Attachment 9.2 – Remediation Duration Estimate Calculations: WA

Remediation and Water Treatment Duration Estimate Calculations

WAA U>DCGL (Alluvium/Transition Zone/SSB)   GE-WAA-01:04

Nitrate

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Nitrate K_d (ml/g)[2]		Retardation [R]
1.81	0.3	0.6		4.62

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft[2])	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft[3]) [PV = b*n*A]	Pore Volume [PV] (gallons)
732,905	0.3	19	4,177,559	31,248,138

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (mg/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	39.26	Average nitrate concentration
Maximum Representative Concentration within Remediation Area	139.00	Representative nitrate concentration for WELL T-63

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (22.9 mg/L)

R	Nitrate Cleanup Concentration (mg/L)[4]	Initial Aqueous-Phase Contaminant Concentration (mg/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
4.62	22.9	139	8.3	Pore volumes required to achieve cleanup goal and discontinue remediation

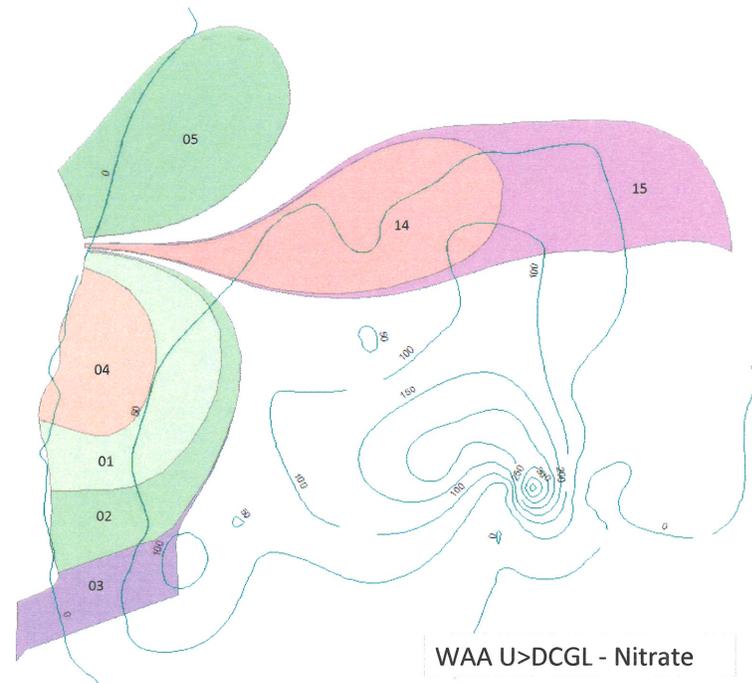**Table 5: Estimated Time to Achieve Remediation Goal (22.9 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
8.3	31,248,138	99	142,560	1,826	60.1	Time to achieve cleanup goal and discontinue remediation.

Definitions:

ml - milliliters
g - gram
ft[3] - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
ACL - alternative contaminant level

Notes:

[1] Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2] K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3] Saturated zone thickness assumed to be 16 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4] Remediation will be discontinued when the nitrate groundwater concentration reaches the ACL (22.9 mg/L)

[5] The larger of the following is assumed as initial nitrate concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6] Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7] Flow rate is based on the nominal combined groundwater recovery rate for extraction wells GE-WAA-01 through GE-WAA-04.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

WAA U>DCGL - Nitrate

Remediation and Water Treatment Duration Estimate Calculations

WAA U>DCGL (Alluvium/Transition Zone/SSB)

Uranium

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.3	2		13.07

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft^2)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft^3) [PV = b*n*A]	Pore Volume [PV] (gallons)
732,905	0.3	19	4,177,559	31,248,138

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	76.16	Average uranium concentration
Maximum Representative Concentration within Remediation Area	177.80	Representative uranium concentration for WELL T-62

WAA U>DCGL - Uranium

DCGL Duration Estimate

Table 4a: Estimated Number of Pore Volumes to Achieve Remediation Goal (119 ug/L)

R	Uranium Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
13.07	119	178	5.2	Pore volumes required to achieve cleanup goal (DCGL) and discontinue remediation

Table 5a: Estimated Time to Achieve Remediation Goal (119 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
5.2	31,248,138	99	142,560	1,150	37.9	Time to achieve cleanup goal (DCGL) and discontinue remediation.

3.16

MCL Duration Estimate

Table 4b: Estimated Number of Pore Volumes to Achieve Remediation Goal (30 ug/L)

R	Uranium Cleanup Concentration (ug/L)	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
13.07	30	178	23.3	Pore volumes required to achieve cleanup goal (MCL) and

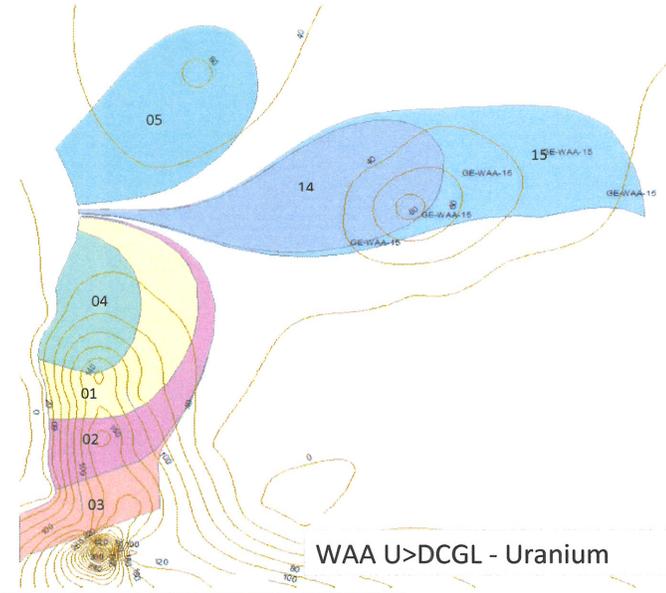**Table 5b: Estimated Time to Achieve Remediation Goal (30 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
23.3	31,248,138	99	142,560	5,097	167.6	Time to achieve cleanup goal (MCL) and discontinue remediation.

Definitions:

ml - milliliters

g - gram

ft^3 - cubic feet

K_d - distribution coefficient

ug - microgram

pCi/L - picocuries per liter

L - liter

gpm - gallons per minute

gpd - gallons per day

DCGL - derived cleanup goal level

MCL - maximum contaminant level

Notes:

[1] Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2] K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3] Saturated zone thickness assumed to be 16 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4] Remediation will be discontinued when the uranium groundwater concentration reaches 119 ug/L, the equivalent of 180 pCi/L as calcuated in *Uranium Activity vs. Mass Concentration_Rev. A (07-30-18).xlsx*, and 30 ug/L.

[5] The larger of the following is assumed as initial uranium concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6] Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7] Flow rate is based on the nominal combined groundwater recovery rate for extraction wells GE-WAA-01 through GE-WAA-04.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations

WU-UP1 (SSA)

Nitrate

Table 1: Retardation Calculation

$$R = 1 + \frac{\rho_b}{n} K_d$$

Bulk Density (g/ml)	Porosity [n][1]	Nitrate K_d (ml/g)[2]		Retardation [R]
1.81	0.1	0.6		11.86

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft²)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft³) [PV = b*n*A]	Pore Volume [PV] (gallons)
484,310	0.1	8	387,448	2,898,111

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (mg/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	203.88	Average nitrate concentration
Maximum Representative Concentration within Remediation Area	379.70	Representative nitrate concentration for WELL 1321

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (22.9 mg/L)

R	Nitrate Cleanup Concentration (mg/L)[4]	Initial Aqueous-Phase Contaminant Concentration (mg/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
11.86	22.9	380	33.3	Pore volumes required to achieve cleanup goal and discontinue remediation

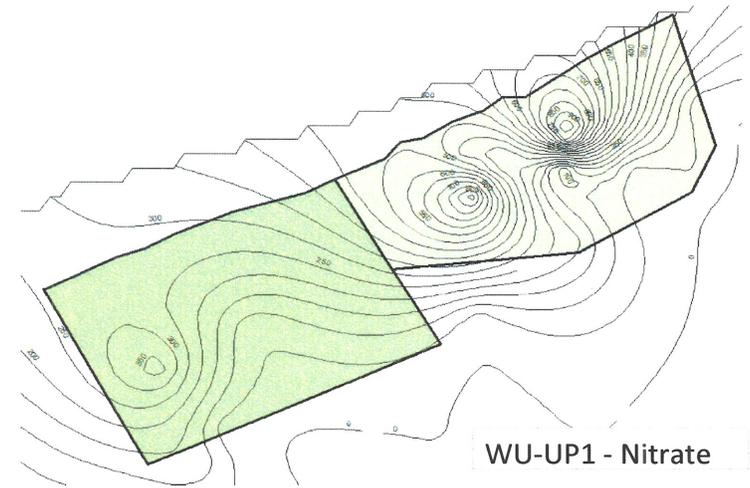**Table 5: Estimated Time to Achieve Remediation Goal (22.9 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
33.3	2,898,111	44	63,360	1,523	50.1	Time to achieve cleanup goal and discontinue remediation.

WU-UP1 - Nitrate

Definitions:

ml - milliliters

g - gram

ft³ - cubic feet

K_d - distribution coefficient

ug - microgram

L - liter

gpm - gallons per minute

gpd - gallons per day

DCGL - derived cleanup goal level

ACL - alternative contaminant level

Notes:

[1] Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2] K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3] Saturated zone thickness assumed to be 8 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4] Remediation will be discontinued when the nitrate groundwater concentration reaches the ACL (22.9 mg/L).

[5] The larger of the following is assumed as initial nitrate concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6] Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7] Flow rate is based on the nominal combined groundwater injection rate for extraction trenches GWI-UP1-02 through GWI-UP1-04.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations
WU-UP1 (SSA)

Uranium

Table 1: Retardation Calculation

$$R = 1 + \frac{\rho_b}{n} K_d$$

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.1	3		55.30

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft[2])	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft[3]) [PV = b*n*A]	Pore Volume [PV] (gallons)
484,310	0.1	8	387,448	2,898,111

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	15.61	Average uranium concentration
Maximum Representative Concentration within Remediation Area	22.11	Representative uranium concentration for WELL 1312

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (30 ug/L)

R	Uranium Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
55.30	30	22	0.0	Pore volumes required to achieve cleanup goal (MCL) and discontinue remediation

Table 5: Estimated Time to Achieve Remediation Goal (30 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
0.0	2,898,111	44	63,360	0	0.0	Time to achieve cleanup goal (MCL) and discontinue remediation.

Definitions:

ml - milliliters
g - gram
ft[3] - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
MCL - maximum contaminant level

Notes:

[1]Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3]Saturated zone thickness assumed to be 8 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.
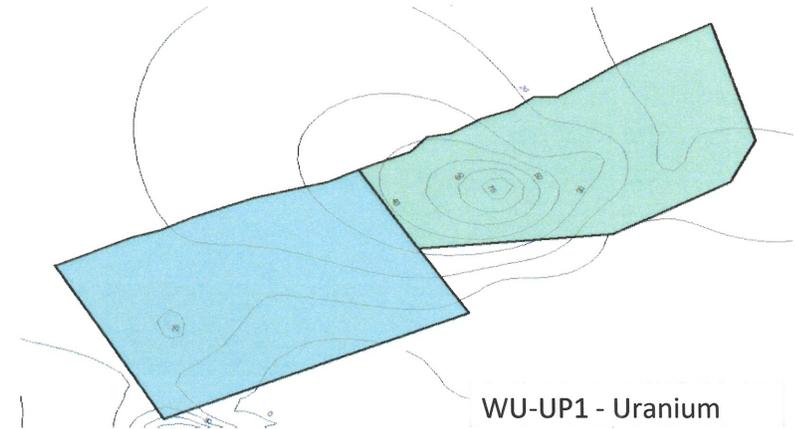
[4]Remediation will be discontinued when the uranium groundwater concentration reaches the MCL (30 ug/L).

[5]The larger of the following is assumed as initial uranium concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7]Flow rate is based on the nominal combined groundwater injection rate for extraction trenches GWI-UP1-02 through GWI-UP1-04.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

WU-UP1 - Uranium

Remediation and Water Treatment Duration Estimate Calculations

WU-UP2-SSA

Nitrate

Table 1: Retardation Calculation

$$R = 1 + \frac{\rho_b}{n} K_d$$

Bulk Density (g/ml)	Porosity [n][1]	Nitrate K_d (ml/g)[2]		Retardation [R]
1.81	0.1	0.6		11.86

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft^2)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft^3) [PV = b*n*A]	Pore Volume [PV] (gallons)
419,878	0.1	8	335,903	2,512,551

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (mg/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	379.27	Average nitrate concentration
Maximum Representative Concentration within Remediation Area	1,006.00	Representative nitrate concentration for WELL 1385

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (22.9 mg/L)

R	Nitrate Cleanup Concentration (mg/L)[4]	Initial Aqueous-Phase Contaminant Concentration (mg/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
11.86	22.9	1,006	44.9	Pore volumes required to achieve cleanup goal and discontinue remediation

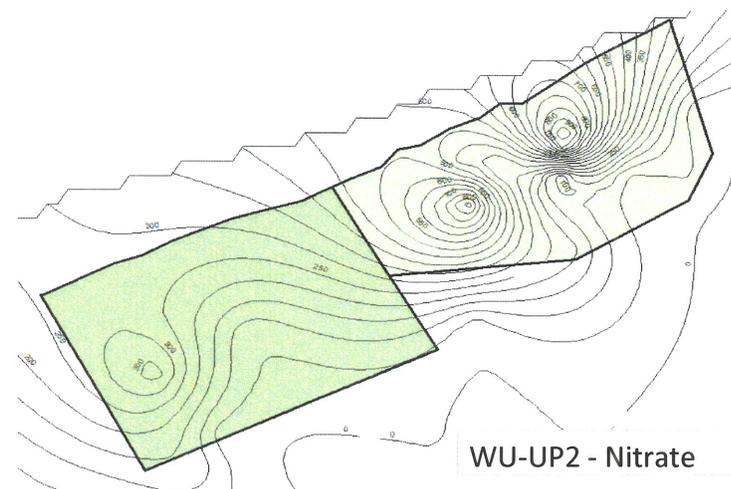**Table 5: Estimated Time to Achieve Remediation Goal (22.9 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
44.9	2,512,551	56	80,640	1,398	46.0	Time to achieve cleanup goal and discontinue remediation.

WU-UP2 - Nitrate

Definitions:

ml - milliliters
g - gram
ft^3 - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
ACL - alternative contaminant level

Notes:

[1] Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2] K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3] Saturated zone thickness assumed to be 8 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4] Remediation will be discontinued when the nitrate groundwater concentration reaches the ACL (22.9 mg/L).

[5] The larger of the following is assumed as initial nitrate concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6] Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7] Flow rate is based on the nominal combined groundwater injection rate for extraction trenches GWI-UP1-02 through GWI-UP1-04.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations

WU-UP2-SSA

Uranium

Table 1: Retardation Calculation

$$R = 1 + \frac{\rho_b}{n} K_d$$

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.1	3		55.30

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft^2)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft^3) [PV = b*n*A]	Pore Volume [PV] (gallons)
419,925	0.1	8	335,940	2,512,831

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	26.34	Average uranium concentration
Maximum Representative Concentration within Remediation Area	81.92	Representative uranium concentration for WELL 1381

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (30 ug/L)

R	Uranium Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
55.30	30	82	55.6	Pore volumes required to achieve cleanup goal (MCL) and discontinue remediation

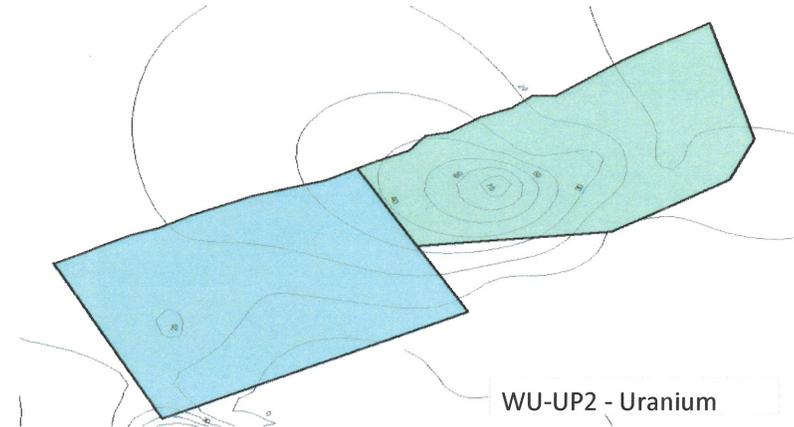**Table 5: Estimated Time to Achieve Remediation Goal (30 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
55.6	2,512,831	56	80,640	1,731	57.0	Time to achieve cleanup goal (MCL) and discontinue remediation.

WU-UP2 - Uranium

Definitions:

ml - milliliters
g - gram
ft^3 - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
MCL - maximum contaminant level

Notes:

[1] Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2] K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3] Saturated zone thickness assumed to be 8 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4] Remediation will be discontinued when the uranium groundwater concentration reaches the MCL (30 ug/L).

[5] The larger of the following is assumed as initial uranium concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6] Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7] Flow rate is based on the nominal combined groundwater injection rate for extraction trenches GWI-UP1-02 through GWI-UP1-04.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations

WAA-WEST (Alluvium/Transition Zone/SSB) (GE-WAA-05)

Nitrate

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.3	0.6		4.62

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft^2)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft^3) [PV = b*n*A]	Pore Volume [PV] (gallons)
397,843	0.3	20	2,387,058	17,855,194

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	-	Average nitrate concentration
Maximum Representative Concentration within Remediation Area	10.22	Representative nitrate concentration for **WELL T-97**

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (22.9 ug/L)

R	Nitrate Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
4.62	22.9	10.2	0.0	Pore volumes required to achieve cleanup goal (ACL) and discontinue remediation

Table 5: Estimated Time to Achieve Remediation Goal (22.9 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
0.0	17,855,194	10	14,400	0.0	0.0	Time to achieve cleanup goal (ACL) and discontinue remediation.

Definitions:

ml - milliliters

g - gram

ft^3 - cubic feet

K_d - distribution coefficient

ug - microgram

L - liter

gpm - gallons per minute

gpd - gallons per day

DCGL - derived cleanup goal level

ACL - alternative contaminant level

Notes:

[1]Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3]Saturated zone thickness assumed to be 20 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4]Remediation will be discontinued when the nitrate groundwater concentration reaches the ACL (22.9 mg/L).

[5]The larger of the following is assumed as initial nitrate concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7]Flow rate is based on the nominal groundwater recovery rate for extraction well GE-BA1-05.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations

WAA-WEST (Alluvium/Transition Zone/SSB)　　　　　　**(GE-WAA-05)**

Uranium

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.3	2		13.07

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft²)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft³) [PV = b*n*A]	Pore Volume [PV] (gallons)
397,843	0.3	20	2,387,058	17,855,194

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	45.95	Average uranium concentration
Maximum Representative Concentration within Remediation Area	64.07	Representative uranium concentration for **WELL T-97**

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (30 ug/L)

R	Uranium Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
13.07	30	64	9.9	Pore volumes required to achieve cleanup goal (MCL) and discontinue remediation

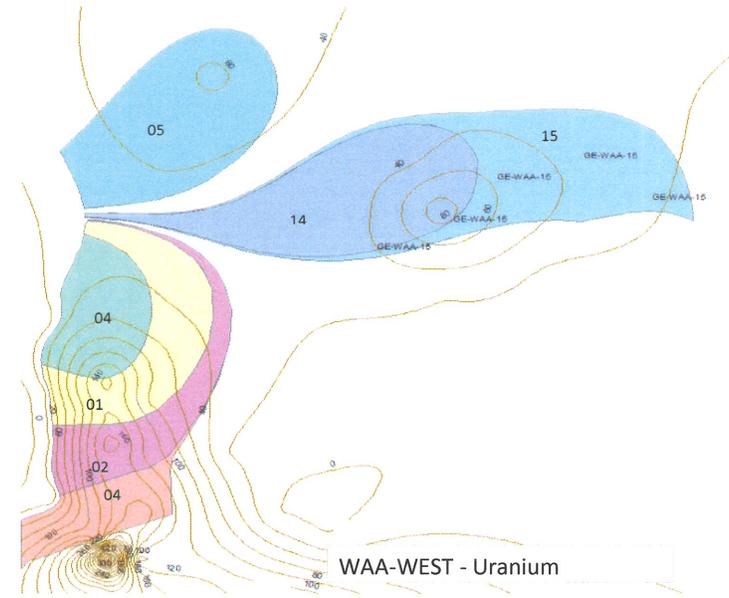**Table 5: Estimated Time to Achieve Remediation Goal (30 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
9.9	17,855,194	10	14,400	12,294	404.2	Time to achieve cleanup goal (MCL) and discontinue remediation.

WAA-WEST - Uranium

Definitions:

ml - milliliters

g - gram

ft³ - cubic feet

K_d - distribution coefficient

ug - microgram

L - liter

gpm - gallons per minute

gpd - gallons per day

DCGL - derived cleanup goal level

MCL - maximum contaminant level

Notes:

[1] Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2] K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3] Saturated zone thickness assumed to be 20 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4] Remediation will be discontinued when the uranium groundwater concentration reaches the MCL (30 ug/L).

[5] The larger of the following is assumed as initial uranium concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6] Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7] Flow rate is based on the nominal groundwater recovery rate for extraction well GE-BA1-05.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations

WAA-EAST (Alluvium/Transition Zone/SSB)   **GE-WAA-14 & GE-WAA-15**

Nitrate

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Nitrate K_d (ml/g)[2]		Retardation [R]
1.81	0.3	0.6		4.62

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft²)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft³) [PV = b*n*A]	Pore Volume [PV] (gallons)
827,431	0.3	19	4,716,357	35,278,348

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (mg/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	55.44	Average nitrate concentration
Maximum Representative Concentration within Remediation Area	112.40	Representative nitrate concentration for WELL T-59

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (22.9 mg/L)

R	Nitrate Cleanup Concentration (mg/L)[4]	Initial Aqueous-Phase Contaminant Concentration (mg/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
4.62	22.9	112	7.4	Pore volumes required to achieve cleanup goal and discontinue remediation

Table 5: Estimated Time to Achieve Remediation Goal (22.9 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
7.4	35,278,348	20	28,800	9,003	296.1	Time to achieve cleanup goal and discontinue remediation.

Definitions:

ml - milliliters
g - gram
ft³ - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
ACL - alternative contaminant level

Notes:

[1]Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3]Saturated zone thickness assumed to be 19 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4]Remediation will be discontinued when the nitrate groundwater concentration reaches the ACL (22.9 mg/L).

[5]The larger of the following is assumed as initial nitrate concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7]Flow rate is based on the nominal combined groundwater recovery rate for extraction wells GE-WAA-14 and GE-WAA-15.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

WAA-EAST - Nitrate

Remediation and Water Treatment Duration Estimate Calculations

WAA-EAST (Alluvium/Transition Zone/SSB)   **GE-WAA-14 & GE-WAA-15**

Uranium

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.3	2		13.07

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft²)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft³) [PV = b*n*A]	Pore Volume [PV] (gallons)
827,431	0.3	19	4,716,357	35,278,348

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	39.88	Average uranium concentration
Maximum Representative Concentration within Remediation Area	92.26	Representative uranium concentration for **WELL T-59**

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (30 ug/L)

R	Uranium Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
13.07	30	92	14.7	Pore volumes required to achieve cleanup goal (MCL) and discontinue remediation

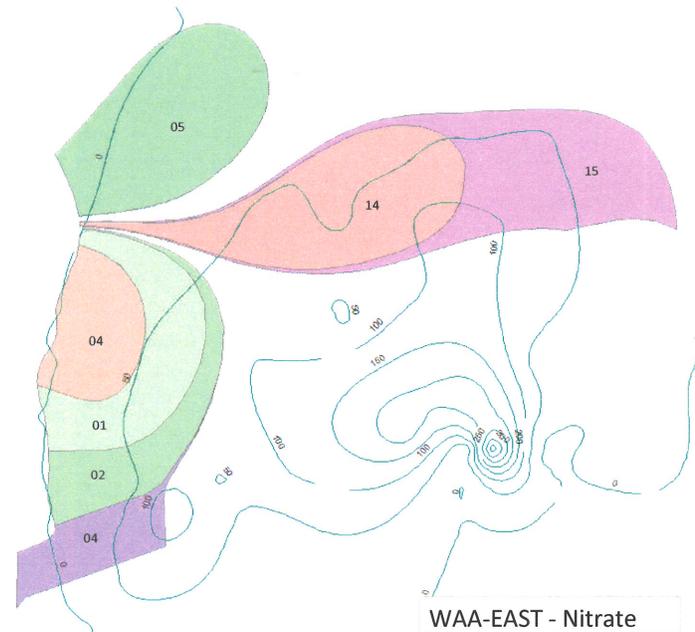**Table 5: Estimated Time to Achieve Remediation Goal (30 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
14.7	35,278,348	20	28,800	17,981	591.2	Time to achieve cleanup goal (MCL) and discontinue remediation.

Definitions:

ml - milliliters
g - gram
ft³ - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
MCL - maximum contaminant level

Notes:

[1]Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3]Saturated zone thickness assumed to be 19 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4]Remediation will be discontinued when the uranium groundwater concentration reaches the MCL (30 ug/L).

[5]The larger of the following is assumed as initial uranium concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7]Flow rate is based on the nominal combined groundwater recovery rate for extraction wells GE-WAA-14 and GE-WAA-15.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

WAA-EAST - Uranium

Remediation and Water Treatment Duration Estimate Calculations
WU-PBA (SSB)
Nitrate

$$R = 1 + \frac{\rho_B}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Nitrate K_d (ml/g)[2]		Retardation [R]
1.81	0.05	0.6		22.72

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft[2])	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft[3]) [PV = b*n*A]	Pore Volume [PV] (gallons)
243,436	0.05	19	231,264	1,729,856

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (mg/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	15.55	Average nitrate concentration
Maximum Representative Concentration within Remediation Area	75.79	Representative nitrate concentration for **WELL 1319B-3**

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (22.9 mg/L)

R	Nitrate Cleanup Concentration (mg/L)[4]	Initial Aqueous-Phase Contaminant Concentration (mg/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
22.72	52	76	8.6	Pore volumes required to achieve cleanup goal and discontinue remediation

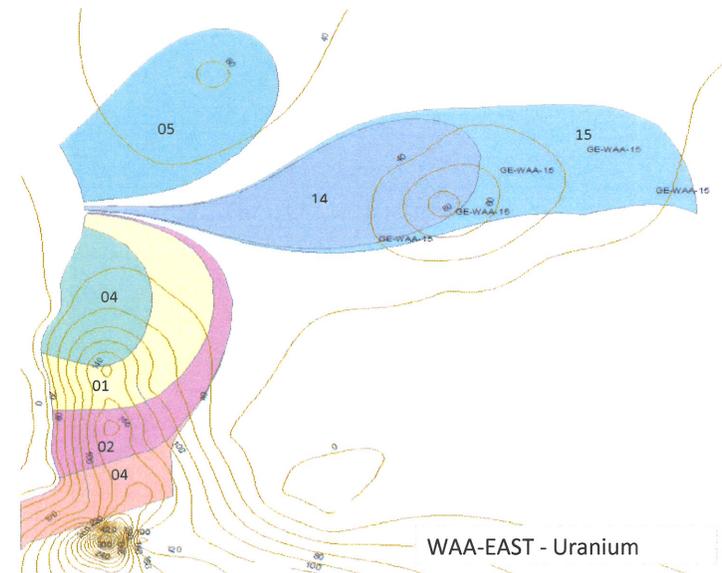**Table 5: Estimated Time to Achieve Remediation Goal (22.9 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
8.6	1,729,856	5	7,200	2,056	67.7	Time to achieve cleanup goal and discontinue remediation.

WU-PBA - Nitrate

Definitions:
ml - milliliters
g - gram
ft[3] - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
ACL - alternative contaminant level

Notes:
[1]Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.
[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.
[3]Saturated zone thickness assumed to be 19 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.
[4]The nitrate remediation goal for the Sandstone B formation in the PBA is the ACL (52 mg/L).

[5]The larger of the following is assumed as initial nitrate concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.
[7]Flow rate is based on the nominal groundwater recovery rate for extraction well GE-WU-01.
- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations

WU-PBA (SSB)

Uranium

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.05	3		109.60

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft²)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft³) [PV = b*n*A]	Pore Volume [PV] (gallons)
243,436	0.05	19	231,264	1,729,856

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	34.69	Average uranium concentration
Maximum Representative Concentration within Remediation Area	38.01	Representative uranium concentration for **WELL 1319B-1**

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (30 ug/L)

R	Uranium Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
109.60	30	38	25.9	Pore volumes required to achieve cleanup goal (MCL) and discontinue remediation

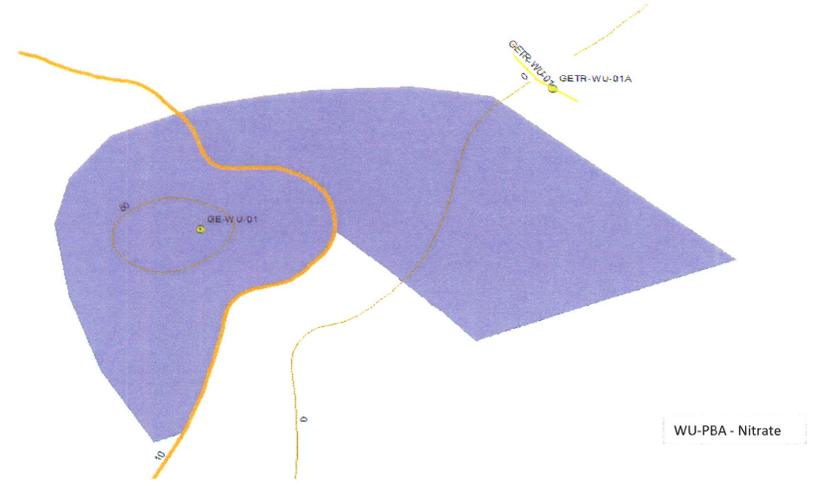**Table 5: Estimated Time to Achieve Remediation Goal (30 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
25.9	1,729,856	5	7,200	6,232	204.9	Time to achieve cleanup goal (MCL) and discontinue remediation.

WU-PBA - Uranium

Definitions:

ml - milliliters
g - gram
ft³ - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
MCL - maximum contaminant level

Notes:

[1]Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3]Saturated zone thickness assumed to be 19 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4]Remediation will be discontinued when the uranium groundwater concentration reaches the MCL (30 ug/L).

[5]The larger of the following is assumed as initial uranium concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7]Flow rate is based on the nominal groundwater recovery rate for extraction well GE-WU-01.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations
1206-NORTH (Alluvium/Transition Zone/SSB)
Nitrate

North 1206 - Nitrate

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Nitrate K_d (ml/g)[2]		Retardation [R]
1.81	0.11	0.6		10.87

Table 2: Remediation Pore Volume Calculation

Bulk Saturated Plume Volume [V][3] (ft³)	Porosity [n][1]	Pore Volume (ft³) [PV = V*n]	Pore Volume [PV] (gallons)
27,396	0.11	3,014	22,541

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (mg/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	42.20	Average nitrate concentration
Maximum Representative Concentration within Remediation Area	43.05	Representative nitrate concentration for WELL MWWA-09

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (22.9 mg/L)

R	Nitrate Cleanup Concentration (mg/L)[4]	Initial Aqueous-Phase Contaminant Concentration (mg/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
10.87	22.9	43	6.9	Pore volumes required to achieve cleanup goal and discontinue remediation

Table 5: Estimated Time to Achieve Remediation Goal (22.9 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
6.9	22,541	8	11,520	13	0.5	Time to achieve cleanup goal and discontinue remediation.

Definitions:
ml - milliliters
g - gram
ft³ - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
ACL - alternative contaminant level

Notes:
[1]Assumes 11% transmissve porosity for BA1 transition zone, as presented in *Environmental Sequence Stratigraphy (ESS) and Porosity Analysis, Burial Area 1*, dated April 6, 2018.

[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3]Plume volume calculated using Earth Volumtric Studio. Includes saturated volume of transition zone and Sandstone B formations within combined capture zone of extraction trenches GETR-BA-01 and GETR-BA1-02, located within area of uranium groundwater contamination exceeding 30 ug/L.
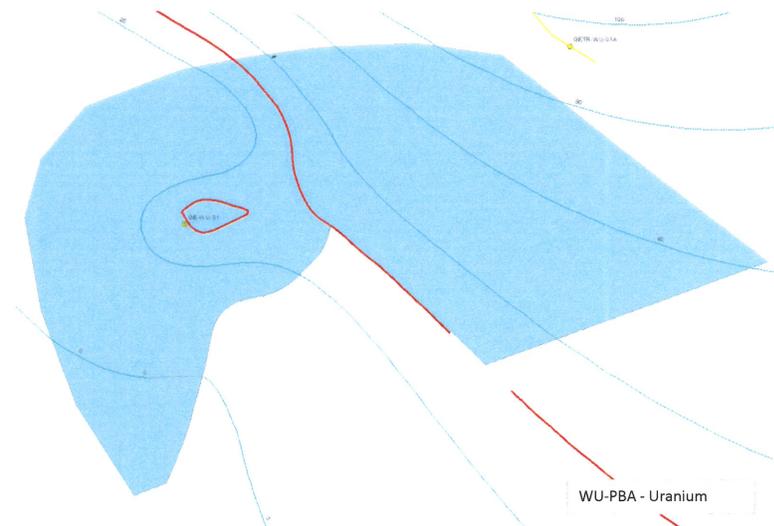
[4]Remediation will be discontinued when the nitrate groundwater concentration reaches the ACL (22.9 mg/L).

[5]The larger of the following is assumed as initial nitrate concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7]Flow rate is based on the nominal groundwater recovery rate for extraction trench GETR-WU-02.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations
1206-NORTH (Alluvium/Transition Zone/SSB)
Uranium

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.11	3		50.36

Table 2: Remediation Pore Volume Calculation

Bulk Saturated Plume Volume [V][3] (ft³)	Porosity [n][1]	Pore Volume (ft³) [PV = V*n]	Pore Volume [PV] (gallons)
27,396	0.11	3,014	22,541

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	248.49	Average uranium concentration
Maximum Representative Concentration within Remediation Area	526.60	Representative uranium concentration for WELL MWWA-03

1206 North - Uranium

DCGL Duration Estimate

Table 4a: Estimated Number of Pore Volumes to Achieve Remediation Goal (119 ug/L)

R	Uranium Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
50.36	119	527	74.9	Pore volumes required to achieve cleanup goal (DCGL) and discontinue remediation

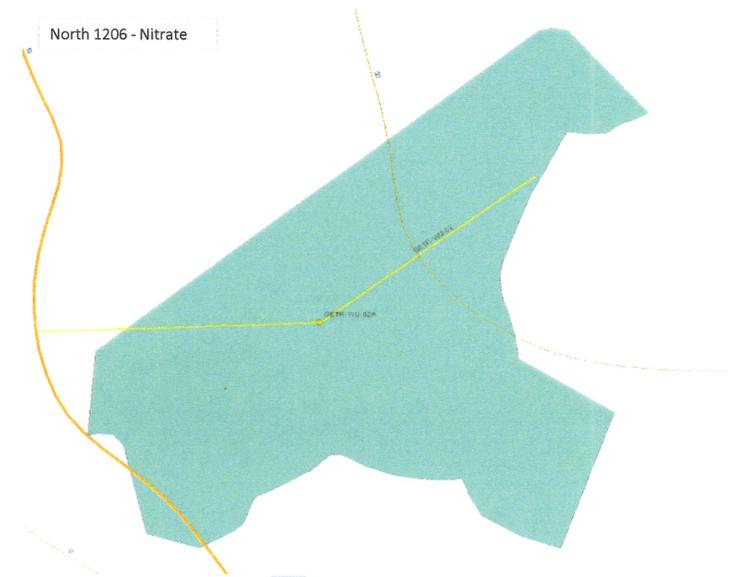**Table 5b: Estimated Time to Achieve Remediation Goal (119 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
74.9	22,541	8	11,520	147	4.9	Time to achieve cleanup goal (DCGL) and discontinue remediation.

MCL Duration Estimate

Table 4b: Estimated Number of Pore Volumes to Achieve Remediation Goal (30 ug/L)

R	Uranium Cleanup Concentration (ug/L)	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
50.36	30	527	144.3	Pore volumes required to achieve cleanup goal (MCL) and

Table 5b: Estimated Time to Achieve Remediation Goal (30 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
144.3	22,541	8	11,520	282	9.3	Time to achieve cleanup goal (MCL) and discontinue remediation.

Definitions:

ml - milliliters
g - gram
ft³ - cubic feet
K_d - distribution coefficient
ug - microgram
pCi/L - picocuries per liter
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
MCL - maximum contaminant level

Notes:

[1] Assumes 11% transmissve porosity for BA1 transition zone, as presented in *Environmental Sequence Stratigraphy (ESS) and Porosity Analysis, Burial Area 1* , dated April 6, 2018.

[2] K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3] Plume volume calculated using Earth Volumtric Studio. Includes saturated volume of transition zone and Sandstone B formations within combined capture zone of extraction trenches GETR-BA-01 and GETR-BA1-02, located within area of uranium groundwater contamination exceeding 30 ug/L.

[4] Remediation will be discontinued when the uranium groundwater concentration reaches 119 ug/L, the equivalent of 180 pCi/L as calcuated in *Uranium Activity vs. Mass Concentration_Rev. A (07-30-18).xlsx* , and 30 ug/L.

[5] The larger of the following is assumed as initial uranium concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6] Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7] Flow rate is based on the nominal groundwater recovery rate for extraction trench GETR-WU-02.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations

WU-1348 (SSA)

Nitrate

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Nitrate K_d (ml/g)[2]		Retardation [R]
1.81	0.1	0.6		11.86

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft^2)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft^3) [PV = b*n*A]	Pore Volume [PV] (gallons)
44,143	0.1	14	61,800	462,265

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	-	Average nitrate concentration
Maximum Representative Concentration within Remediation Area	11.57	Representative nitrate concentration for **WELL 1348**

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (22.9 ug/L)

R	Nitrate Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
11.86	30	12	0.0	Pore volumes required to achieve cleanup goal (ACL) and discontinue remediation

Table 5: Estimated Time to Achieve Remediation Goal (22.9 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
0.0	462,265	4	5,760	0	0.0	Time to achieve cleanup goal (ACL) and discontinue remediation.

Definitions:

ml - milliliters

g - gram

ft^3 - cubic feet

K_d - distribution coefficient

ug - microgram

L - liter

gpm - gallons per minute

gpd - gallons per day

DCGL - derived cleanup goal level

ACL - alternative contaminant level

Notes:

[1] Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2] K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3] Saturated zone thickness assumed to be 14 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4] Remediation will be discontinued when the nitrate groundwater concentration reaches the ACL (22.9 mg/L).

[5] The larger of the following is assumed as initial nitrate concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6] Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7] Flow rate is based on the nominal groundwater recovery rate for extraction trench GETR-WU-01.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations
WU-1348 (SSA)
Uranium

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.1	3		55.30

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft^2)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft^3) [PV = b*n*A]	Pore Volume [PV] (gallons)
44,143	0.1	14	61,800	462,265

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	56.79	Average uranium concentration
Maximum Representative Concentration within Remediation Area	71.26	Representative uranium concentration for **WELL 1348**

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (30 ug/L)

R	Uranium Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
55.30	30	71	47.8	Pore volumes required to achieve cleanup goal (MCL) and discontinue remediation

Table 5: Estimated Time to Achieve Remediation Goal (30 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
47.8	462,265	4	5,760	3,840	126.3	Time to achieve cleanup goal (MCL) and discontinue remediation.

WU-1348 - Uranium

Definitions:

ml - milliliters
g - gram
ft^3 - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
MCL - maximum contaminant level

Notes:

[1]Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3]Saturated zone thickness assumed to be 14 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4]Remediation will be discontinued when the uranium groundwater concentration reaches the MCL (30 ug/L).

[5]The larger of the following is assumed as initial uranium concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7]Flow rate is based on the nominal groundwater recovery rate for extraction trench GETR-WU-01.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations
WU-BA3 (SSA)
Nitrate

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Nitrate K_d (ml/g)[2]		Retardation [R]
1.81	0.1	0.6		11.86

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft^2)	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft^3) [PV = b*n*A]	Pore Volume [PV] (gallons)
41,390	0.1	5	20,695	154,799

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (mg/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	54.02	Average nitrate concentration
Maximum Representative Concentration within Remediation Area	76.09	Representative nitrate concentration for **WELL 1351**

Table 4: Estimated Number of Pore Volumes to Achieve Remediation Goal (22.9 mg/L)

R	Nitrate Cleanup Concentration (mg/L)[4]	Initial Aqueous-Phase Contaminant Concentration (mg/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
11.86	22.9	76	14.2	Pore volumes required to achieve cleanup goal and discontinue remediation

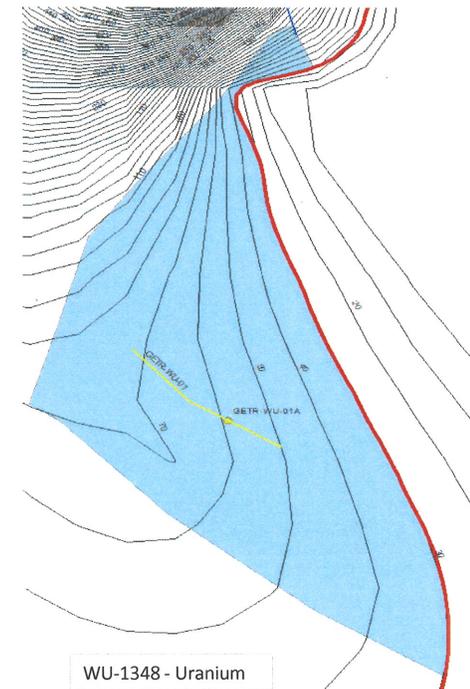**Table 5: Estimated Time to Achieve Remediation Goal (22.9 ug/L)**

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
14.2	154,799	8	11,520	191	6.3	Time to achieve cleanup goal and discontinue remediation.

0.5

WU-BA3 - Nitrate

Definitions:

ml - milliliters
g - gram
ft^3 - cubic feet
K_d - distribution coefficient
ug - microgram
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
ACL - alternative contaminant level

Notes:

[1]Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3]Saturated zone thickness assumed to be 5 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4]Remediation will be discontinued when the nitrate groundwater concentration reaches the ACL (22.9 mg/L).

[5]The larger of the following is assumed as initial nitrate concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7]Flow rate is based on the nominal water injection rate for injection trench GWI-WU-01.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Remediation and Water Treatment Duration Estimate Calculations

WU-BA3 (SSA)

Uranium

$$R = 1 + \frac{\rho_b}{n} K_d$$

Table 1: Retardation Calculation

Bulk Density (g/ml)	Porosity [n][1]	Uranium K_d (ml/g)[2]		Retardation [R]
1.81	0.1	3		55.30

Table 2: Remediation Pore Volume Calculation

Area of Plume [A] (ft[2])	Porosity [n][1]	Average Plume Thickness [b][3] (ft)	Pore Volume (ft[3]) [PV = b*n*A]	Pore Volume [PV] (gallons)
41,390	0.1	5	20,695	154,799

Table 3: Estimated Initial Aqueous-Phase Contaminant Concentration

Concentration Basis	Initial Aqueous-Phase Contaminant Concentration (ug/L)	Remarks
Incremental Averaging of Concentrations within Remediation Area	311.34	Average uranium concentration
Maximum Representative Concentration within Remediation Area	875	Representative uranium concentration for WELL 1351
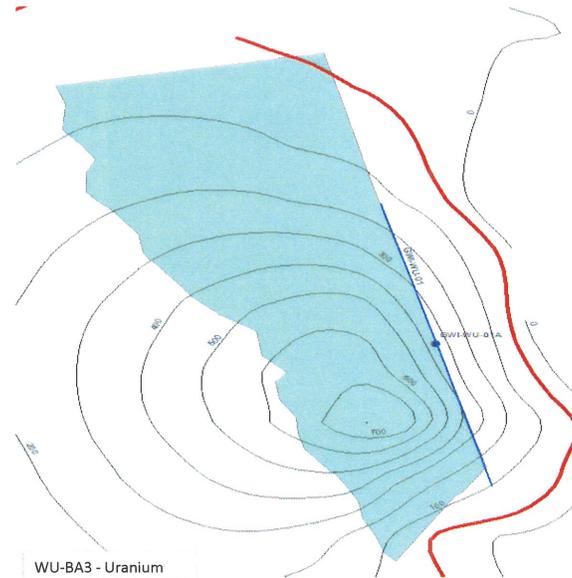
WU-BA3 - Uranium

DCGL Duration Estimate

Table 4a: Estimated Number of Pore Volumes to Achieve Remediation Goal (119 ug/L)

R	Uranium Cleanup Concentration (ug/L)[4]	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
55.30	119	875	110.3	Pore volumes required to achieve cleanup goal (DCGL) and

Table 5a: Estimated Time to Achieve Remediation Goal (119 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
110.3	154,799	8	11,520	1,482	48.8	Time to achieve cleanup goal (DCGL) and discontinue remediation.

MCL Duration Estimate

Table 4b: Estimated Number of Pore Volumes to Achieve Remediation Goal (30 ug/L)

R	Uranium Cleanup Concentration (ug/L)	Initial Aqueous-Phase Contaminant Concentration (ug/L)[5]	No. of Pore Volumes[6] [#PV = -R ln(Cleanup/Initial)]	Remarks
55.30	30	875	186.5	Pore volumes required to achieve cleanup goal (MCL) and

Table 5b: Estimated Time to Achieve Remediation Goal (30 ug/L)

No. of Pore Volumes	Pore Volume (gallons)	Flow Rate (gpm)[7]	Flow Rate (gpd)	Duration Estimate (days)	Duration Estimate (months)	Remarks
186.5	154,799	8	11,520	2,506	82.4	Time to achieve cleanup goal (MCL) and discontinue remediation.

6.9

Definitions:

ml - milliliters
g - gram
ft[3] - cubic feet
K_d - distribution coefficient
ug - microgram
pCi/L - picocuries per liter
L - liter
gpm - gallons per minute
gpd - gallons per day
DCGL - derived cleanup goal level
MCL - maximum contaminant level

Notes:

[1]Assumes 30% transmissve porosity for alluvial sand, as presented in the Technical Memorandum (TM002), September 10, 2018, page 3.

[2]K_d derived from previous studies as mentioned in the Technical Memorandum (TM002), September 10, 2018, page 4.

[3]Saturated zone thickness assumed to be 5 feet, as presented in the Technical Memorandum (TM002), September 10, 2018, page 5.

[4]Remediation will be discontinued when the uranium groundwater concentration reaches 119 ug/L, the equivalent of 180 pCi/L as calcuated in *Uranium Activity vs. Mass Concentration_Rev. A (07-30-18).xlsx* , and 30 ug/L.

[5]The larger of the following is assumed as initial uranium concentration for estimating the groundwater remediation duration: (1) the maximum representative concentration reported for any well within the remediation area (determined using sampling results for monitoring events conducted from 2011 through Q2 2017), (2) the concentration estimated by conducting incremental averaging of concentrations within the specified treatment area. The incremental averaging is performed using isopleth contours developed using representative groundwater concentrations for monitor wells located within the remediation area (see *Incr. AWCA Calcs_Rev. C (09-05-18).xlsx*). Initial aqueous-phase contaminant concentrations will be variable.

[6]Number of pore volumes assumes linear, reversible and instantaneous sorption, and may result in an underestimation of cleanup timeframe estimates.

[7]Flow rate is based on the nominal water injection rate for injection trench GWI-WU-01.

- Remediation durations presented herein are estimates and do not account for all factors contributing to the actual time required to remediate plumes via groundwater injection and extraction. Estimates will be updated using system performance and groundwater monitoring data collected during the early stages of remedial operations.

Attachment 10.1 – Initial and Maximum Influent Contaminant Concentration Calcs. for BA1 and WA

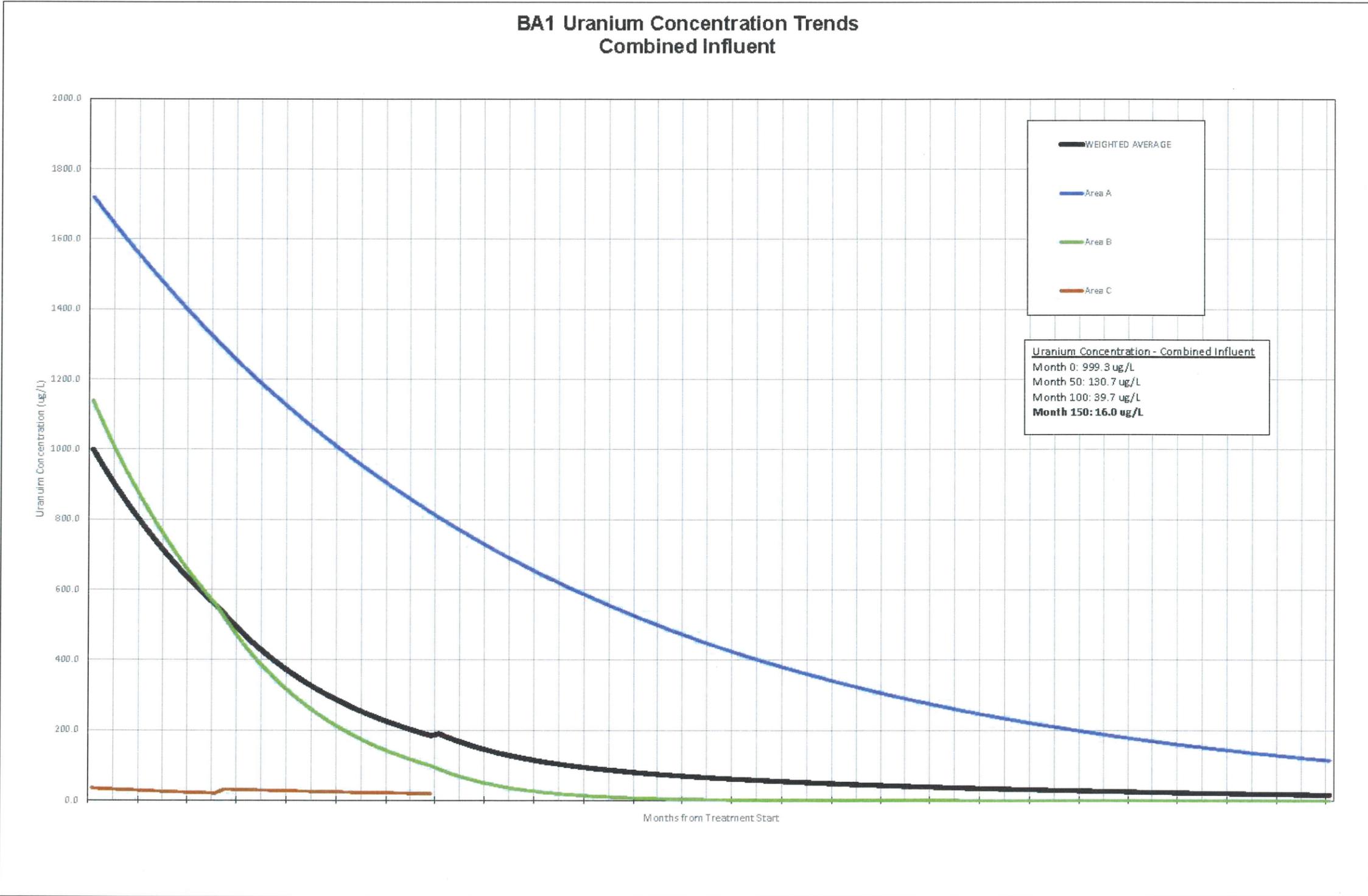| Remediation Area	Extraction Well/Trench	Influent Flow Rate (gpm) q	Adjusted Flow Rate (gpm) $q*\%$	Nitrate (mg/L) c_{max}	Uranium (ug/L) c_{max}	Fluoride (mg/L) c_{max}	Weighted Nitrate (mg/L) $q*c_{max}$	Weighted Uranium (ug/L) $q*c_{max}$	Weighted Fluoride (mg/L) $q*c_{max}$	Comments:
Western Area										Governing Assumptions: - Maximum uranium, nitrate, and fluoride influent concentrations will not occur at time zero for extraction wells GE-WAA-6 through -13; however maximum uranium, nitrate, and fluoride influent concentrations will occur at time zero for all other extraction wells and trenches. - Intitial (time zero) uranium, nitrate, and fluoride influent nitrate concentrations for GE-WAA-6 through -13 are based on representative SSB/TZ/Alluvium concentrations. - Future (time 't') uranium, nitrate, and fluoride influent nitrate concentrations for GE-WAA-6 through -13 are based on representative, upgradient (UP1 & UP2) SSA concentrations. 100% of this SSA groundwater contribution is assumed to be driven by the proposed injection features (i.e., natural groundwater flux from SSA is assumed to be negligible).
WU "1206 NORTH"	GETR-WU-02	8	--	38.6	304	7.03	309.12	2428.36	56.26	- Linear, incremental concentration averaging along trench alignment using isoconcentration contours [see Incr. AWCA Calcs_Rev. B (08-15-18)].
WU-PBA	GE-WU-01	5	--	61.7	29.0	0.32	308.65	145.10	1.58	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
WU "1206 SOUTH"	GETR-WU-01	4	--	10.14	62.0	1.00	40.57	247.90	4.01	- Linear, incremental concentration averaging along trench alignment using isoconcentration contours [see Incr. AWCA Calcs_Rev. B (08-15-18)].
WAA "U>DCGL"	GE-WAA-01	25	--	25.3	134	1.40	632.75	3354.50	35.00	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-WAA-02	30	--	29.0	163	2.62	869.40	4903.20	78.60	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-WAA-03	24	--	67.1	163	3.41	1610.88	3908.40	81.84	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-WAA-04	20	--	21.4	119	1.44	427.40	2380.60	28.80	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
WAA "U<DCGL" WEST	GE-WAA-05	10	--	10.2	58.6	0.45	102.40	586.40	4.50	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
WAA "BLUFF"	GE-WAA-06	13	--	90.8	64.0	3.26	1180.79	832.39	42.38	- Initial Influent Concentration: [SSB/TZ/Alluvium] interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
				204	15.6	18.8	2652.00	202.80	244.40	- Maximum Influent Concentration: [SSA] UP1 area-weighted incremental concentration averaging using isoconcentration contours [see Incr. AWCA Calcs_Rev. C (08-22-18)].
	GE-WAA-07	13	--	73.2	10.9	2.6	951.99	142.09	33.93	- Initial Influent Concentration: [SSB/TZ/Alluvium] interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
				204	15.6	18.8	2652.00	202.80	244.40	- Maximum Influent Concentration: [SSA] UP1 area-weighted incremental concentration averaging using isoconcentration contours [see Incr. AWCA Calcs_Rev. C (08-22-18)].
	GE-WAA-08	13	--	141	7.70	3.54	1833.00	100.10	46.02	- Initial Influent Concentration: [SSB/TZ/Alluvium] interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
				204	15.6	18.8	2652.00	202.80	244.40	- Maximum Influent Concentration: [SSA] UP1 area-weighted incremental concentration averaging using isoconcentration contours [see Incr. AWCA Calcs_Rev. C (08-22-18)].
	GE-WAA-09	13	--	218	4.77	2.46	2829.71	62.01	31.98	- Initial Influent Concentration: [SSB/TZ/Alluvium] interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
				378	26.3	7.80	4914.00	341.90	101.40	- Maximum Influent Concentration: [SSA] UP2 area-weighted incremental concentration averaging using isoconcentration contours [see Incr. AWCA Calcs_Rev. C (08-22-18)].
	GE-WAA-10	13	--	207	6.40	2.03	2692.43	83.20	26.39	- Initial Influent Concentration: [SSB/TZ/Alluvium] interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
				378	26.3	7.80	4914.00	341.90	101.40	- Maximum Influent Concentration: [SSA] UP2 area-weighted incremental concentration averaging using isoconcentration contours [see Incr. AWCA Calcs_Rev. C (08-22-18)].
	GE-WAA-11	14	--	128	6.80	1.76	1794.94	95.20	24.64	- Initial Influent Concentration: [SSB/TZ/Alluvium] interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
				378	26.3	7.80	5292.00	368.20	109.20	- Maximum Influent Concentration: [SSA] UP2 area-weighted incremental concentration averaging using isoconcentration contours [see Incr. AWCA Calcs_Rev. C (08-22-18)].
	GE-WAA-12	13	--	24.5	5.48	0.92	318.24	71.24	11.96	- Initial Influent Concentration: [SSB/TZ/Alluvium] interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
				378	26.3	7.80	4914.00	341.90	101.40	- Maximum Influent Concentration: [SSA] UP2 area-weighted incremental concentration averaging using isoconcentration contours [see Incr. AWCA Calcs_Rev. C (08-22-18)].
	GE-WAA-13	12	--	22.1	8.15	0.84	265.32	97.80	10.08	- Initial Influent Concentration: [SSB/TZ/Alluvium] interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
				378	26.3	7.80	4536.00	315.60	93.60	- Maximum Influent Concentration: [SSA] area-weighted incremental concentration averaging using isoconcentration contours [see Incr. AWCA Calcs_Rev. C (08-22-18)].
WAA "U<DCGL" EAST	GE-WAA-14	10	--	79.1	61.9	0.46	791.00	619.00	4.60	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-WAA-15	10	--	65.4	40.4	0.43	653.50	403.60	4.30	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
Initial $\sum q*c_{max}$		250	0				17612	20461	526.9	
Initial $\sum q$							250	250	250	
Initial Influent Concer							70.4	81.8	2.11	
Burial Area 1										Governing Assumptions: - Maximum uranium influent concentrations for all extraction wells and trenches will occur at time zero.
AREA A	GETR-BA1-01	7	--	--	1,360	--	--	9,520.00	--	- Linear, incremental concentration averaging along trench alignment using isoconcentration contours (see Incr. AWCA Calcs_Rev. A (07-31-18).
	GETR-BA1-02	7	--	--	2,080	--	--	14,560.00	--	- Linear, incremental concentration averaging along trench alignment using isoconcentration contours (see Incr. AWCA Calcs_Rev. A (07-31-18).
AREA B	GE-BA1-02	24	--	--	2,420	--	--	58,080.00	--	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-BA1-03	18	--	--	430	--	--	7,740.00	--	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-BA1-04	24	--	--	389	--	--	9,336.00	--	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
AREA C	GE-BA1-05	0	--	--	168	--	--	0.00	--	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-BA1-06	0	--	--	88.6	--	--	0.00	--	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-BA1-07	0	--	--	43.3	--	--	0.00	--	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-BA1-08	10	--	--	32.1	--	--	321.00	--	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
	GE-BA1-09	10	--	--	37.2	--	--	372.00	--	- Interpolated concentrations calculated in Surfer [see Incr. AWCA Calcs_Rev. B (08-15-18)].
$\sum q*c_{max}$		100						99929.00		
$\sum q$								100		
Max Influent Concent								999		

Notes:
SSA - Sandstone A
SSA - Sandstone B
TZ - Transition Zone
gpm - gallons per minute
ug/L - micrograms per liter
mg/L - milligrams per liter

Attachment 10.2a – BA1 Influent Concentration Decline Analysis

Note: the estimates provided below are preliminary in nature and will require revision during 90% Water Treatment Design Basis development associated with the Groundwater Remediation Project being conducted for the Cimarron Environmental Response Trust.

BA1 Uranium Concentration Trends
Combined Influent

BA1 - Uranium

Remediation Area	C_i (ug/L)	C_i Source	C_{max} (ug/L)	C_{max} Source	Is C_i representative of C_{max}? (Y/N)	Flow Rate (gpm)	R[4]	PV[4] (ft³)	PV (liters)	Q (liters/day)	Time Required for Initial Conc. to Reach Max. Level (days)	C_f (ug/L)	Combined Influent C_f (ug/L)	Time Required for Combined Influent Conc. to Reach MCL (months)
BA1-A1 (GETR-BA1-01 & GETR-BA1-02)	1720	FWCA	1720	FWCA	Y	14	50.4	90,021	2,549,098	76,314	0	114		
BA1-B1 (GE-BA1-02 through GE-BA1-04)	1139	FWCA	1139	FWCA	Y	66	13.1	619,099	17,530,908	359,765	0	556		
BA1-B2 (GE-BA1-02 through GE-BA1-04)	556	FWCA[1]	556	FWCA[1]	Y	66	13.1	446,530	12,644,301	359,765	0	0.0		
BA1-B3 (GE-BA1-02 through GE-BA1-04)													16.0	116
BA1-B3R (GE-BA1-02 through GE-BA1-04)	99.4	FWCA[2]	99.4	FWCA[2]	Y	86	13.1	366,168	10,368,706	468,785	0	0.00		
BA1-C1 (GE-BA1-08 & GE-BA1-09)	34.7	FWCA	34.7	FWCA	Y	20	13.1	250,418	7,091,039	109,020	0	20.3		
BA1-C2 (GE-BA1-06 & GE-BA1-07)	32.2	FWCA[3]	32.2	FWCA[3]	Y	20	13.1	455,345	12,893,899	109,020	0	0.0		
BA1-C3 (GE-BA1-05 & GE-BA1-06)														
Combined Treatment System Influent Flow Rate						100								

$$C_t = C_0 e^{(-Q/(PV*R))t}$$

cubic foot =	28.3168	liters
gpm	5451	liters per day

Notes:

C_i - initial concentration

C_f - final concentration

C_{max} - maximum concentration

gpm - gallons per minute

MCL - maximum contaminant level

ug/L - micrograms per liter

R - retardation

$$R = 1 + \frac{\rho_b}{n} K_d$$

PV - pore volume

Q - flow rate

AWCA - Area-weighted concentration averaging

FWCA - Flow rate-weighted concentration averaging

[1] Initial concentration for Area B2 equals final concentration for Area B1.

[2] Initial concentration for Area B3R equals final concentration for Area B2.

[3] Initial concentration for Area C2 equals flow rate-weighted average concentration decayed over the duration of Area C1 operation. Note that wells GE-BA1-06 and GE-BA1-07 are located in Area B1; consequently Area B1 parameters are used to calculate the concentration decay.

[4] Retardation (R) and pore volume (PV) taken from remediation duration estimate calculations [DRAFT_Remediation Duration Estimates_Rev. B (09-10-18).xlsx].

BA1 Combined Influent - Uranium

Area	BA1-A1 (GETR-BA1-01 & GETR-BA1-02)	BA1-B1 (GE-BA1-02 through GE-BA1-04)	BA1-B2 (GE-BA1-02 through GE-BA1-04)	BA1-B3 (GE-BA1-02 through GE-BA1-04)	BA1-B3R (GE-BA1-02 through GE-BA1-04)	BA1-C1 (GE-BA1-08 & GE-BA1-09)	BA1-C2 (GE-BA1-06 & GE-BA1-07)	BA1-C3 (GE-BA1-05 & GE-BA1-06)
C_i (ug/L)	1720	1139	556		99	35	32	
C_{max} (ug/L)	1720	1139	556		99	35	32	
Flow Rate (gpm)	14	66	66		86	20	20	
R	50.4	13.1	13.1		13.1	13.1	13.1	
PV (liters)	2,549,098	17,530,908	12,644,301		10,368,706	7,091,039	12,893,899	
Q (liters/day)	76,314	359,765	359,765		468,785	109,020	109,020	
Time Required for Initial Conc. to Reach Max. Level (months)	0	0	0		0	0	0	

$$C_t = C_0 e^{(-Q/(PV*R))t}$$

Cumulative Time (Months)	A	B	B2	B3R	C1	C2	WEIGHTED AVERAGE	Combined Influent Flow Rate	Months (for A1/B1/C1 Areas)	Days (for A1/B1/C1 Areas)	Months (for B2/C2 Areas)	Days (for B2/C2 Areas)	Months (for B3/C3 Areas)	Days (for B3/C3 Areas)	Months (for B3R Aea)	Days (for B3R Aea)	Notes
0	1720.000000	1138.727273			34.650000		999.29	100	0	0.0							
1	1689.199612	1085.602640			33.431728		959.67	100	1	30.4							
2	1658.950773	1034.956411			32.256290		921.78	100	2	60.8							
3	1629.243606	986.672962			31.122180		885.52	100	3	91.3							
4	1600.068411	940.642064			30.027944		850.84	100	4	121.7							
5	1571.415663	896.758629			28.972181		817.65	100	5	152.1							
6	1543.276005	854.922472			27.953538		785.90	100	6	182.5							
7	1515.640249	815.038082			26.970710		755.51	100	7	212.9							
8	1488.499373	777.014404			26.022437		726.42	100	8	243.4							
9	1461.844513	740.764631			25.107505		698.58	100	9	273.8							
10	1435.666968	706.206006			24.224741		671.93	100	10	304.2							
11	1409.958189	673.259631			23.373015		646.42	100	11	334.6							
12	1384.709783	641.850292			22.551235		621.99	100	12	365.0							
13	1359.913505	611.906282			21.758348		598.60	100	13	395.5							
14	1335.561259	583.359239			20.993338		576.19	100	14	425.9							
15	1311.645093	556.143990	556.1439905		20.255226	32.209377	554.74	100	15	456.3	0	0.0					According to remediation duration calculations, the uranium MCL is achieved in Area C1 in 15 months.
16	1288.157199		520.4987301			31.581564	530.19	100	16	486.7	1	30.4					
17	1265.089908		487.1381021			30.965988	504.82	100	17	517.1	2	60.8					
18	1242.435687		455.9156763			30.362410	480.92	100	18	547.6	3	91.3					
19	1220.187140		426.6944076			29.770597	458.40	100	19	578.0	4	121.7					
20	1198.337002		399.3460347			29.190319	437.17	100	20	608.4	5	152.1					
21	1176.878139		373.7505169			28.621353	417.16	100	21	638.8	6	182.5					
22	1155.803544		349.7955076			28.063476	398.29	100	22	669.2	7	212.9					
23	1135.106336		327.3758606			27.516473	380.49	100	23	699.7	8	243.4					
24	1114.779757		306.3931691			26.980132	363.68	100	24	730.1	9	273.8					
25	1094.817171		286.7553334			26.454245	347.82	100	25	760.5	10	304.2					
26	1075.212058		268.3761570			25.938609	332.85	100	26	790.9	11	334.6					
27	1055.958019		251.1749678			25.433023	318.70	100	27	821.3	12	365.0					
28	1037.048765		235.0762644			24.937292	305.32	100	28	851.8	13	395.5					
29	1018.478123		220.0093846			24.451223	292.68	100	29	882.2	14	425.9					
30	1000.240029		205.9081951			23.974629	280.73	100	30	912.6	15	456.3					
31	982.328529		192.7108014			23.507324	269.42	100	31	943.0	16	486.7					
32	964.737773		180.3592759			23.049128	258.71	100	32	973.4	17	517.1					
33	947.462019		168.7994038			22.599863	248.57	100	33	1003.9	18	547.6					
34	930.495625		157.9804454			22.159355	238.97	100	34	1034.3	19	578.0					
35	913.833051		147.8549128			21.727433	229.87	100	35	1064.7	20	608.4					
36	897.468858		138.3783619			21.303930	221.24	100	36	1095.1	21	638.8					
37	881.397702		129.5091970			20.888681	213.05	100	37	1125.5	22	669.2					
38	865.614335		121.2084887			20.481527	205.28	100	38	1156.0	23	699.7					
39	850.113604		113.4398025			20.082308	197.90	100	39	1186.4	24	730.1					
40	834.890448		106.1690392			19.690871	190.89	100	40	1216.8	25	760.5					
41	819.939895		99.36428523		99.36428523	19.307064	184.23	100	41	1247.2	26	790.9			0	0.0	According to remediation duration calculations, the uranium MCL is achieved in Area C2 in 25.4 months.
42	805.257066				89.43727224		189.65	100	42	1277.6	27	821.3			1	30.4	
43	790.837165				80.50201989		179.95	100	43	1308.1	28	851.8			2	60.8	
44	776.675484				72.45944609		171.05	100	44	1338.5	29	882.2			3	91.3	
45	762.767399				65.22036758		162.88	100	45	1368.9	30	912.6			4	121.7	
46	749.108369				58.70451095		155.36	100	46	1399.3	31	943.0			5	152.1	
47	735.693934				52.83962256		148.44	100	47	1429.7	32	973.4			6	182.5	
48	722.519714				47.56066727		142.05	100	48	1460.2	33	1003.9			7	212.9	
49	709.581407				42.80910729		136.16	100	49	1490.6	34	1034.3			8	243.4	
50	696.874789				38.53225305		130.70	100	50	1521.0	35	1064.7			9	273.8	
51	684.395711				34.68267898		125.64	100	51	1551.4	36	1095.1			10	304.2	
52	672.140099				31.21769753		120.95	100	52	1581.8	37	1125.5			11	334.6	
53	660.103950				28.0988859		116.58	100	53	1612.3	38	1156.0			12	365.0	
54	648.283335				25.29165989		112.51	100	54	1642.7	39	1186.4			13	395.5	
55	636.674395				22.76489049		108.71	100	55	1673.1	40	1216.8			14	425.9	
56	625.273337				20.49055859		105.16	100	56	1703.5	41	1247.2			15	456.3	
57	614.076441				18.44344437		101.83	100	57	1733.9	42	1277.6			16	486.7	
58	603.080050				16.60084759		98.71	100	58	1764.4	43	1308.1			17	517.1	
59	592.280574				14.94233589		95.77	100	59	1794.8	44	1338.5			18	547.6	
60	581.674486				13.4495182		93.00	100	60	1825.2	45	1368.9			19	578.0	
61	571.258323				12.10584083		90.39	100	61	1855.6	46	1399.3			20	608.4	
62	561.028685				10.89640387		87.91	100	62	1886.0	47	1429.7			21	638.8	
63	550.982231				9.807795999		85.57	100	63	1916.5	48	1460.2			22	669.2	
64	541.115681				8.827945764		83.35	100	64	1946.9	49	1490.6			23	699.7	According to remediation duration calculations, the uranium MCL is achieved in Area B3R in 22.6 months; however groundwater extraction will continue in Area B3R to maintain the minimum treatment system flow rate.
65	531.425813				7.945987704		81.23	100	65	1977.3	50	1521.0			24	730.1	
66	521.909463				7.152141877		79.22	100	66	2007.7	51	1551.4			25	760.5	
67	512.563525				6.43760541		77.30	100	67	2038.1	52	1581.8			26	790.9	
68	503.384946				5.794454882		75.46	100	68	2068.6	53	1612.3			27	821.3	
69	494.370730				5.215558464		73.70	100	69	2099.0	54	1642.7			28	851.8	
70	485.517933				4.694496832		72.01	100	70	2129.4	55	1673.1			29	882.2	
71	476.823666				4.225491989		70.39	100	71	2159.8	56	1703.5			30	912.6	
72	468.285088				3.803343188		68.83	100	72	2190.2	57	1733.9			31	943.0	
73	459.899412				3.423369265		67.33	100	73	2220.7	58	1764.4			32	973.4	
74	451.663900				3.081356729		65.88	100	74	2251.1	59	1794.8			33	1003.9	
75	443.575863				2.773513039		64.49	100	75	2281.5	60	1825.2			34	1034.3	
76	435.632661				2.496424547		63.14	100	76	2311.9	61	1855.6			35	1064.7	
77	427.831699				2.247018648		61.83	100	77	2342.3	62	1886.0			36	1095.1	
78	420.170430				2.022529705		60.56	100	78	2372.8	63	1916.5			37	1125.5	

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BA1 Combined Influent - Uranium

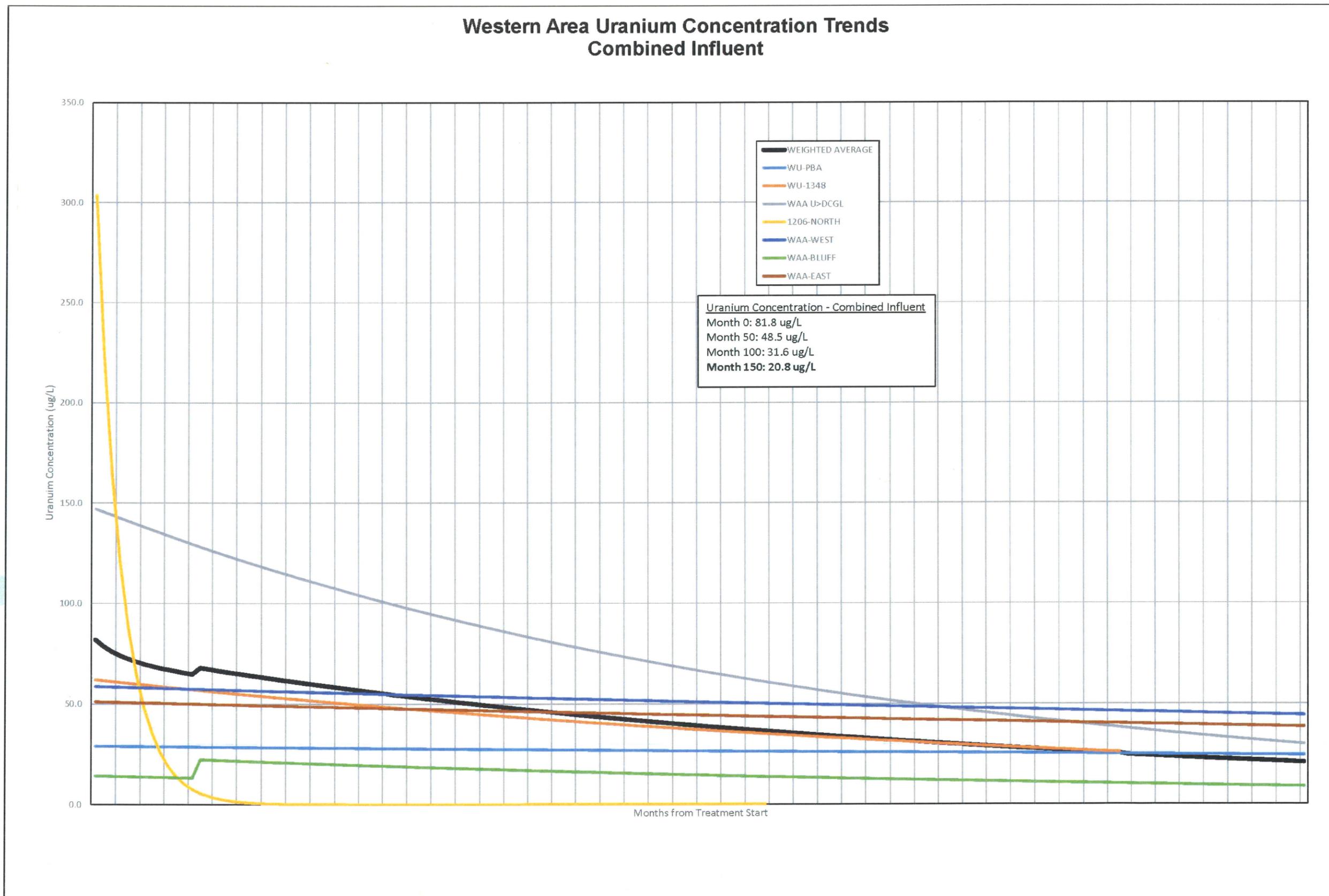| Area	BA1-A1 (GETR-BA1-01 & GETR-BA1-02)	BA1-B1 (GE-BA1-02 through GE-BA1-04)	BA1-B2 (GE-BA1-02 through GE-BA1-04)	BA1-B3 (GE-BA1-02 through GE-BA1-04)	BA1-B3R (GE-BA1-02 through GE-BA1-04)	BA1-C1 (GE-BA1-08 & GE-BA1-09)	BA1-C2 (GE-BA1-06 & GE-BA1-07)	BA1-C3 (GE-BA1-05 & GE-BA1-06)
C_i (ug/L)	1720	1139	556		99	35	32	
C_{max} (ug/L)	1720	1139	556		99	35	32	
Flow Rate (gpm)	14	66	66		86	20	20	
R	50.4	13.1	13.1		13.1	13.1	13.1	
PV (liters)	2,549,098	17,530,908	12,644,301		10,368,706	7,091,039	12,893,899	
Q (liters/day)	76,314	359,765	359,765		468,785	109,020	109,020	
Time Required for Initial Conc. to Reach Max. Level (months)	0	0	0		0	0	0	

$$C_t = C_0 e^{(-Q/(PV*R))t}$$

Cumulative Time (Months)	A	B	B2	B3R	C1	C2	WEIGHTED AVERAGE	Combined Influent Flow Rate	Months (for A1/B1/C1 Areas)	Days (for A1/B1/C1 Areas)	Months (for B2/C2 Areas)	Days (for B2/C2 Areas)	Months (for B3/C3 Areas)	Days (for B3/C3 Areas)	Months (for B3R Aea)	Days (for B3R Aea)	Notes
79	412.646353			1.820468385			59.34	100	79	2403.2	64	1946.9			38	1156.0	
80	405.257011			1.63859405			58.15	100	80	2433.6	65	1977.3			39	1186.4	
81	397.999992			1.474889915			56.99	100	81	2464.0	66	2007.7			40	1216.8	
82	390.872926			1.32754068			55.86	100	82	2494.4	67	2038.1			41	1247.2	
83	383.873485			1.194912407			54.77	100	83	2524.9	68	2068.6			42	1277.6	
84	376.999385			1.075534394			53.70	100	84	2555.3	69	2099.0			43	1308.1	
85	370.248381			0.968082869			52.67	100	85	2585.7	70	2129.4			44	1338.5	
86	363.618268			0.871366316			51.66	100	86	2616.1	71	2159.8			45	1368.9	
87	357.106882			0.784312253			50.67	100	87	2646.5	72	2190.2			46	1399.3	
88	350.712097			0.705955347			49.71	100	88	2677.0	73	2220.7			47	1429.7	
89	344.431825			0.635426707			48.77	100	89	2707.4	74	2251.1			48	1460.2	
90	338.264014			0.571944248			47.85	100	90	2737.8	75	2281.5			49	1490.6	
91	332.206652			0.51480402			46.95	100	91	2768.2	76	2311.9			50	1521.0	
92	326.257761			0.463372399			46.07	100	92	2798.6	77	2342.3			51	1551.4	
93	320.415397			0.417079067			45.22	100	93	2829.1	78	2372.8			52	1581.8	
94	314.677654			0.375410682			44.38	100	94	2859.5	79	2403.2			53	1612.3	
95	309.042657			0.337905187			43.56	100	95	2889.9	80	2433.6			54	1642.7	
96	303.508568			0.304146687			42.75	100	96	2920.3	81	2464.0			55	1673.1	
97	298.073578			0.273760839			41.97	100	97	2950.7	82	2494.4			56	1703.5	
98	292.735915			0.246410696			41.19	100	98	2981.2	83	2524.9			57	1733.9	
99	287.493833			0.221792976			40.44	100	99	3011.6	84	2555.3			58	1764.4	
100	282.345623			0.199634695			39.70	100	100	3042.0	85	2585.7			59	1794.8	
101	277.289603			0.179690142			38.98	100	101	3072.4	86	2616.1			60	1825.2	
102	272.324122			0.161738155			38.26	100	102	3102.8	87	2646.5			61	1855.6	
103	267.447559			0.145579665			37.57	100	103	3133.3	88	2677.0			62	1886.0	
104	262.658321			0.131035494			36.88	100	104	3163.7	89	2707.4			63	1916.5	
105	257.954846			0.117944361			36.22	100	105	3194.1	90	2737.8			64	1946.9	
106	253.335596			0.106161101			35.56	100	106	3224.5	91	2768.2			65	1977.3	
107	248.799064			0.095555051			34.91	100	107	3254.9	92	2798.6			66	2007.7	
108	244.343769			0.0860086			34.28	100	108	3285.4	93	2829.1			67	2038.1	
109	239.968256			0.0774159			33.66	100	109	3315.8	94	2859.5			68	2068.6	
110	235.671096			0.069681637			33.05	100	110	3346.2	95	2889.9			69	2099.0	
111	231.450886			0.062720076			32.46	100	111	3376.6	96	2920.3			70	2129.4	
112	227.306248			0.056454012			31.87	100	112	3407.0	97	2950.7			71	2159.8	
113	223.235829			0.05081396			31.30	100	113	3437.5	98	2981.2			72	2190.2	
114	219.238300			0.045737379			30.73	100	114	3467.9	99	3011.6			73	2220.7	
115	215.312355			0.041167975			30.18	100	115	3498.3	100	3042.0			74	2251.1	
116	211.456713			0.037055078			29.64	100	116	3528.7	101	3072.4			75	2281.5	
117	207.670115			0.033353082			29.10	100	117	3559.1	102	3102.8			76	2311.9	
118	203.951325			0.030020934			28.58	100	118	3589.6	103	3133.3			77	2342.3	
119	200.299127			0.027021685			28.07	100	119	3620.0	104	3163.7			78	2372.8	
120	196.712330			0.024322077			27.56	100	120	3650.4	105	3194.1			79	2403.2	
121	193.189762			0.021892174			27.07	100	121	3680.8	106	3224.5			80	2433.6	
122	189.730274			0.019705031			26.58	100	122	3711.2	107	3254.9			81	2464.0	
123	186.332736			0.017736395			26.10	100	123	3741.7	108	3285.4			82	2494.4	
124	182.996038			0.015964437			25.63	100	124	3772.1	109	3315.8			83	2524.9	
125	179.719091			0.014369506			25.17	100	125	3802.5	110	3346.2			84	2555.3	
126	176.500825			0.012933917			24.72	100	126	3832.9	111	3376.6			85	2585.7	
127	173.340189			0.011641751			24.28	100	127	3863.3	112	3407.0			86	2616.1	
128	170.236151			0.010478679			23.84	100	128	3893.8	113	3437.5			87	2646.5	
129	167.187698			0.009431804			23.41	100	129	3924.2	114	3467.9			88	2677.0	
130	164.193834			0.008489517			22.99	100	130	3954.6	115	3498.3			89	2707.4	
131	161.253582			0.00764137			22.58	100	131	3985.0	116	3528.7			90	2737.8	
132	158.365981			0.006877957			22.18	100	132	4015.4	117	3559.1			91	2768.2	
133	155.530090			0.006190813			21.78	100	133	4045.9	118	3589.6			92	2798.6	
134	152.744981			0.005572318			21.39	100	134	4076.3	119	3620.0			93	2829.1	
135	150.009746			0.005015615			21.01	100	135	4106.7	120	3650.4			94	2859.5	
136	147.323491			0.004514528			20.63	100	136	4137.1	121	3680.8			95	2889.9	
137	144.685339			0.004063503			20.26	100	137	4167.5	122	3711.2			96	2920.3	
138	142.094430			0.003657538			19.90	100	138	4198.0	123	3741.7			97	2950.7	
139	139.549916			0.003292131			19.54	100	139	4228.4	124	3772.1			98	2981.2	
140	137.050967			0.00296323			19.19	100	140	4258.8	125	3802.5			99	3011.6	
141	134.596768			0.002667187			18.85	100	141	4289.2	126	3832.9			100	3042.0	
142	132.186516			0.002400721			18.51	100	142	4319.6	127	3863.3			101	3072.4	
143	129.819426			0.002160877			18.18	100	143	4350.1	128	3893.8			102	3102.8	
144	127.494723			0.001944994			17.85	100	144	4380.5	129	3924.2			103	3133.3	
145	125.211649			0.001750679			17.53	100	145	4410.9	130	3954.6			104	3163.7	
146	122.969459			0.001575777			17.22	100	146	4441.3	131	3985.0			105	3194.1	
147	120.767420			0.001418348			16.91	100	147	4471.7	132	4015.4			106	3224.5	
148	118.604813			0.001276648			16.61	100	148	4502.2	133	4045.9			107	3254.9	
149	116.480933			0.001149104			16.31	100	149	4532.6	134	4076.3			108	3285.4	
150	114.395085			0.001034303			16.02	100	150	4563.0	135	4106.7			109	3315.8	According to remediation duration calculations, the uranium MCL is achieved in Area A in 149.1 months.

Attachment 10.2b – WA Influent Concentration Decline Analysis

Note: the estimates provided below are preliminary in nature and will require revision during 90% Water Treatment Design Basis development associated with the Groundwater Remediation Project being conducted for the Cimarron Environmental Response Trust.

Western Area Uranium Concentration Trends
Combined Influent

Legend:
- WEIGHTED AVERAGE
- WU-PBA
- WU-1348
- WAA U>DCGL
- 1206-NORTH
- WAA-WEST
- WAA-BLUFF
- WAA-EAST

Uranium Concentration - Combined Influent
Month 0: 81.8 ug/L
Month 50: 48.5 ug/L
Month 100: 31.6 ug/L
Month 150: 20.8 ug/L

Y-axis: Uranium Concentration (ug/L)
X-axis: Months from Treatment Start

Note: the estimates provided below are preliminary in nature and will require revision during 90% Water Treatment Design Basis development associated with the Groundwater Remediation Project being conducted for the Cimarron Environmental Response Trust.

Western Area Nitrate Concentration Trends
Combined Influent

Legend:
- WEIGHTED AVERAGE
- WU-PBA
- WU-1348
- WAA U>DCGL
- 1206-NORTH
- WAA-WEST
- WAA-BLUFF
- WAA-EAST

Nitrate Concentration - Combined Influent
Month 0: 70.5 mg/L
Month 50: 72.4 mg/L
Month 100: 30.2 mg/L
Month 150: 13.3 mg/L

Y-axis: Nitrate Concentration (ug/L)
X-axis: Months from Treatment Start

WATF - Uranium

Remediation Area	C_i (ug/L)	C_i Source	C_{max} (ug/L)	C_{max} Source	Is C_i representative of C_{max}? (Y/N)	Flow Rate (gpm)	R^1	$PV^{1,2,3}$ (ft³)	PV (liters)	Q (liters/day)	Time Required for Initial Conc. to Reach Max. Level (days)²	C_f (ug/L)	Combined Influent C_f (ug/L)	Time Required for Combined Influent Conc. to Reach MCL (months)
WU-PBA (GE-WU-01)	29.0	SIC	29.0	SIC	Y	5	110	231,264.20	6,548,662.10	27,254.95	0	24.4		
WU-1348 (GETR-WU-01)	62.0	LWCA	62.0	LWCA	Y	4	55.3	61,800.20	1,749,983.90	21,803.96	0	26.0		
WAA U>DCGL (GE-WAA-01 through GE-WAA-04)	147	FWCA	147	FWCA	Y	99	13.1	4,177,558.50	118,295,088.53	539,648.05	0	29.9		
1206-NORTH (GETR-WU-02)	304	LWCA	304	LWCA	Y	8	50.4	3,013.56	85,334.38	43,607.92	0	13.9	20.8	107
WAA-WEST (GE-WAA-05)	58.6	SIC	58.6	SIC	Y	10	13.1	2,387,058.00	67,593,843.97	54,509.90	0	44.2		
WAA-BLUFF (GE-WAA-06 through GE-WAA-13)	14.27	FWCA	22.29	AWCA/FWCA	N	104	13.1	6,811,932.00	192,892,116.06	566,903.00	365	8.7		
WAA-EAST (GE-WAA-14 & GE-WAA-15)	51.1	FWCA	51.1	FWCA	Y	20	13.1	4,716,356.70	133,552,129.40	109,019.81	0	38.4		
Combined Treatment System Influent Flow Rate⁵						250								

WATF - Nitrate

Remediation Area	C_i^4 (mg/L)	C_i Source	C_{max}^4 (mg/L)	C_{max} Source	Is C_i representative of C_{max}? (Y/N)	Flow Rate (gpm)	R^1	$PV^{1,2,3}$ (ft³)	PV (liters)	Q (liters/day)	Time Required for Initial Conc. to Reach Max. Level (days)²	C_f (mg/L)	Combined Influent C_f (mg/L)	Time Required for Combined Influent Conc. to Reach MCL (months)
WU-PBA (GE-WU-01)	61.7	SIC	61.7	SIC	Y	5	22.7	231,264	6,548,662	27,255	0	26.8		
WU-1348 (GETR-WU-01)	11.6	-	11.6	-	Y	4	11.9	61,800	1,749,984	21,804	0	0.20		
WAA U>DCGL (GE-WAA-01 through GE-WAA-04)	35.8	FWCA	35.8	FWCA	Y	99	4.62	4,177,559	118,295,089	539,648	0	0.40		
1206-NORTH (GETR-WU-02)	38.6	LWCA	38.6	LWCA	Y	8	10.9	3,014	85,334	43,608	0	0.00	13.27	----
WAA-WEST (GE-WAA-05)	10.2	-	10.2	-	Y	10	4.62	2,387,058	67,593,844	54,510	0	4.61		
WAA-BLUFF (GE-WAA-06 through GE-WAA-13)	114	FWCA	313	AWCA/FWCA	N	104	4.62	6,811,932	192,892,116	566,903	365	22		
WAA-EAST (GE-WAA-14 & GE-WAA-15)	72.2	FWCA	72.2	FWCA	Y	20	4.62	4,716,357	133,552,129	109,020	0	32.3		
Combined Treatment System Influent Flow Rate⁵						250								

WATF - Fluoride

Remediation Area	C_i (mg/L)	C_i Source	C_{max} (mg/L)	C_{max} Source	Is C_i representative of C_{max}? (Y/N)
WU-PBA (GE-WU-01)	0.32	SIC	0.32	SIC	Y
WU-1348 (GETR-WU-01)	1.00	LWCA	1.00	LWCA	Y
WAA U>DCGL (GE-WAA-01 through GE-WAA-04)	2.27	FWCA	2.27	FWCA	Y
1206-NORTH (GETR-WU-02)	7.03	LWCA	7.03	LWCA	Y
WAA-WEST (GE-WAA-05)	0.45	SIC	0.45	SIC	Y
WAA-BLUFF (GE-WAA-06 through GE-WAA-13)	2.19	FWCA	11.93	AWCA/FWCA	N
WAA-EAST (GE-WAA-14 & GE-WAA-15)	0.45	FWCA	0.45	FWCA	Y

$$C_t = C_0 e^{(-Q/(PV*R))t}$$

cubic foot = 28.3168 liters
gpm = 5451 liters per day

Notes:

C_i - initial concentration

C_f - final concentration

C_{max} - maximum concentration

gpm - gallons per minute

MCL - maximum contaminant level

mg/L - milligrams per liter

R - retardation

PV - pore volume

Q - flow rate

AWCA - Area-weighted concentration averaging

FWCA - Flow rate-weighted concentration averaging

LWCA - Linear-weighted concentration averaging

SIC - Surfer-interpolated concentration

$$R = 1 + \frac{\rho_b}{n} K_d$$

[1] Retardation (R) and pore volume (PV) taken from remediation duration estimate calculations [DRAFT_Remediation Duration Estimates_Rev. B (09-10-18).xlsx].

[2] Based on forward particle tracking results for WU-UP1 and WU-UP2 injection components, and uranium and nitrate plume distribution depicted on isopleth maps, maxium uranium and nitrate groundwater concentrations will report to WAA "BLUFF" extraction wells approximately 1 year following intiation of water injection at UP1 and UP2.

[3] The WAA "BLUFF" pore voluem is inconsequential for remediation duration since the remediation timeframe for this area is predicated on UP1/UP2 remediation timeframe.

[4] Since initial nitrate groundwater concentrations for WU "1206 SOUTH" and WAA "U<DCGL" WEST are below the applicable remediation criteria, the highest representative nitrate concentration for any well in each area was used in the influent concentration decay analysis.

[5] The combined influent flow rate presented in the table reflects initial operating conditions. The influent flow rate is expected to decline over the course of the remediation campaign. Combined influent flow rates for each month of remediation are provided in the concentration decay analysis tables.

Western Area Combined Influent - Uranium							
Area	WU-PBA (GE-WU-01)	WAA U>DCGL (GE-WAA-01 through GE-WAA-04)	WAA-WEST (GE-WAA-05)	WU-1348 (GETR-WU-01)	WAA-EAST (GE-WAA-14 & GE-WAA-15)	WAA-BLUFF (GE-WAA-06 through GE-WAA-13)	1206-NORTH (GETR-WU-02)
C_i (ug/L)	29.02	146.94	58.64	61.98	51.13	14.27	303.55
C_{max} (ug/L)	29.02	146.94	58.64	61.98	51.13	22.29	303.55
Flow Rate (gpm)	5	99	10	4	20	104	8
R	109.6	13.1	13.1	55.3	13.1	13.1	50.4
PV (liters)	6,548,662	118,295,089	67,593,844	1,749,984	133,552,129	192,892,116	85,334
Q (liters/day)	27,255	539,648	54,510	21,804	109,020	566,903	43,608
Time Required for Initial Conc. to Reach Max. Level (months)	0	0	0	0	0	365	0

$$C_t = C_0 e^{(-Q/(PV*R))t}$$

Cumulative Time (Months)	WU-PBA	WAA U>DCGL	WAA-WEST	WU-1348	WAA-EAST	WAA-BLUFF	1206-NORTH	WEIGHTED AVERAGE	Combined Influent Flow Rate	Months	Days	Notes
0	29.020000	146.936364	58.640000	61.975537	51.130000	14.269519	303.545455	81.84	250	0	0.0	
1	28.986497	145.384107	58.530011	61.552218	51.032924	14.172219	222.932518	78.59	250	1	30.4	
2	28.953032	143.848249	58.420228	61.131790	50.936032	14.075583	163.728058	76.03	250	2	60.8	
3	28.919606	142.328616	58.310652	60.714234	50.839324	13.979605	120.246598	73.97	250	3	91.3	
4	28.886219	140.825037	58.201281	60.299529	50.742800	13.884282	88.312562	72.30	250	4	121.7	
5	28.852870	139.337341	58.092114	59.887658	50.646459	13.789608	64.859287	70.90	250	5	152.1	
6	28.819559	137.865362	57.983153	59.478599	50.550301	13.695581	47.634527	69.71	250	6	182.5	
7	28.786287	136.408933	57.874396	59.072335	50.454326	13.602194	34.984168	68.67	250	7	212.9	
8	28.753054	134.967890	57.765843	58.668845	50.358533	13.509444	25.693380	67.74	250	8	243.4	
9	28.719859	133.542070	57.657494	58.268112	50.262921	13.417327	18.869958	66.90	250	9	273.8	
10	28.686702	132.131313	57.549348	57.870116	50.167491	13.325838	13.858640	66.13	250	10	304.2	According to remediation duration calculations for 1206 North, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 9.3 months; however 1206 North groundwater extraction will continue until water injection in WU-BA3 is discontinued in Month 83.
11	28.653583	130.735459	57.441405	57.474838	50.072243	13.234973	10.178184	65.40	242	11	334.6	
12	28.620503	129.354351	57.333664	57.082260	49.977175	13.144727	7.475151	64.71	242	12	365.0	
13	28.587461	127.987834	57.226125	56.692364	49.882288	22.287500	5.489966	67.89	242	13	395.5	
14	28.554457	126.635753	57.118788	56.305131	49.787581	22.135527	4.031989	67.22	242	14	425.9	
15	28.521491	125.297955	57.011653	55.920543	49.693053	21.984591	2.961209	66.58	242	15	456.3	
16	28.488563	123.974290	56.904718	55.538581	49.598705	21.834684	2.174797	65.95	242	16	486.7	
17	28.455673	122.664608	56.797984	55.159229	49.504537	21.685799	1.597234	65.33	242	17	517.1	
18	28.422822	121.368762	56.691450	54.782468	49.410547	21.537929	1.173054	64.72	242	18	547.6	
19	28.390008	120.086605	56.585116	54.408280	49.316735	21.391068	0.861525	64.13	242	19	578.0	
20	28.357232	118.817993	56.478981	54.036648	49.223102	21.245208	0.632729	63.54	242	20	608.4	
21	28.324493	117.562783	56.373045	53.667555	49.129646	21.100343	0.464694	62.96	242	21	638.8	
22	28.291793	116.320834	56.267309	53.300982	49.036368	20.956465	0.341285	62.38	242	22	669.2	
23	28.259130	115.092004	56.161770	52.936914	48.943267	20.813568	0.250649	61.82	242	23	699.7	
24	28.226506	113.876156	56.056429	52.575332	48.850343	20.671646	0.184084	61.26	242	24	730.1	
25	28.193918	112.673152	55.951286	52.216220	48.757595	20.530692	0.135197	60.70	242	25	760.5	
26	28.161369	111.482857	55.846340	51.859561	48.665023	20.390698	0.099292	60.15	242	26	790.9	
27	28.128857	110.305137	55.741592	51.505338	48.572627	20.251660	0.072923	59.61	242	27	821.3	
28	28.096382	109.139858	55.637039	51.153534	48.480406	20.113569	0.053557	59.07	242	28	851.8	
29	28.063945	107.986889	55.532683	50.804133	48.388361	19.976420	0.039334	58.54	242	29	882.2	
30	28.031545	106.846100	55.428522	50.457119	48.296490	19.840206	0.028888	58.01	242	30	912.6	
31	27.999183	105.717363	55.324557	50.112476	48.204794	19.704921	0.021216	57.48	242	31	943.0	
32	27.966858	104.600550	55.220786	49.770186	48.113271	19.570558	0.015582	56.98	242	32	973.4	
33	27.934571	103.495535	55.117211	49.430234	48.021923	19.437112	0.011444	56.47	242	33	1003.9	
34	27.902321	102.402194	55.013829	49.092604	47.930748	19.304575	0.008405	55.96	242	34	1034.3	
35	27.870108	101.320403	54.910642	48.757281	47.839746	19.172942	0.006173	55.46	242	35	1064.7	
36	27.837932	100.250040	54.807648	48.424248	47.748917	19.042207	0.004533	54.96	242	36	1095.1	
37	27.805793	99.190984	54.704847	48.093489	47.658260	18.912364	0.003329	54.47	242	37	1125.5	
38	27.773692	98.143117	54.602239	47.764990	47.567776	18.783405	0.002445	53.99	242	38	1156.0	
39	27.741627	97.106319	54.499824	47.438735	47.477463	18.655326	0.001796	53.51	242	39	1186.4	
40	27.709600	96.080474	54.397601	47.114708	47.387321	18.528120	0.001319	53.03	242	40	1216.8	
41	27.677609	95.065467	54.295569	46.792894	47.297351	18.401782	0.000969	52.56	242	41	1247.2	
42	27.645656	94.061182	54.193729	46.473279	47.207552	18.276305	0.000711	52.09	242	42	1277.6	
43	27.613739	93.067506	54.092079	46.155846	47.117923	18.151684	0.000522	51.63	242	43	1308.1	
44	27.581859	92.084328	53.990621	45.840582	47.028464	18.027912	0.000384	51.17	242	44	1338.5	
45	27.550016	91.111536	53.889353	45.527471	46.939176	17.904985	0.000282	50.72	242	45	1368.9	
46	27.518210	90.149021	53.788274	45.216499	46.850056	17.782895	0.000207	50.27	242	46	1399.3	
47	27.486440	89.196674	53.687386	44.907651	46.761106	17.661639	0.000152	49.83	242	47	1429.7	
48	27.454708	88.254388	53.586686	44.600912	46.672325	17.541209	0.000112	49.39	242	48	1460.2	
49	27.423011	87.322056	53.486175	44.296269	46.583712	17.421600	0.000082	48.95	242	49	1490.6	
50	27.391352	86.399574	53.385853	43.993706	46.495268	17.302807	0.000060	48.52	242	50	1521.0	
51	27.359729	85.486837	53.285719	43.693211	46.406991	17.184823	0.000044	48.09	242	51	1551.4	
52	27.328142	84.583742	53.185773	43.394767	46.318882	17.067645	0.000032	47.67	242	52	1581.8	
53	27.296592	83.690187	53.086015	43.098362	46.230941	16.951265	0.000024	47.25	242	53	1612.3	
54	27.265078	82.806072	52.986443	42.803982	46.143166	16.835679	0.000018	46.84	242	54	1642.7	
55	27.233601	81.931297	52.887058	42.511612	46.055558	16.720881	0.000013	46.43	242	55	1673.1	
56	27.202160	81.065764	52.787860	42.221240	45.968116	16.606865	0.000009	46.02	242	56	1703.5	
57	27.170755	80.209374	52.688848	41.932851	45.880841	16.493628	0.000007	45.62	242	57	1733.9	According to remediation duration calculations for UP1 and UP2, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 57 Months. However, groundwater extraction will continue in the WAA "BLUFF" Area to maintain the minimum treatment system flow rate.
58	27.139387	79.362031	52.590021	41.646431	45.793731	16.381162	0.000005	45.22	242	58	1764.4	
59	27.108055	78.523639	52.491380	41.361968	45.706786	16.269463	0.000004	44.82	242	59	1794.8	
60	27.076759	77.694104	52.392924	41.079448	45.620007	16.158526	0.000003	44.43	242	60	1825.2	
61	27.045499	76.873333	52.294652	40.798858	45.533392	16.048345	0.000002	44.05	242	61	1855.6	
62	27.014275	76.061232	52.196565	40.520184	45.446942	15.938916	0.000001	43.66	242	62	1886.0	
63	26.983087	75.257711	52.098662	40.243414	45.360656	15.830233	0.000001	43.28	242	63	1916.5	
64	26.951936	74.462678	52.000942	39.968534	45.274533	15.722290	0.000001	42.91	242	64	1946.9	
65	26.920820	73.676043	51.903406	39.695532	45.188575	15.615084	0.000000	42.54	242	65	1977.3	
66	26.889740	72.897719	51.806053	39.424395	45.102779	15.508609	0.000000	42.17	242	66	2007.7	
67	26.858696	72.127618	51.708882	39.155109	45.017146	15.402860	0.000000	41.80	242	67	2038.1	
68	26.827688	71.365651	51.611893	38.887663	44.931676	15.297832	0.000000	41.44	242	68	2068.6	
69	26.796716	70.611735	51.515087	38.622043	44.846368	15.193520	0.000000	41.08	242	69	2099.0	
70	26.765779	69.865782	51.418462	38.358238	44.761222	15.089920	0.000000	40.73	242	70	2129.4	
71	26.734878	69.127710	51.322018	38.096235	44.676238	14.987025	0.000000	40.38	242	71	2159.8	
72	26.704013	68.397436	51.225755	37.836022	44.591415	14.884833	0.000000	40.03	242	72	2190.2	
73	26.673183	67.674875	51.129673	37.577585	44.506753	14.783337	0.000000	39.69	242	73	2220.7	
74	26.642389	66.959949	51.033771	37.320914	44.422252	14.682534	0.000000	39.35	242	74	2251.1	
75	26.611631	66.252574	50.938048	37.065996	44.337912	14.582417	0.000000	39.01	242	75	2281.5	
76	26.580908	65.552673	50.842506	36.812820	44.253731	14.482984	0.000000	38.68	242	76	2311.9	
77	26.550221	64.860165	50.747142	36.561372	44.169710	14.384228	0.000000	38.35	242	77	2342.3	
78	26.519569	64.174973	50.651958	36.311642	44.085849	14.286146	0.000000	38.02	242	78	2372.8	
79	26.488952	63.497020	50.556952	36.063618	44.002147	14.188732	0.000000	37.70	242	79	2403.2	

Western Area Combined Influent - Uranium							
Area	WU-PBA (GE-WU-01)	WAA U>DCGL (GE-WAA-01 through GE-WAA-04)	WAA-WEST (GE-WAA-05)	WU-1348 (GETR-WU-01)	WAA-EAST (GE-WAA-14 & GE-WAA-15)	WAA-BLUFF (GE-WAA-06 through GE-WAA-13)	1206-NORTH (GETR-WU-02)
C_i (ug/L)	29.02	146.94	58.64	61.98	51.13	14.27	303.55
C_{max} (ug/L)	29.02	146.94	58.64	61.98	51.13	22.29	303.55
Flow Rate (gpm)	5	99	10	4	20	104	8
R	109.6	13.1	13.1	55.3	13.1	13.1	50.4
PV (liters)	6,548,662	118,295,089	67,593,844	1,749,984	133,552,129	192,892,116	85,334
Q (liters/day)	27,255	539,648	54,510	21,804	109,020	566,903	43,608
Time Required for Initial Conc. to Reach Max. Level (months)	0	0	0	0	0	365	0

$$C_t = C_0 e^{(-Q/(PV*R))t}$$

Cumulative Time (Months)	WU-PBA	WAA U>DCGL	WAA-WEST	WU-1348	WAA-EAST	WAA-BLUFF	1206-NORTH	WEIGHTED AVERAGE	Combined Influent Flow Rate	Months	Days	Notes
80	26.458371	62.826228	50.462124	35.817288	43.918604	14.091983	0.000000	37.38	242	80	2433.6	
81	26.427825	62.162523	50.367474	35.572641	43.835220	13.995894	0.000000	37.06	242	81	2464.0	
82	26.397314	61.505830	50.273001	35.329665	43.751994	13.900459	0.000000	36.74	242	82	2494.4	
83	26.366839	60.856074	50.178706	35.088348	43.668926	13.805676	0.000000	36.43	242	83	2524.9	
84	26.336398	60.213181	50.084588	34.848679	43.586015	13.711539		36.12	242	84	2555.3	
85	26.305993	59.577081	49.990646	34.610648	43.503262	13.618043		35.82	242	85	2585.7	
86	26.275623	58.947700	49.896886	34.374242	43.420667	13.525185		35.51	242	86	2616.1	
87	26.245288	58.324969	49.803290	34.139451	43.338227	13.432961		35.22	242	87	2646.5	
88	26.214988	57.708815	49.709876	33.906264	43.255945	13.341365		34.92	242	88	2677.0	
89	26.184723	57.099171	49.616637	33.674670	43.173819	13.250394		34.62	242	89	2707.4	
90	26.154493	56.495968	49.523573	33.444658	43.091848	13.160043		34.33	242	90	2737.8	
91	26.124298	55.899136	49.430683	33.216216	43.010034	13.070308		34.05	242	91	2768.2	
92	26.094138	55.308610	49.337968	32.989335	42.928374	12.981185		33.76	242	92	2798.6	
93	26.064012	54.724322	49.245427	32.764004	42.846870	12.892670		33.48	242	93	2829.1	
94	26.033922	54.146207	49.153059	32.540212	42.765520	12.804758		33.20	242	94	2859.5	
95	26.003866	53.574199	49.060864	32.317948	42.684325	12.717446		32.92	242	95	2889.9	
96	25.973845	53.008233	48.968842	32.097203	42.603284	12.630729		32.65	242	96	2920.3	
97	25.943858	52.448247	48.876993	31.877965	42.522397	12.544603		32.37	242	97	2950.7	
98	25.913906	51.894176	48.785317	31.660225	42.441663	12.459065		32.10	242	98	2981.2	
99	25.883989	51.345959	48.693812	31.443972	42.361083	12.374110		31.84	242	99	3011.6	
100	25.854106	50.803533	48.602478	31.229196	42.280656	12.289734		31.57	242	100	3042.0	
101	25.824257	50.266837	48.511317	31.015887	42.200381	12.205934		31.31	242	101	3072.4	
102	25.794444	49.735811	48.420326	30.804035	42.120259	12.122705		31.05	242	102	3102.8	
103	25.764664	49.210395	48.329505	30.593631	42.040289	12.040043		30.80	242	103	3133.3	
104	25.734919	48.690530	48.238855	30.384663	41.960471	11.957945		30.54	242	104	3163.7	
105	25.705208	48.176156	48.148376	30.177123	41.880804	11.876407		30.29	242	105	3194.1	
106	25.675532	47.667216	48.058065	29.971000	41.801289	11.795425		30.04	242	106	3224.5	
107	25.645890	47.163653	47.967925	29.766285	41.721924	11.714995		29.80	242	107	3254.9	
108	25.616282	46.665410	47.877953	29.562969	41.642710	11.635114		29.55	242	108	3285.4	
109	25.586708	46.172430	47.788150	29.361041	41.563647	11.555777		29.31	242	109	3315.8	
110	25.557168	45.684658	47.698515	29.160492	41.484734	11.476981		29.07	242	110	3346.2	
111	25.527663	45.202039	47.609049	28.961314	41.405970	11.398723		28.83	242	111	3376.6	
112	25.498191	44.724518	47.519750	28.763496	41.327356	11.320998		28.60	242	112	3407.0	
113	25.468754	44.252042	47.430619	28.567029	41.248892	11.243803		28.36	242	113	3437.5	
114	25.439350	43.784557	47.341655	28.371904	41.170576	11.167135		28.13	242	114	3467.9	
115	25.409981	43.322011	47.252858	28.178111	41.092409	11.090989		27.91	242	115	3498.3	
116	25.380645	42.864351	47.164228	27.985643	41.014391	11.015362		27.68	242	116	3528.7	
117	25.351344	42.411526	47.075764	27.794489	40.936520	10.940252		27.46	242	117	3559.1	
118	25.322076	41.963485	46.987465	27.604640	40.858797	10.865653		27.23	242	118	3589.6	
119	25.292842	41.520177	46.899333	27.416089	40.781222	10.791563		27.01	242	119	3620.0	
120	25.263641	41.081552	46.811365	27.228825	40.703795	10.717978		26.80	242	120	3650.4	
121	25.234475	40.647561	46.723563	27.042841	40.626514	10.644895		26.58	242	121	3680.8	
122	25.205342	40.218154	46.635925	26.858126	40.549380	10.572310		26.37	242	122	3711.2	
123	25.176242	39.793284	46.548452	26.674674	40.472392	10.500221		26.16	242	123	3741.7	
124	25.147176	39.372902	46.461143	26.492474	40.395551	10.428622		25.95	242	124	3772.1	
125	25.118144	38.956961	46.373997	26.311520	40.318855	10.357512		25.74	242	125	3802.5	
126	25.089146	38.545414	46.287015	26.131801	40.242306	10.286887		25.53	242	126	3832.9	
127	25.060180	38.138215	46.200196	25.953309	40.165901	10.216744		25.33	242	127	3863.3	According to remediation duration calculations 1206 South, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 126.3 Months
128	25.031249	37.735318	46.113540		40.089642	10.147078		24.72	238	128	3893.8	
129	25.002350	37.336676	46.027047		40.013527	10.077888		24.52	238	129	3924.2	
130	24.973485	36.942247	45.940715		39.937557	10.009170		24.33	238	130	3954.6	
131	24.944654	36.551983	45.854546		39.861731	9.940920		24.13	238	131	3985.0	
132	24.915855	36.165843	45.768538		39.786049	9.873135		23.94	238	132	4015.4	
133	24.887090	35.783782	45.682692		39.710510	9.805813		23.75	238	133	4045.9	
134	24.858358	35.405757	45.597006		39.635115	9.738950		23.56	238	134	4076.3	
135	24.829659	35.031726	45.511482		39.559864	9.672543		23.38	238	135	4106.7	
136	24.800994	34.661646	45.426117		39.484755	9.606588		23.19	238	136	4137.1	
137	24.772361	34.295475	45.340913		39.409789	9.541083		23.01	238	137	4167.5	
138	24.743762	33.933173	45.255869		39.334965	9.476025		22.83	238	138	4198.0	
139	24.715195	33.574698	45.170984		39.260283	9.411411		22.65	238	139	4228.4	
140	24.686662	33.220011	45.086259		39.185743	9.347237		22.48	238	140	4258.8	
141	24.658161	32.869070	45.001692		39.111344	9.283500		22.30	238	141	4289.2	
142	24.629694	32.521836	44.917284		39.037087	9.220199		22.13	238	142	4319.6	
143	24.601259	32.178271	44.833034		38.962971	9.157329		21.95	238	143	4350.1	
144	24.572857	31.838335	44.748942		38.888995	9.094887		21.78	238	144	4380.5	
145	24.544488	31.501991	44.665008		38.815160	9.032872		21.62	238	145	4410.9	
146	24.516151	31.169199	44.581232		38.741465	8.971279		21.45	238	146	4441.3	
147	24.487848	30.839923	44.497613		38.667910	8.910106		21.28	238	147	4471.7	
148	24.459577	30.514126	44.414150		38.594495	8.849350		21.12	238	148	4502.2	
149	24.431338	30.191771	44.330844		38.521219	8.789009		20.96	238	149	4532.6	
150	24.403133	29.872820	44.247694		38.448082	8.729079		20.79	238	150	4563.0	

According to remediation duration calculations for WU-PBA, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 204.9 Months
According to remediation duration calculations WAA U>DCGL, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 167.6 Months
According to remediation duration calculations WAA West, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 404.2 Months
According to remediation duration calculations WAA East, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 591.2 Months

Western Area Combined Influent - Nitrate

Area	WU-PBA (GE-WU-01)	WAA U>DCGL (GE-WAA-01 through GE-WAA-04)	WAA-WEST (GE-WAA-05)	WU-1348 (GETR-WU-01)	WAA-EAST (GE-WAA-14 & GE-WAA-15)	WAA-BLUFF (GE-WAA-06 through GE-WAA-13)	1206-NORTH (GETR-WU-02)
C_i (ug/L)	61.73	35.76	10.22	11.57	72.23	114.10	38.64
C_{max} (ug/L)	61.73	35.76	10.22	11.57	72.23	312.75	38.64
Flow Rate (gpm)	5	99	10	4	20	104	8
R	22.7	4.6	4.6	11.9	4.6	4.6	10.9
PV (liters)	6,548,662	118,295,089	67,593,844	1,749,984	133,552,129	192,892,116	85,334
Q (liters/day)	27,255	539,648	54,510	21,804	109,020	566,903	43,608
Time Required for Initial Conc. to Reach Max. Level (months)	0	0	0	0	0	0	0

$$C_t = C_0 e^{(-Q/(PV*R))t}$$

Cumulative Time (Months)	WU-PBA	WAA U>DCGL	WAA-WEST	WU-1348	WAA-EAST	WAA-BLUFF	1206-NORTH	WEIGHTED AVERAGE	Combined Influent Flow Rate	Months	Days	Notes
0	61.730000	35.761919	10.220000	11.570000	72.225000	114.100192	38.640000	70.47	250.00	0	0.0	
1	61.386971	34.703700	10.165877	11.206095	71.837838	111.913425	9.249148	68.16	250.00	1	30.4	
2	61.045849	33.676794	10.112040	10.853635	71.452751	109.768568	2.213942	66.59	250.00	2	60.8	
3	60.706622	32.680274	10.058489	10.512262	71.069729	107.664818	0.529945	65.22	250.00	3	91.3	
4	60.369280	31.713243	10.005221	10.181625	70.688760	105.601386	0.126851	63.92	250.00	4	121.7	
5	60.033812	30.774827	9.952235	9.861388	70.309833	103.577501	0.030364	62.66	250.00	5	152.1	
6	59.700209	29.864178	9.899530	9.551223	69.932937	101.592405	0.007268	61.43	250.00	6	182.5	
7	59.368460	28.980477	9.847104	9.250813	69.558062	99.645353	0.001740	60.22	250.00	7	212.9	
8	59.038554	28.122925	9.794955	8.959852	69.185196	97.735618	0.000416	59.05	250.00	8	243.4	
9	58.710481	27.290749	9.743083	8.678043	68.814328	95.862483	0.000100	57.89	250.00	9	273.8	
10	58.384232	26.483197	9.691485	8.405097	68.445449	94.025247	0.000024	56.77	250.00	10	304.2	According to remediation duration calculations for 1206 North, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 9.3 months; however 1206 North groundwater extraction will continue until water injection in WU-BA3 is discontinued in Month 83.
11	58.059795	25.699541	9.640161	8.140736	68.078548	92.223223	0.000006	55.67	242.00	11	334.6	
12	57.737162	24.939074	9.589108	7.884689	67.713613	90.455735	0.000001	54.59	242.00	12	365.0	
13	57.416321	24.201110	9.538326	7.636696	67.350634	312.750000	0.000000	146.73	242.00	13	395.5	
14	57.097263	23.484983	9.487813	7.396503	66.989601	306.756045	0.000000	143.91	242.00	14	425.9	
15	56.779978	22.790046	9.437567	7.163865	66.630503	300.876965	0.000000	141.15	242.00	15	456.3	
16	56.464456	22.115673	9.387588	6.938544	66.273330	295.110560	0.000000	138.44	242.00	16	486.7	
17	56.150687	21.461255	9.337873	6.720309	65.918072	289.454670	0.000000	135.79	242.00	17	517.1	
18	55.838662	20.826202	9.288421	6.508939	65.564719	283.907177	0.000000	133.19	242.00	18	547.6	
19	55.528371	20.209941	9.239231	6.304217	65.213259	278.466004	0.000000	130.64	242.00	19	578.0	
20	55.219805	19.611915	9.190302	6.105934	64.863683	273.129112	0.000000	128.15	242.00	20	608.4	
21	54.912952	19.031585	9.141632	5.913887	64.515982	267.894504	0.000000	125.70	242.00	21	638.8	
22	54.607805	18.468427	9.093219	5.727880	64.170144	262.760219	0.000000	123.30	242.00	22	669.2	
23	54.304354	17.921934	9.045063	5.547724	63.826160	257.724334	0.000000	120.95	242.00	23	699.7	
24	54.002589	17.391612	8.997162	5.373235	63.484020	252.784963	0.000000	118.65	242.00	24	730.1	
25	53.702501	16.876982	8.949515	5.204233	63.143714	247.940257	0.000000	116.39	242.00	25	760.5	
26	53.404080	16.377581	8.902120	5.040547	62.805232	243.188401	0.000000	114.18	242.00	26	790.9	
27	53.107318	15.892957	8.854976	4.882010	62.468565	238.527617	0.000000	112.01	242.00	27	821.3	
28	52.812205	15.422674	8.808082	4.728458	62.133702	233.956157	0.000000	109.89	242.00	28	851.8	
29	52.518732	14.966306	8.761436	4.579737	61.800634	229.472311	0.000000	107.81	242.00	29	882.2	
30	52.226889	14.523443	8.715037	4.435692	61.469352	225.074400	0.000000	105.76	242.00	30	912.6	
31	51.936669	14.093685	8.668883	4.296179	61.139846	220.760776	0.000000	103.76	242.00	31	943.0	
32	51.648061	13.676643	8.622975	4.161054	60.812106	216.529824	0.000000	101.80	242.00	32	973.4	
33	51.361056	13.271942	8.577309	4.030178	60.486122	212.379959	0.000000	99.88	242.00	33	1003.9	
34	51.075647	12.879216	8.531885	3.903419	60.161887	208.309628	0.000000	98.00	242.00	34	1034.3	
35	50.791824	12.498111	8.486702	3.780647	59.839389	204.317306	0.000000	96.15	242.00	35	1064.7	
36	50.509578	12.128284	8.441758	3.661736	59.518620	200.401499	0.000000	94.34	242.00	36	1095.1	
37	50.228900	11.769400	8.397052	3.546565	59.199570	196.560739	0.000000	92.56	242.00	37	1125.5	
38	49.949782	11.421135	8.352583	3.435017	58.882231	192.793588	0.000000	90.82	242.00	38	1156.0	
39	49.672215	11.083176	8.308349	3.326977	58.566593	189.098636	0.000000	89.12	242.00	39	1186.4	
40	49.396190	10.755217	8.264349	3.222336	58.252647	185.474500	0.000000	87.45	242.00	40	1216.8	
41	49.121699	10.436963	8.220583	3.120985	57.940384	181.919820	0.000000	85.81	242.00	41	1247.2	
42	48.848734	10.128126	8.177048	3.022823	57.629794	178.433268	0.000000	84.20	242.00	42	1277.6	
43	48.577285	9.828428	8.133744	2.927747	57.320870	175.013536	0.000000	82.63	242.00	43	1308.1	
44	48.307345	9.537598	8.090669	2.835662	57.013601	171.659345	0.000000	81.08	242.00	44	1338.5	
45	48.038905	9.255374	8.047822	2.746474	56.707980	168.369438	0.000000	79.57	242.00	45	1368.9	
46	47.771957	8.981501	8.005203	2.660090	56.403997	165.142583	0.000000	78.09	242.00	46	1399.3	
47	47.506492	8.715733	7.962809	2.576424	56.101643	161.977571	0.000000	76.63	242.00	47	1429.7	
48	47.242502	8.457828	7.920639	2.495389	55.800911	158.873219	0.000000	75.21	242.00	48	1460.2	
49	46.979979	8.207555	7.878693	2.416903	55.501790	155.828362	0.000000	73.81	242.00	49	1490.6	
50	46.718915	7.964688	7.836969	2.340885	55.204273	152.841860	0.000000	72.44	242.00	50	1521.0	
51	46.459302	7.729008	7.795465	2.267259	54.908350	149.912596	0.000000	71.09	242.00	51	1551.4	
52	46.201131	7.500301	7.754182	2.195948	54.614014	147.039473	0.000000	69.78	242.00	52	1581.8	
53	45.944395	7.278362	7.713117	2.126880	54.321256	144.221413	0.000000	68.49	242.00	53	1612.3	
54	45.689085	7.062990	7.672270	2.059984	54.030067	141.457363	0.000000	67.22	242.00	54	1642.7	
55	45.435195	6.853992	7.631639	1.995193	53.740439	138.746287	0.000000	65.98	242.00	55	1673.1	
56	45.182715	6.651177	7.591223	1.932439	53.452363	136.087169	0.000000	64.76	242.00	56	1703.5	
57	44.931638	6.454365	7.551022	1.871659	53.165832	133.479014	0.000000	63.57	242.00	57	1733.9	According to remediation duration calculations for UP1 and UP2, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 57 Months. However, groundwater extraction will continue in the WAA "BLUFF" Area to maintain the minimum treatment system flow rate.
58	44.681957	6.263375	7.511033	1.812791	52.880836	130.920845	0.000000	62.40	242.00	58	1764.4	
59	44.433663	6.078038	7.471256	1.755774	52.597369	128.411705	0.000000	61.25	242.00	59	1794.8	
60	44.186748	5.898185	7.431689	1.700550	52.315421	125.950653	0.000000	60.12	242.00	60	1825.2	
61	43.941206	5.723653	7.392332	1.647064	52.034984	123.536768	0.000000	59.02	242.00	61	1855.6	
62	43.697028	5.554287	7.353184	1.595260	51.756050	121.169145	0.000000	57.94	242.00	62	1886.0	
63	43.454207	5.389931	7.314243	1.545085	51.478612	118.846899	0.000000	56.88	242.00	63	1916.5	
64	43.212736	5.230440	7.275508	1.496488	51.202661	116.569160	0.000000	55.84	242.00	64	1946.9	
65	42.972606	5.075667	7.236978	1.449420	50.928189	114.335074	0.000000	54.82	242.00	65	1977.3	
66	42.733810	4.925475	7.198653	1.403832	50.655189	112.143805	0.000000	53.82	242.00	66	2007.7	
67	42.496342	4.779727	7.160530	1.359678	50.383652	109.994532	0.000000	52.84	242.00	67	2038.1	
68	42.260193	4.638292	7.122609	1.316913	50.113570	107.886451	0.000000	51.88	242.00	68	2068.6	
69	42.025357	4.501041	7.084889	1.275493	49.844936	105.818772	0.000000	50.93	242.00	69	2099.0	
70	41.791825	4.367852	7.047369	1.235375	49.577743	103.790721	0.000000	50.01	242.00	70	2129.4	
71	41.559591	4.238605	7.010047	1.196520	49.311981	101.801538	0.000000	49.10	242.00	71	2159.8	
72	41.328648	4.113182	6.972923	1.158886	49.047644	99.850479	0.000000	48.21	242.00	72	2190.2	
73	41.098988	3.991470	6.935996	1.122436	48.784725	97.936812	0.000000	47.34	242.00	73	2220.7	
74	40.870604	3.873359	6.899264	1.087133	48.523214	96.059821	0.000000	46.49	242.00	74	2251.1	
75	40.643489	3.758744	6.862727	1.052940	48.263106	94.218803	0.000000	45.65	242.00	75	2281.5	
76	40.417636	3.647520	6.826383	1.019822	48.004391	92.413069	0.000000	44.83	242.00	76	2311.9	
77	40.193039	3.539588	6.790232	0.987746	47.747064	90.641943	0.000000	44.02	242.00	77	2342.3	
78	39.969689	3.434849	6.754272	0.956679	47.491116	88.904760	0.000000	43.23	242.00	78	2372.8	
79	39.747581	3.333209	6.718503	0.926589	47.236540	87.200872	0.000000	42.45	242.00	79	2403.2	

Western Area Combined Influent - Nitrate							
Area	WU-PBA (GE-WU-01)	WAA U>DCGL (GE-WAA-01 through GE-WAA-04)	WAA-WEST (GE-WAA-05)	WU-1348 (GETR-WU-01)	WAA-EAST (GE-WAA-14 & GE-WAA-15)	WAA-BLUFF (GE-WAA-06 through GE-WAA-13)	1206-NORTH (GETR-WU-02)
C_i (ug/L)	61.73	35.76	10.22	11.57	72.23	114.10	38.64
C_{max} (ug/L)	61.73	35.76	10.22	11.57	72.23	312.75	38.64
Flow Rate (gpm)	5	99	10	4	20	104	8
R	22.7	4.6	4.6	11.9	4.6	4.6	10.9
PV (liters)	6,548,662	118,295,089	67,593,844	1,749,984	133,552,129	192,892,116	85,334
Q (liters/day)	27,255	539,648	54,510	21,804	109,020	566,903	43,608
Time Required for Initial Conc. to Reach Max. Level (months)	0	0	0	0	0	0	0

$$C_t = C_0 e^{(-Q/(PV*R))t}$$

Cumulative Time (Months)	WU-PBA	WAA U>DCGL	WAA-WEST	WU-1348	WAA-EAST	WAA-BLUFF	1206-NORTH	WEIGHTED AVERAGE	Combined Influent Flow Rate	Months	Days	Notes
80	39.526707	3.234577	6.682923	0.897446	46.983328	85.529639	0.000000	41.69	242.00	80	2433.6	
81	39.307060	3.138864	6.647531	0.869219	46.731474	83.890435	0.000000	40.95	242.00	81	2464.0	
82	39.088634	3.045983	6.612327	0.841880	46.480970	82.282648	0.000000	40.21	242.00	82	2494.4	
83	38.871421	2.955850	6.577309	0.815401	46.231809	80.705674	0.000000	39.50	242.00	83	2524.9	
84	38.655416	2.868385	6.542477	0.789754	45.983983	79.158924		40.07	242.00	84	2555.3	
85	38.440611	2.783507	6.507829	0.764915	45.737486	77.641817		39.36	242.00	85	2585.7	
86	38.226999	2.701141	6.473365	0.740856	45.492311	76.153786		38.66	242.00	86	2616.1	
87	38.014575	2.621213	6.439083	0.717554	45.248449	74.694274		37.98	242.00	87	2646.5	
88	37.803331	2.543649	6.404983	0.694985	45.005895	73.262734		37.30	242.00	88	2677.0	
89	37.593261	2.468381	6.371063	0.673126	44.764641	71.858630		36.64	242.00	89	2707.4	
90	37.384358	2.395340	6.337323	0.651955	44.524680	70.481436		35.99	242.00	90	2737.8	
91	37.176616	2.324460	6.303762	0.631449	44.286005	69.130636		35.36	242.00	91	2768.2	
92	36.970028	2.255678	6.270379	0.611589	44.048610	67.805725		34.74	242.00	92	2798.6	
93	36.764589	2.188931	6.237172	0.592353	43.812488	66.506207		34.12	242.00	93	2829.1	
94	36.560291	2.124159	6.204141	0.573722	43.577631	65.231593		33.53	242.00	94	2859.5	
95	36.357128	2.061303	6.171285	0.555677	43.344033	63.981409		32.94	242.00	95	2889.9	
96	36.155094	2.000308	6.138603	0.538199	43.111688	62.755184		32.36	242.00	96	2920.3	
97	35.954183	1.941118	6.106094	0.521272	42.880587	61.552461		31.79	242.00	97	2950.7	
98	35.754389	1.883679	6.073757	0.504876	42.650726	60.372788		31.24	242.00	98	2981.2	
99	35.555705	1.827939	6.041592	0.488997	42.422097	59.215724		30.69	242.00	99	3011.6	
100	35.358124	1.773849	6.009596	0.473617	42.194693	58.080835		30.16	242.00	100	3042.0	
101	35.161642	1.721360	5.977771	0.458720	41.968509	56.967697		29.64	242.00	101	3072.4	
102	34.966252	1.670424	5.946114	0.444292	41.743537	55.875893		29.12	242.00	102	3102.8	
103	34.771947	1.620995	5.914624	0.430318	41.519770	54.805013		28.62	242.00	103	3133.3	
104	34.578722	1.573028	5.883301	0.416784	41.297204	53.754657		28.12	242.00	104	3163.7	
105	34.386571	1.526481	5.852144	0.403675	41.075830	52.724431		27.64	242.00	105	3194.1	
106	34.195487	1.481312	5.821153	0.390978	40.855643	51.713951		27.16	242.00	106	3224.5	
107	34.005465	1.437479	5.790325	0.378681	40.636637	50.722836		26.69	242.00	107	3254.9	
108	33.816500	1.394943	5.759660	0.366771	40.418804	49.750716		26.23	242.00	108	3285.4	
109	33.628584	1.353666	5.729158	0.355235	40.202139	48.797228		25.78	242.00	109	3315.8	
110	33.441713	1.313610	5.698818	0.344062	39.986635	47.862013		25.34	242.00	110	3346.2	
111	33.255880	1.274739	5.668638	0.333240	39.772287	46.944722		24.91	242.00	111	3376.6	
112	33.071079	1.237019	5.638618	0.322759	39.559088	46.045011		24.48	242.00	112	3407.0	
113	32.887306	1.200414	5.608757	0.312607	39.347031	45.162543		24.07	242.00	113	3437.5	
114	32.704554	1.164893	5.579054	0.302775	39.136112	44.296989		23.66	242.00	114	3467.9	
115	32.522817	1.130423	5.549508	0.293252	38.926323	43.448022		23.26	242.00	115	3498.3	
116	32.342091	1.096973	5.520119	0.284028	38.717658	42.615327		22.86	242.00	116	3528.7	
117	32.162368	1.064513	5.490885	0.275095	38.510112	41.798590		22.48	242.00	117	3559.1	
118	31.983644	1.033013	5.461806	0.266443	38.303679	40.997507		22.10	242.00	118	3589.6	
119	31.805914	1.002446	5.432882	0.258062	38.098352	40.211776		21.73	242.00	119	3620.0	
120	31.629171	0.972783	5.404110	0.249946	37.894126	39.441104		21.36	242.00	120	3650.4	
121	31.453410	0.943998	5.375491	0.242084	37.690994	38.685203		21.00	242.00	121	3680.8	
122	31.278626	0.916064	5.347023	0.234470	37.488952	37.943788		20.65	242.00	122	3711.2	
123	31.104813	0.888957	5.318707	0.227095	37.287992	37.216583		20.31	242.00	123	3741.7	
124	30.931966	0.862652	5.290540	0.219953	37.088110	36.503315		19.97	242.00	124	3772.1	
125	30.760079	0.837126	5.262522	0.213035	36.889299	35.803717		19.63	242.00	125	3802.5	
126	30.589148	0.812355	5.234653	0.206334	36.691554	35.117527		19.31	242.00	126	3832.9	
127	30.419167	0.788317	5.206931	0.199844	36.494869	34.444489		18.99	242.00	127	3863.3	According to remediation duration calculations 1206 South, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 126.3 Months
128	30.250130	0.764990	5.179356		36.299238	33.784349		18.98	238.00	128	3893.8	
129	30.082032	0.742353	5.151927		36.104656	33.136861		18.67	238.00	129	3924.2	
130	29.914869	0.720386	5.124643		35.911118	32.501782		18.36	238.00	130	3954.6	
131	29.748634	0.699070	5.097504		35.718616	31.878875		18.06	238.00	131	3985.0	
132	29.583323	0.678384	5.070509		35.527146	31.267906		17.77	238.00	132	4015.4	
133	29.418931	0.658310	5.043656		35.336703	30.668646		17.47	238.00	133	4045.9	
134	29.255452	0.638830	5.016946		35.147281	30.080872		17.19	238.00	134	4076.3	
135	29.092882	0.619927	4.990377		34.958874	29.504362		16.91	238.00	135	4106.7	
136	28.931215	0.601583	4.963949		34.771477	28.938901		16.63	238.00	136	4137.1	
137	28.770447	0.583781	4.937661		34.585084	28.384278		16.36	238.00	137	4167.5	
138	28.610572	0.566507	4.911512		34.399691	27.840284		16.10	238.00	138	4198.0	
139	28.451585	0.549744	4.885501		34.215292	27.306716		15.84	238.00	139	4228.4	
140	28.293482	0.533476	4.859629		34.031881	26.783374		15.58	238.00	140	4258.8	
141	28.136257	0.517690	4.833893		33.849453	26.270062		15.33	238.00	141	4289.2	
142	27.979906	0.502372	4.808293		33.668003	25.766587		15.09	238.00	142	4319.6	
143	27.824424	0.487506	4.782830		33.487525	25.272762		14.85	238.00	143	4350.1	
144	27.669806	0.473080	4.757501		33.308016	24.788402		14.61	238.00	144	4380.5	
145	27.516047	0.459082	4.732306		33.129468	24.313324		14.38	238.00	145	4410.9	
146	27.363142	0.445497	4.707244		32.951878	23.847351		14.15	238.00	146	4441.3	
147	27.211088	0.432315	4.682316		32.775239	23.390309		13.92	238.00	147	4471.7	
148	27.059878	0.419522	4.657519		32.599547	22.942026		13.70	238.00	148	4502.2	
149	26.909508	0.407108	4.632854		32.424798	22.502335		13.49	238.00	149	4532.6	
150	26.759974	0.395061	4.608319		32.250985	22.071070		13.27	238.00	150	4563.0	

According to remediation duration calculations for WU-PBA, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 204.9 Months
According to remediation duration calculations WAA U>DCGL, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 167.6 Months
According to remediation duration calculations WAA West, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 404.2 Months
According to remediation duration calculations WAA East, uranium and nitrate remediation goals (NRC and State Criteria) are both met at 591.2 Months

Attachment 12.0a – Treatment System Effluent Criteria: BA1 and WA

Treatment Effluent Criteria (Table 1)

Constituent Source	Groundwater Contaminant				Treatment Additives																								
Limitation Rationale	Treatment Objectives				Water Quality Objectives (for compliance and injection purposes)																								
Limitation Basis	OPDES Permit Concentration Limits				Injection Criterion	Injection Criterion	Injection Criterion	Injection Criterion	Injection Criterion	Injection Criterion	EPA DWEL[3]	EPA DWEL[3]	C_{mean}[4]	Influent Conc.	C_{mean}	Influent Conc./ Injection Criterion	Influent Conc.	C_{mean}	Injection Criterion/ Influent Conc.	C_{mean}	Influent Conc.	Injection Criterion	Influent Conc.	Influent Conc./ Injection Criterion	Influent Conc.	Injection Criterion	Injection Criterion	OPDES Permit Requirement
	Uranium[1]	Nitrate	Fluoride	pH	Heterotrophic Plate Count	Anaerobic Growth	Sulfate Reducing Bacteria	Fe/Mn Reducing Bacteria	Adenosine Triphosphate (ATP)	LSI	Molybdenum	Boron	Selenium	Sulfate	Copper	Manganese	Chlorides[5]	Nickel	Sodium[5]	Zinc	TOC	Ortho-Phosphate	TDS	Total Iron	Dissolved Iron	Silica	Tannin/ Lignin	Temperature
Groundwater Extraction Process Stream	µg/L	mg/L	mg/L	s.u.	(colonies/ml)	percent population[2]	presence/ absence	percent population[3]	(colonies/ml)	----	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L (as Fe^{2+})	mg/L (as SiO_2)	mg/L	----
BA1 (Outfall 002)	≤30 -or- ND (1.0)	≤5	≤4	6.5 - 9.0	≤300	≤15%	Absent	Absent	≤100,000	-0.5 - +0.5	≤0.20	≤7	≤4.77	≤251	≤0.03	≤0.10	≤100	≤14.3	≤80	≤400	≤3.95	≤1	≤959	≤1.53	≤0.56	<30	<5	There can be no addition of heat from artificial sources to the water discharged at Outfalls 001 & 002
WATF (Outfall 001)													≤8.97	≤240	≤0.01	≤0.54			≤82.6	≤4.34	≤6.31		≤1200	≤1	≤0.05			

Treatment Effluent Criteria (Table 2)

Constituent Source	Water Quality Objectives (for compliance and injection purposes)																					
Limitation Rationale	Treatment Additives	Groundwater Constituents																				
Limitation Basis	OPDES Permit Requirements	C_{mean}	C_{mean}	C_{mean}	C_{mean}	Injection Criterion	C_{mean}	C_{mean}	Influent Conc.	Influent Conc.	Injection Criterion	Injection Criterion	C_{mean}	Injection Criterion/ Influent Conc.	C_{mean}	C_{mean}	C_{mean}	C_{mean}	C_{mean}	C_{mean}	OPDES Permit Requirement
	General Quality	Lead	Mercury	Thallium	Cyanide	TSS	Ammonia	Silver	Total Alkalinity	Bicarbonate Alkalinity	Potassium	Magnesium	Chromium	Calcium	Barium	Arsenic	Cadmium	Bis (2-Ethylhexyl)	1,4-Dichlorobenzene	Dimethyl Phthalate	Total Halogens
Groundwater Extraction Process Stream	----	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	mg/L (as $CaCO_3$)	mg/L (as $CaCO_3$)	mg/L	mg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L
BA1 (Outfall 002)	There shall be no discharge of a visible sheen of oil or globules of oil or grease on or in the water. Oil and grease shall not be present in quantities that adhere to stream banks and coat bottoms of watercourses. Surface waters of the State shall be maintained free from oil and grease and taste and odors. There shall be no discharge of floating solids or visible foam in other than trace amounts. The discharge shall not contain chemical, physical, or biological substances in concentrations that are irritating to skin or sense organs or are toxic or cause illness upon ingestion by human beings.	≤23.6	≤0.2	≤17.3	≤13.3	≤45	≤0.20	≤1.75	≤463	≤462	≤5	≤180	≤36.4	≤180	≤3340	≤59.7	≤0.28	≤3.29	≤0.19	≤881	≤0.1
WATF (Outfall 001)		≤15.5					≤22.3		≤325	≤294			≤102	≤182							

Definitions:
BA1 - Burial Area 1
$CaCO_3$ - calcium carbonate
C_{mean} - mean pollutant effluent concentration calculated in OPDES permit.
Conc. - concentration
DWEL - Drinking water equivalent level
EPA - Environmental Protection Agency
Fe^{2+} - ferrous iron
LSI - Langelier Saturation Index
mg/L - milligrams per liter
OPDES - Oklahoma Pollutant Discharge Elimination System
SiO_2 - silica dioxide
s.u. - Standard Units
TDS - Total Dissolved Solids
TOC - Total Organic Carbon
TSS - Total Suspended Solids
µg/L - micrograms per liter
USEPA - United States Environmental Protection Agency
WATF - Western Area Treatment Facility

Applicable Effluent Standards:
1. Concentration limits specified in the OPDES permit
2. Injection Criterion
3. EPA DWEL
4. C_{mean} presented in the OPDES permit
5. Average influent concentrations for WATF and BA1 groundwater process streams
6. Water quality requirement specified in the OPDES permit

Rationale for Establishing Effluent Criteria:
1. Concentration limits specified in the OPDES permit apply for uranium, nitrate, fluoride, and pH.
2. The injection criterion applies if:
   a. Influent concentration data are not available but an injection criterion exists and the water treatment process may affect the constituent concentration, characteristic, etc. (e.g., heterotrophic plate count, LSI, etc.)
   b. If the injection criterion is less stringent than the corresponding influent concentration.
3. EPA DWELs apply if the water treatment process may affect the constituent concentration, influent concentration data are not available, the constituent is not referenced in the OPDES permit, and no other standard (i.e., USEPA MCL) exits (e.g., molybdenum, boron).
4. The C_{mean} presented in the OPDES permit applies if:
   a. Influent concentration data are not available but the water treatment process may affect the constituent concentration, characteristic, etc. of a regulated constituent (e.g., selenium).
   b. Influent concentration data are not available but an injection criterion exists and the water treatment process may affect the constituent concentration, characteristic, etc. (e.g., copper).
5. The influent concentration applies if:
   a. An injection criterion exists, the water treatment process may affect the constituent concentration, characteristic, etc., and the influent concentration is more stringent than other standards (e.g., C_{mean}) [e.g., sulfate].
   b. An injection criterion exists but the injection criterion is more stringent than the influent concentration (e.g., manganese – WATF process stream).
6. Water quality requirement specified in the OPDES permit applies if there are no other applicable criteria or standards (e.g., total halogens).

Notes:
[1] The maximum treatment effluent uranium concentration for re-injection or OPDES discharge is 30 µg/L. Maximum concentration prior to nitrate removal is non-detect (1.0 µg/L detection limit).
[2] Anaerobic growth analysis is conducted by analyzing the population of sulfate reducing bacteria (SRB), as a percentage of the total microbial population, because SRB are the most probable, prolific and observable anaerobes in groundwater.
[3] EPA DWEL used for constituents for which groundwater data and C_{mean} levels are not available.
[4] C_{mean} values presented in OPDES discharge permit used for constituents for which groundwater data are not available.
[5] Sodium and chloride concentrations in groundwater extracted from wells located near the Cimarron River may be significantly higher than the concentrations reported for site monitoring wells.

Attachment 12.0b – Treatment System Influent Characteristics: BA1 and WA

Water Treatment Design Basis
Cimmaron Environmental Response Trust

Influent Characteristics[1]

Groundwater Extraction Process Stream	Designated Remediation Area	Flow Rates Nominal (gpm)	Flow Rates Range (gpm)	Total Uranium (Initial) (µg/L)	Total Uranium (Maximum) (µg/L)	Nitrogen, Nitrate-Nitrite (Initial) (mg/L)	Nitrogen, Nitrate-Nitrite (Maximum) (mg/L)	Fluoride (Initial) (mg/L)	Fluoride (Maximum) (mg/L)	pH (s.u.)	LSI[1]	RSI[1]	Bicarbonate Alkalinity (mg/L)	Carbonate Alkalinity (mg/L)	Hydroxide Alkalinity (mg/L)	Phenolphthalein Alkalinity (mg/L)	Total Alkalinity (mg/L)	Aluminum (µg/L)	Calcium (µg/L)	Chlorides[2] (mg/L)	Ferrous Iron (mg/L)	Iron (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Ortho-Phosphate (mg/L)	Potassium (µg/L)	Silica (µg/L)	Sodium[2] (µg/L)	Sulfate (mg/L)	TDS (mg/L)	TOC (mg/L)	Phosphorous (mg/L)	Methane (mg/L)	Temperature (°C)
BA1	"U>DCGL" AREA A	14	10 - 26	1720	1720	2.35	2.35	0.72	0.72	7.12	0.00	7.10	439.32	0.94	1.00	1.00	436.46	80.59	108831.03	20.43	0.40	545.93	49279.31	633.23	0.20	605.21	24072.41	30758.62	50.54	606.61	3.07	-	-	15.19
BA1	"U>DCGL" AREA B	66	30 - 90	1139	1139	0.27	0.27	0.49	0.49	7.09	0.16	6.76	460.92	1.53	1.00	1.00	462.96	62.57	163440.00	73.38	0.75	763.78	61892.00	436.98	0.13	2133.20	26132.00	91940.00	266.42	985.04	3.79	-	-	15.29
BA1	"U<DCGL" AREA C	20	10 - 40	34.7	34.7	0.06	0.06	0.43	0.43	7.24	0.89	5.93	480.00	-	-	-	481.00	26.70	186000.00	149.00	0.05	4740.00	64300.00	807.00	-	1930.00	26000.00	58400.00	338.00	1120.00	5.13	-	-	15.57
WATF	WAA U>DCGL	99	60 - 120	147	147	35.8	35.8	2.27	2.3	6.96	-0.06	7.07	343.13	0.84	1.00	1.00	343.67	105.65	194200.00	99.37	0.05	107.53	77986.67	86.78	0.20	3346.67	22266.67	115640.00	369.13	1235.33	7.19	-	0.03	13.79
WATF	WAA-WEST	10	10 - 30	58.6	58.6	10.2	10.2	0.45	0.5	7.32	0.10	7.01	359.33	-	-	-	360.67	-	135666.67	94.40	0.05	346.50	38433.33	81.83	-	2930.00	17300.00	96200.00	169.23	944.00	-	-	-	14.85
WATF	WAA "U<DCGL" EAST	20	20 - 60	51.1	51.1	72.2	72.2	0.45	0.4	7.25	-	-	-	-	-	-	324.00	-	-	61.60	-	100.00	-	28.60	-	1890.00	14700.00	-	270.00	-	4.09	-	0.03	14.97
WATF	WU-1206 "SOUTH"	4	1 - 5	62.0	62.0	11.57	11.57	1.00	1.00	7.40	-0.44	8.28	277.00	-	-	-	278.00	26.70	24700.00	3.72	0.05	100.00	9130.00	18.90	-	-	-	15300.00	20.20	206.00	-	-	-	16.90
WATF	WU-PBA	5	1 - 5	29.0	29.0	61.7	61.7	0.32	0.3	6.93	-	-	-	-	-	-	-	-	-	8.28	-	-	-	-	-	-	-	-	30.40	654.00	-	-	-	19.47
WATF	WAA "BLUFF"	104	90 - 210	14.27	22.29	114	312.75	2.19	11.93	7.06	-0.43	7.55	290.00	-	-	-	285.33	16.55	182500.00	12.78	0.05	100.00	65550.00	9.04	-	3580.00	21050.00	52250.00	148.40	1281.50	5.91	-	-	13.39
WATF	WU-1206 "NORTH"	8	3 - 15	304	304	38.6	38.6	7.03	7.0	7.05	0.25	6.55	579.50	1.26	1.00	1.00	580.50	-	156500.00	17.85	-	204.50	57300.00	160.25	0.20	2439.00	-	84050.00	72.80	859.50	-	-	-	16.10

Definitions:
BA1 - Burial Area 1
°C - degrees Celcius
DCGL - Derived Concentration Goal Level
gpm - gallons per minute
LSI - Langelier Saturation Index
mg/L - milligrams per liter
PBA - Process Building Area
RSI - Ryzner Stability Index
s.u. - Standard Units
TDS - Total Dissolved Solids
TOC - Total Organic Carbon
U - Uranium Concentration
µg/L - micrograms per liter
µm - micrometer
UP1 - Uranium Pond #1 Area
UP2 - Uranium Pond #2 Area
WAA - Western Alluvial Area
WU - Western Upland Area

Notes:
- The averages presented in this summary are not necessarily representative of influent characteristics at all times. The actual characteristics of each process stream may vary based on the groundwater extraction and injection components in operation at any given time.
- With the exception of uranium, nitrate, and flouride concentrations, the data used to prepare this summary is limited to the most recent groundwater analytical results available for each sample location and parameter, as specified in the MS Excel® workbook file entitled **2015-2-28 Comprehensive Analytical Data.xlsx**.
- Influent characteristics for each process stream were estimated by averaging concentrations reported for monitoring wells considered representative of each groundwater remediation area and extraction stream.
[1] Total Alkalinity, Calcium and TDS concentrations used for LSI and RSI calculations at each location were taken from the same sampling event which occurred in either 2004, 2005, or 2007, depending on the location. Temperature and pH values used for LSI and RSI calculations were taken from the 2015 sampling event at each location.
[2] Sodium and chloride concentrations in groundwater extracted from wells located near the Cimmaron River may be significantly higher than the concentrations reported for site monitoring wells.

Attachment 13.0 – Treated Water Injection Criteria

Limitation Basis	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation				WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation	WSE Evaluation
Parameter	Nitrate	Chlorides	Ortho-Phosphate	Calcium[3]	LSI	TOC	Total Alkalinity	Bicarbonate Alkalinity	TDS	Conductivity	ORP[1]	Total Hardness	Carbonate Hardness	Non-Carbonate Hardness	Sodium	Magnesium	Potassium	Dissolved Iron	Total Iron[2]	Copper	Manganese	Sulfate[2]	Silica	Tannin/Lignin	pH	TSS	TSS	Heterotrophic Plate Count	Anaerobic Growth	Sulfate Reducing Bacteria	Fe/Mn Reducing Bacteria	Adenosine Triphosphate (ATP)
Units	mg/L	mg/L	mg/L	mg/L	----	mg/L	mg/L (as CaCO$_3$)	mg/L (as CaCO$_3$)	mg/L	µS/cm	mV	mg/L (as CaCO$_3$)	mg/L (as CaCO$_3$)	mg/L (as CaCO$_3$)	mg/L	mg/L	mg/L	mg/L (as Fe^{2+})	mg/L	mg/L	mg/L	mg/L	mg/L (as SiO$_2$)	mg/L	s.u.	µm	mg/L	(colonies/ml)	percent population	presence/absence	presence/absence	(colonies/ml)
Limit	≤5	≤100	≤1	≤180	-0.5 - +0.5	≤1	≤180	≤180	≤400	≤750	150 - 220	≤180	≤180	≤50	≤80	≤180	≤5	≤0.02	≤1	≤0.04	≤0.10	≤150	≤30	≤5	6.5 - 9.0	≤10	≤45	≤300	≤15%	Absent	Absent	≤100,000

Definitions:
BA1 - Burial Area 1
CaCO$_3$ - calcium carbonate
LSI - Langelier Saturation Index
mg/L - milligrams per liter
ml - milliliter
mV - millivolt
ORP - oxidation-reduction potential
SiO$_2$ - silica dioxide
s.u. - standard units
TDS - total dissolved solids
TOC - total organic carbon
TSS - total suspended solids
µg/L - micrograms per liter
µm - micrometer
uS/cm - microSiemens per centimeter
WATF - Western Area Treatment Facility
WSE - Water Systems Engineering Inc.
BOLD - treated effluent is expected to exceed injection criterion. Pretreatment will be required prior to injection unless otherwise noted.
BOLD - treated effluent is expected to exceed injection criterion; however pretreatment will not be required initially. In-process monitoring results will be evaluated to assess the need for future pretreatment.

Notes:
- An underground injection control (UIC) permit will not be required for treated water injection; therefore there will be no permit requirements for the injectate.
- Results of the WSE evaluation were presented in a letter report entitled *Injection Well Water Quality Criteria* (dated 9/25/18).
- The criteria presented in this table apply only to treatment system effluents utilized for aquifer injection.
[1]ORP is dependent on natural water chemistry and any induced subsurface treatment technologies employed.
[2]Treated effluent is expected to exceed injection criterion for BA1 only.
[3]Treated effluent is expected to exceed injection criterion for WATF only.

Memorandum

BURNS & McDONNELL

Document No.: BMCD-GWREMED-TM006

Revision: A

Date: February 24, 2021

To: Jeff Lux, EPM

From: John Hesemann, Burns & McDonnell

Ashley Anstaett, Burns & McDonnell

Subject: Basis of Design Addendum No. 2 for Groundwater Remediation

An addendum to the *Basis of Design for Groundwater Remediation* (2018 BOD)[1] was prepared in February 2019 to review additional groundwater monitoring data and assess the potential need for revisions to the 2018 BOD to support detailed remediation design activities (i.e., 90% Design). Since the February 2019 BOD Addendum (BOD Addendum No. 1)[2] was issued, the original site remediation approach has transitioned to a phased approach, necessitating revisions to the remediation design and Facility Decommissioning Plan. Detailed (90%) design of the phased remediation approach will occur following completion and submittal of the *Cimarron Facility Decommissioning Plan – Revision 2* (D. Plan-Rev.2)[3].

This memorandum serves as Remediation BOD Addendum No. 2 to support remediation design activities (i.e., Preliminary Design activities) and preparation of D. Plan-Rev.2 for the Cimarron Environmental Response Trust (CERT) remediation project at the Cimarron Site located in Guthrie, Oklahoma (Site). The following analyses and evaluations, conducted to support revisions to the Remediation BOD, are documented in this memorandum:

- Particle tracking analysis using the existing groundwater flow models
- Remediation area, capture zone, and pore volume estimation
- Area-weighted concentration averaging for uranium and nitrate
- Time-specific concentration averaging for nitrate
- Estimation of uranium groundwater remediation timeframes
- Estimation of uranium treatment timeframes for recovered groundwater
- Estimation of Uranium and nitrate influent concentrations

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[1] Burns & McDonnell Engineering Company, Inc. (2018). *Basis of Design for Groundwater Remediation-Rev. C* (Document No.: BMCD-GWREMED-TM001). Kansas City: John Hesemann.

[2] Burns & McDonnell Engineering Company, Inc. (2019). *Basis of Design Addendum for Groundwater Remediation.* (Document No.: BMCD-GWREMED-TM003). Kansas City: John Hesemann.

[3] Burns & McDonnell Engineering Company, Inc. (2021). *Cimarron Facility Decommissioning Plan – Revision 2.* Kansas City: John Hesemann.

Memorandum

- Estimation of Nitrate effluent concentrations

The first phase (Phase I) of the phased remediation approach will remediate uranium to the derived concentration goal level (DCGL) required for NRC license termination. Phase I includes groundwater remediation in the Western Area (WA) and Burial Area #1 (BA1) at the Site. Phase I WA remediation areas include the Western Alluvial Area (WAA) U>DCGL, 1206-NORTH and Western Upland Burial Area #3 (WU-BA3). Phase I BA1 remediation areas include BA1 Areas A, B, and C (BA1-A through BA1-C). In the WA, the WAA U>DCGL and 1206-NORTH will be remediated via groundwater extraction and WU-BA3 will be remediated via treated water injection. In BA1, groundwater extraction will occur in BA1-A through BA1-C, and treated water injection will occur in BA1-A. Water treatment during Phase I will be limited to uranium removal via ion exchange. All groundwater will be treated at the Western Area Treatment Facility (WATF) and treated water that is not injected will be discharged to the Cimarron River via Outfall 001. This BOD addendum is focused on the design evaluations and revisions required to implement Phase I remediation.

BOD revisions associated with the phased remediation approached required particle tracking analyses to estimate capture zones for alluvial extraction wells, and to estimate influent groundwater concentrations for uranium and nitrate. Since nitrate treatment will not be conducted during Phase I, an additional analysis of nitrate effluent concentration was conducted to confirm nitrate levels will not exceed the concentration anticipated to be acceptable to the Oklahoma Department of Environmental Quality (DEQ) [approximately 30 milligrams per liter (mg/L)]. None of the Phase I remediation component locations or pumping rates were altered; however, the elimination of remediation components in WA and BA1 alluvial areas altered the capture zones of the components that were retained, thus altering the remediation areas and influent uranium and nitrate concentrations associated with these components. These changes in remediation areas resulted in changes to pore volumes and, consequently, timeframes for uranium remediation and treatment. Finally, because hydraulic capture zones within the WAA U>DCGL and BA1-B areas changed, the stagnation zone analyses were reperformed for these areas.

The methods used to perform the analyses, evaluations and estimations described above were similar to those used in the previous BOD development effort. BOD updates and/or revisions are detailed in the following sections.

1.0   Phased Remediation Approach – Phase I Components and Operating Conditions
As stated above, updates to the remediation BOD are based on the infrastructure and operating
conditions associated with Phase I of the phased remediation approach planned for the Site.

1.1   As stated above, WA remediation areas included in Phase I include WAA U>DCGL,
        1206-NORTH, and WU-BA3. WAA U>DCGL includes extraction wells GE-WAA-01
        through GE-WAA-04; 1206-NORTH includes extraction trench GETR-WU-02; and
        WU-BA3 includes injection trench GWI-WU-01. None of the groundwater extraction
        flow rates or treated water injection flow rates associated with these remediation
        components were altered from the 2018 BOD (see figure provided in Attachment 1.1).

        Groundwater extracted from the WA remediation components identified above will be
        treated for uranium via ion exchange. Following treatment, a portion of the treated water
        (8 gallons per minute [gpm]) will be injected into WU-BA3 via GWI-WU-01. The
        remaining treated water will be combined with the treated BA1 effluent not used for
        injection and discharged to Outfall 001.

        Remediation for nitrate is not included as part of Phase I groundwater remediation.
        However, the nitrate concentration discharged to Outfall 001 must be reported to the
        DEQ in accordance with anticipated Oklahoma Pollutant Discharge Elimination System
        (OPDES) permit requirements. Consequently, the estimation of influent nitrate
        groundwater concentrations for individual WA remediation components and areas, and
        the estimation of combined treated water effluent nitrate concentrations were required to
        update the remediation BOD.

1.2   All BA1 remediation areas (BA1-A, BA1-B and BA1-C) will be remediated as part of
        Phase I of the proposed remediation approach. Infrastructure and operating conditions
        associated with BA1-A and BA1-B were not altered from the 2018 Basis of Design.
        BA1-A includes groundwater extraction trenches GETR-BA1-01 and GETR-BA1-02 and
        injection trenches GWI-BA1-01 through GWI-BA1-03 (see figure provided in
        Attachment 1.1).

        BA1-B includes extraction wells GE-BA1-02, GE-BA1-03, and GE-BA1-04, and BA1-C
        includes extraction wells GE-BA1-05 and GE-BA1-06. BA1-B and BA1-C will operate
        until the maximum contaminant level (MCL) for uranium (30 micrograms per liter
        [µg/L]) is achieved in Area C, at which point wells GE-BA1-05 and GE-BA1-06 will
        cease operation. The combined pumping capacity of GE-BA1-05 and GE-BA1-06 will

then be distributed evenly among BA1-B wells GE-BA1-02 through GE-BA1-04. For the purposes of estimating water treatment influent uranium concentrations and treatment and remediation timeframes, BA1-B is referred to as BA1-B3R once wells in BA1-C are no longer operational. The area and pore volume of BA1-B3R differ from BA1-B due the change in hydraulic capture zone resulting from the shutdown of BA1-C wells GE-BA1-05 and GE-BA1-06.

Water extracted from BA1 will be routed to the WATF for uranium removal via a dedicated ion exchange treatment train. Following treatment, a portion of the treated water (approximately 18 gpm) will be returned to BA1 for re-injection via injection trenches GWI-BA1-01 through GWI-BA1-03. The remaining treated effluent will be combined with the WA uranium treatment effluent and discharged via Outfall 001.

2.0 Revised Remediation Simulation and Particle Tracking Analysis

The particle tracking analyses for the alluvial remediation areas (WAA U>DCGL and BA1-B, BA1-C, and BA1-B3R) were updated to reflect the phased groundwater treatment approach described in Section 1.0. Figures depicting the updated particle tracking analysis outputs are provided in Attachment 2.0.

2.1 The particle tracking analysis for BA1 was updated to reflect the elimination of extraction wells GE-BA1-07 through GE-BA1-09. In addition, the original BOD assumed GE-BA1-05 through GE-BA1-07 would initially remain idle. As discussed in Section 1.2, GE-BA1-02 through GE-BA1-06 will be operational at the start of Phase I operations. Once the uranium MCL is achieved in Area C, GE-BA1-05 and GE-BA1-06 will cease operation and the combined pumping capacity of these wells will be distributed evenly among BA1-B wells GE-BA1-02 through GE-BA1-04, creating a new remediation area referred to as BA1-B3R. A forward particle tracking analysis was used for BA1 since the remediation area is defined by the 30 µg/L uranium concentration contour (see Attachment 2.0). The only substantive change resulting from the modifications described above was a change in the boundary between Areas BA1-B and BA1-C, as defined by the capture zones of GE-BA1-04 and GE-BA1-06.

2.2 As shown on the WA particle tracking figure included in Attachment 2.0, the capture zone of the WAA U>DCGL expanded significantly in the easterly direction due to the elimination of the WAA-BLUFF extraction wells from Phase I of the phase remediation approach. Consequently, a larger portion of the WAA nitrate plume, and higher concentrations of nitrate, will be captured by WAA U>DCGL extraction wells. As stated above, recalculation of estimated influent nitrate groundwater concentrations for

individual WA remediation components and areas was required to estimate nitrate concentrations in the combined WATF effluent, and confirm compliance with anticipated OPDES permit requirements.

To accurately estimate influent uranium and nitrate groundwater concentrations for individual WAA U>DCGL extraction wells, a reverse particle tracking analysis was used to account for uranium and nitrate concentrations across the entire estimated capture zone for each well. Also, because nitrate concentrations for individual WAA U>DCGL extraction wells are anticipated to increase over time (i.e., nitrate concentrations increase with distance east of the WAA U>DCGL extraction well alignment), a time-specific averaging approach was used to estimate influent nitrate concentrations for these wells. Time-specific averaging was not required for uranium since the highest uranium concentrations are located along the WAA U>DCGL extraction well alignment. Likewise, time-specific averaging was not required for BA1 remediation components since the highest uranium concentrations are located along the BA1 extraction well alignment. Uranium and nitrate iso-concentration contours are presented on the WA particle tracking figure included in Attachment 2.0.

Remediation area and pore volume estimate calculations are discussed in Section 3.0 and area and time-specific concentration averaging for individual alluvial remediation components and areas is discussed in Section 4.0.

3.0   Revised Remediation Area and Pore Volume Estimates
As discussed in Section 2.0, the capture zones of remediation components located in alluvial remediation areas WAA U>DCGL and BA1-B, BA1-C and BA1-B3R were altered as a result of the phased remediation approach. This necessitated the re-estimation of lateral extent (area) of each remediation area to support calculations of pore volume, influent concentration, and remediation and treatment timeframe.

3.1   Updated BA1 remediation areas were calculated for BA1-B, BA1-C and BA1-B3R. As described in the 2018 BOD, the lateral extent of each remediation area was estimated based on the extent of the hydraulic capture zone within which uranium concentrations are at or above the MCL (30 µg/L) (see Attachment 3.1). The aquifer pore volume targeted for remediation in each area was estimated based on the lateral extent and saturated thickness of the area, estimated as described in the 2018 Technical

Memorandum entitled *Input Parameters for Updated Remediation Duration Estimates* (2018 Input Parameters Memo)[4].

3.2   Two separate remediation areas, one for uranium and another for nitrate, were estimated for the WAA U>DCGL area based on the updated particle tracking analysis results discussed above. Although nitrate is not a target constituent for Phase I groundwater remediation, it is necessary to establish nitrate "remediation areas" to estimate influent nitrate concentrations for the purposes described above. The uranium WAA U>DCGL remediation area was estimated based on the extent of the hydraulic capture zone in which uranium concentrations are at or above the MCL. The complete zone of WAA U>DCGL hydraulic capture was established as the nitrate remediation area. Uranium and nitrate remediation areas are depicted on the figures included in Attachment 3.2.

As described in the 2018 Input Parameters Memo, the updated WAA U>DCGL aquifer pore volumes targeted for remediation were calculated estimated based on the lateral extents of the uranium and nitrate remediation areas and the saturated thickness of the WAA U>DCGL area.

3.3   Uranium pore volumes were used to calculate area-weighted concentrations, influent concentrations and remediation and treatment durations. Nitrate pore volumes were used to calculate area-weighted concentrations, influent concentrations and effluent concentrations.

4.0   Revised Area-Weighted and Time-Specific Influent Concentration Estimates

Area-weighted influent uranium concentrations were updated for remediation areas WAA U>DCGL, BA1-B, BA1-C and BA1-B3R using the same methodology described in the 2018 BOD. Area-weighted influent concentrations were used to support uranium remediation duration estimate calculations. Area-weighted influent nitrate concentrations were also updated for WAA U>DCGL and time-specific nitrate influent concentrations were calculated to support estimations of WATF influent and effluent nitrate concentrations.

4.1   Uranium and nitrate (WAA U>DCGL only) isopleths and updated particle tracking outputs (Section 2.0) were used to conduct incremental groundwater concentration

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[4] Burns & McDonnell Engineering Company, Inc. (2018). *Input Parameters for Updated Remediation Duration Estimates.* Kansas City: John Hesemann.

averaging within the capture zone of each alluvial remediation area (WAA U>DCGL, BA1-B, BA1-C and BA1-B3R). Results of the area-weighted averaging analysis completed for each remediation area are presented in Attachment 4.1.

4.2   Nitrate isopleths and updated particle tracking outputs (Section 2.0) were used to conduct incremental groundwater concentration averaging within time-specific (annual) capture zones of each WAA U>DCGL extraction well to account for increasing influent nitrate concentrations over the course of groundwater extraction. The time-specific concentrations were estimated by conducting incremental, area-weighted concentration averaging within the hydraulic capture zone of a given year. The entire WAA U>DCGL nitrate plume is anticipated to be captured within 5 years; therefore, time-specific concentration averaging was only performed for Years 1 through 5 (see Attachment 4.2). The time-specific nitrate concentration estimates are considered conservative since the effects of dilution and dispersion are not accounted for in the analysis. As groundwater with elevated nitrate concentrations (located significant distances from the extraction wells) migrates toward the extraction wells, it will encounter and mix with groundwater with lower nitrate concentrations; however, the nitrate concentration estimated at the original plume location is assumed to persist over the entire groundwater capture flow path.

Influent nitrate concentrations were assumed to increase above the initial concentration for the following extraction wells:

- GE-WAA-01 – the estimated initial nitrate influent concentration for this well is 32 mg/L; however, the concentration is assumed to increase as groundwater with higher nitrate concentrations, located to the east, are drawn toward the well. For the purposes of estimating WATF influent concentrations, the influent nitrate concentration for this well is assumed to increase to a maximum of approximately 59 mg/L in Year 5 (see Attachment 4.2).

- GE-WAA-02 – the estimated initial nitrate influent concentration for this well is 31 mg/L; however, the concentration is also expected to increase as higher concentrations, located to the east, are drawn toward the well. For the purposes of estimating WATF influent concentrations, the influent nitrate concentration for this well is assumed to increase to approximately 47 mg/L, during Year 3 of operation, then decline thereafter (see Attachment 4.2).

4.3   Results from the incremental, area-weighted (and time-specific) averaging analysis for each applicable remediation area and groundwater extraction component are presented in Attachments 4.1 and 4.2. Calculation files in native (MS Excel®) format can be provided to facilitate review of calculation methods (i.e., formulas, references, inputs, etc.) by Nuclear Regulatory Commission (NRC) and DEQ personnel.

5.0   Revised Remediation Duration Estimates

Uranium remediation duration estimates were revised for the WAA U>DCGL, BA1-B, BA1-C, and BA1-B3R remediation areas using the remediation areas and pore volumes described in Section 3.0, in accordance with the calculation methodology and input parameters described in the 2018 BOD. The remediation duration estimate calculations and results for WAA U>DCGL, BA1-B, BA1-C, and BA1-B3R are included as Attachment 5.0. Remediation duration estimate calculation files in native (MS Excel®) format can be provided to facilitate review of calculation methods (i.e., formulas, references, inputs, etc.) by NRC and DEQ personnel.

The duration estimates for BA1-B and BA1-C were evaluated for achievement of both the DCGL and MCL. The DCGL in BA1-B is achieved in approximately 36 months. BA1-C is already below the DCGL upon commencement of operation. The MCL is achieved in approximately 60 months in BA1-B and 108 months in BA1-C. As discussed in Section 1.2, BA1-C extraction components cease operation upon achievement of the MCL. The capacity is then evenly distributed across the wells operating in area B3, which continue to operate until the DCGL is achieved in BA1-A in order to maintain the minimum flow rate requirement for treatment. It is predicted that the uranium concentration in both BA1-B and BA1-C will be below the MCL upon commencement of B3R operations.

6.0   Revised Nitrate Influent Concentration Estimates

As discussed in Section 4.0, incremental groundwater concentration averaging was conducted within time-specific (annual) capture zones of each WAA U>DCGL extraction well to account for increasing influent nitrate concentrations over the course of remediation. Future maximum nitrate influent concentrations are anticipated to be higher than initial concentrations for wells GE-WAA-01 and GE-WAA-02, while future maximum nitrate influent concentrations are anticipated to be lower than initial concentrations for GE-WAA-03 and GE-WAA-04. Due to the potential for influent WAA U>DCGL nitrate concentrations to increase over time, time-specific influent nitrate concentrations for each WAA U>DCGL were factored into the influent nitrate concentration analysis. The process is described below in detail.

6.1   As described in Section 4.0, time-specific, area-weighted nitrate concentrations were calculated for each WAA U>DCGL extraction well for each of the first five years of groundwater extraction (i.e., C_1, C_2, …, C_5). The C_1 concentration for each WAA U>DCGL extraction well was then compared to the nitrate concentration estimated via interpolation at each extraction component location (interpolation performed using the Surfer® software application). The higher of the two concentrations was then selected as the representative initial concentration (C_i) for the extraction well. The highest of the time-specific nitrate concentrations for each well was established as the maximum nitrate concentration (C_{max}). The time-specific nitrate concentrations for each WAA U>DCGL extraction well are presented in Attachment 4.2 and the C_i and C_{max} nitrate concentration for each well are presented in Attachment 6.1.

6.2   Because groundwater is recovered from both the WAA U>DCGL and 1206-NORTH remediation areas in the WA, flow-rate weighted averaging was used to was used to calculate the estimated initial and time-specific influent nitrate concentrations for the combined influent WA treatment stream. The flow-rate weighted average calculations used to estimate the initial WA influent nitrate concentration were conducted in accordance with the methodology described in the 2018 BOD. The results of these calculations are summarized in Attachment 6.2. As shown in the attachment, the influent concentration for 1206-NORTH (extraction trench GETR-WU-02) is expected to decline below measurable levels by the end of Year 1. Calculation files in native (MS Excel®) format can be provided to facilitate review of calculation methods (i.e., formulas, references, inputs, etc.) by NRC and DEQ personnel.

6.3   Flow rate-weighted average nitrate concentrations for the combined WA influent for Years 1 through 5 are summarized in Attachment 6.3. Although influent nitrate concentrations for GE-WAA-01 and GE-WAA-02 increase over time, results of the flow rate-weighted averaging reveals that the maximum combined WA influent nitrate concentration still occurs at time zero (i.e., $C_i = C_{max}$). Calculation files in native (MS Excel®) format can be provided to facilitate review of calculation methods (i.e., formulas, references, inputs, etc.) by NRC and DEQ personnel.

6.4   To model long-term nitrate concentrations for the WAA U>DCGL influent stream, and its contribution to the combined WATF influent, the flow rate-weighted average, time-specific concentrations calculated for Years 1 through 4 were assumed as the initial nitrate influent concentration for each corresponding year. Due to the potential for influent nitrate concentrations to increase between Years 2 and 3, based on flow rate-

weighted averaging results (see Section 6.3), WAA U>DCGL influent nitrate concentrations during the first three years of operation were held constant and the first-order kinetic concentration decay model described in the 2018 BOD was not applied. Following Year 3, the influent nitrate concentration was increased to the Year 4 time-specific concentration and the first-order kinetic concentration decay equation was applied to model continuous influent nitrate concentration reductions through the end of operations.

The concentration decay model was applied to the 1206-NORTH nitrate influent concentration from the start of operations, with no nitrate expected in the influent after month 13. The results of the WA nitrate influent concentration decay analysis are presented in Attachment 6.4. In addition, calculation files in native (MS Excel®) format can be provided to facilitate review of calculation methods (i.e., formulas, references, inputs, etc.) by NRC and DEQ personnel.

7.0   Revised Uranium Influent Concentration Estimates

Uranium influent concentrations were recalculated for WAA U>DCGL, BA1-B, BA1-C, and BA1-B3R. Using the same process described in the 2018 BOD, the uranium influent concentration calculations for WAA U>DCGL and BA1-B, BA1-C and BA1-B3R were updated using the revised remediation areas and pore volume estimates presented in Section 3.0. A decay analysis was performed in accordance with the 2018 BOD to estimate uranium flow rate weighted-average influent concentrations for each combined remediation area at the conclusion of remediation operations. Results of the WA influent uranium concentration estimates are presented in Attachment 6.3. Results of the WA uranium decay analysis, BA1 uranium influent concentration estimates, and BA1 uranium decay analysis are presented in Attachment 7.0.

8.0   Calculation of Combined WA, BA1 Nitrate Effluent Concentration

To determine the concentration of nitrate discharged at Outfall 001, a new flow rate-weighted average concentration was calculated for the initial nitrate concentration (C_i) and final nitrate concentration (C_f) once the WA treatment effluent is combined with the treatment effluent from BA1. Based on the proposed process, 8 gpm of nitrate-impacted water will be re-injected into the WA, via GWI-WU-01A, and 18 gpm of treated effluent from BA1 will be re-injected via GWI-BA1-01 through GWI-BA1-03. The combined WA/BA1 nitrate flow weight-rated average nitrate concentration was therefore based on a combined flow rate of 181 gpm, equal to the sum of the WA and BA1 groundwater extraction flow rates, minus the treated water injection flow rate for each area. As described in Sections 4.0 and 6.0, C_i is also projected to represent the maximum nitrate influent concentration during the treatment process. Results of the combined

WA/BA1 effluent nitrate concentration estimates and decay analysis are presented in Attachment 8.0.

9.0   Reassessment of Stagnation Zone Potential

The potential for hydraulic stagnation in alluvial remediation areas exceeding the NRC uranium criterion (WAA U>DCGL and BA1-B) was reassessed in accordance with the methodology outlined in the 2018 BOD. The results of the stagnation zone analysis for WAA U>DCGL and BA1-B are presented in the figures included as Attachment 9.0. The figures indicate that the alternating operating scenarios should eliminate the potential for hydraulic stagnation.

Attachments:

Attachment 1.1 – Remediation Area Extraction/Injection Components
Attachment 2.0 – Particle Tracking Figures

Attachment 3.1 – BA1 Remediation Areas
Attachment 3.2 – WA Remediation Areas

Attachment 4.1 – Area-Weighted Concentration Averaging Results
Attachment 4.2 – Time-Weighted Concentration Averaging Results

Attachment 5.0 – Remediation Duration Estimates

Attachment 6.1 – Initial & Maximum Influent Concentrations
Attachment 6.2 – Nitrate Influent Concentrations by Year
Attachment 6.3 – Western Area Treatment Duration Analysis
Attachment 6.4 – Western Area Nitrate Decay Analysis

Attachment 7.0 – BA1 Uranium Analysis
Attachment 8.0 – Western Area, BA1 Nitrate Effluent Analysis
Attachment 9.0 – Stagnation Zone Analysis Figures