

**APPENDIX D**  
**POST-SHUTDOWN MONITORED NATURAL ATTENUATION (MNA) EVALUATION**  
**FOR THE BACK VALLEY**

## APPENDIX D

### Post-Shutdown Monitored Natural Attenuation (MNA) Evaluation for the Back Valley

This appendix presents an assessment of the monitored natural attenuation (MNA) potential in the groundwater of the Back Valley (BV) at the Chemtronics Site in Swannanoa, Buncombe County, North Carolina (the Site) following shutdown of the existing BV groundwater extraction and treatment system<sup>1</sup>. MNA consists of long-term monitoring of the attenuation of groundwater constituents through natural biotic and abiotic mechanisms. Specifically, this appendix provides a review and evaluation of groundwater data collected following the shutdown (as reported in the Shutdown Report<sup>2</sup>) for general consistency with the pre-groundwater extraction and treatment system shutdown (pre-shutdown) MNA evaluation documented in the *Assessment of Monitored Natural Attenuation (MNA) Potential in the Back Valley* (BV MNA Report; dated April 30, 2015). This appendix is meant to be viewed alongside of, and in context with, the BV MNA Report and Shutdown Report (i.e., this appendix is not standalone). This appendix focuses solely on MNA within the BV; a similar comparison of pre- and post-shutdown data in the Front Valley (FV) of the Site is provided as **Appendix C** of the *Feasibility Study Report* (FS Report, dated July 2016).

As discussed in the FS Report, the remedial strategy envisioned for the BV is active source mass flux reduction efforts for the Acid Pits Area (APA) and Disposal Area 9 (DA 9) coupled with passive remediation approaches, including MNA. As such, MNA was evaluated as a component of each active remedial alternative considered in the FS Report.

The analysis presented in the previous FV MNA Report indicated ongoing natural attenuation, under pre-shutdown conditions, of the following 15 Site constituents (i.e., termed the MNA Target Compounds [MNA TCs]):

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<sup>1</sup> The BV groundwater and extraction system shutdown began on September 25, 2014.

<sup>2</sup> Altamont, 2016a. Front Valley and Back Valley Extraction Well and Treatment System Temporary Shutdown Report. Chemtronics Site, Swannanoa, Buncombe County, North Carolina. January 15, 2016.

- tetrachloroethene (PCE)
- trichloroethene (TCE)
- cis-1,2-dichloroethene (cis-DCE)
- vinyl chloride (VC)
- 1,1,2-trichloroethane (1,1,2-TCA)
- 1,2-dichloroethane (1,2-DCA)
- chloroform (CF)
- dichloromethane (DCM)
- 1,2-dichloropropane (1,2-DCP)
- perchlorate
- research department explosive (RDX)
- methyl-tert-butyl ether (MTBE)
- tert-butyl alcohol (TBA)
- tetrahydrofuran (THF)
- benzene

To document existing evidence of natural attenuation of the MNA TCs, a common “lines of evidence approach” was employed in the BV MNA Report to evaluate: (i) MNA TC concentration trends with distance and time; (ii) supporting geochemical and daughter product evidence; and (iii) direct evidence of natural attenuation.

As summarized in the following sections, post-shutdown MNA conditions are generally similar to those observed pre-shutdown based on a review of the first two lines of evidence (i.e., concentration trends, geochemical conditions). This is consistent with, and supported by, the prior observation of limited effects that the shutdown had on groundwater hydraulic conditions, groundwater quality, and general plume geometry in the BV (see the Shutdown Report). Review of post-shutdown data, therefore, further supports that ongoing natural attenuation of the MNA TCs is occurring in BV groundwater and confirms inclusion of MNA as a component of each active remedial alternative evaluated in the FS Report. Review of post-shutdown data for the first two lines of evidence (i.e., concentration trends, geochemical conditions) is described below. Additional direct evidence of natural attenuation (i.e., the third line of evidence) was not generated via molecular analysis or treatability testing during the shutdown period and therefore was not further considered herein.

## Concentration Trends

### Comparison of Pre- and Post-Shutdown Concentration Trends in Groundwater

The BV MNA Report included an evaluation of both spatial and temporal concentration trends in groundwater for each MNA TC. Review of pre-shutdown (baseline) concentration trends indicated the following: (i) concentrations of each MNA TC generally decrease with distance from the APA and DA 9 in each aquifer zone<sup>3</sup> along the direction of groundwater flow; and (ii)

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<sup>3</sup> Three primary aquifer systems exist beneath the Site: a Surficial Aquifer System (Zone AB), a Transition Zone Aquifer System (Zone CD), and a Bedrock Aquifer System (Zone EF). For a more detailed description, refer to the BV MNA Report.

concentrations over time at many locations are declining throughout the plume. These observations are indicative of mass reduction and ongoing natural attenuation in BV groundwater under pre-shutdown conditions.

Monitoring associated with the shutdown program included both pre-shutdown (August/September 2014) and post-shutdown (August/September 2015) sampling at select BV wells screened within each aquifer zone. Pre- and post-shutdown data for MNA TCs are illustrated on **Figures 1a to 3-16b**. In general, post-shutdown MNA TC concentrations in groundwater for most locations in the BV are relatively consistent with pre-shutdown concentrations, as discussed further below.

#### *BV-Wide Evaluation*

To assess the potential for systemic changes in groundwater beneath the BV, summary statistics for the pre- and post-shutdown data sets from 2014 and 2015, respectively, were prepared, as illustrated on **Figures 1a to 1d**. Review of these data indicates similar concentrations between pre- and post-shutdown. This is consistent with the conclusions presented in the Shutdown Report that the groundwater plumes in the BV are relatively stable.

#### *MNA TC Concentrations in Groundwater Relative to Screening Criteria*

Pre- and post-shutdown concentrations of MNA TCs were compared to applicable screening criteria<sup>4</sup> and grouped into “concentration categories” (e.g., less than screening criteria, 1 to 10 times screening criteria, etc.). This evaluation is illustrated in map view on **Figures 2a and 2b** for pre- and post-shutdown data, respectively. The comparison between **Figures 2a and 2b** indicate that 55 of the 68 locations sampled as part of the shutdown monitoring program remained in the same concentration category. Similar to the evaluation provided on **Figures 1a and 1b**, this analysis indicates that post-shutdown MNA TC concentrations for most monitoring locations in the BV are relatively consistent with pre-shutdown concentrations. As summarized below, seven monitoring locations moved down a concentration category (i.e., concentrations declined), while six locations moved up a category (i.e., concentrations increased), as detailed below:

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<sup>4</sup> North Carolina Administrative Code Subchapter 02L Standards (2L Standards), Interim Maximum Allowable Concentration (IMAC) Standards, or for constituents without a 2L or IMAC, risk-based criteria from the *Baseline Risk Assessment* (Altamont, 2015a).

- decline in concentration category:
  - Zone AB – MW276-L22AB, M85L-8, P-4D, MW-3S, MW188-M27AB, and MW275-Q29AB; and
  - Zone CD – MW266-L26CD.
- increase in concentration category:
  - Zone AB – MW-3D, MW205-M27AB, and MW274-O28AB; and
  - Zone EF – MW273-O26EF, MW273-O26F, and MW172-T32E.

Declines in concentration category were observed both upgradient and downgradient of the BV extraction wells. The location of the BV extraction well system is shown in **Attachment A**, with a footprint that is roughly similar to that of BV Transect 2/East Transect 1 illustrated on **Figures 2a to 2c**. Increases in concentration category were observed at select locations downgradient of the BV extraction wells. As discussed further below, the increases at select locations may be due to natural variability (i.e., not related to shutdown), especially when viewed in context of historical data.

For well MW274-O28AB located along Transect 4 and well MW172-T32E located at the property boundary (**Figures 2a and 2b**), the magnitude of groundwater concentration increases was relatively minor. For example, at MW274-O28AB, the RDX concentration increased from a non-detectable concentration (non-detect; method detection limit [MDL] of 0.2 micrograms per liter [ $\mu\text{g/L}$ ]) to 0.78  $\mu\text{g/L}$ , which is slightly above the 0.32  $\mu\text{g/L}$  screening criteria. Perchlorate concentrations also increased at this location, from 0.23 J to 0.41 J  $\mu\text{g/L}$  (both below the 2  $\mu\text{g/L}$  screening criteria). Similarly, concentrations of benzene and 1,2-DCA increased from non-detect (MDLs of 0.1  $\mu\text{g/L}$  and 4.0  $\mu\text{g/L}$ ) to 0.2 J  $\mu\text{g/L}$  and 6.3 J  $\mu\text{g/L}$  at MW172-T32E, respectively. These concentrations are below the applicable screening criteria. Low-level detections of 1,2-DCA have been sporadically detected in groundwater at this location in the past, and sporadic detections of select MNA TCs (MTBE, TBA, benzene) have been observed in the paired Zone D well (MW172-T32D). The detections observed in these property boundary wells are thought to be related to a former leak in the underground discharge line from the BV treatment system, which runs adjacent to MW172-T32D and MW172-T32E, as discussed by Altamont (2015b)<sup>5</sup>. These relatively minor increases at MW274-O28AB and MW172-T32D may be the result of natural variability and unrelated to the shutdown, especially when viewed in context of historical data and consistent with the distance between the extraction wells and these monitoring

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<sup>5</sup> Altamont, 2015b. 2014 Annual Assessment Monitoring Report. Chemtronics Site, Swannanoa, Buncombe County, North Carolina. April 8, 2015.

locations. Historical concentration trends at the other locations with an increase in concentration category are discussed in the *Groundwater Concentration Trends with Time* subsection below.

To further assess spatial trends, pre- and post-shutdown concentration categories (i.e., concentrations divided by applicable screening criteria) at each location were directly compared, as shown on **Figure 2c**. This evaluation indicates that minor changes (both increasing and decreasing) are generally observed upgradient of the extraction wells (i.e., near the APA and DA 9; represented by Transects 1 and 2), with more pronounced changes at select locations downgradient of the extraction wells (e.g., along Transect 3).

In general, **Figures 2a to 2c** indicate relative consistency for most locations in the BV between the pre- and post-shutdown data sets and pre- and post-shutdown groundwater concentration trends with distance.

#### *Groundwater Concentration Trends with Distance*

**Figures 3-1a to 3-16a** and **Figures 3-1b to 3-16b** present MNA TC groundwater concentration trends with distance for the pre- and post-shutdown data, respectively. Note that the pre-shutdown figures are identical to those presented in the BV MNA Report. For Zones AB and CD, each figure (i.e., **Figures 3-1a to 3-15b**) presents spatial trends for a given MNA TC using two approaches, including:

- (1) data for select wells along the flow paths relative to the screening criteria; and
- (2) average concentrations for select representative wells along five downgradient transects (all significantly upgradient of the property boundary) that are roughly perpendicular to groundwater flow (henceforth referred to as transect averages).

The reader is referred to Section 5.1 of the BV MNA Report for additional information on the construction of these figures with respect to generalized flow paths, transects, selection of representative wells along flow paths/transects, etc. For Zone EF, pre- and post-shutdown trends with distance are provided on **Figure 3-16a and 3-16b**, respectively, for select MNA TCs (i.e., the eleven MNA TCs with concentrations in Zone EF greater than screening criteria).

Review of concentration with distance plots indicates that, in general, spatial concentration trends in groundwater near the disposal areas (i.e., along Transects 1 and 2) are generally similar pre- and post-shutdown. More substantial changes were observed between pre- and post-shutdown downgradient of the extraction wells (e.g., at the MW-3 cluster and along Transect 3) consistent with the discussion above. Most of the changes along Transect 3 occurred at two well clusters associated with monitoring wells MW205-M27AB and MW-2B, respectively. As discussed in the next subsection, time trends for these well clusters indicate that the concentrations changes are not specifically related to the shutdown (e.g., the changes may be due to natural variability). Further downgradient at Transect 4 and 5, however, conditions are

generally similar between pre- and post-shutdown. This evaluation is consistent with that presented in the Shutdown Report, where significant changes were noted at select locations within the interior of the plume and within 500 feet of the extraction wells but not at the leading edge of the plume.

Despite the increases observed for select wells/locations, concentrations of each MNA TC generally decrease with distance in each aquifer zone along the direction of groundwater flow both prior to and following the shutdown. This is indicative of mass reduction and ongoing natural attenuation in BV groundwater under shutdown conditions.

#### *Groundwater Concentration Trends with Time*

Based on the data discussed above, three well clusters (each downgradient of the extraction system) were selected for further evaluation. The well clusters included the following locations:

- MW-3S, MW-3D, MW-3B, and MW269-M26EF;
- MW205-M27AB, MW206-M27CD, MW272-M27EF, and MW272-M27F; and
- MW-2D, MW-2B, MW273-O26EF, and MW273-O26F.

Pre- and post-shutdown data for these locations are provided in **Table 1**. These data indicate concentration increases and/or detection of new constituents at select locations (e.g., MW-3D, MW205-M27AB, and MW273-O26EF/F) in each well cluster. The most substantial changes were generally associated with 1,2-DCA, TBA, THF, and benzene.

**Figures 4a to 4c** illustrate groundwater concentration versus time trends for locations in each well cluster for 1,2-DCA, TBA, THF, and benzene. These four MNA TCs were selected based on review of the data summarized in **Table 1**, as discussed above. Data for each well cluster are discussed below:

- As shown on **Figure 4a**, groundwater concentrations at well MW205-M27AB detected post-shutdown were basically equivalent to the concentrations observed in the well during the four annual sampling events leading up to the baseline sampling event. The groundwater concentrations observed in this well during the baseline event were anomalously low which may have been a temporary artifact associated with the installation of an adjacent monitoring wells in April 2014. Concentrations at other locations in this well cluster were relatively stable or only slightly increased following shutdown.
- As shown on **Figure 4b**, concentration increases in groundwater following shutdown were observed at MW-3D, although historic variability in constituent levels have been observed at this location. At MW-3B, concentrations generally declined following shutdown, which is in contrast to steady increases observed for select constituents (i.e.,

TBA) prior to shutdown. Concentration declines were observed at MW269-M26F, while concentrations remained low or non-detect for MW-3S.

- As shown on **Figure 4c**, concentration increases in groundwater were observed at wells MW-2B, MW273-O26EF, and MW273-O26F. These increases, however, began prior to shutdown, pointing to the need for continued groundwater monitoring to assess concentration trends.

The groundwater concentration versus time trends for select locations/constituents generally indicate that the observed concentration increases represent a return to historic levels and/or began prior to shutdown. As such, the increases may be due to natural variability and unrelated to the shutdown. Trends at other locations were generally stable or declining, consistent with the observations in the BV MNA Report.

### **Bulk Attenuation Rate Estimation**

This section discusses estimation of bulk attenuation rates with post-shutdown data for the BV. In comments on the BV MNA Report, the Agencies requested estimation of MNA attenuation rates<sup>6</sup>. Geosyntec Consultants of NC, P.C. (Geosyntec) proposed use of distance-based rates, as recommended by Agency guidance<sup>7</sup>, for both Zones AB and CD in the BV and FV during the September 30, 2015, technical meeting with the Agencies in Asheville, North Carolina. Two approaches based on concentration versus distance plots were proposed by Geosyntec, including:

- a qualitative approach, consistent with guidance documents<sup>8,9</sup>, in which changes in concentration versus distance trends from year to year are visually assessed; and
- a quantitative approach, consistent with guidance documents<sup>8,10</sup>, in which bulk attenuation rates ( $k$ ) are estimated and compared from year to year.

Geosyntec completed the qualitative approach using the trend analysis (detailed in the *Groundwater Concentration Trends with Distance* subsection above) and the qualitative approach is discussed below.

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<sup>6</sup> EPA, 2015. Comments on the April 2015 Assessment of Monitored Natural Attenuation (MNA) Potential in the Back Valley for the Chemtronics Superfund Site, Swannanoa, Buncombe County, North Carolina. August 6, 2015.

<sup>7</sup> EPA, 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. OSWER Directive 9200.4-17P. April, 1999.

<sup>8</sup> EPA, 1998. Monitoring and Assessment of In-Situ Biocontainment of Petroleum Contaminated Ground-Water Plumes. EPA/60/SR-98/0220. July 1998.

<sup>9</sup> AFCEE, 2000. Designing Monitoring Programs to Effectively Evaluation the Performance of Natural Attenuation. January 2000.

<sup>10</sup> EPA, 2002. Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies. EPA/540/S-02/500. November 2002.

Bulk attenuation rates were estimated for each MNA TC following the approach outlined by the United States Environmental Protection Agency (EPA) (2002)<sup>10</sup>. The approach to estimate bulk attenuation rates consisted of the following general steps, including:

- plotting and performing regression analysis on concentration versus distance plots for Zones AB and CD for each MNA TC (**Figure 5a to 5e**); and
- calculating the bulk attenuation rate as the product of the absolute value of the regression slope for each MNA TC by its respective contaminant velocity ( $v_c$ ); estimated bulk attenuation rates are summarized in **Table 2**.

Each step is further described below.

**Figures 5a to 5e** show regression curves (with associated regression equations and correlation coefficients) of post-shutdown transect average groundwater concentrations versus distance for each MNA TC. Use of transect averages was proposed to the Agencies during the technical meeting discussed above, and is consistent with the conclusion in the BV MNA Report that average transect concentrations, in general, provided a useful approximation of the overall spatial trends that are representative of those observed for the individual wells located along the transect. Regression analysis was performed over the relatively linear (on the logarithmic scale) portion of the concentration versus distance plot, generally over the same distance for Zones AB and CD. The resulting value for each regression slope for each MNA TC and aquifer zone is summarized in **Table 2**.

Estimates for  $v_c$  by MNA TC and aquifer zone were calculated by dividing the estimated groundwater velocity ( $v_{gw}$ ) for each zone by the respective retardation factor ( $R$ ) as follows:

$$v_c = \frac{v_{gw}}{R} \quad (1)$$

$v_{gw}$  was estimated to be 0.14 foot per day (ft/day) for Zone AB and 0.15 ft/day for Zone CD, based on previous estimates for the BV<sup>11</sup>.

$R$  for each MNA TC was calculated as follows:

$$R = 1 + \frac{K_{oc} f_{oc} \rho_b}{n} \quad (2)$$

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<sup>11</sup> Altamont, 2016b. Refined Hydrogeologic Conceptual Site Model Focused on the Back Valley. Chemtronics Site, Swannanoa, Buncombe County, North Carolina. February 19, 2016.

where:

- $K_{oc}$  is the organic carbon-water partition coefficient for each MNA TC, as summarized in **Table 2**;
- $f_{oc}$  is the fraction of organic carbon, which was assumed to be 0.002 kilogram/kilogram, consistent with EPA guidance<sup>12</sup>;
- $\rho_b$  is the bulk density of soil, which was assumed to be 1.48 kg per liter; and
- $n$  is the soil porosity, assumed to be 0.21 for Zone AB and 0.3 for Zone CD (Altamont, 2016b<sup>11</sup>).

Values for  $K_{oc}$ ,  $f_{oc}$ , and  $\rho_b$  are consistent with those utilized in the *Baseline Risk Assessment*<sup>13</sup>. Estimates for  $v_c$ , calculated as outlined above, are provided in **Table 2**.

Estimated bulk attenuation rates ranged from approximately  $3.5 \times 10^{-4}$  to  $1.4 \times 10^{-3}$  day<sup>-1</sup> in Zone AB and from approximately  $1.3 \times 10^{-4}$  to  $3 \times 10^{-3}$  day<sup>-1</sup> for Zone CD (**Table 2**). In general, estimated bulk attenuation rates were slightly higher in Zone CD than Zone AB for most MNA TCs, perhaps due to the prevalence of more reducing conditions in deeper aquifer zones (as discussed in the BV MNA Report). Estimated bulk attenuation rates were generally higher for those MNA TCs that are more amenable to aerobic degradation (e.g., MTBE, TBA, THF) compared to those typically degraded under anaerobic conditions.

The qualitative and/or quantitative approach described and employed herein may be used, in part, as one of many metrics to assess the effectiveness of natural attenuation (in conjunction with other remedial measures) to meet remedial objectives for the Site.

## Geochemical Conditions

The BV MNA Report included an evaluation of select geochemical parameters to assess if pre-shutdown (baseline) geochemical conditions were conducive to natural attenuation processes. The pre-shutdown MNA assessment indicated that geochemical conditions (e.g., redox, pH, common electron acceptors/donors) were generally favorable for natural attenuation of MNA TCs in each aquifer zone. The pre-shutdown redox zonation present in the BV had a tendency toward predominantly anaerobic/anoxic conditions closest to the disposal areas with a transition to aerobic/oxic conditions further downgradient, which supports natural attenuation of a broad

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<sup>12</sup> EPA, 1996. Soil Screening Guidance: User's Guide. Second Edition. EPA/540/R-96-018. Publication 9355.4-23. July 1996.

<sup>13</sup> Altamont, 2015a. Final Remedial Investigation Report. Chemtronics Site, Swannanoa, Buncombe County, North Carolina. December 21, 2015.

range of constituents (i.e., those more amenable to anaerobic or aerobic degradation processes, respectively).

Monitoring associated with the shutdown program included both pre-and post-shutdown field measurement of select geochemical parameters (i.e., pH, oxidation-reduction potential [ORP], and dissolved oxygen [DO]) at select BV locations. **Table 3** summarizes pH, ORP, and DO data for BV locations sampled pre- and post-shutdown. In general, the post-shutdown geochemical data are consistent with the pre-shutdown data. Although there is variability in geochemical data in each aquifer zone, the following general conclusions are based on a review of the geochemical data:

- post-shutdown pH data are similar to pre-shutdown data (i.e., groundwater pH is typically between 5 and 7 [Zones AB and CD] or between 6 and 8 [Zone EF]; pH tends to increase with depth [for example, see data for MW-3S, MW-3D, MW-3B, and MW269-M26EF]);
- redox state (either negative ORP or positive ORP) remained consistent between pre- and post-shutdown for 61 of the 68 wells sampled as part of shutdown program, indicating the redox zonation was similar pre- and post-shutdown; and
- post-shutdown DO data are generally consistent with pre-shutdown data, although there is more variability in pre- and post-shutdown DO data compared to the ORP and pH data sets (which is common for DO vs. ORP measurements).

Review of the pre- and post-shutdown data also indicates that geochemical influences resulting from the ongoing enhanced in situ bioremediation pilot test activities are observed near P-5B (e.g., pH increased and ORP and DO decreased between pre- and post-shutdown at P-5B [Zone CD]). Similar geochemical changes were not observed in the shallower wells paired with P-5B (i.e., P-5S and P-5B) or other nearby Zone CD wells (e.g., MW265-N25CD and MW-3B).

Collectively, review of the post-shutdown geochemical data generally supports the prior geochemical assessment presented in the BV MNA Report (i.e., conditions are favorable for natural attenuation of MNA TCs throughout the BV).

## Conclusions

As summarized above, post-shutdown MNA groundwater conditions are generally similar to those observed pre-shutdown based on review of concentration trends and geochemical conditions. This is consistent with, and supported by, the prior observation of limited effects that the shutdown had on groundwater hydraulic conditions, groundwater quality, and general plume geometry in the BV (see the Shutdown Report).

Collectively, the observations described herein and in the BV MNA Report indicate ongoing natural attenuation of the MNA TCs in BV groundwater as they migrate in the direction of groundwater flow from the APA and DA 9. The pre- and post-shutdown MNA assessments for the BV further support evaluation of MNA as a component of each active remedial alternative in the FS Report.

# TABLES

**Table 1**  
**Pre- and Post-Shutdown MNA Target Compound Data for Select Back Valley Well Clusters**  
**Chemtronics Site, Swannanoa, NC**

Parameter	Screening Criteria (µg/L)	Well Cluster	Well Cluster at MW205-M27AB, MW206-M27CD, MW272-M27EF, and MW272-M27F							
		Category	Transect 3	Transect 3	Transect 3	Transect 3	Other MNA Wells	Other MNA Wells	Other MNA Wells	Other MNA Wells
Zone			AB	AB	CD	CD	EF	EF	EF	EF
Well			MW205-M27AB	MW205-M27AB	MW206-M27CD	MW206-M27CD	MW272-M27EF	MW272-M27EF	MW272-M27F	MW272-M27F
Date			9/5/2014	9/2/2015	9/5/2014	9/2/2015	9/4/2014	8/31/2015	9/17/2014	9/2/2015
Tetrachloroethene (PCE)	0.7		0.1 U	1 U	0.2 U	0.2 U	2 U	2 U	10 U	10 U
Trichloroethene (TCE)	3		<b>3.4</b>	<b>27</b>	<b>27</b>	<b>34</b>	<b>7.5 J</b>	<b>4 J</b>	<b>160</b>	<b>190</b>
cis-1,2-Dichloroethene (cis-DCE)	70		<b>1</b>	<b>21</b>	<b>3.6</b>	<b>17</b>	<b>4.4 J</b>	<b>2.3 J</b>	<b>35 J</b>	<b>49 J</b>
Vinyl Chloride (VC)	0.03		0.1 U	<b>3.4 J</b>	<b>0.8 J</b>	<b>2.7</b>	<b>2.8 J</b>	2 U	10 U	10 U
1,1,2-Trichloroethane (1,1,2-TCA)	0.6		0.1 U	1 U	0.2 U	<b>0.3 J</b>	2 U	2 U	10 U	10 U
1,2-Dichloroethane (1,2-DCA)	0.4		0.1 U	<b>180</b>	<b>19</b>	<b>210</b>	<b>260</b>	<b>170</b>	<b>2600</b>	<b>2800</b>
Chloroform (CF)	70		0.1 U	<b>8.4</b>	0.2 U	<b>9.5</b>	2 U	2 U	<b>96</b>	<b>90</b>
Dichloromethane (DCM)	5		0.2 U	<b>4.2 J</b>	<b>0.7 J</b>	<b>0.5 J</b>	<b>14</b>	<b>11</b>	<b>130</b>	<b>150</b>
1,2-Dichloropropane (1,2-DCP)	0.6		0.1 U	<b>16</b>	<b>0.7 J</b>	<b>19</b>	<b>11</b>	<b>8.3 J</b>	<b>130</b>	<b>210</b>
Perchlorate	2		<b>0.37 J</b>	<b>2.2</b>	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Research Department Explosive (RDX)	0.32		0.2 U	<b>1.9</b>	<b>3</b>	<b>0.65</b>	0.7 U	0.2 U	0.2 U	0.2 U
Methyl-Tert-Butyl Ether (MTBE)	20		0.1 U	<b>33</b>	<b>15</b>	<b>38</b>	<b>150</b>	<b>140</b>	<b>260</b>	<b>290</b>
Tert-Butyl Alcohol (TBA)	10		4 U	<b>4700</b>	<b>1600</b>	<b>4000</b>	<b>9500</b>	<b>10000</b>	<b>23000</b>	<b>32000</b>
Tetrahydrofuran (THF)	6300		2 U	<b>410</b>	<b>250</b>	<b>16</b>	<b>230</b>	<b>250</b>	<b>1200</b>	<b>4200</b>
Benzene	1		<b>0.2 J</b>	<b>120</b>	<b>14</b>	<b>100</b>	<b>160</b>	<b>75</b>	<b>1100</b>	<b>1200</b>

MNA - monitored natural attenuation.

Concentrations are in micrograms per liter (µg/L).

Screening criteria - North Carolina 2L or IMAC groundwater standards. For constituents without a 2L/IMAC, risk-based criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* (Altamont, 2015a) were used.

Detected constituents are in **bold**.

Concentrations greater than the respective screening criteria are shaded in yellow.

**Table 1**  
**Pre- and Post-Shutdown MNA Target Compound Data for Select Back Valley Well Clusters**  
**Chemtronics Site, Swannanoa, NC**

Parameter	Screening Criteria (µg/L)	Well Cluster	Well Cluster at MW-3S, MW-3D, MW-3B, and MW269-M26EF							
		Category	Other MNA Wells	Other MNA Wells	Other MNA Wells	Other MNA Wells	Other MNA Wells	Other MNA Wells	Other MNA Wells	Other MNA Wells
		Zone	AB	AB	AB	AB	CD	CD	EF	EF
		Well	MW-3S	MW-3S	MW-3D	MW-3D	MW-3B	MW-3B	MW269-M26EF	MW269-M26EF
Date	8/26/2014	8/18/2015	8/26/2014	8/19/2015	8/26/2014	8/19/2015	9/15/2014	8/27/2015		
Tetrachloroethene (PCE)	0.7		0.1 U	0.1 U	0.1 U	0.1 U	10 U	10 U	0.1 U	0.1 U
Trichloroethene (TCE)	3		0.1 U	0.1 U	<b>0.6</b>	<b>2.7</b>	<b>170</b>	<b>100</b>	<b>1.9</b>	<b>0.4 J</b>
cis-1,2-Dichloroethene (cis-DCE)	70		0.1 U	0.1 U	0.1 U	<b>3.8</b>	<b>200</b>	<b>100</b>	<b>1.3</b>	<b>0.4 J</b>
Vinyl Chloride (VC)	0.03		0.1 U	0.1 U	0.1 U	<b>1.2</b>	<b>17 J</b>	<b>22 J</b>	<b>0.1 J</b>	0.1 U
1,1,2-Trichloroethane (1,1,2-TCA)	0.6		0.1 U	0.1 U	0.1 U	<b>0.5 J</b>	<b>14 J</b>	<b>10 J</b>	0.1 U	0.1 U
1,2-Dichloroethane (1,2-DCA)	0.4		0.1 U	<b>0.2 J</b>	<b>1.1</b>	<b>15</b>	<b>4100</b>	<b>1200</b>	<b>27</b>	<b>4.7</b>
Chloroform (CF)	70		0.1 U	0.1 U	0.1 U	<b>1</b>	<b>17 J</b>	<b>17 J</b>	<b>0.1 J</b>	0.1 U
Dichloromethane (DCM)	5		0.2 U	0.2 U	0.2 U	<b>1</b>	20 U	<b>20 J</b>	<b>1.8</b>	0.2 U
1,2-Dichloropropane (1,2-DCP)	0.6		0.1 U	0.1 U	0.1 U	0.1 U	10 U	10 U	0.1 U	0.1 U
Perchlorate	2		<b>340</b>	<b>140</b>	<b>35</b>	<b>74</b>	<b>47</b>	<b>30</b>	0.2 U	0.2 U
Research Department Explosive (RDX)	0.32		0.2 U	0.2 U	0.2 U	<b>0.5</b>	<b>4.3 J</b>	<b>3.7</b>	0.2 U	0.2 U
Methyl-Tert-Butyl Ether (MTBE)	20		0.1 U	<b>0.3 J</b>	<b>0.4 J</b>	<b>56</b>	<b>1800</b>	<b>1600</b>	<b>17</b>	<b>3.1</b>
Tert-Butyl Alcohol (TBA)	10		4 U	4 U	<b>12</b>	<b>2600</b>	<b>96000</b>	<b>79000</b>	<b>700</b>	<b>280</b>
Tetrahydrofuran (THF)	6300		2 U	2 U	2 U	<b>36</b>	200 U	<b>320 J</b>	<b>5.9</b>	2 U
Benzene	1		0.1 U	0.1 U	<b>0.2 J</b>	<b>28</b>	<b>680</b>	<b>760</b>	<b>15</b>	<b>7.7</b>

MNA - monitored natural attenuation.

Concentrations are in micrograms per liter (µg/L).

Screening criteria - North Carolina 2L or IMAC groundwater standards. For constituents without a 2L/IMAC, risk-based criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* (Altamont, 2015a) were used.

Detected constituents are in **bold**.

Concentrations greater than the respective screening criteria are shaded in yellow.

**Table 1**  
**Pre- and Post-Shutdown MNA Target Compound Data for Select Back Valley Well Clusters**  
**Chemtronics Site, Swannanoa, NC**

Parameter	Screening Criteria (µg/L)	Well Cluster	Well Cluster at MW-2D, MW-2B, MW273-O26EF, and MW273-O26F							
		Category	Transect 3	Transect 3	Transect 3	Transect 3	Other MNA Wells	Other MNA Wells	Other MNA Wells	Other MNA Wells
		Zone	AB	AB	CD	CD	EF	EF	EF	EF
		Well	MW-2D	MW-2D	MW-2B	MW-2B	MW273-O26EF	MW273-O26EF	MW273-O26F	MW273-O26F
Date	8/26/2014	8/19/2015	8/26/2014	8/19/2015	9/12/2014	9/2/2015	9/17/2014	9/2/2015		
Tetrachloroethene (PCE)	0.7	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	1 U	
Trichloroethene (TCE)	3	0.1 U	0.1 U	<b>26</b>	<b>2.3</b>	<b>4.3</b>	<b>1.7</b>	<b>1.1</b>	1 U	
cis-1,2-Dichloroethene (cis-DCE)	70	0.1 U	0.1 U	<b>1.4</b>	<b>24</b>	<b>0.2 J</b>	<b>2.3</b>	<b>0.1 J</b>	<b>1.8 J</b>	
Vinyl Chloride (VC)	0.03	0.1 U	0.1 U	<b>0.4 J</b>	<b>0.3 J</b>	0.1 U	<b>0.1 J</b>	0.1 U	1 U	
1,1,2-Trichloroethane (1,1,2-TCA)	0.6	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	1 U	
1,2-Dichloroethane (1,2-DCA)	0.4	0.1 U	0.1 U	<b>27</b>	<b>3.2</b>	<b>1</b>	<b>3</b>	<b>0.5 J</b>	<b>2.7 J</b>	
Chloroform (CF)	70	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	1 U	
Dichloromethane (DCM)	5	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	2 U	
1,2-Dichloropropane (1,2-DCP)	0.6	0.1 U	0.1 U	0.1 U	<b>0.4 J</b>	0.1 U	<b>0.3 J</b>	0.1 U	1 U	
Perchlorate	2	<b>3.4</b>	<b>4.2</b>	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	
Research Department Explosive (RDX)	0.32	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	
Methyl-Tert-Butyl Ether (MTBE)	20	0.1 U	0.1 U	<b>6.7</b>	<b>11</b>	<b>0.5 J</b>	<b>6.4</b>	<b>0.3 J</b>	<b>6.3</b>	
Tert-Butyl Alcohol (TBA)	10	4 U	4 U	<b>240</b>	<b>670</b>	<b>8.4 J</b>	<b>470</b>	<b>15</b>	<b>720</b>	
Tetrahydrofuran (THF)	6300	2 U	2 U	2 U	2 U	2 U	<b>2.2 J</b>	2 U	20 U	
Benzene	1	0.1 U	0.1 U	<b>2.9</b>	<b>21</b>	<b>0.2 J</b>	<b>23</b>	<b>0.4 J</b>	<b>27</b>	

MNA - monitored natural attenuation.

Concentrations are in micrograms per liter (µg/L).

Screening criteria - North Carolina 2L or IMAC groundwater standards. For constituents without a 2L/IMAC, risk-based criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* (Altamont, 2015a) were used.

Detected constituents are in **bold**.

Concentrations greater than the respective screening criteria are shaded in yellow.

**Table 2**  
**Estimated Bulk Attenuation Rates for Back Valley MNA Target Compounds**  
**Chemtronics Site, Swannanoa, North Carolina**

MNA Target Compound	K <sub>oc</sub> (L/kg) <sup>2</sup>	Retardation Factor, R <sup>3</sup>		Contaminant Velocity, v <sub>c</sub> <sup>4</sup> (ft/day)		Regression Slope of Transect Average Concentration vs. Distance Plots (ft <sup>-1</sup> ) <sup>5</sup>		Bulk Attenuation Rate Constant, k (day <sup>-1</sup> ) <sup>6</sup>	
		Zone AB	Zone CD	Zone AB	Zone CD	Zone AB	Zone CD	Zone AB	Zone CD
Tetrachloroethene (PCE)	1.60E+02	3.3	2.6	0.043	0.058	-8.73E-03	-1.23E-02	3.75E-04	7.15E-04
Trichloroethene (TCE)	1.70E+02	3.4	2.7	0.041	0.056	-1.41E-02	-1.13E-02	5.81E-04	6.33E-04
cis-1,2-Dichloroethene (cis-DCE)	3.60E+01	1.5	1.4	0.093	0.111	-8.27E-03	-7.68E-03	7.68E-04	8.50E-04
Vinyl Chloride (VC)	1.80E+01	1.3	1.2	0.112	0.127	-6.46E-03	-6.59E-03	7.21E-04	8.39E-04
1,1,2-Trichloroethane (1,1,2-TCA)	5.00E+01	1.7	1.5	0.082	0.100	-6.90E-03	-9.88E-03	5.67E-04	9.92E-04
1,2-Dichloroethane (1,2-DCA)	1.70E+01	1.2	1.2	0.113	0.128	-1.21E-02	-1.38E-02	1.37E-03	1.77E-03
Chloroform (CF)	4.00E+01	1.6	1.4	0.090	0.108	-7.62E-03	-9.54E-03	6.82E-04	1.03E-03
Dichloromethane (DCM)	1.20E+01	1.2	1.1	0.120	0.134	-5.83E-03	-1.42E-02	6.98E-04	1.90E-03
1,2-Dichloropropane (1,2-DCP)	4.30E+01	1.6	1.4	0.087	0.105	-7.61E-03	-8.59E-03	6.63E-04	9.05E-04
Perchlorate	N/A	1.0	1.0	0.140	0.150	-4.98E-03	-5.91E-03	6.97E-04	8.87E-04
Research Department Explosive (RDX)	7.20E+00	1.1	1.1	0.127	0.140	-2.72E-03	-9.35E-04	3.46E-04	1.31E-04
Methyl-Tert-Butyl Ether (MTBE)	1.10E+01	1.2	1.1	0.121	0.135	-8.39E-03	-1.17E-02	1.02E-03	1.58E-03
Tert-Butyl Alcohol (TBA)	2.30E+00	1.0	1.0	0.136	0.147	-8.94E-03	-1.29E-02	1.21E-03	1.89E-03
Tetrahydrofuran (THF)	2.80E+00	1.0	1.0	0.135	0.146	-5.98E-03	-2.02E-02	8.05E-04	2.95E-03
Benzene	5.80E+01	1.8	1.6	0.077	0.095	-8.17E-03	-1.08E-02	6.29E-04	1.03E-03

Notes:

- MNA - Monitored Natural Attenuation.
- K<sub>oc</sub> - organic carbon-water partition coefficient; values obtained from the *Final Remedial Investigation Report, Baseline Risk Assessment* (Appendix L; Altamont, 2015a).
- Retardation factors for each constituent and aquifer zone were calculated using:  $R=1+[(K_{oc} * f_{oc} * p_b)/n]$ , where  $f_{oc}=0.002$  kg/kg,  $p_b=1.48$  kg/L, and  $n=0.21$  (Zone AB) and  $n=0.3$  (Zone CD). R=1 was assumed for perchlorate.  $f_{oc}$  (fraction of organic carbon in soil) and  $p_b$  (bulk density) values obtained from the *Final Remedial Investigation Report, Baseline Risk Assessment* (Appendix L; Altamont, 2015a).  $n$  (porosity) values obtained from the *Refined Hydrogeologic Conceptual Site Model* (Altamont, 2016b).
- Contaminant velocity, in feet per day (ft/day), of each constituent and aquifer zone was calculated using:  $v_c=v_{gw}/R$ , where  $v_{gw}=0.14$  ft/day (Zone AB) and  $0.15$  ft/day (Zone CD) and R is as shown in the table.  $v_{gw}$  (groundwater velocity) values obtained from the *Refined Hydrogeologic Conceptual Site Model* (Altamont, 2016b).
- As shown on Figures 5a to 5d.
- k (bulk attenuation rate constant) calculated using:  $k = -(\text{Regression Slope}) * v_c$ .
- L - Liter.
- kg - kilogram.
- ft - foot.
- N/A - not applicable.

**Table 3**  
**Comparison of Pre- and Post-Shutdown Field Parameter Data for the Back Valley<sup>1</sup>**  
**Chemtronics Site, Swannanoa, NC**

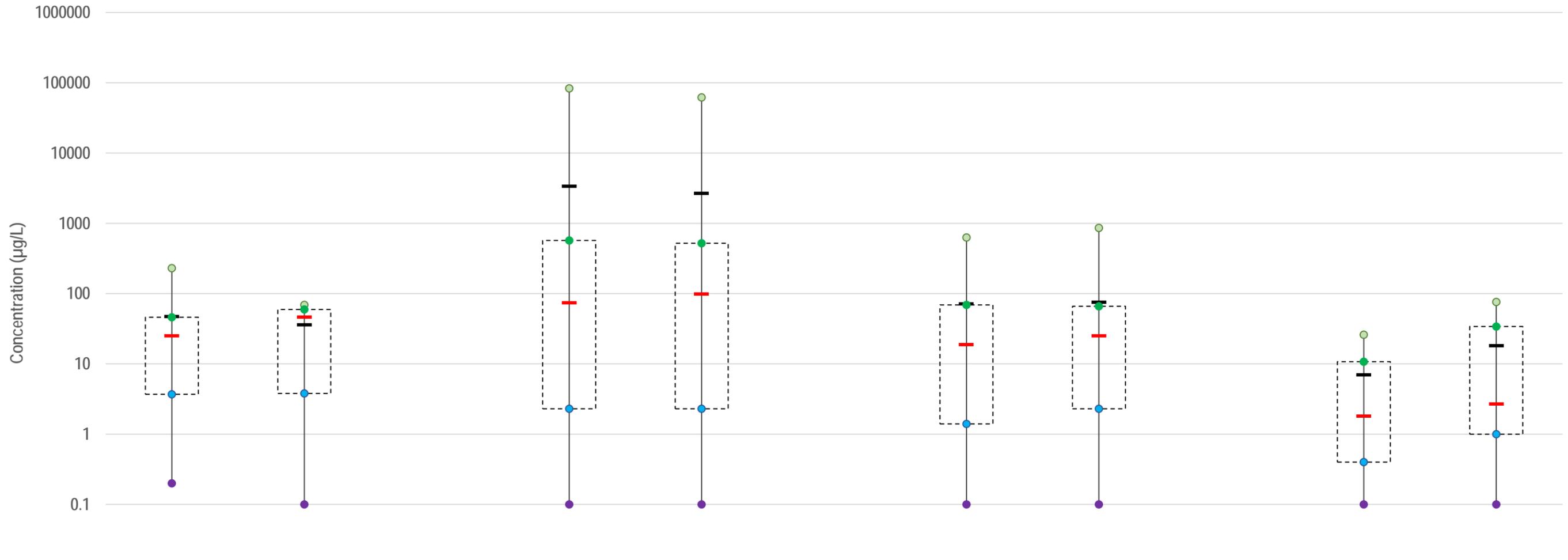
Legend <sup>2</sup>	pH		ORP (mV)		DO (mg/L)	
	> 8		> 50		> 4	
	6 to 8		50 to 0		2 to 4	
	5 to 6		0 to -50		1 to 2	
< 5		< -50		< 1		

Location	Zone	pH		ORP (mV)		DO (mg/L)		
		Pre-Shutdown (2014)	Post-Shutdown (2015)	Pre-Shutdown (2014)	Post-Shutdown (2015)	Pre-Shutdown (2014)	Post-Shutdown (2015)	
MW276-L22AB	AB	6.87	5.45	166.4	286.4	3.83	2.37	
MW207-M23AB		5.51	5.13	252.5	243.9	3.57	2.25	
SW-12		6.09	6.24	213.6	247.5	7.50	5.03	
SW-13		6.02	6.31	200.9	219.9	6.54	4.38	
MW208-L26AB		6.43	6.57	177.4	162.9	7.19	3.80	
M85L-9		6.41	6.88	-60.0	-2.5	2.81	3.74	
M85L-5		7.09	6.88	-136.0	-29.7	0.53	0.35	
M85L-8		6.31	6.16	17.0	215.0	1.06	1.32	
MW185-L26AB		5.11	5.24	343.0	299.9	3.39	3.00	
MW187-M25AB		5.69	5.69	113.7	141.7	1.20	2.93	
MW223-L26AB		5.70	6.07	-67.3	45.3	0.36	0.38	
MW261-N24AB		5.88	6.17	207.3	119.9	0.96	1.00	
MW-5S		5.01	4.84	328.4	232.5	9.06	8.40	
IW-2		6.63	6.55	-170.0	-54.6	0.98	5.11	
P-7D		6.31	6.74	123.3	49.5	2.22	1.62	
P-7S		5.06	5.48	357.5	229.2	3.45	1.42	
MW263-N25AB		5.69	6.29	133.9	92.3	0.40	0.39	
MW268-L26AB		5.67	5.57	170.1	174.4	0.56	0.42	
P-2D		5.85	6.42	126.2	165.1	1.28	0.88	
P-2S		5.75	5.88	98.5	227.9	6.33	7.12	
P-5D		6.26	6.19	-69.3	-6.8	0.98	0.48	
P-5S		4.44	4.57	369.7	277.1	6.38	5.95	
MW-3D		5.57	5.23	268.5	175.0	3.86	4.44	
MW-3S		4.58	4.89	301.6	311.3	3.83	2.97	
P-4D		5.35	5.56	199.6	227.8	5.88	4.83	
MW-2D		5.03	5.07	316.4	194.6	2.25	4.21	
MW188-M27AB		5.49	5.19	264.9	314.1	5.98	7.99	
MW205-M27AB		5.15	5.97	299.3	65.6	1.18	0.18	
MW168-O28B		5.86	5.70	214.5	280.9	2.27	3.57	
MW274-O28AB		4.57	5.38	312.9	290.0	0.86	1.96	
MW275-Q29AB		5.26	5.63	302.8	183.2	1.35	0.35	
MW166-T32A		5.43	5.84	263.5	208.3	0.71	2.52	
M85L-12		CD	5.91	5.57	197.2	223.2	1.22	2.17
MW258-M23CD			6.44	6.47	-57.5	-21.5	0.82	1.13
MW259-M24CD	4.70		5.09	163.9	156.5	1.52	0.57	
MW260-N24CD	6.59		7.00	-72.4	-72.9	0.44	0.54	
BW-9	6.56		6.67	-153.3	-50.1	1.76	2.61	
MW-4B	6.38		6.65	306.9	164.9	1.12	1.07	
MW256-M25CD	6.00		6.37	-85.5	-89.8	0.66	0.35	
MW257-M25CD	3.78		3.74	144.6	339.3	0.82	0.92	
MW266-L26CD	6.06		6.24	50.3	228.0	1.14	0.70	
P-7B	6.46		6.93	-56.9	-48.6	0.81	0.52	
MW265-N25CD	5.14		5.15	41.9	135.7	0.78	0.52	
MW267-L26CD	6.92		6.81	-144.5	208.3	0.49	0.54	
P-5B	5.87		6.41	-46.5	-75.8	0.61	0.29	
MW-3B	6.28		5.94	-52.3	-29.9	2.82	3.66	
MW262-N25CD	6.56		6.89	-83.8	-56.7	0.87	0.39	
MW264-N25CD	6.73		6.99	-108.9	10.4	0.72	1.25	
MW195-M27CD	5.54		5.60	268.9	305.1	6.64	8.08	
MW206-M27CD	5.93		5.92	27.2	71.2	0.24	0.19	
MW270-N27CD	5.46		5.33	175.8	255.0	2.92	2.54	
MW-2B	6.38		6.81	99.4	-13.7	1.59	0.52	
MW149-O28C	6.41		6.40	198.6	204.5	3.97	3.78	
MW150-O28C	5.77		5.99	221.8	230.7	5.40	6.45	
MW152-Q27C	5.70		5.94	292.8	271.1	5.06	4.71	
MW198-Q30CD	5.91		6.02	240.4	122.4	7.32	7.82	
MW199-R29CD	5.99		5.99	222.8	222.6	4.41	4.99	
MW172-T32D	6.72		6.63	131.20	157.00	0.24	0.16	
MW170-J23E	EF		6.27	6.78	-34.9	-22.0	0.71	0.54
MW269-M26EF			8.61	7.59	-94.4	-79.6	0.65	0.37
MW272-M27EF			12.13	10.88	-107.3	-186.7	0.49	0.28
MW272-M27F			5.88	6.11	-22.8	-19.9	0.80	1.57
MW273-O26EF			8.15	7.28	74.3	42.8	2.56	0.79
MW273-O26F			7.89	8.39	67.0	-65.9	1.09	0.51
BW-11			6.53	7.54	71.7	172.3	1.67	7.72
MW228-O27EF			7.59	7.54	-50.6	-35.6	1.84	0.44
MW172-T32E		6.49	7.00	149.0	-15.4	0.42	0.24	
MW225-T32F		7.26	7.54	45.5	86.5	2.00	1.99	

Notes:

1. Pre- and post-shutdown samples collected in August/September 2014 and August/September 2015, respectively, in accordance with the *Revised Work Plan for Temporary Shutdown of the Front and Back Valley Extraction Wells and Treatment Systems* (Altamont, 2014).
2. Shading correlates with colors used to display field parameter data in the *Assessment of Monitored Natural Attenuation (MNA) Potential in the Back Valley* (Geosyntec, 2015).
3. ORP - oxidation-reduction potential.
4. mV - millivolt.
5. DO - dissolved oxygen.
6. mg/L - milligrams per liter.

# FIGURES



	n = 8 PCE (Pre)	n = 8 PCE (Post)		n = 42 TCE (Pre)	n = 40 TCE (Post)		n = 29 cis-DCE (Pre)	n = 31 cis-DCE (Post)		n = 8 VC (Pre)	n = 13 VC (Post)
● Minimum	0.2	0.1		0.1	0.1		0.1	0.1		0.1	0.1
○ Maximum	230	69		83000	62000		630	860		26	76
— Average	47.3	36.2		3391	2690		71.4	76		7	18.3
— Median	25	46.5		74.5	99		19	25		1.8	2.7
● 25th%	3.7	3.8		2.3	2.3		1.4	2.3		0.4	1
● 75th%	46	59.3		570	520		69	66		10.7	34

**Notes:**

- MNA TCs - Monitored Natural Attenuation Target Compounds.
- Pre- and post-shutdown samples were collected in August/September 2014 and August/September 2015, respectively, from 68 Back Valley Zone AB, Zone CD and Zone EF wells. Summary statistics are based on detected constituents (i.e., non-detects were not included in the calculation of summary statistics).
- µg/L – micrograms per liter.
- "n" is the number of locations sampled in the pre-/post-shutdown events with a detection for the respective MNA TC.
- MNA TC abbreviations:  
 PCE - tetrachloroethene                      TCE - trichloroethene                      cis-DCE - 1,2-cis-dichloroethene  
 VC - vinyl chloride

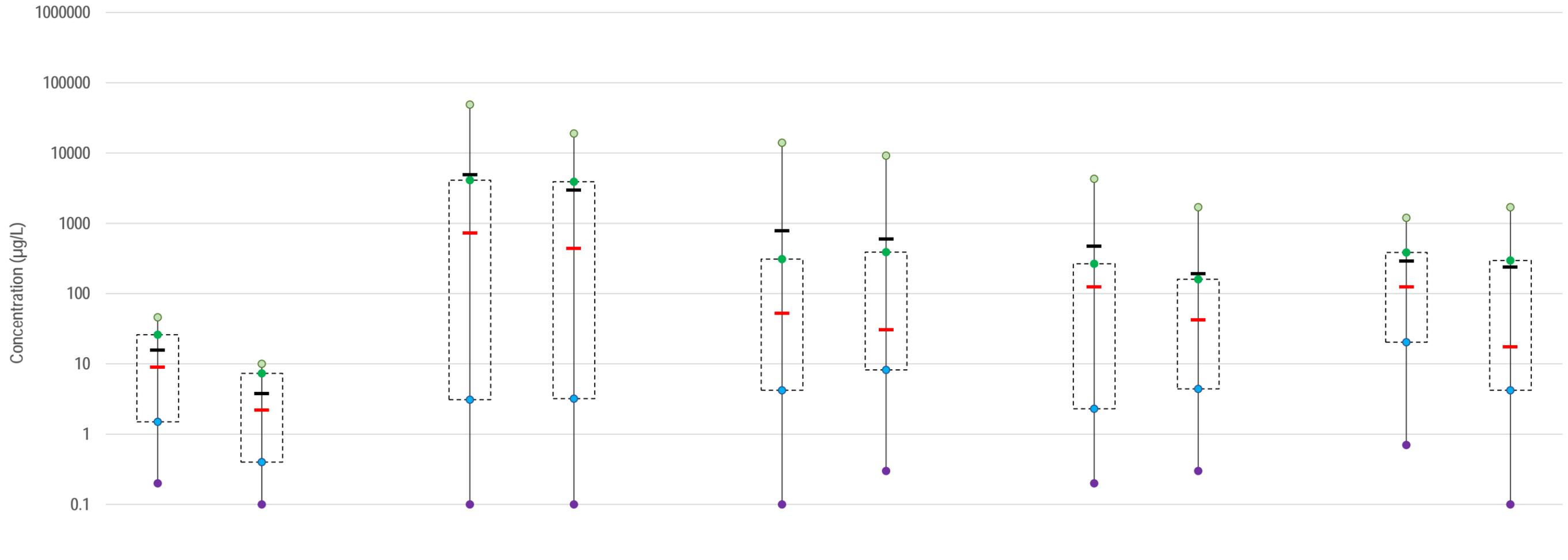
**Comparison of Pre- and Post-Shutdown Concentrations for PCE, TCE, cis-DCE, and VC in the Back Valley**  
Chemtronics Site, Swannanoa, North Carolina

**Geosyntec**  
consultants

Kennesaw                      July 2016

Figure  
1a

N:\C\Chemtronics\MNA\Back Valley\Post-Shutdown\Figures\MND\Fig1a-1d\_2014 and 2015 BV MNA TC Box Plot.ksl\BV Box Plot - Chlorinated (2)



	n = 6 1,1,2-TCA (Pre)	n = 8 1,1,2-TCA (Post)		n = 41 1,2-DCA (Pre)	n = 41 1,2-DCA (Post)		n = 25 CF (Pre)	n = 24 CF (Post)		n = 18 DCM (Pre)	n = 20 DCM (Post)		n = 14 1,2-DCP (Pre)	n = 20 1,2-DCP (Post)
● Minimum	0.2	0.1		0.1	0.1		0.1	0.3		0.2	0.3		0.7	0.1
○ Maximum	46	10		49000	19000		14000	9200		4300	1700		1200	1700
— Average	15.8	3.8		4925	3010		779	604		478	193		292	240
— Median	9	2.2		730	440		53	30.5		125	42.5		125	17.5
● 25th%	1.5	0.4		3.1	3.2		4.2	8.2		2.3	4.4		20.3	4.2
● 75th%	26	7.3		4100	3900		310	388		265	160		385	295

**Notes:**

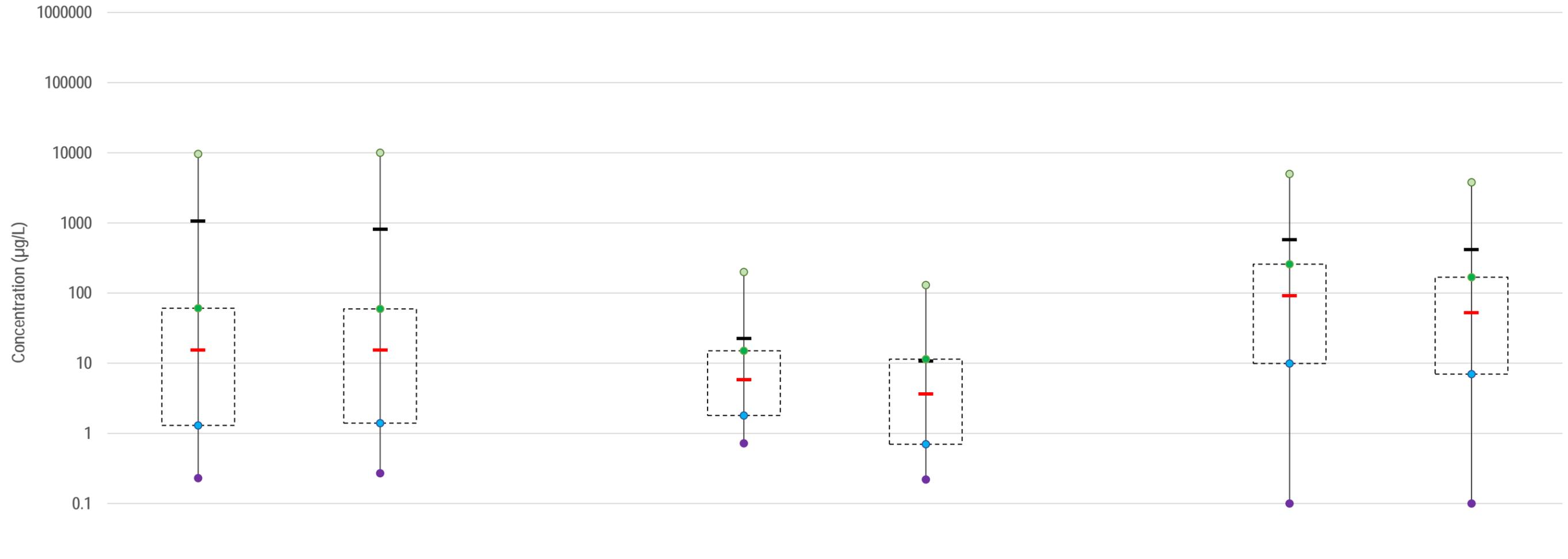
- MNA TCs - Monitored Natural Attenuation Target Compounds.
- Pre- and post-shutdown samples were collected in August/September 2014 and August/September 2015, respectively, from 68 Back Valley Zone AB, Zone CD and Zone EF wells. Summary statistics are based on detected constituents (i.e., non-detects were not included in the calculation of summary statistics).
- µg/L – micrograms per liter.
- "n" is the number of locations sampled in the pre-/post-shutdown events with a detection for the respective MNA TC.
- MNA TC abbreviations:  
 1,1,2-TCA - 1,1,2-trichloroethane      1,2-DCA - 1,2-dichloroethane      CF - chloroform  
 DCM - dichloromethane      1,2-DCP - 1,2-dichloropropane

**Comparison of Pre- and Post-Shutdown Concentrations for 1,1,2-TCA, 1,2-DCA, CF, DCM, and 1,2-DCP in the Back Valley Chemtronics Site, Swannanoa, North Carolina**

  
 Kennesaw      July 2016

Figure 1b

N:\C\Chemtronics\MA Back Valley\Post-Shutdown\Figures\MND\Fig 1b-1d\_2014 and 2015 BV\MNA TC Box Plots\Box Plot - Chlorinated (2)



	n = 40 Perchlorate (Pre)	n = 40 Perchlorate (Post)		n = 25 RDX (Pre)	n = 27 RDX (Post)		n = 30 MTBE (Pre)	n = 34 MTBE (Post)
● Minimum	0.23	0.27		0.72	0.22		0.1	0.1
● Maximum	9600	10000		200	130		5000	3800
— Average	1076	812		22.5	10.7		574	421
— Median	15.5	15.5		5.9	3.7		92	52.5
● 25th%	1.3	1.4		1.8	0.7		9.9	7
● 75th%	61	59.5		15	11.4		258	168

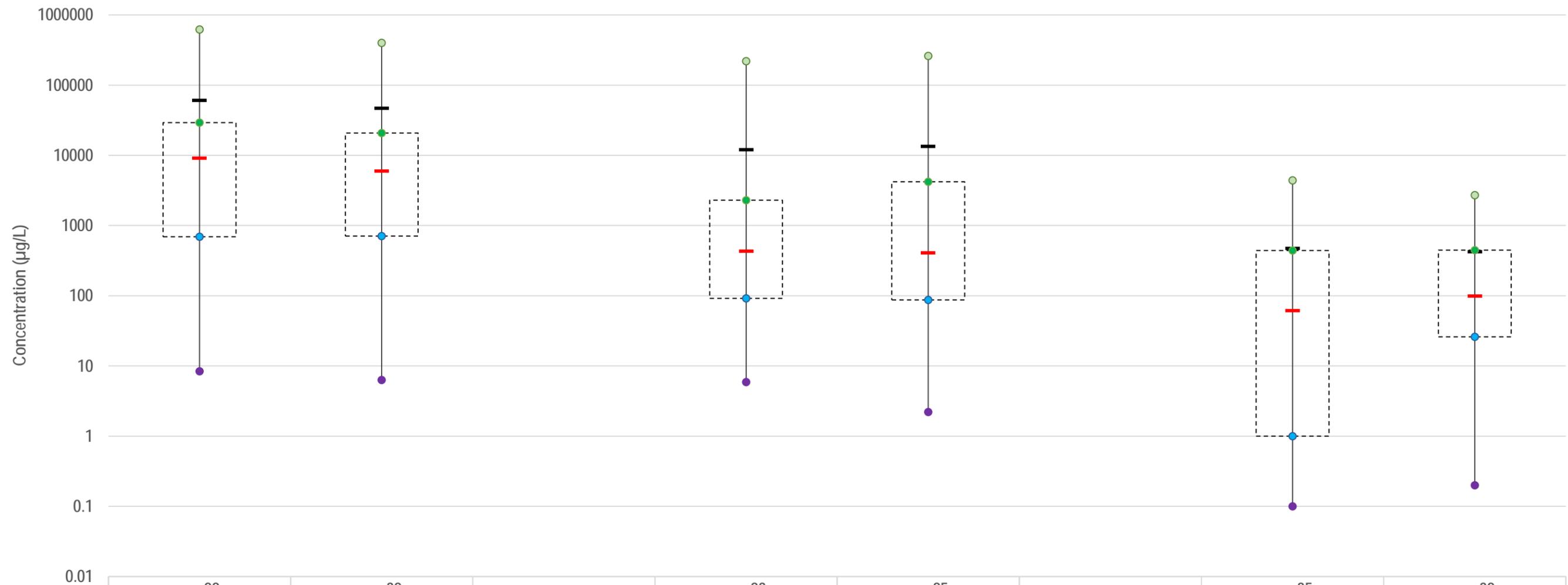
**Notes:**

- MNA TCs - Monitored Natural Attenuation Target Compounds.
- Pre- and post-shutdown samples were collected in August/September 2014 and August/September 2015, respectively, from 68 Back Valley Zone AB, Zone CD and Zone EF wells. Summary statistics are based on detected constituents (i.e., non-detects were not included in the calculation of summary statistics).
- µg/L – micrograms per liter.
- "n" is the number of locations sampled in the pre-/post-shutdown events with a detection for the respective MNA TC.
- MNA TC abbreviations:  
RDX - Research Department Explosive      MTBE - methyl-tert-butyl ether

**Comparison of Pre- and Post-Shutdown Concentrations for Perchlorate, RDX, and MTBE in the Back Valley**  
Chemtronics Site, Swannanoa, North Carolina

		<b>Figure</b>  1c
Kennesaw	July 2016	

N:\C\Chemtronics\Back Valley\Post-Shutdown\Figures\MND\Fig 1b-1d\_2014 and 2015 BV MNA TC Box Plots.ksl\Box Plot - Chlorinated (2)



	n = 28 TBA (Pre)	n = 32 TBA (Post)	n = 23 THF (Pre)	n = 25 THF (Post)	n = 35 Benzene (Pre)	n = 32 Benzene (Post)
● Minimum	8.4	6.3	5.9	2.2	0.1	0.2
○ Maximum	620000	400000	220000	260000	4400	2700
— Average	60473	46781	12175	13502	474	420
— Median	9150	6000	430	410	62	99
● 25th%	690	708	91.5	87	1	26
● 75th%	29250	20750	2300	4200	440	445

**Notes:**

- MNA TCs - Monitored Natural Attenuation Target Compounds.
- Pre- and post-shutdown samples were collected in August/September 2014 and August/September 2015, respectively, from 68 Back Valley Zone AB, Zone CD and Zone EF wells. Summary statistics are based on detected constituents (i.e., non-detects were not included in the calculation of summary statistics).
- µg/L – micrograms per liter.
- "n" is the number of locations sampled in the pre-/post-shutdown events with a detection for the respective MNA TC.
- MNA TC abbreviations:  
TBA - tert-butyl alcohol                      THF - tetrahydrofuran

**Comparison of Pre- and Post-Shutdown Concentrations for TBA, THF, and Benzene in the Back Valley**  
Chemtronics Site, Swannanoa, North Carolina



Figure  
1d

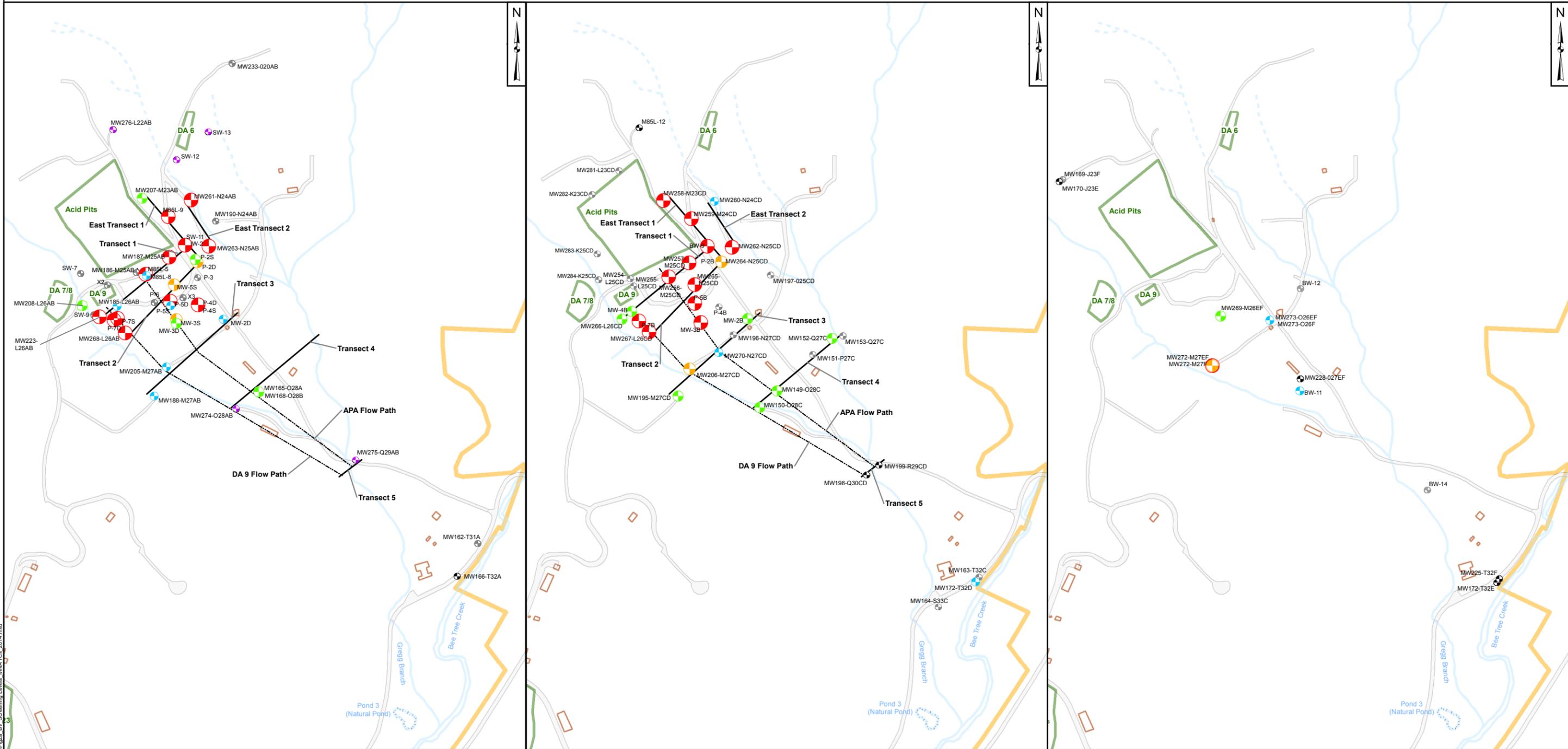
Kennesaw

July 2016

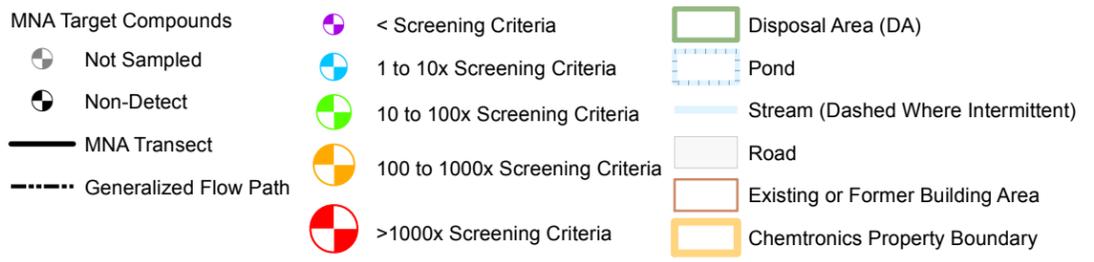
Zone AB

Zone CD

Zone EF



Path: N:\Chemtronics\Back Valley\Post-Shutdown\Figures\Map\Fig2a - BY Screening Levels - MNA (CA) - 2014.mxd



Notes:

- MNA - monitored natural attenuation.
- Screening criteria - North Carolina 2L or IMAC groundwater standards. For constituents without a 2L/IMAC, risk-based criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* (Altamont, 2015a) were used.
- MNA target compounds for the Back Valley include: tetrachloroethene (PCE); trichloroethene (TCE); cis-DCE (cis-1,2-dichloroethene); vinyl chloride (VC); 1,1,2-TCA (1,1,2-trichloroethane); 1,2-DCA (1,2-dichloroethane); chloroform (CF); dichloromethane (DCM); 1,2-DCP (1,2-dichloropropane); perchlorate; research department explosive (RDx); methy-ethyl-butyl ether (MTBE); tert-butyl alcohol (TBA); tetrahydrofuran (THF); and benzene.
- For each location sampled as part of the pre-shutdown sample event in August/September 2014, MNA target compound data were compared to screening criteria. The maximum value relative to screening criteria is illustrated.
- Extraction wells are not shown.

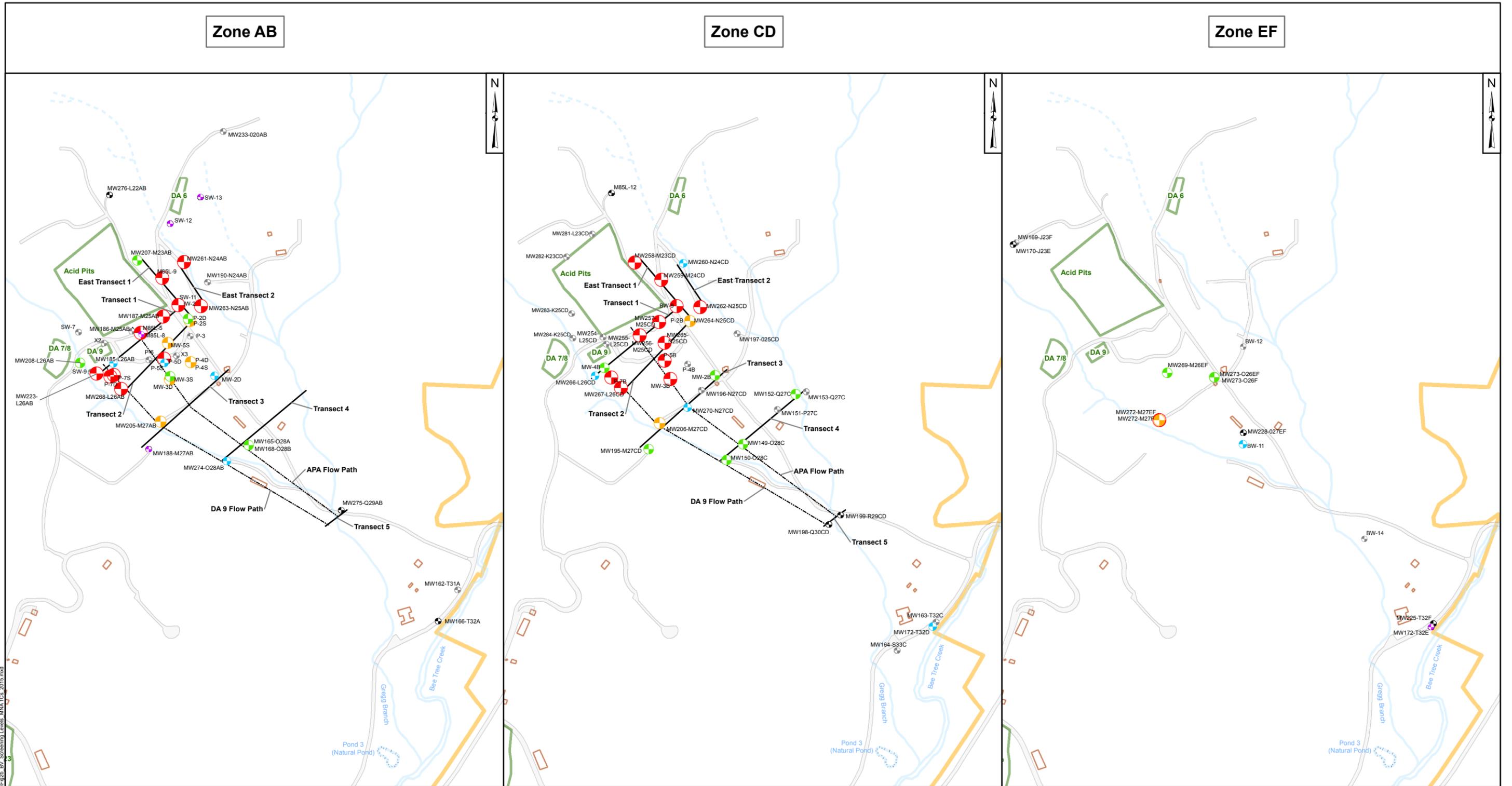


**Comparison of Pre-Shutdown MNA Target Compound Concentrations to Screening Criteria in the Back Valley**  
Chemtronics Site, Swannanoa, North Carolina

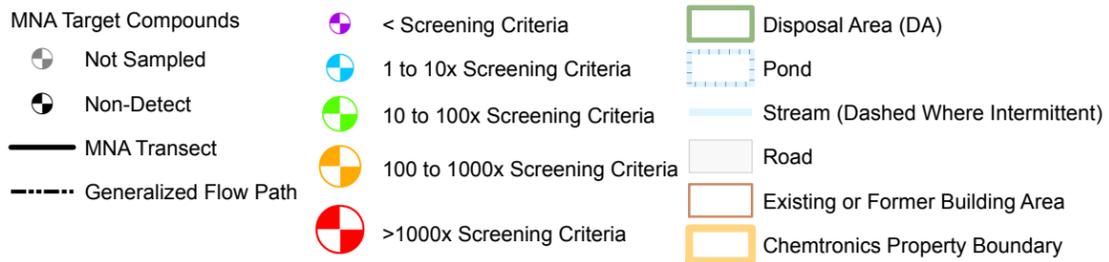


Figure  
**2a**

Kennesaw July 2016



Path: N:\Chemtronics\Back Valley\Post-Shutdown\Figures\Map\Fig2b\_VJ\_Screening Levels\_MNA\_TCA\_2015.mxd



Notes:

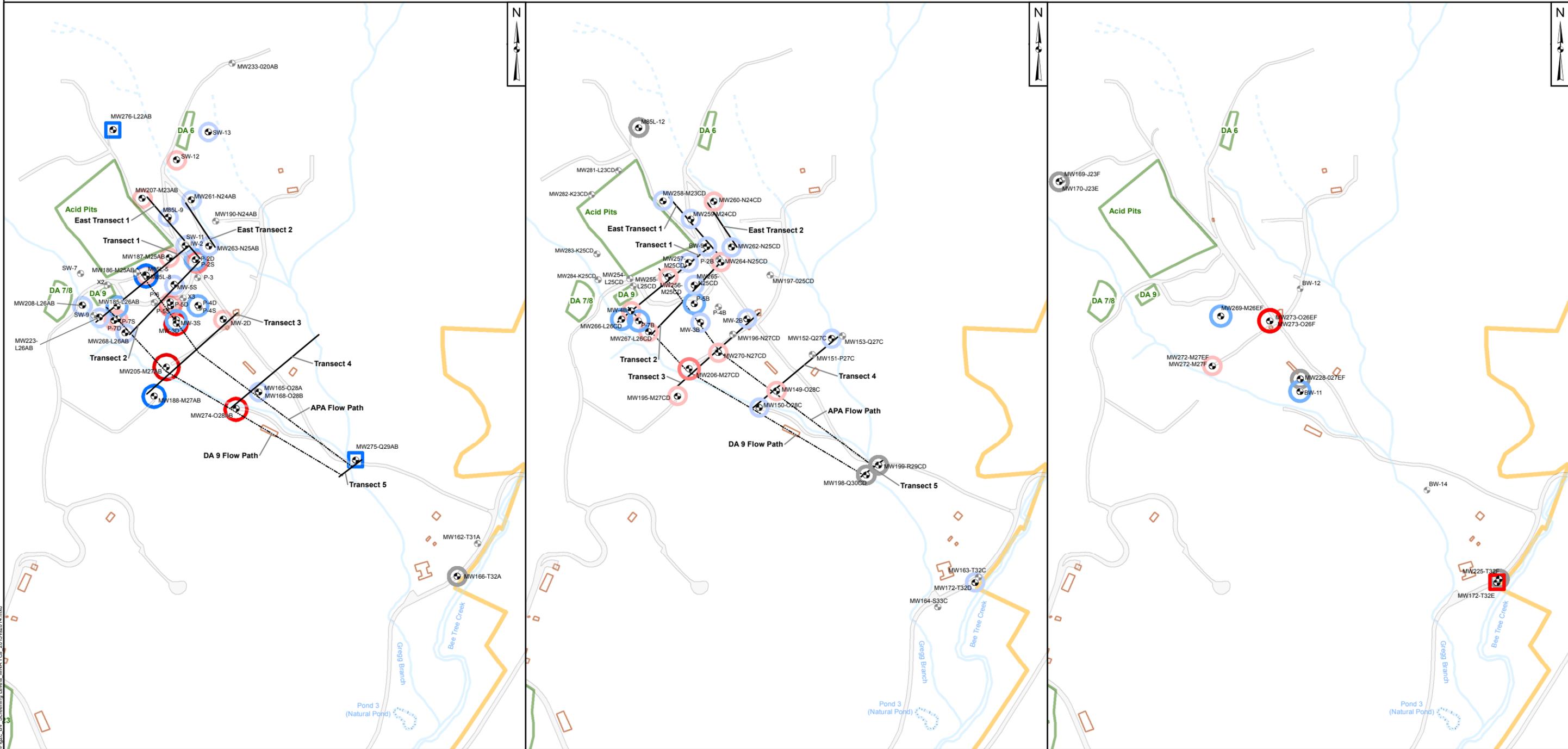
- MNA - monitored natural attenuation.
- Screening criteria - North Carolina 2L or IMAC groundwater standards. For constituents without a 2L/IMAC, risk-based criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* (Altamont, 2015a) were used.
- MNA target compounds for the Back Valley include: tetrachloroethene (PCE); trichloroethene (TCE); cis-DCE (cis-1,2-dichloroethene); vinyl chloride (VC); 1,1,2-TCA (1,1,2-trichloroethane); 1,2-DCA (1,2-dichloroethane); chloroform (CF); dichloromethane (DCM); 1,2-DCP (1,2-dichloropropane); perchlorate; research department explosive (RDx); methy-ethyl-butyl ether (MTBE); tert-butyl alcohol (TBA); tetrahydrofuran (THF); and benzene.
- For each location sampled as part of the post-shutdown sample event in August/September 2015, MNA target compound data were compared to screening criteria. The maximum value relative to screening criteria is illustrated.
- Extraction wells are not shown.

<b>Comparison of Post-Shutdown MNA Target Compound Concentrations to Screening Criteria in the Back Valley</b> Chemtronics Site, Swannanoa, North Carolina	
Kennesaw	July 2016
<b>Figure 2b</b>	

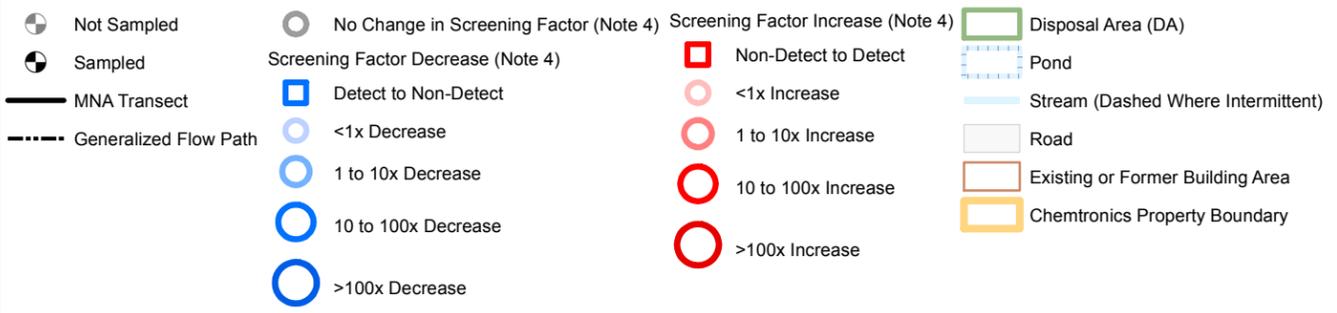
**Zone AB**

**Zone CD**

**Zone EF**



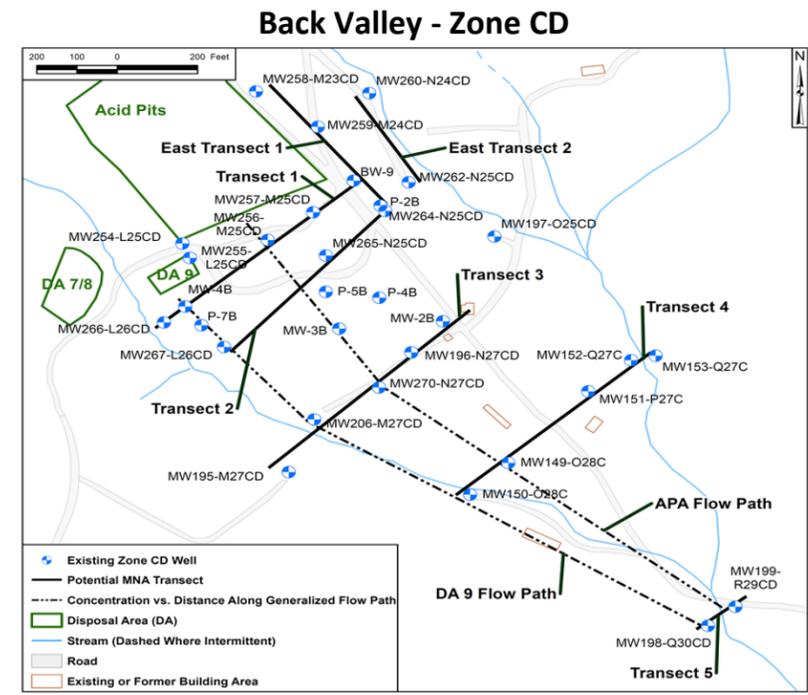
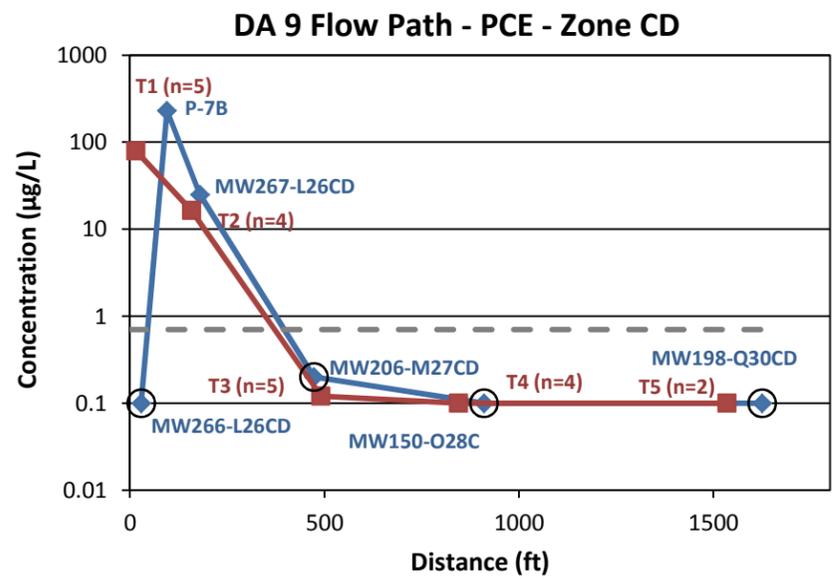
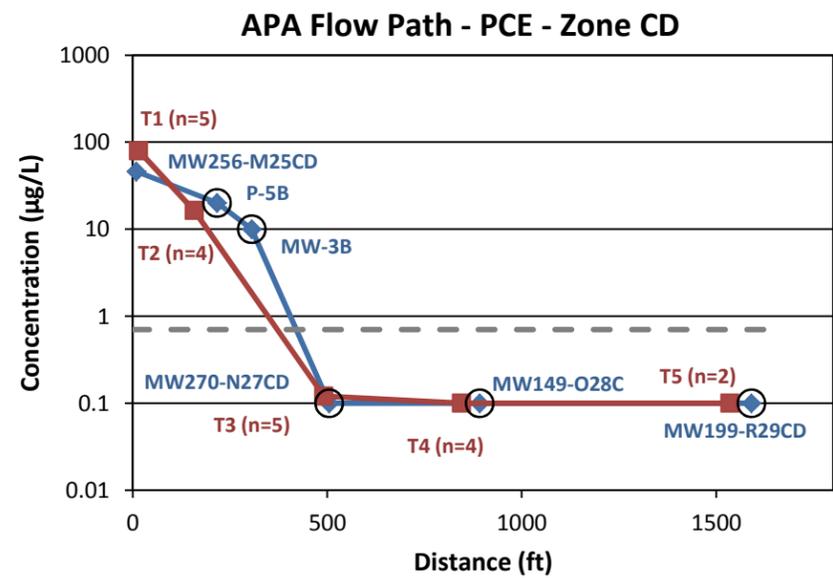
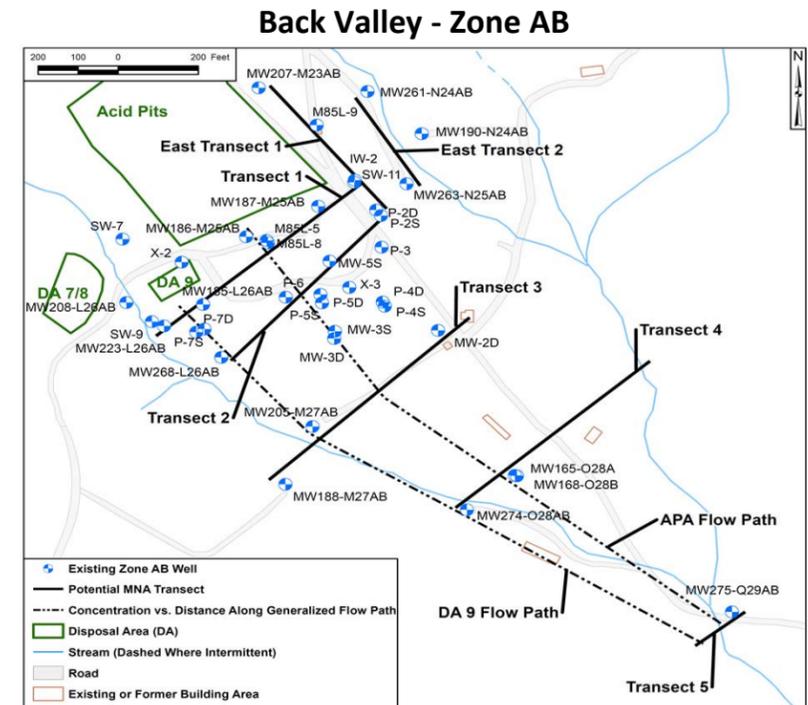
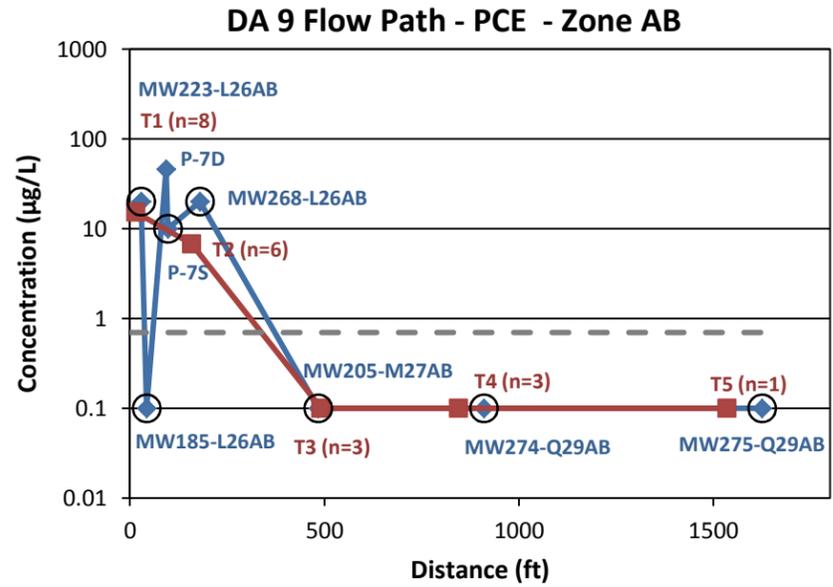
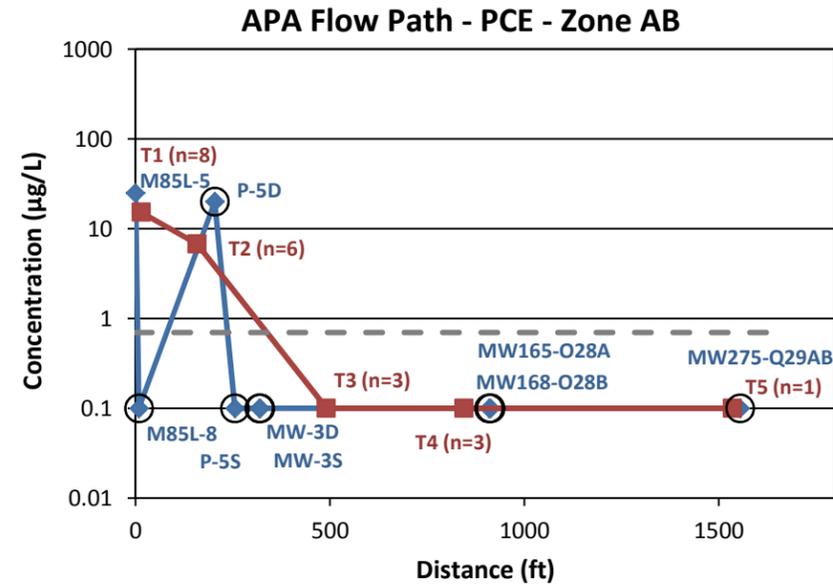
Path: N:\Chemtronics\Back Valley\Post-Shutdown\Figures\Map\Fig2\_BV\_Screening Levels\_MNA\_TC\_2015\sv2014.mxd



Notes:

- MNA - monitored natural attenuation.
- Screening criteria - North Carolina 2L or IMAC groundwater standards. For constituents without a 2L/IMAC, risk-based criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* (Altamont, 2015a) were used.
- MNA target compounds for the Back Valley include: tetrachloroethene (PCE); trichloroethene (TCE); cis-DCE (cis-1,2-dichloroethene); vinyl chloride (VC); 1,1,2-TCA (1,1,2-trichloroethane); 1,2-DCA (1,2-dichloroethane); chloroform (CF); dichloromethane (DCM); 1,2-DCP (1,2-dichloropropane); perchlorate; research department explosive (RDX); methy-ethyl-butyl ether (MTBE); tert-butyl alcohol (TBA); tetrahydrofuran (THF); and benzene.
- Screening factors represent a comparison of MNA target compound concentrations to screening criteria. The relative change of the maximum screening factor for each location between pre- and post-shutdown is illustrated.
- Extraction wells are not shown.

<p><b>Change in Pre-/Post-Shutdown MNA Target Compound Concentrations Relative to Screening Criteria in the Back Valley</b> Chemtronics Site, Swannanoa, North Carolina</p>	
Kennesaw	July 2016
<p><b>Figure</b> <b>2c</b></p>	



**Notes:**

1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. PCE - tetrachloroethene.

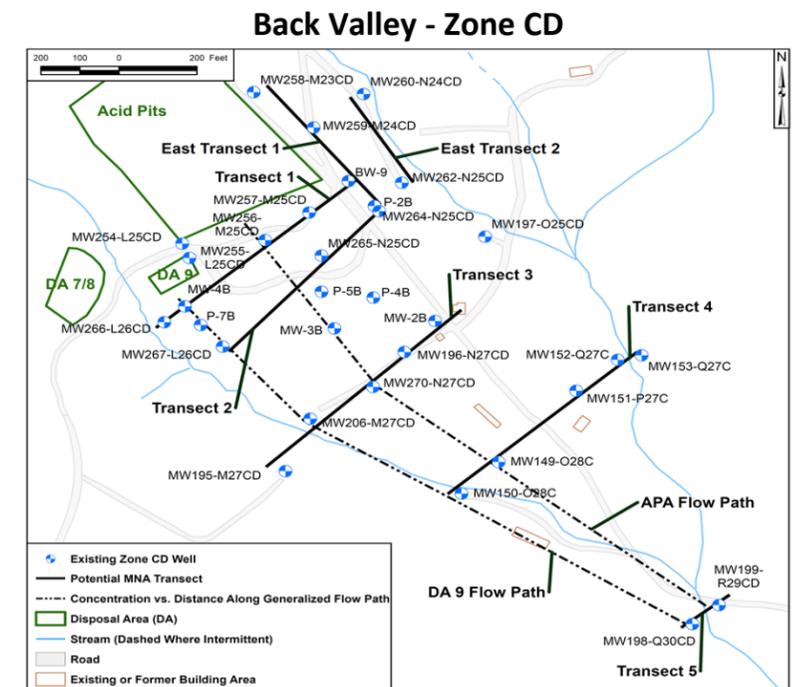
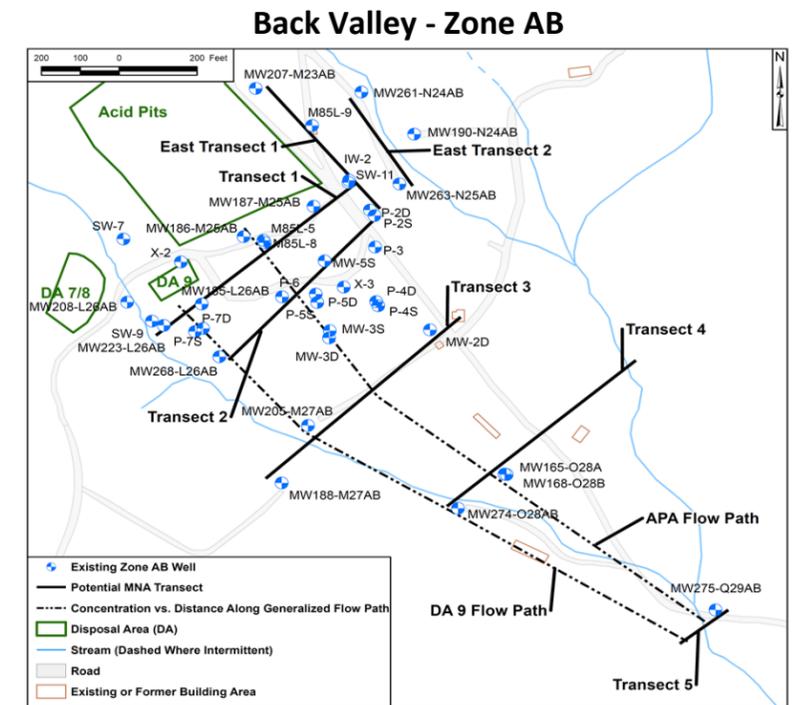
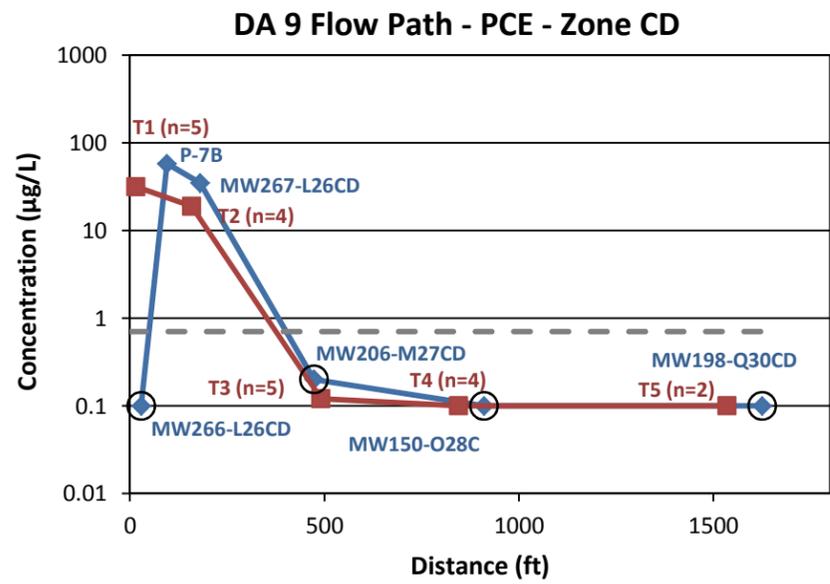
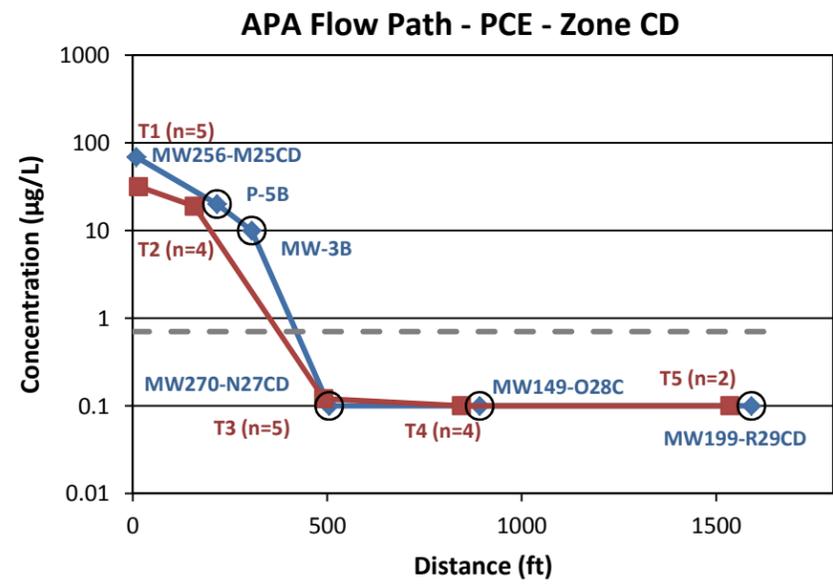
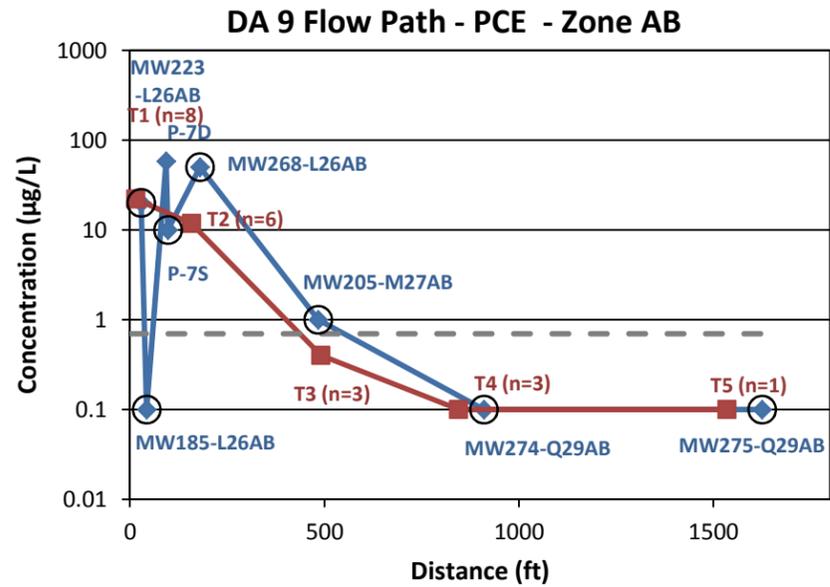
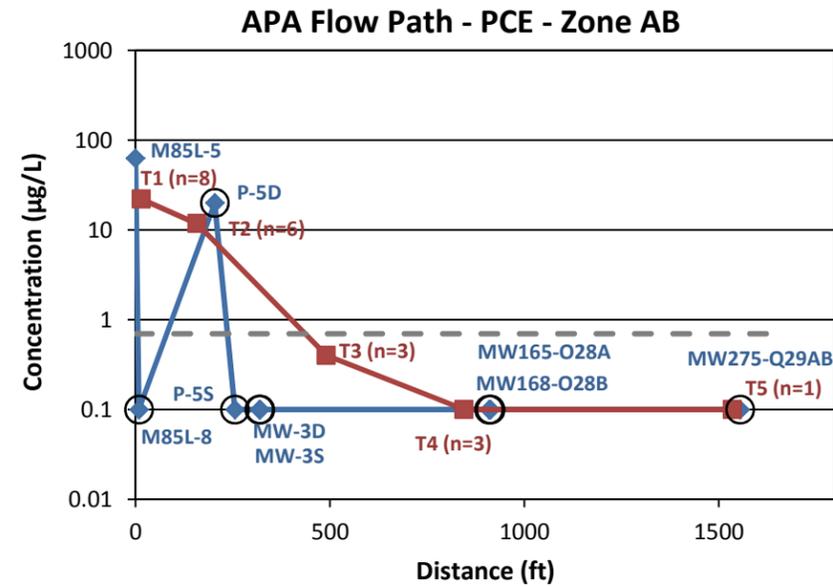
**Pre-Shutdown PCE Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure  
3-1a

Kennesaw July 2016

N:\C:\Chemtronics\MA Back Valley Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\_AB\_CD Distance Trends.xlsx\Benzene\_FlowPath 8



**Notes:**

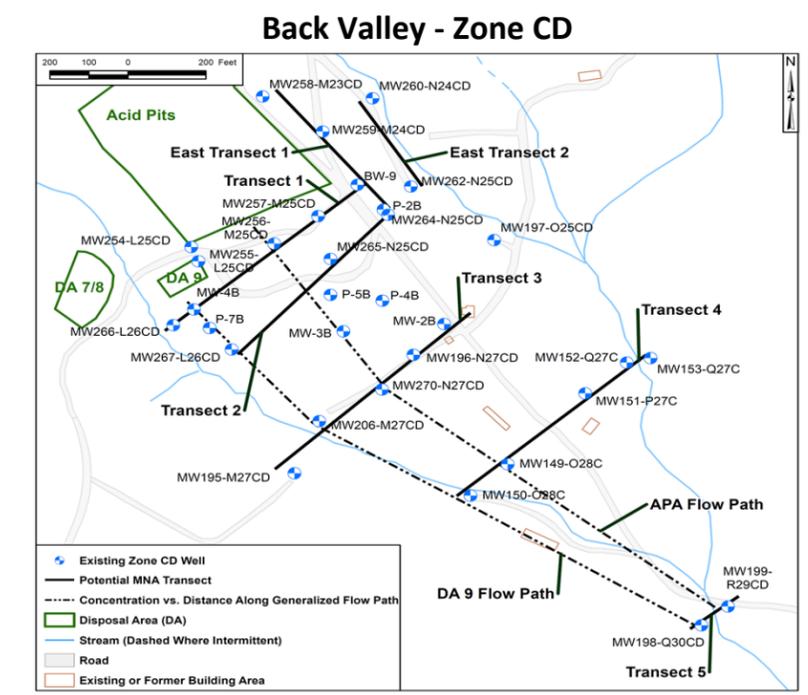
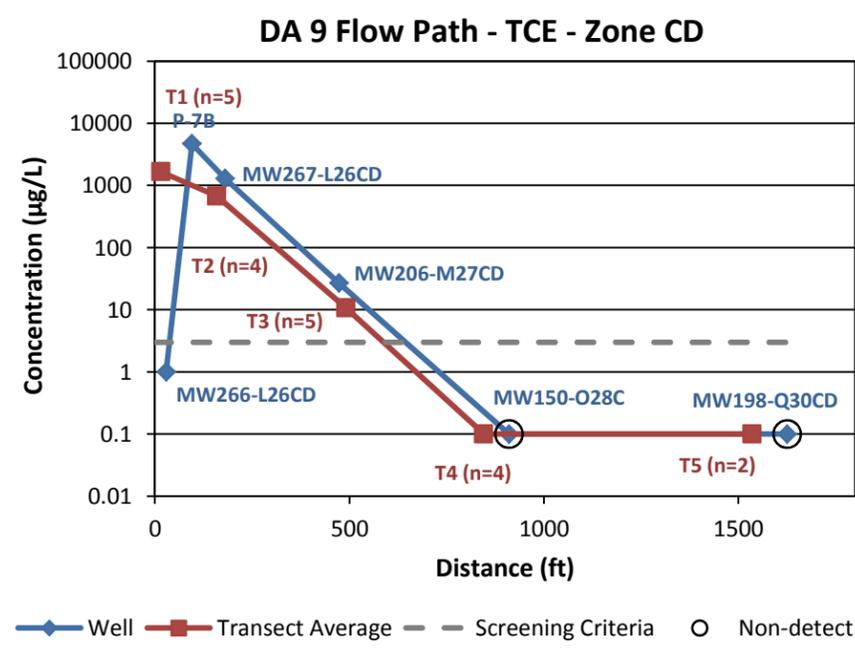
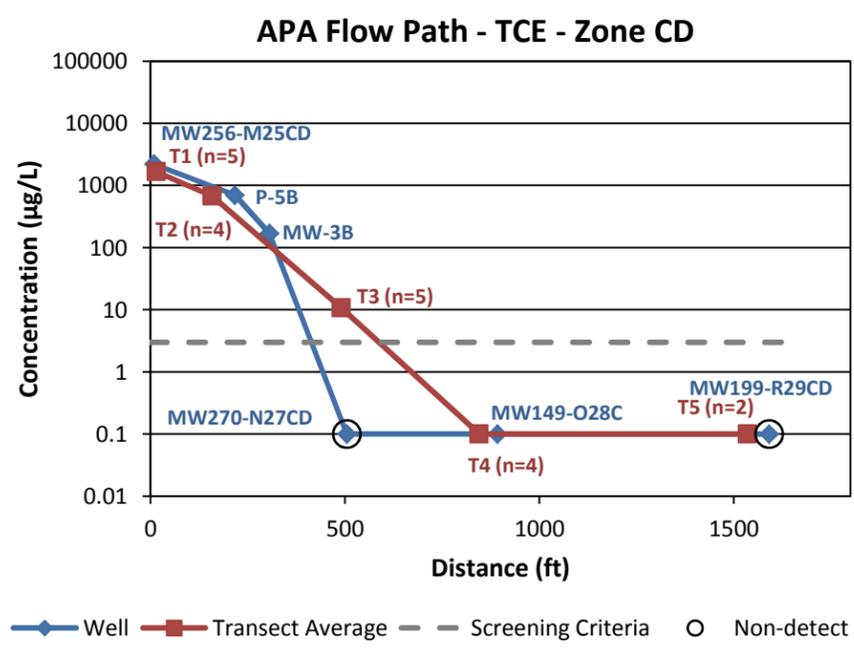
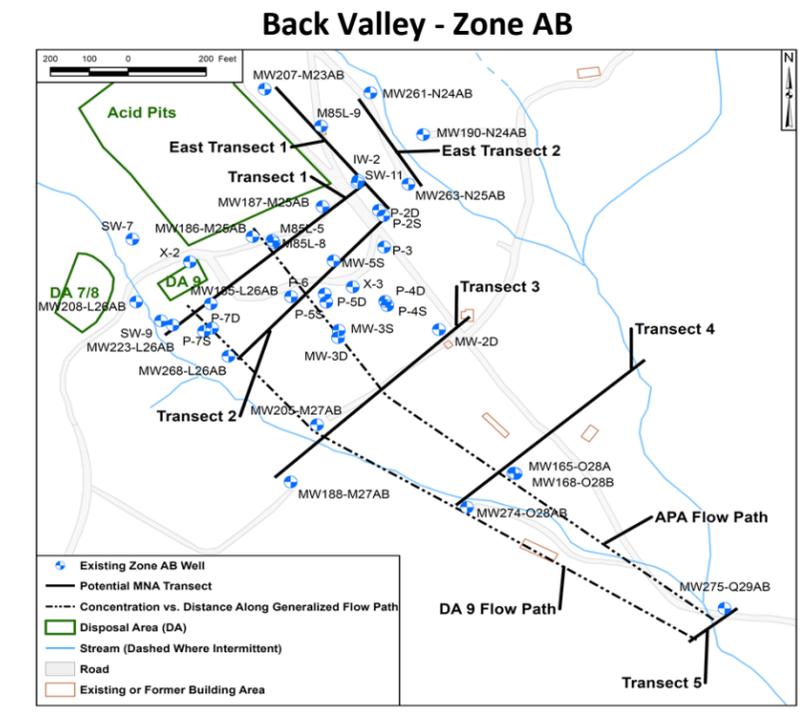
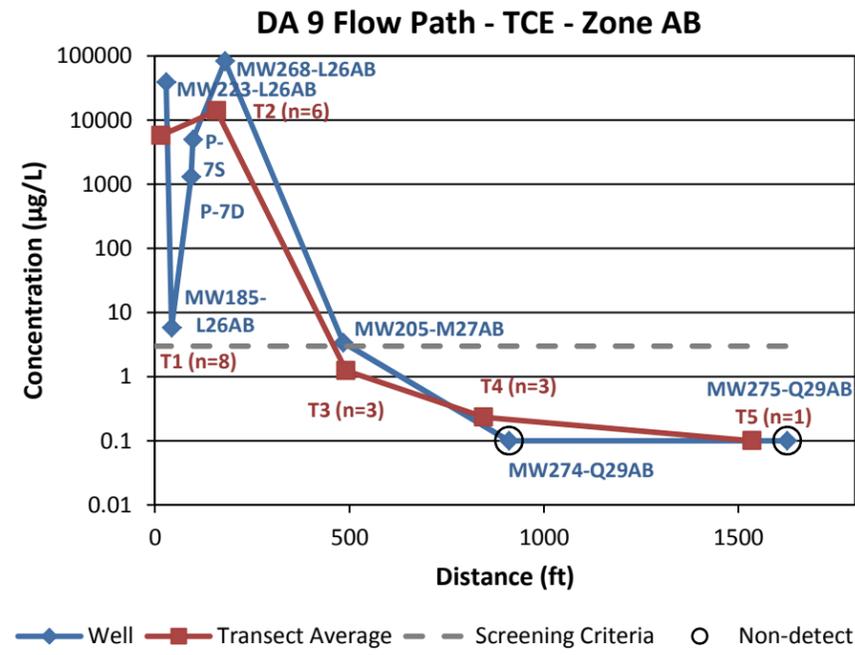
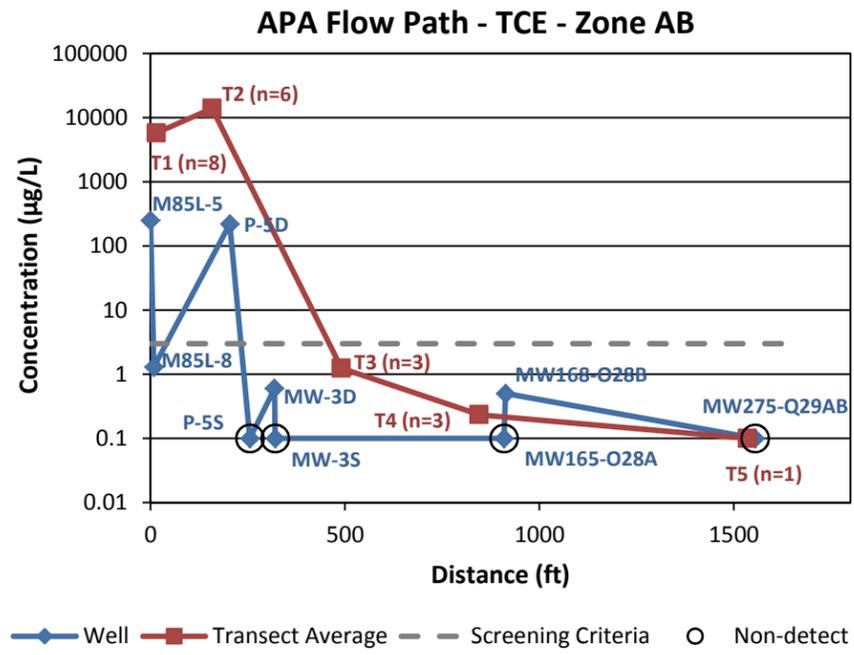
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. PCE - tetrachloroethene.

**Post-Shutdown PCE Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Kennesaw July 2016

Figure 3-1b



N:\C\Chemtronics\Back Valley\Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\AB\_CD Distance Trends.xlsx\Benzene\_FlowPath 8

**Notes:**

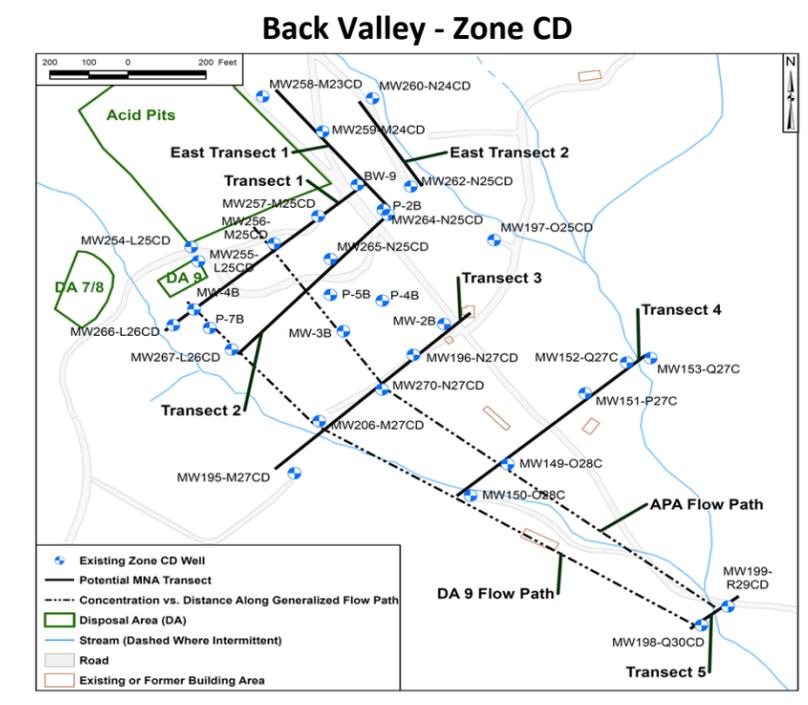
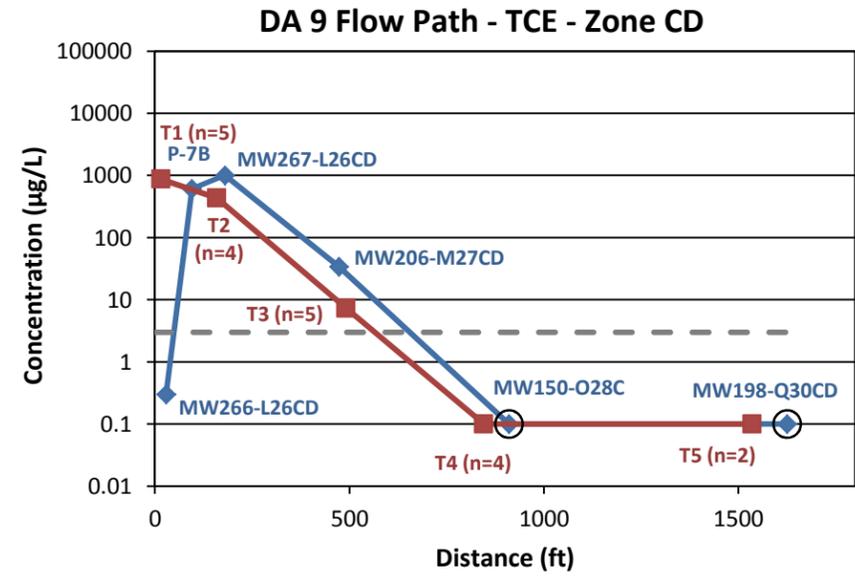
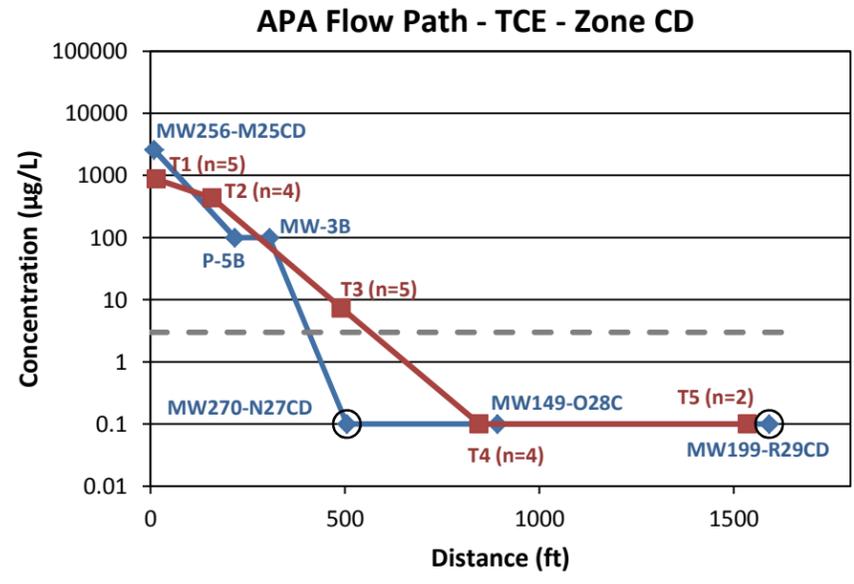
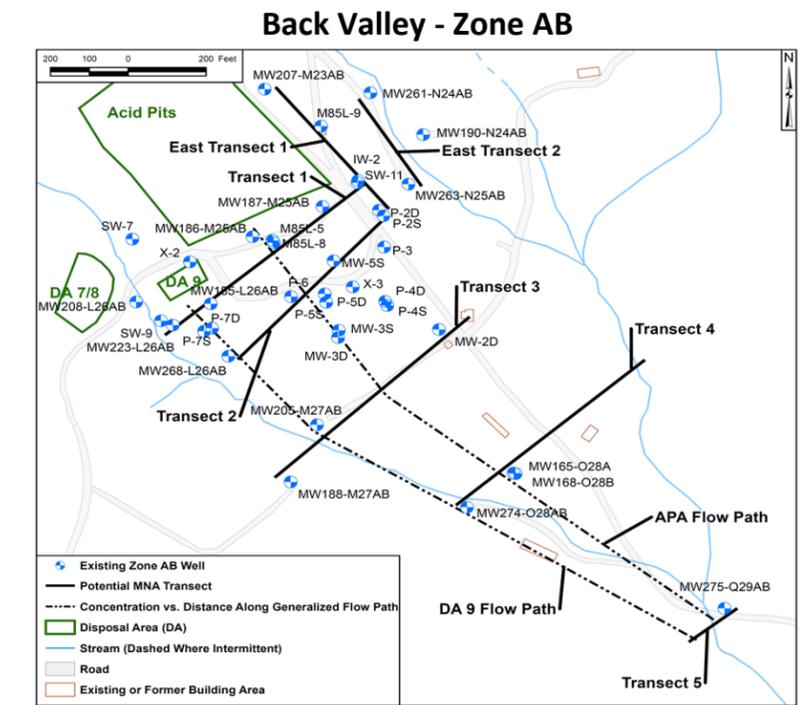
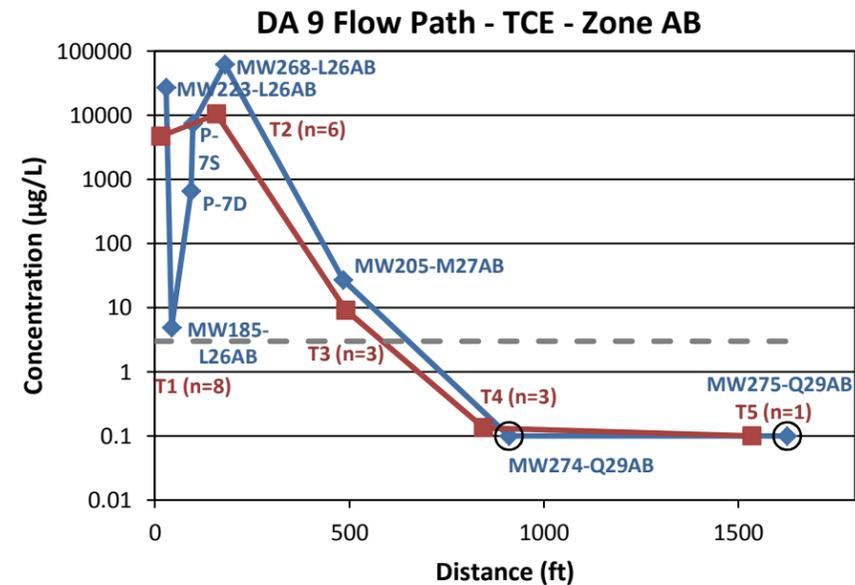
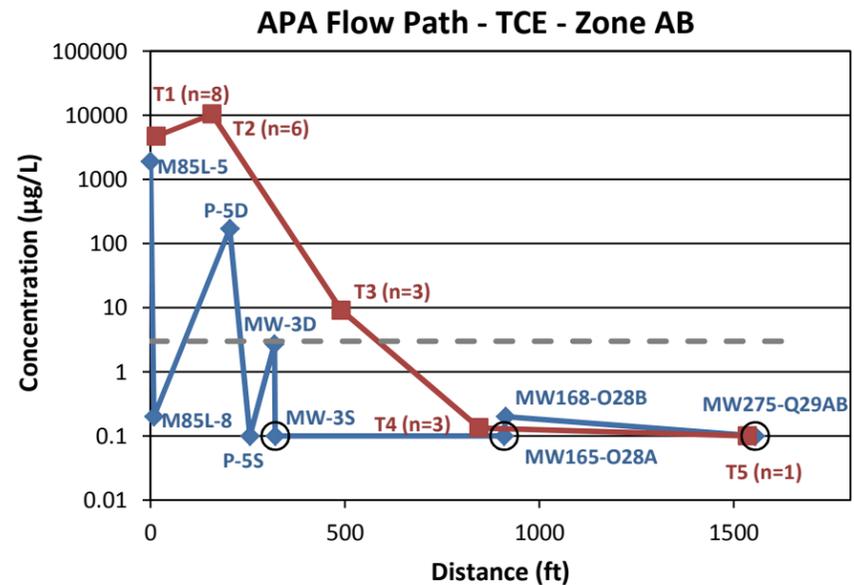
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. TCE - trichloroethene.

**Pre-Shutdown TCE Concentration vs. Distance  
Along Flow Paths  
Chemtronics Site  
Swannanoa, North Carolina**

**Geosyntec**  
consultants

Kennesaw      July 2016

Figure  
3-2a



N:\C\Chemtronics\Back Valley Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\_AB\_CD Distance Trends.xlsx\Benzene\_FlowPath B

**Notes:**

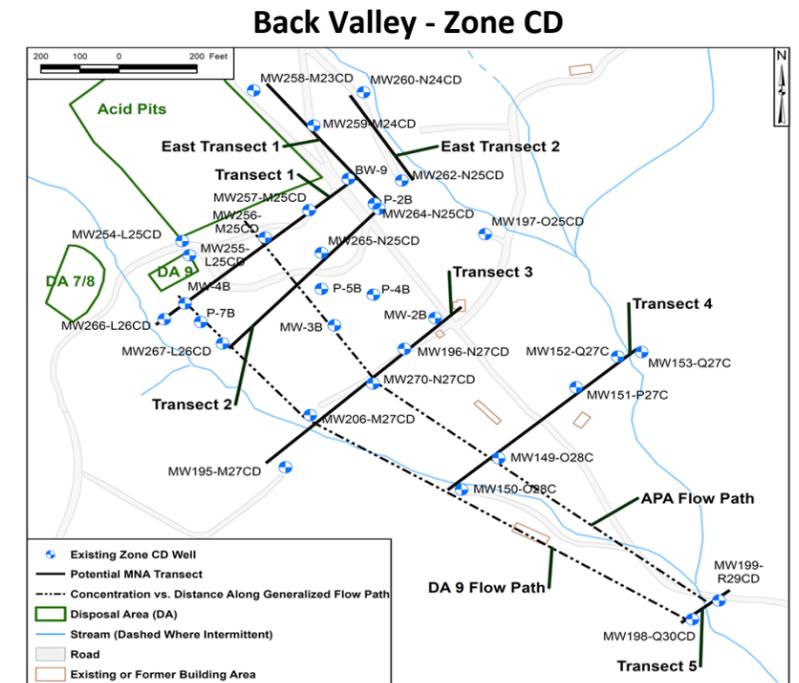
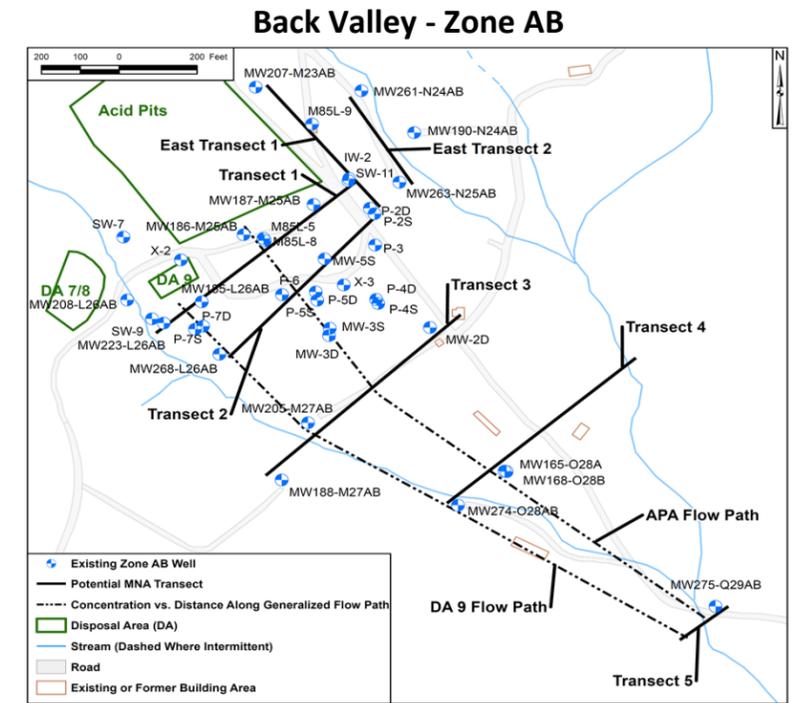
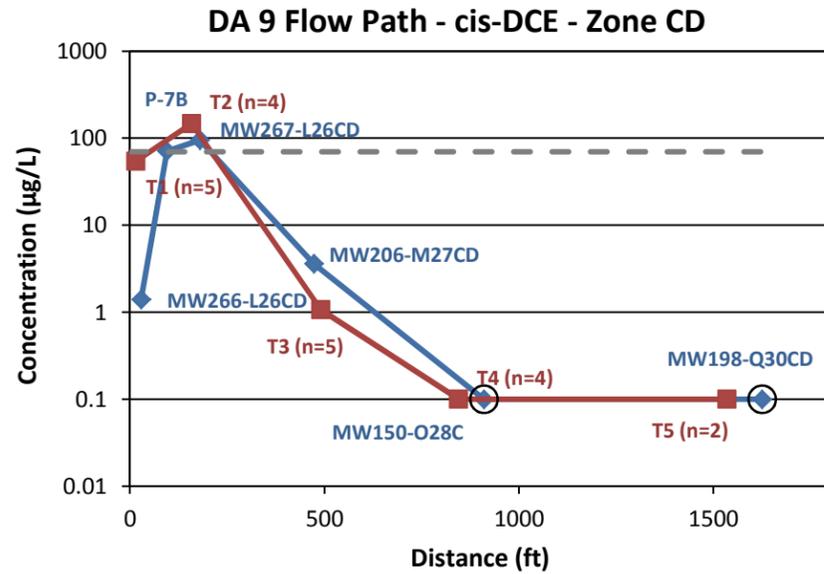
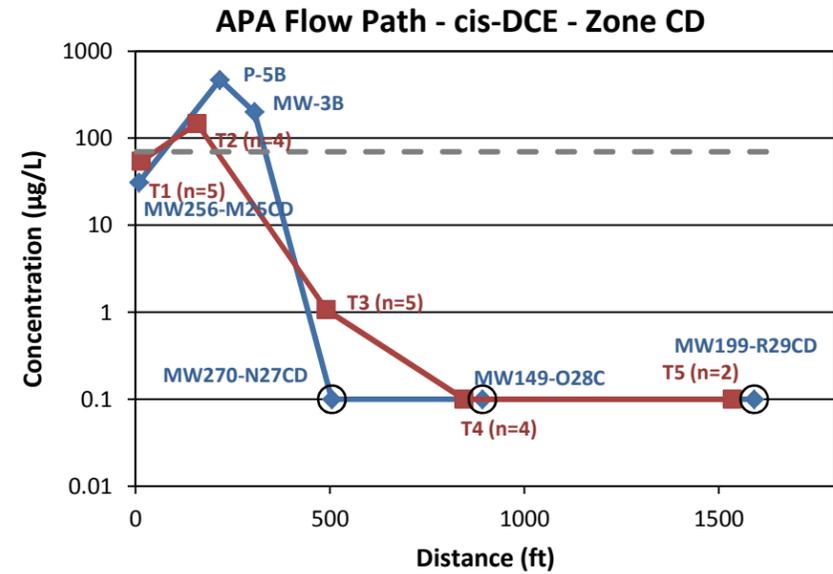
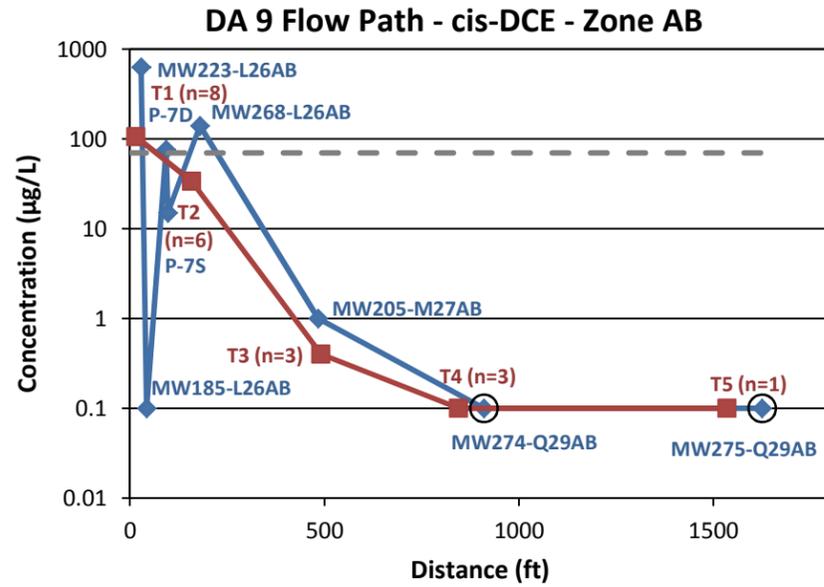
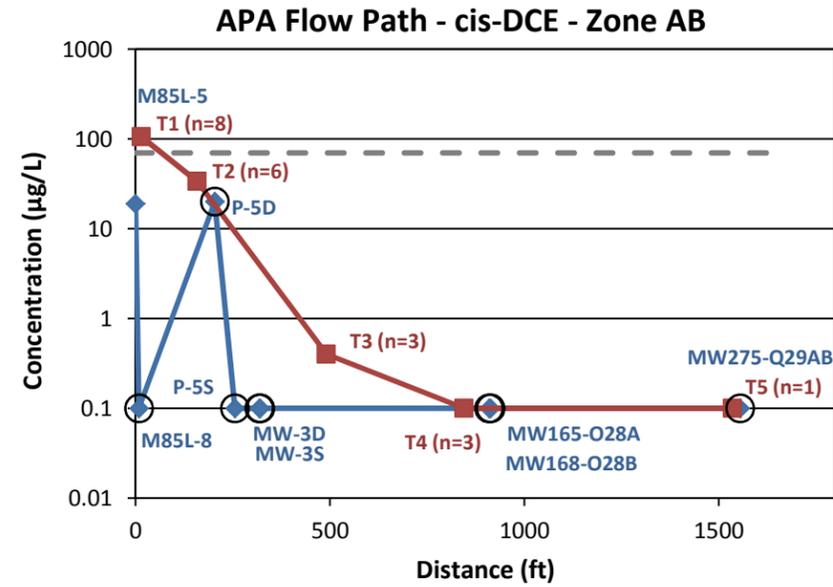
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5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. TCE - trichloroethene.

**Post-Shutdown TCE Concentration vs. Distance  
Along Flow Paths  
Chemtronics Site  
Swannanoa, North Carolina**

**Geosyntec**  
consultants

Kennesaw      July 2016

Figure  
3-2b



N:\C\Chemtronics\Back Valley\Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\_AB\_CD Distance Trends.xlsx\Benzene\_FlowPath 8

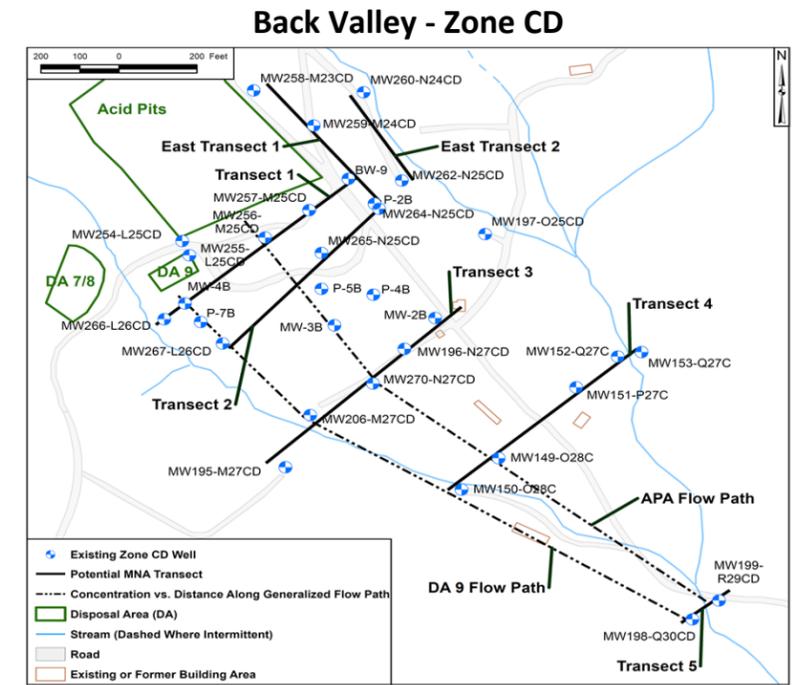
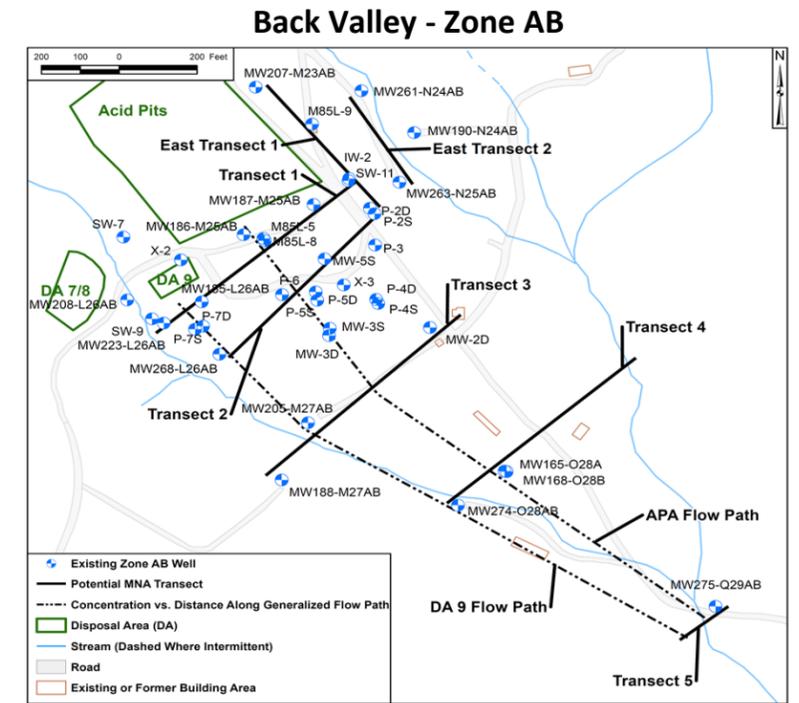
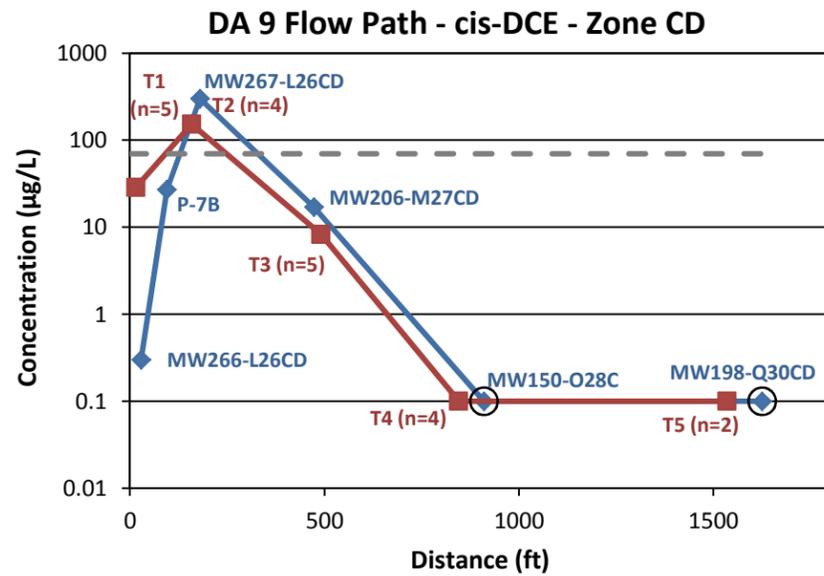
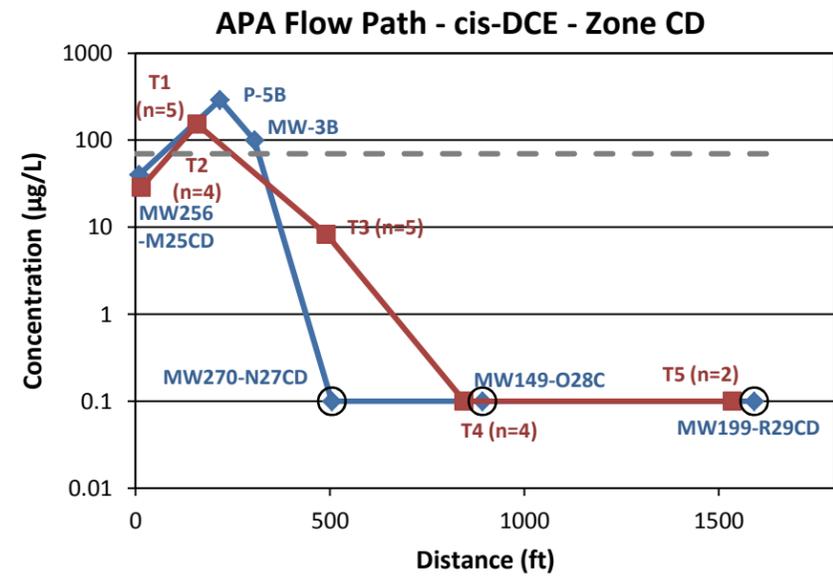
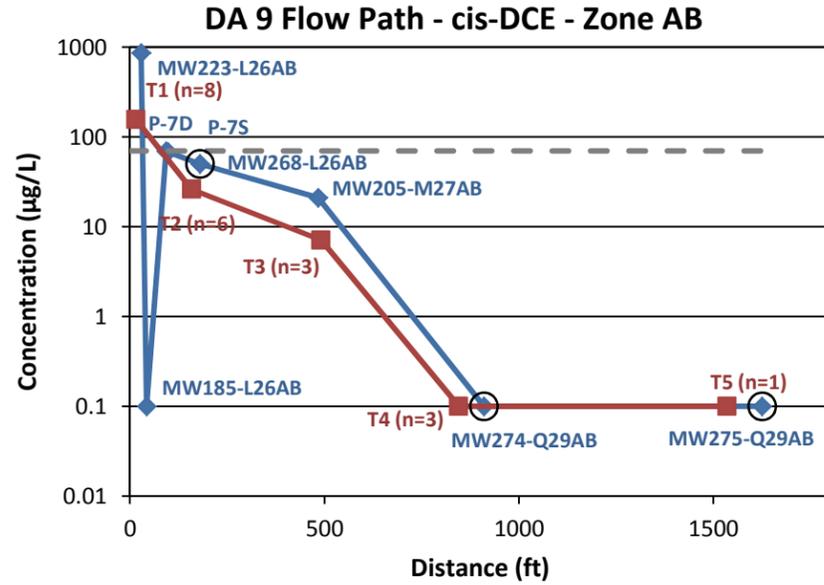
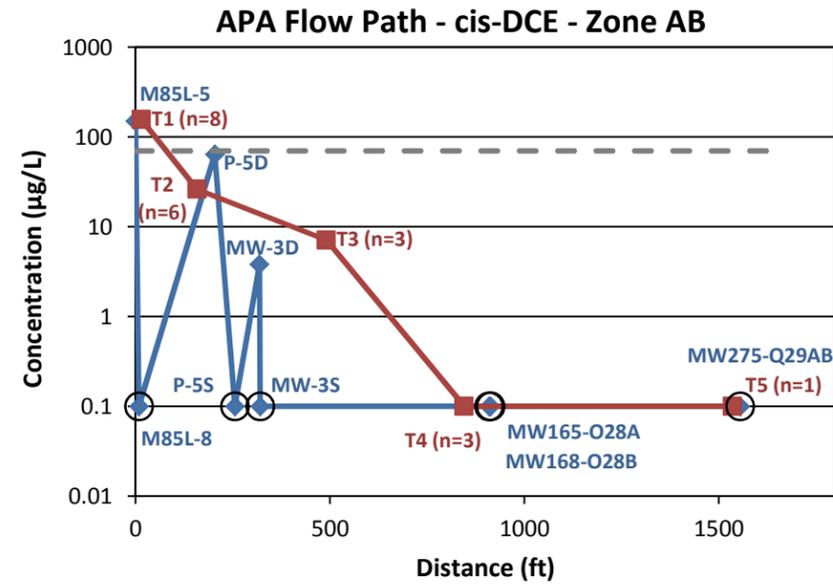
- Notes:**
1. µg/L – micrograms per liter.
  2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
  3. Non-detects are displayed at the method detection limit (MDL).
  4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
  5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
  6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
  7. cis-DCE - cis-1,2-dichloroethene.

**Pre-Shutdown cis-DCE Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure  
3-3a

Kennesaw July 2016



**Notes:**

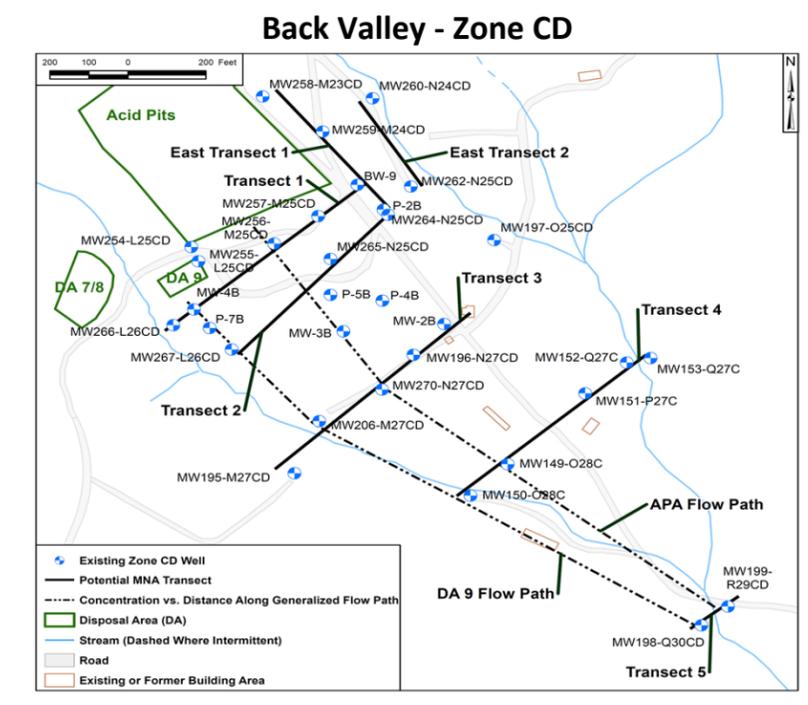
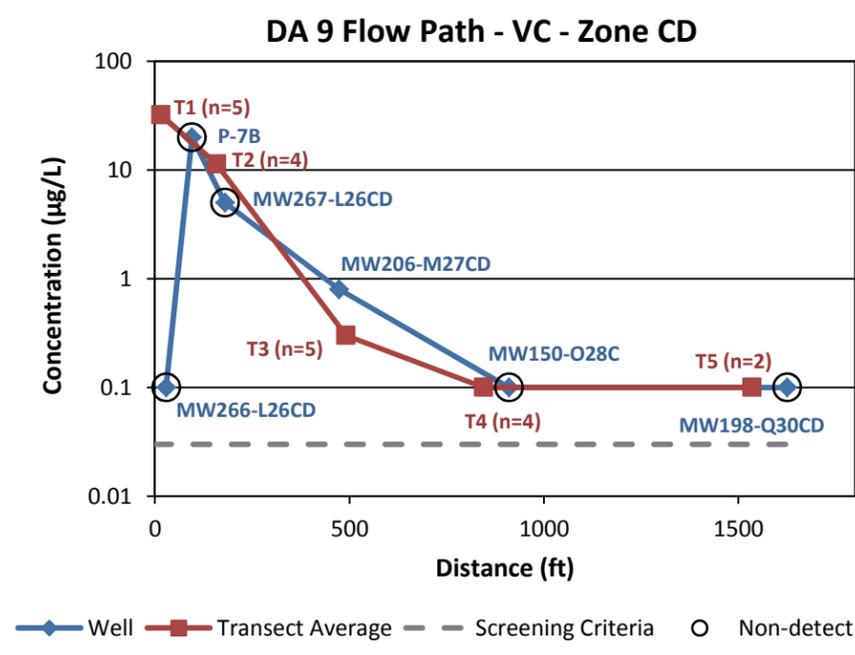
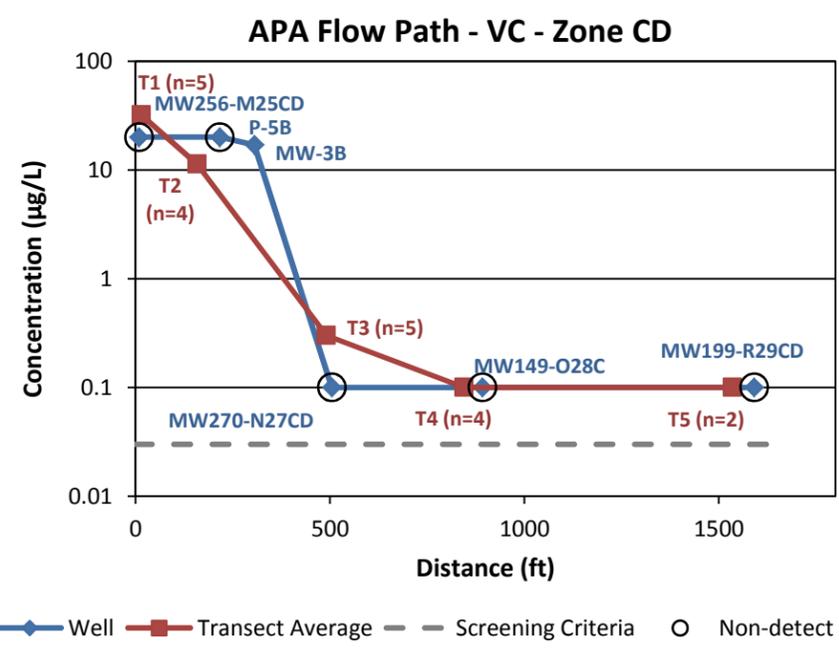
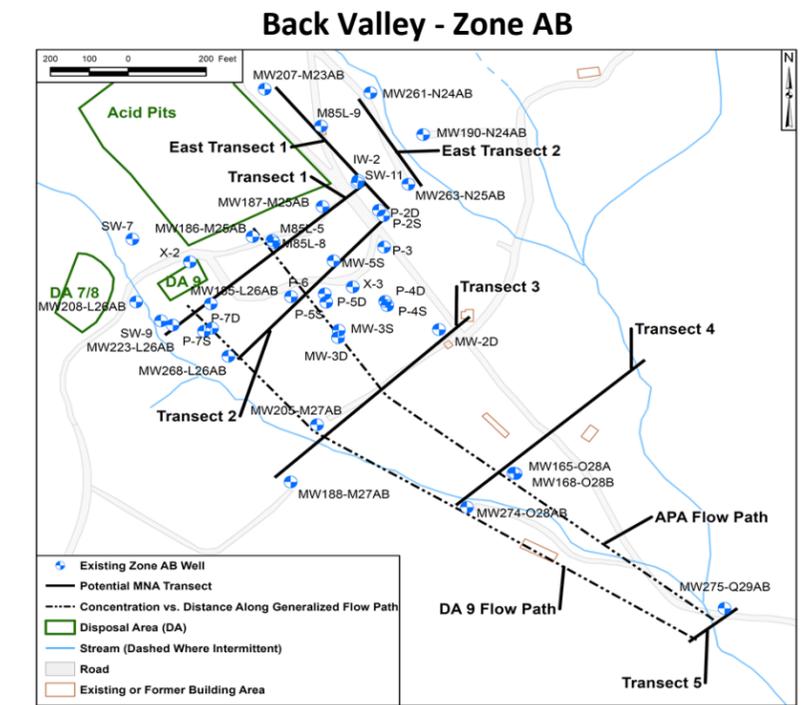
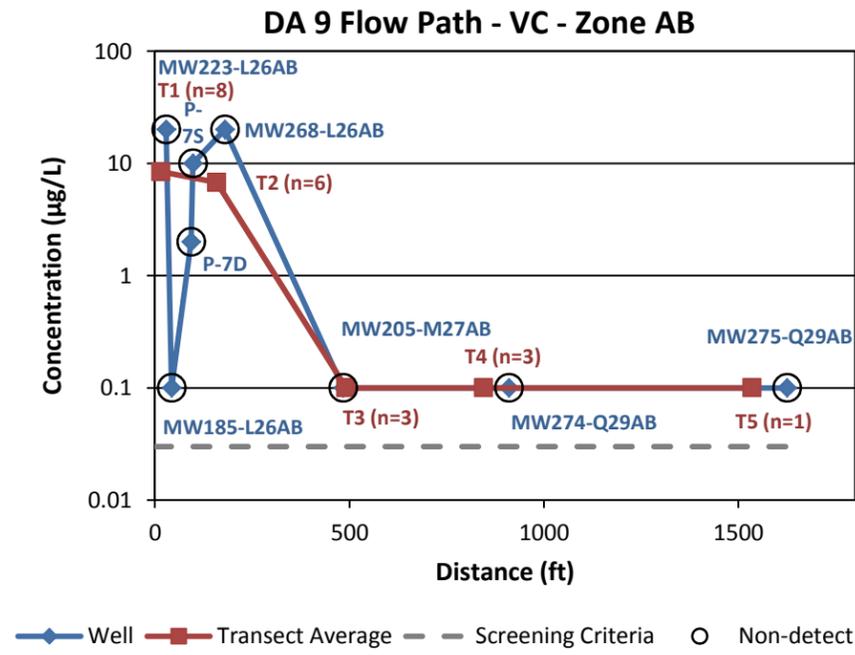
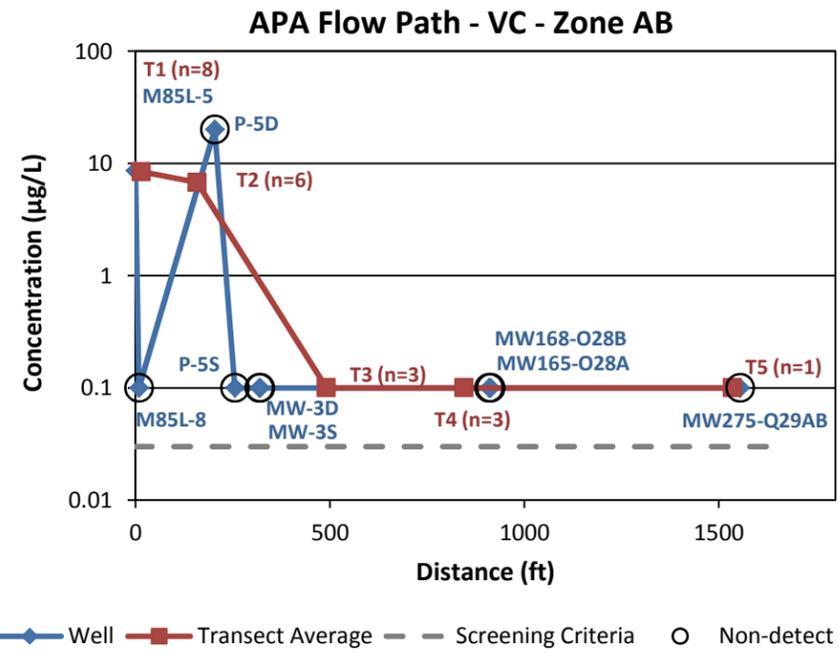
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. cis-DCE - cis-1,2-dichloroethene.

**Post-Shutdown cis-DCE Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Kennesaw July 2016

Figure  
3-3b



N:\VC\Chemtronics\Back Valley\Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\AB\_CD Distance Trends.xlsx\Benzene\_FlowPath 8

**Notes:**

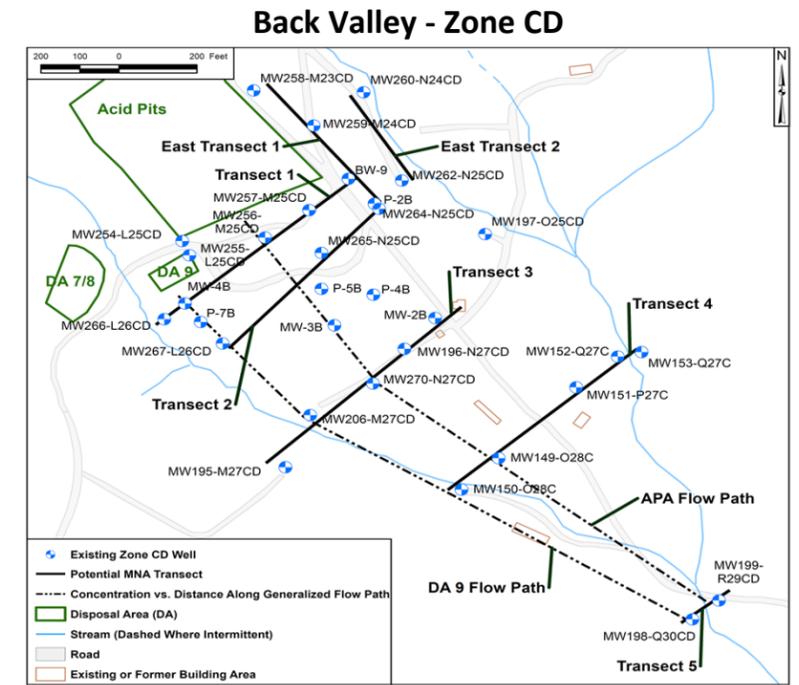
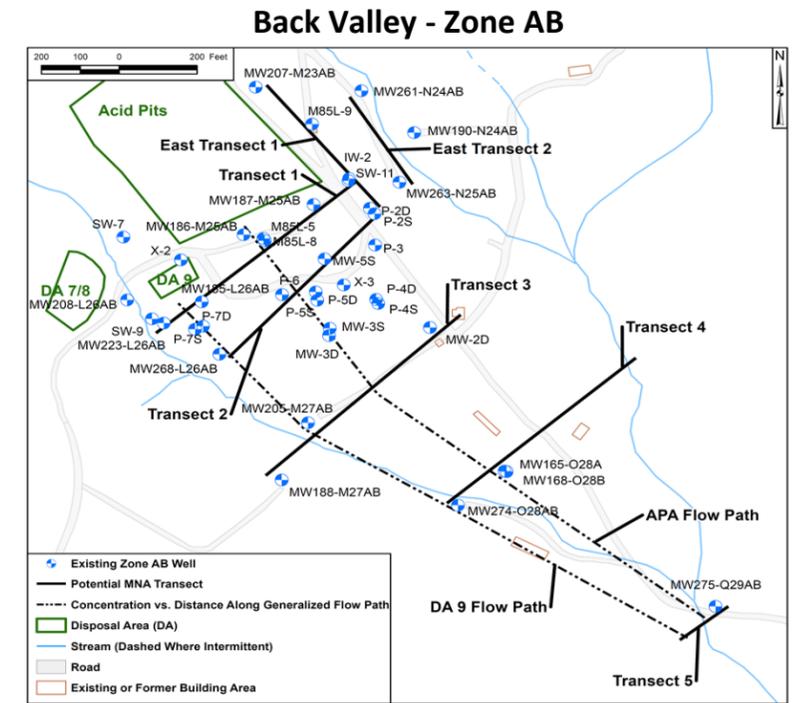
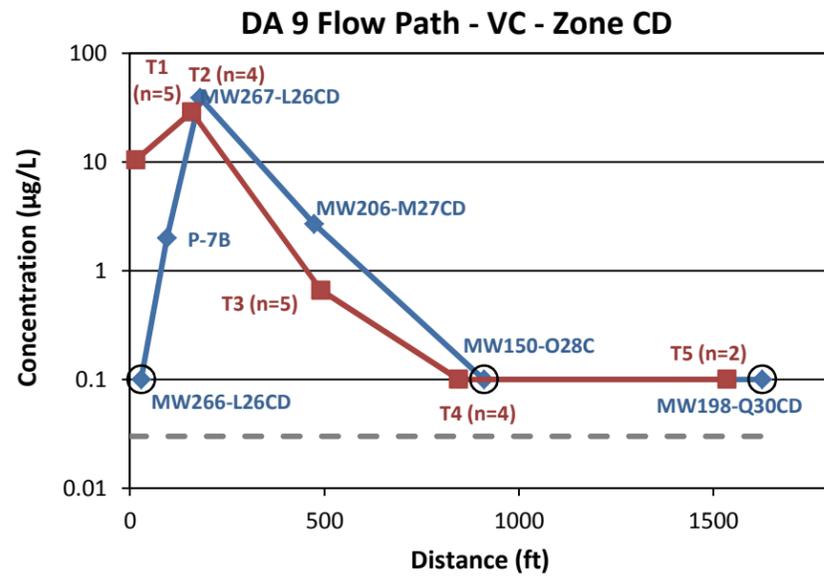
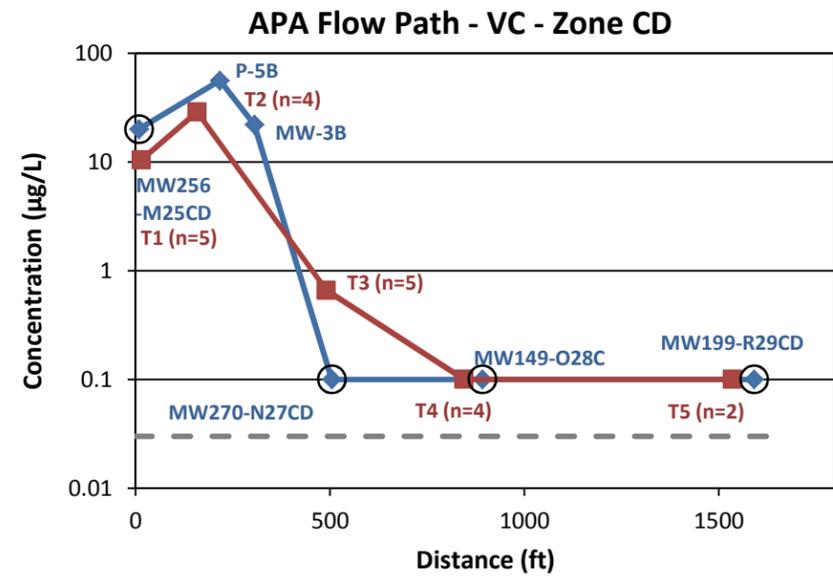
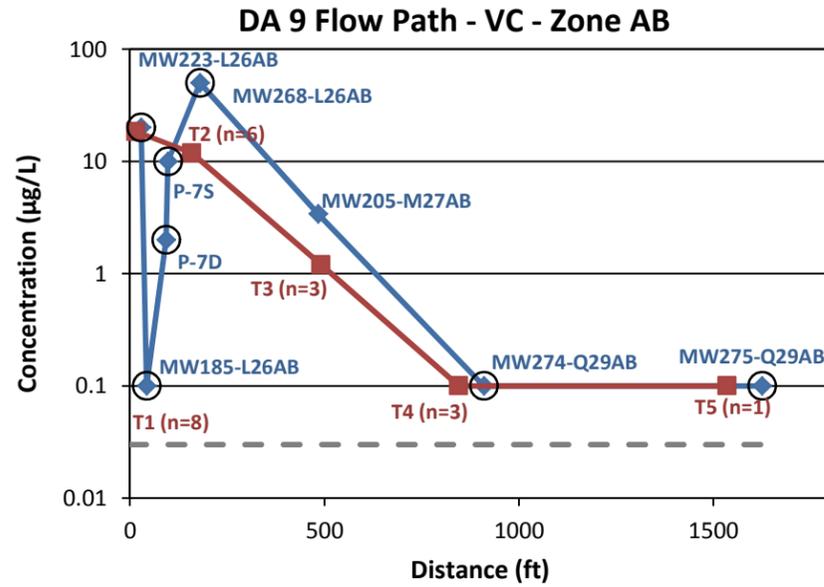
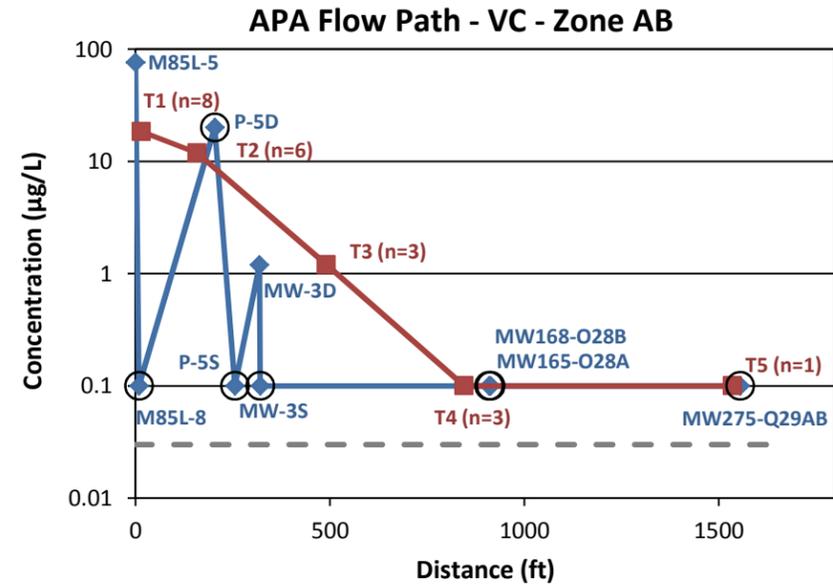
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. VC - vinyl chloride.

**Pre-Shutdown VC Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Kennesaw July 2016

Figure 3-4a



**Notes:**

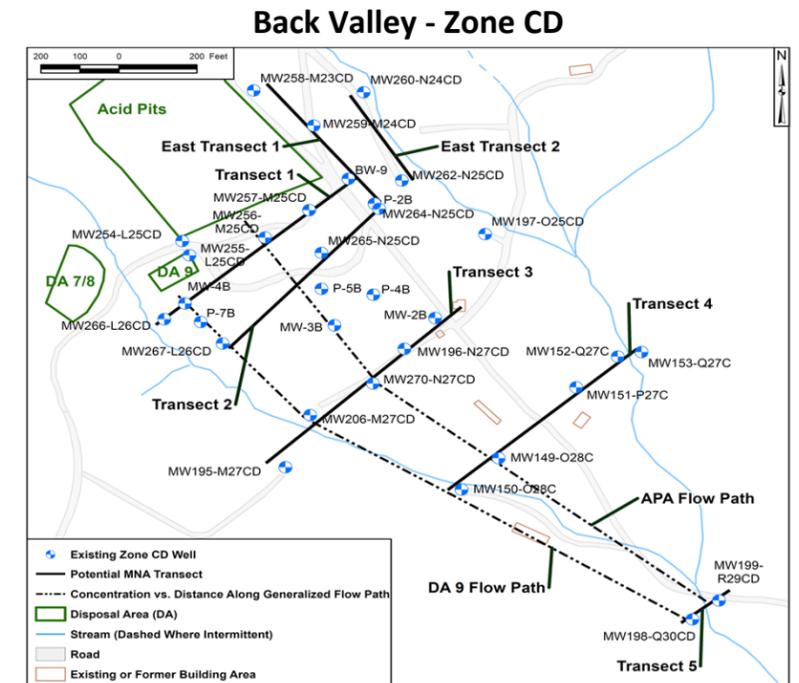
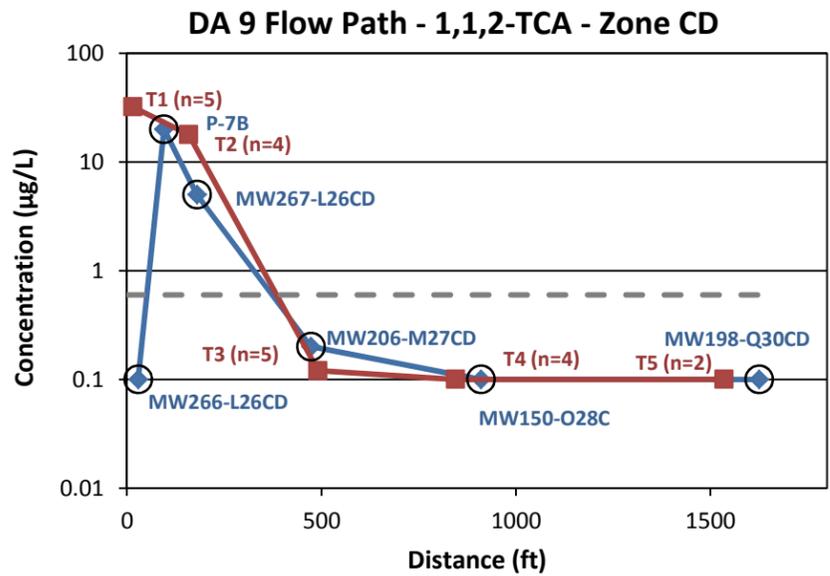
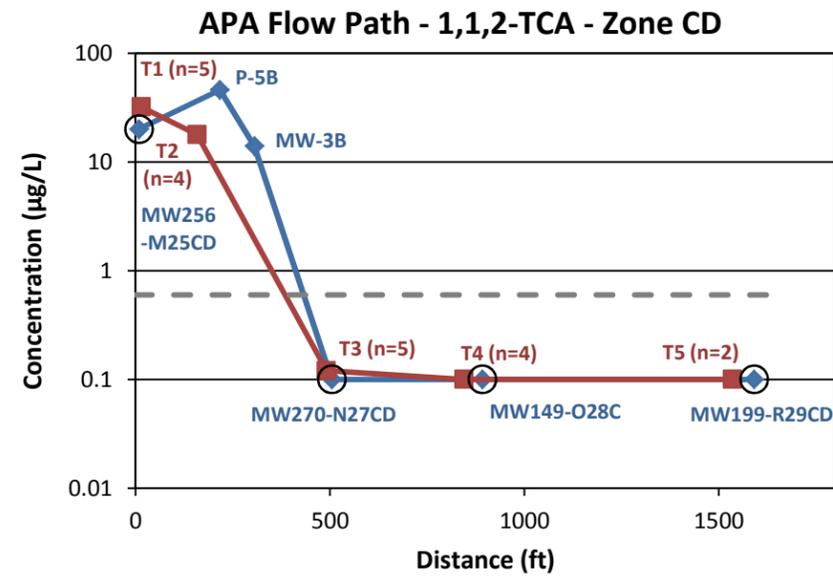
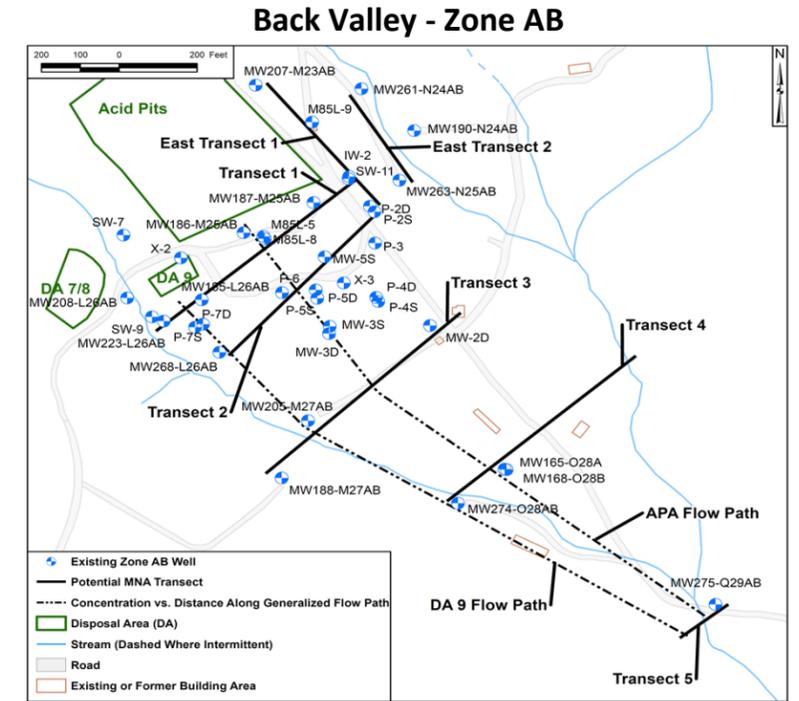
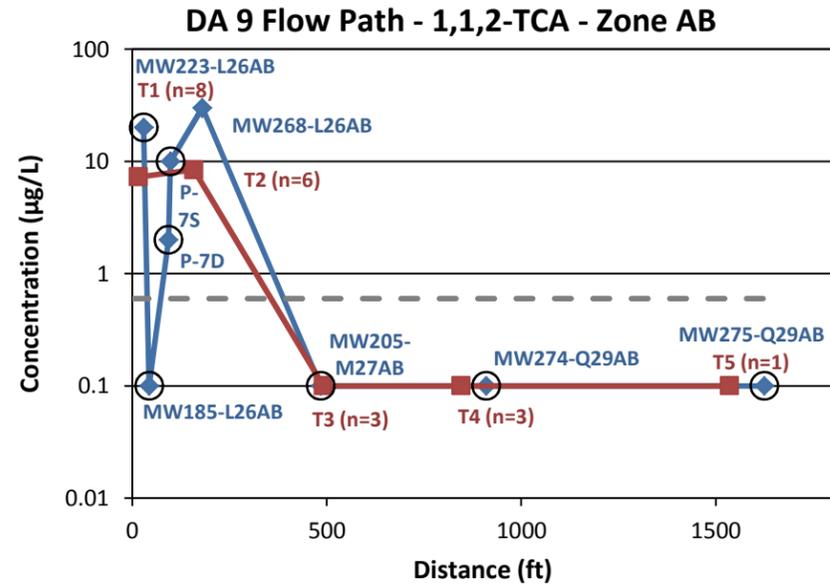
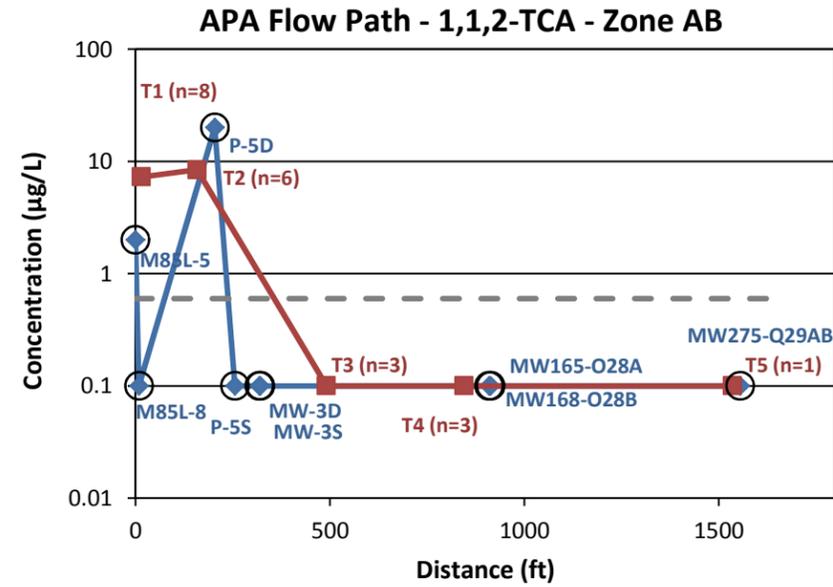
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. VC - vinyl chloride.

**Post-Shutdown VC Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure  
3-4b

Kennesaw July 2016



N:\C:\Chemtronics\Back Valley\Post-Shutdown\Figures\MMD\Fig3-1 to 3-1E\_BV\AB\_CD Distance Trends.xlsx\Benzene\_FlowPath B

**Notes:**

1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. 1,1,2-TCA - 1,1,2-trichloroethane.

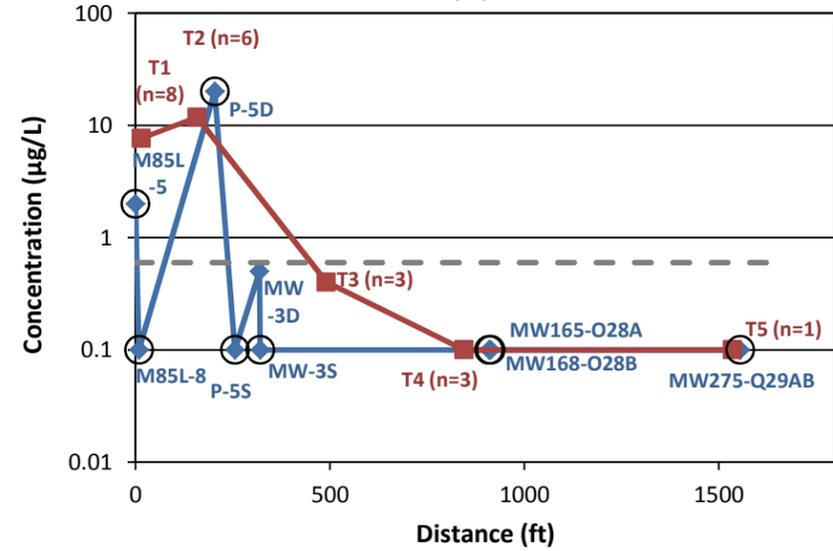
**Pre-Shutdown 1,1,2-TCA Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure  
3-5a

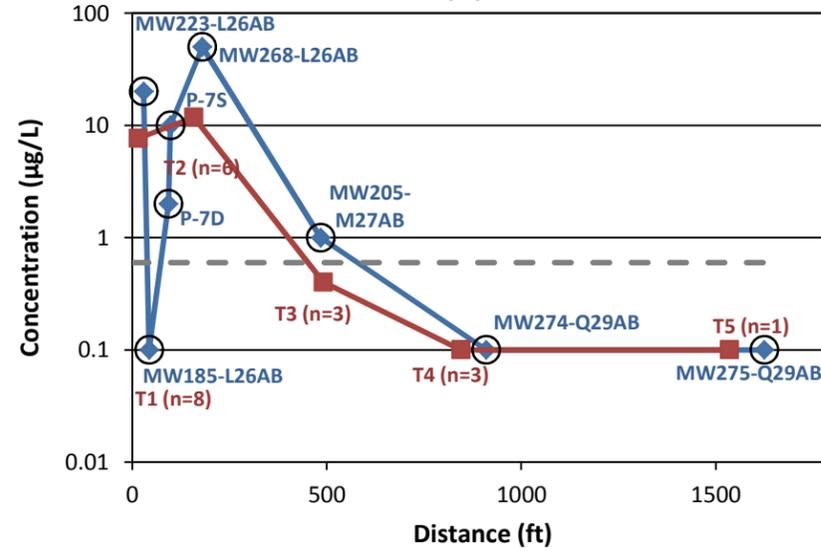
Kennesaw July 2016

**APA Flow Path - 1,1,2-TCA - Zone AB**



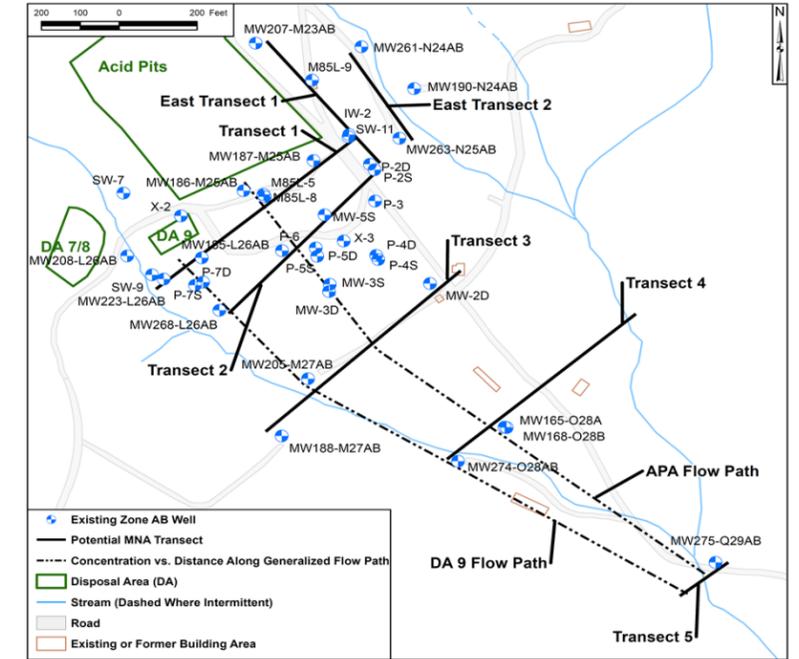
Well Transect Average Screening Criteria Non-detect

**DA 9 Flow Path - 1,1,2-TCA - Zone AB**

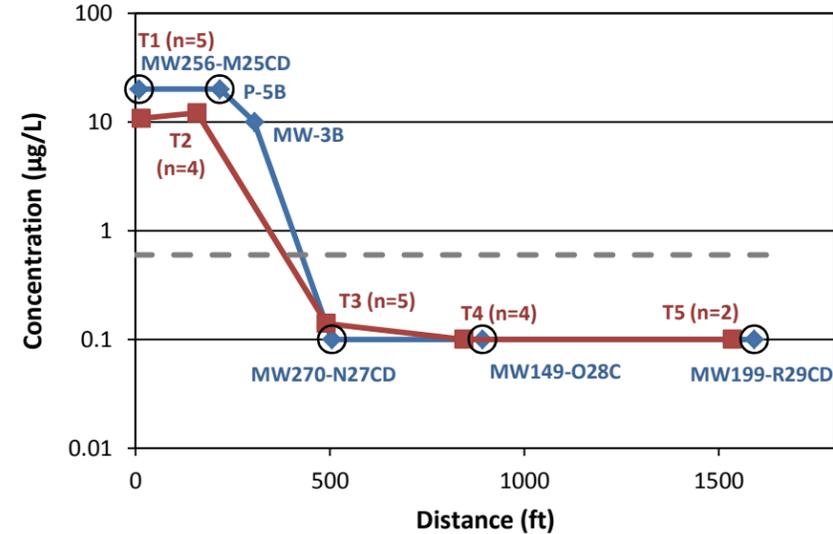


Well Transect Average Screening Criteria Non-detect

**Back Valley - Zone AB**

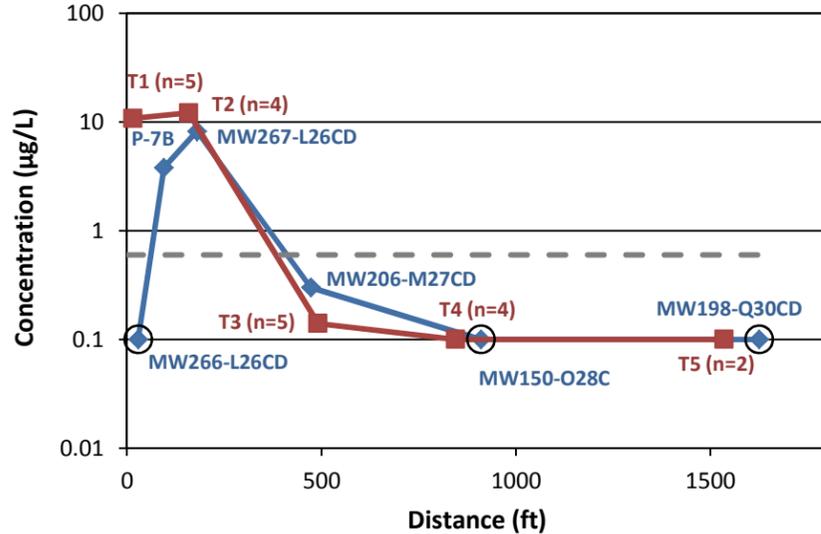


**APA Flow Path - 1,1,2-TCA - Zone CD**



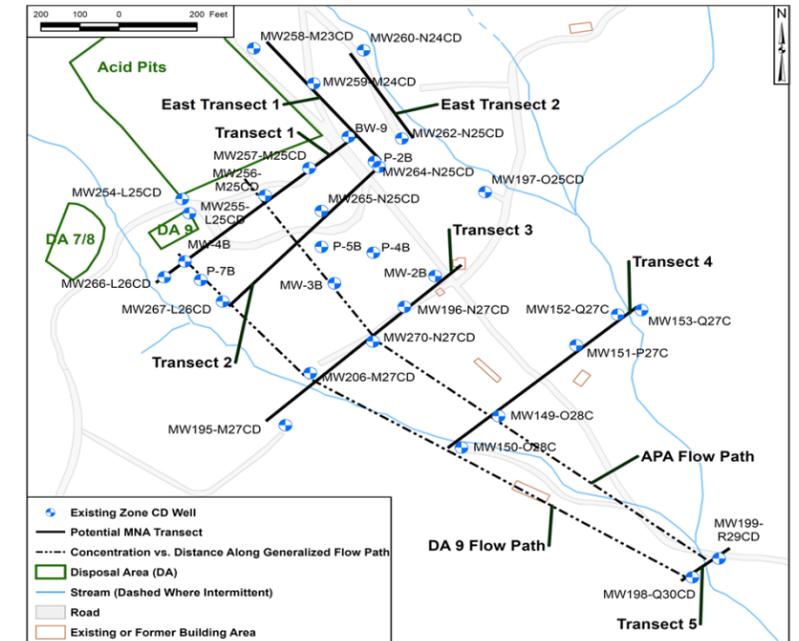
Well Transect Average Screening Criteria Non-detect

**DA 9 Flow Path - 1,1,2-TCA - Zone CD**



Well Transect Average Screening Criteria Non-detect

**Back Valley - Zone CD**



**Notes:**

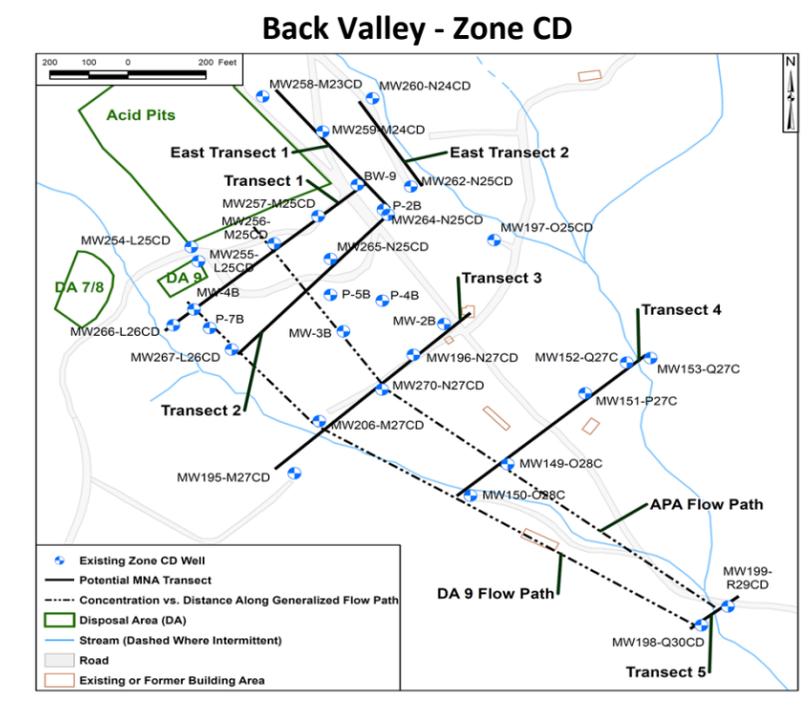
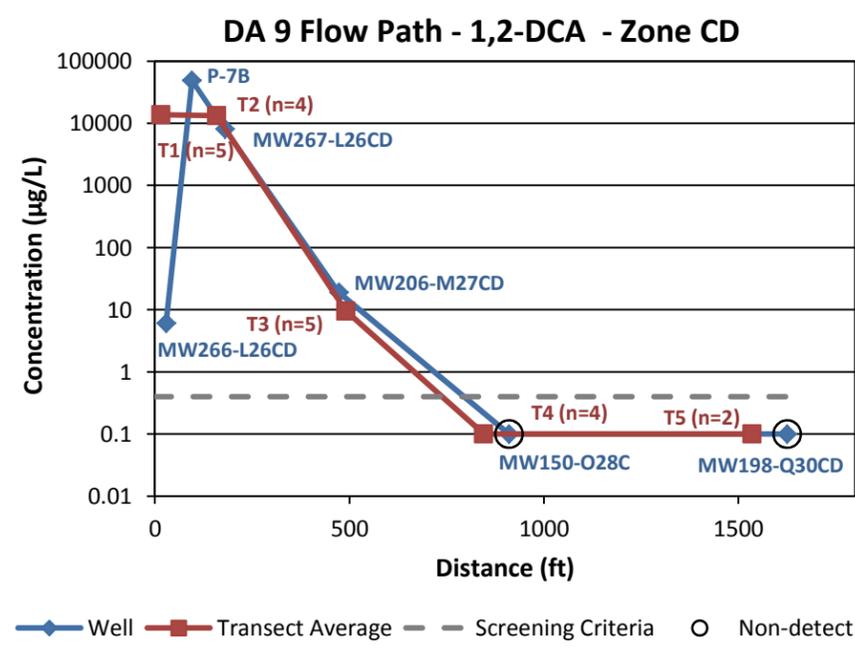
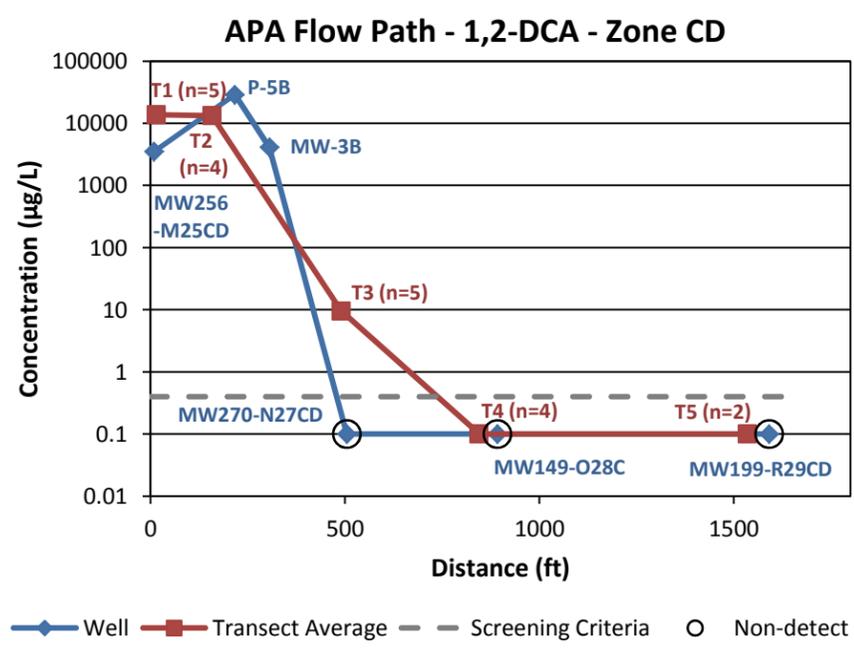
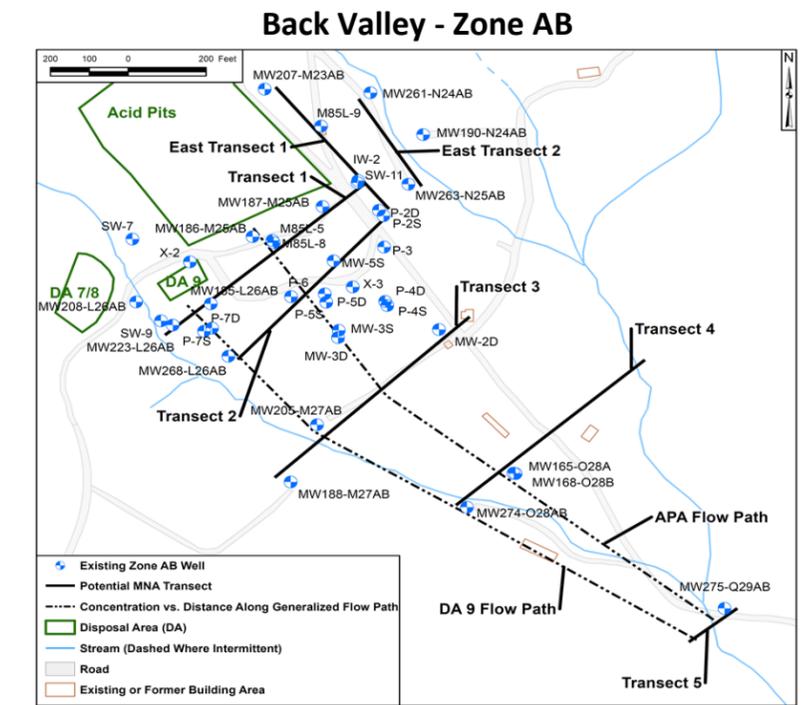
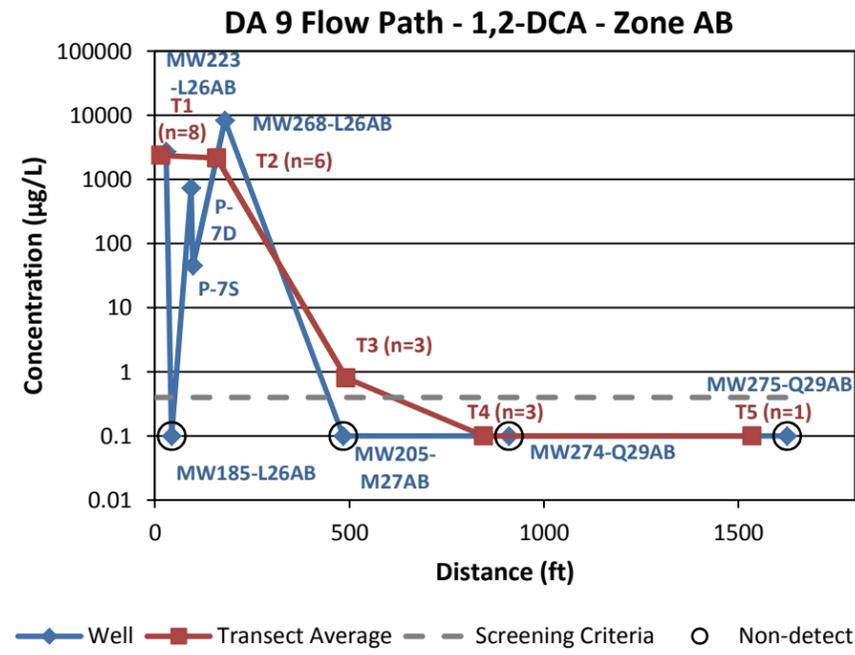
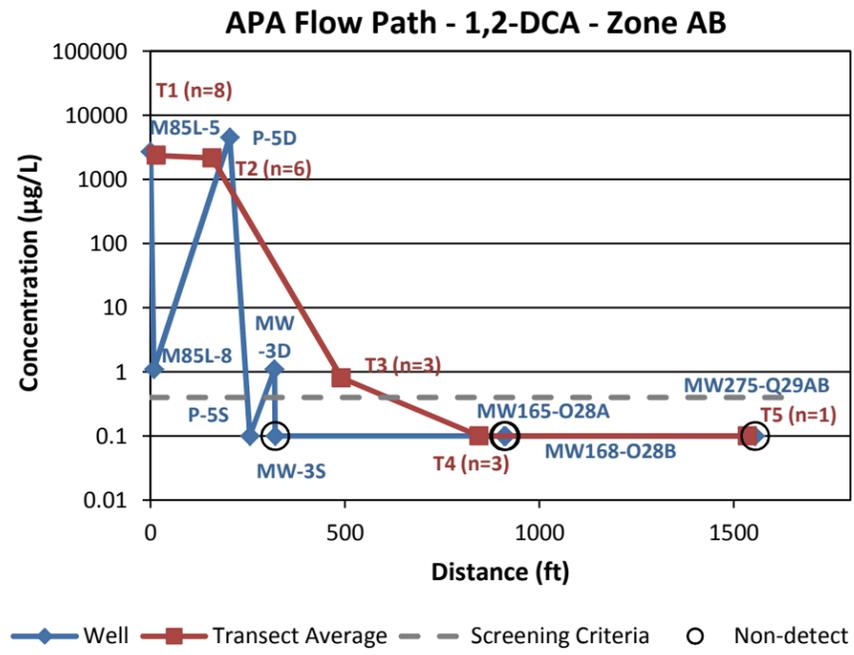
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
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5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. 1,1,2-TCA - 1,1,2-trichloroethane.

**Post-Shutdown 1,1,2-TCA Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina

**Geosyntec**  
consultants

Kennesaw July 2016

Figure  
3-5b



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**Notes:**

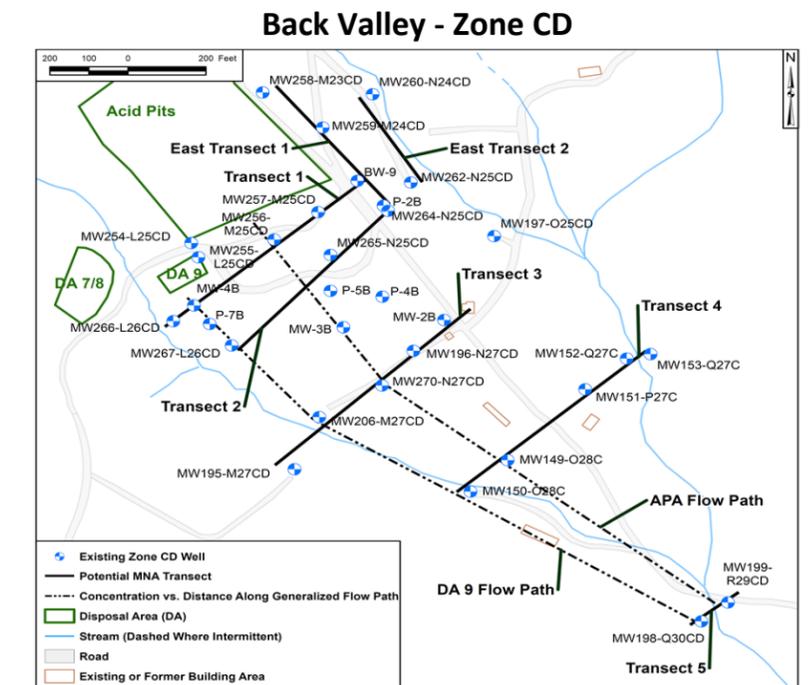
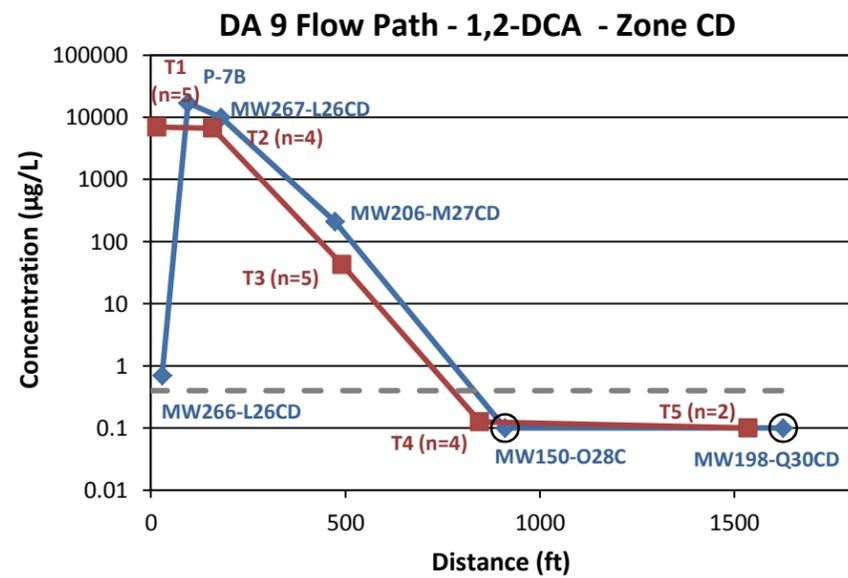
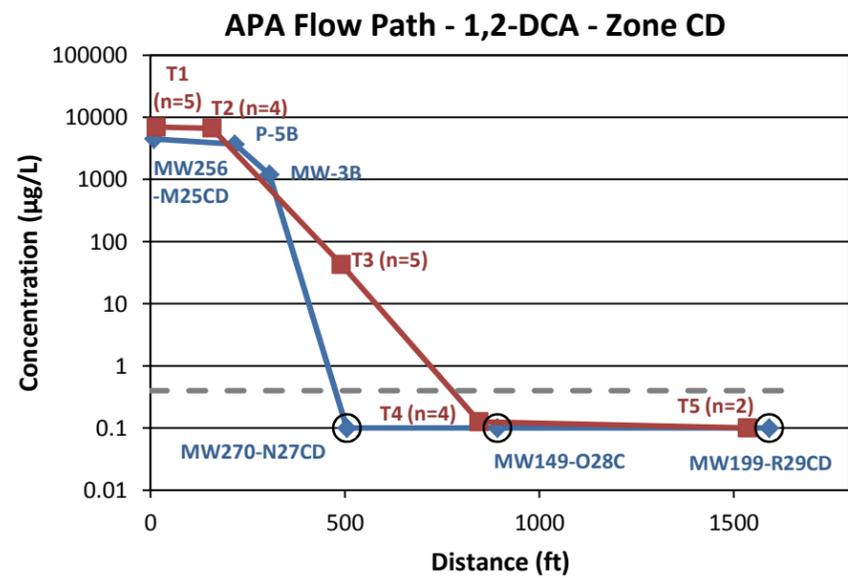
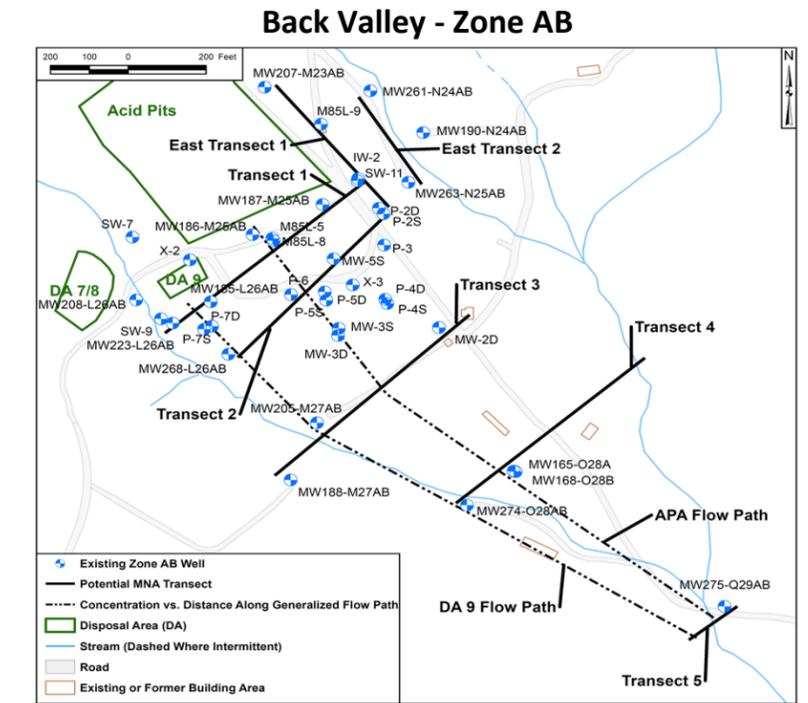
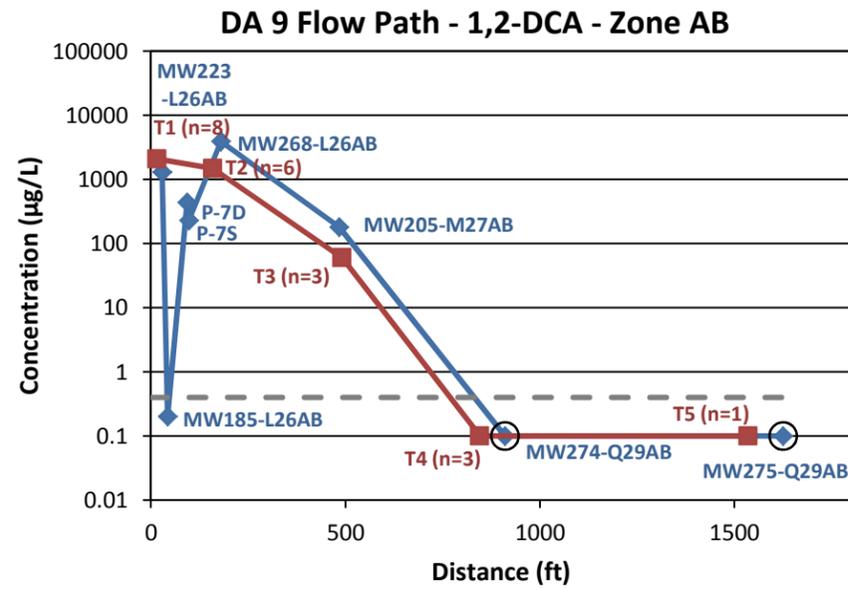
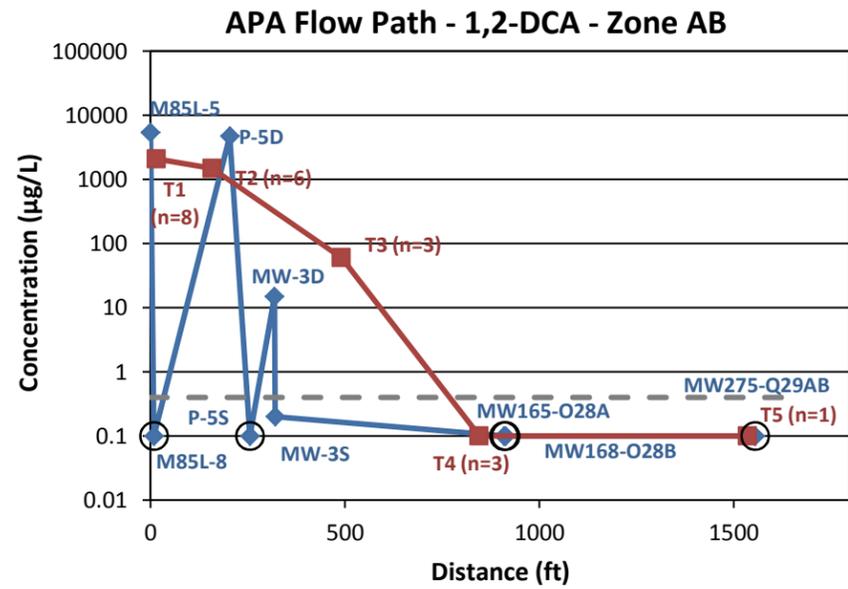
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6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. 1,2-DCA - 1,2-dichloroethane.

**Pre-Shutdown 1,2-DCA Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure  
3-6a

Kennesaw July 2016



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**Notes:**

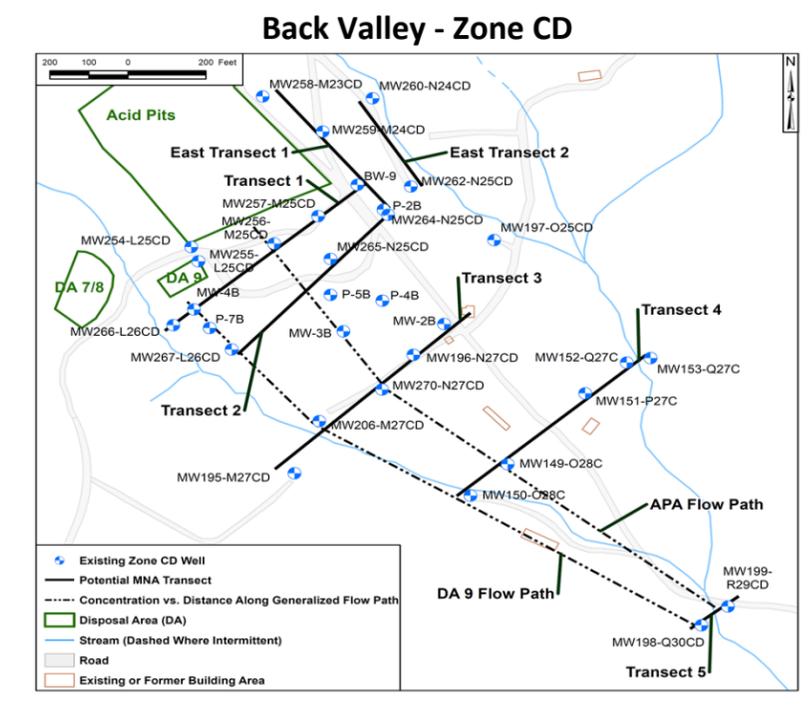
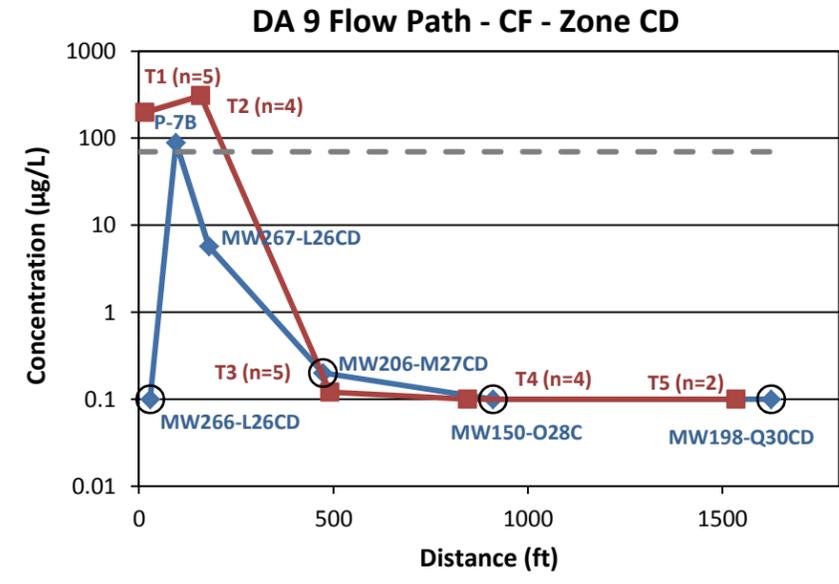
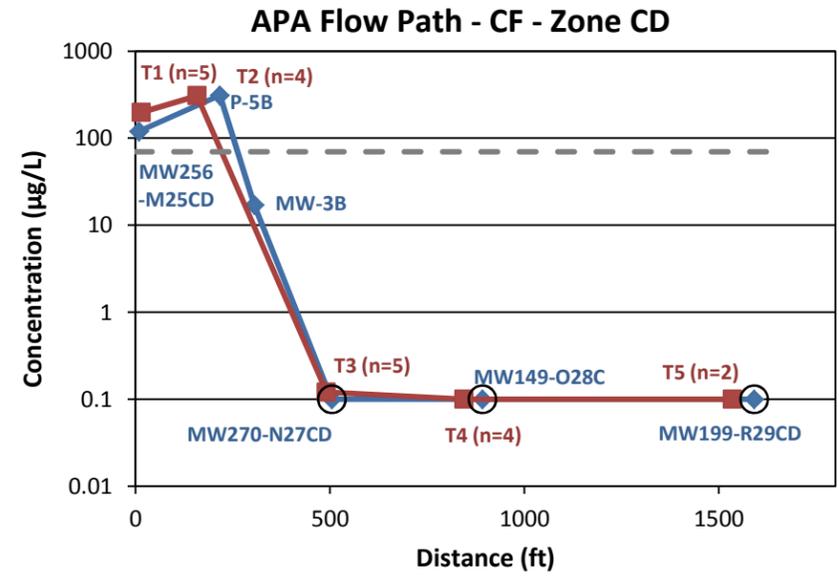
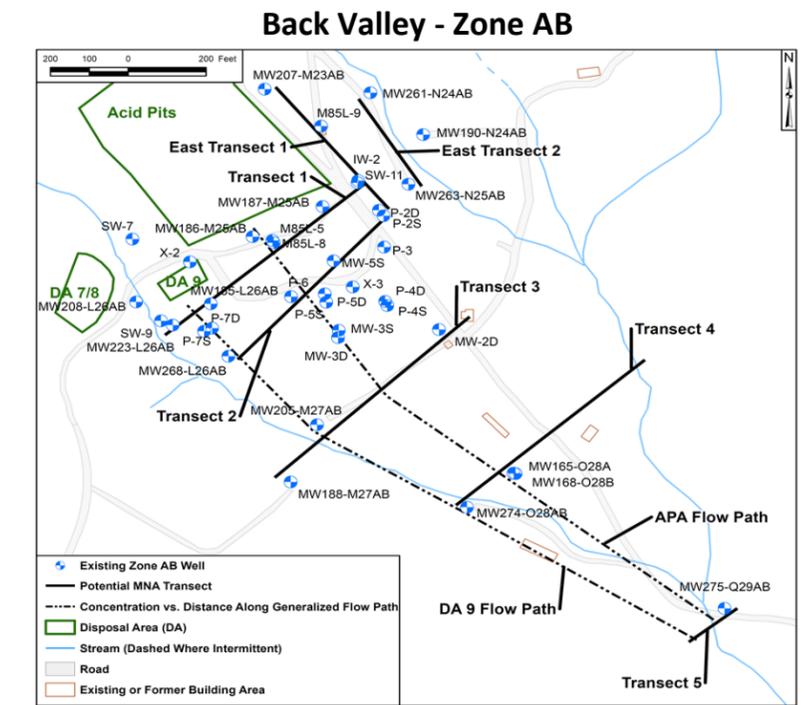
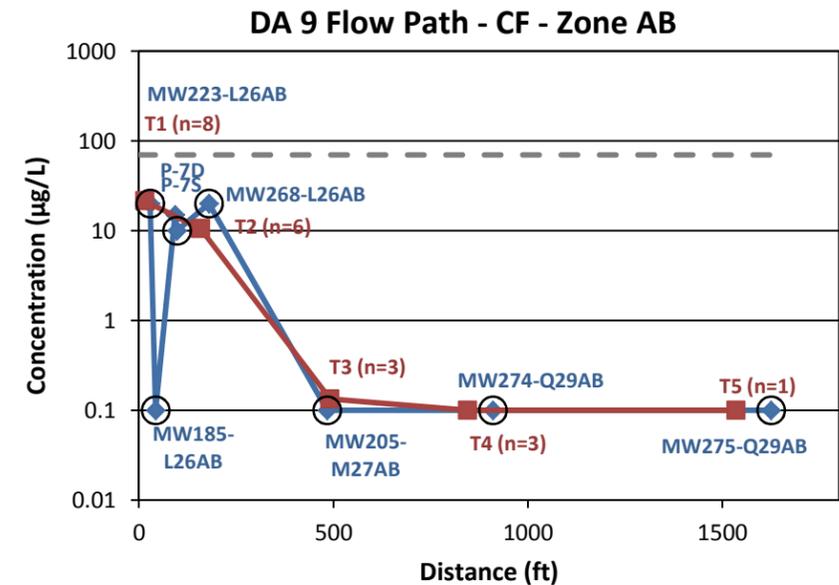
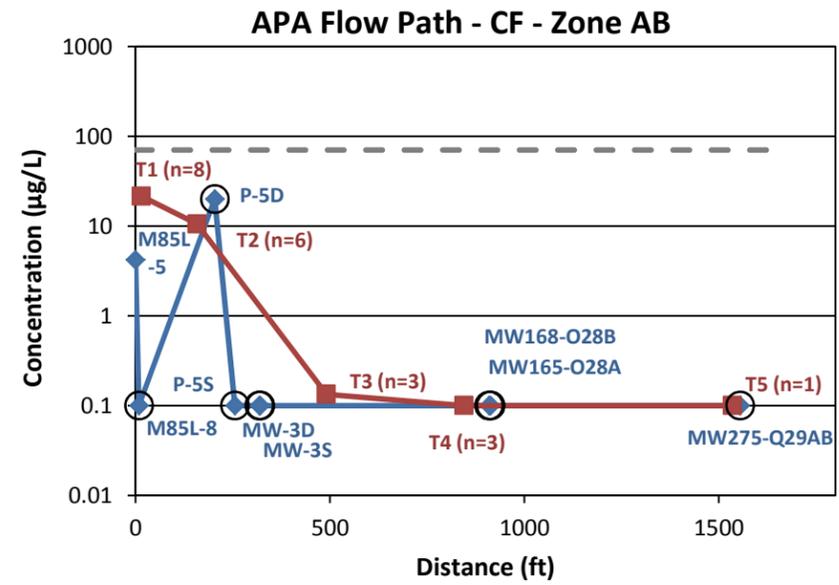
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6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. 1,2-DCA - 1,2-dichloroethane.

**Post-Shutdown 1,2-DCA Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina

**Geosyntec**  
consultants

Figure  
3-6b

Kennesaw	July 2016
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**Notes:**

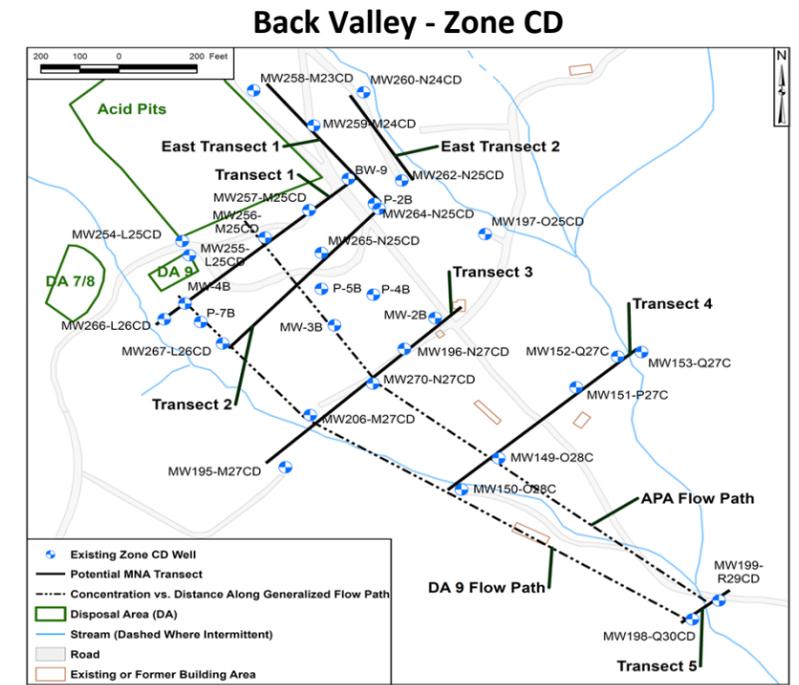
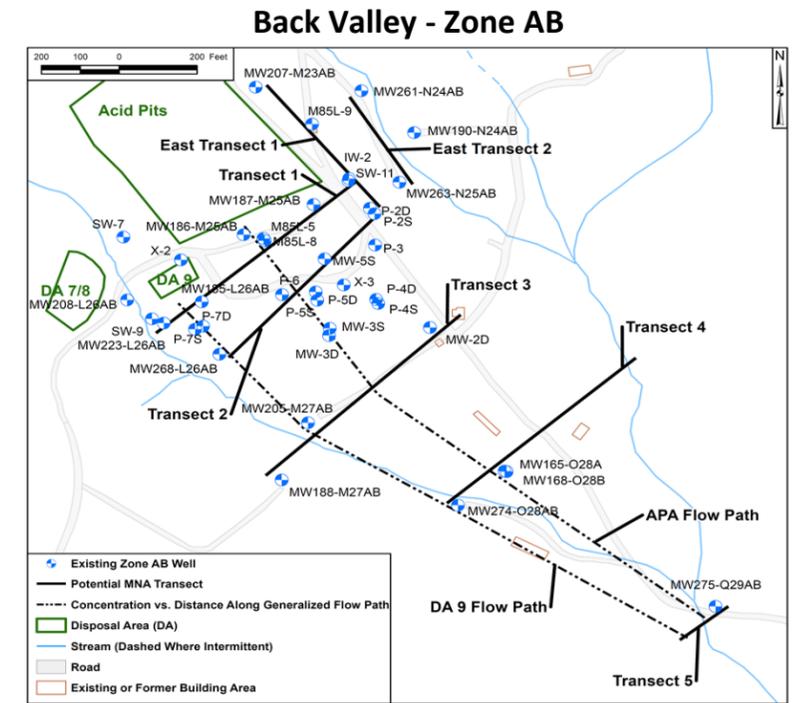
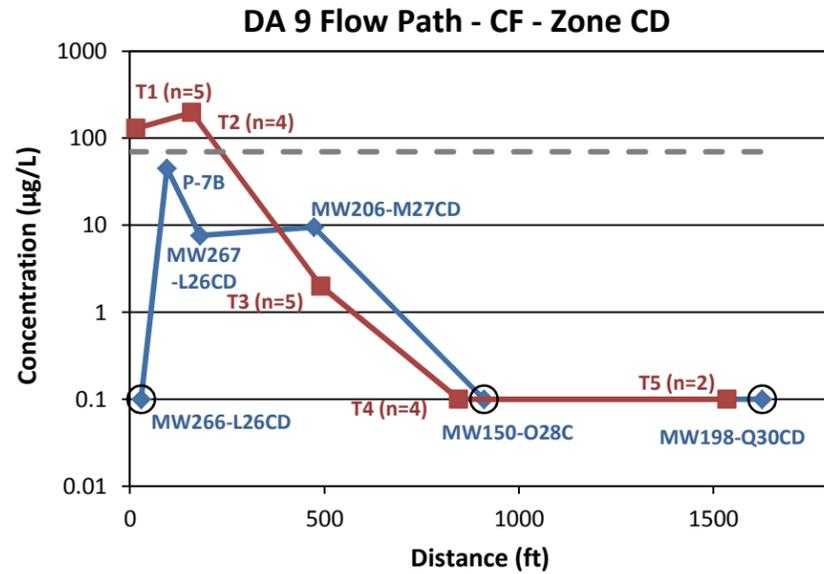
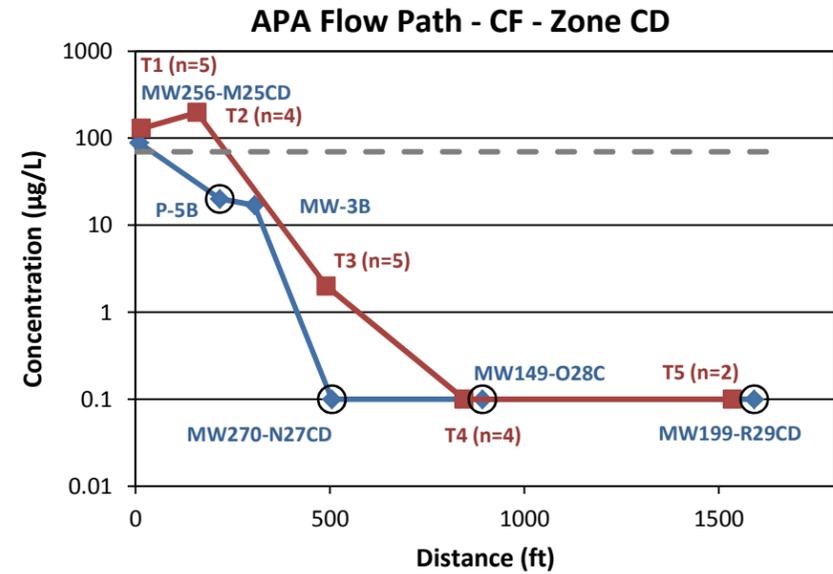
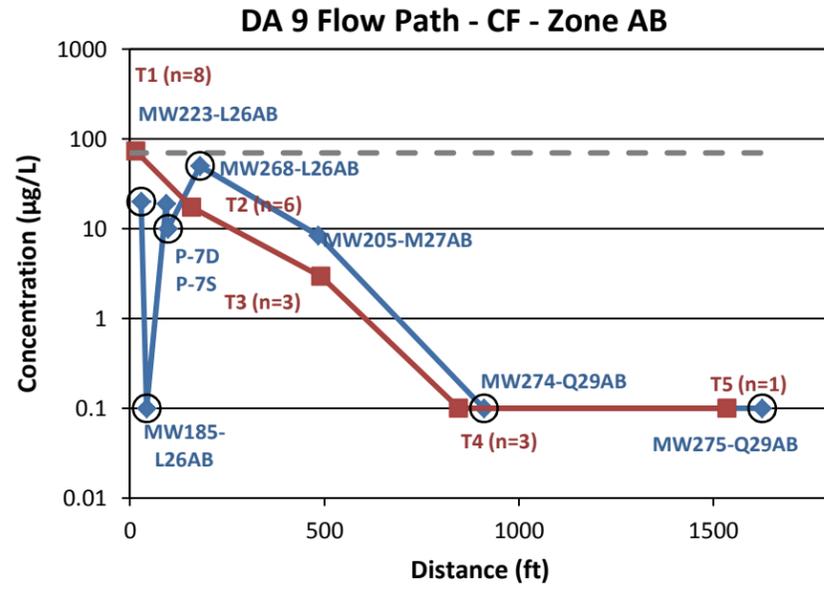
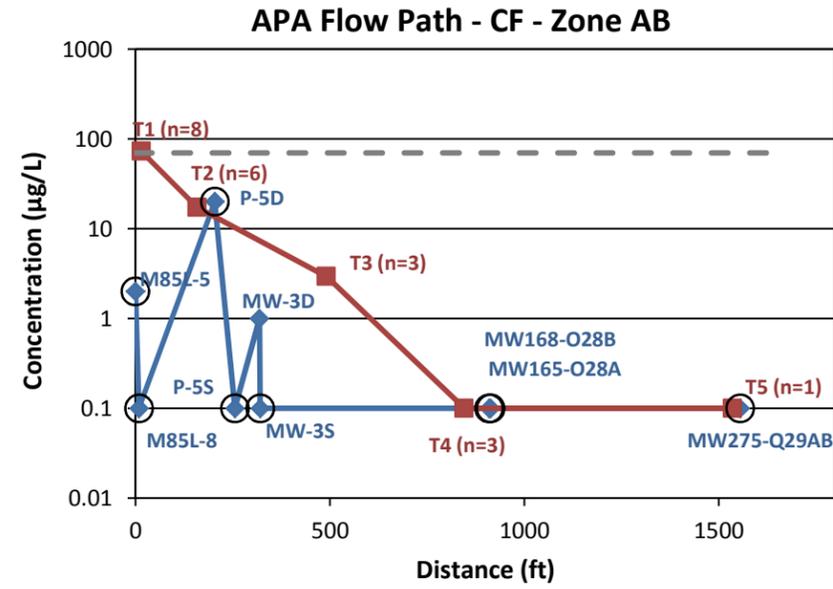
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5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. CF - chloroform.

**Pre-Shutdown CF Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Kennesaw July 2016

Figure 3-7a



**Notes:**

1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. CF - chloroform.

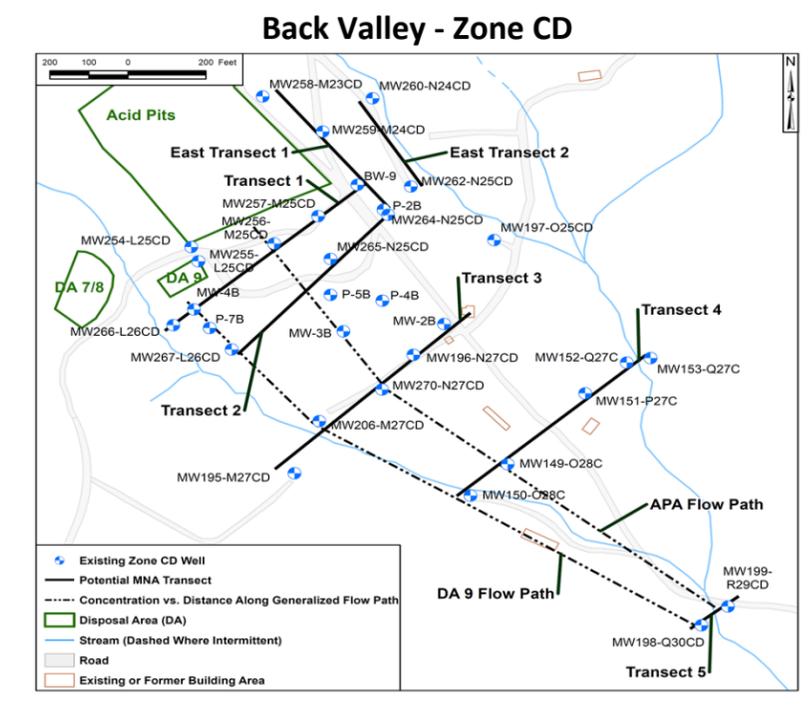
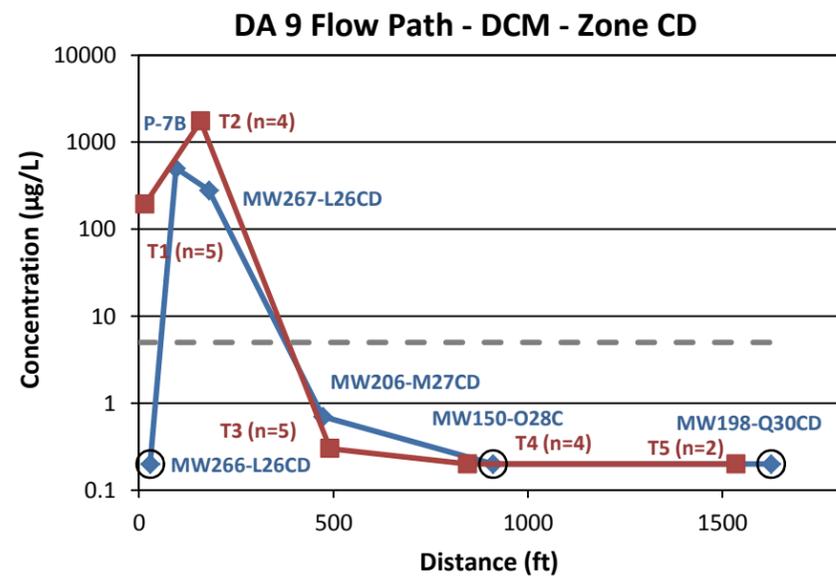
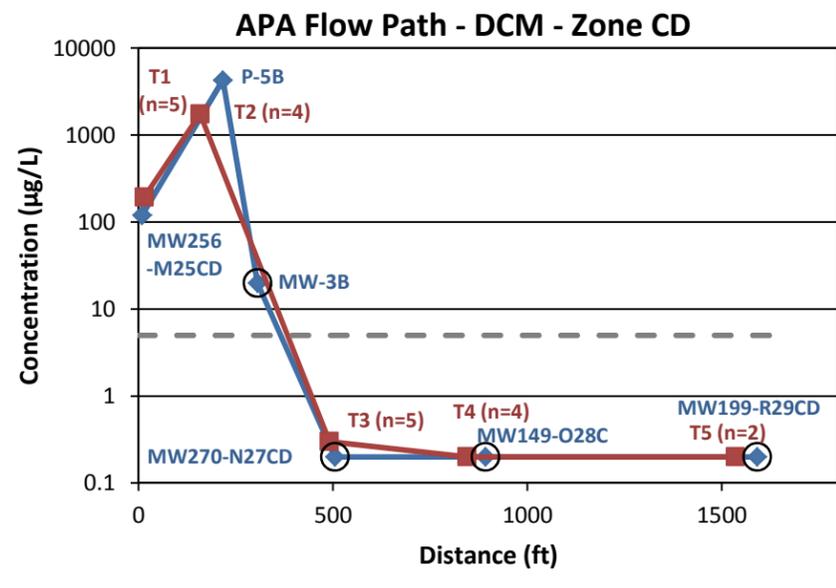
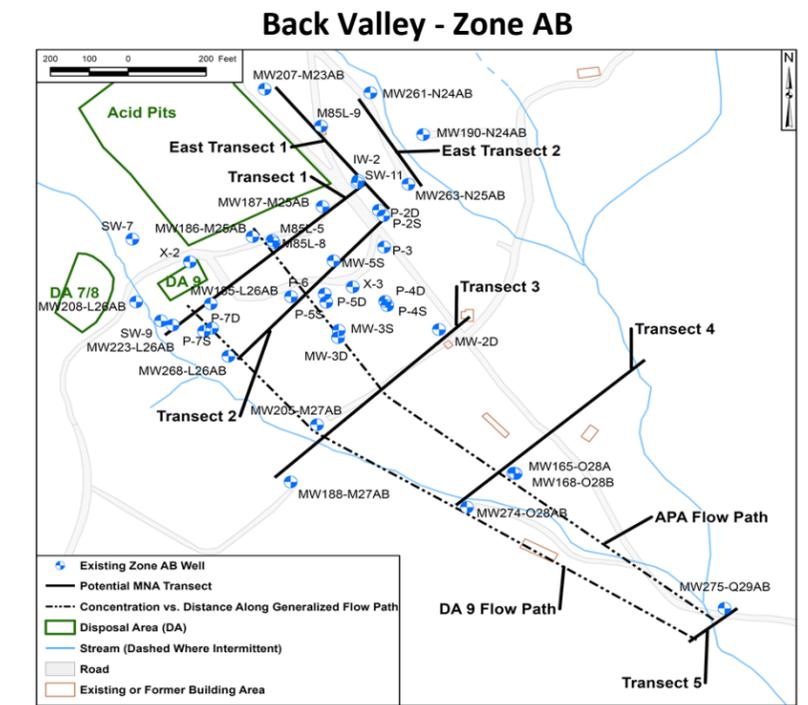
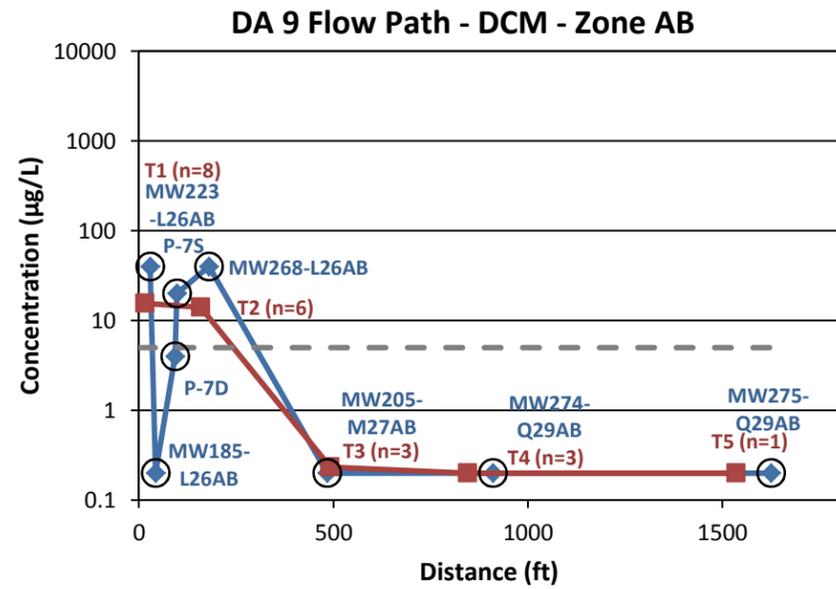
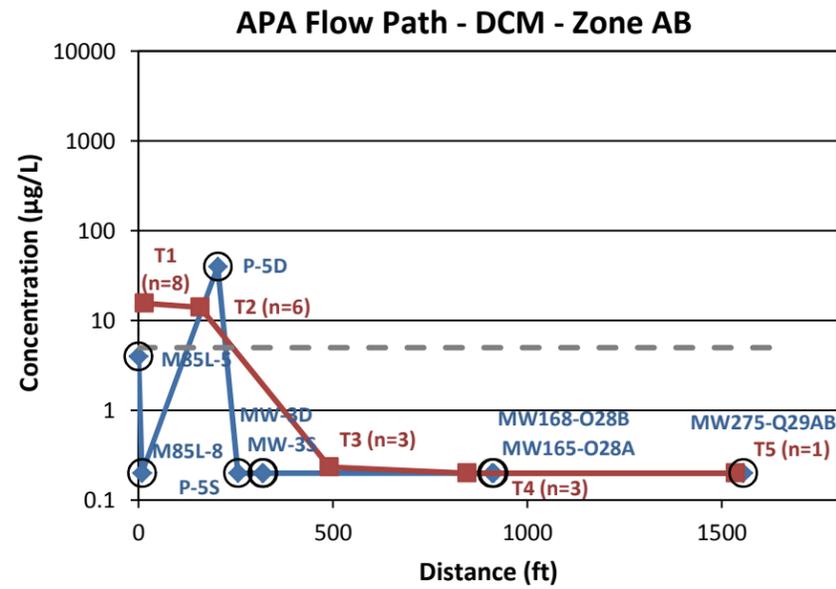
**Post-Shutdown CF Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Kennesaw July 2016

Figure 3-7b

N:\C\Chemtronics\Back Valley Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\_AB\_CD Distance Trends.xlsx\Benzene\_FlowPath 8



N:\C\Chemtronics\Back Valley\Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\_AB\_CD Distance Trends.xlsx\Benzene\_FlowPath B

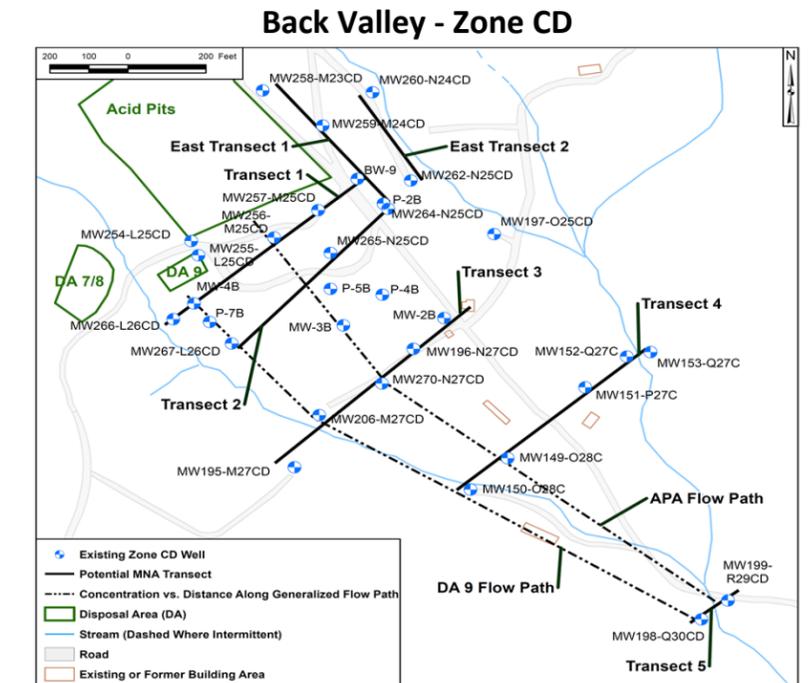
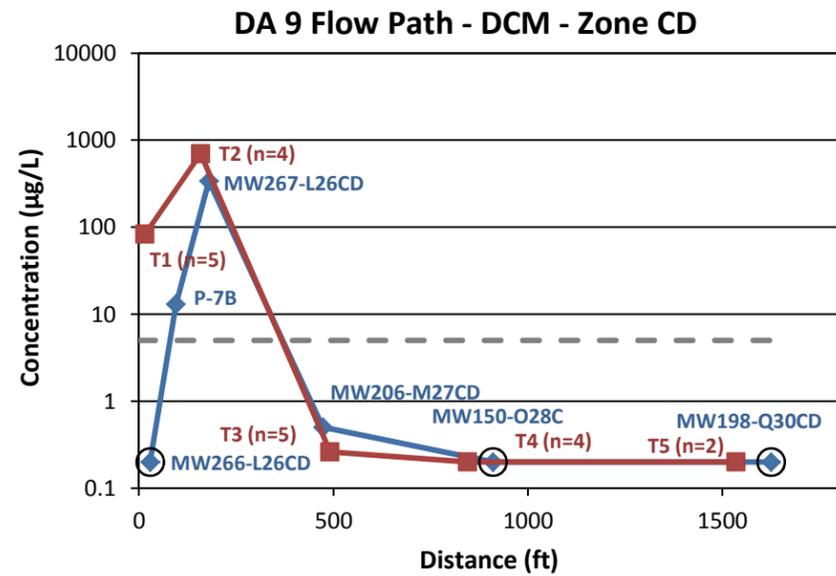
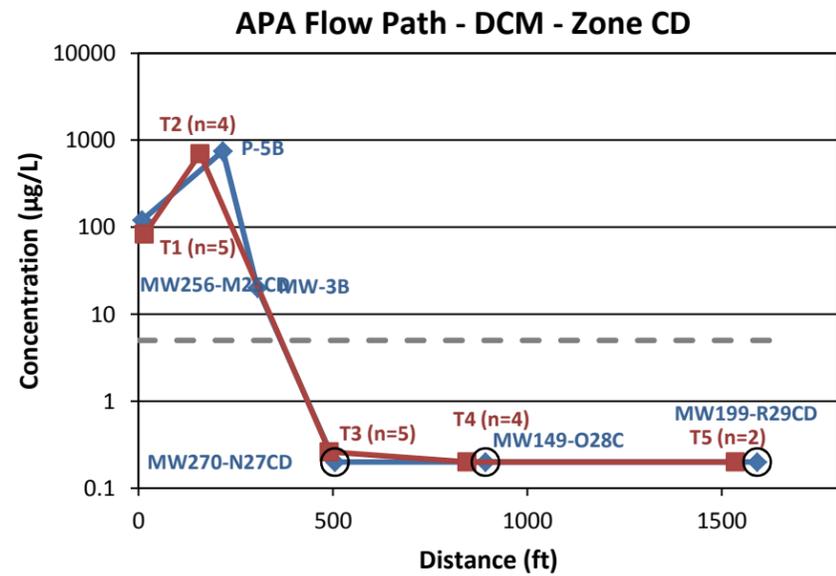
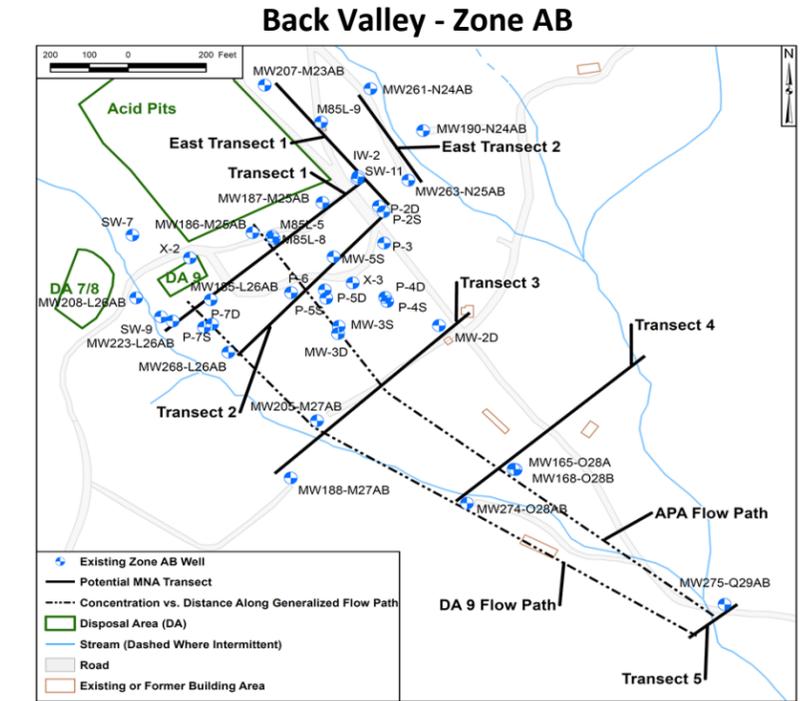
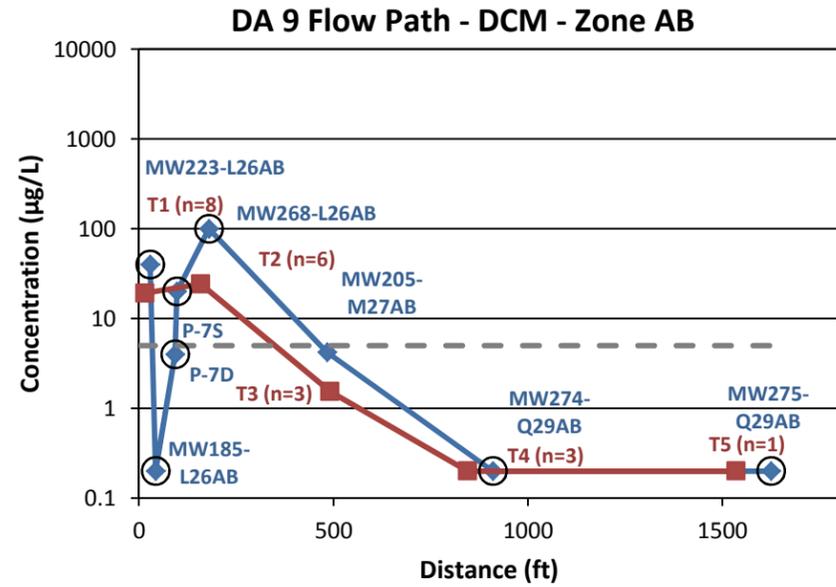
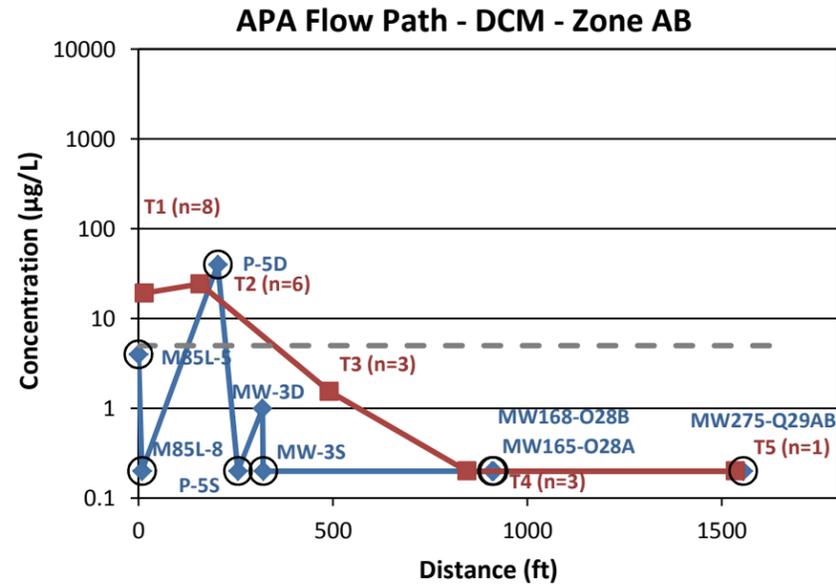
**Notes:**

1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. DCM - dichloromethane.

**Pre-Shutdown DCM Concentration vs. Distance  
Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina

Figure  
3-8a

Kennesaw	July 2016
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N:\C\Chemtronics\Back Valley Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\AB\_CD Distance Trends.xlsx\Benzene\_FlowPath B

**Notes:**

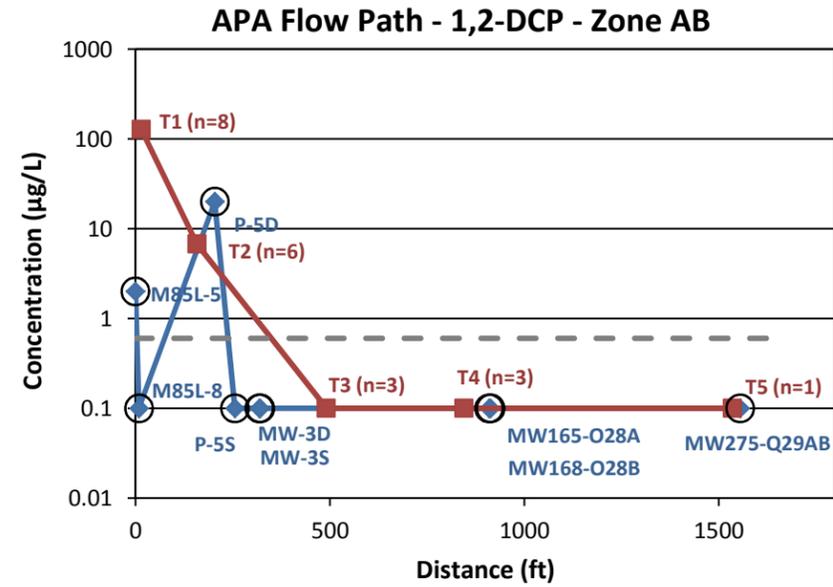
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. DCM - dichloromethane.

**Post-Shutdown DCM Concentration vs. Distance Along Flow Paths  
Chemtronics Site  
Swannanoa, North Carolina**

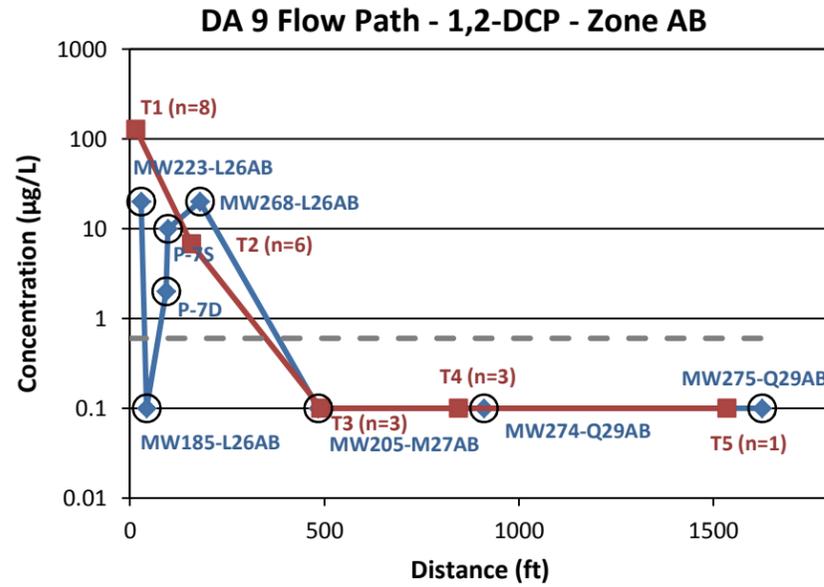


Figure  
3-8b

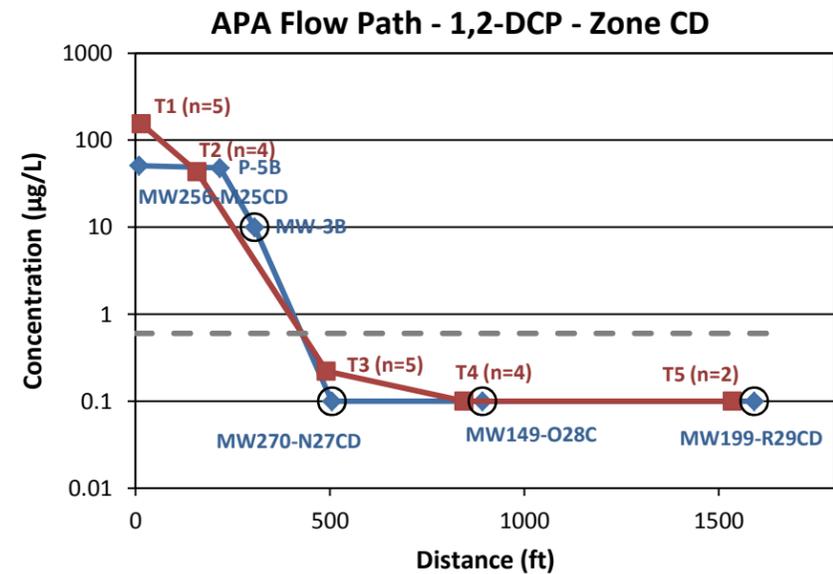
Kennesaw July 2016



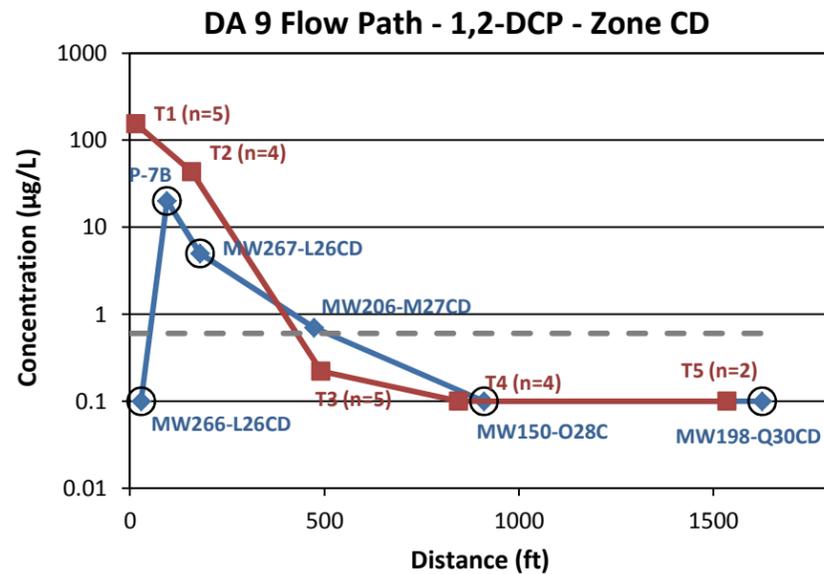
Well Transect Average Screening Criteria Non-detect



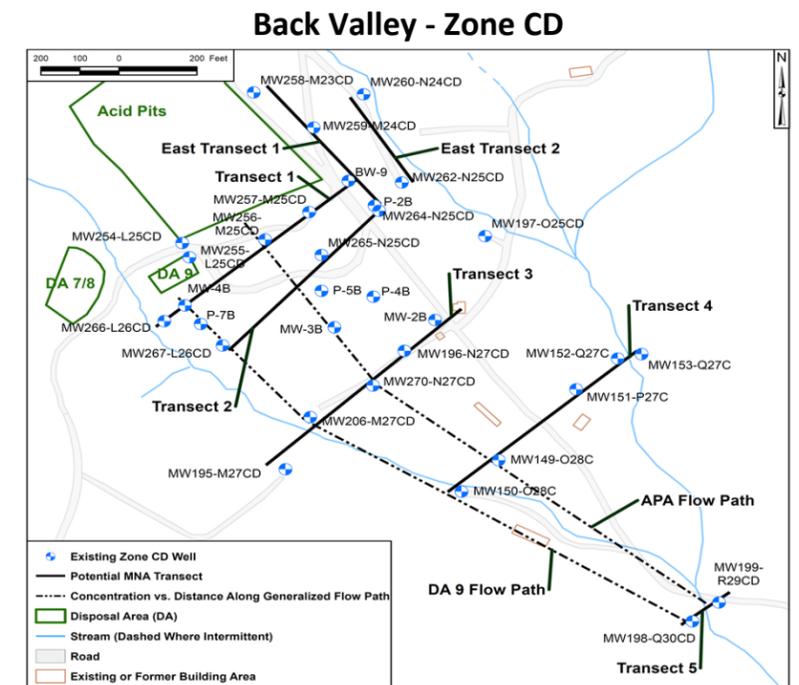
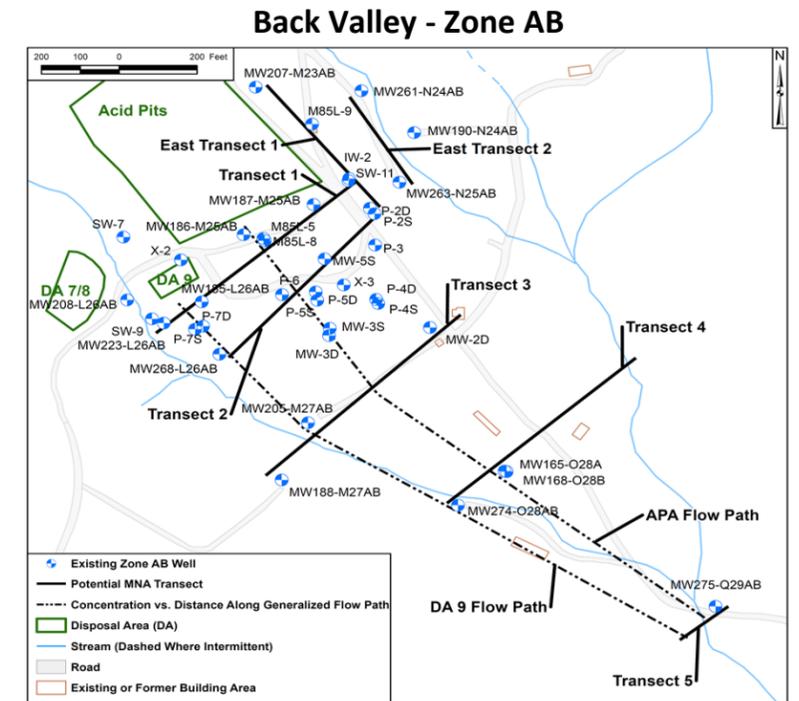
Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



**Notes:**

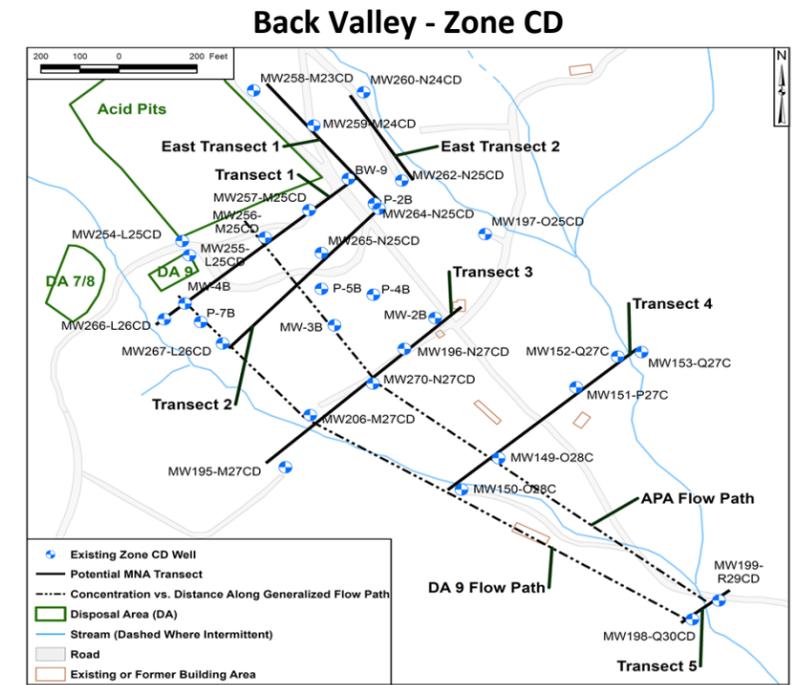
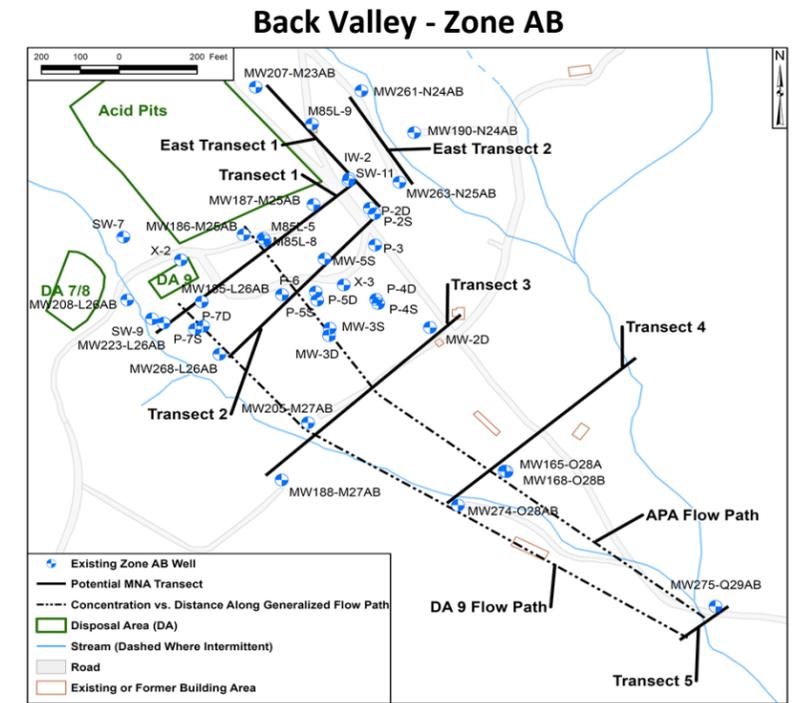
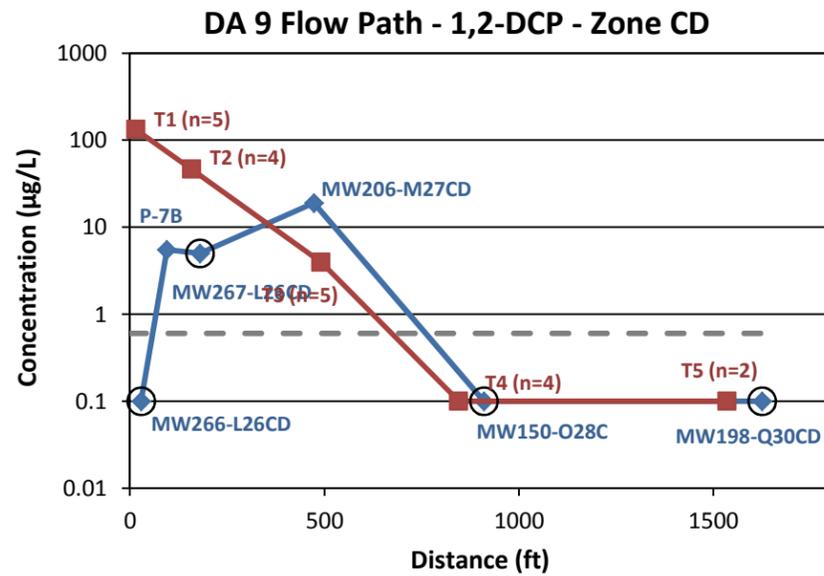
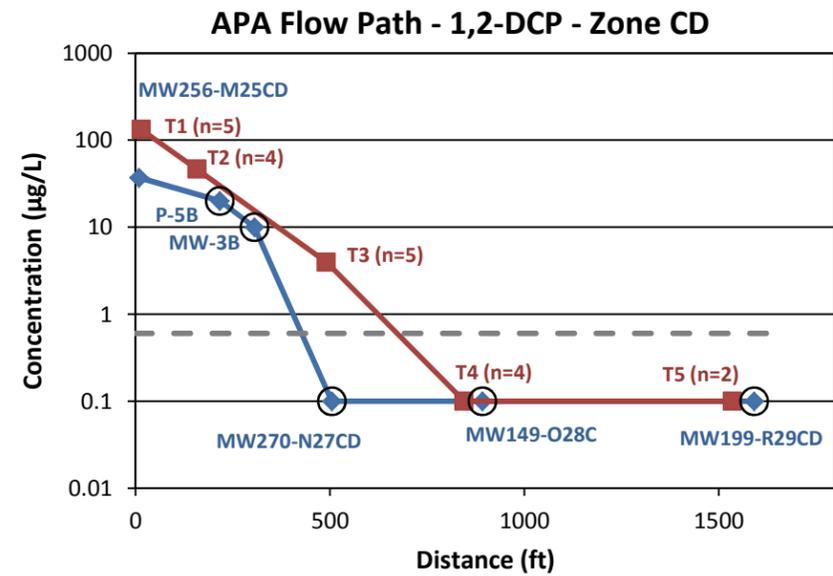
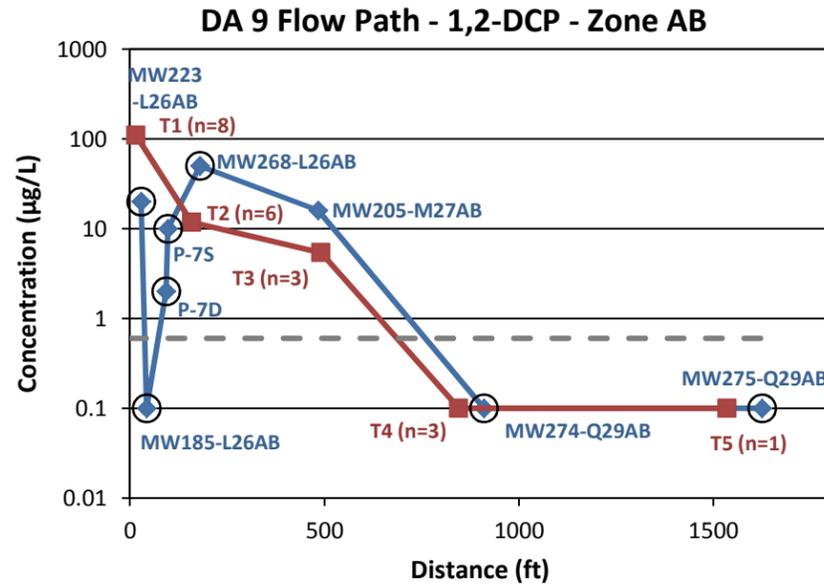
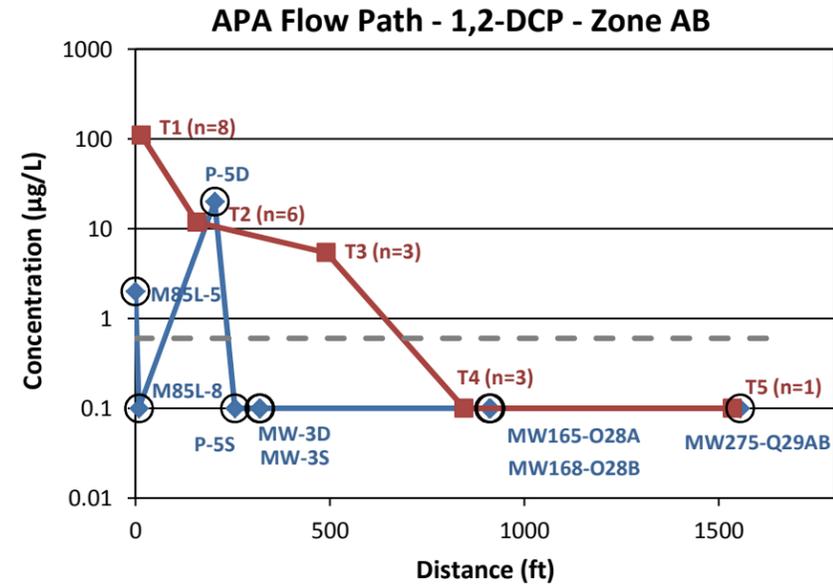
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. 1,2-DCP - 1,2-dichloropropane.

**Pre-Shutdown 1,2-DCP Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure  
3-9a

Kennesaw July 2016



N:\C:\Chemtronics\Back Valley Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\AB\_CD Distance Trends.xlsx\Benzene\_FlowPath B

**Notes:**

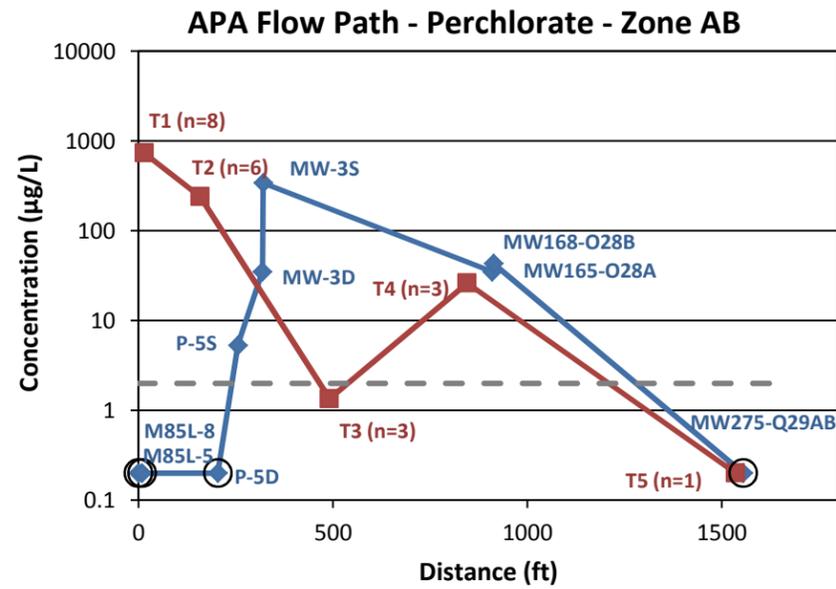
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. 1,2-DCP - 1,2-dichloropropane.

**Post-Shutdown 1,2-DCP Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina

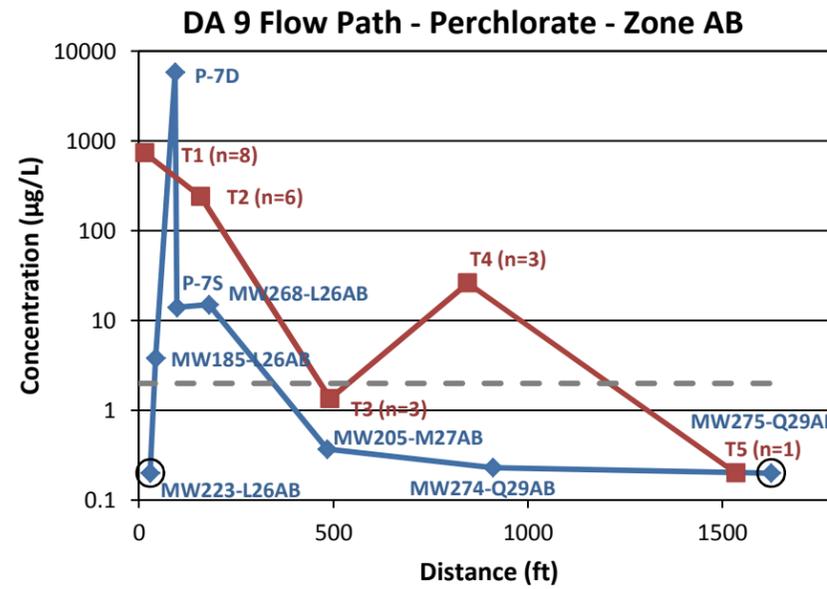


Figure  
3-9b

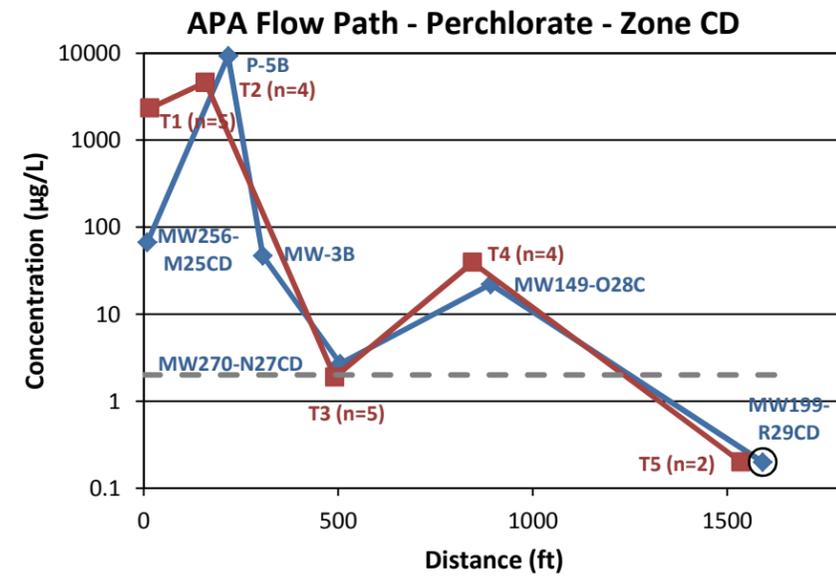
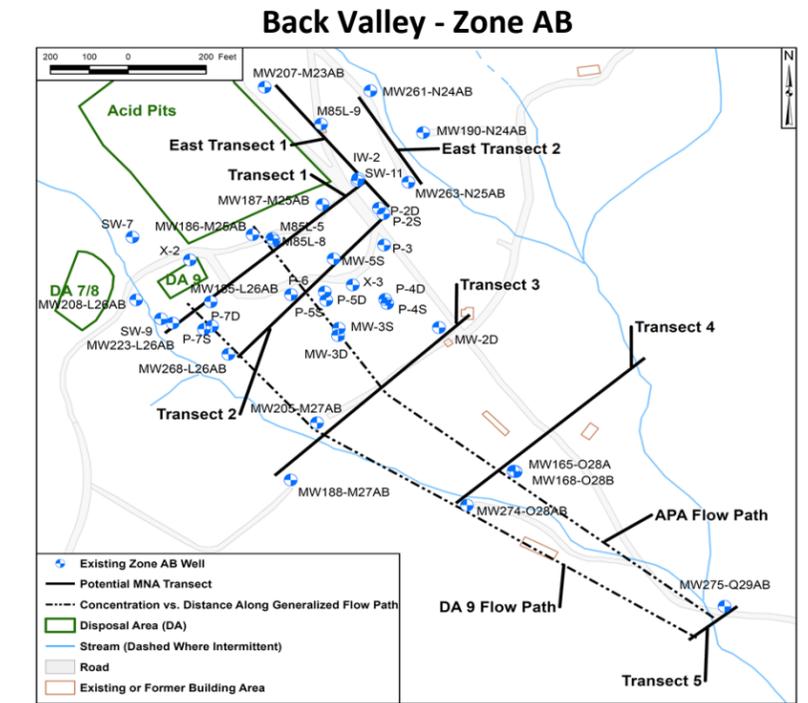
Kennesaw July 2016



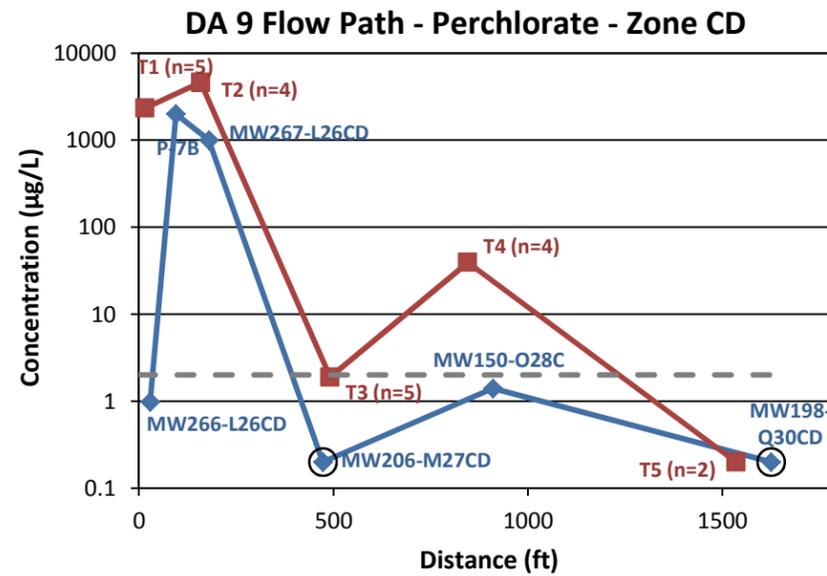
Well Transect Average Screening Criteria Non-detect



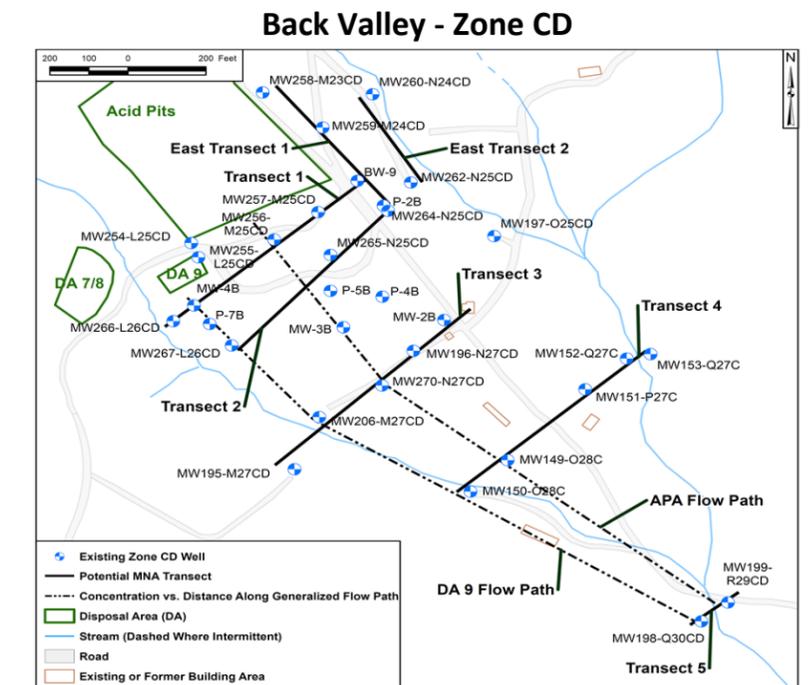
Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect

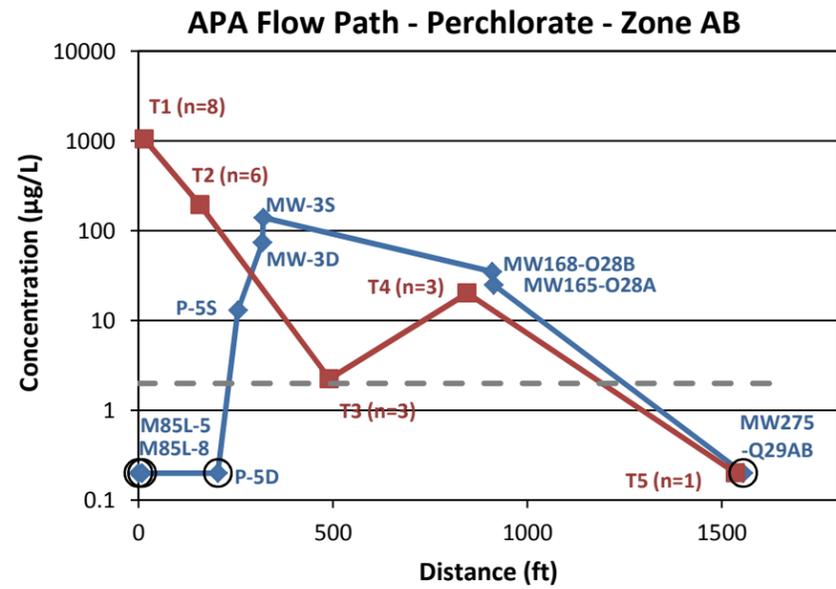


N:\C\Chemtronics\Back Valley\Perchlorate\Figures\MXD\Fig3-1 to 3-1E\_BV\_AB\_CD Distance Trends.xlsx\Benzene\_FlowPath B

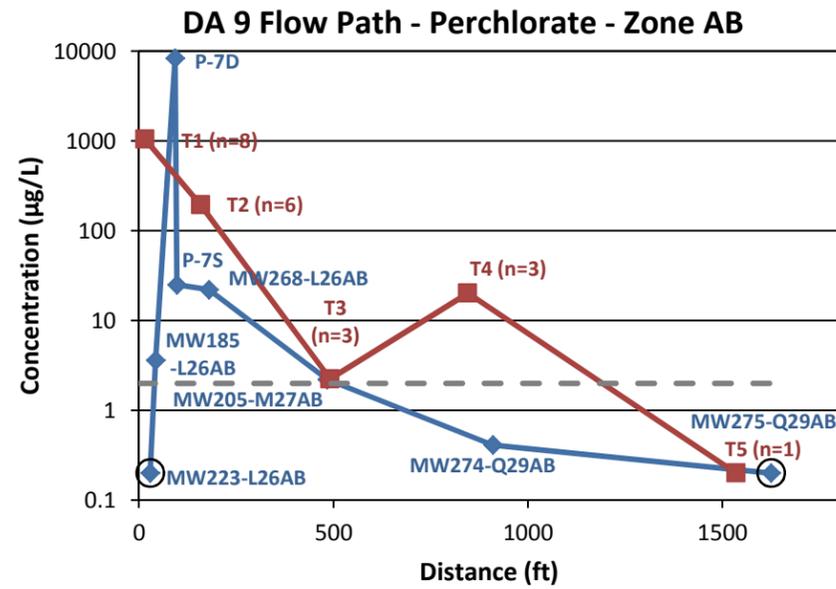
**Notes:**

1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.

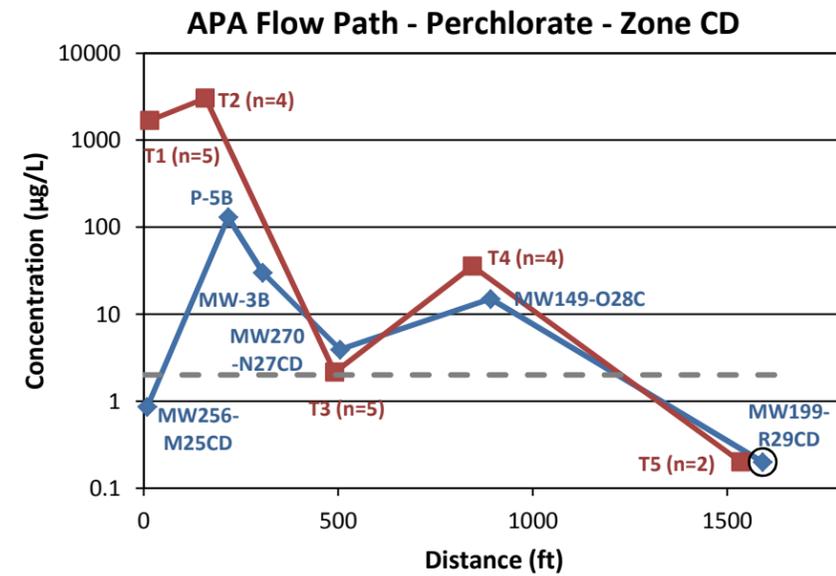
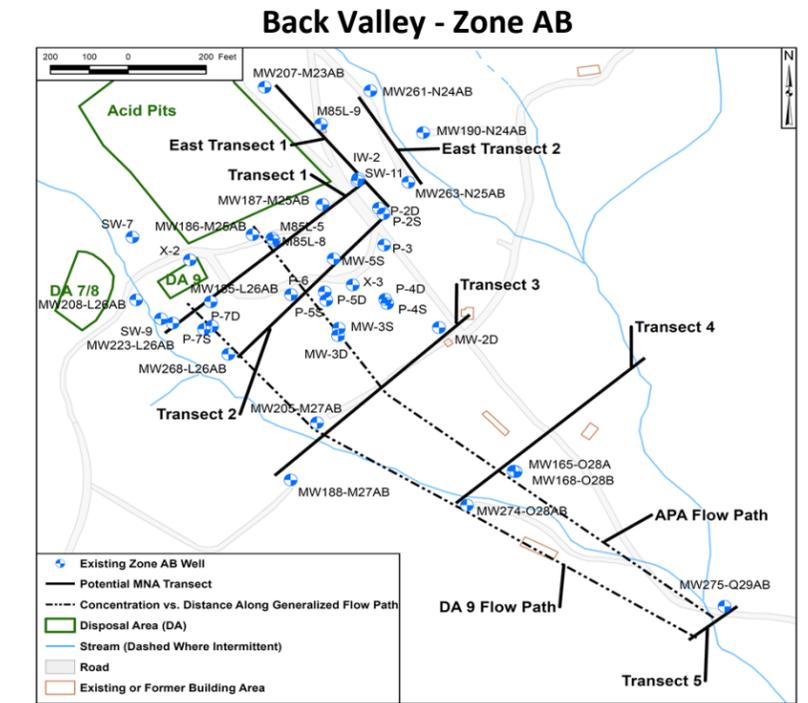
<b>Pre-Shutdown Perchlorate Concentration vs. Distance Along Flow Paths</b> Chemtronics Site Swannanoa, North Carolina		Figure 3-10a
Kennesaw	July 2016	



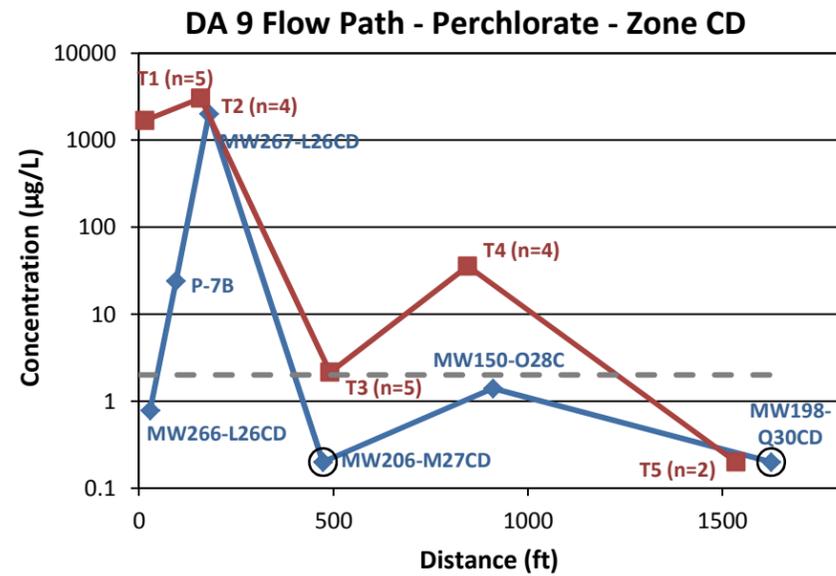
Well Transect Average Screening Criteria Non-detect



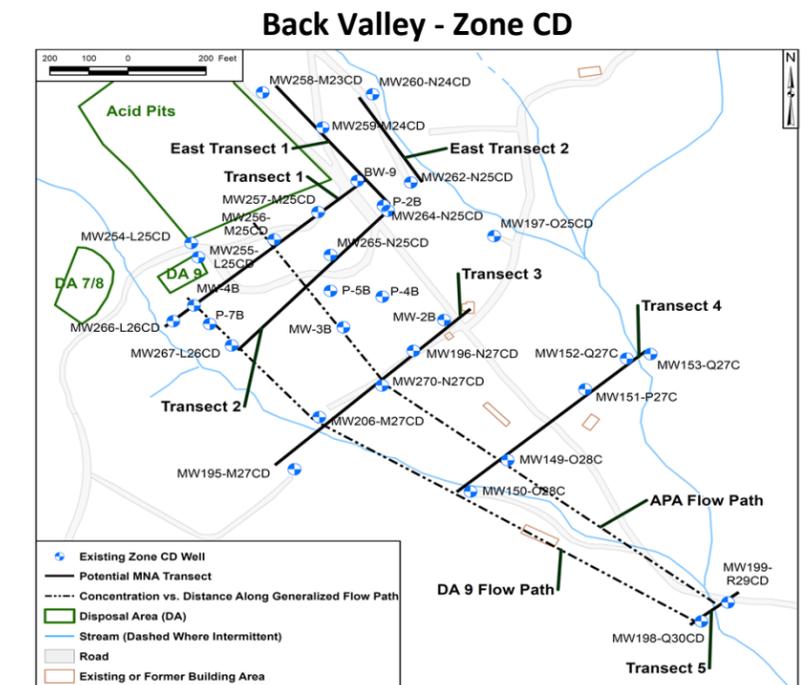
Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



- Notes:**
1. µg/L – micrograms per liter.
  2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
  3. Non-detects are displayed at the method detection limit (MDL).
  4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
  5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
  6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.

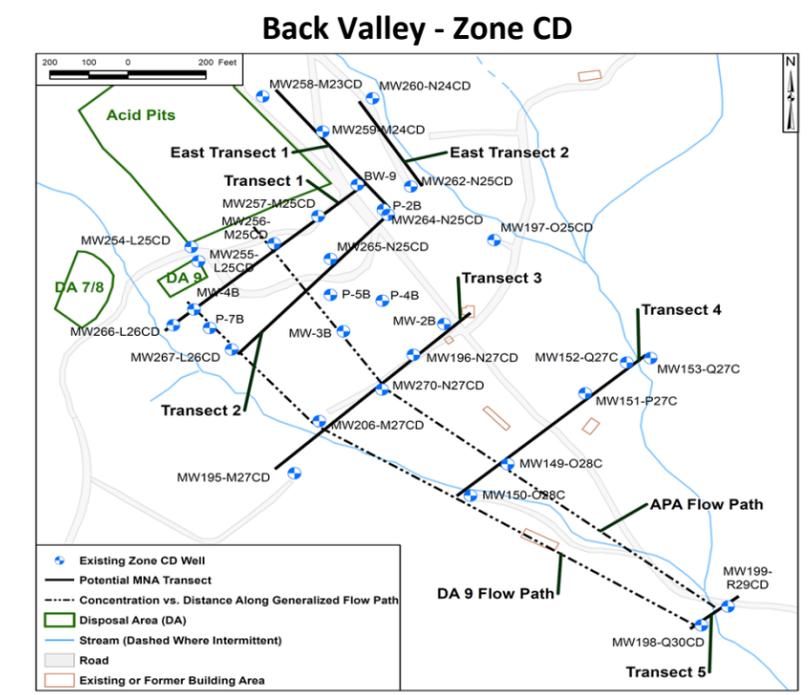
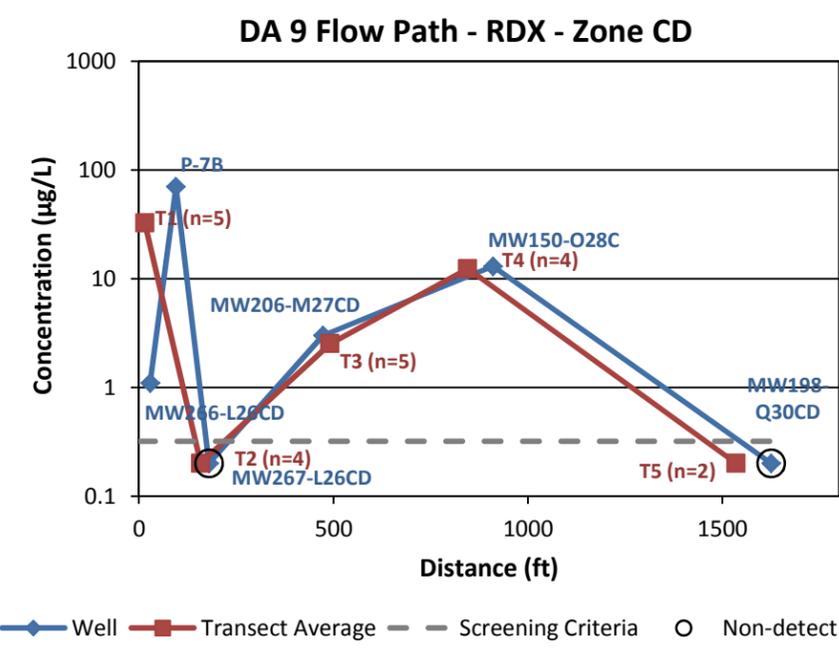
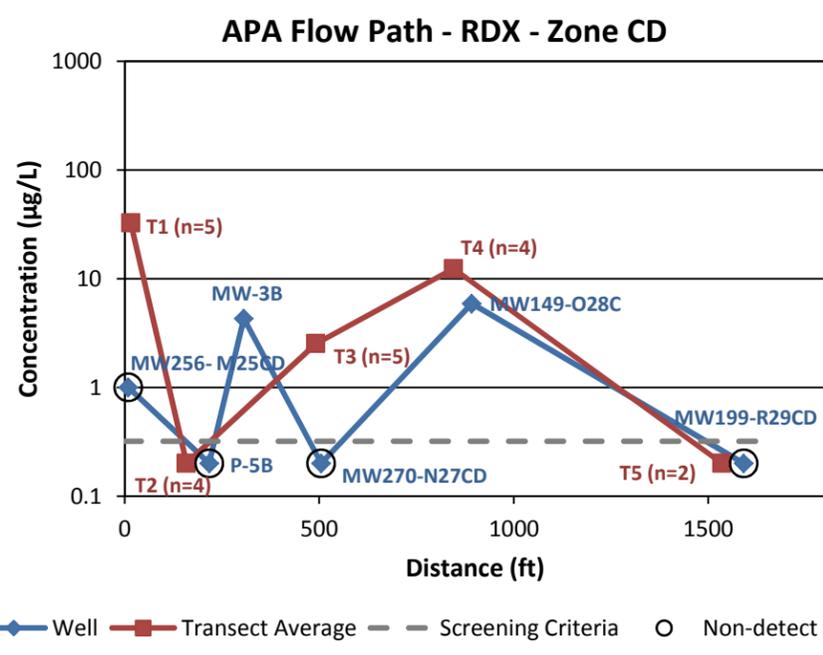
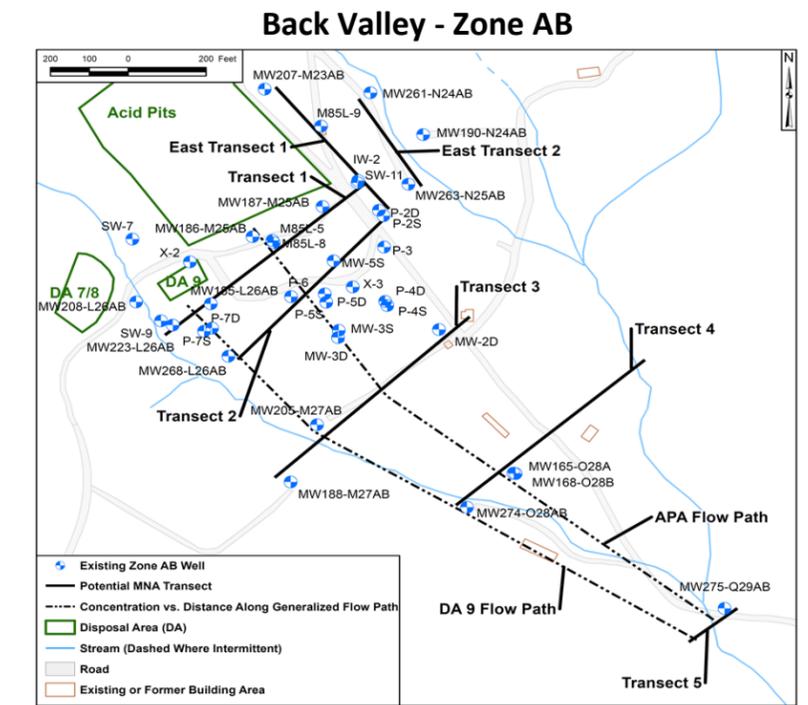
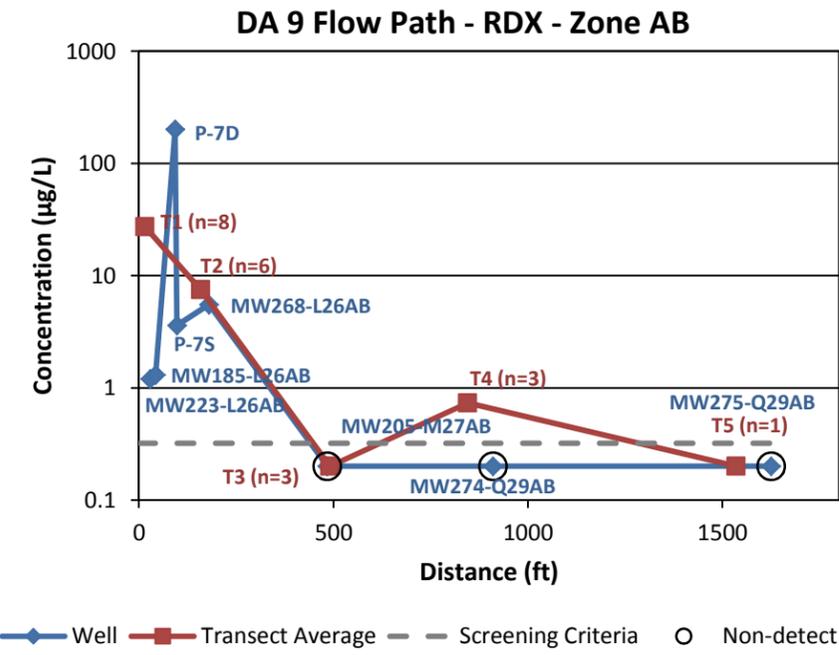
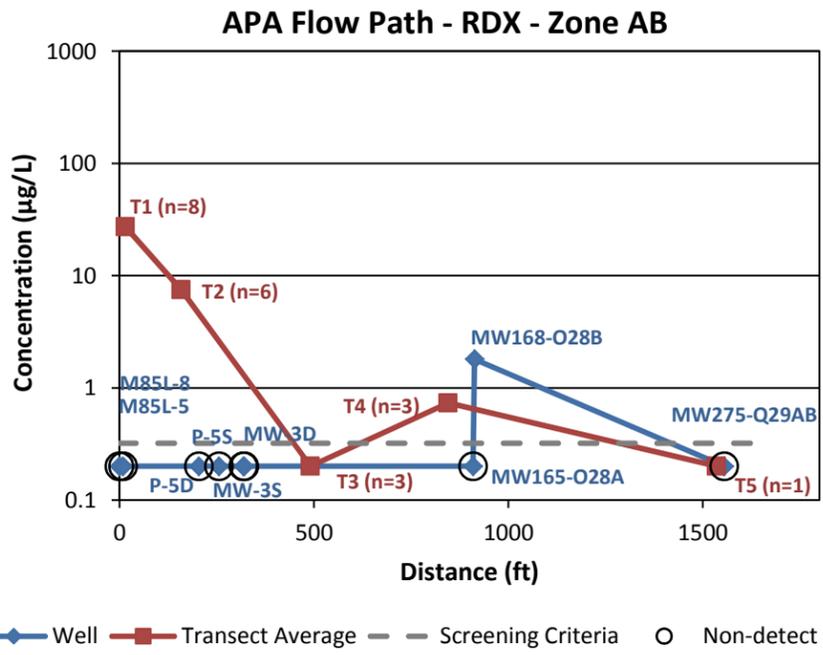
**Post-Shutdown Perchlorate Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure 3-10b

Kennesaw July 2016

N:\C\Chemtronics\Back Valley Post-Shutdown\Figures\MXD\Fig3-10 to 3-10c\BA\AB\_CD Distance Trends.xlsx\Benzene\_FlowPath B



N:\C:\Chemtronics\Back Valley\Post-Shutdown\Figures\MXD\Fig3-11 to 3-11E\_BV\_AB\_CD Distance Trends.xlsx\Benzene\_FlowPath B

**Notes:**

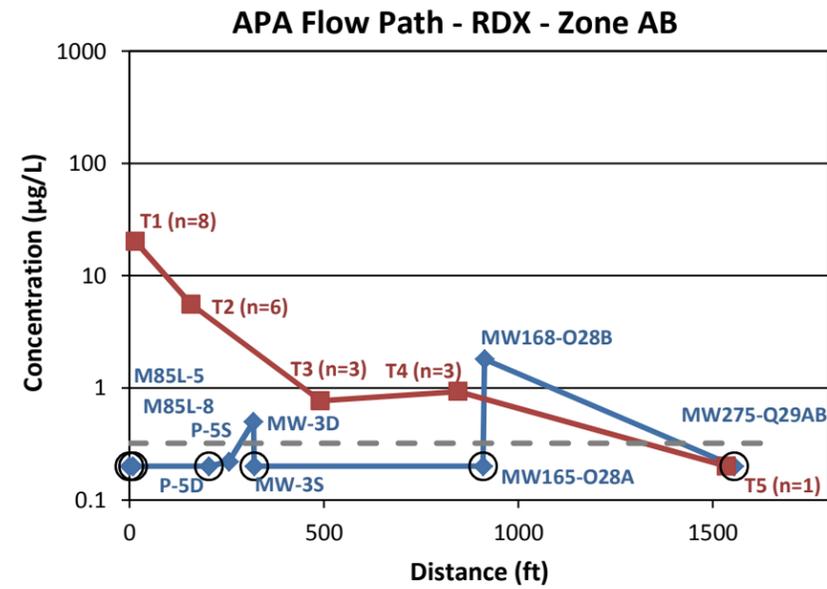
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. RDX - Research Department Explosive.

**Pre-Shutdown RDX Concentration vs. Distance  
Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina

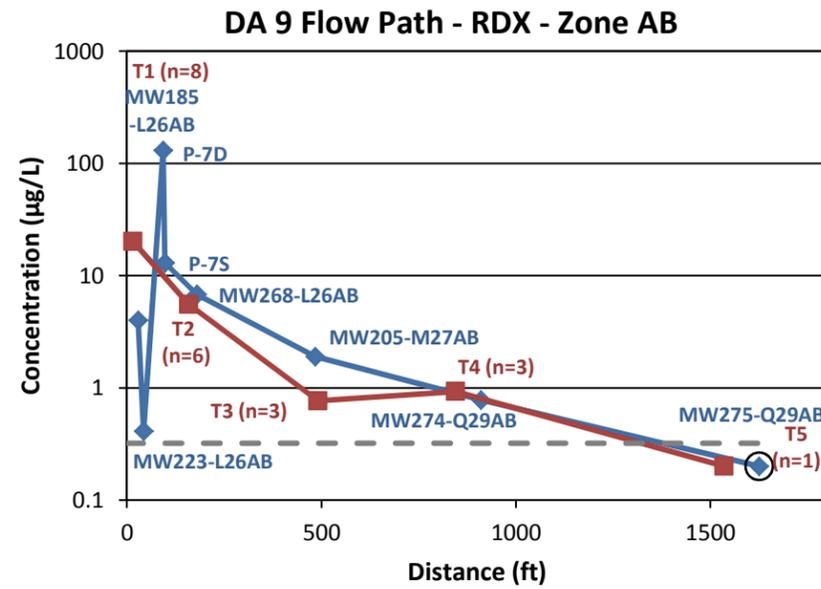
**Geosyntec**  
consultants

Kennesaw      July 2016

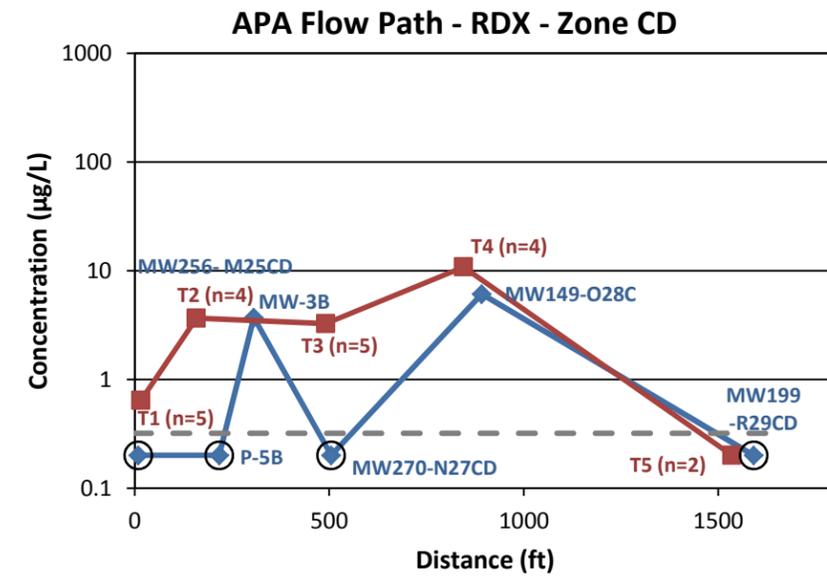
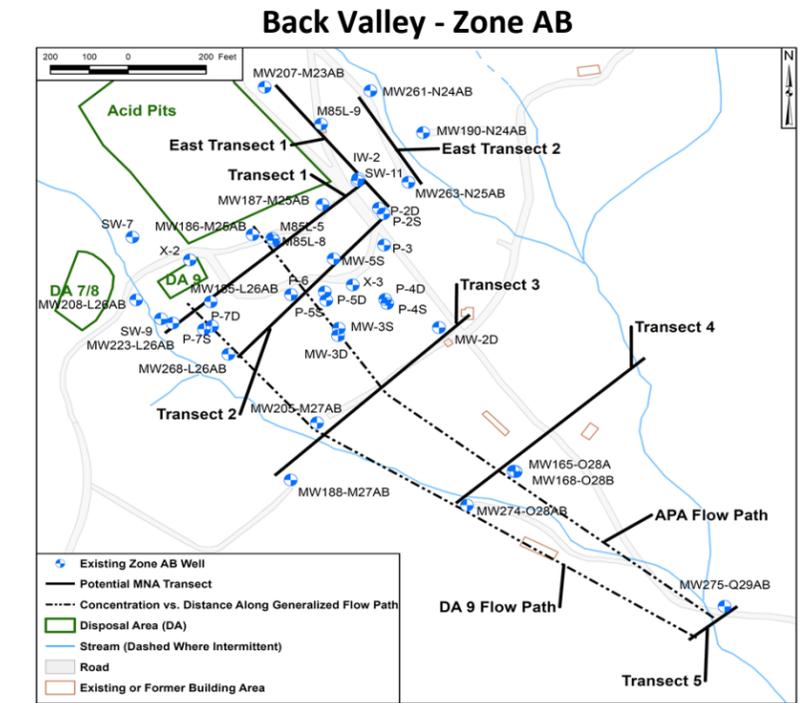
Figure  
3-11a



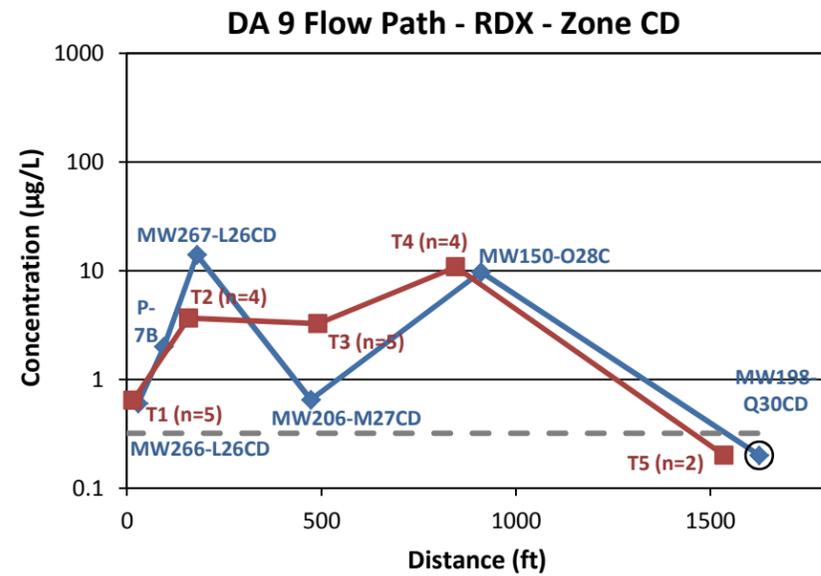
Well Transect Average Screening Criteria Non-detect



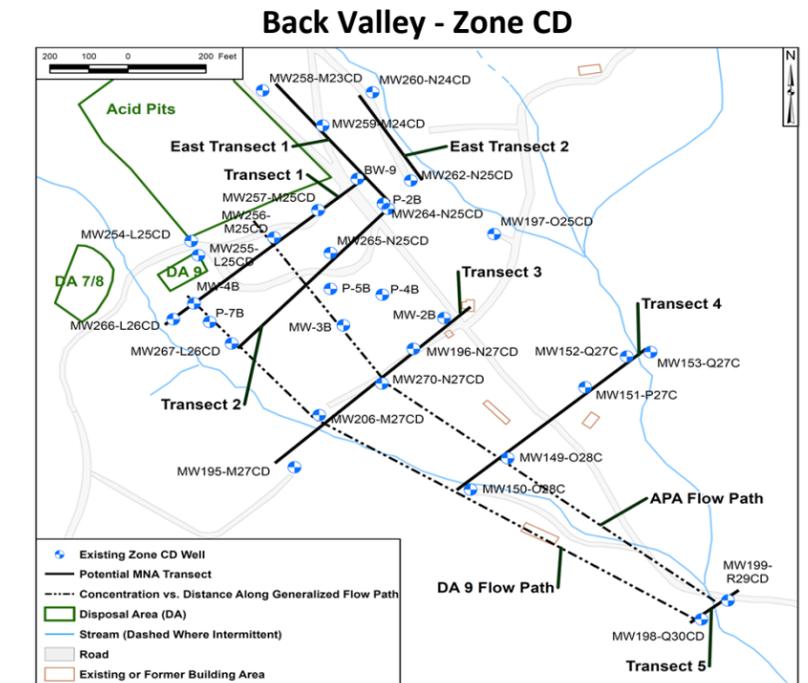
Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



**Notes:**

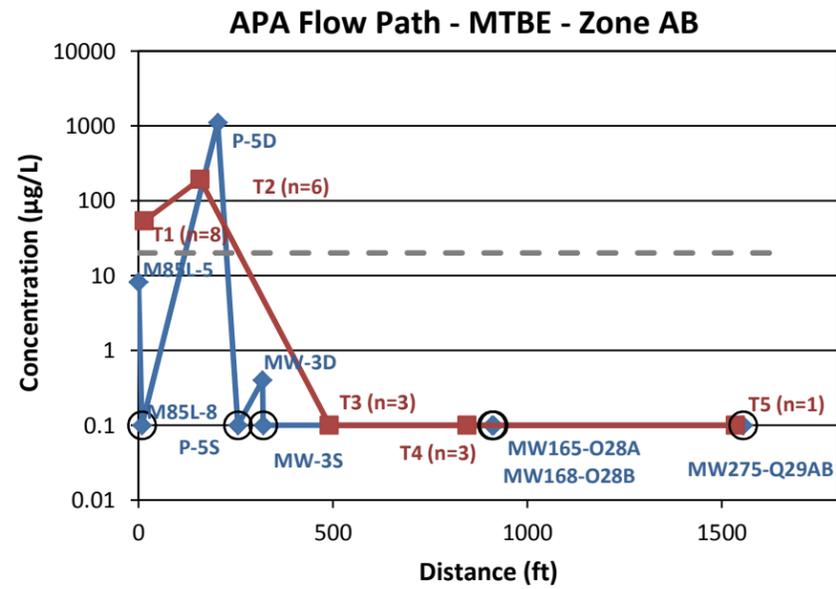
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. RDX - Research Department Explosive.

**Post-Shutdown RDX Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina

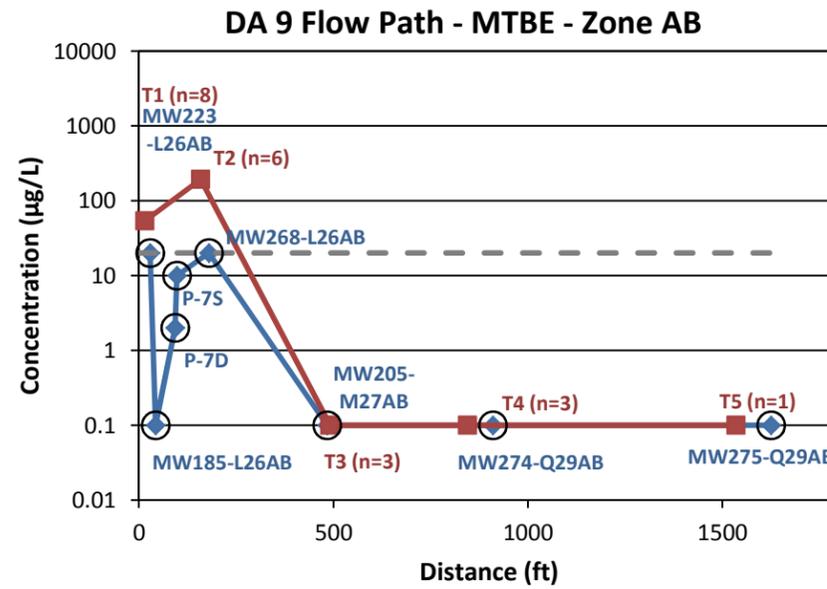


Figure  
3-11b

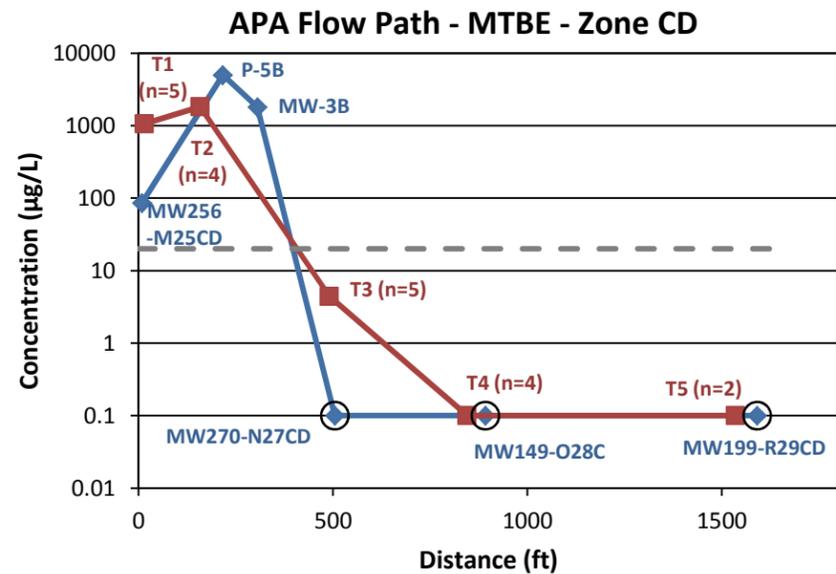
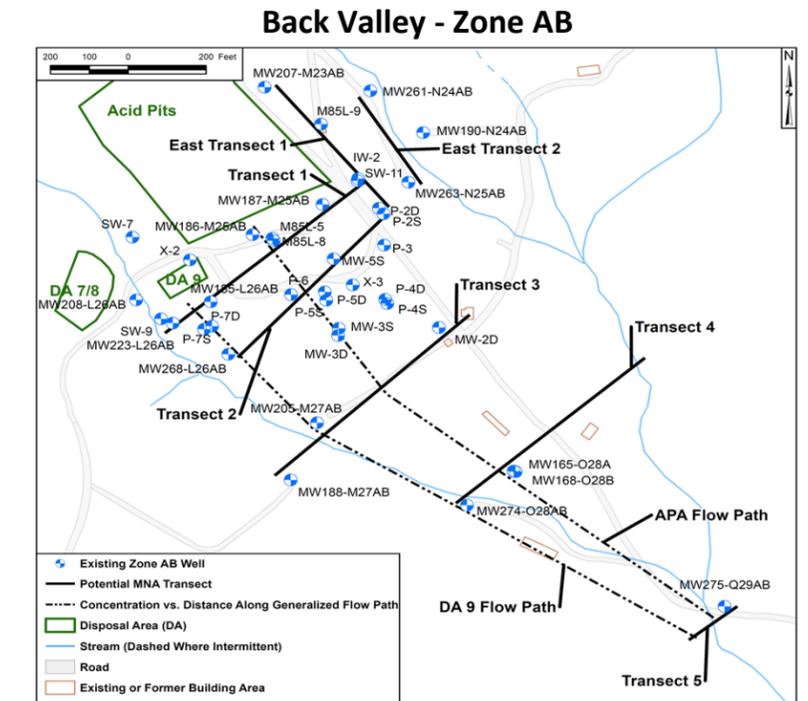
Kennesaw July 2016



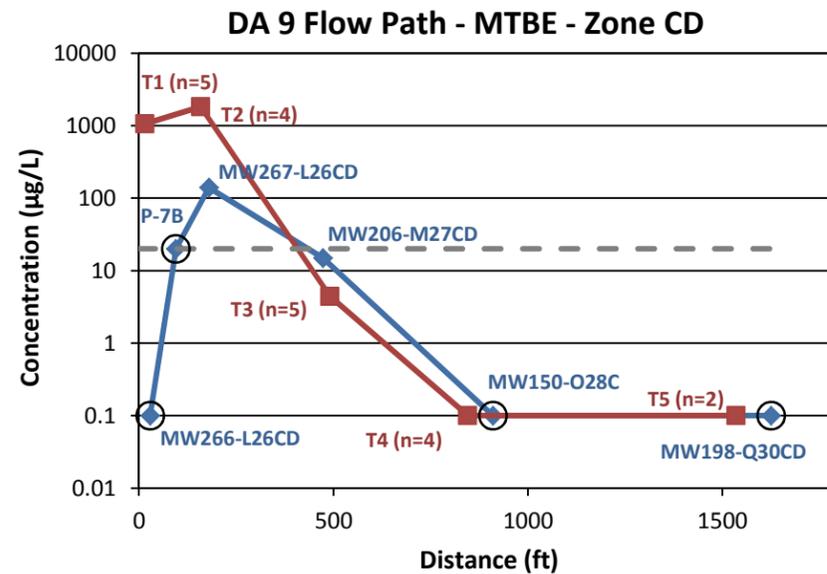
Well Transect Average Screening Criteria Non-detect



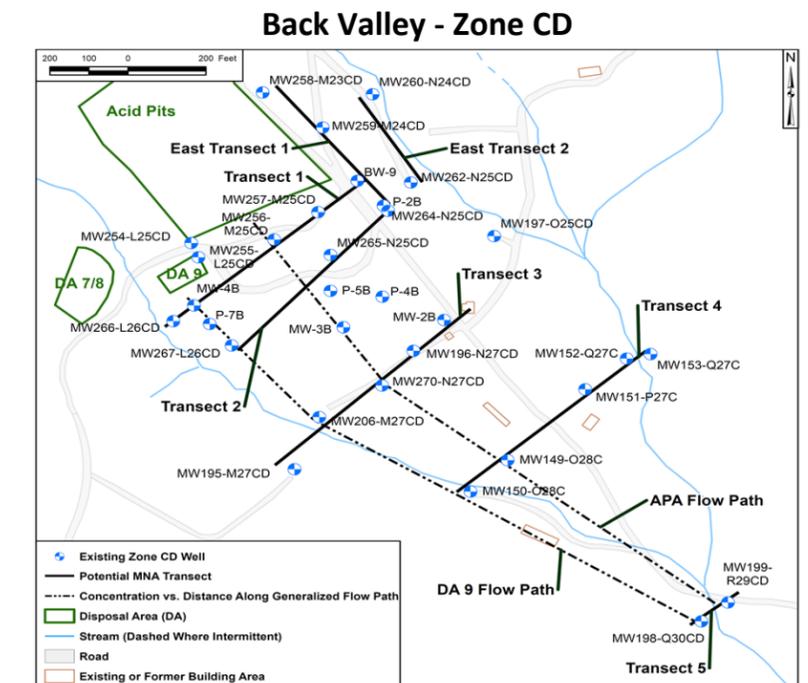
Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



**Notes:**

1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. MTBE - methyl-tert-butyl ether.

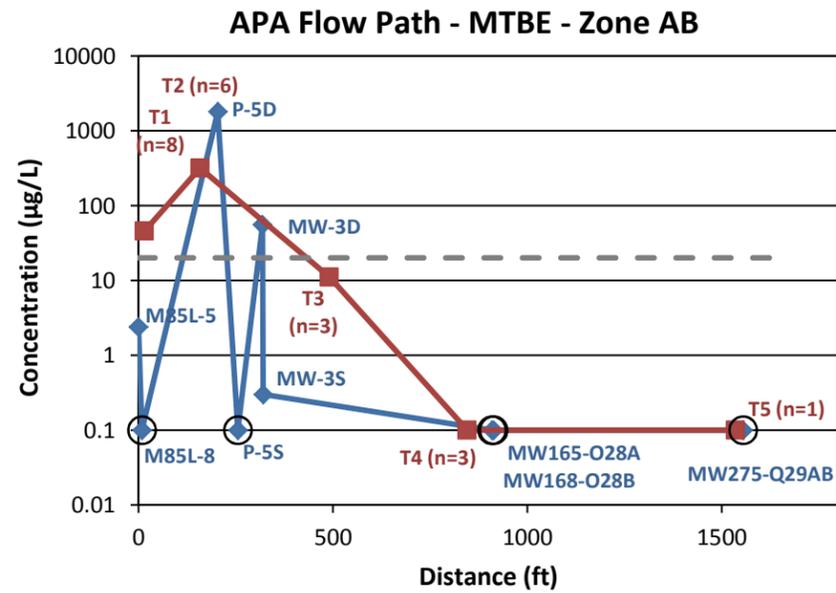
**Pre-Shutdown MTBE Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina

Geosyntec  
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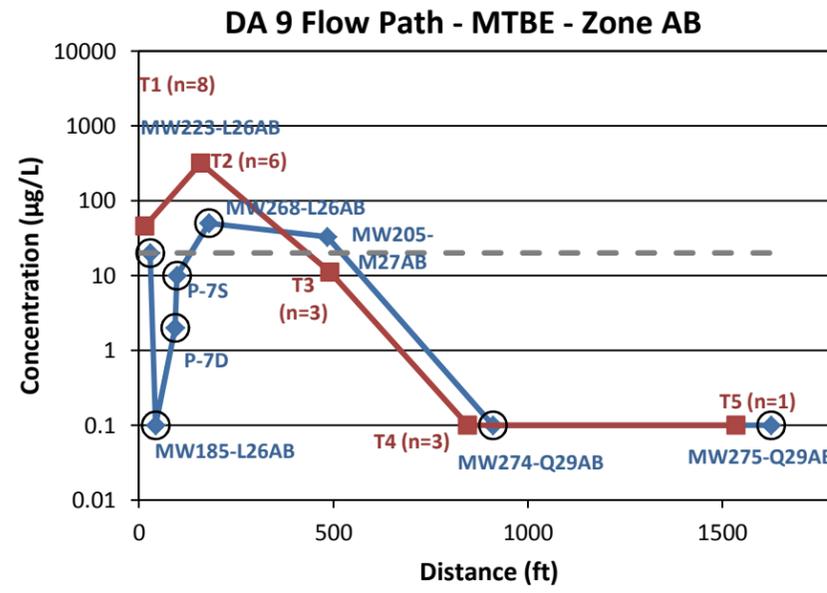
Figure  
3-12a

Kennesaw

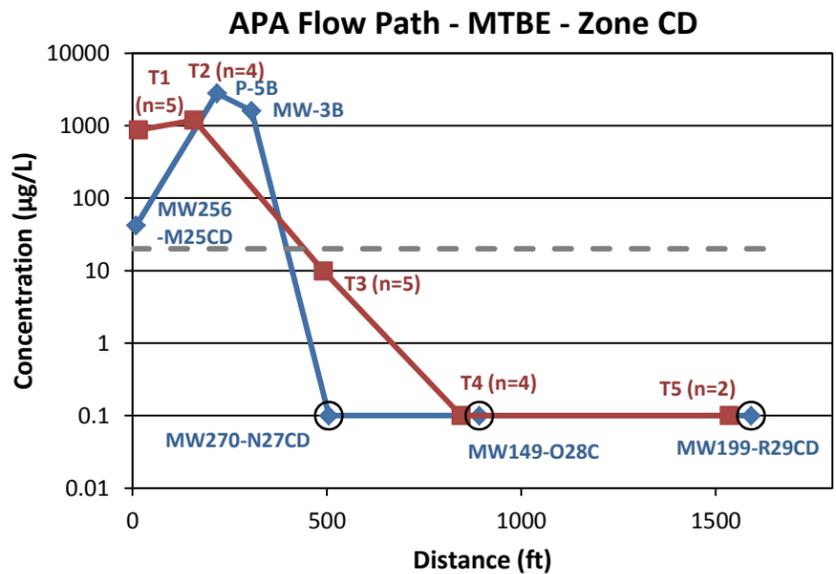
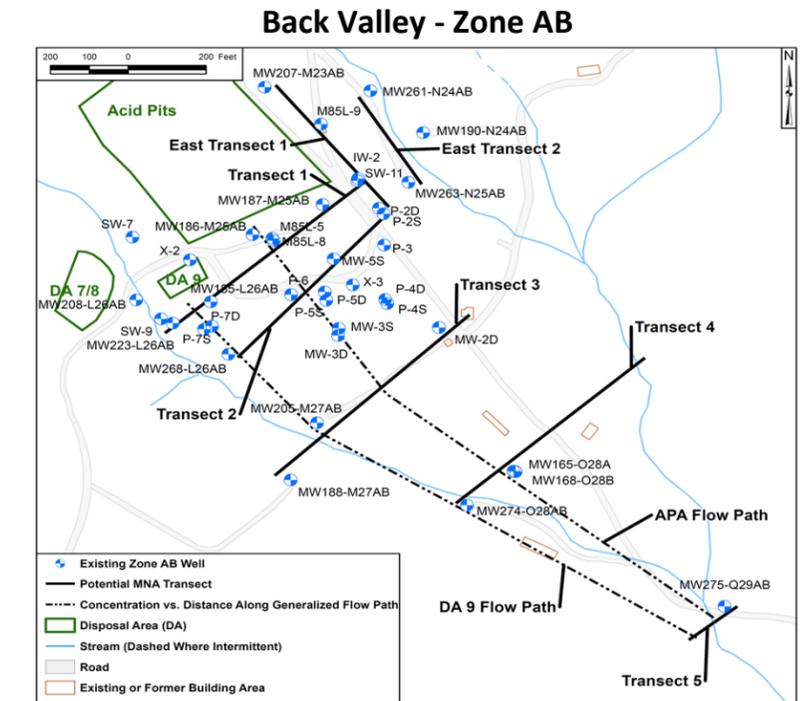
July 2016



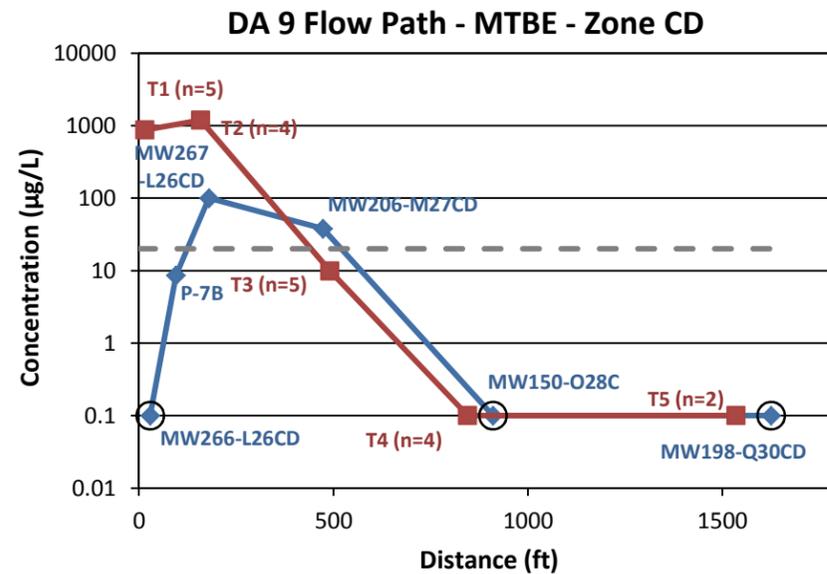
Well Transect Average Screening Criteria Non-detect



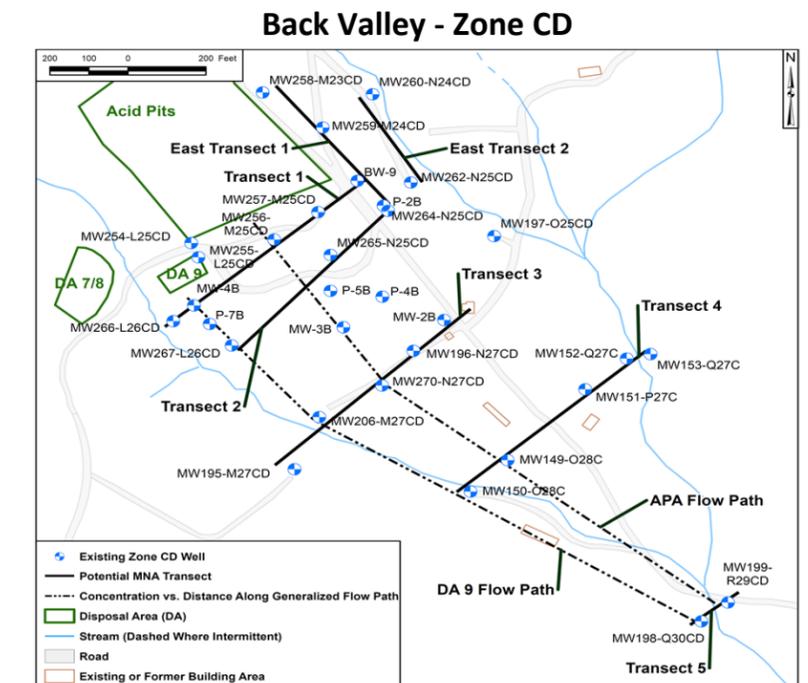
Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



#### Notes:

1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. MTBE - methyl-tert-butyl ether.

**Post-Shutdown MTBE Concentration vs. Distance  
Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina

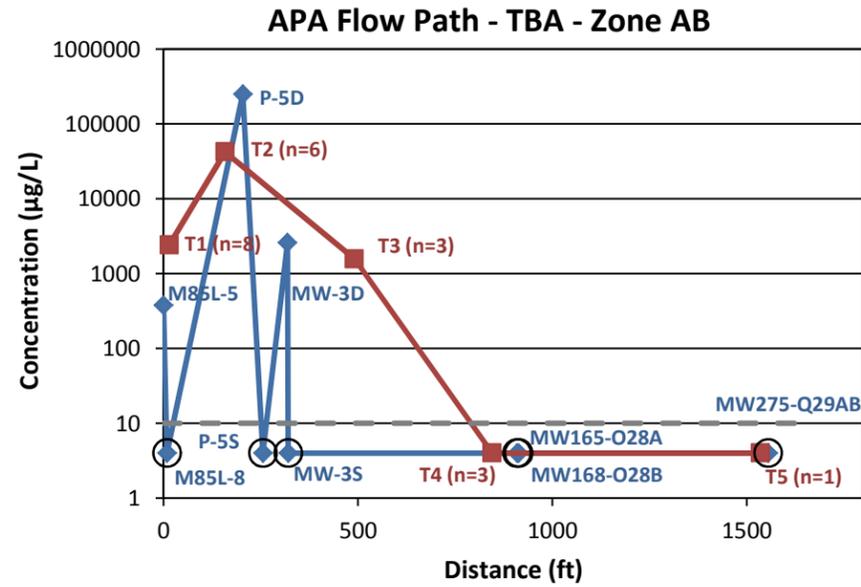
**Geosyntec**  
consultants

Figure  
3-12b

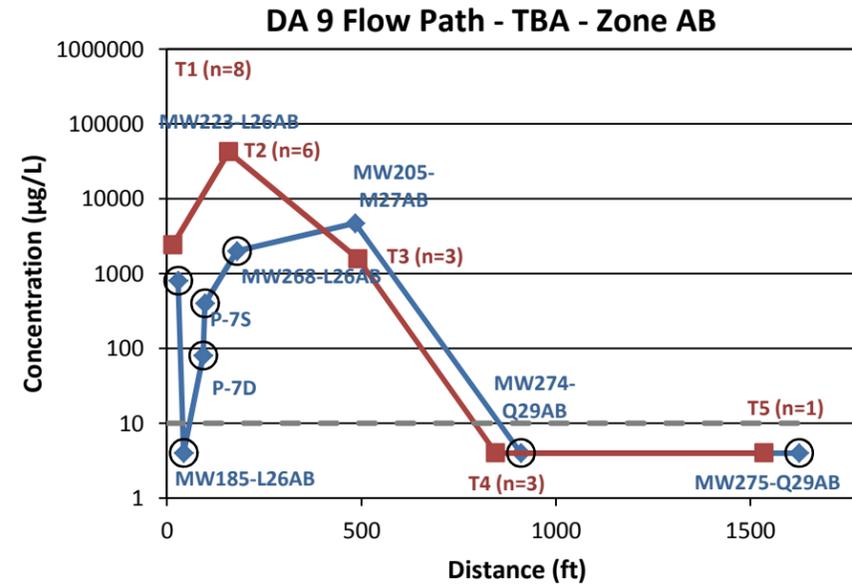
Kennesaw

July 2016

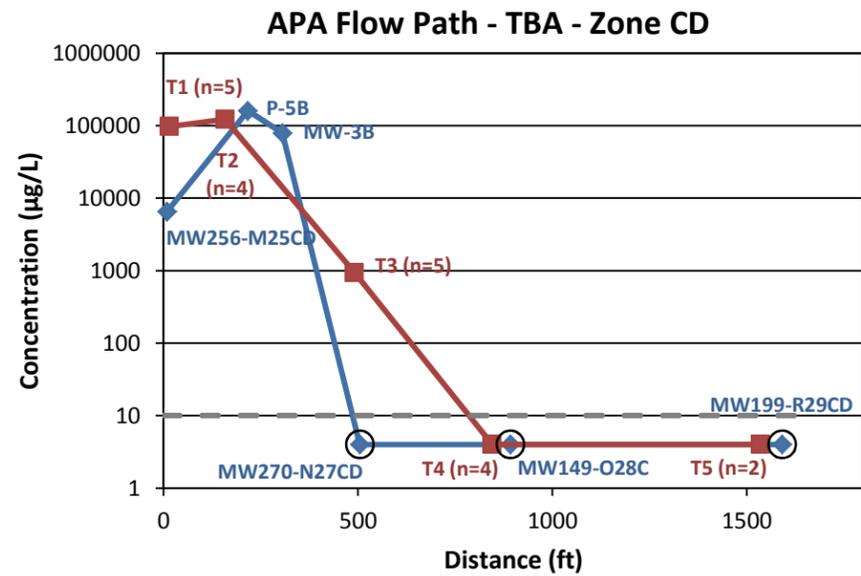
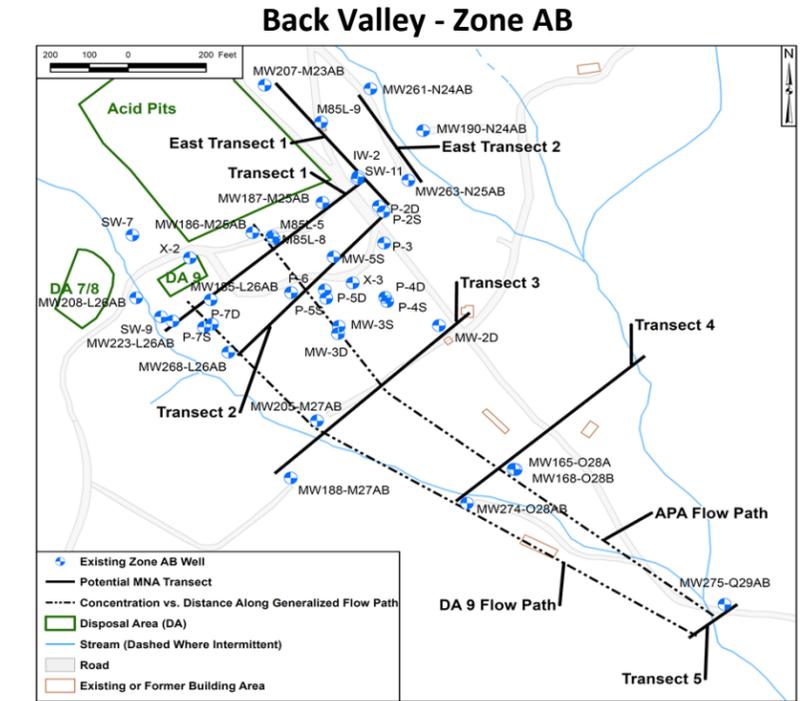




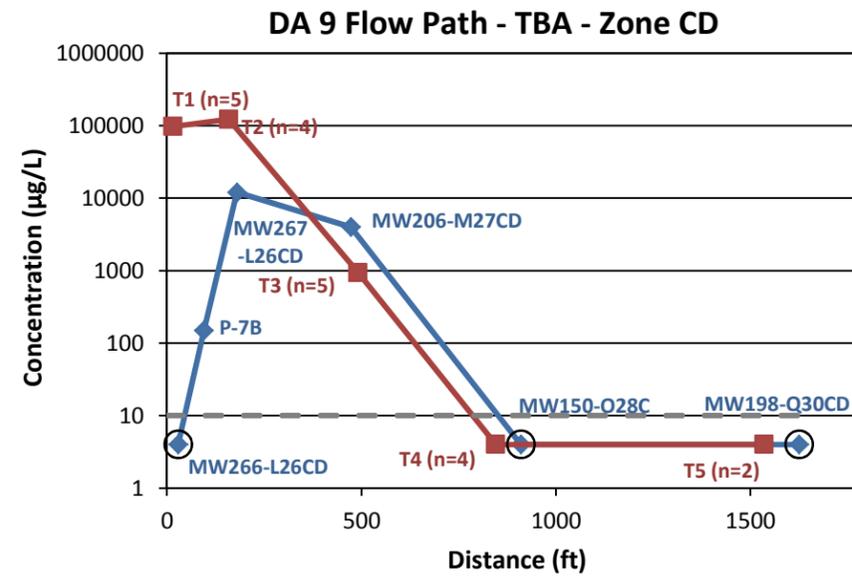
Well Transect Average Screening Criteria Non-detect



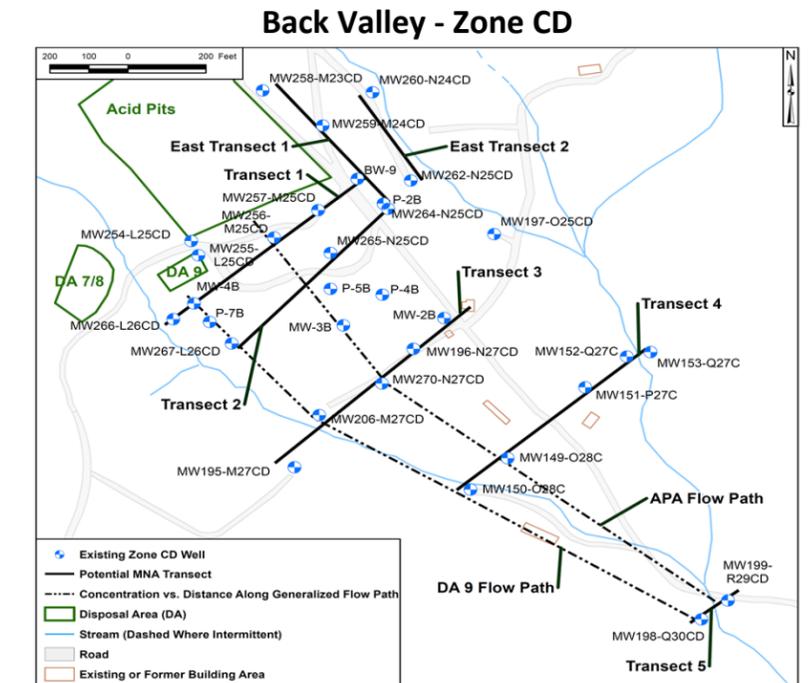
Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



Well Transect Average Screening Criteria Non-detect



**Notes:**  
 1. µg/L – micrograms per liter.  
 2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).  
 3. Non-detects are displayed at the method detection limit (MDL).  
 4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).  
 5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.  
 6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.  
 7. TBA - tert-butyl alcohol.

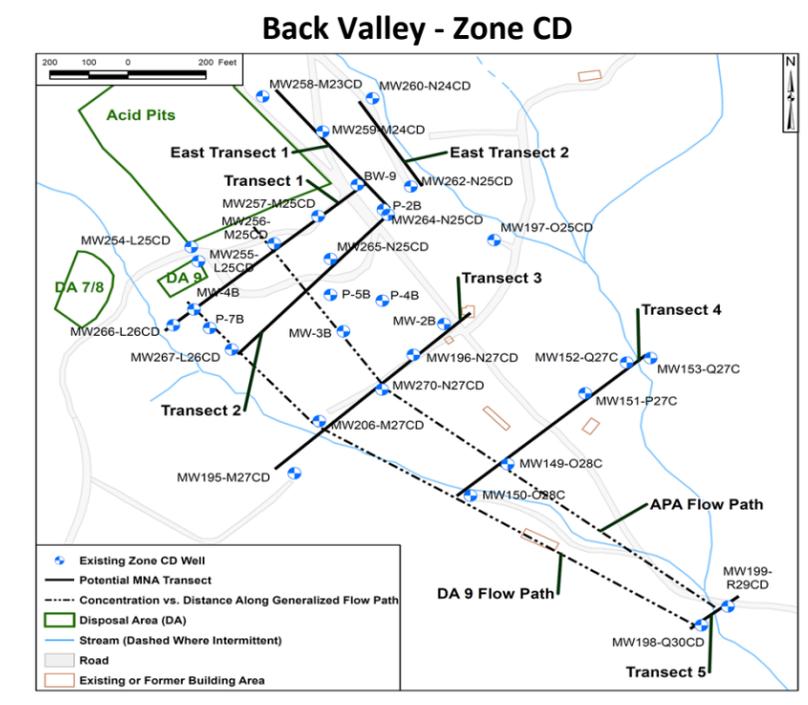
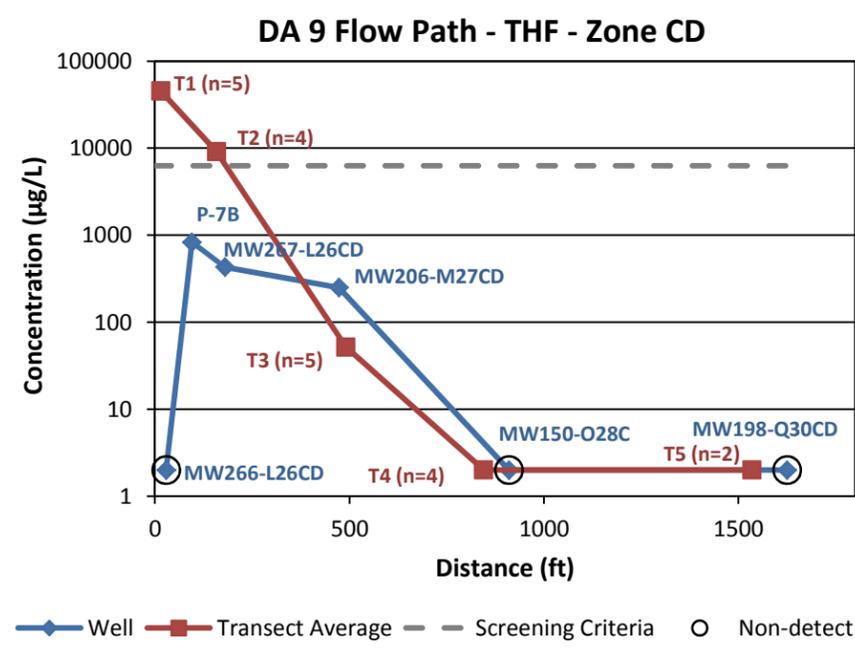
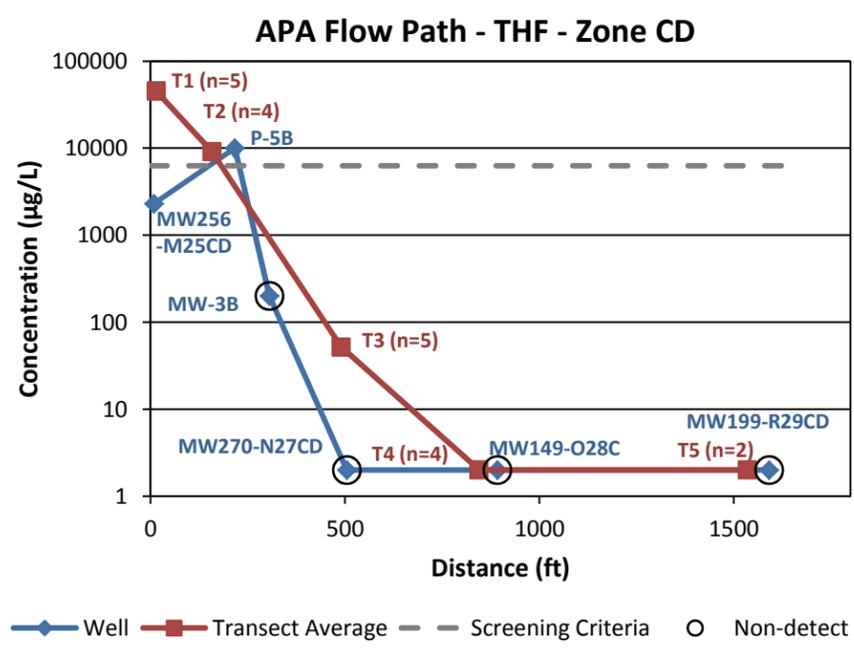
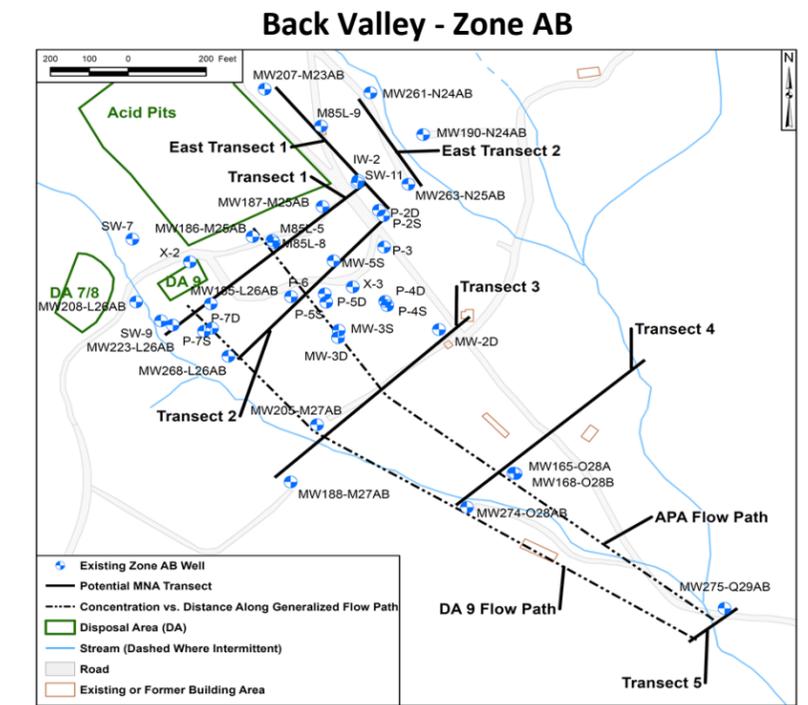
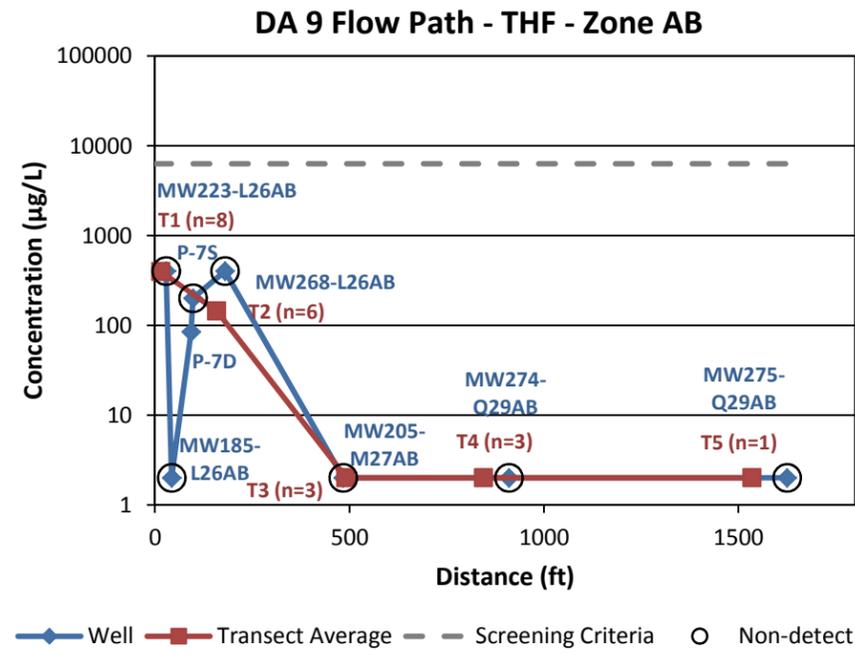
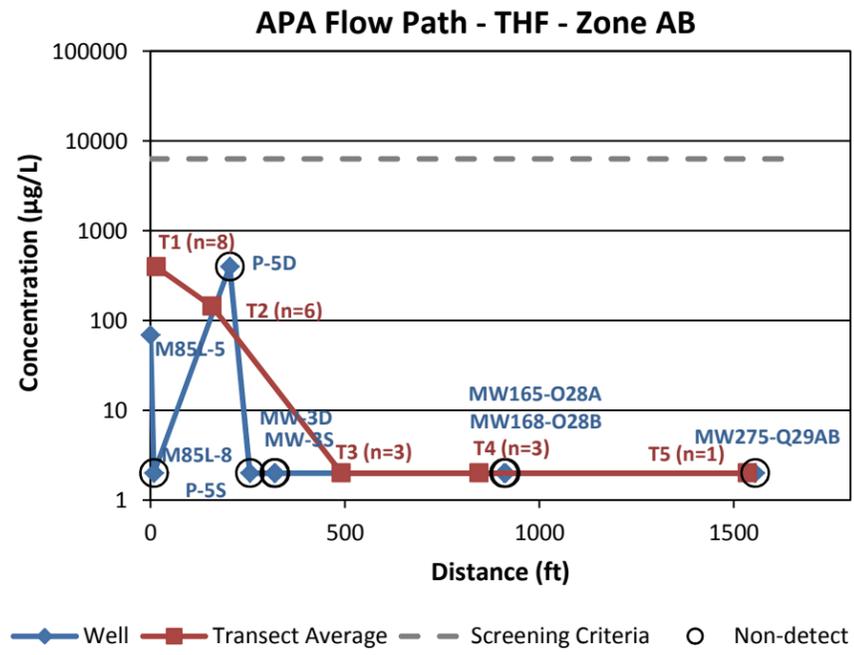
**Post-Shutdown TBA Concentration vs. Distance Along Flow Paths**  
 Chemtronics Site  
 Swannanoa, North Carolina



Figure  
3-13b

Kennesaw July 2016

N:\C\Chemtronics\Back Valley\Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\AB\_CD Distance Trends.xlsx\Benzene\_FlowPath 8



N:\C:\Chemtronics\Back Valley\Post-Shutdown\Figures\MMD\Fig3-1 to 3-1E\_BV\AB\_CD Distance Trends.xlsx\Benzene\_FlowPath 8

**Notes:**

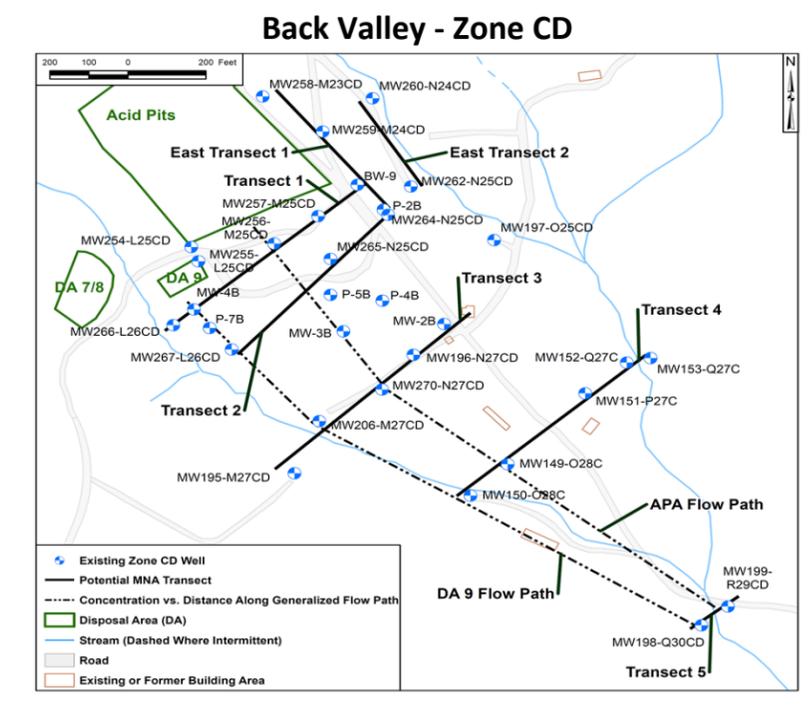
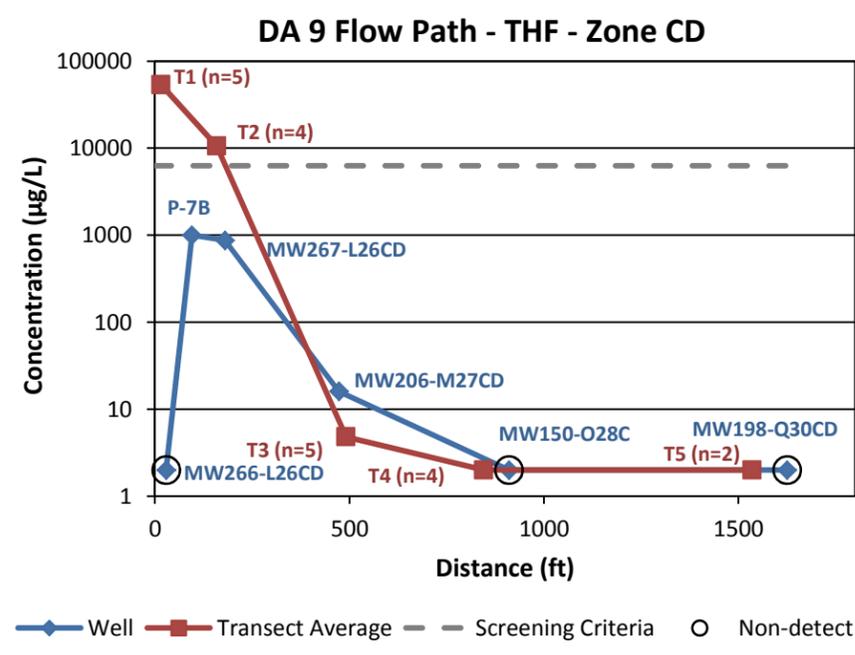
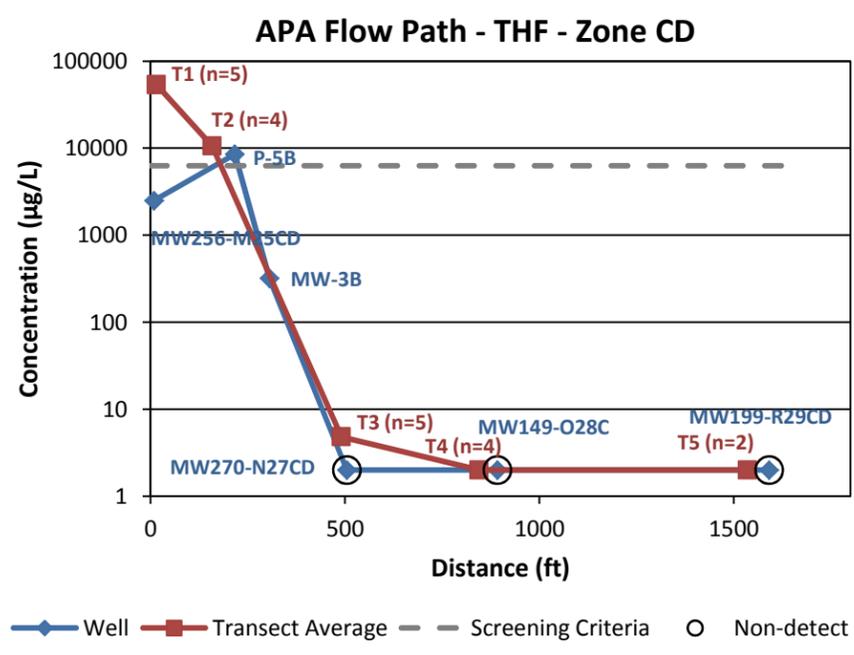
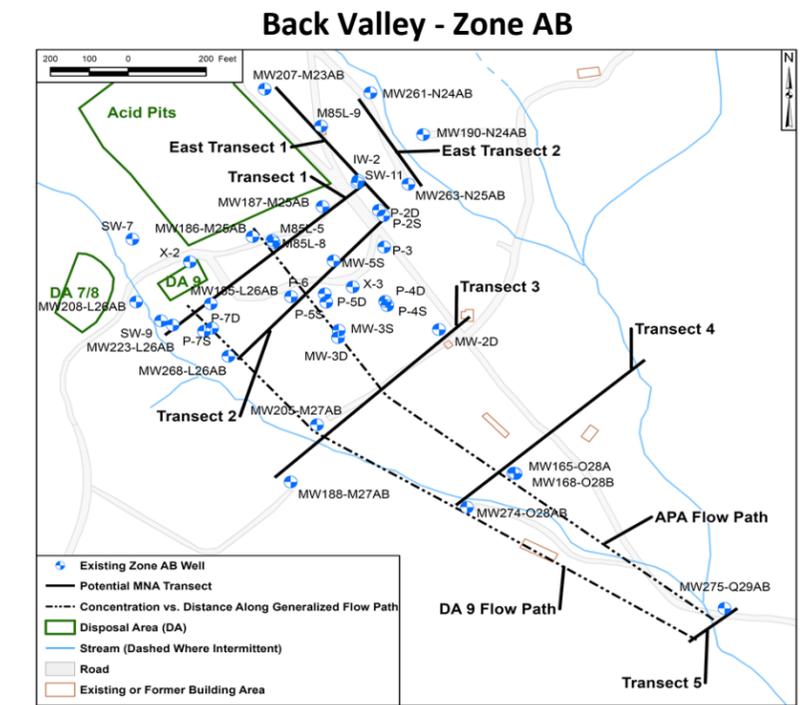
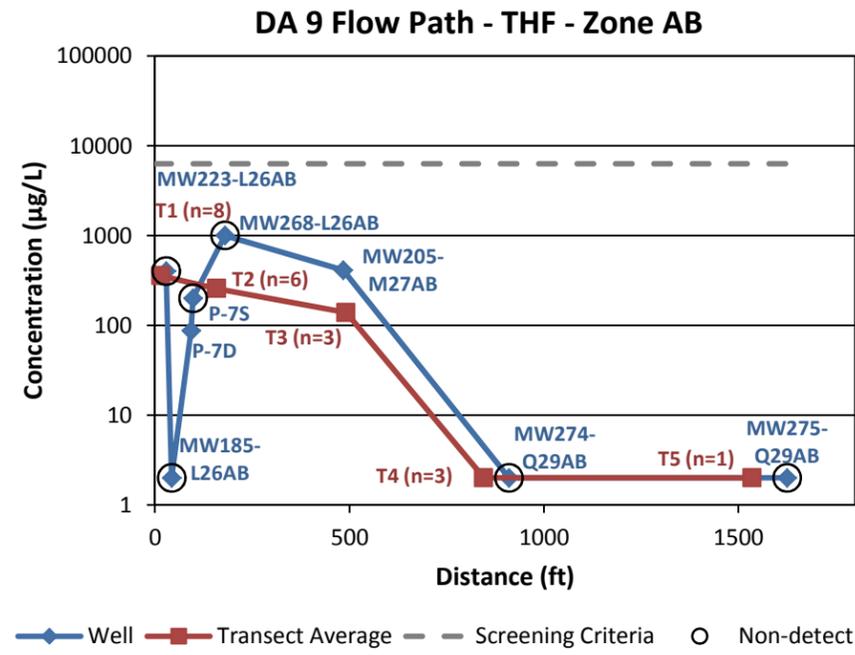
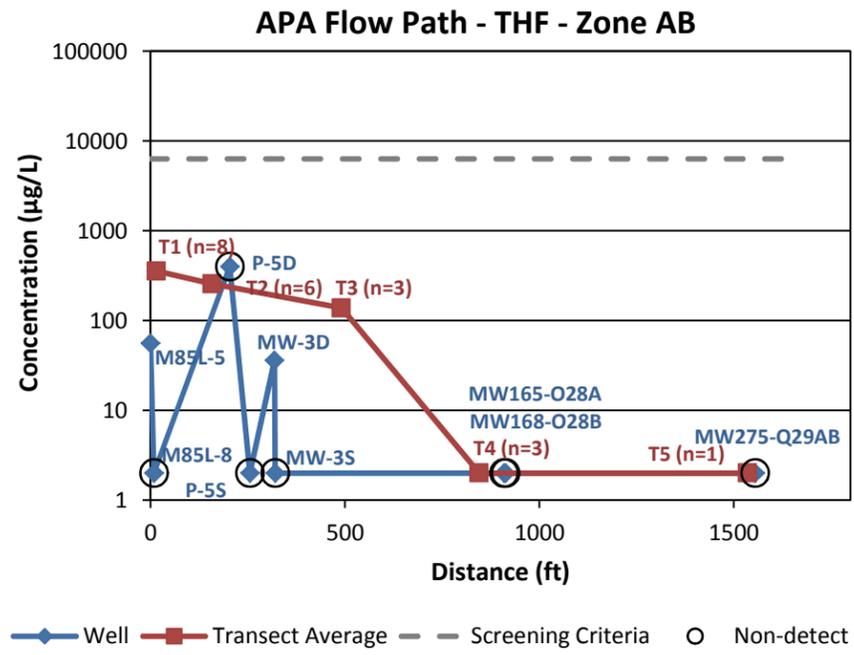
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. THF - tetrahydrofuran.

**Pre-Shutdown THF Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure  
3-14a

Kennesaw July 2016



N:\C\Chemtronics\Back Valley Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\_AB\_CD Distance Trends.xlsx\Benzene\_FlowPath 8

**Notes:**

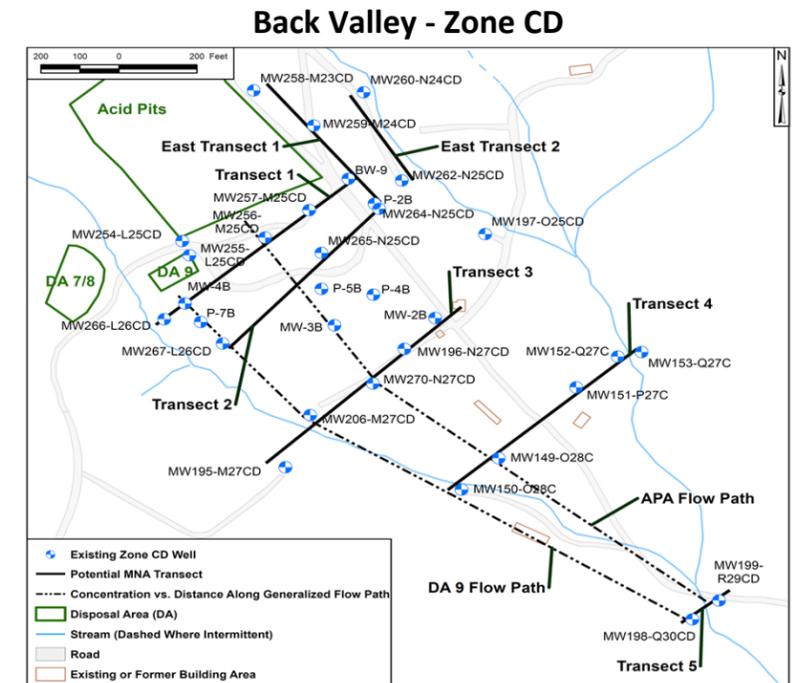
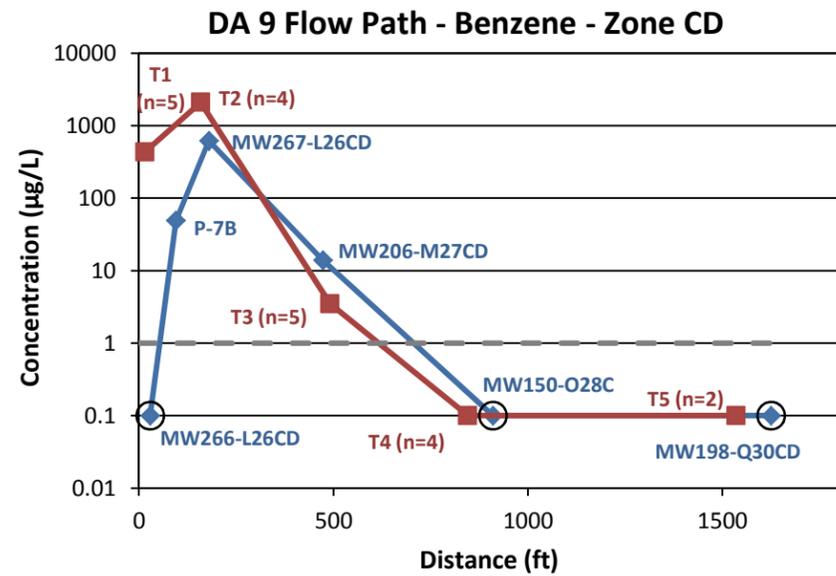
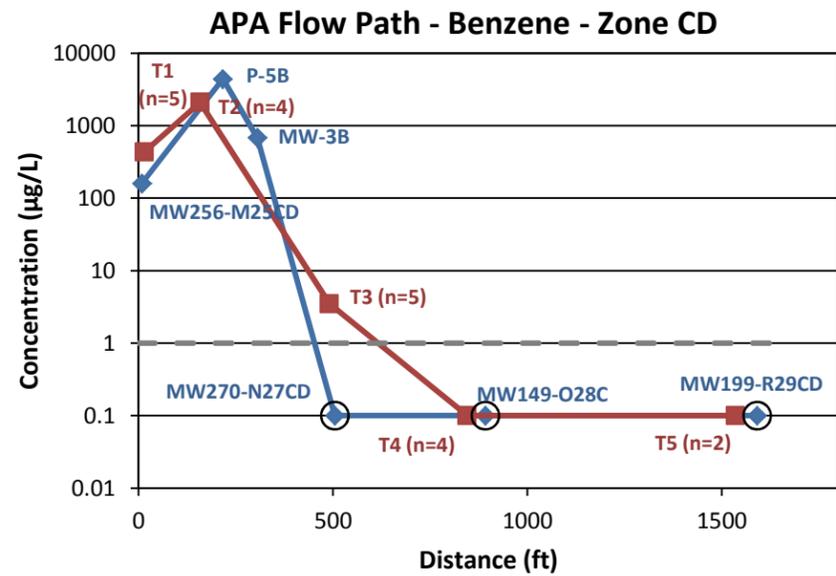
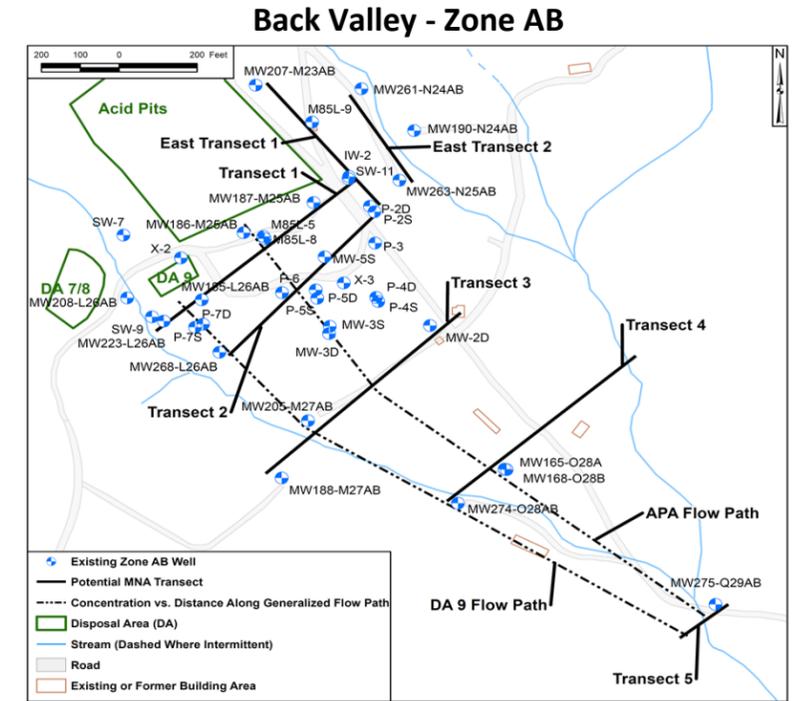
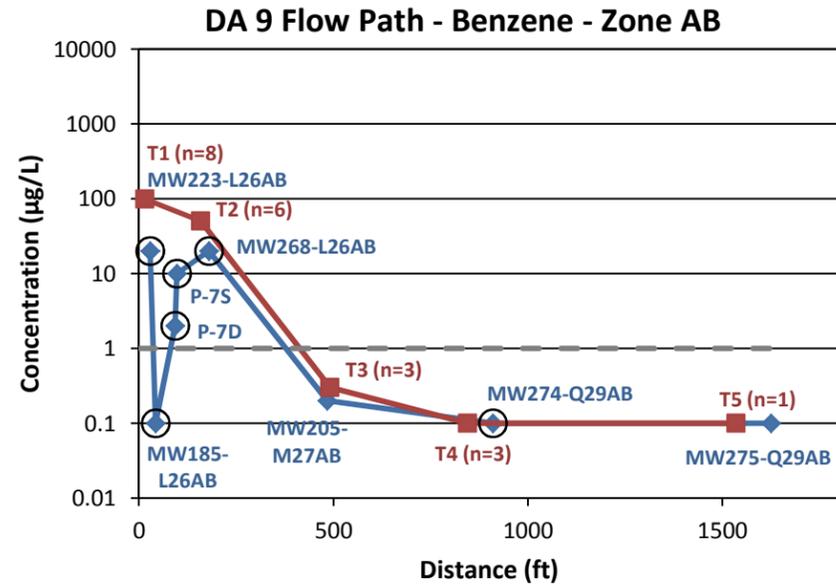
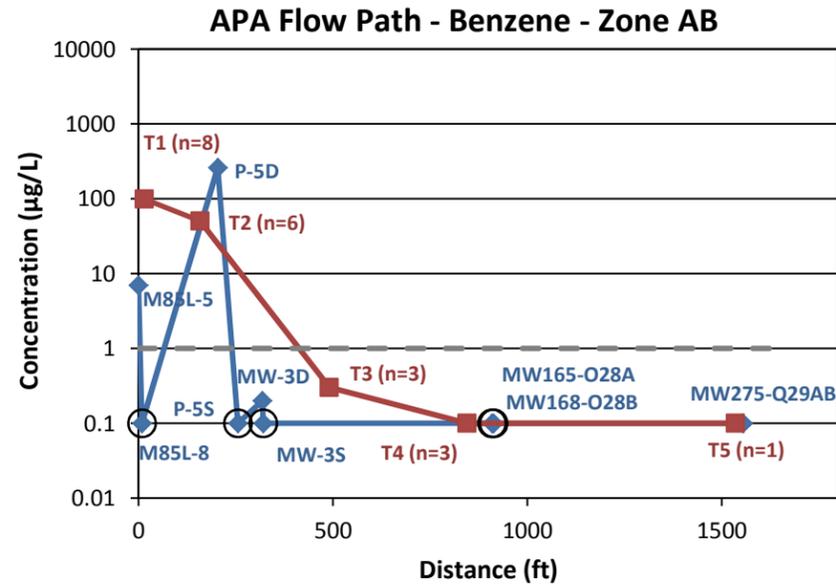
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.
7. THF - tetrahydrofuran.

**Post-Shutdown THF Concentration vs. Distance  
Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina

**Geosyntec**  
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Kennesaw      July 2016

Figure  
3-14b



**Notes:**

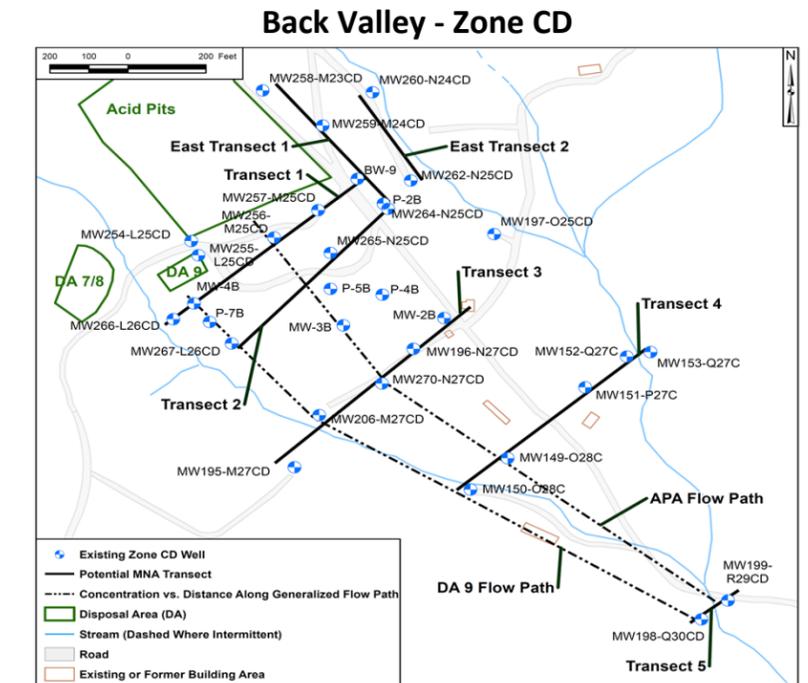
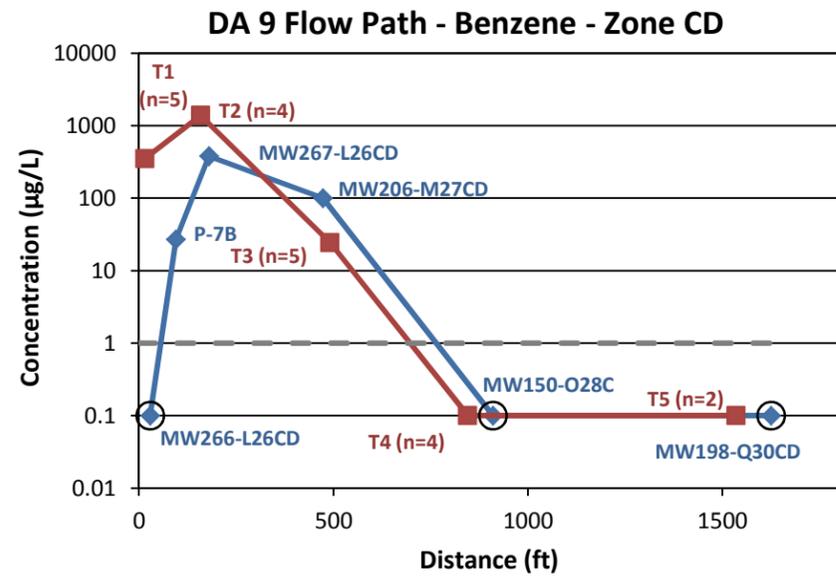
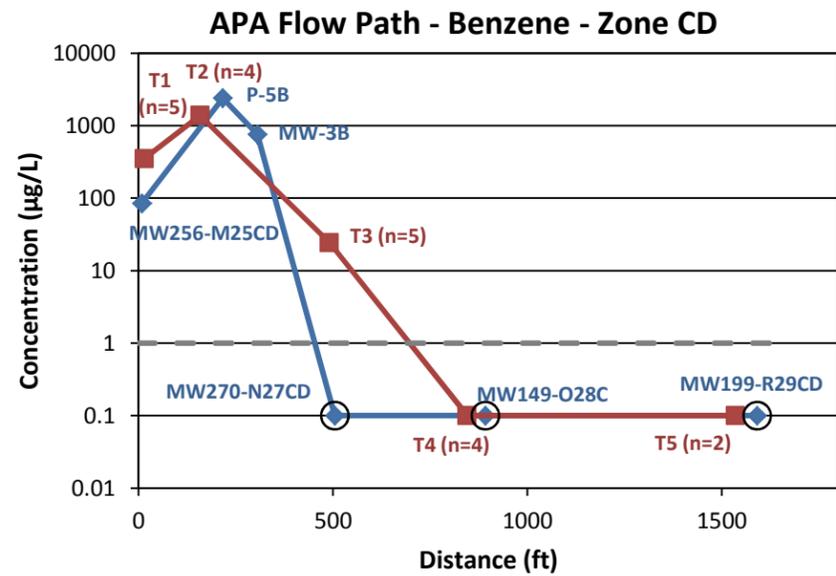
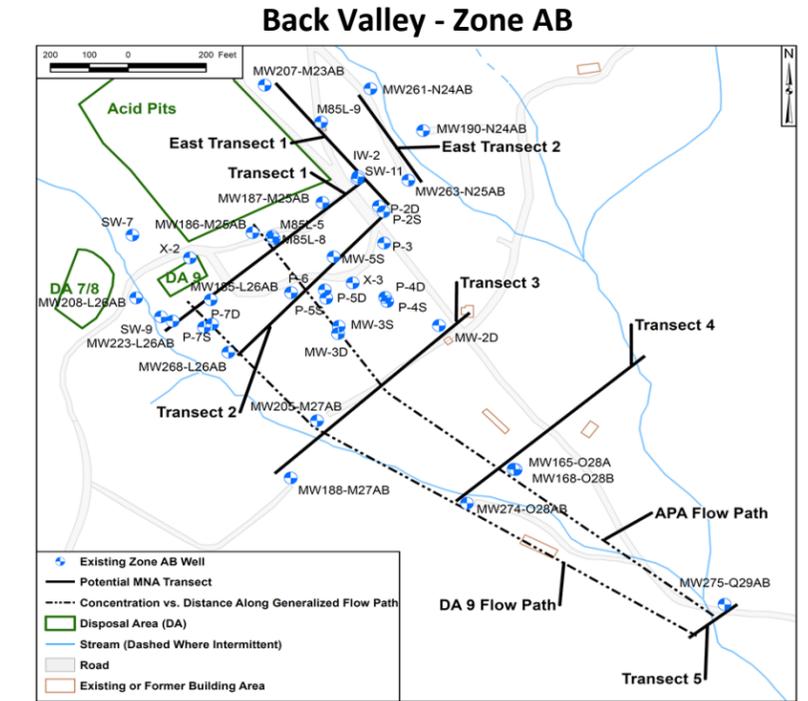
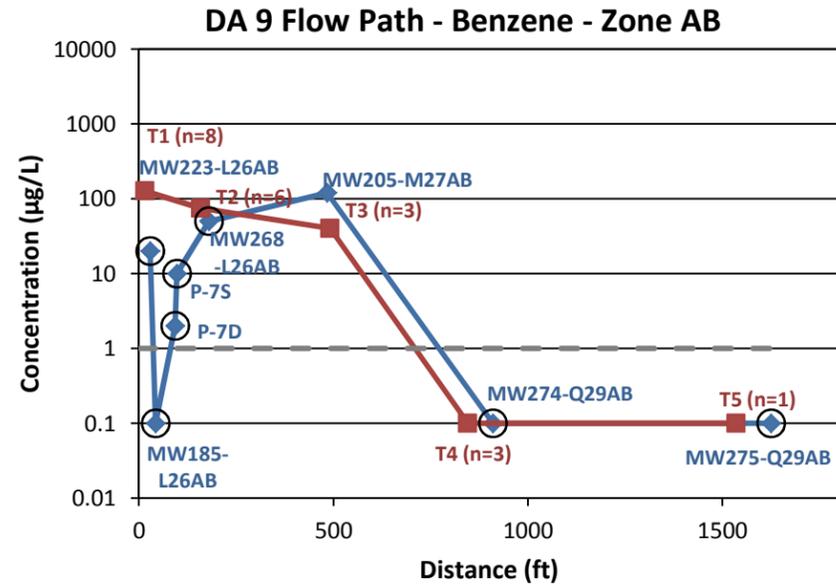
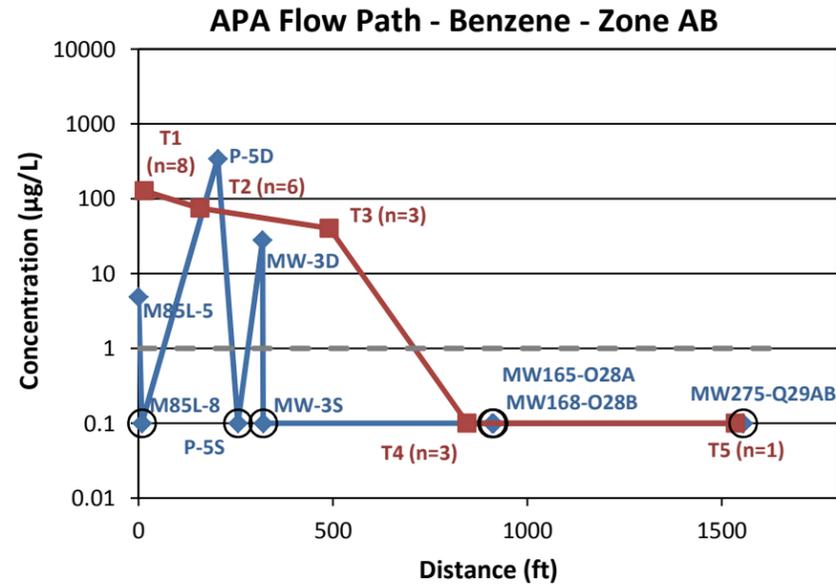
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2014. For select wells, the latest sample event occurred prior to 2014 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2014 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.

**Pre-Shutdown Benzene Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure  
3-15a

Kennesaw July 2016



N:\C\Chemtronics\Back Valley Post-Shutdown\Figures\MXD\Fig3-1 to 3-1E\_BV\_AB\_CD Distance Trends.xlsx\Benzene\_FlowPath B

**Notes:**

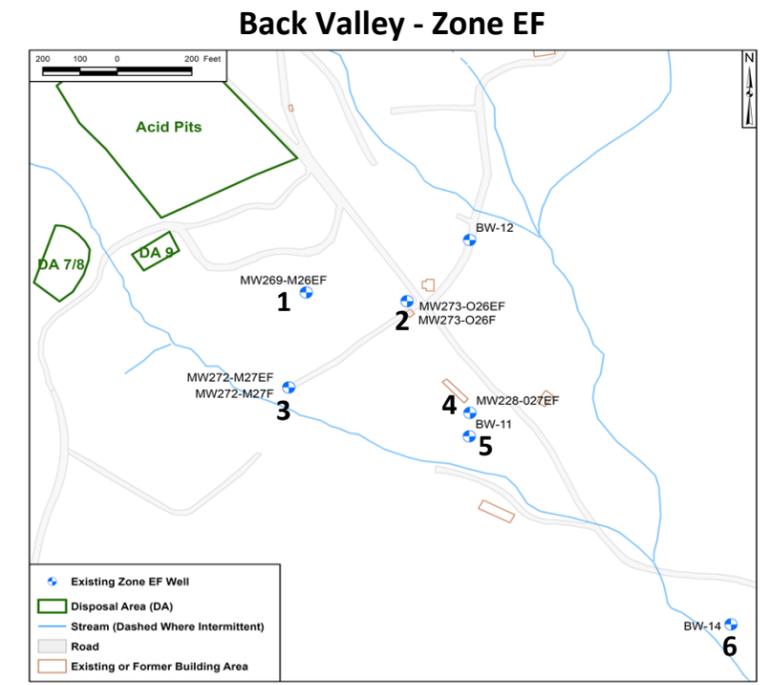
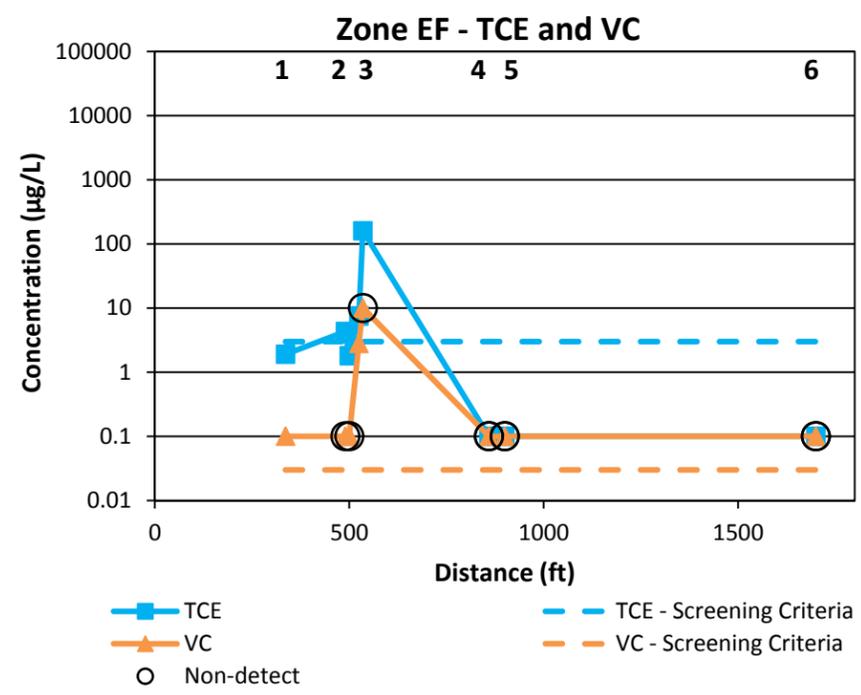
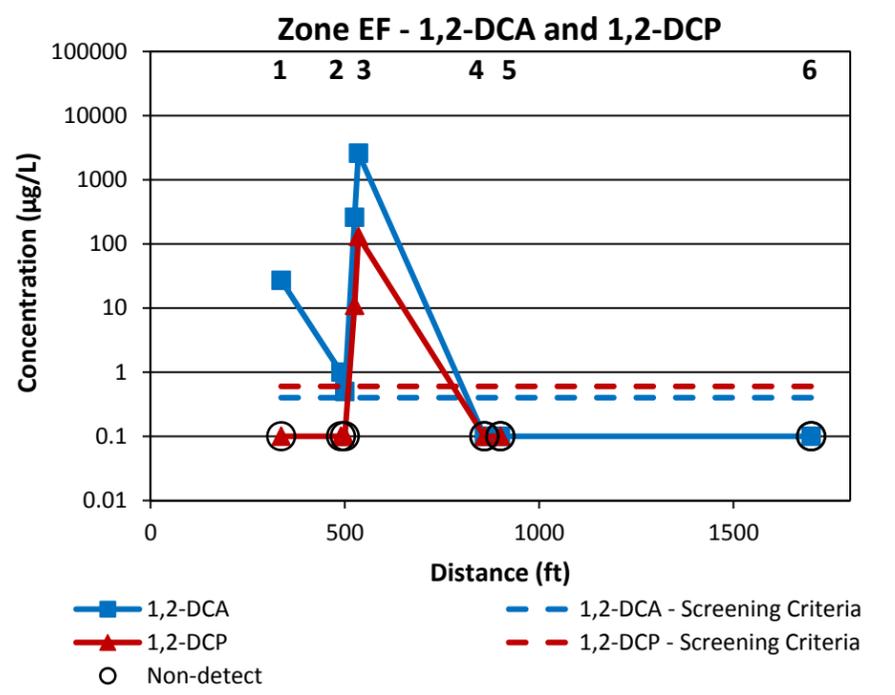
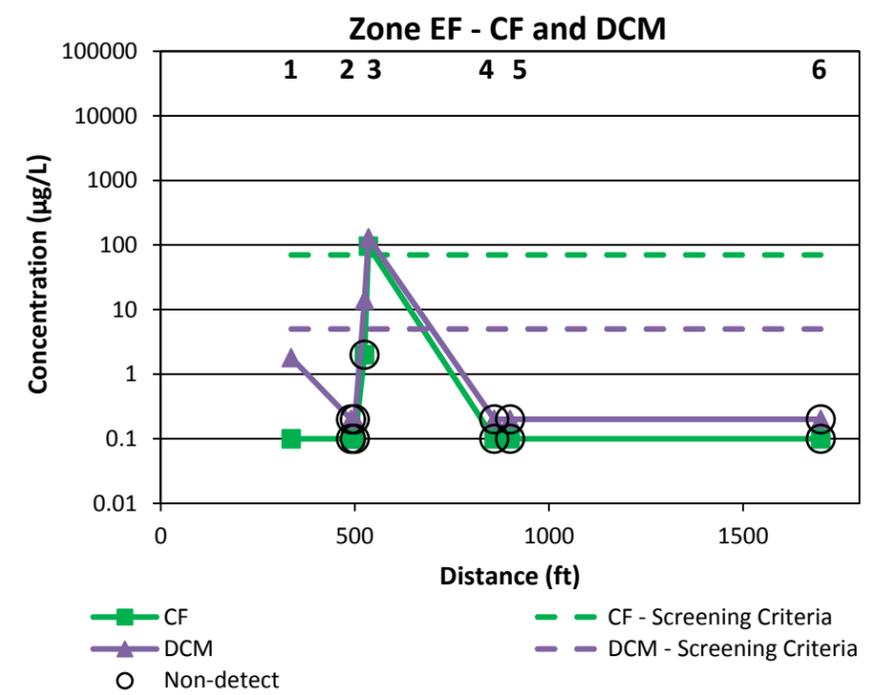
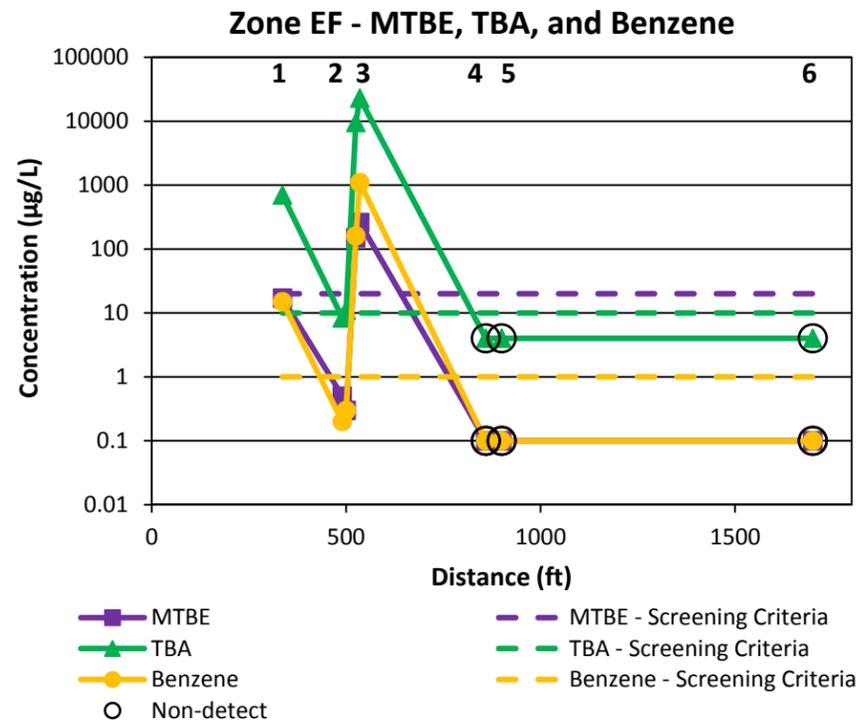
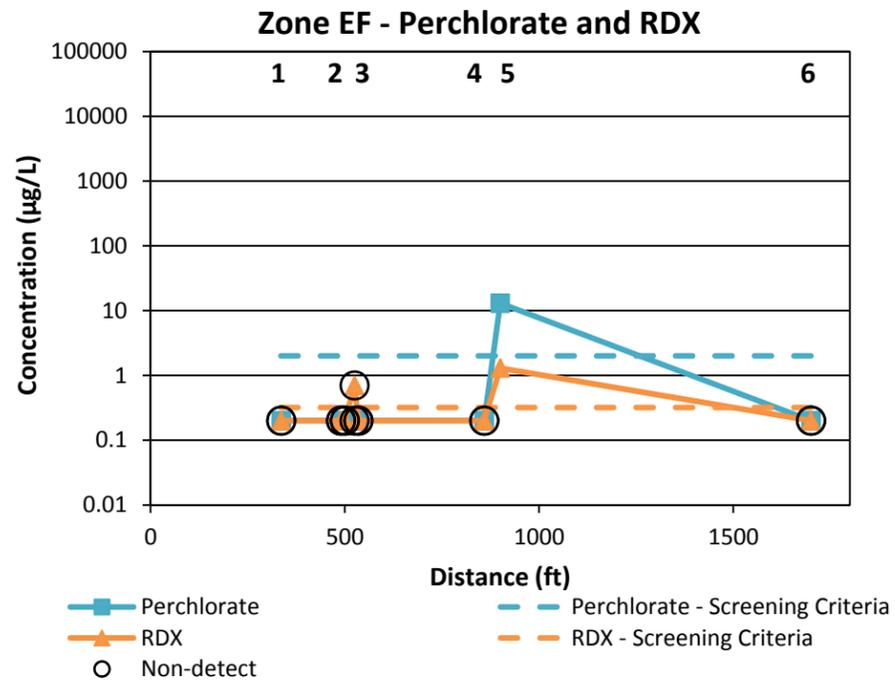
1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.
6. Individual well data represent are from 2015 for each analyte for each location, except for MW-165-O28A which was last sampled in 2008.

**Post-Shutdown Benzene Concentration vs. Distance Along Flow Paths**  
Chemtronics Site  
Swannanoa, North Carolina



Figure  
3-15b

Kennesaw July 2016



N:\C:\Chemtronics\Back Valley\Pre-Shutdown\Figures\MDA\Fig 3-16\_BV\_Zone EF Trend.kmz\ZoneEF\_FlowPath\_A

**Notes:**

1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Only Monitored Natural Attenuation (MNA) Target Compounds (TCs) with exceedances in Zone EF are shown.
5. MNA TC abbreviations:  
 RDX - Research Department Explosive      MTBE - methyl-tert-butyl ether      TBA - tert-butyl alcohol  
 1,2-DCA - 1,2-dichloroethane              1,2-DCP - 1,2-dichloropropane      TCE - trichloroethene  
 VC - vinyl chloride                              CF - chloroform

6. Zone EF wells locations are noted in each panel as follows:

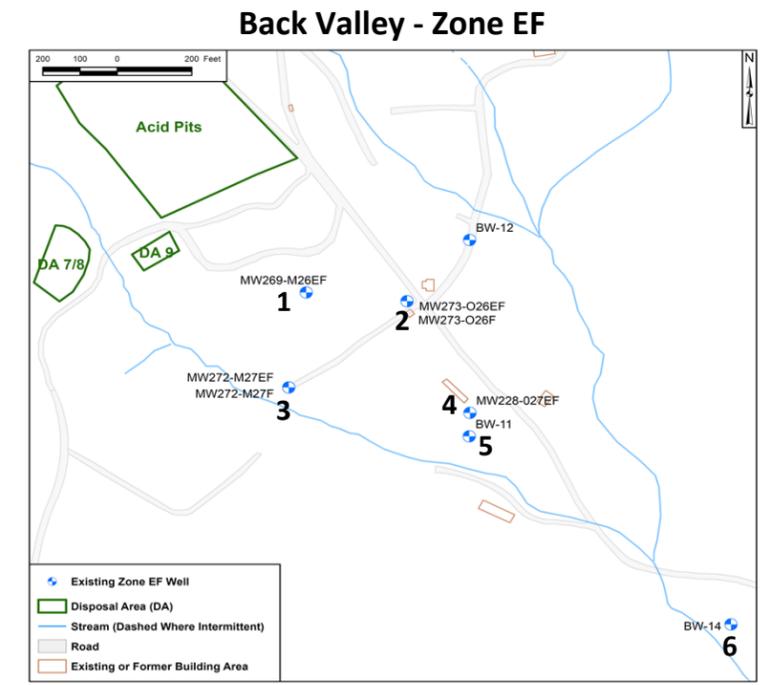
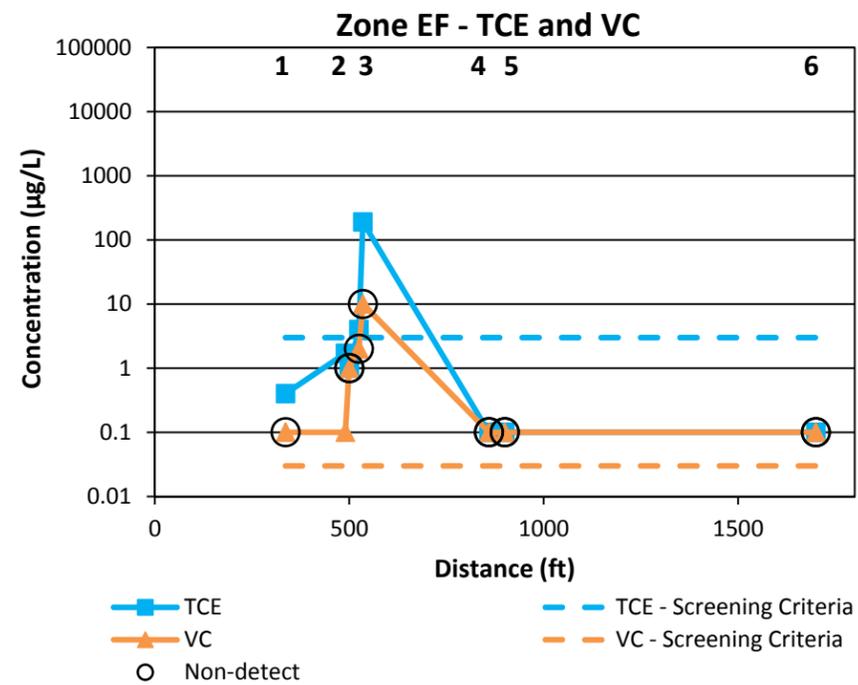
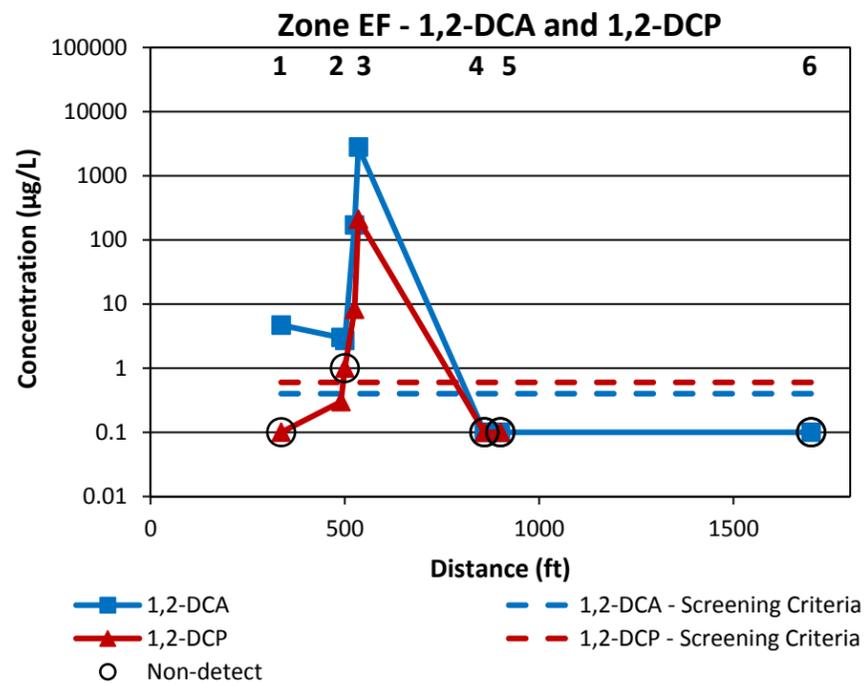
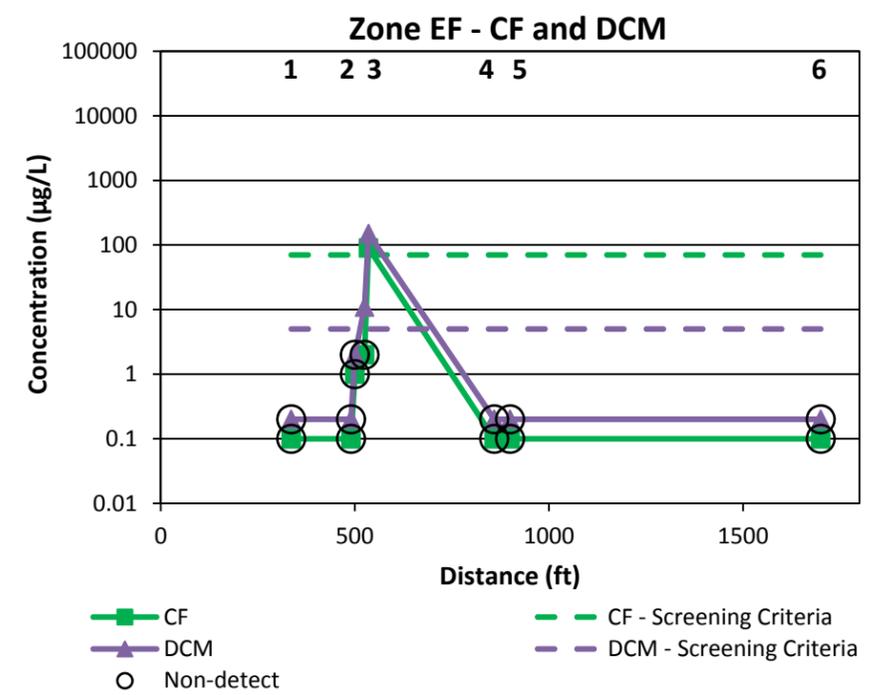
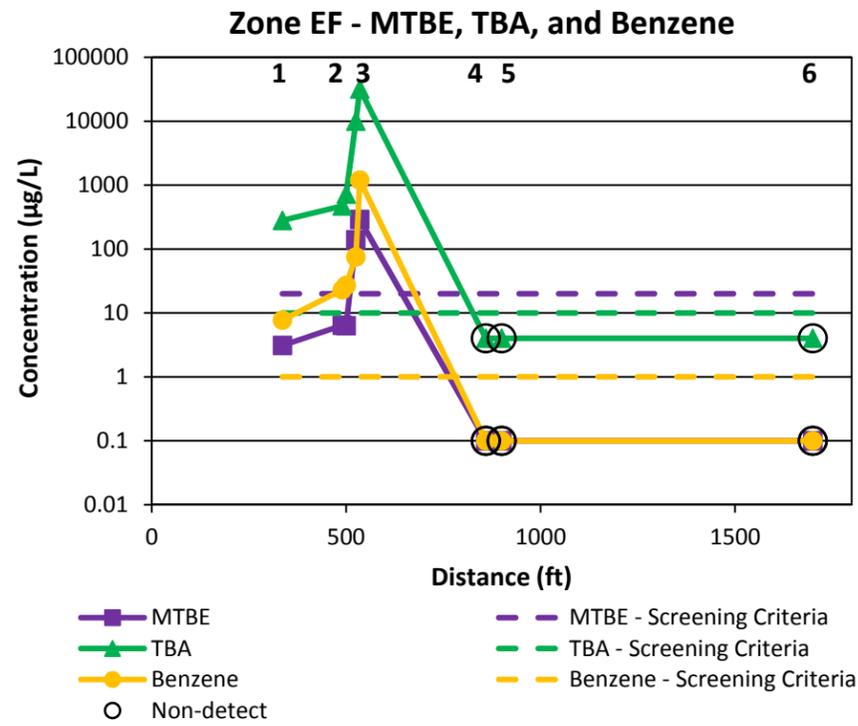
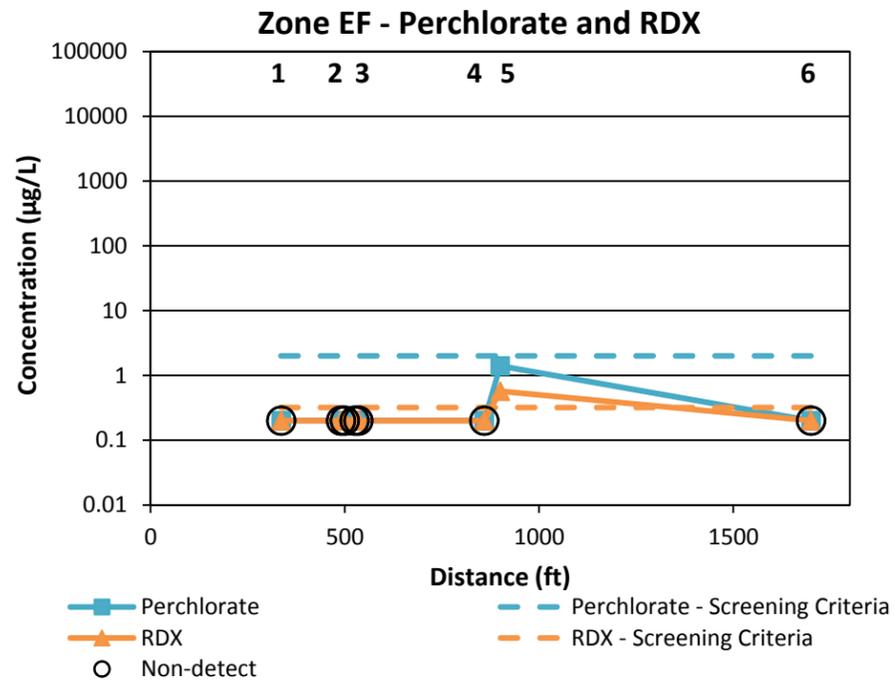
- 1 - MW269-M26EF
- 2 - MW273-O26EF & MW273-O26F (data from both wells are displayed on the trend graphs)
- 3 - MW272-O26EF & MW272-O26E (data from both wells are displayed on the trend graphs)
- 4 - MW228-O27EF
- 5 - BW-11
- 6 - BW-14

**Zone EF Pre-Shutdown Concentrations vs. Distance from  
APA - Select MNA TCs  
Chemtronics Site  
Swannanoa, North Carolina**

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Figure  
3-16a



N:\C:\Chemtronics\Back Valley\Post-Shutdown\Figures\MDA\Fig 3-16\_BV\_Zone EF Trend.kmz\ZoneEF\_FlowPath\_A

**Notes:**

1. µg/L – micrograms per liter.
2. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
3. Non-detects are displayed at the method detection limit (MDL).
4. Only Monitored Natural Attenuation (MNA) Target Compounds (TCs) with exceedances in Zone EF are shown.
5. MNA TC abbreviations:  
 RDX - Research Department Explosive  
 1,2-DCA - 1,2-dichloroethane  
 VC - vinyl chloride  
 MTBE - methyl-tert-butyl ether  
 1,2-DCP - 1,2-dichloropropane  
 CF - chloroform  
 TBA - tert-butyl alcohol  
 TCE - trichloroethene  
 DCM - dichloromethane

6. Zone EF wells locations are noted in each panel as follows:

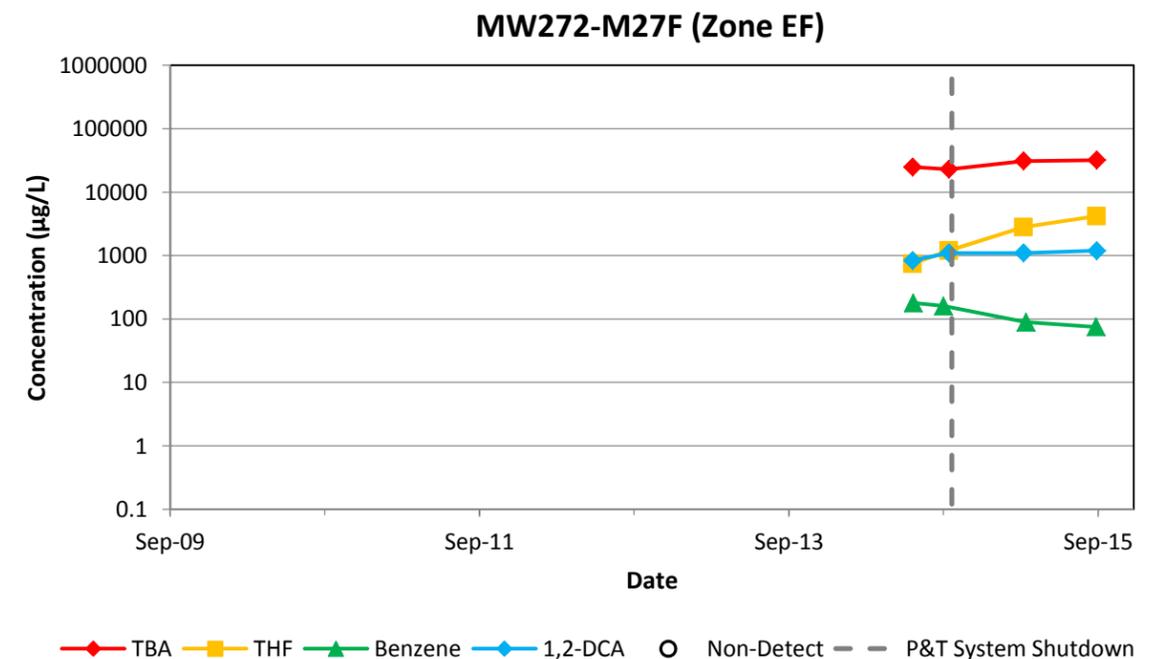
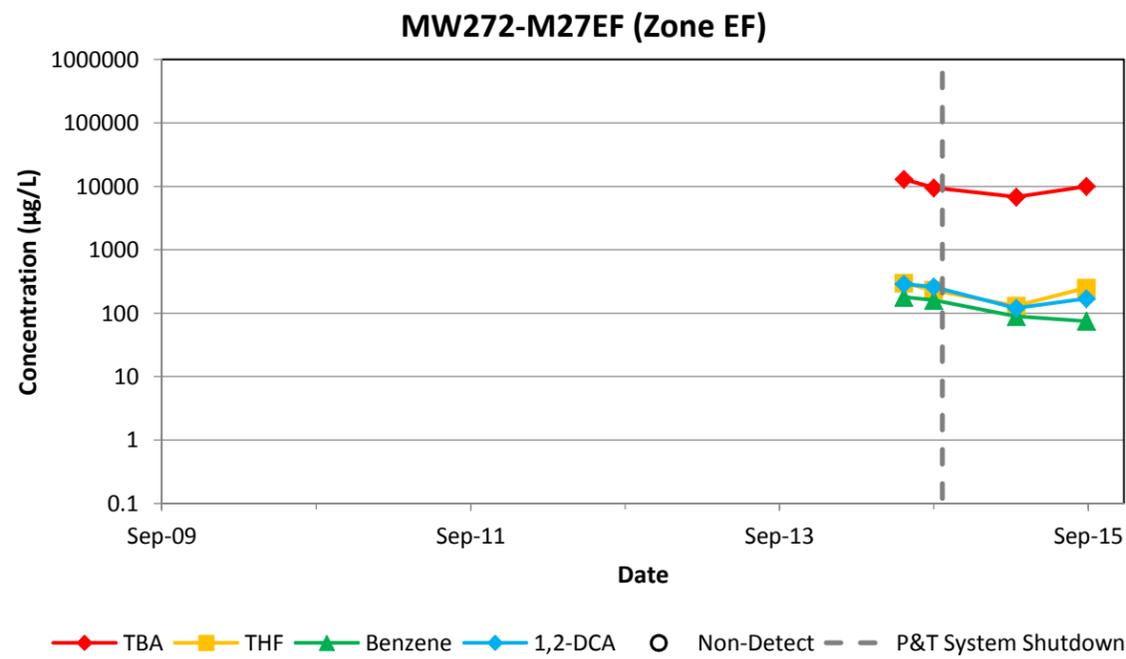
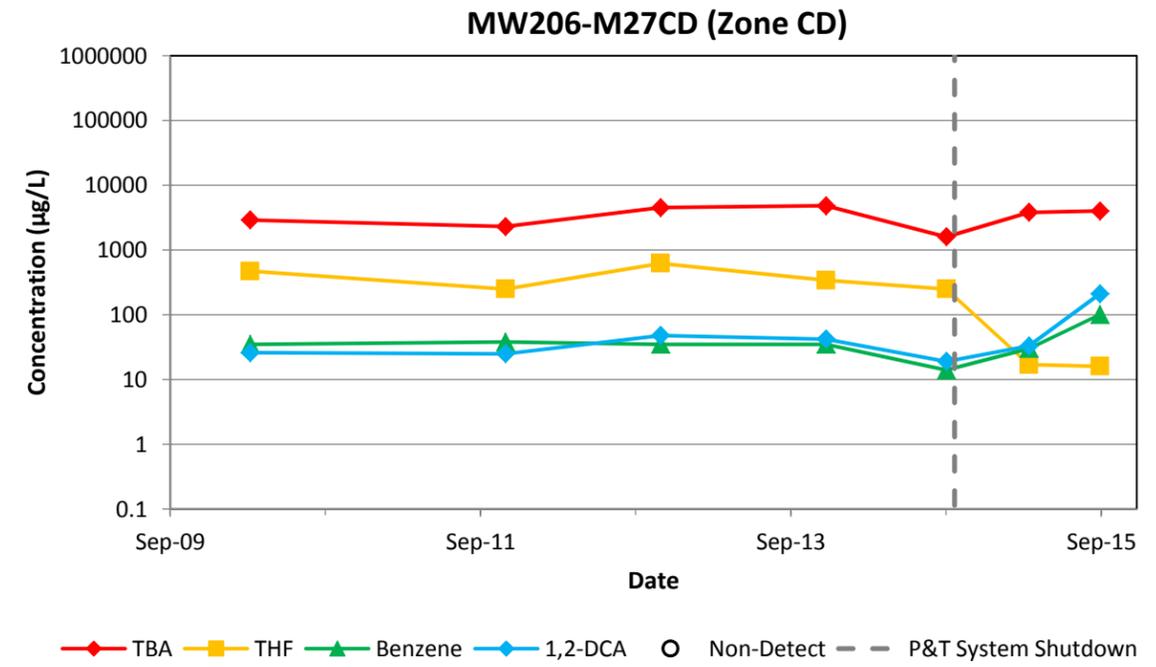
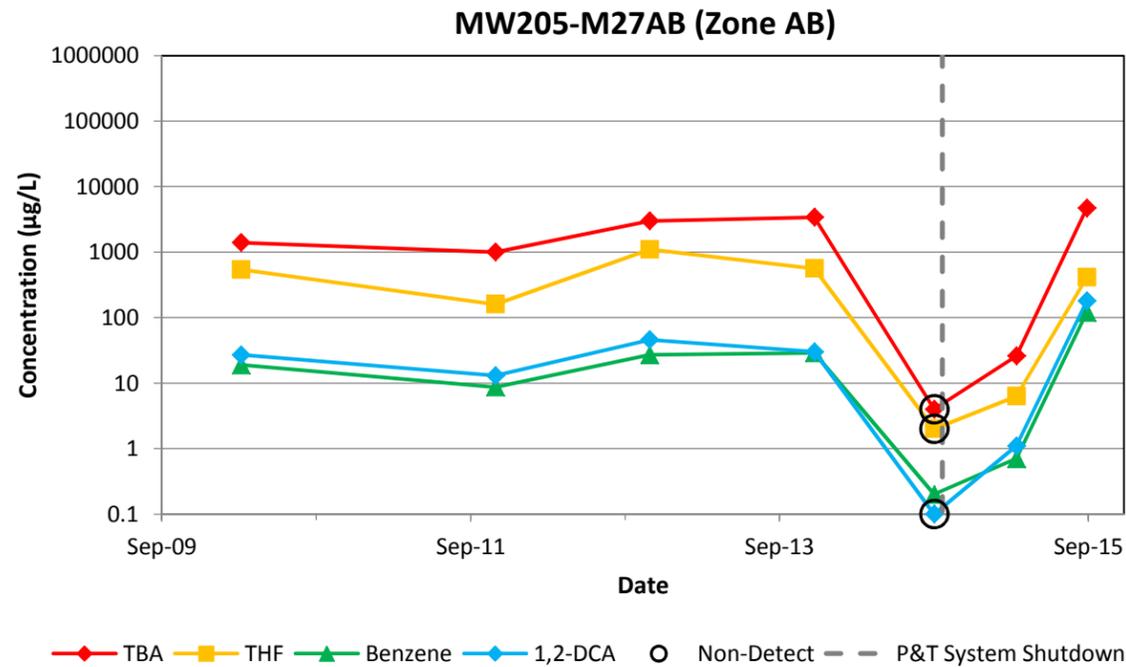
- 1 - MW269-M26EF
- 2 - MW273-O26EF & MW273-O26F (data from both wells are displayed on the trend graphs)
- 3 - MW272-O26EF & MW272-O26E (data from both wells are displayed on the trend graphs)
- 4 - MW228-O27EF
- 5 - BW-11
- 6 - BW-14

**Zone EF Post-Shutdown Concentrations vs. Distance from**  
**APA - Select MNA TCs**  
 Chemtronics Site  
 Swannanoa, North Carolina

**Geosyntec**  
 consultants

Kennesaw July 2016

Figure 3-16b



**Notes:**

- MNA TCs - Monitored Natural Attenuation Target Compounds.
- µg/L - micrograms per liter.
- TBA - tert-butyl alcohol.
- THF - tetrahydrofuran.
- 1,2-DCA - 1,2-dichloroethane.
- For reference, the screening criteria (North Carolina 2L or IMAC groundwater standards) are 10 µg/L for TBA, 6300 µg/L for THF, 1 µg/L for benzene, and 0.4 µg/L for 1,2-DCA.
- Non-detects are displayed at the method detection limit (MDL).

**Time Trends for Select MNA TCs at MW205-M27AB, MW206-M27CD, MW272-M27EF, and MW272-M27F**  
Chemtronics Site  
Swannanoa, North Carolina

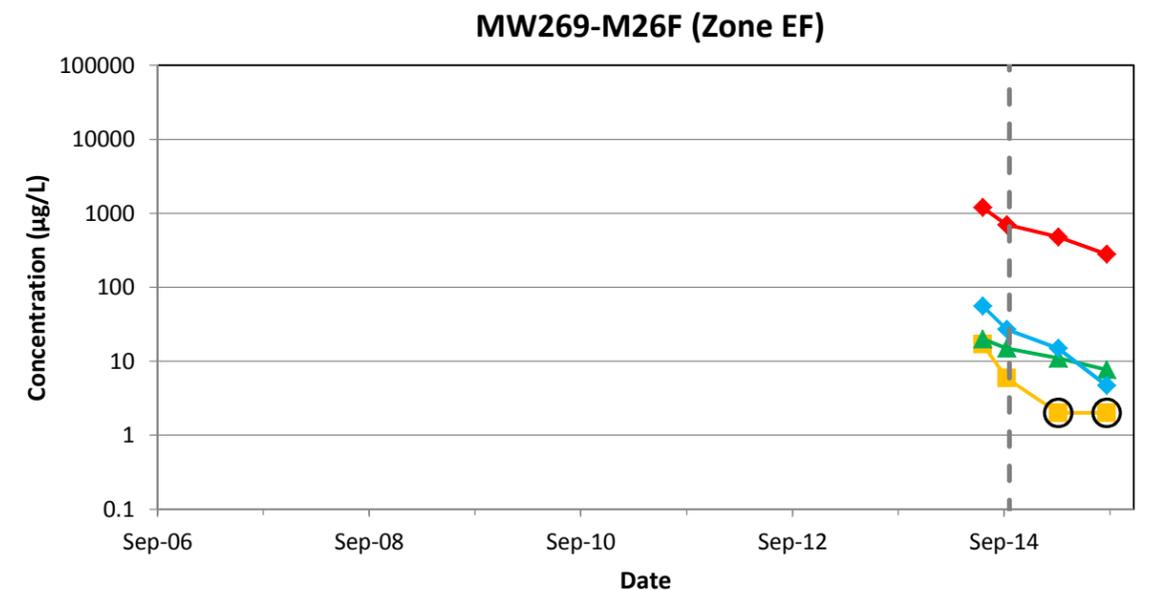
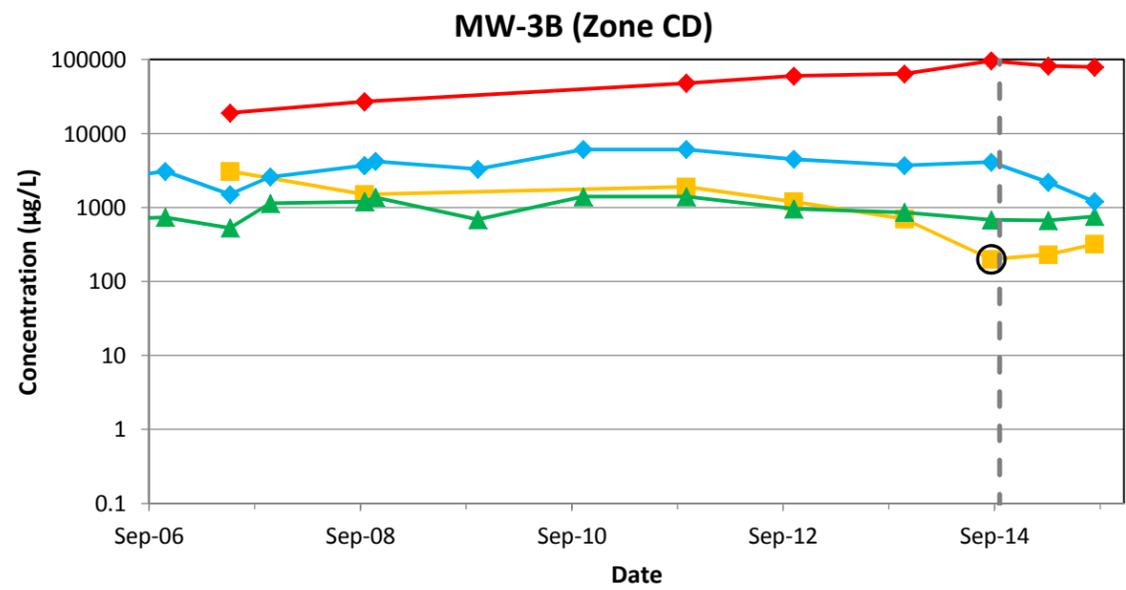
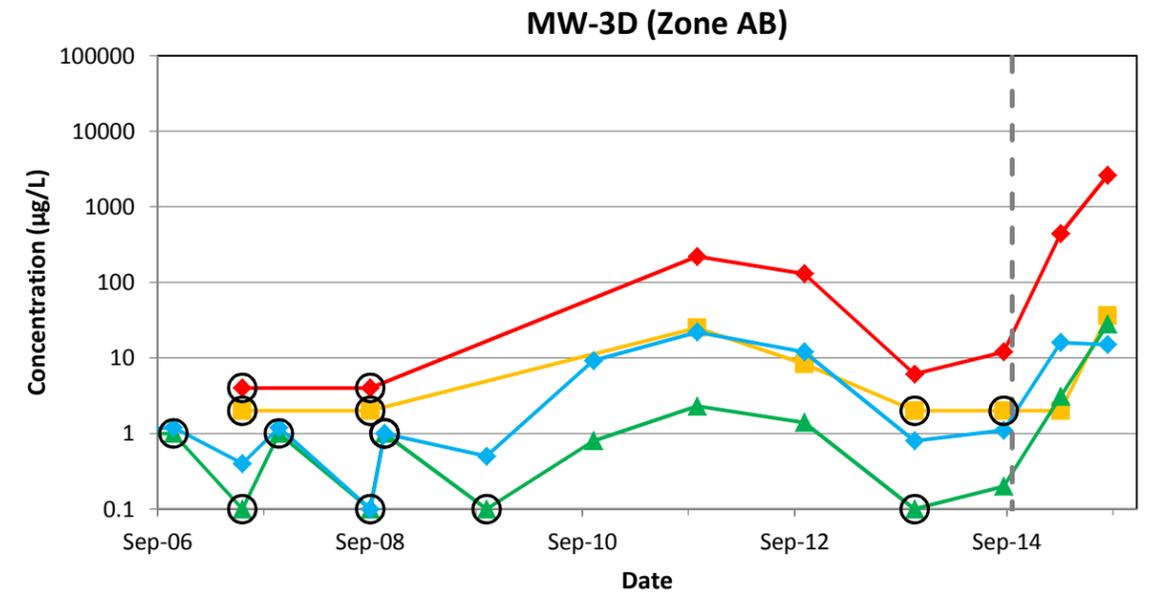
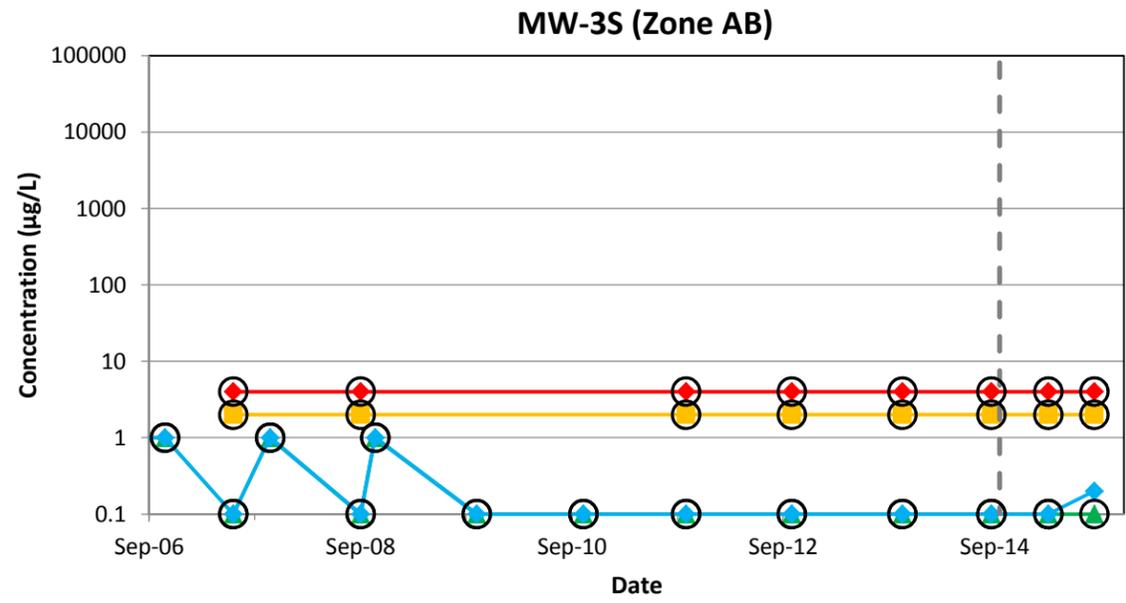


Figure

4a

Kennesaw

July 2016



**Notes:**

- MNA TCs - Monitored Natural Attenuation Target Compounds.
- µg/L - micrograms per liter.
- TBA - tert-butyl alcohol.
- THF - tetrahydrofuran.
- 1,2-DCA - 1,2-dichloroethane.
- For reference, the screening criteria (North Carolina 2L or IMAC groundwater standards) are 10 µg/L for TBA, 6300 µg/L for THF, 1 µg/L for benzene, and 0.4 µg/L for 1,2-DCA.
- Non-detects are displayed at the method detection limit (MDL).

**Time Trends for Select MNA TCs at MW-3S, MW-3D, MW-3B, and MW269-M26F**  
Chemtronics Site  
Swannanoa, North Carolina

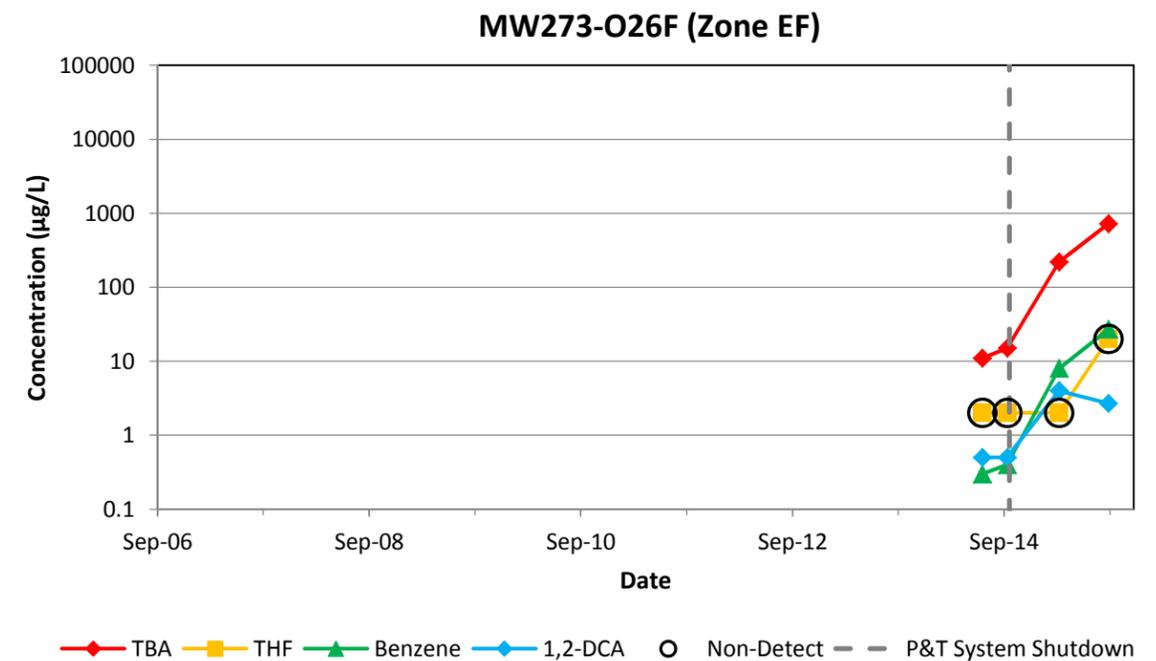
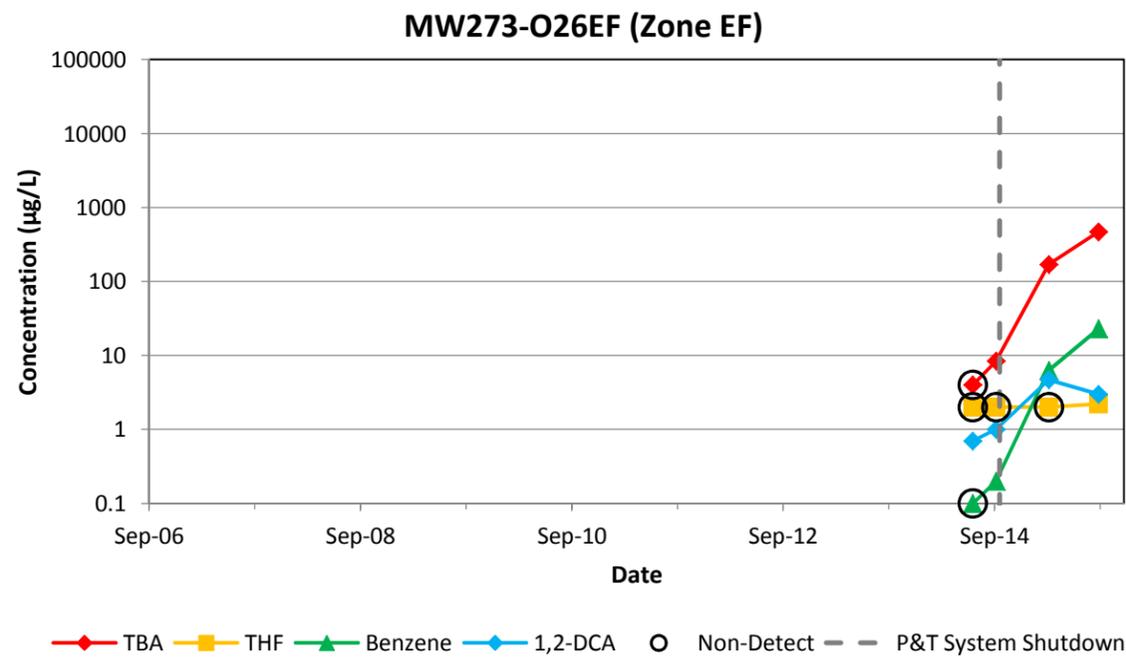
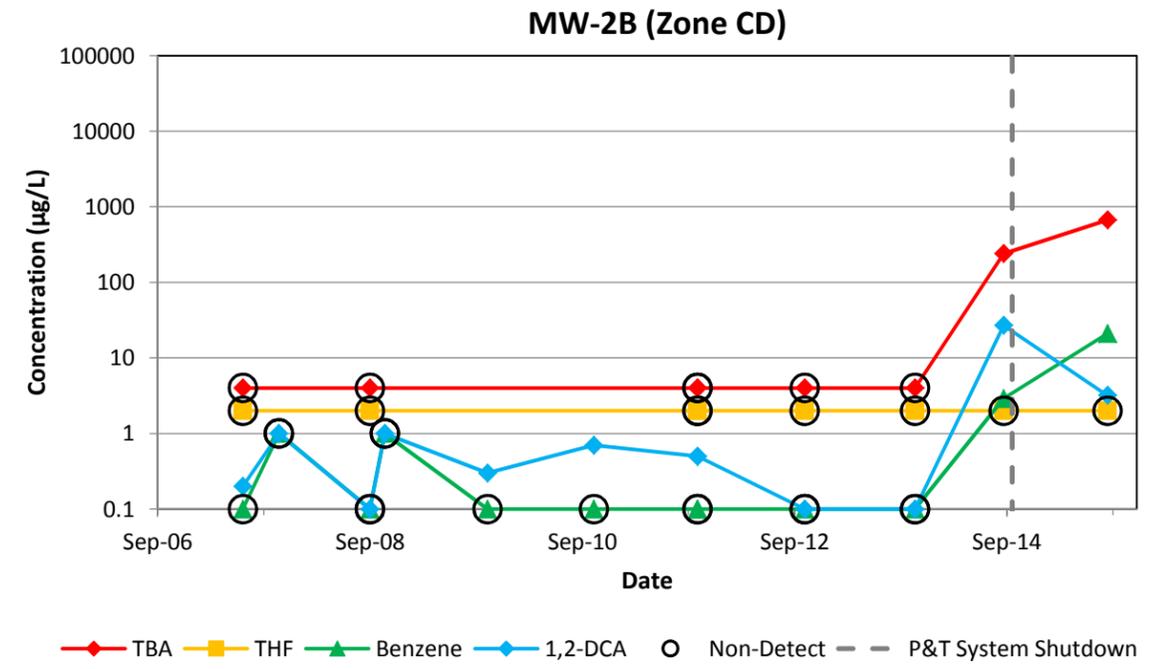
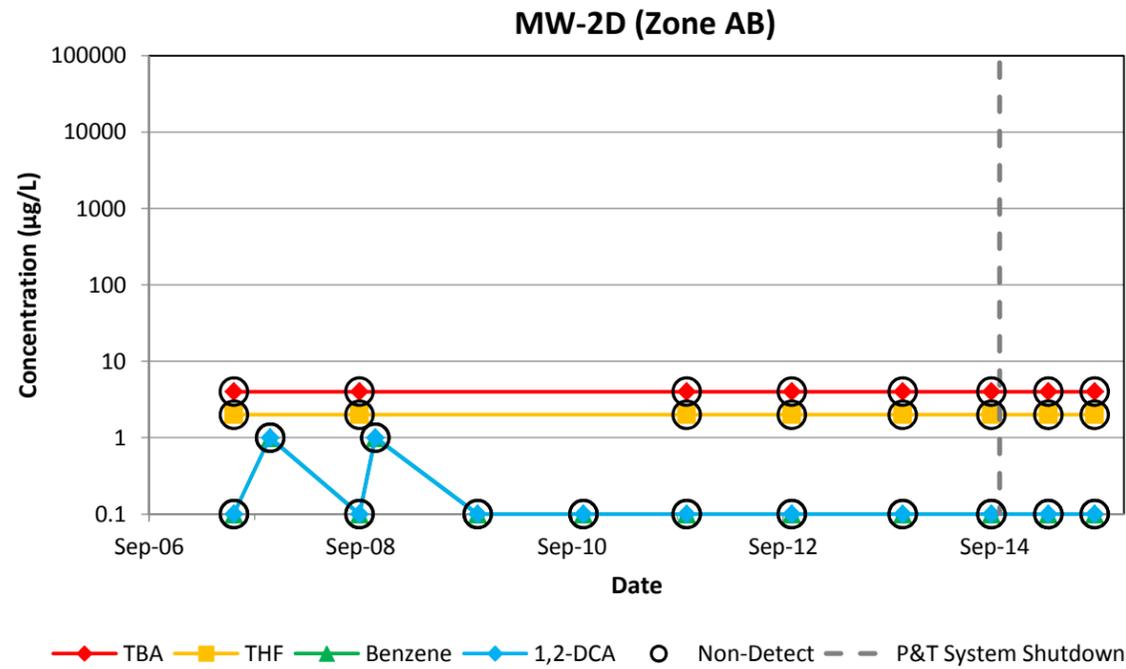


Figure  
4b

Kennesaw

July 2016

N:\C\Chemtronics\MNA\Barck Valley\Post-Shutdown\Figures\MXD\Fig4\_Time Trends for Select Works.xlsx Time Trend - MW3S - MW273



**Notes:**

- MNA TCs - Monitored Natural Attenuation Target Compounds.
- µg/L - micrograms per liter.
- TBA - tert-butyl alcohol.
- THF - tetrahydrofuran.
- 1,2-DCA - 1,2-dichloroethane.
- For reference, the screening criteria (North Carolina 2L or IMAC groundwater standards) are 10 µg/L for TBA, 6300 µg/L for THF, 1 µg/L for benzene, and 0.4 µg/L for 1,2-DCA.
- Non-detects are displayed at the method detection limit (MDL).

**Time Trends for Select MNA TCs at MW-2D, MW-2B, MW273-O26EF, and M273-O26F**  
Chemtronics Site  
Swannanoa, North Carolina



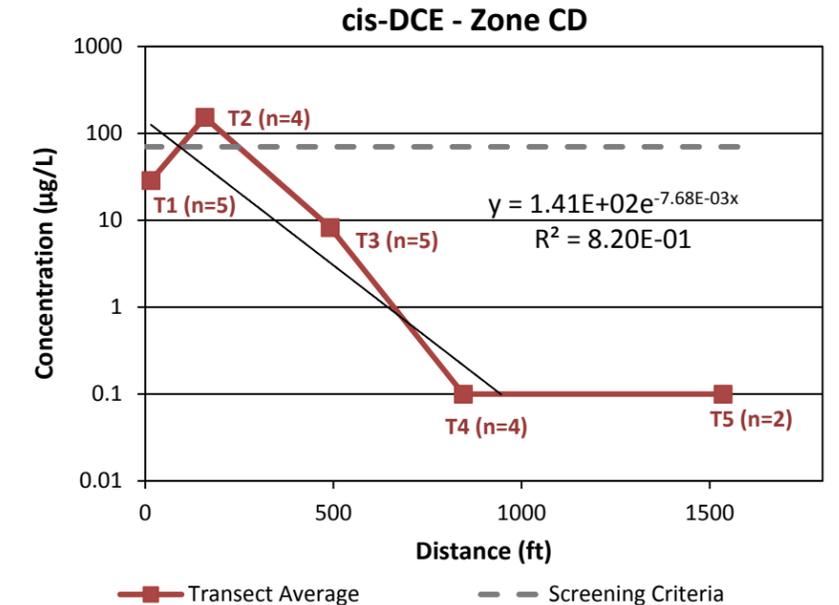
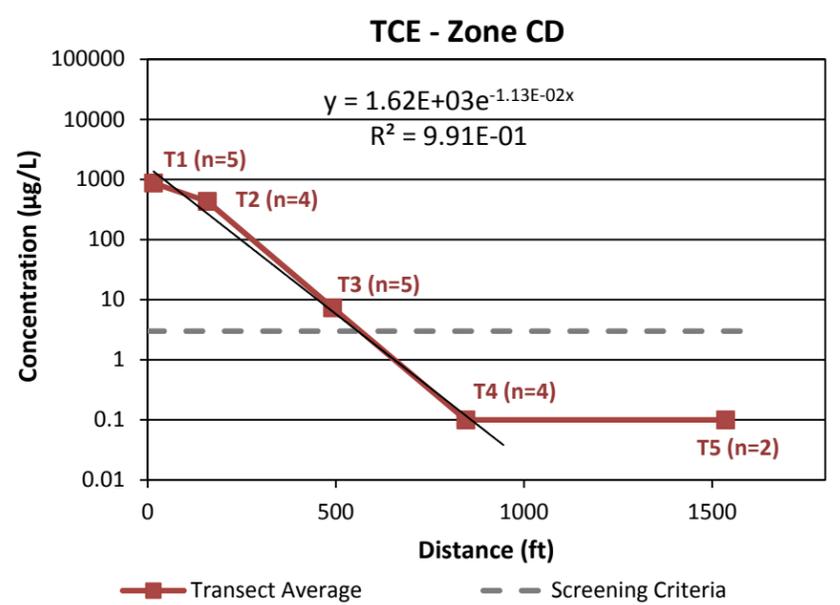
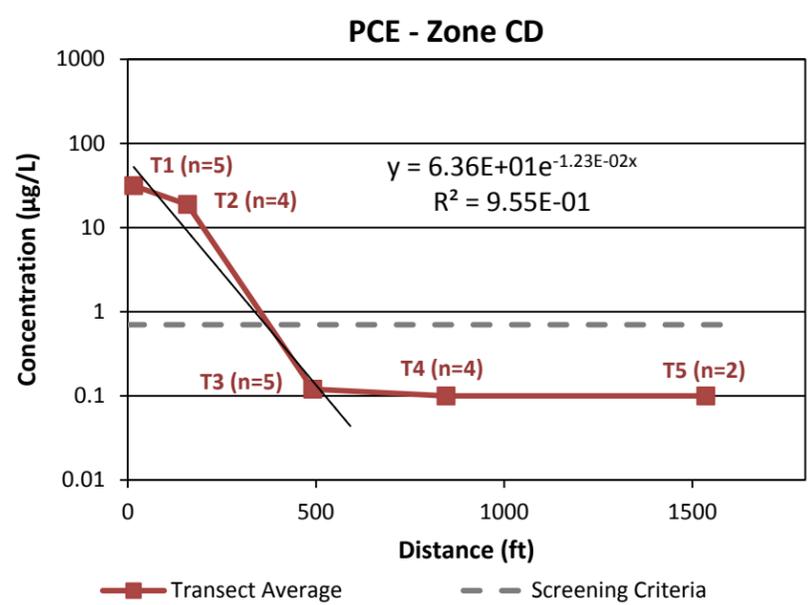
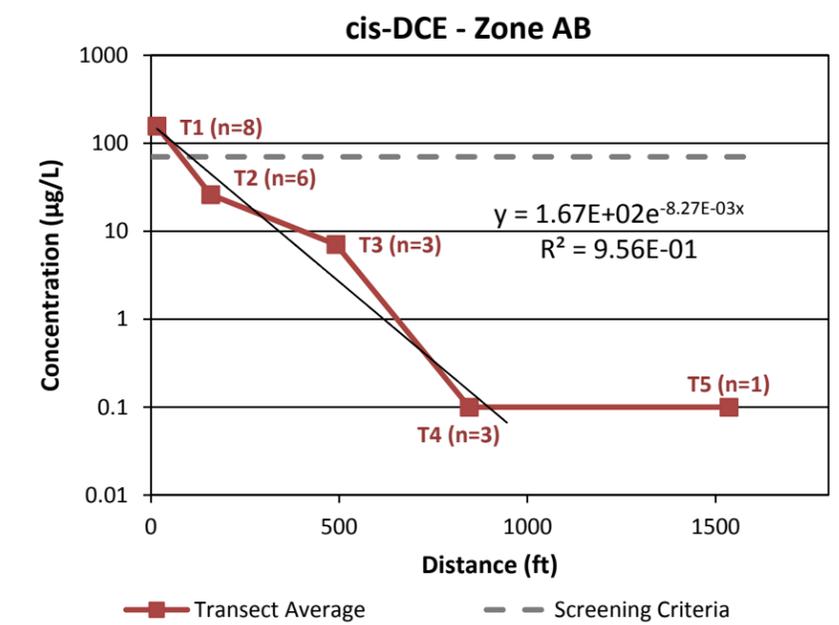
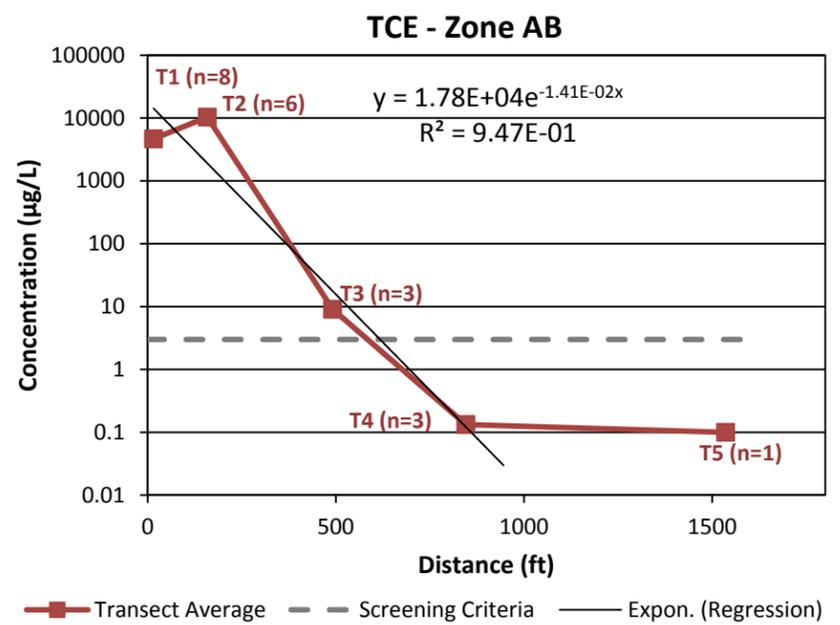
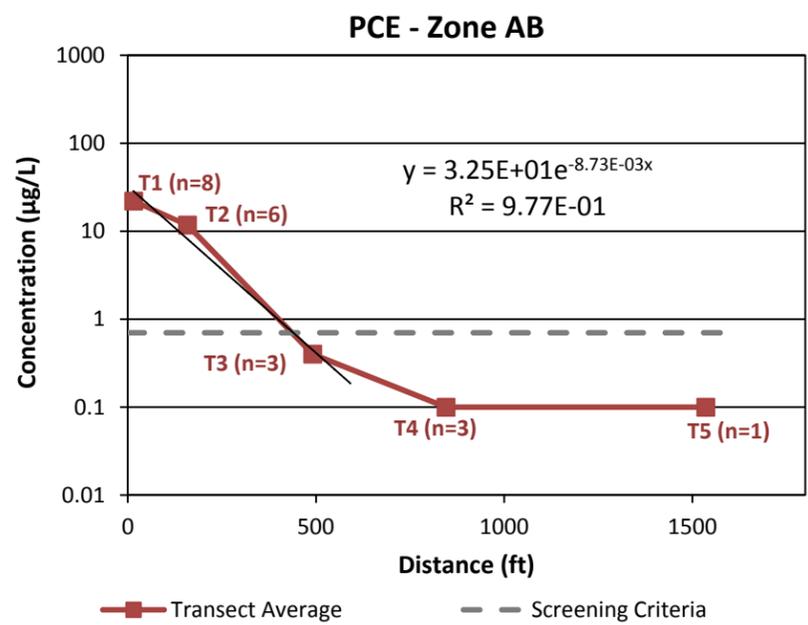
Figure  
4c

Kennesaw

July 2016

N:\C\Chemtronics\MNA\Back Valley\Post-Shutdown\Figures\MXD\Fig4\_Time Trends for Select MNA TCs at MW-2D, MW-2B, MW273-O26EF, and M273-O26F

N:\VC\Chemtronics\WMA\Black Valley\Post-Shutdown\Figures\Regression Figures\Fig5\_Regression Figures.xlsx\Fig5\_PCE\_TCE\_cis-DCE



**Notes:**

1. PCE - tetrachloroethene; TCE - trichloroethene; cis-DCE - 1,2-cis-dichloroethene
2. µg/L – micrograms per liter.
3. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-028A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.

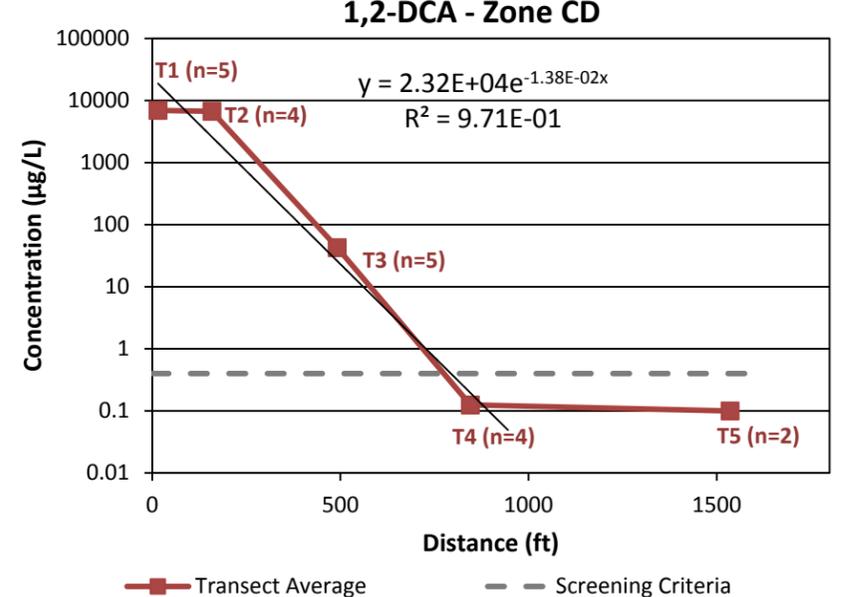
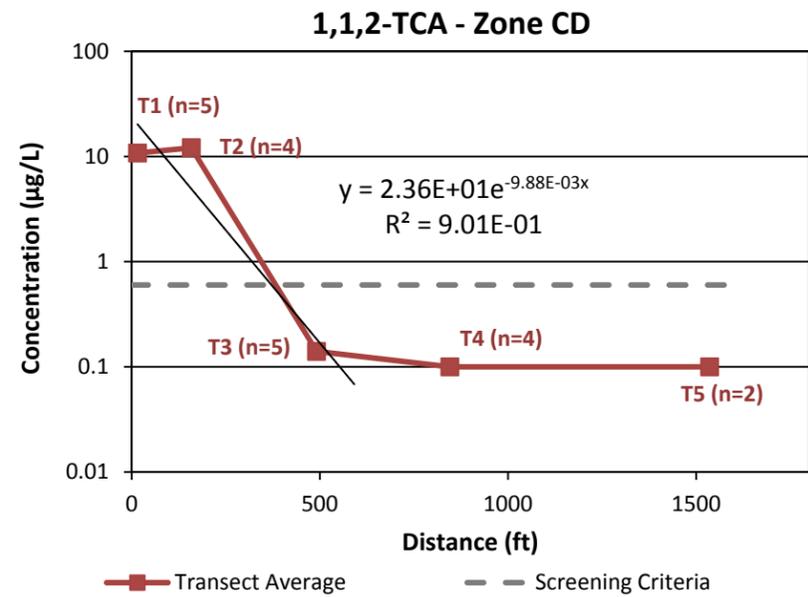
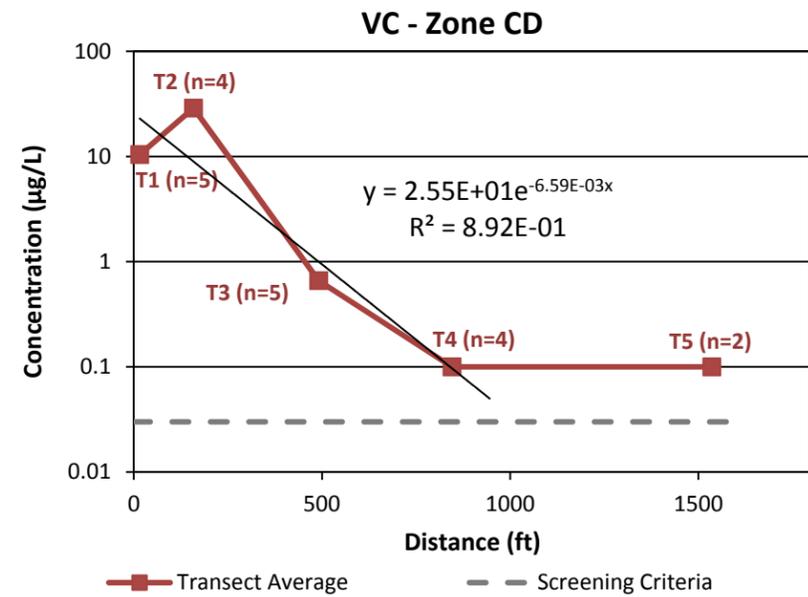
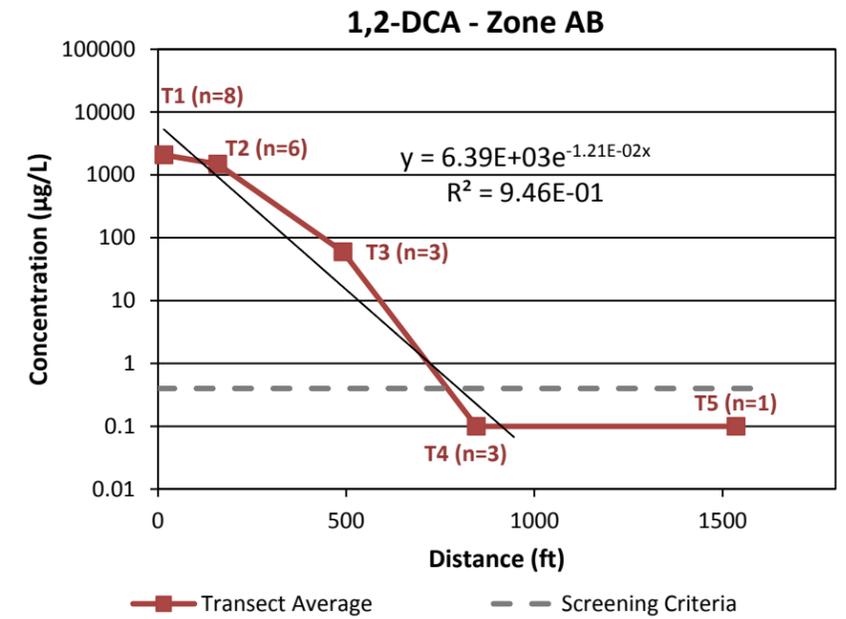
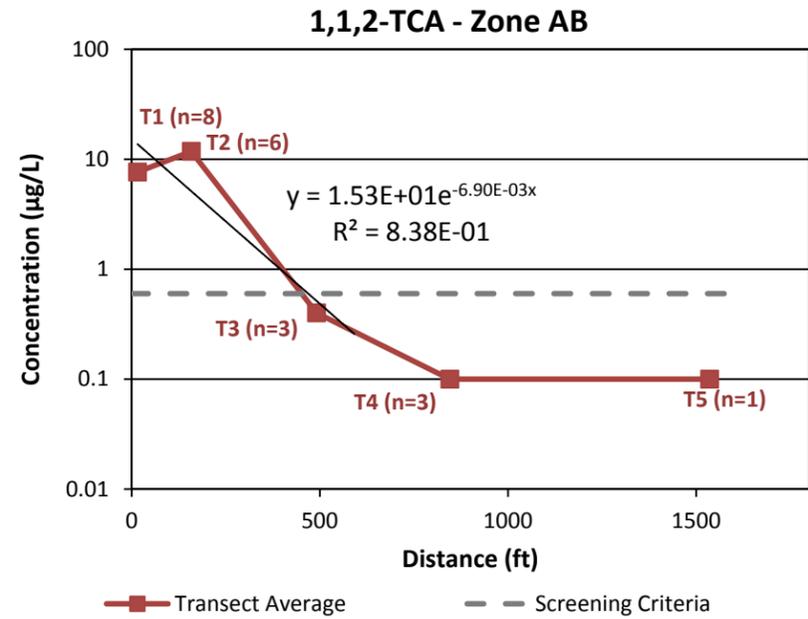
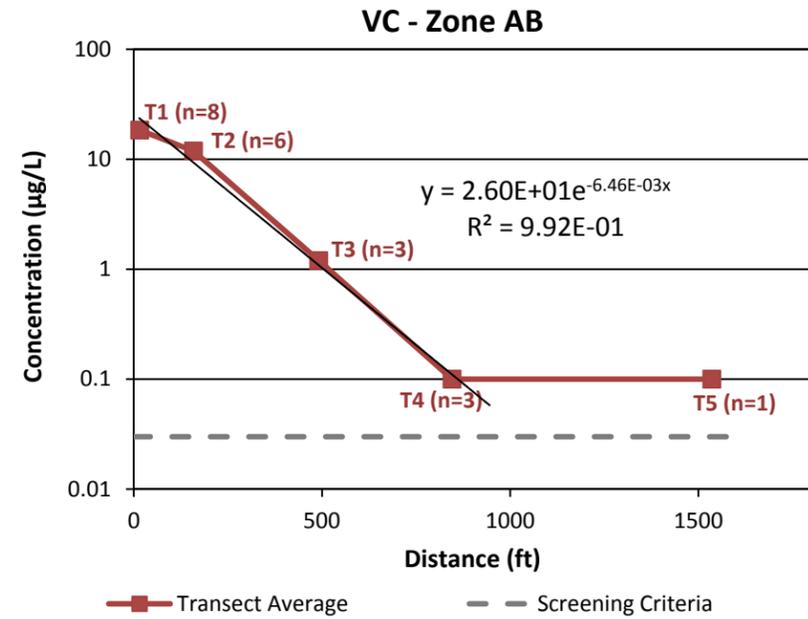
**Regression of Post-Shutdown Transect Average Concentrations vs. Distance for PCE, TCE and cis-DCE**  
Chemtronics Site, Swannanoa, North Carolina



Kennesaw July 2016

Figure  
5a

N:\VC\Chemtronics\VA\Black Valley\Post-Shutdown\Figures\Fig5\_Regression Figures\Fig5\_Regression Figures\VC\_TCE.cdx



**Notes:**

1. VC - vinyl chloride; 1,1,2-TCA - 1,1,2-trichloroethane; 1,2-DCA - 1,2-dichloroethane.
2. µg/L – micrograms per liter.
3. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.

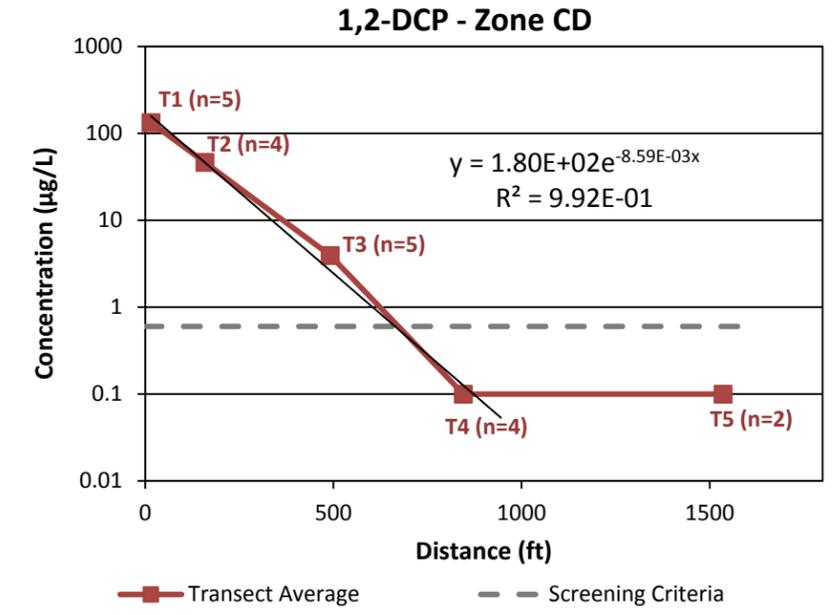
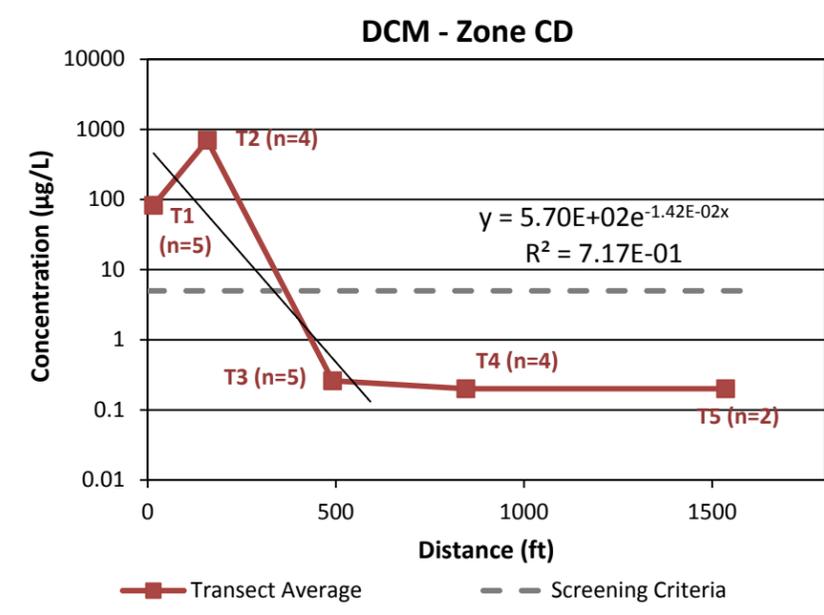
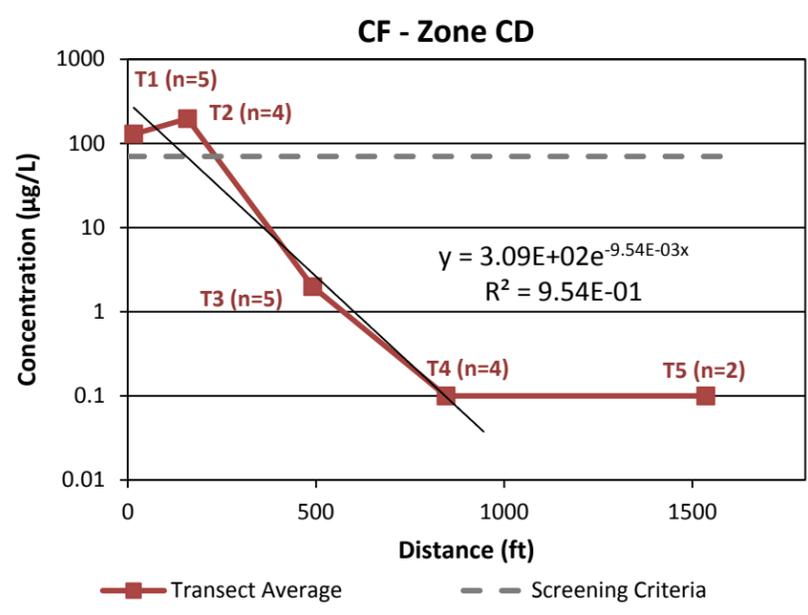
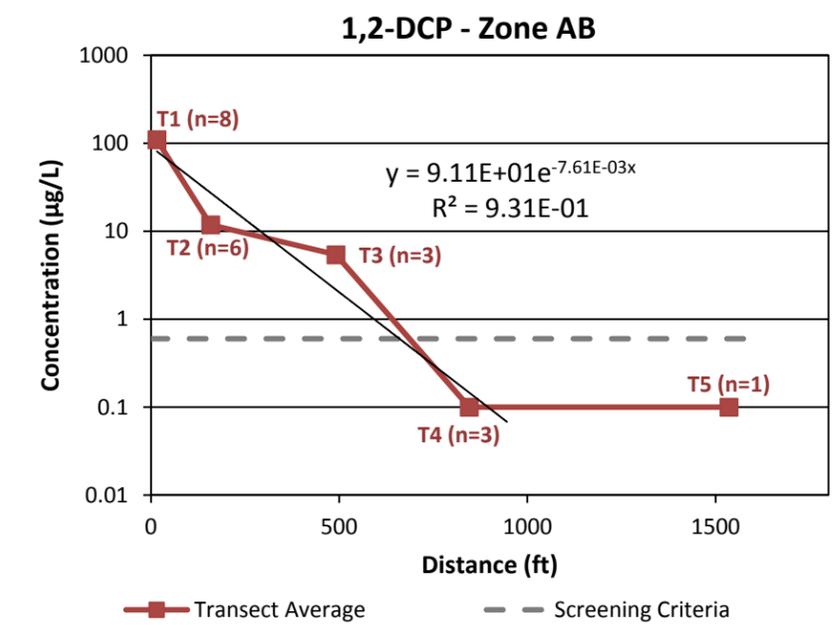
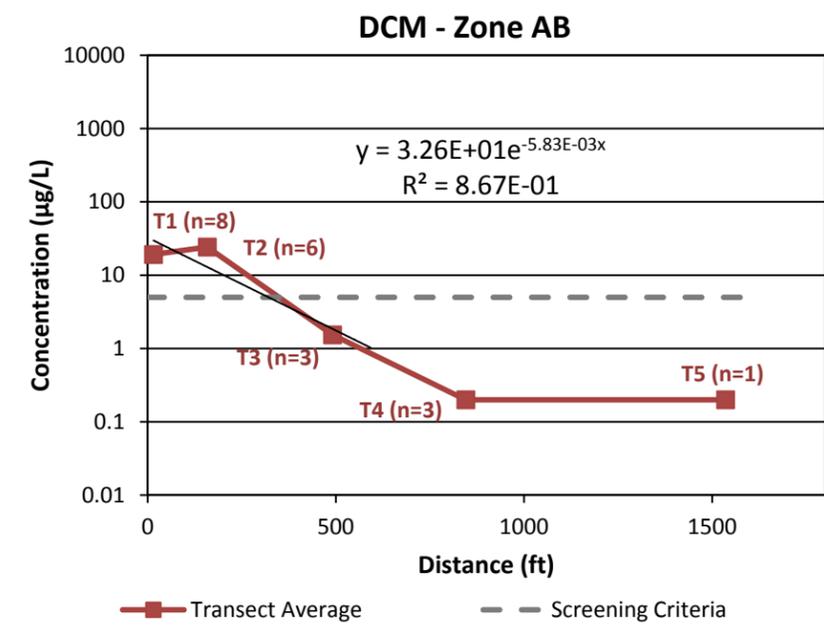
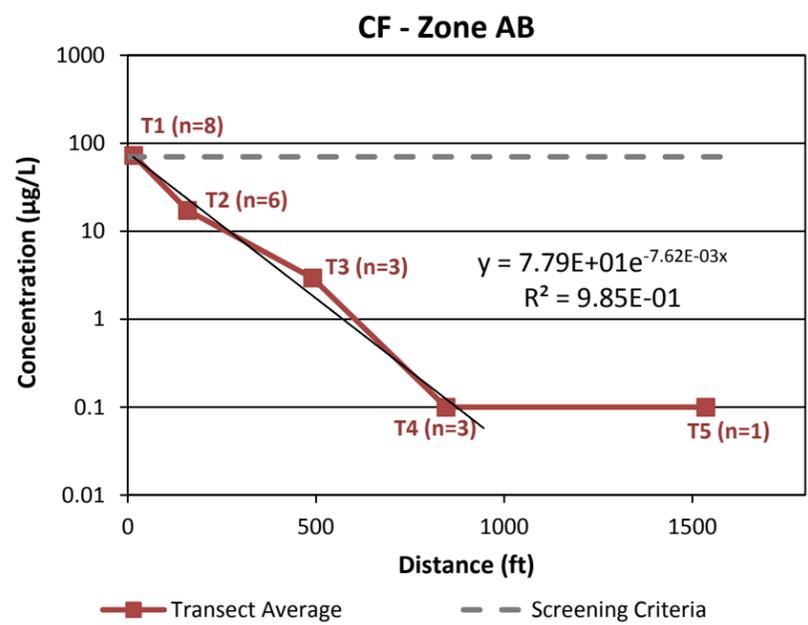
**Regression of Post-Shutdown Transect Average Concentrations vs. Distance for VC, 1,1,2-TCA and 1,2-DCA**  
Chemtronics Site, Swannanoa, North Carolina



Kennesaw July 2016

Figure 5b

N:\CV\Chemtronics\WMA\Black Valley\Post-Shutdown\Figures\Regression Figures\Fig5\_Regression Figures\MXD\Fig5\_Regression Figures\FCE\FCE.chx



- Notes:**
1. CF -chloroform; DCM -dichloromethane; 1,2-DCP - 1,2-dichloropropane.
  2. µg/L – micrograms per liter.
  3. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
  4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
  5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.

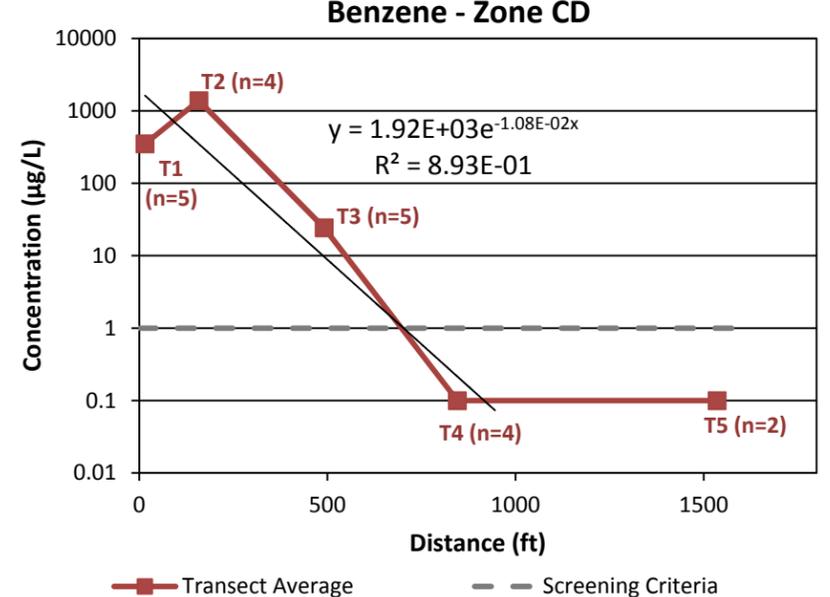
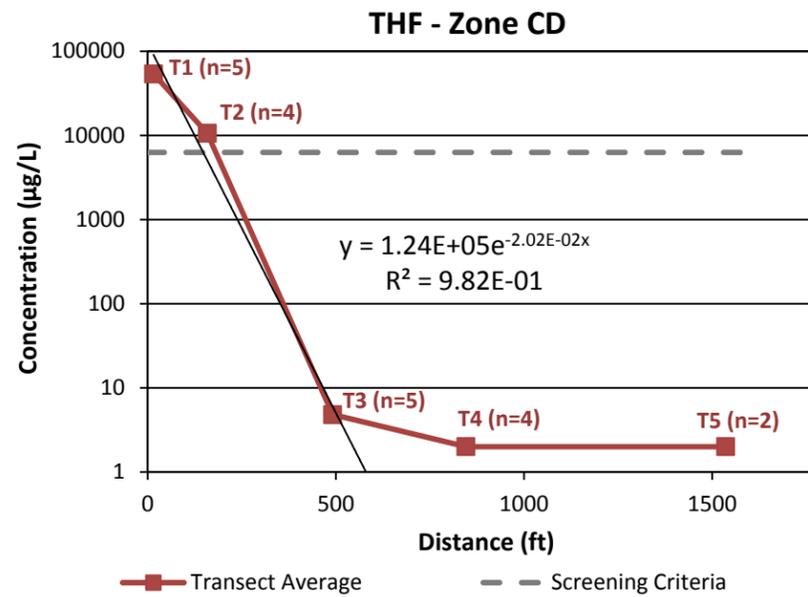
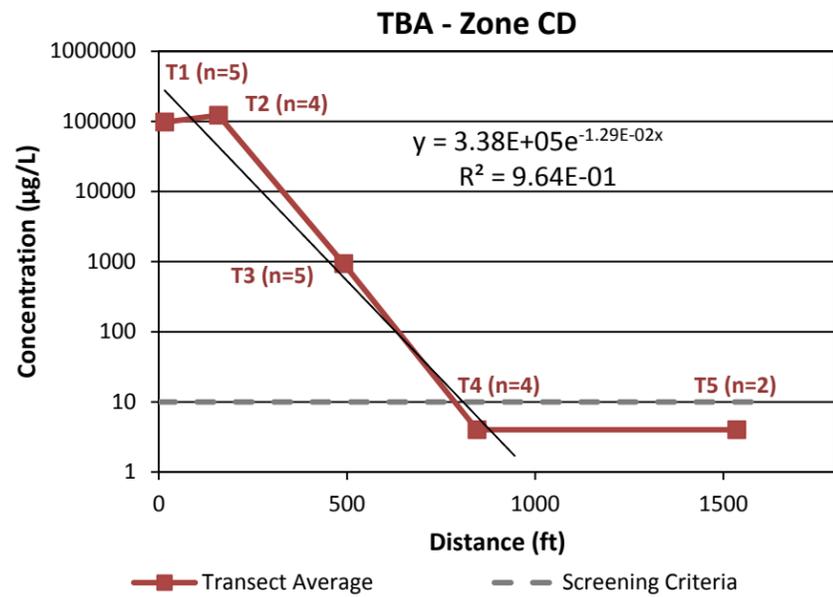
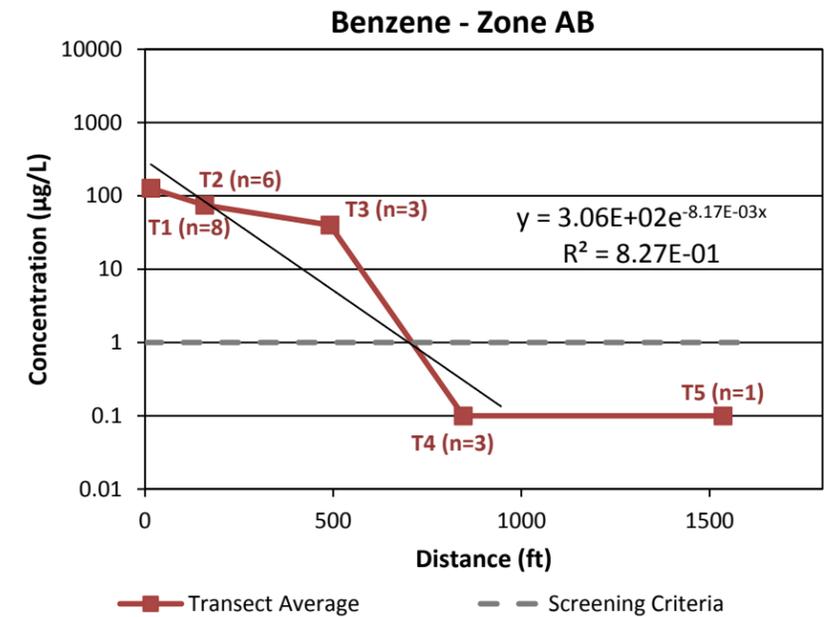
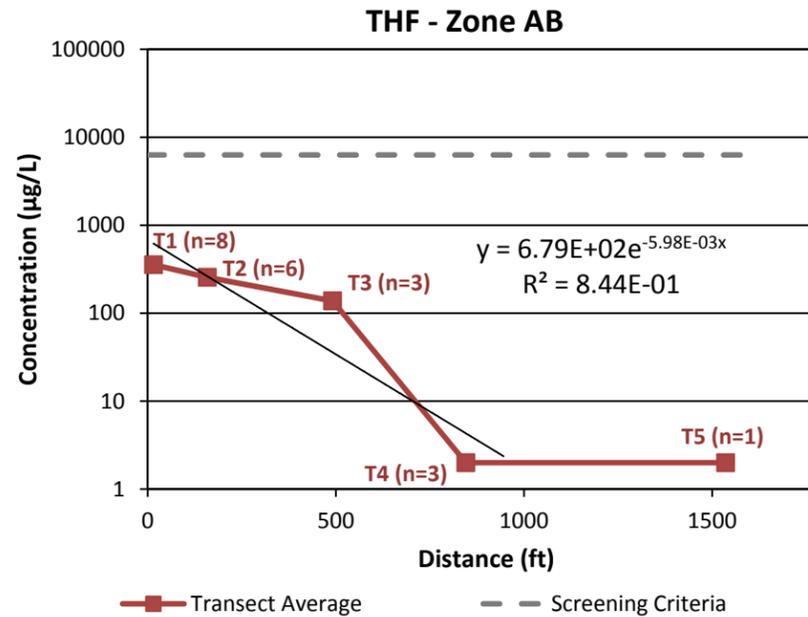
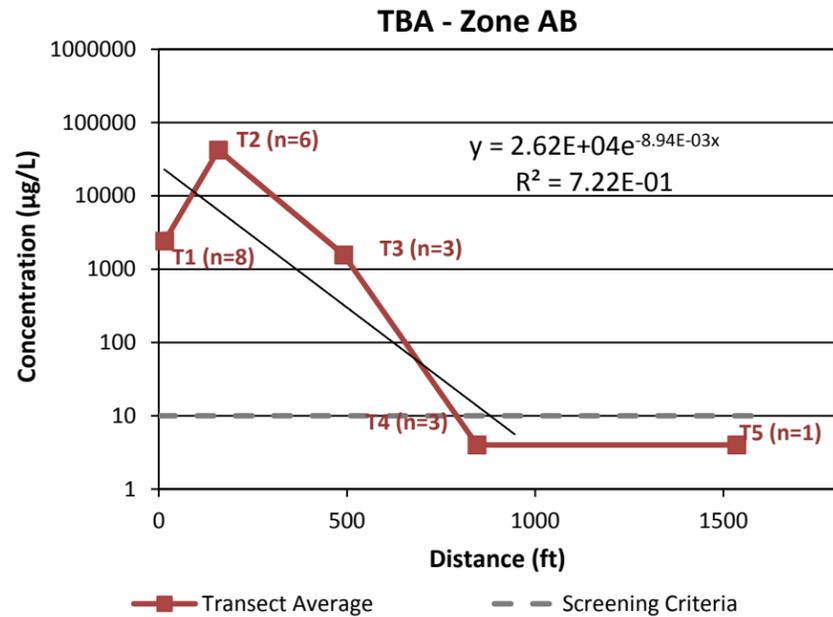
**Regression of Post-Shutdown Transect Average Concentrations vs. Distance for CF, DCM and 1,2-DCP**  
Chemtronics Site, Swannanoa, North Carolina



Kennesaw July 2016

Figure  
5c





**Notes:**

1. TBA - tert-butyl alcohol; THF - tetrahydrofuran.
2.  $\mu\text{g/L}$  – micrograms per liter.
3. Screening criteria are the North Carolina 2L or IMAC groundwater standards. For chemicals without a 2L/IMAC, the drinking water criteria from the *Final Remedial Investigation Report, Baseline Risk Assessment (Appendix L)* were used (Altamont, 2015a).
4. Transect average represents the average concentration (detections plus MDLs for non-detects) for wells along each MNA transect in each respective zone. Unless otherwise noted, individual well data used to calculate transect averages are from 2015. For select wells, the latest sample event occurred prior to 2015 (latest sample year in parentheses): MW165-O28A on Transect 4 in Zone AB (2008); MW196-N27CD on Transect 3 in Zone CD (2010); and MW151-P27C on Transect 4 in Zone CD (2008).
5. T# (n=##) – Transect number (e.g., Transect 1, Transect 2, etc.), where "n" is the number of samples included in the transect average.

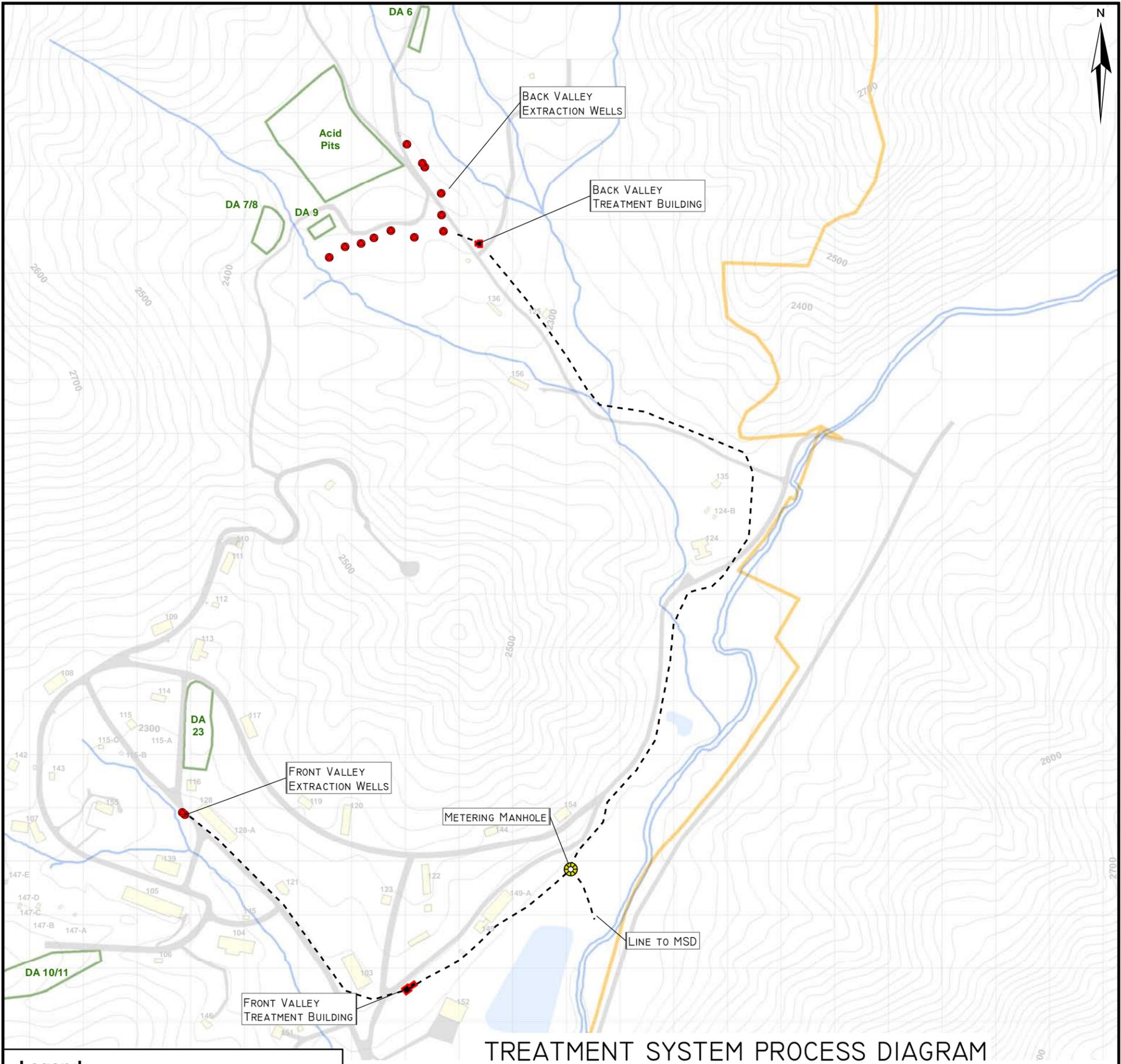
**Regression of Post-Shutdown Transect Average Concentrations vs. Distance for TBA, THF and Benzene**  
Chemtronics Site, Swannanoa, North Carolina



Kennesaw July 2016

Figure  
5e

# ATTACHMENT A

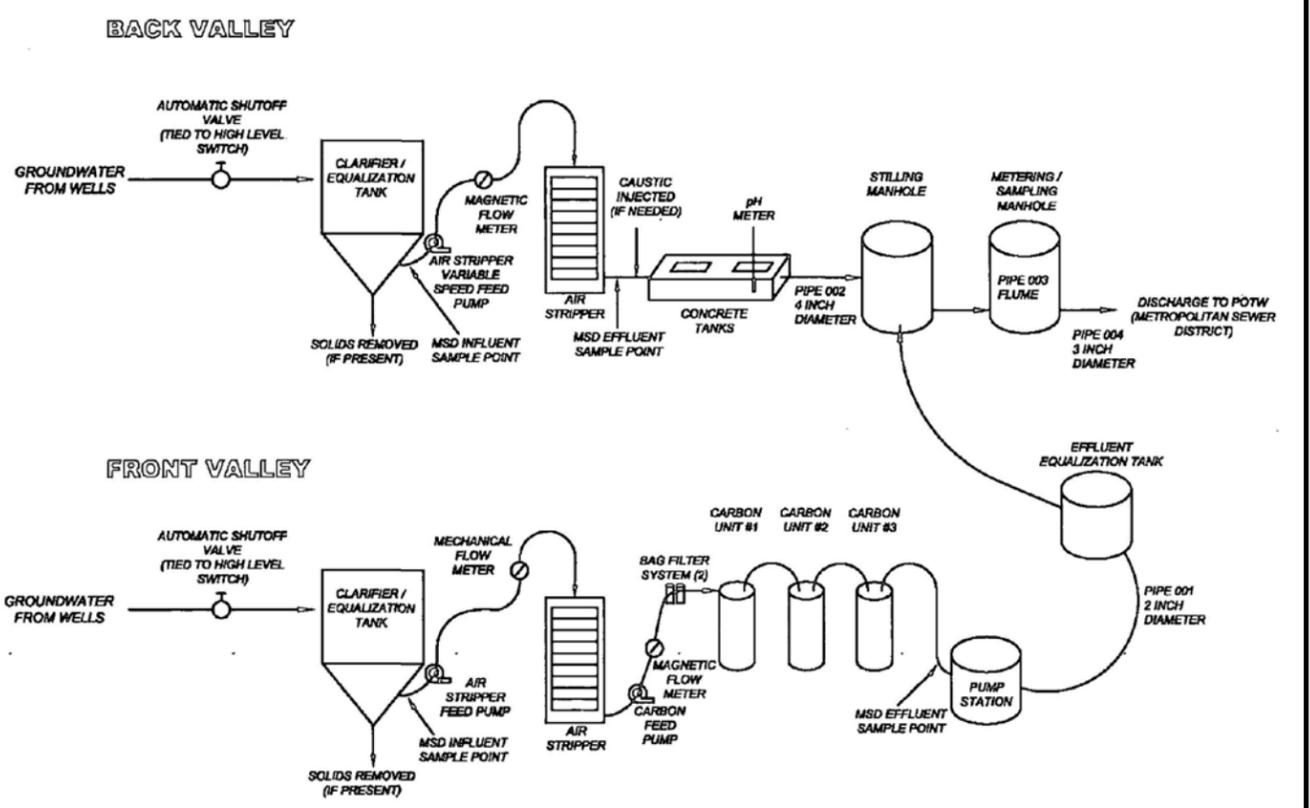


TREATMENT SYSTEM PROCESS DIAGRAM

**Legend**

- Treatment Buildings
- Treatment System Lines (Approximate)
- Extraction Wells
- Metering Manhole Location (Approximate)
- Pond
- Stream
- Chemtronics Property Boundary
- Former Building Location
- Road
- Disposal Area (DA)
- Surface Elevation Contour (20 Foot Interval)
- 250-ft by 250-ft Reference Grid (Not to Scale in Legend)

Notes:  
 Coordinate System: NAD 1983 StatePlane North Carolina FIPS 3200 Feet  
 Projection: Lambert Conformal Conic  
 Datum: North American 1983



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 WWW.ALTAMONTENVIRONMENTAL.COM

FRONT AND BACK VALLEY  
 EXTRACTION AND TREATMENT  
 SYSTEM COMPONENTS  
 CHEMTRONICS SITE  
 SWANNANOVA, NORTH CAROLINA

FIGURE  
 1

DRAWN BY: CHUCK PIPPIN  
 PROJECT MANAGER: STU RYMAN  
 CLIENT: CHEMTRONICS, INC.  
 DATE: 05/15/2014



File Path: P:\Chemtronics - GIS\Projects\Shutdown Report\MXD\F1-treatment system FV adn BV Final-ShutdownRPT.mxd