Remedial Action Operations
Groundwater Treatment Facility at OU1 and
Groundwater Monitoring at OU1 and OU3

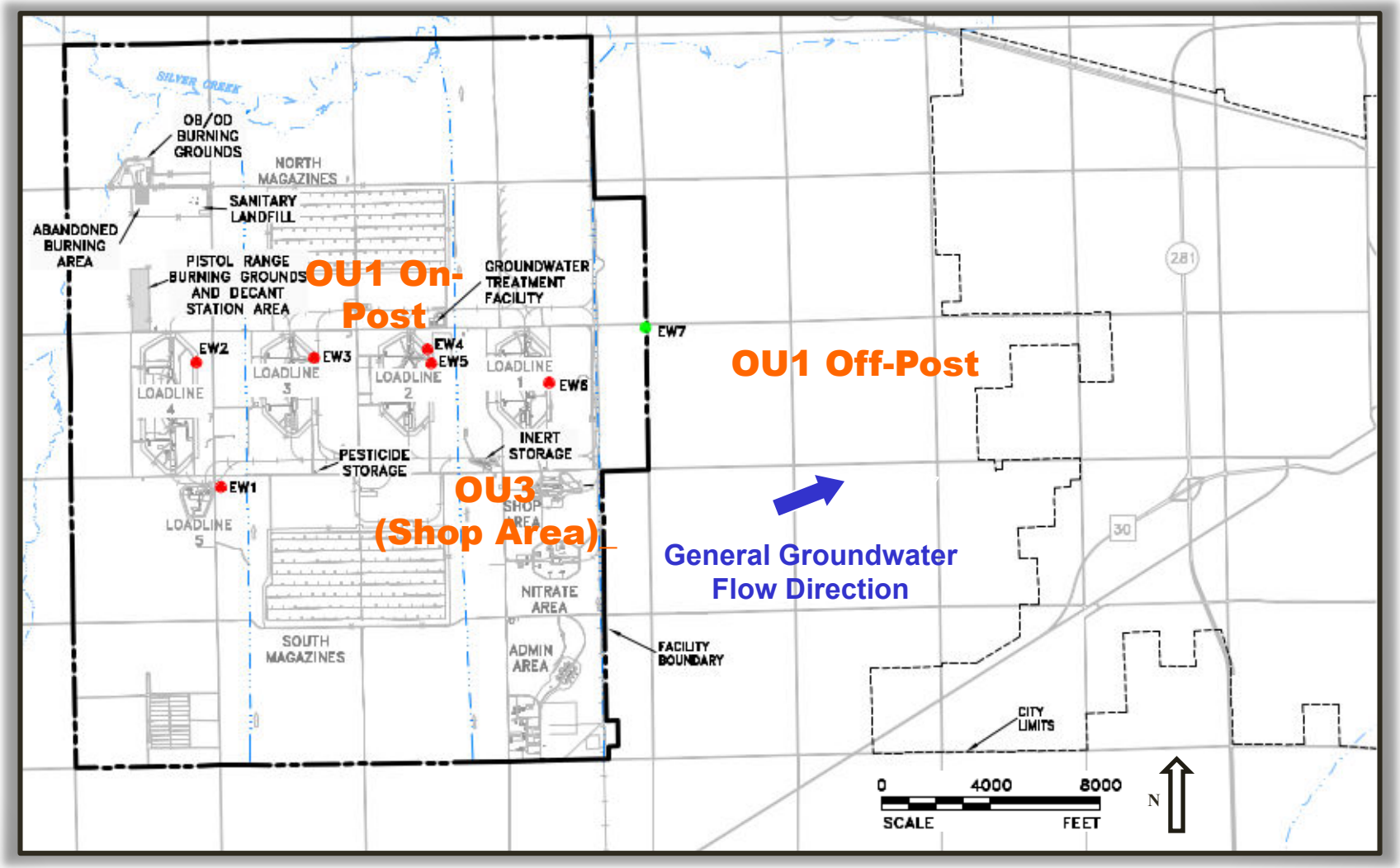
Cornhusker Army Ammunition Plant
Grand Island, NE

October 22, 2019

ANC 8(a) Brice ENGINEERING

AECOM

CHAAP OU1 and OU3



Groundwater Remediation Overview

2019 TASKS (SCHEDULE)

- Groundwater Treatment Facility (GWTF) (year-round)
  - Maintain explosives plume capture at facility boundary - extraction well (EW7), extraction/treatment of groundwater (NPDES sampling)
- Groundwater Monitoring Program − OU1/OU3 (June 2019)
  - Collect site-wide groundwater level measurements
  - Monitor explosives plume (OU1) and VOC (OU3 − Shop Area) concentrations and migration trends over time
  - Evaluate Remedial Actions in place: on-post pump and treatment, monitored natural attenuation (MNA), institutional controls (ICs)
- Initiate OU1 Rebound Study and subsurface injections (Oct − Nov 2019)
  - Evaluate explosives concentrations and migration trends near facility boundary with EW7 temporarily off (2-year study)
  - OU1 Rebound Study Work Plan *(Draft Final submitted August 2019)*
  - Supplemental injection treatments with performance monitoring

Groundwater Remediation Overview

2019 TASKS (SCHEDULE) continued

- Monitoring Well Installation and Abandonments (late fall/early spring)
  - Install two (2) OU1 wells (at LL2) based on 2018 Direct Push sampling
  - Abandon 35 OU1 wells (3 on-post, 32 off-post) removed from the OU1 program
- 2019 Annual Reporting (early 2020)
  - Present results of GWTF, annual OU1/OU3 groundwater monitoring activities, Groundwater Flow and Contaminant Fate and Transport modeling, summarize OU1 Rebound Study and injection activities completed
  - Provide conclusions and recommendations for 2020

Groundwater Treatment Facility

1 JANUARY 2019 – 1 SEPTEMBER 2019

- Average pumping rate – 315 gallons per minute (gpm)
- Total Volume of GW treated – 104 million gallons
- Operational Reliability – 95% Run Time

Scheduled Maintenance/Down Time

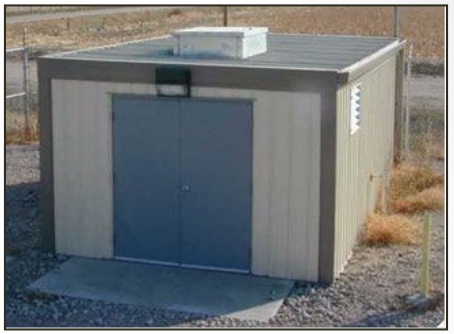
- Monthly Specific Capacity Measurements – 152 hours

Unscheduled Maintenance/Down Time

- Storm-related Power Outages – 331.5 hours

Carbon Change-Out Trends

- 2007 and years prior – 3 times/year
- Post 2007 – 10, 16, 16, 20, and 19 months
- May 2015 – Most recent change out



On-Post Extraction Well

Effluent Piping

Granular Activated Carbon Treatment Units

Groundwater Treatment Facility

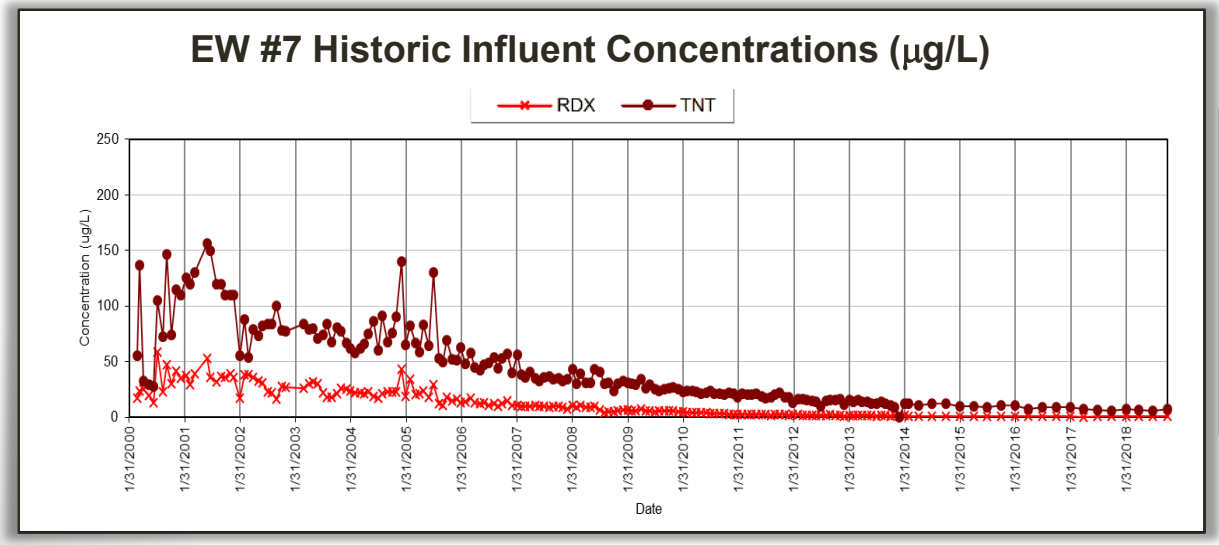
1 JANUARY 2019 – 1 SEPTEMBER 2019

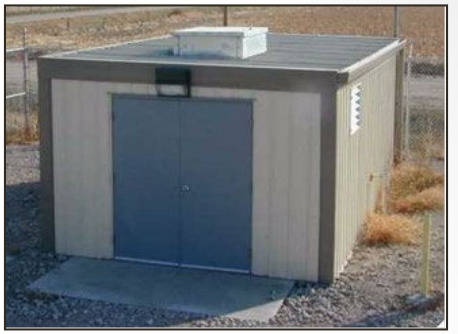
GETS Influent/Effluent Concentrations

- Average Influent RDX Concentration – 0.61 µg/L
- Average Influent TNT Concentration – 7.0 µg/L
- Effluent RDX and TNT Concentration – 0.14 µg/L

EW7 Specific Capacity

- 2012 avg. – 46.3 gpm per foot of drawdown (gpm/ft)
- 2015 avg. – 36.3 gpm/ft
- 2018 avg. – 31.5 gpm/ft
- September 2019 – 30.9 gpm/ft





On-Post Extraction Well

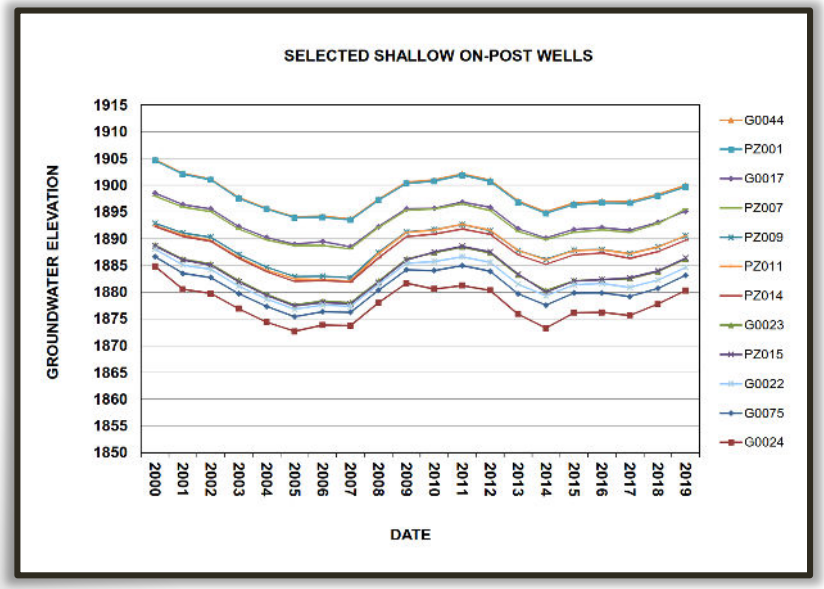
Effluent Piping

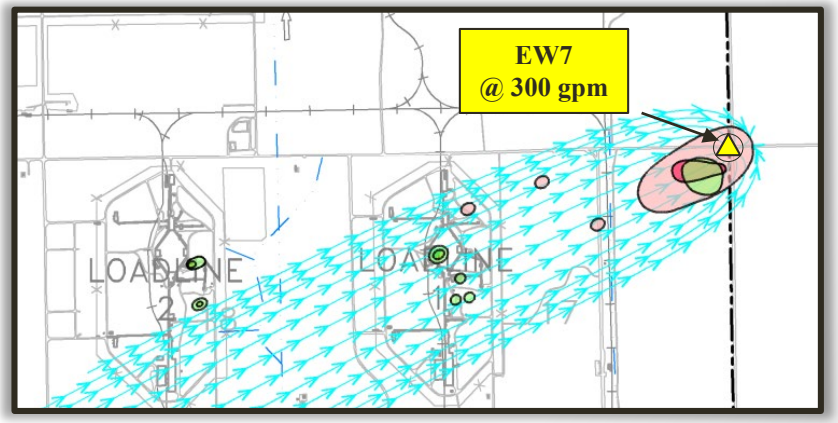
Granular Activated Carbon Treatment Units

2019 Groundwater Monitoring Program

OU1 (EXPLOSIVES PLUME) MONITORING OBJECTIVES

- Completed site-wide water level measurement round (148 wells OU1/OU3)
- Collected groundwater samples at 3 off-post (explosives only) and 74 on-post wells and piezometers (explosives and MNA parameters)
  - **Since 2014, all off-post wells remain below HALs (< 2 µg/L)**
- Evaluated plume concentrations, migration trends, EW7 capture zone analysis, model predicted remediation timeframes, and ICs





2019 Groundwater Monitoring Program

OU3 (SHOP AREA VOC PLUME) MONITORING OBJECTIVES

- Collected groundwater samples at 6 Shop Area wells (VOCs, TPH-DRO, and MNA parameters)
- Evaluated concentrations, natural attenuation trends, and ICs

OPTIMIZE OU1/OU3 GROUNDWATER MONITORING PROGRAM

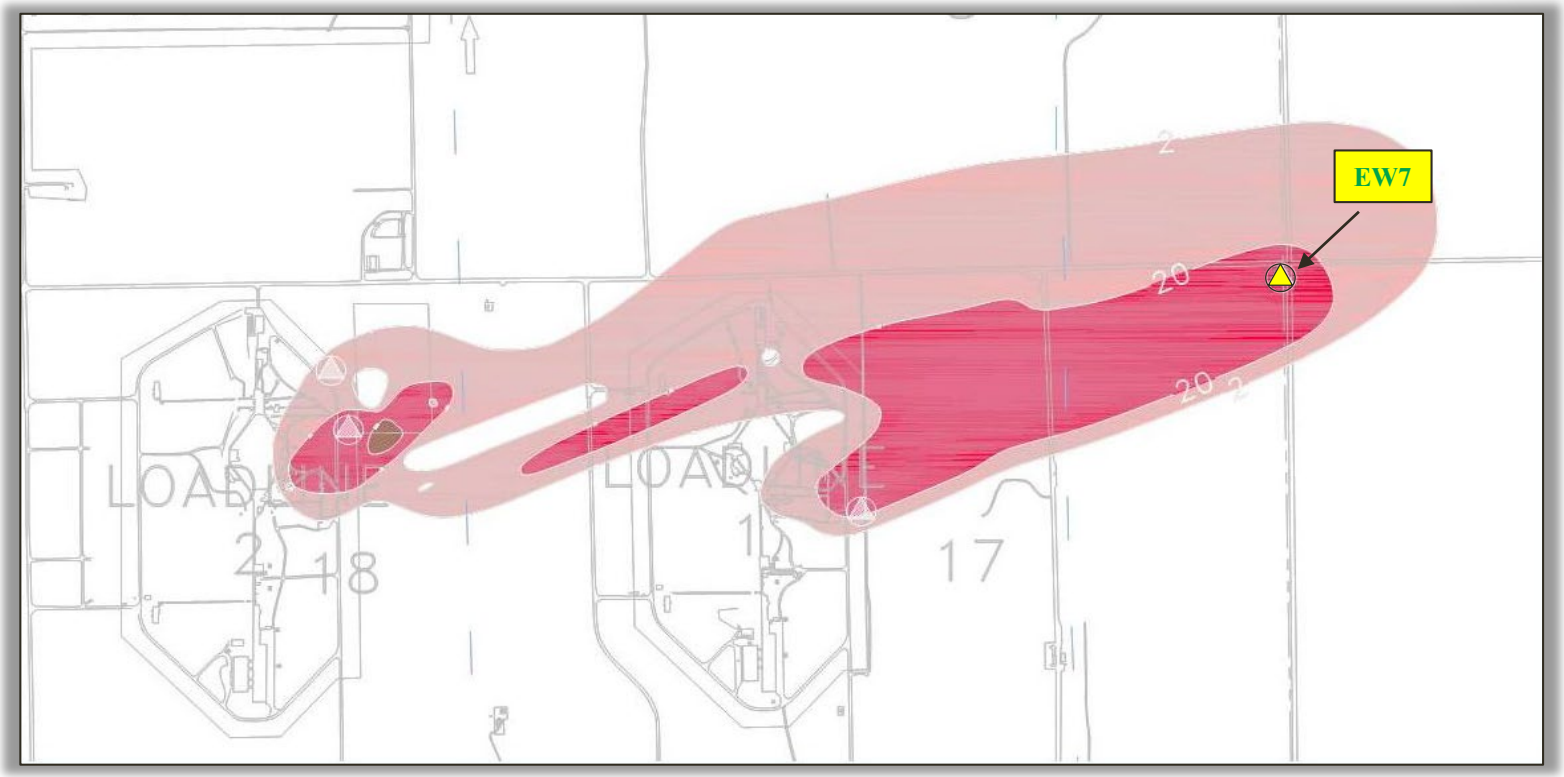
- In 2018, recommended removal of additional 16 off-post wells (distal end) from OU1 LTM Program (< HALs 5 years or longer)
- Since 2013, 70 OU1 monitoring wells (51 off-post, 19 on-post) approved for removal from the program; as of 2019, 35 remain to be abandoned.
- 4 of 6 OU3 Shop Area wells remain on 3-year sampling frequency

PREVIOUS SUBSURFACE INJECTION OBJECTIVE

- Enhance anaerobic in situ bioremediation processes and cometabolically biodegrade TNT and RDX by injecting amendments into on-post groundwater to expedite groundwater remediation
- Injections completed from 2007 to 2016 have significantly reduced plume concentrations. Only small residual plumes remain on-post.

OU1 On-Post Results and Plume History

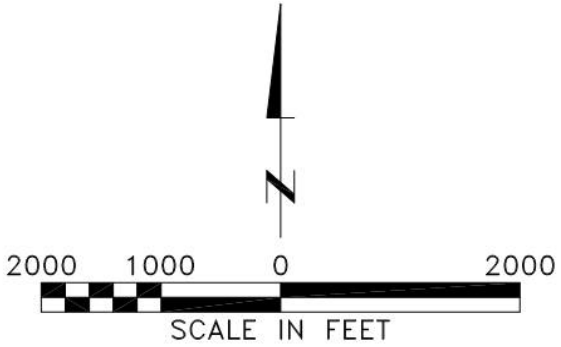
March 2007 – Plume Extent



RDX+TNT >2 µg/L

RDX+TNT >20 µg/L

RDX+TNT >200 µg/L



*Health Advisor Levels (Cleanup Goals)
for RDX or TNT = 2 µg/L or parts per billion

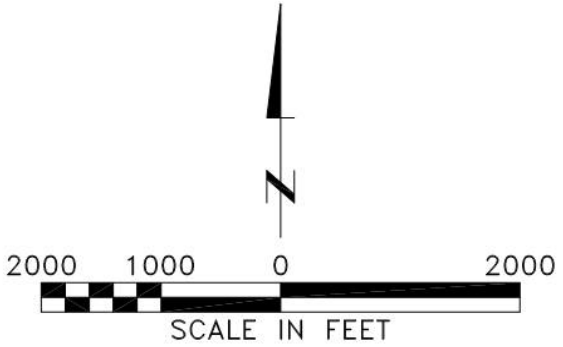
March 2011 – Plume Extent

RDX+TNT >2 µg/L

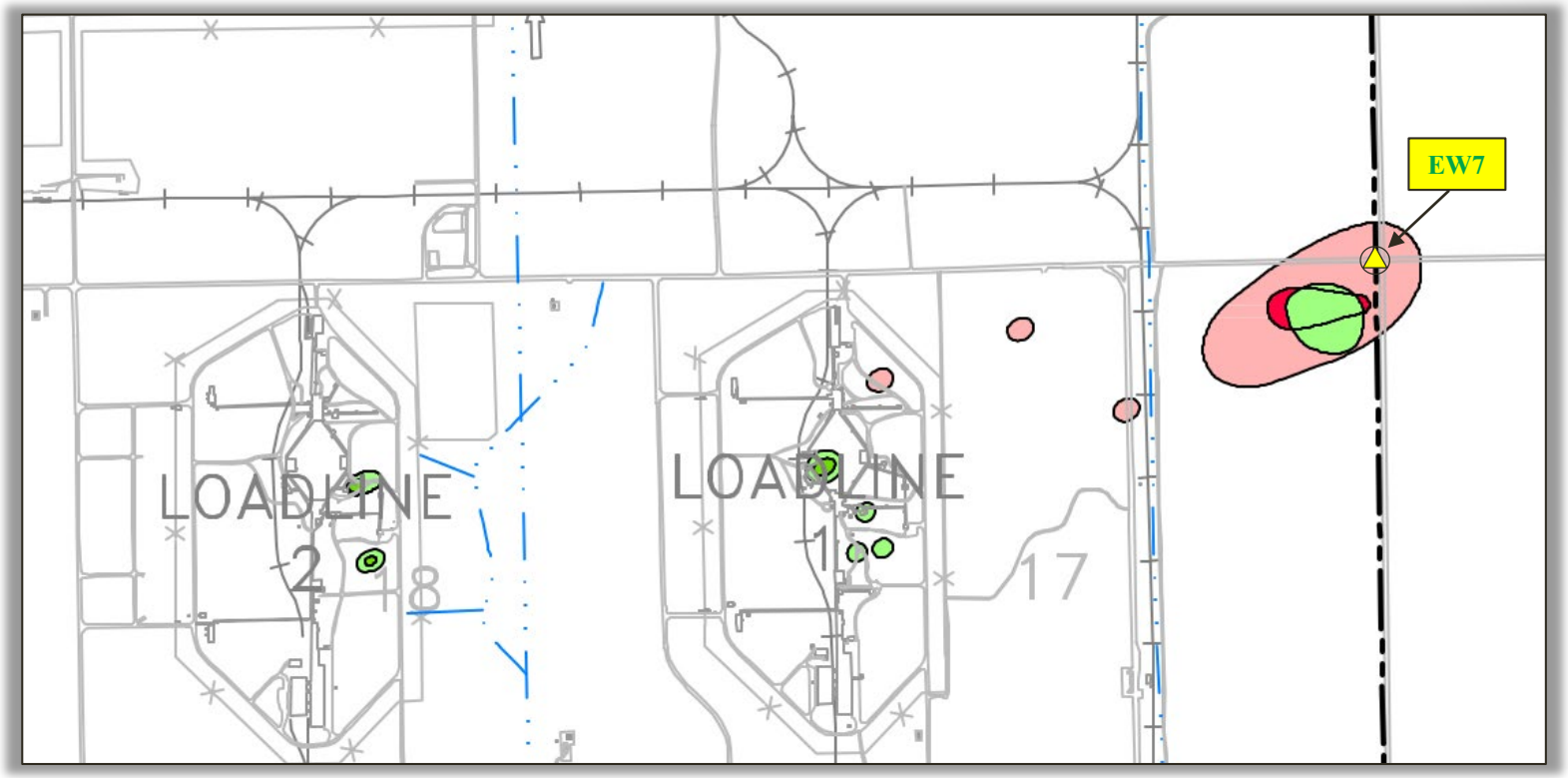
RDX+TNT >20 µg/L

RDX+TNT >200 µg/L

*Health Advisor Levels (Cleanup Goals)
for RDX or TNT = 2 µg/L or parts per billion



June 2019 – Plume Extent



TNT >2 µg/L

TNT >20 µg/L

RDX >2 µg/L

RDX >20 µg/L

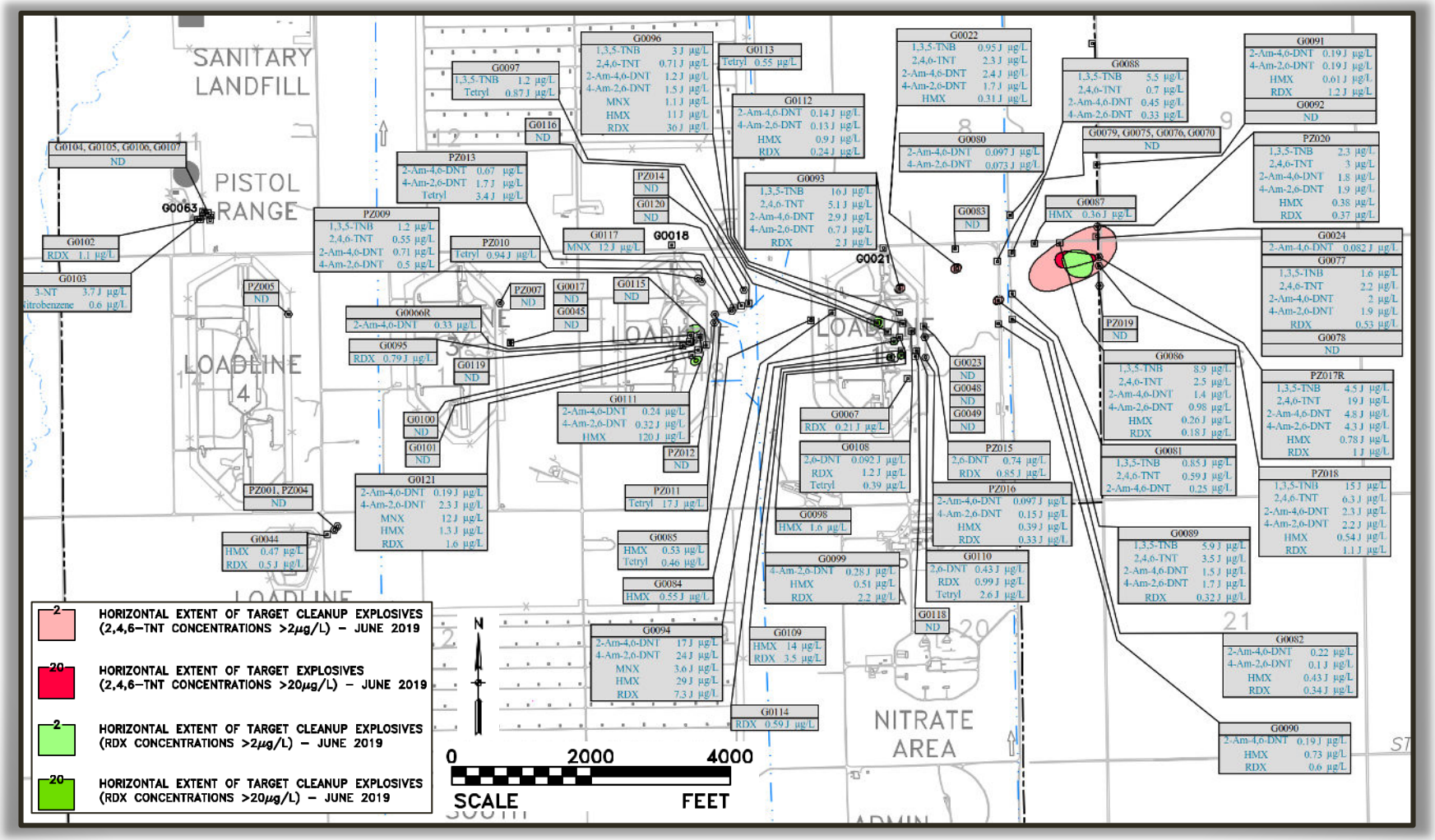
*Health Advisor Levels (Cleanup Goals)
for RDX or TNT = 2 µg/L or parts per billion

N

2000 1000 0 2000

SCALE IN FEET

OU1 On-Post Explosives Plume June 2019



OU1 On-Post Concentrations

Load Lines 1 and 2

- Explosives concentrations (RDX+TNT) continue to remain low within past injection treatment areas (2007 and 2019 concentrations are shown)
  - **LL1:** G0023 (from 38 μg/L to nondetect [**below HALs since 2012**])
    PZ015 (from 84 μg/L to 0.85 μg/L [**below HALs since 2013**])
  - **LL2:** G0066* (from 176 μg/L to nondetect [**below HALs since 2015**])
    PZ013 (from 629 μg/L to nondetect [**below HALs since 2011**])
- **LL1 and LL2**: In 2019, 29 of 38 wells showed declines in explosives concentrations (or remained nondetect), 5 wells remain above HALs

Between EW6 and EW7

- In 2019, 21 of 23 wells showed declines in explosives concentrations (or remained nondetect), 7 wells remain above HALs

- Explosives concentrations west of LL2 (i.e., LL3, LL4, LL5, and Decant Station) have remained below HALs since 2014 or longer

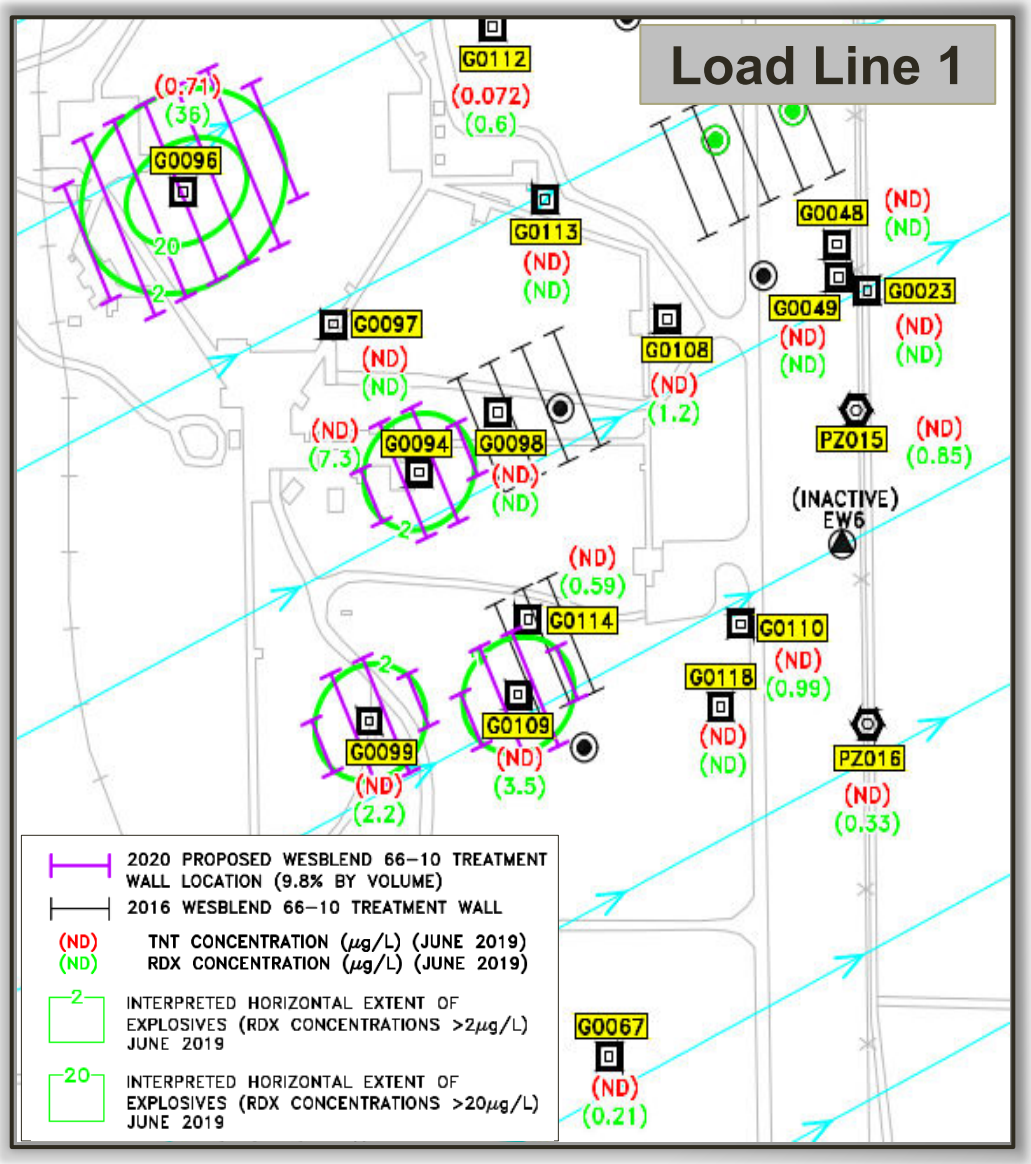
OU1 On-Post Concentrations

Compared to 2018, the 2019 **RDX** concentrations increased at three wells in Load Line 1:

- G0096 RDX = **19** to **36 µg/L**
- G0099 RDX = **1.7** to **2.2 µg/L**
- G0109 RDX = **ND** to **3.5 µg/L**
  - *G0094 RDX = **16** to **7.3 µg/L** (**decreased**)*

- These wells had previous/limited treatment zones (prior to 2013)
- Water levels increased 6 feet (2014 to 2019) causing mobilization of explosives previously trapped in vadose zone during period of lower water levels (2012 to 2014)

- Areas near these wells are recommended for subsurface injections in 2020 (purple).



2019 OU1 Groundwater Monitoring Summary

- RDX and TNT concentrations continue to decrease steadily over time
- Groundwater extraction system continues to contain the on-post groundwater explosives plume
- Significant denitrification is occurring in the feedlot area and in subsurface injection treatment areas (explosives degradation products present)

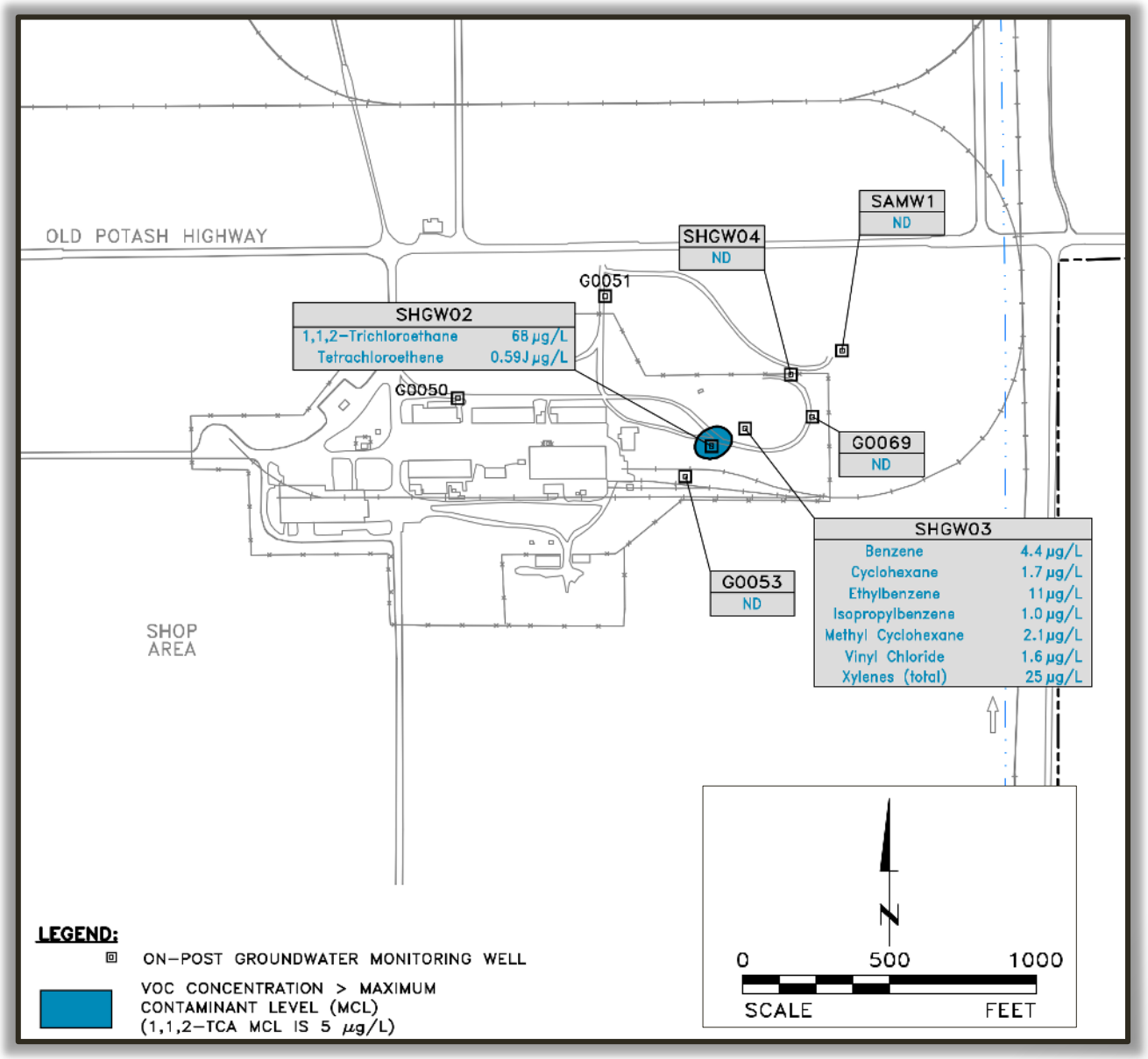
Explosives Mass Estimations: 2007 / 2019

Explosives Parameter(s)	March 2007			June 2019		
	Load Line Treatment Areas (mass in pounds)	Area Between EW6 and EW7 (mass in pounds)	Total Area (mass in pounds)	Load Line Treatment Areas (mass in pounds)	Area Between EW6 and EW7 (mass in pounds)	Total Area (mass in pounds)
RDX	28.28	156.66	184.94	1.19	0.71	1.90
TNT	157.19	419.69	576.88	0.22	37.80	38.02
RDX+TNT	185.47	576.35	761.82	1.41	38.51	39.92

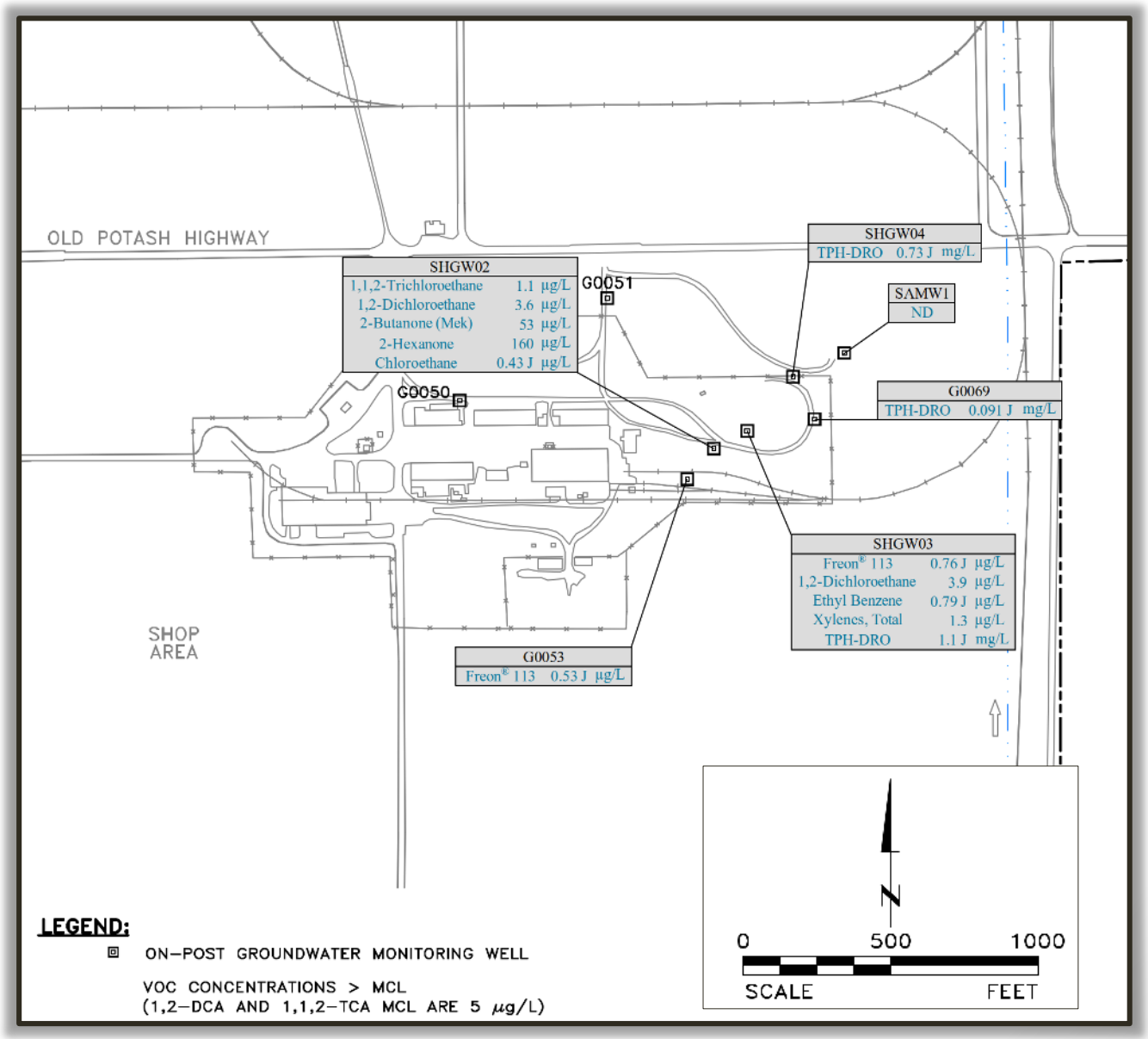
- Since 2014, all off-post wells remain below the explosives cleanup goals (< 2 µg/L)
- Since 2014, annual Contaminant Fate & Transport modeling scenarios continue to show no off-site plume migration (if EW7 turned off in 2019)
  - Concentrations of RDX (max of 1.1 µg/L) and TNT (max of 19 µg/L) low at facility boundary

OU3 Results and Plume History

OU3 Historic VOC Plume March 2002



OU3 VOC Plume June 2019



OU3 Concentration Summary

- 2019 results are below federal Maximum Contaminant Levels (MCLs) for VOCs (i.e., 1,1,2-TCA) and action limits for TPH-DRO
- VOC concentrations have decreased over time
- VOC degradation products have been present
- At SHGW02 and SHGW03, water quality data indicates optimal conditions for natural attenuation process and anaerobic/reducing conditions are present (low ORP and DO values, higher methane and Fe^{2+} values)
- Injections completed in 2009 have reduced 1,1,2-TCA concentrations below its MCL (5 µg/L) since 2010
- Since 2014, breakdown product 1,2-DCA has been fluctuating above its MCL (5 µg/L) but was below its MCL in 2019
- Downgradient well SHGW03 and wells on 3-year sampling frequency indicate that VOCs remain isolated at SHGW02, with no downgradient migration

2019 OU1 Modeling Scenarios

2019 model used to predict long-term contaminant transport conditions

No change:

- Years 1-18 (2019-2036): no injection effects and EW7 on @ 300 gpm

Scenario 1:

- Years 1-18 (2019-2036): no injection effects and EW7 off

Scenario 2 (Proposed Rebound Study):

- Years 1-4 (2019-2022): treatment effects from 2019 and 2020 injections, EW7 off
- Years 5-11 (2023-2028): no further injection effects and EW7 off

	EW7 Pumping at 300 gpm (Years)	Treatment Effects (Years)	Concentrations below HALs at EW7 (Years)	Concentrations below HALs Site-wide (Years)	Off-site Migration
	Based on 2019 conditions				
No change	18	0	7	18	No
Scenario 1	0	0	12	18	No
Scenario 2	0	4	5	11	No

Planned OU1 Rebound Study and Subsurface Injections (2019-2021)

OU1 Rebound Study and Injections Overview

Based on current explosives concentrations and modeling results, actions are being taken to optimize the program including: 'temporary' shutdown of EW7, performing an OU1 Rebound Study, and completing subsurface injections near the former facility boundary (upgradient of EW7).

1. Temporary Shutdown of GWTF and EW7 (November 2019)
2. OU1 Rebound Study Monitoring (Baseline October 2019 through 2021)
3. Subsurface Injections (November 2019 / November 2020)

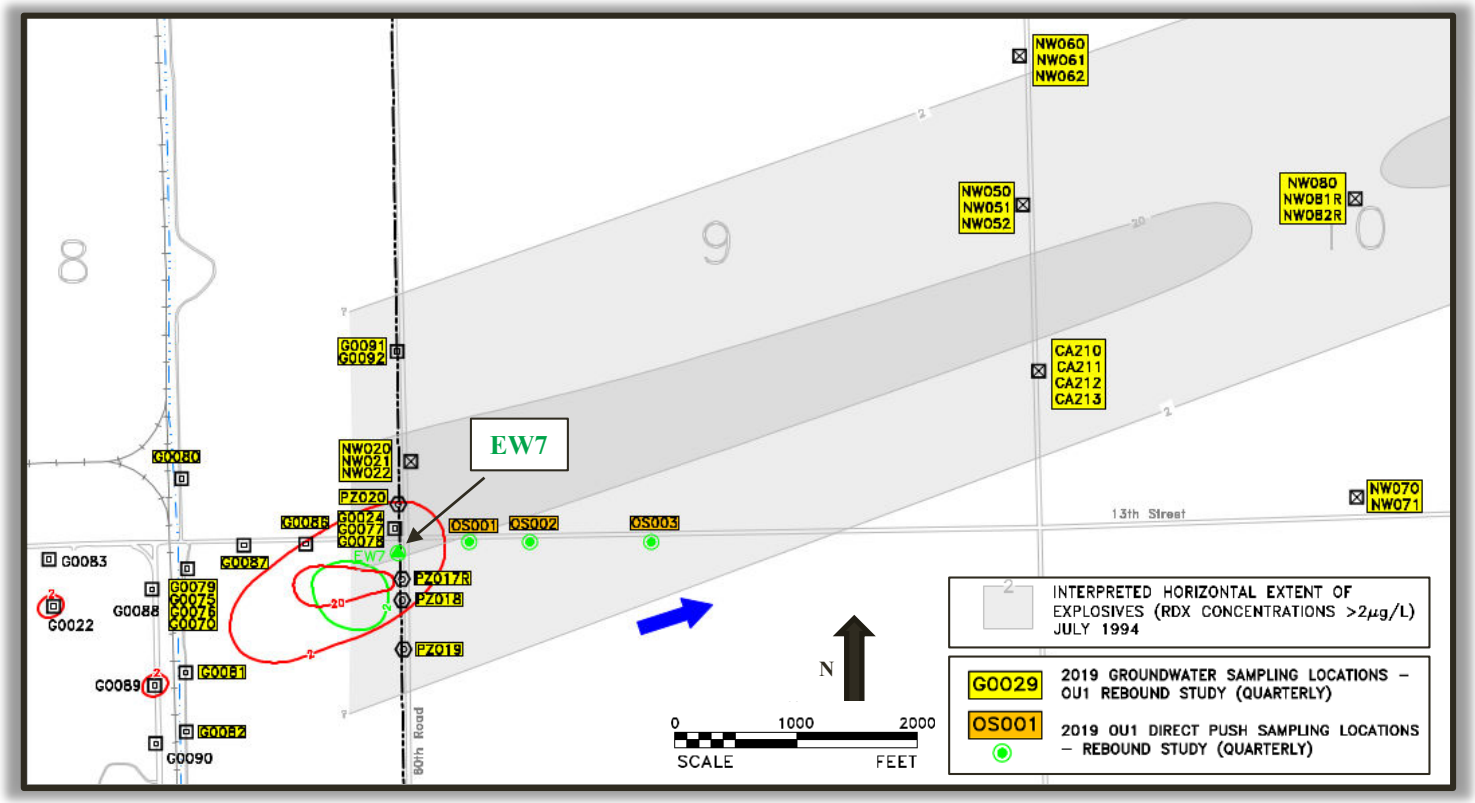
OU1 Rebound Study and Injection Benefits

- Subsurface injections will establish explosives-reducing conditions in groundwater (EW7 off);
- Verify if off-post explosives migration occurs with evaluation of injection performance and nature and extent of concentrations;
- On- and off-post ICs and drilling restrictions continue;
- EW7 and GWTF will remain in 'standby' status for resuming, if necessary.

OU1 Rebound Study and Injections

1. **Temporary Shutdown of GWTF and EW7 (November 2019)**
   - Pump and treat system set to 0 gpm in 'stand-by' condition
     - Winterize GWTF and EWs, maintain routine O&M (i.e., mowing/snow removal, pest control, inspections and security)
2. **Rebound Study Monitoring (October 2019 through 2021)**
   - Monitoring Events (8 sampling events: 1- baseline event prior to EW7 shutdown, 7- subsequent quarterly events)
     - Baseline (prior to EW7 shutdown)
       - 36 select wells (Explosives and MNA analysis)
         - Add 15 off-post wells back to LTM program (removed in 2013, 2016)
       - Direct push sampling (Explosives analysis only)
         - Off-post sample locations to verify clean zone off-site
         - Vertical profile sampling
     - Data Reporting
       - Summarize field activities, present data analysis and extent of explosives and migration, and analysis of statistical trends

OU1 Rebound Study and Injections



- Baseline monitoring well sampling: Determine baseline conditions and verify plume extent prior to EW7 shutdown.
- Direct push locations: Define plume extent directly downgradient from EW7 where no wells exist. Locations will be directly south of feedlot (due to access restrictions).

OU1 Rebound Study and Injections

3. **Subsurface Injections (November 2019) – 600 points total**

Similar injection designs successful in past (direct push, horizontal spacing, vertical intervals, custom-blend amendment and mixture, low injection pressures)

- 2019 Subsurface Injections focus upgradient of EW7/facility boundary (with EW7 off)
  - 16 transects (600 pts total)
  - Increased volume of amendment injected within the core of the explosives plume
  - Injection depths between 15 and 40 feet bgs
  - A 9.8% by volume Wesblend 66-10

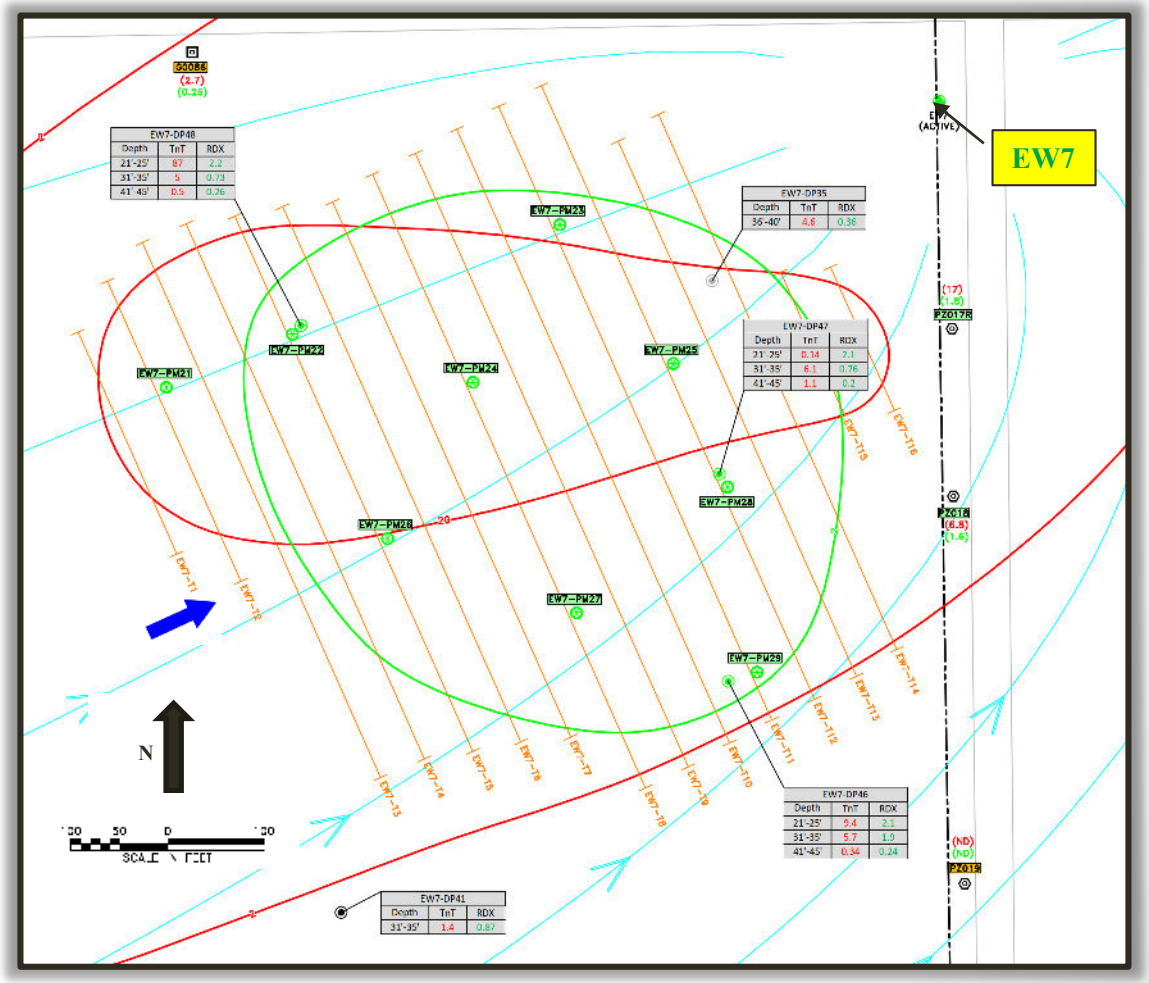
- 2020 Subsurface Injections (600 pts) focus on LL1 and LL2 areas and retreatment of EW7/facility boundary area, if necessary

OU1 Rebound Study and Injections

2019: Focus on RDX plume >2 μg/L and TNT plume >20 μg/L

Performance Monitoring:

- 4 events in 2019 (including baseline)
- 2 monitoring wells, 9 temporary well locations (2 interval depths each)



Planned Activities 2019 through 2021

OU1 Rebound Study (October 2019-2021)

- Conduct 8 monitoring events (including baseline) with quarterly reporting

GWTF and EW7 (November 2019)

- Continue Pump and Treat operations through October (EW7 @ 300 gpm), NPDES sampling, O&M activities, CIH inspection, reporting
- Prepare GWTF/EWs for 'standby' status and continue necessary O&M

Subsurface Injections (November 2019 / November 2021)

- 2019- Complete 600 injection points upgradient of EW7 (off)
- 2020- Complete 600 injection points at LL1, LL2, near EW7 (if needed)
- Quarterly Performance Monitoring for both events

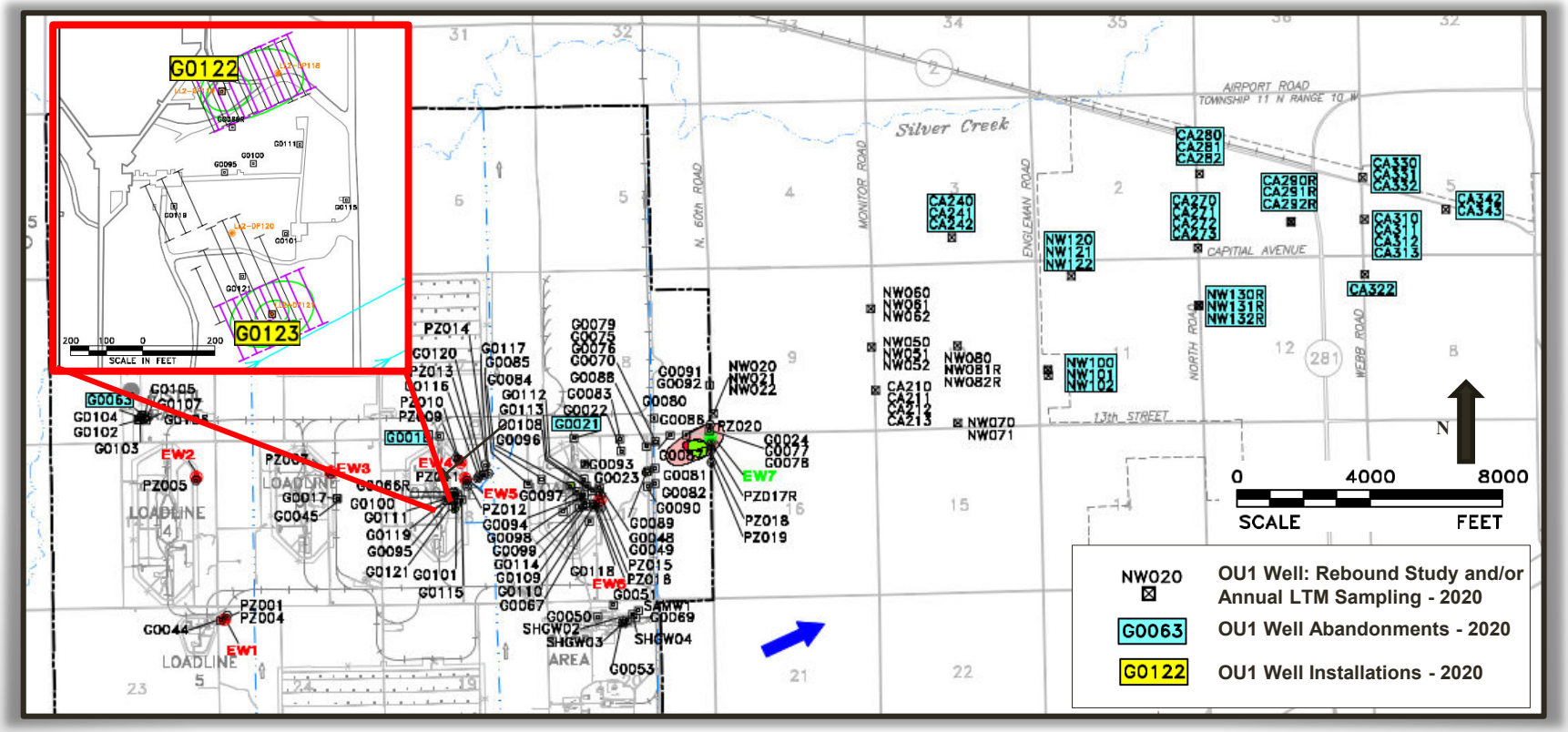
Annual OU1 and OU3 LTM (Spring 2020, 2021)

- Conduct annual sampling (coinciding with Rebound Study activities), reporting and meetings
  - OU1: Sample 18 off-post wells, 76 on-post wells
  - OU3: Sample 2 Shop Area wells

Planned Activities 2019 through 2021

OU1 Well Installations and Abandonments (Spring 2020)

- Complete two (2) well installations (at LL2) based on 2018 Direct Push sampling results and proposed subsurface injections (November 2020)
- Complete 35 well abandonments (3 on-post, 32 off-post). Of the 35 wells, 19 are part of remaining OU1 wells removed from program in 2013.



Planned Activities Schedule 2019 through 2021

Date	GWTF LTO	OU1 Rebound Study	LTM	Injection
Jan-19	Operation			
Feb-19	Operation			
Mar-19	Operation			
Apr-19	Operation			
May-19	Operation			
Jun-19	Operation		LTM Completed	
Jul-19	Operation			
Aug-19	Operation			
Sep-19	Operation			
Oct-19	Operation	Q-1 (baseline)		PM-1 (baseline)
Nov-19	Standby O&M			Complete Injections (600 points)
Dec-19	Standby O&M			
Jan-20	Standby O&M			
Feb-20	Standby O&M	Q-2		PM-2
Mar-20	Standby O&M			
Apr-20	Standby O&M			
May-20	Standby O&M	Q-3	Complete LTM	PM-3
Jun-20	Standby O&M			
Jul-20	Standby O&M			
Aug-20	Standby O&M	Q-4		PM-4
Sep-20	Standby O&M			
Oct-20	Standby O&M			PM-1 (baseline)
Nov-20	Standby O&M	Q-5		Complete Injections (600 points)
Dec-20	Standby O&M			
Jan-21	Standby O&M			
Feb-21	Standby O&M	Q-6		PM-2
Mar-21	Standby O&M			
Apr-21	Standby O&M			
May-21	Standby O&M	Q-7	Complete LTM	PM-3
Jun-21	Standby O&M			
Jul-21	Standby O&M			
Aug-21	Standby O&M	Q-8		PM-4

Notes:

- OU1 Rebound Study (8 quarters) includes using 2 LTM events

GWTF = groundwater treatment facility

LTM = long-term monitoring (annual)

O&M = operations and maintenance

PM = performance monitoring

Q = quarterly event

Questions?