Lafayette (Teays) Bedrock Valley
Mud Pine Creek to Indiana-Illinois State Line

In this segment the valley continues due west, straddling the Benton-Warren county line. The valley is much wider here than in the previous segment, averaging four to five miles. Data in this segment are sparse, but it appears that the sediment fill in the valley becomes progressively more clay rich to the west. The basal sand and gravel in the segment to the east discussed previously, is still present here and is still the main aquifer; but it is thinner and narrower and may be split by a clay layer. Cross-Section O-O' (Plate 1, Figure 21) clearly illustrates the thicker clay fill of this segment and the decreasing thickness of the basal sand and gravel aquifer. As before, thinner sand and gravel zones are present above the basal aquifer.

Two test holes were drilled in this segment. Test Hole 2 is located near the east edge of the segment in T. 24 N., R. 8 W., Section 31 (east of the intersection of U.S. 41 on County Road 1050, less than a mile west of Mud Pine Creek). From the surface to 100 feet there is a sequence of clay with thin layers of sand and gravel. The upper surface of the basal sand and gravel zone lies at a depth of 100 feet and extends downward to 303 feet with only one thin clay break near the top. The bedrock floor of the valley is encountered at 303 feet. Near the west edge of the segment, in T. 24 N., R. 9 W., Section 31 (north of the Benton/Warren County Line near County Road 900W) is Test Hole 1. At this location, clay extends down to 244 feet with scattered sand and gravel zones. The basal sand and gravel zone is found from 244 to 340 feet and is split by a 21 foot layer of sandy clay from 284 to 305 feet. Bedrock lies at 340 feet. Comparison of the two test holes shows the basal aquifer thinning to the west.

Ground-water availability in this segment is more limited than areas previously discussed due to thinner sand and gravel zones. Although most domestic wells provide adequate water (5 to 25 gpm), the area is poorly tested for high-capacity well volumes. One municipal well at Ambia reportedly produced 100 gpm, the highest documented well yield in this segment of the bedrock valley. It is expected that wells drilled into the basal sand and gravel aquifer should produce from 300-600 gpm.

Generalized Ground Water Availability of the Bedrock Aquifers Underlying the Lafayette (Teays) Bedrock Valley

In addition to the unconsolidated materials filling the Lafayette (Teays) Bedrock Valley, the bedrock underlying the valley also contains water-producing units. Because the bedrock supplies water for much of the area around the valley, the potential of obtaining water from the bedrock was evaluated. Many bedrock types are present along the path of the bedrock valley, and the availability of ground water varies with the bedrock type.

Ground-water availability of the bedrock occurring along the valley floor, flanks, and uplands of the Lafayette (Teays) Bedrock Valley is discussed from east to west and oldest to youngest. This discussion focuses primarily on the water-bearing characteristics of the bedrock. For detail on lithology and stratigraphy of the bedrock, refer to the Bedrock Geology section of this report under the heading of Geologic Setting. Figure 4 also provides a map showing the location of bedrock types in and near the bedrock valley.

Ordovician Age bedrock subcrops in the deepest portion of the valley in the eastern part of the state. To the west, progressively younger bedrock units of Silurian, Devonian, and Mississippian Age are present in the valley floor.

Ordovician Age Bedrock

The bedrock formations of Ordovician Age are generally not considered to be a potential source of ground water. Because of the typically shaley nature of this alternating limestone-shale bedrock, little water is usually encountered. However, in some of the test holes drilled for this study, substantial losses in drilling mud occurred where the Ordovician bedrock was encountered which would seem to indicate the potential for sizable volumes of ground water. Excluding these anomalous circumstances, the Ordovician bedrock (Maquoketa Group) is not expected to be a source of water, and dry wells are common.

Silurian Age Bedrock

Overlying the Ordovician bedrock are various formations of Silurian Age. These formations have varying degrees of water-bearing potential depending upon the physical properties and units present. In general the Silurian is considered as a significant aquifer for moderate to large volumes of ground water (150 to 600 gpm).

Silurian Aquifers

The Salamonie Dolomite is present in and near the bedrock valley in Adams, Jay, and Blackford Counties (Figure 4). This unit and the underlying Cataract Formation appear to be capable of yielding, in most cases, 75 to 300 gpm to properly constructed large-diameter wells. An occasional well in the range of 500 gpm may be obtained.

The Pleasant Mills Formation is present in and near the bedrock valley in portions of Jay, Blackford, Grant, Huntington, Wabash and Miami Counties (Figure 4). It is a moderate producer of ground water as denoted by various large-diameter wells drilled for industrial and municipal purposes. Yields of wells penetrating this formation and the underlying Salamonie Dolomite and Cataract Formation are in the range of 50 to 250 gpm. Some wells have yielded larger amounts where the Pleasant Mills Formation forms the subcrop, but such wells are an exception.

The Lower Wabash (Mississinewa Shale) is present in and near the Lafayette (Teays) Bedrock Valley in portions of Grant, Huntington, Wabash, and Miami Counties (Figure 4). This unit is not normally considered to be a good source of ground water; however, locally some wells penetrating this bedrock aquifer may yield up to 100 gpm. Well yields of 25 gpm or less can be expected to properly constructed large-diameter wells in most cases.

The rocks making up the Upper Wabash comprise the upper most bedrock units of Silurian Age that are found in and near the bedrock valley in much of Miami, Cass, White, and Carroll Counties (Figure 4). Wells drilled into these bedrock aquifers and the underlying deeper units of Silurian Age can be expected to yield limited to moderate amounts of ground water (75 to 250 gpm) to properly constructed large-diameter wells.

In the uplands away from the bedrock valley and its tributaries, where the bedrock topography assumes a more plain-like appearance (Plate 1), the yields of wells in the Silurian Aquifers appear to be more predictable and approach expected average maximum yields of 300 gpm on a more consistent basis. This may be due in part to the greater thickness of weathered bedrock containing numerous joints, fractures and solution enlarged zones.

Devonian Aquifers

Devonian Age bedrock of the Muscatatuck Group is present in and near the bedrock valley in Carroll, White and Tippecanoe Counties (Figure 4). Although the Muscatatuck subcrop is narrow (Figure 4), these rocks constitute a portion of the bedrock aquifer system present in the western part of the state. These formations are similar in water-bearing characteristics to the earlier mentioned Silurian age dolomites and limestone bedrock. Wells drilled into the Muscatatuck Group, and the deeper Silurian bedrock can be expected to yield limited to moderate (50 to 250 gpm) amounts of ground water.

Devonian-Mississippian Age

The New Albany Shale of Devonian-Mississippian Age is present in and near the bedrock valley in White, Carroll, Tippecanoe, Benton, and Warren Counties (Figure 4). The New Albany Shale is not normally considered as an aquifer, but some wells completed in it have yields up to 5 gpm.

Mississippian Age

Rocks of the Borden Group of early Mississippian Age subcrop in and near the bedrock valley in portions of Tippecanoe, Warren and Benton Counties (Figure 4).

The Borden rocks are not normally considered to be a significant aquifer, and wells drilled into it often encounter little water. Wells drilled deep into the Borden bedrock formation run an increasing risk of encountering high levels of mineralized water, including sodium chloride (salt water) and other salts.

Pennsylvanian Age

Erosional remnants of the Pennsylvanian Age bedrock are present near the Lafayette (Teays) Bedrock Valley in Warren County at the higher elevations of the bedrock surface. These rocks constitute a minor aquifer source and wells typically yield from a

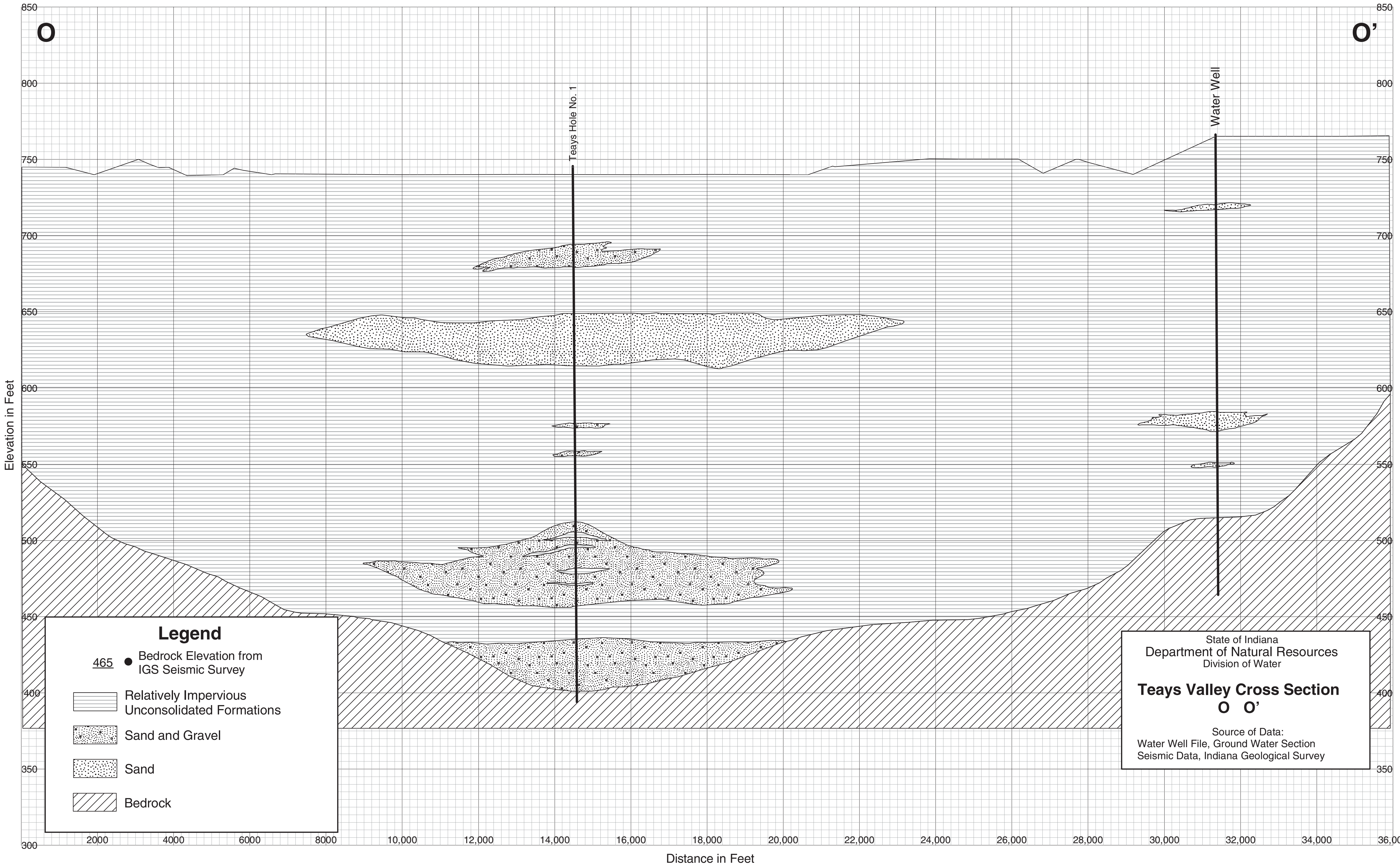
O
O'
Teays Hole No. 1
Water Well
Elevation in Feet
Elevation in feet
850
800
750
700
650
600
550
500
450
400
350
300
2000
4000
6000
8000
10,000
12,000
14,000
16,000
18,000
20,000
22,000
24,000
26,000
28,000
30,000
32,000
34,000
36,000
Distance in Feet
Legend
465 ● Bedrock Elevation from IGS Seismic Survey
Relatively Impervious Unconsolidated Formations
Sand and Gravel
Sand
Bedrock
State of Indiana
Department of Natural Resources
Division of Water
Teays Valley Cross Section
O O'
Source of Data:
Water Well File, Ground Water Section
Seismic Data, Indiana Geological Survey

Figure 21

few gallons per minute to a maximum of 25 gallons per minute to properly constructed large-diameter wells.

Ground-Water Flow
Potentiometric Surface

Many view the Lafayette (Teays) Bedrock Valley as an underground river with water moving down a stream channel to some unknown distant point. Nothing could be further from the truth. As shown earlier, the valley is filled with varying types of glacial deposits through which ground water moves.

Ground water flow, or movement of ground water, in the area underlain by the Lafayette (Teays) Bedrock Valley is generally in a direction toward the major rivers, which serve as the discharge points, or drains, for the various hydrologically connected aquifer systems. The movement of ground water is down gradient from areas of higher ground to areas of low ground, which normally are the major rivers.

The bedrock valley exerts no discernible influence on the regional ground-water flow system. The valley is not a discharge point for the regional ground-water system, nor does ground water flow through the valley like a river. Water is contained within the deposits filling the valley, and generally moves at a very slow rate, typically from less than one foot per day to a maximum of about ten feet per day toward the point of discharge laterally and/or upward into one of the major rivers. The water level map developed for the area surrounding the Lafayette (Teays) Bedrock Valley (Plate 2) shows a gradual but consistent decline in elevation as the water moves to the points of discharge.

Ground water discharged from the regional aquifer systems maintains flow in the streams even during the driest periods of the year. Essentially all streams and rivers in this area of the state are effluent, or gaining streams; they are receiving water from the ground water system rather than losing flow to it.

In the central and western part of the state underlain by the Lafayette (Teays) Bedrock Valley the Wabash River is the major discharge point for the ground-water system, along with various major tributary streams such as the Eel and Tippecanoe Rivers, and Wildcat Creek. In the area west of Lafayette and toward the Illinois state line, the ground-water flow is to the east and southeast toward the Wabash River.

Ground-Water Quality
Lafayette (Teays) Bedrock Valley

Only a limited number of chemical analyses are available for wells tapping aquifers in or above the Lafayette (Teays) Bedrock Valley; however, these analyses provide valuable insights into the general ground-water chemistry that can be expected from wells drilled into the bedrock valley aquifers. The chemical analyses tabulated in Table 1 are presented in east-to-west order.

General Chemical Analysis

In the eastern part of the state, the ground water for aquifers in the bedrock valley is hard and contains high levels of sulfate and iron. Sulfate content in the range of 100 to 600 milligrams per liter (mg/L) is common. Iron levels are typically in the range of 1 to 3 mg/L. Fluoride above 1 mg/L is present in much of this area, and levels up to 4 mg/L are noted, negating the need for supplemental fluoridation of waters for schools and other public uses. Other chemical constituents are fairly typical for much of Indiana, except for the sodium level, which is slightly elevated (See Table 1).

In the north-central part of the state, the available analyses for aquifers in the Lafayette (Teays) Bedrock Valley indicate lower hardness and sulfate levels relative to areas to the east. Fluoride levels are well below 1 mg/L and sodium is typically less than 50 mg/L. The iron content is generally in the range of 1 to 2 mg/L and the manganese level is often high enough to require removal. The levels of other constituents are fairly typical of ground water in Indiana.

In the western part of the state, the chemistry of waters contained within the aquifers of the bedrock valley is similar in composition to much of the ground water generally present in that portion of the state. Hardness levels are typically in the range of 300 mg/L or greater, and iron is in excess of 1 mg/L. All other constituents generally are at moderate levels, except for manganese whose elevated levels may require removal. Further to the west, the manganese levels are substantially lower.

In general, the chemical content of ground water from aquifers in or above the Lafayette (Teays) Bedrock Valley is considered satisfactory for most household, municipal, commercial, and irrigation uses without significant treatment. The water is typically above a hardness level of 300 mg/L and iron removal is required for aesthetic purposes in most cases. Manganese levels above 0.1 mg/L, common in the central and western portions of the state, require removal along with the iron present. Sulfate levels are substantially elevated in portions of the eastern part of the state and fluoride concentrations above 1 mg/L are common. Beyond these noted constituents most other components of the ground-water chemistry are of a moderate level and bear little consideration for further treatment.

Recharge
Lafayette (Teays) Bedrock Valley

Recharge to aquifers within the Lafayette (Teays) Bedrock Valley occurs in much the same manner as it does to any of the other aquifers in the state, namely by the downward percolation of local rainfall through the soil horizon and underlying formations. Recharge does not occur to these aquifers from remote sources such as Lake Michigan, Lake Superior, or the Appalachian Mountains, but from precipitation falling in the immediate area. Observation wells equipped with automatic, continuous, water-level recording devices positioned at various places throughout the state attest to the quick response of aquifers to localized rainfall events. This condition is particularly noticeable during certain periods of the year when local rain storms only a few miles in width cause significant water level rises in affected wells, while other wells outside of these storms paths show no change at all.

Available information on recharge to the Lafayette (Teays) Bedrock Valley aquifers indicates no departure from the expected normal recharge pattern. In fact the observation well in Benton County (Be #4), which is completed in a thick basal fill sand and gravel aquifer contained within the bedrock valley at the depth of 310 feet, exhibits a recharge pattern typical for observation wells in that area of the state and typical for aquifers having similar hydraulic characteristics.

Conclusions

It is perhaps an understatement to say that the Lafayette (Teays) Bedrock Valley is an important source of ground water for north-central Indiana. The work completed in the joint effort by the IDNR Division of Water and the Indiana Geological Survey, while generating significant amounts of new data, provided only a "snapshot" of the geologic and hydrologic characteristics of this unique major buried valley system. New ground-water development projects, completed after the project's test drilling, have provided verification of the highly productive nature of the aquifer systems contained in the Lafayette (Teays) Bedrock Valley.

In the eastern segment of the valley, the most prolific ground-water supplies are generally associated with the entrance of tributary valleys into the main-stem. In other locations within this area of the state, only minor amounts of ground water can be obtained, particularly in those segments containing thick sequences of reddish-brown clay.

Further west, in the stretch from Richvalley to Peru, is found some of the greatest potential for ground-water development. Exhumation of the buried valley, coupled with the addition of more recent sand and gravel deposits, has created a highly transmissive and easily recharged aquifer complex. Individual well yields in excess of 2,000 gpm have been obtained from this aquifer in Peru.

From Peru west to I-65 near Lafayette the aquifers contained in the bedrock valley offer good to excellent ground-water potential. In some areas, cementation of sand and gravel units reduces their productivity. This segment of the buried valley system is largely untapped at the present time and will be an important source of water for agricultural irrigation and public water supply purposes.

In the Lafayette and West Lafayette area, the superposition of the Wabash River valley on the underlying buried valley system has created ideal conditions for major ground-water development. The aquifer complex in this segment has been a significant factor in the economic development of the area. In July of 1988 up to 36 mgd of ground water was pumped from the aquifer system without any significant decline in water levels.

From West Lafayette to the Illinois State Line, the Lafayette (Teays) Bedrock Valley was virtually uncharted until this study. Today, it is clear that this area still holds some geologic "secrets." It is a complex area where overflow channels and classic stream course morphology lie buried beneath deposits from multiple glacial advances. To the communities of Otterbein and Oxford, the buried valley has become an essential source of high-quality ground water. And, as the valley exits Indiana, its geologic character appears to change once again, as do ground-water conditions.

The aquifers associated with the Lafayette (Teays) Bedrock Valley system will continue to be an important source of water for portions of north-central Indiana and can be expected to provide additional quantities of water for agricultural, industrial, and public water-supply needs.

Table 1. Teays Valley Chemical Analsis

County	Owner	Usage	Twp	Rng	Sec	Turb	pH	Hardness (CaCO3)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Iron (Fe)	Manganese (Mn)	Alkalinity (CaCO3)	Chloride (Cl)	Sulfate (SO4)	Phosp (PO4)	Flouride (F)	Nitrates (NO3)	Spc Cond	Diss Solids	Arsenic (As)	Other Paras	Well Data Depth	Geol Unit	Yield	Remarks	Date
Adams	Decatur	Muni	25N	14E	2		7.8	536	126	53	70	3	1.8	0.03	172	11	510	<0.1	1.6	<0.1					150	G	2100	#1- West Well	Apr-76
Adams	Decatur	Muni	25N	14E	2		7.6	636	157	59	79	3	2.2	0.04	162	10	630	<0.1	1.6	<0.1			<.01		151	G	2100	#2- East Well	Apr-76
Adams	Decatur	Muni	25N	14E	2		7.3	552	131	54	61	2.7	1.9	0.02	170	12	510	0.09	1.5	0.1					150	G	2100	#1- West Well	Jun-81
Adams	Decatur	Muni	25N	14E	2		7.3	684	160	69	69	2.8	2.4	0.04	176	11	670	0.1	1.5	0.1					151	G	2100	#2- East Well	Jun-81
Adams	Decatur	Muni	25N	14E	2		7.8	550	131	54	65	2.7	1.5	0.03	168	12	470	0.09	1.4	0.2					150	G	2100	#1- West Well	May-82
Adams	Decatur	Muni	25N	14E	2		7.7	676	165	64	72	2.7	2.2	0.05	160	11	630	0.12	1.5	0.5					151	G	2100	#2- East Well	May-82
Adams	Geneva	Muni	25N	14E	29		7.7	478	118	45	72	3	1.5	0.02	178	14	440	<0.1	1.6	0.3			<.01		131	S/G	550	#1- Downtown	Jul-74
Grant	Marion	Muni	25N	8E	27	10	7.4	436	96	48	40	2	1	0.03	328	5	170	<0.1	1.2	<0.1			<.01		236	S/G	2200	#1- NE Field	Jul-70
Grant	Marion	Muni	25N	8E	27	7	7.4	434	97	47	40	2	0.9	0.02	318	5	175	<0.1	1.1	<0.1					209	S/G	2118	#2- NE Field	Jul-70
Grant	Marion	Muni	25N	8E	27	8	7.4	430	97	46	39	2	1	0.03	312	5	180	<0.1	1.1	<0.1			<.01		184	S/G	1740	#3- NE Field	Jul-70
Grant	Marion	Muni	25N	8E	27	6	7.5	432	97	46	38	2	0.7	0.02	316	7	170	<0.1	1.1	<0.1			<.01		203	S/G	1810	#4- NE Field	Jul-70
Wabash	LaFontaine	Muni	26N	7E	27		7.7	340	72	39	38	2	1.7	0.04	342	3	88	0.1	1.6	1.3					89	S/G		#1	Mar-76
Wabash	LaFontaine	Muni	26N	7E	27		7.6	336	75	36	34	2	1.6	0.02	342	4	68	<0.1	1.4	0.7									
Wabash	Wabash	Muni	27N	6E	28	4	7.8	352	92	30	4	<1	1.4	0.04	315	3	26		0.4	0.1			<.01		203	S/G	1016	#1- Smith Field	May-69
Wabash	Wabash	Muni	27N	6E	28	10	7.1	331	86	28	5	2	1.6	0.05	321	2	23		0.3	0.1					187	S/G	1529	#2- Smith Field	Jan-67
Miami	Peru	Muni	27N	4E	22	15	7.3	474	136	33	5	2	1.8	0.2	340	21	110	<0.1	0.2	<0.1			<.01		118	S/G	1800	#3	Aug-70
Miami	Peru	Muni	27N	4E	22	2	7.2	600	163	47	45	4	0.6	0.2	332	94	215		0	1.2					117	S/G	760	#4	Aug-65
Miami	Peru	Muni	27N	4E	22	15	7.3	560	151	44	34	3	4.1	0.19	332	66	183	0.2	0.2	1.1					117	S/G	760	#4	Aug-70
Miami	Peru	Muni	27N	4E	22		7.5	440	118	35	5	2	1.6	0.13	318	10	115	<0.1	0.2	0.1					117	S/G	760	#4	Oct-76
Miami	Peru	Muni	27N	4E	22	30	7.4	628	175	46	59	4	2.7	0.2	334	133	220		0.2	1.1			<.01		135	S/G	2000	#5	Jun-71
Miami	Peru	Muni	27N	4E	22		7.6	544	152	40	33	4	1.8	0.23	338	64	178	<0.1	0.2	1.2					135	S/G	2000	#5	Oct-76
Miami	Peru	Muni	27N	4E	22		7.3	516					1.7		328	62	163				925				135	S/G	2000	#5	Feb-80
Miami	Peru- T.W.	Muni	27N	4E	22		7.8	408	104				1.8	0.1	329	4	69		0.6	8	700				152	S/G	695	TW #1priv.lab	Apr-81
Miami	Peru- T.W.	Muni	27N	4E	22		7.3	400	104	34	64	1.6	1.2	0.07	332	11	65	0.09	0.3	0.1					152	S/G	695	TW #1 (SBH)	Apr-81
Miami	Stokely	Ind	27N	4E	22		7.5	432	113	36	4.4	2.1	2	0.09	312	2.9	112		0.1	0.2	754	485		SiO_2 13 HCO_3 380	73	S/G	250	USGS Tmp 53	Aug-53
Tippe	Battleground	Muni	24N	4W	23	1	7.5	310	79	28	8	2	1.1	0.2	289	3	38		0.1	0								East Well	Oct-63
Tippe	Battleground	Muni	24N	4W	23		7.9	298	71	29	10	2	1.2	0.15	260	10	46	<0.1	0.3	<0.1			<.01					#1- South Well	Jul-75
Tippe	Battleground	Muni	24N	4W	23	2	7.5	316	79	28	11	3	1.1	0.19	310	4	25	<0.1	0.3	<0.1								#1- South Well	Oct-76
Tippe	Battleground	Muni	24N	4W	23	2	7.5	298	78	25	12	2	1.1	0.2	294	3	24		0	0								West Well	Oct-63
Tippe	Battleground	Muni	24N	4W	23		7.7	320	78	31	13	3	1.1	0.18	322	4	18	0.1	0.3	0.1			<0.1					#2- West Well	Jul-75
Tippe	Battleground	Muni	24N	4W	23	0.8	7.5	344	88	30	10	3	1.2	0.15	294	9	58	0.2	0.2	<0.1								#2- West Well	Oct-76
Tippe	Grn Meadows	PS	23N	5W	15	6	7.6	292	75	25	2	2	0.6	0.11	238	5	60	<0.1	0.2	<0.1			<.01		191	S/G	156		
Tippe	Carriage Est.	PS	23N	5W	9	10	7.5	336	80	33	18	2	1.4	0.05	350	3	20	0.2	0.5	0.1					138	S/G	350	#1 Well	May-76
Tippe	Lafayette	Muni				0.1	7.9	304	82	24	13	3	<0.1	0.15	246	25	60	<0.1	0.3	0.5			<0.1					#1 Well (old)	Apr-76
Tippe	Lafayette	Muni					7.7	280	75	22	10	3	0.9	0.29	212	20	56		0.3	0.3			<0.1					#2 Well (old)	Sep-69
Tippe	Lafayette	Muni				0.4	7.9	316	85	25	13	3	0.1	0.38	232	32	74	<0.1	0.2	0.8			<0.1					#3 Well (old)	Apr-76
Tippe	Lafayette	Muni				0.2	7.9	280	76	22	12	3	<0.1	0.24	210	25	66	<0.1	0.2	0.5			<0.1					#4 Well (old)	Apr-76
Tippe	Lafayette	Muni				0.1	7.6	304	80	25	14	3	<0.1	0.5	208	27	80	<0.1	0.2	2			<0.1	Pb <.02				#5 Well (old)	Mar-75
Tippe	Lafayette	Muni				0.2	7.6	376	101	30	18	3	0.1	0.3	306	35	64	<0.1	0.2	0.8			<0.1					#6 Well (old)	Apr-76
Tippe	Lafayette	Muni				0.4	7.4	436	115	36	38	5	0.4	0.09	342	64	91	<0.1	0.3	1.4								#7 Well (old)	Apr-76
Tippe	Lafayette	Muni				0.2	7.2	464	130	34	23	4	<0.1	<.02	356	41	99	<0.1	0.2	2.4								#8 Well (old)	Apr-76
Tippe	Lafayette	Muni				5	7.7	266	74	20	12	3	1	0.6	194	25	64	<0.1	0.3	0.1			<0.1	Pb <.02				#9 Well (old)	Mar-75
Tippe	Lafayette	Muni				25	7.6	282	78	21	12	3	2.1	0.13	216	18	61		0.2	0.1			<0.1					#12 Well (old)	Sep-71
Tippe	Lafayette	Muni				0.1	7.7	268	72	21	11	3	<0.1	0.4	196	24	69	<0.1	0.2	0.6								#13 Well (old)	Apr-76

Tippe	Lafayette	Muni	23N	4W	17	2	7.3	332	88	27	14	2	0.2	0.16	268	19	59	0.1	0.2	0.4			0.002	Pb<.02	98	S/G	2641	#1 New Well	Jun-78
Tippe	Lafayette	Muni	23N	4W	17		7.3	336	93	25	8	1.5	0.96	0.2	278	13	60	0.09	0.2	0.1					98	S/G	2641	#1 New Well	Nov-82
Tippe	Lafayette	Muni	23N	4W	17	5	7.4	328	86	27	8	2	0.6	0.21	268	10	55	0.1	0.2	0.1			0.002	Pb <.02	101	S/G	2676	#2 New Well	Jun-78
Tippe	Lafayette	Muni	23N	4W	17		7.5	342	90	28	8	1.5	0.74	0.19	276	14	61	0.09	0.2	0.1					101	S/G	2676	#2 New Well	Nov-82
Tippe	Lafayette	Muni	23N	4W	17	15	7.3	336	84	31	7	2	1.4	0.13	286	12	43	0.1	0.2	0.1			0.002	Pb <.02	100	S/G	2597	#3 New Well	Jun-78
Tippe	Purdue Univ.	PS				0.04	7.3	402	105	34	9	3	<0.1	0.06	290	26	95		0.1	2.5								#1 Well	Sep-71
Tippe	Purdue Univ.	PS				0.5	7.5	348	86	32	6	3	0.2	0.14	266	10	76	<0.1	0.2	0.2				Pb .05				#1 Well	Aug-76
Tippe	Purdue Univ.	PS				1	7.4	382	94	35	5	3	0.3	0.11	286	6	80		0.1	0.4								#4 Well	Sep-71
Tippe	Purdue Univ.	PS				20	7.4	348	93	28	7	4	2.4	0.19	238	13	90		<0.1	0.5								#5 Well	Sep-71
Tippe	Purdue Univ.	PS				0.7	7.5	352	86	33	4	2	0.6	0.14	268	5	83		0.1	0.3								#7 Well	Dec-70
Tippe	Purdue Univ.	PS				3	7.6	360	91	32	8	3	0.6	0.16	264	16	83	1.5	0.1	0.6				Pb .04				#8 Well	Aug-76
Tippe	Purdue Univ.	PS				0.7	7.6	380	99	32	6	3	0.3	0.2	278	18	82	<0.1	0.1	1.2				Pb .04				#11 Well	Aug-76
Tippe	Purdue Univ.	PS				20	7.5	338	85	31	3	3	1.1	0.17	258	<1	75		<0.1	<0.1								#12 Well	Sep-71
Tippe	Purdue Univ.	PS				0.7	7.6	344	86	31	5	3	0.4	0.15	260	12	72	1.6	0.2	0.1				Pb .04				#14 Well	Aug-76
Tippe	W. Lafayette	Muni				0.5	7.2	332	87	28	13	2	<0.1	0.11	250	24	66	<0.1	0.2	0.1								#2 Well	Nov-77
Tippe	W. Lafayette	Muni				15	7.2	354	90	32	9	2	1.4	0.15	284	16	59	0.1	0.2	<.01								#3 Well	Nov-77
Tippe	W. Lafayette	Muni				3	7.1	364	94	32	12	2	0.4	0.12	277	21	73	<0.1	0.2	0.4								#4 Well	Nov-77
Tippe	W. Lafayette	Muni				10	7.2	317	85	26	11	2	1.2	0.18	240	15	73	<0.1	0.2	<0.1								#5 Well	Nov-77
Tippe	W. Lafayette	Muni				2	7.2	363	93	32	12	3	0.6	0.13	286	21	65	0.3	0.2	0.5								#6 Well	Nov-77
Tippe	W. Lafayette	Muni				1	7.2	352	92	30	12	3	0.4	0.09	279	9	65	12	0.3	0.1								#7 Well	Nov-77
Tippe	W. Lafayette	Muni				20	7.4	332	82	31	6	2	1.9	0.09	298	3	39	0.1	0.3	<0.1								#8 Well	Mar-77
Tippe	Otterbein	Muni	24N	6W	34		7.7	280	66	28	22	2.5	2	0.02	326	5	5	0.09	0.5	0.1					260	S/G	643	10" at tower	Mar-81
Tippe	Otterbein	Muni	24N	6W	34		7.8	250	66	21	22	2.3	2	0.03	300	5	5		0.5		360		0.002		260	S/G	643	10" at tower	Nov-80
Tippe	Otterbein	Muni	24N	6W	34		7.6	280	65	28	23	2.3	1.3	0.03	329	5	5	0.09	0.5	0.1					260	S/G	643	10" at tower	Mar-82
Benton	Otterbein	Muni	24N	6W	33	5	7.6	400	97	38	15	2	1	0.1	339	13	78		0.2	0.2								#1 Well	Aug-60
Benton	Otterbein	Muni	24N	6W	33	10	7.4	442	106	43	21	2	1.1	0.2	350	32	80		0.3	0.3			<.01					#2 Well	Aug-70
Benton	Otterbein	Muni	24N	6W	33	0.7	7.2	448	107	44	18	3	1.9	0.05	338	23	115		0.2	0.2								#3 Well	Nov-65
Benton	Oxford	Muni	24N	7W	31		7.6	284	63	31	24	2.6	1.7	0.02	334	3	8		0.5	0.1	640	420	0.003		211	S/G	750	#1 New Well	Aug-79
Benton	Oxford	Muni	24N	7W	31		7.6	282	63	30	24	2.5	1.6	0.02	346	3	10		0.5	0.1	640	420	0.002		211	S/G	750	#1 New Well	Aug-79
Benton	Oxford	Muni	24N	7W	31		7.7	296	67	31	27	2.5	2.3	0.05	346	7	5	5	0.5	0.1					211	S/G	750	#1 New Well	Jun-82
Benton	Ambia	Muni	24N	10W	35		7.8	280	62	30	22	4	1.7	0.06	326	<1	1	0.6	0.7	0.4					125	S/G		#1 Well	Jul-73
Benton	Ambia	Muni	24N	10W	35		8.1	282	60	32	21	4	1	0.04	320	3	1	<0.1	0.6	0.1			<.01						Jan-69

Table 1 continued...

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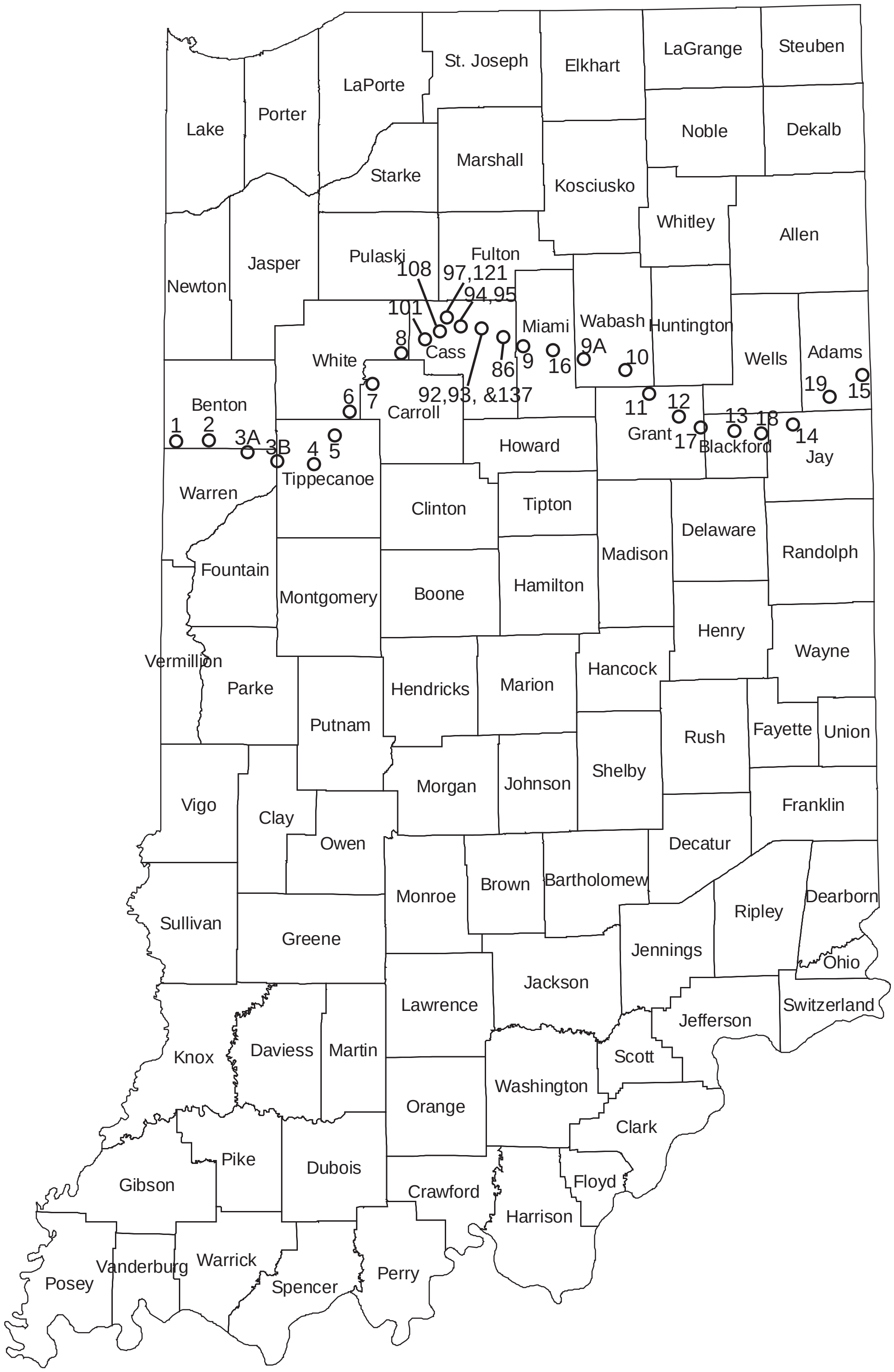
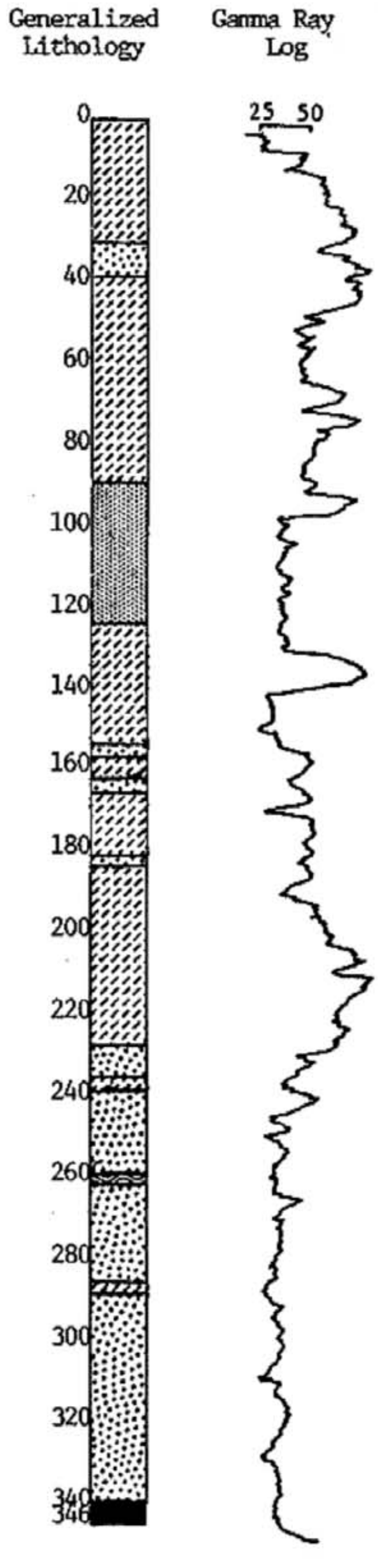
APPENDIX A

GEOLOGIC DESCRIPTIONS OF TEAYS VALLEY TEST HOLES

The following test hole information is a summation and tabulation of the data at sites for which driller's logs, gamma ray logs are available. The location of each test hole is depicted below and in Figure 6 of the text.

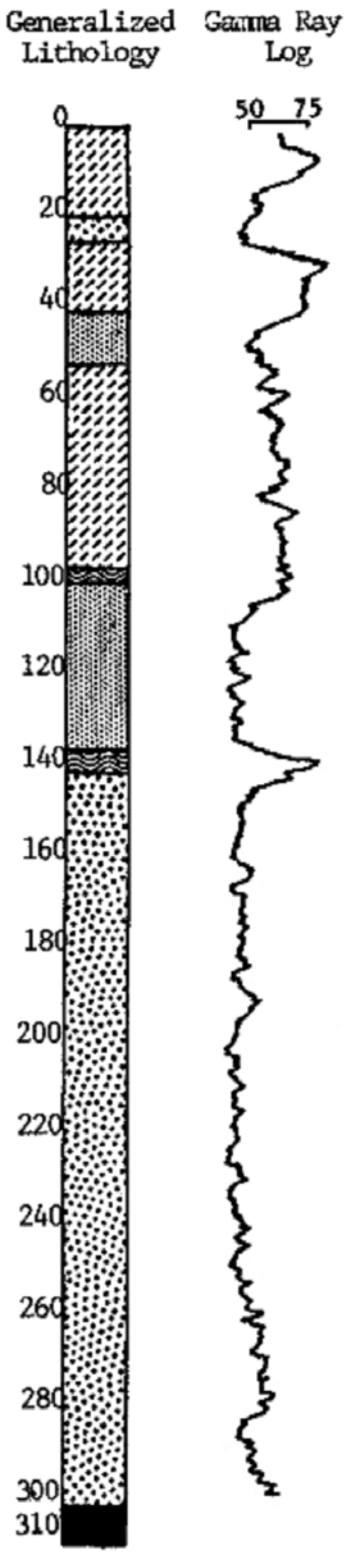


I.D.N.R. Test hole #1 – Ambia site; SW¼ of NW¼, Section 31, T. 24 N., R. 9 W. Hickory Grove Township, Benton County, Elevation: 742 feet. Total depth is 346 feet. Drilled by Ortman Drilling, Inc., September 6, 1978.



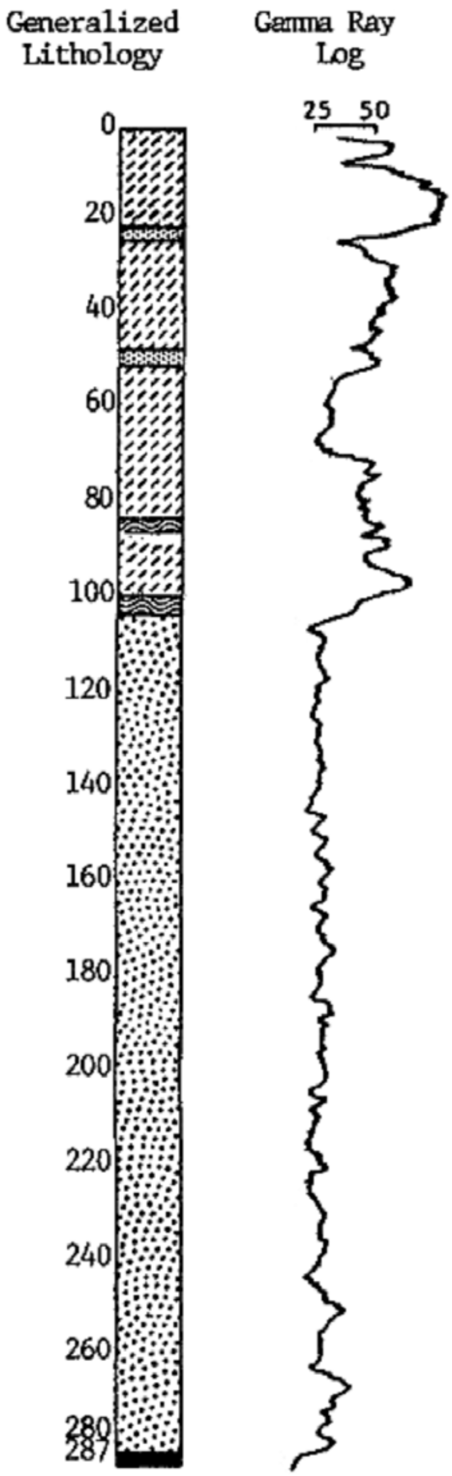
Driller's Log	Interval
Black dirt	0-2
Brown clay	2-8
Gray clay (sticky)	8-38
Soft gray clay	38-45
Gray fine to med. gravel	45-59
Gray clay (very sticky)	59-63
Gray clay	63-77
Soft gray sticky clay	77-90
Very fine silty sand	90-125
Soft sticky sand gray clay	125-155
Gravelly gray clay	155-163
Sand and fine-med. gravel	163-166
Gray clay	166-182
Sand and fine gravel	182-184
Gray clay, some gravel	184-189
Sticky gray clay	189-210
Sticky gray clay	210-228
Sand and med. gravel	228-235
Brown clay	235-239
Sand & dirty gravel	239-243
Clay	243-244
Sand & fine med. gravel	244-259
Greenish brown clay	259-262
Brown sand & med. gravel	262-284
Sandy gravelly gray clay	284-305
Sandy fine to med. gravel	305-340
Brown weathered bedrock	340-342
White putty stone	342-346

I.D.N.R. Test hole #2 – Mud Pine Creek site; NE¼ of SE¼, Section 31, T. 24 N., R. 8 W., Grant Township, Benton County. Elevation: 710 feet. Total depth is 310 feet. Drilled By Ortman Drilling, Inc., September 5, 1978. Used as U.S. Geological Survey Observation Well Benton #4.



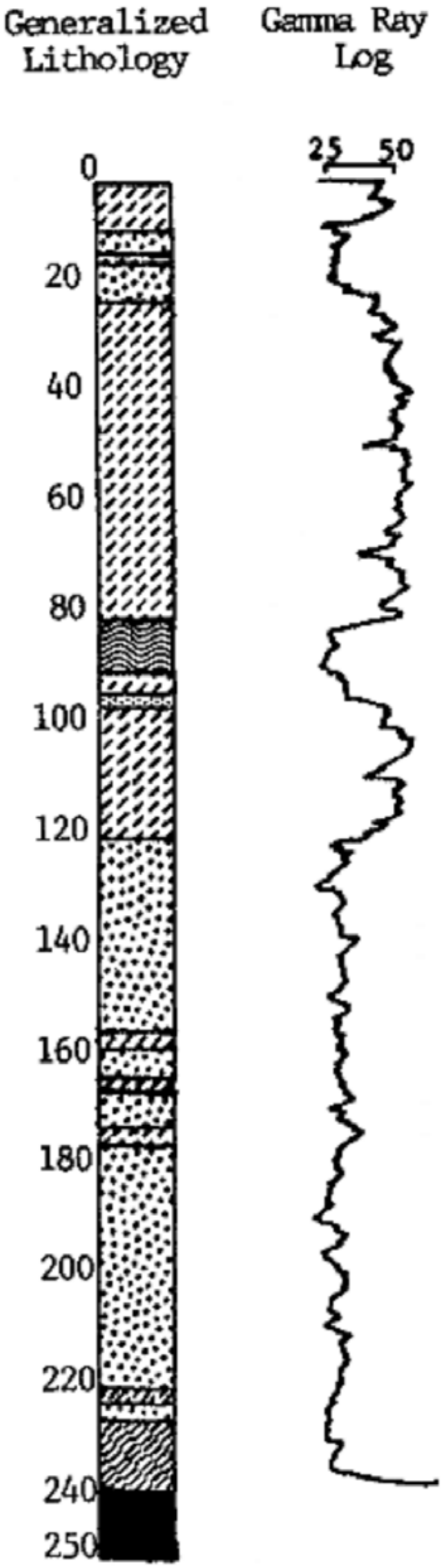
Driller's Log	Interval
Black dirt and gray clay	0-20
Red, med. sand and gravel	20-25
Gray clay	25-41
Gray med. gravel and broken stone	41-52
Gray clay with some gravel	52-97
Gray clay	97-100
Fine silty sand	100-137
Gray clay	137-142
Fine to med. sand & gravel	142-255
Sandy gravel with some broken stone	255-303
Blue gray stone	303-310

I.D.N.R. Test hole #3A – Pine Village site; SE¼ of NE¼, Section 4, T. 23 N., R. 7 W., Adams Township, Warren County. Elevation: 693 feet. Total depth is 287 feet. Drilled by Ortman Drilling, Inc., September 7, 1978.



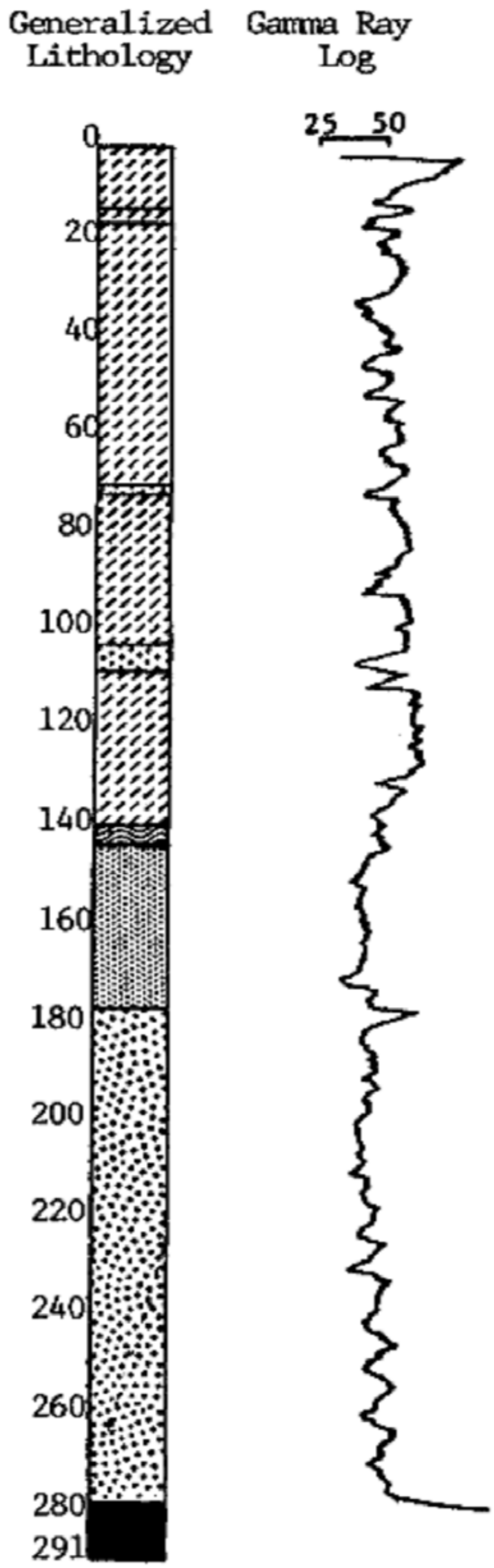
Driller's Log	Interval
Black dirt	0-2
Sandy yellow clay	2-12
Gray clay	12-22
Sand	22-24
Gray clay	24-33
Gray clay	33-40
Gray clay	40-49
Brown clay	49-51
Very fine silty sand	51-69
Brownish gray clay	69-82
Sand	82-83
Sticky gray clay	83-88
Gravelly silty gray clay	88-90
Gray clay	90-98
Silty brown gray clay	98-100
Brown silty with some sand	100-110
Sandy fine to med. brown gravel	110-120
Fine-med. sand	120-138
Med. to coarse sand and gravel	138-283
Yellow limestone	283-285
Gray limestone	285-287

I.D.N.R. Test hole #3b – Green Hill site; NW¼ of SW¼, Section 22, T. 23 N., R. 6 W., Shelby Township, Tippecanoe County. Elevation: 645 feet. Total depth is 250 feet. Drilled by Ortman Drilling, Inc., September 14, 1978.



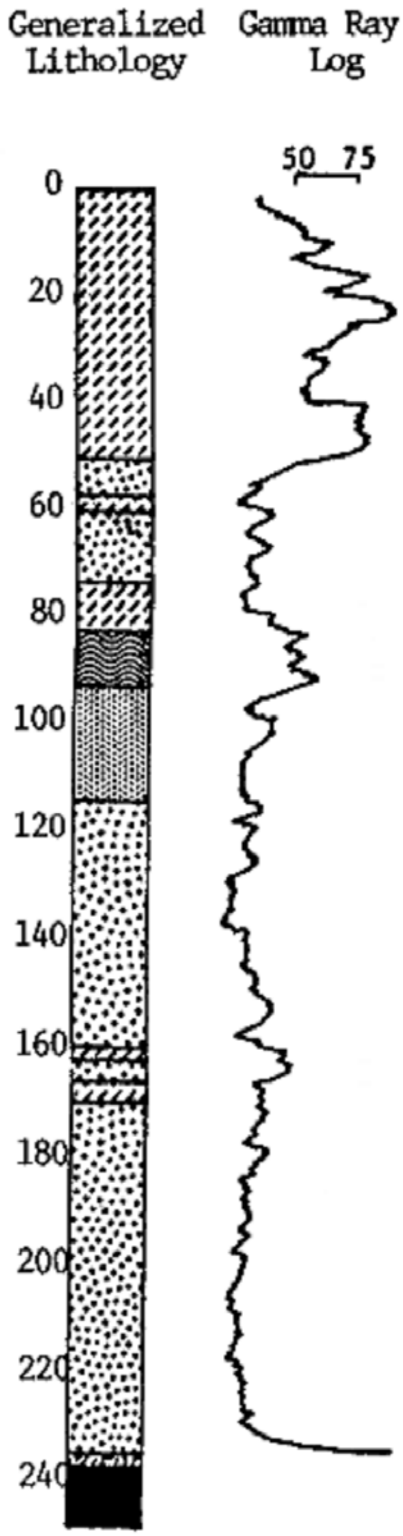
Driller's Log	Interval
Gravelly brown clay	0-5
Gray clay	5-9
Loose fine-med. sand and gravel	9-13
Sandy gray clay	13-15
Loose med. sand & gravel	15-22
Gray to brown clay	22-80
Silt	80-90
Very fine silty sand	90-95
Gray clay	95-117
Soft sandy brownish gray clay	117-127
Fine to med. sand	127-149
Sand fine to med. gravel	149-155
Sand and fine gravel with clay	155-165
Sand and fine to med. gravel	165-175
Sand and fine gravel with clay	175-200
Fine to med. gravel with sand	200-220
Dirty sand	220-228
Yellow fine-med. gravel and broken stone	228-238
Blue shale	238-250

I.D.N.R. Test hole #4 – West Lafayette site; SE¼ of NE¼ of Section 21, T. 23 N., R. 5 W., Wabash Township, Tippecanoe County. Elevation: 682 feet. Total depth is 291 feet. Drilled by Ortman Drilling, Inc., September 7, 1978.



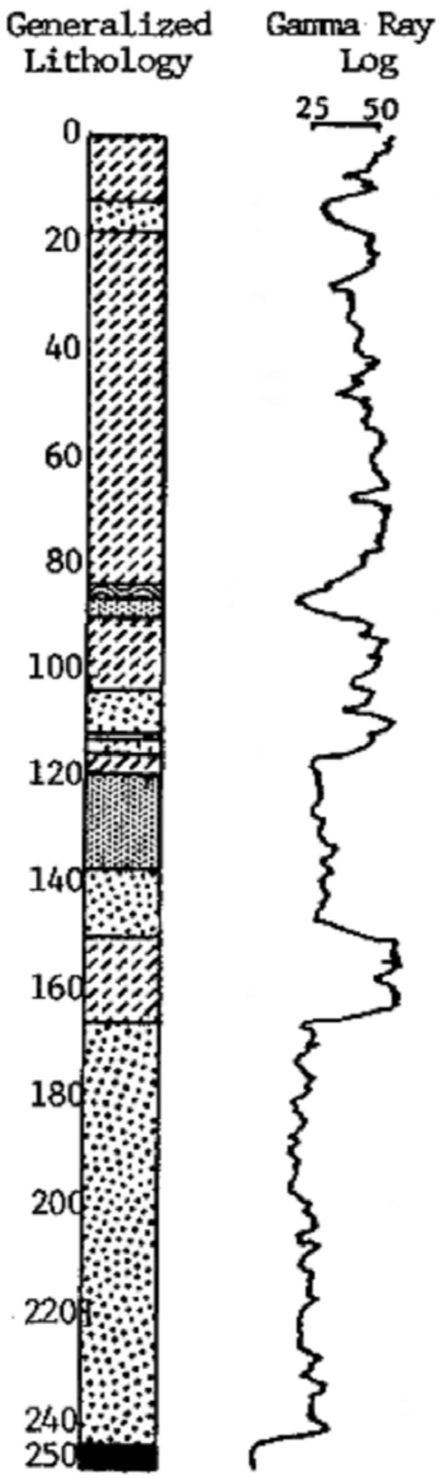
Driller's Log	Interval
Brown clay	0-5
Brown to gray clay, some sand	5-14
Sand and fine gravel	14-16
Gray clay with some boulders	16-43
Sandy gravelly clay	43-46
Sandy clay	46-71
Sand and gravel	71-72
Brownish gray clay	72-103
Very sandy fine yellow gravel	103-108
Brownish gray clay	108-140
Very fine silty sand	140-160
Fine to med. sand	160-177
Sandy, tight med. to coarse gravel	177-190
Cemented sand and fine gravel	190-264
Boulders and med. to coarse cemented gravel (sandy)	264-278
Soft blue shale	278-287
Hard bedrock	287-291

I.D.N.R. Test hole #5 – North Lafayette site; SE¼ of SE¼, Section 36, T. 24 N. R. 5 W., Wabash Township, Tippecanoe County. Elevation: 677 feet. Total depth is 240 feet. Drilled by Ortman Drilling, Inc., September 8, 1978.



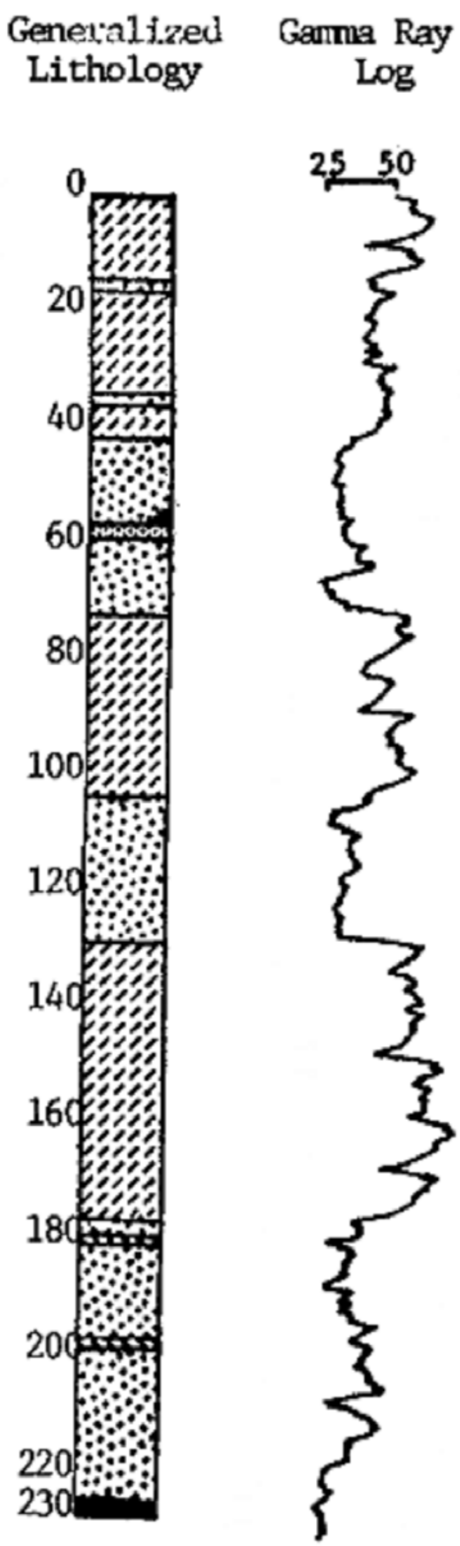
Driller's Log	Interval
Black dirt	0-2
Brown clay	2-8
Gray clay	8-51
Sandy fine to med. gravel	51-57
Gravelly gray clay	57-60
Sandy fine to med. gravel	60-78
Gray clay	78-94
Very fine to fine brown silty sand	94-116
Brown sandy fine gravel	116-117
Brown sand	127-147
Brown sandy fine-med. gravel	147-152
Gray sandy fine gravel	152-160
Gravelly greenish to gray clay	160-175
Gray sandy fine gravel	175-185
Med. to coarse gravel, sand some cementing	185-235
Pink clay	235-236
Brown shale	236-240

I.D.N.R. Test hole #6 – Battleground site; SE¼ of SE¼, Section 35, T. 25 N., R. 4 W., Prairie Township, White County. Elevation: 668 feet. Total depth is 250 feet. Drilled by Ortman Drilling, Inc., September 13, 1978.



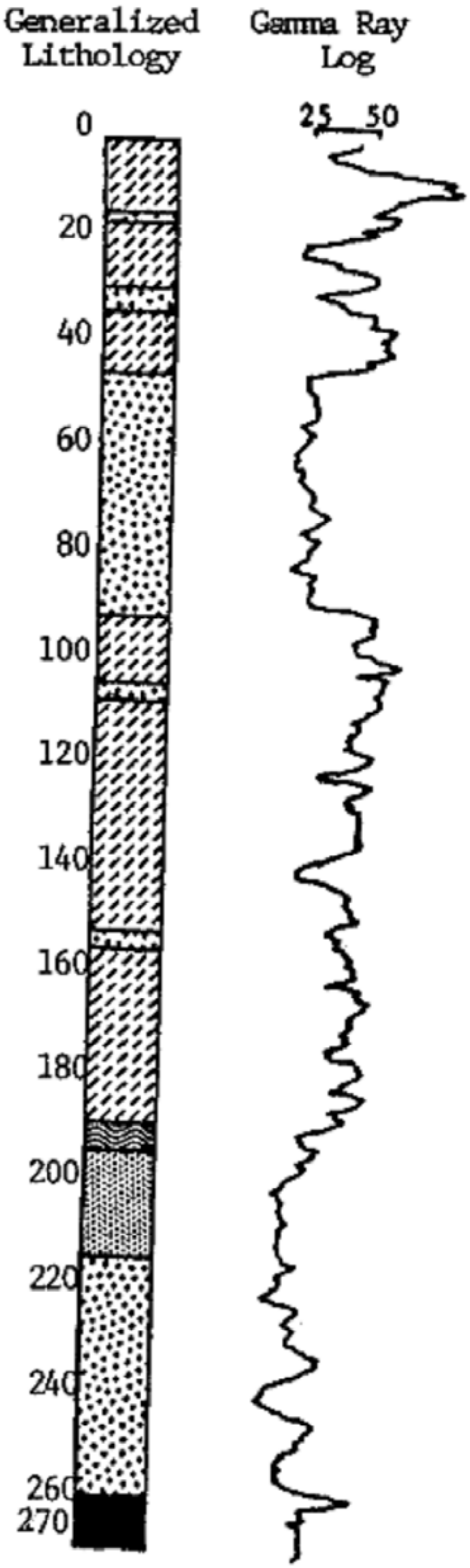
Driller's Log	Interval
Black dirt and yellow clay	0-7
Greenish-brown to gray clay	7-12
Brown to gray sand and gravel	12-18
Gritty gray clay	18-64
Pink clay	64-85
Dirty fine sand	85-90
Gray clay	90-112
Gray clay with layers of sand and gravel	112-117
Fine-very fine sand	117-130
Very sandy fine gravel	130-150
Silty gritty gray clay	150-167
Fine brown sand	167-178
Brown fine to medium sand	178-198
Medium to coarse gravel and broken stone	198-245
White limestone	245-250

I.D.N.R. Test hole #7 – Yeoman site; SW¼ of SE¼, Section 34, T. 26 N., R. 3 W., Tippecanoe Township, Carroll County. Elevation: 660 feet. Total depth is 230 feet. Drilled by Ortman Drilling, Inc., September 13, 1978.



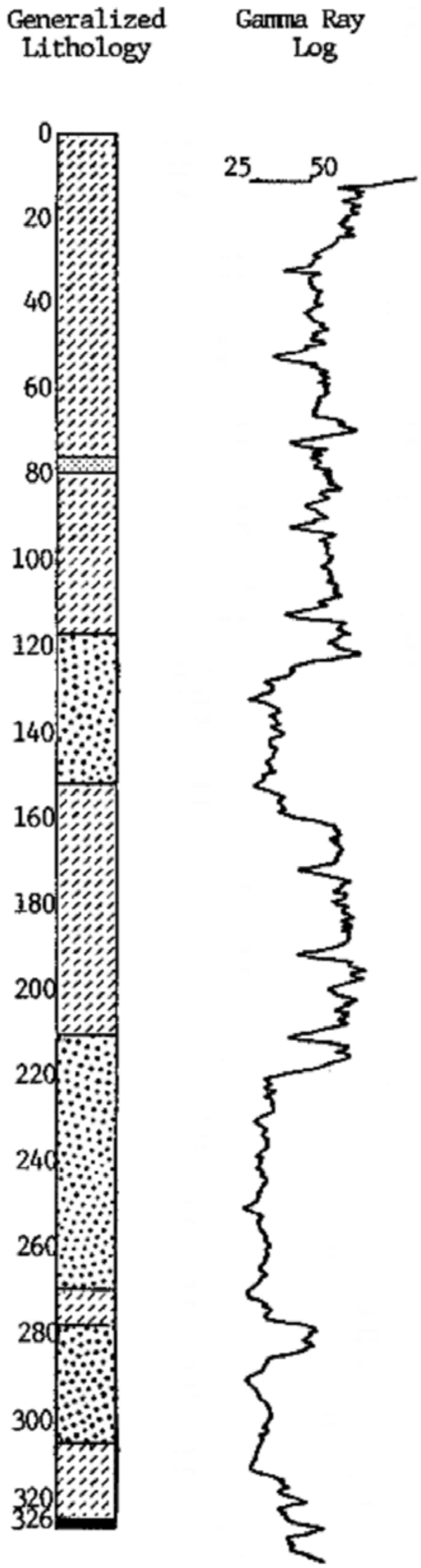
Driller's Log	Interval
Yellow clay	0-10
Gray clay	10-15
Sandy gravel	15-16
Sandy gray clay	16-34
Sand	34-35
Sandy gray clay	35-42
Very sandy fine gravel	42-60
Soft gray clay	60-66
Fine to med. sand	66-72
Slightly gritty gray clay	72-80
Thin alternating gray clay and sand	80-83
Slightly gritty gray clay	83-104
Sand	104-115
Sandy fine to med. gravel	115-130
Slightly gritty gray clay	130-177
Sand and gravel	177-179
Clay	179-180
Coarse-vcrs. gravel with broken stone	180-195
Clay streaks & gravel	195-202
Med.-vcrs. gravel and broken stone	202-225
White limestone	225-230

I.D.N.R. Test hole #8 – Burnettsville site; NW¼ of NE¼, Section 36, T. 27 N., R. 2 W., Jackson Township, White County. Elevation: 698 feet. Total depth is 270 feet. Drilled by Ortman Drilling, Inc., September 12, 1978.



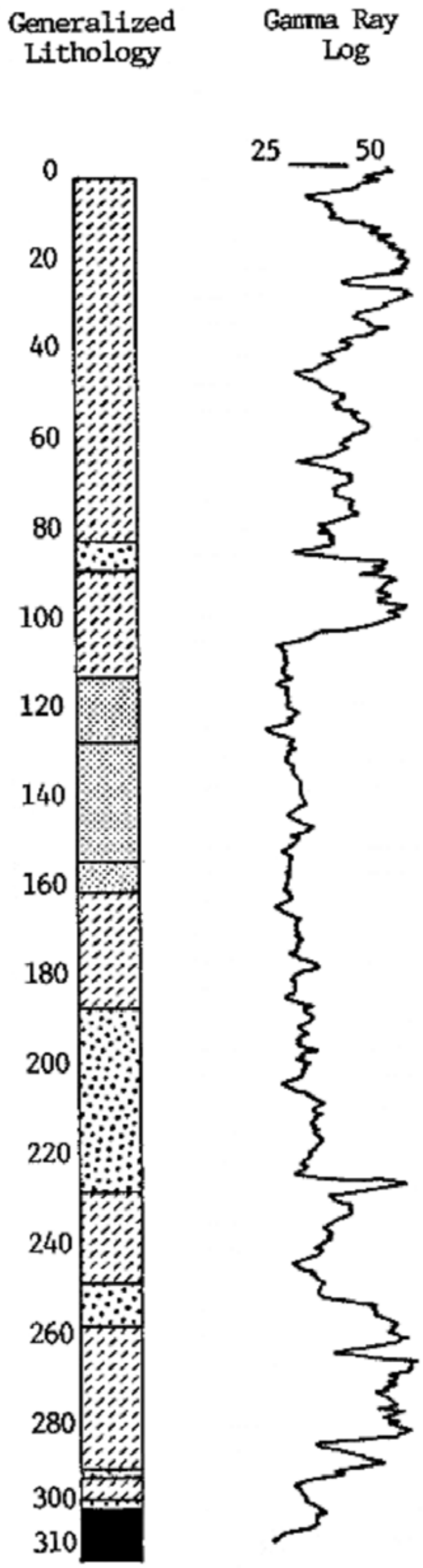
Driller's Log	Interval
Dark brown muck	0-5
Sandy gray gravel and clay	5-15
Greenish brown gravelly clay	15-20
Sandy clay with gravel	20-26
Sandy gray clay	26-30
Sandy gravel	30-33
Gray clay	33-44
Sandy fine to med. loose gravel	44-85
Sandy fine gravel	85-92
Gray clay with sand streaks	92-114
Pink-brown clay	114-129
Sand & fine gravel	129-130
Brownish gray clay, some sand	130-153
Sandy fine gravel	153-155
Brownish gray clay	155-159
Sandy gravel	159-160
Gritty brownish gray clay, some sand and gravel	160-190
Sandy silt - fine	190-210
Sandy fine gravel	210-215
Med. to very coarse gravel	215-232
Brown soft clay	232-237
Very coarse gravel and broken stone	237-260
Blue-gray limestone	260-270

I.D.N.R. Test hole #9 – Peru Airport site; SW¼ of NW¼, Section 13, T. 27 N., R. 3 E., Jefferson Township, Miami County. Elevation: 770 feet. Total depth is 326 feet. Drilled by Ortman Drilling, Inc., October 16, 1978.



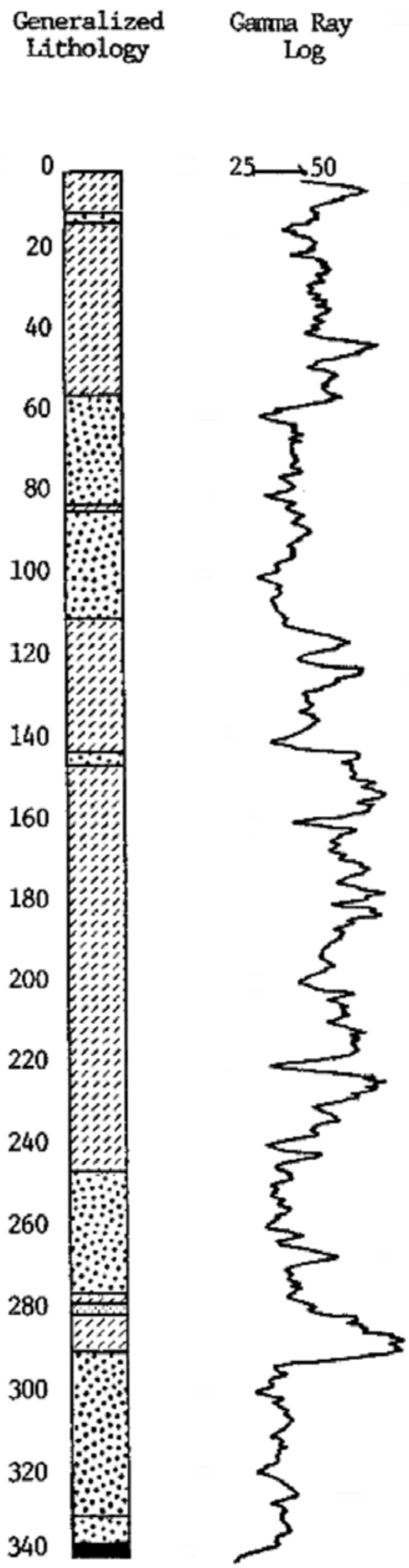
Driller's Log	Interval
Brown clay	0-9
Gray clay	9-19
Brown clay	19-25
Gray clay	25-40
Gravelly clay	40-43
Gray clay	43-77
Fine gray sand	77-80
Gray clay	80-115
Clay and gravel	115-117
Tight angular gravel with broken stone	117-123
Sandy fine-med. gravel	123-153
Slightly gritty gray clay	153-212
Tight fine-med. gravel and broken stone	212-240
Gravel with clay stringers	240-248
Sandy fine-med. gravel with broken stone	248-270
Reddish brown smooth clay	270-278
Cemented sand and gravel	278-305
Sandy brown clay	305-324
Blue gray limestone	324-326

I.D.N.R. Test hole #9A – Richvalley site; NW¼ of SE¼, Section 30, T. 27 n., R. 6 E., Noble Township, Wabash County. Elevation: 770 feet. Total depth is 310 feet. Drilled by Ortman Drilling, Inc., October 17, 1978.



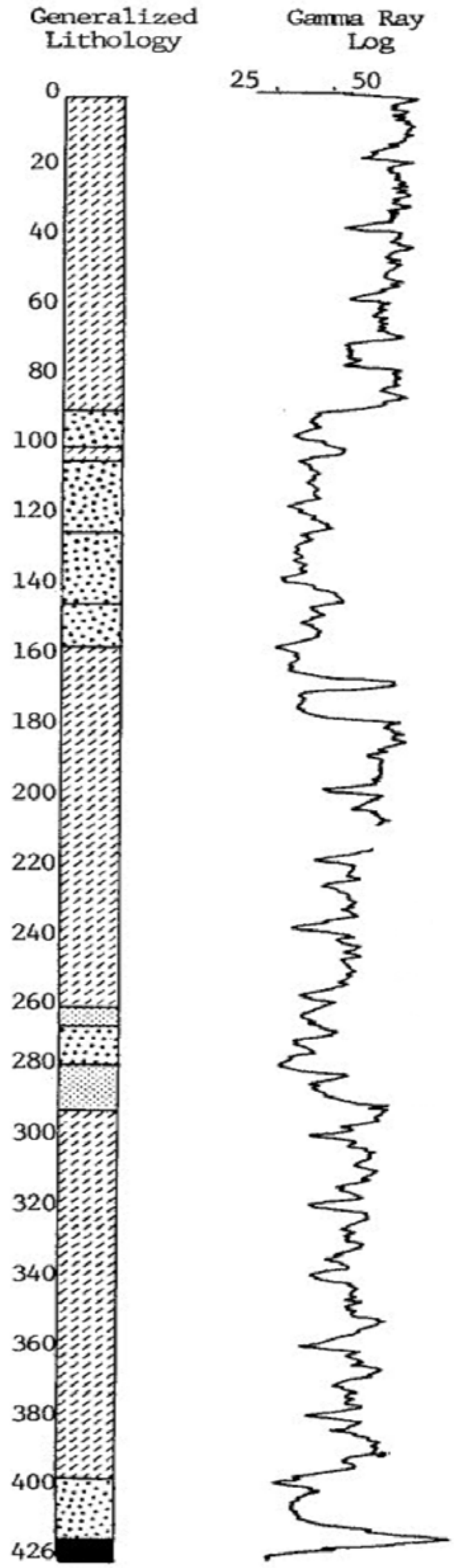
Driller's Log	Interval
Yellowish brown sandy clay	0-14
Sticky gray clay	14-34
Sandy brown clay	34-48
Sandy gray clay, some gravel streaks	48-82
Sandy fine-med. gravel -clay	82-88
Smooth brown clay	88-106
Gritty brown clay	106-112
Cemented sand	112-127
Fine gravel, brown silty sand, red-brown clay	127-153
Fine-med. sandy gravel broken stone	153-160
Layers red-brown clay and sand	160-187
Sandy fine-med. gravel broken stone	187-228
Red-brown clay streaks gravel & broken stone	228-248
Sandy fine-med. gravel, clay	248-258
Red brown clay	258-289
Sand and gravel	289-290
Red-brown clay streaks gravel & broken stone	290-297
Blue-gray limestone	297-308
White limestone	308-310

I.D.N.R. Test hole #10 – Treaty site; SE¼ of SE¼, Section 18, T. 26 N., R. 7 E., Liberty Township, Wabash County. Elevation: 805 feet. Total depth is 340 feet. Drilled by Ortman Drilling, Inc., October 18, 1978.



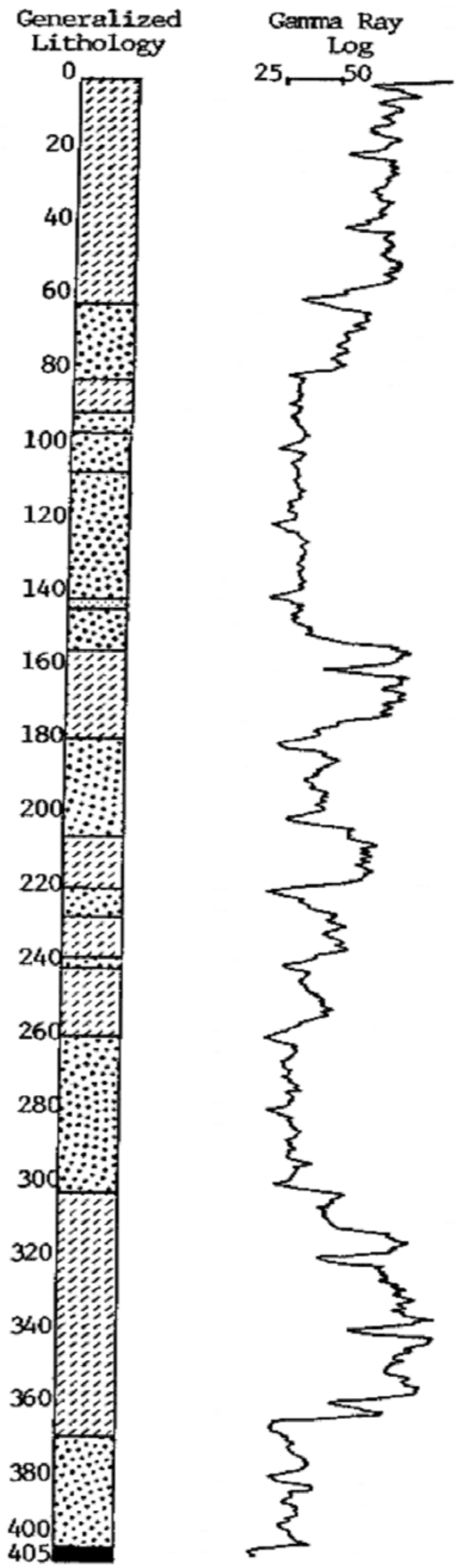
Driller's Log	Interval
Yellow clay	0-11
Brown silty clay-med. gravel	11-13
Sandy gritty gray clay	13-55
Dirty fine sand and fine-med. gravel	55-83
Sandy gray clay	83-85
Sandy fine gravel	85-87
Sandy fine-med. gravel	87-95
Coarse sand with clay stringers	95-105
Sandy fine gravel	105-111
Red-brown clay	111-114
Gray clay, layers silt and sand	114-149
Red-brown soft sticky clay	149-197
Red-brown clay, layers sand	197-219
Limestone boulder, gray	219-221
Brown clay with rocks and gravel	221-245
Fine-med. gravel with broken stone	245-265
Brown clay	265-267
Cemented fine sand, gravel, clay	267-278
Grayish-brown silty gray clay	278-291
Cemented fine med. gravel, sand, stone	291-334
Sand and gravel	334-336
Blue gray stone	336-340

I.D.N.R. Test hole #11 – LaFontaine site; NE¼ of NW¼, Section 8, T. 25 N., R. 8 E., Washington Township, Grant County. Elevation: 885 feet. Total depth is 426 feet. Drilled by Ortman Drilling, Inc. October 13, 1978.



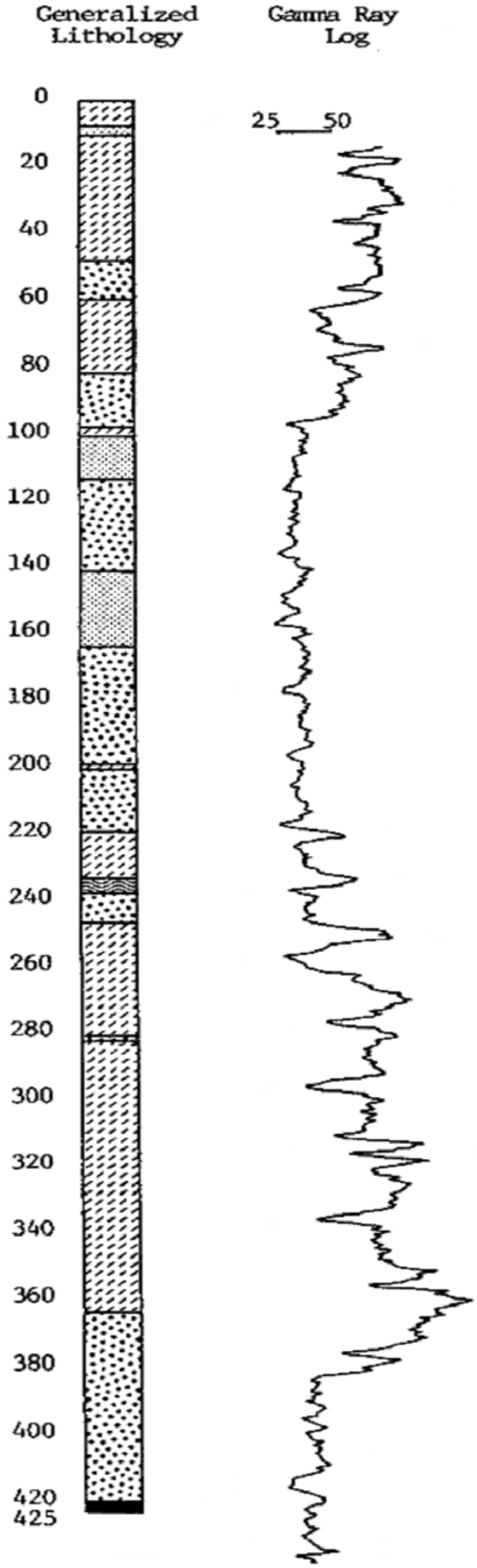
Driller's Log	Interval
Brown clay	0-15
Gray clay	15-90
Sandy silty brown gravel	90-101
Sandy brown clay	101-104
Broken stone and gravel with clay stringers	104-110
Sandy brown fine to med. gravel	110-144
Gray clay	144-145
Gray sandy gravel and broken stone	145-157
Soft gray clay with layers gravel	157-168
Sticky gray clay	168-170
Very fine and	170-179
Gray clay-smooth, sticky	179-204
Gray clay	204-223
Gravel	223-227
Gray silty clay	227-241
Gray clay	241-262
Sandy fine to med. gravel	262-269
Brown clay	269-270
Tight gravel and broken stone	270-277
Loose fine-med. sand and gravel	277-290
Soft red-brown smooth clay	290-353
Brown clay and sand	353-374
Brown clay with sand streaks	374-395
Fine sand and gravel	395-413
Blue gray shale	413-418
Gray limestone	418-426

I.D.N.R. Test hole #12 – Van Buren site; NE¼ of NE¼, Section 36, T. 25 N., R. 8 E., Washington Township, Grant County. Elevation: 860 feet. Total depth is 405 feet. Drilled by Ortman Drilling, Inc., October 12, 1978.



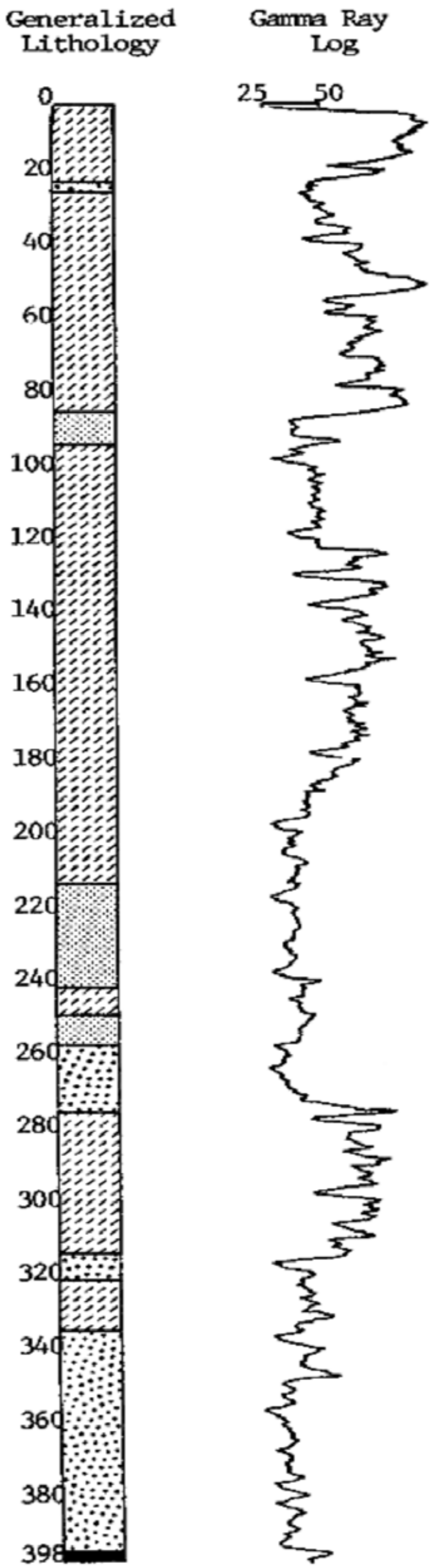
Driller's Log	Interval
Brown clay	0-10
Gray clay	10-57
Dirty sand & gravel	57-62
Sandy med. gravel	62-81
Gritty silty gray clay	81-85
Gritty silty sand-some gravel	85-105
Sandy fine to med. gravel	105-156
Brown smooth clay	156-176
Sandy silt	176-180
Very sandy fine to med. gravel	180-206
Gritty red-brown clay	206-221
Sandy fine-med. angular gravel	221-228
Soft reddish-brown clay	228-239
Sand and gravel	239-241
Gritty soft red-brown clay-some sand and gravel	241-260
Tight angular sand, gravel & broken stone	260-303
Brown clay	303-305
Gray clay	305-370
Fine gravel & sand	370-400
Blue gray shale	400-405

I.D.N.R. Test hole #13 – Hartford City site; SW¼ of SW¼, Section 25, T. 24 N., R. 10 E., Washington Township, Blackford County. Elevation: 885 feet. Total depth is 425 feet. Drilled by Ortman Drilling, Inc., October 11, 1978.



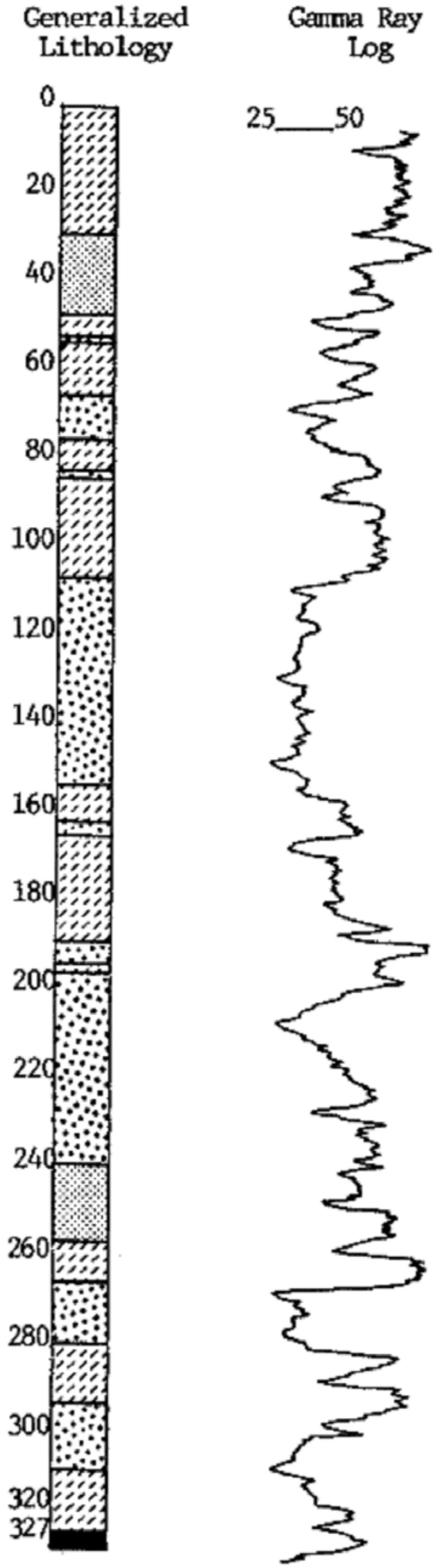
Driller's Log	Interva.
Top soil and dark gray clay	0-4
Greenish gray clay	4-8
Dirty med. coarse sand	8-11
Brownish gray-gray clay	11-49
Sandy fine gravel with clay stringers	49-59
Silty sandy brown gray clay	59-82
Sandy fine-med. gravel	82-90
Sand and gravel with clay stringers	90-98
Silty clay	98-101
Sand and fine-med. gravel	101-200
Clay	200-202
Sandy fine gravel with clay stringers	202-207
Coarse sand and med. gravel, angular	207-220
Red silty clay	220-235
Brown gritty clay	235-239
Sand and gravel	239-248
Reddish brown clay with sand and gravel streaks	248-253
Reddish brown smooth clay	253-282
Sand, gravel & boulders	282-284
Gray brown silty clay	284-312
Brown sticky clay	312-368
Coarse sand and fine to med. gravel	368-422
Limey light green shale	422-425

I.D.N.R. Test hole #14 – Domestic site; NW¼ of SW¼, Section 8, T. 24 N., R. 13 E., Jackson Township, Jay County. Elevation: 870 feet. Total depth is 398 feet. Drilled by Ortman Drilling, Inc. October 9, 1978.



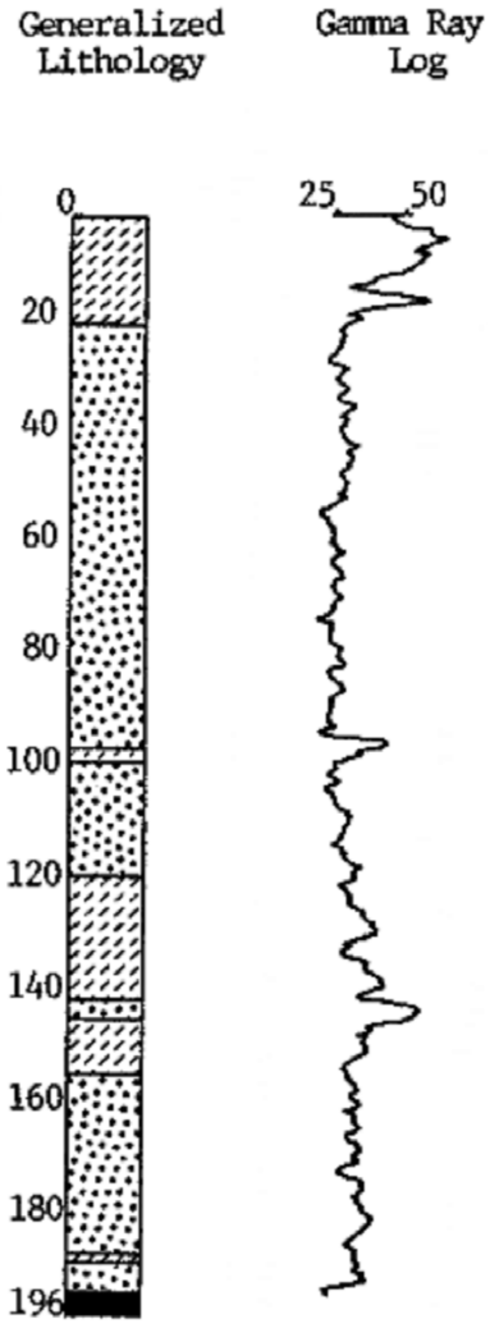
Driller's Log	Interval
Sandy yellowish clay	0-5
Brown to gray clay	5-18
Gray clay	18-19
Sandy silt	19-21
Fine silty sand and gravel	21-24
Silty clay	24-29
Gray clay	29-51
Gray clay	51-60
Gray clay	60-83
Fine silty sand	83-92
Alternate layers clay and sand	92-94
Very gritty gray clay	94-112
Brownish gritty clay	112-117
Very sandy gray clay	117-122
Gray gritty clay	122-129
Very sticky gray clay, some silt	129-212
Silty fine sand	212-220
Fine sand, some gravel and silt	220-240
Fine sand with clay stringers	240-248
Sandy gravel	248-274
Very silty brown clay	274-313
Med. gravel and broken stone, tight	313-320
Fine-med. gravel and silty clay	320-333
Fine-med. gravel and broken stone	333-345
Med.-course gravel and broken stone	345-394
Blue-green limestone and shale, alternating layers	394-398

I.D.N.R. Test hole #15 – State line site; NW¼ of NE¼, Section 27, T. 26 N., R. 15 E., Blue Creek Township, Adams County. Elevation: 815 feet. Total depth is 327 feet. Drilled by Ortman Drilling, Inc., October 10, 1978.



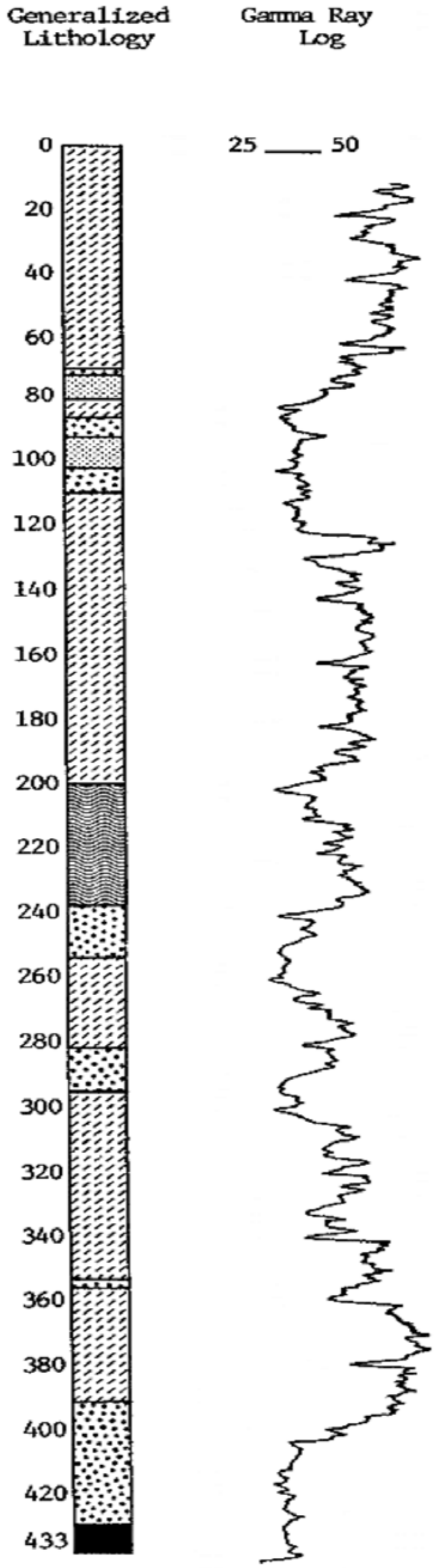
Driller's Log	Interval
Brown-brownish gray clay	0-10
Gray clay	10-30
Fine black and gray sand with gravel	30-47
Gray clay	47-53
Alternating gray clay with sand and gravel	53-76
Reddish brown clay	76-83
Coarse sand and fine gravel	83-85
Gritty reddish-brown clay	85-107
Very coarse gravel and broken stone	107-154
Sandy brown clay	154-163
Sand and gravel	163-166
Reddish to brown gritty clay	166-183
Gritty brown clay	183-190
Alternating clay, sand and gravel	190-195
Sticky brown clay	195-197
Fine sand and gravel	197-240
Silty sand	240-258
Brown sandy clay	258-263
Sticky brown clay	263-266
Sand and gravel	266-280
Brown clay	280-286
Sand and gravel	286-287
Brown clay	287-295
Sand and gravel	295-297
Fine sand and gravel	297-308
Laminated brownish gray clay	308-323
Limey shale	323-327

D.N.R. Test hole #16 – East Peru site; NE¼ of SW¼ of Section 19, T. 27 N., R. 5 E., Peru Township, Miami County. Elevation: 650 feet. Total depth is 196 feet. Drilled by Ortman Drilling, Inc. November 2, 1979.



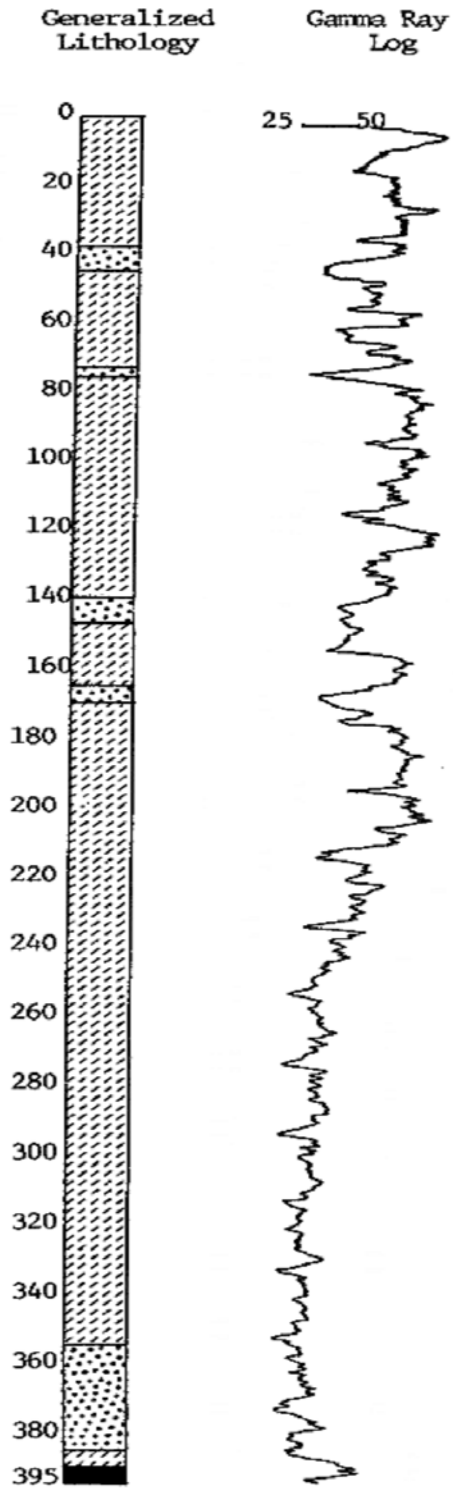
Driller's Log	Interval
Fill packed sand and gravel	0-2
Brown silt	2-8
Gray sand clay	8-11
Brown silty clay	11-18
Black-gray organic muck	18-19
Coarse gray sand & gravel	19-95
Reddish brown silty clay	95-98
Cemented sand & gravel	98-118
Gravelly brown clay	118-135
Gray-brown silty clay/ pebbles	135-140
Rocks and boulders	140-143
Gray silty gravelly clay	143-153
Coarse-med. sand and gravel	153-186
Coarse sand and gravel some clay	186-193
Hard gray limestone	193-196

I.D.N.R. Test hole #17 – Roll site; NE¼ of NE¼, Section 13, T. 24 N., R. 9 E., Monroe Township, Grant County. Elevation: 900 feet. Total depth is 433 feet. Drilled by Ortman Drilling, Inc. November 7, 1979.



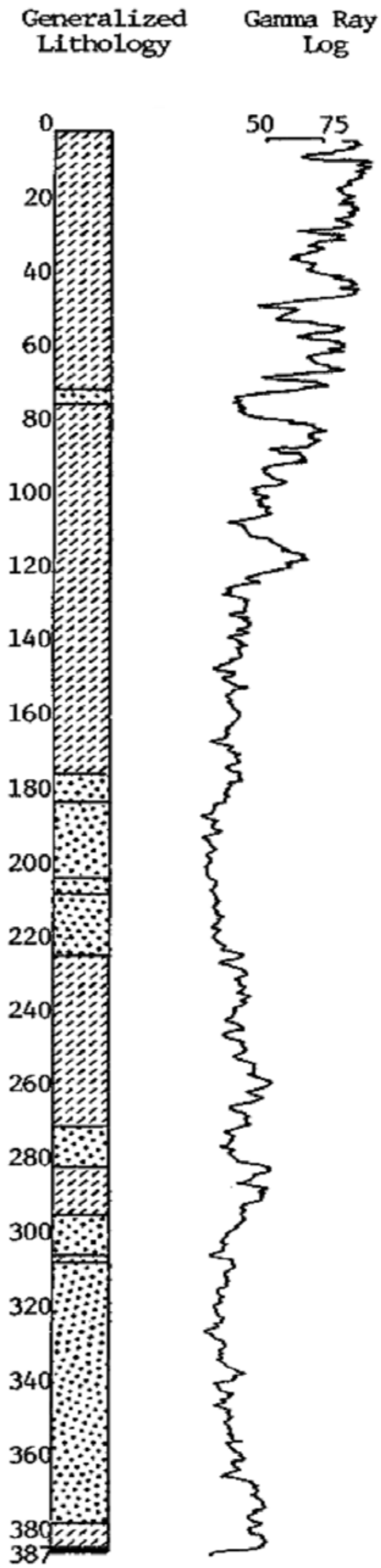
Driller's Log	Interval
Brown silty clay	0-5
Brown clay	5-11
Brownish-gray clay	11-38
Greenish-gray clay	38-40
Brownish gray-gray gritty clay	40-71
Clay and gravel	71-83
Silty fine sand, some gravel	83-103
Sand and gravel	103-110
Gray clay with some pebbles	110-121
Greenish brown-gray silty clay	121-133
Reddish brown clay	133-183
Soft gray clay	183-199
Reddish-brown gravelly clay, sand	199-238
Med. sand and gravel	238-254
Gray clay	254-255
Coarse sand & gravel	255-258
Alternate layers of brown clay, sand and gravel	258-295
Brownish gray clay	295-300
Reddish-brown clay	300-306
Brownish gray clay, some grit	306-322
Layers brown clay with sand & gravel	322-331
Brownish gray clay	331-347
Gritty gray clay	347-354
Sand & fine gravel	354-357
Gray-brownish gray clay	357-392
Fine-med. gravel, some sand	392-430
Blue gray shale & limestone	430-433

I.D.N.R. Test hole #18 – Pennville site; SE¼ of NE¼, Section 19, T. 24 N., R. 9 E., Harrison Township, Blackford County. Elevation: 855. Total depth is 395 feet. Drilled by Ortman Drilling, Inc. November 6, 1979.



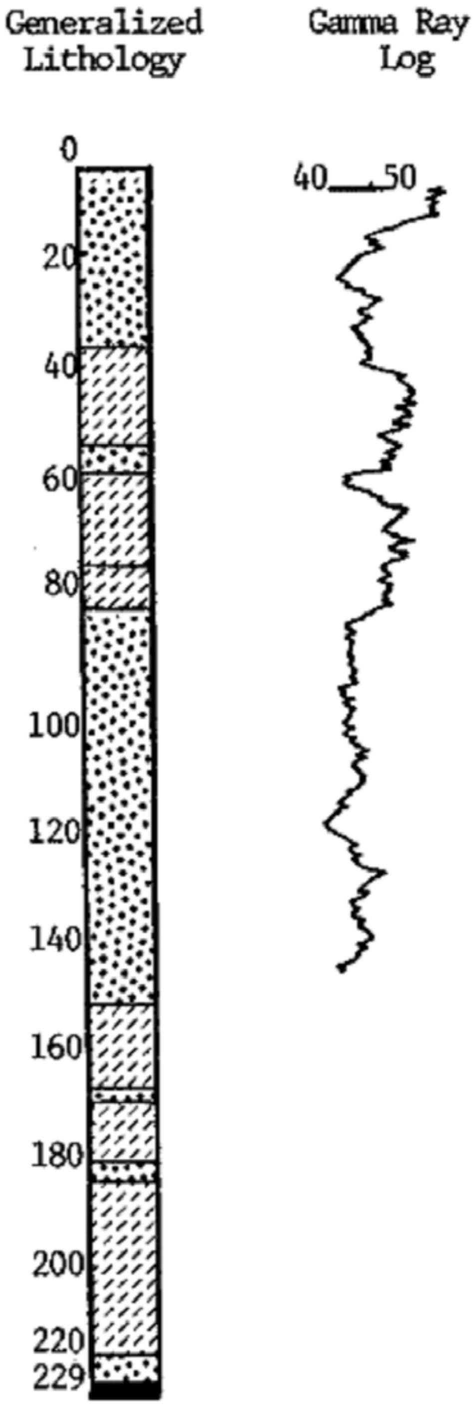
Driller's Log	Interval
Brown clay	0-7
Gravelly brown clay	7-10
Dirty red-gray sand and gravel	10-13
Gray clay	13-39
Fine-med. sand and gravel	39-46
Silty to sandy gray brown-gray clay	46-64
Brownish gray-gray clay with sand and gravel zones	64-140
Tight sand & gravel	140-147
Gray silty clay with sand and gravel layers	147-165
Fine med. tight angular gravel with shale chips	165-170
Sticky gray clay	170-206
Gray clay with thin sand and gravel layers	206-210
Sticky gray clay, some thin sand and gravel layers	210-351
Cemented sand and fine gravel	351-363
Gravelly gray clay	363-371
Cemented sand & fine gravel	371-380
Loose sand and fine gravel	380-384
Cemented sand and fine gravel	384-388
Gray clay with some pebbles	388-390
Alternate layers blue shale and blue-gray limestone	390-395

I.D.N.R. Test hole #19 – Berne site; SW¼ of SW¼, Section 10, T. 25 N., R. 14 E., Wabash Township, Adams County. Elevation: 840 feet. Total depth is 387 feet. Drilled by Ortman Drilling, Inc., November 5, 1979.



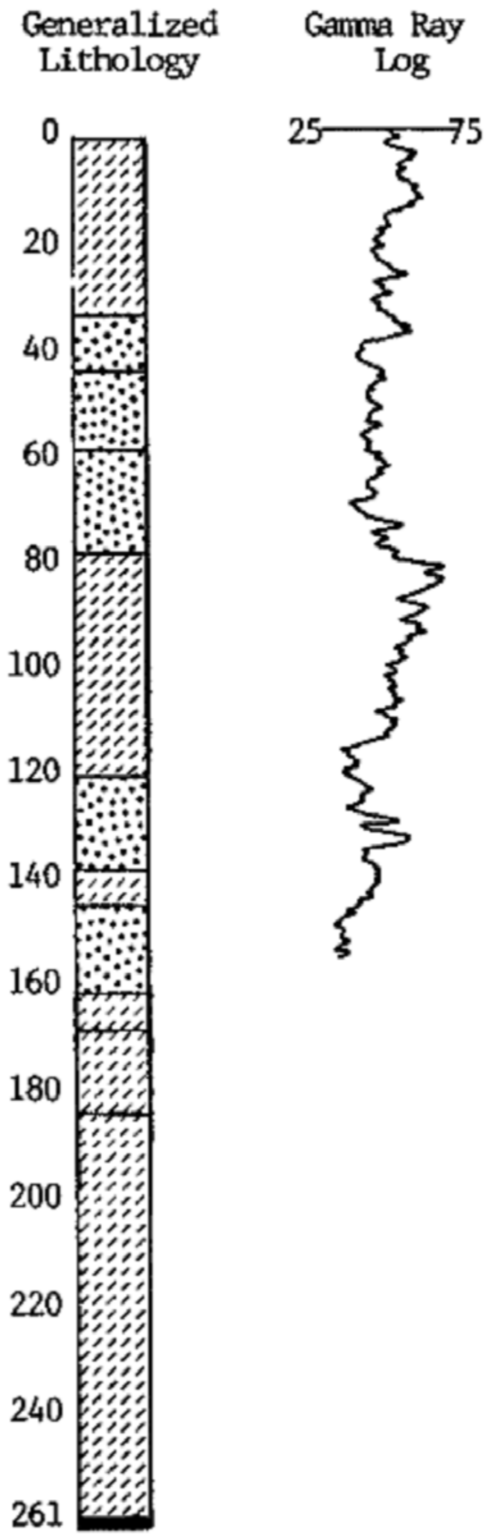
Driller's Log	Interval
Brown clay	0-14
Sticky gritty gray clay	14-43
Brownish gray-gray sandy clay	43-71
Silty fine sand	71-75
Silty brownish gray-gray clay	75-96
Silty gray clay	96-135
Sandy gravelly clay	135-175
Med.-coarse-very coarse gravel & boulders	175-224
Silty fine-med. sand with clay stringers	224-28
Reddish brown silt	282-295
Med. gravel	295-306
Gray silty clay	306-308
Med. tight gravel, some sand	308-378
Med. tight gravel, some silt	378-385
Alternate layers of blue-gray limestone	385-387

U.S.G.S. Logansport Test hole #86 – Twelve Mile site; NW¼ of NW¼, Section 7, T. 27 N., R. 3 E., Adams Township, Cass County. Elevation: 669 feet. Total depth is 229 feet. Drilled by Ortman Drilling, Inc., August 9, 1977.



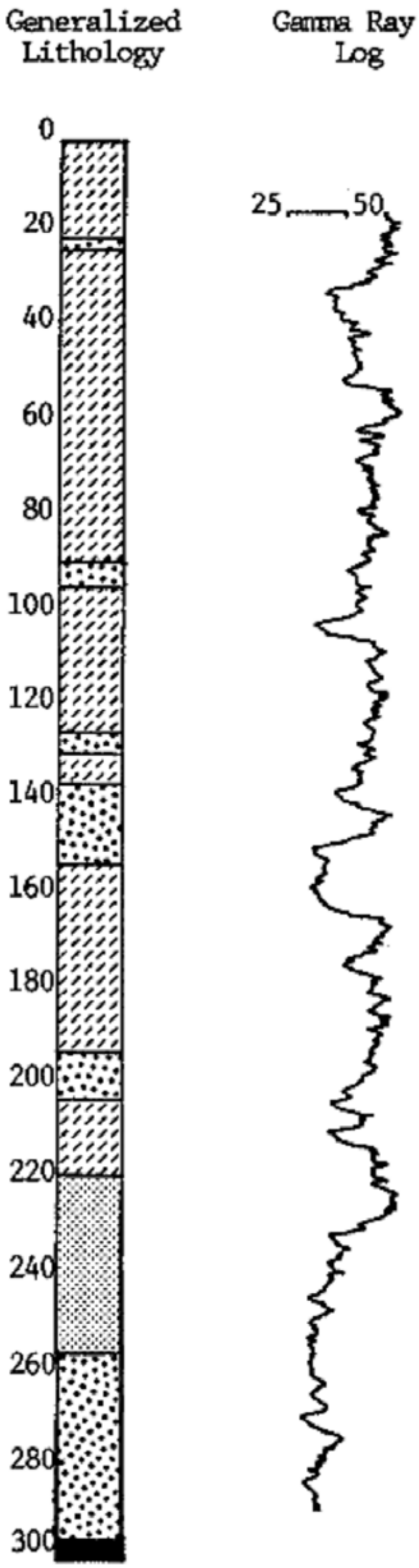
Driller's Log	Interval
Dirt	0-2
Sand and Gravel	2-32
Gray clay	32-52
Sand and Gravel	52-57
Brown clay	57-83
Very coarse gravel	83-126
Light gray clay	126-127
Med. sand and gravel	127-157
Brown clay	157-173
Sand and gravel	173-175
Sand, gravel & clay	175-186
Sand and gravel	186-190
Sand and gravel (60-70% gray clay)	190-222
Soft stone	222-227
Blue limestone	227-229

U.S.G.S. Logansport Test hole #92 – Logansport site; County Road 315 N.; SE¼ of SE¼, Section 3, T. 27 N., R. 2 E., Clay Township, Cass County. Elevation: 708 feet. Total depth is 265. Drilled by Ortman Drilling, Inc., August 11, 1977.



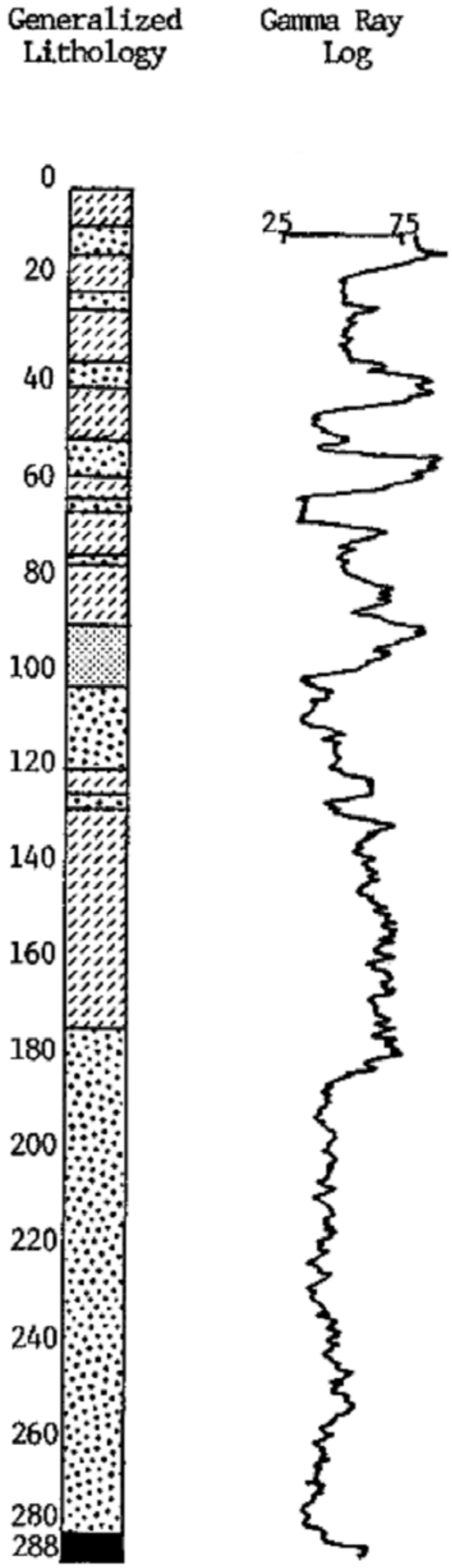
Driller's Log	Interval
Brownish gray clay	0-15
Soft gray clay	15-22
Gray clay	22-35
Med.-crs. sand & gravel	35-80
Gray brown clay	80-122
Sand and gravel-loose	122-135
Tight crs. sand and gravel	135-140
Clay	140-146
Med.-crs. sand and gravel	146-163
Light gray sand clay	163-170
Red clay	170-210
Sand, gravel & clay	210-225
Red clay	225-235
Sand, gravel, red clay and rocks	235-261
Blue limestone	261-

U.S.G.S. Logansport Test hole #94 – Logansport site; County Road 275 E.; NE¼ of SE¼, Section 5, T. 27 N., R. 2 E., Clay Township, Cass County. Elevation: 740 feet. Total depth is 300 feet. Drilled by Ortman Drilling, Inc., September 17, 1979.



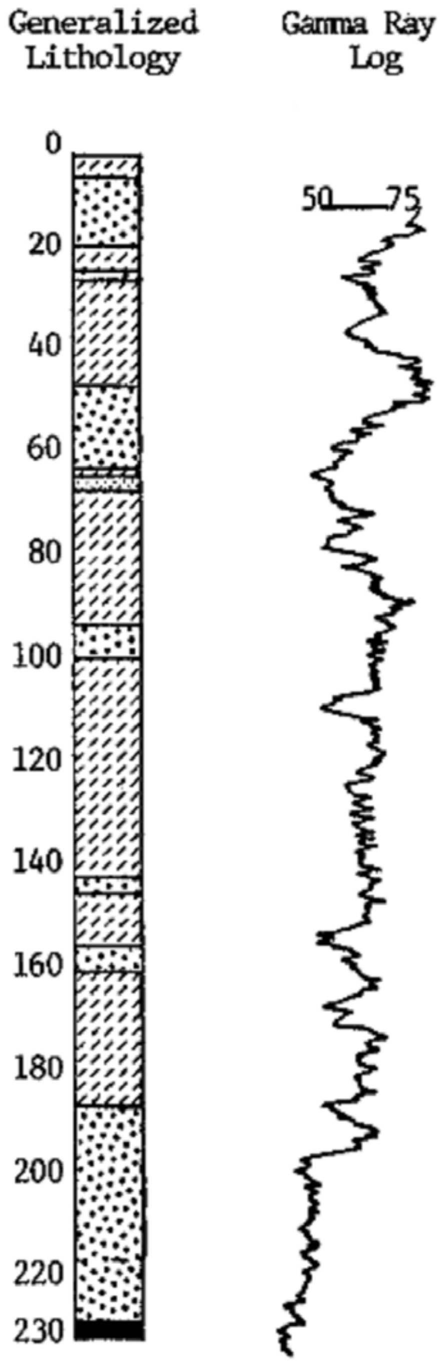
Driller's Log	Interval
Brown clay	0-14
Gray clay	14-21
Fine-med. gravel	21-23
Sandy gray clay	23-38
Sand and gravel	38-39
Med. gray clay "sticky"	39-51
Gray clay mixed with sand and gravel	51-63
Sandy gray clay-gritty	63-89
Fine-med. gravel	89-94
Greenish brown clay	94-97
Sandy med. gray clay	97-126
Sand-fine med. gravel	126-130
Gritty med. gray clay	130-136
Fine-med. gravel	136-153
Gritty light gray clay	153-163
Fine gravel with clay stringers	163-166
Gritty light gray clay	166-169
Fine gravel	169-170
Gritty brown clay	170-189
Fine gravel with clay stringers	189-193
Sand, fine gravel	193-196
Greenish brown clay	196-197
Fine-med. gravel	197-203
Gritty brown clay	203-219
Fine-med. silty sand	219-257
Limestone boulder	257-258
Broken stone-med. to coarse	258-296
Lt. brown limestone with putty stone	296-300

U.S.G.S. Logansport Test hole #101 – Lake Cicott site; SW¼ of SE¼, Section 15, T. 27 N., R. 1 W., Jefferson Township, Cass County. Elevation: 717 feet. Total depth is 288 feet. Drilled by Ortman Drilling, Inc., November 24, 1976.



Driller's Log	Interval
Black dirt	0-1
Brown clay	1-8
Med. sand and gravel (clean)	8-14
Gray clay	14-22
Med. gravel & sand	22-26
Gray clay	26-38
Med. coarse sand and gravel	38-42
Olive clay	42-47
Blue clay - smooth	47-53
Fine gravel (very sandy)	53-61
Smooth gray clay	61-65
Fine gravel & sand	65-68
Gritty gray clay	68-77
Med. to crs. gravel and sand	77-79
Gritty gray clay	79-91
Fine sand	91-105
Medium gravel (sandy)	105-122
Very gritty gray clay	122-127
Med. gravel (some sand)	127-130
Gritty gray clay	130-160
Gritty gray clay	160-176
Med.-coarse gravel, sand	176-215
Med.-coarse gravel, some clay	215-220
Med.-coarse gravel, broken stone, sand	220-282
Weathered limestone light gray	282-288

U.S.G.S. Logansport Test hole #108 – Lucerne site; NE¼ of NE¼, Section 18, T. 27 N., R. 1 E., Noble Township, Cass County. Elevation: 734 feet. Total depth is 230 feet. Drilled by Ortman Drilling, Inc., November 15, 1976.



Driller's Log	Interval
Black dirt	0-2
Gray clay	2-5
Med.-crs. sand & gravel	5-18
Gray clay	18-23
Fine sand and gravel	23-25
Gritty gray clay	25-46
Crs. sand and fine gravel	46-58
Med. to crs. gravel with sand	58-62
Gray gritty clay	62-63
Med. gravel with sand	63-66
Gritty gray clay	66-92
Med. to crs. gravel with sand	92-98
Pinkish brown clay (gritty)	98-100
Gray clay (gritty)	100-110
Light brown clay (gritty)	110-141
Fine to med. gravel with sand	141-144
Gritty gray clay	144-154
Med. gravel with sand	154-156
Gritty gray clay	156-157
Med. gravel with sand	157-159
Gritty gray clay	159-170
Wood	170-172
Gritty gray clay	172-175
Fine gravel, some clay	175-225
Fine gravel	225-227
Light yellowish-brown stone	227-230