MEMORANDUM

TO: Roger Hoogerheide, USEPA Region 8
Lisa DeWitt, Montana Department of Environmental Quality (MDEQ)
Kathy Yager, USEPA, OSRTI

FROM: Doug Sutton, GeoTrans, Inc.
Rob Greenwald, GeoTrans, Inc.

DATE: February 3, 2009

RE: Concept Review Related to Discontinuing Active Remediation at the Burlington Northern (Somers Plant)

The Burlington Northern Somers site (the site) is a former railroad tie treating facility located in northwestern Montana. Wood preservatives used at the site were creosote, zinc chloride, and for a short time, chromated zinc chloride. Contaminated soils were excavated and treated in an on-site Land Treatment Unit, and soil treatment is complete. A ground water pump and treat (P&T) system operated at the site starting in 1994, but pumped at lower rates than designed and did not achieve significant progress toward aquifer remediation. A Technical Impracticability (TI) evaluation for ground water restoration was submitted and approved in 2003, and a request to modify the ground water remedy by shutting down the P&T system was made in 2004. The system was shut down in October 2007 for a 2-year interim monitoring period during which time data would be collected and evaluated. The original request to modify the ground water remedy was approved in May 2008.

Potential receptors of ground water contamination include Flathead Lake and the town supply well for Somers, Montana. In conjunction with the request to modify the ground water remedy, the site contractor has performed analytical transport modeling to evaluate the fate and transport of site contaminants with respect to these receptors and is implementing an interim plan to ascertain both the stability of the contaminant plume and the effect that natural attenuation may have on improving water quality at the site during the temporary shut-down period.

USEPA Region 8 and MDEQ have requested that GeoTrans, under contract to Tetra Tech, provide the following evaluations:

- Review/confirm the site conceptual model related to source areas, receptors, and plume transport.

- Evaluate the analytical transport modeling performed by the site contractor regarding validity of assumptions, consistency with site conceptual model, and reasonableness of conclusions. Also, provide recommendations for how this model can be validated with data currently available and/or with future data that will be collected.

- Provide guidance regarding proper approach for evaluating plume stability prior to, and subsequent to, the shutdown of the P&T system, and make recommendations regarding how to evaluate site data collected during the 2-year shut-off period of the P&T system. As part of this effort, review the first two quarters of data since system shutdown within the context of the suggested evaluation approach.

- Provide recommendations with respect to establishment of point of compliance monitoring points.

- Evaluate qualitatively the spatial distribution of ground water monitoring locations to determine if it is adequate for monitoring of flow directions and contaminant transport, and make recommendations regarding frequency of ground water monitoring at those locations.

Each of these items is discussed below.

Site Conceptual Model

The site conceptual model is illustrated in Figure 5-1 from the Request to Modify Groundwater Treatment System (RETEC, 2008). The conceptual model depicts multiple units of low-permeability material, discontinuous sand lenses interspersed in low-clayey sandy silt, residual DNAPL below the water table, gradation into silty clay with depth, and fractured bedrock at approximately 100 feet that dips to the east. A gravel layer is depicted overlying bedrock in some portions of the schematic. Figure 1 from the 2007 Annual CERCLA Report (RETEC, 2008) provides a layout of the site and well locations. Figure 2-2 from the Request to Modify Groundwater Treatment System (RETEC, 2008) depicts well locations in relation to the CERCLA Lagoon source area. Figure 4-1 from the same report depicts a potentiometric surface map and ground water flow directions in the absence of remediation pumping. The above-mentioned figures are included in Attachment A.

The supply well for the town of Somers, Montana is completed in bedrock approximately 1,300 feet to the west of the source area. Flathead Lake is located to the southeast approximately 1,300 feet downgradient. The water level in Flathead Lake is controlled artificially. The water level is full (at approximately 2893 feet above mean sea level) by June 15th of every year, and after Labor Day each year is lowered 10 feet to approximately 2883 feet above mean sea level to accommodate for snow melt. The lake recharges the aquifer in the Spring and Summer and receives water from the aquifer in the Fall and Winter.

A TI waiver has been requested for the site, establishing an area where applicable or relevant and appropriate requirements (ARARs) would not need to be met. The primary objective for addressing ground water contamination at the site would be to prevent site contaminants from migrating beyond the proposed TI area at concentrations above ARARs. The most mobile site compound is naphthalene, and the ARAR for naphthalene is 40 ug/L. The boundary of the proposed TI area is shown in Attachment A.

Total polyaromatic hydrocarbons (TPAHs), carcinogenic polyaromatic hydrocarbons (CPAHs), and phenols, which are constituents of creosote, and zinc are the primary contaminants of concern for the ground water remedy. Sampling results from five monitoring wells are of particular interest when considering the site conceptual model and contaminant fate and transport. S-93-2S and S-93-2D are located approximately 150 feet downgradient of the source area. S-93-2S, which is 30 feet deep, has typically had TPAH concentrations on the order of 1 mg/L, relative to a standard of 40 ug/L. CPAHs were also present during the first several years of P&T operation. S-93-2D, which is co-located with S-93-2S but is 60 feet deep, has shown a general increase in contamination since the P&T system began operating, indicating that EW-6 of the P&T system (which is also 60 feet deep) has pulled contamination down to the S-93-2D interval. S-88-1 is also 150 feet downgradient of the source area but along a different ground water flow path. As illustrated in Figure 1, this well has experienced an increase in TPAH contamination associated with extraction, treatment, and reinjection. S-88-2 is 150 feet downgradient of S-88-1, and S-88-3 is 300 feet downgradient of S-88-2. S-88-1 and S-88-2 are 37 feet and 39 feet deep, respectively, and S-88-3 is 53.5 feet deep.

As indicated in Figure 1, S-88-2 and S-88-3 also have a history of TPAH contamination. TPAH concentrations in S-88-2 (approximately 300 feet from the source area) had concentrations as high as 3,000 ug/L prior to operation of the P&T system. There has been an overall downward trend since the P&T system began operating; however, temporary increases as high as 1,000 ug/L generally occur at S-88-2 in the Spring and Summer of each year. It is unclear if these increases are associated with a change in groundwater flow direction associated with water elevation changes at the lake, infiltration of precipitiation through contaminated overlying sediments, contact of a high water table with overlying contamination, or mobilization of contamination from upgradient during periods of increased recharge. S-88-3 (approximately 600 feet from the source area) had concentrations as high as approximately 500 ug/L prior to (or during the early years) of P&T system operation. These concentrations have substantially declined since P&T operation began, indicating that the P&T system may have captured the upgradient portion of the plume and that clean water from side-gradient has flushed contamination from the areas screened by these wells. The decrease occurred approximately 3 years after the P&T system began operation but the actual change only took approximately one year, which is a reasonably fast hydraulic response for a site with a conceptual model that is dominated by low permeability material. The contamination at these distances from the original source area also indicated that there is some degree of interconnectedness among the sand lenses that have been considered discontinuous in the site conceptual model.

The P&T system operated from the Spring of 1994 to October 2007. The extraction rate in the last several years of operation was approximately 1.5 gpm from six extraction wells. The treated water was oxygenated, enriched with nutrients and reinjected to enhance in-situ bioremediation. The potentiometric surface maps generated from measured water levels prior to P&T system operation suggested a convergence of water in the vicinity of where EW-6 is now located, and operation of the P&T system (with extraction from EW-6) substantially enhanced this convergence of water. Monthly intervals of starting and stopping ground water extraction confirmed that convergence of water was still present in the absence of pumping. The reason for the natural convergence of water in this area in the absence of pumping is unclear. It may be due to a localized change in hydraulic conductivity. Aquifer testing in this vicinity suggested relatively higher hydraulic conductivities than those measured elsewhere on site, and EW-6 reportedly produced approximately 40% of the extracted water during operation. Both of these findings suggest that a trough of relatively higher hydraulic conductivity in this area could cause a convergence of ground water in this area. A trough, if it exists, could form a preferential pathway for contaminant transport along the line of the S-88-1, S-88-2, and S-88-3 wells.

Review of Analytical Transport Modeling

Transport modeling was done independently for each of the two receptors. The site contractor used a particle path analysis model to estimate travel time for the most mobile constituent (naphthalene) to the town well to be over 500 years and the travel time to Flathead Lake to be approximately 5,000 years. The site contractor assumed the distance to Flathead Lake is approximately 1,000 feet, but review of the site maps suggests this distance may be longer and closer to 1,300 feet. Modeling for the town well was a time of travel calculation that incorporated the seepage velocity and retardation due to partitioning of contaminants to soil. Modeling toward Flathead Lake utilized the Domenico model and incorporated seepage velocity, dispersion, retardation, and degradation. Based on the exceptionally long transport times to reach receptors, they argued that protectiveness would be maintained in the absence of P&T system operation. The primary parameters involved in calculating these travel times are summarized in the following table.

Parameter	Assumed Value(s) for Migration to Town Well	Assumed Value for Migration to Flathead Lake
Hydraulic conductivity	0.0285 ft/day (clay) 13 ft/day (bedrock)	1 ft/day
Hydraulic gradient	0.064 (clay) 0.002 (bedrock)	0.002
Porosity	0.15 (clay) 0.28 (bedrock)	0.28
Bulk density of soil	1.43 g/cm^3 (clay) 1.7 g/cm^3 (bedrock)	1.7 g/cm^3
Organic carbon partitioning coefficient	2000 L/kg (naphthalene)	2000 L/kg (naphthalene)
Fraction of organic carbon in soil	0.001	0.001
Rate of degradation	Not considered	0.0027 1/day

Based on the historic sampling results from S-88-1, S-88-2, and S-88-3, these parameters do not appear to be appropriate for this site. For example, the above parameters for migration toward Flathead Lake result in a solute velocity (including retardation) of approximately 0.2 feet per year for naphthalene. Given that naphthalene is one of the more mobile PAHs and is the primary constituent of the TPAH detected at these monitoring wells, this solute velocity cannot explain how the TPAH concentrations on the order of 500 ug/L were detected at S-88-3 approximately 600 feet from the source area in the 80 year span since creosote was first used at the Somers facility. Over 80 years, naphthalene would have only traveled approximately 16 feet according to the site contractor's model. Attachment B presents the input and output from a simulation using BIOSCREEN in which the concentrations at S-88-1, S-88-2, and S-88-3 are more reasonably simulated based on different parameter values. BIOSCREEN is a publicly available fate and transport model available from USEPA that is based on the Domenico solution and is therefore similar in modeling simplifying assumptions made by the site contractor. Although the actual concentrations at S-88-1 were historically lower than current values, it is believed that this is because S-88-1 was not along the centerline of the plume and that the contaminant concentrations now observed at S-88-1 are more representative of the concentrations approximately 150 feet downgradient of the source area. The historical sampling results and the BIOSCREEN simulation results are presented in the following table.

Parameter	**150 ft Downgradient of Source (S-88-1)***	**300 ft Downgradient of Source (S-88-2)**	**600 ft Downgradient of Source (S-88-3)**	**900 ft Downgradient of Source (S-85-6a/b)**
Representative Historical Value (1988)	5,000 ug/L	2,200 ug/L	120 ug/L	< 1 ug/L
Calibrated Value from BIOSCREEN Simulations (40 years of transport)	4,400 ug/L	2,000 ug/L	140 ug/L	1 ug/L

** In Attachment B, refer to the blue line in the model output for the "1st Order Decay"*

The relatively reasonable match between the simulated results at 40 years of transport and the actual sampling results from 1988 suggest that the original source may have occurred around 1948, which is comfortably within the operating period at the facility. Progressing the simulation for another 10 years results in a simulated concentration of 368 ug/L at S-88-3, which is very comparable to the values detected in that well in 1996 and 1997 (400 ug/L and 380 ug/L, respectively), and a simulated concentration of 9 ug/L at S-85-6a/b, which is comparable to the 2 ug/L detected in 1996. The parameters used for this simulation are summarized in the following table.

Parameter	**Calibrated Value from BIOSCREEN Simulations**
Hydraulic conductivity	7 ft/day
Hydraulic gradient	0.002
Porosity	0.2
Bulk density of soil	1.7 g/cm^3
Organic carbon partitioning coefficient	2000 L/kg (naphthalene)
Fraction of organic carbon in soil	0.0001
Rate of degradation	5.4×10^{-5} 1/day

The hydraulic conductivity value is a factor of 7 higher than the value used in the site contractor's analysis. This value of 7 feet per day is within the hydraulic conductivity values for the site reported in the Request to Modify the Groundwater Treatment System (RETEC, 2008), and this higher value is also consistent with the concept of an area of relatively higher hydraulic conductivity near S-88-1, S-88-2, and S-88-3 that contribute to the appearance of ground water convergence even in the absence of pumping. The porosity is lower than that assumed by the site contractor but is still consistent with typical values reported in literature. The fraction of organic carbon in soil is an order of magnitude lower than that assumed by the site contractor. This value used in this BIOSCREEN modeling is a very low value that might be appropriate on a site-specific basis, but would need to be confirmed with soil sampling. One supporting line of evidence for a very low value for the fraction or organic carbon is the historical presence of CPAHs in S-88-3. These compounds have a significantly higher partitioning coefficient than naphthalene, and their presence at this downgradient well suggest that retardation is not significant at this site and that the fraction of organic carbon in soil is likely very low.

The rate of degradation is a factor of 50 lower than that assumed by the site contractor. The rate of degradation for naphthalene (and other PAHs) is dependent on the dissolved oxygen, nitrate, and other electron acceptors in the saturated soil and ground water. Given that much of the electron acceptors may be consumed when migrating through the source area, it is not unreasonable for there to be low levels in the plume and therefore lower than expected degradation. This relatively low estimate for degradation conflicts with the *2006 Evaluation of Natural Attenuation and Biodegradation Capacity for the Somers Former Tie-Treating Plant.* That evaluation suggested substantial degradation between the source area and downgradient wells. Even the conservatively low estimate of assimilative (degradation) capacity between the source and downgradient wells of 7,273 mg/day far exceeds the maximum flux of naphthalene that would have migrated between the source and downgradient wells. There are several factors that make this analysis unreliable for estimating natural attenuation in the absence of pumping:

- The sampling for the natural attenuation parameters was conducted during P&T operation and is therefore not indicative of non-pumping conditions.

- The data used for the analysis is based on a single event. Averages from several events should be used to account for fluctuations in the data due to sampling and analysis procedures and for potential seasonal variation. For example, a 20% error in the methane concentration between two points could result in 67% change in the estimated assimilative (degradation) capacity.

- Concentrations from wells that are not necessarily in the same flow path (under pumping or non-pumping conditions) are compared whereas the evaluation should be conducted on data from wells within the same flow path.

- Results vary greatly depending on which data are used. For example, little or no degradation would be observed between S-88-2 and S-88-3.

- The data appear to include some outliers that bias the data. For example, the methane and ferrous iron concentrations from S-85-6A are the highest at the site (including the source areas) despite the distant downgradient location of the well and the substantially lower concentrations that are present at S-88-3, which is located between the source area and the S-85-6A.

It is emphasized that the parameter values derived from calibrating the BIOSCREEN model to field data are not suggested to be the actual parameters for the site; rather, they were chosen as one potential set of realistic parameter values that reasonably represent historical sampling results and could potentially be used to forecast contaminant transport. The results using these parameters provide a much better match to observed conditions than the results of the modeling by the site contractor and suggest substantially faster transport times than previous modeling for the site. This raises concern about the validity of the previous modeling findings presented as part of the request for discontinuing P&T operation.

Using the above BIOSCREEN parameters for simulations further into the future, the model suggests that plume stabilization would likely occur around 200 years as is evident by the relative lack of change in simulated concentration values between 180 and 200 years (not shown). According to the BIOSCREEN model, in the absence of P&T, this would be approximately in the year 2148. The following table indicates the simulated concentrations at various distances downgradient after 200 years of migration. The input and output is presented in Attachment B (refer to the blue line in the output for “1st Order Decay”).

Parameter	Simulated Concentration with Stable Plume (200 years)
150 feet downgradient (S-88-1)	4,550
300 feet downgradient (S-88-2)	2,570
600 feet downgradient (S-88-3)	1,050
900 feet downgradient (S-85-6A/B)	480
1,350 feet downgradient (Flathead Lake)	160

Note: A concentration of 40 ug/L is simulated to reach Flathead Lake after approximately 120 years. The simulation for 120 years is also included in Attachment B.

The above simulated concentrations indicate that in the absence of active remediation the concentrations in the aquifer increase substantially above the TPAH standard of 40 ug/L and that ground water with TPAH concentrations over 40 ug/L will eventually discharge to Flathead Lake. This simulation, however, is based on limited data and actual conditions could eventually be much better or worse than indicated by this simulation. The P&T operation over a 13 year period has substantially lowered concentrations in the plume and interrupted plume migration. In the absence of P&T operation, 2008 would be 60 years into the simulation period (i.e., 2008 is approximately 60 years after 1948), but with P&T operation, it may be more appropriate to restart the simulation period in 2007 (i.e., the year P&T was discontinued) such that simulated plume stability would be reached in approximately 2207.

The historic sampling results and above modeling suggest that transport is likely substantially faster than presented in the request to modify the P&T system, that concentrations above standards could impact Flathead Lake, but that this impact would not occur for approximately 120 years and plume stability would not be reached for 200 years.

The above findings from the analysis of the transport toward Flathead Lake also have significant implications for the previous modeling conducted for evaluating transport toward the town well. The results from the previous modeling are highly dependent on the soil partitioning coefficient, which may be substantially lower if the fraction of organic material is lower than what was assumed. More directly, it appears inappropriate to use a fraction of organic matter of 0.1% for bedrock. Bedrock likely has little or no organic matter, and therefore retardation may be substantially lower than what was assumed. Using the retardation coefficient from the BIOSCREEN simulations, the travel time for migration vertically through the clay would be approximately 15 years (instead of 74 years), and the horizontal travel time through the bedrock would be approximately 100 years (instead of 500 years). Retardation through bedrock may even be lower, which would further decrease the transport time.

There are more important factors when evaluating the potential for contaminant transport toward the town well. The observed gradient between the bedrock and surficial zone is upward, suggesting that contaminated ground water would not migrate vertically into bedrock unless it was in the form of DNAPL. There is no bedrock well in the source area to determine if contamination or DNAPL is present in bedrock, but installation of such a well could result in inadvertently introducing a small amount contamination into bedrock and potentially giving the false impression that substantial contamination is present. The town well is also 1,300 feet away, and very little is known or reported about ground water flow in the bedrock. It is quite possible that contamination that could enter bedrock near the source area would not be within the capture zone of the town well. The only bedrock well between the source area and the town well (S-85-8b) suggests little or no contamination migrating toward the town well.

It is reiterated that the analysis conducted here is not intended to be a definitive representation of the true transport parameters for the site. However, the analysis does present a set of parameters that more reasonably represents historical sampling results than the model presented as part of the request to discontinue P&T. The faster transport times associated with the BIOSCREEN simulations suggest that contaminant fate and transport for the site should be further evaluated when considering the use of active remediation to prevent plume migration beyond the proposed TI area toward Flathead Lake. Model calibration and model reliability will improve as additional information becomes available from future monitoring.

Approach to Evaluating Plume Stability, Recommended Points of Compliance, and Evaluation of the Monitoring Plan

Evaluating plume stability is relatively difficult given the amount of limited data available after the shutdown of the P&T system. As discussed above, historic sampling results and preliminary parameter estimation with modeling indicate that the site contaminants have the ability to migrate at least 600 feet from the source area. Given that a continuing source is still present, the ability of the contaminants to migrate this far in the past suggests that they would be able to migrate this far again in the future. This alone, would suggest that the plume is not stable. It is likely that in the absence of active remediation that the plume will resume or exceed its previous extent over time.

Another concern regarding plume stability is the seasonal spikes of naphthalene in S-88-2. In general, naphthalene seemed to decrease between 1996 and 2000 as a result of P&T operation. However, seasonal spikes as high as 1,000 ug/L of naphthalene continued through 2006, suggesting that these spikes may be the result of source material in the vicinity of S-88-2 being mobilized during seasonal water level changes. Sampling results from January 2008 (in the absence of pumping) suggest substantial increases in the naphthalene concentration at S-88-2 to 8,640 ug/L, which far exceeds the maximum detected naphthalene concentration in this well since 1996 (1,300 ug/L in August 1996). In addition, S-88-2 was not sampled for PAHs during the second, third, and fourth quarters of 2008 because of the presence of emulsified creosote in the well. These results suggest that the area near S-88-2 is part of the source area. The abrupt appearance of the high naphthalene concentrations and emulsified product after shutdown of the P&T system in October 2007, suggest a relationship between P&T system operation/shutdown and the increased contamination at S-88-2. Operation of the P&T system may have played a role in directing the flow of high concentrations and emulsified product in a manner that it would affect S-88-2 relatively quickly upon system shutdown (see Figure 2). Therefore, the abrupt appearance of contamination at S-88-2 is not necessarily an indication of the ability or speed with which contamination will migrate to S-88-3. It is also conceivable that S-88-2 has been a part of the source as far back as the initial sampling during the Remedial Investigation. There was apparently an odor and evidence of soil staining during the construction of S-88-2. Regardless, the presence of high levels of contamination at S-88-2, whether dissolved or emulsified product, suggest the ability for contamination to migrate from the source area in the absence of hydraulic control.

The historical extent of product to the north and northeast of S-88-2 is unknown based on the reviewed documents. It is possible that the extent of product extended northeast and east of the area indicated in Figure 2. Furthermore, the 84-15/S-91-2 cluster is too far to the north/northeast to effectively evaluate extent of product and may be sufficiently far north that it is sidegradient to the direction of ground water flow and contaminant transport from the source area.

Recommendations

The current extent of emulsified product should be determined and compared with the original source area to determine the rate and direction that emulsified product is migrating. The extent of emulsified product may best be delineated using direct-push ground water sampling and a TRIAD-based dynamic work plan. Three permanent monitoring wells could then be installed outside of the area impacted by product to help monitor conditions over time. Figure 3 presents potential locations for direct-push sampling locations and permanent wells. Additional direct-push locations and the locations of the presented permanent wells are subject to findings from the initial direct-push results. The newly installed monitoring wells from this effort (plus S-88-2) should be sampled for PAHs and gauged for four quarters. Samples should be analyzed for PAHs even if product is identified in the wells to confirm that the product observed is a source of the observed dissolved contamination. The data should be reviewed along with the site conceptual model and historical source area data to determine the rate at which source material is migrating. If it is determined that source migration via emulsified product is occurring, it is a reasonable conclusion that contamination will have the potential to migrate beyond the boundaries of the proposed TI area above standards, and operation of the P&T system, or perhaps a modified P&T system, would be appropriate to provide hydraulic control. Based on the findings of this investigation, it may be necessary to revisit the boundaries of the proposed TI area.

If it is determined that the P&T system is not required to prevent the migration of emulsified product, the site team can use the information from the above characterization to determine the primary migration pathways at the site and the appropriate locations for point of compliance wells. S-85-6A/B can be used as point of compliance wells to the east, and S-88-3 can be used as a sentry well to help determine the degree to which contamination is migrating toward these co-located point of compliance wells. Appropriate sentry and point of compliance wells are not available to the northeast, but information from the above suggested characterization should be evaluated before locating such wells. Potential locations for sentry and point of compliance wells are indicated on Figure 3.

Sentry and point of compliance wells should be monitored quarterly for up to 15 years before making the determination that the plume is stable. This extensive monitoring duration is suggested because of the long time frames needed to observe actual increases in concentrations at S-88-3, S-85-6A/B, and other sentry or point of compliance wells that might be located to the northeast of the source area. For reference, the table below provides the anticipated naphthalene concentrations at S-88-3 using the previously noted BIOSCREEN parameters and assuming S-88-2 (approximately 300 feet upgradient) is a source area with a concentration of approximately 10,000 ug/L.

Time	Anticipated S-88-3 Naphthalene Concentration (ug/L)
3 years	0
6 years	0
9 years	8
12 years	57
15 years	184

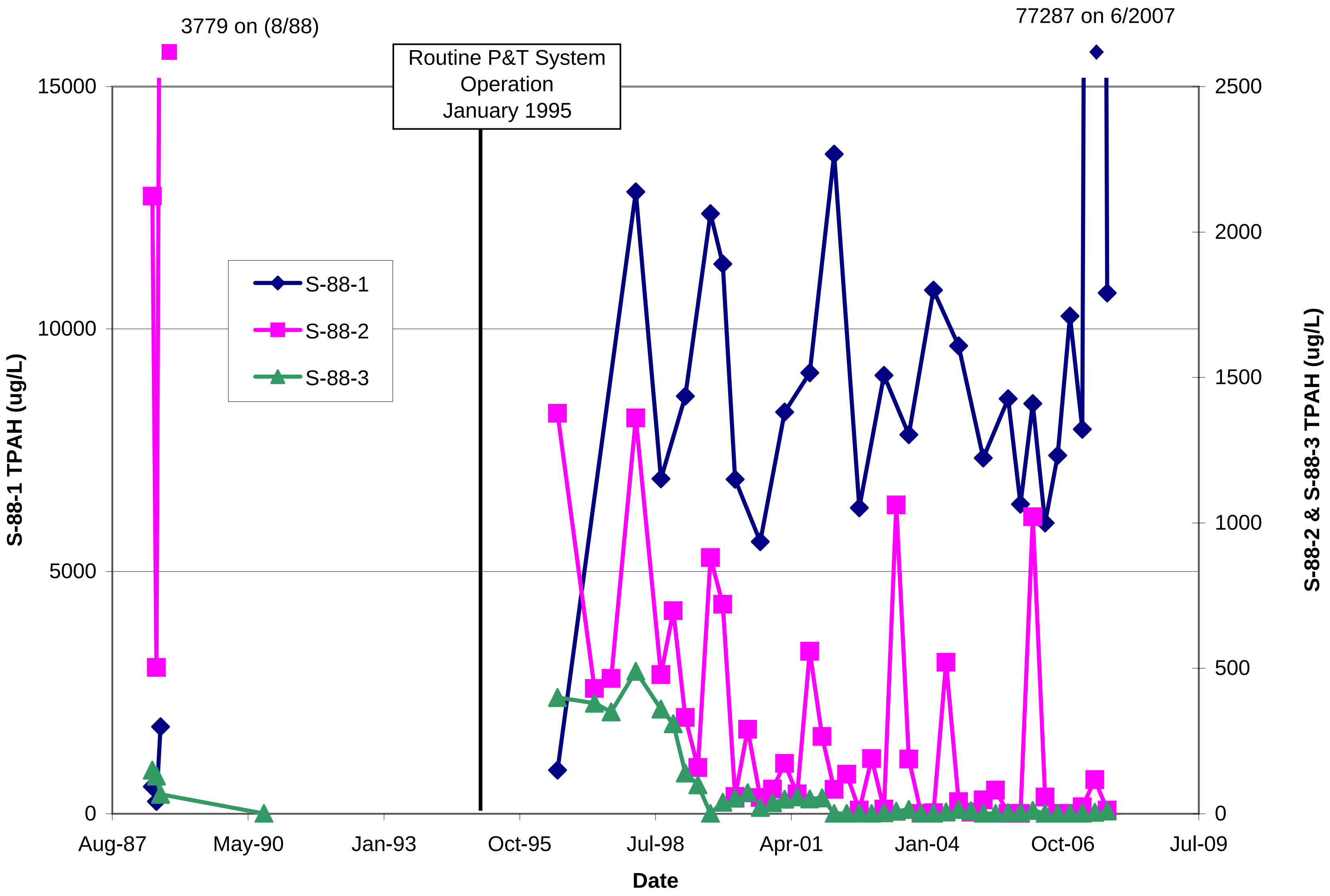
Note: Recalibration of the model with new data could significantly affect the above-noted anticipated naphthalene concentrations at S-88-3.

Quarterly monitoring is suggested because of the historical high variance in concentrations at some locations. Each year, with four new quarters of monitoring, the concentration trends can be evaluated and an appropriate transport model recalibrated. Despite the quarterly frequency for monitoring, overall trends will occur sufficiently slowly that annual reporting and analysis is sufficiently frequent. If monitoring and modeling results suggest potential migration of contamination above standards beyond the proposed TI area, then the P&T system should be restarted. Additionally, if the concentration of a site contaminant equal to 50% of the ARAR is detected at a point of compliance well in more than one event (not necessarily consecutive), then the P&T system should be started within 90 days of receiving the result from the laboratory. If after 15 years of quarterly monitoring and rigorous modeling/evaluation, plume stability is clear and concentrations outside of the TI area will not exceed ARARs, then the proposed TI area is likely appropriate and active remediation would not need to be resumed.

Based on the reviewed information, it does not appear that the town well is a likely potential receptor of site-related contamination. There is generally an upward gradient from bedrock to the surficial aquifer, so downward migration of dissolved contamination to bedrock is not expected. The most likely potential pathway (if any) for contamination to reach bedrock would be vertical migration of DNAPL from the surficial aquifer to bedrock. Source area data, however, suggest that concentrations decrease with depth (see S-93-2S and S-93-2D). In addition, S-88-8b is slightly to the side of the direct path between the source area and the town well and has had favorable analytical results. The highest naphthalene concentration in over 20 samples was 1.1 ug/L in 2002. It is reasonable to conclude that site-related contamination will not leave the southern boundary of the proposed TI area (in the direction of the town well) at detectable levels. If additional assurance is needed, then another bedrock monitoring well could be installed midway between the S-85-8 cluster and S-85-7 and sampled for four quarters. This well would be located in the direct path between the source area and the town well. If contamination is detected above a given threshold (perhaps 10% of the ARAR value), then monitoring could continue on a quarterly basis along with the surficial aquifer monitoring. If an increasing trend is noted, then additional characterization and evaluation would likely be required.

A study, independent of this review, was conducted by Mindy Vanderford of GSI Environmental, Inc. (another contractor of U.S. EPA OSRTI). Conclusions of the GSI study are similar to those made by GeoTrans in this study. Similarities between the two studies include the variance in site data (e.g., the variability observed at S-88-2), the insufficient information available in a 2-year time period to evaluate plume stability, the relatively long period of time (e.g., on the order of 10 years) to collect sufficient information regarding plume stability, and the need for sentry and point of compliance wells. The GSI study also provides several valuable suggestions regarding statistical evaluation of data and the use of the MAROS software. This study conducted by GeoTrans focuses more on modeling results and visually observable trends than on statistical analysis; however, if statistical analyses are performed in conjunction with the GeoTrans recommendations, GeoTrans recommends following the advice in the attached study regarding the use of the appropriate software and techniques.

Figure 1. TPAH Concentration Trends at S-88-1, S-88-2, and S-88-3 Relative to P&T Operation



Under pumping conditions (as shown below), extraction from EW-6 could likely capture emulsified product from the former lagoon source area while also bringing it into proximity of S-88-2, such that S-88-2 could be impacted upon shutdown of the P&T system.

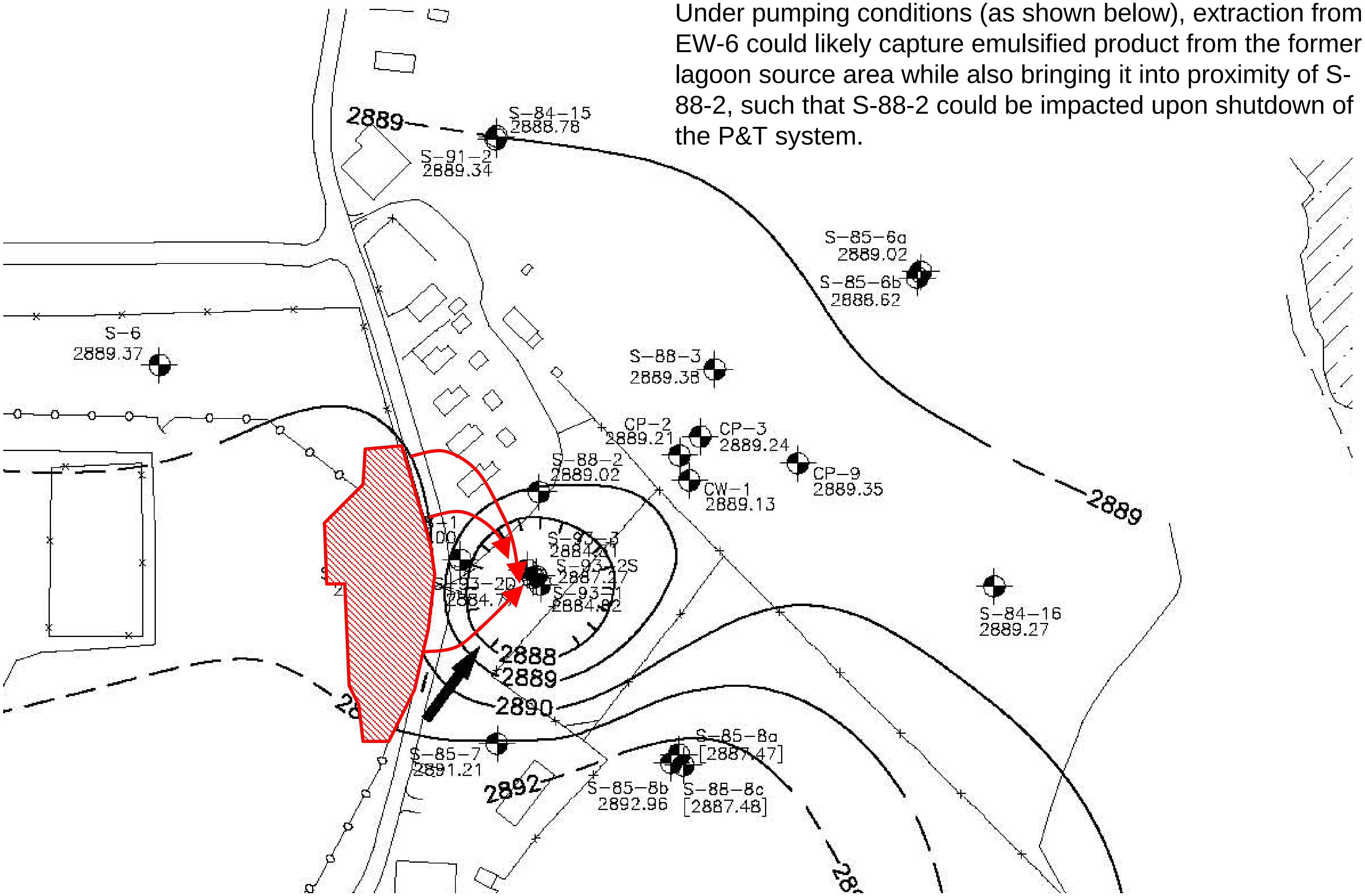


Figure 2. Conceptual model for emulsified product migration during P&T operation

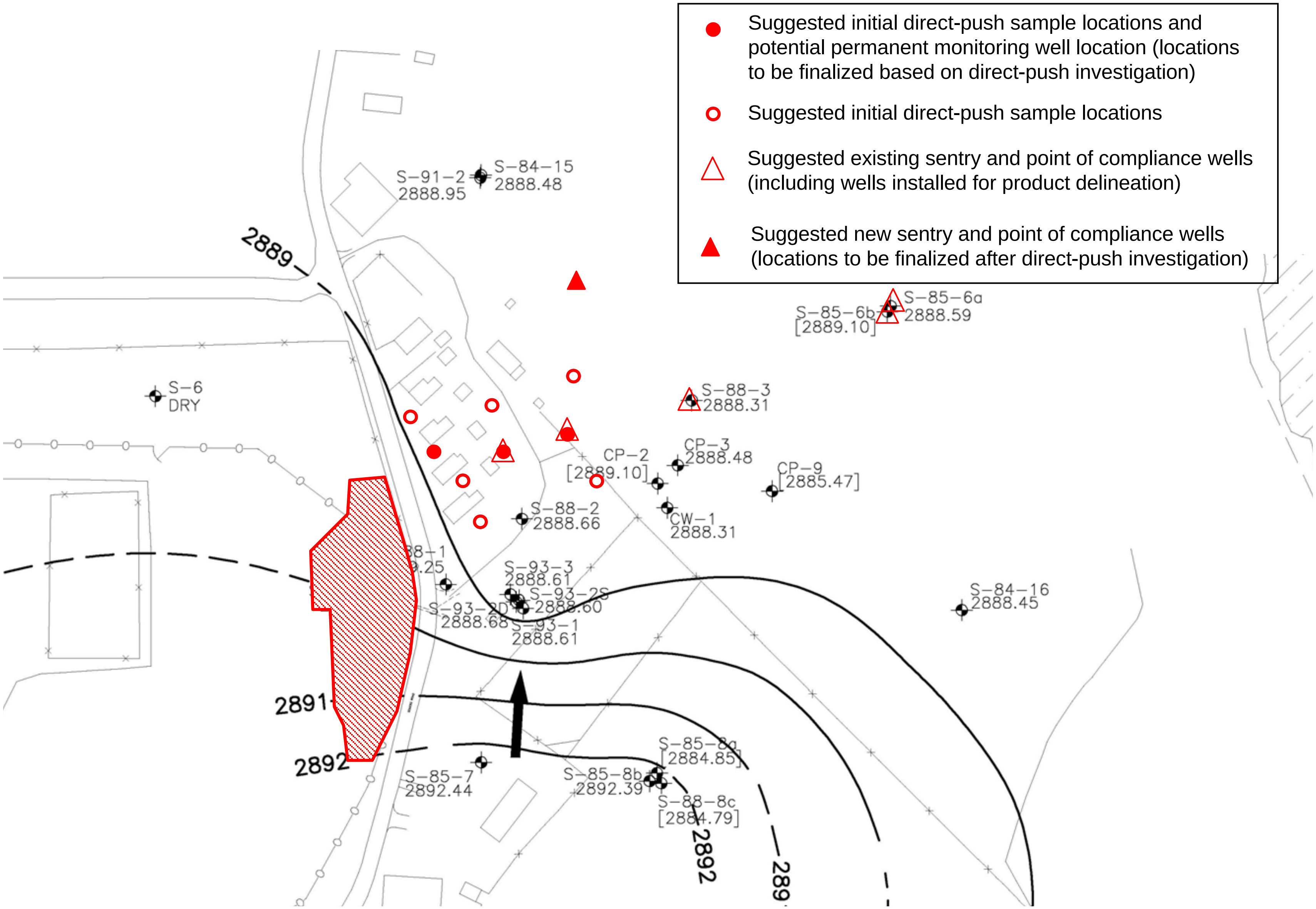
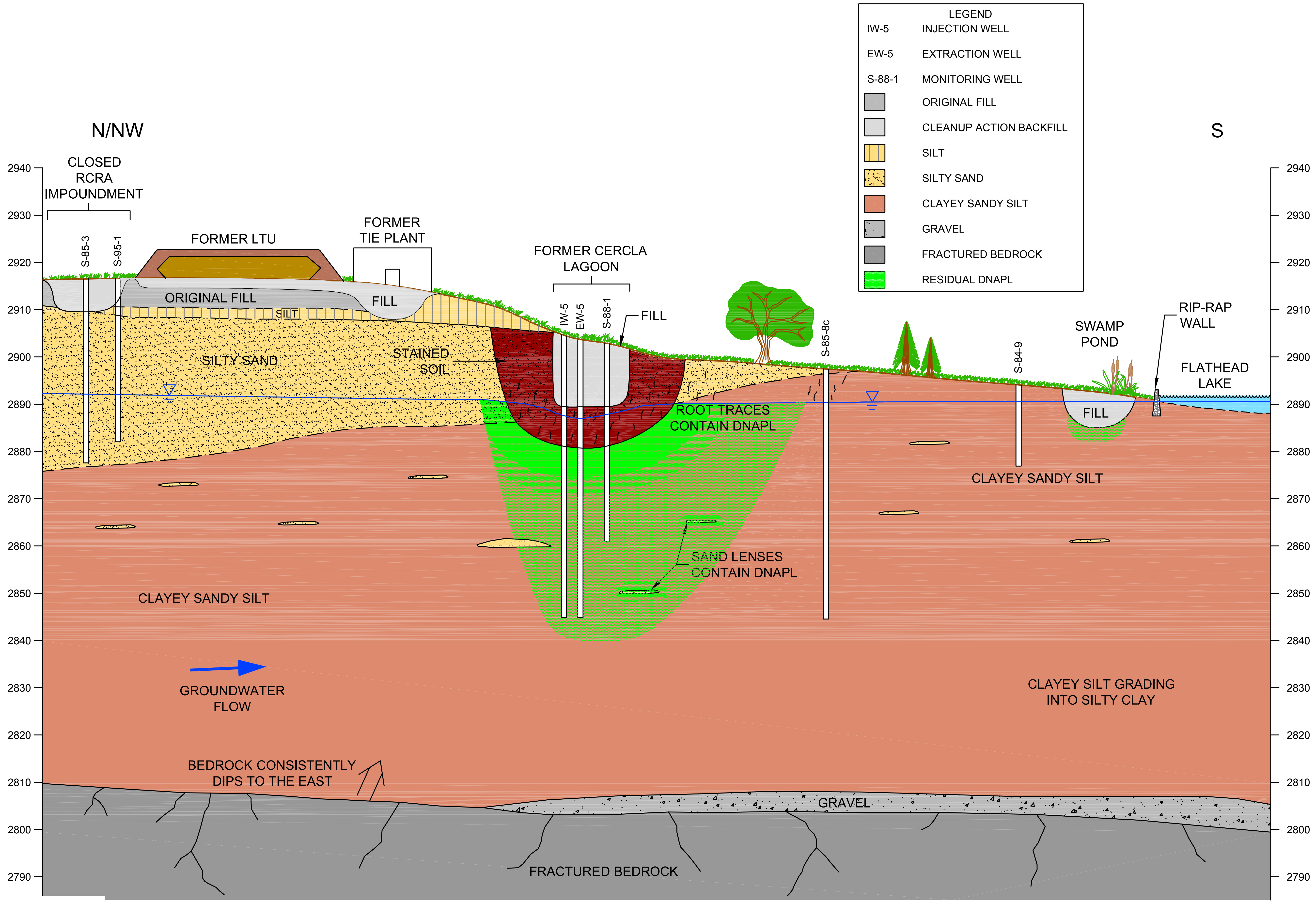


Figure 3. Suggested initial direct-push sampling locations and potential permanent monitoring well locations

ATTACHMENT A
FIGURES FROM SITE REPORTS



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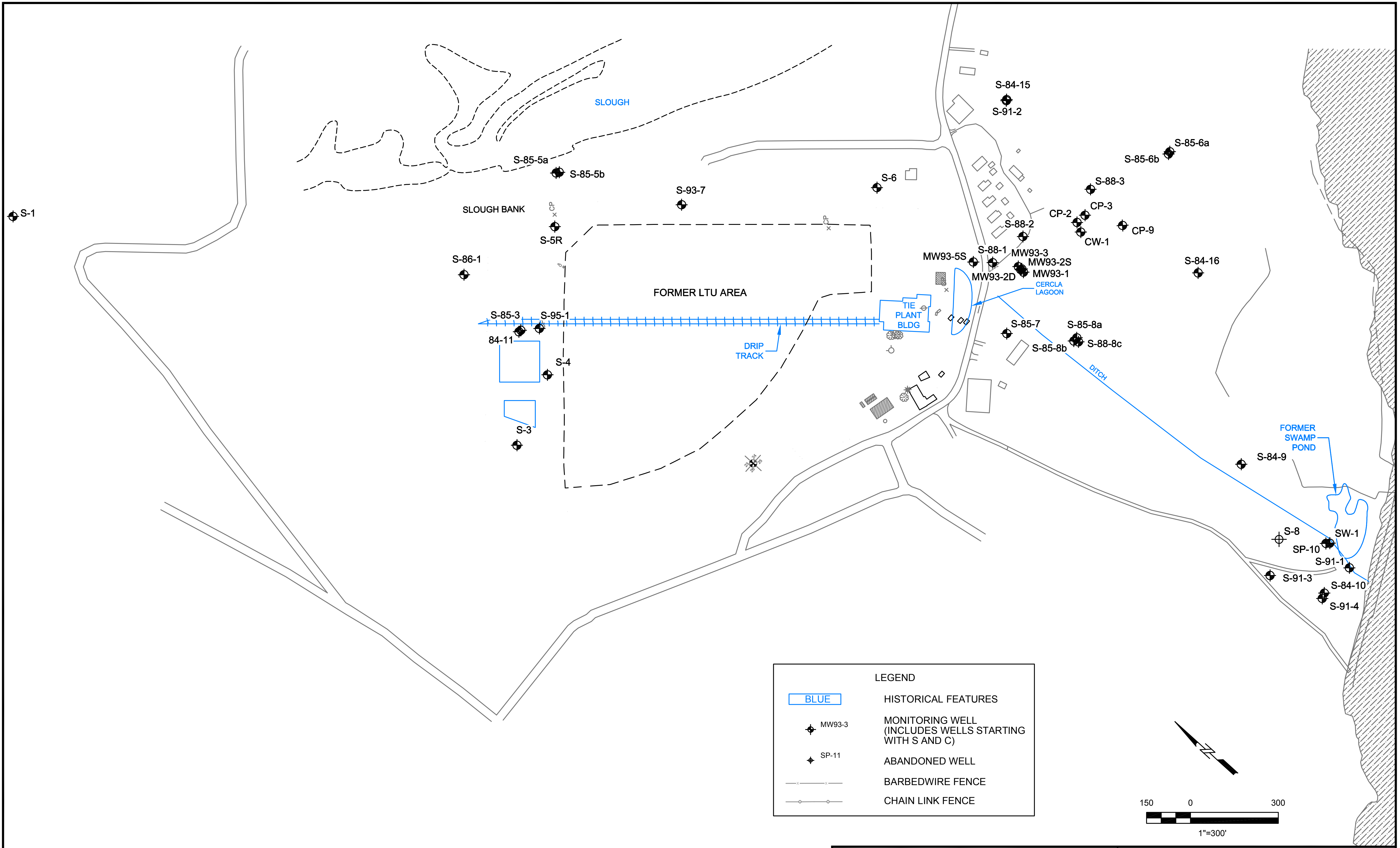
ENSR | AECOM

Request to Modify
Groundwater Treatment System
BNSF, Somers, Montana (01140176-241)

SITE CONCEPTUAL MODEL

DATE: 03/13/08
DRWN: E.S.S./DEN

FIGURE 5-1



ENSR | AECOM

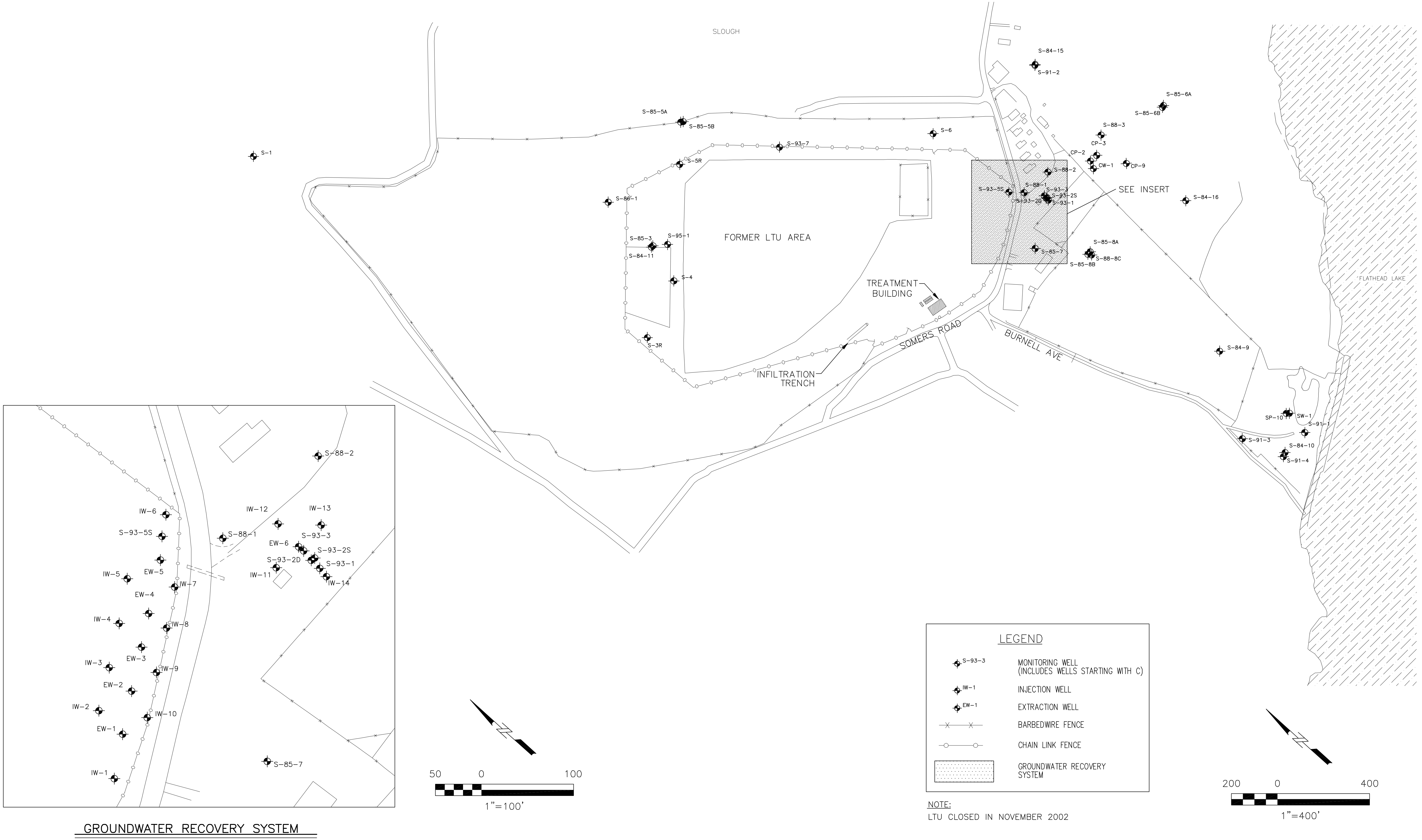
Request to Modify
Groundwater Treatment System
BNSF, Somers, Montana (01140176-241)

**HISTORICAL SITE FEATURES
AND STRUCTURES**

DATE: 03/13/08 | DRWN: E.S.S./DEN

FIGURE 2-2

File: J:\01140176\240\2008_GWTS_REQ\SOM-MGWTS_2-2.dwg Layout: Layout1 User: mawilliamson Plotted: Mar 27, 2008 – 8:59am Xref's:



LEGEND

S-93-3	MONITORING WELL (INCLUDES WELLS STARTING WITH C)
IW-1	INJECTION WELL
EW-1	EXTRACTION WELL
—×—×—	BARBEDWIRE FENCE
—o—o—	CHAIN LINK FENCE
▨	GROUNDWATER RECOVERY SYSTEM

NOTE:
LTU CLOSED IN NOVEMBER 2002

File: J:\01140176\230-07\2007 ANNUAL CERCLA\FIG1.dwg Layout: Layout1 User: mawilliamson Plotted: Apr 08, 2008 - 11:17am Xref's:

ENSR | AECOM

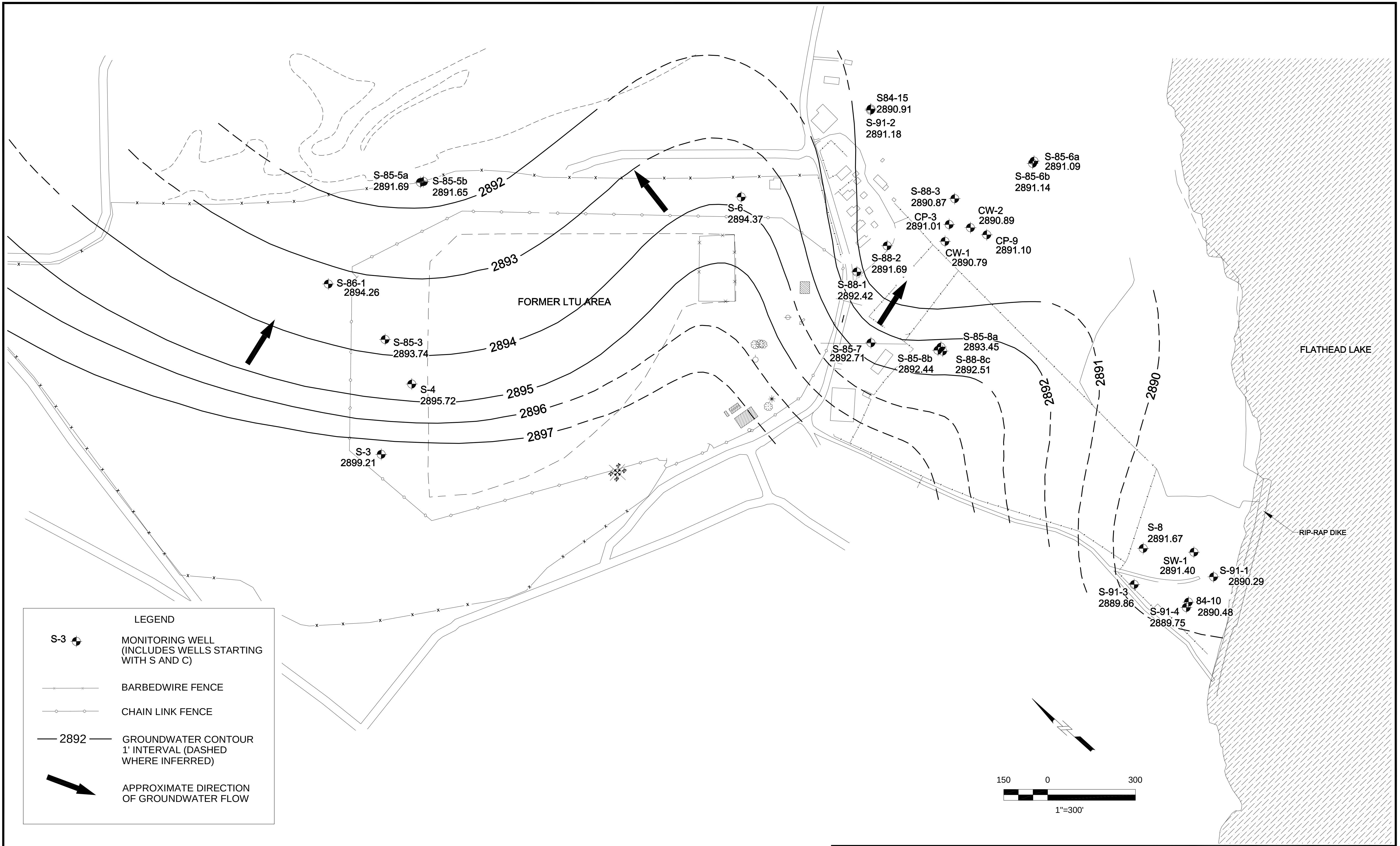
PHASE I GROUNDWATER REMEDY
ANNUAL CERCLA REPORT
01140-176-230

DATE: 4/08/08
DRWN: MAW/BIL

SITE LAYOUT

BNSF - SOMERS, MT

FIGURE 1



File: J:\01140176\240\2008_GWTS_REQ\SOM-MGWTS_4-1.dwg Layout: Layout1 User: mawilliamson Plotted: Mar 13, 2008 - 9:22am Xref's:

ENSR | AECOM

Request to Modify
Groundwater Treatment System

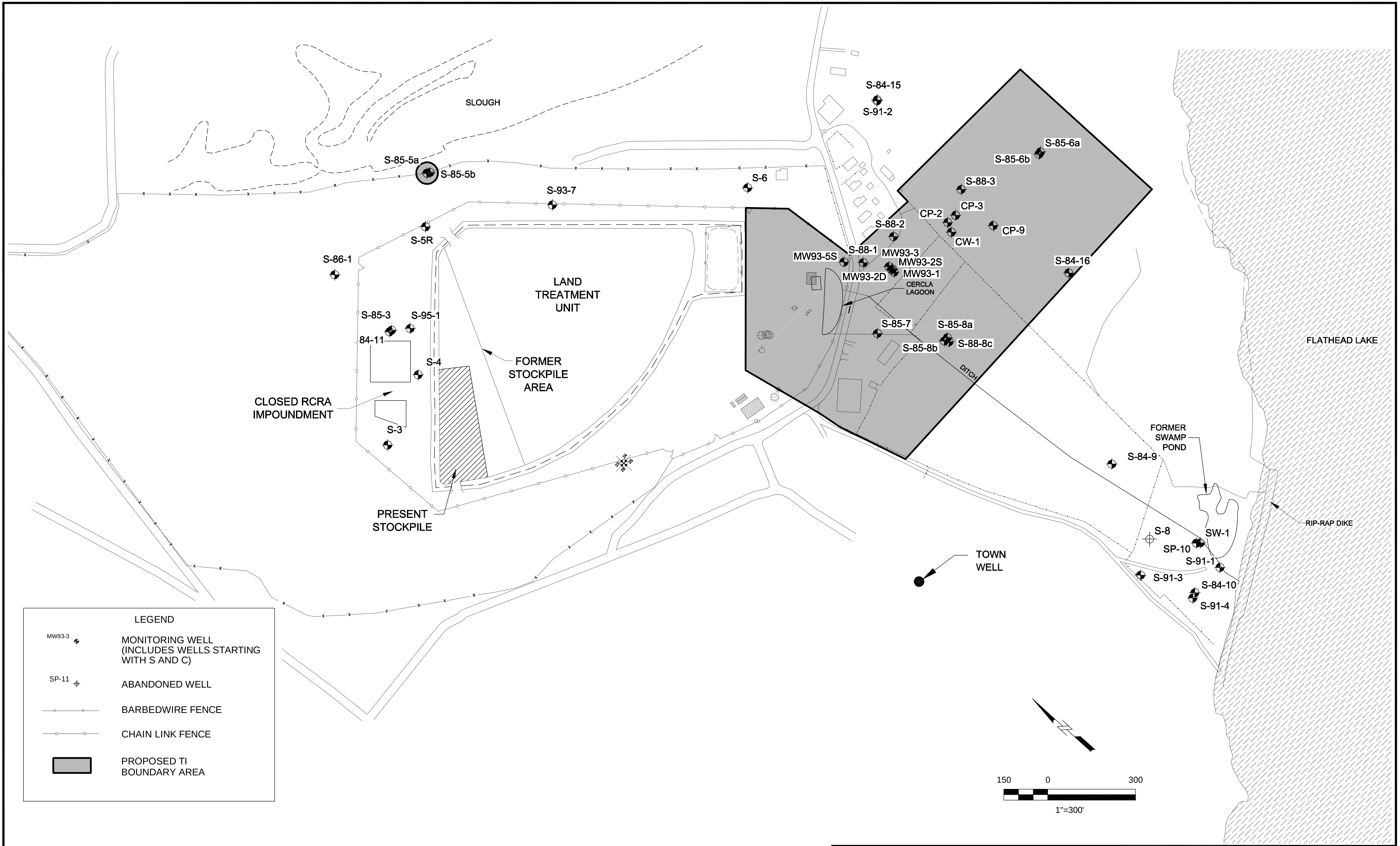
BNSF, Somers, Montana (01140176-241)

DATE: 03/13/08
DRWN: E.S.S./DEN

POTENTIOMETRIC SURFACE MAP
PRE-TREATMENT SYSTEM
MARCH 15, 1993

FIGURE 4-1

File: F:\PROJECTS\BNSF RAILWAY\01140_176 Somers\Golden Files_2006\01860\TI Nov2002\Figures\SOM-TIE_5-1.DWG Layout: Layout1 User: mawilliamson Plotted: Jul 23, 2008 - 7:24am Xref's:



Technical Impracticability Evaluation
for Groundwater Restoration
BNSF, Somers, Montana (BN080-01860-240)

PROPOSED TI BOUNDARY

DATE: 02/07/03
DRWN: RLL / E.S.S.

FIGURE 5-1

ATTACHMENT B
BIOSCREEN MODELING INPUT/OUTPUT

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Somers, MT
40-Year Simulation
Run Name

Data Input Instructions:

115	*1. Enter value directly....or*
↑ or	*2. Calculate by filling in grey cells below. (To restore formulas, hit button below).*
0.02	
Variable*	*Data used directly in model.*
20	*Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	25.6	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	2.5E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.002	*(ft/ft)*
Porosity	*n*	0.2	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	32.3	*(ft)*
Transverse Dispersivity*	*alpha y*	3.2	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	2000	*(ft)*

3. ADSORPTION

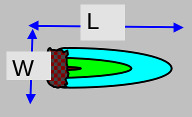
Retardation Factor*	*R*	2.7	*(-)*
or		↑ or	
Soil Bulk Density	*rho*	1.7	*(kg/l)*
Partition Coefficient	*Koc*	2000	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E-4	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	2.0E-2	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*	0.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	1.65	*(mg/L)*
Delta Nitrate*	*NO3*	0.7	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	16.6	*(mg/L)*
Delta Sulfate*	*SO4*	22.4	*(mg/L)*
Observed Methane*	*CH4*	6.6	*(mg/L)*

5. GENERAL

Modeled Area Length*	1500	*(ft)*
Modeled Area Width*	1000	*(ft)*
Simulation Time*	40	*(yr)*



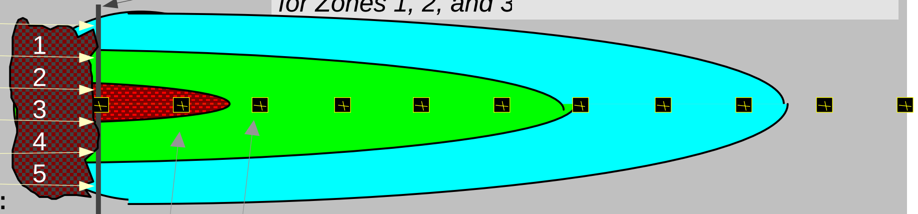
6. SOURCE DATA

Source Thickness in Sat.Zone* 25 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
10	0.1
25	1
50	10
25	1
10	0.1

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)		5.0	2.2		.12		.001				
Dist. from Source (ft)	*0*	*150*	*300*	*450*	*600*	*750*	*900*	*1050*	*1200*	*1350*	*1500*

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

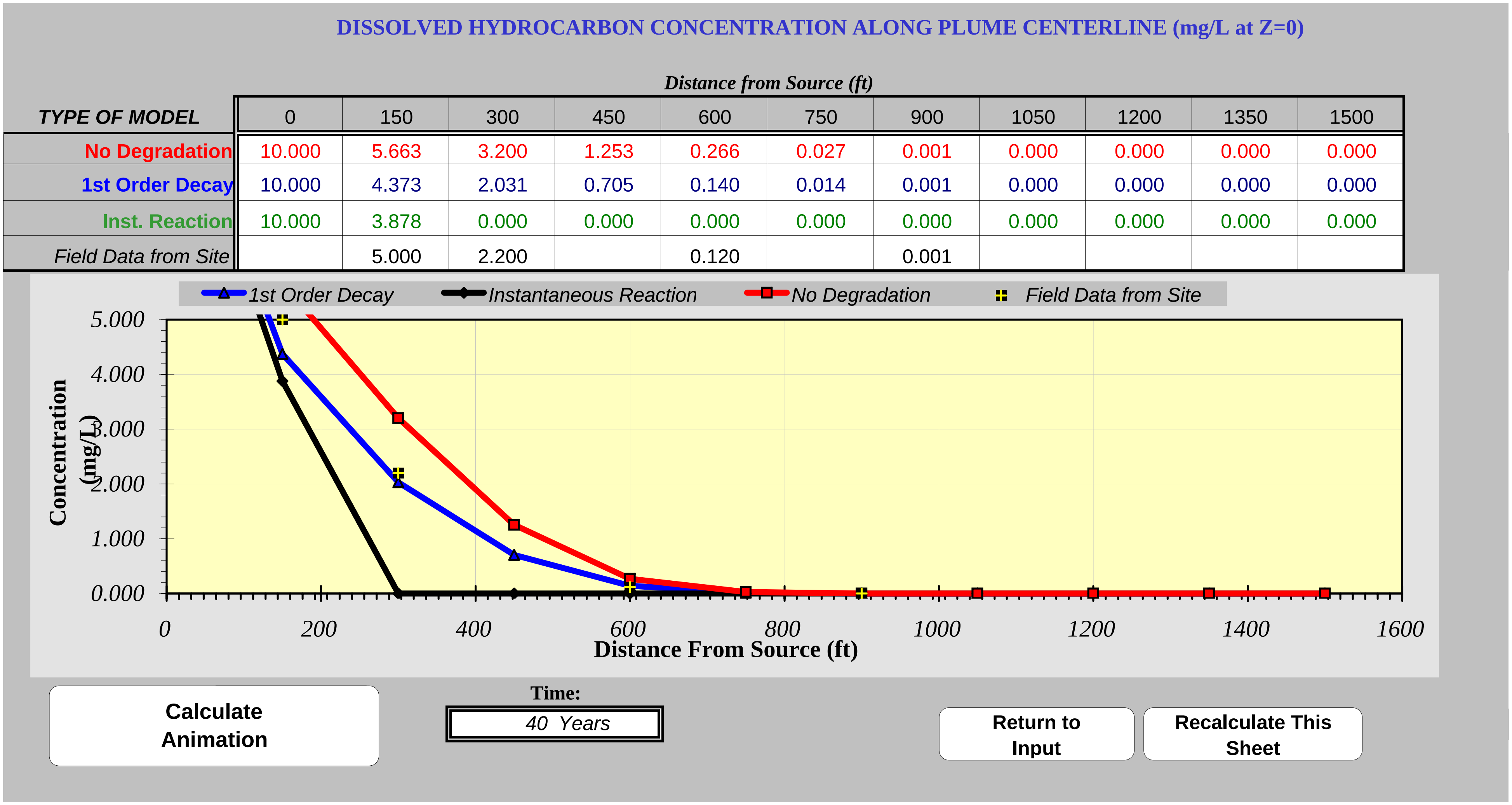
View Output

Help

Recalculate This Sheet

Paste Example Dataset

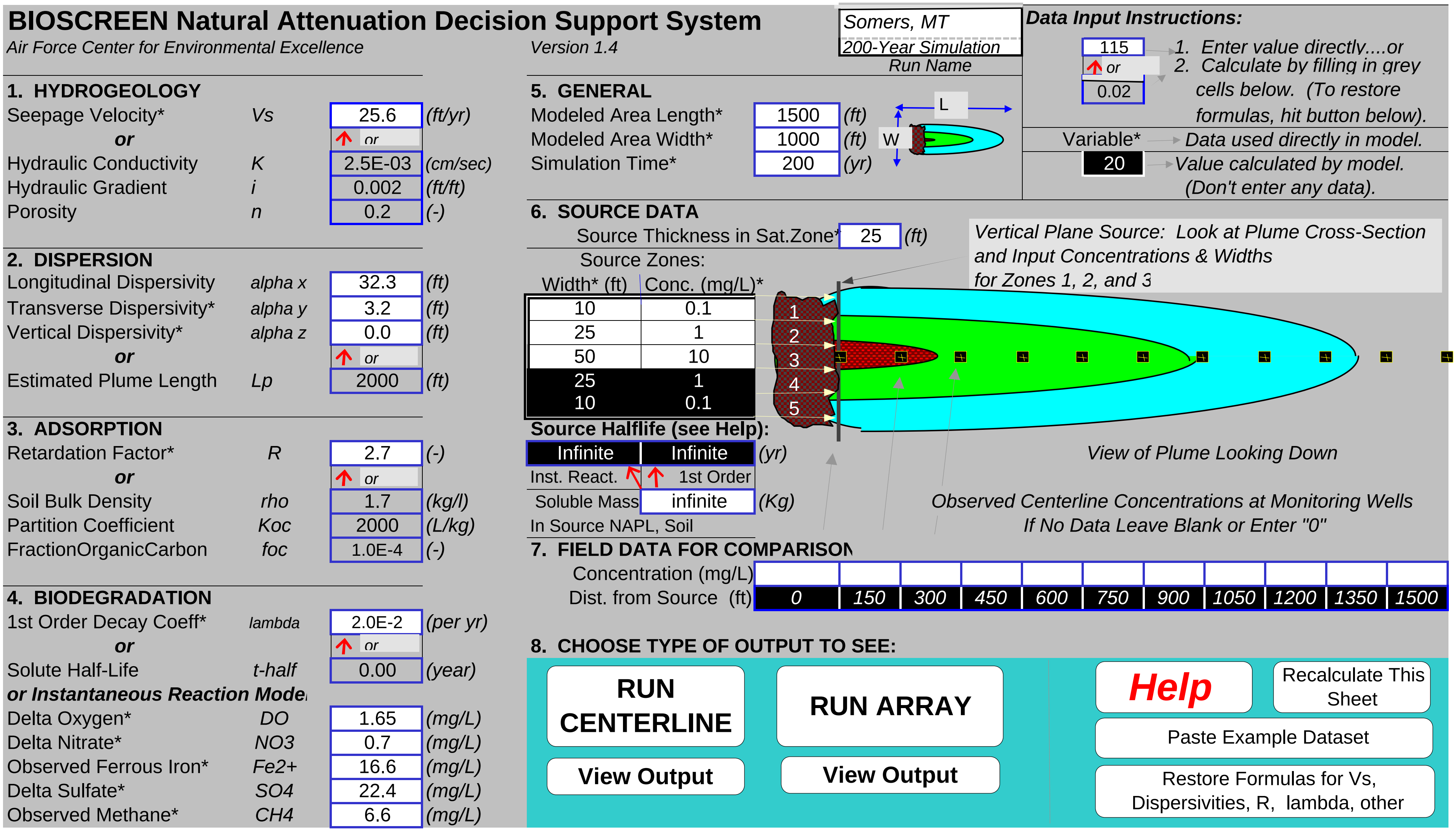
Restore Formulas for Vs, Dispersivities, R, lambda, other



DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	10.000	5.663	3.200	1.253	0.266	0.027	0.001	0.000	0.000	0.000	0.000
1st Order Decay	10.000	4.373	2.031	0.705	0.140	0.014	0.001	0.000	0.000	0.000	0.000
Inst. Reaction	10.000	3.878	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site		5.000	2.200		0.120		0.001				



BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Somers, MT
200-Year Simulation
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
or 2. Calculate by filling in grey
0.02 cells below. (To restore formulas, hit button below).

Variable* → Data used directly in model.

20 → Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	25.6	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	2.5E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.002	*(ft/ft)*
Porosity	*n*	0.2	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	32.3	*(ft)*
Transverse Dispersivity*	*alpha y*	3.2	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	2000	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	2.7	*(-)*
or		or	
Soil Bulk Density	*rho*	1.7	*(kg/l)*
Partition Coefficient	*Koc*	2000	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E-4	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	2.0E-2	*(per yr)*
or		or	
Solute Half-Life	*t-half*	0.00	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*	1.65	*(mg/L)*
Delta Nitrate*	*NO3*	0.7	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	16.6	*(mg/L)*
Delta Sulfate*	*SO4*	22.4	*(mg/L)*
Observed Methane*	*CH4*	6.6	*(mg/L)*

5. GENERAL

Modeled Area Length*	1500	*(ft)*
Modeled Area Width*	1000	*(ft)*
Simulation Time*	200	*(yr)*

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
10	0.1
25	1
50	10
25	1
10	0.1

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

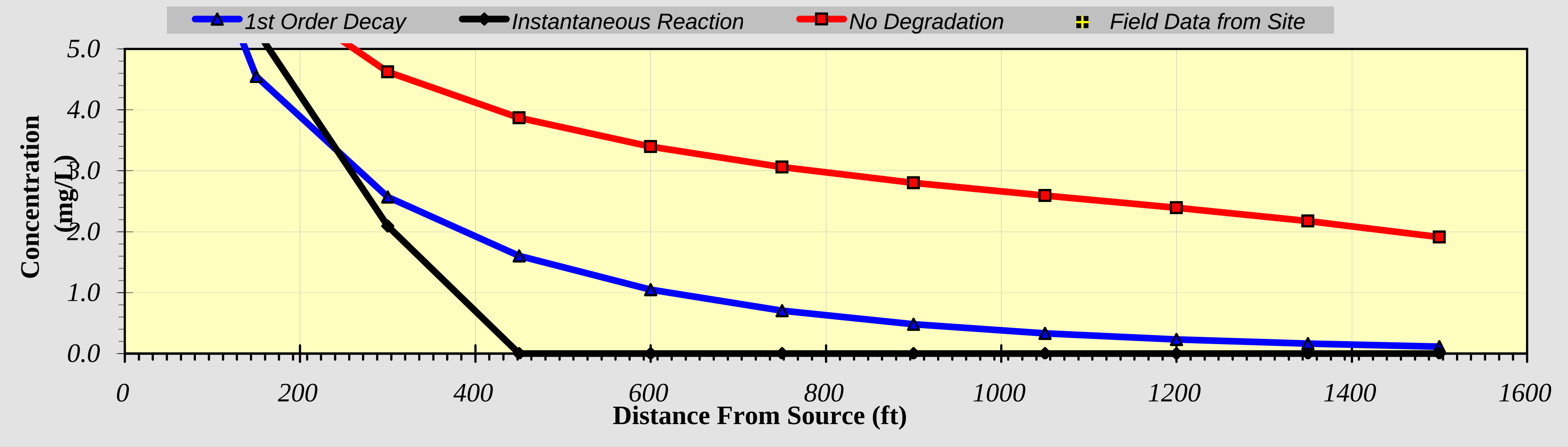
Concentration (mg/L)											
Dist. from Source (ft)	*0*	*150*	*300*	*450*	*600*	*750*	*900*	*1050*	*1200*	*1350*	*1500*

8. CHOOSE TYPE OF OUTPUT TO SEE:

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	10.000	6.102	4.623	3.871	3.396	3.060	2.804	2.591	2.392	2.176	1.913
1st Order Decay	10.000	4.548	2.569	1.603	1.048	0.704	0.482	0.334	0.233	0.162	0.112
Inst. Reaction	10.000	5.313	2.091	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation

Next Timestep

Prev Timestep

Time:

200 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

Somers, MT
120-Year Simulation
Run Name

Data Input Instructions:

115 ↑ or 0.02	*1. Enter value directly....or* *2. Calculate by filling in grey cells below. (To restore formulas, hit button below).*
Variable*	*Data used directly in model.*
20	*Value calculated by model.* *(Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	25.6	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	2.5E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.002	*(ft/ft)*
Porosity	*n*	0.2	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	32.3	*(ft)*
Transverse Dispersivity*	*alpha y*	3.2	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	2000	*(ft)*

3. ADSORPTION

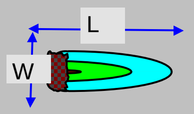
Retardation Factor*	*R*	2.7	*(-)*
or		↑ or	
Soil Bulk Density	*rho*	1.7	*(kg/l)*
Partition Coefficient	*Koc*	2000	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E-4	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	2.0E-2	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*	0.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	1.65	*(mg/L)*
Delta Nitrate*	*NO3*	0.7	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	16.6	*(mg/L)*
Delta Sulfate*	*SO4*	22.4	*(mg/L)*
Observed Methane*	*CH4*	6.6	*(mg/L)*

5. GENERAL

Modeled Area Length*	1500	*(ft)*
Modeled Area Width*	1000	*(ft)*
Simulation Time*	120	*(yr)*



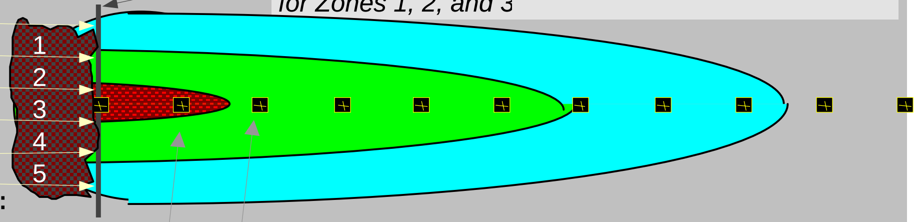
6. SOURCE DATA

Source Thickness in Sat.Zone* 25 *(ft)*

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

Source Zones:

Width* (ft)	Conc. (mg/L)*
10	0.1
25	1
50	10
25	1
10	0.1



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	*0*	*150*	*300*	*450*	*600*	*750*	*900*	*1050*	*1200*	*1350*	*1500*

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

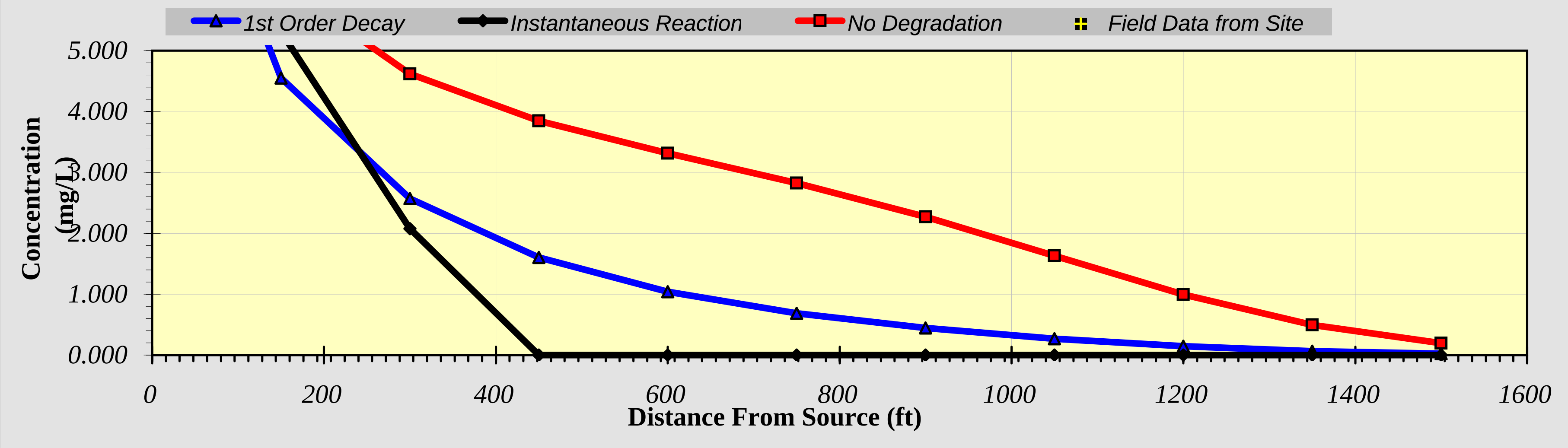
Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	150	300	450	600	750	900	1050	1200	1350	1500
No Degradation	10.000	6.101	4.618	3.849	3.315	2.825	2.270	1.630	0.995	0.496	0.196
1st Order Decay	10.000	4.548	2.568	1.601	1.042	0.687	0.443	0.268	0.144	0.065	0.024
Inst. Reaction	10.000	5.311	2.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Time:

120 Years

Return to Input

Recalculate This Sheet