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****** CONFIDENTIAL ******
******PRE-DECISIONAL DOCUMENT ******
****** SUMMARY SCORESHEET ******
****** FOR COMPUTING PROJECTED HRS SCORE ******

****** Do Not Cite or Quote ******

Site Name: Libbey-Owens-Ford

Region: 3

City, County, State: Kanawha County WV

Evaluator: KJP

EPA ID#:

Date: 1/11/2008

Lat/Long: 38 14 40" N / 81 33 50" W

T/R/S:

Congressional District:

This Scoresheet is for: SI

Scenario Name: ERC Scoring 2008

Description: Existing Conditions

	S pathway	S^2 pathway
Ground Water Migration Pathway Score (S_{gw})	0.33	0.1089
Surface Water Migration Pathway Score (S_{sw})	28.4	806.56
Soil Exposure Pathway Score (S_s)	100	10000
Air Migration Score (S_a)	0.0263030303030303	0.00069184940312213
$S^2_{gw} + S^2_{sw} + S^2_s + S^2_a$		10806.6696
$(S^2_{gw} + S^2_{sw} + S^2_s + S^2_a)/4$		2701.6674
$/ (S^2_{gw} + S^2_{sw} + S^2_s + S^2_a)/4$		51.98

υ Pathways not assigned a score (explain):

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TABLE 3-1 --GROUND WATER MIGRATION PATHWAY SCORESHEET

Factor categories and factors	Maximum Value	Value Assigned	
Aquifer Evaluated: Unconsolidated Sand & Gravel			
Likelihood of Release to an Aquifer:			
1. Observed Release	550	0	
2. Potential to Release:			
2a. Containment	10	10	
2b. Net Precipitation	10	6	
2c. Depth to Aquifer	5	5	
2d. Travel Time	35	35	
2e. Potential to Release [lines 2a(2b + 2c + 2d)]	500	460	
3. Likelihood of Release (higher of lines 1 and 2e)	550		460
Waste Characteristics:			
4. Toxicity/Mobility	(a)	10000	
5. Hazardous Waste Quantity	(a)	1	
6. Waste Characteristics	100		3
Targets:			
7. Nearest Well	(b)	5	
8. Population:			
8a. Level I Concentrations	(b)	0	
8b. Level II Concentrations	(b)	0	
8c. Potential Contamination	(b)	10	
8d. Population (lines 8a + 8b + 8c)	(b)	10	
9. Resources	5	5	
10. Wellhead Protection Area	20	0	
11. Targets (lines 7 + 8d + 9 + 10)	(b)		20
Ground Water Migration Score for an Aquifer:			
12. Aquifer Score [(lines 3 x 6 x 11)/82,5000][c]	100		0.334545454545455
Ground Water Migration Pathway Score:			
13. Pathway Score (S_{gw}), (highest value from line 12 for all aquifers evaluated)[c]	100		0.334545454545455

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] Do not round to nearest integer

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TABLE 4-1 --SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET

Factor categories and factors	Maximum Value	Value Assigned	
Watershed Evaluated: Kanawha River			
Drinking Water Threat			
Likelihood of Release:			
1. Observed Release	550	550	
2. Potential to Release by Overland Flow:			
2a. Containment	10	10	
2b. Runoff	10	25	
2c. Distance to Surface Water	5	25	
2d. Potential to Release by Overland Flow [lines 2a(2b + 2c)]	35	500	
3.Potential to Release by Flood:			
3a. Containment (Flood)	10	10	
3b. Flood Frequency	50	25	
3c. Potential to Release by Flood (lines 3a x 3b)	500	250	
4. Potential to Release (lines 2d + 3c, subject to a maximum of 500)	500	500	
5. Likelihood of Release (higher of lines 1 and 4)	550		550
Waste Characteristics:			
6. Toxicity/Persistence	(a)	10000	
7. Hazardous Waste Quantity	(a)	100	
8. Waste Characteristics	100		32
Targets:			
9. Nearest Intake	50	0	
10. Population:			
10a. Level I Concentrations	(b)		
10b. Level II Concentrations	(b)	0	
10c. Potential Contamination	(b)	10	
10d. Population (lines 10a + 10b + 10c)	(b)	10	
11. Resources	5	5	
12. Targets (lines 9 + 10d + 11)	(b)		15
Drinking Water Threat Score:			
13. Drinking Water Threat Score [(lines 5x8x12)/82,500, subject to a max of 100]	100		3.2
Human Food Chain Threat			
Likelihood of Release:			
14. Likelihood of Release (same value as line 5)	550		550
Waste Characteristics:			
15. Toxicity/Persistence/Bioaccumulation	(a)	50000000	
16. Hazardous Waste Quantity	(a)	100	
17. Waste Characteristics	1000		180
Targets:			
18. Food Chain Individual	50	10	
19. Population			
19a. Level I Concentration	(b)	0	
19b. Level II Concentration	(b)	0	
19c. Potential Human Food Chain Contamination	(b)	1	
19d. Population (lines 19a + 19b + 19c)	(b)	1	
20. Targets (lines 18 + 19d)	(b)		11
Human Food Chain Threat Score:			
21. Human Food Chain Threat Score [(lines 14x17x20)/82500, subject to max of 100]	100		13.2
Environmental Threat			
Likelihood of Release:			
22. Likelihood of Release (same value as line 5)	550		550
Waste Characteristics:			
23. Ecosystem Toxicity/Persistence/Bioaccumulation	(a)	50000000	
24. Hazardous Waste Quantity	(a)	100	
25. Waste Characteristics	1000		180

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Targets:			
26. Sensitive Environments			
26a. Level I Concentrations	(b)	0	
26b. Level II Concentrations	(b)	0	
26c. Potential Contamination	(b)	10	
26d. Sensitive Environments (lines 26a + 26b + 26c)	(b)	10	
27. Targets (value from line 26d)	(b)		10
Environmental Threat Score:			
28. Environmental Threat Score [(lines 22x25x27)/82,500 subject to a max of 60]	60		12
Surface Water Overland/Flood Migration Component Score for a Watershed			
29. Watershed Score[c] (lines 13+21+28, subject to a max of 100}	100		28.4
Surface Water Overland/Flood Migration Component Score			
30. Component Score (S_{sw})[c] (highest score from line 29 for all watersheds evaluated)	100		28.4

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] Do not round to nearest integer

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TABLE 5-1 --SOIL EXPOSURE PATHWAY SCORESHEET

Factor categories and factors	Maximum Value	Value Assigned	
Likelihood of Exposure:			
1. Likelihood of Exposure	550		550
Waste Characteristics:			
2. Toxicity	(a)	10000	
3. Hazardous Waste Quantity	(a)	100	
4. Waste Characteristics	100		32
Targets:			
5. Resident Individual	50	50	
6. Resident Population:			
6a. Level I Concentrations	(b)	9000	
6b. Level II Concentrations	(b)	0	
6c. Population (lines 6a + 6b)	(b)	9000	
7. Workers	15	5	
8. Resources	5	0	
9. Terrestrial Sensitive Environments	(c)	0	
10. Targets (lines 5 + 6c + 7 + 8 + 9)	(b)		9055
Resident Population Threat Score			
11. Resident Population Threat Score (lines 1 x 4 x 10)	(b)		159368000
Nearby Population Threat			
Likelihood of Exposure:			
12. Attractiveness/Accessibility	100	25	
13. Area of Contamination	100	20	
14. Likelihood of Exposure	500		5
Waste Characteristics:			
15. Toxicity	(a)	10000	
16. Hazardous Waste Quantity	(a)	100	
17. Waste Characteristics	100		10
Targets:			
18. Nearby Individual	1	1	
19. Population Within 1 Mile	(b)	9000	
20. Targets (lines 18 + 19)	(b)		1.47
Nearby Population Threat Score			
21. Nearby Population Threat (lines 14 x 17 x 20)	(b)		73.5
Soil Exposure Pathway Score:			
22. Pathway Score[d] (S_s), [lines (11+21)/82,500, subject to max of 100]	100		100

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] No specific maximum value applies to factor. However, pathway score based solely on terrestrial sensitive environments is limited to a maximum of 60
[d] Do not round to nearest integer

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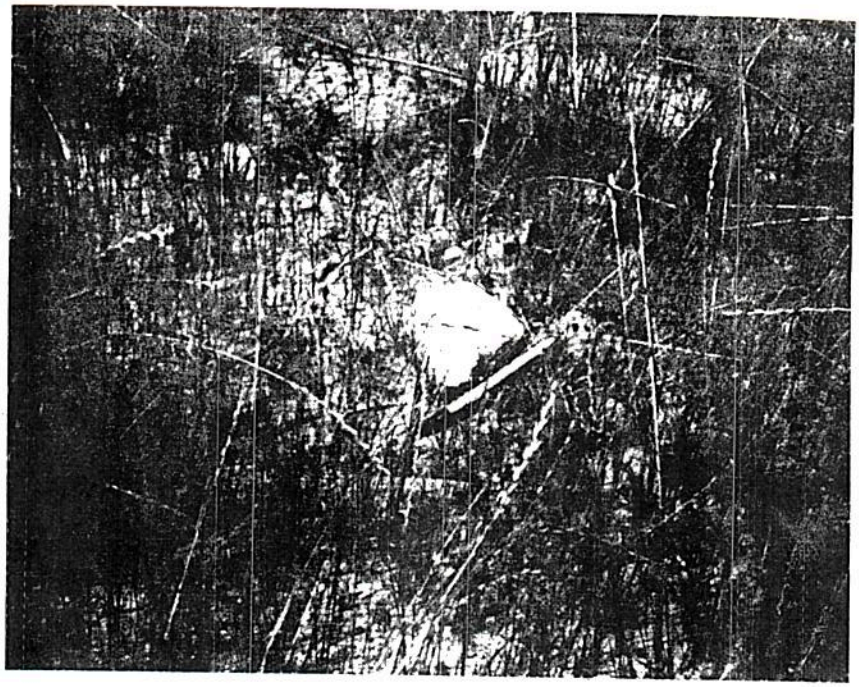

Photo 9 - Waste material as pointed out by Tom Koralewski of Libbey Owens Ford.

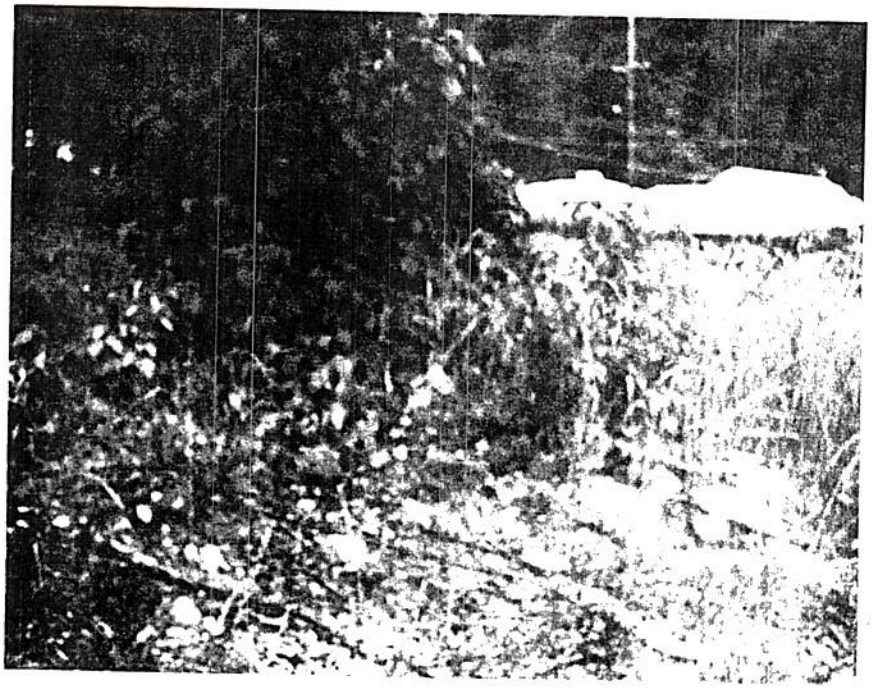

Photo 10 - Old waste pile of bricks, potentially from old stacks.

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Photo 11 - Tiles on hillside to stop leachate from waste area no. 2, leading to the Kanawha River.

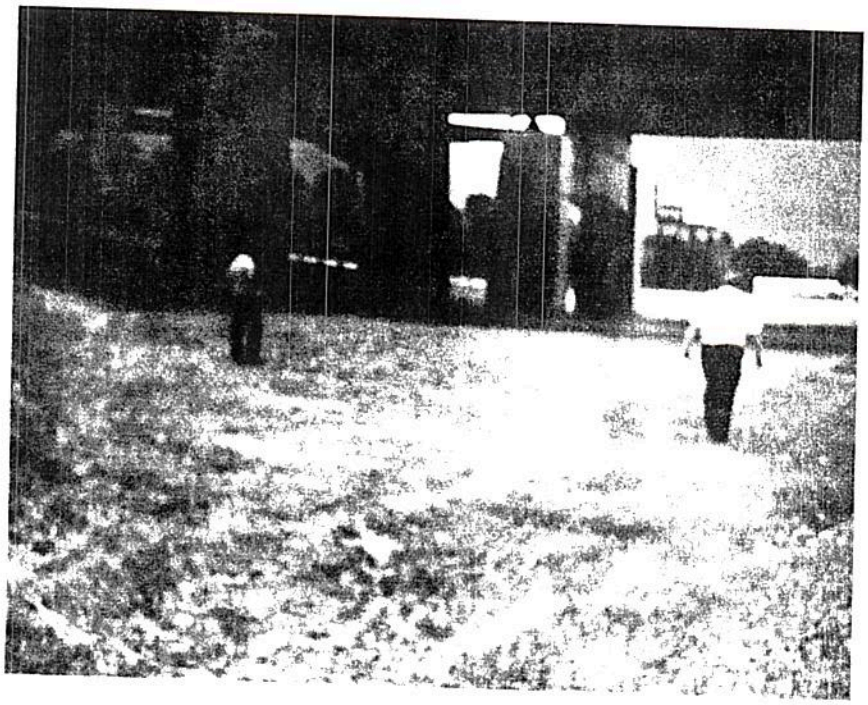

Photo 12 - Location of the largest area of disposal area no. 3.

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F3-8405-39

EPA POTENTIAL HAZARDOUS WASTE SITE IDENTIFICATION AND PRELIMINARY ASSESSMENT

REGION	SITE NUMBER (to be assigned by Hq)
III	WV-128

NOTE: This form is completed for each potential hazardous waste site to help set priorities for site inspection. The information submitted on this form is based on available records and may be updated on subsequent forms as a result of additional inquiries and on-site inspections.

GENERAL INSTRUCTIONS: Complete Sections I and III through X as completely as possible before Section II *(Preliminary Assessment)*. File this form in the Regional Hazardous Waste Log File and submit a copy to: U.S. Environmental Protection Agency; Site Tracking System; Hazardous Waste Enforcement Task Force *(EN-335)*; 401 M St., SW; Washington, DC 20460.

I. SITE IDENTIFICATION

A. SITE NAME: Libbey Owens Ford

B. STREET *(or other identifier)*: 57th Street and MacCorkle Avenue

C. CITY: Charleston

D. STATE: WV

E. ZIP CODE: 25304

F. COUNTY NAME: Kanawha

G. OWNER/OPERATOR *(if known)*

1. NAME: Libbey Owens Ford Company

2. TELEPHONE NUMBER: (419) 247-4339

H. TYPE OF OWNERSHIP

☐ 1. FEDERAL ☐ 2. STATE ☐ 3. COUNTY ☐ 4. MUNICIPAL ☒ 5. PRIVATE ☐ 6. UNKNOWN

I. SITE DESCRIPTION The area was used as a manufacturing plant for glass production. Three areas were used for the disposal of waste batch material. Area No. 1 is located behind the on-site smoke stacks. Area Nos. 2 and 3 are located across from MacCorkle Avenue on the bank of the Kanawha Riv

J. HOW IDENTIFIED *(i.e., citizen's complaints, OSHA citations, etc.)*: Erris Listing

K. DATE IDENTIFIED *(mo., day, & yr.)*: 1/29/84

L. PRINCIPAL STATE CONTACT

1. NAME: Robert Jelaesic

2. TELEPHONE NUMBER: (304) 348-5935

II. PRELIMINARY ASSESSMENT *(complete this section last)*

A. APPARENT SERIOUSNESS OF PROBLEM

☐ 1. HIGH ☐ 2. MEDIUM ☐ 3. LOW ☒ 4. NONE ☐ 5. UNKNOWN

B. RECOMMENDATION

☒ 1. NO ACTION NEEDED *(no hazard)*

☐ 2. IMMEDIATE SITE INSPECTION NEEDED
a. TENTATIVELY SCHEDULED FOR:
b. WILL BE PERFORMED BY:

☐ 3. SITE INSPECTION NEEDED
a. TENTATIVELY SCHEDULED FOR:
b. WILL BE PERFORMED BY:

☐ 4. SITE INSPECTION NEEDED *(low priority)*

C. PREPARER INFORMATION

1. NAME: Charles Meyer

2. TELEPHONE NUMBER: (215) 687-9510

3. DATE *(mo., day, & yr.)*: 9/26/84

III. SITE INFORMATION

A. SITE STATUS

☐ 1. ACTIVE *(Those industrial or municipal sites which are being used for waste treatment, storage, or disposal on a continuing basis, even if infrequently.)*

☒ 2. INACTIVE *(Those sites which no longer receive wastes.)*

☐ 3. OTHER *(specify)*: *(Those sites that include such incidents like "midnight dumping" where no regular or continuing use of the site for waste disposal has occurred.)*

B. IS GENERATOR ON SITE?

☒ 1. NO

☐ 2. YES *(specify generator's four-digit SIC Code)*:

C. AREA OF SITE *(in acres)*: 16 acres

D. IF APPARENT SERIOUSNESS OF SITE IS HIGH, SPECIFY COORDINATES

1. LATITUDE *(deg.-min.-sec.)*: 38° 18' 34"

2. LONGITUDE *(deg.-min.-sec.)*: 81° 34' 16"

E. ARE THERE BUILDINGS ON THE SITE?

☐ 1. NO ☒ 2. YES *(specify)*: Area No. 1 presently used for shopping center.

T2070-2 (10-79)

Continue On Reverse

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Continued From Page 2

V. WASTE RELATED INFORMATION (continued)

3. LIST SUBSTANCES OF GREATEST CONCERN WHICH MAY BE ON THE SITE (place in descending order of hazard).

Arsenic was the only substance which was tested for by the state of West Virginia in 1973.

4. ADDITIONAL COMMENTS OR NARRATIVE DESCRIPTION OF SITUATION KNOWN OR REPORTED TO EXIST AT THE SITE.

Presently all of the sites are inactive. Area No. 1 is presently a shopping center. In 1973, Area No. 2 (located on the bank of the Kanawha River) had remedial action done to it. Area No. 3 is presently the Kanawha City Interchange of Interstate 77.

VI. HAZARD DESCRIPTION

A. TYPE OF HAZARD	B. POTENTIAL HAZARD (mark 'X')	C. ALLEGED INCIDENT (mark 'X')	D. DATE OF INCIDENT (mo., day, yr.)	E. REMARKS
1. NO HAZARD				
2. HUMAN HEALTH				
3. NON-WORKER INJURY/EXPOSURE				
4. WORKER INJURY				
5. CONTAMINATION OF WATER SUPPLY				
6. CONTAMINATION OF FOOD CHAIN				
7. CONTAMINATION OF GROUND WATER				
8. CONTAMINATION OF SURFACE WATER		X	1973	State took leachate sample flowing into the Kanawha River.
9. DAMAGE TO FLORA/FAUNA				
10. FISH KILL				
11. CONTAMINATION OF AIR				
12. NOTICEABLE ODORS				
13. CONTAMINATION OF SOIL		X	1973	State site inspection showed soil contamination through out the plant site.
14. PROPERTY DAMAGE				
15. FIRE OR EXPLOSION				
16. SPILLS/LEAKING CONTAINERS/ RUNOFF/STANDING LIQUIDS		X	1973	State site inspection showed areas of erosion.
17. SEWER, STORM DRAIN PROBLEMS				
18. EROSION PROBLEMS		X	1973	State site observations and need for stabilizing plates.
19. INADEQUATE SECURITY	X		1984	Areas are open to the public
20. INCOMPATIBLE WASTES				
21. MIDNIGHT DUMPING				
22. OTHER (specify):				

Continue On Reverse

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APPENDIX A

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1. COST CENTER:	REM/FIT ZONE CONTRACT TECHNICAL DIRECTIVE DOCUMENT (TDD)	2. NO.:
ACCOUNT NO.:		F3-8405-39

3. PRIORITY:	4. ESTIMATE OF TECHNICAL HOURS:	5. EPA SITE ID:	6. COMPLETION DATE:	7. REFERENCE INFO.:
☒ HIGH ☐ MEDIUM ☐ LOW	100	WV-128	8/8/84	☒ YES ☐ NO ☐ ATTACHED ☐ PICK UP
	4A. ESTIMATE OF SUBCONTRACT COST:	5A. EPA SITE NAME: Libbey-Owens Ford Co. Kanawha, Cty WVa		

8. GENERAL TASK DESCRIPTION: Conduct a preliminary assessment of the subject site.

9. SPECIFIC ELEMENTS:

1.) Contact Pam Hayes of W Va - DNR.
2.) Review background information.
3.) Conduct a brief on and off site inspection.
4.) Prepare and submit report including proposed sampling plan, if applicable.

10. INTERIM DEADLINES:

11. DESIRED REPORT FORM: FORMAL REPORT ☒ LETTER REPORT ☐ FORMAL BRIEFING ☐

OTHER (SPECIFY):

12. COMMENTS:

13. AUTHORIZING RPO: Harold G Byer (SIGNATURE)

14. DATE: 7/2/84

15. RECEIVED BY: ☒ ACCEPTED ☐ ACCEPTED WITH EXCEPTIONS ☐ REJECTED

(CONTRACTOR RPM SIGNATURE)

16. DATE: 7/6/84

Sheet 1 White — FITL Copy
Sheet 2 Canary — DPO Copy
Sheet 3 Pink — Contracting Officer's Copy (Washington, D. C.)
Sheet 4 Goldenrod — Project Officer's Copy (Washington, D. C.)

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APPENDIX B

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APPENDIX C

NUS CORPORATION

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TELECON NOTE

CONTROL NO:	DATE:	TIME:
	9/28/84	10:30 - 10:40

DISTRIBUTION:

BETWEEN:	OF:	PHONE:
Robert Jalasic	West Virginia Department of Natural Resources	(304) 348-5935

AND:

Chuck Meyer (NUS)

DISCUSSION:

Libbey Owens Ford Company site in Charleston WV
Back in 1973 a site Inspection by the state showed
Arsenic in leachate flowing into the Kanawha River at
260 ppm. Solid material from the site showed
measurments of arsenic of 45 to 7000 mg/kg. Arsenic
was the only substance tested for. Regulator action
was taken by the state to stop leachate flow from
the site

ACTION ITEMS:

NUS 067 REVISED 0581

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APPENDIX D

NUS CORPORATION

REF ORIGINAL

TELECON NOTE

CONTROL NO:	DATE:	TIME:
	10/1/84	9:45

DISTRIBUTION:

BETWEEN:	OF:	PHONE:
Tom Koralewsk	Libbey Owens Ford Company (Glass Division)	(419) 247-4339

AND:

Chuck Meyer (NUS)

DISCUSSION:

Back ground information on when each disposal was discontinued Area No 1 behind the plant in use from 1917 - 1980 Area No 2 Area along the Kanawha River 1980 Area No 3 clover leaf interchange of ~~route~~ Interstate 77 Finished in Feburary 1984

Plant Property sold to Fred Haddad of charleston West Virginia 1012 Kanawha Blvd east Charleston WV 25301

ACTION ITEMS:

NUS 067 REVISED 0581

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APPENDIX E

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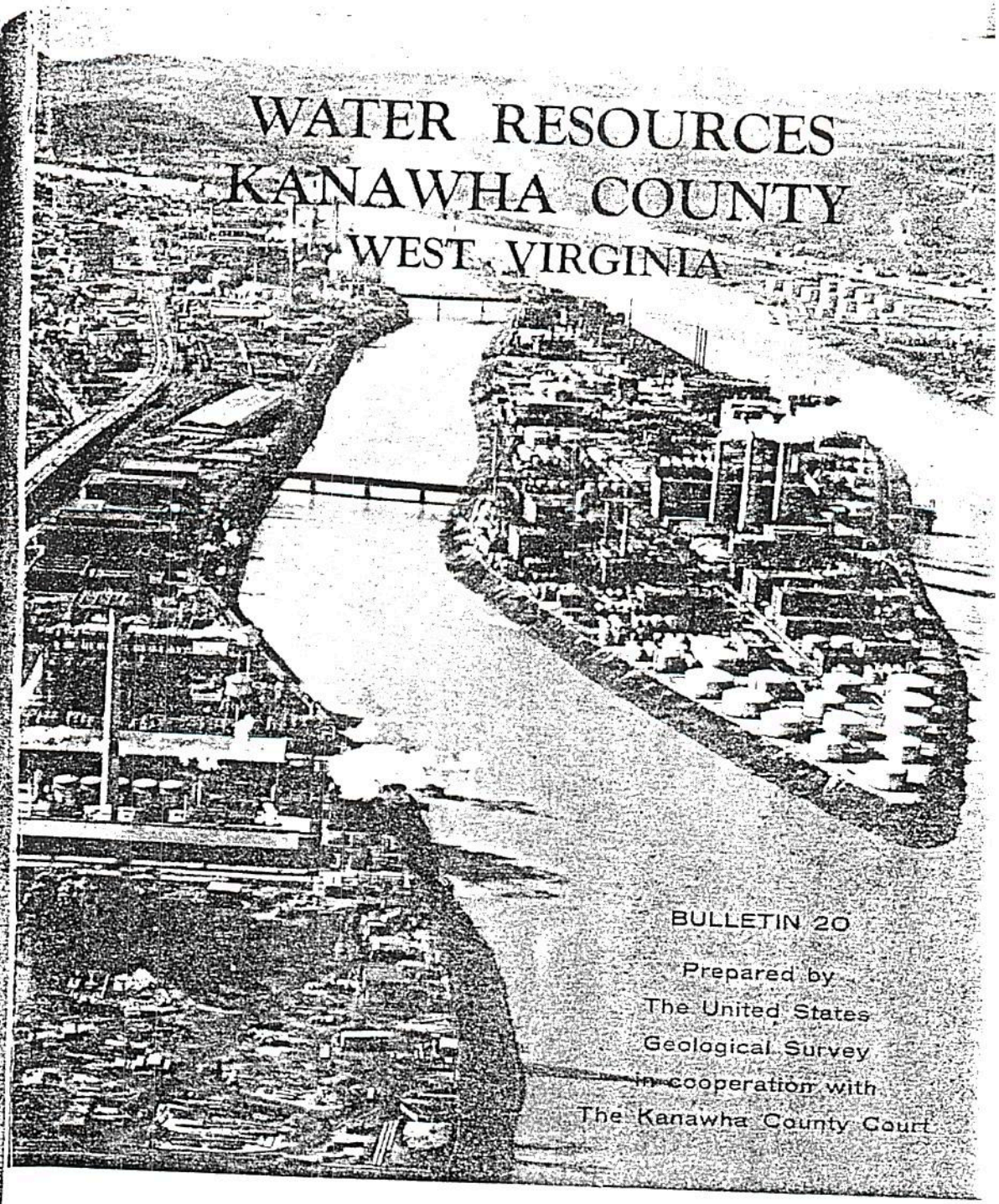
WATER RESOURCES KANAWHA COUNTY WEST VIRGINIA



BULLETIN 20

Prepared by
The United States
Geological Survey
in cooperation with
The Kanawha County Court

STATE OF WEST VIRGINIA — CECIL H. UNDERWOOD, Governor

GEOLOGICAL and ECONOMIC SURVEY

PAUL H. PRICE, Director and State Geologist - 1960 - MORGANTOWN, WEST VIRGINIA

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The size of the original openings between the large sand grains were reduced by the compaction of fine-grained sand and silt into these spaces during the formation of the beds of sandstone, and later reduced by the cementation of the sandstone. Water in small openings is released relatively slowly. The openings between the particles making up shale are so small that water moves through them at an extremely slow rate or not at all.

The yields of wells that tap the Pottsville and Allegheny series range from less than 1 to as much as 600 gpm and average about 120 gpm. The yields of wells that tap the Conemaugh series range from less than 1 to 66 gpm and average about 12 gpm. The yields of wells tapping the Monongahela series probably are similar to the yields of wells in the Conemaugh.

Pottsville Series

Distribution and Character. The Pottsville series includes the oldest rocks exposed in Kanawha County. They are exposed throughout the southeast half of the county where they overlie the Mauch Chunk series of Mississippian age. The Pottsville ranges in thickness from 394 to 1,985 feet and is composed mainly of gray and brown, massive, coarse-grained, locally crossbedded sandstone and conglomerates. Thin beds of coal, shale, fire clay, and limestone are present also. In the lower part of the Pottsville are the brine-yielding "Salt sandstones" of the well drillers, which occur in a zone ranging from about 300 to 500 feet in thickness.

Availability of ground water. The yield of a well drilled in the Pottsville series depends on the kind of rock and the number of joint openings the well penetrates. The sandstone beds generally contain more joints and have larger intergranular openings and, therefore, yield water more readily than the shale beds.

A total of 258 wells tapping the Pottsville series were inventoried. Of there, 249 are drilled wells, ranging in depth from 23 to 600 feet and averaging 123 feet; and 9 are dug wells, ranging in depth from 13 to 30 feet and averaging 22 feet. The deepest drilled well that yields fresh water is well 40-8-9, near Ruth, which is 345 feet deep. At Kayford, an exploratory water well (40-10-138) bottoming in the Pottsville was drilled 1,297 feet deep, but it yielded salty water. About 3 mile northeast of Charleston an exploratory gas well (40-7-1), was drilled 1,863 feet deep. Much water was encountered in drilling and the well was subsequently abandoned. The well was reported to have flowed for several years and is now used as a source of water; however, it does not flow at the present time (1957). The owner believes that

most of the ater comes from a depth of less tha 50 feet below the land surface.

Reported yields of 74 wells drilled in the Pottsville range from less than 1 gpm to as much as 522 gpm, and average 118 gpm. The specific capacities of 13 wells range from 0.1 to 5.6 and average 2.1 gpm per foot of drawdown. Wells having the highest yields from the Pottsville are listed in table 16.

Only 15 drilled wells and 3 dug wells of the 258 wells inventoried were reported to be inadequate in quantity for domestic supply. Six drilled wells were reported to be inadequate in quantity for industrial supply. About 27 percent of all wells in the Pottsville series are used for industrial supplies, 61 percent for domestic supplies, and 12 percent for public supplies.

Table 16.—Wells having highest yields from the Pottsville Series

Type of Use and Location	Well No.	Average Yield (gpm)
Cooling at Charleston laundry, Charleston	40-5-13	470
Boiler and air conditioning at Mount Vernon Dairy, Charleston	40-5-18	300
Air conditioning at Purity Maid Baking Co., Charleston	40-5-19	522
Air conditioning at Daniel Boone Hotel, Charleston	40-5-30	300
Cooling at Diamond Alkali Co. chemical plant, Belle	40-7-28	180
Do	40-7-29	350
Cooling at United Fuel Gas Co. compressor station, Ward	40-10-7	200
Do	40-10-8	200
Do	40-10-9	200
Cooling at Pure Oil Co. refinery, Chelyan	40-10-31	225
Cooling at Appalachian Power Co. steam-electric power plant, Glascow	40-10-63	171
Do	40-10-64	171
Cooling and boiler at Fayette Bottling and Ice Co., Montgomery	42-4-2	250
Do	42-4-3	250
Do	42-4-4	250

The "Salt sandstones" of drillers have been encountered in wells at depths ranging from about 550 to 1,200 feet. Most of the brine produced in Kanawha County for industrial use comes from these sandstones. The yields of brine wells ending in the "Salt sandstones" range from 5 to 60 gpm and average 32 gpm.

Sprin of small yield are not uncommon in the Pottsville series, but no large springs are known. The measured flow of four unused springs (40-10-11 40-10-26, 20-10-33, and 40-10-112) along the right-of-way of the West Virginia Turnpike near Chelyan ranged from only 0.3 to 0.7 gpm (table 5).

The rate of flow of water from individual coal mines in the area is small; however, it is considerable in total over a long period of time. Large amounts of ground water may accumulate in sealed, abandoned coal mines and may be relatively easy to obtain by either pumping or gravity flow; however, this water may also be of poor chemical quality. Five coal mines (40-7-18, 40-10-49, 40-10-55, 40-10-140, and 40-10-146) that yield water from the Pottsville are used as sources of public-water supplies (table 5). One of these (40-7-18) is a shaft mine 109 feet deep located in a stream valley. Water is pumped from a collecting basin at the bottom of the shaft. The other four are slope mines on hillsides, which drain by gravity.

Pumping and aquifer tests. Well 40-9-25, at the Conlon Baking Company, Charleston, was pumped at an average rate of 190 gpm for 7 hours and 35 minutes in a test made by the Ensign Electric and Manufacturing Co., Huntington, W. Va., on March 21, 1946. The well was drilled to a depth of 100 feet on the flood-plain of Kanawha River. It penetrates 60 feet of sandy alluvium and 40 feet of sandstone of the Pottsville series. Inasmuch as the alluvium was cased off and the static water level prior to pumping was only 20 feet below the land surface, it is likely that the water-bearing zone is artesian. The test data are given in table 17.

Table 17.—Pumping-test data for well 40-9-25, at Charleston

Time Since Pumping Started, In Hours	Drawdown, In Feet	Pumping Rate, In gpm	Specific Capacity In gpm per foot of Drawdown
0.42	23.17	200	8.6
1.27	28.92	195	6.7
1.42	30.09	192	6.4
2.00	31.25	190	6.1
5.58	33.50	188	5.6
7.58	34.17	186	5.4

The pumping rate decreased constantly during the test. As the well was being pumped at approximately the rated capacity of the pump, the decreasing yield presumably indicates the effect of the increasing lift. The decreasing specific capacity indicates that an equilibrium condition had not been reached. Analysis of the data by the non-equilibrium method

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(p. 62) indicates a transmissibility of about 8,[illegible] gpd per foot. It is possible that the alluvium contributes some water to fractures in the consolidated rocks of the Pottsville as water is withdrawn from it by pumping.

Data were collected for a 1940 test on another well at the same bakery, well 40-9-26, which was tested by the Ensign Electric and Manufacturing Co. by pumping it for 6 hours and 10 minutes at an average rate of 98 gpm. The well is 90 feet deep and penetrates 57.5 feet of alluvium, which is cased off above the sandstone bedrock. The pumping rate declined from 127 gpm 25 minutes after pumping started, to 88 gpm at the end of the test. Drawdowns at these times were 30.0 feet and 52.0 feet respectively. A 100 percent reduction in specific capacity occurred—from 3.3 gpm per foot near the start of the test to 1.7 gpm per foot at the conclusion of the test. The substantial drop in specific capacity suggests that the decline was largely due to aquifer characteristics. It was not possible to satisfactorily analyze these data for a determination of transmissibility.

"Slug" tests were made by the author on several wells tapping the Pottsville. The results for wells 40-10-18, in the Kanawha River valley, and 40-7-13, in the Campbell Creek valley, are the most satisfactory. These wells are 78 and 105 feet deep, respectively. A transmissibility of only 318 gpd per foot was calculated for well 40-7-13. Little is known of the capacity of this well, as a check on the small transmissibility value obtained in the "slug" test, other than that the well furnished an adequate domestic supply. The test for well 40-10-18 gave a much higher transmissibility, 2,820 gpd per foot. This seems reasonable in the light of the fact that the well reportedly is capable of supplying water to 70 houses. Both values probably indicate only the general order of magnitude of transmissibility.

Chemical character of ground water. Ground water from the Pottsville series is generally harder and more mineralized than most other ground water in Kanawha County. The analyses of the water from these rocks are summarized in table 30. The chloride concentrations in 62 water samples collected for chemical analysis ranged from 1.5 to 5,320 ppm but the most frequently occurring concentration was 20 ppm. The hardness in 59 samples ranged from 20 to 928 ppm; the most frequently occurring concentration was 82 ppm. The iron content in 42 samples varied from 0.00 to 38 ppm and the most frequently occurring concentration was 1.0 ppm. Waters from the deep wells in the valleys are more mineralized than waters from wells of equal depth at higher elevations, and in general the mineralization increases with depth. A chemical com[illegible]y at Belle, in the valley of the Kanawha River, uses saline water from two deep wells drilled in the Pottsville series. Water from well 40-7-28, 600 feet deep, contains 14,180 ppm of chloride; and water from well 40-7-29, 440 feet deep, contains 2,400 ppm of chloride.

Only one dug well and 14 drilled wells of 258 wells inventoried were reported to yield water that would be unsatisfactory for domestic use, and 26 wells were reported to yield water unsatisfactory for various industrial uses.

Allegheny Series

Distribution and character. The Allegheny series in Kanawha County resembles lithologically the underlying Pottsville series. The top of the Allegheny is drawn at the top of the Upper Freeport coal and the bottom at the top of the Homewood sandstone. The Allegheny ranges in thickness from 115 to 241 feet and is widely exposed throughout the southeast half of the county. Sandstone strata dominate the Allegheny, and in some places, they merge into major thick sandstone units. The sandstones generally are gray and brown, massive, locally crossbedded, and coarse grained. They contain discontinuous conglomerate zones, and are moderately to poorly cemented. Small amounts of coal, shale, fire clay, and limestone also are present.

Availability of ground water. The conditions that govern the yield of wells in the Allegheny series are very similar to those in the Pottsville series, because the Allegheny also has a predominance of fractured sandstone.

A total of 67 wells were inventoried in the Allegheny. Of these, 66 are drilled wells ranging in depth from 38 to 306 feet and averaging 111 feet, and one is a dug well 27 feet deep. The deepest drilled well (40-3-20) yielding fresh water is 306 feet deep.

Reported yields of 17 wells drilled in the Allegheny range from less than 1 to as much as 600 gpm and average about 125 gpm. The specific capacities of 5 wells range from 2.0 to 4.7 and average 3.5 gpm per foot of drawdown. Wells having the highest yields that tap the Allegheny are given in table 18.

Nine drilled wells of the 67 wells inventoried in the Allegheny were reported inadequate in quantity for industrial supply and 2 were reported inadequate for domestic supply.

About one-third of all wells that tap the Allegheny series are used for industrial supplies and about two-thirds are used for domestic supplies.

Springs of small yield are not uncommon in the Allegheny series, but no large springs are known. Two springs (40-2-18 and 40-6-69) that were inventoried yielded water

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	Thickness (feet)	Depth (feet)	Remarks
Sandstone, white	9	203	
Shale, white	8	211	
Sandstone, white	4	215	

Well 40-5-28

Altitude of land surface: 598 ft. above mean sea level.
Driller's log of water well.

Quaternary System			
Topsoil and clay	35	35	Static water level, 30 ft.
Quicksand	18	53	Bedrock at 53 ft.
Pennsylvanian System			
Pottsville Series			
Sandstone, white	25	78	Encountered water at at 60 ft.
Shale	4	82	
Sandstone	16	98	
Shale	42	140	Encountered water at 99 to 105 ft.
Sandstone	42	182	
Shale	9	191	
Sandstone	14	205	

Well 40-5-29

Altitude of land surface: 598 ft. above mean sea level.
Driller's log of water well.

Quaternary System			
Sand	48	48	Bedrock at 48 ft.
Pennsylvanian System			
Pottsville Series			
Sandstone	9	57	Encountered water at 51 ft.; static water level, 55 ft.
Coal	1	58	
Sandstone	28	86	
Shale	8	94	
Sandstone	18	112	
Shale	22	134	
Sandstone	33	167	

Well 40-5-31

Altitude of land surface: 598 ft. above mean sea level.
Driller's log of water well.

Quaternary System			
Quicksand	50	50	Bedrock at 50 ft.
Pennsylvanian System			
Pottsville Series			
Sandstone	36	86	Static water level, 56.80 ft.
Shale	12	98	
Sandstone	18	116	
Shale	19	135	
Sandstone	40	175	

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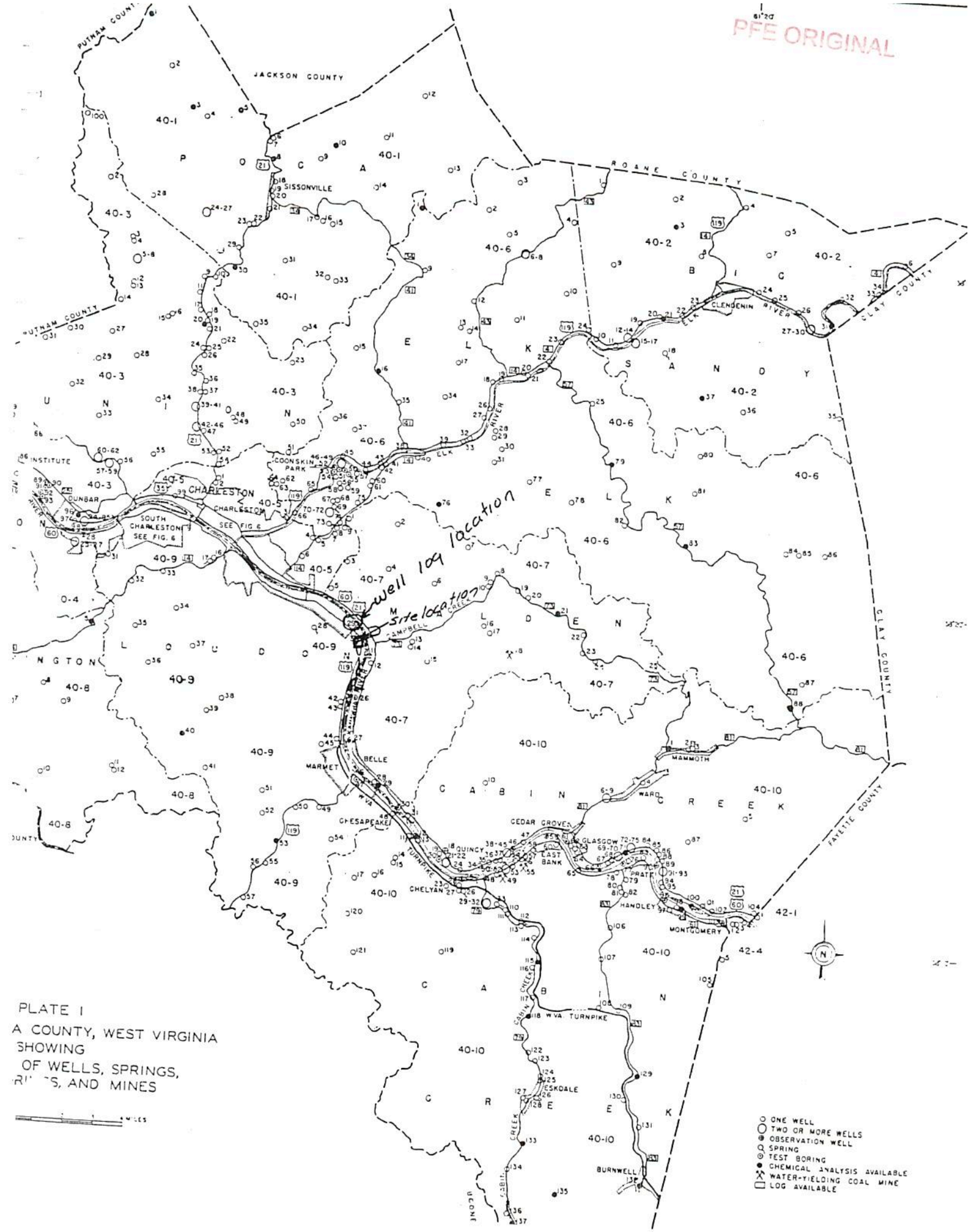

PLATE I

A COUNTY, WEST VIRGINIA
SHOWING
OF WELLS, SPRINGS,
RI' 'S, AND MINES

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APPENDIX F

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OIL SURVEY OF Kanawha County, West Virginia

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ecology and environment, inc.
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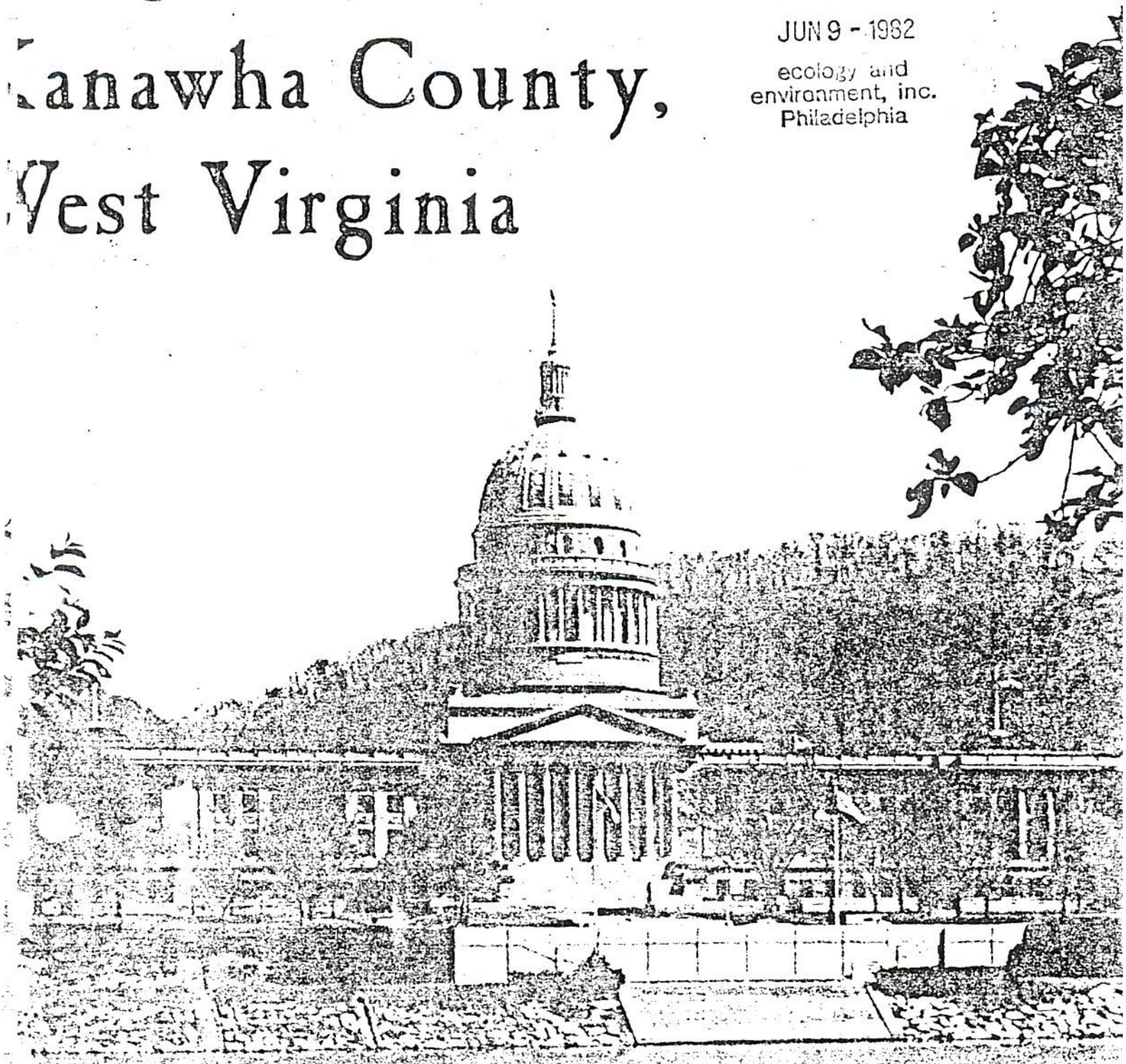

U.S. Department of Agriculture, Soil Conservation Service,
in cooperation with the
ginia University Agricultural Experiment Station and the Kanawha County Commission

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ferent kinds of soil in different uses under different of management. Also, data are assembled from sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under fined practices are assembled from farm records and om field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils ve been named, described, interpreted, and delineated n aerial photographs and when the laboratory data and her data have been assembled. The mass of detailed information then needs to be organized so that it is readily ailable to different groups of users, among them farers, managers of rangeland and woodland, engineers, nners, developers and builders, homebuyers, and those king recreation.

eneral soil map for broad land use a ing

The general soil map at the back of this publication ows, in color, map units that have a distinct pattern of ils and of relief and drainage. Each map unit is a unique atural landscape. Typically, a map unit consists of one or re major soils and some minor soils. It is named for e major soils. The soils making up one unit can occur in ther units but in a different pattern.

T general soil map provides a broad perspective of s and landscapes in the survey area. It provides a asis for comparing the potential of large areas for eneral kinds of land use. Areas that are, for the most rt, suited to certain kinds of farming or to other land es can be identified on the map. Likewise, areas of soils aving properties that are distinctly unfavorable for cerin land uses can be located.

Because of its small scale, the map does not show the nd of soil at a specific site. Thus, it is not suitable for lanning the management of a farm or field or for select te for a road or building or other structure. The ds of soil in any one map unit differ from place to lace in slope, depth, stoniness, drainage, or other characeristics that affect their management.

The names of the map units on the general soil map of anawha County do not in all instances agree with those f adjacent map units on the general soil map of the soil vey of Fayette and Raleigh Counties. The differences names of adjoining units are a result of improvements the classification of the soils, differences in the pattern f occurrence of the major soils in the adjoining units, d variations in the material in which the soils formed.

. Urban land-Kanawha

ban land and nearly level and gently sloping, well ined, lime-influenced soils; on high flood plains

map unit consists of Urban land and soils on flood ins along the Kanawha and Coal Rivers.

This map unit makes up about 3 percent of the county. It is about 44 percent Urban land, 11 percent Kanawha soils, and 45 percent minor soils and water.

Urban land consists of areas that are covered by streets, highways, parking lots, buildings, industrial complexes, and other structures of urban areas. Urban land is mapped with Fluvaquents, with Kanawha soils, and with Tyler soils in some areas.

Kanawha soils are deep. They formed in lime-influenced alluvial material washed from uplands underlain by interbedded shale, siltstone, and sandstone. Kanawha soils have a dark brown, moderately coarse textured surface layer and a dark yellowish brown to dark brown, moderately coarse textured to medium textured subsoil. Kanawha soils are mapped with Urban land in some areas. They are rarely flooded.

The minor soils in this map unit are mostly somewhat poorly drained Tyler soils and moderately well drained Cotaco soils on terraces; excessively drained to moderately well drained Udifluvents, loamy, somewhat poorly drained and poorly drained Fluvaquents, and moderately well drained Senecaville soils on flood plains; and well drained Laidig soils on foot slopes.

The major part of the urban development of the county is on the soils within this map unit (fig. 2). The flood hazard of these soils is the major limitation for nonfarm uses.

2. Kanawha-Hackers

Nearly level and gently sloping, well drained, lime-influenced soils; on high flood plains

This map unit consists of soils adjacent to the Elk River and Big Sandy Creek. These soils are rarely flooded.

This map unit makes up less than 1 percent of the county. It is about 26 percent Kanawha soils, 11 percent Hackers soils, and 63 percent minor soils and water.

Kanawha soils are deep. They formed in lime-influenced alluvial material washed from soils on uplands underlain by interbedded shale, siltstone, and sandstone. Kanawha soils have a dark brown, moderately coarse textured surface layer and a dark yellowish brown to dark brown, moderately coarse textured to medium textured subsoil.

Hackers soils are deep. They formed in lime-influenced alluvial material washed from soils on uplands underlain by shale, siltstone, and sandstone. Hackers soils have a dark brown, medium textured surface layer and a reddish brown to yellowish red, medium textured to moderately fine textured subsoil.

The minor soils in this map unit are mostly moderately well drained Cotaco soils on terraces; well drained Vandalia and Laidig soils on foot slopes; and well drained Moshannon soils and excessively drained to moderately well drained Udifluvents, loamy, on flood plains.

This unit is used mainly for urban development. The flood hazard is the main limitation for nonfarm uses.

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APPENDIX G

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STATE OF WEST VIRGINIA

CLARENCE W. MEADOWS, GOVERNOR

STATE GEOLOGICAL AND ECONOMIC SURVEY
Paul H. Price, State Geologist
Morgantown

REPORT OF INVESTIGATIONS—NO. 2

GROUND WATER CONDITIONS AT CHARLESTON, W.VA.

by

Russell M. Jeffords and R. L. Nace

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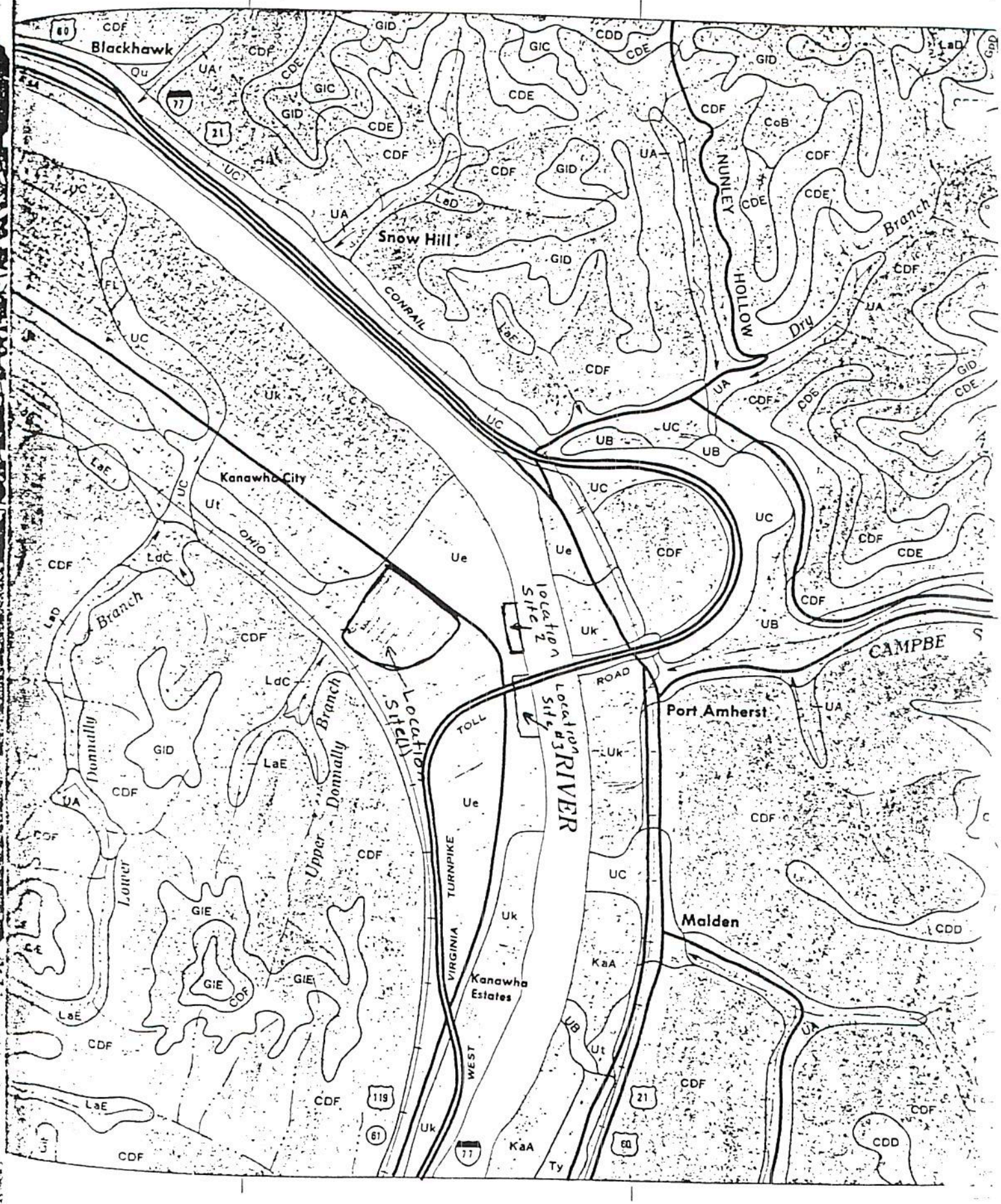
Morgantown, West Virginia

1946



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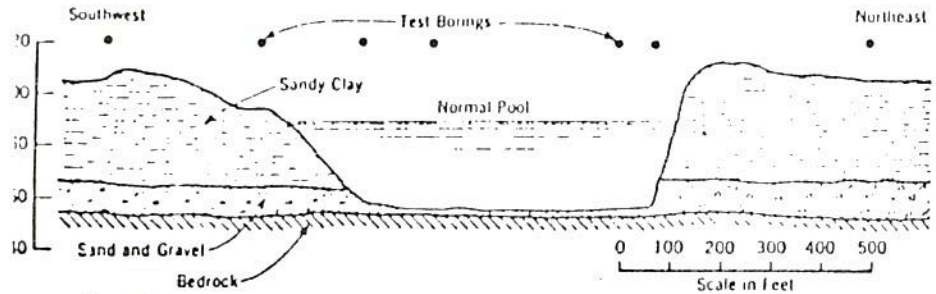

FIG. 1. Geologic Section Across Kanawha River Near Belle, W.Va.

TABLE 1

*ical Section Through the Terrace Alluvium**

Material	Thickness	Depth
	ft.	*ft.*
and sandy clay	18.7	18.7
l	11.0	29.7
l, micaceous	10.0	39.7
ly clay	2.2	41.9
l, coarse micaceous	4.1	46.0
l and gravel, partly consolidated, containing fragments of chert and carbonized leaves and wood	5.7	51.7
lstone (bedrock)	—	—

Generalized log of test borings at site of sapeake and Potomac Telephone Co. ding, Charleston. The average water l was 29.5 ft. below the land surface.

d information on the character of alluvial deposits throughout the . but it is evident that the charac- of the alluvial deposits varies siderably.

Iost of the well logs in Charleston not indicate that appreciable quanti- of water were encountered in these l deposits, but a few of the better ls do rely upon water in these ter- deposits. Other wells were drilled bedrock during the war because ens were not available. About 2 l. were pumped from 7 test borings ing the construction of the Chesa- ke & Ohio Building (1), and rela- ly large quantities of water were ountered also during the construc- of other large buildings, such as the Kanawha Valley Building. Moderately large supplies of water are obtained from the thick terrace alluvium on Blaine Island and at the Ohio-Apex plant in Nitro.

It is reported that the water level in the wells of the Charleston Laundry rose about 8 ft. following the increase in the pool stage of the Kanawha River (2). This suggests that it may be possible to locate wells so as to permit river water to enter the aquifer and replace a part of the water withdrawn. Wells depending partly upon recharge from the river are relatively common along the Ohio River (3).

These records indicate that the terrace alluvium will yield important supplies of water to properly constructed and developed wells in some localities in Charleston, but that these deposits are too fine to yield important quantities of water in some other localities. It appears that the supplies of water in the alluvial terraces have not been utilized fully because their water-bearing properties have not been realized adequately and the installation of screens has not been understood.

Consolidated Rock Formations

The consolidated bedrock strata beneath Charleston are, largely, alternating sandstones and shales, with minor beds of coal and limestone. These strata under most of the city comprise

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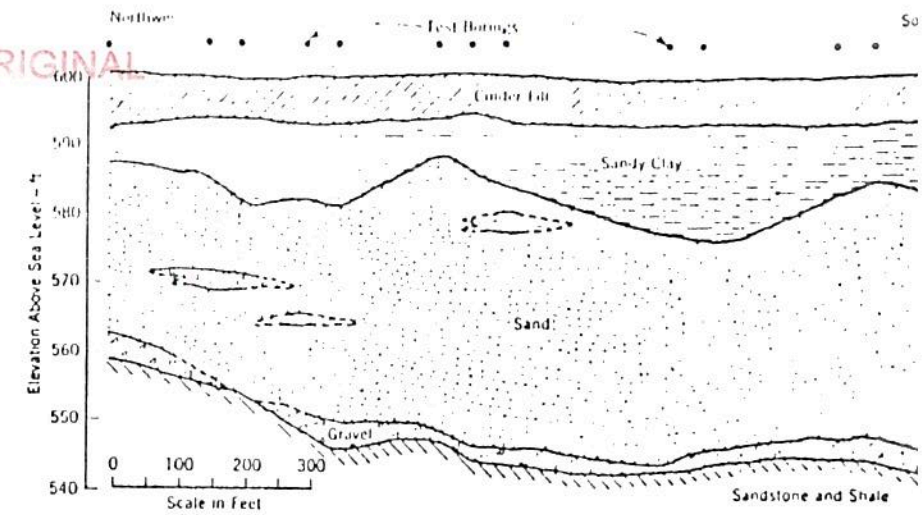

FIG. 2. Geologic Section Along Foundation of Bridge at South Charleston, W.V

TABLE 2

*Typical Section Through the Bedrock Strata**

Material	Thickness	Depth
	ft.	*ft.*
Quarternary Alluvium		
Sandy clay	20	20
Sand and gravel	33	53
Kanawha Unit of Pottsville Age		
Sandstone, white	9	62
Shale, white	6	68
Sandstone, water (12 gpm. at 70 ft.)	3	71
Shale	5	76
Sandstone	14	90
Shale, well full of water at 95 ft.	5	95
Sandstone	9	101
Shale	14	118
Limestone (?)	14	132
Shale	12	144
Sandstone, water	26	170
Shale	30	200
Sandstone	7	207
Coal	1	208
Limestone (?)	9	217

* Log of well at Coyle and Richardson Dept. Store, Charleston.

the Kanawha unit of Pottsville age, but the eastern section of the city is underlain by similar rocks of Allegheny age. The strata dip about 75 to 100 ft. to a mile as they roll in a northwe direction.

These strata have been divide many named and unnamed units they crop out at the surface (4 commonly the logs of water we Charleston contain too little inf tion to permit identification or lation of the minor stratigraphic The log given in Table 2 illus the rock encountered in drilling.

Most of the wells in Charlesto tain water from these consoli sandstones at depths averaging 160 ft., and a few wells have en tered significant quantities of p water more than 225 ft. below the face. The yield of these wells r from less than 15 to more than gpm. The thickness and permea of the water-bearing formations somewhat, but some differences in also seem to be due to differenc depth and method of developme the wells.

The principal aquifer at Charl cannot be correlated positively named units, but the water-be sandstones are tentatively consid

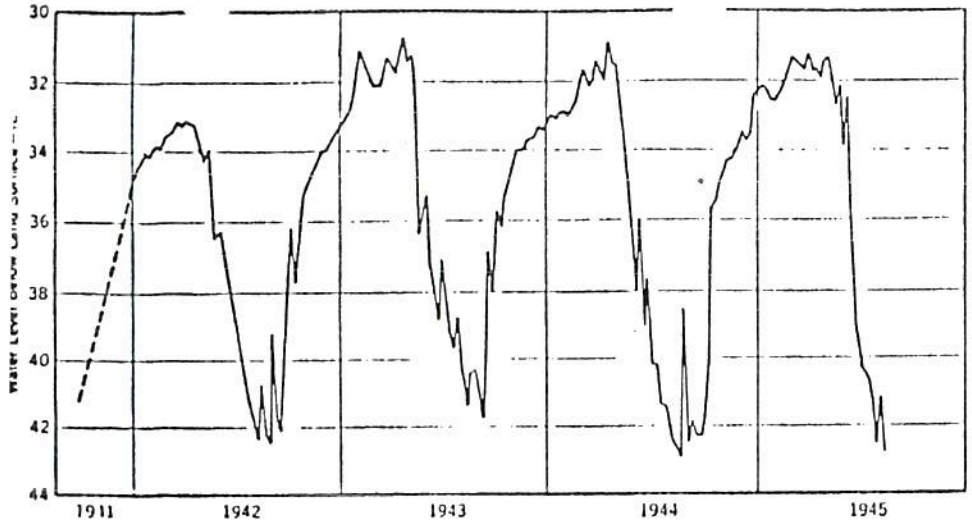

FIG. 3. Fluctuations in Water Level at an Observation Well

o be near the horizon of the Coalburg andstone. In South Charleston, wells btain water from the Mahoning sandtone of Conemaugh age, and in Nitro mall quantities of water are pumped rom another shallow sandstone in the Conemaugh.

The water in the bedrock formations s under moderate artesian pressure, o that it rises in wells above the level f the water-bearing stratum, and probbly above the water table in the terace alluvium. Data are not available ow to indicate the general trend of vater levels in wells throughout the ity. The water level in a well at 800 Pennsylvania Ave. was 2.03 ft. higher n April 1943 than in October 1942. Weekly measurements of water level n an unused well near the corner of Lee and Dickenson Sts., shown in Fig. 3, indicate that increases in the withdrawal of water during the summer ause a large decline of the water level n these months, but that the levels reover during the winter and spring. Minor changes are probably due to the ntermittent operation of pumps on nearby wells. The water level in this well was at its lowest observed stage on record in early August 1945. Operators of wells throughout the city report that water levels have declined appreciably since about 1939, but records of reliable measurements of water level are not available.

Quality of the Water

Most of the wells in Charleston yield water that is high in iron and rather corrosive. The water is clear as it comes from the wells, but the iron oxidizes rapidly to a flocculent reddish brown precipitate when exposed to the air. Since the waters are corrosive, a considerable proportion of the iron probably is dissolved from the casing and pipes as the water is withdrawn.

The character of water from representative wells is shown in Fig. 4. Water from the terrace alluvium is rather soft and generally contains less than 100 ppm. of dissolved solids. The relatively large percentages of sodium suggest that there may be some migration of water from the deeper bedrock aquifers through wells into the unconsolidated sand and gravel. This

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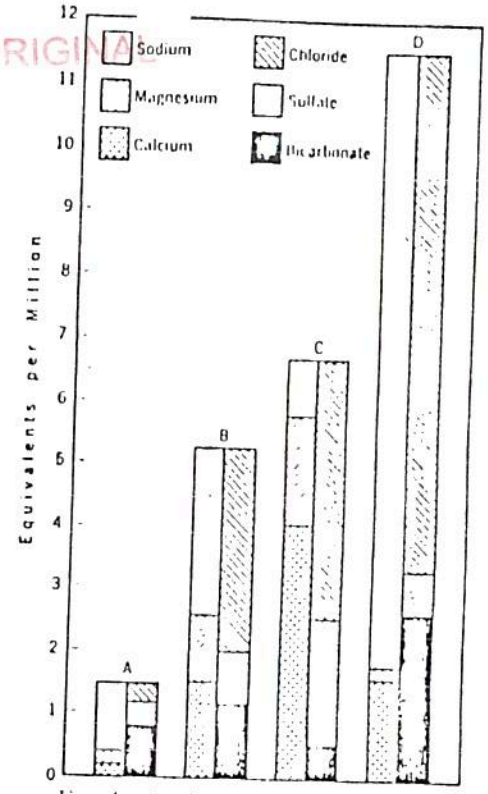

FIG. 4. Analyses of Water From Charleston Wells

Well A, analyzed by the U.S. Geological Survey, is drilled in terrace alluvium at the Conlon Baking Co. in Charleston. Well B, also analyzed by the U.S. Geological Survey, is in bedrock sandstone at the Daniel Boone Hotel. Well C is in bedrock sandstone at the Conlon Baking Co. and was analyzed by the West Virginia Geological Survey. Moderately deep bedrock sandstone at the S. S. Kresge Co. store provides the water for Well D, analyzed by T. A. Bordadoile of Charleston.

water from the terrace deposits is similar in general to the water in the public water supply system at Charleston. The water in the deeper aquifers, as shown in Fig. 4, contains appreciably more dissolved solids. The quantities of sodium and chloride increase rapidly with depth, so that the aquifers more than 230 ft. deep contain water that is a moderately concentrated brine.

Temperatures of ground Charleston range from abou 62° F.

Utilization of Ground Wate

Ground water in Charleston extensively by industrial and cial establishments for the co condensers in air-conditioning cooling in dairy-product pr general cooling in ice and plants, cooling machinery, boi and laundering. Although t perature is somewhat higher desirable for efficient cooling, cost and relatively constant t ture result in material savings users. The water must be tre fore use in laundries or boile commonly, treatment is desira waters used in some cooling pr

Available records indicate tha 1 mgd. of ground water is use city of Charleston during the and more than twice as much summer months. The pumpage ½ mile of the post office comprise than half of this withdrawal in s The total known pumpage in t therefore, is about 535 mil.g year. Records for the surro industrialized area are relativ complete, but indicate that at le additional 345 mil.gal. of ground are used yearly at industrial pla

Conclusions

About 535 mil.gal. of water a are obtained from wells in Char and 345 mil.gal. a year are ob in the surrounding industrial This ground-water supply const a valuable natural resource. Th of ground water has depleted ava supplies in certain sections and ha versely affected some of the existin stallations. Additional supplies