Ground Water for Industry in the Scioto River Valley

Buried Valley Investigation

REPORT NO. 1

State of Ohio
Department of Natural Resources
Division of Water

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Prepared by the Ground-Water Geology Section
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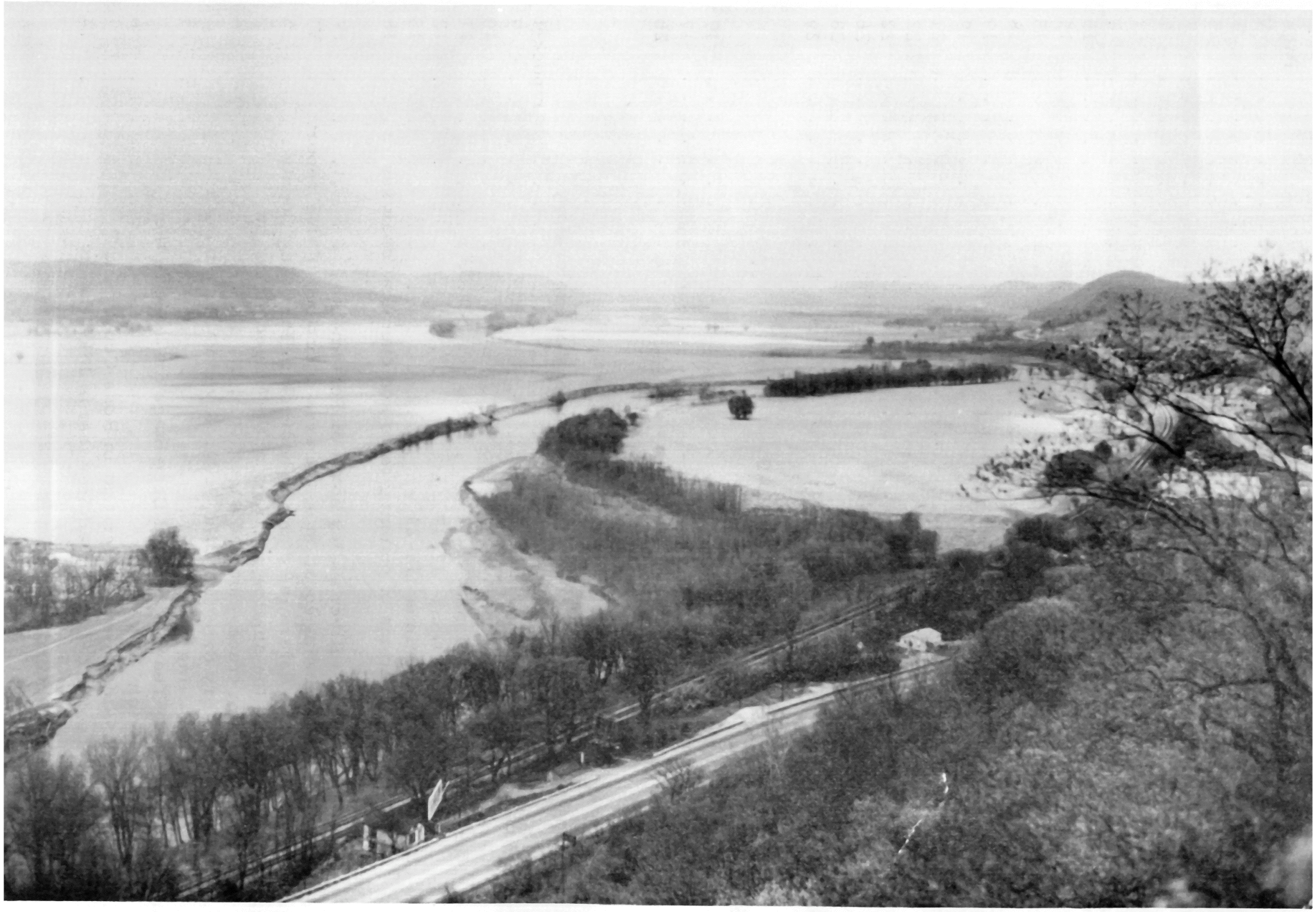

Figure 1. View of the Scioto River valley, north of Portsmouth.

ABSTRACT

Permeable sand and gravel deposits in the valley of the Scioto River constitute one of the most important sources of large ground-water supplies in Ohio.

Large perennial yields from industrial wells are developed by inducing infiltration from streams. Pumping a well, or group of wells, close to the Scioto River lowers the ground-water level below river level and causes a reversal of the normal ground-water flow. Water moves from the river into the valley fill and toward the pumping wells.

It is conservatively estimated that there is a potential ground-water supply of one and a half billion gallons per day available in the area adjacent to the Scioto Rive r .

The large ground-water potential of the Scioto River valley, combined with other favorable factors, should ultimately result in important industrial development.

Figure 2. Map of Ohio showing location of the area described in this report.

PURPOSE AND SCOPE OF THIS INVESTIGATION

Ohio's ground-water resources are among the State's most valuable assets which will be drawn upon heavily as our population grows and our economy expands. Yet, in many areas, large quantities of this important industrial raw material have been untapped.

By far, the most promising source of ground water in Ohio is our system of buried valleys. These are ancient stream channels which were cut into the bedrock formations. During interglacial periods, many of these drainage channels were partially filled with thick deposits of sand and gravel, particularly those channels which formed the main drainage for debris-laden meltwater flowing from the ice fronts. Permeable sands and gravels in these valleys are huge reservoirs for storage of ground water and, in addition, the valley fill may receive direct re charge from present streams. Under the proper conditions, large municipal and industrial well supplies can be withdrawn because of water entering the fill materials from the rivers.

Buried valleys underlying the present valleys of the Miami, Scioto, Tuscarawas, and Ohio rivers offer excellent possibilities. Of these four areas, only the Miami valley has seen extensive ground-water development. Municipal and industrial ground-water withdrawals in the Miami valley account for almost one-half of the total ground-water use in Ohio! Geologic and hydrologic conditions appear to be similar to this in portions of the Scioto valley, yet only meager quantities of ground water have been developed.

Can ground-water supplies of similar quantity and quality be developed in the Scioto valley to serve Ohio's expanding needs? If so, where are the best locations for future development? This investigation was planned to answer these questions. In order to arrive at the answers, the width and depth of the buried valley and the nature of the fill materials were determined. Next, the most promising areas for large ground-water developments were outlined, and finally, reasonable estimates of the amounts available and chemical quality of the water were made .

The area studied (see location map, Fig. 2.) lies adjacent to the Scioto River and extends through Pickaway, Ross, Pike, and Scioto counties. The total area covers approximately 320 square miles.

The investigation was started during the summer of 1962 and completed in 1965. It is the first in a series of buried valley aquifer studies to be prepared by the Ground-Water Geology Section of the Ohio Division of Water. The completed report is the result of a "team effort" and cannot be attributed to any one man. Much valuable assistance in evaluating quantitative data was received from Edward J. Schaefer, Engineer, Ohio Division of Water.

Many local residents were extremely cooperative in granting permission for exploratory work on their properties. We are also indebted to the County Engineers of Pickaway, Ross, Pike, and Scioto counties, as well as the many Township Trustees who permitted test drilling and seismic exploration along roads under their jurisdiction.

The cooperation of the following persons and organizations is gratefully acknowledged:

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George Mayhew, Consultant, Powell.
Joel Watkins, U. S. Geological Survey, Flagstaff, Arizona.
Richard A. Struble, Ohio State University, Columbus.

METHODS OF STUDY

Figure 3. Seismic shot to determine depth to bedrock in Pickaway County.

To determine the extent of the buried valley areas and the nature of the fill materials, the study area was divided into three parts In the northern portion, extending from the Franklin-Pickaway county line to Circleville, seismic refraction methods were used to determine the size and shape of the bedrock valley.

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The seismic refraction technique consists of exploding small charges buried a few feet below the surface and recording velocities at which energy travels through the ground. The glacial deposits in this buried valley generally consist of three layers, each having a significantly higher velocity than the layer immediately above it. The upper layer is made up of unconsolidated deposits above the water table which are not saturated with water. This layer has a characteristic velocity of about 1, 800 feet per second (fps). Water-saturated clays, silts, sands, and gravels below the water table form a second layer with a characteristic velocity of about 6, 000 fps. These two layers lie above the bedrock, which has velocities ranging from 10, 000 to 25, 000 fps in this area.

From Circleville (Pickaway County) to Waverly (Pike County), deep test drilling with a rotary drilling rig was used. The drilling was done by private contractors under the supervision of Division of Water geologists who collected samples during the drilling and logged the materials. Depths drilled in this portion of the valley ranged from 90 to more than 260 feet. In the southern third of the area, below Waverly, unconsolidated deposits rarely exceed 80 feet. Here, a truck-mounted power auger proved to be a satisfactory tool for exploration.

A total of 64 seismic shot points and more than 100 test holes were used to obtain bedrock data for this study. Locations of these, as well as 200 water wells drilled to bedrock are shown on plate 1. A summary of the results of the seismic exploration is given in the appendix. Logs of the deep test drilling and shallow augering are also contained in the appendix of this report. Data on several hundred water wells, which did not encounter bedrock, were utilized. However, only wells drilled into bedrock are shown in the report. These well drilling records and other field data were the primary sources of information on the valley fill deposits.

In addition, miscellaneous unpublished data were collected and studied. These include geologic reports and pumping test results.

Although quantitative data are lacking for some portions of the valley area, adequate detail is available to determine the best locations for large ground-water developments as well as estimates of the quantities which can be developed.

Samples of the water from wells, throughout the area1 were collected for chemical analyses. These analyses are given in the appendix (Table 3).

Figure 4. Exploration of the shallow portions of the buried valley by means of a truck-mounted auger.

Figure 5. Deep exploratory drilling in the Scioto River valley, using a rotary drilling rig. (Photo by Bette Snyder, Chillicothe Gazette)

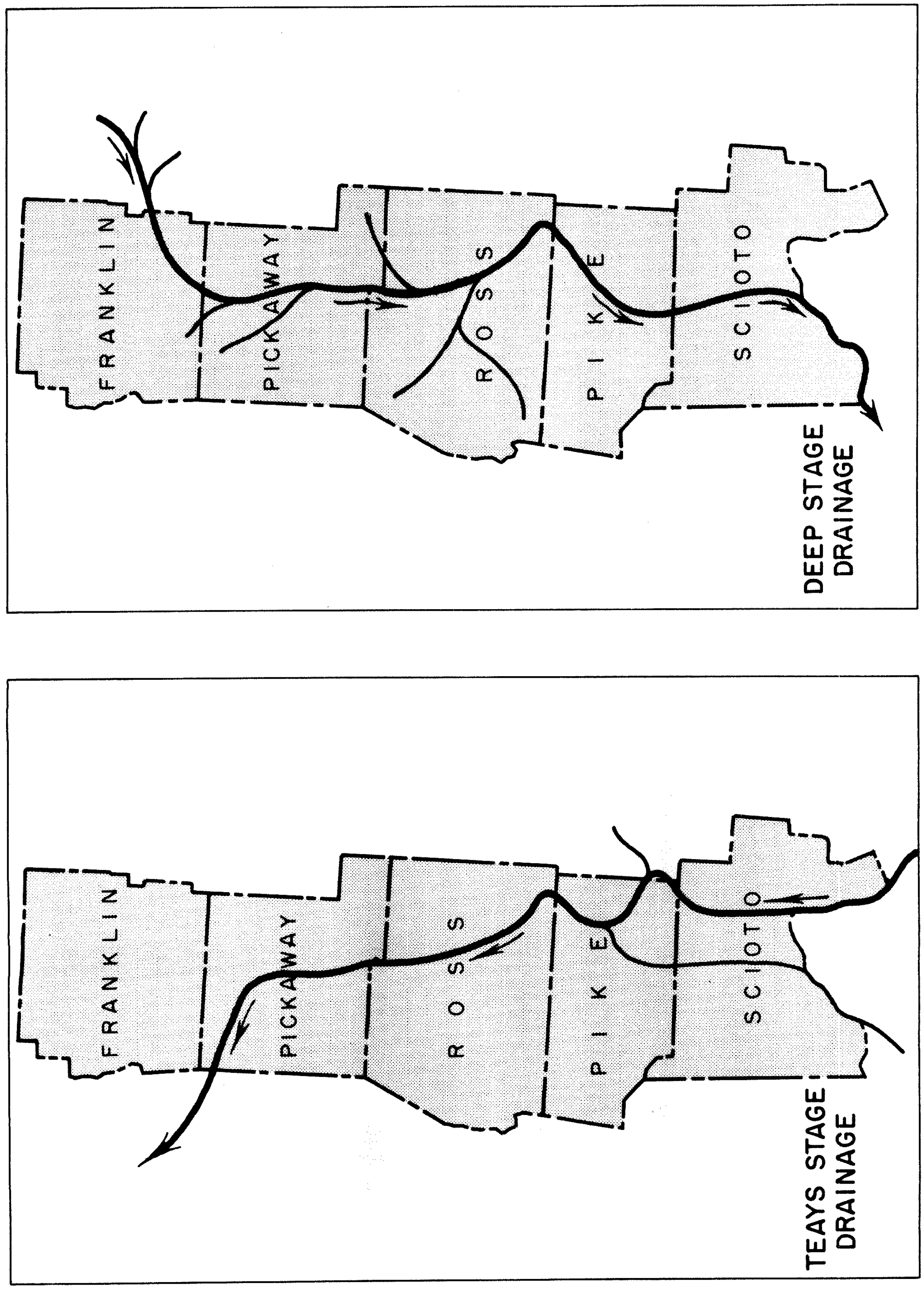

Figure 6. Maps showing Teays Stage and Deep Stage drainage in the lower Scioto River valley.

PHYSICAL NATURE OF THE BURIED VALLEY

Brief Geologic History:

All of the major buried valleys in Ohio have rather complex histories and the Scioto valley is no exception. The buried valley, as outlined in this study, is the result of several cycles of erosion.

The earliest drainage system that can be adequately traced is the Teays, named for the Teays Valley in Cabell and Putnam counties, West Virginia. The Teays River was a mature stream which cut a broad valley into the bedrock surface. It entered Ohio from the present Ohio River valley near Wheelersburg, Scioto County, and flowed northward (Fig. 6.) through eastern Scioto County and southeastern Pike County. From a point south of Waverly (near cross section 16, Plate 1) to Richmondale it followed the general course of the present Scioto River. At Richmondale it again left the present Scioto valley, re-entering about five miles south of Chillicothe. Here, the elevation of the Teays Valley floor is approximately 600 feet above sea level. From Chillicothe to South Bloomfield, Pickaway County, it followed, or closely paralleled the present valley. Near South Bloomfield, it flowed westward across northwestern Pickaway County, leaving our study area. The valley floor in this vicinity has an altitude of 570 feet. This represents a gradient of .95 feet per mile in its course through this four-county area. The materials filling remnants of this old valley are largely clay, silt, and fine sand which are not sources of large ground-water supplies.

Eventually a new system of drainage was established, called the Deep Stage drainage cycle. A major river, the Newark River, was formed. Rising in northeastern Ohio, it flowed southward and entered our area north of Ashville, Pickaway County, (Fig. 6.). From Pickaway County southward, this river cut its valley along the course of the present Scioto River. The Deep Stage drainage is characterized by much deeper erosion than the earlier Teays Stage drainage. At Circleville, the Deep Stage valley floor is 90 feet below Teays level; at Chillicothe, 120 feet; at Piketon, 185 feet; and, at Portsmouth more than 195 feet.

With the advance of the Illinoian and Wisconsin glacial stages, the last two ice advances, the broad, deep channel cut by the Newark River was filled with sand, gravel, and silt. This material was carried and deposited by the meltwaters flowing away from the glaciers. The present Scioto River meanders freely across its broad floodplain cutting a narrow, shallow channel into the valley fill deposits.

Size, Shape, and Depth of the Valley:

The configuration of the buried valley area is best shown on the series of cross sections (1 through 21) plate 2. Throughout the area, it has the typical U-shape of a mature stream valley.

In the northern part of the study area, from Ashville to Circleville (cross sections 2 through 9), the valley is eight miles wide and, in places, contains as much as 250 feet of fill. In contrast, the narrowest part of the valley, near

Wakefield (cross section 18), is 14 miles across and 73 feet deep. South of cross-section 9, the valley rapidly becomes more constricted and shallower. Four miles north of Chillicothe (cross section 11), it is four miles wide and less than 200 feet deep. At Waverly and Piketon, its width is about two miles and it contains approximately 80 feet of fill. At Lucasville (cross section 20), the width is 11 miles and the depth 65 feet. Cross section 21, near Portsmouth, shows a depth of 52 feet.

As can be seen in these cross sections, the valley does not have a flat, even floor. On the contrary, it is complicated by bedrock highs as well as occasional deep channels cut into the main floor. Two large bedrock highs are very apparent on Plate 1, in the Ashville-Circleville area. Here the valley area is separated into two valleys, the western portion being a remnant of Teays Stage erosion deepened by later action. The main Deep Stage drainage channel is assumed to have followed the eastern trough. A short distance south of the Pickaway-Ross county line, these two channels have reversed positions with the Deep Stage channel occupying a position west of the Teays Stage. The valley floor south of the glacial boundary (south of Chillicothe) is essentially flat.

Nature of the Fill Materials:

The deposits of sand, gravel, and clay which fill these valleys vary greatly, both horizontally and vertically. Comparisons of well logs show that it is extremely difficult, and often impossible, to trace a particular sand or clay layer from one well to another less than a quarter of a mile away.

The conditions under which the various deposits were laid down were not uniform throughout the area at any one time. This is typical of water-laid deposits. Various degrees of stratification, sorting, and washing are encountered. Many of the sand and gravel layers appear to have greater continuity in directions parallel to the axes of the valley. These represent channel deposits of changing streams within the main valley. Relatively small streams, overloaded with glacial debris, probably split into many smaller channels and wandered back and forth as do present braided streams.

In some localities (portions of cross sections 6 through 10), thick deposits of sand and gravel mixed with clay show that the materials were deposited with little sorting. In other areas, gravel containing very little fine sand and clay indicates that the fine clastic materials were washed away leaving only the medium and coarse behind. Such a deposit is located west of the Scioto River south of Chillicothe (cross section 12).

Persistent clay confining layers occur throughout much of the Miami buried valley, separating the sand and gravel deposits into two aquifers. This does not appear to be the situation in the Scioto valley. Although clay layers are present, test drilling has not indicated that they are regionally extensive.

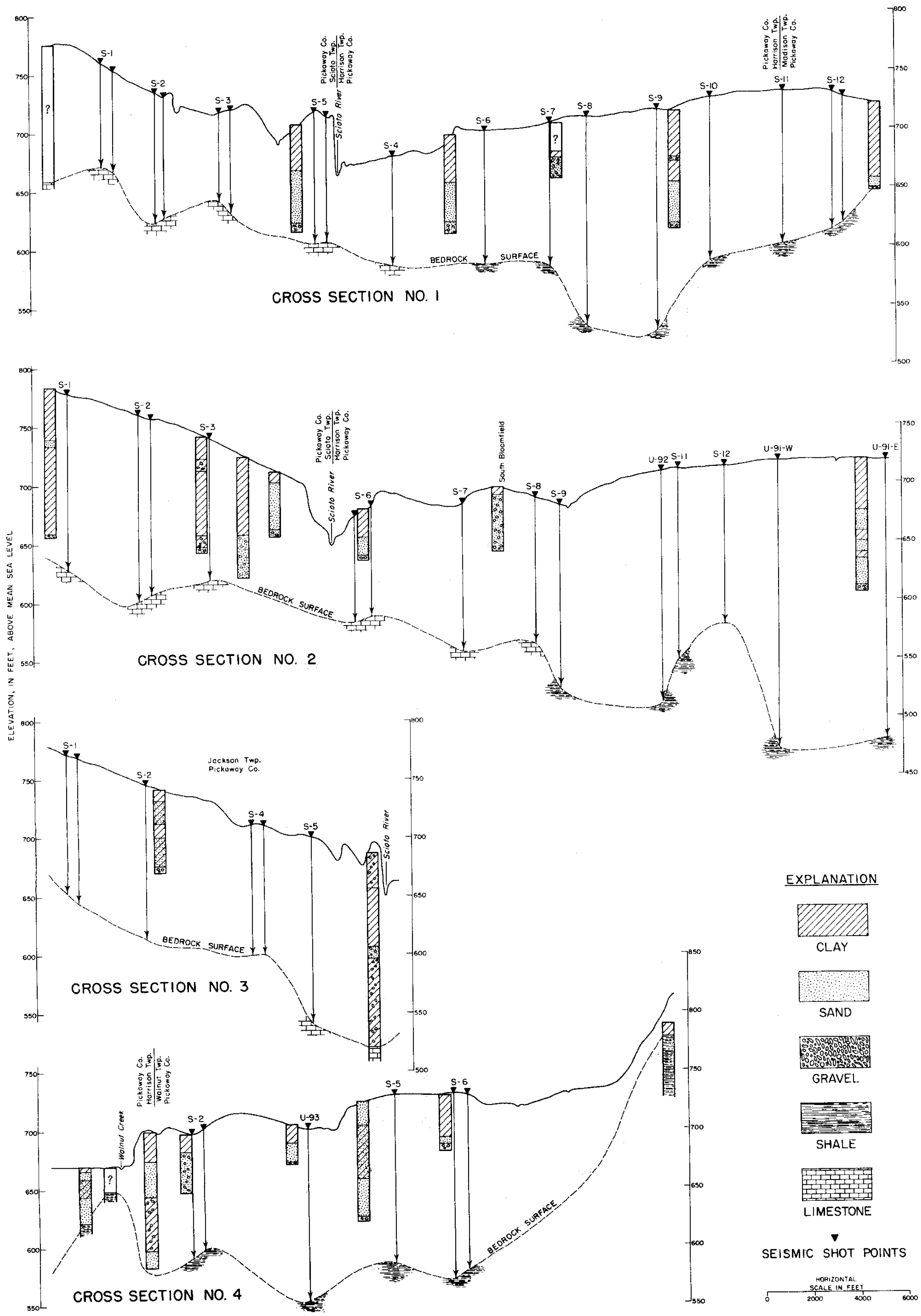

Plate 2-a. Cross sections in the Scioto Valley.

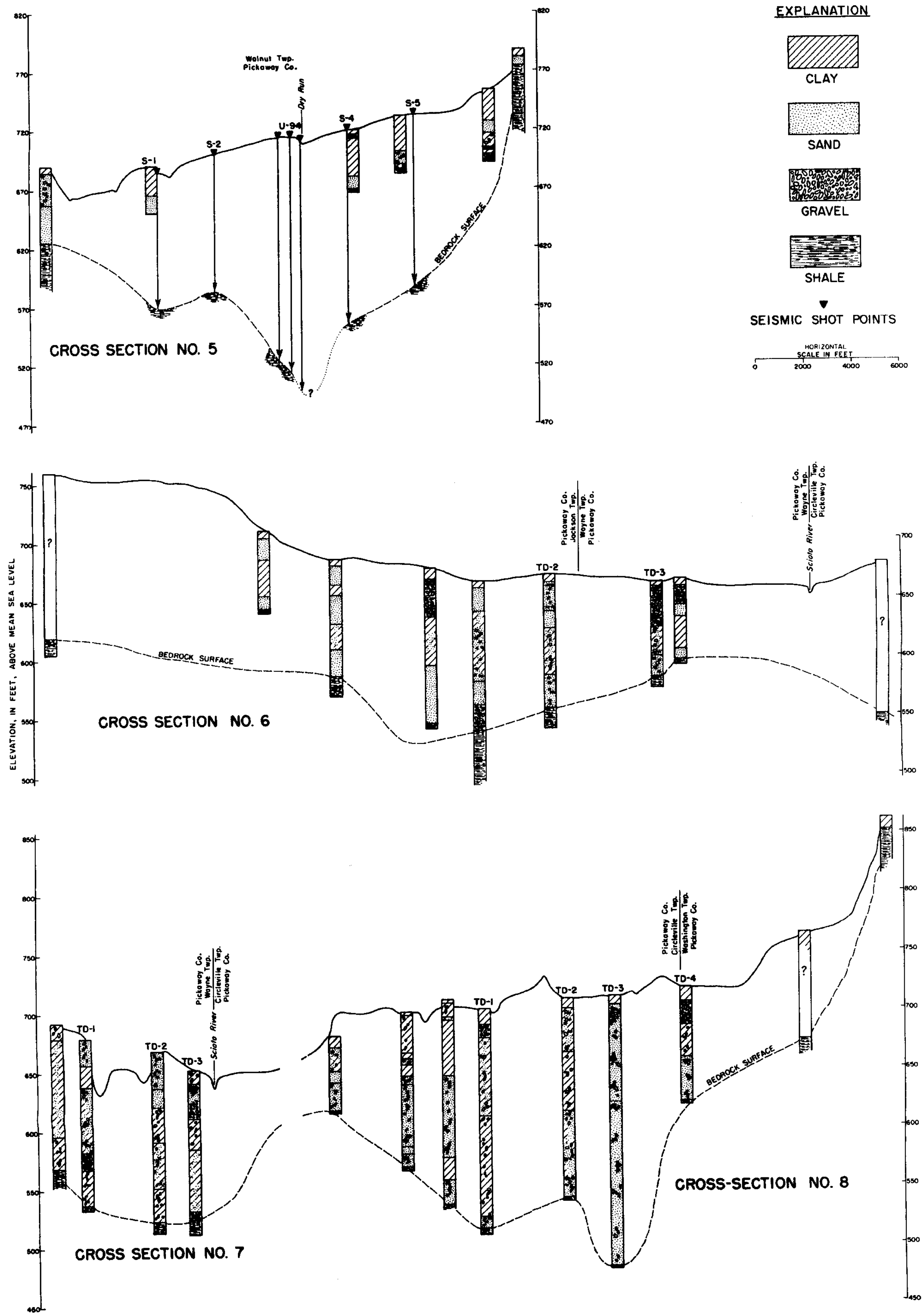

Plate 2-b. Cross sections in the Scioto Valley.

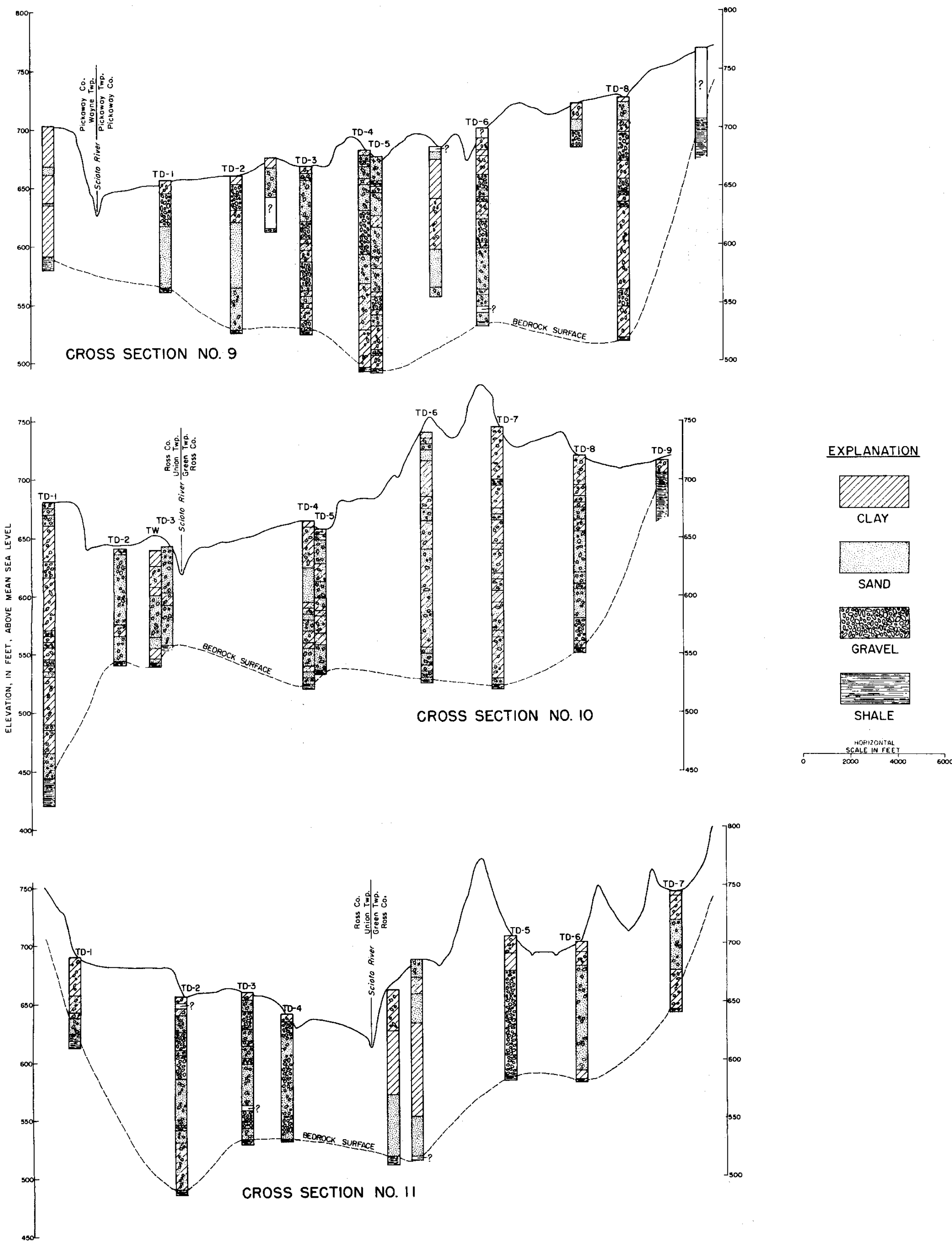

Plate 2-c. Cross sections in the Scioto Valley.

PLEASE NOTE:

The elevation scale for Cross sections 13, 15, 16, and 17 are incorrect.

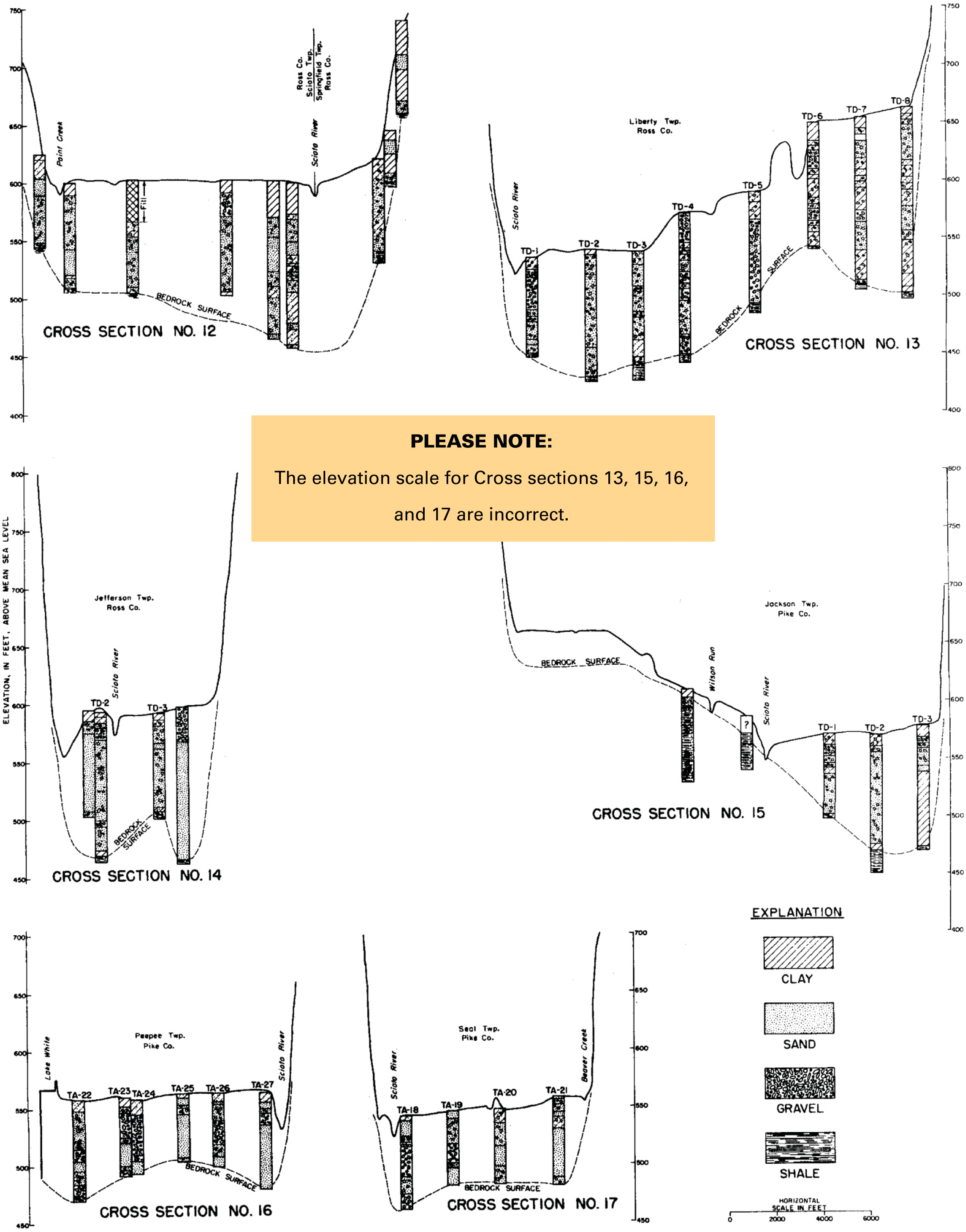

Plate 2-d. Cross sections in the Scioto Valley.

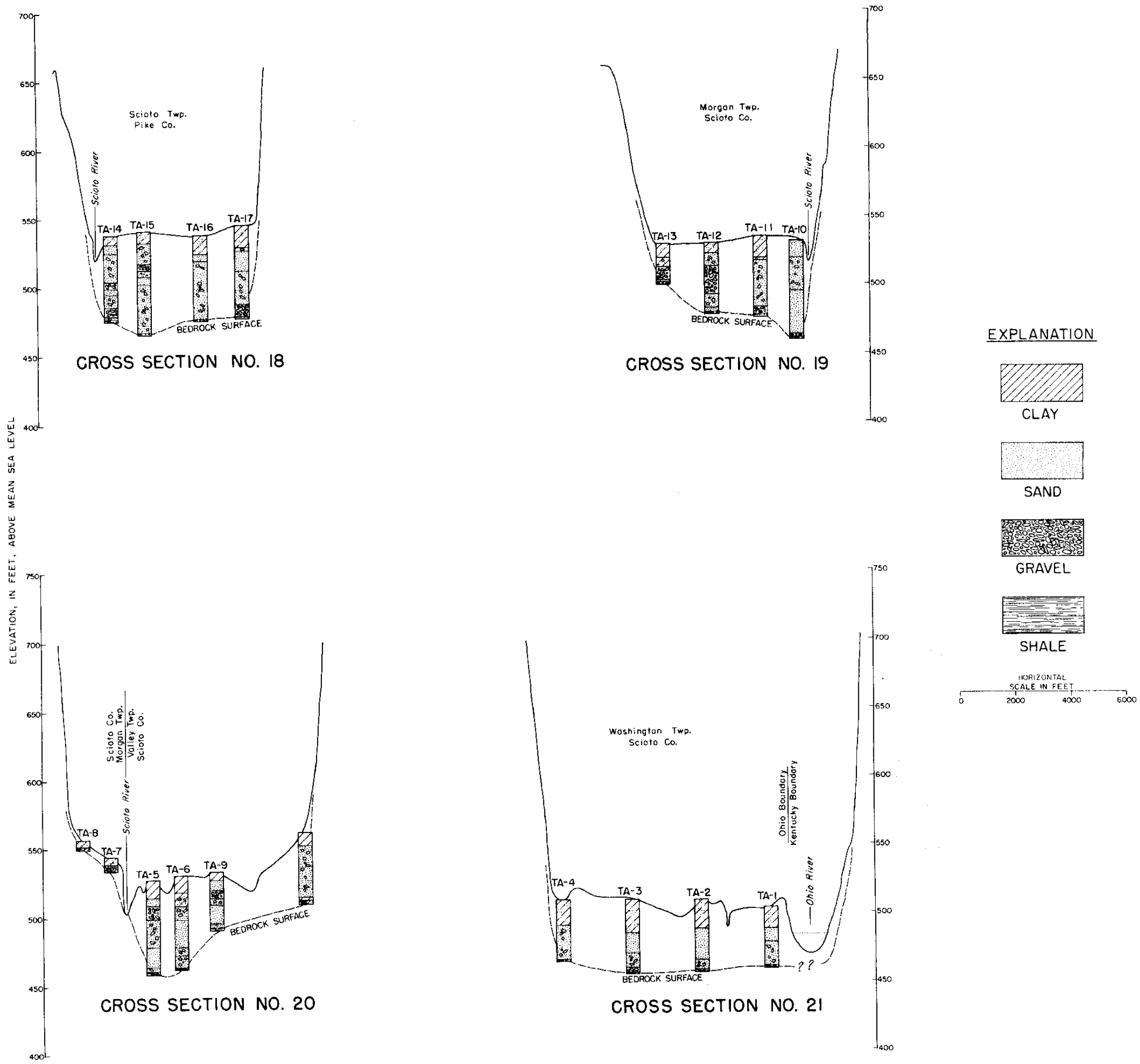

Plate 2-e. Cross sections in the Scioto Valley.

Figure 7. (Top) Ohio Division of Water aquifer test in Ross County.
(Bottom) U. S. Geological Survey aquifer test in Pike County.

GROUND-WATER POTENTIAL OF THE BURIED VALLEY

Factors Affecting Ground-Water Supply:

The materials that form the earth's crust are not solid, but contain numerous open spaces ranging in size from microscopic openings to large voids. Usually, the openings are interconnected so that water can circulate through the material, but the ease with which water can circulate depends on the size, shape, and arrangement of the openings. Thus, the occurrence of ground water in any region depends on the geology of the region. The available ground water in the Scioto valley, for the purposes of this report, is considered to be the water which occurs in the pore spaces of the unconsolidated valley fill deposits.

The normal movement of ground water in an area is from the area of recharge to some lower area of discharge. The pattern of normal ground-water flow in a water-bearing formation (aquifer) is altered by pumping. When a well is pumped, water enters the well from all directions. At first, water is withdrawn only from storage in the immediate vicinity of the well. The water level declines in the form of an inverted cone, called the cone of depression. As pumping continues, more water flows to the well from progressively greater distances, the water level continues to decline, and the cone of depression expands until it intercepts enough natural recharge to balance the pumping. The size and the shape of the cone of depression are controlled, largely, by the permeability, the thickness, the storage properties of the aquifer, and the distances to the areas of recharge or discharge of the aquifer.

Whenever the discharge from an aquifer is greater than the recharge, water levels in the aquifer decline. Depending on the volume of storage in an aquifer, water can be withdrawn from storage in quantities in excess of the recharge providing that the water is replaced during a later period when the recharge exceeds the withdrawal and before the storage is exhausted. The long-term sustained yield of wells in any one area is limited to the long-term average recharge received.

Natural recharge in the Scioto valley occurs from precipitation, from ground water flowing from the bedrock at the edges of the valley, and from the Scioto River when it is in flood stage. Under non-pumping conditions the latter represents only temporary recharge because it returns to the river soon after the flood waters recede. Such recharge is termed bank storage. The large perennial yields of well fields are obtained by induced infiltration from the Scioto River. Pumping a well, or group of wells, near the river lowers the ground-water level below river level and causes a reversal of the normal ground-water flow. Water flows from the river, into the valley fill material, and toward the wells. The amount of induced infiltration available depends upon the condition of the river bottom, permeability of the unconsolidated material, thickness of the aquifers, and the distance and ground-water gradient between the wells and the source of recharge .

Hydraulic Properties:

The hydraulic properties of an aquifer are measured by the coefficients of - 15

transmissibility, or permeability, and storage. The coefficient of transmissibility (T) is defined as the rate of flow of water in gallons per day through a strip of aquifer one foot wide, and extending the full saturated thickness, under a hydraulic gradient of one foot per foot. The coefficient of permeability (P) is defined as the rate of flow of water in gallons per day through a cross-sectional area of one square foot of the aquifer under a hydraulic gradient of 100 percent. The coefficient of permeability is obtained by dividing the coefficient of transmissibility by the thickness of the aquifer. The coefficient of storage (S) is defined as the amount of water in cubic feet released from a vertical column of the aquifer with a base one foot square, when the hydraulic head is lowered one foot.

These properties can be determined by making controlled aquifer tests. In such a test one well is pumped continuously at a known pumping rate, and water level measurements are obtained in several observation wells as the test progresses. The results of several such tests are available in the Scioto valley.

Aquifer tests performed close to a surface stream are also used to determine whether water from a stream will infiltrate into the water-bearing formation in response to pumping wells placed near the stream. By using aquifer test data, the distance from the pumping well to the so-called "line of recharge" may be computed. Although infiltration actually occurs over an area of stream bed rather than along a line, the distance to the line of recharge and the coefficient of transmissibility are used for determining yields of well systems placed close to surface streams .

If wells are placed at some distance from a surface stream so that recharge is derived largely from local precipitation, the ultimate yields of wells for comparable geologic conditions will be much less than if the wells were located close to the stream.

Locations of eight aquifer tests in the Scioto River valley are shown on plate 3, and a summary of the data obtained is given in table 1.

A well production test consists of pumping an individual well at a constant rate and frequently measuring the drawdown in the pumping well. Observation wells are not used. In this way, information is gained on the characteristics of the specific well, although not on the aquifer as in the more detailed aquifer tests.

The yield of a well may be given in terms of its specific capacity, which is commonly expressed as the yield in gallons per minute per foot of drawdown (gpm/ft.) for a stated pumping period and rate.

Table 2 gives well production test data for a number of large-yielding wells in the Scioto valley. The table indicates that the specific capacity of sand and gravel wells in the valley ranges from 1. 1 to 120. 0 gpm/ft. and averages about 43.4 gpm/ft. The average depth and diameter of wells are 104 feet and 16 inches, respectively.

TABLE 1.
SUMMARY OF AQUIFER TEST RESULTS
IN SCIOTO VALLEY SAND AND GRAVEL DEPOSITS

Identification on Plate 3	Location		Date	Duration of test (hrs)	Pumping rate (gpm)	Aquifer thickness (ft.)	Transmissibility T (gpD/ft.)	Permeability P (gpD/sq. ft.)
	County	Township						
Test A	Ross	Union	1964	3	115	68	138,000	2,030
Test B	Ross	Scioto	1953	88	415	70	322,000	4,600
Test C	Ross	Scioto	1958	74	800	67.9	228,000	3,360
Test D	Ross	Scioto	1958	72	800	70	182,000	2,600
Test E	Ross	Scioto	1965	50	505	48.8	177,000	3,630
Test F	Pike	Seal	1964	216	1, 000	62.5	200,000	3,200
Test G	Pike	Seal	1952	60	795	40.5	166,000	4,100
Test H	Scioto	Nile	1965	3.5	60	30	75,000	2,500

TABLE 2.
SUMMARY OF WELL PRODUCTION TEST DATA
IN SCIOTO VALLEY SAND AND GRAVEL DEPOSITS

No. on Pl. 3	Div. of Water number	Location		Total depth (ft.)	Casing diam. (in.)	Screen length (ft.)	Date of test	Duration of test (hrs.)	Static level (ft.)	Pumping rate (gpm)	Drawdown (ft.)	Specific Capacity (gpm/ft.)
		County	Township									
1	187	Pickaway	Harrison	45	48	15	1946	- -	12	800	34	23.5
2	186	Pickaway	Harrison	106	38	10	1950	- -	24	800	60	13.3
3	266009	Pickaway	Harrison	74	12	10	1961	12	26	240	2	120.0
4	- -	Pickaway	Circleville	136	20	37.5	1962	24	14	2000	32.7	61.2
5	281093	Pickaway	Circleville	136	30	50	1963	- -	40	1200	16	75.0
6	321	Pickaway	Circleville	92	- -	- -	- -	4	- -	225	18	12.5
7	137352	Pickaway	Circleville	88	8	8	1954	10	48	25	12	2.0
8	256205	Pickaway	Circleville	136	38	30	1960	- -	33.2	1500	17	88.2
9	266021	Pickaway	Circleville	151	10	15	1962	8	43	400	17	23.5
10	30	Pickaway	Circleville	76	6	- -	1947	12	36	40	10	4.0
11	- -	Pickaway	Circleville	130	8	12	1964	5	35	180	28	6.4
12	179972	Pickaway	Pickaway	176	16	55	1960	24	47	1500	21	71.4
13	106120	Pickaway	Pickaway	117	16	15	1953	10	36.5	1000	60	16.7
14	179961	Pickaway	Pickaway	166	16	53	1959	24	47	1505	22	68.4
15	266017	Pickaway	Pickaway	135	20	50	1962	24	28.9	1500	31.9	47.0
16	266018	Pickaway	Pickaway	63	8	15	1962	8	21.5	50	1.9	26.3
17	140202	Pickaway	Pickaway	121	4	- -	1954	4	32	18	3	6.0
18	294345	Pickaway	Pickaway	139	12	20	1965	8	38	400	42	9.5
19	183379	Pickaway	Pickaway	65.5	12	15	1957	- -	28	1000	9	111.1
20	294316	Ross	Green	141	14	20	1963	8	8	1000	80	12.5
21	236150	Ross	Green	85	14	25	1961	- -	3	800	52	15.4
22	266010	Ross	Green	89	6	10	1961	8	23	60	45	1.3
23	256203	Ross	Green	201	12	25	1959	- -	80	150	39	3.8
24	201	Ross	Scioto	128	18	25	1949	- -	32	1900	54	35.1
25	- -	Ross	Scioto	76	- -	- -	1965	- -	30	1150	10	115.0
26	- -	Ross	Scioto	94	- -	- -	1965	- -	30	1500	14	107.1
27	- -	Ross	Scioto	81	- -	- -	1965	- -	30	1100	15	73.3
28	281079	Ross	Scioto	95	26	40	1965	- -	30	1200	12	100.0
29	134	Ross	Scioto	99	10	15	1949	6	30	500	10	50.0
30	132	Ross	Scioto	94	38	23	1949	- -	12	1000	11	90.9
31	149658	Ross	Scioto	90	12	18	1955	4	14	1500	25	60.0
32	83733	Scioto	Valley	37	6	4	1952	6	11	30	27	1.1
33	125068	Scioto	Clay	73	8	10	1954	5	43	120	8.0	15.0
34	173784	Scioto	Clay	79	8	15. 5	1959	24	50.5	500	8.3	60.2
35	125067	Scioto	Clay	68	8	10	1954	10	40	120	9	13.3
36	109165	Scioto	Clay	73	8	8	1953	6	43	135	6	22.5

Summary of Quantitative Data:

The development of large ground-water supplies involves a sizeable investment which should be protected by preliminary investigation and careful advance planning. The need for such careful investigation and planning is shown by the wide range of well yields given in table 2, and the range in transmissibilities and permeabilities in table 1

The transmissibilities (table 1J range from 75, 000 gpD/ft. to 322, 000 gpD/ft. and average 186, 000 gpD/ft. The permeabilities range from 2030 gpD/ sq. ft. to 4600 gpD/ sq. ft. and average 32 53 gpD/ sq. ft. More test data, if available, would probably show an even greater range than is indicated above.

The most successful aquifer test performed in the Scioto valley was test F (table 1). This test was conducted by the U. S. Geological Survey in 1964 adjacent to the Scioto River near Piketon, Pike County. The test is particularly significant because the transmissibility determined is close to the average of data in table 1. The infiltration rate of the stream bottom in this area is also assumed to be about average for the valley.

From the data obtained in the Piketon test, it was determined that a series of 10 properly constructed, large diameter wells located parallel to the river and spaced 400 feet apart would produce 20 million gallons per day (mgD). This represents a yield per mile of about 29 mgD.

What would be a reasonable estimate of the total potential yield of the Scioto valley fill, based upon this figure? The portion of the valley extending from the southern Franklin County line south to the southern Pike County line covers a distance of about 100 river miles. A high percentage of this reach, according to geologic data gathered for this report, is underlain and bordered by sand and gravel of sufficient depth and permeability for the development of large ground-water supplies. It can be conservatively assumed that at least half of this area is suitable for ground-water development. On this basis, 50 miles of aquifer would be available for development of well supplies. Using the yield per mile of 29 mgD, a potential supply of 1450 mgD would be available. Such a yield would require that each user return the pumped water to the river after it has served its purpose. However, this is normally done because very little industrial or municipal water is actually consumed. This potential yield would also require that wells be located near the river and that all well systems be properly designed and constructed.

Areas for Future Ground-Water Development:

The largest concentrations of ground-water pumpage at the present time are located in the immediate vicinities of Circleville and Chillicothe. Extensive areas of equally promising, yet undeveloped, ground-water resources are indicated throughout much of the valley.

The ideal site is one which has thick deposits of permeable sands and gravels (storage) and is located near the river (recharge). There are few sites in the valley where large supplies cannot be developed from large-diameter, properly screened wells drilled near the Scioto River. Although much of the fill material is highly stratified with alternating sand, gravel, and clay layers, it is quite permeable and permits large sustained yields recharged by stream infiltration. The minimum saturated thickness of the aquifer in the areas shown on plate 3 as having a "large industrial ground-water potential" is 40 feet. The yields of wells in the valley fill generally increase with an increase in the saturated thickness of the aquifer. Thus, in the northern two-thirds of the valley area where the fill averages well over 100 feet in thickness, wells may yield in excess of 1, 000 gallons per minute .

The western half of the broad valley west of Circleville (see plate 3) is a good area for ground-water storage. It contains as much as 150 feet of largely permeable materials.

However, it receives very little recharge from surface streams. Similar conditions exist in parts of Harrison; Walnut, Circleville, and Pickaway townships in Pickaway County; Union, Green, Liberty, and Franklin townships in Ross County; Jackson and Pee Pee townships in Pike County; and several narrow valley margin areas in Scioto County.

In the Scioto valley, south of the Pike-Scioto county line, recharge possibilities are good, but ground-water storage is more limited. Industrial supplies should be available in this area. Although no attempt has been made to estimate the quantity available south of the Pike-Scioto county line, it would undoubtedly be large.

The best areas from the standpoint of both stream recharge and groundwater storage, as has already been stated, lie adjacent to the Scioto River north of this line .

Chemical Quality:

Analyses of 14 water samples collected from wells developed in the unconsolidated deposits of the Scioto Valley and two surface water samples from the Scioto River are shown in Table 3. The majority of the samples were analyzed by the Quality of Water Branch, U.S. Geological Survey. Samples at Ashville, Kingston, Chillicothe, and Waverly are from municipal wells and were collected and analyzed by the Ohio Department of Health. The locations of the sampling sites are indicated on plate 3.

The chemical constituents of ground water in the study area are closely related to the mineral composition of the surrounding rock materials. The bulk of the rock fragments, which constitute the outwash sands and gravels, are composed of limestone and dolomite pebbles derived from the predominantly limestone terrain in the upper reaches of the Scioto River Basin. Because of its contact with soluble materials in the outwash deposits, ground water in the area may be classified as moderate to very hard, and the total dissolved solids, based on the samples analyzed, averages between 300 and 500 parts per million. Reported concentrations of chloride, fluoride, sulfate, and nitrate are well within the limits of the drinking water standards of the U.S. Public Health Service. Iron is one of the most abundant elements in the soil and in the mantle of glacial drift which blankets the area. Iron content in the 14 ground-water samples averages between 1.5 and 2.0 ppm. Although this represents a rather small percentage of the total dissolved solids, the presence of iron even in small quantities is important in evaluating the water quality for domestic, municipal and many industrial uses. Softening and complete or partial iron removal would be desirable for most users.

The surface water samples revealed lower concentrations of dissolved solids, iron, and hardness because of less contact time with the soluble minerals beneath the surface. Scioto River water, however, carries a rather high suspended sediment load due to extensive agriculture in the Basin and is further polluted with industrial wastes and many other organic and inorganic impurities. Consequently, cost of treatment is high when compared to ground water which is virtually free of those constituents. Furthermore, ground water is more favorable for industrial cooling because of its nearly uniform temperature which generally ranges between 52 and 55 degrees Fahrenheit.

Heavy pumpage from industrial or municipal wells located immediately adjacent to the river, as previously stated, induces river water to infiltrate into the underlying gravels and flow toward pumping wells. Because of this, the chemical quality of ground water from wells receiving induced infiltration may be lower in iron, total dissolved solids and hardness than from wells pumping water which has moved long distances through the aquifer.

Appendix

I. SEISMIC DATA

Identification numbers of seismic stations correspond to those shown on Plate 1-a and on cross sections numbered I through 5, (pages 9 and 10).

Station Number	Bedrock depth (ft.)	Bedrock elevation (msl)	Lithology
CROSS SECTION 1			
S-1 (W)	87	668	Limestone
S-1 (E)	87	668	Limestone
S-2 (W)	110	628	Limestone
S-2 (E)	106	624	Limestone
S-3 (W)	78	631	Limestone
S-3 (E)	90	643	Limestone
S-4	93	585	Limestone
S-5 (W)	112	606	Limestone
S-5 (E)	109	603	Limestone
S-6	113	585	Shale
S-7	125	582	Shale
S-8	176	532	Shale
S-9	190	527	Shale
S-10	138	589	Shale
S-11	128	603	Shale
S-12 (W)	111	617	Shale
S-12 (E)	108	614	Shale
CROSS SECTION 2			
S-l	145	631	Limestone
S-2 (W)	159	610	Limestone
S-2 (E)	150	601	Limestone
S-3	126	620	Limestone
S-6 (W)	90	572	Limestone
S-6 (E)	92	574	Limestone

Station Number	Bedrock depth (ft.)	Bedrock elevation (msl)	Lithology
(Cross section 2, continued)			
S-7	130	555	Limestone
S-8	125	564	Limestone
S-9	180	523	Shale
S-11	132	510	Shale
S-12	137	580	Shale
U-91-W	245	470	Shale
U-91-E	240	480	Shale
U-92	195	550	Shale
CROSS SECTION 3			
S-1 (W)	119	651	?
S-1 (E)	125	657	?
S-2	132	618	?
S-4 (W)	110	60	?
S-4 (E)	110	602	?
S-5	160	545	Limestone
CROSS SECTION 4			
S-2 (W)	108	602	Shale
S-2 (E)	102	596	Shale
S-5	141	588	Shale
S-6 (W)	159	577	Shale
S-6 (E)	150	568	Shale
U-93	150	551	Shale

Station Number	Bedrock depth (ft.)	Bedrock elevation (msl)	Lithology
CROSS SECTION 5			
S-1	118	570	Shale
S-2	116	586	Shale
S-4	175	555	Shale
S-5	148	585	Shale
U-94 (W)	190	510	Shale
U-94	200	520	Shale
U-94 (E)	212	532	Shale
MISCELLANEOUS SEISMIC			
PICKAWAY COUNTY, JACKSON TWP.			
U-95	142	548	Shale
U-96	155	543	Shale
PICKAWAY COUNTY, HARRISON TWP.			
U-88	230	490	Shale
U-89	200	490	Shale
U-90	230	485-510	Shale
ROSS COUNTY. UNION TWP.			
U-97	±100	590	Limestone
U-98	± 100	590	Limestone

II. TEST DRILLING LOGS (Depths shown in feet)

Log numbers correspond to those shown on plates 1-a and 1-b, and on cross sections numbered 6 through 15, (pages 10, 11, and12).

CROSS SECTION 6	From	To
T. D. -2		
Topsoil with gravel	0	5
Gravel, coarse, to fine, sand	5	25
Gravel, coarse, to medium, cobbles	25	30
Sand, coarse to fine, fine gravel	30	35
Sand, fine to medium, some small pieces clay	35	40
Sand, fine to medium, fine to medium gravel	40	45
Gravel, fine to coarse, coarse sand, few pieces of clay	45	85
Gravel, fine to coarse, coarse sand, clay @86'	85	110
Gravel, fine to coarse, coarse sand, large amount gray clay	110	115
Gravel, fine to coarse, coarse sand, larger amount gray clay	115	120
Gravel, fine to coarse, sand, clay, black shale	120	125
Gravel, fine to coarse, black shale (shale @ 114')	125	130
CROSS SECTION 6		
T. D. -3		
Coarse gravel, cobbles	0	5
Coarse gravel, cobbles	5	10
Cobbles, coarse gravel	10	30
Cobbles, coarse gravel, coarse sand	30	35
Cobbles, coarse gravel, coarse sand	35	40
Cobbles, coarse gravel, coarse sand, blue clay	40	45
Cobbles, coarse gravel, coarse sand, blue clay	45	50
Blue clay, cobbles, coarse gravel, sand	50	55
Blue clay, cobbles, coarse gravel, sand	55	60
Cobbles, coarse gravel, sand, blue clay	60	82
Shale	82	90
CROSS SECTION 7		
T. D. - 1		
Cobbles, coarse gravel, coarse sand, some clay	0	23
Blue clay, fine gravel	23	30
Blue clay, gravel	30	36
Fine sand (no sample)	36	38
Gravel, coarse sand, some clay	38	40
Coarse gravel, cobbles, sand, clay	40	45
Clay, coarse gravel, sand, cobbles	45	50
Gravel, coarse, cobbles, some sand, clay	50	55
Gravel, medium, coarse sand	55	60
Gravel, medium, coarse sand, clay	60	65
Blue clay, gravel, coarse sand	65	70
Dark gray clay, gravel, coarse sand	70	75
Dark gray clay, gravel, coarse sand, some shale	75	83
Sand	83	87
Dark gray clay, gravel, coarse sand	87	90
Blue clay, gravel, coarse sand	90	95
Gravel, cobbles (clean)	95	100
Gravel	100	110
Gravel, small amount clay	110	115
Gravel, few cobbles, small amount clay	115	120
Gravel, small amount gray clay	120	125
Gravel, clean	125	130
Gravel, few small pieces of clay	130	142
Shale, black	142	147
CROSS SECTION 7		
T. D. - 2		
Fill	0	5
Gravel, coarse sand	5	15
Gravel, coarse sand, cobbles	15	30

(Cross section 7, T. D. 2, continued)	From	To
Sand, fine	30	45
Clay, dark gray, with gravel	45	70.
Sand, coarse, fine gravel, small amount clay	70	75
Gravel, cobbles, sand, clay	75	55
Gravel, cobbles, sand, no clay	85	90
Gravel, gray clay	90	95
Clay, gray, gravel	95	110
Gravel, cobbles, gray clay	110	115
Gravel, gray clay	115	145
Gravel, clean	145	146
Shale	146	155
CROSS SECTION 7		
T. D. - 3		
Clay w/large gravel	0	11
Large rock & gravel	11	42
Clay w/gravel strips	42	70
Fine sand w/tight strips	70	123
Large to medium gravel	123	129
Shale	129	135
CROSS SECTION 8		
T. D. - 1		
Clay with loose rock	0	12
Large gravel	12	22
Sand &, gravel tight with clay	22	90
Clay with tight gravel strips	90	175
Large to medium gravel with fine sand	175	185
Shale	185	190
CROSS SECTION 8		
T. D. - 2		
Clay w/rock	6	8
Gravel large w/fine sand	8	45
Clay w/gravel (tight)	45	95
Gravel w/clay & fine sand	95	169
Shale	169	170
CROSS SECTION 8		
T. D. - 3		
Clay with rocks	0	7
Large gravel &, w/sand	7	90
Loose sand & gravel	90	228
Shale	228	230
CROSS SECTION 8		
T. D. - 4		
Road fill	0	
Clay	5	12
Gravel - large	12	32
Clay with gravel	32	60
Gravel with fine sand	60	98
Shale	98	100
CROSS SECTION 9		
T. D. - 1		
Clay with gravel	0	12
Large gravel and boulders	12	40
Fine sand - loose with gravel	40	92
Shale	92	95

CROSS SECTION 9	From	To
T. D. - 2		
Clay	0	7
Large gravel	1	29
Clay w/large gravel	29	40
Fine sand w/gravel	40	95
Coarse sand & gravel	95	132
Shale	132	
CROSS SECTION 9		
T. D. - 3		
Brown clay & medium gravel	0	5
Fine-coarse gravel	5	10
Coarse sand to coarse gravel	10	20
Coarse sand w/medium to coarse gravel	20	25
Fine- coarse sand w/some gravel	25	30
Sand w/fine to medium gravel	30	35
Coarse sand and fine gravel	35	45
Fine to medium gravel	45	60
Clay w/fine gravel	60	65
Fine to medium gravel	65	70
Coarse sand to medium gravel w/clay	70	75
Coarse sand to coarse gravel w/clay	75	80
Fine to medium gravel	80	85
Fine gravel w/some medium gravel	85	95
Fine to medium gravel	95	100
Coarse sand and fine gravel	100	105
Fine to coarse gravel w/sand & clay	105	110
Course sand w/fine to medium gravel	110	115
Fine to medium gravel w/clay	115	120
Sand & clay w/fine gravel	120	125
Sand & clay w/fine to medium gravel	125	130
Fine to medium gravel	130	140
Sand & fine gravel w/shale fragments (?)	140	142
CROSS SECTION 9		
T. D. - 4		
Brawn sand & clay	0	5
Medium gravel w/sand	5	10
Fine to coarse gravel	10	15
Sand w/little coarse gravel	15	20
Sand w/fine to medium gravel	20	25
Sand w/fine gravel & clay	25	30
Fine gravel & sand	30	40
Fine gravel & sand w/medium gravel	40	45
Sand w/medium to coarse gravel	45	50
Fine gravel & sand	50	55
Fine to medium gravel	55	65
Fine gravel	65	80
Fine to medium gravel	80	90
Sand w/fine gravel	90	115
Clay, sand & fine gravel	115	145
Clay, sand & medium gravel	145	150
Clay, sands, fine gravel	150	155
Clay & medium gravel	155	160
Clay & fine gravel	160	190
Shale	190	192
CROSS SECTION 9		
T. D. - 5		
Sand w/medium gravel	0	10
Sand w/fine gravel	10	20
Fine to medium gravel	20	25
Medium gravel w/clay	25	30
Sand w/fine gravel	30	45
(Sample missing)	45	50
Coarse sand & clay	50	60
Sand, fine gravel & clay	60	65
Sand and medium gravel	65	70
Sand w/medium-coarse gravel	70	75
Coarse gravel w/sand	75	80
Fine to medium gravel w/sand	80	85
Clay, sand & medium gravel	85	95
Sand & fine gravel	95	100
Sand & medium gravel	100	110
Sand & fine gravel	110	115
Clay, sand &, medium-coarse gravel	115	120
Fine to medium gravel	120	130
Fine gravel w/clay	130	135
Sand w/medium gravel	135	145
Fine gravel w/clay	145	155
Clay w/fine gravel	155	160
Clay w/fine to medium gravel	160	165
Fine to medium gravel	165	170
Fine gravel & clay	170	175
Fine to medium gravel & clay	175	180
Shale	180	182
CROSS SECTION 9		
T. D. - 6		
(Sample missing)	0	5
Brown clay & medium gravel	5	10
Gray clay w/medium gravel	10	15
Gray clay	15	20
Gray clay and fine gravel	20	30
Fine to medium gravel w/clay	30	35
Fine gravel	35	40
Fine to medium gravel	40	50
Coarse sand to medium gravel	50	55
Fine to medium gravel	55	60

(Cross section 9, T. D. - 6, continued)	From	Te
Clay w/fine gravel	60	65
Clay w/fine to medium gravel	65	70
Coarse sand & fine gravel w/some clay	75	75
Fine to medium gravel	75	so
Fine gravel w/ medium gravel	55	85
Fine to medium gravel	85	90
Fine to coarse gravel	90	95
Fine to medium gravel w/clay	95	100
Sand w/medium gravel	110	105
Medium gravel w/sand	105	110
Sand w/fine gravel	110	115
Sand w/fine to medium gravel	115	120
Sand w/fine gravel	120	135
Medium to coarse gravel w/sand & some clay	130	140
Sand w/fine gravel	140	145
Sand w/fine to medium gravel	145	150
(Sample missing)	150	155
Sand w/fine gravel	155	160
Sand w/fine gravel (shale fragments)	160	165
(Sample missing)	165	195
Clay & Shale	195	200
CROSS SECTION 9		
T. D. - 8		
Brown clay	0	5
Fine gravel	5	10
Fine to medium gravel	10	15
Coarse sand to medium gravel w/clay	15	20
Clay w/fine to medium gravel	20	30
Fine to medium gravel	30	40
Fine gravel	40	45
Sand and fine to medium gravel	45	50
Fine gravel w/some medium gravel	50	55
Fine to medium gravel w/clay	55	90
Fine gravel	90	95
Fine gravel and clay	95	115
Clay w/fine to medium gravel	115	120
Clay w/fine gravel	120	125
Fine gravel w/clay	125	130
Clay w/fine gravel	130	135
Fine gravel w/clay	135	145
Fine to medium gravel w/clay	145	165
Fine to medium gravel	165	190
Fine gravel w/clay	190	195
(Sample missing)	195	200
Clay w/fine gravel	200	205
Shale @ 208'	205	210
CROSS SECTION 10		
T. D. - 1		
Clay and medium gravel	0	5
Sand, medium gravel w/some clay	5	10
Sand w/fine to coarse gravel	10	15
Fine to coarse gravel	15	20
Limey clay & fine gravel	20	25
Limey clay & medium gravel	25	30
Limey clay & fine gravel	30	35
Limey clay w/medium to coarse gravel	35	40
Limey clay w/fine to medium gravel	40	45
Limey clay w/medium gravel	45	50
Fine to medium gravel	50	55
Fine to coarse gravel	55	60
Fine to medium gravel	60	65
Clay w/fine to medium gravel	65	75
Clay w/fine gravel	75	90
Clay w/fine to medium gravel	90	105
Fine to medium gravel w/little clay	105	110
Fine to medium gravel	110	115
Fine to medium gravel w/clay	115	120
Fine to medium gravel	120	125
Fine to medium gravel w/little clay	125	135
Fine gravel	135	140
Fine to medium gravel w/clay	140	145
Coarse sand, fine gravel and clay	145	150
Clay & medium gravel	150	155
Clay w/fine to medium gravel	155	185
Fine gravel w/clay	185	190
Medium gravel	190	195
Fine to medium gravel w/little clay	195	215
Fine to medium gravel	215	220
Fine gravel	220	230
Fine to medium gravel	230	235
Shale	235	260
CROSS SECTION 10		
T. D. - 2		
Brown clay w/fine gravel	0	5
Fine to medium gravel	5	40
Fine to coarse gravel	40	45
Fine to medium gravel	45	55
Fine gravel	55	65
Fine gravel w/clay	65	70
Fine to medium gravel w/clay	70	75
Sand and fine to medium gravel	75	80
Brown sand, medium-coarse & gravel, fine	80	85
Brown-gray gravel, medium-coarse & sand, coarse cobbles	85	90
Brown, sand, medium-coarse, some gravel, fine	90	95
Black-gray shale	95	100

CROSS SECTION 10	From	To
T. D. - 3		
Brown fill coarse gravel, cobbles	5	5
Brown fill, cobbles, coarse coed	5	10
Brown gravel, medium-coarse & sand, medium-coarse, cobbles	10	40
Gray clay (till), sand & gravel	40	45
Gray clay, sand, gravel, cobbles	45	50
Gray coed, medium-coarse, some gravel, fine, cobbles	50	55
Gray sand, medium-coarse, some gravel, fine-medium	55	80
Gray sand, medium-coarse, gravel, fine & shale	80	85
CROSS SECTION 10		
T. D. - 4		
Brown sandy, gravelly clay	0	5
Brown sand, medium-coarse & gravel, fine, some coarse	5	10
Brown gravel, fine-coarse, some sand, coarse	10	15
Brown sand, medium-coarse & gravel, fine-coarse, cobbles	15	40
Gray-brown sand, fine-coarse, trace fine gravel	40	45
Gray-brown sand, fine-coarse	45	55
Gray-brown sand, medium coarse, some fine, some clay	55	75
Gray sand, medium-coarse & gravel, fine-coarse & clay	75	80
Gray sand, medium-coarse, some fine	80	85
Gray sand, medium-coarse & gravel, fine, some medium	85	95
Gray sand, medium-coarse, some fine, some gravel, fine & clay	95	115
Gray sand, medium-coarse & gravel, fine	115	125
Gray sand, medium-coarse, some clay	125	130
Gray sand, fine-coarse, trace gravel	130	135
Gray sand, coarse & gravel, fine, some medium	135	140
Gray sand, medium-coarse & shale	140	145
CROSS SECTION 10		
T. D. - 5		
Brown gravel clay	0	5
Brown gravel, fine to coarse & clay, some sand	5	10
Brown gravel, fine-coarse, some sand, coarse	10	15
Brown-gray sand, medium-coarse & gravel, fine, some medium	15	30
Brown-gray sand, fine-coarse, some gravel, medium &, clay	30	35
Brown-gray sand, medium-coarse & gravel, fine & clay	35	40
Brown-gray sand, medium-coarse & gravel, fine-coarse, some cobbles, clay	40	45
Brown-gray sand, medium-coarse & gravel, fine-coarse	45	50
Brown-gray sand, coarse & gravel, fine-medium, trace clay	50	55
Brown-gray gravel, medium-coarse, & sand, coarse, cobbles	55	60
Gray sand, medium-coarse & clay, some gravel, fine	60	70
Gray sand, fine-coarse & clay	70	100
Gray sand, coarse, some gravel, fine	100	115
Gray sand, medium-coarse & gravel, fine-medium	115	120
Sand, coarse & gravel, fine, and shale, trace limestone	120	125
Depth to bedrock 122'		
CROSS SECTION 10,		
T. D. - 6		
Brown sandy clay	0	5
Brown sandy clay, some sand & gravel	5	10
Brown sand, coarse & gravel, fine-medium	10	15
Brown sand, medium-coarse & clay	15	25
Gray clay till, some sand, coarse	25	55
Gray clay& sand, medium-coarse, come gravel, fine	55	60
Gray clay & sand, medium-coarse, cobbles	60	65
Brown-gray sand, coarse & gravel, fine, some medium	65	70
Brown-gray sand, medium-coarse, some gravel, fine & clay, cobbles	70	75
Gray clay & sand, coarse, some fine gravel	75	100
Gray gravel, fine-coarse & sand, coarse, some clay	100	175
Gray sand, medium-coarse & gravel, fine-medium	175	180
Gray gravel, fine-coarse & clay	180	185
Gray gravel, fine-coarse & clay & sand, coarse	185	190
Gray sand, medium-coarse & gravel, fine, some medium	190	200
Gray gravel, fine-medium & sand, medium-coarse, some clay	200	205
Gray sand, medium-coarse & gravel, fine-medium	205	210
Gray dirty sand, medium-coarse & gravel, fine, & clay & shale	210	215
Depth to bedrock 213'		
CROSS SECTION 10		
T. D. - 7		
Brown clay w/fine to medium gravel	0	10
(Samples missing)	10	15
Gray clay w/fine to medium gravel	15	40
Fine to medium gravel w/clay	40	45
Fine to medium gravel	45	50
Fine to medium gravel w/trace of clay	50	60
Clay w/fine to coarse gravel	60	65
Clay w/sand	65	70
Fine gravel w/clay	70	75
Sand, fine gravel & clay	75	80
Clay w/fine gravel	80	85
Clay w/fine to medium gravel	85	100
Gray clay & sand, medium-coarse	100	105
Gray clay & sand, medium-coarse, some fine gravel	105	110
Gray gravel, fine-medium & sand, coarse & clay	110	115
Gray sand, medium-coarse & clay, some gravel, medium-coarse	115	150
Gray sand, fine-coarse, some clay & gravel, fine	150	160
Gray gravel, fine-medium, some coarse, some sand & clay	160	170
Gray sand, fine-coarse & clay, some fine gravel	170	175
Gray sand, medium-coarse & clay	175	180
Gray gravel - fine - coarse, come clay & sand	185	220
Black sand, clay, shale	220	225
Depth to Bedrock 221'		

CROSS SECTION 10	From	To
T. D.		
Brown gravely, sandy clay	0	10
Gray clay, sand & gravel	10	40
Gray clay & fine-coarse gravel, some sand	40	45
Brown-gray fine-coarse sand & fine-coarse gravel	45	55
Brown-gray fine-coarse sand, some fine gravel & clay	55	65
Brown fine-coarse gravel & medium-coarse sand	65	100
Brown-gray coarse sand & fine-coarse gravel	100	l05
Brown-gray coarse gravel, some fine-medium trace sand	105	110
Brown-gray medium-coarse sand & clay, some fine gravel	110	120
Brown coarse gravel, cobbles, some coarse sand	120	130
Brown-gray medium gravel, some fine	130	135
Brown-gray medium-coarse gravel, some fine, some coarse sand	135	140
Brown-gray coarse gravel, cobbles, some medium	140	160
Sand & gravel w/clay	160	166
Shale	166	170
CROSS SECTION 10		
T. D. - 9		
Clay-/large gravel	0	11
Shale	11	50
CROSS SECTION 11		
T. D. -		
Brown clay & gravel	0	10
Gray clay & fine gravel	10	20
Gray clay w/fine to medium gravel	20	35
Clay & sand w/medium gravel	35	45
Sand & medium gravel w/clay	45	50
Fine to medium gravel w/clay	50	55
Sand w/fine to medium gravel	55	70
Sand w/fine to medium gravel (shale fragments)	70	75
Shale	75	80
CROSS SECTION 11		
T. D. - 2		
Yellow clay and fine gravel	0	5
(Sample missing)	5	10
Clay, sand and fine to medium gravel	10	15
Coarse sand to medium gravel	15	20
Fine to coarse gravel w/sand	20	30
Fine to coarse gravel	30	35
Coarse gravel w/some fine gravel	35	40
Fine to coarse gravel	40	45
Coarse sand to medium gravel	45	50
Fine to medium gravel w/little coarse	50	55
Fine to medium gravel	55	60
Fine gravel w/little medium gravel	60	65
Fine to medium gravel	65	70
Sand and fine gravel	70	75
Sand and fine gravel w/some medium gravel	75	80
Sand and fine gravel	80	85
Sand w/medium to coarse gravel	85	90
Coarse sand to coarse gravel	90	95
Coarse sand to medium gravel	95	100
Coarse sand and fine gravel	100	105
Fine to coarse gravel w/some coarse sand	105	110
Fine to medium gravel	110	115
Coarse sand to coarse gravel	115	120
Sand w/little medium & coarse gravel	120	125
Sand w/clay and medium gravel	125	130
Sand and limey clay w/fine gravel	130	135
Sand and limey clay w/medium gravel	135	150
Sand and limey clay w/fine gravel	150	155
Sand and limey clay w/fine to medium gravel	155	160
Sand and limey clay w/fine to coarse gravel	160	165
Sand and fine gravel w/shale @ 168'	165	170
CROSS SECTION 11		
T. D. - 3		
Brown clay w/fine gravel	0	5
Sand & medium gravel	5	30
Coarse sand to medium gravel	30	35
Medium sand to coarse gravel	35	40
Fine to medium gravel	40	45
Coarse sand to medium gravel	45	50
Coarse sand to coarse gravel	50	55
Medium sand to medium gravel	60	65
Coarse sand to medium gravel	65	70
Coarse sand and fine gravel	70	75
Coarse sand to medium gravel	75	80
Coarse sand and fine gravel	80	85
Sand w/fine gravel	85	90
Sand and fine to medium gravel	90	95
(Sample missing)	95	100
Coarse and fine gravel	100	110
Fine to medium gravel	110	115
Coarse sand and fine gravel	115	125
Coarse sand and fine gravel w/shale	125	130
Coarse sand and fine gravel w/ shale	130	135
CROSS SECTION 11		
T. D. - 4		
Clay and rock	0	6
Large gravel w/fine sand	6	108
Shale	108	110

CROSS SECTION 11	From	To
T. D. - 5		
Clay w/gravel	0	5
Clay w/gravel	15	30
Gravel w/fine sand & clay	30	121
Shale	121	125
CROSS SECTION 11		
T. D. - 6		
Fill	0	9
Clay w/gravel	9	20
Gravel w/fine sand	20	110
Clay	110	118
Shale	118	120
CROSS SECTION 11		
T. D. - 7		
Clay w/few large gravel	0	20
Gravel w/fine sand	20	65
Clay w/gravel	65	96
Shale	96	100
CROSS SECTION 13		
T. D. - 1		
Brown clay	0	5
Brown clay w/medium to coarse gravel	5	10
Fine to coarse gravel	10	25
Fine to medium gravel	25	30
Fine gravel	30	35
Fine to coarse gravel	35	45
Coarse sand w/some medium gravel	45	50
Fine to medium gravel	50	55
Coarse sand w/some medium gravel	55	70
Coarse sand	70	75
Coarse sand to medium gravel	75	80
Coarse sand w/medium gravel & shale fragments	80	85
Shale @ 82'		
CROSS SECTION 13		
T. D. - 2		
Brown clay	0	5
Fine to medium gravel	5	10
Fine to medium gravel w/little coarse gravel	10	15
Fine to coarse gravel	15	20
Fine to medium gravel	20	30
Fine gravel	30	35
Fine gravel w/some medium gravel	35	45
Fine to coarse gravel	45	55
Fine to medium gravel	55	60
Fine to coarse gravel	60	70
Fine to medium gravel	70	80
Fine to coarse gravel	80	85
Fine to medium gravel w/some sand	85	110
Shale @ 111'	110	115
CROSS SECTION 13		
T. D. - 3		
Brown clay, some sand & gravel	0	10
Gravel, medium-coarse & sand, coarse, some clay	10	30
Gravel, fine-medium some coarse	30	35
Sand, medium-coarse & gravel, fine	35	40
Gravel, fine-coarse & sand, coarse	40	45
Gravel, fine, name medium, & sand, coarse	45	50
Gravel, fine-medium, some coarse	50	60
Gravel, fine-medium, some sand, coarse	60	80
Clay, gray, some sand, coarse	80	85
Clay, gray, & sand, medium-coarse	85	90
Clay, gray & gravel, fine, some sand coarse	90	95
Gray clay & black shale	95	110
Shale - 95'		
CROSS SECTION 13		
T. D. - 4		
Fine to medium gravel	0	5
Fine to coarse gravel	5	20
Fine to medium gravel	20	25
Fine to medium gravel w/clay	25	30
Fine gravel	30	35
Fine to medium gravel w/clay	35	40
Sand and medium gravel	40	45
Coarse sand to fine gravel	45	50
Fine gravel	55	55
Fine to coarse gravel	05	60
Coarse sand to medium gravel	60	65
Fine gravel	65	75
Coarse sand & fine gravel	75	85
Sand and fine gravel	55	90
Course sand and fine gravel	90	105
Fine to medium gravel	105	115
Medium gravel w/some fine gravel	115	120
Soft gray shale w/medium gravel	120	125
Soft gray shale	125	130

CROSS SECTION 13	From	To
T. D. - 5		
Brown clay sandy, gravelly	0	5
Clay, gravelly & cobbles	5	10
Gravel fine-coarse & cobbles	10	25
Gravel, fine-medium, some coarse & sand, coarse	25	45
Sand, medium-coarse & gravel, fins, some medium-coarse	45	50
Gravel, medium-coarse, some fine, some sand, coarse	50	65
Sand, coarse & gravel, fine-medium	65	75
Gravel, fine-coarse, some sand, coarse	75	90
Sand, fine-coarse, some gravel, fine	90	95
Gray clay & shale, some sand, coarse	95	100
Gray clay & shale	100	105
Shale - 98' - 155'		
CROSS SECTION 13		
T. D. - 6		
Brown clay	0	10
Brown clay, sand & medium gravel	10	15
Brown clay, fine to medium gravel	15	20
Sand & fine gravel	20	25
Fine to coarse gravel	25	30
Coarse sand - fine gravel	30	40
Gray clay w/fine gravel	40	65
Clay, sand & fine gravel	65	70
Coarse sand & fine gravel	70	75
Fine to medium gravel	75	85
Fine gravel w/brown clay	85	90
Sand, clay and little gravel	90	95
Fine to medium gravel w/clay	95	105
Fine to medium gravel w/black shale fragments	105	110
CROSS SECTION 13		
T. D. - 7		
Brown clay	0	10
Clay, sand & gravel	10	15
(Sample missing)	15	20
Coarse sand to coarse gravel	20	35
Gray clay w/coarse sand & coarse gravel	35	45
Gray clay w/coarse sand	45	50
Gray clay w/coarse sand and medium gravel	50	55
Gray clay w/coarse sand	55	60
Gray clay w/fine to medium gravel	60	80
Fine to medium gravel	80	90
Sand and fine gravel	90	95
Sand and fine to medium gravel	95	l15
Greenish-gray clay w/fine gravel	115	120
Fine gravel w/clay	120	125
Fine to medium gravel w/little clay	125	135
Green clay w/little fine gravel	135	140
Fine to medium gravel w/shale	140	145
Shale	145	148
CROSS SECTION 13		
T. D. - 8		
Brown clay	0	5
Brown clay, sandy	5	10
Clay, sand, & gravel, fine-coarse	10	15
Gravel, medium-coarse, some fine	15	20
Gravel, fine-coarse, cobbles	20	25
Gravel, fine-coarse & sand, coarse	25	45
Gray clay & sand, coarse	45	50
Gray clay, gravel	50	60
Gray clay & sand, coarse	60	65
Yellow & gray clay, gravely	65	70
Gray clay & sand coarse, some fine gravel	70	85
Gravel, fine-coarse & sand, medium-coarse	85	95
Sand, medium-coarse, some fine, some gravel	90	105
Gravel, fine-coarse, some sand, coarse	105	125
Gray clay, gravelly	125	155
Gray clay & shale	155	160
Shale	160	165
(Weathered shale 135±')		
(Solid Bedrock 160' - 165')		
CROSS SECTION 14		
T. D. - 2		
Brown clay	0	5
Clay w/fine to coarse	5	10
Coarse sand to medium gravel	10	15
Fine to coarse gravel	15	25
Coarse sand to medium gravel	25	30
Coarse sand w/little gravel	30	35
Course sand to medium gravel	35	60
Sand and fine gravel	60	65
Coarse sand to medium gravel	65	70
Sand and medium gravel	70	85
Sand and coarse gravel	85	90
Sand and medium gravel	90	95
Fine to medium gravel	95	100
Sand and medium gravel	100	110
Sand w/some medium gravel	110	115
Sand and medium gravel/with shale fragments	115	120
Clay and shale	120	125
Shale	125	130

CROSS SECTION 14	From	To
T. D. - 3		
Brown clay	0	5
Clay and medium gravel	5	10
Sand and medium gravel	10	15
Coarse sand to medium gravel	15	20
Coarse sand to coarse gravel	20	25
Coarse gravel w/little sand	25	30
Medium to coarse sand	30	35
Coarse sand to medium gravel	35	45
Coarse sand and fine gravel	45	50
Coarse sand to medium gravel	50	55
Coarse sand to coarse gravel	55	60
Coarse sand to medium gravel	60	70
Sand and fine gravel	70	75
Sand and fine to medium gravel	75	80
Sand, limey clay and shale fragments	80	85
Sand, clay and gray shale @ 83'	85	90
CROSS SECTION 15		
T. D. - 1		
Clay w/coarse to medium gravel	0	5
Clay w/medium gravel	5	10
Fine to coarse gravel w/little sand	10	20
Sand w/medium gravel	20	25
Coarse gravel w/little sand	25	30
Medium sand w/clay	30	35
Sand w/fine gravel	30	45
Sand w/medium gravel	45	60
Fine to coarse sand w/medium gravel	60	60
Medium sand and gravel	65	70
Limey clay w/shale fragments	70	75
Shale (71' - 80')		

CROSS SECTION 15	From	To
T. D. - 2		
Yellow clay and gravel	0	5
Medium gravel	5	10
Fine to coarse gravel	10	15
Medium sand to coarse gravel	15	30
Coarse sand w/gravel	30	45
Fine to coarse sand w/gravel	45	50
Coarse sand w/gravel	50	55
Fine to coarse sand w/gravel	55	70
Medium to coarse sand w/gravel	70	75
Coarse gravel w/sand	75	80
Medium to coarse gravel w/sand	80	90
Sand w/medium gravel	90	95
Limey clay w/shale fragments	95	100
Shale	100	120
CROSS SECTION 15		
T. D. - 3		
Yellow clay	0	10
Medium to coarse gravel	10	15
Clay, sand, and gravel	15	20
Coarse sand to medium gravel	20	35
Fine to coarse sand	35	40
Coarse sand w/coarse gravel	40	45
Coarse sand w/medium gravel	45	55
Sand and medium gravel	55	80
Sand and fine gravel	80	85
Sand and medium gravel	85	105
Shale	105	108

III. TEST AUGERING LOGS (Depths shown in feet)

Log numbers correspond to those shown on plates 1-a, b and c, and on cross sections numbered 16 through 21, (pages 12 and13).

CROSS SECTION 16	From	To
T. A. - 22		
Sand and clay, brown	0	8.9
Sand and gravel, brown	8.9	12.7
Gravel and sand, brown	12.7	42.7
Gravel, gray	42.7	52.7
Sand, gray	52.7	60.7
Sand and gravel, gray	60.7	67.7
Gravel and sand, gray	67.7	72.7
Gravel, gray	72.7	87.0
Shale, gray-black	87.0	87.3
CROSS SECTION 16		
T. A. - 23		
Clay, brown	0	4.8
Sand and gravel, brown	4.8	12.7
Gravel, brown	12.7	32.7
Sand and gravel, gray	32.7	37.7
Sand, gray	37.7	57.7
Sand and gravel, gray	57.7	62.7
Gravel, gray	62.7	66.5
Shale, gray-black	66.5	67.0
CROSS SECTION 16		
T. A. - 24		
Clay, silt, sand, brown	0	2.7
Clay and silt, brown	2.7	11.6
Gravel, brown	11.6	52.5
Sand, gray	52.5	62.4
Shale, black-gray	62.4	62.7
CROSS SECTION 16		
T. A. - 25		
Sand, clay, silt, brown	0	2.7
Sand, brown	2.7	9.4
Sand and gravel, brown	9.4	12.7
Gravel, brown	12.7	18.6
Sand, brown	18.6	32.7
Sand, brown-gray	32.7	55.2
Gravel and sand, gray	55.2	57.7
Sand and gravel, gray	57.7	57.8
Shale, gray	57.8	88.4
CROSS SECTION 16		
T. A. - 26		
Sand, silt, clay, brown	0	2.7
Sand, brown	2.7	5.4
Gravel and sand, brown	5.4	12.7
Gravel, brown	12.7	42.7
Gravel and sand, brown	42.7	47.7
Sand and gravel, brown	47.7	52.7
Sand, gray	52.7	64.0
Shale, gray-black	64.0	64.5

CROSS SECTION 16	From	To
T. A. - 27		
Silt and sand, brown	0	2.8
Sand and silt, brown	2.8	7.8
Sand, brown	7.8	13.0
Sand and gravel, brown	13.0	17.8
Gravel and sand, brown	17.8	22.8
Gravel, brown	22.8	27.8
Sand, brown	27.8	42.8
Sand, gray-brown	42.8	47.8
Sand, gray	47.8	82.3
Shale, gray	82.3	82.6
PIKE COUNTY, PEE PEE TWP.		
T. A. - 35		
Clay and silt, brown	0	8.1
Clay and silt, black-gray	8.1	16.4
Sand, brown	16.4	18.1
Sand and gravel, brown	18.1	38.1
Gravel, brown	38.1	48.1
Gravel and sand, brown	48.1	53.1
Gravel and sand, gray	53.1	58.1
Sand and gravel, gray	58.1	69.1
Gravel	69.1	73.1
Shale, gray	73.1	73.6
PIKE COUNTY. PEE PEE TWP.		
T. A. - 37		
Clay and silt, brown-black	0	13.0
Clay, silt, and sand, gray-black	13.0	15.0
Wood, yellow-white	15.0	15.6
Gravel, gray	15.6	19.0
Sand, clay, silt, gravel	19.0	23.0
Sand and gravel, brown	23.0	48.0
Gravel and sand, gray	48.0	53.0
Sand and gravel, gray	53.0	58.0
Gravel and sand, gray	58.0	63.0
Clay, gray	63.0	69.7
Shale, gray	69.7	70.1
PIKE COUNTY, PEE PEE TWP.		
T. A. - 38		
Clay, silt, sand, brown	0	3.5
Sand, brown	3.5	15.5
Sand and gravel, brown	15.5	18.5
Gravel and sand, brown	18.5	23.5
Gravel, brown	23.5	33.5
Gravel, brown-gray	33.5	38.5
Gravel and sand, brown-gray	38.5	48.5
Sand, gray	48.5	49.5
Shale, gray	49.5	50.0

PIKE COUNTY, PEE PEE TWP.	From	To -
T. A. - 39		
Clay, sand, silt, brown	0	3.0
Sand, brown	3.0	12.5
Sand and gravel, brown	12.5	17.0
Wood, yellow-white	17.0	18.5
Gravel and sand, brown	18.5	23.0
Gravel, brown	23.0	28.0
Gravel and sand, brown	28.0	33.0
Sand, gray	33.0	43.0
Gravel, gray	43.0	44.6
Sand, gray	44.6	50.2
Shale, gray	50.2	50.6
PIKE COUNTY, PEE PEE TWP.		
T. A. - 40		
Clay, sand, silt, brown	0	6.0
Sand, brown	6.0	12.0
Clay and sand, brown	12.0	18.4
Sand, gravel, clay, silt	18.4	23.0
Gravel and sand, brown	23.0	38.0
Gravel and sand, brown-gray	38.0	43.0
Sand and gravel, gray	43.0	52.1
Shale, gray	52.1	53.3
PIKE COUNTY, SEAL TWP.		
T. A. - 42		
Clay, silt, sand, brown	0	3.0
Clay and silt	3.0	8.0
Clay, silt and sand, brown	8.0	13.0
Clay, silt and sand, gray	13.0	14.5
Sand, brown	14.5	43.0
Sand, brown-gray	43.0	48.0
Sand, gray	48.0	68.0
Sand and gravel, gray	68.0	73.0
Gravel and sand, gray	73.0	77.3
Shale, gray	77.3	77.7
PIKE COUNTY, SEAL TWP.		
T. A. - 43		
Clay and silt, brown	0	2.9
Clay and silt, brown-gray	2.9	12.9
Sand, brown	12.9	42.9
Sand, gray	42.9	67.9
Clay	67.9	70.7
Shale, gray	70.7	71.1
PIKE COUNTY, SEAL TWP.		
T. A. - 44		
Clay and silt, brown	0	8.0
Sand, brown	8.0	28.0
Sand, brown-gray	28.0	43.0
Sand, gray	43.0	48.0
Sand and gravel, gray	48.0	53.4
Shale, gray	53.4	53.7

PIKE COUNTY, SEAL TWP.	From	To
T. A. - 45		
Clay and silt, brown	0	15.0
Gravel, sand, clay and silt	15.0	28.0
Sand and gravel, brown	28.0	38.0
Sand and gravel, gray	38.0	43.0
Sand, gray	43.0	58.7
Gravel, gray	58.7	62.0
Gravel and sand, gray	62.0	82.0
Shale, gray	82.0	82.4
CROSS SECTION 17		
T. A. - 18		
Clay, silt and sand, gray-black	0	4.0
Sand, brown	4.0	17.0
Gravel and sand, brown	17.0	22.7
Gravel, brown-gray	22.7	37.7
Gravel, gray	37.7	52.7
Gravel and sand, gray	52.7	67.7
Gravel, gray	67.7	81.6
Shale, gray	81.6	82.0
CROSS SECTION 17		
T. A. - 19		
Sand, brown	0	5.8
Sand and gravel, brown	5.8	12.9
Gravel and sand, brown	12.9	27.9
Gravel, brown-gray	27.9	42.9
Gravel and sand, brown-gray	42.9	47.9
Sand, gray	47.9	64.1
Shale, gray	64.1	64.4
CROSS SECTION 17		
T. A. - 20		
Clay, sand, silt, brown	0	7.7
Clay, Sand, silt, brown-gray	7.7	10.4
Clay, sand, gravel, silt, brown	10.4	12.7
Gravel and sand, brown	12.7	22.7
Gravel and sand, brown-gray	22.7	32.7
Sand, gray	32.7	50.0
Gravel and sand, gray	50.0	65.8
Shale, gray	65.8	66.2
CROSS SECTION 17		
T. A. - 21		
Sand, brown	0	2.7
Gravel, brown	2.7	7.7
Gravel and sand, brown	7.7	12.7
Sand, brown	12.7	17.7
Clay, sand, gravel, silt	17.7	22.7
Sand, gravel and clay, brown	22.7	27.7
Sand, brown-gray	27.7	32.7
Sand, gray	32.7	69.4
Gravel and sand, gray	69.4	78.3
Shale, gray	78.3	78.5
CROSS SECTION 18		
T. A. - 14		
Clay, silt, sand, brown	0	5.0
Sand, brown	5.0	8.4
Sand and gravel, brown	8.4	12.7
Gravel, brown	12.7	27.7
Gravel, brown-gray	27.7	32.7
Gravel and sand, gray	32.7	37.7
Sand, gray	37.7	42.0
Sand and gravel, gray	42.5	47.5
Gravel and sand, gray	47.5	51.7
Gravel, gray	51.7	58.9
Gravel and sand, brown	58.9	61.6
Shale, gray-black	61.6	63.0
CROSS SECTION 18		
T. A. - l5		
Clay and silt, brown	0	4.0
Sand, brown	4.0	5.5
Clay, silt and sand, brown	5.5	8.1
Gravel and sand, brown	8.1	22.7
Gravel brown	22.7	27.7
Sand and gravel, brown-gray	27.7	32.7
Sand, gray	32.7	37.7
Sand and gravel, gray	37.7	62.7
Gravel and sand, gray	62.7	73.3
Shale, gray-black	73.3	73.6
CROSS SECTION 18		
T. A. - 16		
Clay and silt, brown	0	13.0
Gravel, clay, silt and clay	13.0	17.7
Sand, brown	17.7	27.7
Sand, brown-gray	27.7	32.7
Sand, gray	32.7	47.7
Sand and gravel, gray	47.7	61.1
Shale, gray-black	61.1	61.8

CROSS SECTION 18	From	To
T. A. - 17		
Clay and silt, brown	0	15.0
Gravel and clay, brown	15.0	17.7
Sand, brown	17.7	32.7
Sand and gravel, brown-gray	32.7	37.7
Gravel, brown-gray	37.7	42.7
Gravel and sand, gray	42.7	57.7
Gravel, gray	57.7	67.2
Shale	67.2	68.5
CROSS SECTION 19		
T. A. - 10		
Sand, clay, silt, brown	0	5.5
Sand, brown	5.5	12.7
Sand and gravel, brown	12.7	17.1
Gravel, brown	17.1	18.7
Gravel and sand, brown	18.7	27.7
Gravel and sand, brown_ gray	27.7	32.7
Sand and gravel, gray	32.7	37.7
Sand, gray	37.7	66.9
Gravel, gray	66.9	70.8
Shale	70.8	71.6
CROSS SECTION 19		
T. A. - 11		
Sand, clay, silt, brown	0	2.7
Clay, silt, sand	2.7	15.4
Sand, gravel, clay, silt	15.4	17.7
Sand and gravel, brown	17.7	22.7
Gravel and sand, brown	22.7	37.7
Sand and gravel, brown	37.7	42.1
Gravel and sand, brown	42.1	43.6
Sand and gravel, brown-gray	43.6	61.0
Gravel, gray	61.0	66.8
Shale	66.8	67.3
CROSS SECTION 19		
T. A. - 12		
Clay, silt, sand, brown	0	6.0
Sand, brown	6.0	7.7
Gravel and sand, brown	7.7	17.7
Gravel, brown	17.7	32.7
Gravel, gray-brown	32.7	37.7
Gravel and sand, gray	37.7	42.7
Sand and gravel, gray	42.7	47.7
Sand, gray	47.7	51.7
Gravel, gray	51.7	51.9
Shale	51.9	52.5
CROSS SECTION 19		
T. A. - 13		
Clay and silt, brown	0	10.6
Clay, silt, sand and gravel	10.6	12.7
Gravel, clay, sand and silt	12.7	17.7
Gravel, brown	17.7	27.1
Rock	27.1	27.6
CROSS SECTION 20		
T. A. - 5		
Fill	0	4.0
Sand, brown	4.0	5.5
Clay and silt, brown	5.5	7.2
Sand and silt layers	7.2	12.4
Sand, brown	12.4	14.8
Sand and gravel, brown	14.8	17.2
Gravel, brown	17.2	27.2
Gravel and sand, brown	27.2	32.2
Sand and gravel, gray	32.2	47.2
Sand, gray	47.2	64.0
Sand and gravel, gray	64.0	67.7
Rock	67.7	68.2
CROSS SECTION 20		
T. A. - 6		
Clay and silt, brown	0	13.1
Gravel and clay	13.1	22.7
Gravel and sand, brown	22.7	32.7
Sand, gray	32.7	52.7
Sand and gravel, gray	52.7	57.7
Gravel and sand, gray	57.7	67.7
Shale	67.7	69.0
CROSS SECTION 20		
T. A. - 7		
Clay and silt, brown	0	6.0
Sand, brown	6.0	8.0
Gravel, brown	8.0	14.6
Rock	14.6	14.8
Clay and silt, brown-gray	14.8	17.2
Clay and silt, gray	17.2	17.8
Rock	17.8	18.0
Clay and gravel, brown	18.0	20.7
Rock, yellow-brown	20.7	21.0

CROSS SECTION 20	From	To
T. A. - 8		
Clay and silt, brown	0	2.0
Gravel	2.0	3.0
Clay and silt, gray-brown	3.0	5.8
Rock	5.8	6.0
Clay and silt, brown	6.0	8.7
Rock	8.7	8.8
Clay and silt, brown	8.8	9.1
Rock	9. 1	9.2
Clay, brown	9.2	9.6
Rock	9.6	10.6
CROSS SECTION 20		
T. A. - 9		
Clay and silt, brown	0	2.3
Clay, silt and sand, brown	2.3	8.1
Sand, brown	8.1	12.3
Gravel, brown	12.3	17.3
Gravel and sand, brown	17.3	22.3
Sand, gray-brown	22.3	36.6
Gravel, gray	36.6	39.1
Rock	39.1	40.6
CROSS SECTION 21		
T. A. - 1		
Fill	0	1.0
Clay and silt, gray-black	1.0	2.7
Clay and silt, gray	2.7	11.0
Clay and silt, brown-gray	11.0	13.5
Sand, brown	13.5	22.7
Sand and gravel, brown	22.7	37.7
Gravel and sand, brown	37.7	43.0
Rock	43.0	43.7
CROSS SECTION 21		
T. A. - 2		
Clay and silt, brown	0	20.0
Sand, brown	20.0	42.9
Sand and gravel, brown	42.9	44.0
Gravel and sand, brown	44.0	51.7
Rock, black shale	51.7	52.3
CROSS SECTION 21		
T. A. - 3		
Clay and silt, brown	0	25.0
Sand, brown	25.0	37.7
Sand and gravel, brown	37.7	50.5
Gravel, brown	50.5	53.7
Shale, gray-black	53.7	54.3
CROSS SECTION 21		
T. A. - 4		
Clay and silt, brown	0	9.0
Clay and silt, gray-brown	9.0	17.0
Sand, gray-brown	17.0	18.0
Sand and gravel, brown	18.0	43.0
Shale, blank	43.0	43.3
PICKAWAY COUNTY, CIRCLEVILLE TWP.		
T. A. - 51		
Gravel, clay and silt	0	3.0
Clay, silt, brown	3.0	8.0
Clay, silt, sand, brown	8.0	14.0
Clay and silt, gray	14.0	20.0
Gravel	20.0	23.0
Clay	23.0	25.0
Gravel and clay, brown	25.0	28.0
Gravel and sand	28.0	40.6
Shale, black	40.6	40.8
CROSS SECTION 10		
T. W.		
Clay and silt, brown	0	12.3
Gravel, brown	12.3	27.3
Clay	27.3	28.1
Gravel and clay	28.1	30.1
Clay	30.1	32.3
Sand and gravel	32.3	70.3
Clay, sand and gravel	70.3	93.5
Shale, gray	93.5	93.8

TABLE 3.
CHEMICAL ANALYSES (parts per million)

No.	Location	Township	Date analyzed	Depth (feet)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total Dissolved solids	Total Hardness as $CaCO_3$	Noncarbonate Hardness	Specific conductance (micromhos at 25° C)	pH	Color
Ground-Water Samples Sand and Gravel Wells																					
	FRANKLIN COUNTY																				
1.	Shadeville, 2 miles south	Hamilton	6-53	50	9.4	2.2	0	92	31	2.4	308	93	5	.2	.8	397	356	-	637	7.4	2
	PICKAWAY COUNTY																				
2.	Ashville	Walnut	8-62	151	14	1.8	.1	75	32	15	408	-	3	.4	-	435	320	0	-	7.2	1
3.	Commercial Point, 2 miles east	Scioto	1-54	56	11	1.1	0	98	35	3.3	386	71	7	.1	.1	423	388	72	696	7.4	1
4.	Circleville, 5 miles north	Circleville	1-54	34	16	1.2	.51	96	40	81	485	172	3.6	.3	2.7	642	404	7	992	7.4	2
5.	Circleville, 7 miles south	Pickaway	1-54	67	12	1.9	0	83	32	3	380	33	1.2	.2	0	354	338	27	606	7.5	1
	ROSS COUNTY																				
6.	Yellow Bud, 2 miles southeast	Union	4-64	75	18	2.4	.04	79	40	7	418	15	2	.6	1.1	374	362	19	635	6.6	5
7.	Kingston	Green	10-62	69	15	2.5	.15	102	35	18	494	-	12	.5	-	480	400	0	-	7.6	2
8.	Chillicothe	Scioto	9-62	94	10	.7	.25	89	26	13	317	-	12	.2	-	440	330	70	-	7.7	2
9.	Richmondale, 1 mile northwest	Jefferson	7-53	82	13	4.9	0	40	31	96	296	16	121	.2	4.2	470	228	-	874	7.5	0
	PIKE COUNTY																				
10.	Waverly	Pee Pee	2-63	64	10	.9	.4	103	26	25	362	-	43	0	-	510	366	69	-	7.4	0
11.	Piketon, 3 miles south	Scioto	9-53	58	9	1.9	.26	76	34	4	348	48	3.8	0	.3	348	328	-	597	7.2	0
	SCIOTO COUNTY																				
12.	Lucasville	Valley	3-53	55	10	1.7	.5	71	28	12	270	84	12	.1	0	364	292	-	586	7.4	2
13.	Portsmouth	Clay	4-53	74	10	.12	.5	42	6.3	15	80	72	17	.2	3.1	216	130	-	347	7.1	2
14.	Friendship	Nile	3-65	72	12	.22	.49	52	16	4.9	205	23	10	0	.7	222	196	28	392	7.7	3
Surface Water Samples Scioto River																					
	ROSS COUNTY																				
15.	Yellow Bud, 2 miles south	Union	9-56	-	9.7	.06	-	80	25	38	248	119	32	.6	15	464	302	99	729	7.0	30
	PIKE COUNTY																				
16.	Lucasville	Valley	3-58	-	6.8	.10	.01	56	24	12	181	78	18	.3	8.7	286	238	84	438	8.3	6

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PLATE 3.
MAP OF THE SCIOTO RIVER VALLEY SHOWING LOCATIONS OF PUMPING TESTS AND CHEMICAL ANALYSES

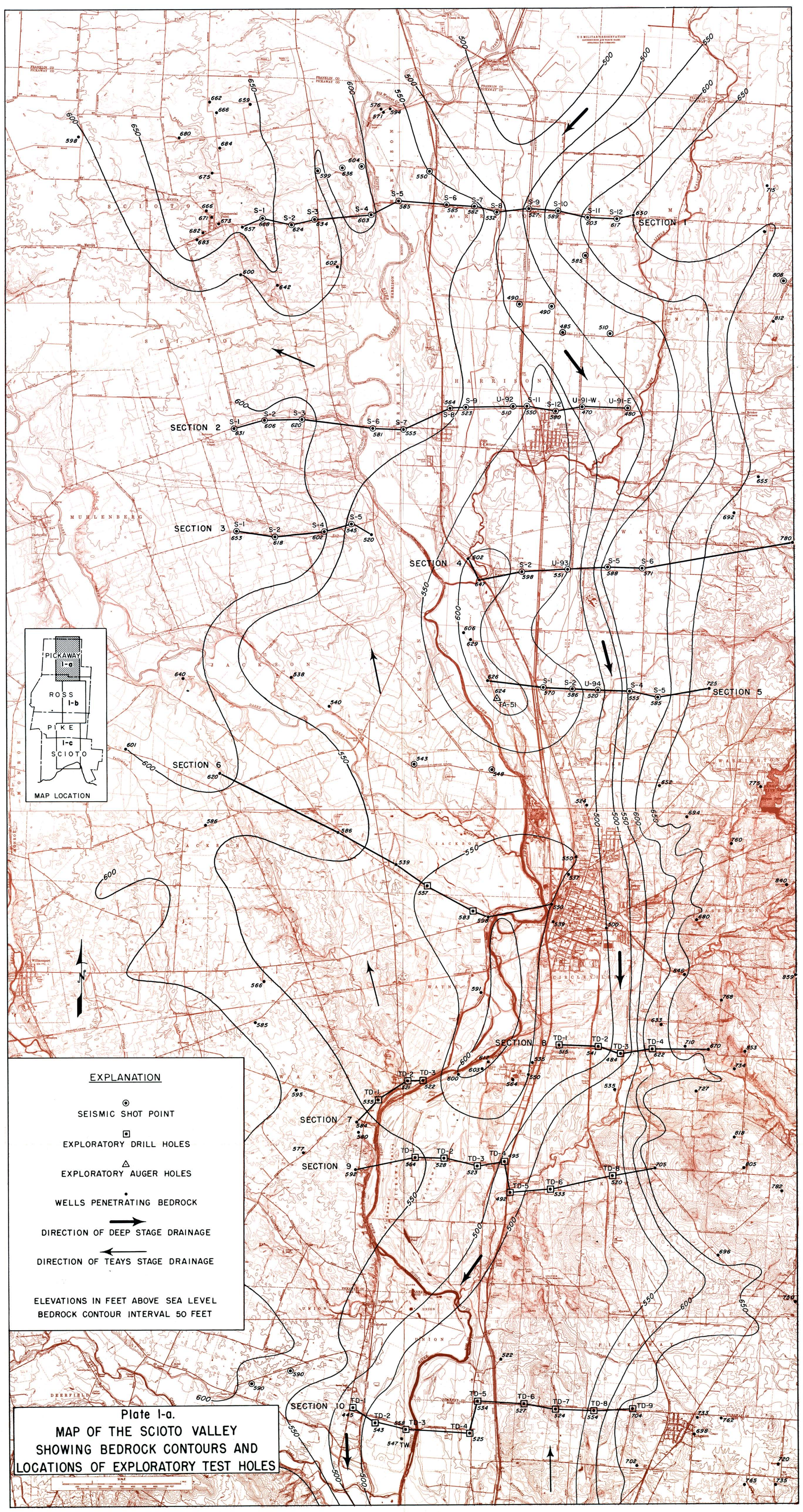

Plate I-a.
MAP OF THE SCIOTO VALLEY
SHOWING BEDROCK CONTOURS AND
LOCATIONS OF EXPLORATORY TEST HOLES

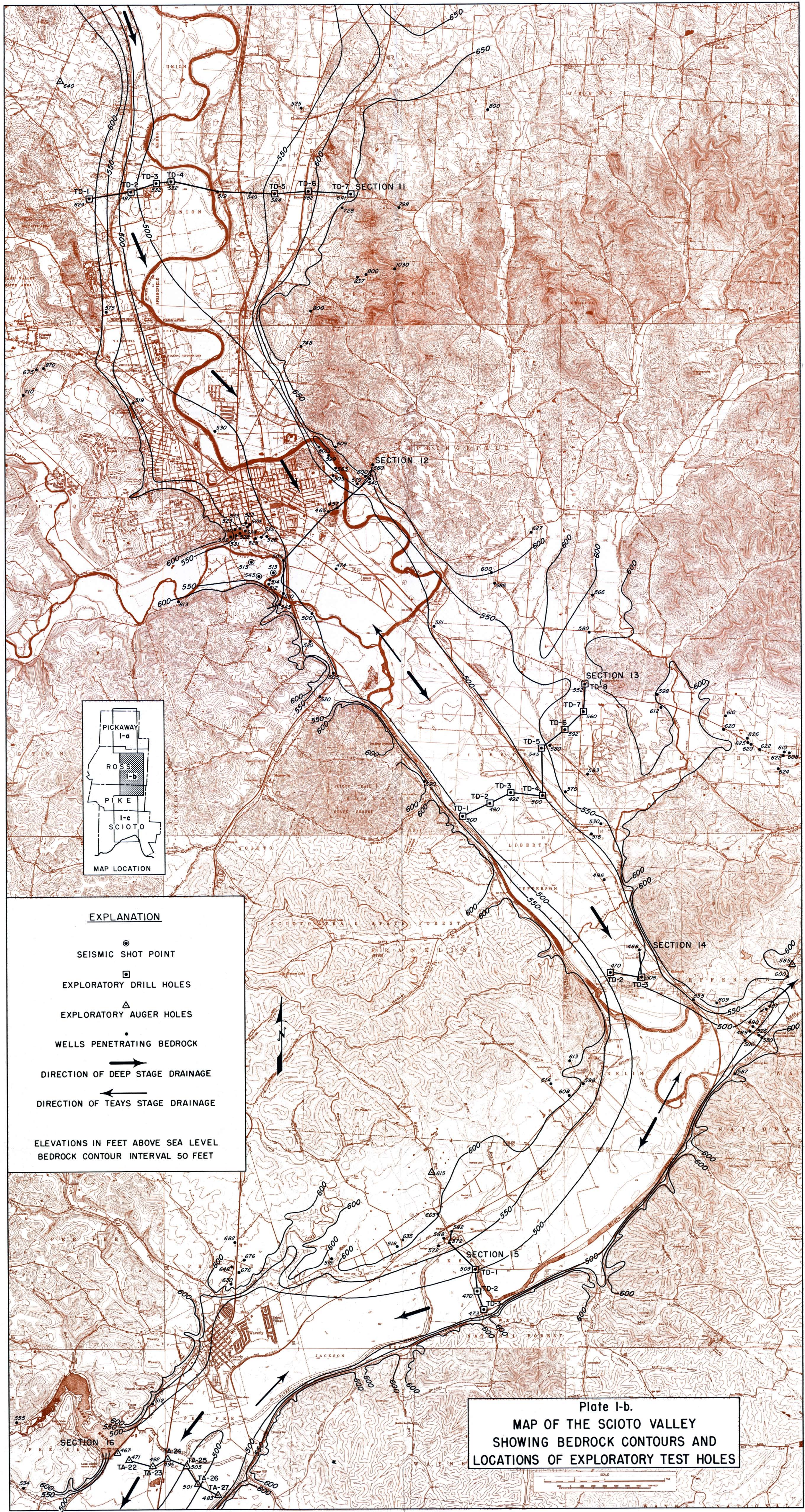

Plate I-b.
MAP OF THE SCIOTO VALLEY
SHOWING BEDROCK CONTOURS AND
LOCATIONS OF EXPLORATORY TEST HOLES

Plate I-c.
MAP OF THE SCIOTO VALLEY
SHOWING BEDROCK CONTOURS AND
LOCATIONS OF EXPLORATORY TEST HOLES