Health Consultation

RUMPKE–MEDORA LANDFILL

JACKSON COUNTY, INDIANA

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

RUMPKE-MEDORA LANDFILL

JACKSON COUNTY, INDIANA

Prepared By:

Exposure Investigation and Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

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Summary

On August 6, 2004, the Agency for Toxic Substances and Disease Registry (ATSDR) accepted a petition from a local resident to evaluate the potential for community exposure to contaminants released from the Rumpke of Indiana, L.L.C. solid waste municipal landfill, as well as the Gideon T property and landfill expansion area (Rumpke Landfill Site) west of Medora, Indiana. Of particular concern were reports of improper dumping of chromium (Cr III) hydroxide sludge in residential areas and on agricultural fields in the Medora area of Jackson County, Indiana. The latter issue was addressed in a previous health consultation released by ATSDR on February 1, 2007. That document concluded that metals in sediments and water samples posed no apparent public health hazard, and recommended further characterization of certain soil sample locations.

This second public health consultation has been written to address the potential for landfill-related contaminants to migrate in groundwater to private wells in amounts that could pose a public health hazard to local residents. Community members who live in the vicinity of the Rumpke-Medora Landfill strongly oppose a proposal to expand the landfill because of concerns that exposure to landfill-related contaminants could cause a variety of adverse health effects, including**:** cancer, immune system disorders, nervous system disorders, birth defects, liver problems, skin problems, respiratory illnesses, muscular problems, nosebleeds, and headaches.

Based on a review of all the data available to the agency, ATSDR determined that groundwater contaminants originating at the Rumpke-Medora Landfill pose no public health hazard to area residents due to the absence of exposure. This determination is based on the following factors: (1) the interception of landfill-related contaminants by a leachate collection/disposal system and composite liner at the landfill; (2) the relatively low concentrations of substances that occur in the collected landfill leachate; (3) several natural geological features that impede groundwater movement toward the few existing downgradient private wells; and (4) ATSDR's finding that most people in the area derive their drinking water from the Jackson County Rural Water System, rather than from private wells, virtually all of which are either closed, non-productive, unused, or used only for irrigation and other non-drinking purposes. The finding that no one is known to be drinking regularly from private wells downgradient from the landfill supports a conclusion of no public health hazard due to the absence of exposure.

Although no off-site monitoring data were available, the engineering controls in place at the landfill, combined with protective features of the local geology, would preclude the occurrence of significant amounts of landfill-related contaminants in off-site private wells. There is no identifiable aquifer *per se* near the landfill. The little groundwater that does exist is apparently unconfined and occurs primarily in the unconsolidated material at or near the soil/bedrock interface, where it is vulnerable to contamination from the surface. The low productivity of groundwater in the area necessitated the construction of the Jackson County Rural Water System and made the rise to the west of Medora (i.e., the eastern edge of the Knobstone Escarpment of the Norman Upland) a relatively safe location for a landfill.

Background

Rumpke-Medora Site Description and History

The Emconite Division of Amerace-Esna Corporation began operating the Medora, Jackson County, Indiana plant in the 1950s and through its industrial process created, as a by-product, sludge which contained chromium and other metals such as copper and nickel. International Telephone and Telegraph (ITT) purchased the Medora plant in April 1977. After eight years, ITT sold the plant to United Plastics Company, a subsidiary of Foster Little Industries, a predecessor to Thomas and Betts. The Medora plant eventually closed in the late 1980s, and the property is currently owned by the Town of Medora.

A Jackson County resident owned and operated a municipal dump (Robertson Landfill) on property currently located on the northeast corner of the present Rumpke of Indiana (Medora) Landfill. In the early 1970s, the resident received permission from the Indiana State Board of Health (now the Indiana State Department of Health) to spread the metal-plating sludge produced by the Amerace-Esna Corporation's Medora plant in shallow furrows on his farm, which was located southwest of the current (Medora) landfill, near the boundary of Owen and Carr Townships. It wasn't until 1974 that the state of Indiana first adopted waste-handling rules. After the death of the landfill owner, his son-in-law continued to operate the Robertson Landfill and contracted with Amerace-Esna Corporation to dispose of industrial waste products from the Medora plant.

In 1978, the new owner submitted a proposal to construct plastic-lined lagoons on the Robertson farm in order to dispose of the industrial sludge coming from the Medora plant as a means to comply with upcoming Federal rules for hazardous waste disposal. In 1979, officials from the Indiana State Board of Health gave permission for the sludge to be placed in the lined lagoons "on an experimental basis," but later withdrew permission after discovering this method of disposal was unsatisfactory.

By 1980, Federal waste-handling rules were being adopted, and by 1982, after the creation of the Indiana Environmental Management Board (IEMB), it was determined that the sludge originally placed in the lagoons had to be removed and taken to a special location at the county landfill, formerly the Robertson dump. The pre-determined "special location" became known as the Gideon T property, and it occupies land running from the southern boundary of the active portion of the (Medora) landfill cell to what used to be the west section of Byarlay Road (75S) as it intersected with Landfill Road, a.k.a. 870W (Fig. 3).

The owner complied with the IEMB order and removed the sludge from the farm and placed it in trenches lined with naturally occurring clay on the Gideon T portion of the county landfill (Figure 3). When the county landfill was sold to Rumpke of Indiana, the son-in-law retained control and ownership of the parcel known as the Gideon T. On November 23, 2004, Rumpke of Indiana requested a permit from the Indiana Department of Environmental Management (IDEM, formerly IEMB) for "acreage expansion" of the Medora landfill. The permit for expansion was approved on July 16, 2007. As part of the landfill expansion, Rumpke of Indiana stated that it would remove the sludge from the trenches on the Gideon T property and place the sludge into a Resource Conservation and Recovery Act (RCRA) approved Corrective Action Management

Unit (CAMU) cell, or vault (Figure 3). This was done over a 3-week period in June of 2008 (Phone conversation with Ralph Collins, Operations Manager of Rumpke Landfill).

In 2004, ATSDR accepted a petition from a Jackson County, Indiana resident who was concerned about health problems in his family and among his neighbors and friends living in the Medora area. The petition suggested that the health problems were possibly associated with the waste materials that came from the Medora plant, which were alleged to have been dumped or deposited into the Robertson/Rumpke of Indiana (Medora) Landfill.

A three person site team from ATSDR conducted a site visit to Jackson County, Indiana in early June 2005. The team met with Jackson County Health officials, IDEM staff, Rumpke of Indiana personnel, and many local residents.

Community concerns were documented which included statements regarding the "dumping" of waste materials from the Medora plant at the Robertson Landfill, the disposal of waste into ravines and other "low areas," the application of waste materials onto agricultural fields in the surrounding community, as well as other disposal practices. Residents also reported seeing bluish-green material visible on the surface of various farm fields throughout rural areas surrounding the Town of Medora.

ATSDR sent a letter on October 5, 2005 to both IDEM and the U.S. Environmental Protection Agency (EPA), Region 5 Office requesting further investigation into the complaints of improper disposal of hazardous waste at the landfill and in the surrounding community. In addition, in August 2005, Indiana State Senator Brent Steele contacted IDEM and requested an investigation. ATSDR committed to reviewing all data created as a result of any site assessment conducted by IDEM and/or EPA.

ATSDR determined it would be beneficial to take a multi-phased approach in assessing whether hazardous materials that may be present in the Rumpke of Indiana (Medora) Landfill, and in surrounding rural areas, posed a health hazard to residents living in the community. The first phase was designed to investigate the community concerns of possibly hazardous materials having been disposed of in areas other than the Rumpke of Indiana (Medora) Landfill, particularly on farm fields and in ravines. That investigation was accomplished through the Exposure Investigation (EI) process and was completed when the EI consultation document was released on February 1, 2007 [**1**]. That report concluded that metals in sediment and water samples posed no public health hazard, and recommended further characterization of certain soil sample locations.

This final document reports the evaluation of the Rumpke of Indiana (Medora) Landfill itself and focuses on groundwater as the exposure pathway of concern. In September 2007, a new three person site team from ATSDR visited Indianapolis and met with IDEM staff and the Indiana State Department of Health (ISDH) Epidemiologist. The team then conducted a tour of the Medora area, met with officials from Rumpke of Indiana and toured the landfill, had a meeting with Jackson County Health Department personnel, participated in an impromptu evening meeting with local residents who had health concerns and issues, and visited the Indiana Geological Survey at Indiana University in Bloomington in order to gather geological information pertinent to the landfill. This Health Consultation addresses the potential for landfill-related contaminants to migrate in groundwater to private wells in amounts that could pose a public health hazard to local residents.

Community Health Concerns

Community members who live in the vicinity of the Rumpke-Medora Landfill strongly oppose the latter's expansion because of concerns that exposure to landfill-related contaminants could cause a variety of adverse health effects, including: cancer, immune system disorders, nervous system disorders, birth defects, liver problems, skin problems, respiratory illnesses, muscular problems, nosebleeds, and headaches. Due to the very small number of potentially exposed people living near the landfill, a valid epidemiological analysis of site-specific disease rates is not possible. Figure 1 shows the demographic statistics within one mile of the Rumpke-Medora Landfill.

Discussion

Chemicals in On-site Groundwater:

Several years worth of leachate and groundwater monitoring data for the Rumpke-Medora Landfill were made available to ATSDR during its investigation. The majority of the groundwater data points were reported as "ND" (non-detect) at the corresponding reporting limit, which means only that the true concentration, whether it was detectable or not, was below the specified concentration at or above which the laboratory was required to report the actual value. (The use and meaning of reporting limits have been discussed in detail, elsewhere [**2**].)

However, the reporting limits (and, hence, all of the concentrations reported as "ND") were generally well below levels known to produce adverse effects in animals or humans. VOCs in leachate and groundwater were generally "ND" (i.e., at or below the reporting limit), and metals were generally low, i.e., when a concentration was detected at all. Exceptions are listed in the accompanying table of Maximum Contaminant Level (MCL) exceedances (Table 1). As shown in Table 1, in 1993 and 1995, respectively, benzene and methylene chloride in some on-site monitoring wells exceeded primary (i.e., health-based) MCLs, which are safe drinking water standards that are not applicable to landfill leachate or groundwater. In March of 2000, detected levels of manganese, sulfate and total dissolved solids in some on-site monitoring wells exceeded secondary (i.e., non-health-based) MCLs, as did iron in September of 2004. Secondary MCLs are based on esthetic considerations of taste, odor and color. Also in September of 2004, arsenic, lead, beryllium, nickel, and vinyl chloride in some on-site monitoring wells exceeded primary MCLs [**3, 4**].

With only two exceptions, even the maximum concentrations of substances that exceeded MCLs and sMCLs during the period from 1993 to 2004 in on-site monitoring wells were below all levels known to produce adverse health effects. The exceptions were sulfate and lead. In March of 2000, the concentration of sulfate in water from an on-site monitoring well (2660 ppm) was high enough to cause diarrhea in infants, had it been used to make baby formula. Controlled studies suggest that between 1000 and 2000 ppm dietary sulfate is an effective osmotic laxative **(5)**. The preparers of the March 2000 report concluded (and IDEM concurred) that this elevated sulfate concentration was due to the naturally high levels in local bedrock and/or an unidentified

"non-landfill impact" [**4**]. On page 8 of the "September and October 2004 Ground Water and Surface Water Semi-Annual Data with Evaluation", IDEM letters dated September 17, 1999 and April 16, 2002 are cited in support of that agency's concurrence with the conclusions that (1) the detected high sulfate concentrations were "the result of a non-landfill impact," and (2) that "sulfate concentrations are naturally high due to a combination of bedrock mineralogy and fracturing due to past excavation practices in the area."

Table 1. Contaminants in On-Site Groundwater: MCL Exceedances

ANALYTE	DATE	MONITORING WELL #	MAXIMUM CONCENTRATION (ppb)	MCL/sMCL (ppb)
Benzene	1995	MED-4	8.4	MCL, 5
Methylene Chloride	1993	MED-5RR	110	MCL, 5
Vinyl Chloride	September 2004	MED-9	5	MCL, 2
Arsenic	September 2004	MED-1	20	MCL, 10
Beryllium	September 2004	MED-2R	5.8	MCL, 4
Iron	September 2004	MED-9	169,000	sMCL, 3
Lead	September 2004	MED-9	918	MCL, 15
Manganese	March 2000	MED-2R	11,400	sMCL, 5
Nickel	September 2004	MED-2R	170	MCL, 100
Sulfate	March 2000	MED-7R	2,660,000	sMCL, 250,000

Source: Historical detection summaries (Tables 2 and 3) in reference #3, "March 2000 Ground Water and Surface Water Data with Evaluation," representing data extracted from semi-annual reports Water Data with Evaluation," representing data extracted from semi-annual reports.
ppb = parts per billion.
MCL = EPA's Maximum Contaminant Level (designed to protect against adverse health effects)
sMCL = EPA's secondary Maximum Contaminant Level (designed to protect against undesirable esthetic properties such as taste and color.)

In September of 2004, the concentration of lead in water from an on-site monitoring well (918 ppb, which would result in a dose of 0.026 mg/kg/day in a 70-kg adult who drank 2 L/d of that water) was high enough to inhibit the enzyme ALAD (alpha levulinic acid dehydrogenase), the most sensitive indicator of lead exposure. An estimated acute human LOAEL (Lowest Observed Adverse Effect Level) for this effect is 0.02 mg/kg **(6).** However, no one is using groundwater from on-site monitoring wells for drinking purposes, and this groundwater is not migrating off-site. (See section entitled "Absence of Exposure".)

Chemicals in Landfill Leachate:

Table 2 shows the only substances that were detected above reporting limits in the leachate collection pond (sample L-1) during the July 2004 monitoring event. Of these five substances (ethylbenzene, arsenic, barium, chromium, and lead), only arsenic exceeded its corresponding MCL or other comparison value for drinking water. But, even the maximum detected concentration of arsenic (27 ppb) was still well below all known effect levels. (ATSDR's acute

Table 2. Maximum Concentrations of Substances in the Leachate Collection Pond (2004)

SUBSTANCE	DATE	CONC (ppb)	COMPARISON VALUE (ppb)
VOCs:			
Ethylbenzene [1]	7/09/04	7.7	MCL, 700
Metals:			
Arsenic [2, 3]	7/09/04	26	MCL, 10; EMEG, 10
Barium [2]	7/09/04	900	MCL, 2,000
Chromium [2, 4]	7/09/04	19	Adult RMEG, CrIII, 50000
(Valence not specified)			Adult RMEG, CrVI, 100
Lead [2]	7/09/04	4.1	MCL, 15

[1] Severn Trent Laboratories, Inc., Preliminary Summary (page 4 of 15). This is the only non-metal analyte detected above reporting limits in the leachate collection pond during the July 2004 monitoring event. (See text for an explanation of reporting limits.) All other VOCs, pesticides, PCBs, semivolatiles and non-metal inorganics (cyanide and sulfate) were "ND" at the indicated reporting limits.

[2] Severn Trent Laboratories, Inc., Preliminary Summary (page 2 of 15). These were the only metal analytes detected above reporting limits in the leachate collection pond during the July 2004 monitoring event, and only one of these (arsenic) exceeded drinking water standards.

[3] ATSDR's acute oral MRL from which the EMEG is derived was based on a human LOAEL of 0.05 mg/kg/day for gastric distress which is equivalent to the dose a 70-lb person would get from drinking 2 liters of water containing 1,750 ppb arsenic.

[4] Unless otherwise specified, chromium in water samples is typically reported as total chromium, i.e., a mixture of trivalent and hexavalent chromium. Chromium III, the form that predominates in nature, is an essential nutrient. Chromium VI, the form that may occur in certain industrial atmospheres, can be toxic when inhaled in sufficient amounts, but when consumed orally, even at several thousand parts per billion, Cr VI is readily converted to Cr III (the essential nutrient) by the naturally occurring acids in food, drink, saliva, and gastric juice.

ppb = parts per billion
MCL = Maximum Contaminant Level for drinking water (EPA)
EMEG = Environmental Media Evaluation Guide
RMEG = Reference Dose Media Evaluation Guide

oral MRL is based on a human LOAEL of 0.05 mg/kg/day for gastric distress which is equivalent to the dose a 70-lb person would get from drinking 2 liters of water containing 1,750 ppb arsenic.) All other substances in the leachate collection pond were reported as "ND" at the chemical-specific reporting limits. Thus, none of the substances detected in the leachate collection pond would cause actual harm, even if water from it were occasionally ingested.

Chemicals in Surface Water:

Based on ATSDR's evaluation of the available data, chemical substances in surface water do not pose a public health hazard, either. The concentrations of all metals in surface water samples previously collected in 2006 by ATSDR from 3 locations (including Guthrie Creek directly downstream of the Rumpke Landfill) were below comparison values [**1**]. Table 3 shows the only substances that were detected in samples from the Guthrie Creek monitoring station MEDS-2 at concentrations above the reporting limits during the monitoring event of 2004 [**4**].

Table 3. Maximum Concentrations of Substances in Guthrie Creek (2004)

SUBSTANCE	DATE	CONC (ppb)	COMPARISON VALUE (ppb)
VOCs:			
"ND" at the specified substance- and concentration-dependent reporting limits.			
Metals:			
Barium [1]	7/9/04	48	2,000 (MCL)
Iron [2]	9/16/04	1,200	300 (sMCL); 11,000 (EPA 6 RBC)
Manganese [2]	9/16/04	2,300	50 (sMCL); 1,700 (EPA 6 RBC);
Sulfate [2]	9/16/04	566,000	250,000 (sMCL)

[1] Severn Trent Laboratories, Inc., Preliminary Data Summary (page 11 of 15). This is the only substance detected in Guthrie Creek above reporting limits in July 2004. (See text for an explanation of reporting limits.) All other metals and VOCs in July of 2004 were "ND" at the specified reporting limits.
[2] Andrews Environmental Engineering Inc., Rumpke Waste Collection and Disposal Systems, September and October 2004 Groundwater and Surface water Semi-Annual Data with Evaluation. These are the only substances detected in Guthrie Creek above secondary MCLs in 2004. Secondary MCLs are based on aesthetic factors like taste, color and odor; they are not based on health considerations, as are primary MCLs.
MCL = EPA's Maximum Contaminant Level (designed to protect against adverse health effects)
sMCL = EPA's secondary Maximum Contaminant Level based on esthetic properties such as taste and color.
ppb = parts per billion.
RBC = Risk-Based Concentration (EPA Region 6) for the substance in tap water.

Barium was present at less than 3% of the MCL of 2000 ppb. Iron, manganese and sulfate exceeded secondary MCLs, which are based on aesthetic rather than health considerations. Iron and manganese, both essential dietary mineral nutrients, also exceeded (marginally) their corresponding Risk-Based Concentrations (RBCs, EPA's Region 6) which are comparison values based on chronic exposure to the substance in drinking water. None of these substances would cause actual harm, even if water from the creek were occasionally ingested by animals or humans. All other substances were reported as "ND" at specified the chemical-specific reporting limits.

Public Health Implications:

Despite the absence of monitoring data of sufficient quantity, quality, and practical relevance to support an exposure estimate, ATSDR was still able to address the public health implications of groundwater contaminants at Rumpke-Medora Landfill. Although the precise concentrations of the measured contaminants were usually not reported, because they were below reporting limits, the corresponding reporting limits were, themselves, well below all known effects levels. In addition, it is highly unlikely that anyone off site is being, or ever has been, exposed to toxicologically significant quantities of landfill-related groundwater contaminants. (See next section.)

Absence of Exposure:

A combination of factors related to both landfill engineering and local geology precludes significant migration of leachate-contaminated groundwater from the landfill to surrounding wells. Additionally, no one appears to be using contaminated or potentially contaminated groundwater as a source of drinking water. Therefore, ATSDR concludes that residents living in the vicinity of the Rumpke-Medora Landfill have not been, are not being, and will not be exposed to potentially toxic levels of landfill-related contaminants via groundwater migrating from the site. This conclusion is supported by the following observations:

1) Engineering Measures: Over 92% of the 150.2 acres of the Rumpke-Medora Sanitary Landfill is underlain by a composite liner and a leachate collection system. The oldest and northernmost 7.9% part of the landfill is unlined, but it is closed, and capped to prevent percolation of rainwater down through the old waste burden (John Hattersley, Sr. Site Engineer, Rumpke, personal communication, October 9, 2009). The leachate collection system that underlies the rest of the landfill empties into a leachate collection pond at the northwest corner of the property near Guthrie Creek (Figures 2 and 3). A contractor periodically carries the accumulated leachate to Seymour, approximately 20 miles East on Hwy 50, for treatment and disposal. A review of data submitted by Rumpke to IDEM indicates that neither on-site groundwater nor landfill leachate contain chemical substances at concentrations that might be toxic if ingested (Tables 1 and 2). And, monitoring events in Guthrie Creek have not identified any substances at hazardous levels (Table 3) [**1, 4, 7**]. As shown in Figure 4, the proposed expansion area will also be both lined and underlain with a leachate collection system [**8**].

2) Protective Geology: The unconsolidated and bedrock aquifer systems of Jackson County, Indiana, are described by maps and accompanying articles by the Indiana Department of Natural Resources, Division of Water, all of which are available on-line at http://www.in.gov/dnr/water/4615.htm. These materials, in combination with the more site-

specific references cited in this consultation, suggest that, even if the landfill were not underlain by a composite liner and an effective leachate collection system, the regional geology would likely preclude any significant migration of the leachate off-site, for the following reasons:

a) The landfill sits on a high plateau, and is surrounded on all three downgradient sides by steep, incised ravines. Deep ravines to the northeast and southwest drain the ridge between (on which the landfill is situated) and flow into Guthrie Creek to the northwest [**7**]**.** (See topographic Figures 5, 6 and 7). No aquifer has been identified at the facility within 100 feet below the lowest elevation of waste [**4**]. Neither are any of the stratigraphic bedrock units at the soil/bedrock interface or the siltstone in the proposed expansion area considered aquifers suitable for water supply [**7**]. Any landfill leachate that is mobile at the soil-bedrock interface will most likely drain to the flanking ravines. Landfill leachate (as well as surface runoff) that is not collected in small settling ponds is intercepted in these gullies and eventually discharged into Guthrie Creek. In addition, downgradient from the landfill expansion area is another ravine to the west-southwest, and further to the south is Dry Creek, which also drains to Guthrie Creek several miles to the southwest (Figure **7**). (A note about the creek is necessary to avoid confusion. After the confluence of the southward flowing Clear Spring Creek with the southwestward flowing Guthrie Creek near the northwestern end of the Rumpke-Medora landfill, their combined waters continue to the southwest and are variously named on different maps as either Clear Spring Creek or Guthrie Creek. For the purposes of this consultation, the entire length of the creek, before and after its confluence with the southward flowing Clear Spring Creek, will be referred to as Guthrie Creek.)

b) Because of their low permeability, the geologic formations surrounding and underlying the landfill, i.e., silty clay soil of the Dissected Till and Residuum, and the predominantly siltstone bedrock (unless highly fractured), could not conduct significant quantities of leachate-contaminated groundwater toward local private wells, even if the latter were downgradient (Figures 8 and 9). The siltstone bedrock below the soil/bedrock interface is considered to be an aquitard. This means that, owing to a limited ability to transmit water, the bedrock does not allow groundwater from the soil/bedrock interface to readily percolate down to a potential deeper aquifer [**7**]. The same geological conditions account for the fact that groundwater availability and vulnerability in the vicinity of the Rumpke-Medora Landfill is among the lowest in the state of Indiana (Figure 10).

c) The wells to the north along Hwy 50, and the wells to the east (except for those in the valley of the East Fork White River), are all upgradient from the landfill, and they are drilled into a geological formation (the Borden Group Siltstone), which is a very poor producer/conductor of groundwater (Figure 11). The downgradient wells to the west and south are separated from the landfill by several streams and ravines.

d) Only two wells that were identified to the south of the landfill, and at similar elevations, are even potentially vulnerable to contamination from the landfill (Figure 7). Well # 221505 (Indiana Department of Natural Resources, IDNR) is approximately 1500 meters (0.9 miles) south southwest of the landfill on the opposite side of Dry Creek; Well # 221510 (IDNR) is approx 2000 meters (1.2 miles) south southwest of the landfill. These two wells obtain their minimal water from low permeability materials (Mississippian blue shale of the Borden Group) with very low recharge. Any groundwater migrating off-site in a southerly direction would tend to flow downgradient towards the intervening ravine and Dry Creek, rather than follow the

equipotential path indicated by the dashed line in Figure 7. (Under non-artesian conditions, groundwater tends to flow downgradient, just as surface water flows downhill.) However, what little groundwater there is in the expansion area generally flows northwest, toward the base of the two drainage valleys onsite that trend northwest to southeast in the northwest quadrant of the expansion area [**7**]. This is toward Guthrie Creek and away from the few private wells located to the south. Finally, as stated earlier, no aquifer producing useable amounts of groundwater is known to exist in this area.

3) Jackson County Water System: Ground water extraction rates for wells in the vicinity of the Rumpke-Medora landfill are generally less than 1 gallon per minute [**9]**. Because local hydrogeology so severely limits the availability of groundwater, this region has been served since the early 1970s by the non-profit Jackson County Rural Water System which draws its water from high-capacity wells near the East Fork White River at Brownstown, about 13 miles east of the landfill (Figures 12, 13). Consequently, local groundwater (to the extent that it even exists) is not being used by local residents as a source of drinking water. The latter fact was confirmed by a "door-to-door" well survey conducted in June of 2004 [**7**], and a review of area well logs [**10**]. Of the dozen homes closest to the landfill, all received their drinking water from the Jackson County Rural Water System. Five of the 12 residences had private wells, but none had ever been used [**7**]. Well records indicate that private wells within one mile of the proposed solid waste boundary have either been closed, are not in use, or are only occasionally used for irrigation and other non-drinking purposes [**10**]. Therefore, it is highly unlikely that anyone living near the Rumpke-Medora Landfill is being exposed to landfill-related contaminants in groundwater.

The remaining domestic wells within a mile of the landfill (all of which appear to be located up-gradient or behind protective hydrogeological barriers) are, like wells 221505 and 221510, also located in the Borden Group siltstone (a poor producer of groundwater), with no overlying Sanders Group limestone (a better conductor of groundwater). Although, in some geological maps, these wells are shown as located in an area with Sanders Group limestones overlying the Borden Group siltstones, the lithologic logs show unconsolidated, dissected till and/or residuum (referred to as “dirt” and “clay”) overlying “blue shale,” which is likely to be in the Borden Group [**10**]. The well logs also indicate that most of the wells in the area of interest were bailed wells, which further supports the conclusion that these wells were attempting to obtain water from into low-yielding, non-limestone, Borden Group bedrock.

The latter point is important because with limestone comes the possibility of karst development and unpredictable groundwater flow. However, the only karst regions in Indiana are the Mitchell Plateau to the west and south of Jackson County, and the Muscatatuck Plateau farther to the east (Figure 14). In the vicinity of the Rumpke-Medora Landfill, only the occasional discontinuous lens of limestone occurs (e.g., Figure 8). A measure of the relative paucity of limestone formations in Jackson Co. is the fact that it has only 4 known limestone caves (none within 10 mi of the landfill), while its western neighbor, Lawrence Co., has 490. [**11**].

For additional information on the geology and hydrogeology of Indiana, visit the Indiana Geological Survey website at http://igs.indiana.edu/.

Conclusions

1. Based on the data made available to, and reviewed by, this agency, ATSDR concludes that the groundwater contaminants detected in on-site leachate from the Rumpke-Medora Landfill pose no public health hazard to off-site residents.
2. Leachate contaminants are not present at high levels on-site. Even in collected leachate and on-site monitoring wells, concentrations of "contaminants" (the highest of which may be naturally occurring) are generally well below all known effects levels. The only exceptions, lead and sulfate found in one onsite monitoring well in September 2004, were not of public health concern due to the absence of exposure.
3. A combination of engineering interventions (e.g., landfill liners, and a leachate collection system) and regional geology (e.g., deeply incised ravines, low groundwater production, and relatively impermeable rock strata) preclude the off-site migration of contaminated leachate in significant amounts. It is, therefore, unlikely that any landfill-related contaminants ever have reached, or ever will reach, private wells in this area.
4. The private wells that ATSDR could identify in the area were either closed, dry, or were not being used as sources of drinking water. Data suggest that all residents in the area are on the Jackson County Rural Water System which draws its water from high-capacity wells at Brownstown near the East Fork White River, about 13 miles east of the landfill. The single known exception is a resident who gets his drinking water from a pond on his property, upgradient of the landfill. Anecdotal evidence suggests that some people in the area may also be drinking spring water. However, the protective qualities of the engineering controls at RLM, plus the local geology, apply just as well to local springs and ponds as they do to local private wells.
5. The health concerns expressed by local residents are not specific to any landfill-related substances detected in groundwater. Even if those contaminants could potentially cause those health effects, the absence of exposure would preclude any causal relationship between the two.

Recommendations

Because the available data indicate that no groundwater exposure is occurring, and that on-site groundwater contaminant concentrations are not at levels of concern, no further actions regarding groundwater at this site are recommended.

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Appendix A. Figures

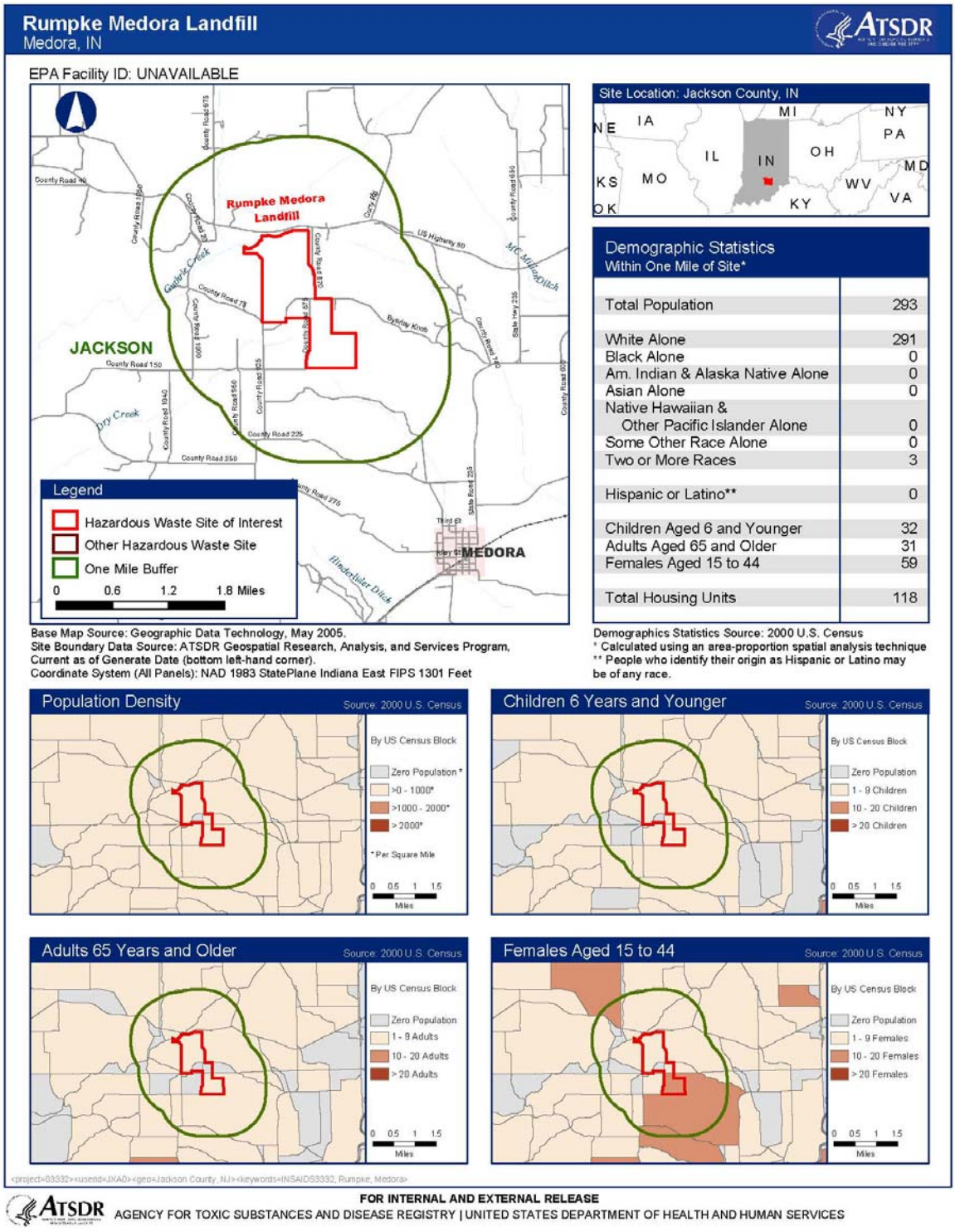

Figure 1. Demographic information for the area within 1 mile of the site.

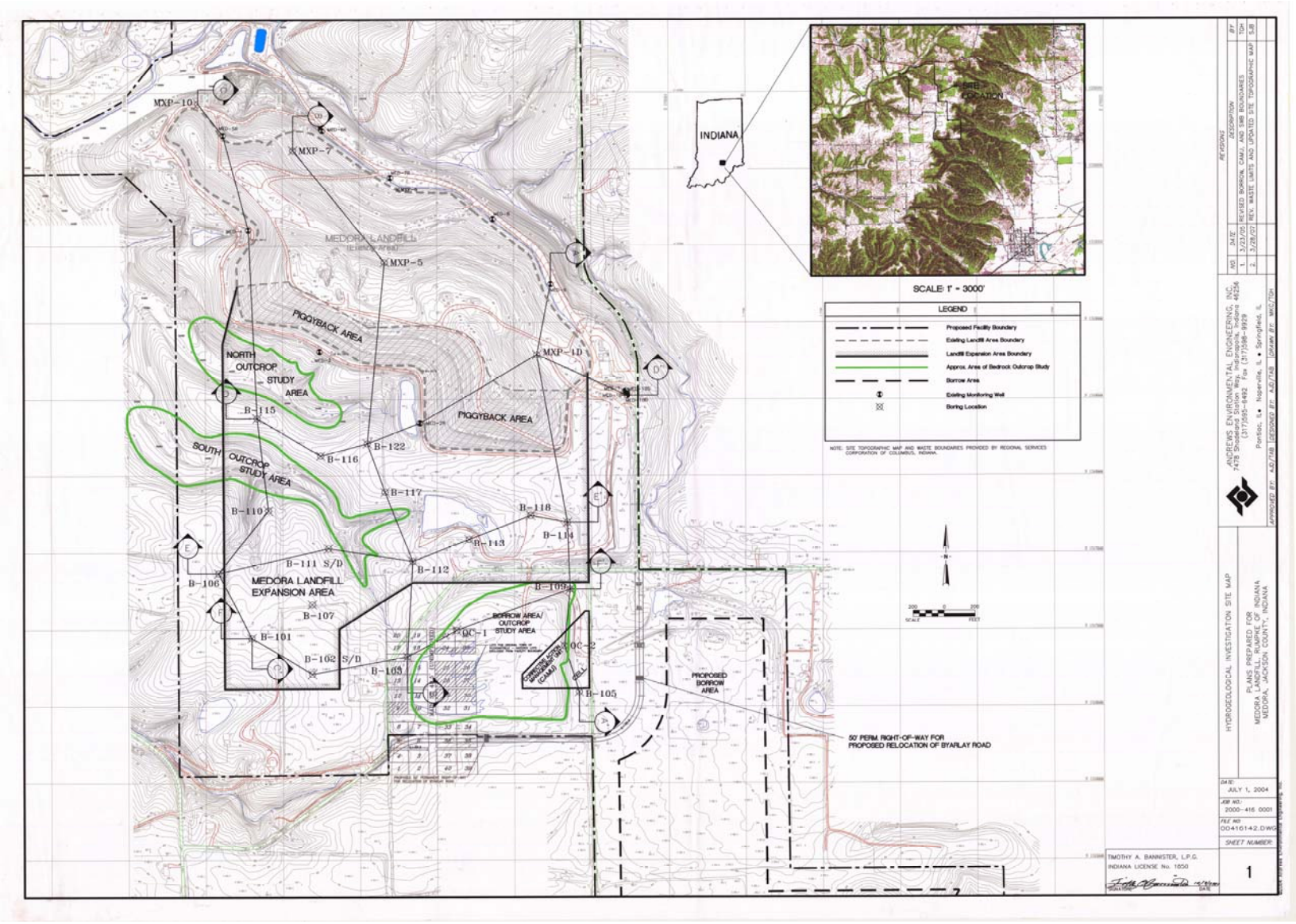

Figure 2. Hydrogeologic Investigation Site Map of Rumpke-Medora Landfill. The small blue rectangle at the top left of this map, near Guthrie Creek, is a composite-lined leachate storage basin. The ravines on either side of the original Rumpke-Medora Landfill drain the latter and flow northwest into Guthrie Creek which flows southwest toward its nearby confluence with Clear Spring Creek from the north (just off the top left corner of this map). The expansion area is also drained by two unnamed ravines that flow into Guthrie Creek. A third drainage ravine is situated just south of the expansion area. (Andrews Environmental Engineering, Inc., 2004)

Figure 3. Aerial view of the Rumpke-Medora Landfill showing the leachate collection pond and its position relative to U.S. Highway 50, the former Robertson Landfill, the current landfill and expansion area, the Corrective Action Management Area (CAMU), the so-called Gideon T property, and the confluence of Guthrie Creek with Clear Spring Creek. The combined waters of the two creeks flow to the southwest and are referred to variously on different maps by the name of one or the other of the two tributaries. Locally, the entire Northeast to Southwest stretch of stream is commonly referred to as Guthrie Creek. The yellow triangles are unused domestic wells. The red triangles are stockyard wells.

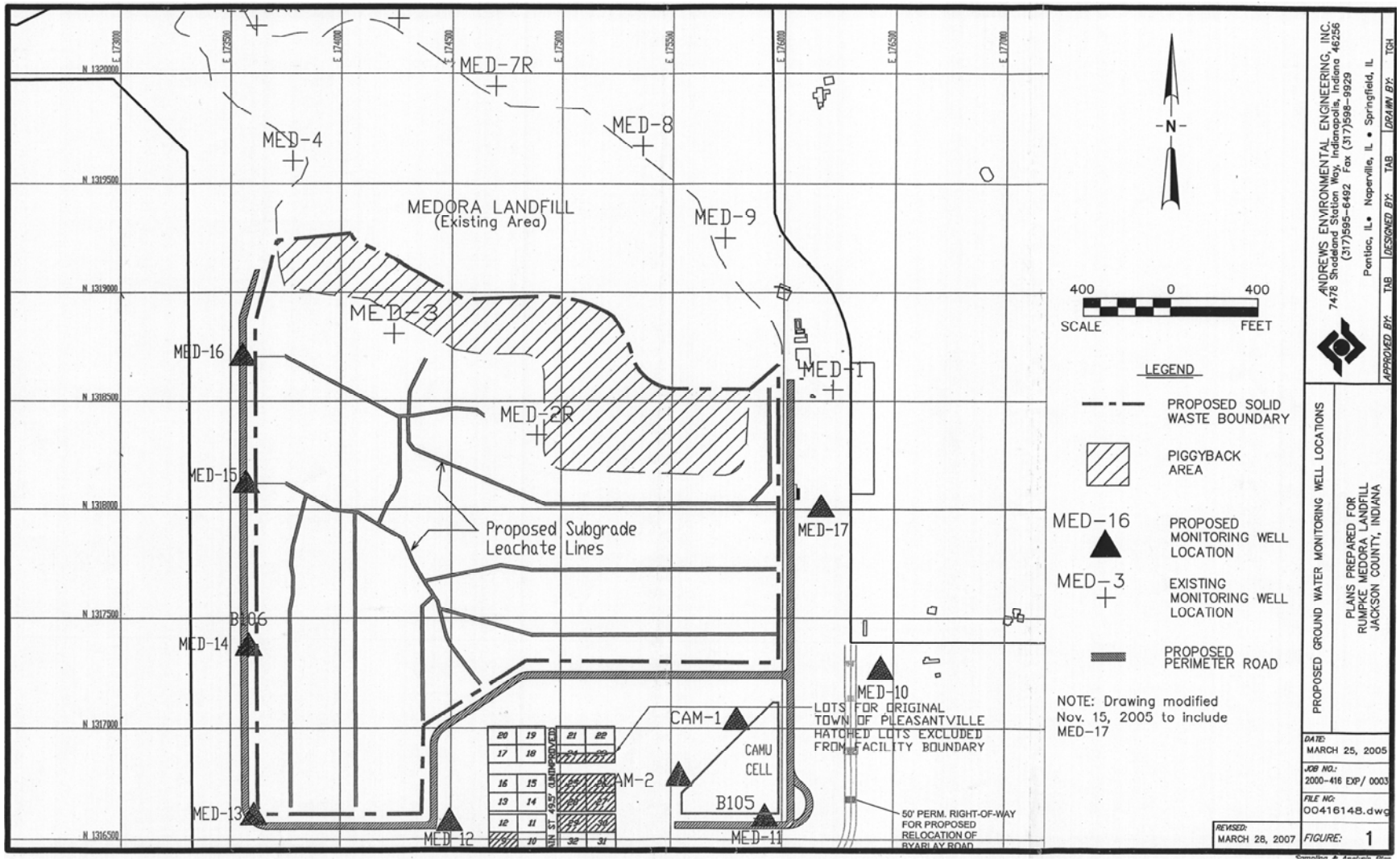

Figure 4. View of the leachate lines proposed for the expansion area. A similar system underlies the existing landfill .

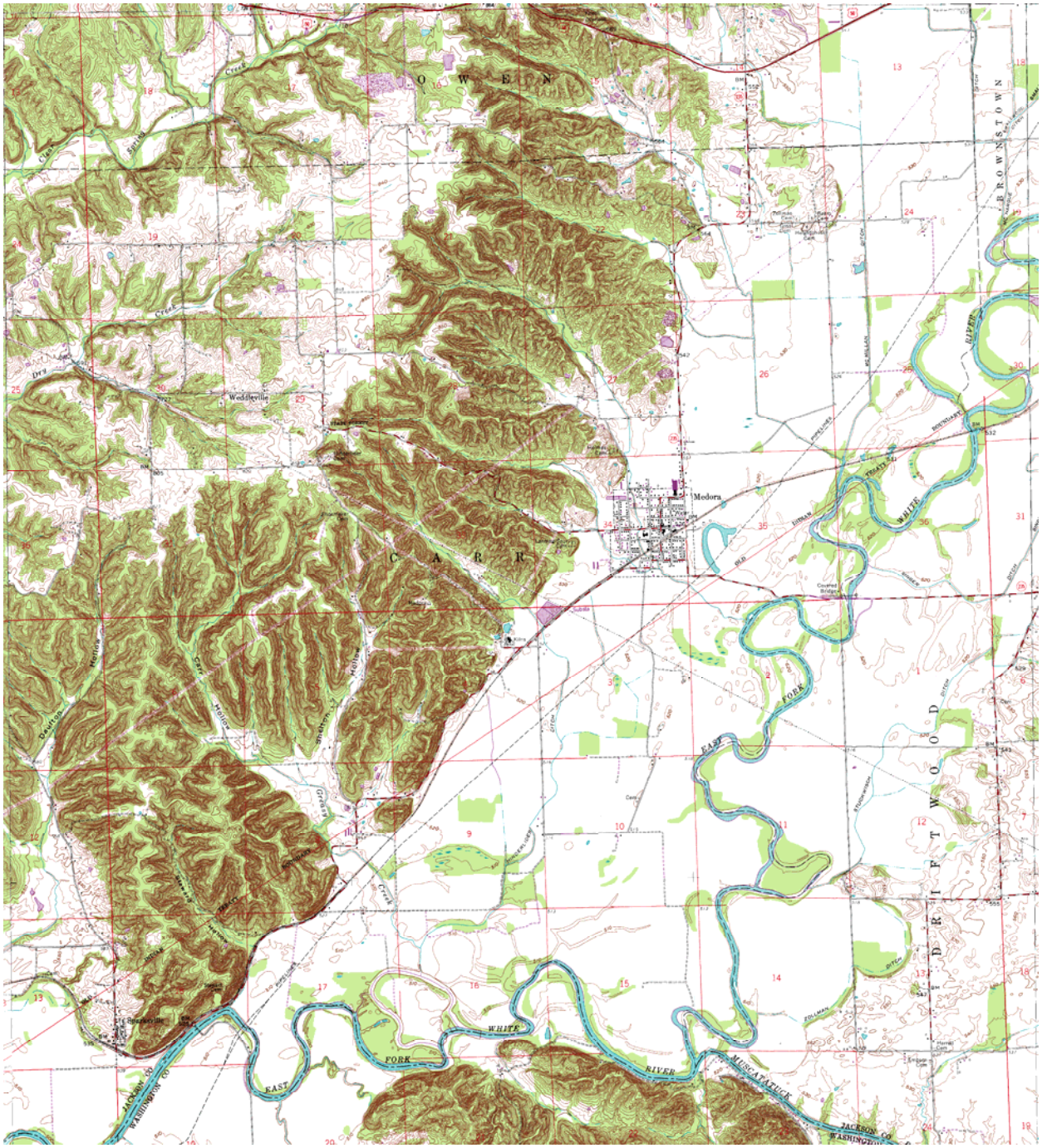

Figure 5. USGS Topographic map (Medora 1:24,000-scale quadrangle) showing landfill position (light purple shape at top of map) on the Knobstone Escarpment of the Norman Upland, overlooking Medora and the valley of the East Fork of the White River.

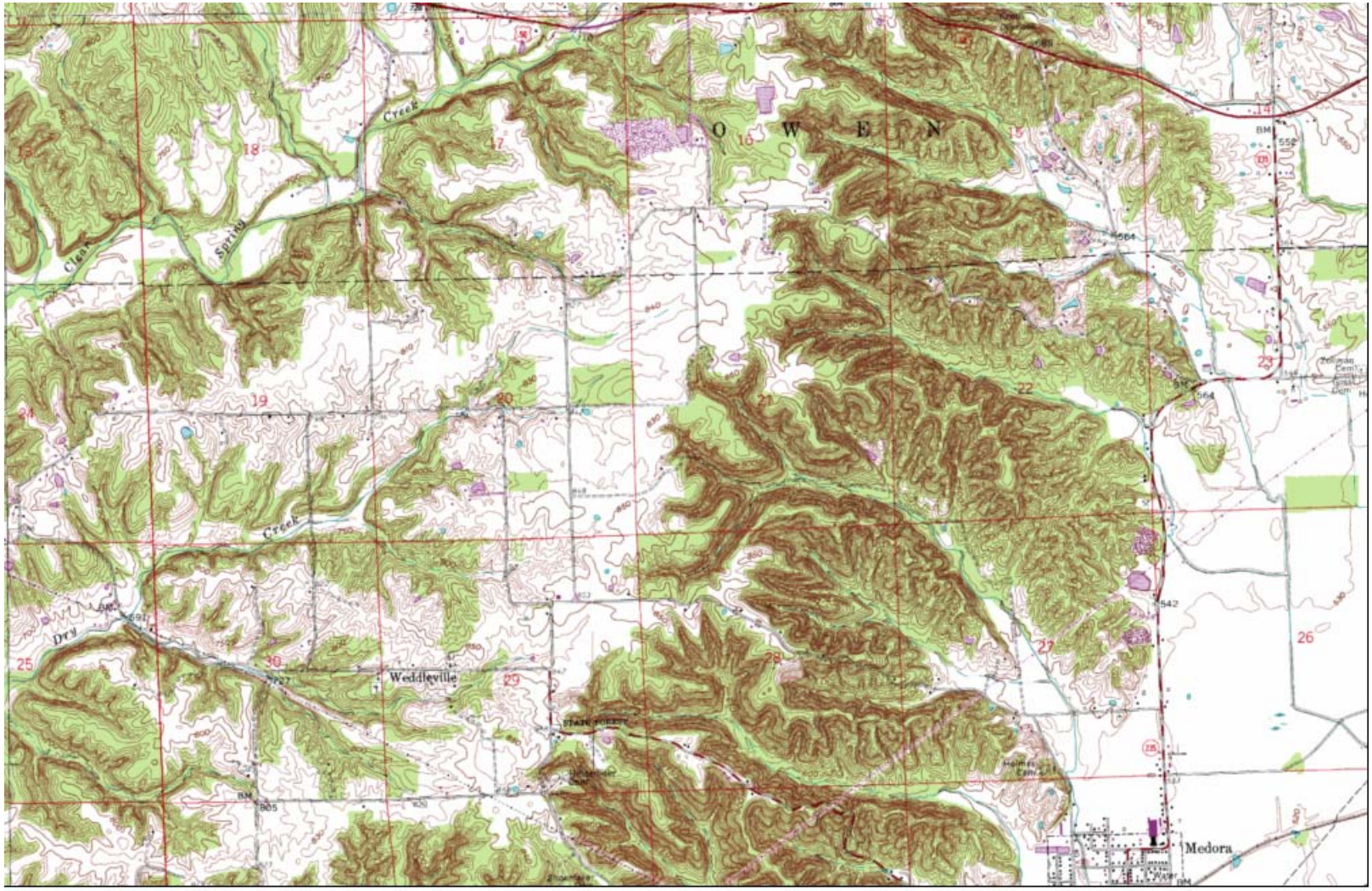

Figure 6. Closeup of the top left quadrant of Figure 4. Both the existing landfill and the expansion area are drained by ravines that flow into Guthrie Creek, which flows to the southwest. Dry Creek drains the area south of the expansion area. It too empties into Guthrie Creek several miles to the southwest (off the left margin of this map). Though locally known as Guthrie creek, both above and below its confluence with Clear Spring Creek, it is referred to as Clear Spring Creek in this USGS Medora Quadrangle map below the confluence of the two creeks.

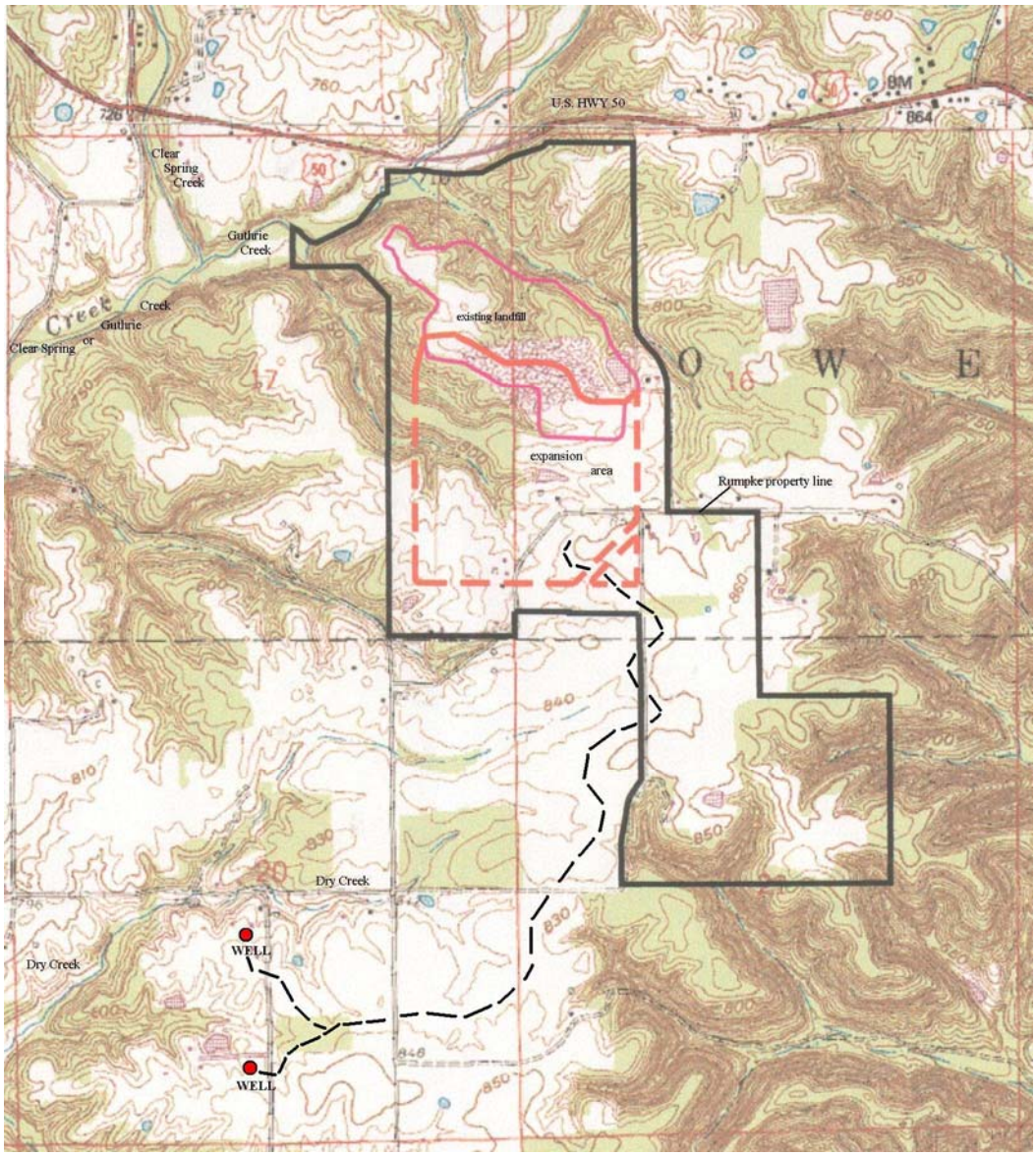

Figure 7. Closeup of Figure 5, showing the property boundaries of Rumpke, and delineating the existing landfill, the expansion area, and the so-called "piggyback" area in between. The land elevations and local drainage systems are depicted in greater detail, illustrating just how unlikely it is that groundwater from the landfill or expansion area could reach area wells.

The dotted line (- - - -) between the expansion area and two southerly wells (red dots ●) at similar elevations trace the erratic equipotential path that groundwater from the expansion area would have to travel in order to evade interception by the intervening ravines. At every point along that dotted line, however, the natural tendency would be for groundwater to flow downgradient into either the large unnamed ravine or into Dry Creek.

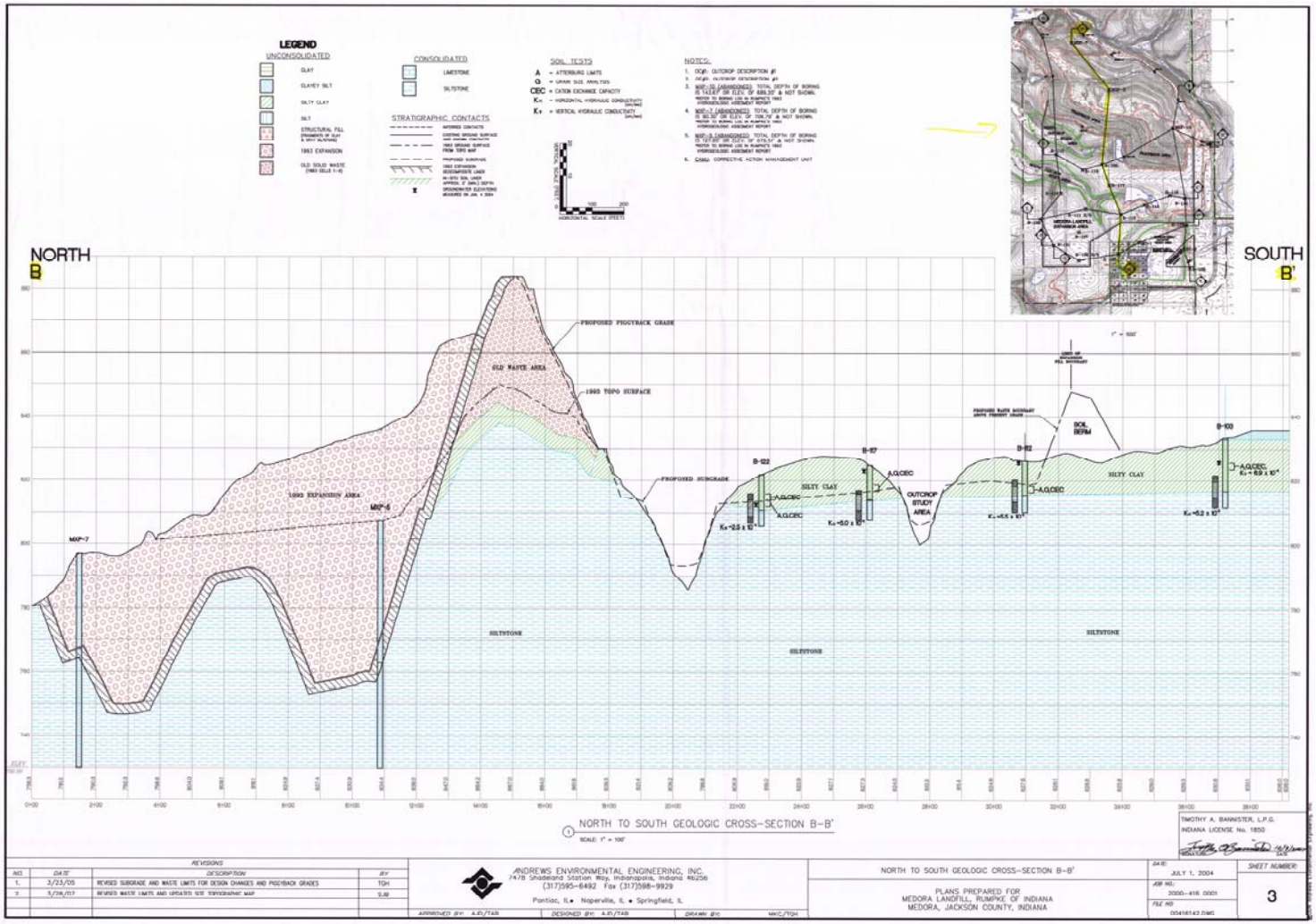

Figure 8. North to south geologic cross-section through the middle of the existing landfill and the expansion area, showing the massive siltstone bedrock, the overlying silty clay to clay, the old waste area and the underlying composite liner. The location of this cross-section on the topographic insert at the upper right is indicated by the yellow-highlighted B-B' line. (Note: The two monitoring wells to the left do not penetrate the liner. Despite appearances on this figure, all monitoring wells are outside the liner.

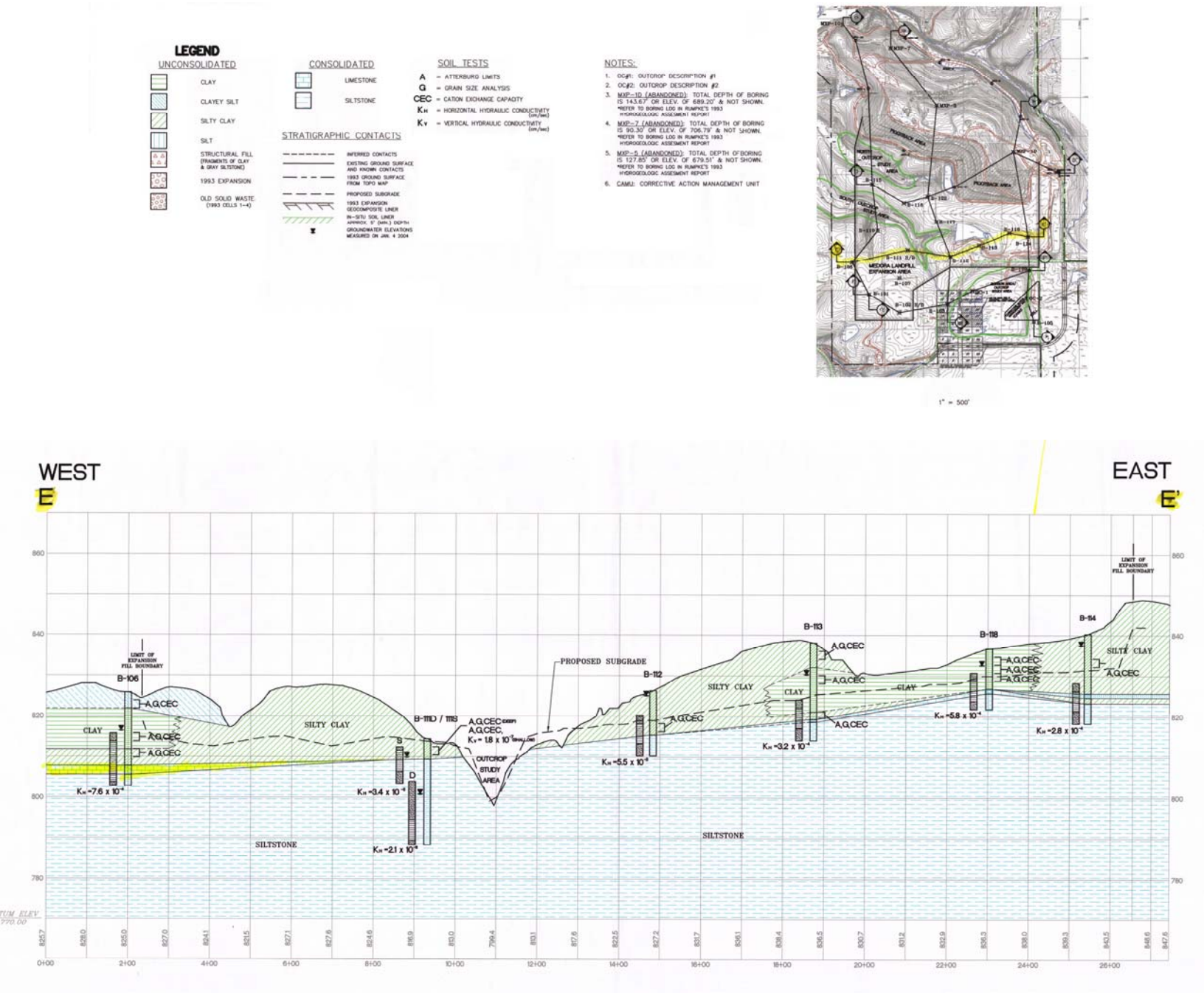

Figure 9. West to east geologic cross-section across the middle of the expansion area, showing the massive siltstone bedrock, the overlying silty clay to clay, and a thin lens of limestone to the west, i.e., toward Guthrie Creek (aka Clear Spring Creek). The location of this cross-section on the topographic insert at the upper right is indicated by the yellow-highlighted E-E' line. After Andrews Environmental Engineering, Inc., Plans prepared for Medora Landfill, Rumpke of Indiana, Medora, Jackson County, Indiana, Sheet No. 6, July 1, 2004.

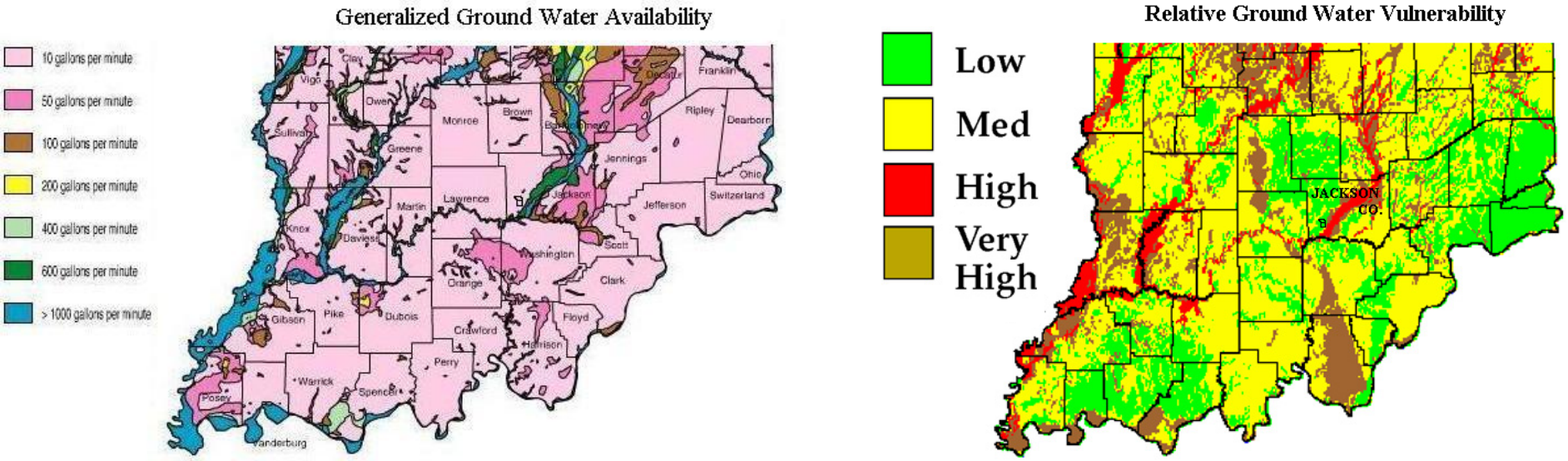

Figure 10. Groundwater availability and vulnerability in Southern Indiana. In the vicinity of the Rumpke-Medora Landfill (the icon in southwestern Jackson County), both groundwater availability and vulnerability are among the lowest in the entire state of Indiana. Wells in the area typically yield less than one (1) gallon per minute, rather than the 10 gallons per minute that the generalized map above indicates. After maps by: Indiana Dept. of Natural Resources, Division of Water; http://www.in.gov/dnr/water/3650.htm.

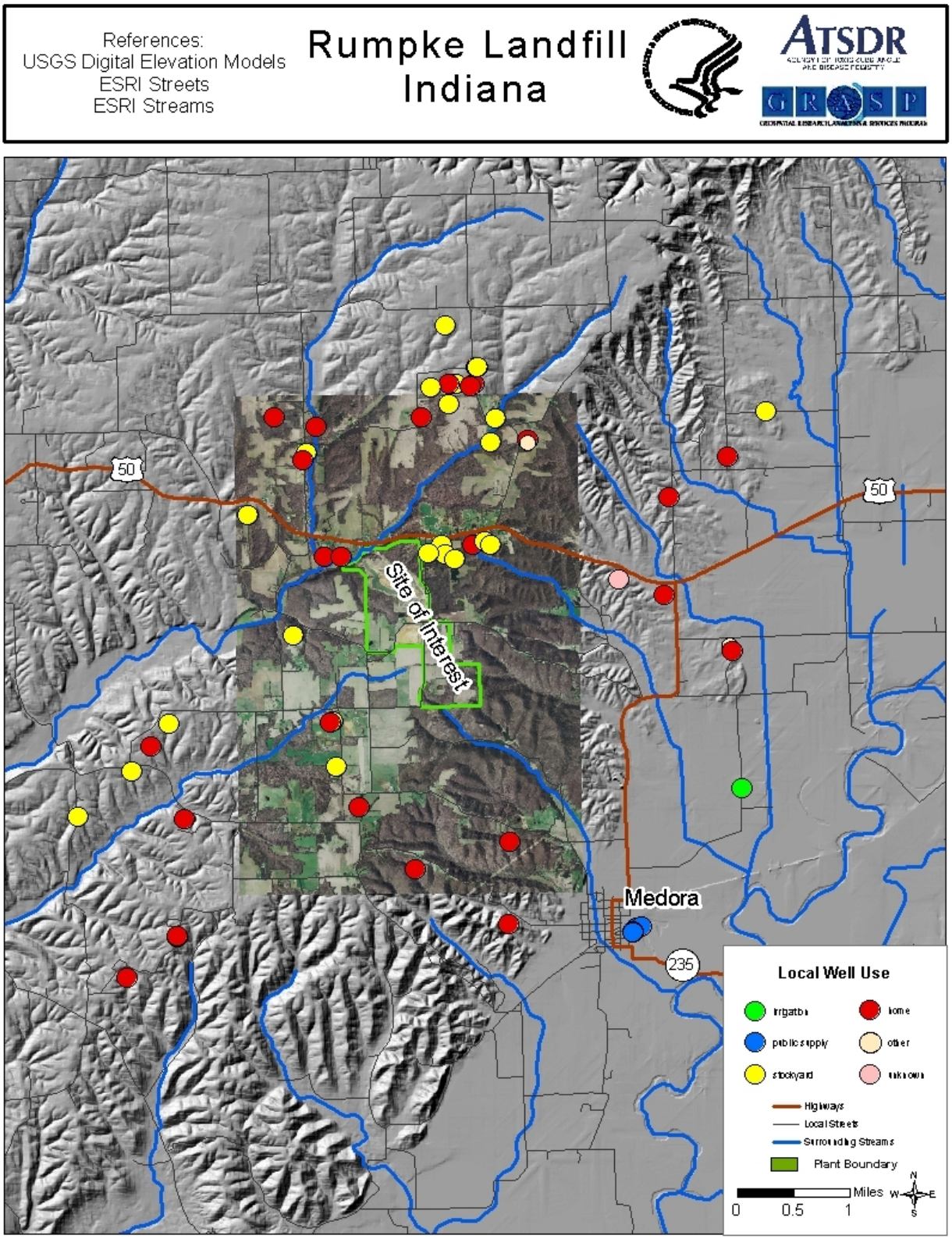

Figure 11. Wells in the vicinity of the Rumpke-Medora Landfill. None are used as sources of drinking water. People in the area are on the Jackson County rural water supply system.

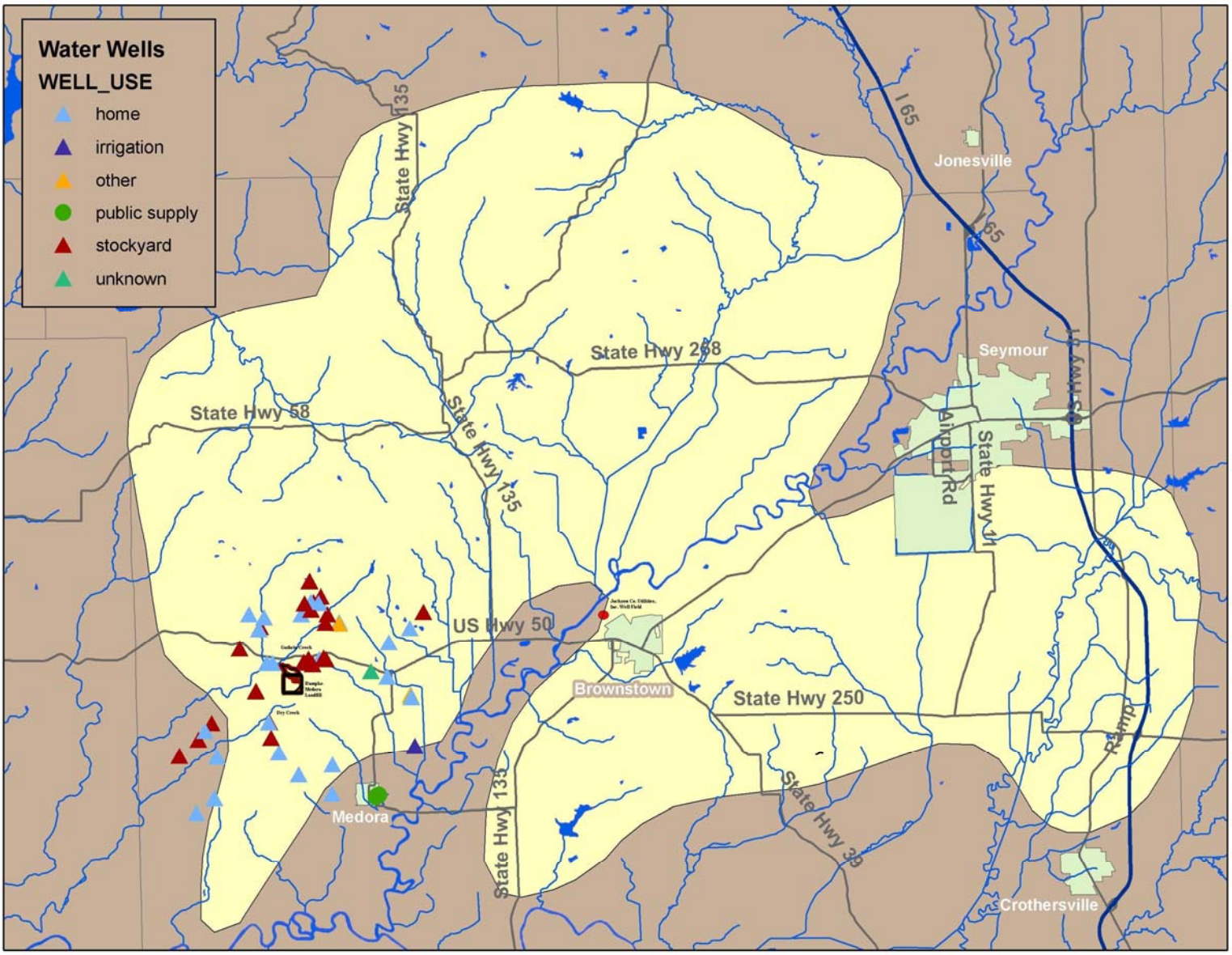

Figure 12. The service area of the Jackson County rural water supply system. Due to the unavailability of local groundwater, people living in the vicinity of the Rumpke-Medora landfill get their drinking water from the Jackson Co. Rural Water Supply system. The service area for this water system is approximated by the bilobed yellow shape on this map. The solid red circle between Brownstown and the East Fork White River marks the location of the deep, high-capacity wells that supply water for the Jackson Co. Rural Water Utility System. The yellow-filled brown square in the midst of the red and blue triangles marks the location of the Rumpke-Medora Landfill north-northwest of Medora and just south of US Hwy 50. Well records indicate that none of the wells represented by these triangles are being used as drinking water supply wells. ATSDR derived this composite by superimposing the water district outline (obtained from Jackson County Water Utilities, Inc.) on a well use map.

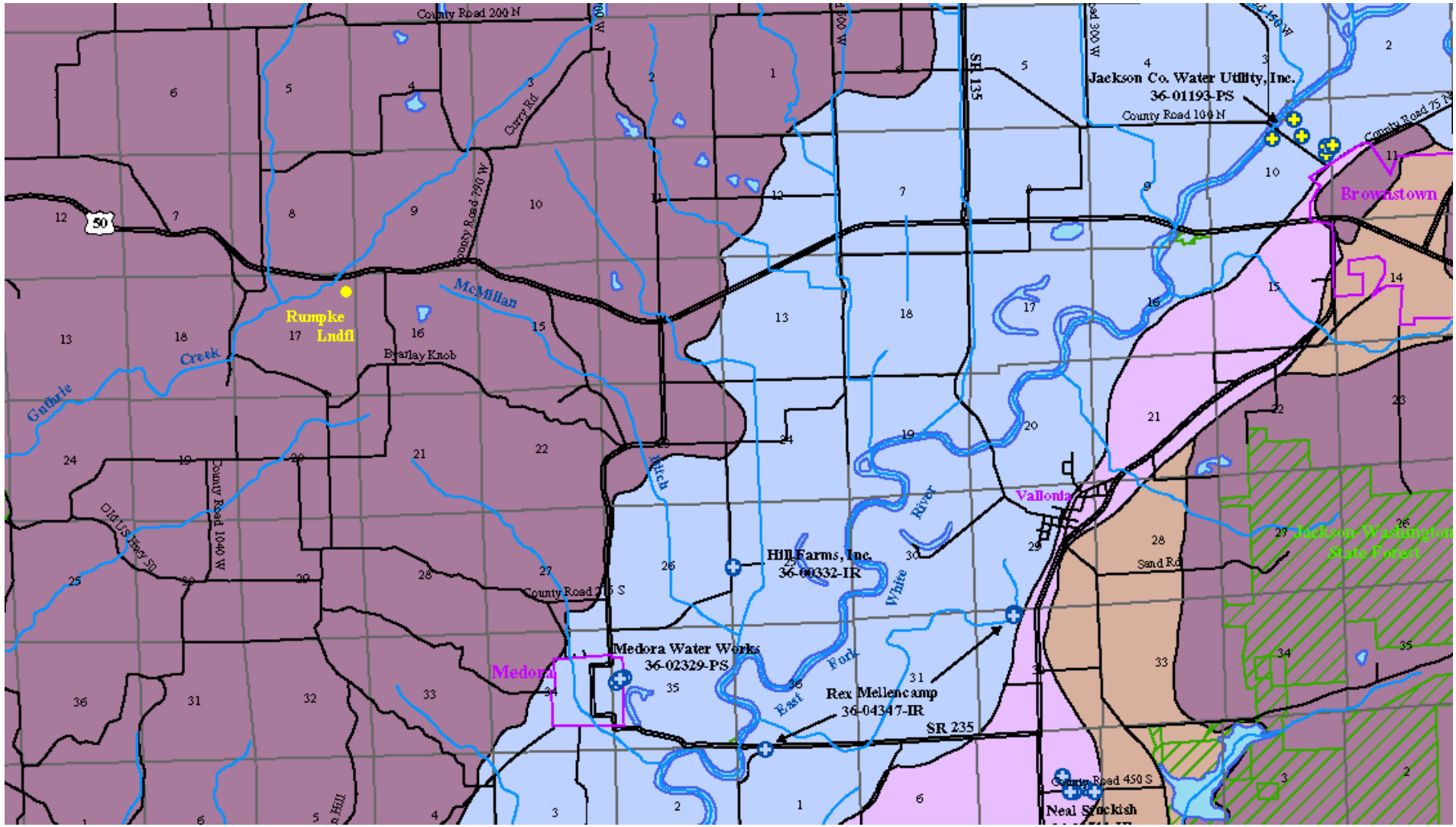

Figure 13. Closeup of Figure 12 showing the respective locations of the Rumpke-Medora Landfill and the wells on the eastern bank of the East Fork White River near Brownstown that provide the water distributed by the Jackson County rural water supply system. Residents living in the vicinity of the Rumpke-Medora Landfill derive their drinking water from this system, rather than from the old, privately owned wells in the area. After: Bedrock Aquifer Systems of Jackson Co, IN, Dept. of Natural Resources, Division of Water.

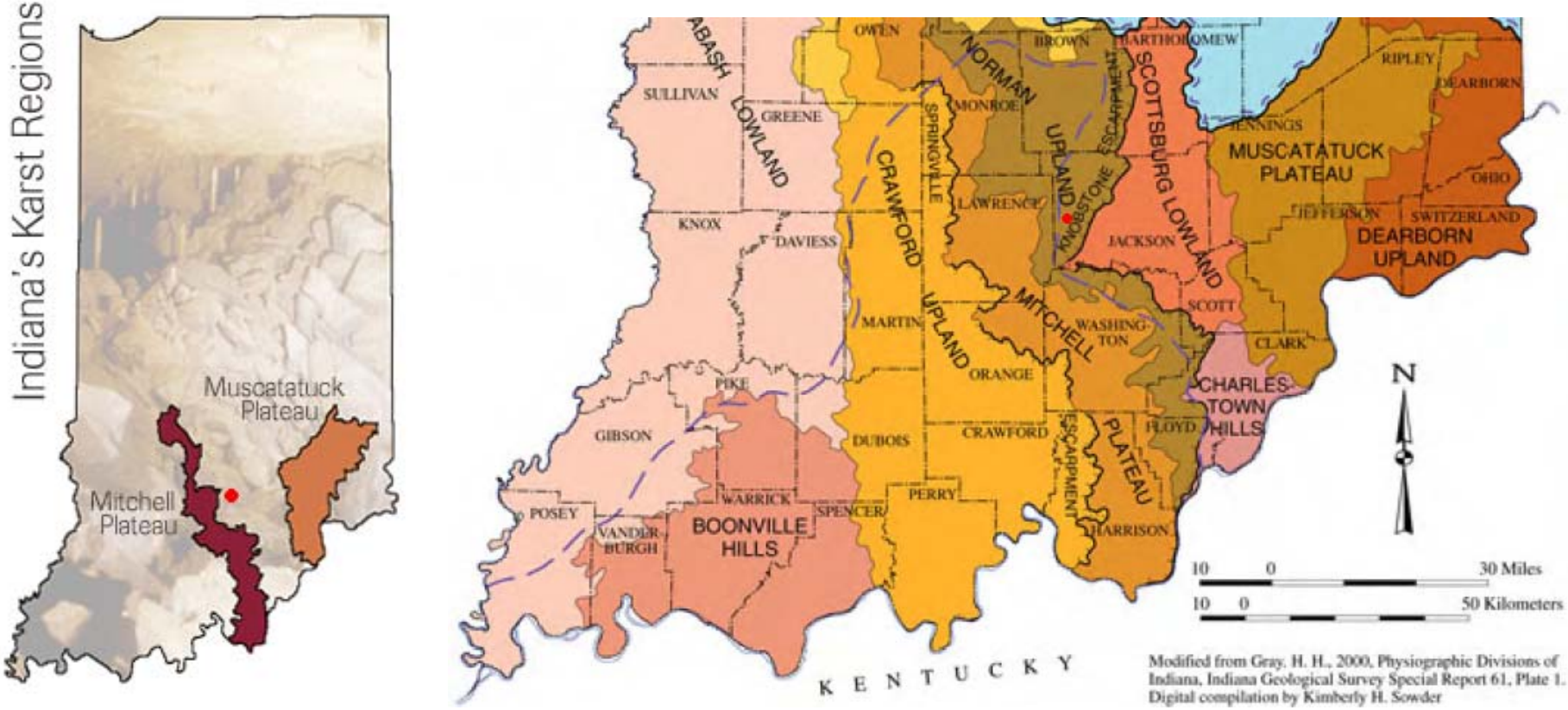

Figure 14. The two Karst regions of southern Indiana. One, the Mitchell Plateau, is to the west and south of the Rumpke-Medora Landfill. The other, the Muscatatuck Plateau, is farther to the east of the landfill. The landfill itself (indicated on these maps by a solid red circle) is not underlain by any significant limestone strata; the occasional, discontinuous limestone lens does occur. However, they are generally to the southwest (i.e., toward Guthrie Creek) and the southeast (i.e., upgradient of the landfill). After: http://www.nature.org/wherewework/northamerica/states/indiana/misc/art22919.html (The Nature Conservancy in Indiana), and http://igs.indiana.edu/geology/maps/statephysiography/physiography.cfm (Indiana Geological Survey)