Memorandum

BURNS & McDONNELL

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Subject: Basis of Design for Groundwater Remediation

This Basis of Design (BOD) for Groundwater Remediation has been developed to support remediation design activities and preparation of the *Facility Decommissioning Plan – Revision 3* (D-Plan) for the Cimarron Environmental Response Trust (CERT) remediation project at the Cimarron Site located in Guthrie, Oklahoma (Site).

The initial development of a groundwater remediation system design to support the initial D-Plan submitted in 2015 included groundwater extraction, treatment, and injection infrastructure required to facilitate remediation of uranium and nitrate exceeding their respective Maximum Contamination Levels (MCLs). The first revision of the D-Plan, submitted in 2015, included an evaluation of Technetium-99 (Tc-99) concentrations in groundwater recovered by the remediation system. This evaluation resulted in modifications to treatment waste disposal criteria and costs, leading to a determination that available funding was not sufficient to support nitrate treatment. The design and D-Plan were revised a second time to develop a phased approach to groundwater remediation that contemplated the addition of remediation and treatment infrastructure, provided adequate funding would be available, as groundwater criteria across the Site were achieved. However, this revision did not provide a clear path to achieving remedial objectives. The remediation system design and D-Plan have subsequently been revised a third time, to provide a clear path to achieving the primary goal for the Site – to reduce uranium concentrations below the Nuclear Regulatory Commission (NRC) criteria, for unrestricted release of the Site. While uranium is the only contaminant exceeding these criteria, this BOD includes other select contaminants (such as nitrate and Tc-99, as detailed above) associated with former operations at the Site that may impact water treatment technologies and/or discharge considerations. Hereafter, the NRC criterion for uranium is referred to as the Derived Concentration Goal Level (DCGL).

The efficacy of the groundwater remediation technologies proposed for implementation at the Site (groundwater extraction and injection) have been demonstrated through previous investigative activities (e.g., pump testing, packer testing, site investigation, groundwater modeling, etc.) as well as pilot testing conducted in late 2017 and early 2018. Likewise, the efficacy of the technology proposed for treatment of recovered groundwater at the Site (ion exchange) was demonstrated through treatability testing conducted in 2015[1]. Results of the treatability testing demonstrated that ion exchange is capable of reducing the concentration of uranium in groundwater recovered at the Site to below the permissible discharge concentration of 30 micrograms per liter (µg/L).

The processes used to develop the remediation basis of design are summarized in the following sections.

1.0 Uranium Groundwater Data Review

Laboratory analytical results for samples collected from select monitor wells from 2011 through 2017 were used to establish representative groundwater concentrations to support detailed design, pilot testing, D-Plan development, etc. (see Section 3.0 below). A review of these results was performed in accordance with the United States Environmental Protection Agency's *National Functional Guidelines for Inorganics Superfund Methods Data Review* (National Functional Guidelines for Inorganics)[2]. The review was performed to assess the validity of the laboratory data, including uranium mass concentrations used in calculating representative groundwater concentrations to support design basis development (see Section 3.0 below). No uranium mass concentration data were rejected as a result of the analytical data review. The uranium concentration data are included as Attachment 1.

2.0 Tc-99 Groundwater Data Review

In 2019, additional sampling was conducted to assess the nature and extent of Tc-99 in groundwater and to estimate potential concentrations recovered from the proposed groundwater extraction network. A review of the laboratory analytical results was performed in accordance with the National Functional Guidelines for Inorganics to assess the validity of the laboratory data. Tc-99 activity concentration data were rejected as a result of the analytical data review for the following WA monitor wells: T-79, 1348, 1395, 1396, 1337, and 1319B-2. Tc-99 activity concentration data were rejected for the following BA1 monitor wells: 1314, TMW-08, 02W06, 02W44, TMW-13, and TMW-24. The Tc-99 activity concentration result was also rejected for the surface water sample 1201 (Upstream). The primary cause for the rejection of Tc-99 activity concentration data was a negative activity concentration result; Tc-99 concentrations cannot be

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[1] Kurion, Inc. (2015). *Cimarron Environmental Response Trust, 2015 Groundwater Treatability Tests* (KUR-ENVI01-001-RPT-002 Rev. 0). Richland: Barker, Luey, Gholami, Mertz, Walton.

[2] United States Environmental Protection Agency. (2017). *National Functional Guidelines for Inorganics Superfund Methods Data Review* (EPA-540-R-201 7-001). Office of Superfund Remediation and Technology Innovation. Washington, DC.

negative. All rejected data were qualified as not detected above the minimum detectable concentration (MDC). The Tc-99 activity concentration data are included in Attachment 1.

The Tc-99 activity concentrations were converted to mass concentrations using specific activity. The specific activity of Tc-99 is 0.017 curies per gram (Ci/g), equivalent to 0.059 nanograms per picocurie (ng/pCi).

3.0 Calculation of Representative Groundwater Concentrations

Representative groundwater concentrations were calculated for the Site in accordance with the following process:

3.1 Monitor wells for which data are available for years 2011 through Second Quarter (Q2) 2017, located within and in the vicinity of remediation areas, and screened within the appropriate aquifer units, were selected for use in design basis development. Groundwater data associated with these wells were transferred from the project database into an MS Excel® data workbook. Uranium, nitrate, and fluoride data sheets exported from the MS Excel® data workbook are included as Attachment 1.

If multiple concentrations were reported for a given monitor well in a single sampling event (e.g., a sample and a duplicate), the highest of the available concentrations for a given monitor well within the same event were used.

3.2 For monitor wells with at least four independent sample results, data from the worksheets identified in Attachment 1 were imported into the ProUCL® Ver. 5.1002 software application for calculation of the ninety-five percent upper confidence level of the arithmetic mean (95% UCL) concentration. The software application calculated the uranium, nitrate, and fluoride 95% UCL data concentrations.

If the 95% UCL value recommended by ProUCL® exceeded the maximum observed value for a given monitor well, the maximum observed value was used in place of the 95% UCL. The 95% UCL values calculated by the software application assumed normal distribution using the 95% Student's-t UCL. This methodology was employed due to the small sample size and relatively varied concentrations at some monitor wells. ProUCL® provides suggested UCL determination methods based on the characteristics of the data set. The Student's-t UCL method was suggested for the majority of the data sets, and for instances in which the data set did not exhibit a normal distribution and the Student's-t method was not suggested, ProUCL® was unable to recommend an alternative method, based on data set characteristics and methods available within the program. In addition, tests conducted using other statistical methods provided concentration results that were comparable to those calculated using the Student's-t method. Based on these factors, the Student's-t determination method was used to calculate the 95% UCL contaminant concentration for all applicable data sets.

The 95% UCL concentrations calculated by ProUCL® for uranium, nitrate, and fluoride are tabulated in Attachment 1.

3.3 For each monitor well, the representative groundwater concentrations used in basis of design development consisted of:

- The 95% UCL concentration (if calculated);
- The maximum contaminant concentration (if used in place of the 95% UCL value); or,
- The average contaminant concentration (if data were not sufficient to determine the 95% UCL concentration).

These representative uranium, nitrate, and fluoride concentrations were added to the data sheets included as Attachment 1, in the column labeled "Representative Groundwater Concentration".

3.4 Representative uranium groundwater concentrations were evaluated in 2019 during the first revision of the D-Plan to incorporate additional groundwater concentration data generated from Q3 2017 through Q4 2018. The updated representative uranium groundwater concentrations were compared to the previous representative concentrations to determine if concentrations increased or decreased. The updated representative uranium concentrations associated with monitor wells in each remediation area were also evaluated to determine if the concentration data caused an appreciable increase in any of the following for each remediation area: the uranium groundwater plume area or pore volume, initial treatment system influent uranium concentration, and/or maximum uranium groundwater concentration. The representative uranium groundwater concentration did increase for several individual monitor wells; however, there were no appreciable increases to the values listed above. Therefore, the original representative uranium groundwater concentrations calculated using data from 2011 to Q2 2017 were considered appropriate for use in the updated D-Plan.

3.5 The 2019 Tc-99 groundwater analytical results are considered "representative concentrations" for the purposes of the isopleth map generation and influent concentration estimates described in the following sections. The historical Tc-99 groundwater dataset was not used in this evaluation due to issues related to the quality, quantity, and distribution of the data.

4.0 Isopleth Map Generation

The representative groundwater concentrations were used to generate isopleth maps for the Site. Representative groundwater concentrations for each monitor well and contaminant, and northing and easting coordinates for each monitor well were transferred into an input data file that was subsequently imported into the Surfer® software application developed by Golden Software.

Surfer® was used to generate isopleth concentration plots for both Burial Area 1 (BA1) and the Western Area (WA).

For BA1, representative uranium groundwater concentrations for wells screened within the Sandstone B (SSB), transition zone (TZ), and alluvium formations were combined to develop a uranium isopleth map.

For the WA, representative uranium, Tc-99, nitrate, and fluoride groundwater concentrations for wells screened within SSB, TZ, and alluvium formations were combined to develop isopleth maps for each contaminant. In addition, representative uranium, Tc-99, nitrate, and fluoride groundwater concentrations for wells screened within Sandstone A (SSA) were used to develop separate isopleth maps for each contaminant. Copies of the BA1 and WA isopleth maps are included as Attachment 2.

The isopleth maps described above provided a refined understanding of contaminant nature and extent. This served as the basis for assessing groundwater injection and extraction component quantities and locations. Each remediation area was reviewed to determine the location of remediation components to maximize contaminant capture, mass removal, and overall performance.

5.0 Groundwater Modeling and Remediation Simulations

A groundwater model was developed for both the BA1 and WA to support the evaluation of groundwater remediation alternatives and subsequent remediation design. The groundwater model generation, review, and calibrations are documented in the *Groundwater Flow Model Report Cimarron Remediation Site.*[3]

Once remediation component quantities, locations, and dimensions of proposed groundwater extraction and injection infrastructure were established, a comprehensive review of geospatial coordinate data and data acquisition protocols was conducted to confirm proper control of coordinate data and the consistent use of current coordinate data by all design applications (e.g., ArcGIS, AutoCAD, Surfer®, EVS®, MODPATH/MODFLOW). This review confirmed that consistent geospatial coordinate data were utilized by all applications during the ongoing design efforts. This review was documented in a memorandum entitled *CERT Groundwater*

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[3]Burns & McDonnell Engineering Company. *Groundwater Flow Model Report Cimarron Remediation Site.* October 2022. Kansas City, Missouri.

Remediation Project – Review of Geospatial Coordinate Systems and Data Management Practices[4].

Groundwater flow models were revised multiple times based on information obtained from additional groundwater assessment, pilot testing, remedial objectives, and comments received from the NRC. The groundwater flow model results were used to determine target flow rates for individual extraction and injection components. The groundwater model was used to perform particle tracking analyses and generate capture zone depictions for remediation components located in alluvial areas. Iterative remediation simulations (particle tracking model runs) were then performed to confirm adequate capture of injected water and groundwater contamination exceeding remediation criteria. The criteria used in this evaluation are as follows:

- Extraction components in both the WA and BA1 remediation areas must achieve capture of uranium contamination exceeding the DCGL.
- Extraction components in the BA1 and 1206-NORTH areas must achieve capture of injected water.
  - At a minimum, the total recovery rate for extraction components located downgradient of injection components must equal the total injection rate for those injection components.
  - The capture zone of extraction components must encompass the zone of injection influence.

Results of the particle tracking analyses, including finalized remediation component locations and capture zones, are depicted in figures included as Attachment 3.

Pilot test results (discussed below in Section 6.0) for trenches installed within the transition zone and sandstone formations were determined to be more reflective of actual conditions than those predicted by the model; consequently, numerical groundwater modeling was not used for these areas. Instead, potentiometric surface contours, pumping test drawdown analyses, and dye tracer test results were used to optimize designs for remediation components proposed for construction in these formations.

Final nominal combined flow rates for the BA1 and WA remediation systems are 100 and 107 gpm, respectively. Determination of these flow rates was based on numerous factors including

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[4]Burns & McDonnell Engineering Company. *CERT Groundwater Remediation Project – Review of Geospatial Coordinate Systems and Data Management Practices.* August 24, 2018. Kansas City, Missouri.

contaminant distribution, aquifer characteristics, groundwater modeling, pilot testing, remedial objectives, and NRC comments.

Nominal treated water infiltration rates used to estimate remediation timeframes for remediation areas are as follows:

Remediation Area	Nominal Infiltration Rate (gpm)
BA1-A	28
WU-BA3	8

Nominal groundwater extraction rates used to estimate remediation timeframes for remediation areas are as follows:

Remediation Area	Nominal Extraction Rate (gpm)
BA1-A	14
BA1-B	86
WAA U>DCGL	99
1206-NORTH	8

Notable updates resulting from pilot testing activities are described below.

6.0 Design Revisions Resulting from Pilot Testing

A pilot test consisting of injection and extraction trench construction, injection pilot testing, and extraction pump testing, began in the Fourth Quarter (Q4) of 2017 and was completed in the First Quarter (Q1) of 2018. Pilot test results were used to refine the location of remediation components to maximize contaminant capture, mass removal, and optimize the overall design. Results were also used to revise anticipated recovery rates for the following remediation components.

BA1 injection and extraction component quantities, locations, dimensions, and design parameters were updated to maximize contaminant mass removal, minimize remediation duration, and optimize the overall design. Updates included the following:

- The anticipated groundwater recovery rate for extraction trench GETR-BA1-01 is 7 gallons per minute (gpm) based on pumping test results.
- Extraction trench GETR-BA1-02 was relocated and the anticipated groundwater recovery rate is 7 gpm. The position and length of this trench were also refined based on a detailed review of the lithology within this zone. The results of this review are detailed in

Environmental Sequence Stratigraphy and Porosity Analysis, conducted by Burns & McDonnell in April 2018[5].

- The anticipated water infiltration rate for injection trench GWI-BA1-01 is 10 gpm based on water injection test results.
- Injection trench GWI-BA1-02 was reconfigured and a third injection trench (GWI-BA1-03) was added. The anticipated water infiltration rate for each of these trenches (GWI-BA1-02 and GWI-BA1-03) is approximately 4 gpm.

Additional details regarding these design modifications were presented in the *Remediation Pilot Test Report*, prepared by Burns & McDonnell in June 2018[6]. The final locations and dimensions of the remediation components described above are presented on the figure included as Attachment 4 and in Figure 8-2 of the D-Plan.

WA injection and extraction component quantities, locations, dimensions, and design parameters were updated to maximize contaminant mass removal, minimize remediation duration, and optimize the overall design. Updates included the following:

- The anticipated water infiltration rate for injection trench GWI-WU-01, located in WU Burial Area 3 (WU-BA3), was revised based on the results of water injection pilot tests conducted at WU-UP1. The WU-UP1 pilot test injection trenches are located approximately 600 feet from GWI-WU-01 and are constructed in the same formation (SSA) as GWI-WU-01.
- The anticipated groundwater extraction rate for extraction trench GETR-WU-01, proposed for construction within TZ deposits in the 1206-NORTH remediation area, was revised based on the results of the groundwater pumping test conducted at GETR-BA1-01, the extraction trench constructed within BA1 TZ deposits.

Additional details regarding these design modifications were presented in the Remediation Pilot Test Report. The final locations and dimensions of the remediation components described above are presented on the figure included as Attachment 5 and in Figure 8-1 of the D-Plan.

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[5] Burns & McDonnell Engineering Company. (2018). *Environmental Sequence Stratigraphy (ESS) and Porosity Analysis, Burial Area 1, Cimarron Former Nuclear Fuel Production Facility*. Concord: Mike Shultz.

[6] Burns & McDonnell Engineering Company. (2018). *Remediation Pilot Test Report*. Kansas City.

7.0 Remediation Area and Pore Volume Estimates

Pore volume, calculated by multiplying the aquifer volume targeted for remediation by effective porosity, is one of the input parameters required to calculate the remediation timeframe required to achieve remediation goals. The input values selected for the remediation area and pore volume calculations are summarized below.

7.1 Porosity

Based on the results of previous site investigations, Environmental Properties Management LLC (EPM) and Burns & McDonnell concluded that the porosity used in the remediation duration estimates should be the ***effective*** porosity rather than the total porosity. Previous investigations have indicated that most contaminant mass requiring remediation, particularly in the less permeable TZ and weathered/fractured sandstone formations, resides within the interconnected pore space of the aquifer. Since the groundwater extraction/injection remedies will also affect contaminant removal and transport within the interconnected pore space, effective porosity is the most appropriate input parameter for estimating remediation timeframes.

Geotechnical data generated by Standard Testing in 2015 indicated that the ***total*** porosity for soils collected in the UP1 area varied from 0.34 to 0.46 in the six soil samples collected during the 2014 design investigation. As with density, the soils submitted for porosity analyses are considered representative of TZ and weathered bedrock formations.

Effective porosity values were developed for sandstone and alluvial soils based on: a) a lack of analytically-derived effective porosity values, b) a minimum ***total*** porosity of 0.34, and c) characteristics of the materials comprising the water-bearing units at the Site. The ***effective*** porosity of TZ soils was based on the findings of the ESS Report[5].

In summary, the effective porosity values used in calculations associated with the remediation duration estimates are as follows:

Remediation Area	Formation / Soil Type	Effective Porosity
BA1-A	TZ / SSB (weathered/fractured)	0.11
BA1-B	Alluvium	0.30
WAA U>DCGL		
WU-BA3		
1206-NORTH	TZ	0.11

7.2 The lateral extent of each remediation area was estimated based on:

- The approximate hydraulic capture zone of extraction component(s) exhibiting uranium concentrations at or above 30 µg/L; and/or

- The approximate hydraulic zone of influence associated with injection component(s).

The formation specific uranium isopleth maps generated for BA1 and the WA (see Section 4.0), and particle tracking depictions generated during remediation simulation analysis (see Section 5.0) were used to estimate the lateral extent of each remediation area.

Two separate remediation areas, one for uranium and another for nitrate/Tc-99, were estimated for the WAA U>DCGL area based on the updated particle tracking analysis results discussed above. Although nitrate and Tc-99 are not target constituents for groundwater remediation, it is necessary to establish these "remediation areas" based on area of hydraulic influence to estimate water treatment system influent concentrations. These influent concentrations are then used to evaluate compliance with treatment system effluent discharge limitations. 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 Oklahoma Department of Environmental Quality (DEQ) criterion (30 µg/L). The complete zone of WAA U>DCGL hydraulic capture was established as the nitrate/Tc-99 remediation area.

7.3 For most remediation areas, the targeted aquifer volume was calculated by multiplying the lateral extent of each remediation area by saturated thickness. Due to the variability in vertical formation thickness in the 1206-NORTH and BA1 TZ remediation areas, the aquifer volumes targeted for remediation in these areas were estimated using Earth Volumetric Studio® (EVS®), a three-dimensional visualization (3DV) application.

8.0 Area and Linear-Weighted Influent Concentration Estimates

Area-weighted influent concentration estimates were performed to support remediation duration estimate calculations and the development of influent concentrations, as described in Sections 9.0 and 10.0, respectively. The contaminant and formation specific isopleth maps generated for BA1 and the WA (see Section 4.0), and particle tracking depictions generated during remediation simulation analysis (see Section 5.0) were used to perform incremental groundwater concentration averaging within the combined capture zone of each remediation area containing groundwater extraction components.

The isopleth maps were also used to conduct linear-weighted averaging for all three groundwater extraction trenches (GETR-BA1-01, GETR-BA1-02, and GETR-WU-01) to approximate initial influent uranium concentrations. Results of the area and linear-weighted averaging analysis completed for each applicable remediation area and groundwater extraction component are presented in Attachment 6. These 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.

For the uranium remediation areas, the larger of the following was assumed as the initial concentration for estimating the required 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 the Q2 2017), (2) the concentration estimated by conducting incremental area-weighted averaging of concentrations within the specified treatment area.

The maximum representative uranium concentration reported for wells within the remediation areas are listed below:

Remediation Area	Maximum Representative Uranium Concentration (µg/L)
BA1-A	2,975 (TMW-09)
BA1-B	3,516 (TMW-13)
WAA U>DCGL	177.8 (T-62)
1206-NORTH	526.6 (MWWA-03)
WU-BA3	875 (1351)

Note: the monitor well associated with each result is identified in parentheses.

The area-weighted average concentrations used in calculations associated with remediation duration estimates are also summarized below:

Remediation Area	Area-Weighted Average Uranium Concentration (µg/L)
BA1-A	824
BA1-B	248
WAA U>DCGL	90.9
1206-NORTH	248
WU-BA3	311

For each remediation area, the maximum representative uranium concentration was greater than the area-weighted average uranium concentration.

9.0 Remediation Duration Estimates

Remediation at the Site will require two separate but related functions – groundwater remediation and water treatment. The remediation function involves the extraction and injection of groundwater for the purposes of achieving groundwater remediation criteria. The water treatment function involves the removal of uranium from extracted groundwater to facilitate injection or discharge of the water. The duration of remediation varies by area and is generally determined by groundwater remediation criteria (DCGL) and injection and/or extraction flow rates. Operation of the BA1 and WA treatment systems must continue until uranium concentrations are below the MCL, thereby facilitating injection and/or discharge without treatment. Consequently, it may be possible for water treatment in either area to conclude before remediation (groundwater pumping and injection) is discontinued. Estimated remediation timeframes are discussed below and anticipated water treatment timeframes are discussed in Sections 9.0 and 10.0.

The estimated time required to achieve the remediation criterion in each remediation area and formation was calculated using the input parameters described below.

Density

The results of geotechnical analyses performed by Standard Testing and Engineering Company (Standard Testing) on site-specific soils collected from the UP1 area in 2015 yielded bulk densities varying from 99.9 pounds per cubic foot (pcf) to 122.4 pcf, averaging 113 pcf (1.81 grams per milliliter [g/ml]). The soils submitted for these analyses are considered representative of TZ and weathered bedrock formations and the average density resulting from the analyses is considered appropriate for calculating remediation durations for alluvial areas as well. Consequently, 1.81 g/ml was used as the bulk density for all remediation areas in calculations associated with the pore volume estimates. The use of the highest density results in the estimation of the greatest mass of sorbed contaminant, yielding longer duration estimates than if a lower density were used.

Distribution Coefficient (K_d)

Tests performed in 2002 and 2006 by Hazen and Associates reported uranium K_d values for various site-specific materials. The test demonstrated that uranium K_d increased as particle size decreased. Alluvial sand yielded a K_d of 0.5 milliliters per gram (ml/g), silt yielded a K_d of 2.0 ml/g, and clay yielded a K_d of 3.4 ml/g. All tests were conducted with groundwater from BA1; minor variations in groundwater geochemistry present across the site may impact K_d. Consequently, more conservative values than those reported were in calculations associated with the remediation duration estimates.

None of the borings completed in TZ formations yielded only clay; they yielded of a mixture of clay, silt, and fine sand, and the use of a uranium K_d value of 3.4 ml/g for all TZ material was deemed overly conservative. Consequently, a value of 3.0 ml/g was selected for TZ soils. Similarly, borings drilled in SSA and SSB contained a high degree of silt. Based on these observations, it was decided that a K_d lower than that reported for clay should be used for SSA and SSB. Consequently, a value of 3.0 ml/g was selected for SSA and SSB.

Clean sand yielded a uranium K_d of 0.5 ml/g during the Hazen tests. However, although borings in the floodplain do contain intervals of very "clean" sand, there is sufficient silt and/or clay to justify the use of a higher K_d value than that reported for clean sand. Consequently, a uranium K_d of 2.0 ml/g was used in Remediation Duration Estimates conducted for alluvial areas.

Remediation duration calculations were not needed for nitrate, since nitrate is not a target constituent for groundwater remediation; however, a K_d value was required to evaluate influent nitrate concentrations over time as described below in Section 9.0. For nitrate, a K_d value of 0.6 ml/g was used for all formations and soil types. This value was deemed sufficiently conservative based on a review of applicable technical references.[7,8] K_d values were not evaluated/selected for fluoride or Tc-99 since a concentration decay analysis was not required, as discussed below in Section 10.1.

In summary, the K_d values used in calculations associated with the remediation duration estimates and/or influent concentration analysis are as follows:

Formation / Soil Type	Uranium K_d (ml/g)	Nitrate K_d (ml/g)
TZ	3.0	0.6
SSA	3.0	0.6
SSB	3.0	0.6
Alluvium	2.0	0.6

Using comparatively high K_d values results in a greater total mass of uranium requiring removal, increasing the estimated duration of remediation.

A summary remediation and water treatment schedule is included as Attachment 7 and as Figure 9-3 of the D-Plan. The remediation duration estimate calculations and results for BA1 and the WA are presented in Attachments 8 and 9, respectively. A first-order kinetic sorption equation that assumes linear, reversible and instantaneous sorption was determined to be appropriate for modeling concentration decline and the time required to achieve remediation criteria in each area[9]. 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.

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[7] Krupka et al. (2004). Linearity and reversibility of iodide adsorption on sediments from Hanford, Washington under water saturated conditions. *Water Research* (Volume 38, Issue 8, April 2004, pp. 2009-2016). Elsevier.

[8] Serne, R.J. *Kd Values for Agricultural and Surface Soils for Use in Hanford Site Farm, Residential, and River Shoreline Scenarios (PNNL-16531)*. (2007). Washington: Pacific Northwest National Laboratory.

[9] Fetter, C.W. (1993). Contaminant Hydrogeology (pp. 129-130). New York: Macmillan Publishing Company.

9.1 BA1 was divided into two remediation areas (BA1-A and BA1-B) for the purpose of calculating duration estimates. BA1-A is defined as the area in which uranium exceeds the DCGL in SSB and the TZ. BA1-B is defined as the area in which uranium exceeds the DCGL in the alluvial material. BA1-A is expected to require more time to achieve the DCGL than any other remediation area at the Site; consequently, BA1-A is expected to drive the overall site remediation schedule. The BA1-A remediation timeframe is estimated to be 150 months. Groundwater extraction activities will continue in both BA1 remediation areas through 150 months to maintain the minimum required flow rate for treatment equipment.

9.2 Uranium groundwater concentrations exceed the DCGL in three WA remediation areas – 1206-NORTH (the drainage area in which uranium exceeds the DCGL), WAA U>DCGL (the area in which uranium exceeds the DCGL in alluvial material), and WU-BA3 (the area surrounding former Burial Area #3 in which uranium exceeds the DCGL); consequently, the time required to achieve the DCGL for uranium was calculated for each of these areas. The 1206-NORTH remediation area is expected to achieve the DCGL after approximately 5 months. However, extraction will continue in 1206-NORTH until the WU-BA3 remediation area achieves the DCGL at approximately 48 months, to maintain downgradient capture of the treated water injected in WU-BA3. After 48 months, injection in WU-BA3 and extraction in 1206-NORTH will be discontinued. The WAA U>DCGL remediation area is expected to require the longest treatment timeframe of the WA remediation areas to achieve the DCGL for uranium, at 135 months. After 135 months, groundwater extraction activities will cease in the WA.

The remediation flow rates used in calculations associated with the remediation duration estimates consist of pumping rates and treated water infiltration rates associated with groundwater extraction and injection components, respectively, located within each remediation area.

10.0 Influent Contaminant Concentration and Treatment Duration Estimates

The estimated concentrations of uranium, nitrate, Tc-99, and fluoride in BA1 and WA treatment system groundwater influents were calculated to support treatment system design and calculation of treatment system operational timeframes. The BA1 uranium treatment system and the WA uranium treatment system must operate until the uranium concentration in the combined influent falls below the MCL of 30 µg/L. An analysis was performed to estimate the time at which this will occur, and a separate analysis of nitrate effluent concentrations over time was conducted to confirm nitrate levels will not exceed the concentration anticipated to be acceptable to the DEQ [30 milligrams per liter (mg/L)]. Since there will be no treatment of nitrate recovered with the extracted groundwater, the terms influent and effluent are used interchangeably when referring to nitrate water concentrations.

A detailed description of the processes used to estimate treatment system influent contaminant concentrations and operational timeframes is provided below and a summary remediation and water treatment schedule is included as Attachment 7.

10.1 Influent Concentrations

Initial (i.e., time zero) and maximum (i.e., time "t") influent contaminant concentrations were estimated for each groundwater extraction component. The initial and maximum contaminant concentrations were equivalent for all components and contaminants, except for nitrate and Tc-99 in three WAA U>DCGL wells. Nitrate and Tc-99 concentrations are expected to increase over time due to capture of groundwater with higher concentrations toward the edge of the capture zones for these wells. The initial and maximum influent contaminant concentrations for each extraction component were estimated using one of three methods:

- Concentration isopleth interpolation conducted using the Surfer® software application;
- Linear-weighted concentration averaging (see Section 8.0);
- Area-weighted concentration averaging (see Section 8.0); or,
- Time-weighted concentration averaging (see below).

Since 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. 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 10). 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-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 WA Treatment Facility (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 10).

- GE-WAA-05 – 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, is 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 10).

Initial influent fluoride concentrations were estimated using concentration isopleth interpolation conducted using the Surfer® software application for wells and using linear-weighted concentration averaging (see Section 8.0) for trenches. These interpolated initial concentrations are assumed to be representative of the maximum influent fluoride concentrations, based on the location of the WA remediation components relative to the fluoride plume as depicted on Attachment 2. Fluoride is not present at detectable levels in the BA1 remediation areas.

The initial Tc-99 concentration for all remediation components is zero, since all components are located outside of the Tc-99 plume. However, a portion of the Tc-99 plume is within the estimated capture zones for extraction wells GE-WAA-02, GE-WAA-03, and GE-WAA-05. Therefore, the purpose of the Tc-99 concentration estimating process described in this paragraph is to estimate the maximum Tc-99 influent concentration that will occur sometime after groundwater extraction is initiated. These maximum influent Tc-99 concentrations were estimated using incremental area-weighted averaging of concentrations within the specified remediation areas as follows:

- GE-WAA-02 – the estimated area-weighted average Tc-99 concentration within the capture zone of this well is 2.67 nanograms per liter (ng/L).
- GE-WAA-03 – the estimated area-weighted average Tc-99 concentration within the capture zone of this well is 1.32 ng/L.
- GE-WAA-05 – the estimated area-weighted average Tc-99 concentration within the capture zone of this well is 0.92 ng/L.

Initial influent uranium concentrations were estimated using concentration isopleth interpolation conducted using the Surfer® software application for wells, and using linear-weighted concentration averaging (see Section 8.0) for trenches. These interpolated initial concentrations are assumed to be representative of the maximum influent uranium concentrations, since the highest uranium concentrations are located along the WAA U>DCGL and BA1 extraction well alignments and trenches, as depicted on Attachment 2.

If a remediation area included more than one groundwater extraction component, flow rate-weighted averaging was used to calculate the estimated initial/maximum influent concentrations for each remediation area (i.e., influent treatment stream). If a remediation area included only one groundwater extraction component, flow rate-weighted averaging was not required and the initial/maximum component-specific concentrations estimated as described above were used.

Flow rate-weighted average nitrate concentrations for the combined WA influent for Years 1 through 5 are summarized in Attachment 11. Although influent nitrate concentrations for GE-WAA-02 and GE-WAA-05 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., $C_i = C_{max}$).

10.2 Influent Concentration Decay Analysis

The estimated/calculated initial and maximum influent contaminant concentrations (C_i and C_{max}, respectively), along with the parameters used to calculate estimated remediation durations (see Section 9.0), were used to predict declining influent concentrations and calculate operational timeframes for both the BA1 and WA treatment systems. The same first-order kinetic sorption equation used to calculate groundwater remediation durations (see Section 9.0) was used to model the decline in nitrate and uranium concentrations for influent streams associated with each remediation area contributing to the combined influent. The estimated maximum influent fluoride and Tc-99 concentrations are below the anticipated effluent discharge criterion. Therefore, a concentration decay analysis was not performed for these constituents.

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 10.1), WAA U>DCGL influent nitrate concentrations during the first three years of operation were held constant and the first-order kinetic concentration decay model 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 12.

Based on the results of the WA uranium concentration decline analysis, the influent uranium groundwater concentration is not projected to fall below the MCL (30 µg/L) during the course of remediation. As described above in Section 9.0, groundwater extraction and uranium treatment will be discontinued in the WA after approximately 135 months.

Based on the results of the BA1 uranium concentration decline analysis, the influent uranium groundwater concentration is projected to fall below the MCL (30 µg/L) after approximately 126 months of remedial operations. Consequently, it is expected that the uranium treatment system will be bypassed after 126 months and recovered groundwater will be directly injected or discharged to Outfall 001 through the end of the 150-month groundwater remediation operation.

These concentration decay analyses were then used to estimate the operational timeframe required for the combined treatment train influent to reach the MCL for uranium, at which time treatment can be bypassed and the groundwater influent can be directly injected or discharged to the outfall. The results of the BA1 influent concentration decline analysis are presented in Attachment 13 and the results of the WA analysis are presented in Attachment 12. 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.

11.0 Combined Effluent Nitrate Concentration Calculations

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 treated effluent from WA will be re-injected via GWI-WU-01A, and 28 gpm of treated effluent from BA1 will be re-injected via GWI-BA1-01 through GWI-BA1-04. The combined WA/BA1 nitrate flow weight-rated average nitrate concentration was therefore based on a combined discharge rate of 171 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 Section 10.1, 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 14.

Based on the results of the combined WA-BA1 effluent concentration decline analysis, the nitrate groundwater concentration is expected to remain below the anticipated discharge limit (30 mg/L) throughout the groundwater remediation process.

12.0 Limitations and Assumptions Associated with Duration Estimates

The accuracy of the groundwater remediation and water treatment duration estimates presented above are potentially limited by the quantity of available data, subsurface heterogeneity, variability in the concentration and distribution of contaminants in the aquifer units targeted for remediation, and other factors. In developing this basis of design, Burns & McDonnell and EPM consistently applied reasonably conservative assumptions to minimize the potential for remediation and water treatment durations to be underestimated. This in turn reduced the probability that long-term remediation costs would be underestimated. These assumptions included the following:

- As discussed in Section 3.0, the 95% UCL concentration (if available), maximum contaminant concentration (if used in place of the 95% UCL value), or the average contaminant concentration (if data sufficient for determining the 95% UCL concentration were not available) was used for each monitor well and contaminant in developing the basis of design. This method of establishing groundwater concentrations was selected to address variability in the concentrations of contaminants in the aquifer units targeted for remediation.
- As discussed in Section 9.0, conservatively high bulk soil density, distribution coefficient (K_d), and saturated thickness values were applied in remediation duration estimates.
- As discussed in Section 9.0, the larger of the following concentration values were used as the initial groundwater concentration for the purposes of estimating the remediation timeframe required for each area:
    - The maximum representative concentration reported for any well within the remediation area (determined as described in Section 3.0)
    - The concentration estimated by conducting area-weighted averaging of representative concentrations within the remediation area (determined as described in Section 8.0)
- As discussed in Section 8.0, the lateral extent of remediation areas was extended to the limit of impacts exceeding the uranium MCL (30 µg/L). Because the uranium remediation criterion is 180 pCi/L, this assumption results in a larger (i.e., more conservative) pore volume input for remediation and water treatment duration calculations.
- As discussed in Section 7.0, the pore volume calculated for use in the nitrate influent concentration decay analysis included the entire estimated capture area. This assumption results in a relatively large pore volume input for water treatment duration calculations.
- The methods used to estimate remediation and water treatment durations assume contaminants are evenly distributed throughout the entire saturated thickness of each remediation area. Previous investigation activities have demonstrated that contaminants are likely to be stratified within alluvium and TZ formations at the Site. In order optimize remediation and water treatment efficiency, additional contaminant and hydraulic conductivity profiling will be conducted at each alluvial extraction well location, prior to well installation, and extraction wells will be constructed with

screen intervals focused on zones exhibiting uranium concentrations exceeding remediation criteria. This well construction approach is likely to result in mass removal rates that are higher than those predicted by the duration estimate models since groundwater extraction efforts will be focused on aquifer intervals containing the greatest contaminant mass. It should be noted that in-process and post-remediation monitoring will be conducted using results for groundwater samples collected from monitor wells screened across the full extent of the saturated zone.

While focusing alluvial extraction well screen intervals on zones of elevated contaminant concentration could result in water treatment influent concentrations higher than currently predicted (i.e., predicted concentrations are based on sample results from monitor wells with screen intervals that fully penetrate the saturated alluvium), the influent and effluent concentrations presented in Attachments 12, 13, and 14 are considered sufficiently conservative. In addition, the ion exchange treatment systems specified for uranium removal are capable of treating water with uranium concentrations significantly higher than predicted, and the uranium treatment systems will be closely monitored, particularly during the initial phases of remediation, for appropriate contaminant removal efficiencies and achievement of discharge criteria. Ion exchange treatment systems will also be monitored for U-235 accumulation.

The maximum combined fluoride and Tc-99 influent concentrations for the WA treatment system are 2.6 mg/L and 1.26 ng/L, respectively. This fluoride concentration is below the anticipated permitted discharge limit for fluoride (10 mg/L). Tc-99 is not anticipated to be limited in the system discharge, and the estimated influent Tc-99 concentrations are below the drinking water standard. However, WA treatment system influent concentrations will be monitored closely to assess the potential for exceedances.

Attachments:

- Attachment 1 – Nitrate, Uranium, Tc-99, and Fluoride Data Sheets
- Attachment 2 – BA1 and WA Contaminant Isopleth Maps: Nitrate, Uranium, Tc-99, and Fluoride
- Attachment 3 – BA1 and WA Particle Tracking Results
- Attachment 4 – BA1 Remediation Component Locations
- Attachment 5 – WA Remediation Component Locations
- Attachment 6 – Area and Linear-Weighted Averaging Results
- Attachment 7 – Remediation and Water Treatment Summary Schedule
- Attachment 8 – Remediation Duration Estimate Calculations: BA1
- Attachment 9 – Remediation Duration Estimate Calculations: WA
- Attachment 10 – Nitrate Time-Weighted Concentration Averaging Results

Attachment 11 – Nitrate Flow Rate-Weighted Concentration Averaging Results
Attachment 12 – WA Influent Concentration Analysis Results
Attachment 13 – BA1 Influent Concentration Analysis Results
Attachment 14 – WA-BA1 Nitrate Combined Effluent Analysis Results

Attachment 1 – Nitrate, Uranium, Fluoride, and Tc-99 Data Sheets

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Fluoride Concentration (mg/L)			
02W01	0.474		0.4740	0.4740
02W02				
02W03	0.651		0.6510	0.6510
02W04	0.765		0.7650	0.7650
02W05	0.550		0.5500	0.5500
02W06	0.503	0.483	0.4147	0.4830
02W07	0.484		0.4840	0.4840
02W08				
02W09	1.040	0.985	0.8920	0.9850
02W10				
02W11				
02W12				
02W13				
02W14	0.513		0.5130	0.5130
02W15	0.727		0.7270	0.7270
02W16				
02W17				
02W18	0.459		0.4590	0.4590
02W19	0.486		0.4860	0.4860
02W20				
02W21				
02W22				
02W23				
02W24				
02W25				
02W26				
02W27	0.565			
02W28	0.789	0.742	0.6886	0.7420
02W29	0.673		0.6730	0.6730
02W30	0.724		0.7240	0.7240
02W31	0.638		0.6380	0.6380
02W32	0.769	0.726	0.5940	0.7260
02W33				
02W34				
02W35				
02W36				
02W37	0.443		0.4430	0.4430
02W38	0.506		0.5060	0.5060
02W39	0.716		0.7160	0.7160
02W40	0.654		0.6540	0.6540
02W41	0.519		0.5190	0.5190
02W42	0.601	0.541	0.4761	0.5410
02W43	0.449	0.435	0.4067	0.4350
02W44	0.571	0.546	0.4883	0.5460

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Fluoride Concentration (mg/L)			
02W45	0.413		0.4130	0.4130
02W46	1.180		1.1800	1.1800
02W47				
02W48				
02W50				
02W51				
02W52				
02W53				
02W62				
1311	0.561		0.4773	0.4773
1312	12.200	10.46	9.4440	10.4600
1313	55.800	48.9	46.3300	48.9000
1314	0.329	0.318	0.2846	0.3180
1315R	2.000		2.0000	2.0000
1316R	0.549		0.5490	0.5490
1319A-1				
1319A-2	0.366		0.3415	0.3415
1319A-3				
1319B-1	0.348	0.337	0.3206	0.3370
1319B-2	0.455	0.447	0.4010	0.4470
1319B-3	0.314	0.307	0.2850	0.3070
1319B-4	0.424	0.412	0.3486	0.4120
1319B-5	0.430	0.403	0.3414	0.4030
1319C-1				
1319C-2				
1319C-3				
1320	0.643		0.5750	0.5750
1321	0.303		0.2933	0.2933
1322	0.549		0.5490	0.5490
1323				
1324	0.530		0.5153	0.5153
1325	0.522		0.5055	0.5055
1326	0.322		0.3130	0.3130
1327B	0.348		0.3355	0.3355
1328				
1329	0.480		0.4125	0.4125
1330	0.629		0.6095	0.6095
1331	0.557		0.5570	0.5570
1332				
1333	0.705		0.7050	0.7050
1334	0.602		0.5533	0.5533
1335A	0.386		0.3577	0.3577
1336A	9.890	9.627	9.0717	9.6270
1337	14.400	14.16	12.1050	14.1600

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Fluoride Concentration (mg/L)			
1338	0.879	0.878	0.7723	0.8780
1339				
1340	20.900	18	15.0667	18.0000
1341	0.687	0.645	0.5910	0.6450
1342	0.050			
1343	0.406		0.3950	0.3950
1344	0.384		0.3840	0.3840
1345	0.530	0.534	0.4870	0.5300
1346	10.600	9.641	8.8509	9.6410
1347	4.950	4.753	4.3860	4.7530
1348	9.770	8.858	8.4882	9.7700
1349	1.030	1.016	0.7915	1.0300
1350	1.590		1.5900	1.5900
1351	1.280	1.063	0.8170	1.0630
1352	0.589	0.528	0.4608	0.5280
1353	1.720	1.795	1.1608	1.7200
1354	0.520	0.499	0.4580	0.4990
1355	0.439		0.4390	0.4390
1356	0.981	0.739	0.5421	0.7390
1357	0.557		0.5555	0.5555
1358	0.335		0.3350	0.3350
1359	0.973		0.9730	0.9730
1360	1.600		1.6000	1.6000
1361	0.513		0.4675	0.4675
1362				
1363	0.447		0.4115	0.4115
1364	0.424		0.4240	0.4240
1365	0.504		0.4770	0.4770
1366	0.492		0.4830	0.4830
T-51	0.452		0.4385	0.4385
T-52	1.640		1.5400	1.5400
T-53	0.934		0.8850	0.8850
T-54	2.440	2.228	1.6720	2.2280
T-55	2.410	2.193	1.8240	2.1930
T-56	1.020	0.984	0.8928	0.9840
T-57	5.030	4.636	4.3470	4.6360
T-58	0.887	0.861	0.7325	0.8610
T-59	0.405		0.3283	0.3283
T-60	0.496		0.4845	0.4845
T-61	0.498		0.4560	0.4560
T-62	4.410	3.747	3.4091	3.7470
T-63	5.740	5.279	4.3660	5.2790
T-64	3.450	2.506	1.6803	2.5060
T-65	3.290	3.219	2.8700	3.2190

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Fluoride Concentration (mg/L)			
T-66	1.850	1.841	1.5750	1.8410
T-67	2.700	2.77	2.4200	2.7000
T-68	1.760	1.724	1.5400	1.7240
T-69	1.290	1.244	1.0216	1.2440
T-70R	1.440	1.327	1.1417	1.3270
T-72	1.420	1.395	1.2525	1.3950
T-73	0.320		0.3200	0.3200
T-74	0.329		0.3290	0.3290
T-75	0.895		0.8440	0.8440
T-76	3.010	2.929	2.8609	2.9290
T-77	1.220	1.085	0.9936	1.0850
T-78	0.365		0.3650	0.3650
T-79	1.000	0.898	0.7960	0.8980
T-81	0.415		0.4150	0.4150
T-82	0.585	0.49	0.4404	0.4930
T-83	0.397		0.3970	0.3970
T-84	0.800		0.7900	0.7900
T-85	1.490		1.4467	1.4467
T-86	3.170	3.032	2.3475	3.0320
T-87	1.300	1.28	1.1480	1.2800
T-88	1.370	1.261	1.0558	1.2610
T-89	0.559		0.5050	0.5050
T-90	0.737		0.7065	0.7065
T-91	0.622		0.5837	0.5837
T-93	0.518		0.4680	0.4680
T-94	0.555		0.5395	0.5395
T-95	1.640		1.5650	1.5650
T-96	0.533		0.5330	0.5330
TMW-01	0.607		0.6070	0.6070
TMW-02				
TMW-05				
TMW-06				
TMW-07				
TMW-08	0.563	0.502	0.4506	0.5020
TMW-09	0.874	0.744	0.6559	0.7440
TMW-13	0.796	0.711	0.6047	0.7110
TMW-17				
TMW-18	0.340		0.3400	0.3400
TMW-19				
TMW-20				
TMW-21				
TMW-23				
TMW-24	0.448		0.4160	0.4160
TMW-25	0.375		0.3750	0.3750

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Fluoride Concentration (mg/L)			
CDW-1				
CDW-1A	Abandonded			
CDW-2	Abandonded			
CDW-2A	Abandonded			
CDW-3	Abandonded			
CDW-3A	Abandonded			
CDW-4	Abandonded			
CDW-4A	Abandonded			
CDW-5	Abandonded			
CDW-5A	Abandonded			
CDW-6	Abandonded			
CDW-6A	Abandonded			
CDW-7	Abandonded			
CDW-7A	Abandonded			
GE-BA1-01	Abandonded			
GE-WA-01	Abandonded			
MWWA-03	13.300	9.663	7.7222	9.6630
MWWA-09	4.200	3.965	3.8027	3.9650
1370	0.449		0.4490	0.4490
1371	0.405		0.4050	0.4050
1367	0.469		0.4690	0.4690
T-97	0.385		0.3850	0.3850
T-98	0.340		0.3400	0.3400
T-99	0.552		0.5520	0.5520
T-100	0.772		0.7720	0.7720
T-101	0.534		0.5340	0.5340
T-102	0.315		0.3150	0.3150
T-103	0.356		0.3560	0.3560
1368	0.458		0.4580	0.4580
1372	0.422		0.4220	0.4220
1373	0.369		0.3690	0.3690
1374				
1375	0.386		0.3710	0.3710
1376	0.713		0.5640	0.5640
1377	0.464		0.4640	0.4640
1378	0.281		0.2810	0.2810
1379	0.754		0.7250	0.7250
1380	0.505		0.5050	0.5050
1381	2.120		1.6477	1.6477
1382	0.507		0.4817	0.4817
1383	19.400		11.7633	11.7633
1384	0.455		0.4307	0.4307
1385	9.680	7.651	6.6288	7.6510
1386	0.453		0.4370	0.4370

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Fluoride Concentration (mg/L)			
1387	9.240	8.206	7.3438	8.2060
1388	2.160		1.9300	1.9300
1389	0.211		0.1753	0.1753
1390	1.070		0.9607	0.9607
1391	3.430		2.8533	2.8533
1392	0.698		0.6860	0.6860
1393	21.300	11.89	7.3700	11.8900
1394	0.399		0.3820	0.3820
T-92R	0.407		0.3960	0.3960
1369	0.430		0.4300	0.4300

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Nitrate Concentration (mg/L)			
02W01	0.353		0.3530	0.3530
02W02				
02W03	0.683		0.6830	0.6830
02W04	0.192		0.1920	0.1920
02W05	0.050		0.0500	0.0500
02W06	0.202	0.139	0.0780	0.1390
02W07	0.185		0.1850	0.1850
02W08				
02W09	0.774	0.458	0.2463	0.4580
02W10				
02W11				
02W12				
02W13				
02W14	0.050		0.0500	0.0500
02W15	0.534		0.5340	0.5340
02W16				
02W17				
02W18	0.050		0.0500	0.0500
02W19	0.050		0.0500	0.0500
02W20				
02W21				
02W22				
02W23				
02W24				
02W25				
02W26				
02W27	1.590		1.5900	1.5900
02W28	0.500	0.239	0.1135	0.2390
02W29	13.400		13.4000	13.4000
02W30	2.520		2.5200	2.5200
02W31	0.050		0.0500	0.0500
02W32	0.921	0.505	0.2188	0.5050
02W33				
02W34				
02W35				
02W36				
02W37	0.050		0.0500	0.0500
02W38	0.160		0.1600	0.1600
02W39	0.173		0.1730	0.1730
02W40	0.223		0.2230	0.2230
02W41	0.722		0.7220	0.7220
02W42	7.690	4.083	2.1141	4.0830
02W43	0.500	0.339	0.1878	0.3390
02W44	0.800	0.589	0.3390	0.5890

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Nitrate Concentration (mg/L)			
02W45	0.019		0.0191	0.0191
02W46	0.053		0.0529	0.0529
02W47				
02W48				
02W50				
02W51				
02W52				
02W53				
02W62				
1311	30.000		21.5667	21.5667
1312	465.000	379.7	352.3000	379.7000
1313	464.000	240.3	172.9000	240.3000
1314	2.040	1.869	1.6600	1.8690
1315R	9.820		9.8200	9.8200
1316R	10.900		10.9000	10.9000
1319A-1				
1319A-2	33.000		31.9000	31.9000
1319A-3	1.620		1.6200	1.6200
1319B-1	85.500	57.44	47.4700	57.4400
1319B-2	2.680	2.699	2.3875	2.6800
1319B-3	90.100	75.79	69.5818	75.7900
1319B-4	3.770	3.699	3.3280	3.6990
1319B-5	13.100	11.33	8.7320	11.3300
1319C-1				
1319C-2				
1319C-3				
1320	18.600	19.14	17.0500	18.6000
1321	0.826		0.7560	0.7560
1322	19.400		19.4000	19.4000
1323				
1324	6.450		3.7600	3.7600
1325	20.500		19.6500	19.6500
1326	33.800		27.1000	27.1000
1327B	38.700		36.3667	36.3667
1328				
1329	33.000		31.3667	31.3667
1330	16.000		13.0633	13.0633
1331	10.100		10.1000	10.1000
1332				
1333	4.190		4.1900	4.1900
1334	6.810		5.8300	5.8300
1335A	2.770		2.5033	2.5033
1336A	414.000	376.6	323.5000	376.6000

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Nitrate Concentration (mg/L)			
1337	63.700	53.34	43.1500	53.3400
1338	10.500		7.0133	7.0133
1339				
1340	66.500	53.77	44.9667	53.7700
1341	29.300	28.63	25.3800	28.6300
1342	0.050		0.0500	0.0500
1343	6.890	6.448	4.6225	6.4480
1344	0.050		0.0500	0.0500
1345	7.800	7.663	6.5080	7.6630
1346	499.000	406.5	357.3636	406.5000
1347	95.900	64.97	28.2600	64.9700
1348	16.500	11.57	10.0609	11.5700
1349	21.500	20.21	11.0800	20.2100
1350	15.600		11.7333	11.7333
1351	87.400	76.09	59.3000	76.0900
1352	61.500	54.99	49.1700	54.9900
1353	7.750	8.789	5.5100	7.7500
1354	190.000	141.8	106.1143	141.8000
1355	14.500		14.0333	14.0333
1356	18.800	14.77	12.4127	14.7700
1357	55.400	51.99	38.1500	51.9900
1358	20.600		16.9333	16.9333
1359	23.100		21.7333	21.7333
1360	16.400		13.4167	13.4167
1361	0.080		0.0651	0.0651
1362				
1363	0.141		0.0913	0.0913
1364	0.050		0.0500	0.0500
1365	0.091		0.0857	0.0857
1366	0.147		0.1224	0.1224
T-51	16.000	14.73	8.5700	14.7300
T-52	58.000	56.69	30.0250	56.6900
T-53	47.700	47.7	41.7500	47.7000
T-54	431.000	238.6	179.5800	238.6000
T-55	281.000	236	134.0000	236.0000
T-56	26.400	24.89	21.0800	24.8900
T-57	125.000	111.5	98.0900	111.5000
T-58	61.000	44.87	35.8333	44.8700
T-59	150.000	112.4	100.8400	112.4000
T-60	101.000	97.42	74.8500	97.4200
T-61	56.800	34.93	25.4580	34.9300
T-62	143.000	88	66.7727	88.0000
T-63	150.000	138.6	80.1800	138.6000

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Nitrate Concentration (mg/L)			
T-64	20.700	14.03	9.5500	14.0300
T-65	55.500	56.7	51.6750	55.5000
T-66	40.300	40.73	32.1500	40.3000
T-67	29.400	26.98	17.4000	26.9800
T-68	21.400	21.22	17.4400	21.2200
T-69	140.000	72.14	53.0200	72.1400
T-70R	6.920	4.407	3.1057	4.4070
T-72	25.800	27.82	14.0125	25.8000
T-73	0.034		0.0282	0.0282
T-74	1.570		1.4700	1.4700
T-75	1.970		1.6633	1.6633
T-76	47.800	30.35	26.0364	30.3500
T-77	5.500	3.068	2.1665	3.0680
T-78	0.251		0.1639	0.1639
T-79	3.560	1.258	0.7224	1.2580
T-81	0.074		0.0710	0.0710
T-82	0.086	0.0677	0.0532	0.0677
T-83	0.063		0.0542	0.0542
T-84	51.000	46.54	30.0250	46.5400
T-85	123.000	100.4	64.9800	100.4000
T-86	58.000	43.88	36.5778	43.8800
T-87	110.000	108.4	80.0400	108.4000
T-88	130.000	75.36	58.9700	75.3600
T-89	72.500	68.53	60.7400	68.5300
T-90	34.500	35.2	27.5750	34.5000
T-91	38.900	30.87	25.4300	30.8700
T-93	58.500	54.5	39.1500	54.5000
T-94	18.900	18.7	16.2250	18.7000
T-95	49.000	49.17	38.6750	49.0000
T-96	33.000	31.58	27.3750	31.5800
TMW-01	0.172		0.1720	0.1720
TMW-02				
TMW-05				
TMW-06				
TMW-07				
TMW-08	2.630	2.189	1.8543	2.1890
TMW-09	1.280	0.633	0.2893	0.6330
TMW-13	0.500	0.342	0.2025	0.3420
TMW-17				
TMW-18	0.374		0.3740	0.3740
TMW-19				
TMW-20				
TMW-21				
TMW-23				

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Nitrate Concentration (mg/L)			
TMW-24	0.050		0.0356	0.0356
TMW-25	1.470		1.4700	1.4700
CDW-1	Abandonded			
CDW-1A	Abandonded			
CDW-2	Abandonded			
CDW-2A	Abandonded			
CDW-3	Abandonded			
CDW-3A	Abandonded			
CDW-4	Abandonded			
CDW-4A	Abandonded			
CDW-5	Abandonded			
CDW-5A	Abandonded			
CDW-6	Abandonded			
CDW-6A	Abandonded			
CDW-7	Abandonded			
CDW-7A	Abandonded			
GE-BA1-01				
GE-WA-01				
MWWA-03	84.600	42.37	25.1172	42.3700
MWWA-09	56.000	43.05	34.9364	43.0500
1370	0.040		0.0404	0.0404
1371	0.050		0.0500	0.0500
1367	0.035		0.0354	0.0354
T-97	13.800	10.22	6.8763	10.2200
T-98	2.000		0.8617	0.8617
T-99	46.600	37.37	31.0625	37.3700
T-100	51.600	39.49	30.6125	39.4900
T-101	36.500		27.2333	27.2333
T-102	24.400		22.2667	22.2667
T-103	8.640		4.0198	4.0198
1368	0.050		0.0500	0.0500
1372	0.050		0.0500	0.0500
1373	0.050		0.0500	0.0500
1374	27.300		27.3000	27.3000
1375	37.900		34.2667	34.2667
1376	17.700		17.0000	17.0000
1377	8.730		8.7300	8.7300
1378	8.550		8.5500	8.5500
1379	7.370		7.3700	7.3700
1380	17.100		17.1000	17.1000
1381	881.000	839.1	790.8750	839.1000
1382	3.060		2.4400	2.4400
1383	308.000		226.6667	226.6667
1384	0.505		0.4003	0.4003

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Nitrate Concentration (mg/L)			
1385	1,200.000	1006	876.5000	1006.0000
1386	17.600		15.4333	15.4333
1387	71.900	60.17	47.2875	60.1700
1388	10.400		9.1500	9.1500
1389	31.600		21.6667	21.6667
1390	7.030		4.8933	4.8933
1391	5.250		4.0850	4.0850
1392	1.560		1.1093	1.1093
1393	505.000	274.9	153.1750	274.9000
1394	5.140		4.2500	4.2500
T-92R	40.500		36.2500	36.2500
1369	0.017		0.0173	0.0173

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Uranium Concentration (ug/L)			
02W01	2,720.0	2,495	2,217	2495
02W02	2,345.9		2,128	2,128
02W03	1,190.0		862	862
02W04	497.0		300.9467	300.95
02W05	638.1		388.2333	388.23
02W06	1,950.0	1310	548.2800	1,310.00
02W07	1,478.0		924	924
02W08	744.0	429.3	268.9600	429.30
02W09	10.0	6.965	4.1978	6.97
02W10	4.4		3.9908	3.99
02W11	311.0		136.2610	136.26
02W12	448.0		203.4697	203.47
02W13	33.8		28.3637	28.36
02W14	305.5		278.5033	278.50
02W15	261.0		100.5027	100.50
02W16	20.2	17.38	11.6140	17.38
02W17	15.7	13.94	11.8400	13.94
02W18	504.0		289.0133	289.01
02W19	1,305.9		711.6333	711.63
02W20	1.5		1.2368	1.24
02W21	5.5		5.4850	5.49
02W22	10.5		8.6250	8.63
02W23	7.4		7.2400	7.24
02W24	15.7		13.2763	13.28
02W25	28.4		18.9760	18.98
02W26	7.1		4.0421	4.04
02W27	188.0	134.5	94.8733	134.50
02W28	428.0	352.5	296.7350	352.50
02W29	1,570.0		1,115	1,115
02W30	338.0		309.6500	309.65
02W31	997.0		861	861
02W32	3,410.0	1,577	949	1,577
02W33	31.1		17.4460	17.45
02W34	5.6		4.9700	4.97
02W35	29.3	24.51	18.1200	24.51
02W36	18.6		15.1800	15.18
02W37	789.4		333.3833	333.38
02W38	392.0		255.4133	255.41
02W39	851.0	613.1	504.2600	613.10
02W40	1,430.0	1,137	1,001	1,137
02W41	517.0		420.6067	420.61
02W42	516.0	407.6	248.5517	407.60
02W43	134.0	124.2	99.8400	124.20
02W44	945.0	506.2	360.9044	506.20

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Uranium Concentration (ug/L)			
02W45	62.4		48.6243	48.62
02W46	4,330.0		2,663	2,663
02W47	342.0		264.2467	264.25
02W48	27.0	27.1	26.0710	27.00
02W50	4.0		3.8450	3.85
02W51	4.6		4.5200	4.52
02W52	2.5		2.2750	2.28
02W53	63.6		41.6280	41.63
02W62	5.6		5.0700	5.07
1311	2.9		2.7195	2.72
1312	22.3	22.11	19.3693	22.11
1313	18.8	19.9	15.2885	18.80
1314	1.4	1.274	1.1700	1.27
1315R	1,510.0	1,103	881	1,103
1316R	144.0		137.2367	137.24
1319A-1				
1319A-2	11.0		6.2751	6.28
1319A-3	5.8		5.7997	5.80
1319B-1	42.8	38.01	28.9918	38.01
1319B-2	1.4	1.445	1.3451	1.41
1319B-3	31.0	28.53	26.6360	28.53
1319B-4	1.6	1.621	1.5215	1.62
1319B-5	2.6	2.445	2.1298	2.45
1319C-1				
1319C-2				
1319C-3				
1320	2.2	2.204	2.0139	2.20
1321	11.0		10.7333	10.73
1322	19.9		12.8343	12.83
1323				
1324	1.8		1.6209	1.62
1325	1.0		0.9375	0.94
1326	5.5		4.1996	4.20
1327B	4.4		4.0995	4.10
1328				
1329	4.9		4.3892	4.39
1330	6.1		5.6513	5.65
1331	36.8	32.12	27.6421	32.12
1332				
1333	21.7		20.9777	20.98
1334	16.2		11.4740	11.47
1335A	8.0		6.0887	6.09
1336A	39.8	36.14	30.3278	36.14
1337	7.0	6.688	5.5819	6.69

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Uranium Concentration (ug/L)			
1338	0.8		0.7640	0.76
1339				
1340	9.0	8.456	7.6270	8.46
1341	2.4	2.359	2.2038	2.36
1342	4.9		4.9422	4.94
1343	21.9	21.28	17.6058	21.28
1344	2.4		1.9633	1.96
1345	2.2	2.081	1.8054	2.08
1346	7.0	5.457	3.4180	5.46
1347	40.3	34.45	24.0490	34.45
1348	73.5	71.26	69.6464	71.26
1349	30.0	29.62	19.5160	29.62
1350	19.4		14.2513	14.25
1351	1,547.6	874.5	412.4571	874.50
1352	149.0	124.9	102.4046	124.90
1353	44.7	50.29	25.2725	44.68
1354	3.1	3.046	2.8494	3.05
1355	2.6		2.5763	2.58
1356	1,260.2	572.4	394.6864	572.40
1357	2.2	2.193	1.9486	2.16
1358	1.7		1.5702	1.57
1359	14.3		12.0857	12.09
1360	39.3		23.9407	23.94
1361	271.0	172.9	117.8241	172.90
1362	77.7		40.1847	40.18
1363	104.0	111.1	73.9918	104.00
1364	15.9		7.1612	7.16
1365	123.0	100.9	80.2549	100.90
1366	6.0	5.54	3.6919	5.54
T-51	36.8	36.37	28.0220	36.37
T-52	23.5	23.21	19.9468	23.21
T-53	33.6	34.41	27.6440	33.60
T-54	4.1	3.785	3.1545	3.79
T-55	8.5	7.391	5.6136	7.39
T-56	7.4	5.773	3.7763	5.77
T-57	14.5	13.61	12.1542	13.61
T-58	20.4	19.92	17.4588	19.92
T-59	101.0	92.26	87.4233	92.26
T-60	50.1	48.59	42.2678	48.59
T-61	35.0	30.44	27.6090	30.44
T-62	238.0	177.8	159.2327	177.80
T-63	104.2	104.8	83.9900	104.15
T-64	208.0	125.7	77.0700	125.70
T-65	156.0	152	135.7775	152.00

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Uranium Concentration (ug/L)			
T-66	123.0	121.6	98.6600	121.60
T-67	159.0	159.6	140.8975	159.00
T-68	162.0	150.2	131.3200	150.20
T-69	92.3	77.29	65.6090	77.29
T-70R	119.0	97.71	79.1283	97.71
T-72	142.0	141	118.0350	141.00
T-73	11.9		10.3976	10.40
T-74	16.1		13.8050	13.81
T-75	86.4		76.7367	76.74
T-76	194.0	173.2	163.6891	173.20
T-77	95.8	86.79	78.7345	86.79
T-78	21.8		17.4677	17.47
T-79	77.0	62.76	56.1982	62.76
T-81	12.7		11.0281	11.03
T-82	37.6	34.28	31.2042	34.28
T-83	15.1		14.3363	14.34
T-84	48.1	48.6	44.9458	48.10
T-85	27.8	28.09	25.1590	27.80
T-86	25.4	22.91	19.5178	22.91
T-87	24.1	21.99	18.8868	21.99
T-88	10.2	9.943	9.3855	9.94
T-89	52.1	50.65	46.4850	50.65
T-90	25.0	24.82	23.5475	24.82
T-91	28.0	27.82	25.5998	27.82
T-93	33.5	32.68	29.0985	32.68
T-94	20.2	20.9	18.4360	20.24
T-95	29.5	29.25	27.8630	29.25
T-96	36.1	34.73	33.4118	34.73
TMW-01	767.0		462.5667	462.57
TMW-02	5.4		3.7566	3.76
TMW-05	3.9		3.5830	3.58
TMW-06	2.4		2.2583	2.26
TMW-07	221.0		210.3733	210.37
TMW-08	3,230.0	2589	1,670	2,589
TMW-09	3,760.0	2,975	2,750	2,975
TMW-13	4,510.0	3516	2,090	3,516
TMW-17	7.9		4.5299	4.53
TMW-18	17.2		14.7947	14.79
TMW-19	48.2		48.2170	48.22
TMW-20	8.9		6.4000	6.40
TMW-21	96.6		62.3787	62.38
TMW-23	6.8	6.909	6.2923	6.76
TMW-24	82.3	68.34	57.7092	68.34
TMW-25	123.0		116.4167	116.42

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Uranium Concentration (ug/L)			
CDW-1	Abandonded			
CDW-1A	Abandonded			
CDW-2	Abandonded			
CDW-2A	Abandonded			
CDW-3	Abandonded			
CDW-3A	Abandonded			
CDW-4	Abandonded			
CDW-4A	Abandonded			
CDW-5	Abandonded			
CDW-5A	Abandonded			
CDW-6	Abandonded			
CDW-6A	Abandonded			
CDW-7	Abandonded			
CDW-7A	Abandonded			
GE-BA1-01	Abandonded			
GE-WA-01	Abandonded			
MWWA-03	666.0	526.6	431.2667	526.60
MWWA-09	156.0	139.8	130.6627	139.80
1370	15.5		7.2520	7.25
1371	31.3		27.8763	27.88
1367	13.1		8.3432	8.34
T-97	67.8	64.07	61.4413	64.07
T-98	63.3		53.0600	53.06
T-99	48.1	42.06	38.2223	42.06
T-100	31.6		29.0630	29.06
T-101	36.0		34.7830	34.78
T-102	33.2		32.3393	32.34
T-103	11.1		10.1850	10.18
1368	8.6		5.8936	5.89
1372	10.5		9.3553	9.36
1373	64.3	51.21	40.9325	51.21
1374	12.8		12.8230	
1375	4.7		3.5549	3.55
1376	27.1		15.4350	15.44
1377	20.3		16.4543	16.45
1378	2.4		2.2522	2.25
1379	19.9		18.3437	18.34
1380	11.1		10.4790	10.48
1381	92.5	81.92	72.2913	81.92
1382	1.3		1.2550	1.26
1383	13.5		10.0430	10.04
1384	0.7		0.6345	0.63
1385	20.4		18.9790	18.98
1386	1.3		1.2300	1.23

Monitor Well	Max Observed Value	95% UCL	Well Average	Representative Concentration
	Uranium Concentration (ug/L)			
1387	23.7		20.3647	20.36
1388	1.4		1.3500	1.35
1389	2.3		1.4023	1.40
1390	1.5		1.5400	1.54
1391	1.8		1.6600	1.66
1392	1.1		1.0450	1.05
1393	35.0	24.2	18.0671	24.20
1394	1.0		1.0005	1.00

Tc-99 Data Table
Cimarron Remediation Site

1/30/2020

Technetium-99 Activity and Mass Concentration Results

Area	Location ID	Collection Date	Activity Concentration (pCi/L)	Mass Concentration (ng/L)[1,2]	Uncertainty (pCi/L)	Lab or Data Review Qual	MDC (pCi/L)
WAA U>DCGL	T-62	8/26/2019	80.1	4.7	30.9		48.7
	T-64	8/26/2019	24.4	1.4	23	U	38.3
	T-76	8/26/2019	101	5.9	27.3		41.3
	T-79	8/26/2019	-1.59	N/A	22.1	U, R	38.5
WAA-WEST	T-97	9/3/2019	24.8	1.5	24.5	U	41
WAA-BLUFF	T-54	9/3/2019	567	33.4	43.8		47.8
	T-55	9/3/2019	341	20.1	35.2		43
	T-56	9/3/2019	45.6	2.7	26.4		43.1
	T-57	9/3/2019	185	10.9	33.7		47.8
	T-58	9/3/2019	368	21.6	36.4		43.6
	T-63	9/3/2019	272	16.0	34.1		44.2
	T-86	9/3/2019	57.5	3.4	26.3		42.1
	T-87	9/3/2019	175	10.3	31		43.7
WAA-EAST	T-59	9/3/2019	15.2	0.9	25.6	U	43.5
	T-60	9/3/2019	46.4	2.7	25.7		41.8
	T-90	9/3/2019	19.5	1.1	25.1	U	42.4
WU-1348	1348	9/4/2019	-6.01	N/A	26.8	U, R	46.9
WU-UP1	1312	9/4/2019	662	38.9	40.8		40
	1313	9/4/2019	251	14.8	32.4		42.4
	1313DUP	9/4/2019	299	17.6	32.1		39.5
	1395	9/4/2019	-16.5	N/A	25.1	U, R	44.7
	1396	9/4/2019	-9.17	N/A	25.8	U, R	45.4
WU-UP2	1336A	9/4/2019	982	57.8	48.1		40.7
	1336ADUP	9/4/2019	963	56.6	48.5		41.7
	1337	9/4/2019	-13.4	N/A	22.8	U, R	40.6
	1346	9/5/2019	1650	97.1	59.4		40.9
	1346DUP	9/5/2019	1600	94.1	58.3		40.5
	1347	9/4/2019	4.98	0.3	24.7	U	42.7
	1387	9/4/2019	23.5	1.4	25.5	U	42.9
	1389	9/4/2019	35.4	2.1	24.6	U	40.4
	1401	9/5/2019	705	41.5	44.5		43.6
	1402	9/5/2019	941	55.4	49.8		44.1
WU-BA3	1351	8/26/2019	28.2	1.7	23.5	U	39.1
	1351DUP	8/26/2019	13.2	0.8	23	U	39.2
	1352	8/26/2019	12.3	0.7	22.2	U	37.7
	1356	8/26/2019	51.4	3.0	24.1		38.7
WU-PBA	1319B-1	9/4/2019	5.26	0.3	25.2	U	43.5
	1319B-2	9/4/2019	-9.58	N/A	22.9	U, R	40.5

Tc-99 Data Table
Cimarron Remediation Site

1/30/2020

Technetium-99 Activity and Mass Concentration Results

Area	Location ID	Collection Date	Activity Concentration (pCi/L)	Mass Concentration (ng/L)[1,2]	Uncertainty (pCi/L)	Lab or Data Review Qual	MDC (pCi/L)
1206-NORTH	MWWA-03	8/27/2019	11.4	0.7	22.8	U	38.9
	MWWA-09	8/27/2019	46	2.7	24.7		40
SURFACE WATER	1201 (Upstream)	8/27/2019	-1.8	N/A	22.5	U, **R**	39.2
	1202 (Downstream)	8/27/2019	2.27	0.1	27.3	U	47.3
BA1-A	1314	8/27/2019	-5.81	N/A	21.5	U, **R**	37.7
	1315R	9/5/2019	23	1.4	24.4	U	40.9
	TMW-08	8/28/2019	-4	N/A	22.4	U, **R**	39.1
	TMW-09	8/28/2019	12.5	0.7	22.2	U	37.7
	TMW-09DUP	8/28/2019	-8.09	N/A	23.5	U, **R**	41.3
BA1-B	02W06	8/27/2019	-5.14	N/A	21.2	U, **R**	37.2
	02W08	8/28/2019	6.17	0.4	21.7	U	37.3
	02W19	9/5/2019	11.2	0.7	22.8	U	38.9
	02W44	8/28/2019	-3.96	N/A	23.6	U, **R**	41.2
	1363	9/5/2019	4	0.2	23.8	U	41.2
	TMW-13	8/28/2019	-4.22	N/A	21.2	U, **R**	37.2
	TMW-24	9/5/2019	-17.2	N/A	22	U, **R**	39.4

Notes:

[1]Activity to mass conversion factor for Tc-99 is 1.7E-02 Ci/g (17 pCi/ng) [49 CFR 173.435 Table of A1 and A2 values for radionuclides].

[2]Any results qualified with a U were adjusted to the MDC of 50 pCi/L (2.9 ng/L) in subsequent assessments.

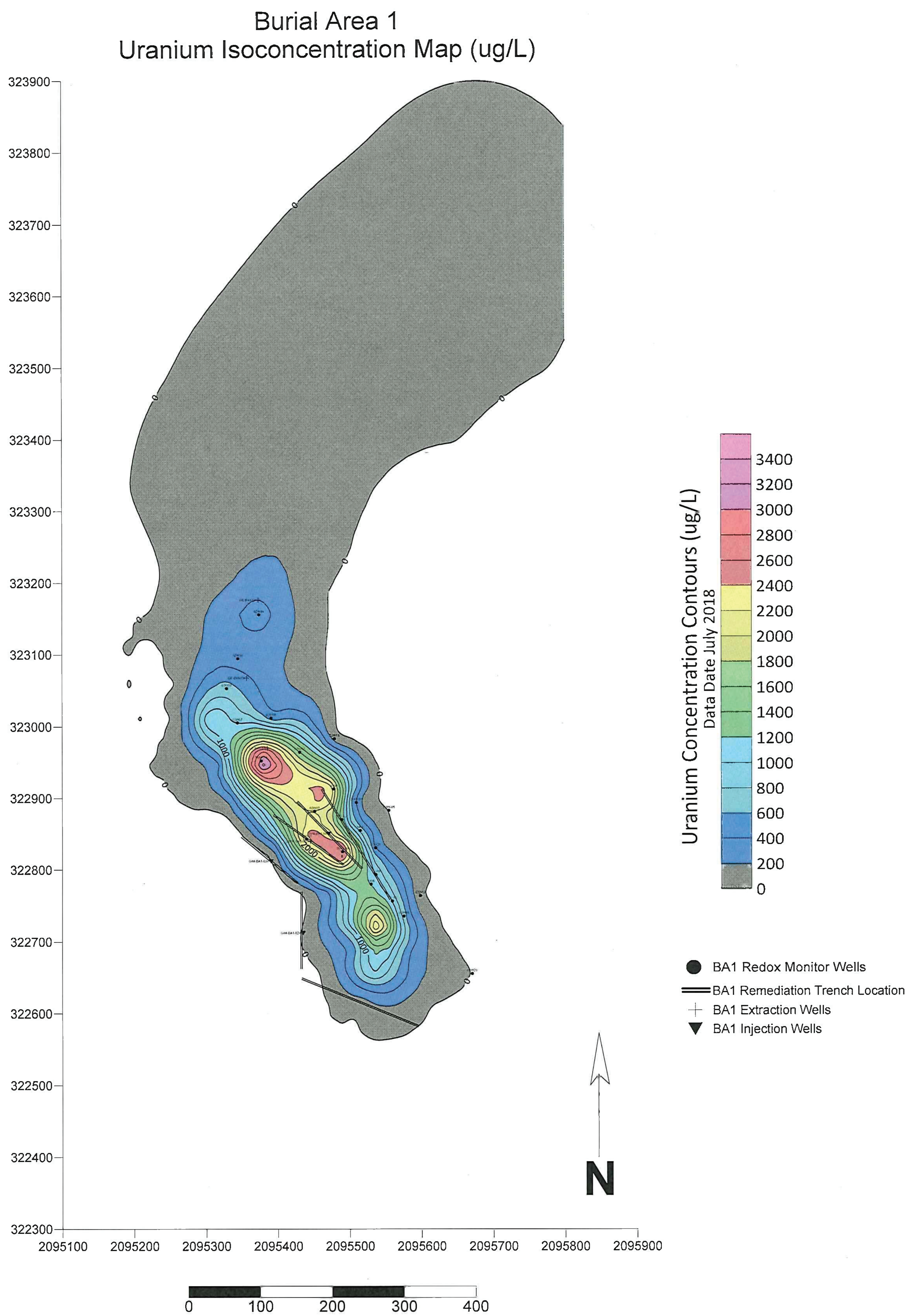
Tc-99 exceeds 900 pCi/L (MCL)

Red bold font indicates qualifier was added during internal data validation

Qualifier Definitions:

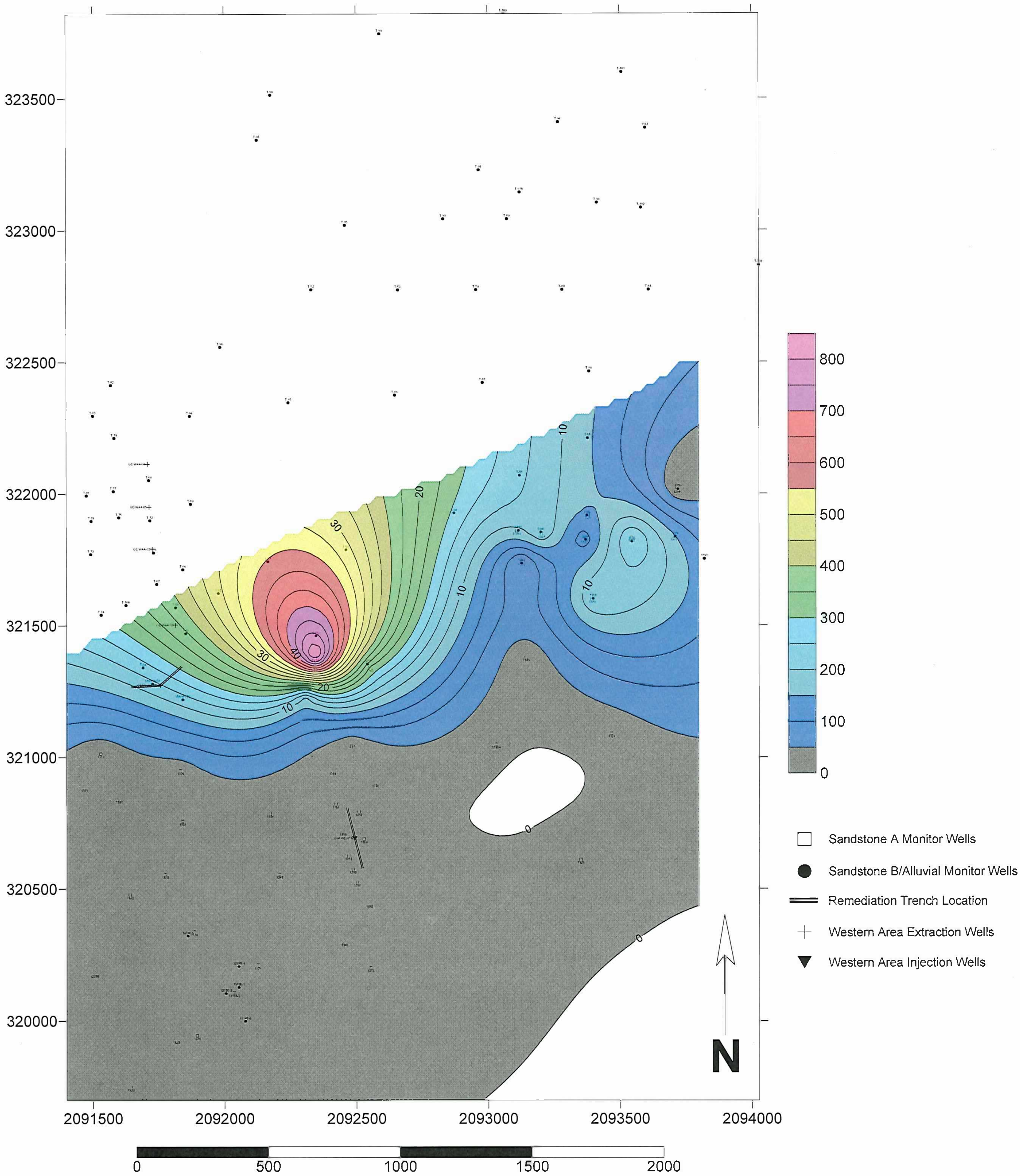
J - Qualified as estimated during the data evaluation
R - Rejected during the reasonableness review
U - Analyte not detected above the minimum detectable concentration (MDC)
MDC - Minimum Detectable Concentration
pCi/L - PicoCuries per liter
ng/L - Nanograms per liter

Attachment 2 – BA1 and WA Contaminant Isopleth Maps: Nitrate, Uranium, Fluoride, and Tc-99

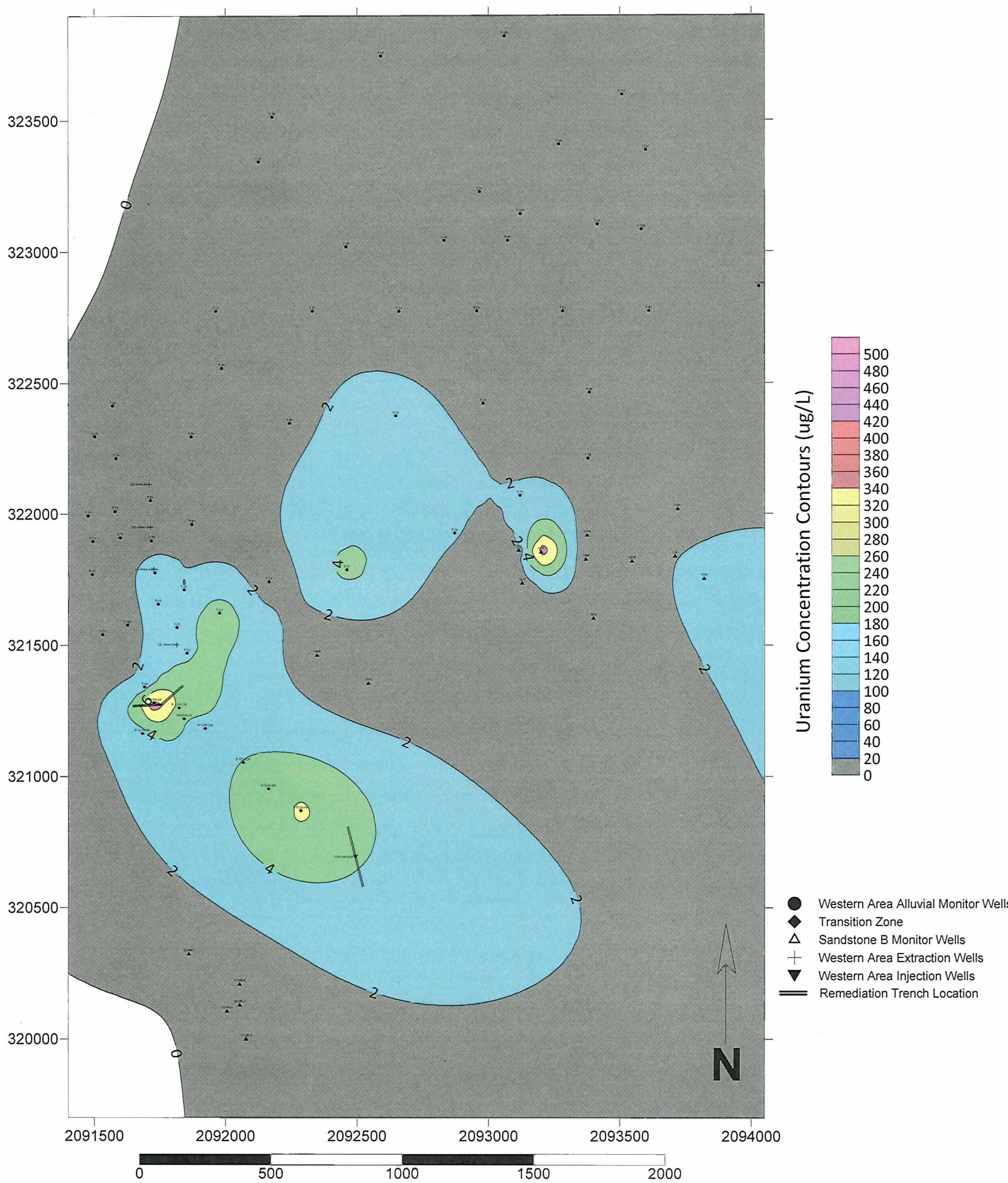


CREATED 09/12/2022 BY BURNS & MCDONNELL ENGINEERING, INC.

Sandstone A
Fluoride Isoconcentration Map (mg/L)

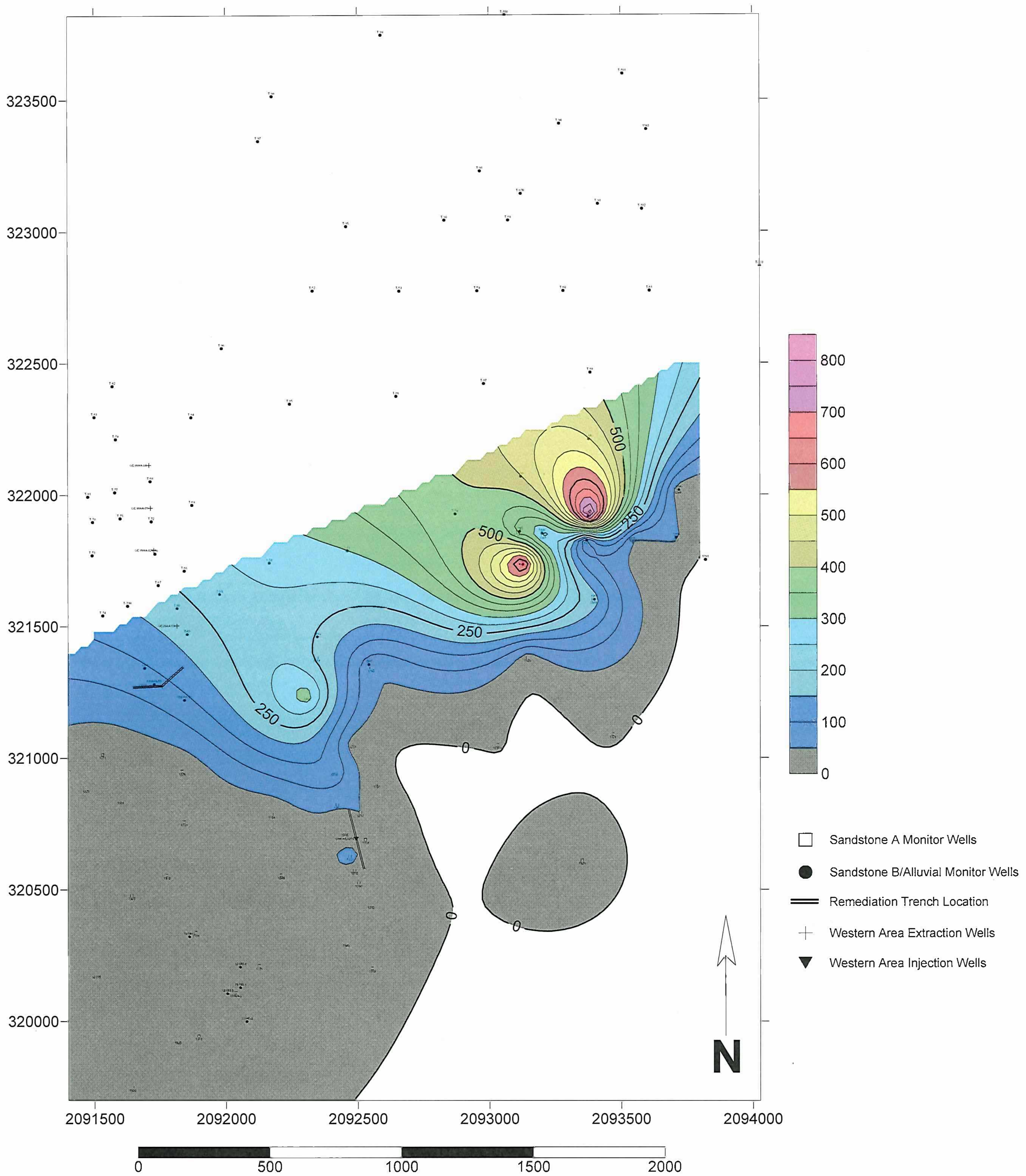


Sandstone B, Transition Zone, and Alluvium Fluoride Isoconcentration Map (mg/L)

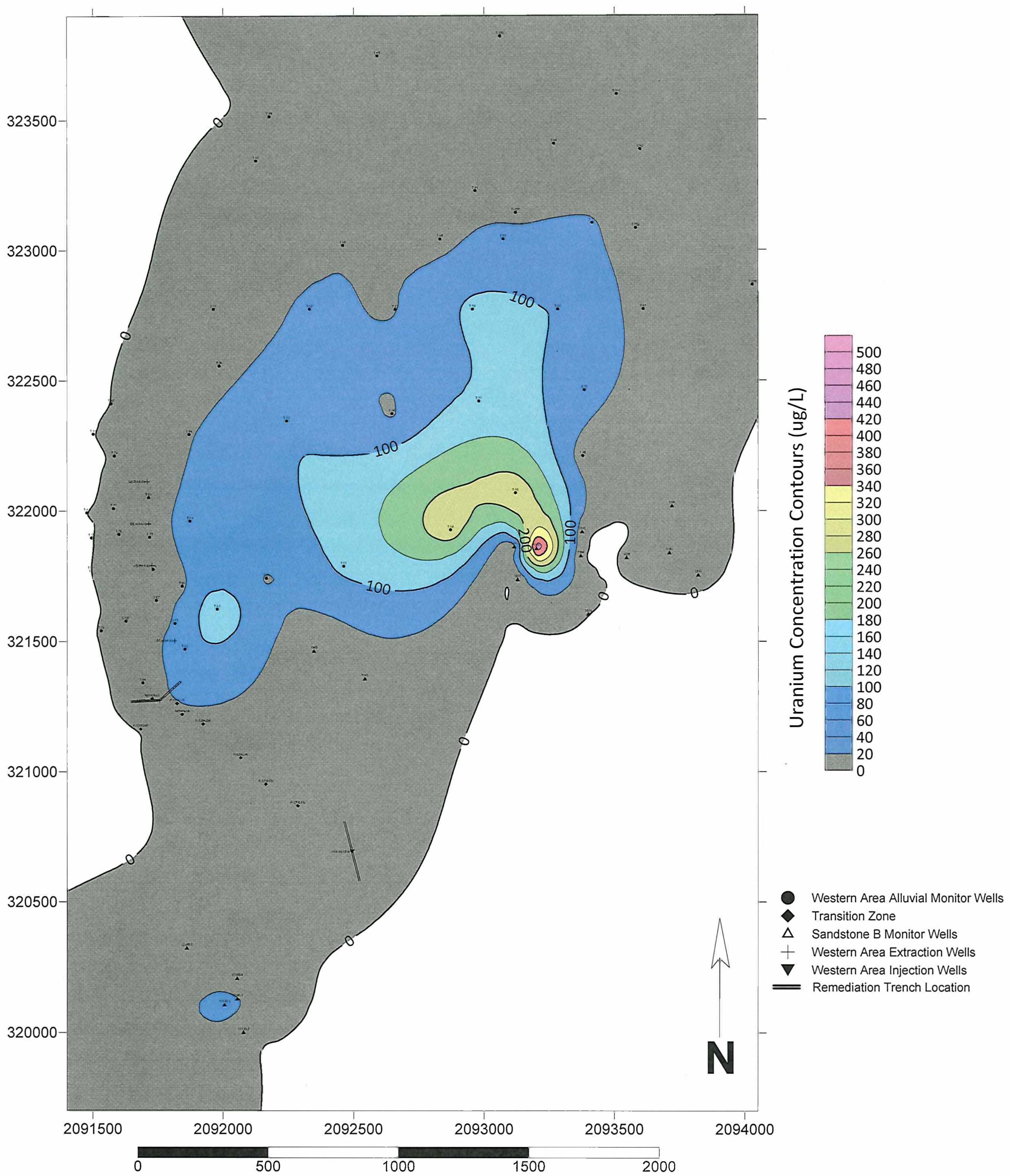


CREATED 09/12/2022 BY BURNS & MCDONNELL ENGINEERING

Sandstone A
Nitrate-Nitrite Isoconcentration Map (mg/L)

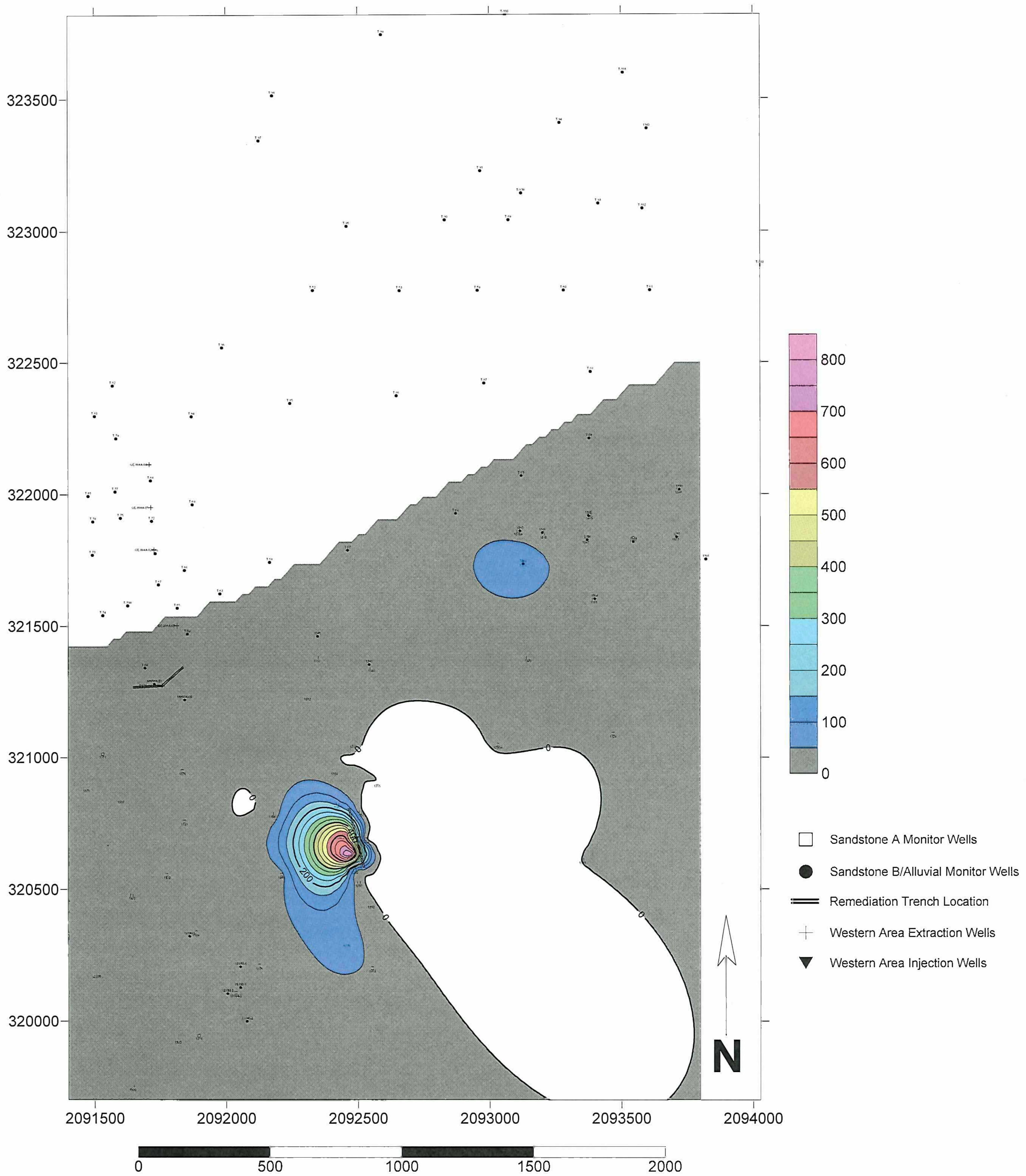


Sandstone B, Transition Zone, and Alluvium
Nitrate-Nitrite Isoconcentration Map (mg/L)

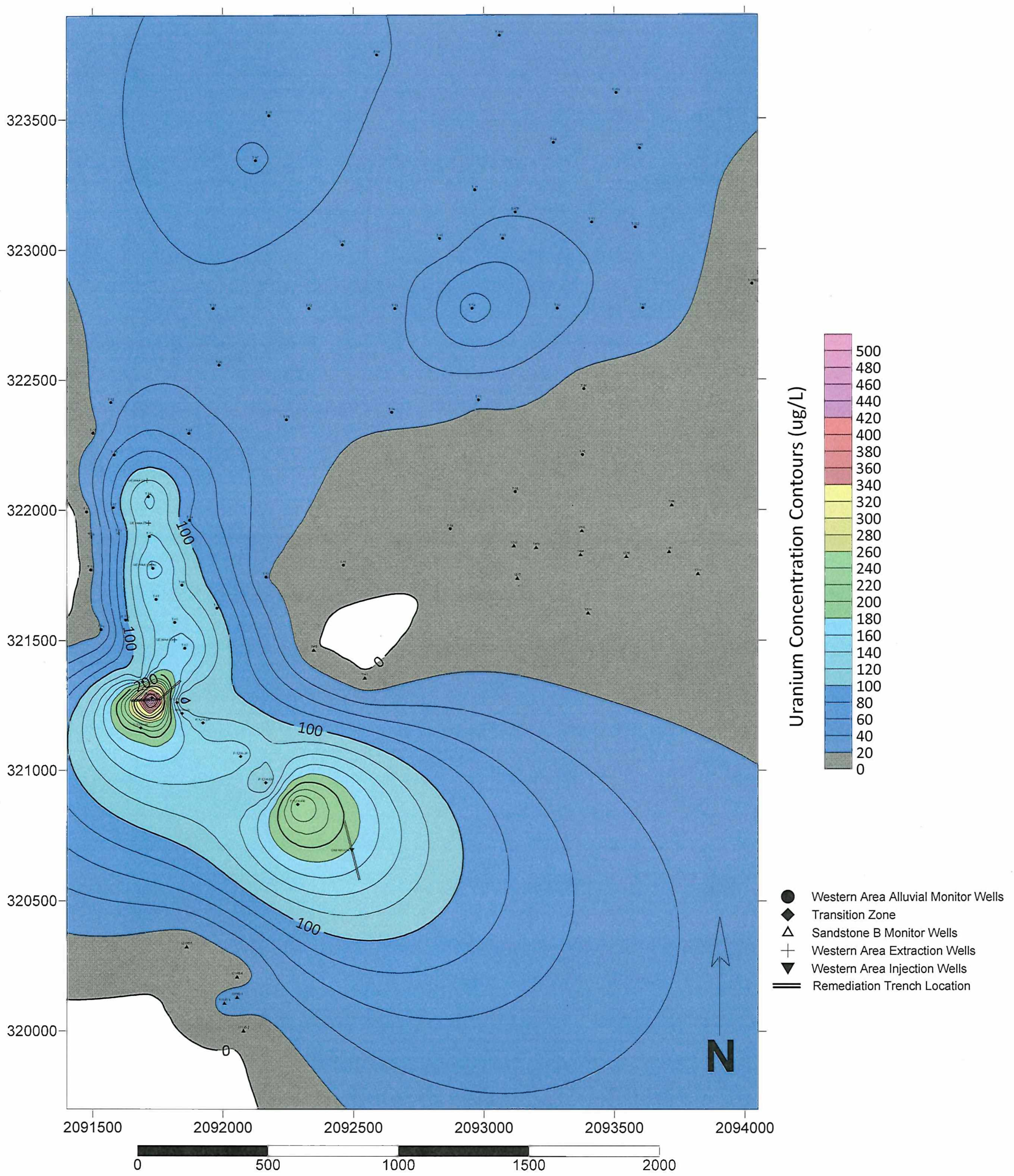


CREATED 09/12/2022 BY BURNS & MCDONNELL ENGINEERING

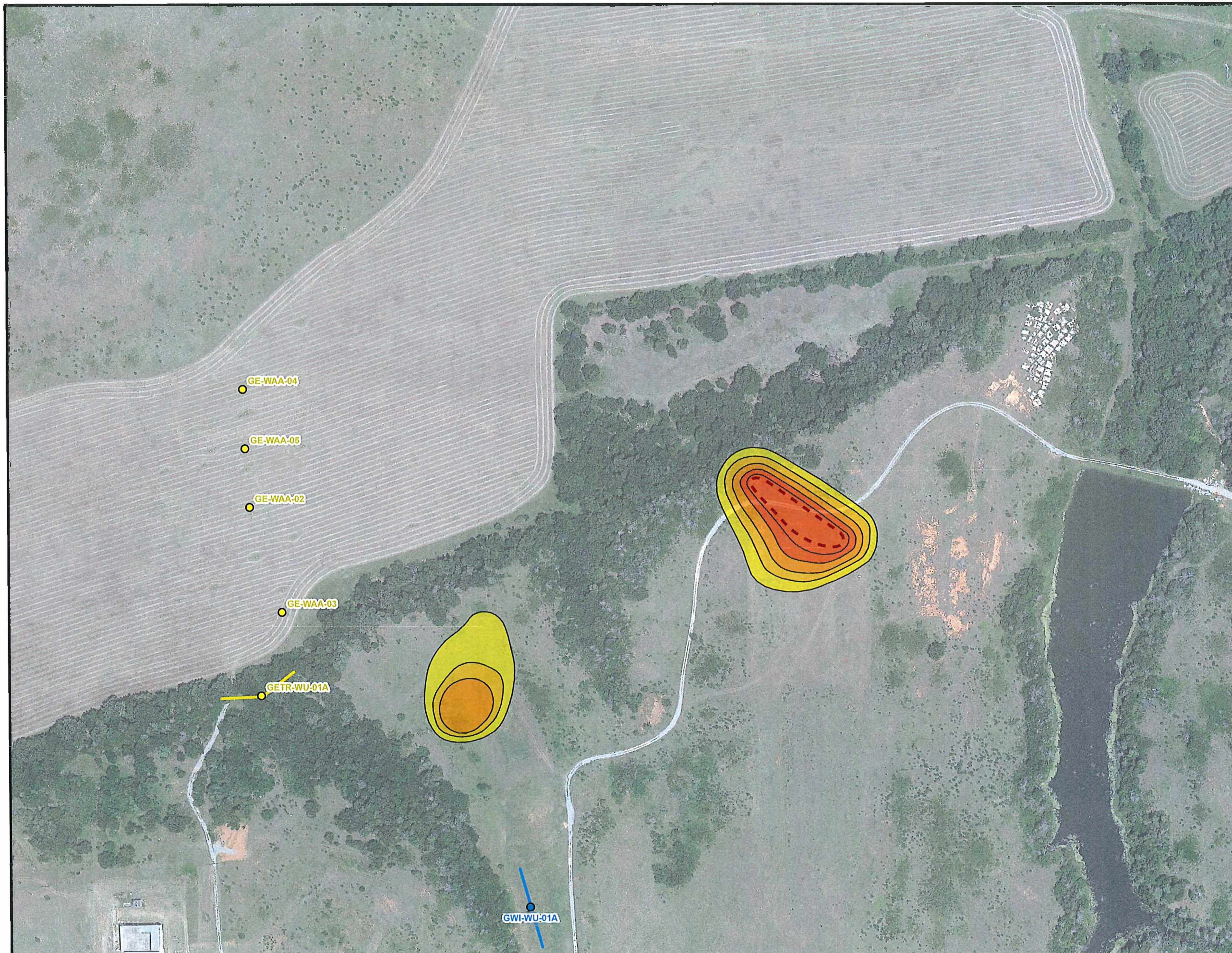
Sandstone A
Total Uranium Isoconcentration Map (ug/L)



Sandstone B, Transition Zone, and Alluvium Total Uranium Isoconcentration Map (ug/L)



CREATED 09/12/2022 BY BURNS & MCDONNELL ENGINEERING



ATTACHMENT 2
Tc-99 ISOPLETH IN THE WESTERN AREA
SANDSTONE A
CIMARRON SITE, OKLAHOMA

BURNS McDONNELL. CREATE AMAZING.

environmental properties management, LLC

LEGEND

- SANDSTONE A MONITOR WELL
- EXTRACTION WELL
- INJECTION WELL
- EXTRACTION TRENCH
- INJECTION TRENCH
- US EPA Tc-99 CONCENTRATION LIMIT OF 52.9 ng/L (900 pCi/L)
- 10 ng/L (170 pCi/L)
- 20 ng/L (340 pCi/L)
- 30 ng/L (510 pCi/L)
- 40 ng/L (680 pCi/L)
- 50 ng/L (850 pCi/L)

NOTES
1. AERIAL IMAGE MOSAICKED USING GOOGLE EARTH 2017 AERIAL PHOTOS.
2. SOME CONCENTRATIONS EXCEEDED THE US EPA ACTIVITY CONCENTRATION LIMIT OF 900 pCi/L (52.9 ng/L):1346 - 95.6 ng/L.
NO CONCENTRATIONS EXCEEDED THE NRC Tc-99 ACTIVITY CONCENTRATION LIMIT OF 3,790 pCi/L (222.9 ng/L).

N

0 250 500
SCALE IN FEET

NAD 1983 2011 StatePlane Oklahoma North FIPS 3501 Ft US

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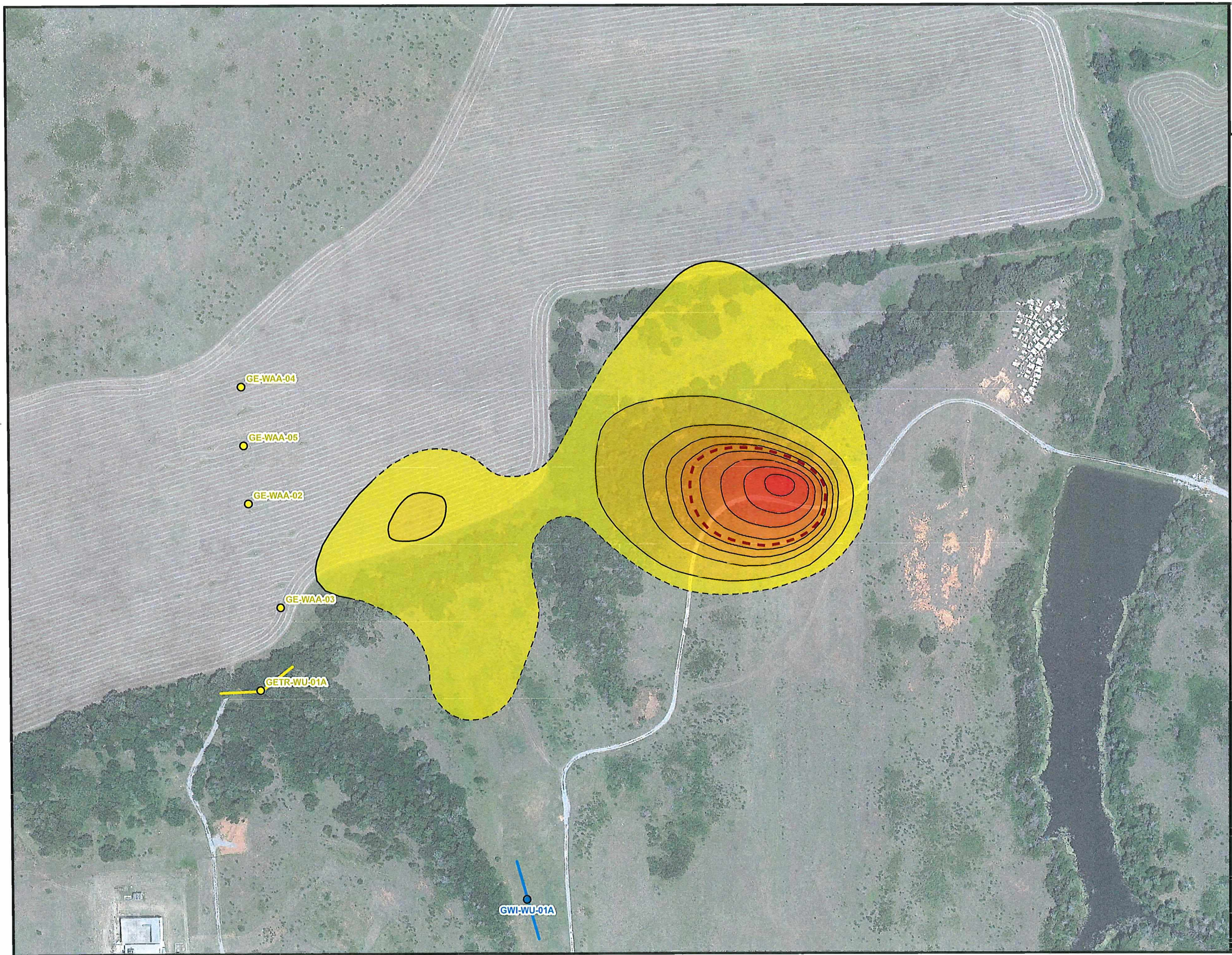

ATTACHMENT 2
Tc-99 ISOPLETH IN THE WESTERN AREA
SANDSTONE B, TRANSITION ZONE, ALLUVIUM
CIMARRON SITE, OKLAHOMA

BURNS McDONNELL. CREATE AMAZING.

environmental properties management, LLC

LEGEND

- ALLUVIUM MONITOR WELL
- SANDSTONE B MONITOR WELL
- TRANSITION ZONE MONITOR WELL
- EXTRACTION WELL
- INJECTION WELL
- EXTRACTION TRENCH
- INJECTION TRENCH
- US EPA Tc-99 CONCENTRATION LIMIT OF 52.9 ng/L (900 pCi/L)
- 10 ng/L (170 pCi/L)
- 20 ng/L (340 pCi/L)
- 30 ng/L (510 pCi/L)
- 40 ng/L (680 pCi/L)
- 50 ng/L (850 pCi/L)
- 60 ng/L (1020 pCi/L)
- 70 ng/L (1190 pCi/L)
- 80 ng/L (1360 pCi/L)
- 90 ng/L (1530 pCi/L)

NOTES

1. AERIAL IMAGE MOSAICKED USING GOOGLE EARTH 2017 AERIAL PHOTOS.
2. SOME CONCENTRATIONS EXCEEDED THE US EPA ACTIVITY CONCENTRATION LIMIT OF 900 pCi/L (52.9 ng/L):1346 - 95.6 ng/L.
NO CONCENTRATIONS EXCEEDED THE NRC Tc-99 ACTIVITY CONCENTRATION LIMIT OF 3,790 pCi/L (222.9 ng/L).

N

0 250 500

SCALE IN FEET

NAD 1983 2011 StatePlane Oklahoma North FIPS 3501 Ft US

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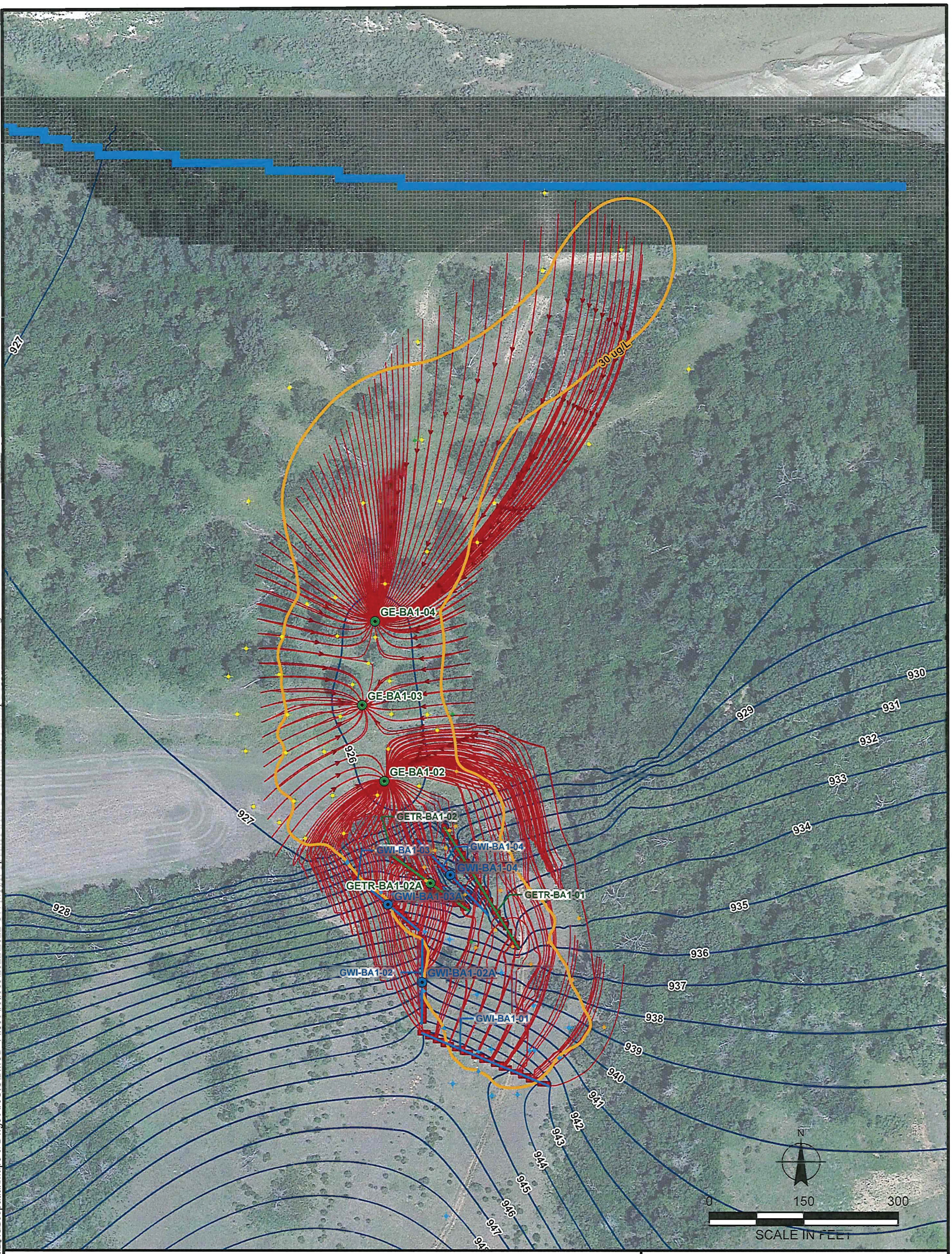
Attachment 3 – BA1 and WA Particle Tracking Results



LEGEND

- MONITOR WELL IN ALLUVIUM
- MONITOR WELL IN SANDSTONE B
- MONITOR WELL IN SANDSTONE C
- MONITOR WELL IN TRANSITION ZONE
- EXTRACTION WELL/SUMP
- INJECTION WELL
- GROUNDWATER EXTRACTION TRENCH
- GROUNDWATER INJECTION TRENCH
- PARTICLE FLOW DIRECTION ARROWS
- PARTICLE TRACKING
- PUMPING HEAD CONTOURS (1 FT)
- BA1 URANIUM CONTOUR (30 UG/L)
- GENERAL HEAD BOUNDARY CELLS
- RIVER BOUNDARY CELLS
- NO FLOW BOUNDARIES
- TRENCH MODEL CELLS

NOTES

1) GROUNDWATER ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (NORTH AMERICAN VERTICAL DATUM OF 1988).

2) BASEMAP: GOOGLE EARTH 2017

FIGURE 4-2
BA1 GROUNDWATER FLOW MODEL
MODPATH PARTICLE TRACKING RESULTS
SITE FACILITY DECOMMISSIONING PLAN
(REVISION 3)

BURNS McDONNELL

environmental properties management, LLC

	Rev No: 0
Preparer: BELOCKWOOD	Date: 9/20/2022
Reviewer: DCLEMENT	Date: 9/20/2022

Coordinate System
WGS 1984 Web Mercator Auxiliary Sphere

Path: Z:\Clients\ENS\CERT_Client\Info\Sites\Database\Geospatial\Maps & Dwgs\ArcGIS\BMCD_Files\Arcdocs\2022\2022 GW Model Updates from DClement\Site Facility Decommissioning Plan Rev 3 MODPATH Results.aprx

Nominal Pumping Scenario | **Operating Scenario 1** | **Operating Scenario 2**

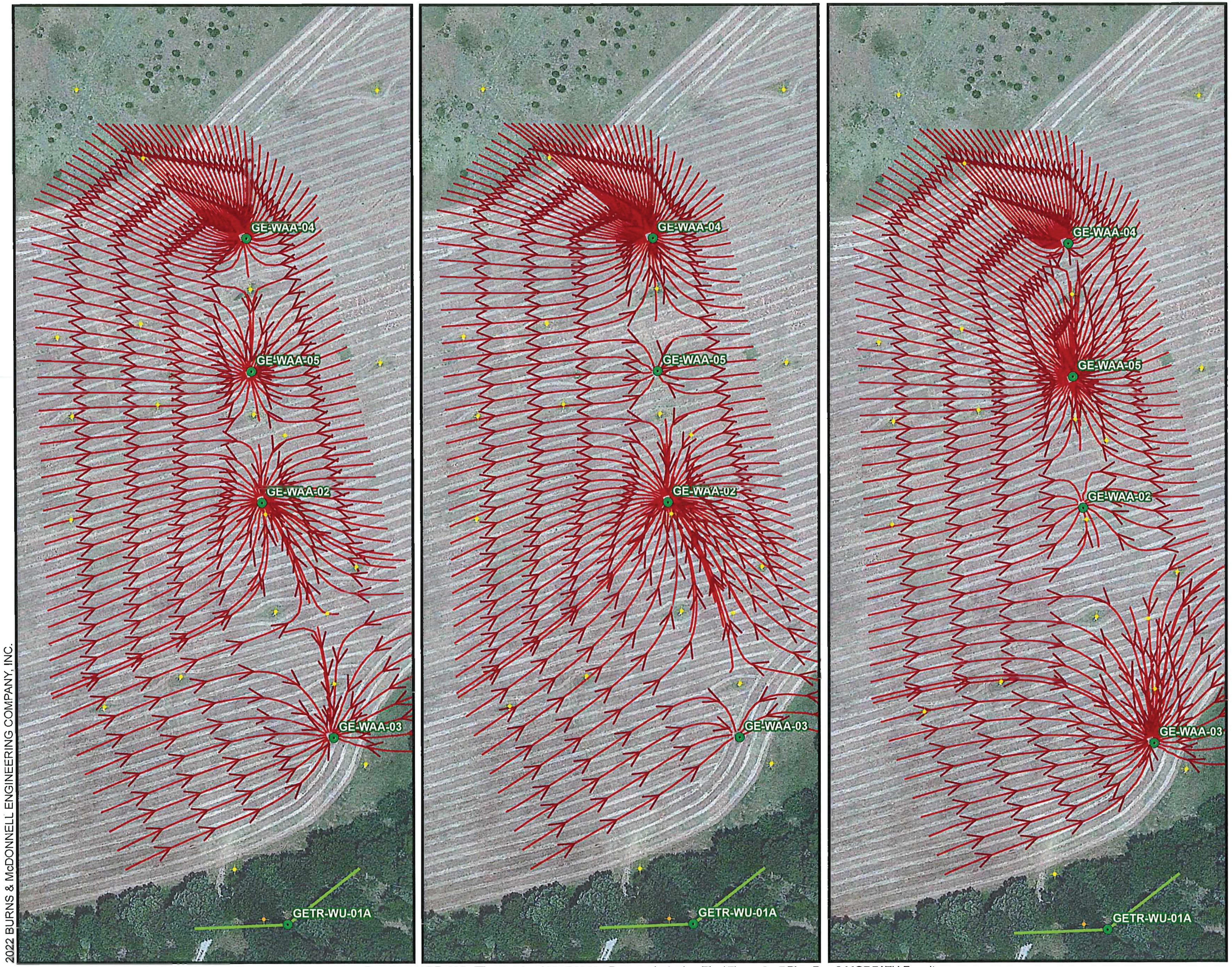


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FIGURE 9
WESTERN AREA PARTICLE TRACKING
FACILITY DECOMMISSIONING PLAN
REVISION 3

BURNS McDONNELL | environmental properties management, LLC

LEGEND

- MONITOR WELL IN ALLUVIUM
- MONITOR WELL IN TRANSITION ZONE
- EXTRACTION WELL
- GROUNDWATER EXTRACTION TRENCH
- PARTICLE TRACKING
- PARTICLE FLOW DIRECTION ARROWS

NOTES

1) THE DISTANCE BETWEEN ARROW HEADS REPRESENTS THE DISTANCE THE PARTICLE TRAVELS IN 60 DAYS.

2) GPM - GALLONS PER MINUTE.

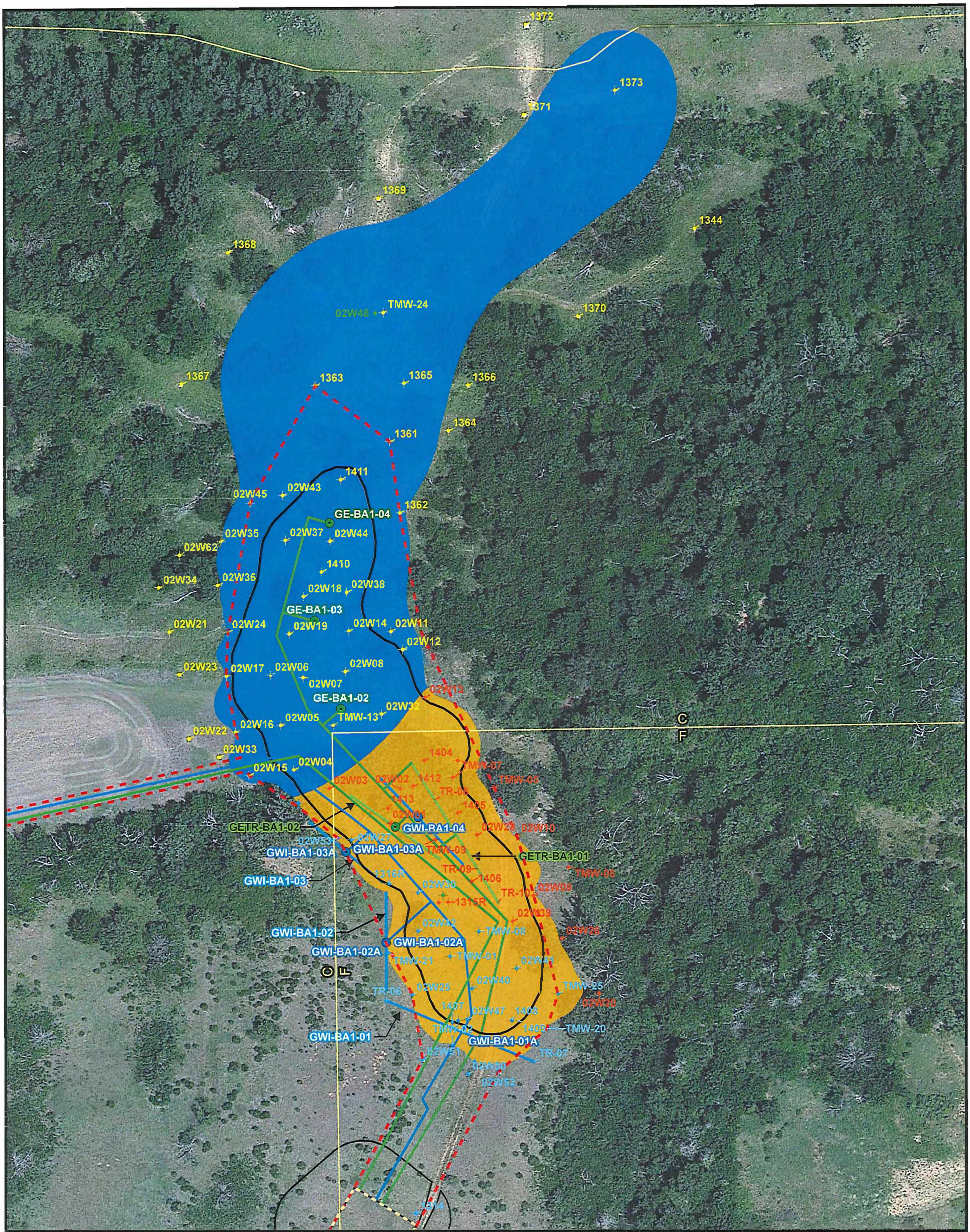
3) BASEMAP: GOOGLE EARTH 2017

0 125 250
SCALE IN FEET
N

	Rev No: 0
Preparer: DHORNE	Date: 10/6/22
Reviewer: DCLEMENT	Date: 10/6/22

Coordinate System
NAD 1983 StatePlane Oklahoma North FIPS 3501 Feet

Attachment 4 – BA1 Remediation Component Locations



LEGEND

- MONITOR WELL IN ALLUVIUM
- MONITOR WELL IN SANDSTONE B
- MONITOR WELL IN SANDSTONE C
- MONITOR WELL IN TRANSITION ZONE
- EXTRACTION WELL/SUMP
- INJECTION WELL
- GROUNDWATER EXTRACTION PIPING
- TREATED WATER INJECTION PIPING
- GROUNDWATER EXTRACTION TRENCH
- TREATED WATER INJECTION TRENCH
- 201 ug/L URANIUM ISOPLETH
- REMEDIATION FACILITY
- BA1-A REMEDIATION AREA
- BA1-B REMEDIATION AREA
- SUBAREAS
- PROPOSED LICENSED AREA
- RADIOLOGICALLY CONTROLLED AREA

NOTES

1) Injection trench GWI-BA1-01 and extraction trench GETR-BA1-01 were installed in 2017.

2) Injection well GWI-BA1-01A and extraction wells GETR-BA1-01A and GETR-BA1-01B were installed in 2017.

3) Isopleths are drawn based on "representative" uranium concentrations, expressed in micrograms per liter (µg/L). With a conservatively estimated value of 1.3% for U -235 enrichment, the 201 µg/L isopleth, as shown, represents the 180 pCi/L (picocuries per liter) isopleth.

4) Basemap: Google Earth 2017

0 100 200

SCALE IN FEET

N

FIGURE 8-2
BURIAL AREA #1 GROUNDWATER
REMEDIATION AREAS
FACILITY DECOMMISSIONING PLAN
REVISION 3

BURNS McDONNELL

environmental properties management, LLC

	Rev No: 0
Preparer: TJKIMMEL	Date: 9/14/2022
Reviewer: EDULLE	Date: 9/14/2022

Coordinate System
NAD 1983 StatePlane Oklahoma North FIPS 3501 Feet

Z:\Clients\ENS\CERT_ClientInfoSites\Database\Geospatial\Maps & Dwgs\ArcGIS\BMCD_Files\Arcdocs\2020\2022 - Decommissioning Plan\Figure 8-2_BA1 GW Remediation Areas