UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
EMERGENCY RESPONSE BRANCH
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GROSSE ILE, MI 48138-1697

July 18, 2013

REPLY TO ATTENTION OF:

Mr. Pete Cappel
Mr. Nick Billings
AIMCO
4582 S. Ulster Street, Suite 1100
Denver, Colorado 80237

**RE: West Vermont Street Drinking Water Contamination Site (B5UJ)
Speedway, Marion County, Indiana**

Dear Messrs. Cappel and Billings:

The U.S. Environmental Protection Agency completed its review of the *Technical Response to "Technical Memorandum: Analytical and Hydrogeological Evaluation, West Vermont Street Site, Speedway, Marion County, Indiana," Prepared for USEPA by Weston Solutions, Inc. (January 30, 2013)*. The *Technical Response* was prepared by R.C. Minning & Associates, Inc. and Mundell & Associates, Inc. on behalf of AIMCO Michigan Meadows Holdings, LLC (AMMH) for the Michigan Plaza Site in Indianapolis, Indiana.

The *Technical Response* makes three arguments as to why the Michigan Plaza Site could not be a contributor to groundwater contamination in residential wells at the West Vermont Drinking Water Contamination Site (also referred to as the West Vermont Site, West Vermont, or the Residential Area). Each of the arguments and EPA's response is presented below.

Potentiometric Surface and Direction of Flow

AMMH's *Technical Response* states that "the first and foremost factor to consider is the direction of groundwater flow. That is, the [West Vermont] Site must be or must have been down-gradient of the Source Areas and groundwater flow lines passing through one or more of the Source Area also must pass through the [West Vermont] Site."

There are few comprehensive potentiometric surface maps that show temporal and spatial variation of groundwater conditions throughout the entire area of the West Vermont Site, and those that exist were prepared by EPA. Even with EPA's comprehensive potentiometric maps, there is a lack of site-wide spatial and temporal data to accurately discern changes in flow directions in critical areas throughout time. As such, EPA had to rely on other data to evaluate claims that the Michigan Plaza plume only flows to the south or southeast. EPA believes that there are many factors to groundwater flow direction that the *Technical Response* and previous reports for the Michigan Plaza Site do not consider, such as the extent of the Michigan Plaza source areas, preferential pathways, effects of surface water flow on groundwater flow, effects of various groundwater pumping regimes on groundwater flow, and a detailed analysis of groundwater flow at or near Michigan Plaza.

Source Areas

The Source Areas (referenced in various reports as Source Areas A, B, and C) have not been fully delineated. AMMH has defined the Source Areas as locations where the sanitary sewer line turns and where tetrachloroethene (PCE) is likely to have leaked from the sewer. However, AMMH has not fully delineated these sources. In meetings with EPA, IDEM indicated that the pump station for the sanitary sewer lines did not function at certain periods in time causing backups along the sewer, forcing flow to the west. This sanitary sewer line trends west to east, north of West Michigan Street on the Michigan Meadows Apartments property. In a meeting with EPA in March 2013, AMMH indicated that Source Area B was expanded to the west based on soil and groundwater data EPA collected in November and December 2011 along the sanitary sewer line in an area where sewer backups would have occurred; this area had not been adequately investigated prior to EPA's work.

The Indiana Department of Environmental Management (IDEM) stated in a letter to AIMCO (parent company of AMMH) dated June 22, 2011 that "IDEM cannot concur that the Michigan Plaza source areas and groundwater plume are fully defined" and that "it is inaccurate to definitively state that the source areas are fully delineated or that the vinyl chloride in the residential drinking water well cannot be from the Michigan Plaza source areas." In another letter dated November 1, 2012 to AIMCO about the Michigan Plaza Site, IDEM reiterated that "the interpretation of the plume's nature and extent is unsupported." Therefore, it is difficult to assert that the West Vermont Site is not down-gradient of the Michigan Plaza Source Areas as the full extent of contamination has not been adequately defined.

Preferential Pathways

The sanitary sewer line referenced above is a known contaminant migration pathway that caused PCE to flow north, contrary to groundwater flow, onto the Michigan Meadows Apartments property and comingle with a plume from the Genuine Parts site. The extent of contamination flowing through and from this sewer line has not been fully delineated. In their June 22, 2011 letter to AIMCO, IDEM stated that "a review of the 2005 sewer line investigation shows that the line along the immediate west side of the Michigan Plaza building was in poor condition, with worn joints and sags in the line. Since this part of the line was in similar condition to the lines in the known source area, is closer to the dry cleaner, and has not been investigated, it is inaccurate to definitively state that the source areas are fully delineated or that the vinyl chloride in the residential drinking water wells cannot be from the Michigan Plaza source areas."

AMMH's consultant, Mundell & Associates (Mundell), encountered another sewer line approximately three ft below ground surface (bgs) while installing groundwater monitoring well MMW-P-11B. According to information provided by Mundell, the sewer line belongs to Floral Park Cemetery and is aligned east to west along the northern edge of the Floral Park parking area. AMMH has assumed that "there is no preferential pathway caused by the construction of the sewer" (Mundell, December 21, 2012). As such, this sewer line has not been investigated as a preferential pathway despite being less than 80 feet down-gradient of Source Area A and 200 feet up-gradient of the nearest contaminated residential well.

Effects of Surface Water on Groundwater Flow

The West Vermont area has complex groundwater flow due to the many hydraulic stresses. One of the factors influencing groundwater flow is surface water. There are two creeks in the West Vermont area, Eagle Creek to the west and southwest and Little Eagle Creek to the east. Both of these creeks affect groundwater gradients.

There have been two recent low-flow events on Eagle Creek that would have had significant impacts on groundwater gradient flow directions. One low-flow event occurred May through December of 2007 (Figure 1) and another from July through December 2008 (Figure 2). The effects of these low-flow stream conditions on groundwater flow can be compared to the well-studied state-wide drought in 1988, although the effects of the 2007 event exceeded the 1988 state-wide drought (Figure 3). In 1988, groundwater levels throughout the state were affected by a significant drought, as described in the 1992 U.S. Geological Survey (USGS) report 91-4100, "*Description and Effects of 1988 Drought on Ground Water Levels, Streamflow and Reservoir Levels In Indiana.*" The USGS reported that as groundwater levels declined in 1988, particularly in areas of extensive irrigation, problems of water distribution and use occurred. The USGS report states that "ground-water levels were affected substantially in many areas of the State. Record low-water levels were observed at 12 of the 20 monitoring wells included in [the] report." In another study the Illinois Department of Natural Resources (1994) stated that "streamflow during a drought period originates almost entirely from subsurface storage that seeps into the streambed." In other words, during drought conditions stream flow is derived from groundwater.

During 2007, stream flow gaging stations on Eagle Creek, as well as the monthly mean stream flows, approached record low flows similar to the 1988 calendar year. A similar five-month low-flow event occurred in the Eagle Creek during July through December of 2008. These recent low-flow events, or droughts, in Eagle Creek occurred at approximately the same time as one of the CAP18 injections at Michigan Plaza. The stresses on surface water flow would likely have had a similar effect on groundwater to those described in the 1992 USGS report and would likely have caused a more westerly or southwesterly flow of groundwater from Michigan Plaza toward Eagle Creek.

The Eagle Creek long-term (72 year) monthly mean stream flow ranges from a low of 38 cubic feet per second (cfs) (August) to a high of 312 cfs (March) with annual mean of 164 cfs (Figure 4 and Table 1). The large temporal variations between the extended low-flow drought-like conditions (about 11 cfs) in 2007 and 2008 and normal monthly mean flow conditions of these two creeks would affect groundwater flow gradients by creating a gaining stream.

No consideration of the changes in groundwater flow gradients due to changes in the stream flow conditions have been presented in the *Technical Response* or other reports for Michigan Plaza.

Effects of various groundwater pumping regimes on groundwater flow

There are at least three different pumping systems in relatively continuous operation in the site-wide area, including 25 residential drinking water wells and two Allison Transmission remediation systems at Areas of Interest (AOI) 40 and 51, with AOI-40 west and the AOI-51 system northwest of the West Vermont Site. These remediation systems directly affect groundwater gradients. There are also golf course irrigation wells located directly west of the residential wells on the west side of Eagle Creek that may affect groundwater gradients.

According to EPA's WaterSense Program, the average household uses 400 gallons of water per day. Multiplying this average daily use value by the number of homes in the West Vermont area results in a daily withdrawal of groundwater in the range of 8,000 to 10,000 gallons per day, or between 1069.4 to 1336.8 cubic feet per day (ft^3/day). Groundwater withdrawal could be as much as three to four times these amounts when considerable lawn irrigation is occurring. Based on general groundwater capture zone calculations and assuming that an average pumping rate of 1,203.1 ft^3/day is occurring from one well located in the approximate centroid of the 25 residential wells, the maximum extent of the zone of capture (Ymax) would likely extend past Holt Road close to groundwater monitoring wells MW-170S/D. If there was considerable lawn irrigation occurring, combined pumping rates up to 3,500 ft^3/day could occur. Under these rates, the zone of capture of the combined residential wells would extend east of the center of the Michigan Plaza contaminant plume.

There is a significant capture zone that the Allison Transmission AOI-51 remediation system creates while it is operating. There are a number of Allison Transmission potentiometric maps that show potentiometric lines trending northwest to southeast (Figures 5a and 5b). In the northeast quadrant of the figures, the down-gradient flow direction is to the west-southwest. It appears that the groundwater extraction system may in part cause this southwest flow in groundwater. This west-southwest gradient may extend into the groundwater under Michigan Plaza. However, due to an insufficient number of monitoring wells in this area, one cannot determine how far to the southeast this west-southwest trending groundwater occurs.

The spatial extent of capture zones created by groundwater extractions systems, such as the residential wells and the Allison Transmission remediation systems, will normally increase in extent in response to the drought, such as in 2007 and 2008, inducing flatter groundwater gradients and causing more westerly or southwesterly groundwater flow from Michigan Plaza toward Eagle Creek. The combined effect of these areas of considerable groundwater extraction could have been a factor in the westward migration of the Michigan Plaza plume. During low-flow drought conditions, these hydraulic stresses would tend to increase their extent of capture.

Detailed analysis of groundwater flow

There are a number of historic potentiometric surface maps prepared for the Michigan Plaza Site and presented in AMMH's *Technical Response* that show a west-southwest component of groundwater flow gradient. The method of triangulation appears to show gradient flow directions greater than 180 to 351 degrees for many triplicates source area monitoring wells for different dates of measurement. Figure 20 of the *Technical Response*, with sampling data from 12/12-14/2007, had at least four triplicates that showed gradient flow directions of 190, 219, 242 and

274 degrees, with north representing 0 degrees. Figure 25 in the *Technical Response* (sampling date of 8/5/2009) had at least five triplicates that showed gradient directions of 237, 253, 239, 302, and 351 degrees. These flow gradients show that some part of the groundwater plume from Michigan Plaza Site was migrating toward the Residential Area.

There are a number of issues that limit interpretation of groundwater flow directions with the potentiometric maps presented in AMMH's *Technical Response*. There are critical areas within these maps that have large spatial and temporal data gaps with no groundwater elevation data. Furthermore, the *Technical Response* omits the influence of considerable groundwater extraction or the effects of surface water stresses on groundwater flow. Additionally, maps in the *Technical Response* show that part of the Michigan Plaza plume flowed to the west or southwest, and migrated toward the Residential Area. Therefore, EPA does not agree with the conclusion in the Technical Response that groundwater could not flow from Michigan Plaza or its off-site Source Areas to the Residential Area wells.

Influence of CAP18 Injections

The *Technical Response* discusses the influence of CAP18 injections on groundwater by presenting information on groundwater flow and vinyl chloride detections in wells between Michigan Plaza and the Residential Area wells.

Groundwater Flow Direction

The *Technical Response* argues that Michigan Plaza could not be a contributor to residential well contamination despite injecting CAP18 into the groundwater and dramatically increasing concentrations of cis-1,2-dichloroethene (DCE) and vinyl chloride by several orders of magnitude. This argument is based on the premise that CAP18 injections did not cause groundwater mounding and, therefore, could not have increased hydraulic head or changed groundwater flow direction.

AMMH collected relatively little data to support the argument that CAP18 injections did not cause changes in hydraulic conductivity, groundwater levels, or groundwater flow direction. AMMH did not collect any antecedent water level data prior to CAP18 injections. The *Technical Response* instead refers to groundwater elevation data collected in June 2007, two months prior to CAP18 injections, as antecedent data. Generally, antecedent data is collected a few days prior to aquifer tests or injections.

AMMH collected very little water level data during or after CAP18 injections. For example, Source Area A injections were conducted from August 16 to September 4, 2007. AMMH's consultant began monitoring water levels in Source Area A wells on August 23, 2007 – one week after injections started. Water levels in Source Area A were measured again on August 28, 29, 30, 31, and September 4, 2007. As such, there is insufficient data to conclude that CAP18 injections had no influence on groundwater mounding or flow.

PCE is a principal contaminant and not a degradation daughter product. Therefore, PCE concentrations should not increase after CAP18 injections. Figure 4 in the *Technical Response* shows increases of PCE after the 2007 CAP18 treatment in several groundwater monitoring wells. The hydraulic action of injecting liquids into the aquifer may have also hydraulically mobilized daughter products of PCE, including trichloroethene (TCE), cis-1,2-DCE, and vinyl chloride. The additional mobile mass of PCE within the aquifer would also likely lead to increased concentrations of degradation daughter products TCE, cis-1,2-DCE and vinyl chloride. Following CAP18 injections, vinyl chloride in monitoring well MMW-P-08 increased from about 6,000 micrograms per liter (ug/L) to about 10,000 ug/L; MMW-P-07 increased from about 2,900 ug/L to about 5,200 ug/L; MMW-P-9S increased from about 900 ug/L to about 1,500 ug/L; MMW-10S increased from about 90 ug/L to about 540 ug/L; MMW-P-01 increased from about 240 ug/L to about 350 ug/L. These rebounding concentrations indicate that the hydraulic action of injecting liquids into the aquifer may have hydraulically mobilized PCE. EPA collected groundwater samples in June 2013 from EPA's groundwater monitoring wells. PCE was detected in monitoring well MW-WES-01c at a concentration of 6.0 ug/L. Therefore, it is likely that CAP18 injections not only increased the production of PCE daughter products, but may have also mobilized PCE contamination within the aquifer.

To gain additional information on groundwater characteristics and presumably to test whether mounding occurred after CAP18 injections, AMMH conducted slug tests on seven wells on March 29 and April 1, 2013. EPA (1994) has determined that slug test data are limited to the hydraulic conductivity of the area immediately surrounding the well being tested, and may not be representative of the average hydraulic conductivity of the entire area. Therefore, it is incorrect for AMMH to draw conclusions about the average hydraulic conductivity for the entire site based on limited slug test data in a few monitoring wells.

Analysis of VC Detections at MW-170D

In Weston's Technical Memorandum, Weston stated that vinyl chloride concentrations increased in monitoring well MW-170D approximately 10 to 17 months after each CAP18 injection. The *Technical Response* states that "there are a number of difficulties with attributing variations in VC [vinyl chloride] at MW-170D to the CAP18 injections. First, VC was detected at MW-170D at a level of 80 ug/L as early as 2001, almost six (6) years prior to remediation activities at the Michigan Plaza/Apartments properties. Therefore, this VC could not have been caused by remediation activities that were not undertaken until six years later."

EPA agrees, and it is stated as such in the Weston memo, that low level vinyl chloride contamination in monitoring well MW-170D was not initially caused by the active remediation at Michigan Plaza but likely resulted from the natural degradation of a large comingled plume migrating from both the Genuine Parts Site to the north and the leaking sewer lines from Michigan Plaza/Michigan Meadows Apartments. Attributing all the vinyl chloride contamination to the Genuine Parts site does not explain increases in vinyl chloride concentrations in the area following CAP18 injections in monitoring well MW-170D or other monitoring wells.

AMMH's *Technical Response* also implies that it is not possible for vinyl chloride to have traveled from the Source Areas in the same time frame (10 to 17 months) in which vinyl chloride increases were detected in monitoring well MW-170D. The distance between Source Area B and monitoring well MW-170 is approximately 450 feet, according to AMMH's *Technical*

Response. The AMMH *Technical Response* based the time travel calculations on an average hydraulic conductivity of 70 feet/day from the slug tests, although as noted above the methodology used to calculate that hydraulic conductivity has limited applicability across the entire site.

EPA used Darcy's Law to calculate the amount of time needed to travel from monitoring well MMW-8S in Source Area B to monitoring wells MW-170S/D using the average, minimum, and maximum hydraulic conductivities provided in the Technical Response. Groundwater from MMW-8S could have arrived at MW-170D in as little as nine months. Using the distance from the northwest corner of Michigan Plaza to MW-170S/D and hydraulic head data from monitoring wells MMW-P-12S/D and MW-170S/D, groundwater could travel to MW-170D in as little as eight months.

Using data from the Michigan Plaza quarterly monitoring reports, EPA determined that vinyl chloride began to increase in monitoring well MMW-8S in Source Area B almost immediately following CAP18 injections (NOTE: Monitoring wells MMW-P-12S/D were not drilled until the third quarter of 2011 so data following CAP18 injections from these wells are not available). The first CAP18 injection was conducted from August 1-16, 2007 in Source Area B.

According to Barbee (1994) citing Feenstra and Cherry (1988), "in the saturated zone, CHCs [chlorinated aliphatic hydrocarbons] tend to be mobile for several reasons. First, as concentrations below their water solubility limit, CHCs will dissolve in ground water, enhancing their mobility in it. Second, when CHCs are dissolved in ground water, the density of the solution is increased so slightly as to have little or no effect on their mobility. Third, as uncharged nonpolar molecules, CHC migration as dissolved constituents is not strongly attenuated by soils and geologic materials."

Mobility of an organic contaminant is based on a combination of solubility(s) and soil adsorption (Koc) (Cohen and Mercer,1993; Ney, 1990). Vinyl chloride, a CHC, has a reported water solubility of 2,700 milligrams per liter (mg/L) and a Koc of 56. As such, vinyl chloride is highly mobile in groundwater.

Vinyl chloride could have arrived in monitoring well MW-170D from Source Area B as early as March 2008. Prior to CAP18 injections in February 2007, vinyl chloride was detected at a concentration of 105 ug/L in MW-170D. In June 2008, the vinyl chloride concentration had increased to 230 ug/L. The data indicate that vinyl chloride could indeed have traveled from one of the Source Areas (Source Area B, in this case) in a time frame of 10 to 17 months or less. As such, EPA does not agree with AMMH's conclusion that "non-degrading and non-retarding VC impacts might be expected to arrive at a distance of 450 ft down-gradient of the injection location after about 4.6 years."

Blind Drilled Wells

In March 2013, Mundell drilled soil borings to collect geologic data around several monitoring wells that were initially blind drilled. After drilling soil borings, AMMH concluded that their geologic data "confirms the continuity of the upper glacial till surface in the vicinity of MMW-P-

10S/D that acts as a boundary to the vertical extent of chlorinated solvent impacts near the Source Areas."

It is very confusing which unit is referred to as the upper glacial till unit as it is not labeled as such on cross-sections or boring logs in the *Technical Response*. Cross-section C-C' (*Technical Response* Figure 35) shows three clay (till) units encountered while drilling soil borings around monitoring wells MMW-P-10S/D. The C-C' cross-section shows that the upper two units are discontinuous, which does not support AMMH's claim that the upper glacial till surface acts as a boundary to contaminant migration. AMMH shows a continuous lower clay unit. However, it is unclear why this unit is depicted as being continuous as very few of the AMMH monitoring wells are deep enough to encounter the lower clay unit and the few that do only penetrate the unit a foot or two at most. The cross-sections in the Weston Technical Memo show that this lower till unit is interspersed with sand and silt unit and may not be continuous throughout the site area. Therefore, AMMH lacks sufficient data to claim that this lower clay surface acts as a boundary to contaminant migration.

Conclusions

The *Technical Response* makes claims and conclusions supported by insufficient data. The data EPA has collected, reviewed, and analyzed conflicts with the conclusions in AMMH's *Technical Response*. As such, EPA does not agree with its conclusions. EPA concluded that the most likely source of vinyl chloride contamination in groundwater affecting the residential wells is a comingled plume from both the Michigan Plaza and Genuine Parts Sites.

Sincerely,

Shelly Lam
ty

Shelly Lam, LPG
Federal On-Scene Coordinator

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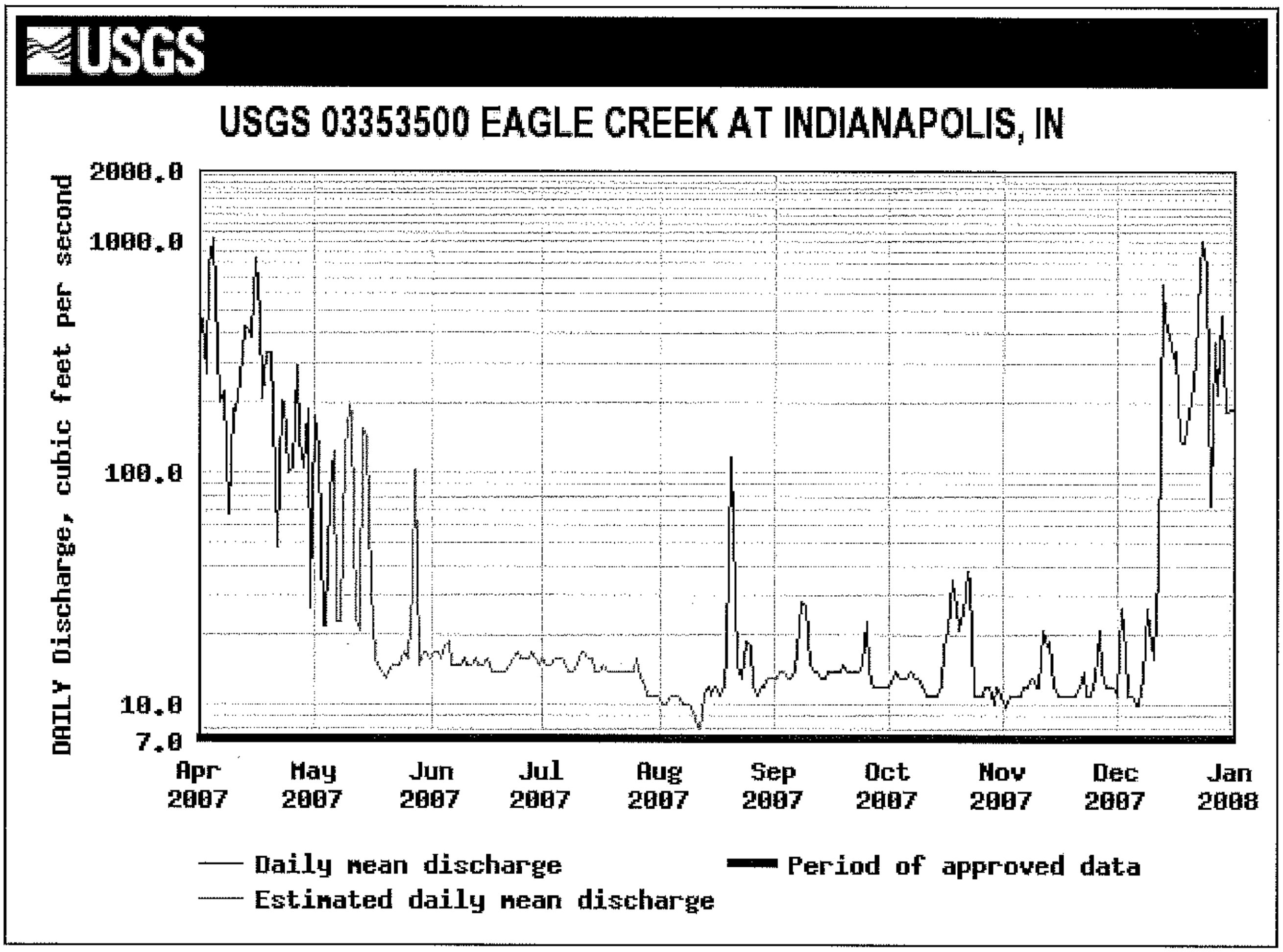
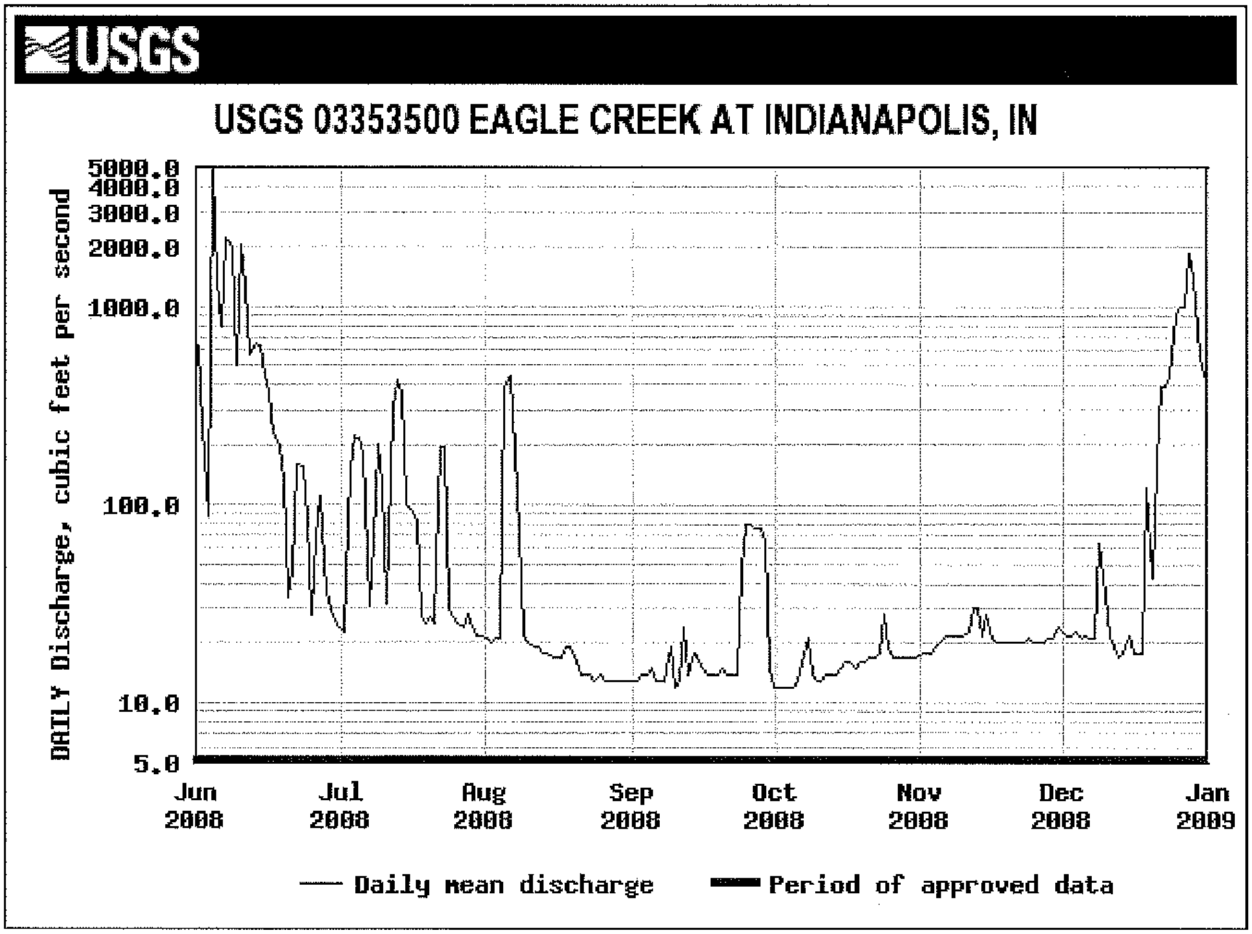
FIGURES AND TABLE

Figure 1
Eagle Creek Gaging Data
April 2007 – January 2008



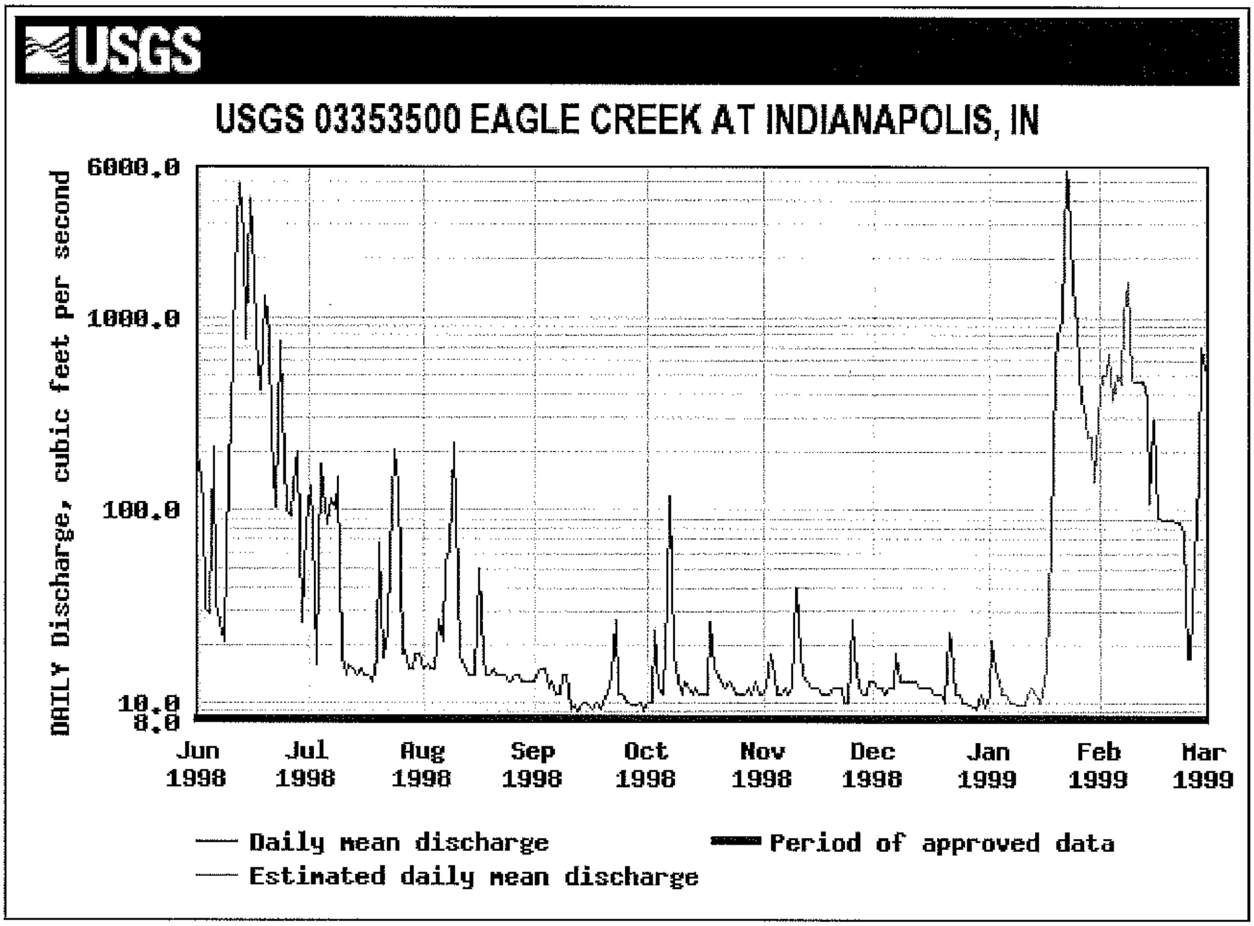
Source: US Geological Survey

Figure 2
Eagle Creek Gaging Data
June 2008 to January 2009



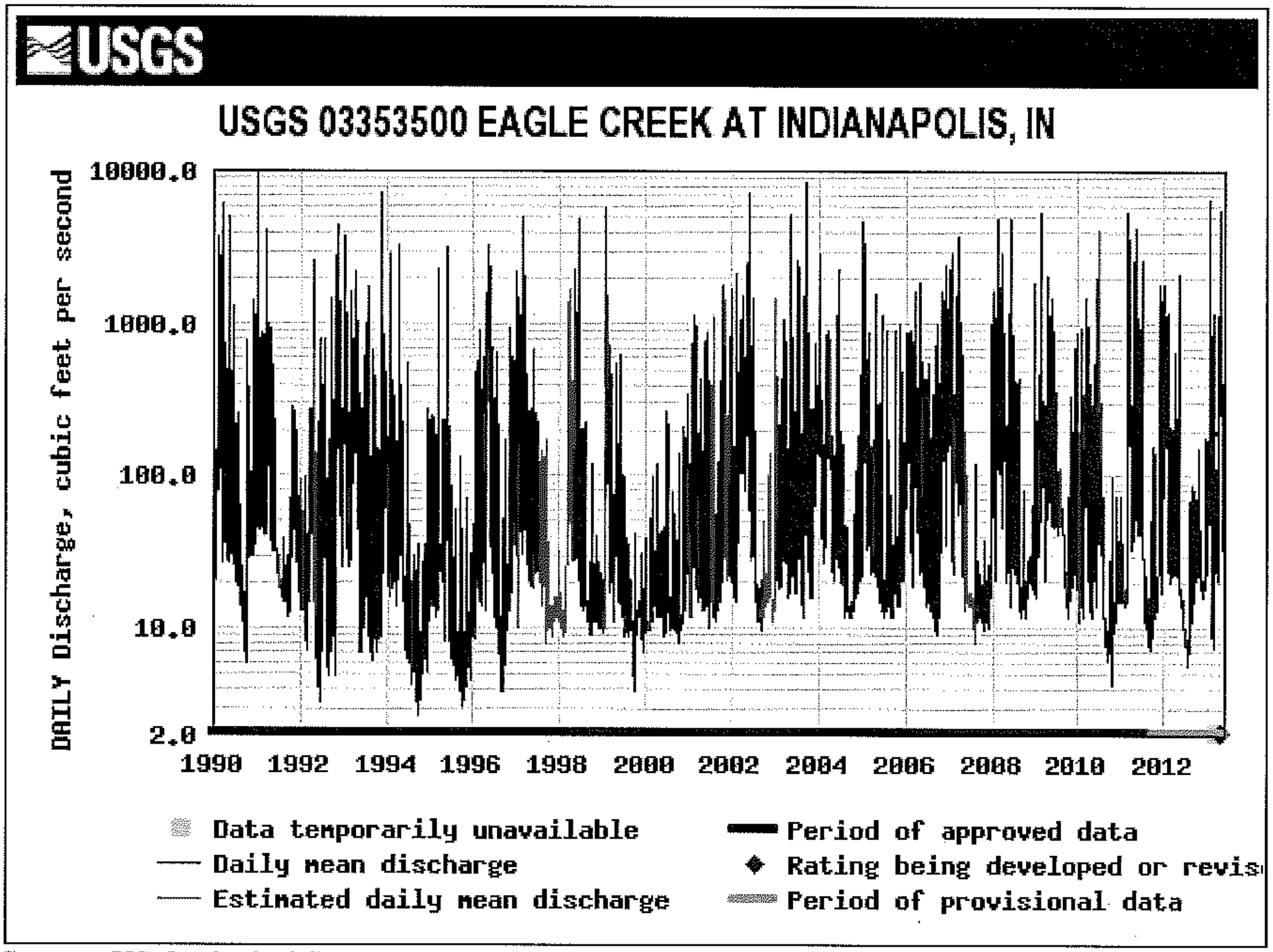
Source: US Geological Survey

Figure 3
Eagle Creek Gaging Data
June 1998 59 March 1999



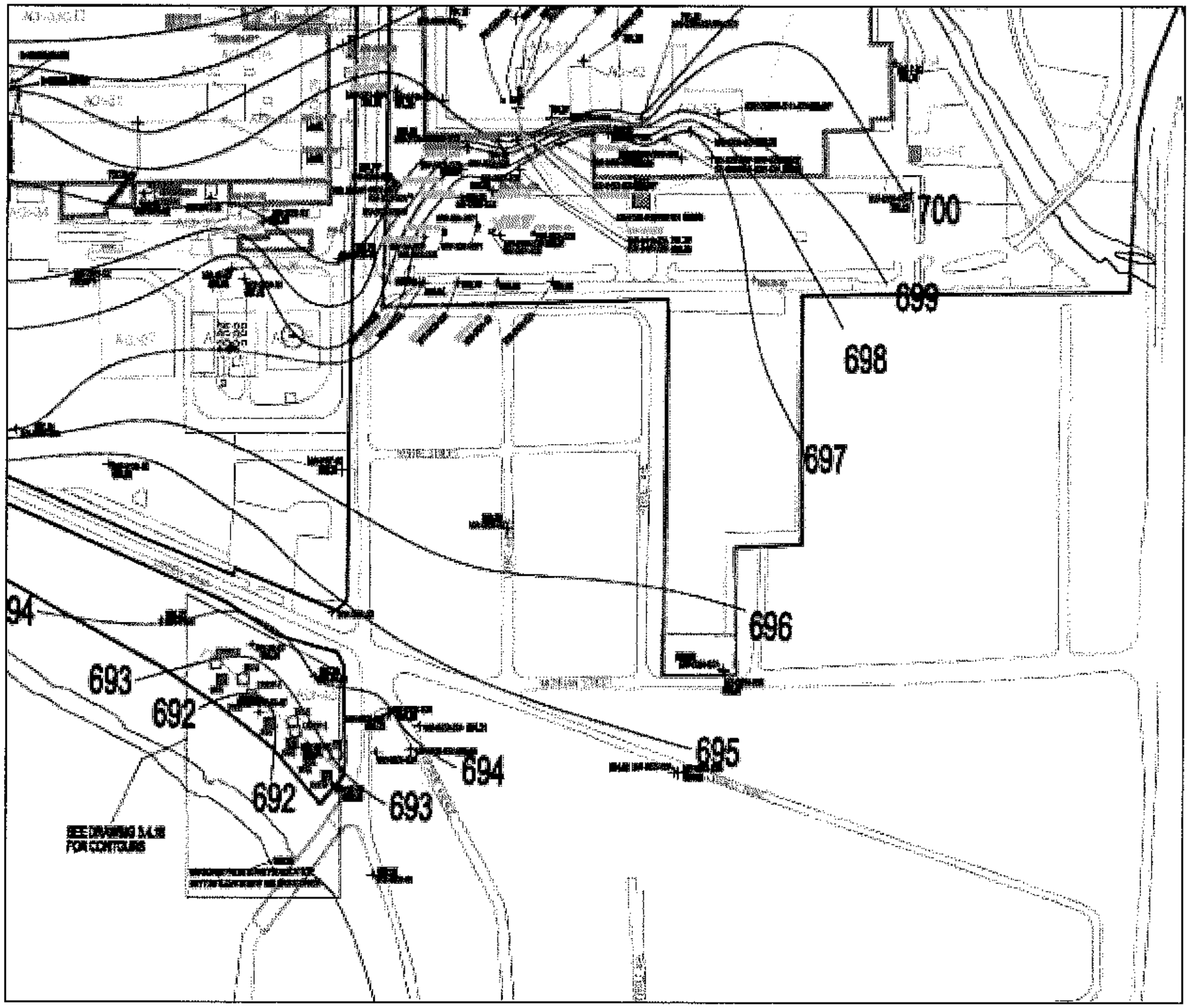
Source: US Geological Survey

Figure 4
Eagle Creek Gaging Data
1990 to 2012



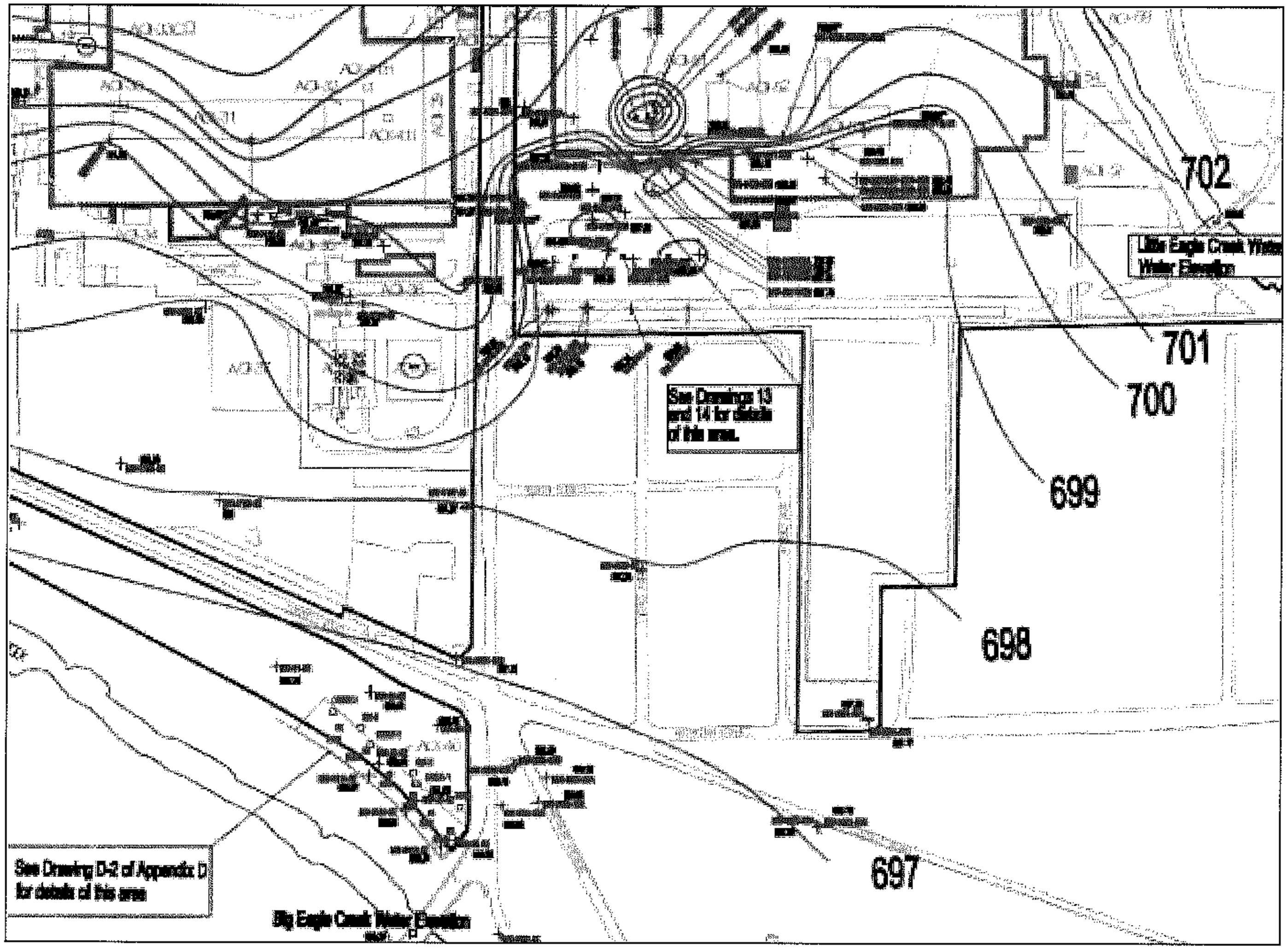
Source: US Geological Survey

Figure 5a
Allison Transmission Potentiometric Surface Maps



Source: Excerpt from Figure 3.4.16, Potentiometric Surface of Uppermost Sand Units – S1 and S2, October 2007, Allison Transmission, RCRA Facility Investigation from RCRA Facility Investigation Report (Favero Geosciences, 2009)

Figure 5b
Allison Transmission Potentiometric Surface Maps



Source: Excerpt from Figure 4, Potentiometric Surface - Shallow Sand Unit S2, April 2009, Allison Transmission, Second Quarter 2009 Progress Report (Favero Geosciences, 2009)

Table 1
Statistics of Monthly Mean Data for Water
1939-2011

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1939 - 2011, BY WATER YEAR (WY)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean	44.6	109	174	220	249	312	295	220	166	88.6	37.8	51.2
Max	574	851	906	1,485	765	900	906	1,127	904	800	490	780
(WY)	(2002)	(1993)	(1991)	(1950)	(1976)	(1978)	(1964)	(1943)	(1957)	(1979)	(1958)	(2003)
Min	1.52	3.05	3.48	4.06	10.8	16.5	25.4	14.3	4.66	3.69	0.19	0.40
(WY)	(1941)	(1941)	(1945)	(1945)	(1998)	(2000)	(2000)	(1976)	(1988)	(1968)	(1941)	(1941)

Source: US Geological Survey