49-6adb formerly published as 139-49-6ad1 in WSP 845, p. 351 by L. K. Wenzel and F. W. Voedisch (1938).

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-49															
6dcd1	Cityof W. Fargo	215.5	12	Dr	10-19-63	102.60	10-21-63	P,S	S&G	Qd	T	2,420	11-9-63	892	L, MP 1.4 ft above ls, C.
6dcd2	Test hole 1	182	2 3/8	Dr	11-3-63	102.89	11-4-63	O	S	Qd	..	2,420	11-3-63	892	MP 1.04 ft above ls, L, C.
6ddc	Test hole 2	182	2 3/8	Dr	11-4-63	103.00	11-4-63	O	S	Qd	..	2,090	11-4-63	892	MP 1.14 ft above ls, L, C.
7aab	L. E. Roisen	107.0	3	Dr	1940	.....	....	U	S	Qd	..	.....	....	900	
7aac	Steve Murray	197	3	Dr	1947	.....	....	D	S&G	Qd	Cy	.....	....	900	
7abb1	John McDonald	197.0	3	Dr	1955	104.99	10-12-63	U	S	Qd	..	.....	....	899	MP 1.9 ft above ls.
7abb2	City of S. W. Fargo	204	16	Dr	1960	105.13	11-6-63	P,S	S	Qd	T	1,590	6-18-65	899	L, C.
7ddc	T. Tollefson	193.0	4	Dr	1963	95.96	11-5-63	U	S	Qd	..	.....	....	901	MP 1.8 ft above ls, L.
8bba1	City of S. W. Fargo	131.7	8	Dr	1942	100.53	8-22-62	O	S	Qd	..	.....	....	898	P, MP 1.12 ft above ls, well abandoned.
8bba2	..do...	112	8	Dr	1946	.....	....	U	S	Qd	..	.....	....	898	P, well abandoned.
8bda	..do...	155	16	Dr	1954	73	1954	P,S	S	Qd	T	1,250	6-18-65	896	L, C, Yield 600 gpm.
8ddc	Meyers Bros.	210	4	Dr	1961	.....	....	D,S	S	Qd	S	.....	....	901	
9aab	Iseman Corp.	153	4	Dr	8-61	63.77	10-1-63	P,S	S	Qd	S	.....	....	900	MP 1.1 ft above ls, L.
9aba	A. H. Barnes	210	4	Dr	1957	.....	....	Ind	S	Qd	J	.....	....	900	
9aab1	..do...	145	6	Dr	1951	.....	....	Ind	S	Qd	J	.....	....	900	
9abb2	Lloyd Hills	140	4	Dr	1957	.....	....	P,S	S	Qd	Cy	.....	....	900	
9baa	..do...	160	3 1/2	Dr	1954	.....	....	P,S	S	Qd	Cy	.....	....	900	
9bbb	W. Fargo Invest.Corp.	160	8	Dr	1942	.....	....	Ind	S	Qd	Cy	.....	....	900	
9cbb	A. Hamilton Barnes	158	..	Dr	6-8-60	90	6-8-60	...	S	Qd	..	.....	....	900	L, Well destroyed.
9ddd1	Carl Rabanus	168	4	Dr	1954	.....	....	D,S	...	Qd	J	.....	....	901	
9ddd2	..do...	100	4	Dr	1941	.....	....	D,S	...	Qd	J	.....	....	900	
9ddd3	Test hole 3113	180	1 1/4	Dr	7-6-64	43.16	8-1-64	O	S&G	Qd	..	838	7-9-64	905	L, C, MP 2.0 ft above ls, TH depth 257 ft.
10aab	Biltmore Motel	320	8	Dr	1959	.....	....	P,S	S	Qd	T	.....	......	900	
10abb	Cummins Diesel	214	..	Dr	7-61	90	7-61	Ind	S	Qd	S	.....	......	900	L, Yield 20 gpm.
10bab1	Branick-Swedberg	365	8	Dr	1957	.....	....	Ind	...	..	..	.....	......	900	
10bab2	General Diesel Co.	239	4	Dr	1959	102	11-59	Ind	S	Qd	S	1,290	9-64	900	L.
10bab3	..do...	70.1	48	Dr	1957	7.50	11-1-63	U	...	Qd	..	.....	....	900	MP at ls reported unfit for drinking .
10bab4	..do...	380	..	Dr	1959	.....	....	...	...	..	..	.....	....	900	Well destroyed.
10bab5	Dakota Tractor & Equip. Co.	80	2	Dr	1954	.....	....	Ind	...	Qd	..	.....	....	900	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-49 Cont.															
10bbd	R. Loberg	150	4	Dr	1955	.....	....	D,S	...	Qd	Cy	.....	....	900	
10ccc	Adolp Henke	105	4	Dr	1949	.....	....	D,S	...	Qd	Cy	.....	....	900	
11aaa	N. P. Railroad Co.	168	12	Dr	9-18-46	52	9-17-46	...	S&G	Qd	..	.....	....	898	L, Well destroyed.
11baa	Valley Veternary Clinic	15.5	18	Du	1938	5.90	10-1-63	U	...	Qla	..	312	10-5-64	900	MP 0.6 ft above ls - rept'd unfit for drinking, L.
11bba	Butler Machinery Co.	292	6	Dr	8-58	.....	....	Ind	...	Qd	T	.....	....	900	
11cbb	Fredrickson's Inc.	403	8	Dr	4-11-63	74.96	5-15-63	Ind	S	Qd	S	1,120	3-13-64	902	MP at ls, L, C.
11cda	K. R. Johnson	30	24	Du	1957	.....	....	U	...	Qla	Cy	.....	....	902	
11cdc1	Olvena Ostwald	197	4	Dr	1951	.....	....	U	...	Qd	Cy	.....	....	901	
11cdc2	..do...	311	4	Dr	7-28-61	80	7-28-61	D,S	S	Qd	S	1,080	9-64	901	Yield 5 gpm, L.
11dcb	Jane Burke	30	24	Du	1957	12	10-4-62	U	...	Qla	...	.....	....	901	
11dcd2	Anthony Darval	12	3	Dr	1962	.....	....	D	...	Qla	...	.....	....	900	Rept'd unfit for drinking.
12aca	E. Spiker	130.0	4	Dr	....	39.90	10-22-63	U	...	Qd	...	.....	....	901	MP at ls.
12ccd	A. M. Jacobson	200	4	Dr	1950	.....	....	D	...	Qd	Cy	.....	....	900	
12cdc	Clarence Braunberger	200	..	Dr	....	.....	....	Ind	...	Qd	Cy	.....	....	901	
13bbd	Harold A. Janson	150	..	Dr	1930	.....	....	D	...	Qd	..	.....	....	901	Supply rept'd I.
13ccc	Test hole 2174	178	..	Dr	8-30-63	.....	....	T	...	..	..	.....	....	902	L, E.
15cdc	Charles Asp	281	4	Dr	9-64	.....	....	Ind	...	Qd	S	.....	....	905	L.
17cbd	Harvey Loberg	117	4	Dr	6-1-63	85	6-1-63	D	S&G	Qd	Cy	.....	....	885	
18aab	R. W. Simpson	203	4	Dr	1951	.....	....	D,S	S	Qd	Cy	.....	....	900	
18aad	Woodlee Water Co.	198	8	Dr	11-57	84	11-57	P,S	S	Qd	S	.....	....	900	L.
18bbb	Test hole 2169	210	1 1/4	Dr	8-26-63	59.77	8-30-63	O	S	Qd	..	2,616	8-26-63	900	L, C, MP 2.02 ft above ls, E, TH Depth 231 ft.
18ccd	Test hole 2177	204	..	Dr	9-5-63	.....	....	T	...	..	..	.....	....	895	L, E.
18daa	Kenneth Beaton	102	3	Dr	1945	.....	....	D	...	Qd	..	.....	....	900	
19aaa	Test hole 2170	242	..	Dr	8-26-63	.....	....	T	...	..	..	.....	....	900	L, D.
19dad	Herman Heiden	120	..	..	....	.....	....	D	...	Qd	Cy	.....	....	900	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-49 Cont.															
21aaa	L. C. Barnes	145	..	Dr	1943	.....	....	D,S	...	Qd	Cy	.....	....	906	
21bbb	Test hole 2171	294	..	Dr	8-27-63	.....	....	T	...	..	..	.....	....	903	L, E.
22baa	George Anderson	200	6	Dr	....	49.50	10-3-63	D,S	...	Qd	T	.....	....	905	MP 1.9 ft above ls.
22bbb	Test hole 2172	236	1 1/4	Dr	8-28-63	47.82	9-17-63	O	S&G	Qd	..	1,046	8-30-63	911	L, C, MP 2.0 ft above ls, E, TH depth 464 ft.
23baa	Arthur Montplaisir	170	3	Dr	.....	.....	....	D,S	...	Qd	Cy	.....	....	905	
23bbb	Test hole 2173	440	..	Dr	8-29-63	.....	....	T	...	..	..	.....	....	904	L, E.
24aaa	Oak Manor Motel	298	..	Dr	2-20-60	.....	....	...	S	Qd	..	.....	....	904	L, Well destroyed.
24ada	Wm. Anderson	132	4	Dr	1960	.....	....	D	...	Qd	Cy	.....	....	906	
24cbc	Ernest Rheault	106	4	..	....	.....	....	D,S	...	Qd	Cy	.....	....	906	
24daa	Baker Nursery Gardens	90	4	Dr	1960	.....	....	Irr	...	Qd	Cy	4,370	5-13-65	906	C, Supply rept'd inadequate and unfit for drinking.
24ddd	Am. Tel. & Tel.	100	..	Dr	1957	.....	....	Ind	...	Qd	S	.....	....	906	..Do...
25aaa	Test hole 2175	518.5	..	Dr	9-3-63	.....	....	T	...	..	..	.....	....	903	L, E.
25bab	Mike Brunelle	152	..	Dr	1928	.....	....	D,S	...	Qd	Cy	.....	....	904	
26dcc	Kenneth Hennen	236	4	Dr	1962	37.37	10-3-63	D,S	S	Qd	S	.....	....	905	MP 1.2 ft above ls, L.
27ada	Adolph Asleson	120	3	..	....	.....	....	D	...	Qd	Cy	.....	....	905	
28bab	Test hole 2176	309	..	Dr	9-4-63	.....	....	T	...	..	..	.....	....	906	L, E.
28cbb	George Kounovsky	118	3	Dr	1939	30	5-63	D	...	Qd	Cy	.....	....	910	
29bcd	Loberg Bros.	238	4	Dr	9-61	43.28	10-3-63	D,S	S	Qd	S	1,350	....	902	L, C, MP 1.5 ft above ls.
29cba	John Runert	219	4	Dr	.....	40.22	4-16-64	D,S	S	Qd	S	.....	....	902	L, MP 2.4 ft above ls.
30bad	Everett Olson	200	4	Dr	.....	.....	....	D,S	...	Qd	Cy	.....	....	903	
31ddd	Horace Sauvageau	111	6	Dr	1948	.....	....	D,S	...	Qd	Cy	.....	....	903	
32bba	Oscar Furnberg	180	3	Dr	1947	.....	....	D	S	Qd	J	.....	....	903	
32cca	Earl Northrup	183.0	4	Dr	6-60	40.15	10-3-63	D,S	S	Qd	S	1,120	11-18-64	900	L, C, MP 1.5 ft above ls.
36aad1	W. A. Sweeney	386	4	Dr	1958	.....	.....	D	...	..	J	.....	....	893	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(1)	(11)	(12)	(13)	(14)	(15)	(16)
139-49															
36aad2	W. A. Sweeney	86	4	Dr	1960	.....	....	D	S	Qd	S	......	....	893	Supply rept'd I.
36aad3	Dr. G. A. Dodd	216	4	Dr	12-61	37.13	5-14-63	U	S	Qd	...	......	....	893	MP 2.0 ft above ls, L.
36aad4	Loren Oliver	215	4	Dr	9-60	32	9-60	D	S	Qd	S	1,620	9-64	893	Yield 5 gpm, L.
36acd	Westly Chandler	355	4	Dr	1963	50	9-63	Ind	S	..	S	.....	....	906	L.
36dac1	Ray Anderson	108	4	Dr	9-61	39.30	10-7-63	D	S	Qd	S	.....	....	905	MP 1.2 ft above ls, L.
36dac2	Bruce Brownlee	184	4	Dr	....	.....	....	D	S	Qd	S	.....	....	905	L, yield 7 gpm.
36dac3	Vern Otterson	108.0	3	J	10-7-63	14.80	10-7-63	D	S	Qd	Cy	.....	....	905	MP 1.5 ft above ls.
36dca	Norman Przybilla	282.0	4	Dr	7-6-61	43.06	10-4-63	D	S	Qd	S	.....	....	900	L, MP 0.8 ft above ls.
139-50															
1dcd	Howard Emerson	212	4	Dr	10-60	52.16	5-22-63	U	S	Qd	..	.....	....	899	L, MP 2.22 ft above ls.
2aaa	Ed Robinson	246	4	Dr	5-59	35	5-59	D	S	Qd	S	1,820	9-64	898	L, yield 35 gpm.
2aab	Ervin Wiebusch	175	4	Dr	1960	.....	....	D	...	Qd	Cy	.....	....	898	
2abb	Wayne Wateland	196	4	Dr	12-62	.....	....	D	...	Qd	Cy	.....	....	901	
2dbc	Jack Hledechuk	250.0	4	Dr	....	45.94	10-2-63	D,S	...	Qd	S	1,860	5-13-65	900	C, MP 2.0 ft above ls, L.
4dcd	Charles Thompson	60	12	..	1875	.....	....	D,S	...	Qd	S	.....	....	901	Supply rept'd I.
5cda	Wayne Cross	65	5	B	1931	.....	....	D,S	...	Qd	S	.....	....	902	
6bbb1	Village of Mapleton	75	2	Dr	1946	.....	....	U	...	Qd	Cy	.....	....	904	
6bbb2	..do...	165	6	Dr	12-60	34	12-16-60	P,S	S	Qd	T	4,060	10-5-64	904	L, C.
8dcc	Arnold Utke	52	18	B	1958	.....	....	D,S	S	Qla	Cy	.....	....	900	
9abb	Cliff Moe	160	3	Dr	....	.....	....	D	...	Qd	Cy	.....	....	900	
10add	Fargo Catholic Diocese	116	4	Dr	8-64	32.17	8-64	...	...	Qd	S	1,360	7-15-64	900	L, C, Well destroyed
10daa1	..do...	100	2	Dr	8-64	31.90	8-64	...	S	Qd	..	.....	....	900	Well destroyed, L.
10daa2	..do...	106	2	Dr	8-64	32.67	8-64	...	S	Qd	...	.....	....	900	..Do...
10daa3	..do...	110	2	Dr	8-64	32.46	8-64	...	S	Qd	...	.....	....	900	..Do...
10dac	..do...	99	4	Dr	8-64	32.88	8-64	...	S	Qd	...	.....	....	900	..Do...
10dcd	Emil Coster	160	4	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	902	
11bba	Libbrecht Bros.	170	..	Dr	1936	.....	....	D,S	...	Qd	Cy	1,530	9-64	902	
12bbc	Test hole 2178	280	..	Dr	9-6-63	.....	....	T	...	Qd	..	.....	....	898	L, E.
13ddc	George Coster	180	4	..	....	.....	....	D	...	Qd	Cy	......	....	901	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-50 Cont.															
14aab	Bernard Lisberg	72	6	..	....	.....	....	D,S	...	Qd	Cy	.....	....	901	
14ccb	Frank Werman	105	4	Dr	1948	.....	....	D	...	Qd	Cy	.....	....	905	Supply rept'd I.
15bbb1	M. Piersall	120	..	Dr	1949	.....	....	D	...	Qd	Cy	.....	....	905	
15bbb2	..do...	108.7	..	..	....	5.49	6-3-63	U	...	Qd	..	.....	....	905	MP 1.0 ft above ls.
15bbb3	..do...	117.7	3	Dr	1919	27.30	10-24-63	U	...	Qd	..	.....	....	905	MP 0.7 ft above ls.
16baa	Leo Murphy	150	8	..	....	.....	....	D	...	Qd	Cy	.....	....	905	
17abb1	Gerald Hagenson	244	4	Dr	10-58	12	10-58	D	S	Qd	S	.....	....	901	L, Supply rept'd I.
17abb2	..do...	80	..	Dr	....	.....	....	U	S	Qla	S	.....	....	901	E.
18bcc	Arlo Lindsay	68	4	B	1938	.....	.....	S	...	Qla	Cy	.....	....	906	
22cbc	John Murphy	166	3	Dr	1951	.....	....	D	...	Qd	Cy	.....	....	910	
22ddc	Fern Eggert	80	..	B	1937	.....	....	D,S	...	Qla	Cy	.....	....	906	Supply rept'd I.
23aaa	Test hole 3103	150	1 1/4	Dr	6-3-64	26.09	6-5-64	O	S	Qd	..	1,400	7-9-64	900	L, C, MP 1.98 ft above ls, E, TH depth 219 ft.
23ccd	Leo Murphy	350	4	Dr	....	.....	....	D,S	...	..	Cy	2,110	9-64	901	
23ddd	USBR test hole	255	..	..	....	.....	....	T	...	..	..	.....	....	907	L.
24ccd	USBR test hole	282	..	Dr	4-7-54	.....	....	T	...	..	..	.....	....	904	L.
24cdd1	USBR test hole	150	6	Dr	8-55	32.40	5-20-63	Ind	S	Qd	T	.....	....	903	MP 7.55 ft below ls.
24cdd2	..do...	150	6	Dr	8-55	32.89	5-20-63	Ind	S	Qd	T	.....	....	903	MP 7.55 ft below ls.
24cdd3	..do... 3-B	220	..	Dr	4-15-54	23	4-15-54	T	...	..	..	.....	....	903	L.
24ddd	Harold Gaard	173	4	Dr	1928	.....	....	D,S	...	Qd	Cy	.....	....	901	
25ddc	E. W. Hartmann	86	3	..	1922	.....	....	D,S	...	Qla	Cy	.....	....	903	
26aba	Paul Matthys	80	36	B	....	17.65	1-21-64	U	...	Qla	..	.....	....	901	MP 1.0 ft above ls.
26bbb	Robert Dobrinz	120	4	Dr	....	20.02	10-2-63	U	...	Qd	..	.....	....	901	MP 1.2 ft above ls.
27add	..do...	219	4	Dr	7-21-60	28.00	5-20-63	D,S	S	Qd	S	.....	....	902	L, MP 0.5 ft above ls.
28aaa	Test hole 3135	227	..	Dr	7-29-64	.....	....	T	...	..	..	.....	....	911	L, E.
28bdc	Leo Murphy	236	5	Dr	1950	.....	....	D	...	Qd	Cy	.....	....	905	
31bbb	Lawrence Kraft	417	3	Dr	1958	18	1958	D,S	...	..	Cy	3,930	3-4-64	909	C.
32ccc	Test hole 3116	82	..	Dr	7-10-64	.....	....	T	...	..	..	.....	....	914	L.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
33baa1	Leo Murphy	190	4	Dr	1943	.....	....	D	...	Qd	Cy	.....	....	906	
33baa2	..do...	200	..	..	....	20	1962	S	...	Qd	Cy	.....	....	909	
34aba	Wm. Rutten	95	4	..	....	.....	....	D,S	...	Qd	J	1,680	9-64	907	
35add	Lowman Trust	70	4	..	....	.....	....	D,S	...	Qla	Cy	.....	....	907	
35ddd	Test hole 3107	320	..	Dr	6-11-64	.....	....	T	...	...	..	.....	....	904	L, E.
139-51															
1aaa	Henry Schweitzer	107	4	Dr	9-19-59	29	9-9-59	D	S	Qd	S	3,450	9-64	905	L, Yield 90 gpm.
5abb	Leo Askew	40.0	48x48	Du	....	13.00	7-2-63	U	...	Qla	Cy	.....	....	915	
7cbc	Gerald Maderow	300	..	Dr	....	6	7-3-63	D,S	...	...	Cy	4,100	9-64	915	
8baa	A. Rachenski	35.0	18	Du	.....	11.85	7-3-63	U	...	Qla	Cy	.....	....	915	MP 1.0 ft above ls.
10cad	Hilbert Gohdes	400	6	Dr	1948	20	1962	D,S	...	...	Cy	4,120	9-64	906	
14add1	John Ellison	403	3	Dr	1954	16	1962	S	...	...	Cy	.....	....	906	
14add2	..do...	125	3	Dr	1952	.....	....	D	...	Qd	Cy	.....	....	906	Supply rept'd I.
14bbb1	Maurice Hartz	184	4	Dr	12-61	.....	....	D,S	...	Qd	S	2,880	9-4	905	L, Yield 20 gpm.
14bbb2	..do...	480	3	Dr	....	Flow	....	U	...	Kd	..	.....	....	905	Flow shut off.
15bab	Royal Berstler	390	3	Dr	1930	3	7-63	D,S	...	..	Cy	.....	....	905	
18cbb	Kenneth Christl	120	6	..	....	.....	....	S	...	Qd	Cy	.....	....	919	
19add	Ernest Pietsch	85	6	Dr	....	.....	....	D,S	...	..	Cy	.....	....	924	
19ccd1	E. Olson	400	6	Dr	1937	10	1962	D,S	...	..	Cy	.....	....	925	
19ccd2	Test hole 3118	463	..	Dr	7-11-64	.....	....	T	...	..	..	.....	....	928	L, E.
20baa	Frank Lynch	470	6	Dr	....	15	1962	D	...	Kd	..	.....	....	924	
21ccc	Test hole 3117	152	..	Dr	7-11-64	.....	....	T	...	Qd	..	.....	....	915	E.
23aaa	John Zurcher	52	4	Dr	1961	32	1962	D,S	S	Qla	Cy	.....	....	905	L, Yield 6 gpm.
26aaa	James Simpson	160	3	Dr	12-59	20	12-59	D,S	S	Qd	Cy	.....	....	906	Yield 8 gpm, L.
27ccd	C. E. Gust	186	6	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	912	
30daa	D. C. Schulze	405	3	Dr	1960	Flow	....	S	...	..	Cy	.....	....	915	L.
31bba	Richard Baumgarten	300	3	Dr	1943	30	1962	D,S	...	..	J	.....	....	916	
32caa	Durbin Elevator	159	4	Dr	10-63	.....	....	D	S	Qd	Cy	.....	....	916	L.
32cab1	Durbin School	180	3	Dr	1950	.....	....	P,S	...	Qd	Cy	1,390	5-13-65	919	C.
32cab2	Wallace Jahnke	87	4	Dr	7-58	18	7-17-58	D	S	Qla	S	.....	....	919	L.
32cab3	Great Northern R. R.	60	6	Dr	4-22	.....	....	...	...	Qla	..	.....	....	919	Well destroyed, L.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-51 Cont.															
33caa	Evelyn Miller	186	3	Dr	....	.....	....	S	...	Qd	Cy	.....	....	916	
33cba	..do...	86	18	B	....	.....	....	D	...	Qla	J	.....	....	915	
34dda	D. Gust	385	4	Dr	1932	5	1962	D,S	...	..	Cy	.....	....	910	
35aaa	Louise Miller	45	20	B	....	21.70	7-5-63	D,S	...	Qla	Cy	.....	....	908	MP 1.0 ft above ls.
36cba	..do...	40	30	B	....	18.73	7-5-63	D,S	...	Qla	..	.....	....	.....	MP 1.4 ft above ls.
139-52															
2aaa	E. Bautz	120	2	Dr	1935	.....	....	D,S	S&G	Qd	J	.....	....	930	
2abb	Robert Askew	188	4	Dr	9-61	.....	....	Irr	S	Qd	S	.....	....	936	C.
2dcc	Warner Richman	296	4	Dr	10-19-61	15.98	10-30-63	Ind	S	Qd	S	3,910	11-10-64	930	L, MP 2.25 ft above ls, C.
3dcc	NDSU Agronomy Farm	70	6	Dr	1955	14	1955	D	G	Qla	Cy	.....	....	937	
3ddd	Casselton Elevator	97	8	Dr	1937	.....	....	Ind	G	Qd	Cy	2,540	9-64	936	Rept'd unfit for drinking.
4aaa	E. Mark	40	18	Dr	....	.....	....	S	...	Qla	Cy	.....	....	940	
5abb	Henry Langer	380	2	Dr	1911	Flow	7-23-63	D,S	...	..	..	.....	....	.....	Yield 0.3 gpm.
8dcc	Frank Fiebiger	400	4	Dr	1912	Flow	7-22-63	D,S	...	..	..	.....	....	.....	Yield 1.0 gpm.
9daa	Bill Geerdes	400	..	Dr	1900	Flow	....	D,S	...	..	..	.....	....	935	
10acd	Weber Bros.	410	3	Dr	1922	Flow	....	S	...	..	Cen	3,900	9-64	935	
11bcc	Oscar Spoerl	410	4	Dr	1953	Flow	7-19-63	D,S	G	..	..	.....	....	935	
12cbc1	John Dalrymple	208	4	Dr	1963	19	1963	D,S	S	Qd	S	4,090	9-64	925	Yield 60 gpm, L.
12cbc2	..do...	400	4	Dr	1918	Flow	7-19-63	S	...	..	..	.....	....	925	
13bcb	Sinner Bros.	400	3	Dr	1920	0.63	7-19-63	D	...	..	Cen	.....	....	930	MP 2.0 ft above ls, rept'd unfit for drinking.
14ada	..do...	90	1 1/2	..	....	.....	....	D	...	Qd	Cy	.....	....	930	
15aba1	A. J. Lux	450	3	Dr	1947	Flow	....	D,S	...	Kd	Cy	.....	....	935	
15aba2	..do...	80	18	B	1945	20	7-19-63	S	S&G	Qla	Cy	.....	....	935	
17abb	Leo Heger	403	4	Dr	1951	Flow	1951	D,S	...	..	..	.....	....	..	Yield 4 gpm.
22daa	Victor Roesler	535	2	Dr	1952	Flow	7-22-63	D,S	...	Kd	..	3,800	9-64	925	Yield 2.0 gpm.
23bbb	Clarence Hendrickson	420	3	Dr	....	Flow	....	D,S	S&G	..	..	.....	....	930	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-52 Cont.															
25ddb	E. C. Marschke	400	3	Dr	1953	Flow	....	D,S	S	..	Cy	.....	....	926	
26abb	Frank Nilles	378	2	Dr	1936	Flow	1936	...	S	..	J	.....	....	927	Yield 3 gpm.
27aaa	Test hole 3119	467	..	Dr	7-14-64	.....	....	T	...	..	..	.....	....	928	L.
27daa1	Clayton Runck Sr.	440	3	Dr	1950	Flow	7-22-63	D,S	S	..	..	.....	....	925	
27daa2	..do...	75	4	Dr	1941	20	1961	D	G	Qla	Cy	.....	....	925	
28bbc1	Fluegal Bros.	450	3	Dr	1916	Flow	7-22-63	D,S	...	Kd	..	.....	....	.....	Yield 1 gpm.
28bbc2	..do...	63	4	Dr	1950	12	1950	D	S	Qla	Cy	.....	....	.....	
29daa	Arthur Dittmer	57	3	Dr	1950	2.00	7-22-63	D	...	Qla	..	.....	....	.....	
30bbb	...do...	290	3	Dr	1910	Flow	....	D,S	S	Qd	..	4,080	9-64	.....	
32cdd	B. Bautz	480	3	Dr	1918	Flow	7-22-63	D,S	S	Kd	..	4,210	9-64	.....	Yield 1.3 gpm.
33cdc1	Rienhold Rieck	25	18	B	1962	17	1962	D	S	Qla	..	2,130	9-64	.....	
33cdc2	..do...	22	48	Du	....	12.26	7-22-63	S	S	Qla	..	.....	....	.....	MP 0.4 ft above ls rept'd unfit for drinking.
34bbb	A. Glasow	62	4	Dr	1935	8	1959	D,S	...	Qla	Cy	.....	....	935	
36dcd	G. Buchholz	30	36	Du	1935	18	1963	D,S	S	Qla	Cy	.....	....	927	
139-53															
1cdc	Linus Kensok	...	..	..	....	Flow	....	S	...	..	..	.....	....	.....	
5ada1	R. S. Locket	395	3	Dr	1955	Flow	....	S	...	..	..	.....	....	.....	
5ada2	..do...	29	1 1/2	Dr	1940	.....	....	D	...	Qla	..	3,120	9-64	.....	
5ddd1	E. Frietag	497	3	Dr	1950	Flow	....	D,S	...	Kd	..	.....	....	.....	
5ddd2	..do...	22	36	Du	1948	.....	....	D	S	Qla	..	.....	....	.....	Supply rept'd I.
9bcb	Ruben Wittmar	110	4	Dr	1960	10	1960	D,S	G	Qd	J	1,140	9-64	.....	
10daa	Ward Sheldon	18	1 1/4	Dr	....	.....	....	D,S	G	Qla	J	.....	....	.....	
11bcc	Albert Frey	23	1 1/4	Dr	1939	.....	....	D	G	Qla	J	1,300	11-10-64	.....	C.
14add	Norbert Kensok	400	3	Dr	1944	Flow	8-14-63	D,S	...	..	..	.....	....	.....	Yield 3.0 gpm.
15aaa	Chris Madsen	420	1	Dr	1945	Flow	8-9-63	D,S	...	..	..	3,400	9-64	.....	Yield 2.0 gpm.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-53 Cont.															
16aaa	E. Frietag	...	36	B	1940	.....	....	D,S	G	..	Cy	.....	....	.....	
17aad	W. C. Peterson	560	1 3/4	Dr	1959	Flow	8-13-63	S	...	Kd	..	3,980	9-64	.....	Yield 3 gpm.
18baa1	Frank Smylie	27.4	36	Du	1900	13.06	8-13-63	S	G	Qla	Cy	.....	....	.....	MP 1.2 ft above ls, rept'd unfit for drinking.
18baa2	..do...	30	30	Du	1900	.....	....	S	G	Qla	Cy	.....	....	.....	Rept'd unfit for drinking.
18baa3	..do...	90	4	Dr	1953	14	1953	D	...	Qd	J	.....	....	.....	
19abb	Hugo Hoffman	480	3	Dr	1961	Flow	8-13-63	D,S	...	Kd	..	.....	....	.....	Yield 3.0 gpm.
21ccd	Edwin Martin	614	1 3/4	Dr	1919	Flow	8-13-63	D,S	...	Kd	..	.....	....	.....	
22dca	W. E. Marshall	400	1 1/2	Dr	1915	Flow	8-14-63	D,S	...	..	..	.....	....	.....	Yield 2.5 gpm.
24ccb	Francis Weber	400	3	Dr	....	Flow	8-13-63	D,S	...	..	..	.....	....	.....	
26aaa	..do...	600	1	Dr	1920	Flow	8-12-63	D,S	...	Kd	..	.....	....	.....	
26bba	Eugene Dooley	360	3	Dr	1920	Flow	8-12-63	D,S	...	..	..	.....	....	.....	Yield 1 gpm.
27dda	E. Ownes	350	3	Dr	1935	Flow	8-12-63	D,S	...	..	..	4,290	9-64	.....	Yield 1 gpm.
28dcc	Walter Opperman	315	1 1/2	Dr	1931	Flow	8-12-63	D,S	...	..	..	.....	....	.....	
29aaa	John Duckstad	640	4	Dr	5-19-61	Flow	8-13-63	D,S	...	Kd	S	4,020	9-64	.....	Yield 1 gpm.
30baa	Arno Kresse	370	1 1/4	Dr	1933	Flow	8-13-63	D,S	...	..	..	.....	....	.....	Yield 2 gpm.
31dda	Carl Schultz	530	3	Dr	1940	Flow	8-12-63	D,S	...	Kd	..	.....	....	.....	..Do...
32cdc	Carlie Schultz	33	36	Du	1926	.....	....	D,S	G	Qla	Cy	.....	....	.....	
34cbc	Lawrence Baumler	365	3	Dr	1937	Flow	8-12-63	D,S	...	..	..	.....	....	.....	..Do...
35bbb1	Clarence Reed	402	2	Dr	1951	Flow	8-12-63	D,S	...	..	..	.....	....	.....	..Do...
35bbb2	..do...	247	2	Dr	1937	Flow	8-12-63	S	...	..	..	4,220	9-64	.....	..Do...
36caa	Harold Schatzke	80	18	Dr	1940	9.10	8-12-63	S	...	Qla	Cy	.....	....	.....	MP 1.5 ft. above ls.
139-54															
2ccc	Walter Fraase	60	18	B	1952	.....	....	D,S	...	Qla	J	3,520	9-64	.....	
2ccd	..do...	500	2	Dr	1929	Flow	8-8-63	D,S	...	Kd	..	3,800	9-64	.....	
3ddd	..do...	450	3	Dr	1950	Flow	8-8-63	S	...	Kd	..	.....	....	.....	Yield 4 gpm.
6aaa	Robert von Bank	500	4	Dr	....	6.06	8-9-63	S	...	Kd	Cy	.....	....	.....	MP 1.22 ft above ls, well used to flow.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-54 Cont.															
6dad	Clayton Nudell	800	3	Dr	1920	Flow	8-9-63	S	...	Kd	J	4,050	9-64	.....	Supply rept'd I.
7dda	Gerold Burns	760	3	Dr	....	Flow	....	D,S	...	..	..	.....	....	.....	
8bbb1	Lorne Nudell	670	4	Dr	1961	Flow	8-6-63	S	...	Kd	..	.....	....	.....	Yield 2 gpm.
8bbb2	..do...	50	..	Du	1915	.....	....	D	G	Qd	J	.....	....	.....	Supply rept'd I.
9ccc	Dwight Biggers	718	4	Dr	1912	Flow	8-8-63	D,S	...	Kd	..	.....	....	.....	
11ddd	Test hole 3151	212	1 1/4	Dr	8-12-64	Flow	8-12-64	D	S	Qd	..	.....	....	1,074	L, C, E, TH depth 467 ft.
12aaa	Walter Fraase	120	2	Dr	1920	.....	....	S	S	Qd	Cy	.....	....	.....	
12dcc	Arnold Hoffman	50	48	Du	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
14dad1	Edwin Keiffer	222	2	Dr	1945	Flow	8-6-63	D,S	G	..	..	.....	....	.....	Yield 1.0 gpm.
14dad2	..do...	60	36	Du	1930	10.78	8-6-63	S	S	Qd	Cy	.....	....	.....	MP 1.4 ft above ls.
16ddd	Henry Beilke	900	4	Dr	1910	Flow	8-6-63	D,S	...	Kd	..	3,990	9-64	.....	
18aaa	Test hole 3150	332	..	Dr	8-11-64	.....	....	T	...	Qd	..	.....	....	1,156	L, E.
20ccc	James Pfeifer	700	3	Dr	1939	Flow	8-8-63	D,S	...	Kd	..	4,550	9-64	.....	
22ada	Dwight Biggers	...	3	Dr	1930	Flow	8-8-63	D,S	...	..	..	.....	....	.....	
23aaa	Charles Fraase	500	4	Dr	1910	Flow	8-6-63	D,S	...	Kd	..	.....	....	.....	
23baa	W. Beilke	...	2	Dr	....	Flow	8-6-63	D,S	...	..	..	.....	....	.....	Yield 3.0 gpm.
24cdb	F. Buttke	95	24	Du	1932	.....	....	S	...	Qd	Cy	2,500	9-64	.....	Supply rept'd I.
25ddc	Kenneth Manthei	250	1 1/2	Dr	1953	Flow	8-6-63	S	...	..	..	.....	....	.....	Yield 15.0 gpm.
26aab	Albert Buttke	600	8	Dr	1910	Flow	8-6-63	U	...	Kd	..	.....	....	.....	Yield 1 gpm.
26dcd	Clarence Kresse	443	1	Dr	1900	Flow	8-8-63	D,S	...	..	..	.....	....	.....	
27bbb	Ralph Smith	171	4	Dr	1-4-61	5.94	12-5-63	D,S	...	Qd	S	.....	....	.....	L, Yield 70 gpm, MP 0.3 ft above ls.
28aaa	Emma Grommesh	485	4	Dr	1950	Flow	8-8-63	D,S	...	Kd	..	.....	....	.....	Yield 2.5 gpm.
29bbb	Joe Langer	72	24	B	1950	.....	....	D	...	Qd	J	.....	....	.....	
30dda	Marvin Ries	90	36	B	1941	12.91	12-5-63	D,S	G	Qd	J	1,610	11-10-64	.....	C, MP 0.5 ft above ls.
31dda	Clem Pollock	515	3	Dr	1909	Flow	8-8-63	D,S	...	Kd	..	.....	....	.....	Yield 1 gpm.
33dad	Robert Prischman	490	3	Dr	1906	Flow	8-8-63	D,S	...	Kd	..	.....	....	.....	Yield 3.0 gpm.
35abb	R. E. Gust	24	30	Dr	1940	.....	....	D	S	Qla	Cy	.....	....	.....	Supply rept'd I.
35dad	..do...	400	..	Dr	1954	Flow	8-8-63	D,S	...	..	..	3,500.0	9-64	.....	Yield 3 gpm.
36dcd	A. F. Gust	40	36	B	1959	9.90	8-2-63	D	S	Qd	J	.....	....	.....	MP 0.5 ft above ls.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
139-55															
1daa	Gordon W. Coon	604	3	Dr	1946	10	1963	D,S	...	Kd	Cy	4,110	9-64	.....	
2add	Herman Anderson	105	3	Dr	....	.....	....	D	S	Qd	Cy	.....	....	.....	
2bba	Gordon W. Coon	700	3	Dr	....	Flow	8-13-63	S	...	Kd	..	4,090	9-64	.....	Yield 4.0 gpm.
3bbb	Fred Bayliss	60	24	B	.....	.....	....	D,S	G	Qd	Cy	.....	....	.....	
4abb	Fred Buschold	80	28	B	1951	35	8-13-63	D,S	G	Qd	J	4,410	11-10-64	.....	
5baa	Leif Erickson	60	36	B	.....	....	....	D	S	Qd	Cy	1,860	9-64	.....	
6acc	Joe Aljoe Sr.	32	24	B	1961	4	8-13-63	D,S	S	Qd	Cy	.....	....	.....	Supply rept'd I.
7baa	L. Pommerer	...	2	Dr	....	Flow	8-13-63	U	...	..	..	.....	....	.....	Yield 2.0 gpm.
8daa	Harry Japel	600	4	Dr	5-24-62	Flow	5-24-62	D,S	...	Kd	..	.....	....	1,188	Yield 6.5 gpm, L.
14bab	William Rakow	690	3	Dr	1956	Flow	8-14-63	D,S	...	Kd	..	.....	....	.....	Yield 2.0 gpm.
15bbb	Arthur Beyer	100	18	B	....	.....	....	D,S	S	Qd	Cy	2,600	9-64	.....	
15ddb	Duane Miller	50	30	B	....	20	8-14-63	D,S	G	Qd	J	.....	....	.....	
16ddd	Test hole 3149	69	..	Dr	8-11-64	.....	....	T	...	Qd	..	.....	....	1,164	L, E.
17ada	Herbert Rutherford	129	3	Dr	1959	30	8-13-63	S	G	Qd	Cy	.....	....	.....	
18abc	Leif Erickson	32	28	Dr	1939	16	8-14-63	D,S	G	Qd	J	.....	....	.....	
20bbb	James Griffin	37	24	Dr	1960	18	8-13-63	D,S	...	Qd	J	.....	....	.....	
23ada	L. A. Saunders	907	3	Dr	....	Flow	8-14-63	D,S	...	Kd	..	.....	9-64	.....	Yield 6.5 gpm.
24aaa	Robert Miller	80	30	B	.....	45	8-14-63	D,S	...	Qd	J	.....	....	.....	
25ccd	Wesley Anderson	90	3	Dr	1963	27	8-14-63	D	...	Qd	J	.....	....	.....	
26ddd	Frank Matzke	80	18	B	1953	30	8-14-63	D,S	S	Qd	J	.....	....	.....	
28acc	Ella Maloney	560	2	Dr	1945	Flow	8-14-63	D,S	...	Kd	..	.....	....	.....	Yield 10.0 gpm.
30bbb	Donald Kapaun	650	3	Dr	1953	Flow	8-13-63	S	...	Kd	..	.....	....	.....	Yield 3.5 gpm.
31ccc	Lawrence Lindner	25	30	B	1943	12	8-13-63	D,S	S	Qd	Cy	1,530	9-64	.....	
31dcd	John Pommerer	...	2	Dr	....	Flow	8-13-63	U	...	..	..	.....	....	.....	Yield 2.0 gpm.
32aaa	Alma Spraul	39.00	18	B	....	15.00	8-14-63	U	...	Qd	Cy	.....	....	.....	MP 1.7 ft above ls.
32bbb	Alice Kapaun	820	2	Dr	....	Flow	8-13-63	S	...	Kd	..	3,780	9-64	.....	Yield 3.0 gpm.
34aaa	A. W. Paul	703	3	Dr	1942	.....	8-14-63	D,S	...	Kd	Cy	.....	....	.....	Well would flow if permitted.
34ccc	Robert Card	72	4	Dr	5-28-62	17.66	12-5-63	D	S&G	Qow	S	.....	....	.....	L, MP 1.64 ft above ls.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-48															
18bcb	A. G. Larson	128	8	Dr	1932	25	6-20-63	D,S	S	Qd	Cy	.....	....	885	
19bdd	Paul Utke	138	3	Dr	1957	30	6-20-63	D,S	G	Qd	Cy	.....	....	890	
19ddd1	Test hole 3094	135	..	Dr	5-15-64	.....	....	T	...	..	..	.....	....	897	L, E.
19ddd2	Test hole 3094 A	132	..	Dr	5-16-64	.....	....	T	...	..	..	.....	....	897	L, E.
20acb	Fargo Park District	144	4	Dr	12-26-60	30	6-20-63	P,S	S	Qd	S	.....	....	896	L, Yield 75 gpm.
29abb	F. H. Peterson	160	3	Dr	1958	.....	....	D,S	G	Qd	Cy	.....	....	892	
29cdb	Test hole 2165	388.5	..	Dr	9-17-63	.....	....	T	...	..	..	.....	....	890	L, E.
30bcc	Lawrence Yunker	190	3	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	896	
30ccc	Ken Hill	278	3	Dr	1955	.....	....	P,S	...	Qd	Cy	.....	....	896	
140-49															
1dcd1	Lambert Vogel	256	..	Dr	1963	.....	....	T	...	Qd	..	.....	....	890	L, well destroyed.
1dcd2	..do...	176	..	Dr	1963	.....	....	T	...	Qd	..	.....	....	890	..Do...
1ddd	Westlund Bros.	300	3	Dr	1945	.....	....	D,S	...	..	Cy	1,330	7-64	891	
3add	E. T. Conmy	300	4	Dr	....	.....	....	D	...	..	Cy	.....	....	891	
4caa	Alton Barker	126	3	Dr	1949	.....	....	D,S	S	Qd	Cy	.....	....	886	
5cab	John Storely	128	2	Dr	1955	.....	....	D	...	Qd	J	1,120	7-64	897	
5dcd	Edgar Olsen	150	4	Dr	1955	.....	....	D	G	Qd	J	.....	....	896	
6cdb	Edwin Borg	120	5	Dr	1950	.....	....	D,S	...	Qd	Cy	1,330	7-64	891	
7daa	Robert Olson	96	4	Dr	1961	75.60	10-18-63	D	S	Qd	S	.....	....	895	L, MP 1.4 ft above ls.
7dab	Ralph Dallman	130	4	Dr	1961	68	10-11-61	D	S	Qd	J	.....	....	905	L, Yield 50 gpm.
7dad1	Waa Bros.	140	4	Dr	....	60	6-19-63	D,S	S	Qd	Cy	1,360	7-64	893	
7dad2	Eugene Kapaun	141	3	Dr	1961	68	4-28-61	D	S	Qd	J	.....	....	893	L, Yield 35 gpm.
7dca1	Everett Barker	154	4	Dr	1961	71	5-15-61	D	S	Qd	S	1,170	5-12-65	890	L, C, Yield 65 gpm.
7dca2	Glen Cole	154	4	Dr	1959	.....	....	D	S	Qd	Cy	.....	....	890	
8aba	Edgar Olson	190	4	Dr	1963	.....	....	D,S	G	Qd	Cy	.....	....	896	
8bbd	Maurice Mulvaney	129	4	Dr	1961	73.50	10-18-63	D	S	Qd	S	.....	....	892	L, MP 2.0 ft above ls.
8bcc	Jacob Bros.	106	3	Dr	1961	62	5-20-61	D	S	Qd	Cy	.....	....	887	L.
9cdc	Charles Shur	180	3	Dr	....	.....	....	D,S	S	Qd	Cy	1,050	7-64	890	
11aaa	Harold Gill	125	3	Dr	1949	30	6-20-63	D,S	...	Qd	Cy	1,230	7-64	891	
12acd	Ward Harris	148	6	Dr	1932	.....	....	D	...	Qd	Cy	1,410	7-64	891	Supply rept'd I.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-49 Cont.															
13aac	Quentin Sodata	90	3	Dr	....	.....	....	D	...	Qd	J	.....	....	891	
14dcd	Test hole 3093	275	..	Dr	5-14-64	.....	....	T	...	...	..	.....	....	890	L, E.
14dda	Richard Kilfoyl	150	4	Dr	....	.....	....	D	...	Qd	Cy	.....	....	891	
14ddc	Gary Griffith	265	4	Dr	1956	10	6-20-63	D,S	...	Qd	Cy	.....	....	891	
15ddc1	Kenneth Holmquist	80	24	B	....	30	6-20-63	S	S	Qd	Cy	12,400	6-24-64	893	C.
15ddc2	..do...	71	24	B	.....	14.92	6-20-63	U	...	Qla	..	.....	....	893	MP 0.3 ft above ls.
16daa	Curtis Johnke	146	2	Dr	1957	60	6-20-63	D	S	Qd	Cy	912	6-26-64	894	C.
17ddd	Herman Heiden	145	3	Dr	....	.....	....	D	...	Qd	J	1,050	7-64	890	
18ada	Wm. Keller	37	4	Dr	6-9-61	28	6-9-61	S	S	Qla	Cy	3,160	7-64	891	L, Yield 10 gpm.
18bbb	Test hole 3095	290	..	Dr	5-18-64	.....	....	T	...	..	..	.....	....	895	L.
18cad	Bertha Landblom	160	4	Dr	1951	.....	....	D,S	S	Qd	Cy	.....	....	895	
19baa	Helen Rust	183	3	Dr	4-11-63	60	4-11-63	D	S	Qd	Cy	.....	....	890	L, Yield 15 gpm.
19caa	C. R. Landblom	150	4	Dr	1958	.....	....	D	...	Qd	Cy	1,400	7-64	891	
19ccc	Eugene Christl	177	4	Dr	1963	100	1963	D	...	Qd	S	.....	....	890	L, Yield 50 gpm.
19ddd	Test hole 3091	100	1 1/4	Dr	5-11-64	90.08	5-25-64	O	S	Qd	..	.....	....	897	L, MP 2.0 ft above ls, E, TH depth 230.
20ddd	A. J. Anderson	140	4	Dr	1958	.....	....	D,S	...	Qd	Cy	1,040	7-64	888	
21aaa	Test hole 3092	165	..	Dr	5-13-64	.....	....	T	...	Qd	..	.....	....	893	L, E.
21dda	E. F. Hehr	130	3	Dr	1960	.....	....	D,S	...	Qd	Cy	.....	....	888	
23cdc	Henry Dorval	200	3	Dr	1956	.....	....	D,S	...	Qd	Cy	920	7-64	894	
23dda	Norman Hanson	140	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	897	
24ddd	Mary Holland	80	30	B	....	40	6-20-63	S	...	Qd	Cy	2,090	3-12-65	895	C, Rept'd unfit for drinking.
26bab	W. E. Brentzel	13.0	48	Du	....	7.10	8-20-63	U	...	Qla	Cy	.....	....	891	MP 0.3 ft above ls.
26ddc	Selma Merrin	150	4	Dr	1958	20	6-20-63	D	S	Qd	Cy	.....	....	895	Supply rept'd I.
26ddd	Test hole 2164	226	..	Dr	8-8-63	.....	....	T	...	Qd	..	.....	....	895	L, E.
28ccc	Kelly Sherlock	190	4	Dr	....	.....	....	D,S	G	Qd	Cy	.....	....	895	
28dda	Clarence Hayek	127	4	Dr	1958	80	6-19-63	D,S	G	Qd	Cy	3,220	7-64	892	
28ddd	Test hole 2161	189	..	Dr	8-5-63	.....	....	T	S&G	Qd	..	.....	....	894	E. L.
29ddd	Test hole 2160	210.7	1 1/4	Dr	7-30-63	91.10	8-19-63	O	S&G	Qd	..	.....	....	894	MP 2.02 ft above ls, E, TH depth 212 ft.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-49 Cont.															
30aba	W. T. Selberg	130	4	Dr	....	40	6-19-63	D,S	...	Qd	Cy	1,060	7-64	891	
30dbb	E. Crugle	160	4	Dr	1956	.....	....	D,S	S	Qd	Cy	.....	....	892	Supply rept'd I.
30dcc	Robert Dougherty	185	3	Dr	1962	.....	....	S	...	Qd	Cy	.....	....	894	
30dcd	Earl Highness	165	3	Dr	1948	.....	....	D,S	S	Qd	Cy	.....	....	891	
31aab	Ray Quam	180	3	Dr	1955	.....	....	D,S	G	Qd	Cy	1,540	7-64	891	
31aac1	H. Allen Drake	183	2 1/2	Dr	1960	.....	....	D	S	Qd	Cy	.....	....	892	
31aac2	Russell Ferch	200	4	Dr	1962	.....	....	D	...	Qd	Cy	.....	....	892	
31aac3	Frank Bayer	185	2	Dr	....	60	8-21-63	D,S	S	Qd	Cy	1,520	7-64	892	
31aad1	Howard Bessette	190	1 1/2	Dr	1961	.....	....	D	...	Qd	Cy	.....	....	892	
31aad2	Louis Sternberg	190	4	Dr	1962	.....	....	D	S	Qd	Cy	.....	....	892	
31acb	E. Ornberg	18	42	Du	....	12	8-21-63	D	...	Qla	Cy	1,830	5-12-65	890	C.
31acc	Kenneth Johnson	217	4	Dr	1951	80	8-21-63	D	S	Qd	Cy	.....	....	890	
31bab	Test hole 2167	250.5	..	Dr	8-14-63	.....	....	T	...	Qd	..	.....	....	895	E, L.
31cdc	Test hole 2168	200.0	1 1/4	Dr	8-20-63	101.46	8-28-63	O	...	Qd	..	2,025	8-23-63	894	L, C, MP 2.01 ft above ls, E, TH depth 241.5.
31dca	Paul Federa	147	4	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	891	
32adc	Ernest Quam	135	3	Dr	....	.....	....	D,S	...	Qd	Cy	1,610	7-64	895	
32bbb	Test hole 2166	237	1 1/4	Dr	8-12-63	97.41	8-19-63	O	S&G	Qd	..	.....	....	894	L, MP 2.01 ft above ls, E.
32bbc	Walter Quam	170	4	Dr	....	.....	....	D,S	S&G	Qd	S	1,670	6-16-65	892	L, C, Yield 75 gpm.
32cdc	Goldena Mills	132.0	4	Dr	6-17-61	106.01	10-1-63	Ind	...	Qd	S	1,360	7-64	894	L, MP 1.2 ft above ls, yield 6 gpm.
34caa	E. B. Pederson	130	6	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	898	
34cad1	Arlow Dahl	17	10	B	....	7.60	8-19-63	S	...	Qla	..	4,770	7-64	898	MP 1.4 ft above ls.
34cad2	Henry Palm	125	3	Dr	....	40	8-19-63	D	...	Qd	Cy	950	7-64	898	Supply rept'd I.
34cca	Amos Whiteside	18	12	Du	.....	7.40	8-19-63	U	...	Qla	..	.....	....	896	MP 2.6 ft above ls.
34ccd	Schultz and Lindsay Const. Co. Test hole 9	248	..	Dr	....	.....	....	T	...	..	..	.....	....	.....	L.
34cdc	Arvel Gulsvig	112	4	Dr	1957	.....	....	D	G	Qd	Cy	.....	....	898	
34cdd	Isabel Dewandler	17	3	Dr	....	.....	....	U	...	Qla	Cy	.....	....	898	
35bbb	Test hole 2162	187.5	..	Dr	8-6-63	.....	....	T	...	..	..	.....	....	897	L, E.
35ddd	Western Fruit Express	189	8	Dr	12-22-60	92	12-22-60	Ind	S	Qd	S	1,180	3-13-64	901	L, C, Yield 60 gpm.
36aaa	Test hole 2163	223.0	1 1/4	Dr	8-7-63	52.25	8-19-63	O	S&G	Qd	...	1,793	8-8-63	896	L, C, MP 2.0 ft above ls, E, TH depth 291 ft.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-50															
2adb	Laura Krough	140	3	Dr	1938	.....	....	D,S	...	Qd	Cy	1,980	6-64	889	Supply rept'd I.
3bcc	D. W. Backstrom	171	3	Dr	1945	.....	....	D,S	S	Qd	Cy	.....	....	894	Yield 100 gpm.
3ddd	Dean Rust	146	4	Dr	10-28-61	27	10-28-61	D,S	S	Qd	S	2,390	6-64	893	
4bcc	Ken McIntyre	303	4	Dr	6-23-61	31.50	10-25-63	D,S	S	Qd	S	.....	....	900	MP 1.0 ft above ls, L.
5cdd	George Rust	125	3	Dr	.....	....	....	D	...	Qd	J	2,560	6-64	899	
6abb	Mabel Larson	165	3	Dr	1959	30	6-21-63	D,S	...	Qd	Cy	1,390	6-64	904	
6ccb	Mandius Ueland	150	6	Dr	.....	15	6-21-63	D,S	...	Qd	Cy	2,840	6-64	904	
7aaa	Ralph Peterson	247	4	Dr	5-21-62	30	5-21-62	D,S	S	Qd	S	2,060	6-64	899	L, Yield 10 gpm.
8aaa	C. J. Bowman	100	3	Dr	1962	30	1962	D,S	S	Qd	S	1,760	6-64	897	Yield 35 gpm, L.
8baa	Great Northern Railroad	121	4	Dr	8-25-49	17	8-25-49	U	S	Qd	Cy	.....	....	899	L.
9ccc	Charles Bowman	70	4	Dr	....	20	6-21-63	D,S	...	Qd	Cy	.....	....	897	
10baa	Emma Hogland	240	3	Dr	1935	60	6-24-63	D,S	...	Qd	Cy	2,360	6-64	894	
12bbc	Louis Sundberg	167	4	Dr	1959	30	6-24-63	D	...	Qd	J	2,120	6-64	892	
13add	Archie Kyllo	115	4	Dr	1948	.....	....	D,S	S	Qd	Cy	1,430	6-64	894	
14bcc	Clarence Stromberg	115	3	Dr	....	.....	....	S	...	Qd	Cy	.....	....	894	Reported unfit for drinking.
15cbb	Oscar Johnson	264	3	Dr	1957	.....	....	D,S	S	Qd	Cy	2,480	6-64	895	
18dbd	D. Warner	80	4	Dr	1961	.....	....	D,S	...	Qd	Cy	1,750	6-64	901	
19cbb	Nellie Dale	60	18	B	1957	20	6-21-63	S	...	Qla	Cy	3,820	6-64	911	..Do...
19dad	Test hole 3133	197	..	Dr	7-28-64	.....	....	T	...	..	..	.....	....	913	L, E.
20add1	Mark Andrews	257.0	4	Dr	1960	22.30	6-24-63	D,S	...	Qd	S	.....	....	903	MP 1.0 ft above ls.
20add2	..do...	101	4	Dr	1955	.....	....	D	S	Qd	Cy	1,650	6-64	903	
21bcc	..do...	178	4	Dr	1955	.....	....	D	S	Qd	S	3,150	6-64	906	Yield 35 gpm.
21cbb	..do...	174	4	Dr	1960	19	1960	D,S	S	Qd	S	3,430	6-64	896	L.
22bbd	Liebrecht Bros.	252	4	Dr	8-23-60	32	8-23-60	D,S	S	Qd	S	2,970	6-64	901	
24add	Emil Bjorkman	148	4	Dr	5-8-61	.....	....	D,S	S	Qd	S	1,490	6-64	891	L, E, Yield 8 gpm.
24bcc	Leo Murphy	280	4	Dr	1948	.....	....	D,S	...	Qd	Cy	.....	....	896	
24ddd	Orville Erickson	191	4	Dr	1963	.....	....	D	S	Qd	J	.....	....	895	L.
25aba	S. P. Swisher	134	4	Dr	1939	.....	....	D,S	S	Qd	Cy	1,490	6-64	895	
26cdc	Edward Johnson	159	4	Dr	10-10-60	37	10-10-60	D	S	Qd	J	.....	....	896	Yield 100 gpm, L.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
<u>140-50</u> Cont.															
28ddd	K. McKinnon	100	6	Dr	....	30	6-21-63	D,S	...	Qd	Cy	2,000	6-64	898	
32dcc	Harry Warner	198	4	Dr	....	30	6-21-63	D	..	Qd	Cy	2,480	6-64	902	
33ccb	L. M. Baugh	...	24	B	....	31.65	6-21-63	D	...	..	J	.....	....	901	Rept'd unfit for drinking.
33ccc	Merton Sheldon	82	4	Dr	12-29-63	32	12-29-63	D	S	Qd	Cy	.....	....	901	L, Yield 60 gpm.
34ccc1	M. Sigbert Awes	198.0	4	Dr	....	25.00	10-25-63	U	...	Qd	..	.....	....	901	MP 2.0 ft below ls.
34ccc2	Test hole 3134	242	..	Dr	7-28-64	.....	....	T	...	..	..	.....	....	900	L, E.
35cdc	Albert Akason	96	4	Dr	1932	40	6-21-63	D,S	...	Qd	Cy	1,260	11-6-64	898	P.
35ddd	Oscar Bjorkman	70	3	Dr	1937	.....	....	D	S	Qla	Cy	1,100	11-5-64	898	P.
36cdd	E. Swanson	130	2	Dr	1925	.....	....	U	...	Qd	Cy	.....	......	896	
<u>140-51</u>															
1aaa	Waxler Bros.	70	24	B	1955	20	7-3-63	D,S	...	Qla	J	2,520	6-64	906	
3bdb	Murray Baldwin	255	4	Dr	4-29-58	36	4-29-58	D,S	S	Qd	Cy	1,230	6-64	915	L, E.
6ccc	Albert Sinner	84	5	Dr	1962	23	1962	D	S	Qd	S	1,270	5-13-65	936	L, C, Yield 7 gpm.
6ddd1	Ernest Pyle	65	4	Dr	....	.....	....	U	...	Qla	Cy	.....	....	929	
6ddd2	..do...	90	4	Dr	1964	.....	....	D	S	Qd	Cy	2,280	6-64	929	L.
12ddd	J. G. Milles	50	24	B	1920	.....	....	U	S	Qla	Cy	.....	....	904	
13dda	Waxler Bros.	150	3	Dr	1957	.....	....	D,S	...	Qd	Cy	1,460	6-64	904	
14ddb	Merton Sheldon	325	4	Dr	11-1-60	21	11-1-60	D,S	S	Qd	S	.....	....	909	L.
15ccc	Lloyd Roden	285	4	Dr	1-13-59	13	1-13-59	D,S	S	Qd	S	3,890	6-64	916	L, Yield 10 gpm.
17bbb	George Howe	235	4	Dr	1958	20	1958	D,S	S	Qd	Cy	1,160	6-64	929	L.
18ddd	..do...	307	4	Dr	4-30-58	3	4-30-58	D	S	Qd	S	3,620	6-64	926	Yield 7 gpm.
20ccb	Austin Estates	400	3	Dr	....	.....	....	S	...	..	Cy	1,170	6-64	922	Well rept'd to have flowed at one time.
21ccb	Sinner Bros.	80	..	Dr	....	.....	....	D	...	Qd	Cy	.....	....	917	
22cbb	John Coster	80	24	B	1947	.....	....	D	S	Qd	Cy	.....	....	914	
23ccc	Howard Nelson	300	3	Dr	1928	5	1960	U	...	..	..	.....	....	909	
24dcd1	R. M. Ruliffson	75	3	Dr	1900	.....	....	D,S	...	Qd	Cy	.....	....	911	
24dcd2	..do...	84	4	Dr	7-6-60	27.19	10-29-63	U	S	Qd	..	3,960	6-64	911	L, MP 1.5 ft above ls.
26ccd	Otis Nelson	80	3	Dr	1950	.....	....	D,S	S	Qd	Cy	.....	....	914	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-51 Cont.															
28bcc	J. Kasowski	67	6	Dr	1958	15	7-2-63	D,S	G	Qd	S	2,060	6-64	914	L.
29cbb	Vernon Grommesh	48	6	Dr	....	.....	....	S	...	Qla	J	3,210	6-64	921	
31ccc	John Dalrymple	327	3	Dr	1936	.....	....	D,S	...	..	J	.....	....	924	
33abb	J. Kasowski test hole	350	..	Dr	5-58	.....	....	T	...	..	..	.....	....	914	L, E.
34add	Albert Kasowski	90	3	Dr	1900	20	7-2-63	D,S	...	Qd	Cy	3,810	6-64	914	
35bba	Melvin Scherweit	34	30	B	1940	.....	....	S	S	Qla	Cy	3,220	6-64	916	
36cdd	H. Donald Otos	135	3	Dr	1944	.....	....	D,S	...	Qd	Cy	4,150	6-64	901	
140-52															
1cbb	Oscar Johnson	250	2	Dr	1886	.....	....	D,S	...	Qd	Cy	2,150	6-64	942	
4aaa	J. Larson	75	24	B	1928	22	8-1-63	D,S	S	Qd	Cy	.....	....	949	
5ccc	Earl Vining	400	3	Dr	1945	Flow	8-1-63	D,S	...	..	..	.....	....	.....	Yield 5 gpm.
6cbc1	D. McIntyre	475	4	Dr	6-30-59	Flow	6-30-59	D,S	S	Kd	..	3,970	6-64	.....	L.
6cbc2	..do...	511	4	Dr	1963	Flow	....	D,S	S	Kd	..	.....	....	.....	L.
7bbb	Earl Vining	500	2	Dr	....	Flow	8-1-63	D	...	Kd	..	4,110	6-64	.....	Yield 10.0 gpm.
7ddd	Marjorie Bell	400	2	Dr	1955	Flow	8-1-63	S	...	..	..	.....	......	.....	Yield 0.8 gpm.
8ddd	Pollock Estates	450	3	Dr	1900	Flow	8-1-63	D,S	...	Kd	..	3,770	6-64	.....	Yield 2.0 gpm.
9dab	J. Tarkington	90	4	Dr	....	40	8-1-63	D,S	...	Qd	J	.....	......	949	
10ddd	Fred Niemeyer	131	4	Dr	12-12-58	41	12-12-58	D,S	S	Qd	Cy	1,350	11-17-64	945	L, C, Yield 15 gpm.
12caa	Ralph Johnson	316	4	Dr	12-19-59	30	12-19-59	S	S	..	S	3,290	6-64	936	
13bbc	E. Nesemeir	320	4	Dr	....	.....	....	D,S	S	..	S	3,750	6-64	938	L.
15dcd	Dayton Byram	60	36	Du	....	.....	....	D,S	S	Qd	Cy	1,470	6-64	941	
16cdd	A. V. Stoll	70	24	B	....	.....	....	D,S	...	Qd	J	2,490	6-64	.....	Supply rept'd I.
17dcc	Cass County School Dist.	172	3	Dr	1940	Flow	4-3-64	U	...	Qd	Cy	3,900	6-64	.....	Yield < 1.gpm.
18dcc	Fred Kingsley	...	2	Dr	....	Flow	8-1-63	D,S	...	..	..	4,340	6-64	.....	
19baa	J. Tyrlick	465	4	Dr	1953	Flow	8-1-63	D,S	...	Kd	..	4,020	6-64	.....	
20caa	Earl Vining	398	2	Dr	....	Flow	8-1-63	D	...	..	..	.....	....	.....	Yield 1.0 gpm.
21abb	D. McIntyre	318	3	Dr	1953	Flow	8-1-63	D	...	..	..	4,160	6-64	.....	Yield 1.3 gpm.
22add	John Sinner Sr.	196	3	Dr	1945	15	8-1-63	D,S	S	Qd	Cy	3,290	6-64	939	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-52															
22dda	Hulda Esser	350	..	Dr	....	.....	....	D,S	...	..	..	.....	....	939	
23dcc	Robert Runck	384	2	Dr	1914	Flow	8-2-63	S	...	..	..	4,180	6-64	936	Yield 1 gpm.
24bcc	George Nesemeier	296	4	Dr	11-11-58	2	11-11-58	D,S	S	Qd	S	3,630	6-64	936	Yield 9 gpm.
25ddd	Sinner Bros.	259	4	Dr	11-4-59	6	11-4-59	D,S	S	Qd	S	2,930	6-64	926	Yield 15 gpm.
27dcc	Henry Woell	320	3	Dr	1914	Flow	8-2-63	D,S	...	..	..	4,460	6-64	940	Yield <1 gpm.
30ddb	Eugene Kieffer	393	3	Dr	1948	Flow	8-2-63	D,S	...	..	..	4,370	6-64	.....	Yield 2.0 gpm.
31bbc1	Pearl G. English	390	4	Dr	1953	Flow	8-2-63	D	S	..	..	4,550	6-64	.....	Yield 0.8 gpm.
31bbc2	..do...	84	24	B	....	.....	....	U	S	Qd	Cy	.....	....	.....	
32bac	D. McIntyre	...	..	Dr	....	Flow	....	D	...	..	..	4,200	6-64	.....	Yield 1 gpm.
33aaa	..do...	220	..	Dr	1964	.....	....	U	S	Qd	..	.....	....	.....	Supply rept'd I.
33aad	..do...	...	..	Dr	....	Flow	8-12-63	D,S	...	..	..	.....	....	940	Yield 0.3 gpm.
35abc	Grant Matson	78	4	Dr	4-25-61	.....	....	D	S	Qla	S	.....	....	935	L, Yield 25 gpm.
35adb	City of Casselton	315	16	Dr	1947	.....	....	U	...	..	T	.....	....	931	P, **well abandoned.**
35bcb	Great Northern Railroad	350	10	Dr	1907	.....	....	...	S	..	..	.....	....	935	L, Well destroyed.
140-53															
1ddd	Justus Peterson	...	4	Dr	....	Flow	7-31-63	D,S	...	..	..	.....	....	.....	Yield 4.5 gpm.
2bcd	Earl Vining	450	3	Dr	....	Flow	7-31-63	D,S	...	Kd	..	4,260	6-64	.....	Yield 2.0 gpm.
3baa	Alan Marshall	22	30	B	1943	9	7-31-63	D	S	Qd	J	1,330	6-64	.....	
5aba	Curt Punton	35	24	B	1955	.....	....	D	...	Qd	Cy	745	11-10-64	.....	C.
7add	Bell Bros.	32	18	..	....	.....	....	D,S	S	Qd	Cy	1,630	6-64	.....	Well rept'd to go dry occasionally.
8aba	Jules Morris	32	30	B	1904	.....	....	D	S	Qd	J	1,050	6-64	.....	..Do...
9bca	Fletcher Roach	35	36	B	....	15	7-31-63	D	...	Qd	J	2,250	6-64	.....	
10bdd	Erickson Bros.	500	4	Dr	....	Flow	7-31-63	D,S	...	Kd	..	.....	....	.....	Yield 5.5 gpm.
12cdc	L. Madsen	505	3	Dr	1938	Flow	8-1-63	D,S	...	Kd	..	4,340	6-64	.....	Yield 13.0 gpm.
13ddd	Joseph Tyrlick	463	4	Dr	1963	Flow	7-31-63	U	...	Kd	..	3,960	6-64	.....	
14ccc	Carl Lauritsen	400	2	Dr	1935	Flow	8-1-63	S	...	..	..	4,040	6-64	.....	
15cdc	Bertha McLean	395	2	Dr	....	Flow	8-1-63	D,S	...	..	..	4,290	6-64	.....	
17aad	Oliver Klauss	600	4	Dr	1915	Flow	7-31-63	D,S	...	..	..	2,420	6-64	.....	
19bab	Ronald McLean	30	24	B	1957	.....	....	D	S	Qd	J	.....	....	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-53 Cont.															
20ddd	L. D. Sharp	535	4	Dr	1940	Flow	7-31-63	D,S	...	Kd	..	4,430	6-64	.....	Yield 1.0 gpm.
21dcd	Albert Johnson	60	24	B	1953	.....	....	D	S	Qd	..	3,920	6-64	.....	
22cdb	Fred Swanson	24	20	B	1959	.....	....	D	S	Qd	J	1,730	6-64	.....	
23dcc	Ray Kieffer	50	24	B	....	6	7-31-63	D,S	S	Qd	J	2,020	6-64	.....	
24bbc	D. Kingsley	360	4	Dr	1918	Flow	7-31-63	D,S	...	..	..	4,290	6-64	.....	Yield 0.3 gpm.
25cca	J. Kensok	475	2	Dr	1963	Flow	7-29-63	D,S	...	Kd	S	4,120	6-64	.....	Yield 4.0 gpm.
25ccc	Test hole 3155	32	..	Dr	8-14-64	.....	....	T	...	..	..	.....	....	967	L.
26bda	Truman Kingsley	397	4	Dr	1959	Flow	4-16-59	D,S	S	..	S	4,200	6-64	.....	Yield 5 gpm , L.
26cbd	Test hole 3154	107	..	Dr	8-14-64	.....	....	T	...	..	..	.....	....	989	L, E.
26ccb	Northern Pacific Railroad	20	28	Du	....	.....	....	D	S	Qd	Cy	1,020	8-2-64	.....	C.
28bdc	H. H. Wheeler	25	48	Du	....	8	7-29-63	D,S	S	Qd	Cy	1,620	6-64	.....	
29bbb	Harry Smith	...	3	Dr	....	Flow	7-29-63	D,S	...	..	..	4,760	6-64	.....	Yield 1.3 gpm.
30ddc	Ella Garsteig	...	2	Dr	1910	Flow	7-29-63	D,S	...	..	..	4,860	6-64	.....	Yield 3.0 gpm.
31aaa	Test hole 3153	32	..	Dr	8-14-64	.....	....	T	...	..	..	......	....	1,106	L.
31baa	Margaret Carlisle	...	3	Dr	....	Flow	7-29-63	S	...	..	..	4,610	6-64	.....	Yield 20.0 gpm.
32cdd	R. C. Bartholomew	672	4	Dr	1957	Flow	7-29-63	D,S	...	Kd	..	4,670	6-64	.....	Yield 3.5 gpm.
33aaa	Clayton Jendra	498	4	Dr	1960	Flow	1960	D,S	...	Kd	..	4,370	6-64	.....	Yield 40 gpm.
34baa	Wm. Grieger	425	3	Dr	....	Flow	7-29-63	D,S	...	Kd	..	3,890	6-64	.....	Yield 2.0 gpm.
35bbb	W. S. Lowman Trust	...	3	Dr	1940	Flow	7-29-63	D,S	...	..	..	4,040	6-64	.....	
36dad	Morgan Ford	400	4	Dr	Flow	.....	7-29-63	D,S	...	..	..	4,280	6-64	.....	
140-54															
1daa	Earl Kasowski	750	4	Dr	1949	Flow	7-26-63	D,S	...	Kd	..	5,530	6-64	.....	Yield 4.5 gpm.
2bcc	Ewald Moderow	700	4	Dr	....	6	7-26-63	S	...	Kd	Cy	5,570	6-64	.....	
2daa1	Elsie Hans	52	24	B	1961	.....	....	S	...	Qd	Cy	3,190	11-10-64	.....	C.
2daa2	..do...	161	..	Dr	1963	20	1961	U	...	Qd	..	.....	....	.....	L, Supply rept'd I.
2daa3	..do...	48	18	B	1957	.....	....	D	...	Qd	J	.....	....	.....	
4ccc	Frank Indra	50	24	B	....	.....	....	D,S	...	Qd	Cy	3,950	6-64	.....	
4dad	Vern Smith	700	3	Dr	1949	15	7-25-63	D,S	...	Kd	Cy	.....	....	.....	
7daa	Edward Eastley	30	36	B	....	.....	....	D	...	Qd	J	3,130	6-64	.....	
9dcb	Jack Peterson	700	4	Dr	....	8	7-25-63	D,S	...	Kd	J	5,470	6-64	.....	
10bbc	Floyd Larson	735	3	Dr	1941	10	7-25-63	D,S	...	Kd	Cy	4,930	6-64	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-54 Cont.															
11cbc	Ray Kasowski	70	30	B	1934	45	7-25-63	D,S	...	Qd	Cy	1,250	6-64	.....	
12bcb	Harold Kasowski	666	4	Dr	1962	Flow	7-26-63	D,S	...	Kd	..	5,410	6-64	.....	Yield 10 gpm.
13add	Richard Schock	670	3	Dr	1939	Flow	7-26-63	D,S	...	Kd	..	4,340	6-64	.....	P, Yield 3 gpm.
15cbb	Clarence Beilke	700	3	Dr	....	Flow	7-26-63	S	...	Kd	J	2,550	6-64	.....	Yield 15 gpm.
18d	Village of Buffalo No. 7	53	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
18dda	Francis Killoran	40	36	B	1920	10	7-25-63	D,S	S	Qd	Cy	1,940	6-64	.....	
19cda1	Village of Buffalo No. 9	311	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
19cda2	Village of Buffalo No. 10	56	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
19cdb	Village of Buffalo No. 11	254	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
19cdd	Village of Buffalo	768	6	Dr	6-18-65	49	....	P,S	S	Kd	S	.....	....	1,207	L.
19dcc	Frank Sproul	750	4	Dr	....	50	7-25-63	S	...	Kd	..	.....	....	.....	
20aab	E. Buttke	26	36	B	.....	15	7-25-63	D	...	Qd	Cy	3,730	6-64	.....	
20ccc	Quincy Smith	30	18	B	1957	20	7-25-63	D	...	Qd	J	2,480	6-64	.....	Supply rept'd I.
22bbb	Orin Hogen	30	24	Du	....	4	7-26-63	D,S	S	Qd	Cy	2,830	6-64	.....	..Do...
23ccb	N. Holland	64	4	Dr	1960	15	7-26-63	D	S	Qd	Cy	.....	....	.....	
24bbb	Zephon Smith	510	4	Dr	1944	Flow	7-26-63	D,S	...	Kd	..	4,380	6-64	.....	
25add	J. Tyrlick	55	24	B	1951	13	7-26-63	U	G	Qd	Cy	.....	....	.....	Supply rept'd I.
26dad	Glenn Strain	425	3	Dr	1938	Flow	7-26-63	D,S	...	Kd	..	4,200	6-64	.....	
27bba	I. O. Nilles	750	3	Dr	1957	Flow	7-25-63	D,S	...	Kd	..	5,890	6-64	.....	
29caa	Pehrson Bros.	730	3	Dr	1955	4	7-25-63	U	...	Kd	..	4,790	6-64	.....	
30abc	Harry Marcks	29	36	B	....	.....	....	D,S	S	Qd	S	2,340	6-64	.....	
30bbb	Village of Buffalo No. 12	269	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
30d	Village of Buffalo No. 8	47	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
31aaa	Ervin Marcks	900	4	Dr	1927	24	7-25-63	D,S	...	Kd	J	.....	....	.....	
34bbb	Curtiss Hogen	560	4	Dr	1959	.....	....	D,S	...	Kd	..	4,790	6-64	.....	
35aad	Test hole 3152	32	..	Dr	8-14-64	.....	....	T	...	..	..	.....	....	1,186	L.
35ccb	Walter Fraase	460	3	Dr	1957	Flow	7-23-63	S	...	Kd	..	.....	....	.....	
140-55															
3ddd	Duane Grieger	85	4	Dr	1953	10	7-18-63	D,S	S	Qd	Cy	1,340	6-64	.....	
4bdb	Wm. Stuber	60	..	Dr	1957	.....	....	D	S	Qd	J	.....	....	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-55 Cont.															
8add	Carl Smith	825	3	Dr	1937	Flow	7-18 -63	D,S	...	Kd	..	5,280	6-64	.....	
8bca	Arnold Glemming	60	18	B	1938	55.00	7-19-63	D,S	S	Qd	Cy	.....	....	.....	Supply rept'd I.
10ccc	Dagmar Gubrud	28	48	Du	1870	12	7-18-63	D,S	...	Qd	Cy	1,830	6-64	.....	
13dac	Mary Norgard	800	4	Dr	....	.....	....	D,S	...	Kd	Cy	5,590	6-64	.....	
14aac	Elmer Holland	750	3	Dr	....	.....	....	S	...	Kd	Cy	5,370	6-64	.....	
15dcc	Henry Richman	835	3	Dr	1946	Flow	7-23-63	D,S	...	Kd	..	6,060	6-64	.....	
15dcd	..do...	Spring	2	..	....	Flow	7-23-63	S	...	Qd	..	.....	....	.....	
17cbb	Martin Richman	40	30	B	1948	22	7-18-63	D,S	S	Qd	Cy	3,320	6-64	.....	
18acb	Edwin Richman	700	3	Dr	1943	Flow	7-18-63	D,S	...	Kd	..	.....	....	.....	Yield 7 gpm.
19acc	Charles Easton	40	8	B	1925	.....	....	D	S	Qd	Cy	3,760	6-64	.....	Water rept'd to be contaminated and is used only for watering lawn.
19bac1	Tower City	27	3	Dr	1960	11.93	12-5-63	O	S	Qow	..	.....	....	.....	MP 2.84 ft above ls.
19bac2	..do...	28	10	Dr	7-18-60	13	7-18-60	P,S	S	Qow	T	785	6-16-64	.....	L, Yield 70 gpm ,C.
19caa	..do...	31.5	12	B	....	19.93	12-5-63	U	...	Qd	Cy	.....	....	.....	MP at ls.
20cab	Otto Wilner	620	2	Dr	1939	Flow	7-18-63	D,S	...	Kd	..	.....	....	.....	
22add	T. Knight	62.0	15	B	....	7.00	7-19-63	U	...	Qd	Cy	.....	....	.....	MP 0.5 ft above ls.
22cda	Village of Buffalo No. 3	47	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
22dbb	Village of Buffalo No. 4	32	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
22dbc1	Village of Buffalo No. 1	71	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
22dbc2	Village of Buffalo No. 2	32	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.
22dca	Test hole 3121	17	..	Dr	7-16-64	.....	....	T	...	..	..	.....	....	1,135	L.
22dcd	Village of Buffalo No. 5	32	..	Dr	9-64	.....	....	T	...	...	..	.....	....	.....	L.
24dda	K. Alinder	640	3	Dr	1943	19	7-19-63	S	...	Kd	Cy	.....	....	.....	
25aaa	Test hole 3120	220	1 1/4	Dr	7-15-64	30.20	7-15-64	O	S	Qd	..	1,290	7-17-64	1,195	MP 1.96 ft above ls, TH depth 392, L. C.
25bab	Victor Pfeifer	740	3	Dr	1945	.....	7-23-63	D,S	...	Kd	J	.....	....	.....	
27bab	A. L. Holter	540	4	Dr	....	Flow	7-19-63	D,S	...	Kd	..	5,220	11-10-64	.....	C, Yield 1.0 gpm.
27caa	Village of Buffalo No. 6	32	..	Dr	9-64	.....	....	T	...	..	..	.....	....	.....	L.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
140-55 Cont.															
28bbb	Raymond Langer	65	30	B	....	25	7-19-63	D,S	...	Qd	Cy	2,050	6-64	....	
29dcb	Ray Hinrichs	45	18	Dr	....	18	7-19-63	D	S	Qd	J	......	....	.....	
30baa	O. J. Redmann	40	24	B	1956	25	7-19-63	D,S	...	Qd	J	.....	....	.....	Well rept'd to pump dry occasionally.
31acc	Wayne Redmann	30	18	B	....	10	7-19-63	U	...	Qd	Cy	1,700	6-64	.....	Supply rept'd I and unfit for drinking.
33aaa	Wiley Estate	70	26	B	1935	20	7-19-63	D,S	S	Qd	J	1,390	6-64	.....	
34bbb	Myron Stenseth	70	28	B	1958	28.77	12-5-63	D,S	S	Qd	S	.....	....	.....	MP at ls.
35ada	Wm. Fraase	710	2 1/2	Dr	1967	5	7-18-63	S	...	Kd	Cy	5,940	6-64	.....	
141-49															
3ccc	John Posch	220	3	Dr	1956	.....	....	D,S	S	Qd	J	1,590	6-64	884	
4cdc	Paul Lasburg	280	4	Dr	1955	.....	....	D,S	...	Qd	Cy	3,650	6-64	885	
6cdb	Great Northern Railroad	225	6	Dr	1951	.....	....	D	...	Qd	Cy	2,310	5-12-65	885	L, C.
9baa1	Test hole 3096	73	..	Dr	5-19-64	.....	....	T	...	..	..	.....	....	886	L.
9baa2	Test hole 3096A	274	..	Dr	5-20-64	.....	....	T	...	..	..	.....	....	886	L, E.
9ddd	Luella Keith	180	3	Dr	....	.....	....	U	...	Qd	Cy	.....	....	886	
11cbc	Kenneth Soberg	120	2	Dr	1943	.....	....	D,S	S	Qd	Cy	1,030	6-64	884	
12aba	Ray Olsen	152	3	Dr	1958	.....	....	D,S	S	Qd	J	7,770	6-64	883	
12dcd	Lloyd Kragnes	122	18	Dr	1956	22	6-18-63	D,S	S	Qd	Cy	.....	....	886	Supply rept'd I.
14adb	Arne Stangeland	120	2	Dr	1930	35	6-18-63	D,S	S	Qd	Cy	.....	....	886	
15bdc	Karl Brunsdale	140	4	Dr	1955	.....	....	D,S	S	Qd	Cy	.....	....	886	
16ddd	Oscar Simonson	125	3	Dr	1952	22	6-18-63	D,S	G	Qd	Cy	.....	....	887	
17dab	Victor Simonson	196	3	Dr	1943	60	6-18-63	D,S	...	Qd	Cy	.....	....	886	
20ddc	Inar Amundson	207	3	Dr	1930	40	6-18-63	D	G	Qd	Cy	.....	....	888	
21dac	Wallace Tvedt	125	3	Dr	1961	.....	....	D,S	S	Qd	Cy	.....	....	889	
24bcb	Evert Flesberg	212	3	Dr	1930	12	6-18-63	D	G	Qd	Cy	.....	....	886	
25acc	W. H. Wright	72.0	3	Dr	....	23.00	6-20-63	U	...	Qla	Cy	.....	....	887	
26baa	Wm. Rabanus	220	3	Dr	1940	10	6-18-63	D	G	Qd	Cy	.....	....	885	
26daa	Henry Matthys	130	3	Dr	1953	40	6-18-63	D	S	Qd	Cy	830	6-64	887	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
141-49 Cont.															
27aba	Elfreda Hatlen	125	2	Dr	1920	50	6-18-63	D	S	Qd	Cy	.....	....	887	
28aca	Wm. Timke	193	3	Dr	1963	60	6-18-63	D	S	Qd	Cy	.....	....	890	L, Yield 40 gpm.
28bdb	ASP Construction Co.	206	4	Dr	8-22-61	63	8-22-61	D	...	Qd	..	.....	....	890	L, Yield 100 gpm.
30dda	C. Brandvick	170	2	Dr	1910	50	6-18-63	D	...	Qd	Cy	.....	....	891	
33bba	G. Freedland	160	3	Dr	....	40	6-18-63	D	...	Qd	Cy	.....	....	891	
33cab	David Sayre	185.0	4	Dr	5-19-61	67.37	10-18-63	D,S	S	Qd	S	1,330	5-12-65	891	L, C, MP 0.7 ft a-bove ls, Yield 75 gpm.
33cac	Philip Martins	190	3	Dr	1940	.....	....	D,S	S	Qd	Cy	.....	....	891	
33cda	George Lind	150	3	Dr	....	20	6-18-63	D	...	Qd	Cy	.....	....	891	
33daa	Robert Miller	116	4	Dr	1961	61.91	5-5-64	D	S	Qd	S	.....	....	893	L, MP 0.95 ft above ls.
34bcb	Fred Cory	128	3	Dr	1931	50	6-18-63	D	S	Qd	Cy	940	6-64	892	
34ccc	John Weeks	155	4	Dr	9-19-61	58	9-19-61	D	S	Qd	Cy	.....	....	891	L, Yield 8 gpm.
35aaa	Henry Matthys	136	3	Dr	....	.....	.....	D	S	Qd	Cy	.....	....	887	
36dcd	John S. Westlund	80.0	18	B	....	9.35	6-20-63	U	...	Qd	Cy	.....	....	891	MP 0.7 ft above ls.
141-50															
1abc	Harold Sorvaag	146	3	Dr	1952	30	6-26-63	D	...	Qd	J	.....	....	887	
2add	Veitch Estate	159	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	890	P.
4bbb	Sam Pachalke	212	3	Dr	1951	.....	....	D	S	Qd	Cy	.....	....	903	
4ddc	Bonnie Hagemeister	156	3	Dr	1957	.....	....	D,S	S	Qd	J	390	6-64	900	
5ddc	Sigurd Sorvaag	226	3	Dr	1942	.....	....	D,S	S	Qd	Cy	.....	....	905	
6bcc	Harold Veitch	420	4	Dr	1952	14	1952	D,S	...	Kd	Cy	910	6-64	913	
6ddd	Test hole 3098	130	1 1/4	Dr	5-23-64	29.41	5-27-64	O	S	Qd	..	1,700	5-26-64	908	L, C, TH depth 355, MP 1.29 ft above ls, E.
7baa	Chester Bergman	360	2 1/2	Dr	1950	14	6-26-63	D,S	S	..	J	1,890	6-64	911	
9aaa1	Test hole 3097	80	..	Dr	5-22-64	.....	....	T	...	..	..	.....	....	898	L.
9aaa2	Test hole 3097A	280	1 1/4	Dr	5-22-64	24.15	5-25-64	O	S	Qd	..	4,560	5-23-64	898	MP 2.0 ft above ls, E, TH depth 312.5, L, C.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
141-50 Cont.															
11cdc	Robert Erickson	195	4	Dr	2-22-61	21.90	10-28-63	D	S	Qd	S	4,580	5-12-65	893	MP 1.2 ft above ls,L,C.
13bcb	Otis Mays	200	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	890	
17cbc	Harry Bergman	77	3	Dr	....	18	....	D,S	S	Qla	Cy	980	6-64	906	
18bcc	Victor Mattson	193	3	Dr	1934	.....	....	D,S	S	Qd	Cy	.....	....	911	
20bcb	Carl Aabye	210	3	Dr	....	8	6-26-63	D,S	...	Qd	Cy	.....	....	906	
20dcd	Ludvig Ganges	130	3	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	902	
22baa	Gordon Erickson	206	4	Dr	6-1-62	26.52	11-2-64	D	S	Qd	S	.....	....	896	L, MP 1.3 ft above ls.
22ddd	Gordon Langseth	150	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	895	
23bbb	Margaret Schlosser	250	3	Dr	....	.....	....	D	...	Qd	Cy	.....	....	895	
29ddd	Alvin Anderson	121	4	Dr	1948	.....	....	D,S	S	Qd	J	4,280	6-24	904	
30bab	R. F. Kelly	146	3	Dr	1952	.....	....	D,S	S	Qd	Cy	.....	....	907	
31ccc	G. Schutt	270	3	Dr	1955	.....	....	D	S	Qd	Cy	.....	....	909	
32bcc	Henry Eggert	252	3	Dr	1952	.....	....	D	S	Qd	J	.....	....	906	
33abb	Duane Rust	120	2	Dr	....	.....	....	D	...	Qd	Cy	.....	....	902	
34bcc	R. P. Chamberlin	96	4	Dr	1953	8	6-25-63	D	S	Qd	Cy	2,960	6-24	898	
35dcc	E. Rust	310	4	Dr	1953	.....	....	D	S	..	Cy	.....	....	892	
141-51															
1bbb	Alick Lundwall	131	4	Dr	9-24-63	33	9-24-63	D,S	S	Qd	S	.....	....	923	L.
1dcd	Schwarz Bros.	187	4	Dr	1962	27.80	10-29-63	D,S	S	Qd	S	1,230	7-64	916	L, MP 0.5 ft above ls.
2abb	Albin Olson	65	3	Dr	1948	20	8-8-63	D,S	S	Qla	J	.....	....	929	
2ccc	Walter Olson	157	4	Dr	1960	14	8-8-63	D,S	S	Qd	Cy	1,360	7-64	929	
4bcb	Charles Turner	120	4	Dr	....	3	8-8-63	D,S	S	Qd	J	.....	....		
5ccc	Lester Zimmerman	119	3	Dr	1945	.....	....	D,S	S	Qd	Cy	.....	....		
7abd	Lloyd Zimmerman	120	3	Dr	1948	.....	....	D,S	S	Qd	J	.....	....		
8dad	Johann Weerts	300	4	Dr	....	Flow	8-8-63	D,S	...	..	..	.....	....	.....	Yield 0.8 gpm.
9aba	Allan Knight	192	4	Dr	1958	44	6-5-58	D,S	S	Qd	S	.....	....	.....	L, Yield 10 gpm.
9ddc	Raymond Cramer	72	24	B	1959	.....	....	U	S	Qd	Cy	.....	....	.....	Rept'd unfit for drinking.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
141-51 Cont.															
11aab	Gene Pearson	125	4	Dr	1951	.....	....	D,S	S	Qd	Cy	.....	....	924	Supply rept'd I.
11dcc	George Blixt	59	24	B	1951	25	8-12-63	S	S	Qla	Cy	770	7-64	924	
12dcc	Philip Bergman	300	3	Dr	1960	.....	....	D,S	S	...	Cy	.....	....	914	
14cdd	Dallas Lehman	165	3	Dr	....	.....	....	D,S	G	Qd	Cy	.....	....	923	
15cdd	Allen Knight	85	4	Dr	1924	15	8-12-63	D,S	...	Qd	Cy	.....	....	.....	
16bcc	Frank Cramer	151	4	Dr	8-22-60	52	8-22-60	D,S	S	Qd	Cy	.....	....	.....	L, Yield 10 gpm.
17cdd	George Smith	180	3	Dr	....	6	8-8-63	D,S	S	Qd	S	.....	....	.....	
19cdd	Mabel Lorshbough	319	4	Dr	1962	Flow	....	D,S	...	Qd	S	3,880	6-25-64	947	L, C.
20ccc	Walter Colberg	97.7	4	Dr	1910	1.7	10-29-63	U	S	Qd	..	.....	....	945	MP at ls.
21cdd	Fred Cederberg	...	24	B	....	.....	....	D,S	S	..	Cy	.....	....	935	
22dcc	Allan Knight	180	4	Dr	1952	10	8-9-63	D	S	Qd	Cy	.....	....	924	
25aad	Lawrence Kuklok	400	4	Dr	1958	.....	....	D,S	...	Qd	Cy	690	7-64	910	
25ddd	Test hole 3132	257	..	Dr	7-27-64	.....	....	T	...	..	..	.....	....	909	L, E.
26cbb	Ellis McConnel	350	3	Dr	....	20	8-9-63	D,S	S	..	Cy	.....	....	922	
28bcc	Wendell Jonas	100	4	Dr	....	15	8-9-63	D,S	...	Qd	Cy	.....	....	.....	
29ddc	..do...	100	3	Dr	....	20	8-9-63	D,S	S	Qd	Cy	.....	....	.....	
30ccc	E. Fowler	55	48	Du	....	15	8-9-63	D,S	...	Qd	J	3,140	7-64	.....	
31ccb	Gladys McKinnon	365	4	Dr	10-27-61	.....	....	D	S	..	J	1,650	7-64	.....	Well rept'd to have flowed when drilled,L.
32dad	Mabel Andrist	170	3	Dr	....	Flow	....	D,S	S	Qd	..	.....	....	.....	Rept'd unfit for drinking.
33cbc	..do...	170	3	Dr	1900	Flow	....	D,S	S	Qd	..	.....	....	.....	..Do...
34bbb	Armond Nilles	300	6	Dr	....	.....	....	D,S	S	..	Cy	.....	....	.....	
35ddd	Gunnard Nelson	80	2	Dr	....	12	8-9-63	D,S	S	Qd	Cy	.....	....	913	
141-52															
1dab	George Iwen	380	2	Dr	....	Flow	8-7-63	D,S	...	..	..	.....	....	.....	Yield 0.3 gpm.
2dcd	Rosa Rode	140	4	Dr	....	.....	....	D	S	Qd	Cy	.....	....	.....	
3ccd	Williams Bros.	160	3	Dr	1959	.....	....	D,S	...	Qd	Cy	2,950	9-64	.....	
4baa	E. Steffes	200	4	Dr	1950	5	....	D,S	S	Qd	Cy	1,280	9-64	.....	
4cdd	Hugo Priewe	340	3	Dr	1963	Flow	8-7-63	D,S	...	..	..	.....	....	.....	Yield 0.5 gpm.
5cdc	Frank Branstad	330	3	Dr	1941	.....	....	D,S	...	..	Cy	.....	....	.....	Rept'd to flow occasionally.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
141-52 Cont.															
6ccd	Gideus Hersch	450	2	Dr	....	Flow	8-7-63	D,S	S	Kd	..	.....	....	.....	Yield 5 gpm.
7daa	Roger Foster	325	2	Dr	1959	Flow	8-7-63	D	...	..	..	.....	....	.....	Yield 4.0 gpm.
8bab	Frank Branstad	333	3	Dr	1940	.....	....	D,S	...	..	Cy	.....	....	.....	Rept'd to flow occasionally.
11bad	Floyd Longlet	280	3	Dr	....	.....	....	D,S	...	..	Cy	.....	....	.....	
12ada	Orville Iwen	127	3	Dr	1943	.....	....	S	G	Qd	Cy	.....	....	.....	
13bbb	Great Northern Railroad	200	12	Dr	6-5-26	Flow	4-3-64	U	S&G	..	..	.....	....	.....	L, Yield 1 gpm.
13dcc	E. Nesemeier	167	4	Dr	....	Flow	8-6-63	D,S	...	Qd	..	.....	....	.....	Yield 7 gpm.
14cdc	Frank King	280	3	Dr	....	Flow	8-6-63	D,S	...	..	..	.....	....	.....	Yield 2.0 gpm.
15cdc	Elmer Nohr	117	3	Dr	8-12-60	.....	....	D,S	S	Qd	Cy	1,050	9-64	.....	Yield 10 gpm, L.
16cdd	Clemence Kuklak	135	3	Dr	....	60	8-7-63	D,S	S	Qd	Cy	.....	....	.....	
17cca	Victor Holgerson	420	3	Dr	....	Flow	8-7-63	D	...	..	..	.....	....	.....	Yield 1 gpm.
18bbb	B. R. Farr	400	3	Dr	....	Flow	8-7-63	S	...	..	..	4,100	9-64	.....	Yield 1.3 gpm.
20aaa	A. Roden	300	3	Dr	....	Flow	....	D,S	...	..	..	.....	....	.....	
21cdd	Village of Amenia No. 1322-6	63	..	Dr	6-22-63	.....	....	T	...	..	..	.....	....	.....	Drilled by State Water Commission, L.
23daa	Village of Amenia No. 1322-2	357	..	Dr	6-18-63	.....	....	T	...	..	..	.....	....	.....	L.
24add	L. F. Chaffee	72	18	B	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
24dcc	Village of Amenia No. 1322-3	357	..	Dr	6-19-63	.....	....	T	...	..	..	.....	....	.....	L, drilled by State Water Commission.
24ddd	WDAY, Inc.	216	4	Dr	...	Flow	....	Ind	...	Qd	Cy	2,370	6-13-63	.....	Well rept'd to have flowed 12 gpm when drilled.
25bbc	Village of Amenia	280	1 1/4	Dr	....	Flow	....	P,S	...	Qd	S	3,168	6-13-63	.....	C.
26aad	..do...	260	1 1/4	Dr	....	Flow	....	P,S	...	Qd	S	3,574	6-13-63	.....	C.
26adc	Monroe Farms	305	3	Dr	1920	Flow	....	D,S	...	Qd	..	.....	....	.....	
26bbb	Village of Amenia No.1322-1	614	..	Dr	6-13-63	.....	....	T	...	..	..	.....	....	.....	L, drilled by State Water Commission.
27bbb	Village of Amenia No. 1322-5	357	..	Dr	6-20-63	.....	....	T	...	..	..	.....	....	.....	L.
27ddd	Wesley Flatt	90	36	B	....	60	8-6-63	U	S	Qd	Cy	.....	....	.....	Rept'd unfit for drinking.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
141-52 Cont.															
28aac	Berna Olson	456	4	Dr	4-18-62	Flow	....	D,S	...	Kd	..	.....	....	.....	Pumped 65 gpm, L.
29dcc	Lester Chaffee	330	2	Dr	1955	Flow	8-6-63	D,S	...	..	..	.....	....	.....	
30ccb	Tom Hanson	20 -	24	B	1948	4	8-6-63	D,S	S	Qla	J	540	9-64		
31daa	Harley Sell	550	2	Dr	1923	Flow	8-6-63	D,S	...	Kd	..	4,000	9-64	.....	
32bab	Paul Henson	525	2	Dr	1959	Flow	8-6-63	D,S	...	Kd	..	.....	....	.....	
33addl	Leo Baumler	420	3	Dr	1952	Flow	9-23-64	D	...	Kd	..	.....	....	.....	Supply rept. I.
34ddd	A. Schneider	350	3	Dr	....	5	8-6-63	D,S	...	..	Cy	.....	....	.....	
35aaa	Village of Amenia No.1322-4	357	..	Dr	6-19-63	.....	....	T	...	..	..	.....	....	.....	L, drilled by State Water Commission.
36bab	Bill Sinz	360	3	Dr	1954	.....	....	D,S	...	..	J	.....	....	.....	
141-53															
1bbb	L. Grieger	70	36	B	1920	.....	....	D,S	S	Qd	Cy	.....	....	.....	
1ddd	..do...	65	2	Dr	10-12-63	20	10-12-63	D	...	Qd	Cy	.....	....	.....	L.
3dcd	G. Hersch	21.0	24	B	....	9.40	12-4-63	U	...	Qal	J	1,500	9-64	.....	MP 1.5 ft above ls .
4ddd	G. Mitchell	22	48	Du	1948	3	7-25-63	D,S	S	Qal	Cy	.....	....	.....	
6dcd	Wm. Rose	141	4	Dr	1-20-64	36	1-20-64	D,S	S	Qd	S	.....	....	.....	L, Yield 35 gpm.
6ddc	Norman Nelson	110.0	4	Dr	5-24-61	17.35	12-4-63	D	S	Qd	S	1,290	9-64	.....	L, Yield 30 gpm.
8dbb	G. Schmeck	76	3	Dr	1925	20	7-24-63	D,S	S	Qd	Cy	.....	....	.....	
9ada	Thomas Palmer	30	36	B	1958	15	7-25-63	D,S	...	Qd	J	.....	....	.....	
10add	Minnie Bissett	625	4	Dr	1961	Flow	1961	D,S	...	Kd	..	.....	....	.....	Rept'd to have flowed 300 gpm when drilled.
12bca	Gerald Grieger	40	..	Dr	1961	.....	....	D,S	S	Qd	Cy	.....	....	.....	
13daa	Robert Smith	520	3	Dr	1949	Flow	7-24-63	D,S	...	Kd	..	.....	....	.....	Yield 1.0 gpm.
14cba	Howard Pueppke	480	1 1/2	Dr	1912	Flow	7-24-63	D,S	...	Kd	..	.....	....	.....	Yield 5.5 gpm.
15dad	Glen Pueppke	580	2	Dr	1948	Flow	7-24-63	D,S	...	Kd	..	.....	....	.....	Yield 27.0 gpm.
17aab	H. Brainerd	60	3	Dr	1958	.....	....	U	...	Qd	Cy	.....	....	.....	
18dcd	J. Beattie	80	2	Dr	1963	.....	....	S	S	Qd	Cy	.....	....	.....	
19dda	L. W. Eckert	660	3	Dr	1958	.....	....	D,S	...	Kd	J	.....	....	.....	Will flow if permitted.
20add	Leo Hagemeister	675	1 1/2	Dr	1961	.....	....	D,S	...	Kd	J	4,940	10-8-64	.....	C.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
141-53															
21dcd	Irvin Boyce	47	36	B	1943	15	7-24-63	D,S	...	Qd	Cy	.....	....	.....	
22cdd	John Hocking	28	24	B	1959	3	7-24-63	D	S	Qd	Cy	.....	....	.....	
23dda	Russel Idso	31	36	Du	....	.....	....	D	G	Qd	J	.....	....	.....	
24aab	Robert Hill	50	36	B	1949	.....	....	D,S	S	Qd	Cy	.....	....	.....	
25cda	Elmer Krueger	496	3	Dr	1941	Flow	7-24-63	D,S	...	Kd	..	.....	....	.....	
26add	Adeline Krueger	20	36	B	1928	.....	....	D,S	...	Qla	Cy	.....	....	.....	
27bcb	Clarence Gulland	40	24	B	1958	30	7-24-63	D	...	Qd	J	.....	....	.....	
29baa	Wallace McLeod	530	..	Dr	1923	Flow	7-19-63	S	...	Kd	..	.....	....	.....	Yield 3 gpm.
29ccc	L. R. Faught	60	24	B	....	.....	....	D	...	Qd	J	.....	....	.....	
30bcc	Donald Eckert	Spring	24	..	....	Flow	....	D,S	...	Qd	Cen	1,310	9-64	.....	
30ccc	Kenneth Marshall	60	30	B	....	.....	....	D	S	Qd	Cen	.....	....	.....	Rept'd unfit for drinking.
32aab	Fred Gavin	30	36	Du	1915	.....	....	D,S	...	Qd	J	.....	....	.....	Supply rept'd I.
32bbb	Henry Corniea	520	3	Dr	1915	Flow	7-19-63	D,S	...	Kd	J	3,820	9-64	.....	Yield 1.1 gpm.
33dcc	Great Northern Railroad	12.55	14	Dr	....	9.44	4-3-64	U	S	Qla	Cyl	.....	....	.....	MP .75 ft above ls.
33dcd	C. V. Nepp	31.0	24	B	5-2-64	16.60	5-6-64	D	S	Qd	..	.....	....	.....	
34caa	I. N. Hocking	675	3	Dr	1959	Flow	....	D	...	Kd	..	.....	....	.....	
35dcc	Wayne Hocking	25	24	Du	1920	15	7-23-63	D,S	...	Qla	Cy	.....	....	.....	
36dcc	E. Brandt	400	4	Dr	....	Flow	7-23-63	D,S	...	..	..	3,700	9-64	.....	Yield 5 gpm.
141-54															
2cba	Harvey Wheeler, Jr.	146	2	Dr	....	.....	....	D,S	S	Qd	J	.....	....	.....	
4bbc	A. Mitchell	136	2	Dr	1958	.....	....	D,S	S	Qd	Cy	770	9-64	.....	
4cdd	Howard Fox	158	2	Dr	1943	45	7-17-63	D,S	S	Qd	Cy	1,200	5-12-65	.....	C.
8dcd	Harry Wilcox	140	3	Dr	1951	.....	....	D,S	S	Qd	J	.....	....	.....	
10bdc	Murlen Hagen	136	2	Dr	1955	40	7-10-63	D	S	Qd	Cy	.....	....	.....	
11cca	E. W. Rand	145	2	Dr	....	.....	....	D	S	Qd	Cy	.....	....	.....	
11cdc	Test hole 2344	210	..	Dr	6-8-65	.....	....	T	...	..	..	.....	....	.....	L.
12ccc	Josephine Rueckert	135	4	..	1958	.....	....	..	...	..	Cy	.....	....	.....	L.
13caa	Emma Rueckert	128	2	Dr	1948	.....	....	D	S	Qd	J	.....	....	.....	
14baa	Bernard Mullen	136	3	Dr	6-13-60	32	6-13-60	D	S	Qd	J	.....	....	.....	L, Yield 30 gpm.
14ccc	Tom Cameron	164	5	Dr	12-21-61	40	12-21-61	S	S	Qd	S	.....	....	.....	L, Yield 15 gpm.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
141-54															
15aab	Nathan Idso	128	2	Dr	....	.....	....	D	S&C	Qd	Cy	.....	....	.....	
17bdc	A. R. Pilgrim	135	3	Dr	....	40	7-17-63	D	S	Qd	Cy	.....	....	.....	
18cdc	Erwin Buhr	30	2	Dr	....	.....	....	D	S	Qd	Cy	1,150	9-64	.....	
19ddc	A. Buhr	30	30	Du	....	.....	....	D,S	G	Qd	J	.....	....	.....	Supply rept'd I.
21ddc1	James Burns	126	2	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
21ddc2	..do...	166	3	Dr	8-15-63	.....	....	S	S	Qd	Cy	.....	....	.....	L.
23cdc	Fargo Loan Agency	138	2	Dr	1945	.....	....	D,S	S	Qd	Cy	.....	....	.....	
26bcc	Thompson Sisters	140	2	Dr	1948	.....	....	D	...	Qd	Cy	.....	....	.....	
27add	Lloyd Hutchinson	140	2	Dr	1949	.....	....	D,S	...	Qd	Cy	.....	....	.....	
28bcb	Maggie Hovland	28	24	B	1961	.....	....	D	...	Qd	J	.....	....	.....	
30bdd	Norman Marcks	30	3	Dr	1952	.....	....	D,S	...	Qd	Cy	.....	....	.....	
30cda	Arnold Kaim	740	3	Dr	1955	.....	....	S	...	Kd	Cy	.....	....	.....	
31dad	Jack Wilcox	600	3 1/2	Dr	....	.....	....	D,S	...	Kd	Cy	5,250	9-64	.....	
32bcb	..do...	800	3 1/2	Dr	1946	40	7-17-63	D,S	S	Kd	J	.....	....	.....	Well rept'd to have flowed at one time.
32ddc	Dewey Grieve	25.0	30	Du	.....	16.72	12-4-63	D	...	Qd	J	.....	....	.....	MP 0.3 ft above ls, supply rept'd I and unfit for drinking.
33bdc1	Elmer Grieve	147	2	Dr	1955	.....	....	D,S	S	Qd	Cy	.....	....	.....	
33bdc2	..do...	29.0	24	Du	....	15.00	7-17-63	U	...	Qd	..	.....	....	.....	MP 2.0 ft above ls.
34abd	Clara Boyd	145	2	Dr	1951	.....	....	D	...	Qd	Cy	1,160	11-1-64	.....	C.
34cbb	Moum Bros.	140	2	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
35aba	Ben Rueckert	42	24	B	....	20	7-17-63	D	...	Qd	J	.....	....	.....	Supply rept'd I.
141-55															
1daa	Paul Feder	52	4	Dr	....	.....	....	D,S	...	Qd	J	.....	....	.....	
2cdc	Warren L. Bayley	45	24	B	....	15.35	12-4-63	D,S	G	Qd	J	.....	....	.....	
2dcd	Mike Bankers	85	2	Dr	....	.....	....	D,S	S	Qd	S	1,820	7-64	.....	
3cdc1	Warren L. Bayley	57	2	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	MP 2.0 ft above ls.
3cdc2	..do...	65	3	Dr	8-63	12	....	D,S	...	Qd	Cy	.....	....	.....	L.
4dcc	Robert W. Brock	24	36	Du	....	.....	....	S	S	Qow	Cy	1,550	7-64	.....	Supply rept'd I.
5dab	Henry Baasch	32	18	B	....	.....	....	D,S	S	Qow	Cy	1,390	7-64	.....	
7ada1	William O. Clark	48	36	B	....	23.34	12-4-63	D,S	S	Qd	Cy	.....	....	.....	MP at ls, rept'd unfit for drinking.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
141-55 Cont.															
7ada2	William O. Clark	43	20	B	1945	.....	....	D	S	Qd	J	3,910	11-10-64	.....	C, MP at ls, supply rept'd I.
9ccd	Daniel Dobler	58	18	Du	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	..Do...
12ddc	Virgil E. Miller	86	2	Dr	1946	.....	....	D,S	S	Qd	Cy	1,000	11-17-64	.....	C.
15abb	Raymond Miller	660	4	Dr	....	.....	....	D,S	...	Kd	Cy	4,890	7-64	.....	Well rept'd to have flowed at one time.
16add	Clara Grieve	65	24	B	....	.....	....	D,S	...	Qd	..	.....	....	.....	
19daa	Philip Miles, et. al.	42.0	36	B	....	18.60	7-16-63	U	...	Qd	Cy	.....	....	.....	MP 1.4 ft above ls.
20add	Lyle Wical	26.0	36	Du	....	11.50	7-16-63	U	...	Qd	..	.....	....	.....	MP 1.5 ft above ls.
20ccd	Claude Schmitz	835	4	Dr	1950	Flow	7-16-63	D,S	...	Kd	..	5,170	7-64	.....	Well rept'd to have flowed, 9 gpm when drilled.
20dda	John Dunham	38	..	B	....	.....	....	D,S	...	Qd	Cy	2,070	7-64	.....	
24aaa	Lorenz Buhr	100	2	Dr	1929	.....	....	D	S	Qd	Cy	1,750	7-64	.....	
24ddb	George Killoran	107	4	Dr	1960	.....	....	S	S	Qd	Cy	1,790	7-64	.....	
27dcc	Loren Muir	16	..	Du	....	.....	....	D	...	Qd	..	1,250	7-64	.....	
28cdd	Edith Lonney	60	24	B	....	.....	....	D,S	S	Qd	..	3,520	7-64	.....	
31add	Floyd Preston	818	3	Dr	1953	Flow	7-16-63	D,S	...	Kd	J	4,840	7-64	.....	Yield ∠1 gpm.
32bbb	Wm. O. Hills	1200	3	Dr	....	Flow	....	D	...	..	..	.....	....	.....	
33bcc	Edward Krueger	50	20	B	....	.....	....	D	G	Qd	Cy	.....	....	.....	
33ccd	Rice Bros.	60	36	Du	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
34aaa	Loren Muir	640	2 1/2	Dr	....	Flow	....	D,S	...	Kd	..	.....	....	.....	P.
34dab	Elmer Schneekloth	640	4	Dr	1947	Flow	7-16-63	D,S	...	Kd	..	.....	....	.....	Yield 2 gpm.
35cbb	Wm. Peterson	640	3	Dr	....	Flow	7-16-63	D,S	...	Kd	..	.....	....	.....	Yield 4.0 gpm.
36ccd	Donovan Astrup	75	20	B	....	.....	....	D,S	S	Qd	J	.....	....	.....	
142-49															
2baa1	Joseph Reierson	175	2	Dr	1950	10	6-14-63	D,S	...	Qd	..	.....	....	876	
2baa2	..do...	138.0	3	Dr	....	17.65	10-28-63	U	...	Qd	..	.....	....	876	MP 2.65 ft above ls.
3bda	Trygve Risdahl	140	3	Dr	1957	10	6-14-63	D,S	...	Qd	..	2,190	6-64	879	
4aba	Wayne Thurlow	120	2	Dr	....	20	6-14-63	D,S	S	Qd	..	.....	....	879	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
142-49 Cont.															
6add	Deane Barker	150	3	Dr	1955	.....	....	D	G	Qd	..	760	6-64	881	
8bcb	Kenneth Larson	168	2 1/2	Dr	1943	15	6-14-63	D	...	Qd	..	.....	....	881	
9dcc	Donald Wieers	120	3	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	881	
11ddc	Leland Melbostad	187	3	Dr	....	50	6-13-63	D,S	S	Qd	Cy	.....	....	867	
12bab	Benny Ohnstad	162	3	Dr	1959	20	6-13-63	D,S	...	Qd	..	.....	....	875	
17bbb	James Melander	130	..	Dr	1953	15	6-14-63	D	...	Qd	..	.....	....	882	
18cdd	Benny Nedrepo	240	..	Dr	1955	20	6-14-63	D	...	Qd	..	4,680	6-16-65	884	C.
19ccc	Henry Wischer	210	3	Dr	1945	27	6-14-63	D	...	Qd	J	.....	....	885	
24dac	George Sebestl	185	3	Dr	....	20	6-14-63	D	G	Qd	..	.....	....	881	
25bda	Robert Richards	121	3	Dr	....	60	6-14-63	D	G	Qd	..	.....	....	881	
26baa	Ohnstad Bros.	125	2	Dr	1962	28.75	10-28-63	D,S	...	Qd	S	1,610	6-16-65	880	MP 0.9 ft above ls.
27ddc	Severin Ohnstad	141	2	Dr	1935	18	6-14-63	D	...	Qd	..	.....	....	881	
28ddc	Jerry Costello	160	..	Dr	....	.....	....	D	S	Qd	..	.....	....	882	
30ccd	Wilma Stair	110	2	Dr	1930	35	6-14-63	D	...	Qd	J	4,050	6-64	886	
32dad	Einar Buringrad	228	..	Dr	1956	28	6-14-63	D,S	...	..	..	5,610	6-64	885	
35dad	Wm. Ihnken	115	..	Dr	1956	.....	.....	D,S	...	Qd	..	810	6-64	881	
142-50															
1bcc	Barker Bros.	200	4	Dr	....	.....	....	D	...	Qd	Cy	.....	....	888	
2bbb	Cecil Barker	180	4	Dr	1962	.....	....	D	S	Qd	Cy	.....	....	891	
2dab	Great Northern Railroad	107.00	6	Dr	1924	12.02	5-8-63	...	S	Qd	..	.....	....	888	L.
3bba	Barker Bros.	275	3	Dr	1950	10	7-9-63	D,S	S	Qd	Cy	.....	....	895	
3bbb	Test hole 3100	355	..	Dr	5-27-64	.....	....	T	...	..	..	.....	....	895	L, E.
5bbb	Robert Krueger	208	3	Dr	1956	80	7-4-63	D,S	S	Qd	Cy	.....	....	914	
6dda	John Stimmal	196	3	Dr	1953	15	7-4-63	D,S	S	Qd	Cy	.....	....	911	
7aaa	L. A. Meyer	165	2	Dr	1939	.....	....	D	S	Qd	J	5,590	6-64	911	
8aab1	Arthur Burley	337	2	Dr	...	14.55	7-9-63	U	...	..	..	.....	....	905	MP 4.20 ft above ls.
8aab2	..do...	342	4	Dr	1959	.....	....	D	S	..	S	2,140	6-16-65	905	L, C.
10aad	Edison Colwell	180	2	Dr	1953	.....	....	U	S	Qd	Cy	.....	....	893	
11ccc	E. L. Burley	200	2	Dr	....	12	7-12-63	D,S	S	Qd	Cy	1,290	6-64	892	Well rept'd to flow
14ccc	Taft Burley	230	4	Dr	1953	12	7-12-63	D,S	S	Qd	Cy	.....	....	890	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
142-50	Cont.														
15cdd	Duane Sullivan	221	4	Dr	1953	.....	....	D,S	S	Qd	Cy	.....	....	896	
16aad	Alex Zimney	247	2	Dr	....	10	7-3-63	D	S	Qd	Cy	.....	....	898	
18ccc	Kent Hodgson	200	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	918	
19acc	Clarence Classon	80	3	Dr	....	.....	....	S	...	Qd	Cy	1,220	6-64	916	
19bcc	Rudolph Classon	120	3	Dr	1962	.....	....	D,S	G	Qd	Cy	3,790	6-16-65	921	C.
21cdd	Barbara Burley	136.0	3	Dr	1959	27.00	7-1-63	S	...	Qd	Cy	.....	....	902	
22cdd	Robert Haworth	190	3	Dr	1948	.....	....	D,S	S	Qd	Cy	.....	....	897	
24bcb	Dima Waterfall	180	3	Dr	1959	.....	....	D,S	...	Qd	Cy	.....	....	889	
26cbb	Guy Bush	230	3	Dr	1952	.....	....	D,S	...	Qd	Cy	.....	....	893	
27dcc	W. F. Eggert	200	3	Dr	1960	.....	....	D	S	Qd	J	.....	....	896	
28ddd	Alice Hodgson	385	3	Dr	1948	.....	....	D,S	S	Kd	Cy	6,290	6-64	898	
29bab	Victor Pacholke	217	3	Dr	1961	.....	....	D	S	Qd	Cy	.....	....	910	
30cbc	Ray Anderson	222	3	Dr	1962	.....	....	D,S	S	Qd	Cy	.....	....	918	
32add	Warron Walkinshaw	190	3	Dr	1957	.....	....	D	...	Qd	Cy	.....	....	904	
33ddc	W. F. Eggert	285	4	Dr	1948	.....	....	D,S	S	Qd	J	.....	....	901	
35add	Ralph Burmeister	219	4	Dr	5-25-60	15	5-25-60	D	S	Qd	S	4,770	6-16-65	891	L, C, Yield 75 gpm.
142-51															
2dcc	J. Burgum	85	3	Dr	....	.....	....	D	S	Qd	Cy	.....	....	937	
5cbc	Ellen Murch	201.0	2	Dr	....	5.20	7-16-63	U	...	Qd	..	.....	....	.....	MP 2.1 ft above ls.
6ccb	Melvin Nyberg	135	2 1/2	Dr	1950	15	7-16-63	D	S	Qd	J	.....	....	.....	
9aad	Gunard Pearson	400	3	Dr	1930	.....	....	D,S	S	Kd	J	.....	....	.....	
9cca	August Nelson	156	3	Dr	1961	10	7-16-63	D,S	S	Qd	J	.....	....	.....	
10bba	Randolph Moen	250	4	Dr	1961	.....	....	D	S	Qd	J	912	7-64	931	
11cdc	Cedarberg Bros.	122	3	Dr	1960	.....	....	D	...	Qd	..	.....	....	939	
12baa	Frank Waxler	134	4	Dr	1937	20	7-16-63	D,S	S	Qd	Cy	.....	....	919	
13bbc	Wilmer Zimmerman	110	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	929	
13dca	Carl Swanson	230	4	Dr	1937	.....	....	D,S	S	Qd	Cy	.....	....	923	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
142-51															
16ccd	Alvin Wilson	280	2	Dr	....	6	7-16-63	D,S	S	Qd	Cy	.....	....	.....	
17daa	Harold Quaife	411	3	Dr	1938	Flow	7-16-63	D,S	...	Kd	..	4,990	6-16-65	.....	C, Yield 2 gpm.
18dcd	H. B. Farnham	212	4	Dr	1948	Flow	7-17-63	D	...	Qd	R	4,980	6-16-65	.....	C, Yield <1 gpm.
19cbc	Joe Pelter	150	4	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	970	
20dcd	George Parkhouse	160	4	Dr	1920	Flow	7-17-63	D	...	Qd	..	.....	....	946	Yield <1 gpm.
21bab	Melvin Zimmerman	185	3	Dr	1958	Flow	....	D,S	...	Qd	Cy	.....	....	943	
22baa	Sam Lako	275	3	Dr	1953	.....	....	D,S	S	Qd	Cy	.....	....	940	
23bba	Pauline Lako	120	3	Dr	1955	.....	....	D	S	Qd	J	.....	....	936	
26bbb	M. F. Gogolin	28	36	Du	....	15	7-17-63	D	...	Qla	Cy	930	7-64	939	
27dcc	Rollo Winings	100	4	Dr	1951	12	7-17-63	D,S	S	Qd	Cy	.....	....	941	
30cdd	Dorothy Burgum	136	4	Dr	6-7-58	124	6-7-58	D,S	S	Qd	Cy	1,070	6-16-65	.....	L, C, E.
31dbc	Emil Iwen	24	32	Du	1929	12	7-17-63	D,S	S	Qla	Cy	3,570	7-64	.....	
32bcc	Wm. Senn	108	3	Dr	1945	10	7-17-63	D,S	S	Qd	Cy	2,440	7-64	.....	
33cbb	Myrtle Wiesbach	73	3	Dr	1952	.....	....	D	...	Qd	J	.....	....	.....	
34baa	Rollo Winings	98	4	Dr	1951	18	7-17-63	D,S	S	Qd	Cy	960	7-64	941	
35bcb	Walter Pearson	40	24	B	1957	.....	....	D	...	Qla	J	.....	....	931	
36abb	K. Dickson	104	3	Dr	1952	.....	....	D,S	S	Qd	Cy	.....	....	921	
142-52															
2baa	Fred Williams Jr.	20	48	Du	....	.....	....	D	S	Qla	Cy	1,310	9-64	.....	
3cdd	H. F. Gale	20	..	Du	....	.....	....	D	S	Qla	J	.....	....	.....	Supply rept'd I.
4bba	Irving Bratholt	23.0	48	Du	....	6.0	6-18-63	D	...	Qla	Cy	.....	....	.....	MP at ls, supply rept'd I.
5bba	Clifford Rosendahl	180	..	Dr	....	.....	....	U	...	Qd	Cy	.....	....	.....	..do...
6add	Ben Frost	200	4	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
7dcc	Edward Steffes	198	3	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
8add	Vernon Smith	148	..	Dr	....	Flow	....	S	...	Qd	J	.....	....	.....	Yield <1 gpm.
11aab	Herbert Johnson	...	4	Dr	1958	.....	....	D	...	..	Cy	.....	....	.....	
12ddd	Rudolph Grieger	135	2	Dr	4-23-63	.....	....	D,S	S	Qd	Cy	.....	....	.....	L.
16cdd	Fred Williams	180	3	Dr	....	8	7-11-63	D,S	S	Qd	Cy	1,050	9-64	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
142-52 Cont.															
17aaa	Lloyd Williams	180	3	Dr	....	4.34	10-30-63	D,S	...	Qd	Cen	1,370	6-25-64	.....	MP 1.65 ft above ls.
18ddd	Edna Sommerfeld	210	3	Dr	....	.....	....	D,S	S	Qd	Cy	1,320	9-64		
21dcc	Charles Viestenz	23	42	Du	....	.....	....	D	...	Qla	J	.....	....	.....	
22add	John Lako	200	3	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	L.
22daa	..do...	485	..	Dr	7-63	.....	....	...	S	Kd	..	.....	....	.....	L, Well destroyed.
23dbc	..do...	140.0	4 1/2	Dr	8-10-63	.....	....	D,S	S&G	Qd	Cy	.....	....	.....	L, Yield 14 gpm.
24bbc	Village of Arthur	170.0	6	Dr	....	46.34	7-24-62	U	...	Qd	..	.....	....	.....	MP 1.2 ft above ls, Well abandoned
24bca	..do...	189	8	Dr	1961	53.24	4-1-64	P,S	...	Qd	T	1,694	8-4-61	.....	MP 1.7 ft above ls.
25bbd	Elmer Wilhelm	180	3	Dr	1950	.....	....	D,S	...	Qd	Cy	.....	....	.....	
29dcc	Herbert Schultz	199	4	Dr	1953	.....	....	D	...	Qd	Cy	.....	....	.....	
30dcc	E. Mergner	50	24	B	....	.....	....	S	...	Qd	Cy	2,610	9-64	.....	
31ccc	Gerald Viestenz	207	2	Dr	....	.....	....	D	S	Qd	Cy	.....	....	.....	Supply rept'd I.
33ada	Edward Steffes	178	3	Dr	1951	.....	....	D,S	S	Qd	Cy	.....	....	.....	
35abb	Clark Lincoln	130	4	Dr	1929	.....	....	S	S	Qd	Cy	1,090	9-64	.....	..Do...
36cbb	Wm. Boettcher	148	4	Dr	1959	.....	....	D	S	Qd	Cy	.....	....	.....	..Do...
142-53															
1bab	Test hole 3130	317	..	Dr	7-24-64	.....	....	T	...	..	..	.....	....	1,052	L, E.
1ddd	Lee Lawyer	36.0	36	Du	....	5.00	7-8-63	U	...	Qd	..	.....	....	.....	
3bdc	Ervin Berndt	50	36	Du	....	.....	....	D,S	...	Qd	Cy	1,020	9-64	.....	
3dad	..do...	32	24	Du	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
4ccc	Wayne Kyser	45	3	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
5ada	Frank Ferguson	300	2	Dr	....	.....	....	D,S	...	..	J	4,000	9-64	.....	
7ddd	Hulett & Berg	80	2 1/2	Dr	1958	.....	....	D,S	S	Qd	Cy	.....	....	.....	
8ddd	W. R. Kyser	41	2	Dr	....	.....	....	D	...	Qd	Cy	.....	....	.....	
11ccb	Willis Schroeder	20	16	Du	....	.....	....	D	...	Qla	Cy	.....	....	.....	
13cdd	Eunice Iwen	...	3	Dr	....	Flow	7-8-63	S	...	..	..	.....	....	.....	
15cba	Harry Albert	57.0	18	B	....	35.80	7-9-63	D,S	S	Qd	Cy	.....	....	.....	MP 2.2 ft above ls, supply rept'd I.
16ada	Wm. J. Jenkins	30	..	Dr	....	.....	....	D	...	Qd	J	.....	....	.....	
18dad	Mosher Bros.	65	2	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
142-53 Cont.															
20cdd	Louis Rieke	55	2	Dr	1951	.....	....	D,S	S	Qd	J	894	11-5-64	.....	C.
21cdd	Robert Schroeder	65	4	Dr	....	.....	....	D	...	Qd	Cy	.....	....	.....	
22daa	Melvin Kopp	56	2	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
25cdc	Earl Franke	340	4	Dr	....	Flow	7-8-63	S	...	..	..	.....	....	.....	Yield 2.0 gpm.
27aaa	Thomas Tate	20	48	Du	....	.....	....	D,S	...	Qla	J	.....	....	.....	Supply rept'd I.
28cdd	J. W. Morrow	68	2	Dr	1938	.....	....	D,S	S	Qd	Cy	.....	....	.....	
28ddc	Ted Godejohn	90	2	Dr	1958	30	7-5-63	D,S	S	Qd	Cy	1,160	9-64	.....	
30ddc	Ralph Kephart	145	3	Dr	.....	.....	....	D	S	Qd	Cy	960	9-64	.....	
31cbb	Harry Brown	120	4	Dr	1955	.....	....	D,S	S	Qd	Cy	.....	....	.....	
32abb1	Wayne Berndt	80	2	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	......	
32abb2	..do...	120	3	..	10-10-63	.....	....	D,S	S	Qd	Cy	.....	....	.....	L.
33bbb	Test hole 2345	168	..	Dr	6-8-65	.....	....	T	S	Qd	..	.....	....	.....	L.
34cda	Harry Albert	60	2	Dr	1960	.....	....	S	S	Qd	Cy	.....	....	.....	
35bbc	Fred Peach	10	8	B	....	.....	....	D	...	Qla	J	1,510	9-64	.....	Supply rept'd I.
36abb	L. F. Chaffee	...	14	B	....	15.10	1-22-64	U	...	..	..	.....	....	.....	MP 0.5 ft above ls.
36add	John Grieger	20	..	Du	....	.....	....	D,S	S	Qla	Cy	.....	....	.....	
36cdb	Dalice Grieger	413	3	Dr	1963	Flow	....	S	S	..	..	.....	....	.....	L.
142-54															
1bbb	Test hole 3129	160	1 1/4	Dr	7-22-64	7.48	7-30-64	O	S	Qd	..	543	11-6-54	1,180	L, C, E, TH depth 447 ft, MP 2.0 ft above ls.
2ccd	Alfred Huso	66	3	Dr	....	.....	....	D	...	Qd	Cy	.....	....	.....	
3cbb	Robert Eastly	100	2	Dr	1957	.....	....	D,S	...	Qd	Cy	810	9-64	.....	
4aaa	Ione McClellan	113	2	Dr	1960	.....	....	D	...	Qd	Cy	.....	....	.....	
6ddd	Great Northern Railroad	124	8	Dr	1936	13.78	2-4-64	R R	...	Qd	J	.....	....	.....	L, MP at ls.
7aab	Melvin Moen	80	2	Dr	1953	.....	....	D,S	S	Qd	J	800	9-64	.....	
8aab	Henry Suhr	88	2	Dr	....	.....	....	D,S	S	Qd	J	.....	....	.....	
8ddd	Test hole 3125	100	1 1/4	Dr	7-20-64	28.21	7-30-64	O	S	Qd	..	474	11-6-64	1,189	L, C, TH depth 257.
10dcd	T. E. Thompson	47	2	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
12ddd	Rudolph Grieger	120	2	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
142-54															
14bac	Ralph Thompson	175	3	Dr	4-15-64	.....	....	D,S	S	Qd	Cy	.....	....	.....	
17abb	Harold Nelson	110	2	Dr	1962	.....	....	D,S	S	Qd	J	.....	....	.....	
20ccc	Hall Bros.	92	3	Dr	1957	.....	....	D,S	S	Qd	Cy	.....	....	.....	
23daa	Alex Punton	90	2 1/2	Dr	....	30	7-5-63	D	S	Qd	J	.....	....	.....	
25cbc	M. Warmington	136	..	Dr	1955	.....	....	D	...	Qd	J	869	11-5-64	.....	C.
26bcb	Mabel Hassing	40	3	Dr	....	.....	....	D	...	Qd	Cy	.....	....	.....	
29daa	John Anderson	34	2	Dr	....	.....	....	D,S	...	Qd	Cy	720	9-64	.....	
32bdd	R. M. Brock	125	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
34aad	Test hole 2343	90	1 1/4	Dr	6-7-65	18.49	....	O	S	Qd	J	1,120	6-9-65	.....	L, C, TH depth 115.5 ft, MP 2.45 above ls
34bcb	Norman Alm	150	2	Dr	1955	.....	....	D,S	S	Qd	Cy	780	9-64	.....	
35daa	Ralph Cameron	160	..	Dr	1961	.....	....	D	...	Qd	Cy	.....	....	.....	
142-55															
1bba	Test hole 3124	96	1 1/4	Dr	7-20-64	29.70	7-30-64	O	S	Qd	..	.....	....	1,184	TH depth 137 ft, MP 2.01 ft above ls.
2aab	Riney Reger	80	2	Dr	....	.....	....	D	...	Qd	Cy	1,360	8-64	.....	
2baa	Harry Unsted	85	2	Dr	1951	.....	....	D	...	Qd	J	1,330	8-64	.....	
4cab	John Baasch	34.5	33	Du	....	11.22	12-3-63	D	...	Qd	J	.....	....	.....	MP at ls.
6ddd	Harry Davis	24	33	Du	....	.....	....	D,S	...	Qd	J	1,900	8-64	.....	Supply rept'd I.
8cbc	Wm. Suhr	23	24	B	....	.....	....	D	S	Qd	J	1,940	8-64	.....	
8ddd	Frieda Suhr	800	3	Dr	1919	Flow	....	D,S	...	Kd	..	5,530	6-25-64	.....	C.
11bab	Earl Davis	70	2 1/2	Dr	1950	.....	....	D	S	Qd	J	1,390	8-64	.....	
12bcc	Wesley Retterath	80	3	Dr	....	.....	....	D	...	Qd	J	.....	....	.....	
12daa	J. Harbeke	96	2	Dr	....	.....	....	D	S	Qd	J	1,290	8-64	.....	
14ddd	Dwayne Davis	87	2 1/2	Dr	....	.....	....	D,S	S	Qd	J	1,320	8-64	.....	
18ddd	Leo Lammers	57	2	Dr	....	.....	....	D	S	Qd	Cy	2,440	8-64		
26baa	Test hole 3122	107	..	Dr	7-17-64	.....	....	T	...	..	..	.....	....	1,161	L, E.
28acc	Chester Tysdal	700	4	Dr	....	Flow	7-1-63	U	...	Kd	..	5,280	8-64	.....	Yield 1.3 gpm.
30ddd	James Zerface	16	22	Du	....	.....	....	D	S	Qow	J	1,640	8-64	.....	Supply rept'd I.
32baa	Blanche McInnes	20.0	36	Du	....	12.50	7-1-63	D,S	...	Qow	Cy	.....	....	.....	MP 1.5 ft above ls, Supply rept'd I.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
142-55 Cont.															
33bba	Test hole 3126	107	..	Dr	7-21-64	.....	....	T	...	..	..	.....	....	1,149	L, E.
34dac	Charles Jannsen	29.0	18	B	....	16.02	2-4-64	U	...	Qd	..	2,320	8-64	.....	MP at ls.
143-49															
2dac	James McAndrew	171.5	2	Dr	1939	11.93	10-31-63	D	...	Qd	J	.....	....	874	MP 0.7 ft above ls.
6ccc	Christ Anderson	150	..	..	....	6	6-12-63	D	...	Qd	..	710	6-64	882	
7dcc	Louis Grage	280	..	Dr	1935	10	6-13-63	D	...	Qd	..	.....	....	880	Rept'd unfit for drinking.
8abb	Lewie Jalbert	150	..	Dr	1958	10	6-13-63	D	...	Qd	J	.....	....	877	
8ccd	Louis Grage	133.2	2	Dr	....	20.05	10-31-63	U	...	Qd	..	.....	....	878	MP 0.65 ft above ls.
9dac	Carl Ellenson	128	..	Dr	1910	8	6-13-63	D	...	Qd	Cy	.....	....	876	
10bbb	Emil Ellenson	125	3	Dr	....	20	6-12-63	D	...	Qd	..	.....	....	876	
10dda	Albert Anderson	160	2	Dr	1920	.....	....	D	...	Qd	Cy	4,920	6-64	874	
11ada	S. H. Hogstad	145	2	Dr	1885	15	6-12-63	D	S	Qd	Cy	.....	....	875	
15daa	Johnson Bros.	145	..	..	1953	35	6-13-63	D	...	Qd	Cy	.....	....	874	
16cdc	Alan Ellenson	163	2	Dr	1935	20	6-13-63	D,S	...	Qd	J	.....	....	877	
19ccc	Lindgren Bros.	108	3	Dr	1942	5	6-13-63	D,S	...	Qd	Cy	1,690	6-64	882	
20ccb	Walter Durkop	110	..	Dr	1945	.....	....	D,S	...	Qd	Cy	1,910	6-64	879	
22ddd	Lloyd Lougheed	120	..	Dr	1950	20	6-13-63	D	...	Qd	J	.....	....	876	
23bac1	G. A. Larson	250	..	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	872	
23bac2	..do...	271	..	Dr	1963	.....	....	...	...	Qd	..	.....	....	872	L, well destroyed.
25cda	Harold Malen	220	..	Dr	1944	6	6-13-63	D	...	Qd	J	.....	....	876	
26daa	C. O. Swenson	144	2	Dr	....	10	6-13-63	D	...	Qd	J	.....	....	876	
27cdd	Otto Hual	224	..	Dr	1956	.....	....	D	...	Qd	J	.....	....	877	
29ccb	Robert Bell	400	..	Dr	....	.....	....	D	...	..	Cy	840	6-64	880	
30cdd	Arthur Monson	460	4	Dr	....	150	6-13-63	D	...	..	Cy	4,980	4-27-65	883	C.
33bcc	Test hole 3101	265	..	Dr	5-27-64	.....	....	T	...	..	..	.....	....	876	L, E.
33cad	Nils Buringrud	150	..	Dr	1958	.....	....	D,S	...	Qd	..	.....	....	880	
34dda	Milton Aasen	140	..	Dr	1955	15	6-13-63	D	...	Qd	J	.....	....	878	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
143-50															
2ccb	Oscar Lindgren	105	3	Dr	1946	.....	....	D	S	Qd	Cy	1,640	6-64	890	
3bac	Gunkelman Elev.	220	4	Dr	1947	.....	....	D	S	Qd	Cy	.....	....	892	
5bab	Grathman Bros.	535	3	Dr	1959	8	7-11-63	D,S	S	Kd	Cy	.....	....	903	
6bab	G. W. Dockson	65	3	Dr	1948	24	7-11-63	U	S	Qd	..	.....	....	921	
7daa	George Haworth	80	4	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	916	
8daa	Francis Foster	320	3	Dr	1960	15	7-10-63	D,S	S	..	Cy	.....	....	901	
9cbc	Lester Satram	235	3	Dr	1960	.....	....	D,S	S	Qd	Cy	.....	....	900	
11cbb	V. E. Lindgren	120	3	Dr	1947	.....	....	D,S	S	Qd	Cy	2,280	6-64	890	
14abb	Hanna Skunes	200	2	Dr	....	.....	....	U	...	Qd	..	.....	....	889	
14dcc	L. M. Lawrence	130	3	Dr	1880	.....	....	U	...	Qd	..	.....	....	890	Rept'd to have flowed until 1948.
16dad	Arthur Woitzel	103	2	Dr	1959	8	7-11-63	D	S	Qd	Cy	.....	....	896	
17bbb	Daniel Backstrom	320	3	Dr	1961	18	7-10-63	D,S	...	..	Cy	.....	....	919	
18baa	Blake Humphrey	335	4	Dr	1918	.....	....	D,S	S	..	Cy	.....	....	916	
19aba	George Stockman	80	3	Dr	1959	13	7-10-63	D,S	S	Qd	Cy	572	5-12-65	927	C.
21aaa	Conrad Woitzel	280	3	Dr	1958	.....	....	S	S	Qd	Cy	.....	....	897	
22ccd	J. Hestbeck	125	2	Dr	1940	.....	....	D	S	Qd	Cy	.....	....	895	
24cbc	John Brorson	220	2	Dr	1950	.....	....	D	...	Qd	Cy	.....	....	888	
25bcc	Stirling Bros.	186	3	Dr	1938	.....	....	U	S	Qd	Cy	.....	....	887	
26baa	M. H. Gifford	110	2	Dr	1949	12	7-9-63	D	S	Qd	J	.....	....	889	
28dbb	Gus Woitzel	153	2	Dr	1939	2	7-11-63	S	S	Qd	Cy	.....	....	899	Well rept'd to have flowed when drilled.
29daa	Elmer Woitzel	370	3	Dr	....	.....	....	D,S	S	...	Cy	4,910	4-27-65	902	C.
30bab	Wm. Grage	60	4	Dr	1956	20	7-11-63	D,S	S	Qd	Cy	5,090	6-64	922	
31ccc1	E. Biwer	28	36	Du	....	3	7-11-63	D,S	...	Qla	Cy	4,980	6-64	922	
31ccc2	Test hole 3099	455	..	Dr	5-24-64	.....	....	T	...	..	..	.....	....	923	L, E.
32bcd	Johnson Bros.	80	2	Dr	1943	.....	....	D,S	S	Qd	Cy	.....	....	912	
32dcd	Carl Carlson	365	2	Dr	1950	.....	....	D,S	S	..	Cy	1,090	6-64	905	
33bab	George Adamson	240	3	Dr	1937	.....	....	U	S	Qd	Cy	.....	....	899	
34ddd	Howard Dullum	200	2	Dr	1942	10	7-11-63	D	S	Qd	Cy	.....	....	892	Supply rept'd I.
35ccd	Ellis McConnell	250	3	Dr	1950	.....	....	D	S	Qd	Cy	.....	....	891	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
143-51															
1baa	Rudolph Rosenau	125	3	Dr	1955	15	7-16-63	D,S	S	Qd	Cy	1,230	8-64	917	
1ddc	L. G. Radebaugh	150	4	Dr	1955	.....	....	D,S	S	Qd	Cy	1,180	8-64	917	
6ccb	August Judisch	370	4	Dr	....	Flow	7-12-63	U	...	..	..	.....	......	.....	Yield <1 gpm.
7ccd	C. D. McAuley	117	3	Dr	1962	5	7-12-63	D,S	S	Qd	..	.....	......	.....	
8dcc	Anderson Bros.	98	2	Dr	1960	.....	....	U	S	Qd	..	.....	......	.....	
11dba	Haugen Bros.	275	4	Dr	....	10	7-16-63	D,S	...	Qd	Cy	.....	......	914	
12baa	Berton Graalum	125	3	Dr	1956	30	7-16-63	D,S	S	Qd	Cy	.....	......	918	
13ada	Norman Griffin	500	4	Dr	....	30	7-15-63	D,S	...	Kd	Cy	7,710	8-64	916	
14aba	Fred Quittschreiper	200	4	Dr	....	6	7-17-63	D,S	...	Qd	..	.....	......	914	
15ddd	Ann Hull	390	3	Dr	1959	7	7-16-63	D,S	...	Kd	Cy	.....	......	911	
18dad	Bernard Holes	352	4	Dr	1963	Flow	....	D,S	...	..	S	4,070	4-27-65	911	L, C.
19cbc	Murray Baldwin	370	4	Dr	1942	Flow	7-12-63	S	...	..	..	.....	......	959	Yield 3.0 gpm.
21ccc	C. R. Hanson	60	32	Du	1900	25	7-12-63	D,S	...	Qd	S	2,710	8-64	930	
22aad	Hans Peter	95	3	Dr	1937	12	7-15-63	D,S	S	Qd	Cy	1,360	8-64	916	
23baa	Gust Johnson	500	1 1/2	Dr	....	6	7-15-63	D,S	...	Kd	..	.....	....	916	
30ddd	Melvin Lien	199	2	Dr	1945	.....	....	D	G	Qd	Cy	.....	....	.....	
32aaa1	Harvey Madsen	118	48x48	Dr	....	11.67	10-29-63	S	...	Qd	Cy	.....	....	.....	MP 1.0 ft above ls.
32aaa2	..do...	145	4	Dr	4-28-58	.....	....	D	S	Qd	S	.....	....	.....	L, Yield 7 gpm.
32bcc	Louis Sutton	450	3	Dr	1955	4	7-12-63	D,S	S	Kd	Cyl	.....	....	.....	
33ddd1	Test hole 3102	117	..	Dr	5-28-64	.....	....	T	...	Qd	..	.....	....	925	L.
33ddd2	Test hole 3102A	135	..	Dr	5-30-64	.....	....	T	...	Qd	..	.....	....	925	L.
34ccc	Test hole 3102B	138	..	Dr	6-2-64	.....	....	T	...	Qd	..	.....	....	925	L.
34ddd	Robert Schroeder	400	4	Dr	....	.....	....	D,S	...	..	Cy	.....	....	925	
35daa	Roy Bell	225	4	Dr	5-2-58	28	5-2-58	D,S	S	Qd	S	.....	....	928	L, Yield 40 gpm.
143-52															
4cdd	Emma Stibbe	515	3	Dr	....	10	6-18-63	S	...	Kd	Cy	4,400	10-64	.....	
5aaa	Arthur Rasmussen	640	4	Dr	1954	60	6-18-63	S	...	Kd	J	4,100	10-64	.....	Rept'd unfit for drinking.
6add	Kay Kloth	18	54x54	Du	....	6	6-19-63	D,S	...	Qla	Cy	.....	....	.....	
8aad	Clyde Larson	16	48	B	.....	.....	....	D	...	Qla	J	1,060	10-64	.....	
9ada	Carl Olson	28.0	36	Du	.....	12.00	6-18-63	U	...	Qla	Cy	.....	....	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
143-52															
9cdd	Earl Amel	400	2	Dr	....	.....	....	Dr	...	..	Cy	3,300	10-64	.....	
12cdc	Howard Larsen	94	4	Dr	9-5-63	12	9-5-63	D	...	Qd	J	.....	....	.....	L.
12cdd	Victor Larsen	35	..	Du	....	.....	....	S	...	Qla	Cy	.....	....	.....	
13bcc	L. O. Lane	124	3	Dr	1955	.....	....	D	...	Qd	Cy	.....	....	.....	
14cdd	Albert Peterson	145	3	Dr	....	.....	....	D	...	Qd	Cy	1,250	10-64	.....	
15aad	Emma Stibbe	500	3	Dr	1959	8	6-18-63	S	...	Kd	Cy	.....	....	.....	Rept'd corrosive.
17cdc	J. Redman	24.0	48	Du	....	11.00	6-19-63	D,S	...	Qla	Cy	.....	....	.....	MP 2.0 ft above ls.
18baa	Hudson Bros.	15.0	..	Du	....	6.50	6-19-63	D	S	Qla	Cy	.....	....	.....	Supply rept'd I.
18ddd	Rolland Doe	20	60	Du	....	10	6-19-63	D,S	...	Qla	Cy	.....	....	.....	
21aaa	Karl Schmusser	165	2	Dr	....	20	6-19-63	D,S	...	Qd	R	.....	....	.....	..Do...
22aad	Earl Maker	160	3	Dr	1953	.....	....	D,S	S	Qd	Cy	.....	....	.....	
22cdc	Dwight Marvel	411	2	Dr	1947	.....	....	S	...	..	R	.....	....	.....	Rept'd unfit for drinking.
23bda	Bertha Horganson	30	36	Du	....	.....	....	D	S	Qla	Cy	.....	....	.....	
24cbd	Lloyd Otteson	20	48x48	Du	....	.....	....	D,S	S	Qla	Cy	.....	....	963	
25ccd	Ruth Warner	480	..	Dr	....	Flow	....	S	...	Kd	..	.....	....	.....	
26cbb1	Elsie Leidal	160	..	Dr	.....	.....	....	U	...	Qd	Cy	.....	....	.....	
26cbb2	..do...	18	..	Du	....	.....	....	D	...	Qla	Cy	.....	....	.....	Rept'd to go dry occasionally.
27baa	Ernest Maker	17	18	Du	....	5.0	6-17-63	U	...	Qla	Cy	.....	....	.....	MP 1.0 ft above ls.
27cbb	Clarence Martin	490	4	Dr	....	Flow	....	S	...	Kd	..	.....	....	.....	
28ccd	Leslie Powlison	27	36	B	....	.....	....	U	...	Qla	Cy	.....	....	.....	
30baa	George Burchill	460	2	Dr	....	Flow	....	U	...	Kd	..	.....	....	.....	
32cbb	H.H. Worsley	165	2	Dr	1936	.....	....	D,S	...	Qd	Cy	.....	....	.....	
32daa	W. C. Peterson	206	6	Dr	....	.....	....	D	S	Qd	Cy	.....	....	.....	
33aba	Ray Martin	392	4	Dr	11-1-61	3	11-1-61	D,S	S	..	J	4,890	11-5-64	.....	L, C, Yield 100 gpm.
35ada	Lloyd Martin	128	3/4	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
36ddd	Test hole 3131	272	..	Dr	7-25-64	.....	....	T	...	..	..	.....	....	969.0	L, S.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
143-53															
1aba	Bert Ban Zee	45	24	B	....	.....	....	D	...	..	J	.....	....	.....	
2abb	Wilmer Moen	42	36	Dr	....	.....	....	D	...	..	J	.....	....	.....	Supply rept'd I.
4cdd	Albert Amb	100	3	Dr	....	.....	....	D,S	...	Qd	J	1,190	10-64	.....	
7aba	C. J. Ahrlin	31.0	48	Du	....	8.00	6-21-63	D	...	..	Cy	.....	....	.....	MP 1.0 ft above ls.
8daa	Orville Satrom	80	6	Dr	....	3	6-20-63	D	G	Qd	..	.....	....	.....	
10bbb	Borund Bros.	70	4	B	....	12	6-20-63	S	...	Cy	..	.....	....	.....	
10ddc	Rubin Borud	468	2	Dr	1951	Flow	6-20-63	D,S	...	Kd	..	4,400	10-64	.....	
11dac	Alfred Johnson	14.0	48	Du	....	7.00	6-19-63	U	...	Qla	..	.....	....	.....	MP 1.0 ft above ls.
12bdd	James Borud	446	2	Dr	....	Flow	6-19-63	D,S	...	..	..	.....	....	.....	
12ddd	Harry Grage	19	36	B	....	.....	....	D	...	Qla	J	2,740	10-64	.....	Rept'd unfit for drinking.
13bbb	George Benzmiller	22.0	40	Du	....	10.00	6-19-63	D,S	...	Qla	Cy	.....	....	.....	MP 3.0 ft above ls, supply rept'd I.
15cdb1	W. R. Stibbe	24	36	Du	1944	.....	....	D,S	S	Qla	Cy	.....	....	.....	Supply rept'd I and unfit for drinking.
15cdb2	..do...	60	..	Dr	1962	.....	....	D	S&G	Qla	..	1,630	11-5-64	.....	C.
16cbc	J. K. Miller	135	2	Dr	....	.....	.....	D,S	S	Qd	Cy	550	10-64	.....	
17abb	Carl Richtmeier	80	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
18aab	Lawrence Benzmiller	36.0	48x48	Du	....	8.00	6-21-63	D	...	..	Cy	.....	....	.....	MP 0.9 ft above ls.
19bbb	George Schur	160	3	Dr	....	.....	....	D	...	Qd	J	.....	....	.....	
20cdd	S. N. Rosevold	100	2	Dr	1940	30	6-21-63	D	...	Qd	J	.....	....	.....	
21aaa	Evelyn Meyers	45	48	Du	....	.....	....	D	...	..	J	.....	....	.....	
22aaa	George Dickson	46	60x60	Du	1907	7	6-20-63	S	...	..	Cy	.....	....	.....	Supply rept'd I.
22dcd	Ole Robberstad	20	24	B	....	12.0	6-20-63	U	...	Qla	Cy	.....	....	.....	MP 1.0 ft above ls.
24ddd	George Burchill	447	2 1/2	Dr	1937	Flow	6-19-63	D,S	...	..	..	.....	....	.....	Yield 15.0 gpm.
25aaa	..do...	48	20	B	....	7	6-19-63	D	...	..	J	3,550	10-64	.....	
26ddd	George Dickson	15.0	36	Du	....	6.00	6-19-63	U	...	Qla	Cy	.....	....	.....	MP 1.0 ft above ls.
27bcd	Arnold Albert	60	3	Dr	1962	.....	....	D,S	G	..	Cy	.....	....	.....	
27ddb	Elmer Herold	75	3	Dr	1952	.....	....	D	...	Qd	J	.....	....	.....	
28bda	Paul Stibbe	521	3	Dr	1962	100	6-20-63	S	...	Kd	Cy	4,150	10-64	.....	
31ddc	John Vos	30	2	Dr	1957	.....	....	D	...	..	J	.....	....	.....	
34bdc	John Conrad	20	3	Dr	1955	.....	....	D	...	Qla	J	.....	....	.....	
34dad	Cledith Dows	23	4	Dr	1947	.....	....	S	S	Qla	Cy	.....	....	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
<u>143-54</u>															
2abb	Pauli Olstad	141	2	Dr	1955	.....	....	D,S	S	Qd	Cy	940	10-64	.....	
5ada	Carl Johnson	56	4	Dr	....	.....	....	D,S	S	Qd	Cy	890	10-64	.....	
6add	Alvin Langdahl	75	2	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
6cca	Anton Drogen	65	2	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
8aaa	Arnold Erickson	65	3	Dr	....	25	6-24-63	D,S	S&G	Qd	J	.....	....	.....	
11dda	George Jefferson	120	2	Dr	....	.....	....	D,S	G	Qd	Cy	960	10-64	.....	
12aaa	Ronald Kyllo	60	2	Dr	....	.....	....	D,S	...	Qd	J	.....	....	.....	
18cdd	Yvonne Bower	40	3	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
20dcd	R. Gronn	120	3	Dr	....	.....	....	D,S	S	Qd	J	.....	....	.....	
23bba	Wm. Larson	120	2	Dr	1956	30	6-21-63	D,S	S	Qd	J	920	11-5-64	.....	C.
23ccc	Ella Port	134	2	Dr	1961	.....	....	D,S	...	Qd	J	.....	....	.....	
24dcc	Mike Amb	42	2	Dr	....	.....	....	U	S	Qd	Cy	.....	....	.....	
26dcd	Wm. Conrad	90	3	Dr	1962	.....	....	D	S	Qd	J	1,500	10-64	.....	
28dcc	James Noble	120	2	Dr	....	.....	....	D,S	S	Qd	J	.....	....	.....	
29ccc	Albert Johnk	72	2	Dr	1956	30	6-25-63	D	S	Qd	J	.....	....	.....	
30bdc	Max Walz	70	2	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
31bdd	Village of Page	121	8	Dr	1962	23.95	12-3-63	P,S	S	Qd	T	869	11-5-64	.....	C, MP 3.7 ft above ls, Yield 230 gpm.
31cab	Page Lutheran Church	102	3	Dr	7-22-60	.....	....	D	S	Qd	S	.....	....	.....	L, Yield 50 gpm.
31cac	Great Northern Railroad	93	6	Dr	9-10-51	25.50	9-10-51	D	S	Qd	Cy	.....	....	.....	L.
31cca	..do...	115	6	Dr	8-13-29	.....	....	...	S	Qd	Cy	.....	....	.....	Well destroyed, L.
31daa	Howard Speers	70	3	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
33ccd	Mary Smith	100	2	Dr	....	.....	....	D	...	Qd	J	.....	....	.....	
34aaa	B. Webber	120	3	Dr	1960	.....	....	D,S	S	Qd	Cy	.....	....	.....	
35ccc	George Hagen	100	2	Dr	....	.....	....	D,S	...	Qd	Cy	.....	....	.....	
<u>143-55</u>															
1aba	Sigurd Londahl	65	2	Dr	....	.....	....	D	S	Qd	Cy	850	10-64	.....	
2caa	Sven Langager	65	3	Dr	....	.....	....	D,S	S	Qd	Cy	.....	....	.....	
4aba	D. Whitmore	60	..	Dr	....	.....	....	D,S	S	Qd	J	.....	....	.....	
6dda	Alfred Johnson	20	30	Du	....	10	6-25-63	D	...	Qd	J	1,240	10-64	.....	
7dac	Walter Satrom	755	3	Dr	....	55	6-25-63	S	...	Kd	Cy	4,890	10-64	.....	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
143-55 Cont.															
8aad	Martin Grey	25	30	Du	....	.....	....	D	S	Qd	Cy	.....	....	.....	
10bab	A. F. Cole	56	2	Dr	....	30	6-26-63	D,S	S	Qd	J	.....	....	.....	
15dcd	John Suhr	62	2	Dr	1950	20	6-26-63	D	S	Qd	Cy	929	11-6-64	.....	C.
16aad	Test hole 3128	122	..	Dr	7-22-64	.....	....	T	...	..	..	.....	....	1,173	L, E.
16dda	Willard Davis	52	2	Dr	....	.....	....	D	...	Qd	Cy	.....	....	.....	
19aba	Forest Brudevold	30	24	Du	....	.....	....	S	S	Qd	Cy	.....	....	.....	
24dcc	Kenneth Koenig	89	3	Dr	11-21-61	40	11-21-61	D,S	S	Qd	Cy	790	10-64	.....	L, Yield 25 gpm.
25adc	Esther Koenig	80	2	Dr	....	.....	....	D	...	Qd	J	.....	....	.....	
26bba	Frank Lemmers	30	3	Dr	....	.....	....	D,S	S	Qd	Cy	450	2-24-56	.....	P.
27bda	R. Carl Satran	75	2	Dr	....	.....	....	D	...	Qd	J	.....	....	.....	
30adc	Kathryn Tiernan	25	30	B	....	20	6-26-63	D,S	S	Qd	Cy	.....	....	.....	
31baa	Test hole 3127	137	..	Dr	7-21-64	.....	....	T	...	..	..	.....	....	1,167	L, E.
31ddd	Ken Warner	30	42	Du	....	24	6-26-63	D	S	Qd	Cy	.....	....	.....	Supply rept'd I.
32daa	Irma Davis	40	36	Du	1884	.....	....	D	...	Qd	Cy	.....	....	.....	
33ddd	Test hole 3123	347	..	Dr	7-17-64	.....	....	T	...	..	..	.....	....	1,151.0	L, E.

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.

Water levels are referred to land-surface datum (lsd). The symbol + indicates that the water level was above land surface. Numbers that are not preceded by any symbol indicate that the water level in the well was below land surface.

137-49-17daa2

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 24	26.71	April 2	26.70	July 1	26.11
1964		May 7	26.45	Aug. 1	26.37
Jan. 30	26.67	June 1	26.71		

137-49-25ccc

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
Sept. 3	25.56	Nov. 2	21.99	Dec. 9	22.02
Oct. 1	20.85				

137-49-30aaa

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
Sept. 3	25.57	Nov. 2	30.56	Dec. 9	30.43
Oct. 1	30.43				

137-50-4baa2

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
May 17	30.90	April 2	31.66	July 31	31.75
Oct. 24	31.40	May 7	31.39	Sept. 3	31.83
1964		June 1	31.64	Nov. 2	31.90
Jan. 30	31.63	July 1	31.65		

137-50-29dca 1/

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
Jan. 20	8.27	July 1	5.39	Oct. 1	6.90
April 3	7.45	Aug. 1	6.40	Nov. 2	7.73
May 7	4.30	Sept. 3	7.13	Dec. 9	7.99
June 1	8.56				

137-51-10bca

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
June 14	3.18	April 2	3.79	June 1	3.50
Oct. 24	3.9	May 7	4.26	July 1	5.1
1964					
Jan. 30	3.47				

137-51-17aaa1

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
June 14	2.50	April 2	1.11	Aug. 1	1.30
Oct. 24	3.00	May 7	3.00	Sept. 3	1.35
1964		June 1	1.96	Oct. 1	1.09
Jan. 30	0.91	July 1	1.07		

137-51-35cdd1

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 24	124.90	July 1	134.74	Oct. 1	139.75
1964		Aug. 1	135.08	Nov. 3	140.68
May 7	134.15	Sept. 3	138.78	Dec. 9	141.25
June 1	135.35				

1/ Well 137-50-29dca formerly published as 137-50-29dda5 in WSP 1128 by J. E. Powell (1948)

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

137-52-4dad

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 10	14.77	April 2	17.80	Aug. 1	21.10
Oct. 24	20.17	May 7	17.75	Sept. 3	30.12
1964		June 1	19.60	Oct. 1	10.54
Jan. 30	19.32	July 1	22.45		

137-52-16ddc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 24	+0.43	May 7	+1.41	Sept. 3	+0.49
1964		June 1	+1.22	Oct. 1	+1.71
Jan. 30	+0.28	July 1	+1.27		
April 2	+0.29	Aug. 1	+0.90		

137-52-25ccd2

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 12	34.14	April 3	34.47	June 1	34.40
Oct. 24	34.43	May 7	34.30	July 1	34.53
1964					
Jan. 30	34.40				

137-52-28dba

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 12	11.00	April 2	13.00	May 7	12.15
1964					
Jan. 30	12.91				

137-52-31bbb

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
Sept. 3	5.66	Nov. 3	6.10	Dec. 9	6.47
Oct. 1	5.55				

137-53-22abc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
June 25	6.56	May 7	4.65	Sept. 3	7.30
1964		May 28	7.26	Oct. 1	9.58
Jan. 20	9.79	July 1	6.20		
April 2	8.56	Aug. 1	7.36		

137-53-34ccc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 31	+1.06	Feb. 5	2.62	July 30	2.29
Nov. 16	+1.06	March 9	3.22	Aug 27	1.77
Dec. 2	0.89	April 9	3.58	Sept. 29	2.22
1964		April 28	0.24	Nov. 10	2.84
Jan. 2	1.77	May 27	1.48	Dec. 10	3.12

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

137-54-12daa

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
April 4	7.58	May 28	6.27	Aug. 1	7.84
May 7	6.04	July 1	5.80	Sept. 2	7.02

137-54-36ccc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 15	8.93	Feb. 5	10.12	July 30	8.78
Oct. 31	9.04	March 9	10.30	Aug. 27	8.14
Nov. 18	9.23	April 9	9.07	Sept. 29	8.91
Dec. 2	9.28	April 28	7.84		
1964		May 27	6.61		
Jan. 2	9.74	June 26	4.59		

137-55-30abb

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 16	23.20	April 3	26.07	May 7	25.45
1964					
Jan. 21	25.06				

137-55-33cdd

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 16	38.57	April 3	39.83	June 30	39.01
1964		May 7	39.09	Aug. 1	39.20
Jan. 21	38.78	May 28	39.29	Sept. 2	38.85

137-55-35ddd

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
Sept. 2	47.90	Nov. 3	48.04	Dec. 9	47.86
Oct. 1	47.93				

137-56-30bcb

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
Sept. 2	22.46	Nov. 3	22.33	Dec. 9	22.64
Oct. 1	22.35				

138-48-7ccc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 4	41.86	May 7	41.13	Oct. 1	41.85
Oct. 23	41.82	June 1	41.47	Nov. 2	41.68
1964		July 1	41.69	Nov. 10	41.42
Jan. 30	41.43	Aug. 1	41.24		
April 2	41.23	Sept. 3	42.02		

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

Date	Water level	Date	Water level	Date	Water level
138-48-18acd					
1963		1964		1964	
May 14	34.20	May 7	45.35	Oct. 1	35.65
Oct. 23	48.70	June 2	43.56	Nov. 2	37.98
1964		July 1	44.70	Dec. 10	34.91
Jan. 30	34.08	Aug. 1	44.15		
April 2	33.62	Sept. 3	35.65		
138-49-4aaa					
1964		1964		1964	
July 1	38.48	Aug. 26	38.60	Nov. 2	38.58
Aug. 1	38.75	Oct. 1	38.47	Dec. 9	38.60
138-49-18ddc					
1963		1964		1964	
June 4	44.20	April 2	38.83	April 2	45.50
Oct. 24	41.18	May 6	48.85*	July 1	41.70
1964					
Jan. 21	39.86				
138-49-29ccc					
1964		1964		1964	
Aug. 1	32.17	Oct. 1	33.90	Dec. 9	34.05
Sept. 3	34.00	Nov. 2	34.02		
138-49-34ccc					
1964		1964		1964	
June 30	25.04	Sept. 3	23.57	Nov. 3	23.52
Aug. 1	24.88	Oct. 1	23.45	Dec. 9	23.49
138-49-36dda2					
1963		1964		1964	
May 15	20.70	Jan. 21	23.87	May 7	23.55
Oct. 23	24.05	April 2	23.90		
138-50-13bcb					
1963		1964		1964	
Oct. 23	26.17	April 2	27.29	June 2	27.86
1964		May 7	27.12		
Jan. 21	27.30				

*Pumping

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

Date	Water level	Date	Water level	Date	Water level
		138-51-7ada			
1963		1964		1964	
July 9	6.64	April 2	6.60	Aug. 1	6.65
Oct. 24	6.84	May 7	6.40	Sept. 3	6.74
1964		June 1	7.64		
Jan. 21	6.73	July 1	7.55		
		138-51-11ddd			
1963		1964		1964	
June 27	27.69	April 2	26.15	Aug. 1	26.94
Oct. 24	27.64	May 7	28.89	Sept. 3	36.31
1964		June 1	31.21	Oct. 1	29.44
Jan. 20	32.57	July 1	27.77		
		138-51-18bab			
1964		1964		1964	
Jan. 22	12.90	May 7	13.24	July 1	14.8
April 2	12.30	June 1	17.21		
		138-52-9add			
1964		1964		1964	
Jan. 22	11.67	June 1	10.16	Sept. 3	10.20
April 2	11.87	July 1	10.12		
May 7	10.78	Aug. 1	10.25		
		138-52-21aad			
1963		1964		1964	
July 17	11.67	April 2	12.47	July 1	12.04
1964		May 7	12.40		
Jan. 22	12.27	June 1	13.60		
		138-53-6abb			
1963		1964		1964	
June 23	10.64	April 3	12.93	July 1	10.59
1964		May 7	11.01		
Jan. 20	11.14	May 28	11.09		
		138-53-21abb			
1963		1964		1964	
June 19	17.18	May 7	18.74	Sept. 3	19.66
1964		May 28	19.31	Oct. 1	19.00
Jan. 20	18.38	July 1	19.01		
April 2	20.52	Aug. 1	18.94		
		138-53-35abd3			
1963		1964		1964	
June 17	11.69	April 2	12.55	July 1	12.75
1964		May 7	12.42		
Jan. 20	12.43	June 1	15.64		

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

138-54-20bbb

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
Jan. 22	11.51	May 28	9.17	Sept. 2	9.60
April 3	11.22	July 1	9.20		
May 7	10.52	Aug. 1	9.32		

138-55-30aab

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
Jan. 21	18.52	May 7	17.76	June 30	17.22
April 3	19.21	May 28	16.49	Aug. 1	17.50

139-49-2ccc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 1	74.95	April 1	74.38	Aug. 1	75.45
Nov. 1	78.07	May 5	75.36	Aug. 24	75.54
1964		May 28	75.67	Nov. 2	74.74
Jan. 15	74.23	June 29	76.20	Dec. 10	75.89

139-49-5add

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 22	100.48	April 1	100.33	July 29	99.80
Nov. 1	101.15	May 6	99.76	Aug. 24	100.00
1964		May 28	101.26		
Jan. 15	100.46	July 2	99.31		

139-49-6bcc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 17	90.30	Jan. 14	102.51	Sept. 30	95.90
Sept. 17	101.73	May 6	101.54	Oct. 29	100.16
Sept. 24	101.66	May 27	98.00	Dec. 10	96.90
Oct. 22	101.83	July 2	96.40		
Nov. 1	101.91	July 27	95.40		
Dec. 2	102.31	Aug. 31	95.60		

139-49-6dcd2

Date	Water level	Date	Water level	Date	Water level
1963		1963		1964	
Nov. 4	102.89	Dec. 2	103.21	May 6	101.70
Nov. 5	102.90	1964			
Nov. 6	103.28	Jan. 14	102.16		
Nov. 7	103.24	April 1	101.97		

139-49-6ddc

Date	Water level	Date	Water level	Date	Water level
1963		1963		1964	
Nov. 4	103.00	Dec. 2	102.76	May 6	101.22
Nov. 5	102.57	1964			
Nov. 6	102.86	Jan. 14	101.71		
Nov. 7	102.82	April 1	101.54		

TABLE 2.--Water-level measurements in selected wells in Cass County, N.Dak.--Cont.

139-49-7abb1

Date	Water level	Date	Water level	Date	Water level
1963		1963		1964	
Oct. 17	104.99	Dec. 2	103.47	Aug. 1	105.73
Oct. 22	105.72	1964		Aug. 24	104.14
Oct. 31	103.70	Jan. 14	103.43	Sept. 30	101.95
Nov. 1	104.81	April 1	102.27	Nov. 2	104.72
Nov. 5	103.29	April 22	104.90	Dec. 10	104.77
Nov. 6	103.56	May 28	103.45		
Nov. 8	103.48	June 3	103.20		

139-49-7ddc

1963		1964		1964	
Nov. 5	95.96	April 1	95.57	Aug. 1	96.14
Dec. 2	96.41	May 6	95.15	Sept. 4	96.79
1964		May 27	96.37		
Jan. 14	95.78	July 1	93.47		

139-49-8bba1

1962		1963		1964	
Aug. 22	100.53	May 22	101.64	March 13	101.34
Sept. 5	100.20	June 14	101.45	March 29	102.84
Sept. 19	101.70	June 29	101.37	April 13	101.42
Sept. 30	101.01	July 11	101.66	April 18	102.75
Oct. 16	100.97	July 29	102.27	May 6	101.55
Oct. 25	102.06	Aug. 16	101.60	May 19	103.76
Nov. 2	101.80	Aug. 30	102.20	June 1	103.08
Nov. 20	99.99	Sept. 11	101.68	June 9	101.81
Dec. 12	101.31	Sept. 21	102.62	July 5	102.61
Dec. 28	99.90	Oct. 5	101.19	July 27	103.43
1963		Oct. 11	102.85	Aug. 21	103.09
Jan. 8	99.35	Nov. 12	103.47	Aug. 31	103.98
Jan. 11	100.75	Nov. 26	102.63	Sept. 11	104.51
Feb. 4	99.83	Dec. 15	103.36	Sept. 26	103.23
Feb. 21	100.77	Dec. 25	101.85	Oct. 7	103.45
March 21	101.18	1964		Oct. 22	104.65
March 29	99.98	Jan. 2	101.51	Nov. 10	103.43
April 16	100.32	Jan. 12	102.96	Nov. 29	104.47
April 30	102.00	Feb. 20	102.40	Dec. 17	104.93
May 7	100.75	Feb. 24	101.30	Dec. 23	103.60

139-49-9aab

1963		1964		1964	
Oct. 1	63.77	May 6	55.65	Sept. 30	56.57
Nov. 1	55.59	May 28	57.20	Nov. 2	57.08
1964		July 2	60.46	Dec. 10	57.43
Feb. 14	55.39	July 29	58.60		
April 1	55.58	Aug. 24	58.14		

139-49-9ddd3

1964		1964		1964	
Aug. 1	43.16	Sept. 30	42.82	Dec. 10	42.91
Aug. 25	43.53	Nov. 2	42.90		

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

139-49-10bab3

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Nov. 1	7.50	May 28	6.35	Aug. 24	6.44
1964		July 2	5.40		
April 1	8.60	July 29	6.10		
May 6	5.89				

139-49-12aca

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 22	39.90	March 1	42.03	July 27	22.28
Nov. 1	38.29	April 1	42.39	Aug. 31	27.60
Dec. 2	39.27	May 6	17.84	Sept. 30	37.37
1964		May 28	22.85	Nov. 2	38.80
Jan. 15	40.95	June 26	13.98	Dec. 10	39.95

139-49-18bbb

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 30	59.77	Jan. 14	60.23	Sept. 4	61.13
Sept. 17	59.80	April 1	59.87	Sept. 30	61.23
Sept. 24	59.83	May 6	59.51	Nov. 2	61.42
Oct. 22	60.00	May 28	60.10	Dec. 10	61.58
Nov. 1	60.28	July 1	60.20		
Dec. 2	60.48	Aug. 1	60.48		

139-49-22bbb

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Sept. 17	47.82	March 1	47.76	Oct. 1	48.36
Sept. 24	47.81	April 1	47.68	Nov. 2	48.48
Oct. 3	47.87	May 6	47.46	Dec. 9	48.46
Nov. 1	47.92	June 1	47.22		
Dec. 2	47.92	July 1	47.89		
1964		Aug. 1	47.48		
Jan. 14	47.82	Aug. 26	48.03		

139-49-26dcc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 3	37.37	March 1	39.72	June 1	40.30
1964		April 2	38.67	July 1	41.65
Jan. 30	38.62	May 6	37.95	Nov. 2	38.68

139-49-29bcd

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 3	43.28	April 1	44.55	July 31	43.47
1964		May 6	43.45	Sept. 3	44.73
Jan. 21	43.45	June 2	43.60	Nov. 2	44.43
March 1	44.04	July 1	42.45		

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

139-49-32cca

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 3	40.15	March 1	41.20	June 1	41.84
1964		April 1	42.94		
Jan. 21	41.62	May 6	40.29		

139-49-36aad3

1963		1964		1964	
May 14	37.13	Jan. 30	37.88	April 2	37.65
Oct. 23	39.07	March 1	37.68		

139-49-36dac1

1963		1964		1964	
Oct. 7	39.30	April 1	32.01	Sept. 3	36.40
Oct. 23	33.03	May 7	31.79	Oct. 1	36.30
1964		June 1	31.44	Nov. 2	35.03
Jan. 30	31.74	July 1	30.74	Dec. 10	33.70
March 1	32.04	Aug. 1	31.12		

139-49-36dca

1963		1964		1964	
Oct. 4	43.06	March 1	49.43	July 1	43.60
Oct. 23	43.30	April 1	43.07	Aug. 1	44.42
1964		May 7	44.67	Sept. 3	53.08
Jan. 30	54.34	June 2	45.20		

139-50-1dcd

1963		1963		1964	
May 22	52.16	Dec. 2	53.11	June 29	52.77
Oct. 2	52.51	1964		July 27	53.10
Oct. 22	52.64	Jan. 14	52.89	Aug. 31	53.30
Nov. 1	52.77	April 1	52.60	Sept. 30	53.46
Nov. 8	52.81	April 29	52.53	Nov. 2	53.60
Nov. 9	52.81	May 28	52.84	Dec. 10	53.75

139-50-2dbc

1963		1964		1964	
Oct. 2	45.94	April 1	46.11	July 2	48.28
1964		May 6	45.84	July 29	47.34
Jan. 22	46.11	May 27	46.88	Sept. 4	46.38

139-50-15bbb2

1963		1964		1964	
June 3	5.49	Jan. 20	6.81	July 1	7.90
Oct. 23	6.10	June 1	4.10		

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

139-50-15bbb3

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 24	27.30	April 1	27.37	May 6	27.18
1964					
Jan. 20	27.39				

139-50-23aaa

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
June 5	26.09	Sept. 3	26.61	Dec. 9	26.80
July 1	26.43	Oct. 1	26.16		
Aug. 1	26.40	Nov. 2	26.54		

139-50-24cdd2

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
May 20	32.89	Jan. 14	34.23	May 6	33.90
Oct. 3	34.18	April 1	34.11	June 1	34.20

139-50-26bbb

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 2	20.02	April 1	19.97	May 6	18.54
1964					
Jan. 20	20.08				

139-50-27add

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
May 20	28.00	May 6	28.97	July 1	29.86
Oct. 2	24.09	June 2	29.83	Nov. 2	29.50

139-51-36cba

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 5	18.73	April 1	18.57	July 1	18.06
1964		May 7	18.17		
Jan. 21	19.37	June 1	19.54		

139-52-2dcc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 30	15.98	May 7	14.93	Aug. 24	13.08
1964		May 28	13.34	Oct. 1	12.35
Jan. 22	15.97	June 30	14.04	Nov. 3	11.92
April 3	15.25	July 29	15.07		

139-52-13bcb

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 19	0.63	June 1	+1.46	Oct. 1	+1.28
1964		July 1	+1.33	Nov. 3	+0.96
April 3	+0.72	July 31	+0.82		
May 7	+1.60	Sept. 3	+1.01		

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

139-53-18baa1

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 13	13.06	May 7	13.55	Sept. 2	10.80
1964		May 28	12.66	Oct. 1	11.51
Jan. 22	13.90	July 1	11.39		
April 3	14.67	July 31	11.08		

139-53-36caa

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 12	9.10	April 3	9.67	July 1	7.50
1964		May 7	9.38		
Jan. 22	8.27	June 1	8.90		

139-54-27bbb

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Dec. 5	5.94	May 7	8.28	Sept. 2	5.86
1964		May 28	7.43	Oct. 1	5.34
Feb. 5	5.96	July 1	6.89		
April 5	6.18	July 31	6.57		

139-55-32aaa

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 14	15.00	Feb. 5	17.22	May 7	18.26
Dec. 5	17.54	April 3	18.19		

139-55-34ccc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Dec. 5	17.66	May 7	16.30	Sept. 2	15.65
1964		May 28	16.86	Oct. 1	15.43
Feb. 5	16.54	June 30	16.70	Nov. 3	15.55
April 3	17.72	July 31	15.65	Dec. 9	15.58

140-49-7daa

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 18	75.60	May 5	74.25	Aug. 24	75.30
1964		May 27	73.40	Nov. 2	75.52
Feb. 14	74.29	June 29	76.35		
April 1	74.90	July 30	74.80		

140-49-19ddd

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
May 25	90.08	Aug. 24	90.62	Dec. 9	91.25
June 28	90.38	Sept. 30	90.91		
July 30	90.78	Nov. 2	91.10		

TABLE 2.--Water-level measurements in selected wells in Cass County, N.Dak.--Cont.

140-49-29ddd

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 19	91.10	Jan. 14	91.99	Aug. 24	92.57
Sept. 17	91.47	April 1	91.62	Sept. 30	91.31
Sept. 24	91.50	May 5	91.70	Nov. 2	91.48
Oct. 22	91.68	May 27	92.40	Dec. 9	91.28
Nov. 1	92.26	June 28	92.19		
Dec. 21	92.51	July 30	92.71		

140-49-31cdc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 28	101.46	Jan. 20	101.16	Aug. 24	102.22
Sept. 17	102.04	April 1	101.80	Sept. 30	103.89
Sept. 24	102.20	May 5	101.92	Nov. 2	103.99
Oct. 22	102.78	June 2	104.14	Dec. 9	104.64
Nov. 1	103.79	June 28	101.54		
Dec. 2	102.97	July 30	102.22		

140-49-32bbb

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 19	97.41	Jan. 14	98.15	Aug. 24	98.91
Sept. 17	97.76	April 1	97.82	Sept. 30	99.45
Sept. 24	97.73	May 5	99.50	Nov. 2	99.64
Oct. 22	97.82	May 27	98.95	Dec. 9	99.49
Nov. 1	98.63	June 28	98.85		
Dec. 2	98.80	July 30	99.01		

140-49-32cdc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 1	106.01	April 1	102.33	Aug. 24	104.54
Oct. 22	103.25	May 5	102.35	Sept. 30	104.07
Nov. 1	105.36	May 27	106.24	Nov. 2	102.90
1964		June 28	106.78	Dec. 9	110.04
Jan. 15	102.23	July 29	105.77		

140-49-36aaa

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Aug. 19	52.25	March 1	50.87	Sept. 30	18.10
Sept. 17	52.04	April 1	50.02	Nov. 2	17.94
Sept. 24	51.64	May 4	44.14	Dec. 9	14.10
Nov. 1	51.61	May 27	31.60		
Dec. 2	51.22	June 28	22.30		
1964		July 24	18.90		
Jan. 14	51.15	July 30	19.83		

140-50-4bcc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 25	31.50	April 1	31.27	May 29	31.00
1964		May 5	30.33	June 30	31.89
Jan. 20	29.87	May 27	31.74	Aug. 24	31.24

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

140-50-20addl

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
June 24	22.30	April 1	23.00	Aug. 24	23.39
Oct. 28	22.94	May 5	22.92		
1964		June 29	22.98		
Jan. 20	22.94	July 30	23.52		

140-50-34cccl

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 25	25.00	April 1	25.10	June 28	25.23
1964		May 5	25.00	July 29	25.11
Jan. 20	25.05	May 27	25.27	Aug. 24	25.37

140-51-24dcd2

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 29	27.19	April 1	28.93	June 29	29.00
1964		May 5	28.64	July 30	30.17
Jan. 20	27.77	May 27	30.88	Aug. 24	29.95

140-55-19bacl

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Dec. 5	11.93	May 6	10.41	Aug. 25	12.03
1964		May 28	10.20	Sept. 30	10.56
Feb. 5	11.99	June 30	9.92	Nov. 3	10.67
April 2	12.23	July 30	10.76	Dec. 9	10.88

140-55-19caa

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Dec. 5	19.93	April 2	20.70	June 30	19.10
1964		May 6	18.91	July 30	19.31
Feb. 5	20.30	May 28	18.75	Aug. 25	18.75

140-55-22add

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 19	7.00	Feb. 4	7.87	May 6	8.18
Dec. 5	7.59	April 2	8.30	May 28	8.40

140-55-25aaa

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
July 15	30.20	Aug. 25	28.75	Nov. 3	28.16
July 29	29.60	Sept. 30	28.34	Dec. 9	27.46

141-49-33daa

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
May 5	61.91	July 30	62.92	Nov. 2	63.38
May 21	62.32	Aug. 24	63.01	Dec. 9	63.53
June 29	61.45	Sept. 30	63.12		

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

141-50-6ddd

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
May 27	29.41	July 30	29.84	Aug. 24	29.81
June 29	28.50				

141-50-9aaa2

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
May 25	24.15	Aug. 24	24.68	Dec. 9	24.25
June 29	24.13	Sept. 30	24.07		
July 30	24.53	Nov. 2	24.22		

141-50-11cdc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 28	21.90	April 1	21.91	June 29	24.33
1964		May 5	21.78	Sept. 30	23.97
Jan. 20	21.86	May 27	23.77	Nov. 2	25.80

141-51-1dcd

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 29	27.80	April 1	26.93	May 27	23.98
1964		May 5	28.50		
Jan. 20	29.09				

141-51-20ccc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 29	1.70	April 1	0.0	May 27	1.44
1964		May 5	1.40		
Jan. 22	1.50				

141-53-6ddc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Dec. 4	17.35	April 3	18.73	June 30	18.69
1964		May 6	18.57	July 30	20.09
Jan. 22	17.81	May 28	18.89	Aug. 24	18.90

141-53-33dcc

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
April 3	9.44	May 25	4.96	July 30	4.22
May 6	4.23	June 30	3.88	Aug. 24	4.85

141-53-33dcd

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
May 6	16.60	June 30	14.47	Aug. 24	13.88
May 28	13.92	July 30	13.65		

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

141-54-32ddc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Dec. 4	16.72	May 6	15.63	June 30	18.50
1964		May 27	14.22		
Feb. 4	17.40				

141-55-7adal

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Dec. 4	23.34	April 2	27.10	June 30	22.30
1964		May 6	22.00	July 30	22.44
Feb. 4	25.09	May 28	24.33	Aug. 25	21.07

141-55-19daa

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 16	18.60	Feb. 4	21.33	May 6	20.59
Dec. 4	20.89	April 2	20.07	May 28	19.95

142-49-2baa2

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 28	17.65	May 5	17.18	July 30	17.85
1964		May 27	18.08	Aug. 24	18.44
Feb. 14	18.90	June 29	12.04		

142-49-26baa

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 28	28.75	April 1	27.95	June 29	29.80
1964		May 5	28.30		
Jan. 20	28.78	May 27	29.10		

142-50-8aabl

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 9	14.55	April 1	15.50	July 30	15.20
Oct. 28	16.40	May 5	15.84	Aug. 24	14.33
1964		May 27	16.69		
Jan. 20	15.58	June 29	16.45		

142-51-5cbc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 16	5.20	April 2	5.53	June 29	1.85
Oct. 29	5.86	May 5	1.70		
1964		May 27	2.89		
Jan. 22	5.81				

142-52-4bba

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
June 18	6.00	April 3	16.28	June 30	6.40
Oct. 30	10.10	May 5	6.73		
1964		May 27	6.67		
Jan. 22	11.00				

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

142-52-17aaa

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 30	4.34	April 3	7.08	June 30	4.60
1964		May 5	4.48	July 30	4.20
Jan. 22	4.16	May 27	16.75	Aug. 24	4.30

142-52-24bbc

Date	Water level	Date	Water level	Date	Water level
1962		1962		1964	
July 24	46.34	Oct. 24	48.14	May 4	49.65
Aug. 2	47.35	Nov. 30	47.48	May 27	53.75
Aug. 10	48.34	Dec. 14	47.55	June 25	52.47
Aug. 17	46.86	1963		July 30	56.90
Aug. 23	47.60	Jan. 10	46.60	Aug. 24	53.24
Sept. 5	48.80	Feb. 5	47.16	Sept. 30	51.44
Sept. 18	48.50	March 5	47.07	Nov. 3	51.55
Sept. 23	49.23	Oct. 28	51.97	Dec. 9	54.24
Oct. 5	47.36	1964			
Oct. 12	50.00	Jan. 22	52.04		
Oct. 17	47.50	April 2	50.07		

142-53-15cba

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 9	35.80	May 6	39.51	Sept. 30	41.58
Dec. 4	43.64	May 27	40.04	Nov. 3	40.72
1964		June 30	39.38	Dec. 9	43.31
Jan. 22	42.77	July 30	40.50		
April 3	41.01	Aug. 24	40.91		

142-53-36abb

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
Jan. 22	15.10	May 27	11.56	July 30	10.08
May 6	14.43	June 30	9.82	Aug. 24	10.24

142-54-1bbb

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
July 30	7.48	Sept. 30	2.16	Dec. 9	2.68
Aug. 25	3.91	Nov. 3	2.45		

142-54-8ddd

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
July 30	28.21	Sept. 30	23.38	Dec. 9	23.27
Aug. 25	24.17	Nov. 3	23.40		

142-55-1bba

Date	Water level	Date	Water level	Date	Water level
1964		1964		1964	
July 30	29.70	Sept. 30	28.31	Dec. 9	28.58
Aug. 25	29.36	Nov. 3	28.34		

TABLE 2.--Water-level measurements in selected wells in Cass County, N. Dak.--Cont.

142-55-4cab

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Dec. 3	11.22	April 2	10.83	June 30	9.25
1964		May 6	10.16	July 30	9.50
Feb. 4	11.77	May 28	9.75	Aug. 25	9.85

142-55-32baa

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
July 1	12.50	April 2	13.23	June 31	14.41
Dec. 3	14.29	May 6	13.68		
1964		May 28	13.84		
Feb. 4	14.36				

143-49-8ccd

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 31	20.05	April 1	20.22	June 29	20.11
1964		May 5	20.19	July 30	19.85
Jan. 20	20.20	May 27	20.19	Aug. 24	20.44

143-51-32aaa1

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Oct. 29	11.67	April 2	11.04	June 29	4.79
1964		May 5	9.29	July 30	9.04
Jan. 22	10.88	May 27	9.13	Aug. 24	9.47

143-52-17cdc

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
June 19	11.00	April 2	14.04	July 30	11.65
Oct. 31	13.29	May 6	11.77	Aug. 24	12.33
1964		May 27	11.66		
Jan. 22	14.12	June 30	11.00		

143-53-13bbb

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
June 19	10.00	Jan. 22	14.06	April 2	14.00
Oct. 31	12.76				

143-53-18aab

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
June 21	8.00	April 2	10.64	June 30	8.89
Oct. 31	8.61	May 6	8.20		
1964		May 27	8.19		
Jan. 22	9.60				

143-54-31bdd

Date	Water level	Date	Water level	Date	Water level
1963		1964		1964	
Dec. 3	23.95	May 6	24.66	Aug. 25	24.04
1964		May 27	24.60	Dec. 9	21.71
Feb. 4	23.95	June 30	32.66		
April 2	25.03	July 30	32.83		

TABLE 3. – Chemical analyses of selected water samples, Cass County, N. Dak.

Source of water: Qd, glacial drift and associated sand and gravel deposits; Qla, Lake Agassiz silt, sand, and gravel deposits; Qsd, Sheyenne River Delta sand and gravel deposits; Kd, Dakota Sandstone; Qow, outwash deposits of sand and gravel. Remarks: Analyses by North Dakota State Laboratory Department, Bismarck, N. Dak. unless otherwise noted; a, deviation between equivalents per million (epm) of cations and anions exceeds one percent of sum of cation and anion epm; b, analysis by North Dakota State Health Department, Bismarck, N. Dak.; c, apparently $CaCO_3$ precipitated before analysis; d, sample frozen.

[Analytical results in parts per million except as indicated]

Location	Depth	Source	Date of collection	Temperature (°F)	Silica (SiO_2)	Total iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Sum	Dissolved solids: Residue on evaporation at 180°C	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Sodium-adsorption-ratio	Specific conductance (micromhos at 25°C)	pH	Remarks
137-49-22adb	190	Qd	11-18-64	48	22	0.37	35	9.4	132	5.3	344	0	58	56	0.5	0.0	0.35	488	498	126	0	68	5.1	811	8.0	
137-49- 6bcb	150	Qd	6-24-64	53	22	.17	146	38	320	16	309	0	550	290	.4	3.0	.95	1,540	1,600	520	267	56	6.1	2,200	8.2	
137-49- 9dcd	75	Qd	11-18-64	49	22	.07	78	35	152	10	376	0	130	173	.2	1.0	.15	786	780	338	30	48	3.6	1,350	7.8	
137-49-12cdd	98	Qd	5-13-65	48	23	.12	64	17	144	8.6	334	0	139	100	.4	1.8	.25	663	743	228	0	57	4.1	1,220	8.0	
137-49-17daa1	102	Qd	11-18-64	42	23	.48	85	24	142	8.0	382	0	132	139	.2	1.0	.32	743	737	310	0	49	3.5	1,270	7.9	a
137-49-18bbd	105	Qd	6-17-64	56	21	.26	156	47	285	10	295	0	480	331	.6	3.0	.85	1,478	1,590	585	344	51	5.7	2,390	8.2	
137-49-19bbb	83	Qd	11-18-64	45	20	2.9	191	46	400	13	295	0	624	476	.2	1.0	.65	1,920	2,030	665	423	56	6.8	3,000	8.1	
137-49-24bda	107	Qd	11-17-64	..	24	.13	56	19	97	7.3	305	0	129	45	.3	.0	.00	528	530	219	0	48	2.9	861	7.9	
137-49-25ccc	240	Qd	8-21-64	..	25	.40	147	81	131	8.2	393	0	583	48	.4	2.0	.00	1,220	1,260	700	378	29	2.1	1,760	7.6	
137-49-28cdd	190	Qd	11-18-64	45	23	.44	55	15	167	4.8	442	0	46	113	.6	.0	.00	643	638	200	0	64	5.1	1,110	8.1	
137-50- 8caa	142	Qd	11-17-64	48	20	.26	60	14	82	6.3	333	0	22	76	.4	.0	.35	445	430	208	0	45	2.5	810	8.1	6.
137-50-19ddc	246	Qd	6-17-64	51	22	.36	86	39	742	18	337	0	612	838	.6	30 ?	1.5	2,480	2,590	375	99	80	17	4,040	8.2	
137-50-26daa	108	Qd	11-18-64	..	20	.13	112	38	396	12	305	0	595	316	.3	1.0	1.0	1,640	1,750	435	185	66	8.2	2,590	8.1	
137-50-28dad	49	Qla	3-30-61	..	....	8.3	162	50		71	561	0	300	.5	.55	11	....	1,170	.....	610	150	....	....	.....	7.3	b
137-50-30cad	183	Qd	11-17-64	47	23	1.3	63	23	656	12	371	0	504	625	.4	1.0	2.3	2,090	2,010	250	0	84	18	3,340	8.0	
137-51- 6cbb	107	Qd	11-17-64	46	22	.29	92	21	181	14	506	0	227	51	.2	.0	.90	858	834	314	0	54	4.4	1,300	8.2	
137-51-21bcc	167	Qd	6-25-64	52	23	.36	120	52	358	16	336	0	606	300	.6	2.0	1.0	1,640	1,670	515	240	59	6.9	2,320	8.2	
137-51-28cdc	84	Qla	6-24-64	52	24	.40	120	26	133	14	578	0	196	21	.4	11	1.0	830	836	405	0	40	2.9	1,240	7.8	
137-51-35cdd2	207	Qd	11-17-64	46	26	1.8	43	18	635	10	569	0	441	476	.4	1.0	2.0	1,930	1,900	180	0	88	21	3,090	8.2	
137-52-16ddc	160	Qd	11-17-64	45	21	2.3	140	48	584	20	298	0	891	461	.4	1.0	2.4	2,320	2,330	545	301	69	11	3,480	8.1	
137-52-31bab	55	Qsd	11-17-64	..	24	.36	106	38	14	6.5	403	0	115	15	.4	.0	.15	518	520	420	90	7	.3	853	8.2	a
137-52-31bbb	17	Qsd	8-19-64	..	26	7.2	21	57	58	19	429	34	25	4.0	.2	2.0	.00	464	512	288	0	29	1.5	818	8.7	c
137-53- 3ddc	495	Kd	1963	..	....	.6	.....	.....	....	.....	276	0	1,350	560	....	0	....	2,985	2,790	44	.....	....	....	.....	8.2	
137-53- 4dbb	420	Kd	11-17-64	..	6.0	.48	10	4.0	1,000	12	376	10	1,070	639	3.8	2.0	3.6	2,940	2,970	41	0	98	68	4,630	8.3	
137-53-19ccb	33	Qsd	11-17-64	45	22	.14	256	105	214	18	278	0	739	380	.2	.0	.75	1,870	1,980	1,070	843	30	2.8	2,770	7.9	
137-54-28ccc	12	Qow	11-17-64	50	23	.11	113	26	24	8.5	417	0	86	6.0	.4	7.0	.00	499	511	388	46	12	.5	833	8.1	
137-55-20ccc	835	Kd	6-25-64	58	7.8	4.7	146	39	1,100	63	212	0	1,490	925	4.3	36	2.4	3,910	3,940	525	.....	80	21	5,400	8.0	
137-55-30bcb	80	Qd	8-6-64	..	24	.36	132	51	227	28	343	0	610	109	.2	3.0	1.5	1,350	1,350	540	259	46	4.2	1,780	7.8	
137-55-35ddd	125	Qd	8-16-64	..	26	.56	112	110	66	8.7	362	0	473	46	.4	3.0	.00	1,020	1,030	700	404	17	1.1	1,440	7.9	c
138-48- 7cdd	153	Qd	11-13-64	..	21	.90	43	14	158	6.2	342	0	159	55	.4	.0	.35	633	614	164	0	67	5.4	1,030	8.0	
138-49- 4aaa	150	Qd	6-6-64	..	21	.27	44	10	80	5.2	283	0	22	50	.4	6.4	.00	377	376	153	0	52	2.8	670	8.2	
138-49-12aab	320	...	11-13-64	50	6.4	.40	26	9.0	1,250	14	322	0	1,360	852	3.4	1.5	2.8	3,690	3,720	102	0	96	54	5,680	8.0	
138-49-13aaa	132	Qd	11-13-64	46	20	.21	52	12	148	6.5	337	0	171	46	.4	.0	.48	623	608	178	0	63	4.8	1,000	8.0	
138-49-15bab	179	Qd	6-25-64	51	22	.20	33	12	66	5.5	222	0	46	37	.5	.0	.40	331	354	132	0	51	2.5	577	8.2	
138-49-19aaa	303	Qd ?	3-4-64	..	8.5	.62	16	3.6	345	13	327	0	323	156	1.4	1.0	1.9	1,030	1,070	55	0	91	20	1,660	7.4	
138-49-20bbb	110	Qd	11-13-64	..	24	.53	76	30	135	7.9	356	0	162	105	.4	1.0	.20	718	713	312	21	48	3.3	1,210	8.1	
138-49-27baa	240	Qd	11-13-64	49	17	.46	34	11	126	5.2	373	0	22	58	.5	.0	.48	459	467	131	0	67	4.8	745	8.0	
138-49-28dcc	90	Qd	11-13-64	46	19	.31	53	23	156	8.0	390	0	114	105	.4	.0	.55	671	652	226	0	59	4.5	1,160	8.2	
138-49-29ccc	280	Qd	8-20-64	..	24	.24	108	41	273	8.0	281	0	358	315	.5	3.0	.00	1,270	1,280	440	210	57	5.6	2,020	7.8	
138-49-31bab	243	Qd	11-13-64	50	3.5	.56	17	8.4	610	10	329	0	576	383	3.4	2.0	2.8	1,780	1,820	77	0	94	30	2,820	7.9	
138-49-34ccc	100	Qd	6-11-64	..	23	.47	38	14	123	6.4	349	0	39	70	.6	4.4	.30	490	482	152	0	63	4.3	858	8.2	
138-50- 5add	455	...	3-4-64	..	5.5	.64	16	4.9	830	18	383	0	756	557	5.9	1.0	3.9	2,380	2,480	60	0	96	46	3,790	7.5	
138-50- 5bbb	240	Qd	7-14-64	..	22	.28	44	16	263	10	634	0	33	163	.5	142	.85	1,000	925	176	0	75	8.6	1,440	8.1	a
138-50-13bcb	123.0	Qd	11-13-64	50	23	2.3	80	21	264	8.8	349	0	252	231	.2	1.0	.85	1,060	1,120	285	0	66	6.8	1,740	8.1	
138-50-20cdd	180	Qd	11-13-64	49	12	.24	80	20	246	7.2	387	0	64	310	.3	.0	.00	931	931	280	0	65	6.4	1,660	8.1	

TABLE 3. – Chemical analyses of selected water samples. Cass County, N. Dak. Cont.

[Analytical results in parts per million except as indicated]

Location	Depth	Source	Date of collection	Temperature (°F)	Silica (SiO_2)	Total iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Sum	Dissolved solids: Residue on evaporation at 180°C	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Sodium-adsorption-ratio	Specific conductance (micromhos at 25°C)	pH	Remarks
138-50-35aaa	100	Qd	7-31-64	..	20	0.24	104	42	240	18	332	0	302	288	0.5	0.0	0.00	1,180	1,190	432	160	53	5.0	1,920	8.1	
138-51- 4bbb	380	...	6-25-64	55	5.0	.52	26	9.2	1,320	64	232	17	1,440	928	4.5	53	4.3	3,980	4,060	103	0	94	56	5,650	8.4	
138-51- 9ccd	80	Qd	11-18-64	48	22	.04	94	30	250	14	366	0	384	158	.3	1.0	.80	1,130	1,140	358	58	59	5.8	1,770	8.0	
138-51-24ccb	80	Qd	11-18-64	50	21	.20	117	41	171	14	409	0	278	162	.2	1.0	.60	1,010	1,030	462	127	44	3.5	1,620	7.8	
138-51-32ebb	69	Qd	11-18-64	44	23	.12	103	37	180	15	407	0	418	42	.2	.0	.65	1,020	1,040	410	77	48	3.9	1,530	7.8	
138-52-11ccc	276	Qd	11-10-64	49	23	1.2	130	37	980	19	422	0	1,280	682	.6	.0	1.8	3,360	3,470	475	129	81	20	4,800	7.9	
138-53- 6abb	32	Qla	11-10-64	48	18	.26	274	150	74	55	391	0	744	209	.1	178	.00	1,900	2,100	1,300	980	11	.9	2,610	7.9	
138-53-10ddc	115	Qd	11-11-64	..	24	.41	66	23	479	15	446	0	490	319	.4	1.0	1.3	1,640	1,610	260	0	79	13	2,500	8.1	
138-54- 8bbb	70	Qd	6-25-64	51	24	.13	154	36	190	18	360	0	638	16	.4	1.0	.00	1,250	1,230	535	240	42	3.6	1,650	7.9	
138-55- 6bbc	900	Kd	6-24-64	53	6.8	.24	137	35	1,150	60	282	0	1,360	1,010	3.3	.0	2.6	3,900	3,990	485	254	82	23	5,770	7.8	
138-55-24ccc	65	Qd	11-10-64	46	20	.16	282	109	226	20	325	0	1,100	152	.1	52	.35	2,120	2,210	1,150	884	29	2.9	2,730	7.9	
139-49- 2ccd1	25	Qla	5-13-65	44	22	.26	35	15	255	6.6	337	0	168	178	.5	5.7	1.3	854	822	150	0	78	9.1	1,380	7.8	
139-49- 6acc	208	Qd	6-14-65	48	23	.66	67	14	303	9.1	377	0	151	310	.5	5.3	.48	1,070	1,030	224	0	74	8.8	1,760	7.9	
139-49- 6cdd	191.7	Qd	3-13-64	..	21	1.8	52	17	415	15	417	0	134	450	1.0	1.0	.55	1,310	1,370	200	0	80	13	2,280	7.4	
139-49- 6dcd1	215.5	Qd	11-9-63	..	24	.96	57	20	450	13	410	0	207	478	.9	1.0	.70	1,450	1,510	224	0	80	13	2,420	7.5	d
139-49- 6dcd2	182	Qd	11-3-63	..	15	.52	57	19	440	14	388	0	217	472	.8	1.0	.75	1,430	1,470	220	0	80	13	2,420	7.8	d
139-49- 6ddc	182	Qd	11-4-63	..	18	.40	57	19	372	13	346	0	179	410	.9	1.0	1.1	1,240	1,270	220	0	77	11	2,090	7.7	d
139-49- 7abb2	204	Qd	6-18-65	43	20	.44	45	12	287	9.1	366	0	168	238	.6	2.4	1.0	970	949	162	0	78	9.8	1,590	8.0	
139-49- 8bba1	131.7	Qd	5-22-53	..	....	.38	47.6	14.8	240	....	334	19.2	39.7	252	.7	4.4	....	953	.....	180	.....	..	....	.....	...	b
139-49- 8bba2	112	Qd	5-22-53	..	....	.70	52.9	19.0	151	....	322	24	10	160	.4	4.4	.....	745	.....	210	.....	..	....	.....	...	b
139-49- 8bda	155	Qd	6-18-65	45	23	.12	41	12	214	8.1	344	0	130	146	.6	1.6	.82	749	751	150	0	74	7.6	1,250	7.9	
139-49- 9ddd3	180	Qd	7-9-64	..	20	.29	50	14	101	6.6	256	6	92	72	.4	.0	0.60	488	501	184	0	53	3.2	838	8.5	
139-49-11baa	30	Qla	10-5-64	59	3.2	.12	18	9.7	28	3.6	70	3.8	70	11	1.1	.0	.00	182	204	86	22	40	1.3	312	8.5	
139-49-11cbb	403	Qd	3-13-64	..	20	.46	38	9.0	191	7.0	351	0	108	112	.9	1.0	.00	659	680	132	0	75	7.2	1,120	7.7	
139-49-18bbb	210	Qd	8-26-63	..	23	.54	62	23	470	20	381	0	300	472	1.0	1.0	1.55	1,562	1,624	250	0	79	13	2,616	7.3	
139-49-22bbb	236	Qd	8-30-63	..	20	.20	48	17	128	8.0	264	0	112	108	.5	0	1.45	573	596	192	0	58	4.2	1,046	7.6	
139-49-24daa	90	Qd	5-13-65	46	19	.11	352	524	322	4.4	654	0	2,790	15	.4	12	.50	4,360	4,540	3,030	2,500	19	2.5	4,370	7.8	a
139-49-29bcd	238	Qd	11-18-64	45	16	.48	28	9.2	257	8.2	432	0	140	125	1.1	1.0	.85	800	796	108	0	83	10	1,350	7.8	
139-49-32cca	183	Qd	11-18-64	..	22	.12	56	37	142	9.0	317	0	113	140	.4	9.8	.15	685	640	291	30	51	3.6	1,120	7.8	
139-50- 2dbc	250	Qd	5-13-65	47	22	.12	54	23	340	9.7	361	0	170	345	.5	3.2	1.8	1,150	1,080	228	0	75	9.8	1,860	7.7	
139-50- 6bbb2	165	Qd	10-5-64	57	5.0	.32	102	46	808	24	379	0	1,070	573	1.3	5.0	3.1	2,820	2,900	445	135	79	17	4,060	7.9	
139-50-10add	116	Qd	7-13-64	46	18	.31	51	21	227	17	381	0	126	209	.6	.0	.00	877	886	214	0	68	6.7	1,380	8.2	
139-50-10add	116	Qd	7-14-64	46	25	.28	54	19	215	11	371	0	94	202	.4	17	.00	823	818	214	0	67	6.4	1,380	7.5	
139-50-10add	116	Qd	7-15-64	46	24	.28	53	20	215	11	368	0	94	205	.4	17	.00	821	820	216	0	67	6.4	1,360	7.3	
139-50-23aaa	150	Qd	7-9-64	..	24	1.6	139	58	90	8.5	784	0	42	76	.2	.0	.65	825	849	585	0	25	1.6	1,400	8.0	
139-50-31bbb	417	...	3-4-64	..	22	.24	98	24	740	16	412	0	500	793	1.0	1.0	1.5	2,400	2,530	344	6	82	17	3,930	7.2	
139-51-32cab1	180	Qd	5-13-65	48	21	.11	76	26	189	11	339	0	238	132	.2	1.9	1.2	863	859	295	10	57	4.8	1,390	7.8	
139-52- 2dcc	296	Qd	11-10-64	..	5.2	1.5	40	15	884	16	376	0	1,040	511	3.1	2.0	4.1	2,710	2,680	160	0	91	30	3,910	8.0	
139-53-11bcc	23	Qla	11-10-64	50	24	.18	162	54	70	11	388	0	408	41	.2	1.5	.00	963	1,010	625	307	20	1.2	1,300	7.9	
139-54-11ddd	212	Qd	8-21-64	..	25	.78	26	20	217	11	478	0	149	61	.5	1.0	3.0	746	760	148	0	74	7.7	1,160	8.1	
139-54-30dda	90	Qd	11-10-64	47	21	.21	147	37	184	15	373	0	594	12	.1	.0	.40	1,190	1,250	520	214	43	3.5	1,610	7.8	
139-55- 4abb	80	Qd	11-10-64	46	22	.06	516	464	76	14	442	0	2,140	241	.1	540	.00	4,230	4,590	3,200	2,840	5	.6	4,410	7.8	
140-49- 7dca1	154	Qd	5-12-65	47	23	.86	81	28	159	7.3	693	0	17	58	.3	1.2	.90	718	690	318	0	51	3.9	1,170	7.7	
140-49-15ddc1	80	Qd	6-24-64	53	15	.40	446	996	2,000	83	585	0	7,480	568	4.0	556	.0	12,400	13,000	5,210	4,740	45	12	12,400	7.9	
140-49-16daa	146	Qd	6-26-64	58	24	.44	40	13	145	10	412	5	19	84	.4	2.0	.65	545	572	154	0	65	5.1	912	8.3	

TABLE 3. – Chemical analyses of selected water samples. Cass County, N. Dak. Cont.

[Analytical results in parts per million except as indicated]

Location	Depth	Source	Date of collection	Temperature (°F)	Silica (SiO_2)	Total iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids		Hardness as $CaCO_3$		Percent sodium	Sodium-adsorption-ratio	Specific conductance (micromhos at 25°C)	pH	Remarks
																		Sum	Residue on evaporation at 180°C	Calcium, magnesium	Noncarbonate					
140-49-24ddd	80	Qd	5-12-65	46	21	0.10	268	123	85	5.3	617	0	749	28	0.2	46	0.25	1,630	1,740	1,180	670	14	1.4	2,090	7.6	
140-49-31acb	18	Qla	5-12-65	42	16	.38	160	124	74	14	373	0	435	95	.1	210	.35	1,310	1,440	910	105	15	1.1	1,830	7.7	a
140-49-31cdc	200	Qd	8-23-63	..	20	.72	34	18	402	12	517	0	18	430	1.3	2.0	1.55	1,190	1,090	160	0	83	14	2,025	7.9	
140-49-32bbc	170	Qd	6-16-65	48	22	.50	81	15	247	9.5	494	0	48	305	.3	1.2	.50	973	904	263	0	66	6.6	1,670	7.8	a
140-49-35ddd	191	Qd	3-13-64	..	18	.35	49	15	200	6.0	315	0	162	143	.7	1.0	.0	750	762	185	0	69	6.4	1,18C	7.6	
140-49-36aaa	223	Qd	8-8-63	..	23	.39	35	77	220	5.0	305	15	370	166	.7	2.0	.18	1,063	1,129	400	150	54	4.9	1,793	8.3	
140-50-35cdc	96	Qd	11-6-64	..	....	.8	...	......	.....	....	365	0	91	145	...	6	1.05	671	.....	170	.....	73	7.1	1,260	...	
140-50-35ddd	70	Qla ?	11-5-64	..	....	.3	...	......	.....	....	420	0	89	59	...	0	.15	487	.....	250	.....	55	3.8	1,100	...	
140-51- 6ccc	84	Qd	5-13-65	47	21	.12	91	26	150	11	329	0	262	90	.2	1.0	1.0	815	808	332	55	49	3.6	1,270	7.9	
140-52-10ddd	131	Qd	11-17-64	46	22	.25	59	28	212	10	379	0	298	87	.3	.0	.00	904	850	264	0	63	5.7	1,350	7.9	
140-52-35adb	315	...	5-28-47	..	..	.15	7.2	4.4	851	....	364	..	1,129	330	4.5	.....	....	......	2,760	36	.....	..	....	.....	8.0	b
140-53- 5aba	35	Qd	11-10-64	50	23	.12	102	31	13	7.0	329	0	107	25	.2	2.0	.35	473	502	384	115	7	.3	745	7.9	
140-53-26ccb	20	Qla	8-25-64	54	26	.19	114	62	17	4.0	439	0	213	6.0	.5	.0	.00	658	715	540	180	6	.3	1,020	7.4	
140-54- 2daal	52	Qd	11-10-64	46	23	.12	222	84	445	27	371	0	1,060	341	.1	27	1.2	2,410	2,420	900	596	51	6.5	3,190	7.7	
140-54-13add	670	Kd	4-15-57	..	....	....	...	......	.....	....	344	Trace	.....	....	...	0	....	......	2,810	160	.....	..	....	.....	8.3	b
140-55-19bac2	28	Qow	6-16-64	..	21	.11	90	40	24	3.2	300	4	151	17	.5	8.0	.00	505	505	390	138	12	.5	785	8.3	
140-55-25aaa	220	Qd	7-17-64	..	22	.14	40	36	188	22	289	0	391	20	.4	15	.60	876	890	246	9	60	5.2	1,290	8.1	
140-55-27bab	540	Kd	11-10-64	51	6.2	.28	46	9.7	1,140	44	368	0	900	1,040	3.9	.0	3.2	3,370	3,420	155	0	91	36	5,220	8.1	
141-49- 6cdb	225	Qd	5-12-65	46	6.4	.38	14	8.5	492	11	381	5	180	450	.6	3.6	1.9	1,360	1,330	70	0	93	26	2,310	8.5	
141-49-33cab	185	Qd	5-12-65	47	20	.42	44	18	221	8.0	325	0	139	189	.5	1.1	1.2	800	784	186	0	71	7.1	1,330	8.0	
141-50- 2add	159	Qd	7-10-63	..	....	....	...	.....	574	.....	372	Trace	.....	....	...	7.9	....	......	2,378	240	.....	..	....	.....	...	b
141-50- 6ddd	130	Qd	5-26-64	..	23	.73	56	17	278	10	508	5	52	248	.5	1.0	.00	940	948	210	0	73	8.3	1,700	8.3	
141-50- 9aaa2	280	Qd	5-23-64	..	25	.36	91	33	930	30	401	0	789	913	.9	.00	2.7	3,010	2,940	365	37	83	21	4,560	8.1	
141-50-11cdc	195	Qd	5-12-65	..	23	.22	128	50	866	18	353	0	760	975	.1	6.4	2.6	3,000	2,960	525	236	77	16	4,580	7.6	
141-51-19cdd	317	Qd	6-25-64	52	8.9	.36	46	14	862	26	305	0	991	545	3.5	16	2.6	2,660	2,680	172	0	90	29	3,880	7.8	
141-52-24ddd	216	Qd	6-13-63	..	20	.30	124	54	302	13	249	0	571	294	.6	5.0	.86	1,508	1,576	530	325	55	5.8	2,370	7.9	
141-52-25bbc	280	Qd	6-13-63	..	23	.60	120	49	524	17	298	0	818	402	.8	6.0	2.10	2,109	2,162	500	255	69	11	3,168	8.1	
141-52-26aad	260	Qd	6-13-63	..	17	.56	40	19	720	14	273	14	900	394	2.7	5.5	2.70	2,264	2,230	180	0	89	24	3,574	8.4	
141-53-20add	675	Kd	10-8-64	..	5.2	.85	124	41	966	42	241	0	1,380	710	.5	.0	2.6	3,380	3,340	480	283	80	19	4,940	7.9	
141-54- 4cdd	158	Qd	5-12-65	48	22	.33	172	32	57	12	423	0	343	2.5	.3	.9	.00	850	866	560	214	18	1.0	1,200	7.6	
141-54-34abd	145	Qd	11-11-64	..	17	4.0	90	28	130	16	487	0	230	6.7	.1	.0	1.1	763	762	342	0	44	3.1	1,160	7.8	
141-55- 7ada2	43	Qd	11-10-64	48	23	.30	480	98	503	25	283	0	2,240	140	.1	2.0	.65	3,650	3,740	1,600	1,370	40	5.5	3,910	7.8	
141-55-12ddc	86	Qd	11-17-64	48	20	.20	85	32	82	13	337	0	250	2.8	.0	.0	.35	651	650	346	70	33	1.9	1,000	7.8	
141-55-34aaa	640	Kd	10-25-60	..	....	....	...	.....	.....	.....	451	0	750	....	.9	0	....	......	3,810	145	.....	..	....	.....	...	b
142-49-18cdd	210	Qd	6-16-65	48	23	.48	138	38	373	27	336	0	275	975	.7	4.0	1.9	3,020	2,890	500	225	78	17	4,680	7.9	
142-49-26baa	125	Qd	6-16-65	49	26	.14	91	10	244	10	308	0	156	299	.4	1.6	.40	991	971	270	18	65	6.5	1,610	7.8	a
142-50- 8aab2	342	Qd ?	6-16-65	47	36	.37	272	78	90	12	1,190	0	48	192	.2	.9	.00	1,320	1,280	1,000	25	16	1.2	2,140	7.8	a
142-50-19bcc	120	Qd	6-16-65	46	25	1.4	98	8.1	737	15	652	0	213	847	.6	13	2.2	2,280	2,260	278	0	84	19	3,790	8.1	a
142-50-35add	219	Qd	6-16-65	46	25	.48	107	25	959	28	416	0	835	910	.8	3.1	2.5	3,100	3,000	370	29	84	21	4,770	8.2	
142-51-17daa	411	Kd	6-16-65	46	5.0	.40	32	8.0	1,120	23	362	0	1,200	776	2.9	4.0	3.3	3,350	3,190	113	0	94	46	4,990	8.2	a
142-51-18dcd	212	Qd	6-16-65	47	20	.60	48	7.3	1,010	18	336	0	1,240	697	2.8	2.2	3.8	3,220	3,220	150	0	93	36	4,980	8.0	a
142-51-20dcd	160	Qd	6-16-65	56	24	.08	58	17	980	11	312	0	1,200	659	2.6	5.8	3.0	3,110	3,200	216	0	90	29	4,590	7.9	a
142-51-30cdd	136	Qd	6-16-65	48	25	.17	85	9.2	130	9.7	280	0	217	75	.4	.5	.39	690	665	250	21	52	3.6	1,070	7.8	a
142-52-17aaa	180	Qd	6-25-64	56	21	.68	51	22	220	11	295	7	246	166	.7	1.0	.35	891	868	220	0	67	6.4	1,370	8.3	
142-52-24bca	189	Qd	8-4-61	..	....	.6	...	.....	.....	.....	.....	..	237	197	0	Trace	....	921	887	172	.....	..	.....	1,694	7.9	

TABLE 3. – Chemical analyses of selected water samples. Cass County, N. Dak. Cont.

[Analytical results in parts per million except as indicated]

Location	Depth	Source	Date of collection	Temperature (°F)	Silica (SiO_2)	Total iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids		Hardness as $CaCO_3$		Percent sodium	Sodium-adsorption-ratio	Specific conductance (micromhos at 25°C)	pH	Remarks
																		Sum	Residue on evaporation at 180°C	Calcium, magnesium	Noncarbonate					
142-53-20cdd	55	Qd	11-5-64	50	25	13	133	26	14	11	415	0	140	2.9	.1	0.0	0.00	569	564	440	100	6	0.3	894	7.5	
142-54- 1bbb	160	Qd	11-6-64	46	21	.14	65	17	24	10	295	0	51	1.9	.2	2.0	.00	337	330	232	0	17	.7	543	7.7	
142-54- 8ddd	100	Qd	11-6-64	46	21	.19	63	17	8.4	7.1	264	0	40	1.0	.2	.0	.00	288	323	226	10	7	.2	474	7.9	a
142-54-25cbc	136	Qd	11-5-64	..	23	1.3	114	27	38	12	482	0	97	3.8	.0	.0	.35	553	544	394	0	17	.8	869	7.3	
142-54-34aad	90	Qd	6-9-65	..	32	.11	152	49	32	11	344	0	365	1.9	.4	.4	.00	812	810	580	298	10	.6	1,120	7.9	
142-55- 8dda	800	Kd	6-25-64	53	6.2	2.1	30	5:6	1,170	34	485	0	259	1,420	4.5	3.0	4.0	3,170	3,210	98	0	95	51	5,530	7.7	
143-49-30cdd	460	...	4-27-65	..	4.8	1.4	15	5.5	1,130	9.4	293	0	912	954	.6	8.9	4.5	3,190	3,180	60	0	97	63	4,980	8.0	
143-50-19aba	80	Qd	5-12-65	47	22	.13	74	27	3.7	2.8	311	0	48	.5	.0	.0	.00	331	320	294	39	2.6	.1	572	7.9	
143-50-29daa	370	...	4-27-65	48	22	.82	135	34	974	30	315	0	979	930	.7	14	2.5	3,140	3,320	475	217	80	19	4,910	7.6	
143-51-18dad	352	...	4-27-65	44	6.4	.26	30	5.6	1,150	23	322	0	1,260	797	3.6	..0	3.6	3,440	3,340	98	0	95	50	4,970	8.2	a
143-52-33aba	392	...	11-5-64	54	19	2.2	120	27	1,020	43	254	0	1,350	767	2.0	3.5	2.9	3,480	3,430	410	202	83	22	4,890	7.5	
143-53-15cdb2	60	Qla	11-5-64	46	20	.09	202	71	83	7.2	422	0	454	51	.2	120	.10	1,220	1,180	795	449	18	1.3	1,630	7.6	
143-54-23bba	120	Qd	11-5-64	..	24	8.6	134	34	13	9.6	392	0	190	3.4	.2	1.0	.00	611	648	475	154	5	.3	920	7.2	
143-54-31bdd	121	Qd	11-5-64	47	24	.18	124	25	37	11	395	0	164	2.9	.2	2.0	.25	586	614	412	88	16	.8	869	7.4	
143-55-15dcd	62	Qd	11-6-64	48	20	.49	126	34	19	11	415	0	160	3.8	.1	.0	.00	579	626	456	116	8	.4	929	7.9	
143-55-26bba	80	Qd	2-6-56	..	..	....	...	.....	....	....	115	14.4	.....	....	....	Trace	....	.....	360	220	80	..	....	.....	...	b

TABLE 4.–Logs of test holes and selected wells.

137-49-17aaa
Test hole 2347

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, silty, dusky-yellow to light-olive-gray; scattered lignite flakes, calcareous	16	17
	Clay, silty, olive-gray to dark-greenish-gray; scattered lignite flakes, calcareous	35	52
Till and associated glacioaqueous deposits:			
	Clay, silty, gravelly, olive-gray; calcareous	9	61
	Sand, coarse, gravelly, predominantly quartz and limestone	11	72
	Sand, coarse, gravelly, clay lenses; predominantly quartz and limestone	25	97
	Clay, silty, gravelly, olive-gray; highly calcareous	70	167
	Boulder, limestone	1	168
Graneros Shale:			
	Clay, dark-greenish-gray; white silt and sand laminations, noncalcareous	22	190
	Clay, silty, brownish-black to black; scattered lignite flakes, noncalcareous	10	200
Granite(?):			
	Decomposed granite; clay, cohesive, grayish-orange-pink; noncalcareous	10	210

137-49-25ccc
Test hole 3158

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Silt, clayey, moderate yellowish-brown; cohesive, scattered sand, calcareous	27	29
	Clay, silty, olive-gray; plastic, calcareous	42	71
Till and associated glacioaqueous deposits:			
	Clay, olive-gray	2	73
	Gravel, fine to medium, sandy; subrounded, predominantly limestone	5	78
	Clay, silty, sandy, gravelly, olive-gray; numerous boulders, highly calcareous	15	93
	Clay, silty, sandy, gravelly, olive-black; highly calcareous	25	118
	Clay, silty, olive-gray; scattered lignite fragments, highly calcareous	20	138
	Sand, fine to coarse, gravelly; subangular to subrounded, scattered lignite fragments, predominantly limestone	109	247
Granite:			
	Decomposed granite; clay, sandy, pale-blue-green	10	257

1/ Geologic names used herein conform to the usage followed by the North Dakota Geological Survey rather than that of the U. S. Geological Survey.

137-49-28cdd
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, yellow	26	28
	Clay; blue	39	67
Till and associated glacioaqueous deposits:			
	Clay, sandy, boulders; blue	8	75
	Clay, sandy, hard; blue	23	98
	Clay; blue	23	121
	Clay, sandy; blue	6	127
	Sand, fine, dirty; gray	5	132
	Sand, fine; gray	9	141
	Clay, soft; blue	3	144
	Sand, fine; gray	5	149
	Clay, sandy, soft; blue	25	174
	Sand; gray	18	192

137-49-30aaa
Test hole 3138

Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, silty, sandy, olive-gray; plastic, calcareous	1	2
	Clay, dusky-yellow; plastic, calcareous	22	24
	Clay, olive-gray; plastic, scattered lignite fragments, calcareous	40	64
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, dark-greenish-gray; occasional boulders	19	83
	Sand and gravel, unsorted; abundant lignite fragments, predominantly quartz, shale, and limestone	69	152
	Gravel, fine to very coarse; numerous boulders, scattered lignite fragments, predominantly limestone	27	179
	Clay, silty, sandy, gravelly, dark-greenish-gray; occasional boulders, highly calcareous	21	200
Graneros Shale:			
	Shale, silty, olive-black; pockets of very fine white sand, slightly calcareous to noncalcareous	36	236
Granite:			
	Decomposed granite; clay, greenish-gray; noncalcareous	21	257

137-50-11ddd
Test hole 3137

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Silt, sandy, olive-gray; scattered lignite flakes, calcareous	1	2
	Clay, sandy, light-olive-gray; scattered lignite flakes, calcareous	3	5
	Clay, sandy, yellowish-brown; plastic, lignite fragments, calcareous	12	17
	Clay, olive-gray; plastic, calcareous	12	29
	Clay, dark-greenish-gray; plastic, scattered fine sand, calcareous	34	63
Till and associated glacioaqueous deposits:			
	Clay, sandy, olive-gray; soft, calcareous	24	87
	Clay, sandy, dark-greenish-gray; hard, calcareous	75	162
Graneros Shale:			
	Shale, silty, olive-black; numerous pockets of fine white sand-some containing lignite fragments, slightly calcareous to noncalcareous	46	208
Granite:			
	Decomposed granite; clay, grayish-green; numerous quartz fragments	4	212

137-50-29dad
Kindred Municipal well
Driller's log by Frederickson's Inc.

Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, yellow	12	14
	Clay, blue	4	18
	Sand, fine, gray	24	42
	Sand	5	47
	Clay, blue; soft	22	69
Till and associated glacioaqueous deposits:			
	Clay, blue; hard	2	71

137-50-35ccb
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil; black	1	1
	Clay; brown	4	5
	Sand, fine, dirty; brown	25	30
	Clay; green	19	49
	Clay; blue	32	81
Till and associated glacioaqueous deposits:			
	Clay, hard; blue	78	159
	Clay, sandy, soft; gray	17.5	236.5
	Sand; gray	1.5	238
	Clay, sandy; gray	14	252
	Sand, dirty; gray	3	255
	Clay, sandy; gray	13	268
	Sand; gray	2	270
	Clay, sandy; gray	13	283
Granite:			
	Decomposed granite; white	95	378

137-51-29cda
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil; black	1	1
	Sand, fine; brown	6	7
	Clay; brown	20	27
	Clay; blue	64	91
Till and associated glacioaqueous deposits:			
	Clay; blue	42	133
	Sand	2	135
	Clay with sand lenses; blue	5	140
	Sand	3	143
	Clay; blue	3	146

137-51-35bbb
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil; black	2	2
	Clay; brown	19	21
	Clay; blue	72	93
Till and associated glacioaqueous deposits:			
	Clay with boulders; blue	11	104
	Clay, soft; blue	11	115
	Clay, hard; blue	6	121
	Sand; brown	1	122
	Clay, hard; blue	9.5	131.5
	Sand; brown	.5	132
	Clay, hard; blue	3	135
	Sand, fine; brown	6	141
	Clay with boulders; blue	14	155
	Clay, soft; blue	23	178
	Sand; brown	1	179
	Clay, sandy, hard; blue	68	247
	Clay, soft; gray	18	265
Granite:			
	Decomposed granite; white	78	343

137-52-27aaa
Test hole 3156

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Silt, clayey, moderate yellowish-brown; soft, cohesive, calcareous	20	22
	Silt, olive-gray; soft, cohesive, scattered lignite fragments, calcareous	10	32
	Sand, very fine; scattered lignite fragments, predominantly quartz; silt lenses 76-82 feet	50	82
	Clay, silty, olive-gray; soft, calcareous	77	159
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; numerous boulders, calcareous	105	264
	Silt, olive-gray	8	272
	Clay, silty, sandy, gravelly, olive-gray; numerous boulders, calcareous	38	310
	Silt, clayey, light-olive-gray; cohesive, scattered lignite fragments, calcareous	45	355
	Sand, fine to medium, clayey; subangular to rounded, predominantly quartz	67	422
Granite:			
	Decomposed granite; clay, sandy, light-greenish-gray; hard, quartz fragments	49	471

137-52-31bbb
Test hole 3157

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, silty, clayey, yellow	3	3
	Sand, fine to medium; angular to rounded, scattered lignite fragments, predominantly quartz	40	43
	Silt, clayey, olive-gray; soft, cohesive, few lignite fragments, scattered shale pebbles	19	62
	Sand, very fine to fine; scattered shale pebbles and lignite chips	62	124
	Clay, silty, olive-gray; soft, calcareous	28	152
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; soft, calcareous	30	182
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous; gravel lense at 224 feet, sand lenses 242-251 feet, numerous boulders 251-266 feet	113	295
Graneros Shale:			
	Shale, olive-black; hard, very fine sand and silt, laminae, fish scales, highly calcareous	22	317

137-53-15bbb
Test hole 2205

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, sandy, black	1	1
	Sand, very fine to fine; dry	5	6
	Silt, clayey, light-yellowish-gray; soft, cohesive, calcareous	5	11
	Silt, clayey, olive-gray; soft, cohesive	9	20
	Clay, olive-gray; plastic, occasional silt lense, calcareous	60	80
Till and associated glaciofluvial deposits:			
	Clay, silty, sandy, olive-gray; soft, numerous pebbles and cobbles, calcareous	25	105

137-53-30aad

U. S. Bureau of Reclamation

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Sand	12	12
	Silt, sandy	11	23
Till and associated glacioaqueous deposits:			
	Till	2	25

137-53-34ccc
Test hole 2206

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, sandy, black	1	1
	Sand, fine to medium, brown; rounded	9	10
	Sand, fine to medium, clayey, olive-gray; scattered shale pebbles and lignite chips	10	20
	Sand, fine to medium, olive-gray	20	40
	Sand, fine to coarse, olive-gray	10	50
	Silt, clayey, olive-gray; soft, cohesive	10	60
	Sand, silty, fine to medium, rounded	20	80
	Clay, silty, olive-gray; plastic	10	90
	Silt, clayey, olive-gray; soft, cohesive, scattered granules, calcareous	20	110
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; soft	10	120
	Clay, gravelly, olive-gray	16	136

137-54-32ddd
Test hole 3146

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, silty, yellow	3	3
	Sand and gravel, unsorted; subrounded, predominantly quartz, limestone, and shale	39	42
	Sand, very fine to very coarse, silty; scattered lignite fragments, predominantly quartz and limestone	10	52
	Silt, olive-gray; soft, calcareous; scattered lignite fragments	10	62
	Clay, silty, sandy, gravelly, olive-gray; numerous shale pebbles and lignite chips; sand lenses 117-146 feet and from 152-158 feet; shale boulder 174-183 feet	143	205
Greenhorn Formation:			
	Shale, silty, olive-black; hard, white specks, fish scales, highly calcareous	9	214
	Shale, silty, olive-black; hard, numerous hard thin limestone lenses, highly calcareous	13	227

137-54-36ccc
Test hole 2204

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, sandy, brown	1	1
	Clay, silty, sandy, dusky-yellow; calcareous	9	10
	Clay, silty, sandy, olive-gray; calcareous	20	30
	Clay, silty, olive-gray; calcareous	20	50
Till and associated glacioaqueous deposits:			
	Silt, clayey, olive-gray; soft, scattered sand grains, calcareous	30	80
	Silt, clayey, sandy, olive-gray; abundant granules, calcareous	20	100
	Clay, sandy, gravelly, olive-gray; calcareous	110	210
Greenhorn Formation:			
	Shale, olive-black; soft, mottled, calcareous	10	220
	Shale, olive-black; hard	11	231

137-55-18ddd
Test hole 3140

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, dark-yellowish-orange; calcareous	14	14
	Clay, silty, sandy, gravelly, olive-gray; calcareous, numerous shale and quartz fragments	16	30
	Sand, fine to coarse, gravelly; subrounded to rounded; predominantly shale and limestone; abundant lignite fragments	10	40
	Clay, silty, sandy, gravelly, olive-gray; numerous shale and lignite fragments, calcareous	22	62

137-55-29aaa
Test hole 3142

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, silty, sandy, gravelly, moderate yellowish-gray, calcareous	25	26
	Clay, silty, olive-gray; scattered sand and gravel, calcareous	11	37
	Gravel, coarse, sandy; predominantly shale and limestone	10	47
	Clay, silty, sandy, gravelly; olive-gray, calcareous	15	62

137-55-29ddd
Test hole 3143

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, silty, sandy, gravelly, yellowish-brown; calcareous	18	19
	Clay, silty, sandy, gravelly, olive-gray; calcareous	1	20
	Sand	2	22
	Clay, silty, sandy, gravelly, olive-gray, calcareous	10	32
	Clay, silty, olive-gray; calcareous	5	37
	Clay, silty, sandy, gravelly, olive-gray; calcareous	30	67
	Clay, silty, olive-gray; calcareous	10	77

137-55-30bcb
Test hole 3139

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glaciofluvial deposits:			
	Clay, silty, sandy, gravelly, dark-yellowish-orange; abundant shale granules	22	22
	Sand, fine to coarse; gravelly, subangular to well rounded, predominantly quartz, shale and limestone	20	42
	Gravel, fine to coarse; sandy, numerous boulders, predominantly limestone and shale	60	102
	Silt, clayey, olive-gray; cohesive, scattered lignite fragments, calcareous	8	110
	Clay, silty, sandy, gravelly, olive-gray; hard, scattered shale and lignite fragments	27	137

137-55-32ddd
Test hole 3144

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, silty, sandy, gravelly, dark-yellowish-brown; calcareous	17	18
	Clay, silty, olive-gray; calcareous, scattered sand and gravel	16	34
	Sand, gravelly; predominantly rounded shale and limestone fragments	7	41
	Clay, silty, olive-gray; calcareous, scattered sand and gravel	11	52
	Clay, silty, sandy, olive-gray; calcareous, scattered gravel and lignite fragments	25	77

137-55-35ddd
Test hole 3145

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	2	2
	Clay, silty, sandy, gravelly, moderate yellowish-brown; calcareous, numerous shale pebbles; sand lenses 22-32 feet	30	32
	Sand, fine to medium, subangular to rounded; scattered lignite fragments; predominantly quartz and limestone	30	62
	Sand, very fine to coarse; scattered lignite fragments, predominantly quartz and limestone	15	77
	Sand, coarse; silty, gravelly, predominantly quartz and lignite	30	107
	Gravel, medium; sandy, angular to well rounded, predominantly limestone	29	136
	Clay, silty, sandy, gravelly, olive-gray; soft becoming hard at 145 feet, scattered lignite fragments, calcareous	56	192
	Clay, silty, olive-gray; hard, scattered lignite fragments, calcareous	63	255
	Clay, silty, sandy, gravelly, olive-gray; hard, scattered lignite fragments, calcareous	17	272
Greenhorn Formation:			
	Shale, olive-black; hard, white specks, fish scales, highly calcareous	30	302

138-49-4aaa
Test hole 3104

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, silty, grayish-orange; calcareous	16	18
	Clay, silty, olive-gray; calcareous	40	58
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; scattered boulders and lignite fragments, highly calcareous	53	111
	Sand and gravel, unsorted; subangular to rounded, predominantly limestone and quartz	111	222
Graneros Shale:			
	Silt, brownish-gray; soft, cohesive, scattered lignite fragments, non-calcareous	78	300
	Clay, sandy, light-gray to medium-gray; occasional seams of lignitic material, non-calcareous	10	310
	Silt, brownish-gray, soft, cohesive, abundant lignite fragments, non-calcareous	8	318

138-49-4aaa--Continued
Test hole 3104

Geologic source	Material	Thickness (feet)	Depth (feet)
Granite:			
	Decomposed granite; clay, white; scattered sand grains, non-calcareous	22	340
	Clay, pale-blue-green; scattered sand grains, calcareous	15	355

138-49-8ccd
Test hole 2346

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, silty, light-olive-gray to greenish-gray; calcareous	11	12
	Clay, silty, dark-greenish-gray to medium-bluish gray; plastic, scattered sand, calcareous	7	19
	Sand, fine to coarse, predominantly shale and quartz	20	39
	Clay, dark greenish gray, plastic, calcareous	34	73
Till and associated glacioaqueous deposits:			
	Clay, silty, gravelly, dark-greenish-gray, calcareous	7	80
	Boulder, limestone	1	81
	Clay, silty, gravelly, dark-greenish-gray, calcareous	36	117
	Gravel, fine to coarse, sandy; predominantly limestone and granite	2	119
	Clay, silty, gravelly, dark-greenish-gray; occasional boulders, calcareous	96	215
	Clay, silty, gravelly, dark-greenish-gray; calcareous--interbedded with olive-black, non-calcareous clay	8	223
Graneros Shale:			
	Clay, silty, sandy, brownish-black to black; scattered lignite fragments, non-calcareous	29	252

138-49-13baa
Test hole 3114

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, silty, dark-yellowish-brown; calcareous	14	15
	Clay, silty, olive-gray; calcareous	67	80
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	46	126
	Sand, fine to coarse, rounded; scattered gravel	8	134
Graneros Shale:			
	Shale, silty, olive-gray to black, hard, slightly calcareous; occasional shell fragments	57	191
	Clay, sandy, white	3	194
	Clay, silty, olive-gray; hard, non-calcareous	6	200
	Boulder, yellowish-gray to bluish-gray; non-calcareous	1	210
	Clay, silty, dark-yellowish-brown; abundant lignite fragments, non-calcareous	12	222
	Clay, silty, medium light-gray; metallic luster, non-calcareous	7	229
	Clay, silty, variegated (brownish-black, yellowish-brown, light-gray); non-calcareous	31	260
	Clay, silty, yellowish-gray; scattered quartz grains, non-calcareous	18	278
	Clay, silty, dark-yellowish-brown; abundant lignite fragments, non-calcareous	6	284
	Clay, sandy, yellowish-gray to yellowish-brown, non-calcareous	4	288

138-49-13baa--Continued
Test hole 3114

Geologic source	Material	Thickness (feet)	Depth (feet)
Granite:			
	Decomposed granite; clay, bluish-white, abundant angular quartz grains, non-calcareous	14	302

138-49-16ddd
Test hole 3105

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	2	2
	Clay, silty, sandy, light-olive-gray; highly calcareous	5	7
	Clay, silty, grayish-orange; calcareous	9	16
	Clay, silty, olive-gray; calcareous	45	61
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; abundant shale and lignite fragments, highly calcareous	10	71
	Sand, gravelly, coarse; subangular to rounded; numerous lignite fragments, predominantly shale and limestone	7	78
	Clay, silty, sandy, gravelly, olive-gray, highly calcareous	7	85
	Clay, silty, sandy, gravelly, light-olive-gray, highly calcareous	50	135
	Clay, sandy, mottled light-olive-gray to olive-gray; highly calcareous	25	160
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	14	174
	Shale boulder; silt, brownish-black; abundant lignite fragments, scattered organic material, non-calcareous	16	190
	Clay, sandy, dark-greenish-gray; abundant shale pebbles, calcareous	93	283
	Clay, silty, olive-gray; scattered sand and gravel, highly calcareous	31	314
Granite:			
	Decomposed granite; clay, light-brown to pale-orange, abundant white sand grains, non-calcareous	4.5	318.5
	Granite, dusky-green; hard chips	.5	319

138-49-29ccc
Test hole 3115

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	1	1
	Silt, clayey, yellowish-brown; cohesive, calcareous	13	14
	Clay, silty, olive-gray; calcareous	50	64
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; soft, highly calcareous	10	74
	Sand, fine to coarse, angular to rounded; predominantly quartz with limestone, shale, granite, and lignite; scattered pebbles	15	89
	Clay, silty, sandy, gravelly, olive-gray, highly calcareous	53	142
	Silt, clayey, olive-gray; cohesive, highly calcareous	30	172
	Sand, very fine to very coarse; subrounded to well rounded, predominantly quartz and limestone, scattered lignite fragments	38	210
	Sand, medium to coarse; subangular to well rounded, predominantly quartz and limestone, scattered lignite fragments	37	247
	Sand, coarse with abundant gravel and numerous boulders	48	295

138-49-29ccc--Continued
Test hole 3115

Geologic source	Material	Thickness (feet)	Depth (feet)
Granite:			
	Decomposed granite; clay, pale-green; abundant angular and subangular quartz grains, non-calcareous	22	317

138-49-34ccc
Test hole 3106

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	1	1
	Clay, silty, olive-gray; laminated, highly calcareous	.5	1.5
	Clay, silty, yellowish-brown; few laminations, calcareous	12.5	14
	Clay, mottled brown and greenish-gray; calcareous	4	18
	Clay, silty, grayish-orange to olive-gray; calcareous	4	22
	Clay, silty, olive-gray; calcareous	43	65
Till and associated glacioaqueous deposits:			
	Clay, gravelly, olive-gray; scattered sand, highly calcareous	8	73
	Clay, silty, olive-gray; abundant sand and gravel, highly calcareous	6	79
	Gravel, sandy; subrounded to rounded; predominantly limestone and quartz	21	100
	Clay, silty, sandy, gravelly, olive-gray, highly calcareous	30	130
	Clay, silty, sandy, gravelly, greenish-gray; hard, scattered lignite fragments, highly calcareous	86	216
Graneros Shale:			
	Silt, clayey, brown to black; abundant organic and lignitic material, non-calcareous	17	233
Granite:			
	Decomposed granite; clay, silty, white changing to green at 245 feet; soft, scattered quartz grains, non-calcareous	47	280
	Granite, pink and green chips; hard, scattered angular quartz grains, non-calcareous	65	345

138-50-5bbb
Test hole 3116-A

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, silty, olive-gray; scattered sand grains, highly calcareous	7	9
	Clay, silty, yellowish-brown; occasional sand grains and gypsum crystals, highly calcareous	14	23
	Clay, silty, olive-gray; calcareous	31	54
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	46	100
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, silt lenses 137-170 feet, highly calcareous	123	223
	Gravel, sandy, subrounded to rounded; predominantly limestone	17	240
	Sand, gravelly, coarse to very coarse; subangular, predominantly limestone and shale	16	256
	Clay, silty, greenish-gray; hard, highly calcareous	10	266
	Sand, very fine to granules, subrounded; predominantly shale and limestone	14	280

138-50-5bbb--Continued
Test hole 3116-A

Geologic source	Material	Thickness (feet)	Depth (feet)
Graneros Shale:			
	Silt, variegated (olive-gray, gray, greenish-gray, brownish-gray, black); organic material and lignite fragments common, slightly calcareous to non-calcareous	23	302
	Silt, clayey, sandy, olive-gray; few pyrite crystals	36	338
	Sand, very fine to coarse, angular to subangular quartz grains; white; some pyrite cemented quartz grains	8	346
Granite:			
	Decomposed granite; clay, sandy, greenish-gray grading to blue-green with depth; numerous angular to subangular quartz grains	31	377

138-50-35aaa
Test hole 3136

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, sandy, silty, olive-gray; highly calcareous	1	2
	Clay, sandy, silty, olive-black; hard, scattered lignite fragments, non-calcareous	6	8
	Clay, silty, variegated (olive-brown, olive-gray, greenish-gray); hard, scattered lignite fragments, calcareous	22	30
	Clay, olive-gray; plastic, scattered lignite fragments, calcareous	32	62
Till and associated glacioaqueous deposits:			
	Clay, sandy, olive-gray; soft, calcareous; occasional boulder	9	71
	Sand, coarse, gray; angular to rounded, predominantly quartz	11	82
	Clay, silty, sandy, greenish-gray to light-olive gray; soft, highly calcareous	2	84
	Sand, coarse, gray; angular to rounded, predominantly quartz	16	100
	Clay, silty, sandy, greenish-gray to light-olive-gray; soft, highly calcareous	6	106
	Sand, coarse, gray; angular to rounded, occasional boulder, predominantly quartz	10	116
	Clay, silty, sandy, dark-greenish-gray; soft, scattered lignite fragments, highly calcareous	20	136
	Clay, silty, olive-gray to dark-greenish-gray; scattered lignite particles, highly calcareous	8	144
	Clay, sandy, dark-greenish-gray to olive-black; scattered lignite fragments, highly calcareous	10	154
Graneros shale:			
	Shale, silty, olive-black; hard, pockets of fine white sand, non-calcareous	45	199
Granite:			
	Decomposed granite; clay, sandy, pale-blue to greenish-gray; angular to rounded quartz grains	25	227

138-54-6ddd
Test hole 3148

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Sand, fine, gravelly, brown	1.5	1.5
	Clay, silty, sandy, gravelly, yellowish-brown; highly calcareous	17.5	19
	Clay, silty, sandy, gravelly, olive-gray; numerous lignite fragments, calcareous	53	72
	Silt, sandy, olive-gray; soft, cohesive, lignite fragments and shale pebbles, granite boulder 106-107 feet, calcareous	49	121
	Clay, sandy, olive-gray; scattered gravel, few lignite fragments, sand lenses 132-146 feet, calcareous	31	152

138-55-31bbb
Test hole 3141

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	.5	.5
	Clay, silty, sandy, dusky-yellow; slightly calcareous	2.5	3
	Sand, gravelly, dusky-yellow; angular to rounded; clay lenses, predominantly limestone and shale	6	9
	Clay, silty, sandy, gravelly, olive-gray; numerous boulders 9-42 feet, highly calcareous	53	62

138-55-36cdd
Test hole 3147

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	2	2
	Clay, brown	2	4
	Clay, yellow	4	8
	Clay, yellow and orange; sand and gravel lenses	3	11
	Clay, silty, sandy, gravelly, yellowish-brown; calcareous	10	21
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, calcareous	21	42
	Silt, olive-gray; soft, few lignite flakes, calcareous laminae	39	81
	Clay, sandy, gravelly, olive-gray; numerous lignite fragments, highly calcareous--extremely silty 157-172 feet, numerous boulders 187-207 feet and 232-249 feet	181	262
	Clay, sandy, olive-black; some lignite fragments	8	270
Greenhorn Formation:			
	Shale, silty, clayey, olive-black; hard, white specks, abundant shell fragments, highly calcareous	17	287

139-49-1cdb
Cass-Clay Creamery
Driller's log by Layne-Minnesota Co.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Clay	92	92
Till and associated glacioaqueous deposits:			
	Clay, hard, numerous boulders	58	150
	Sand and gravel	44	194
	Clay	?	

139-49-6acc
Union Stockyards
Driller's log by McCarthy Well Co.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	2	2
	Clay	61	63
Till and associated glacioaqueous deposits:			
	Clay and boulders	10	73
	Clay, boulders, and gravel	8	81
	Clay and boulders	5	86
	Clay with lenses of fine sand, numerous boulders	4	90
	Clay and boulders with lenses of gravel and fine sand	8	98
	Clay and boulders	3	101
	Gravel, coarse; numerous boulders	6	107
	Clay, hard	4	111
	Clay and boulders	4	115
	Gravel, coarse, numerous boulders and clay lenses	3	118
	Gravel, coarse	12	130
	Gravel, coarse; clay lenses	56	186
	Gravel, coarse; numerous boulders	3	189
	Sand, gravelly, coarse	19	208

139-49-6bda
Siouxland Dressed Beef Co.
Driller's log by McCarthy Well Co.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Clay	76	76
Till and associated glacioaqueous deposits:			
	Clay and boulders	27	103
	Sand, gravelly, fine; numerous boulders	14	117
	Sand, fine	18	135
	Sand, gravelly, fine	10	145
	Sand, fine	10	155
	Sand and gravel	55	210

$139\text{-}49\text{-}6dcd_1$
West Fargo Municipal Well
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, silty, grayish-yellow-brown; cohesive	9	12
	Clay, dark-olive-gray; plastic	55	67
Till and associated glacioaqueous deposits:			
	Clay, sandy, dark-olive-gray; scattered gravel	4	71
	Clay, sandy, gravelly, bluish-gray; scattered lignite fragments	13	84
	Clay, sandy, gravelly, bluish-gray; abundant boulders	2	86
	Clay, sandy, gravelly, olive-gray	5	91
	Clay, silty, olive-gray; numerous fine sand lenses	10	101
	Clay, sandy, gravelly, olive-gray	27	128
	Sand, very fine to very coarse; clean, scattered fine gravel	3	131
	Sand, silty, very fine to very coarse; scattered fine gravel	12	143
	Clay, sandy, olive-gray; scattered fine gravel	8	151
	Sand, clayey, fine	9	160
	Sand, very fine to very coarse	59	219
	Clay, sandy, dark-olive-gray	3	222
	Clay, sandy, dark-greenish-gray	15	237

139-49-6dcd2
Test hole 1

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, silty, grayish-yellow-brown; plastic, laminated	9	12
	Clay, dark-olive-gray; plastic	48	60
Till and associated glacioaqueous deposits:			
	Clay, sandy, dark-olive-gray; scattered fine gravel	12	72
	Clay, sandy, gravelly, olive-gray; boulders 107-109 feet	50	122
	Sand, fine (?) no samples	10	132
	Clay, silty, olive-gray; lenses of fine sand	5	137
	Clay, sandy, olive-gray; scattered fine gravel	12	149
	Clay, sandy, olive-gray	3	152
	Sand, very fine to fine; occasional clay lenses	10	162
	Sand, silty, very fine to fine	5	167
	Sand, very fine to very coarse	15	182

139-49-6ddc
Test hole 2

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, silty, yellowish-brown; plastic	9	12
	Clay, dark-olive-gray; plastic	48	60
Till and associated glacioaqueous deposits:			
	Clay, sandy, olive-gray; scattered fine gravel	40	100
	Sand, clayey, very fine to very coarse	30	130
	Sand, very fine to very coarse; predominantly quartz	50	180

139-49-7abb2
South west Fargo municipal well
Driller's log by Layne-Minnesota Co.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Clay	69	69
Till and associated glacioaqueous deposits:			
	Clay and gravel	6	75
	Clay and boulders	45	120
	Clay and gravel	41	161
	Clay, gravel, and lignite	29	190
	Sand and gravel	14	204

139-49-8bda
South west Fargo municipal well
Driller's log by Layne-Minnesota Co.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	6	6
	Clay, gravelly	58	64
Till and associated glacioaqueous deposits:			
	Clay, gravel, and boulders	24	88
	Sand and gravel	2	90
	Clay, gravel, and boulders	8	98
	Sand, medium, gray	10	108
	Clay and boulders	13	121
	Clay, gray	6	127
	Sand, medium to coarse	29	156
	Clay, blue	8	164

139-49-9ddd3
Test hole 3113

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Tcpsoil, black	1	1
	Clay, silty, yellowish-brown; scattered fine sand, highly calcareous	13	14
	Clay, silty, olive-gray; plastic, lenses of very fine sand, calcareous	1	15
	Sand, very fine to coarse, brown; subrounded, predominantly quartz, scattered lignite fragments	5	20
	Clay, silty, olive-gray; plastic, calcareous	59	79
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; calcareous	19	98
	Silt, clayey, sandy, olive-gray; cohesive, scattered lignite fragments, calcareous	9	107
	Clay, silty, sandy, gravelly, olive-gray; calcareous--few boulders	11	118
	Sand, very fine to coarse, gravelly; subrounded to rounded; scattered lignite fragments, predominantly quartz and limestone	104	222
Graneros Shale:			
	Silt, brownish-black; cohesive, contains organic and lignitic material, non-calcareous	15	237
Granite:			
	Decomposed granite; clay, white; hard, scattered angular quartz grains	20	257

139-49-13ccc
Test hole 2174

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Tcpsoil, black	2	2
	Clay, silty, yellowish-gray; plastic, scattered pebbles, calcareous	8	10
	Clay, silty, yellowish-gray; plastic, calcareous	10	20
	Clay, silty, olive-gray; plastic, calcareous	68	88
	Sand, fine to coarse, subangular to subrounded; predominantly quartz and limestone	3	91
Till and associated glacioaqueous deposits:			
	Clay, sandy, gravelly, olive-gray; numerous boulders, calcareous	9	100
	Clay, silty, sandy, olive-gray; lenses of sand and gravel	16	116
	Granite boulder	1	117
	Clay, silty, sandy, olive-gray; lenses of gravel	13	130
	Clay, sandy, silty, olive-gray; scattered gravel, numerous boulders	36	166
	Gravel and boulders, predominantly limestone	11	177
Granite:			
	Granite, green; hard	1	178

139-49-18aad
Woodlee Water Co.
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Tcpsoil, black	1	1
	Clay, brown	10	11
	Sand, silty, brown	5	16
	Clay, silty, blue	6	22
	Clay, blue, plastic	58	80

139-49-18aad--continued
Woodlee Water Co.
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay, gray; numerous limestone pebbles	3	83
	Clay, blue, hard	14	97
	Clay, sandy, blue; soft	3	100
	Clay, sandy, blue; hard	2	102
	Clay, gravelly, blue	2	104
	Clay, blue; hard	2	106
	Clay, blue; soft	16	122
	Clay, blue; hard	47	169
	Clay, sandy, blue	19	188
	Sand, coarse, multicolored	10	198
Granite:			
	Decomposed granite; clay, brown and white	4	202

139-49-18bbb
Test hole 2169

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Fill	4	4
	Clay, silty, dusky-yellow; plastic, calcareous	13	17
	Clay, silty, olive-gray; plastic, calcareous	48	65
Till and associated glacioaqueous deposits:			
	Clay, silty, gravelly, olive-gray; numerous boulders, calcareous	17	77
	Sand, fine to medium	3	80
	Clay, silty, olive-gray; scattered gravel and boulders	10	90
	Sand, fine to coarse; subrounded, predominantly quartz	10	100
	Clay, sandy, silty, olive-gray; calcareous	15	115
	Sand, fine to coarse, subrounded; predominantly quartz	31	146
	Clay, silty, olive-gray; plastic, calcareous	4	150
	Sand, fine to coarse, subrounded, lenses of clay and gravel	12	162
	Sand, fire to medium, well sorted, subrounded to rounded; predominantly quartz	48	210
Granite:			
	Decomposed granite; clay, sandy, light-greenish-gray; soft, non-calcareous	21	231

139-49-18ccd
Test hole 2177

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil and fill	11	11
	Clay, silty, sandy, brownish-gray; plastic, calcareous	5	16
	Clay, silty, sandy, yellowish-brown; plastic, calcareous	5	21
	Clay, silty, olive-gray; plastic, calcareous	37	58
Till and associated glacioaqueous deposits:			
	Clay, sandy, silty, gravelly, olive-gray; soft, calcareous	29	87
	Sand, fine, gray; angular to subrounded, scattered lignite fragments, predominantly quartz	5	92
	Clay, sandy, silty, gravelly, olive-gray; soft, calcareous	13	105
	Sand, fine, gray; angular to rounded, scattered lignite fragments, predominantly quartz	12	117
	Clay, sandy, silty, gravelly, olive-gray; soft, calcareous	30	147
	Clay, silty, bluish-gray; plastic, numerous hard nodules, calcareous	10	157

139-49-18ccd--Continued
Test hole 2177

Geologic source	Material	Thickness (feet)	Depth (feet)
Graneros Shale:			
	Clay, silty, grayish-black; plastic, numerous hard nodules, non-calcareous	27	186
	Clay, silty, grayish-black; plastic, few clay cemented nodules composed of quartz, sand, shale, and decomposed granitic material, occasional lignite fragments, non-calcareous	45	231
Granite:			
	Decomposed granite; clay, silty, sandy, white to green; numerous angular quartz fragments, non-calcareous	63	294

139-49-19aaa
Test hole 2170

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, silty, yellowish-gray; soft, calcareous	17	20
	Clay, silty, light-olive-gray; plastic, calcareous	42	62
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; soft, calcareous	9	71
	Gravel, fine to coarse, sandy, subangular to subrounded; predominantly limestone and shale	7	78
	Clay, silty, sandy, olive-gray; numerous cobbles, calcareous	18	96
	Sand, fine to coarse, subangular to subrounded; clay lenses, few pebbles, granitic material predominant	12	108
	Clay, silty, sandy, gravelly, olive-gray; sand lenses, calcareous	22	130
	Sand, fine to coarse, clayey; subrounded, scattered gravel, granitic material predominant	27	157
	Clay, silty, sandy, olive-gray; scattered gravel, calcareous	19	176
Graneros Shale:			
	Clay, silty, sandy, olive-gray to olive-black; soft, thinly laminated, moderately to highly calcareous	47	223
Granite:			
	Decomposed granite; clay, greenish-gray; non-calcareous	19	242

139-49-21bbb
Test hole 2171

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil and fill, black	4	4
	Clay, silty, yellowish-gray; plastic, calcareous	13	17
	Clay, silty, olive-gray; plastic, calcareous	53	70
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, olive-gray; soft, numerous pebbles and cobbles, calcareous	30	100
	Silt, clayey, sandy, olive-gray; soft, calcareous	90	190
	Sand, silty, clayey, olive-gray; cohesive, occasional gravel	68	258
	Sand, fine to coarse, gravelly; subrounded	12	270
	Sand, fine to medium, clayey, olive-gray; firm, scattered gravel, predominantly quartz	10	280
Granite:			
	Decomposed granite; clay, brown and black grading to green and red; soft, non-calcareous	14	294

139-49-22bbb
Test hole 2172

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, silty, black	2	2
	Clay, silty, yellowish-gray; soft, calcareous	17	19
	Clay, sandy, olive-gray; slightly plastic, calcareous	11	30
	Sand, fine to medium, subrounded; predominantly quartz, numerous pelecypod shells	16	46
	Clay, silty, olive-gray; soft, calcareous	40	86
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; few boulders, calcareous	27	113
	Gravel, fine to very coarse, sandy, subrounded to angular; predominantly limestone	7	120
	Clay, silty, olive-gray; soft, calcareous	10	130
	Sand, medium to very coarse, gravelly; subangular to subrounded, predominantly quartz	28	158
	Sand, fine to coarse; predominantly quartz	57	215
	Sand, fine to coarse; abundant fine gravel, predominantly quartz	12	227
Graneros Shale:			
	Clay, silty, light-olive-gray to olive-black; soft, organic material 250-260 feet, non-calcareous	51	278
Granite:			
	Decomposed granite; clay, sandy, gray with green and red splotches; soft, non-calcareous	66	344
	Clay, green; soft, non-calcareous	119	463
	Granite, green; hard	1	464

139-49-23bbb
Test hole 2173

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, silty, yellowish-gray; soft, calcareous	13	14
	Clay, silty, olive-gray; plastic, calcareous	64	78
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; few boulders, calcareous	30	108
	Sand, fine to medium, clayey, olive-gray	18	126
	Boulder, granite	1	127
	Clay, silty, sandy, olive-gray; scattered gravel, calcareous	33	160
	Clay, sandy, light-olive-gray; numerous pebbles and cobbles, calcareous	119	279
	Clay, silty, olive-black; plastic, occasional sand lenses, thinly laminated, calcareous	10	289
	Clay, sandy, olive-gray; numerous lenses of fine to coarse gravel, calcareous	118	407
	Sand, fine to coarse, gravelly, subangular to subrounded; predominantly limestone	18	425
Granite:			
	Decomposed granite; clay, greenish-gray; soft, contains fragments of partially decomposed granite, non-calcareous	14	439
	Granite, green, hard	1	440

139-49-24aaa
Oak Manor Test 1
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, yellow	15	16
	Clay, blue, soft, plastic	76	92
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue; hard	15	107
	Clay, sandy, blue; soft	12	119
	Clay, sandy, blue; hard	9	128
	Sand, dirty, white	3	131
	Clay, sandy, gray; hard, numerous boulders	18	149
	Clay, blue; hard	35	184
	Clay, sandy, blue	9	193
Graneros (?) Shale:			
	Clay, black; lenses of lignite	8	201
	Clay, multicolored; hard	22	223
	Clay, hard; sandstone lenses	16	239
Granite:			
	Decomposed granite; clay, white, green, and blue	59	298

139-49-25aaa
Test hole 2175

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, silty, yellowish-brown; plastic, calcareous	18	21
	Clay, olive-gray; plastic, calcareous	65	84
	Sand, fine to coarse, gravelly; predominantly quartz	16	100
	Sand, coarse, gravelly; predominantly quartz	3	103
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, dark-olive-gray; occasional lenses of fine to medium gravel, calcareous	73	176
Graneros Shale:			
	Shale, silty, sandy, dark-olive-gray; plastic, non-calcareous	26	202
	Clay, silty, dark-olive-black; plastic, laminated with very fine white sand, occasional wood and lignite fragments, non-calcareous	73	275
Granite:			
	Decomposed granite; clay, gray to green; plastic, occasional orange splotches, slightly calcareous	50	325
	Clay, green; plastic, numerous fine to medium quartz grains 441-518, slightly calcareous	193	518
	Granite, white and pink, hard	.5	518.5

139-49-28bab
Test hole 2176

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Clay, silty, sandy, yellowish-brown; plastic, calcareous	12	12
	Clay, olive-gray; plastic, calcareous	6	18
	Sand, very fine to medium, gray; angular to subrounded, numerous gastropod and pelecypod shells, wood and lignite fragments, predominantly quartz	22	40
	Clay, silty, olive-gray; plastic, calcareous	33	73
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray, calcareous	21	94
	Sand, fine to coarse; angular to subrounded, scattered gravel, predominantly quartz	14	108
	Clay, silty, sandy, gravelly, olive-gray; calcareous	7	115
	Clay, silty, sandy, olive-gray; calcareous	11	126

139-49-28bab--Continued
Test hole 2176

Geologic source	Material	Thickness (feet)	Depth (feet)
Older till and associated glacioaqueous deposits (?):			
	Clay, silty, sandy, brownish-gray; plastic, calcareous	42	168
	Clay, sandy, olive-gray; plastic, numerous lignite fragments, calcareous	136	304
Granite:			
	Decomposed granite; clay, silty, greenish-gray to white	4	308
	Granite, white, black, and pink chips; hard	1	309

139-50-6bbb2
Mapleton municipal well
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, brown	20	22
	Clay, blue	21	43
Till and associated glacioaqueous deposits:			
	Clay, blue	31	74
	Sand, coarse	5	79
	Clay, blue	71	150
	Sand, fine	15	165
	Clay, sandy	42	207

139-50-12bbc
Test hole 2178

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, silty, yellowish-brown; plastic, calcareous	16	19
	Clay, silty, olive-gray; plastic, calcareous	40	59
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; calcareous	76	135
	Sand, fine to coarse; angular to subangular, predominantly quartz	5	140
	Clay, silty, sandy, gravelly, olive-gray; calcareous	47	187
	Clay, silty, olive-gray; calcareous	2	189
	Sand, very fine to medium, subrounded to well rounded; scattered fine gravel, predominantly quartz	7	196
	Clay, silty, sandy, gravelly; olive-gray, calcareous	9	205
	Sand, fine to coarse, gravelly; subrounded to well rounded, predominantly limestone	16	221
	Clay, silty, sandy; olive-gray, calcareous	51	272
Granite:			
	Granite, green, hard	8	280

139-50-23aaa
Test hole 3103

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Silt, clayey, grayish-orange; cohesive, scattered fine sand, occasional laminae, calcareous	18	18
	Silt, clayey, olive-gray; cohesive, calcareous	35	53
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	75	128
	Silt, clayey, sandy; olive-gray; soft, cohesive, calcareous	5	133

139-50-23aaa--Continued
Test hole 3103

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:(Cont.)			
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite and wood fragments, highly calcareous---	12	145
	Sand, very fine to coarse, gravelly; angular to rounded, predominantly quartz-------------------	9	154
	Clay, silty, sandy, olive-gray; scattered gravel, few lignite fragments, highly calcareous--------	15	169
	Sand, very fine to very coarse, gravelly; angular to rounded, predominantly quartz----------------	18	187
	Silt, brownish-black to light-olive-gray; soft, laminated, scattered sand grains and lignite fragments, gastroped shells at 205 feet, highly calcareous---	27	214
Graneros Shale:			
	Clay, silty, greenish-gray with brownish-black splotches, some lignite and organic material, hard, slightly calcareous-----------------------	5	219

139-50-23ddd
U. S. Bureau of Reclamation
Test hole

Lake Agassiz deposits:			
	Topsoil--	2	2
	Clay, silty, tan; plastic--------------------------	18	20
	Sand, silty, fine; well sorted---------------------	15	35
	Silt, sandy, tan-----------------------------------	4	39
	Sand, silty, fine, tan-----------------------------	13	52
	Sand, clayey, fine, tan----------------------------	8	60
	Sand, silty, fine, gray; well sorted---------------	5	65
Till and associated glacioaqueous deposits:			
	Clay, gravelly, gray; compact ---------------------	50	115
	Sand---	14	129
	Clay, gravelly, gray; compact----------------------	98	227
	Sand, gravelly, coarse-----------------------------	4	231
	Clay, gravelly, gray; compact----------------------	24	255

139-50-24ccd
U. S. Bureau of Reclamation
Test hole

Lake Agassiz deposits:			
	Topsoil, black-------------------------------------	2	2
	Clay, gray; plastic--------------------------------	65	67
Till and associated glacioaqueous deposits:			
	Clay, gravelly, gray; compact----------------------	15	82
	Sand, silty, very fine, gray-----------------------	18	110
	Sand, fine, gray; well sorted----------------------	2	112
	Clay, silty, gray; firm, laminated-----------------	51	163
	Clay, gravelly, gray-------------------------------	119	282

139-50-24cdd3
U. S. Bureau of Reclamation
Test hole

Lake Agassiz deposits:			
	Topsoil, black-------------------------------------	2	2
	Clay, silty, gray; plastic-------------------------	60	62
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, gray-----------------	18	80
	Silt, clayey, sandy, gray; laminated---------------	5	85
	Sand, very fine, light-gray; loose, clay lense 97-100 feet---------------------------------------	20	105

139-50-24cdd3--Continued
U. S. Bureau of Reclamation
Test hole 3-B

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits: (cont.)			
	Sand, fine, light-gray; loose	5	110
	Sand, fine to medium, light-gray; loose, scattered silt lenses and gravel	15	125
	Sand, medium to coarse, light-gray; loose	10	135
	Sand, coarse, light-gray; loose scattered fine gravel	19	154
	Sand, clayey, gray	1	155
	Sand, coarse, gray; loose	2	157
	Sand, clayey, fine, gray	1	158
	Silt, clayey, sandy, gray	3	161
	Sand, medium, gray	3	164
	Silt, sandy, clayey, gray	1	165
	Sand, coarse, gray; scattered gravel	9	174
	Sand, silty, coarse	1	175
	Sand, gravelly, medium	14	189
	Sand, silty, fine, gray	12	201
	Sand, gravelly	7	208
	Sand, silty, fine to medium	2	210
	Sand, gravelly, fine to medium	10	220

139-50-28aaa
Test hole 3135

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, silty, yellowish-brown; soft, laminated, calcareous	6	7
	Clay, yellowish-brown; soft, calcareous	13	20
	Clay, olive-gray; soft, few lignite fragments, calcareous	6	26
	Boulder, granite	1	27
	Clay, olive-gray; soft, few lignite fragments	23	50
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly; olive-gray; hard to moderately soft, scattered lignite fragments, highly calcareous	39	89
	Sand, coarse, gravelly; angular to rounded, predominantly shale and limestone	10	99
	Clay, sandy, olive-gray; hard, highly calcareous	25	124
	Sand, medium to coarse, angular to rounded; predominantly quartz	12	136
	Clay, sandy, dark-greenish-gray; hard, scattered fine white sand, few laminae, very small lignite particles, highly calcareous	10	146
	Sand, medium to very coarse; angular to rounded, predominantly quartz	16	162
	Clay, sandy, dark-greenish-gray; hard, scattered fine white sand, few laminae, very small lignite fragments, highly calcareous	5	167
	Sand, medium to very coarse; angular to rounded, predominantly quartz	7	174
	Clay, sandy, dark-greenish-gray; hard, scattered fine white sand, few laminae, very small lignite particles, highly calcareous	10	184
	Sand, medium to very coarse; angular to rounded, predominantly quartz	2	186
Graneros Shale:			
	Shale, olive-gray; hard, numerous pockets of fine white sand, highly calcareous	8	194
	Shale, olive-black; hard, laminated with fine white sand, scattered lignite fragments and pyrite crystals, non-calcareous	33	227

139-50-32ccc
Test hole 3116

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil and fill	6	6
	Clay, silty, yellowish-brown; scattered sand and gypsum crystals, highly calcareous	16	22
	Clay, silty, olive-gray; calcareous	34	56
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	26	82

139-50-35ddd
Test hole 3107

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	1	1
	Clay, silty, grayish-orange; calcareous	12	13
	Clay, silty, olive-gray; calcareous	11	24
	Clay, silty, yellowish-brown; calcareous	4	28
	Clay, silty, olive-gray; calcareous	24	52
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; soft, scattered lignite fragments, highly calcareous	14	66
	Boulder, limestone	3	69
	Clay, silty, sandy, gravelly, gray; hard, scattered lignite fragments, highly calcareous	25	94
	Sand, coarse to very coarse, gravelly; angular to rounded, predominantly shale and limestone--wood fragments 95-102 feet	10	104
	Clay, sandy, silty, gravelly, olive-gray; highly calcareous	51	155
	Clay, silty, sandy, gravelly, light-olive-gray to dark-greenish-gray; highly calcareous	20	175
	No record	42	222
Graneros Shale:			
	Silt, clayey, variegated, light-brownish-gray, olive-gray and black; cohesive, abundant lignitic and organic material, noncalcareous	53	275
	Sand, very fine to granules, angular	5	280
	Silt, clayey, variegated light-brownish-gray, olive-gray, and black; noncalcareous	20	300
Granite:			
	Decomposed granite; clay, silty, greenish-gray; noncalcareous	20	320

139-51-14bbb1
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil; black	2	2
	Clay, brown	10	12
	Clay; blue	34	46
Till and associated glacioaqueous deposits:			
	Clay, sandy; brown	6	52
	Sand	2.5	54.5
	Clay, sandy, hard; brown	6.5	61
	Clay, sandy, hard; blue	15	76
	Clay, sandy, soft; blue	5	81
	Clay, sandy, hard; blue	24	105
	Clay, sandy, with boulders	26	131
	Sand; gray	15	146
	Clay, sandy, soft; blue	10	156
	Clay, sandy, hard; blue	9	165
	Sand; blue	19	184

139-51-19ccd2
Test hole 3118

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	1	1
	Silt, yellowish-brown; cohesive, laminated, calcareous	8	9
	Sand, very fine to coarse; subrounded, predominantly shale and limestone	22	31
	Silt, clayey, olive-gray; cohesive, calcareous	25	56
Till and associated glacioaqueous deposits:			
	Clay, olive-gray; scattered sand and gravel, highly calcareous	16	72
	Silt, clayey, olive-gray; soft to hard	5	77
	Gravel, coarse, sandy; subrounded to well rounded, predominantly limestone	2	79
	Clay, gravelly, silty, olive-gray; scattered lignite fragments, calcareous	18	97
	Clay, sandy, gravelly, silty, olive-gray; hard, scattered lignite fragments, highly calcareous	99	196
	Sand, gravelly, very fine to coarse; angular to rounded, scattered lignite fragments--clay lenses 202-209 feet	23	219
	Clay, sandy, gravelly, olive-gray; highly calcareous	19	238
	Silt, clayey, olive-gray; cohesive, laminated, scattered fine sand, highly calcareous	46	284
	Clay, gravelly, sandy, olive-gray; hard, lenses of silt, highly calcareous	34	318

139-51-19ccd2--Continued
Test hole 3118

Geologic source	Material	Thickness (feet)	Depth (feet)
Graneros Shale:			
	Silt, clayey, sandy, olive-gray to black; soft, cohesive, scattered lignite fragments and organic material, calcareous	14	332
	Sand, very fine to very coarse, angular to well rounded; scattered lignite fragments, predominantly quartz	18	350
	Silt, clayey, sandy, olive-gray; scattered lignite fragments, gravel lenses, noncalcareous	13	363
	Sand, fine to medium; angular to rounded, predominantly quartz	13	376
	Silt, clayey, sandy, olive-gray; scattered lignite fragments, noncalcareous	14	390
	Boulder	1	391
Dakota (?) Sandstone:			
	Silt, clayey, light-bluish-gray; cohesive, scattered sand grains and lignite fragments, sand lenses, noncalcareous	48	439
Granite:			
	Decomposed granite; clay, silty, light-brown, cohesive, noncalcareous	7	446
	Clay, greenish-gray; abundant angular sand grains, noncalcareous	16	462
	Granite, white to green; hard	1	463

139-51-21ccc
Test hole 3117

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	1	1
	Clay, silty, yellowish-brown; highly calcareous	5	6
	Clay, silty, yellowish-brown; calcareous	21	27
	Clay, olive-gray; calcareous	19	46
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	10	56
	Clay, silty, gravelly, sandy, olive-gray; scattered lignite fragments and boulders, sand lenses 82-87 feet, highly calcareous	63	119
	Silt, clayey, olive-gray; cohesive, highly calcareous	6	125
	Gravel, fine to medium; subangular to well rounded, predominantly limestone	7	132
	Silt, clayey, sandy, greenish-gray; cohesive, abundant shale particles, calcareous	20	152

139-51-26aaa
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil; black	1	1
	Clay; blue	2	3
	Clay; yellow	21	24
	Clay; blue	24	48
Till and associated glacioaqueous deposits:			
	Clay, sandy; blue	13	61
	Clay with gravel lenses; blue	11	72
	Clay, sandy, hard; blue	32	104
	Clay with gravel lenses; blue	10	114
	Sand, gravelly	13	127
	Clay, hard; blue	3	130
	Sand; gray	2	132
	Clay, hard; blue	15	147
	Sand, gray	13	160

139-51-32cab3
Great Northern Railroad

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	4	4
	Clay, yellow	14	18
	Clay, blue	36	54
	Gravel	6	60

139-52-27aaa
Test hole 3119

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	1	1
	Clay, silty, yellowish-brown; calcareous	30	31
	Clay, silty, olive-gray; calcareous	14	45
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	16	61
	Gravel, fine to coarse, sandy; subangular to rounded, predominantly limestone	1	62
	Clay, silty, sandy, gravelly, olive-gray; abundant limestone fragments, highly calcareous	10	72
	Gravel, medium, sandy; subangular to rounded, predominantly limestone and shale -- lenses of olive-gray, lignitic silt	9	81
	Clay, sandy, silty, olive-gray; scattered gravel, highly calcareous	102	183
	Sand, fine to very coarse; subrounded to well rounded, scattered lignite fragments, predominantly shale	5	188
	Clay, sandy, silty, gravelly, olive-gray; firm, scattered lignite fragments, highly calcareous	34	222
Graneros Shale:			
	Silt, clayey, sandy, light-olive-gray, to olive-black; cohesive, laminated with fine white sand, non-calcareous	51	273
	Sand, fine to coarse, clayey, silty; angular to rounded, predominantly quartz	11	284
	Silt, clayey, olive-gray; firm, cohesive, laminated, non-calcareous	7	291
Dakota Sandstone:			
	Silt, clayey, brownish-black to olive-gray; scattered lignite and wood fragments, non-calcareous	76	367
	Sand, very fine to coarse, silty; subangular to rounded, scattered lignite fragments, predominantly quartz and shale	11	378
	Sand, very fine to very coarse; predominantly coarse, angular quartz	13	391
	Clay, silty, various shades of gray; scattered lignitic and organic material, non-calcareous	15	406
	Boulder, sandstone, coarse, angular quartz grains; cementing material, calcareous	2	408
	Clay, sandy, light-bluish-gray; non-calcareous	27	435
	Clay, sandy, light-bluish-gray to brownish-gray, scattered lignite fragments	7	442
	Sand, coarse, mostly angular; predominantly quartz	7	449
Granite (?):			
	Decomposed granite; clay, sandy, white; non-calcareous, scattered fine quartz	18	467
	Sand		

139-54-11ddd
Test hole 3151

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, silty, sandy, gravelly, yellowish-orange; calcareous	18	19
	Clay, silty, sandy, gravelly, olive-gray; calcareous	43	62
	Silt, clayey with very fine sand, olive-gray; few laminae, scattered lignite particles, calcareous	59	121

139-54-11ddd--Continued
Test hole 3151

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits: (cont.)			
	Clay, silty, sandy, gravelly, olive-gray; firm, highly calcareous	41	162
	Gravel, fine to medium, sandy; predominantly limestone	6	168
	Clay, silty, sandy, gravelly, olive-gray; firm, scattered lignite fragments, highly calcareous	41	209
	Sand, very fine to coarse; angular to rounded, predominantly shale and limestone--silt lenses 218-235 feet	44	253
	Clay, gravelly, silty, sandy, olive-gray	19	272
	Clay, silty, sandy, gravelly, olive-gray	150	422
	Clay, sandy, silty, gravelly, olive-gray; highly calcareous	25	447
Graneros(?) Shale:			
	Silt, clayey, olive-gray to black; cohesive, highly calcareous	20	467

139-54-18aaa
Test hole 3150

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	3	3
	Clay, silty, sandy, gravelly, yellowish-brown; calcareous	17	20
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	7	27
	Clay, silty, sandy, olive-gray; scattered lignite fragments, highly calcareous	63	90
	Clay, silty and silt, clayey, gray; silt laminated	39	129
	Clay, sandy, silty, gravelly, olive-gray; scattered lignite fragments, highly calcareous	44	173
	Shale boulder, greenish-gray; non-calcareous--shale fragments mixed with sand and gravel	4	177
	Silt, sandy, olive-gray; cohesive, scattered lignite fragments, calcareous	5	182
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, calcareous--gravel lenses 197-203	65	247
	Clay, silty, sandy, gravelly, olive-gray; firm, scattered lignite fragments, calcareous--numerous boulders 270-302 feet	55	302
	Gravel, fine; few shell fragments, predominantly shale and limestone	10	312
	Clay, silty, sandy, gravelly, olive-gray; hard, scattered lignite fragments, highly calcareous	4	316
Greenhorn Formation:			
	Shale, silty, olive-black; hard, white specks, abundant shell fragments, highly calcareous	16	332

139-55-16ddd
Test hole 3149

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil	1	1
	Gravel, sandy, fine to medium, brown; predominantly limestone and shale	9	10
	Clay, silty, sandy, gravelly, yellowish-brown, calcareous	1	11
	Clay, silty, sandy, gravelly, greenish-gray; few lignite fragments, calcareous	10	21
	Clay, silty, greenish-gray; scattered sand and gravel, few lignite fragments, calcareous	22	43
	Clay, sandy, olive-brown; scattered gravel, slightly calcareous	6	49
	Clay, silty, sandy, gravelly, greenish-gray; scattered lignite fragments, calcareous--numerous boulders 62-69 feet	20	69

140-48-19ddd1
Test hole 3094

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	1	1
	Clay, silty, yellowish-brown; laminated, highly calcareous	18	19
	Silt, clayey, fine sand, dark-gray; scattered organic material, calcareous	9	28
	Clay, silty, greenish-gray; plastic, calcareous	69	97
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, greenish-gray; calcareous	9	106
	Gravel, medium, sandy; scattered shell fragments, predominantly shale and limestone	8	114
	Clay, silty, sandy, gravelly, greenish-gray; calcareous	8	122
	Clay, silty, sandy, gravelly, olive-gray; numerous small boulders	12	134
Granite (?):			
	Granite, blue-green; hard	1	135

140-48-19ddd2
Test hole 3094-A

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	1	1
	Clay, silty, sandy, yellowish-brown; laminated, highly calcareous	18	19
	Silt, clayey, fine sand, dark-gray; scattered organic material, laminated, calcareous	11	30
	Clay, silty, olive-gray; plastic, calcareous	74	104
Till and associated glacioaqueous deposits:			
	Clay, gravelly, sandy, silty, olive-gray; highly calcareous	1	105
	Gravel, fine to coarse; predominantly shale and limestone	5	110
	Clay, silty, sandy, gravelly, olive-black; abundant shale pebbles, calcareous	8	118
	Clay, silty, olive-gray; scattered sand and gravel, highly calcareous	4	132
Granite (?):			
	Granite, blue-green; hard		132

140-48-29cdb
Test hole 2165

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, silty, yellowish-brown; plastic, highly calcareous	13	16
	Clay, silty, olive-gray; plastic, scattered sand, highly calcareous	78	94
	Sand, very fine to coarse, silty, gravelly, well rounded to angular; predominantly limestone	5	99
Till and associated glacioaqueous deposits:			
	Clay, sandy, silty, dark-greenish gray; scattered gravel, highly calcareous	14	113
	Sand, very fine to coarse, angular to well rounded, gray; predominantly quartz and shale	9	122
	Clay, silty, sandy, dark-greenish gray; scattered gravel and lignite fragments	4	126
	Clay, silty, sandy, gravelly, dark-greenish-gray; highly calcareous	10	136

140-48-29cdb--Continued
Test hole 2165

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits: (cont.)			
	Clay, gravelly, sandy, olive-gray; highly calcareous	19	155
	Sand, coarse, subangular to well rounded, gravelly, clayey, greenish-gray; predominantly shale and limestone	4	159
	Clay, sandy, silty, dark-greenish-gray; scattered gravel, highly calcareous	47	206
	Clay, silty, olive-gray to dark-greenish-gray; scattered sand and limestone pebbles, highly calcareous	114	320
Older till and associated glacioaqueous deposits: (?)			
	Clay, sandy, silty, gravelly, olive-gray to brownish-gray; highly calcareous	40	360
	Sand, very fine to very coarse, gravelly, clayey; angular to subrounded, predominantly quartz	28	388.5

140-49-14dcd
Test hole 3093

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Silt, clayey, yellowish-brown; laminated, calcareous	13	13
	Clay, silty, olive-gray; laminated, calcareous	77	90
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, calcareous	20	110
	Clay, silty, sandy, light-olive-gray; scattered gravel, highly calcareous--limestone boulders 131-145 feet	32	142
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	44	186
Older till and associated glacioaqueous deposits: (?)			
	Clay, silty, sandy, gravelly, pale-brown; highly calcareous	31	217
	Gravel, fine, sandy; predominantly granitic derivatives and limestone	5	222
	Clay, silty, sandy, gravelly, pale-brown; sand and gravel constituents, highly weathered	9	231
	Sand, very fine to coarse, gravelly; angular to subrounded, predominantly quartz	26	257
Granite:			
	Decomposed granite; clay, blue-green; soft to hard, calcareous	16	275

140-49-18bbb
Test hole 3095

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	4	4
	Silt, clayey, yellowish-brown; laminated, highly calcareous	13	17
	Clay, silty, olive-gray; plastic, calcareous	52	69
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; abundant shale pebbles, highly calcareous	11	80
	Granite boulder	1	81
	Clay, silty, sandy, greenish-gray; scattered gravel and lignite fragments, abundant wood fragments, few shell fragments, highly calcareous	138	219
	Clay, silty, greenish-gray; laminated, calcareous	7	226
	Clay, silty, greenish-gray; abundant sand and gravel, numerous lignite fragments, highly calcareous	52	278
Granite:			
	Decomposed granite, blue-green to pale-green, hard	12	290

140-49-19ddd
Test hole 3091

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Silt, clayey, sandy, light-olive-gray; highly calcareous	2	5
	Silt, sandy, grayish-orange; laminated, highly calcareous	13	18
	Clay, silty, olive-gray; plastic, calcareous	54	72
	Gravel, sandy, angular to subrounded; predominantly limestone and shale	3	75
Till and associated glacioaqueous deposits:			
	Clay, gravelly, olive-gray; scattered lignite fragments, highly calcareous	10	85
	Gravel, fine to medium, sandy, angular to rounded; predominantly limestone	17	102
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	12	114
	Gravel, fine to medium, sandy, angular to well rounded; predominantly quartz and limestone	16	130
	Sand, very fine to very coarse, angular to well rounded; predominantly quartz, gravel and boulders 150-185 feet	48	178
Granite:			
	Decomposed granite; clay, pale-green to pale-blue; soft, calcareous	47	225
	Granite, grayish-blue-green; hard	5	230

140-49-21aaa
Test hole 3092

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, sandy, olive-gray; organic material, calcareous	3	5
	Clay, silty, sandy, light-olive-gray; organic material, calcareous	3	8
	Silt, pale-yellowish-brown; some very fine sand laminations	7	15
	Silt, olive-gray; some very fine sand laminations	5	20
	Clay, silty, olive-gray; plastic, calcareous	62	82
Till and associated glacioaqueous deposits:			
	Clay, sandy, silty, olive-gray; firm, scattered gravel and lignite fragments, highly calcareous	16	98
	Gravel, fine, sandy, angular to rounded; scattered lignite fragments, predominantly limestone	6	104
	Clay, gravelly, sandy, olive-gray; numerous boulders	11	115
	Sand, coarse, gravelly, angular to rounded, predominantly limestone	4	119
	Clay, sandy	7	126
	Gravel, fine to medium, sandy, angular to well rounded; predominantly granite and limestone	10	136
	Clay, silty, sandy; light-olive-gray; scattered gravel and few boulders	5	141
	Gravel, medium, boulders; predominantly granite and limestone	12	153
	Clay--no record	11	164
	Boulder	1	165

140-49-26ddd
Test hole 2164

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, silty, light-olive-gray; plastic, highly calcareous	3	6
	Clay, silty, light-olive-gray; plastic, highly calcareous	25	31
	Clay, silty, olive-gray; plastic, calcareous	53	84
	Clay, silty, olive-gray; plastic, scattered sand grains and pebbles, calcareous	8	92
	Sand, very fine to very coarse, gravelly, angular to well rounded	4	96
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; calcareous	9	105
	Clay, silty, sandy, olive-gray; calcareous	10	115
	Clay, silty, sandy, gravelly, olive-gray; calcareous	11	126
	Gravel, fine, sandy, clayey, gray; angular to well rounded, predominantly granite and limestone fragments	26	152
	Clay, gravelly, sandy, olive-gray; highly calcareous	21	173
	Clay, sandy, gravelly, olive-gray; highly calcareous	16	189
	Clay, sandy, olive-gray; scattered gravel, highly calcareous	5	194
	Clay, gravelly, olive-gray; scattered sand, highly calcareous	5	199
	Clay, sandy, gravelly, olive-gray; highly calcareous	26	225
Granite:			
	Granite, greenish-black; hard	1	226

140-49-28ddd
Test hole 2161

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, olive-gray to yellowish-brown; plastic, calcareous	7	10
	Clay, silty, greenish-gray; plastic, laminated, few scattered pebbles, trace of organic material, calcareous	5	15
	Clay, silty, greenish-gray; plastic, slightly calcareous	6	21
	Clay, silty, dark-olive gray; plastic, calcareous--scattered sand 52-63 feet and 73-84 feet	63	84
Till and associated glacioaqueous deposits:			
	Clay, sandy, dark-olive-gray; plastic, scattered pebbles, calcareous	15	99
	Sand, fine to coarse, gravelly, clayey; loose to cohesive	11	110
	Sand, fine to coarse, subangular to well rounded, predominantly quartz	11	121
	Sand, fine to coarse, gravelly; subangular to well rounded; predominantly quartz	21	142
	Sand, coarse, gravelly; angular to well rounded, predominantly quartz	5	147
	Sand, fine to coarse, gravelly; subangular to well rounded, predominantly quartz	20	167
	Boulder	1	168
Granite:			
	Decomposed granite; clay, sandy, gravelly, white to red; non-calcareous	21	189

140-49-29ddd
Test hole 2160

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	4	4
	Clay, pale-brown; plastic, slightly calcareous	7	11
	Clay, dark-olive-gray; plastic, few pebbles, calcareous	6	17
	Clay, dark-olive-gray; plastic, calcareous	18	35
	Clay, silty, dark-olive-gray; plastic, calcareous	4	39
	Clay, dark-olive-gray; plastic, few pebbles 53-70 feet, calcareous	33	72
Till and associated glacioaqueous deposits:			
	Clay, sandy, gravelly, dark-olive-gray; calcareous	19	91
	Sand, fine to coarse, gravelly, slightly clayey; subangular to well rounded, predominantly quartz	24	115
	Sand, fine to coarse and gravel; subangular to well rounded, predominantly quartz	10	125
	Sand, fine to coarse and fine gravel; subangular to well rounded, predominantly quartz	32	157
	Gravel, sandy, subangular to well rounded; predominantly shale and limestone	5	162
	Sand, coarse, gravelly, angular to well rounded; predominantly quartz	6	168
	Clay, silty, sandy, gravelly, olive-gray; plastic, few wood fragments, calcareous	6	174
Older till and associated glacioaqueous deposits: (?)			
	Clay, silty, sandy, reddish-brown to blue-green; scattered fine gravel, slightly calcareous	4	178
	Clay, sandy, gravelly, dark-olive-gray; calcareous	11	189
Granite:			
	Decomposed granite; clay, greenish-gray to black; numerous angular to rounded quartz grains, calcareous to non-calcareous	23	212

140-49-31bab
Test hole 2167

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	2	2
	Clay, silty, light-olive-gray; plastic, scattered sand grains, highly calcareous	6	8
	Clay, silty, yellowish-brown; plastic, highly calcareous	13	21
	Clay, dark-greenish-gray; plastic, scattered silt and sand, highly calcareous	47	68
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, dark-greenish-gray; scattered fine gravel, highly calcareous	12	80
	Clay, sandy, gravelly, dark-greenish-gray, highly calcareous	4	84
	Clay, silty, dark-greenish-gray to olive-black; plastic, scattered fine sand and some organic material, highly calcareous	37	121
	Clay, sandy, silty, dark-greenish-gray; scattered fine gravel, highly calcareous	15	136
	Clay, sandy, silty, gravelly, dark-greenish-gray; highly calcareous--numerous boulders 157-168 feet	32	168
	No record	73	241
	Gravel, fine; sand, coarse; angular to well rounded; predominantly quartz and limestone	9	250
Granite:			
	Granite, multicolored	.5	250.5

140-49-31cdc
Test hole 2168

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	4	4
	Clay, light-olive-brown; plastic, scattered organic material, calcareous	12	16
	Clay, silty, olive-gray; plastic, calcareous	42	58
Till and associated glacioaqueous deposits:			
	Clay, sandy, gravelly, olive-gray; highly calcareous	21	79
	Sand, fine to coarse, subrounded to well rounded; predominantly quartz and limestone	15	94
	Clay, silty, olive-gray with yellowish-brown streaks; plastic, highly calcareous	2	96
	Sand, fine to coarse, subrounded to well rounded, predominantly quartz and limestone	6	102
	Clay, silty, olive-gray; plastic, highly calcareous	4	106
	Sand, fine to coarse, subrounded to well rounded, predominantly quartz and limestone	9	115
	Sand, fine to coarse, gravelly, well rounded; predominantly quartz	11	126
	Sand, fine to coarse, well rounded; scattered lignite fragments, predominantly quartz	68	194
	Sand, fine to medium, gravelly, subangular to well rounded, predominantly quartz	11	205
Granite:			
	Decomposed granite; chert (?), yellowish-gray; hard; vitreous	10	215
	Clay, moderate-reddish-brown; plastic, non-calcareous	6	221
	Clay, light-bluish-gray; plastic, scattered sand grains, non-calcareous	19.5	241.5

140-49-32bbb
Test hole 2166

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	3	3
	Clay, silty, light-olive-gray; plastic, highly calcareous	8	11
	Clay, silty, moderate-yellowish-brown; plastic, highly calcareous	5	16
	Clay, silty, moderate-yellowish-brown; plastic, non-calcareous	6	22
	Clay, silty, dark-greenish-gray; plastic, highly calcareous	45	67
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, dark-greenish-gray; highly calcareous	6	73
	Clay, silty, sandy, dark-greenish-gray; plastic, scattered pebbles, highly calcareous	4	77
	Gravel, fine, sandy, angular to well rounded; predominantly limestone and sandstone	4	81
	Clay, silty, sandy, gravelly, dark-greenish-gray; scattered shale pebbles, highly calcareous	24	105
	Clay, silty, sandy, dark-greenish-gray; scattered coarse gravel, highly calcareous	33	138
	Gravel, fine to coarse, sandy, clayey	9	147
	Clay, silty, sandy, dark-greenish-gray; scattered coarse gravel, highly calcareous	21	168
	Clay, silty, dark-greenish-gray; scattered sand and gravel, highly calcareous	6	174
	Sand, fine to coarse, gravelly; angular to well rounded, scattered lignite fragments	15	189
	Gravel, fine to coarse, sandy, angular to well rounded	10	199

140-49-32bbb--Continued
Test hole 2166

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits: (cont.)			
	Sand, fine to coarse, gravelly, angular to well rounded; few clay lenses, predominantly quartz--	21	220
	Gravel, fine, sandy, angular to well rounded; few clay lenses--------------------------------------	8	228
Granite:			
	Decomposed granite; clay, grayish-blue-green; plastic--	9	237

140-49-35bbb
Test hole 2162

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black-------------------------------------	1	1
	Clay, silty, grayish-brown; plastic, calcareous----	4	5
	Clay, silty, yellowish-brown; plastic, calcareous--	10	15
	Clay, silty, dark-olive-gray; plastic, calcareous--	6	21
	Sand, very fine to medium, olive-gray; subangular to well rounded, predominantly quartz-----------	5	26
	Clay, silty, olive-gray; plastic, calcareous-------	4	30
	Clay, silty, olive-gray; plastic, scattered sand and gravel, calcareous--------------------------	60	90
	Sand, gravelly, clayey, angular to well rounded; cohesive, predominantly limestone and shale-----	8	98
Till and associated glacioaqueous deposits:			
	Clay, sandy, olive-gray; scattered gravel, calcareous---	10	108
	Sand, gravelly, clayey; angular to well rounded, loose to cohesive------------------------------	55	163
	Boulder, granite-----------------------------------	1	164
	Gravel, sandy, angular to well rounded; predominantly limestone------------------------------	3	167
	Gravel, fine to coarse, sandy, clayey, angular to well rounded; abundant cobbles and small boulders	17	184
Granite:			
	Granite, hard--------------------------------------	3.5	187.5

140-49-36aaa
Test hole 2163

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black-------------------------------------	2	2
	Clay, silty, moderate-olive-brown; plastic, calcareous---	14	16
	Clay, silty, light-olive-gray; plastic, calcareous-	15	31
	Clay, dark-olive-gray; plastic, calcareous---------	67	98
Till and associated glacioaqueous deposits:			
	Sand, gravelly, clayey, well rounded; predominantly quartz--	7	105
	Clay, sandy, light-olive-gray; scattered gravel, calcareous-------------------------------------	15	120
	Sand, fine to coarse, gravelly, well rounded; predominantly quartz-------------------------------	6	126
	Clay, sandy, gravelly, olive-gray; scattered lignite fragments, calcareous----------------------	31	157
	Sand, fine to medium, gravelly, well rounded; predominantly quartz-------------------------------	21	178
	Sand, fine to coarse, gravelly, well rounded; predominantly quartz-------------------------------	37	215
	Gravel, sandy, subrounded to angular---------------	5	220

140-49-36aaa--Continued
Test hole 2163

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits: (cont.)			
	Sand, fine to coarse, gravelly, well rounded; predominantly quartz	8	228
	Clay, silty, olive-gray; scattered sand and wood fragments, calcareous	24	252
	Clay, silty, light-olive-gray; scattered sand, calcareous	38	290
Granite:			
	Granite, reddish-brown; hard	1	291

140-50-19dad
Test hole 3133

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Silt, sandy, brownish-black, cohesive, highly calcareous	1	3
	Clay, silty, dark-yellowish-brown; scattered sand and lignite fragments, calcareous	6	9
	Silt, dark-greenish-gray; soft, cohesive, scattered lignite fragments, calcareous	6	15
	Clay, silty, dark-greenish-gray; calcareous	7	22
	Sand, silty, clayey, dark-yellowish-brown; scattered lignite fragments, predominantly quartz	14	36
	Clay, olive-gray; soft, calcareous	20	56
Till and associated glacioaqueous deposits:			
	Clay, olive-gray; hard, scattered coarse sand and lignite fragments, few boulders, highly calcareous	82	138
	Sand, gravelly, medium, angular to rounded; clay lenses, scattered wood fragments, predominantly limestone	22	160
Graneros Shale:			
	Shale, dark-greenish-gray to black; hard, scattered lignite fragments near top, numerous calcite pockets, highly calcareous to non-calcareous	37	197

140-50-34ccc2
Test hole 3134

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, pale-yellowish-brown; scattered lignite fragments, calcareous	13	14
	Clay, dark-greenish-gray; calcareous	30	44
Till and associated glacioaqueous deposits:			
	Clay, sandy, olive-gray; calcareous	34	78
	Boulder, limestone	1	79
	Clay, silty, sandy, olive-gray; calcareous	43	122
	Clay, sandy, olive-gray; calcareous	56	178
	Sand, medium to coarse, angular to well rounded; scattered lignite fragments, predominantly quartz	7	185
	Silt, sandy, olive-gray; scattered lignite fragments, calcareous	11	196
	Clay, silty, olive-gray; hard, occasional brown spots, scattered lignite fragments, highly calcareous	6	202
	Clay, dark-greenish-gray; scattered shale pebbles and lignite fragments	6	208
	Gravel, fine, angular to well rounded; scattered lignite fragments, predominantly quartz	17	225
Granite:			
	Decomposed granite; clay, greenish-gray; scattered quartz fragments, non-calcareous	17	242

140-51-33abb
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, yellow	18	20
	Clay, blue	27	47
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	55	102
	Clay, blue	8	110
	Sand, multicolored	2	112
	Clay, blue	83	195
	Clay, sandy, blue	8	203
	Sand, fine, blue	3	206
Graneros (?) Shale:			
	Shale, gray	79	285
	Shale, variegated	20	305
Granite:			
	Decomposed granite; clay, green	45	350

140-53-25ccc
Test hole 3155

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Silt, dark-yellowish-brown; cohesive, highly calcareous	10	13
Till and associated glacioaqueous deposits:			
	Clay, sandy, moderate-yellowish-brown; scattered gravel, highly calcareous	13	26
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	6	32

140-53-26cbd
Test hole 3154

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	1.5	1.5
	Clay, silty, sandy, moderate-yellowish-brown; plastic, calcareous	7.5	9
	Clay, silty, olive-gray; plastic, calcareous	5	14
Till and associated glacioaqueous deposits:			
	Clay, sandy, gravelly, olive-gray; calcareous	8	22
	Silt, clayey, olive-gray; cohesive, brown spots, calcareous	67	89
	Sand, gravelly, coarse, subrounded; predominantly shale and limestone	4	93
	Clay, sandy, olive-gray; scattered gravel and lignite fragments, highly calcareous	14	107

140-53-31aaa
Test hole 3153

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	2	2
	Clay, silty, sandy, gravelly, dark-yellowish-orange; highly calcareous	11	13
	Clay, silty, sandy, gravelly, olive-gray; calcareous	19	32

140-54-18d
Buffalo Test 7
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	2	2
	Clay, yellow	13	15
	Sand, brown	3	18
	Sand, blue	5	23
	Clay, blue	16	39
	Sand, blue; clay lenses	9	48
	Clay, blue	5	53

140-54-19cda1
Buffalo Test 9
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, yellow	18	19
	Clay, blue	12	31
	Sand, silty, fine, blue	10	41
	Clay, silty, blue; soft	44	85
	Clay, blue	37	122
	Clay, sandy, blue; soft	5	127
	Clay, sandy, blue; hard	18	145
	Clay, sandy, blue; soft	8	153
	Sand, fine, blue	8	161
	Silt, blue; soft	22	183
	Sand, fine, blue	4	187
	Clay, sandy, blue; hard, scattered boulders	22	209
	Clay, sandy, blue; hard, scattered shale fragments	13	222
	Sand, scattered shale fragments	5	227
	Clay, sandy, blue; hard	17	244
	Clay, sandy, blue; soft	9	253
	Clay, blue; soft, sand lenses	18	271
	Clay, blue; hard, scattered shale fragments	6	277
	Sand, scattered shale fragments	2	279
	Clay, blue; hard, scattered shale fragments	16	295
	Sand, clean	5	300
	Clay, sandy, blue; hard	10	310
	Boulder	1	311

140-54-19cda2
Buffalo Test 10
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, sandy, yellow	18	19
	Clay, sandy, blue	13	32
	Sand, fine, blue; clay lenses	3	35
	Sand, fine, blue	13	48
	Clay, sandy, blue	8	56

140-54-19cdb
Buffalo Test 11
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, brown	15	16
	Clay, blue	4	20
	Sand, blue	4	24
	Clay, sandy, blue	1	25
	Sand, silty, blue	4	29

140-54-19cdb--Continued
Buffalo test 11
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits: (cont.)			
	Clay, silty, blue	81	110
	Clay, silty, blue; scattered limestone pebbles	47	157
	Clay, sandy, blue; soft	25	182
	Sand, silty, blue	7	189
	Clay, sandy, blue	38	227
	Sand, blue	1	228
	Clay, sandy, blue	6	234
	Clay, blue; sand lenses	3	237
	Sand, blue	4	241
	Clay, sandy, blue	13	254

140-54-19cdd
Buffalo Village
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	2	2
	Clay, brown	12	14
	Sand, brown	3	17
	Clay, sandy, hard, blue	53	70
	Clay, blue	71	141
	Sand, blue	6	147
	Clay, sandy, soft, blue	13	160
	Clay, sandy with shale fragments, blue	9	169
	Sand, blue	5	174
	Clay, sandy, soft, blue	10	184
	Clay, sandy with boulders, blue	61	245
	Clay, sandy, hard, blue	29	274
	Sand	8	282
	Clay, sandy with boulders, blue	17	299
	Clay, sandy with sand lenses and boulders, blue	40	339
	Clay, sandy, soft, blue	50	389
	Clay, sandy with shale fragments, gray	31	420
Greenhorn Formation:			
	Shale, soft, black	104	524
	Shale, hard, black	6	530
Graneros Shale:			
	Shale, hard, with sandstone lenses, black	59	589
	Shale, hard, black	13	602
	Sand, gray	4	606
	Shale, hard, black	4	610
	Sand, gray	3	613
	Shale, sandy, hard, black	16	629
	Shale, soft, with sand lenses, black	7	636
	Shale, sandy, hard, black	3	639
	Sand, white	6	645
	Shale, soft, with sand lenses, gray	9	654
Dakota (?) Sandstone:			
	Shale, sandy, soft, black	9	663
	Shale, sandy, hard, black	3	666
	Sand, white	3	669
	Shale, sandy, hard, white and black	4	673
	Shale, sandy, soft, black	5	678
	Shale, sandy, hard, black	6	684
	Shale, with sand lenses, gray	13	697
	Shale, sandy, hard, gray and black	17	714
	Sandstone, white	45	759
	Shale, black	1	760
	Sand, white	7	767
	Shale, sandy, hard, gray	21	788
	Sandstone, white	2	790

140-54-30bbb
Buffalo test 12
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, yellow	24	25
	Clay, blue	7	32
	Clay, sandy, blue; soft	5	37
	Clay, silty, blue	93	130
	Clay, silty, blue; soft	7	137
	Clay, silty, blue	7	144
	Clay, sandy, blue	3	147
	Sand, fine, blue	7	154
	Clay, sandy, blue; soft	15	169
	Clay, sandy, blue	12	181
	Sand, fine, blue	2	183
	Clay, sandy, blue	1	184
	Sand, blue; clay lenses	5	189
	Sand, fine, blue	4	193
	Clay, sandy, blue	16	209
	Clay, blue; sand lenses	5	214
	Sand, blue	6	220
	Clay, sandy, blue	7	227
	Sand, blue; clay lenses, scattered shale fragments	42	269

140-54-30d
Buffalo test 8
(Driller's log)

Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, yellow	13	14
	Clay, blue	28	42
	Clay, blue; sand lenses	3	45
	Clay, blue	2	47

140-54-35aad
Test hole 3152

Lake Agassiz deposits:			
	Topsoil, gravelly, black	2	2
	Gravel, sandy, fine to very coarse, subrounded to rounded; predominantly shale and limestone	6	8
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, dark-yellowish-orange; calcareous	10	18
	Clay, silty, olive-gray; scattered sand and gravel, calcareous	14	32

140-55-19bac2
Tower City municipal well
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Sand and gravel, brown	22	23
	Clay, blue	7	30
	Clay, sandy, blue	2	32

140-55-22cda
Buffalo Test 3
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, yellow	1	2
	Sand	7	9
	Clay, blue	4	13
	Gravel	5	18
	Clay, blue	6	24
	Sand	3	27
	Clay, blue; lenses of gravel	6	33
	Clay, blue	14	47

140-55-22dbb
Buffalo Test 4
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, yellow	8	9
	Clay, blue	23	32

140-55-22dbc1
Buffalo Test 1
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, yellow	11	12
	Clay, blue	3	15
	Sand, black; shale fragments	1	16
	Clay, blue	37	53
	Clay, sandy, blue	18	71

140-55-22dbc2
Buffalo Test 2
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, yellow	4	5
	Sand, dirty	2	7
	Clay, blue	25	32

140-55-22dca
Test hole 3121

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Silt, clayey, sandy, dusky-yellow; cohesive, few laminae, highly calcareous	3	4
	Gravel, sandy, unsorted, subrounded to rounded; predominantly limestone and shale	6	10
	Clay, silty, olive-gray; scattered sand, calcareous	7	17

140-55-22dcd
Buffalo Test 5
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	2	2
	Clay, yellow	3	5
	Sand	2	7
	Clay, blue	25	32

140-55-25aaa
Test hole 3120

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, silty, moderate-yellowish-brown; abundant sand and gravel, scattered lignite fragments, calcareous	10	11
	Clay, silty, olive-gray; scattered sand and few lignite fragments	31	42
	Clay, silty, light-olive-gray; scattered sand and granules, calcareous	120	162
	Clay, sandy, olive-gray; scattered gravel and lignite fragments, highly calcareous	35	197
	Sand, medium, gray; predominantly quartz	32	229
	Clay, sandy, olive-gray; scattered gravel and lignite fragments, highly calcareous	73	302
	Clay, silty, sandy, gravelly, olive-gray; abundant shale pebbles, scattered lignite fragments, highly calcareous	68	370
Greenhorn Formation:			
	Shale, silty, olive-black, mottled-dark-brown and white; shell fragments	22	392

140-55-27caa
Buffalo Test 6
(Driller's log)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, yellow	2	3
	Sand, brown	6	9
	Clay, yellow	6	15
	Clay, blue	17	32

141-49-9baa1
Test hole 3096

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, silty, moderate-yellowish-brown; plastic, few laminae, highly calcareous	14	15
	Clay, silty, dark-greenish-gray; plastic, calcareous	56	71
	Boulder, granite	2	73

141-49-9baa2
Test hole 3096-A

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, silty, moderate-olive-brown; plastic, few laminae, highly calcareous	13	15
	Clay, silty, olive-gray; plastic, calcareous	57	72
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, light-olive-gray; numerous boulders, highly calcareous	20	92
	Gravel, sandy, fine to medium, subangular to rounded, predominantly limestone	15	107
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	142	249
Older till and associated glacioaqueous deposits: (?)			
	Clay, sandy, gravelly, pale-brown; highly calcareous	24	273
Granite:			
	Granite, pale-blue-green to dusky-blue-green; hard-	1	274

141-50-6ddd
Test hole 3098

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, silty, moderate-yellowish-brown; slightly calcareous	5	6
	Clay, silty, grayish-orange; plastic, calcareous	11	17
	Clay, silty, olive-gray; plastic, calcareous	47	64
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	18	82
	Silt, clayey, olive-gray; soft, scattered lignite fragments, highly calcareous	3	85
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	18	103
	Sand, very fine to coarse; silty, scattered gravel; predominantly quartz	12	115
	Sand, very fine to very coarse, subrounded to rounded; predominantly limestone	20	135
	Gravel, fine to coarse; sandy, scattered boulders	8	143
	Clay, silty, brownish-black to olive-gray	102	245
Graneros Shale:			
	Silt, clayey, brownish-black to olive-gray; soft, cohesive, laminated; scattered lignite, non-calcareous	86	331
Granite:			
	Decomposed granite; clay, light-olive-brown to pale-green; soft, non-calcareous	24	355

141-50-9aaa1
Test hole 3097

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Silt, pale-yellowish-brown; cohesive, highly calcareous	13	13
	Silt, light-olive-gray; cohesive, highly calcareous	12	25
	Silt, clayey, olive-gray; plastic, highly calcareous	20	45
	Clay, silty, olive-gray; plastic, slightly calcareous	20	65
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	14	79
	Boulder	1	80

141-50-9aaa2
Test hole 3097-A

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Silt, pale-yellowish-brown; cohesive, highly calcareous	13	13
	Silt, clayey, pale-yellowish-brown to olive-gray; cohesive, highly calcareous	12	25
	Silt, clayey, olive-gray; plastic, highly calcareous	15	40
	Clay, silty, olive-gray; plastic, scattered sand grains, highly calcareous	22	62
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; few lignite fragments, highly calcareous	23	85
	Silt, clayey, sandy, olive-gray; cohesive, scattered lignite fragments, highly calcareous	15	100
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous	17	117
	Clay, silty, sandy, olive-gray; scattered gravel, highly calcareous	30	147
	Silt, sandy, olive-gray; laminated, highly calcareous	63	210
	Clay, sandy, olive-gray; scattered gravel, highly calcareous	50	260
	Sand, fine to very coarse, gravelly, angular to well rounded; few lignite fragments, predominantly shale and limestone	52	312
Granite:			
	Decomposed granite; clay, pale-blue-green; soft	.5	312.

141-51-25ddd
Test hole 3132

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Silt, pale-yellowish-brown; cohesive, few lignite fragments, slightly calcareous	23	25
	Silt, olive-gray; cohesive, few lignite fragments, slightly calcareous	27	52
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, olive-gray; scattered gravel, highly calcareous	35	87
	Clay, silty, olive-gray; scattered sand, shell fragments, highly calcareous	29	116
Older till and associated glacioaqueous deposits: (?)			
	Silt, dusky-yellowish-brown; scattered wood and lignite fragments	17	133
	Silt, dark-greenish-gray; cohesive, laminated, highly calcareous	3	136
	Clay, sandy, dark-yellowish-brown; few lignite fragments, highly calcareous	7	143
	Silt, sandy, dark-greenish-gray; scattered lignite fragments, highly calcareous	7	150
	Silt, sandy, dark-greenish-gray; highly calcareous	10	160
	Sand, fine to medium, angular to rounded, gray; predominantly quartz	20	180
	Silt, clayey, greenish-gray; soft, cohesive, scattered fine sand and lignite fragments, highly calcareous	51	231
Graneros Shale:			
	Shale, dark-greenish-gray; hard, laminated, slightly calcareous	26	257

141-52-21cdd
Amenia test 1322-6
(N. D. State Water Comm.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, sandy, yellowish-gray	3	5
	Clay, silty, sandy, dusky-yellow to moderate-olive-brown; plastic, scattered fine gravel, calcareous	18	23
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, olive-gray; scattered fine gravel, calcareous	17	40
	Silt, clayey, olive-gray; cohesive, scattered sand and fine gravel, calcareous	23	63

141-52-23daa
Amenia test 1322-2
(N. D. State Water Comm.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, silty, sandy, yellowish-gray; soft, calcareous	2	3
	Clay, sandy, dusky-yellowish-brown; soft, calcareous	7	10
	Clay, dusky-yellow to light-olive-brown; plastic, calcareous	29	39
Till and associated glacioaqueous deposits:			
	Clay, silty, olive-gray; scattered shale pebbles; calcareous	26	65
	Clay, silty, olive-gray; soft, calcareous	5	70
	Gravel, fine to coarse; subangular to subrounded, predominantly limestone	1	71
	Clay, silty, olive-gray; soft, calcareous	2	73
	Gravel, fine to coarse; subangular to subrounded, predominantly limestone	2	75
	Clay, silty, sandy, olive-gray; soft, scattered shale pebbles, calcareous	32	107
	Clay, silty, olive-gray; soft, scattered gravel, calcareous	23	130
	Gravel, fine to coarse; subangular to subrounded, predominantly limestone and shale	3	133
	Clay, silty, sandy, olive-gray; soft, occasional boulder, calcareous	17	150
	Boulder, limestone	2	152
	Clay, silty, sandy, olive-gray; soft, scattered gravel, calcareous	58	210
	Clay, silty, olive-gray; soft, occasional boulder, calcareous	27	237
	Clay, silty, sandy, olive-gray; gravel lenses, calcareous	25	262
	Gravel, fine to coarse; clayey	8	270
	Clay, sandy, silty, gravelly, olive-gray; occasional boulder, calcareous	22	292
	Clay, sandy, light-olive-gray; soft, scattered gravel, calcareous	48	340
Graneros Shale:			
	Clay, silty, sandy, olive-gray to olive-black; soft, non-calcareous	10	350
	Silt, sandy, light-greenish-gray; soft, non-calcareous	7	357

141-52-24dcc
Amenia test 1323-3
(N. D. State Water Comm.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Silt, clayey, olive-black; loose to slightly cohesive	3	5
	Clay, silty, yellowish-gray; soft, calcareous	5	10
	Clay, yellowish-gray to dusky-yellow; soft, plastic, calcareous	10	20
	Clay, silty, dusky-yellow to greenish-gray; soft, plastic, calcareous	10	30
	Silt, clayey, olive-gray; soft, cohesive, calcareous	6	36
Till and associated glacioaqueous deposits:			
	Silt, sandy, clayey, olive-gray; soft, scattered pebbles, calcareous	44	80
	Clay, silty, sandy, olive-gray; soft, scattered pebbles, calcareous	10	90
	Sand, fine, silty, clayey, olive-gray to light-olive gray; loose to cohesive, scattered gravel	40	130
	Clay, silty, sandy, gravelly, olive-gray; soft, calcareous	60	190
	Sand, fine, clayey, silty, light-olive-gray;loose to cohesive	20	210
	Clay, sandy, silty, gravelly; light-olive-gray; cohesive to slightly loose, calcareous	80	290
	Clay, silty, sandy, olive-gray; soft to hard, scattered pebbles, calcareous	50	340
Graneros Shale:			
	Clay, silty, olive-black; soft, non-calcareous	17	357

141-52-26bbb
Amenia test 1322-1
(N. D. State Water Comm.)

Lake Agassiz deposits:			
	Sand, medium, gravelly; moderately well sorted, subrounded, predominantly quartz and limestone	5	5
	Clay, silty, light-olive-gray; plastic, calcareous	5	10
	Clay, silty, brownish-gray; plastic, calcareous	16	26
	Clay, silty, olive-gray; plastic, calcareous	14	40
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, olive-gray; soft, cohesive, scattered pebbles, highly calcareous	30	70
	Clay, silty, sandy, olive-gray; soft, cohesive, numerous sand and gravel lenses, highly calcareous	10	80
	Clay, silty, sandy, olive-gray; soft, numerous shale and limestone pebbles, highly calcareous	20	100
	Clay, sandy, gravelly, olive-gray; soft, occasional boulder, highly calcareous	110	210
	Clay, silty, olive-gray; soft, plastic	20	230
	Clay, silty, sandy, olive-gray; soft, scattered gravel, occasional boulder, highly calcareous	127	357
Graneros Shale:			
	Clay, silty, olive-black; cohesive, slightly calcareous	3	360
	Clay, sandy, reddish-brown; soft, abundant black organic material, slightly calcareous	10	370
Dakota (?) Sandstone:			
	Sand, very fine, clayey, light-greenish-gray; micaceous subrounded to rounded, predominantly quartz	10	380
	Clay, yellowish-gray; soft, non-calcareous	10	390

141-52-26bbb--Continued
Amenia test 1322-1
(N. D. State Water Comm.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Dakota (?) Sandstone: (cont.)			
	Silt, clayey, olive-gray; soft, non-calcareous-----	3	393
	Clay, white to light-gray; soft, non-calcareous----	6	399
	Clay, white to light-gray; soft, with lenses of olive-gray; calcareous silt and moderate olive-brown, slightly calcareous clay------------------	11	410
	Clay, silty, olive-gray; contains moderate olive-brown, calcareous streaks-----------------------	20	430
Granite:			
	Decomposed granite; clay, light-green to white, soft, non-calcareous----------------------------	170	600
	Granite, green, hard, non-calcareous---------------	14	614

141-52-27bbb
Amenia test 1322-5
(N. D. State Water Comm.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black---------------------------------------	2	2
	Silt, yellowish-gray to dark-yellowish-brown; slightly cohesive, calcareous-------------------	8	10
	Clay, silty, yellowish-gray; soft, plastic, calcareous---	15	25
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, greenish-gray; scattered pebbles, calcareous---------------------------------	7	32
	Clay, silty, sandy, olive-gray; soft, calcareous---	29	61
	Clay, olive-gray; soft, plastic, calcareous--------	12	73
	Clay, silty, sandy, olive-gray; scattered gravel, calcareous---------------------------------------	10	83
	Gravel, fine to coarse; subrounded, predominantly limestone and shale----------------------------	3	86
	Clay, silty, sandy, olive-gray; soft, scattered gravel; calcareous-----------------------------	11	97
	Gravel---	2	99
	Clay, silty, sandy, light-olive-gray; soft, scattered gravel, calcareous--------------------------	35	134
	Sand, fine to medium, clayey, light-olive-gray; loose to slightly cohesive----------------------	4	138
	Clay, silty, sandy, olive-gray; scattered pebbles and boulders, calcareous------------------------	42	180
	Clay, sandy, light-olive-gray to olive-gray; soft, scattered gravel, calcareous--------------------	30	210
	Clay, silty, sandy, olive-gray; soft, scattered gravel and boulders, calcareous-----------------	124	334
Graneros Shale:			
	Clay, sandy, olive-black; soft, non-calcareous-----	23	357

141-52-35aaa
Amenia test 1322-4
(N. D. State Water Comm.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black---------------------------------------	2	2
	Silt, sandy, yellowish-gray; soft------------------	3	5
	Sand, fine, dark-yellowish-brown; subrounded, dry--	5	10
	Clay, yellowish-gray; soft, plastic, calcareous----	7	17
	Clay, silty, sandy, moderate-olive-brown, soft, calcareous---------------------------------------	22	39

141-52-35aaa--Continued
Amenia test 1322-4
(N. D. State Water Comm.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, greenish-gray; soft, scattered pebbles, calcareous	24	63
	Clay, silty, olive-gray; soft, scattered pebbles, calcareous	9	72
	Clay, silty, olive-gray; soft, scattered gravel and boulders, calcareous	34	106
	Clay, silty, sandy, light-olive-gray; soft, calcareous	54	160
	Clay, silty, sandy, olive-gray; soft, calcareous	20	180
	Clay, silty, gravelly, olive-gray; soft, calcareous	7	187
	Clay, sandy, light-olive-gray to olive-gray; soft, calcareous	23	210
	Clay, silty, sandy, olive-gray; scattered gravel and boulders, calcareous	63	273
	Gravel, fine to coarse; cemented, numerous boulders	8	281
	Clay, silty, sandy, olive-gray; soft to slightly hard, scattered gravel, calcareous	63	344
Graneros Shale:			
	Clay, sandy, olive-black; soft, noncalcareous	13	357

141-54-11cdc
Test hole 2344

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, silty, grayish-orange to dark-yellowish-orange; abundant shale pebbles, calcareous	5	6
	Clay, silty, grayish-orange to pale-olive, calcareous	8	14
	Silt, clayey, soft, cohesive, yellowish-brown to pale-olive; scattered lignite fragments	5	19
	Silt, clayey, soft, cohesive, olive-gray to dark-greenish-gray; scattered sand and gravel	99	118
	Sand, fine to medium, dark-gray; angular to rounded, clay lenses	28	146
	Silt, clayey, sandy, cohesive, olive-gray to dark-greenish-gray; scattered lignite fragments, calcareous	64	210

142-50-2dab
Great Northern Railroad

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	4	4
	Clay, blue	58	62
	Clay, gray	8	70
Till and associated glacioaqueous deposits:			
	Clay, sandy	12	82
	Clay, blue	6	88
	Sand	20	108
	Clay, sandy, blue	12	120
	Clay, blue	2	122
	Sand and gravel	10	132

142-50-3bbb
Test hole 3100

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Clay, silty, moderate-yellowish-brown; highly calcareous	32	32
	Clay, silty, olive-gray; highly calcareous	25	57
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, olive-gray; scattered gravel, highly calcareous	51	108
	Clay, sandy, silty, olive-gray; scattered gravel and few lignite fragments, highly calcareous	44	152
	Silt, sandy, olive-gray; cohesive, laminated, highly calcareous	72	224
	Silt, gray; soft, cohesive; scattered fine sand, abundant lignite fragments, calcareous	13	237
	Silt, sandy, gray; abundant lignite fragments, calcareous	81	318
	Silt, light olive-gray; soft, laminated with fine lignite, calcareous	14	332
Older till and associated glacioaqueous deposits: (?)			
	Clay, silty, sandy, gravelly, pale-brown; numerous cobbles, highly calcareous	6	338
	Boulders, limestone, granite	2	340
Dakota (?) Sandstone:			
	Shale, variegated gray, white, and orange; laminated, scattered pyrite and quartz grains, highly calcareous	4	344
Granite:			
	Decomposed granite; clay, light-olive to pale-green; hard, noncalcareous	11	355

142-53-1bab
Test hole 3130

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Silt, grayish-orange; cohesive, scattered lignite fragments, highly calcareous	9	11
	Clay, silty, dark-greenish-gray; soft, scattered lignite fragments, few pebbles	15	26
Till and associated glacioaqueous deposits:			
	Silt, dark-greenish-gray; cohesive, laminated, scattered pebbles, calcareous	134	160
	Clay, sandy, gravelly, dark-greenish-gray; scattered lignite fragments	24	184
	Clay, sandy, olive-gray; scattered gravel	33	217
Older till and associated glacioaqueous deposits: (?)			
	Clay, sandy, dark-yellowish-brown; scattered gravel	5	222
	Clay, silty, sandy, dark-greenish-gray; scattered lignite fragments, highly calcareous	30	258
	Sand, gravelly, gray	3	261
	Clay, sandy, gravelly, olive-gray; highly calcareous	25	286
Greenhorn Formation:			
	Shale, silty, olive-black; soft, cohesive, numerous small white specks, highly calcareous	29	317

142-53-33bbb
Test hole 2345

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Silt, clayey, cohesive, pale-orange to grayish-orange; scattered sand	4	5
	Clay, silty, sandy, grayish-orange to olive-gray; calcareous	7	12
	Silt, clayey, cohesive, dark-yellowish-orange; scattered sand and shale fragments, calcareous	10	22
	Silt, clayey, cohesive, olive-gray to dark-greenish-gray; highly calcareous	41	63
	Sand, fine to medium, dark-gray; predominantly quartz	9	72
	Clay, sandy, olive-gray to dark-greenish-gray; calcareous	12	84
	Sand, fine to medium, dark-gray; predominantly quartz	5	89
	Clay, olive-gray to dark-greenish-gray; scattered lignite fragments, calcareous	79	168

142-54-1bbb
Test hole 3129

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	2	2
	Clay, silty, sandy, moderate-yellowish-brown; highly calcareous	7	9
	Sand, fine to coarse, blue; angular to rounded, scattered lignite fragments, predominantly quartz	78	87
	Clay, silty, sandy, olive-gray; scattered lignite fragments, highly calcareous	27	114
	Sand, medium to coarse, blue; angular to rounded, scattered lignite fragments, predominantly quartz	51	165
	Silt, olive-gray; cohesive, laminated, highly calcareous	72	237
	Clay, silty, sandy, gravelly, olive-gray; numerous boulders, highly calcareous	18	255
	Boulder, dolomite	3	258
	Clay, silty, olive-gray; few sand and gravel lenses, highly calcareous	34	292
	Sand, medium to very coarse; gravelly, angular to well rounded, predominantly quartz and shale	10	302
	Clay, silty, sandy, gravelly, olive-gray; numerous boulders, scattered lignite fragments, highly calcareous	54	356
	Clay, sandy, olive-gray; scattered lignite fragments, highly calcareous	36	392
	Clay, silty, sandy, gravelly; scattered lignite fragments, highly calcareous	28	420
Greenhorn Formation:			
	Shale, silty, olive-black; cohesive, numerous small white specks, highly calcareous	27	447

142-54-6ddd
Great Northern Railroad

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay, yellow	45	45
	Clay, blue	23	68
	Clay and sand, blue	6	74
	Sand, fine	30	104
	Sand, fine and blue clay	20	124

142-54-8ddd
Test hole 3125

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, silty, sandy, gravelly, moderate-yellowish-brown; highly calcareous	13	14
	Sand, very fine to fine, brown; subangular, few lignite fragments, predominantly quartz	10	24
	Clay, silty, olive-gray; scattered sand and gravel, few lignite fragments, highly calcareous	7	31
	Sand, very fine to fine, blue; angular to rounded, predominantly quartz, few lignite fragments	29	60
	Clay, silty, olive-gray; scattered sand, few lignite fragments, highly calcareous	27	87
	Sand, very fine to medium, gray; angular to rounded, predominantly quartz; abundant fine to coarse lignite fragments	50	137
	Silt, clayey, olive-gray; cohesive, scattered fine sand, lignite fragments, highly calcareous	36	173
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous; gravel lenses 187-192 feet, 205-257 feet	84	257

142-54-34aad
Test hole 2343

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, silty, grayish-orange to dark-yellowish-orange; highly calcareous	5	6
	Clay, silty, moderate-yellowish-brown; scattered sand, calcareous	13	19
	Sand, clayey, fine to medium, dark-gray	42	61
	Clay, silty, dark-greenish-gray; scattered sand and lignite fragments, calcareous	23	84
	Sand, fine to medium, dark-gray	8	92
	Clay, silty, dark-greenish-gray; scattered sand and lignite fragments, calcareous	23.5	115.5

142-55-1bba
Test hole 3124

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, moderate-yellowish-brown; highly calcareous	24	24
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	38	62
	Silt, clayey, sandy, olive-gray; cohesive, few lignite fragments	15	77
	Sand, fine to medium, gray; angular to rounded, scattered lignite fragments, predominantly shale	27	104
	Gravel, fine, sandy; abundant lignite fragments, predominantly shale and limestone	20	124
	Clay, silty, sandy, gravelly, olive-gray; abundant shale pebbles, highly calcareous	13	137

142-55-26baa
Test hole 3122

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, light-olive-gray	3	3
	Gravel, sandy, fine, brown; subangular to rounded	5	8
	Clay, sandy, moderate-yellowish-brown; scattered gravel, calcareous	1	9
	Gravel, sandy, fine, brown; subangular to rounded	1	10
	Clay, sandy, olive-gray; scattered gravel and lignite fragments, highly calcareous	10	20
	Clay, silty, olive-gray; scattered sand, few lignite fragments, highly calcareous	50	70
	Silt, olive-gray; soft, cohesive, few lignite fragments, highly calcareous	10	80
	Sand, very fine to coarse, gray; subangular to rounded, predominantly quartz	10	90
	Clay, silty, sandy, olive-gray; scattered gravel, few lignite fragments, calcareous	17	107

142-55-33bba
Test hole 3126

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, moderate-yellowish-brown; highly calcareous	11	11
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	4	15
	Silt, sandy, olive-gray; cohesive, scattered lignite fragments, highly calcareous	15	30
	Clay, silty, sandy, gravelly, moderate-olive-brown; frequent gypsum crystals, highly calcareous	2	32
	Sand, fine to medium, blue; angular to rounded, predominantly quartz	2	34
	Clay, sandy, olive-gray; scattered gravel lenses, few lignite fragments, highly calcareous	73	107

143-49-33bcc
Test hole 3101

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, yellowish-brown	6	6
	Clay, silty, moderate-yellowish-brown; calcareous	30	36
	Clay, silty, olive-gray; calcareous	41	77
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; numerous boulders, calcareous	21	98
	Clay, sandy, silty, olive-gray; scattered gravel, highly calcareous	12	110
	Gravel, fine to medium; rounded, predominantly limestone	5	115
	Clay, silty, sandy, light-olive-gray; scattered gravel and lignite fragments	63	178
	Gravel, sandy, fine; angular to rounded, few lignite fragments, predominantly limestone	6	184
	Sand, silty, clayey, gray; angular to rounded, predominantly limestone	16	200
	Gravel, sandy, fine; angular to rounded, few lignite fragments, predominantly limestone	2	202

143-49-33bcc--Continued
Test hole 3101

Geologic source	Material	Thickness (feet)	Depth (feet)
Graneros Shale:			
	Clay, silty, dark-greenish-gray; noncalcareous-----	48	250
Dakota (?) Sandstone:			
	Clay, sandy, dark-reddish-brown; scattered gravel, highly calcareous--------------------------------	8	258
Granite:			
	Decomposed granite; clay, grayish-blue-green; noncalcareous--------------------------------------	7	265

143-50-31ccc2
Test hole 3099

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black--------------------------------------	1	1
	Clay, moderate-yellowish-brown; calcareous---------	25	26
	Clay, silty, olive-gray; slightly calcareous-------	4	30
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray, highly calcareous--------------------------------------	2	32
	Sand, fine, silty; few lignite fragments, predominantly shale and quartz---------------------	34	66
	Gravel, sandy, fine; subangular to rounded, predominantly limestone----------------------------	8	74
	Clay, silty, sandy, gravelly, olive-gray; abundant shale pebbles, few lignite fragments, highly calcareous--------------------------------------	45	119
	Sand, fine to coarse, gravelly; subangular to rounded, predominantly quartz-------------------	5	124
	Clay, gravelly, olive-gray; abundant shale pebbles, highly calcareous-------------------------------	25	149
	Sand, very fine to coarse; angular to rounded, predominantly quartz------------------------------	4	153
	Clay, silty, sandy, gravelly, olive-gray; highly calcareous--------------------------------------	15	168
	Silt, olive-gray; laminated, highly calcareous-----	40	208
	Clay, sandy, olive-gray; abundant silt lenses, scattered lignite fragments, highly calcareous--	65	273
Graneros Shale:			
	Silt, clayey, sandy, variegated-olive-black, light-olive-gray, and light-brownish-gray; laminated, some lignite, noncalcareous---------------------	129	402
Dakota (?) Sandstone:			
	Sandstone, fine, moderate-yellowish-brown; scattered pyrite crystals-----------------------------	20	422
Granite:			
	Decomposed granite; clay, light-brown to light-greenish-gray; soft, noncalcareous--------------	8	430
	Clay, light-greenish-gray; soft, numerous granitic fragments, noncalcareous------------------------	20	450
	Clay, pale-blue-green; hard, noncalcareous---------	5	455

143-51-18dad
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black--------------------------------------	3	3
	Clay, tan---	27	30
	Clay, blue--	35	65
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue-----------------------------------	20	85
	Clay with sand lenses, blue-------------------------	7	92
	Clay, sandy, blue-----------------------------------	20	112
	Sand--	2.5	114.5
	Clay, sandy, blue-----------------------------------	23.5	138

143-51-18dad--Continued
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits: (cont.)			
	Clay with sand lenses, blue	7	145
	Clay, sandy, blue	61	206
	Clay, sandy, with boulders, blue	14	220
Graneros Shale:			
	Shale, blue	28	248
	Sandstone, brown	2	250
	Shale, blue	13	263
	Sandstone	3	266
	Shale, blue	2	268
	Sandstone	3	271
	Shale, sandy, blue	17	288
	Sandstone, white	2	290
	Shale, blue	14	304
	Sandstone, white	3	307
Dakota Sandstone:			
	Shale	36	343
	Sandstone, white	15	358

143-51-32aaa2

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, blue	3	5
	Clay, brown	22	27
	Clay, blue	25	52
	Clay, blue	10	62
Till and associated glacioaqueous deposits:			
	Clay, gravelly, blue	8	70
	Clay, blue	11	81
	Boulder	3	84
	Clay, blue	16	100
	Gravel, brown	2	102
	Clay, blue	28	130
	Sand, blue	15	145

143-51-33ddd1
Test hole 3102

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, silty, dark-yellowish-brown; scattered gypsum crystals, calcareous	23	26
	Clay, silty, olive-gray; calcareous	7	33
	Clay, silty, dark-yellowish-brown; scattered sand, few pebbles	7	40
	Silt, clayey, sandy, moderate-olive-brown; cohesive, calcareous	10	50
Till and associated glacioaqueous deposits:			
	Clay, sandy, olive-gray; scattered gravel, few lignite fragments, highly calcareous	54	104
	Clay, silty, dark-greenish-gray; scattered sand and gravel, highly calcareous	12	116
	Boulder, granite	1	117

143-51-33ddd2
Test hole 3102-A

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, silty, moderate-olive-brown; numerous gypsum crystals, calcareous	23	25
	Clay, silty, olive-gray; calcareous	3	28
	Clay, silty, grayish-orange; scattered sand, calcareous	12	40
	Silt, clayey, moderate-olive-brown; cohesive, calcareous	10	50
	Gravel, fine to medium, brown; subrounded, predominantly limestone	1	51
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	19	70
	Gravel, fine to medium; predominantly shale	2	72
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	12	84
	Clay, sandy, light-olive-gray; highly calcareous	41	125
	Clay, silty, sandy, gravelly, dark-greenish-gray; scattered lignite fragments, calcareous	10	135

143-51-34ccc
Test hole 3102-B

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Silt, clayey, dark-yellowish-brown; cohesive, numerous gypsum crystals, calcareous	36	38
	Silt, light-olive-brown; cohesive, laminated, numerous gypsum crystals, calcareous	11	49
	Gravel, sandy, fine to coarse; subrounded, predominantly limestone	2	51
Till and associated glacioaqueous deposits:			
	Clay, sandy, moderate-olive-brown; few lignite fragments, calcareous	4	55
	Clay, gravelly, sandy, olive-gray; numerous boulders, scattered lignite fragments, highly calcareous	82	137
	Boulder	1	138

143-51-35daa
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil	2	2
	Clay, silty, yellow	26	28
	Clay, silty, blue	58	86
Till and associated glacioaqueous deposits:			
	Clay, hard, dark-green	12	98
	Clay, soft, gray	17	115
	Clay, blue	37	152
	Clay with sand lenses, blue	18	170
	Sand, clayey, blue	12	182
	Clay, sandy, soft, blue	5	187
	Sand, fine, blue	38	225

143-52-33aba
Driller's log by Frederickson's Inc.

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, yellow	13	14
	Clay, sandy; yellow	11	25
	Clay, hard; blue	4	29
Till and associated glacioaqueous deposits:			
	Clay, sandy, hard; blue	56	85
	Shale, soft; blue	40	125
	Clay, sandy, soft; blue	10	135
	Clay, sandy, hard; blue	30	165
	Sand, brown	2	167
	Clay, sandy, hard; blue	3	170
	Sand, brown	3	173
	Clay, sandy, hard; blue	17	190
	Sand, white	5	195
	Clay, sandy, hard; blue	5	200
	Sand, gray	1	201
	Clay, sandy, hard; blue	11	212
	Sand, gray	1	213
	Clay, sandy, hard; blue	41	254
Greenhorn Formation:			
	Shale, hard; black	44	298
Graneros Shale:			
	Shale, soft; black	54	352
Dakota Sandstone:			
	Sandstone	47	399

143-52-36ddd
Test hole 3131

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Silt, sandy, dark-yellowish-brown; cohesive, highly calcareous	16	17
	Silt, sandy, moderate-yellowish-brown; cohesive, scattered lignite fragments, highly calcareous	38	55
	Silt, sandy, dark-greenish-gray; cohesive, scattered lignite fragments, highly calcareous	10	65
	Silt, olive-gray; cohesive, highly calcareous	12	77
Till and associated glacioaqueous deposits:			
	Boulder, limestone	2	79
	Clay, sandy, dark-greenish-gray; scattered lignite fragments, highly calcareous	38	117
	Clay, sandy, olive-gray; scattered lignite fragments, highly calcareous	11	128
	Sand, coarse, gray; angular to well rounded, few shell fragments, predominantly quartz	3	131
	Clay, sandy, olive-gray; scattered lignite fragments, occasional boulder, highly calcareous	66	197
	Clay, dark-greenish-gray; scattered sand, highly calcareous	22	219
Graneros Shale:			
	Shale, olive-black, hard, laminated, shell fragments, slightly calcareous	43	262
	Shale, dark-greenish-gray; laminated, abundant fine sand disseminated through shale and concentrated in laminations, slightly calcareous	10	272

143-54-31cac
Great Northern Railroad

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay	19	19
	Clay, blue	31	50
	Clay and gravel, hard	8	58
	Sand	35	93

143-54-31cca
Great Northern Railroad

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Gravel fill	2	2
	Soil, black	2	4
	Clay and boulders, yellow	23	27
	Clay, soft, gray	41	68
	Clay, blue	14	82
	Sand, fine	33	115

143-55-16aad
Test hole 3128

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay, silty, sandy, gravelly, moderate-yellowish-brown; highly calcareous	2	2
	Sand, medium to coarse; subangular to subrounded, predominantly quartz	3	5
	Clay, silty, sandy, gravelly, moderate-yellowish-brown; highly calcareous	3	8
	Gravel, sandy, medium; subangular, predominantly limestone	6	14
	Clay, silty, sandy, gravelly, moderate-yellowish-brown; highly calcareous	7	21
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous	11	32
	Silt, olive-gray; cohesive, laminated, few lignite fragments	28	60
	Sand, fine to coarse; subangular to rounded, few lignite fragments, predominantly limestone and shale	10	70
	Clay, silty, sandy, gravelly, olive-gray; few lignite fragments, calcareous	52	122

143-55-31baa
Test hole 3127

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	1	1
	Clay, silty, sandy, gravelly, moderate-yellowish-brown; highly calcareous	10	11
	Silt, olive-gray; cohesive, few lignite fragments, highly calcareous	8	19
	Sand, gravelly, medium, black; rounded, predominantly shale and limestone	2	21
	Silt, olive-gray; cohesive, few lignite fragments, highly calcareous	3	24
	Clay, sandy, olive-gray; abundant shale pebbles, few lignite fragments, calcareous; sand lenses 42-47 feet, 47-55 feet	31	55
	Silt, olive-gray; cohesive, few lignite fragments, calcareous	11	66
	Boulder, granite	2	68
	Clay, silty, sandy, gravelly, olive-gray; scattered lignite fragments, highly calcareous; sand lenses 92-102 feet	69	137

143-55-33ddd
Test hole 3123

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil	2	2
	Clay, sandy, light-olive-gray; highly calcareous	2	4
	Clay, sandy, gravelly, moderate-yellowish-brown; highly calcareous	4	8
	Clay, silty, sandy, olive-gray; scattered gravel, few lignite fragments, highly calcareous	24	32
	Silt, olive-gray; cohesive, laminated, few lignite fragments, calcareous	13	45
	Gravel, sandy, fine to very coarse; flat to well rounded, predominantly shale	14	59
	Clay, silty, sandy, gravelly, olive-gray; numerous boulders, scattered lignite fragments, highly calcareous	25	84
	Gravel, fine to very coarse; numerous boulders, predominantly shale and limestone	4	88
	Clay, silty, sandy, gravelly, olive-gray; numerous boulders, scattered lignite fragments, highly calcareous	236	324
Greenhorn Formation:			
	Shale, silty, clayey, olive-black; hard, numerous white specks and pyrite crystals, highly calcareous	23	347

NORTH DAKOTA GEOLOGICAL SURVEY

WILSON M. LAIRD, *State Geologist*

BULLETIN 47

NORTH DAKOTA STATE

WATER COMMISSION

MILO W. HOISVEEN, *State Engineer*

COUNTY GROUND WATER STUDIES 8

GEOLOGY and GROUND WATER RESOURCES

of

CASS COUNTY, NORTH DAKOTA

PART III

HYDROLOGY

By

ROBERT L. KLAUSING

Geological Survey

United States Department of the Interior

Prepared by the United States Geological Survey in cooperation with the North Dakota State Water Commission, North Dakota Geological Survey, and Cass County Board of Commissioners.

GRAND FORKS, NORTH DAKOTA

1968

This is one of a series of county reports published cooperatively by the North Dakota Geological Survey and the North Dakota State Water Commission. The reports are in three parts; Part I describes the geology, Part II represents ground water basic data, and Part III describes the ground water resources.

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GEOLOGY AND GROUND WATER RESOURCES
of Cass County, North Dakota

Part III - Ground Water Resources

By
Robert L. Klausing

ABSTRACT

Ground water in Cass County is obtainable from sand and gravel deposits associated with the glacial drift and from sand and (or) sandstone beds in the Dakota Sandstone.

Six major drift aquifers are identified and described. These are, the Fargo, West Fargo, Page, Tower City, Bantel, and Sheyenne Delta aquifers. The West Fargo aquifer is the most permeable and productive and will yield as much as 1,300 gallons per minute to individual wells. Heavy pumping from the West Fargo aquifer has caused the water levels to decline as much as 85 feet since 1938. During 1965, water levels declined more than 2.5 feet at West Fargo and more than 0.5 foot in areas 20 miles away. The declines will continue as long as withdrawals exceed recharge.

Potentially important sources of water are the Sheyenne Delta aquifer in the southern part of the county and the Page aquifer in the northwestern part. Neither of these is extensively developed.

Water from the glacial drift aquifers generally contains less than 1,500 parts per million dissolved solids, whereas water from the Dakota Sandstone contains more than 2,500 parts per million dissolved solids.

INTRODUCTION

Purpose and Scope

This is the third in a series of three reports describing the results of a study of the geology and ground-water resources of Cass County. The study was requested and supported by the Cass County Board of Commissioners and was made under the cooperative program of the U.S. Geological Survey, the North Dakota State Water Commission, and the North Dakota Geological Survey.

The primary purpose of the study was to determine the occurrence, availability, and quality of ground water in Cass County. This report describes the location and extent of the various sources of ground water in the county, discusses the chemical quality of the water available from each source, and evaluates the potential of each ground-water source for future dvelopment.

Much of the basic data on which this interpretive report is based has been tabulated in an earlier report entitled "Geology and Ground Water Resources of Cass County, North Dakota, Part II, Ground Water Basic Data." However, 43 well logs that were collected since publication of the basic data report are included as an appendix to this report. Another report—"Geology and Ground Water Resources of Cass County, North Dakota, Part I, Geology"—describes the geology of the county and provides a framework for evaluating the ground-water resources. The three reports are meant to complement each other, and the usefulness of any of them will be greatly enchanced by having all three available for reference.

Location and Physiography

Cass County (fig. 1) is in southeastern North Dakota and encompasses an area of 1,749 square miles. The county is in the Central Lowland physiographic province of Fenneman (1938, p. 559), and occupies parts of the Drift Prairie and Red River Valley areas as defined by Simpson (1929, p. 4-7). The entire county is in the drainage basin of the Red River of the North (fig. 2).

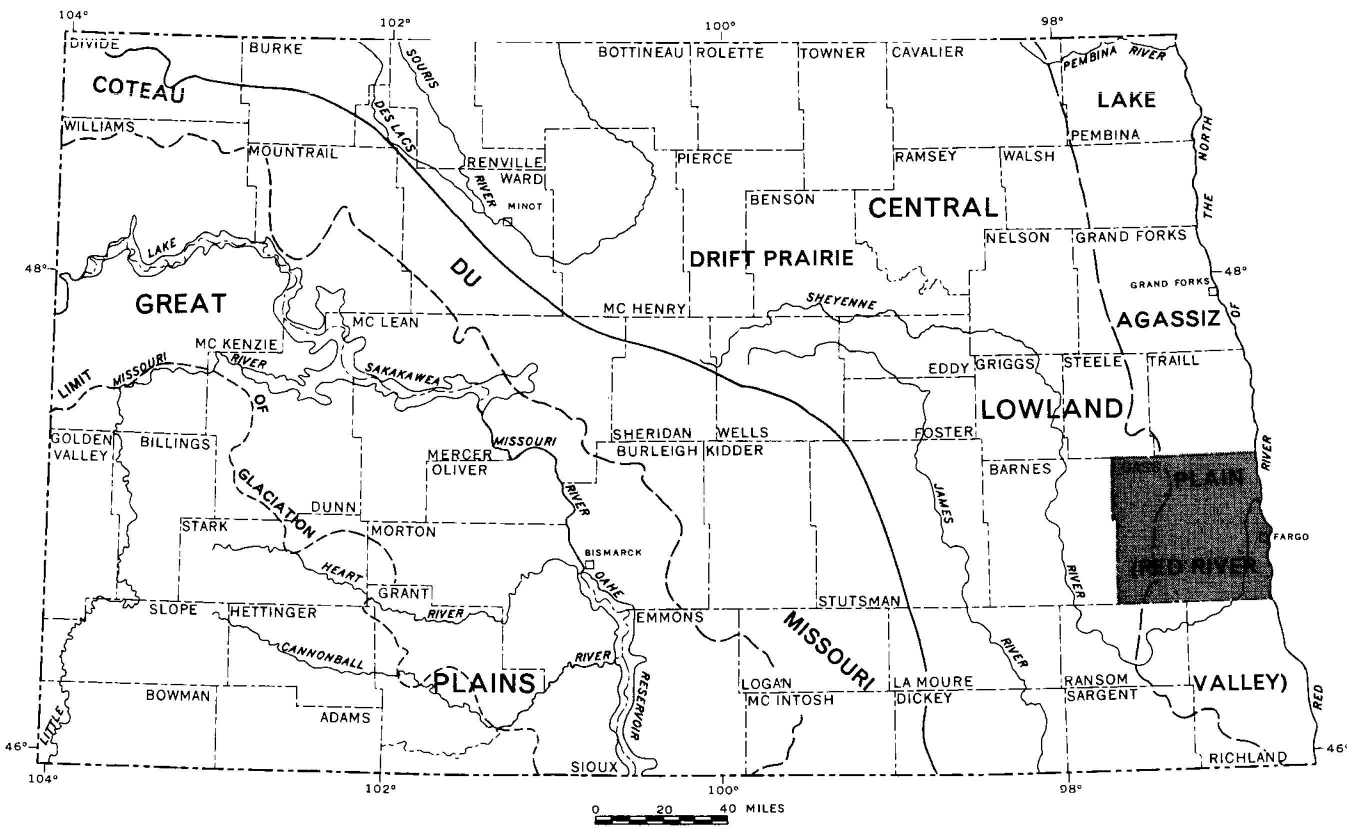


FIGURE 1. Physiographic divisions in North Dakota and location of report area.

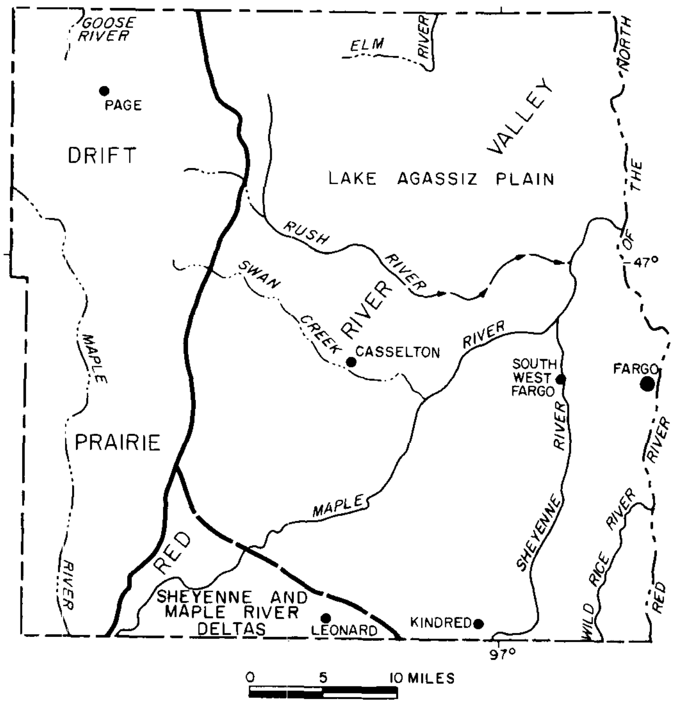


FIGURE 2. Major geomorphic units and drainage.

Climate

The climate of the area is variable. The winters are generally long and cold with temperatures occasionally falling to as much as 40° below zero. The summers usually are hot with midday temperatures occasionally rising to 100°. The average annual temperature is 39.9°.

Most of the annual precipitation is in the form of rain, which falls during the spring and summer. Precipitation in the Fargo area during the period 1930 to 1965 ranged from about 9 to 30 inches per year and averaged 18.65 inches. Precipitation in the vicinity of Amenia during the period 1934 to 1965 ranged from about 9 to 27 inches and averaged 19.46 inches. Precipitation data for the stations at Fargo and Amenia are shown graphically on figure 3.

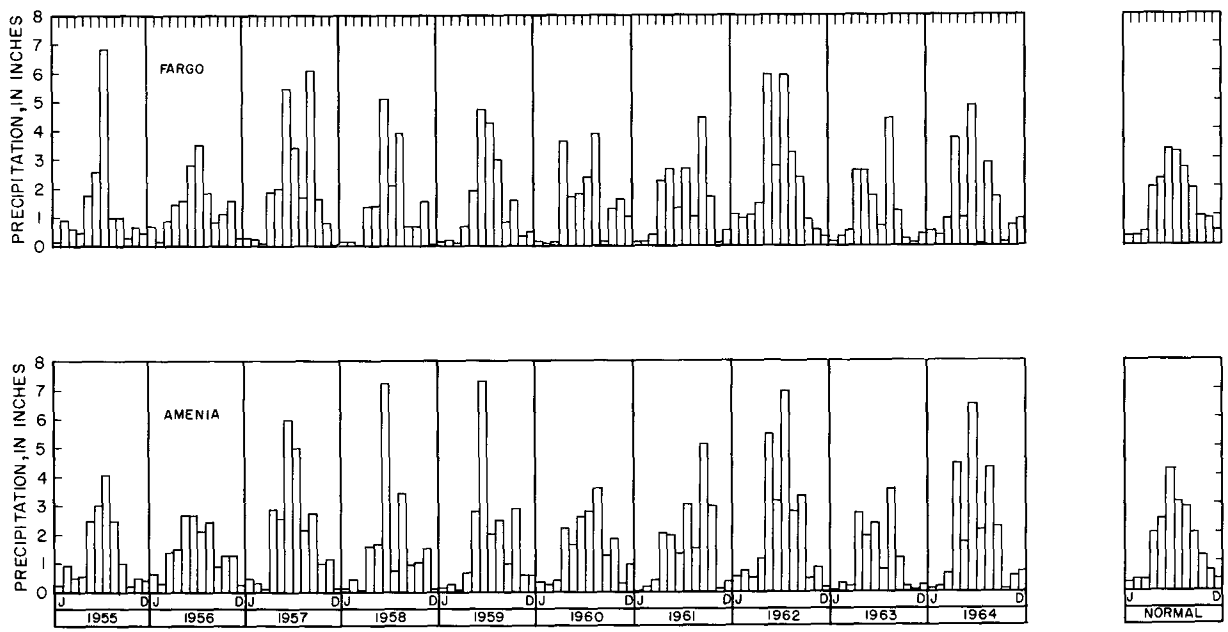


FIGURE 3. Monthly precipitation recorded at Fargo and Amenia, 1955-64.

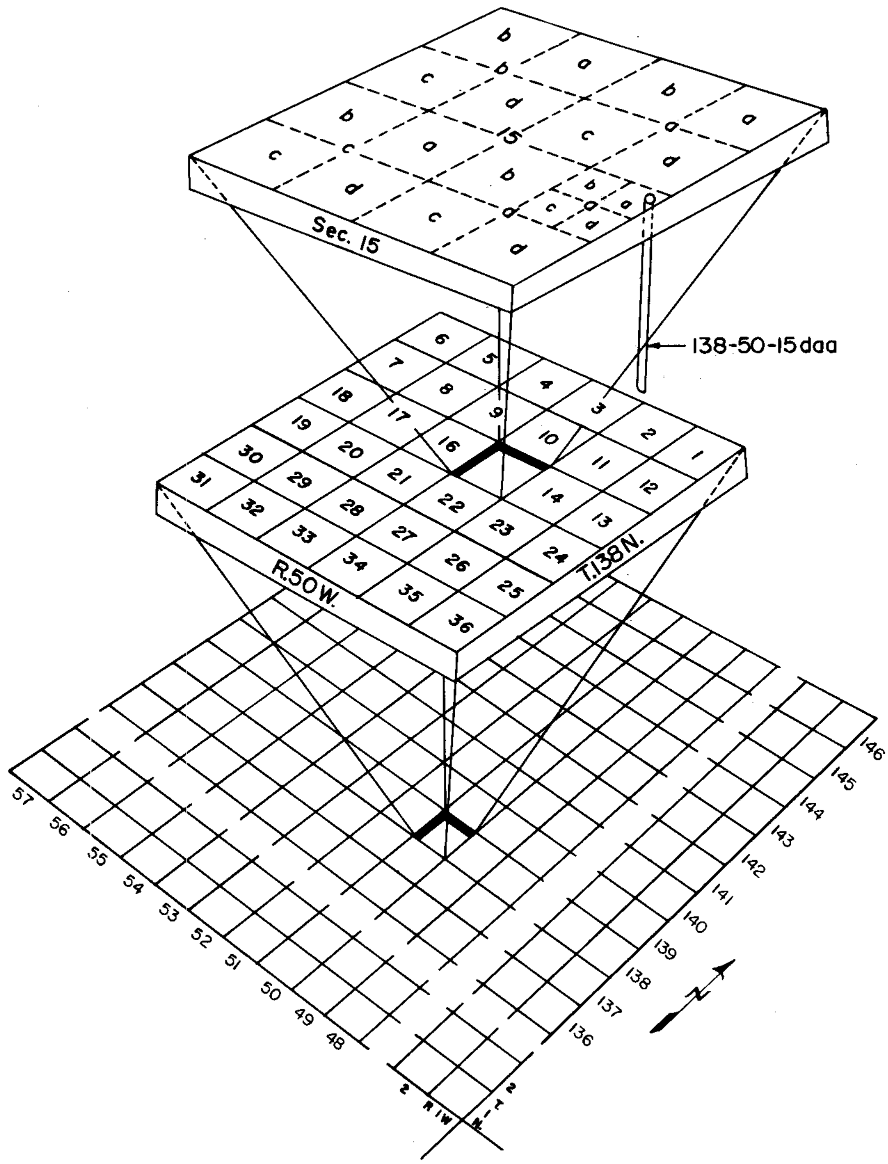


FIGURE 4. System of numbering wells, springs, and test holes.

Well-Numbering System

The wells and test holes mentioned in this report are numbered according to a system based on the public land classification of the U.S. Bureau of Land Management. The system is illustrated in figure 4. The first numeral denotes the township north of the base line, the second numeral the range west of the fifth principal meridian, and the third indicates the section in which the well or test hole is located. The letters a, b, c, and d designate, respectively, the northeast, northwest, southwest, and southeast quarter sections, quarter-quarter sections, and quarter-quarter-quarter sections (10-acre tracts). For example, well 138-50-15daa is in the NE¼-NE¼SE¼ sec. 15, T. 138 N., R. 50 W. Consecutive terminal numbers are added if more than one well is recorded within a 10-acre tract.

Previous Investigation

The geology and ground-water resources of the southern half of the county were described by Hall and Willard (1905) and by Willard (1909). Simpson (1929, p. 97-108) gave a brief summary of the geology and ground-water resources of the county. Byers and others (1946) discussed ground-water conditions in the Fargo-Moorhead area, North Dakota and Minnesota. Dennis and others (1949) reported on the results of a ground-water investigation in parts of Cass and Clay Counties, North Dakota and Minnesota. This report contains an excellent summary of the history of ground-water development in the Fargo-Moorhead area. Dennis and others (1950) described the ground-water resources in the vicinity of Kindred. Brookhart and Powell (1961) reported on the results of test drilling in the vicinity of Hunter, and Froelich (1964) made a ground-water survey in the Amenia area.

Acknowledgments

The author is grateful to all the residents of Cass County who provided information during the study. Messrs. R. Fuller, K. R. Lehman of South West Fargo, and M. O. Gunderson of Fargo deserve special mention for their cooperation. The writer gratefully acknowledges the sample logs furnished by Frederickson's Inc., Fargo, and Lako Drilling Co., Arthur.

GEOLOGIC SETTING
Glacial Deposits

All of Cass County is covered with glacial drift, which ranges in thickness from 80 to 470 feet. Four major surface units, based on lithology, landform, and mode of deposition, are recognized. They are: ground moraine, lake plain, shore, and deltaic deposits (Klausing, 1968).

Ground-moraine deposits believed to have formed at the base of the glacier occupy an area of about 450 square miles in the western part of the county. The ground moraine is characterized by a nearly flat to gently rolling surface, and local relief generally does not exceed 20 feet. The ground-moraine deposits are composed chiefly of till, heterogeneous mixture of clay, silt, sand, gravel, and boulders with clay and silt predominating.

Isolated deposits of sand and gravel occur at numerous places on the ground-moraine surface. These are referred to as ice-contact and outwash deposits. The ice-contact deposits, characterized by sharp changes in sorting and bedding, are closely associated with the till and are believed to have formed within or along the edges of the glacial ice. These deposits commonly form low ridges and hills and are called, respectively, eskers and kames. The outwash deposits that were laid down on or in front of the glacier consist for the most part of poorly sorted to moderately well-sorted silt, sand, and gravel. The outwash deposits underlie nearly flat plains, terraces, and channels.

The lake-plain deposits occupy approximately the eastern three-fourths of the county and consist chiefly of silt and clay that were laid down in glacial Lake Agassiz (Upham, 1895). The lake plain is characterized by its unusually flat and nearly featureless surface. Dennis and others (1949, p. 18) divided the lake deposits into two units: a silt unit that comprises the surficial deposits and a lower clay unit. The contact between the two units is disconformable and in places is marked by dessication and vegetal remnant zones. The silt unit has known thicknesses ranging from 10-50 feet. The clay unit ranges from 0 to about 80 feet in thickness.

The deposits bordering the lake plain on the west consist of sorted and stratified deposits of clay, silt, sand, and gravel. The deposits were derived from the till by wave action along the lake shore, and range in thickness from 0 to about 15 feet.

Deltaic deposits, which consist of silt and fine to medium sand, were formed in the southern part of the county where the sediment-laden waters of the Sheyenne and Maple Rivers discharged into glacial Lake Agassiz. The deltaic deposits range in thickness from 0 to about 120 feet.

Throughout most of the county, the glacial drift unconformably overlies sedimentary rocks of Cretaceous age; however, in the extreme eastern part, the Cretaceous shale has been eroded away and the drift rests on Precambrian crystalline rocks.

Bedrock Units

The three Cretaceous bedrock units known to underlie the area are the Greenhorn Formation, Graneros Shale, and the Dakota Sandstone (Klausing, 1968). Much of the Greenhorn Formation was eroded away during the period following the cessation of Cretaceous deposition and the beginning of Pleistocene glaciation, and now it underlies the glacial deposits only in the western part of the area. The Greenhorn Formation is a black, calcareous shale characterized by the presence of numerous white specks. It lies 200 to 420 feet below land surface. The thickness of this unit is unknown.

The Graneros Shale is a black, silty, noncalcareous shale containing thin beds and lenses of fine white sand. In places it contains lignitic and other organic material. Where the Graneros Shale is not overlain by the Greenhorn Formation, it has a deeply eroded surface and ranges in thickness from 10 to about 100 feet. In the western and central parts of the area, it is generally underlain by the Dakota Sandstone, but in the eastern part it rests on Precambrian crystalline rocks.

The Dakota Sandstone consists chiefly of interbedded black shale and fine to coarse sand. Although absent in the eastern and southeastern parts of the area, it underlies the rest of the county at depths ranging from about 300 to more than 650 feet. The total thickness of the Dakota Sandstone in Cass County is unknown.

The Precambrian crystalline rocks form the basement rock in the area. The upper part of the Precambrian rocks is weathered in many places, and consists mostly of red and green clay that appears to have been derived from granite. In some places the weathered material has been removed by glacial erosion and fresh unaltered rock underlies the glacial drift. The depth to the Precambrian below land surfaces ranges from about 160 feet in the eastern part of the area to more than 900 feet in the western part.

GROUND-WATER RESOURCES

Principles of Ground-Water Occurrence

All ground water of economic importance is derived from precipitation. After precipitation falls on the earth's surface, a part is returned to the atmosphere by evaporation, a part runs off to the streams, and a part sinks into the ground. Much of the water that sinks into the ground is held temporarily in the soil and then is returned to the atmosphere either by evaporation or by transpiration of plants. However, part of the water infiltrates downward to a saturated zone (zone of saturation) where it becomes ground water.

Ground water moves under the influence of gravity from areas where water enters (recharge) to areas where water leaves the aquifer (discharge). Its rate of movement is governed by the permeability of the deposits through which it moves and by the hydraulic gradient or slope of the water table or piezometric surface. Because of frictional resistance, the rate of ground-water movement is generally very slow; it may be only a few feet per year.

Porosity is the ratio of the volume of the open or pore space in a rock to its total volume and is an index of the storage capacity of the material.

Permeability refers to the ease with which a fluid will pass through porous material. The degree of permeability is determined by the size and shape of the pore spaces in the rock and extent of their interconnections. Gravel, well-sorted medium or coarse sand, and fractured lignite beds generally are highly permeable. Well-cemented sandstone or gravel and fine-grained materials such as silt, clay, and shale usually have low permeability, and may act as barriers impeding the movement of water into or out of more permeable rocks.

The coefficient of transmissibility is a measure of the rate of flow through porous material. It is expressed as the number of gallons of water that will move in 1 day under a unit hydraulic gradient (1 foot per foot) through a vertical strip of the aquifer 1-foot wide extending the full saturated height of the aquifer at a temperature of 60°F.

The coefficient of permeability is the rate of flow in gallons per day through a cross section of 1 square foot under a unit hydraulic gradient. Thus, the field coefficient of permeability is equal to the coefficient of transmissibility divided by the thickness of the aquifer. The field coefficient of permeability is stated at prevailing water temperature.

The coefficient of storage is the volume of water released from or taken into storage per unit of surface area of the aquifer per unit change in the component of head normal to that surface. Under water-table conditions, the coefficient of storage is practically equal to the specific yield, which is the volume of water released by gravity drainage divided by the volume of the material drained. The specific yield may be equal to only about half of the total porosity, and the coefficient of storage only a very small fraction of the porosity.

The upper surface of the zone of saturation is called the water table. Water-table conditions refer to ground water that is not confined by overlying impermeable beds. As the water is subject only to atmospheric pressure, it does not rise in wells above the level at which it is encountered. If an aquifer is overlain by relatively impermeable beds, the water is confined and is under pressure exerted by water at higher elevations. It will rise above the level at which it is first encountered; wells supplied from this type of aquifer are said to be artesian. The piezometric surface is that level to which artesian water would rise in an open column.

The water level in a well fluctuates in response to changes in recharge to, and discharge from, the aquifer, including the effect of pumping from other wells. Atmospheric pressure changes and land surface loadings also cause minor water-level fluctuations in artesian aquifers. The static level is the level at which water stands in a well when it is not being pumped. When water is withrawn from a well, the water level in and around the well is lowered, and the piezometric surface resembles an inverted cone with the well at its center. The slope produces a hydraulic gradient toward the well, and the inverted cone is called the cone of depression. The amount of water-level drawdown, or the difference between the static level and the pumping level, is determined by the capacity of the aquifer, the physical characteristics of the well, and the rate and duration of pumping. During constant and uniform discharge from a well, the water level declines rapidly at first and then continues to lower at a decreasing rate as the cone of depression slowly broadens.

Specifc capacity is a measure of well performance and is determined by dividing the rate of pumping, in gallons per minute, by the drawdown, in feet, in a pumping well. Specific capacity is expressed as gallons per minute per foot of drawdown.

The water level in a pumping well necessarily must decline in order that water may flow from the aquifer to the well. However, the amount of water-level decline becomes serious only if (1) it causes water of undesirable quality to move into the aquifer, (2) if the yield of the well decreases because of interference from other wells or from other aquifer boundaries, (3) if the pumping lift increases to the point where pumping becomes uneconomical, or (4) if the water level declines below the top of the screen. When pumping is stopped, the water level rises in the well and its vicinity at a decreasing rate until the water level again approaches the static level.

Under natural conditions, over a long period of time, the rate of discharge from an aquifer approximately equals the rate of recharge. When equilibrium exists, the amount of water in storage remains essentially the same. However, some water-level fluctuations may occur when periods of peak recharge and discharge are at different times.

Withdrawal of water from an aquifer causes one or a combination of the following: (1) a decrease in the rate of natural discharge, (2) an increase in the rate of recharge, or (3) a reduction in the volume of water in storage. If ground-water withdrawal plus natural discharge does not exceed recharge to an aquifer, the water level will approach equilibrium. If they exceed recharge, the excess will be withdrawn from storage. When water is taken from storage, the water level continues to decline as long as water is discharged.

The maximum rate of ground-water withdrawal that can be maintained indefinitely is related directly to the rate of recharge. However, recharge is regulated largely by climate and geologic controls and is impossible to evaluate quantitatively without large amounts of data.

Quality of Water

All natural water contains some dissolved solids. As precipitation, it begins to dissolve mineral matter as it falls to earth and continues to dissolve minerals as it infiltrates through the earth. The amount and kind of mineral matter dissolved depends upon the solubility and types of rocks encountered, the length of time the water is in contact with them, and the amount of carbon dioxide and soil acids in the water. Water that has been underground a long time, or has traveled a long distance from the recharge area, generally is more highly mineralized than water that has been in transit for only a short time and is recovered near the recharge area. Ground water usually contains more dissolved minerals than surface water.

The dissolved mineral constituents in water are usually reported in parts per million (ppm) or grains per U.S. gallon. A part per million is a unit weight of a constituent in a million unit weights of water. This can be converted to grains per gallon by dividing by 17.12. Equivalents per million (epm) is the unit chemical combining weight of a constituent in a million weights of water. These units are usually not reported, but are necessary to calculate percent sodium, the sodium-adsorption ratio (SAR), or to check the results of a chemical analysis.

The suitability of water for various uses is determined largely by the kind and amount of dissolved mineral matter. The various constituents of water in Cass County were listed by Klausinig (1966, table 3). The data are summarized in the discussion of each of the major aquifers described in the section of this report dealing with the rock units and their water-bearing properties.

Table 1 shows the major constituents in water, their major sources in Cass County, and their effects upon usuability. Most of the minerals, rocks, and mineral substances shown in the major source column are present in the rock formations underlying Cass County.

The chemical properties and constituents most likely to be of concern to residents of Cass County are: (1) dissolved solids and the related specific conductance, (2) sodium-adsorption ratio, (3) hardness, (4) iron, (5) sulfate, (6) nitrate, and (7) fluoride. The relative importance of the above properties and constituents of water depends primarily on the use of the water. For example, hardness has very little effect on the suitability of water for drinking, but it can make a water undesirable for use in a commercial laundry. Additional information may be found in "Drinking Water Standards" published by the U.S. Public Health Service (1962).

TABLE 1.—Major chemical constituents in water—their sources, concentrations, and effects upon usability (Concentrations are in parts per million)

(Modified after Durfor and Becker, 1964, Table 2)

Constituents	Major source	Effects upon usability	U.S. Public Health Service recommended limits for drinking water[1/]
Silica (SiO_2)	Feldspars, ferromagnesium, and clay minerals.	In presence of calcium and magnesium, silica forms a scale in boilers and on steam turbines that retards heat.	
Iron (Fe)	Natural sources: Amphiboles, ferromagnesium minerals, ferrous and ferric sulfides, oxides, and carbonates, and clay minerals. Manmade sources: well casings, pump parts, storage tanks.	If more than 0.1 ppm iron is present, it will precipitate when exposed to air; causing turbidity, staining plumbing fixtures, laundry and cooking utensils, and imparting tastes and colors to food and drinks. More than 0.2 ppm is objectionable for most industrial uses.	0.3 ppm
Calcium (Ca)	Amphiboles, feldspars, gypsum, pyroxenes, calcite, aragonite, dolomite, and clay minerals.	Calcium and magnesium combine with bicarbonate, carbonate, sulfate, and silica to form scale in heating equipment. Calcium and magnesium retard the suds-forming action of soap. High concentrations of magnesium have a laxative effect.	
Magnesium (Mg)	Amphiboles, olivine, pyroxenes, dolomite, magnesite, and clay minerals.		
Sodium (Na)	Feldspars, clay minerals, and evaporites.	More than 50 ppm sodium and potassium with suspended matter causes foaming, which accelerates scale formation and corrosion in boilers.	
Potassium (K)	Feldspars, feldspathoids, some micas, and clay minerals.		
Boron (B)	Tourmaline, biotite, and amphiboles.	Many plants are damaged by concentrations of 2.0 ppm.	
Bicarbonate (HCO_3)	Limestone and dolomite.	Upon heating, bicarbonate is changed to steam, carbonate, and carbon dioxide. Carbonate combines with alkaline earth (principally calcium and magnesium) to form scale.	
Carbonate (CO_3)			
Sulfate (SO_4)	Gypsum, anhydrite, and oxidation of sulfide minerals.	Combines with calcium to form scale. More than 500 ppm tastes bitter and may be a laxative.	250 ppm
Chloride (Cl)	Halite and sylvite.	In excess of 250 ppm may impart salty taste, greatly in excess may cause physiological distress. Food processing industries usually require less than 250 ppm.	250 ppm
Fluoride (F)	Amphiboles, apatite, fluorite, and mica.	Optimum concentration in drinking water has a beneficial effect on the structure and resistance to decay of children's teeth. Concentrations in excess of optimum may cause mottling of children's teeth.	Recommended limits depend on average of maximum daily temperature. Limits range from 0.6 ppm at 90.5°F to 1.7 ppm at 50°F.
Nitrate (NO_3)	Nitrogenous fertilizers, animal excrement, legumes, and plant debris.	More than 100 ppm may cause a bitter taste and may cause physiological distress. Concentrations greatly in excess of 45 ppm have been reported to cause methemoglobinemia in infants.	45 ppm
Dissolved solids	Anything that is soluble.	More than 500 ppm is not desirable if better water is available. Less than 300 ppm is desirable for some manufacturing processes. Excessive dissolved solids restrict the use of water for irrigation.	500 ppm

1/ U.S. Public Health Service, 1962.

Dissolved Solids and Specific Conductance

The concentration of dissolved solids is a measure of the total mineralization of water. It is significant because it may limit the use of water for many purposes. In general, the suitability of water decreases with an increase in dissolved solids. The limits shown in table 1 for drinking water were originally set for common carriers in interstate commerce. Residents in areas where dissolved solids have ranged as high as 2,000 ppm have consumed the water with no noticeable ill effects. Stock have been known to survive on water containing 10,000 ppm. However, growth and reproduction of stock may be affected by water containing more than 3,000 ppm of dissolved solids.

The specific conductance, in micromhos, of water is a measure of its ability to conduct an electrical current; it is a function of the amount and kind of dissolved mineral matter. An estimate of the total dissolved solids in parts per million can be obtained by multiplying specific conductance by 0.65; however, the conversion factor may range from 0.55 to 0.75, depending upon the type and amount of dissolved minerals.

Irrigation Indices

Two indices used to show the suitability of water for irrigation in this report are SAR and specific conductance. SAR is related to the sodium hazard; the specific conductance is related to the salinity hazard. The hazards increase as the numerical values of the indices increase. Figure 5 shows the SAR versus the specific conductance of analyzed water from Cass County. The analyses are plotted to show the general range of sodium and salinity hazards of water from the major glacial drift aquifers. Most of the samples fall within the C3-S1 and C3-S2 ranges. This type of water can be used for irrigation of plants with good salt tolerance (corn, wheat, rye, and flax) provided there is adequate drainage and the soil salinity is controlled.

Another index used to rate irrigation water is the residual sodium carbonate (RSC). This quantity is determined by subtracting the equivalents per million of calcium and magnesium from the sum of equivalents per million of bicarbonate and carbonate. If the RSC is between 1.25 and 2.5 epm, the water is marginal for irrigation. An RSC of more than 2.5 epm indicates that the water is not suitable for irrigation purposes. Generally the water in Cass County has an RSC index of less than 2.5 epm.

High sodium and high salinity hazard waters can be used successfully with ideal soil conditions and drainage in conjunction with proper water management. Good management practices and the proper use of amendments might make it possible to use successfully some of the marginal RSC water for irrigation. For further information the reader is referred to "Diagnosis and Improvement of Saline and Alkali Soils" (U.S. Salinity Laboratory Staff, 1954).

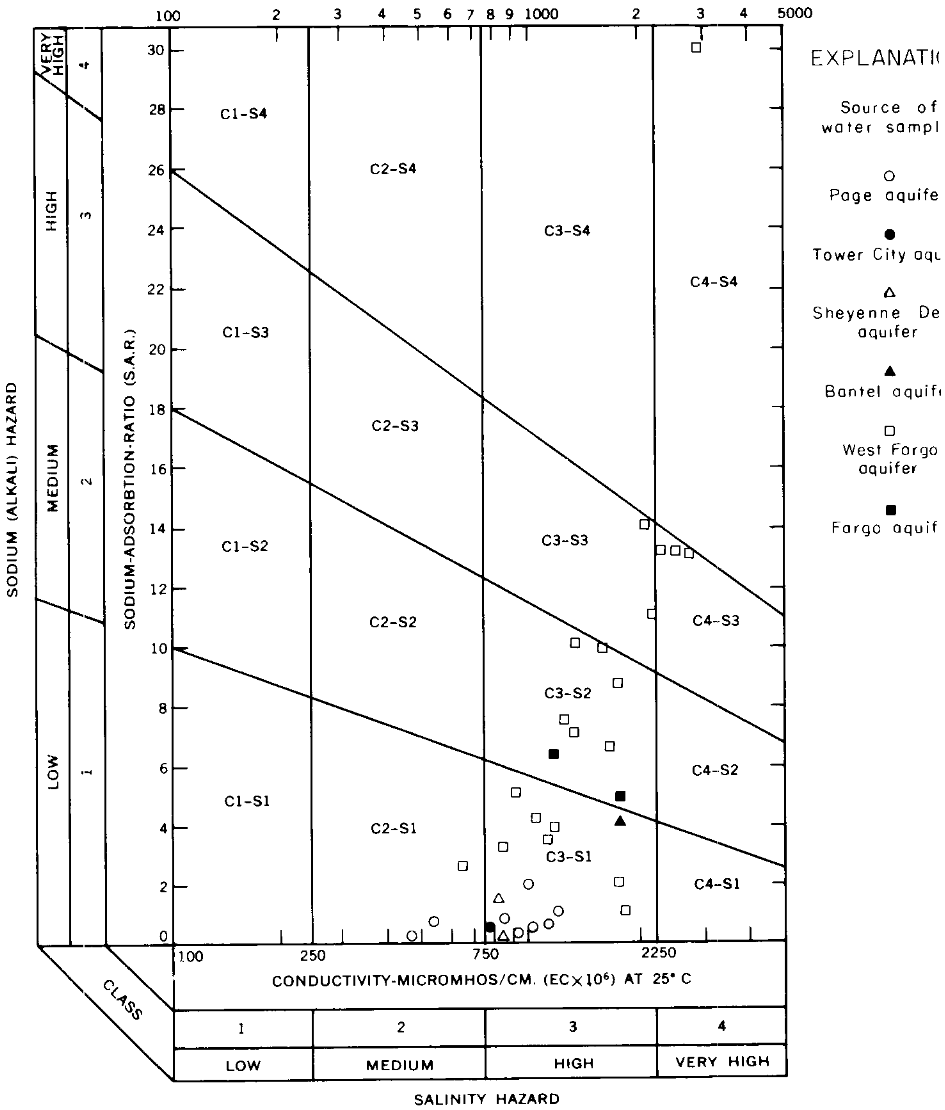


FIGURE 5. Classification of water samples for irrigation purposes.

Hardness

The hardness of water determines its usefulness for laundries and for some industries. Water having a hardness of 0 to 60 ppm as calcium carbonate is rated soft, between 61 and 120 ppm is moderately hard, between 121 and 180 ppm is hard, and more than 180 ppm is very hard. Hardness does not seriously interfere with the use of water for most purposes, but it does increase the consumption of soap. Its removal by a softening process can be profitable for domestic uses, for laundries, and for some industries. Water from the glacial drift in Cass County is generally very hard, whereas the water from the Dakota Sandstone ranges from soft to very hard.

Aquifers in the Glacial Drift

Deposits of sand and gravel of glaciofluvial or glaciolacustine origin are the most important sources of ground water in Cass County. The potential yields from these aquifers, shown on the ground-water availability map (pl. 1, in pocket), were determined from the thickness and estimated permeability of the water-bearing deposits logged at each test hole and well. The logs were examined in detail and the materials were divided into units on the basis of assigned permeabilities according to a method given by Keech (1964, p. 17). The permeabilities of the units were estimated from the grain size, apparent sorting, and drilling characteristics of the materials, and by comparison with available pumping-test data. The test holes were drilled by hydraulic rotary rigs, which on drilling sand and gravel beds commonly produce samples having less silt and clay than is actually the case. In assigning of the permeabilities, some allowances were made for this discrepancy.

The areas shown as yielding more than 250 gpm (gallons per minute) have the greatest potential for the development of industrial, municipal, and irrigation wells. The aquifers generally are lenticular in cross section; that is, they are thinnest along their lateral boundaries. Consequently, the largest yields generally are obtained from the central parts of the aquifers. Also, wells penetrating water-bearing deposits in a narrow channel may be expected to have lower sustained yields than wells tapping deposits of comparable thickness that have a large areal extent. The 250-750 gpm area east of Page is underlain by two sand and gravel zones superimposed in the drift. The maximum yields in this area are obtainable only by tapping both the upper and lower zones.

The availability map should be used with the understanding that the estimated yields are for fully penetrating, properly screened, and properly developed wells of adequate diameter. The map is intended as a general guide in the location of ground water, not as a map to locate specific wells. Few, if any, aquifers are so uniform in their water-bearing properties that production wells may be drilled in them without preliminary test drilling.

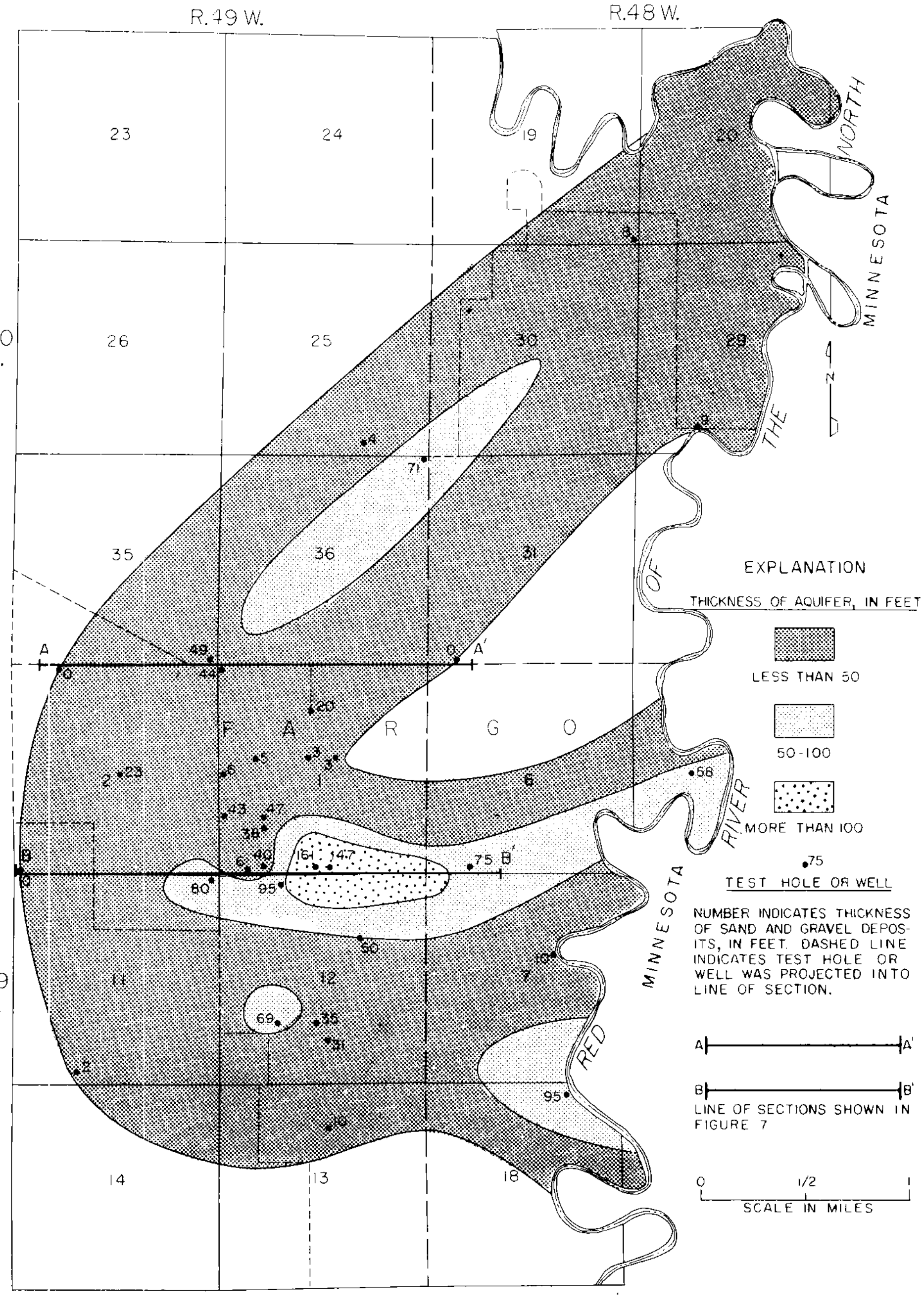


FIGURE 6. Location and thickness of Fargo aquifer, eastern Cass County.

Fargo Aquifer

Location and extent.—The Fargo aquifer is a buried glaciofluvial deposit that underlies an area of at least 10 square miles, mostly within the city limits of Fargo. As shown in figure 6, the aquifer probably extends into Minnesota.

About 25 test holes and wells are known to have penetrated the aquifer. Most of these were drilled prior to 1950 (Dennis and others, 1949, p. 137-150). Four test holes were drilled during the course of the present investigation to delineate the northern part of the aquifer. One test hole in the

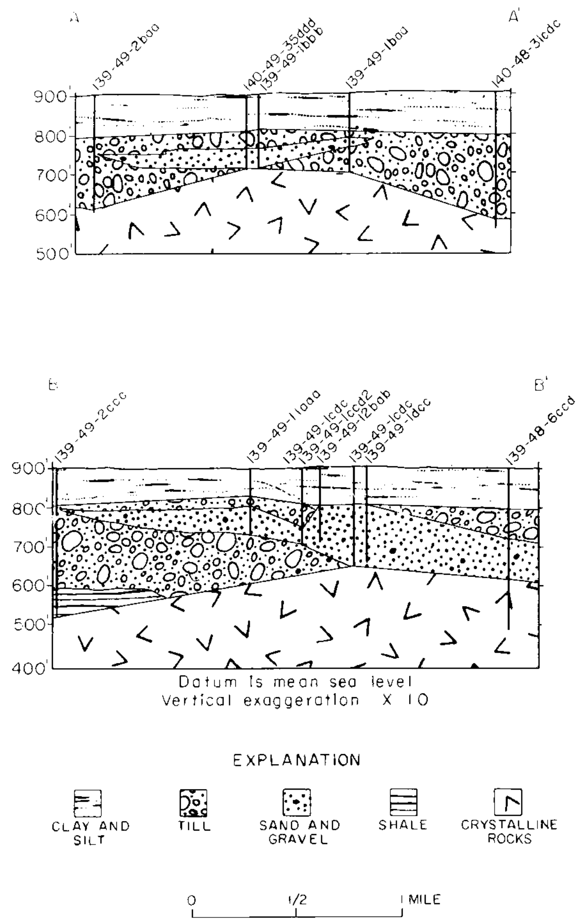


FIGURE 7. Geologic sections in Fargo aquifer.

NE cor. sec. 36, T. 140 N., R. 49 W., penetrated 71 feet of sand and gravel from 157 to 228 feet. Test holes drilled in adjacent sections did not penetrate water-bearing deposits at comparable depths.

Thickness and lithology.—The aquifer ranges in thickness from 0 to about 160 feet and averages about 45 feet. The thickest part is near the south line of sec. 1, T. 139 N., R. 49 W. The aquifer consists of fine to coarse sand interbedded and intermixed with gravel (fig. 7). Boulders were reported in well 139-49-1cdd (Dennis and others, 1949, p. 150).

Reservoir characteristics.—The Fargo aquifer is an artesian system confined at the top by deposits of glacial till and lake clay. The average aggregate thickness of the top confining beds is about 130 feet. The basal confining units may consist either of till or crystalline rock.

Byers and others (1946, p. 35-39) estimated the average coefficient of permeability of the aquifer in the vicinity of well 139-49-1cbd2 (fig. 8) to be 720 gpd (gallons per day) per square foot. Thus for an aquifer 100 feet thick, the coefficient of transmissibility would be 72,000 gpd per foot. However, computations made by Dennis and others (1949, p. 85-86) indicate that the coefficient of transmissibility of the aquifer in the vicinity of wells 139-48-6ccd and 139-49-1cbd2 ranged from a low of 1,190 gpd per foot to a high of 6,180 gpd per foot and averaged 3,700 gpd per foot.

In 1956, a well was developed in the aquifer for industrial use by the Cass-Clay Creamery (139-49-1cdb). Data from the well-development test indicate that the well was pumped for a period of 14 hours at a discharge rate of 400 to 596 gpm and with a drawdown ranging from 68 to 78 feet. The average pumping rate was 478 gpm and the average drawdown was 72 feet.

Because the greater part of the total drawdown in a well pumping from an artesian aquifer occurs during the first few hours of the pumping period, the drawdown data from acceptance and development tests can be used to obtain an estimate of the drawdown in a well at the end of a 24-hour period. These data are useful in estimating the coefficient of transmissibility. As mentioned previously, the average drawdown in well 139-49-1cdb after 14 hours of pumping was 72 feet. Assuming that pumping had continued for an additional 10 hours and that the water level in the well would not have declined more than 4 feet, the drawdown at the end of 24 hours would have been about 76 feet. The pumping rate divided by the drawdown gives a specific capacity of about 6 gallons per foot of drawdown. Using a graph relating specific capacity to transmissibility (Meyer, 1963, p. 338), the estimated coefficient of transmissibility in the vicinity of well 139-49-1cdb is about 10,000 gallons per day per foot.

According to Dennis and others (1949, p. 89), the coefficient of storage ranged from 7.5×10^{-5} to 8.3×10^{-4} and averaged 5.8×10^{-4}.

Recharge, discharge, and movement.—The aquifer could be recharged by lateral movement of water through the till and by downward percolation of water through the overlying sediments. At the present time water levels in the aquifer are well above the top of the till and it seems unlikely

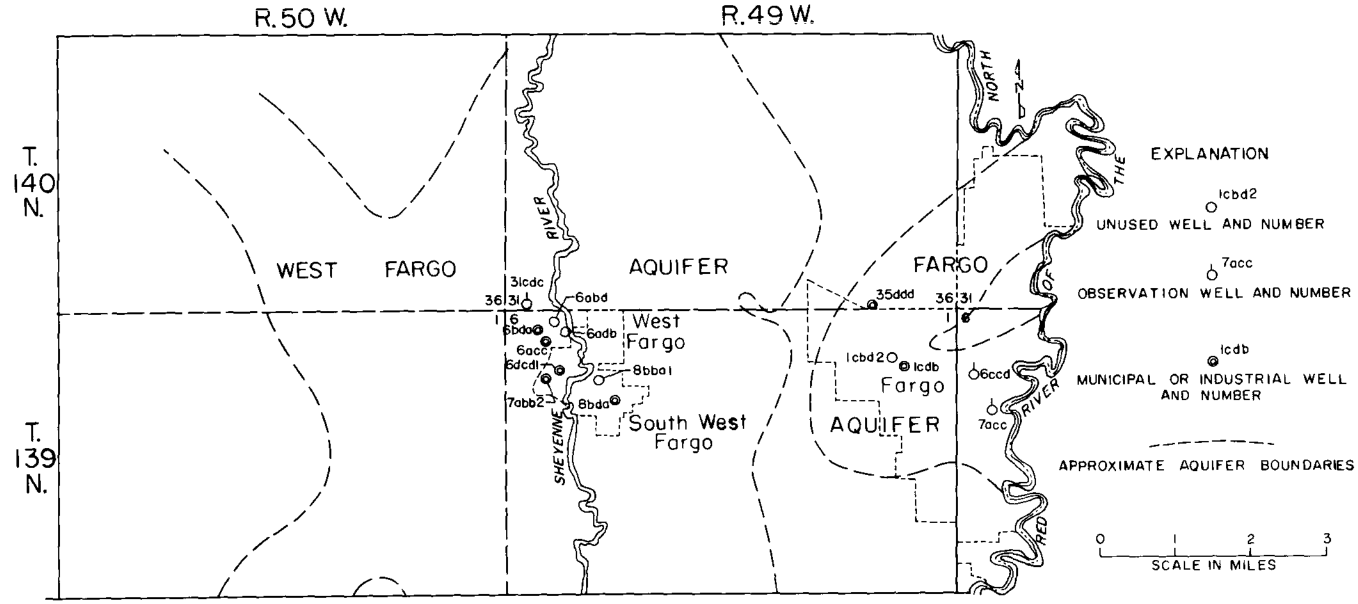


FIGURE 8. Location of key wells in the Fargo and West Fargo aquifers, eastern Cass County.

that the aquifer is receiving significant amounts of recharge from the till. Recharge by downward percolation of water through the overlying materials probably will not take place until water levels in the aquifer are lowered below the base of the lake deposits. The amount of recharge reaching the aquifer by downward percolation of water probably will be insignificant owing to the very low permeability of the overlying sediments and the small areal extent of the aquifer.

Because water levels are 50 feet or more above the top of the aquifer, it seems likely that some water is being discharged into the adjacent deposits. Annual discharge by pumping is estimated to be about 20.5 million gallons. Probably more water is discharged from the aquifer by pumping than by natural means.

According to Dennis and others (1949, p. 73), the hydraulic gradient in the Fargo aquifer in 1937 sloped to the southeast. Excluding temporary reversals of the gradient caused by intermittent pumping of Fargo supply well 139-49-1cbd2 between July 1940 and October 1952, the southeasterly gradient persisted until June 1957, when the hydraulic gradient was reversed. The reversal of the gradient from southeast to northwest was caused by pumping from Cass-Clay Creamery well 139-49-1cdb, which was put into operation June 1, 1956.

Storage.—Assuming an average thickness of 45 feet and a porosity of 30 percent, it is estimated that there is 86,000 acre-feet of water in transient storage; however, the total yield of the aquifer would be much less (see principles of occurrence, p. 9). Pumpage records indicate that at least 1,100 acre-feet of water was withdrawn from storage between July 1938 and October 1952.

Water-level fluctuations.—Dennis and others (1949, p. 73) reported that water levels in the Fargo aquifer had declined 16 to 23 feet between 1910 and 1937. They attributed the decline to pumping from a municipal supply well in Moorhead, Minnesota.

From July 1940 to October 1952, the water level in well 139-48-6ccd declined about 7.5 feet. The decline and the fluctuations of the water level in this well (pl. 2, in pocket) were caused by pumping from Fargo supply well 139-49-1cbd2.

The Fargo supply well was shut down October 7, 1952 and there was no significant amount of pumpage from the aquifer until June 1956. During this period, the water level in well 139-48-6ccd should have recovered to near the 1940 level; however, it did not rise significantly. It is therefore concluded that the water pumped from the aquifer by the Fargo supply well was withdrawn from storage and that the aquifer is receiving little or no recharge.

On June 1, 1956, the Cass-Clay Creamery well, 139-49-1cdb, was put into operation. The water level in well 139-48-6ccd began to decline almost immediately as indicated in plate 2. As of June 1965, the total water-level decline in well 139-48-6ccd caused by pumping of the creamery well was 15.5 feet. The sharp declines of the water level in well 139-48-6ccd during the summers of 1960, 1961, 1963, and 1964 were caused by pumping.

The water-level fluctuations in well 139-48-7acc (pl. 2) are similar to the flucutations in well 139-48-6ccd, but on a smaller scale. The water level in well 139-48-7acc is affected by flood waters in the Red River (Dennis and others, 1949, p. 63). The additional weight of the water in the channel compresses the aquifer and the sediments overlying it, causing a marked rise of the water level. This loading effect is not noticeable in wells farther from the river. The most notable fluctuations of the water level due to loading occurred in April 1947 and May 1962.

The cause of the water-level decline in well 139-48-7acc starting June 1, 1964 is unknown.

Quality of water.—Chemical analyses of two water samples from the aquifer indicate that the water is a hard, sodium bicarbonate type. The total dissolved solids ranged from 750 ppm in the sample taken from Western Fruit Express Co. well 140-49-35ddd, to 1,129 ppm in the sample taken from test hole 140-49-36aaa. The dissolved solids in both samples exceeded the 500 ppm recommended for drinking water by the U.S. Public Health Service. Also, the sample from test hole 140-49-36aaa contained 120 ppm more sulfate than is recommended for drinking water by the U.S. Public Health Service.

A comparison of the following chemical analyses indicates that there has been no significant change of the quality of the water in the aquifer between 1949 and 1964.

Owner:	City of Fargo	Western Fruit Express Co.
Location:	139-49-1cbdl	140-49-35ddd
Date of analysis:	Prior to 1949 (Dennis and others, 1949, p. 112a)	August 19, 1964

Constituents (parts per million)

Silica (SiO_2)	22	18
Iron (Fe)	.43	.35
Calcium (Ca)	45	49
Magnesium (Mg)	15	15
Sodium (Na) and potassium (K)	206	206

Bicarbonate (HOC_3)	324	315
Sulfate (SO_4)	161	162
Chloride (Cl)	132	143
Fluoride (F)	.6	.7
Nitrate (NO_3)	3	1
Hardness as $CaCO_3$	178	185
Total dissolved solids	746	750

Plots of SAR versus specific conductance (fig. 5) show that the two samples have a C3-S2 irrigation classification.

Utilization and potential for future development.—Prior to June 1956, the water pumped from the aquifer was used to supplement the Fargo municipal supply from the Red River in summers when the flow in the river was inadequate or when water demands were unusually high. The pumpage from well 139-49-1cbd2 since its completion in 1938 is given below. Years for which no pumpage is given were wet years in which the flow of the Red River was adequate and the well was not operated.

Year	Months	Gallons pumped
1938	July, August, September, October	22,994,000
1939	July, August, September	18,137,000
1940	July, August, September	14,219,000
1941	June, July, August, September	53,979,000
1942	July, August	9,850,000
1943	April	2,577,000
1944	—	—
1945	—	—
1946	August, September	9,284,000
1947	July, August	13,852,000
1948	June, July, August, September, October	19,037,000
1949	August, September, October	10,700,000
1950	July, August	6,131,000
1951	May, July, August, September	8,650,000
1952	June, August, September	1,285,000
	Total gallons	190,695,000

The Fargo supply well was abandoned on October 7, 1952 and no significant amount of water is known to have been pumped from the aquifer until Cass-Clay Creamery well 139-49-1cdb was placed in operation June 1, 1956. The water from this well is used for cooling and washing purposes. The volume of waste water discharged into the Fargo sewer system indicates that the creamery well pumps about 19.9 million gallons annually.

In November 1960, a well was drilled in the SE cor. sec. 35, T. 140 N., R. 49 W. for the Western Fruit Express Co. The water pumped from this well is used to wash railroad refrigerator cars. Estimated annual pumpage amounts to about 600,000 gallons.

The amount of water withdrawn from the Fargo aquifer between July 1938 and June 1965 is estimated to be about 372.5 million gallons.

The water-bearing properties of the aquifer indicate that wells will yield as much as 1,000 gpm. Dennis and others (1949, p. 105) list data indicating that the maximum seasonal drawdown in well 139-49-1cbd2 was 106.73 feet while pumping at the rate of 850 gpm. A development test for Cass-Clay Creamery well 139-49-1cdb indicated respective drawdowns of 70 and 78 feet when the well was pumped at rates of 400 and 600 gpm. The magnitude and extent of the drawdown cone demonstrate the necessity for locating new developments as far from the creamery well as possible to avoid interference. Because of the shape and limited extent of the aquifer, it is doubtful that any new developments requiring very large quantities of water could be made without producing interference.

At the present time, water levels are well above the top of the aquifer and drainage of the aquifer materials and of the till has not yet begun, even after extended periods of pumping.

West Fargo Aquifer

Location and extent.—The West Fargo aquifer is a buried glaciofluvial deposit that extends in a north-south direction and underlies parts of Tps. 137-140 N., Rs. 49-50 W. The aquifer ranges in width from about 2½ miles in T. 137 N., R. 49 W., to about 8 miles in T. 140 N, R. 49 W. As presently defined, the aquifer underlies an area of about 110 square miles (fig. 9).

Thickness and lithology.—The West Fargo aquifer ranges in thickness from 0 to as much as 140 feet in the northwestern part of T. 139 N. R. 49 W. The average is about 60 feet. The data shown in figures 9 and 10 are from Dennis and others (1949), Klausing (1966), and logs given in the appendix of this report. The orientation of the thick (greater than 90 feet) aquifer segments extending southward from West Fargo suggests that these segments may be buried channel deposits, which probably converge into a single channel about 2 miles north of Horace. This channel may extend southward from Horace; however, additional test drilling would be necessary to verify this assumption.

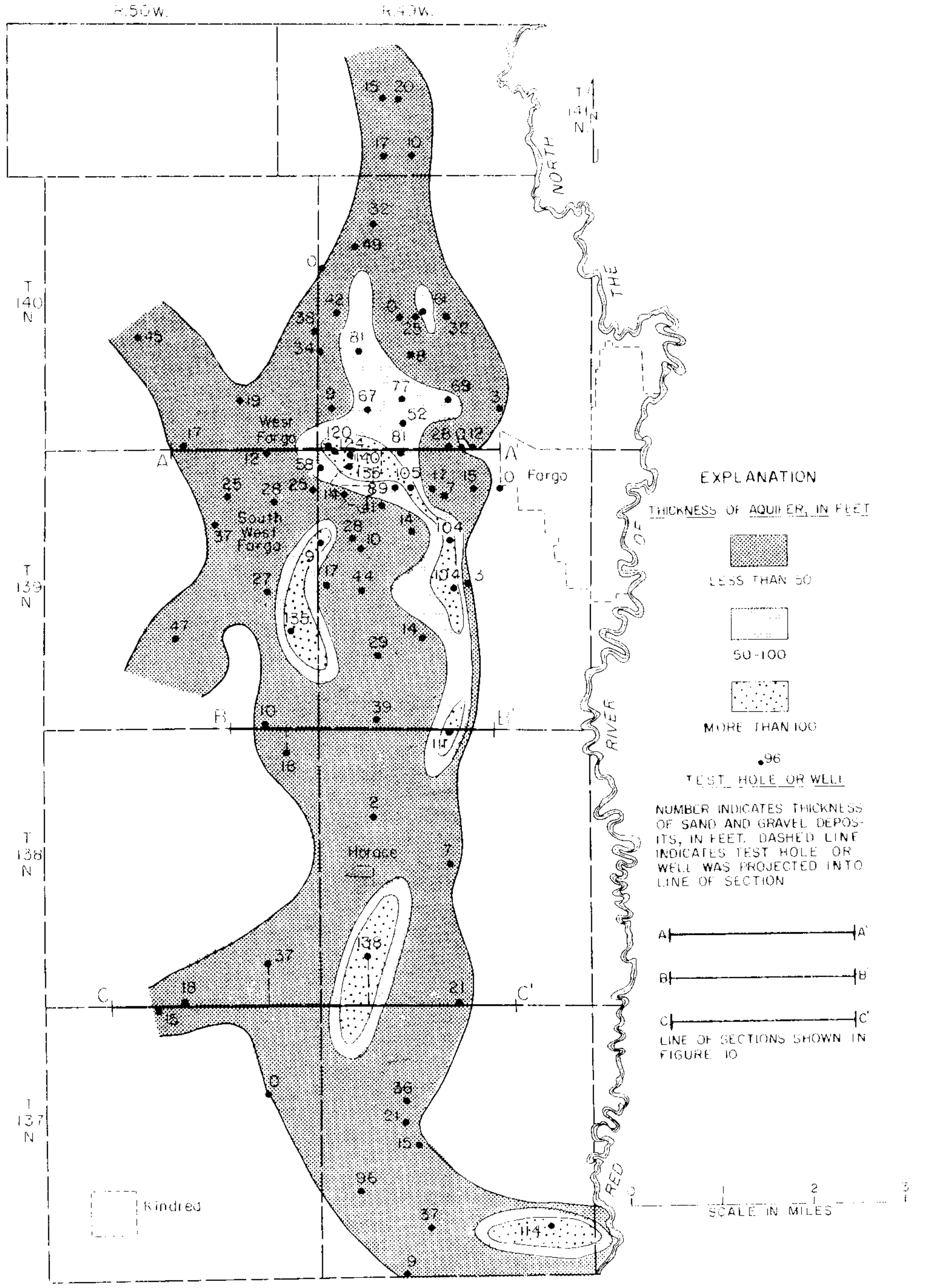


FIGURE 9. Location and thickness of West Fargo aquifer, eastern Cass County.

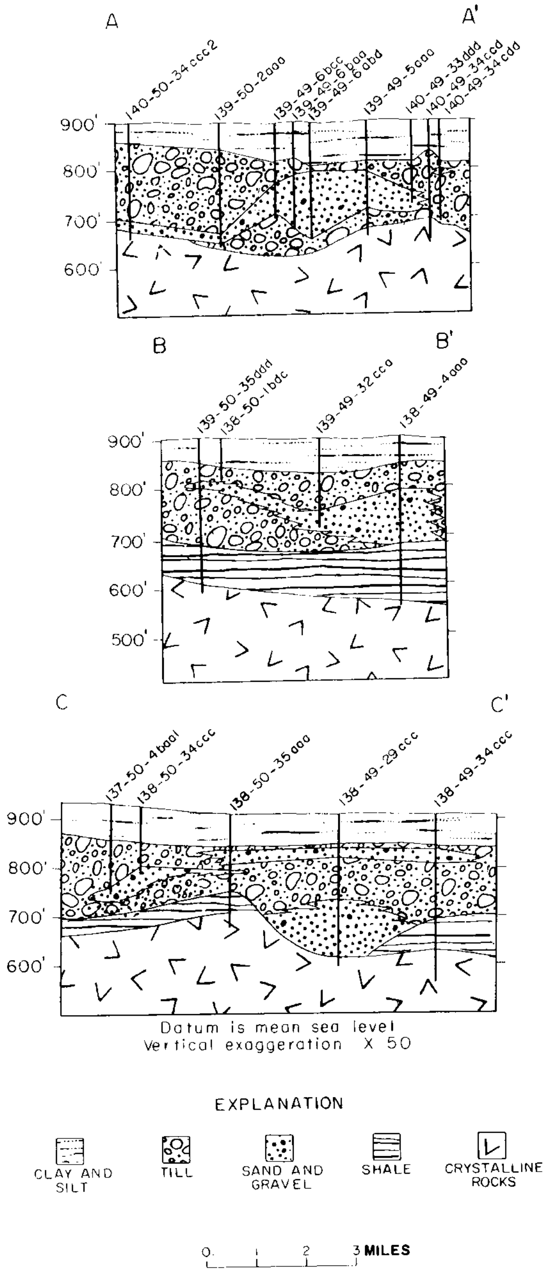


FIGURE 10. Geologic sections in West Fargo aquifer.

The aquifer is composed of material ranging in size from fine sand through boulder, and is mainly fine to coarse sand. In places, the sand and (or) gravel deposits are interlensed with silt and clay. The silt and clay deposits occur most frequently near the top of the aquifer. Non-water-bearing deposits of glacial till lying within the aquifer boundaries were penetrated in a few test holes (Dennis and others, 1949, p. 172-173).

Reservoir characteristics.—The West Fargo aquifer is an artesian aquifer system that is confined at the top by deposits of glacial till and lake clay. The till, which immediately overlies the aquifer, ranges in thickness from 15 to about 90 feet. The till in turn is overlain by lake sediments consisting chiefly of plastic clay that ranges in thickness from 60 to about 90 feet. The aggregate thickness of the top confining beds ranges from 80 to about 170 feet. The basal confining units may be either granite, shale of Cretaceous age, or till. The aquifer is bounded on both sides by deposits of glacial till containing lenses and (or) beds of sand and gravel that may have hydraulic connection with the aquifer.

Dennis and others (1949, p. 87) indicated that the coefficient of transmissibility of the aquifer in the vicinity of Union Stockyards well 139-49-6abd ranged from 33,000 to 125,000 gpd per foot and averaged 71,100. The coefficient of storage as computed by Dennis and others (1949, p. 89) ranged from 1.8×10^{-2} to 4.6×10^{-4} and averaged 3.7×10^{-3}.

In November 1963, a pumping test was run on a newly drilled municipal well in the village of West Fargo. Water levels in the pumped well (139-49-6dcdl) and in three observation wells were measured before, during, and after the pumping period. Computations of the coefficient of transmissibility were made using the Theis nonequilibrium formula (Ferris and others, 1962, p. 62). The computed coefficients of transmissibility ranged from 74,700 gpd per foot to 269,000 gpd per foot and averaged 150,000 gpd per foot. The coefficient of storage ranged from 2.8×10^{-4} to 5.4×10^{-5} and averaged 2.29×10^{-4}.

Records of water-level drawdown occurring in wells during short duration acceptance and development tests were obtained from Siouxland Dressed Beef Co., Union Stockyards Co., and the city of South West Fargo. The drawdown at the end of 24 hours was estimated for each well and the specific capacity of the well was obtained by dividing the pumping rate by the estimated drawdown. Estimates of the coefficient of transmissibility were obtained by using a graph relating specific capacity to transmissibility (Meyer, 1963, p. 338). The physical data and results for the tests made in the West Fargo aquifer are given in table 2.

TABLE 2.--Physical data and results from pumping, development, and acceptance tests in the West Fargo aquifer

Physical data

Owner	Location	Depth	Date of test	Duration (hours)	Pumping rate (gpm)	Drawdown (feet)	Estimated drawdown at end of 24 hours (feet)	Lithology of aquifer at well site
Union Stockyards Co.1/	139-49-6abd	-	7- 7-45	22	900	-	-	Sand and gravel.
City of South West Fargo	139-49-8bda	164	11-19-54	23	610	35	35	Medium to coarse sand.
Union Stockyards Co.	139-49-6acc	208	10-31-57	5	1,290	28	38	Sand and gravel; coarse gravel and boulders with clay lenses.
City of South West Fargo	139-49-7abb2	204	9-22-60	15.50	775	66	68	Sand and gravel.
Siouxland Dressed Beef Co.	139-49-6bda	200	10- 5-60	12	1,150	11	17	Fine sand, sand, gravel, and boulders.
Village of West Fargo	139-49-6dcd1	215.50	11- 8-63	36	508	17.26	-	Fine to coarse sand.

Results

Location	Transmissibility (gpd per foot)	Thickness (feet)	Permeability (gpd per foot)	Storage coefficient	Specific capacity (gallons per minute per foot of drawdown)	Estimated specific capacity, 24 hours (gpm per foot of drawdown)
139-49-6adb1/	71,100	112	634	3.7×10^{-3}	90 estimated	--
139-49-8bda2/	40,000	29	1,380	--	17.4	17.4
139-49-6acc2/	80,000	93	860	--	46.0	34.0
139-49-7abb22/	20,000	14	1,430	--	11.5	11.0
139-49-6bda2/	200,000	107	1,870	--	104.0	67.6
139-49-6dcd13/	150,500	59	2,552	2.29×10^{-4}	29.4	--

1/ U.S. Geological Survey (Dennis and others, 1949, p. 87).

2/ Estimated aquifer coefficients.

3/ Computed aquifer coefficients.

Recharge, discharge, and movement.—Recharge to the aquifer probably occurs by lateral movement of water through the till and associated deposits and by downward percolation of water from the water table in the silt unit of the Lake Agassiz deposits. It is not possible to make an accurate measurement of the amount of water reaching the aquifer, but the following discussions will give some idea to the quantities involved.

The piezometric surface (surface defined by water levels in wells) within the aquifer and adjacent deposits slopes toward the area of heavy pumping. The hydraulic gradient in the area bordering the aquifer on the west and south ranges from about 2 to about 10 feet per mile and probably averages about 5 feet per mile. Assuming that the transmissibility of the till and associated deposits is 1,000 gpd per foot (Dennis and others, 1949, p. 93), the amount of water entering the aquifer along its 28 mile-long western edge would be 1,000 x 5 x 28, or 140,00 gpd. The piezometric surface in the till area east of the aquifer slopes from east to west at about 2 feet per mile. The inflow to the aquifer from the east would be 1,000 x 2 x 28, or 56,000 gpd.

Recharge to the aquifer by downward percolation of water from the silt unit in the Lake Agassiz deposits depends upon the difference in elevation between the water table in the silt unit and the artesian head in the aquifer, and upon the permeability of the material through which the water must pass—the silt and clay units of the Lake Agassiz deposits and the till. Water levels in the West Fargo aquifer range from 22 to about 108 feet below land surface. The average depth to water is 54 feet. The depth to the water table in the silt unit is about 7 feet. Thus, the artesian head in the aquifer is, on the average, 47 feet lower than the water table in the silt unit. The saturated lake deposits and the till have respective average thicknesses of 65 and 50 feet. The water passing downward from the water table to the aquifer will pass through 65 feet of lake deposits and 50 feet of till. The average hydraulic gradient would be $\frac{47}{115}$ feet per foot. Assuming that the lake deposits and the till have a combined average coefficient of permeability of 0.001 gpd per square foot (Dennis and others, 1949, p. 96), the average quantity of water moving downward to the aquifer would be $0.001 \times \frac{47}{115} \times 43{,}560 \times 640 = 11{,}148$ gpd per square mile. The total amount of recharge to the aquifer by movement of water downward from the water table in the silt unit would amount to about 1.2 million gpd over the 110 square mile area considered.

Thus, although the actual amount of recharge reaching the aquifer cannot be measured directly, it seems likely that the daily recharge rate is more than 1 million gallons.

Prior to development, water was probably discharged from the aquifer by lateral and upward movement into the adjacent deposits. The amount of water discharged from the aquifer by natural processes has undoubtedly decreased as the number of wells pumping from the aquifer increased. At the present time it is believed that most of the water leaving the aquifer is discharged by pumping. Approximately 471 million gallons of water was pumped from the aquifer during 1965.

Storage.—A substantial quantity of water is stored in the West Fargo aquifer. Using an estimated porosity of 30 percent and an average saturated thickness of 46 feet, the amount of water in storage would be 110 x 46 x 640 x 0.30, or about 972,000 acre-feet; however, the yield of the aquifer would be much less (see page 9).

The estimated change in storage from November 1964 to November 1965 based on an average water-level change of 1.42 feet and an average coefficient of storage of 4.7 x 10^{-3} is 1.42 x 110 x 0.0047 x 7.5 x 640 x 43,560, or about 153.5 million gallons. This is only 32 percent of the estimated 471 million gallons withdrawn in 1965. The estimated change in storage and the estimated annual recharge together account for about 80 percent of the estimated annual withdrawal. The water levels in the aquifer continue to decline, indicating that discharge exceeds recharge; therefore, it is assumed that an additional 20 percent, or about 90 million gallons of water was withdrawn from storage during the period from November 1964-November 1965.

Water-level fluctuations.—Well 139-49-6adb (139-49-6ad, Dennis and others, 1949, p. 77) is about 700 feet east of the old Union Stockyards supply well, 139-49-6abd (139-49-6ab2, Dennis and others, 1949, p. 54), and about 0.3 mile east of the new supply well, 139-49-6acc (fig. 9). The hydrograph for well 139-49-6adb (pl. 2) spans a period of about 28 years and shows that the water level has declined about 85 feet since January 1938.

The water-level fluctuations occurring between January 1938 and October 1957 reflect variations in the pumping regimen of Union Stockyards well 139-49-6abd. Use of this well was discontinued about November 1, 1957, and the new supply well, 139-49-6acc, was made operational at that time. Thus, the fluctuations of the water level in well 139-49-6adb between November 1, 1957 and September 1960 were caused by variations in the pumping from well 139-49-6acc. South West Fargo municipal well 139-49-7abb2 and Siouxland Dressed Beef Co. supply well 139-49-6bda were developed in the aquifer in 1960. Both these wells were in operation by the middle of November 1960. Pumping from wells 139-49-6acc, 139-49-6bda, and 139-49-7abb2 caused the water level in well 139-49-6adb to decline about 13 feet between November 1960 and November 1962. The water level in this well continued to decline at the rate of about 1 foot per year until October 1, 1964. West Fargo municipal well 139-49-6dcdl was put into operation at this time and the pumping of this well is believed to have caused the 1 foot of water-level decline occurring between the latter part of August and the first part of October.

Well 139-49-8bbal is an abandoned municipal supply well in the city of South West Fargo. The hydrograph (fig. 11) of this well shows that the water level declined about 6 feet between August 1962 and August 1965. The general lowering of the water level represents the combined effect of pumping from municipal and industrial wells in secs. 6-8, T. 139 N., R. 49 W. The short-term fluctuations reflect variations in the pumping regimen of supply well 139-49-8bda, which is about one-third mile southeast.

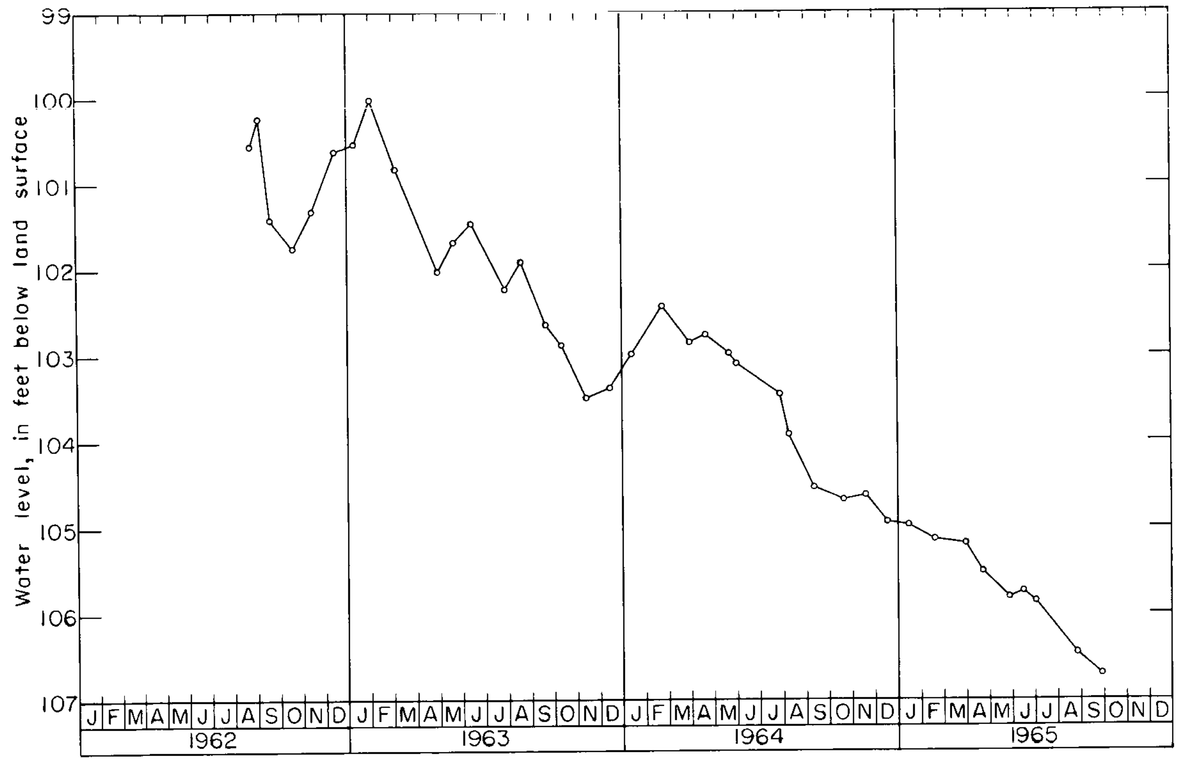


FIGURE 11. Water-level decline in South West Fargo municipal well 139-49-8bbal, 1962-65.

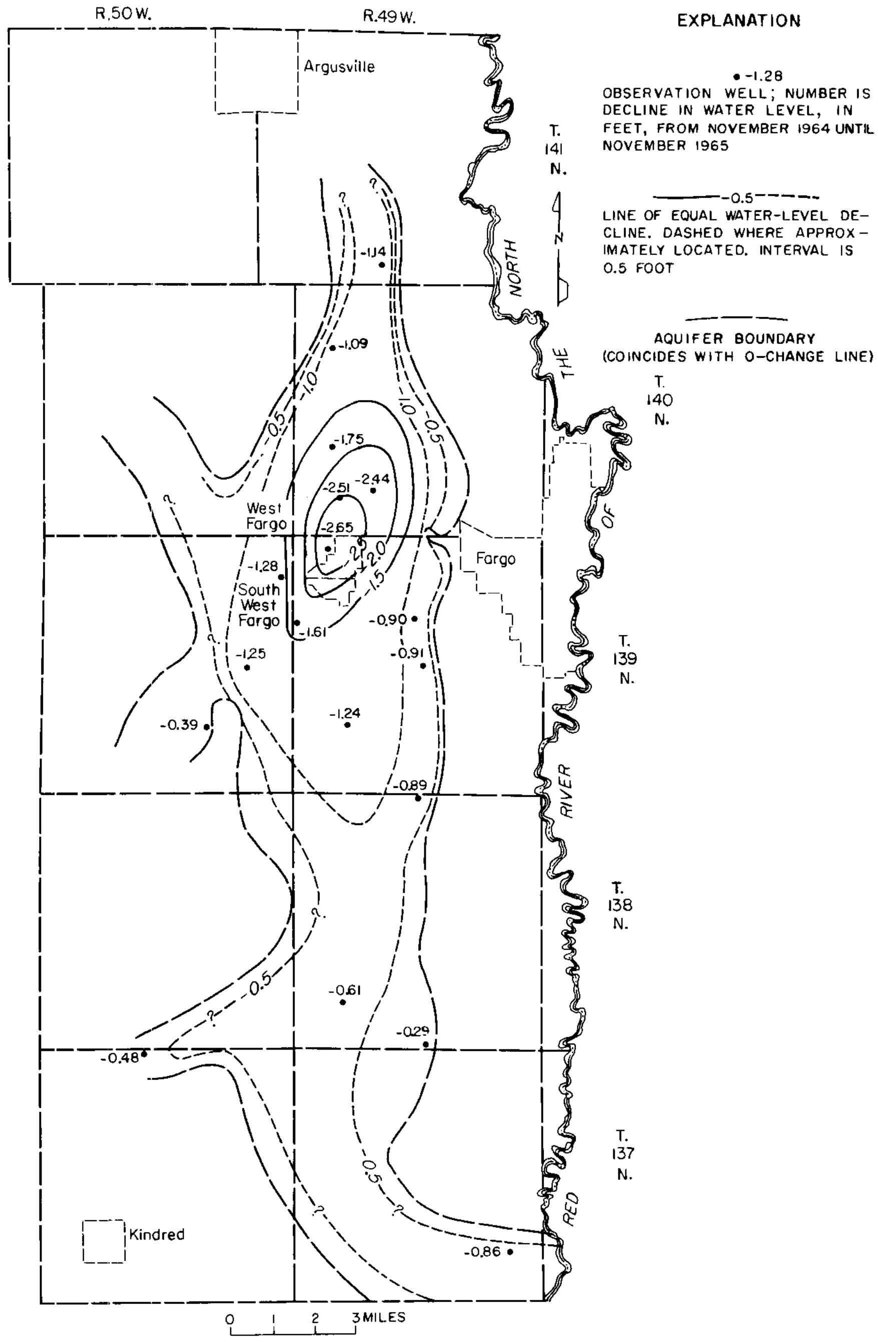


FIGURE 12. Regional water-level decline in West Fargo aquifer from November 1964 to November 1965, eastern Cass County.

Water levels measured during the first week of November 1964 were compared with those measured in the same well during the first week of November 1965. The comparison shows a regional decline of water levels throughout the aquifer (fig. 12). The decline, which ranged from 0.61 to 2.65 feet and averaged 1.42 feet, is attributed to pumping from industrial and municipal wells in the vicinity of West Fargo. The maximum decline of 2.65 feet was in observation well 139-49-6adb, which is near the point of greatest withdrawal.

Quality of water.—Chemical analyses of 21 water samples from the West Fargo aquifer indicate that the water is hard to very hard. Dissolved solids range from 377 ppm to 1,562 ppm. Average iron content is 0.57 ppm.

Sodium is the predominant cation. The predominant anions are bicarbonate and chloride. The bicarbonate content ranges from 256 ppm to 784 ppm and the chloride ranges from 50 to about 480 ppm. Analyses of water samples from wells tapping water-bearing sand and gravel lenses in the outlying areas show that the bicarbonate content of these waters has about the same range as the water in the aquifer. However, this is not the case with chloride. Water samples collected from wells located east of the aquifer generally have a much lower chloride concentration than do those collected from wells west of the aquifer. The general east to west increase in chloride content is accompanied by a transition from a sodium bicarbonate type water to a predominantly sodium chloride type (fig. 13).

The westward increase in the chloride content of the water probably is due to leakage of saline water from the Dakota Sandstone, which underlies the glacial deposits farther west.

A comparison of the following chemical analyses shows that there has been no significant change in the water quality in this part of the aquifer since 1949. Thus, it is possible that the water quality has not changed appreciably since the aquifer was developed.

Owner:	Union Stockyards	Union Stockyards
Location:	139-49-6ab2	139-49-6acc
Date of analysis:	Prior to 1949 (Dennis and others, 1949, p. 112a)	July 25, 1965

Constituents (parts per million)

Silica (SiO_2)	26	23
Iron (Fe)	.39	.66
Calcium (Ca)	57	67
Magnesium (Mg)	21	14

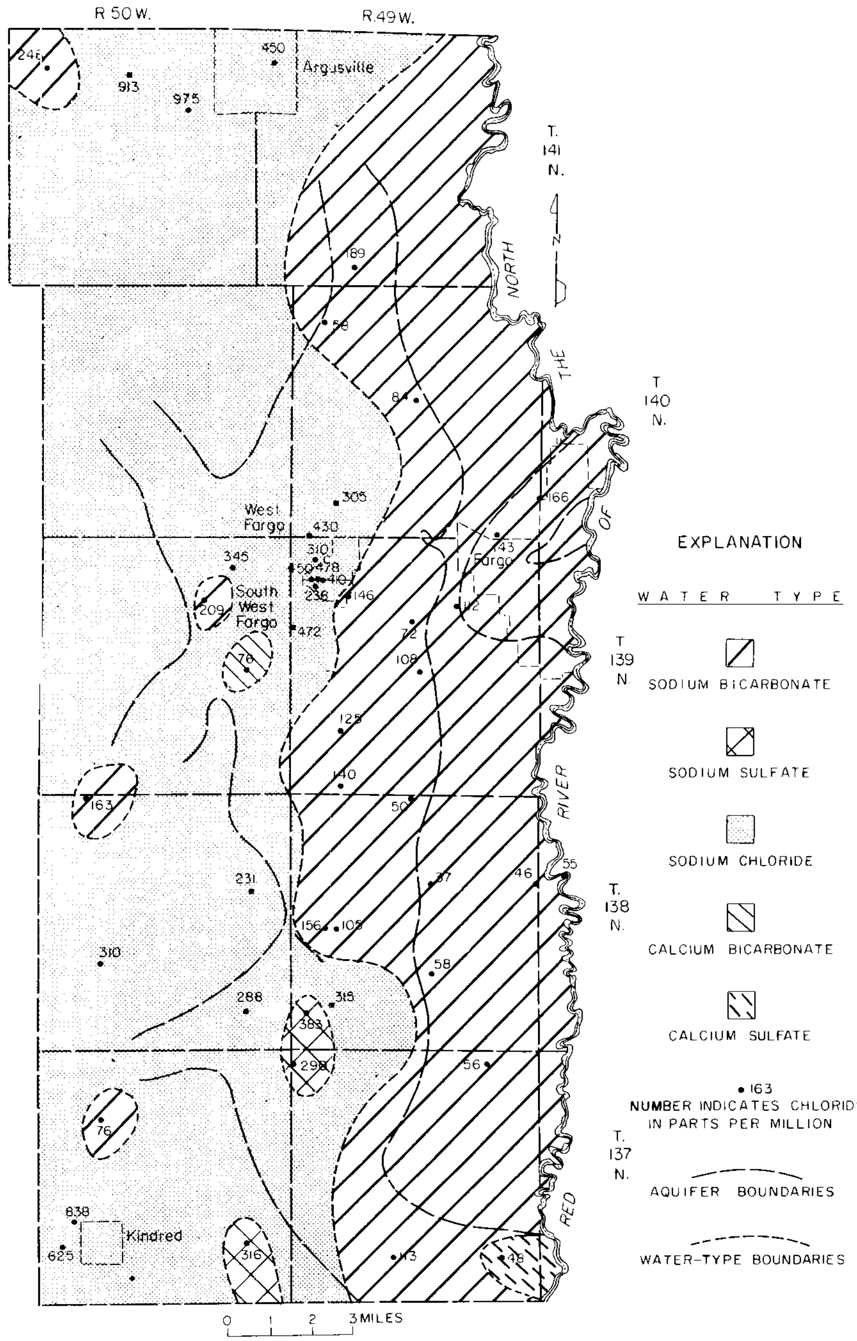


FIGURE 13. Distribution of ground-water types in eastern Cass County.

Sodium (Na) and potassium (K)	325	312
Bicarbonate (HCO_3)	412	377
Sulfate (SO_4)	90	151
Chloride (Cl)	355	310
Fluoride (F)	.6	.5
Nitrate (NO_3)	5.2	5.3
Hardness as $CaCO_3$	228	224
Total dissolved solids	1,090	1,070

Plots of SAR versus specific conductance (fig. 5) show that most of the water samples from the West Fargo aquifer fall in the C3-S1 or C3-S2 irrigation classification.

Utilization and potential for additional development.—The water pumped from the West Fargo aquifer is used to meet industrial and municipal needs in the vicinity of South West Fargo. The use and amount of water pumped annually by individual users are given below.

Pumpage from West Fargo aquifer, 1965

User	Use	Pumpage (gallons)
Union Stockyards [1]	Stock watering and washing	180,000,000
Siouxland Dressed Beef Co. [2]	Cooling and washing	195,616,000
City of South West Fargo [3]	Municipal	83,500,000
Village of West Fargo [4]	Municipal	9,510,000
Goldena Mills [5]	Manufacture of stock feed	600,000
	Total	469,226,000

1 Oral comunication, K. R. Lehman.

2 Determined from sewage records.

3 Metered.

4 Oral communication, Richard Fuller.

5 Oral communication, Howard Emerson.

Another principal user is the Woodlee Water Company, a private company that provides water to 36 residences outside the city of South West Fargo. It is estimated that the pumpage from the water company wells amounts to about 1,730,000 gallons annually. This estimate is based on a water use survey made by the city of South West Fargo, which indicated that the average monthly water use per residence was about 4,000 gallons (J. Dahl, oral communication).

On the basis of these data, about 470 million gallons of water was pumped from the aquifer during 1965. This is believed to be a minimal figure because it does not include pumpage from small industrial, motel, or farm wells.

Water levels are about 22 feet below the land surface in the southern part of the aquifer. Water levels in the northern part range from 60-100 feet below land surface.

Wells 139-49-6acc and 139-49-6bda, which are only about 700 feet apart, are in the center of the ever-expanding cone of depression. The pumping level in well 139-49-6bda was reported to be 112 feet below land surface in October 1964 (Tom Sands, oral communication), which would be about 9 feet below the top of the aquifer. Water levels in observation wells 139-49-6adb, 140-49-29ddd, and 140-49-31cdc also are below the top of the aquifer and indicate that locally the aquifer is being dewatered.

New developments in the aquifer should be located as far as possible from wells 139-49-6acc and 139-49-6bda to avoid large interference effects. Also, the effects of pumping from South West Fargo municipal wells 139-49-7abb2 and 139-49-8bda should be considered before any new development is made in these areas.

Any development in the northern part of the aquifer that requires large daily withdrawals probably will cause the existing low water levels to decline below the top of the aquifer.

Wells developed in that part of the aquifer lying south of the present pumping area probably will intercept water moving toward the wells in secs. 6-8, T. 139 N., R. 49 W. The diversion of water to new wells would decrease the amount of recharge to the original well field. Consequently, the rate of water-level decline in the vicinity of West Fargo would probably increase.

Yields from wells developed in the buried channel deposits comprising the southern extension of the aquifer will be influenced by the aquifer boundaries. For example, if a well developed in these deposits is pumped at a rate comparable to that of well 139-49-6acc (table 2), the drawdown in the new well will be much greater because the flow of water to the well is restricted to the channel segments; whereas the flow of water to well 139-49-6acc is radial. The conditions imposed upon a well pumping from the channel deposits may be such that it would not be possible to pump water at a rate comparable to that pumped by wells tapping more extensive parts of the aquifer.

Interconnection of Fargo and West Fargo aquifers.—Dennis and others (1949, p. 76-77) concluded that the Fargo and West Fargo aquifers were interconnected. Their conclusion was based on the similarity of water-level fluctuations in Union Stockyards well 139-49-6adb in the West Fargo aquifer and in wells 139-49-1ccd2 and 139-48-6ccd, both in the Fargo aquifer. No recent water-level data are available for well 139-49-1ccd2 because it has been destroyed. A comparison of the long-term hydrographs for well 139-49-6ccd and well 139-49-6adb (pl. 2) shows similarity of water-level trends prior to 1952; however, the trends are not believed to be related. From January 1952 to June 1956, the maximum water-level fluctuation in well 139-49-6ccd was only about 1.5 feet, whereas the maximum fluctuation in well 139-49-6adb was about 20 feet. There was no significant change of the water level in well 139-49-6ccd during the period January 1952 to June 1956, but during the same period the water level in well 139-49-6adb declined about 17 feet. If there was good hydraulic connection between the aquifers, the water level in well 139-49-6ccd should have declined in response to the pumping from the West Fargo aquifer.

Although the Fargo and West Fargo aquifers approach each other closely (fig. 8), there is no geologic evidence to indicate that the aquifers are connected (figures 7 and 10). Disregarding the lake deposits, the material lying between the aquifers consists of till, which contains thin lenses of sand and gravel. These lenses generally occur at different horizons and are therefore not considered to be connected.

Page Aquifer

Location and extent.—The Page aquifer, in the northwestern part of the county, extends northward from near the south line of T. 141 N., R. 54 W., into Steele County. In Cass County the aquifer underlies parts of Tps. 141-143 N., Rs. 53-55 W., and has an areal extent of about 155 square miles. The aquifer boundaries are not definitely known; however, the available data indicate that the aquifer probably does not extend beyond the limits shown on plate 1.

Thickness and lithology.—The aquifer consists of two intervals of sand and gravel that are superimposed in the drift. The upper interval, hereafter referred to as "zone A" is a buried glaciofluvial deposit consisting of very fine to coarse sand. It ranges in thickness from 0 to 78 feet. The lower interval, "zone B," is a buried outwash deposit consisting chiefly of fine to medium sand. This interval ranges in thickness from 0 to about 50 feet (fig. 14). Both intervals were penetrated in test holes 142-54-1bbb and 142-54-8ddd where they have respective aggregate thicknesses of 129 feet and 89 feet (fig. 15). In these test holes, zones and A and B are separated by about 30 feet of till; however, it is not known if this separation prevails throughout the extent of zone A.

Reservoir characteristics.—The Page aquifer is an artesian system confined at the top by deposits of glacial till that range in thickness from 9 to 80 feet.

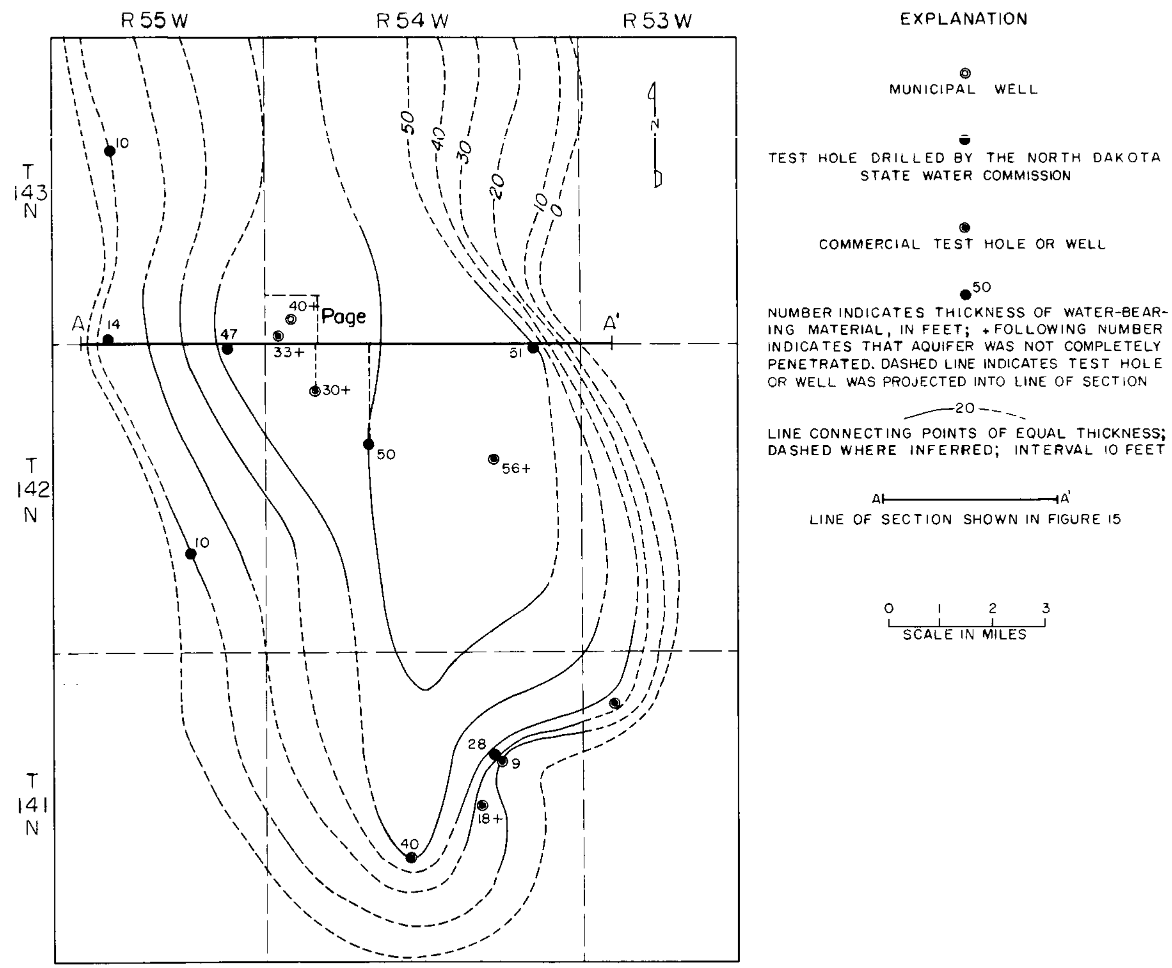


FIGURE 14. Thickness of zone B in Page aquifer, northwestern Cass County.

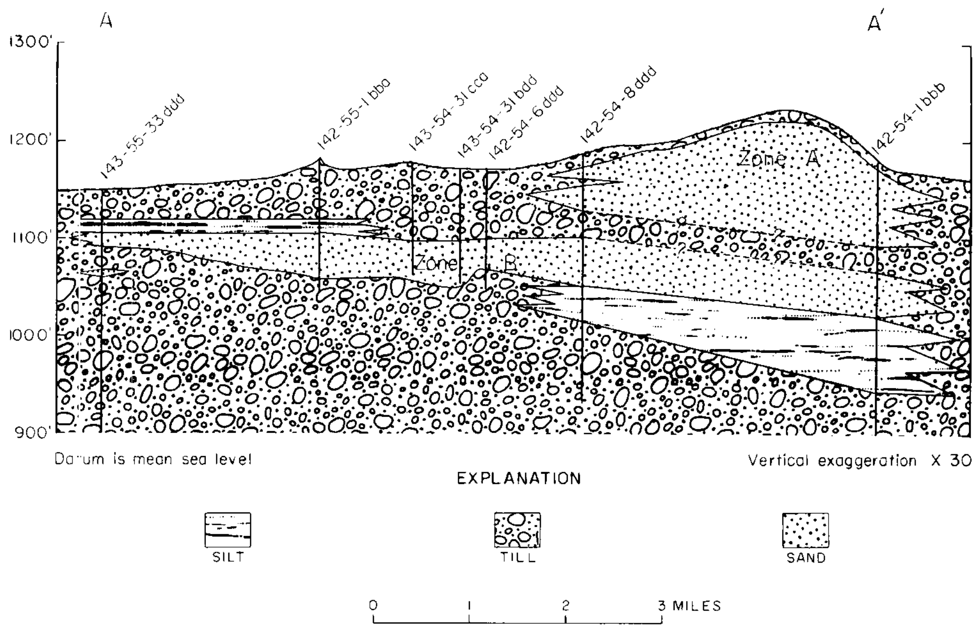


FIGURE 15. Geologic section in Page aquifer.

Page municipal well 143-54-31bdd, which was drilled in zone B and put into operation in July 1962, penetrated 40 feet of fine sand in the interval 81-121 feet and had a static water level of 23.5 feet. During the development test the well was pumped for 12 hours at a rate of 230 gpm with a drawdown of 46 feet. With the exception of 1 foot of water-level rise during the eighth and ninth hours of pumping, the pumping level remained rather constant at 69.5 feet after the second hour of pumping, suggesting that equilibrium between discharge and rate of flow to the well had been reached. Because the pumping level remained relatively constant after the second hour of pumping, it seems unlikely that there would be any appreciable increase in the drawdown at the end of 24 hours.

Assuming that the drawdown remained at near 46 feet, the specific capacity of the well would be 5 gpm per foot of drawdown. Using Meyer's method (1963, p. 338), the coefficient of transmissibility of the aquifer in the vicinity of the well is estimated to be about 10,000 gpd per foot. The estimated coefficient of transmissibility for the aquifer as a whole, based on analyses of drill samples from test holes, ranged from 4,000 gpd per foot to 82,000 gpd per foot.

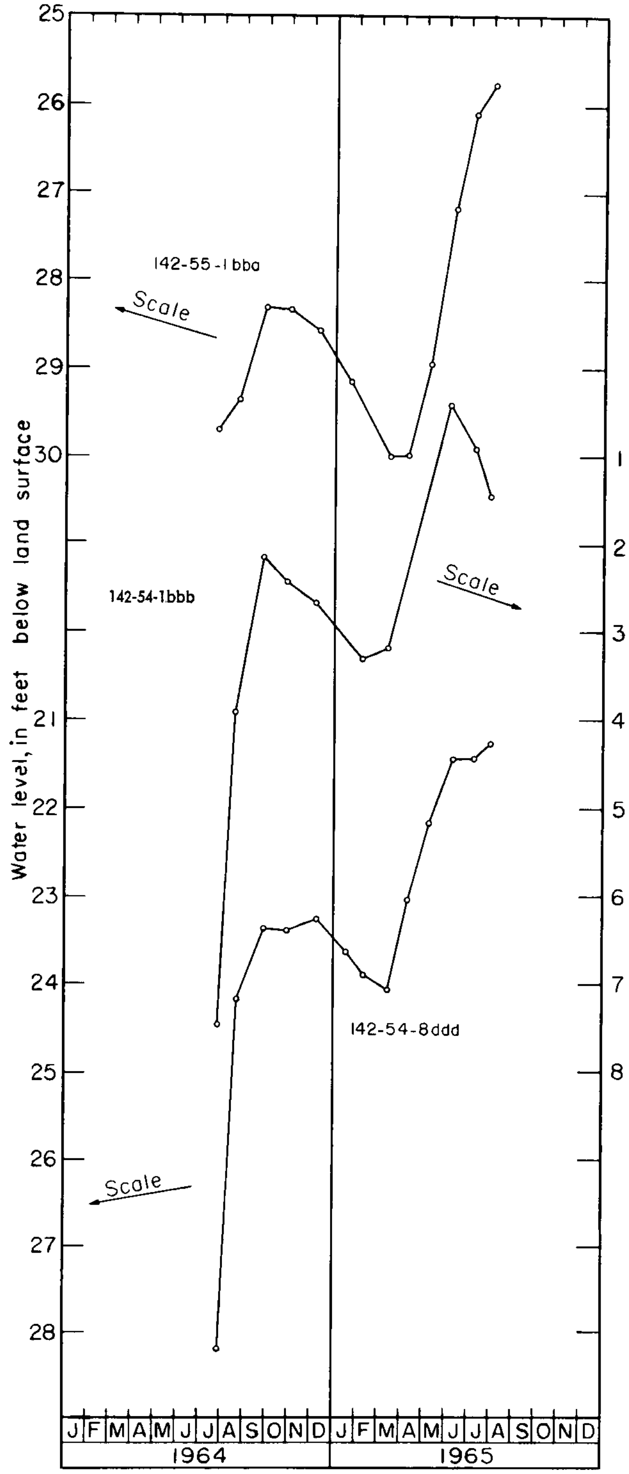


FIGURE 16. Water-level fluctuations in the Page aquifer.

Storage.—Based on an average thickness of 30 feet and an assumed porosity of 30 percent, it is estimated that there is about 900,000 acre-feet of water in transient storage; however, the yield of the aquifer would be much less (see page 9).

Records show that water levels in three wells drilled into the aquifer in 1928, 1951, and 1962 were, respectively, about 26, 27, and 23.5 feet below land surface (Klausing, 1966, p. 77). These water levels are comparable to present-day (1965) levels and indicate that there has been no appreciable decrease in storage in the aquifer during the past 30-40 years.

Water-level fluctuations.—The hydrographs for observation wells 142-54-1bbb, 142-54-8ddd, and 142-55-1bba (fig. 16) span a period of 1 year and are not of sufficient length to permit an accurate analysis of the water-level fluctuations. However, the apparent correlation of the water-level fluctuations in the three wells warrants some discussion.

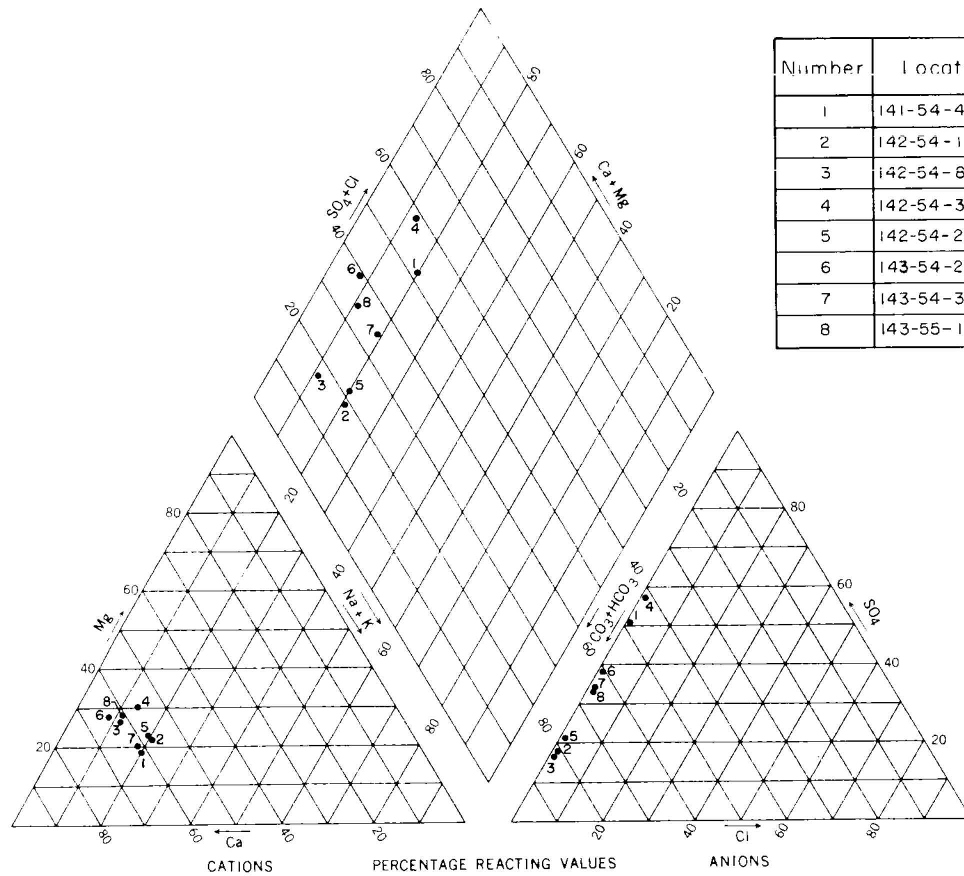
The three observation wells were installed during the latter part of July 1964. The first water-level measurements were made only a few days after the casings were installed. The leveling off and subsequent decline of the water levels, which occur during the late fall and winter, indicate that discharge exceeds recharge and that there is a temporary loss of storage in the aquifer. The rapid rise in water levels in the spring is believed to be the combined result of recharge and compression of the aquifer by water loading on the land surface. Precipitation in the area was unusually high during April, May, and early June.

Quality of Water.—Analyses of eight water samples from the aquifer show that the water is predominantly a calcium bicarbonate type. The water is very hard and the dissolved solids range from 290 to 850 ppm. Average iron content is 1.7 ppm. The percentages of the major constituents in the water are shown on figure 17.

Plots of SAR versus specific conductance (fig. 5) show that most of the water samples from the Page aquifer are classified as a C3-S1 type water for irrigation.

Utilization and potential for additional development.—Most of the water pumped from the aquifer is used for domestic purposes. The public supply well at Page is the only ground-water development of large magnitude in the aquifer. This well pumps about 7 million gallons a year and it is estimated that about 20.4 million gallons of water have been withdrawn from the aquifer during the period extending from August 1962 to July 1965. Lesser amounts of water are pumped from the aquifer to meet rural domestic and stock needs. The total annual pumpage from the aquifer is estimated to be between 8 and 10 million gallons.

From the standpoint of areal distribution and thickness of water-bearing materials, the Page aquifer appears to have a greater potential for additional development than do most of the aquifers in the county. Present information regarding this aquifer is inadequate to estimate the amount of water that could be withdrawn from it under a given set of pumping



Number	Location	Dissolved solids (ppm)
1	141-54-4ccd	850
2	142-54-1bbb	337
3	142-54-8ddd	286
4	142-54-34aad	812
5	142-54-25cbc	553
6	143-54-23bba	611
7	143-54-31bdd	586
8	143-55-15dcd	579

FIGURE 17. Major constituents in water from the Page aquifer.

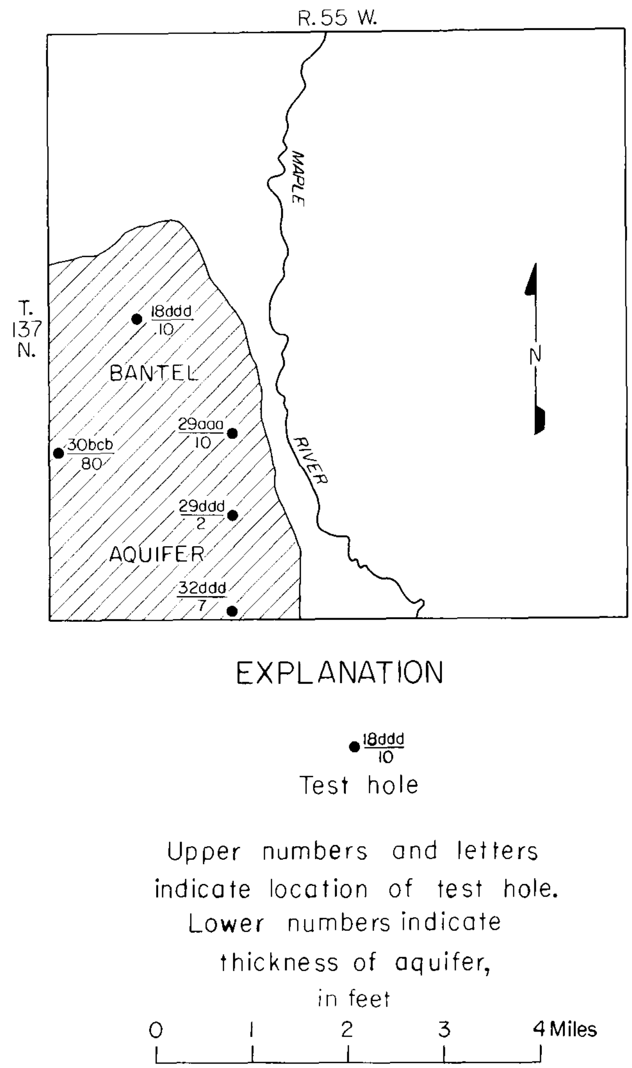


FIGURE 18. Location and thickness of Bantel aquifer, southwestern Cass County.

conditions. Depending upon the local thickness and permeability of the material penetrated, properly constructed wells tapping the aquifer should yield from 250 to 750 gpm.

The drawdown in the Page municipal well (143-54-31bdd) while pumping at a rate of 230 gpm was 46 feet. Comparable drawdowns may be expected in new wells pumping at rates greater than 200 gpm. Although nothing is known about the extent of the cone of depression caused by pumping the Page well, the fairly large drawdown indicates that any new developments should be widely spaced to avoid excessive well interference.

Bantel Aquifer

Location and extent.—The Bantel aquifer underlies about 9 square miles in the southwest corner of Cass County and extends westward into Barnes County (Kelly, 1966 p. 40).

Thickness and lithology.—The aquifer in Cass County ranges in thickness from 0 to 80 feet and consists of fine to coarse sand intermixed with gravel. Two test holes, 137-56-26aaa (Kelly, 1964, p. 68) and 137-55-30bcb (Klausing, 1966, p. 106), penetrated sand and gravel deposits that are 88 and 80 feet thick, respectively. These large thicknesses, when compared with the smaller thicknesses elsewhere, as shown on figure 18, suggest that the thicker parts of the aquifer may be confined to a narrow channel. Also, the aquifer is exposed along the south side of an intermittent stream channel in secs. 31-32, T. 137 N., R. 55 W., suggesting that the aquifer is lenticular and that the thicker sand and gravel deposits may occupy a partly exhumed buried channel.

Reservoir characteristics.—The Bantel aquifer is confined at the top and bottom by deposits of glacial till. The till overlying the aquifer ranges in thickness from 5 to about 40 feet.

The estimated coefficient of transmissibility ranges from about 800 gpd per foot in test hole 137-55-29ddd to about 190,000 gpd per foot in test hole 137-55-30bcb. However, as most of the test holes penetrated 10 feet or less of sand and gravel, the overall transmissibility of the aquifer probably is less than 8,000 gpd per foot.

Recharge, discharge, and movement.—Because the aquifer is small in areal extent, it probably does not receive much recharge from the downward percolation of water derived from melting snow or rainfall. One possible source of recharge to the aquifer is in Barnes County where the aquifer intercepts a glacial melt-water channel (T. E. Kelly, oral communication). The greatest amount of recharge from this source would occur during the spring and early summer when the channel carries runoff from melting snow and rainfall.

Water is discharged from the aquifer naturally by lateral movement into adjacent deposits and by springs where erosion has exposed the aquifer. A small amount of water is discharged by pumping from farm wells.

The available water-level data indicate that the hydraulic gradient within the aquifer slopes from west to east (Kelly, 1966 p. 42).

Water-level fluctuations.—No long-term water-level data are available for this aquifer. The lowest water level measured was 22.75 feet below land surface in January 1965. The highest water level was 21.3 feet below land surface in April 1965.

Quality of water.—An analysis of a water sample taken from observation well 137-55-30bcb shows the water to be a sodium sulfate type. The water is very hard, contains 0.36 ppm iron, and has a dissolved solids concentration of 1,350 ppm. The irrigation classification is C3-S1 (fig. 5).

Utilization and potential for additional development.—Present development in the aquifer consists of farm and stock wells. The amount of water withdrawn annually by these wells is unknown. Developments requiring large daily withdrawals of water probably would not be feasible because the aquifer is small in areal extent and relatively thin.

Sheyenne Delta Aquifer

Location and extent.—The Sheyenne delta occupies an area of about 750 square miles, mostly in Richland and Ransom Counties (Baker and Paulson, 1967, p. 33). The areal extent of the delta in Cass County is about 60 square miles; however, only about two-thirds of this area is underlain by permeable deposits. These are mainly in T. 137 N., Rs. 52-53 W. (pl. 1).

Only four test holes penetrated the full thickness of the aquifer and three of these were near the Cass-Richland county line. The northern limits of the aquifer shown on plate 1 are based on well-inventory data.

Thickness and lithology.—In Cass County, the Sheyenne Delta aquifer consists of two sand bodies that are separated by a silt bed about 20 feet thick (fig. 19). The upper sand, which is fine to medium, ranges in thickness from 0 to about 50 feet. The lower sand, which seems to be finer grained and silty, ranges in thickness from 0 to about 60 feet. The maximum thickness of the aquifer, including the intervening silt bed, is about 120 feet.

Reservoir characteristics.—The estimated transmissibility ranges from 1,500 to 36,500 gpd per foot and averages about 20,000 gpd per foot.

Water in the upper sand and in the underlying silt unit is under water-table conditions. The coefficient of storage of these two units is probably between 0.05 and 0.25. Water in the lower sand is probably under semiartesian conditions caused by the overlying less permeable silt unit. Assuming that the water in the lower unit is semiconfined, the coefficient of storage for that unit may be on the order of 0.01 to 0.001.

Recharge, discharge, and movement.—The aquifer is readily recharged by direct infiltration of water derived from melting snow and rainfall. The greatest amount of recharge to the aquifer occurs during the spring and early summer. Baker and Paulson (1967, p. 25) estimated that the annual recharge in Richland County is about 50,000 acre-feet. The area underlain by the aquifer in Cass County is about 13 percent of the area

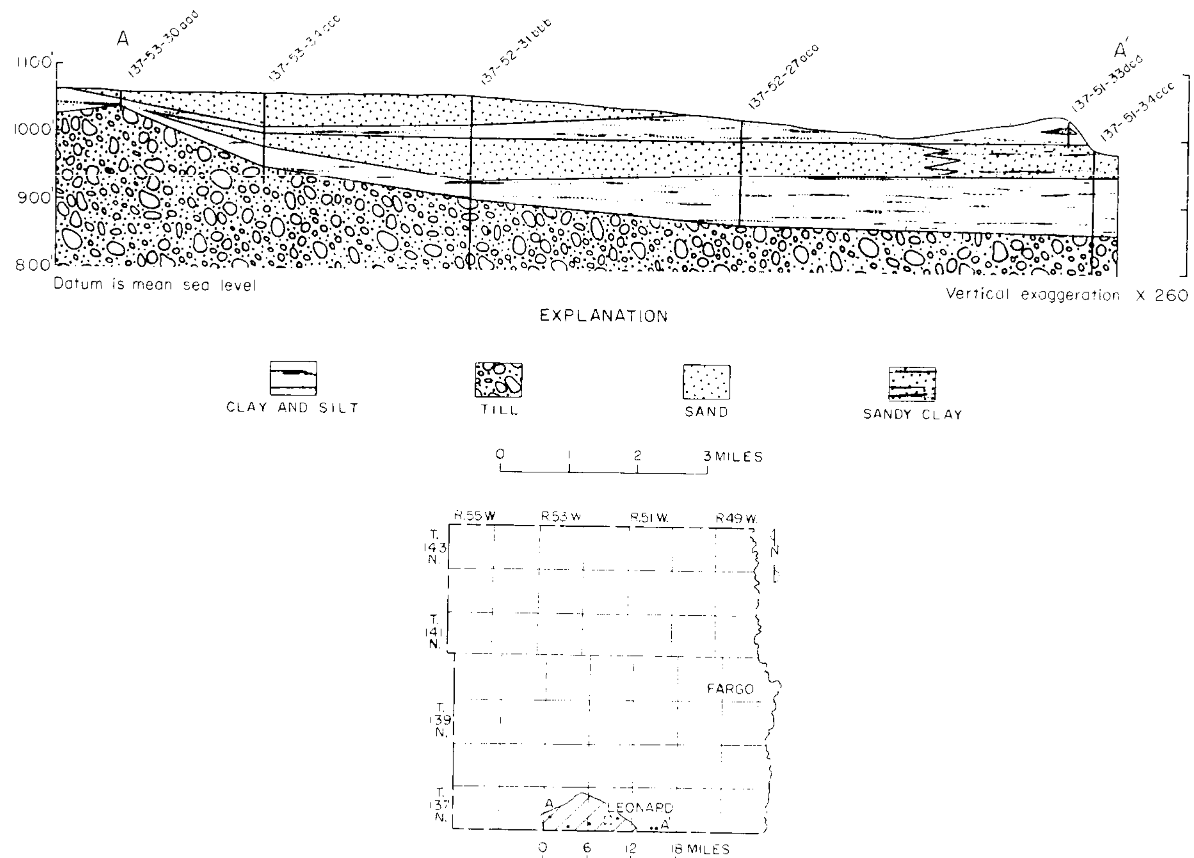


FIGURE 19. Geologic section in the Sheyenne delta.

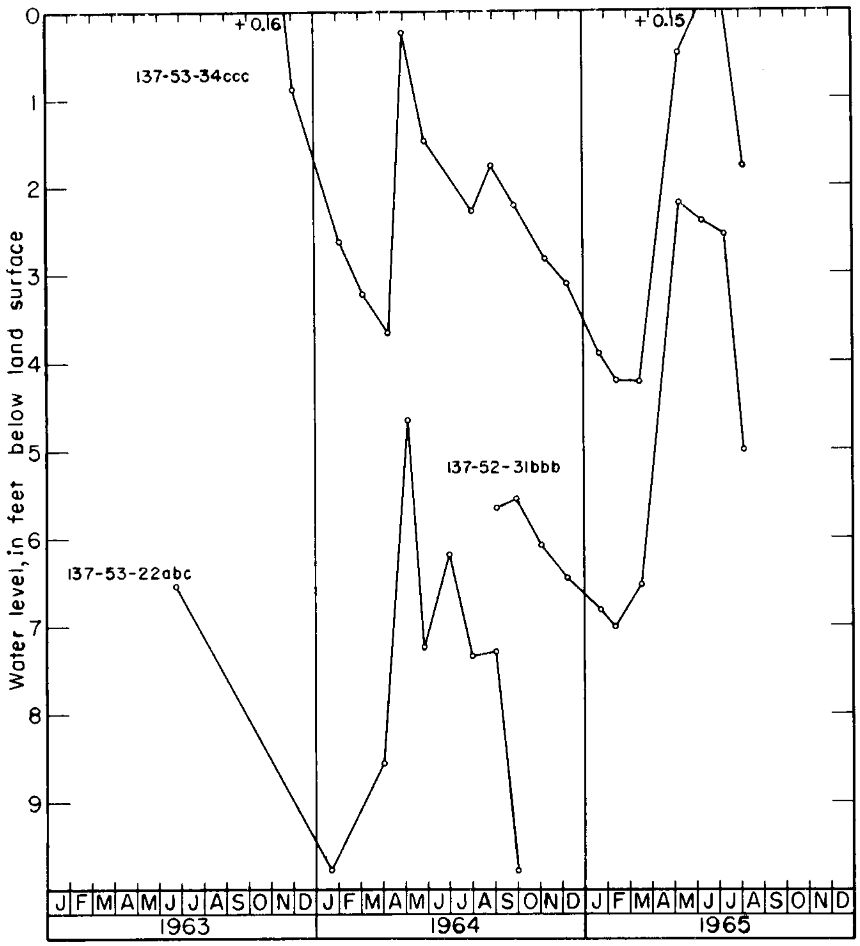


FIGURE 20. Water-level fluctuations in the Sheyenne Delta aquifer.

in Richland County. Assuming similar recharge conditions in Cass County, the annual recharge would be about 6,500 acre-feet.

Water is discharged from the aquifer by evapotranspiration, lateral movement into adjacent deposits, and by pumping. The amount withdrawn to meet rural domestic and stock needs is probably only a small percentage of the total natural discharge.

The hydraulic gradient in the aquifer is to the north and east and ranges from 1 to 2 feet per mile.

Storage.—The average thickness of the aquifer in Cass County is about 40 feet. Thus, if the average porosity is about 40 percent (Baker and Paulson, 1967, p. 21) and the area is 40 square miles, the amount of water stored in the aquifer would be 40 x 40 x 640 x 0.40, or 409,600 acre-feet; however, the total yield of the aquifer would be much less (see page 9).

Water-level fluctuations.—The water-level fluctuations shown on figure 20 reflect for the most part seasonal variations in recharge. The abrupt rise of the water levels in the wells between the latter part of March and the first part of May indicates recharge to the aquifer by infiltration of snowmelt and rainfall. This recharge begins with the spring thaw and continues until May or June. The rise in water levels caused by the recharge appears to be in the order of magnitude of about 5 feet. The subsequent decline of the water levels is a result of discharge from springs, evaporation where the water table is near the land surface, transpiration by crops and other vegetation, and decreased precipitation. Water levels are deepest during January, February, and March when little or no recharge reaches the aquifer.

Quality of water.—Chemical analyses of two water samples from the aquifer indicate that the water is a calcium magnesium bicarbonate type. The water is very hard and the dissolved solids concentration is about 500 ppm. Iron content ranges from 0.3 to 7.2 ppm.

Plots of SAR versus specific conductance on figure 5 show that the water samples have a C3-S1 irrigation classification.

Utilization and potential for additional development.—At the present time there are no large developments in the aquifer. The relatively small amount of water pumped for domestic and stock use has not had noticeable effects on the regional water level in the aquifer.

In view of the areal extent and thickness of the permeable water-bearing deposits, the Sheyenne Delta aquifer appears to have more potential for ground-water development than any of the other aquifers in the county, except possibly the Page aquifer. Very large quantities of ground water should be available to wells, but recovery may be a problem in places because the sand is so fine grained. Although few data are available regarding well yields, it seems likely that properly constructed wells at favorable locations in the aquifer could be pumped at rates ranging from 250 to 400 gpm (pl. 1).

Tower City Aquifer

The Tower City aquifer is a surficial outwash deposit confined in a glacial melt-water channel that enters Cass County near the center of the west line of T. 140 N., R. 55 W. The channel passes through Tower City and extends southeastward to its junction with the Maple River (pl. 1). In most places the channel and deposits are about ¼-mile wide.

The thickness of the aquifer is known in only a few places. The municipal well at Tower City (140-55-19bac2) penetrated 22 feet of sand and gravel and test hole 139-55-16ddd penetrated 9 feet of sandy gravel (fig. 21). This test hole is near the edge of a small delta terrace formed at the mouth of the channel.

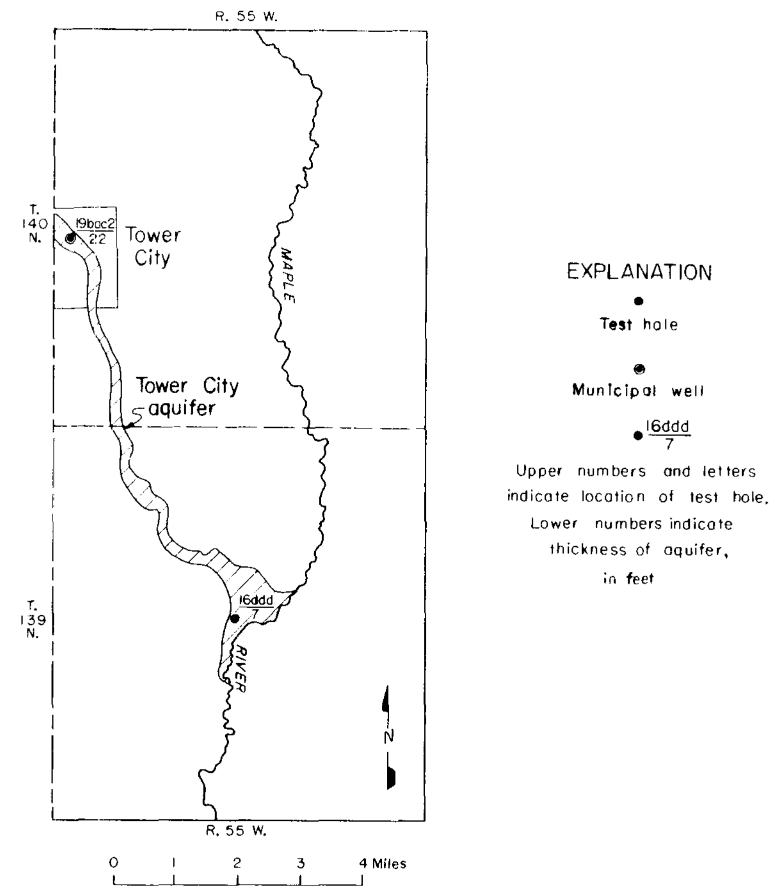


FIGURE 21. Location and thickness of Tower City aquifer, west-central Cass County.

The coefficient of transmissibility of the Tower City aquifer is estimated to be as high as 22,000 gpd per foot. Because the water in the aquifer is under water-table conditions, the coefficient of storage may be between 0.01 and 0.30.

Development-test data show that the Tower City supply well was pumped for 24 hours at a rate of 70 gpm. The drawdown at the end of 1 day was reported to be 13 feet; thus, the specific capacity of the well would be 5.4 gallons per foot of drawdown, indicating a coefficient of transmissibility of 5,400 gpd per foot at that location.

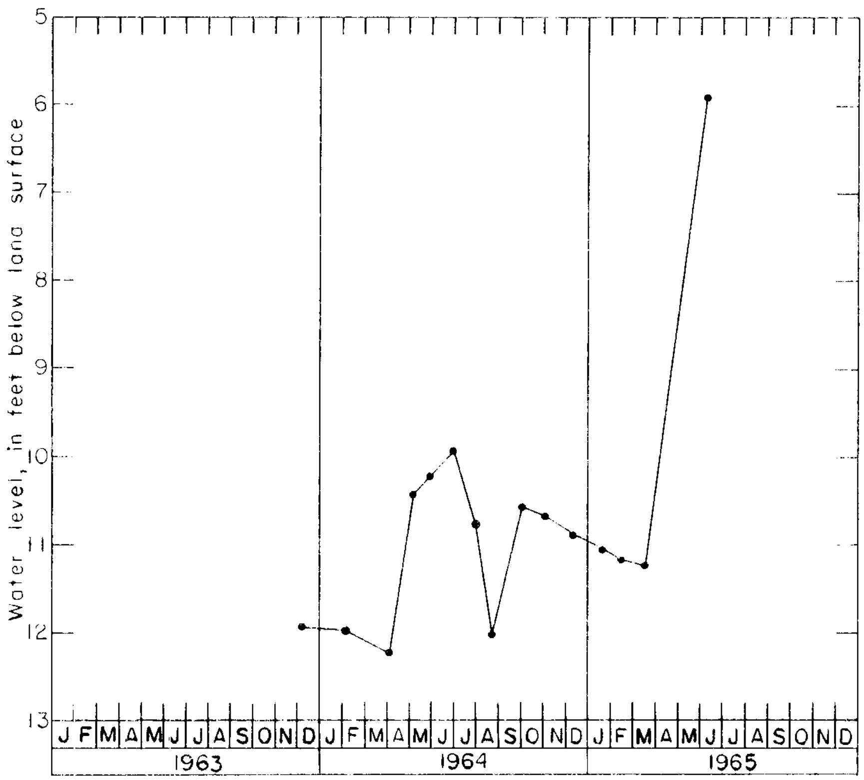


FIGURE 22. Water-level fluctuations in the Tower City aquifer.

Most of the recharge to the aquifer occurs during the spring and early summer when excess water from melting snow and rainfall is diverted into the channel. The channel containing the water-bearing deposits heads in and drains several square miles in Barnes County. Consequently, most of the recharge to the aquifer in Cass County is derived from precipitation that falls in Barnes County.

As far as known, there were no wells pumping from the aquifer prior to the development of the public supply well at Tower City in August 1960. Pumpage records for the period extending from August 1960 to December 1963 indicate that the average annual pumpage is about 2.8 million gallons.

Observation well 140-55-19bacl is about 10 feet south of Tower City supply well 140-55-19bac2. The fluctuations shown in figure 22, though modified somewhat by pumping, are for the most part natural fluctuations. The first three measurements taken during the winter show a low water level and indicate the combined effect of pumping and reduced recharge. The abrupt rise in the water level between March and May 1964 indicates that the aquifer started receiving recharge when the spring thaw set in. This rise continued until about July 1, at which time the amount of recharge to the aquifer declined and pumpage increased. The increased pumpage caused the water level to decline about 2 feet. The subsequent rise in the water level in September 1964 probably was a result of decreased pumpage. The gradual decline extending from October 1964 to March 1965 again shows the effect of pumping and negligible recharge. The 5-foot rise in the water level between mid-March and the first part of May resulted from above-normal precipitation during the spring and early summer of 1965.

An analysis of a water sample taken from the Tower City supply well indicates that the water is a calcium bicarbonate type. The water is hard and has a dissolved-solids concentration of about 500 pm. The sample indicated an irrigation classification of C3-S1 (fig. 5).

The supply well at Tower City is the only known development in the aquifer in Cass County. Pumpage records show that 9,343,000 gallons of water was pumped from the aquifer between August 1960 and December 1963. The average monthly use is about 233,500 gallons. Based on the monthly average, it is estimated that as of July 1, 1965 about 13.8 million gallons had been withdrawn from the aquifer.

In addition to usage by Tower City, the aquifer probably could support a number of farm and stock wells. However, extended drought could seriously limit the amount of water that could be pumped from the aquifer.

Undifferentiated Sand and Gravel Deposits

Undifferentiated sand and gravel deposits that probably were laid down in a glaciofluvial environment are distributed randomly throughout the drift in Cass County. Test holes and wells drilled into the drift commonly penetrate one or more beds of sand and (or) gravel at depths from about 20 feet to more than 400 feet. Individual deposits may range in thickness from 1 foot to 104 feet (test hole 3145, 137-55-35ddd, Klausing, 1966, p. 107). The aggregate thickness of separate beds may be as much as 150 feet. The sand and gravel beds are discontinuous and cannot be correlated from one test hole or well to another.

Wells tapping the undifferentiated deposits may yield less than a gallon per minute to about 100 gpm. The pumps installed on most farm wells are piston or submersible types and have capacities ranging from 3 to 10 gpm. Most of these wells can be pumped at maximum capacity for extended periods. Others, however, are reported to go dry or "suck air" after pumping continuously for several hours.

Some of the wells tapping the undifferentiated deposits flow. Generally they flow only a few gallons per minute, but well 138-52-11ccc, drilled to a depth of 276 feet, was reported to flow 200 gpm from sand and gravel between 245 and 271 feet. The flowing wells are local phenomena and are not indicative of an extensive body of water-bearing material in which flowing wells could be developed.

Water from the undifferentiated sand and gravel deposits differs widely in chemical character and the dissolved solids concentration ranges from 182 to 12,400 ppm; however, 93 percent of the 85 samples collected had dissolved solids concentrations ranging from 445 to 3,220 ppm. The median concentration was 1,020 ppm. Grouping the individual samples according to water type showed that about 33 percent were sodium bicarbonate type, 30.5 percent were sodium sulfate type, 19 percent were sodium chloride, 10.5 percent were calcium sulfate, and 7 percent were calcium bicarbonate type.

On the basis of data from three test holes, Dennis and others (1949, fig. 1) indicated the probable existence of a fairly extensive body of sand and gravel, which they called the Maple Ridge aquifer, in the area west of Mapleton. The deposits comprising the "Maple Ridge aquifer" are herein assigned to the undifferentiated sand and gravel deposits because: (1) the sand and gravel beds in the test holes (139-51-4ccd, 139-51-11abb, and 140-51-34daa, Dennis and others, 1949, p. 116, 168, and 177) do not appear to be correlative, and (2) sand and gravel deposits penetrated in surrounding test holes and wells are not correlative with the deposits penetrated in the test holes listed above (fig. 23).

Most wells tapping the undifferentiated sand and gravel deposits supply water mainly for rural domestic and stock use; however, the villages of Arthur, Kindred, and Mapleton have developed public supply wells in the deposits.

Bedrock Aquifer

Of the bedrock formations underlying the area, only the Dakota Sandstone of Cretaceous age is an important source of ground water. The Greenhorn Formation, the Graneros Shale, and the Precambrian crystalline rocks do not yield water in Cass County.

Dakota Sandstone

Location and extent.—The term Dakota Sandstone is used in this report to include all the Cretaceous rocks older than the Graneros Shale. The Dakota Sandstone underlies all of Cass County except the approximate eastern quarter. The eastern boundary of the Dakota Sandstone shown on plate

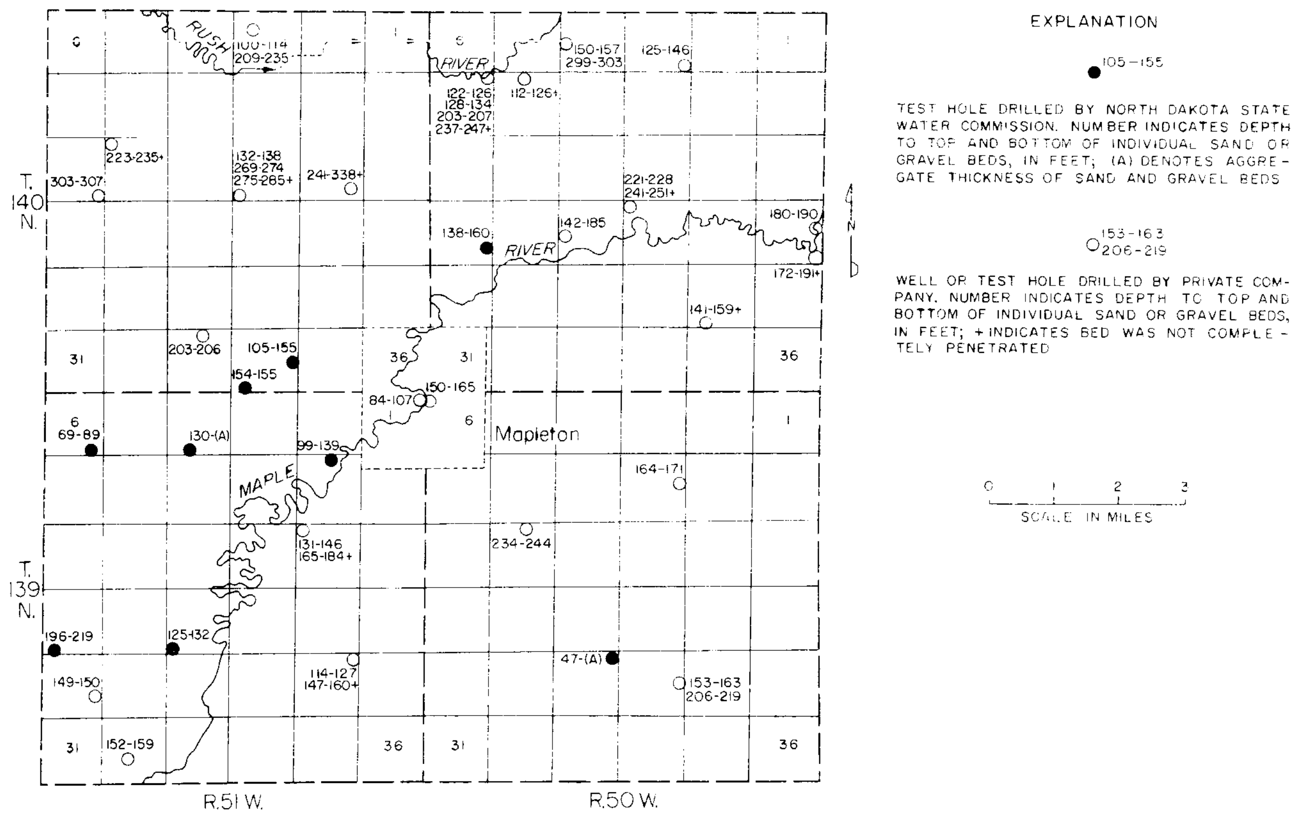


FIGURE 23. Location of wells and test holes tapping undifferentiated glacial drift aquifers in the vicinity of Mapleton, east-central Cass County.

1 is based for the most part on well-inventory data because only a few test holes penetrated the formation. Consequently, the boundary shown is tentative.

Thickness and lithology.—The depth to the top of the Dakota Sandstone ranges from about 300 feet in the eastern part of the area to more than 700 feet in the western part.

The formation underlying that part of the county east of the west line of R. 52 W. ranges from 0 to a known thickness of 158 feet in test hole 139-52-27aaa (Klausing, 1966, p. 127). The total thicknes of the formation underlying the county west of R. 52 W. is unkown.

The Dakota Sandstone consists chiefly of interbedded and (or) interlensed silt, shale, loose sand, and sandstone; however, in places it may consist solely of clay or shale. The water-bearing deposits range in texture from very fine to very coarse sand, but very fine to fine sand is predominant. The sand and sandstone range in thickness from 0 to about 50 feet. Hopkins and Petri (1963, p. 22) estimated that the layers and lenses of sandstone constitute only about one-fourth to one-fifth of the total thickness of the formation in northeastern South Dakota.

Reservoir characteristics.—The Dakota aquifer is confined by the Graneros. Shale, which in turn is overlain by younger Cretaceous rocks and glacial drift. At places along its eastern edge, the aquifer is in direct contact with glacial till that fills pre-Pleistocene drainages that were entrenched into the sandstone.

In its eastern extent, the aquifer is underlain by Precambrian crystalline rocks. The nature of the underlying rocks in the western part of the area is unknown.

Most wells drilled through the Dakota Sandstone penetrate one or more water-bearing sand and (or) sandstone beds. Hall and Willard (1905, p. 6) reported that flows were obtained at 287, 325, 378, 404, and 420 feet in a well drilled to a depth of 420 feet in sec. 15, T. 138 N., R. 53 W. A test hole drilled to a depth of 467 feet in the NE cor. sec. 27, T. 139 N., R. 52 W., penetrated water-bearing sands in the intervals 367-391 feet and 442-449 feet. Neither sand bed produced a flow. A well drilled in the SW¼ sec. 4, T. 139 N., R. 52 W., only 3 miles north of the test hole in sec. 27, penetrated 10 feet of water-bearing sand between 442 and 432 feet. This well was reported to flow 30 gpm. These examples indicate that the sand beds do not have extensive lateral continuity and cannot be correlated from one well to another.

The estimated coefficient of transmissibility for the aquifer ranges from 2,400 gpd per foot to 11,400 gpd per foot. The higher transmissibility was at the public supply well at Buffalo where the aquifer had an aggregate thickness of 57 feet (Klausing, 1966, p. 139). No estimates of the average transmissiblity of the aquifer can be made because so few data are available.

Wenzel and Sand (1942, p. 44) estimated that the coefficient of storage of the Dakota Sandstone in the Ellendale-Jamestown area was 1.1×10^{-3}.

Recharge, discharge, and movement.—The aquifer is overlain by thick and relatively impermeable shale of Cretaceous age and by glacial till. Because the water in the aquifer in many parts of the county is under sufficient pressure to flow from wells, the places where water enters the aquifer must be at a higher altitude; therefore, the recharge area is outside the county. It is also possible that the aquifer receives some recharge by upward movement of water from rocks underlying the Dakota.

Water is discharged from the aquifer by upward and lateral leakage into adjacent deposits. Probably the greatest amount of natural discharge occurs near the eastern limit of the aquifer where the overlying deposits are thin. The rate of natural discharge has undoubtedly decreased over the years owing to the large number of flowing wells that have been developed in the aquifer since the late 1800's.

As of 1963 there were at least 326 flowing wells in the county. Most of these wells are allowed to flow continuously. However, because the flow from most wells is reduced by use of a small-diameter discharge pipe, relatively few wells were flowing at their maximum capacity when visited. It was not possible to measure the maximum flow or pressure on most of the wells. However, the reduced discharge was measured at 246 wells. These ranged from less than one-fourth to 45 gpm and averaged 3.4 gpm. Assuming that this is a general average for all 326 wells, the average annual overflow discharge would amount to 582 million gallons. Most of the flowing wells serve as a source of supply for rural domestic and stock needs. The amount of water required to meet these needs is unkown, but is probably on the order of several million gallons a year. Thus, the annual discharge of water from the aquifer through wells is in excess of 582 million gallons.

The piezometric surface slopes from west to east, but the data are inadequate to determine the hydraulic gradient.

Artesian pressure.—Artesian pressure in the Dakota aquifer and well yields began to decline soon after the first wells were drilled and have declined ever since. Willard (1909, p. 10) reported that a well drilled to a depth of 743 feet in the village of Buffalo flowed at the rate of 55 gpm and had an artesian pressure of 50 psi (pounds per square inch). Because 1 psi is the equivalent of 2.3 feet of head, the water in this well would have risen in a pipe to a height of 115 feet above land surface and the piezometric surface would have had an altitude of 1,322 feet. The water level in the public supply well at Buffalo, which was drilled in June 1965 to a depth of 790 feet, was reported to be 49 feet below land surface, or 1,158 feet above sea level. Thus, the altitude of the piezometric surface in the vicinity of Buffalo declined 164 feet in the 56-year interval since 1909.

Quality of water.—Water from the Dakota Sandstone is highly mineralized, but is used extensively in some areas because adequate supplies of more suitable water are not available.

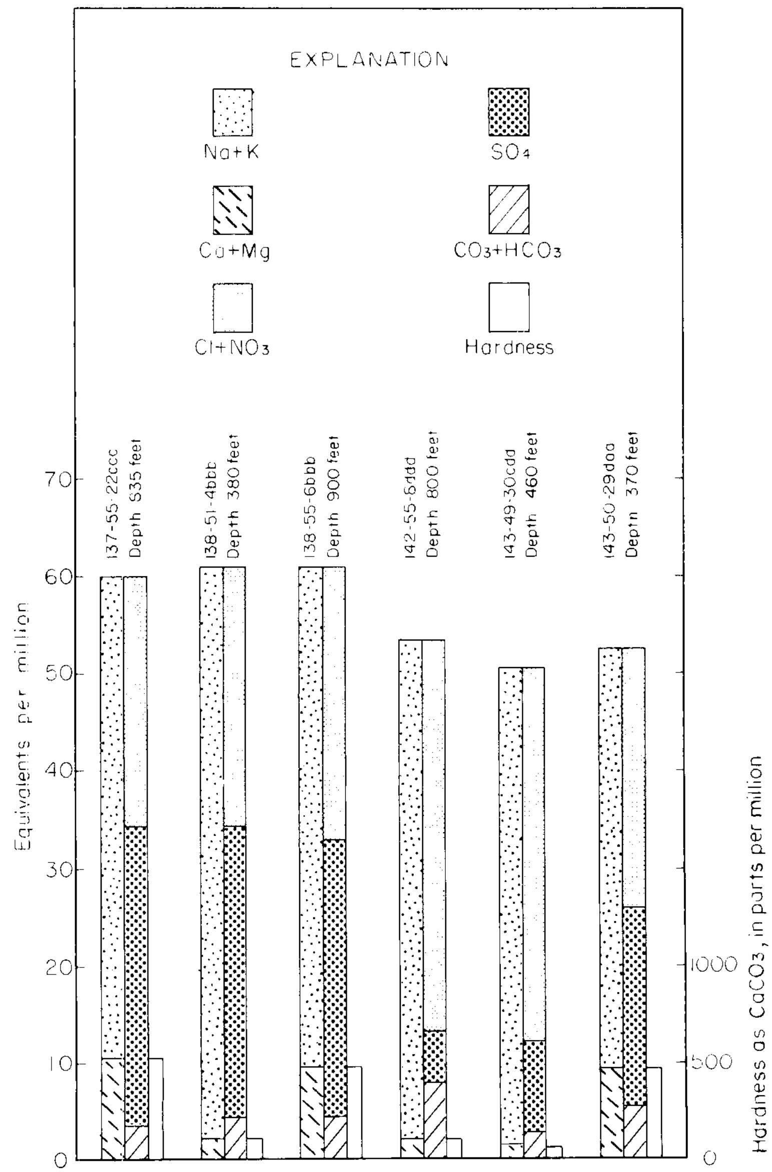


FIGURE 24. Major constituents in and hardness of water from Dakota Sandstone.

The dissolved solids content of 14 water samples from the Dakota ranged from 2,680 to 4,060 ppm. Most of the water is a sodium sulfate type; however, some of the water is a sodium chloride type. The sulfate type water is hard and the sodium chloride type may be either hard or soft.

The average concentrations of boron, fluoride, and silica in water from the Dakota are, respectively, 3.3, 2.9 and 8.2 ppm.

Concentrations of the major constituents in equivalents per million and hardness of water in parts per million from the Dakota Sandstone are shown on figure 24.

Utilization and potential for additional development.—Prior to June 1965, water from the Dakota Sandstone was used only for rural domestic and stock purposes. In June 1965, a public supply well was developed in the aquifer for the village of Buffalo because no other reliable sources of water could be found.

Because water from the Dakota is highly mineralized, it is unsuitable for irrigation and manufacturing purposes. Although the artesian head has decreased greatly over the past 80 years, flowing wells or wells in which the water rises nearly to the land surface can still be developed in the aquifer. The yield of wells tapping the Dakota Sandstone may be expected to range from a few gallons per minute, by natural flow, to as much as 100 gpm, if pumped.

SUMMARY

The surficial deposits in the area consist chiefly of glacial drift that ranges in thickness from 80 to about 470 feet. In the western and central parts of the area, the drift overlies sedimentary rocks of Cretaceous age, but in the southeastern part it rests on Precambrian crystalline rocks.

The important sources of ground water in the county are the sand and gravel deposits in the glacial drift and sand and (or) sandstone beds in the Dakota Sandstone.

Six major aquifers were recognized in the drift. They are the Fargo, West Fargo, Page, Tower City, Bantel, and Sheyenne Delta aquifers. All are artesian aquifers except the Tower City and Sheyenne Delta, which are water-table aquifers. The Page aquifer, with an areal extent of about 155 square miles, is the largest.

The West Fargo aquifer, which underlies about 110 square miles in southeastern Cass County, is the most permeable and productive aquifer in the county. It also is the most heavily pumped aquifer, and water-levels have declined seriously in the West Fargo and surrounding areas. Records show that at the end of 1965, the water level had declined as much as 85 feet since 1938, when the records were started. At the end of 1965, the water level in observation well 139-49-6adb had reached a maxiimum

depth of 110 feet below land surface and was only a few feet above the top of the aquifer. Regional observation-well measurements show that during 1965 water levels in the West Fargo aquifer declined more than 2.5 feet at West Fargo and more than 0.5 foot in areas 20 miles away. Water levels will continue to decline as long as withdrawals exceed recharge.

The quality of the ground water from the major drift aquifers differs considerably from place to place. Generally the water is suitable for domestic and stock use, and some of the water is suitable for irrigation. The dissolved-solids concentration of water from the seven aquifers ranges from about 380 ppm to about 1,560 ppm. The water is hard to very hard and generally contains iron in excess of 0.3 ppm. Water from the Fargo and West Fargo aquifers consists of three types—sodium bicarbonate, sodium chloride, and sodium sulfate. Water from the Page, Tower City, Bantel, and Sheyenne Delta aquifers is of the calcium bicarbonate or calcium sulfate type.

Numerous small aquifers occur in undifferentiated sand and gravel deposits, which generally are only a few feet thick but may be as much as 100 feet thick in a few places. These deposits are distributed randomly throughout the drift and are the chief source of water for many farm wells.

The dissolved-solids concentration of water from the undifferentiated sand and gravel deposits ranges from about 180 ppm to 12,400 ppm; however, most of the water has dissolved-solids concentrations ranging from about 400 to 3,200 ppm. The water types in order of abundance are sodium bicarbonate, sodium sulfate, sodium chloride, calcium sulfate, and calcium bicarbonate.

The Dakota Sandstone of Cretaceous age is the only bedrock unit in the county that is known to yield water to wells. The Dakota consists of interbedded shale, silt, loose sand, and sandstone. Maximum known thickness is about 160 feet. The water-bearing sands in the Dakota have a maximum thickness of about 50 feet.

Water from the Dakota Sandstone is highly mineralized and is unsuitable for most uses except stock watering. The water has dissolved-solids concentrations ranging from about 2,600 ppm to about 4,000 ppm. Chloride and sulfate content generally range from 900 to about 1,500 ppm. The predominant water type is sodium sulfate.

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APPENDIX

137-49-17daa1
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, yellow	24	25
	Clay, blue	17	42
	Shale (clay), soft, sticky, blue	39	81
Till and associated glacioaqueous deposits:			
	Sand and boulders, gray	3	84
	Sand, dirty, gray	4	88
	Sand, fine, gray	14	102

137-49-21bba
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, soft, yellow	20	23
	Shale, soft, blue	46	69
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	2	71
	Sand	15	86

137-49-28cdd
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, yellow	26	28
	Shale, soft, sticky, blue	39	67
Till and associated glacioaqueous deposits:			
	Clay, sandy, boulders, blue	8	75
	Clay, sandy, hard, blue	23	98
	Shale (clay), blue	23	121
	Clay, sandy, blue	6	127
	Sand, fine, gray	14	141
	Clay, soft, blue	3	144
	Sand, fine, gray	5	149
	Clay, soft, sandy, blue	25	174
	Sand, gray	18	192

Note: Parenthetical remarks are authors interpretation.

137-49-32ddd
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, yellow	21	23
	Shale, blue	37	60
Till and associated glacioaqueous deposits:			
	Sandy clay, blue	17	77
	Sand, colored	9	86
	Clay, blue	3	89

137-50-2dac
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, yellow	31	33
	Shale (clay), blue	34	67
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	5	72
	Clay, sandy, boulders, hard, blue	21	93
	Clay, sandy, hard, blue	29	122
	Boulder, red	1	123
	Clay, sandy, hard, blue; sand lenses	25	148
	Clay, sandy, soft	14	162
	Sand	15	177

137-51-34ccc
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, sandy, gray	38	40
	Shale (clay), soft, gray	82	122
Till and associated glacioaqueous deposits:			
	Clay, sandy, hard, gray	24	146
	Clay, sandy, soft gray; sand lenses	66	202
	Sand, white	3	205

138-50-1bdc
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Shale (clay), yellow	14	16
	Shale (clay), blue	46	62
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	7	69
	Sand, gray	18	87
	Clay, sandy, blue	2	89

138-50-34ccc
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black--------------------	1	1
	Clay, yellow----------------------	6	7
	Shale (clay), tan-----------------	22	29
	Shale (clay), soft, sticky, blue--	41	70
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue-----------------	9	79
	Clay, sandy, boulders, hard, blue-	4	83
	Sand, brown-----------------------	1	84
	Clay, hard, blue------------------	30	114
	Sand, fine, brown-----------------	3	117
	Clay, blue------------------------	½	117½
	Sand, brown-----------------------	14	131½

139-49-2ccc
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black--------------------	1	1
	Clay, brown-----------------------	15	16
	Shale (clay), soft, blue----------	78	94
Till and associated glacioaqueous deposits:			
	Clay, sandy, boulders, hard, blue-	14	108
	Sand, blue------------------------	½	108½
	Clay, sandy, hard, blue-----------	22½	131
	Clay, sandy, hard, blue; sand lenses------------------------	21	152
	Clay, sandy, soft, blue; sand lenses------------------------	137	289
	Clay, sandy, hard, gray-----------	13	302
	Shale (clay), blue----------------	17	340
	Sandstone(?), white---------------	17	357

139-49-3cdd2
(Log furnished by Frederickson's Inc)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black--------------------	3	3
	Clay, yellow----------------------	11	14
	Sand, fine, brown-----------------	4½	18½
	Shale (clay), soft, blue----------	57½	76

139-49-3cdd2--Continued
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	15	91
	Sand, dirty, gray and white	3	94
	Clay, sandy, blue	62	156
	Clay, sandy, hard, blue	5	161
	Clay, sandy, soft, blue; sand lenses	22	183
	Sand, dirty, gray	1½	184½
	Clay, sandy, soft, blue; sand lenses	5½	190
	Clay, sandy	12	202
	Sand, gray	1	203
	Clay, sandy, blue	6	209
	Sand, gray	6	215
	Shale (clay), blue	7	222
	Sand, gray	3	225
	Clay, soft, blue; sand lenses	33	258
	Clay, hard, gray	2	260
	Clay, soft, gray	19	279
	Sand, blue	2	281
Granite:			
	Decomposed granite; white, green, black, and red	77	358

139-49-7ddc
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, yellow	22	23
	Shale (clay), blue	43	66
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	14	80
	Boulder	1	81
	Clay, sandy, blue	26	107
	Sand, dirty	8	115
	Clay, blue	3	118
	Sand, gray	3	121
	Clay, sandy, blue	18	139
	Sand, fine, dirty, gray	4	143
	Clay, sandy, soft, blue	37	180
	Sand, fine, gray	13	193
	Clay, gray; sand lenses	6	199
	Shale (clay), brown	24	223
	Clay, sandy, green	14	237

139-49-9aab
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, brown	10	12
	Sand, fine, brown	8	20
	Shale (clay), blue	50	70
Till and associated glacioaqueous deposits:			
	Clay, sandy, hard, blue	12	82
	Clay, sandy, soft, blue	23	105
	Clay, sandy, blue; sand lenses	7	112
	Clay, sandy, soft, blue	18	130
	Clay, sandy, hard, blue	13	143
	Boulder	1	144
	Clay, sandy, hard, blue	2	146
	Sand, brown	7	153

139-49-9ccb
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Shale (clay), yellow	16	19
	Shale (clay), gray	49	68
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	19	87
	Clay, sandy, blue; sand lenses	20	107
	Sand, gray	2	109
	Clay, sandy, soft, blue	21	130
	Clay, sandy, hard, blue	22	152
	Sand, gray	6	158
	Clay, blue; sand lenses	22	180
	Sand, gray	2	182
	Clay, blue; sand lenses	4	186
	Sand, gray	4½	190½
	Clay, sandy, hard, blue	17½	208
	Clay, sandy, soft, blue	14	222
	Clay, blue; sand lenses	8	230
Granite:			
	Decomposed granite; red and green	121	351

139-49-11aaa
(Log furnished by Great Northern Railway)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Fill	3	3
	Clay	13	16
	Sand	1	17
	Clay	52	69
Till and associated glacioaqueous deposits:			
	Till(?)	27	86
	Sand and gravel	15	101
	Clay, sandy	7	108
	Sand and gravel	58	166
	Shale (clay), sandy	2	168

139-49-11cdc2
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, yellow	12	14
	Shale (clay), soft, blue	14	28
	Sand, fine, blue	10	38
	Shale (clay), soft, blue	49	87
Till and associated glacioaqueous deposits:			
	Clay, sandy, soft, blue	5	92
	Clay, sandy, hard, blue	25	117
	Sand, coarse	1	118
	Clay, sandy, hard, blue	2	120
	Sand, brown	2	122
	Clay, sandy, hard, blue	136	258
	Clay, sandy, soft, blue	39	297
	Sandstone(?), white	10	307
	Shale(?), blue	3	310
	Sandstone(?), white	6	316
	Shale(?)	2	318

139-49-15cdc
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Fill, variegated	4	4
	Clay, yellow	14	18
	Clay, blue	62	80
Till and associated glacioaqueous deposits:			
	Clay, sandy, boulders, blue; sand lenses	19	99
	Clay, sandy, gray	8	107
	Sand, gray	3	110
	Sand, gray; clay lenses	8	118
	Clay, sandy, hard, gray	25	143
	Shale (clay), gray	45	188
	Shale (clay), gray, sand lenses	21	209
Graneros(?) Shale:			
	Shale, black	30	239
Granite:			
	Decomposed granite, white and green	42	281

139-49-29bcd
(Log furnished by Frederickson's Inc.)

Lake Agassiz deposits:			
	Topsoil	2	2
	Clay, yellow	16	18
	Shale (clay), blue	60	78
Till and associated glacioaqueous deposits:			
	Clay, blue	114	192
	Clay, blue; sand lenses	15	207
	Clay, blue	13	220
	Sand, coarse	16	236
	Clay, blue	2	238

139-49-32cca
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	5	5
	Silt, brown	7	12
	Sand, fine	12	24
	Shale (clay), gray	46	70
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue; sand lenses	20	90
	Sand, dirty	2	92
	Clay, sandy, blue; sand lenses	2	94
	Sand	3	97
	Clay, hard, blue	48	145
	Clay, sandy	3	148
	Sand, fine	3	151
	Clay	1	152
	Sand, fine	31	183

139-50-2aaa
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, yellow	8	9
	Sand, fine, brown	7	16
	Shale (clay), blue	53	69
Till and associated glacioaqueous deposits:			
	Clay, blue; boulders	17	86
	Sand, brown	2½	88½
	Clay, hard, blue	17½	106
	Gravel, sandy, brown	1	107
	Clay, hard, blue; boulders	3	110
	Sand, brown	1	111
	Clay, hard, blue; boulders	100	211
	Clay, soft, gray	19	230
	Clay, sandy, soft, gray	8	238
	Sand, gray	8	246

139-50-10dac
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	1	1
	Clay, yellow	6	7
	Sand, brown	5	12
	Clay, sandy, blue	4	16
	Sand, blue	8	24
	Shale (clay), blue	41	65
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	20	85
	Sand, blue	14½	99½
	Clay, sandy, blue	28½	128
	Sand, blue	2	130
	Clay, sandy	74	204
	Sand, gray	4	208
	Clay, blue	1	209
	Sand, gray	4	213
	Clay, sandy	22	235
	Sand, gray	5	240
Granite:			
	Decomposed granite; clay, sandy, variegated		

140-49-7dca1
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, tan	25	27
	Shale, soft, blue	43	70
Till and associated glacioaqueous deposits:			
	Clay, sandy, soft, blue	16	86
	Boulder	1	87
	Clay, sandy, hard, blue	16	103
	Clay, silty, hard, gray	8	111
	Clay, sandy	3	114
	Sand, dirty; lenses of clay	17	131
	Sand	20	151
	Sand, fine, gray	12	163

140-49-8bbd
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	4	4
	Clay, yellow	22	26
	Shale (clay), blue	50	76
Till and associated glacioaqueous deposits:			
	Clay, sandy, hard, blue	17	93
	Sand, dirty, gray	6	99
	Sand, clean, gray	12	111
	Clay, blue	6	117
	Sand, gray	14	131

140-49-19baa
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, yellow	22	24
	Shale (clay), blue	48	72
Till and associated glacioaqueous deposits:			
	Clay, sandy, hard, blue	23	95
	Sand, gray; dry	11	106
	Clay, hard, blue	22	128
	Sand, gray	3	131
	Clay, soft, blue; sand lenses	13	144
	Sand, gray	35	179
	Sand, dirty, gray	4	183

140-49-19ccc
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, yellow	13	16
	Shale (clay), blue	56	72
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	20	92
	Sand, dirty, blue	14	106
	Sand, blue	5	111
	Clay, sandy	4	115
	Sand, dirty, blue	8	123
	Clay	5	128

140-49-19ccc--Continued
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits--Continued:			
	Sand, fine, blue------------------	2	130
	Clay, blue------------------------	3	133
	Clay, sandy, blue-----------------	30	163
	Sand, blue------------------------	5	168
	Sand, gravelly--------------------	9	177

140-49-34ccd
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black--------------------	1	1
	Shale (clay), brown---------------	10	11
	Sand, fine, brown-----------------	13	24
	Shale (clay), blue----------------	61	85
Till and associated glacioaqueous deposits:			
	Clay, sandy, soft, blue-----------	7	92
	Clay, sandy, hard, blue-----------	53	145
	Clay, sandy, soft, blue-----------	25	170
	Clay, hard------------------------	32	202
Granite:			
	Decomposed granite, white and green--------------------------	46	248

140-49-35ddd
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black--------------------	1	1
	Shale (clay), soft, yellow--------	17	18
	Shale (clay), soft, blue----------	14	32
	Sand, fine, dirty, gray-----------	7	39
	Sand, fine, gray------------------	20	59
	Shale (clay), blue----------------	12	71
	Shale (clay), soft, blue----------	23	94
Till and associated glacioaqueous deposits:			
	Clay, sandy, hard, blue-----------	8	102
	Clay, sandy, hard, blue; gravel lenses------------------------	15	117
	Sand, fine, gray------------------	2	119

140-49-35ddd--Continued
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits--Continued:			
	Clay, sandy, blue; lenses of sand-	12	131
	Clay, sandy, hard, blue-----------	9	140
	Sand------------------------------	49	189
Granite:			
	Shale, hard, white----------------	2	191

140-50-21cbb
(Log furnished by Frederickson's Inc.)

Lake Agassiz deposits:			
	Topsoil, black--------------------	2	2
	Clay, yellow----------------------	21	23
	Shale (clay), blue----------------	32	55
Till and associated glacioaqueous deposits:			
	Clay, sandy, soft, blue-----------	6	61
	Clay, sandy, boulders, hard, blue-	12	73
	Clay, sandy, hard-----------------	8	81
	Sand, dirty, brown----------------	2	83
	Clay, sandy, hard, blue-----------	49	132
	Sand, fine, gray------------------	32	164
	Sand, fine, dirty, gray-----------	11	175
	Shale (clay?), blue---------------	1	176

140-50-24add
(Log furnished by Frederickson's Inc.)

Lake Agassiz deposits:			
	Topsoil, black--------------------	3	3
	Shale (clay), soft, yellow--------	29	32
	Shale (clay), soft, blue----------	47	79
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue; sand lenses----	14	93
	Clay, blue------------------------	27	120
	Sand, fine, blue------------------	1	121
	Clay, blue------------------------	2½	123½
	Sand, fine, blue------------------	23½	147
	Shale (clay), hard, blue----------	26½	173½
	Sand, fine, dirty, blue-----------	3½	177

140-50-24add--Continued
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits--Continued:			
	Shale (clay), sandy, blue---------	3	180
	Sand, fine, dirty, blue-----------	7	187
	Sand, fine, clean, blue-----------	3	190
	Shale (clay), blue; sand lenses---	29	219
	Shale (clay), sandy, blue---------	6	225
	Shale (clay), blue; sand lenses---	27	252

140-50-26cdc
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil---------------------------	2	2
	Clay, yellow----------------------	21	23
	Clay, blue------------------------	45	68
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue-----------------	41	109
	Sand, blue------------------------	1	110
	Clay, sandy, hard, blue-----------	31	141
	Sand, blue------------------------	18	159

141-49-28aca
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black--------------------	1	1
	Clay, yellow----------------------	20	21
	Shale (clay), blue----------------	58	79
	Clay, blue------------------------	13	92
	Sand------------------------------	2	94
Till and associated glacioaqueous deposits:			
	Clay, sandy, hard, blue-----------	35	129
	Clay, soft, blue------------------	29	158
	Clay, sandy, soft, blue; sand lenses-------------------------	15	173
	Sand, dirty, gray-----------------	10	183
	Sand, clean-----------------------	10	193

141-49-28bdb
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black	2	2
	Clay, sandy, brown	21	23
	Shale (clay), blue	58	81
Till and associated glacioaqueous deposits:			
	Clay, sandy, hard, blue	9	90
	Boulder	1	91
	Clay, sandy, hard, blue	24	115
	Clay, sandy, soft, blue; sand lenses	7	122
	Sand, dirty, brown	3	125
	Clay, sandy, hard, blue; sand lenses	12	137
	Boulder	1	138
	Clay, sandy, hard, blue	42	180
	Clay, silty, soft, gray	14	194
	Sand	12	206
	Clay, gray	1	207

141-49-33cab
(Log furnished by Frederickson's Inc.)

Lake Agassiz deposits:			
	Topsoil, black	3	3
	Clay, yellow	25	28
	Shale (clay), soft, blue	51	79
Till and associated glacioaqueous deposits:			
	Clay, sandy, blue	12	91
	Boulder	1	92
	Clay, sandy, blue	43	135
	Clay, gray; sand lenses	33	168
	Sand, white	17	185

141-49-33daa
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Lake Agassiz deposits:			
	Topsoil, black--------------------	2	2
	Clay, yellow----------------------	16	18
	Shale (clay), blue----------------	62	80
Till and associated glacioaqueous deposits:			
	Clay, sandy, hard, blue-----------	15	95
	Clay, sandy, soft, blue-----------	11	106
	Sand, gray------------------------	10	116
	Boulder---------------------------		

141-53-6dcd
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black--------------------	1	1
	Clay, sandy, yellow---------------	25	26
	Clay, sandy, blue-----------------	35	61
	Clay, sandy, white; sand lenses---	24	85
	Sand, fine, gray------------------	25	110

141-54-14baa
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black--------------------	1	1
	Clay, sandy, yellow---------------	25	26
	Clay, sandy, blue-----------------	11	37
	Clay, blue------------------------	25	62
	Clay, hard, blue------------------	40	102
	Clay, soft, blue------------------	7	109
	Clay, hard, blue------------------	4	113
	Clay, soft, blue------------------	6	119
	Clay, hard, blue------------------	8	127
	Sand, fine, gray------------------	9	136
	Clay, soft, blue------------------	1½	137½

141-54-14ccc
(Log furnished by Frederickson's Inc.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil	2	2
	Clay, sandy, soft, brown	3	5
	Sand, brown	2	7
	Clay, sandy, soft, brown	3	10
	Clay, sandy, hard, brown	17	27
	Clay, sandy, hard, blue	93	120
	Clay, silty, soft, blue	26	146
	Sand, gray	18	164

141-54-21ddc2
(Log furnished by Lako Drilling Co.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil	2	2
	Clay, yellow	16	18
	Clay, sandy, yellow	7	25
	Clay, blue	35	60
	Clay, sandy, blue	20	80
	Clay, blue; sand lenses	10	90
	Sand, gray	40	130
	Clay, blue	45	175

142-54-14bac
(Log furnished by Lako Drilling Co.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Topsoil, black	2	2
	Clay, yellow	13	15
	Clay, gravelly, yellow	25	40
	Clay, sandy, yellow	10	50
	Clay, blue	18	68
	Sand, blue	27	95
	Clay, sandy, blue	5	100
	Clay, blue	46	146
	Sand, gray	29	175

143-54-31bdd
(Log furnished by McCarthy Well Co.)

Geologic source	Material	Thickness (feet)	Depth (feet)
Till and associated glacioaqueous deposits:			
	Clay, sandy; sand lenses----------	81	81
	Sand, gray------------------------	40	121

March 13, 2019

Mr. Winston Crow
NGB/A4OR
Sheppard Hall
3501 Fetchet Avenue
Joint Base Andrews, Maryland 20762-5157

REFERENCE: **Contract W9133L-14-D-0007, Delivery Order 0011, FY17 Phase III Regional Site Inspections for Perfluorinated Compounds at Multiple Air National Guard Installations**

SUBJECT: **Final Site Inspection Report for Hector Field ANGB**

Mr. Crow

Attached please find the above referenced document.

Should you have any questions, please contact me at 606.495.5149 or by email at vestm@leidos.com.

LEIDOS

Matthew B. Vest

Matthew B. Vest, PMP, PG
Project Manager

cc: Mr. Mark Dickerson – NGB/A4OR Program Manager
Mr. Tom Barzyk – BB&E Surveillance and Oversight
Ms. Christine Roob – North Dakota Department of Health Project Manager
Ms. Connie Samson – Leidos Program Manager
Mr. Selvam Arunachalam – Leidos Deputy Project Manager
Ms. Nancy Wahlquist – Leidos Project Controller
Leidos Project File

FINAL

SITE INSPECTION REPORT FOR PERFLUOROOCTANE SULFONATE AND PERFLUOROOCTANOIC ACID AT HECTOR FIELD AIR NATIONAL GUARD BASE FARGO, NORTH DAKOTA

119th Wing
Hector Field Air National Guard Base
North Dakota Air National Guard
Fargo, North Dakota

March 2019

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FINAL

SITE INSPECTION REPORT FOR PERFLUOROOCTANE SULFONATE AND PERFLUOROOCTANOIC ACID AT HECTOR FIELD AIR NATIONAL GUARD BASE, FARGO, NORTH DAKOTA

119th Wing
Hector Field Air National Guard Base
North Dakota Air National Guard
Fargo, North Dakota

March 2019

Contract Number W9133L-14-D-0007
Task Order Number 0011

Prepared for

Air National Guard
Restoration Branch
NGB/A4OR
3501 Fetchet Avenue
Joint Base Andrews, Maryland 20762

Prepared by

Leidos
11951 Freedom Drive
Reston, Virginia 20190

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CONTENTS

TABLES

FIGURES

ACRONYMS

µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
AFFF	Aqueous Film-Forming Foam
AMSL	Above Mean Sea Level
ANG	Air National Guard
ANGB	Air National Guard Base
AST	Aboveground Storage Tank
BGS	Below Ground Surface
COC	Chemical of Concern
COPC	Chemical of Potential Concern
DoD	U.S. Department of Defense
DQO	Data Quality Objective
EPA	U.S. Environmental Protection Agency
ERP	Environmental Restoration Program
FD	Fire Department
FSS	Fire Suppression System
FTA	Fire Training Area
HA	Health Advisory
HDPE	High-Density Polyethylene
HQ	Hazard Quotient
IDW	Investigation-Derived Waste
IRP	Installation Restoration Program
JP-4	Jet Propulsion Fuel No. 4
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NDDOH	North Dakota Department of Health
NFA	No Further Action
ng/L	Nanograms per Liter
OWS	Oil/Water Separator
PA	Preliminary Assessment
PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutane Sulfonate
PFHpA	Perfluoroheptanoic Acid
PFHxS	Perfluorohexane Sulfonate
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PRL	Potential Release Location
QA	Quality Assurance
QC	Quality Control
RI	Remedial Investigation
RSL	Regional Screening Level
SI	Site Inspection
SVOC	Semivolatile Organic Compound
TCE	Trichloroethene
TestAmerica	TestAmerica Analytical Laboratories, Inc.
UCMR3	Third Unregulated Contaminant Monitoring Rule
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WP	Work Plan

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EXECUTIVE SUMMARY

Leidos was contracted to conduct Phase III regional site inspections (SIs) for perfluorinated compounds at multiple Air National Guard Bases (ANGBs). This report documents SI activities conducted at 10 potential release locations (PRLs) at the 119th Wing of the North Dakota Air National Guard (ANG) at Hector Field ANGB, Fargo, North Dakota. The primary objective of the SI was to determine the presence or absence of perfluorinated compounds, more specifically per- and polyfluoroalkyl substances (PFAS) on the U.S. Environmental Protection Agency (EPA) Third Unregulated Contaminant Monitoring Rule (UCMR3), including perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) perfluorobutane sulfonate (PFBS), perfluorononanoic acid (PFNA), perfluoroheptanoic acid (PFHpA), and perfluorohexane sulfonate (PFHxS), herein collectively referred to as PFOS/PFOA at each PRL, and based on the findings:

- Determine if PFOS/PFOA-contaminated groundwater has reached the Installation boundary;
- Provide a defensible no further action (NFA) decision for qualifying PRLs; and
- Develop data quality objectives (DQOs) for additional investigation for PRLs not meeting the NFA criteria or an interim response action, if appropriate.

To meet the objectives, Leidos performed SIs at the following 10 PRLs:

- PRL 1: Former Fire Training Area (FTA) – Environmental Restoration Program (ERP) Site 10,
- PRL 2: Building 217 – Main Hangar,
- PRL 3: Building 215 – Former Fire Station,
- PRL 5: Nozzle Testing Area – East of Building 340,
- PRL 6: Nozzle Testing Area – South of Building 310,
- PRL 7: Nozzle Testing Area – North of Apron,
- PRL 9: Aircraft Parking Apron,
- PRL 10: Stormwater Outfall 002,
- PRL 11: Stormwater Outfall 003, and
- PRL 12: Soils Stockpile Area.

Based on recommendations from the preliminary assessment (PA) and site visit conducted by BB&E in May 2016, soil, groundwater, and surface water and sediment (if available) samples were collected from 10 of 12 PRLs between May 21 and June 8, 2018. Two PRLs (4 and 8) were not recommended for SI. Collected samples were analyzed for PFOS/PFOA compounds. The detected PFOS/PFOA concentrations were compared against screening criteria for PFOS, PFOA, and PFBS, including the EPA lifetime drinking water Health Advisory (HA) for PFOS and PFOA, the EPA Regional Screening Level (RSL) for PFBS in tap water (target hazard quotient [HQ] =1.0), the EPA RSL for PFBS in residential soil, and calculated screening levels using the EPA screening level calculator for PFOS and PFOA in soil (target HQ =1.0), as shown in Table ES-1.

Table ES-1. PFOS/PFOA SI Screening Criteria

Parameter	Chemical Abstract Service Number	EPA RSL for Tap Water[a] (ng/L)	EPA Health Advisory[b] (ng/L)	Residential Risk-based Soil Screening Level[c] (μg/kg)
PFOS	1763-23-1	NA	70.0[d]	1,260
PFOA	335-67-1	NA		1,260
PFBS	375-73-5	400,000[e]	NA	1,260,000

[a] EPA RSL for tap water, November 2018; Target HQ =1.0.
[b] *Drinking Water Health Advisory for Perfluorooctane Sulfonate* (EPA 2016a) and *Drinking Water Health Advisory for Perfluorooctanoic Acid* (EPA 2016b).
[c] Residential risk-based soil screening levels determined by using the EPA RSL calculator (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) and the November 2018 EPA RSL tables (https://epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2018) for soil and sediment; Target HQ =1.0.
[d] When PFOA and PFOS are both present, the combined detected concentrations of the compounds are compared with the 70-ng/L health advisory value.
[e] PFBS analytical results for groundwater and surface water have been compared to the tap water screening levels.

μg/kg = Micrograms per kilogram.
EPA = U.S. Environmental Protection Agency.
HQ = Hazard quotient.
NA = Not available.
ng/L = Nanograms per liter.
PFBS = Perfluorobutane sulfonate.
PFOA = Perfluorooctanoic acid.
PFOS = Perfluorooctane sulfonate.
RSL = Regional screening level.
SI = Site inspection.

PFOS/PFOA compounds were detected in the soil, groundwater, and surface water above the laboratory detection limits. Samples from three monitoring wells (MW-HEC01-02, MW-HEC07-02, MW-HEC12-02) and two surface water samples (HEC10-SW1, HEC11-SW1) were used to evaluate the PFOS/PFOA contamination near the Installation boundary. Screening criteria were not exceeded in the downgradient boundary wells (MW-HEC01-02, MW-HEC07-02, MW-HEC12-02). All six PFOS/PFOA compounds were detected in the two surface water samples collected from near the northern Installation boundary, with combined PFOS and PFOA concentrations exceeding the screening criteria in each sample. PFOS/PFOA compounds are likely migrating offsite given their presence and magnitude in surface water and groundwater near the Installation boundary.

Based on comparison of analytical data to the screening criteria in Table ES-1, Leidos recommends further investigations at all PRLs. Additional investigations are recommended for soil and groundwater at PRLs 1, 2, 3, 5, 6, 7, 9, and 12, and surface water/sediment at PRLs 10 and 11. The recommendations are summarized in Table ES-2 and described briefly below:

- Further investigation is necessary to determine the nature and extent of PFOS/PFOA contamination due to detectable levels at all PRLs.
- Develop an expanded conceptual site model that considers localized groundwater and surface water flow paths to select future sampling locations.
- Complete delineation of nature and extent of PFAS as part of an Expanded SI or a remedial investigation (RI) that could consist of:
    - Additional soil sampling and analysis of an expanded list of PFAS constituents (in addition to the six UCMR3 constituents) to determine if significant source areas related to precursor substances are present. Precursor substances have been demonstrated to oxidize into PFOS and PFOA and thus could provide a lingering source of these compounds to soil and groundwater.

- An expanded groundwater sampling program (including analysis of an expanded list of PFAS constituents) to complete horizontal and vertical delineation of the PFAS impacts. Further groundwater investigation at the Base boundary is recommended due to the presence of PFAS in groundwater above their respective screening criteria.

- The installation and sampling of upgradient monitoring wells and downgradient off-Base monitoring wells to better define the upgradient source of PFAS and define the nature and extent of PFAS that have migrated off Base.

- Conduct preliminary site-specific risk assessment calculations in order to identify chemicals of potential concern (COPCs) in every medium and establish preliminary remedial goals for screening purposes.

DQOs are proposed based on the results of the SI and are presented in Table ES-2. In general, additional samples are required at each PRL in order to establish the nature and extent of PFAS constituents for each applicable medium and determine if a complete receptor pathway exists. For soil, additional samples are proposed to determine if a source area exists and, if so, the vertical and horizontal extent for both the vadose and saturated zones. Additional surface water and sediment samples should be collected at PRLs 10 and 11 (including analysis of an expanded list of PFAS constituents), taking care to sample upstream of and downstream from Outfalls 002 and 003 to assess the nature and extent of PFAS impacts.

Table ES-2. SI Recommendation Summary Table

PRL No.	PRL Description	Constituents Above Screening Criteria	Sampling Recommendations and Objectives
1	Former FTA – ERP Site 10	**Soil:** PFOS	**Soil:** The screening criteria were exceeded in one soil sample. Additional surface and subsurface soil samples are proposed to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Although screening criteria were not exceeded for groundwater, there was one soil exceedance. Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells near HEC01-SB2.
2	Building 217 – Main Hangar	**Groundwater:** PFOS, PFOA, PFOS + PFOA	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
3	Building 215 – Former Fire Station	**Groundwater:** PFOS, PFOA, PFOS + PFOA	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Due to screening criteria exceedances in co-located PRL 2 groundwater, determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
5	Nozzle Testing Area – East of Building 340	**None**	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Although screening criteria were not exceeded, determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
6	Nozzle Testing Area – South of Building 310	**None**	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Although screening criteria were not exceeded, determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells
7	Nozzle Testing Area – North of Apron	**Groundwater:** PFOA, PFOS + PFOA	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.

Table ES-2. SI Recommendation Summary Table (continued)

PRL No.	PRL Description	Constituents Above Screening Criteria	Sampling Recommendations and Objectives
9	Aircraft Parking Apron	**Groundwater:** PFOA (co-located PRL 7); PFOS + PFOA (co-located PRLs 2 and 7)	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
10	Stormwater Outfall 002	**Surface water:** PFOS, PFOA, PFOS + PFOA	**Surface Water and Sediment:** Additional sampling to determine the extent of surface water impacts and support the evaluation of whether unacceptable risks to ecological or human health receptors exist. Additional sampling upstream of Outfall 002 and at downstream off-Base locations.
11	Stormwater Outfall 003	**Surface water:** PFOS, PFOS + PFOA	**Surface Water and Sediment:** Additional sampling to determine the extent of surface water impacts and support the evaluation of whether unacceptable risks to ecological or human health receptors exist. Additional sampling upstream of Outfall 003 and at downstream off-Base locations.
12	Soils Stockpile Area	**Groundwater:** PFOS, PFOA, PFOS + PFOA	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
General			**Groundwater:** (1) Collect additional groundwater samples in upgradient locations to quantify potential impacts from upgradient sources, and (2) collect additional groundwater samples downgradient from the PRLs and off Base through the installation of a limited number of new monitoring wells to assess the nature and extent of PFAS impacts beyond the Base boundary. **Surface Water/Sediment:** (1) Collect additional surface water and sediment samples in upstream locations to quantify potential impacts from upstream sources, and (2) collect additional surface water and sediment samples from downstream locations off Base to assess the nature and extent of PFAS impacts beyond the Base boundary.

ERP = Environmental Restoration Program.
FTA = Fire training area.
PFAS = Per- and polyfluoroalkyl substances.
PFOA = Perfluorooctanoic acid.
PFOS = Perfluorooctane sulfonate.
PRL = Potential release location.
SI = Site inspection.

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1.0 INTRODUCTION

Leidos has prepared this Site Inspection (SI) Report to satisfy the requirements of Task Order 0011 of National Guard Bureau Contract Number W9133L-14-D-0007. Under this Task Order, Leidos was contracted to conduct Phase III regional SIs for perfluorinated compounds at multiple Air National Guard Bases (ANGBs). This report documents SI activities conducted between May 21 and June 8, 2018, at 10 potential release locations (PRLs) at the 119th Wing of the North Dakota Air National Guard (ANG) at Hector Field ANGB, Fargo, North Dakota, herein referred to as Hector Field ANGB, the Installation, or the Base (Figure 1). (Note that all figures and tables are presented at the end of the document.) All field activities were conducted in accordance with the *Work Plan for Fiscal Year 2017 Phase III Regional Site Inspections for Perfluorooctane Sulfonate and Perfluorooctanoic Acid at Hector Field Air National Guard Base, North Dakota* (Leidos 2018).

1.1 PROJECT OBJECTIVES AND SCOPE

The primary objective of the SI was to determine the presence or absence of perfluorinated compounds, more specifically per- and polyfluoroalkyl substances (PFAS) on the U.S. Environmental Protection Agency (EPA) Third Unregulated Contaminant Monitoring Rule (UCMR3), including perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutane sulfonate (PFBS), perfluorononanoic acid (PFNA), perfluoroheptanoic acid (PFHpA), and perfluorohexane sulfonate (PFHxS), herein collectively referred to as PFOS/PFOA.

Surface and subsurface soil, groundwater (downgradient from the PRL), and surface water and sediment (if available) were sampled and analyzed to determine the presence or absence of PFOS/PFOA in environmental media at the PRLs identified during the 2016 preliminary assessment (PA) (BB&E 2016) and to:

- Determine if PFOS/PFOA-contaminated groundwater has reached the Installation boundary;
- Provide a defensible no further action (NFA) decision for qualifying PRLs; and
- Develop data quality objectives (DQOs) for additional investigation for PRLs not meeting the NFA criteria or an interim response action, if appropriate.

The scope of work consisted of three inter-related tasks: (1) prepare an SI Work Plan (WP), (2) conduct SI and data collection activities, and (3) evaluate data from the field effort and applicable historical information to present conclusions and recommendations in an SI Report.

All sampling was performed on ANG property, and only PRLs located on ANG property were included in the project scope. Sampling of drinking water sources (other than the on-Base potable water supply that was used for decontamination activities) was not included, and determination of nature and extent of any identified contamination was not within the scope of this SI.

Ten PRLs, as listed in Table 1 and depicted in Figure 2, were selected for SI activities based upon the PA and site visit conducted by BB&E in January 2016 and reported in the *Perfluorinated Compounds Preliminary Assessment Site Visit Report, 119th Wing, North Dakota Air National Guard, Hector Field Air National Guard Base, Fargo, North Dakota* (BB&E 2016). This SI Report briefly summarizes the PA, describes SI field activities, presents analytical results of environmental sampling, and provides recommendations for each PRL.

1.2 REGULATORY OVERVIEW AND SCREENING CRITERIA

In 2012, EPA published the UCMR3, which required public water supplies across the country to sample for a list of 30 unregulated contaminants, including 6 chemicals of concern (COCs) relevant to this SI (PFOS, PFOA, PFBS, PFNA, PFHpA, and PFHxS; i.e., PFOS/PFOA). Results of UCMR3-required sampling indicated detections of PFOS/PFOA at numerous locations, including several near U.S. Department of Defense (DoD) facilities. PFOS/PFOA detections at DoD facilities are often linked to the use of aqueous film-forming foam (AFFF), which may contain one or more of these chemicals. AFFF is a firefighting agent used to suppress fires involving petroleum hydrocarbons.

Detected concentrations of PFOS/PFOA in environmental samples collected during the Hector Field ANGB SI were compared against soil and water screening criteria for PFOS, PFOA, and PFBS, as described below and listed in Table 2.

The November 2018 EPA generic regional screening level (RSL) table lists a residential risk-based screening level for tap water for PFBS of 400 micrograms per liter (µg/L) (400,000 nanograms per liter (ng/L); target hazard quotient = 1). Currently, no legally enforceable federal standards exist for PFOS/PFOA in water. However, under the Safe Drinking Water Act, EPA issued a series of health advisories (HAs) for PFOS/PFOA, including the most recent in May 2016. To provide Americans, including the most sensitive populations, with a margin of protection from a lifetime of exposure to PFOS/PFOA in drinking water, EPA established an HA level for PFOS and PFOA (combined) of 70 ng/L. The HA of 70 ng/L applies to PFOS and PFOA individually as well as combined. If an individual compound is detected >70 ng/L, the screening criteria are exceeded. However, if individual compounds are <70 ng/L but the sum of the compounds is >70 ng/L, the screening criteria are exceeded. For example, if PFOS = 50 ng/L and PFOA = 25 ng/L, the screening criteria are exceeded. Therefore, screening levels for groundwater and surface water are as follows:

- PFOS and PFOA = 70 ng/L; and
- PFBS = 400,000 ng/L.

There are also no legally enforceable federal standards for PFOS/PFOA in soil or sediment. The November 2018 EPA generic RSL table lists a residential risk-based screening level for soil for PFBS of 1,300,000 micrograms per kilogram (µg/kg). Following the process utilized at other ANG Installations around the country, Leidos will use residential risk-based screening levels for soil determined using the EPA RSL calculator and the November 2018 RSL tables (target hazard quotient (HQ) = 1). The calculated screening value for PFBS is slightly less than the value listed in the generic RSL table. RSLs are only available for three of the six COCs listed above. The calculated screening levels for these three COCs are as follows:

- PFOS = 1,260 µg/kg;
- PFOA = 1,260 µg/kg; and
- PFBS = 1,260,000 µg/kg.

As of the preparation of this SI Report, no site-specific soil screening levels have been developed in North Dakota. Furthermore, no surface water or sediment screening criteria have been established by EPA or the North Dakota Department of Health (NDDOH) at this time.

2.0 INSTALLATION DESCRIPTION

2.1 LOCATION

Hector Field ANGB is the home of the 119th Wing in Fargo, North Dakota. Hector Field ANGB is located approximately 3 miles northeast of downtown Fargo. ANG occupies approximately 209 acres within the primary Installation boundaries. The location of Hector Field ANGB is shown in Figure 1.

2.2 ORGANIZATION AND HISTORY

Hector Field was dedicated on May 27, 1931, for use as an airport after the donation of the land by Martin Hector. The property became Hector Field International Airport in 1982 when the United States Customs opened an office within the airport.

The North Dakota ANG was first formed in January 1947 as host to the 178th Fighter Interceptor Squadron; the squadron was reorganized into the 119th Fighter Interceptor Group in 1956. The primary mission of the 119th Wing has been an Air Defense Mission that has included intercepting, identifying, and destroying enemy airborne objects. During its history, the Base has supported many types of aircraft, including the F-51, AT-6, C-47, B-26, and L-5, as well as the F-94C, T-33, F-89D, F-102, F-101, F-4, and F-16. In its 2005 Base Realignment and Closure recommendations, DoD recommended retiring the 119th Wing F-16s after 60 years of use (URS 2007). The 119th Wing now pilots C-21A aircraft and performs MQ-1 Predator operations. DoD began investigations at military Bases under the Installation Restoration Program with the goal of identifying, evaluating, and remediating areas of contamination (the program is now referred to as the Environmental Restoration Program [ERP]). These investigations included PAs, site investigations, removal action investigations, and remedial investigations (RIs). Prior to the BB&E 2016 PA, potential releases of PFOS/PFOA from use and storage of AFFF had not been evaluated at Hector Field ANGB.

Base operations that could have contributed to PFOS/PFOA contamination of soil, groundwater, sediment, and surface water include fire training areas (FTAs) and non-FTAs. FTA PRLs are sites where AFFF was likely used for fire suppression during training activities. One former FTA (PRL 1) is located on Hector Field ANGB property. Non-FTA PRLs identified at Hector Field ANGB are sites where AFFF was stored, released, and/or likely to have been released, and include hangars (PRL 2), fire stations (PRLs 3 and 4), a flight apron (PRL 9) firefighting equipment testing areas (PRLs 5, 6, and 7), stormwater outfalls and/or surface water drainage features (PRLs 10 and 11), and a soils stockpile area (PRL 12). (BB&E 2016).

When AFFF is released to the environment, PFOS/PFOA can migrate into soil and groundwater. The amount of PFOS/PFOA that migrates to groundwater depends on the type and amount of AFFF used, where it was used, the type of soil, and other factors. PFOS/PFOA may migrate readily from soil to groundwater. The primary exposure pathway for PFOS/PFOA is the ingestion of contaminated drinking water.

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3.0 ENVIRONMENTAL SETTING

3.1 CLIMATE

Hector Field ANGB is located approximately 3 miles northeast of downtown Fargo. The climate is semiarid and the average temperature of nearby Fargo is 41.7°F, which is much lower than the national average temperature of 54.5°F. Annual rainfall amounts in Fargo are 22.66 in. with 47.35 days of 0.1 in. of rain or more of precipitation. Average snowfall for the area is 37.40 in. per year with 38.89 days of 0.1 in. of snow or more of snowfall (USA.com 2017).

3.2 TOPOGRAPHY

Hector Field ANGB is located in Cass County in the southeastern part of North Dakota. Cass County is within the Central Lowland Province, and the study area falls within the Red River Valley physiographic division. The topography at Hector Field ANGB is flat and nearly featureless with an elevation of 900 ft above mean sea level (AMSL) (SAIC 2006).

3.3 GEOLOGY

The Red River Valley represents the base of the prehistoric glacial Lake Agassiz. Lake Agassiz covered much of the land that is currently North Dakota; northwestern Minnesota; north-central South Dakota; and much of Manitoba, Canada. Lake Agassiz drained away from the Fargo area approximately 9,300 years ago. Underlying the Fargo area is approximately 100 ft of sediments whose engineering characteristics are extremely weak. The dominant material is clay, derived as glacial melt-water rivers dispersed fine-grained sediments into Lake Agassiz. The high shrink-swell properties of these clays induce foundation shifting, pavement failure, and utility line rupture. These materials are predominantly till, but localized zones of outwash sands and gravels can provide small aquifers of low yield (Leidos 2018).

Within the sediments, approximately 85 ft of the gray, slickensided, fat clays of the Brenna/Argusville Formations are overlain by 20 ft of the tan-buff, laminated silty-clays of the Sherack Formation. The gray, slickensided, fat clays act as a confining unit, allowing the potential for contaminants to pond in the sand and gravel stringers located above. The interface between the Brenna/Argusville and Sherack Formations is noted as having occasional localized sand and gravel stringers just above the Brenna Formation clay. Within both formations are occasional cobbles and boulders that appear to represent dropstones: rock debris that fell off icebergs floating in Lake Agassiz. Underlying the glacial clays, at an approximate depth of 200 to 300 ft below ground surface (BGS), is Pre-Cambrian granite and gneissic basement rock of the Superior Province Craton (SAIC 2006).

3.4 SOIL

The soils underlying Hector Field ANGB are composed of the Fargo Series and the Ryan soils. The Fargo soils are deep, poorly drained, slowly permeable soil series on glacial lake plains and the Ryan soils are characterized by deep, level, poorly drained, fine-textured soils formed as glacial, lacustrine sediment on flats, swales, and slight depressions of glacial lake plains.

The county soils consist of about 60% Fargo soils, 18% Ryan soils, and 22% of minor soils. The Ryan soils are noted for their alkalinity, while the Fargo soils are noted for their shrink-swell properties (SAIC 2006). Fargo Clay is the dominant soil type occurring at Hector Field ANGB and the surrounding area, ranging from 60 to 90 ft in thickness (URS 2007).

3.5 SURFACE WATER HYDROLOGY

Hector Field ANGB lies in the Red River drainage basin. No naturally occurring drainage systems, streams, or bodies of water are located on Base. Natural drainage at the ANGB and surrounding airport are not very well defined due to the flat topography. A high percentage of the active administrative and industrial areas of the Installation are paved or roofed and exhibit high runoff coefficients. The Aircraft Parking Apron is characterized by long, mildly sloping sheet flow until stormwater drainage enters the conveyance system through storm sewer drains along the northern and eastern edges of the ramp. Stormwater runoff is carried away by a series of storm sewers, culverts, and ditches that flow to several open man-made ditches; these in turn flow north and east to the Red River, which lies about 2 miles east of the Base (ANG 2015).

3.6 HYDROGEOLOGY

The principal aquifers in the Fargo area are the Fargo, West Fargo, Page, and Tower City aquifers. The West Fargo aquifer averages 60 ft thick and the water is hard to very hard. Small isolated aquifers, which range from a few feet to 20 ft thick, are common. The water quality varies, and the available quantity from these aquifers is small.

Although the depth to the water table fluctuates seasonally (with a depth to the high water table of approximately 1 ft BGS following the spring thaw in April or June), the typical depth to groundwater ranges from approximately 4 to 10 ft BGS (SAIC 2013).

The regional groundwater flow direction across the Base is generally from west to east. Because of the small hydraulic gradient (1 to 2 ft per mile) and the permeability rate of the soils, the average groundwater flow velocity (approximately 0.5 meters per year) is very slow (HMTC 1987).

The groundwater information collected from the monitoring wells installed in PRLs 1, 2, 5, 6, 7, and 12 during the Leidos SI field activities confirmed a shallow groundwater table. The shallow water table occurs at varying depths within the ANGB. Soil boring logs indicate shallow groundwater was encountered at depths ranging from 5 ft BGS in HEC03-SB1 to 18 ft BGS in HEC01-SB2. Groundwater levels collected before purging and sampling monitoring wells installed during the SI indicate the depth to shallow groundwater ranged from 2.8 ft BGS in MW11-05-PRL02 to 8.96 ft BGS in MW-HEC12-01. Groundwater elevations were 886.01 ft AMSL in MW-HEC12-01 and 894.72 ft AMSL in MW11-05-PRL02.

Groundwater within a 1-mile radius of the Base is not used for drinking water. The Base and surrounding metropolitan area receive their municipal drinking water from the Red River of the North (USDA 1983).

3.7 CRITICAL HABITATS AND ENDANGERED/THREATENED SPECIES

According to the U.S. Fish and Wildlife Service (USFWS) and a review of the list of federally listed threatened and endangered species, the following federally listed threatened, endangered, or proposed species are known to or are believed to occur in Cass County, North Dakota (USFWS 2017a). The potential for these species to occur in Cass County does not mean they are present at Hector Field ANGB:

- Birds:
  - Whooping crane (*Grus americana*) – Endangered.
- Mammals:
  - Northern long-eared bat (*Myotis septentrionalis*) – Threatened.

The USFWS National Wetlands Inventory indicates no designated wetlands are present at Hector Field ANGB (USFWS 2017b).

3.8 WATER WELLS

The PA Report (BB&E 2016) indicates no federal or public water supply wells are within a 1-mile radius of the Base. A review of the EDR Radius Map™ Report with Geocheck® dated October 9, 2015 (EDR 2015) lists 14 water wells within a 1-mile radius of the Base. Of these wells, seven are listed in the Federal U.S. Geological Survey (USGS) database, all of which are listed under the North Dakota Water Science Center. The remaining seven wells are listed in the North Dakota state database. Of the seven, three are listed as test holes, one as an irrigation well (northwest of the Base), one as an industrial well (northwest of the Base), one as a stock well, and one as an observation well. Drinking water is supplied to the Base by the city of Fargo. According to Base personnel, no drinking water wells are located at the Base.

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4.0 PRELIMINARY ASSESSMENT

In 2016, BB&E conducted a PA to identify potential sites of historical environmental releases of PFOS/PFOA related to AFFF usage and storage at Hector Field ANGB (BB&E 2016). The PA evaluated a total of 12 PRLs and recommended 10 of these for further investigation under an SI (Table 1; see also Figure 2). At the time of the 2016 PA, no documentation was available showing that soil, groundwater, sediment, and surface water at Hector Field ANGB were previously tested for PFOS/PFOA; therefore, these compounds could be present in media at any of these PRLs.

BB&E researched the potential existence of any documented FTAs or any other use or release of AFFF. No evidence exists that a current FTA that utilizes AFFF is located within the footprint of the Hector Field ANGB site boundary. However, one historical FTA was located within the current Base footprint.

The PA site visit included onsite interviews with active and former personnel from the ANG Installation and other parties with relevant historical site knowledge. According to Base personnel, 3% AFFF started being used at Hector Field ANGB in the early 1980s, and AFFF is still stored and used at the fire station. One building (Building 217) is equipped with an AFFF fire suppression system (FSS). In Building 210, the AFFF FSSs were converted to high expansion foam systems.

The sections below briefly describe the operational history and waste characteristics of the PRLs included in this SI, as presented in the PA Report (BB&E 2016). PRL numbers correspond to the area of concern designation used in the PA Report.

4.1 PRL 1: FORMER FTA – ERP SITE 10

The Former FTA – ERP Site 10 is located south of the east end of Runway 3-21, on property formerly owned by the city of Fargo (now ANG property). Fire training exercises were conducted at the site from the late 1950s until mid-1989. Each training exercise involved the use of approximately 300 to 500 gal of jet propulsion fuel No. 4 (JP-4). Solvent use in fire training exercises was minimal. The FTA consisted of an open, generally flat area that contained a burn pit approximately 75 to 100 ft wide. The site is now an open, grassy area, as observed during the PA site visit.

As part of the ERP, a site investigation was conducted in 1992 that indicated elevated levels of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals in soil samples collected at the site. Xylene was the only VOC detected in groundwater. Several metals and SVOCs were detected in groundwater samples. Acetone and carbon disulfide were the only organic compounds detected in surface water samples. VOCs, SVOCs, and a polychlorinated biphenyl were detected in sediment samples (URS 2009).

Contaminated soil removal and treatment activities were conducted during three phases of work, which began in July 1996 and were completed in July 1997. A total of 5,196 yd^3 of fuel-impacted soil were removed from Site 10 and treated on Base in a soil land-farm treatment location near the northeastern corner of the Base (Native Energy and Technology, Inc. 2000). Soils from Site 10 and soils generated during other non-related underground storage tank (UST) removal projects were land-farmed at this general location in the northeastern corner of the Base located directly west (west and north of the county drain) of the current Base main entrance. Approval for reuse of soils as general fill material from the landfarm site was provided by NDDOH, and Site 10 was approved for closure in April 1999 (URS 2009). The former location of the land farm site still serves as a general Base soil stockpile location and heavy equipment training area. The historical ERP site investigations did not include perfluorinated compound analysis. No specific use of AFFF was documented at this FTA, but based on the years of use, AFFF was likely utilized during fire training exercises.

4.2 PRL 2: BUILDING 217 – MAIN HANGAR

The approximate 25,000-ft^2 Main Hangar was originally constructed in the 1950s. An AFFF FSS was installed in approximately 1992 (Burns & McDonnell 2016), which uses a series of seven low-level AFFF oscillating deck guns. The AFFF FSS remained in use at the time of the PA site visit. One 700-gal AFFF storage tank is utilized as part of the system. Per Fire Department (FD) personnel, the AFFF system was likely tested once annually following installation until approximately 2000. From 2000 to 2014, the system was tested approximately biannually. It is estimated that up to approximately one 55-gal drum of AFFF concentrate was utilized during each test. Water and AFFF utilized during the tests would have been ultimately discharged to the sanitary sewer system via the building floor drains.

Installation Restoration Program (IRP) Site 11 is located near the southwestern corner of Building 217. Site 11 was first identified through the investigation of the former aboveground storage tank (AST) that was used to store heating oil. The AST was removed and replaced with a new AST in the mid-1990s. Building 217 was identified as the source area of a chlorinated solvent groundwater plume during the Phase I and II site investigations (SAIC 2004, 2005) and was further delineated during multiple RIs (SAIC 2006, 2008, 2010). Chlorinated solvents were stored in 55-gal drums adjacent to a wash rack located in Building 217. It is believed that the solvents were used as a cleaner in the wash rack. The first phases of the remedial action to address contaminated groundwater were conducted from July 2011 through March 2012 and included institutional controls implementation, injection well installation, baseline groundwater monitoring, bioremediation injection activities, and 90-day performance monitoring (SAIC 2013). Soil and groundwater institutional controls were implemented to minimize the likelihood for a potential receptor to come into contact with contaminated subsurface soil or groundwater until the remedial levels are achieved.

An injection well network was installed in August/September 2011 throughout the trichloroethene (TCE) groundwater plume where concentrations were greater than 50 µg/L. Twenty-nine injection wells were installed inside and surrounding the southern end of Building 217, including inside the Mechanical/Boiler Room (Room 144). A baseline sampling event was conducted prior to injection activities in July/August 2011 to document subsurface conditions prior to beginning treatment. A mixture of biostimulation amendments was injected to facilitate anaerobic biodegradation and abiotic degradation of TCE and its associated daughter products. Amendments included organic substrates, a buffer to neutralize generated acids, and sufficient injection water to provide for dispersion of the amendments in the subsurface. The active treatment zone was defined by the 50 µg/L TCE plume contour at the baseline sampling event.

Amendment quantities were based on baseline contaminant concentrations and distribution. Approximately 78,000 gal of total amendment were injected (SAIC 2013). A second, similar amendment injection was completed in September 2015. A total of approximately 15,000 gal of amendment were injected into a smaller treatment area of residual elevated chlorinated solvent concentrations (Tetra Tech 2016). The performance monitoring results from periodic groundwater sampling events conducted between 2012 and 2017 indicate that enhanced anaerobic bioremediation injection activities have been successful in significantly reducing COCs (Leidos 2014, Tetra Tech 2017). ANG does not believe the remediation activities conducted at IRP Site 11 had an impact on the potential PFOS/PFOA contamination from Building 217.

4.3 PRL 3: BUILDING 215 – FORMER FIRE STATION

The 10,552-ft^2 Building 215 was built in 1955 (ANG 2002) and served as the former Base Fire Station from 1955 until 2011 when Building 340 – Current Fire Station was completed. Fire vehicles with AFFF were historically utilized and parked inside the building's bay area, and they also were cleaned inside the building. Trench or floor drains within the fire station drain to the sanitary sewer via an oil/water separator (OWS) installed in 1989 (ANG 2002).

According to FD personnel, unused AFFF from fire rescue vehicles was discharged to the sanitary sewer in approximately 2001 when the fire station acquired new rescue vehicles. It is estimated that approximately 180 gal of AFFF were released on three occasions during the transition from the old to new fire rescue vehicles. The discharge was coordinated with the local wastewater treatment plant.

At the time of the PA site visit, Building 215 was still present and located immediately west of Building 217. Building 215 was used as the Deployment Processing Center.

4.4 PRL 4: BUILDING 340 – CURRENT FIRE STATION

Building 340 was constructed in 2011 and serves as a combined ANG and Hector International Airport fire station, serving both the ANGB and Hector International Airport. At the time of the PA site visit, a total of 1,835 gal of AFFF were stored in fire rescue vehicles at the Fire Station, as described below:

- Crash vehicle 3: 210 gal,
- Crash vehicle 4: 210 gal,
- Crash vehicle 6: 130 gal,
- Engine 11: 50 gal,
- Tanker 5: 5 gal,
- Foam trailer: 600 gal,
- Hector Airport rescue vehicle 2: 210 gal, and
- Hector Airport rescue vehicle 3: 420 gal.

The foam trailer was manually filled with AFFF from new storage containers (typically 5-gal pails) and the fire trucks were filled from the foam trailer with a pump and hose. No excess AFFF was stored at the Fire Station. Fire vehicles were cleaned inside the building. At the time of the PA site visit, Building 340 was equipped with floor drains in the concrete floor, which discharge to the sanitary sewer system via an OWS. No releases of AFFF have been documented at this building. NFA was recommended in the PA Report (BB&E 2016), and this PRL will not be discussed further or evaluated in the SI Report.

4.5 PRL 5: NOZZLE TESTING AREA – EAST OF BUILDING 340

Fire equipment and nozzle testing was typically conducted annually immediately east of the Current Fire Station in grassy areas off the concrete drive. Testing at this location was likely conducted in the general timeframe of 2011 to 2014. Fire equipment and nozzle testing was discontinued on Base in approximately 2014. The AFFF and water mixture would be allowed to dissipate on the concrete drive and grassy areas to the east side of the Fire Station. It is estimated that less than 1 gal of AFFF and water mixture would have been discharged per testing event, depending on the duration of the test. Storm drainage from this vicinity discharges to storm drains surrounding the Building 340 – Current Fire Station, which discharges to the north-south trending airport drainage ditch in this location. This drainage feature eventually discharges to the county drain running west-east along the northern Base boundary.

4.6 PRL 6: NOZZLE TESTING AREA – SOUTH OF BUILDING 310

Fire equipment and nozzle testing also was periodically conducted, as part of annual testing requirements, immediately south of Building 310 onto the concrete and grassy areas at this location. Testing was done at this location based on wind conditions, as this location is more sheltered due to the high soil berm surrounding the munitions Building 310. The exact dates of testing are unknown. Fire equipment and nozzle testing was discontinued on Base in approximately 2014. The AFFF and water mixture would be allowed to dissipate on the concrete drive and grassy areas to the south of the current fire station. It is estimated that less than 1 gal of AFFF and water mixture would have been discharged per testing event, depending on the duration of the test. Storm drains located in this vicinity discharge to Outfall 003, which discharges to the county drain running west-east along the northern Base boundary.

4.7 PRL 7: NOZZLE TESTING AREA – NORTH OF APRON

Fire equipment and nozzle testing also was periodically conducted, as part of annual testing requirements, immediately north of the Aircraft Parking Apron located north of Building 217 on the grassy area. The exact dates of testing are unknown. Fire equipment and nozzle testing was discontinued on Base in approximately 2014. The AFFF and water mixture would be allowed to dissipate on the grassy areas to the north of the current apron. It is estimated that less than 1 gal of AFFF and water mixture would have been discharged per testing event, depending on the duration of the test. Storm drains located in this vicinity discharge to Outfall 002, which discharges to the county drain running west-east along the northern Base boundary.

4.8 PRL 8: BUILDING 420 – SUPPLY COMPLEX

Building 420 was constructed in 1959 and is the Base Supply Complex. Approximately 940 gal of unused drums and pails of AFFF are periodically stored in this building. No releases of AFFF at this building have been documented. At the time of the PA site visit, the building and warehouse were observed to be very clean with no evidence of any spills. NFA was recommended in the PA Report (BB&E 2016), and this PRL will not be discussed further or evaluated in the SI Report.

4.9 PRL 9: AIRCRAFT PARKING APRON

The Aircraft Parking Apron is located north of the main hangar, Building 217 and north of the Building 215 – Former Fire Station. The Apron is used for aircraft loading and parking and may have been impacted by AFFF due to the historical presence of aircraft.

Nozzle testing was performed in this area during the operation of the Former Fire Station; however, the exact dates of nozzle testing are unknown. The AFFF and water mixture would be allowed to dissipate on the concrete apron in the general area north of the Former Fire Station. Precipitation on the apron would either drain to nearby storm drains located on the apron or sheet flow to grassy areas off the edge of the apron. Storm drains located in this vicinity discharge to Outfall 002, which discharges to the county drain running west-east along the northern Base boundary.

4.10 PRL 10: STORMWATER OUTFALL 002

This storm drain discharge point in the north-central portion of the Base drains areas of the Base that likely had AFFF released to the ground surface, including the main aircraft apron, nozzle testing areas north of the apron, and the Former FTA – ERP Site 10. Outfall 002 discharges to the county drain that flows in a general west to east direction parallel to the northern Base boundary. The precast concrete outfall is physically located off Base, just north of the Base boundary. Standing water was present at the outfall's discharge point and within the county drain at the time of the PA site visit. Evaluation of this outfall will include sampling of accessible locations within the ANGB boundary upstream of the actual outfall location to ensure only ANG stormwater resources are evaluated.

4.11 PRL 11: STORMWATER OUTFALL 003

This storm drain discharge point in the northwest portion of the Base drains areas of the Base that likely had AFFF released to the ground surface, including the Nozzle Testing Area – South of Building 310 and possibly areas surrounding Building 340 – Current Fire Station. Outfall 003 discharges to the county drain that flows in a general west to east direction parallel to the northern Base boundary. The outfall is physically located off Base, just north of the Base boundary. Evaluation of this outfall will include sampling of accessible locations within the ANGB boundary upstream of the actual outfall location to ensure only ANG stormwater resources are evaluated.

4.12 PRL 12: SOILS STOCKPILE AREA

At the time of the PA site visit, this location served as a general Base soils stockpile area and heavy equipment training location. It was dirt and grass covered. Precipitation in this area either infiltrates into shallow soils or drains to the county drain located immediately south and east of this location. No specific storm drains or outfalls are associated with this area. This area also served as a temporary soil treatment land-farm for soils removed from the Former FTA – ERP Site 10 and soils removed from other Base UST removal and closure projects. This general stockpile area was approved for use by NDDOH. Soils removed from the Former FTA – ERP Site 10 are most likely present at this location, and previous land-farming biological treatment would likely not have degraded any potential perfluorinated compounds in the soils transported to this location.

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5.0 SITE INVESTIGATION FIELD PROGRAM

This section summarizes the SI field activities, including soil, groundwater, surface water, and sediment sampling, at Hector Field ANGB. Analytical results for each PRL are presented and identify the presence or absence of PFOS/PFOA and results for PFOS, PFOA, and PFBS that exceed the screening criteria shown in Table 2 and described in Section 1.2 of this SI Report.

The SI field activities were conducted between May 21and June 8, 2018. All sampling and analytical activities were conducted in accordance with the procedures specified in the SI WP (Leidos 2018), except as noted in Section 5.1.2. Boring logs and monitoring well construction logs are provided in Appendix A and groundwater sampling logs are provided in Appendix B. The groundwater monitoring well survey report is included in Appendix C. The data validation report is provided in Appendix D. The full data package is provided in Appendix E.

5.1 GENERAL APPROACH

5.1.1 Field Sampling

SI field activities included the following:

- Surface and subsurface soil sampling;
- Water level measurements at two existing monitoring wells and nine newly installed permanent monitoring wells to confirm local groundwater flow at Hector Field ANGB;
- Installation and sampling of groundwater from nine new monitoring wells and two existing monitoring wells located downgradient from the PRLs and/or at the Installation boundary;
- Surface water and sediment sampling; and
- Global positioning system survey of soil borings and surface water locations (the horizontal location and elevation of all newly installed wells were surveyed by a professional licensed surveyor).

Sample locations were based on known historical or potential releases, and site conditions as observed during the PA. Table 3 summarizes the SI sampling activities at Hector Field ANGB. Figure 2 shows an overview of the Hector Field ANGB SI sample locations. Prior to intrusive activities, an underground utility locator marked and cleared all boring locations.

A total of 19 soil borings were advanced. Borings were advanced in grassy areas using either a direct push technology drill rig or a hand auger to first water or refusal, whichever was encountered first. Soil borings were logged for soil lithology. Boring logs are included in Appendix A. Two grab soil samples were collected from each boring—one from within the 0- to 2-ft BGS interval and one from within the 2-ft interval immediately above the water table.

All soil samples were screened by a photoionization detector as a health and safety precaution due to the potential presence of VOCs. Following collection of soil samples, boreholes not co-located with monitoring wells were abandoned by backfilling with hydrated bentonite chips up to approximately 6 in. from the surface and capped with surrounding soil.

In addition to the two existing wells on Hector Field ANGB, nine permanent monitoring wells were installed and water levels measured to determine groundwater flow direction. The new wells were developed and 11 monitoring wells sampled following ANG guidance, as prescribed in the SI WP (Leidos 2018).

Two surface water samples were collected from manholes located within the Base boundary. The manholes discharge stormwater to Outfall 002 (PRL 10) and Outfall 003 (PRL 11) and are the last available surface water sample locations within the Base boundary, as described in the SI WP (Leidos 2018). No sediment was present in the manholes associated with Outfalls 002 and 003. Additional details on the field activities for each PRL are provided in Sections 5.3 through 5.12.

5.1.2 Deviations from the Work Plan

The following minor deviations were observed during field activities:

- Groundwater samples from three existing wells at Building 217 were proposed for the Hector Field SI. However, existing well MW11-01-PRL02 could not be sampled because the well was dry and an obstruction was noted at approximately 2.8 ft BGS. Therefore, MW-HEC02-01 was installed at co-located soil boring HEC02-SB01 in the vicinity of MW11-01-PRL02 and a groundwater sample was collected from the new well.

- Due to shallow groundwater observed in the PRL 1 monitoring well (MW-HEC01-01 [~6 ft BGS]), soil samples were not collected from the depth below previous soil excavation in 1996/1997 (~11 ft BGS). Samples were collected from the 2-ft interval above the water table and from the 0- to 2-ft BGS surface soil interval.

- No sediment was observed in the accessible manholes for Stormwater Outfall 002 (PRL 10) and Stormwater Outfall 003 (PRL 11). No samples were collected per the SI WP (Leidos 2018).

5.1.3 Data Analysis

5.1.3.1 Laboratory

Environmental samples were submitted to TestAmerica Analytical Laboratories, Inc. (TestAmerica), in West Sacramento, California. TestAmerica is accredited under the DoD Environmental Laboratory Accreditation Program and maintains a National Environmental Laboratory Accreditation Program certification.

5.1.3.2 Screening criteria

Analytical data for three of the 2012 EPA UCMR3 COCs (PFOS, PFOA, PFBS) were compared to appropriate HA or risk-based screening criteria (Section 1.2 and Table 2) to determine whether further investigation is required. No HA or RSL criteria currently exist for PFHpA, PFHxS, or PFNA.

5.1.3.3 Data validation

A Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) was developed for this project as Appendix A of the SI WP (Leidos 2018). The UFP-QAPP was written to apply to all 15 Installations included in the scope of the Phase III SI contract. Specifics on the number and type of samples to be collected in characterizing the site, and the number and type of quality assurance (QA)/quality control (QC) samples to be used to evaluate the quality of the data obtained, were included in the SI WP (Leidos 2018). Soil was collected in one 4-oz. high-density polyethylene (HDPE) container with HDPE cap.

Groundwater and surface water samples were collected in two 250-mL HDPE containers with HDPE caps. The following samples were collected during the Hector Field ANGB SI in June 2018:

- Forty-two soil samples,
- Thirteen groundwater samples,
- Two surface water samples,
- Four soil field duplicate samples,
- Two groundwater field duplicate samples
- Seven equipment rinsates,
- One reagent blank, and
- Two field blanks.

The results of the data quality evaluation indicate that the overall quality of the data is acceptable to confirm the presence or absence of contamination. Through data verification, validation, and review, the analytical information has been qualified as appropriate. Data are considered usable if they are unqualified or qualified as estimated. For groundwater and surface water, 100% of the data was considered usable. For soil, 100% of the data was considered usable. The overall quality of the data meets or exceeds the established project objectives.

Quality Control

Six field duplicate samples were collected, including four for soil and two for groundwater. Field duplicate analytical results were consistent with their associated parent samples, indicating no significant issues with field and laboratory precision. All duplicate pairs had relative percent difference values below the UFP-QAPP guidelines of 50% for all detected analytes.

Seven equipment rinsate samples (four for soil, one for surface water, and two for groundwater) were collected and analyzed for PFOS/PFOA. All results were non-detect for the equipment rinsate samples. One reagent blank was collected following the procedure outlined in the SI WP. PFOS/PFOA were not detected in the reagent blank sample. Field blank samples HEC-FB-DI-01 and HEC-FB-POT-01 were collected from deionized water and a potable water source (preserved with Trizma), respectively, and analyzed for PFOS/PFOA. PFOS/PFOA were not detected in HEC-FB-DI-01. PFHpA was detected at a low estimated concentration in HEC-FB-POT-01. Note that decontamination procedures were followed in the field, including washing with laboratory grade, non-phosphate detergent; rinsing with potable water; final rinsing with deionized, analyte free water; and air drying. The final equipment rinse is with the deionized water; therefore, no qualification of field samples was required based on the potable water field blank. For these reasons, SI data quality was not impacted as a result of the SI COCs being detected in the field blank.

PFOS/PFOA

Some PFOS/PFOA compounds were qualified as estimated due to minor QC outliers. Ten PFOS/PFOA results were qualified as estimated (J) due to surrogate recovery results outside control limits. Forty-one PFOS/PFOA results were qualified as estimated (J) due to internal standard outliers. Five PFOS/PFOA results were qualified as estimated (J) due to matrix spike/matrix spike duplicate (MS/MSD) recovery outliers. Five PFHxS results were qualified as non-detect due to continuing calibration blank contamination. PFOS and PFHxS results for sample MW11-05-PRL02-01 and one PFOS result for sample HEC01-SB2-01 were qualified as estimated due to results reported above the calibration range after maximum dilution. One PFOA result was qualified as estimated (J) due to chromatographic interferences. No other QC outliers resulted in qualification of the data during the data validation process.

Except as noted above, data produced for this investigation demonstrate that it can withstand scientific scrutiny; are appropriate for its intended purpose; are technically defensible; and are of known and acceptable sensitivity, precision, and accuracy. Data integrity has been documented through proper implementation of QA and QC measures. The environmental information presented has an established confidence that allows utilization for the project objectives and provides data for future needs.

5.2 INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) was managed in compliance with the SI WP (Leidos 2018). Fourteen drums of non-hazardous soil IDW, three drums on non-hazardous contact IDW, and eight drums of non-hazardous water IDW were transported to a designated drum staging area located onsite. Two IDW samples (one aqueous and one solid) were collected for this event, and the IDW sample results, in conjunction with the PFOS/PFOA results and historical site process knowledge, were used for characterization of generated IDW. Following approval of the waste profile, the IDW drums were disposed of at the Veolia ES Technical Solutions facility in Menomonee Falls, Wisconsin.

5.3 PRL 1: FORMER FTA – ERP SITE 10

A total of three soil borings and two monitoring wells were installed and sampled at PRL 1 (Table 3), as described below. MW-HEC01-02 was installed east of PRL 1 near the Base boundary to determine if PFOS/PFOA-contaminated groundwater has reached the Base boundary.

5.3.1 Sampling Activities

5.3.1.1 Soil sampling

A total of three soil borings were advanced on June 3, 2018, in the PRL 1 area. HEC01-SB1 was advanced in a grassy area northwest of the burn pit (Figure 3). HEC01-SB2 was advanced in a grassy area immediately east of the burn pit (Figure 3). HEC01-SB3 was advanced in a grassy area at the southern edge of PRL 1 (Figure 3). Borings were advanced to total depths ranging from 15 ft BGS (HEC01-SB01 and HEC01-SB03) to 20 ft BGS (HEC01-SB02). Soil lithology descriptions were logged on the soil boring logs (Appendix A). A total of eight soil samples (including two field duplicates) were collected and analyzed for PFOS/PFOA compounds.

5.3.1.2 Groundwater

MW-HEC01-01 was drilled in the grassy area at the eastern and downgradient edge of the PRL on May 25, 2018 (Figure 6). MW-HEC01-02 was drilled in the grassy area due east of the PRL near the Base boundary on May 23 and 30, 2018 (Figure 6). Well construction details are shown in Table 4. Well construction diagrams are included in Appendix A.

MW-HEC01-01 and MW-HEC01-02 were developed on June 2, 2018, and sampled on June 7, 2018. Water levels are shown in Table 5, and water quality parameters are shown in Table 6. Groundwater sample MW-HEC01-01-01 and MW-HEC01-02-01 were collected and analyzed for PFOS/PFOA compounds. The Groundwater Micro Purge Sheet and Groundwater Micro Purge Log are included in Appendix B.

Wells MW-HEC01-01 and MW-HEC01-02 were surveyed by a licensed surveyor, and the well survey report is included in Appendix C.

5.3.2 Analytical Results

5.3.2.1 Soil

Eight soil samples, including two field duplicates, were collected and analyzed from PRL 1, as described in Section 5.3.1. All surface soil samples from this PRL showed detections above the laboratory detection limit for all six PFOS/PFOA compounds. No screening criteria exist for PFHxS, PFHpA, and PFNA. A PFOS concentration of 20,000 J µg/kg was detected in HEC01-SB2-01, exceeding the EPA RSL of 1,260 µg/kg. None of the concentrations of PFOA or PFBS exceeded the soil screening criteria.

In the subsurface soil samples, all six PFOS/PFOA compounds were detected, except PFNA in HEC01-SB2-01. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria. Soil analytical results for PRL 1 are presented in Table 7 and shown in Figure 3.

5.3.2.2 Groundwater

Two groundwater samples were collected from MW-HEC01-01 and MW-HEC01-02, and analyzed as described in Section 5.3.1. Only PFOA, PFBS, PFHpA, and PFHxS were detected in MW-HEC01-01 above laboratory detection limits. Only PFOA and PFBS were detected above laboratory detection limits in MW-HEC01-02 located near the Base boundary. PFOA concentrations were below the 70-ng/L EPA drinking water HA (EPA 2016b). PFBS was below the EPA RSL. No screening criteria exist for PFHxS, PFHpA, and PFNA. Groundwater analytical results for PRL 1 are presented in Table 8 and shown in Figure 6.

5.4 PRL 2: BUILDING 217 – MAIN HANGAR

A total of one soil boring and one new monitoring well were installed and sampled, and two existing monitoring wells were sampled at PRL 2 (Table 3), as described below. PRL 2 is co-located with PRLs 3 and 9. PRL 3 soil samples (HEC03-SB1 and HEC03-SB2) immediately west of Building 217 are also used in the evaluation of PRL 2. In addition, a soil sample (HEC09-SB1) near the Aircraft Parking Apron (PRL 9) is used in the evaluation of PRL 2.

5.4.1 Sampling Activities

5.4.1.1 Soil

One soil boring was advanced on May 31, 2018, in the PRL 2 area. HEC02-SB1 was advanced in a grassy area east/northeast of the Main Hangar (Figure 3). The soil boring was advanced to a total depth of 20 ft BGS. Soil lithology descriptions were logged on the soil boring log (Appendix A). A total of three soil samples (including one field duplicate) were collected and analyzed for PFOS/PFOA compounds.

5.4.1.2 Groundwater

Existing well MW11-01-PRL02 could not be sampled because the well was dry and an obstruction was noted at approximately 2.8 ft BGS. Therefore, a new well (MW-HEC02-01) was advanced in soil boring HEC02-SB1, located in the grassy area east/northeast of the Main Hangar, on May 24, 2018 (Figure 6). Well construction details are shown in Table 4. The well construction diagram and soil lithology log are included in Appendix A.

MW-HEC02-01 was developed on June 1, 2018, and sampled on June 6, 2018. Existing wells MW11-05-PRL02 and MW11-15-PRL02, located south and inside of the Main Hangar, respectively, were also purged and sampled on June 6, 2018. Water levels are shown in Table 5, and water quality parameters are shown in Table 6. Groundwater samples MW-HEC02-01-01, MW11-05-PRL02-01, and MW11-15-PRL02-01 were collected and analyzed for PFOS/PFOA compounds. The Groundwater Micro Purge Sheet and Groundwater Micro Purge Log are included in Appendix B.

Well MW-HEC02-01 was surveyed by a licensed surveyor, and the well survey report is included in Appendix C.

5.4.2 Analytical Results

5.4.2.1 Soil

Three soil samples from HEC02-SB1 were collected and analyzed as described in Section 5.4.1. All six PFOS/PFOA compounds except PFBS were detected above laboratory detection limits in surface soil sample HEC02-SB1-01. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS or PFOA exceeded the soil screening criteria.

In the subsurface soil samples, all six PFOS/PFOA compounds were detected in HEC02-SB1-02, except PFBS was not detected in the primary sample. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria. PRL 2 soil analytical results are presented in Table 7 and shown in Figure 3.

Evaluation of PRLs 3 and 9 soil sample results indicated all six PFOS/PFOA compounds were detected above laboratory detection limits in surface and subsurface soil samples from HEC03-SB1, HEC03-SB2, and HEC09-SB1, except PFNA was not detected in the subsurface sample at HEC03-SB2. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria. It should be noted that PFOS (1,200J µg/kg) was detected in the surface soil at HEC03-SB2, which is only slightly below the screening criteria of 1,260 µg/kg. PRLs 3 and 9 soil analytical results are presented in Table 7 and shown in Figure 3.

5.4.2.2 Groundwater

One round of groundwater samples was collected from MW-HEC02-01, MW11-05-PRL02, and MW11-15-PRL02, and analyzed as described in Section 5.4.1. All six PFOS/PFOA compounds were detected above laboratory detection limits in all three wells, except PFNA was not detected in MW11-15-PRL02. The combined PFOS and PFOA concentration at HEC02-01 nearly exceeded the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b) at a concentration of 69 ng/L; however, the field duplicate combined PFOS/PFOA concentration at this location is 79 ng/L. PFOS concentrations exceeded the 70-ng/L EPA drinking water HA (EPA 2016a) at concentrations of 58,000 J and 250 ng/L, respectively, at MW-11-05-PRL02 and MW11-15-PRL02. PFOA exceeded the HA at a concentration of 16,000 J ng/L in MW11-05-PRL02. The combined PFOS and PFOA concentrations at MW-11-05-PRL02 and MW11-15-PRL02 exceeded the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b) at concentrations of 74,000 and 263 ng/L, respectively. PFBS concentrations were below the EPA RSL. No screening criteria exist for PFHxS, PFHpA, and PFNA. Groundwater analytical results for PRL 2 are presented in Table 8 and shown in Figure 6.

5.5 PRL 3: BUILDING 215 – FORMER FIRE STATION

A total of two soil borings were installed and sampled at PRL 3 (Table 3), as described below. This PRL is co-located with PRLs 2 and 9. PRL 2 groundwater samples will be used for evaluation of this PRL in conjunction with the soil samples at PRL 3.

5.5.1 Sampling Activities

5.5.1.1 Soil

A total of two soil borings were advanced on June 3 and 4, 2018, in the PRL 3 area. HEC03-SB1 was advanced in a grassy area west of the hangar and near the Aircraft Parking Apron (PRL 9) (Figure 3). HEC03-SB2 was advanced in a grassy area east of the hangar and near the Aircraft Parking Apron (Figure 3). Borings were advanced to total depths ranging from 4.2 ft BGS (HEC03-SB2) to 5 ft BGS (HEC03-SB1). Soil lithology descriptions were logged on the soil boring logs (Appendix A). A total of four soil samples were collected and analyzed for PFOS/PFOA compounds.

5.5.1.2 Groundwater

PRL 3 is co-located with PRLs 2 and 9. PRL 2 groundwater samples are used for evaluation of this PRL in conjunction with the soil samples at PRL 3. No additional wells were sampled for PRL 3.

5.5.2 Analytical Results

5.5.2.1 Soil

Four soil samples from HEC03-SB1 and HEC03-SB2 were collected and analyzed as described in Section 5.5.1. All six PFOS/PFOA compounds were detected above laboratory detection limits in surface soil samples HEC03-SB1-01 and HEC03-SB2-01. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria.

In the subsurface soil samples HEC03-SB1-02 and HEC03-SB2-02, all six PFOS/PFOA compounds were detected above laboratory detection limits, except PFNA was not detected in HEC03-SB2-02 No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria. It should be noted that PFOS (1,200J µg/kg) was detected in the surface soil at HEC03-SB2, which is only slightly below the screening criteria of 1,260 µg/kg. PRL 3 soil analytical results are presented in Table 7 and shown in Figure 3.

5.5.2.2 Groundwater

Evaluation of co-located PRL 2 groundwater sample results indicated all six PFOS/PFOA compounds were detected above laboratory detection limits in all three wells (MW-HEC02-01, MW11-05-PRL02, MW11-15-PRL02), except PFNA was not detected in MW11-15-PRL02. The combined PFOS and PFOA concentration at HEC02-01 nearly exceeded the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b) at a concentration of 69 ng/L; however, the field duplicate combined PFOS/PFOA concentration at this location is 79 ng/L. PFOS concentrations exceeded the 70-ng/L EPA drinking water HA (EPA 2016a) at MW-11-05-PRL02 and MW11-15-PRL02. PFOA exceeded the HA in MW11-05-PRL02. The combined PFOS and PFOA concentrations at MW-11-05-PRL02 and MW11-15-PRL02 exceeded the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b). PFBS concentrations were below the EPA RSL. No screening criteria exist for PFHxS, PFHpA, and PFNA. Groundwater analytical results for PRL 2 are presented in Table 8 and shown in Figure 6.

5.6 PRL 5: NOZZLE TESTING AREA – EAST OF BUILDING 340

A total of three soil borings and one monitoring well were installed and sampled at PRL 5 (Table 3), as described below.

5.6.1 Sampling Activities

5.6.1.1 Soil

A total of three soil borings were advanced on May 30, 2018, in the PRL 5 area. HEC05-SB1 was advanced in a grassy area in the northern portion of the PRL where nozzle testing occurred (Figure 4). HEC05-SB2 was advanced in a grassy area in the central portion of the PRL near the fence, where nozzle testing occurred (Figure 4). HEC05-SB3 was advanced in a grassy area south of the roadway and PRL boundary, where nozzle testing also occurred (Figure 4). Borings were advanced to total depths ranging from 10 ft BGS (HEC05-SB3) to 15 ft BGS (HEC05-SB01 and HEC05-SB2). Soil lithology descriptions were logged on the soil boring logs (Appendix A). A total of six soil samples were collected and analyzed for PFOS/PFOA compounds.

5.6.1.2 Groundwater

MW-HEC05-01 was installed within the co-located soil boring HEC05-SB2 in the grassy area in the central portion of the PRL near the fence, where nozzle testing occurred (Figure 6) on May 30, 2018 (Figure 6). Well construction details are shown in Table 4. The well construction diagram is included in Appendix A and utilizes the lithology described for HEC05-SB2.

MW-HEC05-01 was developed on June 1, 2018, and was sampled on June 6, 2018. Water levels are shown in Table 5, and water quality parameters are shown in Table 6. Groundwater sample MW-HEC05-01-01 was collected and analyzed for PFOS/PFOA compounds. The Groundwater Micro Purge Sheet and Groundwater Micro Purge Log are included in Appendix B.

Well MW-HEC05-01 was surveyed by a licensed surveyor, and the well survey report is included in Appendix C.

5.6.2 Analytical Results

5.6.2.1 Soil

Six soil samples from HEC05-SB01, HEC05-SB2, and HEC05-SB3 were collected and analyzed as described in Section 5.7.1. PFOS, PFOA, PFHxS, PFBS, and PFHpA were detected above laboratory detection limits in surface soil samples at HEC05-SB01-01 and HEC05-SB3-01; PFNA was not detected at either location. Only PFHxS was detected at HEC05-SB2-01. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria.

In the subsurface soil samples, PFOS/PFOA compounds were not detected at HEC05-SB1 and HEC05-SB3; PFOS, PFOA, PFHxS, PFBS, and PFHpA were detected at HEC05-SB2. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOA or PFBS exceeded the soil screening criteria. PRL 5 soil analytical results are presented in Table 7 and shown in Figure 4.

5.6.2.2 Groundwater

One groundwater sample was collected from MW-HEC05-01 and analyzed as described in Section 5.7.1. Only PFOA, PFBS, and PFHxS were detected above laboratory detection limits. The PFOA concentration was below the EPA HA and PFBS concentrations were below the EPA RSL. No screening criteria exist for PFHxS, PFHpA, and PFNA. Groundwater analytical results for PRL 5 are presented in Table 8 and shown in Figure 6.

5.7 PRL 6: NOZZLE TESTING AREA – SOUTH OF BUILDING 310

A total of three soil borings and one monitoring well were installed and sampled at PRL 6 (Table 3), as described below.

5.7.1 Sampling Activities

5.7.1.1 Soil

A total of three soil borings were advanced on May 30, 2018, in the PRL 6 area. HEC06-SB01 was advanced in a grassy area along the western portion of the PRL, where nozzle testing occurred (Figure 4). HEC06-SB2 was advanced in the grassy area along the south-central portion of the PRL and near the fence, where nozzle testing occurred (Figure 4). HEC06-SB3 was advanced in the grassy area along the eastern portion of the PRL and near the fence, where nozzle testing occurred (Figure 4). Borings were advanced to total depths ranging from 10 ft BGS (HEC06-SB2) to 18 ft BGS (HEC06-SB3). Soil lithology descriptions were logged on the soil boring logs (Appendix A). A total of seven soil samples, including one field duplicate, were collected and analyzed for PFOS/PFOA compounds.

5.7.1.2 Groundwater

MW-HEC06-01 was installed at co-located soil boring HEC06-SB3, in the grassy area at the downgradient edge of the PRL on May 30, 2018 (Figure 6). Well construction details are shown in Table 4. The well construction diagram is included in Appendix A and utilizes the lithology described for HEC06-SB3.

MW-HEC06-01 was developed on June 1, 2018, and sampled on June 6, 2018. Water levels are shown in Table 5, and water quality parameters are shown in Table 6. Groundwater sample MW-HEC06-01-01 was collected and analyzed for PFOS/PFOA compounds. The Groundwater Micro Purge Sheet and Groundwater Micro Purge Log are included in Appendix B.

Well MW-HEC06-01 was surveyed by a licensed surveyor, and the well survey report is included in Appendix C.

5.7.2 Analytical Results

5.7.2.1 Soil

Seven soil samples, including one field duplicate, from HEC06-SB01, HEC06-SB2, and HEC06-SB3 were collected and analyzed as described in Section 5.7.1. Only PFHxS was detected above the laboratory detection limit in surface and subsurface soil samples at HEC06-SB1. Only PFOS, PFBS, and PFHxS were detected above the laboratory detection limits in surface and subsurface soil samples at HEC06-SB2. All six PFOS/PFOA compounds were detected above laboratory detection limits in surface soil sample HEC06-SB3-01. However, only PFBS and PFHxS were detected above the laboratory detection limits in subsurface soil sample HEC06-SB3-02. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria. PRL 6 soil analytical results are presented in Table 7 and shown in Figure 4.

5.7.2.2 Groundwater

One groundwater sample was collected from MW-HEC06-01 and analyzed as described in Section 5.7.1. All six PFOS/PFOA compounds were detected above laboratory detection limits. PFOS, PFOA, and

PFBS were below screening criteria. No screening criteria exist for PFHxS, PFHpA, and PFNA. Groundwater analytical results for PRL 6 are presented in Table 8 and shown in Figure 6.

5.8 PRL 7: NOZZLE TESTING AREA – NORTH OF APRON

A total of three soil borings and two monitoring wells were installed and sampled at PRL 7 (Table 3), as described below. MW-HEC07-02 was installed east of PRL 7 near the Base boundary to determine if PFOS/PFOA-contaminated groundwater has reached the Base boundary.

5.8.1 Sampling Activities

5.8.1.1 Soil

A total of three soil borings were advanced on June 4, 2018, in the PRL 7 area. HEC06-SB1 was advanced in a grassy area along the western portion of the PRL, near the northwestern edge of the apron (PRL 9) (Figure 3). HEC07-SB2 was advanced in the grassy area along the central portion of the PRL (Figure 3). HEC07-SB3 was advanced in the grassy area along the eastern portion of the PRL (Figure 3). Borings were advanced to total depths ranging from 5 ft BGS (HEC07-SB1 and HEC07-SB2) to 20 ft BGS (HEC07-SB3). Soil lithology descriptions were logged on the soil boring logs (Appendix A). A total of six soil samples were collected and analyzed for PFOS/PFOA compounds.

5.8.1.2 Groundwater

MW-HEC07-01 was co-located with soil boring HEC07-SB3, in the grassy area at the downgradient edge of the PRL, on May 24, 2018 (Figure 6). MW-HEC07-02 was drilled in the grassy area east of PRLs 7 and 9 on the eastern Base boundary on May 23, 2018 (Figure 6). Well construction details are shown in Table 4. The well construction diagram is included in Appendix A and utilizes the lithology described for HEC07-SB3.

MW-HEC07-01 and MW-HEC07-02 were developed on June 1, 2018, and sampled on June 7, 2018. Water levels are shown in Table 5, and water quality parameters are shown in Table 6. Groundwater samples MW-HEC07-01-01 and MW-HEC07-02-01 were collected and analyzed for PFOS/PFOA compounds. The Groundwater Micro Purge Sheet and Groundwater Micro Purge Log are included in Appendix B.

Well MW-HEC07-01 and MW-HEC07-02 were surveyed by a licensed surveyor, and the well survey report is included in Appendix C.

5.8.2 Analytical Results

5.8.2.1 Soil

Six soil samples from HEC07-SB1, HEC07-SB2, and HEC07-SB3 were collected and analyzed as described in Section 5.8.1. All six PFOS/PFOA compounds were detected above laboratory detection limits in surface soil samples HEC07-SB1-01, HEC07-SB2-01, and HEC07-SB3-01, except PFBS was not detected in HEC07-SB3-01. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria.

In the subsurface soil sample HEC07-SB1-02, no PFOS/PFOA compounds were detected above the laboratory detection limits. All six PFOS/PFOA compounds were detected above laboratory detection limits in subsurface soil samples HEC07-SB2-02. PFOS, PFOA, PFHpA, and PFHxS were detected above laboratory detection limits in HEC07-SB3-02. No screening criteria exist for PFNA, PFHxS, and

PFHpA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria. PRL 7 soil analytical results are presented in Table 7 and shown in Figure 3.

5.8.2.2 Groundwater

One round of groundwater samples were collected from MW-HEC07-01 and MW-HEC07-02, and analyzed as described in Section 5.8.1. PFOS, PFOA, PFBS, PFHpA, and PFHxS were detected above laboratory detection limits in MW-HEC07-01; PFNA was not detected. PFOA exceeded the 70-ng/L EPA drinking water HA (EPA 2016b) at concentrations of 210 ng/L in MW-HEC07-01. The combined PFOS and PFOA concentrations at MW-HEC07-01 is 213.9 ng/L, exceeding the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b). PFBS concentration in this well was below the EPA RSL. In MW-HEC07-02 located near the Base boundary, PFOA and PFHxS were the only compounds detected above laboratory detection limits. The PFOA concentration in this well did not exceed the 70-ng/L EPA drinking water HA (EPA 2016b). No screening criteria exist for PFHxS, PFHpA, and PFNA. Groundwater analytical results for PRL 7 are presented in Table 8 and shown in Figure 6.

5.9 PRL 9: AIRCRAFT PARKING APRON

One soil boring was advanced and sampled at PRL 9 (Table 3), as described below. Due to co-location with PRLs 2, 3, and 7, samples from PRL 9 are used in conjunction with samples from PRLs 2, 3, and 7 to evaluate potential PFOS/PFOA contamination from the Aircraft Parking Apron.

5.9.1 Sampling Activities

5.9.1.1 Soil

One soil boring was advanced on June 4, 2018, in the PRL 9 area. HEC09-SB1 was advanced in a grassy area immediately south of the western portion of the Apron and north of Building 210 (Figure 3). The soil boring was advanced using a hand auger. The boring was advanced to total depth of 5 ft BGS. Soil lithology descriptions were logged on the soil boring logs (Appendix A). A total of two soil samples were collected and analyzed for PFOS/PFOA compounds.

5.9.1.2 Groundwater

PRL 9 is co-located with PRLs 2, 3, and 7. No additional wells were installed and sampled at PRL 9.

5.9.2 Analytical Results

5.9.2.1 Soil

Two soil samples from HEC09-SB1 were collected and analyzed as described in Section 5.9.1. All six PFOS/PFOA compounds were detected above laboratory detection limits in surface and subsurface soil samples at HEC09-SB1. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria. PRL 9 soil analytical results are presented in Table 7 and shown in Figure 3.

Evaluation of PRLs 2, 3, and 7 soil sample results indicated all six PFOS/PFOA compounds were detected above laboratory detection limits in surface and subsurface soil samples with few non-detect concentrations of PFBS and PFNA. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria in PRLs 2, 3 and 7. It should be noted that PFOS (1,200J µg/kg) was detected in the surface soil at HEC03-SB2, which is only slightly below the screening criteria of 1,260 µg/kg. PRLs 2, 3 and 7 soil analytical results are presented in Table 7 and shown in Figure 3.

5.9.2.2 Groundwater

Groundwater samples from PRLs 2 and 7 are also used to evaluate potential PFOS/PFOA contamination from the Aircraft Parking Apron. Evaluation of PRL 2 groundwater samples indicated all six PFOS/PFOA compounds were detected above laboratory detection limits in all three wells (MW-HEC02-01, MW11-05-PRL02, and MW11-15-PRL02), except PFNA was not detected in MW11-15-PRL02. The combined PFOS and PFOA concentration at HEC02-01 nearly exceeded the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b) at a concentration of 69 ng/L; however, the field duplicate combined PFOS and PFOA concentration at this location is 79 ng/L, exceeding the HA. PFOS concentrations exceeded the 70-ng/L EPA drinking water HA (EPA 2016a) at MW-11-05-PRL02 and MW11-15-PRL02. PFOA exceeded the HA in MW11-05-PRL02. The combined PFOS and PFOA concentrations at MW-11-05-PRL02 and MW11-15-PRL02 also exceeded the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b). PFBS concentrations were below the EPA RSL. No screening criteria exist for PFHxS, PFHpA, and PFNA. Groundwater analytical results for PRL 2 are presented in Table 8 and shown in Figure 6.

Evaluation of PRL 7 groundwater samples indicated PFOS, PFOA, PFBS, PFHpA, and PFHxS were detected above laboratory detection limits in MW-HEC07-01; PFNA was not detected. PFOA exceeded the 70-ng/L EPA drinking water HA (EPA 2016b) at a concentration of 210 ng/L in MW-HEC07-01. The combined PFOS and PFOA concentration at MW-HEC07-01 is 213.9 ng/L, exceeding the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b). PFBS concentration were below the EPA RSL. In MW-HEC07-02, PFOA and PFHxS were the only compounds detected above laboratory detection limits. The PFOA concentration in this well did not exceed the 70-ng/L EPA drinking water HA (EPA 2016b). No screening criteria exist for PFHxS, PFHpA, and PFNA. No screening criteria exist for PFHxS, PFHpA, and PFNA. Groundwater analytical results for PRL 7 are presented in Table 8 and shown in Figure 6.

5.10 PRL 10: STORMWATER OUTFALL 002

This storm drain discharge point in the north-central portion of the Base drains areas of the Base that likely had AFFF released to the ground surface, including the main aircraft apron, nozzle testing areas north of the apron, and the Former FTA – ERP Site 10. Outfall 002 discharges to the county drain that flows in a general west to east direction parallel to the northern Base boundary. The precast concrete outfall is physically located off Base, just north of the Base boundary. Evaluation of this outfall included sampling of an accessible location within the ANGB boundary upstream of the actual outfall location to ensure only ANG stormwater resources are evaluated.

5.10.1 Sampling Activities

5.10.1.1 Surface water

Surface water sample HEC10-SW1-01 was collected from a manhole near the outfall and within the Base boundary on June 5, 2018, in the location shown in Figure 6. The last significant precipitation events were 0.34 in. on June 2, 2018, and 0.51 in. on June 5, 2018. Water quality parameters were measured as shown in Table 6. The samples were analyzed for PFOS/PFOA compounds.

5.10.1.2 Sediment

Sediment samples were attempted in the same location where the surface water sample was collected (Figure 6); however, no sediment was present in the manhole.

5.10.2 Analytical Results

5.10.2.1 Surface water

Surface water sample HEC10-SW1-01 was collected and analyzed as described in Section 5.10.1. All six PFOS/PFOA compounds were detected at concentrations exceeding the laboratory detection limit, and PFOS and PFOA were detected at concentrations exceeding the EPA drinking water HA screening level of 70 ng/L in the surface water sample collected from near the Base boundary. The combined PFOS and PFOA concentration in sample HEC10-SW1-01was 4,320 ng/L, exceeding the EPA HA screening criteria. The PFBS concentration was below the EPA RSL. No screening criteria exist for PFHxS, PFHpA, and PFNA. PRL 10 surface water analytical results are presented in Table 8 and shown in Figure 6.

5.11 PRL 11: STORMWATER OUTFALL 003

This storm drain discharge point in the northwestern portion of the Base drains areas of the Base that likely had AFFF released to the ground surface, including the Nozzle Testing Area – South of Building 310 and possibly areas surrounding Building 340 – Current Fire Station. Outfall 003 discharges to the county drain that flows in a general west to east direction parallel to the northern Base boundary. The outfall is physically located off Base, just north of the Base boundary. Evaluation of this outfall included sampling of an accessible location within the ANGB boundary upstream of the actual outfall location to ensure only ANG stormwater resources are evaluated.

5.11.1 Sampling Activities

5.11.1.1 Surface water

Surface water sample HEC11-SW1-01 was collected from a manhole near the outfall and within the Base boundary on June 8, 2018, in the location shown in Figure 6. The last significant precipitation events were 0.51 in. on June 5, 2018, and 0.5 in. on June 6, 2018. The field team observed that there was no water in the manhole during initial mobilization to the PRL, then observed a 15-minute span of sudden flow, which was sampled. Water quality parameters were measured as shown in Table 6. The samples were analyzed for PFOS/PFOA compounds.

5.11.1.2 Sediment

A sediment sample was attempted to be collected in the same location where the surface water sample was collected (Figure 6); however, no sediment was present in the manhole.

5.11.2 Analytical Results

5.11.2.1 Surface water

Surface water sample HEC11-SW1-01 was collected from a manhole near the Base boundary and analyzed as described in Section 5.11.1. All six PFOS/PFOA compounds were detected at concentrations exceeding the laboratory detection limit, and PFOS was detected at a concentration exceeding the EPA drinking water HA screening level of 70 ng/L in the surface water sample collected from near the Base boundary. The combined PFOS and PFOA concentration in sample HEC11-SW1-01 was 430 ng/L, exceeding the EPA HA screening criteria. The PFBS concentration was below the EPA RSL. No screening criteria exist for PFHxS, PFHpA, and PFNA. PRL 11 surface water analytical results are presented in Table 8 and shown in Figure 6.

5.12 PRL 12: SOILS STOCKPILE AREA

A total of three soil borings and two monitoring wells were installed and sampled at PRL 12 (Table 3), as described below. MW-HEC012-02 was installed east of PRL 12 near the Base boundary to determine if PFOS/PFOA-contaminated groundwater has reached the Base boundary.

5.12.1 Sampling Activities

5.12.1.1 Soil

A total of three soil borings were advanced on June 8, 2018, in the PRL 12 area. HEC12-SB1 was advanced in a grassy area near the northwestern edge of the PRL (Figure 5). HEC12-SB2 was advanced in the grassy area south and east of the PRL adjacent to the drain (Figure 5). HEC12-SB3 was advanced in the grassy area in the northeastern portion of the PRL (Figure 5). Borings were advanced to total depths ranging from 10 ft BGS (HEC12-SB1 and HEC12-SB3) to 15 ft BGS (HEC12-SB2). Soil lithology descriptions were logged on the soil boring logs (Appendix A). A total of six soil samples were collected and analyzed for PFOS/PFOA compounds.

5.12.1.2 Groundwater

MW-HEC12-01 was drilled in the grassy area near the downgradient edge of the PRL on May 22, 2018 (Figure 6). MW-HEC12-02 was drilled in the grassy area east/northeast of the PRL near the Base boundary (Figure 6). Well construction details are shown in Table 4. The well construction diagrams and lithology are included in Appendix A.

MW-HEC12-01 was developed on May 31, 2018, and sampled on June 8, 2018. MW-HEC12-02 was developed on June 2, 2018, and sampled on June 7, 2018. Water levels are shown in Table 5, and water quality parameters are shown in Table 6. Groundwater samples MW-HEC12-01-01 and MW-HEC12-02-01 were collected and analyzed for PFOS/PFOA compounds. The Groundwater Micro Purge Sheet and Groundwater Micro Purge Log are included in Appendix B.

Wells MW-HEC12-01 and MW-HEC12-02 were surveyed by a licensed surveyor, and the well survey report is included in Appendix C.

5.12.2 Analytical Results

5.12.2.1 Soil

Six soil samples from HEC12-SB1, HEC12-SB2, and HEC12-SB3 were collected and analyzed as described in Section 5.12.1. All six PFOS/PFOA compounds were detected above laboratory detection limits in surface soil samples HEC12-SB1-01, HEC12-SB2-01, and HEC12-SB3-01. No screening criteria exist for PFHxS, PFHpA, and PFNA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria.

In subsurface soil samples HEC12-SB1-02 and HEC12-SB3-02, all six PFOS/PFOA compounds were detected above laboratory detection limits, except PFNA was not detected. PFOA, PFBS, PFHpA, and PFHxS were detected above laboratory detection limits in HEC12-SB2-02; PFOS and PFNA were not detected. No screening criteria exist for PFNA, PFHxS, and PFHpA. None of the concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria. PRL 12 soil analytical results are presented in Table 7 and shown in Figure 5.

5.12.2.2 Groundwater

One round of groundwater samples were collected from MW-HEC12-01 and MW-HEC12-02, and analyzed as described in Section 5.12.1. PFOS/PFOA compounds were not detected above laboratory detection limits in MW-HEC12-02 located near the Base boundary. All six PFOS/PFOA compounds were detected above laboratory detection limits in MW-HEC12-01. PFOS and PFOA exceeded the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b) at concentrations of 680 J and 350 ng/L, respectively, in MW-HEC12-01. The combined PFOS and PFOA concentrations at this location is 1,030 ng/L, exceeding the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b). PFBS was below the EPA RSL. No screening criteria exist for PFHxS, PFHpA, and PFNA. Groundwater analytical results for PRL 12 are presented in Table 8 and shown in Figure 6.

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6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

This section presents the SI conclusions and recommendations for each PRL. The recommended DQOs are based on data collected by Leidos during this SI and an evaluation of the analytical results compared to applicable screening criteria.

6.1.1 PRL 1: Former FTA – ERP Site 10

Although PFOS/PFOA compounds were detected in PRL 1 soil samples, evaluation of soil analytical data compared to soil screening criteria indicates there are no EPA RSL exceedances for PFBS and no calculated residential risk-based screening level exceedances for PFOA in soil at PRL 1. A PFOS concentration did, however, exceed the calculated residential risk-based screening level in soil at PRL 1, with a result of 20,000 J µg/kg. This PFOS concentration at PRL 1 represents the highest concentration and the only exceedance in soil.

Although PFOS/PFOA compounds were detected in PRL 1 groundwater samples, evaluation of groundwater data compared to screening criteria indicates no exceedances of the EPA HA (70 ng/L).

Based on the SI results, the following DQOs are recommended for PRL 1:

- Additional surface and subsurface soil samples to determine the extent of PFOS exceedance in soil (both laterally and vertically); and
- Additional investigation to determine the nature and extent of PFOS/PFOA in groundwater (both laterally and vertically), through sampling of additional new monitoring wells located both upgradient of and downgradient from HEC01-SB2.

6.1.2 PRL 2: Building 217 – Main Hangar

Although PFOS/PFOA compounds were detected in PRL 2 soil samples, evaluation of soil analytical data compared to soil screening criteria indicates there are no EPA RSL exceedances for PFBS and no calculated residential risk-based screening level exceedances for PFOS or PFOA for soil in PRL 2. Evaluation of co-located PRLs 3 and 9 soil sample results also indicated no concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria.

Evaluation of groundwater data compared to screening criteria indicates an exceedance of the EPA HA (70 ng/L) in MW-HEC02-01 (field duplicate), MW11-05-PRL02, and MW11-15-PRL02 for PFOS and PFOA (combined), with results of 79, 74,000, and 263 ng/L, respectively. MW11-05-PRL02 had the highest reported concentration of PFOS (58,000 J ng/L) and PFOA (16,000 J ng/L) in groundwater or surface water for this SI. This well location is located immediately south of the Main Hangar, and the likely source to the elevated concentrations.

Based on the SI results, the following DQOs are recommended for PRL 2:

- Additional surface and subsurface soil samples to determine if a previously undetected source area exists that is contributing to the groundwater exceedances; and
- Additional investigation to determine the nature and extent of PFOS/PFOA in groundwater (both laterally and vertically), through sampling of additional new monitoring wells located both upgradient of and downgradient from PRLs 2, 3, and 9.

6.1.3 PRL 3: Building 215 – Former Fire Station

Although PFOS/PFOA compounds were detected in PRL 3 soil samples, evaluation of soil analytical data compared to soil screening criteria indicates there are no EPA RSL exceedances for PFBS and no calculated residential risk-based screening level exceedances for PFOS or PFOA for soil in PRL 3.

Evaluation of co-located PRL 2 groundwater data compared to screening criteria indicates an exceedance of the EPA HA (70 ng/L) in HEC02-01 (field duplicate), MW11-05-PRL02, and MW11-15-PRL02 for PFOS and PFOA (combined), with results of 79, 74,000, and 263 ng/L, respectively.

Based on the SI results, the following DQOs are recommended for PRL 3:

- Additional surface and subsurface soil samples to determine if a previously undetected source area exists that is contributing to the groundwater exceedances at co-located PRL 2; and
- Additional investigation to determine the nature and extent of PFOS/PFOA in groundwater (both laterally and vertically), through sampling of additional new monitoring wells located both upgradient of and downgradient from PRL 3, and co-located PRLs 2 and 9.

6.1.4 PRL 5: Nozzle Testing Area – East of Building 340

Although PFOS/PFOA compounds were detected in PRL 5 soil samples, evaluation of soil analytical data compared to soil screening criteria indicates there are no EPA RSL exceedances for PFBS and no calculated residential risk-based screening level exceedances for PFOS or PFOA for soil in PRL 5.

Groundwater results for the downgradient well MW-HEC05-01 indicated only PFOA, PFBS, and PFHxS were detected. Evaluation of groundwater data compared to screening criteria indicates no exceedances of the EPA HA (70 ng/L) for PFOS and PFOA (combined), or EPA RSL for PFBS.

Based on the SI results showing detectable levels of PFOS/PFOA compounds in soil and groundwater, the following DQOs are recommended for PRL 5:

- Additional surface and subsurface soil samples to determine if a previously undetected source area exists that is contributing to the PFOS/PFOA detections in groundwater; and
- Additional investigation to determine the nature and extent of PFOS/PFOA in groundwater (both laterally and vertically), through sampling of additional new monitoring wells located both upgradient of and downgradient from the PRL.

6.1.5 PRL 6: Nozzle Testing Area – South of Building 310

Although PFOS/PFOA compounds were detected in PRL 6 soil samples, evaluation of soil analytical data compared to soil screening criteria indicates there are no EPA RSL exceedances for PFBS and no calculated residential risk-based screening level exceedances for PFOS or PFOA for soil in PRL 6.

Groundwater results for the downgradient well MW-HEC06-01 indicates all six PFOS/PFOA compounds were detected. Evaluation of groundwater data compared to screening criteria indicates no exceedances of the EPA HA (70 ng/L) for PFOS and PFOA (combined), or EPA RSL for PFBS.

Based on the SI results showing detectable levels of PFOS/PFOA compounds in soil and groundwater, the following DQOs are recommended for PRL 6:

- Additional surface and subsurface soil samples to determine if a previously undetected source area exists that is contributing to the PFOS/PFOA detections in groundwater; and
- Additional investigation to determine the nature and extent of PFOS/PFOA in groundwater (both laterally and vertically), through sampling of additional new monitoring wells located both upgradient of and downgradient from the PRL.

6.1.6 PRL 7: Nozzle Testing Area – North of Apron

Although PFOS/PFOA compounds were detected in PRL 7 soil samples, evaluation of soil analytical data compared to soil screening criteria indicates there are no EPA RSL exceedances for PFBS and no calculated residential risk-based screening level exceedances for PFOS or PFOA for soil in PRL 7.

Evaluation of groundwater data compared to screening criteria indicates an exceedance of the EPA HA (70 ng/L) in MW-HEC07-01 for PFOA, and PFOS and PFOA (combined), with results of 210 and 213.9 ng/L, respectively. There were no EPA RSL exceedances for PFBS. There were no exceedances in MW-HEC07-02, which is located at the eastern Base boundary.

Based on the SI results, the following DQOs are recommended for PRL 7:

- Additional surface and subsurface soil samples to determine if a previously undetected source area exists that is contributing to the groundwater exceedances; and
- Additional investigation to determine the nature and extent of PFOS/PFOA in groundwater (both laterally and vertically), through sampling of additional new monitoring wells located both upgradient of and downgradient from PRL 7.

6.1.7 PRL 9: Aircraft Parking Apron

Although PFOS/PFOA compounds were detected in PRL 9 soil samples, evaluation of soil analytical data compared to soil screening criteria indicates there are no EPA RSL exceedances for PFBS and no calculated residential risk-based screening level exceedances for PFOS or PFOA for soil in PRL 9. Evaluation of co-located PRLs 2, 3, and 7 soil sample results also indicated no concentrations of PFOS, PFOA, or PFBS exceeded the soil screening criteria.

Evaluation of co-located PRL 2 groundwater data compared to screening criteria indicates an exceedance of the EPA HA (70 ng/L) in HEC02-01 (field duplicate), MW11-05-PRL02, and MW11-15-PRL02 for PFOS and PFOA (combined), with results of 79, 74,000, and 263 ng/L, respectively.

Evaluation of co-located PRL 7 groundwater data compared to screening criteria indicates an exceedance of the EPA HA (70 ng/L) in MW-HEC07-01 for PFOA, and PFOS and PFOA (combined), with results of 210 and 213.9 ng/L, respectively. There were no EPA RSL exceedances for PFBS. There were no exceedances in MW-HEC07-02, which is located at the eastern Base boundary.

Based on the SI results, the following DQOs are recommended for PRL 9:

- Additional surface and subsurface soil samples to determine if a previously undetected source area exists that is contributing to the groundwater exceedances in the co-located PRLs 2 and 7; and

- Additional investigation to determine the nature and extent of PFOS/PFOA in groundwater (both laterally and vertically), through sampling of additional new monitoring wells located both upgradient of and downgradient from PRLs 2, 3, 7, and 9.

6.1.8 PRL 10: Stormwater Outfall 002

All six PFOS/PFOA compounds were detected at concentrations above the laboratory detection limit in surface water location HEC10-SW1 (Outfall 002). Evaluation of Outfall 002 surface water results compared to screening criteria indicated an exceedance of the EPA HA for PFOS, PFOA, and PFOS and PFOA (combined) with results of 3,800 J, 520 J, and 4,320 J ng/L. No sediment was visible in the concrete culvert inside the manhole upstream of Outfall 002; therefore, no sediment samples were collected.

Based on the SI results, the following DQO is recommended for PRL 10:

- Additional investigation to further evaluate the concentrations of PFOS/PFOA in surface water and sediment. This should include additional sampling of surface water and sediment at upgradient locations, and locations downstream of the Base boundary to evaluate the impact to off-Base surface water and sediment.

6.1.9 PRL 11: Stormwater Outfall 003

All six PFOS/PFOA compounds were detected at concentrations above the laboratory detection limit in surface water location HEC11-SW1 (near Outfall 003). Evaluation of Outfall 003 surface water results compared to screening criteria indicated an exceedance of the EPA HA for PFOS, and PFOS and PFOA (combined) with results of 410 and 430 ng/L, respectively. No sediment was visible in the concrete culvert inside the manhole at Outfall 003; therefore, no sediment samples were collected.

Based on the SI results, the following DQO is recommended for PRL 11:

- Additional investigation to further evaluate the concentrations of PFOS/PFOA in surface water and sediment. This should include additional sampling of surface water and sediment at upgradient locations, and locations downstream from the Base boundary to evaluate the impact to off-Base surface water and sediment.

6.1.10 PRL 12: Soils Stockpile Area

Although PFOS/PFOA compounds were detected in PRL 12 soil samples, evaluation of soil analytical data compared to soil screening criteria indicates there are no EPA RSL exceedances for PFBS and no calculated residential risk-based screening level exceedances for PFOS or PFOA for soil in PRL 12.

Evaluation of groundwater data compared to screening criteria indicates exceedances of the EPA HA (70 ng/L) in MW-HEC12-01 for PFOS, PFOA, and PFOS and PFOA (combined), with a result of 680 J, 350, and 1,030 ng/L, respectively. Well MW-HEC12-02 is adjacent to the Hector Field ANGB boundary and did not have any PFOS/PFOA detections.

Based on the SI results, the following DQOs are recommended for PRL 12:

- Additional surface and subsurface soil samples to determine if other portions of the soil stockpile area are contributing to the groundwater exceedances; and

- Additional investigation to determine the nature and extent of PFOS/PFOA in groundwater (both laterally and vertically), through sampling of additional new monitoring wells located both upgradient of and downgradient from PRL 12.

6.1.11 PFOS/PFOA Contamination Near Installation Boundary

Samples from three monitoring wells (MW-HEC01-02, MW-HEC07-02, and MW-HEC12-02) and two surface water samples (HEC10-SW1, HEC11-SW1) were used to evaluate the PFOS/PFOA contamination near the Installation boundary. There were no detections in boundary well MW-HEC12-02. Only PFOA and PFBS were detected in boundary well MW-HEC01-02, and only PFOA and PFHxS were detected in boundary well MW-HEC07-02. The downgradient boundary wells did not have any exceedances of the screening criteria. All six PFOS/PFOA compounds were detected in the samples collected from HEC10-SW1 and HEC11-SW1. The screening results indicate the consistent presence of PFOS and PFOA at concentrations exceeding the 70-ng/L EPA drinking water HA (EPA 2016a and EPA 2016b). Elevated PFOS and PFOA concentrations were observed in the water sample from locations near the northern Installation boundary. PFBS concentrations did not exceed the RSL at any of the groundwater or surface water sample locations. No screening criteria exist for PFHxS, PFHpA, or PFNA. PFOS/PFOA compounds are likely migrating offsite given their presence and magnitude in surface water and groundwater near the Installation boundary.

6.2 SUMMARY AND RECOMMENDATIONS

PFOS/PFOA compounds were detected in the soil, groundwater, and surface water above the laboratory detection limits. Based on the evaluation of results from three monitoring wells (MW-HEC01-02, MW-HEC07-02, MW-HEC12-02) and two surface water sample locations (HEC10-SW1, HEC11-SW1) near the Installation boundary, PFOS/PFOA compounds are likely migrating offsite given their presence and magnitude in surface water and groundwater near the Installation boundary.

Additional investigations are recommended for soil and groundwater at PRLs 1, 2, 3, 5, 6, 7, 9, and 12, and surface water/sediment at PRLs 10 and 11. The recommendations are summarized in Table 9 and described briefly below:

- Further investigation at all PRLs is necessary to determine the nature and extent of PFOS/PFOA contamination due to detectable levels at these PRLs.

- Develop an expanded conceptual site model that considers localized groundwater and surface water flow paths to select future sampling locations.

- Complete delineation of nature and extent of PFAS as part of an Expanded SI or an RI that could consist of:

  - Additional soil sampling and analysis of an expanded list of PFAS constituents (in addition to the six UCMR3 constituents) to determine if significant source areas related to precursor substances are present. Precursor substances have been demonstrated to oxidize into PFOS and PFOA, and thus could provide a lingering source of these compounds to soil and groundwater.

  - Expanded groundwater sampling program (including analysis of an expanded list of PFAS constituents) to complete horizontal and vertical delineation of the PFOS/PFOA impacts including groundwater investigation at the northern boundary in the vicinity of the stormwater outfalls.

- The installation and sampling of upgradient and downgradient off-Base monitoring wells to better define the upgradient source of PFAS and assess the nature and extent of PFAS that have migrated off Base.

- Conduct preliminary site-specific risk assessment calculations in order to identify COPCs in every medium and establish preliminary remedial goals for screening purposes.

DQOs are proposed based on the results of the SI and are presented in Table 9. In general, additional samples are required at each PRL in order to establish the nature and extent of PFOA/PFOS constituents for each applicable medium and determine if a complete receptor pathway exists. For soil, additional samples are proposed to determine if a source area exists and, if so, the vertical and horizontal extent for both the vadose and saturated zones. Additional surface water and sediment samples should be collected at PRLs 10 and 11 (including analysis of an expanded list of PFAS constituents), taking care to sample downstream from Outfalls 002 and 003.

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TABLES

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Table 1. Preliminary Assessment Report Summary and Recommendations

No.	Potential AFFF PRL	Rationale	Recommendation
1	Former FTA – ERP Site 10	Former on-Base FTA used from the 1950s through mid-1989. AFFF likely utilized during this time.	Proceed to SI. Focus on deeper soils and groundwater.
2	Building 217 – Main Hangar	Main Base Hangar with AFFF FSS since 1992. Regular AFFF FSS testing from 1992 to 2014.	Proceed to SI. Focus on soil and groundwater.
3	Building 215 – Former Fire Station	Main Base Fire Station from the 1950s to 2011. AFFF was stored in fire rescue vehicles, and a known discharge of 180 gal into the building's floor drains occurred in 2001.	Proceed to SI. Focus on soil and groundwater.
4	Building 340 – Current Fire Station	Current Airport and Base Fire Station since 2011. AFFF is stored in this building in fire rescue vehicles.	NFA; no known or documented releases.
5	Nozzle Testing Area – East of Building 340	Documented nozzle testing in this area using AFFF.	Proceed to SI. Focus on soil and groundwater.
6	Nozzle Testing Area – South of Building 310	Documented nozzle testing in this area using AFFF.	Proceed to SI. Focus on soil and groundwater.
7	Nozzle Testing Area – North of Apron	Documented nozzle testing in this area using AFFF.	Proceed to SI. Focus on soil and groundwater.
8	Building 420 – Supply Complex	Periodic storage of unused AFFF with no documented releases.	NFA.
9	Aircraft Parking Apron	Aircraft loading/parking area where potential AFFF releases may have occurred.	Proceed to SI. Focus on soil and groundwater on downgradient edges of ramp.
10	Stormwater Outfall 002	Receives stormwater from several PRLs and may be impacted by AFFF use.	Proceed to SI. Focus on sediment and surface water (if present).
11	Stormwater Outfall 003	Receives stormwater from several PRLs and may be impacted by AFFF use.	Proceed to SI. Focus on sediment and surface water (if present).
12	Soils Stockpile Area	Received post land-farmed soils from Former FTA – ERP Site 10.	Proceed to SI. Focus on soil and groundwater.

AFFF = Aqueous film-forming foam.
ERP = Environmental Restoration Program.
FSS = Fire suppression system.
FTA = Fire training area.
NFA = No further action.
PRL = Potential release location.
SI = Site inspection.

Table 2. PFOS/PFOA SI Screening Criteria

Parameter	Chemical Abstract Service Number	EPA RSL for Tap Water[a] (ng/L)	EPA Health Advisory[b] (ng/L)	Residential Risk-based Soil Screening Level[c] (µg/kg)
PFOS	1763-23-1	NA	70.0[d]	1,260
PFOA	335-67-1	NA		1,260
PFBS	375-73-5	400,000[e]	NA	1,260,000

[a] EPA RSL for tap water, November 2018; Target HQ = 1.0.
[b] *Drinking Water Health Advisory for Perfluorooctanoic Acid* (EPA 2016b) and *Drinking Water Health Advisory for Perfluorooctane Sulfonate* (EPA 2016a).
[c] Residential risk-based soil screening levels determined by using the EPA RSL calculator (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) and the November 2018 EPA RSL tables (https://epa.gov/risk/regional-screening-levels-rsls-generic-tables-november-2018) for soil and sediment; Target HQ = 1.0.
[d] When PFOA and PFOS are both present, the combined detected concentrations of the compounds are compared with the 70-ng/L health advisory value.
[e] PFBS analytical results for groundwater and surface water have been compared to the tap water screening levels.

µg/kg = Micrograms per kilogram.
EPA = U.S. Environmental Protection Agency.
HQ = Hazard quotient.
NA = Not available.
ng/L = Nanograms per liter.
PFBS = Perfluorobutane sulfonate.
PFOA = Perfluorooctanoic acid.
PFOS = Perfluorooctane sulfonate.
RSL = Regional screening level.
SI = Site inspection.

Table 3. Summary of SI Activities

PRL Name	Analyzed Parameters[a]	Soil Borings	Soil Samples	Groundwater Samples[b]	Surface Water Samples	Sediment Samples
1: Former FTA – ERP Site 10	PFOS/PFOA	3	8	3	0	0
2: Building 217 – Main Hangar	PFOS/PFOA	1	3	4	0	0
3: Building 215 – Former Fire Station	PFOS/PFOA	2	4	0	0	0
5: Nozzle Testing Area – East of Building 340	PFOS/PFOA	3	6	1	0	0
6: Nozzle Testing Area – South of Building 310	PFOS/PFOA	3	7	1	0	0
7: Nozzle Testing Area – North of Apron	PFOS/PFOA	3	6	2	0	0
9: Aircraft Parking Apron	PFOS/PFOA	1	2	0	0	0
10: Stormwater Outfall 002	PFOS/PFOA	0	0	0	1	NS
11: Stormwater Outfall 003	PFOS/PFOA	0	0	0	1	NS
12: Soils Stockpile Area	PFOS/PFOA	3	6	2	0	0

[a] PFOS/PFOA is used generically in this SI Report to include the following six 2012 third Unregulated Contaminant Monitoring Rule emerging contaminants: PFOS, PFOA, perfluorobutane sulfonate, perfluorononanoic acid, perfluoroheptanoic acid, and perfluorohexane sulfonate. All samples were analyzed for PFOS/PFOA using U.S. Environmental Protection Agency, Method 537, revision 1.1.
[b] Includes associated field duplicate samples.

ERP = Environmental Restoration Program.
FTA = Fire training area.
NS = No sample collected due to no presence of sediment.
PFOA = Perfluorooctanoic acid.
PFOS = Perfluorooctane sulfonate.
PRL = Potential release location.
SI = Site inspection.

Table 4. Well Construction Details for Hector Field ANGB SI

Monitoring Well	Top of Casing Elevation (ft AMSL)	Ground Elevation (ft AMSL)	Screened Interval (ft BGS)	Total Well Depth (ft BTOC)	Well Diameter (in.)	Casing
			PRL 1			
MW-HEC01-01	897.80	894.90	6.7-16.7	17.5	2	PVC
MW-HEC01-02	894.71	894.90	3.7-13.7	14.1	2	PVC
			PRL 2			
MW-HEC02-01	897.92	898.30	9.1-19.1	20	2	PVC
			PRL 5			
MW-HEC05-01	893.23	892.70	3.6-13.6	14	2	PVC
			PRL 6			
MW-HEC06-01	893.39	893.40	7.5-17.5	18	2	PVC
			PRL 7			
MW-HEC07-01	895.94	896.10	8.55-18.55	19.5	2	PVC
MW-HEC07-02	894.64	894.80	7.6-17.6	18	2	PVC
			PRL 12			
MW-HEC12-01	894.97	892.40	3.64-13.64	14	2	PVC
MW-HEC12-02	894.31	894.70	8.7-18.7	19.1	2	PVC

Source: Top of casing elevation and ground surface elevation data for the new wells are from the monitoring well survey on June 5, 2018, by LJA (see Appendix C). Screened interval, total depth, and well diameter data in this table were obtained from the well construction diagrams provided in Appendix A.

AMSL = Above mean sea level.
ANGB = Air National Guard Base.
BGS = Below ground surface.
BTOC = Below top of casing.
PRL = Potential release location.
PVC = Polyvinyl chloride.
SI = Site inspection.

Table 5. Water Level Measurements

Monitoring Well Identifier	TOC Elevation (ft AMSL)	Screened Interval	June 2018	
			Depth to Water (ft BTOC)	Groundwater Elevation (ft AMSL)
MW-HEC01-01	897.80	6.7-16.7	5.47	892.33
MW-HEC01-02	894.71	3.7-13.7	6.52	888.19
MW-HEC02-01	897.92	9.1-19.1	5.15	892.77
MW-HEC05-01	893.23	3.6-13.6	2.93	890.30
MW-HEC06-01	893.39	7.5-17.5	3.25	890.14
MW-HEC07-01	895.94	8.55-18.55	3.44	892.50
MW-HEC07-02	894.64	7.6-17.6	5.4	889.24
MW-HEC12-01	894.97	3.64-13.64	8.96	886.01
MW-HEC12-02	894.31	8.7-18.7	8.25	886.06
MW11-05-PRL02	897.52	2.90-12.90	2.8	894.72
MW11-15-PRL02	897.84	3.73-13.73	7.55	890.29

Source: TOC elevation and ground surface elevation data for new wells are from the monitoring well survey on June 5, 2018 by LJA (See Appendix C). Screened interval was obtained from the well construction diagrams provided in Appendix A and depth to water was obtained from the groundwater sampling logs provided in Appendix B.

AMSL = Above mean sea level.
BTOC = Below top of casing.
TOC = Top of casing.

Table 6. Water Quality Parameters

Parameter	Groundwater						
	MW-HEC01-01	MW-HEC01-02	MW-HEC02-01	MW-HEC05-01	MW-HEC06-01	MW-HEC07-01	MW-HEC07-02
Dissolved oxygen (mg/L)	7.92	7.43	3.11	4.94	6.99	6.75	4.99
ORP (mV)	182	199	124	149	109	132	156
pH (S.U.)	6.81	6.67	6.77	6.74	6.81	6.91	6.76
Conductivity (mS/cm)	5.87	6.99	4.08	2.01	2.20	1.50	5.61
Temperature (°C)	8.53	7.72	10.01	9.19	10.21	8.03	8.53
Turbidity (NTU)	126	2.77	10.8	5.37	54.7	4.50	4.80

Parameter	Groundwater				Surface Water	
	MW-HEC12-01	MW-HEC12-02	MW11-05-PRL02	MW11-15-PRL02	HEC10-SW1	HEC11-SW1
Dissolved oxygen	0.63	4.52	2.30	0.10	8.69	9.69
ORP (mV)	255	173	-100	-228	162	182
pH (S.U.)	6.42	6.70	7.57	6.96	7.91	6.08
Conductivity (mS/cm)	3.42	3.82	1.96	5.45	1.87	1.65
Temperature (°C)	15.62	14.88	22.64	20.12	14.07	15.02
Turbidity (NTU)	38.1	2.34	145	77.7	3.02	9.40

mg/L = Milligrams per liter.
mS/cm = MicroSiemens per centimeter.
NTU = Nephelometric turbidity unit.
ORP = Oxidation-reduction potential.
S.U. = Standard unit.

Table 7. Summary of Soil Analytical Results

PRL	Location	Sample Identifier	Sample Date	Sample Depth (ft)	Sample Type	Perfluorooctane Sulfonate (PFOS)	Perfluorooctanoic Acid (PFOA)	Perfluorobutane Sulfonate (PFBS)	Perfluoroheptanoic Acid (PFHpA)	Perfluorohexane Sulfonate (PFHxS)	Perfluorononanoic Acid (PFNA)
					Screening Level[a]	1,260	1,260	1,260,000	NA	NA	NA
						(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
					Soil						
1	HEC01-SB1	HEC01-SB1-01	6/3/18	0-1	REG	360 J	6.6 J	1.3	1.1	26	1 J
	HEC01-SB1	HEC01-SB1-02	6/3/18	4.7-5.2	REG	6.1	19	11	4	190 J	0.26 U
	HEC01-SB1	HEC01-SB1-02D	6/3/18	4.7-5.2	FD	11 J	23	9.1 J	3.7 J	240 J	0.11 J
	HEC01-SB2	HEC01-SB2-01	6/3/18	0-0.6	REG	20000 J	18	44 J	6.2	700 J	31 J
	HEC01-SB2	HEC01-SB2-02	6/3/18	5-5.5	REG	120 J	5.4	19	2.5	98 J	0.26 U
	HEC01-SB3	HEC01-SB3-01	6/3/18	0-0.7	REG	110 J	3	0.2 J	1.3	10	3.2
	HEC01-SB3	HEC01-SB3-01D	6/3/18	0-0.7	FD	98	3.2	0.22 J	1.3	11	2.9
	HEC01-SB3	HEC01-SB3-02	6/3/18	4.6-5.4	REG	10	4.3	1.6	0.83	27 J	0.46
2	HEC02-SB1	HEC02-SB1-01	5/31/18	0-0.5	REG	17	2.2	0.22 U	0.65	2.7 J	0.71
	HEC02-SB1	HEC02-SB1-02	5/31/18	3.9-4.8	REG	20	1.1	0.23 U	1.3	3.3	0.49
	HEC02-SB1	HEC02-SB1-02D	5/31/18	3.9-4.8	FD	30	1.3	0.083 J	1.6	3.8	0.76
3	HEC03-SB1	HEC03-SB1-01	6/4/18	0-0.5	REG	270 J	3.1	0.91	1.4	46 J	2.7 J
	HEC03-SB1	HEC03-SB1-02	6/4/18	4.2-4.9	REG	43 J	5.2	0.76	2.2	58 J	0.97
	HEC03-SB2	HEC03-SB2-01	6/3/18	0-0.6	REG	1200 J	23	2	6.9	79 J	10 J
	HEC03-SB2	HEC03-SB2-02	6/3/18	3.5-4.2	REG	1.7	26	1.2	2.7	110 J	0.29 U
5	HEC05-SB1	HEC05-SB1-01	5/30/18	0-0.7	REG	1.1 J	0.17 J	0.13 J	0.11 J	0.74	0.26 U
	HEC05-SB1	HEC05-SB1-02	5/30/18	5-6	REG	0.64 U	0.26 U	0.23 U	0.26 U	0.26 U	0.26 U
	HEC05-SB2	HEC05-SB2-01	5/30/18	0-0.8	REG	0.69 U	0.28 U	0.25 U	0.28 U	0.14 J	0.28 U
	HEC05-SB2	HEC05-SB2-02	5/30/18	2-2.5	REG	0.69 U	0.28 U	0.25 U	0.28 U	0.28 U	0.28 U
	HEC05-SB3	HEC05-SB3-01	5/30/18	0-0.7	REG	14	0.81	8.3	4.2	49 J	0.26 U
	HEC05-SB3	HEC05-SB3-02	5/30/18	5-5.6	REG	0.53 J	1	3.3	0.68	23	0.27 U
6	HEC06-SB1	HEC06-SB1-01	5/30/18	0-1.4	REG	0.66 U	0.26 U	0.24 U	0.26 U	0.37 J	0.26 U
	HEC06-SB1	HEC06-SB1-01D	5/30/18	0-1.4	FD	0.95 J	0.26 U	0.23 U	0.26 U	0.67	0.26 U
	HEC06-SB1	HEC06-SB1-02	5/30/18	5-5.5	REG	0.67 U	0.27 U	0.24 U	0.27 U	0.37 J	0.27 U
	HEC06-SB2	HEC06-SB2-01	5/30/18	0-0.7	REG	0.42 J	0.26 U	0.11 J	0.26 U	0.27 J	0.26 U
	HEC06-SB2	HEC06-SB2-02	5/30/18	5-5.7	REG	0.47 J	0.27 U	0.21 J	0.27 U	0.82	0.27 U
	HEC06-SB3	HEC06-SB3-01	5/30/18	0-0.9	REG	18	1.7	0.17 J	0.36 J	10	0.44
	HEC06-SB3	HEC06-SB3-02	5/30/18	5-5.8	REG	0.69 U	0.28 U	0.23 J	0.28 U	1.3	0.28 U

Table 7. Summary of Soil Analytical Results (continued)

					Analyte	Perfluorooctane Sulfonate (PFOS)	Perfluorooctanoic Acid (PFOA)	Perfluorobutane Sulfonate (PFBS)	Perfluoroheptanoic Acid (PFHpA)	Perfluorohexane Sulfonate (PFHxS)	Perfluorononanoic Acid (PFNA)
					Screening Level[a]	1,260	1,260	1,260,000	NA	NA	NA
PRL	Location	Sample Identifier	Sample Date	Sample Depth (ft)	Sample Type	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
7	HEC07-SB1	HEC07-SB1-01	6/4/18	0-0.5	REG	**61 J**	**3**	**0.1 J**	**1.6**	**5.7**	**1.8**
	HEC07-SB1	HEC07-SB1-02	6/4/18	4.1-4.7	REG	0.73 U	0.29 U	0.26 U	0.29 U	0.29 U	0.29 U
	HEC07-SB2	HEC07-SB2-01	6/4/18	0-0.5	REG	**56 J**	**3.7**	**0.14 J**	**1.5**	**9.2**	**0.77**
	HEC07-SB2	HEC07-SB2-02	6/4/18	4.1-4.6	REG	**16**	**0.58**	**0.34 J**	**0.24 J**	**2.5**	**0.14 J**
	HEC07-SB3	HEC07-SB3-01	6/4/18	0-0.4	REG	**91 J**	**2.2**	0.25 U	**0.42**	**13**	**0.85**
	HEC07-SB3	HEC07-SB3-02	6/4/18	4.7-5.2	REG	**4.6**	**3**	0.24 U	**0.11 J**	**20**	0.27 U
9	HEC09-SB1	HEC09-SB1-01	6/4/18	0-0.5	REG	**99 J**	**1.5**	**0.13 J**	**0.82**	**6.7**	**1.5**
	HEC09-SB1	HEC09-SB1-02	6/4/18	4.7-5.2	REG	**3.8**	**1.7**	**0.44 J**	**1.2**	**13**	**0.21 J**
12	HEC12-SB1	HEC12-SB1-01	6/8/18	0-0.5	REG	**47 J**	**3.2**	**2.2**	**0.54**	**14**	**0.52**
	HEC12-SB1	HEC12-SB1-02	6/8/18	3-3.4	REG	**0.69 J**	**16**	**54 J**	**12**	**79 J**	0.28 U
	HEC12-SB2	HEC12-SB2-01	6/8/18	0-0.5	REG	**18**	**1.8**	**0.24 J**	**0.42 J**	**3**	**0.59**
	HEC12-SB2	HEC12-SB2-02	6/8/18	3-3.4	REG	0.7 U	**0.99**	**1**	**0.42**	**3**	0.28 U
	HEC12-SB3	HEC12-SB3-01	6/8/18	0-0.4	REG	**28 J**	**1.6**	**0.22 J**	**0.12 J**	**4.5**	**0.4**
	HEC12-SB3	HEC12-SB3-02	6/8/18	6-6.5	REG	**1 J**	**1.2**	**5.8 J**	**1**	**10**	0.28 U

[a] U.S. Environmental Protection Agency (EPA) residential risk-based soil screening level determined using the EPA regional screening level (RSL) calculator and November 2018 EPA RSL tables; Target HQ =1.0.

Bold denotes detected concentration.
Bold highlighted denotes concentration that exceeds screening criteria.

µg/kg = micrograms per kilogram.
FD = Field duplicate.
HQ = Hazard quotient.
NA = Not applicable.
NS = Not sampled due to refusal in borehole.
PRL = Potential release location.
REG = Regular.

Data Qualifiers:
J = Estimated concentration.
U = Chemical not detected above the laboratory detection limit.

Table 8. Summary of Groundwater and Surface Water Analytical Results

					Analyte	Perfluorooctane Sulfonate (PFOS)	Perfluorooctanoic Acid (PFOA)	PFOS+PFOA	Perfluorobutane Sulfonate (PFBS)	Perfluoroheptanoic Acid (PFHpA)	Perfluorohexane Sulfonate (PFHxS)	Perfluorononanoic Acid (PFNA)
					Health Advisory[a]	70	70	70	NA	NA	NA	NA
					EPA RSL Tap Water[b]	NA	NA	NA	400,000	NA	NA	NA
PRL	Location	Sample Identifier	Sample Date	Sample Depth (ft)	Sample Type	(ng/L)	(ng/L)	(ng/L)	(ng/L)	(ng/L)	(ng/L)	(ng/L)
					Groundwater							
1	MW-HEC01-01	MW-HEC01-01-01	6/7/18	14.5	REG	2.9 U	**0.83 J**	**3.73**	**4.1**	**0.71 J**	**3.5**	1.5 U
		MW-HEC01-01-01D	6/7/18	14.5	FD	2.9 U	**1.1 J**	**4**	**3.9**	**0.9 J**	**3.2**	1.5 U
	MW-HEC01-02	MW-HEC01-02-01	6/7/18	10.9	REG	2.8 U	**8.5 J**	**11.3**	**0.46 J**	1.4 U	0.36 U	1.4 U
2	MW-HEC02-01	MW-HEC02-01-01	6/6/18	14	REG	**15**	**54**	**69**	**51**	**62**	**360 J**	**1.6**
		MW-HEC02-01-01D	6/6/18	14	FD	**16**	**63**	**79**	**57**	**67**	**400 J**	**1.7**
	MW11-05-PRL02	MW11-05-PRL02-01	6/6/18	8	REG	**58000 J**	**16000 J**	**74000**	**8400 J**	**11000 J**	**79000 J**	**29 J**
	MW11-15-PRL02	MW11-15-PRL02-01	6/6/18	15	REG	**250**	**13**	**263**	**59**	**5.9**	**160**	1.8 U
5	MW-HEC05-01	MW-HEC05-01-01	6/6/18	8.9	REG	2.9 U	**0.56 J**	**3.46**	**1.2 J**	1.4 U	**5.2**	1.4 U
6	MW-HEC06-01	MW-HEC06-01-01	6/6/18	12	REG	**20 J**	**3.2**	**23.2**	**3.9**	**1.9**	**10 J**	**0.99 J**
7	MW-HEC07-01	MW-HEC07-01-01	6/7/18	13.75	REG	**3.9**	**210**	**213.9**	**180**	**54**	**3300 J**	1.5 U
	MW-HEC07-02	MW-HEC07-02-01	6/7/18	12.8	REG	2.6 U	**0.77 J**	**2.93**	0.88 U	1.3 U	**0.69 J**	1.3 U
12	MW-HEC12-01	MW-HEC12-01-01	6/8/18	11.1	REG	**680 J**	**350**	**1030**	**1600 J**	**300**	**2000 J**	**13**
	MW-HEC12-02	MW-HEC12-02-01	6/7/18	13.9	REG	2.8 U	1.4 U	**4.2**	0.93 U	1.4 U	0.49 U	1.4 U
					Surface Water							
10	HEC10-SW1	HEC10-SW1-01	6/5/18	NA	REG	**3800 J**	**520 J**	**4320**	**250**	**140**	**4600 J**	**44**
11	HEC11-SW1	HEC11-SW1-01	6/8/18	NA	REG	**410 J**	**20**	**430**	**39**	**10**	**410 J**	**1.5 J**

Table 8. Summary of Groundwater and Surface water Analytical Results (continued)

[a] May 2016 EPA health advisory for PFOS/PFOA combined.
[b] November 2018 EPA RSL for tap water; Target HQ = 1.0.
Bold denotes detected concentration.
Bold highlighted denotes concentration that exceeds screening criteria.

EPA = U.S. Environmental Protection Agency.
FD = Field duplicate.
HQ = Hazard quotient.
NA = Not applicable.
ng/L = Nanograms per liter.
PRL = Potential release location.
REG = Regular.
RSL = Regional screening level.

Data Qualifiers:
J = Estimated concentration.
U = Chemical not detected above the laboratory detection limit.

Table 9. SI Recommendation Summary Table

PRL No.	PRL Description	Constituents Above Screening Criteria	Sampling Recommendations and Objectives
1	Former FTA – ERP Site 10	**Soil:** PFOS	**Soil:** The screening criteria were exceeded in one soil sample. Additional surface and subsurface soil samples are proposed to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Although screening criteria were not exceeded for groundwater, there was one soil exceedance. Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells near HEC01-SB2.
2	Building 217 – Main Hangar	**Groundwater:** PFOS, PFOA, PFOS + PFOA	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
3	Building 215 – Former Fire Station	**Groundwater:** PFOS, PFOA, PFOS + PFOA	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Due to screening criteria exceedances in co-located PRL 2 groundwater, determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
5	Nozzle Testing Area – East of Building 340	**None**	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Although screening criteria were not exceeded, determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
6	Nozzle Testing Area – South of Building 310	**None**	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Although screening criteria were not exceeded, determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells
7	Nozzle Testing Area – North of Apron	**Groundwater:** PFOA, PFOS + PFOA	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.

Table 9. SI Recommendation Summary Table (continued)

PRL No.	PRL Description	Constituents Above Screening Criteria	Sampling Recommendations and Objectives
9	Aircraft Parking Apron	**Groundwater:** PFOA (co-located PRL 7); PFOS + PFOA (co-located PRLs 2 and 7)	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine if an unidentified source exists, and if so, to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
10	Stormwater Outfall 002	**Surface water:** PFOS, PFOA, PFOS + PFOA	**Surface Water and Sediment:** Additional sampling to determine the extent of surface water impacts and support the evaluation of whether unacceptable risks to ecological or human health receptors exist. Additional sampling upstream of Outfall 002 and at downstream off-Base locations.
11	Stormwater Outfall 003	**Surface water:** PFOS, PFOS + PFOA	**Surface Water and Sediment:** Additional sampling to determine the extent of surface water impacts and support the evaluation of whether unacceptable risks to ecological or human health receptors exist. Additional sampling upstream of Outfall 003 and at downstream off-Base locations.
12	Soils Stockpile Area	**Groundwater:** PFOS, PFOA, PFOS + PFOA	**Soil:** Although screening criteria were not exceeded, additional surface and subsurface soil samples are proposed to determine the nature and extent in the vertical and horizontal directions given the potential for soil to groundwater migration. **Groundwater:** Determine the nature and extent both vertically and horizontally through the sampling of existing and additional new monitoring wells.
General			**Groundwater:** (1) Collect additional groundwater samples in upgradient locations to quantify potential impacts from upgradient sources, and (2) collect additional groundwater samples downgradient from the PRLs and off Base through the installation of a limited number of new monitoring wells to assess the nature and extent of PFAS impacts beyond the Base boundary. **Surface Water/Sediment:** (1) Collect additional surface water and sediment samples in upstream locations to quantify potential impacts from upstream sources, and (2) collect additional surface water and sediment samples from downstream locations off Base to assess the nature and extent of PFAS impacts beyond the Base boundary.

ERP = Environmental Restoration Program.
FTA = Fire training area.
PFAS = Per- and polyfluoroalkyl substances.
PFOA = Perfluorooctanoic acid.
PFOS = Perfluorooctane sulfonate.
PRL = Potential release location.
SI = Site inspection.

FIGURES

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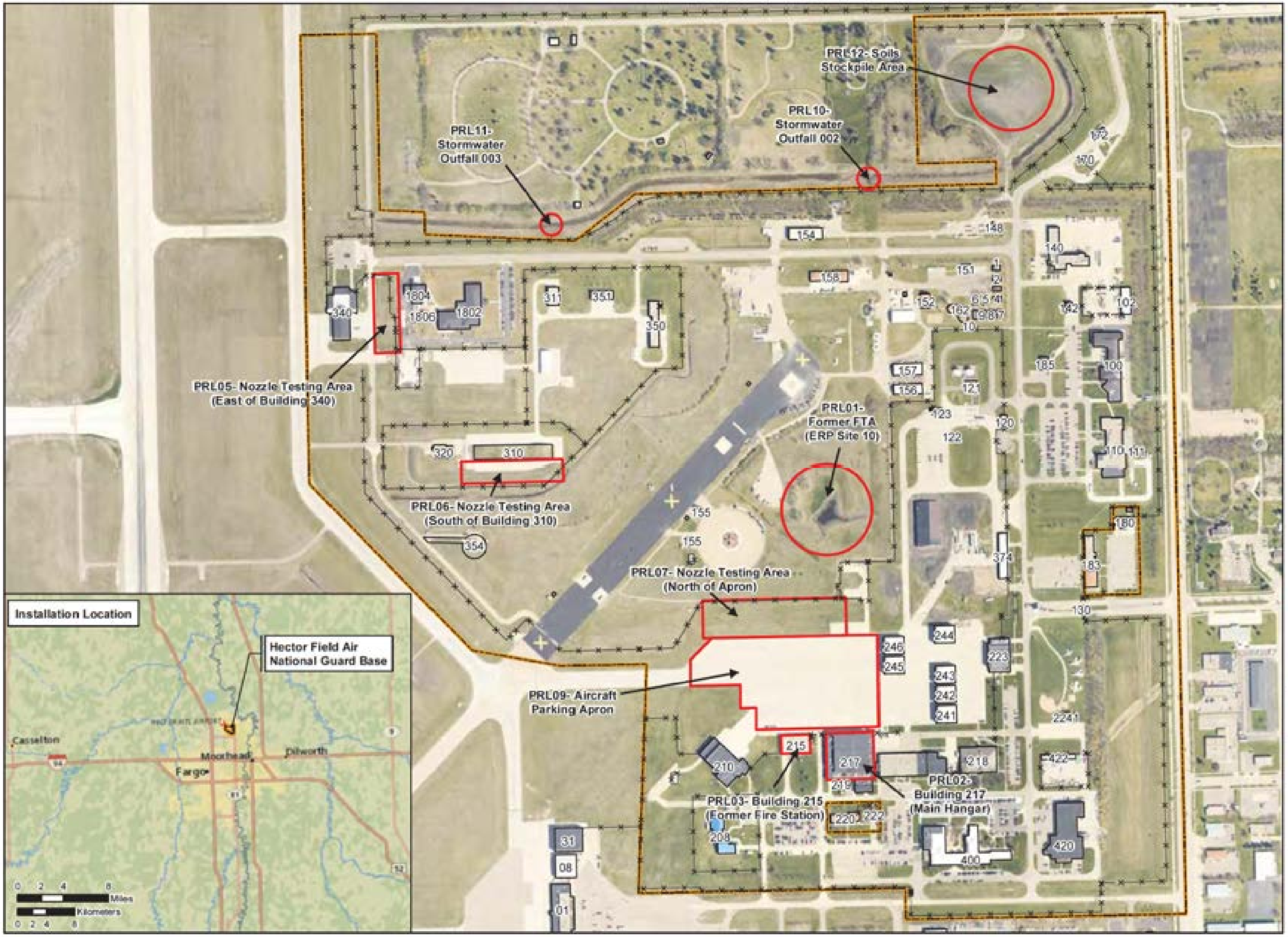

LEGEND:

- Potential Release Location (PRL)
- Installation Boundary*
- Building*
- Fence*

NOTES:

* Source: Common Installation Picture (CIP) geodatabase provided by ANG GeoBase on 07/26/2017.

1. Background Source: ESRI World Imagery (City of Fargo, ND, 05/2017).

0 200 400 800 Feet

0 50 100 200 Meters

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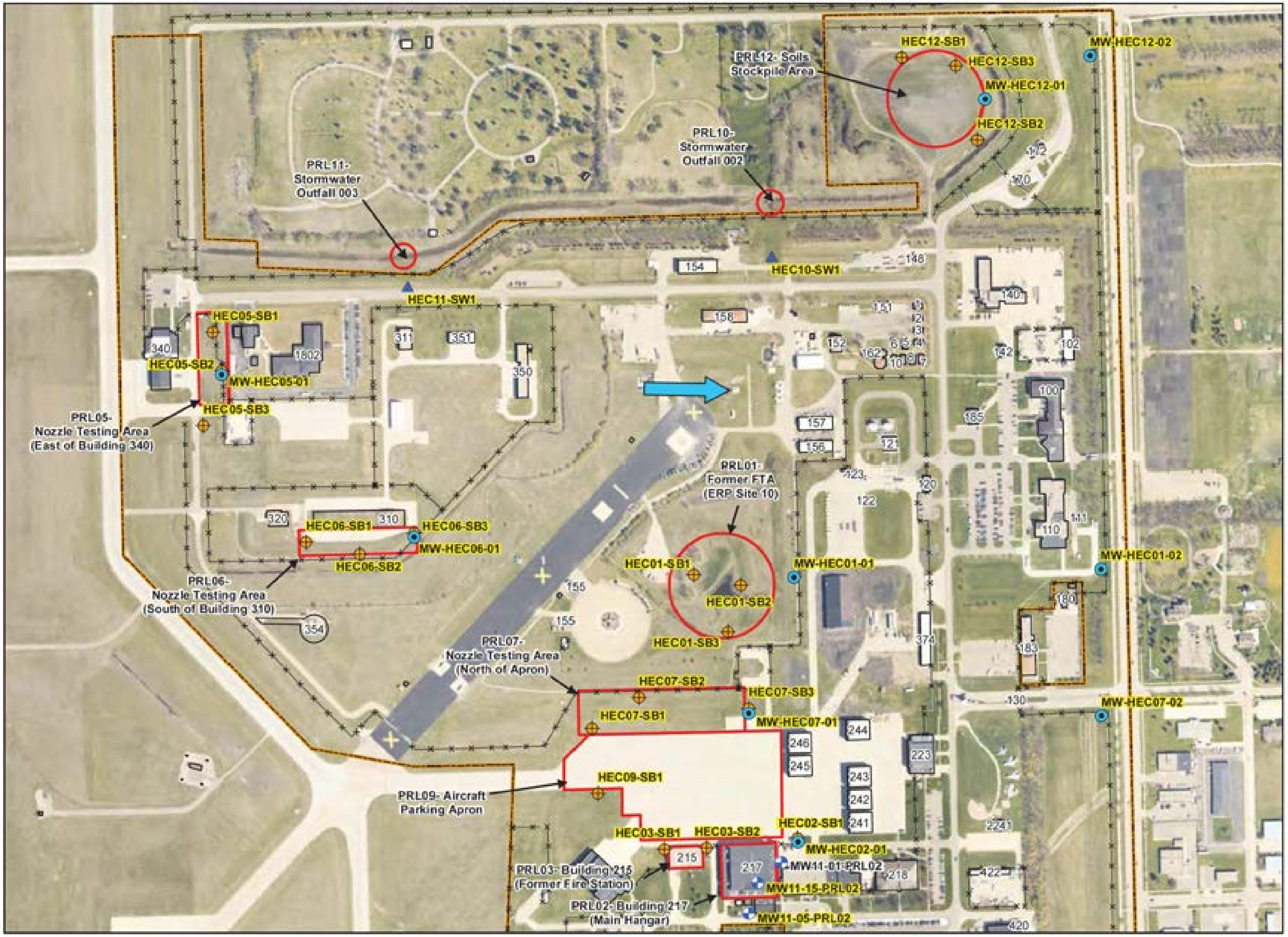
HECTOR FIELD AIR NATIONAL GUARD BASE
FARGO, NORTH DAKOTA

HECTOR FIELD ANGB LOCATION MAP

FIGURE: 1	DATE: 8/16/2018



LEGEND:

- SI Monitoring Well
- Soil Boring
- Surface Water Sample
- Existing Well
- Potential Release Location (PRL)
- Installation Boundary*
- Building*
- Fence*
- Inferred Regional Groundwater Flow
- HEC01-SB1 Location Identifier

NOTES:

* Source: Common Installation Picture (CIP) geodatabase provided by ANG GeoBase on 07/26/2017.

1. The general groundwater flow direction was inferred using historical and 2018 SI water level measurements.
2. MW11-01-PRL02 was not sampled because the well was dry and an obstruction was noted at approximately 2.8 ft BGS.
3. Background Source: ESRI World Imagery (City of Fargo, ND, 05/2017).

0 100 200 400 Feet

0 25 50 100 Meters

Area Shown

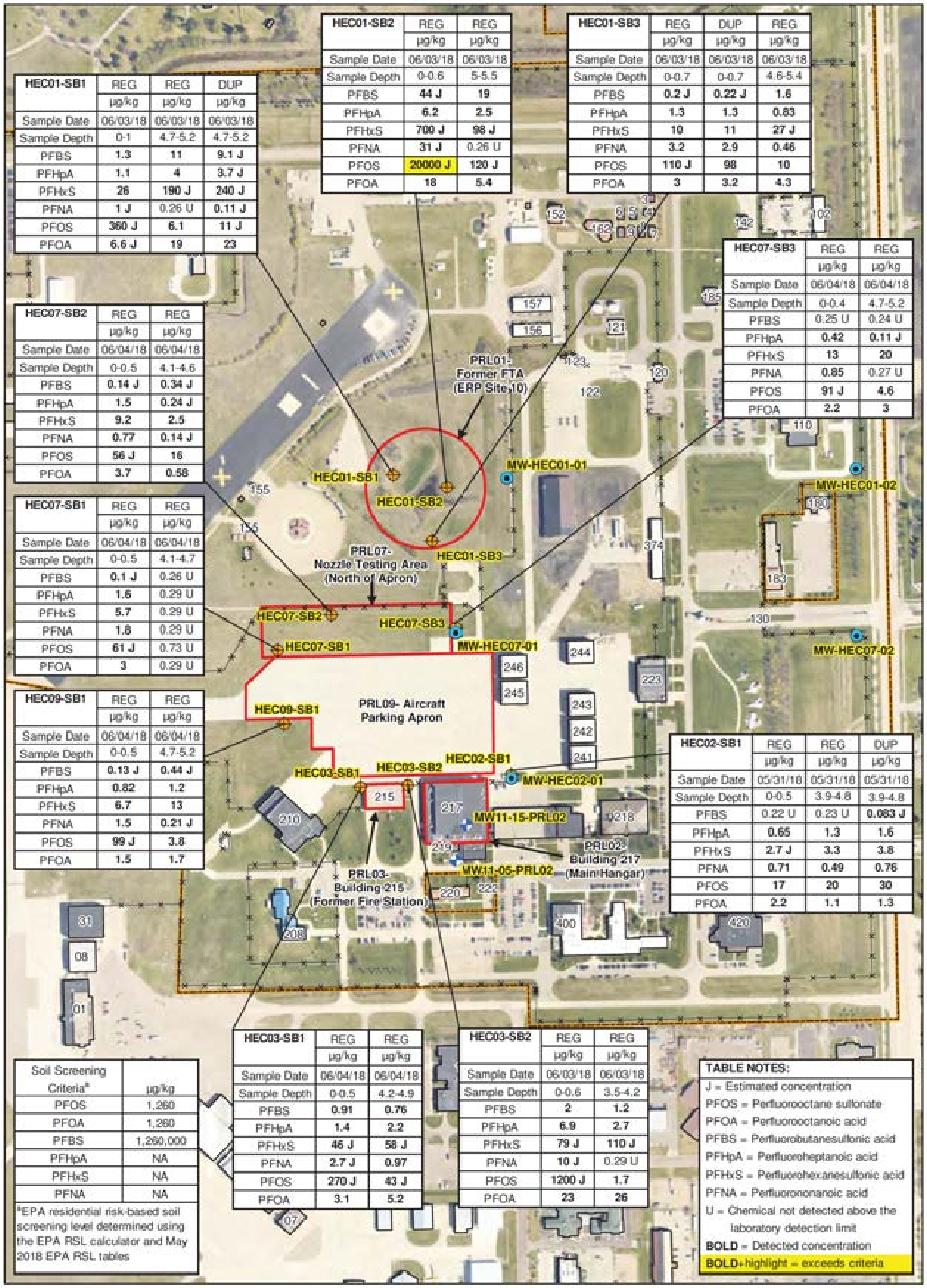
leidos

HECTOR FIELD AIR NATIONAL GUARD BASE
FARGO, NORTH DAKOTA

HECTOR FIELD ANGB
SI SAMPLING OVERVIEW MAP

FIGURE: 2 | DATE: 9/7/2018

PROJECT: \\827\Projects\ANG Phase 3 SI for PFCs\z_GIS\Hector_Field\Projects\SI\Figure 2 PRL Sample Location Overview_11x17.mxd



HEC01-SB1	REG	REG	DUP
	µg/kg	µg/kg	µg/kg
Sample Date	06/03/18	06/03/18	06/03/18
Sample Depth	0-1	4.7-5.2	4.7-5.2
PFBS	**1.3**	**11**	**9.1 J**
PFHpA	**1.1**	**4**	**3.7 J**
PFHxS	**26**	**190 J**	**240 J**
PFNA	**1 J**	0.26 U	**0.11 J**
PFOS	**360 J**	**6.1**	**11 J**
PFOA	**6.6 J**	**19**	**23**

HEC01-SB2	REG	REG
	µg/kg	µg/kg
Sample Date	06/03/18	06/03/18
Sample Depth	0-0.6	5-5.5
PFBS	**44 J**	**19**
PFHpA	**6.2**	**2.5**
PFHxS	**700 J**	**98 J**
PFNA	**31 J**	0.26 U
PFOS	**20000 J**	**120 J**
PFOA	**18**	**5.4**

HEC01-SB3	REG	DUP	REG
	µg/kg	µg/kg	µg/kg
Sample Date	06/03/18	06/03/18	06/03/18
Sample Depth	0-0.7	0-0.7	4.6-5.4
PFBS	**0.2 J**	**0.22 J**	**1.6**
PFHpA	**1.3**	**1.3**	**0.83**
PFHxS	**10**	**11**	**27 J**
PFNA	**3.2**	**2.9**	**0.46**
PFOS	**110 J**	**98**	**10**
PFOA	**3**	**3.2**	**4.3**

HEC07-SB3	REG	REG
	µg/kg	µg/kg
Sample Date	06/04/18	06/04/18
Sample Depth	0-0.4	4.7-5.2
PFBS	0.25 U	0.24 U
PFHpA	**0.42**	**0.11 J**
PFHxS	**13**	**20**
PFNA	**0.85**	0.27 U
PFOS	**91 J**	**4.6**
PFOA	**2.2**	**3**

HEC07-SB2	REG	REG
	µg/kg	µg/kg
Sample Date	06/04/18	06/04/18
Sample Depth	0-0.5	4.1-4.6
PFBS	**0.14 J**	**0.34 J**
PFHpA	**1.5**	**0.24 J**
PFHxS	**9.2**	**2.5**
PFNA	**0.77**	**0.14 J**
PFOS	**56 J**	**16**
PFOA	**3.7**	**0.58**

HEC07-SB1	REG	REG
	µg/kg	µg/kg
Sample Date	06/04/18	06/04/18
Sample Depth	0-0.5	4.1-4.7
PFBS	**0.1 J**	0.26 U
PFHpA	**1.6**	0.29 U
PFHxS	**5.7**	0.29 U
PFNA	**1.8**	0.29 U
PFOS	**61 J**	0.73 U
PFOA	**3**	0.29 U

HEC09-SB1	REG	REG
	µg/kg	µg/kg
Sample Date	06/04/18	06/04/18
Sample Depth	0-0.5	4.7-5.2
PFBS	**0.13 J**	**0.44 J**
PFHpA	**0.82**	**1.2**
PFHxS	**6.7**	**13**
PFNA	**1.5**	**0.21 J**
PFOS	**99 J**	**3.8**
PFOA	**1.5**	**1.7**

HEC02-SB1	REG	REG	DUP
	µg/kg	µg/kg	µg/kg
Sample Date	05/31/18	05/31/18	05/31/18
Sample Depth	0-0.5	3.9-4.8	3.9-4.8
PFBS	0.22 U	0.23 U	**0.083 J**
PFHpA	**0.65**	**1.3**	**1.6**
PFHxS	**2.7 J**	**3.3**	**3.8**
PFNA	**0.71**	**0.49**	**0.76**
PFOS	**17**	**20**	**30**
PFOA	**2.2**	**1.1**	**1.3**

HEC03-SB1	REG	REG
	µg/kg	µg/kg
Sample Date	06/04/18	06/04/18
Sample Depth	0-0.5	4.2-4.9
PFBS	**0.91**	**0.76**
PFHpA	**1.4**	**2.2**
PFHxS	**46 J**	**58 J**
PFNA	**2.7 J**	**0.97**
PFOS	**270 J**	**43 J**
PFOA	**3.1**	**5.2**

HEC03-SB2	REG	REG
	µg/kg	µg/kg
Sample Date	06/03/18	06/03/18
Sample Depth	0-0.6	3.5-4.2
PFBS	**2**	**1.2**
PFHpA	**6.9**	**2.7**
PFHxS	**79 J**	**110 J**
PFNA	**10 J**	0.29 U
PFOS	**1200 J**	**1.7**
PFOA	**23**	**26**

Soil Screening Criteria[a]	µg/kg
PFOS	1,260
PFOA	1,260
PFBS	1,260,000
PFHpA	NA
PFHxS	NA
PFNA	NA

[a]EPA residential risk-based soil screening level determined using the EPA RSL calculator and May 2018 EPA RSL tables

TABLE NOTES:
- J = Estimated concentration
- PFOS = Perfluorooctane sulfonate
- PFOA = Perfluorooctanoic acid
- PFBS = Perfluorobutanesulfonic acid
- PFHpA = Perfluoroheptanoic acid
- PFHxS = Perfluorohexanesulfonic acid
- PFNA = Perfluorononanoic acid
- U = Chemical not detected above the laboratory detection limit
- **BOLD** = Detected concentration
- **BOLD+highlight** = exceeds criteria

LEGEND:
- SI Monitoring Well
- Soil Boring
- Existing Well
- Potential Release Location (PRL)
- Installation Boundary*
- Building*
- Fence*
- HEC01-SB1 Location Identifier

NOTES:

* Source: Common Installation Picture (CIP) geodatabase provided by ANG GeoBase on 07/26/2017.

1. Background Source: ESRI World Imagery (City of Fargo, ND, 05/2017).

Scale: 0 100 200 400 Feet; 0 25 50 100 Meters

Area Shown

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HECTOR FIELD AIR NATIONAL GUARD BASE
FARGO, NORTH DAKOTA

PRLs 1, 2, 3, 7, AND 9
SI SOIL ANALYTICAL RESULTS

FIGURE: 3 | DATE: 9/7/2018

PROJECT: \827Projects\ANG Phase 3 SI for PFCs\a_GIS\Hector_Field\Projects\SI\Figure 3 PRL 1 2 3 7 9 Soil Results_11x17.mxd

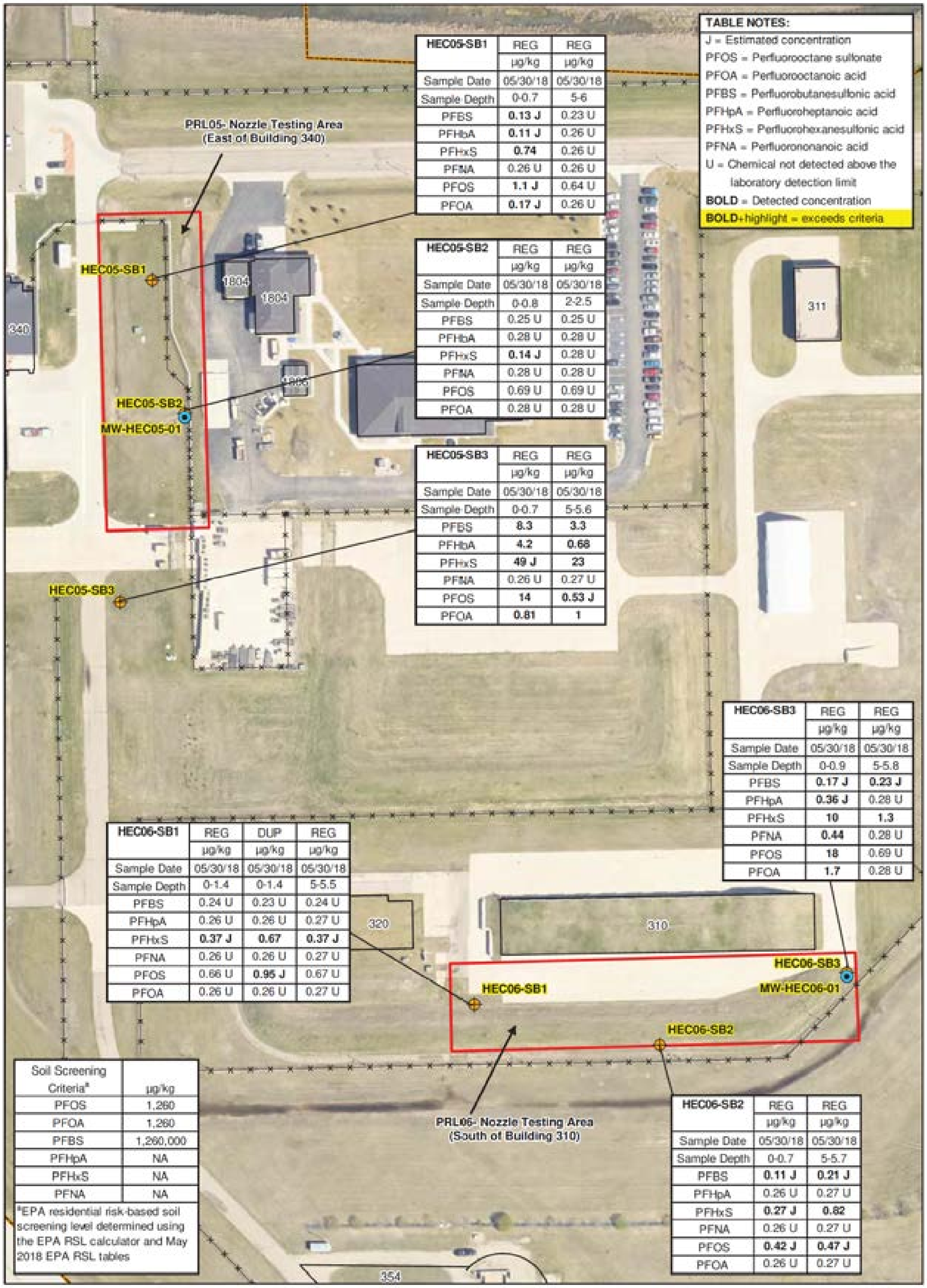


TABLE NOTES:
J = Estimated concentration
PFOS = Perfluorooctane sulfonate
PFOA = Perfluorooctanoic acid
PFBS = Perfluorobutanesulfonic acid
PFHpA = Perfluoroheptanoic acid
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
U = Chemical not detected above the laboratory detection limit
BOLD = Detected concentration
BOLD+highlight = exceeds criteria

HEC05-SB1	REG	REG
	µg/kg	µg/kg
Sample Date	05/30/18	05/30/18
Sample Depth	0-0.7	5-6
PFBS	**0.13 J**	0.23 U
PFHbA	**0.11 J**	0.26 U
PFHxS	**0.74**	0.26 U
PFNA	0.26 U	0.26 U
PFOS	**1.1 J**	0.64 U
PFOA	**0.17 J**	0.26 U

HEC05-SB2	REG	REG
	µg/kg	µg/kg
Sample Date	05/30/18	05/30/18
Sample Depth	0-0.8	2-2.5
PFBS	0.25 U	0.25 U
PFHbA	0.28 U	0.28 U
PFHxS	**0.14 J**	0.28 U
PFNA	0.28 U	0.28 U
PFOS	0.69 U	0.69 U
PFOA	0.28 U	0.28 U

HEC05-SB3	REG	REG
	µg/kg	µg/kg
Sample Date	05/30/18	05/30/18
Sample Depth	0-0.7	5-5.6
PFBS	**8.3**	**3.3**
PFHbA	**4.2**	**0.68**
PFHxS	**49 J**	**23**
PFNA	0.26 U	0.27 U
PFOS	**14**	**0.53 J**
PFOA	**0.81**	**1**

HEC06-SB3	REG	REG
	µg/kg	µg/kg
Sample Date	05/30/18	05/30/18
Sample Depth	0-0.9	5-5.8
PFBS	**0.17 J**	**0.23 J**
PFHpA	**0.36 J**	0.28 U
PFHxS	**10**	**1.3**
PFNA	**0.44**	0.28 U
PFOS	**18**	0.69 U
PFOA	**1.7**	0.28 U

HEC06-SB1	REG	DUP	REG
	µg/kg	µg/kg	µg/kg
Sample Date	05/30/18	05/30/18	05/30/18
Sample Depth	0-1.4	0-1.4	5-5.5
PFBS	0.24 U	0.23 U	0.24 U
PFHpA	0.26 U	0.26 U	0.27 U
PFHxS	**0.37 J**	**0.67**	**0.37 J**
PFNA	0.26 U	0.26 U	0.27 U
PFOS	0.66 U	**0.95 J**	0.67 U
PFOA	0.26 U	0.26 U	0.27 U

Soil Screening Criteria[a]	µg/kg
PFOS	1,260
PFOA	1,260
PFBS	1,260,000
PFHpA	NA
PFHxS	NA
PFNA	NA

[a]EPA residential risk-based soil screening level determined using the EPA RSL calculator and May 2018 EPA RSL tables

HEC06-SB2	REG	REG
	µg/kg	µg/kg
Sample Date	05/30/18	05/30/18
Sample Depth	0-0.7	5-5.7
PFBS	**0.11 J**	**0.21 J**
PFHpA	0.26 U	0.27 U
PFHxS	**0.27 J**	**0.82**
PFNA	0.26 U	0.27 U
PFOS	**0.42 J**	**0.47 J**
PFOA	0.26 U	0.27 U

LEGEND:

- SI Monitoring Well
- Soil Boring
- Potential Release Location (PRL)
- Installation Boundary*
- Building*
- Fence*
- HEC05-SB1 Location Identifier

NOTES:

* Source: Common Installation Picture (CIP) geodatabase provided by ANG GeoBase on 07/26/2017.
1. Background Source: ESRI World Imagery (City of Fargo, ND, 05/2017).

0 50 100 200 Feet
0 10 20 40 Meters

Area Shown

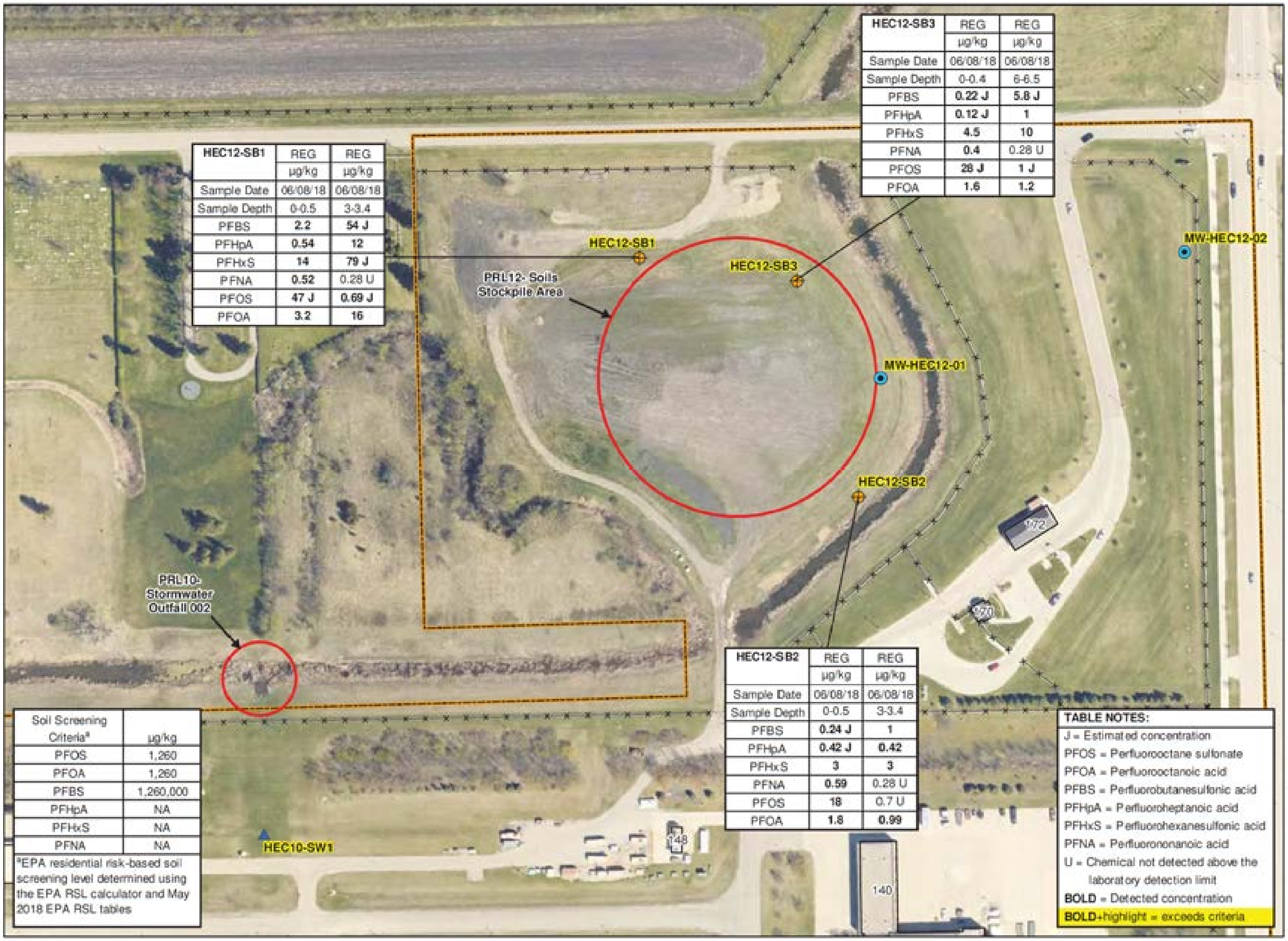
leidos

HECTOR FIELD AIR NATIONAL GUARD BASE
FARGO, NORTH DAKOTA

PRLs 5 AND 6
SI SOIL ANALYTICAL RESULTS

FIGURE: 4 | DATE: 9/7/2018

PROJECT: \I27\Projects\ANG Phase 3 SI for PFCs\a_GIS\Hector_Field\Projects\SI\Figure 4 PRL 5-6 Soil Results_11x17.mxd



HEC12-SB1	REG	REG
	µg/kg	µg/kg
Sample Date	06/08/18	06/08/18
Sample Depth	0-0.5	3-3.4
PFBS	**2.2**	**54 J**
PFHpA	**0.54**	**12**
PFHxS	**14**	**79 J**
PFNA	**0.52**	0.28 U
PFOS	**47 J**	**0.69 J**
PFOA	**3.2**	**16**

HEC12-SB3	REG	REG
	µg/kg	µg/kg
Sample Date	06/08/18	06/08/18
Sample Depth	0-0.4	6-6.5
PFBS	**0.22 J**	**5.8 J**
PFHpA	**0.12 J**	**1**
PFHxS	**4.5**	**10**
PFNA	**0.4**	0.28 U
PFOS	**28 J**	**1 J**
PFOA	**1.6**	**1.2**

HEC12-SB2	REG	REG
	µg/kg	µg/kg
Sample Date	06/08/18	06/08/18
Sample Depth	0-0.5	3-3.4
PFBS	**0.24 J**	**1**
PFHpA	**0.42 J**	**0.42**
PFHxS	**3**	**3**
PFNA	**0.59**	0.28 U
PFOS	**18**	0.7 U
PFOA	**1.8**	**0.99**

Soil Screening Criteria[a]	µg/kg
PFOS	1,260
PFOA	1,260
PFBS	1,260,000
PFHpA	NA
PFHxS	NA
PFNA	NA

[a]EPA residential risk-based soil screening level determined using the EPA RSL calculator and May 2018 EPA RSL tables

TABLE NOTES:

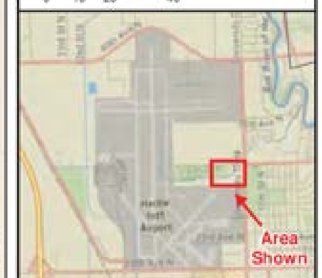
J = Estimated concentration
PFOS = Perfluorooctane sulfonate
PFOA = Perfluorooctanoic acid
PFBS = Perfluorobutanesulfonic acid
PFHpA = Perfluoroheptanoic acid
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
U = Chemical not detected above the laboratory detection limit
BOLD = Detected concentration
BOLD+highlight = exceeds criteria

LEGEND:

- SI Monitoring Well
- Soil Boring
- Surface Water Sample
- Potential Release Location (PRL)
- Installation Boundary*
- Building*
- Fence*
- **HEC12-SB1** Location Identifier

NOTES:

* Source: Common Installation Picture (CIP) geodatabase provided by ANG GeoBase on 07/26/2017.
1. Background Source: ESRI World Imagery City of Fargo, ND, 05/2017).



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HECTOR FIELD AIR NATIONAL GUARD BASE
FARGO, NORTH DAKOTA

PRL 12 SI SOIL ANALYTICAL RESULTS

FIGURE: 5 | DATE: 9/7/2018

PROJECT: \\27Projects\ANG Phase 1 SI for PFCs\z_GIS\Hector_Field\Projects\SI\Figure 5 PRL 12 Soil Results_11x17.mxd

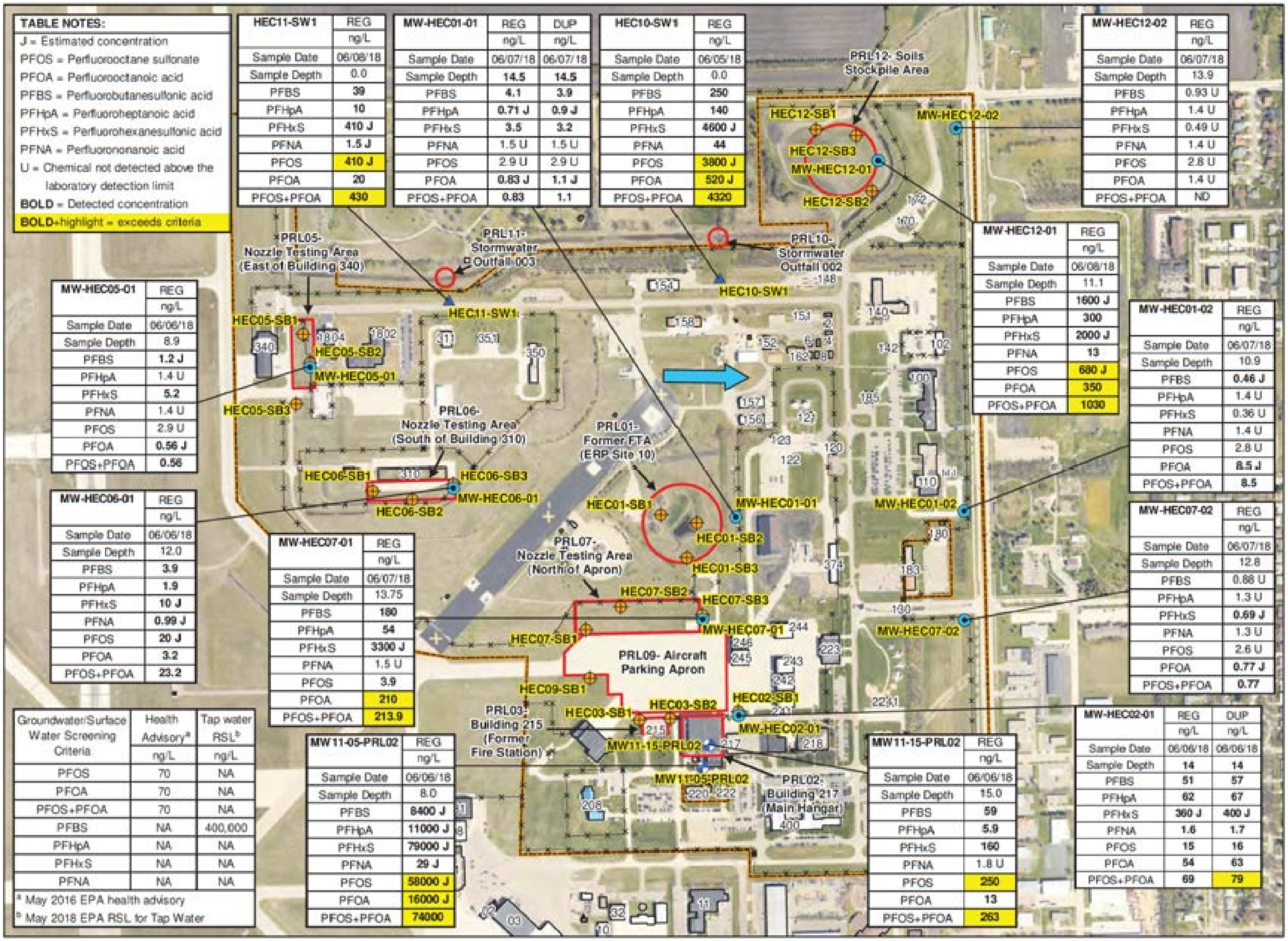

TABLE NOTES:

- J = Estimated concentration
- PFOS = Perfluorooctane sulfonate
- PFOA = Perfluorooctanoic acid
- PFBS = Perfluorobutanesulfonic acid
- PFHpA = Perfluoroheptanoic acid
- PFHxS = Perfluorohexanesulfonic acid
- PFNA = Perfluorononanoic acid
- U = Chemical not detected above the laboratory detection limit
- **BOLD** = Detected concentration
- **BOLD**+highlight = exceeds criteria

HEC11-SW1	REG
	ng/L
Sample Date	06/08/18
Sample Depth	0.0
PFBS	**39**
PFHpA	**10**
PFHxS	**410 J**
PFNA	**1.5 J**
PFOS	**410 J**
PFOA	**20**
PFOS+PFOA	**430**

MW-HEC01-01	REG	DUP
	ng/L	ng/L
Sample Date	06/07/18	06/07/18
Sample Depth	14.5	14.5
PFBS	**4.1**	**3.9**
PFHpA	**0.71 J**	**0.9 J**
PFHxS	**3.5**	**3.2**
PFNA	1.5 U	1.5 U
PFOS	2.9 U	2.9 U
PFOA	**0.83 J**	**1.1 J**
PFOS+PFOA	**0.83**	**1.1**

HEC10-SW1	REG
	ng/L
Sample Date	06/05/18
Sample Depth	0.0
PFBS	**250**
PFHpA	**140**
PFHxS	**4600 J**
PFNA	**44**
PFOS	**3800 J**
PFOA	**520 J**
PFOS+PFOA	**4320**

MW-HEC12-02	REG
	ng/L
Sample Date	06/07/18
Sample Depth	13.9
PFBS	0.93 U
PFHpA	1.4 U
PFHxS	0.49 U
PFNA	1.4 U
PFOS	2.8 U
PFOA	1.4 U
PFOS+PFOA	ND

MW-HEC12-01	REG
	ng/L
Sample Date	06/08/18
Sample Depth	11.1
PFBS	**1600 J**
PFHpA	**300**
PFHxS	**2000 J**
PFNA	**13**
PFOS	**680 J**
PFOA	**350**
PFOS+PFOA	**1030**

MW-HEC05-01	REG
	ng/L
Sample Date	06/06/18
Sample Depth	8.9
PFBS	**1.2 J**
PFHpA	1.4 U
PFHxS	**5.2**
PFNA	1.4 U
PFOS	2.9 U
PFOA	**0.56 J**
PFOS+PFOA	**0.56**

MW-HEC01-02	REG
	ng/L
Sample Date	06/07/18
Sample Depth	10.9
PFBS	**0.46 J**
PFHpA	1.4 U
PFHxS	0.36 U
PFNA	1.4 U
PFOS	2.8 U
PFOA	**8.5 J**
PFOS+PFOA	**8.5**

MW-HEC06-01	REG
	ng/L
Sample Date	06/06/18
Sample Depth	12.0
PFBS	**3.9**
PFHpA	**1.9**
PFHxS	**10 J**
PFNA	**0.99 J**
PFOS	**20 J**
PFOA	**3.2**
PFOS+PFOA	**23.2**

MW-HEC07-01	REG
	ng/L
Sample Date	06/07/18
Sample Depth	13.75
PFBS	**180**
PFHpA	**54**
PFHxS	**3300 J**
PFNA	1.5 U
PFOS	**3.9**
PFOA	**210**
PFOS+PFOA	**213.9**

MW-HEC07-02	REG
	ng/L
Sample Date	06/07/18
Sample Depth	12.8
PFBS	0.88 U
PFHpA	1.3 U
PFHxS	**0.69 J**
PFNA	1.3 U
PFOS	2.6 U
PFOA	**0.77 J**
PFOS+PFOA	**0.77**

Groundwater/Surface Water Screening Criteria	Health Advisory[a]	Tap water RSL[b]
	ng/L	ng/L
PFOS	70	NA
PFOA	70	NA
PFOS+PFOA	70	NA
PFBS	NA	400,000
PFHpA	NA	NA
PFHxS	NA	NA
PFNA	NA	NA

[a] May 2016 EPA health advisory
[b] May 2018 EPA RSL for Tap Water

MW11-05-PRL02	REG
	ng/L
Sample Date	06/06/18
Sample Depth	8.0
PFBS	**8400 J**
PFHpA	**11000 J**
PFHxS	**79000 J**
PFNA	**29 J**
PFOS	**58000 J**
PFOA	**16000 J**
PFOS+PFOA	**74000**

MW11-15-PRL02	REG
	ng/L
Sample Date	06/06/18
Sample Depth	15.0
PFBS	**59**
PFHpA	**5.9**
PFHxS	**160**
PFNA	1.8 U
PFOS	**250**
PFOA	**13**
PFOS+PFOA	**263**

MW-HEC02-01	REG	DUP
	ng/L	ng/L
Sample Date	06/06/18	06/06/18
Sample Depth	14	14
PFBS	**51**	**57**
PFHpA	**62**	**67**
PFHxS	**360 J**	**400 J**
PFNA	**1.6**	**1.7**
PFOS	**15**	**16**
PFOA	**54**	**63**
PFOS+PFOA	**69**	**79**

LEGEND:

- SI Monitoring Well
- Soil Boring
- Surface Water Sample
- Existing Well
- Potential Release Location (PRL)
- Installation Boundary*
- Building*
- Fence*
- Inferred Regional Groundwater Flow
- HEC01-SB1 Location Identifier

NOTES:

* Source: Common Installation Picture (CIP) geodatabase provided by ANG GeoBase on 07/26/2017.

1. The general groundwater flow direction was inferred using historical and 2018 SI water level measurements.
2. Background Source: ESRI World Imagery (City of Fargo, ND, 05/2017).

0 125 250 500 Feet
0 50 100 200 Meters

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FARGO, NORTH DAKOTA

PRLs 1, 2, 3, 5, 6, 7, 9, 10, 11, AND 12 SI GROUNDWATER AND SURFACE WATER ANALYTICAL RESULTS

FIGURE: 6	DATE: 9/7/2018

APPENDIX A

SOIL BORINGS AND WELL CONSTRUCTION LOGS

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BORING LOGS

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HEC12-SB2
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC12
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/22/18 — 11. DATE COMPLETED: 5/22/18
12. OVERBURDEN THICKNESS: >15 FT	15. DEPTH GROUNDWATER ENCOUNTERED: 6.95 FT BGS IN PIEZOMETER
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 15 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES	N/A	

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	PFC	—	—	

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	X	—	—	[signature]

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT: HOLE NUMBER

HTRW DRILLING LOG

PROJECT: HECTOR FIELD PFOS/PFOA SI	INSPECTOR M. KLIDZEJS	HOLE NUMBER HEC12-SB2
		SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-2.9FT: SILTY CLAY (CL) STIFF, SLIGHTLY PLASTIC, DARK GRAYISH BROWN (10YR 4/2). V. SL MOIST	CORE= 0.0ppm		HEC12-SB2-01 ~~0.0-0.7FT~~ 0.0-0.5FT	PROBE: 0-5FT REC: 2.9FT; SAMPLE RE-COLLECTED BY HAND-AUGER ON 6/8/18
	3	2.9-5.0FT: LOSS				
	5	5.0-10.0FT: SAME AS ABOVE SL. MOIST TO MOIST BY 10FT	CORE= 0.0ppm		SAMPLE DISCARDED MK 5/22/18; ~~HEC12-SB2-02 7.5-8.1FT~~; ~~HEC12-SB2-02 6.3-6.9~~ MK 6/8/18; 3.0-3.4FT	PROBE: 5-10FT REC: 5.0FT; SAMPLE DEPTH SELECTED BASED ON DEPTH TO WATER IN ADJACENT DITCH; SOIL SAMPLES RE-COLLECTED ON 6/8/18 USING HAND AUGER
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI — HOLE NUMBER HEC12-SB2

HTRW DRILLING LOG

HOLE NUMBER HECIR-SB2

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
		SAME AS ABOVE BUT w/ GREATER SILT CONTENT, SOFT, MOD. PLASTIC WET AT 10 FT				PROBE: 10-15FT REC. 3.0FT
	11					
	12					
	13					
	14					
	15					TD = 15FT BGS 12:45 PULL RODS SET TEMP PIEZ w/ 10FT, 1-IN SCREEN 13:18 WATER LEVEL IN PIEZOMETER STATIC AT 6.95FT BGS
	16					
	17					
	18					
	19					
	20					

0.37 CON .25

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HECIR-SB2

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER: MW-HEC12-01
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 1

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC12
5. NAME OF DRILLER: C. GREENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: ~~GEOPROBE RODS~~ MK 5/22/18 ~~- 1-IN DIAM ACETATE LINERS~~ -8-IN O.D., 4 1/4-IN I.D. HOLLOW-STEM AUGERS (HSTA) w/ 8 1/2-IN O.D., 0.35 FT LENGTH BIT -WOODEN CENTER PLUG	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/22/18 — 11. DATE COMPLETED: 5/22/18
12. OVERBURDEN THICKNESS: >15 FT	15. DEPTH GROUNDWATER ENCOUNTERED: SEE ACTIVITY LOG
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: ~15 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES	N/A	

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	—	—	—	

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	—	X	—	[signature]

LOCATION SKETCH/COMMENTS

SCALE:

- BORING NOT LOGGED, SEE LOG FOR HEC12-SB2

PROJECT: HOLE NUMBER

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HEC12-SB1
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 2

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 12
5. NAME OF DRILLER: C. GRINSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/22/18 — 11. DATE COMPLETED: 5/22/18
12. OVERBURDEN THICKNESS: >10 FT	15. DEPTH GROUNDWATER ENCOUNTERED: N/A
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 10 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES	N/A		
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	PFC	—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	X	—	—	[signature]		

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER ~~HECIZ-~~ SB1

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0 - 3.3FT: SILTY CLAY (CL) STIFF, LOW TO MOD. PLASTICITY, VERY DARK GRAYISH BROWN (10YR 3/2) DRY	CORE = 0.0ppm		HECIZ-SB1-01 ~~0.0-1.0 FT w/ DUP~~ 0.0 - 0.5FT MK 6/8/18	PROBE: ~~0-10~~ 0-5FT REC: 3.3FT
	1					
	2					SOIL SAMPLES RE-COLLECTED ON 6/8/18 USING HAND AUGER
	3	3.5 - 5.0FT: LOSS				
	4					
	5	5.0 - 9.5FT: SAME AS ABOVE V. MOIST BELOW 9FT.	CORE = 0.0ppm			PROBE: 5-8FT REC: 2.1FT
	6					
	7				HECIZ-SB1-02	
	8		CORE = 0.0ppm		~~8.3-9.0FT~~ 3.0 - 3.4FT MK 6/8/18	PROBE: 8-10FT REC: 2.4FT
	9	9.5 - 10.6FT: LOSS				TD = 10FT
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HECIZ-SB1

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER: HSC12-SB3
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 2
3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HSC 12	
5. NAME OF DRILLER: C. GREENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:	
	9. SURFACE ELEVATION:	
	10. DATE STARTED: 5/22/18	11. DATE COMPLETED: 5/22/18
12. OVERBURDEN THICKNESS: > 10 FT	15. DEPTH GROUNDWATER ENCOUNTERED: N/A	
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A	
14. TOTAL DEPTH OF HOLE: 10 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES: N/A		
20. SAMPLES FOR CHEMICAL ANALYSIS	**VOC**	**METALS**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**
	—	—	PFC	—	—

21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	X	—	—	[signature]

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG	HOLE NUMBER HECIZ-SB3
PROJECT: HECTOR FIELD PFOS/PFOA SI — INSPECTOR M. KLIDZEJS	SHEET 2 OF 2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0 – ~~10.0FT~~ 3.3FT: MK 5/22/18 SILTY CLAY (CL), TRACE FINE GRAVEL MED STIFF, MOD TO SL PLASTIC, DARK GRAYISH BROWN (10YR 4/2) DRY			HECIZ-SB3-01 ~~0.0-0.5FT~~ MK 6/8/18 0.0-0.4FT	PROBE: 0-5FT REC: 3.3
	1		CORE= 0.0ppm			
	2					SOIL SAMPLES RE-COLLECTED ON 6/8/18 USING HAND AUGER
	3	3.3 – 5.0FT: LOSS				
	4					
	5	5.0 – 10.0FT: SAME AS ABOVE BUT MOIST, V. MOIST BY 9.8FT	CORE= 0.0ppm			PROBE: 5-8FT REC: 3.0FT
	6					
	7				HECIZ-SB3-02	
	8		CORE= 0.0ppm		~~8.3-9.0FT~~ MK 6/8/18 6.0-6.5FT	PROBE: 8-10FT REC: 2.7FT
	9					
	10					TD = 10 FT

PROJECT: HECTOR FIELD PFOS/PFOA SI — HOLE NUMBER HECIZ-SB3

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER: MW-HEC12-02
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 12
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS - 1-IN DIAM ACETATE LINERS - 8-IN O.D. 4 1/4-IN I.D. HSA, W/ 8 1/2-IN OD BIT - WOODEN CENTER PLUG	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/23/18 — 11. DATE COMPLETED: 5/29/18
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED: SEE ACTIVITY LOG
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: SEE ACTIVITY LOG
14. TOTAL DEPTH OF HOLE: ~~[illegible]~~ 19 FT (MK 5/29/18)	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): SEE ACTIVITY LOG

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES		

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	GW FOR PFC	—	—	

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	—	X	—	[signature]

LOCATION SKETCH/COMMENTS

SCALE:

BORING DEEPENED ON 5/29/18

PROJECT: HOLE NUMBER MW-HEC12-02

HTRW DRILLING LOG

HOLE NUMBER MW-HEC12-02

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-3.9 FT: SILTY CLAY (CL) SOFT TO MED. STIFF MED. PLASTICITY, DARK GRAYISH BROWN (10YR 4/2) MOIST	CORE = 0.0ppm			PROBE: 0-5FT REC: 3.9FT
	1					
	2					
	3					
	4	3.9-5.0FT: LOSS				
	5	5.0-9.6FT: SAME AS ABOVE COLOR BECOMES MOTTLED w/ YELLOWISH BROWN (10YR 5/4) BELOW 8.3FT.	CORE = 0.0ppm			PROBE: 5-10FT REC: 4.6FT
	6					
	7					
	8	V. MOIST TO WET BELOW ~8FT				
	9	9.6-10.0FT: LOSS				
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER MW-HEC12-02

HTRW DRILLING LOG

HOLE NUMBER MW-HEC12-02

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	10.0-12.7 FT: SAME AS ABOVE. WET.				14 MACROCORE (?) PROBE: 10-18 FT REC: 2.7 FT
	11		CORE =			
	12					
	13	12.7-14.0 FT: LOSS				
	14					
	15					TO OF DPT = 14 FT OPEN HOLE TO 8-IN W HSA
	16					SET WELL
	17					ON 5/29/18 WATER COLUMN IN WELL = 2.81 FT. WL AT 11.30 FT BTOC. PULL WELL, DEEPEN BORING TO ~19 FT AND RE-SET WELL
	18					
	19					
	20					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER MW-HEC12-02

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER: MW-HEC07-02
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 07
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS - 1-IN DIAM ACETATE LINERS - 8-IN O.D., 4 1/4-IN I.D. HSA W/ 8 1/2-IN O.D. BIT - WOODEN CENTER PLUG	8. HOLE LOCATION: 9. SURFACE ELEVATION:
	10. DATE STARTED: 5/23/18 — 11. DATE COMPLETED: 5/29/18
12. OVERBURDEN THICKNESS: ~~>14FT~~, >18 FT MW 5/29/18	15. DEPTH GROUNDWATER ENCOUNTERED: SEE ACTIVITY LOG
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: SEE ACTIVITY LOG
14. TOTAL DEPTH OF HOLE: ~~14FT~~ 18FT MW 5/29/18	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): SEE ACTIVITY LOG

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	GW FOR PFC	—	—	
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	—	X	—	[signature]		

LOCATION SKETCH/COMMENTS — SCALE:

- BORING FOR WELL DEEPENED ON 5/29/18 BASED ON WL MEASURED FROM WELL.

PROJECT: HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER MW-HEC07-a

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-3.2 FT: SILTY CLAY (CL) MED. STIFF TO SOFT IN INTERVALS, MOD PLASTIC. BLACK FROM 0.0 TO ~1.3 FT THEN GRADES TO OLIVE BROWN (10Y 4/3) SL. MOIST	CORE= 0.0 ppm			PROBE: 0-5FT REC: 3.2FT
	3	3.2-5.0 FT: LOSS				
	5	5.0-7.4 FT: VERY MOIST BELOW 5.5 FT. SLIGHTLY MORE SILT, OTHERWISE SAME AS ABOVE, OLIVE BROWN	CORE= 0.0 ppm			PROBE: 5-10 FT REC: 2.4 FT
	7	7.4-10.0 FT: LOSS				

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER MW-HEC07-02

HTRW DRILLING LOG

HOLE NUMBER MW-HFC07-02

SHEET 3 OF 3

PROJECT: HECTOR FIELD PFOS/PFOA SI

INSPECTOR M. KLIDZEJS

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	10.0-13.3FT: SAME AS ABOVE OLIVE BROWN, V. MOIST, WET IN SILTIER INTERVALS				PROBE: 10-15FT REC: 3.3FT
	11					
	12					
	13					
	14					OPT TD = 14FT OPEN HOLE TO 8-IN DIAM W/ HSA TO SET WELL
	15					WELL PULLED, HOLE DEEPENED TO 18FT AND WELL RE-SET ON 5/29/18.
	16					
	17					
	18					
	19					
	20					

PROJECT: HECTOR FIELD PFOS/PFOA SI

HOLE NUMBER MW-HFC07-02

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER MW-HEC01-02
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC01
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS; - 8-IN O.D., 4 1/4-IN ID HSA, W/ 8-1/2-IN O.D. BIT.; - WOODEN CENTER PLUG	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/23/18 — 11. DATE COMPLETED: 5/23/18
12. OVERBURDEN THICKNESS: >14 FT	15. DEPTH GROUNDWATER ENCOUNTERED: BELOW 10 FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: SEE ACTIVITY LOG
14. TOTAL DEPTH OF HOLE: 14 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): SEE ACTIVITY LOG

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES N/A		
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)
	—	—		—	
21. TOTAL CORE RECOVERY %					
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR	
	—	X	—	[signature]	

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:	HOLE NUMBER

HTRW DRILLING LOG						HOLE NUMBER MW-HEC01-02
PROJECT: HECTOR FIELD PFOS/PFOA SI			INSPECTOR M. Kleidezs			SHEET 2 OF 3
ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0 – 3.1 FT.: SILTY CLAY (CL) MED STIFF GRADING DOWN TO SOFT. MOD. PLASTIC. BLACK (10YR 2/1) TO ~1.0FT THEN GRADES TO BROWN (10YR 5/3). MOIST	CORE= 0.0 PPM			PROBE: 0-5FT REC: 3.1FT
	1					
	2					
	3	3.1 – 5.0 FT: LOSS				
	4					
	5	5.0 – 9.6 FT: SAME AS ABOVE BROWN, MOIST				PROBE: 5-10FT REC: 4.6FT
	6		CORE= 0.0PPM			
	7					
	8					
	9					
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI HOLE NUMBER MW-HEC01-02

HTRW DRILLING LOG

HOLE NUMBER MW-HEC01-02	SHEET 3 OF 3

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	10-13.0 FT: SAME AS ABOVE COLOR MOTTLED w/ MINOR LIGHT YELLOWISH BROWN (10YR 6/4) MOIST BUT WET ACROSS SILTIER SEAMS	CORE= 0.0ppm			PROBE: 10-14 FT; REC: 3.0 FT
	11					
	12					
	13	13.0-14.0 FT: LOSS				
	14					TD OPT AT 14 FT. OPEN HOLE TO 8-IN w/ HSA TO SET WELL
	15					
	16					
	17					
	18					
	19					
	20					

HTRW DRILLING LOG

DISTRICT: ANG

HOLE NUMBER: MW-HEC02-[illegible]1 / HEC02-SB1

SHEET 1 **OF** 3

1. COMPANY NAME: LEIDOS
2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES
3. PROJECT: HECTOR FIELD PFOS/PFOA SI
4. LOCATION: HEC 02
5. NAME OF DRILLER: C. GRENSON
6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT:
   - GEOPROBE RODS
   - 1-IN DIAM ACETATE LINERS
   - 8-IN O.D., 4¼-IN ID HSA w/ 8½-IN OD BIT
   - WOODEN CENTER PLUG
8. HOLE LOCATION:
9. SURFACE ELEVATION:
10. DATE STARTED: 5/24/18
11. DATE COMPLETED: 5/24/18
12. OVERBURDEN THICKNESS: >20 FT
13. DEPTH DRILLED INTO ROCK: N/A
14. TOTAL DEPTH OF HOLE: 20 FT
15. DEPTH GROUNDWATER ENCOUNTERED: WET BELOW 17 FT
16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: SEE ACTIVITY LOG
17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): SEE ACTIVITY LOG

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
			N/A

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	PFC	—	—	

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	—	X	—	[signature]

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC02-SB1

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0 - 1.0FT: SILTY CLAY (CL) STIFF, LOW PLASTICITY BLACK (10YR 2/1) DRY.	CORE= N/A		HEC02-SB1-01 ~~0.0 - 1.0~~ MK 5/31/18 0.0 - 0.5FT	PROBE: 0-2FT RSC: 1.0FT
	1	1.0 - 2.0FT: LOSS				
	2	2.0 - 2.4FT: SAME AS ABOVE				PROBE: 2-5FT RSC: 1.8FT
		2.4 - 2.6FT: SAND (SP) FINE, GRAINED, WELL SORTED, LOOSE, LIGHT OLIVE BROWN (7.5YR 5/4) DRY	CORE= 0.0ppm		HEC02-SB1-02 ~~2.8 - 3.5FT~~ MK 5/31/18 3.9 - 4.8FT	SOIL SAMPLES RE-COLLECTED ON 5/31/18 USING HAND AUGER
	4	2.6 - 3.8FT: SILTY CLAY (CL) MED STIFF, MED PLASTIC. LESS SILT THAN NEAR SURFACE. BLACK (10YR 2/1). DRY				
	5	3.8 - 5.0FT: LOSS				PROBE: 5-10FT RSC: 2.7FT
	6	5.0 - 7.7FT: SILTY CLAY, AS ABOVE. COLOR GRADES TO BROWN (10YR 5/3) BY 7.5FT.	CORE= 0.3ppm			
	7	7.7 - 10.0FT: LOSS				
	8					
	9					
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC02-SB1

HTRW DRILLING LOG

HOLE NUMBER HEC02-SB1 MW-HEC02-01

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	10.0-13.7FT: SILTY CLAY (CL) AS ABOVE SOME MOTTLING OF GRAY (10YR 6/1) MOIST TO ~13FT V. MOIST BELOW				PROBE: 10-14FT REC: 3.7FT
	11					
	12					
	13	13.7-15.0FT: LOSS				
	14					TD DPT AT 14FT OPEN HOLE TO 8-IN USING HSA TO SET WELL MW-HEC02-01
	15					
	16					
	17	AUGER CUTTINGS BECOME V. MOIST TO WET BELOW ~17FT. ALL CLAY, NO SOUPY CUTTINGS. CAN BARELY PAT MOISTURE FROM CLAY.				
	18					
	19					TD HSA AT 20FT
	20					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC02-SB1

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER: HEC03-SB1
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 2

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 03
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/24/18 — 11. DATE COMPLETED: 5/24/18
12. OVERBURDEN THICKNESS: >5FT	15. DEPTH GROUNDWATER ENCOUNTERED: N/A
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 5FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES	N/A		
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	PFC	—	—	
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR	[signature]	
	X	—	—			

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT: HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC03-SB1

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-1.0FT SILTY CLAY (CL) SOME SAND AND FINE GRAVEL. CLAY IS MED. STIFF, SL PLASTIC, BLACK (10YR 2/1) DRY.	CORE: N/A		HEC03-SB1-01 ~~0.0-1.0FT~~ 0.0-0.5FT MKL 6/4/18	PROBE: 0-2 FT REC 1.0FT
	1					
	2	1.0-2.0FT: LOSS				
		2.0-3.6FT: CLAY (CH) SOFT, HIGHLY PLASTIC, BLACK (10YR2/1) MOTTLED W/ MINOR GRAY (10YR 6/1) SL. MOIST			HEC03-SB1-02 ~~2.2-2.5FT~~ ~~DUP~~ MK 6/4/18 4.2-4.9FT	PROBE: 2-5FT REC: 1.6 FT
	3					
	4	3.6-5.0FT: LOSS				
	5					TD=5FT
	6					SOIL SAMPLES RE-COLLECTED ON 6/4/18 USING HAND AUGER
	7					
	8					
	9					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC03-SB1

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HEC09-SB1
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 2

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 09
5. NAME OF DRILLER: C. GLENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/24/18 — 11. DATE COMPLETED: 5/24/18
12. OVERBURDEN THICKNESS: > 5FT	15. DEPTH GROUNDWATER ENCOUNTERED: N/A
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 5FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES N/A			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	PFCs	—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	X	—	—	[signature]		

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC09-SB1

SHEET 2 OF 2

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS

ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-1.3 FT: SILTY CLAY (CL) MED STIFF, SL PLASTIC, BLACK (10YR 2/1) DRY	N/A		HEC09-SB1-01 ~~0.0-1.3 FT~~ 0.0-0.5 FT MK 6/4/18	PROBE: 0-2 FT REC: 1.3 FT
	1	1.3-2.0 FT: LOSS				
	2	2.0-3.7 FT: CLAY (CH), SOFT, HIGHLY PLASTIC BLACK (10YR 2/1) MOIST.	CORE= 0.0 PPM		HEC09-SB1-02 ~~2.0-3.5 FT~~ 4.7-5.2 FT MK 6/4/18	PROBE: 2-5 FT REC: 1.7 FT
	3	3.7-5.0 FT: LOSS				
	4					
	5					TD= 5.0 FT
	6					
	7					SOIL SAMPLES RE-COLLECTED ON 6/4/18 USING HAND AUGER
	8					
	9					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC09-SB1

HTRW DRILLING LOG

DISTRICT: ANG

HOLE NUMBER: HEC07-SB1

1. COMPANY NAME: LEIDOS

2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES

SHEET 1 OF 2

3. PROJECT: HECTOR FIELD PFOS/PFOA SI

4. LOCATION: HEC07

5. NAME OF DRILLER: C. GRENSON

6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS

8. HOLE LOCATION:

9. SURFACE ELEVATION:

10. DATE STARTED: 5/24/18

11. DATE COMPLETED: 5/24/18

12. OVERBURDEN THICKNESS: > 5FT

13. DEPTH DRILLED INTO ROCK: N/A

14. TOTAL DEPTH OF HOLE: ~~3~~ 5FT

15. DEPTH GROUNDWATER ENCOUNTERED: N/A

16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A

17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES N/A			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	PFC	—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	X	—	—	[signature]		

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER: HEC07-SB1

HOLE NUMBER HEC07-SB1-

HTRW DRILLING LOG

SHEET 2 OF 2

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. Klidzejs

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0–1	0.0-1.4FT: SILTY CLAY (CL) W/ SOME FINE GRAVEL AND SAND CLAY IS MED STIFF, SL. PLASTIC, BLACK (10YR 2/1) DRY.	CORE = 0.0PPM		HEC07-SB1-01 ~~0.0-0.8FT~~ 0.0-0.5FT	PROBE: 0-2FT REC: 1.4FT MK 6/4/18
	2	1.4-2.0FT: LOSS				
	2–4	2.0-3.2FT: SAME AS 0.0-1.4FT BUT SL MOIST. 3.2-4.6FT: CLAY (CH) MED. STIFF, HIGHLY PLASTIC, GRAY (10YR 5/1) SL MOIST	CORE = 0.0PPM		HEC07-SB1-02 ~~2.6-3.5FT~~ 4.1-4.7FT	PROBE: 2-5FT REC: 2.6FT MK 6/4/18
	5	4.6-5.0FT: LOSS				TD = 5FT
	6–7					SOIL SAMPLES RE-COLLECTED ON 6/4/18 USING HAND AUGER
	8–10					

PROJECT: HECTOR FIELD PFOS/PFOA SI

HOLE NUMBER HEC07-SB1

HTRW DRILLING LOG	DISTRICT: ANG		HOLE NUMBER HEC07-SS2
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES		SHEET 1 OF 2
3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 07		
5. NAME OF DRILLER: C. GREINSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT		
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:		
	9. SURFACE ELEVATION:		
	10. DATE STARTED: 5/24/18	11. DATE COMPLETED: 5/24/18	
12. OVERBURDEN THICKNESS: > 5FT	15. DEPTH GROUNDWATER ENCOUNTERED: N/A		
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A		
14. TOTAL DEPTH OF HOLE: 5 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A		

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES N/A		
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	PFC	—	—	
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR	
	X	—	—	[signature]	

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT: | HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC07-SB2

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-0.8FT: SILTY CLAY (CL) TRACE FINE GRAVEL SOFT, MOD. PLASTIC BLACK (10YR 2/1) SL MOIST.	CORE= 0.0ppm		HEC07-SB2-01 ~~0.0-0.8FT~~ 0.0-0.5FT	PROBE: 0-2FT REC: 0.8FT MK 6/4/18
	1	0.8-2.0FT: LOSS				
	2	2.0-3.3FT: SAME AS ABOVE MOIST	CORE= 0.0ppm		HEC07-SB2-02 ~~2.4-3.3FT~~ MK 6/4/18 4.1-4.6FT	PROBE: 2-5FT REC: 1.3FT
	3	3.3-5.0FT: LOSS				
	4					
	5					TD= 5FT
	6					SOIL SAMPLES RE-COLLECTED ON 6/4/18 USING HAND AUGER
	7					
	8					
	9					
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC07-SB2

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HEC07-SB3 MW-HEC07-01
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 07
5. NAME OF DRILLER: C. GREENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS - 1-IN DIAM ACETATE LINERS - 8-IN O.D., 4 1/4-IN ID HSA, W/ 8 1/2-IN O.D. BIT - WOODEN BOTTOM PLUG	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/24/18 — 11. DATE COMPLETED: 5/24/18
12. OVERBURDEN THICKNESS: > 20 FT	15. DEPTH GROUNDWATER ENCOUNTERED: 12.2 FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: SEE ACTIVITY LOG
14. TOTAL DEPTH OF HOLE: 20 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): SEE ACTIVITY LOG

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES N/A		
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—		

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	—	X	—	[signature]

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC07-SB3 MW-HEC07-01

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-1.6FT: CLAY (CH), TRACE SILT IN UPPER 0.3FT MED STIFF. MOD TO HIGHLY PLASTIC BLACK (10YR2/1) SL MOIST	CORE = 0.0PPM		HEC07-SB3-01 ~~0.0-0.9FT~~ 0.0-0.4FT	PROBE: 0-2FT REC: 1.6 MK 6/4/18
	1					
	2	1.6-2.0FT: LOSS				
		2.0-4.1FT: SAME AS ABOVE BUT GRADES TO DARK GRAY (10YR 4/1) MOIST	CORE = 0.0PPM		HEC07-SB3-02 ~~2.9-3.5FT~~ 4.7-5.2FT	PROBE: 2-5FT REC: 2.1FT MK 6/4/18
	3					SOIL SAMPLES RE-COLLECTED ON 6/4/18 USING HAND AUGER.
	4	4.1-5.0FT: LOSS				
	5	5.0-20.FT: SILTY CLAY (CL) MED. STIFF. SOME SOFT INTERVALS MOD. PLASTIC, BROWN (10YR 5/3) W/ SOME LIGHT GRAY MOTTLING (10YR7/1) MOIST	CORE = 0.0PPM			PROBE: 5-10FT REC: 5.0FT
	6					
	7					
	8					
	9					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC07-SB3 MW-HEC07-01

HTRW DRILLING LOG

HOLE NUMBER ~~HECO7-SB3~~ MW-HEC07-01

SHEET 3 OF 3

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	SAME AS ABOVE, MORE SIGNIFICANT MOTTLING. V. MOIST BELOW 12 FT				PROBE: 10-15FT REC: 3.6FT
	11		CORE= 0.0ppm			
	12					
	13					
	14	~~TS:~~ 13.6-15.0FT: LOSS				
	15					PROBE: 15-20 REC 4.5FT
	16	SAME AS ABOVE WET BETWEEN 17.2-18.2FT, ONLY V. MOIST ABOVE AND BELOW	CORE= 0.0ppm			
	17					
	18					
	19					TD PPT AT 20FT OPEN HOLE TO 8-IN USING HSA TO SET WELL TD OF HSA = 19.5FT
	20					

PROJECT: HECTOR FIELD PFOS/PFOA SI

HOLE NUMBER ~~SB-HEC07-03~~ MW-HEC07-01 HEC07-SB3

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER: HEC03-SO2
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 2

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 03
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: ~~GEOPROBE~~ 7822DT / MC 5/3/18
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS - 1.x DIAM. ACETATE LINERS - 2-IN AND 3-IN HAND AUGER BUCKETS	8. HOLE LOCATION: 9. SURFACE ELEVATION:
	10. DATE STARTED: 5/25/18 — 11. DATE COMPLETED: 5/25/18
12. OVERBURDEN THICKNESS: > 4.2 FT	15. DEPTH GROUNDWATER ENCOUNTERED: N/A
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 4.2 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES: N/A			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—	PFC	—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR	[signature]	
	X	—	—			

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:	HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC03-SB2
SHEET 2 OF 2

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-1.8 FT: SILTY SANDY CLAY w/ GRAVEL (CL/GC) LOOSE, V. SL PLASTIC ~20% COARSE SAND AND GRAVEL; BLACK (10YR2/1) DRY	PID OVER CUTTINGS = 0.0ppm		HEC03-SB2-01 ~~0.0-1.0FT w/ MS/MSD~~ MK 6/3/18 0.0-0.6FT	HAND AUGER
	1					
	2	1.8-3.5 FT: SILTY CLAY (CL) MOD. STIFF, MOD PLASTIC, BLACK (10YR2/1) SL MOIST.			HEC03-SB2-02 ~~2.5-3.5FT w/ MS/MSD~~ 3.5-4.2FT	MK 6/3/18 TD=3.5 FT
	3					
	4					
	5					SOIL SAMPLES RE-COLLECTED ON 6/3/18 USING HAND AUGER.
	6					
	7					
	8					
	9					
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC03-SB2

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER: HEC01-SB2
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 01
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/25/18 — 11. DATE COMPLETED: 5/25/18
12. OVERBURDEN THICKNESS: >20 FT	15. DEPTH GROUNDWATER ENCOUNTERED: V. MOIST TO WET BELOW 10.5 FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 20 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES: N/A			
20. SAMPLES FOR CHEMICAL ANALYSIS	**VOC**	**METALS**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**	**OTHER (SPECIFY)**	**21. TOTAL CORE RECOVERY %**
	—	—		—		
22. DISPOSITION OF HOLE	**BACKFILLED**	**MONITORING WELL**	**OTHER (SPECIFY)**	**23. SIGNATURE OF INSPECTOR**		
	X	—	—	[signature]		

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC01-SB2

PROJECT: HECTOR FIELD PFOS/PFOA SI

INSPECTOR M. Klidzejs

SHEET 2 OF 3 HEC01-SB2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0–1	0.0-0.8 FT: SILTY CLAY (CL) MED STIFF, SL PLASTIC, DARK GRAY (10YR 4/1) DRY.			HEC01-SB2-01 0.0-0.6 FT 6/3/18	PROBE: 0-5 FT REC: 2.9 FT
	1–3	0.8-2.9 FT: SILTY CLAY (CL) LESS SILT THAN ABOVE, MED STIFF MED PLASTIC, DARK GRAY (AS ABOVE) MOTTLED W/ SOME GRAY (10YR 5/1) AND BROWN (10YR 5/3) V. SL MOIST	CORE= 0.0 PPM			
	3–5	2.9-5.0 FT: LOSS			6/3/18	
	5–9	5.0-9.6 FT: CLAY (CH) W/ TRACE SILT. MED STIFF, HIGHLY PLASTIC SL BROWN (10YR 4/3) W/ GRAY (10YR 5/1) MOTTLING. SL MOIST.	CORE= 0.2 PPM		HEC01-SB2-02 5.0-5.5 FT	PROBE: 5-10 FT REC: 4.6 FT
	9–10	9.6-10.0 FT: LOSS				

PROJECT: HECTOR FIELD PFOS/PFOA SI

HOLE NUMBER HEC01-SB2

HTRW DRILLING LOG

HOLE NUMBER HECO1-SB2

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	10.0 - 14.5 FT SILTY CLAY (CH) SOFT, HIGHLY PLASTIC COLORED AS ABOVE MOIST TO 10.5 FT V. MOIST TO WET BELOW 10.5 FT	CORE = 0.0 PPM	MK 6/3/18 MK 6/3/18	~~10.0 - 10.5 FT HEC01-SB2-01~~ ~~HEC01-SB2-02 11.0-11.6 FT~~	PROBE: 10-12 FT REC: 2.0 FT V. MOIST TO WET BELOW 10.5 FT
	11					
	12					PROBE: 12-15 FT REC: 2.5 FT
	13					SOIL SAMPLES RE-COLLECTED USING HAND AUGER ON 6/3/18
	14	14.5 - 15.0 FT: LOSS				
	15	15.0 - 18.8 FT SAME AS ABOVE PREDOM. GRAY (10YR 5/1) WET, SOFT TO VERY SOFT,	CORE = 0.0 PPM			PROBE: 15-20 FT REC: 3.3 FT
	16					
	17					
	18					TD = 20 FT
	19					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC01-SB2

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HEC01-SB3
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 01
5. NAME OF DRILLER: C. GRINSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/25/18 — 11. DATE COMPLETED: 5/25/18
12. OVERBURDEN THICKNESS: >15 FT	15. DEPTH GROUNDWATER ENCOUNTERED: ~~N/A~~ WET IN SEAMS BELOW 10.5 FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 15 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES N/A			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	X	—	—	[signature]		

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER HEC01-SB3

HTRW DRILLING LOG

HOLE NUMBER HEC01-SB3

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-3.7FT SILTY CLAY (CL) MED STIFF, MOD. PLASTIC. DARK GRAY (10YR 4/1) DRY TO ~1.5FT THEN V. SL. MOIST			0.0-0.7FT HEC01-SB3-01	PROBE: 0-5FT REC: 3.7FT
	1					
	2		CORE= 0.0PPM			
	3	3.7-5.0FT: LOSS				
	4				HEC01-SB3-02 4.6-5.4FT	
	5	5.0-7.7FT: SILTY CLAY (CL) MED STIFF, MOD PLASTIC. MOTTLED BROWN (10YR 5/3) AND GRAY (10YR 5/1) SL MOIST				PROBE: 5-8FT REC: 2.7FT
	6		CORE= 0.0PPM			
	7					
	8	SAME AS ABOVE				PROBE: 8-10FT REC: 2.8FT
	9		CORE= 0.0PPM			
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC01-SB3

HTRW DRILLING LOG

PROJECT: HECTOR FIELD PFOS/PFOA SI	INSPECTOR M. KLIDZEJS	HOLE NUMBER HEC01-SB3
		SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	SILTY CLAY AS ABOVE. MED STIFF BUT SOFTENS DOWNWARD. MOIST BUT WET SEAMS (ALMOST AS IF ALONG FRACTURES) AT 10.5FT, 11.2FT, 12.5FT, AND 13.5FT BELOW 13.5FT THE CLAY IS SOFT AND WET	CORE = 0.0PPM		10.0 – 10.5FT HEC01-SB3-01 ML 6/3/18	PROBE: 10-15FT REC = 4.6FT SOIL SAMPLES COLLECTED ON 6/3/18 USING HAND AUGER
	11					
	12					
	13					
	14					
	15					TD = 15FT
	16					
	17					
	18					
	19					
	20					

PROJECT: HECTOR FIELD PFOS/PFOA SI — HOLE NUMBER HEC01-SB3

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HEC01-SB1
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC01
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/25/18 — 11. DATE COMPLETED: 5/25/18
12. OVERBURDEN THICKNESS: > 15 FT	15. DEPTH GROUNDWATER ENCOUNTERED: WET SEAMS BELOW 13 FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 15 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES	N/A		
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	X	—	—	[signature]		

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG						HOLE NUMBER HEC01-SB1
PROJECT: HECTOR FIELD PFOS/PFOA SI		INSPECTOR M. KLIDZEJS				SHEET 2 OF 3
ELEV (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-1.4FT SILTY CLAY (CL) W/ TRACE SAND AND FINE GRAVEL SOFT, SL. PLASTIC BLACK (10YR2/1) V. SL MOIST.			HEC01-SB1-01 0.0-1.0FT W/ MS/MSD	PROBE: 0-5 REC: 3.2FT
	1	1.4-3.2FT: SILTY CLAY (CL) MED STIFF, LOW TO MOD. PLASTICITY DARK GRAYISH BROWN (10YR 4/2) V. SL. MOIST	CORE = 0.0PPM			
	3	3.2-5.0FT: LOSS				
	4				HEC01-SB1-02 4.7-5.2FT	
	5	5.0-14.1FT: SILTY CLAY (CL) MED. STIFF, MOD. PLASTIC, MOTTLED BROWN (10YR 5/3) AND GRAY (10YR5/1) MOIST.	CORE = 0.0PPM			PROBE: 5-10FT REC: 5.0 FT
	8				~~HEC01-SB1-01 9.0-9.0 FT~~ MK 6/3/18	SOIL SAMPLES RE-COLLECTED ON 6/3/18 USING HAND AUGER
	9	WET SEAM AT 9.4FT				
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI HOLE NUMBER HEC01-SB1

HTRW DRILLING LOG		HOLE NUMBER HECØ1-SB1
PROJECT: HECTOR FIELD PFOS/PFOA SI	INSPECTOR M. Kleidzeis	SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10					PROBE: 10-15 REC: 4.1 FT
	11	BECOMES V. MOIST W/ WET SEAMS. HIGHLY MOTTLED W/ MANY COLORS BELOW 13 FT	CORE= 0.0 ppm			
	12					
	13					
	14	14.1-15.0 FT: LOSS				
	15					TD= 15 FT
	16					
	17					
	18					
	19					
	20					

PROJECT: HECTOR FIELD PFOS/PFOA SI HOLE NUMBER HECØ1-SB1

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER MW-HEC01-01
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 01
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/25/18 — 11. DATE COMPLETED: 5/25/18
12. OVERBURDEN THICKNESS: > 17.5 FT	15. DEPTH GROUNDWATER ENCOUNTERED:
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: SEE ACTIVITY LOG
14. TOTAL DEPTH OF HOLE: 17.5 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): SEE ACTIVITY LOG

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES: N/A			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR	[signature]	
	—	X	—			

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER MW-HEC01-01

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-2.9FT: CLAY (CH) TRACE SILT, SOFT, HIGHLY PLASTIC, DARK GRAYISH BROWN (10YR 4/2) MOIST	CORE= 0.0ppm			PROBE: 0-5FT REC: 2.9FT
	1					
	2					
	3	2.9-5.0FT: LOSS				
	4					
	5	5.0-9.7FT: SILTY CLAY (CL) MED. STIFF, MOD PLASTIC, MOTTLED BROWN (10Y 5/3) AND GRAY (10YR 5/1) MOIST TO 7.7FT THEN V. MOIST. SEAM AT 8.5FT W/ VISIBLE WATER. CLAY IS V. MOIST TO WET BELOW 8.5FT.	CORE= 0.0ppm			PROBE: 5-10FT REC: 4.7FT
	6					
	7					
	8					
	9	9.7-10.0FT: LOSS				
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI — HOLE NUMBER MW-HEC01-01

HOLE NUMBER MW-HFC01-01

HTRW DRILLING LOG

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	10.0-10.8 FT SILTY CLAY, AS ABOVE				PROBE: 10-15 FT REC: 3.1 FT
	11	10.8-11.6 FT: CLAY (CH), SOFT, HIGHLY PLASTIC, V. DARK GRAYISH BROWN (10YR 3/2) WET.	CORE = 0.0 ppm			
	12	11.6-13.1 FT: SILTY CLAY, MED STIFF, MED PLASTIC, HIGHLY MOTTLED w/ GRAYS, BROWNS, AND YELLOWISH BROWNS, V. MOIST.				
	13					
	14	13.1-15 FT: LOSS				DPT TD AT 15 FT
	15					PROBE: ~~15-18 FT~~ MK 5/25/10 ~~REC~~: 3.1 FT OPEN HOLE w/ HSA TO 17.5 FT
	16					
	17		~~CORE =~~ MK 5/25/10			
	18					
	19					
	20					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER MW-HFC01-01

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HSC05-SB1
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HSC05
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/30/18 — 11. DATE COMPLETED: 5/30/18
12. OVERBURDEN THICKNESS: >15 FT	15. DEPTH GROUNDWATER ENCOUNTERED: WET SEAMS STARTING AT 6.3 FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: >15 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	X	—	—	[signature]		

LOCATION SKETCH/COMMENTS SCALE:

- SET PIEZOMETER IN BORING
- RECOVERY OF WATER INTO PIEZOMETER TOO SLOW TO BE USEFUL

PROJECT: HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC05-SB1

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-3.1FT: CLAY (CH), SOFT, HIGHLY PLASTIC, V. DARK GRAY (10YR 3/1) SL MOIST			HEC05-SB1-01 0.0-0.7FT	PROBE: 0-5FT REC: 3.1FT
	2		CORE= 0.1PPM			
	3	3.1-5.0FT: LOSS				
	5	5.0-13.0FT: SILTY CLAY (CL) MED STIFF, MOD. PLASTIC, GRAYISH BROWN (10YR 5/2) GRADING TO YELLOWISH BROWN (10YR 5/4) BY 8.7FT SOME GRAY MOTTLING DAMP W/ V. MOIST TO WET SEAMS AT 6.3, 6.6 AND 9.2FT			HEC05-SB1-01 5.0-6.0FT	PROBE: 5-10FT REC: 5.0
	6		CORE= 0.0PPM			

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC05-SB1

HTRW DRILLING LOG

PROJECT: HECTOR FIELD PFOS/PFOA SI	INSPECTOR M. KLIDZEJS	HOLE NUMBER HEC05-SB1 / SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	SAME AS ABOVE WET BELOW ~11FT				PROBE: 5-10FT REC: 3.0FT
	11		CORE= 0.1PPM			
	12					
	13	13.0-15FT: LOSS				
	14					
	15					TD = 15 FT SET TEMP PIEZOMETER
	16					
	17					
	18					
	19					
	20					

PROJECT: HECTOR FIELD PFOS/PFOA SI — HOLE NUMBER HEC05-SB1

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HEC05-SB3
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGY	SHEET 1 OF 2

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 05
5. NAME OF DRILLER: C. GEENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/30/18 — 11. DATE COMPLETED: 5/30/18
12. OVERBURDEN THICKNESS: >10 FT	15. DEPTH GROUNDWATER ENCOUNTERED: WET BELOW 8.5 FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 10 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—	—	
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR	[signature]	
	✓	—	—			

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0 - 3.2FT SILTY CLAY (CL) MED STIFF, LOW TO MOD. PLASTICITY, BLACK (10YR 2/1) GRADING TO GRAYISH BROWN (10YR 5/2) MOIST	CORE = 0.0PPM		HECO5-SB3-01 0.0-0.7FT	PROBE: 0-5FT REC: 3.2FT
	3	3.2 - 5.0FT: LOSS				
	5	5.0 - 9.3FT: SAME AS ABOVE GRAYISH BROWN V. MOIST TO 8.5FT WET BELOW 8.5FT	CORE = 0.0PPM		HECO5-SB3-02 5.0-5.6FT	PROBE: 5-10FT REC: 4.3
	9					TD = 10FT

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HICC5-SB2 MW-HIC05-01
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 05
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS; - 8-IN O.D, 4 1/4-IN I.D HSA W/ 8 1/2-IN BIT; - WOODEN BOTTOM PLUG	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/30/18 — 11. DATE COMPLETED: 5/30/18
12. OVERBURDEN THICKNESS: > 15 FT	15. DEPTH GROUNDWATER ENCOUNTERED: V. MOIST TO WET BELOW 8.4 FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: SEE ACTIVITY LOG
14. TOTAL DEPTH OF HOLE: 15 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): SEE ACTIVITY LOG

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	—	X	—	[signature]		

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC05-SB2 MW-HEC05-01

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-2.5FT: SILTY CLAY (CL) SOFT, MOD. PLASTIC, GRAYISH BROWN (10YR 5/2) MOIST	CORE= 0.0ppm		HEC05-SB2-01 0.0-0.8FT	PROBE: 0-5FT REC 2.5FT
	2				HEC05-SB2-02 2.0-2.5FT	
	2.5	2.5-5.0FT: LOSS				
	5	5.0-9.5FT: SAME AS ABOVE BUT COLOR BECOMES MOTTLED W/ GRAYISH BROWN (AS ABOVE) GRAY (10YR 6/1) AND MINOR YELLOWISH BROWN (10YR 5/4) V. MOIST TO WET WET BELOW 8.4FT	CORE= 0.0ppm			PROBE: 5-10FT REC: 4.5FT
	9.5	9.5-10.0 FT: LOSS				

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC05-SB2 MW-HEC05-01

HTRW DRILLING LOG

HOLE NUMBER: HEC05-SB2 / MW-HEC05-01

SHEET 3 OF 3

PROJECT: HECTOR FIELD PFOS/PFOA SI

INSPECTOR: M. KLIDZEJS

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	10.0 - 13.2FT: SAME AS ABOVE WET, SOFT				PROBE: 10-15 REC: 3.2FT
	11					
	12		CORE= 0.0ppm			
	13					
	14					
	15					TO OF OPT = 15FT HSA TO OPEN HOLE FOR WELL.
	16					
	17					
	18					
	19					
	20					

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HEC06-SB1
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3
3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 06	
5. NAME OF DRILLER: C. GREENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:	
	9. SURFACE ELEVATION:	
	10. DATE STARTED: 5/30/18	11. DATE COMPLETED: 5/30/18
12. OVERBURDEN THICKNESS: > 15 FT	15. DEPTH GROUNDWATER ENCOUNTERED: WET BELOW 11 FT	
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A	
14. TOTAL DEPTH OF HOLE: 15 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES N/A			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—	—	
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR [signature]		
			—			

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:

HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC06-SB1

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-0.7FT SILTY CLAY (CL) TRACE SAND + GRAVEL MED. STIFF, LOW PLASTICITY, BLACK (10YR 2/1) DRY			HEC06-SB1-01 AND DUP 0.0-1.4FT	PROBE: 0-5FT REC = 2.5FT
	1	0.7-2.5FT: SILTY CLAY (CL) MED STIFF, MOD. PLASTIC, DARK GRAY (10YR 4/1) SL. MOIST	CORE = 0.1ppm			
	2					
	3	2.5-5.0FT: LOSS				
	4					
	5	5.0-9.7FT: SILTY CLAY (CL) MED STIFF, MED PLASTIC BROWN (10YR 5/3) MOIST			HEC06-SB1-02 5.0-5.5FT	PROBE: 5-10FT REC: 4.7FT
	6		CORE = 0.0ppm			
	7					
	8					
	9	9.7-10.0FT: LOSS				
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC06-SB1

HTRW DRILLING LOG

HOLE NUMBER HEC06-SB1

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	10.8-13.5FT: SILTY CLAY AS ABOVE				PROBE: 10-15FT REC: 3.5FT
	11	MOIST TO 11FT WET BELOW. COLOR BECOMES HIGHLY MOTTLED BELOW 11FT W/ BROWNS, GRAYS, AND YELLOWISH BROWNS.	CORE: 0.0PPM			
	12					
	13	13.5-15FT: LOSS				
	14					
	15					TD AT 15FT
	16					
	17					
	18					
	19					
	20					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC06-SB1

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER: HEC06-SO2
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGY	SHEET 1 OF 2

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 06
5. NAME OF DRILLER: C. GREENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/30/18 — 11. DATE COMPLETED: 5/30/18
12. OVERBURDEN THICKNESS: >10 FT	15. DEPTH GROUNDWATER ENCOUNTERED: WET BELOW 9.7 FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: N/A
14. TOTAL DEPTH OF HOLE: 10 FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): N/A

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES N/A			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—		
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		
	X	—	—	[signature]		

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT: HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER HEC06-SB2

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 2

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0-3.3FT: SILTY CLAY (CL) SOFT, GRADING DOWN TO MED. STIFF, MOD. PLASTICITY. BLACK (10YR 2/1) GRADING TO BROWN (10YR 5/3) SL MOIST	CORE = 0.0PPM		HEC06-SB2-01 0.0-0.7FT	PROBE: 0-5FT REC: 3.6FT
	3	3.3-3.6FT: SILT (ML). STIFF, NON-PLASTIC, LIGHT GRAY (10YR 7/1) DRY.				
	4	3.6-5.0FT: LOSS				
	5	5.0-10.0FT: SILTY CLAY (CL) MED. STIFF, LOW PLASTICITY PREDOM. LIGHT BROWNISH GRAY (10YR 6/2) W/ MINOR YELLOWISH BROWN (10YR 5/4) MOTTLING SL. MOIST WET FROM 9.7-10FT	CORE = 0.0PPM		HEC06-SB2-02 5.0-5.7FT	PROBE: 5-10FT REC = 5.0FT
	10					TD = 10 FT

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC06-SB2

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: ANG	HOLE NUMBER HEC06-SB3 MW-HEC06-01
1. COMPANY NAME: LEIDOS	2. DRILL SUBCONTRACTOR: DAKOTA TECHNOLOGIES	SHEET 1 OF 3

3. PROJECT: HECTOR FIELD PFOS/PFOA SI	4. LOCATION: HEC 06
5. NAME OF DRILLER: C. GRENSON	6. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: - GEOPROBE RODS; - 1-IN DIAM ACETATE LINERS; - 8-IN OD, 4 1/4-IN ID HSAs w/ 8 1/2-IN BIT; - WOODEN BOTTOM PLUG	8. HOLE LOCATION:
	9. SURFACE ELEVATION:
	10. DATE STARTED: 5/30/18 — 11. DATE COMPLETED: 5/30/18
12. OVERBURDEN THICKNESS: >18FT	15. DEPTH GROUNDWATER ENCOUNTERED: WET BELOW 13FT
13. DEPTH DRILLED INTO ROCK: N/A	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: SEE ACTIVITY LOG
14. TOTAL DEPTH OF HOLE: 18FT	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY): SEE ACTIVITY LOG

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES	N/A	

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
	—	—		—		

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
	—	X	—	[signature]

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT:	HOLE NUMBER

HTRW DRILLING LOG

HOLE NUMBER ~~HEC06-SB3~~ MW-HEC06-01

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 2 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	0	0.0 - 0.4FT: SILT, SOME SAND & GRAVEL (GM) LOOSE, LIGHT BROWNISH GRAY (10YR 6/2). DRY.			HEC06-SB3-01 0.0 - 0.9FT	PROBE: 0-5FT REC: 3.1FT
	1	0.4 - 3.1FT: SILTY CLAY (CL) STIFF, SL PLASTIC BLACK TO 0.6FT THEN GRADING FROM GRAYISH BROWN (10YR 5/2) TO LIGHT BROWNISH GRAY (10YR 6/2) V. SL. MOIST.	CORE= 0.0ppm			
	3	3.1 - 5.0FT: LOSS				
	5	5.0 - 9.3FT: SILTY CLAY (CL) SOFT, MOD. PLASTIC, MOTTLED COLORS RANGING FROM BROWN TO GRAY TO YELLOWISH BROWN. ~~M~~ SL MOIST TO 8.7FT. V. MOIST BELOW	CORE= 0.0ppm		HEC06-SB3-02 5.0-5.8FT	PROBE: REC 4.3FT
	9	9.3 - 10.0FT: LOSS				
	10					

PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC06-SB3 MW-HEC06-01

HTRW DRILLING LOG

HOLE NUMBER HECO06-SB3 / MW-HEC06-01

PROJECT: HECTOR FIELD PFOS/PFOA SI | INSPECTOR M. KLIDZEJS | SHEET 3 OF 3

ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	HEADSPACE SCREENING RESULTS	GEOTECH SAMPLE OR CORE BOX	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)
	10	10.0 - 13.4FT: SAME AS ABOVE. WET ~~FROM~~ BELOW ~13FT				PROBE: 10-15 REC: 3.4 FT
	11		CORE= 0.0ppm			
	12					
	13	13.4-15.0FT: LOSS				
	14					
	15	15.0 - 17.4FT SAME AS ABOVE WET	CORE= 0.0ppm			PROBE: 15 - 18FT REC: 2.4FT
	16					
	17					
	18					TO DPT AT 18FT HSA TO OPEN HOLE FOR WELL
	19					
	20					

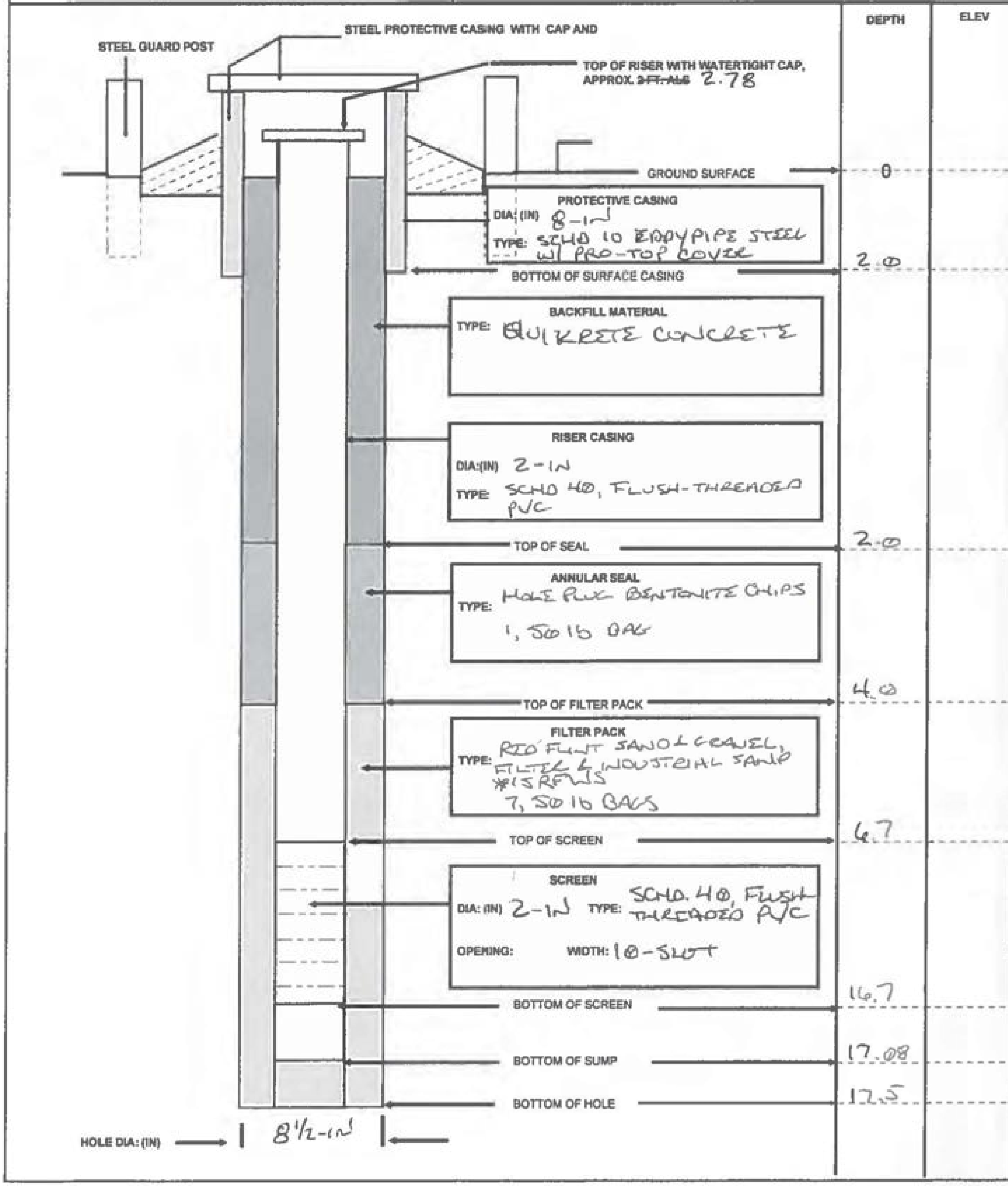
PROJECT: HECTOR FIELD PFOS/PFOA SI | HOLE NUMBER HEC06-SB3 MW-HEC06-01

WELL CONSTRUCTION LOGS

MONITORING WELL (STICK-UP)

PROJECT NAME: **DELIVERY ORDER NO:**

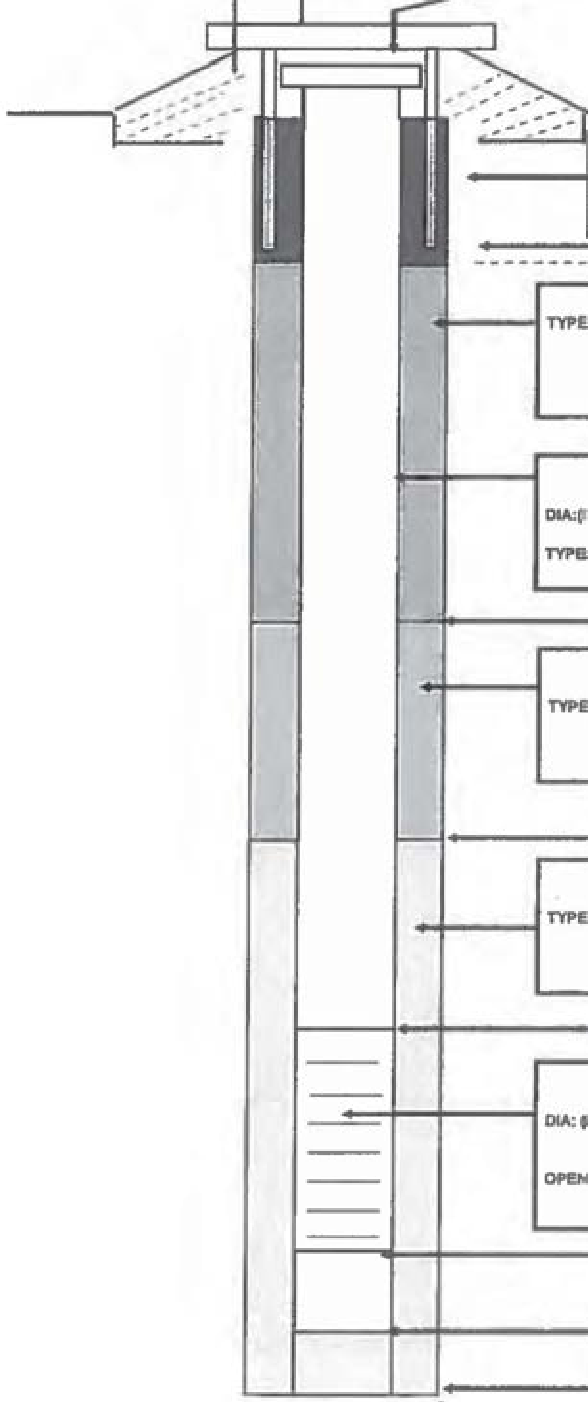
WELL NUMBER: MW-HEC01-01	**BEGIN:** 5/25/18	**END:** 5/29/18
COORDINATES: N: E:	**REFERENCE POINT:**	**ELEVATION:** MSL



MONITORING WELL (FLUSH)

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

WELL NUMBER: MW-HEC01-02	**BEGIN:** 5/23/18	**END:** 5/30/18
COORDINATES: N: E:	**REFERENCE POINT:**	**ELEVATION:**



STEEL PROTECTIVE CASING WITH COVER

TOP OF PVC FLUSH JOINT RISER WITH WATERTIGHT LOCKING CAP

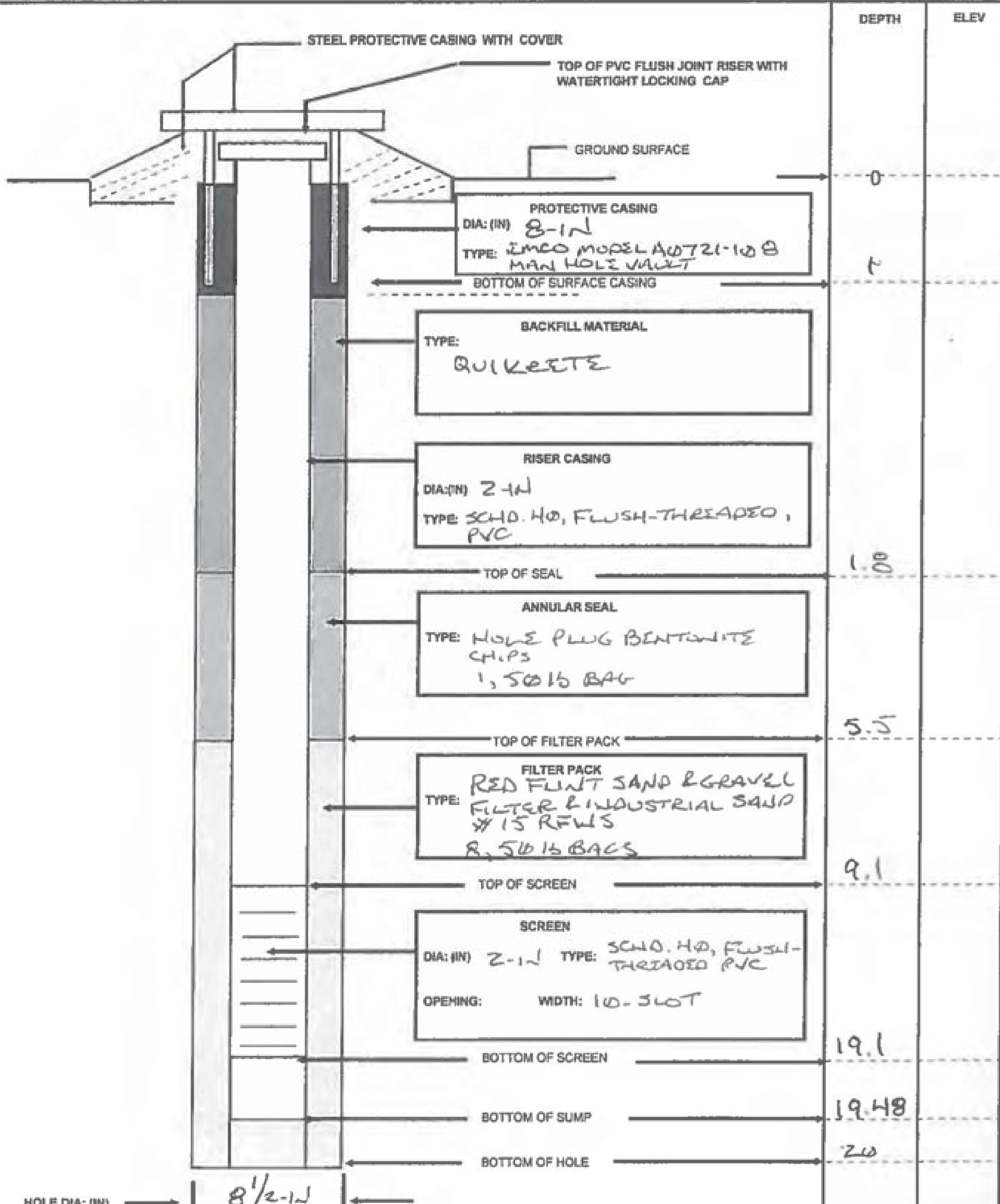
GROUND SURFACE

	DEPTH	ELEV
GROUND SURFACE	0	
PROTECTIVE CASING DIA: (IN) 8-IN TYPE: EMCO MODEL A0721-108 MANHOLE VAULT		
BOTTOM OF SURFACE CASING	1.0	
BACKFILL MATERIAL TYPE: ~~BENSEAL GRANULAR BENTONITE~~ MK 5/23/18 QUIKRETE		
RISER CASING DIA: (IN) 2-IN TYPE: SCH 40, FLUSH-THREADED, PVC		
TOP OF SEAL	1.0	
ANNULAR SEAL TYPE: BENSEAL GRANULAR BENTONITE 1/2, 50 lb BAG		
TOP OF FILTER PACK	2.0	
FILTER PACK TYPE: RED FLINT SAND & GRAVEL FILTER INDUSTRIAL SAND #15 REDS 7, 50 lb BAGS		
TOP OF SCREEN	3.7	
SCREEN DIA: (IN) 2-IN TYPE: SCH 40, FLUSH-THREADED PVC OPENING: WIDTH: 10-SLOT		
BOTTOM OF SCREEN	13.7	
BOTTOM OF SUMP	14.08	
BOTTOM OF HOLE	14.1	

HOLE DIA: (IN) 8 1/2-IN

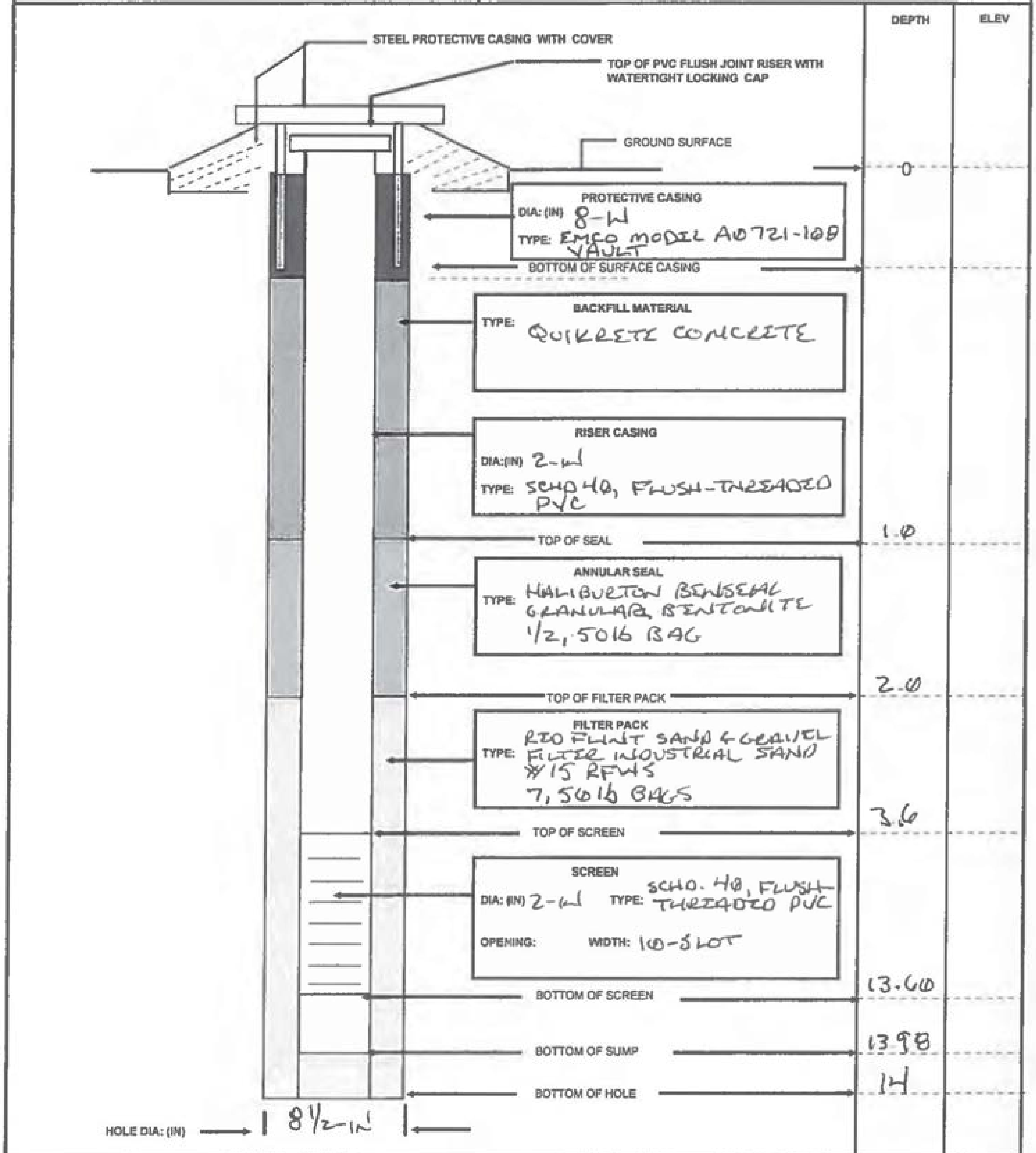
MONITORING WELL (FLUSH)

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI		DELIVERY ORDER NO: 0011
WELL NUMBER: MW-HEC02-01	BEGIN: 5/24/18	END: 5/29/18
COORDINATES: N: E:	REFERENCE POINT:	ELEVATION:



MONITORING WELL (FLUSH)

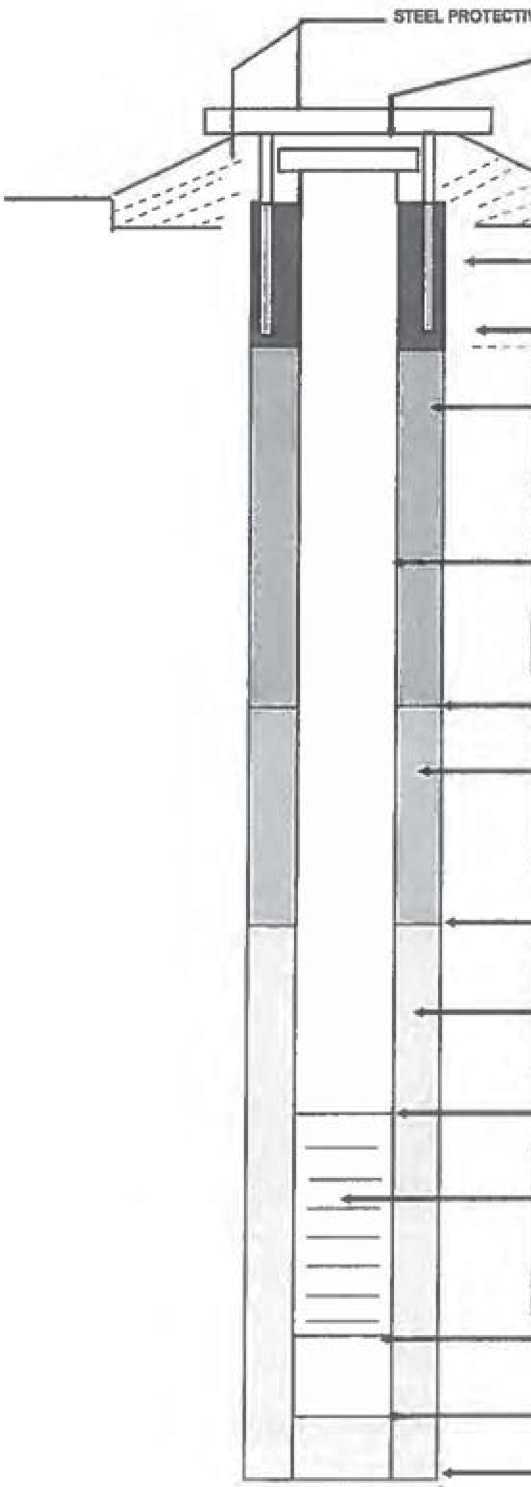
PROJECT NAME: HECTOR FIELD PFOS/PFOA SI		DELIVERY ORDER NO: 0011
WELL NUMBER: MW-HEC05-01	BEGIN: 5/30/18	END: 5/31/18
COORDINATES: N: E:	REFERENCE POINT:	ELEVATION:



MONITORING WELL (FLUSH)

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

WELL NUMBER: MW-HEC06-01	BEGIN: 5/30/18	END: 5/31/18
COORDINATES: N: E:	REFERENCE POINT:	ELEVATION:



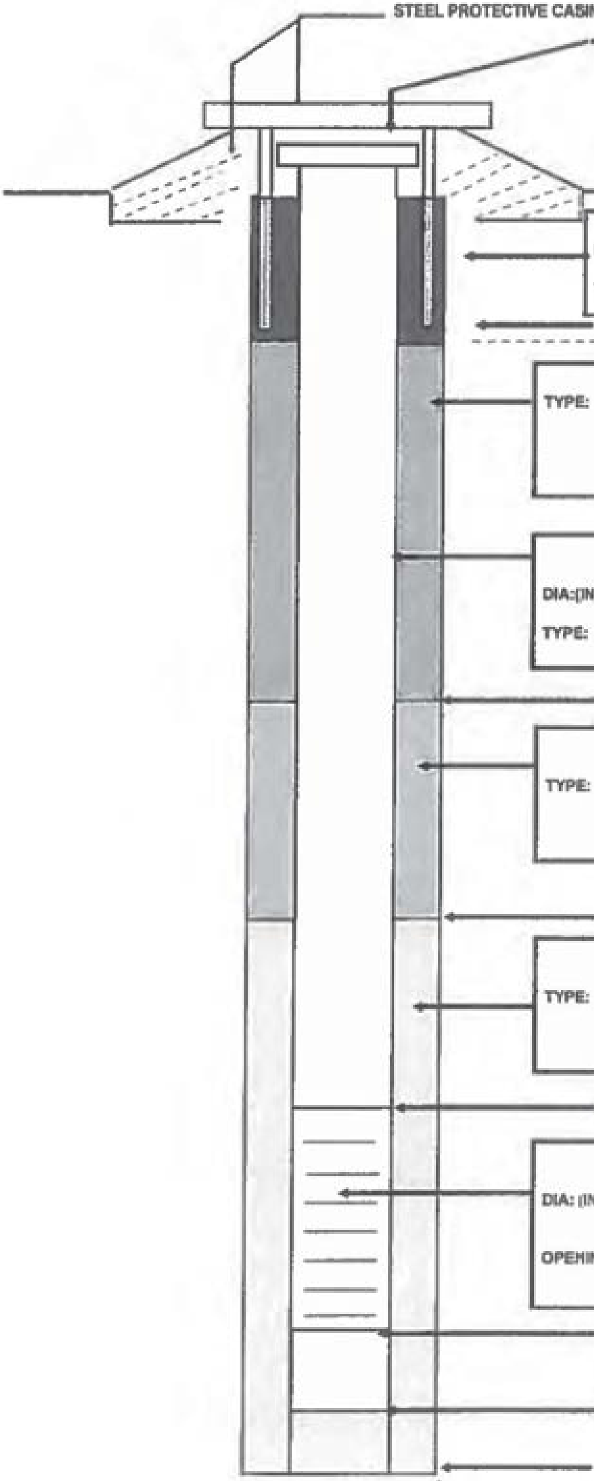
Item	Details	DEPTH	ELEV
STEEL PROTECTIVE CASING WITH COVER			
TOP OF PVC FLUSH JOINT RISER WITH WATERTIGHT LOCKING CAP			
GROUND SURFACE		0	
PROTECTIVE CASING	DIA: (IN) 8-IN TYPE: EMCO MODEL A0721-108 VAULT		
BOTTOM OF SURFACE CASING			
BACKFILL MATERIAL	TYPE: QUIKRETE CONCRETE		
RISER CASING	DIA:(IN) 2-IN TYPE: SCH 40, FLUSH-THREADED PVC		
TOP OF SEAL		1.0	
ANNULAR SEAL	TYPE: HOLE PLUG BENTONITE CHIPS 1, 50 lb BAG		
TOP OF FILTER PACK		4.0	
FILTER PACK	TYPE: RED FLINT SAND + GRAVEL FILTER INDUSTRIAL SAND #15RFWS 7, 50 lb BAGS		
TOP OF SCREEN		7.5	
SCREEN	DIA: (IN) 2-IN TYPE: SCH 40, FLUSH-THREADED PVC OPENING: WIDTH: 10-SLOT		
BOTTOM OF SCREEN		17.5	
BOTTOM OF SUMP		17.88	
BOTTOM OF HOLE		18	

HOLE DIA: (IN) 8 1/2 IN

MONITORING WELL (FLUSH)

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

WELL NUMBER: MW-HEC07-01	**BEGIN:** 5/24/18	**END:** 5/29/18
COORDINATES: N: E:	**REFERENCE POINT:**	**ELEVATION:**



STEEL PROTECTIVE CASING WITH COVER

TOP OF PVC FLUSH JOINT RISER WITH WATERTIGHT LOCKING CAP

GROUND SURFACE

Item	DEPTH	ELEV
GROUND SURFACE	0	
BOTTOM OF SURFACE CASING	1	
TOP OF SEAL	2	
TOP OF FILTER PACK	5.5	
TOP OF SCREEN	8.55	
BOTTOM OF SCREEN	18.55	
BOTTOM OF SUMP	18.93	
BOTTOM OF HOLE	19.5	

PROTECTIVE CASING
DIA: (IN) 8-IN
TYPE: EMCO MODEL A0721-108 MANHOLE VAULT

BACKFILL MATERIAL
TYPE: QUIKRETE CONCRETE

RISER CASING
DIA:(IN) 2-IN
TYPE: SCH40 HD, FLUSH-THREADED PVC

ANNULAR SEAL
TYPE: HOLE PLUG BENTONITE CHIPS 1, 50 lb BAG

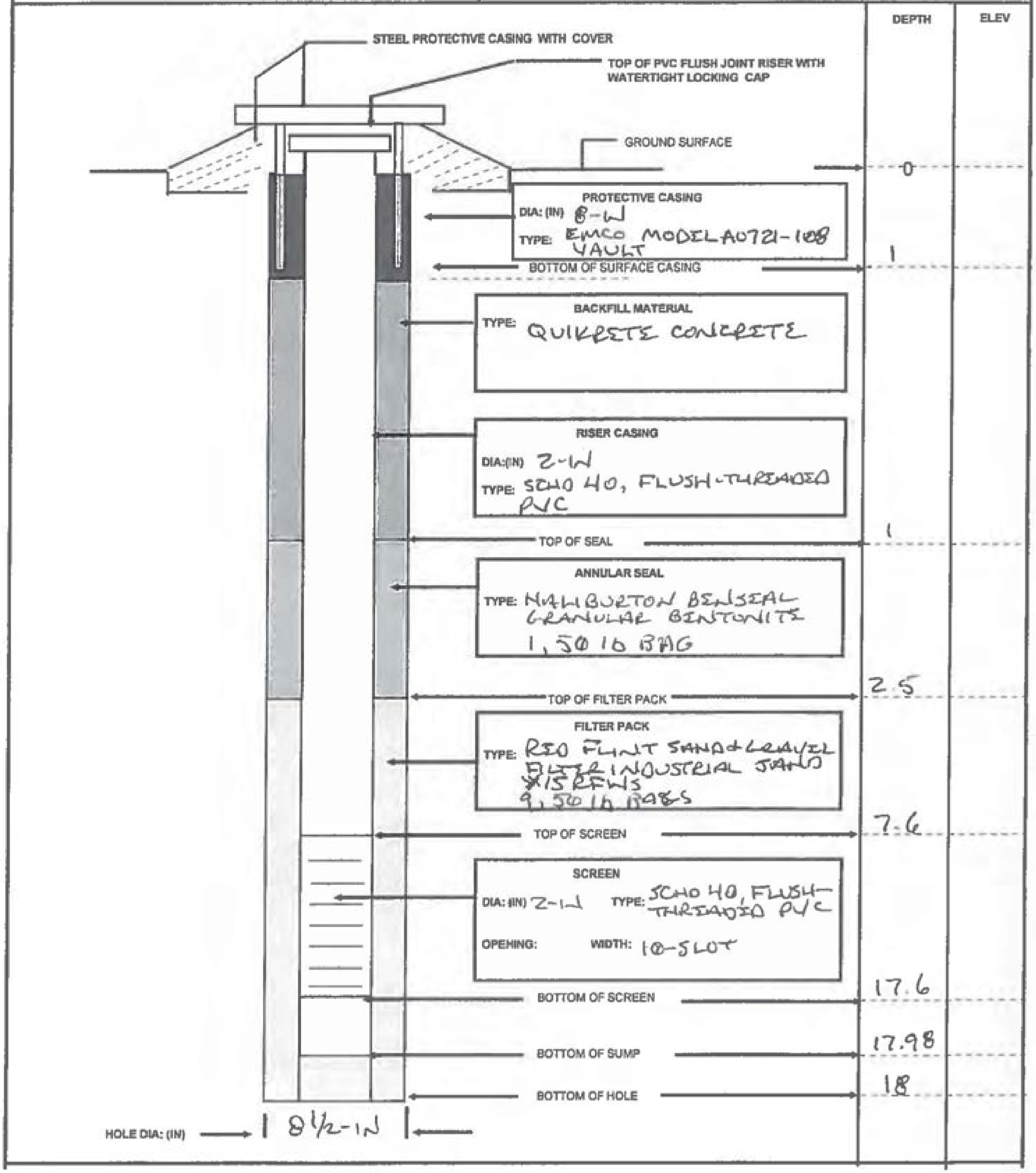
FILTER PACK
TYPE: RED FLINT SAND & GRAVEL FILTER & INDUSTRIAL SAND #15 RFWS 7, 50 lb BAGS

SCREEN
DIA: (IN) 2-IN TYPE: SCH40 HD, FLUSH-THREADED PVC
OPENING: WIDTH: 10-SLOT

HOLE DIA: (IN) 8 1/2-IN

MONITORING WELL (FLUSH)

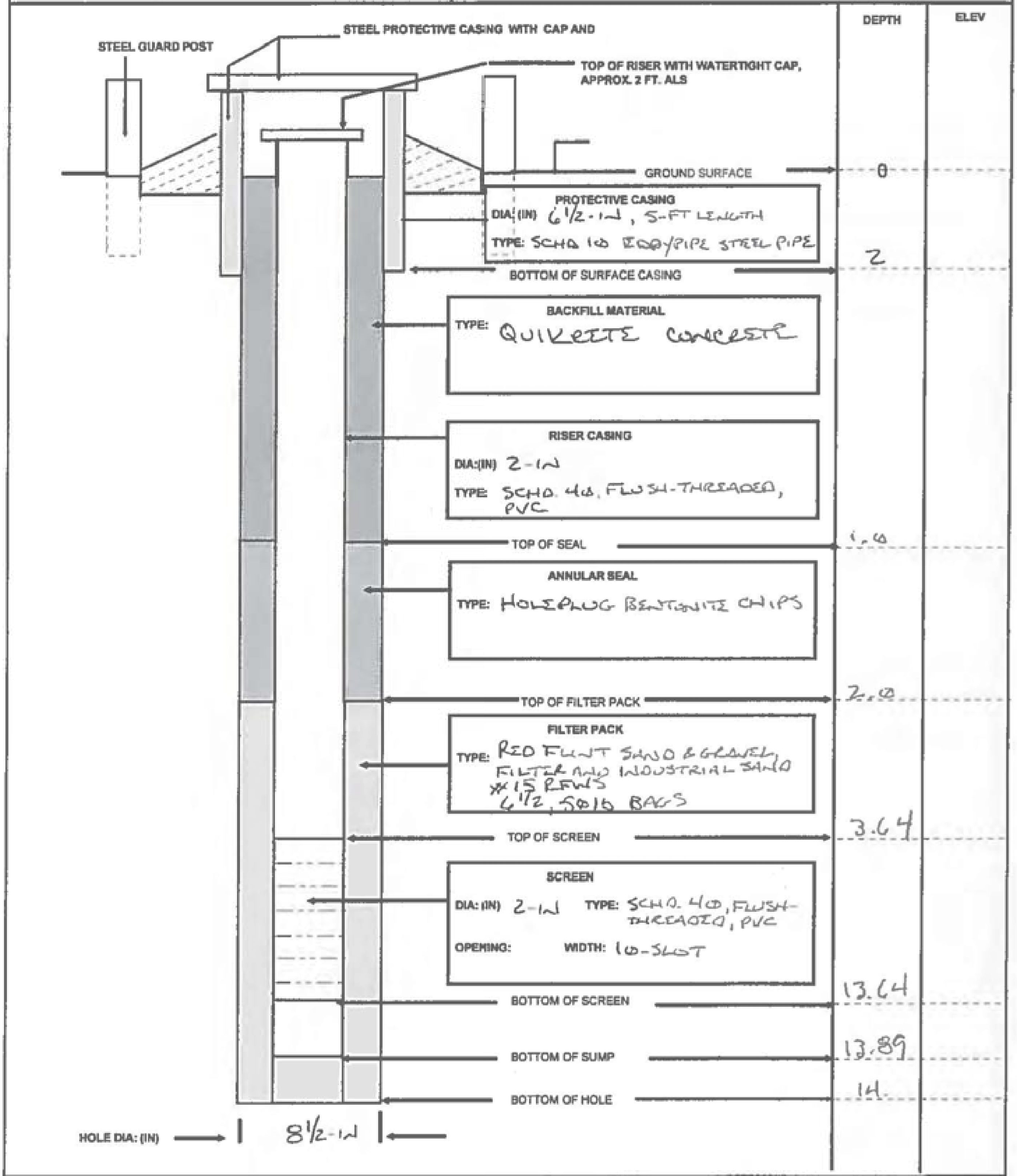
PROJECT NAME: HECTOR FIELD PFOS/PFOA SI		DELIVERY ORDER NO: 0011
WELL NUMBER: MW-HEC07-02	BEGIN: 5/23/18	END: 5/29/18
COORDINATES: N: E:	REFERENCE POINT:	ELEVATION:



MONITORING WELL (STICK-UP)

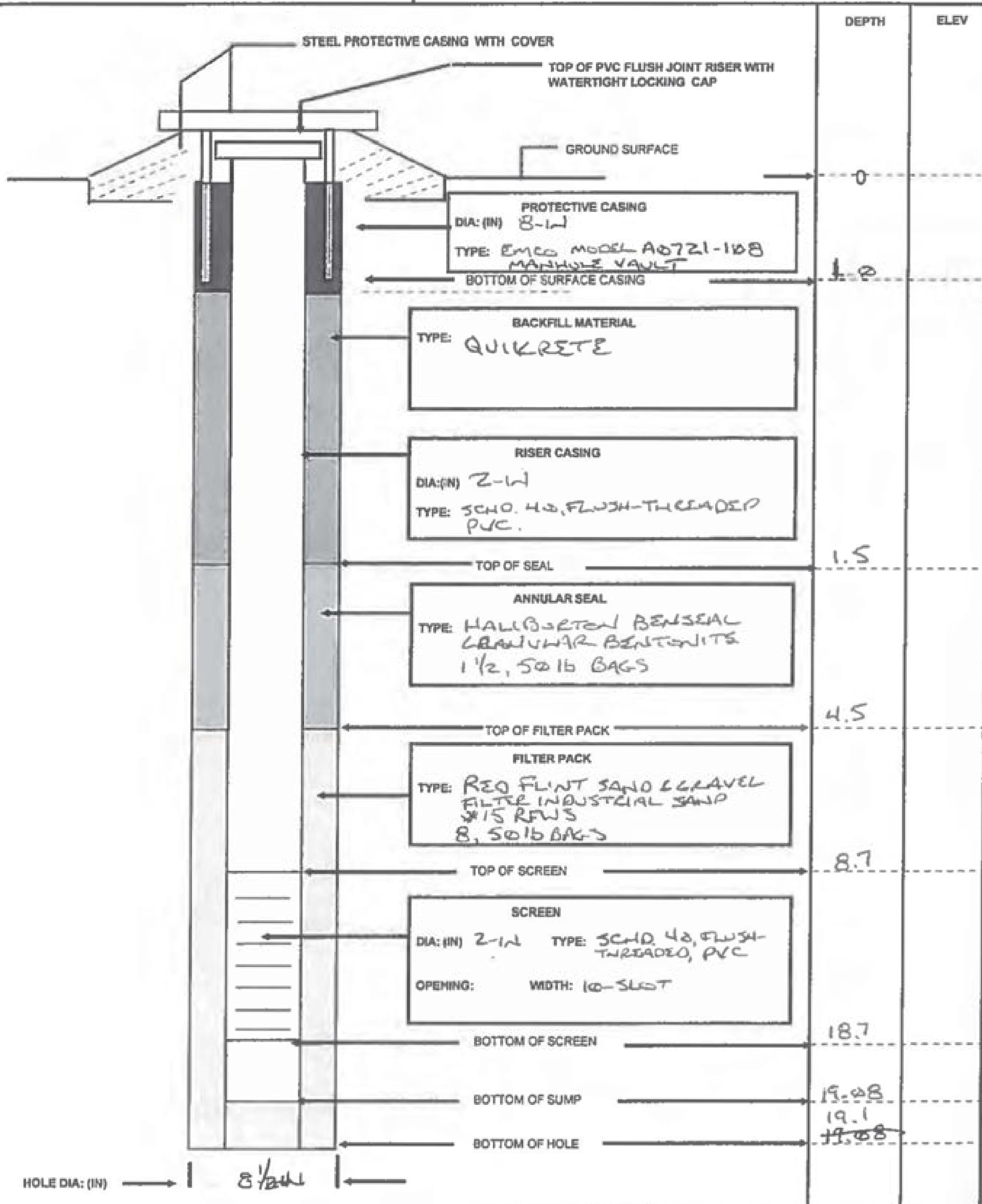
PROJECT NAME: | **DELIVERY ORDER NO:**

WELL NUMBER: MW-HEC12-01	**BEGIN:** 5/22/18	**END:** 5/29/18
COORDINATES: N: E:	**REFERENCE POINT:**	**ELEVATION:** MSL



MONITORING WELL (FLUSH)

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI		DELIVERY ORDER NO: 0011
WELL NUMBER: MW-HEC12-02	BEGIN: 5/23/18	END: 5/29/18
COORDINATES: N: E:	REFERENCE POINT:	ELEVATION:



APPENDIX B

GROUNDWATER SAMPLING LOGS

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GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/7/18 TIME: 08:40

WELL ID NUMBER: MW-HEC01-01 WELL LOCATION: HEC 01

DEPTH OF SCREENED INTERVAL(toc notch): ~9.5 ft. to ~19.5 ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP20' ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 5.47 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ~9.5 FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~14.5 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 0723 PURGE END TIME: 0840

TOTAL VOLUME PURGED 32 LITERS

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS:

WELL PUMPED DRY

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [X] YES [ ] NO IF NO, WHY WAS A DEVIATION NECESSARY:

RECORDED BY: [signature] 6/7/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

WELL ID: MW4-HEC01-001

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND ~~(µmho/cm)~~ mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
0725	1st WATER	30	217	9.57	6.41	5.63	9.21	14.3	6.80	INITIAL WL = 5.47
0735	4	460	195	7.38	6.66	5.47	5.55	6.36	~~8~~ 9.45	1 WELL CASING VOLUME = 8.71 L
0745	7.5	460	189	8.45	6.65	5.44	3.61	~~11.24~~ 6.05 MK 6/7/18	11.24	
0755	11	420	188	7.69	6.71	5.70	5.94	4.96	12.47	
0805	15	420	187	7.60	6.76	5.96	6.20	9.67	13.37	
0815	21	~~420~~ 500 MK 6/7/18	187	7.67	6.70	5.92	6.42	34.2	15.82	
0825	25	500	186	8.25	6.85	6.28	~~8~~ 10.14	25.6	16.93	LOWERED TUBING PRIOR TO READING
0835	30	500	182	8.53	6.81	5.87	7.92	124	18.92	WELL TD = 19.72 FT BTOC
0840	32	500	WELL PUMPED DRY						DRY	~~POST SAMPLING~~ MK 6/7/18
0917	N/A	N/A	163	10.54	7.08	~~5.18~~ 5.58	5.98	303	N/A	POST SAMPLING

MK 6/7/18

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/7/18 TIME: 18:09

WELL ID NUMBER: MW-HEC01-02 WELL LOCATION: HEC01

DEPTH OF SCREENED INTERVAL(toc notch): ~3.9 ft. to ~13.9 ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP20: ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 6.52 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ~3.9 FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~10.9 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 1727 PURGE END TIME: ~~1833~~ 1809 MK 6/7/18

TOTAL VOLUME PURGED 15 LITER

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS:

WELL PUMPED DRY

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [X] YES [ ] NO IF NO, WHY WAS A DEVIATION NECESSARY: N/A

RECORDED BY: [signature] 6/7/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

WELL ID: MW-HEC01-02

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND ~~(µmho/cm)~~ mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
1730	1ST WATER	60	210	16.78	6.30	4.79	4.54	3.21	6.78	INITIAL WL = 6.52 FT
1743	5	500	200	7.83	6.65	6.60	2.89	4.21	8.70	
1750	8	500	199	7.57	6.62	6.69	4.05	2.87	10.1	¶ WL WAS AT TUBING INLET
1800	13	500	199	7.72	6.67	6.99	7.43	2.77	11.95	
1809	15	500	WELL PUMPED DRY							WELL DRY TO TD AT 13.73
1833	N/A	— INSUFFICIENT WATER TO MEASURE —								POST SAMPLING MEASUREMENTS

MC 6/7/18

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/6/18 TIME: 18:00

WELL ID NUMBER: MW-HEC02-01 WELL LOCATION: HEC 02

DEPTH OF SCREENED INTERVAL(toc notch): ~9.3 ft. to ~19.3 ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP20' ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 5.15 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ~9.3 FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~14 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 1610 PURGE END TIME: 1800

TOTAL VOLUME PURGED 39 LITERS

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS: WL FELL AT LOWEST POSSIBLE PUMP SETTING. ATTEMPTED TO PUMP WELL DRY. PARAMETERS STABILIZED DURING PUMPING. ~5 WELL CASING VOLUMES REMOVED.

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [ ] YES [X] NO IF NO, WHY WAS A DEVIATION NECESSARY: WELL NOT MICRO-PURGED BECAUSE ~~FOO~~ LOW-ENOUGH PURGE RATE COULD NOT BE ESTABLISHED.

RECORDED BY: [signature] 6/6/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

WELL ID: MW-HEC02-01

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND ~~(µmho/cm)~~ mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
1611	1ST WATER	N/A	129	13.35	6.46	4.09	2.72	8.27	5.72	INITIAL WL= 5.15 FT BTOC
1620	2	60	119	12.33	6.74	4.08	1.54	~~6.00~~ 17.0 MK 6/6/18	6.00	
1630	~2	60	118	14.66	6.70	4.08	1.84	12.3	6.05	AFTER READING PUMP TO DE-WATER
1640	N/A	500	121	8.86	6.76	3.96	3.70	4.76	7.65	
1650	9.5	500	122	8.74	6.77	3.87	4.96	4.73	8.55	
1700	14	500	124	8.78	6.76	3.81	5.40	3.88	9.90	
1710	19	~~500~~ 420 MK 6/6/18	125	9.06	6.74	3.75	5.40	13.1	11.11	
1720	23	420	127	9.40	6.74	3.90	4.33	14.6	12.02	
1730	27	420	129	9.53	6.76	3.81	3.77	10.3	12.75	
1740	31	420	130	9.81	6.73	4.03	3.19	11.1	13.43	
1750	35	420	127	9.93	6.75	4.08	3.15	10.6	14.02	
1800	39	420	124	10.01	6.77	4.08	3.11	10.8	14.42	
			PURGING COMPLETED - SEE ACTIVITY LOG							
						MK 6/6/18				

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/6/18 TIME: 13 : 17

WELL ID NUMBER: MW-HEC05-01 WELL LOCATION: HEC 05

DEPTH OF SCREENED INTERVAL(toc notch): ~3.9 ft. to ~13.9 ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP20 ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 2.93 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ~3.9 FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~8.9 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 1212 PURGE END TIME: 1317

TOTAL VOLUME PURGED 24 LITERS

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS:

WELL PUMPED DRY

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [X] YES [ ] NO IF NO, WHY WAS A DEVIATION NECESSARY: N/A

RECORDED BY: [signature] 6/6/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

WELL ID: MW-HEC05-01

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND (~~µmho/cm~~) mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
1216	1st WATER	~30	136	15.38	6.23	2.47	9.22	4.47 ~~78.9~~	3.50	INITIAL W/L = 2.93 FT BTOC
1225	<1	~30	123	19.39	6.54	2.43	8.31	MK 6/6/18 6.09	3.81	AFTER READING RAISE RATE TO PUMP WELL DRY.
1235	5	500	131	8.88	6.69	2.41	9.55	8.88	5.65	
1245	9	500	138	9.65	6.67	2.58	9.50	17.1	7.65	
1255	14	500	143	8.80	6.70	2.76	8.93	5.60	9.75	
1305	19	500	146	8.83	6.70	2.82	8.70	2.78	11.63	
1315	24	500	149	9.19	6.74	2.01	4.94	5.37	13.65	
1317	WELL	PUMPED DRY								TD = 13.78

MK 6/6/18

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/5/18 TIME: 16:19

WELL ID NUMBER: MW-HEC06-01 WELL LOCATION: CRL HEC06

DEPTH OF SCREENED INTERVAL(toc notch): ~7.3 ft. to ~17.3 ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP20' ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 3.25 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ~7.3 FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~12 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 1432 PURGE END TIME: 1619

TOTAL VOLUME PURGED 32 L

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS:

WELL PUMPED DRY.

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [X] YES [ ] NO IF NO, WHY WAS A DEVIATION NECESSARY: N/A

RECORDED BY: [signature] 6/5/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

WELL ID: MW-HEC00C-01

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND (µmho/cm)	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
4/5/18 1435	1ST WATER	50	108	13.33	6.72	2.21	3.67	12.6	~~4~~.84	INITIAL WL = 3.25 FT BTOC
1445	~2	30	103	17.63	6.58	2.26	3.12	11.7	~~3.2~~ 4.92	REDUCED RATE AFTER 1ST READING
1455	~2	30	96	23.50	6.53	2.20	2.92	12.3	4.94	30 mL/min IS LOWEST POSSIBLE PUMP RATE
1505	~2	30	93	25.48	6.53	2.20	~~2.19~~ 2.85 MK 6/5/18	10.2	5.05	SEE ACTIVITY LOG BEGIN PUMPING TO DE-WATER WELL
1515	7	480	103	8.70	6.87	2.20	4.37	19.4	6.94	
1530	12.5	480	106	8.65	6.87	2.11	8.24	14.1	9.45	
1545	19	480	114	8.93	6.87	2.14	6.87	20.0	11.85	
1600	26	380	119	10.33	6.80	2.11	7.08	13.6	14.52	
1615	31	360	109	10.21	6.81	2.20	1.99	54.7	16.65	
1619	32	WELL PUMPED DRY							MK 6/5/18	
6/6/18 ~~0800~~	—	—	104	8.78	6.49	2.21	8.41	44.1	N/A	POST SAMPLING
							MK 6/5/18			

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/7/18 TIME: 11:15

WELL ID NUMBER: MW-HEC07-01 WELL LOCATION: HEC 07

DEPTH OF SCREENED INTERVAL(toc notch): ~8.75 ft. to ~18.75ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP 20' ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 3.44 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ~8.75 FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~13.75 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X] Bladder Pump~~ [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 1030 PURGE END TIME: 1115

TOTAL VOLUME PURGED 20 LITERS

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS: WL FELL AT LOWEST POSSIBLE PUMP RATE. ATTEMPTED TO PUMP WELL DRY. PARAMETERS STABILIZED DURING PUMPING. >2 WELL CASING VOLUMES REMOVED.

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [ ] YES [X] NO IF NO, WHY WAS A DEVIATION NECESSARY: WELL NOT MICRO-PURGED. COULD NOT ESTABLISH PUMP RATE LOW ENOUGH TO STABILIZE WL.

RECORDED BY: [signature] 6/7/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

WELL ID: MW-HEC07-01

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND ~~(µmho/cm)~~ mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
1035	1st WATER	30	145	11.23	6.01	1.55	7.38	24.6	4.05	INITIAL WL = 3.44 FT BTOC
1045	5	500	130	8.18	6.74	1.53	4.72	4.17	9.00	
1055	10	500	132	8.11	6.81	1.51	6.58	4.29	9.38	
1105	15	500	133	7.90	6.88	1.50	7.00	4.3C	10.60	
1115	20	500	132	8.03	6.91	1.50	6.75	4.50	12.65	

MK 6/2/18

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/7/18 TIME: 13:05

WELL ID NUMBER: MW-HEC07-02 WELL LOCATION: HEC 07

DEPTH OF SCREENED INTERVAL(toc notch): ~7.8 ft. to ~17.8 ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP 20' ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 5.40 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ~7.8 FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~12.8 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 1204 PURGE END TIME: 1305

TOTAL VOLUME PURGED 25 LITERS

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS: WL FELL AT LOWEST POSSIBLE PUMP SETTING. ATTEMPTED TO PUMP WELL DRY, PARAMETERS STABILIZED DURING PUMPING, >3 CASING VOLUMES REMOVED.

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [ ] YES [X] NO IF NO, WHY WAS A DEVIATION NECESSARY: WELL NOT MICRO-PURGED, COULD NOT ESTABLISH PUMP RATE LOW ENOUGH TO STABILIZE WL.

RECORDED BY: [signature] 6/7/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

WELL ID: MW-HEC07-02

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND ~~(µmho/cm)~~ mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
1205	1ST WATER	65	148	12.80	6.45	5.69	5.77	13.7	5.68	INITIAL WL= 5.40 FT BTOC
1215	~1	~~44~~ 40	147	16.69	6.56	5.67	3.51	12.1	5.83	
1227	6	500	153	8.74	6.82	5.68	3.82	6.71	7.70	AT 12:19 INCREASE PUMP RATE TO MAX
1235	10	500	154	8.68	6.78	5.67	4.89	4.13	8.62	
1245	15	500	156	8.56	6.76	5.63	4.93	4.33	10.25	
1255	20	500	156	8.54	6.76	5.61	4.95	4.56	11.35	
1305	25	500	156	8.53	6.76	5.61	4.99	4.80	11.85	
	END PURGING PARAMETERS STABLE									
						MK 8/7/18				

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/8/18 TIME: 09:00

WELL ID NUMBER: MW-HEC12-01 WELL LOCATION: HEC 12

DEPTH OF SCREENED INTERVAL(toc notch): ~6.1 ft. to ~16.1 ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP20' ~~PURGE SAVER ID~~: ______

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: ______

DEPTH TO WATER: 8.96 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ~6.1 FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~11.1 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 0753 PURGE END TIME: 0900

TOTAL VOLUME PURGED 3.6 LITERS

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS:

NONE

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [X] YES [ ] NO IF NO, WHY WAS A DEVIATION NECESSARY: N/A

RECORDED BY: [signature] 6/8/18 QA CHECKED BY: ______

GROUND WATER MICRO PURGE LOG

WELL ID: MW-HECI2-01

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND ~~(umho/cm)~~ mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
0758	1ST WATER	60	262	15.52	6.42	3.14	8.02	30.0	9.05	INITIAL WL = 8.94 FT BTOC
0810	.6	60	261	15.35	6.44	3.21	5.30	45.8	9.05	
0820	1.2	60	264	14.89	6.44	3.30	2.74	38.2	9.06	
0830	1.8	60	263	14.91	6.44	3.33	1.60	40.9	9.06	
0840	2.4	60	262	15.31	6.42	3.39	0.96	42.6	9.06	
0850	3.0	60	259	15.62	6.41	3.41	0.72	38.6	9.05	
0900	3.6	60	255	15.62	6.42	3.42	0.63	38.1	9.05	
PURGING COMPLETED										

MK 6/8/18

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/7/18 TIME: 16:35

WELL ID NUMBER: MW-HEC12-002 WELL LOCATION: HEC 12

DEPTH OF SCREENED INTERVAL(toc notch): ~8.9 ft. to ~18.9 ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP20' ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 8.25 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ~8.9 FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~13.9 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 1531 PURGE END TIME: 1635

TOTAL VOLUME PURGED 7 LITERS

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS:

NONE

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [X] YES [ ] NO IF NO, WHY WAS A DEVIATION NECESSARY:

RECORDED BY: [signature] 6/7/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

WELL ID: MW-HEC12-02

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND ~~(µmho/cm)~~ mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
1538	1ST WATER	110	160	16.46	6.48	3.97	5.21 ~~3.97~~ MK 6/7/18	39.4	8.25	INITIAL WL = 8.25 FT
1545	~2	110 ~~157~~ MK 6/7/18	157	13.74	6.63	3.98	3.84	10.9	8.25	
1555	3	110	158	12.06	6.74	3.86	4.04	9.34	8.27	TURNPIKE TRUCK ON INCREASED PUMP RATE AFTER 3RD READING
1605	4.5	80	163	11.63	6.77	3.74	4.00	4.07	9.45	
1615	5.5	80	165	13.98	6.72	3.75	4.14	2.14	9.57	
1625	6.25	80	169	14.38	6.72	3.75	4.34	2.19	9.57	
1635	7	80	173	14.88	6.70	3.82	4.52	2.34	9.59	
		PURGING COMPLETED - PARAMETERS STABLE								
						MK 6/7/18				

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/4/18 TIME: 15:00

WELL ID NUMBER: MW-11-05-PRL02 WELL LOCATION: HEC 02

DEPTH OF SCREENED INTERVAL(toc notch): ? ft. to ~13 ft.

INNER CASING: TYPE PVC ID: 2 inches

QED MP20' ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 2.80 FT FROM MEASURE POINT

DEPTH TO TOP OF SCREEN: ? FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~8 FT FROM MEASURE POINT

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 1440 PURGE END TIME: 1500

TOTAL VOLUME PURGED ~2.25

SITE CONDITIONS DURING PURGING:

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS:
OBSTRUCTIONS IN WELL AT ~4 FT AND ~10FT BTOC. COULD BE OLD TUBING. COULD NOT FIT BOTH TUBING + WLI PROBE IN SMALL DIAMETER OF WELL. WELL PUMPED DRY.

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [X] YES [ ] NO IF NO, WHY WAS A DEVIATION NECESSARY: N/A

RECORDED BY: [signature] 6/4/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

WELL ID: MW-11-05-PRL-02

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND ~~(µmhos/cm)~~ mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT BTOC)	COMMENTS
1440	1ST WATER	260	31	14.03	6.35	1.89	5.76	52.8	N/A	SEE ACTIVITY LOG
1451	2	30	110	20.39	7.33	1.91	7.38	111	N/A	
1500	~2.25	30	-100	22.64	7.57	1.94	7.30	145	N/A	END PUMPING TO ALLOW WELL TO RECOVER.
			WELL PUMPED DRY							

MK 6/6/18

GROUND WATER MICRO PURGE SHEET

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI **DELIVERY ORDER NO:** 0011

DATE (mm/dd/yy): 6/6/18 TIME: 10:18

WELL ID NUMBER: MW11-15-PRL02- WELL LOCATION: PRL02

DEPTH OF SCREENED INTERVAL(toc notch): ? ft. to 20.48 ft.

INNER CASING: TYPE PVC ID: ~~2~~ 1 inches MK 6/6/18

QED MP20' ~~PURGE SAVER ID~~: 16369

WATER LEVEL INDICATOR ID: 223319

TURBIDITY ID: 82924

DEPTH TO WATER: 7.55 FT BGS ~~FROM MEASURE POINT~~ MK 6/6/18

DEPTH TO TOP OF SCREEN: UNKNOWN FT FROM MEASURE POINT

DEPTH TO PUMP INTAKE: ~15 FT BGS ~~FROM MEASURE POINT~~ 6/6/18

PURGE/SAMPLE METHOD: [ ] Bailer ~~[X]~~ Bladder Pump [X] Pump Type PERISTALTIC PUMP PUMP ID: N/A

PURGE START TIME: 0927 PURGE END TIME: 1018

TOTAL VOLUME PURGED 4.25 L

SITE CONDITIONS DURING PURGING: TYPICAL HANGAR ACTIVITIES

NOTE: IF WELL HAS A DEDICATED PUMP, IT IS TO BE USED.

FIELD OBSERVATIONS:

PID AT TOC = 20-24 ppm. PURGE WATER HAS CHEMICAL ODOR, WELL PUMPED DRY

S&A PLAN SAMPLING PROCEDURE FOLLOWED: [X] YES [ ] NO IF NO, WHY WAS A DEVIATION NECESSARY: N/A

RECORDED BY: [signature] 6/6/18 QA CHECKED BY:

GROUND WATER MICRO PURGE LOG

PROJECT NAME: HECTOR FIELD PFOS/PFOA SI

WELL ID: MW11-15-PRL02-01

DELIVERY ORDER NO: 0011

TIME	L REMOVED	PURGE RATE (mL/min)	ORP (mv)	TEMP (C)	pH (s.u.)	COND (~~µmho/cm~~) mS/cm	DO (mg/L)	TURBIDITY (NTU)	DEPTH TO WATER (FT ~~BTOC~~ BGS)	COMMENTS
0933	1ST WATER	N/A	-86	19.74	6.77	5.06	0.56	N/A	~8.0FT	WL REMAINING IS ERATIC
0945	2	60	-251	19.74	6.75	5.16	0.22	60.8	16.70	HAVING DIFFICULTY ESTABLISHING FLOW RATE
0955	3	30	-281	20.12	6.74	5.26	0.12	75.4	17.92	WATER STAINED BLACK
1005	3.5	30	-285	20.08	6.78	5.31	0.09	78.9	17.95	OCCASIONALLY WATER QUITS FLOWING
1015	4.25	30	-228	20.12	6.96	5.45	0.10	77.7	18.55	WATER STAINED FLOW CELL LT BLACK
1018 ~~1030~~	—	—	—	WELL	IS	DRY	—	—	—	—

MK 6/6/18

APPENDIX C

SURVEY REPORT FOR NEW MONITORING WELLS

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ARCHITECTS | ENGINEERS | PLANNERS | SURVEYORS

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SURVEY REPORT

Hector Field ANGB, Fargo, North Dakota

Date of Survey: June 5, 2018

Coordinate System: North Dakota State Plane Coordinate System, South Zone, U.S. Survey Feet

Horizontal Datum: NAD83

Vertical Datum: NAVD88

Equipment Used:

Trimble R8 GPS Receiver (Base)

Trimble R6-2 GPS Receiver (Rover)

Topcon At-B4 Auto Level

The horizontal positions were located using GPS as an Observed Control Point (60 second measurement for each well head) with a horizontal accuracy of 10mm + 1ppm RMS per Trimble R8 Data sheet. A level loop was ran and closed for each of the well heads. (See Survey Notes) Each loop was closed within the stated vertical accuracy of 0.01'.

See Excel file for tabulated survey data.

Point Number	Northing	Easting	Well Casing Elevation	Description	Adjacent Ground Elevation
1	481111.8	2893223	897.312	BASE CP REBAR	N/A
12	473849.5	2904039	898.684	LEVEE RESET	N/A
100	476534.5	2890619	893.39	NR-HEC06-01	893.4
101	477144.1	2889869	893.23	NR-HEC-05-01	892.7
102	476392.9	2892079	897.8	NR-HEC-01-01	894.9
103	475882.1	2891916	895.94	NR-HEC-07-01	896.1
104	475392.5	2892113	897.92	NR-HEC-02-01	898.3
105	475884.2	2893271	894.64	NR-HEC-07-02	894.8
106	476446.7	2893257	894.71	NR-HEC-01-02	894.9
107	478243.1	2892779	894.97	NR-HEC-12-01	892.4
108	477086.6	2891585	898.79	BENCHMARK	N/A
109	478417.8	2893178	894.31	NR-HEC-12-02	894.7

APPENDIX D

DATA VALIDATION REPORTS

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LEIDOS
Laboratory Data Verification Checklist

Project: Hector Field

SDG No: J39942

Analyte Group: PFCs
Sample Matrix: Soils
EDD (Y/N):

Disposition of Data Package:
NCR No. (if applicable):

1. Case Narrative

Read SDG Case Narrative	Y
Check Laboratory sample ID vs. Project sample ID lists	Y
Check that discussion covers each analytical type included in the SDG	Y
Check for identified nonconforming items (e.g., missed holding times, etc.)	Y

2. Chain-of-Custody (COC)

Check COC sample collection, shipping, and receiving dates	Y
Check that COC signature blocks are complete	Y
Check COC project sample IDs vs. Lab IDs and Result Form IDs	Y
Match COC requested analyses with Case Narrative and with data package content (Result Forms)	Y

3. Analytical Results Form

Verify that a Result Form is present for each sample and analysis	Y

On each Result Form check:

SDG No.	Y
Sample ID	Y
Lab ID	Y
Date Collected	Y
Date Extracted	Y
Date Analyzed	Y
Result Matrix	Y
Result Units	Y

4. Project Verification

Check project analyte list vs. analytes reported	Y
Check project requested methods vs. analytical methods performed	Y
Check analyte reporting levels vs. project reporting level goals	Y

5. Analytical Quality Control Information

Check for surrogate recovery results (e.g., org. form II)		Y
Check for LCS results (e.g., org. form III, inorg. form XII)		Y
Check for method blank results (e.g., org. form IV, inorg. form III)		Y
Check for MS/MSD results (e.g., inorg. form V)		Y
Check for laboratory duplicate results (e.g., inorg. form VI)		NA
Check for Method Calibration and Run Documentation		
organic:	instrument performance check	Y
	initial calibration data	Y
	continuing calibration data	Y
	internal standard areas	Y
	internal standard retention times	Y
	sample clean-up documentation (org. forms V through X)	Y
metal:	initial calibration data	
	continuing calibration data	
	method detection limits	
	method linear range	
	sample run sequence (inorg. forms II, IV, and VIII through XIV)	
other:	initial calibration data	
	continuing calibration data	
	method detection limits	
	sample run sequence	

6. Incorrect Information

Identify missing items or incorrect information (i.e., missing forms, unsigned forms, incorrect sample IDs, etc.)

Contact the laboratory or project personnel to obtain missing information or correct information

Document corrections below:

7. Nonconforming Items

Document all nonconforming items that can not be resolved above in a Non-Conformance Report (NCR), complete form, file, and follow-up

NCR # Item

Reviewed By: Brooke Francis Date: 7/3/18

QA Review By: Joseph C Peters Date: 7/19/18

LEIDOS
Laboratory Data Package Detail Form

Project: Hector Field

SDG No: J39942 **Analyte Group:** PFCs

SEE ATTACHED

Field Sample ID	Lab ID #	Matrix	Analysis	Notes:

Comments:

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-39942-1	HEC-RB-01	Water	05/29/18 08:40	06/01/18 10:00
320-39942-2	HEC-FB-DI-01	Water	05/29/18 08:50	06/01/18 10:00
320-39942-3	HEC-ER-SB-01	Water	05/30/18 07:30	06/01/18 10:00
320-39942-4	HEC05-SB1-01	Solid	05/30/18 08:30	06/01/18 10:00
320-39942-5	HEC05-SB1-02	Solid	05/30/18 08:40	06/01/18 10:00
320-39942-6	HEC05-SB3-01	Solid	05/30/18 09:12	06/01/18 10:00
320-39942-7	HEC05-SB3-02	Solid	05/30/18 09:20	06/01/18 10:00
320-39942-8	HEC05-SB2-01	Solid	05/30/18 09:42	06/01/18 10:00
320-39942-9	HEC05-SB2-02	Solid	05/30/18 09:47	06/01/18 10:00
320-39942-10	HEC-ER-SB-02	Water	05/30/18 10:45	06/01/18 10:00
320-39942-11	HEC06-SB1-01	Solid	05/30/18 13:21	06/01/18 10:00
320-39942-12	HEC06-SB1-01D	Solid	05/30/18 13:21	06/01/18 10:00
320-39942-13	HEC06-SB1-02	Solid	05/30/18 13:30	06/01/18 10:00
320-39942-14	HEC06-SB2-01	Solid	05/30/18 14:00	06/01/18 10:00
320-39942-15	HEC06-SB2-02	Solid	05/30/18 14:12	06/01/18 10:00
320-39942-16	HEC06-SB3-01	Solid	05/30/18 14:50	06/01/18 10:00
320-39942-17	HEC06-SB3-02	Solid	05/30/18 15:02	06/01/18 10:00
320-39942-18	HEC-FB-POT-01	Water	05/31/18 07:10	06/01/18 10:00
320-39942-19	HEC-ER-SB-03	Water	05/31/18 11:57	06/01/18 10:00
320-39942-20	HEC02-SB1-01	Solid	05/31/18 11:05	06/01/18 10:00
320-39942-21	HEC02-SB1-02	Solid	05/31/18 11:37	06/01/18 10:00
320-39942-22	HEC02-SB1-02D	Solid	05/31/18 11:37	06/01/18 10:00

Leidos - Horsham Project Specific
PFASs by LC/MS/MS Methods Data Verification/Validation

Project: Hector Field

SDG No: J39942

Analysis: PFC

Method: E537

Laboratory: Test America

Matrix: Water/Soil

The above data package has been reviewed and the analytical quality control/quality assurance performance data have been summarized. The general criteria used to assess the analytical integrityof the data were based on DOD QSM 5.1 guidance and examination of the following:

Case Narrative	Instrument Sensitivity Checks
Analytical Holding Times	Internal Standard Performance
Sample Preservation	MS/MSD Recoveries and Differences
Method Calibration	LCS Recoveries
Method and Project Blanks	Re-analysis and Secondary Dilution

Project Specific QA/QC or contract requirements may take priority over validation criteria in this procedure.

*** If this SDG requires full validation; recalculations from the raw data are required for one point for each ICAL, one CCV, one of each QC sample, and one field sample.**

Data verification and data validation are essentially identical, with the exception that validation requires results to be recalculated from the raw data.

Remarks: DoD QSM

Some results were qualified as estimated due to MS/MSD and/or IS discrepancies

One result was qualified as non-detect due to continuing calibration blank contamination

QA review of data validation found no discrepancies.

Definition of Qualifiers:

"U", not detected at the associated level
"UJ", not detected and associated value estimated
"J", associated value estimated
"R", associated value unusable or analyte identity unfounded

Verification/Validation by: Brooke Francis   Date: 7/3/18

QA Reviewed by: Joseph C Peters   Date: 7/19/18

Case Narrative

Verify direct statements made within the Laboratory Case Narrative (note discrepancies).

Remarks: No additional discrepancies were ncted

Re-analysis and Secondary Dilutions

Verify that re-analysis and secondary dilutions were performed and reported as necessary. Determine appropriate results to report.

Remarks: Some samples were reanalyzed at a dilution

Holding Times

Waters - Cool 4°C; 14 days to extraction; 28 days to analysis
collection. Note: Trizma preservative is recommended for aqueous samples, but not required.

Soils - Cool 4°C ; extraction within 28 days of sample collection; analysis within 28 days of sample extraction

Deviations:

Sample #	Date Collected	Date Analyzed	Comments

Actions:

1. If holding times are exceeded, all results are qualified as estimated (J/UJ)
2. If holding times are exceeded by more than 2X, reviewer may qualify non-detected results as unusable (R)

Remarks: All holding times were met

Injection Internal Standards (IS)

List any field samples, field QC samples, or laboratory QC samples where injection internal standards are not within 50 to 150% of the peak areas from the ICAL midpoint or daily initial CCV, as applicable.

Deviations:

Sample #	Injection IS/% Rec	Affected PFAS Compounds
HEC05-SB3-01 DL	PFOA 950513	All sample results J/UJ
	0……….+	

Actions:

If any injection IS is <25%, qualify detects as J; non-detects as R

If any Injection IS is > upper control limit; qualify detects as J, no action for non-detects

If any surrogate is ≥ 25%, but < the lower control limit, then qualify detects as J, non-detects as UJ

Injection IS - Target PFAS Compounds Associations:

13C3-PFBA: PFBS

13C2-PFOA: PFOA, PFHxS, PFHpA

13C4-PFOS: PFOS, PFNA

13C2-PFDA: No PFAS project compounds

Remarks:

Surrogates/Extraction Internal Standards (IS)

List any field samples, field QC samples, or laboratory QC samples where surrogates/extraction internal standards are not within 50% ± of their true value.

Note: Extraction Internal Standards and surrogates are the same thing. For purposes of data validation and applying validation reason codes, they will be treated as surrogates. Injection internal standards will be treated as internal standards and the use of internal standard reason codes will be used.

Deviations:

Sample #	Surrogate - % Rec	Affected PFAS Compounds

Actions:

If any injection IS is <25%, qualify detects as J; non-detects as R

If any Injection IS is > upper control limit; qualify detects as J, no action for non-detects

If any surrogate is ≥ 25%, but < the lower control limit, then qualify detects as J, non-detects as UJ

Surrogate - Target PFAS Compounds Associations:

13C3-PFBS - PFBS
13C3-PFHxS - PFHxS
13C4-PFHpA - PFHpA
13C8-PFOA - PFOA
13C9-PFNA - PFNA
13C8-PFOS - PFOS

Remarks: All surrogates met control limits

VI. Blanks

A method blank was reported for each aqueous analytical batch and one method blank was reported for each soil extraction batch? (Y/N) [Y circled]

Review associated laboratory and project blank samples. List documented contamination below:

Laboratory Method Blanks:

Date:	Sample ID #	Compound	Conc.
6/7/18	MB 320-227757	PFOA	0.550 ng/L

Associated Project Blanks (e.g., equipment rinsates, field reagent blanks, source blanks, etc.)

Date	Sample ID #	Compound	Conc.
5/31/18	HEC-FB-POT-01	PFHpA	0.79

Remarks: The final rinse was with DI water which was free from contamination and no qualification based on FB-POT is required.

VI. Blanks (continued)

Calculate the action level based on 5X the highest blank concentration

Sample weights, volumes, and dilution factors must be taken into account when applying the 5X criteria.
0.00870 ng/mL * 10mL/5g * 1000g/1kg * 1 ug/1000ng = 0.087 ug/kg

0.00870 ng/mL * 10 mL/0.250L = 0.348 ng/L * 5 =

Deviations:

Compound	Maximum Conc. Detected, (ppb)	Action Level (ppb)	Samples Affected
PFOA	0.550 ng/L	2.75 ng/L	320-39942-1, 2, 3, 10, 19
PFHxS	0.00870 ng/mL	0.087 ug/kg or 1.74 ng/L	CCB-All samples No results qualified

Actions:
1. If compound results exceed the action levels, the data are not qualified
2. If compound results are below the required reporting level, report results as non-detect (U) at the LOD
3. If the compound is detected above the reporting level, but below the action level, qualify as not-detected (U)
4. If contamination exists in method blanks < 1/2 LOQ, samples must be re-extracted and reanalyzed. Unlesss the MB results are < 1/10 the amount in associated samples or < 10 the action level, which ever is greater

Remarks:

VII. Initial & Contining Calibration

Date of initial calibration: ______________________

%RSD of RFs < 20% or $r^2 \geq 0.99$ for each analyte?
Analytes within 70-130% of their true value in each ICAL standard?
ICV within ± 30% of true value?

Date(s) of continuing calibration: ______________________
CCV analyzed at beginning and end of analytical sequence and after every 10 field samples?
CCV within ± 30% of true value?

Instrument sensitivity check (ISC) performed at the LOQ prior to analysis and every 12 hours?
ICS within ± 30% of true value?

Deviations:

Compound	Date	r value	%Drift	Samples Affected

Actions:

1. If initial calibration curve criteria are not met, qualify positive results as estimated (J) and non-detects as estimated (UJ), using professional judgement (i.e. if only the low standard is out, and the higher stards are in, then only qualify those results near the low standard).
2. Only evaluate the ICV if it brackets field samples. If the ICV does bracket field samples, then CCV actions apply
3. If a CCV is above the upper control limit, qualify detects as estimated (J). Nondects require no action.
4. If a CCV is below the lower control limit but > 40% recovery, qualify results as estimated (J/UJ).
5. If a CCV is ≤ 40% recovery, qualify detects as estimated (J) and nondetects as rejected (R)
6. If CCVs were not analyzed at the proper frequency, use professional judgement.
7. If ISC is > UCL, estimate (J) detects, no action for non-detects; If ISC is < LCL, estimate data (J/UJ), if ISC is < 30% reject (R) non-detects

Remarks: All calibration results met control limits for target analytes

IX. Matrix Spike/Matrix Spike Duplicate Information

General MS/MSD Criteria:
percent recovery (%R) in-house limits
relative percent difference (RPD) 30% RPD

Project Sample(s) Spiked: HEC02-SB1-01

Deviations:

Compound	%R	%R Limits	RPD	RPD Limits	Samples Affected
PFHxS	129	75-121			HEC02-SB1-01
PFOS	425/301	69-131			↓ >4x spike

Actions:
1. If the spike recovery is above the upper control limit (UCL), qualify all positive values in the unspiked sample as estimated (J) and non-detects as estimated (UJ).
2. If the spike recovery is below the lower control limit (LCL), qualifty positive values as estimated (J). And non-detects as estimated (UJ).
3. If the spike recovery is <10%, qualify non-detect values as unusable (R)
4. If the RPD does not meet criteria, qualify positive values in the unspiked sample as estimated (J)
5. Use professional judgement to qualify additional samples in the analytical group based on MS/MSD results
6. Use professional judgement for qualification of data for unspiked compounds

*** If this SDG requires full validation; recalculate at least one % recovery and one % RPD from the raw data. Attach all calculations at the end of the validation checklist.**

Remarks:

X. Laboratory Control Sample Information

General LCS Criteria:
Percent recovery (%R) = in-house limits
RPD if LCSD performed = 30% RPD

Laboratory LCS Identifications: LCS/D 320-227757 LCS/D 320-227763
LCS 320-228766

Deviations:

Compound	Date	%R	Samples Affected/Qualifiers Applied

Actions:

*** If this SDG requires full validation; recalculate at least one % recovery and one % RPD (if LCSD was performed) from the raw data. Attach all calculations at the end of the validation checklist.**

Action should be based on both the number of compounds outside the criterion and the magnitude of the exceedance.

1. If the LCS recovery is below limits but > one- half the lower limit, qualify valves as estimated (J/UJ).
2. If the LCS recovery is < one-half the lower limit, qualify detect (J) and non-detects (R)
3. If the LCS recovery is greater than the upper limit, qualify positive valves for that analyte as estimated (J).

5. Use professional judgement for qualification of data for compounds with no LCS information

Remarks: All LCS/D %R and RPD results met control limits

Client Sample ID: HEC-RB-01 Lab Sample ID: 320-39942-1
Date Collected: 05/29/18 08:40 **Matrix: Water**
Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.8	0.56	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorooctanoic acid (PFOA)	1.4	U	1.8	0.50	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorononanoic acid (PFNA)	1.4	U	1.8	0.48	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorobutanesulfonic acid (PFBS)	0.92	U	1.8	0.42	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorohexanesulfonic acid (PFHxS)	0.92	U	1.8	0.35	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorooctanesulfonic acid (PFOS)	2.8	U	3.7	1.0	ng/L		06/07/18 10:14	06/25/18 05:28	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*77*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
13C4-PFHpA	*86*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
13C4 PFOA	*88*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
13C5 PFNA	*90*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
18O2 PFHxS	*78*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
13C4 PFOS	*79*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*

Client Sample ID: HEC-FB-DI-01 Lab Sample ID: 320-39942-2
Date Collected: 05/29/18 08:50 **Matrix: Water**
Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.2	U	1.6	0.50	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorooctanoic acid (PFOA)	1.2	U	1.6	0.44	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorononanoic acid (PFNA)	1.2	U	1.6	0.43	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorobutanesulfonic acid (PFBS)	0.82	U	1.6	0.38	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorohexanesulfonic acid (PFHxS)	0.82	U	1.6	0.31	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorooctanesulfonic acid (PFOS)	2.5	U	3.3	0.90	ng/L		06/07/18 10:14	06/25/18 05:36	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*78*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
13C4-PFHpA	*83*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
13C4 PFOA	*90*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
13C5 PFNA	*87*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
18O2 PFHxS	*78*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
13C4 PFOS	*80*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*

Client Sample ID: HEC-ER-SB-01 Lab Sample ID: 320-39942-3
Date Collected: 05/30/18 07:30 **Matrix: Water**
Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3	U	1.8	0.54	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorooctanoic acid (PFOA)	1.3	U	1.8	0.47	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorononanoic acid (PFNA)	1.3	U	1.8	0.46	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorobutanesulfonic acid (PFBS)	0.88	U	1.8	0.40	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorohexanesulfonic acid (PFHxS)	0.88	U	1.8	0.33	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorooctanesulfonic acid (PFOS)	2.6	U	3.5	0.97	ng/L		06/07/18 10:14	06/25/18 05:44	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*79*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:44*	*1*
13C4-PFHpA	*89*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:44*	*1*

Client Sample ID: HEC-ER-SB-01

Lab Sample ID: 320-39942-3

Date Collected: 05/30/18 07:30
Date Received: 06/01/18 10:00
Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFOA	89		50 - 150	06/07/18 10:14	06/25/18 05:44	1
13C5 PFNA	93		50 - 150	06/07/18 10:14	06/25/18 05:44	1
18O2 PFHxS	82		50 - 150	06/07/18 10:14	06/25/18 05:44	1
13C4 PFOS	82		50 - 150	06/07/18 10:14	06/25/18 05:44	1

Client Sample ID: HEC05-SB1-01

Lab Sample ID: 320-39942-4

Date Collected: 05/30/18 08:30
Date Received: 06/01/18 10:00
Matrix: Solid
Percent Solids: 77.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.11**	**J**	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorooctanoic acid (PFOA)	**0.17**	**J**	0.38	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorononanoic acid (PFNA)	0.26	U	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorobutanesulfonic acid (PFBS)	**0.13**	**J**	0.51	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorohexanesulfonic acid (PFHxS)	**0.74**		0.38	0.080	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorooctanesulfonic acid (PFOS)	**1.1**	**J**	1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	61		50 - 150	06/13/18 05:42	06/28/18 03:13	1
13C4-PFHpA	80		50 - 150	06/13/18 05:42	06/28/18 03:13	1
13C4 PFOA	75		50 - 150	06/13/18 05:42	06/28/18 03:13	1
13C5 PFNA	79		50 - 150	06/13/18 05:42	06/28/18 03:13	1
18O2 PFHxS	60		50 - 150	06/13/18 05:42	06/28/18 03:13	1
13C4 PFOS	66		50 - 150	06/13/18 05:42	06/28/18 03:13	1

Client Sample ID: HEC05-SB1-02

Lab Sample ID: 320-39942-5

Date Collected: 05/30/18 08:40
Date Received: 06/01/18 10:00
Matrix: Solid
Percent Solids: 76.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.26	U	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorooctanoic acid (PFOA)	0.26	U	0.38	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorononanoic acid (PFNA)	0.26	U	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorobutanesulfonic acid (PFBS)	0.23	U M U	0.51	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorohexanesulfonic acid (PFHxS)	0.26	U	0.38	0.080	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorooctanesulfonic acid (PFOS)	0.64	U	1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	57		50 - 150	06/13/18 05:42	06/28/18 03:21	1
13C4-PFHpA	70		50 - 150	06/13/18 05:42	06/28/18 03:21	1
13C4 PFOA	70		50 - 150	06/13/18 05:42	06/28/18 03:21	1
13C5 PFNA	72		50 - 150	06/13/18 05:42	06/28/18 03:21	1
18O2 PFHxS	59		50 - 150	06/13/18 05:42	06/28/18 03:21	1
13C4 PFOS	58		50 - 150	06/13/18 05:42	06/28/18 03:21	1

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG- Hector Field

TestAmerica Job ID: 320-39942-1

Client Sample ID: HEC05-SB3-01

Lab Sample ID: 320-39942-6

Date Collected: 05/30/18 09:12
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 76.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	4.2		0.39	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorooctanoic acid (PFOA)	0.81	M =	0.39	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorononanoic acid (PFNA)	0.26	U	0.39	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorobutanesulfonic acid (PFBS)	8.3		0.51	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorohexanesulfonic acid (PFHxS)	45	E *	0.39	0.080	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorooctanesulfonic acid (PFOS)	14	M =	1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*				*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*71*		*50 - 150*				*06/13/18 05:42*	*06/28/18 03:29*	*1*
13C4-PFHpA	*77*		*50 - 150*				*06/13/18 05:42*	*06/28/18 03:29*	*1*
13C4 PFOA	*75*		*50 - 150*				*06/13/18 05:42*	*06/28/18 03:29*	*1*
13C5 PFNA	*89*		*50 - 150*				*06/13/18 05:42*	*06/28/18 03:29*	*1*
18O2 PFHxS	*69*		*50 - 150*				*06/13/18 05:42*	*06/28/18 03:29*	*1*
13C4 PFOS	*73*		*50 - 150*				*06/13/18 05:42*	*06/28/18 03:29*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	4.7	D *	1.9	0.50	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorooctanoic acid (PFOA)	0.88	J D M *	1.9	0.64	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorononanoic acid (PFNA)	1.3	U *	1.9	0.52	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorobutanesulfonic acid (PFBS)	9.1	D *	2.6	0.38	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorohexanesulfonic acid (PFHxS)	49	D J K01	1.9	0.40	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorooctanesulfonic acid (PFOS)	14	D *	6.4	1.5	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*				*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*71*		*50 - 150*				*06/13/18 05:42*	*06/29/18 23:49*	*5*
13C4-PFHpA	*73*		*50 - 150*				*06/13/18 05:42*	*06/29/18 23:49*	*5*
13C4 PFOA	*77*		*50 - 150*				*06/13/18 05:42*	*06/29/18 23:49*	*5*
13C5 PFNA	*78*		*50 - 150*				*06/13/18 05:42*	*06/29/18 23:49*	*5*
18O2 PFHxS	*73*		*50 - 150*				*06/13/18 05:42*	*06/29/18 23:49*	*5*
13C4 PFOS	*78*		*50 - 150*				*06/13/18 05:42*	*06/29/18 23:49*	*5*

Client Sample ID: HEC05-SB3-02

Lab Sample ID: 320-39942-7

Date Collected: 05/30/18 09:20
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 73.0

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.68		0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorooctanoic acid (PFOA)	1.0		0.40	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorononanoic acid (PFNA)	0.27	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorobutanesulfonic acid (PFBS)	3.3		0.54	0.079	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorohexanesulfonic acid (PFHxS)	23		0.40	0.084	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorooctanesulfonic acid (PFOS)	0.53	J	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1

Client Sample ID: HEC05-SB3-02 Lab Sample ID: 320-39942-7

Date Collected: 05/30/18 09:20 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 73.0**

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*67*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
13C4-PFHpA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
13C4 PFOA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
13C5 PFNA	*76*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
13C4 PFOS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*

Client Sample ID: HEC05-SB2-01 Lab Sample ID: 320-39942-8

Date Collected: 05/30/18 09:42 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 70.2**

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.28	U	0.41	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorooctanoic acid (PFOA)	0.28	U M U	0.41	0.14	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorononanoic acid (PFNA)	0.28	U M U	0.41	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorobutanesulfonic acid (PFBS)	0.25	U M U	0.55	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorohexanesulfonic acid (PFHxS)	**0.14**	**J**	0.41	0.086	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorooctanesulfonic acid (PFOS)	0.69	U	1.4	0.33	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
13C4-PFHpA	*74*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
13C4 PFOA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
13C5 PFNA	*74*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
18O2 PFHxS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
13C4 PFOS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*

Client Sample ID: HEC05-SB2-02 Lab Sample ID: 320-39942-9

Date Collected: 05/30/18 09:47 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 70.8**

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.28	U	0.42	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorooctanoic acid (PFOA)	0.28	U M U	0.42	0.14	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorononanoic acid (PFNA)	0.28	U	0.42	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorobutanesulfonic acid (PFBS)	0.25	U	0.55	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorohexanesulfonic acid (PFHxS)	0.28	U	0.42	0.086	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorooctanesulfonic acid (PFOS)	0.69	U M U	1.4	0.33	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*61*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
13C4-PFHpA	*70*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
13C4 PFOA	*72*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
13C5 PFNA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
18O2 PFHxS	*60*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
13C4 PFOS	*61*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG- Hector Field

TestAmerica Job ID: 320-39942-1

Client Sample ID: HEC-ER-SB-02

Lab Sample ID: 320-39942-10

Date Collected: 05/30/18 10:45
Matrix: Water
Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3	U	1.8	0.54	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorooctanoic acid (PFOA)	1.3	U	1.8	0.48	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorononanoic acid (PFNA)	1.3	U	1.8	0.46	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorobutanesulfonic acid (PFBS)	0.88	U	1.8	0.40	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorohexanesulfonic acid (PFHxS)	0.88	U	1.8	0.33	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorooctanesulfonic acid (PFOS)	2.6	U	3.5	0.97	ng/L		06/07/18 10:14	06/25/18 05:52	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*67*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
13C4-PFHpA	*82*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
13C4 PFOA	*75*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
13C5 PFNA	*80*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
18O2 PFHxS	*68*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
13C4 PFOS	*68*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*

Client Sample ID: HEC06-SB1-01

Lab Sample ID: 320-39942-11

Date Collected: 05/30/18 13:21
Matrix: Solid
Date Received: 06/01/18 10:00
Percent Solids: 74.3

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.26	U	0.40	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorooctanoic acid (PFOA)	0.26	U	0.40	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorononanoic acid (PFNA)	0.26	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorobutanesulfonic acid (PFBS)	0.24	U	0.53	0.078	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorohexanesulfonic acid (PFHxS)	**0.37**	**J**	0.40	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorooctanesulfonic acid (PFOS)	0.66	U M U	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
13C4-PFHpA	*77*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
13C4 PFOA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
13C5 PFNA	*81*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
13C4 PFOS	*65*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*

Client Sample ID: HEC06-SB1-01D

Lab Sample ID: 320-39942-12

Date Collected: 05/30/18 13:21
Matrix: Solid
Date Received: 06/01/18 10:00
Percent Solids: 77.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.26	U	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorooctanoic acid (PFOA)	0.26	U	0.38	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorononanoic acid (PFNA)	0.26	U M U	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorobutanesulfonic acid (PFBS)	0.23	U	0.51	0.075	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorohexanesulfonic acid (PFHxS)	**0.67**		0.38	0.079	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorooctanesulfonic acid (PFOS)	**0.95**	**J M** J	1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1

Client Sample ID: HEC06-SB1-01D

Lab Sample ID: 320-39942-12

Date Collected: 05/30/18 13:21
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 77.7

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:08*	*1*
13C4-PFHpA	*77*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:08*	*1*
13C4 PFOA	*79*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:08*	*1*
13C5 PFNA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:08*	*1*
18O2 PFHxS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:08*	*1*
13C4 PFOS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:08*	*1*

Client Sample ID: HEC06-SB1-02

Lab Sample ID: 320-39942-13

Date Collected: 05/30/18 13:30
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 73.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.27	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorooctanoic acid (PFOA)	0.27	U	0.40	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorononanoic acid (PFNA)	0.27	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorobutanesulfonic acid (PFBS)	0.24	U	0.54	0.079	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorohexanesulfonic acid (PFHxS)	**0.37**	**J**	0.40	0.084	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorooctanesulfonic acid (PFOS)	0.67	U	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:23*	*1*
13C4-PFHpA	*75*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:23*	*1*
13C4 PFOA	*74*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:23*	*1*
13C5 PFNA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:23*	*1*
18O2 PFHxS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:23*	*1*
13C4 PFOS	*66*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:23*	*1*

Client Sample ID: HEC06-SB2-01

Lab Sample ID: 320-39942-14

Date Collected: 05/30/18 14:00
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 74.8

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.26	U	0.39	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorooctanoic acid (PFOA)	0.26	U M U	0.39	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorononanoic acid (PFNA)	0.26	U	0.39	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorobutanesulfonic acid (PFBS)	**0.11**	**J**	0.53	0.078	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorohexanesulfonic acid (PFHxS)	**0.27**	**J**	0.39	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorooctanesulfonic acid (PFOS)	**0.42**	**J**	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*57*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:31*	*1*
13C4-PFHpA	*75*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:31*	*1*
13C4 PFOA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:31*	*1*
13C5 PFNA	*80*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:31*	*1*
18O2 PFHxS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:31*	*1*
13C4 PFOS	*65*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:31*	*1*

Client Sample ID: HEC06-SB2-02

Lab Sample ID: 320-39942-15

Date Collected: 05/30/18 14:12
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 74.0

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.27	U	0.40	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorooctanoic acid (PFOA)	0.27	U	0.40	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorononanoic acid (PFNA)	0.27	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorobutanesulfonic acid (PFBS)	**0.21**	**J**	0.53	0.079	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorohexanesulfonic acid (PFHxS)	**0.82**		0.40	0.083	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorooctanesulfonic acid (PFOS)	**0.47**	**J**	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
13C4-PFHpA	*69*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
13C4 PFOA	*71*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
13C5 PFNA	*74*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
18O2 PFHxS	*61*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
13C4 PFOS	*60*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*

Client Sample ID: HEC06-SB3-01

Lab Sample ID: 320-39942-16

Date Collected: 05/30/18 14:50
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 80.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.36**	**J**	0.37	0.096	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorooctanoic acid (PFOA)	**1.7**		0.37	0.12	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorononanoic acid (PFNA)	**0.44**		0.37	0.099	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorobutanesulfonic acid (PFBS)	**0.17**	**J**	0.49	0.072	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorohexanesulfonic acid (PFHxS)	**10**		0.37	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorooctanesulfonic acid (PFOS)	**18**	**M** =	1.2	0.29	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
13C4-PFHpA	*70*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
13C4 PFOA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
13C5 PFNA	*75*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
18O2 PFHxS	*60*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
13C4 PFOS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*

Client Sample ID: HEC06-SB3-02

Lab Sample ID: 320-39942-17

Date Collected: 05/30/18 15:02
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 71.3

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.28	U	0.42	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1
Perfluorooctanoic acid (PFOA)	0.28	U M U	0.42	0.14	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1
Perfluorononanoic acid (PFNA)	0.28	U	0.42	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1
Perfluorobutanesulfonic acid (PFBS)	**0.23**	**J**	0.55	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1

Client Sample ID: HEC06-SB3-02

Lab Sample ID: 320-39942-17

Date Collected: 05/30/18 15:02
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 71.3

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorohexanesulfonic acid (PFHxS)	**1.3**		0.42	0.086	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1
Perfluorooctanesulfonic acid (PFOS)	0.69	U	1.4	0.33	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
13C4-PFHpA	*72*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
13C4 PFOA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
13C5 PFNA	*71*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
13C4 PFOS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*

Client Sample ID: HEC-FB-POT-01

Lab Sample ID: 320-39942-18

Date Collected: 05/31/18 07:10
Date Received: 06/01/18 10:00

Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.79**	**J**	2.0	0.61	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorooctanoic acid (PFOA)	1.5	U M U	2.0	0.54	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorononanoic acid (PFNA)	1.5	U	2.0	0.52	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorobutanesulfonic acid (PFBS)	1.0	U	2.0	0.46	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorohexanesulfonic acid (PFHxS)	**0.40**	**J** U F06	2.0	0.38	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorooctanesulfonic acid (PFOS)	3.0	U	4.0	1.1	ng/L		06/07/18 11:11	06/09/18 01:21	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*72*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
13C4-PFHpA	*77*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
13C4 PFOA	*77*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
13C5 PFNA	*73*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
18O2 PFHxS	*76*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
13C4 PFOS	*74*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*

Client Sample ID: HEC-ER-SB-03

Lab Sample ID: 320-39942-19

Date Collected: 05/31/18 11:57
Date Received: 06/01/18 10:00

Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.8	0.56	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorooctanoic acid (PFOA)	1.4	U	1.8	0.50	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorononanoic acid (PFNA)	1.4	U	1.8	0.48	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorobutanesulfonic acid (PFBS)	0.92	U	1.8	0.42	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorohexanesulfonic acid (PFHxS)	0.92	U	1.8	0.35	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorooctanesulfonic acid (PFOS)	2.8	U	3.7	1.0	ng/L		06/07/18 10:14	06/25/18 06:01	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*75*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*
13C4-PFHpA	*89*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*
13C4 PFOA	*85*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*
13C5 PFNA	*88*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*
18O2 PFHxS	*79*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*

Client Sample ID: HEC-ER-SB-03 Lab Sample ID: 320-39942-19

Date Collected: 05/31/18 11:57 **Matrix: Water**
Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFOS	*77*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*

Client Sample ID: HEC02-SB1-01 Lab Sample ID: 320-39942-20

Date Collected: 05/31/18 11:05 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 80.6**

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.65**			0.37	0.096	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorooctanoic acid (PFOA)	**2.2**			0.37	0.12	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorononanoic acid (PFNA)	**0.71**			0.37	0.099	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorobutanesulfonic acid (PFBS)	0.22	U M	U	0.49	0.072	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorohexanesulfonic acid (PFHxS)	**2.7**	**J1**	J H01	0.37	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorooctanesulfonic acid (PFOS)	**17**	**J1**	=	1.2	0.29	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
13C4-PFHpA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
13C4 PFOA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
13C5 PFNA	*75*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
18O2 PFHxS	*60*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
13C4 PFOS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*

Client Sample ID: HEC02-SB1-02 Lab Sample ID: 320-39942-21

Date Collected: 05/31/18 11:37 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 76.5**

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**1.3**		0.39	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorooctanoic acid (PFOA)	**1.1**		0.39	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorononanoic acid (PFNA)	**0.49**		0.39	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorobutanesulfonic acid (PFBS)	0.23	U	0.52	0.077	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorohexanesulfonic acid (PFHxS)	**3.3**		0.39	0.081	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorooctanesulfonic acid (PFOS)	**20**		1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
13C4-PFHpA	*72*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
13C4 PFOA	*69*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
13C5 PFNA	*68*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
18O2 PFHxS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
13C4 PFOS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*

Client Sample ID: HEC02-SB1-02D

Lab Sample ID: 320-39942-22

Date Collected: 05/31/18 11:37
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 72.4

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.6		0.41	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorooctanoic acid (PFOA)	1.3		0.41	0.14	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorononanoic acid (PFNA)	0.76		0.41	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorobutanesulfonic acid (PFBS)	0.083	J	0.55	0.081	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorohexanesulfonic acid (PFHxS)	3.8		0.41	0.085	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorooctanesulfonic acid (PFOS)	29	M E*	1.4	0.33	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
13C4-PFHpA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
13C4 PFOA	*77*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
13C5 PFNA	*74*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
13C4 PFOS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.7	D *	0.82	0.21	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorooctanoic acid (PFOA)	1.6	D *	0.82	0.27	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorononanoic acid (PFNA)	0.81	J D *	0.82	0.22	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorobutanesulfonic acid (PFBS)	0.49	U *	1.1	0.16	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorohexanesulfonic acid (PFHxS)	3.9	D *	0.82	0.17	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorooctanesulfonic acid (PFOS)	30	D =	2.7	0.66	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*66*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
13C4-PFHpA	*76*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
13C4 PFOA	*74*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
13C5 PFNA	*70*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
18O2 PFHxS	*71*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
13C4 PFOS	*69*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*

LEIDOS
Laboratory Data Verification Checklist

Project: Hector

SDG No: J40148

Analyte Group: PFCs
Sample Matrix: Water/Soil
EDD (Y/N):

Disposition of Data Package:
NCR No. (if applicable):

1. Case Narrative

Read SDG Case Narrative	Y
Check Laboratory sample ID vs. Project sample ID lists	Y
Check that discussion covers each analytical type included in the SDG	Y
Check for identified nonconforming items (e.g., missed holding times, etc.)	Y

2. Chain-of-Custody (COC)

Check COC sample collection, shipping, and receiving dates	Y
Check that COC signature blocks are complete	Y
Check COC project sample IDs vs. Lab IDs and Result Form IDs	Y
Match COC requested analyses with Case Narrative and with data package content (Result Forms)	Y

3. Analytical Results Form

Verify that a Result Form is present for each sample and analysis	Y
On each Result Form check:	
SDG No.	Y
Sample ID	Y
Lab ID	Y
Date Collected	Y
Date Extracted	Y
Date Analyzed	Y
Result Matrix	Y
Result Units	Y

4. Project Verification

Check project analyte list vs. analytes reported	Y
Check project requested methods vs. analytical methods performed	Y
Check analyte reporting levels vs. project reporting level goals	Y

5. Analytical Quality Control Information

Check for surrogate recovery results (e.g., org. form II)		Y
Check for LCS results (e.g., org. form III, inorg. form XII)		Y
Check for method blank results (e.g., org. form IV, inorg. form III)		Y
Check for MS/MSD results (e.g., inorg. form V)		Y
Check for laboratory duplicate results (e.g., inorg. form VI)		NA
Check for Method Calibration and Run Documentation		
organic:	instrument performance check	Y
	initial calibration data	Y
	continuing calibration data	Y
	internal standard areas	Y
	internal standard retention times	Y
	sample clean-up documentation	Y
	(org. forms V through X)	
metal:	initial calibration data	
	continuing calibration data	
	method detection limits	
	method linear range	
	sample run sequence	
	(inorg. forms II, IV, and VIII through XIV)	
other:	initial calibration data	
	continuing calibration data	
	method detection limits	
	sample run sequence	

6. Incorrect Information

Identify missing items or incorrect information (i.e., missing forms, unsigned forms, incorrect sample IDs, etc.)

Contact the laboratory or project personnel to obtain missing information or correct information

Document corrections below:

7. Nonconforming Items

Document all nonconforming items that can not be resolved above in a Non-Conformance Report (NCR), complete form, file, and follow-up

NCR #	Item

Reviewed By: Brooke Francis Date: 7/12/18

QA Review By: Joseph C Peters Date: 7/19/18

LEIDOS
Laboratory Data Package Detail Form

Project: Hector

Page 1 of 1

SDG No: J40148

Analyte Group: PFCs

SEE ATTACHED

Field Sample ID	Lab ID #	Matrix	Analysis	Notes:

Comments:

Sample Summary

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-40148-1	HEC-ER-SB-04	Water	06/03/18 10:00	06/08/18 09:00
320-40148-2	HEC01-SB1-01	Solid	06/03/18 10:15	06/08/18 09:00
320-40148-3	HEC01-SB1-02	Solid	06/03/18 11:05	06/08/18 09:00
320-40148-4	HEC01-SB1-02D	Solid	06/03/18 11:05	06/08/18 09:00
320-40148-5	HEC01-SB3-01	Solid	06/03/18 12:20	06/08/18 09:00
320-40148-6	HEC01-SB3-01D	Solid	06/03/18 12:20	06/08/18 09:00
320-40148-7	HEC01-SB3-02	Solid	06/03/18 12:45	06/08/18 09:00
320-40148-8	HEC01-SB2-01	Solid	06/03/18 13:35	06/08/18 09:00
320-40148-9	HEC01-SB2-02	Solid	06/03/18 13:55	06/08/18 09:00
320-40148-10	HEC03-SB2-01	Solid	06/03/18 15:10	06/08/18 09:00
320-40148-11	HEC03-SB2-02	Solid	06/03/18 15:40	06/08/18 09:00
320-40148-12	HEC-IDW-S-01	Solid	06/03/18 17:25	06/08/18 09:00
320-40148-13	HEC07-SB3-01	Solid	06/04/18 07:35	06/08/18 09:00
320-40148-14	HEC07-SB3-02	Solid	06/04/18 08:03	06/08/18 09:00
320-40148-15	HEC07-SB2-01	Solid	06/04/18 09:03	06/08/18 09:00
320-40148-16	HEC07-SB2-02	Solid	06/04/18 09:35	06/08/18 09:00
320-40148-17	HEC07-SB1-01	Solid	06/04/18 11:10	06/08/18 09:00
320-40148-18	HEC07-SB1-02	Solid	06/04/18 11:38	06/08/18 09:00
320-40148-19	HEC09-SB1-01	Solid	06/04/18 13:17	06/08/18 09:00
320-40148-20	HEC09-SB1-02	Solid	06/04/18 13:47	06/08/18 09:00
320-40148-21	HEC03-SB1-01	Solid	06/04/18 14:55	06/08/18 09:00
320-40148-22	HEC03-SB1-02	Solid	06/04/18 15:25	06/08/18 09:00
320-40148-23	HEC-ER-SW-01	Water	06/05/18 13:00	06/08/18 09:00
320-40148-24	HEC10-SW1-01	Water	06/05/18 13:10	06/08/18 09:00
320-40148-25	MW-HEC06-01-01	Water	06/06/18 08:00	06/08/18 09:00
320-40148-26	MW11-15-PRL02-01	Water	06/06/18 10:35	06/08/18 09:00
320-40148-27	MW-HEC05-01-01	Water	06/06/18 13:27	06/08/18 09:00
320-40148-28	MW11-05-PRL02-01	Water	06/06/18 15:23	06/08/18 09:00
320-40148-29	HEC-ER-MW-01	Water	06/06/18 15:50	06/08/18 09:00
320-40148-30	MW-HEC02-01-01	Water	06/06/18 18:03	06/08/18 09:00
320-40148-31	MW-HEC02-01-01D	Water	06/06/18 18:03	06/08/18 09:00
320-40148-32	MW-HEC01-01-01	Water	06/07/18 09:10	06/08/18 09:00
320-40148-33	MW-HEC01-01-01D	Water	06/07/18 09:10	06/08/18 09:00
320-40148-34	MW-HEC07-01-01	Water	06/07/18 11:17	06/08/18 09:00
320-40148-35	MW-HEC07-02-01	Water	06/07/18 13:07	06/08/18 09:00

Leidos - Horsham Project Specific
PFASs by LC/MS/MS Methods Data Verification/Validation

Project: Hector

SDG No: J40148

Analysis: PFC

Method: E537

Laboratory: Test America

Matrix: Water/Soil

The above data package has been reviewed and the analytical quality control/quality assurance performance data have been summarized. The general criteria used to assess the analytical integrityof the data were based on DOD QSM 5.1 guidance and examination of the following:

Case Narrative	Instrument Sensitivity Checks
Analytical Holding Times	Internal Standard Performance
Sample Preservation	MS/MSD Recoveries and Differences
Method Calibration	LCS Recoveries
Method and Project Blanks	Re-analysis and Secondary Dilution

Project Specific QA/QC or contract requirements may take priority over validation criteria in this procedure.

*** If this SDG requires full validation; recalculations from the raw data are required for one point for each ICAL, one CCV, one of each QC sample, and one field sample.**

Data verification and data validation are essentially identical, with the exception that validation requires results to be recalculated from the raw data.

Remarks: DoD QSM

Some results were qualified as estimated due to IS, surrogate, and MS/MSD discrepancies ; also one missed holding time

Some results were qualified as non-detect due to blank contamination

QA review of data validation found no discrepancies.

Definition of Qualifiers:

"U", not detected at the associated level
"UJ", not detected and associated value estimated
"J", associated value estimated
"R", associated value unusable or analyte identity unfounded

Verification/Validation by: Brooke Francis Date: 7/12/18

QA Reviewed by: Joseph C Peters Date: 7/19/18

Case Narrative

Verify direct statements made within the Laboratory Case Narrative (note discrepancies).

Remarks: No additional discrepancies were noted

Re-analysis and Secondary Dilutions

Verify that re-analysis and secondary dilutions were performed and reported as necessary. Determine appropriate results to report.

Remarks: Some samples were reanalyzed at a dilution

Holding Times

Waters - Cool 4°C; 14 days to extraction; 28 days to analysis
collection. Note: Trizma preservative is recommended for aqueous samples, but not required.

Soils - Cool 4°C ; extraction within 28 days of sample collection; analysis within 28 days of sample extraction

Deviations:

Sample #	Date Collected	Date Analyzed	Comments
MW11-05-PRL02-01	6/6/18	6/28	Prepared 6/22

Actions:

1. If holding times are exceeded, all results are qualified as estimated (J/UJ)
2. If holding times are exceeded by more than 2X, reviewer may qualify non-detected results as unusable (R)

Remarks:

Injection Internal Standards (IS)

List any field samples, field QC samples, or laboratory QC samples where injection internal standards are not within 50 to 150% of the peak areas from the ICAL midpoint or daily inititial CCV, as applicable.

Deviations:

Sample #	Injection IS/% Rec	Affected PFAS Compounds
MW11-05PRL02-01	PFOA 1665732	All reported results J/UJ
HEC10-SW1-01DL	PFOA 229115	All reported results J/UJ
MW-11-05-PRL02-01DL	PFOA 49744	All reported results J/UJ
MW-HEC02-01-01DL	PFOA 1089112	All reported results J/UJ
MW-HEC02-01-01D DL	PFOA 1033702	All reported results J/UJ
MW-HEC07-01-01DL	PFOA 255431	All reported results J/UJ
HEC01-SB1-02D REDL	PFOA 244063	No results reported
	0……….+	

Actions:

If any injection IS is <25%, qualify detects as J; non-detects as R

If any Injection IS is > upper control limit; qualify detects as J, no action for non-detects

If any surrogate is ≥ 25%, but < the lower control limit, then qualify detects as J, non-detects as UJ

Injection IS - Target PFAS Compounds Associations:

~~13C3-PFBA: PFBS~~

~~13C2-PFOA: PFOA, PFHxS, PFHpA~~

~~13C4-PFOS: PFOS, PFNA~~

~~13C2-PFDA: No PFAS project compounds~~

IS PFOA is associated with all target analytes

Remarks:

FORM VIII
LCMS INTERNAL STANDARD AREA AND RETENTION TIME SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-40148-1

SDG No.:

Sample No.: IC 320-231529/5   Date Analyzed: 06/28/2018 13:24

Instrument ID: A8_N   GC Column: GeminiC18 3x100   ID: 3(mm)

Lab File ID (Standard): 2018.06.28LLICAL_00   Heated Purge: (Y/N) N

Calibration ID: 39856

		13PFOA					
		AREA #	RT #	AREA #	RT #	AREA #	RT #
INITIAL CALIBRATION MID-POINT		3739665	2.64				
UPPER LIMIT		5609528	2.84				
LOWER LIMIT		1869843	2.44				
LAB SAMPLE ID	CLIENT SAMPLE ID						
ICB 320-231529/9		3924045	2.63				
ICV 320-231529/10		4017500	2.64				
CCV 320-231593/1		3709171	2.65				
320-40148-28 REDL	MW11-05-PRL02-01 REDL	267668Q	2.64				
CCV 320-231593/6		3808419	2.64				
CCV 320-231597/1		3755105	2.64				
320-40148-2 DL	HEC01-SB1-01 DL	260275Q	2.64				
320-40148-2 MS DL	HEC01-SB1-01 MS DL	235838Q	2.64				
320-40148-2 MSD DL	HEC01-SB1-01 MSD DL	232671Q	2.64				
320-40148-3 DL	HEC01-SB1-02 DL	231410Q	2.64				
320-40148-4 DL	HEC01-SB1-02D DL	222093Q	2.64				
320-40148-5 DL	HEC01-SB3-01 DL	433423Q	2.64				
320-40148-6 DL	HEC01-SB3-01D DL	466538Q	2.64				
320-40148-7 DL	HEC01-SB3-02 DL	459243Q	2.64				
CCV 320-231597/12		3812362	2.65				
320-40148-8 DL	HEC01-SB2-01 DL	453114Q	2.65				
320-40148-9 DL	HEC01-SB2-02 DL	436785Q	2.66				
320-40148-10 DL	HEC03-SB2-01 DL	439669Q	2.65				
320-40148-11 DL	HEC03-SB2-02 DL	435232Q	2.66				
CCV 320-231597/22		3733211	2.65				
320-40148-11	HEC03-SB2-02	3774308	2.64				
320-40148-13 DL	HEC07-SB3-01 DL	497242Q	2.65				
320-40148-15 DL	HEC07-SB2-01 DL	449283Q	2.65				
320-40148-17 DL	HEC07-SB1-01 DL	468357Q	2.66				
320-40148-19 DL	HEC09-SB1-01 DL	432887Q	2.65				
320-40148-21 DL	HEC03-SB1-01 DL	241439Q	2.64				
320-40148-22 DL	HEC03-SB1-02 DL	489357Q	2.65				
CCV 320-231597/33		3688162	2.64				

13PFOA = 13C2-PFOA

Area Limit = 50%-150% of internal standard area
RT Limit = ± 0.2 minutes of internal standard RT

Column used to flag values outside QC limits

FORM VIII EPA 537 (MOD)

Surrogates/Extraction Internal Standards (IS)

List any field samples, field QC samples, or laboratory QC samples where surrogates/extraction internal standards are not within 50% ± of their true value.

Note: Extraction Internal Standards and surrogates are the same thing. For purposes of data validation and applying validation reason codes, they will be treated as surrogates. Injection internal standards will be treated as internal standards and the use of internal standard reason codes will be used.

Deviations:

Sample #	Surrogate - % Rec	Affected PFAS Compounds
HEC01-SB1-01	PFNA 45% PFOS 45%	Results qualified J/UJ
MW11-05-PRL02-01	PFBS 287% PFHpA 26%	
MW11-05-PRL02-01DL	PFBS 425% PFHxS 155%	
HEC01-SB1-02D	PFBS 34% PFHpA 42%	
	PFHxS 31%	
	PFOS 38%	
HEC01-SB1-02D DL	PFBS 43%	
	PFHxS 36%	
	PFOS 39%	
HEC01-SB2-01	PFNA 11% PFOS 8%	
MW11-05-PRL02-01	PFHpA 45%	
HEC01-SB2-01DL	PFNA 38% PFOS 46%	
HEC-10SB2-01RE	PFNA 21% PFOS 16%	
HEC03-SB2-01	PFNA 33% PFOS 28%	

Actions: HEC03-SB1-01 PFNA 47% PFOS 48%

If any injection IS is <25%, qualify detects as J; non-detects as R

If any Injection IS is > upper control limit; qualify detects as J, no action for non-detects

If any surrogate is ≥ 25%, but < the lower control limit, then qualify detects as J, non-detects as UJ

Surrogate - Target PFAS Compounds Associations:

13C3-PFBS - PFBS
13C3-PFHxS - PFHxS
13C4-PFHpA - PFHpA
13C8-PFOA - PFOA
13C9-PFNA - PFNA
13C8-PFOS - PFOS

Remarks: ______________________

VI. Blanks

A method blank was reported for each aqueous analytical batch and one method blank was reported for each soil extraction batch? (Y/N) — Y circled

Review associated laboratory and project blank samples. List documented contamination below:

Laboratory Method Blanks:

Date:	Sample ID #	Compound	Conc.

Associated Project Blanks (e.g., equipment rinsates, field reagent blanks, source blanks, etc.)

Date	Sample ID #	Compound	Conc.

Remarks: MBs and ER were free from contamination

VI. Blanks (continued)

Calculate the action level based on 5X the highest blank concentration

Sample weights, volumes, and dilution factors must be taken into account when applying the 5X criteria.

0.00870 ng/mL * 10mL/0.250L =

0.00870 ng/mL * 10mL * 5g * 1000g/1kg * 1ug/1000ng = 0.0870 ug/kg

Deviations:

Compound	Maximum Conc. Detected, (ppb)	Action Level (ppb)	Samples Affected
PFHxS	0.00870 ng/mL	0.0870 ug/kg or 1.74 ng/L	CCB, all samples

Actions:

1. If compound results exceed the action levels, the data are not qualified
2. If compound results are below the required reporting level, report results as non-detect (U) at the LOD
3. If the compound is detected above the reporting level, but below the action level, qualify as not-detected (U)
4. If contamination exists in method blanks < 1/2 LOQ, samples must be re-extracted and reanalyzed.
   Unlesss the MB results are < 1/10 the amount in associated samples or < 10 the action level, which ever is greater

Remarks:

VII. Initial & Contining Calibration

Date of initial calibration: ____________________

%RSD of RFs < 20% or $r^2 \geq 0.99$ for each analyte?
Analytes within 70-130% of their true value in each ICAL standard?
ICV within ± 30% of true value?

Date(s) of continuing calibration: ____________________

CCV analyzed at beginning and end of analytical sequence and after every 10 field samples?
CCV within ± 30% of true value?

Instrument sensitivity check (ISC) performed at the LOQ prior to analysis and every 12 hours?
ICS within ± 30% of true value?

Deviations:

Compound	Date	r value	%Drift	Samples Affected

Actions:

1. If initial calibration curve criteria are not met, qualify positive results as estimated (J) and non-detects as estimated (UJ), using professional judgement (i.e. if only the low standard is out, and the higher stards are in, then only qualify those results near the low standard).
2. Only evaluate the ICV if it brackets field samples. If the ICV does bracket field samples, then CCV actions apply
3. If a CCV is above the upper control limit, qualify detects as estimated (J). Nondects require no action.
4. If a CCV is below the lower control limit but > 40% recovery, qualify results as estimated (J/UJ).
5. If a CCV is ≤ 40% recovery, qualify detects as estimated (J) and nondetects as rejected (R)
6. If CCVs were not analyzed at the proper frequency, use professional judgement.
7. If ISC is > UCL, estimate (J) detects, no action for non-detects; If ISC is < LCL, estimate data (J/UJ), if ISC is < 30% reject (R) non-detects

Remarks: All calibration results met control limits

IX. Matrix Spike/Matrix Spike Duplicate Information

General MS/MSD Criteria:

percent recovery (%R) in-house limits

relative percent difference (RPD) 30% RPD

Project Sample(s) Spiked: HEC01-SB1-01, HEC01-SB1-01DL, HEC01-SB1-02D, HEC01-SB1-02D DL
MW-HEC06-01-01

Deviations:

Compound	%R	%R Limits	RPD	RPD Limits	Samples Affected
PFOA	74/67%	76-121%			HEC01-SB1-01
PFHxS	-51/-12%	75-121%			>4x spike
PFOS	140/200%	69-131%			>4x spike
PFHpA	132/155%	76-124%			HEC01-SB1-01DL
PFOA	63/65%	76-121%			
PFBS	164/162%	73-142%			
PFHxS	-23/-2%	75-121%			>4x spike
PFOS	-1155/-44%	69-131%			>4x spike
PFBS	144%	73-142			HEC01-SB1-02D RE >4x spike
PFHxS	1543/1111%	75-121			>4x spike
PFOS	-138/102%	69-131			>4x spike
PFHxS	3149/1415	75-121			HEC01-SB1-02D REDL >4x spike
PFOS	-95/-91%	69-131			>4x spike
PFHxS	117%	81-106			MW-HEC06-01-01
PFOS	76/80%	82-112			

Actions:

1. If the spike recovery is above the upper control limit (UCL), qualify all positive values in the unspiked sample as estimated (J) and non-detects as estimated (UJ).
2. If the spike recovery is below the lower control limit (LCL), qualifty positive values as estimated (J). And non-detects as estimated (UJ).
3. If the spike recovery is <10%, qualify non-detect values as unusable (R)
4. If the RPD does not meet criteria, qualify positive values in the unspiked sample as estimated (J)
5. Use professional judgement to qualify additional samples in the analytical group based on MS/MSD results
6. Use professional judgement for qualification of data for unspiked compounds

*** If this SDG requires full validation; recalculate at least one % recovery and one % RPD from the raw data. Attach all calculations at the end of the validation checklist.**

Remarks:

X. Laboratory Control Sample Information

General LCS Criteria:
Percent recovery (%R) = in-house limits
RPD if LCSD performed = 30% RPD

Laboratory LCS Identifications: LCS 320-228993, LCS 320-231862, LCS/D 320-230410, LCS 320-228628

Deviations:

Compound	Date	%R	Samples Affected/Qualifiers Applied

Actions:

*** If this SDG requires full validation; recalculate at least one % recovery and one % RPD (if LCSD was performed) from the raw data. Attach all calculations at the end of the validation checklist.**

Action should be based on both the number of compounds outside the criterion and the magnitude of the exceedance.

1. If the LCS recovery is below limits but > one- half the lower limit, qualify valves as estimated (J/UJ).
2. If the LCS recovery is < one-half the lower limit, qualify detect (J) and non-detects (R)
3. If the LCS recovery is greater than the upper limit, qualify positive valves for that analyte as estimated (J).

5. Use professional judgement for qualification of data for compounds with no LCS information

Remarks: All LCS %R and RPD results met control limits

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40148-1

Client Sample ID: HEC-ER-SB-04

Lab Sample ID: 320-40148-1

Date Collected: 06/03/18 10:00
Date Received: 06/08/18 09:00

Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.8	0.56	ng/L		06/12/18 11:13	06/17/18 09:54	1
Perfluorooctanoic acid (PFOA)	1.4	U M U	1.8	0.50	ng/L		06/12/18 11:13	06/17/18 09:54	1
Perfluorononanoic acid (PFNA)	1.4	U	1.8	0.48	ng/L		06/12/18 11:13	06/17/18 09:54	1
Perfluorobutanesulfonic acid (PFBS)	0.92	U	1.8	0.42	ng/L		06/12/18 11:13	06/17/18 09:54	1
Perfluorohexanesulfonic acid (PFHxS)	0.92	U	1.8	0.35	ng/L		06/12/18 11:13	06/17/18 09:54	1
Perfluorooctanesulfonic acid (PFOS)	2.8	U	3.7	1.0	ng/L		06/12/18 11:13	06/17/18 09:54	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*82*		*50 - 150*	*06/12/18 11:13*	*06/17/18 09:54*	*1*
13C4-PFHpA	*90*		*50 - 150*	*06/12/18 11:13*	*06/17/18 09:54*	*1*
13C4 PFOA	*92*		*50 - 150*	*06/12/18 11:13*	*06/17/18 09:54*	*1*
13C5 PFNA	*89*		*50 - 150*	*06/12/18 11:13*	*06/17/18 09:54*	*1*
18O2 PFHxS	*87*		*50 - 150*	*06/12/18 11:13*	*06/17/18 09:54*	*1*
13C4 PFOS	*83*		*50 - 150*	*06/12/18 11:13*	*06/17/18 09:54*	*1*

Client Sample ID: HEC01-SB1-01

Lab Sample ID: 320-40148-2

Date Collected: 06/03/18 10:15
Date Received: 06/08/18 09:00

Matrix: Solid
Percent Solids: 66.1

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**1.1**		0.45	0.12	ug/Kg	☼	06/14/18 04:15	06/28/18 06:44	1
Perfluorooctanoic acid (PFOA)	**6.6**	**J1** J H02	0.45	0.15	ug/Kg	☼	06/14/18 04:15	06/28/18 06:44	1
Perfluorononanoic acid (PFNA)	**1.0**	J G02	0.45	0.12	ug/Kg	☼	06/14/18 04:15	06/28/18 06:44	1
Perfluorobutanesulfonic acid (PFBS)	**1.3**		0.60	0.089	ug/Kg	☼	06/14/18 04:15	06/28/18 06:44	1
Perfluorohexanesulfonic acid (PFHxS)	**26**	**J1** =	0.45	0.093	ug/Kg	☼	06/14/18 04:15	06/28/18 06:44	1
Perfluorooctanesulfonic acid (PFOS)	**230**	**E M J1** *	1.5	0.36	ug/Kg	☼	06/14/18 04:15	06/28/18 06:44	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*57*		*50 - 150*	*06/14/18 04:15*	*06/28/18 06:44*	*1*
13C4-PFHpA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 06:44*	*1*
13C4 PFOA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 06:44*	*1*
13C5 PFNA	*45*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 06:44*	*1*
18O2 PFHxS	*55*		*50 - 150*	*06/14/18 04:15*	*06/28/18 06:44*	*1*
13C4 PFOS	*45*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 06:44*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	6.0	U J1 *	9.0	2.3	ug/Kg	☼	06/14/18 04:15	06/28/18 16:08	20
Perfluorooctanoic acid (PFOA)	**6.9**	**J D M J1** *	9.0	3.0	ug/Kg	☼	06/14/18 04:15	06/28/18 16:08	20
Perfluorononanoic acid (PFNA)	6.0	U *	9.0	2.4	ug/Kg	☼	06/14/18 04:15	06/28/18 16:08	20
Perfluorobutanesulfonic acid (PFBS)	5.4	U J1 *	12	1.8	ug/Kg	☼	06/14/18 04:15	06/28/18 16:08	20
Perfluorohexanesulfonic acid (PFHxS)	**25**	**D J1** *	9.0	1.9	ug/Kg	☼	06/14/18 04:15	06/28/18 16:08	20
Perfluorooctanesulfonic acid (PFOS)	**360**	**D M J1** J K01	30	7.2	ug/Kg	☼	06/14/18 04:15	06/28/18 16:08	20

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*59*	*M*	*50 - 150*	*06/14/18 04:15*	*06/28/18 16:08*	*20*
13C4-PFHpA	*62*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:08*	*20*

Client Sample ID: HEC01-SB1-01

Lab Sample ID: 320-40148-2

Date Collected: 06/03/18 10:15
Date Received: 06/08/18 09:00

Matrix: Solid
Percent Solids: 66.1

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFOA	67		50 - 150	06/14/18 04:15	06/28/18 16:08	20
13C5 PFNA	64		50 - 150	06/14/18 04:15	06/28/18 16:08	20
18O2 PFHxS	58		50 - 150	06/14/18 04:15	06/28/18 16:08	20
13C4 PFOS	55		50 - 150	06/14/18 04:15	06/28/18 16:08	20

Client Sample ID: HEC01-SB1-02

Lab Sample ID: 320-40148-3

Date Collected: 06/03/18 11:05
Date Received: 06/08/18 09:00

Matrix: Solid
Percent Solids: 73.8

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	4.0		0.39	0.10	ug/Kg	☼	06/14/18 04:15	06/28/18 07:08	1
Perfluorooctanoic acid (PFOA)	19		0.39	0.13	ug/Kg	☼	06/14/18 04:15	06/28/18 07:08	1
Perfluorononanoic acid (PFNA)	0.26	U	0.39	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 07:08	1
Perfluorobutanesulfonic acid (PFBS)	11		0.53	0.078	ug/Kg	☼	06/14/18 04:15	06/28/18 07:08	1
Perfluorohexanesulfonic acid (PFHxS)	150	E *	0.39	0.082	ug/Kg	☼	06/14/18 04:15	06/28/18 07:08	1
Perfluorooctanesulfonic acid (PFOS)	6.1		1.3	0.32	ug/Kg	☼	06/14/18 04:15	06/28/18 07:08	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	63		50 - 150	06/14/18 04:15	06/28/18 07:08	1
13C4-PFHpA	52		50 - 150	06/14/18 04:15	06/28/18 07:08	1
13C4 PFOA	73		50 - 150	06/14/18 04:15	06/28/18 07:08	1
13C5 PFNA	78		50 - 150	06/14/18 04:15	06/28/18 07:08	1
18O2 PFHxS	52		50 - 150	06/14/18 04:15	06/28/18 07:08	1
13C4 PFOS	64		50 - 150	06/14/18 04:15	06/28/18 07:08	1

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	4.0	J D *	7.9	2.1	ug/Kg	☼	06/14/18 04:15	06/28/18 16:32	20
Perfluorooctanoic acid (PFOA)	19	D *	7.9	2.6	ug/Kg	☼	06/14/18 04:15	06/28/18 16:32	20
Perfluorononanoic acid (PFNA)	5.3	U *	7.9	2.1	ug/Kg	☼	06/14/18 04:15	06/28/18 16:32	20
Perfluorobutanesulfonic acid (PFBS)	9.7	J D M *	11	1.6	ug/Kg	☼	06/14/18 04:15	06/28/18 16:32	20
Perfluorohexanesulfonic acid (PFHxS)	190	D J K01	7.9	1.6	ug/Kg	☼	06/14/18 04:15	06/28/18 16:32	20
Perfluorooctanesulfonic acid (PFOS)	13	U *	26	6.3	ug/Kg	☼	06/14/18 04:15	06/28/18 16:32	20

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	80	M	50 - 150	06/14/18 04:15	06/28/18 16:32	20
13C4-PFHpA	73		50 - 150	06/14/18 04:15	06/28/18 16:32	20
13C4 PFOA	74		50 - 150	06/14/18 04:15	06/28/18 16:32	20
13C5 PFNA	75		50 - 150	06/14/18 04:15	06/28/18 16:32	20
18O2 PFHxS	68		50 - 150	06/14/18 04:15	06/28/18 16:32	20
13C4 PFOS	65		50 - 150	06/14/18 04:15	06/28/18 16:32	20

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40148-1

Client Sample ID: HEC01-SB1-02D

Date Collected: 06/03/18 11:05
Date Received: 06/08/18 09:00

Lab Sample ID: 320-40148-4

Matrix: Solid
Percent Solids: 77.4

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	3.7	J G02	0.38	0.10	ug/Kg	☼	06/14/18 04:15	06/28/18 07:16	1
Perfluorooctanoic acid (PFOA)	23		0.38	0.13	ug/Kg	☼	06/14/18 04:15	06/28/18 07:16	1
Perfluorononanoic acid (PFNA)	0.11	J	0.38	0.10	ug/Kg	☼	06/14/18 04:15	06/28/18 07:16	1
Perfluorobutanesulfonic acid (PFBS)	9.1	J G02	0.51	0.075	ug/Kg	☼	06/14/18 04:15	06/28/18 07:16	1
Perfluorohexanesulfonic acid (PFHxS)	170	E *	0.38	0.079	ug/Kg	☼	06/14/18 04:15	06/28/18 07:16	1
Perfluorooctanesulfonic acid (PFOS)	11	M J G02	1.3	0.31	ug/Kg	☼	06/14/18 04:15	06/28/18 07:16	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*34*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 07:16*	*1*
13C4-PFHpA	*42*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 07:16*	*1*
13C4 PFOA	*54*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:16*	*1*
13C5 PFNA	*60*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:16*	*1*
18O2 PFHxS	*31*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 07:16*	*1*
13C4 PFOS	*38*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 07:16*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	3.8	J D *	7.7	2.0	ug/Kg	☼	06/14/18 04:15	06/28/18 16:40	20
Perfluorooctanoic acid (PFOA)	25	D *	7.7	2.6	ug/Kg	☼	06/14/18 04:15	06/28/18 16:40	20
Perfluorononanoic acid (PFNA)	5.1	U *	7.7	2.1	ug/Kg	☼	06/14/18 04:15	06/28/18 16:40	20
Perfluorobutanesulfonic acid (PFBS)	7.7	J D M *	10	1.5	ug/Kg	☼	06/14/18 04:15	06/28/18 16:40	20
Perfluorohexanesulfonic acid (PFHxS)	240	D J K01 G02	7.7	1.6	ug/Kg	☼	06/14/18 04:15	06/28/18 16:40	20
Perfluorooctanesulfonic acid (PFOS)	12	J D *	26	6.1	ug/Kg	☼	06/14/18 04:15	06/28/18 16:40	20

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*43*	*M Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 16:40*	*20*
13C4-PFHpA	*53*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:40*	*20*
13C4 PFOA	*54*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:40*	*20*
13C5 PFNA	*55*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:40*	*20*
18O2 PFHxS	*36*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 16:40*	*20*
13C4 PFOS	*39*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 16:40*	*20*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - RE

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanesulfonic acid (PFBS)	12	J1 H *	0.51	0.075	ug/Kg	☼	06/30/18 10:10	07/03/18 07:07	1
Perfluorohexanesulfonic acid (PFHxS)	200	J1 H E	0.38	0.079	ug/Kg	☼	06/30/18 10:10	07/03/18 07:07	1
Perfluorooctanesulfonic acid (PFOS)	18	H J1	1.3	0.31	ug/Kg	☼	06/30/18 10:10	07/03/18 07:07	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*69*		*50 - 150*	*06/30/18 10:10*	*07/03/18 07:07*	*1*
18O2 PFHxS	*56*		*50 - 150*	*06/30/18 10:10*	*07/03/18 07:07*	*1*
13C4 PFOS	*75*		*50 - 150*	*06/30/18 10:10*	*07/03/18 07:07*	*1*

Client Sample ID: HEC01-SB1-02D

Lab Sample ID: 320-40148-4
Date Collected: 06/03/18 11:05
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 77.4

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - REDL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanesulfonic acid (PFBS)	13	H D *	10	1.5	ug/Kg	☼	06/30/18 10:10	07/04/18 11:33	20
Perfluorohexanesulfonic acid (PFHxS)	300	J1 H D *	7.7	1.6	ug/Kg	☼	06/30/18 10:10	07/04/18 11:33	20
Perfluorooctanesulfonic acid (PFOS)	18	J H J1 D *	26	6.1	ug/Kg	☼	06/30/18 10:10	07/04/18 11:33	20

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*74*		*50 - 150*	*06/30/18 10:10*	*07/04/18 11:33*	*20*
18O2 PFHxS	*75*		*50 - 150*	*06/30/18 10:10*	*07/04/18 11:33*	*20*
13C4 PFOS	*77*		*50 - 150*	*06/30/18 10:10*	*07/04/18 11:33*	*20*

Client Sample ID: HEC01-SB3-01

Lab Sample ID: 320-40148-5
Date Collected: 06/03/18 12:20
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 66.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3		0.44	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 07:23	1
Perfluorooctanoic acid (PFOA)	3.0		0.44	0.15	ug/Kg	☼	06/14/18 04:15	06/28/18 07:23	1
Perfluorononanoic acid (PFNA)	3.2		0.44	0.12	ug/Kg	☼	06/14/18 04:15	06/28/18 07:23	1
Perfluorobutanesulfonic acid (PFBS)	0.20	J	0.58	0.086	ug/Kg	☼	06/14/18 04:15	06/28/18 07:23	1
Perfluorohexanesulfonic acid (PFHxS)	10		0.44	0.090	ug/Kg	☼	06/14/18 04:15	06/28/18 07:23	1
Perfluorooctanesulfonic acid (PFOS)	85	E *	1.5	0.35	ug/Kg	☼	06/14/18 04:15	06/28/18 07:23	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*54*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:23*	*1*
13C4-PFHpA	*68*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:23*	*1*
13C4 PFOA	*69*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:23*	*1*
13C5 PFNA	*58*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:23*	*1*
18O2 PFHxS	*54*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:23*	*1*
13C4 PFOS	*53*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:23*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3	J D *	4.4	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 16:48	10
Perfluorooctanoic acid (PFOA)	3.3	J D *	4.4	1.5	ug/Kg	☼	06/14/18 04:15	06/28/18 16:48	10
Perfluorononanoic acid (PFNA)	3.2	J D *	4.4	1.2	ug/Kg	☼	06/14/18 04:15	06/28/18 16:48	10
Perfluorobutanesulfonic acid (PFBS)	2.6	U *	5.8	0.86	ug/Kg	☼	06/14/18 04:15	06/28/18 16:48	10
Perfluorohexanesulfonic acid (PFHxS)	9.6	D *	4.4	0.90	ug/Kg	☼	06/14/18 04:15	06/28/18 16:48	10
Perfluorooctanesulfonic acid (PFOS)	110	D J K01	15	3.5	ug/Kg	☼	06/14/18 04:15	06/28/18 16:48	10

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*54*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:48*	*10*
13C4-PFHpA	*67*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:48*	*10*
13C4 PFOA	*68*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:48*	*10*
13C5 PFNA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:48*	*10*
18O2 PFHxS	*57*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:48*	*10*
13C4 PFOS	*61*		*50 - 150*	*06/14/18 04:15*	*06/28/18 16:48*	*10*

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40148-1

Client Sample ID: HEC01-SB3-01D

Lab Sample ID: 320-40148-6

Date Collected: 06/03/18 12:20
Date Received: 06/08/18 09:00
Matrix: Solid
Percent Solids: 74.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3		0.40	0.10	ug/Kg	☼	06/14/18 04:15	06/28/18 07:39	1
Perfluorooctanoic acid (PFOA)	3.2		0.40	0.13	ug/Kg	☼	06/14/18 04:15	06/28/18 07:39	1
Perfluorononanoic acid (PFNA)	2.9		0.40	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 07:39	1
Perfluorobutanesulfonic acid (PFBS)	0.22	J	0.53	0.078	ug/Kg	☼	06/14/18 04:15	06/28/18 07:39	1
Perfluorohexanesulfonic acid (PFHxS)	11		0.40	0.082	ug/Kg	☼	06/14/18 04:15	06/28/18 07:39	1
Perfluorooctanesulfonic acid (PFOS)	78	E *	1.3	0.32	ug/Kg	☼	06/14/18 04:15	06/28/18 07:39	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*51*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:39*	*1*
13C4-PFHpA	*69*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:39*	*1*
13C4 PFOA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:39*	*1*
13C5 PFNA	*58*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:39*	*1*
18O2 PFHxS	*53*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:39*	*1*
13C4 PFOS	*52*		*50 - 150*	*06/14/18 04:15*	*06/28/18 07:39*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.2	J D *	4.0	1.0	ug/Kg	☼	06/14/18 04:15	06/28/18 17:11	10
Perfluorooctanoic acid (PFOA)	3.2	J D *	4.0	1.3	ug/Kg	☼	06/14/18 04:15	06/28/18 17:11	10
Perfluorononanoic acid (PFNA)	3.1	J D *	4.0	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 17:11	10
Perfluorobutanesulfonic acid (PFBS)	2.4	U *	5.3	0.78	ug/Kg	☼	06/14/18 04:15	06/28/18 17:11	10
Perfluorohexanesulfonic acid (PFHxS)	9.7	D *	4.0	0.82	ug/Kg	☼	06/14/18 04:15	06/28/18 17:11	10
Perfluorooctanesulfonic acid (PFOS)	98	D M =	13	3.2	ug/Kg	☼	06/14/18 04:15	06/28/18 17:11	10

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*58*		*50 - 150*	*06/14/18 04:15*	*06/28/18 17:11*	*10*
13C4-PFHpA	*73*		*50 - 150*	*06/14/18 04:15*	*06/28/18 17:11*	*10*
13C4 PFOA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 17:11*	*10*
13C5 PFNA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 17:11*	*10*
18O2 PFHxS	*61*		*50 - 150*	*06/14/18 04:15*	*06/28/18 17:11*	*10*
13C4 PFOS	*62*		*50 - 150*	*06/14/18 04:15*	*06/28/18 17:11*	*10*

Client Sample ID: HEC01-SB3-02

Lab Sample ID: 320-40148-7

Date Collected: 06/03/18 12:45
Date Received: 06/08/18 09:00
Matrix: Solid
Percent Solids: 70.0

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.83		0.42	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 07:47	1
Perfluorooctanoic acid (PFOA)	4.3		0.42	0.14	ug/Kg	☼	06/14/18 04:15	06/28/18 07:47	1
Perfluorononanoic acid (PFNA)	0.46		0.42	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 07:47	1
Perfluorobutanesulfonic acid (PFBS)	1.6		0.56	0.083	ug/Kg	☼	06/14/18 04:15	06/28/18 07:47	1
Perfluorohexanesulfonic acid (PFHxS)	29	E *	0.42	0.087	ug/Kg	☼	06/14/18 04:15	06/28/18 07:47	1
Perfluorooctanesulfonic acid (PFOS)	10		1.4	0.34	ug/Kg	☼	06/14/18 04:15	06/28/18 07:47	1

Client Sample ID: HEC01-SB3-02

Lab Sample ID: 320-40148-7

Date Collected: 06/03/18 12:45
Date Received: 06/08/18 09:00

Matrix: Solid
Percent Solids: 70.0

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	61		50 - 150	06/14/18 04:15	06/28/18 07:47	1
13C4-PFHpA	69		50 - 150	06/14/18 04:15	06/28/18 07:47	1
13C4 PFOA	75		50 - 150	06/14/18 04:15	06/28/18 07:47	1
13C5 PFNA	80		50 - 150	06/14/18 04:15	06/28/18 07:47	1
18O2 PFHxS	62		50 - 150	06/14/18 04:15	06/28/18 07:47	1
13C4 PFOS	62		50 - 150	06/14/18 04:15	06/28/18 07:47	1

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	2.8	U	*	4.2	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 17:19	10
Perfluorooctanoic acid (PFOA)	**4.5**	**D**	*	4.2	1.4	ug/Kg	☼	06/14/18 04:15	06/28/18 17:19	10
Perfluorononanoic acid (PFNA)	2.8	U	*	4.2	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 17:19	10
Perfluorobutanesulfonic acid (PFBS)	**1.6**	**J D M**	*	5.6	0.83	ug/Kg	☼	06/14/18 04:15	06/28/18 17:19	10
Perfluorohexanesulfonic acid (PFHxS)	**27**	**D**	J K01	4.2	0.87	ug/Kg	☼	06/14/18 04:15	06/28/18 17:19	10
Perfluorooctanesulfonic acid (PFOS)	**11**	**J D M**	*	14	3.4	ug/Kg	☼	06/14/18 04:15	06/28/18 17:19	10

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	68		50 - 150	06/14/18 04:15	06/28/18 17:19	10
13C4-PFHpA	76		50 - 150	06/14/18 04:15	06/28/18 17:19	10
13C4 PFOA	75		50 - 150	06/14/18 04:15	06/28/18 17:19	10
13C5 PFNA	76		50 - 150	06/14/18 04:15	06/28/18 17:19	10
18O2 PFHxS	71		50 - 150	06/14/18 04:15	06/28/18 17:19	10
13C4 PFOS	67		50 - 150	06/14/18 04:15	06/28/18 17:19	10

Client Sample ID: HEC01-SB2-01

Lab Sample ID: 320-40148-8

Date Collected: 06/03/18 13:35
Date Received: 06/08/18 09:00

Matrix: Solid
Percent Solids: 80.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**6.2**			0.37	0.095	ug/Kg	☼	06/14/18 04:15	06/28/18 07:55	1
Perfluorooctanoic acid (PFOA)	**18**			0.37	0.12	ug/Kg	☼	06/14/18 04:15	06/28/18 07:55	1
Perfluorononanoic acid (PFNA)	**28**	**E**	*	0.37	0.099	ug/Kg	☼	06/14/18 04:15	06/28/18 07:55	1
Perfluorobutanesulfonic acid (PFBS)	**50**	**E**	*	0.49	0.072	ug/Kg	☼	06/14/18 04:15	06/28/18 07:55	1
Perfluorohexanesulfonic acid (PFHxS)	**370**	**E**	*	0.37	0.075	ug/Kg	☼	06/14/18 04:15	06/28/18 07:55	1
Perfluorooctanesulfonic acid (PFOS)	**6700**	**E**	*	1.2	0.29	ug/Kg	☼	06/14/18 04:15	06/28/18 07:55	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	91		50 - 150	06/14/18 04:15	06/28/18 07:55	1
13C4-PFHpA	54		50 - 150	06/14/18 04:15	06/28/18 07:55	1
13C4 PFOA	72		50 - 150	06/14/18 04:15	06/28/18 07:55	1
13C5 PFNA	11	Q	50 - 150	06/14/18 04:15	06/28/18 07:55	1
18O2 PFHxS	50		50 - 150	06/14/18 04:15	06/28/18 07:55	1
13C4 PFOS	8	Q	50 - 150	06/14/18 04:15	06/28/18 07:55	1

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	24	U	*	37	9.5	ug/Kg	☼	06/14/18 04:15	06/28/18 17:50	100

Client Sample ID: HEC01-SB2-01

Date Collected: 06/03/18 13:35
Date Received: 06/08/18 09:00

Lab Sample ID: 320-40148-8
Matrix: Solid
Percent Solids: 80.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL (Continued)

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorooctanoic acid (PFOA)	19	J D *	37	12	ug/Kg	☼	06/14/18 04:15	06/28/18 17:50	100
Perfluorononanoic acid (PFNA)	31	J D J K01 G02	37	9.9	ug/Kg	☼	06/14/18 04:15	06/28/18 17:50	100
Perfluorobutanesulfonic acid (PFBS)	44	J D M J K01	49	7.2	ug/Kg	☼	06/14/18 04:15	06/28/18 17:50	100
Perfluorohexanesulfonic acid (PFHxS)	700	D J K01	37	7.5	ug/Kg	☼	06/14/18 04:15	06/28/18 17:50	100
Perfluorooctanesulfonic acid (PFOS)	20000	E D J N03 G02	120	29	ug/Kg	☼	06/14/18 04:15	06/28/18 17:50	100

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*97*	*M*	*50 - 150*	*06/14/18 04:15*	*06/28/18 17:50*	*100*
13C4-PFHpA	*66*		*50 - 150*	*06/14/18 04:15*	*06/28/18 17:50*	*100*
13C4 PFOA	*75*		*50 - 150*	*06/14/18 04:15*	*06/28/18 17:50*	*100*
13C5 PFNA	*38*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 17:50*	*100*
18O2 PFHxS	*67*		*50 - 150*	*06/14/18 04:15*	*06/28/18 17:50*	*100*
13C4 PFOS	*46*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 17:50*	*100*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - RE

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorononanoic acid (PFNA)	25	H *	1.8	0.49	ug/Kg	☼	06/30/18 10:13	07/03/18 07:30	1
Perfluorooctanesulfonic acid (PFOS)	11000	H E *	6.0	1.4	ug/Kg	☼	06/30/18 10:13	07/03/18 07:30	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C5 PFNA	*21*	*Q*	*50 - 150*	*06/30/18 10:13*	*07/03/18 07:30*	*1*
13C4 PFOS	*16*	*Q*	*50 - 150*	*06/30/18 10:13*	*07/03/18 07:30*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - REDL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorononanoic acid (PFNA)	120	U H *	180	49	ug/Kg	☼	06/30/18 10:13	07/03/18 13:49	100
Perfluorooctanesulfonic acid (PFOS)	22000	H E D *	600	140	ug/Kg	☼	06/30/18 10:13	07/03/18 13:49	100

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C5 PFNA	*78*		*50 - 150*	*06/30/18 10:13*	*07/03/18 13:49*	*100*
13C4 PFOS	*91*		*50 - 150*	*06/30/18 10:13*	*07/03/18 13:49*	*100*

Client Sample ID: HEC01-SB2-02

Date Collected: 06/03/18 13:55
Date Received: 06/08/18 09:00

Lab Sample ID: 320-40148-9
Matrix: Solid
Percent Solids: 74.6

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	2.5		0.40	0.10	ug/Kg	☼	06/14/18 04:15	06/28/18 08:03	1
Perfluorooctanoic acid (PFOA)	5.4		0.40	0.13	ug/Kg	☼	06/14/18 04:15	06/28/18 08:03	1
Perfluorononanoic acid (PFNA)	0.26	U	0.40	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 08:03	1
Perfluorobutanesulfonic acid (PFBS)	19		0.53	0.078	ug/Kg	☼	06/14/18 04:15	06/28/18 08:03	1
Perfluorohexanesulfonic acid (PFHxS)	83	E *	0.40	0.082	ug/Kg	☼	06/14/18 04:15	06/28/18 08:03	1
Perfluorooctanesulfonic acid (PFOS)	56	E M *	1.3	0.32	ug/Kg	☼	06/14/18 04:15	06/28/18 08:03	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*62*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:03*	*1*

Client Sample Results

Client: Leidos, Inc. TestAmerica Job ID: 320-40148-1
Project/Site: Phase III, ANG-Hector Field

Client Sample ID: HEC01-SB2-02 Lab Sample ID: 320-40148-9

Date Collected: 06/03/18 13:55 **Matrix: Solid**
Date Received: 06/08/18 09:00 **Percent Solids: 74.6**

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4-PFHpA	*57*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:03*	*1*
13C4 PFOA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:03*	*1*
13C5 PFNA	*64*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:03*	*1*
18O2 PFHxS	*57*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:03*	*1*
13C4 PFOS	*61*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:03*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**2.4**	**J D** *	4.0	1.0	ug/Kg	☼	06/14/18 04:15	06/28/18 18:06	10
Perfluorooctanoic acid (PFOA)	**5.5**	**D** *	4.0	1.3	ug/Kg	☼	06/14/18 04:15	06/28/18 18:06	10
Perfluorononanoic acid (PFNA)	2.6	U M *	4.0	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 18:06	10
Perfluorobutanesulfonic acid (PFBS)	**22**	**D** *	5.3	0.78	ug/Kg	☼	06/14/18 04:15	06/28/18 18:06	10
Perfluorohexanesulfonic acid (PFHxS)	**98**	**D** J K01	4.0	0.82	ug/Kg	☼	06/14/18 04:15	06/28/18 18:06	10
Perfluorooctanesulfonic acid (PFOS)	**120**	**D** J K01	13	3.2	ug/Kg	☼	06/14/18 04:15	06/28/18 18:06	10

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*68*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:06*	*10*
13C4-PFHpA	*76*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:06*	*10*
13C4 PFOA	*76*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:06*	*10*
13C5 PFNA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:06*	*10*
18O2 PFHxS	*74*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:06*	*10*
13C4 PFOS	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:06*	*10*

Client Sample ID: HEC03-SB2-01 Lab Sample ID: 320-40148-10

Date Collected: 06/03/18 15:10 **Matrix: Solid**
Date Received: 06/08/18 09:00 **Percent Solids: 78.6**

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**6.9**		0.38	0.098	ug/Kg	☼	06/14/18 04:15	06/28/18 08:10	1
Perfluorooctanoic acid (PFOA)	**23**		0.38	0.13	ug/Kg	☼	06/14/18 04:15	06/28/18 08:10	1
Perfluorononanoic acid (PFNA)	**10**	J G02	0.38	0.10	ug/Kg	☼	06/14/18 04:15	06/28/18 08:10	1
Perfluorobutanesulfonic acid (PFBS)	**2.0**		0.50	0.074	ug/Kg	☼	06/14/18 04:15	06/28/18 08:10	1
Perfluorohexanesulfonic acid (PFHxS)	**65**	**E** *	0.38	0.078	ug/Kg	☼	06/14/18 04:15	06/28/18 08:10	1
Perfluorooctanesulfonic acid (PFOS)	**660**	**E** *	1.3	0.30	ug/Kg	☼	06/14/18 04:15	06/28/18 08:10	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*62*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:10*	*1*
13C4-PFHpA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:10*	*1*
13C4 PFOA	*78*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:10*	*1*
13C5 PFNA	*33*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 08:10*	*1*
18O2 PFHxS	*58*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:10*	*1*
13C4 PFOS	*28*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 08:10*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	25	U *	38	9.8	ug/Kg	☼	06/14/18 04:15	06/28/18 18:29	100

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40148-1

Client Sample ID: HEC03-SB2-01

Lab Sample ID: 320-40148-10
Date Collected: 06/03/18 15:10
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 78.6

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL (Continued)

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorooctanoic acid (PFOA)	**22**	**J D**	*	38	13	ug/Kg	☼	06/14/18 04:15	06/28/18 18:29	100
Perfluorononanoic acid (PFNA)	**11**	**J D**	*	38	10	ug/Kg	☼	06/14/18 04:15	06/28/18 18:29	100
Perfluorobutanesulfonic acid (PFBS)	23	U	*	50	7.4	ug/Kg	☼	06/14/18 04:15	06/28/18 18:29	100
Perfluorohexanesulfonic acid (PFHxS)	**79**	**D**	J K01	38	7.8	ug/Kg	☼	06/14/18 04:15	06/28/18 18:29	100
Perfluorooctanesulfonic acid (PFOS)	**1200**	**D**	J K01	130	30	ug/Kg	☼	06/14/18 04:15	06/28/18 18:29	100

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*52*	*M*	*50 - 150*	*06/14/18 04:15*	*06/28/18 18:29*	*100*
13C4-PFHpA	*74*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:29*	*100*
13C4 PFOA	*82*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:29*	*100*
13C5 PFNA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:29*	*100*
18O2 PFHxS	*60*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:29*	*100*
13C4 PFOS	*63*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:29*	*100*

Client Sample ID: HEC03-SB2-02

Lab Sample ID: 320-40148-11
Date Collected: 06/03/18 15:40
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 66.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**2.7**			0.44	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 18:53	1
Perfluorooctanoic acid (PFOA)	**26**			0.44	0.15	ug/Kg	☼	06/14/18 04:15	06/28/18 18:53	1
Perfluorononanoic acid (PFNA)	0.29	U		0.44	0.12	ug/Kg	☼	06/14/18 04:15	06/28/18 18:53	1
Perfluorobutanesulfonic acid (PFBS)	**1.2**	**M**	=	0.58	0.086	ug/Kg	☼	06/14/18 04:15	06/28/18 18:53	1
Perfluorohexanesulfonic acid (PFHxS)	**82**	**E**	*	0.44	0.090	ug/Kg	☼	06/14/18 04:15	06/28/18 18:53	1
Perfluorooctanesulfonic acid (PFOS)	**1.7**	**M**	=	1.5	0.35	ug/Kg	☼	06/14/18 04:15	06/28/18 18:53	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*78*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:53*	*1*
13C4-PFHpA	*72*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:53*	*1*
13C4 PFOA	*72*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:53*	*1*
13C5 PFNA	*79*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:53*	*1*
18O2 PFHxS	*73*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:53*	*1*
13C4 PFOS	*80*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:53*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**2.7**	**J D**	*	4.4	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 18:37	10
Perfluorooctanoic acid (PFOA)	**27**	**D**	*	4.4	1.5	ug/Kg	☼	06/14/18 04:15	06/28/18 18:37	10
Perfluorononanoic acid (PFNA)	2.9	U M	*	4.4	1.2	ug/Kg	☼	06/14/18 04:15	06/28/18 18:37	10
Perfluorobutanesulfonic acid (PFBS)	**1.2**	**J D**	*	5.8	0.86	ug/Kg	☼	06/14/18 04:15	06/28/18 18:37	10
Perfluorohexanesulfonic acid (PFHxS)	**110**	**D**	J K01	4.4	0.90	ug/Kg	☼	06/14/18 04:15	06/28/18 18:37	10
Perfluorooctanesulfonic acid (PFOS)	7.3	U M	*	15	3.5	ug/Kg	☼	06/14/18 04:15	06/28/18 18:37	10

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*66*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:37*	*10*
13C4-PFHpA	*74*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:37*	*10*

Client Sample ID: HEC03-SB2-02

Lab Sample ID: 320-40148-11

Date Collected: 06/03/18 15:40
Date Received: 06/08/18 09:00

Matrix: Solid
Percent Solids: 66.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFOA	*73*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:37*	*10*
13C5 PFNA	*72*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:37*	*10*
18O2 PFHxS	*72*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:37*	*10*
13C4 PFOS	*69*		*50 - 150*	*06/14/18 04:15*	*06/28/18 18:37*	*10*

Client Sample ID: HEC-IDW-S-01

Lab Sample ID: 320-40148-12

Date Collected: 06/03/18 17:25
Date Received: 06/08/18 09:00

Matrix: Solid

Method: 8260B - Volatile Organic Compounds (GC/MS) - TCLP

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	0.0040	U	0.010	0.0016	mg/L			06/20/18 16:58	1
2-Butanone (MEK)	0.040	U	0.10	0.018	mg/L			06/20/18 16:58	1
Carbon tetrachloride	0.0040	U	0.010	0.0019	mg/L			06/20/18 16:58	1
Chlorobenzene	0.0040	U	0.010	0.0017	mg/L			06/20/18 16:58	1
Chloroform	0.0040	U	0.010	0.0016	mg/L			06/20/18 16:58	1
1,2-Dichloroethane	0.0040	U	0.010	0.0013	mg/L			06/20/18 16:58	1
1,1-Dichloroethene	0.0080	U	0.010	0.0023	mg/L			06/20/18 16:58	1
Tetrachloroethene	0.0040	U	0.010	0.0020	mg/L			06/20/18 16:58	1
Trichloroethene	0.0040	U	0.010	0.0016	mg/L			06/20/18 16:58	1
Vinyl chloride	0.0020	U	0.010	0.0010	mg/L			06/20/18 16:58	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*107*		*78 - 120*		*06/20/18 16:58*	*1*
1,2-Dichloroethane-d4 (Surr)	*116*		*64 - 129*		*06/20/18 16:58*	*1*
4-Bromofluorobenzene (Surr)	*100*		*78 - 121*		*06/20/18 16:58*	*1*
Dibromofluoromethane (Surr)	*104*		*79 - 119*		*06/20/18 16:58*	*1*

Client Sample ID: HEC07-SB3-01

Lab Sample ID: 320-40148-13

Date Collected: 06/04/18 07:35
Date Received: 06/08/18 09:00

Matrix: Solid
Percent Solids: 72.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.42**		0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 08:26	1
Perfluorooctanoic acid (PFOA)	**2.2**		0.41	0.14	ug/Kg	☼	06/14/18 04:15	06/28/18 08:26	1
Perfluorononanoic acid (PFNA)	**0.85**		0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 08:26	1
Perfluorobutanesulfonic acid (PFBS)	0.25	U	0.55	0.082	ug/Kg	☼	06/14/18 04:15	06/28/18 08:26	1
Perfluorohexanesulfonic acid (PFHxS)	**13**		0.41	0.086	ug/Kg	☼	06/14/18 04:15	06/28/18 08:26	1
Perfluorooctanesulfonic acid (PFOS)	**78**	E *	1.4	0.33	ug/Kg	☼	06/14/18 04:15	06/28/18 08:26	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*55*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:26*	*1*
13C4-PFHpA	*68*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:26*	*1*
13C4 PFOA	*73*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:26*	*1*
13C5 PFNA	*58*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:26*	*1*
18O2 PFHxS	*54*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:26*	*1*
13C4 PFOS	*51*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:26*	*1*

Client Sample ID: HEC07-SB3-01

Lab Sample ID: 320-40148-13

Date Collected: 06/04/18 07:35

Matrix: Solid

Date Received: 06/08/18 09:00

Percent Solids: 72.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	2.8	U	*	4.1	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 19:08	10
Perfluorooctanoic acid (PFOA)	**2.6**	**J D**	*	4.1	1.4	ug/Kg	☼	06/14/18 04:15	06/28/18 19:08	10
Perfluorononanoic acid (PFNA)	2.8	U	*	4.1	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 19:08	10
Perfluorobutanesulfonic acid (PFBS)	2.5	U M	*	5.5	0.82	ug/Kg	☼	06/14/18 04:15	06/28/18 19:08	10
Perfluorohexanesulfonic acid (PFHxS)	**13**	**D**	*	4.1	0.86	ug/Kg	☼	06/14/18 04:15	06/28/18 19:08	10
Perfluorooctanesulfonic acid (PFOS)	**91**	**D**	J K01	14	3.3	ug/Kg	☼	06/14/18 04:15	06/28/18 19:08	10

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*54*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:08*	*10*
13C4-PFHpA	*69*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:08*	*10*
13C4 PFOA	*68*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:08*	*10*
13C5 PFNA	*68*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:08*	*10*
18O2 PFHxS	*58*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:08*	*10*
13C4 PFOS	*59*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:08*	*10*

Client Sample ID: HEC07-SB3-02

Lab Sample ID: 320-40148-14

Date Collected: 06/04/18 08:03

Matrix: Solid

Date Received: 06/08/18 09:00

Percent Solids: 72.1

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.11**	**J**	0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 08:34	1
Perfluorooctanoic acid (PFOA)	**3.0**		0.41	0.14	ug/Kg	☼	06/14/18 04:15	06/28/18 08:34	1
Perfluorononanoic acid (PFNA)	0.27	U	0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 08:34	1
Perfluorobutanesulfonic acid (PFBS)	0.24	U	0.54	0.080	ug/Kg	☼	06/14/18 04:15	06/28/18 08:34	1
Perfluorohexanesulfonic acid (PFHxS)	**20**		0.41	0.084	ug/Kg	☼	06/14/18 04:15	06/28/18 08:34	1
Perfluorooctanesulfonic acid (PFOS)	**4.6**		1.4	0.33	ug/Kg	☼	06/14/18 04:15	06/28/18 08:34	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*56*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:34*	*1*
13C4-PFHpA	*66*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:34*	*1*
13C4 PFOA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:34*	*1*
13C5 PFNA	*73*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:34*	*1*
18O2 PFHxS	*60*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:34*	*1*
13C4 PFOS	*62*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:34*	*1*

Client Sample ID: HEC07-SB2-01

Lab Sample ID: 320-40148-15

Date Collected: 06/04/18 09:03

Matrix: Solid

Date Received: 06/08/18 09:00

Percent Solids: 71.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**1.5**		0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 08:42	1
Perfluorooctanoic acid (PFOA)	**3.7**		0.41	0.14	ug/Kg	☼	06/14/18 04:15	06/28/18 08:42	1
Perfluorononanoic acid (PFNA)	**0.77**		0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 08:42	1
Perfluorobutanesulfonic acid (PFBS)	**0.14**	**J**	0.55	0.081	ug/Kg	☼	06/14/18 04:15	06/28/18 08:42	1
Perfluorohexanesulfonic acid (PFHxS)	**9.2**		0.41	0.085	ug/Kg	☼	06/14/18 04:15	06/28/18 08:42	1

Client Sample ID: HEC07-SB2-01

Lab Sample ID: 320-40148-15

Date Collected: 06/04/18 09:03
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 71.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorooctanesulfonic acid (PFOS)	**52**	**E M** *	1.4	0.33	ug/Kg	☼	06/14/18 04:15	06/28/18 08:42	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*54*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:42*	*1*
13C4-PFHpA	*67*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:42*	*1*
13C4 PFOA	*67*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:42*	*1*
13C5 PFNA	*62*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:42*	*1*
18O2 PFHxS	*53*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:42*	*1*
13C4 PFOS	*53*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:42*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**1.5**	**J D** *	4.1	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 19:24	10
Perfluorooctanoic acid (PFOA)	**3.8**	**J D** *	4.1	1.4	ug/Kg	☼	06/14/18 04:15	06/28/18 19:24	10
Perfluorononanoic acid (PFNA)	2.7	U *	4.1	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 19:24	10
Perfluorobutanesulfonic acid (PFBS)	2.5	U *	5.5	0.81	ug/Kg	☼	06/14/18 04:15	06/28/18 19:24	10
Perfluorohexanesulfonic acid (PFHxS)	**8.5**	**D** *	4.1	0.85	ug/Kg	☼	06/14/18 04:15	06/28/18 19:24	10
Perfluorooctanesulfonic acid (PFOS)	**56**	**D** J K01	14	3.3	ug/Kg	☼	06/14/18 04:15	06/28/18 19:24	10

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*54*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:24*	*10*
13C4-PFHpA	*73*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:24*	*10*
13C4 PFOA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:24*	*10*
13C5 PFNA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:24*	*10*
18O2 PFHxS	*61*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:24*	*10*
13C4 PFOS	*65*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:24*	*10*

Client Sample ID: HEC07-SB2-02

Lab Sample ID: 320-40148-16

Date Collected: 06/04/18 09:35
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 70.6

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.24**	**J**	0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 08:50	1
Perfluorooctanoic acid (PFOA)	**0.58**		0.41	0.14	ug/Kg	☼	06/14/18 04:15	06/28/18 08:50	1
Perfluorononanoic acid (PFNA)	**0.14**	**J**	0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 08:50	1
Perfluorobutanesulfonic acid (PFBS)	**0.34**	**J**	0.55	0.082	ug/Kg	☼	06/14/18 04:15	06/28/18 08:50	1
Perfluorohexanesulfonic acid (PFHxS)	**2.5**		0.41	0.086	ug/Kg	☼	06/14/18 04:15	06/28/18 08:50	1
Perfluorooctanesulfonic acid (PFOS)	**16**	**M** =	1.4	0.33	ug/Kg	☼	06/14/18 04:15	06/28/18 08:50	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*60*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:50*	*1*
13C4-PFHpA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:50*	*1*
13C4 PFOA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:50*	*1*
13C5 PFNA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:50*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:50*	*1*
13C4 PFOS	*59*		*50 - 150*	*06/14/18 04:15*	*06/28/18 08:50*	*1*

Client Sample ID: HEC07-SB1-01

Lab Sample ID: 320-40148-17

Date Collected: 06/04/18 11:10
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 72.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.6		0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 09:05	1
Perfluorooctanoic acid (PFOA)	3.0		0.41	0.14	ug/Kg	☼	06/14/18 04:15	06/28/18 09:05	1
Perfluorononanoic acid (PFNA)	1.8		0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 09:05	1
Perfluorobutanesulfonic acid (PFBS)	0.10	J	0.55	0.082	ug/Kg	☼	06/14/18 04:15	06/28/18 09:05	1
Perfluorohexanesulfonic acid (PFHxS)	5.7		0.41	0.086	ug/Kg	☼	06/14/18 04:15	06/28/18 09:05	1
Perfluorooctanesulfonic acid (PFOS)	56	E M *	1.4	0.33	ug/Kg	☼	06/14/18 04:15	06/28/18 09:05	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	*59*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:05*	*1*
13C4-PFHpA	*75*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:05*	*1*
13C4 PFOA	*75*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:05*	*1*
13C5 PFNA	*66*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:05*	*1*
18O2 PFHxS	*59*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:05*	*1*
13C4 PFOS	*56*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:05*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.6	J D *	4.1	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 19:32	10
Perfluorooctanoic acid (PFOA)	3.3	J D *	4.1	1.4	ug/Kg	☼	06/14/18 04:15	06/28/18 19:32	10
Perfluorononanoic acid (PFNA)	2.0	J D *	4.1	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 19:32	10
Perfluorobutanesulfonic acid (PFBS)	2.5	U *	5.5	0.82	ug/Kg	☼	06/14/18 04:15	06/28/18 19:32	10
Perfluorohexanesulfonic acid (PFHxS)	5.2	D *	4.1	0.86	ug/Kg	☼	06/14/18 04:15	06/28/18 19:32	10
Perfluorooctanesulfonic acid (PFOS)	61	D J K01	14	3.3	ug/Kg	☼	06/14/18 04:15	06/28/18 19:32	10

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	*65*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:32*	*10*
13C4-PFHpA	*81*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:32*	*10*
13C4 PFOA	*75*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:32*	*10*
13C5 PFNA	*72*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:32*	*10*
18O2 PFHxS	*65*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:32*	*10*
13C4 PFOS	*67*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:32*	*10*

Client Sample ID: HEC07-SB1-02

Lab Sample ID: 320-40148-18

Date Collected: 06/04/18 11:38
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 67.9

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.29	U	0.44	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 09:13	1
Perfluorooctanoic acid (PFOA)	0.29	U	0.44	0.15	ug/Kg	☼	06/14/18 04:15	06/28/18 09:13	1
Perfluorononanoic acid (PFNA)	0.29	U	0.44	0.12	ug/Kg	☼	06/14/18 04:15	06/28/18 09:13	1
Perfluorobutanesulfonic acid (PFBS)	0.26	U	0.59	0.087	ug/Kg	☼	06/14/18 04:15	06/28/18 09:13	1
Perfluorohexanesulfonic acid (PFHxS)	0.29	U	0.44	0.091	ug/Kg	☼	06/14/18 04:15	06/28/18 09:13	1
Perfluorooctanesulfonic acid (PFOS)	0.73	U	1.5	0.35	ug/Kg	☼	06/14/18 04:15	06/28/18 09:13	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	*62*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:13*	*1*
13C4-PFHpA	*73*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:13*	*1*

Client Sample ID: HEC07-SB1-02

Lab Sample ID: 320-40148-18

Date Collected: 06/04/18 11:38
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 67.9

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFOA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:13*	*1*
13C5 PFNA	*77*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:13*	*1*
18O2 PFHxS	*61*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:13*	*1*
13C4 PFOS	*63*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:13*	*1*

Client Sample ID: HEC09-SB1-01

Lab Sample ID: 320-40148-19

Date Collected: 06/04/18 13:17
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 79.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.82**		0.37	0.096	ug/Kg	☼	06/14/18 04:15	06/28/18 09:21	1
Perfluorooctanoic acid (PFOA)	**1.5**		0.37	0.12	ug/Kg	☼	06/14/18 04:15	06/28/18 09:21	1
Perfluorononanoic acid (PFNA)	**1.5**		0.37	0.099	ug/Kg	☼	06/14/18 04:15	06/28/18 09:21	1
Perfluorobutanesulfonic acid (PFBS)	**0.13**	**J**	0.49	0.072	ug/Kg	☼	06/14/18 04:15	06/28/18 09:21	1
Perfluorohexanesulfonic acid (PFHxS)	**6.7**		0.37	0.076	ug/Kg	☼	06/14/18 04:15	06/28/18 09:21	1
Perfluorooctanesulfonic acid (PFOS)	**76**	**E** *	1.2	0.29	ug/Kg	☼	06/14/18 04:15	06/28/18 09:21	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*58*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:21*	*1*
13C4-PFHpA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:21*	*1*
13C4 PFOA	*74*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:21*	*1*
13C5 PFNA	*62*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:21*	*1*
18O2 PFHxS	*57*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:21*	*1*
13C4 PFOS	*55*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:21*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	2.5	U *	3.7	0.96	ug/Kg	☼	06/14/18 04:15	06/28/18 19:40	10
Perfluorooctanoic acid (PFOA)	**1.8**	**J D** *	3.7	1.2	ug/Kg	☼	06/14/18 04:15	06/28/18 19:40	10
Perfluorononanoic acid (PFNA)	**1.7**	**J D** *	3.7	0.99	ug/Kg	☼	06/14/18 04:15	06/28/18 19:40	10
Perfluorobutanesulfonic acid (PFBS)	2.2	U *	4.9	0.72	ug/Kg	☼	06/14/18 04:15	06/28/18 19:40	10
Perfluorohexanesulfonic acid (PFHxS)	**6.4**	**D** *	3.7	0.76	ug/Kg	☼	06/14/18 04:15	06/28/18 19:40	10
Perfluorooctanesulfonic acid (PFOS)	**99**	**D** J K01	12	2.9	ug/Kg	☼	06/14/18 04:15	06/28/18 19:40	10

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*61*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:40*	*10*
13C4-PFHpA	*81*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:40*	*10*
13C4 PFOA	*77*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:40*	*10*
13C5 PFNA	*75*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:40*	*10*
18O2 PFHxS	*63*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:40*	*10*
13C4 PFOS	*66*		*50 - 150*	*06/14/18 04:15*	*06/28/18 19:40*	*10*

Client Sample ID: HEC09-SB1-02

Lab Sample ID: 320-40148-20

Date Collected: 06/04/18 13:47
Date Received: 06/08/18 09:00

Matrix: Solid
Percent Solids: 71.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.2		0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 09:29	1
Perfluorooctanoic acid (PFOA)	1.7		0.41	0.14	ug/Kg	☼	06/14/18 04:15	06/28/18 09:29	1
Perfluorononanoic acid (PFNA)	0.21	J	0.41	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 09:29	1
Perfluorobutanesulfonic acid (PFBS)	0.44	J	0.55	0.081	ug/Kg	☼	06/14/18 04:15	06/28/18 09:29	1
Perfluorohexanesulfonic acid (PFHxS)	13		0.41	0.085	ug/Kg	☼	06/14/18 04:15	06/28/18 09:29	1
Perfluorooctanesulfonic acid (PFOS)	3.8		1.4	0.33	ug/Kg	☼	06/14/18 04:15	06/28/18 09:29	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*61*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:29*	*1*
13C4-PFHpA	*70*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:29*	*1*
13C4 PFOA	*75*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:29*	*1*
13C5 PFNA	*78*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:29*	*1*
18O2 PFHxS	*64*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:29*	*1*
13C4 PFOS	*64*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:29*	*1*

Client Sample ID: HEC03-SB1-01

Lab Sample ID: 320-40148-21

Date Collected: 06/04/18 14:55
Date Received: 06/08/18 09:00

Matrix: Solid
Percent Solids: 74.6

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4		0.39	0.10	ug/Kg	☼	06/14/18 04:15	06/28/18 09:37	1
Perfluorooctanoic acid (PFOA)	3.1		0.39	0.13	ug/Kg	☼	06/14/18 04:15	06/28/18 09:37	1
Perfluorononanoic acid (PFNA)	2.7	J G02	0.39	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 09:37	1
Perfluorobutanesulfonic acid (PFBS)	0.91		0.52	0.077	ug/Kg	☼	06/14/18 04:15	06/28/18 09:37	1
Perfluorohexanesulfonic acid (PFHxS)	40	E *	0.39	0.081	ug/Kg	☼	06/14/18 04:15	06/28/18 09:37	1
Perfluorooctanesulfonic acid (PFOS)	170	E M *	1.3	0.31	ug/Kg	☼	06/14/18 04:15	06/28/18 09:37	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*60*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:37*	*1*
13C4-PFHpA	*68*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:37*	*1*
13C4 PFOA	*71*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:37*	*1*
13C5 PFNA	*47*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 09:37*	*1*
18O2 PFHxS	*58*		*50 - 150*	*06/14/18 04:15*	*06/28/18 09:37*	*1*
13C4 PFOS	*48*	*Q*	*50 - 150*	*06/14/18 04:15*	*06/28/18 09:37*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	5.2	U *	7.8	2.0	ug/Kg	☼	06/14/18 04:15	06/28/18 19:55	20
Perfluorooctanoic acid (PFOA)	3.3	J D *	7.8	2.6	ug/Kg	☼	06/14/18 04:15	06/28/18 19:55	20
Perfluorononanoic acid (PFNA)	2.6	J D *	7.8	2.1	ug/Kg	☼	06/14/18 04:15	06/28/18 19:55	20
Perfluorobutanesulfonic acid (PFBS)	4.7	U *	10	1.5	ug/Kg	☼	06/14/18 04:15	06/28/18 19:55	20
Perfluorohexanesulfonic acid (PFHxS)	46	D J K01	7.8	1.6	ug/Kg	☼	06/14/18 04:15	06/28/18 19:55	20
Perfluorooctanesulfonic acid (PFOS)	270	D J K01	26	6.2	ug/Kg	☼	06/14/18 04:15	06/28/18 19:55	20

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40148-1

Client Sample ID: HEC03-SB1-01

Lab Sample ID: 320-40148-21
Date Collected: 06/04/18 14:55
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 74.6

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	67	M	50 - 150	06/14/18 04:15	06/28/18 19:55	20
13C4-PFHpA	75		50 - 150	06/14/18 04:15	06/28/18 19:55	20
13C4 PFOA	76		50 - 150	06/14/18 04:15	06/28/18 19:55	20
13C5 PFNA	71		50 - 150	06/14/18 04:15	06/28/18 19:55	20
18O2 PFHxS	62		50 - 150	06/14/18 04:15	06/28/18 19:55	20
13C4 PFOS	62		50 - 150	06/14/18 04:15	06/28/18 19:55	20

Client Sample ID: HEC03-SB1-02

Lab Sample ID: 320-40148-22
Date Collected: 06/04/18 15:25
Matrix: Solid
Date Received: 06/08/18 09:00
Percent Solids: 75.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	2.2		0.39	0.10	ug/Kg	☼	06/14/18 04:15	06/28/18 09:45	1
Perfluorooctanoic acid (PFOA)	5.2		0.39	0.13	ug/Kg	☼	06/14/18 04:15	06/28/18 09:45	1
Perfluorononanoic acid (PFNA)	0.97		0.39	0.11	ug/Kg	☼	06/14/18 04:15	06/28/18 09:45	1
Perfluorobutanesulfonic acid (PFBS)	0.76		0.52	0.077	ug/Kg	☼	06/14/18 04:15	06/28/18 09:45	1
Perfluorohexanesulfonic acid (PFHxS)	54	E *	0.39	0.081	ug/Kg	☼	06/14/18 04:15	06/28/18 09:45	1
Perfluorooctanesulfonic acid (PFOS)	43	E M *	1.3	0.31	ug/Kg	☼	06/14/18 04:15	06/28/18 09:45	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	65		50 - 150	06/14/18 04:15	06/28/18 09:45	1
13C4-PFHpA	67		50 - 150	06/14/18 04:15	06/28/18 09:45	1
13C4 PFOA	74		50 - 150	06/14/18 04:15	06/28/18 09:45	1
13C5 PFNA	76		50 - 150	06/14/18 04:15	06/28/18 09:45	1
18O2 PFHxS	61		50 - 150	06/14/18 04:15	06/28/18 09:45	1
13C4 PFOS	63		50 - 150	06/14/18 04:15	06/28/18 09:45	1

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	2.7	J D *	3.9	1.0	ug/Kg	☼	06/14/18 04:15	06/28/18 20:03	10
Perfluorooctanoic acid (PFOA)	6.0	D *	3.9	1.3	ug/Kg	☼	06/14/18 04:15	06/28/18 20:03	10
Perfluorononanoic acid (PFNA)	1.1	J D *	3.9	1.1	ug/Kg	☼	06/14/18 04:15	06/28/18 20:03	10
Perfluorobutanesulfonic acid (PFBS)	0.79	J D *	5.2	0.77	ug/Kg	☼	06/14/18 04:15	06/28/18 20:03	10
Perfluorohexanesulfonic acid (PFHxS)	58	D J K01	3.9	0.81	ug/Kg	☼	06/14/18 04:15	06/28/18 20:03	10
Perfluorooctanesulfonic acid (PFOS)	43	D M J K01	13	3.1	ug/Kg	☼	06/14/18 04:15	06/28/18 20:03	10

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	63	M	50 - 150	06/14/18 04:15	06/28/18 20:03	10
13C4-PFHpA	64		50 - 150	06/14/18 04:15	06/28/18 20:03	10
13C4 PFOA	66		50 - 150	06/14/18 04:15	06/28/18 20:03	10
13C5 PFNA	67		50 - 150	06/14/18 04:15	06/28/18 20:03	10
18O2 PFHxS	67		50 - 150	06/14/18 04:15	06/28/18 20:03	10
13C4 PFOS	64		50 - 150	06/14/18 04:15	06/28/18 20:03	10

Client Sample Results

Client: Leidos, Inc. TestAmerica Job ID: 320-40148-1
Project/Site: Phase III, ANG-Hector Field

Client Sample ID: HEC-ER-SW-01 Lab Sample ID: 320-40148-23
Date Collected: 06/05/18 13:00 Matrix: Water
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.9	0.58	ng/L		06/12/18 11:13	06/17/18 10:02	1
Perfluorooctanoic acid (PFOA)	1.4	U M U	1.9	0.51	ng/L		06/12/18 11:13	06/17/18 10:02	1
Perfluorononanoic acid (PFNA)	1.4	U	1.9	0.50	ng/L		06/12/18 11:13	06/17/18 10:02	1
Perfluorobutanesulfonic acid (PFBS)	0.95	U	1.9	0.44	ng/L		06/12/18 11:13	06/17/18 10:02	1
Perfluorohexanesulfonic acid (PFHxS)	**0.39**	**J** U F06	1.9	0.36	ng/L		06/12/18 11:13	06/17/18 10:02	1
Perfluorooctanesulfonic acid (PFOS)	2.9	U	3.8	1.0	ng/L		06/12/18 11:13	06/17/18 10:02	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*85*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:02*	*1*
13C4-PFHpA	*96*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:02*	*1*
13C4 PFOA	*90*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:02*	*1*
13C5 PFNA	*89*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:02*	*1*
18O2 PFHxS	*88*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:02*	*1*
13C4 PFOS	*85*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:02*	*1*

Client Sample ID: HEC10-SW1-01 Lab Sample ID: 320-40148-24
Date Collected: 06/05/18 13:10 Matrix: Water
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**140**		1.8	0.56	ng/L		06/12/18 11:13	06/17/18 10:10	1
Perfluorooctanoic acid (PFOA)	**480**	**E** *	1.8	0.49	ng/L		06/12/18 11:13	06/17/18 10:10	1
Perfluorononanoic acid (PFNA)	**44**		1.8	0.47	ng/L		06/12/18 11:13	06/17/18 10:10	1
Perfluorobutanesulfonic acid (PFBS)	**250**		1.8	0.42	ng/L		06/12/18 11:13	06/17/18 10:10	1
Perfluorohexanesulfonic acid (PFHxS)	**2700**	**E** *	1.8	0.35	ng/L		06/12/18 11:13	06/17/18 10:10	1
Perfluorooctanesulfonic acid (PFOS)	**3100**	**E** *	3.6	1.0	ng/L		06/12/18 11:13	06/17/18 10:10	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*88*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:10*	*1*
13C4-PFHpA	*73*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:10*	*1*
13C4 PFOA	*86*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:10*	*1*
13C5 PFNA	*79*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:10*	*1*
18O2 PFHxS	*66*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:10*	*1*
13C4 PFOS	*72*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:10*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**150**	**D** *	36	11	ng/L		06/12/18 11:13	06/20/18 04:17	20
Perfluorooctanoic acid (PFOA)	**520**	**D** J K01	36	9.8	ng/L		06/12/18 11:13	06/20/18 04:17	20
Perfluorononanoic acid (PFNA)	**46**	**D** *	36	9.5	ng/L		06/12/18 11:13	06/20/18 04:17	20
Perfluorobutanesulfonic acid (PFBS)	**270**	**D** *	36	8.4	ng/L		06/12/18 11:13	06/20/18 04:17	20
Perfluorohexanesulfonic acid (PFHxS)	**4600**	**D** J K01	36	6.9	ng/L		06/12/18 11:13	06/20/18 04:17	20
Perfluorooctanesulfonic acid (PFOS)	**3800**	**D** J K01	73	20	ng/L		06/12/18 11:13	06/20/18 04:17	20

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*83*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:17*	*20*

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40148-1

Client Sample ID: HEC10-SW1-01

Lab Sample ID: 320-40148-24
Date Collected: 06/05/18 13:10
Matrix: Water
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4-PFHpA	*92*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:17*	*20*
13C4 PFOA	*88*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:17*	*20*
13C5 PFNA	*89*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:17*	*20*
18O2 PFHxS	*83*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:17*	*20*
13C4 PFOS	*76*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:17*	*20*

Client Sample ID: MW-HEC06-01-01

Lab Sample ID: 320-40148-25
Date Collected: 06/06/18 08:00
Matrix: Water
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**1.9**		1.9	0.59	ng/L		06/12/18 11:13	06/17/18 10:17	1
Perfluorooctanoic acid (PFOA)	**3.2**		1.9	0.53	ng/L		06/12/18 11:13	06/17/18 10:17	1
Perfluorononanoic acid (PFNA)	**0.99**	**J**	1.9	0.51	ng/L		06/12/18 11:13	06/17/18 10:17	1
Perfluorobutanesulfonic acid (PFBS)	**3.9**	**M** =	1.9	0.45	ng/L		06/12/18 11:13	06/17/18 10:17	1
Perfluorohexanesulfonic acid (PFHxS)	**10**	**J1 M** J H01	1.9	0.37	ng/L		06/12/18 11:13	06/17/18 10:17	1
Perfluorooctanesulfonic acid (PFOS)	**20**	**J1 M** J H02	3.9	1.1	ng/L		06/12/18 11:13	06/17/18 10:17	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*72*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:17*	*1*
13C4-PFHpA	*84*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:17*	*1*
13C4 PFOA	*87*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:17*	*1*
13C5 PFNA	*84*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:17*	*1*
18O2 PFHxS	*83*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:17*	*1*
13C4 PFOS	*81*		*50 - 150*	*06/12/18 11:13*	*06/17/18 10:17*	*1*

Client Sample ID: MW11-15-PRL02-01

Lab Sample ID: 320-40148-26
Date Collected: 06/06/18 10:35
Matrix: Water
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**5.9**	**M** =	2.4	0.74	ng/L		06/12/18 11:13	06/18/18 05:04	1
Perfluorooctanoic acid (PFOA)	**13**		2.4	0.66	ng/L		06/12/18 11:13	06/18/18 05:04	1
Perfluorononanoic acid (PFNA)	1.8	U M U	2.4	0.63	ng/L		06/12/18 11:13	06/18/18 05:04	1
Perfluorobutanesulfonic acid (PFBS)	**59**	**M** =	2.4	0.56	ng/L		06/12/18 11:13	06/18/18 05:04	1
Perfluorohexanesulfonic acid (PFHxS)	**160**	**M** =	2.4	0.46	ng/L		06/12/18 11:13	06/18/18 05:04	1
Perfluorooctanesulfonic acid (PFOS)	**250**	**M** =	4.9	1.3	ng/L		06/12/18 11:13	06/18/18 05:04	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*64*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:04*	*1*
13C4-PFHpA	*69*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:04*	*1*
13C4 PFOA	*80*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:04*	*1*
13C5 PFNA	*79*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:04*	*1*
18O2 PFHxS	*71*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:04*	*1*
13C4 PFOS	*70*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:04*	*1*

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40148-1

Client Sample ID: MW-HEC05-01-01

Lab Sample ID: 320-40148-27

Date Collected: 06/06/18 13:27
Matrix: Water
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.9	0.58	ng/L		06/12/18 11:13	06/18/18 05:19	1
Perfluorooctanoic acid (PFOA)	**0.56**	**J**	1.9	0.52	ng/L		06/12/18 11:13	06/18/18 05:19	1
Perfluorononanoic acid (PFNA)	1.4	U	1.9	0.50	ng/L		06/12/18 11:13	06/18/18 05:19	1
Perfluorobutanesulfonic acid (PFBS)	**1.2**	**J**	1.9	0.44	ng/L		06/12/18 11:13	06/18/18 05:19	1
Perfluorohexanesulfonic acid (PFHxS)	**5.2**		1.9	0.36	ng/L		06/12/18 11:13	06/18/18 05:19	1
Perfluorooctanesulfonic acid (PFOS)	2.9	U	3.8	1.1	ng/L		06/12/18 11:13	06/18/18 05:19	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*83*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:19*	*1*
13C4-PFHpA	*97*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:19*	*1*
13C4 PFOA	*94*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:19*	*1*
13C5 PFNA	*89*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:19*	*1*
18O2 PFHxS	*90*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:19*	*1*
13C4 PFOS	*84*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:19*	*1*

Client Sample ID: MW11-05-PRL02-01

Lab Sample ID: 320-40148-28

Date Collected: 06/06/18 15:23
Matrix: Water
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**11000**	**E** *	1.9	0.58	ng/L		06/12/18 11:13	06/18/18 05:27	1
Perfluorooctanoic acid (PFOA)	**9200**	**E M** *	1.9	0.52	ng/L		06/12/18 11:13	06/18/18 05:27	1
Perfluorononanoic acid (PFNA)	**29**	J K01	1.9	0.50	ng/L		06/12/18 11:13	06/18/18 05:27	1
Perfluorobutanesulfonic acid (PFBS)	**1300**	**E** *	1.9	0.44	ng/L		06/12/18 11:13	06/18/18 05:27	1
Perfluorohexanesulfonic acid (PFHxS)	**14000**	**E M** *	1.9	0.36	ng/L		06/12/18 11:13	06/18/18 05:27	1
Perfluorooctanesulfonic acid (PFOS)	**29000**	**E** *	3.8	1.1	ng/L		06/12/18 11:13	06/18/18 05:27	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*287*	*Q*	*50 - 150*	*06/12/18 11:13*	*06/18/18 05:27*	*1*
13C4-PFHpA	*26*	*Q*	*50 - 150*	*06/12/18 11:13*	*06/18/18 05:27*	*1*
13C4 PFOA	*79*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:27*	*1*
13C5 PFNA	*89*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:27*	*1*
18O2 PFHxS	*62*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:27*	*1*
13C4 PFOS	*77*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:27*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**11000**	**D** J K01	190	58	ng/L		06/12/18 11:13	06/20/18 04:33	100
Perfluorooctanoic acid (PFOA)	**16000**	**D** J K01	190	52	ng/L		06/12/18 11:13	06/20/18 04:33	100
Perfluorononanoic acid (PFNA)	140	U M *	190	50	ng/L		06/12/18 11:13	06/20/18 04:33	100
Perfluorobutanesulfonic acid (PFBS)	**8400**	**D** J K01 G01	190	44	ng/L		06/12/18 11:13	06/20/18 04:33	100
Perfluorohexanesulfonic acid (PFHxS)	**79000**	**E D** *	190	36	ng/L		06/12/18 11:13	06/20/18 04:33	100
Perfluorooctanesulfonic acid (PFOS)	**58000**	**E D** J N03	380	110	ng/L		06/12/18 11:13	06/20/18 04:33	100

Client Sample ID: MW11-05-PRL02-01 Lab Sample ID: 320-40148-28

Date Collected: 06/06/18 15:23 **Matrix: Water**
Date Received: 06/08/18 09:00

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*425*	*Q*	*50 - 150*	*06/12/18 11:13*	*06/20/18 04:33*	*100*
13C4-PFHpA	*69*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:33*	*100*
13C4 PFOA	*84*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:33*	*100*
13C5 PFNA	*86*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:33*	*100*
18O2 PFHxS	*155*	*Q*	*50 - 150*	*06/12/18 11:13*	*06/20/18 04:33*	*100*
13C4 PFOS	*65*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:33*	*100*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - RE

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**11000**	**H** *	100	31	ng/L		06/22/18 10:03	06/27/18 06:51	1
Perfluorobutanesulfonic acid (PFBS)	**38000**	**H E** *	100	23	ng/L		06/22/18 10:03	06/27/18 06:51	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*73*		*50 - 150*	*06/22/18 10:03*	*06/27/18 06:51*	*1*
13C4-PFHpA	*45*	*Q*	*50 - 150*	*06/22/18 10:03*	*06/27/18 06:51*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - REDL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**12000**	**H D** *	2000	610	ng/L		06/22/18 10:03	06/28/18 15:29	20
Perfluorobutanesulfonic acid (PFBS)	**56000**	**H D** *	2000	460	ng/L		06/22/18 10:03	06/28/18 15:29	20

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*82*		*50 - 150*	*06/22/18 10:03*	*06/28/18 15:29*	*20*
13C4-PFHpA	*72*		*50 - 150*	*06/22/18 10:03*	*06/28/18 15:29*	*20*

Client Sample ID: HEC-ER-MW-01 Lab Sample ID: 320-40148-29

Date Collected: 06/06/18 15:50 **Matrix: Water**
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.9	0.57	ng/L		06/12/18 11:13	06/20/18 04:49	1
Perfluorooctanoic acid (PFOA)	1.4	U M U	1.9	0.51	ng/L		06/12/18 11:13	06/20/18 04:49	1
Perfluorononanoic acid (PFNA)	1.4	U	1.9	0.49	ng/L		06/12/18 11:13	06/20/18 04:49	1
Perfluorobutanesulfonic acid (PFBS)	0.94	U	1.9	0.43	ng/L		06/12/18 11:13	06/20/18 04:49	1
Perfluorohexanesulfonic acid (PFHxS)	**0.60**	**J** U F06	1.9	0.36	ng/L		06/12/18 11:13	06/20/18 04:49	1
Perfluorooctanesulfonic acid (PFOS)	2.8	U	3.8	1.0	ng/L		06/12/18 11:13	06/20/18 04:49	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*79*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:49*	*1*
13C4-PFHpA	*89*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:49*	*1*
13C4 PFOA	*93*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:49*	*1*
13C5 PFNA	*87*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:49*	*1*
18O2 PFHxS	*88*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:49*	*1*
13C4 PFOS	*86*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:49*	*1*

Client Sample ID: MW-HEC02-01-01

Lab Sample ID: 320-40148-30

Date Collected: 06/06/18 18:03
Date Received: 06/08/18 09:00

Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	62		1.6	0.49	ng/L		06/12/18 11:13	06/18/18 05:43	1
Perfluorooctanoic acid (PFOA)	54	M =	1.6	0.44	ng/L		06/12/18 11:13	06/18/18 05:43	1
Perfluorononanoic acid (PFNA)	1.6	M =	1.6	0.42	ng/L		06/12/18 11:13	06/18/18 05:43	1
Perfluorobutanesulfonic acid (PFBS)	51	M =	1.6	0.37	ng/L		06/12/18 11:13	06/18/18 05:43	1
Perfluorohexanesulfonic acid (PFHxS)	360	E *	1.6	0.31	ng/L		06/12/18 11:13	06/18/18 05:43	1
Perfluorooctanesulfonic acid (PFOS)	15		3.2	0.89	ng/L		06/12/18 11:13	06/18/18 05:43	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*74*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:43*	*1*
13C4-PFHpA	*86*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:43*	*1*
13C4 PFOA	*92*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:43*	*1*
13C5 PFNA	*90*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:43*	*1*
18O2 PFHxS	*78*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:43*	*1*
13C4 PFOS	*80*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:43*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	62	D *	8.1	2.5	ng/L		06/12/18 11:13	06/20/18 04:56	5
Perfluorooctanoic acid (PFOA)	56	D *	8.1	2.2	ng/L		06/12/18 11:13	06/20/18 04:56	5
Perfluorononanoic acid (PFNA)	6.1	U *	8.1	2.1	ng/L		06/12/18 11:13	06/20/18 04:56	5
Perfluorobutanesulfonic acid (PFBS)	47	D M *	8.1	1.9	ng/L		06/12/18 11:13	06/20/18 04:56	5
Perfluorohexanesulfonic acid (PFHxS)	360	D J K01	8.1	1.5	ng/L		06/12/18 11:13	06/20/18 04:56	5
Perfluorooctanesulfonic acid (PFOS)	14	J D *	16	4.4	ng/L		06/12/18 11:13	06/20/18 04:56	5

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*81*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:56*	*5*
13C4-PFHpA	*87*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:56*	*5*
13C4 PFOA	*93*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:56*	*5*
13C5 PFNA	*83*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:56*	*5*
18O2 PFHxS	*83*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:56*	*5*
13C4 PFOS	*80*		*50 - 150*	*06/12/18 11:13*	*06/20/18 04:56*	*5*

Client Sample ID: MW-HEC02-01-01D

Lab Sample ID: 320-40148-31

Date Collected: 06/06/18 18:03
Date Received: 06/08/18 09:00

Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	67		1.7	0.53	ng/L		06/12/18 11:13	06/18/18 05:51	1
Perfluorooctanoic acid (PFOA)	63		1.7	0.47	ng/L		06/12/18 11:13	06/18/18 05:51	1
Perfluorononanoic acid (PFNA)	1.7	M =	1.7	0.45	ng/L		06/12/18 11:13	06/18/18 05:51	1
Perfluorobutanesulfonic acid (PFBS)	57	M =	1.7	0.40	ng/L		06/12/18 11:13	06/18/18 05:51	1
Perfluorohexanesulfonic acid (PFHxS)	390	E *	1.7	0.33	ng/L		06/12/18 11:13	06/18/18 05:51	1
Perfluorooctanesulfonic acid (PFOS)	16		3.5	0.96	ng/L		06/12/18 11:13	06/18/18 05:51	1

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40148-1

Client Sample ID: MW-HEC02-01-01D

Lab Sample ID: 320-40148-31

Date Collected: 06/06/18 18:03
Date Received: 06/08/18 09:00

Matrix: Water

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*75*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:51*	*1*
13C4-PFHpA	*90*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:51*	*1*
13C4 PFOA	*95*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:51*	*1*
13C5 PFNA	*90*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:51*	*1*
18O2 PFHxS	*83*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:51*	*1*
13C4 PFOS	*83*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:51*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**70**	**D**	*	8.7	2.7	ng/L		06/12/18 11:13	06/20/18 05:04	5
Perfluorooctanoic acid (PFOA)	**66**	**D**	*	8.7	2.4	ng/L		06/12/18 11:13	06/20/18 05:04	5
Perfluorononanoic acid (PFNA)	6.6	U	*	8.7	2.3	ng/L		06/12/18 11:13	06/20/18 05:04	5
Perfluorobutanesulfonic acid (PFBS)	**55**	**D M**	*	8.7	2.0	ng/L		06/12/18 11:13	06/20/18 05:04	5
Perfluorohexanesulfonic acid (PFHxS)	**400**	**D**	J K01	8.7	1.7	ng/L		06/12/18 11:13	06/20/18 05:04	5
Perfluorooctanesulfonic acid (PFOS)	**17**	**D**	*	17	4.8	ng/L		06/12/18 11:13	06/20/18 05:04	5

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*80*		*50 - 150*	*06/12/18 11:13*	*06/20/18 05:04*	*5*
13C4-PFHpA	*88*		*50 - 150*	*06/12/18 11:13*	*06/20/18 05:04*	*5*
13C4 PFOA	*89*		*50 - 150*	*06/12/18 11:13*	*06/20/18 05:04*	*5*
13C5 PFNA	*84*		*50 - 150*	*06/12/18 11:13*	*06/20/18 05:04*	*5*
18O2 PFHxS	*83*		*50 - 150*	*06/12/18 11:13*	*06/20/18 05:04*	*5*
13C4 PFOS	*78*		*50 - 150*	*06/12/18 11:13*	*06/20/18 05:04*	*5*

Client Sample ID: MW-HEC01-01-01

Lab Sample ID: 320-40148-32

Date Collected: 06/07/18 09:10
Date Received: 06/08/18 09:00

Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.71**	**J**		2.0	0.60	ng/L		06/12/18 11:13	06/18/18 05:59	1
Perfluorooctanoic acid (PFOA)	**0.83**	**J M**	J	2.0	0.53	ng/L		06/12/18 11:13	06/18/18 05:59	1
Perfluorononanoic acid (PFNA)	1.5	U M	U	2.0	0.51	ng/L		06/12/18 11:13	06/18/18 05:59	1
Perfluorobutanesulfonic acid (PFBS)	**4.1**			2.0	0.45	ng/L		06/12/18 11:13	06/18/18 05:59	1
Perfluorohexanesulfonic acid (PFHxS)	**3.5**			2.0	0.37	ng/L		06/12/18 11:13	06/18/18 05:59	1
Perfluorooctanesulfonic acid (PFOS)	2.9	U M	U	3.9	1.1	ng/L		06/12/18 11:13	06/18/18 05:59	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*75*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:59*	*1*
13C4-PFHpA	*94*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:59*	*1*
13C4 PFOA	*90*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:59*	*1*
13C5 PFNA	*88*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:59*	*1*
18O2 PFHxS	*85*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:59*	*1*
13C4 PFOS	*78*		*50 - 150*	*06/12/18 11:13*	*06/18/18 05:59*	*1*

Client Sample ID: MW-HEC01-01-01D — Lab Sample ID: 320-40148-33

Date Collected: 06/07/18 09:10 — **Matrix: Water**
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.90**	**J**	1.9	0.59	ng/L		06/12/18 11:13	06/18/18 06:07	1
Perfluorooctanoic acid (PFOA)	**1.1**	**J M** J	1.9	0.52	ng/L		06/12/18 11:13	06/18/18 06:07	1
Perfluorononanoic acid (PFNA)	1.5	U	1.9	0.50	ng/L		06/12/18 11:13	06/18/18 06:07	1
Perfluorobutanesulfonic acid (PFBS)	**3.9**	**M** =	1.9	0.45	ng/L		06/12/18 11:13	06/18/18 06:07	1
Perfluorohexanesulfonic acid (PFHxS)	**3.2**		1.9	0.37	ng/L		06/12/18 11:13	06/18/18 06:07	1
Perfluorooctanesulfonic acid (PFOS)	2.9	U	3.9	1.1	ng/L		06/12/18 11:13	06/18/18 06:07	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*79*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:07*	*1*
13C4-PFHpA	*92*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:07*	*1*
13C4 PFOA	*91*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:07*	*1*
13C5 PFNA	*91*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:07*	*1*
18O2 PFHxS	*87*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:07*	*1*
13C4 PFOS	*84*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:07*	*1*

Client Sample ID: MW-HEC07-01-01 — Lab Sample ID: 320-40148-34

Date Collected: 06/07/18 11:17 — **Matrix: Water**
Date Received: 06/08/18 09:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**54**		1.9	0.59	ng/L		06/12/18 11:13	06/18/18 06:14	1
Perfluorooctanoic acid (PFOA)	**210**	**M** =	1.9	0.52	ng/L		06/12/18 11:13	06/18/18 06:14	1
Perfluorononanoic acid (PFNA)	1.5	U M U	1.9	0.50	ng/L		06/12/18 11:13	06/18/18 06:14	1
Perfluorobutanesulfonic acid (PFBS)	**180**		1.9	0.45	ng/L		06/12/18 11:13	06/18/18 06:14	1
Perfluorohexanesulfonic acid (PFHxS)	**2200**	**E** *	1.9	0.37	ng/L		06/12/18 11:13	06/18/18 06:14	1
Perfluorooctanesulfonic acid (PFOS)	**3.9**		3.9	1.1	ng/L		06/12/18 11:13	06/18/18 06:14	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*79*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:14*	*1*
13C4-PFHpA	*75*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:14*	*1*
13C4 PFOA	*90*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:14*	*1*
13C5 PFNA	*89*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:14*	*1*
18O2 PFHxS	*69*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:14*	*1*
13C4 PFOS	*84*		*50 - 150*	*06/12/18 11:13*	*06/18/18 06:14*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**57**	**D** *	39	12	ng/L		06/12/18 11:13	06/20/18 05:20	20
Perfluorooctanoic acid (PFOA)	**210**	**D M** *	39	10	ng/L		06/12/18 11:13	06/20/18 05:20	20
Perfluorononanoic acid (PFNA)	29	U *	39	10	ng/L		06/12/18 11:13	06/20/18 05:20	20
Perfluorobutanesulfonic acid (PFBS)	**190**	**D** *	39	8.9	ng/L		06/12/18 11:13	06/20/18 05:20	20
Perfluorohexanesulfonic acid (PFHxS)	**3300**	**D** J K01	39	7.4	ng/L		06/12/18 11:13	06/20/18 05:20	20
Perfluorooctanesulfonic acid (PFOS)	58	U *	77	21	ng/L		06/12/18 11:13	06/20/18 05:20	20

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*77*		*50 - 150*	*06/12/18 11:13*	*06/20/18 05:20*	*20*

Client Sample ID: MW-HEC07-01-01

Lab Sample ID: 320-40148-34

Date Collected: 06/07/18 11:17
Date Received: 06/08/18 09:00
Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL (Continued)

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4-PFHpA	85		50 - 150	06/12/18 11:13	06/20/18 05:20	20
13C4 PFOA	96		50 - 150	06/12/18 11:13	06/20/18 05:20	20
13C5 PFNA	88		50 - 150	06/12/18 11:13	06/20/18 05:20	20
18O2 PFHxS	86		50 - 150	06/12/18 11:13	06/20/18 05:20	20
13C4 PFOS	85		50 - 150	06/12/18 11:13	06/20/18 05:20	20

Client Sample ID: MW-HEC07-02-01

Lab Sample ID: 320-40148-35

Date Collected: 06/07/18 13:07
Date Received: 06/08/18 09:00
Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3	U M	U	1.8	0.54	ng/L		06/12/18 11:13	06/18/18 06:30	1
Perfluorooctanoic acid (PFOA)	**0.77**	**J M**	J	1.8	0.47	ng/L		06/12/18 11:13	06/18/18 06:30	1
Perfluorononanoic acid (PFNA)	1.3	U		1.8	0.46	ng/L		06/12/18 11:13	06/18/18 06:30	1
Perfluorobutanesulfonic acid (PFBS)	0.88	U		1.8	0.40	ng/L		06/12/18 11:13	06/18/18 06:30	1
Perfluorohexanesulfonic acid (PFHxS)	**0.69**	**J**		1.8	0.33	ng/L		06/12/18 11:13	06/18/18 06:30	1
Perfluorooctanesulfonic acid (PFOS)	2.6	U		3.5	0.97	ng/L		06/12/18 11:13	06/18/18 06:30	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	78		50 - 150	06/12/18 11:13	06/18/18 06:30	1
13C4-PFHpA	96		50 - 150	06/12/18 11:13	06/18/18 06:30	1
13C4 PFOA	94		50 - 150	06/12/18 11:13	06/18/18 06:30	1
13C5 PFNA	89		50 - 150	06/12/18 11:13	06/18/18 06:30	1
18O2 PFHxS	93		50 - 150	06/12/18 11:13	06/18/18 06:30	1
13C4 PFOS	87		50 - 150	06/12/18 11:13	06/18/18 06:30	1

LEIDOS
Laboratory Data Verification Checklist

Project: Hector Field

SDG No: J40191

Analyte Group: PFC
Sample Matrix: Soil/Water
EDD (Y/N):

Disposition of Data Package:
NCR No. (if applicable):

1. Case Narrative

Read SDG Case Narrative	Y
Check Laboratory sample ID vs. Project sample ID lists	Y
Check that discussion covers each analytical type included in the SDG	Y
Check for identified nonconforming items (e.g., missed holding times, etc.)	Y

2. Chain-of-Custody (COC)

Check COC sample collection, shipping, and receiving dates	Y
Check that COC signature blocks are complete	Y
Check COC project sample IDs vs. Lab IDs and Result Form IDs	Y
Match COC requested analyses with Case Narrative and with data package content (Result Forms)	Y

3. Analytical Results Form

Verify that a Result Form is present for each sample and analysis	Y

On each Result Form check:

SDG No.	Y
Sample ID	Y
Lab ID	Y
Date Collected	Y
Date Extracted	Y
Date Analyzed	Y
Result Matrix	Y
Result Units	Y

4. Project Verification

Check project analyte list vs. analytes reported	Y
Check project requested methods vs. analytical methods performed	Y
Check analyte reporting levels vs. project reporting level goals	Y

5. Analytical Quality Control Information

Check for surrogate recovery results (e.g., org. form II)		Y
Check for LCS results (e.g., org. form III, inorg. form XII)		Y
Check for method blank results (e.g., org. form IV, inorg. form III)		Y
Check for MS/MSD results (e.g., inorg. form V)		Y
Check for laboratory duplicate results (e.g., inorg. form VI)		NA
Check for Method Calibration and Run Documentation		
organic:	instrument performance check	Y
	initial calibration data	Y
	continuing calibration data	Y
	internal standard areas	Y
	internal standard retention times	Y
	sample clean-up documentation	Y
	(org. forms V through X)	
metal:	initial calibration data	
	continuing calibration data	
	method detection limits	
	method linear range	
	sample run sequence	
	(inorg. forms II, IV, and VIII through XIV)	
other:	initial calibration data	
	continuing calibration data	
	method detection limits	
	sample run sequence	

6. Incorrect Information

Identify missing items or incorrect information (i.e., missing forms, unsigned forms, incorrect sample IDs, etc.)

Contact the laboratory or project personnel to obtain missing information or correct information

Document corrections below:

7. Nonconforming Items

Document all nonconforming items that can not be resolved above in a Non-Conformance Report (NCR), complete form, file, and follow-up

NCR #	Item

Reviewed By: Brooke Francis Date: 7/3/18

QA Review By: Joseph C Peters Date: 7/19/18

LEIDOS
Laboratory Data Package Detail Form

Project: Hector Field Page 1 of 1

SDG No: J40191 **Analyte Group:** PFCs

Field Sample ID	Lab ID #	Matrix	Analysis	Notes:
HEC-ER-MW-02	320-40191-1	W	PFCs	
MW-HEC12-02-01	320-40191-2			
MW-HEC01-02-01	320-40191-3			
HEC-IDW-W-01	320-40191-4			Not validated
MW-HEC12-01-01	320-40191-5	S		
HEC12-SB2-01	320-40191-6			
HEC12-SB2-02	320-40191-7			
HEC12-SB3-01	320-40191-8			
HEC12-SB3-02	320-40191-9			
HEC12-SB1-01	320-40191-10			
HEC12-SB1-02	320-40191-11	W		
HEC11-SW1-01	320-40191-12			

Comments:

Leidos - Horsham Project Specific
PFASs by LC/MS/MS Methods Data Verification/Validation

Project: Hector Field

SDG No: J40191

Laboratory: Test America

Analysis: PFC

Method: E537

Matrix: Water/Soil

The above data package has been reviewed and the analytical quality control/quality assurance performance data have been summarized. The general criteria used to assess the analytical integrityof the data were based on DOD QSM 5.1 guidance and examination of the following:

Case Narrative	Instrument Sensitivity Checks
Analytical Holding Times	Internal Standard Performance
Sample Preservation	MS/MSD Recoveries and Differences
Method Calibration	LCS Recoveries
Method and Project Blanks	Re-analysis and Secondary Dilution

Project Specific QA/QC or contract requirements may take priority over validation criteria in this procedure.

*** If this SDG requires full validation; recalculations from the raw data are required for one point for each ICAL, one CCV, one of each QC sample, and one field sample.**

Data verification and data validation are essentially identical, with the exception that validation requires results to be recalculated from the raw data.

Remarks: DoD QSM

Some results were qualified as estimated due to MS/MSD and/or IS discrepancies

Some results were qualified as non-detect due to blank contamination

One PFOA result was qualified as estimated due to chromatographic interferences

Definition of Qualifiers:

"U", not detected at the associated level
"UJ", not detected and associated value estimated
"J", associated value estimated
"R", associated value unusable or analyte identity unfounded

Verification/Validation by: Brooke Francis — Date: 7/3/18

QA Reviewed by: Joseph C Peters — Date: 7/19/18

Case Narrative

Verify direct statements made within the Laboratory Case Narrative (note discrepancies).

Remarks:

Method(s) EPA 537 (Mod): The following sample has chromatographic interferences that could adversely impact the identification and quantitation of Perfluorooctanoic acid (PFOA): MW-HEC01-02-01 (320-40191-3). These interferences could cause false positive results. Result qualified as estimated J, with reason code V02

Re-analysis and Secondary Dilutions

Verify that re-analysis and secondary dilutions were performed and reported as necessary. Determine appropriate results to report.

Remarks: Some samples were reanalyzed at a dilution

Holding Times

Waters - Cool 4°C; 14 days to extraction; 28 days to analysis
collection. Note: Trizma preservative is recommended for aqueous samples, but not required.

Soils - Cool 4°C ; extraction within 28 days of sample collection; analysis within 28 days of sample extraction

Deviations:

Sample #	Date Collected	Date Analyzed	Comments

Actions:

1. If holding times are exceeded, all results are qualified as estimated (J/UJ)
2. If holding times are exceeded by more than 2X, reviewer may qualify non-detected results as unusable (R)

Remarks: All holding times were met

Injection Internal Standards (IS)

List any field samples, field QC samples, or laboratory QC samples where injection internal standards are not within 50 to 150% of the peak areas from the ICAL midpoint or daily initial CCV, as applicable.

Deviations:

Sample #	Injection IS/% Rec	Affected PFAS Compounds
HEC12-SB3-01DL	PFOA 854880	All associated results
HEC12-SB1-01DL	PFOA 919715	↓
HEC12-SB1-02 DL	PFOA 388960	↓
MW-HEC12-01-01DL	PFOA 453722	↓
HEC11-SW1-01DL	PFOA 820166	↓
	0……….+	

Actions:

If any injection IS is <25%, qualify detects as J; non-detects as R

If any Injection IS is > upper control limit; qualify detects as J, no action for non-detects

If any surrogate is ≥ 25%, but < the lower control limit, then qualify detects as J, non-detects as UJ

Injection IS - Target PFAS Compounds Associations:

13C3-PFBA: PFBS
13C2-PFOA: PFOA, PFHxS, PFHpA
13C4-PFOS: PFOS, PFNA
13C2-PFDA: No PFAS project compounds

Remarks:

Surrogates/Extraction Internal Standards (IS)

List any field samples, field QC samples, or laboratory QC samples where surrogates/extraction internal standards are not within 50% ± of their true value.
Note: Extraction Internal Standards and surrogates are the same thing. For purposes of data validation and applying validation reason codes, they will be treated as surrogates. Injection internal standards will be treated as internal standards and the use of internal standard reason codes will be used.

Deviations:

Sample #	Surrogate - % Rec	Affected PFAS Compounds

Actions:

If any injection IS is <25%, qualify detects as J; non-detects as R

If any Injection IS is > upper control limit; qualify detects as J, no action for non-detects

If any surrogate is ≥ 25%, but < the lower control limit, then qualify detects as J, non-detects as UJ

Surrogate - Target PFAS Compounds Associations:

13C3-PFBS - PFBS
13C3-PFHxS - PFHxS
13C4-PFHpA - PFHpA
13C8-PFOA - PFOA
13C9-PFNA - PFNA
13C8-PFOS - PFOS

Remarks: All surrogates met control limits

VI. Blanks

A method blank was reported for each aqueous analytical batch and one method blank was reported for each soil extraction batch? (Y/N)
Review associated laboratory and project blank samples. List documented contamination below:

Laboratory Method Blanks:

Date:	Sample ID #	Compound	Conc.
6/12/18	MB 320-228719	PFOA	0.589 ng/L

Associated Project Blanks (e.g., equipment rinsates, field reagent blanks, source blanks, etc.)

Date	Sample ID #	Compound	Conc.

Remarks:

VI. Blanks (continued)

Calculate the action level based on 5X the highest blank concentration

Sample weights, volumes, and dilution factors must be taken into account when applying the 5X criteria.

0.00860 ng/mL * 10mL/0.250L = 0.344

0.00860 ng/mL * 10mL/5g * 1000g/1kg * 1ug/1000ng = 0.0172 ug/kg

Deviations:

Compound	Maximum Conc. Detected, (ppb)	Action Level (ppb)	Samples Affected
PFOA	0.589 ng/L	2.945 ng/L	MB 320-228719 320- 40191-1, 2, 3, 5, 12
PFHxS	0.00860 ng/mL	1.72 ng/L or 0.086 ug/kg	CCB, all samples

Actions:

1. If compound results exceed the action levels, the data are not qualified
2. If compound results are below the required reporting level, report results as non-detect (U) at the LOD
3. If the compound is detected above the reporting level, but below the action level, qualify as not-detected (U)
4. If contamination exists in method blanks < 1/2 LOQ, samples must be re-extracted and reanalyzed. Unlesss the MB results are < 1/10 the amount in associated samples or < 10 the action level, which ever is greater

Remarks:

VII. Initial & Contining Calibration

Date of initial calibration: ______________________________

%RSD of RFs < 20% or $r^2 \geq 0.99$ for each analyte?
Analytes within 70-130% of their true value in each ICAL standard?
ICV within ± 30% of true value?

Date(s) of continuing calibration: ______________________________
CCV analyzed at beginning and end of analytical sequence and after every 10 field samples?
CCV within ± 30% of true value?

Instrument sensitivity check (ISC) performed at the LOQ prior to analysis and every 12 hours?
ICS within ± 30% of true value?

Deviations:

Compound	Date	r value	%Drift	Samples Affected

Actions:

1. If initial calibration curve criteria are not met, qualify positive results as estimated (J) and non-detects as estimated (UJ), using professional judgement (i.e. if only the low standard is out, and the higher stards are in, then only qualify those results near the low standard).
2. Only evaluate the ICV if it brackets field samples. If the ICV does bracket field samples, then CCV actions apply
3. If a CCV is above the upper control limit, qualify detects as estimated (J). Nondects require no action.
4. If a CCV is below the lower control limit but > 40% recovery, qualify results as estimated (J/UJ).
5. If a CCV is ≤ 40% recovery, qualify detects as estimated (J) and nondetects as rejected (R)
6. If CCVs were not analyzed at the proper frequency, use professional judgement.
7. If ISC is > UCL, estimate (J) detects, no action for non-detects; If ISC is < LCL, estimate data (J/UJ), if ISC is < 30% reject (R) non-detects

Remarks: All calibration results met control limits

IX. Matrix Spike/Matrix Spike Duplicate Information

General MS/MSD Criteria:
percent recovery (%R) in-house limits
relative percent difference (RPD) 30% RPD

Project Sample(s) Spiked: HEC12-SB3-02

Deviations:

Compound	%R	%R Limits	RPD	RPD Limits	Samples Affected
PFBS	53	73-142			HEC12-SB3-02
PFHxS	34	75-121			↓ >4x spike, no qual

Actions:

1. If the spike recovery is above the upper control limit (UCL), qualify all positive values in the unspiked sample as estimated (J) and non-detects as estimated (UJ).
2. If the spike recovery is below the lower control limit (LCL), qualifty positive values as estimated (J). And non-detects as estimated (UJ).
3. If the spike recovery is <10%, qualify non-detect values as unusable (R)
4. If the RPD does not meet criteria, qualify positive values in the unspiked sample as estimated (J)
5. Use professional judgement to qualify additional samples in the analytical group based on MS/MSD results
6. Use professional judgement for qualification of data for unspiked compounds

*** If this SDG requires full validation; recalculate at least one % recovery and one % RPD from the raw data. Attach all calculations at the end of the validation checklist.**

Remarks:

X. Laboratory Control Sample Information

General LCS Criteria:
Percent recovery (%R) = in-house limits
RPD if LCSD performed = 30% RPD

Laboratory LCS Identifications: LCS 320-229205 LCS/D 320-228719

Deviations:

Compound	Date	%R	Samples Affected/Qualifiers Applied

Actions:

*** If this SDG requires full validation; recalculate at least one % recovery and one % RPD (if LCSD was performed) from the raw data. Attach all calculations at the end of the validation checklist.**

Action should be based on both the number of compounds outside the criterion and the magnitude of the exceedance.

1. If the LCS recovery is below limits but > one- half the lower limit, qualify valves as estimated (J/UJ).
2. If the LCS recovery is < one-half the lower limit, qualify detect (J) and non-detects (R)
3. If the LCS recovery is greater than the upper limit, qualify positive valves for that analyte as estimated (J).

5. Use professional judgement for qualification of data for compounds with no LCS information

Remarks: All LCS/D %R and RPD results met control limits

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40181-1

Client Sample ID: HEC-ER-MW-02

Date Collected: 06/07/18 15:20
Date Received: 06/09/18 09:10

Lab Sample ID: 320-40191-1
Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.8	0.56	ng/L		07/12/19 17:41	07/26/19 06:36	1
Perfluorooctanoic acid (PFOA)	1.4	U M U	1.8	0.50	ng/L		07/12/19 17:41	07/26/19 06:36	1
Perfluorononanoic acid (PFNA)	1.4	U	1.8	0.49	ng/L		07/12/19 17:41	07/26/19 06:36	1
Perfluorobutanesulfonic acid (PFBS)	0.83	U M U	1.8	0.43	ng/L		07/12/19 17:41	07/26/19 06:36	1
Perfluorohexanesulfonic acid (PFHxS)	0.83	U	1.8	0.35	ng/L		07/12/19 17:41	07/26/19 06:36	1
Perfluorooctanesulfonic acid (PFOS)	2.9	U	3.6	1.0	ng/L		07/12/19 17:41	07/26/19 06:36	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*80*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:37*	*1*
13C4-PFHpA	*90*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:37*	*1*
13C4 PFOA	*88*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:37*	*1*
13C5 PFNA	*83*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:37*	*1*
18O2 PFHxS	*79*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:37*	*1*
13C4 PFOS	*77*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:37*	*1*

Client Sample ID: MW-HEC12-02-01

Date Collected: 06/07/18 16:37
Date Received: 06/09/18 09:10

Lab Sample ID: 320-40191-2
Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.8	0.56	ng/L		07/12/19 17:41	07/26/19 06:45	1
Perfluorooctanoic acid (PFOA)	1.4	U M U	1.8	0.50	ng/L		07/12/19 17:41	07/26/19 06:45	1
Perfluorononanoic acid (PFNA)	1.4	U	1.8	0.49	ng/L		07/12/19 17:41	07/26/19 06:45	1
Perfluorobutanesulfonic acid (PFBS)	0.83	U	1.8	0.43	ng/L		07/12/19 17:41	07/26/19 06:45	1
Perfluorohexanesulfonic acid (PFHxS)	**0.49**	**J** U F06	1.8	0.35	ng/L		07/12/19 17:41	07/26/19 06:45	1
Perfluorooctanesulfonic acid (PFOS)	2.9	U	3.6	1.0	ng/L		07/12/19 17:41	07/26/19 06:45	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*69*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:45*	*1*
13C4-PFHpA	*87*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:45*	*1*
13C4 PFOA	*87*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:45*	*1*
13C5 PFNA	*87*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:45*	*1*
18O2 PFHxS	*75*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:45*	*1*
13C4 PFOS	*76*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:45*	*1*

Client Sample ID: MW-HEC01-02-01

Date Collected: 06/07/18 18:30
Date Received: 06/09/18 09:10

Lab Sample ID: 320-40191-3
Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.8	0.59	ng/L		07/12/19 17:41	07/26/19 06:53	1
Perfluorooctanoic acid (PFOA)	**8.5**	**M *** J V02	1.8	0.51	ng/L		07/12/19 17:41	07/26/19 06:53	1
Perfluorononanoic acid (PFNA)	1.4	U M U	1.8	0.48	ng/L		07/12/19 17:41	07/26/19 06:53	1
Perfluorobutanesulfonic acid (PFBS)	**0.46**	**J M** J	1.8	0.44	ng/L		07/12/19 17:41	07/26/19 06:53	1
Perfluorohexanesulfonic acid (PFHxS)	**0.36**	**J M** U F06	1.8	0.37	ng/L		07/12/19 17:41	07/26/19 06:53	1
Perfluorooctanesulfonic acid (PFOS)	2.9	U	3.9	1.0	ng/L		07/12/19 17:41	07/26/19 06:53	1

Client Sample ID: MW-HEC01-02-01

Lab Sample ID: 320-40191-3

Date Collected: 06/07/18 18:30

Matrix: Water

Date Received: 06/09/18 09:10

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*62*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:53*	*1*
13C4-PFHpA	*82*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:53*	*1*
13C4 PFOA	*86*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:53*	*1*
13C5 PFNA	*86*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:53*	*1*
18O2 PFHxS	*75*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:53*	*1*
13C4 PFOS	*75*		*50 - 150*	*06/12/18 16:41*	*06/27/18 07:53*	*1*

Client Sample ID: HEC-IDW-W-01

Lab Sample ID: 320-40191-4

Date Collected: 06/07/18 19:00

Matrix: Water

Date Received: 06/09/18 09:10

Method: 8260B - Volatile Organic Compounds (GC/MS) - TCLP

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
BenKene	0.0040	U	0.010	0.0017	mg/L			07/20/19 11:51	1
2-Butanone (MzE)	0.040	U	0.10	0.019	mg/L			07/20/19 11:51	1
Carbon tetrachloride	0.0040	U	0.010	0.0018	mg/L			07/20/19 11:51	1
ChlorobenKene	0.0040	U	0.010	0.0016	mg/L			07/20/19 11:51	1
Chloroform	0.0040	U	0.010	0.0017	mg/L			07/20/19 11:51	1
1,2-Dichloroethane	0.0040	U	0.010	0.0013	mg/L			07/20/19 11:51	1
1,1-Dichloroethene	0.0090	U	0.010	0.0023	mg/L			07/20/19 11:51	1
Tetrachloroethene	0.0040	U	0.010	0.0020	mg/L			07/20/19 11:51	1
Trichloroethene	0.0040	U	0.010	0.0017	mg/L			07/20/19 11:51	1
Vinyl chloride	0.0020	U	0.010	0.0010	mg/L			07/20/19 11:51	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*107*		*78 - 120*		*06/20/18 11:51*	*1*
1,2-Dichloroethane-d4 (Surr)	*113*		*64 - 129*		*06/20/18 11:51*	*1*
4-Bromofluorobenzene (Surr)	*100*		*78 - 121*		*06/20/18 11:51*	*1*
Dibromofluoromethane (Surr)	*107*		*79 - 119*		*06/20/18 11:51*	*1*

Client Sample ID: MW-HEC12-01-01

Lab Sample ID: 320-40191-5

Date Collected: 06/08/18 09:02

Matrix: Water

Date Received: 06/09/18 09:10

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**300**		2.0	0.70	ng/L		07/12/19 17:41	07/26/19 09:01	1
Perfluorooctanoic acid (PFOA)	**350**	**M** =	2.0	0.53	ng/L		07/12/19 17:41	07/26/19 09:01	1
Perfluorononanoic acid (PFNA)	**13**	**M** =	2.0	0.51	ng/L		07/12/19 17:41	07/26/19 09:01	1
Perfluorobutanesulfonic acid (PFBS)	**980**	**E** *	2.0	0.45	ng/L		07/12/19 17:41	07/26/19 09:01	1
Perfluorohexanesulfonic acid (PFHxS)	**1500**	**E** *	2.0	0.36	ng/L		07/12/19 17:41	07/26/19 09:01	1
Perfluorooctanesulfonic acid (PFOS)	**660**	**E** *	3.8	1.1	ng/L		07/12/19 17:41	07/26/19 09:01	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*66*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:01*	*1*
13C4-PFHpA	*66*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:01*	*1*
13C4 PFOA	*85*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:01*	*1*
13C5 PFNA	*85*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:01*	*1*
18O2 PFHxS	*65*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:01*	*1*
13C4 PFOS	*78*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:01*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	300	D	*	20	7.0	ng/L		07/12/19 17:41	07/29/19 15:36	10
Perfluorooctanoic acid (PFOA)	360	D M	*	20	5.3	ng/L		07/12/19 17:41	07/29/19 15:36	10
Perfluorononanoic acid (PFNA)	17	J D M	*	20	5.1	ng/L		07/12/19 17:41	07/29/19 15:36	10
Perfluorobutanesulfonic acid (PFBS)	1600	D	J K01	20	4.5	ng/L		07/12/19 17:41	07/29/19 15:36	10
Perfluorohexanesulfonic acid (PFHxS)	2000	D	J K01	20	3.6	ng/L		07/12/19 17:41	07/29/19 15:36	10
Perfluorooctanesulfonic acid (PFOS)	680	D	J K01	38	11	ng/L		07/12/19 17:41	07/29/19 15:36	10

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*88*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:37*	*10*
13C4-PFHpA	*82*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:37*	*10*
13C4 PFOA	*85*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:37*	*10*
13C5 PFNA	*84*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:37*	*10*
18O2 PFHxS	*82*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:37*	*10*
13C4 PFOS	*77*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:37*	*10*

Client Sample ID: HEC12-SB2-01 Lab Sample ID: 320-40191-6

Date Collected: 06/08/18 09:50 Matrix: Solid
Date Received: 06/09/18 09:10 Percent Solids: 66.0

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.42	J M	J	0.45	0.12	ug/Eg	☼	07/14/19 19:41	07/25/19 23:08	1
Perfluorooctanoic acid (PFOA)	1.8			0.45	0.15	ug/Eg	☼	07/14/19 19:41	07/25/19 23:08	1
Perfluorononanoic acid (PFNA)	0.59			0.45	0.12	ug/Eg	☼	07/14/19 19:41	07/25/19 23:08	1
Perfluorobutanesulfonic acid (PFBS)	0.24	J M	J	0.70	0.098	ug/Eg	☼	07/14/19 19:41	07/25/19 23:08	1
Perfluorohexanesulfonic acid (PFHxS)	3.0			0.45	0.083	ug/Eg	☼	07/14/19 19:41	07/25/19 23:08	1
Perfluorooctanesulfonic acid (PFOS)	18			1.5	0.37	ug/Eg	☼	07/14/19 19:41	07/25/19 23:08	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*61*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:09*	*1*
13C4-PFHpA	*73*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:09*	*1*
13C4 PFOA	*76*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:09*	*1*
13C5 PFNA	*74*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:09*	*1*
18O2 PFHxS	*64*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:09*	*1*
13C4 PFOS	*65*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:09*	*1*

Client Sample ID: HEC12-SB2-02 Lab Sample ID: 320-40191-7

Date Collected: 06/08/18 10:13 Matrix: Solid
Date Received: 06/09/18 09:10 Percent Solids: 70.8

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier		LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.42			0.42	0.11	ug/Eg	☼	07/14/19 19:41	07/25/19 23:16	1
Perfluorooctanoic acid (PFOA)	0.99			0.42	0.14	ug/Eg	☼	07/14/19 19:41	07/25/19 23:16	1
Perfluorononanoic acid (PFNA)	0.29	U M	U	0.42	0.11	ug/Eg	☼	07/14/19 19:41	07/25/19 23:16	1
Perfluorobutanesulfonic acid (PFBS)	1.0			0.57	0.093	ug/Eg	☼	07/14/19 19:41	07/25/19 23:16	1
Perfluorohexanesulfonic acid (PFHxS)	3.0			0.42	0.096	ug/Eg	☼	07/14/19 19:41	07/25/19 23:16	1
Perfluorooctanesulfonic acid (PFOS)	0.60	U M	U	1.4	0.34	ug/Eg	☼	07/14/19 19:41	07/25/19 23:16	1

Client Sample ID: HEC12-SB2-02

Lab Sample ID: 320-40191-7

Date Collected: 06/08/18 10:13
Date Received: 06/09/18 09:10

Matrix: Solid
Percent Solids: 70.8

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*64*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:17*	*1*
13C4-PFHpA	*75*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:17*	*1*
13C4 PFOA	*73*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:17*	*1*
13C5 PFNA	*73*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:17*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:17*	*1*
13C4 PFOS	*62*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:17*	*1*

Client Sample ID: HEC12-SB3-01

Lab Sample ID: 320-40191-8

Date Collected: 06/08/18 10:45
Date Received: 06/09/18 09:10

Matrix: Solid
Percent Solids: 78.3

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.12**	**J**	0.39	0.088	ug/Kg	☼	07/14/19 19:41	07/25/19 23:25	1
Perfluorooctanoic acid (PFOA)	**1.6**		0.39	0.13	ug/Kg	☼	07/14/19 19:41	07/25/19 23:25	1
Perfluorononanoic acid (PFNA)	**0.40**	**M** =	0.39	0.10	ug/Kg	☼	07/14/19 19:41	07/25/19 23:25	1
Perfluorobutanesulfonic acid (PFBS)	**0.22**	**J**	0.51	0.065	ug/Kg	☼	07/14/19 19:41	07/25/19 23:25	1
Perfluorohexanesulfonic acid (PFHxS)	**4.5**		0.39	0.068	ug/Kg	☼	07/14/19 19:41	07/25/19 23:25	1
Perfluorooctanesulfonic acid (PFOS)	**26**	**E** *	1.3	0.30	ug/Kg	☼	07/14/19 19:41	07/25/19 23:25	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*61*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:25*	*1*
13C4-PFHpA	*75*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:25*	*1*
13C4 PFOA	*75*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:25*	*1*
13C5 PFNA	*71*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:25*	*1*
18O2 PFHxS	*61*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:25*	*1*
13C4 PFOS	*65*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:25*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3	U *	1.8	0.48	ug/Kg	☼	07/14/19 19:41	07/27/19 12:35	5
Perfluorooctanoic acid (PFOA)	**1.7**	**J D** *	1.8	0.73	ug/Kg	☼	07/14/19 19:41	07/27/19 12:35	5
Perfluorononanoic acid (PFNA)	1.3	U *	1.8	0.51	ug/Kg	☼	07/14/19 19:41	07/27/19 12:35	5
Perfluorobutanesulfonic acid (PFBS)	1.1	U *	2.5	0.36	ug/Kg	☼	07/14/19 19:41	07/27/19 12:35	5
Perfluorohexanesulfonic acid (PFHxS)	**4.4**	**D** *	1.8	0.38	ug/Kg	☼	07/14/19 19:41	07/27/19 12:35	5
Perfluorooctanesulfonic acid (PFOS)	**28**	**D M** J K01	7.3	1.5	ug/Kg	☼	07/14/19 19:41	07/27/19 12:35	5

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*70*		*50 - 150*	*06/14/18 18:41*	*06/26/18 12:35*	*5*
13C4-PFHpA	*84*		*50 - 150*	*06/14/18 18:41*	*06/26/18 12:35*	*5*
13C4 PFOA	*77*		*50 - 150*	*06/14/18 18:41*	*06/26/18 12:35*	*5*
13C5 PFNA	*77*		*50 - 150*	*06/14/18 18:41*	*06/26/18 12:35*	*5*
18O2 PFHxS	*67*		*50 - 150*	*06/14/18 18:41*	*06/26/18 12:35*	*5*
13C4 PFOS	*66*		*50 - 150*	*06/14/18 18:41*	*06/26/18 12:35*	*5*

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40181-1

Client Sample ID: HEC12-SB3-02

Lab Sample ID: 320-40191-9

Date Collected: 06/08/18 11:10
Date Received: 06/09/18 09:10

Matrix: Solid
Percent Solids: 70.4

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.0		0.42	0.11	ug/Eg	☼	07/14/19 19:41	07/25/19 23:40	1
Perfluorooctanoic acid (PFOA)	1.2	M =	0.42	0.14	ug/Eg	☼	07/14/19 19:41	07/25/19 23:40	1
Perfluorononanoic acid (PFNA)	0.29	U	0.42	0.11	ug/Eg	☼	07/14/19 19:41	07/25/19 23:40	1
Perfluorobutanesulfonic acid (PFBS)	5.8	J1 J H02	0.57	0.093	ug/Eg	☼	07/14/19 19:41	07/25/19 23:40	1
Perfluorohexanesulfonic acid (PFHxS)	10	J1 =	0.42	0.096	ug/Eg	☼	07/14/19 19:41	07/25/19 23:40	1
Perfluorooctanesulfonic acid (PFOS)	1.0	J M J	1.4	0.34	ug/Eg	☼	07/14/19 19:41	07/25/19 23:40	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*66*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:40*	*1*
13C4-PFHpA	*74*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:40*	*1*
13C4 PFOA	*75*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:40*	*1*
13C5 PFNA	*74*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:40*	*1*
18O2 PFHxS	*67*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:40*	*1*
13C4 PFOS	*62*		*50 - 150*	*06/14/18 18:41*	*06/25/18 23:40*	*1*

Client Sample ID: HEC12-SB1-01

Lab Sample ID: 320-40191-10

Date Collected: 06/08/18 11:55
Date Received: 06/09/18 09:10

Matrix: Solid
Percent Solids: 77.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.54		0.39	0.088	ug/Eg	☼	07/14/19 19:41	07/27/19 00:04	1
Perfluorooctanoic acid (PFOA)	3.2		0.39	0.13	ug/Eg	☼	07/14/19 19:41	07/27/19 00:04	1
Perfluorononanoic acid (PFNA)	0.52		0.39	0.10	ug/Eg	☼	07/14/19 19:41	07/27/19 00:04	1
Perfluorobutanesulfonic acid (PFBS)	2.2		0.51	0.065	ug/Eg	☼	07/14/19 19:41	07/27/19 00:04	1
Perfluorohexanesulfonic acid (PFHxS)	14		0.39	0.068	ug/Eg	☼	07/14/19 19:41	07/27/19 00:04	1
Perfluorooctanesulfonic acid (PFOS)	45	E *	1.3	0.31	ug/Eg	☼	07/14/19 19:41	07/27/19 00:04	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*63*		*50 - 150*	*06/14/18 18:41*	*06/26/18 00:04*	*1*
13C4-PFHpA	*73*		*50 - 150*	*06/14/18 18:41*	*06/26/18 00:04*	*1*
13C4 PFOA	*72*		*50 - 150*	*06/14/18 18:41*	*06/26/18 00:04*	*1*
13C5 PFNA	*67*		*50 - 150*	*06/14/18 18:41*	*06/26/18 00:04*	*1*
18O2 PFHxS	*60*		*50 - 150*	*06/14/18 18:41*	*06/26/18 00:04*	*1*
13C4 PFOS	*60*		*50 - 150*	*06/14/18 18:41*	*06/26/18 00:04*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.52	J D *	1.8	0.50	ug/Eg	☼	07/14/19 19:41	07/27/19 12:43	5
Perfluorooctanoic acid (PFOA)	3.4	D M *	1.8	0.74	ug/Eg	☼	07/14/19 19:41	07/27/19 12:43	5
Perfluorononanoic acid (PFNA)	0.58	J D *	1.8	0.52	ug/Eg	☼	07/14/19 19:41	07/27/19 12:43	5
Perfluorobutanesulfonic acid (PFBS)	2.1	J D *	2.7	0.39	ug/Eg	☼	07/14/19 19:41	07/27/19 12:43	5
Perfluorohexanesulfonic acid (PFHxS)	14	D M *	1.8	0.40	ug/Eg	☼	07/14/19 19:41	07/27/19 12:43	5
Perfluorooctanesulfonic acid (PFOS)	47	D M J K01	7.4	1.5	ug/Eg	☼	07/14/19 19:41	07/27/19 12:43	5

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40181-1

Client Sample ID: HEC12-SB1-01

Lab Sample ID: 320-40191-10

Date Collected: 06/08/18 11:55
Matrix: Solid
Date Received: 06/09/18 09:10
Percent Solids: 77.2

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	62		50 - 150	06/14/18 18:41	06/26/18 12:43	5
13C4-PFHpA	73		50 - 150	06/14/18 18:41	06/26/18 12:43	5
13C4 PFOA	71		50 - 150	06/14/18 18:41	06/26/18 12:43	5
13C5 PFNA	68		50 - 150	06/14/18 18:41	06/26/18 12:43	5
18O2 PFHxS	62		50 - 150	06/14/18 18:41	06/26/18 12:43	5
13C4 PFOS	61		50 - 150	06/14/18 18:41	06/26/18 12:43	5

Client Sample ID: HEC12-SB1-02

Lab Sample ID: 320-40191-11

Date Collected: 06/08/18 12:25
Matrix: Solid
Date Received: 06/09/18 09:10
Percent Solids: 70.9

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	12		0.42	0.11	ug/Eg	☼	07/14/19 19:41	07/27/19 00:12	1
Perfluorooctanoic acid (PFOA)	16	M =	0.42	0.14	ug/Eg	☼	07/14/19 19:41	07/27/19 00:12	1
Perfluorononanoic acid (PFNA)	0.29	U	0.42	0.11	ug/Eg	☼	07/14/19 19:41	07/27/19 00:12	1
Perfluorobutanesulfonic acid (PFBS)	45	E *	0.57	0.093	ug/Eg	☼	07/14/19 19:41	07/27/19 00:12	1
Perfluorohexanesulfonic acid (PFHxS)	73	E *	0.42	0.096	ug/Eg	☼	07/14/19 19:41	07/27/19 00:12	1
Perfluorooctanesulfonic acid (PFOS)	0.69	J	1.4	0.34	ug/Eg	☼	07/14/19 19:41	07/27/19 00:12	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	70		50 - 150	06/14/18 18:41	06/26/18 00:12	1
13C4-PFHpA	71		50 - 150	06/14/18 18:41	06/26/18 00:12	1
13C4 PFOA	76		50 - 150	06/14/18 18:41	06/26/18 00:12	1
13C5 PFNA	77		50 - 150	06/14/18 18:41	06/26/18 00:12	1
18O2 PFHxS	65		50 - 150	06/14/18 18:41	06/26/18 00:12	1
13C4 PFOS	69		50 - 150	06/14/18 18:41	06/26/18 00:12	1

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	12	D *	4.2	1.1	ug/Eg	☼	07/14/19 19:41	07/27/19 12:51	10
Perfluorooctanoic acid (PFOA)	16	D M *	4.2	1.4	ug/Eg	☼	07/14/19 19:41	07/27/19 12:51	10
Perfluorononanoic acid (PFNA)	2.9	U *	4.2	1.1	ug/Eg	☼	07/14/19 19:41	07/27/19 12:51	10
Perfluorobutanesulfonic acid (PFBS)	54	D J K01	5.7	0.93	ug/Eg	☼	07/14/19 19:41	07/27/19 12:51	10
Perfluorohexanesulfonic acid (PFHxS)	79	D J K01	4.2	0.96	ug/Eg	☼	07/14/19 19:41	07/27/19 12:51	10
Perfluorooctanesulfonic acid (PFOS)	6.1	U *	14	3.4	ug/Eg	☼	07/14/19 19:41	07/27/19 12:51	10

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	79		50 - 150	06/14/18 18:41	06/26/18 12:51	10
13C4-PFHpA	79		50 - 150	06/14/18 18:41	06/26/18 12:51	10
13C4 PFOA	83		50 - 150	06/14/18 18:41	06/26/18 12:51	10
13C5 PFNA	81		50 - 150	06/14/18 18:41	06/26/18 12:51	10
18O2 PFHxS	75		50 - 150	06/14/18 18:41	06/26/18 12:51	10
13C4 PFOS	70		50 - 150	06/14/18 18:41	06/26/18 12:51	10

Client Sample Results

Client: Leidos, Inc.
Project/Site: Phase III, ANG-Hector Field

TestAmerica Job ID: 320-40181-1

Client Sample ID: HEC11-SW1-01

Lab Sample ID: 320-40191-12

Date Collected: 06/08/18 13:15
Date Received: 06/09/18 09:10
Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	10		2.0	0.70	ng/L		07/12/19 17:41	07/26/19 09:08	1
Perfluorooctanoic acid (PFOA)	20	M =	2.0	0.53	ng/L		07/12/19 17:41	07/26/19 09:08	1
Perfluorononanoic acid (PFNA)	1.5	J	2.0	0.51	ng/L		07/12/19 17:41	07/26/19 09:08	1
Perfluorobutanesulfonic acid (PFBS)	39		2.0	0.45	ng/L		07/12/19 17:41	07/26/19 09:08	1
Perfluorohexanesulfonic acid (PFHxS)	390	E *	2.0	0.36	ng/L		07/12/19 17:41	07/26/19 09:08	1
Perfluorooctanesulfonic acid (PFOS)	410	E *	3.8	1.1	ng/L		07/12/19 17:41	07/26/19 09:08	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*77*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:09*	*1*
13C4-PFHpA	*83*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:09*	*1*
13C4 PFOA	*83*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:09*	*1*
13C5 PFNA	*81*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:09*	*1*
18O2 PFHxS	*73*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:09*	*1*
13C4 PFOS	*77*		*50 - 150*	*06/12/18 16:41*	*06/27/18 08:09*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	12	D *	8.9	3.0	ng/L		07/12/19 17:41	07/29/19 15:45	5
Perfluorooctanoic acid (PFOA)	23	D *	8.9	2.7	ng/L		07/12/19 17:41	07/29/19 15:45	5
Perfluorononanoic acid (PFNA)	6.3	U M *	8.9	2.5	ng/L		07/12/19 17:41	07/29/19 15:45	5
Perfluorobutanesulfonic acid (PFBS)	37	D *	8.9	2.2	ng/L		07/12/19 17:41	07/29/19 15:45	5
Perfluorohexanesulfonic acid (PFHxS)	410	D J K01	8.9	1.8	ng/L		07/12/19 17:41	07/29/19 15:45	5
Perfluorooctanesulfonic acid (PFOS)	410	D J K01	20	5.4	ng/L		07/12/19 17:41	07/29/19 15:45	5

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*90*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:45*	*5*
13C4-PFHpA	*92*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:45*	*5*
13C4 PFOA	*86*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:45*	*5*
13C5 PFNA	*86*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:45*	*5*
18O2 PFHxS	*84*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:45*	*5*
13C4 PFOS	*79*		*50 - 150*	*06/12/18 16:41*	*06/28/18 15:45*	*5*

APPENDIX E

LABORATORY ANALYTICAL DATA REPORTS

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THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

Job Number: 320-39942-1

Job Description: Phase III, ANG- Hector Field

For:
Leidos, Inc.
11251 Roger Bacon Drive
Reston, VA 20190

Attention: Selvam Arunachalam

Approved for release.
David R Alltucker
Project Manager I
6/30/2018 1:39 PM

David R Alltucker, Project Manager I
880 Riverside Parkway, West Sacramento, CA, 95605
(916)374-4383
david.alltucker@testamericainc.com
06/30/2018

TestAmerica Laboratories, Inc.
TestAmerica Sacramento 880 Riverside Parkway, West Sacramento, CA 95605
Tel (916) 373-5600 Fax (916) 372-1059 www.testamericainc.com

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Qualifiers

LCMS

Qualifier	Qualifier Description
U	Undetected at the Limit of Detection.
J	Estimated: The analyte was positively identified; the quantitation is an estimation
M	Manual integrated compound.
J1	Estimated: The quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria.
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.
E	Result exceeded calibration range.
D	The reported value is from a dilution.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job Narrative
320-39942-1

Comments
No additional comments.

Receipt
The samples were received on 6/1/2018 10:00 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 4.8° C.

Receipt Exceptions

The Chain-of-Custody (COC) was incomplete as received and/or improperly completed. The second page of the COC did not have the tests checked.

LCMS
Method(s) EPA 537 (Mod), EPA 537(Mod): The first level standard from the initial calibration curve is used to evaluate the tune criteria. The instrument mass windows are set at +/- 0.5amu; therefore, detection of the analyte serves as verification that the assigned mass is within +/- 0.5amu of the true value, which meets the DoD/DOE QSM tune criterion.

Method(s) EPA 537 (Mod), EPA 537(Mod): The first level standard from the initial calibration curve is used to evaluate the tune criteria. The instrument mass windows are set at +/- 0.5amu; therefore, detection of the analyte serves as verification that the assigned mass is within +/- 0.5amu of the true value, which meets the DoD/DOE QSM tune criterion.

Method(s) EPA 537 (Mod): The matrix spike / matrix spike duplicate (MS/MSD) have detections which exceeded the instrument calibration range as a result of fortification with standard solution. The parent sample result was within the calibration range.

HEC02-SB1-01 (320-39942-20[MS]) and HEC02-SB1-01 (320-39942-20[MSD])

Method(s) EPA 537 (Mod): The concentration of Perfluorohexanesulfonic acid (PFHxS) or Perfluorooctanesulfonic acid (PFOS) associated with the following samples exceeded the instrument calibration range: HEC05-SB3-01 (320-39942-6) and HEC02-SB1-02D (320-39942-22). These analytes have been qualified; however, the peaks did not saturate the instrument detector. The samples were also re-analyzed at dilution to bring the results withing the calibration range and both sets of data were reported.

Method(s) EPA 537 (Mod): The matrix spike (MS) recovery for Perfluorohexanesulfonic acid (PFHxS) in preparation batch 320-228766 and analytical batch 320-231442 was outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

Method(s) EPA 537 (Mod): Due to the high concentration of Perfluorooctanesulfonic acid (PFOS), the matrix spike / matrix spike duplicate (MS/MSD) for preparation batch 320-228766 and analytical batch 320-231442 could not be evaluated for accuracy and precision for this analyte. The associated laboratory control sample (LCS) met acceptance criteria.

Method(s) EPA 537 (Mod): The first level standard from the initial calibration curve is used to evaluate the tune criteria. The instrument mass windows are set at +/- 0.5amu; therefore, detection of the analyte serves as verification that the assigned mass is within +/- 0.5amu of the true value, which meets the DoD/DOE QSM tune criterion.

Method(s) EPA 537 (Mod): Results for sample HEC05-SB3-01 (320-39942-6) and HEC02-SB1-02D (320-39942-22) were reported from the analysis of a diluted extract due to high concentration of the target analyte in the analysis of the undiluted extract. The dilution factor was applied to the labeled internal standard area counts and these area counts were within acceptance limits.

Method(s) EPA 537 (Mod): The following samples were diluted to bring the concentration of target analytes within the calibration range: HEC05-SB3-01 (320-39942-6) and HEC02-SB1-02D (320-39942-22). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
Method(s) 3535: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 320-227763.

3535 - water - 320-227763

Method(s) 3535: A deviation from the Standard Operating Procedure (SOP) occurred. Details are as follows: The following sample(s) HEC-FB-POT-01 (320-39942-18) were received to the laboratory with Trizma preserved labels, which is a standard deviation from our Standard Operating Procedures. Therefore, the Method Blank and the Laboratory Control Sample and the Laboratory Control Sample Duplicate were also preserved with Trizma.

3535 - water - 320-227763

Method(s) 3535: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 320-227757.

3535 - water - 320-227757

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Detection Summary

Client: Leidos, Inc.
Project/Site: Phase III, ANG- Hector Field

TestAmerica Job ID: 320-39942-1

Client Sample ID: HEC-RB-01 — Lab Sample ID: 320-39942-1

No Detections.

Client Sample ID: HEC-FB-DI-01 — Lab Sample ID: 320-39942-2

No Detections.

Client Sample ID: HEC-ER-SB-01 — Lab Sample ID: 320-39942-3

No Detections.

Client Sample ID: HEC05-SB1-01 — Lab Sample ID: 320-39942-4

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluoroheptanoic acid (PFHpA)	0.11	J	0.38	0.10	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanoic acid (PFOA)	0.17	J	0.38	0.13	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorobutanesulfonic acid (PFBS)	0.13	J	0.51	0.076	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	0.74		0.38	0.080	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	1.1	J	1.3	0.31	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC05-SB1-02 — Lab Sample ID: 320-39942-5

No Detections.

Client Sample ID: HEC05-SB3-01 — Lab Sample ID: 320-39942-6

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluoroheptanoic acid (PFHpA)	4.2		0.39	0.10	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanoic acid (PFOA)	0.81	M	0.39	0.13	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorobutanesulfonic acid (PFBS)	8.3		0.51	0.076	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	45	E	0.39	0.080	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	14	M	1.3	0.31	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluoroheptanoic acid (PFHpA) - DL	4.7	D	1.9	0.50	ug/Kg	5	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanoic acid (PFOA) - DL	0.88	J D M	1.9	0.64	ug/Kg	5	☼	EPA 537 (Mod)	Total/NA
Perfluorobutanesulfonic acid (PFBS) - DL	9.1	D	2.6	0.38	ug/Kg	5	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS) - DL	49	D	1.9	0.40	ug/Kg	5	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS) - DL	14	D	6.4	1.5	ug/Kg	5	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC05-SB3-02 — Lab Sample ID: 320-39942-7

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluoroheptanoic acid (PFHpA)	0.68		0.40	0.11	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanoic acid (PFOA)	1.0		0.40	0.13	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorobutanesulfonic acid (PFBS)	3.3		0.54	0.079	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	23		0.40	0.084	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	0.53	J	1.3	0.32	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC05-SB2-01 — Lab Sample ID: 320-39942-8

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanesulfonic acid (PFHxS)	0.14	J	0.41	0.086	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HEC05-SB2-02 — Lab Sample ID: 320-39942-9

No Detections.

Client Sample ID: HEC-ER-SB-02 — Lab Sample ID: 320-39942-10

No Detections.

Client Sample ID: HEC06-SB1-01 — Lab Sample ID: 320-39942-11

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanesulfonic acid (PFHxS)	0.37	J	0.40	0.082	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC06-SB1-01D — Lab Sample ID: 320-39942-12

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanesulfonic acid (PFHxS)	0.67		0.38	0.079	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	0.95	J M	1.3	0.31	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC06-SB1-02 — Lab Sample ID: 320-39942-13

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanesulfonic acid (PFHxS)	0.37	J	0.40	0.084	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC06-SB2-01 — Lab Sample ID: 320-39942-14

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanesulfonic acid (PFBS)	0.11	J	0.53	0.078	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	0.27	J	0.39	0.082	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	0.42	J	1.3	0.32	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC06-SB2-02 — Lab Sample ID: 320-39942-15

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanesulfonic acid (PFBS)	0.21	J	0.53	0.079	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	0.82		0.40	0.083	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	0.47	J	1.3	0.32	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC06-SB3-01 — Lab Sample ID: 320-39942-16

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluoroheptanoic acid (PFHpA)	0.36	J	0.37	0.096	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanoic acid (PFOA)	1.7		0.37	0.12	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorononanoic acid (PFNA)	0.44		0.37	0.099	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorobutanesulfonic acid (PFBS)	0.17	J	0.49	0.072	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	10		0.37	0.076	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	18	M	1.2	0.29	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC06-SB3-02 — Lab Sample ID: 320-39942-17

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanesulfonic acid (PFBS)	0.23	J	0.55	0.082	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	1.3		0.42	0.086	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HEC-FB-POT-01 — Lab Sample ID: 320-39942-18

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluoroheptanoic acid (PFHpA)	0.79	J	2.0	0.61	ng/L	1		EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	0.40	J	2.0	0.38	ng/L	1		EPA 537 (Mod)	Total/NA

Client Sample ID: HEC-ER-SB-03 — Lab Sample ID: 320-39942-19

No Detections.

Client Sample ID: HEC02-SB1-01 — Lab Sample ID: 320-39942-20

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluoroheptanoic acid (PFHpA)	0.65		0.37	0.096	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanoic acid (PFOA)	2.2		0.37	0.12	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorononanoic acid (PFNA)	0.71		0.37	0.099	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	2.7	J1	0.37	0.076	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	17	J1	1.2	0.29	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC02-SB1-02 — Lab Sample ID: 320-39942-21

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluoroheptanoic acid (PFHpA)	1.3		0.39	0.10	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanoic acid (PFOA)	1.1		0.39	0.13	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorononanoic acid (PFNA)	0.49		0.39	0.11	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	3.3		0.39	0.081	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	20		1.3	0.31	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA

Client Sample ID: HEC02-SB1-02D — Lab Sample ID: 320-39942-22

Analyte	Result	Qualifier	LOQ	DL	Unit	Dil Fac	D	Method	Prep Type
Perfluoroheptanoic acid (PFHpA)	1.6		0.41	0.11	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanoic acid (PFOA)	1.3		0.41	0.14	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorononanoic acid (PFNA)	0.76		0.41	0.11	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorobutanesulfonic acid (PFBS)	0.083	J	0.55	0.081	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	3.8		0.41	0.085	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS)	29	M E	1.4	0.33	ug/Kg	1	☼	EPA 537 (Mod)	Total/NA
Perfluoroheptanoic acid (PFHpA) - DL	1.7	D	0.82	0.21	ug/Kg	2	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanoic acid (PFOA) - DL	1.6	D	0.82	0.27	ug/Kg	2	☼	EPA 537 (Mod)	Total/NA
Perfluorononanoic acid (PFNA) - DL	0.81	J D	0.82	0.22	ug/Kg	2	☼	EPA 537 (Mod)	Total/NA
Perfluorohexanesulfonic acid (PFHxS) - DL	3.9	D	0.82	0.17	ug/Kg	2	☼	EPA 537 (Mod)	Total/NA
Perfluorooctanesulfonic acid (PFOS) - DL	30	D	2.7	0.66	ug/Kg	2	☼	EPA 537 (Mod)	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: HEC-RB-01

Lab Sample ID: 320-39942-1

Date Collected: 05/29/18 08:40

Matrix: Water

Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.8	0.56	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorooctanoic acid (PFOA)	1.4	U	1.8	0.50	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorononanoic acid (PFNA)	1.4	U	1.8	0.48	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorobutanesulfonic acid (PFBS)	0.92	U	1.8	0.42	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorohexanesulfonic acid (PFHxS)	0.92	U	1.8	0.35	ng/L		06/07/18 10:14	06/25/18 05:28	1
Perfluorooctanesulfonic acid (PFOS)	2.8	U	3.7	1.0	ng/L		06/07/18 10:14	06/25/18 05:28	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*77*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
13C4-PFHpA	*86*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
13C4 PFOA	*88*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
13C5 PFNA	*90*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
18O2 PFHxS	*78*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*
13C4 PFOS	*79*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:28*	*1*

Client Sample ID: HEC-FB-DI-01

Lab Sample ID: 320-39942-2

Date Collected: 05/29/18 08:50

Matrix: Water

Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.2	U	1.6	0.50	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorooctanoic acid (PFOA)	1.2	U	1.6	0.44	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorononanoic acid (PFNA)	1.2	U	1.6	0.43	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorobutanesulfonic acid (PFBS)	0.82	U	1.6	0.38	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorohexanesulfonic acid (PFHxS)	0.82	U	1.6	0.31	ng/L		06/07/18 10:14	06/25/18 05:36	1
Perfluorooctanesulfonic acid (PFOS)	2.5	U	3.3	0.90	ng/L		06/07/18 10:14	06/25/18 05:36	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*78*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
13C4-PFHpA	*83*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
13C4 PFOA	*90*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
13C5 PFNA	*87*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
18O2 PFHxS	*78*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*
13C4 PFOS	*80*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:36*	*1*

Client Sample ID: HEC-ER-SB-01

Lab Sample ID: 320-39942-3

Date Collected: 05/30/18 07:30

Matrix: Water

Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3	U	1.8	0.54	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorooctanoic acid (PFOA)	1.3	U	1.8	0.47	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorononanoic acid (PFNA)	1.3	U	1.8	0.46	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorobutanesulfonic acid (PFBS)	0.88	U	1.8	0.40	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorohexanesulfonic acid (PFHxS)	0.88	U	1.8	0.33	ng/L		06/07/18 10:14	06/25/18 05:44	1
Perfluorooctanesulfonic acid (PFOS)	2.6	U	3.5	0.97	ng/L		06/07/18 10:14	06/25/18 05:44	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*79*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:44*	*1*
13C4-PFHpA	*89*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:44*	*1*

Client Sample Results

Client Sample ID: HEC-ER-SB-01

Lab Sample ID: 320-39942-3
Date Collected: 05/30/18 07:30
Matrix: Water
Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFOA	*89*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:44*	*1*
13C5 PFNA	*93*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:44*	*1*
18O2 PFHxS	*82*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:44*	*1*
13C4 PFOS	*82*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:44*	*1*

Client Sample ID: HEC05-SB1-01

Lab Sample ID: 320-39942-4
Date Collected: 05/30/18 08:30
Matrix: Solid
Date Received: 06/01/18 10:00
Percent Solids: 77.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.11**	**J**	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorooctanoic acid (PFOA)	**0.17**	**J**	0.38	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorononanoic acid (PFNA)	0.26	U	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorobutanesulfonic acid (PFBS)	**0.13**	**J**	0.51	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorohexanesulfonic acid (PFHxS)	**0.74**		0.38	0.080	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1
Perfluorooctanesulfonic acid (PFOS)	**1.1**	**J**	1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 03:13	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*61*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:13*	*1*
13C4-PFHpA	*80*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:13*	*1*
13C4 PFOA	*75*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:13*	*1*
13C5 PFNA	*79*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:13*	*1*
18O2 PFHxS	*60*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:13*	*1*
13C4 PFOS	*66*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:13*	*1*

Client Sample ID: HEC05-SB1-02

Lab Sample ID: 320-39942-5
Date Collected: 05/30/18 08:40
Matrix: Solid
Date Received: 06/01/18 10:00
Percent Solids: 76.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.26	U	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorooctanoic acid (PFOA)	0.26	U	0.38	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorononanoic acid (PFNA)	0.26	U	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorobutanesulfonic acid (PFBS)	0.23	U M	0.51	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorohexanesulfonic acid (PFHxS)	0.26	U	0.38	0.080	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1
Perfluorooctanesulfonic acid (PFOS)	0.64	U	1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 03:21	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*57*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:21*	*1*
13C4-PFHpA	*70*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:21*	*1*
13C4 PFOA	*70*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:21*	*1*
13C5 PFNA	*72*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:21*	*1*
18O2 PFHxS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:21*	*1*
13C4 PFOS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:21*	*1*

Client Sample ID: HEC05-SB3-01

Lab Sample ID: 320-39942-6
Date Collected: 05/30/18 09:12
Matrix: Solid
Date Received: 06/01/18 10:00
Percent Solids: 76.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	4.2		0.39	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorooctanoic acid (PFOA)	0.81	M	0.39	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorononanoic acid (PFNA)	0.26	U	0.39	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorobutanesulfonic acid (PFBS)	8.3		0.51	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorohexanesulfonic acid (PFHxS)	45	E	0.39	0.080	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1
Perfluorooctanesulfonic acid (PFOS)	14	M	1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 03:29	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*71*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:29*	*1*
13C4-PFHpA	*77*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:29*	*1*
13C4 PFOA	*75*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:29*	*1*
13C5 PFNA	*89*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:29*	*1*
18O2 PFHxS	*69*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:29*	*1*
13C4 PFOS	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:29*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	4.7	D	1.9	0.50	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorooctanoic acid (PFOA)	0.88	J D M	1.9	0.64	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorononanoic acid (PFNA)	1.3	U	1.9	0.52	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorobutanesulfonic acid (PFBS)	9.1	D	2.6	0.38	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorohexanesulfonic acid (PFHxS)	49	D	1.9	0.40	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5
Perfluorooctanesulfonic acid (PFOS)	14	D	6.4	1.5	ug/Kg	☼	06/13/18 05:42	06/29/18 23:49	5

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*71*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:49*	*5*
13C4-PFHpA	*73*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:49*	*5*
13C4 PFOA	*77*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:49*	*5*
13C5 PFNA	*78*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:49*	*5*
18O2 PFHxS	*73*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:49*	*5*
13C4 PFOS	*78*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:49*	*5*

Client Sample ID: HEC05-SB3-02

Lab Sample ID: 320-39942-7
Date Collected: 05/30/18 09:20
Matrix: Solid
Date Received: 06/01/18 10:00
Percent Solids: 73.0

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.68		0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorooctanoic acid (PFOA)	1.0		0.40	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorononanoic acid (PFNA)	0.27	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorobutanesulfonic acid (PFBS)	3.3		0.54	0.079	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorohexanesulfonic acid (PFHxS)	23		0.40	0.084	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1
Perfluorooctanesulfonic acid (PFOS)	0.53	J	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 03:37	1

Client Sample Results

Client Sample ID: HEC05-SB3-02

Lab Sample ID: 320-39942-7

Date Collected: 05/30/18 09:20
Date Received: 06/01/18 10:00
Matrix: Solid
Percent Solids: 73.0

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*67*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
13C4-PFHpA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
13C4 PFOA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
13C5 PFNA	*76*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*
13C4 PFOS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:37*	*1*

Client Sample ID: HEC05-SB2-01

Lab Sample ID: 320-39942-8

Date Collected: 05/30/18 09:42
Date Received: 06/01/18 10:00
Matrix: Solid
Percent Solids: 70.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.28	U	0.41	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorooctanoic acid (PFOA)	0.28	U M	0.41	0.14	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorononanoic acid (PFNA)	0.28	U M	0.41	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorobutanesulfonic acid (PFBS)	0.25	U M	0.55	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorohexanesulfonic acid (PFHxS)	**0.14**	**J**	0.41	0.086	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1
Perfluorooctanesulfonic acid (PFOS)	0.69	U	1.4	0.33	ug/Kg	☼	06/13/18 05:42	06/28/18 03:44	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
13C4-PFHpA	*74*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
13C4 PFOA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
13C5 PFNA	*74*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
18O2 PFHxS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*
13C4 PFOS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:44*	*1*

Client Sample ID: HEC05-SB2-02

Lab Sample ID: 320-39942-9

Date Collected: 05/30/18 09:47
Date Received: 06/01/18 10:00
Matrix: Solid
Percent Solids: 70.8

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.28	U	0.42	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorooctanoic acid (PFOA)	0.28	U M	0.42	0.14	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorononanoic acid (PFNA)	0.28	U	0.42	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorobutanesulfonic acid (PFBS)	0.25	U	0.55	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorohexanesulfonic acid (PFHxS)	0.28	U	0.42	0.086	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1
Perfluorooctanesulfonic acid (PFOS)	0.69	U M	1.4	0.33	ug/Kg	☼	06/13/18 05:42	06/28/18 03:52	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*61*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
13C4-PFHpA	*70*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
13C4 PFOA	*72*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
13C5 PFNA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
18O2 PFHxS	*60*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*
13C4 PFOS	*61*		*50 - 150*	*06/13/18 05:42*	*06/28/18 03:52*	*1*

Client Sample ID: HEC-ER-SB-02

Lab Sample ID: 320-39942-10

Date Collected: 05/30/18 10:45
Date Received: 06/01/18 10:00

Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3	U	1.8	0.54	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorooctanoic acid (PFOA)	1.3	U	1.8	0.48	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorononanoic acid (PFNA)	1.3	U	1.8	0.46	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorobutanesulfonic acid (PFBS)	0.88	U	1.8	0.40	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorohexanesulfonic acid (PFHxS)	0.88	U	1.8	0.33	ng/L		06/07/18 10:14	06/25/18 05:52	1
Perfluorooctanesulfonic acid (PFOS)	2.6	U	3.5	0.97	ng/L		06/07/18 10:14	06/25/18 05:52	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*67*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
13C4-PFHpA	*82*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
13C4 PFOA	*75*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
13C5 PFNA	*80*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
18O2 PFHxS	*68*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*
13C4 PFOS	*68*		*50 - 150*	*06/07/18 10:14*	*06/25/18 05:52*	*1*

Client Sample ID: HEC06-SB1-01

Lab Sample ID: 320-39942-11

Date Collected: 05/30/18 13:21
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 74.3

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.26	U	0.40	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorooctanoic acid (PFOA)	0.26	U	0.40	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorononanoic acid (PFNA)	0.26	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorobutanesulfonic acid (PFBS)	0.24	U	0.53	0.078	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorohexanesulfonic acid (PFHxS)	**0.37**	**J**	0.40	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1
Perfluorooctanesulfonic acid (PFOS)	0.66	U M	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 04:00	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
13C4-PFHpA	*77*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
13C4 PFOA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
13C5 PFNA	*81*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*
13C4 PFOS	*65*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:00*	*1*

Client Sample ID: HEC06-SB1-01D

Lab Sample ID: 320-39942-12

Date Collected: 05/30/18 13:21
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 77.7

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.26	U	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorooctanoic acid (PFOA)	0.26	U	0.38	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorononanoic acid (PFNA)	0.26	U M	0.38	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorobutanesulfonic acid (PFBS)	0.23	U	0.51	0.075	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorohexanesulfonic acid (PFHxS)	**0.67**		0.38	0.079	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1
Perfluorooctanesulfonic acid (PFOS)	**0.95**	**J M**	1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 04:08	1

Client Sample ID: HEC06-SB1-01D

Lab Sample ID: 320-39942-12

Date Collected: 05/30/18 13:21
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 77.7

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	59		50 - 150	06/13/18 05:42	06/28/18 04:08	1
13C4-PFHpA	77		50 - 150	06/13/18 05:42	06/28/18 04:08	1
13C4 PFOA	79		50 - 150	06/13/18 05:42	06/28/18 04:08	1
13C5 PFNA	78		50 - 150	06/13/18 05:42	06/28/18 04:08	1
18O2 PFHxS	62		50 - 150	06/13/18 05:42	06/28/18 04:08	1
13C4 PFOS	63		50 - 150	06/13/18 05:42	06/28/18 04:08	1

Client Sample ID: HEC06-SB1-02

Lab Sample ID: 320-39942-13

Date Collected: 05/30/18 13:30
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 73.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.27	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorooctanoic acid (PFOA)	0.27	U	0.40	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorononanoic acid (PFNA)	0.27	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorobutanesulfonic acid (PFBS)	0.24	U	0.54	0.079	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorohexanesulfonic acid (PFHxS)	**0.37**	**J**	0.40	0.084	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1
Perfluorooctanesulfonic acid (PFOS)	0.67	U	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 04:23	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	63		50 - 150	06/13/18 05:42	06/28/18 04:23	1
13C4-PFHpA	75		50 - 150	06/13/18 05:42	06/28/18 04:23	1
13C4 PFOA	74		50 - 150	06/13/18 05:42	06/28/18 04:23	1
13C5 PFNA	78		50 - 150	06/13/18 05:42	06/28/18 04:23	1
18O2 PFHxS	62		50 - 150	06/13/18 05:42	06/28/18 04:23	1
13C4 PFOS	66		50 - 150	06/13/18 05:42	06/28/18 04:23	1

Client Sample ID: HEC06-SB2-01

Lab Sample ID: 320-39942-14

Date Collected: 05/30/18 14:00
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 74.8

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.26	U	0.39	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorooctanoic acid (PFOA)	0.26	U M	0.39	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorononanoic acid (PFNA)	0.26	U	0.39	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorobutanesulfonic acid (PFBS)	**0.11**	**J**	0.53	0.078	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorohexanesulfonic acid (PFHxS)	**0.27**	**J**	0.39	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1
Perfluorooctanesulfonic acid (PFOS)	**0.42**	**J**	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 04:31	1

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3-PFBS	57		50 - 150	06/13/18 05:42	06/28/18 04:31	1
13C4-PFHpA	75		50 - 150	06/13/18 05:42	06/28/18 04:31	1
13C4 PFOA	78		50 - 150	06/13/18 05:42	06/28/18 04:31	1
13C5 PFNA	80		50 - 150	06/13/18 05:42	06/28/18 04:31	1
18O2 PFHxS	58		50 - 150	06/13/18 05:42	06/28/18 04:31	1
13C4 PFOS	65		50 - 150	06/13/18 05:42	06/28/18 04:31	1

Client Sample ID: HEC06-SB2-02

Lab Sample ID: 320-39942-15

Date Collected: 05/30/18 14:12
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 74.0

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.27	U	0.40	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorooctanoic acid (PFOA)	0.27	U	0.40	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorononanoic acid (PFNA)	0.27	U	0.40	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorobutanesulfonic acid (PFBS)	0.21	J	0.53	0.079	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorohexanesulfonic acid (PFHxS)	0.82		0.40	0.083	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1
Perfluorooctanesulfonic acid (PFOS)	0.47	J	1.3	0.32	ug/Kg	☼	06/13/18 05:42	06/28/18 04:39	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
13C4-PFHpA	*69*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
13C4 PFOA	*71*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
13C5 PFNA	*74*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
18O2 PFHxS	*61*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*
13C4 PFOS	*60*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:39*	*1*

Client Sample ID: HEC06-SB3-01

Lab Sample ID: 320-39942-16

Date Collected: 05/30/18 14:50
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 80.2

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.36	J	0.37	0.096	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorooctanoic acid (PFOA)	1.7		0.37	0.12	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorononanoic acid (PFNA)	0.44		0.37	0.099	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorobutanesulfonic acid (PFBS)	0.17	J	0.49	0.072	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorohexanesulfonic acid (PFHxS)	10		0.37	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1
Perfluorooctanesulfonic acid (PFOS)	18	M	1.2	0.29	ug/Kg	☼	06/13/18 05:42	06/28/18 04:47	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
13C4-PFHpA	*70*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
13C4 PFOA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
13C5 PFNA	*75*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
18O2 PFHxS	*60*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*
13C4 PFOS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:47*	*1*

Client Sample ID: HEC06-SB3-02

Lab Sample ID: 320-39942-17

Date Collected: 05/30/18 15:02
Date Received: 06/01/18 10:00

Matrix: Solid
Percent Solids: 71.3

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.28	U	0.42	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1
Perfluorooctanoic acid (PFOA)	0.28	U M	0.42	0.14	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1
Perfluorononanoic acid (PFNA)	0.28	U	0.42	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1
Perfluorobutanesulfonic acid (PFBS)	0.23	J	0.55	0.082	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1

Client Sample ID: HEC06-SB3-02

Lab Sample ID: 320-39942-17

Date Collected: 05/30/18 15:02
Date Received: 06/01/18 10:00
Matrix: Solid
Percent Solids: 71.3

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorohexanesulfonic acid (PFHxS)	**1.3**		0.42	0.086	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1
Perfluorooctanesulfonic acid (PFOS)	0.69	U	1.4	0.33	ug/Kg	☼	06/13/18 05:42	06/28/18 04:55	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
13C4-PFHpA	*72*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
13C4 PFOA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
13C5 PFNA	*71*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*
13C4 PFOS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 04:55*	*1*

Client Sample ID: HEC-FB-POT-01

Lab Sample ID: 320-39942-18

Date Collected: 05/31/18 07:10
Date Received: 06/01/18 10:00
Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	**0.79**	**J**	2.0	0.61	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorooctanoic acid (PFOA)	1.5	U M	2.0	0.54	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorononanoic acid (PFNA)	1.5	U	2.0	0.52	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorobutanesulfonic acid (PFBS)	1.0	U	2.0	0.46	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorohexanesulfonic acid (PFHxS)	**0.40**	**J**	2.0	0.38	ng/L		06/07/18 11:11	06/09/18 01:21	1
Perfluorooctanesulfonic acid (PFOS)	3.0	U	4.0	1.1	ng/L		06/07/18 11:11	06/09/18 01:21	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*72*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
13C4-PFHpA	*77*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
13C4 PFOA	*77*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
13C5 PFNA	*73*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
18O2 PFHxS	*76*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*
13C4 PFOS	*74*		*50 - 150*	*06/07/18 11:11*	*06/09/18 01:21*	*1*

Client Sample ID: HEC-ER-SB-03

Lab Sample ID: 320-39942-19

Date Collected: 05/31/18 11:57
Date Received: 06/01/18 10:00
Matrix: Water

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.4	U	1.8	0.56	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorooctanoic acid (PFOA)	1.4	U	1.8	0.50	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorononanoic acid (PFNA)	1.4	U	1.8	0.48	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorobutanesulfonic acid (PFBS)	0.92	U	1.8	0.42	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorohexanesulfonic acid (PFHxS)	0.92	U	1.8	0.35	ng/L		06/07/18 10:14	06/25/18 06:01	1
Perfluorooctanesulfonic acid (PFOS)	2.8	U	3.7	1.0	ng/L		06/07/18 10:14	06/25/18 06:01	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*75*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*
13C4-PFHpA	*89*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*
13C4 PFOA	*85*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*
13C5 PFNA	*88*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*
18O2 PFHxS	*79*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*

Client Sample ID: HEC-ER-SB-03 Lab Sample ID: 320-39942-19

Date Collected: 05/31/18 11:57 **Matrix: Water**
Date Received: 06/01/18 10:00

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C4 PFOS	*77*		*50 - 150*	*06/07/18 10:14*	*06/25/18 06:01*	*1*

Client Sample ID: HEC02-SB1-01 Lab Sample ID: 320-39942-20

Date Collected: 05/31/18 11:05 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 80.6**

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.65		0.37	0.096	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorooctanoic acid (PFOA)	2.2		0.37	0.12	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorononanoic acid (PFNA)	0.71		0.37	0.099	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorobutanesulfonic acid (PFBS)	0.22	U M	0.49	0.072	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorohexanesulfonic acid (PFHxS)	2.7	J1	0.37	0.076	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1
Perfluorooctanesulfonic acid (PFOS)	17	J1	1.2	0.29	ug/Kg	☼	06/13/18 05:42	06/28/18 05:03	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
13C4-PFHpA	*73*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
13C4 PFOA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
13C5 PFNA	*75*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
18O2 PFHxS	*60*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*
13C4 PFOS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:03*	*1*

Client Sample ID: HEC02-SB1-02 Lab Sample ID: 320-39942-21

Date Collected: 05/31/18 11:37 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 76.5**

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.3		0.39	0.10	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorooctanoic acid (PFOA)	1.1		0.39	0.13	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorononanoic acid (PFNA)	0.49		0.39	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorobutanesulfonic acid (PFBS)	0.23	U	0.52	0.077	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorohexanesulfonic acid (PFHxS)	3.3		0.39	0.081	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1
Perfluorooctanesulfonic acid (PFOS)	20		1.3	0.31	ug/Kg	☼	06/13/18 05:42	06/28/18 05:26	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
13C4-PFHpA	*72*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
13C4 PFOA	*69*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
13C5 PFNA	*68*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
18O2 PFHxS	*58*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*
13C4 PFOS	*59*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:26*	*1*

Client Sample ID: HEC02-SB1-02D

Date Collected: 05/31/18 11:37
Date Received: 06/01/18 10:00

Lab Sample ID: 320-39942-22

Matrix: Solid
Percent Solids: 72.4

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.6		0.41	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorooctanoic acid (PFOA)	1.3		0.41	0.14	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorononanoic acid (PFNA)	0.76		0.41	0.11	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorobutanesulfonic acid (PFBS)	0.083	J	0.55	0.081	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorohexanesulfonic acid (PFHxS)	3.8		0.41	0.085	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1
Perfluorooctanesulfonic acid (PFOS)	29	M E	1.4	0.33	ug/Kg	☼	06/13/18 05:42	06/28/18 05:34	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
13C4-PFHpA	*78*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
13C4 PFOA	*77*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
13C5 PFNA	*74*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
18O2 PFHxS	*63*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*
13C4 PFOS	*62*		*50 - 150*	*06/13/18 05:42*	*06/28/18 05:34*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 - DL

Analyte	Result	Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.7	D	0.82	0.21	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorooctanoic acid (PFOA)	1.6	D	0.82	0.27	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorononanoic acid (PFNA)	0.81	J D	0.82	0.22	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorobutanesulfonic acid (PFBS)	0.49	U	1.1	0.16	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorohexanesulfonic acid (PFHxS)	3.9	D	0.82	0.17	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2
Perfluorooctanesulfonic acid (PFOS)	30	D	2.7	0.66	ug/Kg	☼	06/13/18 05:42	06/29/18 23:57	2

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*66*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
13C4-PFHpA	*76*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
13C4 PFOA	*74*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
13C5 PFNA	*70*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
18O2 PFHxS	*71*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*
13C4 PFOS	*69*		*50 - 150*	*06/13/18 05:42*	*06/29/18 23:57*	*2*

Default Detection Limits

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Prep: 3535

Analyte	LOQ	DL	Units	Method
Perfluorobutanesulfonic acid (PFBS)	2.0	0.46	ng/L	EPA 537 (Mod)
Perfluoroheptanoic acid (PFHpA)	2.0	0.61	ng/L	EPA 537 (Mod)
Perfluorohexanesulfonic acid (PFHxS)	2.0	0.38	ng/L	EPA 537 (Mod)
Perfluorononanoic acid (PFNA)	2.0	0.52	ng/L	EPA 537 (Mod)
Perfluorooctanesulfonic acid (PFOS)	4.0	1.1	ng/L	EPA 537 (Mod)
Perfluorooctanoic acid (PFOA)	2.0	0.54	ng/L	EPA 537 (Mod)

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Prep: SHAKE

Analyte	LOQ	DL	Units	Method
Perfluorobutanesulfonic acid (PFBS)	0.40	0.059	ug/Kg	EPA 537 (Mod)
Perfluoroheptanoic acid (PFHpA)	0.30	0.078	ug/Kg	EPA 537 (Mod)
Perfluorohexanesulfonic acid (PFHxS)	0.30	0.062	ug/Kg	EPA 537 (Mod)
Perfluorononanoic acid (PFNA)	0.30	0.081	ug/Kg	EPA 537 (Mod)
Perfluorooctanesulfonic acid (PFOS)	1.0	0.24	ug/Kg	EPA 537 (Mod)
Perfluorooctanoic acid (PFOA)	0.30	0.10	ug/Kg	EPA 537 (Mod)

Isotope Dilution Summary

Client: Leidos, Inc.
Project/Site: Phase III, ANG- Hector Field

TestAmerica Job ID: 320-39942-1

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Matrix: Solid **Prep Type: Total/NA**

		Percent Isotope Dilution Recovery (Acceptance Limits)					
		3C3-PFB!	PFHpA	PFOA	PFNA	PFHxS	PFOS
Lab Sample ID	Client Sample ID	(50-150)	(50-150)	(50-150)	(50-150)	(50-150)	(50-150)
320-39942-4	HEC05-SB1-01	61	80	75	79	60	66
320-39942-5	HEC05-SB1-02	57	70	70	72	59	58
320-39942-6	HEC05-SB3-01	71	77	75	89	69	73
320-39942-6 - DL	HEC05-SB3-01	71	73	77	78	73	78
320-39942-7	HEC05-SB3-02	67	73	78	76	63	63
320-39942-8	HEC05-SB2-01	62	74	73	74	59	63
320-39942-9	HEC05-SB2-02	61	70	72	73	60	61
320-39942-11	HEC06-SB1-01	62	77	78	81	63	65
320-39942-12	HEC06-SB1-01D	59	77	79	78	62	63
320-39942-13	HEC06-SB1-02	63	75	74	78	62	66
320-39942-14	HEC06-SB2-01	57	75	78	80	58	65
320-39942-15	HEC06-SB2-02	59	69	71	74	61	60
320-39942-16	HEC06-SB3-01	58	70	73	75	60	62
320-39942-17	HEC06-SB3-02	59	72	73	71	63	62
320-39942-20	HEC02-SB1-01	58	73	78	75	60	63
320-39942-20 MS	HEC02-SB1-01	65	76	80	80	65	67
320-39942-20 MSD	HEC02-SB1-01	62	77	80	77	63	61
320-39942-21	HEC02-SB1-02	58	72	69	68	58	59
320-39942-22	HEC02-SB1-02D	63	78	77	74	63	62
320-39942-22 - DL	HEC02-SB1-02D	66	76	74	70	71	69
LCS 320-228766/2-A	Lab Control Sample	76	88	84	88	76	75
MB 320-228766/1-A	Method Blank	74	86	87	87	76	74

Surrogate Legend

13C3-PFBS = 13C3-PFBS
PFHpA = 13C4-PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Matrix: Water **Prep Type: Total/NA**

		Percent Isotope Dilution Recovery (Acceptance Limits)					
		3C3-PFB!	PFHpA	PFOA	PFNA	PFHxS	PFOS
Lab Sample ID	Client Sample ID	(50-150)	(50-150)	(50-150)	(50-150)	(50-150)	(50-150)
320-39942-1	HEC-RB-01	77	86	88	90	78	79
320-39942-2	HEC-FB-DI-01	78	83	90	87	78	80
320-39942-3	HEC-ER-SB-01	79	89	89	93	82	82
320-39942-10	HEC-ER-SB-02	67	82	75	80	68	68
320-39942-18	HEC-FB-POT-01	72	77	77	73	76	74
320-39942-19	HEC-ER-SB-03	75	89	85	88	79	77
LCS 320-227757/2-A	Lab Control Sample	81	90	88	91	81	82
LCS 320-227763/2-A	Lab Control Sample	89	94	92	88	90	87
LCSD 320-227757/3-A	Lab Control Sample Dup	80	96	90	92	83	81
LCSD 320-227763/3-A	Lab Control Sample Dup	85	90	87	82	90	81
MB 320-227757/1-A	Method Blank	61	74	70	71	61	62
MB 320-227763/1-A	Method Blank	81	89	87	80	85	79

Surrogate Legend

13C3-PFBS = 13C3-PFBS
PFHpA = 13C4-PFHpA
PFOA = 13C4 PFOA
PFNA = 13C5 PFNA
PFHxS = 18O2 PFHxS
PFOS = 13C4 PFOS

QC Sample Results

Client: Leidos, Inc. | TestAmerica Job ID: 320-39942-1
Project/Site: Phase III, ANG- Hector Field

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15

Lab Sample ID: MB 320-227757/1-A | **Client Sample ID: Method Blank**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 230711 | **Prep Batch: 227757**

Analyte	MB Result	MB Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.5	U	2.0	0.61	ng/L		06/07/18 10:14	06/25/18 05:03	1
Perfluorooctanoic acid (PFOA)	0.550	J M	2.0	0.54	ng/L		06/07/18 10:14	06/25/18 05:03	1
Perfluorononanoic acid (PFNA)	1.5	U	2.0	0.52	ng/L		06/07/18 10:14	06/25/18 05:03	1
Perfluorobutanesulfonic acid (PFBS)	1.0	U	2.0	0.46	ng/L		06/07/18 10:14	06/25/18 05:03	1
Perfluorohexanesulfonic acid (PFHxS)	1.0	U	2.0	0.38	ng/L		06/07/18 10:14	06/25/18 05:03	1
Perfluorooctanesulfonic acid (PFOS)	3.0	U	4.0	1.1	ng/L		06/07/18 10:14	06/25/18 05:03	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*71*		*50 - 150*	*07604618 10:12*	*076'5618 05:03*	*1*
13C2-PFHpA	*42*		*50 - 150*	*07604618 10:12*	*076'5618 05:03*	*1*
13C2 PFOA	*40*		*50 - 150*	*07604618 10:12*	*076'5618 05:03*	*1*
13C5 PFNA	*41*		*50 - 150*	*07604618 10:12*	*076'5618 05:03*	*1*
18O/ PFH9S	*71*		*50 - 150*	*07604618 10:12*	*076'5618 05:03*	*1*
13C2 PFOS	*7/*		*50 - 150*	*07604618 10:12*	*076'5618 05:03*	*1*

Lab Sample ID: LCS 320-227757/2-A | **Client Sample ID: Lab Control Sample**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 230711 | **Prep Batch: 227757**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluoroheptanoic acid (PFHpA)	40.0	37.1		ng/L		93	80 - 113
Perfluorooctanoic acid (PFOA)	40.0	38.7		ng/L		97	80 - 107
Perfluorononanoic acid (PFNA)	40.0	38.3		ng/L		96	83 - 113
Perfluorobutanesulfonic acid (PFBS)	35.4	35.2		ng/L		100	87 - 120
Perfluorohexanesulfonic acid (PFHxS)	36.4	34.5		ng/L		95	81 - 106
Perfluorooctanesulfonic acid (PFOS)	37.1	35.8		ng/L		97	82 - 112

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C3-PFBS	*81*		*50 - 150*
13C2-PFHpA	*x0*		*50 - 150*
13C2 PFOA	*88*		*50 - 150*
13C5 PFNA	*x1*		*50 - 150*
18O/ PFH9S	*81*		*50 - 150*
13C2 PFOS	*8/*		*50 - 150*

Lab Sample ID: LCSD 320-227757/3-A | **Client Sample ID: Lab Control Sample Dup**
Matrix: Water | **Prep Type: Total/NA**
Analysis Batch: 230711 | **Prep Batch: 227757**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Perfluoroheptanoic acid (PFHpA)	40.0	34.8		ng/L		87	80 - 113	7	30
Perfluorooctanoic acid (PFOA)	40.0	36.4		ng/L		91	80 - 107	6	30
Perfluorononanoic acid (PFNA)	40.0	36.9		ng/L		92	83 - 113	3	30
Perfluorobutanesulfonic acid (PFBS)	35.4	35.3		ng/L		100	87 - 120	0	30
Perfluorohexanesulfonic acid (PFHxS)	36.4	34.2		ng/L		94	81 - 106	1	30

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Lab Sample ID: LCSD 320-227757/3-A
Matrix: Water
Analysis Batch: 230711

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 227757

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Perfluorooctanesulfonic acid (PFOS)	37.1	36.5		ng/L		98	82 - 112	2	30

Isotope Dilution	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
13C3-PFBS	*80*		*50 - 150*
13C2-PFHpA	*x7*		*50 - 150*
13C2 PFOA	*x0*		*50 - 150*
13C5 PFNA	*x/*		*50 - 150*
18O/ PFH9S	*83*		*50 - 150*
13C2 PFOS	*81*		*50 - 150*

Lab Sample ID: MB 320-227763/1-A
Matrix: Water
Analysis Batch: 228177

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 227763

Analyte	MB Result	MB Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	1.5	U	2.0	0.61	ng/L		06/07/18 10:59	06/09/18 00:49	1
Perfluorooctanoic acid (PFOA)	1.5	U M	2.0	0.54	ng/L		06/07/18 10:59	06/09/18 00:49	1
Perfluorononanoic acid (PFNA)	1.5	U	2.0	0.52	ng/L		06/07/18 10:59	06/09/18 00:49	1
Perfluorobutanesulfonic acid (PFBS)	1.0	U	2.0	0.46	ng/L		06/07/18 10:59	06/09/18 00:49	1
Perfluorohexanesulfonic acid (PFHxS)	1.0	U	2.0	0.38	ng/L		06/07/18 10:59	06/09/18 00:49	1
Perfluorooctanesulfonic acid (PFOS)	3.0	U	4.0	1.1	ng/L		06/07/18 10:59	06/09/18 00:49	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*81*		*50 - 150*	*07604618 10:5x*	*0760x618 00:2x*	*1*
13C2-PFHpA	*8x*		*50 - 150*	*07604618 10:5x*	*0760x618 00:2x*	*1*
13C2 PFOA	*84*		*50 - 150*	*07604618 10:5x*	*0760x618 00:2x*	*1*
13C5 PFNA	*80*		*50 - 150*	*07604618 10:5x*	*0760x618 00:2x*	*1*
18O/ PFH9S	*85*		*50 - 150*	*07604618 10:5x*	*0760x618 00:2x*	*1*
13C2 PFOS	*4x*		*50 - 150*	*07604618 10:5x*	*0760x618 00:2x*	*1*

Lab Sample ID: LCS 320-227763/2-A
Matrix: Water
Analysis Batch: 228177

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 227763

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluoroheptanoic acid (PFHpA)	40.0	36.4		ng/L		91	80 - 113
Perfluorooctanoic acid (PFOA)	40.0	36.4		ng/L		91	80 - 107
Perfluorononanoic acid (PFNA)	40.0	37.7		ng/L		94	83 - 113
Perfluorobutanesulfonic acid (PFBS)	35.4	34.0		ng/L		96	87 - 120
Perfluorohexanesulfonic acid (PFHxS)	36.4	33.2		ng/L		91	81 - 106
Perfluorooctanesulfonic acid (PFOS)	37.1	33.1		ng/L		89	82 - 112

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C3-PFBS	*8x*		*50 - 150*
13C2-PFHpA	*x2*		*50 - 150*
13C2 PFOA	*x/*		*50 - 150*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Lab Sample ID: LCS 320-227763/2-A
Matrix: Water
Analysis Batch: 228177

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 227763

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C5 PFNA	*88*		*50 - 150*
18O/ PFH9S	*x0*		*50 - 150*
13C2 PFOS	*84*		*50 - 150*

Lab Sample ID: LCSD 320-227763/3-A
Matrix: Water
Analysis Batch: 228177

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 227763

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Perfluoroheptanoic acid (PFHpA)	40.0	35.4		ng/L		88	80 - 113	3	30
Perfluorooctanoic acid (PFOA)	40.0	35.5		ng/L		89	80 - 107	3	30
Perfluorononanoic acid (PFNA)	40.0	38.9		ng/L		97	83 - 113	3	30
Perfluorobutanesulfonic acid (PFBS)	35.4	33.9		ng/L		96	87 - 120	0	30
Perfluorohexanesulfonic acid (PFHxS)	36.4	30.9		ng/L		85	81 - 106	7	30
Perfluorooctanesulfonic acid (PFOS)	37.1	34.6		ng/L		93	82 - 112	4	30

Isotope Dilution	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
13C3-PFBS	*85*		*50 - 150*
13C2-PFHpA	*x0*		*50 - 150*
13C2 PFOA	*84*		*50 - 150*
13C5 PFNA	*8/*		*50 - 150*
18O/ PFH9S	*x0*		*50 - 150*
13C2 PFOS	*81*		*50 - 150*

Lab Sample ID: MB 320-228766/1-A
Matrix: Solid
Analysis Batch: 231442

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 228766

Analyte	MB Result	MB Qualifier	LOQ	DL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoroheptanoic acid (PFHpA)	0.20	U	0.30	0.078	ug/Kg		06/13/18 05:42	06/28/18 02:57	1
Perfluorooctanoic acid (PFOA)	0.20	U	0.30	0.10	ug/Kg		06/13/18 05:42	06/28/18 02:57	1
Perfluorononanoic acid (PFNA)	0.20	U	0.30	0.081	ug/Kg		06/13/18 05:42	06/28/18 02:57	1
Perfluorobutanesulfonic acid (PFBS)	0.18	U M	0.40	0.059	ug/Kg		06/13/18 05:42	06/28/18 02:57	1
Perfluorohexanesulfonic acid (PFHxS)	0.20	U	0.30	0.062	ug/Kg		06/13/18 05:42	06/28/18 02:57	1
Perfluorooctanesulfonic acid (PFOS)	0.50	U	1.0	0.24	ug/Kg		06/13/18 05:42	06/28/18 02:57	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3-PFBS	*42*		*50 - 150*	*0761368 05:2/*	*076 868 0/ :54*	*1*
13C2-PFHpA	*87*		*50 - 150*	*0761368 05:2/*	*076 868 0/ :54*	*1*
13C2 PFOA	*84*		*50 - 150*	*0761368 05:2/*	*076 868 0/ :54*	*1*
13C5 PFNA	*84*		*50 - 150*	*0761368 05:2/*	*076 868 0/ :54*	*1*
18O/ PFH9S	*47*		*50 - 150*	*0761368 05:2/*	*076 868 0/ :54*	*1*
13C2 PFOS	*42*		*50 - 150*	*0761368 05:2/*	*076 868 0/ :54*	*1*

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Lab Sample ID: LCS 320-228766/2-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 231442 **Prep Batch: 228766**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluoroheptanoic acid (PFHpA)	2.00	1.73		ug/Kg		87	76 - 124
Perfluorooctanoic acid (PFOA)	2.00	1.74		ug/Kg		87	76 - 121
Perfluorononanoic acid (PFNA)	2.00	1.87		ug/Kg		93	74 - 126
Perfluorobutanesulfonic acid (PFBS)	1.77	1.66		ug/Kg		94	73 - 142
Perfluorohexanesulfonic acid (PFHxS)	1.82	1.63		ug/Kg		90	75 - 121
Perfluorooctanesulfonic acid (PFOS)	1.86	1.71	M	ug/Kg		92	69 - 131

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C3-PFBS	*47*		*50 - 150*
13C2-PFHpA	*88*		*50 - 150*
13C2 PFOA	*82*		*50 - 150*
13C5 PFNA	*88*		*50 - 150*
18O/ PFH9S	*47*		*50 - 150*
13C2 PFOS	*45*		*50 - 150*

Lab Sample ID: 320-39942-20 MS **Client Sample ID: HEC02-SB1-01**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 231442 **Prep Batch: 228766**

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Perfluoroheptanoic acid (PFHpA)	0.65		2.43	2.74		ug/Kg	☼	86	76 - 124
Perfluorooctanoic acid (PFOA)	2.2		2.43	4.34		ug/Kg	☼	88	76 - 121
Perfluorononanoic acid (PFNA)	0.71		2.43	2.65		ug/Kg	☼	80	74 - 126
Perfluorobutanesulfonic acid (PFBS)	0.22	U M	2.15	2.06		ug/Kg	☼	96	73 - 142
Perfluorohexanesulfonic acid (PFHxS)	2.7	J1	2.21	5.56	J1	ug/Kg	☼	129	75 - 121
Perfluorooctanesulfonic acid (PFOS)	17	J1	2.25	26.8	M E 4	ug/Kg	☼	425	69 - 131

Isotope Dilution	*MS %Recovery*	*MS Qualifier*	*Limits*
13C3-PFBS	*75*		*50 - 150*
13C2-PFHpA	*47*		*50 - 150*
13C2 PFOA	*80*		*50 - 150*
13C5 PFNA	*80*		*50 - 150*
18O/ PFH9S	*75*		*50 - 150*
13C2 PFOS	*74*		*50 - 150*

Lab Sample ID: 320-39942-20 MSD **Client Sample ID: HEC02-SB1-01**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 231442 **Prep Batch: 228766**

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Perfluoroheptanoic acid (PFHpA)	0.65		2.45	2.75		ug/Kg	☼	86	76 - 124	1	30
Perfluorooctanoic acid (PFOA)	2.2		2.45	4.23		ug/Kg	☼	83	76 - 121	3	30
Perfluorononanoic acid (PFNA)	0.71		2.45	2.77		ug/Kg	☼	84	74 - 126	4	30

Method: EPA 537 (Mod) - PFAS for QSM 5.1, Table B-15 (Continued)

Lab Sample ID: 320-39942-20 MSD
Matrix: Solid
Analysis Batch: 231442

Client Sample ID: HEC02-SB1-01
Prep Type: Total/NA
Prep Batch: 228766

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Perfluorobutanesulfonic acid (PFBS)	0.22	U M	2.16	2.09		ug/Kg	☼	97	73 - 142	2	30
Perfluorohexanesulfonic acid (PFHxS)	2.7	J1	2.23	5.08		ug/Kg	☼	107	75 - 121	9	30
Perfluorooctanesulfonic acid (PFOS)	17	J1	2.27	24.0	M E 4	ug/Kg	☼	301	69 - 131	11	30

Isotope Dilution	*MSD %Recovery*	*MSD Qualifier*	*Limits*
13C3-PFBS	*71*		*50 - 150*
13C2-PFHpA	*44*		*50 - 150*
13C2 PFOA	*80*		*50 - 150*
13C5 PFNA	*44*		*50 - 150*
18O/ PFH9S	*73*		*50 - 150*
13C2 PFOS	*71*		*50 - 150*

LCMS

Prep Batch: 227757

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-1	HEC-RB-01	Total/NA	Water	3535	
320-39942-2	HEC-FB-DI-01	Total/NA	Water	3535	
320-39942-3	HEC-ER-SB-01	Total/NA	Water	3535	
320-39942-10	HEC-ER-SB-02	Total/NA	Water	3535	
320-39942-19	HEC-ER-SB-03	Total/NA	Water	3535	
MB 320-227757/1-A	Method Blank	Total/NA	Water	3535	
LCS 320-227757/2-A	Lab Control Sample	Total/NA	Water	3535	
LCSD 320-227757/3-A	Lab Control Sample Dup	Total/NA	Water	3535	

Prep Batch: 227763

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-18	HEC-FB-POT-01	Total/NA	Water	3535	
MB 320-227763/1-A	Method Blank	Total/NA	Water	3535	
LCS 320-227763/2-A	Lab Control Sample	Total/NA	Water	3535	
LCSD 320-227763/3-A	Lab Control Sample Dup	Total/NA	Water	3535	

Analysis Batch: 228177

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-18	HEC-FB-POT-01	Total/NA	Water	EPA 537 (Mod)	227763
MB 320-227763/1-A	Method Blank	Total/NA	Water	EPA 537 (Mod)	227763
LCS 320-227763/2-A	Lab Control Sample	Total/NA	Water	EPA 537 (Mod)	227763
LCSD 320-227763/3-A	Lab Control Sample Dup	Total/NA	Water	EPA 537 (Mod)	227763

Prep Batch: 228766

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-4	HEC05-SB1-01	Total/NA	Solid	SHAKE	
320-39942-5	HEC05-SB1-02	Total/NA	Solid	SHAKE	
320-39942-6	HEC05-SB3-01	Total/NA	Solid	SHAKE	
320-39942-6 - DL	HEC05-SB3-01	Total/NA	Solid	SHAKE	
320-39942-7	HEC05-SB3-02	Total/NA	Solid	SHAKE	
320-39942-8	HEC05-SB2-01	Total/NA	Solid	SHAKE	
320-39942-9	HEC05-SB2-02	Total/NA	Solid	SHAKE	
320-39942-11	HEC06-SB1-01	Total/NA	Solid	SHAKE	
320-39942-12	HEC06-SB1-01D	Total/NA	Solid	SHAKE	
320-39942-13	HEC06-SB1-02	Total/NA	Solid	SHAKE	
320-39942-14	HEC06-SB2-01	Total/NA	Solid	SHAKE	
320-39942-15	HEC06-SB2-02	Total/NA	Solid	SHAKE	
320-39942-16	HEC06-SB3-01	Total/NA	Solid	SHAKE	
320-39942-17	HEC06-SB3-02	Total/NA	Solid	SHAKE	
320-39942-20	HEC02-SB1-01	Total/NA	Solid	SHAKE	
320-39942-21	HEC02-SB1-02	Total/NA	Solid	SHAKE	
320-39942-22	HEC02-SB1-02D	Total/NA	Solid	SHAKE	
320-39942-22 - DL	HEC02-SB1-02D	Total/NA	Solid	SHAKE	
MB 320-228766/1-A	Method Blank	Total/NA	Solid	SHAKE	
LCS 320-228766/2-A	Lab Control Sample	Total/NA	Solid	SHAKE	
320-39942-20 MS	HEC02-SB1-01	Total/NA	Solid	SHAKE	
320-39942-20 MSD	HEC02-SB1-01	Total/NA	Solid	SHAKE	

Analysis Batch: 230711

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-1	HEC-RB-01	Total/NA	Water	EPA 537 (Mod)	227757

LCMS (Continued)

Analysis Batch: 230711 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-2	HEC-FB-DI-01	Total/NA	Water	EPA 537 (Mod)	227757
320-39942-3	HEC-ER-SB-01	Total/NA	Water	EPA 537 (Mod)	227757
320-39942-10	HEC-ER-SB-02	Total/NA	Water	EPA 537 (Mod)	227757
320-39942-19	HEC-ER-SB-03	Total/NA	Water	EPA 537 (Mod)	227757
MB 320-227757/1-A	Method Blank	Total/NA	Water	EPA 537 (Mod)	227757
LCS 320-227757/2-A	Lab Control Sample	Total/NA	Water	EPA 537 (Mod)	227757
LCSD 320-227757/3-A	Lab Control Sample Dup	Total/NA	Water	EPA 537 (Mod)	227757

Analysis Batch: 231442

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-4	HEC05-SB1-01	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-5	HEC05-SB1-02	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-6	HEC05-SB3-01	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-7	HEC05-SB3-02	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-8	HEC05-SB2-01	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-9	HEC05-SB2-02	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-11	HEC06-SB1-01	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-12	HEC06-SB1-01D	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-13	HEC06-SB1-02	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-14	HEC06-SB2-01	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-15	HEC06-SB2-02	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-16	HEC06-SB3-01	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-17	HEC06-SB3-02	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-20	HEC02-SB1-01	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-21	HEC02-SB1-02	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-22	HEC02-SB1-02D	Total/NA	Solid	EPA 537 (Mod)	228766
MB 320-228766/1-A	Method Blank	Total/NA	Solid	EPA 537 (Mod)	228766
LCS 320-228766/2-A	Lab Control Sample	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-20 MS	HEC02-SB1-01	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-20 MSD	HEC02-SB1-01	Total/NA	Solid	EPA 537 (Mod)	228766

Analysis Batch: 231839

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-6 - DL	HEC05-SB3-01	Total/NA	Solid	EPA 537 (Mod)	228766
320-39942-22 - DL	HEC02-SB1-02D	Total/NA	Solid	EPA 537 (Mod)	228766

General Chemistry

Analysis Batch: 227420

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-4	HEC05-SB1-01	Total/NA	Solid	D 2216	
320-39942-5	HEC05-SB1-02	Total/NA	Solid	D 2216	
320-39942-6	HEC05-SB3-01	Total/NA	Solid	D 2216	
320-39942-7	HEC05-SB3-02	Total/NA	Solid	D 2216	
320-39942-8	HEC05-SB2-01	Total/NA	Solid	D 2216	
320-39942-9	HEC05-SB2-02	Total/NA	Solid	D 2216	
320-39942-11	HEC06-SB1-01	Total/NA	Solid	D 2216	
320-39942-12	HEC06-SB1-01D	Total/NA	Solid	D 2216	
320-39942-13	HEC06-SB1-02	Total/NA	Solid	D 2216	
320-39942-5 DU	HEC05-SB1-02	Total/NA	Solid	D 2216	

General Chemistry (Continued)

Analysis Batch: 227595

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-14	HEC06-SB2-01	Total/NA	Solid	D 2216	
320-39942-15	HEC06-SB2-02	Total/NA	Solid	D 2216	
320-39942-16	HEC06-SB3-01	Total/NA	Solid	D 2216	
320-39942-17	HEC06-SB3-02	Total/NA	Solid	D 2216	

Analysis Batch: 227612

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
320-39942-20	HEC02-SB1-01	Total/NA	Solid	D 2216	
320-39942-21	HEC02-SB1-02	Total/NA	Solid	D 2216	
320-39942-22	HEC02-SB1-02D	Total/NA	Solid	D 2216	

Lab Chronicle

Client: Leidos, Inc.
Project/Site: Phase III, ANG- Hector Field

TestAmerica Job ID: 320-39942-1

Client Sample ID: HEC-RB-01
Lab Sample ID: 320-39942-1
Date Collected: 05/29/18 08:40
Matrix: Water
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			227757	06/07/18 10:14	LAC	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	230711	06/25/18 05:28	S1M	TAL SAC

Client Sample ID: HEC-FB-DI-01
Lab Sample ID: 320-39942-2
Date Collected: 05/29/18 08:50
Matrix: Water
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			227757	06/07/18 10:14	LAC	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	230711	06/25/18 05:36	S1M	TAL SAC

Client Sample ID: HEC-ER-SB-01
Lab Sample ID: 320-39942-3
Date Collected: 05/30/18 07:30
Matrix: Water
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			227757	06/07/18 10:14	LAC	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	230711	06/25/18 05:44	S1M	TAL SAC

Client Sample ID: HEC05-SB1-01
Lab Sample ID: 320-39942-4
Date Collected: 05/30/18 08:30
Matrix: Solid
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227420	06/05/18 19:00	JMD	TAL SAC

Client Sample ID: HEC05-SB1-01
Lab Sample ID: 320-39942-4
Date Collected: 05/30/18 08:30
Matrix: Solid
Date Received: 06/01/18 10:00
Percent Solids: 77.2

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 03:13	JRB	TAL SAC

Client Sample ID: HEC05-SB1-02
Lab Sample ID: 320-39942-5
Date Collected: 05/30/18 08:40
Matrix: Solid
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227420	06/05/18 19:00	JMD	TAL SAC

Client Sample ID: HEC05-SB1-02

Lab Sample ID: 320-39942-5

Date Collected: 05/30/18 08:40
Date Received: 06/01/18 10:00
Matrix: Solid
Percent Solids: 76.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 03:21	JRB	TAL SAC

Client Sample ID: HEC05-SB3-01

Lab Sample ID: 320-39942-6

Date Collected: 05/30/18 09:12
Date Received: 06/01/18 10:00
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227420	06/05/18 19:00	JMD	TAL SAC

Client Sample ID: HEC05-SB3-01

Lab Sample ID: 320-39942-6

Date Collected: 05/30/18 09:12
Date Received: 06/01/18 10:00
Matrix: Solid
Percent Solids: 76.2

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 03:29	JRB	TAL SAC
Total/NA	Prep	SHAKE	DL		228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)	DL	5	231839	06/29/18 23:49	ABH	TAL SAC

Client Sample ID: HEC05-SB3-02

Lab Sample ID: 320-39942-7

Date Collected: 05/30/18 09:20
Date Received: 06/01/18 10:00
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227420	06/05/18 19:00	JMD	TAL SAC

Client Sample ID: HEC05-SB3-02

Lab Sample ID: 320-39942-7

Date Collected: 05/30/18 09:20
Date Received: 06/01/18 10:00
Matrix: Solid
Percent Solids: 73.0

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 03:37	JRB	TAL SAC

Client Sample ID: HEC05-SB2-01

Lab Sample ID: 320-39942-8

Date Collected: 05/30/18 09:42
Date Received: 06/01/18 10:00
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227420	06/05/18 19:00	JMD	TAL SAC

Client Sample ID: HEC05-SB2-01 Lab Sample ID: 320-39942-8

Date Collected: 05/30/18 09:42 **Matrix: Solid**

Date Received: 06/01/18 10:00 **Percent Solids: 70.2**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 03:44	JRB	TAL SAC

Client Sample ID: HEC05-SB2-02 Lab Sample ID: 320-39942-9

Date Collected: 05/30/18 09:47 **Matrix: Solid**

Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227420	06/05/18 19:00	JMD	TAL SAC

Client Sample ID: HEC05-SB2-02 Lab Sample ID: 320-39942-9

Date Collected: 05/30/18 09:47 **Matrix: Solid**

Date Received: 06/01/18 10:00 **Percent Solids: 70.8**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 03:52	JRB	TAL SAC

Client Sample ID: HEC-ER-SB-02 Lab Sample ID: 320-39942-10

Date Collected: 05/30/18 10:45 **Matrix: Water**

Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			227757	06/07/18 10:14	LAC	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	230711	06/25/18 05:52	S1M	TAL SAC

Client Sample ID: HEC06-SB1-01 Lab Sample ID: 320-39942-11

Date Collected: 05/30/18 13:21 **Matrix: Solid**

Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227420	06/05/18 19:00	JMD	TAL SAC

Client Sample ID: HEC06-SB1-01 Lab Sample ID: 320-39942-11

Date Collected: 05/30/18 13:21 **Matrix: Solid**

Date Received: 06/01/18 10:00 **Percent Solids: 74.3**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 04:00	JRB	TAL SAC

Client Sample ID: HEC06-SB1-01D — Lab Sample ID: 320-39942-12

Date Collected: 05/30/18 13:21 — **Matrix: Solid**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227420	06/05/18 19:00	JMD	TAL SAC

Client Sample ID: HEC06-SB1-01D — Lab Sample ID: 320-39942-12

Date Collected: 05/30/18 13:21 — **Matrix: Solid**
Date Received: 06/01/18 10:00 — **Percent Solids: 77.7**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 04:08	JRB	TAL SAC

Client Sample ID: HEC06-SB1-02 — Lab Sample ID: 320-39942-13

Date Collected: 05/30/18 13:30 — **Matrix: Solid**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227420	06/05/18 19:00	JMD	TAL SAC

Client Sample ID: HEC06-SB1-02 — Lab Sample ID: 320-39942-13

Date Collected: 05/30/18 13:30 — **Matrix: Solid**
Date Received: 06/01/18 10:00 — **Percent Solids: 73.2**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 04:23	JRB	TAL SAC

Client Sample ID: HEC06-SB2-01 — Lab Sample ID: 320-39942-14

Date Collected: 05/30/18 14:00 — **Matrix: Solid**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227595	06/06/18 15:15	CFR	TAL SAC

Client Sample ID: HEC06-SB2-01 — Lab Sample ID: 320-39942-14

Date Collected: 05/30/18 14:00 — **Matrix: Solid**
Date Received: 06/01/18 10:00 — **Percent Solids: 74.8**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 04:31	JRB	TAL SAC

Client Sample ID: HEC06-SB2-02 Lab Sample ID: 320-39942-15
Date Collected: 05/30/18 14:12 **Matrix: Solid**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227595	06/06/18 15:15	CFR	TAL SAC

Client Sample ID: HEC06-SB2-02 Lab Sample ID: 320-39942-15
Date Collected: 05/30/18 14:12 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 74.0**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 04:39	JRB	TAL SAC

Client Sample ID: HEC06-SB3-01 Lab Sample ID: 320-39942-16
Date Collected: 05/30/18 14:50 **Matrix: Solid**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227595	06/06/18 15:15	CFR	TAL SAC

Client Sample ID: HEC06-SB3-01 Lab Sample ID: 320-39942-16
Date Collected: 05/30/18 14:50 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 80.2**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 04:47	JRB	TAL SAC

Client Sample ID: HEC06-SB3-02 Lab Sample ID: 320-39942-17
Date Collected: 05/30/18 15:02 **Matrix: Solid**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227595	06/06/18 15:15	CFR	TAL SAC

Client Sample ID: HEC06-SB3-02 Lab Sample ID: 320-39942-17
Date Collected: 05/30/18 15:02 **Matrix: Solid**
Date Received: 06/01/18 10:00 **Percent Solids: 71.3**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 04:55	JRB	TAL SAC

Client Sample ID: HEC-FB-POT-01 — Lab Sample ID: 320-39942-18

Date Collected: 05/31/18 07:10 — **Matrix: Water**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			227763	06/07/18 11:11	KMK	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	228177	06/09/18 01:21	CBW	TAL SAC

Client Sample ID: HEC-ER-SB-03 — Lab Sample ID: 320-39942-19

Date Collected: 05/31/18 11:57 — **Matrix: Water**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3535			227757	06/07/18 10:14	LAC	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	230711	06/25/18 06:01	S1M	TAL SAC

Client Sample ID: HEC02-SB1-01 — Lab Sample ID: 320-39942-20

Date Collected: 05/31/18 11:05 — **Matrix: Solid**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227612	06/06/18 15:15	CFR	TAL SAC

Client Sample ID: HEC02-SB1-01 — Lab Sample ID: 320-39942-20

Date Collected: 05/31/18 11:05 — **Matrix: Solid**
Date Received: 06/01/18 10:00 — **Percent Solids: 80.6**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 05:03	JRB	TAL SAC

Client Sample ID: HEC02-SB1-02 — Lab Sample ID: 320-39942-21

Date Collected: 05/31/18 11:37 — **Matrix: Solid**
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227612	06/06/18 15:15	CFR	TAL SAC

Client Sample ID: HEC02-SB1-02 — Lab Sample ID: 320-39942-21

Date Collected: 05/31/18 11:37 — **Matrix: Solid**
Date Received: 06/01/18 10:00 — **Percent Solids: 76.5**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 05:26	JRB	TAL SAC

Client Sample ID: HEC02-SB1-02D
Lab Sample ID: 320-39942-22

Date Collected: 05/31/18 11:37
Matrix: Solid
Date Received: 06/01/18 10:00

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	D 2216		1	227612	06/06/18 15:15	CFR	TAL SAC

Client Sample ID: HEC02-SB1-02D
Lab Sample ID: 320-39942-22

Date Collected: 05/31/18 11:37
Matrix: Solid
Date Received: 06/01/18 10:00
Percent Solids: 72.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	SHAKE			228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)		1	231442	06/28/18 05:34	JRB	TAL SAC
Total/NA	Prep	SHAKE	DL		228766	06/13/18 05:42	HJA	TAL SAC
Total/NA	Analysis	EPA 537 (Mod)	DL	2	231839	06/29/18 23:57	ABH	TAL SAC

Laboratory References:

TAL SAC = TestAmerica Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Laboratory: TestAmerica Sacramento

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	EPA Region	Identification Number	Expiration Date
Oregon	NELAP	10	4040	01-29-19

Analysis Method	Prep Method	Matrix	Analyte

Method Summary

Method	Method Description	Protocol	Laboratory
EPA 537 (Mod)	PFAS for QSM 5.1, Table B-15	DOD 5.1	TAL SAC
D 2216	Percent Moisture	ASTM	TAL SAC
3535	Solid-Phase Extraction (SPE)	SW846	TAL SAC
SHAKE	Shake Extraction with Ultrasonic Bath Extraction	SW846	TAL SAC

Protocol References:

ASTM = ASTM International

DOD 5.1 = Department of Defense Quality Systems Manual V5.1

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL SAC = TestAmerica Sacramento, 880 Riverside Parkway, West Sacramento, CA 95605, TEL (916)373-5600

Sample Summary

Client: Leidos, Inc.
Project/Site: Phase III, ANG- Hector Field

TestAmerica Job ID: 320-39942-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
320-39942-1	HEC-RB-01	Water	05/29/18 08:40	06/01/18 10:00
320-39942-2	HEC-FB-DI-01	Water	05/29/18 08:50	06/01/18 10:00
320-39942-3	HEC-ER-SB-01	Water	05/30/18 07:30	06/01/18 10:00
320-39942-4	HEC05-SB1-01	Solid	05/30/18 08:30	06/01/18 10:00
320-39942-5	HEC05-SB1-02	Solid	05/30/18 08:40	06/01/18 10:00
320-39942-6	HEC05-SB3-01	Solid	05/30/18 09:12	06/01/18 10:00
320-39942-7	HEC05-SB3-02	Solid	05/30/18 09:20	06/01/18 10:00
320-39942-8	HEC05-SB2-01	Solid	05/30/18 09:42	06/01/18 10:00
320-39942-9	HEC05-SB2-02	Solid	05/30/18 09:47	06/01/18 10:00
320-39942-10	HEC-ER-SB-02	Water	05/30/18 10:45	06/01/18 10:00
320-39942-11	HEC06-SB1-01	Solid	05/30/18 13:21	06/01/18 10:00
320-39942-12	HEC06-SB1-01D	Solid	05/30/18 13:21	06/01/18 10:00
320-39942-13	HEC06-SB1-02	Solid	05/30/18 13:30	06/01/18 10:00
320-39942-14	HEC06-SB2-01	Solid	05/30/18 14:00	06/01/18 10:00
320-39942-15	HEC06-SB2-02	Solid	05/30/18 14:12	06/01/18 10:00
320-39942-16	HEC06-SB3-01	Solid	05/30/18 14:50	06/01/18 10:00
320-39942-17	HEC06-SB3-02	Solid	05/30/18 15:02	06/01/18 10:00
320-39942-18	HEC-FB-POT-01	Water	05/31/18 07:10	06/01/18 10:00
320-39942-19	HEC-ER-SB-03	Water	05/31/18 11:57	06/01/18 10:00
320-39942-20	HEC02-SB1-01	Solid	05/31/18 11:05	06/01/18 10:00
320-39942-21	HEC02-SB1-02	Solid	05/31/18 11:37	06/01/18 10:00
320-39942-22	HEC02-SB1-02D	Solid	05/31/18 11:37	06/01/18 10:00

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N Analysis Batch Number: 227354

Lab Sample ID: IC 320-227354/2 Client Sample ID:

Date Analyzed: 06/05/18 14:28 Lab File ID: 2018.06.05ICAL_002.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorohexanoic acid (PFHxA)	2.03	Assign Peak	westendorfc	06/05/18 17:02

Lab Sample ID: IC 320-227354/3 Client Sample ID:

Date Analyzed: 06/05/18 14:36 Lab File ID: 2018.06.05ICAL_003.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluoropentanoic acid (PFPeA)	1.74	Baseline	westendorfc	06/05/18 17:02

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N Analysis Batch Number: 228175

Lab Sample ID: CCVL 320-228175/2 Client Sample ID:

Date Analyzed: 06/08/18 22:44 Lab File ID: 2018.06.08LLD_004.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	3.77	Isomers	westendorfc	06/10/18 10:21

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 228177

Lab Sample ID: MB 320-227763/1-A   Client Sample ID:

Date Analyzed: 06/09/18 00:49   Lab File ID: 2018.06.08LLD_020.d   GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)		Invalid Compound ID	westendorfc	06/10/18 10:17

Lab Sample ID: 320-39942-18   Client Sample ID: HEC-FB-POT-01

Date Analyzed: 06/09/18 01:21   Lab File ID: 2018.06.08LLD_024.d   GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.63	Isomers	westendorfc	06/10/18 10:18

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 230408

Lab Sample ID: IC 320-230408/2   Client Sample ID:

Date Analyzed: 06/22/18 09:18   Lab File ID: 2018.06.022LLICALA_002.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluoropentanoic acid (PFPeA)	1.70	Baseline	roycea	06/22/18 10:11
4:2 FTS	1.95	Baseline	roycea	06/22/18 10:11
Perfluoroheptanoic acid (PFHpA)	2.31	Baseline	roycea	06/22/18 10:11
6:2 FTS	2.63	Baseline	roycea	06/22/18 10:30
Perfluorooctanesulfonic acid (PFOS)	3.02	Baseline	roycea	06/22/18 10:10
N-methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)	3.53	Assign Peak	roycea	06/22/18 10:11
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	3.69	Baseline	roycea	06/22/18 10:17

Lab Sample ID: IC 320-230408/3   Client Sample ID:

Date Analyzed: 06/22/18 09:26   Lab File ID: 2018.06.022LLICALA_003.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.67	Baseline	roycea	06/22/18 10:14
Perfluorooctanesulfonic acid (PFOS)	3.03	Baseline	roycea	06/22/18 10:14
Perfluoroundecanoic acid (PFUnA)	3.71	Baseline	roycea	06/22/18 10:16

Lab Sample ID: IC 320-230408/4   Client Sample ID:

Date Analyzed: 06/22/18 09:33   Lab File ID: 2018.06.022LLICALA_004.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanesulfonic acid (PFOS)	3.02	Baseline	roycea	06/22/18 10:18
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	3.71	Baseline	roycea	06/22/18 10:19

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 230408

Lab Sample ID: ICB 320-230408/9   Client Sample ID:

Date Analyzed: 06/22/18 10:13   Lab File ID: 2018.06.022LLICALA_009.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.65	Baseline	roycea	06/22/18 11:14

EPA 537 (Mod)

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 230708

Lab Sample ID: CCB 320-230708/1   Client Sample ID:

Date Analyzed: 06/25/18 01:31   Lab File ID: 2018.06.24LLB_003.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)		Invalid Compound ID	roycea	06/25/18 09:32

EPA 537 (Mod)

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 230711

Lab Sample ID: MB 320-227757/1-A   Client Sample ID:

Date Analyzed: 06/25/18 05:03   Lab File ID: 2018.06.24LLA_052.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.66	Baseline	hannigana	06/25/18 10:07

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 231428

Lab Sample ID: CCB 320-231428/1   Client Sample ID:

Date Analyzed: 06/27/18 21:21   Lab File ID: 2018.06.27LLC_003.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorobutanesulfonic acid (PFBS)		Invalid Compound ID	barnettj	06/28/18 10:02

Lab Sample ID: CCVL 320-231428/2   Client Sample ID:

Date Analyzed: 06/27/18 21:29   Lab File ID: 2018.06.27LLC_004.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorononanoic acid (PFNA)	2.99	Baseline	barnettj	06/28/18 10:03

Lab Sample ID: CCV 320-231428/3 CCVIS   Client Sample ID:

Date Analyzed: 06/27/18 21:36   Lab File ID: 2018.06.27LLC_005.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanesulfonic acid (PFOS)	2.99	Isomers	barnettj	06/28/18 10:06

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N Analysis Batch Number: 231442

Lab Sample ID: CCV 320-231442/1 Client Sample ID:

Date Analyzed: 06/28/18 02:49 Lab File ID: 2018.06.27LLC_045.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanesulfonic acid (PFOS)	3.00	Isomers	barnettj	06/28/18 10:16

Lab Sample ID: MB 320-228766/1-A Client Sample ID:

Date Analyzed: 06/28/18 02:57 Lab File ID: 2018.06.27LLC_046.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorobutanesulfonic acid (PFBS)		Invalid Compound ID	barnettj	06/28/18 10:18

Lab Sample ID: LCS 320-228766/2-A Client Sample ID:

Date Analyzed: 06/28/18 03:05 Lab File ID: 2018.06.27LLC_047.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanesulfonic acid (PFOS)	2.99	Isomers	barnettj	06/28/18 10:19

Lab Sample ID: 320-39942-5 Client Sample ID: HEC05-SB1-02

Date Analyzed: 06/28/18 03:21 Lab File ID: 2018.06.27LLC_049.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorobutanesulfonic acid (PFBS)		Invalid Compound ID	barnettj	06/28/18 10:23

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 231442

Lab Sample ID: 320-39942-6   Client Sample ID: HEC05-SB3-01

Date Analyzed: 06/28/18 03:29   Lab File ID: 2018.06.27LLC_050.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.62	Isomers	barnettj	06/29/18 16:19
Perfluorooctanesulfonic acid (PFOS)	2.99	Isomers	barnettj	06/28/18 10:30

Lab Sample ID: 320-39942-8   Client Sample ID: HEC05-SB2-01

Date Analyzed: 06/28/18 03:44   Lab File ID: 2018.06.27LLC_052.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.63	Split Peak	barnettj	06/28/18 10:32
Perfluorononanoic acid (PFNA)	3.00	Baseline	barnettj	06/28/18 10:33
Perfluorobutanesulfonic acid (PFBS)		Invalid Compound ID	barnettj	06/28/18 10:32

Lab Sample ID: 320-39942-9   Client Sample ID: HEC05-SB2-02

Date Analyzed: 06/28/18 03:52   Lab File ID: 2018.06.27LLC_053.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.63	Split Peak	barnettj	06/28/18 10:34
Perfluorooctanesulfonic acid (PFOS)	2.99	Missed Peak	barnettj	06/28/18 10:34

Lab Sample ID: 320-39942-11   Client Sample ID: HEC06-SB1-01

Date Analyzed: 06/28/18 04:00   Lab File ID: 2018.06.27LLC_054.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	ANALYST	DATE
Perfluorooctanesulfonic acid (PFOS)	2.87	Missed Peak	barnettj	06/28/18 10:35

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 231442

Lab Sample ID: 320-39942-12   Client Sample ID: HEC06-SB1-01D

Date Analyzed: 06/28/18 04:08   Lab File ID: 2018.06.27LLC_055.d   GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorononanoic acid (PFNA)	2.99	Split Peak	barnettj	06/28/18 10:37
Perfluorooctanesulfonic acid (PFOS)	2.99	Isomers	barnettj	06/28/18 10:36

Lab Sample ID: CCV 320-231442/12   Client Sample ID:

Date Analyzed: 06/28/18 04:16   Lab File ID: 2018.06.27LLC_056.d   GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanesulfonic acid (PFOS)	2.99	Isomers	barnettj	06/28/18 10:14

Lab Sample ID: 320-39942-14   Client Sample ID: HEC06-SB2-01

Date Analyzed: 06/28/18 04:31   Lab File ID: 2018.06.27LLC_058.d   GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.62	Baseline	barnettj	06/28/18 10:38

Lab Sample ID: 320-39942-16   Client Sample ID: HEC06-SB3-01

Date Analyzed: 06/28/18 04:47   Lab File ID: 2018.06.27LLC_060.d   GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanesulfonic acid (PFOS)	2.99	Isomers	barnettj	06/28/18 10:39

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 231442

Lab Sample ID: 320-39942-17   Client Sample ID: HEC06-SB3-02

Date Analyzed: 06/28/18 04:55   Lab File ID: 2018.06.27LLC_061.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.63	Split Peak	barnettj	06/28/18 10:40

Lab Sample ID: 320-39942-20   Client Sample ID: HEC02-SB1-01

Date Analyzed: 06/28/18 05:03   Lab File ID: 2018.06.27LLC_062.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	ANALYST	DATE
Perfluorobutanesulfonic acid (PFBS)	1.72	Baseline	barnettj	06/28/18 10:41

Lab Sample ID: 320-39942-20 MS   Client Sample ID: HEC02-SB1-01 MS

Date Analyzed: 06/28/18 05:10   Lab File ID: 2018.06.27LLC_063.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	ANALYST	DATE
Perfluorooctanesulfonic acid (PFOS)	2.99	Baseline	barnettj	06/28/18 10:43

Lab Sample ID: 320-39942-20 MSD   Client Sample ID: HEC02-SB1-01 MSD

Date Analyzed: 06/28/18 05:18   Lab File ID: 2018.06.27LLC_064.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	ANALYST	DATE
Perfluorooctanesulfonic acid (PFOS)	2.99	Isomers	barnettj	06/28/18 10:44

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N   Analysis Batch Number: 231442

Lab Sample ID: 320-39942-22   Client Sample ID: HEC02-SB1-02D

Date Analyzed: 06/28/18 05:34   Lab File ID: 2018.06.27LLC_066.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	MANUAL INTEGRATION ANALYST	MANUAL INTEGRATION DATE
Perfluorooctanesulfonic acid (PFOS)	2.99	Isomers	barnettj	06/28/18 10:46

Lab Sample ID: CCV 320-231442/23   Client Sample ID:

Date Analyzed: 06/28/18 05:42   Lab File ID: 2018.06.27LLC_067.d   GC Column: GeminiC18 3x1   ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION REASON	MANUAL INTEGRATION ANALYST	MANUAL INTEGRATION DATE
Perfluorooctanesulfonic acid (PFOS)	2.99	Isomers	barnettj	06/28/18 10:15

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N Analysis Batch Number: 231836

Lab Sample ID: IC 320-231836/2 Client Sample ID:

Date Analyzed: 06/29/18 21:29 Lab File ID: 2018.06.29LLICALA_002.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorobutanoic acid (PFBA)	1.43	Baseline	roycea	06/30/18 07:10
Perfluorohexanoic acid (PFHxA)	1.99	Baseline	roycea	06/30/18 07:10
6:2 FTS	2.64	Baseline	roycea	06/30/18 07:10
Perfluoroheptanesulfonic Acid (PFHpS)	2.67	Baseline	roycea	06/30/18 07:11
Perfluorooctanoic acid (PFOA)	2.67	Baseline	roycea	06/30/18 07:09
Perfluorooctanesulfonic acid (PFOS)	3.03	Assign Peak	roycea	06/30/18 07:09
Perfluorodecanesulfonic acid (PFDS)	3.69	Baseline	roycea	06/30/18 07:11
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	3.71	Baseline	roycea	06/30/18 07:13

Lab Sample ID: IC 320-231836/3 Client Sample ID:

Date Analyzed: 06/29/18 21:36 Lab File ID: 2018.06.29LLICALA_003.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorobutanoic acid (PFBA)	1.43	Baseline	roycea	06/30/18 07:15
Perfluorobutanesulfonic acid (PFBS)	1.74	Baseline	roycea	06/30/18 07:16
Perfluorooctanoic acid (PFOA)	2.66	Baseline	roycea	06/30/18 07:15

Lab Sample ID: IC 320-231836/4 Client Sample ID:

Date Analyzed: 06/29/18 21:44 Lab File ID: 2018.06.29LLICALA_004.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
13C4 PFBA	1.42	Incomplete Integration	roycea	06/30/18 07:17
Perfluorobutanoic acid (PFBA)	1.43	Incomplete Integration	roycea	06/30/18 07:17

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento　Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N　Analysis Batch Number: 231836

Lab Sample ID: ICB 320-231836/9　Client Sample ID:

Date Analyzed: 06/29/18 22:23　Lab File ID: 2018.06.29LLICALA_009.d　GC Column: GeminiC18 3x1　ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.65	Baseline	roycea	06/30/18 07:22

LCMS MANUAL INTEGRATION SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Instrument ID: A8_N Analysis Batch Number: 231839

Lab Sample ID: 320-39942-6 DL Client Sample ID: HEC05-SB3-01 DL

Date Analyzed: 06/29/18 23:49 Lab File ID: 2018.06.29LLBBX_011.d GC Column: GeminiC18 3x1 ID: 3(mm)

COMPOUND NAME	RETENTION TIME	MANUAL INTEGRATION		
		REASON	ANALYST	DATE
Perfluorooctanoic acid (PFOA)	2.66	Isomers	hannigana	06/30/18 08:32

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent Reagent ID	Parent Reagent Volume Added	Analyte	Concentration
LCMPFC_ALL_SU_00073	12/01/18	06/01/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM3HFPO-DA_00003	200 uL	13C3 HFPO-DA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
.LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
.LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
.LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
.LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
.LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
.LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
.LCM3HFPO-DA_00003	05/18/21		WELLINGTON, Lot M3HFPODA0518		(Purchased Reagent)		13C3 HFPO-DA	50 ug/mL
.LCM4PFHPA_00014	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL
.LCM5PFPEA_00015	07/20/22		Wellington Laboratories, Lot M5PFPeA0717		(Purchased Reagent)		13C5-PFPeA	50 ug/mL
.LCM8FOSA_00019	10/11/22		Wellington Laboratories, Lot M8FOSA1017I		(Purchased Reagent)		13C8 FOSA	50 ug/mL
.LCMPFBA_00015	02/16/23		Wellington Laboratories, Lot MPFBA0218		(Purchased Reagent)		13C4 PFBA	50 ug/mL
.LCMPFBS_00008	02/15/23		Wellington Laboratories, Lot M3PFBS0218		(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
.LCMPFDA_00020	02/16/23		Wellington Laboratories, Lot MPFDA0218		(Purchased Reagent)		13C2 PFDA	50 ug/mL
.LCMPFDoA_00015	02/16/23		Wellington Laboratories, Lot MPFDoA0218		(Purchased Reagent)		13C2 PFDoA	50 ug/mL
.LCMPFHxA_00022	10/27/22		Wellington Laboratories, Lot MPFHxA1017		(Purchased Reagent)		13C2 PFHxA	50 ug/mL
.LCMPFHxS_00015	03/22/23		Wellington Laboratories, Lot MPFHxS0318		(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
.LCMPFNA_00015	12/14/22		Wellington Laboratories, Lot MPFNA1217		(Purchased Reagent)		13C5 PFNA	50 ug/mL
.LCMPFOA_00019	05/04/23		Wellington Laboratories, Lot MPFOA0418		(Purchased Reagent)		13C4 PFOA	50 ug/mL
.LCMPFOS_00027	02/15/23		Wellington Laboratories, Lot MPFOS0218		(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
.LCMPFUdA_00017	11/22/21		Wellington Laboratories, Lot MPFUdA1116		(Purchased Reagent)		13C2 PFUnA	50 ug/mL
LCMPFC_ALL_SU_00074	12/01/18	06/01/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM3HFPO-DA_00003	200 uL	13C3 HFPO-DA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
.LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
.LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
.LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
.LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
.LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
.LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
.LCM3HFPO-DA_00003	05/18/21		WELLINGTON, Lot M3HFPODA0518		(Purchased Reagent)		13C3 HFPO-DA	50 ug/mL
.LCM4PFHPA_00014	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL
.LCM5PFPEA_00015	07/20/22		Wellington Laboratories, Lot M5PFPeA0717		(Purchased Reagent)		13C5-PFPeA	50 ug/mL
.LCM8FOSA_00019	10/11/22		Wellington Laboratories, Lot M8FOSA1017I		(Purchased Reagent)		13C8 FOSA	50 ug/mL
.LCMPFBA_00015	02/16/23		Wellington Laboratories, Lot MPFBA0218		(Purchased Reagent)		13C4 PFBA	50 ug/mL
.LCMPFBS_00008	02/15/23		Wellington Laboratories, Lot M3PFBS0218		(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
.LCMPFDA_00020	02/16/23		Wellington Laboratories, Lot MPFDA0218		(Purchased Reagent)		13C2 PFDA	50 ug/mL
.LCMPFDoA_00015	02/16/23		Wellington Laboratories, Lot MPFDoA0218		(Purchased Reagent)		13C2 PFDoA	50 ug/mL
.LCMPFHxA_00022	10/27/22		Wellington Laboratories, Lot MPFHxA1017		(Purchased Reagent)		13C2 PFHxA	50 ug/mL
.LCMPFHxS_00015	03/22/23		Wellington Laboratories, Lot MPFHxS0318		(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
.LCMPFNA_00015	12/14/22		Wellington Laboratories, Lot MPFNA1217		(Purchased Reagent)		13C5 PFNA	50 ug/mL
.LCMPFOA_00019	05/04/23		Wellington Laboratories, Lot MPFOA0418		(Purchased Reagent)		13C4 PFOA	50 ug/mL
.LCMPFOS_00027	02/15/23		Wellington Laboratories, Lot MPFOS0218		(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
.LCMPFUdA_00017	11/22/21		Wellington Laboratories, Lot MPFUdA1116		(Purchased Reagent)		13C2 PFUnA	50 ug/mL
LCPFC-IS_00057	12/01/18	06/01/18	Methanol, Lot 090285	200 mL	LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
.LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
LCPFC-IS_00062	12/13/18	06/13/18	Methanol, Lot 090285	200 mL	LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
.LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
LCPFC_LL0_00007	12/01/18	06/05/18	MeOH/H2O, Lot Baker 141039	200 mL	LCMPFC_ALL_SU_00075	10 mL	13C2-PFOA	2.5 ng/mL
.LCMPFC_ALL_SU_00075	12/05/18	06/05/18	Methanol, Lot Baker 141039	200 mL	LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
..LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
LCPFC_LL0_00007	12/01/18	06/05/18	MeOH/H2O, Lot Baker 141039	200 mL	LCMPFC_ALL_SU_00075	10 mL	d3-NMeFOSAA	2.5 ng/mL
							d5-NEtFOSAA	2.5 ng/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							M2-6:2FTS	2.375 ng/mL
							M2-8:2FTS	2.395 ng/mL
							13C2-PFHxDA	2.5 ng/mL
							13C2-PFTeDA	2.5 ng/mL
							13C4-PFHpA	2.5 ng/mL
							13C5-PFPeA	2.5 ng/mL
							13C8 FOSA	2.5 ng/mL
							13C4 PFBA	2.5 ng/mL
							13C3-PFBS	2.325 ng/mL
							13C2 PFDA	2.5 ng/mL
							13C2 PFDoA	2.5 ng/mL
							13C2 PFHxA	2.5 ng/mL
							18O2 PFHxS	2.365 ng/mL
							13C5 PFNA	2.5 ng/mL
							13C4 PFOA	2.5 ng/mL
							13C4 PFOS	2.39 ng/mL
							13C2 PFUnA	2.5 ng/mL
.LCMPFC_ALL_SU_00075	12/05/18	06/05/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
..LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
..LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
..LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
..LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
..LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
..LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
..LCM4PFHPA_00014	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL
..LCM5PFPEA_00015	07/20/22		Wellington Laboratories, Lot M5PFPeA0717		(Purchased Reagent)		13C5-PFPeA	50 ug/mL
..LCM8FOSA_00019	10/11/22		Wellington Laboratories, Lot M8FOSA1017I		(Purchased Reagent)		13C8 FOSA	50 ug/mL
..LCMPFBA_00015	02/16/23		Wellington Laboratories, Lot MPFBA0218		(Purchased Reagent)		13C4 PFBA	50 ug/mL
..LCMPFBS_00008	02/15/23		Wellington Laboratories, Lot M3PFBS0218		(Purchased Reagent)		13C3-PFBS	46.5 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent Reagent ID	Parent Reagent Volume Added	Analyte	Concentration
..LCMPFDA_00020	02/16/23		Wellington Laboratories, Lot MPFDA0218		(Purchased Reagent)		13C2 PFDA	50 ug/mL
..LCMPFDoA_00015	02/16/23		Wellington Laboratories, Lot MPFDoA0218		(Purchased Reagent)		13C2 PFDoA	50 ug/mL
..LCMPFHxA_00022	10/27/22		Wellington Laboratories, Lot MPFHxA1017		(Purchased Reagent)		13C2 PFHxA	50 ug/mL
..LCMPFHxS_00015	03/22/23		Wellington Laboratories, Lot MPFHxS0318		(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
..LCMPFNA_00015	12/14/22		Wellington Laboratories, Lot MPFNA1217		(Purchased Reagent)		13C5 PFNA	50 ug/mL
..LCMPFOA_00019	05/04/23		Wellington Laboratories, Lot MPFOA0418		(Purchased Reagent)		13C4 PFOA	50 ug/mL
..LCMPFOS_00027	02/15/23		Wellington Laboratories, Lot MPFOS0218		(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
..LCMPFUdA_00017	11/22/21		Wellington Laboratories, Lot MPFUdA1116		(Purchased Reagent)		13C2 PFUnA	50 ug/mL
LCPFC_LL1_00006	11/18/18	06/05/18	MeOH/H2O, Lot 90285	200 mL	LCMPFC_ALL_SU_00075	10 mL	d3-NMeFOSAA	2.5 ng/mL
							d5-NEtFOSAA	2.5 ng/mL
							M2-6:2FTS	2.375 ng/mL
							M2-8:2FTS	2.395 ng/mL
							13C2-PFHxDA	2.5 ng/mL
							13C2-PFOA	2.5 ng/mL
							13C2-PFTeDA	2.5 ng/mL
							13C4-PFHpA	2.5 ng/mL
							13C5-PFPeA	2.5 ng/mL
							13C8 FOSA	2.5 ng/mL
							13C4 PFBA	2.5 ng/mL
							13C3-PFBS	2.325 ng/mL
							13C2 PFDA	2.5 ng/mL
							13C2 PFDoA	2.5 ng/mL
							13C2 PFHxA	2.5 ng/mL
							18O2 PFHxS	2.365 ng/mL
							13C5 PFNA	2.5 ng/mL
							13C4 PFOA	2.5 ng/mL
							13C4 PFOS	2.39 ng/mL
							13C2 PFUnA	2.5 ng/mL
					LCPFCSP_00151	500 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.02335 ng/mL
							1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.0237 ng/mL
							1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.02395 ng/mL
							N-ethyl perfluorooctane sulfonamidoacetic acid	0.025 ng/mL
							N-methyl perfluorooctane sulfonamidoacetic acid	0.025 ng/mL
							Perfluorobutyric acid	0.025 ng/mL
							Perfluorobutanesulfonic acid (PFBS)	0.0221 ng/mL
							Perfluorodecanoic acid	0.025 ng/mL
							Perfluorododecanoic acid	0.025 ng/mL
							Perfluorodecane Sulfonic acid	0.0241 ng/mL
							Perfluoroheptanoic acid (PFHpA)	0.025 ng/mL
							Perfluoroheptanesulfonic acid	0.0238 ng/mL
							Perfluorohexanoic acid	0.025 ng/mL

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							Perfluorohexanesulfonic acid (PFHxS)	0.02275 ng/mL
							Perfluorononanoic acid (PFNA)	0.025 ng/mL
							Perfluorooctanoic acid (PFOA)	0.025025 ng/mL
							Perfluorononanesulfonic acid	0.024 ng/mL
							Perfluorooctanesulfonic acid (PFOS)	0.0232 ng/mL
							Perfluorooctane Sulfonamide	0.025 ng/mL
							Perfluoropentanoic acid	0.025 ng/mL
							Perfluoropentanesulfonic acid	0.02345 ng/mL
							Perfluorotetradecanoic acid	0.025 ng/mL
							Perfluorotridecanoic acid	0.025 ng/mL
							Perfluoroundecanoic acid	0.025 ng/mL
.LCMPFC_ALL_SU_00075	12/05/18	06/05/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
..LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
..LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
..LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
..LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
..LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
..LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
..LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
..LCM4PFHPA_00014	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL
..LCM5PFPEA_00015	07/20/22		Wellington Laboratories, Lot M5PFPeA0717		(Purchased Reagent)		13C5-PFPeA	50 ug/mL
..LCM8FOSA_00019	10/11/22		Wellington Laboratories, Lot M8FOSA1017I		(Purchased Reagent)		13C8 FOSA	50 ug/mL
..LCMPFBA_00015	02/16/23		Wellington Laboratories, Lot MPFBA0218		(Purchased Reagent)		13C4 PFBA	50 ug/mL
..LCMPFBS_00008	02/15/23		Wellington Laboratories, Lot M3PFBS0218		(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
..LCMPFDA_00020	02/16/23		Wellington Laboratories, Lot MPFDA0218		(Purchased Reagent)		13C2 PFDA	50 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
..LCMPFDoA_00015	02/16/23	Wellington Laboratories, Lot MPFDoA0218			(Purchased Reagent)		13C2 PFDoA	50 ug/mL
..LCMPFHxA_00022	10/27/22	Wellington Laboratories, Lot MPFHxA1017			(Purchased Reagent)		13C2 PFHxA	50 ug/mL
..LCMPFHxS_00015	03/22/23	Wellington Laboratories, Lot MPFHxS0318			(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
..LCMPFNA_00015	12/14/22	Wellington Laboratories, Lot MPFNA1217			(Purchased Reagent)		13C5 PFNA	50 ug/mL
..LCMPFOA_00019	05/04/23	Wellington Laboratories, Lot MPFOA0418			(Purchased Reagent)		13C4 PFOA	50 ug/mL
..LCMPFOS_00027	02/15/23	Wellington Laboratories, Lot MPFOS0218			(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
..LCMPFUdA_00017	11/22/21	Wellington Laboratories, Lot MPFUdA1116			(Purchased Reagent)		13C2 PFUnA	50 ug/mL
.LCPFCSP_00151	11/18/18	05/17/18	Methanol, Lot 090285	10 mL	LCPFCSP_00148	200 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.00934 ug/mL
							1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.00948 ug/mL
							1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.00958 ug/mL
							N-ethyl perfluorooctane sulfonamidoacetic acid	0.01 ug/mL
							N-methyl perfluorooctane sulfonamidoacetic acid	0.01 ug/mL
							Perfluorobutyric acid	0.01 ug/mL
							Perfluorobutanesulfonic acid (PFBS)	0.00884 ug/mL
							Perfluorodecanoic acid	0.01 ug/mL
							Perfluorododecanoic acid	0.01 ug/mL
							Perfluorodecane Sulfonic acid	0.00964 ug/mL
							Perfluoroheptanoic acid (PFHpA)	0.01 ug/mL
							Perfluoroheptanesulfonic acid	0.00952 ug/mL
							Perfluorohexanoic acid	0.01 ug/mL
							Perfluorohexanesulfonic acid (PFHxS)	0.0091 ug/mL
							Perfluorononanoic acid (PFNA)	0.01 ug/mL
							Perfluorooctanoic acid (PFOA)	0.01001 ug/mL
							Perfluorononanesulfonic acid	0.0096 ug/mL
							Perfluorooctanesulfonic acid (PFOS)	0.00928 ug/mL
							Perfluorooctane Sulfonamide	0.01 ug/mL
							Perfluoropentanoic acid	0.01 ug/mL
							Perfluoropentanesulfonic acid	0.00938 ug/mL
							Perfluorotetradecanoic acid	0.01 ug/mL
							Perfluorotridecanoic acid	0.01 ug/mL
							Perfluoroundecanoic acid	0.01 ug/mL
..LCPFCSP_00148	11/18/18	05/17/18	Methanol, Lot 090285	10 mL	LC4:2FTS_00005	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.467 ug/mL
					LC6:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.474 ug/mL
					LC8:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.479 ug/mL
					LCbr-NEtFOSAA_00001	100 uL	N-ethyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LCbr-NMeFOSAA_00001	100 uL	N-methyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCPFBA_00008	100 uL	Perfluorobutyric acid	0.5 ug/mL
					LCPFBS_00009	100 uL	Perfluorobutanesulfonic acid (PFBS)	0.442 ug/mL
					LCPFDA_00008	100 uL	Perfluorodecanoic acid	0.5 ug/mL
					LCPFDoA_00008	100 uL	Perfluorododecanoic acid	0.5 ug/mL
					LCPFDS_00008	100 uL	Perfluorodecane Sulfonic acid	0.482 ug/mL
					LCPFHpA_00011	100 uL	Perfluoroheptanoic acid (PFHpA)	0.5 ug/mL
					LCPFHpSA_00003	100 uL	Perfluoroheptanesulfonic acid	0.476 ug/mL
					LCPFHxA_00010	100 uL	Perfluorohexanoic acid	0.5 ug/mL
					LCPFHxS-br_00006	100 uL	Perfluorohexanesulfonic acid (PFHxS)	0.455 ug/mL
					LCPFNA_00010	100 uL	Perfluorononanoic acid (PFNA)	0.5 ug/mL
							Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFNS_00003	100 uL	Perfluorononanesulfonic acid	0.48 ug/mL
					LCPFOA_00011	100 uL	Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFOS-br_00007	100 uL	Perfluorooctanesulfonic acid (PFOS)	0.464 ug/mL
					LCPFOSA_00013	100 uL	Perfluorooctane Sulfonamide	0.5 ug/mL
					LCPFPeA_00008	100 uL	Perfluoropentanoic acid	0.5 ug/mL
					LCPFPeS_00003	100 uL	Perfluoropentanesulfonic acid	0.469 ug/mL
					LCPFTeDA_00008	100 uL	Perfluorotetradecanoic acid	0.5 ug/mL
					LCPFTrDA_00008	100 uL	Perfluorotridecanoic acid	0.5 ug/mL
					LCPFUdA_00008	100 uL	Perfluoroundecanoic acid	0.5 ug/mL
...LC4:2FTS_00005	12/12/21		WELLINGTON, Lot 42FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	46.7 ug/mL
...LC6:2FTS_00007	04/20/22		WELLINGTON, Lot 62FTS0417		(Purchased Reagent)		1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	47.4 ug/mL
...LC8:2FTS_00007	12/12/21		WELLINGTON, Lot 82FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	47.9 ug/mL
...LCbr-NEtFOSAA_00001	01/17/23		WELLINGTON, Lot brNEtFOSAA0118		(Purchased Reagent)		N-ethyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
...LCbr-NMeFOSAA_00001	01/17/23		WELLINGTON, Lot brNMeFOSAA0118		(Purchased Reagent)		N-methyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
...LCPFBA_00008	05/29/22		Wellington Laboratories, Lot PFBA0517		(Purchased Reagent)		Perfluorobutyric acid	50 ug/mL
...LCPFBS_00009	09/21/22		Wellington Laboratories, Lot LPFBS0917		(Purchased Reagent)		Perfluorobutanesulfonic acid (PFBS)	44.2 ug/mL
...LCPFDA_00008	05/29/22		Wellington Laboratories, Lot PFDA0517		(Purchased Reagent)		Perfluorodecanoic acid	50 ug/mL
...LCPFDoA_00008	05/29/22		Wellington Laboratories, Lot PFDoA0517		(Purchased Reagent)		Perfluorododecanoic acid	50 ug/mL
...LCPFDS_00008	11/08/22		Wellington Laboratories, Lot LPFDS1117		(Purchased Reagent)		Perfluorodecane Sulfonic acid	48.2 ug/mL
...LCPFHpA_00011	09/27/22		Wellington Laboratories, Lot PFHpA0917		(Purchased Reagent)		Perfluoroheptanoic acid (PFHpA)	50 ug/mL
...LCPFHpSA_00003	09/01/22		Wellington Laboratories, Lot LPFHpS0817		(Purchased Reagent)		Perfluoroheptanesulfonic acid	47.6 ug/mL
...LCPFHxA_00010	09/27/22		Wellington Laboratories, Lot PFHxA0917		(Purchased Reagent)		Perfluorohexanoic acid	50 ug/mL
...LCPFHxS-br_00006	01/04/22		Wellington Laboratories, Lot brPFHxSK0117		(Purchased Reagent)		Perfluorohexanesulfonic acid (PFHxS)	45.5 ug/mL
...LCPFNA_00010	07/20/22		Wellington Laboratories, Lot PFNA0717		(Purchased Reagent)		Perfluorononanoic acid (PFNA)	50 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							Perfluorooctanoic acid (PFOA)	0.05 ug/mL
...LCPFNS_00003	09/27/22	Wellington Laboratories, Lot LPFNS0917			(Purchased Reagent)		Perfluorononanesulfonic acid	48 ug/mL
...LCPFOA_00011	09/27/22	Wellington Laboratories, Lot PFOA0917			(Purchased Reagent)		Perfluorooctanoic acid (PFOA)	50 ug/mL
...LCPFOS-br_00007	01/12/22	Wellington Laboratories, Lot brPFOSK0117			(Purchased Reagent)		Perfluorooctanesulfonic acid (PFOS)	46.4 ug/mL
...LCPFOSA_00013	09/01/22	Wellington Laboratories, Lot FOSA0817I			(Purchased Reagent)		Perfluorooctane Sulfonamide	50 ug/mL
...LCPFPeA_00008	06/14/22	Wellington Laboratories, Lot PFPeA0617			(Purchased Reagent)		Perfluoropentanoic acid	50 ug/mL
...LCPFPeS_00003	01/11/22	Wellington Laboratories, Lot LPFPeS0117			(Purchased Reagent)		Perfluoropentanesulfonic acid	46.9 ug/mL
...LCPFTeDA_00008	09/30/21	Wellington Laboratories, Lot PFTeDA0916			(Purchased Reagent)		Perfluorotetradecanoic acid	50 ug/mL
...LCPFTrDA_00008	05/02/22	Wellington Laboratories, Lot PFTrDA0517			(Purchased Reagent)		Perfluorotridecanoic acid	50 ug/mL
...LCPFUdA_00008	10/18/21	Wellington Laboratories, Lot PFUdA1016			(Purchased Reagent)		Perfluoroundecanoic acid	50 ug/mL
LCPFC_LL2_00005	11/18/18	06/05/18	MeOH/H2O, Lot 090285	200 mL	LCMPFC_ALL_SU_00075	10 mL	d3-NMeFOSAA	2.5 ng/mL
							d5-NEtFOSAA	2.5 ng/mL
							M2-6:2FTS	2.375 ng/mL
							M2-8:2FTS	2.395 ng/mL
							13C2-PFHxDA	2.5 ng/mL
							13C2-PFOA	2.5 ng/mL
							13C2-PFTeDA	2.5 ng/mL
							13C4-PFHpA	2.5 ng/mL
							13C5-PFPeA	2.5 ng/mL
							13C8 FOSA	2.5 ng/mL
							13C4 PFBA	2.5 ng/mL
							13C3-PFBS	2.325 ng/mL
							13C2 PFDA	2.5 ng/mL
							13C2 PFDoA	2.5 ng/mL
							13C2 PFHxA	2.5 ng/mL
							18O2 PFHxS	2.365 ng/mL
							13C5 PFNA	2.5 ng/mL
							13C4 PFOA	2.5 ng/mL
							13C4 PFOS	2.39 ng/mL
							13C2 PFUnA	2.5 ng/mL
					LCPFCSP_00151	1000 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.0467 ng/mL
							1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.0474 ng/mL
							1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.0479 ng/mL
							N-ethyl perfluorooctane sulfonamidoacetic acid	0.05 ng/mL
							N-methyl perfluorooctane sulfonamidoacetic acid	0.05 ng/mL
							Perfluorobutyric acid	0.05 ng/mL
							Perfluorobutanesulfonic acid (PFBS)	0.0442 ng/mL
							Perfluorodecanoic acid	0.05 ng/mL
							Perfluorododecanoic acid	0.05 ng/mL
							Perfluorodecane Sulfonic acid	0.0482 ng/mL

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							Perfluoroheptanoic acid (PFHpA)	0.05 ng/mL
							Perfluoroheptanesulfonic acid	0.0476 ng/mL
							Perfluorohexanoic acid	0.05 ng/mL
							Perfluorohexanesulfonic acid (PFHxS)	0.0455 ng/mL
							Perfluorononanoic acid (PFNA)	0.05 ng/mL
							Perfluorooctanoic acid (PFOA)	0.05005 ng/mL
							Perfluorononanesulfonic acid	0.048 ng/mL
							Perfluorooctanesulfonic acid (PFOS)	0.0464 ng/mL
							Perfluorooctane Sulfonamide	0.05 ng/mL
							Perfluoropentanoic acid	0.05 ng/mL
							Perfluoropentanesulfonic acid	0.0469 ng/mL
							Perfluorotetradecanoic acid	0.05 ng/mL
							Perfluorotridecanoic acid	0.05 ng/mL
							Perfluoroundecanoic acid	0.05 ng/mL
.LCMPFC_ALL_SU_00075	12/05/18	06/05/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
..LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
..LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
..LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
..LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
..LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
..LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
..LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
..LCM4PFHPA_00014	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL
..LCM5PFPEA_00015	07/20/22		Wellington Laboratories, Lot M5PFPeA0717		(Purchased Reagent)		13C5-PFPeA	50 ug/mL
..LCM8FOSA_00019	10/11/22		Wellington Laboratories, Lot M8FOSA1017I		(Purchased Reagent)		13C8 FOSA	50 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
..LCMPFBA_00015	02/16/23	Wellington Laboratories, Lot MPFBA0218			(Purchased Reagent)		13C4 PFBA	50 ug/mL
..LCMPFBS_00008	02/15/23	Wellington Laboratories, Lot M3PFBS0218			(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
..LCMPFDA_00020	02/16/23	Wellington Laboratories, Lot MPFDA0218			(Purchased Reagent)		13C2 PFDA	50 ug/mL
..LCMPFDoA_00015	02/16/23	Wellington Laboratories, Lot MPFDoA0218			(Purchased Reagent)		13C2 PFDoA	50 ug/mL
..LCMPFHxA_00022	10/27/22	Wellington Laboratories, Lot MPFHxA1017			(Purchased Reagent)		13C2 PFHxA	50 ug/mL
..LCMPFHxS_00015	03/22/23	Wellington Laboratories, Lot MPFHxS0318			(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
..LCMPFNA_00015	12/14/22	Wellington Laboratories, Lot MPFNA1217			(Purchased Reagent)		13C5 PFNA	50 ug/mL
..LCMPFOA_00019	05/04/23	Wellington Laboratories, Lot MPFOA0418			(Purchased Reagent)		13C4 PFOA	50 ug/mL
..LCMPFOS_00027	02/15/23	Wellington Laboratories, Lot MPFOS0218			(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
..LCMPFUdA_00017	11/22/21	Wellington Laboratories, Lot MPFUdA1116			(Purchased Reagent)		13C2 PFUnA	50 ug/mL
.LCPFCSP_00151	11/18/18	05/17/18	Methanol, Lot 090285	10 mL	LCPFCSP_00148	200 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.00934 ug/mL
							1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.00948 ug/mL
							1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.00958 ug/mL
							N-ethyl perfluorooctane sulfonamidoacetic acid	0.01 ug/mL
							N-methyl perfluorooctane sulfonamidoacetic acid	0.01 ug/mL
							Perfluorobutyric acid	0.01 ug/mL
							Perfluorobutanesulfonic acid (PFBS)	0.00884 ug/mL
							Perfluorodecanoic acid	0.01 ug/mL
							Perfluorododecanoic acid	0.01 ug/mL
							Perfluorodecane Sulfonic acid	0.00964 ug/mL
							Perfluoroheptanoic acid (PFHpA)	0.01 ug/mL
							Perfluoroheptanesulfonic acid	0.00952 ug/mL
							Perfluorohexanoic acid	0.01 ug/mL
							Perfluorohexanesulfonic acid (PFHxS)	0.0091 ug/mL
							Perfluorononanoic acid (PFNA)	0.01 ug/mL
							Perfluorooctanoic acid (PFOA)	0.01001 ug/mL
							Perfluorononanesulfonic acid	0.0096 ug/mL
							Perfluorooctanesulfonic acid (PFOS)	0.00928 ug/mL
							Perfluorooctane Sulfonamide	0.01 ug/mL
							Perfluoropentanoic acid	0.01 ug/mL
							Perfluoropentanesulfonic acid	0.00938 ug/mL
							Perfluorotetradecanoic acid	0.01 ug/mL
							Perfluorotridecanoic acid	0.01 ug/mL
							Perfluoroundecanoic acid	0.01 ug/mL
..LCPFCSP_00148	11/18/18	05/17/18	Methanol, Lot 090285	10 mL	LC4:2FTS_00005	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.467 ug/mL
					LC6:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.474 ug/mL
					LC8:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.479 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LCbr-NEtFOSAA_00001	100 uL	N-ethyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCbr-NMeFOSAA_00001	100 uL	N-methyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCPFBA_00008	100 uL	Perfluorobutyric acid	0.5 ug/mL
					LCPFBS_00009	100 uL	Perfluorobutanesulfonic acid (PFBS)	0.442 ug/mL
					LCPFDA_00008	100 uL	Perfluorodecanoic acid	0.5 ug/mL
					LCPFDoA_00008	100 uL	Perfluorododecanoic acid	0.5 ug/mL
					LCPFDS_00008	100 uL	Perfluorodecane Sulfonic acid	0.482 ug/mL
					LCPFHpA_00011	100 uL	Perfluoroheptanoic acid (PFHpA)	0.5 ug/mL
					LCPFHpSA_00003	100 uL	Perfluoroheptanesulfonic acid	0.476 ug/mL
					LCPFHxA_00010	100 uL	Perfluorohexanoic acid	0.5 ug/mL
					LCPFHxS-br_00006	100 uL	Perfluorohexanesulfonic acid (PFHxS)	0.455 ug/mL
					LCPFNA_00010	100 uL	Perfluorononanoic acid (PFNA)	0.5 ug/mL
							Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFNS_00003	100 uL	Perfluorononanesulfonic acid	0.48 ug/mL
					LCPFOA_00011	100 uL	Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFOS-br_00007	100 uL	Perfluorooctanesulfonic acid (PFOS)	0.464 ug/mL
					LCPFOSA_00013	100 uL	Perfluorooctane Sulfonamide	0.5 ug/mL
					LCPFPeA_00008	100 uL	Perfluoropentanoic acid	0.5 ug/mL
					LCPFPeS_00003	100 uL	Perfluoropentanesulfonic acid	0.469 ug/mL
					LCPFTeDA_00008	100 uL	Perfluorotetradecanoic acid	0.5 ug/mL
					LCPFTrDA_00008	100 uL	Perfluorotridecanoic acid	0.5 ug/mL
					LCPFUdA_00008	100 uL	Perfluoroundecanoic acid	0.5 ug/mL
...LC4:2FTS_00005	12/12/21		WELLINGTON, Lot 42FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	46.7 ug/mL
...LC6:2FTS_00007	04/20/22		WELLINGTON, Lot 62FTS0417		(Purchased Reagent)		1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	47.4 ug/mL
...LC8:2FTS_00007	12/12/21		WELLINGTON, Lot 82FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	47.9 ug/mL
...LCbr-NEtFOSAA_00001	01/17/23		WELLINGTON, Lot brNEtFOSAA0118		(Purchased Reagent)		N-ethyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
...LCbr-NMeFOSAA_00001	01/17/23		WELLINGTON, Lot brNMeFOSAA0118		(Purchased Reagent)		N-methyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
...LCPFBA_00008	05/29/22		Wellington Laboratories, Lot PFBA0517		(Purchased Reagent)		Perfluorobutyric acid	50 ug/mL
...LCPFBS_00009	09/21/22		Wellington Laboratories, Lot LPFBS0917		(Purchased Reagent)		Perfluorobutanesulfonic acid (PFBS)	44.2 ug/mL
...LCPFDA_00008	05/29/22		Wellington Laboratories, Lot PFDA0517		(Purchased Reagent)		Perfluorodecanoic acid	50 ug/mL
...LCPFDoA_00008	05/29/22		Wellington Laboratories, Lot PFDoA0517		(Purchased Reagent)		Perfluorododecanoic acid	50 ug/mL
...LCPFDS_00008	11/08/22		Wellington Laboratories, Lot LPFDS1117		(Purchased Reagent)		Perfluorodecane Sulfonic acid	48.2 ug/mL
...LCPFHpA_00011	09/27/22		Wellington Laboratories, Lot PFHpA0917		(Purchased Reagent)		Perfluoroheptanoic acid (PFHpA)	50 ug/mL
...LCPFHpSA_00003	09/01/22		Wellington Laboratories, Lot LPFHpS0817		(Purchased Reagent)		Perfluoroheptanesulfonic acid	47.6 ug/mL
...LCPFHxA_00010	09/27/22		Wellington Laboratories, Lot PFHxA0917		(Purchased Reagent)		Perfluorohexanoic acid	50 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
...LCPFHxS-br_00006	01/04/22	Wellington Laboratories, Lot brPFHxSK0117			(Purchased Reagent)		Perfluorohexanesulfonic acid (PFHxS)	45.5 ug/mL
...LCPFNA_00010	07/20/22	Wellington Laboratories, Lot PFNA0717			(Purchased Reagent)		Perfluorononanoic acid (PFNA)	50 ug/mL
							Perfluorooctanoic acid (PFOA)	0.05 ug/mL
...LCPFNS_00003	09/27/22	Wellington Laboratories, Lot LPFNS0917			(Purchased Reagent)		Perfluorononanesulfonic acid	48 ug/mL
...LCPFOA_00011	09/27/22	Wellington Laboratories, Lot PFOA0917			(Purchased Reagent)		Perfluorooctanoic acid (PFOA)	50 ug/mL
...LCPFOS-br_00007	01/12/22	Wellington Laboratories, Lot brPFOSK0117			(Purchased Reagent)		Perfluorooctanesulfonic acid (PFOS)	46.4 ug/mL
...LCPFOSA_00013	09/01/22	Wellington Laboratories, Lot FOSA0817I			(Purchased Reagent)		Perfluorooctane Sulfonamide	50 ug/mL
...LCPFPeA_00008	06/14/22	Wellington Laboratories, Lot PFPeA0617			(Purchased Reagent)		Perfluoropentanoic acid	50 ug/mL
...LCPFPeS_00003	01/11/22	Wellington Laboratories, Lot LPFPeS0117			(Purchased Reagent)		Perfluoropentanesulfonic acid	46.9 ug/mL
...LCPFTeDA_00008	09/30/21	Wellington Laboratories, Lot PFTeDA0916			(Purchased Reagent)		Perfluorotetradecanoic acid	50 ug/mL
...LCPFTrDA_00008	05/02/22	Wellington Laboratories, Lot PFTrDA0517			(Purchased Reagent)		Perfluorotridecanoic acid	50 ug/mL
...LCPFUdA_00008	10/18/21	Wellington Laboratories, Lot PFUdA1016			(Purchased Reagent)		Perfluoroundecanoic acid	50 ug/mL
LCPFC_LL3_00005	11/18/18	06/05/18	MeOH/H2O, Lot 090285	200 mL	LCMPFC_ALL_SU_00075	10 mL	d3-NMeFOSAA	2.5 ng/mL
							d5-NEtFOSAA	2.5 ng/mL
							M2-6:2FTS	2.375 ng/mL
							M2-8:2FTS	2.395 ng/mL
							13C2-PFHxDA	2.5 ng/mL
							13C2-PFOA	2.5 ng/mL
							13C2-PFTeDA	2.5 ng/mL
							13C4-PFHpA	2.5 ng/mL
							13C5-PFPeA	2.5 ng/mL
							13C8 FOSA	2.5 ng/mL
							13C4 PFBA	2.5 ng/mL
							13C3-PFBS	2.325 ng/mL
							13C2 PFDA	2.5 ng/mL
							13C2 PFDoA	2.5 ng/mL
							13C2 PFHxA	2.5 ng/mL
							18O2 PFHxS	2.365 ng/mL
							13C5 PFNA	2.5 ng/mL
							13C4 PFOA	2.5 ng/mL
							13C4 PFOS	2.39 ng/mL
							13C2 PFUnA	2.5 ng/mL
					LCPFCSP_00148	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.2335 ng/mL
							1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.237 ng/mL
							1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.2395 ng/mL
							N-ethyl perfluorooctane sulfonamidoacetic acid	0.25 ng/mL
							N-methyl perfluorooctane sulfonamidoacetic acid	0.25 ng/mL
							Perfluorobutyric acid	0.25 ng/mL
							Perfluorobutanesulfonic acid (PFBS)	0.221 ng/mL
							Perfluorodecanoic acid	0.25 ng/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							Perfluorododecanoic acid	0.25 ng/mL
							Perfluorodecane Sulfonic acid	0.241 ng/mL
							Perfluoroheptanoic acid (PFHpA)	0.25 ng/mL
							Perfluoroheptanesulfonic acid	0.238 ng/mL
							Perfluorohexanoic acid	0.25 ng/mL
							Perfluorohexanesulfonic acid (PFHxS)	0.2275 ng/mL
							Perfluorononanoic acid (PFNA)	0.25 ng/mL
							Perfluorooctanoic acid (PFOA)	0.25025 ng/mL
							Perfluorononanesulfonic acid	0.24 ng/mL
							Perfluorooctanesulfonic acid (PFOS)	0.232 ng/mL
							Perfluorooctane Sulfonamide	0.25 ng/mL
							Perfluoropentanoic acid	0.25 ng/mL
							Perfluoropentanesulfonic acid	0.2345 ng/mL
							Perfluorotetradecanoic acid	0.25 ng/mL
							Perfluorotridecanoic acid	0.25 ng/mL
							Perfluoroundecanoic acid	0.25 ng/mL
.LCMPFC_ALL_SU_00075	12/05/18	06/05/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
..LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
..LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
..LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
..LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
..LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
..LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
..LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
..LCM4PFHPA_00014	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
..LCM5PFPEA_00015	07/20/22	Wellington Laboratories, Lot M5PFPeA0717			(Purchased Reagent)		13C5-PFPeA	50 ug/mL
..LCM8FOSA_00019	10/11/22	Wellington Laboratories, Lot M8FOSA1017I			(Purchased Reagent)		13C8 FOSA	50 ug/mL
..LCMPFBA_00015	02/16/23	Wellington Laboratories, Lot MPFBA0218			(Purchased Reagent)		13C4 PFBA	50 ug/mL
..LCMPFBS_00008	02/15/23	Wellington Laboratories, Lot M3PFBS0218			(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
..LCMPFDA_00020	02/16/23	Wellington Laboratories, Lot MPFDA0218			(Purchased Reagent)		13C2 PFDA	50 ug/mL
..LCMPFDoA_00015	02/16/23	Wellington Laboratories, Lot MPFDoA0218			(Purchased Reagent)		13C2 PFDoA	50 ug/mL
..LCMPFHxA_00022	10/27/22	Wellington Laboratories, Lot MPFHxA1017			(Purchased Reagent)		13C2 PFHxA	50 ug/mL
..LCMPFHxS_00015	03/22/23	Wellington Laboratories, Lot MPFHxS0318			(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
..LCMPFNA_00015	12/14/22	Wellington Laboratories, Lot MPFNA1217			(Purchased Reagent)		13C5 PFNA	50 ug/mL
..LCMPFOA_00019	05/04/23	Wellington Laboratories, Lot MPFOA0418			(Purchased Reagent)		13C4 PFOA	50 ug/mL
..LCMPFOS_00027	02/15/23	Wellington Laboratories, Lot MPFOS0218			(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
..LCMPFUdA_00017	11/22/21	Wellington Laboratories, Lot MPFUdA1116			(Purchased Reagent)		13C2 PFUnA	50 ug/mL
.LCPFCSP_00148	11/18/18	05/17/18	Methanol, Lot 090285	10 mL	LC4:2FTS_00005	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.467 ug/mL
					LC6:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.474 ug/mL
					LC8:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.479 ug/mL
					LCbr-NEtFOSAA_00001	100 uL	N-ethyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCbr-NMeFOSAA_00001	100 uL	N-methyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCPFBA_00008	100 uL	Perfluorobutyric acid	0.5 ug/mL
					LCPFBS_00009	100 uL	Perfluorobutanesulfonic acid (PFBS)	0.442 ug/mL
					LCPFDA_00008	100 uL	Perfluorodecanoic acid	0.5 ug/mL
					LCPFDoA_00008	100 uL	Perfluorododecanoic acid	0.5 ug/mL
					LCPFDS_00008	100 uL	Perfluorodecane Sulfonic acid	0.482 ug/mL
					LCPFHpA_00011	100 uL	Perfluoroheptanoic acid (PFHpA)	0.5 ug/mL
					LCPFHpSA_00003	100 uL	Perfluoroheptanesulfonic acid	0.476 ug/mL
					LCPFHxA_00010	100 uL	Perfluorohexanoic acid	0.5 ug/mL
					LCPFHxS-br_00006	100 uL	Perfluorohexanesulfonic acid (PFHxS)	0.455 ug/mL
					LCPFNA_00010	100 uL	Perfluorononanoic acid (PFNA)	0.5 ug/mL
							Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFNS_00003	100 uL	Perfluorononanesulfonic acid	0.48 ug/mL
					LCPFOA_00011	100 uL	Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFOS-br_00007	100 uL	Perfluorooctanesulfonic acid (PFOS)	0.464 ug/mL
					LCPFOSA_00013	100 uL	Perfluorooctane Sulfonamide	0.5 ug/mL
					LCPFPeA_00008	100 uL	Perfluoropentanoic acid	0.5 ug/mL
					LCPFPeS_00003	100 uL	Perfluoropentanesulfonic acid	0.469 ug/mL
					LCPFTeDA_00008	100 uL	Perfluorotetradecanoic acid	0.5 ug/mL
					LCPFTrDA_00008	100 uL	Perfluorotridecanoic acid	0.5 ug/mL
					LCPFUdA_00008	100 uL	Perfluoroundecanoic acid	0.5 ug/mL
..LC4:2FTS_00005	12/12/21	WELLINGTON, Lot 42FTS1216			(Purchased Reagent)		1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	46.7 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
..LC6:2FTS_00007	04/20/22		WELLINGTON, Lot 62FTS0417		(Purchased Reagent)		1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	47.4 ug/mL
..LC8:2FTS_00007	12/12/21		WELLINGTON, Lot 82FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	47.9 ug/mL
..LCbr-NEtFOSAA_00001	01/17/23		WELLINGTON, Lot brNEtFOSAA0118		(Purchased Reagent)		N-ethyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCbr-NMeFOSAA_00001	01/17/23		WELLINGTON, Lot brNMeFOSAA0118		(Purchased Reagent)		N-methyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCPFBA_00008	05/29/22		Wellington Laboratories, Lot PFBA0517		(Purchased Reagent)		Perfluorobutyric acid	50 ug/mL
..LCPFBS_00009	09/21/22		Wellington Laboratories, Lot LPFBS0917		(Purchased Reagent)		Perfluorobutanesulfonic acid (PFBS)	44.2 ug/mL
..LCPFDA_00008	05/29/22		Wellington Laboratories, Lot PFDA0517		(Purchased Reagent)		Perfluorodecanoic acid	50 ug/mL
..LCPFDoA_00008	05/29/22		Wellington Laboratories, Lot PFDoA0517		(Purchased Reagent)		Perfluorododecanoic acid	50 ug/mL
..LCPFDS_00008	11/08/22		Wellington Laboratories, Lot LPFDS1117		(Purchased Reagent)		Perfluorodecane Sulfonic acid	48.2 ug/mL
..LCPFHpA_00011	09/27/22		Wellington Laboratories, Lot PFHpA0917		(Purchased Reagent)		Perfluoroheptanoic acid (PFHpA)	50 ug/mL
..LCPFHpSA_00003	09/01/22		Wellington Laboratories, Lot LPFHpS0817		(Purchased Reagent)		Perfluoroheptanesulfonic acid	47.6 ug/mL
..LCPFHxA_00010	09/27/22		Wellington Laboratories, Lot PFHxA0917		(Purchased Reagent)		Perfluorohexanoic acid	50 ug/mL
..LCPFHxS-br_00006	01/04/22		Wellington Laboratories, Lot brPFHxSK0117		(Purchased Reagent)		Perfluorohexanesulfonic acid (PFHxS)	45.5 ug/mL
..LCPFNA_00010	07/20/22		Wellington Laboratories, Lot PFNA0717		(Purchased Reagent)		Perfluorononanoic acid (PFNA)	50 ug/mL
							Perfluorooctanoic acid (PFOA)	0.05 ug/mL
..LCPFNS_00003	09/27/22		Wellington Laboratories, Lot LPFNS0917		(Purchased Reagent)		Perfluorononanesulfonic acid	48 ug/mL
..LCPFOA_00011	09/27/22		Wellington Laboratories, Lot PFOA0917		(Purchased Reagent)		Perfluorooctanoic acid (PFOA)	50 ug/mL
..LCPFOS-br_00007	01/12/22		Wellington Laboratories, Lot brPFOSK0117		(Purchased Reagent)		Perfluorooctanesulfonic acid (PFOS)	46.4 ug/mL
..LCPFOSA_00013	09/01/22		Wellington Laboratories, Lot FOSA0817I		(Purchased Reagent)		Perfluorooctane Sulfonamide	50 ug/mL
..LCPFPeA_00008	06/14/22		Wellington Laboratories, Lot PFPeA0617		(Purchased Reagent)		Perfluoropentanoic acid	50 ug/mL
..LCPFPeS_00003	01/11/22		Wellington Laboratories, Lot LPFPeS0117		(Purchased Reagent)		Perfluoropentanesulfonic acid	46.9 ug/mL
..LCPFTeDA_00008	09/30/21		Wellington Laboratories, Lot PFTeDA0916		(Purchased Reagent)		Perfluorotetradecanoic acid	50 ug/mL
..LCPFTrDA_00008	05/02/22		Wellington Laboratories, Lot PFTrDA0517		(Purchased Reagent)		Perfluorotridecanoic acid	50 ug/mL
..LCPFUdA_00008	10/18/21		Wellington Laboratories, Lot PFUdA1016		(Purchased Reagent)		Perfluoroundecanoic acid	50 ug/mL
LCPFC_LL4_00005	11/18/18	06/05/18	MeOH/H2O, Lot 090285	200 mL	LCMPFC_ALL_SU_00075	10 mL	d3-NMeFOSAA	2.5 ng/mL
							d5-NEtFOSAA	2.5 ng/mL
							M2-6:2FTS	2.375 ng/mL
							M2-8:2FTS	2.395 ng/mL
							13C2-PFHxDA	2.5 ng/mL
							13C2-PFOA	2.5 ng/mL
							13C2-PFTeDA	2.5 ng/mL
							13C4-PFHpA	2.5 ng/mL
							13C5-PFPeA	2.5 ng/mL
							13C8 FOSA	2.5 ng/mL
							13C4 PFBA	2.5 ng/mL
							13C3-PFBS	2.325 ng/mL
							13C2 PFDA	2.5 ng/mL
							13C2 PFDoA	2.5 ng/mL
							13C2 PFHxA	2.5 ng/mL
							18O2 PFHxS	2.365 ng/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent Reagent ID	Parent Reagent Volume Added	Analyte	Concentration
							13C5 PFNA	2.5 ng/mL
							13C4 PFOA	2.5 ng/mL
							13C4 PFOS	2.39 ng/mL
							13C2 PFUnA	2.5 ng/mL
					LCPFCSP_00148	400 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.934 ng/mL
							1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.948 ng/mL
							1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.958 ng/mL
							N-ethyl perfluorooctane sulfonamidoacetic acid	1 ng/mL
							N-methyl perfluorooctane sulfonamidoacetic acid	1 ng/mL
							Perfluorobutyric acid	1 ng/mL
							Perfluorobutanesulfonic acid (PFBS)	0.884 ng/mL
							Perfluorodecanoic acid	1 ng/mL
							Perfluorododecanoic acid	1 ng/mL
							Perfluorodecane Sulfonic acid	0.964 ng/mL
							Perfluoroheptanoic acid (PFHpA)	1 ng/mL
							Perfluoroheptanesulfonic acid	0.952 ng/mL
							Perfluorohexanoic acid	1 ng/mL
							Perfluorohexanesulfonic acid (PFHxS)	0.91 ng/mL
							Perfluorononanoic acid (PFNA)	1 ng/mL
							Perfluorooctanoic acid (PFOA)	1.001 ng/mL
							Perfluorononanesulfonic acid	0.96 ng/mL
							Perfluorooctanesulfonic acid (PFOS)	0.928 ng/mL
							Perfluorooctane Sulfonamide	1 ng/mL
							Perfluoropentanoic acid	1 ng/mL
							Perfluoropentanesulfonic acid	0.938 ng/mL
							Perfluorotetradecanoic acid	1 ng/mL
							Perfluorotridecanoic acid	1 ng/mL
							Perfluoroundecanoic acid	1 ng/mL
.LCMPFC_ALL_SU_00075	12/05/18	06/05/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
..LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
..LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
..LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
..LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
..LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
..LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
..LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
..LCM4PFHPA_00014	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL
..LCM5PFPEA_00015	07/20/22		Wellington Laboratories, Lot M5PFPeA0717		(Purchased Reagent)		13C5-PFPeA	50 ug/mL
..LCM8FOSA_00019	10/11/22		Wellington Laboratories, Lot M8FOSA1017I		(Purchased Reagent)		13C8 FOSA	50 ug/mL
..LCMPFBA_00015	02/16/23		Wellington Laboratories, Lot MPFBA0218		(Purchased Reagent)		13C4 PFBA	50 ug/mL
..LCMPFBS_00008	02/15/23		Wellington Laboratories, Lot M3PFBS0218		(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
..LCMPFDA_00020	02/16/23		Wellington Laboratories, Lot MPFDA0218		(Purchased Reagent)		13C2 PFDA	50 ug/mL
..LCMPFDoA_00015	02/16/23		Wellington Laboratories, Lot MPFDoA0218		(Purchased Reagent)		13C2 PFDoA	50 ug/mL
..LCMPFHxA_00022	10/27/22		Wellington Laboratories, Lot MPFHxA1017		(Purchased Reagent)		13C2 PFHxA	50 ug/mL
..LCMPFHxS_00015	03/22/23		Wellington Laboratories, Lot MPFHxS0318		(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
..LCMPFNA_00015	12/14/22		Wellington Laboratories, Lot MPFNA1217		(Purchased Reagent)		13C5 PFNA	50 ug/mL
..LCMPFOA_00019	05/04/23		Wellington Laboratories, Lot MPFOA0418		(Purchased Reagent)		13C4 PFOA	50 ug/mL
..LCMPFOS_00027	02/15/23		Wellington Laboratories, Lot MPFOS0218		(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
..LCMPFUdA_00017	11/22/21		Wellington Laboratories, Lot MPFUdA1116		(Purchased Reagent)		13C2 PFUnA	50 ug/mL
.LCPFCSP_00148	11/18/18	05/17/18	Methanol, Lot 090285	10 mL	LC4:2FTS_00005	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.467 ug/mL
					LC6:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.474 ug/mL
					LC8:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.479 ug/mL
					LCbr-NEtFOSAA_00001	100 uL	N-ethyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCbr-NMeFOSAA_00001	100 uL	N-methyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCPFBA_00008	100 uL	Perfluorobutyric acid	0.5 ug/mL
					LCPFBS_00009	100 uL	Perfluorobutanesulfonic acid (PFBS)	0.442 ug/mL
					LCPFDA_00008	100 uL	Perfluorodecanoic acid	0.5 ug/mL
					LCPFDoA_00008	100 uL	Perfluorododecanoic acid	0.5 ug/mL
					LCPFDS_00008	100 uL	Perfluorodecane Sulfonic acid	0.482 ug/mL
					LCPFHpA_00011	100 uL	Perfluoroheptanoic acid (PFHpA)	0.5 ug/mL
					LCPFHpSA_00003	100 uL	Perfluoroheptanesulfonic acid	0.476 ug/mL
					LCPFHxA_00010	100 uL	Perfluorohexanoic acid	0.5 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LCPFHxS-br_00006	100 uL	Perfluorohexanesulfonic acid (PFHxS)	0.455 ug/mL
					LCPFNA_00010	100 uL	Perfluorononanoic acid (PFNA)	0.5 ug/mL
							Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFNS_00003	100 uL	Perfluorononanesulfonic acid	0.48 ug/mL
					LCPFOA_00011	100 uL	Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFOS-br_00007	100 uL	Perfluorooctanesulfonic acid (PFOS)	0.464 ug/mL
					LCPFOSA_00013	100 uL	Perfluorooctane Sulfonamide	0.5 ug/mL
					LCPFPeA_00008	100 uL	Perfluoropentanoic acid	0.5 ug/mL
					LCPFPeS_00003	100 uL	Perfluoropentanesulfonic acid	0.469 ug/mL
					LCPFTeDA_00008	100 uL	Perfluorotetradecanoic acid	0.5 ug/mL
					LCPFTrDA_00008	100 uL	Perfluorotridecanoic acid	0.5 ug/mL
					LCPFUdA_00008	100 uL	Perfluoroundecanoic acid	0.5 ug/mL
..LC4:2FTS_00005	12/12/21		WELLINGTON, Lot 42FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	46.7 ug/mL
..LC6:2FTS_00007	04/20/22		WELLINGTON, Lot 62FTS0417		(Purchased Reagent)		1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	47.4 ug/mL
..LC8:2FTS_00007	12/12/21		WELLINGTON, Lot 82FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	47.9 ug/mL
..LCbr-NEtFOSAA_00001	01/17/23		WELLINGTON, Lot brNEtFOSAA0118		(Purchased Reagent)		N-ethyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCbr-NMeFOSAA_00001	01/17/23		WELLINGTON, Lot brNMeFOSAA0118		(Purchased Reagent)		N-methyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCPFBA_00008	05/29/22		Wellington Laboratories, Lot PFBA0517		(Purchased Reagent)		Perfluorobutyric acid	50 ug/mL
..LCPFBS_00009	09/21/22		Wellington Laboratories, Lot LPFBS0917		(Purchased Reagent)		Perfluorobutanesulfonic acid (PFBS)	44.2 ug/mL
..LCPFDA_00008	05/29/22		Wellington Laboratories, Lot PFDA0517		(Purchased Reagent)		Perfluorodecanoic acid	50 ug/mL
..LCPFDoA_00008	05/29/22		Wellington Laboratories, Lot PFDoA0517		(Purchased Reagent)		Perfluorododecanoic acid	50 ug/mL
..LCPFDS_00008	11/08/22		Wellington Laboratories, Lot LPFDS1117		(Purchased Reagent)		Perfluorodecane Sulfonic acid	48.2 ug/mL
..LCPFHpA_00011	09/27/22		Wellington Laboratories, Lot PFHpA0917		(Purchased Reagent)		Perfluoroheptanoic acid (PFHpA)	50 ug/mL
..LCPFHpSA_00003	09/01/22		Wellington Laboratories, Lot LPFHpS0817		(Purchased Reagent)		Perfluoroheptanesulfonic acid	47.6 ug/mL
..LCPFHxA_00010	09/27/22		Wellington Laboratories, Lot PFHxA0917		(Purchased Reagent)		Perfluorohexanoic acid	50 ug/mL
..LCPFHxS-br_00006	01/04/22		Wellington Laboratories, Lot brPFHxSK0117		(Purchased Reagent)		Perfluorohexanesulfonic acid (PFHxS)	45.5 ug/mL
..LCPFNA_00010	07/20/22		Wellington Laboratories, Lot PFNA0717		(Purchased Reagent)		Perfluorononanoic acid (PFNA)	50 ug/mL
							Perfluorooctanoic acid (PFOA)	0.05 ug/mL
..LCPFNS_00003	09/27/22		Wellington Laboratories, Lot LPFNS0917		(Purchased Reagent)		Perfluorononanesulfonic acid	48 ug/mL
..LCPFOA_00011	09/27/22		Wellington Laboratories, Lot PFOA0917		(Purchased Reagent)		Perfluorooctanoic acid (PFOA)	50 ug/mL
..LCPFOS-br_00007	01/12/22		Wellington Laboratories, Lot brPFOSK0117		(Purchased Reagent)		Perfluorooctanesulfonic acid (PFOS)	46.4 ug/mL
..LCPFOSA_00013	09/01/22		Wellington Laboratories, Lot FOSA0817I		(Purchased Reagent)		Perfluorooctane Sulfonamide	50 ug/mL
..LCPFPeA_00008	06/14/22		Wellington Laboratories, Lot PFPeA0617		(Purchased Reagent)		Perfluoropentanoic acid	50 ug/mL
..LCPFPeS_00003	01/11/22		Wellington Laboratories, Lot LPFPeS0117		(Purchased Reagent)		Perfluoropentanesulfonic acid	46.9 ug/mL
..LCPFTeDA_00008	09/30/21		Wellington Laboratories, Lot PFTeDA0916		(Purchased Reagent)		Perfluorotetradecanoic acid	50 ug/mL
..LCPFTrDA_00008	05/02/22		Wellington Laboratories, Lot PFTrDA0517		(Purchased Reagent)		Perfluorotridecanoic acid	50 ug/mL
..LCPFUdA_00008	10/18/21		Wellington Laboratories, Lot PFUdA1016		(Purchased Reagent)		Perfluoroundecanoic acid	50 ug/mL
LCPFC_LL5_00005	11/18/18	06/05/18	MeOH/H2O, Lot 090285	200 mL	LCMPFC_ALL_SU_00075	10 mL	d3-NMeFOSAA	2.5 ng/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							d5-NEtFOSAA	2.5 ng/mL
							M2-6:2FTS	2.375 ng/mL
							M2-8:2FTS	2.395 ng/mL
							13C2-PFHxDA	2.5 ng/mL
							13C2-PFOA	2.5 ng/mL
							13C2-PFTeDA	2.5 ng/mL
							13C4-PFHpA	2.5 ng/mL
							13C5-PFPeA	2.5 ng/mL
							13C8 FOSA	2.5 ng/mL
							13C4 PFBA	2.5 ng/mL
							13C3-PFBS	2.325 ng/mL
							13C2 PFDA	2.5 ng/mL
							13C2 PFDoA	2.5 ng/mL
							13C2 PFHxA	2.5 ng/mL
							18O2 PFHxS	2.365 ng/mL
							13C5 PFNA	2.5 ng/mL
							13C4 PFOA	2.5 ng/mL
							13C4 PFOS	2.39 ng/mL
							13C2 PFUnA	2.5 ng/mL
					LCPFCSP_00148	1000 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	2.335 ng/mL
							1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	2.37 ng/mL
							1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	2.395 ng/mL
							N-ethyl perfluorooctane sulfonamidoacetic acid	2.5 ng/mL
							N-methyl perfluorooctane sulfonamidoacetic acid	2.5 ng/mL
							Perfluorobutyric acid	2.5 ng/mL
							Perfluorobutanesulfonic acid (PFBS)	2.21 ng/mL
							Perfluorodecanoic acid	2.5 ng/mL
							Perfluorododecanoic acid	2.5 ng/mL
							Perfluorodecane Sulfonic acid	2.41 ng/mL
							Perfluoroheptanoic acid (PFHpA)	2.5 ng/mL
							Perfluoroheptanesulfonic acid	2.38 ng/mL
							Perfluorohexanoic acid	2.5 ng/mL
							Perfluorohexanesulfonic acid (PFHxS)	2.275 ng/mL
							Perfluorononanoic acid (PFNA)	2.5 ng/mL
							Perfluorooctanoic acid (PFOA)	2.5025 ng/mL
							Perfluorononanesulfonic acid	2.4 ng/mL
							Perfluorooctanesulfonic acid (PFOS)	2.32 ng/mL
							Perfluorooctane Sulfonamide	2.5 ng/mL
							Perfluoropentanoic acid	2.5 ng/mL
							Perfluoropentanesulfonic acid	2.345 ng/mL

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							Perfluorotetradecanoic acid	2.5 ng/mL
							Perfluorotridecanoic acid	2.5 ng/mL
							Perfluoroundecanoic acid	2.5 ng/mL
.LCMPFC_ALL_SU_00075	12/05/18	06/05/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
..LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
..LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
..LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
..LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
..LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
..LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
..LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
..LCM4PFHPA_00014	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL
..LCM5PFPEA_00015	07/20/22		Wellington Laboratories, Lot M5PFPeA0717		(Purchased Reagent)		13C5-PFPeA	50 ug/mL
..LCM8FOSA_00019	10/11/22		Wellington Laboratories, Lot M8FOSA1017I		(Purchased Reagent)		13C8 FOSA	50 ug/mL
..LCMPFBA_00015	02/16/23		Wellington Laboratories, Lot MPFBA0218		(Purchased Reagent)		13C4 PFBA	50 ug/mL
..LCMPFBS_00008	02/15/23		Wellington Laboratories, Lot M3PFBS0218		(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
..LCMPFDA_00020	02/16/23		Wellington Laboratories, Lot MPFDA0218		(Purchased Reagent)		13C2 PFDA	50 ug/mL
..LCMPFDoA_00015	02/16/23		Wellington Laboratories, Lot MPFDoA0218		(Purchased Reagent)		13C2 PFDoA	50 ug/mL
..LCMPFHxA_00022	10/27/22		Wellington Laboratories, Lot MPFHxA1017		(Purchased Reagent)		13C2 PFHxA	50 ug/mL
..LCMPFHxS_00015	03/22/23		Wellington Laboratories, Lot MPFHxS0318		(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
..LCMPFNA_00015	12/14/22		Wellington Laboratories, Lot MPFNA1217		(Purchased Reagent)		13C5 PFNA	50 ug/mL
..LCMPFOA_00019	05/04/23		Wellington Laboratories, Lot MPFOA0418		(Purchased Reagent)		13C4 PFOA	50 ug/mL
..LCMPFOS_00027	02/15/23		Wellington Laboratories, Lot MPFOS0218		(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
..LCMPFUdA_00017	11/22/21		Wellington Laboratories, Lot MPFUdA1116		(Purchased Reagent)		13C2 PFUnA	50 ug/mL
.LCPFCSP_00148	11/18/18	05/17/18	Methanol, Lot 090285	10 mL	LC4:2FTS_00005	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.467 ug/mL
					LC6:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.474 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LC8:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.479 ug/mL
					LCbr-NEtFOSAA_00001	100 uL	N-ethyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCbr-NMeFOSAA_00001	100 uL	N-methyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCPFBA_00008	100 uL	Perfluorobutyric acid	0.5 ug/mL
					LCPFBS_00009	100 uL	Perfluorobutanesulfonic acid (PFBS)	0.442 ug/mL
					LCPFDA_00008	100 uL	Perfluorodecanoic acid	0.5 ug/mL
					LCPFDoA_00008	100 uL	Perfluorododecanoic acid	0.5 ug/mL
					LCPFDS_00008	100 uL	Perfluorodecane Sulfonic acid	0.482 ug/mL
					LCPFHpA_00011	100 uL	Perfluoroheptanoic acid (PFHpA)	0.5 ug/mL
					LCPFHpSA_00003	100 uL	Perfluoroheptanesulfonic acid	0.476 ug/mL
					LCPFHxA_00010	100 uL	Perfluorohexanoic acid	0.5 ug/mL
					LCPFHxS-br_00006	100 uL	Perfluorohexanesulfonic acid (PFHxS)	0.455 ug/mL
					LCPFNA_00010	100 uL	Perfluorononanoic acid (PFNA)	0.5 ug/mL
							Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFNS_00003	100 uL	Perfluorononanesulfonic acid	0.48 ug/mL
					LCPFOA_00011	100 uL	Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFOS-br_00007	100 uL	Perfluorooctanesulfonic acid (PFOS)	0.464 ug/mL
					LCPFOSA_00013	100 uL	Perfluorooctane Sulfonamide	0.5 ug/mL
					LCPFPeA_00008	100 uL	Perfluoropentanoic acid	0.5 ug/mL
					LCPFPeS_00003	100 uL	Perfluoropentanesulfonic acid	0.469 ug/mL
					LCPFTeDA_00008	100 uL	Perfluorotetradecanoic acid	0.5 ug/mL
					LCPFTrDA_00008	100 uL	Perfluorotridecanoic acid	0.5 ug/mL
					LCPFUdA_00008	100 uL	Perfluoroundecanoic acid	0.5 ug/mL
..LC4:2FTS_00005	12/12/21		WELLINGTON, Lot 42FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	46.7 ug/mL
..LC6:2FTS_00007	04/20/22		WELLINGTON, Lot 62FTS0417		(Purchased Reagent)		1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	47.4 ug/mL
..LC8:2FTS_00007	12/12/21		WELLINGTON, Lot 82FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	47.9 ug/mL
..LCbr-NEtFOSAA_00001	01/17/23		WELLINGTON, Lot brNEtFOSAA0118		(Purchased Reagent)		N-ethyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCbr-NMeFOSAA_00001	01/17/23		WELLINGTON, Lot brNMeFOSAA0118		(Purchased Reagent)		N-methyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCPFBA_00008	05/29/22		Wellington Laboratories, Lot PFBA0517		(Purchased Reagent)		Perfluorobutyric acid	50 ug/mL
..LCPFBS_00009	09/21/22		Wellington Laboratories, Lot LPFBS0917		(Purchased Reagent)		Perfluorobutanesulfonic acid (PFBS)	44.2 ug/mL
..LCPFDA_00008	05/29/22		Wellington Laboratories, Lot PFDA0517		(Purchased Reagent)		Perfluorodecanoic acid	50 ug/mL
..LCPFDoA_00008	05/29/22		Wellington Laboratories, Lot PFDoA0517		(Purchased Reagent)		Perfluorododecanoic acid	50 ug/mL
..LCPFDS_00008	11/08/22		Wellington Laboratories, Lot LPFDS1117		(Purchased Reagent)		Perfluorodecane Sulfonic acid	48.2 ug/mL
..LCPFHpA_00011	09/27/22		Wellington Laboratories, Lot PFHpA0917		(Purchased Reagent)		Perfluoroheptanoic acid (PFHpA)	50 ug/mL
..LCPFHpSA_00003	09/01/22		Wellington Laboratories, Lot LPFHpS0817		(Purchased Reagent)		Perfluoroheptanesulfonic acid	47.6 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
..LCPFHxA_00010	09/27/22	Wellington Laboratories, Lot PFHxA0917			(Purchased Reagent)		Perfluorohexanoic acid	50 ug/mL
..LCPFHxS-br_00006	01/04/22	Wellington Laboratories, Lot brPFHxSK0117			(Purchased Reagent)		Perfluorohexanesulfonic acid (PFHxS)	45.5 ug/mL
..LCPFNA_00010	07/20/22	Wellington Laboratories, Lot PFNA0717			(Purchased Reagent)		Perfluorononanoic acid (PFNA)	50 ug/mL
							Perfluorooctanoic acid (PFOA)	0.05 ug/mL
..LCPFNS_00003	09/27/22	Wellington Laboratories, Lot LPFNS0917			(Purchased Reagent)		Perfluorononanesulfonic acid	48 ug/mL
..LCPFOA_00011	09/27/22	Wellington Laboratories, Lot PFOA0917			(Purchased Reagent)		Perfluorooctanoic acid (PFOA)	50 ug/mL
..LCPFOS-br_00007	01/12/22	Wellington Laboratories, Lot brPFOSK0117			(Purchased Reagent)		Perfluorooctanesulfonic acid (PFOS)	46.4 ug/mL
..LCPFOSA_00013	09/01/22	Wellington Laboratories, Lot FOSA0817I			(Purchased Reagent)		Perfluorooctane Sulfonamide	50 ug/mL
..LCPFPeA_00008	06/14/22	Wellington Laboratories, Lot PFPeA0617			(Purchased Reagent)		Perfluoropentanoic acid	50 ug/mL
..LCPFPeS_00003	01/11/22	Wellington Laboratories, Lot LPFPeS0117			(Purchased Reagent)		Perfluoropentanesulfonic acid	46.9 ug/mL
..LCPFTeDA_00008	09/30/21	Wellington Laboratories, Lot PFTeDA0916			(Purchased Reagent)		Perfluorotetradecanoic acid	50 ug/mL
..LCPFTrDA_00008	05/02/22	Wellington Laboratories, Lot PFTrDA0517			(Purchased Reagent)		Perfluorotridecanoic acid	50 ug/mL
..LCPFUdA_00008	10/18/21	Wellington Laboratories, Lot PFUdA1016			(Purchased Reagent)		Perfluoroundecanoic acid	50 ug/mL
LCPFC_LL6_00006	11/18/18	06/05/18	MeOH/H2O, Lot 090285	200 mL	LCMPFC_ALL_SU_00075	10 mL	d3-NMeFOSAA	2.5 ng/mL
							d5-NEtFOSAA	2.5 ng/mL
							M2-6:2FTS	2.375 ng/mL
							M2-8:2FTS	2.395 ng/mL
							13C2-PFHxDA	2.5 ng/mL
							13C2-PFOA	2.5 ng/mL
							13C2-PFTeDA	2.5 ng/mL
							13C4-PFHpA	2.5 ng/mL
							13C5-PFPeA	2.5 ng/mL
							13C8 FOSA	2.5 ng/mL
							13C4 PFBA	2.5 ng/mL
							13C3-PFBS	2.325 ng/mL
							13C2 PFDA	2.5 ng/mL
							13C2 PFDoA	2.5 ng/mL
							13C2 PFHxA	2.5 ng/mL
							18O2 PFHxS	2.365 ng/mL
							13C5 PFNA	2.5 ng/mL
							13C4 PFOA	2.5 ng/mL
							13C4 PFOS	2.39 ng/mL
							13C2 PFUnA	2.5 ng/mL
					LCPFCSP_00148	2 mL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	4.67 ng/mL
							1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	4.74 ng/mL
							1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	4.79 ng/mL
							N-ethyl perfluorooctane sulfonamidoacetic acid	5 ng/mL
							N-methyl perfluorooctane sulfonamidoacetic acid	5 ng/mL
							Perfluorobutyric acid	5 ng/mL
							Perfluorobutanesulfonic acid (PFBS)	4.42 ng/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento   Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							Perfluorodecanoic acid	5 ng/mL
							Perfluorododecanoic acid	5 ng/mL
							Perfluorodecane Sulfonic acid	4.82 ng/mL
							Perfluoroheptanoic acid (PFHpA)	5 ng/mL
							Perfluoroheptanesulfonic acid	4.76 ng/mL
							Perfluorohexanoic acid	5 ng/mL
							Perfluorohexanesulfonic acid (PFHxS)	4.55 ng/mL
							Perfluorononanoic acid (PFNA)	5 ng/mL
							Perfluorooctanoic acid (PFOA)	5.005 ng/mL
							Perfluorononanesulfonic acid	4.8 ng/mL
							Perfluorooctanesulfonic acid (PFOS)	4.64 ng/mL
							Perfluorooctane Sulfonamide	5 ng/mL
							Perfluoropentanoic acid	5 ng/mL
							Perfluoropentanesulfonic acid	4.69 ng/mL
							Perfluorotetradecanoic acid	5 ng/mL
							Perfluorotridecanoic acid	5 ng/mL
							Perfluoroundecanoic acid	5 ng/mL
.LCMPFC_ALL_SU_00075	12/05/18	06/05/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
..LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
..LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
..LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
..LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
..LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
..LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
..LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
..LCM4PFHPA_00014	05/03/22	Wellington Laboratories, Lot M4PFHpA0517			(Purchased Reagent)		13C4-PFHpA	50 ug/mL
..LCM5PFPEA_00015	07/20/22	Wellington Laboratories, Lot M5PFPeA0717			(Purchased Reagent)		13C5-PFPeA	50 ug/mL
..LCM8FOSA_00019	10/11/22	Wellington Laboratories, Lot M8FOSA1017I			(Purchased Reagent)		13C8 FOSA	50 ug/mL
..LCMPFBA_00015	02/16/23	Wellington Laboratories, Lot MPFBA0218			(Purchased Reagent)		13C4 PFBA	50 ug/mL
..LCMPFBS_00008	02/15/23	Wellington Laboratories, Lot M3PFBS0218			(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
..LCMPFDA_00020	02/16/23	Wellington Laboratories, Lot MPFDA0218			(Purchased Reagent)		13C2 PFDA	50 ug/mL
..LCMPFDoA_00015	02/16/23	Wellington Laboratories, Lot MPFDoA0218			(Purchased Reagent)		13C2 PFDoA	50 ug/mL
..LCMPFHxA_00022	10/27/22	Wellington Laboratories, Lot MPFHxA1017			(Purchased Reagent)		13C2 PFHxA	50 ug/mL
..LCMPFHxS_00015	03/22/23	Wellington Laboratories, Lot MPFHxS0318			(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
..LCMPFNA_00015	12/14/22	Wellington Laboratories, Lot MPFNA1217			(Purchased Reagent)		13C5 PFNA	50 ug/mL
..LCMPFOA_00019	05/04/23	Wellington Laboratories, Lot MPFOA0418			(Purchased Reagent)		13C4 PFOA	50 ug/mL
..LCMPFOS_00027	02/15/23	Wellington Laboratories, Lot MPFOS0218			(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
..LCMPFUdA_00017	11/22/21	Wellington Laboratories, Lot MPFUdA1116			(Purchased Reagent)		13C2 PFUnA	50 ug/mL
.LCPFCSP_00148	11/18/18	05/17/18	Methanol, Lot 090285	10 mL	LC4:2FTS_00005	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.467 ug/mL
					LC6:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.474 ug/mL
					LC8:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.479 ug/mL
					LCbr-NEtFOSAA_00001	100 uL	N-ethyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCbr-NMeFOSAA_00001	100 uL	N-methyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCPFBA_00008	100 uL	Perfluorobutyric acid	0.5 ug/mL
					LCPFBS_00009	100 uL	Perfluorobutanesulfonic acid (PFBS)	0.442 ug/mL
					LCPFDA_00008	100 uL	Perfluorodecanoic acid	0.5 ug/mL
					LCPFDoA_00008	100 uL	Perfluorododecanoic acid	0.5 ug/mL
					LCPFDS_00008	100 uL	Perfluorodecane Sulfonic acid	0.482 ug/mL
					LCPFHpA_00011	100 uL	Perfluoroheptanoic acid (PFHpA)	0.5 ug/mL
					LCPFHpSA_00003	100 uL	Perfluoroheptanesulfonic acid	0.476 ug/mL
					LCPFHxA_00010	100 uL	Perfluorohexanoic acid	0.5 ug/mL
					LCPFHxS-br_00006	100 uL	Perfluorohexanesulfonic acid (PFHxS)	0.455 ug/mL
					LCPFNA_00010	100 uL	Perfluorononanoic acid (PFNA)	0.5 ug/mL
							Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFNS_00003	100 uL	Perfluorononanesulfonic acid	0.48 ug/mL
					LCPFOA_00011	100 uL	Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFOS-br_00007	100 uL	Perfluorooctanesulfonic acid (PFOS)	0.464 ug/mL
					LCPFOSA_00013	100 uL	Perfluorooctane Sulfonamide	0.5 ug/mL
					LCPFPeA_00008	100 uL	Perfluoropentanoic acid	0.5 ug/mL
					LCPFPeS_00003	100 uL	Perfluoropentanesulfonic acid	0.469 ug/mL
					LCPFTeDA_00008	100 uL	Perfluorotetradecanoic acid	0.5 ug/mL
					LCPFTrDA_00008	100 uL	Perfluorotridecanoic acid	0.5 ug/mL
					LCPFUdA_00008	100 uL	Perfluoroundecanoic acid	0.5 ug/mL
..LC4:2FTS_00005	12/12/21	WELLINGTON, Lot 42FTS1216			(Purchased Reagent)		1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	46.7 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
..LC6:2FTS_00007	04/20/22		WELLINGTON, Lot 62FTS0417		(Purchased Reagent)		1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	47.4 ug/mL
..LC8:2FTS_00007	12/12/21		WELLINGTON, Lot 82FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	47.9 ug/mL
..LCbr-NEtFOSAA_00001	01/17/23		WELLINGTON, Lot brNEtFOSAA0118		(Purchased Reagent)		N-ethyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCbr-NMeFOSAA_00001	01/17/23		WELLINGTON, Lot brNMeFOSAA0118		(Purchased Reagent)		N-methyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCPFBA_00008	05/29/22		Wellington Laboratories, Lot PFBA0517		(Purchased Reagent)		Perfluorobutyric acid	50 ug/mL
..LCPFBS_00009	09/21/22		Wellington Laboratories, Lot LPFBS0917		(Purchased Reagent)		Perfluorobutanesulfonic acid (PFBS)	44.2 ug/mL
..LCPFDA_00008	05/29/22		Wellington Laboratories, Lot PFDA0517		(Purchased Reagent)		Perfluorodecanoic acid	50 ug/mL
..LCPFDoA_00008	05/29/22		Wellington Laboratories, Lot PFDoA0517		(Purchased Reagent)		Perfluorododecanoic acid	50 ug/mL
..LCPFDS_00008	11/08/22		Wellington Laboratories, Lot LPFDS1117		(Purchased Reagent)		Perfluorodecane Sulfonic acid	48.2 ug/mL
..LCPFHpA_00011	09/27/22		Wellington Laboratories, Lot PFHpA0917		(Purchased Reagent)		Perfluoroheptanoic acid (PFHpA)	50 ug/mL
..LCPFHpSA_00003	09/01/22		Wellington Laboratories, Lot LPFHpS0817		(Purchased Reagent)		Perfluoroheptanesulfonic acid	47.6 ug/mL
..LCPFHxA_00010	09/27/22		Wellington Laboratories, Lot PFHxA0917		(Purchased Reagent)		Perfluorohexanoic acid	50 ug/mL
..LCPFHxS-br_00006	01/04/22		Wellington Laboratories, Lot brPFHxSK0117		(Purchased Reagent)		Perfluorohexanesulfonic acid (PFHxS)	45.5 ug/mL
..LCPFNA_00010	07/20/22		Wellington Laboratories, Lot PFNA0717		(Purchased Reagent)		Perfluorononanoic acid (PFNA)	50 ug/mL
							Perfluorooctanoic acid (PFOA)	0.05 ug/mL
..LCPFNS_00003	09/27/22		Wellington Laboratories, Lot LPFNS0917		(Purchased Reagent)		Perfluorononanesulfonic acid	48 ug/mL
..LCPFOA_00011	09/27/22		Wellington Laboratories, Lot PFOA0917		(Purchased Reagent)		Perfluorooctanoic acid (PFOA)	50 ug/mL
..LCPFOS-br_00007	01/12/22		Wellington Laboratories, Lot brPFOSK0117		(Purchased Reagent)		Perfluorooctanesulfonic acid (PFOS)	46.4 ug/mL
..LCPFOSA_00013	09/01/22		Wellington Laboratories, Lot FOSA0817I		(Purchased Reagent)		Perfluorooctane Sulfonamide	50 ug/mL
..LCPFPeA_00008	06/14/22		Wellington Laboratories, Lot PFPeA0617		(Purchased Reagent)		Perfluoropentanoic acid	50 ug/mL
..LCPFPeS_00003	01/11/22		Wellington Laboratories, Lot LPFPeS0117		(Purchased Reagent)		Perfluoropentanesulfonic acid	46.9 ug/mL
..LCPFTeDA_00008	09/30/21		Wellington Laboratories, Lot PFTeDA0916		(Purchased Reagent)		Perfluorotetradecanoic acid	50 ug/mL
..LCPFTrDA_00008	05/02/22		Wellington Laboratories, Lot PFTrDA0517		(Purchased Reagent)		Perfluorotridecanoic acid	50 ug/mL
..LCPFUdA_00008	10/18/21		Wellington Laboratories, Lot PFUdA1016		(Purchased Reagent)		Perfluoroundecanoic acid	50 ug/mL
LCPFC_LL7_00005	11/18/18	06/05/18	MeOH/H2O, Lot 090285	200 mL	LCMPFC_ALL_SU_00075	10 mL	d3-NMeFOSAA	2.5 ng/mL
							d5-NEtFOSAA	2.5 ng/mL
							M2-6:2FTS	2.375 ng/mL
							M2-8:2FTS	2.395 ng/mL
							13C2-PFHxDA	2.5 ng/mL
							13C2-PFOA	2.5 ng/mL
							13C2-PFTeDA	2.5 ng/mL
							13C4-PFHpA	2.5 ng/mL
							13C5-PFPeA	2.5 ng/mL
							13C8 FOSA	2.5 ng/mL
							13C4 PFBA	2.5 ng/mL
							13C3-PFBS	2.325 ng/mL
							13C2 PFDA	2.5 ng/mL
							13C2 PFDoA	2.5 ng/mL
							13C2 PFHxA	2.5 ng/mL
							18O2 PFHxS	2.365 ng/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							13C5 PFNA	2.5 ng/mL
							13C4 PFOA	2.5 ng/mL
							13C4 PFOS	2.39 ng/mL
							13C2 PFUnA	2.5 ng/mL
					LCPFCSP_00148	4 mL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	9.34 ng/mL
							1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	9.48 ng/mL
							1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	9.58 ng/mL
							N-ethyl perfluorooctane sulfonamidoacetic acid	10 ng/mL
							N-methyl perfluorooctane sulfonamidoacetic acid	10 ng/mL
							Perfluorobutyric acid	10 ng/mL
							Perfluorobutanesulfonic acid (PFBS)	8.84 ng/mL
							Perfluorodecanoic acid	10 ng/mL
							Perfluorododecanoic acid	10 ng/mL
							Perfluorodecane Sulfonic acid	9.64 ng/mL
							Perfluoroheptanoic acid (PFHpA)	10 ng/mL
							Perfluoroheptanesulfonic acid	9.52 ng/mL
							Perfluorohexanoic acid	10 ng/mL
							Perfluorohexanesulfonic acid (PFHxS)	9.1 ng/mL
							Perfluorononanoic acid (PFNA)	10 ng/mL
							Perfluorooctanoic acid (PFOA)	10.01 ng/mL
							Perfluorononanesulfonic acid	9.6 ng/mL
							Perfluorooctanesulfonic acid (PFOS)	9.28 ng/mL
							Perfluorooctane Sulfonamide	10 ng/mL
							Perfluoropentanoic acid	10 ng/mL
							Perfluoropentanesulfonic acid	9.38 ng/mL
							Perfluorotetradecanoic acid	10 ng/mL
							Perfluorotridecanoic acid	10 ng/mL
							Perfluoroundecanoic acid	10 ng/mL
.LCMPFC_ALL_SU_00075	12/05/18	06/05/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00008	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00008	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00008	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00010	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00016	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
					LCM2PFTeDA_00014	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM4PFHPA_00014	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00015	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00019	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00015	200 uL	13C4 PFBA	0.05 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LCMPFBS_00008	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00020	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00015	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00022	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00015	200 uL	18O2 PFHxS	0.0473 ug/mL
					LCMPFNA_00015	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00019	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00027	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00017	200 uL	13C2 PFUnA	0.05 ug/mL
..LCd3-NMeFOSAA_00008	11/08/22		WELLINGTON, Lot d3NMeFOSAA1117		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
..LCd5-NEtFOSAA_00008	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
..LCM2-6:FTS_00008	02/16/23		WELLINGTON, Lot M262FTS0218		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
..LCM2-8:2FTS_00010	01/24/23		WELLINGTON, Lot M282FTS0118		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
..LCM2PFHxDA_00016	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
..LCM2PFOA_00008	02/12/21		Wellington Laboratories, Lot M2PFOA0216		(Purchased Reagent)		13C2-PFOA	50 ug/mL
..LCM2PFTeDA_00014	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
..LCM4PFHPA_00014	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL
..LCM5PFPEA_00015	07/20/22		Wellington Laboratories, Lot M5PFPeA0717		(Purchased Reagent)		13C5-PFPeA	50 ug/mL
..LCM8FOSA_00019	10/11/22		Wellington Laboratories, Lot M8FOSA1017I		(Purchased Reagent)		13C8 FOSA	50 ug/mL
..LCMPFBA_00015	02/16/23		Wellington Laboratories, Lot MPFBA0218		(Purchased Reagent)		13C4 PFBA	50 ug/mL
..LCMPFBS_00008	02/15/23		Wellington Laboratories, Lot M3PFBS0218		(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
..LCMPFDA_00020	02/16/23		Wellington Laboratories, Lot MPFDA0218		(Purchased Reagent)		13C2 PFDA	50 ug/mL
..LCMPFDoA_00015	02/16/23		Wellington Laboratories, Lot MPFDoA0218		(Purchased Reagent)		13C2 PFDoA	50 ug/mL
..LCMPFHxA_00022	10/27/22		Wellington Laboratories, Lot MPFHxA1017		(Purchased Reagent)		13C2 PFHxA	50 ug/mL
..LCMPFHxS_00015	03/22/23		Wellington Laboratories, Lot MPFHxS0318		(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
..LCMPFNA_00015	12/14/22		Wellington Laboratories, Lot MPFNA1217		(Purchased Reagent)		13C5 PFNA	50 ug/mL
..LCMPFOA_00019	05/04/23		Wellington Laboratories, Lot MPFOA0418		(Purchased Reagent)		13C4 PFOA	50 ug/mL
..LCMPFOS_00027	02/15/23		Wellington Laboratories, Lot MPFOS0218		(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
..LCMPFUdA_00017	11/22/21		Wellington Laboratories, Lot MPFUdA1116		(Purchased Reagent)		13C2 PFUnA	50 ug/mL
.LCPFCSP_00148	11/18/18	05/17/18	Methanol, Lot 090285	10 mL	LC4:2FTS_00005	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.467 ug/mL
					LC6:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.474 ug/mL
					LC8:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.479 ug/mL
					LCbr-NEtFOSAA_00001	100 uL	N-ethyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCbr-NMeFOSAA_00001	100 uL	N-methyl perfluorooctane sulfonamidoacetic acid	0.5 ug/mL
					LCPFBA_00008	100 uL	Perfluorobutyric acid	0.5 ug/mL
					LCPFBS_00009	100 uL	Perfluorobutanesulfonic acid (PFBS)	0.442 ug/mL
					LCPFDA_00008	100 uL	Perfluorodecanoic acid	0.5 ug/mL
					LCPFDoA_00008	100 uL	Perfluorododecanoic acid	0.5 ug/mL
					LCPFDS_00008	100 uL	Perfluorodecane Sulfonic acid	0.482 ug/mL
					LCPFHpA_00011	100 uL	Perfluoroheptanoic acid (PFHpA)	0.5 ug/mL
					LCPFHpSA_00003	100 uL	Perfluoroheptanesulfonic acid	0.476 ug/mL
					LCPFHxA_00010	100 uL	Perfluorohexanoic acid	0.5 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LCPFHxS-br_00006	100 uL	Perfluorohexanesulfonic acid (PFHxS)	0.455 ug/mL
					LCPFNA_00010	100 uL	Perfluorononanoic acid (PFNA)	0.5 ug/mL
							Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFNS_00003	100 uL	Perfluorononanesulfonic acid	0.48 ug/mL
					LCPFOA_00011	100 uL	Perfluorooctanoic acid (PFOA)	0.5005 ug/mL
					LCPFOS-br_00007	100 uL	Perfluorooctanesulfonic acid (PFOS)	0.464 ug/mL
					LCPFOSA_00013	100 uL	Perfluorooctane Sulfonamide	0.5 ug/mL
					LCPFPeA_00008	100 uL	Perfluoropentanoic acid	0.5 ug/mL
					LCPFPeS_00003	100 uL	Perfluoropentanesulfonic acid	0.469 ug/mL
					LCPFTeDA_00008	100 uL	Perfluorotetradecanoic acid	0.5 ug/mL
					LCPFTrDA_00008	100 uL	Perfluorotridecanoic acid	0.5 ug/mL
					LCPFUdA_00008	100 uL	Perfluoroundecanoic acid	0.5 ug/mL
..LC4:2FTS_00005	12/12/21		WELLINGTON, Lot 42FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	46.7 ug/mL
..LC6:2FTS_00007	04/20/22		WELLINGTON, Lot 62FTS0417		(Purchased Reagent)		1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	47.4 ug/mL
..LC8:2FTS_00007	12/12/21		WELLINGTON, Lot 82FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	47.9 ug/mL
..LCbr-NEtFOSAA_00001	01/17/23		WELLINGTON, Lot brNEtFOSAA0118		(Purchased Reagent)		N-ethyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCbr-NMeFOSAA_00001	01/17/23		WELLINGTON, Lot brNMeFOSAA0118		(Purchased Reagent)		N-methyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
..LCPFBA_00008	05/29/22		Wellington Laboratories, Lot PFBA0517		(Purchased Reagent)		Perfluorobutyric acid	50 ug/mL
..LCPFBS_00009	09/21/22		Wellington Laboratories, Lot LPFBS0917		(Purchased Reagent)		Perfluorobutanesulfonic acid (PFBS)	44.2 ug/mL
..LCPFDA_00008	05/29/22		Wellington Laboratories, Lot PFDA0517		(Purchased Reagent)		Perfluorodecanoic acid	50 ug/mL
..LCPFDoA_00008	05/29/22		Wellington Laboratories, Lot PFDoA0517		(Purchased Reagent)		Perfluorododecanoic acid	50 ug/mL
..LCPFDS_00008	11/08/22		Wellington Laboratories, Lot LPFDS1117		(Purchased Reagent)		Perfluorodecane Sulfonic acid	48.2 ug/mL
..LCPFHpA_00011	09/27/22		Wellington Laboratories, Lot PFHpA0917		(Purchased Reagent)		Perfluoroheptanoic acid (PFHpA)	50 ug/mL
..LCPFHpSA_00003	09/01/22		Wellington Laboratories, Lot LPFHpS0817		(Purchased Reagent)		Perfluoroheptanesulfonic acid	47.6 ug/mL
..LCPFHxA_00010	09/27/22		Wellington Laboratories, Lot PFHxA0917		(Purchased Reagent)		Perfluorohexanoic acid	50 ug/mL
..LCPFHxS-br_00006	01/04/22		Wellington Laboratories, Lot brPFHxSK0117		(Purchased Reagent)		Perfluorohexanesulfonic acid (PFHxS)	45.5 ug/mL
..LCPFNA_00010	07/20/22		Wellington Laboratories, Lot PFNA0717		(Purchased Reagent)		Perfluorononanoic acid (PFNA)	50 ug/mL
							Perfluorooctanoic acid (PFOA)	0.05 ug/mL
..LCPFNS_00003	09/27/22		Wellington Laboratories, Lot LPFNS0917		(Purchased Reagent)		Perfluorononanesulfonic acid	48 ug/mL
..LCPFOA_00011	09/27/22		Wellington Laboratories, Lot PFOA0917		(Purchased Reagent)		Perfluorooctanoic acid (PFOA)	50 ug/mL
..LCPFOS-br_00007	01/12/22		Wellington Laboratories, Lot brPFOSK0117		(Purchased Reagent)		Perfluorooctanesulfonic acid (PFOS)	46.4 ug/mL
..LCPFOSA_00013	09/01/22		Wellington Laboratories, Lot FOSA0817I		(Purchased Reagent)		Perfluorooctane Sulfonamide	50 ug/mL
..LCPFPeA_00008	06/14/22		Wellington Laboratories, Lot PFPeA0617		(Purchased Reagent)		Perfluoropentanoic acid	50 ug/mL
..LCPFPeS_00003	01/11/22		Wellington Laboratories, Lot LPFPeS0117		(Purchased Reagent)		Perfluoropentanesulfonic acid	46.9 ug/mL
..LCPFTeDA_00008	09/30/21		Wellington Laboratories, Lot PFTeDA0916		(Purchased Reagent)		Perfluorotetradecanoic acid	50 ug/mL
..LCPFTrDA_00008	05/02/22		Wellington Laboratories, Lot PFTrDA0517		(Purchased Reagent)		Perfluorotridecanoic acid	50 ug/mL
..LCPFUdA_00008	10/18/21		Wellington Laboratories, Lot PFUdA1016		(Purchased Reagent)		Perfluoroundecanoic acid	50 ug/mL
LCPFCIC_FULL_00011	07/02/18	02/22/18	MeOH/H2O, Lot 09285	200 mL	LCMPFC_ALL_SU_00041	10 mL	13C2-PFOA	2.5 ng/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent Reagent ID	Parent Reagent Volume Added	Analyte	Concentration
.LCMPFC_ALL_SU_00041	08/20/18	02/20/18	Methanol, Lot Baker 141039	200 mL	LCM2PFOA_00008	200 uL	13C2-PFOA	0.05 ug/mL
..LCM2PFOA_00008	02/12/21	Wellington Laboratories, Lot M2PFOA0216			(Purchased Reagent)		13C2-PFOA	50 ug/mL
LCPFCIC_FULL_00011	07/02/18	02/22/18	MeOH/H2O, Lot 09285	200 mL	LCMPFC_ALL_SU_00041	10 mL	d3-NMeFOSAA	2.5 ng/mL
							d5-NEtFOSAA	2.5 ng/mL
							M2-6:2FTS	2.375 ng/mL
							M2-8:2FTS	2.395 ng/mL
							13C2-PFHxDA	2.5 ng/mL
							13C2-PFTeDA	2.5 ng/mL
							13C4-PFHpA	2.5 ng/mL
							13C5-PFPeA	2.5 ng/mL
							13C8 FOSA	2.5 ng/mL
							13C4 PFBA	2.5 ng/mL
							13C3-PFBS	2.325 ng/mL
							13C2 PFDA	2.5 ng/mL
							13C2 PFDoA	2.5 ng/mL
							13C2 PFHxA	2.5 ng/mL
							18O2 PFHxS	2.365 ng/mL
							13C5 PFNA	2.5 ng/mL
							13C4 PFOA	2.5 ng/mL
							13C4 PFOS	2.39 ng/mL
							13C2 PFUnA	2.5 ng/mL
					LCPFAC-24PAR_00001	250 uL	Perfluorobutanesulfonic acid (PFBS)	2.2125 ng/mL
							Perfluoroheptanoic acid (PFHpA)	2.5 ng/mL
							Perfluorohexanesulfonic acid (PFHxS)	2.28 ng/mL
							Perfluorononanoic acid (PFNA)	2.5 ng/mL
							Perfluorooctanesulfonic acid (PFOS)	2.31375 ng/mL
							Perfluorooctanoic acid (PFOA)	2.5 ng/mL
.LCMPFC_ALL_SU_00041	08/20/18	02/20/18	Methanol, Lot Baker 141039	200 mL	LCd3-NMeFOSAA_00006	200 uL	d3-NMeFOSAA	0.05 ug/mL
					LCd5-NEtFOSAA_00006	200 uL	d5-NEtFOSAA	0.05 ug/mL
					LCM2-6:FTS_00006	200 uL	M2-6:2FTS	0.0475 ug/mL
					LCM2-8:2FTS_00008	200 uL	M2-8:2FTS	0.0479 ug/mL
					LCM2PFHxDA_00013	200 uL	13C2-PFHxDA	0.05 ug/mL
					LCM2PFTeDA_00012	200 uL	13C2-PFTeDA	0.05 ug/mL
					LCM4PFHPA_00012	200 uL	13C4-PFHpA	0.05 ug/mL
					LCM5PFPEA_00013	200 uL	13C5-PFPeA	0.05 ug/mL
					LCM8FOSA_00016	200 uL	13C8 FOSA	0.05 ug/mL
					LCMPFBA_00013	200 uL	13C4 PFBA	0.05 ug/mL
					LCMPFBS_00006	200 uL	13C3-PFBS	0.0465 ug/mL
					LCMPFDA_00018	200 uL	13C2 PFDA	0.05 ug/mL
					LCMPFDoA_00013	200 uL	13C2 PFDoA	0.05 ug/mL
					LCMPFHxA_00019	200 uL	13C2 PFHxA	0.05 ug/mL
					LCMPFHxS_00013	200 uL	18O2 PFHxS	0.0473 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LCMPFNA_00013	200 uL	13C5 PFNA	0.05 ug/mL
					LCMPFOA_00017	200 uL	13C4 PFOA	0.05 ug/mL
					LCMPFOS_00025	200 uL	13C4 PFOS	0.0478 ug/mL
					LCMPFUdA_00014	200 uL	13C2 PFUnA	0.05 ug/mL
..LCd3-NMeFOSAA_00006	05/19/22		WELLINGTON, Lot d3NMeFOSAA0517		(Purchased Reagent)		d3-NMeFOSAA	50 ug/mL
..LCd5-NEtFOSAA_00006	11/08/22		WELLINGTON, Lot d5NEtFOSAA1117		(Purchased Reagent)		d5-NEtFOSAA	50 ug/mL
..LCM2-6:FTS_00006	02/17/22		WELLINGTON, Lot M262FTS0217		(Purchased Reagent)		M2-6:2FTS	47.5 ug/mL
..LCM2-8:2FTS_00008	07/05/22		WELLINGTON, Lot M282FTS0717		(Purchased Reagent)		M2-8:2FTS	47.9 ug/mL
..LCM2PFHxDA_00013	07/13/22		Wellington Laboratories, Lot M2PFHxDA0717		(Purchased Reagent)		13C2-PFHxDA	50 ug/mL
..LCM2PFTeDA_00012	11/30/22		Wellington Laboratories, Lot M2PFTeDA1117		(Purchased Reagent)		13C2-PFTeDA	50 ug/mL
..LCM4PFHPA_00012	05/03/22		Wellington Laboratories, Lot M4PFHpA0517		(Purchased Reagent)		13C4-PFHpA	50 ug/mL
..LCM5PFPEA_00013	07/20/22		Wellington Laboratories, Lot M5PFPeA0717		(Purchased Reagent)		13C5-PFPeA	50 ug/mL
..LCM8FOSA_00016	10/11/22		Wellington Laboratories, Lot M8FOSA1017I		(Purchased Reagent)		13C8 FOSA	50 ug/mL
..LCMPFBA_00013	04/12/22		Wellington Laboratories, Lot MPFBA0417		(Purchased Reagent)		13C4 PFBA	50 ug/mL
..LCMPFBS_00006	05/24/22		Wellington Laboratories, Lot M3PFBS0815		(Purchased Reagent)		13C3-PFBS	46.5 ug/mL
..LCMPFDA_00018	07/13/22		Wellington Laboratories, Lot MPFDA0717		(Purchased Reagent)		13C2 PFDA	50 ug/mL
..LCMPFDoA_00013	05/23/22		Wellington Laboratories, Lot MPFDoA0517		(Purchased Reagent)		13C2 PFDoA	50 ug/mL
..LCMPFHxA_00019	10/27/22		Wellington Laboratories, Lot MPFHxA1017		(Purchased Reagent)		13C2 PFHxA	50 ug/mL
..LCMPFHxS_00013	02/17/22		Wellington Laboratories, Lot MPFHxS0217		(Purchased Reagent)		18O2 PFHxS	47.3 ug/mL
..LCMPFNA_00013	09/30/21		Wellington Laboratories, Lot MPFNA0916		(Purchased Reagent)		13C5 PFNA	50 ug/mL
..LCMPFOA_00017	10/17/22		Wellington Laboratories, Lot MPFOA1017		(Purchased Reagent)		13C4 PFOA	50 ug/mL
..LCMPFOS_00025	10/17/22		Wellington Laboratories, Lot MPFOS1017		(Purchased Reagent)		13C4 PFOS	47.8 ug/mL
..LCMPFUdA_00014	11/22/21		Wellington Laboratories, Lot MPFUdA1116		(Purchased Reagent)		13C2 PFUnA	50 ug/mL
.LCPFAC-24PAR_00001	09/15/22		Wellington Laboratories, Lot PFAC24PAR0917		(Purchased Reagent)		Perfluorobutanesulfonic acid (PFBS)	1.77 ug/mL
							Perfluoroheptanoic acid (PFHpA)	2 ug/mL
							Perfluorohexanesulfonic acid (PFHxS)	1.824 ug/mL
							Perfluorononanoic acid (PFNA)	2 ug/mL
							Perfluorooctanesulfonic acid (PFOS)	1.851 ug/mL
							Perfluorooctanoic acid (PFOA)	2 ug/mL
LCPFCSP_00149	11/18/18	05/17/18	Methanol, Lot 090285	250 mL	LC11CIPF3OUdS_00002	100 uL	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonate	0.01884 ug/mL
					LC4:2FTS_00005	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.01868 ug/mL
					LC6:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.01896 ug/mL
					LC8:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.01916 ug/mL
					LC9CI-PF3ONS_00002	100 uL	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonate	0.01864 ug/mL
					LCbr-NEtFOSAA_00001	100 uL	N-ethyl perfluorooctane sulfonamidoacetic acid	0.02 ug/mL
					LCbr-NMeFOSAA_00001	100 uL	N-methyl perfluorooctane sulfonamidoacetic acid	0.02 ug/mL
					LCDONA_00002	100 uL	Adona	0.02 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
					LCHFPO-DA_00002	100 uL	Perfluoro(2-propoxypropanoic) acid	0.02 ug/mL
					LCPFBA_00008	100 uL	Perfluorobutyric acid	0.02 ug/mL
					LCPFBS_00009	100 uL	Perfluorobutane Sulfonate	0.01768 ug/mL
							Perfluorobutanesulfonic acid (PFBS)	0.01768 ug/mL
					LCPFDA_00008	100 uL	Perfluorodecanoic acid	0.02 ug/mL
					LCPFDoA_00008	100 uL	Perfluorododecanoic acid	0.02 ug/mL
					LCPFDS_00008	100 uL	Perfluorodecane Sulfonic acid	0.01928 ug/mL
					LCPFHpA_00011	100 uL	Perfluoroheptanoic acid (PFHpA)	0.02 ug/mL
					LCPFHpSA_00003	100 uL	Perfluoroheptanesulfonic acid	0.01904 ug/mL
					LCPFHxA_00010	100 uL	Perfluorohexanoic acid	0.02 ug/mL
					LCPFHxDA_00010	100 uL	Perfluorohexadecanoic acid	0.02 ug/mL
					LCPFHxS-br_00006	100 uL	Perfluorohexane Sulfonate	0.0182 ug/mL
							Perfluorohexanesulfonic acid (PFHxS)	0.0182 ug/mL
					LCPFNA_00010	100 uL	Perfluorononanoic acid (PFNA)	0.02 ug/mL
							Perfluorooctanoic acid (PFOA)	0.02002 ug/mL
					LCPFNS_00003	100 uL	Perfluorononanesulfonic acid	0.0192 ug/mL
					LCPFOA_00011	100 uL	Perfluorooctanoic acid (PFOA)	0.02002 ug/mL
					LCPFODA_00010	100 uL	Perfluorooctadecanoic acid	0.02 ug/mL
					LCPFOS-br_00007	100 uL	Perfluorooctanesulfonic acid (PFOS)	0.01856 ug/mL
					LCPFOSA_00013	100 uL	Perfluorooctane Sulfonamide	0.02 ug/mL
					LCPFPeA_00008	100 uL	Perfluoropentanoic acid	0.02 ug/mL
					LCPFPeS_00003	100 uL	Perfluoropentanesulfonic acid	0.01876 ug/mL
					LCPFTeDA_00008	100 uL	Perfluorotetradecanoic acid	0.02 ug/mL
					LCPFTrDA_00008	100 uL	Perfluorotridecanoic acid	0.02 ug/mL
					LCPFUdA_00008	100 uL	Perfluoroundecanoic acid	0.02 ug/mL
.LC11ClPF3OUdS_00002	09/30/21		Wellington Labs, Lot 11ClPF3OUdS0916		(Purchased Reagent)		11-Chloroeicosafluoro-3-oxaundecane-1-sulfonate	47.1 ug/mL
.LC4:2FTS_00005	12/12/21		WELLINGTON, Lot 42FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	46.7 ug/mL
.LC6:2FTS_00007	04/20/22		WELLINGTON, Lot 62FTS0417		(Purchased Reagent)		1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	47.4 ug/mL
.LC8:2FTS_00007	12/12/21		WELLINGTON, Lot 82FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	47.9 ug/mL
.LC9Cl-PF3ONS_00002	09/30/21		Wellington Labs, Lot 9ClPF3ONS0916		(Purchased Reagent)		9-Chlorohexadecafluoro-3-oxanonane-1-sulfonate	46.6 ug/mL
.LCbr-NEtFOSAA_00001	01/17/23		WELLINGTON, Lot brNEtFOSAA0118		(Purchased Reagent)		N-ethyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
.LCbr-NMeFOSAA_00001	01/17/23		WELLINGTON, Lot brNMeFOSAA0118		(Purchased Reagent)		N-methyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
.LCDONA_00002	03/26/23		WELLINGTON, Lot NADONA0318		(Purchased Reagent)		Adona	50 ug/mL
.LCHFPO-DA_00002	03/26/21		WELLINGTON, Lot HFPODA0318		(Purchased Reagent)		Perfluoro(2-propoxypropanoic) acid	50 ug/mL
.LCPFBA_00008	05/29/22		Wellington Laboratories, Lot PFBA0517		(Purchased Reagent)		Perfluorobutyric acid	50 ug/mL
.LCPFBS_00009	09/21/22		Wellington Laboratories, Lot LPFBS0917		(Purchased Reagent)		Perfluorobutane Sulfonate	44.2 ug/mL

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
							Perfluorobutanesulfonic acid (PFBS)	44.2 ug/mL
.LCPFDA_00008	05/29/22		Wellington Laboratories, Lot PFDA0517		(Purchased Reagent)		Perfluorodecanoic acid	50 ug/mL
.LCPFDoA_00008	05/29/22		Wellington Laboratories, Lot PFDoA0517		(Purchased Reagent)		Perfluorododecanoic acid	50 ug/mL
.LCPFDS_00008	11/08/22		Wellington Laboratories, Lot LPFDS1117		(Purchased Reagent)		Perfluorodecane Sulfonic acid	48.2 ug/mL
.LCPFHpA_00011	09/27/22		Wellington Laboratories, Lot PFHpA0917		(Purchased Reagent)		Perfluoroheptanoic acid (PFHpA)	50 ug/mL
.LCPFHpSA_00003	09/01/22		Wellington Laboratories, Lot LPFHpS0817		(Purchased Reagent)		Perfluoroheptanesulfonic acid	47.6 ug/mL
.LCPFHxA_00010	09/27/22		Wellington Laboratories, Lot PFHxA0917		(Purchased Reagent)		Perfluorohexanoic acid	50 ug/mL
.LCPFHxDA_00010	07/13/22		Wellington Laboratories, Lot PFHxDA0717		(Purchased Reagent)		Perfluorohexadecanoic acid	50 ug/mL
.LCPFHxS-br_00006	01/04/22		Wellington Laboratories, Lot brPFHxSK0117		(Purchased Reagent)		Perfluorohexane Sulfonate	45.5 ug/mL
							Perfluorohexanesulfonic acid (PFHxS)	45.5 ug/mL
.LCPFNA_00010	07/20/22		Wellington Laboratories, Lot PFNA0717		(Purchased Reagent)		Perfluorononanoic acid (PFNA)	50 ug/mL
							Perfluorooctanoic acid (PFOA)	0.05 ug/mL
.LCPFNS_00003	09/27/22		Wellington Laboratories, Lot LPFNS0917		(Purchased Reagent)		Perfluorononanesulfonic acid	48 ug/mL
.LCPFOA_00011	09/27/22		Wellington Laboratories, Lot PFOA0917		(Purchased Reagent)		Perfluorooctanoic acid (PFOA)	50 ug/mL
.LCPFODA_00010	07/13/22		Wellington Laboratories, Lot PFODA0717		(Purchased Reagent)		Perfluorooctadecanoic acid	50 ug/mL
.LCPFOS-br_00007	01/12/22		Wellington Laboratories, Lot brPFOSK0117		(Purchased Reagent)		Perfluorooctanesulfonic acid (PFOS)	46.4 ug/mL
.LCPFOSA_00013	09/01/22		Wellington Laboratories, Lot FOSA0817I		(Purchased Reagent)		Perfluorooctane Sulfonamide	50 ug/mL
.LCPFPeA_00008	06/14/22		Wellington Laboratories, Lot PFPeA0617		(Purchased Reagent)		Perfluoropentanoic acid	50 ug/mL
.LCPFPeS_00003	01/11/22		Wellington Laboratories, Lot LPFPeS0117		(Purchased Reagent)		Perfluoropentanesulfonic acid	46.9 ug/mL
.LCPFTeDA_00008	09/30/21		Wellington Laboratories, Lot PFTeDA0916		(Purchased Reagent)		Perfluorotetradecanoic acid	50 ug/mL
.LCPFTrDA_00008	05/02/22		Wellington Laboratories, Lot PFTrDA0517		(Purchased Reagent)		Perfluorotridecanoic acid	50 ug/mL
.LCPFUdA_00008	10/18/21		Wellington Laboratories, Lot PFUdA1016		(Purchased Reagent)		Perfluoroundecanoic acid	50 ug/mL
LCPFCSP_00150	11/18/18	05/17/18	Methanol, Lot 090285	250 mL	LC11CIPF3OUdS_00002	100 uL	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonate	0.01884 ug/mL
					LC4:2FTS_00005	100 uL	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	0.01868 ug/mL
					LC6:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	0.01896 ug/mL
					LC8:2FTS_00007	100 uL	1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	0.01916 ug/mL
					LC9CI-PF3ONS_00002	100 uL	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonate	0.01864 ug/mL
					LCbr-NEtFOSAA_00001	100 uL	N-ethyl perfluorooctane sulfonamidoacetic acid	0.02 ug/mL
					LCbr-NMeFOSAA_00001	100 uL	N-methyl perfluorooctane sulfonamidoacetic acid	0.02 ug/mL
					LCDONA_00002	100 uL	Adona	0.02 ug/mL
					LCHFPO-DA_00002	100 uL	Perfluoro(2-propoxypropanoic) acid	0.02 ug/mL
					LCPFBA_00008	100 uL	Perfluorobutyric acid	0.02 ug/mL
					LCPFBS_00009	100 uL	Perfluorobutane Sulfonate	0.01768 ug/mL
							Perfluorobutanesulfonic acid (PFBS)	0.01768 ug/mL
					LCPFDA_00008	100 uL	Perfluorodecanoic acid	0.02 ug/mL
					LCPFDoA_00008	100 uL	Perfluorododecanoic acid	0.02 ug/mL

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent		Analyte	Concentration
					Reagent ID	Volume Added		
					LCPFDS_00008	100 uL	Perfluorodecane Sulfonic acid	0.01928 ug/mL
					LCPFHpA_00011	100 uL	Perfluoroheptanoic acid (PFHpA)	0.02 ug/mL
					LCPFHpSA_00003	100 uL	Perfluoroheptanesulfonic acid	0.01904 ug/mL
					LCPFHxA_00010	100 uL	Perfluorohexanoic acid	0.02 ug/mL
					LCPFHxDA_00010	100 uL	Perfluorohexadecanoic acid	0.02 ug/mL
					LCPFHxS-br_00006	100 uL	Perfluorohexane Sulfonate	0.0182 ug/mL
							Perfluorohexanesulfonic acid (PFHxS)	0.0182 ug/mL
					LCPFNA_00010	100 uL	Perfluorononanoic acid (PFNA)	0.02 ug/mL
							Perfluorooctanoic acid (PFOA)	0.02002 ug/mL
					LCPFNS_00003	100 uL	Perfluorononanesulfonic acid	0.0192 ug/mL
					LCPFOA_00011	100 uL	Perfluorooctanoic acid (PFOA)	0.02002 ug/mL
					LCPFODA_00010	100 uL	Perfluorooctadecanoic acid	0.02 ug/mL
					LCPFOS-br_00007	100 uL	Perfluorooctanesulfonic acid (PFOS)	0.01856 ug/mL
					LCPFOSA_00013	100 uL	Perfluorooctane Sulfonamide	0.02 ug/mL
					LCPFPeA_00008	100 uL	Perfluoropentanoic acid	0.02 ug/mL
					LCPFPeS_00003	100 uL	Perfluoropentanesulfonic acid	0.01876 ug/mL
					LCPFTeDA_00008	100 uL	Perfluorotetradecanoic acid	0.02 ug/mL
					LCPFTrDA_00008	100 uL	Perfluorotridecanoic acid	0.02 ug/mL
					LCPFUdA_00008	100 uL	Perfluoroundecanoic acid	0.02 ug/mL
.LC11ClPF3OUdS_00002	09/30/21		Wellington Labs, Lot 11ClPF3OUdS0916		(Purchased Reagent)		11-Chloroeicosafluoro-3-oxaundecane-1-sulfonate	47.1 ug/mL
.LC4:2FTS_00005	12/12/21		WELLINGTON, Lot 42FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2)	46.7 ug/mL
.LC6:2FTS_00007	04/20/22		WELLINGTON, Lot 62FTS0417		(Purchased Reagent)		1H,1H,2H,2H-perfluorooctanesulfonic acid (6:2)	47.4 ug/mL
.LC8:2FTS_00007	12/12/21		WELLINGTON, Lot 82FTS1216		(Purchased Reagent)		1H,1H,2H,2H-perfluorodecanesulfonic acid (8:2)	47.9 ug/mL
.LC9Cl-PF3ONS_00002	09/30/21		Wellington Labs, Lot 9ClPF3ONS0916		(Purchased Reagent)		9-Chlorohexadecafluoro-3-oxanonane-1-sulfonate	46.6 ug/mL
.LCbr-NEtFOSAA_00001	01/17/23		WELLINGTON, Lot brNEtFOSAA0118		(Purchased Reagent)		N-ethyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
.LCbr-NMeFOSAA_00001	01/17/23		WELLINGTON, Lot brNMeFOSAA0118		(Purchased Reagent)		N-methyl perfluorooctane sulfonamidoacetic acid	50 ug/mL
.LCDONA_00002	03/26/23		WELLINGTON, Lot NADONA0318		(Purchased Reagent)		Adona	50 ug/mL
.LCHFPO-DA_00002	03/26/21		WELLINGTON, Lot HFPODA0318		(Purchased Reagent)		Perfluoro(2-propoxypropanoic) acid	50 ug/mL
.LCPFBA_00008	05/29/22		Wellington Laboratories, Lot PFBA0517		(Purchased Reagent)		Perfluorobutyric acid	50 ug/mL
.LCPFBS_00009	09/21/22		Wellington Laboratories, Lot LPFBS0917		(Purchased Reagent)		Perfluorobutane Sulfonate	44.2 ug/mL
							Perfluorobutanesulfonic acid (PFBS)	44.2 ug/mL
.LCPFDA_00008	05/29/22		Wellington Laboratories, Lot PFDA0517		(Purchased Reagent)		Perfluorodecanoic acid	50 ug/mL
.LCPFDoA_00008	05/29/22		Wellington Laboratories, Lot PFDoA0517		(Purchased Reagent)		Perfluorododecanoic acid	50 ug/mL
.LCPFDS_00008	11/08/22		Wellington Laboratories, Lot LPFDS1117		(Purchased Reagent)		Perfluorodecane Sulfonic acid	48.2 ug/mL
.LCPFHpA_00011	09/27/22		Wellington Laboratories, Lot PFHpA0917		(Purchased Reagent)		Perfluoroheptanoic acid (PFHpA)	50 ug/mL
.LCPFHpSA_00003	09/01/22		Wellington Laboratories, Lot LPFHpS0817		(Purchased Reagent)		Perfluoroheptanesulfonic acid	47.6 ug/mL

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica Sacramento Job No.: 320-39942-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent		Analyte	Concentration
					Reagent ID	Volume Added		
.LCPFHxA_00010	09/27/22	Wellington Laboratories, Lot PFHxA0917			(Purchased Reagent)		Perfluorohexanoic acid	50 ug/mL
.LCPFHxDA_00010	07/13/22	Wellington Laboratories, Lot PFHxDA0717			(Purchased Reagent)		Perfluorohexadecanoic acid	50 ug/mL
.LCPFHxS-br_00006	01/04/22	Wellington Laboratories, Lot brPFHxSK0117			(Purchased Reagent)		Perfluorohexane Sulfonate	45.5 ug/mL
							Perfluorohexanesulfonic acid (PFHxS)	45.5 ug/mL
.LCPFNA_00010	07/20/22	Wellington Laboratories, Lot PFNA0717			(Purchased Reagent)		Perfluorononanoic acid (PFNA)	50 ug/mL
							Perfluorooctanoic acid (PFOA)	0.05 ug/mL
.LCPFNS_00003	09/27/22	Wellington Laboratories, Lot LPFNS0917			(Purchased Reagent)		Perfluorononanesulfonic acid	48 ug/mL
.LCPFOA_00011	09/27/22	Wellington Laboratories, Lot PFOA0917			(Purchased Reagent)		Perfluorooctanoic acid (PFOA)	50 ug/mL
.LCPFODA_00010	07/13/22	Wellington Laboratories, Lot PFODA0717			(Purchased Reagent)		Perfluorooctadecanoic acid	50 ug/mL
.LCPFOS-br_00007	01/12/22	Wellington Laboratories, Lot brPFOSK0117			(Purchased Reagent)		Perfluorooctanesulfonic acid (PFOS)	46.4 ug/mL
.LCPFOSA_00013	09/01/22	Wellington Laboratories, Lot FOSA0817I			(Purchased Reagent)		Perfluorooctane Sulfonamide	50 ug/mL
.LCPFPeA_00008	06/14/22	Wellington Laboratories, Lot PFPeA0617			(Purchased Reagent)		Perfluoropentanoic acid	50 ug/mL
.LCPFPeS_00003	01/11/22	Wellington Laboratories, Lot LPFPeS0117			(Purchased Reagent)		Perfluoropentanesulfonic acid	46.9 ug/mL
.LCPFTeDA_00008	09/30/21	Wellington Laboratories, Lot PFTeDA0916			(Purchased Reagent)		Perfluorotetradecanoic acid	50 ug/mL
.LCPFTrDA_00008	05/02/22	Wellington Laboratories, Lot PFTrDA0517			(Purchased Reagent)		Perfluorotridecanoic acid	50 ug/mL
.LCPFUdA_00008	10/18/21	Wellington Laboratories, Lot PFUdA1016			(Purchased Reagent)		Perfluoroundecanoic acid	50 ug/mL

Reagent

LC11CIPF3OUdS_00002

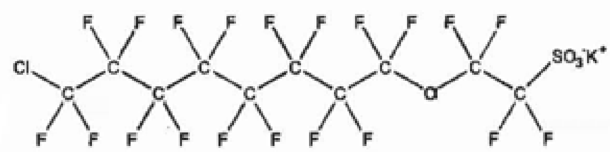
WELLINGTON LABORATORIES

CERTIFICATE OF ANALYSIS DOCUMENTATION

PRODUCT CODE: 11Cl-PF3OUdS **LOT NUMBER:** 11ClPF3OUdS0916

COMPOUND: Potassium 11-chloroeicosafluoro-3-oxaundecane-1-sulfonate

STRUCTURE: **CAS #:** 83329-89-9



MOLECULAR FORMULA: $C_{10}F_{20}ClSO_4K$ **MOLECULAR WEIGHT:** 670.69

CONCENTRATION: 50.0 ± 2.5 µg/ml (K Salt) **SOLVENT(S):** Methanol

47.1 ± 2.4 µg/ml (11Cl-PF3OUdS anion)

CHEMICAL PURITY: >98%

LAST TESTED: (mm/dd/yyyy) 09/30/2016

EXPIRY DATE: (mm/dd/yyyy) 09/30/2021

RECOMMENDED STORAGE: Store ampoule in a cool, dark place

DOCUMENTATION/ DATA ATTACHED:

Figure 1: LC/MS Data (TIC and Mass Spectrum)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.
- This compound is a minor component of the commercial formulation known as F-53B.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

Certified By: B.G. Chittim **Date:** 10/19/2016 (mm/dd/yyyy)

Wellington Laboratories Inc., 345 Southgate Dr. Guelph ON N1G 3M5 CANADA
519-822-2436 • Fax: 519-822-2849 • info@well-labs.com

INTENDED USE:

The products prepared by Wellington Laboratories Inc. are for laboratory use only. This certified reference material (CRM) was designed to be used as a standard for the identification and/or quantification of the specific chemical compound it contains.

HAZARDS:

This product should only be used by qualified personnel familiar with its potential hazards and trained in the handling of hazardous chemicals. Due care should be exercised to prevent unnecessary human contact or ingestion. All procedures should be carried out in a well-functioning fume hood and suitable gloves, eye protection, and clothing should be worn at all times. Waste should be disposed of according to national and regional regulations. Safety Data Sheets (SDSs) are available upon request.

SYNTHESIS / CHARACTERIZATION:

Where possible, all of our products are synthesized using single-product unambiguous routes. They are then characterized, and their structures and purities confirmed, using a combination of the most relevant techniques, such as NMR, GC/MS, LC/MS/MS, SFC/UV/MS/MS, x-ray crystallography, and melting point. Isotopic purities of mass-labelled compounds are also confirmed using HRGC/HRMS and/or LC/MS/MS.

HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products are compared to older lots in the same manner, which further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers.

UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2,...x_n$ on which it depends is:

$$u_c(y(x_1,x_2,...x_n)) = \sqrt{\sum_{i=1}^{n} u(y,x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

TRACEABILITY:

All reference standard solutions are traceable to specific crystalline lots. The microbalances used for solution preparation are regularly tested by an external ISO/IEC 17025 accredited calibration company. In addition, their calibration is verified prior to each weighing using NIST and/or NRC traceable external weights. All volumetric glassware used is of Class A tolerance and has been tested according to the appropriate ASTM procedures, which are ultimately traceable to NIST. For certain products, traceability to international interlaboratory studies has also been established.

EXPIRY DATE / PERIOD OF VALIDITY:

Ongoing stability studies of this product have demonstrated stability in its composition and concentration, until the specified expiry date, in the unopened ampoule. Monitoring for any degradation or change in concentration of the listed analyte(s) is performed on a routine basis.

LIMITED WARRANTY:

At the time of shipment, all products are warranted to be free of defects in material and workmanship and to conform to the stated technical and purity specifications.

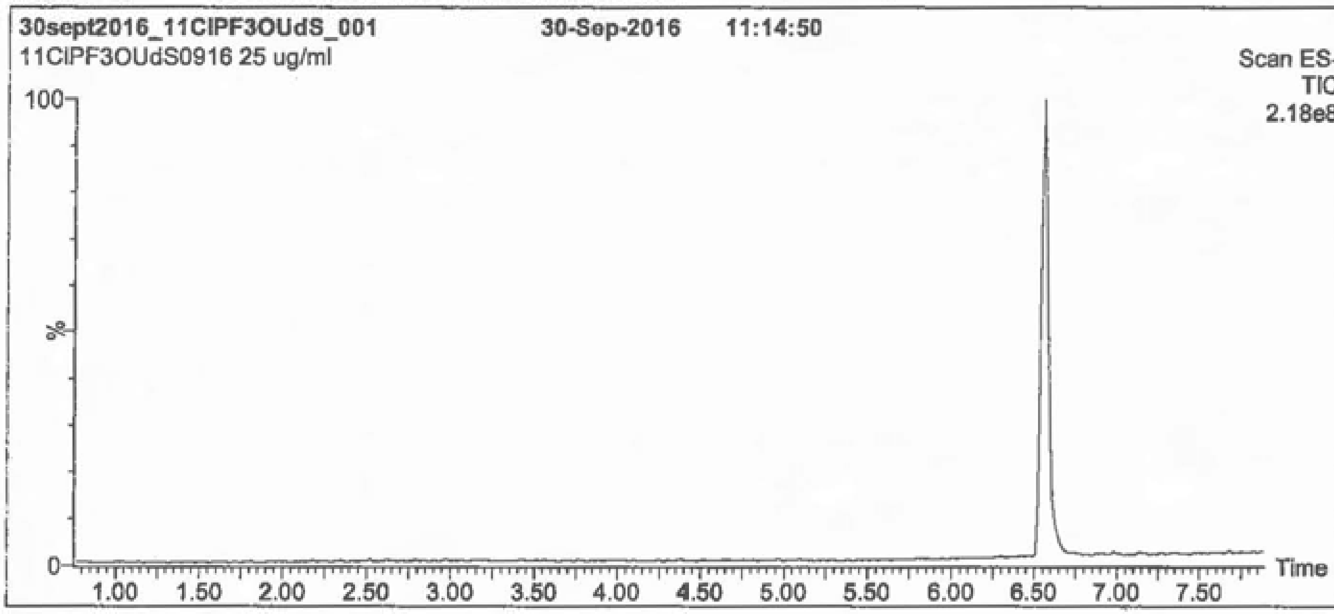
QUALITY MANAGEMENT:

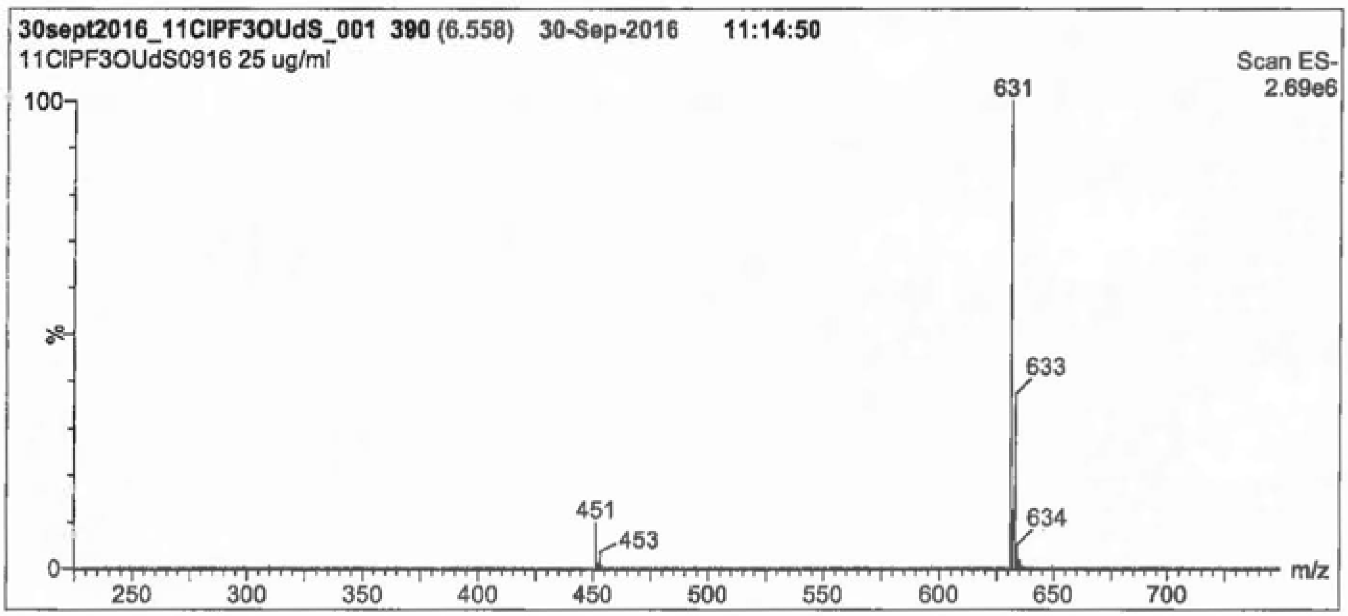
This product was produced using a Quality Management System registered to the latest versions of ISO 9001 by SAI Global, ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA; A 1226), and ISO GUIDE 34 by ANSI-ASQ National Accreditation Board (ANAB; AR-1523).

CALA ANAB ACCREDITED

For additional information or assistance concerning this or any other products from Wellington Laboratories Inc., please visit our website at www.well-labs.com or contact us directly at info@well-labs.com

Figure 1: **11Cl-PF3OUdS; LC/MS Data (TIC and Mass Spectrum)**





Conditions for Figure 1:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% (80:20 MeOH:ACN) / 50% H_2O
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 7 min and hold for
1.5 min before returning to initial conditions in 0.5 min.
Time: 10 min

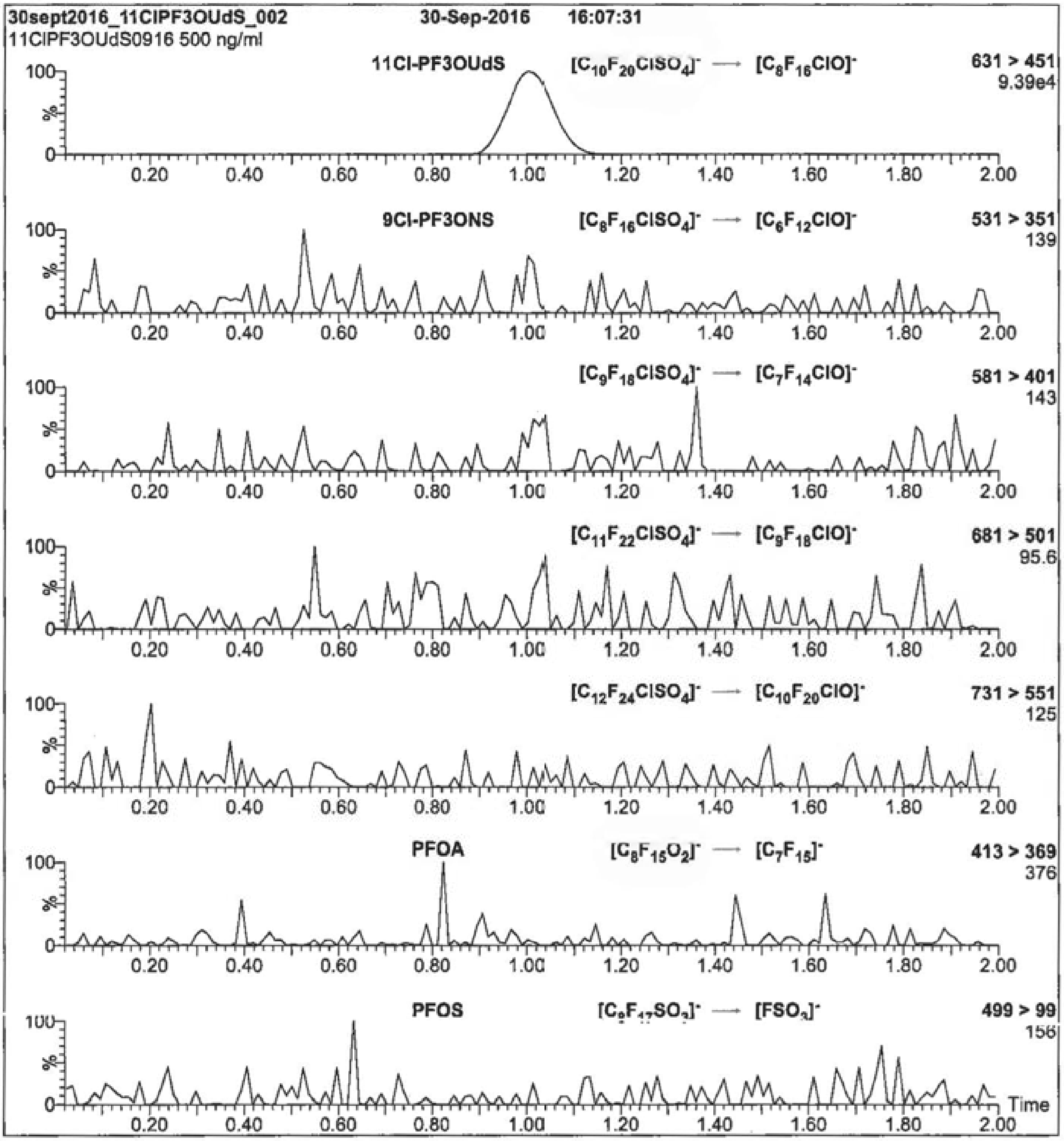
Flow: 300 µl/min

MS Parameters

Experiment: Full Scan (225 - 850 amu)

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = 45.00
Cone Gas Flow (l/hr) = 50
Desolvation Gas Flow (l/hr) = 750

Figure 2: **11Cl-PF3OUdS; LC/MS/MS Data (Selected MRM Transitions)**



Conditions for Figure 2:

Injection:	Direct loop injection 10 µl (500 ng/ml 11Cl-PF3OUdS)	**MS Parameters**
		Collision Gas (mbar) = 3.24e-3 Collision Energy (eV) = 20
Mobile phase:	Isocratic 80% (80:20 MeOH:ACN) / 20% H_2O (both with 10 mM NH_4OAc buffer)	
Flow:	300 µl/min	

Reagent

LC4:2FTS_00005

r: 9/21/17 SKV

WELLINGTON LABORATORIES

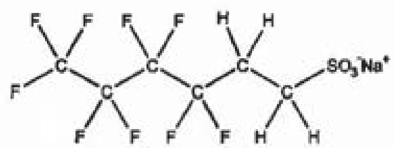
CERTIFICATE OF ANALYSIS DOCUMENTATION

PRODUCT CODE: 4:2FTS

LOT NUMBER: 42FTS1216

COMPOUND: Sodium 1H,1H,2H,2H-perfluorohexane sulfonate

STRUCTURE:



CAS #: Not available

MOLECULAR FORMULA: $C_6H_4F_9SO_3Na$

MOLECULAR WEIGHT: 350.13

CONCENTRATION: 50.0 ± 2.5 µg/ml (Na salt)
46.7 ± 2.3 µg/ml (4:2FTS anion)

SOLVENT(S): Methanol

CHEMICAL PURITY: >98%

LAST TESTED: (mm/dd/yyyy) 12/12/2016

EXPIRY DATE: (mm/dd/yyyy) 12/12/2021

RECOMMENDED STORAGE: Refrigerate ampoule

DOCUMENTATION/ DATA ATTACHED:

Figure 1: LC/MS Data (TIC and Mass Spectrum)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

Certified By: B.G. Chittim **Date:** 12/21/2016 (mm/dd/yyyy)

Wellington Laboratories Inc., 345 Southgate Dr. Guelph ON N1G 3M5 CANADA
519-822-2436 • Fax: 519-822-2849 • info@well-labs.com

INTENDED USE:

The products prepared by Wellington Laboratories Inc. are for laboratory use only. This certified reference material (CRM) was designed to be used as a standard for the identification and/or quantification of the specific chemical compound it contains.

HAZARDS:

This product should only be used by qualified personnel familiar with its potential hazards and trained in the handling of hazardous chemicals. Due care should be exercised to prevent unnecessary human contact or ingestion. All procedures should be carried out in a well-functioning fume hood and suitable gloves, eye protection, and clothing should be worn at all times. Waste should be disposed of according to national and regional regulations. Safety Data Sheets (SDSs) are available upon request.

SYNTHESIS / CHARACTERIZATION:

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HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products are compared to older lots in the same manner, which further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers.

UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, \ldots x_n$ on which it depends is:

$$u_c(y(x_1, x_2, \ldots x_n)) = \sqrt{\sum_{i=1}^{n} u(y, x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

TRACEABILITY:

All reference standard solutions are traceable to specific crystalline lots. The microbalances used for solution preparation are regularly tested by an external ISO/IEC 17025 accredited calibration company. In addition, their calibration is verified prior to each weighing using NIST and/or NRC traceable external weights. All volumetric glassware used is of Class A tolerance and has been tested according to the appropriate ASTM procedures, which are ultimately traceable to NIST. For certain products, traceability to international interlaboratory studies has also been established.

EXPIRY DATE / PERIOD OF VALIDITY:

Ongoing stability studies of this product have demonstrated stability in its composition and concentration, until the specified expiry date, in the unopened ampoule. Monitoring for any degradation or change in concentration of the listed analyte(s) is performed on a routine basis.

LIMITED WARRANTY:

At the time of shipment, all products are warranted to be free of defects in material and workmanship and to conform to the stated technical and purity specifications.

QUALITY MANAGEMENT:

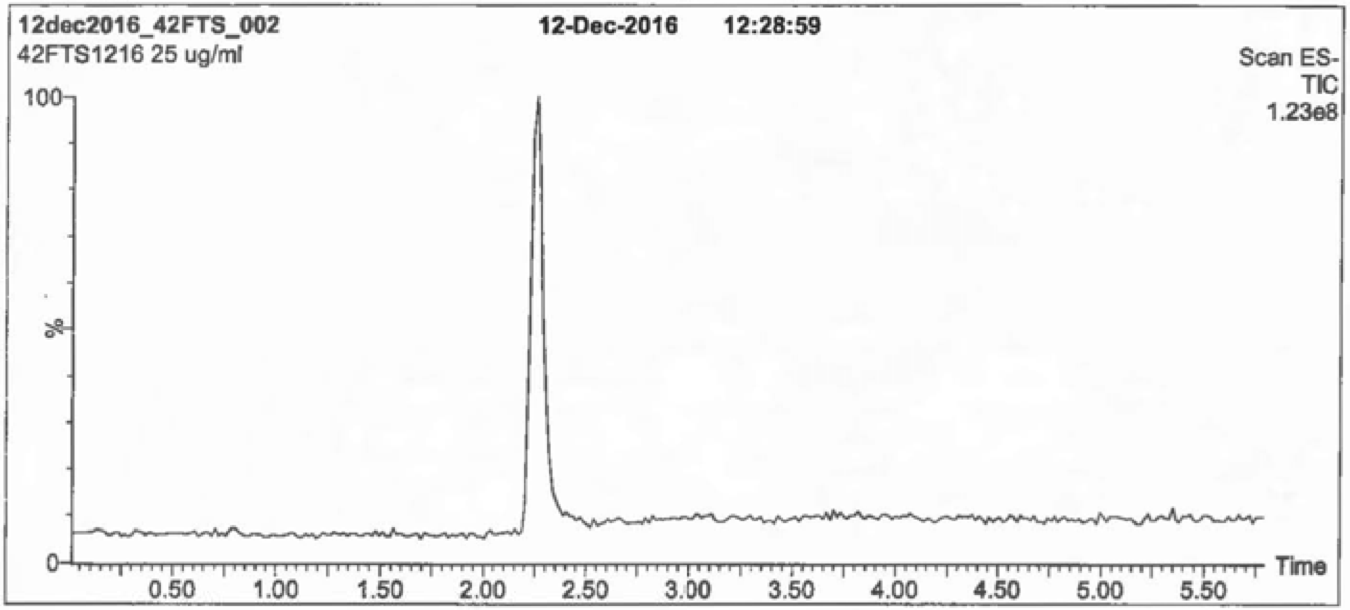
This product was produced using a Quality Management System registered to the latest versions of ISO 9001 by SAI Global, ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA; A 1226), and ISO GUIDE 34 by ANSI-ASQ National Accreditation Board (ANAB; AR-1523).

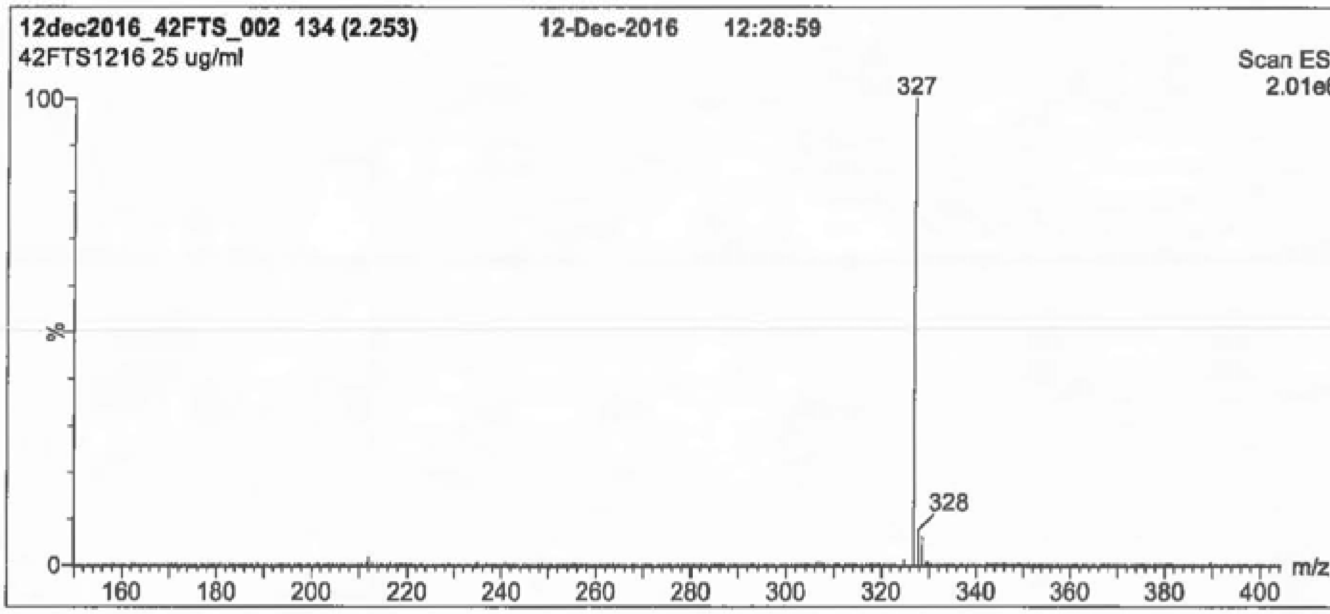
CALA

ANAB

For additional information or assistance concerning this or any other products from Wellington Laboratories Inc., please visit our website at www.well-labs.com or contact us directly at info@well-labs.com

Figure 1: **4:2FTS; LC/MS Data (TIC and Mass Spectrum)**





Conditions for Figure 1:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% (80:20 MeOH:ACN) / 50% H_2O
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 7.5 min and hold for 1.5 min before returning to initial conditions in 0.5 min.
Time: 10 min

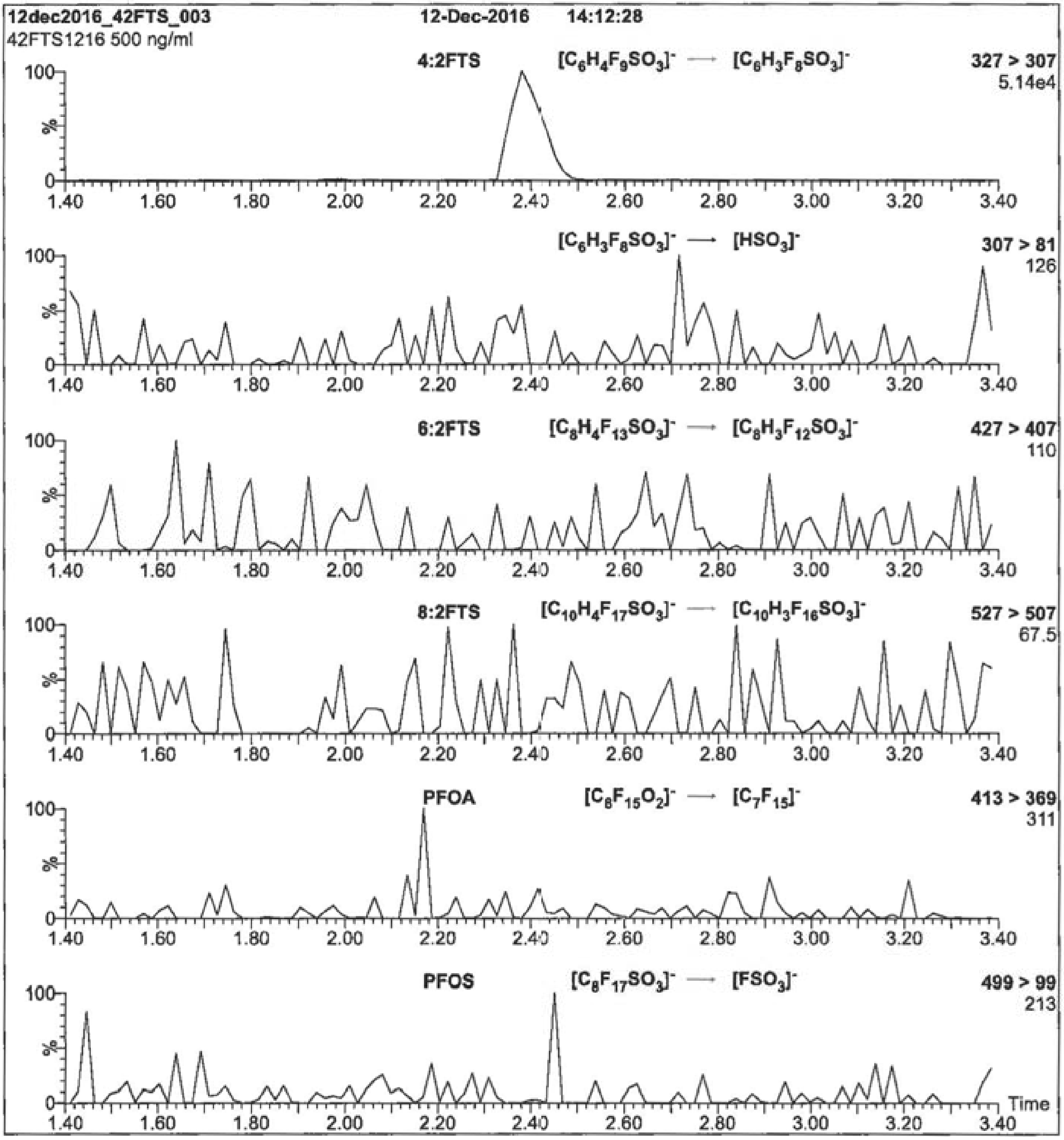
Flow: 300 µl/min

MS Parameters

Experiment: Full Scan (150 - 850 amu)

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = 25.00
Cone Gas Flow (l/hr) = 100
Desolvation Gas Flow (l/hr) = 750

Figure 2: **4:2FTS; LC/MS/MS Data (Selected MRM Transitions)**



Conditions for Figure 2:

Injection:	Direct loop injection 10 µl (500 ng/ml 4:2FTS)	**MS Parameters**
		Collision Gas (mbar) = 3.31e-3 Collision Energy (eV) = 25
Mobile phase:	Isocratic 80% (80:20 MeOH:ACN) / 20% H_2O (both with 10 mM NH_4OAc buffer)	
Flow:	300 µl/min	

Reagent

LC6:2FTS_00007

r: 9/21/17 SW

WELLINGTON LABORATORIES

CERTIFICATE OF ANALYSIS DOCUMENTATION

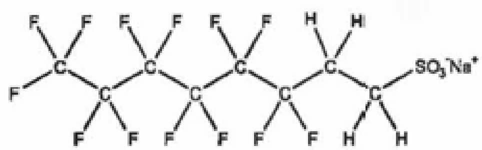
PRODUCT CODE: 6:2FTS

LOT NUMBER: 62FTS0417

COMPOUND: Sodium 1H,1H,2H,2H-perfluorooctane sulfonate

STRUCTURE:

CAS #: Not available



MOLECULAR FORMULA: $C_8H_4F_{13}SO_3Na$

MOLECULAR WEIGHT: 450.15

CONCENTRATION: 50.0 ± 2.5 µg/ml (Na salt)
47.4 ± 2.4 µg/ml (6:2FTS anion)

SOLVENT(S): Methanol

CHEMICAL PURITY: >98%

LAST TESTED: (mm/dd/yyyy) 04/20/2017

EXPIRY DATE: (mm/dd/yyyy) 04/20/2022

RECOMMENDED STORAGE: Refrigerate ampoule

DOCUMENTATION/ DATA ATTACHED:

Figure 1: LC/MS Data (TIC and Mass Spectrum)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

Certified By: [signature]
B.G. Chittim, General Manager

Date: 04/24/2017 (mm/dd/yyyy)

Wellington Laboratories Inc., 345 Southgate Dr. Guelph ON N1G 3M5 CANADA
519-822-2436 • Fax: 519-822-2849 • info@well-labs.com

INTENDED USE:

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SYNTHESIS / CHARACTERIZATION:

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UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, ... x_n$ on which it depends is:

$$u_c(y(x_1, x_2, ... x_n)) = \sqrt{\sum_{i=1}^{n} u(y, x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

TRACEABILITY:

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EXPIRY DATE / PERIOD OF VALIDITY:

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LIMITED WARRANTY:

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QUALITY MANAGEMENT:

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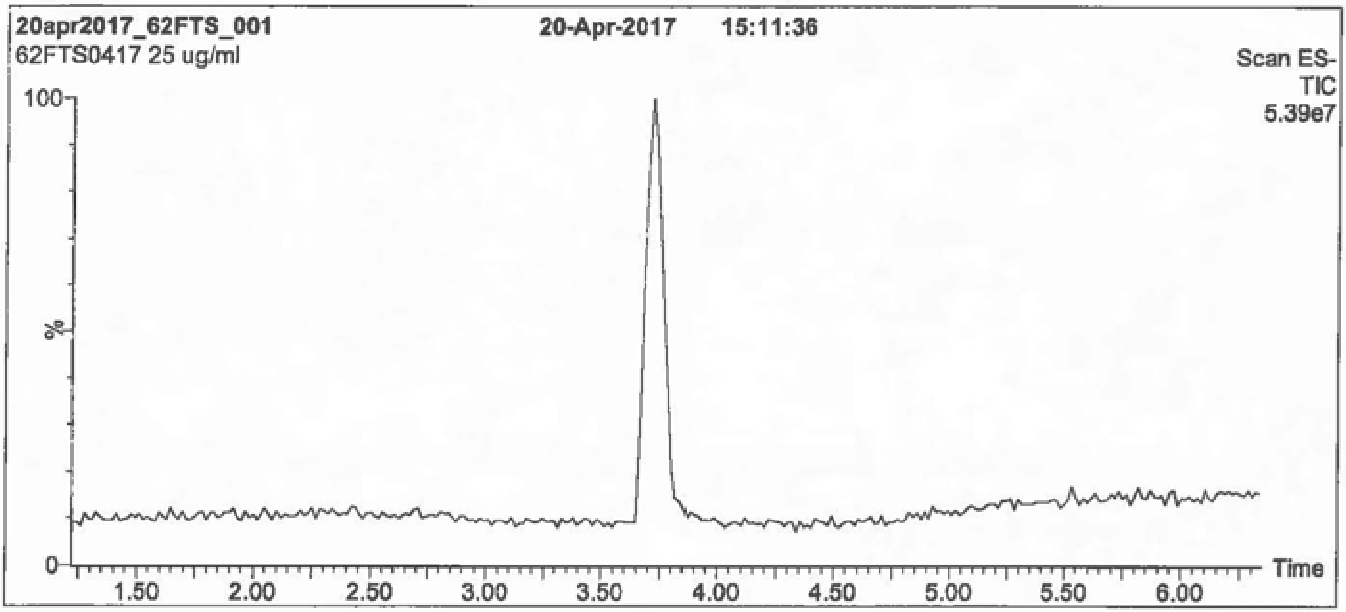
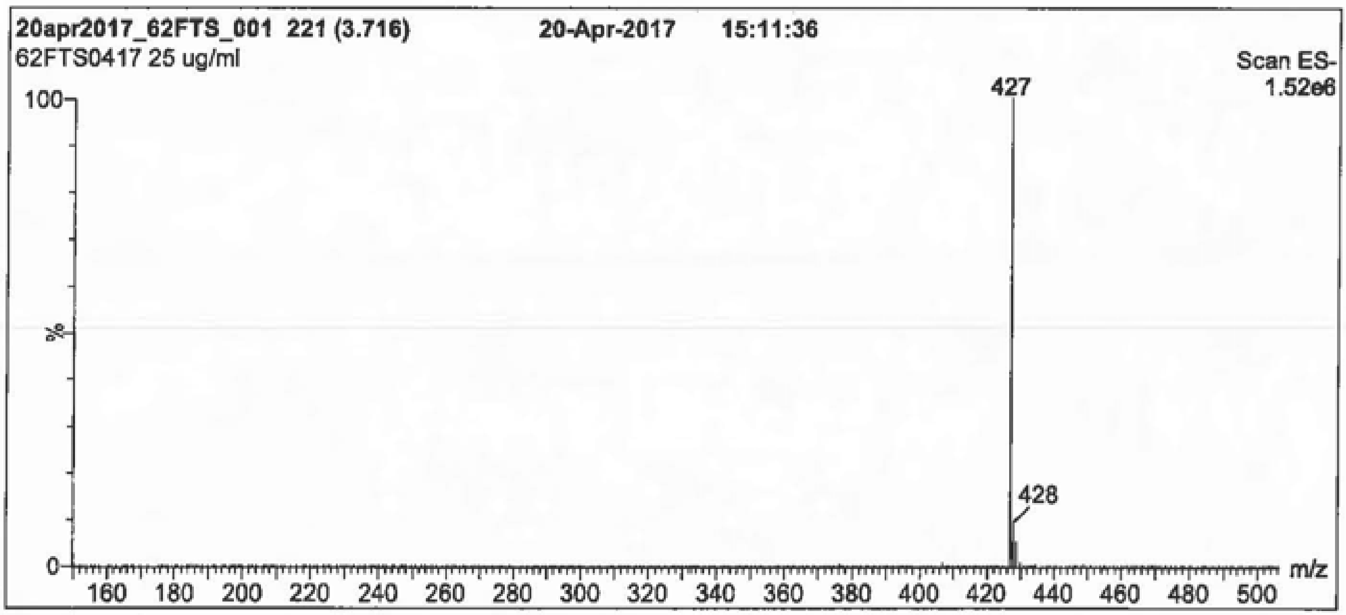
Figure 1: **6:2FTS; LC/MS Data (TIC and Mass Spectrum)**





Conditions for Figure 1:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% (80:20 MeOH:ACN) / 50% H_2O
(both with 10 mM NH_4OAc buffer)
Ramp to 85% organic over 7.5 min and hold for 1.5 min before returning to initial conditions in 0.5 min.
Time: 10 min

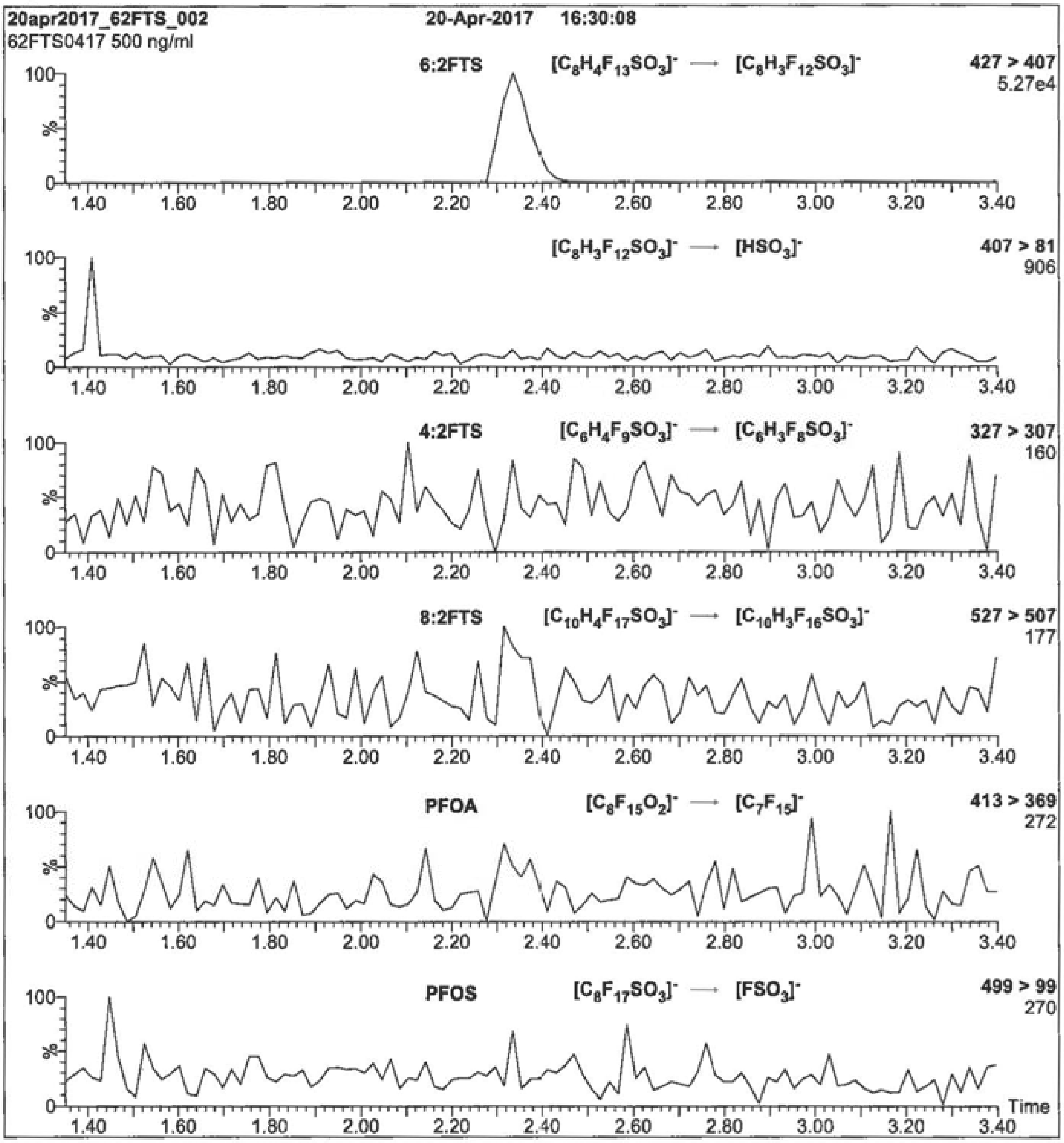
Flow: 300 µl/min

MS Parameters

Experiment: Full Scan (150 - 850 amu)

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = 30.00
Cone Gas Flow (l/hr) = 50
Desolvation Gas Flow (l/hr) = 750

Figure 2: **6:2FTS; LC/MS/MS Data (Selected MRM Transitions)**



Conditions for Figure 2:

Injection: Direct loop injection
10 µl (500 ng/ml 6:2FTS)

Mobile phase: Isocratic 80% (80:20 MeOH:ACN) / 20% H_2O
(both with 10 mM NH_4OAc buffer)

Flow: 300 µl/min

MS Parameters

Collision Gas (mbar) = 3.35e-3
Collision Energy (eV) = 25

Reagent

LC8:2FTS_00007

r: 9/21/17 SKJ

CERTIFICATE OF ANALYSIS DOCUMENTATION

WELLINGTON LABORATORIES

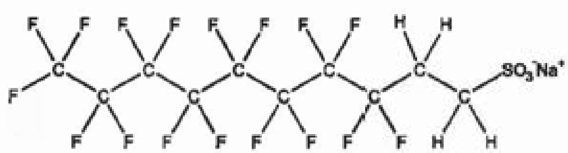
PRODUCT CODE: 8:2FTS

LOT NUMBER: 82FTS1216

COMPOUND: Sodium 1H,1H,2H,2H-perfluorodecane sulfonate

STRUCTURE:

CAS #: Not available



MOLECULAR FORMULA: $C_{10}H_4F_{17}SO_3Na$

MOLECULAR WEIGHT: 550.16

CONCENTRATION: 50.0 ± 2.5 µg/ml (Na salt)
47.9 ± 2.4 µg/ml (8:2FTS anion)

SOLVENT(S): Methanol

CHEMICAL PURITY: >98%

LAST TESTED: (mm/dd/yyyy) 12/12/2016

EXPIRY DATE: (mm/dd/yyyy) 12/12/2021

RECOMMENDED STORAGE: Refrigerate ampoule

DOCUMENTATION/ DATA ATTACHED:

Figure 1: LC/MS Data (TIC and Mass Spectrum)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

Certified By: B.G. Chittim **Date:** 12/21/2016 (mm/dd/yyyy)

Wellington Laboratories Inc., 345 Southgate Dr. Guelph ON N1G 3M5 CANADA
519-822-2436 • Fax: 519-822-2849 • info@well-labs.com

INTENDED USE:

The products prepared by Wellington Laboratories Inc. are for laboratory use only. This certified reference material (CRM) was designed to be used as a standard for the identification and/or quantification of the specific chemical compound it contains.

HAZARDS:

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LIMITED WARRANTY:

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QUALITY MANAGEMENT:

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CALA ANAB

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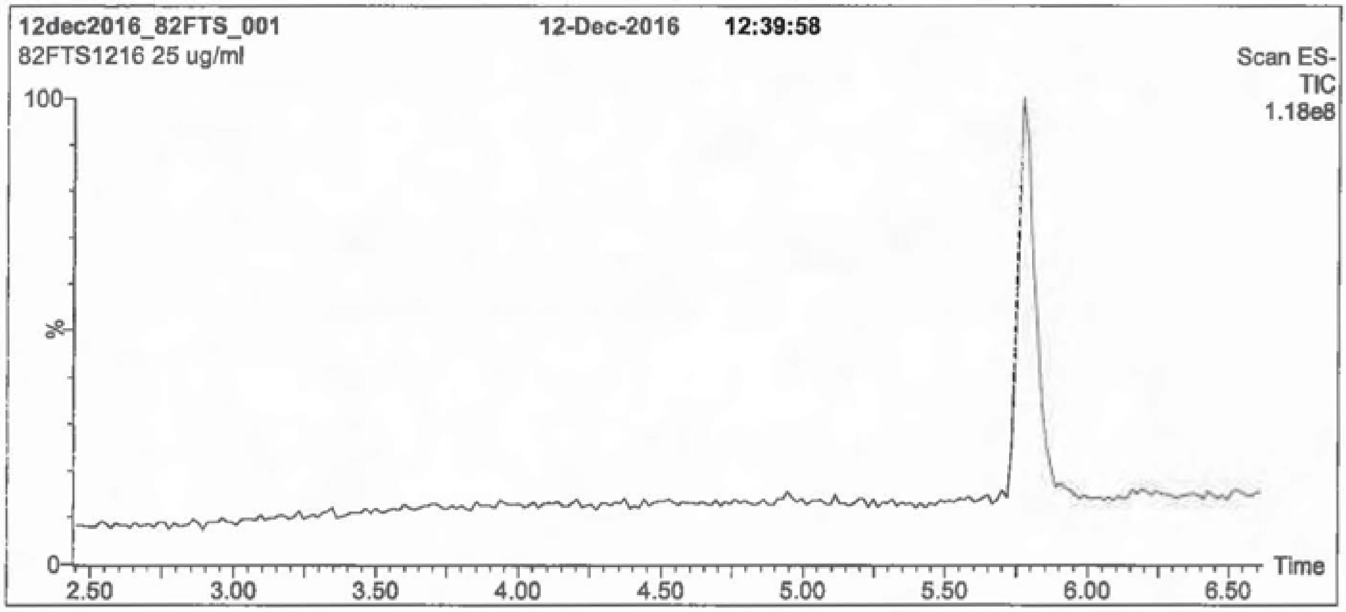
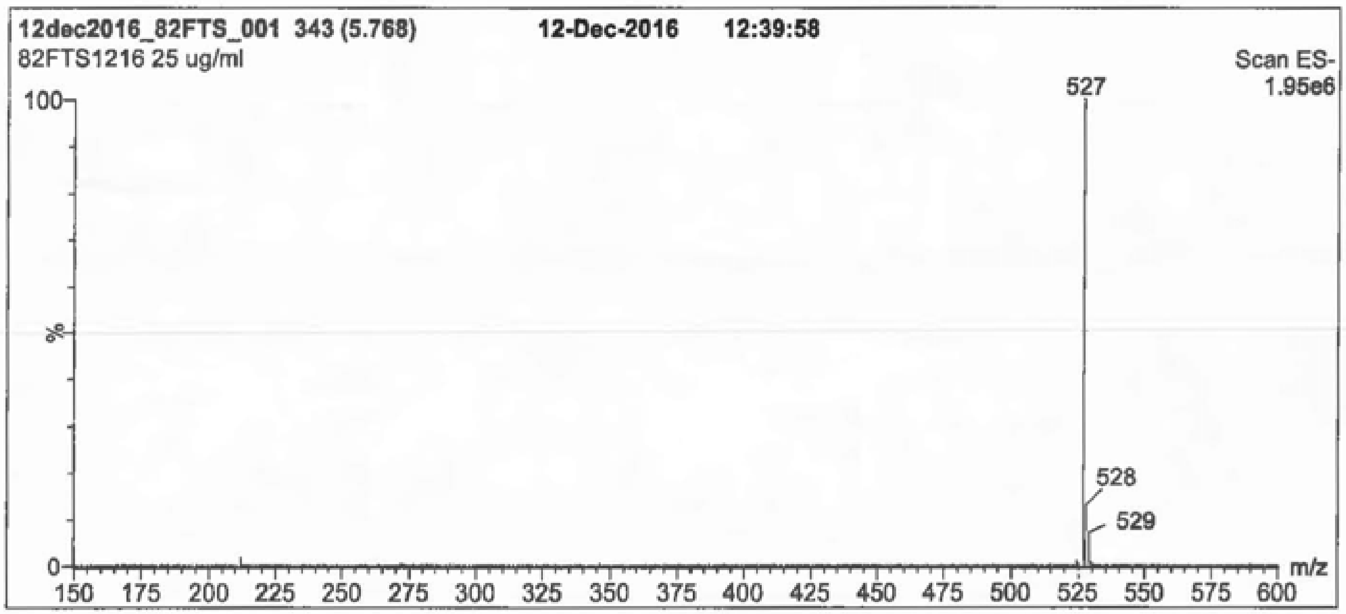
Figure 1: **8:2FTS; LC/MS Data (TIC and Mass Spectrum)**





Conditions for Figure 1:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% (80:20 MeOH:ACN) / 50% H_2O
(both with 10 mM NH_4OAc buffer)
Ramp to 85% organic over 7.5 min and hold for 1.5 min before returning to initial conditions in 0.5 min.
Time: 10 min

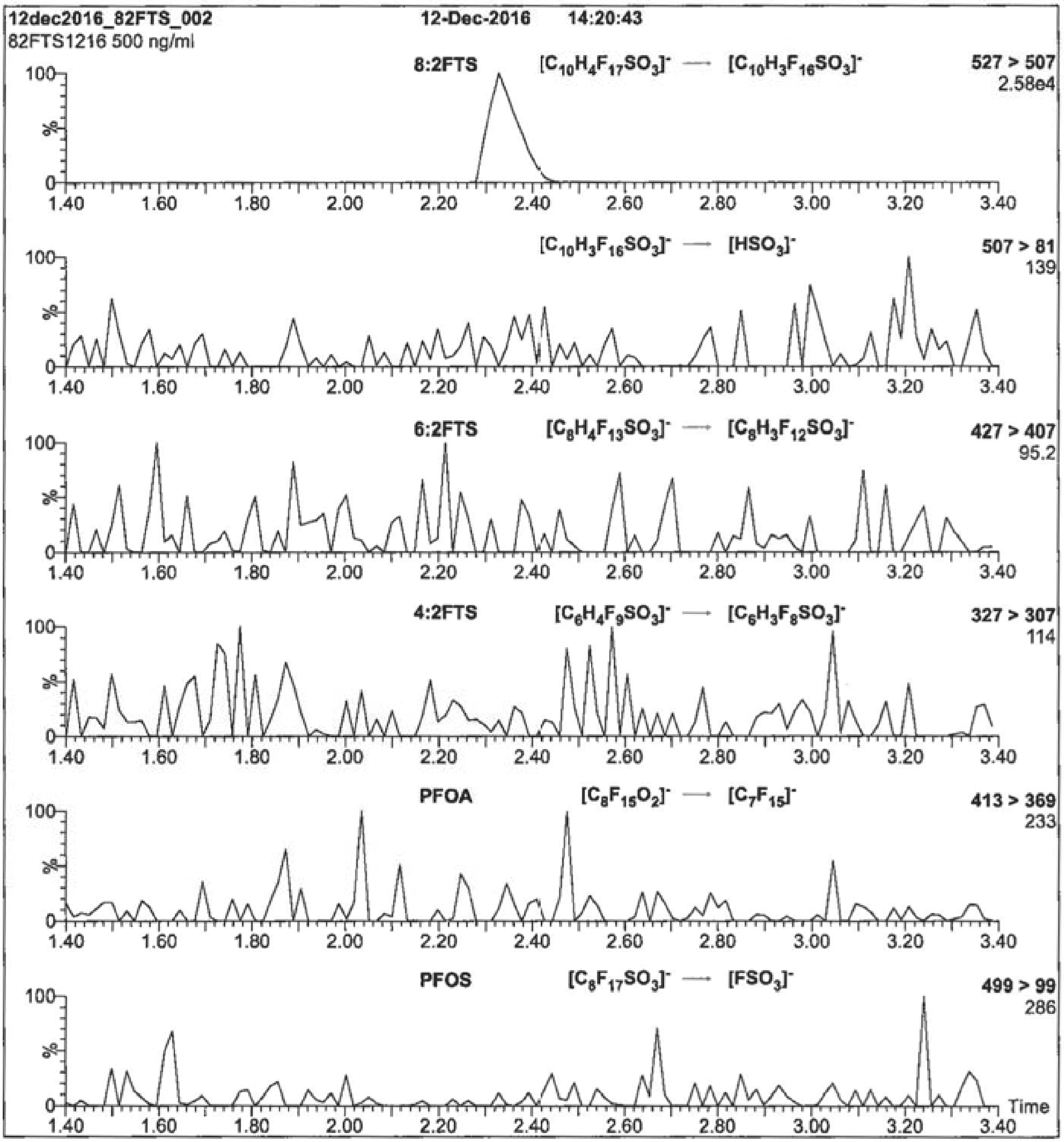
Flow: 300 µl/min

MS Parameters

Experiment: Full Scan (150 - 850 amu)

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = 30.00
Cone Gas Flow (l/hr) = 100
Desolvation Gas Flow (l/hr) = 750

Figure 2: 8:2FTS; LC/MS/MS Data (Selected MRM Transitions)



Conditions for Figure 2:

Injection: Direct loop injection
10 µl (500 ng/ml 8:2FTS)

Mobile phase: Isocratic 80% (80:20 MeOH:ACN) / 20% H_2O
(both with 10 mM NH_4OAc buffer)

Flow: 300 µl/min

MS Parameters

Collision Gas (mbar) = 3.28e-3
Collision Energy (eV) = 30

Reagent

LC9CI-PF3ONS_00002

r: 4/05/18 SKJ

WELLINGTON LABORATORIES

CERTIFICATE OF ANALYSIS DOCUMENTATION

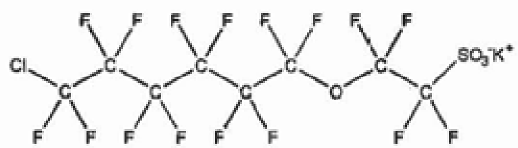
PRODUCT CODE: 9Cl-PF3ONS

LOT NUMBER: 9ClPF3ONS0916

COMPOUND: Potassium 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate

STRUCTURE:

CAS #: 73606-19-6



MOLECULAR FORMULA: $C_8F_{16}ClSO_4K$

MOLECULAR WEIGHT: 570.67

CONCENTRATION: 50.0 ± 2.5 µg/ml (K Salt)
46.6 ± 2.3 µg/ml (9Cl-PF3ONS anion)

SOLVENT(S): Methanol

CHEMICAL PURITY: >98%

LAST TESTED: (mm/dd/yyyy) 09/30/2016

EXPIRY DATE: (mm/dd/yyyy) 09/30/2021

RECOMMENDED STORAGE: Store ampoule in a cool, dark place

DOCUMENTATION/ DATA ATTACHED:

Figure 1: LC/MS Data (TIC and Mass Spectrum)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.
- This compound is the major component of the commercial formulation known as F-53B.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

Certified By: [signature] B.G. Chittim

Date: 10/19/2016 (mm/dd/yyyy)

Wellington Laboratories Inc., 345 Southgate Dr. Guelph ON N1G 3M5 CANADA
519-822-2436 • Fax: 519-822-2849 • info@well-labs.com

INTENDED USE:

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LIMITED WARRANTY:

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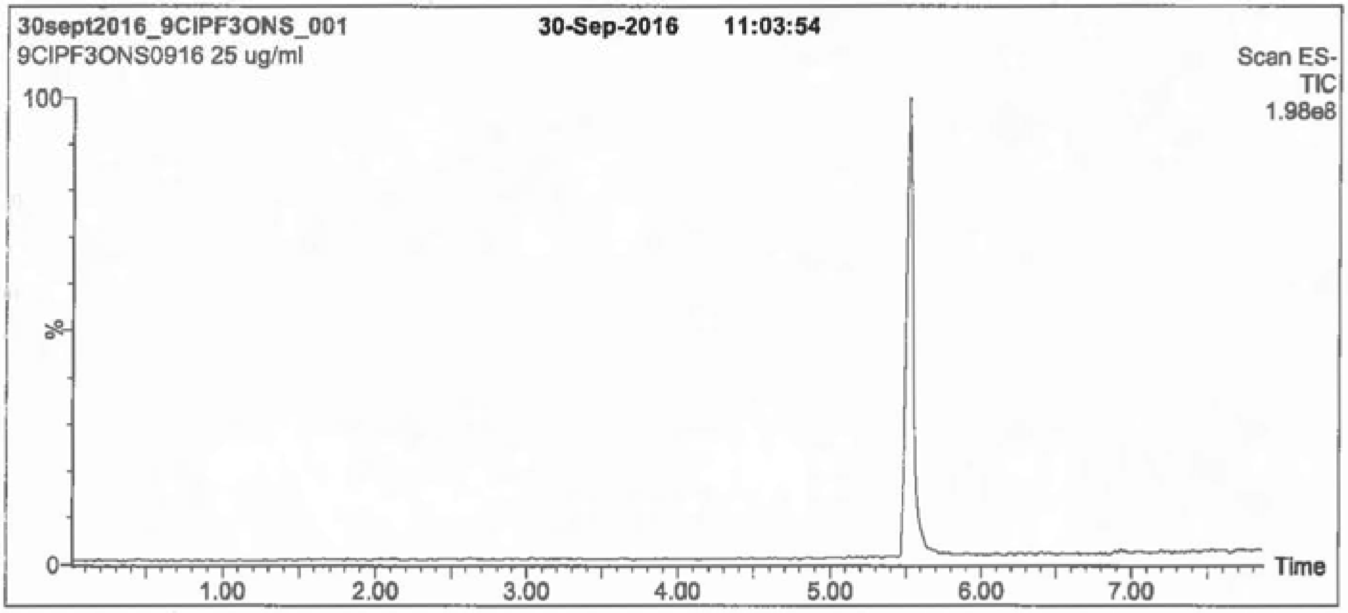
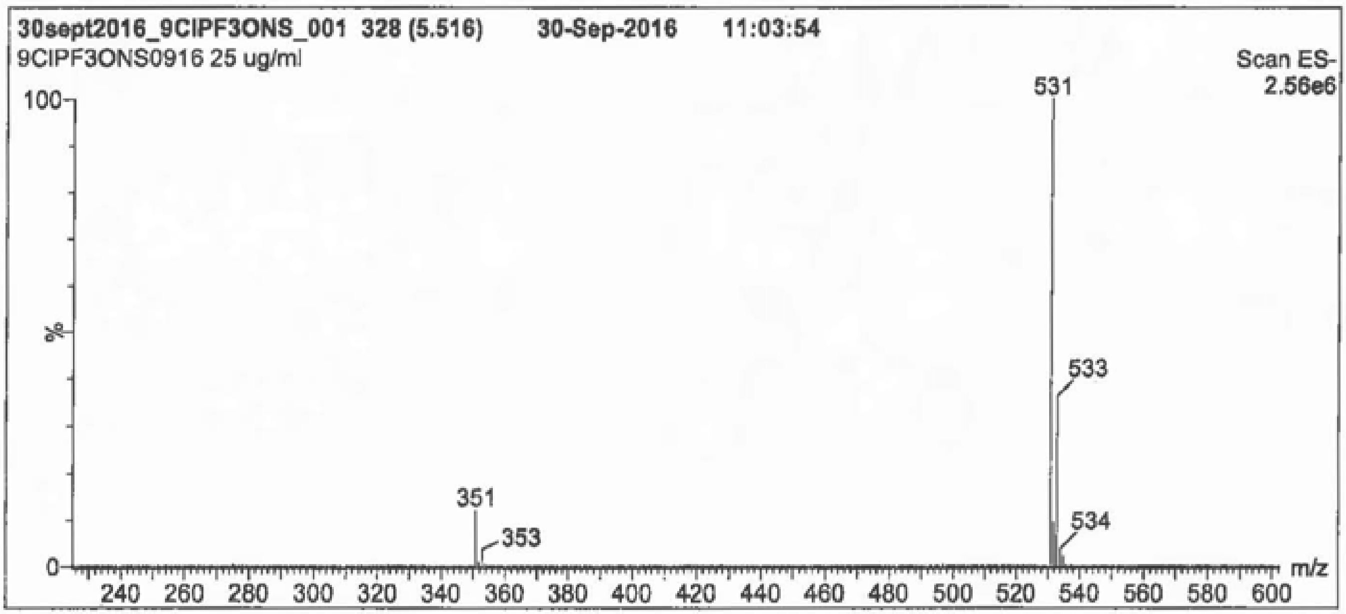
Figure 1: 9Cl-PF3ONS; LC/MS Data (TIC and Mass Spectrum)





Conditions for Figure 1:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% (80:20 MeOH:ACN) / 50% H_2O
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 7 min and hold for
1.5 min before returning to initial conditions in 0.5 min.
Time: 10 min

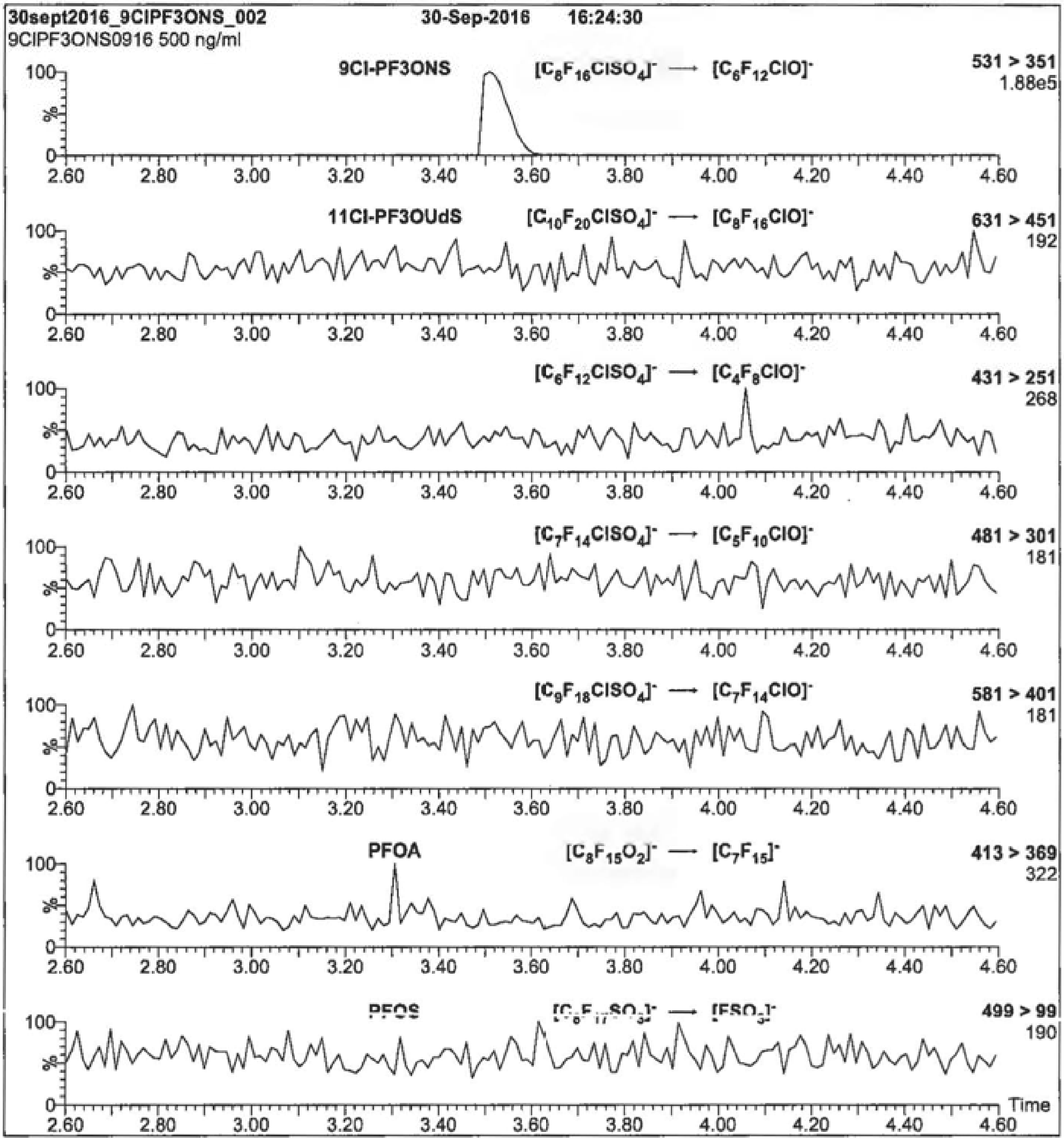
Flow: 300 µl/min

MS Parameters

Experiment: Full Scan (225 - 850 amu)

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = 40.00
Cone Gas Flow (l/hr) = 50
Desolvation Gas Flow (l/hr) = 750

Figure 2: **9Cl-PF3ONS; LC/MS/MS Data (Selected MRM Transitions)**



Conditions for Figure 2:		
Injection:	Direct loop injection 10 µl (500 ng/ml 9Cl-PF3ONS)	**MS Parameters**
Mobile phase:	Isocratic 80% (80:20 MeOH:ACN) / 20% H_2O (both with 10 mM NH_4OAc buffer)	Collision Gas (mbar) = 3.35e-3 Collision Energy (eV) = 25
Flow:	300 µl/min	

Reagent

LCbr-NEtFOSAA_00001

P: 4/18/19 SW

WELLINGTON LABORATORIES

CERTIFICATE OF ANALYSIS DOCUMENTATION

br-NEtFOSAA

N-Ethylperfluorooctanesulfonamidoacetic Acid Solution/Mixture of Linear and Branched Isomers

PRODUCT CODE:	br-NEtFOSAA
LOT NUMBER:	brNEtFOSAA0118
CONCENTRATION:	50.0 ± 2.5 μg/ml
SOLVENT(S):	Methanol/Water (<1%)
DATE PREPARED: (mm/dd/yyyy)	01/10/2018
LAST TESTED: (mm/dd/yyyy)	01/17/2018
EXPIRY DATE: (mm/dd/yyyy)	01/17/2023
RECOMMENDED STORAGE:	Refrigerate ampoule

DESCRIPTION:

The chemical purity has been determined to be ≥98% N-ethylperfluorooctanesulfonamidoacetic acid (linear and branched isomers). The full name, structure and percent composition for each of the identified isomeric components are given in Table A.

DOCUMENTATION/ DATA ATTACHED:

Table A: Isomeric Components and Percent Composition by ^{19}F-NMR
Figure 1: LC/MS Data (TIC and Mass Spectrum)
Figure 2: LC/MS Data (SIR)
Figure 3: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.
- Contains 4 mole eq. of NaOH to prevent conversion of the acetic acid moiety to its respective methyl ester.

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ANAB ACCREDITED REFERENCE MATERIAL PRODUCER

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Table A: **br-NEtFOSAA; Isomeric Components and Percent Composition (by [19]F-NMR)***

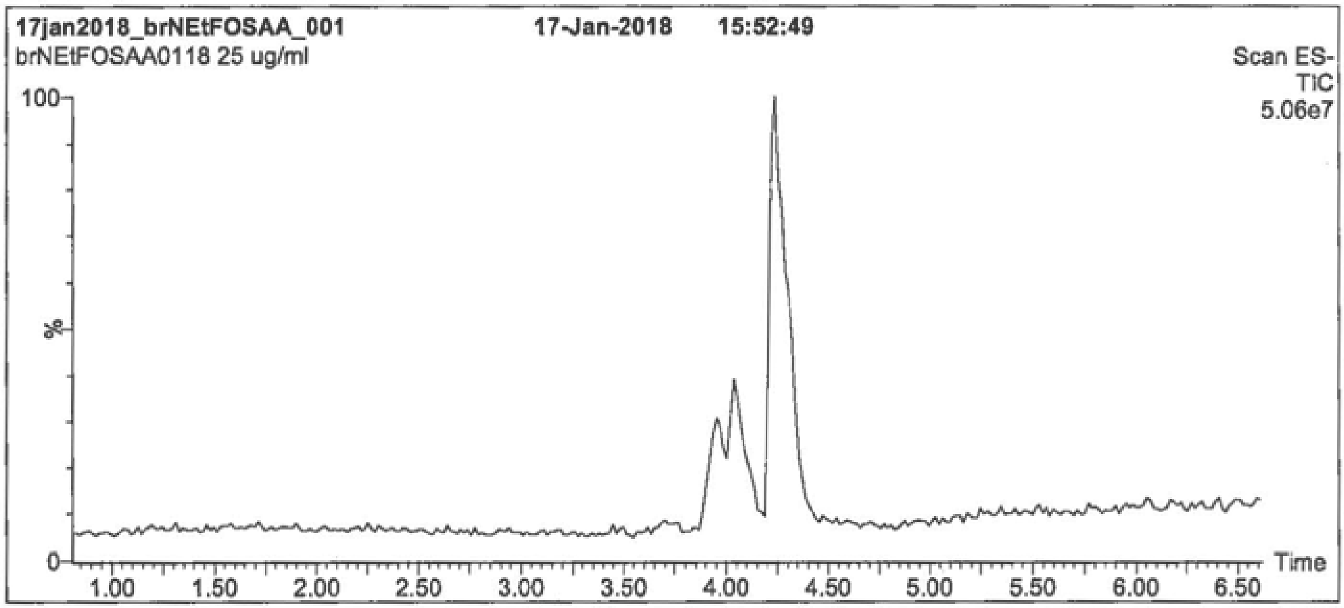
Isomer	Name	Structure	Percent Composition by [19]F-NMR
1	N-ethylperfluoro-1-octanesulfonamidoacetic acid	$CF_3(CF_2)_7SO_2NCH_2CO_2H$ C_2H_5	77.5
2	N-ethylperfluoro-3-methylheptanesulfonamidoacetic acid	$CF_3(CF_2)_3CF(CF_2)_2SO_2NCH_2CO_2H$ CF_3 C_2H_5	2.3
3	N-ethylperfluoro-4-methylheptanesulfonamidoacetic acid	$CF_3(CF_2)_2CF(CF_2)_3SO_2NCH_2CO_2H$ CF_3 C_2H_5	2.2
4	N-ethylperfluoro-5-methylheptanesulfonamidoacetic acid	$CF_3CF_2CF(CF_2)_4SO_2NCH_2CO_2H$ CF_3 C_2H_5	5.4
5	N-ethylperfluoro-6-methylheptanesulfonamidoacetic acid	$CF_3CF(CF_2)_5SO_2NCH_2CO_2H$ CF_3 C_2H_5	10.4
6	N-ethylperfluoro-5,5-dimethylhexanesulfonamidoacetic acid	CF_3 $CF_3C(CF_2)_4SO_2NCH_2CO_2H$ CF_3 C_2H_5	0.3
7	N-ethylperfluoro-4,5-dimethylhexanesulfonamidoacetic acid	CF_3 $CF_3CFCF(CF_2)_3SO_2NCH_2CO_2H$ CF_3 C_2H_5	0.3
8	N-ethylperfluoro-3,5-dimethylhexanesulfonamidoacetic acid	CF_3 $CF_3CFCF_2CF(CF_2)_2SO_2NCH_2CO_2H$ CF_3 C_2H_5	0.3
9	Other Unidentified Isomers		1.3

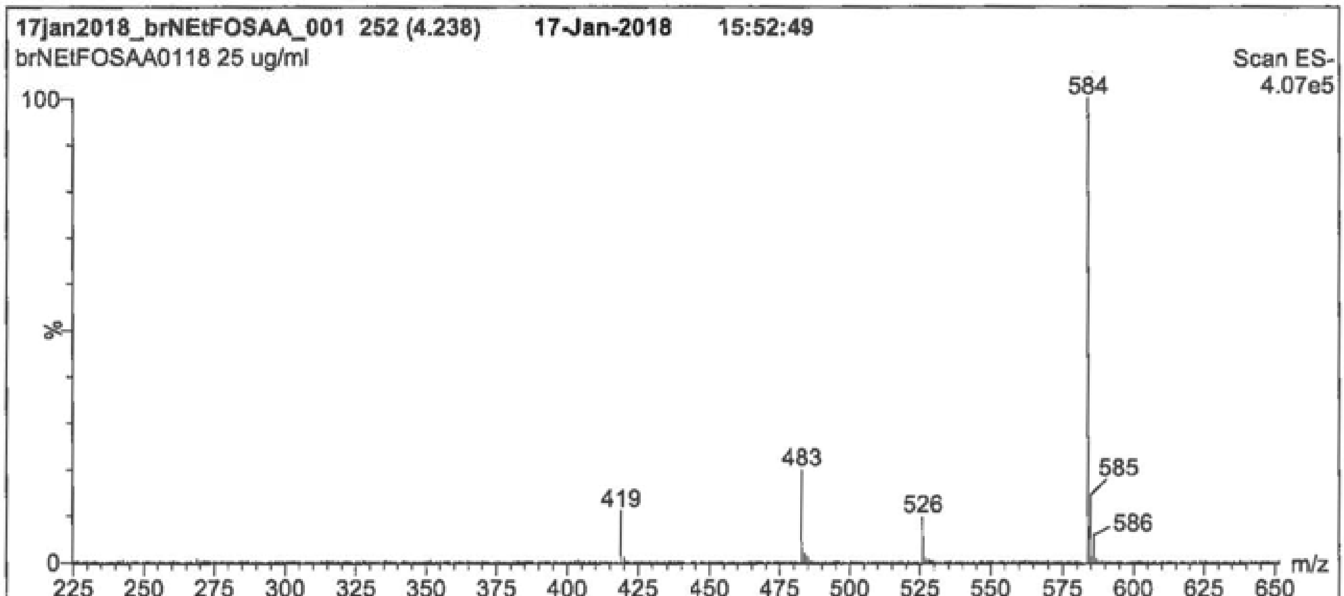
* Percent of total N-ethylperfluorooctanesulfonamidoacetic acid isomers only.

Certified By: ______________ **Date:** 03/22/2018 (mm/dd/yyyy)

B.G. Chittim, General Manager

Figure 1: **br-NEtFOSAA; LC/MS Data (TIC and Mass Spectrum)**





Conditions for Figure 1:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 55% (80:20 MeOH:ACN) / 45% H_2O
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 7 min and hold for
2 min before returning to initial conditions in 0.5 min.

Time: 10 min

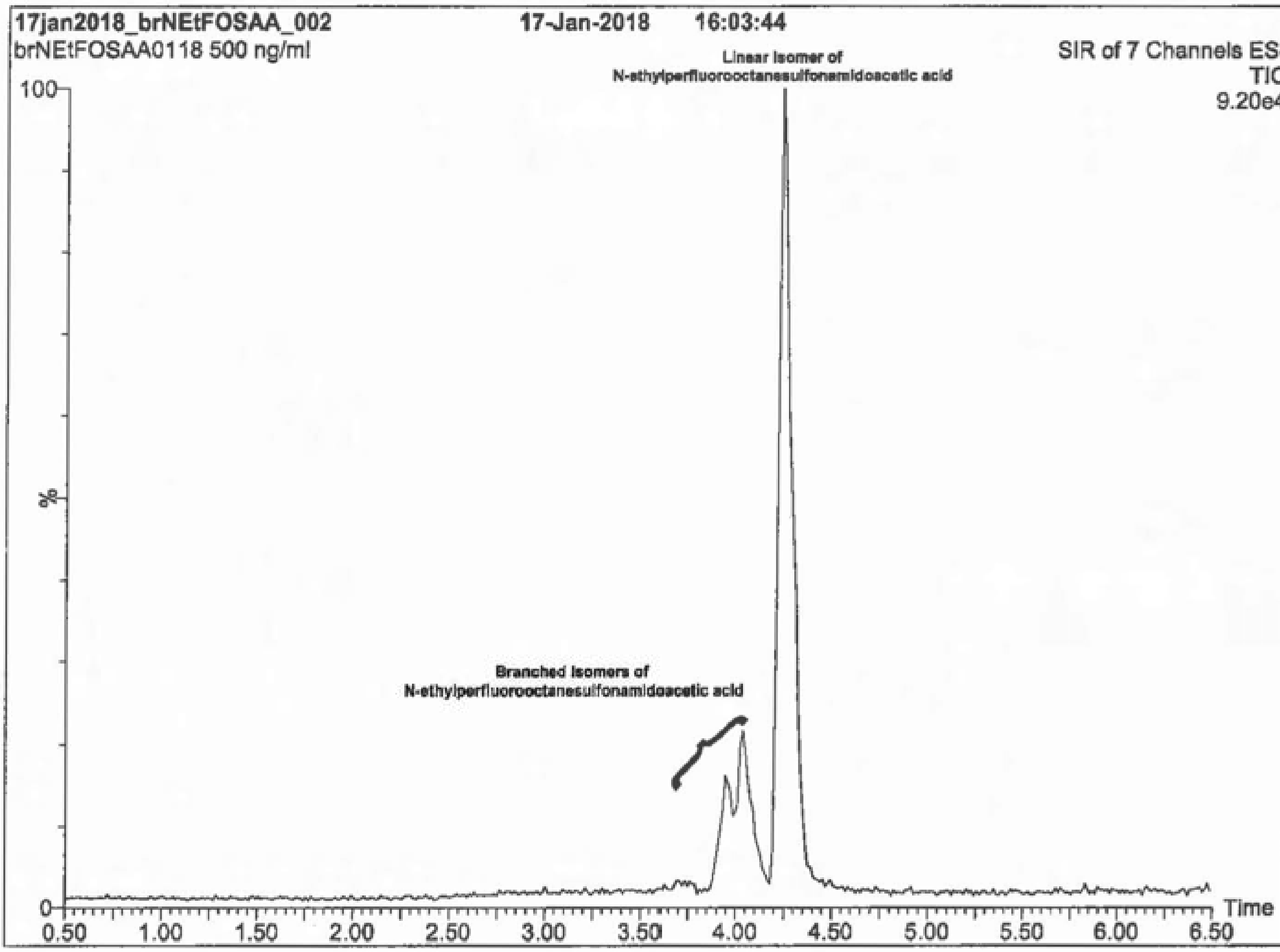
Flow: 300 µl/min

MS Parameters

Experiment: Full Scan (225 - 850 amu)

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = 35.00
Cone Gas Flow (l/hr) = 50
Desolvation Gas Flow (l/hr) = 750

Figure 2: **br-NEtFOSAA; LC/MS Data (SIR)**



Conditions for Figure 2:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 55% (80:20 MeOH:ACN) / 45% H_2O
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 7 min and hold for
2 min before returning to initial conditions in 0.5 min.

Time: 10 min

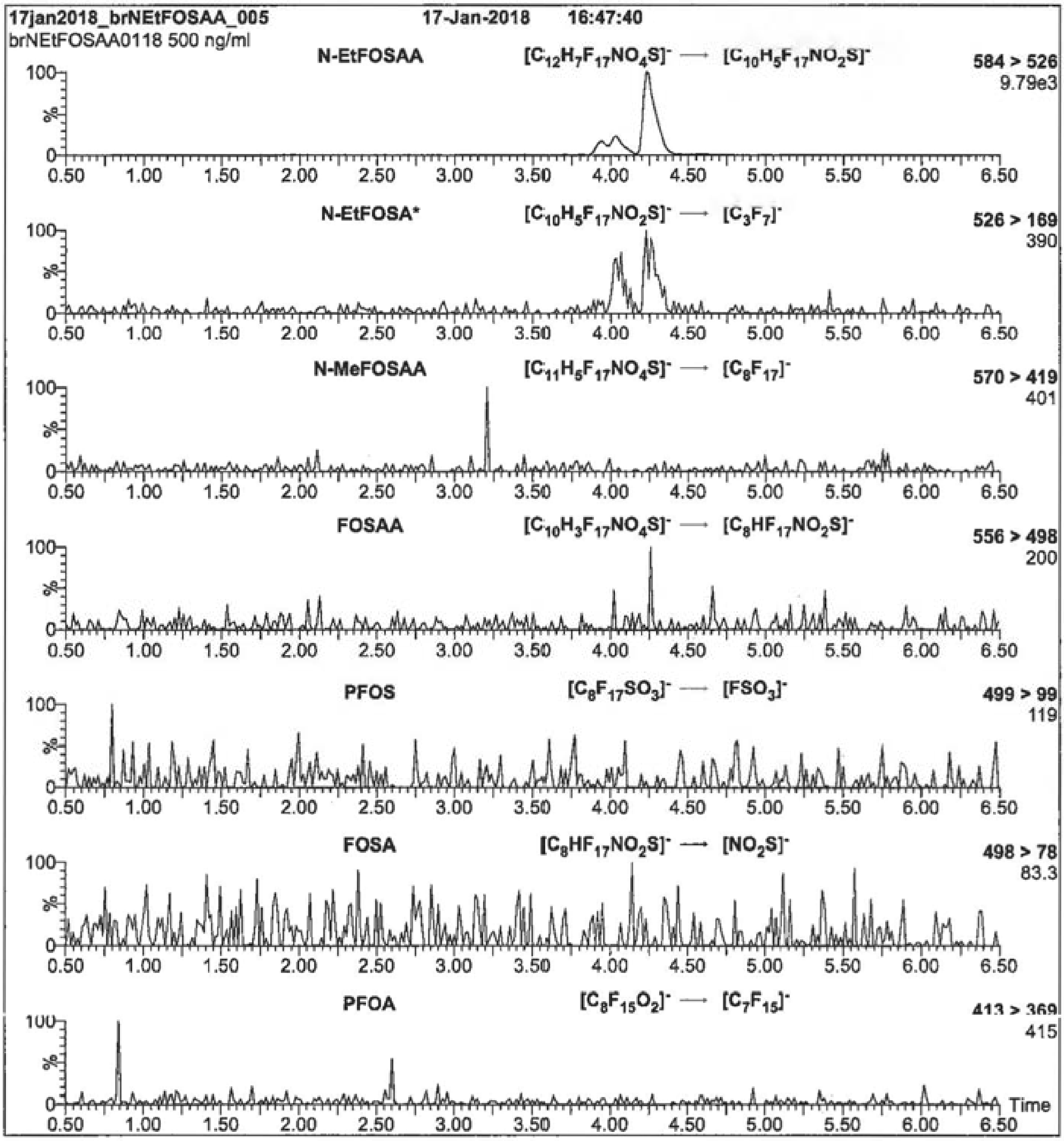
Flow: 300 µl/min

MS Parameters

Experiment: SIR (7 channels)

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = 15-60
Cone Gas Flow (l/hr) = 50
Desolvation Gas Flow (l/hr) = 750

Figure 3: **br-NEtFOSAA; LC/MS/MS Data (Selected MRM Transitions)**



*Note: N-EtFOSA is formed by in-source fragmentation.

Conditions for Figure 3:		
Injection:	On-column	**MS Parameters**
Mobile phase:	Same as Figure 2	Collision Gas (mbar) = 3.39e-3 Collision Energy (eV) = 11-40 (variable)
Flow:	300 µl/min	

Reagent

LCbr-NMeFOSAA_00001

r. 4/18/18 [handwritten initials]

WELLINGTON LABORATORIES

CERTIFICATE OF ANALYSIS DOCUMENTATION

br-NMeFOSAA

N-Methylperfluorooctanesulfonamidoacetic Acid Solution/Mixture of Linear and Branched Isomers

PRODUCT CODE:	br-NMeFOSAA
LOT NUMBER:	brNMeFOSAA0118
CONCENTRATION:	50.0 ± 2.5 µg/ml
SOLVENT(S):	Methanol/Water (<1%)
DATE PREPARED: (mm/dd/yyyy)	01/10/2018
LAST TESTED: (mm/dd/yyyy)	01/17/2018
EXPIRY DATE: (mm/dd/yyyy)	01/17/2023
RECOMMENDED STORAGE:	Refrigerate ampoule

DESCRIPTION:

The chemical purity has been determined to be ≥98% N-methylperfluorooctanesulfonamidoacetic acid (linear and branched isomers). The full name, structure and percent composition for each of the identified isomeric components are given in Table A.

DOCUMENTATION/ DATA ATTACHED:

Table A: Isomeric Components and Percent Composition by ^{19}F-NMR
Figure 1: LC/MS Data (TIC and Mass Spectrum)
Figure 2: LC/MS Data (SIR)
Figure 3: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.
- Contains 4 mole eq. of NaOH to prevent conversion of the acetic acid moiety to its respective methyl ester.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

Wellington Laboratories Inc., 345 Southgate Dr. Guelph ON N1G 3M5 CANADA
519-822-2436 • Fax: 519-822-2849 • info@well-labs.com

INTENDED USE:

The products prepared by Wellington Laboratories Inc. are for laboratory use only. This certified reference material (CRM) was designed to be used as a standard for the identification and/or quantification of the specific chemical compounds it contains.

HANDLING:

This product should only be used by qualified personnel familiar with its potential hazards and trained in the handling of hazardous chemicals. Due care should be exercised to prevent unnecessary human contact or ingestion. All procedures should be carried out in a well-functioning fume hood and suitable gloves, eye protection, and clothing should be worn at all times. Waste should be disposed of according to national and regional regulations. Safety Data Sheets (SDSs) are available upon request.

SYNTHESIS / CHARACTERIZATION:

Our products are synthesized using single-product unambiguous routes whenever possible. They are then characterized, and their structures and purities confirmed, using a combination of the most relevant techniques, such as NMR, GC/MS, LC/MS/MS, SFC/UV/MS/MS, x-ray crystallography, and melting point. Isotopic purities of mass-labelled compounds are also confirmed using HRGC/HRMS and/or LC/MS/MS.

HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS, and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products, as well as mixtures and calibration solutions, are compared to older lots in a similar manner. This further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers. In order to maintain the integrity of the assigned value(s), and associated uncertainty, the dilution or injection of a subsample of this product should be performed using calibrated measuring equipment.

UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, \ldots x_n$ on which it depends is:

$$u_c(y(x_1, x_2, \ldots x_n)) = \sqrt{\sum_{i=1}^{n} u(y, x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

TRACEABILITY:

All reference standard solutions are traceable to specific crystalline lots. The microbalances used for solution preparation are regularly calibrated by an external ISO/IEC 17025 accredited laboratory. In addition, their calibration is verified prior to each weighing using calibrated external weights traceable to an ISO/IEC 17025 accredited laboratory. All volumetric glassware used is calibrated, of Class A tolerance, and traceable to an ISO/IEC 17025 accredited laboratory. For certain products, traceability to international interlaboratory studies has also been established.

EXPIRY DATE / PERIOD OF VALIDITY:

Ongoing stability studies of this product have demonstrated stability in its composition and concentration, until the specified expiry date, in the unopened ampoule. Monitoring for any degradation or change in concentration of the listed analyte(s) is performed on a routine basis.

LIMITED WARRANTY:

At the time of shipment, all products are warranted to be free of defects in material and workmanship and to conform to the stated technical and purity specifications.

QUALITY MANAGEMENT:

This product was produced using a Quality Management System registered to the latest versions of ISO 9001 by SAI Global, ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA; A 1226), and ISO 17034 by ANSI-ASQ National Accreditation Board (ANAB; AR-1523).

CALA

ANAB ACCREDITED

For additional information or assistance concerning this or any other products from Wellington Laboratories Inc., please visit our website at www.well-labs.com or contact us directly at info@well-labs.com

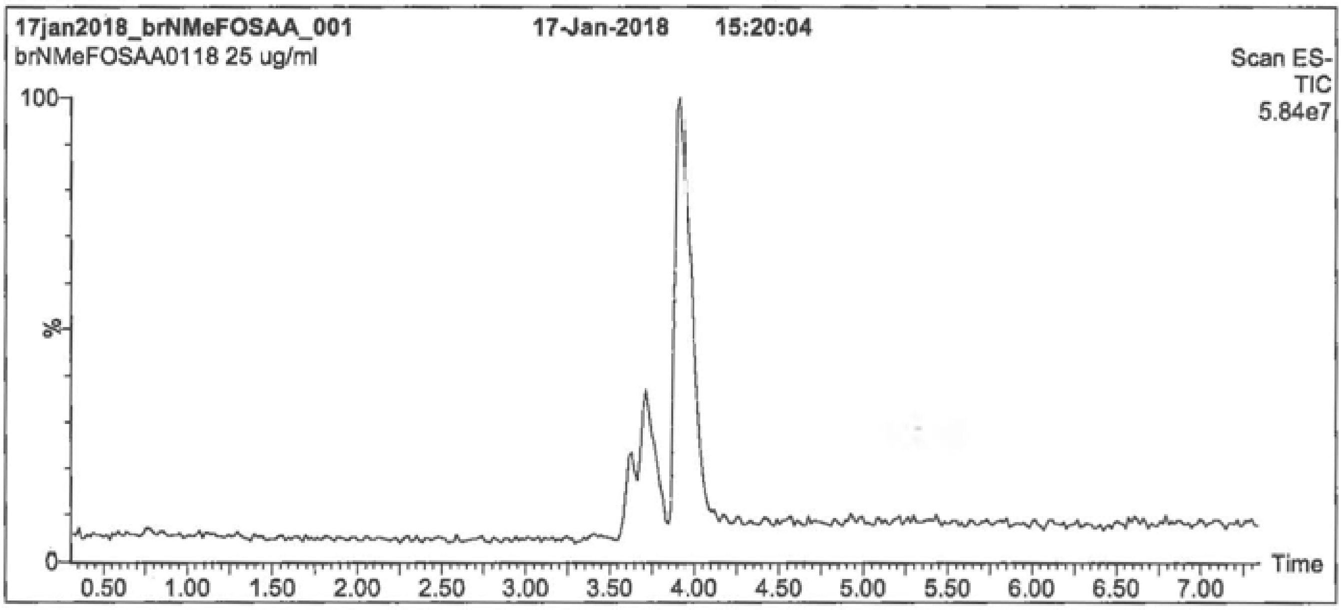
Table A: **br-NMeFOSAA; Isomeric Components and Percent Composition (by ^{19}F-NMR)***

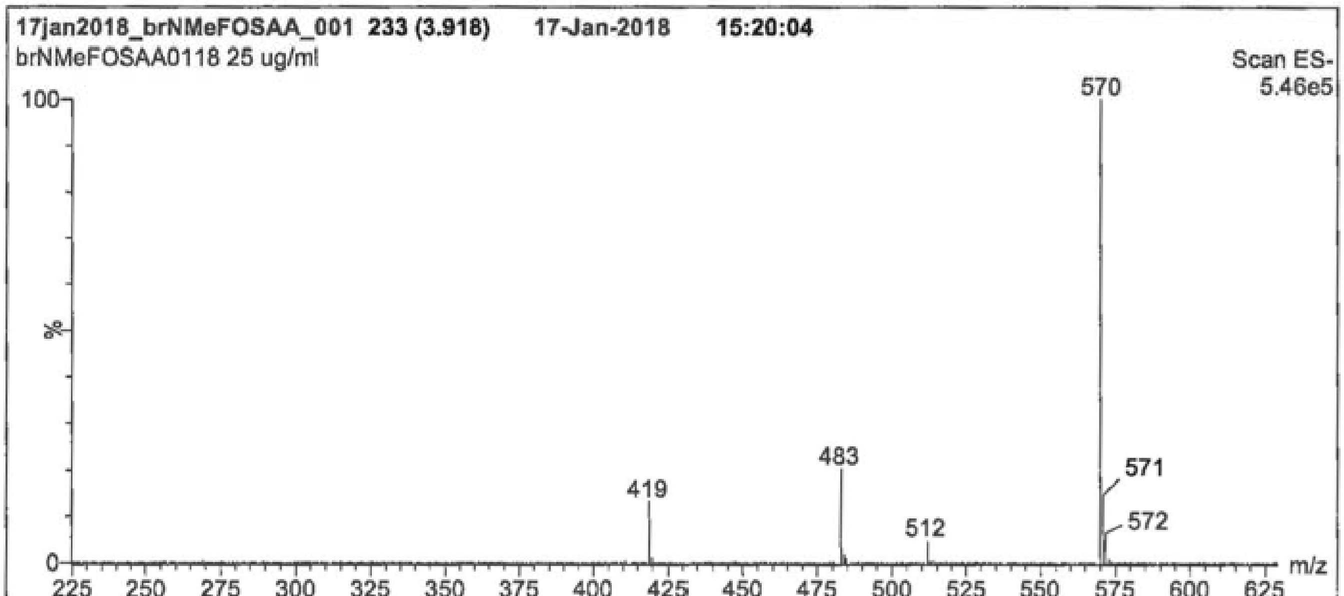
Isomer	Name	Structure	Percent Composition by ^{19}F-NMR
1	N-methylperfluoro-1-octanesulfonamidoacetic acid	$CF_3(CF_2)_7SO_2NCH_2CO_2H$ CH_3	76.0
2	N-methylperfluoro-3-methylheptanesulfonamidoacetic acid	$CF_3(CF_2)_3CF(CF_2)_2SO_2NCH_2CO_2H$ CF_3 CH_3	0.7
3	N-methylperfluoro-4-methylheptanesulfonamidoacetic acid	$CF_3(CF_2)_2CF(CF_2)_3SO_2NCH_2CO_2H$ CF_3 CH_3	2.0
4	N-methylperfluoro-5-methylheptanesulfonamidoacetic acid	$CF_3CF_2CF(CF_2)_4SO_2NCH_2CO_2H$ CF_3 CH_3	6.0
5	N-methylperfluoro-6-methylheptanesulfonamidoacetic acid	$CF_3CF(CF_2)_5SO_2NCH_2CO_2H$ CF_3 CH_3	14.0
6	N-methylperfluoro-5,5-dimethylhexanesulfonamidoacetic acid	CF_3 $CF_3C(CF_2)_4SO_2NCH_2CO_2H$ CF_3 CH_3	0.2
7	Other Unidentified Isomers		1.1

* Percent of total N-methylperfluorooctanesulfonamidoacetic acid isomers only.

Certified By: ______________ **Date:** 03/22/2018
B.G. Chittim, General Manager (mm/dd/yyyy)

Figure 1: **br-NMeFOSAA; LC/MS Data (TIC and Mass Spectrum)**





Conditions for Figure 1:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 55% (80:20 MeOH:ACN) / 45% H_2O
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 7 min and hold for
2 min before returning to initial conditions in 0.5 min.

Time: 10 min

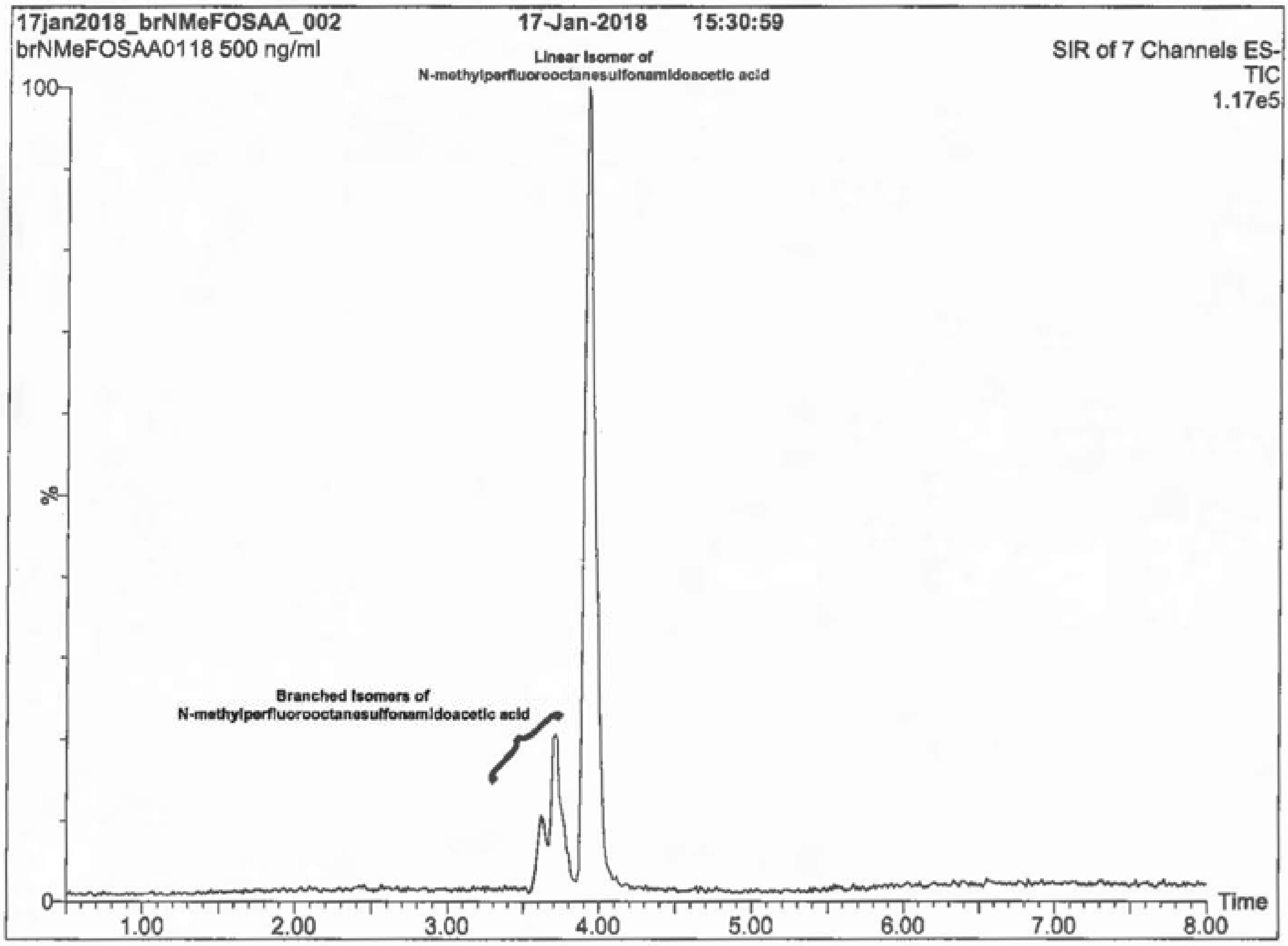
Flow: 300 µl/min

MS Parameters

Experiment: Full Scan (225 - 850 amu)

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = 35.00
Cone Gas Flow (l/hr) = 50
Desolvation Gas Flow (l/hr) = 750

Figure 2: **br-NMeFOSAA; LC/MS Data (SIR)**



Conditions for Figure 2:

LC: **Waters Acquity Ultra Performance LC**
MS: **Micromass Quattro *micro* API MS**

Chromatographic Conditions

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 55% (80:20 MeOH:ACN) / 45% H_2O
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 7 min and hold for
2 min before returning to initial conditions in 0.5 min.

Time: 10 min

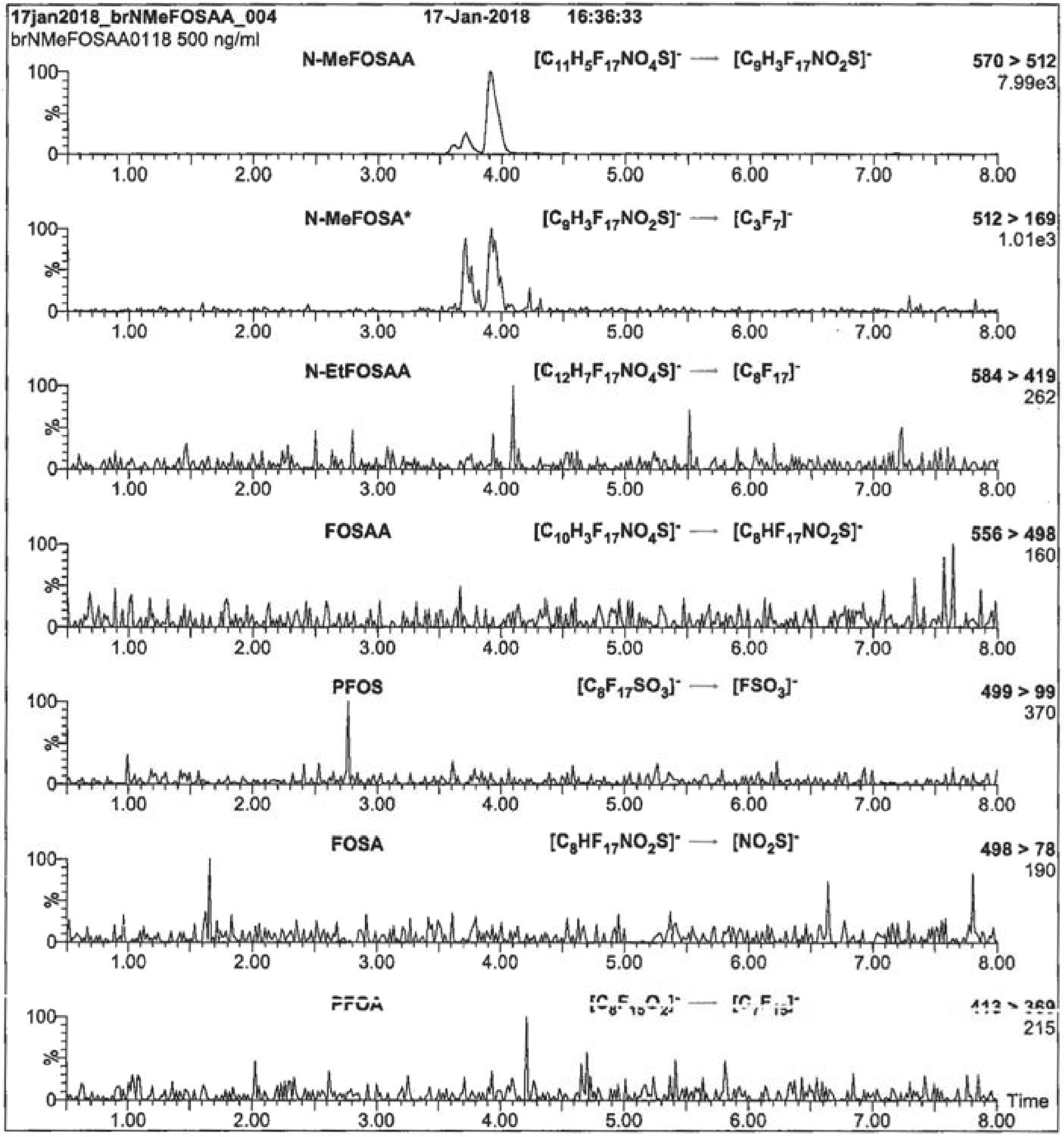
Flow: 300 µl/min

MS Parameters

Experiment: SIR (7 channels)

Source: Electrospray (negative)
Capillary Voltage (kV) = 3.00
Cone Voltage (V) = 15-60
Cone Gas Flow (l/hr) = 50
Desolvation Gas Flow (l/hr) = 750

Figure 3: **br-NMeFOSAA; LC/MS/MS Data (Selected MRM Transitions)**



***Note**: N-MeFOSA is formed by in-source fragmentation.

Conditions for Figure 3:		
Injection:	On-column	**MS Parameters**
Mobile phase:	Same as Figure 2	Collision Gas (mbar) = 3.39e-3 Collision Energy (eV) = 11-40 (variable)
Flow:	300 µl/min	

Reagent

LCd3-NMeFOSAA_00006

Fargo AASF #2

1760 North 23rd Avenue

Fargo, ND 58102

Inquiry Number: 5872123.12

November 18, 2019

The EDR Aerial Photo Decade Package

EDR®

6 Armstrong Road, 4th floor
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Toll Free: 800.352.0050
www.edrnet.com

EDR Aerial Photo Decade Package

11/18/19

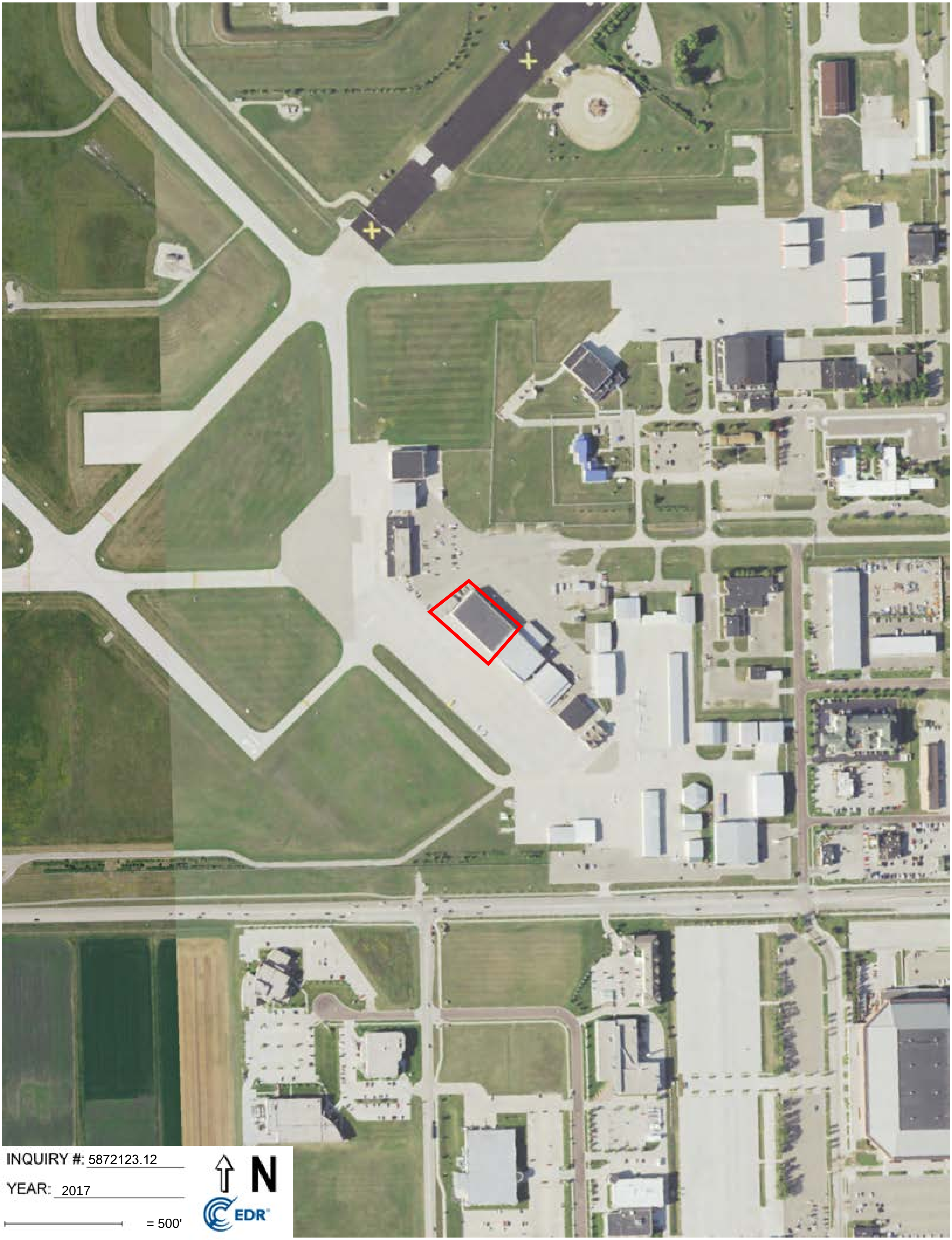
Site Name:	**Client Name:**
Fargo AASF #2	AECOM
1760 North 23rd Avenue	12120 Shamrock Plaza
Fargo, ND 58102	Omaha, NE 68154
EDR Inquiry # 5872123.12	Contact: Hans Sund

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

Search Results:

Year	Scale	Details	Source
2017	1"=500'	Flight Year: 2017	USDA/NAIP
2014	1"=500'	Flight Year: 2014	USDA/NAIP
2010	1"=500'	Flight Year: 2010	USDA/NAIP
2006	1"=500'	Flight Year: 2006	USDA/NAIP
1997	1"=500'	Acquisition Date: September 24, 1997	USGS/DOQQ
1991	1"=750'	Flight Date: April 20, 1991	USGS
1976	1"=500'	Flight Date: May 29, 1976	USGS
1972	1"=500'	Flight Date: January 01, 1972	CASS COUNTY
1962	1"=500'	Flight Date: September 13, 1962	CASS COUNTY
1954	1"=500'	Flight Date: August 28, 1954	CASS COUNTY
1952	1"=500'	Flight Date: August 23, 1952	USGS
1941	1"=500'	Flight Date: October 10, 1941	CASS COUNTY

When delivered electronically by EDR, the aerial photo images included with this report are for ONE TIME USE ONLY. Further reproduction of these aerial photo images is prohibited without permission from EDR. For more information contact your EDR Account Executive.



INQUIRY #: 5872123.12

YEAR: 2017

= 500'

N

EDR


INQUIRY #: 5872123.12
YEAR: 2014
= 500'
N
EDR

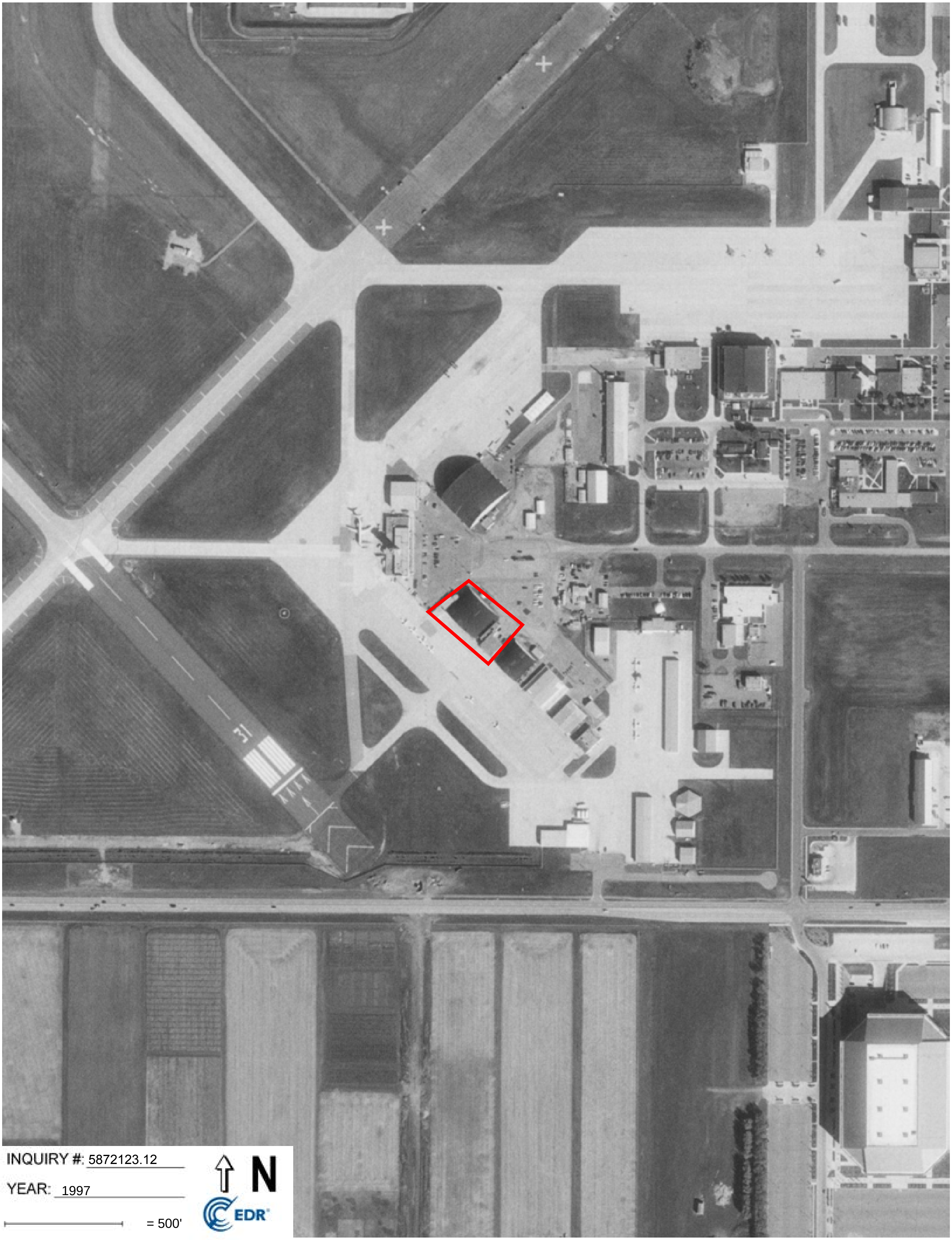

INQUIRY #: 5872123.12
YEAR: 2010
= 500'
N
EDR

INQUIRY #: 5872123.12

YEAR: 2006

= 500'

N



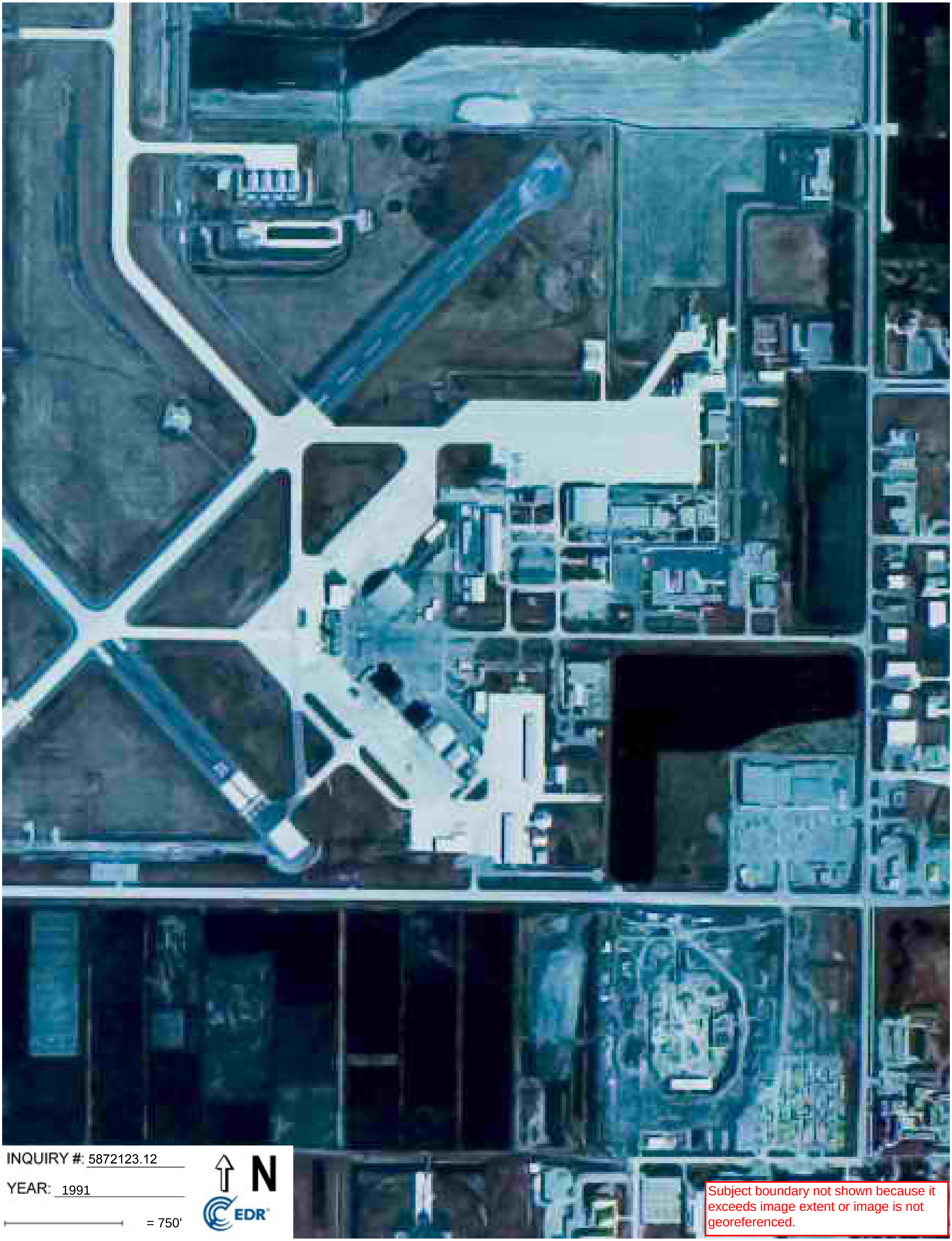
INQUIRY #: 5872123.12

YEAR: 1997

= 500'

N

EDR



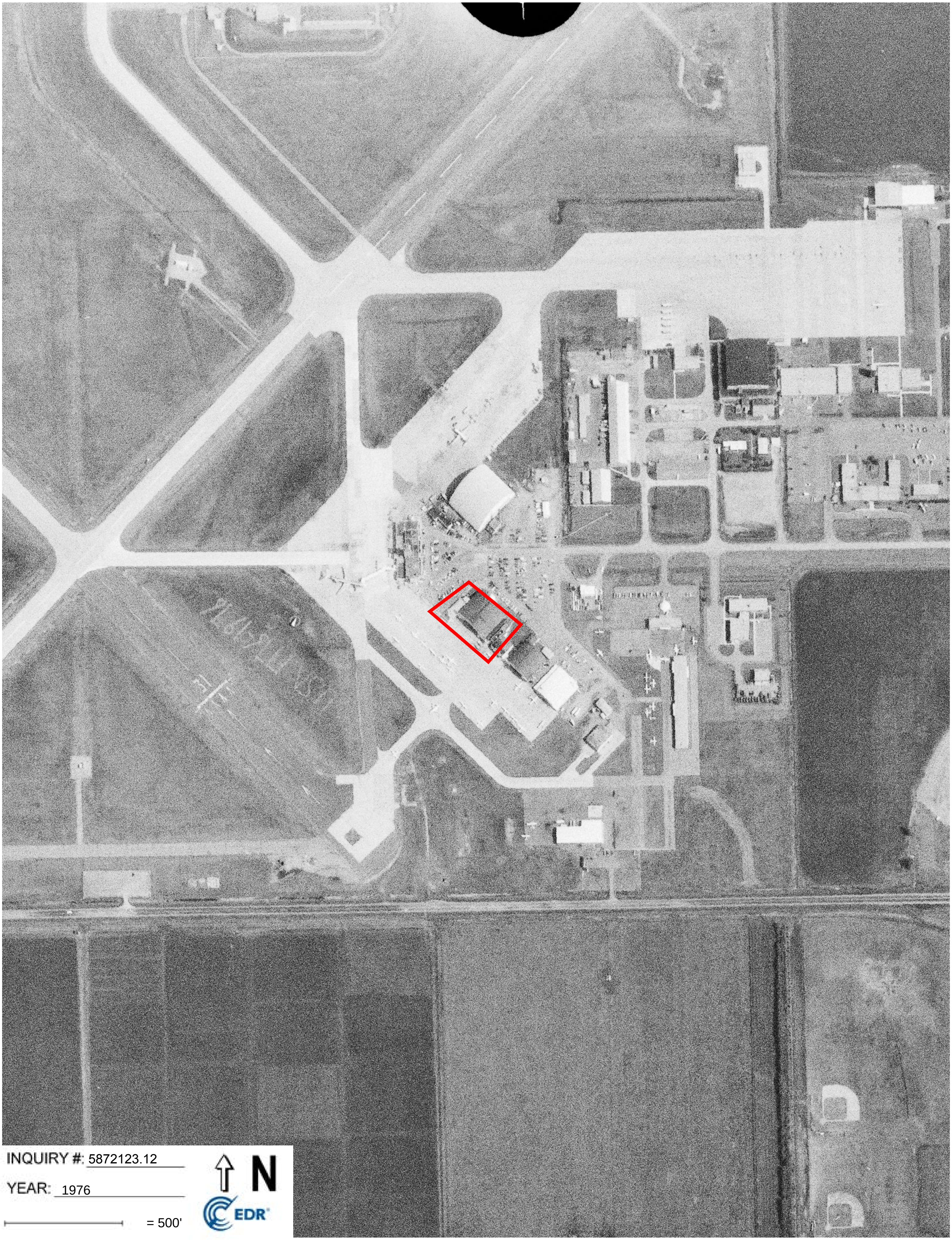
INQUIRY #: 5872123.12

YEAR: 1991

= 750'

N

EDR



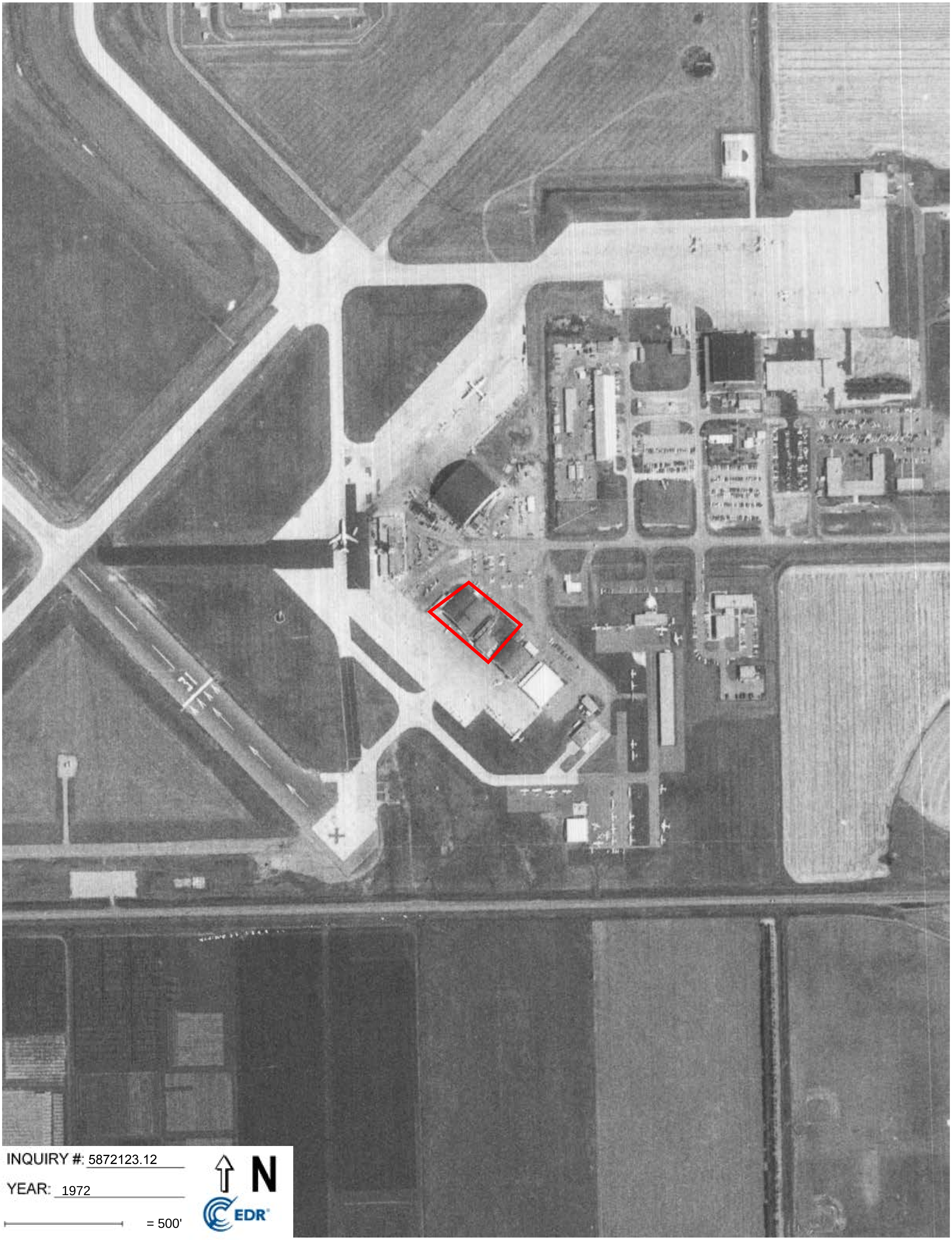
INQUIRY #: 5872123.12

YEAR: 1976

= 500'

N

EDR



INQUIRY #: 5872123.12

YEAR: 1972

= 500'

N

EDR

INQUIRY #: 5872123.12

YEAR: 1962

= 500'

EDR

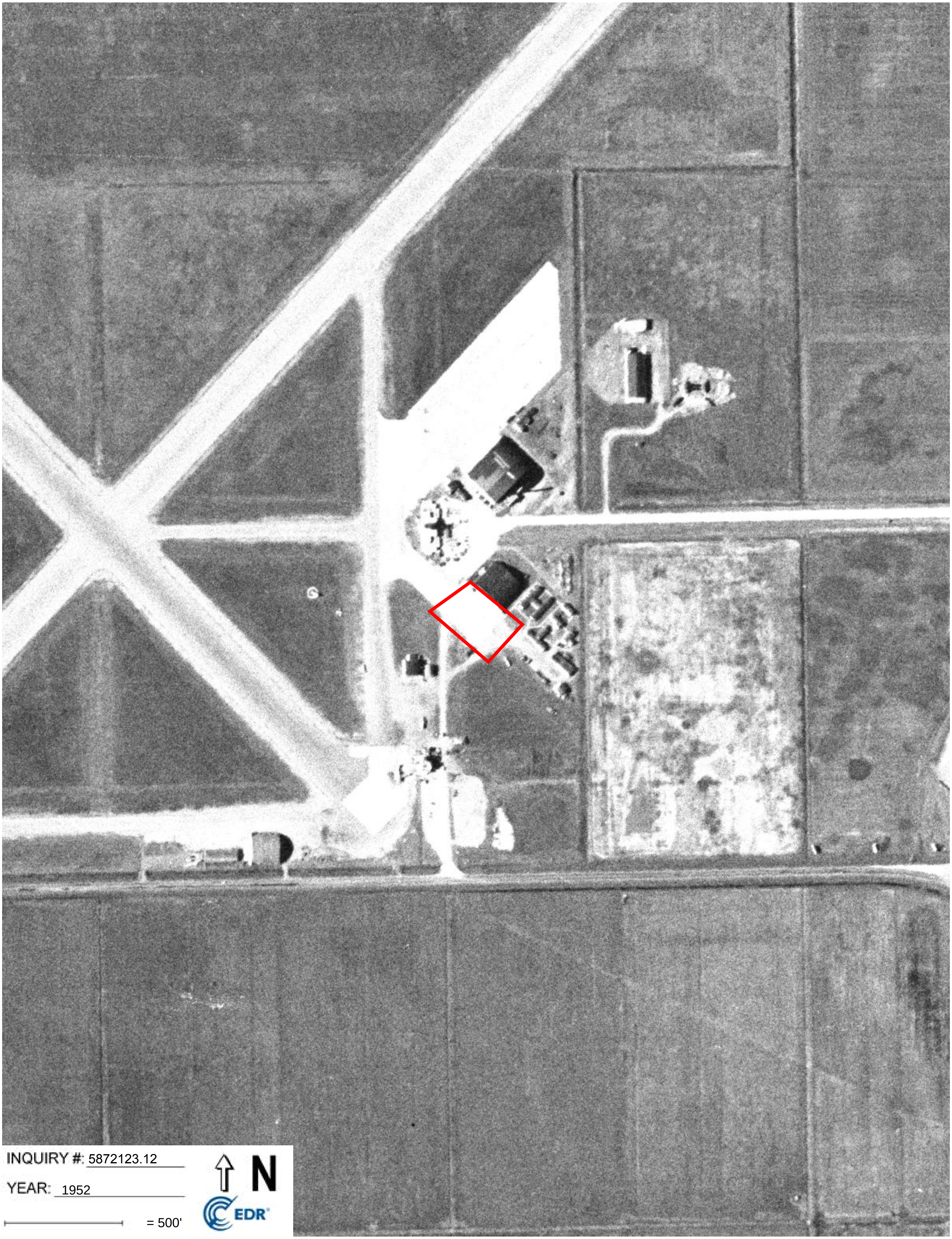
INQUIRY #: 5872123.12

YEAR: 1954

= 500'

N

EDR



INQUIRY #: 5872123.12

YEAR: 1952

= 500'

N

EDR

INQUIRY #: 5872123.12

YEAR: 1941

= 500'

N

Fargo AASF #2
1760 North 23rd Avenue
Fargo, ND 58102

Inquiry Number: 5872123.9s
November 15, 2019

The EDR Radius Map™ Report with GeoCheck®

EDR®

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

TABLE OF CONTENTS

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-13), the ASTM Standard Practice for Environmental Site Assessments for Forestland or Rural Property (E 2247-16), the ASTM Standard Practice for Limited Environmental Due Diligence: Transaction Screen Process (E 1528-14) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

1760 NORTH 23RD AVENUE
FARGO, ND 58102

COORDINATES

Latitude (North):	46.9077880 - 46˚ 54' 28.03''
Longitude (West):	96.8078630 - 96˚ 48' 28.30''
Universal Tranverse Mercator:	Zone 14
UTM X (Meters):	666947.4
UTM Y (Meters):	5197031.5
Elevation:	896 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	6049346 FARGO NORTH, ND
Version Date:	2014

AERIAL PHOTOGRAPHY IN THIS REPORT

Portions of Photo from:	20150902, 20150901
Source:	USDA

MAPPED SITES SUMMARY

Target Property Address:
1760 NORTH 23RD AVENUE
FARGO, ND 58102

Click on Map ID to see full detail.

MAP ID	SITE NAME	ADDRESS	DATABASE ACRONYMS	RELATIVE ELEVATION	DIST (ft. & mi.) DIRECTION
1	VALLEY AVIATION	1803 23RD AVENUE NOR	UST	Higher	206, 0.039, NNE
A2	GROUP VI	1722 23RD AVENUE NOR	AST	Higher	222, 0.042, SE
B3	HECTOR INTERNATIONAL	1801 23RD AVENUE N	LUST, UST	Lower	249, 0.047, NW
B4	NATIONAL WEATHER SER	1801 23RD AVENUE NOR	UST	Lower	249, 0.047, NW
A5	HECTOR AIRPORT	N UNIVERSITY	UST	Higher	270, 0.051, SSE
6	HERTZ RENT A CAR	1725 NORTH 23RD AVE	UST	Higher	530, 0.100, ENE
7	FARGO AIR, INC.	1705 NORTH 19TH AVEN	AST	Higher	713, 0.135, SSE
8	USARC - DAVID F. JOH	1610 23RD AVE N	RCRA NonGen / NLR	Higher	842, 0.159, ENE
9	NORTHWEST AIRLINES I		LUST, UST	Higher	903, 0.171, NNE
C10	BIG BLUE	1704 19TH AVE N, UNI	RCRA NonGen / NLR	Higher	1017, 0.193, SSE
C11	FARGO AIR INC	1700 BLOCK OF 19TH A	UST	Higher	1054, 0.200, SSE
12	FORMER ROCKET REPAIR		UXO	Higher	1802, 0.341, NNE
D13	FORMER SMALL ARMS RA		UXO	Higher	2158, 0.409, ENE
D14	FORMER SMALL ARMS RA		UXO	Higher	2158, 0.409, ENE
15	SMALL ARMS RANGE		UXO	Higher	2501, 0.474, NE
16	FORMER EOD RANGE		UXO	Lower	2675, 0.507, North
17	FARGO ARMY AF		FUDS	Higher	4050, 0.767, North
18	FORMER SMALL ARMS RA		UXO	Higher	4113, 0.779, NNE

EXECUTIVE SUMMARY

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL........................ National Priority List
Proposed NPL........................ Proposed National Priority List Sites
NPL LIENS........................ Federal Superfund Liens

Federal Delisted NPL site list

Delisted NPL........................ National Priority List Deletions

Federal CERCLIS list

FEDERAL FACILITY........................ Federal Facility Site Information listing
SEMS........................ Superfund Enterprise Management System

Federal CERCLIS NFRAP site list

SEMS-ARCHIVE........................ Superfund Enterprise Management System Archive

Federal RCRA CORRACTS facilities list

CORRACTS........................ Corrective Action Report

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF........................ RCRA - Treatment, Storage and Disposal

Federal RCRA generators list

RCRA-LQG........................ RCRA - Large Quantity Generators
RCRA-SQG........................ RCRA - Small Quantity Generators
RCRA-VSQG........................ RCRA - Very Small Quantity Generators (Formerly Conditionally Exempt Small Quantity Generators)

Federal institutional controls / engineering controls registries

LUCIS........................ Land Use Control Information System

EXECUTIVE SUMMARY

US ENG CONTROLS.......... Engineering Controls Sites List
US INST CONTROL.......... Sites with Institutional Controls

Federal ERNS list

ERNS.......................... Emergency Response Notification System

State- and tribal - equivalent CERCLIS

SHWS.......................... This state does not maintain a SHWS list. See the Federal CERCLIS list and Federal NPL list.

State and tribal landfill and/or solid waste disposal site lists

SWF/LF........................ Solid Waste Landfills/Special Use Landfills

State and tribal leaking storage tank lists

INDIAN LUST.................. Leaking Underground Storage Tanks on Indian Land

State and tribal registered storage tank lists

FEMA UST...................... Underground Storage Tank Listing
INDIAN UST.................... Underground Storage Tanks on Indian Land

State and tribal institutional control / engineering control registries

AUL............................. Land Use Controls Listing

State and tribal voluntary cleanup sites

INDIAN VCP.................... Voluntary Cleanup Priority Listing

State and tribal Brownfields sites

BROWNFIELDS................ List of Brownfields Sites

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS........... A Listing of Brownfields Sites

Local Lists of Landfill / Solid Waste Disposal Sites

SWRCY......................... Recycling Centers
INDIAN ODI.................... Report on the Status of Open Dumps on Indian Lands
ODI.............................. Open Dump Inventory
DEBRIS REGION 9........... Torres Martinez Reservation Illegal Dump Site Locations
IHS OPEN DUMPS............ Open Dumps on Indian Land

Local Lists of Hazardous waste / Contaminated Sites

US HIST CDL.................. Delisted National Clandestine Laboratory Register

EXECUTIVE SUMMARY

CDL - Clandestine Drug Lab Location Listing
US CDL - National Clandestine Laboratory Register

Local Land Records

LIENS 2 - CERCLA Lien Information

Records of Emergency Release Reports

HMIRS - Hazardous Materials Information Reporting System
SPILLS - State Spills

Other Ascertainable Records

DOD - Department of Defense Sites
SCRD DRYCLEANERS - State Coalition for Remediation of Drycleaners Listing
US FIN ASSUR - Financial Assurance Information
EPA WATCH LIST - EPA WATCH LIST
2020 COR ACTION - 2020 Corrective Action Program List
TSCA - Toxic Substances Control Act
TRIS - Toxic Chemical Release Inventory System
SSTS - Section 7 Tracking Systems
ROD - Records Of Decision
RMP - Risk Management Plans
RAATS - RCRA Administrative Action Tracking System
PRP - Potentially Responsible Parties
PADS - PCB Activity Database System
ICIS - Integrated Compliance Information System
FTTS - FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
MLTS - Material Licensing Tracking System
COAL ASH DOE - Steam-Electric Plant Operation Data
COAL ASH EPA - Coal Combustion Residues Surface Impoundments List
PCB TRANSFORMER - PCB Transformer Registration Database
RADINFO - Radiation Information Database
HIST FTTS - FIFRA/TSCA Tracking System Administrative Case Listing
DOT OPS - Incident and Accident Data
CONSENT - Superfund (CERCLA) Consent Decrees
INDIAN RESERV - Indian Reservations
FUSRAP - Formerly Utilized Sites Remedial Action Program
UMTRA - Uranium Mill Tailings Sites
LEAD SMELTERS - Lead Smelter Sites
US AIRS - Aerometric Information Retrieval System Facility Subsystem
US MINES - Mines Master Index File
ABANDONED MINES - Abandoned Mines
FINDS - Facility Index System/Facility Registry System
ECHO - Enforcement & Compliance History Information
DOCKET HWC - Hazardous Waste Compliance Docket Listing
FUELS PROGRAM - EPA Fuels Program Registered Listing
AIRS - Permitted Airs Facility Listing
ASBESTOS - Asbestos Notification Listing
DRYCLEANERS - Drycleaner Facility Listing
NPDES - Wastewater Facility Listing
TIER 2 - Tier 2 Information Listing
UIC - Underground Injection Wells

EXECUTIVE SUMMARY

MINES MRDS - - - - - - - - - - - - - - - Mineral Resources Data System

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP - - - - - - - - - - - - - - - - - - - EDR Proprietary Manufactured Gas Plants
EDR Hist Auto - - - - - - - - - - - - - - - EDR Exclusive Historical Auto Stations
EDR Hist Cleaner - - - - - - - - - - - - EDR Exclusive Historical Cleaners

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA LUST - - - - - - - - - - - - - - - - - - Recovered Government Archive Leaking Underground Storage Tank

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified in the following databases.

Elevations have been determined from the USGS Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property.
Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

STANDARD ENVIRONMENTAL RECORDS

State and tribal leaking storage tank lists

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Department of Health’s LUST List

A review of the LUST list, as provided by EDR, and dated 08/26/2019 has revealed that there are 2 LUST sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
NORTHWEST AIRLINES I Facility Id: 2763 Facility Status: Site Cleanup Completed		***NNE 1/8 - 1/4 (0.171 mi.)***	***9***	***16***

Lower Elevation	Address	Direction / Distance	Map ID	Page
HECTOR INTERNATIONAL Facility Id: 5357 Facility Status: Site Cleanup Completed	***1801 23RD AVENUE N***	***NW 0 - 1/8 (0.047 mi.)***	***B3***	***10***

EXECUTIVE SUMMARY

State and tribal registered storage tank lists

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the Department of Health's UST Data (Facility & Owner Address of the Tanks Currently Recorded in North Dakota).

A review of the UST list, as provided by EDR, and dated 08/26/2019 has revealed that there are 7 UST sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
VALLEY AVIATION Facility Status: Inactive Facility Id: 2520	1803 23RD AVENUE NOR	NNE 0 - 1/8 (0.039 mi.)	1	8
HECTOR AIRPORT Facility Status: Inactive Facility Id: 3726	N UNIVERSITY	SSE 0 - 1/8 (0.051 mi.)	A5	13
HERTZ RENT A CAR Facility Status: Inactive Facility Id: 6782	1725 NORTH 23RD AVE	ENE 0 - 1/8 (0.100 mi.)	6	14
NORTHWEST AIRLINES I Facility Status: Inactive Facility Id: 2763		***NNE 1/8 - 1/4 (0.171 mi.)***	***9***	***16***
FARGO AIR INC	1700 BLOCK OF 19TH A	SSE 1/8 - 1/4 (0.200 mi.)	C11	19

Lower Elevation	Address	Direction / Distance	Map ID	Page
HECTOR INTERNATIONAL Facility Status: Inactive Facility Id: 5357	***1801 23RD AVENUE N***	***NW 0 - 1/8 (0.047 mi.)***	***B3***	***10***
NATIONAL WEATHER SER Facility Status: Inactive Facility Id: 2813	1801 23RD AVENUE NOR	NW 0 - 1/8 (0.047 mi.)	B4	13

AST: The Aboveground Storage Tank database contains registered ASTs. The data come from the Department of Health & Consolidated Laboratories' AST Data (Facility & Owner Address of the Tanks Currently Recorded in North Dakota).

A review of the AST list, as provided by EDR, and dated 07/22/2019 has revealed that there are 2 AST sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
GROUP VI Facility Id: 2530 Facility Status: Active	1722 23RD AVENUE NOR	SE 0 - 1/8 (0.042 mi.)	A2	9
FARGO AIR, INC. Facility Id: 278 Facility Status: Active	1705 NORTH 19TH AVEN	SSE 1/8 - 1/4 (0.135 mi.)	7	15

EXECUTIVE SUMMARY

ADDITIONAL ENVIRONMENTAL RECORDS

Other Ascertainable Records

RCRA NonGen / NLR: RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

A review of the RCRA NonGen / NLR list, as provided by EDR, and dated 06/24/2019 has revealed that there are 2 RCRA NonGen / NLR sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
USARC - DAVID F. JOH EPA ID:: NDR000002766	1610 23RD AVE N	ENE 1/8 - 1/4 (0.159 mi.)	8	15
BIG BLUE EPA ID:: NDR000010785	1704 19TH AVE N, UNI	SSE 1/8 - 1/4 (0.193 mi.)	C10	18

FUDS: The Listing includes locations of Formerly Used Defense Sites Properties where the US Army Corps Of Engineers is actively working or will take necessary cleanup actions.

A review of the FUDS list, as provided by EDR, and dated 05/15/2019 has revealed that there is 1 FUDS site within approximately 1 mile of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
FARGO ARMY AF		N 1/2 - 1 (0.767 mi.)	17	21

UXO: A listing of unexploded ordnance site locations

A review of the UXO list, as provided by EDR, and dated 12/31/2017 has revealed that there are 6 UXO sites within approximately 1 mile of the target property.

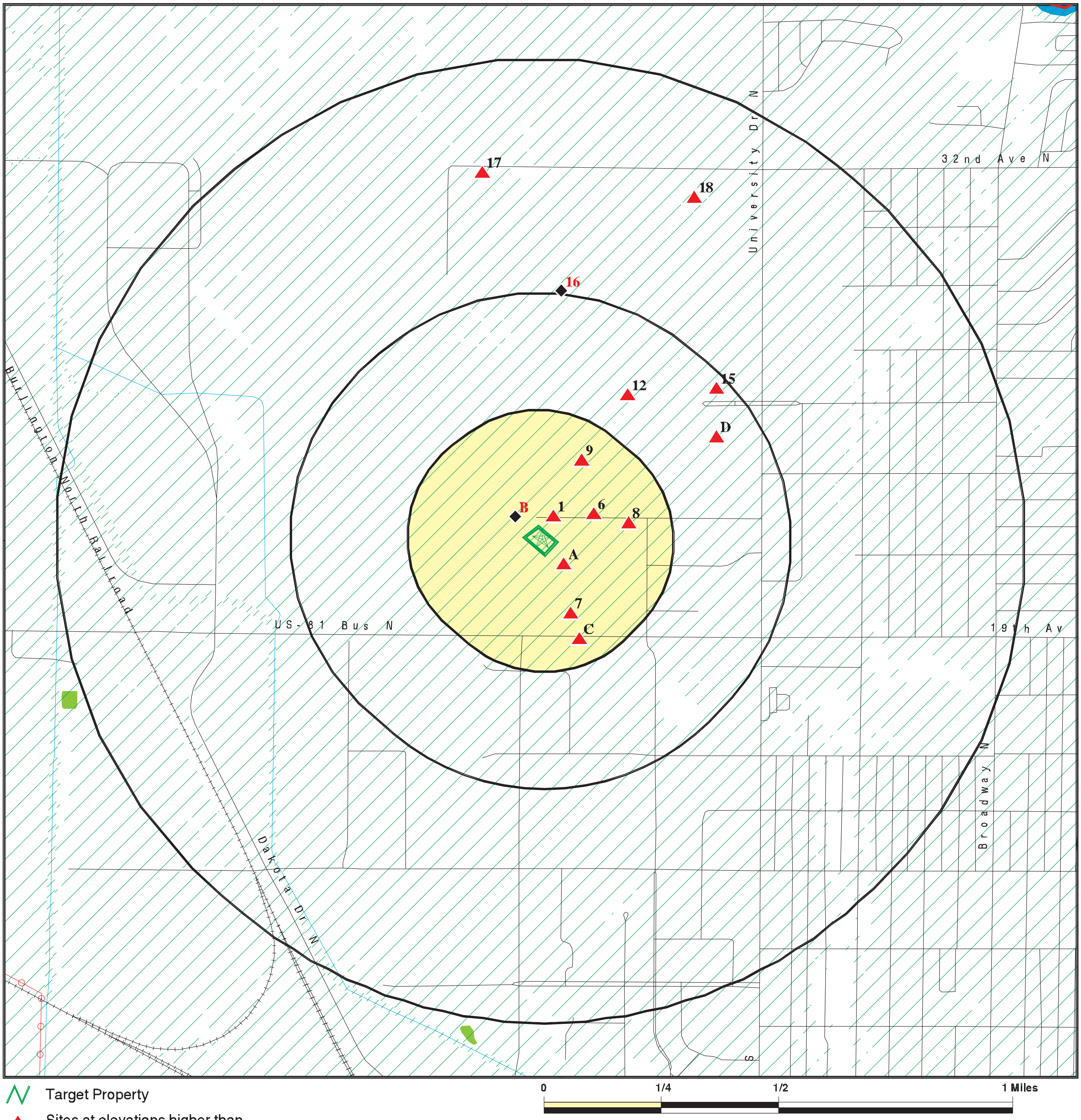
Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
FORMER ROCKET REPAIR		NNE 1/4 - 1/2 (0.341 mi.)	12	19
FORMER SMALL ARMS RA		ENE 1/4 - 1/2 (0.409 mi.)	D13	20
FORMER SMALL ARMS RA		ENE 1/4 - 1/2 (0.409 mi.)	D14	20
SMALL ARMS RANGE		NE 1/4 - 1/2 (0.474 mi.)	15	20
FORMER SMALL ARMS RA		NNE 1/2 - 1 (0.779 mi.)	18	21

Lower Elevation	Address	Direction / Distance	Map ID	Page
FORMER EOD RANGE		N 1/2 - 1 (0.507 mi.)	16	21

EXECUTIVE SUMMARY

There were no unmapped sites in this report.

OVERVIEW MAP - 5872123.9S



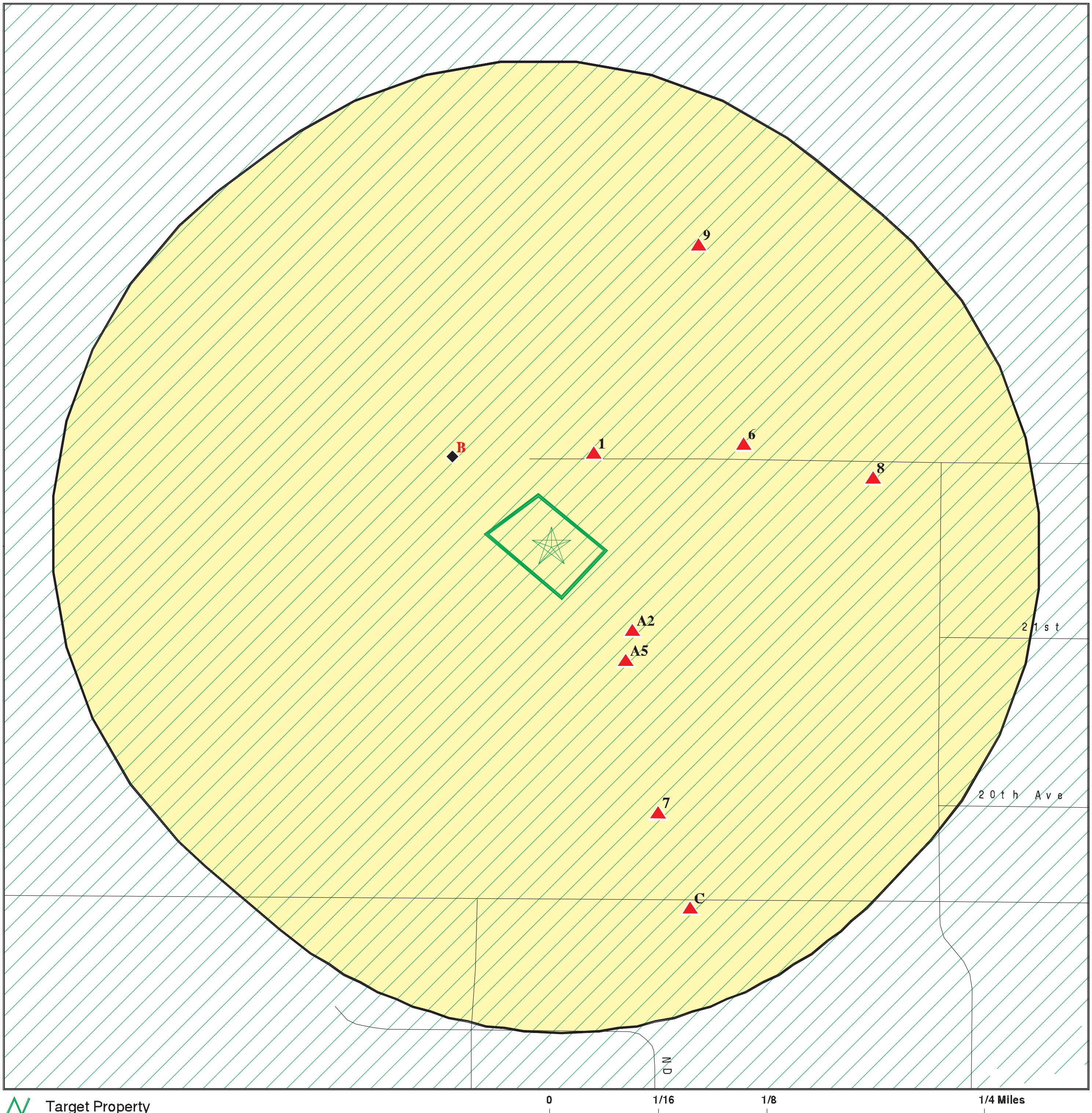
Target Property
Sites at elevations higher than or equal to the target property
Sites at elevations lower than the target property
Manufactured Gas Plants
National Priority List Sites
Dept. Defense Sites

Indian Reservations BIA
County Boundary
Power transmission lines
Special Flood Hazard Area (1%)
0.2% Annual Chance Flood Hazard
National Wetland Inventory

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: Fargo AASF #2	CLIENT: AECOM
ADDRESS: 1760 North 23rd Avenue	CONTACT: Hans Sund
Fargo ND 58102	INQUIRY #: 5872123.9s
LAT/LONG: 46.907788 / 96.807863	DATE: November 15, 2019 4:17 pm

DETAIL MAP - 5872123.9S



Target Property
Sites at elevations higher than or equal to the target property
Sites at elevations lower than the target property
Manufactured Gas Plants
Sensitive Receptors
National Priority List Sites
Dept. Defense Sites

Indian Reservations BIA
Special Flood Hazard Area (1%)
0.2% Annual Chance Flood Hazard

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME:	Fargo AASF #2	CLIENT:	AECOM
ADDRESS:	1760 North 23rd Avenue	CONTACT:	Hans Sund
	Fargo ND 58102	INQUIRY #:	5872123.9s
LAT/LONG:	46.907788 / 96.807863	DATE:	November 15, 2019 4:18 pm

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
STANDARD ENVIRONMENTAL RECORDS								
Federal NPL site list								
NPL	1.000		0	0	0	0	NR	0
Proposed NPL	1.000		0	0	0	0	NR	0
NPL LIENS	1.000		0	0	0	0	NR	0
Federal Delisted NPL site list								
Delisted NPL	1.000		0	0	0	0	NR	0
Federal CERCLIS list								
FEDERAL FACILITY	0.500		0	0	0	NR	NR	0
SEMS	0.500		0	0	0	NR	NR	0
Federal CERCLIS NFRAP site list								
SEMS-ARCHIVE	0.500		0	0	0	NR	NR	0
Federal RCRA CORRACTS facilities list								
CORRACTS	1.000		0	0	0	0	NR	0
Federal RCRA non-CORRACTS TSD facilities list								
RCRA-TSDF	0.500		0	0	0	NR	NR	0
Federal RCRA generators list								
RCRA-LQG	0.250		0	0	NR	NR	NR	0
RCRA-SQG	0.250		0	0	NR	NR	NR	0
RCRA-VSQG	0.250		0	0	NR	NR	NR	0
Federal institutional controls / engineering controls registries								
LUCIS	0.500		0	0	0	NR	NR	0
US ENG CONTROLS	0.500		0	0	0	NR	NR	0
US INST CONTROL	0.500		0	0	0	NR	NR	0
Federal ERNS list								
ERNS	TP		NR	NR	NR	NR	NR	0
State- and tribal - equivalent CERCLIS								
SHWS	N/A		N/A	N/A	N/A	N/A	N/A	N/A
State and tribal landfill and/or solid waste disposal site lists								
SWF/LF	0.500		0	0	0	NR	NR	0
State and tribal leaking storage tank lists								
LUST	0.500		1	1	0	NR	NR	2
INDIAN LUST	0.500		0	0	0	NR	NR	0
State and tribal registered storage tank lists								
FEMA UST	0.250		0	0	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
UST	0.250		5	2	NR	NR	NR	7
AST	0.250		1	1	NR	NR	NR	2
INDIAN UST	0.250		0	0	NR	NR	NR	0
State and tribal institutional control / engineering control registries								
AUL	0.500		0	0	0	NR	NR	0
State and tribal voluntary cleanup sites								
INDIAN VCP	0.500		0	0	0	NR	NR	0
State and tribal Brownfields sites								
BROWNFIELDS	0.500		0	0	0	NR	NR	0
ADDITIONAL ENVIRONMENTAL RECORDS								
Local Brownfield lists								
US BROWNFIELDS	0.500		0	0	0	NR	NR	0
Local Lists of Landfill / Solid Waste Disposal Sites								
SWRCY	0.500		0	0	0	NR	NR	0
INDIAN ODI	0.500		0	0	0	NR	NR	0
ODI	0.500		0	0	0	NR	NR	0
DEBRIS REGION 9	0.500		0	0	0	NR	NR	0
IHS OPEN DUMPS	0.500		0	0	0	NR	NR	0
Local Lists of Hazardous waste / Contaminated Sites								
US HIST CDL	TP		NR	NR	NR	NR	NR	0
CDL	TP		NR	NR	NR	NR	NR	0
US CDL	TP		NR	NR	NR	NR	NR	0
Local Land Records								
LIENS 2	TP		NR	NR	NR	NR	NR	0
Records of Emergency Release Reports								
HMIRS	TP		NR	NR	NR	NR	NR	0
SPILLS	TP		NR	NR	NR	NR	NR	0
Other Ascertainable Records								
RCRA NonGen / NLR	0.250		0	2	NR	NR	NR	2
FUDS	1.000		0	0	0	1	NR	1
DOD	1.000		0	0	0	0	NR	0
SCRD DRYCLEANERS	0.500		0	0	0	NR	NR	0
US FIN ASSUR	TP		NR	NR	NR	NR	NR	0
EPA WATCH LIST	TP		NR	NR	NR	NR	NR	0
2020 COR ACTION	0.250		0	0	NR	NR	NR	0
TSCA	TP		NR	NR	NR	NR	NR	0
TRIS	TP		NR	NR	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
SSTS	TP		NR	NR	NR	NR	NR	0
ROD	1.000		0	0	0	0	NR	0
RMP	TP		NR	NR	NR	NR	NR	0
RAATS	TP		NR	NR	NR	NR	NR	0
PRP	TP		NR	NR	NR	NR	NR	0
PADS	TP		NR	NR	NR	NR	NR	0
ICIS	TP		NR	NR	NR	NR	NR	0
FTTS	TP		NR	NR	NR	NR	NR	0
MLTS	TP		NR	NR	NR	NR	NR	0
COAL ASH DOE	TP		NR	NR	NR	NR	NR	0
COAL ASH EPA	0.500		0	0	0	NR	NR	0
PCB TRANSFORMER	TP		NR	NR	NR	NR	NR	0
RADINFO	TP		NR	NR	NR	NR	NR	0
HIST FTTS	TP		NR	NR	NR	NR	NR	0
DOT OPS	TP		NR	NR	NR	NR	NR	0
CONSENT	1.000		0	0	0	0	NR	0
INDIAN RESERV	1.000		0	0	0	0	NR	0
FUSRAP	1.000		0	0	0	0	NR	0
UMTRA	0.500		0	0	0	NR	NR	0
LEAD SMELTERS	TP		NR	NR	NR	NR	NR	0
US AIRS	TP		NR	NR	NR	NR	NR	0
US MINES	0.250		0	0	NR	NR	NR	0
ABANDONED MINES	0.250		0	0	NR	NR	NR	0
FINDS	TP		NR	NR	NR	NR	NR	0
ECHO	TP		NR	NR	NR	NR	NR	0
UXO	1.000		0	0	4	2	NR	6
DOCKET HWC	TP		NR	NR	NR	NR	NR	0
FUELS PROGRAM	0.250		0	0	NR	NR	NR	0
AIRS	TP		NR	NR	NR	NR	NR	0
ASBESTOS	TP		NR	NR	NR	NR	NR	0
DRYCLEANERS	0.250		0	0	NR	NR	NR	0
NPDES	TP		NR	NR	NR	NR	NR	0
TIER 2	TP		NR	NR	NR	NR	NR	0
UIC	TP		NR	NR	NR	NR	NR	0
MINES MRDS	TP		NR	NR	NR	NR	NR	0
EDR HIGH RISK HISTORICAL RECORDS								
EDR Exclusive Records								
EDR MGP	1.000		0	0	0	0	NR	0
EDR Hist Auto	0.125		0	NR	NR	NR	NR	0
EDR Hist Cleaner	0.125		0	NR	NR	NR	NR	0
EDR RECOVERED GOVERNMENT ARCHIVES								
Exclusive Recovered Govt. Archives								
RGA LUST	TP		NR	NR	NR	NR	NR	0
- Totals --		0	7	6	4	3	0	20

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted

NOTES:

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

N/A = This State does not maintain a SHWS list. See the Federal CERCLIS list.

1 **VALLEY AVIATION** **UST** **U004150520**
NNE **1803 23RD AVENUE NORTH** **N/A**
< 1/8 **FARGO, ND 58102**
0.039 mi.
206 ft.

Relative: **Higher**
Actual: **896 ft.**

UST:

Name:	VALLEY AVIATION
Address:	1803 23RD AVENUE NORTH
City,State,Zip:	FARGO, ND 58102
Facility ID:	2520
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	AVIATION RESOURCE LTD.
Owner Address:	1803 N 23RD AVENUE
Owner City,St,Zip:	FARGO, ND 58102
Latitude:	46.908631
Longitude:	-96.806669
Tank Number:	1
Tank Alternate ID:	R-1
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	12000
Date Closed:	02/14/1990
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

Name:	VALLEY AVIATION
Address:	1803 23RD AVENUE NORTH
City,State,Zip:	FARGO, ND 58102
Facility ID:	2520
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	AVIATION RESOURCE LTD.
Owner Address:	1803 N 23RD AVENUE
Owner City,St,Zip:	FARGO, ND 58102
Latitude:	46.908631
Longitude:	-96.806669
Tank Number:	2
Tank Alternate ID:	R-2
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	12000
Date Closed:	02/14/1990
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False

VALLEY AVIATION (Continued) **U004150520**

Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

Name:	VALLEY AVIATION
Address:	1803 23RD AVENUE NORTH
City,State,Zip:	FARGO, ND 58102
Facility ID:	2520
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	AVIATION RESOURCE LTD.
Owner Address:	1803 N 23RD AVENUE
Owner City,St,Zip:	FARGO, ND 58102
Latitude:	46.908631
Longitude:	-96.806669
Tank Number:	3
Tank Alternate ID:	R-3
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	12000
Date Closed:	02/14/1990
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

A2 **GROUP VI** **AST** **A100212401**
SE **1722 23RD AVENUE NORTH** **N/A**
< 1/8 **FARGO, ND 58102**
0.042 mi.
222 ft. **Site 1 of 2 in cluster A**

Relative: **Higher**
Actual: **896 ft.**

AST:

Name:	GROUP VI
Address:	1722 23RD AVENUE NORTH
Address line 2:	Not reported
City,State,Zip:	FARGO, ND 58102
Facility Id:	2530
Latitude:	Not reported
Longitude:	Not reported
Facility Status:	Active
Total Tanks:	2

B3 **HECTOR INTERNATIONAL AIRPORT** **LUST** **U003035158**
NW **1801 23RD AVENUE N** **UST** **N/A**
< 1/8 **FARGO, ND 58108**
0.047 mi.
249 ft. **Site 1 of 2 in cluster B**

Relative: Lower

Actual: 895 ft.

LUST:

Name:	HECTOR INTERNATIONAL AIRPORT
Address:	1801 23RD AVENUE N
City,State,Zip:	FARGO, ND 58108
Facility ID:	5357
Facility Status:	Site Cleanup Completed
Facility Latitude:	46.908631
Facility Longitude:	-96.80664
Status Date:	10/09/1991
Event ID:	5357
Owner Name:	MUNICIPAL AIRPORT AUTHORITY
Owner Address:	PO BOX 2845
Owner City,St,Zip:	FARGO, ND 58108-

UST:

Name:	HECTOR INTERNATIONAL AIRPORT
Address:	1801 23RD AVENUE N
City,State,Zip:	FARGO, ND 58108
Facility ID:	5357
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	MUNICIPAL AIRPORT AUTHORITY
Owner Address:	PO BOX 2845
Owner City,St,Zip:	FARGO, ND 58108-
Latitude:	46.908631
Longitude:	-96.80664
Tank Number:	1
Tank Alternate ID:	R-1
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	10000
Date Closed:	10/08/1991
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

Name:	HECTOR INTERNATIONAL AIRPORT
Address:	1801 23RD AVENUE N
City,State,Zip:	FARGO, ND 58108
Facility ID:	5357
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	MUNICIPAL AIRPORT AUTHORITY
Owner Address:	PO BOX 2845
Owner City,St,Zip:	FARGO, ND 58108-

HECTOR INTERNATIONAL AIRPORT (Continued) **U003035158**

Latitude:	46.908631
Longitude:	-96.80664
Tank Number:	2
Tank Alternate ID:	R-2
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	10000
Date Closed:	10/08/1991
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

Name:	HECTOR INTERNATIONAL AIRPORT
Address:	1801 23RD AVENUE N
City,State,Zip:	FARGO, ND 58108
Facility ID:	5357
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	MUNICIPAL AIRPORT AUTHORITY
Owner Address:	PO BOX 2845
Owner City,St,Zip:	FARGO, ND 58108-
Latitude:	46.908631
Longitude:	-96.80664
Tank Number:	3
Tank Alternate ID:	R-3
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	10000
Date Closed:	10/08/1991
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

Name:	HECTOR INTERNATIONAL AIRPORT
Address:	1801 23RD AVENUE N
City,State,Zip:	FARGO, ND 58108
Facility ID:	5357
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	MUNICIPAL AIRPORT AUTHORITY
Owner Address:	PO BOX 2845

HECTOR INTERNATIONAL AIRPORT (Continued) **U003035158**

Owner City,St,Zip:	FARGO, ND 58108-
Latitude:	46.908631
Longitude:	-96.80664
Tank Number:	4
Tank Alternate ID:	R-4
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	10000
Date Closed:	10/08/1991
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

Name:	HECTOR INTERNATIONAL AIRPORT
Address:	1801 23RD AVENUE N
City,State,Zip:	FARGO, ND 58108
Facility ID:	5357
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	MUNICIPAL AIRPORT AUTHORITY
Owner Address:	PO BOX 2845
Owner City,St,Zip:	FARGO, ND 58108-
Latitude:	46.908631
Longitude:	-96.80664
Tank Number:	5
Tank Alternate ID:	R-5
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	500
Date Closed:	10/08/1991
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

B4 **NATIONAL WEATHER SERVICE** **UST** **U003177303**
NW **1801 23RD AVENUE NORTH** **N/A**
< 1/8 **FARGO, ND 58102**
0.047 mi.
249 ft. **Site 2 of 2 in cluster B**

Relative: **Lower**
Actual: **895 ft.**

UST:

Name:	NATIONAL WEATHER SERVICE
Address:	1801 23RD AVENUE NORTH
City,State,Zip:	FARGO, ND 58102
Facility ID:	2813
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Owner Address:	601 EAST 12TH STREET
Owner City,St,Zip:	KANSAS CITY, MO 64106
Latitude:	46.908631
Longitude:	-96.80664
Tank Number:	1
Tank Alternate ID:	1
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	True
Tank Capacity:	500
Date Closed:	09/18/1996
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

A5 **HECTOR AIRPORT** **UST** **U003035157**
SSE **N UNIVERSITY** **N/A**
< 1/8 **FARGO, ND 58108**
0.051 mi.
270 ft. **Site 2 of 2 in cluster A**

Relative: **Higher**
Actual: **896 ft.**

UST:

Name:	HECTOR AIRPORT
Address:	N UNIVERSITY
City,State,Zip:	FARGO, ND 58108
Facility ID:	3726
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	RAY LARSON
Owner Address:	PO BOX 3085
Owner City,St,Zip:	FARGO, ND 58108
Latitude:	46.906828
Longitude:	-96.806962
Tank Number:	1
Tank Alternate ID:	R-1
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False

HECTOR AIRPORT (Continued) **U003035157**

Tank Capacity:	8000
Date Closed:	10/31/1989
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

6
ENE
< 1/8
0.100 mi.
530 ft.

HERTZ RENT A CAR
1725 NORTH 23RD AVE
FARGO, ND 58107

UST **U003542535**
N/A

Relative:
Higher

Actual:
896 ft.

UST:

Name:	HERTZ RENT A CAR
Address:	1725 NORTH 23RD AVE
City,State,Zip:	FARGO, ND 58107
Facility ID:	6782
Facility Status:	Inactive
Facility Phone:	7012388665
Owner Name:	HANSEN LEASE AND RENTAL
Owner Address:	PO BOX 627
Owner City,St,Zip:	FARGO, ND 58107
Latitude:	46.908629
Longitude:	-96.805527
Tank Number:	1
Tank Alternate ID:	R-1
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	265
Date Closed:	05/17/1995
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

7 **SSE** **1/8-1/4** **0.135 mi.** **713 ft.**	**FARGO AIR, INC.** **1705 NORTH 19TH AVENUE REAR** **FARGO, ND 58103**	**AST**	**A100307485** **N/A**

Relative: **Higher**
Actual: **896 ft.**

AST:

Name: FARGO AIR, INC.
Address: 1705 NORTH 19TH AVENUE REAR
Address line 2: Hector Airport South G.A.
City,State,Zip: FARGO, ND 58103
Facility Id: 278
Latitude: Not reported
Longitude: Not reported
Facility Status: Active
Total Tanks: 1

---

8 **ENE** **1/8-1/4** **0.159 mi.** **842 ft.**	**USARC - DAVID F. JOHNSON** **1610 23RD AVE N** **FARGO, ND 58102**	**RCRA NonGen / NLR**	**1015745438** **NDR000002766**

Relative: **Higher**
Actual: **896 ft.**

RCRA NonGen / NLR:

Date form received by agency: 1999-11-12 00:00:00.0
Facility name: USARC - DAVID F. JOHNSON
Facility address: 1610 23RD AVE N
FARGO, ND 58102
EPA ID: NDR000002766
Mailing address: 23RD AVE N
FARGO, ND 58102
Contact: RYAN H SMITH
Contact address: 23RD AVE N
FARGO, ND 58102
Contact country: US
Contact telephone: 701-235-3964
Contact email: Not reported
EPA Region: 08
Classification: Non-Generator
Description: Handler: Non-Generators do not presently generate hazardous waste

Owner/Operator Summary:

Owner/operator name: HQ 96TH REGIONAL SUPPORT COMMAND
Owner/operator address: SADAFRC BLDG 102 AFRC-CUT-ENE
SALT LAKE, UT 84113
Owner/operator country: Not reported
Owner/operator telephone: 801-736-4570
Owner/operator email: Not reported
Owner/operator fax: Not reported
Owner/operator extension: Not reported
Legal status: Federal
Owner/Operator Type: Owner
Owner/Op start date: Not reported
Owner/Op end date: Not reported

Owner/operator name: US ARMY RESERVE
Owner/operator address: 23RD AVE N
FARGO, ND 58102
Owner/operator country: US

USARC - DAVID F. JOHNSON (Continued) **1015745438**

Owner/operator telephone:	Not reported
Owner/operator email:	Not reported
Owner/operator fax:	Not reported
Owner/operator extension:	Not reported
Legal status:	Federal
Owner/Operator Type:	Operator
Owner/Op start date:	1963-12-01 00:00:00.0
Owner/Op end date:	Not reported

Handler Activities Summary:

U.S. importer of hazardous waste:	No
Mixed waste (haz. and radioactive):	No
Recycler of hazardous waste:	No
Transporter of hazardous waste:	No
Treater, storer or disposer of HW:	No
Underground injection activity:	No
On-site burner exemption:	No
Furnace exemption:	No
Used oil fuel burner:	No
Used oil processor:	No
User oil refiner:	No
Used oil fuel marketer to burner:	No
Used oil Specification marketer:	No
Used oil transfer facility:	No
Used oil transporter:	No

Violation Status: No violations found

---

9 **NNE** **1/8-1/4** **0.171 mi.** **903 ft.**	**NORTHWEST AIRLINES INC** **FARGO, ND 58108**	**LUST** **UST**	**U003035218** **N/A**

Relative:
Higher

Actual:
896 ft.

LUST:

Name:	NORTHWEST AIRLINES INC
Address:	Not reported
City,State,Zip:	FARGO, ND 58108
Facility ID:	2763
Facility Status:	Site Cleanup Completed
Facility Latitude:	46.910284
Facility Longitude:	-96.806074
Status Date:	04/19/1999
Event ID:	2763
Owner Name:	NORTHWEST AIRLINES INC.
Owner Address:	MPLS ST PAUL INTL AIRPORT
Owner City,St,Zip:	SAINT PAUL, MN 55111

UST:

Name:	NORTHWEST AIRLINES INC
Address:	Not reported
City,State,Zip:	FARGO, ND 58108
Facility ID:	2763
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	NORTHWEST AIRLINES INC.
Owner Address:	MPLS ST PAUL INTL AIRPORT
Owner City,St,Zip:	SAINT PAUL, MN 55111

NORTHWEST AIRLINES INC (Continued) **U003035218**

Latitude:	46.910284
Longitude:	-96.806074
Tank Number:	1
Tank Alternate ID:	R-1
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	25000
Date Closed:	07/27/1989
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

Name:	NORTHWEST AIRLINES INC
Address:	Not reported
City,State,Zip:	FARGO, ND 58108
Facility ID:	2763
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	NORTHWEST AIRLINES INC.
Owner Address:	MPLS ST PAUL INTL AIRPORT
Owner City,St,Zip:	SAINT PAUL, MN 55111
Latitude:	46.910284
Longitude:	-96.806074
Tank Number:	2
Tank Alternate ID:	R-2
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	25000
Date Closed:	07/27/1989
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

Name:	NORTHWEST AIRLINES INC
Address:	Not reported
City,State,Zip:	FARGO, ND 58108
Facility ID:	2763
Facility Status:	Inactive
Facility Phone:	Not reported
Owner Name:	NORTHWEST AIRLINES INC.
Owner Address:	MPLS ST PAUL INTL AIRPORT

NORTHWEST AIRLINES INC (Continued) **U003035218**

Owner City,St,Zip:	SAINT PAUL, MN 55111
Latitude:	46.910284
Longitude:	-96.806074
Tank Number:	3
Tank Alternate ID:	R-3
Tank Status:	Permanently Out of Use
Tank Fed Regulated:	True
Tank AST:	False
Tank Standby:	False
Tank Capacity:	10000
Date Closed:	07/27/1989
Tank Closure Status:	Tank removed from ground
Tank Material:	Asphalt Coated or Bare Steel
Tank Sec Material:	None
Tank Vapor Monitor:	False
Tank GW Monitor:	False
Tank Double Wall:	False
Tank Sec Contain:	False
Pipe Vapor Monitor:	False
Pipe GW Monitor:	False

C10 **BIG BLUE** **RCRA NonGen / NLR** **1016169472**
SSE **1704 19TH AVE N, UNIT 4E** **NDR000010785**
1/8-1/4 **FARGO, ND 58102**
0.193 mi.
1017 ft. **Site 1 of 2 in cluster C**

Relative:
Higher

Actual:
896 ft.

RCRA NonGen / NLR:

Date form received by agency:	2013-07-10 00:00:00.0
Facility name:	BIG BLUE
Facility address:	1704 19TH AVE N, UNIT 4E FARGO, ND 58102
EPA ID:	NDR000010785
Mailing address:	UNIVERSITY DRIVE S FARGO, ND 58103-4169
Contact:	BERNIE NESS
Contact address:	UNIVERSITY DRIVE S FARGO, ND 58103-4169
Contact country:	US
Contact telephone:	701-306-2201
Contact email:	BERNIENESS@YAHOO.COM
EPA Region:	08
Classification:	Non-Generator
Description:	Handler: Non-Generators do not presently generate hazardous waste

Owner/Operator Summary:

Owner/operator name:	NW LEASING LLP
Owner/operator address:	UNIVERSITY DRIVE S FARGO, ND 58103
Owner/operator country:	US
Owner/operator telephone:	701-306-2201
Owner/operator email:	Not reported
Owner/operator fax:	Not reported
Owner/operator extension:	Not reported
Legal status:	Private
Owner/Operator Type:	Operator
Owner/Op start date:	1999-01-01 00:00:00.0

BIG BLUE (Continued) **1016169472**

Owner/Op end date: Not reported

Owner/operator name: NW LEASING LLP
Owner/operator address: UNIVERSITY DRIVE S
FARGO, ND 58103
Owner/operator country: US
Owner/operator telephone: 701-306-2201
Owner/operator email: Not reported
Owner/operator fax: Not reported
Owner/operator extension: Not reported
Legal status: Private
Owner/Operator Type: Owner
Owner/Op start date: 1999-01-01 00:00:00.0
Owner/Op end date: Not reported

Handler Activities Summary:
U.S. importer of hazardous waste: No
Mixed waste (haz. and radioactive): No
Recycler of hazardous waste: No
Transporter of hazardous waste: No
Treater, storer or disposer of HW: No
Underground injection activity: No
On-site burner exemption: No
Furnace exemption: No
Used oil fuel burner: No
Used oil processor: No
User oil refiner: No
Used oil fuel marketer to burner: No
Used oil Specification marketer: No
Used oil transfer facility: No
Used oil transporter: No

Violation Status: No violations found

C11
SSE
1/8-1/4
0.200 mi.
1054 ft.

FARGO AIR INC
1700 BLOCK OF 19TH AVENUE NORTH
FARGO, ND 58107

UST **U004150516**
N/A

Site 2 of 2 in cluster C

Relative:
Higher
Actual:
896 ft.

UST:
No Details: Please contact your EDR Account Executive for more information about this site

---

12
NNE
1/4-1/2
0.341 mi.
1802 ft.

FORMER ROCKET REPAIR BUILDING

FARGO, ND

UXO **1024717009**
N/A

Relative:
Higher
Actual:
896 ft.

UXO:
DoD Component: Air Force
Installation Name: HECTOR IAP
Facility Address 2: Not reported
Site ID: MU742
Site Type: Multi Use Range

FORMER ROCKET REPAIR BUILDING (Continued) **1024717009**

Latitude: 46.912300000000002
Longitude: -96.804000000000002

D13
ENE
1/4-1/2
0.409 mi.
2158 ft.

FORMER SMALL ARMS RANGE (A) — **UXO** — **1024717695** **N/A**

FARGO, ND

Site 1 of 2 in cluster D

Relative: Higher
Actual: 896 ft.

UXO:
DoD Component: Air Force
Installation Name: HECTOR IAP
Facility Address 2: Not reported
Site ID: SR744A
Site Type: Small Arms Range
Latitude: 46.911000000000001
Longitude: -96.799999999999997

D14
ENE
1/4-1/2
0.409 mi.
2158 ft.

FORMER SMALL ARMS RANGE — **UXO** — **1024717696** **N/A**

FARGO, ND

Site 2 of 2 in cluster D

Relative: Higher
Actual: 896 ft.

UXO:
DoD Component: Air Force
Installation Name: HECTOR IAP
Facility Address 2: Not reported
Site ID: SR744
Site Type: Small Arms Range
Latitude: 46.911000000000001
Longitude: -96.799999999999997

15
NE
1/4-1/2
0.474 mi.
2501 ft.

SMALL ARMS RANGE — **UXO** — **1024717641** **N/A**

FARGO, ND

Relative: Higher
Actual: 896 ft.

UXO:
DoD Component: Air Force
Installation Name: HECTOR IAP
Facility Address 2: Not reported
Site ID: SR506
Site Type: Small Arms Range
Latitude: 46.912500000000001
Longitude: -96.799999999999997

16 **North** **1/2-1** **0.507 mi.** **2675 ft.**	**FORMER EOD RANGE** **FARGO, ND**	**UXO**	**1024716061** **N/A**

Relative: **Lower**

Actual: **891 ft.**

UXO:

DoD Component:	Air Force
Installation Name:	HECTOR IAP
Facility Address 2:	Not reported
Site ID:	ED743
Site Type:	EOD Range
Latitude:	46.915500000000002
Longitude:	-96.807000000000002

---

17 **North** **1/2-1** **0.767 mi.** **4050 ft.**	**FARGO ARMY AF** **FARGO, ND**	**FUDS**	**1024898914** **N/A**

Relative: **Higher**

Actual: **901 ft.**

FUDS:

EPA Region:	8
Installation ID:	ND89799F070600
Congressional District Number:	0
Facility Name:	FARGO ARMY AF
FUDS Number:	B08ND0401
City:	FARGO
State:	ND
County:	CASS
Telephone:	402-995-2416
USACE Division:	Northwestern Division (NWD)
USACE District:	Omaha District (NWO)
Status:	Properties without projects
Current Owner:	Local Government
X Coord:	-96.810555560290197
Y Coord:	46.919166669706897
Latitude:	46.919166670000003
Longitude:	-96.810555559999997

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18 **NNE** **1/2-1** **0.779 mi.** **4113 ft.**	**FORMER SMALL ARMS RANGE BERM** **FARGO, ND**	**UXO**	**1024717697** **N/A**

Relative: **Higher**

Actual: **896 ft.**

UXO:

DoD Component:	Air Force
Installation Name:	HECTOR IAP
Facility Address 2:	Not reported
Site ID:	SR745
Site Type:	Small Arms Range
Latitude:	46.918399999999998
Longitude:	-96.801000000000002

Count: 0 records.

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
		NO SITES FOUND			

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Number of Days to Update: Provides confirmation that EDR is reporting records that have been updated within 90 days from the date the government agency made the information available to the public.

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL: National Priority List

National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 07/19/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 35

Source: EPA
Telephone: N/A
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 01/13/2020
Data Release Frequency: Quarterly

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 3
Telephone 215-814-5418

EPA Region 4
Telephone 404-562-8033

EPA Region 5
Telephone 312-886-6686

EPA Region 10
Telephone 206-553-8665

EPA Region 6
Telephone: 214-655-6659

EPA Region 7
Telephone: 913-551-7247

EPA Region 8
Telephone: 303-312-6774

EPA Region 9
Telephone: 415-947-4246

Proposed NPL: Proposed National Priority List Sites

A site that has been proposed for listing on the National Priorities List through the issuance of a proposed rule in the Federal Register. EPA then accepts public comments on the site, responds to the comments, and places on the NPL those sites that continue to meet the requirements for listing.

Date of Government Version: 07/19/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 35

Source: EPA
Telephone: N/A
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 01/13/2020
Data Release Frequency: Quarterly

NPL LIENS: Federal Superfund Liens

Federal Superfund Liens. Under the authority granted the USEPA by CERCLA of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner received notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/1991
Date Data Arrived at EDR: 02/02/1994
Date Made Active in Reports: 03/30/1994
Number of Days to Update: 56

Source: EPA
Telephone: 202-564-4267
Last EDR Contact: 08/15/2011
Next Scheduled EDR Contact: 11/28/2011
Data Release Frequency: No Update Planned

Federal Delisted NPL site list

Delisted NPL: National Priority List Deletions

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 07/19/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 35

Source: EPA
Telephone: N/A
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 01/13/2020
Data Release Frequency: Quarterly

Federal CERCLIS list

FEDERAL FACILITY: Federal Facility Site Information listing

A listing of National Priority List (NPL) and Base Realignment and Closure (BRAC) sites found in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Database where EPA Federal Facilities Restoration and Reuse Office is involved in cleanup activities.

Date of Government Version: 04/03/2019
Date Data Arrived at EDR: 04/05/2019
Date Made Active in Reports: 05/14/2019
Number of Days to Update: 39

Source: Environmental Protection Agency
Telephone: 703-603-8704
Last EDR Contact: 10/04/2019
Next Scheduled EDR Contact: 01/13/2020
Data Release Frequency: Varies

SEMS: Superfund Enterprise Management System

SEMS (Superfund Enterprise Management System) tracks hazardous waste sites, potentially hazardous waste sites, and remedial activities performed in support of EPA’s Superfund Program across the United States. The list was formerly know as CERCLIS, renamed to SEMS by the EPA in 2015. The list contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This dataset also contains sites which are either proposed to or on the National Priorities List (NPL) and the sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 07/19/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 35

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 01/27/2020
Data Release Frequency: Quarterly

Federal CERCLIS NFRAP site list

SEMS-ARCHIVE: Superfund Enterprise Management System Archive

SEMS-ARCHIVE (Superfund Enterprise Management System Archive) tracks sites that have no further interest under the Federal Superfund Program based on available information. The list was formerly known as the CERCLIS-NFRAP, renamed to SEMS ARCHIVE by the EPA in 2015. EPA may perform a minimal level of assessment work at a site while it is archived if site conditions change and/or new information becomes available. Archived sites have been removed and archived from the inventory of SEMS sites. Archived status indicates that, to the best of EPA's knowledge, assessment at a site has been completed and that EPA has determined no further steps will be taken to list the site on the National Priorities List (NPL), unless information indicates this decision was not appropriate or other considerations require a recommendation for listing at a later time. The decision does not necessarily mean that there is no hazard associated with a given site; it only means that. based upon available information, the location is not judged to be potential NPL site.

Date of Government Version: 07/19/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 35

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 01/27/2020
Data Release Frequency: Quarterly

Federal RCRA CORRACTS facilities list

CORRACTS: Corrective Action Report
CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 06/24/2019
Date Data Arrived at EDR: 06/26/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 113

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 10/28/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Quarterly

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF: RCRA - Treatment, Storage and Disposal
RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Transporters are individuals or entities that move hazardous waste from the generator offsite to a facility that can recycle, treat, store, or dispose of the waste. TSDFs treat, store, or dispose of the waste.

Date of Government Version: 06/24/2019
Date Data Arrived at EDR: 06/26/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 113

Source: Environmental Protection Agency
Telephone: 303-312-6149
Last EDR Contact: 10/28/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Quarterly

Federal RCRA generators list

RCRA-LQG: RCRA - Large Quantity Generators
RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Large quantity generators (LQGs) generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month.

Date of Government Version: 06/24/2019
Date Data Arrived at EDR: 06/26/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 113

Source: Environmental Protection Agency
Telephone: 303-312-6149
Last EDR Contact: 10/28/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Quarterly

RCRA-SQG: RCRA - Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Small quantity generators (SQGs) generate between 100 kg and 1,000 kg of hazardous waste per month.

Date of Government Version: 06/24/2019
Date Data Arrived at EDR: 06/26/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 113

Source: Environmental Protection Agency
Telephone: 303-312-6149
Last EDR Contact: 10/28/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Quarterly

RCRA-VSQG: RCRA - Very Small Quantity Generators (Formerly Conditionally Exempt Small Quantity Generators)

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Very small quantity generators (VSQGs) generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.

Date of Government Version: 06/24/2019
Date Data Arrived at EDR: 06/26/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 113

Source: Environmental Protection Agency
Telephone: 303-312-6149
Last EDR Contact: 10/28/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Quarterly

Federal institutional controls / engineering controls registries

LUCIS: Land Use Control Information System

LUCIS contains records of land use control information pertaining to the former Navy Base Realignment and Closure properties.

Date of Government Version: 08/13/2019
Date Data Arrived at EDR: 08/20/2019
Date Made Active in Reports: 08/26/2019
Number of Days to Update: 6

Source: Department of the Navy
Telephone: 843-820-7326
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 02/24/2020
Data Release Frequency: Varies

US ENG CONTROLS: Engineering Controls Sites List

A listing of sites with engineering controls in place. Engineering controls include various forms of caps, building foundations, liners, and treatment methods to create pathway elimination for regulated substances to enter environmental media or effect human health.

Date of Government Version: 08/19/2019
Date Data Arrived at EDR: 08/20/2019
Date Made Active in Reports: 08/26/2019
Number of Days to Update: 6

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 08/20/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Varies

US INST CONTROL: Sites with Institutional Controls

A listing of sites with institutional controls in place. Institutional controls include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post remediation care requirements intended to prevent exposure to contaminants remaining on site. Deed restrictions are generally required as part of the institutional controls.

Date of Government Version: 08/19/2019
Date Data Arrived at EDR: 08/20/2019
Date Made Active in Reports: 08/26/2019
Number of Days to Update: 6

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 08/20/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Varies

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

Federal ERNS list

ERNS: Emergency Response Notification System
Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 09/09/2019	Source: National Response Center, United States Coast Guard
Date Data Arrived at EDR: 09/09/2019	Telephone: 202-267-2180
Date Made Active in Reports: 09/23/2019	Last EDR Contact: 09/09/2019
Number of Days to Update: 14	Next Scheduled EDR Contact: 01/06/2020
	Data Release Frequency: Quarterly

State- and tribal - equivalent CERCLIS

SHWS: This state does not maintain a SHWS list. See the Federal CERCLIS list and Federal NPL list.
State Hazardous Waste Sites. State hazardous waste site records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. Available information varies by state.

Date of Government Version: N/A	Source: Department of Environmental Quality
Date Data Arrived at EDR: N/A	Telephone: 701-328-5166
Date Made Active in Reports: N/A	Last EDR Contact: 11/14/2019
Number of Days to Update: N/A	Next Scheduled EDR Contact: 03/02/2020
	Data Release Frequency: N/A

State and tribal landfill and/or solid waste disposal site lists

SWF/LF: Solid Waste Landfills/Special Use Landfills
Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 07/23/2019	Source: Department of Environmental Quality
Date Data Arrived at EDR: 07/29/2019	Telephone: 701-328-5166
Date Made Active in Reports: 10/04/2019	Last EDR Contact: 10/23/2019
Number of Days to Update: 67	Next Scheduled EDR Contact: 02/03/2020
	Data Release Frequency: Quarterly

State and tribal leaking storage tank lists

LUST: Leaking Underground Storage Tank List
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 08/26/2019	Source: Department of Environmental Quality
Date Data Arrived at EDR: 08/27/2019	Telephone: 701-328-5166
Date Made Active in Reports: 10/04/2019	Last EDR Contact: 08/27/2019
Number of Days to Update: 38	Next Scheduled EDR Contact: 12/09/2019
	Data Release Frequency: Quarterly

INDIAN LUST R4: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Florida, Mississippi and North Carolina.

Date of Government Version: 04/12/2019	Source: EPA Region 4
Date Data Arrived at EDR: 07/29/2019	Telephone: 404-562-8677
Date Made Active in Reports: 10/17/2019	Last EDR Contact: 10/25/2019
Number of Days to Update: 80	Next Scheduled EDR Contact: 02/03/2020
	Data Release Frequency: Varies

INDIAN LUST R5: Leaking Underground Storage Tanks on Indian Land
Leaking underground storage tanks located on Indian Land in Michigan, Minnesota and Wisconsin.

Date of Government Version: 04/08/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 79

Source: EPA, Region 5
Telephone: 312-886-7439
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN LUST R1: Leaking Underground Storage Tanks on Indian Land
A listing of leaking underground storage tank locations on Indian Land.

Date of Government Version: 04/11/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 80

Source: EPA Region 1
Telephone: 617-918-1313
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN LUST R8: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming.

Date of Government Version: 05/02/2019
Date Data Arrived at EDR: 10/22/2019
Date Made Active in Reports: 11/11/2019
Number of Days to Update: 20

Source: EPA Region 8
Telephone: 303-312-6271
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN LUST R10: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Alaska, Idaho, Oregon and Washington.

Date of Government Version: 04/16/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 80

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN LUST R6: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in New Mexico and Oklahoma.

Date of Government Version: 05/01/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 80

Source: EPA Region 6
Telephone: 214-665-6597
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN LUST R9: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Arizona, California, New Mexico and Nevada

Date of Government Version: 04/08/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 80

Source: Environmental Protection Agency
Telephone: 415-972-3372
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN LUST R7: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Iowa, Kansas, and Nebraska

Date of Government Version: 07/02/2019
Date Data Arrived at EDR: 10/16/2019
Date Made Active in Reports: 10/24/2019
Number of Days to Update: 8

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

State and tribal registered storage tank lists

FEMA UST: Underground Storage Tank Listing
A listing of all FEMA owned underground storage tanks.

Date of Government Version: 08/27/2019
Date Data Arrived at EDR: 08/28/2019
Date Made Active in Reports: 11/11/2019
Number of Days to Update: 75

Source: FEMA
Telephone: 202-646-5797
Last EDR Contact: 10/11/2019
Next Scheduled EDR Contact: 01/20/2020
Data Release Frequency: Varies

UST: Underground Storage Tank Data
Registered Underground Storage Tanks. UST’s are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 08/26/2019
Date Data Arrived at EDR: 08/27/2019
Date Made Active in Reports: 10/04/2019
Number of Days to Update: 38

Source: Department of Environmental Quality
Telephone: 701-328-5166
Last EDR Contact: 08/27/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Quarterly

AST: Aboveground Storage Tank Listing
Registered Aboveground Storage Tanks.

Date of Government Version: 07/22/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/04/2019
Number of Days to Update: 67

Source: Department of Insurance
Telephone: 701-328-3246
Last EDR Contact: 10/21/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Semi-Annually

INDIAN UST R5: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 5 (Michigan, Minnesota and Wisconsin and Tribal Nations).

Date of Government Version: 04/08/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 80

Source: EPA Region 5
Telephone: 312-886-6136
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN UST R6: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 6 (Louisiana, Arkansas, Oklahoma, New Mexico, Texas and 65 Tribes).

Date of Government Version: 05/01/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 80

Source: EPA Region 6
Telephone: 214-665-7591
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN UST R8: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 8 (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming and 27 Tribal Nations).

Date of Government Version: 05/02/2019
Date Data Arrived at EDR: 10/22/2019
Date Made Active in Reports: 11/11/2019
Number of Days to Update: 20

Source: EPA Region 8
Telephone: 303-312-6137
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN UST R9: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 9 (Arizona, California, Hawaii, Nevada, the Pacific Islands, and Tribal Nations).

Date of Government Version: 04/08/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 80

Source: EPA Region 9
Telephone: 415-972-3368
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN UST R4: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee and Tribal Nations)

Date of Government Version: 04/12/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 80

Source: EPA Region 4
Telephone: 404-562-9424
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN UST R10: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 10 (Alaska, Idaho, Oregon, Washington, and Tribal Nations).

Date of Government Version: 04/16/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 79

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN UST R7: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 7 (Iowa, Kansas, Missouri, Nebraska, and 9 Tribal Nations).

Date of Government Version: 05/02/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 80

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

INDIAN UST R1: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 1 (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont and ten Tribal Nations).

Date of Government Version: 04/11/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 79

Source: EPA, Region 1
Telephone: 617-918-1313
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

State and tribal institutional control / engineering control registries

AUL: Land Use Controls Listing

Land-Use Controls (LUCs) are defined broadly as legal measures that limit human exposure by restricting activity, use, and access to properties with residual contamination.

Date of Government Version: 07/15/2019
Date Data Arrived at EDR: 08/27/2019
Date Made Active in Reports: 10/04/2019
Number of Days to Update: 38

Source: Department of Environmental Quality
Telephone: 701-328-5158
Last EDR Contact: 08/27/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Semi-Annually

State and tribal voluntary cleanup sites

INDIAN VCP R1: Voluntary Cleanup Priority Listing

A listing of voluntary cleanup priority sites located on Indian Land located in Region 1.

Date of Government Version: 07/27/2015
Date Data Arrived at EDR: 09/29/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 142

Source: EPA, Region 1
Telephone: 617-918-1102
Last EDR Contact: 09/19/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Varies

INDIAN VCP R7: Voluntary Cleanup Priority Lisitng

A listing of voluntary cleanup priority sites located on Indian Land located in Region 7.

Date of Government Version: 03/20/2008
Date Data Arrived at EDR: 04/22/2008
Date Made Active in Reports: 05/19/2008
Number of Days to Update: 27

Source: EPA, Region 7
Telephone: 913-551-7365
Last EDR Contact: 04/20/2009
Next Scheduled EDR Contact: 07/20/2009
Data Release Frequency: Varies

State and tribal Brownfields sites

BROWNFIELDS: List of Brownfields Sites

The concept of the Brownfields Program is to take contaminated or potentially contaminated, underdeveloped, unproductive property and convert it into productive real estate. Brownfield sites are defined as abandoned, idled or underused industrial or commercial properties whose redevelopment is complicated by real or perceived environmental contamination.

Date of Government Version: 05/10/2019
Date Data Arrived at EDR: 05/21/2019
Date Made Active in Reports: 06/26/2019
Number of Days to Update: 36

Source: Department of Environmental Quality
Telephone: 701-328-5166
Last EDR Contact: 08/23/2019
Next Scheduled EDR Contact: 12/02/2019
Data Release Frequency: Semi-Annually

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS: A Listing of Brownfields Sites

Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties takes development pressures off of undeveloped, open land, and both improves and protects the environment. Assessment, Cleanup and Redevelopment Exchange System (ACRES) stores information reported by EPA Brownfields grant recipients on brownfields properties assessed or cleaned up with grant funding as well as information on Targeted Brownfields Assessments performed by EPA Regions. A listing of ACRES Brownfield sites is obtained from Cleanups in My Community. Cleanups in My Community provides information on Brownfields properties for which information is reported back to EPA, as well as areas served by Brownfields grant programs.

Date of Government Version: 06/03/2019
Date Data Arrived at EDR: 06/04/2019
Date Made Active in Reports: 08/26/2019
Number of Days to Update: 83

Source: Environmental Protection Agency
Telephone: 202-566-2777
Last EDR Contact: 09/19/2019
Next Scheduled EDR Contact: 12/30/2019
Data Release Frequency: Semi-Annually

Local Lists of Landfill / Solid Waste Disposal Sites

SWRCY: Recycling Centers

A listing of recycling center locations.

Date of Government Version: 04/12/2019
Date Data Arrived at EDR: 09/10/2019
Date Made Active in Reports: 10/07/2019
Number of Days to Update: 27

Source: Department of Environmental Quality
Telephone: 701-328-5266
Last EDR Contact: 09/06/2019
Next Scheduled EDR Contact: 12/16/2019
Data Release Frequency: Varies

INDIAN ODI: Report on the Status of Open Dumps on Indian Lands
Location of open dumps on Indian land.

Date of Government Version: 12/31/1998
Date Data Arrived at EDR: 12/03/2007
Date Made Active in Reports: 01/24/2008
Number of Days to Update: 52

Source: Environmental Protection Agency
Telephone: 703-308-8245
Last EDR Contact: 10/28/2019
Next Scheduled EDR Contact: 02/10/2020
Data Release Frequency: Varies

ODI: Open Dump Inventory
An open dump is defined as a disposal facility that does not comply with one or more of the Part 257 or Part 258 Subtitle D Criteria.

Date of Government Version: 06/30/1985
Date Data Arrived at EDR: 08/09/2004
Date Made Active in Reports: 09/17/2004
Number of Days to Update: 39

Source: Environmental Protection Agency
Telephone: 800-424-9346
Last EDR Contact: 06/09/2004
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

DEBRIS REGION 9: Torres Martinez Reservation Illegal Dump Site Locations
A listing of illegal dump sites location on the Torres Martinez Indian Reservation located in eastern Riverside County and northern Imperial County, California.

Date of Government Version: 01/12/2009
Date Data Arrived at EDR: 05/07/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 137

Source: EPA, Region 9
Telephone: 415-947-4219
Last EDR Contact: 10/17/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: No Update Planned

IHS OPEN DUMPS: Open Dumps on Indian Land
A listing of all open dumps located on Indian Land in the United States.

Date of Government Version: 04/01/2014
Date Data Arrived at EDR: 08/06/2014
Date Made Active in Reports: 01/29/2015
Number of Days to Update: 176

Source: Department of Health & Human Serivces, Indian Health Service
Telephone: 301-443-1452
Last EDR Contact: 11/01/2019
Next Scheduled EDR Contact: 02/10/2020
Data Release Frequency: Varies

Local Lists of Hazardous waste / Contaminated Sites

US HIST CDL: National Clandestine Laboratory Register
A listing of clandestine drug lab locations that have been removed from the DEAs National Clandestine Laboratory Register.

Date of Government Version: 06/11/2019
Date Data Arrived at EDR: 06/13/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 82

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 08/21/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: No Update Planned

CDL: Clandestine Drug Lab Location Listing
A listing of clandestine drug lab locations in North Dakota.

Date of Government Version: 05/16/2018
Date Data Arrived at EDR: 08/28/2018
Date Made Active in Reports: 09/24/2018
Number of Days to Update: 27

Source: Bureau of Criminal Investigation
Telephone: 701-328-8171
Last EDR Contact: 09/05/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Varies

US CDL: Clandestine Drug Labs

A listing of clandestine drug lab locations. The U.S. Department of Justice ("the Department") provides this web site as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments.

Date of Government Version: 06/11/2019
Date Data Arrived at EDR: 06/13/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 82

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 08/21/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Quarterly

Local Land Records

LIENS 2: CERCLA Lien Information

A Federal CERCLA ('Superfund') lien can exist by operation of law at any site or property at which EPA has spent Superfund monies. These monies are spent to investigate and address releases and threatened releases of contamination. CERCLIS provides information as to the identity of these sites and properties.

Date of Government Version: 07/30/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 35

Source: Environmental Protection Agency
Telephone: 202-564-6023
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 01/13/2020
Data Release Frequency: Semi-Annually

Records of Emergency Release Reports

HMIRS: Hazardous Materials Information Reporting System

Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 06/24/2019
Date Data Arrived at EDR: 06/26/2019
Date Made Active in Reports: 09/23/2019
Number of Days to Update: 89

Source: U.S. Department of Transportation
Telephone: 202-366-4555
Last EDR Contact: 09/24/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Quarterly

SPILLS: State Spills

A listing of Department of Health spill records.

Date of Government Version: 01/02/2019
Date Data Arrived at EDR: 01/04/2019
Date Made Active in Reports: 01/17/2019
Number of Days to Update: 13

Source: Department of Environmental Quality
Telephone: 701-328-5150
Last EDR Contact: 10/02/2019
Next Scheduled EDR Contact: 01/20/2020
Data Release Frequency: Varies

Other Ascertainable Records

RCRA NonGen / NLR: RCRA - Non Generators / No Longer Regulated

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

Date of Government Version: 06/24/2019
Date Data Arrived at EDR: 06/26/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 113

Source: Environmental Protection Agency
Telephone: 303-312-6149
Last EDR Contact: 10/28/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Quarterly

FUDS: Formerly Used Defense Sites

The listing includes locations of Formerly Used Defense Sites properties where the US Army Corps of Engineers is actively working or will take necessary cleanup actions.

Date of Government Version: 05/15/2019
Date Data Arrived at EDR: 05/21/2019
Date Made Active in Reports: 08/08/2019
Number of Days to Update: 79

Source: U.S. Army Corps of Engineers
Telephone: 202-528-4285
Last EDR Contact: 08/23/2019
Next Scheduled EDR Contact: 12/02/2019
Data Release Frequency: Varies

DOD: Department of Defense Sites

This data set consists of federally owned or administered lands, administered by the Department of Defense, that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 11/10/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 62

Source: USGS
Telephone: 888-275-8747
Last EDR Contact: 10/11/2019
Next Scheduled EDR Contact: 01/20/2020
Data Release Frequency: Semi-Annually

FEDLAND: Federal and Indian Lands

Federally and Indian administrated lands of the United States. Lands included are administrated by: Army Corps of Engineers, Bureau of Reclamation, National Wild and Scenic River, National Wildlife Refuge, Public Domain Land, Wilderness, Wilderness Study Area, Wildlife Management Area, Bureau of Indian Affairs, Bureau of Land Management, Department of Justice, Forest Service, Fish and Wildlife Service, National Park Service.

Date of Government Version: 04/02/2018
Date Data Arrived at EDR: 04/11/2018
Date Made Active in Reports: 11/06/2019
Number of Days to Update: 574

Source: U.S. Geological Survey
Telephone: 888-275-8747
Last EDR Contact: 10/07/2019
Next Scheduled EDR Contact: 01/20/2020
Data Release Frequency: N/A

SCRD DRYCLEANERS: State Coalition for Remediation of Drycleaners Listing

The State Coalition for Remediation of Drycleaners was established in 1998, with support from the U.S. EPA Office of Superfund Remediation and Technology Innovation. It is comprised of representatives of states with established drycleaner remediation programs. Currently the member states are Alabama, Connecticut, Florida, Illinois, Kansas, Minnesota, Missouri, North Carolina, Oregon, South Carolina, Tennessee, Texas, and Wisconsin.

Date of Government Version: 01/01/2017
Date Data Arrived at EDR: 02/03/2017
Date Made Active in Reports: 04/07/2017
Number of Days to Update: 63

Source: Environmental Protection Agency
Telephone: 615-532-8599
Last EDR Contact: 11/11/2019
Next Scheduled EDR Contact: 02/24/2020
Data Release Frequency: Varies

US FIN ASSUR: Financial Assurance Information

All owners and operators of facilities that treat, store, or dispose of hazardous waste are required to provide proof that they will have sufficient funds to pay for the clean up, closure, and post-closure care of their facilities.

Date of Government Version: 06/24/2019
Date Data Arrived at EDR: 06/26/2019
Date Made Active in Reports: 09/23/2019
Number of Days to Update: 89

Source: Environmental Protection Agency
Telephone: 202-566-1917
Last EDR Contact: 09/24/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Quarterly

EPA WATCH LIST: EPA WATCH LIST

EPA maintains a "Watch List" to facilitate dialogue between EPA, state and local environmental agencies on enforcement matters relating to facilities with alleged violations identified as either significant or high priority. Being on the Watch List does not mean that the facility has actually violated the law only that an investigation by EPA or a state or local environmental agency has led those organizations to allege that an unproven violation has in fact occurred. Being on the Watch List does not represent a higher level of concern regarding the alleged violations that were detected, but instead indicates cases requiring additional dialogue between EPA, state and local agencies - primarily because of the length of time the alleged violation has gone unaddressed or unresolved.

Date of Government Version: 08/30/2013
Date Data Arrived at EDR: 03/21/2014
Date Made Active in Reports: 06/17/2014
Number of Days to Update: 88

Source: Environmental Protection Agency
Telephone: 617-520-3000
Last EDR Contact: 10/31/2019
Next Scheduled EDR Contact: 02/17/2020
Data Release Frequency: Quarterly

2020 COR ACTION: 2020 Corrective Action Program List

The EPA has set ambitious goals for the RCRA Corrective Action program by creating the 2020 Corrective Action Universe. This RCRA cleanup baseline includes facilities expected to need corrective action. The 2020 universe contains a wide variety of sites. Some properties are heavily contaminated while others were contaminated but have since been cleaned up. Still others have not been fully investigated yet, and may require little or no remediation. Inclusion in the 2020 Universe does not necessarily imply failure on the part of a facility to meet its RCRA obligations.

Date of Government Version: 09/30/2017
Date Data Arrived at EDR: 05/08/2018
Date Made Active in Reports: 07/20/2018
Number of Days to Update: 73

Source: Environmental Protection Agency
Telephone: 703-308-4044
Last EDR Contact: 11/08/2019
Next Scheduled EDR Contact: 02/17/2020
Data Release Frequency: Varies

TSCA: Toxic Substances Control Act

Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/2016
Date Data Arrived at EDR: 06/21/2017
Date Made Active in Reports: 01/05/2018
Number of Days to Update: 198

Source: EPA
Telephone: 202-260-5521
Last EDR Contact: 09/19/2019
Next Scheduled EDR Contact: 12/30/2019
Data Release Frequency: Every 4 Years

TRIS: Toxic Chemical Release Inventory System

Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/2016
Date Data Arrived at EDR: 01/10/2018
Date Made Active in Reports: 01/12/2018
Number of Days to Update: 2

Source: EPA
Telephone: 202-566-0250
Last EDR Contact: 08/23/2019
Next Scheduled EDR Contact: 12/02/2019
Data Release Frequency: Annually

SSTS: Section 7 Tracking Systems

Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 09/30/2018
Date Data Arrived at EDR: 04/24/2019
Date Made Active in Reports: 08/08/2019
Number of Days to Update: 106

Source: EPA
Telephone: 202-564-4203
Last EDR Contact: 10/23/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Annually

ROD: Records Of Decision

Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 07/19/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 35

Source: EPA
Telephone: 703-416-0223
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 02/17/2020
Data Release Frequency: Annually

RMP: Risk Management Plans

When Congress passed the Clean Air Act Amendments of 1990, it required EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances. The Risk Management Program Rule (RMP Rule) was written to implement Section 112(r) of these amendments. The rule, which built upon existing industry codes and standards, requires companies of all sizes that use certain flammable and toxic substances to develop a Risk Management Program, which includes a(n): Hazard assessment that details the potential effects of an accidental release, an accident history of the last five years, and an evaluation of worst-case and alternative accidental releases; Prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and Emergency response program that spells out emergency health care, employee training measures and procedures for informing the public and response agencies (e.g the fire department) should an accident occur.

Date of Government Version: 04/25/2019
Date Data Arrived at EDR: 05/02/2019
Date Made Active in Reports: 05/23/2019
Number of Days to Update: 21

Source: Environmental Protection Agency
Telephone: 202-564-8600
Last EDR Contact: 10/21/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Varies

RAATS: RCRA Administrative Action Tracking System

RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/1995
Date Data Arrived at EDR: 07/03/1995
Date Made Active in Reports: 08/07/1995
Number of Days to Update: 35

Source: EPA
Telephone: 202-564-4104
Last EDR Contact: 06/02/2008
Next Scheduled EDR Contact: 09/01/2008
Data Release Frequency: No Update Planned

PRP: Potentially Responsible Parties

A listing of verified Potentially Responsible Parties

Date of Government Version: 08/20/2019
Date Data Arrived at EDR: 09/05/2019
Date Made Active in Reports: 09/23/2019
Number of Days to Update: 18

Source: EPA
Telephone: 202-564-6023
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 02/17/2020
Data Release Frequency: Quarterly

PADS: PCB Activity Database System

PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 03/20/2019
Date Data Arrived at EDR: 04/10/2019
Date Made Active in Reports: 05/14/2019
Number of Days to Update: 34

Source: EPA
Telephone: 202-566-0500
Last EDR Contact: 10/11/2019
Next Scheduled EDR Contact: 01/20/2020
Data Release Frequency: Annually

ICIS: Integrated Compliance Information System

The Integrated Compliance Information System (ICIS) supports the information needs of the national enforcement and compliance program as well as the unique needs of the National Pollutant Discharge Elimination System (NPDES) program.

Date of Government Version: 11/18/2016
Date Data Arrived at EDR: 11/23/2016
Date Made Active in Reports: 02/10/2017
Number of Days to Update: 79

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 10/07/2019
Next Scheduled EDR Contact: 01/20/2020
Data Release Frequency: Quarterly

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-566-1667
Last EDR Contact: 08/18/2017
Next Scheduled EDR Contact: 12/04/2017
Data Release Frequency: No Update Planned

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

A listing of FIFRA/TSCA Tracking System (FTTS) inspections and enforcements.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA
Telephone: 202-566-1667
Last EDR Contact: 08/18/2017
Next Scheduled EDR Contact: 12/04/2017
Data Release Frequency: No Update Planned

MLTS: Material Licensing Tracking System

MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 06/20/2019
Date Data Arrived at EDR: 06/20/2019
Date Made Active in Reports: 08/08/2019
Number of Days to Update: 49

Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
Last EDR Contact: 10/25/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Quarterly

COAL ASH DOE: Steam-Electric Plant Operation Data

A listing of power plants that store ash in surface ponds.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 08/07/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 76

Source: Department of Energy
Telephone: 202-586-8719
Last EDR Contact: 11/06/2019
Next Scheduled EDR Contact: 12/16/2019
Data Release Frequency: Varies

COAL ASH EPA: Coal Combustion Residues Surface Impoundments List

A listing of coal combustion residues surface impoundments with high hazard potential ratings.

Date of Government Version: 01/12/2017
Date Data Arrived at EDR: 03/05/2019
Date Made Active in Reports: 11/11/2019
Number of Days to Update: 251

Source: Environmental Protection Agency
Telephone: N/A
Last EDR Contact: 09/03/2019
Next Scheduled EDR Contact: 12/16/2019
Data Release Frequency: Varies

PCB TRANSFORMER: PCB Transformer Registration Database

The database of PCB transformer registrations that includes all PCB registration submittals.

Date of Government Version: 05/24/2017
Date Data Arrived at EDR: 11/30/2017
Date Made Active in Reports: 12/15/2017
Number of Days to Update: 15

Source: Environmental Protection Agency
Telephone: 202-566-0517
Last EDR Contact: 11/06/2019
Next Scheduled EDR Contact: 02/17/2020
Data Release Frequency: Varies

RADINFO: Radiation Information Database

The Radiation Information Database (RADINFO) contains information about facilities that are regulated by U.S. Environmental Protection Agency (EPA) regulations for radiation and radioactivity.

Date of Government Version: 07/01/2019	Source: Environmental Protection Agency
Date Data Arrived at EDR: 07/01/2019	Telephone: 202-343-9775
Date Made Active in Reports: 09/23/2019	Last EDR Contact: 11/12/2019
Number of Days to Update: 84	Next Scheduled EDR Contact: 01/13/2020
	Data Release Frequency: Quarterly

HIST FTTS: FIFRA/TSCA Tracking System Administrative Case Listing

A complete administrative case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006	Source: Environmental Protection Agency
Date Data Arrived at EDR: 03/01/2007	Telephone: 202-564-2501
Date Made Active in Reports: 04/10/2007	Last EDR Contact: 12/17/2007
Number of Days to Update: 40	Next Scheduled EDR Contact: 03/17/2008
	Data Release Frequency: No Update Planned

HIST FTTS INSP: FIFRA/TSCA Tracking System Inspection & Enforcement Case Listing

A complete inspection and enforcement case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006	Source: Environmental Protection Agency
Date Data Arrived at EDR: 03/01/2007	Telephone: 202-564-2501
Date Made Active in Reports: 04/10/2007	Last EDR Contact: 12/17/2008
Number of Days to Update: 40	Next Scheduled EDR Contact: 03/17/2008
	Data Release Frequency: No Update Planned

DOT OPS: Incident and Accident Data

Department of Transporation, Office of Pipeline Safety Incident and Accident data.

Date of Government Version: 07/01/2019	Source: Department of Transporation, Office of Pipeline Safety
Date Data Arrived at EDR: 07/31/2019	Telephone: 202-366-4595
Date Made Active in Reports: 10/24/2019	Last EDR Contact: 10/29/2019
Number of Days to Update: 85	Next Scheduled EDR Contact: 02/10/2020
	Data Release Frequency: Quarterly

CONSENT: Superfund (CERCLA) Consent Decrees

Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: 06/30/2019	Source: Department of Justice, Consent Decree Library
Date Data Arrived at EDR: 07/16/2019	Telephone: Varies
Date Made Active in Reports: 10/02/2019	Last EDR Contact: 10/02/2019
Number of Days to Update: 78	Next Scheduled EDR Contact: 01/20/2020
	Data Release Frequency: Varies

BRS: Biennial Reporting System

The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/2015	Source: EPA/NTIS
Date Data Arrived at EDR: 02/22/2017	Telephone: 800-424-9346
Date Made Active in Reports: 09/28/2017	Last EDR Contact: 09/16/2019
Number of Days to Update: 218	Next Scheduled EDR Contact: 01/06/2020
	Data Release Frequency: Biennially

INDIAN RESERV: Indian Reservations

This map layer portrays Indian administered lands of the United States that have any area equal to or greater than 640 acres.

Date of Government Version: 12/31/2014
Date Data Arrived at EDR: 07/14/2015
Date Made Active in Reports: 01/10/2017
Number of Days to Update: 546

Source: USGS
Telephone: 202-208-3710
Last EDR Contact: 10/06/2019
Next Scheduled EDR Contact: 01/19/2020
Data Release Frequency: Semi-Annually

FUSRAP: Formerly Utilized Sites Remedial Action Program

DOE established the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 to remediate sites where radioactive contamination remained from Manhattan Project and early U.S. Atomic Energy Commission (AEC) operations.

Date of Government Version: 08/08/2017
Date Data Arrived at EDR: 09/11/2018
Date Made Active in Reports: 09/14/2018
Number of Days to Update: 3

Source: Department of Energy
Telephone: 202-586-3559
Last EDR Contact: 11/04/2019
Next Scheduled EDR Contact: 02/17/2020
Data Release Frequency: Varies

UMTRA: Uranium Mill Tailings Sites

Uranium ore was mined by private companies for federal government use in national defense programs. When the mills shut down, large piles of the sand-like material (mill tailings) remain after uranium has been extracted from the ore. Levels of human exposure to radioactive materials from the piles are low; however, in some cases tailings were used as construction materials before the potential health hazards of the tailings were recognized.

Date of Government Version: 08/01/2019
Date Data Arrived at EDR: 08/21/2019
Date Made Active in Reports: 11/11/2019
Number of Days to Update: 82

Source: Department of Energy
Telephone: 505-845-0011
Last EDR Contact: 08/21/2019
Next Scheduled EDR Contact: 12/02/2019
Data Release Frequency: Varies

LEAD SMELTER 1: Lead Smelter Sites

A listing of former lead smelter site locations.

Date of Government Version: 07/19/2019
Date Data Arrived at EDR: 07/30/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 35

Source: Environmental Protection Agency
Telephone: 703-603-8787
Last EDR Contact: 11/07/2019
Next Scheduled EDR Contact: 01/13/2020
Data Release Frequency: Varies

LEAD SMELTER 2: Lead Smelter Sites

A list of several hundred sites in the U.S. where secondary lead smelting was done from 1931and 1964. These sites may pose a threat to public health through ingestion or inhalation of contaminated soil or dust

Date of Government Version: 04/05/2001
Date Data Arrived at EDR: 10/27/2010
Date Made Active in Reports: 12/02/2010
Number of Days to Update: 36

Source: American Journal of Public Health
Telephone: 703-305-6451
Last EDR Contact: 12/02/2009
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

US AIRS (AFS): Aerometric Information Retrieval System Facility Subsystem (AFS)

The database is a sub-system of Aerometric Information Retrieval System (AIRS). AFS contains compliance data on air pollution point sources regulated by the U.S. EPA and/or state and local air regulatory agencies. This information comes from source reports by various stationary sources of air pollution, such as electric power plants, steel mills, factories, and universities, and provides information about the air pollutants they produce. Action, air program, air program pollutant, and general level plant data. It is used to track emissions and compliance data from industrial plants.

Date of Government Version: 10/12/2016
Date Data Arrived at EDR: 10/26/2016
Date Made Active in Reports: 02/03/2017
Number of Days to Update: 100

Source: EPA
Telephone: 202-564-2496
Last EDR Contact: 09/26/2017
Next Scheduled EDR Contact: 01/08/2018
Data Release Frequency: Annually

US AIRS MINOR: Air Facility System Data
A listing of minor source facilities.

Date of Government Version: 10/12/2016
Date Data Arrived at EDR: 10/26/2016
Date Made Active in Reports: 02/03/2017
Number of Days to Update: 100

Source: EPA
Telephone: 202-564-2496
Last EDR Contact: 09/26/2017
Next Scheduled EDR Contact: 01/08/2018
Data Release Frequency: Annually

US MINES: Mines Master Index File
Contains all mine identification numbers issued for mines active or opened since 1971. The data also includes violation information.

Date of Government Version: 08/01/2019
Date Data Arrived at EDR: 08/27/2019
Date Made Active in Reports: 11/11/2019
Number of Days to Update: 76

Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959
Last EDR Contact: 08/27/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Semi-Annually

MINES VIOLATIONS: MSHA Violation Assessment Data
Mines violation and assessment information. Department of Labor, Mine Safety & Health Administration.

Date of Government Version: 06/06/2019
Date Data Arrived at EDR: 06/06/2019
Date Made Active in Reports: 10/24/2019
Number of Days to Update: 140

Source: DOL, Mine Safety & Health Admi
Telephone: 202-693-9424
Last EDR Contact: 09/12/2019
Next Scheduled EDR Contact: 12/16/2019
Data Release Frequency: Quarterly

US MINES 2: Ferrous and Nonferrous Metal Mines Database Listing
This map layer includes ferrous (ferrous metal mines are facilities that extract ferrous metals, such as iron ore or molybdenum) and nonferrous (Nonferrous metal mines are facilities that extract nonferrous metals, such as gold, silver, copper, zinc, and lead) metal mines in the United States.

Date of Government Version: 12/05/2005
Date Data Arrived at EDR: 02/29/2008
Date Made Active in Reports: 04/18/2008
Number of Days to Update: 49

Source: USGS
Telephone: 703-648-7709
Last EDR Contact: 08/30/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Varies

US MINES 3: Active Mines & Mineral Plants Database Listing
Active Mines and Mineral Processing Plant operations for commodities monitored by the Minerals Information Team of the USGS.

Date of Government Version: 04/14/2011
Date Data Arrived at EDR: 06/08/2011
Date Made Active in Reports: 09/13/2011
Number of Days to Update: 97

Source: USGS
Telephone: 703-648-7709
Last EDR Contact: 08/30/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Varies

ABANDONED MINES: Abandoned Mines
An inventory of land and water impacted by past mining (primarily coal mining) is maintained by OSMRE to provide information needed to implement the Surface Mining Control and Reclamation Act of 1977 (SMCRA). The inventory contains information on the location, type, and extent of AML impacts, as well as, information on the cost associated with the reclamation of those problems. The inventory is based upon field surveys by State, Tribal, and OSMRE program officials. It is dynamic to the extent that it is modified as new problems are identified and existing problems are reclaimed.

Date of Government Version: 09/10/2019
Date Data Arrived at EDR: 09/10/2019
Date Made Active in Reports: 10/17/2019
Number of Days to Update: 37

Source: Department of Interior
Telephone: 202-208-2609
Last EDR Contact: 09/10/2019
Next Scheduled EDR Contact: 12/23/2019
Data Release Frequency: Quarterly

FINDS: Facility Index System/Facility Registry System

Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 05/03/2019
Date Data Arrived at EDR: 06/05/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 90

Source: EPA
Telephone: (303) 312-6312
Last EDR Contact: 09/04/2019
Next Scheduled EDR Contact: 12/16/2019
Data Release Frequency: Quarterly

DOCKET HWC: Hazardous Waste Compliance Docket Listing

A complete list of the Federal Agency Hazardous Waste Compliance Docket Facilities.

Date of Government Version: 05/31/2018
Date Data Arrived at EDR: 07/26/2018
Date Made Active in Reports: 10/05/2018
Number of Days to Update: 71

Source: Environmental Protection Agency
Telephone: 202-564-0527
Last EDR Contact: 08/21/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Varies

UXO: Unexploded Ordnance Sites

A listing of unexploded ordnance site locations

Date of Government Version: 12/31/2017
Date Data Arrived at EDR: 01/17/2019
Date Made Active in Reports: 04/01/2019
Number of Days to Update: 74

Source: Department of Defense
Telephone: 703-704-1564
Last EDR Contact: 10/10/2019
Next Scheduled EDR Contact: 01/27/2020
Data Release Frequency: Varies

ECHO: Enforcement & Compliance History Information

ECHO provides integrated compliance and enforcement information for about 800,000 regulated facilities nationwide.

Date of Government Version: 07/06/2019
Date Data Arrived at EDR: 07/09/2019
Date Made Active in Reports: 10/02/2019
Number of Days to Update: 85

Source: Environmental Protection Agency
Telephone: 202-564-2280
Last EDR Contact: 10/08/2019
Next Scheduled EDR Contact: 01/20/2020
Data Release Frequency: Quarterly

FUELS PROGRAM: EPA Fuels Program Registered Listing

This listing includes facilities that are registered under the Part 80 (Code of Federal Regulations) EPA Fuels Programs. All companies now are required to submit new and updated registrations.

Date of Government Version: 08/19/2019
Date Data Arrived at EDR: 08/20/2019
Date Made Active in Reports: 11/11/2019
Number of Days to Update: 83

Source: EPA
Telephone: 800-385-6164
Last EDR Contact: 08/20/2019
Next Scheduled EDR Contact: 12/02/2019
Data Release Frequency: Quarterly

AIRS: Permitted Airs Facility Listing

A listing of permitted airs facility locations.

Date of Government Version: 07/23/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/04/2019
Number of Days to Update: 67

Source: Department of Environmental Quality
Telephone: 701-328-5188
Last EDR Contact: 10/23/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Semi-Annually

ASBESTOS: Asbestos Notification Listing
A listing of asbestos notification site locations

Date of Government Version: 08/28/2019
Date Data Arrived at EDR: 09/03/2019
Date Made Active in Reports: 10/04/2019
Number of Days to Update: 31

Source: Department of Environmental Quality
Telephone: 701-328-5188
Last EDR Contact: 11/14/2019
Next Scheduled EDR Contact: 02/17/2020
Data Release Frequency: Varies

DRYCLEANERS: Drycleaner facilities
A listing of drycleaner facility locations.

Date of Government Version: 07/23/2019
Date Data Arrived at EDR: 07/29/2019
Date Made Active in Reports: 10/04/2019
Number of Days to Update: 67

Source: Department of Environmental Quality
Telephone: 701-328-5188
Last EDR Contact: 10/23/2019
Next Scheduled EDR Contact: 02/03/2020
Data Release Frequency: Semi-Annually

NPDES: Wastewater Facility Listing
A listing of wastewater facility locations.

Date of Government Version: 07/11/2019
Date Data Arrived at EDR: 07/18/2019
Date Made Active in Reports: 09/13/2019
Number of Days to Update: 57

Source: Department of Environmental Quality
Telephone: 701-328-5260
Last EDR Contact: 10/02/2019
Next Scheduled EDR Contact: 01/20/2020
Data Release Frequency: Semi-Annually

TIER 2: Tier 2 Information Listing
Tier 2 information listing.

Date of Government Version: 12/31/2016
Date Data Arrived at EDR: 06/27/2017
Date Made Active in Reports: 10/05/2017
Number of Days to Update: 100

Source: Department of Emergency Services
Telephone: 701-328-8263
Last EDR Contact: 09/19/2019
Next Scheduled EDR Contact: 01/06/2020
Data Release Frequency: Annually

UIC: Underground Injection Wells
A listing of underground injection control wells.

Date of Government Version: 07/23/2019
Date Data Arrived at EDR: 07/31/2019
Date Made Active in Reports: 10/04/2019
Number of Days to Update: 65

Source: Department of Environmental Quality
Telephone: 701-328-5217
Last EDR Contact: 11/01/2019
Next Scheduled EDR Contact: 02/10/2020
Data Release Frequency: Quarterly

MINES MRDS: Mineral Resources Data System
Mineral Resources Data System

Date of Government Version: 04/06/2018
Date Data Arrived at EDR: 10/21/2019
Date Made Active in Reports: 10/24/2019
Number of Days to Update: 3

Source: USGS
Telephone: 703-648-6533
Last EDR Contact: 08/30/2019
Next Scheduled EDR Contact: 12/09/2019
Data Release Frequency: Varies

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP: EDR Proprietary Manufactured Gas Plants

The EDR Proprietary Manufactured Gas Plant Database includes records of coal gas plants (manufactured gas plants) compiled by EDR's researchers. Manufactured gas sites were used in the United States from the 1800's to 1950's to produce a gas that could be distributed and used as fuel. These plants used whale oil, rosin, coal, or a mixture of coal, oil, and water that also produced a significant amount of waste. Many of the byproducts of the gas production, such as coal tar (oily waste containing volatile and non-volatile chemicals), sludges, oils and other compounds are potentially hazardous to human health and the environment. The byproduct from this process was frequently disposed of directly at the plant site and can remain or spread slowly, serving as a continuous source of soil and groundwater contamination.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

EDR Hist Auto: EDR Exclusive Historical Auto Stations

EDR has searched selected national collections of business directories and has collected listings of potential gas station/filling station/service station sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include gas station/filling station/service station establishments. The categories reviewed included, but were not limited to gas, gas station, gasoline station, filling station, auto, automobile repair, auto service station, service station, etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR's HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

EDR Hist Cleaner: EDR Exclusive Historical Cleaners

EDR has searched selected national collections of business directories and has collected listings of potential dry cleaner sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include dry cleaning establishments. The categories reviewed included, but were not limited to dry cleaners, cleaners, laundry, laundromat, cleaning/laundry, wash & dry etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR's HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA LUST: Recovered Government Archive Leaking Underground Storage Tank

The EDR Recovered Government Archive Leaking Underground Storage Tank database provides a list of LUST incidents derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Health in North Dakota.

Date of Government Version: N/A
Date Data Arrived at EDR: 07/01/2013
Date Made Active in Reports: 01/04/2014
Number of Days to Update: 187

Source: Department of Environmental Quality
Telephone: N/A
Last EDR Contact: 06/01/2012
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

CT MANIFEST: Hazardous Waste Manifest Data

Facility and manifest data. Manifest is a document that lists and tracks hazardous waste from the generator through transporters to a tsd facility.

Date of Government Version: 05/14/2019
Date Data Arrived at EDR: 05/14/2019
Date Made Active in Reports: 08/05/2019
Number of Days to Update: 83

Source: Department of Energy & Environmental Protection
Telephone: 860-424-3375
Last EDR Contact: 11/11/2019
Next Scheduled EDR Contact: 02/24/2020
Data Release Frequency: No Update Planned

NY MANIFEST: Facility and Manifest Data

Manifest is a document that lists and tracks hazardous waste from the generator through transporters to a TSD facility.

Date of Government Version: 01/01/2019
Date Data Arrived at EDR: 05/01/2019
Date Made Active in Reports: 06/21/2019
Number of Days to Update: 51

Source: Department of Environmental Conservation
Telephone: 518-402-8651
Last EDR Contact: 10/29/2019
Next Scheduled EDR Contact: 02/10/2020
Data Release Frequency: Quarterly

WI MANIFEST: Manifest Information

Hazardous waste manifest information.

Date of Government Version: 05/31/2018
Date Data Arrived at EDR: 06/19/2019
Date Made Active in Reports: 09/03/2019
Number of Days to Update: 76

Source: Department of Natural Resources
Telephone: N/A
Last EDR Contact: 09/06/2019
Next Scheduled EDR Contact: 12/23/2019
Data Release Frequency: Annually

Oil/Gas Pipelines

Source: Endeavor Business Media

Petroleum Bundle (Crude Oil, Refined Products, Petrochemicals, Gas Liquids (LPG/NGL), and Specialty Gases (Miscellaneous)) N = Natural Gas Bundle (Natural Gas, Gas Liquids (LPG/NGL), and Specialty Gases (Miscellaneous)). This map includes information copyrighted by Endeavor Business Media. This information is provided on a best effort basis and Endeavor Business Media does not guarantee its accuracy nor warrant its fitness for any particular purpose. Such information has been reprinted with the permission of Endeavor Business Media.

Electric Power Transmission Line Data

Source: Endeavor Business Media

This map includes information copyrighted by Endeavor Business Media. This information is provided on a best effort basis and Endeavor Business Media does not guarantee its accuracy nor warrant its fitness for any particular purpose. Such information has been reprinted with the permission of Endeavor Business Media.

Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

AHA Hospitals:
Source: American Hospital Association, Inc.
Telephone: 312-280-5991
The database includes a listing of hospitals based on the American Hospital Association's annual survey of hospitals.

Medical Centers: Provider of Services Listing
Source: Centers for Medicare & Medicaid Services
Telephone: 410-786-3000
A listing of hospitals with Medicare provider number, produced by Centers of Medicare & Medicaid Services, a federal agency within the U.S. Department of Health and Human Services.

Nursing Homes
Source: National Institutes of Health
Telephone: 301-594-6248
Information on Medicare and Medicaid certified nursing homes in the United States.

Public Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on elementary and secondary public education in the United States. It is a comprehensive, annual, national statistical database of all public elementary and secondary schools and school districts, which contains data that are comparable across all states.

Private Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on private school locations in the United States.

Daycare Centers: Child Care List
Source: Department of Human Services
Telephone: 701-328-2316

Flood Zone Data: This data was obtained from the Federal Emergency Management Agency (FEMA). It depicts 100-year and 500-year flood zones as defined by FEMA. It includes the National Flood Hazard Layer (NFHL) which incorporates Flood Insurance Rate Map (FIRM) data and Q3 data from FEMA in areas not covered by NFHL.
Source: FEMA
Telephone: 877-336-2627
Date of Government Version: 2003, 2015

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002, 2005 and 2010 from the U.S. Fish and Wildlife Service.

Current USGS 7.5 Minute Topographic Map
Source: U.S. Geological Survey

STREET AND ADDRESS INFORMATION

GEOCHECK ®- PHYSICAL SETTING SOURCE ADDENDUM

TARGET PROPERTY ADDRESS

FARGO AASF #2
1760 NORTH 23RD AVENUE
FARGO, ND 58102

TARGET PROPERTY COORDINATES

Latitude (North):	46.907788 - 46˚ 54' 28.04''
Longitude (West):	96.807863 - 96˚ 48' 28.31''
Universal Tranverse Mercator:	Zone 14
UTM X (Meters):	666947.4
UTM Y (Meters):	5197031.5
Elevation:	896 ft. above sea level

USGS TOPOGRAPHIC MAP

Target Property Map:	6049346 FARGO NORTH, ND
Version Date:	2014

EDR's GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

Assessment of the impact of contaminant migration generally has two principle investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata.

GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

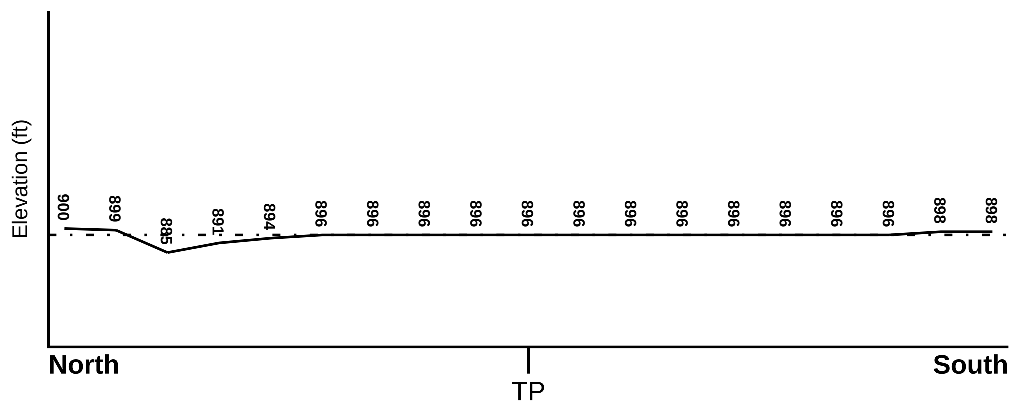
TOPOGRAPHIC INFORMATION

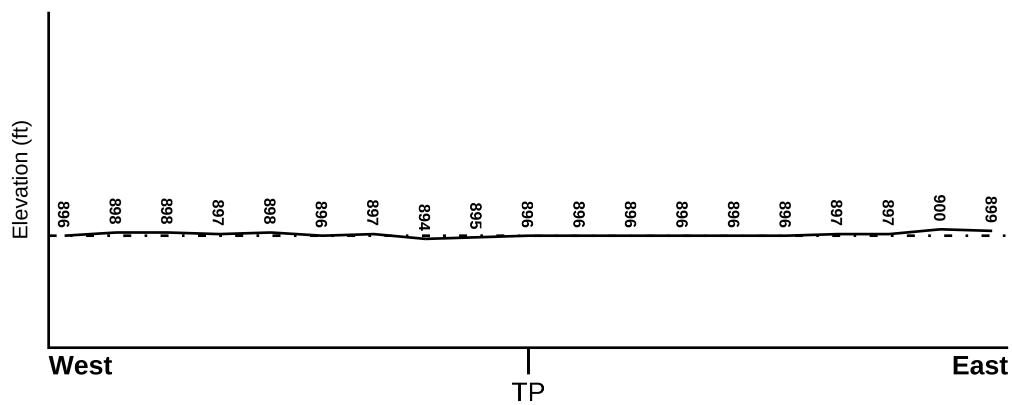
Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

TARGET PROPERTY TOPOGRAPHY

General Topographic Gradient: General West

SURROUNDING TOPOGRAPHY: ELEVATION PROFILES





Target Property Elevation: 896 ft.

0 1/2 1 Miles

Source: Topography has been determined from the USGS 7.5' Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Flood Plain Panel at Target Property	FEMA Source Type
38017C0591G	FEMA FIRM Flood data

Additional Panels in search area:	FEMA Source Type
38017C0587G	FEMA FIRM Flood data
38017C0589G	FEMA FIRM Flood data
38017C0593G	FEMA FIRM Flood data

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
FARGO NORTH	YES - refer to the Overview Map and Detail Map

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

AQUIFLOW®

Search Radius: 1.000 Mile.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

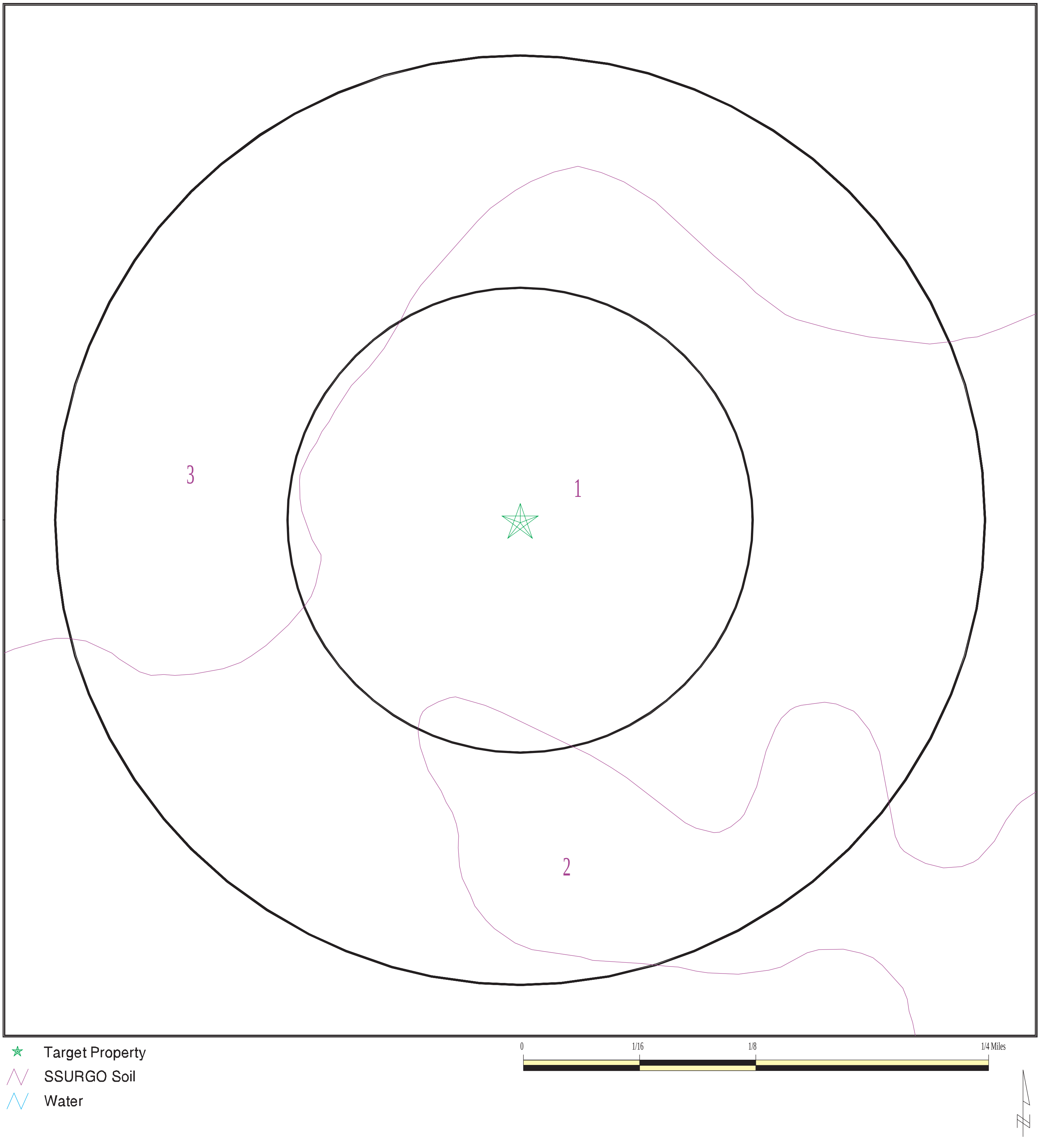
Era:	Precambrian
System:	Precambrian
Series:	W granitic rocks
Code:	Wv *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: Plutonic and Intrusive Rocks

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

SSURGO SOIL MAP - 5872123.9s



SITE NAME: Fargo AASF #2 ADDRESS: 1760 North 23rd Avenue Fargo ND 58102 LAT/LONG: 46.907788 / 96.807863	CLIENT: AECOM CONTACT: Hans Sund INQUIRY #: 5872123.9s DATE: November 15, 2019 4:18 pm

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. The following information is based on Soil Conservation Service SSURGO data.

Soil Map ID: 1

Soil Component Name: FARGO

Soil Surface Texture: silty clay

Hydrologic Group: Class D - Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.

Soil Drainage Class: Poorly drained

Hydric Status: Partially hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 46 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		Soil Reaction (pH)
1	0 inches	9 inches	silty clay	Not reported	Not reported	Max: 1.41 Min: 0.42	Max: 8.4 Min: 7.9
2	9 inches	22 inches		Not reported	Not reported	Max: 1.41 Min: 0.42	Max: 8.4 Min: 7.9
3	22 inches	59 inches		Not reported	Not reported	Max: 1.41 Min: 0.42	Max: 8.4 Min: 7.9

Soil Map ID: 2

Soil Component Name: FARGO

Soil Surface Texture: silty clay

Hydrologic Group: Class D - Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.

Soil Drainage Class: Poorly drained

Hydric Status: Partially hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		Soil Reaction (pH)
1	0 inches	9 inches	silty clay	Not reported	Not reported	Max: 1.41 Min: 0.42	Max: 8.4 Min: 7.9
2	9 inches	22 inches		Not reported	Not reported	Max: 1.41 Min: 0.42	Max: 8.4 Min: 7.9
3	22 inches	59 inches		Not reported	Not reported	Max: 1.41 Min: 0.42	Max: 8.4 Min: 7.9

Soil Map ID: 3

Soil Component Name: FARGO

Soil Surface Texture: silty clay

Hydrologic Group: Class D - Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.

Soil Drainage Class: Poorly drained

Hydric Status: Partially hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		Soil Reaction (pH)
1	0 inches	9 inches	silty clay	Not reported	Not reported	Max: 1.41 Min: 0.42	Max: 8.4 Min: 7.9
2	9 inches	22 inches		Not reported	Not reported	Max: 1.41 Min: 0.42	Max: 8.4 Min: 7.9

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
3	22 inches	59 inches		Not reported	Not reported	Max: 1.41 Min: 0.42	Max: 8.4 Min: 7.9

LOCAL / REGIONAL WATER AGENCY RECORDS

EDR Local/Regional Water Agency records provide water well information to assist the environmental professional in assessing sources that may impact ground water flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 1 mile
State Database	1.000

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
2	USGS40000917469	1/4 - 1/2 Mile ESE
3	USGS40000917521	1/4 - 1/2 Mile ESE
7	USGS40000917726	1/2 - 1 Mile NE
8	USGS40000917539	1/2 - 1 Mile West
11	USGS40000917540	1/2 - 1 Mile West
14	USGS40000917897	1/2 - 1 Mile NNE

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
No PWS System Found		

Note: PWS System location is not always the same as well location.

STATE DATABASE WELL INFORMATION

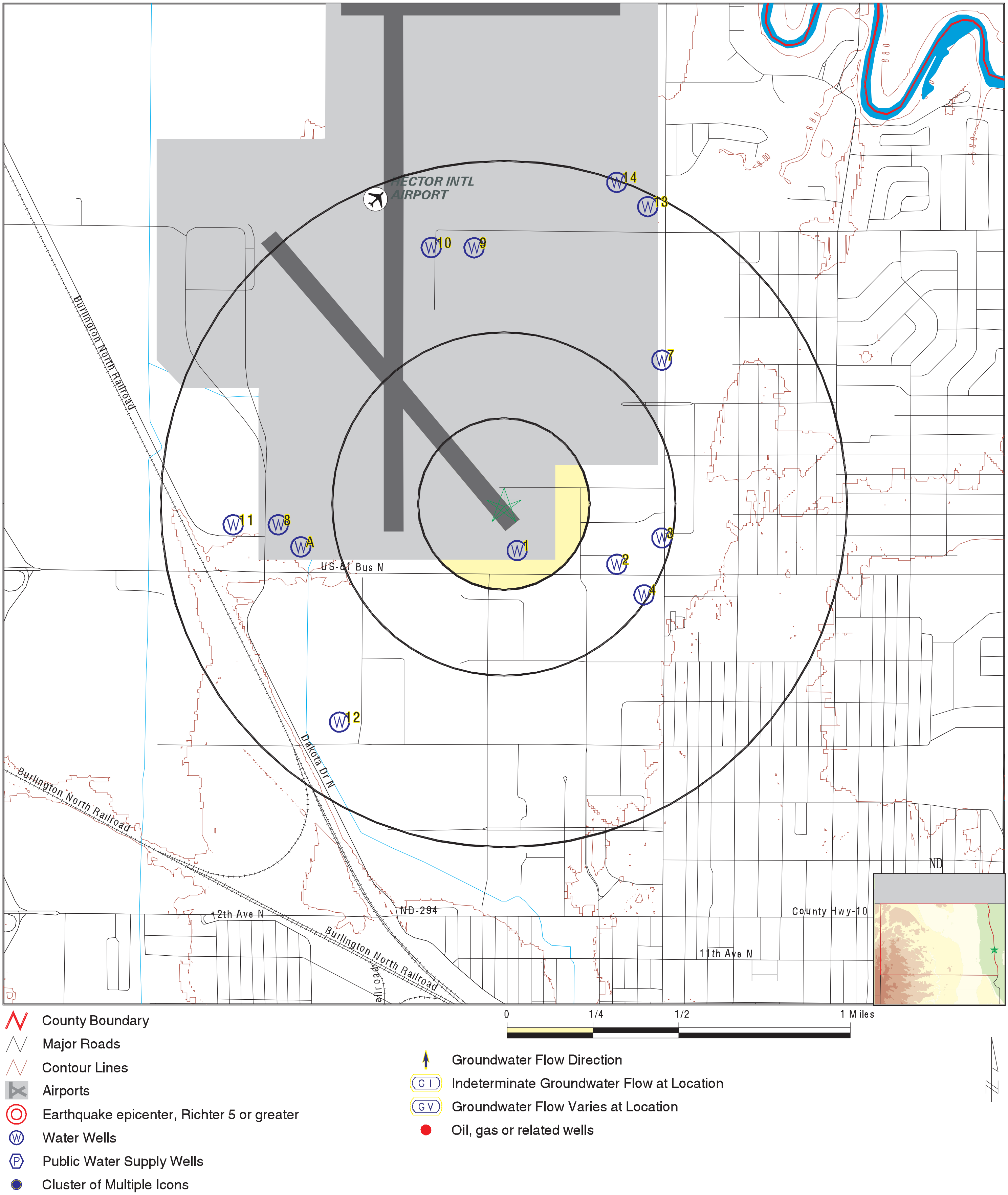
MAP ID	WELL ID	LOCATION FROM TP
1	ND7000000014258	1/8 - 1/4 Mile SSE

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

STATE DATABASE WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
4	ND7000000014298	1/4 - 1/2 Mile ESE
A5	ND7000000014260	1/2 - 1 Mile WSW
A6	ND7000000014259	1/2 - 1 Mile WSW
9	ND7000000014256	1/2 - 1 Mile North
10	ND7000000014257	1/2 - 1 Mile NNW
12	ND7000000014299	1/2 - 1 Mile SW
13	ND7000000014255	1/2 - 1 Mile NNE

PHYSICAL SETTING SOURCE MAP - 5872123.9s



SITE NAME: Fargo AASF #2	CLIENT: AECOM
ADDRESS: 1760 North 23rd Avenue	CONTACT: Hans Sund
Fargo ND 58102	INQUIRY #: 5872123.9s
LAT/LONG: 46.907788 / 96.807863	DATE: November 15, 2019 4:18 pm

Map ID
Direction
Distance
Elevation | Database | EDR ID Number

1
SSE
1/8 - 1/4 Mile
Higher | **ND WELLS** | **ND7000000014258**

Well Index:	13314	Basin:	Red River
Aquifer:	No Obs Well Installed	Purpose:	Test Hole
Casing Type:	None	Diameter:	0
Surface Elevation:	900	Drill Date:	1991 917
Total Depth:	240	Bedrock Depth:	221

2
ESE
1/4 - 1/2 Mile
Higher | **FED USGS** | **USGS40000917469**

Organization ID:	USGS-ND		
Organization Name:	USGS North Dakota Water Science Center		
Monitor Location:	140-049-36AAA	Type:	Well
Description:	Not Reported	HUC:	09020104
Drainage Area:	Not Reported	Drainage Area Units:	Not Reported
Contrib Drainage Area:	Not Reported	Contrib Drainage Area Unts:	Not Reported
Aquifer:	Sand and gravel aquifers (glaciated regions)		
Formation Type:	Fargo Aquifer	Aquifer Type:	Not Reported
Construction Date:	19630807	Well Depth:	228
Well Depth Units:	ft	Well Hole Depth:	291
Well Hole Depth Units:	ft		

Ground water levels,Number of Measurements:	132	Level reading date:	1990-06-19
Feet below surface:	81.21	Feet to sea level:	Not Reported
Note:	Not Reported		
Level reading date:	1990-05-25	Feet below surface:	81.15
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1990-05-05	Feet below surface:	81.20
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1989-11-18	Feet below surface:	81.84
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1989-10-28	Feet below surface:	82.01
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1989-09-30	Feet below surface:	81.92
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1989-09-09	Feet below surface:	81.93
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1989-07-30	Feet below surface:	82.08
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1989-07-01	Feet below surface:	81.75
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1989-06-03	Feet below surface:	81.18

Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1989-05-13	Feet below surface:	81.29
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1989-04-22	Feet below surface:	80.89
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-12-10	Feet below surface:	81.45
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-11-05	Feet below surface:	81.77
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-10-14	Feet below surface:	81.60
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-09-17	Feet below surface:	81.60
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-09-01	Feet below surface:	81.56
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-08-20	Feet below surface:	81.39
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-07-23	Feet below surface:	81.38
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-06-24	Feet below surface:	80.83
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-05-28	Feet below surface:	80.41
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-04-29	Feet below surface:	80.26
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1988-04-01	Feet below surface:	80.22
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1987-12-19	Feet below surface:	80.30
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1987-11-28	Feet below surface:	80.38
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1987-10-31	Feet below surface:	80.30
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1987-09-26	Feet below surface:	80.05
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1987-08-29	Feet below surface:	79.97
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1987-07-31	Feet below surface:	79.80
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1987-06-27	Feet below surface:	79.39
Feet to sea level:	Not Reported	Note:	Not Reported

Level reading date:	1987-05-31	Feet below surface:	79.08
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1987-04-24	Feet below surface:	79.01
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1986-12-07	Feet below surface:	79.17
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1986-11-02	Feet below surface:	79.20
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1986-10-09	Feet below surface:	78.91
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1986-08-31	Feet below surface:	79.04
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1986-08-02	Feet below surface:	78.83
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1986-07-04	Feet below surface:	78.52
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1986-06-06	Feet below surface:	78.50
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1986-05-09	Feet below surface:	78.22
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1985-12-06	Feet below surface:	78.73
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1985-10-25	Feet below surface:	78.83
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1985-09-21	Feet below surface:	78.53
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1985-08-18	Feet below surface:	78.54
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1985-07-08	Feet below surface:	78.26
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1985-06-07	Feet below surface:	77.82
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1985-05-05	Feet below surface:	77.82
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1985-04-09	Feet below surface:	77.76
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1984-12-04	Feet below surface:	77.97
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1984-10-09	Feet below surface:	78.50
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1984-10-03	Feet below surface:	78.00
Feet to sea level:	Not Reported	Note:	Not Reported

Level reading date:	1984-09-11	Feet below surface:	78.74
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1984-08-08	Feet below surface:	78.50
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1984-07-11	Feet below surface:	76.94
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1984-06-20	Feet below surface:	76.72
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1984-05-15	Feet below surface:	76.61
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1984-04-10	Feet below surface:	76.38
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-12-14	Feet below surface:	76.37
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-11-08	Feet below surface:	76.34
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-10-11	Feet below surface:	76.20
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-09-14	Feet below surface:	76.19
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-08-17	Feet below surface:	76.08
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-07-28	Feet below surface:	76.61
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-06-22	Feet below surface:	75.68
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-06-08	Feet below surface:	75.60
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-06-02	Feet below surface:	75.53
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-05-24	Feet below surface:	75.52
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-05-19	Feet below surface:	75.42
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-04-18	Feet below surface:	75.34
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1983-03-17	Feet below surface:	75.18
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1982-11-21	Feet below surface:	72.36
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1982-11-17	Feet below surface:	75.79
Feet to sea level:	Not Reported	Note:	Not Reported

Level reading date:	1982-10-30	Feet below surface:	72.37
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1982-10-27	Feet below surface:	76.10
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1982-08-24	Feet below surface:	75.32
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1982-08-23	Feet below surface:	72.12
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1982-06-30	Feet below surface:	71.63
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1982-05-20	Feet below surface:	71.09
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1982-05-20	Feet below surface:	74.29
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1982-03-29	Feet below surface:	70.82
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1981-12-03	Feet below surface:	71.30
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1981-10-07	Feet below surface:	71.27
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1981-09-08	Feet below surface:	74.36
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1981-09-01	Feet below surface:	71.27
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1981-07-22	Feet below surface:	71.20
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1981-06-11	Feet below surface:	71.04
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1981-04-28	Feet below surface:	70.99
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1981-02-23	Feet below surface:	70.79
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1980-11-17	Feet below surface:	71.05
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1980-10-08	Feet below surface:	71.14
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1980-09-09	Feet below surface:	71.43
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1980-08-12	Feet below surface:	71.31
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1980-07-15	Feet below surface:	70.97
Feet to sea level:	Not Reported	Note:	Not Reported

Level reading date:	1980-06-21	Feet below surface:	70.36
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1980-05-22	Feet below surface:	70.19
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1979-11-27	Feet below surface:	70.55
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1978-11-20	Feet below surface:	70.6
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1977-12-01	Feet below surface:	70.07
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1976-11-29	Feet below surface:	70.58
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1975-12-04	Feet below surface:	69.04
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1974-12-03	Feet below surface:	68.58
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1973-12-05	Feet below surface:	70.38
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1972-12-07	Feet below surface:	67.31
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1971-11-30	Feet below surface:	66.33
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1970-12-01	Feet below surface:	67.88
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1969-12-03	Feet below surface:	64.48
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1969-07-14	Feet below surface:	49.38
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1968-07-23	Feet below surface:	50.24
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1967-07-11	Feet below surface:	46.24
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1966-08-03	Feet below surface:	49.18
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1965-08-03	Feet below surface:	51.19
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1965-06-11	Feet below surface:	50.31
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1965-05-10	Feet below surface:	35.16
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1965-03-15	Feet below surface:	17.13
Feet to sea level:	Not Reported	Note:	Not Reported

Level reading date:	1965-02-12	Feet below surface:	17.01
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1965-01-18	Feet below surface:	17.28
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-12-09	Feet below surface:	14.1
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-11-02	Feet below surface:	17.94
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-09-30	Feet below surface:	18.10
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-08-24	Feet below surface:	18.90
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-07-30	Feet below surface:	19.83
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-06-28	Feet below surface:	22.30
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-05-27	Feet below surface:	31.60
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-05-04	Feet below surface:	44.14
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-04-01	Feet below surface:	50.02
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-03-01	Feet below surface:	50.87
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1964-01-14	Feet below surface:	51.15
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1963-12-02	Feet below surface:	51.22
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1963-11-01	Feet below surface:	51.61
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1963-09-24	Feet below surface:	51.64
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1963-09-17	Feet below surface:	52.04
Feet to sea level:	Not Reported	Note:	Not Reported
Level reading date:	1963-08-19	Feet below surface:	52.25
Feet to sea level:	Not Reported	Note:	Not Reported

3
ESE
1/4 - 1/2 Mile
Higher

FED USGS **USGS40000917521**

Organization ID:	USGS-ND
Organization Name:	USGS North Dakota Water Science Center

Monitor Location:	140-048-30CCC	Type:	Well
Description:	Not Reported	HUC:	09020204
Drainage Area:	Not Reported	Drainage Area Units:	Not Reported
Contrib Drainage Area:	Not Reported	Contrib Drainage Area Unts:	Not Reported
Aquifer:	Not Reported	Formation Type:	Not Reported
Aquifer Type:	Not Reported	Construction Date:	1955
Well Depth:	278	Well Depth Units:	ft
Well Hole Depth:	Not Reported	Well Hole Depth Units:	Not Reported

---

4
ESE
1/4 - 1/2 Mile
Higher

ND WELLS **ND7000000014298**

Well Index:	167	Basin:	Red River
Aquifer:	University	Purpose:	Observation Well
Casing Type:	ABS	Diameter:	0
Surface Elevation:	0	Drill Date:	1963 8 7
Total Depth:	291	Bedrock Depth:	291

A5
WSW
1/2 - 1 Mile
Higher

ND WELLS **ND7000000014260**

Well Index:	13313	Basin:	Red River
Aquifer:	No Obs Well Installed	Purpose:	Test Hole
Casing Type:	None	Diameter:	0
Surface Elevation:	902	Drill Date:	1991 917
Total Depth:	200	Bedrock Depth:	0

A6
WSW
1/2 - 1 Mile
Higher

ND WELLS **ND7000000014259**

Well Index:	13354	Basin:	Red River
Aquifer:	No Obs Well Installed	Purpose:	Test Hole
Casing Type:	None	Diameter:	0
Surface Elevation:	900	Drill Date:	1963 8 8
Total Depth:	226	Bedrock Depth:	225

7
NE
1/2 - 1 Mile
Higher

FED USGS **USGS40000917726**

Organization ID:	USGS-ND		
Organization Name:	USGS North Dakota Water Science Center		
Monitor Location:	140-048-30BCC	Type:	Well
Description:	Not Reported	HUC:	09020204
Drainage Area:	Not Reported	Drainage Area Units:	Not Reported
Contrib Drainage Area:	Not Reported	Contrib Drainage Area Unts:	Not Reported
Aquifer:	Not Reported	Formation Type:	Not Reported

Aquifer Type:	Not Reported	Construction Date:	Not Reported
Well Depth:	190	Well Depth Units:	ft
Well Hole Depth:	Not Reported	Well Hole Depth Units:	Not Reported

---

8
West
1/2 - 1 Mile
Higher

FED USGS **USGS40000917539**

Organization ID:	USGS-ND		
Organization Name:	USGS North Dakota Water Science Center		
Monitor Location:	140-049-26DDD	Type:	Well
Description:	Not Reported	HUC:	09020104
Drainage Area:	Not Reported	Drainage Area Units:	Not Reported
Contrib Drainage Area:	Not Reported	Contrib Drainage Area Unts:	Not Reported
Aquifer:	Sand and gravel aquifers (glaciated regions)		
Formation Type:	Glacial Drift, Undifferentiated - Pleistocene		
Aquifer Type:	Not Reported	Construction Date:	19630808
Well Depth:	Not Reported	Well Depth Units:	Not Reported
Well Hole Depth:	226	Well Hole Depth Units:	ft

9
North
1/2 - 1 Mile
Higher

ND WELLS **ND7000000014256**

Well Index:	15821	Basin:	Red River
Aquifer:	University	Purpose:	Irrigation Well
Casing Type:	Steel	Diameter:	4
Surface Elevation:	896	Drill Date:	1979 929
Total Depth:	201	Bedrock Depth:	0

10
NNW
1/2 - 1 Mile
Lower

ND WELLS **ND7000000014257**

Well Index:	19882	Basin:	Red River
Aquifer:	University	Purpose:	Industrial Well
Casing Type:	Steel	Diameter:	6
Surface Elevation:	896	Drill Date:	1996 111
Total Depth:	257	Bedrock Depth:	0

11
West
1/2 - 1 Mile
Higher

FED USGS **USGS40000917540**

Organization ID:	USGS-ND		
Organization Name:	USGS North Dakota Water Science Center		
Monitor Location:	140-049-26DDC	Type:	Well
Description:	Not Reported	HUC:	09020104
Drainage Area:	Not Reported	Drainage Area Units:	Not Reported
Contrib Drainage Area:	Not Reported	Contrib Drainage Area Unts:	Not Reported

Aquifer:	Not Reported	Formation Type:	Not Reported
Aquifer Type:	Not Reported	Construction Date:	1958
Well Depth:	150	Well Depth Units:	ft
Well Hole Depth:	Not Reported	Well Hole Depth Units:	Not Reported

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12
SW
1/2 - 1 Mile
Higher

ND WELLS **ND7000000014299**

Well Index:	16048	Basin:	Red River
Aquifer:	No Obs Well Installed	Purpose:	Test Hole
Casing Type:	None	Diameter:	0
Surface Elevation:	892	Drill Date:	19931020
Total Depth:	196	Bedrock Depth:	181

13
NNE
1/2 - 1 Mile
Lower

ND WELLS **ND7000000014255**

Well Index:	154	Basin:	Red River
Aquifer:	Undefined	Purpose:	Stock Well
Casing Type:	Unknown	Diameter:	36
Surface Elevation:	895	Drill Date:	0
Total Depth:	80	Bedrock Depth:	0

14
NNE
1/2 - 1 Mile
Lower

FED USGS **USGS40000917897**

Organization ID:	USGS-ND		
Organization Name:	USGS North Dakota Water Science Center		
Monitor Location:	140-049-24DDD	Type:	Well
Description:	Not Reported	HUC:	09020104
Drainage Area:	Not Reported	Drainage Area Units:	Not Reported
Contrib Drainage Area:	Not Reported	Contrib Drainage Area Unts:	Not Reported
Aquifer:	Sand and gravel aquifers (glaciated regions)		
Formation Type:	Lacustrine Deposits	Aquifer Type:	Not Reported
Construction Date:	Not Reported	Well Depth:	80
Well Depth Units:	ft	Well Hole Depth:	Not Reported
Well Hole Depth Units:	Not Reported		

Ground water levels,Number of Measurements:	1	Level reading date:	1963-06-01
Feet below surface:	40.00	Feet to sea level:	Not Reported
Note:	Not Reported		

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

State Database: ND Radon

Radon Test Results

Source	Total Sites	Average	Std. Dev.	Pct > 4 Pci/L	Pct > 20 Pci/L
wic	62	4.19	3.24	43.5	0.0
school	653	1.84	2.16	5.8	0.3
home	125	7.5	8.5	66.4	3.2
daycare	134	7.72	8.65	64.9	5.2
cluster	24	18.10	15.82	91.7	33.3

Federal EPA Radon Zone for CASS County: 1

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

Federal Area Radon Information for Zip Code: 58102

Number of sites tested: 49

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	4.900 pCi/L	60%	40%	0%
Living Area - 2nd Floor	Not Reported	Not Reported	Not Reported	Not Reported
Basement	7.363 pCi/L	31%	69%	0%

PHYSICAL SETTING SOURCE RECORDS SEARCHED

TOPOGRAPHIC INFORMATION

USGS 7.5' Digital Elevation Model (DEM)
Source: United States Geologic Survey
EDR acquired the USGS 7.5' Digital Elevation Model in 2002 and updated it in 2006. The 7.5 minute DEM corresponds to the USGS 1:24,000- and 1:25,000-scale topographic quadrangle maps. The DEM provides elevation data with consistent elevation units and projection.

Current USGS 7.5 Minute Topographic Map
Source: U.S. Geological Survey

HYDROLOGIC INFORMATION

Flood Zone Data: This data was obtained from the Federal Emergency Management Agency (FEMA). It depicts 100-year and 500-year flood zones as defined by FEMA. It includes the National Flood Hazard Layer (NFHL) which incorporates Flood Insurance Rate Map (FIRM) data and Q3 data from FEMA in areas not covered by NFHL.
Source: FEMA
Telephone: 877-336-2627
Date of Government Version: 2003, 2015

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002, 2005 and 2010 from the U.S. Fish and Wildlife Service.

HYDROGEOLOGIC INFORMATION

AQUIFLOW[R] Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit
Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) leads the national Conservation Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

SSURGO: Soil Survey Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
Telephone: 800-672-5559
SSURGO is the most detailed level of mapping done by the Natural Resources Conservation Service, mapping scales generally range from 1:12,000 to 1:63,360. Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships and county natural resource planning and management.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

LOCAL / REGIONAL WATER AGENCY RECORDS

FEDERAL WATER WELLS

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: USGS National Water Inventory System (NWIS)
This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on wells, springs, and other sources of groundwater.

STATE RECORDS

Water Well Locations
Source: State Water Commission
Telephone: 701-328-2754

OTHER STATE DATABASE INFORMATION

Oil and Gas Well Locations Listing
Source: North Dakota Industrial Commission
Telephone: 701-328-8020
A listing of oil and gas well locations in the state.

RADON

State Database: ND Radon
Source: Dept of Health
Telephone: 701-328-5188
Radon Surveys in North Dakota. Includes cluster, day care, school, home, and women with infant children

Area Radon Information
Source: USGS
Telephone: 703-356-4020
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones
Source: EPA
Telephone: 703-356-4020
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

OTHER

Airport Landing Facilities: Private and public use landing facilities
Source: Federal Aviation Administration, 800-457-6656

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

Earthquake Fault Lines: The fault lines displayed on EDR’s Topographic map are digitized quaternary faultlines, prepared in 1975 by the United State Geological Survey

PHYSICAL SETTING SOURCE RECORDS SEARCHED

STREET AND ADDRESS INFORMATION

Fargo AASF #2

1760 North 23rd Avenue

Fargo, ND 58102

Inquiry Number: 5872123.10

November 15, 2019

Certified Sanborn® Map Report

EDR®

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

Certified Sanborn® Map Report

11/15/19

Site Name:	**Client Name:**
Fargo AASF #2	AECOM
1760 North 23rd Avenue	12120 Shamrock Plaza
Fargo, ND 58102	Omaha, NE 68154
EDR Inquiry # 5872123.10	Contact: Hans Sund

The Sanborn Library has been searched by EDR and maps covering the target property location as provided by AECOM were identified for the years listed below. The Sanborn Library is the largest, most complete collection of fire insurance maps. The collection includes maps from Sanborn, Bromley, Perris & Browne, Hopkins, Barlow, and others. Only Environmental Data Resources Inc. (EDR) is authorized to grant rights for commercial reproduction of maps by the Sanborn Library LLC, the copyright holder for the collection. Results can be authenticated by visiting www.edrnet.com/sanborn.

The Sanborn Library is continually enhanced with newly identified map archives. This report accesses all maps in the collection as of the day this report was generated.

Certified Sanborn Results:

Certification # A8C1-4815-AC5F

PO # NA

Project Fargo AASF #2

UNMAPPED PROPERTY

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Sanborn® Library search results

Certification #: A8C1-4815-AC5F

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- ✔ Library of Congress
- ✔ University Publications of America
- ✔ EDR Private Collection

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Appendix B
Preliminary Assessment Documentation

Appendix B.1
Interview Records

PA Interview Questionnaire - Other

Facility: Fargo AASF
Interviewer: [redacted]
Date/Time: September 13, 2019

Interviewee: [redacted] **Title:** Assistant Director at Fargo Airport **Phone Number:** [redacted] **Email:** [redacted]	Can your name/role be used in the PA Report? **Y** or N Can you recommend anyone we can interview? Y or **N** ___________________________

Roles or activities with the Facility/Years working at the Facility:

22 years at the Fargo Airport

PFAS Use: Identify accidental/intentional release locations, time frame of release, frequency of releases, storage container size (maintenance, fire training, firefighting, buildings with suppression systems (as builts), fueling stations, crash sites, pest management, recreational, dining facilities, metals plating, or waterproofing). How are materials ordered/purchased/disposed/shared with others?

	Known Uses
[redacted] stated that there has not been any crashes or fires at the Fargo Airport during his tenure.	Use
	Procurement
	Disposition
	Storage (Mixed)
	Storage (Solution)
	Inventory, Off-Spec
	Containment
	SOP on Filling
	Leaking Vehicles
	Nozzle and Suppression System Testing
	Dining Facilities
	Vehicle Washing
	Ramp Washing
	Fuel Spill Washing and Fueling Stations
	Chrome Plating or Waterproofing

PA Interview Questionnaire - Other

Facility: Fargo AASF
Interviewer: [redacted]
Date/Time: September 13, 2019

Interviewee: [redacted] **Title:** NDANG 119CEF **Phone Number:** [redacted] **Email:** [redacted]	Can your name/role be used in the PA Report? **Y** or N Can you recommend anyone we can interview? Y or **N** ___________________________
Roles or activities with the Facility/Years working at the Facility:	
10 years at the NDANG. <u>Additional Personnel Present for Interview:</u> • [redacted], Assistant Director at Fargo Airport, 22 years at airport, [redacted], • [redacted], NDARNG EPM, 17 years at EPM, [redacted], [redacted] • [redacted], MAA Fire Chief, 29 years at Fire Station, [redacted], [redacted] • [redacted], Fargo Jet Center Manager, 20 years at Fargo Airport, [redacted], [redacted]	
PFAS Use: Identify accidental/intentional release locations, time frame of release, frequency of releases, storage container size (maintenance, fire training, firefighting, buildings with suppression systems (as builts), fueling stations, crash sites, pest management, recreational, dining facilities, metals plating, or waterproofing). How are materials ordered/purchased/disposed/shared with others?	
[redacted] stated that there was some PFAS reports done at the Fargo NDANG facility, where he talked about some of the findings. [redacted] told us where to find the reports to use in our report for the NDARNG.	**Known Uses** Use Procurement Disposition Storage (Mixed) Storage (Solution) Inventory, Off-Spec Containment SOP on Filling Leaking Vehicles Nozzle and Suppression System Testing Dining Facilities Vehicle Washing Ramp Washing Fuel Spill Washing and Fueling Stations Chrome Plating or Waterproofing

PA Interview Questionnaire - Other

Facility: Fargo AASF
Interviewer: [redacted]
Date/Time: September 13, 2019

Interviewee: [redacted] **Title:** Facility Manager **Phone Number:** [redacted] **Email:** [redacted]	Can your name/role be used in the PA Report? **Y** or N Can you recommend anyone we can interview? Y or **N** ___________________________
Roles or activities with the Facility/Years working at the Facility:	
26 years at the Fargo AASF Additional Personnel Present for Interview: • [redacted], Assistant Director at Fargo Airport, 22 years at airport, [redacted], • [redacted], NDARNG EPM, 17 years at EPM, [redacted] • [redacted], MAA Fire Chief, 29 years at Fire Station, [redacted] • [redacted], Fargo Jet Center Manager, 20 years at Fargo Airport, [redacted], • [redacted], ANG 119CEF, 10 years at ANG, [redacted]	
PFAS Use: Identify accidental/intentional release locations, time frame of release, frequency of releases, storage container size (maintenance, fire training, firefighting, buildings with suppression systems (as builts), fueling stations, crash sites, pest management, recreational, dining facilities, metals plating, or waterproofing). How are materials ordered/purchased/disposed/shared with others?	

• No fire training activities • No fire suppression system in hanger • No bulk AFFF • No firetrucks on the facility • ARNG occupies a small building with offices and a hanger • NDARNG has occupied these buildings from 2012 to 2015 and then from 2016 to present • There are ABC and Purple K fire extinguishers in the buildings • There is one TriMax30™ that was found when performing the visual investigation, however no personnel knew when or how the TriMax30™ got to the AASF. [redacted] stated that he had never worked with it and knew nothing about it.	**Known Uses** Use Procurement Disposition Storage (Mixed) Storage (Solution) Inventory, Off-Spec Containment SOP on Filling Leaking Vehicles Nozzle and Suppression System Testing Dining Facilities Vehicle Washing Ramp Washing Fuel Spill Washing and Fueling Stations Chrome Plating or Waterproofing

Appendix B.2
Visual Site Inspection Checklists

Visual Site Inspection Checklist

Names(s) of people performing VSI: [redacted]

Recorded by: [redacted]

ARNG Contact: [redacted]

Date and Time: 9/13/2019

Method of visit (walking, driving, adjacent): walking, driving

Source/Release Information

Site Name / Area Name / Unique ID: Fargo AASF

Site / Area Acreage: The Fargo AASF consists of an approximately 11,730 square foot of commercial hangar rental and approximately 3,000 square foot of commercial administrative rental space.

Historic Site Use (Brief Description): The Fargo AASF #2 is constructed on a parcel of land that has been operated by the NDARNG from 2012-2015 and from 2016-present. Before 2012, the Fargo Jet Center LLC owned and operated the land.

Current Site Use (Brief Description): The AASF provides maintenance support for the NDANRG.

Physical barriers or access restrictions: Access to the area is restricted to NDARNG.

1. Was PFAS used (or spilled) at the site/area? Y / **N**

1a. If yes, document how PFAS was used and usage time (e.g., fire fighting training 2001 to 2014):

N/A

2. Has usage been documented? Y / **N**

2a. If yes, keep a record (place electronic files on a disk):

N/A

3. What types of businesses are located near the site? **Industrial** / **Commercial** / **Plating** / **Waterproofing** / **Residential**

3a. Indicate what businesses are located near the site

The Hector International Airport is located adjacent to the facility. There are commercial and residential properties located to the south and east, and farm land to the north and west.

4. Is this site located at an airport/flightline? **Y** / N

4a. If yes, provide a description of the airport/flightline tenants:

Hector International Airport

Visual Site Inspection Checklist

Other Significant Site Features:

1. Does the facility have a fire suppression system? Y / **N**

1a. If yes, indicate which type of AFFF has been used:

N/A

1b. If yes, describe maintenance schedule/leaks:

N/A

1c. If yes, how often is the AFFF replaced:

N/A

1d. If yes, does the facility have floor drains and where do they lead? Can we obtain an as built drawing?

N/A

Transport / Pathway Information

Migration Potential:

1. Does site/area drainage flow off installation? **Y** / N

1a. If so, note observation and location:

Surface water flows to the northeast towards the Red River.

2. Is there channelized flow within the site/area? Y / **N**

2a. If so, please note observation and location:

N/A

3. Are monitoring or drinking water wells located near the site? **Y** / N

3a. If so, please note the location:

No potable water wells are located within the boundary of the AASF; however, a monitoring, industrial, and irrigation well exist within two miles of the facility

4. Are surface water intakes located near the site? Y / **N**

4a. If so, please note the location:

N/A

5. Can wind dispersion information be obtained? Y / **N**

5a. If so, please note and observe the location.

N/A

6. Does an adjacent non-ARNG PFAS source exist? **Y** / N

6a. If so, please note the source and location.

There are twelve adjacent sources that were/are run by the North Daktoa Air National Guard.

6b. Will off-site reconnaissance be conducted? Y / **N**

Visual Site Inspection Checklist

Significant Topographical Features:

1. Has the infrastructure changed at the site/area? | Y / **N**

1a. If so, please describe change (ex. Structures no longer exist):

N/A

2. Is the site/area vegetated? | Y / **N**

2a. If not vegetated, briefly describe the site/area composition:

Vegetated except for ramps, runways and parking areas

3. Does the site or area exhibit evidence of erosion? | Y / **N**

3a. If yes, describe the location and extent of the erosion:

4. Does the site/area exhibit any areas of ponding or standing water? | Y / **N**

4a. If yes, describe the location and extent of the ponding:

Receptor Information

1. Is access to the site restricted? | **Y** / N

1a. If so, please note to what extent:

The facility has controlled access.

2. Who can access the site? **Site Workers / Construction Workers / Trespassers / Residential / Recreational Users / Ecological**

2a. Circle all that apply, note any not covered above:

3. Are residential areas located near the site? | **Y** / N

3a. If so, please note the location/distance:

Residents to the south and east.

4. Are any schools/day care centers located near the site? | **Y** / N

4a. If so, please note the location/distance/type:

There is multiple schools located within 2 miles of the facility.

5. Are any wetlands located near the site? | **Y** / N

5a. If so, please note the location/distance/type:

The Fargo AASF #2 lies within the Red River Valley of North Dakota. The AASF is located within approximately 2 miles of the Red River and within approximately 5 miles of the Sheyenne River.

Visual Site Inspection Checklist

Additional Notes

Photographic Log

Photo ID/Name	Date & Location	Photograph Description
1	9/13/19, hangar	This is the lone TriMax^{30} fire extinguisher located in the hangar. Information regarding the fire extinguisher is unknown but personnel have not worked with TriMax^{30}s.

Appendix B.3
Conceptual Site Model

Preliminary Assessment – Conceptual Site Model Information

Site Name: Fargo Army Aviation Support Facility

Why has this location been identified as a site?
Facility is an aviation support site with a probability of release due to asset type and historical site usage.

Are there any other activities nearby that could also impact this location?
Yes, there are 12 potential adjacent sources from the North Dakota Air National Guard.

Training Events

Have any training events with AFFF occurred at this site? *No*

If so, how often? *N/A*

How much material was used? Is it documented*? N/A*

Identify Potential Pathways: Do we have enough information to fully understand over land surface water flow, groundwater flow, and geological formations on and around the facility? Any direct pathways to larger water bodies?

Surface Water:

Surface water flow direction? *Surface water flows to the northeast towards the Red River.*

Average rainfall? *22.58 inches*

Any flooding during rainy season? *unknown*

Direct or indirect pathway to ditches? *Direct*

Direct or indirect pathway to larger bodies of water? *Indirect to Red River and Sheyenne River.*

Does surface water pond any place on site? *No*

Any impoundment areas or retention ponds? *No*

Any NPDES location points near the site? *unknown*

How does surface water drain on and around the flight line? *The surface water ultimately drains northeast towards the Red River.*

Groundwater:

Groundwater flow direction? *Groundwater flows to the northeast towards the Red River.*

Depth to groundwater? *Unknown*

Uses (agricultural, drinking water, irrigation)? *Not used.*

Any groundwater treatment systems? *No*

Any groundwater monitoring well locations near the site? *Yes*

Is groundwater used for drinking water? *Drinking water for the AASF is supplied by the City of Fargo, which uses the Red River, Sheyenne River and Lake Ashtabula as its drinking water sources*

Preliminary Assessment – Conceptual Site Model Information

Are there drinking water supply wells on installation? *No*

Do they serve off-post populations? *No*

Are there off-post drinking water wells downgradient? *No potable water wells are located within the boundary of the AASF; however, monitoring, industrial, and irrigation wells exist within two miles of the facility. There is one of each well, for a total of three wells, located near the facility.*

Waste Water Treatment Plant:

Has the installation ever had a WWTP, past or present? *No*

If so, do we understand the process and which water is/was treated at the plant? *N/A*

Do we understand the fate of sludge waste? *N/A*

Is surface water from potential contaminated sites treated? *N/A*

Equipment Rinse Water

1. Is firefighting equipment washed? Where does the rinse water go?
N/A

2. Are nozzles tested? How often are nozzles tested? Where are nozzles tested? Are nozzles cleaned after use? Where does the rinse water flow after cleaning nozzles?
N/A

3. Other?
Hector International Airport provides fire emergency services for the AASF.

Identify Potential Receptors:

Site Worker *Yes*

Construction Worker *Yes*

Recreational User *No*

Residential *No*

Child *No*

Ecological *No*

Note what is located near by the site (e.g. daycare, schools, hospitals, churches, agricultural, livestock)?
Residential area is within two miles of the facility along with schools.

Documentation

Ask for Engineering drawings (if applicable). Has there been a reconstruction or changes to the drainage system? When did that occur? *N/A*

Appendix C
Photographic Log

APPENDIX C – Photographic Log

Army National Guard, Preliminary Assessment for PFAS	Fargo AASF #2	North Dakota

Photograph No. 1

Description:

This is the lone TriMax^{30} fire extinguisher located in the hangar. Information regarding the fire extinguisher is unknown but personnel have not worked with TriMax^{30}s.