APPENDIX 4-A

TECHNICAL MEMORANDUM, PROCESS USED TO SELECT WELL LOCATIONS

TECHNICAL MEMORANDUM

DATE:	April 06, 2015	**PROJECT NO.**	350.0092.000
TO:	K. Bill Clark, NewFields		
FROM:	Joel Jacobson, NewFields		
SUBJECT:	Process Used to Select Well Locations, Groundwater Monitoring Program, Pinedale Anticline Project Area, Sublette County, Wyoming		

This technical memorandum documents the methods and results for selecting monitoring well locations that will be used for the Groundwater Pollution Prevention, Monitoring and Response Action Plan (Plan) for the Pinedale Anticline Project Area (PAPA), a natural gas development in Sublette County, Wyoming. Goals and objectives for the Plan were approved by the BLM Pinedale Field Office on June 19, 2014. One of the Plan's goals is to establish a Groundwater Monitoring Program capable of identifying impacts from natural gas activities based on previous groundwater characterization studies and differing levels of risk in different areas of the PAPA. The Program must monitor groundwater for constituents that are: most indicative of impacts from natural gas activities; most likely to appear first at monitoring sites; and, most hazardous to public health and the environment. Specific objectives for this goal related to monitoring locations are:

- **Objective O2.3** - Develop a tiered approach to groundwater monitoring that includes different water quality parameters and sampling frequencies for monitoring locations based on risk, proximity to active development and when a threshold is reached.
- **Objective O2.5** - Establish groundwater monitoring locations to provide for early detection of potential impacts from oil and gas activities in areas of greatest environmental sensitivity.
- **Objective O2.6** - Establish groundwater monitoring locations to provide spatial coverage of the PAPA.

The following subsections present the methods and results used to select monitoring locations for the Plan and fulfill the objectives listed above. Figures and tables referenced herein are attached to this memorandum.

METHODS

Based on work completed independent of (Hamerlinck and Ameson, 1998; Geomatrix, 2002; Bedessem, et. al., 2005) and pursuant to (Geomatrix, 2008; AMEC, 2012; AMEC, 2013a; AMEC, 2013b) BLM's 2008 Record of Decision (BLM, 2008), three areas were selected for monitoring based on current and future natural gas development and risk to potential environmental receptors from natural gas activities in the PAPA. **Figure 4A-1** presents the three areas which include the North Zone, River Corridor Envelope

(RCE), and South Zone (refer to Section 4.2.3 of the Groundwater Monitoring Program; NewFields, 2016).

The methods used to determine monitoring locations for the three zones were designed to produce the minimum number of monitoring locations needed to: 1) ensure adequate capture of impacted groundwater from potential sources; 2) provide early detection of impacted groundwater upgradient of potential receptors; and, 3) fulfill the objectives listed above. Potential sources and receptors in the PAPA were identified as part of the numerical groundwater modeling process (AMEC, 2013a). Potential sources include well pads and their facilities, centralized liquid gathering system (LGS) facilities, LGS pipelines, and injection wells. Potential receptors include the New Fork River and associated floodplain and riverine system, stock wells, and domestic wells on private land.

North and South Zones

The North and South zones are located north and south of the New Fork River, respectively, and encompass the majority of natural gas development areas in the PAPA (**Figure 4A-1**). Few receptors exist in these zones and groundwater is hosted entirely in the Wasatch HSU. The geographic position of monitoring locations was determined using spatial analysis of existing wells with the goal of optimizing the existing well network. For this analysis, optimization was defined as a monitoring network that contains the minimum number of wells needed in order to provide early detection of potential groundwater degradation and sufficient spatial coverage of the PAPA. Optimization was based on an assumed area of potential degradation which was established using results from AMEC (2012) and AMEC (2013a).

Spatial analysis was performed using Visual Sample Plan (VSP) version 7.0 (PNNL, 2014). The software evaluated positions of existing wells and the zone boundary to calculate the largest unsampled area. If the largest unsampled area was greater than the predetermined extent of potential degradation (see below), it was considered a data gap and a new well was added. If two wells were within an area smaller than the predetermined extent of potential degradation, one of the wells was removed. This method was performed iteratively until the largest unsampled area was reduced to the predetermined extent of potential degradation and there were no redundancies (multiple wells in an area smaller than the predetermined extent of potential degradation) within the zone.

If one or more wells were removed from an area, or a new well was added, the hydrogeologic conceptual model (AMEC, 2012) was considered along with the location of potential sources and receptors. For example, if two wells were located in an area, and one well needed to be removed, the well that was hydraulically down-gradient of the fewest potential sources was removed. Additionally, if a new well was added, it was placed in order to optimize the network (i.e., result in the fewest number of wells) and was positioned hydraulically down-gradient of the most potential sources in the particular sample area.

The area of potential degradation that could occur in the PAPA as a result of natural gas activities was determined using results from AMEC (2012) and AMEC (2013a). AMEC (2012) calculated a maximum contaminant travel distance of 4,400 feet in 110 years (twice the expected development time in the PAPA; refer to BLM [2008]) based on aquifer tests, gradients calculated from groundwater elevations, and effective porosity values of sandstone obtained from literature. AMEC (2013a) reports that potential contamination in the Wasatch HSU could travel 6,000 feet in 110 years based on advective transport modeling. Based on these results, the lesser of the two estimated 110 year travel distances (4,400 feet) was used as the radius of potential degradation that could occur in the PAPA as a result of natural gas activities. Therefore, using the method described above, the radius of the largest unsampled area in the North and South zones was reduced to approximately 4,400 feet.

It is important to note that uncertainty and variability inherent in parameters used to calculate groundwater velocity (e.g., hydraulic conductivity, hydraulic gradient, and effective porosity) and uncertainty related to the potential accuracy of existing well locations results in a range of sizes for the radius of potential degradation. Hydraulic conductivity and horizontal hydraulic gradients in the Wasatch Formation vary by over an order-of-magnitude depending on location in the PAPA and lithology (AMEC, 2012). In addition, recreational grade global positioning satellite (GPS) units used to locate many of the existing wells included in the project geodatabase and typically produce locations accurate to within approximately 8 to 59 feet (BLM, 2010 and Weih et. al., 2009). This uncertainty results in a range of variability in the radius of potential degradation around 4,400 feet. Consequently, 4,400 feet was used as a guideline rather than a strict value.

NewFields' electronic database management system (EDMS) was used to identify existing wells in the PAPA that are currently included in the Operator's monitoring program being conducted by Sublette County Conservation District (SCCD) or were study wells installed as part of AMEC (2012). This dataset consisted of 233 wells of which 24 were stock wells, 82 were industrial water supply wells, 84 were domestic wells, and 43 were wells installed as part of AMEC (2012). This dataset was then reduced to only include wells located in the North and South zones. In addition, domestic and stock wells were removed because these were identified as potential receptors. Objective O2.5 (see above) states that monitoring locations should provide early detection of potential impacts. In order to satisfy this objective, groundwater upgradient of potential receptors will be monitored instead of the potential receptors themselves. Finally, wells with known contamination (e.g., wells enrolled in Wyoming Department of Environmental Quality's [DEQ] Voluntary Remediation Program [VRP]) were removed from consideration. This resulted in an initial dataset of 43 existing wells in the North Zone and 26 existing wells in the South Zone (**Figure 4A-2**).

Results of this analysis are presented below in the 'Results' and 'Conclusions' sections of this memorandum.

RIVER CORRIDOR ENVELOPE (RCE)

The RCE is located in the center of the PAPA and includes several potential sources and receptors, and near-surface groundwater is present in portions of the Wasatch and Alluvial HSUs. AMEC (2013a) initially defined the RCE using advective transport results from potential sources and receptors (refer to Figure 30 in AMEC, 2013a). The extent of the RCE was refined for this analysis because roads were eliminated as a potential source of groundwater contamination because the LGS was installed by the Operators and vastly reduced the risk of transportation accidents being potential sources. In addition, spills resulting from transportation accidents would be immediately addressed through DEQ and BLM regulations for spill response actions. To fulfill objective O2.5 (see above), the RCE was divided into two different areas, the Alluvial RCE and Wasatch RCE.

Existing wells in the RCE are generally not located hydraulically downgradient of most potential sources and therefore would not provide adequate spatial coverage (Objective O2.6) or early detection (Objective O2.5). In order to satisfy these objectives, monitoring wells will be located between potential sources and receptors.

The location of monitoring wells in the Wasatch RCE was determined using the numerical groundwater model of the PAPA and results from AMEC (2012) and AMEC (2013a). Monitoring wells in the Alluvial RCE were placed on the four existing natural gas well pads in the floodplain, between the pad (potential source) and the New Fork River (potential receptor). VSP was not used to select or position monitoring wells in the RCE because of the location of existing wells in relationship to potential sources (i.e., alluvial RCE monitoring wells are located at the potential source) and receptors.

The initial location of monitoring wells in the Wasatch RCE was outside of the New Fork River floodplain, hydraulically down-gradient of potential sources. Wells were spaced 2,100 feet apart north and south of the New Fork River. Spacing between these wells was determined using results of the hypothetical solute transport model simulating a chloride release from a legacy natural gas well (AMEC, 2013a). The 1 milligram per liter (mg/L) isoconcentration contour for chloride was used to calculate the maximum width of a potential plume emanating from a natural gas source (refer to Figure 61 in AMEC, 2013a). These initial locations were then optimized based on simulated flow paths from the model and land use/ownership.

Flow paths from the proposed monitoring wells were evaluated using advective transport modeling with reverse particle tracking. Particle tracking involves tracing the movement of imaginary particles in a groundwater flow field based on groundwater velocities and direction. Particles are given a starting location and traced for a defined time period (110 years for this analysis). In reverse particle tracking, particles are placed in a flow field and tracked backward (opposite direction of groundwater flow) along path lines to a potential source. Particle tracking does not take into account the effects of dispersion, adsorption, or biodegradation, and assumes that dissolved contaminants move at the same velocity as groundwater.

Particles were placed around proposed monitoring wells and traced backward through the groundwater flow field. Results were then analyzed to ensure adequate capture of degradation from any potential sources assuming a potential plume width of 2,100 feet. In addition, it was assumed that a release from potential sources close to Paradise Road would not spread to 2,100 feet prior to reaching the floodplain. Monitoring wells were placed directly down-gradient of these sources to ensure capture of any potential degradation.

Finally, the location of potential receptors and land ownership and access were assessed to determine the final location of monitoring wells. In the western portion of the RCE, there are few potential sources so one monitoring well was placed in this area, hydraulically upgradient of domestic wells. Results of this analysis are presented in the 'Results' and 'Conclusions' sections below.

Vertical Monitoring

In addition to determining the geographic position of monitoring wells, the vertical aspect of monitoring was statistically analyzed to evaluate the potential need for monitoring at various depths in the Wasatch Formation. EDMS was used to identify industrial water supply, stock, domestic, and study wells within the monitoring boundary that have ground surface elevation and depth to screened interval information, have been sampled for chloride or total dissolved solids (TDS), and are screened completely within the Wasatch Formation. Chloride and TDS were used for this analysis because these compounds travel conservatively in groundwater (i.e., do not adsorb or biodegrade and travel at the same velocity as groundwater).

Vertical analysis of the investigated data was initiated by identifying and removing potential outlier values in the dataset. Outlier data points can distort statistics and lead to unrepresentative results. Outliers can occur for several reasons, including: 1) measurement recording errors; 2) measurement from an impacted well; or, 3) rare or unexpected event (Helsel and Hirsch, 2002). Data from wells enrolled in DEQ's VRP were removed for the analysis because these wells were assumed to be potentially impacted, and thus, not representative of background water quality. Next, quantile-quantile (Q-Q) probability plots[1] were used to visually identify outliers. On a Q-Q plot, elevated measurements that are separated from the majority of data were considered outliers and removed from the dataset. The following images are "screen shots" of Q-Q plots generated using EPA's Scout software (EPA, 2009; EPA, 2010). In these images, dots within red circles are outliers. Each time an outlier is removed, the Q-Q plot is reconstructed to identify if other outliers remain. This process continued until no outlier could be visually detected on the Q-Q plot.

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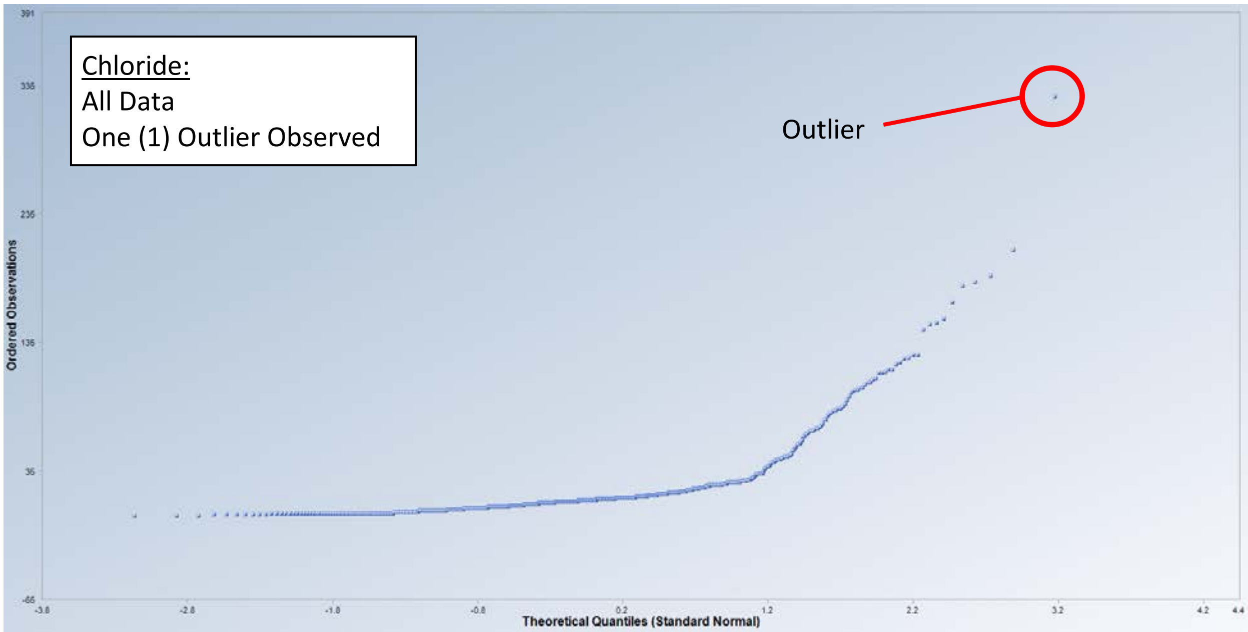
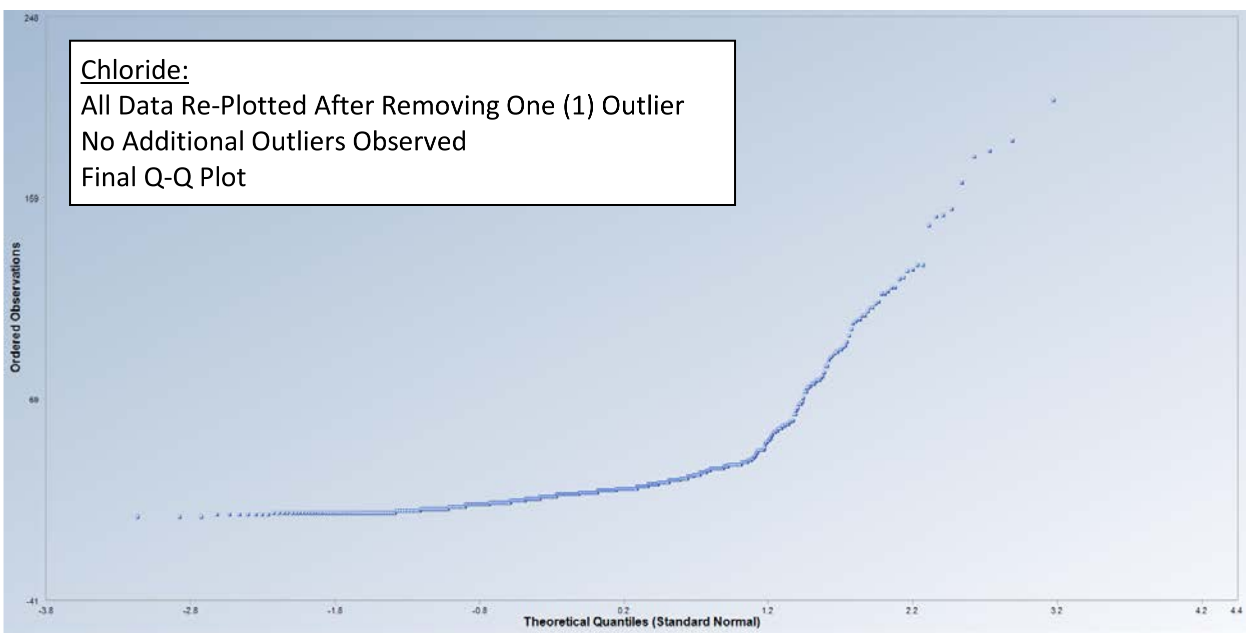
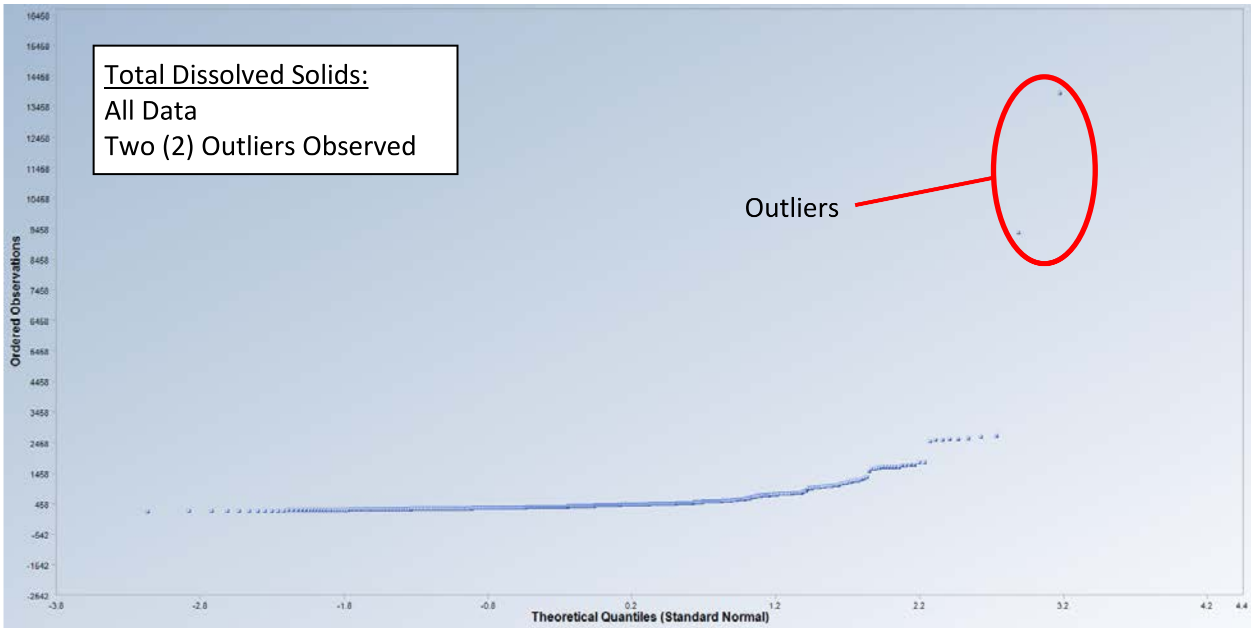
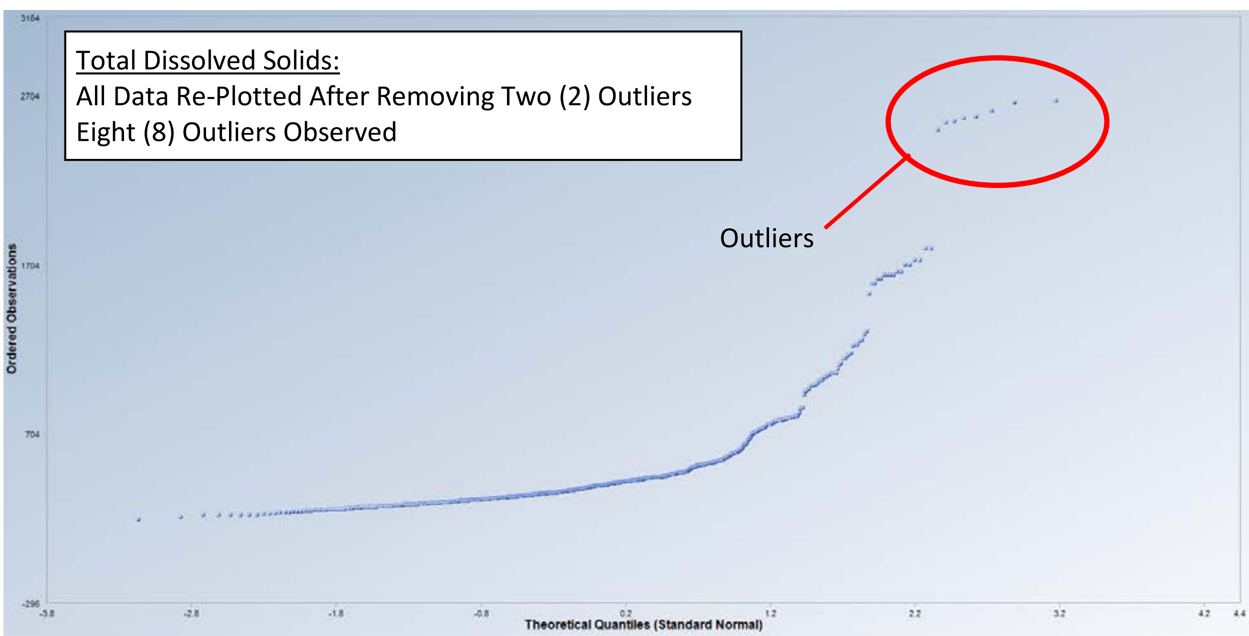
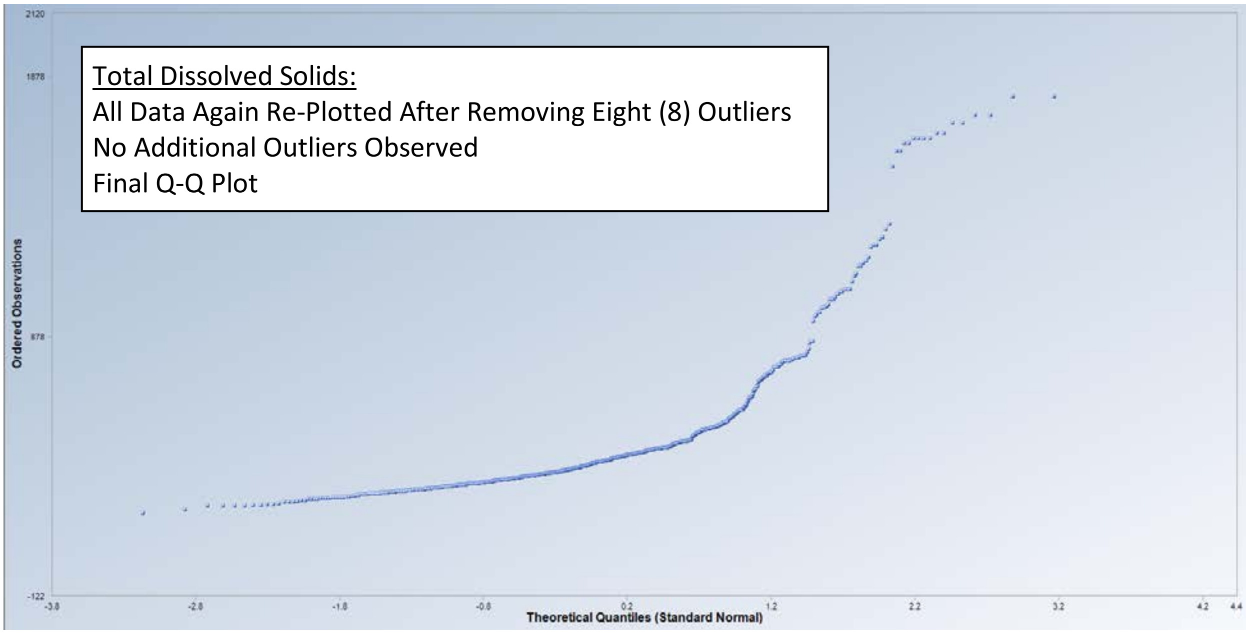
1 Quantile-Quantile or Q-Q plot is a type of a statistical probability plot that displays the investigated data in an ascending order versus their corresponding theoretical quantiles based on an assumed distribution. The most common Q-Q plots are based on assumed normal distributions. In such cases, if a Q-Q plot forms a straight line, then the investigated data are considered as being normally distributed. Q-Q plots with large gaps and/or segmented portions with different slopes are indicative of multiple populations. For more information about probability plots, reviewers are referred to DON (2004; Section 3.3.4)


Chloride:
All Data
One (1) Outlier Observed
Outlier
Ordered Observations
Theoretical Quantiles (Standard Normal)


Chloride:
All Data Re-Plotted After Removing One (1) Outlier
No Additional Outliers Observed
Final Q-Q Plot
Ordered Observations
Theoretical Quantiles (Standard Normal)


Total Dissolved Solids:
All Data
Two (2) Outliers Observed
Outliers
Ordered Observations
Theoretical Quantiles (Standard Normal)


Total Dissolved Solids:
All Data Re-Plotted After Removing Two (2) Outliers
Eight (8) Outliers Observed
Outliers
Ordered Observations
Theoretical Quantiles (Standard Normal)



Removal of data from wells enrolled in the VRP and outliers identified using Q-Q plots resulted in a dataset for vertical monitoring analysis that consisted of 820 chloride samples and 811 TDS samples collected from 95 wells within the monitoring boundary. The depth of the midpoint of well screens ranges from 54 to 1,210 feet below ground surface whereas the elevation of the midpoint of well screens ranges from 6,306 to 7,263 feet above mean sea level (amsl). The average elevation of the midpoints of well screens is approximately 6,700 feet.

Two depth variables (depth below ground surface and elevation) were analyzed due to the relief present in the PAPA, as the ground surface elevations of some natural gas well pads on the Mesa in the North Zone are approximately 7,600 feet and the elevation of the New Fork River in the center of the PAPA is about 6,900 feet. Chloride and TDS datasets were separated into groups based on: 1) wells with a depth (below ground surface) of the midpoint for the well screen interval less than and greater than 500 feet; and, 2) wells with an absolute elevation for the midpoint in the well screen interval above and below 6,700 feet amsl. Depth and elevation values used to separate the datasets were selected in order to create an approximately equal number of data points in each group. Finally, the average chloride and TDS concentration was calculated for each of the 95 wells to create the final dataset for analysis.

These datasets were then evaluated statistically using a t-test. A t-test is a commonly used method for comparing two independent groups of data (Hersel and Hirsch, 2002). The test is performed by producing a t-statistic, which is the ratio of the difference in the mean of the two groups to the pooled sample standard deviation. Each t-statistic is associated with a p-value which is the probability of obtaining that t-statistic. The p-value is compared to a pre-defined significance level to determine if a statistically significant difference exists between the group means. In this work, a 5 percent significance level was used for the test, thus if the calculated p-value is less than or equal to 0.05, there is a statistically significant difference between the mean values for the two groups.

Results of this analysis are presented below in the 'Results' and 'Conclusions' sections of this memorandum.

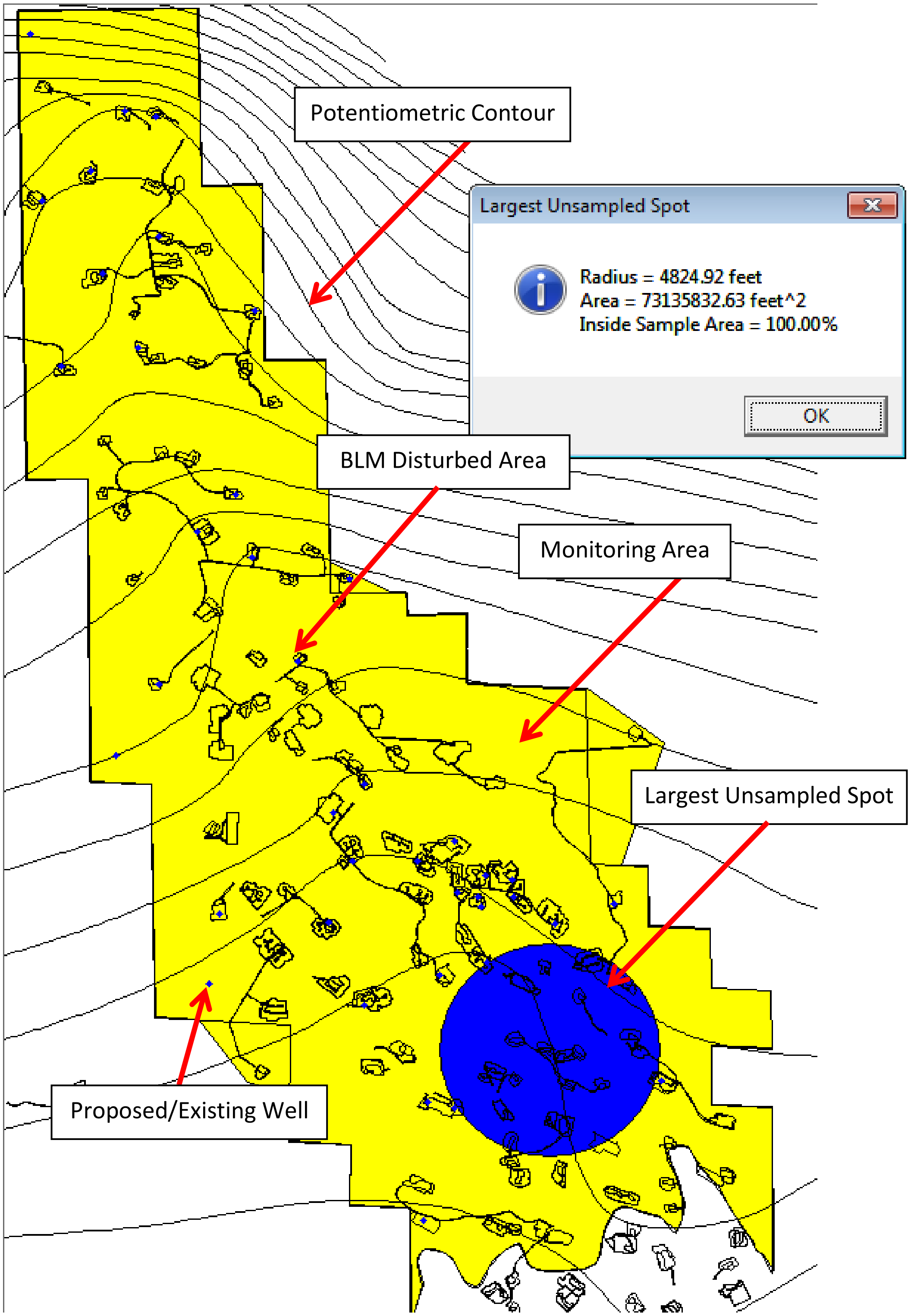
RESULTS

The following presents results for the North Zone, South Zone, and RCE based on the methods described above.

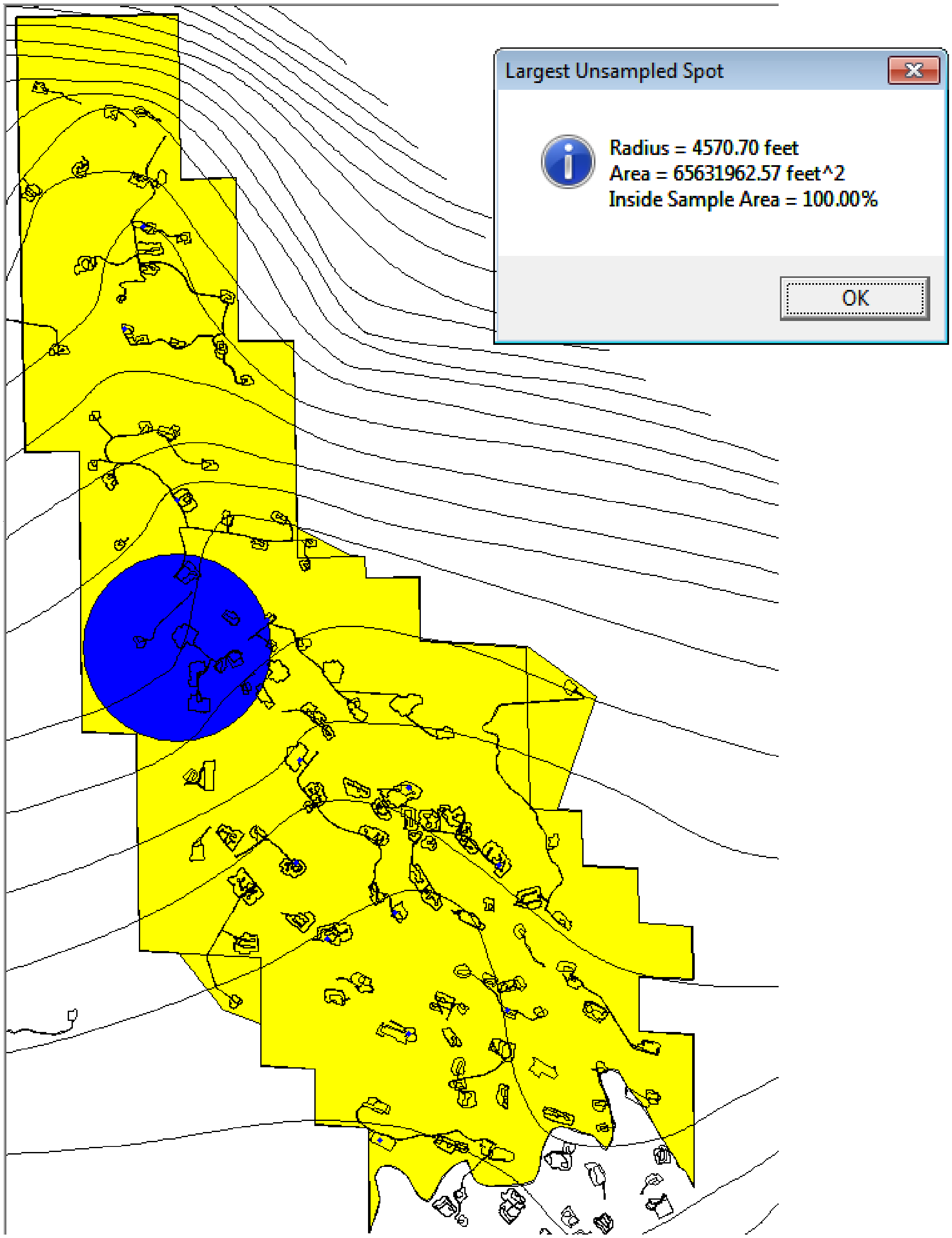
WELL LOCATION ANALYSIS - NORTH AND SOUTH ZONES

The images shown below are "screen shots" from the spatial analysis described above. Each step of the spatial analysis shown sequentially in the screen shots further refined and optimized the monitoring network. The yellow polygon in each screen shot represents either the North or South zone; the September 2010 potentiometric surface and potential natural gas sources are depicted as black lines; and, the existing/proposed monitoring wells are depicted as small blue dots. Each screen shot is accompanied by the value of the largest unsampled area. The goal of the analysis was to reduce the radius of this area to approximately 4,400 feet.

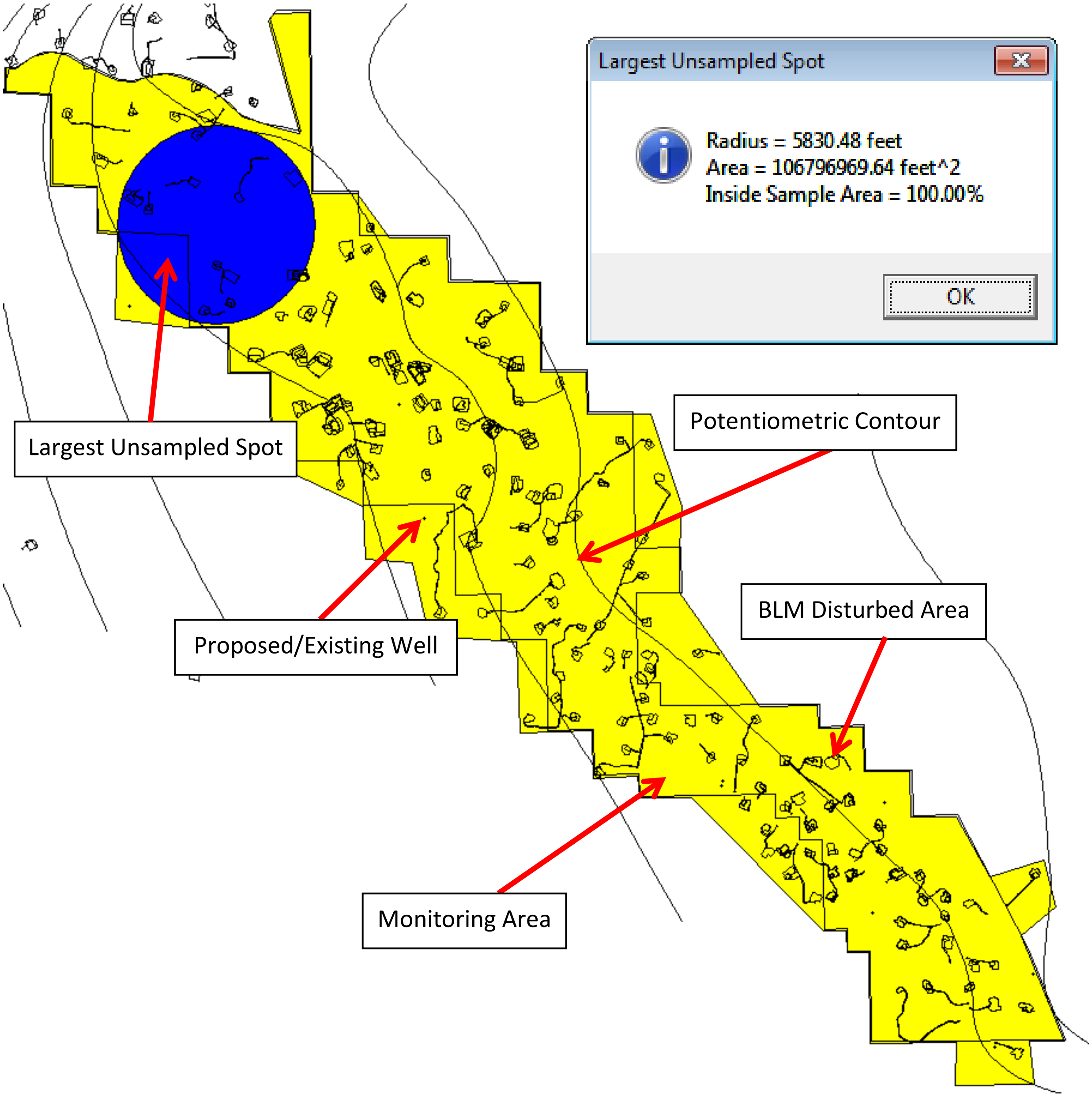
North Zone – All existing wells:



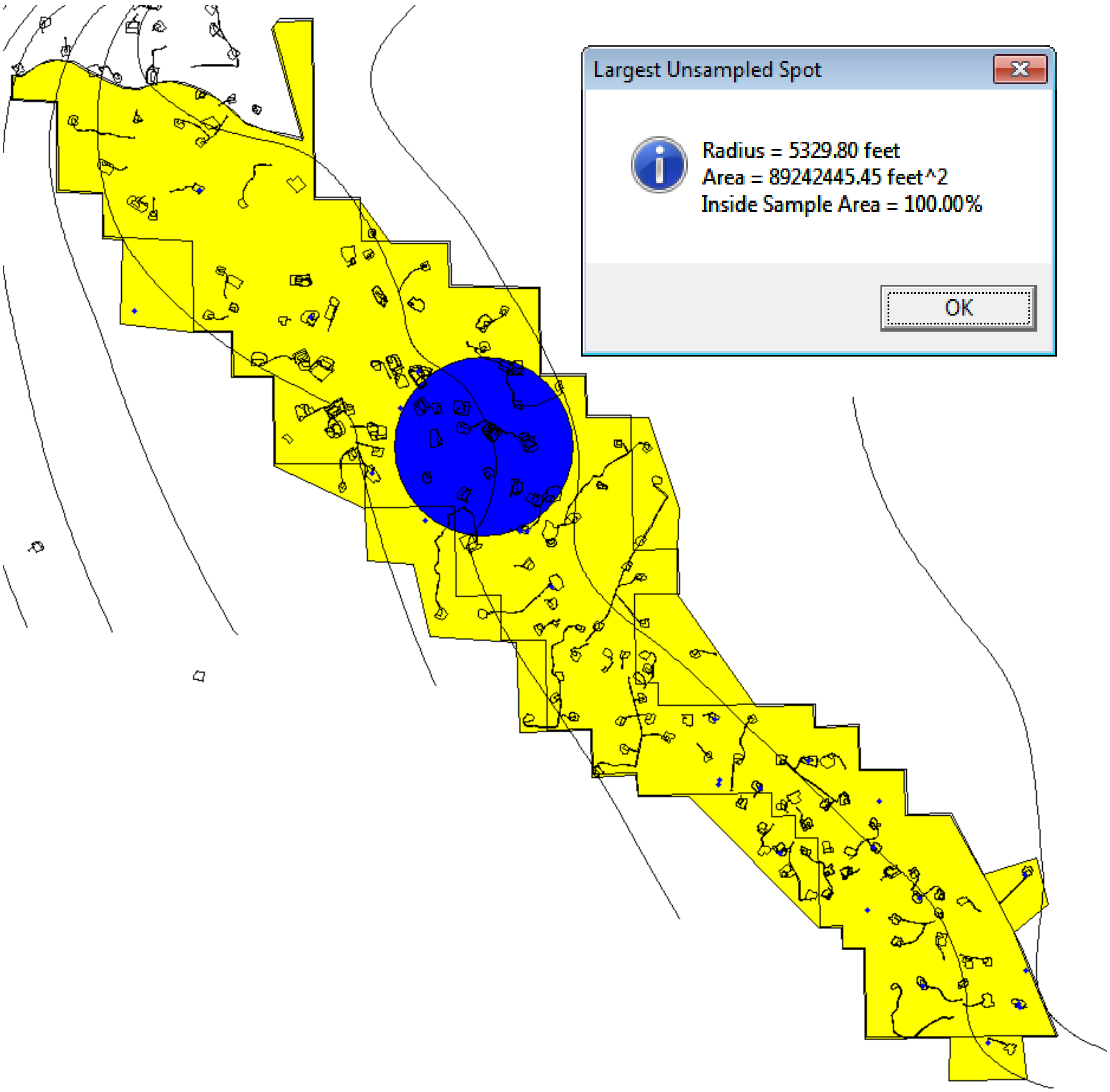
North Zone – Added 1 new well and removed 29 redundant wells:



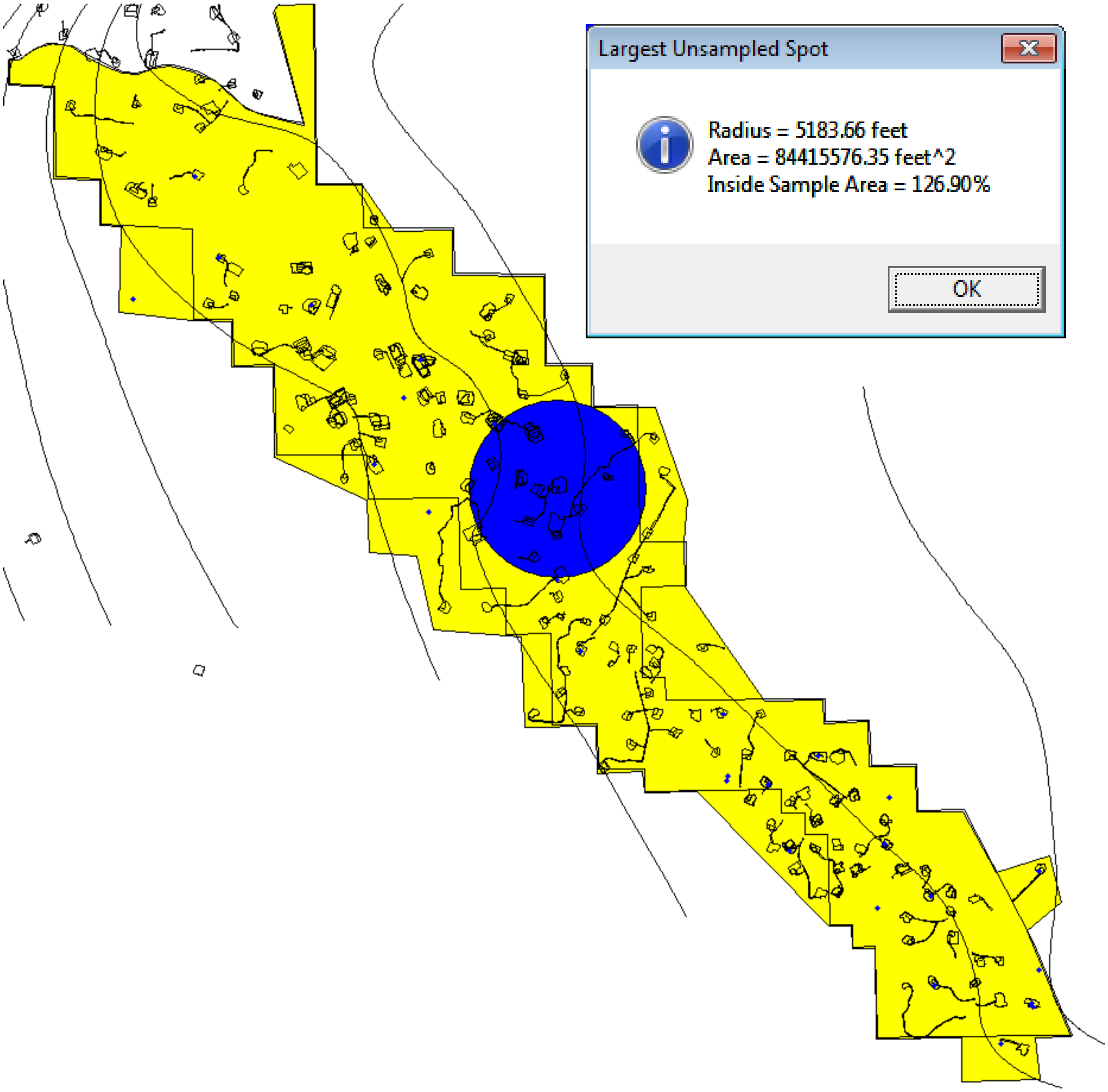
South Zone – All existing wells:



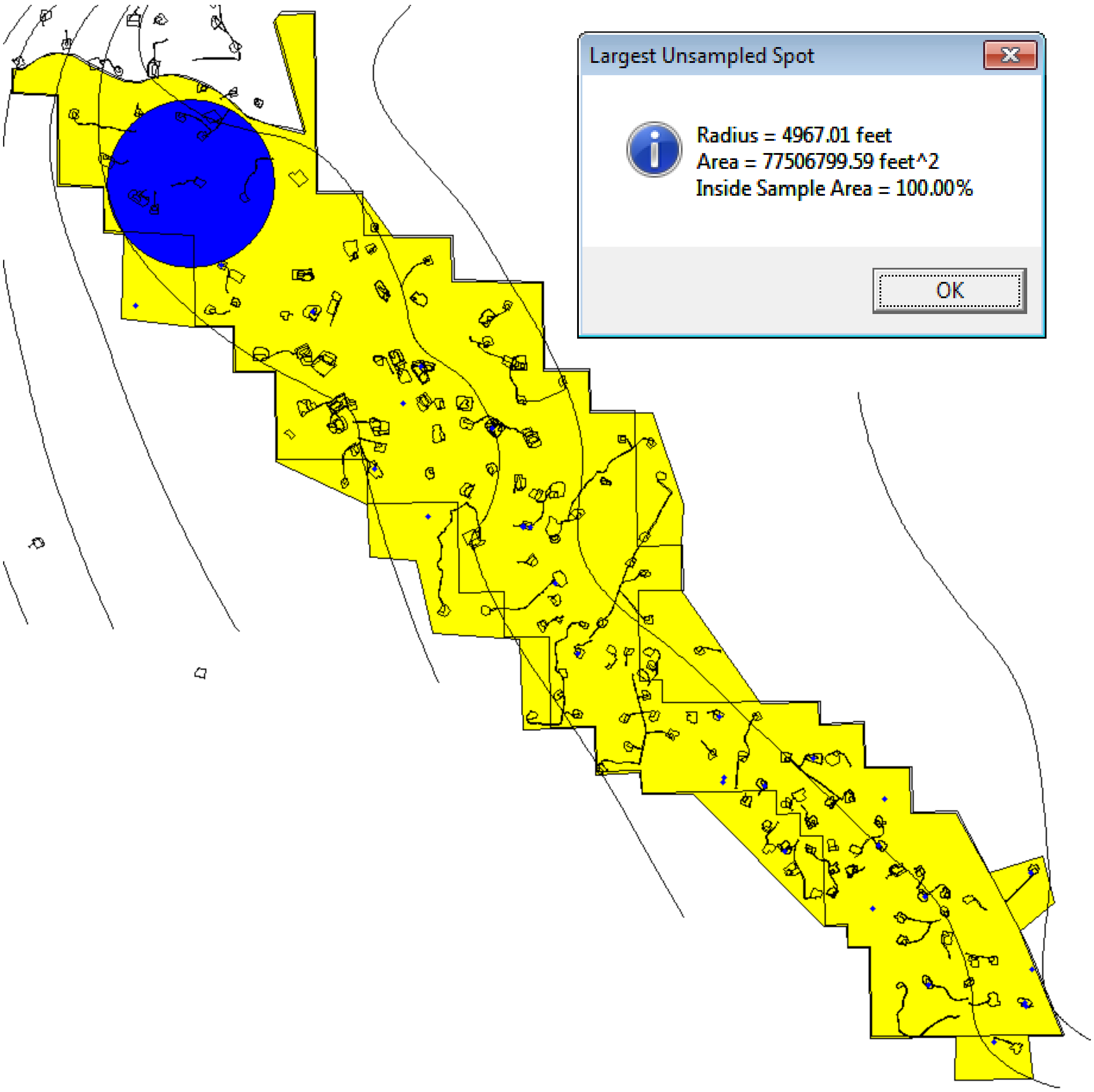
South Zone – Added 1 new well and removed 16 redundant wells:



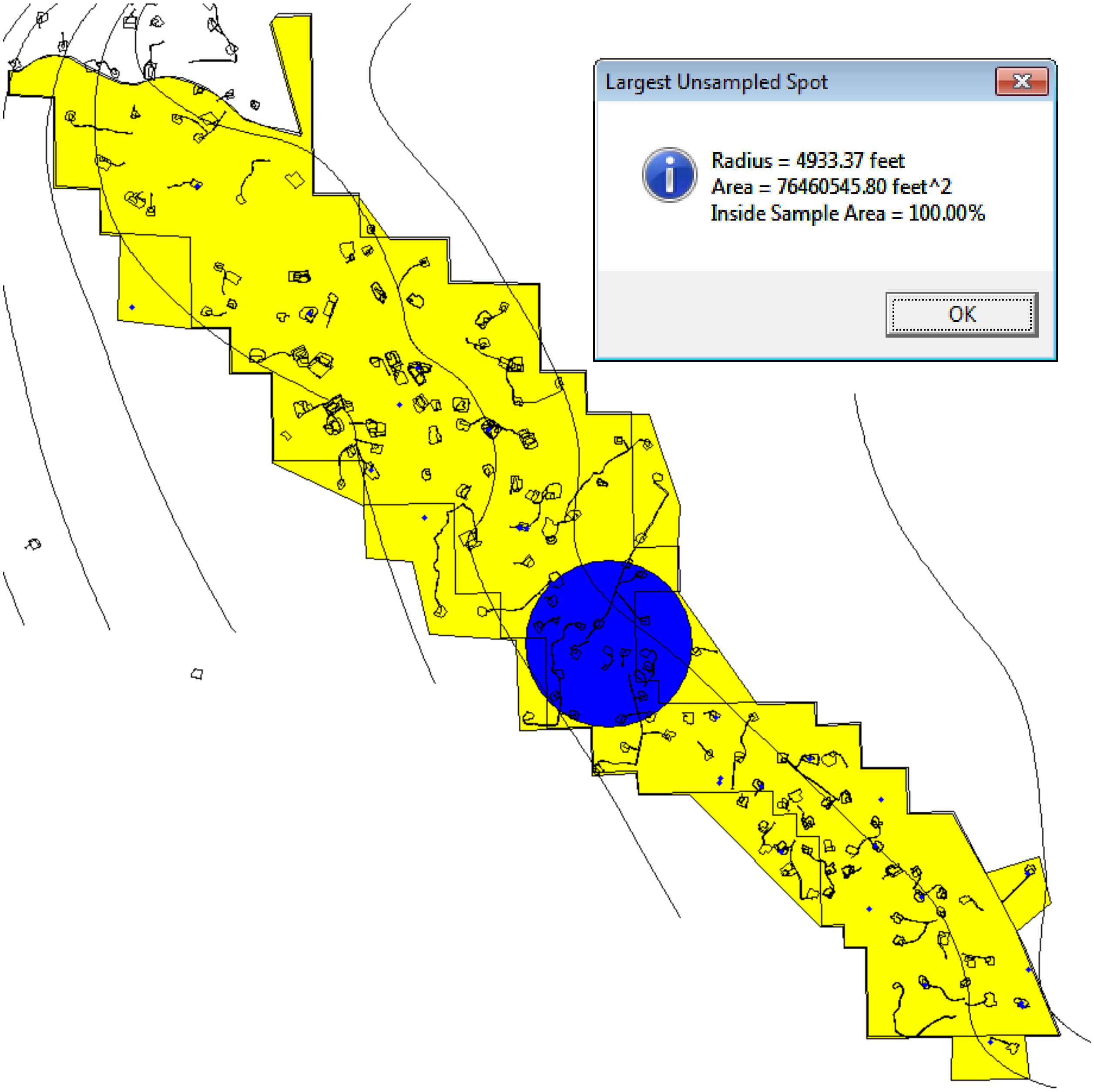
South Zone – Added 1 new well and removed 1 redundant well:



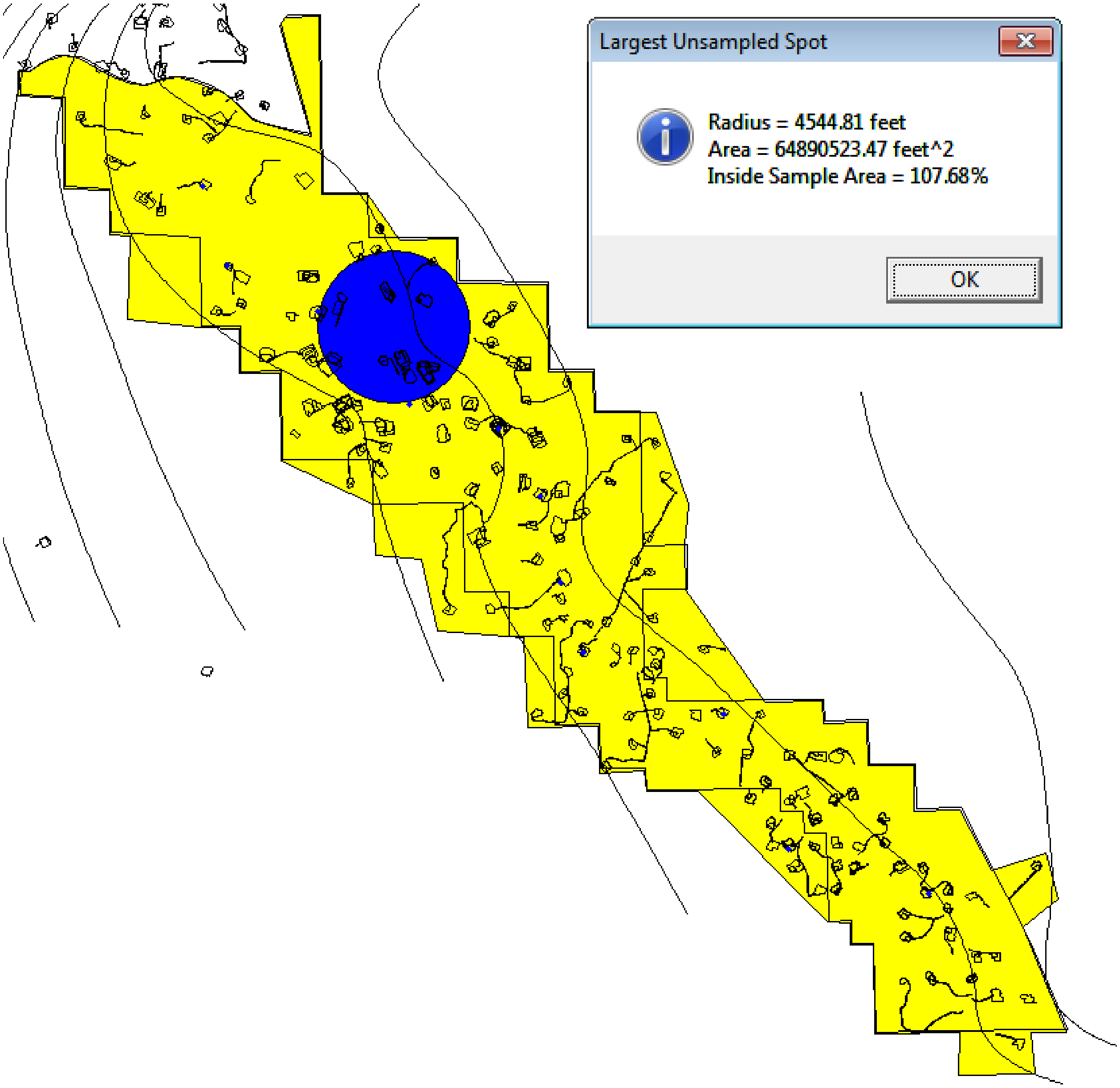
South Zone – Added 1 new well and removed 1 redundant well:



South Zone – Added 1 new well:



South Zone – Added 1 new well:

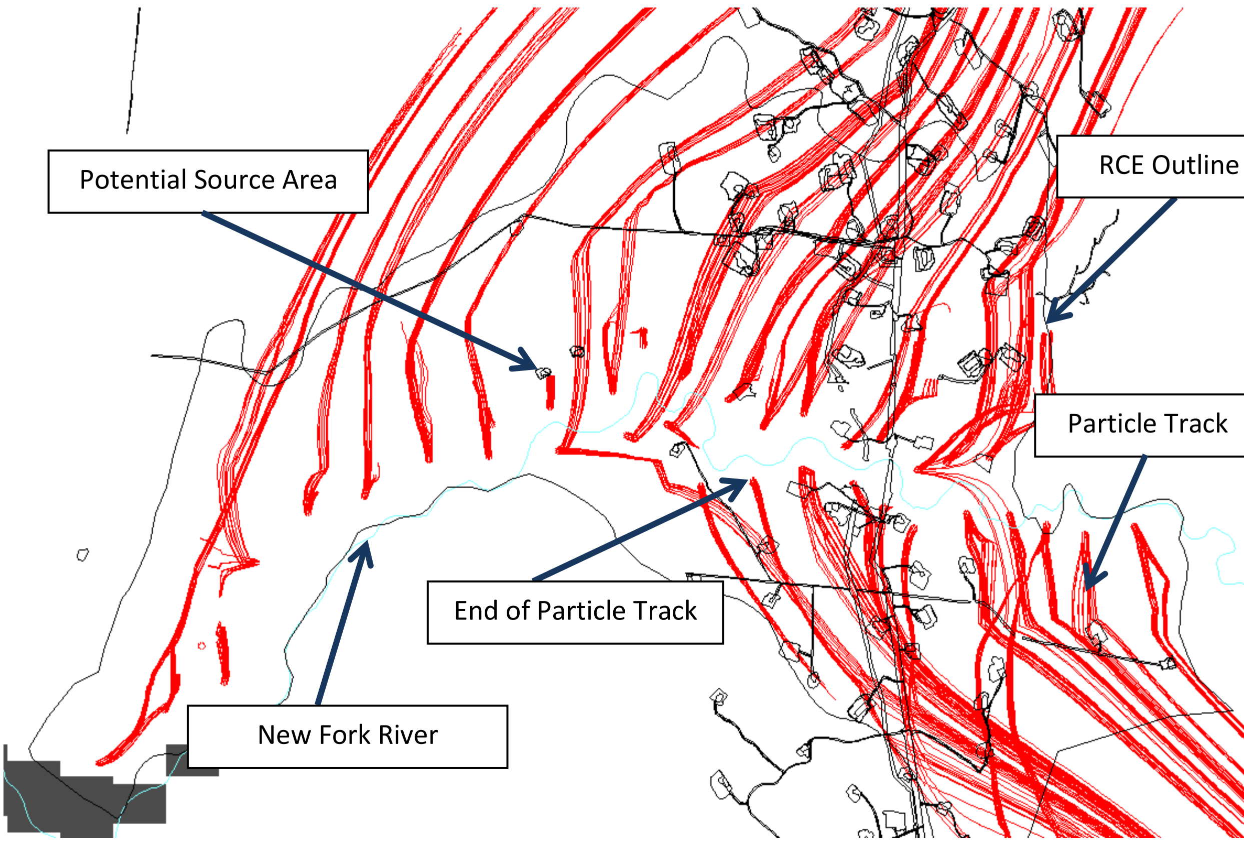


<u>Note</u>: After completing the spatial analysis described above, further investigation of the proposed monitoring network revealed that one existing well selected for monitoring in the South Zone had been plugged and abandoned. Consequently, a new monitoring well for this sample area is necessary to replace the plugged and abandoned well. The total number of monitoring wells required in the South Zone remained the same however, the number of new wells increased to a total of 6.

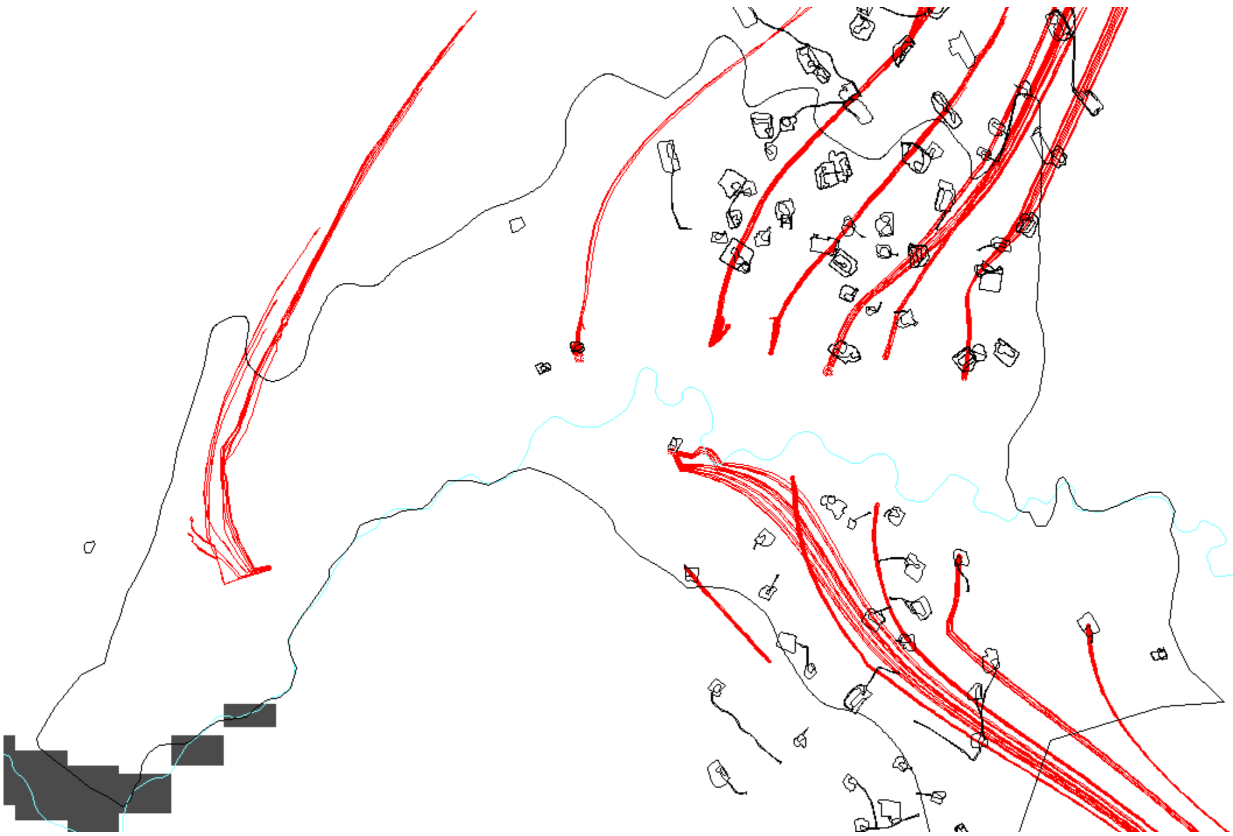
Well Location Analysis - River Corridor Envelope

The following images are screen shots of particle tracking results in the Wasatch RCE based on the methods described above. The light blue line depicts the New Fork River, black lines depict potential sources (including footprints of existing natural gas well pads) and the RCE outline, and red lines depict reverse particle tracks from proposed monitoring wells. Note that proposed monitoring well locations would be located at the end of the red-colored reverse particle tracks. **Figure 4A-3** presents the final monitoring well locations, potential sources, and expected capture zones for the monitoring wells.

Original locations:



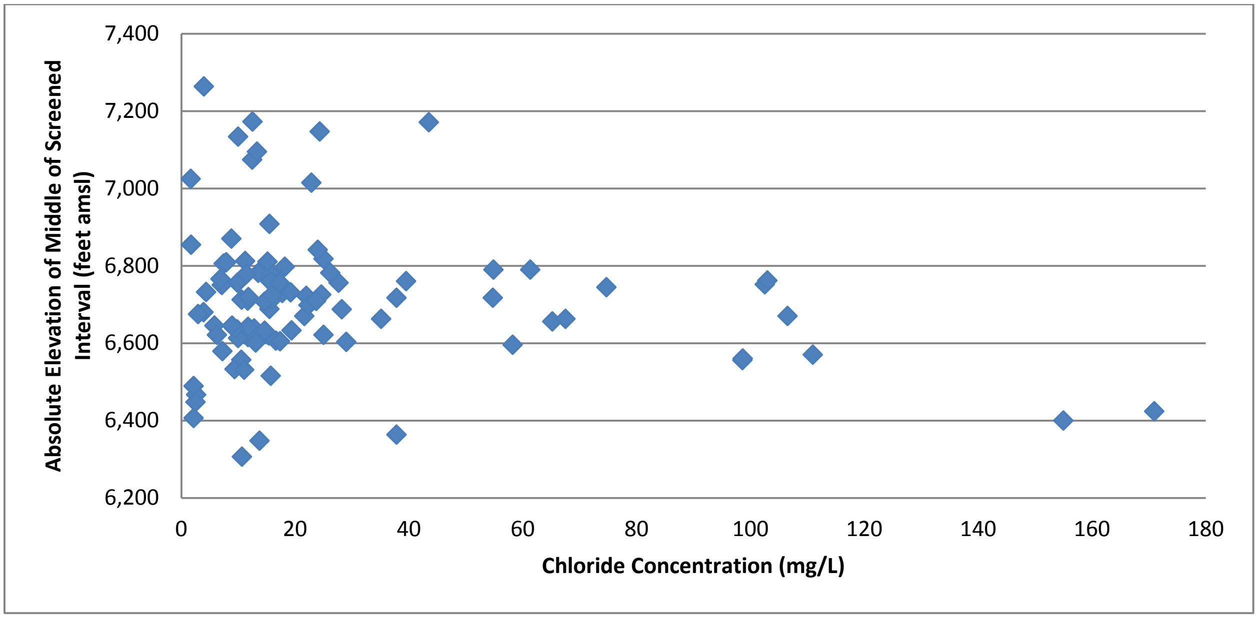
Locations for 13 RCE monitoring wells optimized based on the hydrogeologic conceptual model (AMEC, 2102) and location of potential receptors in relationship to potential sources (note that well locations are at the end of red-colored reverse particle tracks):



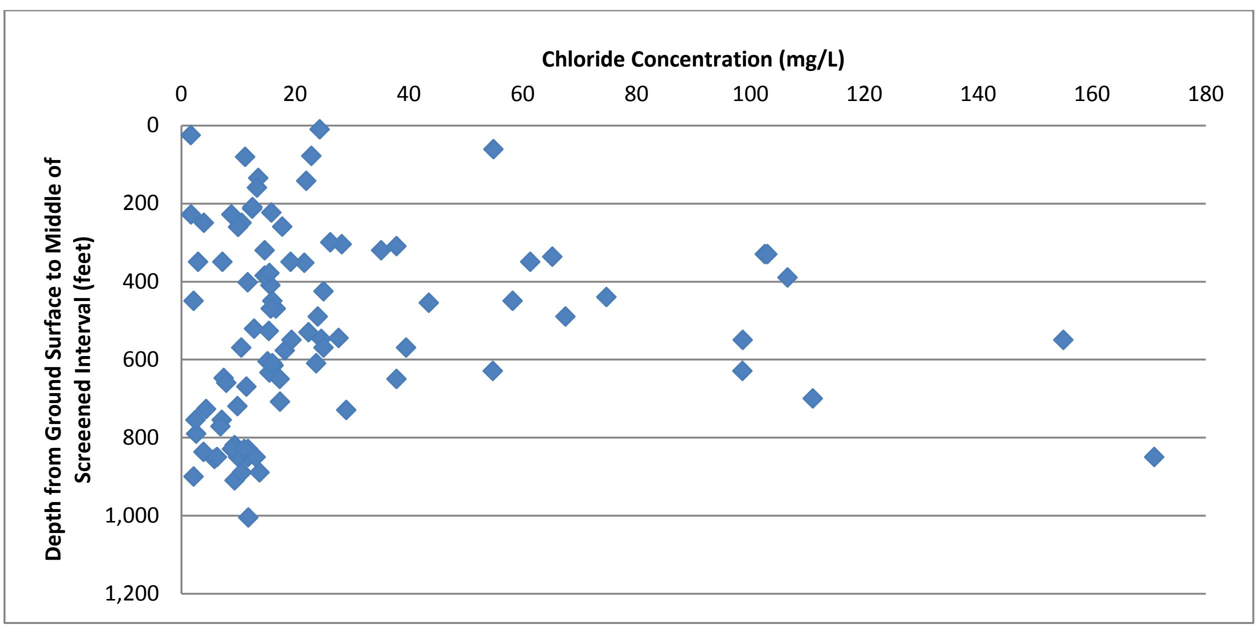
VERTICAL MONITORING ANALYSIS

The figures below present plots of concentration versus depth to the middle of the screened interval and concentration versus absolute elevation of the middle of the screened interval based on average concentrations of chloride and TDS for the 95 wells included in the analysis.

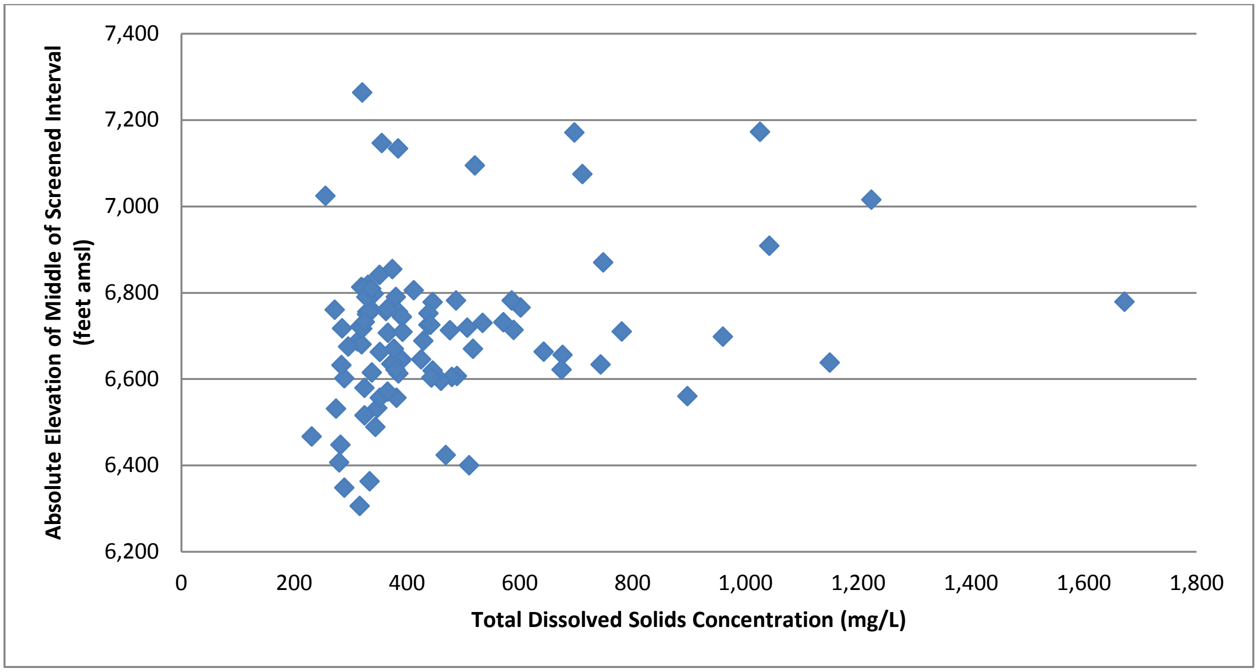
CHLORIDE; AVERAGE CONCENTRATION VERSUS ABSOLUTE ELEVATION:



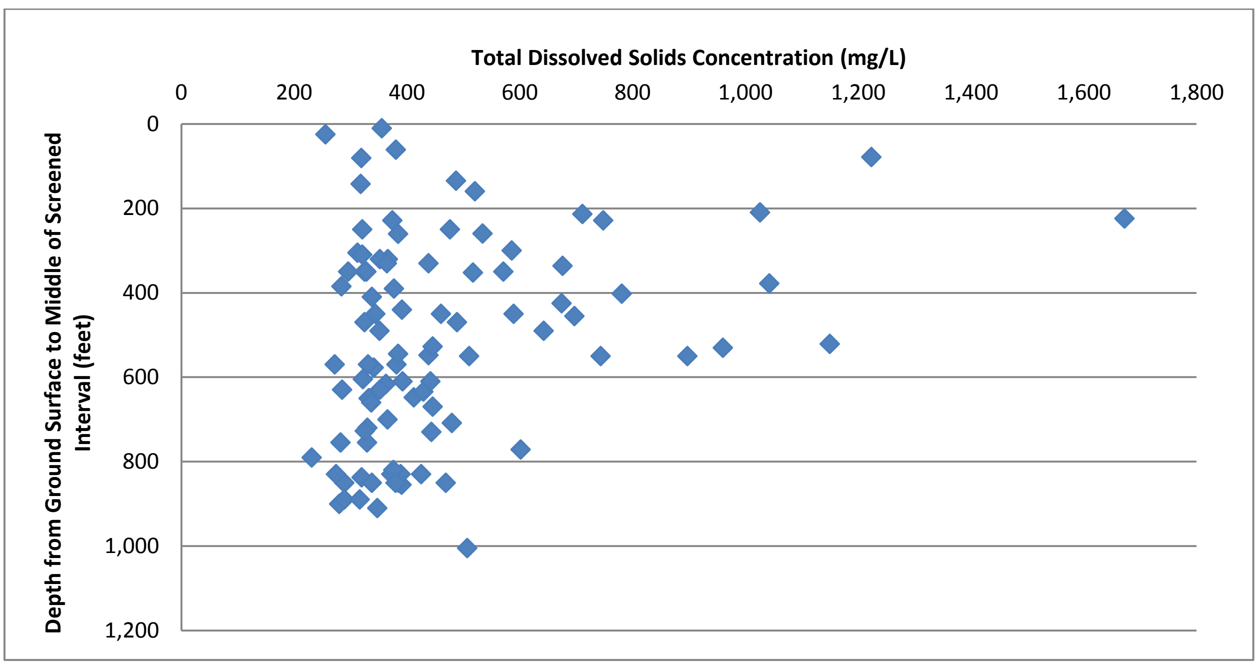
CHLORIDE; AVERAGE CONCENTRATION VERSUS DEPTH FROM GROUND SURFACE:



TOTAL DISSOLVED SOLIDS; AVERAGE CONCENTRATION VERSUS ABSOLUTE ELEVATION:



TOTAL DISSOLVED SOLIDS; AVERAGE CONCENTRATION VERSUS DEPTH FROM GROUND SURFACE:



The following chart presents the mean for each group, p-value, and conclusion for each statistical analysis.

Test	Mean 1 (mg/L; <500 feet or >6,700 feet amsl)	Mean 2 (mg/L; >500 feet or <6,700 feet amsl)	p-value	Conclusion
Chloride vs. Elevation of Screened Interval	32	23	0.23	There is no difference between groups.
Chloride vs. Depth of Screened Interval	29	26	0.69	There is no difference between groups.
TDS vs. Elevation of Screened Interval	453	579	0.12	There is no difference between groups.
TDS vs. Depth of Screened Interval	493	417	0.07	There is no difference between groups.

Calculated p-values were greater than 0.05, indicating that there is not a statistically significant difference between groups. In other words, chloride and TDS concentrations from the 95 wells included in the analysis do not vary with depth. Consequently, comparing sample results from wells completed in the Wasatch Formation at the depth ranges listed above appears to be appropriate. Because there is not significant variability with concentrations and depth, and given that most of the potential sources of contamination are at or near the surface, it is reasonable to complete new monitoring wells required to meet the three objectives to intercept the first continuously saturated sandstone layer in the Wasatch Hydrostratigraphic Unit (HSU).

CONCLUSIONS

Results of these analyses provide adequate spatial coverage in the three monitoring areas and sufficient early detection of potential degradation in the Wasatch and Alluvial HSUs as well as fulfill the objectives listed above. The chart below summarizes results of the completed analysis for the three different monitoring areas.

Area	Existing Wells	New Wells	Total
North Zone	12	1	13
Wasatch RCE	0	13	13
Alluvial RCE	4	0	4
South Zone	5	6	11
TOTALS	**21**	**20**	**41**

Table 4A-1 lists the proposed monitoring wells and **Figure 4A-4** presents the well locations.

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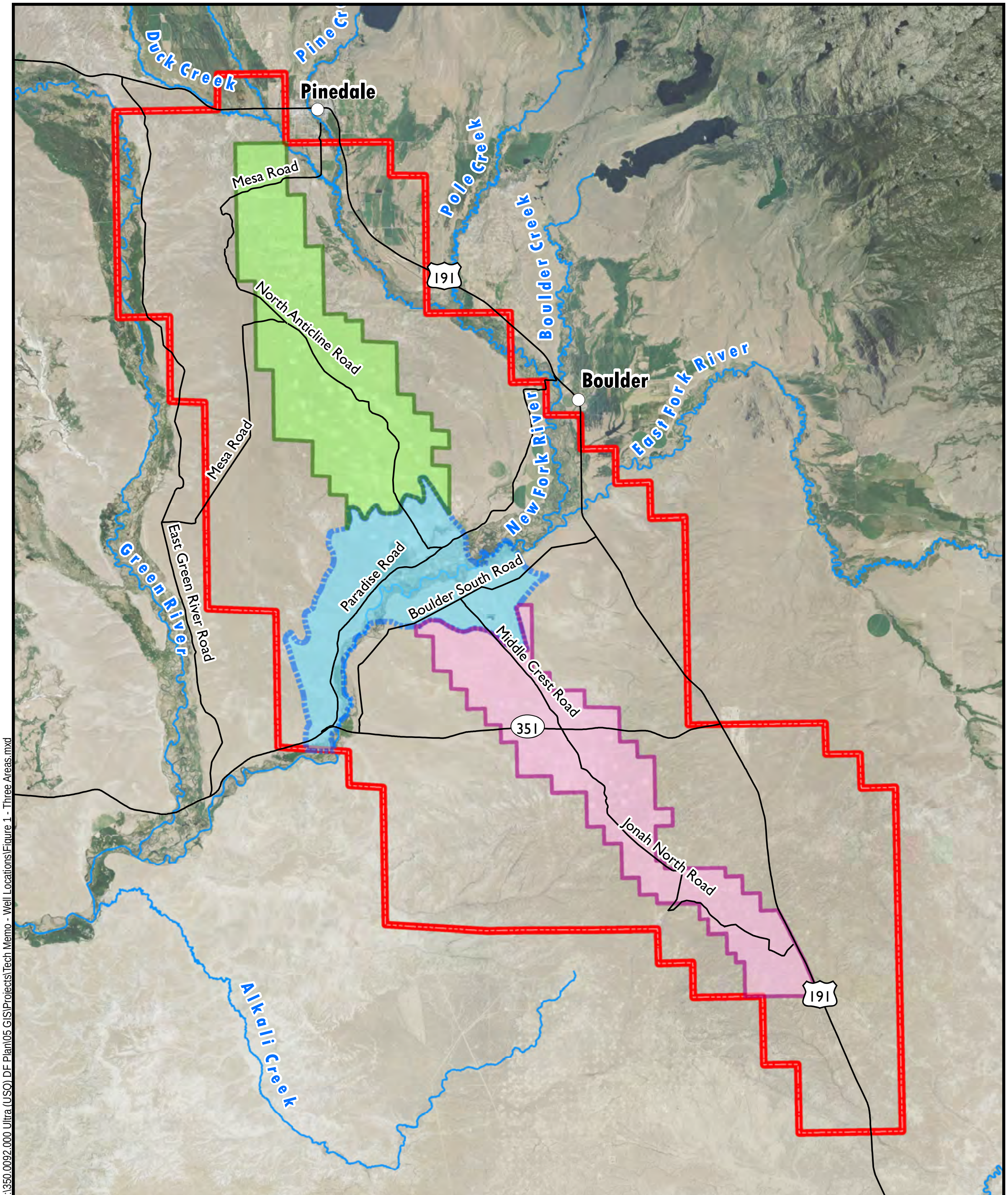
Attachments: Figure 4A-1
Figure 4A-2
Figure 4A-3
Figure 4A-4
Table 4A-1

FIGURES



Source: 2013 NRIS

0 Miles 4

NewFields

North Zone

South Zone

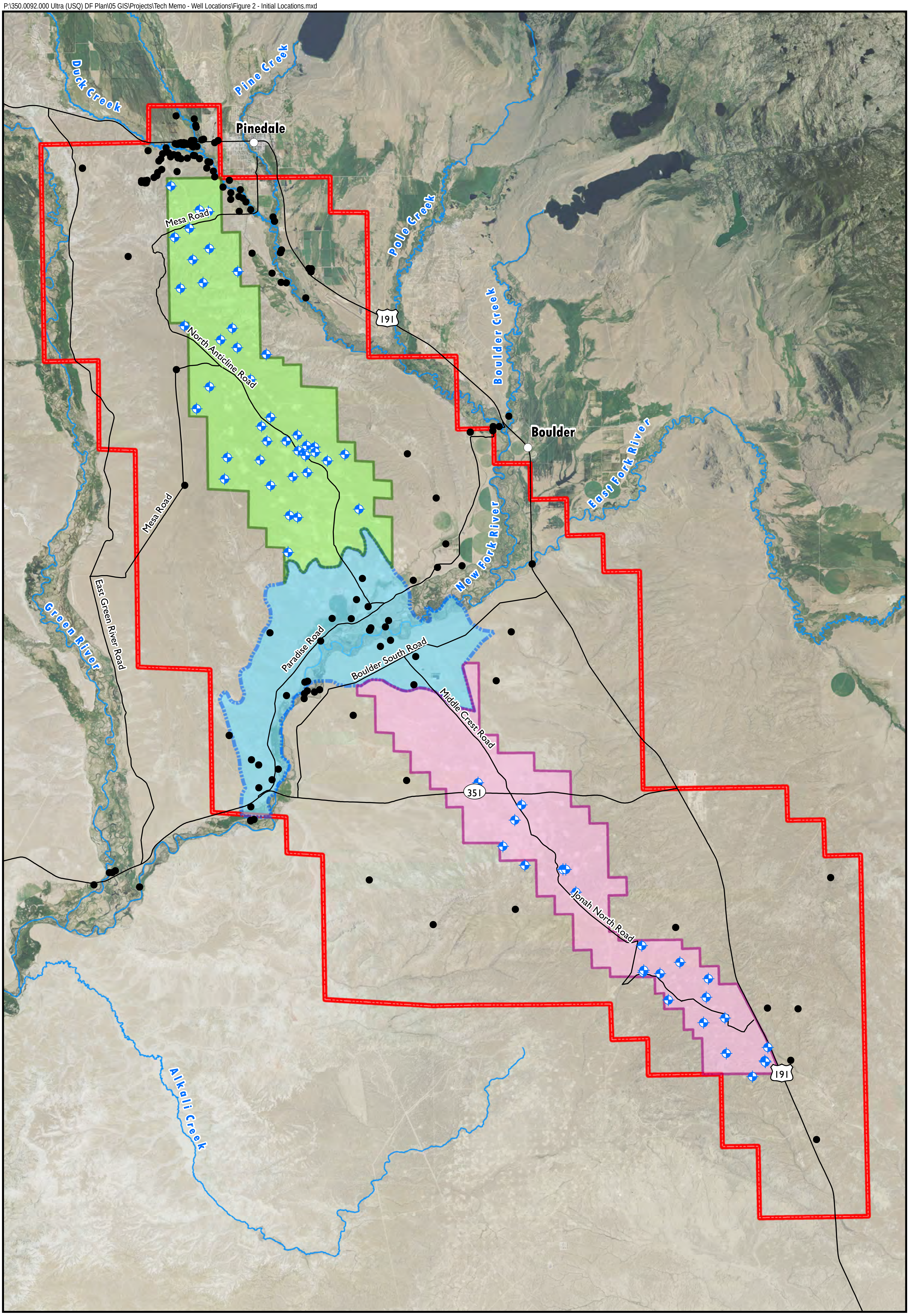
River Corridor Envelope

Pinedale Anticline Project Area

Monitoring Areas
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4A-1

P:\350.0092.000 Ultra (USO) DF Plan\05 GIS\Projects\Tech Memo - Well Locations\Figure 1 - Three Areas.mxd

P:\350.0092.000 Ultra (USQ) DF Plan\05 GIS\Projects\Tech Memo - Well Locations\Figure 2 - Initial Locations.mxd



Source: 2013 NRIS

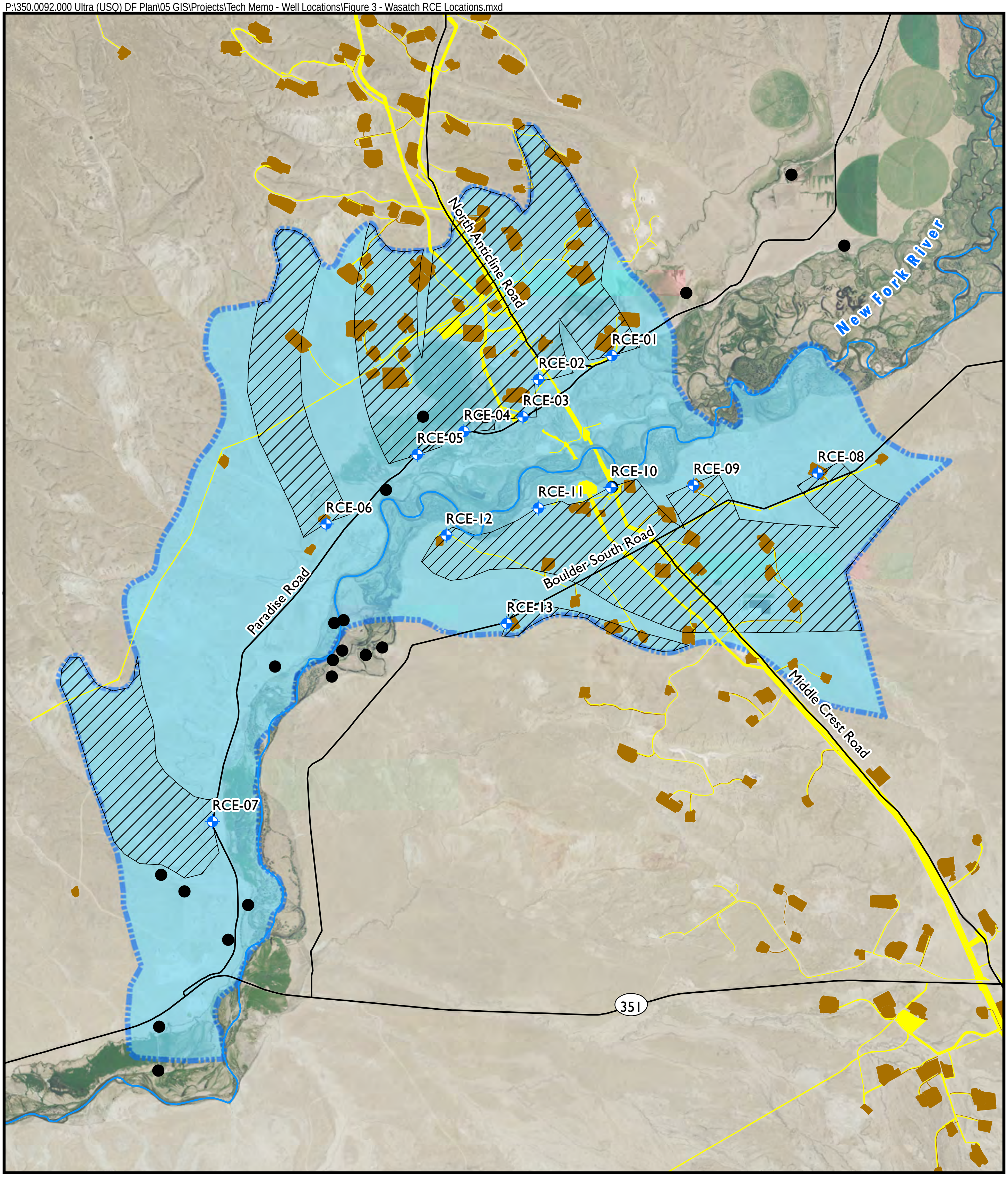
0 Miles 2.5

NewFields

- Removed from North and South zone analysis
- Retained for North and South zone analysis
- North Zone
- South Zone
- River Corridor Envelope
- Pinedale Anticline Project Area

Initial Wells Used for Spatial Analysis
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4A-2

P:\350.0092.000 Ultra (USQ) DF Plan\05 GIS\Projects\Tech Memo - Well Locations\Figure 3 - Wasatch RCE Locations.mxd



Source: 2013 NRIS

0 Feet 6,000

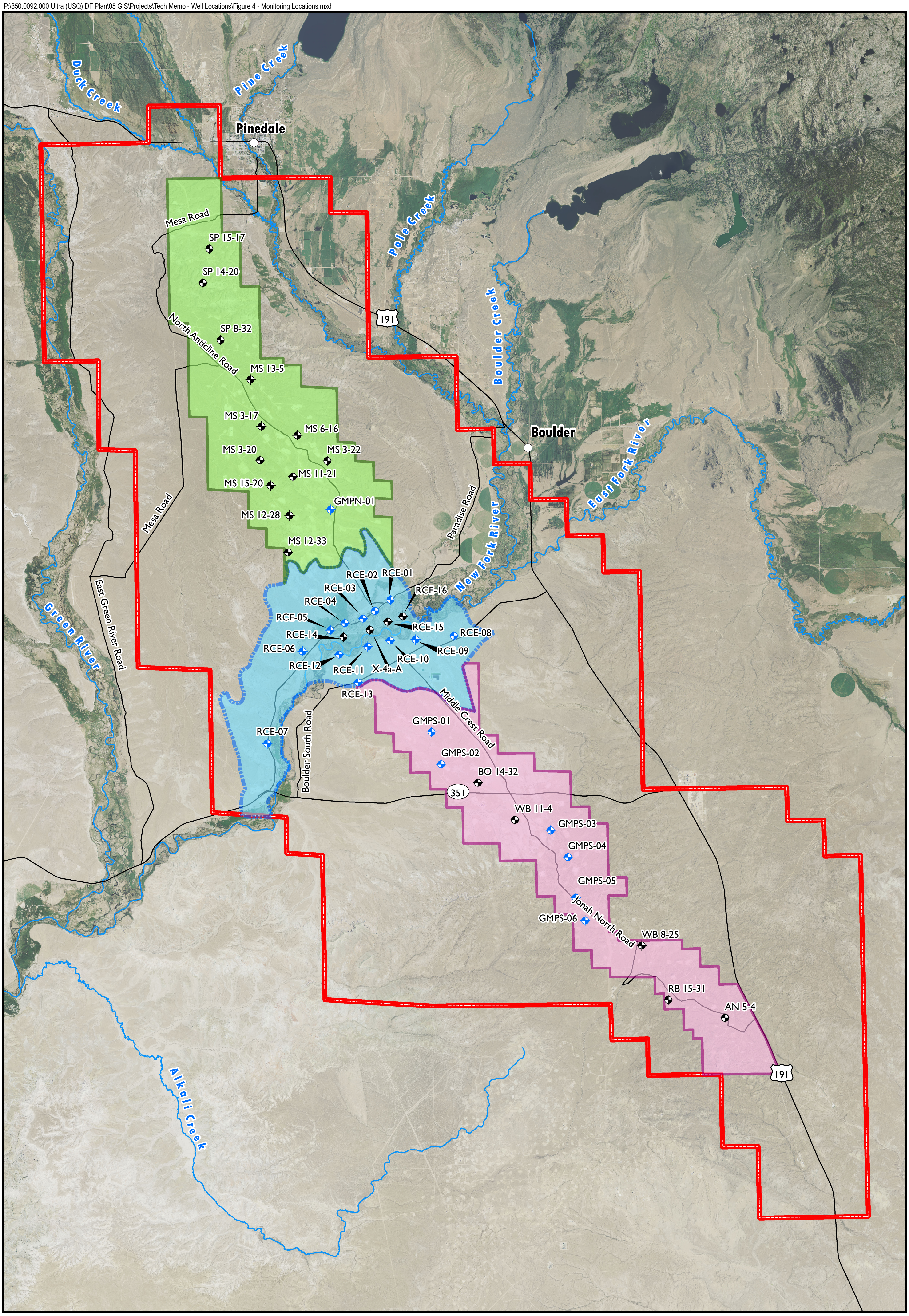
NewFields

Monitoring Well
Domestic Well
Estimated Capture Zone
River Corridor Envelope

Potential Source
Pipeline
Well Pad

Wasatch RCE Monitoring Wells
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4A-3

P:\350.0092.000 Ultra (USQ) DF Plan\05 GIS\Projects\Tech Memo - Well Locations\Figure 4 - Monitoring Locations.mxd



Source: 2013 NRIS

0 Miles 2.5

Monitoring Well
Industrial Water Supply Well
South Zone
North Zone
River Cooridor Envelope
Pinedale Anticline Project Area

NewFields

PAPA Groundwater Monitoring Locations
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4A-4

TABLE

TABLE 4A-1
Proposed Wells for the Groundwater Monitoring Network

AREA or ZONE	WELL NAME	SCCD ID	NATURAL GAS PAD NAME	HSU	EXISTING	NEW	TOTAL DEPTH Existing Wells (feet)	TOTAL DEPTH Anticipated for New Wells (feet)	COORDINATES[1] Northing	COORDINATES[1] Easting	OWNERSHIP - SURFACE MANAGEMENT
NORTH	MS 11-21	AMI154	MS 11-21	Wasatch	X		910		15,523,864	1,950,885	QEP - BLM
	MS 12-28	AMI160	MS 11-28	Wasatch	X		1,020		15,518,183	1,950,403	Ultra - BLM
	MS 12-23	AMI167	MS 12-33	Wasatch	X		1,000		15,512,795	1,950,170	Ultra - BLM
	MS 13-5	AMI029	MS 13-5	Wasatch	X		940		15,538,048	1,944,707	QEP - BLM
	MS 15-20	AMI239	MS 15-20	Wasatch	X		1,120		15,522,558	1,947,624	QEP - BLM
	MS 3-17	AMI112	MS 3-17	Wasatch	X		1,200		15,531,222	1,946,282	QEP - BLM
	MS 3-20	AMI027	MS 3-20	Wasatch	X		940		15,526,279	1,946,080	QEP - BLM
	MS 3-32	AMI014	MS 3-22	Wasatch	X		772		15,526,170	1,955,913	QEP - BLM
	MS 6-16	AMI114	MS 6-16	Wasatch	X		1,000		15,529,939	1,951,551	QEP - State of Wyoming
	SP 14-20	AMI139	SP 14-20	Wasatch	X		1,000		15,552,193	1,937,755	QEP - BLM
	SP 15-17	AMI111	SP 15-17	Wasatch	X		940		15,557,192	1,938,670	QEP - BLM
	SP 8-32	AMI205	SP 8-32	Wasatch	X		1,090		15,543,866	1,940,325	QEP - BLM
	GMPN-01	NA	MS 6-27	Wasatch		X		250 - 300	15,519,064	1,956,395	Ultra - BLM
RIVER CORRIDOR ENVELOPE	RCE-01	NA	NA	Wasatch		X		100 - 200	15,505,864	1,965,144	County Road ROW
	RCE-02	NA	NA	Wasatch		X		100 - 200	15,504,228	1,962,891	County Road ROW
	RCE-03	NA	NA	Wasatch		X		100 - 200	15,503,108	1,961,134	County Road ROW
	RCE-04	NA	NA	Wasatch		X		100 - 200	15,502,442	1,958,472	County Road ROW
	RCE-05	NA	NA	Wasatch		X		100 - 200	15,501,415	1,956,366	County Road ROW
	RCE-06	NA	NA	Wasatch		X		100 - 200	15,498,332	1,952,301	State
	RCE-07	NA	NA	Wasatch		X		100 - 200	15,484,849	1,947,143	County Road ROW
	RCE-08	NA	BR 16-7	Wasatch		X		100 - 200	15,500,575	1,974,417	Ultra - BLM
	RCE-09	NA	RS 15-12	Wasatch		X		100 - 200	15,500,028	1,968,814	Ultra - Private
	RCE-10	NA	JN 16-11	Wasatch		X		100 - 200	15,499,918	1,965,101	Ultra - Private
	RCE-11	NA	JN 3-14	Wasatch		X		100 - 200	15,498,996	1,961,819	Ultra - Private
	RCE-12	NA	NA	Wasatch		X		100 - 200	15,497,859	1,957,639	BLM
	RCE-13	NA	RS 4-23	Wasatch		X		100 - 200	15,493,783	1,960,404	Ultra - Private
	X-4a-A	NA	JN 11-11	Alluvial	X		20		15,501,438	1,962,124	Ultra - Private Land
	RCE-14	NA	JN 15-10	Alluvial	X		13		15,500,425	1,958,285	Ultra - Private Land
	RCE-15	NA	VB 8-11	Alluvial	X		13		15,502,653	1,964,758	Ultra - Private Land
	RCE-16	NA	VB 3-12	Alluvial	X		13		15,503,471	1,966,973	Ultra - Private Land
SOUTH	AN 5-4	AMI131	AN 5-4	Wasatch	X		550		15,444,730	2,014,015	Linn Energy - BLM
	BO 14-32	AMI280	BO 14-32	Wasatch	X		700		15,479,112	1,977,944	Ultra - BLM
	RB 15-31	AMI189	RB 15-31	Wasatch	X		740		15,447,371	2,005,747	Linn Energy - BLM
	WB 11-4	AMI301	WB 11-4	Wasatch	X		800		15,473,663	1,983,316	Ultra - BLM
	WB 8-25	AMI242	WB 8-25	Wasatch	X		670		15,455,310	2,001,889	Ultra - BLM
	GMPS-01	NA	BR 5-30	Wasatch		X		100 - 200	15,486,528	1,971,152	Ultra - BLM
	GMPS-02	NA	BR 6-31	Wasatch		X		150 - 250	15,481,841	1,972,550	Ultra - BLM
	GMPS-03	NA	WB 3-10	Wasatch		X		300 - 400	15,472,189	1,988,568	Ultra - BLM
	GMPS-04	NA	WB 16-10	Wasatch		X		400 - 500	15,468,253	1,991,107	Ultra - BLM
	GMPS-05	NA	WB 4-23	Wasatch		X		500 - 600	15,462,303	1,992,215	Ultra - BLM
	GMPS-06	NA	WB 11-23	Wasatch		X		500 - 600	15,458,969	1,993,604	Ultra - BLM

Notes:

RCE - River Corridor Envelope

SCCD ID - Sublette County Conservation District Identification Number

HSU - Hydrostratigraphic Unit as defined in AMEC (2012)

ROW - Right of Way

NA - Not applicable

Footnotes:

1 - Northing and Easting values are in feet relative to UTM Zone 12; coordinates for new wells are approximate